Prepared for
Oceana Gold (New Zealand) Limited
Co No.: 2274246

Waihi North Project Geochemical Assessment

Geochemistry of Tailings and Overburden, Treatment and Mitigation

19-Feb-2025
Oceana Gold Waihi North Project

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TECHNICAL REPORT

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Client: Oceana Gold (New Zealand) Limited

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Prepared by

AECOM New Zealand Limited,

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Glossary

ANC	Acid Neutralising Capacity
AMD	Acid and Metalliferous Drainage
CAF	Cement Aggregate Fill
HFO	Hydrous Ferric Oxide
MOP4	Martha Open Pit Phase 4
MPA	Maximum Potential Acidity
MUG	Martha Underground Mine including the Rex Vein
NAF	Non-Acid Forming
NAPP	Net Acid Producing Potential
NPR	Net Potential Ratio
NRS	Northern Rock Stack
PAF	Potentially Acid Forming
PPS	Polishing Pond Stockpile
ROM	Run of Mine
RTSA	Rock and Tailings Storage Area
SPLP	Synthetic Precipitation Leaching Procedure
TSF	Tailings Storage Facility
UCL	Upper Confidence Limit

Executive Summary

The proposed Gladstone Open Pit (GOP) and Wharekirauponga Underground Mine (WUG), together with the construction of a new tailings storage facility (TSF3), a Northern Rock Stack (NRS) and a temporary rock stack at Willows Road (WRS), will extend the current Waihi life of mine plan (LoMP) by around a decade, ceasing production in 2042. The WNP will include the recovery and processing of approximately 13,200,000 tonnes of ore and approximately 30,900,000 tonnes of rock.

For GOP, the geology and mineralogy of the project area, as with the greater Waihi epithermal vein system, is expected to be generally consistent with that encountered in the existing Martha, Favona, Trio, and Correnso mines, with the exception of the greater influence of the breccias which overlie the andesite rock in the GOP.

Geology and mineralogy at WUG varies from other ore bodies in that areas of mineralisation are hosted within rhyolitic materials.

Characterisation of the likely geochemical effects as a result of rock utilisation in temporary stockpiles and permanent repositories, has been undertaken by both static and kinetic testing, as well as geochemical modelling. An extensive analytical programme of multi-element testing and acid base accounting testing has been undertaken on rock associated with the project components in order to understand the contaminants that may leach from the material with the potential to adversely influence water quality, and to explore whether this differs from those from current site operations. In addition, laboratory kinetic testing and field columns have been utilised to assess the rate of potential acidification and contaminant release, and to assess the effectiveness of appropriate control measures and management practices to limit the effect of rock placement to the receiving environment.

The static field tests confirmed that in general, Andesite and Breccia material from GOP is elevated in mercury, antimony, and arsenic relative to the historical Waihi dataset and mean concentrations in the earth's crust. Other trace elements were either present in similar or lower concentrations when compared to the existing datasets. In terms of acid generating potential, the rock from GOP was found to have a lower neutralising capacity compared to the existing dataset.

The static field tests confirmed that in general, rhyolite material from the WUG mine is elevated in arsenic but is comparable in terms of acid generating capacity.

Kinetic laboratory and column field tests of potentially acid forming (PAF) rock material from GOP area exhibited depressed pH and associated elevated sulphate and trace element concentrations. 'Treatment' of these PAF rock columns included saturation, limestone blending, and compaction. These treatment strategies were shown to be effective for controlling the leachable trace element mass when compared to the 'non-treated' columns. The degree of effectiveness was related to the timing of the treatment (pre or post column inception), the introduced lag period, and the stage of the acid rock drainage allowed to develop.

The overall rock management strategy is based on temporary storage of material in the existing Rock and Tailings Storage Area (RTSA) and WRS combined with permanent PAF rock disposal to the GOP area, NRS, and the embankment of TSF3, and as backfill in underground mines. The specific recommended mitigation outlined depends on the rock's source and ultimate end state and is discussed in five broad categories:

- Temporary storage of rock sourced from WUG in the proposed WRS prior to placement underground as backfill;
- Disposal of rock to GOP with placement and compaction;
- Disposal of rock to both the NRS and TSF3; and,
- Placement of rock as backfill as part of MUG and WUG mine operations.

PAF rock from WUG placed into the temporary rock stack should be amended with limestone to ensure the introduction of a 30 week lag period. This will ensure that PAF rock is neutralised until the material is placed permanently outside of the zone of oxidation.

Permanent disposal of PAF material sourced from GOP will be undertaken in a manner that will limit the rate of oxygen ingress and potential for acid generation until saturation and/or subsequently placed material (on top) will cover the placed material at a depth below the zone of oxidation. For exposure periods exceeding the material’s natural lag, the addition of limestone will be required to extend this lag period.

The general mitigation measure for the placement of PAF rock within GOP is that material will be compacted in lifts and over time be below the depth of oxidation. This will provide appropriate control until the permanent groundwater table is re-established to provide secure long term control. For material above the recharged groundwater level, compaction and cover will provide long term control. Limestone amendment for both end-tipped and placed and compacted material will be dependent on the required lag period.

The amendment rates outlined are considered conservative and within the current operating limits of the site. Monitoring of the rock material will enable refinement to those calculated and outlined rates and will be part of ongoing operations.

Geochemical modelling of the Gladstone Sump water quality, NRS and TSF3 embankment seepage water quality, and Gladstone Pit pore water quality has been undertaken in the geochemical modelling software PHREEQC version 3.4. The Minteq.v4 database was utilised in order to equilibrate the predicted chemistry based on the oversaturation and secondary co-precipitation of various trace elements. The results inform the potential impact of the planned operations on the wider environment and consequently the short and long term treatment requirements so that adverse effects are avoided.

The assessments undertaken are considered conservative based on a number of factors. These include (but are not necessarily limited to); selection of rock material for kinetic / column tests focussed on non-weathered, high pyritic material; scaling factors to the laboratory / field tests to full scale operations have not been applied; and use of Mean and 95% upper confidence level (UCL) data to calculate applicable limestone dosing rates.

Geochemical testing on GOP ore was found to exhibit similar geochemical characteristics to that of the existing material from MUG with the exception of mercury, which was found to be elevated. The analytical results of the Leach Tests and Synthetic Precipitation Leaching Procedure (SPLP) analysis of the GOP ore material combined with the geochemical modelling undertaken suggest that arsenic, calcium, cadmium, cobalt, chromium, copper, iron, mercury, magnesium, nickel and lead concentrations in porewater will be reduced via adsorption to hydrous ferric oxides, while potassium, sodium and sulphate will remain more mobile. The resultant predicted leachate water quality will be similar in nature to the porewater within the existing TSF facilities, with potentially less mixing with groundwater due to the presence of a geomembrane in the basal structure. As with the existing TSFs, seepage will be collected and treated.

In summary, the mitigation and management practices put forward are considered suitable based on the extensive and targeted datasets collected and on more than thirty years of successful application of these practices at Waihi. The assumptions applied during the calculation of amendment requirements and the predictive geochemical modelling undertaken ensure that the assessment is considered conservative and within the current (or planned) operating limits of the site. Monitoring of the rock material will enable refinement to lime amendment rates calculated, outlined, and presented in this report, and will be part of ongoing operations.

1.0 Introduction

Waihi North Project (WNP) is a multifaceted development proposed by Oceana Gold (New Zealand) Limited (OGNZL) that has the potential to extend the current life of mine to about 2042 by adding in excess of 1.7 million ounces of gold production to its Waihi operations. The project consists of six key and linked components:

- The new Gladstone Open Pit (GOP);
- The new Wharekirauponga Underground Mine (WUG);
- A new tailings storage facility (TSF3) with a crest height of 155 m RL;
- A new rock storage facility (Northern Rock Stack or NRS) as well as a temporary rock stack at Willows Road for the WUG referred to as the Willows Rock Stack (WRS);
- Increasing the throughput capacity of the existing Processing Plant by 1 million tonnes per annum (MTPA) to 2.25 MTPA; and
- Upgrading of the existing Water Treatment Plant (WTP) and reconsenting of the existing treated water discharge to the Ohinemuri River.

In addition, the project will run concurrently with the already consented Project Martha.

OGNZL has engaged AECOM New Zealand Limited (AECOM) to carry out a geochemical study of the ore, tailings, and rock expected to be recovered from the proposed mine areas, and to assess the potential influence these materials may have on the environment.

The purpose of this study is to determine the following, through statistical and geochemical assessment and predictive modelling, in order to support the consenting process:

- Whether rock and ore to be recovered as part of the proposed mining operations will be statistically different in elemental composition from that recovered from the current Waihi operations.
- Whether trace elements are present in rock and ore that may constitute contaminants requiring particular management to ensure they do not give rise to any environmental concern.
- The likely geochemical composition of tailings produced from the ore that will be deposited in tailings storage facilities and the associated effect on decant and seepage water quality.
- The potential for sulphide oxidation and acidification of the rock during stockpiling and the corresponding mass of leachable contaminants released to porewater on mine backfilling and flooding.
- Effectiveness of various treatment requirements to mitigate potential acid generating conditions.

1.1 Background

The Waihi North Mine project elements are presented on Figure 1 and discussed in the following subsections.

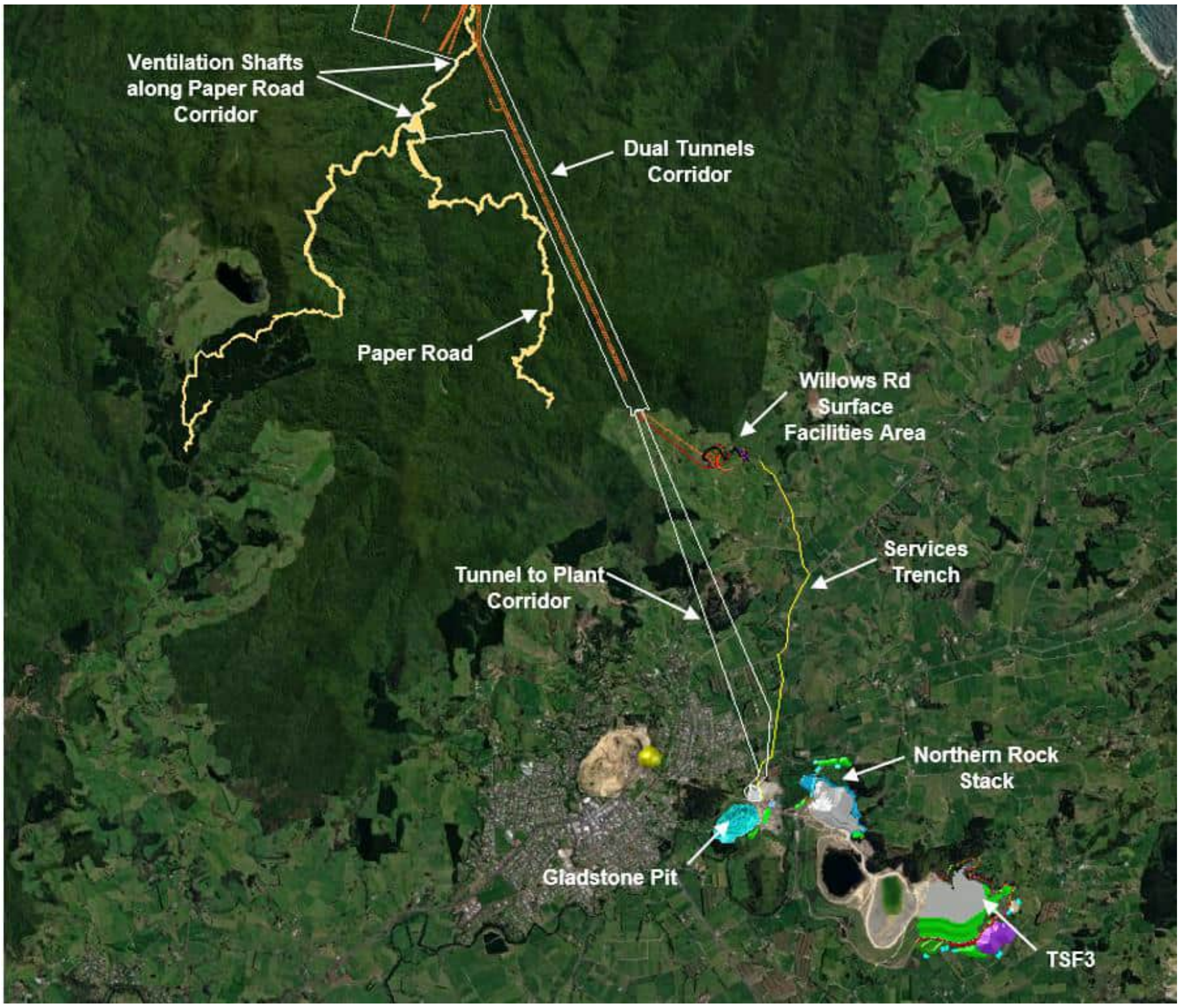

Figure 1 Waihi North Project Elements

1.1.1 The Gladstone Pit

Mining of GOP is expected to occur over a six year period, in order to extract an estimated 2.6 Mt of ore and 21.3 Mt of rock. Rock material will be stored at the stockpile areas adjacent to the existing TSFs, then at the NRS, before being used for the construction of the TSF3 embankment. A portion (approximately 5.0 Mt) of the rock will be utilised as pit backfill material, before the GOP void is converted to a TSF.

1.1.2 Wharekirauponga Underground Mine

The WUG is a new underground mine approximately 10 km north of Waihi town. The development of the mine will require the construction of supporting surface infrastructure and a tunnelling system. The two tunnel access portals will be at Willows Road farm to serve as the initial access portal, with an access portal near the Processing Plant developed later to transport ore out of the mine and backfilling material into the mine once the WRS is exhausted. For this assessment the WUG Access Tunnel and WUG Mine are being treated as distinct entities as follows:

- WUG Access Tunnel and dual tunnels – From Willows Road Farm to the Wharekirauponga Orebody
- WUG Mine – T-Stream and East-Graben-Vein (EG-Vein) orebodies

Rock produced by mining will be stored at the rock storage stacks, WRS and NRS, before being used as backfill for the mined stopes during mining. Rock produced from the tunnel between the access portals will be stored at the process plant or NRS and Willows Farm.

1.1.3 Tailings and Rock Storage Facilities

1.1.3.1 Tailings Facilities

Tailings Storage Facility 1A (TSF1A) with a crest at RL182 and Tailings Storage Facility 2 (TSF2) with a crest at RL159.5 have insufficient capacity to store the tailings volume from processing ore from both Project Martha and WNP. The additional capacity required will be provided via the establishment of TSF3 and GOP TSF. The additional tailings storage capacity (TSF3 and GOP TSF) will also provide some capacity to allow storage of additional tailings as a result of any further ore sources being brought into production in addition to Project Martha and WNP. TSF3 will be constructed in advance of GOP TSF.

TSF 3

A new TSF is proposed to be constructed immediately east of TSF1A. The proposed crest height for the embankment is RL155, providing a total tailings storage volume of approximately 7,200,000 m^3. A 1.5 mm thick high-density polyethylene (HDPE) geomembrane is assumed to be necessary to contain any initial tailings seepage within the tailings impoundment and up to the initial starter embankment height. Above the starter embankment, a low permeability layer of compacted clay is proposed.

GOP TSF

A TSF is proposed to be constructed in the pit void of GOP. The pit will be backfilled with rock (approximately 5.0 Mt) mixed with limestone to form a base layer for converting it into a TSF. A geomembrane will cover the base layer prior to the tailings being deposited, considered necessary to contain any initial tailings seepage within the tailings impoundment.

1.1.3.2 Rock Storage Facility

As described above, rock will be used to partially backfill the Gladstone Pit and to backfill voids at the underground mines. Additionally, rock will be used to construct the new TSF3. In addition to these requirements, a rock surplus is expected. An additional temporary and permanent rock repository (NRS) is proposed..

The proposed location of the NRS is an elevated site located immediately north of the current TSF2. Design of the NRS will be similar to the existing TSFs to limit acid and metalliferous drainage (AMD) and the entry of leachate into surface and groundwater. Design features will include:

- Low permeability soil containment system beneath the NRS;
- Seepage drains installed in the subsurface;
- Leachate collection drains above the low permeability layer; and,
- Capping of the NRS to minimise oxidation and infiltration.

1.2 Report Structure

This report is structured in the following manner:

- Section 2: Geology and Mineralogy – describes the geological setting of the greater Waihi epithermal area and the corresponding mineralogy associated with hydrothermal alteration and ore deposits in the area.
- Section 3: Geochemical Assessment – describes the analysis and assessment of ore and rock undertaken to characterise the geochemistry of these materials.
- Section 4: Rock – describes the geochemistry of rock (non-ore material) and to what extent it differs from rock recovered from the existing Correnso, Martha, Favona, Trio and MUG mines and the consented MOP4 mine.

- Section 5: Gladstone Sump Quality – provides estimated sump water quality during the development stage of GOP prior to backfilling.
- Section 6: Rock Management – describes the proposed management of rock for the proposed developments, including stockpiling and the associated oxidation and release of contaminants from rock stockpiles.
- Section 7: Mine Tailings and Tailings Management – describes management of mine tailings, the assessment of tailings and tailings pore water composition and impacts to the decant and seepage from the tailings storage facility associated with the placement of ore from the proposed mining development into the existing tailings storage facilities and the proposed new storage facility.
- Section 8: Conclusion – outlines the geochemical assessment conclusions with regard to composition of rock and ore and potential effects to groundwater quality and the tailings storage facility discharges (seepage and decant water).

2.0 Geology and Mineralogy

2.1 Local Geology

The mineralised rock types at Waihi, to be encountered in Martha, Gladstone and Wharekirauponga, have been divided into the following main groups:

- **Andesite Host Rock**, which primarily consists of fine to medium porphyritic andesite flows with varying degrees of clay alteration and silicification. Also included within this category are volcanic ash and tephra deposits stratified within the main body of the andesite host rock. This host rock is prevalent throughout the wider area. Characteristic alteration assemblages include quartz, albite, adularia, calcite, pyrite, illite, chlorite, interlayered illite-smectite, and chlorite-smectite clays extending over tens of metres laterally from major veins. There is also an association of quartz, interlayered chlorite-smectite (corrensite) and chlorite, producing a distinctive pale green colouration. The system is locally oxidised to depths in excess of 350 m below ground level along fractures.
- **Quartz Andesite**, which is the dominant host lithology for the Martha Vein system and in the Union Hill epithermal vein system which includes the Trio, Amaranth, and Union veins. This lithology is described as a quartz-feldspar phyric andesite lava.
- **Hydrothermal Vent Breccia**, which is found at shallow levels (above 1000 m RL, mine datum) as NNE - SSW elongated funnel-shaped vents comprising variously clay to quartz altered breccias with variably milled clasts of all pre / syn-mineral lithologies, including vein quartz. These have formed through phreatic eruptions in shallow levels of an active hydrothermal system and vent to the surface forming tuff rings of the vent ejecta.
- **Rhyolite Host Rock,** the WUG ore body is situated in rhyolitic deposits that are predominantly volcanoclastic breccias with some massive lava. The rhyolite is typically intensely silicified with secondary remineralisation of quartz. This hydrothermal alteration and deposition of heavy metals and associated mineralisation is associated with multiple faults in the area.

Ignimbrite, dacite, volcanic ash, and alluvial sediments overlie the andesite. These rocks were formed subsequent to the epithermal activity that resulted in mineralisation phase and previous analyses have confirmed that these rocks are Non-Acid Forming (NAF). Further drill core logs show no hydrothermal alteration or visible sulphides within these lithologies. These NAF materials are collectively referred to as post mineralisation.

The various mining areas of WNP form part of the greater Waihi epithermal vein system. The Waihi vein system, including Martha Hill, Union Hill, Favona, and Correnso, has been interpreted as being located within a series of sub-regional scale NE-trending grabens. The quartz andesite unit attains thicknesses in excess of 400 m in the Union Hill – Waihi East area with only minor variation in texture or modal composition. The quartz andesite is overlain by a fine-grained tuff, which forms a distinctive marker horizon and is overlain in turn by a series of feldspar-phyric andesite flows and volcaniclastics.

The geology and mineralogy of the Gladstone area, as with the greater Waihi epithermal vein system, is expected to be generally consistent with that encountered in the existing Martha, Favona, Trio, and Correnso mines with the exception of the greater influence of the breccias which overlie the andesite rock in the Gladstone Pit.

The lower mafic content of the rhyolitic host material around the Wharekirauponga ore body will influence the rock mineralisation to a limited degree. These rhyolites are intruded through and underlain by andesitic material. The Golden Cross mine is close to the Wharekirauponga ore body however data from this site is not considered in this assessment due to differences in the host rock (rhyolite versus andesite) and the alteration associated with these two ore bodies.

3.0 Geochemical Assessment

3.1 Introduction

The geochemical assessment of ore, tailings and rock produced from the proposed mining components was carried out using statistical comparison of analytical results for Martha, Favona, Trio, WUG, Gladstone and Correnso rock samples, acid-base accounting, and predictive modelling of impacts to water quality.

Existing geochemical data has been sourced from various technical reports that is summarised as follows:

- Appendix A for Martha, Favona, Trio, and Correnso operations, as well as the consented Project Martha (comprising MOP4 and MUG)
- Appendix B for Wharekirauponga

3.1.1 Characterisation Philosophy

The following steps were undertaken to characterise ore and rock trace element composition:

- Initial screening of ore and rock for a broad range of major and trace elements and potential contaminants of environmental concern.
- Additional elements where they had previously been present in elevated concentrations in rock and ore from the Waihi operations, where consent conditions stipulated discharge concentrations, and / or where they had previously been depressed in rock and ore from current and previous operations.

The specific intention of this comparison was the identification of potential contaminants of interest which may require rock management practices that differ from those currently undertaken by OGNZL.

The geochemical composition of ore has been used to determine the likely composition of the mine tailings that would be produced from ore processing. To achieve this, mine tailings produced from Martha mine ore were used as the basis for assessment, with compositional differences between Martha, Gladstone and Wharekirauponga ore assumed to result in proportional differences in tailings composition. A similar approach is used to predict likely effects to decant and seepage quality from the storage facilities as a result of the deposition of mine tailings from the planned operations in the current and future storage facilities.

3.2 Geochemical Testing

The following analytical testing methods are used to characterise ore and rock samples from selected boreholes distributed across the proposed mining areas:

- **Multi-element analysis** - whole rock testing for a range of trace and major elements to allow characterisation of the rock for potential contaminants that may leach and adversely influence water quality.
- **Static testing** – whole rock testing for parameters indicative of the potential for acid generation.
- **Kinetic testing** – accelerated weathering of select crushed rock samples to assess the rate of potential acidification and contaminant release.
- **Column testing** – on-site weathering of selected crushed rock samples exposed to atmospheric conditions and to assess management practices.

The testing methodologies and analytical results are detailed in Appendix A and Appendix B.

4.0 Rock

4.1 Introduction

A combination of rock composition analysis, assumptions around rock management, and acid-base accounting is used to determine the likely geochemical effects of rock stockpiling. The degree of sulphide oxidation and corresponding leaching of trace element contaminants is a function of not only rock composition but also the proposed stockpile size, construction and rock placement, duration of stockpiling, and trace element ratio to sulphur content.

The mass of soluble trace elements generated as a result of sulphide oxidation is used to predict likely effects to groundwater on flooding of the mine at closure.

Samples of rock from borehole core were selected to be spatially representative of the rock produced with mining of the respective ore bodies.

4.2 Rock Composition

Summarised results from the whole rock geochemistry testing for Acid Generating Potential, Major Elements and Trace Elements are presented as follows:

- Table 1 (proposed Gladstone),
- Table 2 (Martha Mine),
- Table 3 (Historical Rock samples from Trio, Favona, Martha and Correnso)

Appendix A outlines the statistical analysis of rock geochemistry datasets for the proposed Gladstone Pit. Appendix A also includes the rock geochemistry results as follows:

- Appendix A, Table 31 (proposed Gladstone),
- Appendix A, Table 32 (Martha Pit),
- Appendix A, Table 33 (Historical Rock samples from Trio, Favona, Martha and Correnso)

Appendix B outlines the statistical analysis of rock geochemistry datasets for the proposed Wharekirauponga Mine.

4.2.1 Distribution of Trace elements in the Rock Material

Figure 2 to Figure 5 show the relative distribution of trace elements in rock that have been identified as elevated based on the analysis in Appendix A and Appendix B and summarised in Table 1. These tables define representative trace element concentration based on lithology and do not segregate materials based on whether they are PAF or NAF which is defined as discussed in Section 4.2 and Appendix A.

Gladstone Pit

When compared to historical rock trace element data, the proposed GOP rock is generally depressed in trace element concentrations with the exception of antimony, arsenic, cadmium, and mercury, which are elevated. The Geochemical Abundance Index (GARD) indicates that cadmium has a GAI of 1 and as such does not warrant further examination as it is not significantly elevated. Although antimony, arsenic, cadmium, and mercury are elevated, geochemical controls such as co-precipitation and complexion, along with the current on-site treatment facilities will control the trace element concentrations from the mine area to within the current operating limits for treated water. It is predicted that elevated trace element concentrations in mine waters arising from elevated concentrations within the rock material (with respect to historical mining areas) will not impact the site’s ability to meet the existing discharge consent conditions.

Of note is mercury, which has largely been recorded below the laboratory method detection limit in site mine waters and shows an order of magnitude increase in total concentration within the Gladstone rock.

As such, mercury leaching potential is further assessed through kinetic leaching tests to determine the likely resultant levels that will be present in the proposed mine waters.

Elevated trace element concentrations (antimony, arsenic and mercury) in the rock (and ore body) relative to historical mined areas need to be assessed for potential implications for consent compliance at the point of discharge (both to water and to air).

An assessment of the distribution of trace elements within the rock shows that mercury is elevated in the highly clay altered Andesitic material located near the surface and associated with the Breccia material.

Relatively low concentrations of other trace elements are noted in areas of elevated mercury. There is also no direct correlation between mercury with sulphur (the highest mean mercury concentrations are found in the hydrothermal breccia samples which tend to coincide with the lowest mean sulphur concentrations). Both these factors may be due to the high volatility of elemental mercury and the capability of more soluble mercury forms being more distal to the ore body, especially through post-mineralisation cover. This can result in the secondary mercury halo around the deposits varying significantly in size (Browne, 2008).

Further assessment of mercury is therefore necessary as sulphide content and management of sulphide alteration will not necessarily limit mercury release in the same way that it will control other elevated trace elements (arsenic and antimony).

Wharekirauponga Underground (WUG)

As noted in Appendix B (Section 4.2.3) arsenic, iron, selenium and antimony are elevated relative to mean concentrations within the earth’s crust. Iron, selenium and antimony concentrations in WUG rock are comparable to concentrations observed in the existing mine operation at Martha.

Arsenic in T Stream and EG ore bodies is elevated with respect to historical Martha rock, but comparable to the concentrations in the Gladstone rock.

Rock from the Wharekirauponga underground mine will be managed within the Willows Rock Stack (WRS) and will primarily be used as backfill within the mine. The only WUG rock being disposed of in the NRS will be from the transport tunnel from the plant and this material will be more similar to the Martha rock.

Table 1 Summary of Geochemical Results for Proposed Gladstone Open Pit and Wharekirauponga Underground Mine Rock

Parameter	Gladstone Pit						Wharekirauponga Mine			Mean Concentration in Earths Crust[1]	Geochemical Abundance Index[2]		
	Andesite			Hydrothermal Breccia			WUG Access Tunnel				Gladstone Pit		WUG
	n	Arithmetic Mean	Range	n	Arithmetic Mean	Range	n	Arithmetic Mean	Range		Andesite	Breccia	Mean
Acid Generating Potential													
Total Sulphur (%)	701	**2.7**	0.01-10	140	**3.2**	0.01-9.77	48	**3.6**	0.01-19.1	0.03	6	6	6
Total Carbon (%)	76	0.04	0.01-0.33	0	-	-	49	0.53	0.02-2.36	-	-	-	-
MPA (%CaCO3)	124	9.2	0.05-29.3	54	7.7	0.025-22.1	49	11.2	0.02-59.6	-	-	-	-
ANC (%CaCO3)	124	-0.1	-0.92-0.92	54	-0.1	-0.82-2.85	49	6.09	0.60-22.8	-	-	-	-
ANC/MPA	124	0.2	-3.63-4.7	54	0.0	-8.2-4.1	49	8.8	0.02-12.5	-	-	-	-
AP (kg CaCO$_3$/tonne)	124	92	0.47-292.8	54	77	0.3-220.6	49	109	0.15-580	-	-	-	-
NP (kg CaCO$_3$/tonne)	124	-1.1	-9.2-9.2	54	-1.2	-8.2-28.6	49	43.8	0.83-197	-	-	-	-
NNP (kg CaCO$_3$/tonne)	124	-93	-293.8-2.4	54	-78	-228.8-15.3	49	-67	-588-94.5	-	-	-	-
NPR[3]	124	0.2	-3.6-4.7	54	0.0	-8.2-4.1	49	4.5	0.00-7.21	-	-	-	-
NAG pH	124	3.4	2-6.4	54	3.2	2.1-5.8	49	5.1	2.00-11.10	-	-	-	-
Major Elements													
Aluminium (%)[4]	154	4.6	0-10	154	4.6	0-10	19	7.50	6.01-9.69	8.2	0	0	0
Iron (%)	701	3.7	0.07-12.5	141	3.2	0.18-9.23	20	**4.21**	3.02-7.45	4.1	0	0	0
Calcium (%)	701	0.03	0.01-0.44	141	0.02	0.01-0.09	20	1.97	0.26-5.9	4.1	0	0	0
Magnesium (%)[4]	154	0.1	0-1	154	0.1	0-1	20	0.99	0.32-2.2	2.3	0	0	0
Sodium (%)	701	0.01	0.01-0.09	141	0.01	0.01-0.02	20	0.11	0.03-0.645	2.3	0	0	0
Potassium (%)[4]	154	0.9	0-4	154	0.9	0-4	20	1.63	0.44-2.81	2.1	0	0	0
Trace Elements													
Antimony[4]	154	**61**	11-214	154	**61**	11-214	20	**0.78**	0.06-1.89	0.2	6	6	1
Arsenic	701	**187**	4.1-4470	141	**130**	5.7-471	20	**45**	2-221	1.5	6	6	4
Barium[4]	154	140	20-1380	154	140	20-1380	19	210	90-412	500	0	0	0
Cadmium	701	**0.22**	0.2-9.3	141	**0.22**	0.2-0.8	20	**0.12**	0.02-0.27	0.1	1	1	0
Cobalt	701	11.8	0.5-55.3	141	12.1	0.5-37.7	20	15	11.5-19.3	20	0	0	0
Chromium[4]	154	44	17-149	154	44	17-149	20	4.4	0.8-33.6	100	0	0	0
Copper	701	17	1.2-120	141	17.1	1.8-150	20	18.8	9.5-43.5	50	0	0	0
Lead	701	10	1.2-68.5	141	12.1	0.6-43.4	20	**17.2**	6.8-37	14	0	0	0
Mercury	701	**4.2**	0.05-131	141	**4.3**	0.17-20.5	20	**0.11**	0.02-0.51	0.05	6	6	1
Manganese	701	67	9-1472	141	70	21-171	20	448	139-1000	950	0	0	0
Molybdenum	701	**1.5**	0.7-85.1	141	**1.6**	0.7-7.3	20	1.34	0.74-2.59	1.5	0	0	0
Nickel	701	14	0.5-113.5	141	11.4	0.5-38.2	20	14.7	11-20.6	80	0	0	0
Selenium	701	**2.5**	0.3-12.3	141	**3.0**	0.3-7.4	20	**3.04**	0.15-10.1	0.05	5	5	5
Vanadium[4]	154	78	4-196	154	78	4-196	20	111	79-167	160	0	0	0
Zinc	698	21.2	1-247	141	16.4	1-170	20	71.0	21-219	75	0	0	0

Notes:

Units are in mg/kg unless stated otherwise.

Arithmitic Mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.

1. Bowen, HJM, 1979, Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 0.7 - National Institute of Acid Prevention.
3. Values based on unadjusted NP.
4. Values representative of all Overburden and Ore samples analysed. See comment in text regarding 2-acid versus 4-acid digestion.

Bold - Concentrations exceed the mean value for the earths crust.

Red - Geochemical Abundance Indices of 3 or greater

\- No data or number of data points insufficient to generate meaningful value.

Table 2 Summary of Geochemical Results for current Martha Mine

Parameter	Martha Underground (MUG)		Rex Vein (Rex)		Martha Phase 4 (MP4)		Mean Concentration in Earths Crust[1]	Geochemical Abundance Index[2]			
	40 ABA / 49 Trace Elements Samples		35 ABA / 41 Trace Elements Samples		30 ABA / 39 Trace Elements Samples						
	Arithmetic Mean	**Range**	**Arithmetic Mean**	**Range**	**Arithmetic Mean**	**Range**		**MUG**	**Rex**	**MP4**	**MP5**
Acid Generating Potential											
Total Sulphur (%)	0.87	0.10 - 3.0	1.6	0.007 - 3.91	3.1	1.37 - 4.7	0.03	4	5	6	6
MPA (%CaCO3)	2.7	0.3 - 9.5	5.0	0.02 - 12.2	9.8	4.3 - 14.6	-	-	-	-	-
ANC (%CaCO3)	6.3	2.3 - 8.9	7.1	2.3 - 12.8	7.2	1.5 - 11.8	-	-	-	-	-
ANC/MPA	2.3	0.9 - 7.1	1.40	1.0 - 105	0.7	0.4 - 0.8	-	-	-	-	-
AP (kg $CaCO_3$/tonne)	27.2	3.2 - 94.7	50	0.2 - 122	98	43 - 146	-	-	-	-	-
NAG pH	8.3	3.3 - 11.2	6.6	2.7 - 11.2	6.2	2.5 - 10.9	-	-	-	-	-
Major Elements											
Aluminium (%)	1.1	0 - 13.4	1.0	0 - 13.1	1.0	0 - 12.8	8.2	0	0	0	0
Iron (%)	3.9	3.1 - 6.6	3.9	3.1 - 6.9	3.9	2.8 - 6.7	4.1	0	0	0	0
Calcium (%)	2.1	0.2 - 5.6	2.7	0.2 - 5.6	3.1	0.3 - 5.7	4.1	0	0	0	0
Magnesium (%)	1.8	1.2 - 3.2	2.0	1 - 2.9	1.7	1 - 2.9	2.3	0	0	0	0
Sodium (%)	1.4	0.1 - 2.4	1.4	0.4 - 2.4	0.5	0 - 2.4	2.3	0	0	0	0
Potassium (%)	**3.6**	0.8 - 6.2	**2.9**	0.7 - 6.4	2.3	0.4 - 7.1	2.1	0	0	0	0
Trace Elements											
Antimony	**1.5**	0.1 - 7.3	**2.5**	0.1 - 6.8	**2.1**	0.1 - 10.6	0.2	2	3	3	4
Arsenic	**19.6**	2.8 - 68.6	**11.8**	1.6 - 63.9	**24.7**	2.7 - 68.3	1.5	3	2	3	4
Barium	**586**	290 - 1650	**485**	270 - 1580	402	40 - 1840	500	0	0	0	0
Cadmium	0.1	0 - 0.4	0.1	0 - 0.5	0.1	<0.02 - 0.7	0.1	0	0	0	0
Cobalt	19	12.2 - 89.6	20	12 - 91.3	18	11.1 - 86.7	20	0	0	0	0
Chromium	75.8	13 - 249	**128.2**	49 - 235	78.0	18 - 146	100	0	0	0	0
Copper[3]	**392**	8.6 - 7820	**244**	13.2 - 7430	**428**	5.4 - 7400	50	2	2	3	0
Lead	14	4.8 - 56.2	11	5.9 - 51.8	14	5.7 - 50.6	14	0	0	0	0
Mercury	**0.1**	<0.005 - 0.5	**0.3**	<0.005 - 1.1	**0.2**	<0.005 - 3.3	0.05	0	2	2	2
Manganese	**1030**	595 - 2370	947	421 - 1840	742	161 - 1700	950	0	0	0	0
Molybdenum	**3.1**	0.2 - 36.8	**2.1**	0.2 - 35.6	**3.1**	0.5 - 37.6	1.5	0	0	0	0
Nickel	34.3	6.4 - 122.5	48.7	18.6 - 100	33.2	5.9 - 87.5	80	0	0	0	0
Selenium	**2.0**	1 - 6	**1.5**	<1 - 7	**1.4**	<1 - 6	0.05	5	4	4	4
Vanadium	111	90 - 179	126	78 - 191	102	59 - 183	160	0	0	0	0
Zinc	**75.2**	52 - 199	72.2	48 - 239	70.6	16 - 221	75	0	0	0	0

Notes:
Units are in mg/kg unless stated otherwise
* Number of data points insufficient to generate meaningful value.
Arithmitic mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.
1. Bowen, HJM, 1979,Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 0.7 - National Institute of Acid Prevention
3. Elevated mean Cu with respect to previous overburden is driven by outliers
Bold Concentrations exceed the mean value for the earths crust.
Red - Geochemical Abundance Indices of 3 or greater

Table 3 Summary of Geochemical Results for Rock – Historical Rock

Parameter	**Trio Andesite Waste Rock**		**Favona Andesite Waste Rock**		**Martha Mine Waste Rock**		**Correnso Andesite Waste Rock**		**Mean Concentration in Earths Crust[1]**	**Geochemical Abundance Index[2]**							
	25 Samples		85 Samples		46 Samples		27 Samples										
	Arithmetic Mean	**Range**	**Arithmetic Mean**	**Range**	**Arithmetic Mean**	**Range**	**Arithmetic Mean**	**Range**		**Trio**	**Favona**	**Martha**	**Correnso**	**North Wall Data**	**MUG**	**Rex**	**MP4**
Acid Generating Potential																	
Total Sulphur (%)	2.1	0.5 - 5.1	2.3	0.01 – 6.0	3.0	0.01 – 9.3	2.15	0.47 - 3.39	0.03	**6**	**6**	**6**	**6**	**6**	**4**	**5**	**6**
Total Carbon (%)	0.3	0.02 - 0.7	-	-	-	-	0.70	0.21 - 1.53	-	-	-	-	-	-	-	-	-
MPA (%CaCO3)	6.5	1.5 – 15.9	7.0	0.03 – 19	9.5	0.03 – 29	6.7	1.5 - 10.6	-	-	-	-	-	-	-	-	-
ANC (%CaCO3)	7.8	<2 – 15.0	1.5	0.03 – 13	3.1	<2 – 16	7.3	2.0 - 15	-	-	-	-	-	-	-	-	-
ANC/MPA	1.6	0.13 - 8.12	1	0.004 – 32	0.9	0 – 18	1.36	0.2 - 4.6	-	-	-	-	-	-	-	-	-
AP (kg $CaCO_3$/tonne)	65	15 - 159	70	0.3 - 190	112	0.3 - 291	67	14.7 - 106	-	-	-	-	-	-	-	-	-
NP (kg $CaCO_3$/tonne)	53 (26)[2]	20 - 150 (1.7 - 58.7)[2]	15	0.3 - 130	31	<2 - 155	58	17.5 - 127	-	-	-	-	-	-	-	-	-
NNP (kg $CaCO_3$/tonne)	-41	-152 - 43	-54	-181 - 114	-73	-252 – 63	-15	-87.8 - 72.5	-	-	-	-	-	-	-	-	-
NAG pH	-	-	-	-	3.4	2.1 - 7.5	8.7	2.3 - 11.2	-	-	-	-	-	-	-	-	-
Major Elements																	
Aluminium (%)	7.1	6.02 - 8.06	4.6	0.5 – 10	7.4	0.7 – 12	7.3	6.2 - 8.2	8.2	0	0	0	0	-	0	0	0
Iron (%)	3.7	2.79 - 4.72	3.0	0.9 – 6	3.4	0.2 – 6	3.5	3.1 - 4.3	4.1	0	0	0	0	-	0	0	0
Calcium (%)	1.4	0.17 - 3.54	0.4	0.01 – 4	1.1	0.03 – 6	2.3	1.2 - 4.2	4.1	0	0	0	0	-	0	0	0
Magnesium (%)	1.8	0.44 - 2.71	0.7	0.01 – 2	1.6	0.01 – 4.5	1.7	1.3 - 2.2	2.3	0	0	0	0	-	0	0	0
Sodium (%)	0.8	0.08 - 1.57	0.1	< 0.01 – 1.6	0.4	<0.01 – 2.1	1.0	0.5 - 1.7	2.3	0	0	0	0	-	0	0	0
Potassium (%)	**3.4**	1.48 - 5.51	1.7	0.1 – 3.5	**2.7**	0.3 – 5.6	4.9	2.1 - 6.2	2.1	0	0	0	1	-	0	0	0
Trace Elements																	
Antimony	**2.4**	1 - 7.07	**24**	1.0 – 118	**6**	0.02 – 50	**12.8**	0.7 - 51	0.2	3	**6**	**4**	**5**	-	2	**3**	**3**
Arsenic	**30.1**	6 - 99.6	**94**	15 – 540	**26**	1.2 – 78	**58.4**	19 - 164	1.5	**4**	**5**	**4**	**5**	-	**3**	2	**3**
Barium	**546**	90 - 710	209	20 - 720	347	34 – 980	**796**	520 - 981	500	0	0	0	0	-	0	0	0
Cadmium	**0.16**	0.04 - 0.4	**0.25**	0.03 – 4	0.1	<0.02 – 0.6	**0.69**	0.1 - 3	0.1	0	1	0	2	-	0	0	0
Cobalt	16.5	12.3 - 24	15	2 – 32	21	0.8 – 57	19.1	12.1 - 29	20	0	0	0	0	-	0	0	0
Chromium	**150**	50 - 281	**163**	44 – 392	**146**	81 – 277	75.1	51 - 125	100	0	0	0	0	-	0	0	0
Copper[3]	24.9	12.6 - 61.8	39	11 – 380	29	8 – 150	24.7	2 - 88	50	0	0	0	0	-	2	2	**3**
Lead	**23.2**	8.2 - 132	**41**	4 – 1070	10	1 – 28	**23.3**	8 - 103	14	0	1	0	0	-	0	0	0
Mercury	**0.15**	0.01 - 0.9	**0.75**	0.06 – 4.5	**0.4**	0.04 – 2	0.05	0.025 - 0.099	0.05	1	**3**	2	0	-	0	2	2
Manganese	915	94 - 1450	294	26 – 1540	**985**	90 – 3400	**1070**	638 - 2731	950	0	0	0	0	-	0	0	0
Molybdenum	**1.6**	0.6 - 4.6	**4**	1 – 12	**1.8**	0.3 – 6	**1.9**	0.6 - 6	1.5	0	1	0	0	-	0	0	0
Nickel	31.8	13.4 - 66	14	6 – 27	57	7 – 159	25.9	14 - 39	80	0	0	0	0	-	0	0	0
Selenium	**2.0**	1 - 6	**2.5**	< 1 – 15	**1.1**	0.1 – 4	**6.37**	2 - 36	0.05	**5**	**5**	**4**	**6**	-	**5**	**4**	**4**
Vanadium	113	84 - 146	86	5 – 180	104	3 – 206	**194**	181 - 205	160	0	0	0	0	-	0	0	0
Zinc	**92.6**	44 - 227	**96**	7 – 1670	63	<2 – 152	**82.6**	31 - 201	75	0	0	0	0	-	0	0	0

Notes:
Units are in mg/kg unless stated otherwise
* Number of data points insufficient to generate meaningful value.
Arithmitic mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.
1. Bowen, HJM, 1979,Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 0.7 - National Institute of Acid Prevention
3. Elevated mean Cu with respect to previous overburden is driven by outliers
Bold Concentrations exceed the mean value for the earths crust.
Red - Geochemical Abundance Indices of 3 or greater

4.3 Rock Acid Generating Potential

4.3.1 Static Testing

Static testing provides a mass balance for the potential acid generating and neutralising minerals and reactions but does not account for the potential rate of reactions that can significantly influence whether rock will generate AMD.

Summarised static data is presented Table 1 (proposed Gladstone), Table 2 (Martha) and Table 3 (Historical Rock samples from Trio, Favona, Correnso) and presented in boxplots Figure 2 to Figure 5. Raw data is also presented in Appendix B.

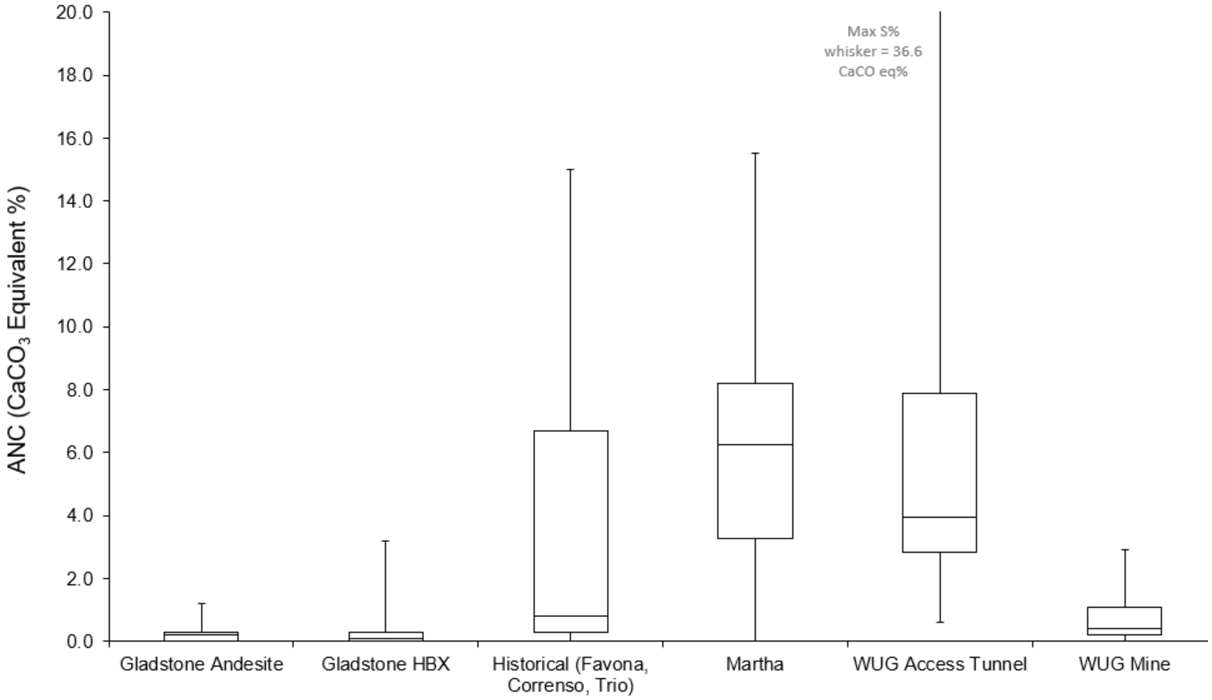

Figure 2. Box plot showing calculated Acid Neutralising Capacity range in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Data extending below 0% on the Y-axis are not shown.

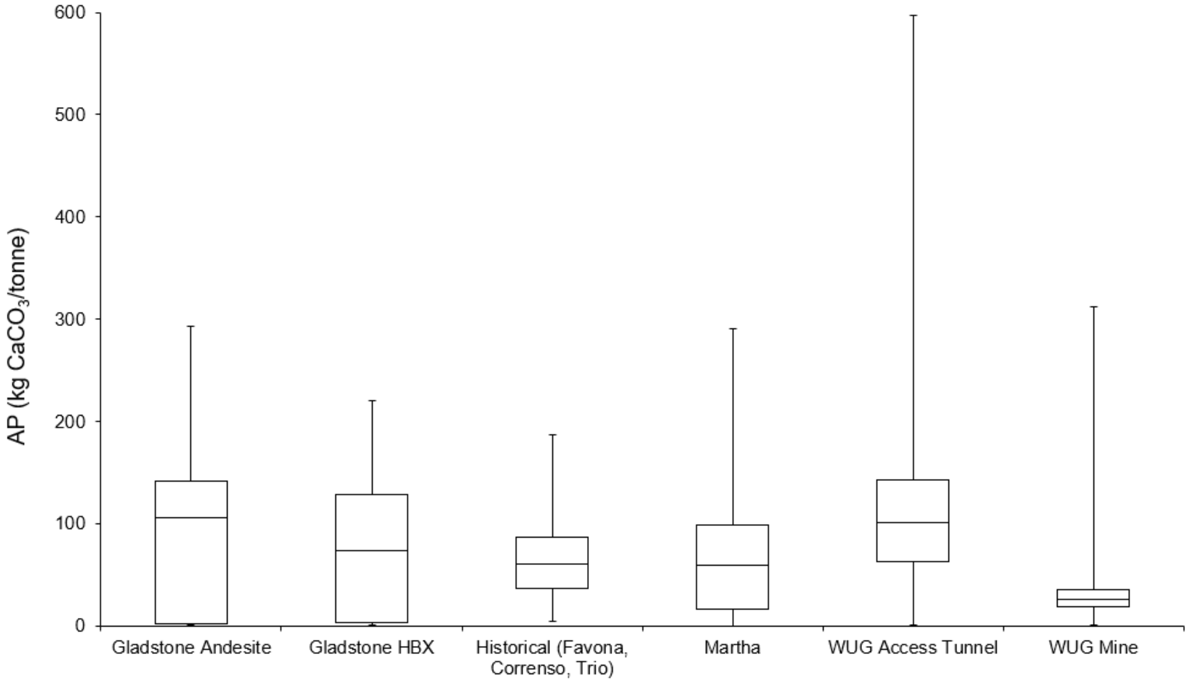

Figure 3. Box plot showing range of calculated Acid Potential in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. AP calculation based on total Sulphur content. Data extending below 0 kg/tonne on the Y-axis and are not shown.

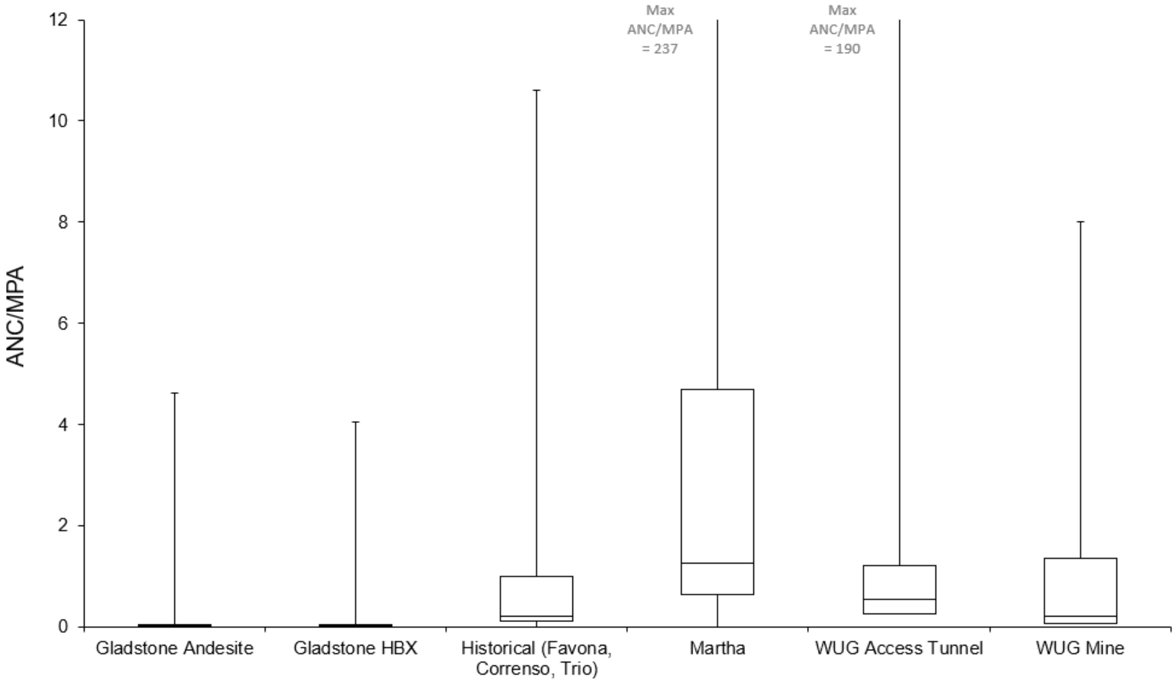

Figure 4. Box plot showing range of calculated ANC/MPA ratio in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations**.** Data with a value below 0 on the Y-axis and are not shown.

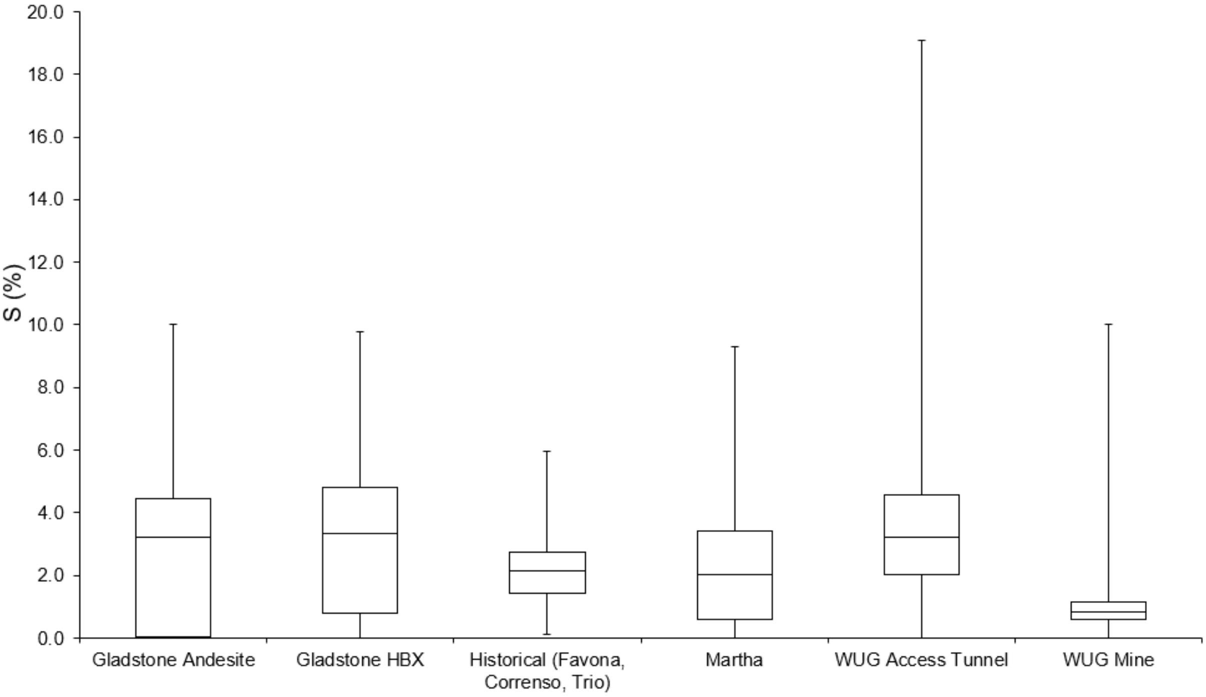

Figure 5. Box plot showing range of Sulphur concentrations in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Data with a value below 0 on the Y-axis and are not shown.

In general, the acid generating potential of the rock from within the proposed GOP and WUG is similar to that of historical mining areas. This includes:

- Mean sulphur concentrations in the Gladstone rock ranging from 2.7% in the andesite to 3.2% in the hydrothermal breccia.
- Mean sulphur concentrations in the Wharekirauponga rock ranging from 0.91% in the WUG mine to 3.7% in the WUG access tunnel.
- These are comparable to the historical rock sulphur concentrations (including Martha, Trio, Favona ranging from 2.1 to 3.0%. As a result the acid potential (AP) in kg $CaCO_3$ per tonne of the Gladstone and WUG rock is considered comparable.

The acid base accounting of the rock from within the proposed Gladstone Pit and the WUG mine has the following differences (Appendix C):

- The largest difference between the datasets is the lower neutralising capacity within the Gladstone Pit. This is highlighted with respect to a lower overall mean acid neutralising capacity (ANC), ANC/ MPA, and neutralisation potential (NP) values within the proposed Gladstone Pit rock when compared with mined rock.
- The acid neutralising capacity of the WUG rock is comparable to existing mining operations as shown in Figure 2.
- As a result of the similar AP and ANC in WUG rock to historical mined rock, the ANC/MPA is also comparable to previously mined rock.

When plotted on a net potential ratio (NPR) / net acid generating (NAG) pH diagram (Figure 6), the majority of the samples from WUG and Gladstone are PAF exhibiting a low pH ($pH < 4.5$) and low NPR ($NPR < 1$). Of the remaining samples, approximately one third are classified as ‘uncertain’. In general, the Martha Pit material (MOP4) exhibits a lower acid producing potential.

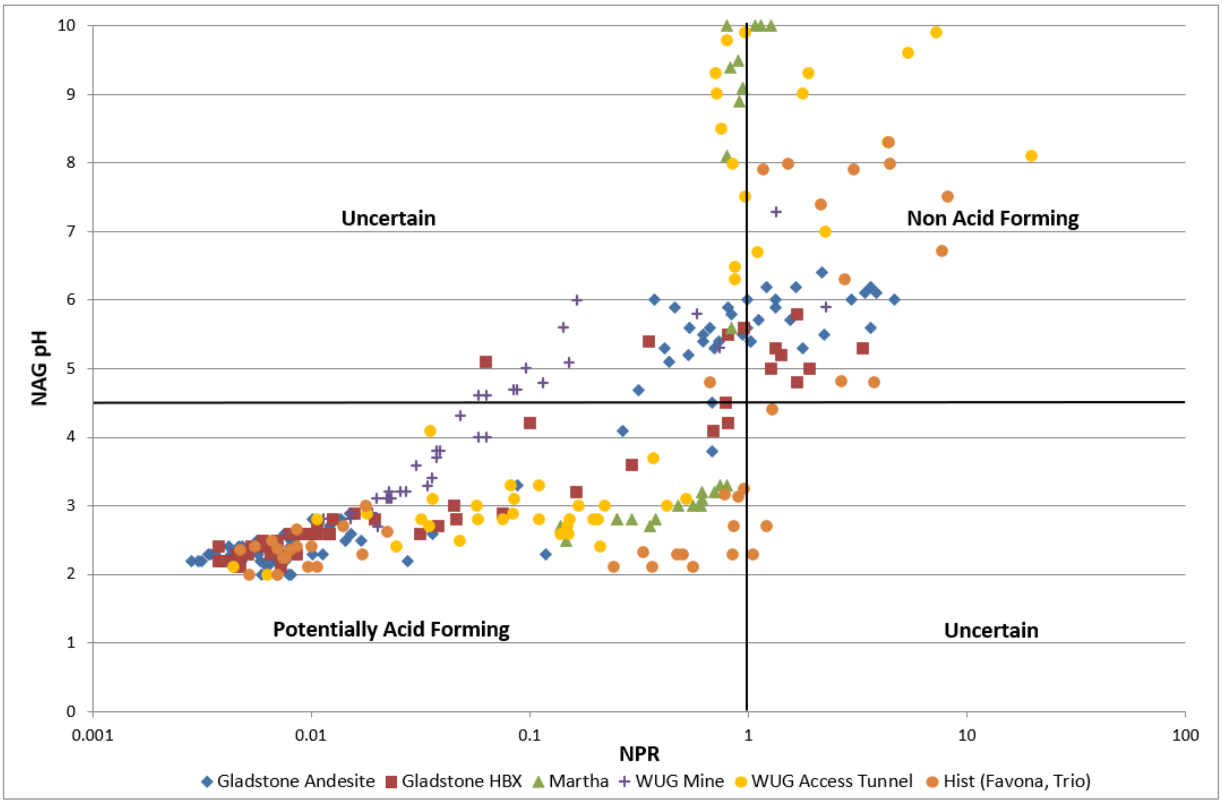

Figure 6. NPR/NAG pH diagram for Rock Material

4.3.1.1 NAG pH Distribution in Gladstone Pit

NAG pH data and its relative distribution throughout the Gladstone Pit is shown in Figure 7. NAG pH appears to exhibit a generally decreasing trend with pit depth. This may indicate that the capacity for rock to generate AMD will increase as the pit is advanced. It is expected that (deeper) geology occurring beneath the groundwater table has been exposed to relatively reducing conditions, limiting the natural oxidation of minerals. Conversely, oxidising conditions above the groundwater table are likely to have resulted in natural weathering of the rock, reducing the acid producing potential of this material over time.

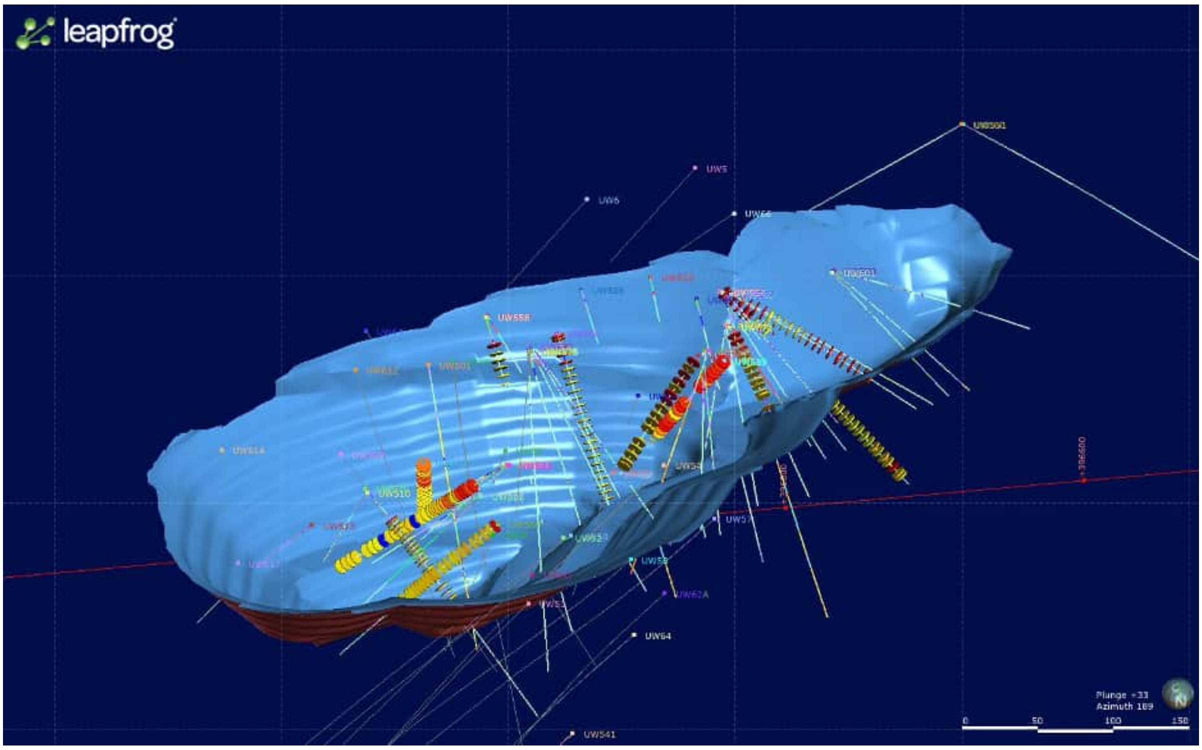

Figure 7. NAG pH distribution in Gladstone Pit.

Cores: Red, NAG ph >5; Orange, NAG pH 2.5-5; Yellow, NAG pH 2-2.5; Blue, NAG pH < 2.

4.4 Rock Leaching Potential

4.4.1 Gladstone Pit

Kinetic and field column testing of Gladstone rock samples has been undertaken to further refine the assessment of potentially acid generating materials, as well as to characterise the influence of reaction rates. Details of the kinetic and column testing is provided in Appendix D, with a summary provided below.

The kinetic testing was undertaken on six rock samples representative of the Gladstone vent breccias, with one additional control blank of the testing equipment. Test results showed that rock samples with depressed pH and elevated trace element concentrations coincided with the highest acid producing potential. Conversely, the rock with the highest NAG pH showed depressed trace element concentrations and a pH similar to the control sample. Mercury, which has elevated total concentrations in the breccia rock compared to the wider site, was only detected in 3.8% of the kinetic leachate samples analysed throughout the testing period. As such, the rock samples tested do not leach elevated levels of mercury under acid generating conditions simulated in the kinetic tests.

In general, the kinetic test samples indicated leaching characteristics consistent with the waste from the historical and existing mine rock samples. There were two samples that represented high sulphur and very low ANC that rapidly became acid generating and leached trace elements at levels greater than rock from the wider site.

The field column testing results suggest that the application of limestone, compaction of material, and saturation are all valid strategies to mitigate AMD from both exposed and placed rock during the proposed mining operations. Specific strategies depend on the rock destination, method of placement, length of exposure, and specific ABA characteristics of the rock. This is explored and discussed in Section 6.0. A component of the high sulphur and very low ANC samples identified in the kinetic testing were included in these column samples in proportions equivalent to their overall proportion in the total rock. As a result, the column results are considered to reasonably represent the leachability of the total Gladstone Pit rock once placed in a rock storage area (GHD column results included as Appendix E).

4.4.2 Wharekirauponga Underground Mine

Field column testing of Wharekirauponga rock samples has been undertaken to further refine the assessment of trace element leaching and sulphate generation rates. Details of the column testing data available to date is provided in Appendix E and will be reviewed as data becomes available.

5.0 Gladstone Sump Water Quality

During development, the pit walls of Gladstone Pit will be subject to oxidation and pit wall run-off which will contribute a significant dissolved solids load to the base of the pit. The area of pit wall will increase as the pit progresses and decrease as the pit is backfilled. Water chemistry of the run-off is dictated primarily by the mineralogy of the pit wall in the run-off flow path. Distinct differences in resultant water quality reporting to the sump will depend on whether infiltrating water passes over PAF rock or NAF rock.

Key to the AMD process is the oxidation of sulphide minerals, which produces sulphuric acid and increases leaching of trace elements. During episodes of rainfall, oxidation products are dissolved by rainfall, forming an acidic solution that contains trace elements at potentially high concentrations. Where elevated sulphide concentrations are present in the pit wall rock (PAF rock), the run-off is likely to have low pH, high sulphate concentrations, and detectable levels of trace elements.

The degree to which pit wall rock is likely to be acid forming is dictated primarily by the minerals present, which is a function of pit wall lithology (alteration) and the degree of mineral oxidation. As such, the pit wall can be divided into areas referred to as pit wall associations, grouped by analogous mineralogy and weathering profiles, which generally produce similar run-off chemistry. In order to estimate sump water quality, a conservative approach has been adopted in which two distinctive runoff water qualities have been devised and mixed accordingly. The method adopted is outlined and summarised in the sections below and shown in Figure 8.

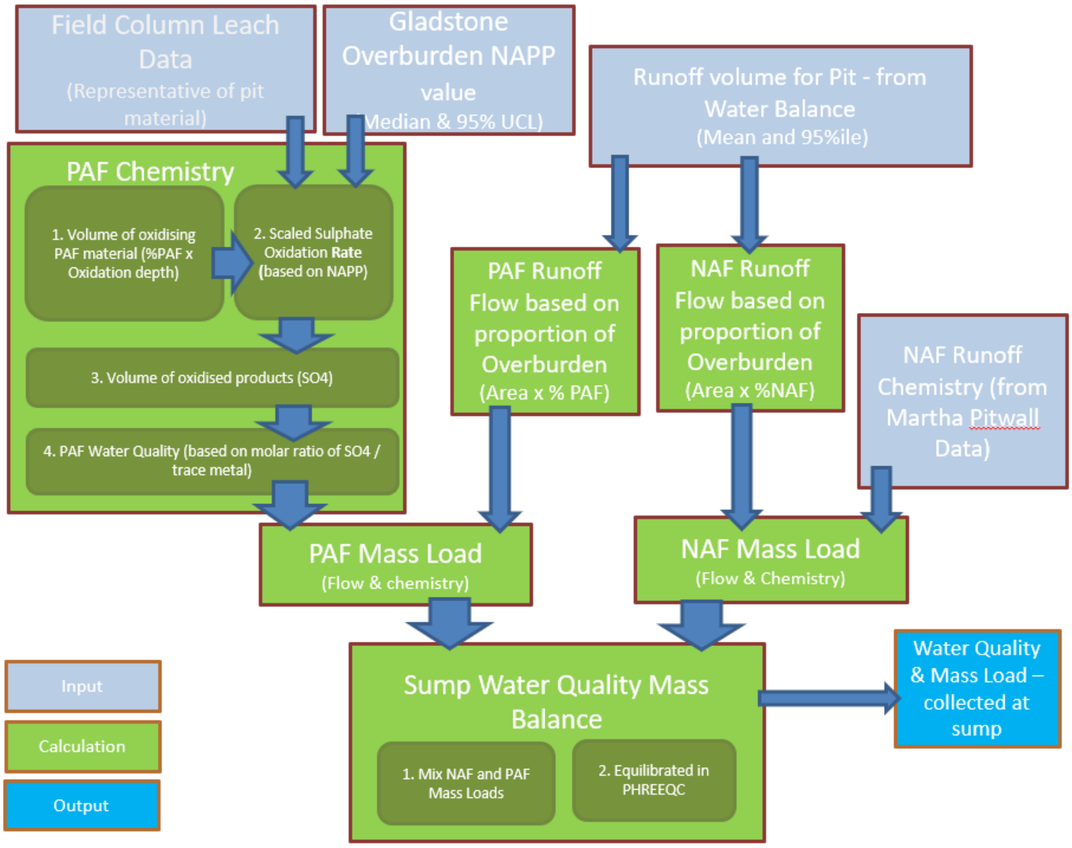

Figure 8 **Gladstone Pit – Water Quality reporting to sump**

5.1 Sulphate Generation Rate of Gladstone Pit Walls

The unmodified leachate data from the field column Col1 (refer to Appendix D) has been summarised as it is considered the most representative field column in terms of ratio of Andesite and hydrothermal breccia material compared to the total exposed wall areas of the final Gladstone Pit.

The raw leachate data has been summarised from week 10 to week 79, in order to exclude the initial lag period which was present in the column tests. The approach is considered appropriate as by the time the pit reaches its maximum extent (and exposed surface area), the bulk of the exposed walls would have been exposed to the atmosphere for a period exceeding any inherent lag period.

The mean sulphate generation has been calculated based on the volume of the material in the column. This value has been adjusted to account for the Net Acid Producing Potential (NAPP) differences between the material in the field column and the median and 95% UCL of the rock material within Gladstone Pit (Table 4).

Table 4 Sulphate Generation Rate for Pit Walls

Item	NAPP (kg H_2SO_4/t)	Sulphate Generation Rate (mg SO_4/kg/day)
Column test (column 4 Glad 1)	129	34
Gladstone Rock (95th % UCL)	110	29
Gladstone Rock (Median)	95	25

The calculated sulphate generation rate of between 25 to 29 mg SO_4 per kilogram of oxidising material per day of exposure is therefore assumed for oxidation of the pit walls. In order to account for the total volume of oxidising material and therefore the total mass of oxidation products, the total pit wall area has been divided into PAF and NAF areas based on the volumes of PAF and NAF material from the rock waste schedule. An oxidation depth of 0.1 m has then been applied to this area to calculate the total volume of oxidising pit wall which is conservative based on observation of the existing pit walls. This is based on visual observation of PAF areas on the north wall of the Martha open pit which had been exposed to oxidation for in excess 20 years. The adopted values are outlined in Table 5.

Table 5 Total Oxidising Volume in Gladstone Pit Wall

Item	Units	Value
Total Exposed Wall Area	Ha	18.7
Density	t/m^3	2.1
Percentage of PAF	%	73
Depth of Oxidation Profile	m	0.1
Total Volume Available for Oxidation	m^3	13,605
Tonnes of material Available for Oxidation	t	28,570

5.2 Gladstone Pit Runoff Water Quality

PAF Pit Wall Runoff water quality has been derived by applying the mean (711 m^3/day) and the 95%ile (3,583 m^3/day) runoff volumes from the Gladstone Pit Water balance[1] (GHD, 2019) to the total predicted sulphate load (Table 4) based on the derived sulphate generation rate and the material available for oxidation (Table 5). Trace metal data has been calculated based on the molecular ratio of sulphate to trace element generation from the field column data for Gladstone.

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[1] Revised calculations pending updated modelling results from GHD.

NAF Pit Wall Runoff water quality for the Gladstone Pit is based on field data from the Martha Pit representative of runoff interacting with NAF pit wall material (AECOM 2018, Appendix A).

The derived pit wall runoff water quality is summarised in Table 6, alongside pit wall runoff data from the Martha Open Pit (NAF and Martha Fresh PAF). This pit water quality data is derived from leachability data for the field columns and shows that the Martha High PAF Hg is elevated relative to the field column leach data. As mentioned in Section 4.4.1, the kinetic test results determined that high total Hg doesn't necessarily result in high leachability.

In order to estimate sump water quality, a conservative approach has been adopted in which two distinctive runoff water qualities have been derived and mixed accordingly (refer to Figure 8):

- Derived PAF water quality calculated from field column leach data and Gladstone overburden NAPP
- Martha Pit NAF water quality (AECOM 2018, Appendix A)

The Martha Fresh PAF samples in Table 6 represent a highly mineralised, intensely clay altered area of pit wall that represents a worst case in terms of Martha pit wall runoff.

Table 6 Gladstone Pit Wall Runoff Water Quality

Pit Wall Type	Derived PAF (range)		NAF	Martha Fresh PAF
	Minimum	Maximum		
SO4	145	2390	160	2500
pH	2.5	4.1	7.1	2.5
Al	14	223	28	125
Sb	0.00001	0.0002	0.0002	0.0005
Ba	0.00015	0.002	-	-
Co	0.06	0.96	0.0002	0.30
Fe	9	151	0.020	125
Mn	0.06	1.04	0.010	2.35
Hg	0.00001	0.00002	0.00001	0.00040
Mo	0.0000	0.0003	-	-
Se	0.000	0.0003	0.001	0.008
As	0.04	0.73	0.001	0.15
Cd	0.000	0.002	0.000	0.002
Cu	0.03	0.50	0.001	0.32
Pb	0.0004	0.001	0.0001	0.0003
Ni	0.026	0.423	0.001	0.700
Zn	0.042	0.698	0.006	0.980
Cr	0.004	0.073	0.001	0.335
Ca	3	55	107	34
Mg	0.004	0.073	5	59

All concentrations reported in mg/L.

5.3 Geochemical Modelling

Sump water quality modelling was undertaken utilising the geochemical modelling software PHREEQC Interactive version 3.6.2 and the Minteq.v4 database (Appendix F). PHREEQC is utilised to assess geochemical reactions of the combined water qualities reporting to the sump in order to account for and assess overall pit sump water quality that a mass balance approach will not account for.

Derived PAF and NAF pit wall runoff from Table 6 were mixed at a ratio of 0.73:0.27 respectively to account for their relative proportions in the final exposed pit walls. The results of the modelling are shown in Table 7 where the range of predicted trace elements and pH concentrations are given. Table **7** presents the range of model scenario outputs with the minimum and maximum columns not necessarily representing the same model scenario. In the case of pH, we have used the 95 percentile low (5th percentile) as a model input.

Table 7 Modelled Sump Water Quality Predictions

	Min	Med	Max
pH	2.5	4.0	4.4
Al	13	77	234
As	0.042	0.23	1.2
Ba	0.0001	0.0007	0.002
Ca	32	46	85
Cd	0.0001	0.0006	0.0018
Co	0.055	0.30	1.0
Cr	0.004	0.02	0.08
Cu	0.03	0.16	0.51
Fe	2.5	45	150
Hg	0.00003	0.00003	0.00004
Mg	1.4	2.3	2.3
Mn	0.06	0.33	1.1
Mo	0.00002	0.00009	0.0003
Ni	0.02	0.13	0.43
Pb	0.0001	0.0004	0.0011
S	180	785	2,470
Sb	0.0001	0.0001	0.0002
Se	0.0003	0.0012	0.0035
Zn	0.04	0.22	0.71

All concentrations reported in mg/L.

5.4 Key Assumptions

The key assumptions used in assessing and calculating the pit sump water quality are:

- Rock used within the field column tests is representative of exposed pit wall rock (refer Appendix D) with the range of concentrations representing successive flushing events by rainfall
- Sulphate generation rates in the columns are assumed representative of sulphate generation rates in the pit wall. This is considered conservative.
- Trace element leaching is proportional to the molecular ratio of sulphate / trace element leaching observed in the field columns.
- No lag has been taken into account and this data has been excluded from the column data.
- Pit wall runoff is the only source of water to the pit sump. Additional water sources are likely to have a dilution effect and therefore the results are considered conservative in this respect.
- The geochemical modelling assumes the entire calculated daily oxidised mass (and associated leachate metals) is dissolved into the applied daily runoff volume.
- Parameters that are at the limits of detection (e.g. silver) have been shown in the source terms (Appendix F) but not included in the geochemical modelling (Table 7).

6.0 Rock Management

6.1 Introduction

During development and mining, rock is to be managed to minimise the requirement for surface stockpiling and the need for externally sourced backfill materials. Some temporary surface stockpiles are however necessary hence the need for the WRS.

Likewise, rock in the TSF stockpiles, or used within the NRS or TSF3 embankment will be compacted upon deposition, which will limit oxygen ingress within these storage facilities. Rock placed within the zone of oxidation for the final proposed landforms (typically within the final 2 m of directly placed and/or stockpiled material) should comprise NAF material only.

Within temporary stockpiles at the RTSA, appropriate mitigation measures in the form of limestone amendment will be required to limit sulphide oxidation rates and/or limit the effects of already oxidised material. Similarly, the mixing and/or layering of limestone may be required for rock material used as backfill within the Gladstone Pit. The actual requirements and quantities depend on the acid forming potential of the material deposited, the exposure time of material once placed and whether the material is to be placed below the groundwater table or not.

A schematic detailing the overall management strategy for PAF rock sourced during the project and its final destination is illustrated in Figure 9. The schematic also refers to underground disposal of Martha PAF rock. This is covered in more detail in AECOM, 2018a. The process for classification of rock as NAF or PAF is provided Appendix G.

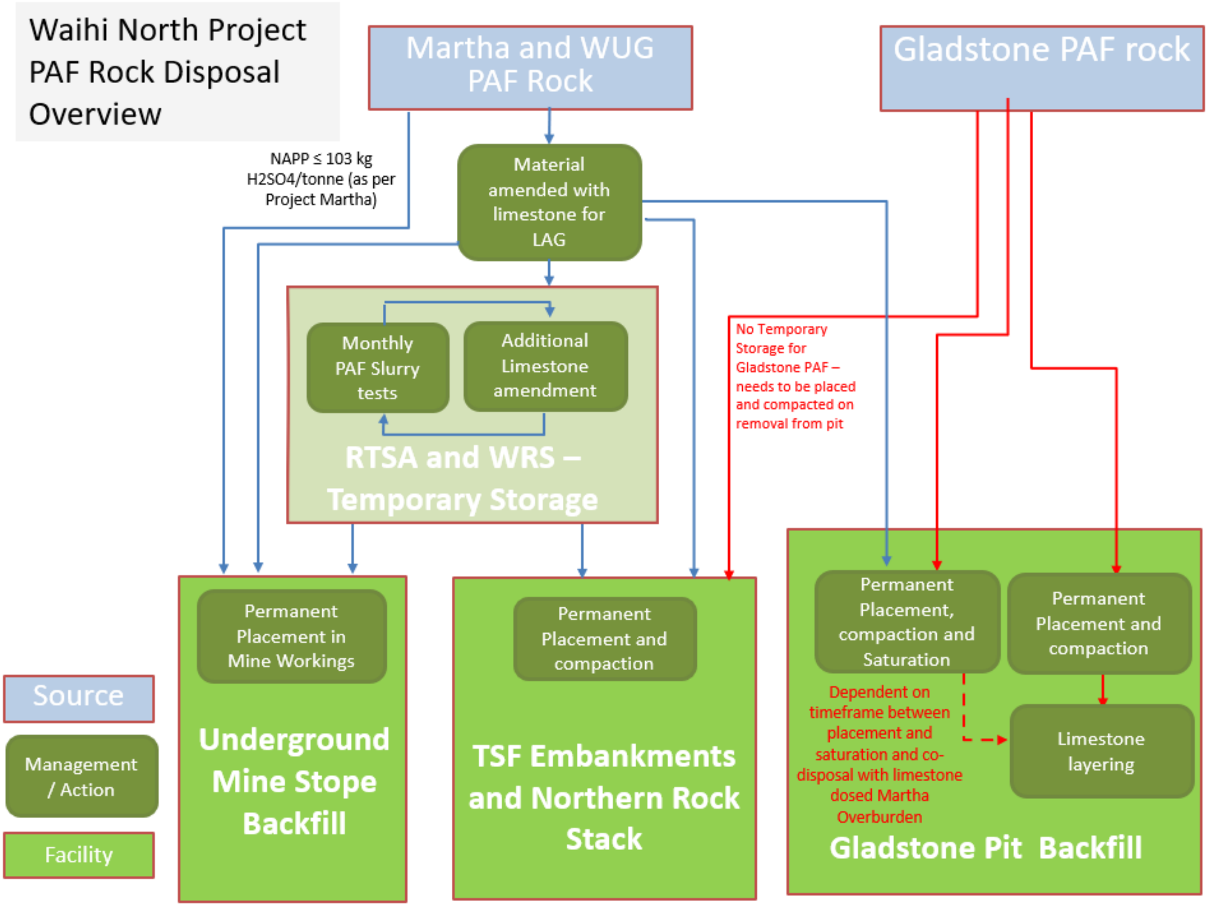


Figure 9 Conceptualised Rock Management

To ensure geochemical management of PAF rock and to reduce adverse effects on water quality, the implementation of an appropriate management strategy is required. Commonly used methods for the management of mined rock that has the potential to impact water quality includes:

1. Oxidation effective control - Control of oxygen flux to reactive sulphides, such as by deposition under water.
2. Geochemical control - Blending rock types or addition of neutralising materials to control pH and oxidation rates.
3. Hydrological control - Placement of low permeability layers, evapotranspiration layers and rock management structures to control the release rate from the disposal facility.

A combination of these methods has been effectively employed where necessary in the management of previously mined rock at Waihi, and it is envisaged that management of rock sourced from Waihi North Project will be similar. The most appropriate means of minimising acid generation is likely to include one or more of the following methods:

- Covering PAF rock with NAF material to limit oxidation of sulphides either as sealing intermediate layers or as final cover. Cover design for the stockpiles will be consistent with the TSF embankments which have been in operation for over 30 years. The outer surfaces will be covered with Zone H (oxidised NAF), Zone G (oxidised NAF), and Zone F layers (oxidised and unoxidized NAF and PAF). A cross-section of TSF2 is provided as Figure 10 for reference.
- Adding oxygen traps (goose necks) to all leachate drains within the stockpiles to limit oxygen ingress and associated ongoing oxidation and AMD generation within the stockpiles.
- Compaction of surface material to reduce permeability and ingress of oxygen and water.
- Treatment with limestone in order to prevent the onset of acidification prior to permanent disposal.
- Limiting exposure time of PAF rock and disposal before on-set of oxidation.

Any PAF working surfaces will be regularly tested and limed. Extensive monitoring and geochemistry and water quality will be undertaken and reported to the council each year. This is subject to an annual peer review process.

Trace element leaching may also result from rock that is enriched in trace elements but where these trace elements are not associated with sulphides and may leach without the oxidation of sulphides. These rocks are defined as potential for trace element leaching (PTEL) and waste management practices give consideration to mitigating the potential adverse effects from this rock.

Methods 2 and 3 above are effective at controlling leaching of trace elements in this regard as neutral pH and reduced water flux both limit the leaching of trace elements. The same waste management practices can therefore be adopted for waste with potential for trace element leaching (PTEL).

The effectiveness of waste management practices for combined rock types that are PAF and PTEL is assessed by the column leaching tests which combine rock from both categories. These results are outlined in Section 4.4 and Appendix D.

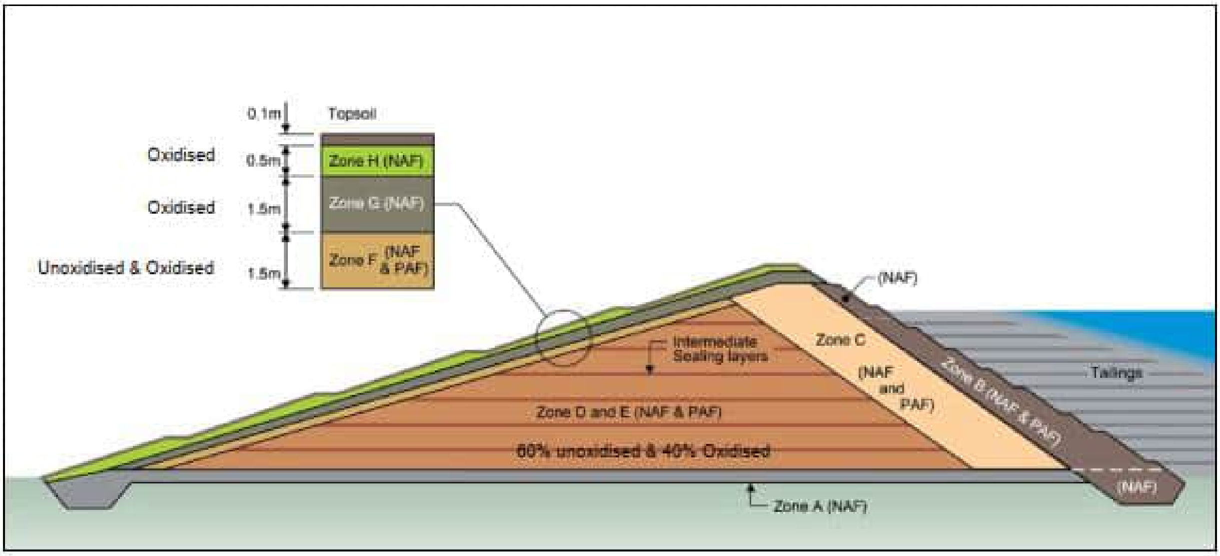


Figure 10 Cross-section of TSF2

6.1.1 Rock Management Strategy Philosophy for PAF Material

The rock management strategy for PAF material is based on current rock management practices adopted on site. The overriding philosophy is:

- The rock will likely be geochemically consistent with the materials produced by the current mining operations;
- Addition of limestone to PAF material may be required to create a lag in acid generation until rock is encapsulated within a permanent repository;
- The refinements to the management practices over the past decades are based on maintaining a pH of above 5.5 until final capping is complete to control the rate of sulphate release;
- Testing of the material prior to removal allows the limestone addition to be adjusted as necessary;
- Regular (monthly) PAF slurry testing and regular surface limestone application after placement have proven to be effective at managing the material prior to placement of subsequent layers or permanent cover; and,
- The current rock management practices are effective at controlling the mine rock materials and preventing acid rock drainage.

Gladstone Pit Rock Removal

The management strategy for PAF and PTEL rock sourced from the Gladstone pit component of the project is based on the following philosophy:

- Gladstone PAF rock will be placed in permanent repositories immediately following removal from the pit (ca. within a 10 week period);
- PTEL rock has been characterised based on mercury concentrations as other elevated trace elements (arsenic and selenium) are released as a function of sulphide oxidation and are therefore addressed by PAF rock management practices. A block model has been developed to enable management of waste based on mercury concentrations.
- Addition of limestone to Gladstone PAF material will be required to create a lag in acid generation until rock is encapsulated within a permanent repository and this will be introduced by layering limestone over compacted lifts of high PAF rock;
- Alternatively, if the high sulphur (>3%), low ANC (<2 kg H_2SO_4 per tonne) component of this Gladstone PAF material can practically be delineated and separated during mining, then immediate placement and compaction of this material with limestone amendment would enable the

remaining Gladstone PAF to be managed in the same manner as the PAF from the wider Waihi North Project;

- Low capacity PAF (NAG pH<4.5, NAPP<10 kg H_2SO_4/t) and PTEL (Hg>3.5 mg/kg) material from the Gladstone pit can be managed in the same manner as PAF from the wider Waihi North Project;
- Regular (monthly) PAF slurry testing and regular surface limestone application after placement have proven to be effective at managing material prior to placement of a permanent cover. This frequency of testing is considered adequate for the more reactive Gladstone PAF rock based kinetic testing.

Gladstone Pit PAF Rock Backfill

For PAF rock being deposited into the Gladstone Pit, the following philosophy applies:

- PAF rock will be placed in lifts within the Gladstone pit. Limestone addition will be required to introduce a buffer to acidity from the exposed pit walls;
- PAF rock placed in the base of the pit will be placed and compacted in order to limit oxidation. The base of the pit refers to material placed below the Gladstone TSF liner;
- The application of limestone (by spreading on each placed lift) may be required at the base of the pit as it is progressively backfilled. This will depend on the rate of back filling and hence exposure period of the placed rock and the specific acid forming characteristics of the material deposited; and
- Regular (monthly) PAF slurry testing and regular surface limestone application after placement have proven to be effective at managing material.

6.2 RTSA Temporary Disposal and WRS

While OGNZL prefers to place PAF rock directly into the permanent repositories, there are times of the year (generally during the winter) when that is not possible, and the material needs to be stored temporarily prior to permanent placement. It is proposed that only material from the MOP4, MUG and WUG (due to the higher acid neutralising capacity and different physical properties compared to the Gladstone Pit material) is stored in temporary repositories.

Sulphate generation rates for rock from MOP4 and MUG have been conservatively estimated by utilising the adopted static geochemical results from the Martha Phase 4 cutback and kinetic testing of Martha rock collected within the open Martha Pit.

The adopted values for the PAF rock from Martha operations to determine limestone dosing rates are as follows:

- NAPP mean of 48 kg H_2SO_4/t and a 95% Upper Confidence Limit (UCL) of 84 kg H_2SO_4/t.
- Sulphate Generation Rate mean of 27 mg SO_4/kg/day and a 95% UCL of 47 mg SO_4/kg/day.

6.2.1 WRS Construction

Underdrainage will comprise a rock drain (permeable gravel/boulder zone infilling the base of the gully) to direct seepage into the small pond at the toe of the WRS. All seepage from the toe of the WRS will be directed to the pond at the toe and then directed to the water treatment plant. Surface runoff from the surface of the WRS will also be directed to the water treatment plant. The application is structured so that the water treatment plant will operate until an acceptable discharge water quality is achieved.

The likely timeframe for improvement in water quality is estimated to be comparable to the TSF where oxidation during construction mobilises sulphate and associated trace elements, and once capped and the residual oxygen is consumed the water quality improves.

6.2.2 Limestone Dosing Requirements

The limestone amendment required for PAF rock placed within the temporary stockpiles at the RTSA and the WRS will be dependent upon the results of testing of the material prior to it leaving the open pit or WUG. Current operational practises see daily testing of the rock for NAG pH and NAPP. Depending on the results, material is then classified as PAF or NAF, a limestone amendment rate is calculated, and the application rate is adjusted accordingly. These same practices are proposed for calculating limestone amendment rates for rock produced by the WUG and placed within the WRS.

The WRS is a temporary repository for material that will ultimately be used as backfill during the mining operation. Segregation of PAF/NAF is not proposed with effects of AMD being controlled by capture and treatment of runoff.

As with other stockpiles at the site, the generation of AMD can be managed with limestone amendment as required to provide lag for the duration lifts are exposed. The nature of placement and compaction of lifts of material will provide some limitation of ongoing oxidation of sulphide at depth within the waste rock stockpile. Limestone amendment of outer faces that will be in place for the duration that the stockpile is operating can be implemented either during construction and/or following placement as required.

PAF rock placed in temporary storage structures should not be left exposed for a period of more than 30 weeks. This PAF rock should be blended with crushed limestone at a rate designed to provide a lag period appropriate to mitigate generation of AMD for a 30 week period (Table 8).

Monitoring of placed rock will ensure these dosing rates are appropriate and enable refinement as part of ongoing operations. The dosing rate given in Table 8 is considered conservative based on the assumptions outlined in Section 6.2.3.

Table 8 Martha PAF rock Limestone Dosing Requirements – Short Term Exposure

Item	Mean	95% UCL
NAPP (kg H_2SO_4/tonne)	48	84
Adopted Sulphate Generation Rate (kg SO_4/tonne/day)	0.027	0.047
Limestone Dosing Requirement (kg $CaCO_3$/tonne rock) (for 210 day lag)	2.3	4.0
Limestone Amendment Rate	0.2 %	0.4 %

6.2.3 Key Assumptions

The calculated limestone dosage rates given in Table 8 are considered to provide a high degree of conservatism in that it is assumed that all sulphur is present as acid generating pyrite (FeS_2), with no allowance for other sulphide minerals that do not generate equivalent acidity, such as sphalerite. In addition, the use of a 95th UCL NAPP provides a degree of conservatism that on average, the given dosing rate requirement should provide sufficient excess limestone to account for any variation encountered. The mean values given are considered to be more realistic over the entire mass of rock, however the 95th UCL derived dosing rates are considered a worst-case scenario and may be required periodically when high PAF material is being extracted from Martha or WUG and stored within the RTSA or WRS respectively.

Refinement of the predicted dosage rates for rock will be undertaken as additional information from routine monitoring becomes available. Specific information requirements to allow such a review may include the period of exposure and changes in NAPP values outside the initial values adopted.

The key assumptions used in assessing and calculating the amendment requirements are as follows:

- That collected static data and calculated NAPP (based on the mean and 95th UCL of the Martha dataset) is representative of the mass of the PAF rock material to be excavated as part of Waihi North Project.
- PAF rock used within the kinetic column tests is representative of rock from the proposed mining areas (with calculated sulphate generation rates proportional to calculated NAPP values).
- No scaling factors have been applied to the sulphate generation rates calculated from the column leachate tests. This is considered a conservative assumption as it does not take into account likely differences in porosity and particle size distribution.

No inherent lag within the PAF rock material has been taken into account and it is assumed that sulphides within rock will oxidise immediately upon removal. This is considered a conservative approach as it is likely an inherent lag period will exist within the PAF rock.

6.3 Permanent Rock Disposal

A large quantity of PAF rock material sourced from both the Martha and Gladstone Pits is assumed to be stored permanently within the proposed NRS. Material will also be utilised within the embankment of the TSF. The PAF rock from Wharekirauponga will be placed in a storage area at Willows Farm prior to placement as backfill within the WUG.

Disposal of PAF rock to the NRS and TSF embankments will be undertaken in a manner that will limit the rate of oxygen ingress and limit the potential of the material producing acidity until consecutively placed material (on top) will remove the underlying material from oxygen exposure.

It is proposed that no limestone amendment will be required for:

- Gladstone PAF material likely to be exposed for a period of less than 10 weeks
- Martha and WUG PAF material likely to be exposed for a period of less than 30 weeks.

This difference is due to the greater natural lag in the Martha material, which contains higher ANC than the Gladstone rock material (refer Section 4.2). The WUG rock is inferred to have a comparable lag to Martha PAF rock which will be further verified by ongoing column testing. Lime amendment rates for WUG are therefore expected to be comparable to Martha PAF rock material which will be confirmed by column testing results.

For material likely to be exposed for a period of greater than its defined natural lag period, it is recommended that limestone be either blended (via conveyor during transport to the RTSA) or applied atop the placed rock prior to compaction in order to introduce alkalinity via infiltrating rainfall into the backfill/embankments.

It is proposed that limestone spreading is based on current site management practises, where regular (monthly) slurry testing and regular surface limestone application is undertaken. However, it is proposed that the amendment rate is adjusted to account for the required lag period (the period from placement and being outside of the zone of oxidation). This rate of amendment should be related to the sulphur % of the rock material, the NAG pH and the required lag period.

For illustration, Table 9 shows an example where rock material with ABA characteristics as per the average and 95% UCL Martha and Gladstone Rock material (Appendix A) is placed and compacted and left uncovered for a period of 210 days. The calculated amendment rates of between 0.2 and 1.7 % are conservatively recommended in order to extend the lag period to the required 210 day period.

Table 9 Limestone Requirements for Permanent Disposal

Item	Mean (Martha & WUG)	95% UCL (Martha & WUG)	Mean (Gladstone)	95% UCL (Gladstone)
NAPP (kg H_2SO_4/tonne)	48	84	85	110
Assumed lag (days) – from ANC	140	140	70	70
Required lag (days)	210	210	210	210
Sulphate generation rate (mg/SO4/kg/day)	27		49	
Limestone Dosing Requirement (kg $CaCO_3$/tonne rock) (for 210 day lag)	2.3	4.0	13.3	17.2
Limestone Amendment Rate	0.2 %	0.4 %	1.3 %	1.7 %

Rock placed within the zone of oxidation for the final proposed landforms (typically within the final 2 m of directly placed materials) should comprise NAF material only, as has been the practice throughout the life of mine to date.

6.3.1 NRS Construction

Cover design for the NRS will be consistent with the TSF embankments which have been in operation for over 30 years. This includes progressive and final rehabilitation of outer surfaces with Zone H, Zone G, and Zone F layers which limit oxygen and water ingress. Any PAF working surfaces are regularly tested and limed.

6.3.2 NRS and Embankment Seepage Water Quality

Predicted NRS and TSF embankment leachate water quality has been calculated using the following steps:

- Gladstone Rock sample leachate concentrations from both the compacted and limestone blended column have been summarised in Appendix D. Both columns consist of Gladstone material with a NAPP of 103 kg H_2SO_4/t. The mean Gladstone NAPP is 95 kg H_2SO_4/t; the SGR based on kinetic test for Gladstone PAF rock is 49 mg SO_4/kg/day.
- During the life of the current proposed mining including MUG, MOP4, WUG and Gladstone, PAF rock from Gladstone is expected to comprise in the order of 62% of the total PAF rock that could be placed in TSF embankments or the NRS. The predicted PAF seepage from the NRS and TSF embankment is therefore assessed by mixing predicted seepage from the Gladstone and Martha in this 0.62 to 0.38 proportion.
- The NRS could include rock from the WUG development tunnel close to the current process plant. This rock is expected to have a comparable composition to existing Favona, Trio and Correnso underground developments and is not included in the above proportions.
- Summarised data from the columns include data only up to a point where the lag (whether it is natural, in the case of the compacted column, or added as in the case on the limestone blended column) is exhausted. This is defined as the point at which the leachate acidity reaches pH 3.0. Data reflective of the post-lag period is considered not reflective of actual as-built conditions.
- The modelled seepage is therefore derived using the following inputs:
    - Working Area (62%) - Gladstone PAF seepage based on average of limestone amended and compacted columns. The use of unscaled column leach data (NAPP of 103 kg H_2SO_4/t) is considered a conservative representation of the seepage from Gladstone PAF rock.
    - Working Area (38%) – MUG, MOP4 and WUG PAF rock seepage based on average of limestone amended and compacted columns factored by the difference in sulphate generation rates (SGR) between Gladstone and Martha from kinetic testing (SGR of 49 and 23 mg SO_4/kg/day respectively).
    - Rehabilitated areas – The combined Gladstone, MUG, MOP4 and WUG PAF rock factored by the reduction in sulphate generation rates achieved by capping and closure determined by Global SGR (GSGR) testing over the past two decades. The minimum GSGR for operating areas is 75 Kg SO_4 per ha per day and the average for rehabilitated areas is 5.5 Kg SO_4 per ha per day.
- Mixing of the solutions has been carried out at a range of ratios considered to reflect the maximum proportion of the working area to rehabilitated area (0.6 : 0.4) to a fully closed / rehabilitated area. (0 : 1).
- A mix of the two derived leachate concentrations has been undertaken in the geochemical modelling software PHREEQC Interactive version 3.6.2 utilising the Minteq.v4 (December 2021) database in order to equilibrate the predicted chemistry based on the oversaturation and secondary co-precipitation of various trace elements. The steps undertaken in PHREEQC are as follows:
    1. Equilibrate the mixed leachate solution to allow for precipitation of over saturated species.

2. Calculation of the number of hydrous ferric oxides (HFO) sites that are available within the rock material - assuming they are present as ferrihydrite, for the availability of sorption reactions. Sensitivity analysis around the number of available sites has been undertaken and these analyses are included in the summarised results.
3. Determine the influence of hydrous ferric oxides on the adsorption/desorption of trace elements. In this manner a new equilibrium between adsorbed and soluble trace elements can be modelled.

- Modelled results from the above process are then compared to TSF1A leachate data and where the above modelling indicates changes from the existing data, modelled results are adopted in Table 10.

Results of the modelling for both the development / construction and closed / rehabilitated stages are presented in Table 10.

The likely timeframe for improvement in water quality is estimated to be comparable to the TSF where oxidation during construction mobilises sulphate and associated trace elements and once capped and the residual oxygen is consumed, water quality improves.

In terms of surface water runoff from the completed areas of NRS, a number of the collection ponds (S3, S4 and S5) have consistently had water quality since 2014 that has allowed direct discharge of surface water. These ponds collect runoff from the TSF1a embankment.

Leachate drains, toe drains and subsoil drains are all collected and directed to the water treatment plant. This will continue until such time as water quality is acceptable for discharge. Passive treatment systems for these flows are not proposed as part of the current proposal but may be assessed in the future where flows and quality are amenable to this type of treatment.

Table 10 Predicted NRS / Embankment Leachate Water Quality

	DEVELOPMENT				CLOSURE		
	Min	Med	Max		Min	Med	Max
pH	*(5.5)* **4.5**	*(6.7)* **4.6**	*7.9*	pH	*(5.5)* **4.8**	*(6.7)* **6.9**	*7.9*
Ag	*0.0001*	*0.0002*	*0.0005*	Ag	*0.0001*	*0.0002*	*0.0005*
Al	*0.003*	*(0.006)* **12**	*(0.3)* **25**	Al	*0.003*	*(0.006)* **0.7**	*(0.3)* **1.4**
As	*0.001*	*0.002*	*(0.01)* **0.07**	As	*0.001*	*0.002*	*0.01*
Ba	*0.013*	*0.020*	*0.044*	Ba	*0.013*	*0.02*	*0.04*
Ca	*31*	*480*	*590*	Ca	*31*	*480*	*590*
Cd	*0.00005*	*(0.00012)* **0.007**	*(0.0019)* **0.012**	Cd	*0.00005*	*(0.00012)* **0.0005**	*0.002*
Co	*0.0002*	*(0.026)* **1.9**	*(0.175)* **3.0**	Co	*0.0002*	*(0.026)* **0.33**	*(0.175)* **0.60**
Cr	*0.0005*	*0.001*	*(0.003)* **0.13**	Cr	*0.0005*	*0.001*	*0.003*
Cu	*0.0005*	*(0.001)* **0.027**	*(0.003)* **0.36**	Cu	*0.0005*	*(0.001)* **0.008**	*(0.003)* **0.009**
Fe	*0.02*	*(0.07)* **300**	*(7.3)* **470**	Fe	*0.02*	*(0.07)* **90**	*(7.3)* **120**
Hg	*0.00008*	*(0.00008)* **0.0001**	*0.0005*	Hg	*0.00008*	*(0.00008)* **0.00011**	*0.00047*
K	*4*	*14*	*22*	K	*4*	*14*	*22*
Mg	*15.4*	*115*	*280*	Mg	*15.4*	*115*	*280*
Mn	*0.3*	*15*	*61*	Mn	*0.3*	*15*	*61*
Na	*12*	*37*	*101*	Na	*12*	*37*	*101*
Ni	*0.003*	*(0.063)* **0.78**	*(0.5)* **1.4**	Ni	*0.003*	*0.063*	*0.5*
Pb	*0.0001*	*(0.0002)* **0.002**	*(0.0007)* **0.005**	Pb	*0.0001*	*0.0002*	*0.0007*
SO_4	*198*	*1,440*	*2,400*	SO_4	*198*	*1,440*	*2400*
Sb	*0.00002*	*(0.0004)* **0.002**	*(0.0025)* **0.003**	Sb	*0.00002*	*(0.0025)* **0.0006**	*0.0025*
Se	*0.001*	*0.002*	*0.005*	Se	*0.001*	*0.002*	*0.005*
Zn	*0.003*	*(0.0425)* **1.2**	*(0.39)* **2.8**	Zn	*0.003*	*0.043*	*0.4*

Notes:
Bold denotes numbers based on modelling, italics denote TSF1A data, brackets denote TSF1A data for comparison.
Development modelling numbers are based on six scenarios.
Closure modelling numbers are based on two scenarios.
All concentrations reported in mg/L.

6.3.3 Permanent Rock Disposal to Gladstone Pit

The closure of Gladstone pit involves backfilling with approximately 5 Mt of rock placed and construction of a liner over this rock to enable tailings placement.

NAF/PAF rock material sourced from both Martha and the Gladstone Pit will be utilised to backfill the Gladstone Pit. Furthermore, the neutralisation capacity of NAF / low PAF material from the Martha together with amended limestone will introduce a buffer to acidity from the exposed pit walls.

The key mitigation measures for the placement of PAF rock within Gladstone Pit are as follows:

- For rock placed below GOP TSF liner material will be paddock dumped and spread and compacted in lifts in the order of 1m in height, lime amendment of these layers will be completed to provide lag to limit acid generation until subsequent lifts are placed and compaction via track rolling vehicle movement across each of these lifts.

- For rock above the GOP TSF liner the continued placement and encapsulation of material will be in the same manner as other RTSA permanent storage facilities.

The rate of limestone amendment for both the rock material is dependent on the required lag period.

Both saturation of the placed PAF rock and the sealing effect of the overlying liner and tailings will be highly effective long-term controls on oxidation of this material. The degree of oxidation during filling will therefore be the primary factor influencing the post closure water quality within this fill.

As the rate of material placement and hence burial beneath the oxidation zone will vary, the lag of placed rock will need to be adequate to limit oxidation of material for this time. The working lift of placed PAF rock material will be compacted to limit oxidation. The lag required will depend on the rate of infilling, the compacted nature of the PAF material after successive lifts of rock are placed, and the time period until the material is either saturated from groundwater recharge or at a sufficient depth below the active surface to limit oxygen ingress.

Groundwater recharge in the pit is expected to take an extended period from when underground mining and dewatering cease. This includes a period of approximately 3.5 years to fill the underground voids and an additional 6 years for recharge from base of pit to natural groundwater levels.

It is therefore expected that low permeability layers created from rock placement in lifts with compaction and depth below the active surface will be the primary control on oxidation and hence porewater quality in the short term (during backfilling and prior to tailings placement). Based on oxygen probes in existing TSF embankments the effective depth of oxidation in uncovered PAF rock is likely to be in the order of 8m (SRK, 2011). A conservative average period of exposure for limestone amendment has therefore been estimated based on the maximum duration that any placed rock will be within 8m from the active filling surface.

The majority of the GOP rock backfill is placed in a period of less than 2 years beneath the 13 ha lined area. Based on the rate of backfilling and the assumed 8 m oxidation profile, Table 11 and Table 12 show the lag required for PAF material during backfilling of the Gladstone pit in the rock placed immediately beneath TSF Liner would be in the order of 250 days.

Table 11 Martha Rock Acidity Neutralisation Requirements

Year (of backfilling)	Total lag Required (days)	Additional lag required	Limestone Amendment Rate (Mean NAPP)	Limestone Amendment Rate (95% UCL NAPP)
1	70	-	-	
2	250	110	0.4%	0.6%

Table 12 Gladstone Rock Acidity Neutralisation Requirements

Year (of backfilling)	Total lag Required (days)	Additional lag required	Limestone Amendment Rate (Mean NAPP)	Limestone Amendment Rate (95% UCL NAPP)
1	70	-	-	-
2	250	180	1.0%	1.4%

The calculated exposure period and hence required limestone amendment increases rapidly in year 2 of backfilling. This is due to the increased timeframe for placed lifts of waste to achieve a depth of 8 metres from the active placement as a result of the greater base pit surface area relative to the volume being deposited.

It is also noted that while Gladstone PAF rock could be placed in the base of the pit in year 1 of backfilling without limestone amendment, the inability to stockpile the material limits the volume that could be placed in this manner to material that could be placed and compacted within the 70 days lag period.

Additional limestone requirements for the neutralisation of acidity produced from the pit walls during backfilling have also been calculated, based on variables outlined in Table 13.

Table 13 Pit Wall Acidity Neutralisation Requirements

Item	Value
NAPP (95% UCL Gladstone Rock)	110 kg H_2SO_4/tonne
Adopted oxygen ingress depth	0.1 m
PAF Pit Wall Area	136,050 m^2
Limestone required to fully neutralise acidity	112 kg $CaCO_3$/tonne
Pit wall neutralisation requirements	3,500 tonne $CaCO_3$
Volume of Gladstone Backfill	2,619,260 m^3
Limestone amendment rate for pitwall neutralisation	<0.1%

Due to the volume of material being backfilled into the pit and the limited oxygen ingress into the pit walls, the actual calculated amendment rate (to account for this acidity) is proportionally small. It is therefore recommended that additional limestone addition to account for the pit wall oxidation is adequately provided for by the calculated neutralisation requirements conservatively estimated for backfill lag extension.

Notwithstanding the values and assumptions provided, the key assumptions used in assessing and calculating the amendment requirements are as follows:

- That all PAF rock placed has NAPP characteristics reflective of the mean and 95% UCL figures given.
- PAF rock used within the column tests is representative of rock from the proposed mining areas (with calculated sulphate generation rates proportional to calculated NAPP values).
- No scaling factors have been applied to the sulphate generation rates calculated from the column leachate tests. This is considered a conservative assumption as it does not take into account likely differences in porosity and particle size distribution.
- That exposure periods given are conservative based on the backfilling schedule, the rate of perched water saturation and assumed oxidation depth.
- For pit wall acidity, it is assumed that exposed PAF material has a NAPP value based on the Gladstone rock of 95% UCL of 110 kg H_2SO_4/t. This is considered conservative.

6.3.4 Placement and Compaction of Rock

Disposal of rock via placement and compaction within Gladstone Pit (and within TSF3 embankment and the NRS) will be undertaken in a manner that will limit the rate of oxygen ingress and limit the potential of the material producing acidity until consecutively placed material (on top) is of sufficient thickness to prevent ongoing oxidation.

Requirements for limestone amendment, required lag and derivation of the dosing rate for PAF are as outlined in this Section (Section 6.0) for other permanent repositories.

For material sourced from Gladstone Pit it is recommended that limestone spreading be applied atop the placed layer and then compacted in order to introduce alkalinity (via infiltrating rainfall) into the material and to extend the natural lag of the PAF rock after placement. Alternatively, for material sourced from Martha, this material should be blended on the conveyor at the appropriate rate before placement and compaction within the pit.

It is proposed that limestone spreading is based on current site management practises, where regular (monthly) slurry testing and regular surface limestone application is undertaken. However, it is proposed that the amendment rate be adjusted to account for the required lag period (the period from placement and being outside of the zone of oxidation). This rate of amendment should be related to the sulphur % of the rock material, the NAG pH, the classification of the material based on the sulphur % and the NAG pH, and the required lag period.

For illustration, Table 14 and Table 15 show examples where PAF rock material with ABA characteristics as per the mean and 95% UCL of Martha and Gladstone rock respectively are placed and compacted and left uncovered for a period of 210 days. A calculated amendment rate of between 0.2% and 1.7% is conservatively recommended in order to extend the lag period assuming a 2 m oxygen profile is present.

Table 14 Martha Compacted Rock - Acidity Neutralisation Requirements

Total lag Required (days)	Additional lag required	Limestone Amendment Rate (Mean NAPP)	Limestone Amendment Rate (95% UCL NAPP)
210	70	0.2 %	0.4 %

Table 15 Gladstone Compacted Rock - Acidity Neutralisation Requirements

Total lag Required (days)	Additional lag required	Limestone Amendment Rate (Mean NAPP)	Limestone Amendment Rate (95% UCL NAPP)
210	140	1.3 %	1.7 %

Rock placed within the zone of oxidation for the final proposed landforms (typically within the final 2 m of directly placed materials) should comprise NAF material only.

6.3.5 Estimated Backfill Rock Porewater Quality

As discussed, rock will be placed in a manner to limit oxidation (refer Section 6.3.4) and appropriate limestone amendment will be carried out to extend the lag period where deemed necessary. With these control measures in place, a limited volume of oxidation is expected to occur within the backfilled material. Oxidation products will nevertheless be evident in porewater and hence a small volume may become evident in groundwater within the immediate vicinity of the backfilled Gladstone Pit.

Porewater quality associated with rock has been calculated using the following steps:

- Leachate concentrations from field columns has been assessed and summarised for likely pore fluid composition and concentration (Appendix D). The limestone blended and compacted columns are used for the assessment of post closure backfill water quality. These columns utilise high sulphur Gladstone material and replicate proposed placement methods (limestone blended/loose placement) and compacted placement. Long term post closure porewater quality also considers the saturated column water data to assess effects of groundwater saturating the backfill.
- This summarised leachate data has then been analysed in the geochemical modelling software PHREEQC Interactive version 3.6.2 utilising the Minteq.v4 database in order to equilibrate the predicted chemistry based on the oversaturation and secondary co-precipitation of various trace elements. The steps undertaken in PHREEQC are as follows:
    1. Equilibrate leachate from the column tests with a range of minerals that typically influence the solubility of the various contaminants of concern. The minerals considered include sulphides, hydroxides, carbonates and sulphates.
    2. Determine the influence of changing groundwater conditions on the adsorption/desorption of trace elements to iron oxy-hydroxides or hydrous ferric oxides (HFO). The insoluble iron mass from over saturation is assumed to be present as iron hydroxides and is provided for sorption reactions. In this manner a new equilibrium between adsorbed and soluble trace elements can be modelled.
    3. Modelled results from the above process are then compared to TSF1A leachate data and where the above modelling indicates changes from the existing data, modelled results are adopted in Table 16.

Modelled porewater quality is considered to reflect the range of porewater chemistry that would be expected to occur within the backfilled Gladstone Pit upon backfilling. Localised differences are expected, with the result of the variability of waste rock material, the degree of oxidation, the presence of neutralising minerals and the availability of iron hydroxide minerals for adsorption of trace elements.

The range of predicted contaminant concentrations is summarised in (Table 16).

Trace element concentrations vary considerably depending on the assumptions around adsorption sites, whether limestone is present (solution is equilibrated against calcite or not) and the assumed non-equilibrated porewater concentration.

Concentrations are expected to be diluted considerably outside of the pit area with the natural groundwater. The degree of dilution will depend on the distance from the pit and it is expected that a high degree of attenuation through additional adsorption will occur.

Table 16 Gladstone Pit Porewater Quality

Parameter	Post Closure			Long Term		
	Min	Median	95 Percentile	Min	Median	95 Percentile
pH	3.83	5.6	7.9	3.83	6.7	7.9
Al	0.003	6.9	22	0.003	0.9	2.1
As	0.0001	0.0016	0.01	0.0001	0.0013	0.1
Ba	0.01	0.015	0.04	0.01	0.01	0.04
Ca	31	312	590	31	540	630
Cd	<0.00005	0.007	0.01	<0.00005	0.002	0.01
Co	0.0002	3.4	4.5	0.0002	0.57	4.3
Cr	< 0.0001	0.003	0.04	< 0.0001	0.0005	0.003
Cu	0.0005	0.09	2.0	0.0005	0.0005	0.3
Fe	0.02	325	435	0.02	30	430
Hg	0.00008	0.0001	0.0005	0.00008	0.00019	0.0005
K	4	20	30	4	20	46
Mg	15	50	280	15	70	280
Mn	0.3	8.1	61	0.3	8.9	61
Mo	0.0002	0.0003	0.001	0.0002	0.0002	0.001
Na	12	240	750	12	140	750
Ni	0.003	1.3	2.9	0.003	0.26	1.7
Pb	0.0001	0.0001	0.0007	0.0001	0.0001	0.0007
SO_4	200	2400	2,800	200	1600	2700
Sb	0.0002	0.003	0.004	0.0002	0.0004	0.004
Se	0.001	0.002	0.02	0.001	0.002	0.01
Zn	0.003	2.9	4.4	0.003	0.05	1.5

All concentrations reported in mg/ except pH.

6.4 Estimated WUG Underground Water Quality

A highly conservative worst-case assessment of groundwater quality within voids of the saturated backfill (porewater) in the WUG mine post closure is determined using the following approach:

- The backfilled mine is flooded with groundwater of a composition comparable to the existing groundwater quality within the vein system; and,
- The total oxidised mass of sulphate and associated trace elements (determined based on their individual molar ratios to the amount of oxidised sulphur) within the waste rock is dissolved within the total volume of the initial porewater within the waste rock backfill of the underground mine. This is calculated from sulphate generation rates from the WUG columns.

Table 17 includes the worst case backfill water quality predictions determined by this method in square brackets. The acid sulphate generation rates estimated for the waste rock stockpile and the underground mine are such that the chemistry of mine water is likely to be limited by solubilities of the species present rather than the available mass of constituents produced by sulphide oxidation of the waste rock. Concentrations calculated on the basis of the oxidised mass of contaminants as described above are therefore theoretical estimates of worst-case groundwater quality within the backfill. In addition, these estimates are unlikely to be in geochemical equilibrium depending on pH and redox conditions, which are present in the underground mine post mining.

Table 17 summarises the existing groundwater quality within the WUG system, and for comparative purposes includes the pre mining chemistry of samples collected from the Waihi No.7 Shaft. The water chemistry for the Waihi No.7 Shaft was evaluated using PHREEQC, , based on equilibrium chemistry of aqueous solutions interacting with minerals, gases, solid solutions, exchangers, and sorption surfaces. It is estimated from PHREEQC modelling that the water within the Waihi No 7 Shaft at 206.5 m depth was at equilibrium with iron species at an Eh of approximately –320 mV.

It is assumed for the purposes of modelling that similar redox conditions would develop within the WUG Mine. Geochemical modelling of these chemistries allowing for precipitation of oversaturated species and adsorption is included in Table 17 as best estimates of backfill porewater quality post closure (values not in brackets). The PHREEQC model used the worst-case predictions referred to above as inputs for a range of scenarios including the following: ·

- simulating iron oxy hydroxides precipitation to achieve equilibrium with mineral phases such as goethite ($FeOOH$), lepidocrocite ($FeOOH$) or ferrihydrite ($Fe(OH)3$);
- simulating equilibrium with carbonate species using the mineral phase calcite to account for the dissolution of carbonate species associated with the residual acid neutralising capacity within the waste rock;
- simulating equilibrium with sulphate species using the mineral phases gypsum or anhydrite to account for the precipitate of oversaturated sulphate species which are present;
- simulating adsorption of trace elements present in the resultant solution onto hydrous ferric oxides surfaces using a two layer model with no diffuse layer (Dzombak and Morel, 1990); and,
- in all scenarios it was ensured that the redox conditions remained at or about the value determined for the Waihi No.7 Shaft (-320 mV).

The values presented in Table 17 reflect the range of predicted concentrations determined for the above simulations.

Under strongly reducing conditions and with adequate residence time it is possible that precipitation of sulphides species will occur within the saturated backfill. In the event that these conditions do develop, extremely low levels of trace elements would be expected within groundwater.

An assessment of movement of WUG Underground Water Quality beyond the WUG domain has been completed and is included in **Appendix H**.

Table 17 Existing Groundwater Quality Within the WUG System

Parameter	Existing WUG Groundwater			Waihi No.7 Shaft Premining		Predicted Favona Backfill Water Quality	
				1984			
	Min	Median	Max	84.5 m depth	206.5 m depth	Unmitigated	Mitigated
pH(pH units)	5.2	6.3	7.4	6.5	6.9	6.9 [3.2]	7.3 [5.5]
Alkalinity - Total (g/m3 as CaCO3)	3.7	32.5	300	-	-	-	-
Sulphate(g/m3)	5	7.5	200	550	1200	1020	500
Aluminium-Dissolved(g/m3)	0.003	0.011	0.62	-	-	0.001 [55]	0.001 [27]
Arsenic-Dissolved(g/m3)	0.001	0.00135	0.035	0.017	0.05	0.12 [6.4]	0.04 [3.1]
Antimony-Dissolved(g/m3)	0.0002	0.0002	0.0045	-	-	0.001	0.0004
Calcium-Dissolved(g/m3)	0.36	6.8	121	545	391	320 [48]	170 [23]
Cadmium-Dissolved(g/m3)	0.00005	0.00005	0.00005	-	-	-	-
Copper-Dissolved(g/m3)	0.0005	0.0009	0.011	< 0.001	< 0.001	1.1	0.55
Iron-Dissolved(g/m3)	0.02	0.295	24	7.9	11.3	150 [180]	38 [90]
Magnesium-Dissolved(g/m3)	0.57	1.535	17.2	67	172	31	15
Manganese-Dissolved(g/m3)	0.004	0.2595	1.24	18.2	21	-	-
Lead-Dissolved(g/m3)	0.0001	0.0001	0.0034	< 0.005	< 0.005	0.0001 [0.001]	0.0001 [0.0003]
Nickel-Dissolved(g/m3)	0.0005	0.0024	0.0173	-	-	0.09 [0.15]	0.01 [0.07]
Potassium-Dissolved(g/m3)	1.1	5	14.3	11	14.1	14.2	7
Sodium-Dissolved(g/m3)	5.7	9.2	70	26	49.7	8.4	4
Zinc-Dissolved(g/m3)	0.0022	0.0144	1.09	1.32	0.4	1.8 [3.7]	1.8

Note: The values in brackets represent the worst case backfill water quality predictions

7.0 Mine Tailings and Tailings Management

7.1 Introduction

The tailings generated from the Waihi North Project will be deposited in the proposed TSF3 and the GOP TSF. Existing tailings solids and pore fluid data have been used for comparison with the geochemistry of the proposed mine tailings generated from the Waihi North Project.

Geochemical assessments involved the analysis of available ore geochemistry data for the existing mine operations and proposed mining areas, and a review of seepage and decant water quality within the existing tailings impoundments. These datasets were used to estimate tailings decant pond and seepage water quality for TSF3 and GOP TSF proposed as part of the Waihi North Project.

7.2 Laboratory Analytical Work

7.2.1 Statistical Analysis of Ore Geochemistry

The objective of the statistical analysis was to determine whether any significant variation exists between the ore chemistry at the proposed Gladstone Pit and WUG mine, and the ore being mined from the current and past operations.

Summarised results from the ore geochemistry testing (acid generating potential, major elements and trace elements) are provided in Table 18 (proposed GOP and WUG) and Table 19 (historical ore samples from Trio, Favona, Martha and Correnso).

Table 18 uses the geochemical abundance index (GARD guide), to identify those trace elements that may be present at elevated concentrations relative to a typical background (mean earth crust). The specific intention of this comparison being the identification of potential contaminants of interest which may differ from current tailings at the Waihi operations. Boxplots showing the relative concentration range of mercury, arsenic, antimony, copper, selenium and manganese within the Gladstone and Wharekirauponga ore material are shown in Figure to Figure .

In general, the acid generating potential of the ore from within the proposed GOP and the WUG is similar to that of historical mining areas. This includes:

- Mean sulphur concentrations in the Gladstone ore are higher than historical ore processed from Martha Pit but within the range of existing underground developments (Favona, Trio, Correnso).
- Mean sulphur concentrations in the Wharekirauponga ore are comparable to the historical mining operations.
- The Gladstone ore has low acid neutralising capacity relative to the historical mining operations.
- WUG ore has comparable acid neutralising capacity to the historical mining operations.

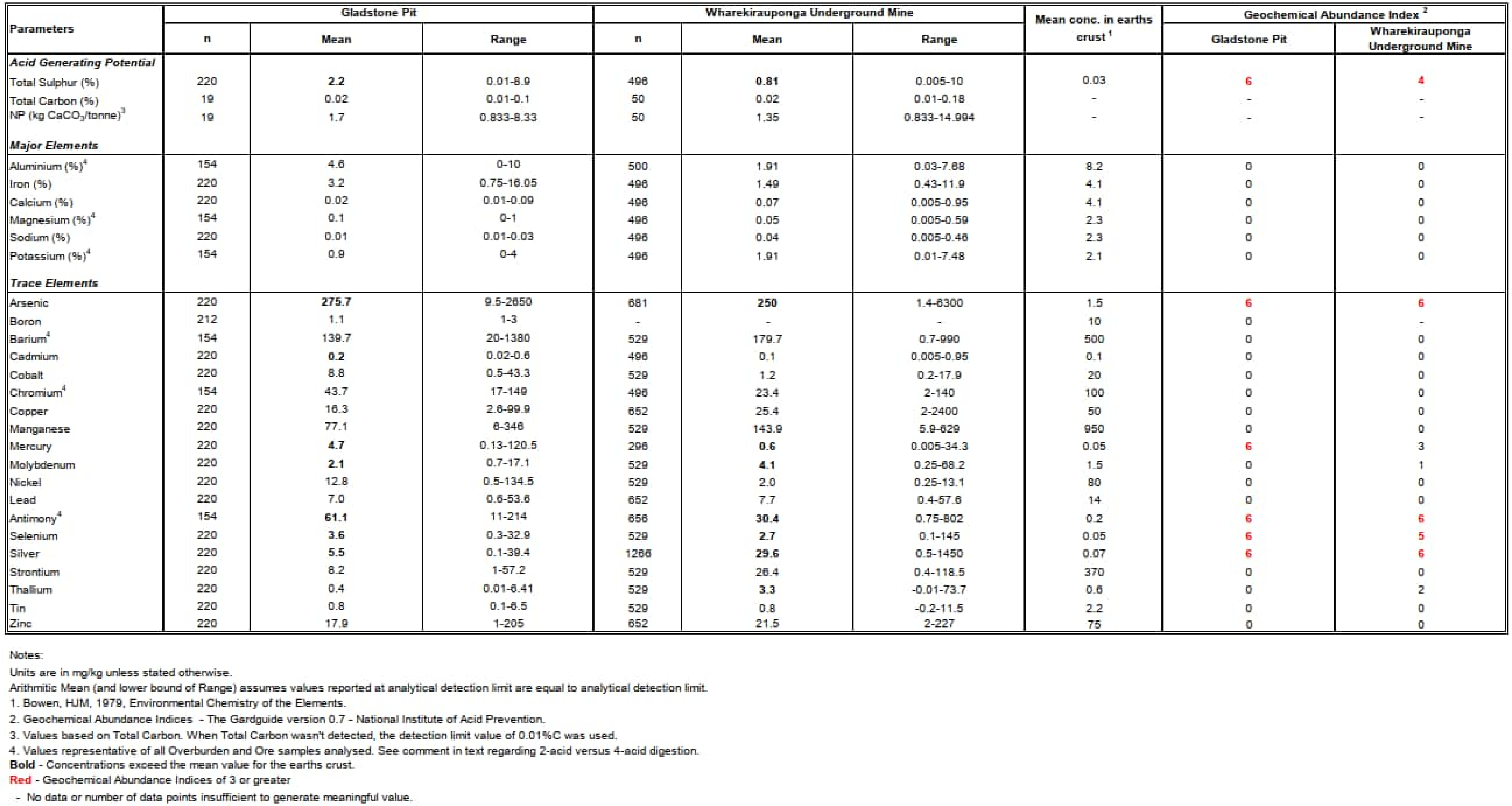
7.2.2 Tailings Leaching Potential

Table 18 indicates arsenic, manganese, mercury, antimony and selenium are enriched based on geochemical abundance indices. The following is noted for these trace elements with respect to ore from the existing mining operations:

- Arsenic concentrations in Gladstone and WUG ore show a similar concentration and distribution to historical ore with a slightly lower mean concentration in WUG ore.
- Antimony is elevated in Gladstone ore relative to historical data but is within a similar range in both datasets. WUG has slightly lower mean concentrations than historical ore with some outliers with elevated concentrations.
- Mercury is more elevated in Gladstone ore and is therefore the primary focus area with regard to management of mine tailings. WUG has comparable concentrations to historical ore.
- Manganese concentrations in Gladstone and WUG ore are lower than in historical ore.
- Mean selenium concentrations in Gladstone and WUG ore are comparable to historical ore.

- Mean copper, lead and zinc concentrations in Gladstone and WUG ore are generally lower than in historical ore.
- Gold and silver are extracted as part of mineral processing and assessment of GAI in ore is therefore not relevant. While silver has a consent compliance limit existing mine waters show that it is not elevated in TSF waters and leaching tests (Table 18) suggest the Gladstone and WUG ores will not result in any increase in dissolved concentrations.

Table 18 Summary of Geochemical Results for Gladstone Ore and Wharekirauponga Ore



Parameters	Gladstone Pit			Wharekirauponga Underground Mine			Mean conc. in earths crust [1]	Geochemical Abundance Index [2]	
	n	Mean	Range	n	Mean	Range		Gladstone Pit	Wharekirauponga Underground Mine
Acid Generating Potential									
Total Sulphur (%)	220	**2.2**	0.01-8.9	496	**0.81**	0.005-10	0.03	6	4
Total Carbon (%)	19	0.02	0.01-0.1	50	0.02	0.01-0.18	-	-	-
NP (kg $CaCO_3$/tonne)[3]	19	1.7	0.833-8.33	50	1.35	0.833-14.994	-	-	-
Major Elements									
Aluminium (%)[4]	154	4.6	0-10	500	1.91	0.03-7.68	8.2	0	0
Iron (%)	220	3.2	0.75-16.05	496	1.49	0.43-11.9	4.1	0	0
Calcium (%)	220	0.02	0.01-0.09	496	0.07	0.005-0.95	4.1	0	0
Magnesium (%)[4]	154	0.1	0-1	496	0.05	0.005-0.59	2.3	0	0
Sodium (%)	220	0.01	0.01-0.03	496	0.04	0.005-0.46	2.3	0	0
Potassium (%)[4]	154	0.9	0-4	496	1.91	0.01-7.48	2.1	0	0
Trace Elements									
Arsenic	220	**275.7**	9.5-2650	681	**250**	1.4-6300	1.5	6	6
Boron	212	1.1	1-3	-	-	-	10	0	-
Barium[4]	154	139.7	20-1380	529	179.7	0.7-990	500	0	0
Cadmium	220	**0.2**	0.02-0.6	496	0.1	0.005-0.95	0.1	0	0
Cobalt	220	8.8	0.5-43.3	529	1.2	0.2-17.9	20	0	0
Chromium[4]	154	43.7	17-149	496	23.4	2-140	100	0	0
Copper	220	16.3	2.6-99.9	652	25.4	2-2400	50	0	0
Manganese	220	77.1	6-346	529	143.9	5.9-629	950	0	0
Mercury	220	**4.7**	0.13-120.5	296	**0.6**	0.005-34.3	0.05	6	3
Molybdenum	220	**2.1**	0.7-17.1	529	**4.1**	0.25-68.2	1.5	0	1
Nickel	220	12.8	0.5-134.5	529	2.0	0.25-13.1	80	0	0
Lead	220	7.0	0.6-53.6	652	7.7	0.4-57.6	14	0	0
Antimony[4]	154	**61.1**	11-214	656	**30.4**	0.75-802	0.2	6	6
Selenium	220	**3.6**	0.3-32.9	529	**2.7**	0.1-145	0.05	6	5
Silver	220	**5.5**	0.1-39.4	1266	**29.6**	0.5-1450	0.07	6	6
Strontium	220	8.2	1-57.2	529	26.4	0.4-118.5	370	0	0
Thallium	220	0.4	0.01-6.41	529	**3.3**	-0.01-73.7	0.6	0	2
Tin	220	0.8	0.1-6.5	529	0.8	-0.2-11.5	2.2	0	0
Zinc	220	17.9	1-205	652	21.5	2-227	75	0	0

Notes:

Units are in mg/kg unless stated otherwise.

Arithmitic Mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.

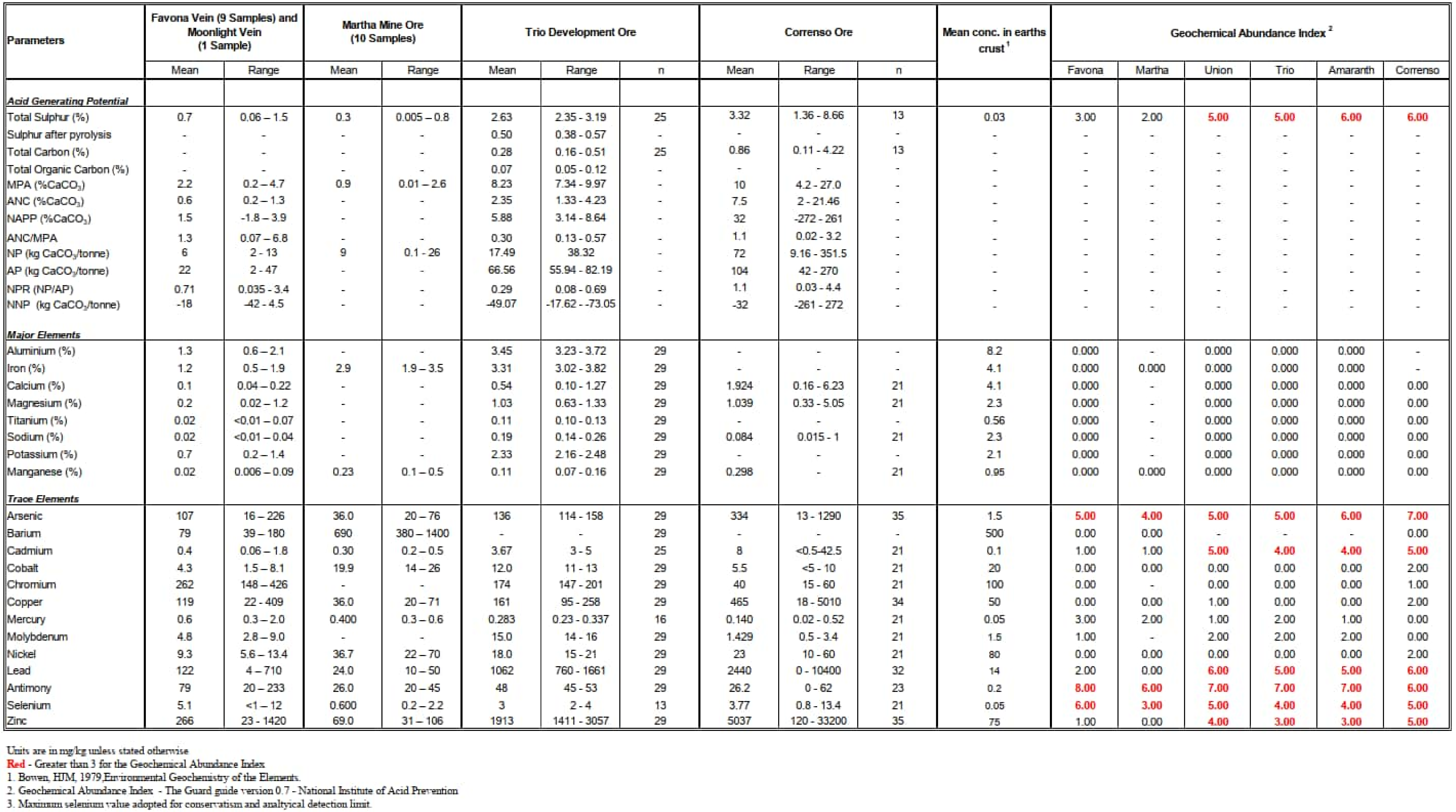
1. Bowen, HJM, 1979, Environmental Chemistry of the Elements.
2. Geochemical Abundance Indices – The Gardguide version 0.7 - National Institute of Acid Prevention.
3. Values based on Total Carbon. When Total Carbon wasn't detected, the detection limit value of 0.01%C was used.
4. Values representative of all Overburden and Ore samples analysed. See comment in text regarding 2-acid versus 4-acid digestion.

Bold - Concentrations exceed the mean value for the earths crust.

Red - Geochemical Abundance Indices of 3 or greater

\- No data or number of data points insufficient to generate meaningful value.

Table 19 Summary of Geochemical Results for Historic Ore



Parameters	Favona Vein (9 Samples) and Moonlight Vein (1 Sample)		Martha Mine Ore (10 Samples)		Trio Development Ore			Correnso Ore			Mean conc. in earths crust [1]	Geochemical Abundance Index [2]					
	Mean	Range	Mean	Range	Mean	Range	n	Mean	Range	n		Favona	Martha	Union	Trio	Amaranth	Correnso
Acid Generating Potential																	
Total Sulphur (%)	0.7	0.06 – 1.5	0.3	0.005 – 0.8	2.63	2.35 - 3.19	25	3.32	1.36 - 8.66	13	0.03	3.00	2.00	**5.00**	**5.00**	**6.00**	**6.00**
Sulphur after pyrolysis	-	-	-	-	0.50	0.38 - 0.57	-	-	-	-	-	-	-	-	-	-	-
Total Carbon (%)	-	-	-	-	0.28	0.16 - 0.51	25	0.86	0.11 - 4.22	13	-	-	-	-	-	-	-
Total Organic Carbon (%)	-	-	-	-	0.07	0.05 - 0.12	-	-	-	-	-	-	-	-	-	-	-
MPA (%$CaCO_3$)	2.2	0.2 – 4.7	0.9	0.01 – 2.6	8.23	7.34 - 9.97	-	10	4.2 - 27.0	-	-	-	-	-	-	-	-
ANC (%$CaCO_3$)	0.6	0.2 – 1.3	-	-	2.35	1.33 - 4.23	-	7.5	2 - 21.46	-	-	-	-	-	-	-	-
NAPP (%$CaCO_3$)	1.5	-1.8 – 3.9	-	-	5.88	3.14 - 8.64	-	32	-272 - 261	-	-	-	-	-	-	-	-
ANC/MPA	1.3	0.07 – 6.8	-	-	0.30	0.13 - 0.57	-	1.1	0.02 - 3.2	-	-	-	-	-	-	-	-
NP (kg $CaCO_3$/tonne)	6	2 - 13	9	0.1 - 26	17.49	38.32	-	72	9.16 - 351.5	-	-	-	-	-	-	-	-
AP (kg $CaCO_3$/tonne)	22	2 - 47	-	-	66.56	55.94 - 82.19	-	104	42 - 270	-	-	-	-	-	-	-	-
NPR (NP/AP)	0.71	0.035 - 3.4	-	-	0.29	0.08 - 0.69	-	1.1	0.03 - 4.4	-	-	-	-	-	-	-	-
NNP (kg $CaCO_3$/tonne)	-18	-42 - 4.5	-	-	-49.07	-17.62 - -73.05	-	-32	-261 - 272	-	-	-	-	-	-	-	-
Major Elements																	
Aluminium (%)	1.3	0.6 – 2.1	-	-	3.45	3.23 - 3.72	29	-	-	-	8.2	0.000	-	0.000	0.000	0.000	-
Iron (%)	1.2	0.5 – 1.9	2.9	1.9 – 3.5	3.31	3.02 - 3.82	29	-	-	-	4.1	0.000	0.000	0.000	0.000	0.000	-
Calcium (%)	0.1	0.04 – 0.22	-	-	0.54	0.10 - 1.27	29	1.924	0.16 - 6.23	21	4.1	0.000	-	0.000	0.000	0.000	0.00
Magnesium (%)	0.2	0.02 – 1.2	-	-	1.03	0.63 - 1.33	29	1.039	0.33 - 5.05	21	2.3	0.000	-	0.000	0.000	0.000	0.00
Titanium (%)	0.02	<0.01 – 0.07	-	-	0.11	0.10 - 0.13	29	-	-	-	0.56	0.000	-	0.000	0.000	0.000	0.00
Sodium (%)	0.02	<0.01 – 0.04	-	-	0.19	0.14 - 0.26	29	0.084	0.015 - 1	21	2.3	0.000	-	0.000	0.000	0.000	0.00
Potassium (%)	0.7	0.2 – 1.4	-	-	2.33	2.16 - 2.48	29	-	-	-	2.1	0.000	-	0.000	0.000	0.000	0.00
Manganese (%)	0.02	0.006 – 0.09	0.23	0.1 – 0.5	0.11	0.07 - 0.16	29	0.298	-	21	0.95	0.000	0.000	0.000	0.000	0.000	0.00
Trace Elements																	
Arsenic	107	16 – 226	36.0	20 – 76	136	114 - 158	29	334	13 - 1290	35	1.5	**5.00**	**4.00**	**5.00**	**5.00**	**6.00**	**7.00**
Barium	79	39 – 180	690	380 – 1400	-	-	29	-	-	-	500	0.00	0.00	-	-	-	0.00
Cadmium	0.4	0.06 – 1.8	0.30	0.2 – 0.5	3.67	3 - 5	25	8	<0.5-42.5	21	0.1	1.00	1.00	**5.00**	**4.00**	**4.00**	**5.00**
Cobalt	4.3	1.5 – 8.1	19.9	14 – 26	12.0	11 - 13	29	5.5	<5 - 10	21	20	0.00	0.00	0.00	0.00	0.00	2.00
Chromium	262	148 – 426	-	-	174	147 - 201	29	40	15 - 60	21	100	0.00	-	0.00	0.00	0.00	1.00
Copper	119	22 - 409	36.0	20 – 71	161	95 - 258	29	465	18 - 5010	34	50	0.00	0.00	1.00	0.00	0.00	2.00
Mercury	0.6	0.3 – 2.0	0.400	0.3 – 0.6	0.283	0.23 - 0.337	16	0.140	0.02 - 0.52	21	0.05	3.00	2.00	1.00	2.00	1.00	0.00
Molybdenum	4.8	2.8 – 9.0	-	-	15.0	14 - 16	29	1.429	0.5 - 3.4	21	1.5	1.00	-	2.00	2.00	2.00	0.00
Nickel	9.3	5.6 – 13.4	36.7	22 – 70	18.0	15 - 21	29	23	10 - 60	21	80	0.00	0.00	0.00	0.00	0.00	2.00
Lead	122	4 – 710	24.0	10 – 50	1062	760 - 1661	29	2440	0 - 10400	32	14	2.00	0.00	**6.00**	**5.00**	**5.00**	**6.00**
Antimony	79	20 – 233	26.0	20 – 45	48	45 - 53	29	26.2	0 - 62	23	0.2	**8.00**	**6.00**	**7.00**	**7.00**	**7.00**	**6.00**
Selenium	5.1	<1 – 12	0.600	0.2 – 2.2	3	2 - 4	13	3.77	0.8 - 13.4	21	0.05	**6.00**	**3.00**	**5.00**	**4.00**	**4.00**	**5.00**
Zinc	266	23 - 1420	69.0	31 – 106	1913	1411 - 3057	29	5037	120 - 33200	35	75	1.00	0.00	**4.00**	**3.00**	**3.00**	**5.00**

Units are in mg/kg unless stated otherwise

Red - Greater than 3 for the Geochemical Abundance Index

1. Bowen, HJM, 1979,Environmental Geochemistry of the Elements.
2. Geochemical Abundance Index - The Guard guide version 0.7 - National Institute of Acid Prevention
3. Maximum selenium value adopted for conservatism and analtyical detection limit.

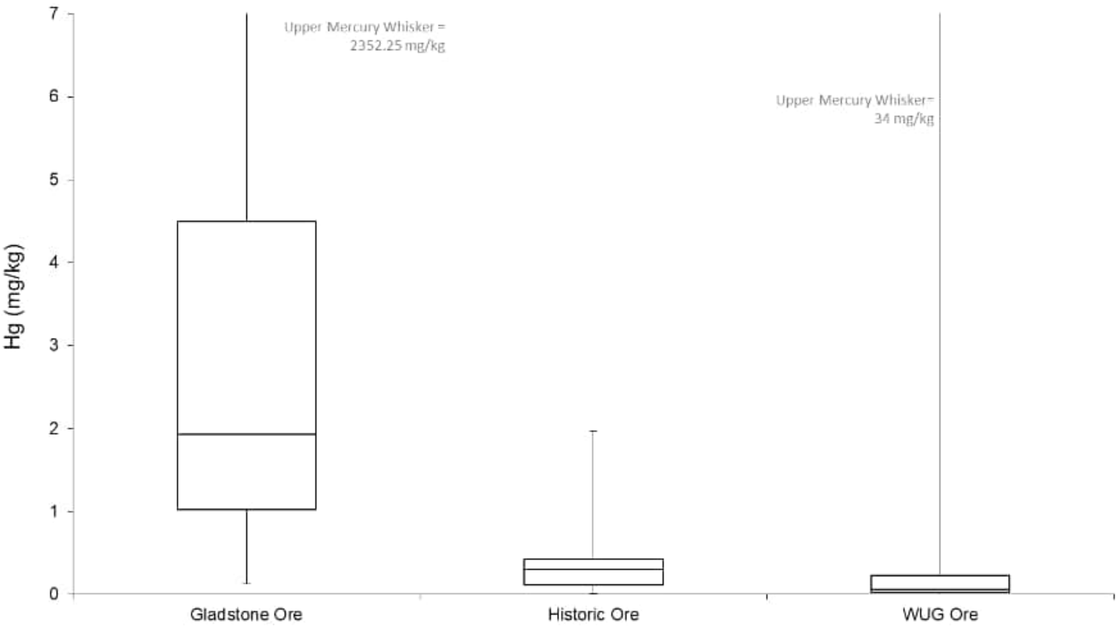


Figure 11. Box plot showing concentration range of Hg in ore material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

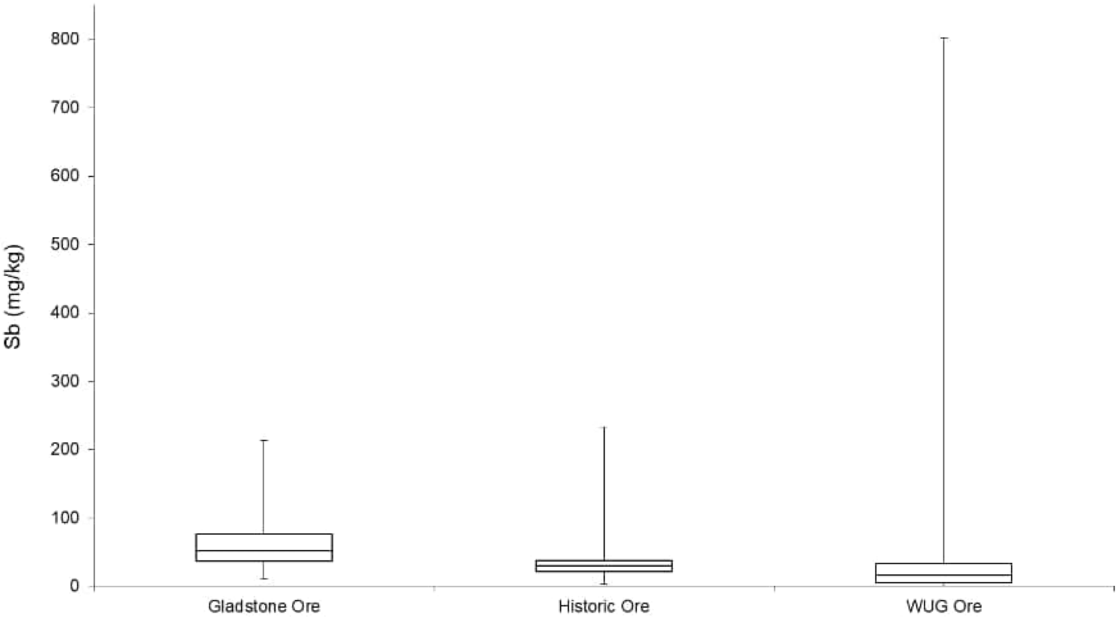


Figure 12. Box plot showing concentration range of Sb in ore material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

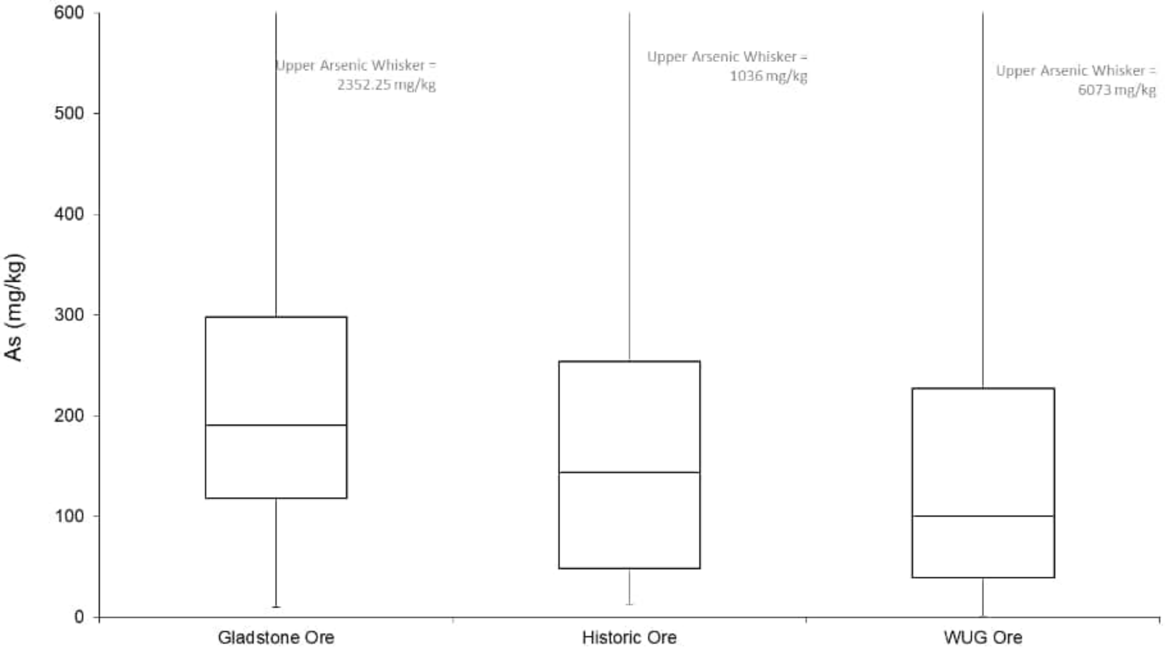


Figure 13. Box plot showing concentration range of As in ore material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

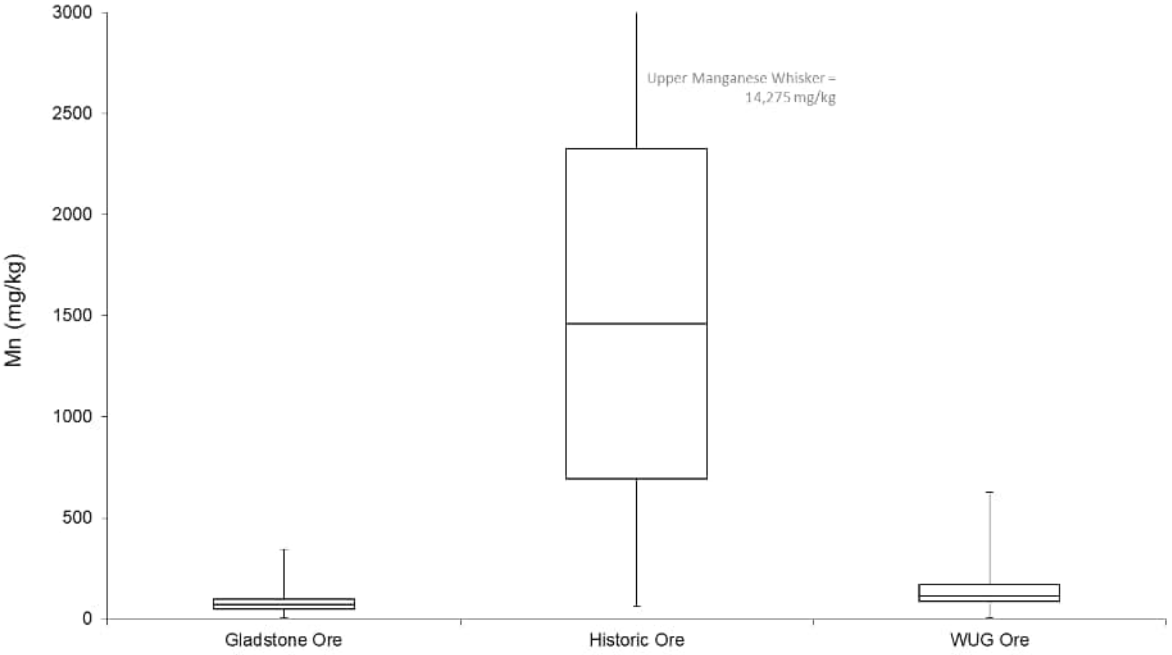


Figure 14. Box plot showing concentration range of Mn in ore material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

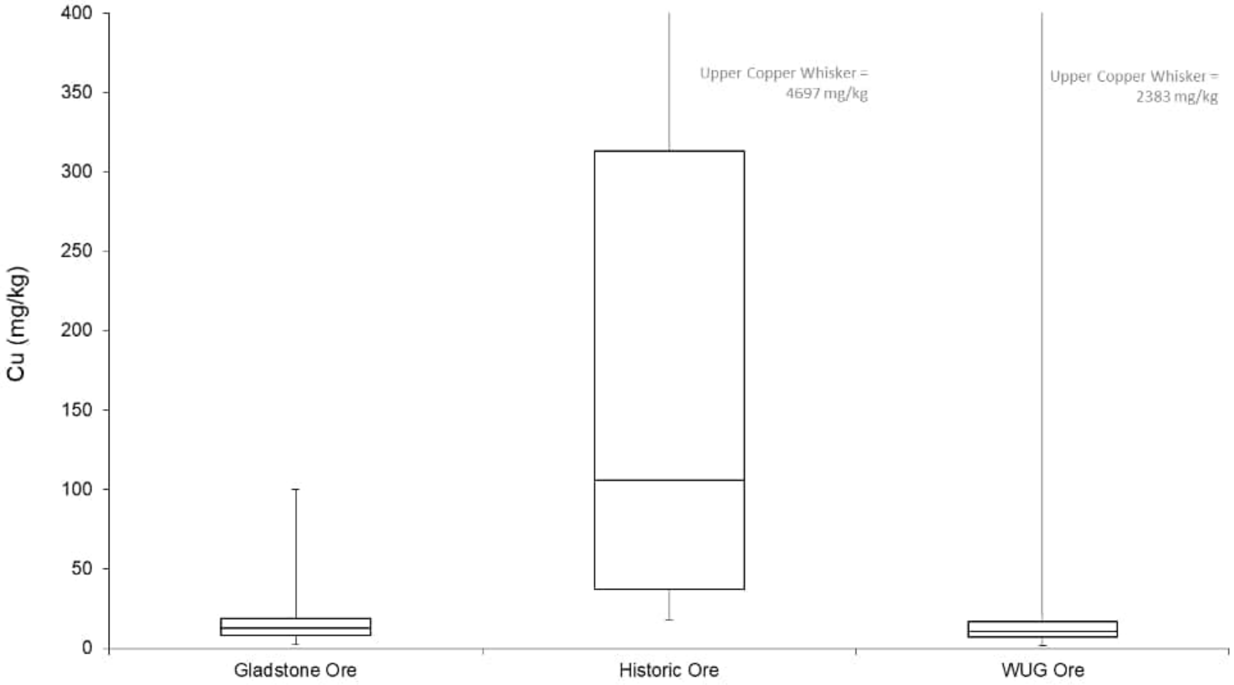


Figure 15. Box plot showing concentration range of Cu in ore material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

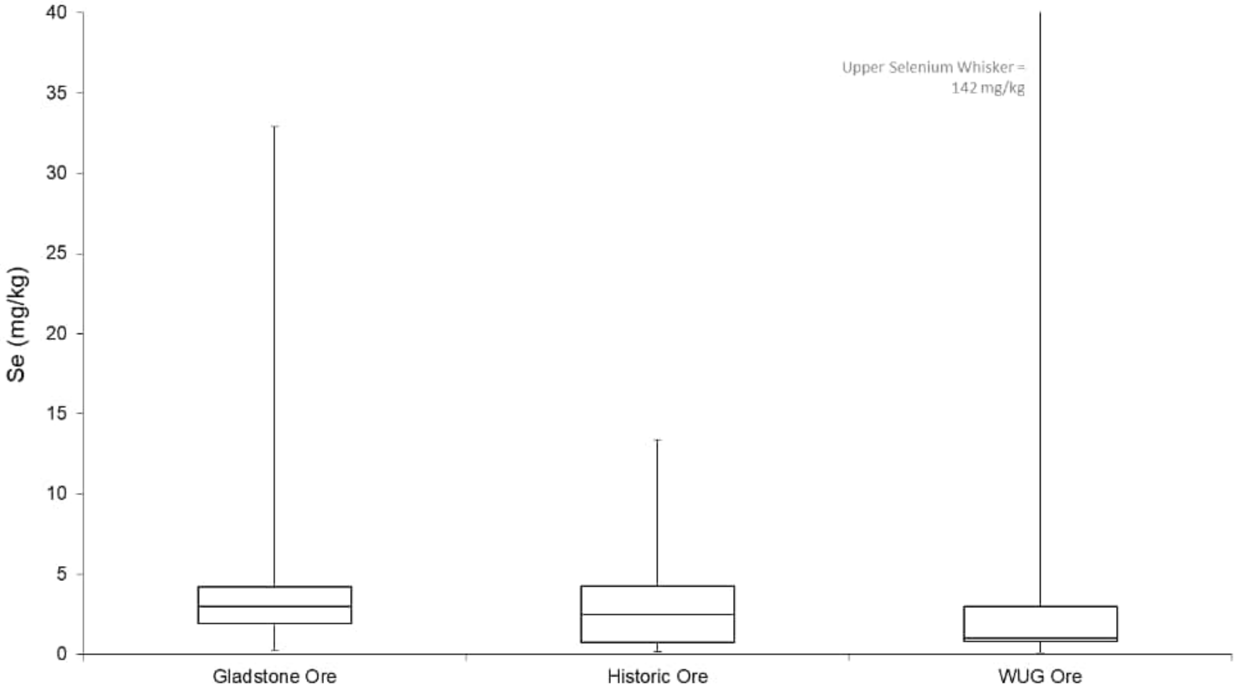


Figure 16. Box plot showing concentration range of Se in ore material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

Laboratory leach tests were undertaken on ore material (head) from the proposed Gladstone Pit to produce a liquor and residue that would make up the tailings from ore processing. Laboratory results for these ore (head), liquor (porewater) and residue (tailings solids) components are summarised in Table 20. Ore was processed in three different grind sizes (53, 75 and 90 µm) to investigate relative recovery rates. Data from the 75 µm tests has been presented here as it is most representative of likely ore processing during mining. The liquor data is used to calculate predicted porewater quality and seepage quality from the consolidated tailings. The mineral extraction process introduces considerable alkalinity as can be seen in the liquor and residue samples which is consistent with actual data for the TSFs at site as shown in Table 24.

In addition, samples of tailing solids were sent for SPLP analysis (USEPA method 1312). This method is designed to determine the mobility of analytes present in processed tailings and partially simulates conditions within the tailings facility where water passes through the consolidated tails and adsorption-desorption of soluble trace elements can occur. The results of the SPLP analyses undertaken on three Gladstone and three WUG ore are presented in Table 21. The results suggest that the trace elements of concern present in the liquor that have been mobilised during the processing of the ore rapidly reduce and ongoing leaching of trace elements from the tailings after the initial process water release are orders of magnitude lower.

The SPLP data is used to assess relative leachability of trace elements from respective ores which is used in the predictions of porewater quality and seepage quality. The partition coefficient for the tailings residues were calculated using the ratio of residue geochemistry to SPLP extraction concentration correcting for the 20:1 liquid to solid ratio in the SPLP test method.

For trace elements where the leachability has increased in Gladstone and Wharekirauponga ore from the historical Waihi dataset, the difference in leachability has been summarised in Table 22, where the increases are greater than an order of magnitude and are therefore included in the assessment of decant and porewater.

Table 20 Summary of Geochemical Results for Gladstone Ore Processing

Parameters	**Gladstone Pit - Head**			**Gladstone Pit - Liquor**			**Gladstone Pit - Residue**		
	n	**Arithmetic Mean**	**Range**	**n**	**Arithmetic Mean**	**Range**	**n**	**Arithmetic Mean**	**Range**
Major Elements		%	%		(mg/L)	(mg/L)		%	%
Aluminium	6	2.57	2.09 - 3.07	6	7.87	3.2 - 15.3	6	2.6	2.03 - 3.19
Iron	6	2.23	1.66 - 4.17	6	23.87	4.1 - 40.2	6	2.62	2.08 - 4.28
Calcium	6	0.03	0.02 - 0.03	6	31.17	3 - 90	6	0.17	0.15 - 0.21
Magnesium	6	0.06	0.04 - 0.08	6	1.0	1 - 1	6	0.06	0.04 - 0.09
Sodium	6	0.01	0.01 - 0.02	6	970.33	791 - 1185	6	0.02	0.01 - 0.02
Potassium	6	0.54	0.44 - 0.67	6	11.17	9 - 15	6	0.52	0.43 - 0.65
Trace Elements		(mg/kg)	(mg/kg)		(mg/L)	(mg/L)		(mg/kg)	(mg/kg)
Arsenic	6	290	199.5 - 375	6	0.17	0.1 - 0.3	6	302	213 - 390
Barium	6	130	20 - 280	6	0.10	0.1 - 0.1	6	130	20 - 290
Cadmium	6	0.05	0.02 - 0.07	6	0.01	0.01 - 0.01	6	0.07	0.04 - 0.1
Cobalt	6	7.22	0.9 - 13.6	6	0.58	0.1 - 1.1	6	14.03	10.1 - 17.6
Chromium	6	54.83	50 - 62	6	0.10	0.1 - 0.1	6	838.5	736 - 944
Copper	6	19.17	11.6 - 24.8	6	2.92	2.1 - 4.4	6	45.93	35.9 - 57.4
Manganese	6	29.67	23 - 39	6	1.07	0.6 - 1.8	6	103.17	80 - 127
Mercury	6	4.98	0.887 - 21.7	6	0.50	0.05 - 1.41	6	3.81	0.817 - 15.9
Molybdenum	6	2.75	1.5 - 3.91	6	0.30	0.1 - 0.6	6	26.4	20.3 - 29.4
Nickel	6	114.17	98.5 - 134.5	6	2.92	2.6 - 3.1	6	498.67	413 - 537
Lead	6	5.33	3.2 - 8.5	6	0.20	0.2 - 0.2	6	15.32	7.3 - 37.5
Antimony	6	85.35	68.6 - 94.5	6	0.40	0.4 - 0.4	6	88.73	72.1 - 102.5
Selenium	6	2.83	2 - 4	6	0.12	0.1 - 0.2	6	2.83	2 - 4
Zinc	6	55.83	46 - 75	6	1.08	1 - 1.2	6	25.83	20 - 37

Table 21 SPLP Results from Tailings Pulps

Gladstone Tail

Sample Name	**WL8 (Breccia) - Analytical Results**	**Residue Geocehmistry**	**Liquor**	**SPLP Extraction (18 Hours)**	**SPLP Extraction (36 Hours)**	**SPLP Extraction (54 Hours)**	**SPLP Extraction (72 Hours)**	**SPLP Extraction (90 Hours)**
Date								
Laboratory Reference				1856610.1 / 1856610.4	1856610.7 / 1856610.1	1856610.13 / 1856610.16	1856610.19 / 1856610.22	1856610.25 / 1856610.29
SPLP Sample Weight	g	-	-	50	50	50	50	50
SPLP Final pH		-	-	8.7	8.8	9.3	9.4	9.5
SPLP Extractant Type	De-ionised Water, pH 5.8 +/- 0.4							
pH	pH Units	-	-	8.5	9.2	9.2	9.3	9.5
Acidity (pH 3.7)	g/m3 as CaCO3	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Alkalinity	g/m3 as CaCO3	-	-	49	33	29	23	25
Electrical Conductivity (EC)	mS/m	-	-	28.6	4.8	3	4.9	4.8
Dissolved Aluminium	g/m3	29900	3.2	*0.003*	-	-	-	-
Dissolved Antimony	g/m3	99.3	0.4	0.02	0.0121	0.0069	0.0043	0.0027
Dissolved Barium	g/m3	290	0.1	0.031	0.0187	-	0.0089	0.0165
Dissolved Calcium	g/m3	1800	90	47	3.5	-	-	-
Dissolved Cobalt	g/m3	17.6	1.1	0.0026	0.0007	0.0003	0.0003	0.0003
Dissolved Iron	g/m3	42800	40.2	0.03	0.07	0.11	0.18	0.22
Dissolved Magnesium	g/m3	600	1	1.46	-	-	-	-
Dissolved Manganese	g/m3	80	0.7	*0.0005*	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Mercury	g/m3	15.9	1.41	< 0.00008	< 0.00008	< 0.00008	0.0001	0.00011
Dissolved Molybdenum	g/m3	20.3	0.2	0.0017	0.0006	< 0.0002	< 0.0002	< 0.0002
Dissolved Potassium	g/m3	4400	15	0.97	0.08	-	-	-
Dissolved Selenium	g/m3	4	0.1	0.001	< 0.0010	0.0012	< 0.0010	< 0.0010
Dissolved Silver	g/m3	1.04	0.59	*0.0001*	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Strontium	g/m3	15.9	0.1	0.024	0.002	0.0013	0.0007	-
Dissolved Uranium	g/m3	0.9	0.01	0.00007	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Dissolved Vanadium	g/m3	68	0.1	< 0.0010	< 0.0010	< 0.0010	0.0019	0.0014
Dissolved Arsenic	g/m3	390	0.1	0.0039	-	-	0.132	0.071
Dissolved Cadmium	g/m3	0.06	0.01	*0.000053*	-	-	< 0.000053	< 0.000053
Dissolved Chromium	g/m3	736	0.1	0.001	-	-	-	-
Dissolved Copper	g/m3	44.8	2.9	< 0.00053	-	-	< 0.00053	0.00148
Dissolved Lead	g/m3	8.6	0.2	< 0.00011	-	-	0.00069	0.0005
Dissolved Nickel	g/m3	413	2.9	< 0.00053	-	-	0.00094	0.00074
Dissolved Zinc	g/m3	32	1	*0.0011*	-	-	-	< 0.0011
Sulphate	g/m3			98	3.7	1.7	0.8	< 0.5

Gladstone Tail

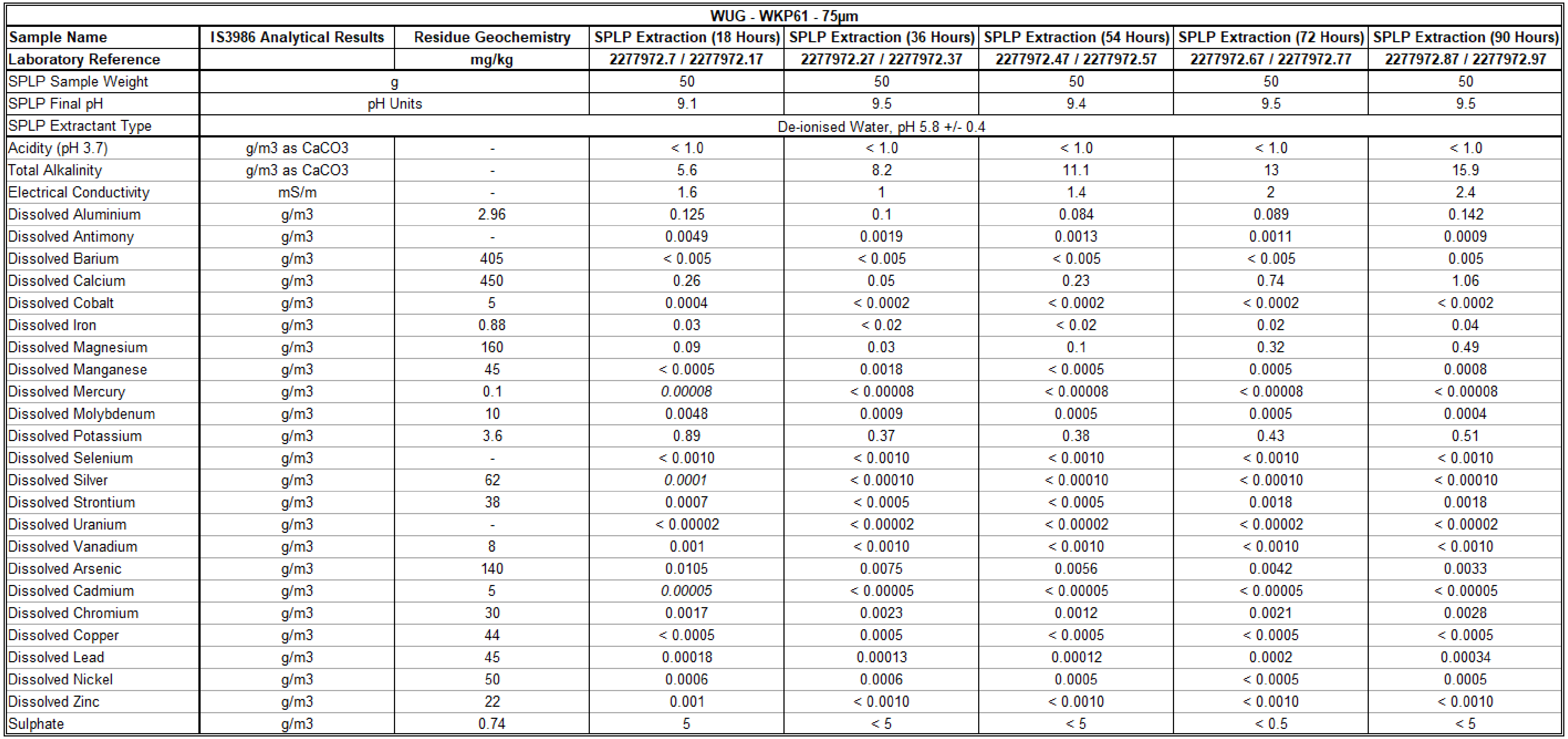
Sample Name	**WL14 (Vein) - Analytical Results**	**Residue Geocehmistry**	**Liquor**	**SPLP Extraction (18 Hours)**	**SPLP Extraction (36 Hours)**	**SPLP Extraction (54 Hours)**	**SPLP Extraction (72 Hours)**	**SPLP Extraction (90 Hours)**
Date								
Laboratory Reference				1856610.2 / 1856610.5	1856610.8 / 1856610.11	1856610.14 / 1856610.17	1856610.2 / 1856610.23	1856610.26 / 1856610.29
SPLP Sample Weight	g	-	-	50	50	50	50	50
SPLP Final pH		-	-	8.9	9.1	9.5	9.5	9.6
SPLP Extractant Type	De-ionised Water, pH 5.8 +/- 0.4							
pH	pH Units	-	-	8.8	9.4	9.4	9.4	9.5
Acidity (pH 3.7)	g/m3 as CaCO3	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Alkalinity	g/m3 as CaCO3	-	-	39	36	34	19.3	22
Electrical Conductivity (EC)	mS/m	-	-	20.4	5.3	4.1	4.2	4.2
Dissolved Aluminium	g/m3	21500	14.3	0.019	-	-	-	-
Dissolved Antimony	g/m3	89.5	0.4	0.0176	0.007	0.0041	0.0031	0.0019
Dissolved Barium	g/m3	50	0.1	0.0012	0.00019	-	-	-
Dissolved Calcium	g/m3	1800	12	33	4.6	3.3	-	-
Dissolved Cobalt	g/m3	15.3	0.9	0.0017	0.0003	< 0.0002	< 0.0002	< 0.0002
Dissolved Iron	g/m3	21100	38.4	< 0.02	< 0.02	< 0.02	0.03	0.05
Dissolved Magnesium	g/m3	700	1	1.54	-	-	-	-
Dissolved Manganese	g/m3	112	1.8	0.0029	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Mercury	g/m3	1.095	0.47	*0.00008*	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Molybdenum	g/m3	28.2	0.4	0.0071	0.0017	0.001	0.0011	0.0006
Dissolved Potassium	g/m3	6500	14	1.1	0.09	-	-	-
Dissolved Selenium	g/m3	3	0.1	0.0016	0.0013	< 0.0010	< 0.0010	< 0.0010
Dissolved Silver	g/m3	3.14	0.99	*0.0001*	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Strontium	g/m3	17.4	0.1	0.0142	0.0016	0.0009	< 0.0005	-
Dissolved Uranium	g/m3	0.1	0.01	0.00004	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Dissolved Vanadium	g/m3	40	0.1	< 0.0010	0.001	< 0.0010	< 0.0010	< 0.0010
Dissolved Arsenic	g/m3	371	0.2	0.042	-	-	0.139	0.063
Dissolved Cadmium	g/m3	0.1	0.01	*0.000053*	-	-	< 0.000053	< 0.000053
Dissolved Chromium	g/m3	899	0.1	0.00082	-	-	-	-
Dissolved Copper	g/m3	47.8	4.4	< 0.00053	-	-	< 0.00053	0.00088
Dissolved Lead	g/m3	19.8	0.2	< 0.00011	-	-	0.0015	0.002
Dissolved Nickel	g/m3	537	3.1	< 0.00053	-	-	0.00118	0.0012
Dissolved Zinc	g/m3	37	1	< 0.0011	-	-	-	0.0017
Sulphate	g/m3			63	2	0.5	< 0.5	< 0.5

Gladstone Tail

Sample Name	**WL2 (Andesite) - Analytical Results**	**Residue Geochemistry**	**Liquor**	**SPLP Extraction (18 Hours)**	**SPLP Extraction (36 Hours)**	**SPLP Extraction (54 Hours)**	**SPLP Extraction (72 Hours)**	**SPLP Extraction (90 Hours)**
Date								
Laboratory Reference				1856610.3 / 1856610.6	1856610.9 / 1856610.12	1856610.15 / 1856610.18	1856610.21 / 1856610.24	1856610.27 / 1856610.3
SPLP Sample Weight	g	-	-	50	50	50	50	50
SPLP Final pH		-	-	8.6	9	9.4	9.5	9.6
SPLP Extractant Type	De-ionised Water, pH 5.8 +/- 0.4							
pH	pH Units	-	-	8.4	9.2	9.3	9.3	9.4
Acidity (pH 3.7)	g/m3 as CaCO3	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Alkalinity	g/m3 as CaCO3	-	-	45	35	27	12.7	14
Electrical Conductivity (EC)	mS/m	-	-	33	5.7	3.1	3.2	2.9
Dissolved Aluminium	g/m3	27700	4	0.024	-	-	-	-
Dissolved Antimony	g/m3	78	0.4	0.024	0.0113	0.0064	0.0034	0.0021
Dissolved Barium	g/m3	50	0.1	0.0024	0.00185	-	-	-
Dissolved Calcium	g/m3	1500	41	59	5	-	-	-
Dissolved Cobalt	g/m3	17.1	0.6	0.0076	0.0016	0.0008	0.0006	0.0005
Dissolved Iron	g/m3	24700	26.3	0.23	0.08	0.05	0.03	0.04
Dissolved Magnesium	g/m3	700	1	1.69	-	-	-	-
Dissolved Manganese	g/m3	104	1.3	0.0028	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Mercury	g/m3	0.928	0.05	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Molybdenum	g/m3	29.4	0.6	0.0066	0.0012	0.0006	0.0005	0.0004
Dissolved Potassium	g/m3	4300	9	2.6	0.27	-	-	-
Dissolved Selenium	g/m3	3	0.1	< 0.0010	0.0011	0.001	< 0.0010	< 0.0010
Dissolved Silver	g/m3	4.54	2.43	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Strontium	g/m3	25	0.1	0.029	0.0025	0.0008	< 0.0005	-
Dissolved Uranium	g/m3	0.3	0.01	0.00004	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Dissolved Vanadium	g/m3	49	0.1	< 0.0010	< 0.0010	0.0016	0.0022	0.0017
Dissolved Arsenic	g/m3	240	0.2	0.0059	0.024	0.065	0.179	0.066
Dissolved Cadmium	g/m3	0.08	0.01	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Dissolved Chromium	g/m3	758	0.1	< 0.00053	0.0012	0.00156	-	-
Dissolved Copper	g/m3	48	2.9	< 0.00053	0.00081	< 0.00053	< 0.00053	< 0.00053
Dissolved Lead	g/m3	9.1	0.2	< 0.00011	< 0.00011	0.00019	0.00063	0.00086
Dissolved Nickel	g/m3	521	2.6	< 0.00053	< 0.00053	< 0.00053	0.00059	0.00072
Dissolved Zinc	g/m3	21	1.2	< 0.0011	< 0.0011	0.0017 #1	-	0.0017
Sulphate	g/m3			112	4.4	1.3	1	< 0.5

WUG - WKP60-1 - 75µm

Sample Name	**IS3983 Analytical Results**	**Residue Geochemistry**	**SPLP Extraction (18 Hours)**	**SPLP Extraction (36 Hours)**	**SPLP Extraction (54 Hours)**	**SPLP Extraction (72 Hours)**	**SPLP Extraction (90 Hours)**
Laboratory Reference		**mg/kg**	**2277972.3 / 2277972.13**	**2277972.23 / 2277972.33**	**2277972.43 / 2277972.53**	**2277972.63 / 2277972.73**	**2277972.83 / 2277972.93**
SPLP Sample Weight	g		50	50	50	50	50
SPLP Final pH	pH Units		9.6	9.5	9.4	9.4	9.5
SPLP Extractant Type	De-ionised Water, pH 5.8 +/- 0.4						
Acidity (pH 3.7)	g/m3 as CaCO3	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Alkalinity	g/m3 as CaCO3	-	14.4	13.5	13.5	13.8	14.4
Electrical Conductivity	mS/m	-	3.7	2.2	2.1	2.2	2.2
Dissolved Aluminium	g/m3	1.2	0.063	0.044	0.047	0.068	0.085
Dissolved Antimony	g/m3	-	0.003	0.0011	0.0009	0.0008	0.0005
Dissolved Barium	g/m3	75	0.005	< 0.005	< 0.005	< 0.005	< 0.005
Dissolved Calcium	g/m3	1100	3.8	2.3	1.38	1.14	1.11
Dissolved Cobalt	g/m3	5	0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dissolved Iron	g/m3	0.58	0.03	0.03	0.04	0.06	0.06
Dissolved Magnesium	g/m3	460	0.3	0.2	0.21	0.31	0.34
Dissolved Manganese	g/m3	190	0.0026	0.0025	0.0038	0.0062	0.0081
Dissolved Mercury	g/m3	0.1	0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Molybdenum	g/m3	10	0.0045	0.0008	0.0006	0.0005	0.0005
Dissolved Potassium	g/m3	1.2	0.38	0.16	0.14	0.17	0.17
Dissolved Selenium	g/m3	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Silver	g/m3	26	0.0001	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Strontium	g/m3	24	0.0089	0.0035	0.0017	0.0013	0.0012
Dissolved Uranium	g/m3	-	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Dissolved Vanadium	g/m3	2	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Arsenic	g/m3	80	0.026	0.013	0.0094	0.0075	0.0045
Dissolved Cadmium	g/m3	5	0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m3	40	0.0019	0.0012	0.0019	0.0028	0.0033
Dissolved Copper	g/m3	32	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Lead	g/m3	30	0.00045	0.00041	0.00052	0.00099	0.00098
Dissolved Nickel	g/m3	5	< 0.0005	< 0.0005	< 0.0005	0.0007	0.0011
Dissolved Zinc	g/m3	56	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Sulphate	g/m3	0.28	5	< 5	< 5	< 0.5	< 5



WUG - WKP61 - 75µm

Sample Name	**IS3986 Analytical Results**	**Residue Geochemistry**	**SPLP Extraction (18 Hours)**	**SPLP Extraction (36 Hours)**	**SPLP Extraction (54 Hours)**	**SPLP Extraction (72 Hours)**	**SPLP Extraction (90 Hours)**
Laboratory Reference		**mg/kg**	**2277972.7 / 2277972.17**	**2277972.27 / 2277972.37**	**2277972.47 / 2277972.57**	**2277972.67 / 2277972.77**	**2277972.87 / 2277972.97**
SPLP Sample Weight	g		50	50	50	50	50
SPLP Final pH	pH Units		9.1	9.5	9.4	9.5	9.5
SPLP Extractant Type	De-ionised Water, pH 5.8 +/- 0.4						
Acidity (pH 3.7)	g/m3 as CaCO3	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Alkalinity	g/m3 as CaCO3	-	5.6	8.2	11.1	13	15.9
Electrical Conductivity	mS/m	-	1.6	1	1.4	2	2.4
Dissolved Aluminium	g/m3	2.96	0.125	0.1	0.084	0.089	0.142
Dissolved Antimony	g/m3	-	0.0049	0.0019	0.0013	0.0011	0.0009
Dissolved Barium	g/m3	405	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Dissolved Calcium	g/m3	450	0.26	0.05	0.23	0.74	1.06
Dissolved Cobalt	g/m3	5	0.0004	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dissolved Iron	g/m3	0.88	0.03	< 0.02	< 0.02	0.02	0.04
Dissolved Magnesium	g/m3	160	0.09	0.03	0.1	0.32	0.49
Dissolved Manganese	g/m3	45	< 0.0005	0.0018	< 0.0005	0.0005	0.0008
Dissolved Mercury	g/m3	0.1	*0.00008*	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Molybdenum	g/m3	10	0.0048	0.0009	0.0005	0.0005	0.0004
Dissolved Potassium	g/m3	3.6	0.89	0.37	0.38	0.43	0.51
Dissolved Selenium	g/m3	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Silver	g/m3	62	*0.0001*	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Strontium	g/m3	38	0.0007	< 0.0005	< 0.0005	0.0018	0.0018
Dissolved Uranium	g/m3	-	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Dissolved Vanadium	g/m3	8	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Arsenic	g/m3	140	0.0105	0.0075	0.0056	0.0042	0.0033
Dissolved Cadmium	g/m3	5	*0.00005*	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m3	30	0.0017	0.0023	0.0012	0.0021	0.0028
Dissolved Copper	g/m3	44	< 0.0005	0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Lead	g/m3	45	0.00018	0.00013	0.00012	0.0002	0.00034
Dissolved Nickel	g/m3	50	0.0006	0.0006	0.0005	< 0.0005	0.0005
Dissolved Zinc	g/m3	22	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Sulphate	g/m3	0.74	5	< 5	< 5	< 0.5	< 5

WUG - WKP54 - 75µm							
Sample Name	**IS3982 Analytical Results**	**Residue Geochemistry**	**SPLP Extraction (18 Hours)**	**SPLP Extraction (36 Hours)**	**SPLP Extraction (54 Hours)**	**SPLP Extraction (72 Hours)**	**SPLP Extraction (90 Hours)**
Laboratory Reference		**mg/kg**	**2277972.10 / 2277972.20**	**2277972.30 / 2277972.40**	**2277972.50 / 2277972.60**	**2277972.70 / 2277972.80**	**2277972.90 / 2277972.100**
SPLP Sample Weight	g		50	50	50	50	50
SPLP Final pH	pH Units		9.6	9.8	9.6	9.6	9.5
SPLP Extractant Type	De-ionised Water, pH 5.8 +/- 0.4						
Acidity (pH 3.7)	g/m3 as CaCO3	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Alkalinity	g/m3 as CaCO3	-	16.4	15.9	13.4	13	15.7
Electrical Conductivity	mS/m	-	4.1	2.7	2.2	2.2	2.4
Dissolved Aluminium	g/m3	2.16	0.108	0.082	0.066	0.082	0.153
Dissolved Antimony	g/m3	-	0.0069	0.003	0.0019	0.0014	0.0011
Dissolved Barium	g/m3	200	0.005	< 0.005	< 0.005	< 0.005	< 0.005
Dissolved Calcium	g/m3	900	3.8	3.2	2	0.79	1.5
Dissolved Cobalt	g/m3	5	0.0005	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Dissolved Iron	g/m3	0.64	0.03	< 0.02	< 0.02	0.02	0.05
Dissolved Magnesium	g/m3	520	0.33	0.21	0.18	0.13	0.25
Dissolved Manganese	g/m3	320	0.0031	0.002	0.0029	0.0042	0.0098
Dissolved Mercury	g/m3	0.1	0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Molybdenum	g/m3	10	0.0047	0.0008	0.0007	0.0004	0.0004
Dissolved Potassium	g/m3	2.4	0.99	0.42	0.23	0.2	0.35
Dissolved Selenium	g/m3	-	0.0012	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Silver	g/m3	98	0.0001	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Strontium	g/m3	42	0.0099	0.0051	0.0038	0.0018	0.002
Dissolved Uranium	g/m3	-	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Dissolved Vanadium	g/m3	8	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Arsenic	g/m3	230	0.03	0.0118	0.0074	0.0059	0.0048
Dissolved Cadmium	g/m3	5	0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m3	40	0.0021	0.001	0.0009	0.0013	0.003
Dissolved Copper	g/m3	30	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Lead	g/m3	40	0.00032	0.00018	0.00018	0.00027	0.00059
Dissolved Nickel	g/m3	5	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0007
Dissolved Zinc	g/m3	184	0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Sulphate	g/m3	0.36	5	< 5	< 5	< 0.5	< 5

Table 22 Trace Element Leachability

Parameter	Existing TSF Tailings (log Kd*)	Gladstone (log Kd*)	WUG (log Kd*)	Changes in Leachability
Arsenic	4.6	2.2	2.6	Increased leachability in Gladstone and WUG
Cadmium	4.2	1.8	3.7	Increased leachability in Gladstone
Chromium	5.2	4.6	2.8	Increased leachability in WUG
Lead	5.1	2.8	3.6	Increased leachability in Gladstone and WUG

*Kd: Partition Coefficient (Allison, J.D and Allison, T.L. 2005)

7.3 Estimated TSF Water Quality

The geochemistry of the ore from Wharekirauponga underground and Gladstone has the principle differences outlined in Section 7.2. Aside from these specific differences, which are accounted for as outlined below, the tailings produced from these ores are expected to be of similar characteristics to tailings currently within TSF1A and TSF2.

As both current tailings storage facilities will be ore from the Waihi area (approximately 70 to 100% for TSF1A and TSF2 respectively) it is unlikely that the geochemistry of the ore deposited from the WNP component of the project will differ sufficiently to materially alter what is already present. The resultant leachate should therefore not differ significantly from what has (to date) been recorded from TSF1A and TSF2. Comparison of previous assessments (URS 2001) to actual results factoring existing underdrains and decant chemistry by differences in whole ore trace element concentrations provides a reliable assessment of resultant geochemical composition for these components.

The validity of this approach is dependent on the leachability of trace elements in the respective ore which will depend to a degree on ore mineralogy and metallurgical processes used in gold extraction.

The approach of factoring existing seepage and decant based on ore trace element composition requires further evaluation for the TSF3 and GOP TSF which could initially receive a greater proportion of ore from the Gladstone Pit and Wharekirauponga Underground resulting in a greater influence of any differences in pore fluid composition from this ore. TSF3 and GOP TSF decant and porewater is therefore based on both geochemical modelling, factoring of existing facility underdrains and decant, and correction for leachability of trace elements from Gladstone and WUG ore.

The mining schedule suggests that TSF1A, TSF2, TSF3 and GOP TSF could receive ore from the respective ore bodies as outlined in Table 23. The maximum values are based on the maximum proportion received in any given quarter.

Table 23 Processed Ore Deposition

TSF Receiving Tailings	Martha Ore (MUG, MOP4 etc)	GOP Ore	WUG Ore
TSF1A	94%	6%	-
TSF2	95%	5%	-
TSF3			
Mean all sources	20%	9%	71%
Maximum Gladstone (by quarter)	50%	47%	3%
Maximum WUG (by quarter)	-	-	100%
GOP TSF			
Mean all sources	8%	-	92%
Maximum WUG (by quarter)	-	-	100%

Water quality assessment for TSF3 and GOP TSF considers two key components, surface water chemistry and pore-fluid chemistry. The surface water component (representing the tailings pond supernatant) is also likely to reflect the composition of the decant solution, pumped back to the processing plant. The pore-fluid component represents the water within pore spaces of the tailings material which will report as seepage to underdrains.

For the purposes of this assessment the TSF decant water quality scenarios are based on mean and maximum component of the Gladstone or Wharekirauponga ore that could be placed in TSF3 and GOP TSF from Table 23. The predicted porewater is, however, only assessed based on the mean from Table 23 as the seepage will be controlled by the overall mix of tailings placed within a tailings storage facility.

7.3.1 TSF Pond Water Quality

Water chemistry associated with TSF1A, TSF2, TSF3 and GOP TSF pond water (decant) was predicted using the following steps:

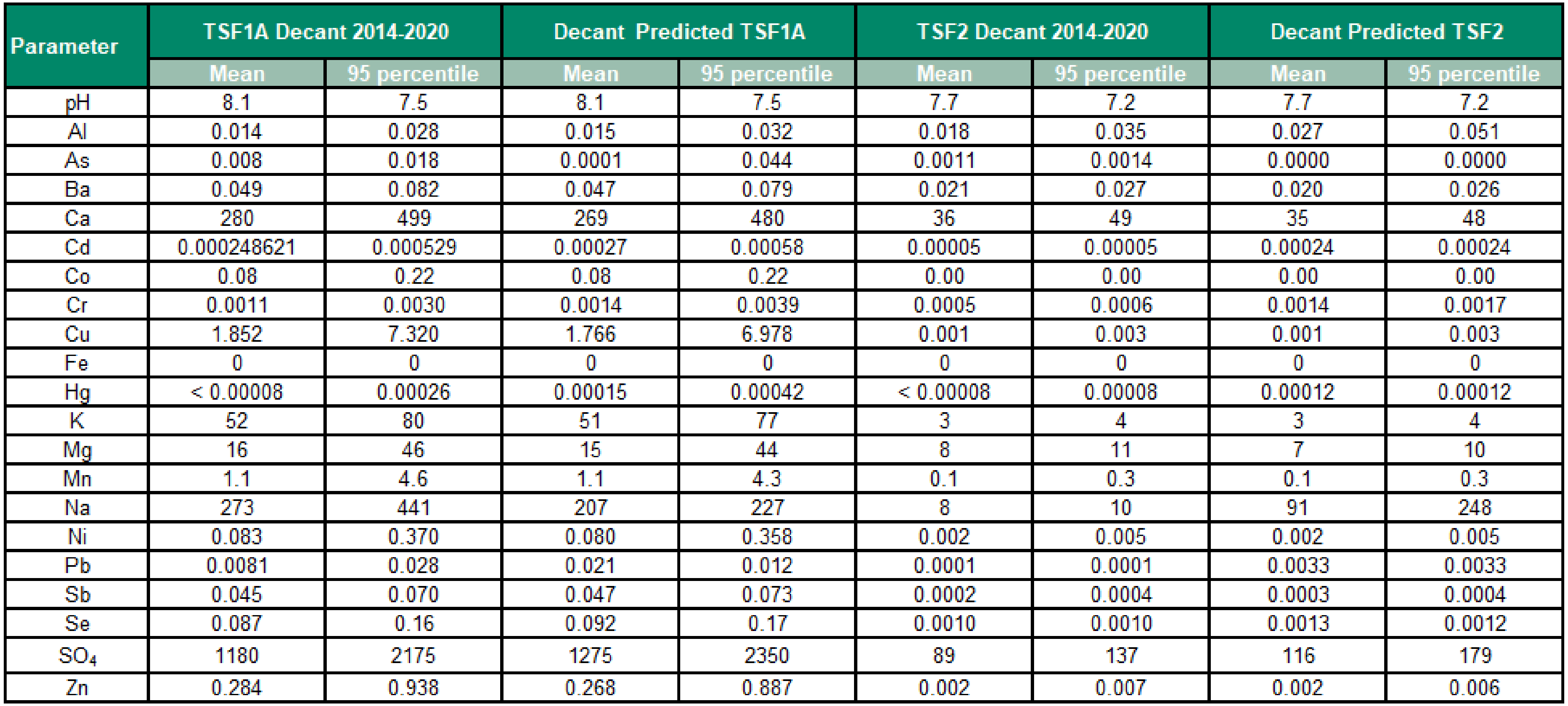
- The samples of tailing liquor from laboratory leach tests (Table 20) indicate an initial porefluid solution. Mean raw liquor data measured from processed Gladstone ore material was adjusted using mean elemental concentrations representing the entire Gladstone ore sample dataset (Table 18). The chemistry of this solution was taken to represent the initial fluid portion of the tailings slurry prior to deposition in the tailings facility.
- The SPLP results are used to assess the relative leachability of trace elements in tailings once placed within the storage facility
- Only trace elements elevated with respect to previously placed tails and with increased trace element leachability are assessed in this way (arsenic). For other trace elements the default values in existing TSF underdrains and decant are adopted.
- The above steps define the adjusted liquor shown in Table 21.
- Geochemical modelling is undertaken using geochemical modelling software PHREEQC Interactive version 3.6.2 , utilising the Minteq.v4 database. This assesses the speciation of chemicals present and any oversaturation of phases that would potentially precipitate out of solution as a result of the above adjustments. This modelled solution (Table 24) was taken to represent tailings’ pond water (decant) chemistry.
- Rainfall into the TSF (and associated dilution), and evaporation from the TSF (and associated concentration) of pond water were not accounted for making the assessment of any trace elements with elevated total concentrations conservative.

PHREEQC modelling predicts that as water pumped into the TSF reaches equilibrium with expected TSF mineral species, pH will reduce towards neutrality, and Iron and Aluminium will largely precipitate out of solution. This is expected to occur primarily in response to the formation of the Gibbsite (Aluminium hydroxide), and hydrous ferric oxide minerals including Ferrihydrite.

When compared with average decant chemistry from TSF1A and TSF2 from 2014 to 2020, modelled equilibrated pond water exhibits similar chemical trends to measured averages from existing facilities (Table 24). Calcium, potassium, sodium and sulphate remain elevated relative to other components, and concentrations of iron and aluminium are low relative to their concentration in the liquor.

Predicted TSF3 and GOP TSF Decant Chemistry are presented on Table 25.

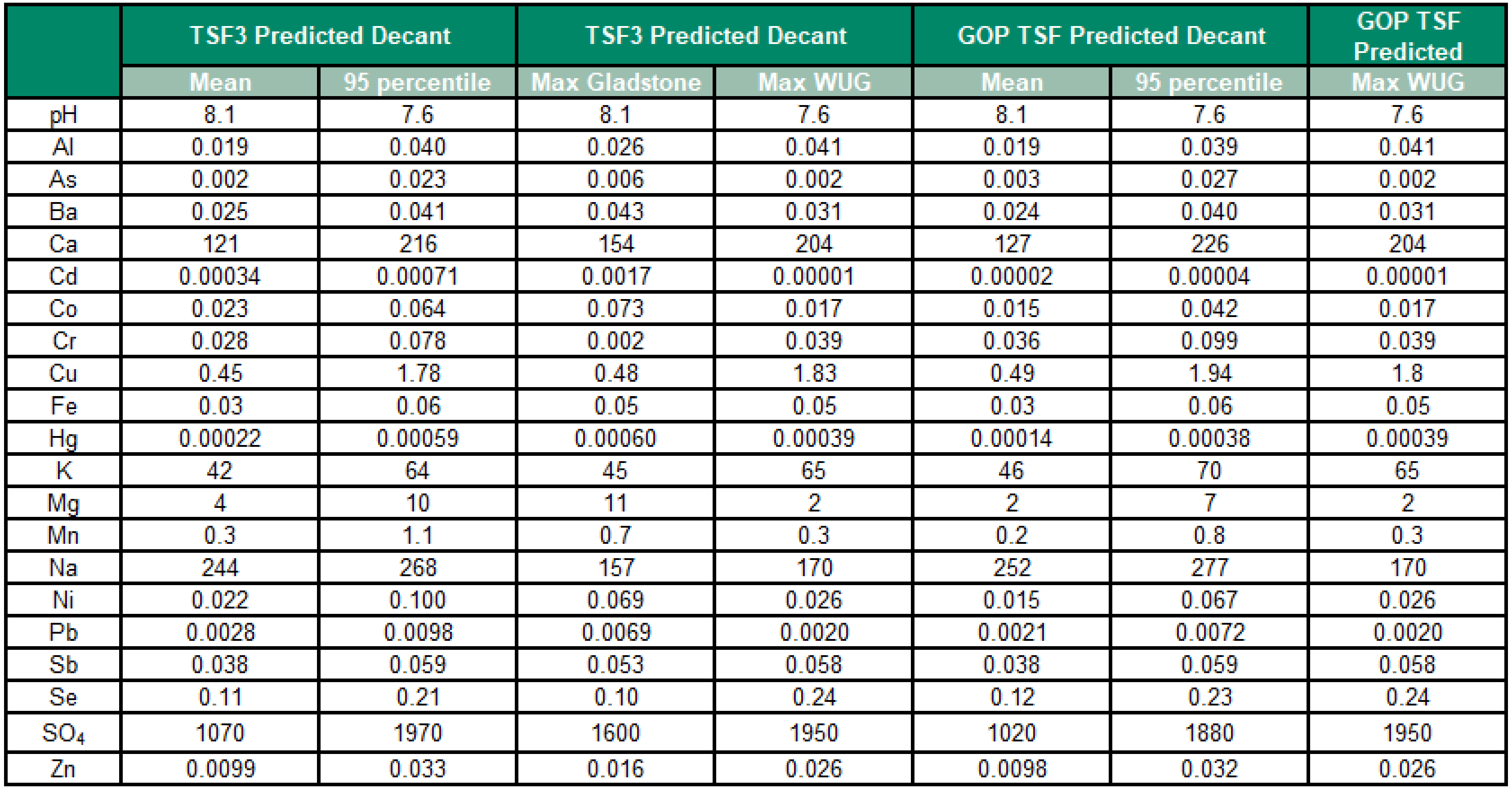
Table 24 Predicted TSF1A and TSF2 Pond Water (Decant) Chemistry



Parameter	TSF1A Decant 2014-2020		Decant Predicted TSF1A		TSF2 Decant 2014-2020		Decant Predicted TSF2	
	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile
pH	8.1	7.5	8.1	7.5	7.7	7.2	7.7	7.2
Al	0.014	0.028	0.015	0.032	0.018	0.035	0.027	0.051
As	0.008	0.018	0.0001	0.044	0.0011	0.0014	0.0000	0.0000
Ba	0.049	0.082	0.047	0.079	0.021	0.027	0.020	0.026
Ca	280	499	269	480	36	49	35	48
Cd	0.000248621	0.000529	0.00027	0.00058	0.00005	0.00005	0.00024	0.00024
Co	0.08	0.22	0.08	0.22	0.00	0.00	0.00	0.00
Cr	0.0011	0.0030	0.0014	0.0039	0.0005	0.0006	0.0014	0.0017
Cu	1.852	7.320	1.766	6.978	0.001	0.003	0.001	0.003
Fe	0	0	0	0	0	0	0	0
Hg	< 0.00008	0.00026	0.00015	0.00042	< 0.00008	0.00008	0.00012	0.00012
K	52	80	51	77	3	4	3	4
Mg	16	46	15	44	8	11	7	10
Mn	1.1	4.6	1.1	4.3	0.1	0.3	0.1	0.3
Na	273	441	207	227	8	10	91	248
Ni	0.083	0.370	0.080	0.358	0.002	0.005	0.002	0.005
Pb	0.0081	0.028	0.021	0.012	0.0001	0.0001	0.0033	0.0033
Sb	0.045	0.070	0.047	0.073	0.0002	0.0004	0.0003	0.0004
Se	0.087	0.16	0.092	0.17	0.0010	0.0010	0.0013	0.0012
SO_4	1180	2175	1275	2350	89	137	116	179
Zn	0.284	0.938	0.268	0.887	0.002	0.007	0.002	0.006

All concentrations reported in mg/L.
Decant data for TSF1A and TSF2 (2014-2020) supplied by OGNZL.
Adjusted Liquor values were calculated using the head:liquor relationship of six processed Gladstone ore samples. The head:liquor ratio of these samples was used to factor the ‘mean liquor’ data using the more complete Gladstone ore head dataset.

Table 25 Predicted TSF3 and GOP TSF Decant Chemistry



	TSF3 Predicted Decant		TSF3 Predicted Decant		GOP TSF Predicted Decant		GOP TSF Predicted
	Mean	95 percentile	Max Gladstone	Max WUG	Mean	95 percentile	Max WUG
pH	8.1	7.6	8.1	7.6	8.1	7.6	7.6
Al	0.019	0.040	0.026	0.041	0.019	0.039	0.041
As	0.002	0.023	0.006	0.002	0.003	0.027	0.002
Ba	0.025	0.041	0.043	0.031	0.024	0.040	0.031
Ca	121	216	154	204	127	226	204
Cd	0.00034	0.00071	0.0017	0.00001	0.00002	0.00004	0.00001
Co	0.023	0.064	0.073	0.017	0.015	0.042	0.017
Cr	0.028	0.078	0.002	0.039	0.036	0.099	0.039
Cu	0.45	1.78	0.48	1.83	0.49	1.94	1.8
Fe	0.03	0.06	0.05	0.05	0.03	0.06	0.05
Hg	0.00022	0.00059	0.00060	0.00039	0.00014	0.00038	0.00039
K	42	64	45	65	46	70	65
Mg	4	10	11	2	2	7	2
Mn	0.3	1.1	0.7	0.3	0.2	0.8	0.3
Na	244	268	157	170	252	277	170
Ni	0.022	0.100	0.069	0.026	0.015	0.067	0.026
Pb	0.0028	0.0098	0.0069	0.0020	0.0021	0.0072	0.0020
Sb	0.038	0.059	0.053	0.058	0.038	0.059	0.058
Se	0.11	0.21	0.10	0.24	0.12	0.23	0.24
SO_4	1070	1970	1600	1950	1020	1880	1950
Zn	0.0099	0.033	0.016	0.026	0.0098	0.032	0.026

All concentrations reported in mg/L.
Decant data for TSF1A and TSF2 (2014-2020) supplied by OGNZL.
Adjusted Liquor values were calculated using the head:liquor relationship of six processed Gladstone ore samples. The head:liquor ratio of these samples was used to factor the ‘mean liquor’ data using the more complete Gladstone ore head dataset.

7.3.2 TSF Porewater Quality

Water chemistry associated with TSF3 and GOP TSF porewater was predicted using the following methods:

- Existing underdrain data was factored by the differences in total element composition of tailings that comprise seepage to these underdrains.
- Comparison of process water in laboratory leach tests (Table 23) to process water from previous tailings porefluid (Table 24) immediately post processing data, identified differences in leachability of trace elements with respect to trace elements the Gladstone and WUG ore.
- The geochemical model PHREEQC was used to simulate the complexation of heavy metal ions on hydrous ferric oxides based on the model of Dzombak and Morel[2]. The chemistry of the starting model solution comprised the equilibrated porewater. The model simulation represents the equilibration of this process water in the TSF and represents a theoretical end point for water chemistry within pore spaces in the tailings storage facility. Existing underdrain data factored by tailings composition changes is therefore checked against this modelled data to validate predictions presented in Table 26.

Porewater within the tailings material when discharged to the TSFs is notably different from actual fluids collected in the tailings underdrains and decant. Metal ion adsorption is therefore having a significant effect on dissolved species. Surface complexation modelling predicts that arsenic, calcium, cadmium, cobalt, chromium, copper, iron, mercury, magnesium, nickel, and lead concentrations in solution will be reduced via adsorption to hydrous ferric oxides, while potassium, sodium, and sulphate are not significantly altered by adsorption.

Predicted porewater is compared to existing underdrain data from TSF1A in Table 26.

Unlike the existing tailings facilities, it is proposed TSF3 and GOP TSF will be lined beneath the tailings pond with a geomembrane to limit the migration of tailings seepage into groundwater in the early years of tailings deposition (for TSF3), prior to tailings consolidation.

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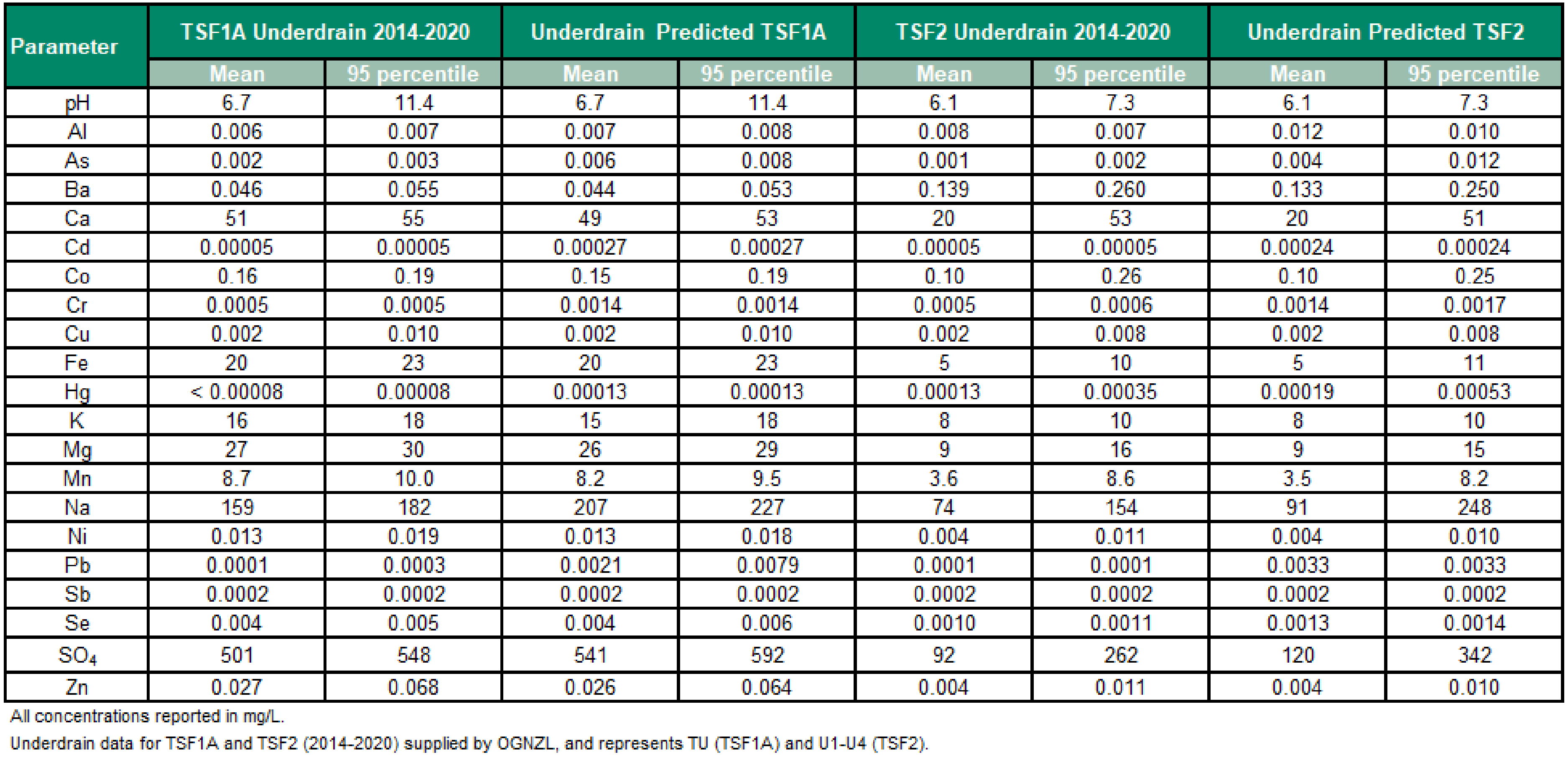
[2] Dzombak, D.A., and Morel, F.M.M., 1990, Surface complexation modeling—Hydrous ferric oxide: New York, John Wiley, 393 p.

Table 26 Predicted TSF Porewater Chemistry



Parameter	TSF1A Underdrain 2014-2020		Underdrain Predicted TSF1A		TSF2 Underdrain 2014-2020		Underdrain Predicted TSF2	
	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile
pH	6.7	11.4	6.7	11.4	6.1	7.3	6.1	7.3
Al	0.006	0.007	0.007	0.008	0.008	0.007	0.012	0.010
As	0.002	0.003	0.006	0.008	0.001	0.002	0.004	0.012
Ba	0.046	0.055	0.044	0.053	0.139	0.260	0.133	0.250
Ca	51	55	49	53	20	53	20	51
Cd	0.00005	0.00005	0.00027	0.00027	0.00005	0.00005	0.00024	0.00024
Co	0.16	0.19	0.15	0.19	0.10	0.26	0.10	0.25
Cr	0.0005	0.0005	0.0014	0.0014	0.0005	0.0006	0.0014	0.0017
Cu	0.002	0.010	0.002	0.010	0.002	0.008	0.002	0.008
Fe	20	23	20	23	5	10	5	11
Hg	< 0.00008	0.00008	0.00013	0.00013	0.00013	0.00035	0.00019	0.00053
K	16	18	15	18	8	10	8	10
Mg	27	30	26	29	9	16	9	15
Mn	8.7	10.0	8.2	9.5	3.6	8.6	3.5	8.2
Na	159	182	207	227	74	154	91	248
Ni	0.013	0.019	0.013	0.018	0.004	0.011	0.004	0.010
Pb	0.0001	0.0003	0.0021	0.0079	0.0001	0.0001	0.0033	0.0033
Sb	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Se	0.004	0.005	0.004	0.006	0.0010	0.0011	0.0013	0.0014
SO_4	501	548	541	592	92	262	120	342
Zn	0.027	0.068	0.026	0.064	0.004	0.011	0.004	0.010

All concentrations reported in mg/L.

Underdrain data for TSF1A and TSF2 (2014-2020) supplied by OGNZL, and represents TU (TSF1A) and U1-U4 (TSF2).

Table 26 Predicted TSF Porewater Chemistry - continued

	TSF3 Predicted Porewater		GOP TSF Predicted Porewater	
	Mean	95 percentile	Mean	95 percentile
pH	6.7	7.6	6.7	7.6
Al	0.009	0.010	0.009	0.010
As	0.033	0.088	0.033	0.087
Ba	0.023	0.028	0.021	0.025
Ca	22	24	22	24
Cd	0.00034	0.00034	0.00010	0.00010
Co	0.046	0.056	0.027	0.033
Cr	0.028	0.028	0.035	0.035
Cu	0.0005	0.0024	0.0006	0.0025
Fe	13	15	12	14
Hg	0.00018	0.00018	0.00014	0.00014
K	13	14	13	15
Mg	6	7	3	4
Mn	2.0	2.3	1.3	1.5
Na	240	270	250	280
Ni	0.004	0.005	0.002	0.003
Pb	0.0028	0.0067	0.0023	0.0054
Sb	0.0002	0.0002	0.0002	0.0002
Se	0.005	0.007	0.005	0.008
SO_4	450	490	450	490
Zn	0.0009	0.0024	0.0009	0.0022

All concentrations reported in mg/L.

8.0 Conclusions

Mercury, antimony, and arsenic are generally elevated in Gladstone rock relative to the historical Waihi dataset and mean concentrations in the earth's crust. These elements are enriched in both the Breccia and Andesitic rock material, with mercury showing the greatest difference. Within the Andesitic material, mercury is more elevated in the highly clay altered rock, in rock located closer to the surface, and in rock located near the borders of the Breccia material. The acid-generating potential data suggests that the rock from the Gladstone Pit has a lower neutralising capacity compared to the existing dataset.

The static field tests confirmed that in general, rhyolite material from the WUG mine is elevated in arsenic but is comparable to the historical Waihi dataset in terms of acid generating capacity.

Kinetic laboratory and field column tests suggest that due to the low neutralising capacity of the Gladstone material, the natural lag time is short and material has the potential to exhibit depressed pH and associated elevated sulphate and trace element concentrations in leachate within 10 weeks of placement. Treatment methods employed on some of the columns (limestone dosing, saturation, and compaction) and existing operations at the site show there are valid strategies to avoid and/or mitigate the effects of AMD from exposed and placed rock during operations associated with the Waihi North Project.

The specific method and strategy employed to limit the onset of acidification depends on the rock destination, method of placement, length of exposure, and specific ABA characteristics of the rock. The overall rock management strategy is based on temporary storage of material in the existing Rock and Tailings Storage Area (RTSA) area or at Willows Road combined with permanent rock disposal to the Gladstone Pit Area, NRS and the embankment of TSF3, or as backfill in the underground mine. The specific recommended mitigation outlined depends on the rock's source and ultimate end state and is broadly discussed in three broad categories:

- Temporary storage of rock sourced from WUG in the WRS prior to placement underground as backfill or within permanent disposal structures; and
- Disposal of rock to Gladstone Pit with placement and compaction; and
- Disposal of rock to both the NRS and TSF3.

PAF rock placed into temporary stockpiles at the RTSA should be amended with limestone to ensure the introduction of a 30-week lag period. This will ensure that PAF rock material is neutralised until the material is placed permanently outside of the zone of oxidation. For PAF rock that will potentially be exposed for a period in excess of this, additional amendment may be required, as is currently practised.

Permanent disposal of PAF material sourced from both WUG and Gladstone Pit will be undertaken in a manner that will limit the rate of oxygen ingress and limit the potential of the material producing acidity until saturation and/or consecutively placed material (on top) will remove the placed material from oxygen exposure. For exposure periods exceeding the materials natural lag, the addition of limestone will extend this lag period.

The general mitigation measure for the placement of PAF rock within GOP is for material to be placed and compacted in lifts. Saturation with perched water will provide appropriate control until the returning groundwater table will secure long term control. For material above the recharged groundwater level, compaction will provide long term control. Limestone amendment for compacted material will be dependent on the required lag period.

The amendment rates outlined are considered conservative and within the current operating limits of the site. Monitoring of the PAF rock material will enable refinement to those calculated and outlined rates, and will be part of ongoing operations.

Geochemical modelling has predicted water quality associated with specific disposal locations and mitigation strategies in order to inform the impact of the planned operations on the wider environment and short and long term treatment requirements. The assessments undertaken are considered conservative based on a number of factors. These include (but are not necessarily limited to); selection of rock material for kinetic / column tests focussed on non-weathered, high pyritic material; scaling factors not being applied to the laboratory / field tests; and use of Mean and 95% UCL data to calculate applicable limestone dosing rates.

Ore geochemical testing on GOP and WUG ore material was found to exhibit generally similar geochemical characteristics to that of the existing ore material with the exception of mercury, which was found to be elevated in the Gladstone ore. The analytical results of the Leach Tests and SPLP analysis of the Gladstone ore material combined with the geochemical modelling undertaken suggest that arsenic, calcium, cadmium, cobalt, chromium, copper, iron, mercury, magnesium, nickel and lead concentrations in porewater will be reduced via adsorption to hydrous ferric oxides, while potassium, sodium and sulphate will not be significantly altered. The resultant predicted leachate water quality will be similar in nature to that monitored at the existing TSF facilities, with potentially less mixing with groundwater due to the presence of a geomembrane in some areas of the basal structure.

In summary, the mitigation and management practices put forward are considered suitable based on the extensive and targeted datasets collected and on more than thirty years of successful application of these practices at Waihi. The assumptions applied during the calculation of amendment requirements and the predictive geochemical modelling undertaken ensure that the assessment is considered conservative and within the current (or planned) operating limits of the site. Monitoring of the rock material will enable refinement to lime amendment rates calculated, outlined, and presented in this report, and will be part of ongoing operations.

9.0 References

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10.0 Standard Limitations

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Appendix A

Whole Rock
Geochemistry Dataset A

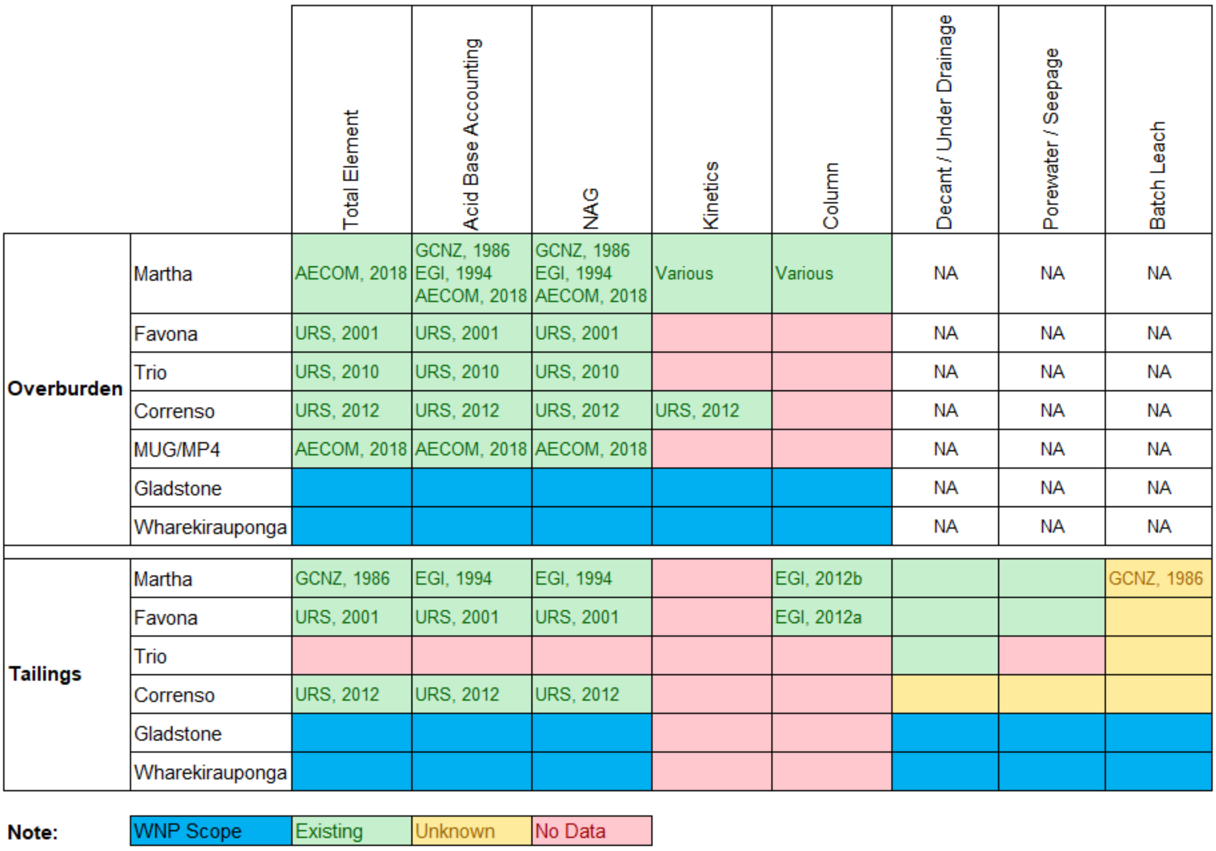
Appendix A Whole Rock Geochemistry Dataset A

A1. Geochemical Assessment

A1.1 Introduction

The geochemical assessment of ore, tailings, and rock produced from the proposed mining components was carried out using statistical comparison of analytical results for Martha, Favona, Trio, WUG, Gladstone and Correnso rock samples, acid-base accounting, and predictive modelling of impacts to water quality. Existing geochemical data has been sourced from Martha, Favona, Trio, Wharekirauponga, Gladstone and Correnso operations, as well as the consented Project Martha (comprising MOP4 and MUG) and the various technical reports that were produced for these mining operations. The source of this information is summarised in Table 27.

Table 27 Geochemistry Source Data Summary



		Total Element	Acid Base Accounting	NAG	Kinetics	Column	Decant / Under Drainage	Porewater / Seepage	Batch Leach
Overburden	Martha	AECOM, 2018	GCNZ, 1986 EGI, 1994 AECOM, 2018	GCNZ, 1986 EGI, 1994 AECOM, 2018	Various	Various	NA	NA	NA
	Favona	URS, 2001	URS, 2001	URS, 2001	🟥	🟥	NA	NA	NA
	Trio	URS, 2010	URS, 2010	URS, 2010	🟥	🟥	NA	NA	NA
	Correnso	URS, 2012	URS, 2012	URS, 2012	URS, 2012	🟥	NA	NA	NA
	MUG/MP4	AECOM, 2018	AECOM, 2018	AECOM, 2018	🟥	🟥	NA	NA	NA
	Gladstone	🟦	🟦	🟦	🟦	🟦	NA	NA	NA
	Wharekirauponga	🟦	🟦	🟦	🟦	🟦	NA	NA	NA
Tailings	Martha	GCNZ, 1986	EGI, 1994	EGI, 1994	🟥	EGI, 2012b	🟩	🟩	GCNZ, 1986
	Favona	URS, 2001	URS, 2001	URS, 2001	🟥	EGI, 2012a	🟩	🟩	🟨
	Trio	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟨
	Correnso	URS, 2012	URS, 2012	URS, 2012	🟥	🟥	🟨	🟨	🟨
	Gladstone	🟦	🟦	🟦	🟥	🟥	🟦	🟦	🟦
	Wharekirauponga	🟦	🟦	🟦	🟥	🟥	🟦	🟦	🟦

Note:	🟦 WNP Scope	🟩 Existing	🟨 Unknown	🟥 No Data

A1.1.1 Characterisation Philosophy

Initial screening of ore and rock was undertaken for a broad range of major and trace elements typically considered in the assessment of rock composition and potential contaminants of environmental concern. Additional elements were also included where they had previously been present in elevated concentrations in rock and ore from the Waihi operations, where consent conditions stipulated discharge concentrations, and / or where they had previously been depressed in rock and ore from current and previous operations but had the potential to be present at elevated concentrations in the new mining areas.

This testing was undertaken as screening, to identify those trace elements that may be present at elevated concentrations relative to a typical background (mean earth crust) and that differ from rock and ore recovered from existing mining operations in the Waihi area. The specific intention of this comparison was the identification of potential contaminants of interest which may require rock management practices that differ from those currently undertaken by OGNZL.

Additional testing, beyond the initial multi-element screening, was undertaken where appropriate to further assess the identified contaminants of interest. The geochemical composition of ore has been used to determine the likely composition of the mine tailings that would be produced from ore processing. To achieve this, mine tailings produced from Martha mine ore were used as the basis for assessment, with compositional differences between Martha, Gladstone and WUG ore assumed to result in proportional differences in tailings composition. A similar approach is used to predict likely effects to decant and seepage quality from the storage facilities as a result of the deposition of mine tailings from the planned operations in the current and future storage facilities.

The initial elements screened, their recommended detection limits, and additional static tests carried out are provided in Table 28.

Table 28 Initial Static Analysis Suite

Multi Analysis Testing	Favona & Martha Trace Elements Screened Previously	Water Quality Compliance Limits	Recommended detection limit (mg / kg)
Total Sulphur (%)	Y		
Total Carbon (%)	Y		
ANC (kg CaCO3/tonne)	Y		
Aluminium	Y		500
Iron	Y	Y	500
Calcium	Y		500
Magnesium	Y		500
Sodium	Y		500
Potassium	Y		500
Antimony	Y	Y	0.1
Arsenic	Y	Y	0.1
Barium	Y		1
Cadmium	Y	Y	0.01
Cobalt	Y		1
Chromium	Y	Y	5
Copper	Y	Y	1
Lead	Y	Y	1
Mercury	Y	Y	0.01
Manganese	Y	Y	5
Molybdenum	Y		0.1
Nickel	Y	Y	1
Selenium	Y	Y	0.05
Vanadium			1
Zinc	Y	Y	5
Titanium	Y		100
Boron			1

Multi Analysis Testing	Favona & Martha Trace Elements Screened Previously	Water Quality Compliance Limits	Recommended detection limit (mg / kg)
Strontium			1
Thorium			0.1
Tin			0.1
Silver		Y	0.01
Thallium			0.1
Fluoride			1
Uranium			0.01

A1.2 Geochemical Testing

The following analytical testing methods are used to characterise ore and rock samples from selected boreholes distributed across the proposed mining areas:

- **Multi-element analysis -** whole rock testing for a range of trace and major elements to allow characterisation of the rock for potential contaminants that may leach and adversely influence water quality.
- **Static testing** – whole rock testing for parameters indicative of the potential for acid generation.
- **Kinetic testing** – accelerated weathering of select crushed rock samples to assess the rate of potential acidification and contaminant release.
- **Column testing** – on site weathering of selected crushed rock samples exposed to atmospheric conditions and to assess management practices.

Laboratory analyses for multi-element and static testing parameters were carried out by SGS Laboratories, with kinetic testing of selected rock samples carried out by AECOM. Column tests were conducted by OGNZL, on site at Waihi. Water analysis of samples from the kinetic and column tests was carried out by R J Hill Laboratories.

A2. Rock

A2.1 Introduction

A combination of rock composition analysis, assumptions around rock management, and acid-base accounting is used to determine the likely geochemical effects of rock stockpiling. The degree of sulphide oxidation and corresponding leaching of trace element contaminants is a function of not only rock composition but also the proposed stockpile size, construction, duration of stockpiling, and molar ratio of trace elements to sulphur. The mass of soluble trace elements generated as a result of sulphide oxidation is used to predict likely effects to groundwater on flooding of the mine at closure.

Samples of rock from borehole core were selected to be spatially representative of the rock produced with mining.

A2.2 Rock Composition

Summarised results from the whole rock geochemistry testing (Acid Generating Potential, Major Elements and Trace Elements) are given in Table 31 (proposed Gladstone, WUG), Table 32 (current Martha Mine, MUG, Rex and MP4), and Table 33 (Historical Rock samples from Trio, Favona, Marhta and Correnso).

A2.2.1 Sample Selection

Samples for trace element testing for the Gladstone Pit were selected from the following 14 drillholes within the proposed pit void to provide spatially representative sample of the mineralised andesite and hydrothermal breccia (Table 29). The locations of these drillholes are shown in Figure 17.

Table 29 Sample Selection

Drillhole	Sample Number (n)	Depth Interval (m)
UW540	23	1.6 to 25.9
UW542	53	4 to 56.4
UW549	55	5 to 70.9
UW557	85	18.2 to 110.2
UW558	27	14 to 49.2
UW563	44	7.9 to 164.5
UW566	57	10.1 to 107.5
UW567	67	12.8 to 94.1
UW568	65	56.7 to 156.6
UW569	29	19.7 to 94.1
UW570	27	8.1 to 80.4
UW571	38	5 to 52.9
UW574	58	5.4 to 101.2
UW601	73	6 to 118.5

A2.2.2 Trace Element Digestion Method

Two digestion methods were used for trace element analysis; a 2-acid and a 4-acid digestion method. The 2-acid digestion method has been adopted for elements susceptible to volatilisation, such as mercury, as digestion using the 4-acid method can potentially result in under reporting of these elements.

The 4-acid digestion method allows a more complete digestion of the rock sample, liberating a greater proportion of elements from minerals more resistant to digestion.

For selected core intervals, samples were analysed using both the 2-acid (Nitric Acid and Hydrochloric Acid) and the 4-acid (Nitric Acid, Perchloric Acid, Hydrofluoric Acid and Hydrochloric Acid) digestion method. This allowed for a direct comparison of results between methods. A comprehensive set of samples were analysed using the 2-acid digestion method. A subset of 157 samples were analysed utilising the 4-acid digestion method. Distributions of the corresponding 2-acid data and 4-acid data were compared using the Wilcoxon Mann-Whitney (WMW) test and the results are summarised in Table 30.

Results for a number of elements analysed following 2-acid digestion were found to be statistically different than their 4-acid counterpart. Bivariate linear regression plots were produced for these elements to determine the relationship (if any) between 2-acid and 4-acid test data. Where a strong linear relationship (R^2 value >0.9) could be demonstrated between variables, a correction factor was applied to the 2-acid data (elements included manganese, molybdenum, lead and selenium). Where a weak relationship was observed (aluminium, magnesium, potassium, antimony, barium, chromium and vanadium), 4-acid data was used. Due to the limited sample size of the 4-acid data for each element (n^{max} = 157), data are presented together (i.e. data is not split across geology or rock/ore).

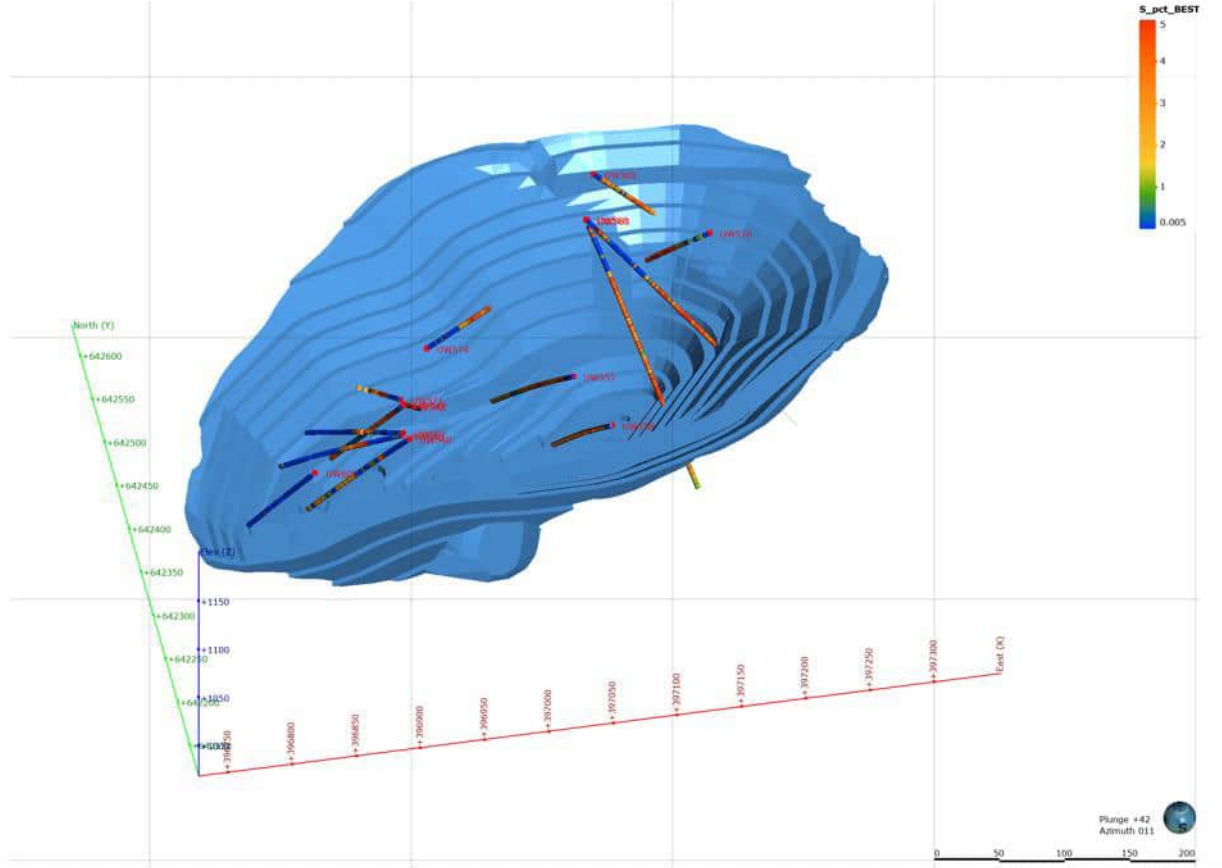


Figure 17 Sample Locations within Gladstone Open Pit

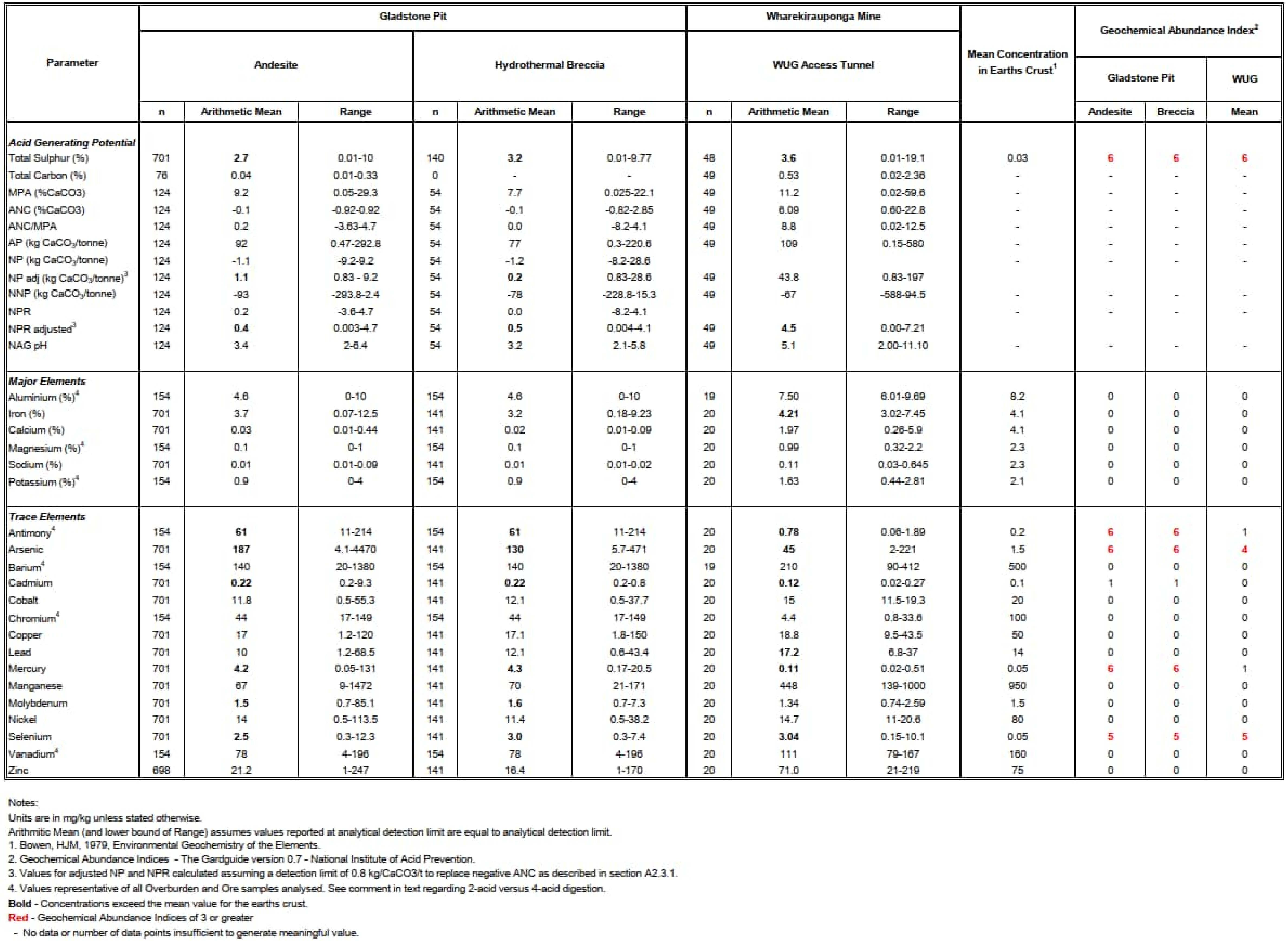
Table 30 2-Acid and 4-Acid Digestion Method Comparison

	Dataset Mean		P-Value*	Dataset used
	2-Acid	4-Acid		
n^{max}	157[#]	157		
Al	0.49	4.67	<0.01	4-Acid
As	144	156	NS	2-Acid
Ba	43	140	<0.01	4-Acid
Ca	0.04	0.05	<0.01	2-Acid
Cd	0.25	0.09	<0.01	2-Acid
Co	12.5	11.5	NS	2-Acid
Cr	8.4	43.4	<0.01	4-Acid
Cu	16.4	17.0	NS	2-Acid
Fe	3.0	3.0	NS	2-Acid
K	0.12	0.95	<0.01	4-Acid
Mg	0.04	0.15	<0.01	4-Acid
Mn	55	82	<0.01	2-Acid with 4-Acid correction applied
Mo	1.1	1.5	<0.01	2-Acid with 4-Acid correction applied
Na	0.01	0.02	NS	2-Acid
Ni	12.4	13.0	NS	2-Acid
Pb	7.2	9.3	<0.01	2-Acid with 4-Acid correction applied
S	2.7	2.6	NS	2-Acid
Sb	17.2	60.7	<0.01	4-Acid
Se	2.2	3.0	<0.01	2-Acid with 4-Acid correction applied
V	8.5	78.0	<0.01	4-Acid
Zn	15.7	19.5	<0.01	2-Acid

[#] The number of 2-Acid samples given is only reflective of where there is a corresponding 4-Acid sample.

*P-Value calculated using the Wilcoxon–Mann–Whitney test to compare 2-acid data distribution with the 4-acid data distribution. P-Values < 0.01 provide strong evidence against the null hypothesis (which in this case assumes that 2-acid and 4-acid data distributions are identical). P-Values labelled as not significant (NS) are sufficiently high to infer 2-acid data and 4-acid data distributions are consistent with the null hypothesis. Difference is attributed to difference in detection limits

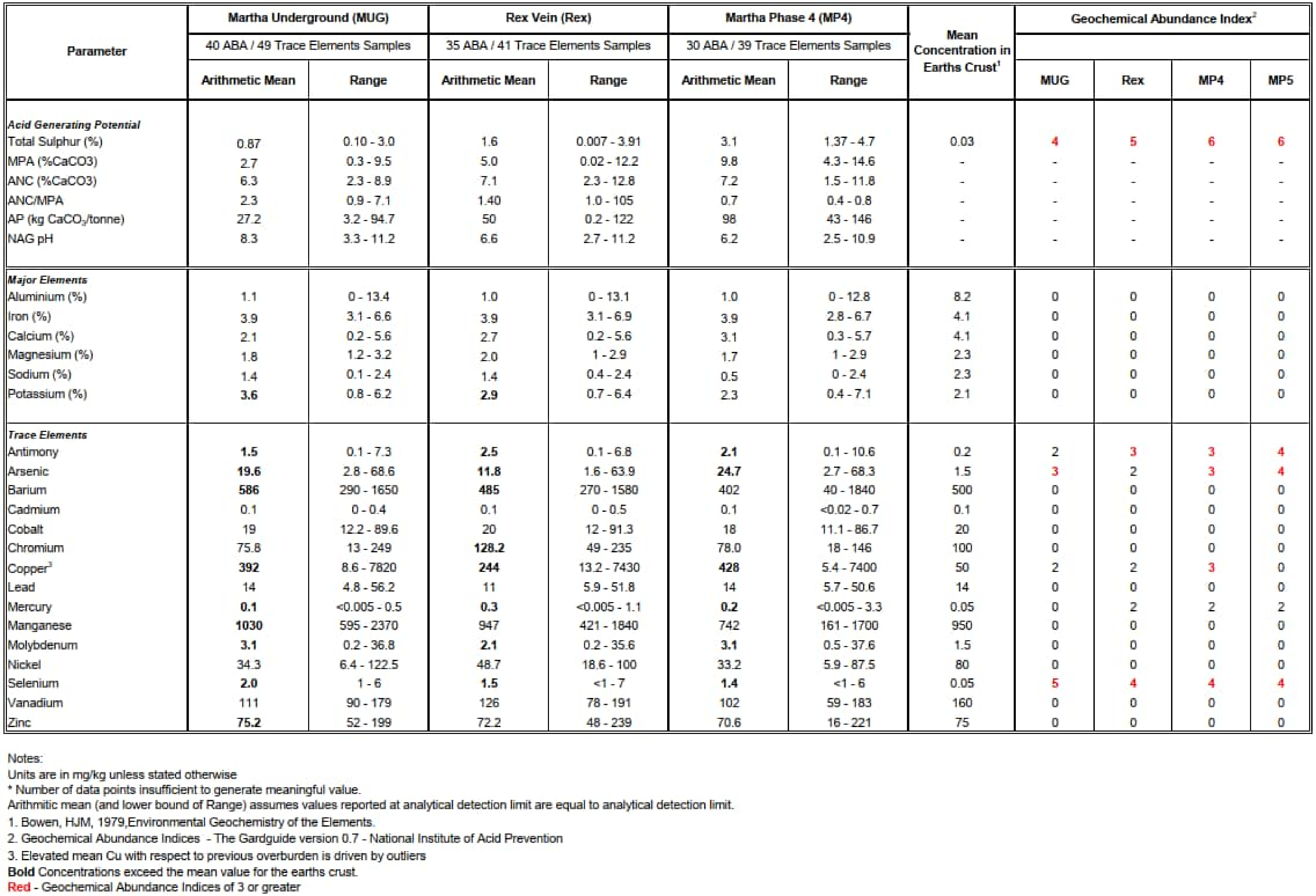
Table 31 Summary of Geochemical Results for Proposed Gladstone Open Pit and Wharekirauponga Underground Mine Rock



Parameter	Gladstone Pit						Wharekirauponga Mine			Mean Concentration in Earths Crust[1]	Geochemical Abundance Index[2]		
	Andesite			Hydrothermal Breccia			WUG Access Tunnel				Gladstone Pit		WUG
	n	Arithmetic Mean	Range	n	Arithmetic Mean	Range	n	Arithmetic Mean	Range		Andesite	Breccia	Mean
Acid Generating Potential													
Total Sulphur (%)	701	**2.7**	0.01-10	140	**3.2**	0.01-9.77	48	**3.6**	0.01-19.1	0.03	6	6	6
Total Carbon (%)	76	0.04	0.01-0.33	0	-	-	49	0.53	0.02-2.36	-	-	-	-
MPA (%CaCO3)	124	9.2	0.05-29.3	54	7.7	0.025-22.1	49	11.2	0.02-59.6	-	-	-	-
ANC (%CaCO3)	124	-0.1	-0.92-0.92	54	-0.1	-0.82-2.85	49	6.09	0.60-22.8	-	-	-	-
ANC/MPA	124	0.2	-3.63-4.7	54	0.0	-8.2-4.1	49	8.8	0.02-12.5	-	-	-	-
AP (kg $CaCO_3$/tonne)	124	92	0.47-292.8	54	77	0.3-220.6	49	109	0.15-580	-	-	-	-
NP (kg $CaCO_3$/tonne)	124	-1.1	-9.2-9.2	54	-1.2	-8.2-28.6				-	-	-	-
NP adj (kg $CaCO_3$/tonne)[3]	124	**1.1**	0.83 - 9.2	54	**0.2**	0.83-28.6	49	43.8	0.83-197				
NNP (kg $CaCO_3$/tonne)	124	-93	-293.8-2.4	54	-78	-228.8-15.3	49	-67	-588-94.5	-	-	-	-
NPR	124	0.2	-3.6-4.7	54	0.0	-8.2-4.1				-	-	-	-
NPR adjusted[3]	124	**0.4**	0.003-4.7	54	**0.5**	0.004-4.1	49	**4.5**	0.00-7.21				
NAG pH	124	3.4	2-6.4	54	3.2	2.1-5.8	49	5.1	2.00-11.10	-	-	-	-
Major Elements													
Aluminium (%)[4]	154	4.6	0-10	154	4.6	0-10	19	7.50	6.01-9.69	8.2	0	0	0
Iron (%)	701	3.7	0.07-12.5	141	3.2	0.18-9.23	20	**4.21**	3.02-7.45	4.1	0	0	0
Calcium (%)	701	0.03	0.01-0.44	141	0.02	0.01-0.09	20	1.97	0.26-5.9	4.1	0	0	0
Magnesium (%)[4]	154	0.1	0-1	154	0.1	0-1	20	0.99	0.32-2.2	2.3	0	0	0
Sodium (%)	701	0.01	0.01-0.09	141	0.01	0.01-0.02	20	0.11	0.03-0.645	2.3	0	0	0
Potassium (%)[4]	154	0.9	0-4	154	0.9	0-4	20	1.63	0.44-2.81	2.1	0	0	0
Trace Elements													
Antimony[4]	154	**61**	11-214	154	**61**	11-214	20	**0.78**	0.06-1.89	0.2	6	6	1
Arsenic	701	**187**	4.1-4470	141	**130**	5.7-471	20	**45**	2-221	1.5	6	6	4
Barium[4]	154	140	20-1380	154	140	20-1380	19	210	90-412	500	0	0	0
Cadmium	701	**0.22**	0.2-9.3	141	**0.22**	0.2-0.8	20	**0.12**	0.02-0.27	0.1	1	1	0
Cobalt	701	11.8	0.5-55.3	141	12.1	0.5-37.7	20	15	11.5-19.3	20	0	0	0
Chromium[4]	154	44	17-149	154	44	17-149	20	4.4	0.8-33.6	100	0	0	0
Copper	701	17	1.2-120	141	17.1	1.8-150	20	18.8	9.5-43.5	50	0	0	0
Lead	701	10	1.2-68.5	141	12.1	0.6-43.4	20	**17.2**	6.8-37	14	0	0	0
Mercury	701	**4.2**	0.05-131	141	**4.3**	0.17-20.5	20	**0.11**	0.02-0.51	0.05	6	6	1
Manganese	701	67	9-1472	141	70	21-171	20	448	139-1000	950	0	0	0
Molybdenum	701	**1.5**	0.7-85.1	141	**1.6**	0.7-7.3	20	1.34	0.74-2.59	1.5	0	0	0
Nickel	701	14	0.5-113.5	141	11.4	0.5-38.2	20	14.7	11-20.6	80	0	0	0
Selenium	701	**2.5**	0.3-12.3	141	**3.0**	0.3-7.4	20	**3.04**	0.15-10.1	0.05	5	5	5
Vanadium[4]	154	78	4-196	154	78	4-196	20	111	79-167	160	0	0	0
Zinc	698	21.2	1-247	141	16.4	1-170	20	71.0	21-219	75	0	0	0

Notes:
Units are in mg/kg unless stated otherwise.
Arithmitic Mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.
1. Bowen, HJM, 1979, Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 0.7 - National Institute of Acid Prevention.
3. Values for adjusted NP and NPR calculated assuming a detection limit of 0.8 kg/CaCO3/t to replace negative ANC as described in section A2.3.1.
4. Values representative of all Overburden and Ore samples analysed. See comment in text regarding 2-acid versus 4-acid digestion.
Bold - Concentrations exceed the mean value for the earths crust.
Red - Geochemical Abundance Indices of 3 or greater
- No data or number of data points insufficient to generate meaningful value.

Table 32 Summary of Geochemical Results for current Martha Mine



Parameter	Martha Underground (MUG)		Rex Vein (Rex)		Martha Phase 4 (MP4)		Mean Concentration in Earths Crust[1]	Geochemical Abundance Index[2]			
	40 ABA / 49 Trace Elements Samples		35 ABA / 41 Trace Elements Samples		30 ABA / 39 Trace Elements Samples						
	Arithmetic Mean	**Range**	**Arithmetic Mean**	**Range**	**Arithmetic Mean**	**Range**		**MUG**	**Rex**	**MP4**	**MP5**
Acid Generating Potential											
Total Sulphur (%)	0.87	0.10 - 3.0	1.6	0.007 - 3.91	3.1	1.37 - 4.7	0.03	4	5	6	6
MPA (%CaCO3)	2.7	0.3 - 9.5	5.0	0.02 - 12.2	9.8	4.3 - 14.6	-	-	-	-	-
ANC (%CaCO3)	6.3	2.3 - 8.9	7.1	2.3 - 12.8	7.2	1.5 - 11.8	-	-	-	-	-
ANC/MPA	2.3	0.9 - 7.1	1.40	1.0 - 105	0.7	0.4 - 0.8	-	-	-	-	-
AP (kg CaCO$_3$/tonne)	27.2	3.2 - 94.7	50	0.2 - 122	98	43 - 146	-	-	-	-	-
NAG pH	8.3	3.3 - 11.2	6.6	2.7 - 11.2	6.2	2.5 - 10.9	-	-	-	-	-
Major Elements											
Aluminium (%)	1.1	0 - 13.4	1.0	0 - 13.1	1.0	0 - 12.8	8.2	0	0	0	0
Iron (%)	3.9	3.1 - 6.6	3.9	3.1 - 6.9	3.9	2.8 - 6.7	4.1	0	0	0	0
Calcium (%)	2.1	0.2 - 5.6	2.7	0.2 - 5.6	3.1	0.3 - 5.7	4.1	0	0	0	0
Magnesium (%)	1.8	1.2 - 3.2	2.0	1 - 2.9	1.7	1 - 2.9	2.3	0	0	0	0
Sodium (%)	1.4	0.1 - 2.4	1.4	0.4 - 2.4	0.5	0 - 2.4	2.3	0	0	0	0
Potassium (%)	**3.6**	0.8 - 6.2	**2.9**	0.7 - 6.4	2.3	0.4 - 7.1	2.1	0	0	0	0
Trace Elements											
Antimony	**1.5**	0.1 - 7.3	**2.5**	0.1 - 6.8	**2.1**	0.1 - 10.6	0.2	2	3	3	4
Arsenic	**19.6**	2.8 - 68.6	**11.8**	1.6 - 63.9	**24.7**	2.7 - 68.3	1.5	3	2	3	4
Barium	**586**	290 - 1650	**485**	270 - 1580	402	40 - 1840	500	0	0	0	0
Cadmium	0.1	0 - 0.4	0.1	0 - 0.5	0.1	<0.02 - 0.7	0.1	0	0	0	0
Cobalt	19	12.2 - 89.6	20	12 - 91.3	18	11.1 - 86.7	20	0	0	0	0
Chromium	75.8	13 - 249	**128.2**	49 - 235	78.0	18 - 146	100	0	0	0	0
Copper[3]	**392**	8.6 - 7820	**244**	13.2 - 7430	**428**	5.4 - 7400	50	2	2	3	0
Lead	14	4.8 - 56.2	11	5.9 - 51.8	14	5.7 - 50.6	14	0	0	0	0
Mercury	**0.1**	<0.005 - 0.5	**0.3**	<0.005 - 1.1	**0.2**	<0.005 - 3.3	0.05	0	2	2	2
Manganese	**1030**	595 - 2370	947	421 - 1840	742	161 - 1700	950	0	0	0	0
Molybdenum	**3.1**	0.2 - 36.8	**2.1**	0.2 - 35.6	**3.1**	0.5 - 37.6	1.5	0	0	0	0
Nickel	34.3	6.4 - 122.5	48.7	18.6 - 100	33.2	5.9 - 87.5	80	0	0	0	0
Selenium	**2.0**	1 - 6	**1.5**	<1 - 7	**1.4**	<1 - 6	0.05	5	4	4	4
Vanadium	111	90 - 179	126	78 - 191	102	59 - 183	160	0	0	0	0
Zinc	**75.2**	52 - 199	72.2	48 - 239	70.6	16 - 221	75	0	0	0	0

Notes:
Units are in mg/kg unless stated otherwise
* Number of data points insufficient to generate meaningful value.
Arithmitic mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.
1. Bowen, HJM, 1979,Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 0.7 - National Institute of Acid Prevention
3. Elevated mean Cu with respect to previous overburden is driven by outliers
Bold Concentrations exceed the mean value for the earths crust.
Red - Geochemical Abundance Indices of 3 or greater

Table 33 Summary of Geochemical Results for Rock – Historical Rock

Parameter	Trio Andesite Waste Rock		Favona Andesite Waste Rock		Martha Mine Waste Rock		Correnso Andesite Waste Rock		Mean Concentration in Earths Crust[1]	Geochemical Abundance Index[2]							
	25 Samples		85 Samples		46 Samples		27 Samples										
	Arithmetic Mean	Range	Arithmetic Mean	Range	Arithmetic Mean	Range	Arithmetic Mean	Range		Trio	Favona	Martha	Correnso	North Wall Data	MUG	Rex	MP4
Acid Generating Potential																	
Total Sulphur (%)	2.1	0.5 - 5.1	2.3	0.01 – 6.0	3.0	0.01 – 9.3	2.15	0.47 - 3.39	0.03	**6**	**6**	**6**	**6**	**6**	**4**	**5**	**6**
Total Carbon (%)	0.3	0.02 - 0.7	-	-	-	-	0.70	0.21 - 1.53	-	-	-	-	-	-	-	-	-
MPA (%CaCO3)	6.5	1.5 – 15.9	7.0	0.03 – 19	9.5	0.03 – 29	6.7	1.5 - 10.6	-	-	-	-	-	-	-	-	-
ANC (%CaCO3)	7.8	<2 – 15.0	1.5	0.03 – 13	3.1	<2 – 16	7.3	2.0 - 15	-	-	-	-	-	-	-	-	-
ANC/MPA	1.6	0.13 - 8.12	1	0.004 – 32	0.9	0 – 18	1.36	0.2 - 4.6	-	-	-	-	-	-	-	-	-
AP (kg $CaCO_3$/tonne)	65	15 - 159	70	0.3 - 190	112	0.3 - 291	67	14.7 - 106	-	-	-	-	-	-	-	-	-
NP (kg $CaCO_3$/tonne)	53 (26)[2]	20 - 150 (1.7 - 58.7)[2]	15	0.3 - 130	31	<2 - 155	58	17.5 - 127	-	-	-	-	-	-	-	-	-
NNP (kg $CaCO_3$/tonne)	-41	-152 - 43	-54	-181 - 114	-73	-252 – 63	-15	-87.8 - 72.5	-	-	-	-	-	-	-	-	-
NAG pH	-	-	-	-	3.4	2.1 - 7.5	8.7	2.3 - 11.2	-	-	-	-	-	-	-	-	-
Major Elements																	
Aluminium (%)	7.1	6.02 - 8.06	4.6	0.5 – 10	7.4	0.7 – 12	7.3	6.2 - 8.2	8.2	0	0	0	0	-	0	0	0
Iron (%)	3.7	2.79 - 4.72	3.0	0.9 – 6	3.4	0.2 – 6	3.5	3.1 - 4.3	4.1	0	0	0	0	-	0	0	0
Calcium (%)	1.4	0.17 - 3.54	0.4	0.01 – 4	1.1	0.03 – 6	2.3	1.2 - 4.2	4.1	0	0	0	0	-	0	0	0
Magnesium (%)	1.8	0.44 - 2.71	0.7	0.01 – 2	1.6	0.01 – 4.5	1.7	1.3 - 2.2	2.3	0	0	0	0	-	0	0	0
Sodium (%)	0.8	0.08 - 1.57	0.1	< 0.01 – 1.6	0.4	<0.01 – 2.1	1.0	0.5 - 1.7	2.3	0	0	0	0	-	0	0	0
Potassium (%)	**3.4**	1.48 - 5.51	1.7	0.1 – 3.5	**2.7**	0.3 – 5.6	4.9	2.1 - 6.2	2.1	0	0	0	1	-	0	0	0
Trace Elements																	
Antimony	**2.4**	1 - 7.07	**24**	1.0 – 118	**6**	0.02 – 50	**12.8**	0.7 - 51	0.2	3	**6**	**4**	**5**	-	2	**3**	**3**
Arsenic	**30.1**	6 - 99.6	**94**	15 – 540	**26**	1.2 – 78	**58.4**	19 - 164	1.5	**4**	**5**	**4**	**5**	-	**3**	2	**3**
Barium	**546**	90 - 710	209	20 - 720	347	34 – 980	**796**	520 - 981	500	0	0	0	0	-	0	0	0
Cadmium	**0.16**	0.04 - 0.4	**0.25**	0.03 – 4	0.1	<0.02 – 0.6	**0.69**	0.1 - 3	0.1	0	1	0	2	-	0	0	0
Cobalt	16.5	12.3 - 24	15	2 – 32	21	0.8 – 57	19.1	12.1 - 29	20	0	0	0	0	-	0	0	0
Chromium	**150**	50 - 281	**163**	44 – 392	**146**	81 – 277	75.1	51 - 125	100	0	0	0	0	-	0	0	0
Copper[3]	24.9	12.6 - 61.8	39	11 – 380	29	8 – 150	24.7	2 - 88	50	0	0	0	0	-	2	2	**3**
Lead	**23.2**	8.2 - 132	**41**	4 – 1070	10	1 – 28	**23.3**	8 - 103	14	0	1	0	0	-	0	0	0
Mercury	**0.15**	0.01 - 0.9	**0.75**	0.06 – 4.5	**0.4**	0.04 – 2	0.05	0.025 - 0.099	0.05	1	**3**	2	0	-	0	2	2
Manganese	915	94 - 1450	294	26 – 1540	**985**	90 – 3400	**1070**	638 - 2731	950	0	0	0	0	-	0	0	0
Molybdenum	**1.6**	0.6 - 4.6	**4**	1 – 12	**1.8**	0.3 – 6	**1.9**	0.6 - 6	1.5	0	1	0	0	-	0	0	0
Nickel	31.8	13.4 - 66	14	6 – 27	57	7 – 159	25.9	14 - 39	80	0	0	0	0	-	0	0	0
Selenium	**2.0**	1 - 6	**2.5**	< 1 – 15	**1.1**	0.1 – 4	**6.37**	2 - 36	0.05	**5**	**5**	**4**	**6**	-	**5**	**4**	**4**
Vanadium	113	84 - 146	86	5 – 180	104	3 – 206	**194**	181 - 205	160	0	0	0	0	-	0	0	0
Zinc	**92.6**	44 - 227	**96**	7 – 1670	63	<2 – 152	**82.6**	31 - 201	75	0	0	0	0	-	0	0	0

Notes:
Units are in mg/kg unless stated otherwise
* Number of data points insufficient to generate meaningful value.
Arithmitic mean (and lower bound of Range) assumes values reported at analytical detection limit are equal to analytical detection limit.
1. Bowen, HJM, 1979,Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 0.7 - National Institute of Acid Prevention
3. Elevated mean Cu with respect to previous overburden is driven by outliers
Bold Concentrations exceed the mean value for the earths crust.
Red - Geochemical Abundance Indices of 3 or greater

A2.2.3 Statistical Analysis of Rock Geochemistry

Rock geochemistry datasets for the proposed Gladstone Pit were assessed using the WMW test (probability of sample population being equivalent) to determine whether significant variation exists between the following:

- Rock chemistry at the proposed Gladstone Pit relative to rock from historically mined areas; and
- Proposed hydrothermal breccia rock relative to proposed andesitic rock (regardless of proposed source).

Statistical WMW analyses were undertaken using ProUCL software (version 5.1) using a confidence coefficient of 95%. The datasets tested were sulphur, aluminium, iron, calcium, antimony, arsenic, barium, cadmium, cobalt, chromium, copper, lead, mercury, manganese, molybdenum, nickel, selenium, vanadium and zinc. Summarised results of the analyses are presented in Table 34 and box and whisker plots showing the relative distribution are provided in Figure 18 to Figure 23.

Table 34 Summary of Wilcoxon Mann-Whitney Test Results

	Gladstone relative to historical	Andesite relative to Breccia
Total S	Equivalent	Elevated
Al	Depressed	Elevated
Fe	Equivalent	Elevated
Ca	Depressed	Elevated
Sb	Elevated	Depressed
As	Elevated	Equivalent
Ba	Depressed	Depressed
Cd	Elevated	Depressed
Co	Depressed	Elevated
Cr	Depressed	Depressed
Cu	Depressed	Elevated
Pb	Depressed	Equivalent
Hg	Elevated	Depressed
Mn	Depressed	Depressed
Mo	Depressed	Depressed
Ni	Depressed	Elevated
Se	Depressed	Depressed
V	Depressed	Elevated
Zn	Depressed	Elevated

The Wilcoxon Mann-Whitney Test suggests the distribution and / range of the two data sets are different, however the means / median are similar. A non-significant p-value may therefore be a function of differing sample sizes.

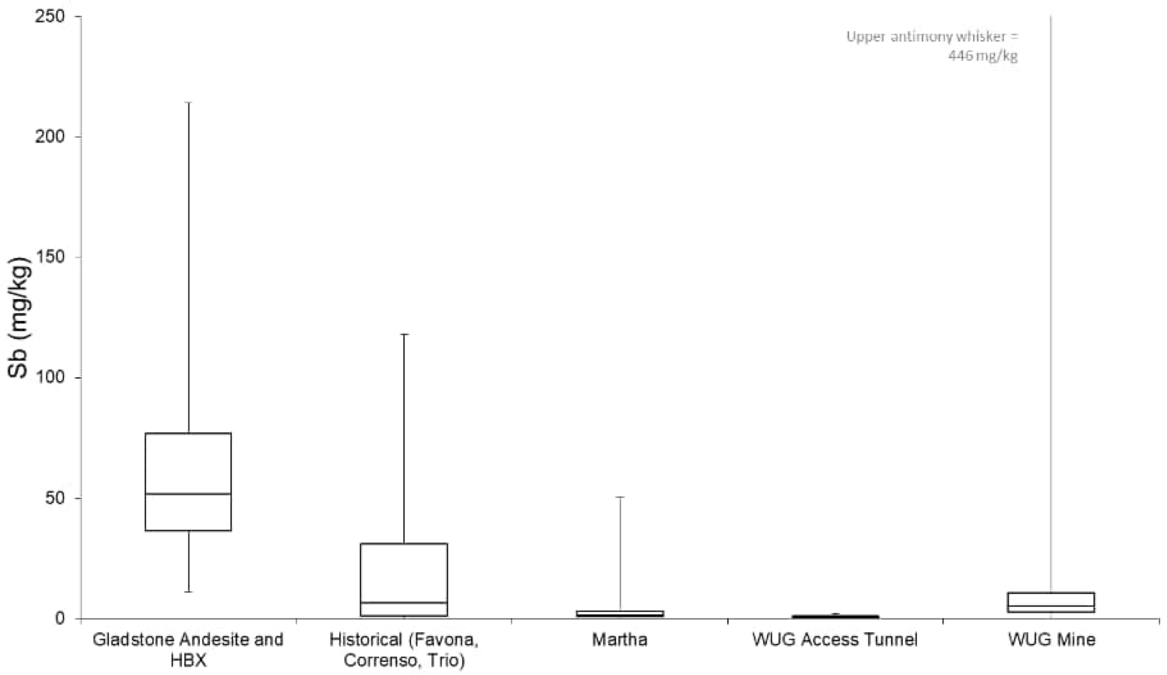


Figure 18. Box plot showing concentration range of Antimony in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

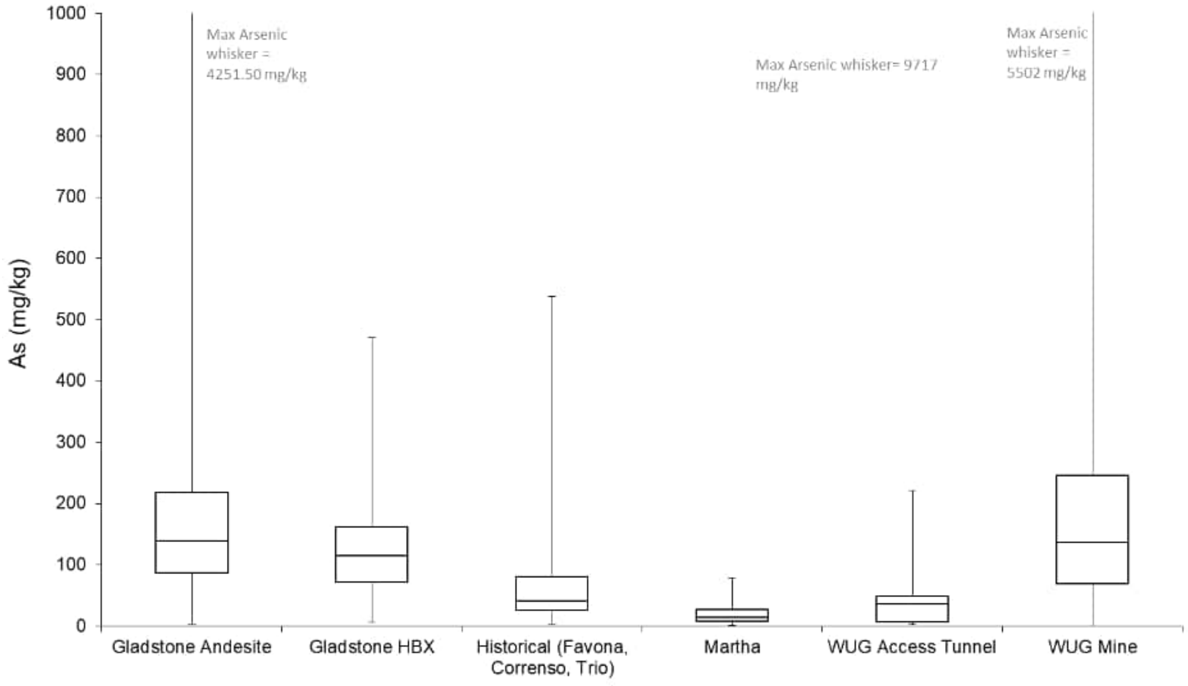


Figure 19. Box plot showing concentration range of Arsenic in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

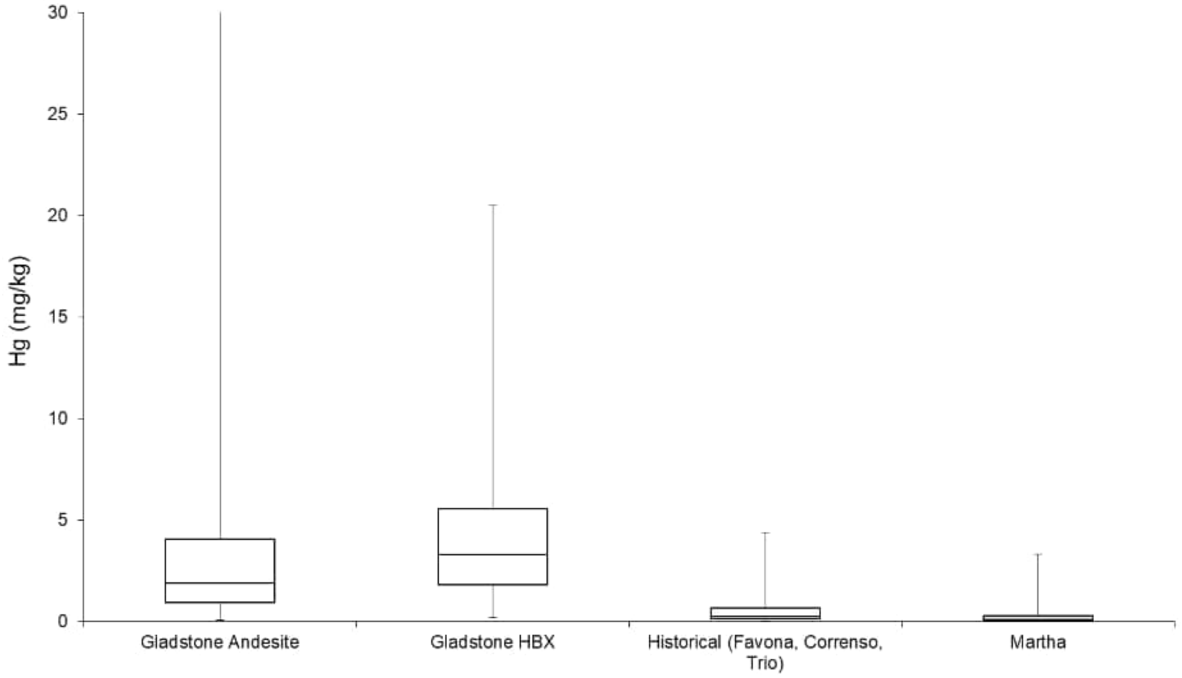


Figure 20. Box plot showing concentration range of Mercury in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

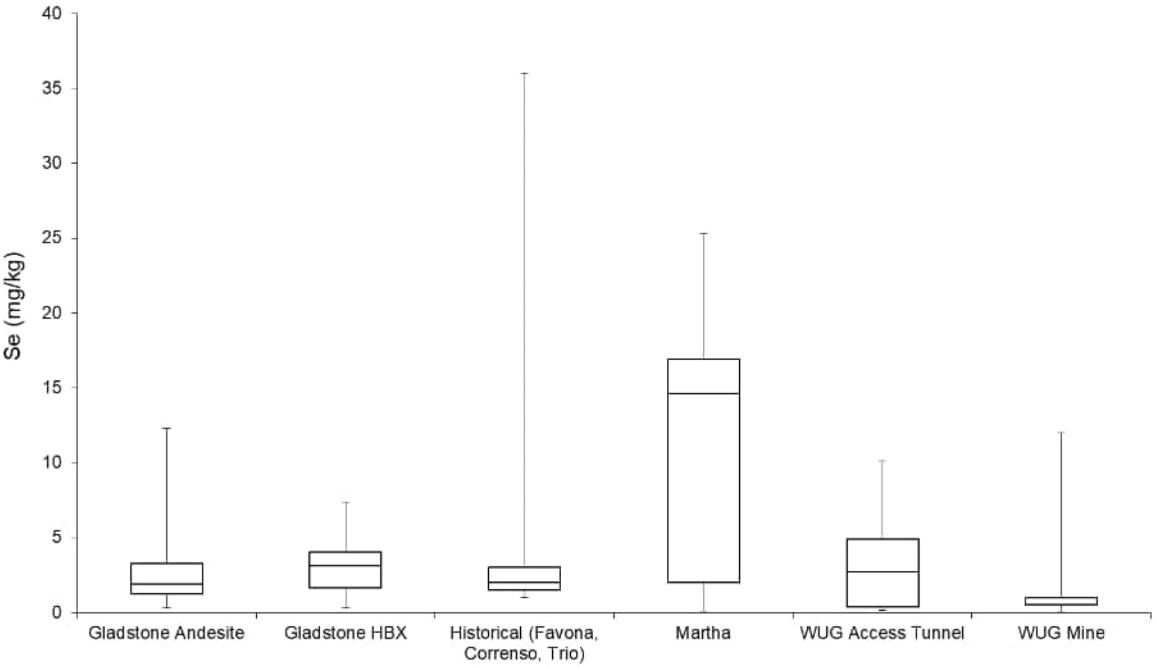


Figure 21. Box plot showing concentration range of Selenium in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

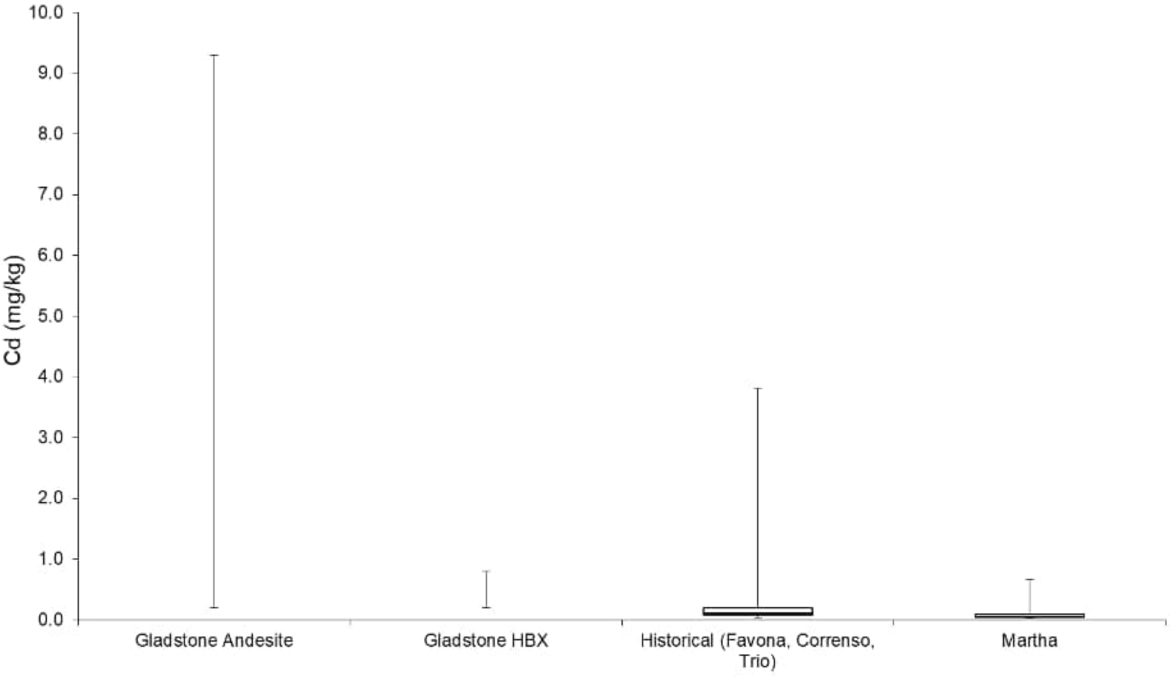


Figure 22. Box plot showing concentration range of Cadmium in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg). Where only two nodes are shown (lowest and highest) 75% of the samples are below the method detection limit.

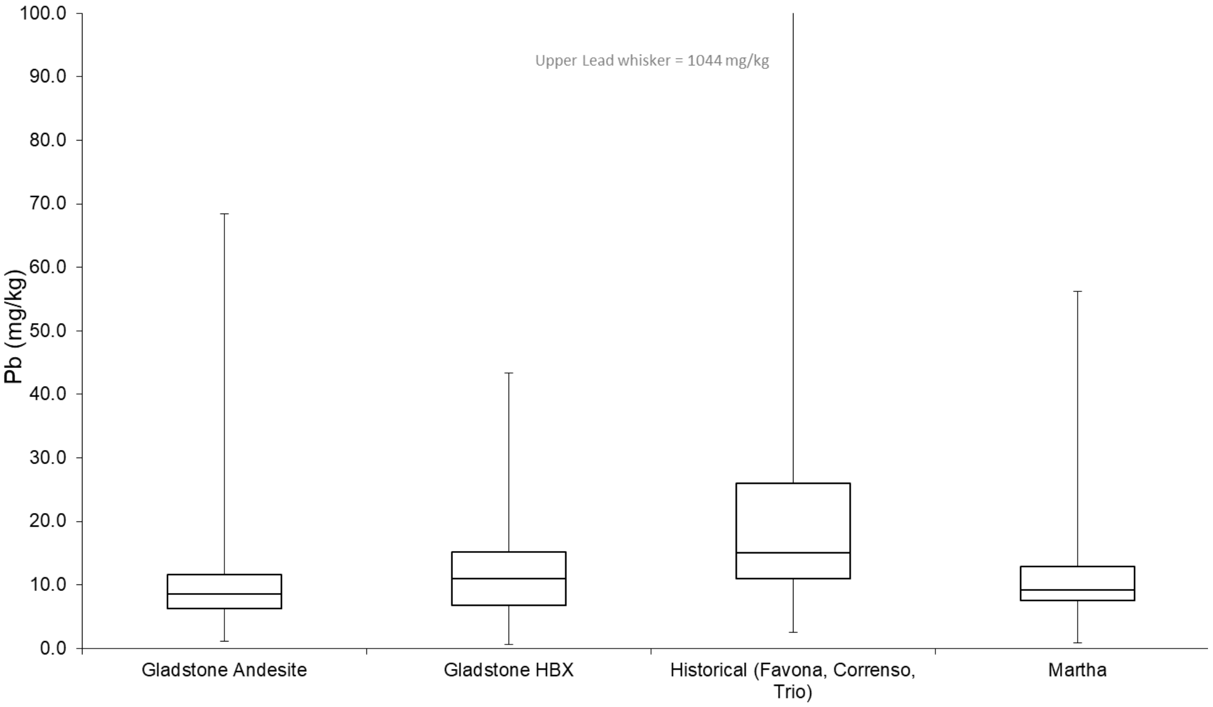


Figure 23. Box plot showing concentration range of Lead in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Box and whisker source data assumes values reported at the laboratory analytical detection limit are equal to the analytical detection limit (e.g. a laboratory value of <0.02 mg/kg is represented as 0.02 mg/kg).

When compared to historical rock trace element data, the proposed Gladstone Pit rock is generally depressed in trace element concentrations with the exception of antimony, arsenic, and mercury, which are elevated. Although these elements are elevated, geochemical controls such as co-precipitation and complexion, along with the current on-site treatment facilities will control the trace element concentrations from the mine area to within the current operating limits for treated water. It is predicted that elevated trace element concentrations in mine waters arising from elevated concentrations within the rock material (with respect to historical mining areas) will not impact the site’s ability to meet the existing discharge consent conditions.

Of note is mercury, which has largely been recorded below the laboratory method detection limit in site mine waters and shows an order of magnitude increase within the rock material. As such, mercury leaching potential is further assessed through kinetic leaching tests to determine the likely resultant levels that will be present in the proposed mine waters.

A2.2.3.1 Distribution of Trace elements in the Rock Material

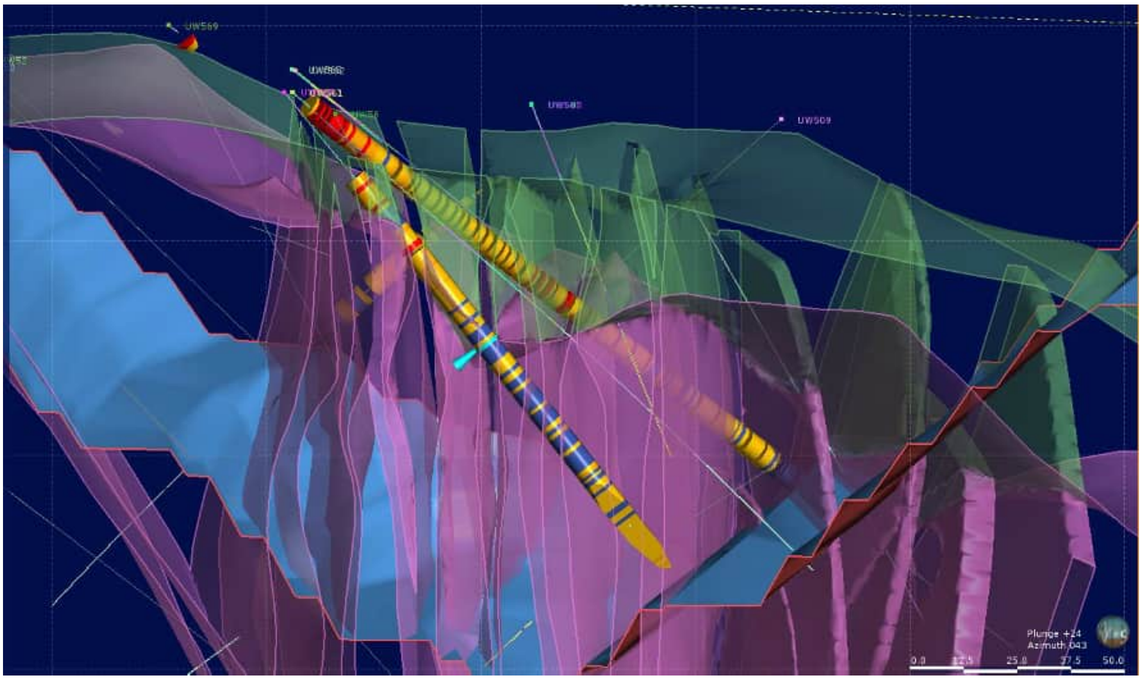
Elevated trace element concentrations (antimony, arsenic and mercury) in the rock (and ore body) relative to historically mined areas need to be assessed for potential implications for consent compliance at the point of discharge (both to water and to air).

An assessment of the distribution of trace elements within the rock shows that mercury is elevated in the highly clay altered Andesitic material located near the surface and associated with the Breccia material.

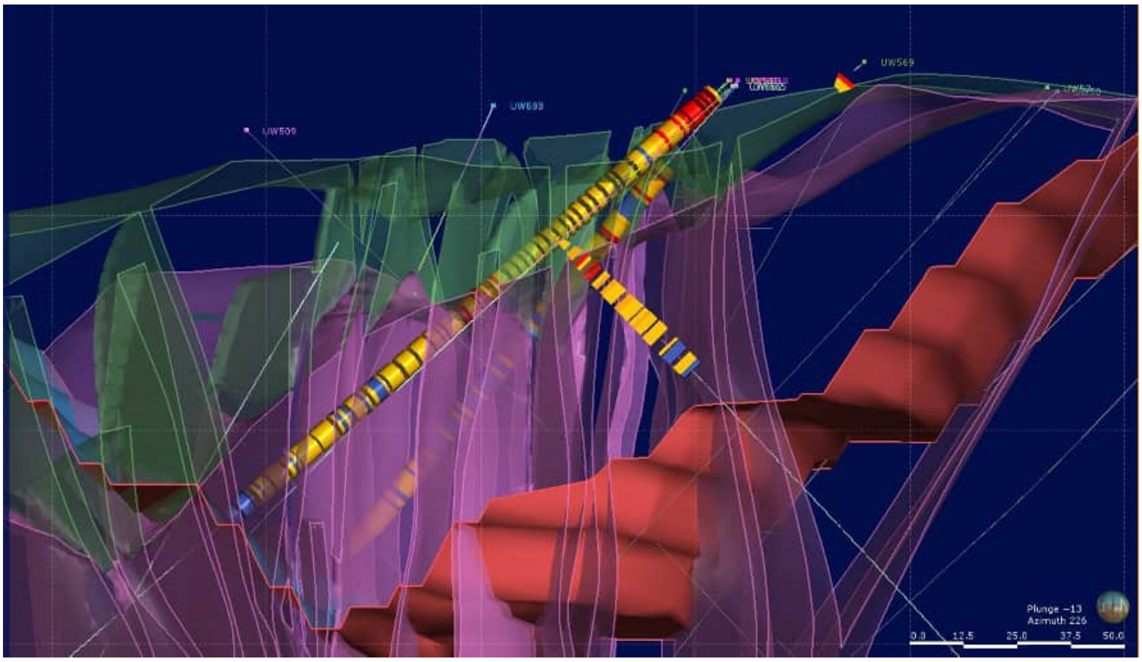
Cross sections of the Gladstone pit profile with associated drill holes and cores showing categorised mercury concentrations are presented in Figure 24.

From the figure, a pattern of decreasing mercury concentration with depth can be observed with the higher mercury concentrations (red > 10 ppm, orange 5-10 ppm) focused on the Breccia rock material or within the Andesitic material bordering the Breccia material. Core with a mercury concentration of < 1 ppm (signified as blue) is typically located within the deeper Andesitic material. This pattern is evident through the pit profiles and the distributions are consistent with those previously identified in the area (Browne, 2008).

Relatively low concentrations of other trace elements are noted in areas of elevated mercury. There is also no positive or negative correlation between mercury with sulphur although the highest mean mercury concentrations are found in breccia samples which tend to coincide with the lowest mean sulphur concentrations. Both these factors may be due to the high volatility of elemental mercury and the capability of more soluble mercury forms being more distal to the ore body, especially through post-mineralisation cover. This can result in the secondary mercury halo around the deposits varying significantly in size (Browne, 2008).



View looking East



View looking West

Figure 24. Cross Sectional View of Gladstone Pit

Cores: Red, Hg >10ppm; Orange, Hg 5-10ppm; Yellow, Hg 1-5ppm; Blue, Hg <1ppm.

Rock: Green, Breccia; Purple, Andesite.

A2.3 Rock Acid Generating Potential

A2.3.1 Static Testing

Static testing provides a mass balance for the potential acid generating and neutralising minerals and reactions but does not account for the potential rate of reactions that can significantly influence whether rock will generate ARD.

Summarised static data is presented in Table 31 (proposed Gladstone), Table 32 (Martha Mine) and Table 33 (Historical rock samples from Trio, Favona, Martha and Correnso) and presented in boxplots Figure to Figure 5 of the main report.

In general, the acid generating potential of the rock from within the proposed GOP and WUG is similar to that of historical mining areas. This includes:

- Mean sulphur concentrations in the Gladstone rock ranging from 2.7% in the andesite to 3.2% in the hydrothermal breccia.
- Mean sulphur concentrations in the Wharekirauponga rock ranging from 0.91% in the WUG mine to 3.7% in the WUG access tunnel.
- These are comparable to the historical rock sulphur concentrations ranging from 2.1 to 3.0%. As a result the acid potential (AP) in kg $CaCO_3$ per tonne of the Gladstone and WUG rock is considered comparable.

The acid base accounting of the rock from within the proposed Gladstone Pit and the WUG mine has the following differences:

- The largest difference between the datasets is the lower neutralising capacity within the Gladstone Pit. This is highlighted with respect to a lower overall mean acid neutralising capacity (ANC), ANC/MPA, and neutralisation potential (NP) values within the proposed Gladstone Pit rock when compared with mined rock.
- The acid neutralising capacity of the WUG rock is comparable to existing mining operations as shown in Figure 25.
- As a result of the similar AP and ANC in WUG rock to historical mined rock, the ANC/MPA is also comparable to previously mined rock.

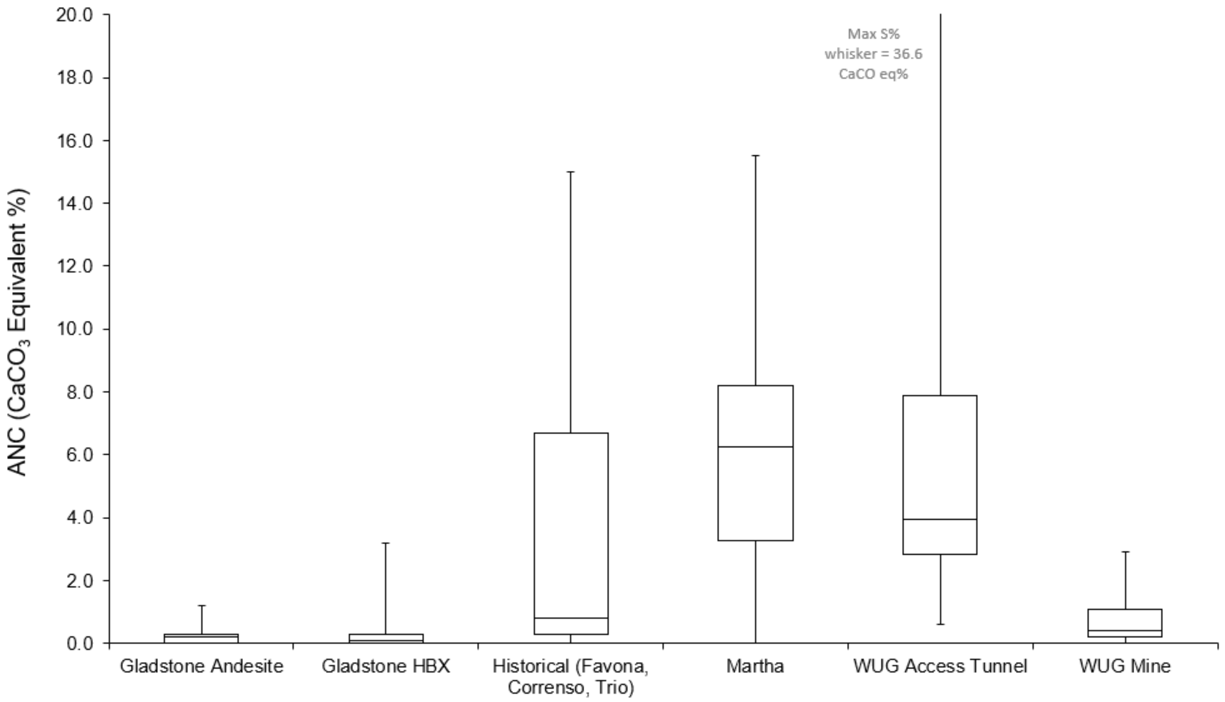


Figure 25 Box plot showing calculated Acid Neutralising Capacity range in rock material

Box plot shows from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Data extending below 0% on the Y-axis are not shown.

Samples tested for acid base accounting have been collected from existing drillcore. As such low ANC samples with highly reactive sulphur may have consumed all acid neutralising capacity and be acid producing before sampling. Total sulphur is used to calculate the maximum potential acidity (MPA) and acid potential (AP) and as such these values accurately represent the acid producing potential of the rock material.

Acid neutralising capacity based on titration may however be understated. This makes calculation of NAPP (NAPP=MPA-ANC) conservative for the rock materials assessed.

Neutralising potential (NP) is a calculated from ANC results.

Net potential ratio (NPR), net acid producing potential (NAPP) and net neutralisation potential (NNP) are calculated as follows:

- Net potential ratio (NPR) = NP/AP
- Net acid producing potential (NAPP) = MPA - ANC
- Net neutralisation potential (NNP) = NP - AP

Table 31 includes 37 samples that have zero ANC and 105 samples that have negative ANC which is as a result of sulphides within drillcore samples oxidising and consuming the acid neutralising capacity. To avoid excluding these from NPR/NAG classification plots drill core samples with negative ANC values have been set at a nominal detection limit value of 0.8 kg $CaCO_3$ per tonne . These adjusted values are shown as NP (adjusted) and are used to calculate NPR (adjusted). This also enables comparison to historic datasets.

It is also noted that some of the negative ANC's are a function of sulphides in drillcore oxidising post drilling. As outlined in Appendix G, sampling of drilling core in the future should ensure fresh unoxidized samples are analysed wherever possible.

When plotted on a net potential ratio (NPR) / net acid generating (NAG) pH diagram (Figure 26), the majority of the samples from WUG and Gladstone are PAF exhibiting a low pH (pH < 4.5) and low NPR

(NPR <1). Of the remaining samples, approximately one third are classified as ‘uncertain’. In general, the Martha Pit material (MOP4) exhibits a lower acid producing potential.

To further evaluate the availability of ANC from the static test data the NAG and NAPP results have been compared to assess how readily the acid and neutralising potential is liberated by NAG tests relative to the acid based accounting (NAPP) which is based on total acid generating and neutralising potential. As shown in Figure 27 there is a strong correlation suggesting that the majority of acid generating and neutralising components are readily liberated in the NAG tests.

In this regard it is also noted that the Correnso materials that are generated as part of the existing mine are high in carbonates and associated deposition deep within the Martha system. The mineralogy and liberation of the ANC from these samples is therefore not reasonably comparable to the GOP materials which are shallow within the epithermal system.

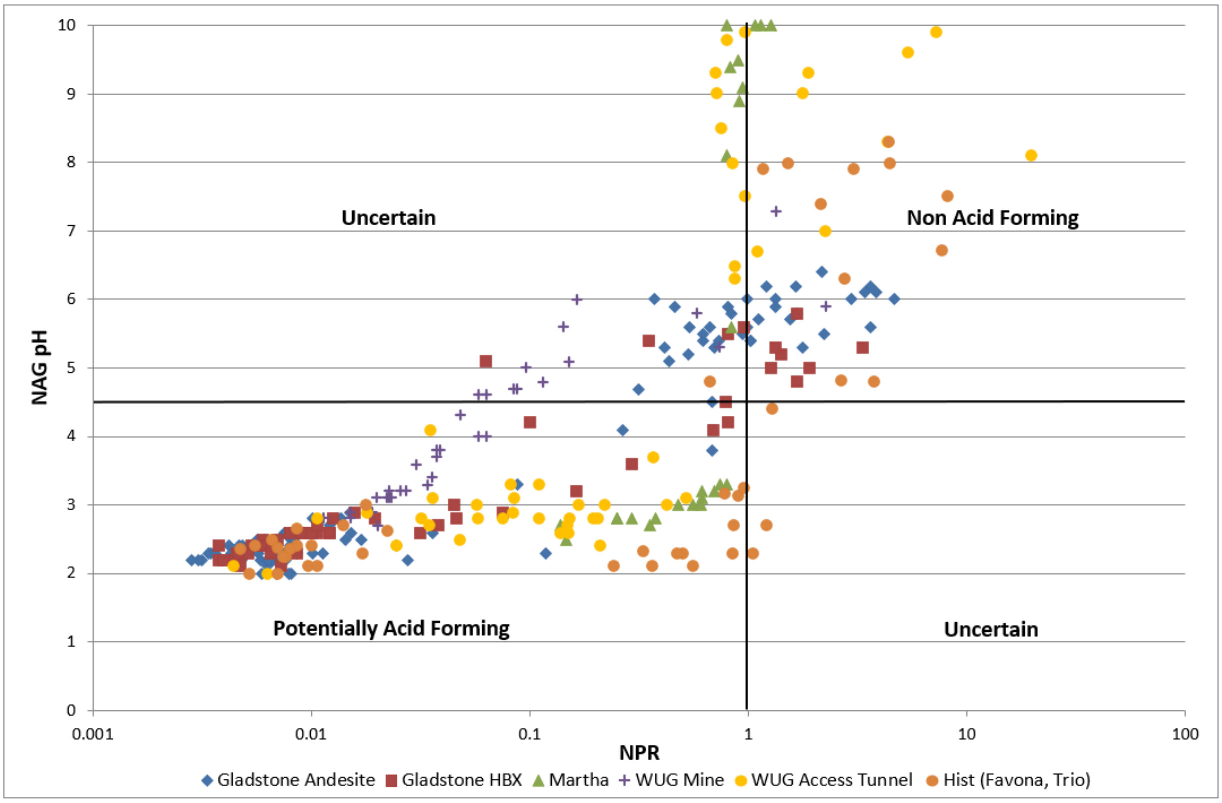


Figure 26. NPR/NAG pH diagram for Rock Material

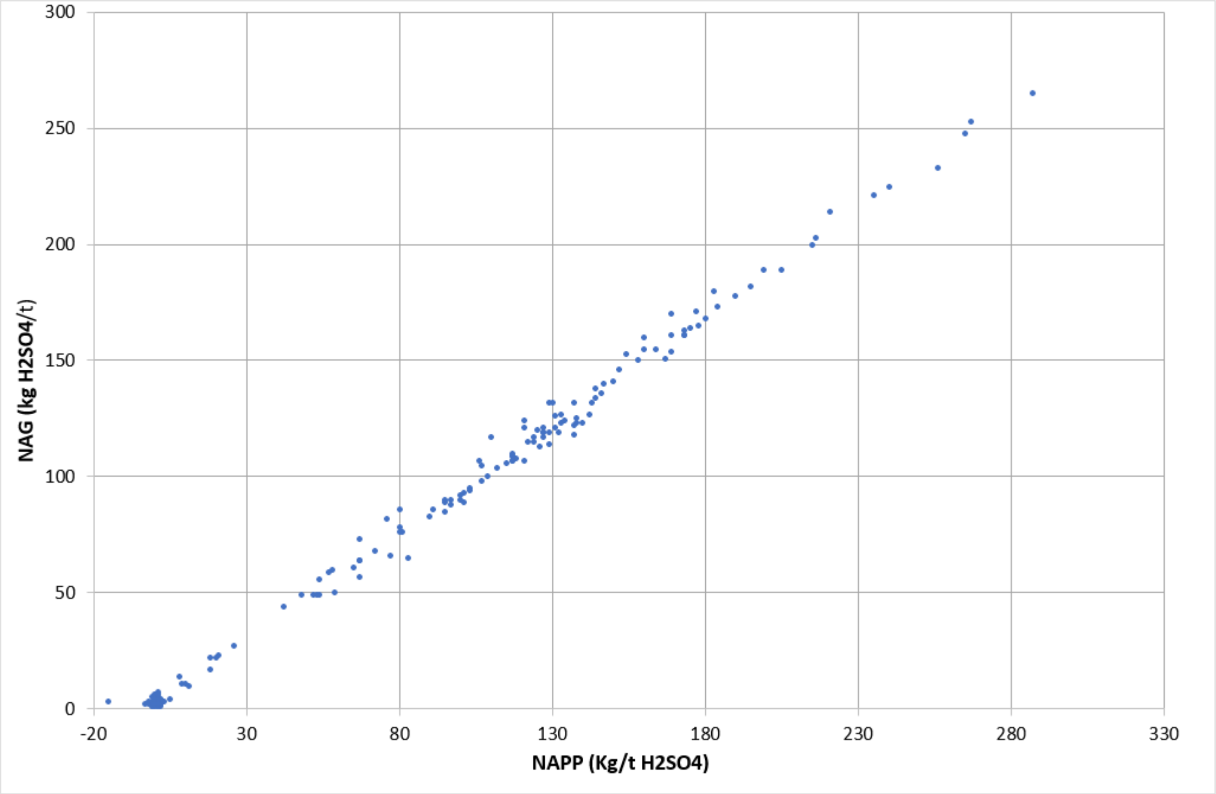
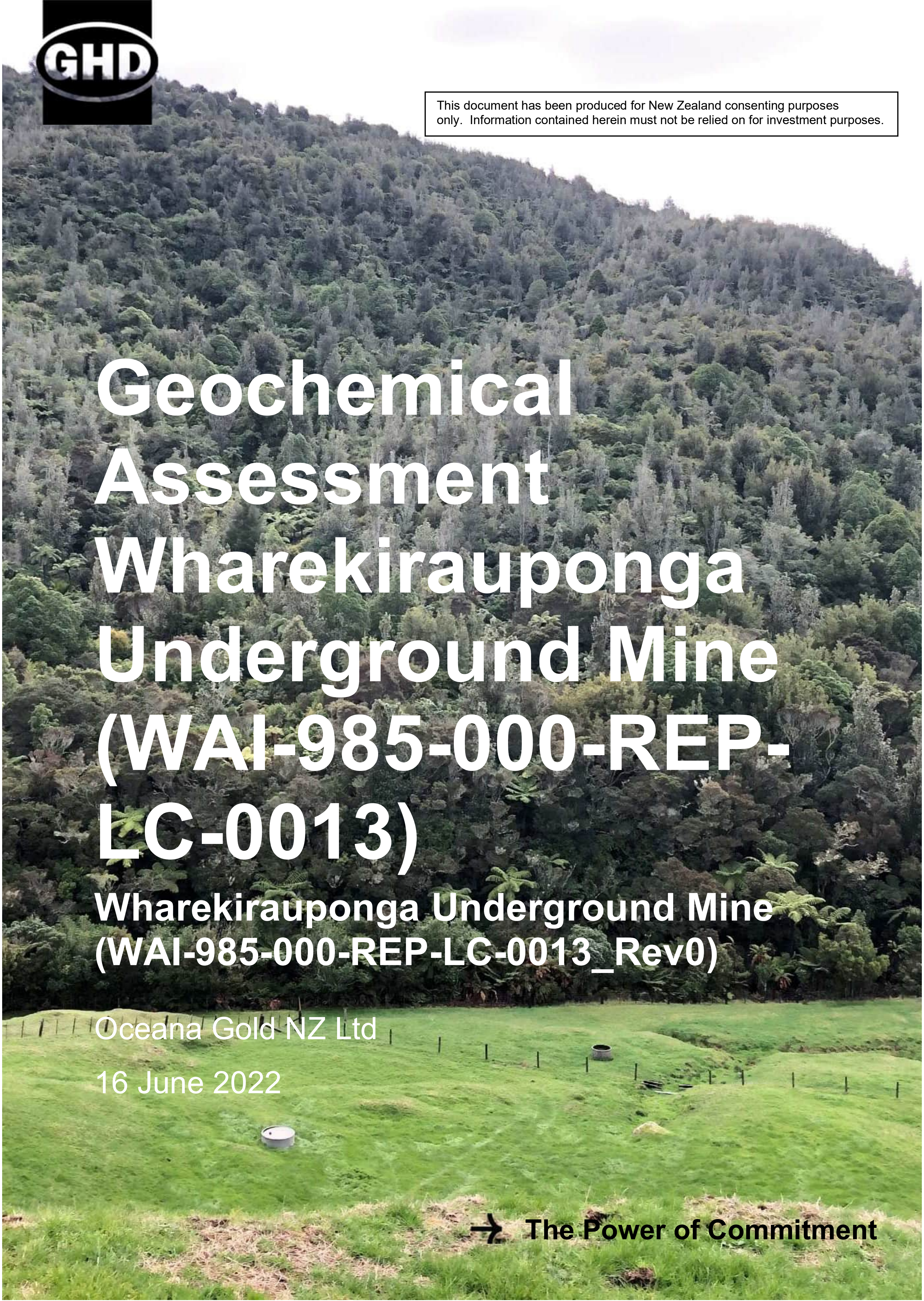


Figure 27 NAG versus NAPP diagram for Gladstone Rock

Appendix B

Geochemical Assessment Wharekirauponga Underground Mine



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Geochemical Assessment Wharekirauponga Underground Mine (WAI-985-000-REP-LC-0013)

Wharekirauponga Underground Mine (WAI-985-000-REP-LC-0013_Rev0)

Oceana Gold NZ Ltd

16 June 2022

The Power of Commitment

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Executive Summary

Oceana Gold NZ Ltd (OceanaGold) are in the process of developing a new underground mine at Wharekirauponga referred to as the “Wharekirauponga Underground” or “WUG Mine”. Development of the mine initially involves developing a dual tunnel drive (the Willows Access Tunnel) to link the Wharekirauponga gold resource and a portal located on farmland near Willows Road (Willows Road Farm) approximately 5 km north of Waihi and OceanaGold’s current Martha operations. The portal area will be linked to the current Waihi site via road and an additional access tunnel. The WUG Mine is a component of OceanaGold’s Waihi North Project.

This report comprises the following studies for the WUG Mine component of the Waihi North Project:

- Review of available geochemical data, characterisation and assessment of the acid forming properties of the Willows Access Tunnel and WUG Mine spoil material and how this will influence spoil storage, runoff and seepage;
- Outline of recommended strategies to minimise the onset of acidification (where applicable) and predict likely groundwater inflow, leachate and runoff water quality from the access tunnels, mine, and rock storage area in order to inform collection and treatment requirements.

The Willows Access Tunnel alignment, as in OceanaGold’s current operations at Waihi, is situated in predominantly andesite material, with minor occurrences of more felsic rocks (rhyolite and ignimbrite) encountered toward the northern terminus. The WUG Mine is hosted predominantly in rhyolitic material overlain by andesitic material.

Representative spoil material has been selected from exploration core in both the WUG Mine ore body and the tunnel portal area and analysed for multi-element and acid base accounting (ABA) data in order to characterise the geochemical makeup of the two areas and explore similarities / differences to material encountered at OceanaGold’s current Waihi operations.

Analysis suggests that spoil material from the portal area and within the majority of the Willows Access Tunnel alignment is comparable in trace element composition and acid generating potential to spoil material currently encountered at OceanaGold’s Waihi operations based on the data collected to date.

Multi-element analysis data for the WUG Mine show that arsenic is elevated and iron is depressed with respect to the current Martha dataset. In addition, both sulphur (and hence maximum potential acidity (MPA)) and the acid neutralising capacity (ANC) of spoil material within the WUG Mine is depressed compared to spoil within the WUG Access Tunnel alignment. Similar to the current operations at Waihi, element enrichment and a greater abundance of trace elements is apparent in both the rhyolitic and andesitic spoil material as depth increases.

As the majority of the spoil material to be stored in a rock stack at Willows Farm (the WRS) will be sourced from the Willows Access Tunnel (spoil from the WUG Mine will form a minor component), the WRS is expected to behave geochemically similar to rock stacks at OceanaGold’s existing operations at Waihi.

Groundwater inflow (into the WUG Mine and Willows Access Tunnel), WRS runoff and seepage water quality predictions are conservatively based on 95th percentile data from the current Waihi operations. This is considered appropriate when considering the similarities between the geology of the current Waihi operations and the Willows Access Tunnel, but also takes into account observed geochemical differences within the WUG Mine. The predicted water quality is utilised within the water balance assessment (reported separately), which takes into account the water treatment capacity and availability, trace element removal rates and consented discharge requirements.

Field column testing utilising spoil from the WUG Mine was considered necessary to determine, inform and enable refinement of this assessment with time and give greater certainty of predicted leachate quality. The test columns have been constructed at OceanaGold’s current Waihi operations and the leachate data was utilised to confirm predictions outlined.

Appropriate management of the rock material (both from the Willows Access Tunnel and the WUG Mine) is crucial to limit potential impacts on the surrounding environment and to limit the volume of water requiring treatment. Similar management practises for spoil material that have been successfully employed at OceanaGold’s current Waihi operations are to be utilised at the WRS (e.g., compaction, limestone amendment and seepage/runoff collection).

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1. Introduction

1.1 Project Description and Background

Oceana Gold NZ Ltd (OceanaGold) proposes to proceed with developing a new underground mine at Wharekirauponga referred to as the “Wharekirauponga Underground” or “WUG” Mine. Development of the mine initially involves developing a tunnel drive (the Willows Access Tunnel) to link the Wharekirauponga gold resource and a portal located on farmland near Willows Road, approximately 5 km north of Waihi. This portal area will be linked to the current Waihi site via road, water conveyance pipelines and an additional access tunnel. For the following assessment the Willows Access Tunnel and WUG Mine are being treated as distinct entities and have been consequently separated into the following groupings as shown in Figure 1:

> **Willows Access Tunnel** – Comprising a single decline from Willows Road Farm to vent raise 1, then dual parallel tunnels to the Wharekirauponga Orebodies and a single decline from the Waihi plant to the base of vent raise 1. Predominately for ore and rock transportation, development, exploration and vent drives.
>
> **WUG Mine** – T-Stream and East-Graben-Vein (EG-Vein) orebodies

The location of the surface facilities area (SFA) and the WUG Mine in relation to the current OceanaGold Waihi operations is shown on Figure 1. The key components of the portal infrastructure are outlined in Figure 2 .

The WUG Mine and associated infrastructure will be progressed under the wider project – Waihi North Project. Key components of the project pertaining to the WUG Mine portion of the site include:

- Development of an access tunnel, associated portal and infrastructure located on Willows Road Farm, located approximately 5 km north of the current site processing plant, to access the WUG Mine;
- A new underground mine targeting the Wharekirauponga orebodies located approximately 11 km northwest of the township of Waihi;
- A pipeline connecting the Willows Access Tunnel portal area with the site Water Treatment Plant (WTP);
- An additional access tunnel connecting the orebodies and portal area with the current site Processing Plant; and
- A new temporary rock stack (WRS) adjacent the Willows Road Farm portal to store tunnel spoil during the exploration and operation of the WUG Mine.

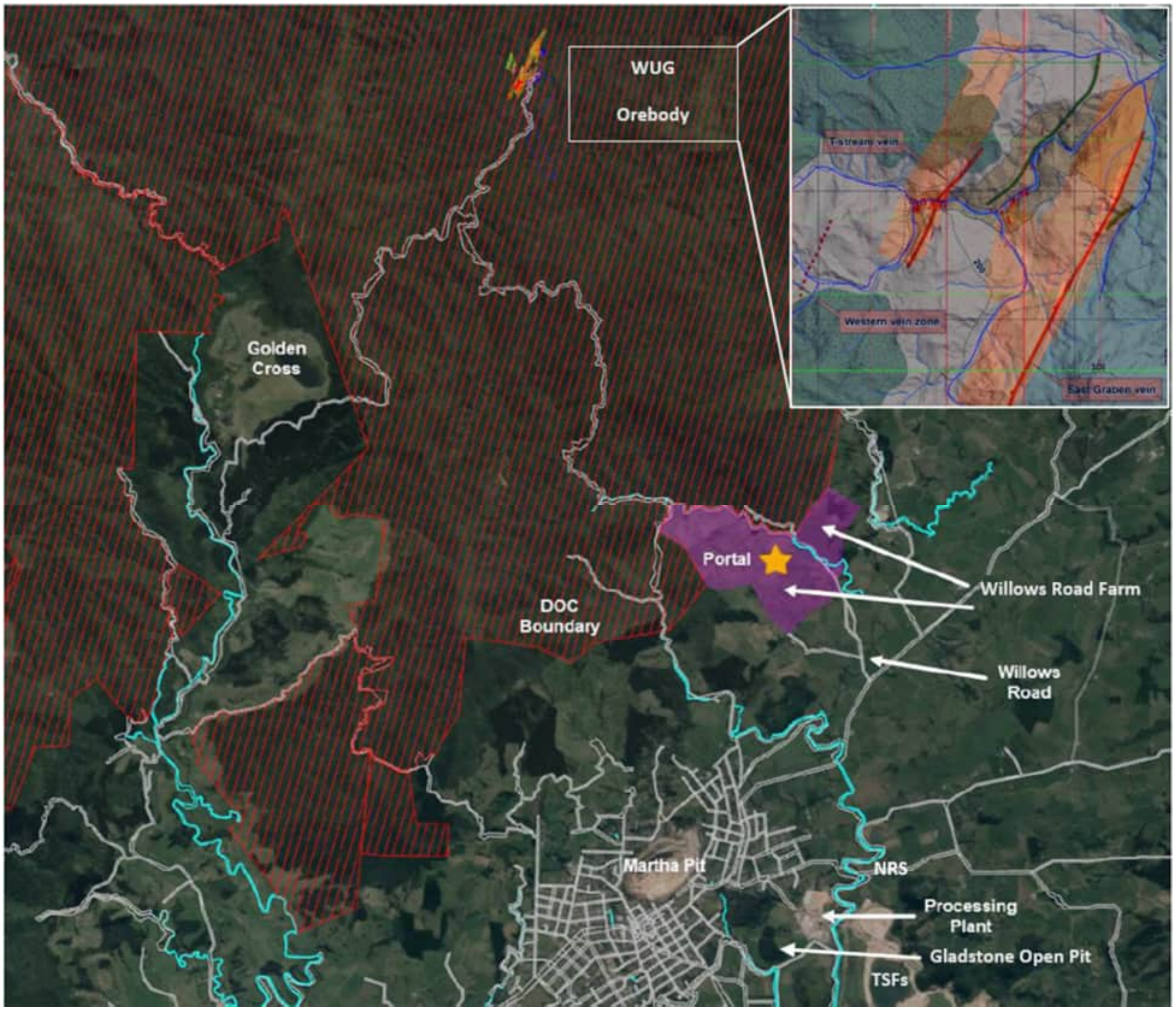

Figure 1 Overview of the WUG components showing the Willows Road Portal area and the Wharekirauponga orebodies in relation to the current OceanaGold facilities at Waihi.

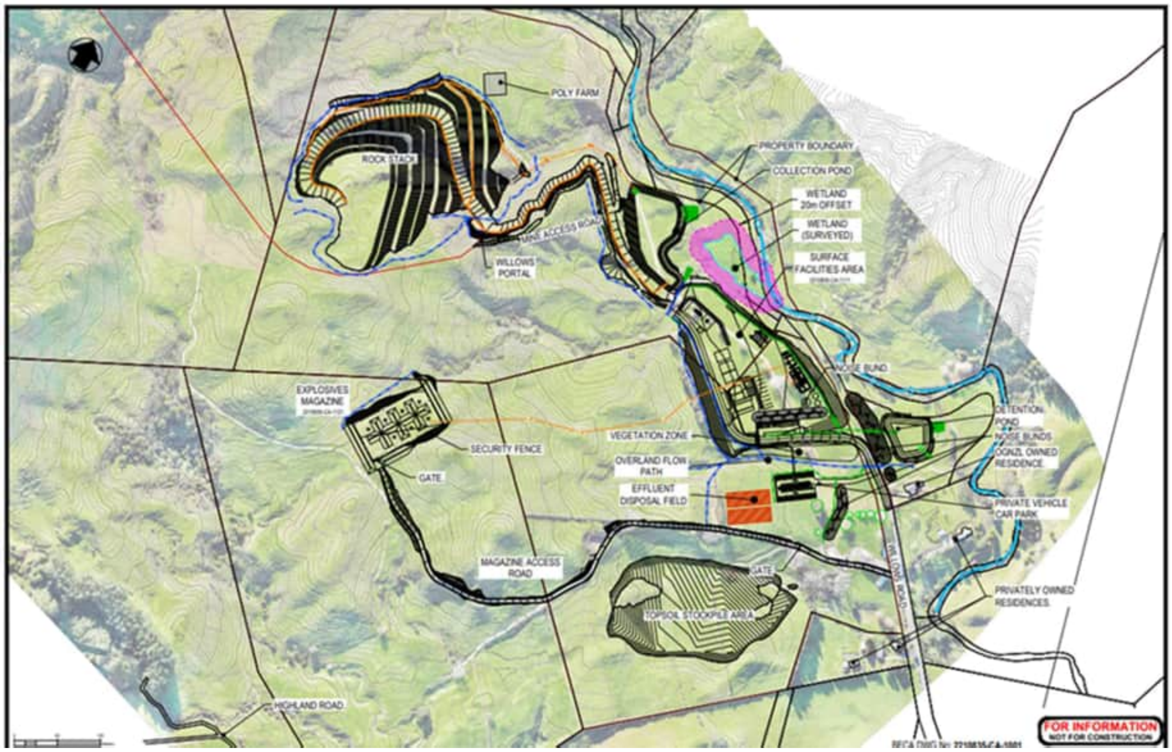

Figure 2 Willows Road Farm Portal Area and Associated Surface Facilities Area

1.2 Scope of Works

GHD Limited (GHD) has been commissioned by OceanaGold to build on work previously completed and to deliver the following studies relating to geochemistry for the Wharekirauponga component of the Waihi North Project:

- Review of available geochemical data, characterisation and assessment of the acid forming properties of the Willows Access Tunnel spoil material and how this will influence spoil storage and resultant runoff and seepage;
- Review of available geochemical data, characterisation and assessment of the acid forming properties of the WUG Mine and how this will influence spoil storage and resultant runoff and seepage;
- Outline any recommended strategies to minimise the onset of acidification (where applicable) and likely leachate and runoff water quality from the rock storage area;
- Derive representative water quality for the Willows Access Tunnel / mine groundwater inflow and WRS runoff and seepage in order to inform collection and treatment requirements.

1.3 Scope and limitations

This report: has been prepared by GHD for OceanaGold NZ Ltd and may only be used and relied on by OceanaGold NZ Ltd. for the purpose agreed between GHD and the OceanaGold NZ Ltd as set out in the document “Waihi North Project Technical Studies to Support Resource Consent Application – Water Studies (Project Scope and Cost Estimate) dated 08 June 2021 and subsequent variations to this scope”.

GHD otherwise disclaims responsibility to any person other than Oceana Gold NZ Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (Section 1.4). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Oceana Gold NZ Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.4 Assumptions

Notwithstanding the assumptions outlined in the respective sections of this report, the following list of key assumptions are applicable to the assessment provided:

- The current geochemical dataset is limited to samples taken from drill cores located in the vicinity of proposed Willows Access Tunnel and adjacent Willows Road Farm area and exploration drilling core material within the Wharekirauponga orebodies. It has been assumed that this dataset is representative of all spoil material.
- Based on the assumption that all spoil material is acid-producing, it is assumed that the WRS is constructed in a manner that will limit oxidation (i.e., placed on low permeability material, placed in compacted lifts, amended with limestone).

2. Geology and Mineralogy

2.1 Local Geology

The Willows Access Tunnel alignment is situated in largely monolithic Miocene aged volcanic rocks, predominantly comprised of intermediary composition andesite, with minor occurrences of more felsic rocks (rhyolite and ignimbrite) encountered toward the northern terminus of the Willows Access Tunnel. Felsic rocks dominate the area within which the WUG Mine is located.

The andesite predominantly comprises two units, termed “Waipupu Formation” and “Whiritoa Formation”, which are both mineralogically similar, iron-magnesium silicates, with quartz phenocrysts common. Texturally, the rock fabric alternates between porphyritic lava flows to more broken and rubbly breccia/autoclastic breccia, with less common tuff (aerial ash) deposits. Isolated occurrences of diorite intrusions are also present. At surficial depths, a relatively thin but extensive brecciated tuff mantles the central section of the Willows Access Tunnel alignment (Whakamoehau Andesite). The stratigraphy of the Waipupu and Whiritoa Formations is often non-sequential and cross cutting, with the depositional age of each unit being significantly overlapped. However, the Waipupu Formation Andesite underlies the majority of materials expected to be encountered. This unit extends further south and hosts the Martha Mine open pit and therefore similarities in mineralogy and hydrothermal alteration between the sites are expected.

At the location of the ore deposit, the local host geology is characterised by several rhyolitic deposits (part of the Coroglen Subgroup). These vary between volcaniclastic breccias (predominant material) and more massive lava. The rhyolite is likely to be laterally confined at depth (as a function of several notable faults; Edmonds Fault and several splays of this), and to be locally intruded into the surrounding andesitic basement rock (outlined above). At the surface, the material locally overlies the surrounding andesite host rock, which is typical of the relative stratigraphy between these deposits within the Coromandel Region.

Associated with the rhyolite in this region of the site is intense silicification (secondary remineralisation with quartz). Through available borehole core and surface sampling, in the area immediately surrounding the ore deposit, the rhyolite and ignimbrite rock has been almost completely replaced with quartz. This is attributed to post deposition hydrothermal re-mineralisation of the rock, via several notable faults as outlined above and in further detail below.

The region surrounding Waihi and including the site is strongly influenced by the presence of multiple faults with a distinct set of structural orientations that frequently intersect the Access Tunnel alignment: Northeast – Southwest (primary) and Northwest-Southeast (auxiliary) comprise the main fault sequences. The nature of faulting is typically steep walled extensional (dipping greater than 60 degrees). The faulting has provided the primary conduit for post-depositional hydrothermal circulation to occur (5-10 Mya) that has resulted in extensive remineralisation of the host rock, hydrothermal alteration and deposition of heavy metal and mineral assemblages (i.e., gold and silver bearing minerals). The alteration geochemistry within host rock is typically confined to the major Andesite sequences outlined above. It predominantly comprises wide-field chlorite and acidic clay alternation halos (tens of kilometres from source) with quartz replacement (‘silicification’), sulphur and iron remineralisation being confined more directly to the vein/fault system (<1 km).

The geological conceptual site model outlining the Willows Access Tunnel alignment with respect to the main geological features is provided in Appendix A.

3. Geochemical Assessment

3.1 Acid and Metalliferous Drainage

Acid and metalliferous drainage (AMD) is a broad term for the natural process of sulphide oxidation (which occurs when rocks containing sulphide minerals such as pyrite are exposed to air and water) leading to the formation of acid drainage and metalliferous drainage. Although AMD is a naturally occurring phenomenon, this process can be exacerbated by external activities such as mining that reduce particle size and increase oxidising surface areas.

Contaminants are often mobilised by water and can then report into the downstream receiving environment. Elevated metal concentrations and depressed pH levels in waterways need to be avoided as they can create toxicity issues for aquatic ecology leading to chronic or acute health issues.

AMD can be subdivided into three main categories:

1. **Acid Rock Drainage (ARD)** – acidic, low pH drainage caused by the oxidation of acid producing sulphide minerals and generally contains toxic heavy metals.
2. **Neutral Metalliferous Drainage (NMD)** – where the acid generated from sulphide mineral oxidation is neutralised by other minerals such as carbonates resulting in the drainage has circum-neutral pH values while containing toxic heavy metals
3. **Saline Mine Drainage (SMD)** – circum-neutral to alkaline in pH with elevated sulphate concentrations.

Adverse environmental effects from AMD due to a depressed pH and/or elevated trace metal concentrations can be avoided by sufficient characterisation, handling practices, and storage and/or treatment strategies.

As outlined in this report, characterisation of the spoil material generated from the advancement and excavation of an access tunnel and excavation associated with mining out the Wharekirauponga Orebodies and its AMD potential is a key consideration in the development of appropriate practices and strategies to manage potential adverse outcomes from AMD. This is because the nature and likely geochemical composition of the highly mineralised spoil material from the project (at least in part) suggests that that the spoil may generate AMD.

Pyrite (FeS_2) is the predominant "acid" forming sulphide mineral present in the area. When pyrite is exposed to air and water, it decomposes into water-soluble components, including ferrous iron (Fe^{2+}) and sulphate (SO_4) and generates acid (H^+). The reduced water-soluble components are then further oxidised to form ferric iron (Fe^{3+}) and water. The formation of low solubility ferric iron (Fe^{3+}) in water leads to the precipitation of ferric hydroxide type minerals ($Fe(OH)_3$ - an orange precipitate); a process that generates additional acidity (H^+).

This process can be described using the following chemical reaction:

$$FeS_2 + 3.75\ O_2 + 3.5\ H_2O \rightarrow Fe(OH)_3 + 2SO_4^{2-} + 4H^+$$

Acidic waters increase the mobility of trace elements that can be elevated as a result of the mineralisation. Acid (H^+ ions) generated by sulphide mineral oxidation can be neutralised by carbonate minerals such as limestone ($CaCO_3$) such that the drainage is no longer acidic (low pH), but can still contain elevated metals concentrations:

$$CaCO_3 + 2H^+ \rightarrow Ca^{2+} + H_2O + CO_2$$

The actual potential for, and rate of oxidation of pyrite (and other sulphide minerals), and the potential impact to the receiving environment is dependent on many factors. These factors include the concentration of the sulphides in the spoil material, morphology of the sulphides, oxygen concentration and exposure time, wetting and drying cycles, temperature, presence of bacteria, and presence of acid consuming materials (neutralisation capacity).

The following analytical testing methods are commonly used to characterise spoil material with respect to its acid generating potential:

- Multi-element analysis – whole-rock testing for a range of trace and major elements to allow characterisation of the rock for potential contaminants that may leach and adversely influence water quality.
- Kinetic testing – accelerated weathering of selected crushed spoil samples to assess the potential acid generation and trace element leaching.
- Column testing – on site weathering of selected crushed spoil samples exposed to atmospheric conditions to assess the rate of reactions and management practices.

The geochemistry of the area associated with mining activities in and surrounding the Waihi area is well understood and characterised as a result of 30 years of mining by OceanaGold at its Waihi operations. During this time existing spoil management practices on the Waihi site have been developed and refined. These practices have proven to be appropriate for controlling AMD. It is considered that due to the location of the proposed Willows Access Tunnel and WUG Mine in relation to the well characterised material (associated with the operations at Waihi), and the conceptual knowledge of the geology and geochemistry of the area of interest (i.e., the Access Tunnel and WUG Mine), the spoil material is likely to behave in a manner that is geochemically similar to spoil associated with operations at Waihi.

4. Spoil Geochemistry

The geochemistry of the Willows Access Tunnel and spoil from the WUG Mine has been assessed using multi-element and acid-base accounting (ABA) analysis of drill core material thought to best represent the likely spoil material. At the time of writing the available data is sourced from the following locations: The Willows Access Tunnel at Willows Road Farm, and the T-Stream and EG-Vein orebodies at Wharekirauponga. It should be noted that there is no data available along the majority of Willows Access Tunnel. However, data from the Willows Road Farm area in the vicinity between the tunnel portal to the DOC reserve border is considered to be representative of the majority of the tunnel spoil material based on the conceptual model of the geology (as shown in Appendix A). In addition, field columns utilising material from the WUG Mine, and leachate data collected from them, will further inform the assessment when available.

As with past OceanaGold Waihi mining projects, geochemical analyses will continue for a period beyond the start of the physical works. This will ensure that spoil management practises can be refined and updated if required and that they are suitable based on the waste geochemical properties.

4.1 Data Sources

4.1.1 Willows Access Tunnel

Two drill cores (WNDD005 and WNDD006) located approximately 300-500m south and southeast of the proposed Willows Access Tunnel route, drill core material from the location of the proposed vent shaft located within the Willows Road Farm (WNDD007) and a drill core (WNDD008) running parallel to the proposed Access Tunnel within the Willows Road Farm area, have been utilised to characterise the Willows Access Tunnel spoil beneath the Willows Road Farm area extending into the adjacent DOC estate.

Spoil from the far end of the Willows Access Tunnel is considered to be reflective of the orebody characterisation (Section 4.1.2), however based on the conceptual geological understanding, it is considered that the majority of the tunnel spoil material is likely represented by samples from the Willows Road Farm area.

The location of the drill cores in relation to the Willows Access Tunnel alignment is indicated on Figure 3 and Figure 4. The vent shaft (from which core and analytical data exists) is located near the border of the Willows Road Farm and DOC estate on the Willows Access Tunnel alignment, due north of the surface of drill core WNDD006.

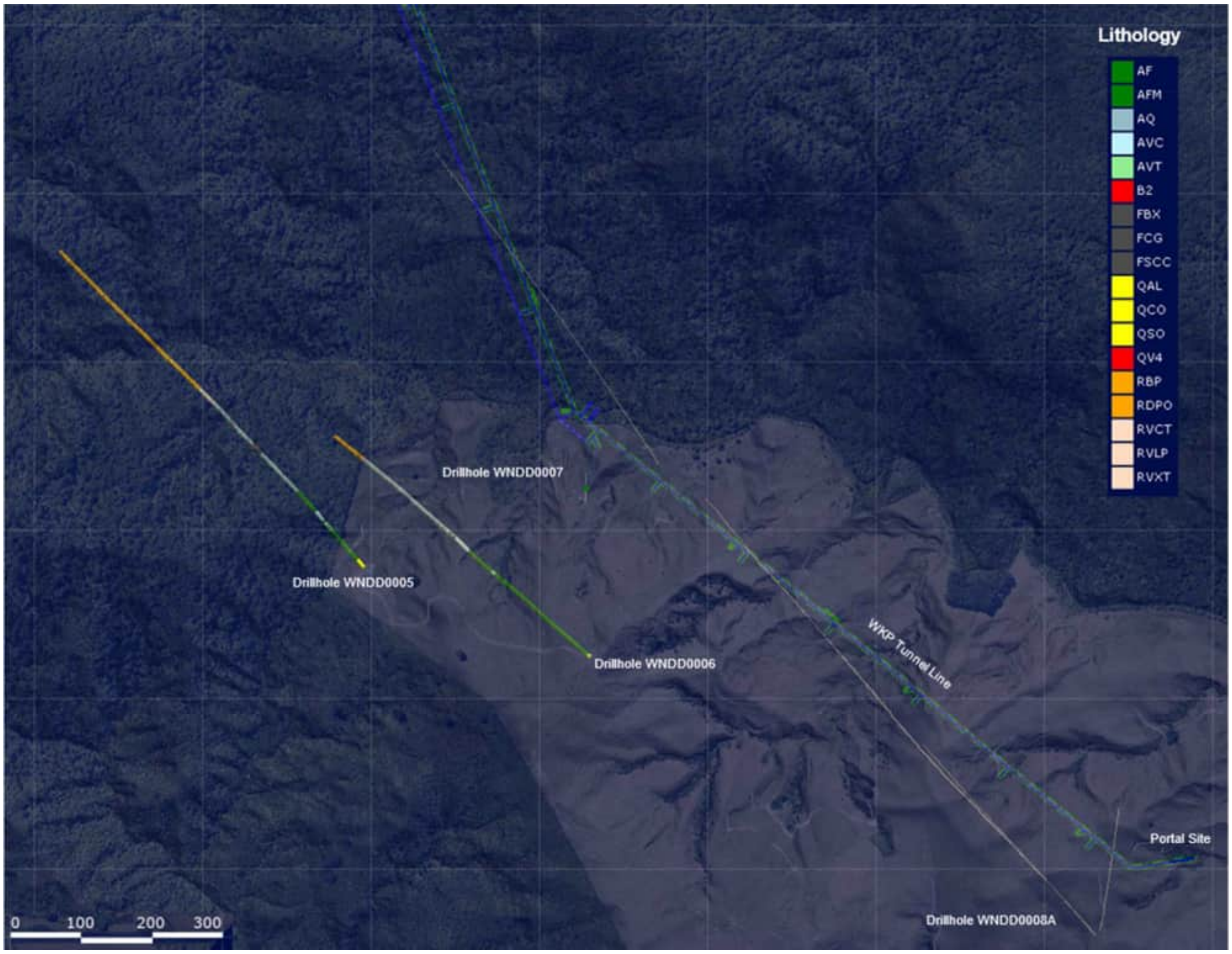

Figure 3 Map showing location of drill core in relation to Willows Access Tunnel alignment

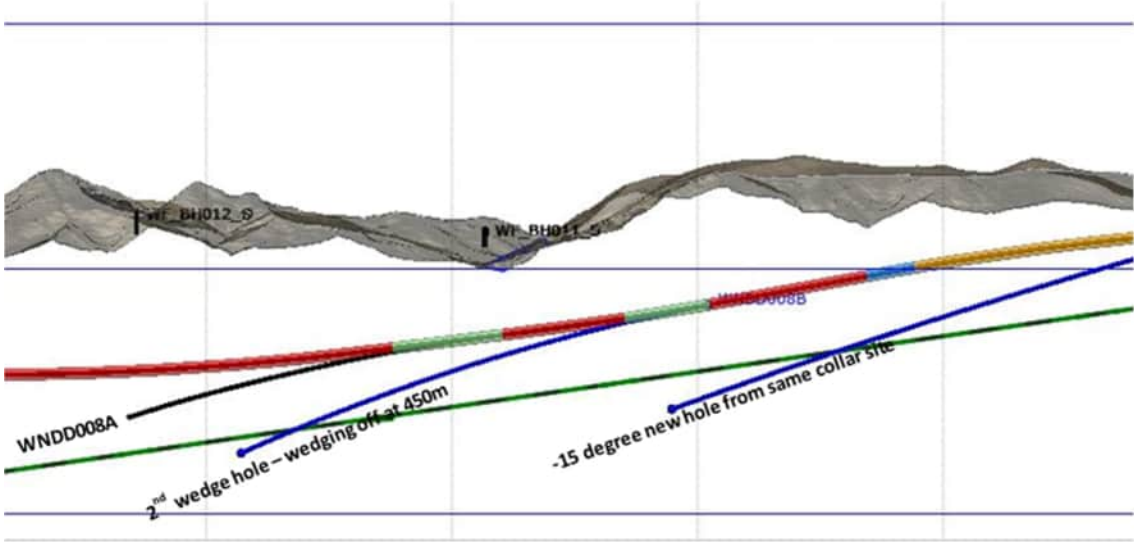

Figure 4 Cross section showing location of core and its daughter holes following the Willows Access Tunnel alignment

4.1.2 WUG Mine (Wharekirauponga Orebodies)

For this assessment exploration drilling has been utilised to characterise the spoil surrounding the Wharekirauponga orebodies. Core samples consist of material taken from the T-Stream and the EG-Vein orebodies. Drillhole locations in relation to each orebody are indicated on Figure 5. To better characterise the EG-Vein orebody geochemistry, it has been separated into two distinct areas (North and South) which roughly coincide with areas covered from Drill Site 4 – North and Drill Site 1 – South. Drill core from Drill Site 2 is used as representative of the T-Stream Vein. In addition, core from drill hole location WKP100 and WKP102 located at the southern boundary of the identified orebody and close to where the Willows Access Tunnel alignment meets the WKP Mine are considered representative of spoil from the far end of the Willows Access Tunnel.

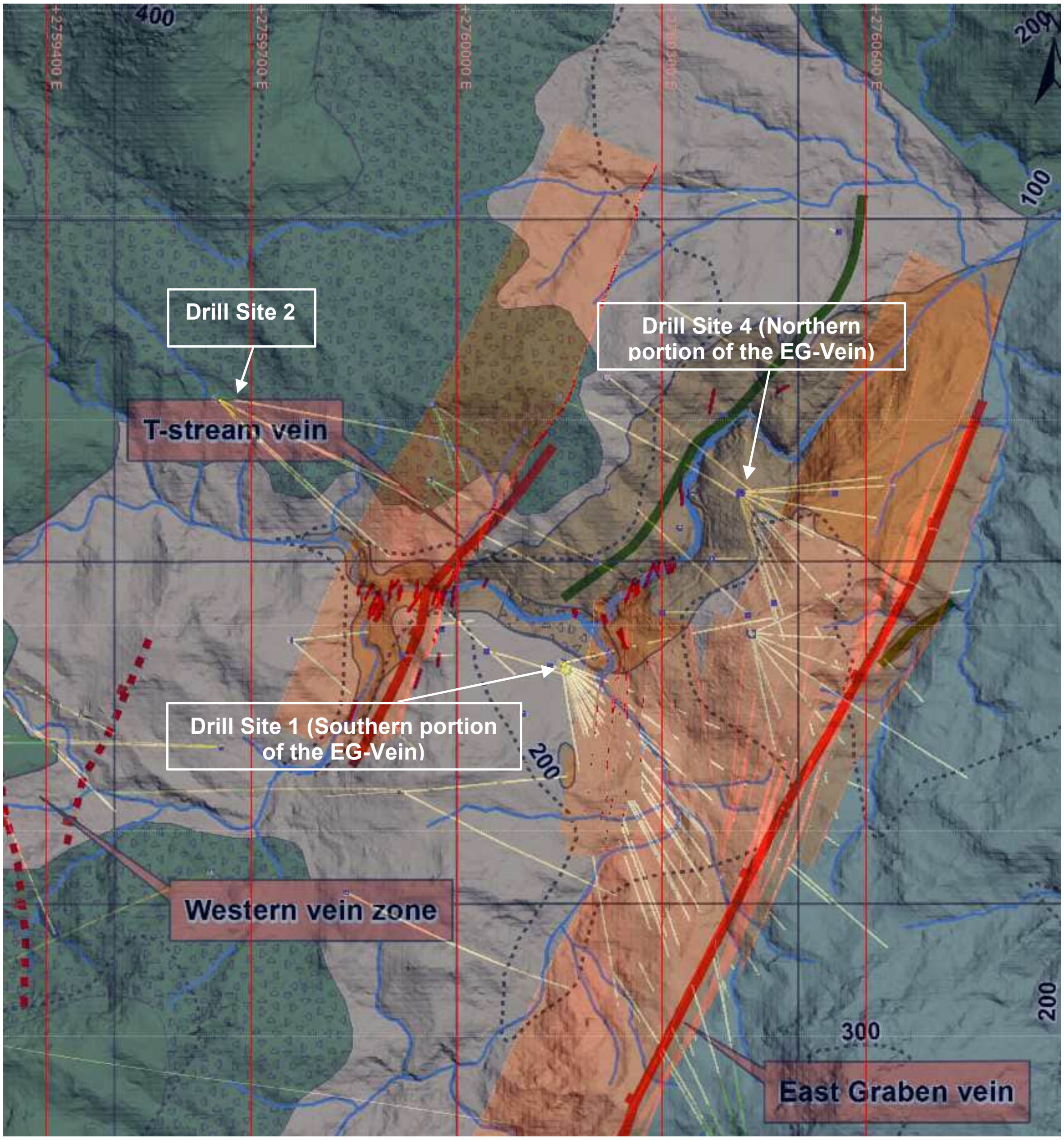

Figure 5 *Map showing the drillhole distribution within the T-Stream and EG-Veins*

4.2 Spoil Composition

4.2.1 Willows Access Tunnel – Multi Element Analysis

Analytical results from spoil representative of the Willows Access Tunnel at the Willows Road Farm end are summarised in Table 1. The dataset includes the results from drill core samples that intersect with the proposed Willows Access Tunnel (WNDD005 and WNDD006) and core samples collected from the vent shaft location. Additionally, samples have been taken from the southern boundary of the identified orebody - (WKP100 – WKP102) and are considered to be comparable to the deeper sections of the Willows Access Tunnel in the vicinity of the orebodies. These samples are represented in WUG Mine dataset (Table 2).

Based on the conceptual model of the geology (shown in Appendix A), spoil from the Willows Access Tunnel is expected to be predominantly sourced from the andesitic material. The data presented in Table 1 is considered to be comparative to the geochemistry of spoil material from current operations at Waihi (AECOM, 2018; AECOM, 2022).

The acid generating potential and trace element composition of the Willows Access Tunnel is therefore considered comparable to that currently encountered at OceanaGold's Waihi operations based on the data collected to date.

Table 1 Geochemistry of Spoil Material – Willows Access Tunnel

Parameter	Willows Access Tunnel					Mean Concentration in Earth's Crust [1]	Geochemical Abundance Index[2]	Martha Material Abundance Index[2/5]
	n	Arithmetic Mean	Median	Minimum	Maximum			
Acid Generating Potential								
Total Sulphur (%)	48	**3.57**	**3.18**	0.01	19.1	0.03	**6**	**4-6**
Total Carbon (%)	49	0.53	0.29	0.01	2.36	-	-	-
MPA (%$CaCO_3$)	49	11.2	9.93	0.02	59.6	-	-	-
ANC (%$CaCO_3$)[6]	49	6.09	4.10	0.60	22.8	-	-	-
ANC/MPA	49	8.83	0.54	0.02	12.5	-	-	-
NPR	49	4.47	0.20	0.00	7.21	-	-	-
NAG pH	49	5.10	3.10	2.00	11.1	-	-	-
Major Elements								
Aluminium (%)	19	7.50	7.48	6.01	9.69	8.2	0	0
Iron (%)	20	**4.21**	4.06	3.02	7.45	4.1	0	0
Calcium (%)	20	1.97	1.58	0.26	5.90	4.1	0	0
Magnesium (%)	20	0.99	1.06	0.32	2.20	2.3	0	0
Sodium (%)	20	0.11	0.06	0.03	0.65	2.3	0	0
Potassium (%)	20	1.63	1.74	0.44	2.81	2.1	0	**0-1**
Trace Elements [4]								
Antimony	20	**0.78**	**0.87**	0.06	1.89	0.2	**1**	**2-6**
Arsenic	20	**44.8**	**36.6**	1.95	221	1.5	**4**	**2-5**
Barium	19	210	201	90.0	412	500	0	0
Cadmium	20	**0.12**	0.10	0.02	0.27	0.1	0	**0-2**
Cobalt	20	15.0	15.5	11.5	19.3	20	0	0
Chromium	20	4.44	2.37	0.78	33.6	100	0	0
Copper	20	18.8	17.2	9.54	43.5	50	0	**0-3**
Lead	20	**17.2**	13.8	6.81	37.0	14	0	**0-1**
Mercury	20	**0.11**	**0.08**	0.02	0.51	0.05	0	**0-3**

Manganese	20	448	402	139	1,000	950	0	0
Molybdenum	20	1.34	1.25	0.74	2.59	1.5	0	**0-1**
Nickel	20	14.7	14.4	11.0	20.6	80	0	0
Selenium	20	**3.04**	**2.74**	0.15	10.1	0.05	**5**	**4-6**
Vanadium	20	111	109	79.3	167	160	0	0
Zinc	20	71.1	57.1	21.0	219	75	0	0

Notes:

Units are in mg/kg unless stated otherwise

Arithmetic Mean (and lower bound range) assumes values reported at analytical detection limit are equal to analytical detection limit

Bold - Concentrations exceed the mean value for the Earth's crust

Red - Geochemical Abundance Indices of 3 or greater

- No data or number of points insufficient to generate a meaningful value

1. Bowen, HJM, 1979, Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 1.0 - National Institute of Acid Prevention.
3. Values based on Total Carbon. Where Total Carbon data is unavailable, a Total Carbon value of 0.1 mg/kg was applied.
4. Trace element sample analysis was undertaken using 4-acid digestion method which is likely to result in given concentrations of volatile elements (such as mercury) being underrepresented
5. Based on Project Martha Geochemical Assessment, AECOM, 2018 and Waihi North Project Geochemical Assessment, AECOM, 2022.
6. ANC determined by titration, not derived from Total Carbon

4.2.2 WUG Mine – Multi Element Analysis

Analytical results from core representative of WUG Mine spoil surrounding the EG-Vein and the T-Stream orebodies are summarised in Table 2. The dataset includes the multi-element analysis from core samples collected from drill cores that intersect with each of the orebodies. Data from EG-Vein and T-Stream were considered comparable and therefore these datasets have been combined throughout the assessment.

When assessing the trace and major elements, arsenic concentrations (Table 2) have an elevated geochemical abundance index of 7 compared to the range observed at Waihi (geochemical abundance index of 2 – 5). Average iron concentrations at the WUG Mine (1.5 %) are lower compared to mean concentrations for the various Waihi areas (3.1 % – 6.6 %) (AECOM, 2022).

Other trace and major elements have either lower or comparable concentrations (and range) to the existing Waihi datasets outlined in both AECOM 2018 and AECOM 2022.

Table 2 *Geochemistry of Spoil Material – WUG Mine*

Parameter	WUG Mine					Mean Concentration in Earth's Crust [1]	Geochemical Abundance Index[2]	Martha Material Abundance Index[2/5]
	n	Arithmetic Mean	Median	Minimum	Maximum			
Acid Generating Potential								
Total Sulphur (%)	9,495	**0.91**	**0.84**	0.01	10.0	0.03	**4**	**4-6**
Total Carbon (%)	34	0.02	0.01	0.01	0.18	-	-	-
MPA (%$CaCO_3$)	34	2.60	2.15	0.04	8.77	-	-	-
ANC (%$CaCO_3$)	34	0.73	0.40	-0.40	2.90	-	-	-
ANC/MPA	34	0.89	0.20	-0.31	8.01	-	-	-
AP (kg $CaCO_3$/tonne)	34	26.1	21.9	0.37	87.8	-	-	-
NP (kg $CaCO_3$/tonne)[3]	34	1.30	0.83	0.83	15.0	-	-	-
NNP (kg $CaCO_3$/tonne)	34	-10.6	-8.9	-86.1	81.0	-	-	-
NPR	34	0.19	0.04	0.01	2.27	-	-	-
NAG pH	34	4.10	3.80	2.70	7.30	-	-	-
Major Elements								
Aluminium (%)	9,495	3.32	4.67	0.02	14.3	8.2	0	0
Iron (%)	9,495	1.52	1.46	0.10	10.2	4.1	0	0
Calcium (%)	9,495	0.18	0.06	0.01	9.78	4.1	0	0
Magnesium (%)	9,495	0.14	0.07	0.01	2.54	2.3	0	0
Sodium (%)	9,495	0.09	0.04	0.01	1.85	2.3	0	0
Potassium (%)	9,495	**2.80**	**2.88**	0.01	7.83	2.1	0	**0-1**
Trace Elements [4]								
Antimony	14,736	**9.08**	**5.26**	0.02	460	0.2	**5**	**2-6**
Arsenic	14,773	**214**	**136**	0.50	10,000	1.5	**7**	**2-5**
Barium	10,894	323	120	0.50	3,790	500	0	0
Cadmium	10,894	0.05	0.03	0.02	0.99	0.1	0	0-**2**
Cobalt	10,894	2.46	1.90	0.10	48.1	20	0	0
Trace Elements [4]								

Parameter	WUG Mine					Mean Concentration in Earth's Crust [1]	Geochemical Abundance Index[2]	Martha Material Abundance Index[2/5]
	n	Arithmetic Mean	Median	Minimum	Maximum			
Chromium	9,495	9.62	8.00	1.00	130	100	0	0
Copper	14,736	9.08	5.26	0.02	460	50	0	0-**3**
Lead	14,773	10.9	10.2	0.50	1,230	14	0	0-**1**
Mercury	10,894	**0.19**	**0.06**	0.01	18.7	0.05	**1**	0-**3**
Manganese	10,894	0.05	0.03	0.02	0.99	950	0	0
Molybdenum	10,894	2.46	1.90	0.10	48.1	1.5	0	0-1
Nickel	10,894	2.21	1.50	0.20	74.5	80	0	0
Selenium	10,894	**0.63**	**0.50**	0.50	12.0	0.05	**3**	**4-6**
Vanadium	9,495	11.4	8.00	0.25	135	160	0	0
Zinc	14,773	25.1	25.0	5.00	510	75	0	0

Notes:

Units are in mg/kg unless stated otherwise

Arithmetic Mean (and lower bound range) assumes values reported at analytical detection limit are equal to analytical detection limit

Bold - Concentrations exceed the mean value for the Earth's crust

Red - Geochemical Abundance Indices of 3 or greater

- No data or number of points insufficient to generate a meaningful value

1. Bowen, HJM, 1979, Environmental Geochemistry of the Elements.
2. Geochemical Abundance Indices - The Gardguide version 1.0 - National Institute of Acid Prevention.
3. Values based on Total Carbon. Where Total Carbon data is unavailable, a Total Carbon value of 0.1 mg/kg was applied.
4. Trace element sample analysis was undertaken using 4-acid digestion method which is likely to result in given concentrations of volatile elements (such as mercury) being underrepresented
5. Based on Project Martha Geochemical Assessment, AECOM, 2018 and Waihi North Project Geochemical Assessment, AECOM, 2022.

4.2.3 Statistical Analysis of Spoil Geochemistry

Spoil geochemistry datasets for the proposed Willows Access Tunnel and the WUG Mine were assessed to determine whether significant variation exists between each of the sites. The following analytes were selected due to having either elevated geochemical abundance indexes or elevated mean values compared to the Earth's crust:

- Arsenic (As);
- Iron (Fe);
- Selenium (Se); and
- Antimony (Sb).

Figure 6 to Figure 9 show the summarised results and show the distribution from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations. Each of the box plots assumes that values reported at the laboratory analytical detection limit are equal to the analytical detection limit.

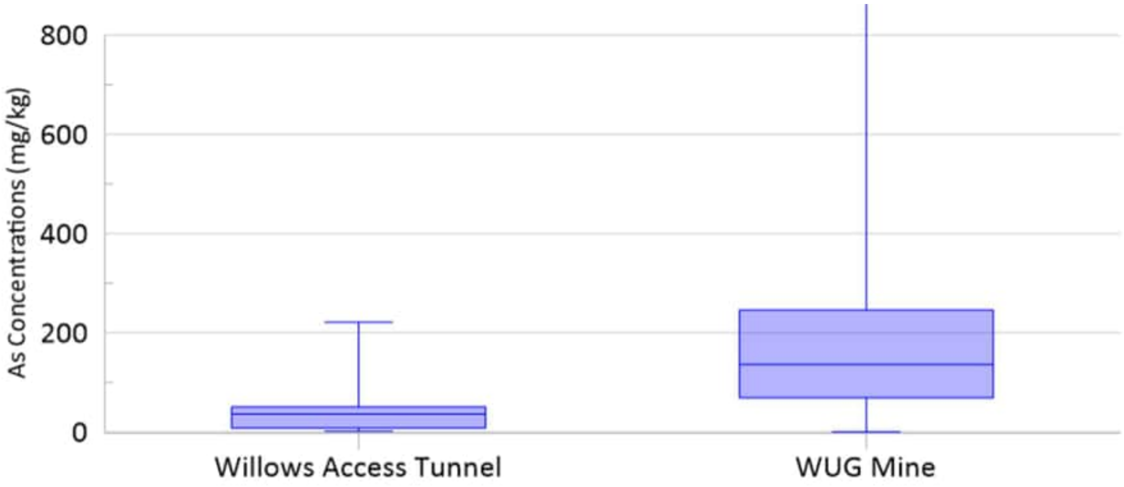

Figure 6 *Box plot showing the concentration ranges of arsenic in spoil material*

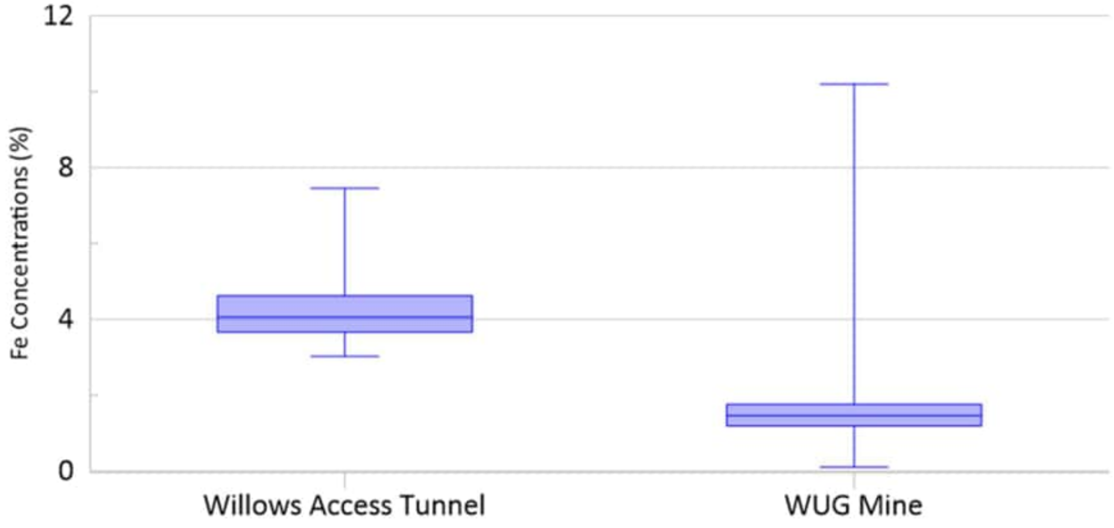

Figure 7 *Box plot showing the concentration ranges of iron in spoil material*

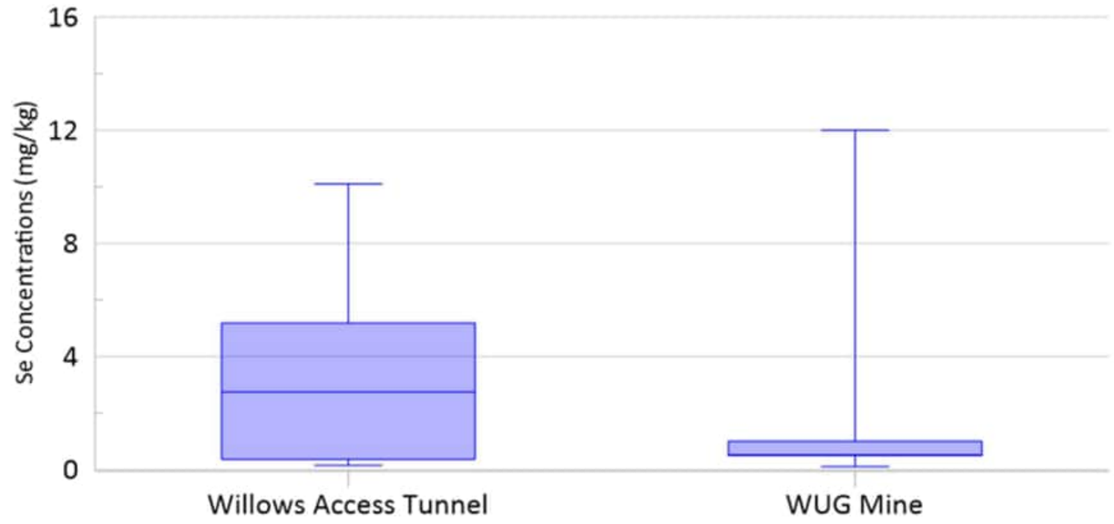

Figure 8 ***Box plot showing the concentration ranges of selenium in spoil material***

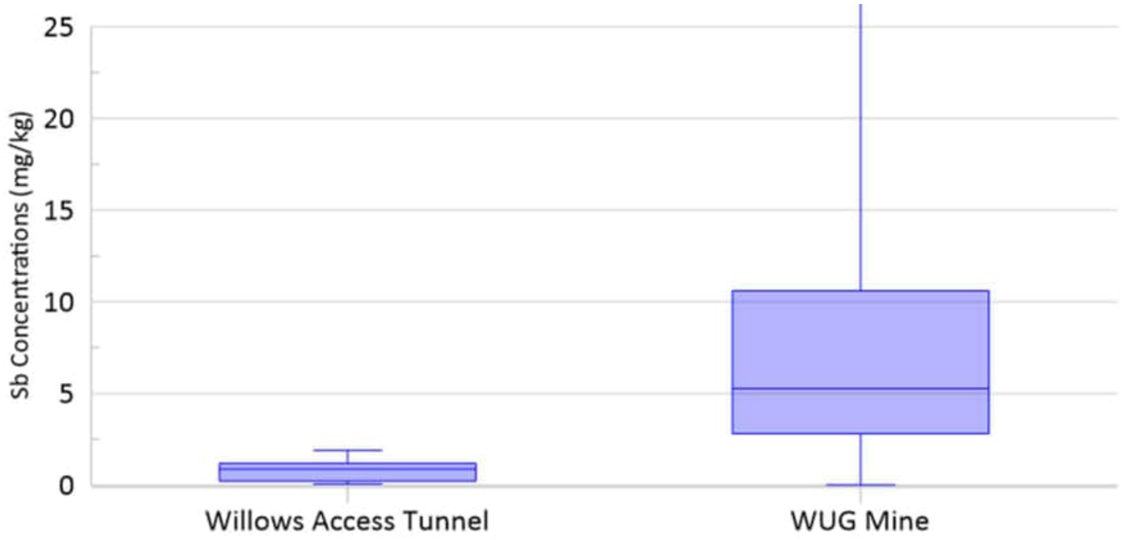

Figure 9 ***Box plot showing the concentration ranges of antimony in spoil material***

The box and whisker data show that statistical variation exists between each of sites. Arsenic and antimony show elevated concentrations surrounding the orebodies while iron and selenium are comparatively depressed. Spoil material from the portal area and within the Willows Access Tunnel alignment is comparable in trace element composition currently encountered at OceanaGold's Waihi operations. The WUG Mine shows that arsenic is elevated while iron shows relatively depressed concentrations in respect to the Willows Access Tunnel and the current Martha dataset.

4.2.4 Distribution of Trace and Major Elements

An assessment of the distribution of the trace and major elements within the spoil shows that elevated concentrations are most prevalent the closer to the orebody the cores are located. Figure 10 - Figure 12 show cross section profiles of the T-Stream and EG-Vein orebodies with associated drill holes and cores showing categorised concentrations.

From Figure 10 - Figure 12 a pattern of increasing concentrations with depth (and closeness to the identified ore bodies) can be observed with the higher concentrations (signified as red and pink) focused within the rhyolitic material closest to the orebodies. This pattern is evident throughout the drillhole profiles in both orebodies.

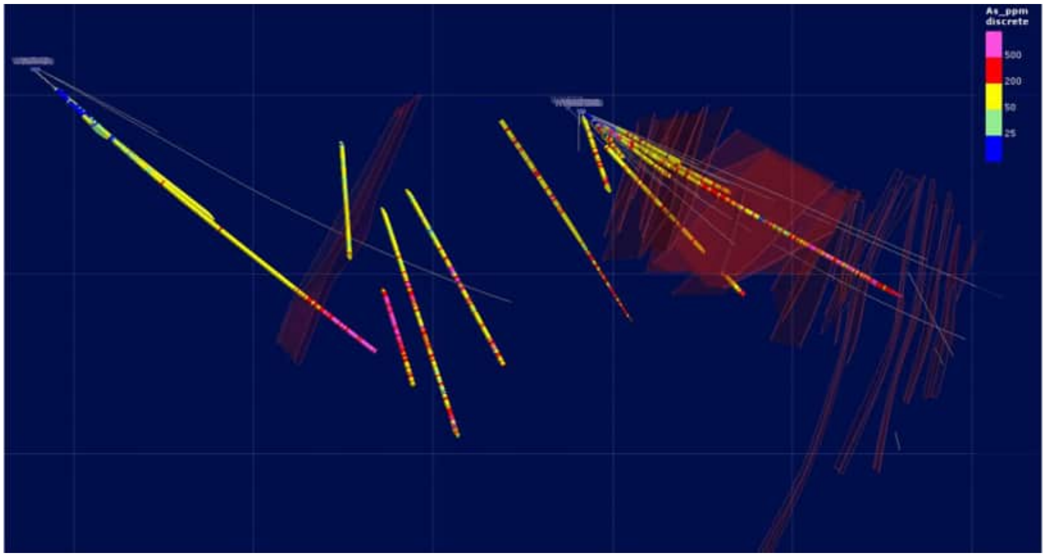

Figure 10 **Cross-sectional View displaying Arsenic Concentrations for the EG-Vein (right) and T-Stream (left) Orebodies**

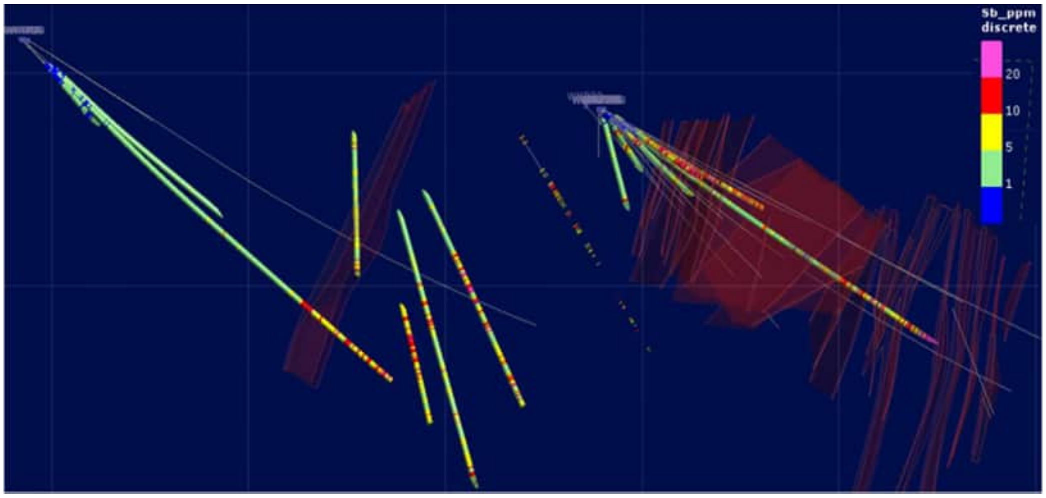

Figure 11 **Cross-sectional View displaying Antimony Concentrations for the EG-Vein (right) and T-Stream (left) Orebodies**

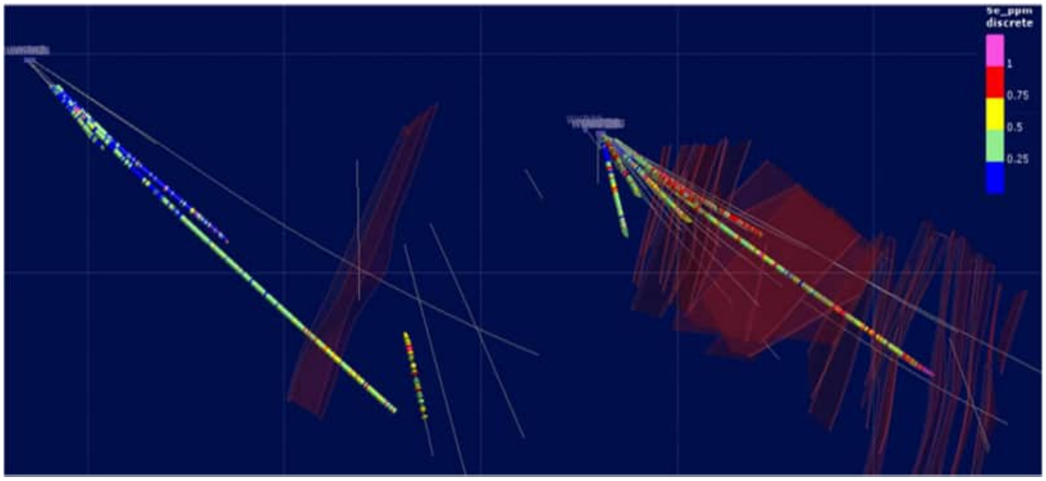

Figure 12 *Cross-sectional View displaying Selenium Concentrations for the EG-Vein (right) and T-Stream (left) Orebodies*

4.3 Spoil Acid Generating Potential

4.3.1 Static Testing

Similar to the trace and major elements, datasets relating the acid generating potential of the spoil associated with the Willows Access Tunnel and the WUG Mine were assessed to determine whether significant variation exists between the each of the sites. Data for the WUG Mine is combined (both EG-Vein and T-Stream) based on there being no significant observed differences in the datasets between these two areas.

- Sulphur (S); and
- Acid Neutralising Capacity (ANC).

Figure to Figure 14 show the summarised results show the distribution from highest node to lowest node: maximum / 75%ile / Median / 25%ile / minimum concentrations.

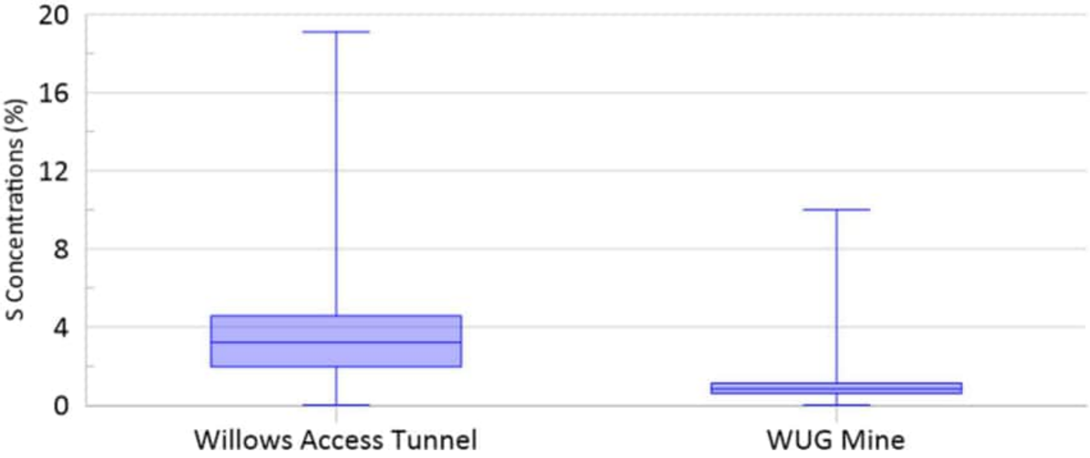

Figure 13 *Box plot showing the concentration ranges of sulphur in spoil material*

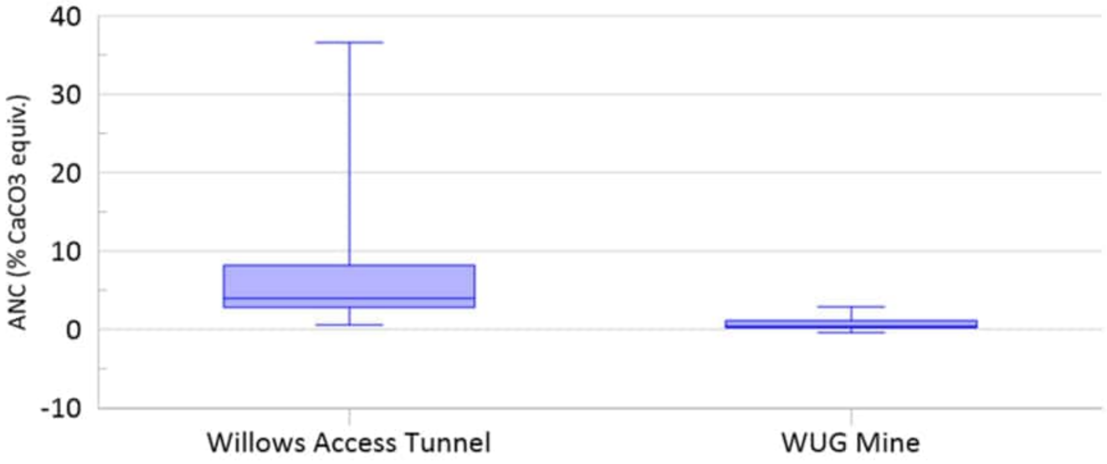

Figure 14 ***Box plot showing the acid neutralising capacity in spoil material***

Figure 13 shows that data associated with the WUG Mine has a significantly lower mean sulphur concentration of 0.91 % when compared to the Willows Access Tunnel dataset (mean concentration of 3.57 %). Moreover, sulphur concentrations for Willows Access Tunnel are comparable to the current Waihi dataset (AECOM, 2018; AECOM, 2022) which ranges from 0.1 % to 3.0 %. It should be noted that the geochemical abundance index for WUG Mine still has a value of four which is on par with the lower limits of the existing Waihi dataset (Table 1 and Table 2).

Similar to the trace and major elements, the distribution of sulphur in Figure 15 shows a pattern of increasing concentrations for sulphur with depth or within the rhyolitic material closest to the orebodies.

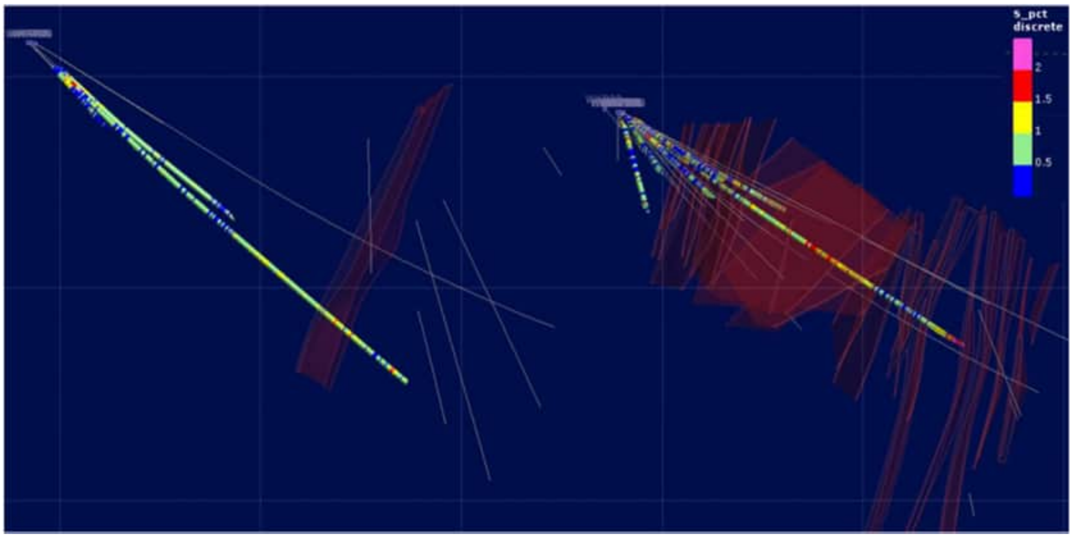

Figure 15 ***Cross-sectional View displaying Sulphur Concentrations for the EG-Vein (right) and T-Stream (left) Orebodies***

ANC values derived from core representative of the Willows Access Tunnel are comparable to the Waihi dataset. AECOM (2022) noted that historic overburden concentrations for the Waihi Martha material had a mean ANC value of approximately 6.0 % $CaCO_3$ equiv. ANC values derived from core representative of the WUG Mine are depressed when compared to the Willows Access Tunnel (mean values of 0.73 % $CaCO_3$ equiv. and 6.09 % $CaCO_3$ equiv. respectively). AECOM (2022) noted that historic overburden concentrations for the Waihi Martha material had a mean ANC value of approximately 6.0 % $CaCO_3$ equiv. which is comparable to ANC values observed within the Willows Access Tunnel.

The ABA data is visualised on Figure 16 which assesses the likelihood of the spoil material to be acid generating based on the net acid generation (NAG) pH and the neutralisation potential ratio (NPR) (GARD, 2021). The data shows that the majority of the spoil is currently categorised as potentially acid forming (PAF). The vent shaft material appears less acid producing than the Willows Access Tunnel alignment data and the WUG Mine data. When looking at the data in the context of depth to surface, core representative of the Willows Access Tunnel alignment and the WUG Mine spoil generally appears more susceptible to oxidation and the generation of ARD compared to material representative of the vent shaft. The PAF characterisation of the Willows Access Tunnel alignment is likely a function of the oxidised state of the rock, with material closer to the surface being more oxidised than the deeper material whereas the WUG Mine spoil is likely a function of the rhyolitic material closest to the orebodies.

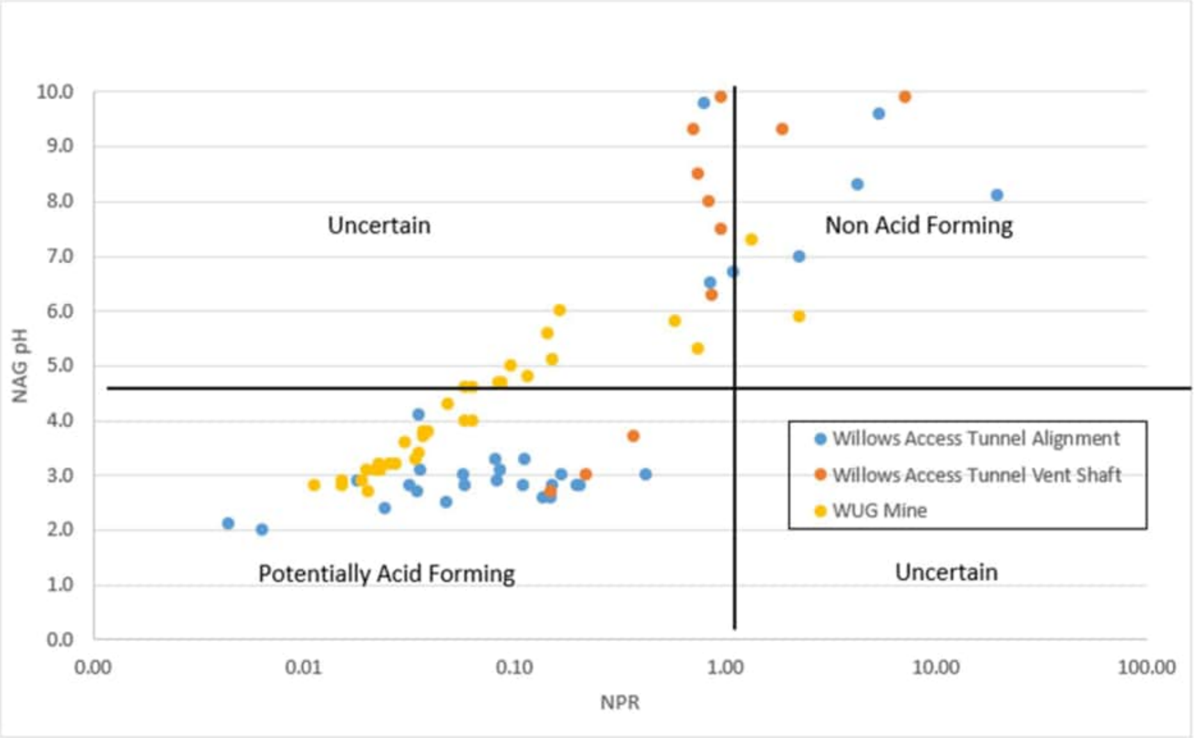

Figure 16 NPR/NAH pH Diagram for WUG Mine and Willows Access Tunnel

4.3.2 Column Testing

The purpose of the column tests is to investigate the onset of acid producing conditions and leachate water quality from the spoil material associated with the WUG Mine. Column testing was considered necessary to determine any geochemical differences in spoil leachate between WUG Mine spoil and the existing Waihi dataset, to provide greater confidence in the water quality predictions and, should there be any difference, provide guidance as to any amendments required to the current waste management practices.

Three separate columns were set-up on site using core material representative of waste rock and/or access tunnel/stope lining material from the WUG Mine. One column consists of material surrounding the T-Stream Vein (Drill Site 2) and two columns consist of material associated with the EG-Vein (Drill Site 4 (Northern area) and Drill Site 1 (Southern area) (Figure 5). Full column specifications are described in Appendix B.

The rock sample selection criteria were based on the following:

- Core intervals were selected from cores spatially distributed across the projected areas of interest;

- Core intervals that contained concentrations of gold (where existing data was available) and veins of highly silicified zones were excluded;
- Core intervals logged as not having an ‘Argillic’ or strong clay alteration were excluded; and
- Core intervals logged as heavily weathered or, displaying prevalent oxidation were excluded.

Figure 17 shows a visual comparison of some of the sample cores selected for column testing.

T-Stream Core Sample (WKP47)

Southbound EG-Vein Core Sample (WKP81)

Northbound EG-Vein Core Sample (WKP91)

Figure 17 ***Visual comparison between selected core samples utilised for column testing***

These columns were set up at OceanaGold’s existing operations at Waihi in October 2021. Results to date (May 2022) are included in Appendix C.

6. Spoil Management

A single rock stack with a footprint of 5.5 ha will be required to be constructed to store tunnel and mine spoil at Willows Road Farm. The temporary WRS is proposed to be constructed in a valley west of the portal area at Willows Road Farm as shown on Figure 18. The WRS will be built in a manner that will limit the oxidation of PAF material stored within and will be progressively built over the duration of the tunnelling activities.

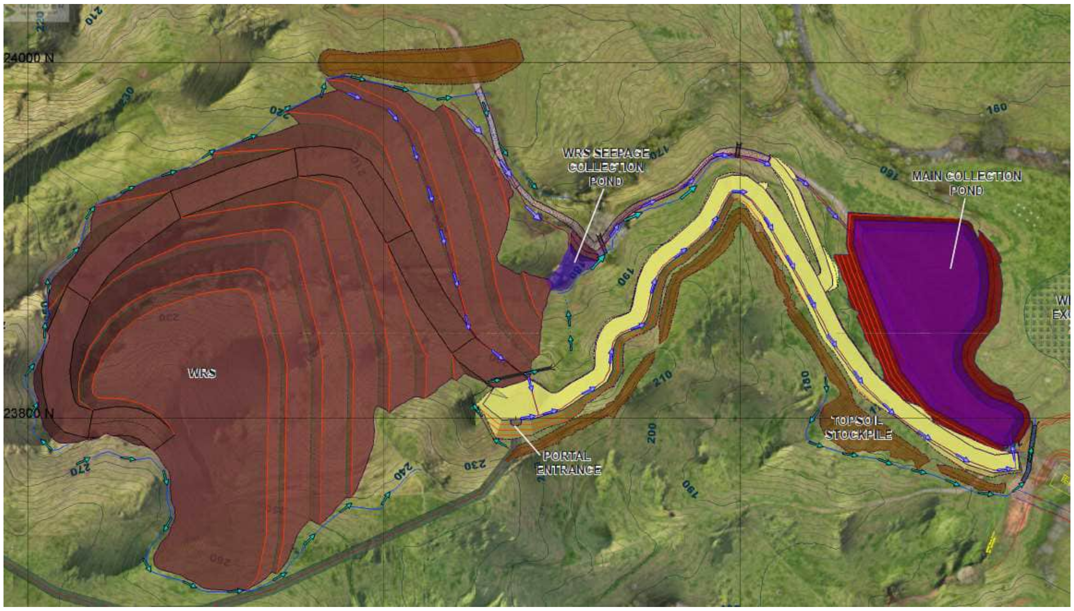

Figure 18 WRS and Collection Pond Outline

It is assumed the working area of the WRS is proportional to the tunnel spoil produced as per the provided production schedule. Eventually the spoil within the WRS will be returned to the tunnel as backfill. The assumed WRS development is outlined in Figure 19.

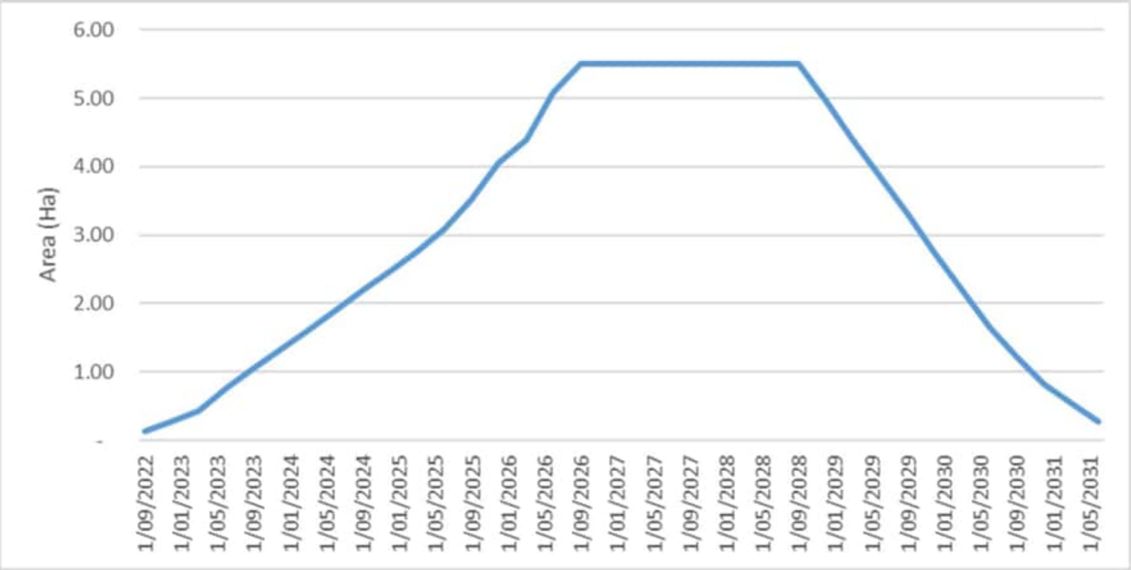

Figure 19 WRS Development

All WRS runoff and collected seepage will be collected in collection ponds and pumped to Waihi for treatment at the existing WTP. As the available dataset is expanded, consideration will be given to the segregation of non-acid forming (NAF) material should it be present.

6.1 General Management Philosophy

To ensure appropriate geochemical management of PAF spoil and to reduce potential effects on water quality, the implementation of an appropriate spoil management strategy is required. Commonly used methods for the management of mine spoil that have the potential to mitigate adverse effects to water quality include:

- Oxidation control – Control of oxygen flux to reactive sulphides, such as by deposition under water or through the application of low permeability layers;
- Geochemical control - Blending rock types or addition of neutralising materials to control pH and oxidation rates; and
- Hydrological control - Placement of low permeability layers, evapotranspiration layers and spoil management structures to control the potential leaching rate from the disposal facility.

OceanaGold has utilised a combination of these methods to effectively manage spoil at its Waihi operations to date and it is envisaged that management of rock sourced from the Willows Access tunnel and WUG Mine will employ similar methods. The means of minimising acid generation of the spoil from the WUG development is likely to include:

- Limiting exposure time of spoil between excavation and disposal to the WRS;
- Blending and/or layering the spoil with limestone, in order to prevent the onset of acidification where the specific acid forming characteristics of the material being excavated suggest that the material is at risk of producing ARD;
- Compaction of placed spoil material in the WRS to reduce permeability, limiting oxygen and water ingress; and
- Covering PAF spoil with NAF material to sufficient thickness to limit oxygen ingress to the encapsulated PAF material.

The design of the WRS is outlined in WSP, 2022 and will be constructed with the above principles in mind. These principals are implemented at OGNZL current Waihi operations and have proven to be successful throughout the mine’s operations.

7. Water Quality

Based on the current geochemical dataset outlined in Section 4, the geochemistry of the Willows Access Tunnel is deemed to be not significantly different from what has been previously observed from OceanaGold's Waihi operations. The WUG Mine data however, does show some variation and therefore a conservative approach to water quality predictions has been applied. As the spoil within the WRS at Willows Farm will be dominated by the Willow Access Tunnel, it is considered that runoff and leachate water quality will therefore likely be in line with what has been observed at the current Waihi operations. Data from the field column tests can be utilised to inform differences in leachate characteristics and inform amendments to the rock management when it is available.

It is considered that in general, water (ground and surface) interacting with PAF rock material will require treatment before discharge to the receiving surface water environment.

The quality of water requiring treatment has been estimated for representative WRS seepage, WRS active area runoff and dewatering water from the Willows Access Tunnel and WUG Mine. Water quality from these respective sources have been derived from monitoring data from the operational mine at Waihi and other available data. The water qualities derived here are utilised in the Water Balance assessment which takes into account the water treatment capacity and availability, trace element removal rates and consented discharge requirements. This assessment is detailed in Waihi North Water Management Assessment (GHD, 2022).

It is considered that the water quality data from the Waihi operations is reflective of water quality associated with the Willows Access Tunnels due to similarities in the whole rock trace element concentrations. However, due to the nature of the host rock and observed geochemical differences associated with the WUG Mine it is possible that the concentrations of some elements may differ. A conservative approach has therefore been applied to account for uncertainty in the contaminant concentrations and acid producing potential from the WUG Mine. Comparative datasets from OceanaGold's Waihi operations have been utilised and the 95%ile concentrations from monitoring data records have been utilised. This approach allows for likely variability in actual runoff, seepage, and inflow water quality, while also capturing periods where monitoring data suggests the waste stream has a higher trace element load. Ultimately, leachate data from the on-site column tests comprising material from the WUG Mine (when available) can be utilised to refine these numbers.

Runoff Water Quality

It is considered that existing water quality data from collection ponds associated with embankments at the active tailings facilities at Waihi (TSF1A), temporary spoil storage areas and the water treatment plant (WTP) area is likely to be representative of water quality associated with runoff from the active WRS at the WUG portal site.

Seepage Water Quality

It is considered that seepage water quality from the TSF1A embankment is likely to be representative of water quality associated with seepage from the active WRS at the WUG portal site owing to inferred similarities between Martha spoil, from which the TSF1A embankment is constructed, and Willows Access Tunnel. The 95%ile from the dataset is utilised to allow for geochemical differences and geological variation. The following design components are assumed:

- Leachate drains;
- Naturally or engineered liner;
- Spoil placed in small, compacted lifts; and

- Capping (with NAF material) and rehabilitation.

Willows Access Tunnel and WUG Mine Inflow Water Quality

The data presented in Table 4 illustrates the considered conservative estimates required to assess both the water treatment requirements and the impact on the receiving environment and has been sourced from the operational water quality monitoring. The Willows Access Tunnel will likely intersect areas of lower mineralisation and portions of the Willows Access Tunnel are expected to be lined with grout / shotcrete to limit groundwater inflow in high inflow zones (i.e., fracture zones). This will likely introduce alkalinity into the discharge water and will, to some degree, provide some buffering capacity to AMD affected waters. This has not been considered within this assessment, however, it is noted that the mine water from the MUG also includes similar influences.

Underground dewatering water quality data for Waihi mine operations is assumed to be representative of potential water quality of groundwater inflow to the Willows Access Tunnel due to the similarity in geology and host rock between the sites. This assumption may not hold for the WUG Mine portion; however, it is considered that utilising the 95%ile of the Waihi dewatering data provides sufficient conservatism to account for geochemical differences observed. The relative volume of water from the WUG Mine compared to the Willows Access Tunnel is also small which adds in additional conservatism to the estimates provided. This is considered appropriate given that the Waihi dewatering water is exposed to significant areas of underground workings and backfill areas, resulting in elevated trace element concentrations in water, whereas the oxidation profile of the Willows Access Tunnel walls is expected to be small in comparison.

Field Column Derived Inflow Water Quality

WUG field column data (Refer Appendix C) has been used to validate the assumptions made for deriving WUG Mine inflow water quality. Antimony, arsenic, selenium, and sulphur have been found to be elevated in the WUG spoil relative to the Martha dataset (Table 3) therefore these elements have been the focus of the field column leachate data. Antimony and selenium were found to not be significantly elevated in the field leachate data (relative to the high sulphate oxidation rates observed), however significantly elevated sulphate and arsenic leachate concentrations were observed (Appendix C). Based on these observations, the field column results have been utilised to predict WUG Mine inflow water quality for arsenic and sulphate to compare to the Waihi Dewatering derived water quality (Table 4). This ensures that the infiltrating groundwater used within the water balance model (GHD, 2022) is appropriate.

To reflect the differences in rock mineralogy, the findings of WUG spoil field column leachate data has been used as the basis for predicting sulphate and arsenic concentrations of WUG inflow (Refer Table 4) using the following methodology:

1. Field column sulphate oxidation rates (mg SO_4/kg/day) have been calculated for the acidity producing columns (defined as when leachate pH <3);
2. The total exposed area within the WUG tunnel walls has been estimated based on oxidation profile, roughness;
3. The calculcated sulphate oxidation has been factored to account for differences in the mean spoil NAPP and the field spoil NAPP;
4. The total volume of daily oxidation products has been calculated based 1 and 2;
5. The sulphate concentration is calculated based on the daily total expected WUG tunnel inflow water (GWS, 2022) and the daily total oxidation products;
6. The column leachate arsenic / sulphate relationship was determined
7. Based on 5 and 6, the derived WUG tunnel inflow arsenic concentration was calculated. .

The methodology as outlined is considered conservative as it assumes all oxidation products are mobilised daily and that the tunnel walls are represented by WUG mine spoil along its entire length. The column leachate sulphate and arsenic relationship is provided in (Figure 20).

Utilising this methodology, the predicted WUG tunnel inflow sulphate concentration was estimated at 535 mg/L and the predicted arsenic concentration of the leachate is estimated at a concentration of 0.036 mg/L (Table 3). The column derived arsenic concentration compares well with the derived arsenic concentration based on the 95th percentile Waihi dewatering data – 0.036 mg/L (Table 4). Calculated sulphate and arsenic concentrations based on conservative sensitivity parameters (Spoil NAPP concentration, tunnel roughness factor, oxidation profile depth, PAF fraction of tunnel exposed walls and inflow volume of water) are up to 1,817 mg/L and 0.125 mg/L respectively (Table 3) and likely represent the upper bounds of the tunnel and mine inflow water.

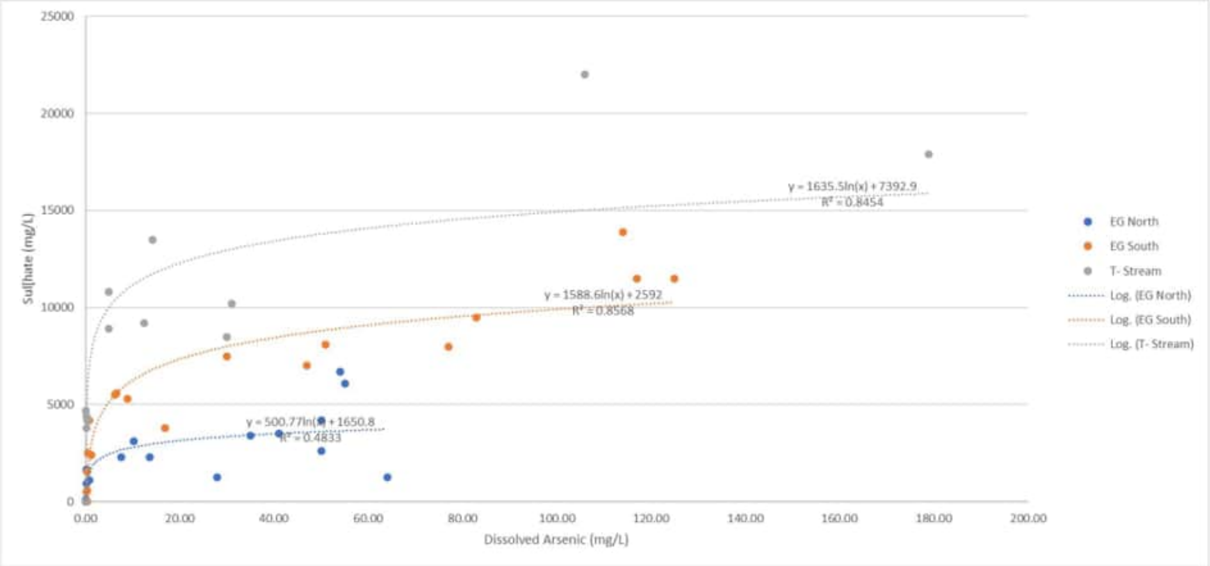

Figure 20 ***Column sulphate / arsenic leachate relationship***

Table 3 ***Predicted sulphate and arsenic concentrations based on column sulphate generation rate***

				Sensitivity					
			High Flow	Low Flow	High Flow	High O2 profil	High Flow	High Flow	High Flow
			med O2 profil	med O2 profile	med O2 profile	High O2 profil	med O2 profile	med O2 profil	med O2 profile
			Mean	Mean	95%ile	Mean	Mean	Mean	Mean
			Sulphate Generation Rate (mg SO4/kg/day)						Average Sulphate Generation Rate (mg SO4/kg/day)
NAPP Column mean	H_2SO_4	25	33	33	33	33	33	33	33
NAPP Spoil mean	H_2SO_4	18	24	24		24	24	24	80
NAPP Spoil 95%ile	H_2SO_4	61	80		80				
Length of tunnel*	km		11	11	11	11	11	11	11
Tunnel Roughness Factor			5	5	5	5	10	5	10
Area per m	m2		118	118	118	118	236	118	236
Total surface area	m2		1,298,000	1,298,000	1,298,000	1,298,000	2,596,000	1,298,000	2,596,000
Oxidation Profile	m		0.2	0.2	0.2	0.3	0.2	0.2	0.2
Total oxidising area	m3		259,600	259,600	259,600	389,400	519,200	259,600	519,200
Vol of water*	m3/day		12,076	6,650	12,076	12,076	12,076	12,076	6,650
Vol/tonne (in-situ)			2.1	2.1	2.1	2.1	2.1	2.1	2.1
Percentage PAF	%		0.5	0.5	0.5	0.5	0.5	0.75	0.75
Tonnes of oxidising material	t		272,580	272,580	272,580	408,870	545,160	408,870	817,740
Sulphate generation per day	kg		6,464	6,464	21,942	9,696	12,928	9,696	65,825
SO4 concentration	mg/L		535	972	1,817	803	1,071	803	9,899
As Concentration	mg/L		0.036	0.055	0.125	0.047	0.061	0.047	296.453

*Based on assumed inflow and tunnel length as per GWS, 2022, but calculated oxidising volume and water inflow is proportional at any length

#Highlighted values depict the sensitivities applied

When considering the conservatism built into the predicted arsenic concentration (from column leachate data), the generally depressed field column leachate concentrations of other WUG spoil elevated elements (relative to Martha) and the lower concentrations of other trace elements in the WUG soil dataset compared to the Martha dataset, the assumed water quality dataset adopted for water balance modelling in Table 4 is considered representative and suitable for use in the site wide water balance model.

Table 4 Assumed Water Quality Dataset from Waihi

Source	Statistic	Model Input	pH (pH Units)	Nickel Dissolved	Selenium Dissolved	Copper Dissolved	Arsenic Dissolved	Lead Dissolved	Antimony Dissolved	Aluminium Dissolved	Mercury Dissolved	Zinc Dissolved	Sulphate	Iron Dissolved	Manganese Dissolved
TSF1A Seepage	Median	RS Seepage	6.3	0.004	0.001	0.001	0.001	0.0001	0.0002	0.01	0.00008	0.02	194	0.04	0.56
TSF1A Seepage	95%ile[1]	RS Seepage	5.4	0.300	0.005	0.003	0.003	0.0004	0.0050	0.33	0.00054	0.19	2,400	19	48
Waihi Dewatering	Median	Infiltrating Ground	7.3	0.020	0.009	0.001	0.010	0.0002	0.0067	0.02	0.00008	0.32	1,550	27	9
Waihi Dewatering	95%ile[1]	Infiltrating Ground	6.7	0.079	0.009	0.011	0.036	0.0046	0.0107	0.05	0.00008	1.21	1,780	62	10
Collection Ponds	Median	RS Runoff (Development)	7.2	0.100	0.001	0.001	0.001	0.0001	0.0010	0.10	0.00008	0.01	93	0.02	0.35
Collection Ponds	95%ile[1]	RS Runoff (Development)	6.7	0.194	0.001	0.001	0.001	0.0001	0.0010	0.19	0.00008	0.02	492	0.07	1.69

Notes:

Units are in mg/L unless stated otherwise.

[1] Given pH is based on the 5th percentile

8. Conclusions

Antimony, arsenic, selenium, and sulphur concentrations are elevated (geochemical abundance indexes of greater than three) in the spoil from both the Willows Access Tunnel and spoil associated with the WUG Mine. With the exception of arsenic, the geochemical abundance indexes for the Willows Access Tunnel, the WUG Mine and the existing Waihi dataset, exhibit similar ranges. Based on the available data, the WUG Mine area has a higher average arsenic concentration and geochemical abundance index and a lower average iron concentration compared to the Willows Access Tunnel and the existing Waihi dataset. Similar to the current operations at Waihi, element enrichment and a greater abundance of trace elements is apparent in both the rhyolitic and andesitic spoil material as depth increases.

The acid-generating potential data for spoil from the Willows Access Tunnel and WUG Mine suggests that the spoil has similar low ANC values compared to the existing Waihi dataset and may result in acid generation and leaching of trace elements unless appropriate control measures are implemented.

Appropriate management of the spoil material (from the Willows Access Tunnel and the WUG Mine) is crucial to limit potential impacts on the surrounding environment and to limit the volume of water requiring treatment. Based on existing operations at Waihi, OceanaGold has utilised a combination of methods to effectively manage spoil. It is envisaged that management of spoil sourced from the Willows Access Tunnel and WUG Mine will employ similar methods. The means of minimising acid generation of the spoil from the WUG development should consider:

- Limiting exposure time of rock between excavation and disposal to the WRS;
- Blending and/or layering the rock with limestone, in order to prevent the onset of acidification where the specific acid forming characteristics of the material being excavated suggest that the material is at risk of producing ARD;
- Compaction of placed spoil material in the WRS to reduce permeability, limiting oxygen and water ingress; and
- Covering PAF spoil with NAF material, of sufficient thickness to limit oxygen ingress to the encapsulated PAF.

Water quality predictions are based on $95^{\%}$ile data from the current Waihi operations. This is considered appropriate when considering the similarities between the geology of Waihi and the Willows Access Tunnel and WUG Mine, and proposed spoil management practises, but also takes into account the observed geochemical differences (i.e., increased arsenic concentration in the WUG Mine geochemical dataset). Leachate data from field columns utilising rock from the WUG Mine have enabled comparison to the derived WUG inflow water quality. The comparison suggests the assumed water quality dataset adopted for water balance modelling is considered appropriate for use in the water balance model which takes into account the water treatment capacity and availability, trace element removal rates and consented discharge requirements.

Additional trace element and ABA data collection and analysis will enable further characterisation and a refinement of this assessment.

9. References

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GWS, 2022. Assessment of Groundwater Effects – Tunnel Elements. . WAI-985-000-REP-LC-0040.A.4.IAC

Appendices

Appendix A

Conceptual Geological Model –Access Tunnel Alignment

19 August 2020

Rory McNeil
Project Manager
OceanaGold Limited

Our ref: 125/336/58

Your ref:

Dear Rory

WKP Exploration Tunnel - Water Assessment
Conceptual Geological Model Data Report: August 2020

1 Introduction

1.1 General

GHD Limited have been commissioned by OceanaGold New Zealand Limited (OGL) to provide a preliminary Conceptual Geological Site Model (CSM) for the proposed underground exploration tunnel from a tunnel portal located on the Willows Farm block directly north of Waihi township, extending northward for approximately 7 km to terminate underground in the vicinity of the Wharekirauponga (WKP) Stream (referred to as the WKP Tunnel). The development of a CSM is required to provide an initial interpretation of the ground conditions along the alignment of the tunnel to support both the surface water and groundwater assessments of effects associated with the proposed WKP Tunnel.

1.2 Scope of Conceptual Geological Site Model

The scope of the CSM was to develop a high level geological model. Due to a limited amount of engineering geological subsurface data, no interpretation of engineering geological conditions has been completed at this time. The model has been developed for the following end-use requirements:

- To support high level 2D groundwater modelling by others (GWS): along tunnel alignment
- To support high level surface water and surface water geochemistry modelling

As such, the following features have been given focus:

- Significant faults / lineaments that are identifiable from surface mapping – likely to locally effect subsurface permeability's and hydrothermal alteration/mineralisation
- Known rock-water hydrothermal alteration zones, with focus given to those that have an effect of groundwater permeability values (argillite sequences and silicification/quartz replacement).

1.3 Data Sources

1.3.1 Used data

The development of the ground model has made use of the following data sources:

- 1:50,000 GNS Geological Map “Geology of the Waihi Area, map 21, 1996”
- Historical Aerial Photographs (1940’s and 1960’s, 1:16,000 set (GHD Sourced)
- LiDAR generated Digital Elevation Model, 0.1 m vertical resolution (OGL sourced)
    - Rendering of hill shade and topographic contour sets by GHD
- Geochemical surface field mapping shape files, corresponding alteration halos (OGL sourced)
    - Simplification of data into broader regions of alteration by GHD
- Proposed route alignment (OGL supplied)

1.3.2 Unused Data

Data made available to GHD that has not been used for the development of the CSM is as follows:

- Window Sample 005 and 006 boreholes (OGL supplied)
    - Referred to for general interpretation of ground conditions. To be included within future developments of geological model when made into a 3D dataset.
- CSMAT survey lines (OGL Supplied)
    - Referred to for general interpretation of ground conditions and presence of faulting however seen as being located too far west, south and east of the proposed site to be extrapolated reliably.

1.4 Datum and Scale

1.4.1 Datum

The data supplied to GHD from OGL has been recorded to the following projection and datum. GHD has produced the CSM to the same datum and projection:

- Map Projection: New Zealand Map Grid (NZMG)
- Datum: New Zealand 1949

1.4.2 Scale

Surface Maps

The topographic scale shown on the maps (see section 1.6 below) is 1:8,000.

The lithological data shown on the maps is based off the 1:50,000 scale mapping undertaken by GNS (see section 1.3.1 for map reference).

Tunnel Long Section

The scale on the tunnel long-section (see section 1.6) is 1:2,500.

1.5 Assumptions and Interpretations

The following geological assumptions and interpretations have been made during the development of the CSM:

- Mapped structural features (faults, lineaments) have been classified per the orientation of their trend line.

- North-east orientated faults or lineaments represent extensional/normal displacements (where displacement is inferred) and generally dip to the north-northwest. This inference is made based on general knowledge of the structural relationships of the region, as well as various anecdotal level conversations with the OGL and supporting consultants.
    - Dip has been set at 60°
- South-east, east-west and north-north-west (i.e. south-south-east) orientated lineaments have been inferred to dip vertically/ near vertically. This is under the presumption that the local stress field within the region would see these orientations typically comprising more strike-slip displacement as opposed to extensional displacement.
- Faults or lineaments with surface exposures that project further than several hundred meters across the ground have been inferred to extend to significant depths and therefore have been extrapolated to the boundaries of the long-section. Where this is not the case, the lineaments have been extended a nominal 200 – 250 m depth below ground.
- Lithologies shown on the CSM are taken directly from the 1:50,000 GNS Waihi area map with the following simplifications made:
    - Tauranga Group and Whitianga Group Deposits that outcrop at the southern end of the map series have been grouped into a single unit
    - Ryolite and tuff eruptive sequences outcropping at the northern end of the map series have been grouped into a single unit, “Coroglen Subgroup”
- Standard relative stratigraphical relationships have been observed for the lithology shown, based on the ageing data for the various units presented by the 1:50,000 GNS Waihi area map
- Geochemical surface mapping data supplied by OGl has been simplified to show only the significant argillic alteration zones, and zones were strong quartz replacement (silicification) has been recorded.
    - The relatively large halos of smectite alteration have been assumed to represent predominantly surficial weathering processes however this is unconfirmed. As such, the projection of this zone within the long-section remains shallow.
    - Illite-smectite and silification mapped zones have been inferred to be more directly controlled by subsurface hydrothermal upwelling’s (based on typical hydrothermal epithermal mineral assemblages known for the Waihi region), and as such to be fault-controlled. Accordingly, they have been projected below ground to be orientated to the dominant structural fabric (NE orientated, NW dipping).
    - Some extrapolation and inclusion of geochemical alteration zones has been made by GHD based on interpretation of surface features identifiable from review of historical aerial photographs).
- The lithological contact and distinction between Waipupu Formation Andesite and Whiritoa Andesite has been extended from the interpretation of thse units per the mapped 1:50,000 GNS Waihi geology. In reality, we expect these two units to be largely monolithic.

1.6 Output

The CSM is given is presented in the following outputs:

- Surface 1:8000 scale Geological Map Series
- 1:2500 scale 2D tunnel long-section (project looking west)

GHD is able to provide, on request and at the permission of OGL, the following supporting data:

- Shape files and map files associated with all geological features shown on the above outputs

1.7 Limitations

This report has been prepared by GHD Limited for OceanaGold New Zealand Limited and may only be used and relied on by For OceanaGold New Zealand Limited for the purpose agreed between GHD and For OceanaGold New Zealand Limited as set out in Section 1.0 of this report.

GHD otherwise disclaims responsibility to any person other than for OceanaGold New Zealand Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The development the CSM has been based on interpretations and processing of the data provided to GHD by OGL, and supplementary data sourced directly by GHD (see section 1.3). A brief walkover of the Willows Farm site where the portal is located was made. No site specific field mapping or subsurface investigations have been conducted to support the development of the CSM, at this time. The interpretations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by OceanaGold New Zealand Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

An understanding of the geological site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended, abbreviated, or issued in part in any way without prior written approval by GHD. GHD does not accept liability in connection with the issuing of an unapproved or modified version of this report.

The interpretations made in this report and attached CSM are intended to support high level groundwater and surface water modelling. The level of technical detail shown is correspondingly low. As such, reliance of the CSM in its current form should not be relied on for tasks that extend beyond the above stated.

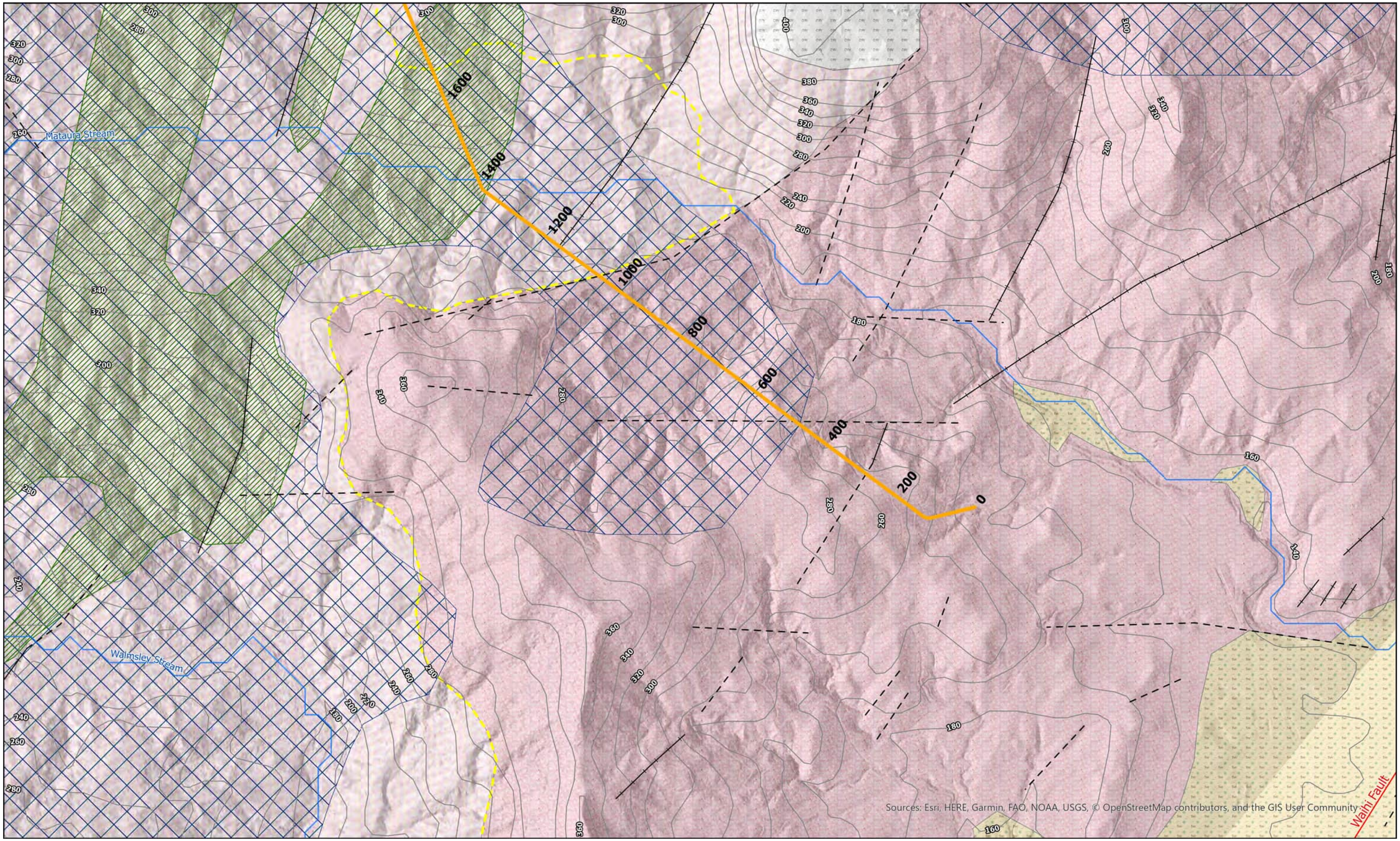
Sincerely
GHD Limited

Nick Burke
Senior Engineering Geologist

Nick Eldred
Principal Engineering Geologist

<u>Attachments:</u>

- **Geological Map Series**
- **Geological Long-Section (Tunnel)**



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

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Metres

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Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

LEGEND

GNS 1:50k geological lithological units

- Tauranga Group and Whitianga Group
- Ratarua Ignimbrite: Welded, dacitic ignimbrite
- Whakamoehau Andesite: Andesite and dacite with minor quartz phenocrysts. Andesite tuff breccias
- Whiritoa Andesite : Phyric andesite and dacite flows and domes with tuff-breccias and lithic crystal tuff
- Waipupu Formation : Andesite and dacite, locally with quartz phenocrysts. Minor tuff breccia, crystal tuff and lacustrine sediments

Geologic features

- Fault
- Inferred liniament
- Liniament
- GNS-mapped hydrothermal alteration zone
- Watercourse
- OGL tunnel centreline

OGL-mapped and GHD-inferred surface hydrothermal alteration

- Argilite Alt - Illite / Illite, Smectite
- Argilite Alt - Smectite Surficial
- Quartz Alt / Silicification

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WKP Exploration Tunnel -
Water Assessment

Job Number	125336958
Revision	0
Date	19 Aug 2020

Conceptual Engineering Geological Model

Figure 1
Page 1 of 5

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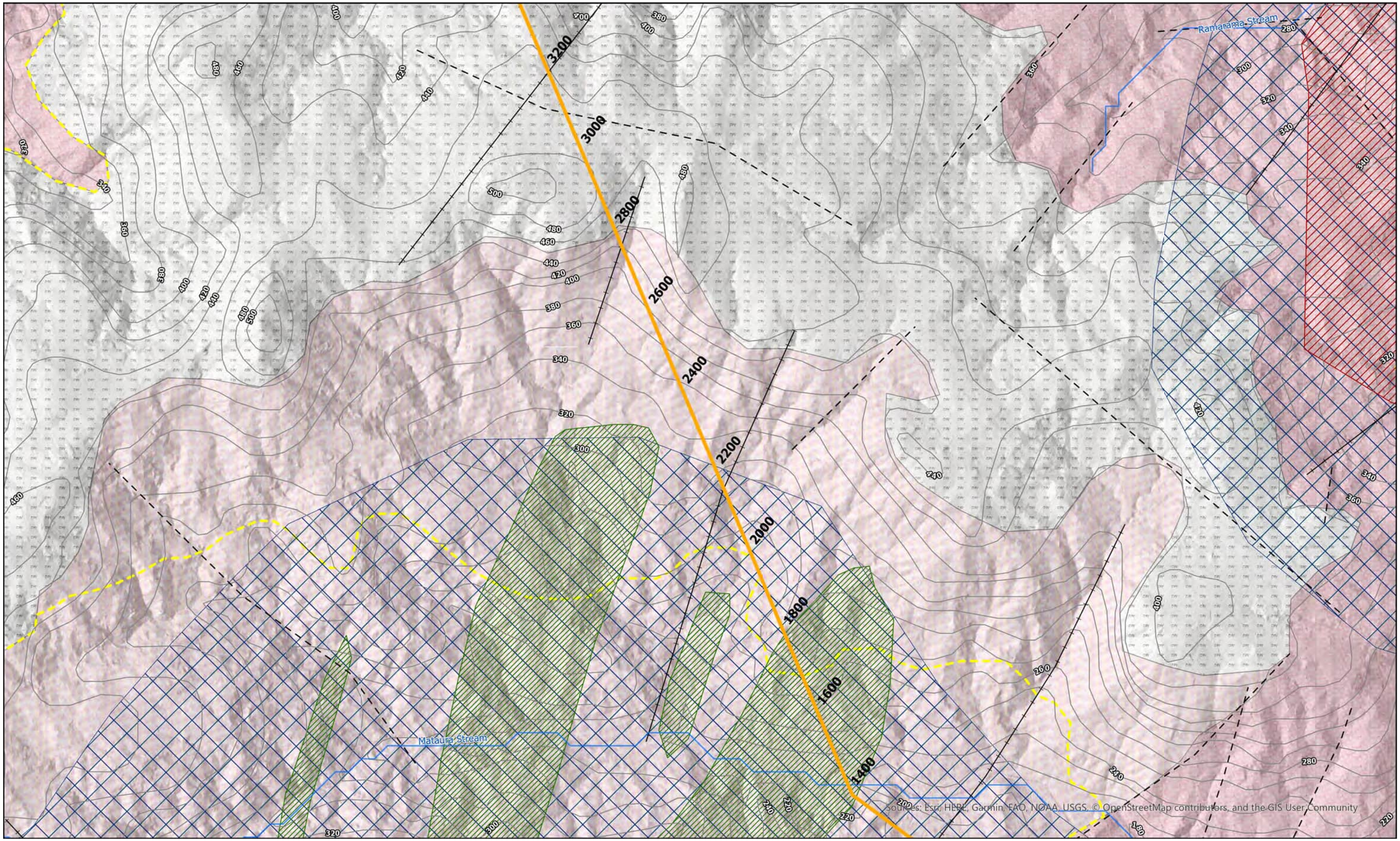
Data source: ESRI: World topographic Map and World Hillshade; Oceanea Gold: DEMs (20190503); GNS: 1:50k 1996 Waihi Area map, pdf; Waikato Regional Council: REC named watercourses (20200715); LINZ: 1:50k contours (20200721); GHD: tunnel diagram (20200715) Created by:nrama



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Map Projection: New Zealand Map Grid
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Grid: GD 1949 New Zealand Map Grid

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LEGEND

GNS 1:50k geological lithological units

- ☐ Whakamoehau Andesite: Andesite and dacite with minor quartz phenocrysts. Andesite tuff breccias
- ▨ Whiritoa Andesite : Phyric andesite and dacite flows and domes with tuff-breccias and lithic crystal tuff
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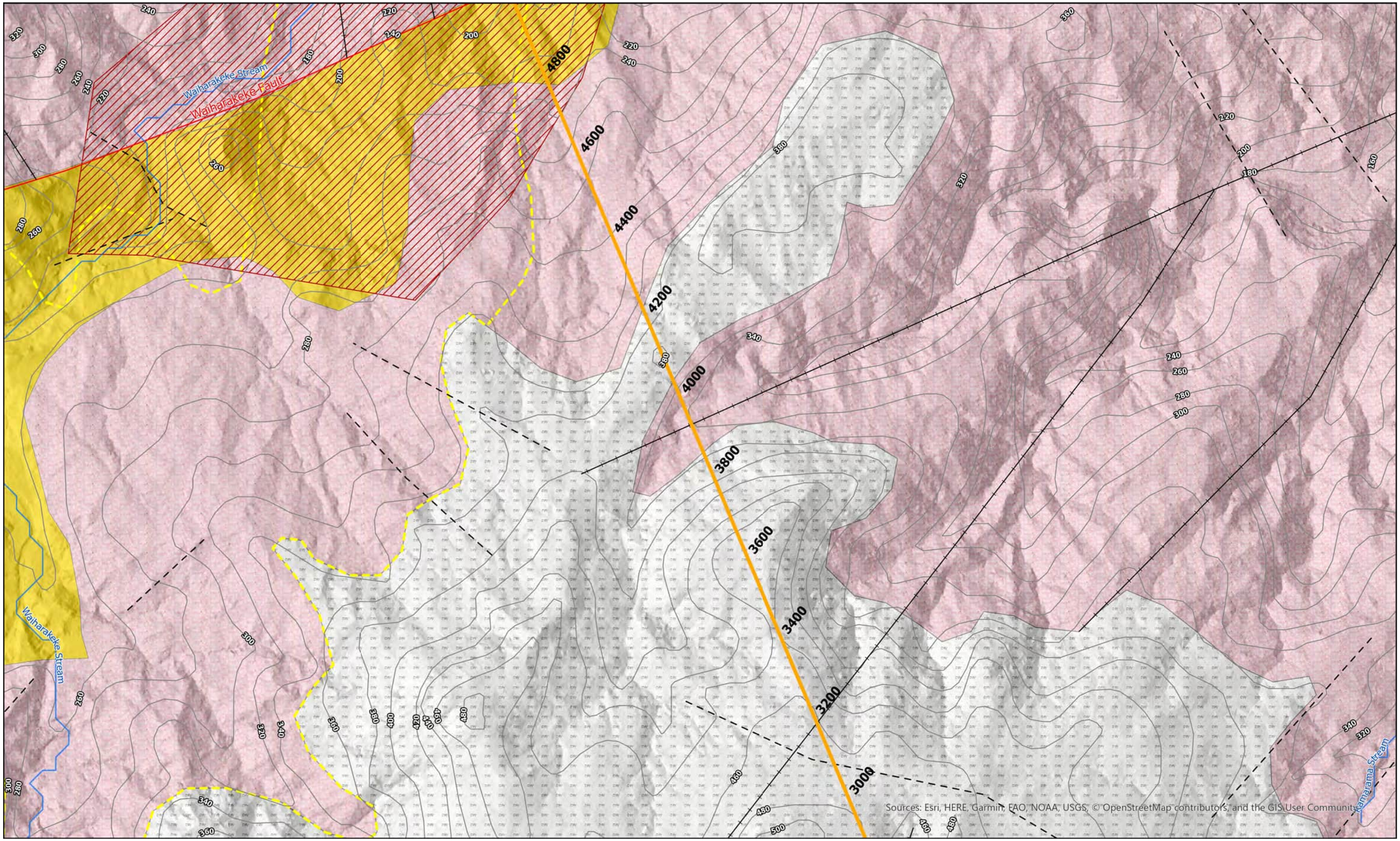

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- 🟨 Waiharakeke Dacite : Dacite flows, tuff breccia and minor tuff. Local intercalated rhyolite flows and tuffs

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Figure 1
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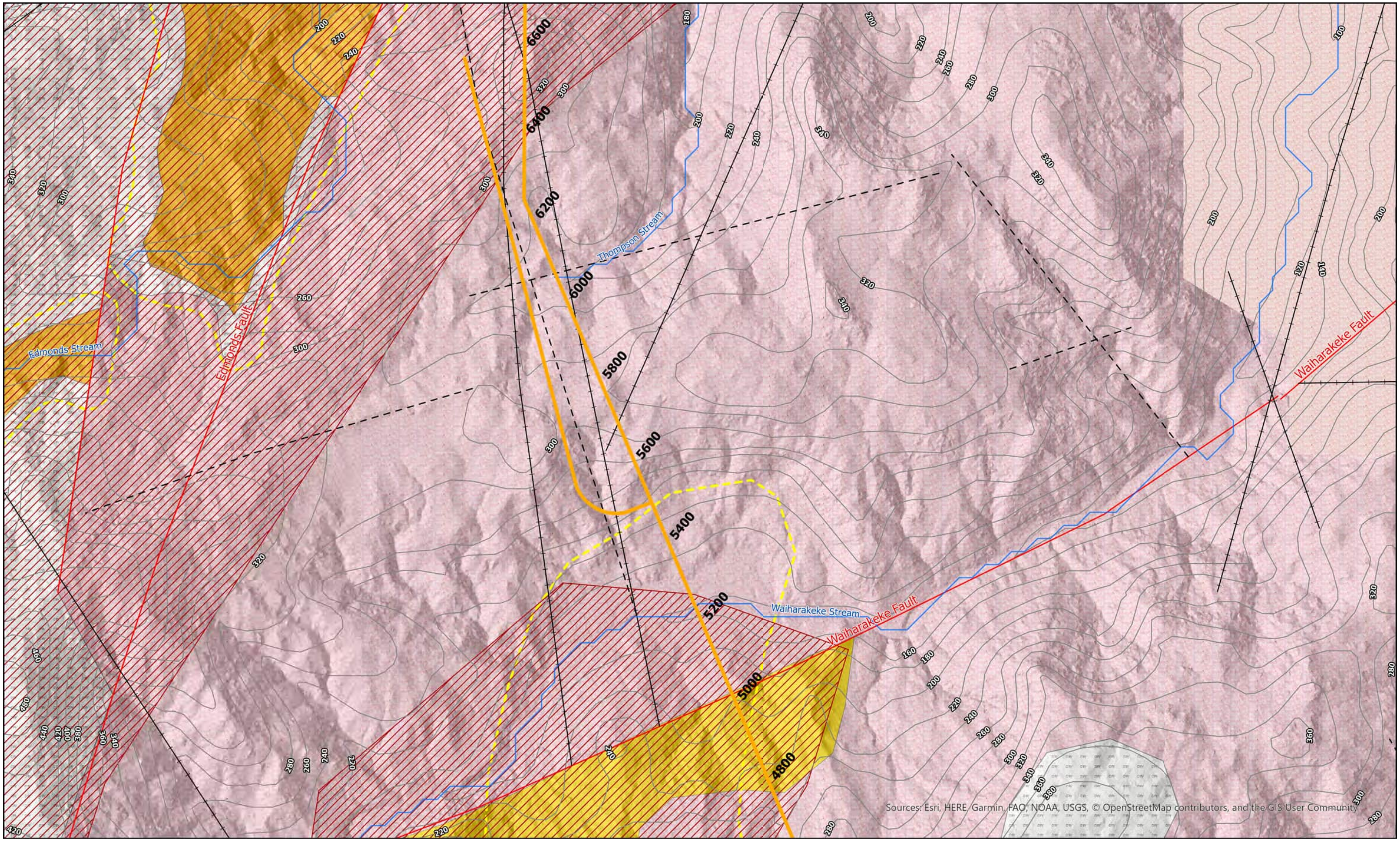

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▨	Coroglen Subgroup : Rhyolitic tuff - crystal, lithic and lapille tuff
▨	Waiharakeke Dacite : Dacite flows, tuff breccia and minor tuff. Local intercalated rhyolite flows and tuffs

Geologic features

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– –	Inferred liniament
—+—	Liniament
▭	GNS-mapped hydrothermal alteration zone
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Conceptual Engineering Geological Model

Figure 1

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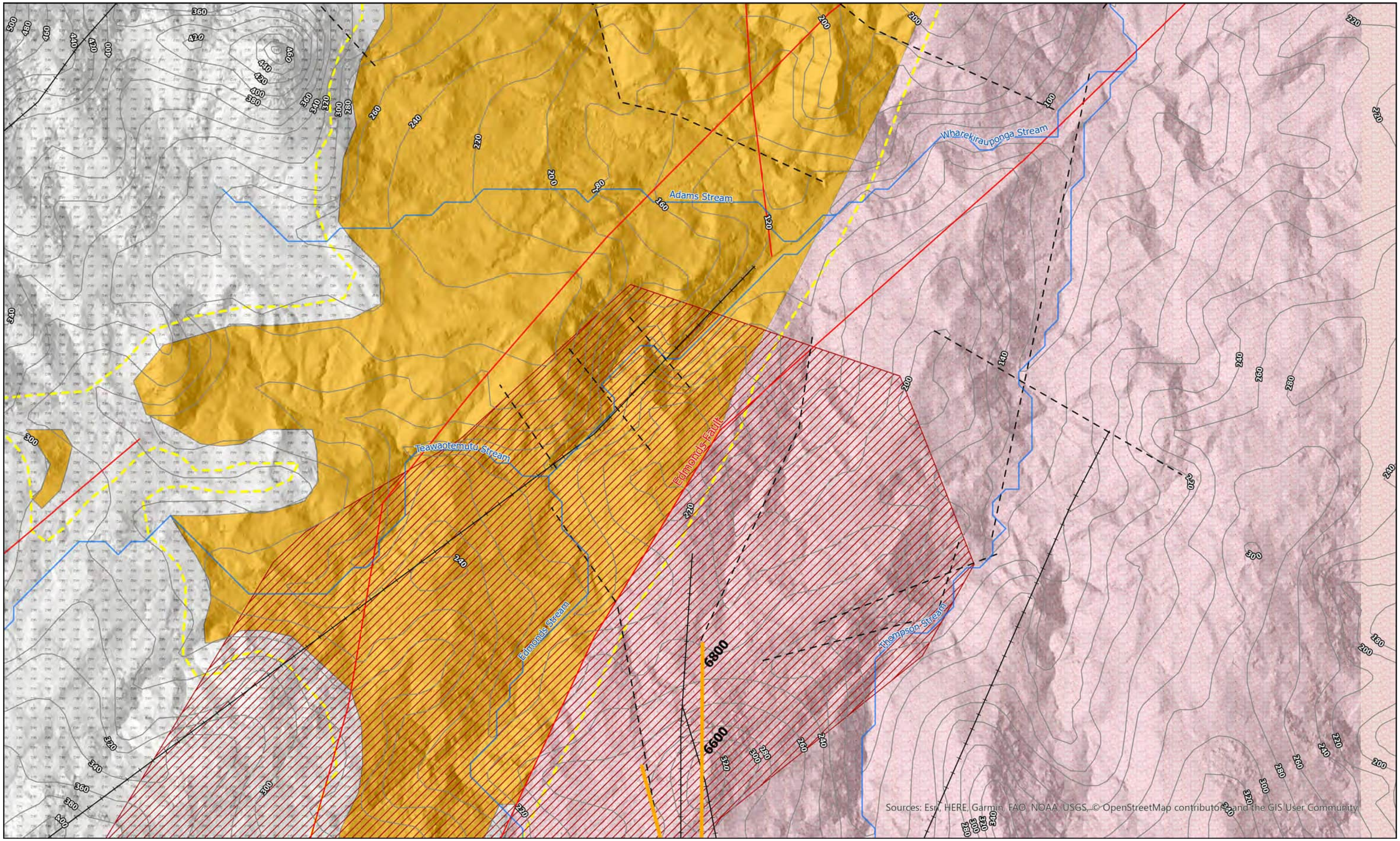

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Conceptual Engineering Geological Model

Figure 1
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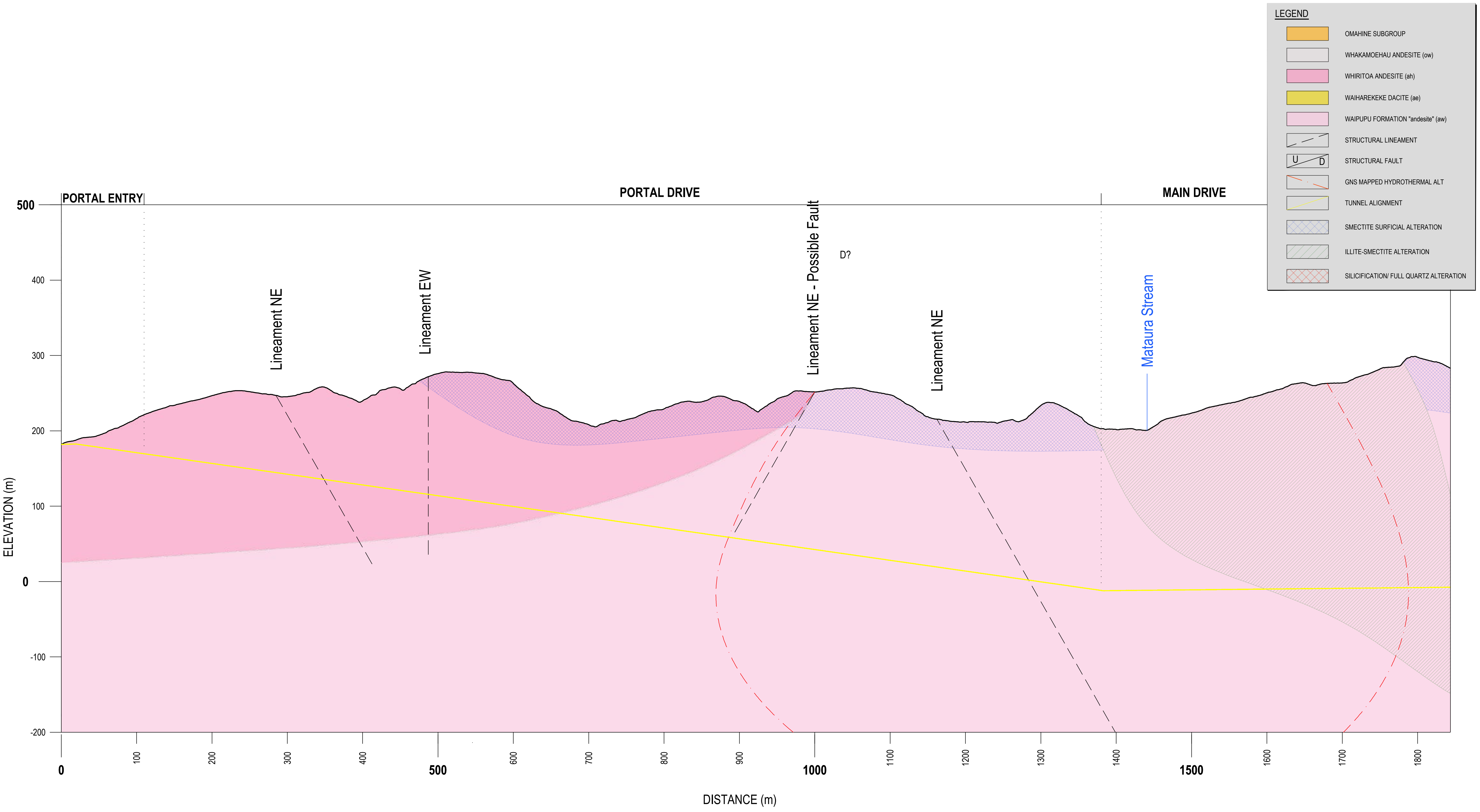

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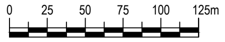

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PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	CONCEPTUAL	NB	TM	NE	082020Y

Note: * indicates signatures on original issue of drawing or last revision of drawing

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Design Check NE
Approved (Project Director) NE
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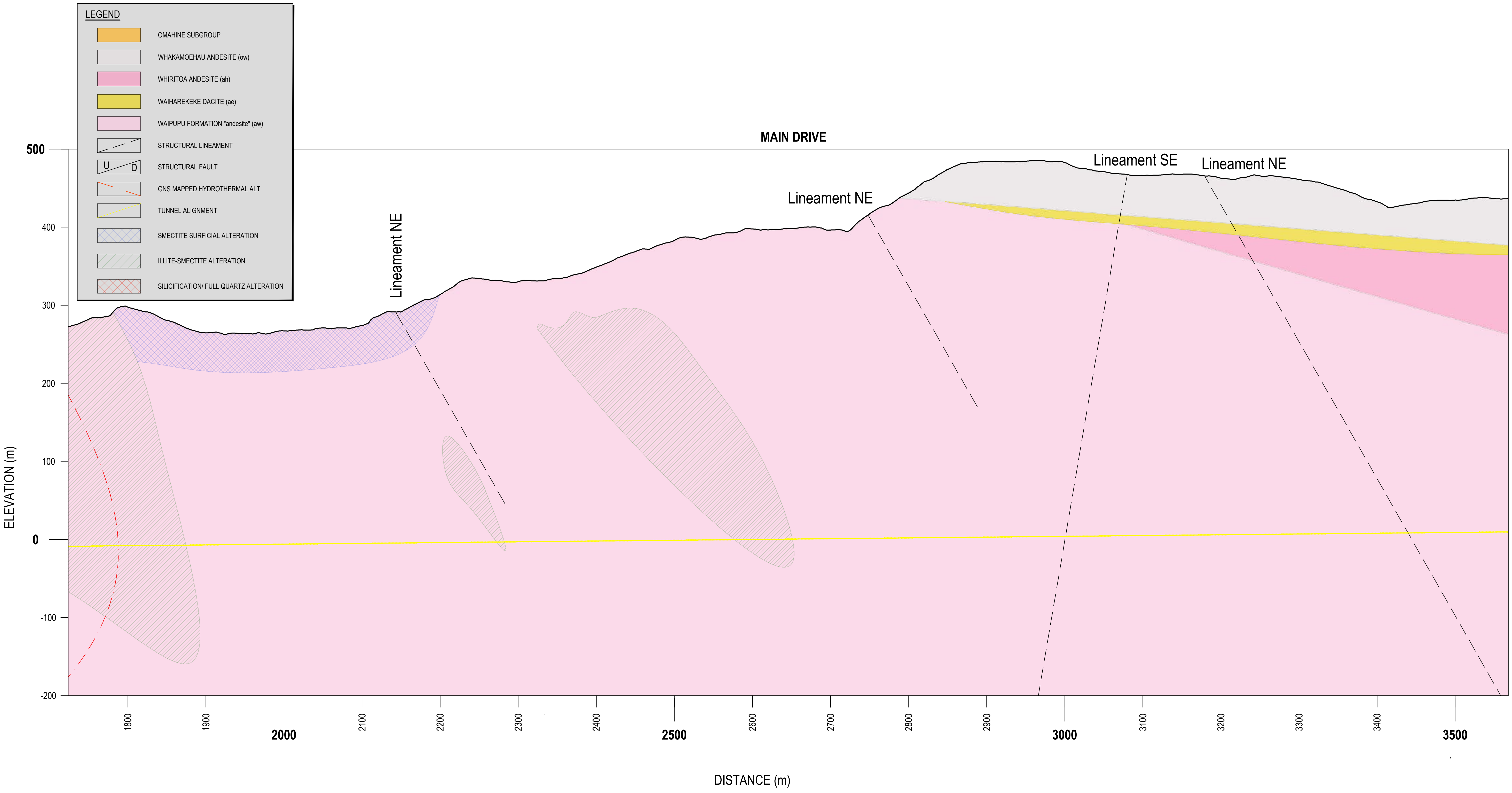
Client **OCEANA GOLD LIMITED**
Project **WKP EXPLORATION TUNNEL - WATER ASSESSMENT**
Title **CONCEPTUAL GEOLOGICAL LONGSECTION DRAFT 17082020**

Original Size **A1** **Drawing No: Q001** **Rev: A**

Plot Date: 17 August 2020 - 2:31 PM Plotted by: Nick Burke Cad File No: C:\Users\nburke\Desktop\WKP C drive\master_section_newalignment.dwg



LONGSECTION 2 - CH 1723 TO CH 3567

SCALE 1:2500

0 25 50 75 100 125m

SCALE 1:2500 AT ORIGINAL SIZE

PRELIMINARY

A	CONCEPTUAL	NB	TM	NE	082020Y
No	Revision Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

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Designer NICK BURKE
Drafting Check DM
Design Check NE
Approved (Project Director) NE
Date 17082020
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Project **WKP EXPLORATION TUNNEL - WATER ASSESSMENT**
Title **CONCEPTUAL GEOLOGICAL LONGSECTION**
DRAFT 17082020

Original Size **A1** **Drawing No: Q002** **Rev: A**

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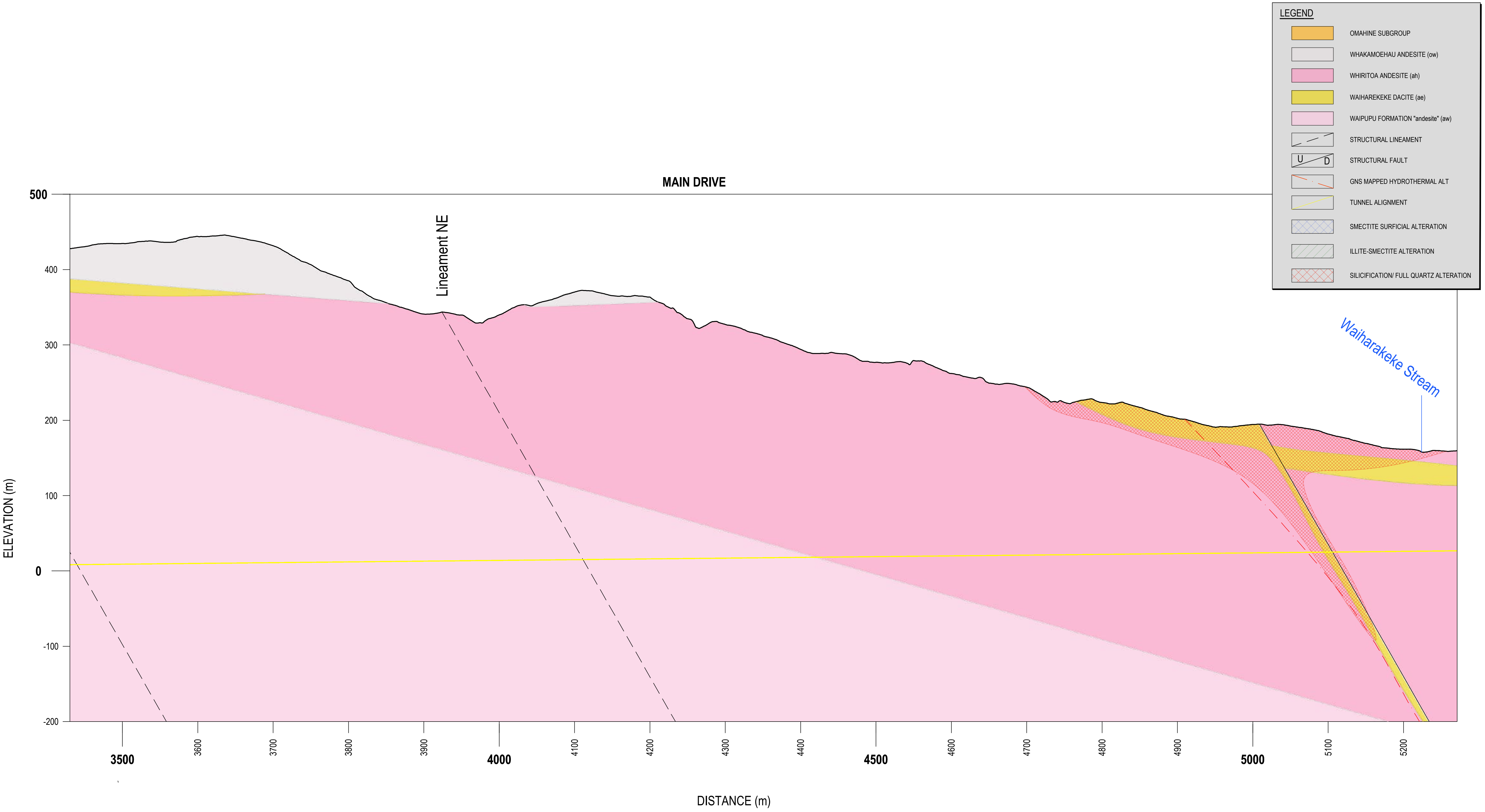

LONGSECTION 3 - CH 3430 TO CH 5271

SCALE 1:2500

0 25 50 75 100 125m

SCALE 1:2500 AT ORIGINAL SIZE

PRELIMINARY

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Project **WKP EXPLORATION TUNNEL - WATER ASSESSMENT**
Title **CONCEPTUAL GEOLOGICAL LONGSECTION**
DRAFT 17082020

Original Size **A1**
Drawing No: Q003
Rev: A

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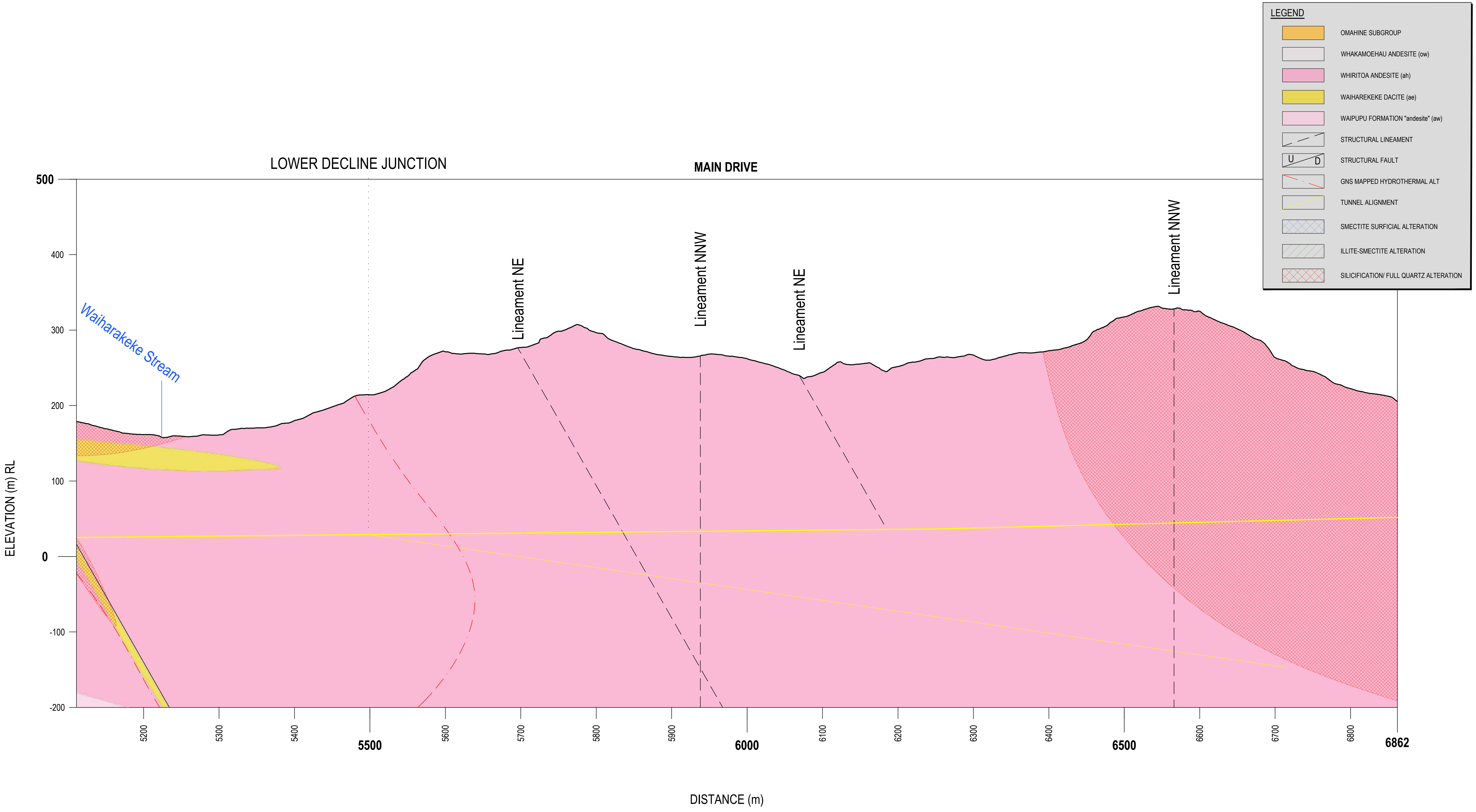

LONGSECTION 4 - CH 5112 TO CH 6862

SCALE 1:2500

0 25 50 75 100 125m

SCALE 1:2500 AT ORIGINAL SIZE

PRELIMINARY

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A	CONCEPTUAL		NB	TM	NE	082020Y

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Drafting Check	DM	Design Check	NE
Approved (Project Director)	NE		
Date	17082020		
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Project **WKP EXPLORATION TUNNEL - WATER ASSESSMENT**
Title **CONCEPTUAL GEOLOGICAL LONGSECTION**
DRAFT 17082020

Original Size **A1** **Drawing No: Q004** **Rev: A**

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Appendix B

Column Testing and Specification

May 12, 2022

To	Mark Burroughs, Euan Leslie (Oceana Gold)	**Contact No.**	
Copy to	Ian Jenkins (AECOM)	**Email**	**tim.mulliner@ghd.com**
From	Tim Mulliner	**Project No.**	12552081
Project Name	Waihi North Project		
Subject	Wharekirauponga Column Summary		

1. Introduction

This technical memorandum summarises laboratory analytical acid base accounting (ABA), whole rock geochemistry and leachate data from field columns set up consisting of representative waste rock material associated with the Wharekirauponga Ore Body. The column set up methodology is provided in Appendix A of this document.

2. Column Set up Analysis

Representative sub-samples of the mixed and crushed column material were assessed using multi-element and acid base accounting (ABA) accounting. The collated data is summarised in Table 2.1 and the laboratory data is provided in Appendix B.

In addition, particle size distribution (PSD) analysis was undertaken on the columns. This data is provided in Appendix C.

Before placement in each column, material was weighed so that the total weight of the material in the column was known. This data is summarised and presented in Table 2.2.

Table 2.1 Column Weights

	T-Stream	EG-South	EG-North
Volume of Waste in Column (kg)	63.506	70.106	80.442

Table 2.2 Whole Rock Geochemistry

Sample Origin		**T-Stream**	**EG-North**	**EG-South**
Sample Name		**T-Stream (B1-SS3)**	**EG-North (B2-SS3)**	**EG-South (B3-SS3)**
Date and Time		**11/24/2021**	**11/24/2021**	**11/24/2021**
Laboratory Reference	**Unit**	**WP21-09045**	**WP21-09045**	**WP21-09045**
Total Sulphur (S)	%	1.05	0.77	0.94
Total Carbon (C)	%	0.03	0.02	0.02
Acid Neutralising Capacity (ANC)	kg H_2SO_4/T	2.00	2.00	5.00
Acid Neutralising Capacity (ANC)	% $CaCO_3$ equiv.	0.20	0.20	0.50
Total Acid Producing (TAP)	kg H_2SO_4/T	32.0	24.0	29.0
Total Acid Producing (TAP)	kg $CaCO_3$/T	32.7	24.5	29.6
Acid Producing	kg H_2SO_4/T	32.13	23.56	28.70
Acid Producing	% $CaCO_3$ equiv.	3.28	2.40	2.93
Acid Neutralising Capacity / Total Acid Producing (ANC/PA Ratio)		0.06	0.08	0.17
Net Acid Producing Potential (NAPP)	kg H_2SO_4/T	31.0	21.0	24.0
Net Acid Generation pH (NAG pH)	pH unit	3.10	3.30	3.20
Net Acid Generation (NAG)	kg H_2SO_4/T	30.0	21.0	25.0
NP	kg H2SO4/T	2.33	1.67	1.58
NNP	kg $CaCO_3$/T	-30.32	-22.82	-28.01
NPR Ratio	%	0.07	0.07	0.05
Sulphide Sulphate (S-)	%	0.83	0.62	0.78
S	%	1.06	0.75	0.95
Major Elements				
Al	%	7.37	5.18	5.71
Fe	%	1.33	1.32	1.64
Ca	%	0.46	0.18	0.4
Mg	%	0.12	0.04	0.15
Na	%	0.07	0.15	0.13
K	%	3.1	4.19	3.39
Trace Elements				
Sb	ppm	7.6	11.5	9.23
As	ppm	134.5	201	228
Ba	ppm	390	600	630
Cd	ppm	0.02	0.02	0.03
Co	ppm	2.5	1.3	2.8
Cr	ppm	9	7	10
Cu	ppm	12.9	6.2	6.5
Pb	ppm	15.8	11.4	10.7
Hg	ppm	0.55	0.076	0.064
Mn	ppm	79	90	216
Mo	ppm	2	1.41	1.65
Ni	ppm	3.1	1.6	2.6
Se	ppm	<1	<1	<1
V	ppm	38	10	16
Zn	ppm	13	19	32

This Technical Memorandum is provided as an interim output under our agreement with Oceana Gold NZ Ltd. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

3. Column Leachate Data

Leachate data has been collected throughout the column operation on a weekly basis. Field parameters and measurements taken along with analytical laboratory data are presented for each three columns in Figures 1-3. Leachate analytical data is provided in Appendix D.

This Technical Memorandum is provided as an interim output under our agreement with Oceana Gold NZ Ltd. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

Sample Origin		**Figure 1. EG-Vein (Northern Area) Column Results**								
Sample Name		**Column Set-Up**	1836721 09-Nov-2021	1838001 19-Nov-2021	1838178 24-Nov-2021	1838286 02-Dec-2021	1838667 13-Dec-2021	1838692 20-Dec-2021	1838749 30-Dec-2021	1838757 06-Jan-2022
Date and Time		**10/21/2021**	8-Nov-21	19-Nov-21	24-Nov-21	2-Dec-21	13-Dec-21	20-Dec-21	30-Dec-21	6-Jan-22
Laboratory Reference		-	2763341.1	2773857.2	2778761.1	2787988.1	2798790.1	2807535.1	2815489.2	2823026.2
Field Parameters										
FLS Electrical Conductivity	mS/m	-		149.7	225.7	280.9			469.6	991.7
FLS pH	pH Units	-		3.99	3.78	4.77	4.65	4.65	3.51	2.12
FLS Temperature	°C	-		21.3	24.1	19.7	17.7	17.7	24.2	19.2
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	-	1.0	1.0	1.0	1.0	1.0			780
Alkalinity - Total	m^3 as CaC	-	3.4	1.0	1.0	1.0	1.0			1.0
Dissolved Heavy Metals and Trace Elements										
Aluminium-Dissolved	g/m^3	-	0.004	105	196		1,280			290
Antimony-Dissolved	g/m^3	-	0.0002	0.002	0.0004		0.002			0.004
Arsenic-Dissolved	g/m^3	-	0.103	0.162	0.21	0.029	0.83	4	0.153	64
Barium-Dissolved	g/m^3	-	0.005	0.016	0.021		0.012			0.005
Cadmium-Dissolved	g/m^3	-	0.00005	0.0088	0.0154	0.0083	0.115	0.066	0.0049	0.0191
Calcium-Dissolved	g/m^3	-	0.35	52	86	-	510			310
Chromium-Dissolved	g/m^3	-	0.023	0.168	0.29	0.121	2	2.1	0.151	1.06
Cobalt-Dissolved	g/m^3	-	0.0002	0.59	1.05		6.5			0.91
Copper-Dissolved	g/m^3	-	0.028	1.69	3.4	1.63	21	18.2	1.14	5.4
Iron-Dissolved	g/m^3	-	0.02	71	122		670			1,050
Lead-Dissolved	g/m^3	-	0.0001	0.0013	0.0016	0.0002	0.0029	0.001	0.001	0.001
Magnesium-Dissolved	g/m^3	-	0.11	32	52		250			33
Manganese-Dissolved	g/m^3	-	0.0051	6.8	11.1		67			7.5
Mercury-Dissolved	g/m^3	-	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00015
Molybdenum-Dissolved	g/m^3	-	0.0002	0.002	0.0004		0.002			0.02
Nickel-Dissolved	g/m^3	-	0.0005	0.2	0.34	0.173	2.3	1.22	0.099	0.33
Potassium-Dissolved	g/m^3	-	0.17	31	58		310			68
Selenium-Dissolved	g/m^3	-	0.001	0.01	0.013		0.11			0.019
Silver-Dissolved	g/m^3	-	0.0001	0.001	0.0002		0.001			0.001
Sodium-Dissolved	g/m^3	-	0.81	29	45		220			13
Strontium-Dissolved	g/m^3	-	0.0008	0.44	0.72		4.1			0.8
Sulphate	g/m^3	-	5	940	1,640	114	1,110			1,240
Uranium-Dissolved	g/m^3	-	0.00002	0.046	0.088		0.58			0.14
Vanadium-Dissolved	g/m^3	-			0.006		0.064			0.24
Zinc-Dissolved	g/m^3	-	0.065	9.4	16.4	8.5	104	45	5	19.6
Laboratory Field Parameters										
pH(pH units)	pH units	-	6	4.2	4.1	4.5	4			2.4
Electrical Conductivity	(mS/m)	-	1	141.8	216	26.2	155.9			259
Leachate										
Volume in Tubing	mL						80	100	200	200
Volume in Bucket	mL	-					500		40	330
Volume Sampled	mL	-	2,100	1,000	400	350	580	100	240	530

Notes
NES - Not enough to sample
Cells shaded yellow are below the laboratory limit of reporting

Sample Origin										
Sample Name		1838824 12-Jan-2022	1838923 20-Jan-2022	1839223 03-Feb-2022	1839306 11-Feb-2022	1839334 15-Feb-2022	1839575 28-Feb-2022	1839844 07-Mar-2022	1839990 10-Mar-2022	1840315 18-Mar-2022
Date and Time		12-Jan-22	20-Jan-22	3-Feb-22	11-Feb-22	15-Feb-22	28-Feb-22	7-Mar-22	10-Mar-22	18-Mar-22
Laboratory Reference		2825714.1	2836064.1	2854592.1	2867192.1	2873486.1	2900847.2	2909016.1	2914098.3	2925270.1
Field Parameters										
FLS Electrical Conductivity	mS/m	789.3	620	915.9	897.9	821.8		977.1	987.7	1073.7
FLS pH	pH Units	2.1	2.2	2.09	2.08	1.77		1.6	1.65	1.66
FLS Temperature	°C	26.7	21	22.8	21.9	20.6		27.7	24.2	22.5
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	1,950		2,500	3,800	2,900	1060		5,500	6,200
Alkalinity - Total	m^3 as CaC	1.0		1.0	1.0	1.0	1.0		1.0	1.0
Dissolved Heavy Metals and Trace Element										
Aluminium-Dissolved	g/m^3		75	150		95		127		109
Antimony-Dissolved	g/m^3		0.002	0.0034		0.0036		0.0056		0.0077
Arsenic-Dissolved	g/m^3	41	13.6	50	50	35	28	61	55	54
Barium-Dissolved	g/m^3		0.005	0.005		0.005		0.005		0.005
Cadmium-Dissolved	g/m^3	0.0073	0.0043	0.0072	0.0053	0.0033	0.0031	0.0041	0.0031	0.0031
Calcium-Dissolved	g/m^3		48	61		21		21		15.3
Chromium-Dissolved	g/m^3	0.46	0.22	0.46	0.35	0.22	0.193	0.28	0.26	0.25
Cobalt-Dissolved	g/m^3		0.195	0.32		0.21		0.26		0.24
Copper-Dissolved	g/m^3		1.09	1.76	1.25	0.94	0.8	1.1	0.97	0.96
Iron-Dissolved	g/m^3	2	440	1,170		960		1,570		1,620
Lead-Dissolved	g/m^3	0.001	0.001	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005
Magnesium-Dissolved	g/m^3		8.1	15.3		11.1		14.4		11.8
Manganese-Dissolved	g/m^3		2.6	4.2		3.5		4.5		4.3
Mercury-Dissolved	g/m^3	0.00008	0.00015	0.00015	0.00015	0.00015	0.00015	0.00008	0.00015	0.00015
Molybdenum-Dissolved	g/m^3		0.005	0.0128		0.0157		0.026		0.03
Nickel-Dissolved	g/m^3	0.118	0.07	0.121	0.081	0.064	0.057	0.075	0.187	0.098
Potassium-Dissolved	g/m^3		5.2	1.2		1.5		0.4		0.5
Selenium-Dissolved	g/m^3		0.01	0.008		0.011		0.02		0.023
Silver-Dissolved	g/m^3		0.001	0.0005		0.0005		0.0008		0.0006
Sodium-Dissolved	g/m^3		1.5	2.3		1.58		1.73		2
Strontium-Dissolved	g/m^3		0.105	0.121		0.045		0.048		0.044
Sulphate	g/m^3	3,500	2,300	2,600	4,200	3,400	1,270		6,100	6,700
Uranium-Dissolved	g/m^3		0.0158	0.029		0.0155		0.0199		0.0193
Vanadium-Dissolved	g/m^3		0.083	0.23		0.109		0.147		0.134
Zinc-Dissolved	g/m^3	8.7	5.3	8.4	7.2	5.1	4.3	5.6	4.8	4.5
Laboratory Field Parameters										
pH(pH units)	pH units	1.9	2.0	2.0	1.8	1.9	2.2		1.8	1.7
Electrical Conductivity	(mS/m)	677	582	550	798	688	328		1,030	1,086
Leachate										
Volume in Tubing	mL	1,190	1,000	430	1,150	730	420	240	730	400
Volume in Bucket	mL			325	1,050	140	620	0	0	0
Volume Sampled	mL	1,190	1,000	755	2,200	870	1,040	240	730	400

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin							
Sample Name		1840620 25-Mar-2022					1841580 28-Apr-2022
Date and Time		25-Mar-22	31-Mar-22	7-Apr-22	13-Apr-22	21-Apr-22	28-Apr-22
Laboratory Reference		2934532.1					2972202.1
Field Parameters							
FLS Electrical Conductivity	mS/m	454.8					
FLS pH	pH Units	1.77					
FLS Temperature	°C	19.8					
Acidity and Alkalinity							
Acidity (pH 3.7)	m^3 as CaC	2,800					2,200
Alkalinity - Total	m^3 as CaC	1.0					1.0
Dissolved Heavy Metals and Trace Element							
Aluminium-Dissolved	g/m^3						29
Antimony-Dissolved	g/m^3						0.0029
Arsenic-Dissolved	g/m^3	10.3					7.6
Barium-Dissolved	g/m^3						0.005
Cadmium-Dissolved	g/m^3	0.001					0.0008
Calcium-Dissolved	g/m^3						3.5
Chromium-Dissolved	g/m^3	0.072					0.045
Cobalt-Dissolved	g/m^3						0.088
Copper-Dissolved	g/m^3	0.4					0.3
Iron-Dissolved	g/m^3						470
Lead-Dissolved	g/m^3	0.0005					0.0005
Magnesium-Dissolved	g/m^3						3
Manganese-Dissolved	g/m^3						0.74
Mercury-Dissolved	g/m^3	0.00008					0.00008
Molybdenum-Dissolved	g/m^3						0.0056
Nickel-Dissolved	g/m^3	0.034					0.029
Potassium-Dissolved	g/m^3						0.3
Selenium-Dissolved	g/m^3						0.007
Silver-Dissolved	g/m^3						0.0005
Sodium-Dissolved	g/m^3						2.2
Strontium-Dissolved	g/m^3						0.016
Sulphate	g/m^3	3,100					2,300
Uranium-Dissolved	g/m^3						0.0046
Vanadium-Dissolved	g/m^3						0.021
Zinc-Dissolved	g/m^3	1.58					0.87
Laboratory Field Parameters							
pH(pH units)	pH units	1.9					2.00
Electrical Conductivity	(mS/m)	677					595
Leachate							
Volume in Tubing	mL	1,600		100	30	2,000	300
Volume in Bucket	mL			290	0	500	400
Volume Sampled	mL	1,600	550	390	30	2,500	700

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin		**Figure 2. EG-Vein (Southern Area) Column Results**								
Sample Name		**Column Set-Up**	1836722 09-Nov-2021	1838002 19-Nov-2021	1838179 24-Nov-2021	1838287 02-Dec-2021	1838668 13-Dec-2021	1838693 20-Dec-2021	1838738 - 22-Dec-2021	1838750 30-Dec-2021
Sample Date and Time		**10/21/2021**	8-Nov-21	19-Nov-21	24-Nov-21	2-Dec-21	13-Dec-21	20-Dec-21	22-Dec-21	30-Dec-21
Laboratory Reference		-	2763341.2	2773857.3	2778761.2	2787988.2	2798790.2	2807535.2	2812321.2	2815489.3
Field Parameters										
FLS Electrical Conductivity	mS/m	-		0.3	251.2	65.5			336.9	
FLS pH	pH Units	-		3.96	4.07	4.96	5.09		3.28	
FLS Temperature	°C	-		22.2	23.7	19.8	18.2		25.7	
Acidity and Alkalinity										
Acidity (pH 3.7)	m^{3} as CaC	-	1.0	1.0	1.0	1.0	1.0	46	32	
Alkalinity - Total	m^{3} as CaC	-	9.4	1.0	1.0	1.0	1.0	1.0	1.0	
Dissolved Heavy Metals and Trace Elements										
Aluminium-Dissolved	g/m^{3}	-	0.012	230	70		166		230	
Antimony-Dissolved	g/m^{3}	-	0.0003	0.002	0.0004		0.001		0.002	
Arsenic-Dissolved	g/m^{3}	-	0.32	0.43	0.4	0.41	0.22	0.75	1.18	1.2
Barium-Dissolved	g/m^{3}	-	0.005	0.093	0.026		0.063		0.044	
Cadmium-Dissolved	g/m^{3}	-	0.00005	0.106	0.029	0.09	0.09	0.082	0.062	0.055
Calcium-Dissolved	g/m^{3}	-	1.45	530	162		530		480	
Chromium-Dissolved	g/m^{3}	-	0.071	0.053	0.061	0.039	0.023	0.047	0.075	0.078
Cobalt-Dissolved	g/m^{3}	-	0.0002	6.4	1.84		5.2		3	
Copper-Dissolved	g/m^{3}	-	0.075	6	1.95	5.7	5.2	8.1	7.8	7.2
Iron-Dissolved	g/m^{3}	-	0.02	91	26		5.7		1	
Lead-Dissolved	g/m^{3}	-	0.00013	0.0132	0.0028	0.0102	0.0101	0.006	0.0073	0.0083
Magnesium-Dissolved	g/m^{3}	-	0.35	480	144		330		200	
Manganese-Dissolved	g/m^{3}	-	0.024	137	39		108		65	
Mercury-Dissolved	g/m^{3}	-	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008
Molybdenum-Dissolved	g/m^{3}	-	0.0002	0.002	0.0004		0.001		0.002	
Nickel-Dissolved	g/m^{3}	-	0.0005	2.2	0.64	1.91	1.8	1.55	1.11	1.02
Potassium-Dissolved	g/m^{3}	-	0.57	380	110		340		270	
Selenium-Dissolved	g/m^{3}	-	0.001	0.086	0.023		0.063		0.045	
Silver-Dissolved	g/m^{3}	-	0.0001	0.001	0.0002		0.0005		0.001	
Sodium-Dissolved	g/m^{3}	-	2.6	184	57		145		49	
Strontium-Dissolved	g/m^{3}	-	0.003	3.8	1.06		3.2		1.94	
Sulphate	g/m^{3}	-	6	2500	1,540	590	520	4,200	2400	
Uranium-Dissolved	g/m^{3}	-	0.00002	0.136	0.042		0.131		0.163	
Vanadium-Dissolved	g/m^{3}	-			0.002		0.005		0.01	
Zinc-Dissolved	g/m^{3}	-	0.069	59	16.9	53	45	45	34	31
Laboratory Field Parameters										
pH(pH units)	pH units	-	6.4	4.1	4.7	4.5	4.3	3.6	3.7	
Electrical Conductivity	(mS/m)	-	3.5	353	240	107.8	99.2	520	318	
Leachate										
Volume in Tubing	mL	-					50	480	250	60
Volume in Bucket	mL	-					400	550	100	110
Volume Sampled	mL	-	1,200	1,000	350	450	450	1030	350	170

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory limit of reporting

Sample Origin										
Sample Name		1838758 06-Jan-2022	1838825 12-Jan-2022	1838924 20-Jan-2022	1839224 20-Jan-2022	1839307 11-Feb-2022	1839335 15-Feb-2022	1839574 28-Feb-2022	1839845 07-Mar-2022	1839989 10-Mar-2022
Sample Date and Time		6-Jan-22	12-Jan-22	20-Jan-22	3-Feb-22	11-Feb-22	15-Feb-22	28-Feb-22	7-Mar-22	10-Mar-22
Laboratory Reference		2823026.2	2825714.2	2836064.2	2854592.2	2867192.2	2873486.2	2900847.1	2909016.2	2914098.2
Field Parameters										
FLS Electrical Conductivity	mS/m	514.9	626	642	719.6	898.8	982.2		736.4	971.4
FLS pH	pH Units	2.76	2.49	2.6	2.4	2.35	1.92		1.94	1.8
FLS Temperature	°C	25.1	26.8	21.9	21.4	23.1	24		29.1	22.5
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	1,110	1,030	2,100	3,900	6,900	5100	4400	5,400	7,800
Alkalinity - Total	m^3 as CaC	1.0	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Dissolved Heavy Metals and Trace Element										
Aluminium-Dissolved	g/m^3	230		360	390		440		320	
Antimony-Dissolved	g/m^3	0.002		0.004	0.005		0.013		0.0104	
Arsenic-Dissolved	g/m^3	6.6	8.9	6.3	30	117	83	51	77	114
Barium-Dissolved	g/m^3	0.05		0.012	0.005		0.005		0.005	
Cadmium-Dissolved	g/m^3	0.047	0.032	0.033	0.033	0.038	0.026	0.0164	0.0157	0.0152
Calcium-Dissolved	g/m^3	480		480	470		350		220	
Chromium-Dissolved	g/m^3	0.21	0.6	0.6	0.69	0.8	0.59	0.33	0.34	0.39
Cobalt-Dissolved	g/m^3	2.2		1.64	1.79		1.52		1	
Copper-Dissolved	g/m^3	6.1	5.6	5	5.1	4.8	3.5	2.3	2.5	2.4
Iron-Dissolved	g/m^3	187		570	750		1990		1740	
Lead-Dissolved	g/m^3	0.0153	0.0011	0.001	0.0005	0.0013	0.001	0.0005	0.0006	0.0011
Magnesium-Dissolved	g/m^3	139		105	121		144		106	
Manganese-Dissolved	g/m^3	44		54	57		60		36	
Mercury-Dissolved	g/m^3	0.00008	0.00008	0.00015	0.00015	0.00015	0.0003	0.00015	0.00015	0.00015
Molybdenum-Dissolved	g/m^3	0.002	-	0.002	0.0053		0.016		0.0161	
Nickel-Dissolved	g/m^3	0.81	0.58	0.57	0.62	0.61	0.53	0.37	0.53	0.43
Potassium-Dissolved	g/m^3	167		39	6.2		0.5		0.6	
Selenium-Dissolved	g/m^3	0.031		0.015	0.013		0.02		0.021	
Silver-Dissolved	g/m^3	0.001		0.0019	0.001		0.0035		0.0028	
Sodium-Dissolved	g/m^3	25		8.3	8		2.1		1.08	
Strontium-Dissolved	g/m^3	1.39		0.65	0.5		0.156		0.113	
Sulphate	g/m^3	5,600	5,300	5,500	7,500	11,500	9,500	8,100	8,000	13,900
Uranium-Dissolved	g/m^3	0.172		0.164	0.178		0.095		0.056	
Vanadium-Dissolved	g/m^3	0.025		0.32	0.159		0.73		0.25	
Zinc-Dissolved	g/m^3	26	24	23	25	39	31	21	22	19.6
Laboratory Field Parameters										
pH(pH units)	pH units	2.4	2.4	2.5	2.2	2	2.1	2.1	2.1	2
Electrical Conductivity	(mS/m)	594	591	570	785	1018	844	709	784	977
Leachate										
Volume in Tubing	mL	260	1,170	1,160	1,310	1,170	1,140	1,110	770	1100
Volume in Bucket	mL	0	0	0	70	110	170	190	0	0
Volume Sampled	mL	260	1,170	1,160	1,380	1,280	1,310	1,300	770	1100

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin								
Sample Name		1840316 18-Mar-2022	1840621 25-Mar-2022					1841581 28-Apr-2022
Sample Date and Time		18-Mar-22	25-Mar-22	31-Mar-22	7-Apr-22	13-Apr-22	21-Apr-22	28-Apr-22
Laboratory Reference		2925270.2	2934532.2					2972202.2
Field Parameters								
FLS Electrical Conductivity	mS/m	949.4	795.3					
FLS pH	pH Units	1.86	1.89					
FLS Temperature	°C	23.1	20.2					
Acidity and Alkalinity								
Acidity (pH 3.7)	m^3 as CaC	9,200	5,800					2,900
Alkalinity - Total	m^3 as CaC	1.0	6					1.0
Dissolved Heavy Metals and Trace Element								
Aluminium-Dissolved	g/m^3	400						104
Antimony-Dissolved	g/m^3	0.02						0.005
Arsenic-Dissolved	g/m^3	125	47					16.9
Barium-Dissolved	g/m^3	0.005						0.005
Cadmium-Dissolved	g/m^3	0.0147	0.0077					0.0025
Calcium-Dissolved	g/m^3	240						74
Chromium-Dissolved	g/m^3	0.37	0.182					0.059
Cobalt-Dissolved	g/m^3	1.11						0.4
Copper-Dissolved	g/m^3	2.3	1.44					0.7
Iron-Dissolved	g/m^3	3000						830
Lead-Dissolved	g/m^3	0.0013	0.0005					0.0005
Magnesium-Dissolved	g/m^3	125						40
Manganese-Dissolved	g/m^3	35						8.7
Mercury-Dissolved	g/m^3	0.00015	0.00015					0.00008
Molybdenum-Dissolved	g/m^3	0.032						0.0077
Nickel-Dissolved	g/m^3	0.43	0.28					0.16
Potassium-Dissolved	g/m^3	0.3						0.3
Selenium-Dissolved	g/m^3	0.045						0.013
Silver-Dissolved	g/m^3	0.0013						0.0011
Sodium-Dissolved	g/m^3	1.01						1.15
Strontium-Dissolved	g/m^3	0.043						0.017
Sulphate	g/m^3	11,500	7,000					3,800
Uranium-Dissolved	g/m^3	0.075						0.0137
Vanadium-Dissolved	g/m^3	0.41						0.096
Zinc-Dissolved	g/m^3	17	9.3					2.9
Laboratory Field Parameters								
pH(pH units)	pH units	2	2					2.1
Electrical Conductivity	(mS/m)	987	754					2900
Leachate								
Volume in Tubing	mL	2,000	2,600		680	780	6,710	1,560
Volume in Bucket	mL	0	-		0	0	90	0
Volume Sampled	mL	2,000	2,600	2,100	680	780	6,800	1,560

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin		Figure 3. T-Stream Vein Column Results								
Sample Name		**Column Set-Up**	1836721 09-Nov-2021	1838000 19-Nov-2021	1838180 24-Nov-2021	1838288 02-Dec-2021	1838669 13-Dec-2021	1838694 20-Dec-2021	1838737 22-Dec-2021	1838748 30-Dec-2021
Date and Time		**10/21/2021**	8-Nov-21	19-Nov-21	24-Nov-21	2-Dec-21	13-Dec-21	20-Dec-21	22-Dec-21	30-Dec-21
Laboratory Reference		-	2763341.3	2773857.1	2778761.3	2787988.3	2798790.3	2807535.3	2812321.1	281.5489.1
Field Parameters										
FLS Electrical Conductivity	mS/m	-		19.13	2.566	7.8			2.5	
FLS pH	pH Units	-		6.2	6.18	5.57	7.01		5.7	
FLS Temperature	°C	-		22.7	23.5	18.8	18.5		27	
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	-	1.0	1.0		1.0	1.0	1	1	
Alkalinity - Total	m^3 as CaC	-	3.6	4.3		4.0	17.6	1.0	2.2	
Dissolved Heavy Metals and Trace Elements										
Aluminium-Dissolved	g/m^3	-	0.003	0.009	0.008		0		30	
Antimony-Dissolved	g/m^3	-	0.0002	0.0002	0.0002		0.0002		0.002	-
Arsenic-Dissolved	g/m^3	-	0.0042	0.0164	0.0045	0.0045	0.0053	0.144	0.096	0.057
Barium-Dissolved	g/m^3	-	0.005	0.005	0.005		0.005		0.064	-
Cadmium-Dissolved	g/m^3	-	0.00005	0.00005	0.00005	0.00005	0.00005	0.0105	0.0107	0.0064
Calcium-Dissolved	g/m^3	-	0.38	1.02	1.24		1.73		560	
Chromium-Dissolved	g/m^3	-	0.0012	0.0035	0.0014	0.0021	0.003	0.005	0.006	0.006
Cobalt-Dissolved	g/m^3	-	0.0002	0.0002	0.0002		0.0002		2.3	
Copper-Dissolved	g/m^3	-	0.002	0.0064	0.0086	0.0052	0.0117	2.5	3.7	1.76
Iron-Dissolved	g/m^3	-	0.02	0.02	0.02		0.02		28	
Lead-Dissolved	g/m^3	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0015	0.0019	0.0014
Magnesium-Dissolved	g/m^3	-	0.1	0.24	0.44		0.82	-	440	
Manganese-Dissolved	g/m^3	-	0.0037	0.0015	0.006		0.0043	-	12.4	
Mercury-Dissolved	g/m^3	-	0.00008	0.00008	0.00039	0.00008	0.00008	0.00017	0.00008	0.00008
Molybdenum-Dissolved	g/m^3	-	0.0002	0.0002	0.0002		0.0002		0.002	
Nickel-Dissolved	g/m^3	-	0.0005	0.0005	0.0005	0.0005	0.0005	1.26	1.32	0.7
Potassium-Dissolved	g/m^3	-	0.1	0.65	1.1		2.5		94	
Selenium-Dissolved	g/m^3	-	0.001	0.001	0.001		0.001		0.126	
Silver-Dissolved	g/m^3	-	0.0001	0.0001	0.0001		0.0001		0.001	
Sodium-Dissolved	g/m^3	-	0.7	1.4	2.1		5.5		175	
Strontium-Dissolved	g/m^3	-	0.001	0.0027	0.0033		0.0056		2.7	
Sulphate	g/m^3	-	5	5	5	1.9	5	3,800	4.1	
Uranium-Dissolved	g/m^3	-	0.00002	0.00002	0.00002		0.00002		0.042	
Vanadium-Dissolved	g/m^3	-			0.001		0.001		0.01	
Zinc-Dissolved	g/m^3	-	0.024	0.053	0.027	0.026	0.019	4.1	4.6	2.6
Laboratory Field Parameters										
pH(pH units)	pH units	-	5.9	6.2	7.3	6.3	7.1	4.5	5.4	
Electrical Conductivity	(mS/m)	-	0.8	1.8	2.5	1.8	8.2	546	2.3	
Leachate										
Volume in Tubing	mL						0	355	80	10
Volume in Bucket	mL	-					700	600	450	80
Volume Sampled	mL	-	1,800	1,000	200	350	700	955	530	85

Notes

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Sample Origin										
Sample Name		1838759 06-Jan-2022	1838826 12-Jan-2022	1838925 20-Jan-2022	1839225 03-Feb-2022	1839308 11-Feb-2022	1839336 15-Feb-2022	1839576 28-Feb-2022	1839846 07-Mar-2022	1839988 10-Mar-2022
Date and Time		6-Jan-22	12-Jan-22	20-Jan-22	3-Feb-22	11-Feb-22	15-Feb-22	28-Feb-22	7-Mar-22	10-Mar-22
Laboratory Reference		2823026.3	2825714.3	2836064.3	2854592.3	2867192.3	2873486.3	2900847.3	2909016.3	2914098.1
Field Parameters										
FLS Electrical Conductivity	mS/m	566.9	569	568	558.6	896.4	964.2		906.1	913.9
FLS pH	pH Units	3.43	3.2	3.3	3.09	3.14	2.14		2.36	2.34
FLS Temperature	°C	26.1	29.2	23	22.7	23.6	26.2		26	24.2
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	156	156	440	340	2,700	2800	2200	2,200	1,900
Alkalinity - Total	m^3 as CaC	1.0	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Dissolved Heavy Metals and Trace Element										
Aluminium-Dissolved	g/m^3	76		131	123		370		460	
Antimony-Dissolved	g/m^3	0.002		0.002	0.001		0.004		0.0027	
Arsenic-Dissolved	g/m^3	0.119	0.22	0.28	0.29	30	31	12.4	4.9	4.9
Barium-Dissolved	g/m^3	0.047		0.035	0.024		0.009		0.005	
Cadmium-Dissolved	g/m^3	0.0129	0.0124	0.0119	500	0.015	0.0164	0.0169	0.0199	0.019
Calcium-Dissolved	g/m^3	520		510	0.0122		440		430	
Chromium-Dissolved	g/m^3	0.037	0.083	0.074	0.072	0.26	0.36	0.37	0.39	0.4
Cobalt-Dissolved	g/m^3	2.4		2.2	2.3		2.7		3.4	
Copper-Dissolved	g/m^3	6.6	10.5	9.2	9.3	12.5	13.9	16	19.4	17.3
Iron-Dissolved	g/m^3	34		196	141		1390		780	
Lead-Dissolved	g/m^3	0.0118	0.024	0.0124	0.0066	0.0005	0.001	0.0005	0.0005	0.0005
Magnesium-Dissolved	g/m^3	440		430	460		480		630	
Manganese-Dissolved	g/m^3	11.4		9.5	9.7		16		22	
Mercury-Dissolved	g/m^3	0.00008	0.00008	0.00008	0.00008	0.00015	0.00015	0.00015	0.00015	0.00008
Molybdenum-Dissolved	g/m^3	0.002		0.002	0.001		0.016		0.0018	
Nickel-Dissolved	g/m^3	1.44	1.63	1.47	1.49	1.62	1.88	2	2.3	2.3
Potassium-Dissolved	g/m^3	91		80	78		48		22	
Selenium-Dissolved	g/m^3	0.086		0.042	0.038		0.018		0.019	
Silver-Dissolved	g/m^3	0.001		0.001	0.0005		0.001		0.0005	
Sodium-Dissolved	g/m^3	126		64	63		18.7		19.7	
Strontium-Dissolved	g/m^3	2.6		2.5	2.5		2.5		2.8	
Sulphate	g/m^3	4,700	4,400	4,300	4,200	8,500	10,200	9,200	8,900	10,800
Uranium-Dissolved	g/m^3	0.118		0.125	0.117		0.197		0.27	
Vanadium-Dissolved	g/m^3	0.013		0.066	0.048		0.76		0.88	
Zinc-Dissolved	g/m^3	5.4	6.1	5.7	5.5	7.9	8.1	9.3	10.1	10
Laboratory Field Parameters										
pH(pH units)	pH units	3.1	3.1	3.2	3.3	2.4	2.3	2.4	2.5	2.6
Electrical Conductivity	(mS/m)	563	523	511	534	811	937	895	862	796
Leachate										
Volume in Tubing	mL	170	1,190	1,190	1,150	1,180	1,180	1,100	1,140	820
Volume in Bucket	mL	0	500	0	360	4,300	680	600	0	50
Volume Sampled	mL	170	1,690	1,190	1,510	5,480	1,860	1,700	1,140	870

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin								
Sample Name		1840317 18-Mar-2022	1840622 25-Mar-2022					1841582 28-Apr-2022
Date and Time		18-Mar-22	25-Mar-22	31-Mar-22	7-Apr-22	13-Apr-22	21-Apr-22	28-Apr-22
Laboratory Reference		2925270.3	2934532.3					2972202.3
Field Parameters								
FLS Electrical Conductivity	mS/m	1215.9	1517.1					
FLS pH	pH Units	2.2	1.68					
FLS Temperature	°C	20.5	20.1					
Acidity and Alkalinity								
Acidity (pH 3.7)	m^3 as CaC	3,100	11,400					11,900
Alkalinity - Total	m^3 as CaC	1.0	6					1.0
Dissolved Heavy Metals and Trace Element								
Aluminium-Dissolved	g/m^3	760						540
Antimony-Dissolved	g/m^3	0.0063						0.0069
Arsenic-Dissolved	g/m^3	14.2	179					106
Barium-Dissolved	g/m^3	0.005						0.005
Cadmium-Dissolved	g/m^3	0.024	0.0141					0.0088
Calcium-Dissolved	g/m^3	410						420
Chromium-Dissolved	g/m^3	0.71	0.7					0.53
Cobalt-Dissolved	g/m^3	3.3						1.1
Copper-Dissolved	g/m^3	20	10.6					5.5
Iron-Dissolved	g/m^3	1870						4900
Lead-Dissolved	g/m^3	0.0005	0.002					0.0005
Magnesium-Dissolved	g/m^3	660						230
Manganese-Dissolved	g/m^3	18.8						12.4
Mercury-Dissolved	g/m^3	0.00016	0.0004					0.0004
Molybdenum-Dissolved	g/m^3	0.0029						0.139
Nickel-Dissolved	g/m^3	2.4	1.5					0.96
Potassium-Dissolved	g/m^3	32						0.4
Selenium-Dissolved	g/m^3	0.014						0.03
Silver-Dissolved	g/m^3	0.0005						0.0005
Sodium-Dissolved	g/m^3	11.3						2.1
Strontium-Dissolved	g/m^3	2.6						0.84
Sulphate	g/m^3	13,500	17,900					22,000
Uranium-Dissolved	g/m^3	0.3						0.053
Vanadium-Dissolved	g/m^3	1.47						1.37
Zinc-Dissolved	g/m^3	11.5	8					6.1
Laboratory Field Parameters								
pH(pH units)	pH units	2.4	1.8					1.8
Electrical Conductivity	(mS/m)	1161	1608					1569
Leachate								
Volume in Tubing	mL	2,000	2,900		180	610	4,400	1,850
Volume in Bucket	mL				310	0	3100	500
Volume Sampled	mL	2,000	2,900	2,000	490	610	7,500	2,350

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

4. Limitations

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

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The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report. Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has not been involved in the preparation of the Assessment of Environmental Effects (AEE), prepared by Mitchell Daysh and has had no contribution to, or review of the AEE other than in this technical report for water management. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the AEE. The GHD document containing the disclaimer is to be included in any other document, the entirety of GHD's report must be used (including the disclaimers contained herein), as opposed to reproductions or inclusions solely of sections of GHD's report.

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Regards

Tim Mulliner
Technical Lead - Environment

This Technical Memorandum is provided as an interim output under our agreement with Oceana Gold NZ Ltd. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

Appendices

Appendix A

Column Set Up Methodology

Memorandum

16 June 2021

To	Mark Burroughs, Oceana Gold NZ Ltd.		
Copy to	Thomas Gardner, Oceana Gold NZ Ltd.; Ian Jenkins, AECOM NZ Ltd.		
From	Carlos Hillman, Tim Mulliner	**Tel**	+64 3 378 0900
Subject	WKP Waste Rock Field Column Testing Set-up	**Project no.**	12552081

Introduction and Background

GHD Limited (GHD) has been engaged by Oceana Gold New Zealand Ltd (Oceana Gold) to undertake Geochemical characterisation of the WKP tunnel and mine spoil. This memorandum outlines specifications, set up and operational procedures for the field column tests to aid the geochemical characterisation and assessment.

The purpose of the column tests is to investigate the onset of acid producing leachate and leachate water quality from the waste rock material associated with the WKP Ore Body. Data gathered will enable geochemical characterisation of waste material and its similarity or dissimilarity to waste material currently handled at the existing and proposed Waihi operations. This will then aid methodology for the development of backfill placement and estimating WKP tunnel inflow water quality.

The methodology outlined here is an adaptation of the methodology as outlined in AECOM, 2017[1]

Column Setup and Specification

The existing columns on site (dimensions approximately 800 mm high, 300 mm diameter equalling a total volume of approximately 0.057 m^3 each) will be utilised. The existing columns should be prepared for use by emptying and cleaning, replacing all tubing and buckets (with sealed lids) with food grade plastic and setting up the columns as outlined in Figure 1. Any new or pre-existing equipment should be thoroughly flushed with an acid wash to remove any existing contaminants. It is recommended that if possible, the column cylinders be replaced.

K1 gravel material is recommended at the base of the columns and placed at a thickness that will allow free drainage of leachate to occur (approximately 100 mm). Tubing should be sealed to the base of the columns to collect drainage and avoid any leakage. The length of the tubing should be sufficient so that it can be connected to the collection buckets beneath the columns and long enough so the outlet of the piping can be attached to the side of the column at a height above the maximum level of the waste rock within the column (introducing a head pressure gradient to enable the column to become fully saturated). Tubing should be secured in place (at side of column and top of bucket) in a way that it can easily be released (when sampling) and repositioned when required. Where the tubing connects at the top of the leachate buckets it should be ‘sealed’ in a manner that avoids water other than leachate entering the buckets and enables the removal of the tubing for sampling during the column operation. An approximate tubing length of 1000 – 2000 mm is therefore recommended.

---

[1] Standard Operating Procedure for PYE Field Columns, Waihi – Set up and sample collection. AECOM, (2017).

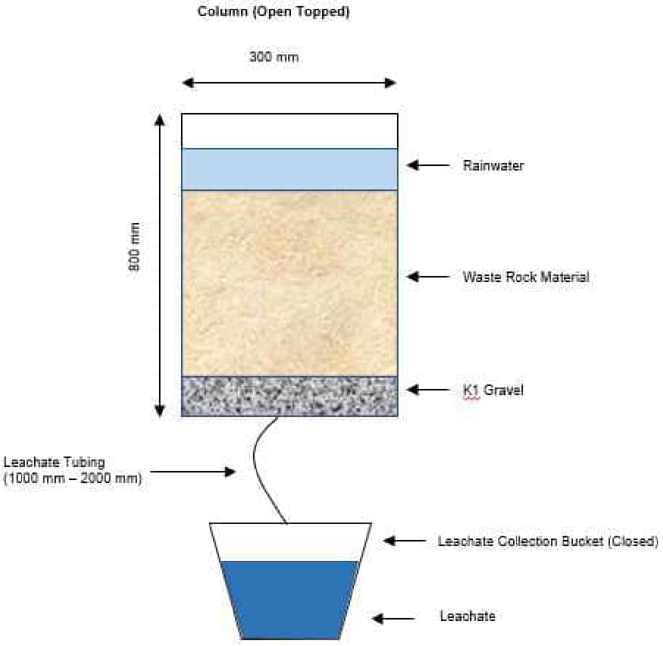

Figure 1 Column Set-up and Specifications

Figure 2 Historical On-site Column Setup (2019)

Waste Rock Selection and Preparation

Three separate columns will be set-up using core material representative of waste spoil and/or tunnel/stope lining material from the WKP Ore body. One column will consist of material surrounding the T-Stream Vein (Drill Site 2) and two columns will exist of material associated with the EG Vein (Drill Site 4 (Northern area) and Drill Site 1 (Southern area)). Each column will contain approximately 60 kg of waste rock representative of the Rhyolitic waste material. Waste rock should be sourced from core material as identified by GHD in the provided spreadsheets (to be provided separately). Appropriate material is selected based on core logs, assay data and photos previously provided to GHD from Oceana Gold.

Once the selected material for each individual column is selected, the material should be fully mixed prior to being crushed (crushing was previously undertaken by the local SGS lab). This will ensure the maximum particle size is not greater than 60 mm or 20% of the column diameter.

Representative samples from each column should be sent for analysis for the parameters detailed in Table 1

The balance of the material should then be placed directly on top of the K1 gravel within the columns. This material should be weighed prior to placing in the column so that total mass of waste within each column is known. A minimum of 150 mm should be maintained between the top of the sample and the top of the column.

Table 1 Recommended Analytical Suite for Column Waste Rock

Required Analytes
PSD (Particle Size Distribution)
NAG pH
Total Sulphur (%)
Total Carbon (%)
ANC (kg $CaCO_3$/tonne)
Aluminium
Iron
Calcium
Magnesium
Sodium
Potassium
Antimony
Arsenic
Barium
Cadmium
Cobalt
Chromium
Copper
Lead
Mercury
Manganese
Molybdenum
Nickel
Selenium
Vanadium
Zinc
Titanium
Tin
Silver
Thallium
Fluoride
Uranium

Column Operation and Sample Procedure

The columns should be left exposed to atmospheric conditions for a minimum of 10 weeks. This initial phase is to ensure that oxidation of the waste rock takes place and becomes acid producing. During this initial phase, leachate generated should be monitored weekly. Depending on the results, the monitoring frequency may be extended with time.

Samples can be obtained by carefully removing the leachate tubing from the bucket and collecting leachate directly from the tubing into laboratory supplied containers suitable for the analysis of the parameters detailed in Table 2 and Table 3.

The expanded and reduced analytical suite should be undertaken on alternate weeks. It is recommended that the expanded suite is utilised for the first flush sample (the first leachate collection event).

Field parameters should be collected utilising a calibrated multi-parameter (or similar individual meters) and the following field parameters recorded:

- pH
- Conductivity
- Temperature

It is recommended that calibration of pH and conductivity is undertaken using appropriate calibration solutions that cover the likely range of measured parameters.

The remaining leachate should be left to drain into the bucket until the tubing runs dry. The volume of leachate within the bucket should be recorded and sampled before reconnecting the tubing to the empty bucket.

If insufficient leachate drains from the tubing and base of column to enable the collection of water samples and/or accurate measurement of field parameters, static water within the bucket should be utilised.

If no leachate water (or insufficient leachate water) is available, a measured volume of 500 mL of de-ionised water should be poured into the column at the top, and the leachate should be collected as described above. Where this is required, it should be recorded on the sampling sheet. In the event that there is frequently not enough leachate to sample within the tubing, a measured volume of deionised water should be added to the top of the column several days before sampling to ensure sufficient water is available. The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommended that field parameters (as above) be recorded prior to the disposal of the leachate water.

The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommended that field parameters (as above) be recorded prior to the disposal of the leachate water.

Table 2 Recommended Analytical Suite for the Leachate Sample Collection – Expanded Suite

Required Analytes
pH
Conductivity
Acidity (mg $CaCO_3$/L)
Alkalinity (mg $CaCO_3$/L)
Sulphate
Dissolved Aluminium
Dissolved Iron
Dissolved Calcium
Dissolved Magnesium
Dissolved Sodium
Dissolved Potassium
Dissolved Antimony
Dissolved Arsenic
Dissolved Barium
Dissolved Cadmium
Dissolved Cobalt
Dissolved Chromium
Dissolved Copper
Dissolved Lead
Dissolved Mercury
Dissolved Manganese
Dissolved Molybdenum
Dissolved Nickel
Dissolved Selenium
Dissolved Vanadium
Dissolved Zinc
Dissolved Titanium
Dissolved Tin
Dissolved Silver
Dissolved Thallium
Dissolved Fluoride
Dissolved Uranium

*It is recommended that samples are field filtered and are analysed at trace level.

*Table 3 Recommended Analytical Suite for the Leachate Sample Collection – Reduced Suite_*

Required Analytes
pH
Conductivity
Acidity (mg $CaCO_3$/L)
Alkalinity (mg $CaCO_3$/L)
Sulphate
Dissolved Arsenic
Dissolved Cadmium
Dissolved Chromium
Dissolved Copper
Dissolved Lead
Dissolved Nickel
Dissolved Zinc

*It is recommended that samples are field filtered and are analysed at trace level.

Results should be forwarded to GHD upon receipt and will be reviewed in terms of the acid generating. Once the columns are verified as being acid producing (generally based on a measured pH <3 and elevated sulphate) GHD will review and advise on requirements for ongoing monitoring.

Regards

Carlos Hillman
Geochemist

Appendix B

Whole Rock Laboratory Data

ANALYSIS REPORT

WP21-09045

Client: Oceana Gold (New Zealand) Ltd
PO Box 190

Waihi 3641 NEW ZEALAND
Attention: Mark Burroughs

Received: 24-Nov-2021
Completed: 23/12/2021
Job Number: WP21-09045
Report Number: 0000019912
Order Reference: 70057883

Sample ID	ESO_CSA06V S % LOR 0.01	ESO_CSA06V C % LOR 0.01	ESO_CLA48V ANC H2SO4 KGH2SO4/T LOR -1,000.00	ESO_CLA48V ANC CaCO3 % LOR -100.00	ESO_CLA48V TAP KGH2SO4/T LOR 0.15
T-Stream (B1-SS3)	1.05	0.028	2	0.2	32
EG North (B2-SS3)	0.770	0.020	2	0.2	24
EG south (B3-SS3)	0.938	0.019	5	0.5	29

ANALYSIS REPORT

WP21-09045

Client: Oceana Gold (New Zealand) Ltd
PO Box 190

Waihi 3641 NEW ZEALAND
Attention: Mark Burroughs

Received: 24-Nov-2021
Completed: 23/12/2021
Job Number: WP21-09045
Report Number: 0000019912
Order Reference: 70057883

Sample ID	ESO_CLA48V NAPP KGH2SO4/T LOR -1,000.00	ESO_CLA49V NAG pH pH unit LOR 2.00	ESO_CLA49V NAG KGH2SO4/T	ESO_CSA08V Sulphide S % LOR 0.01
T-Stream (B1-SS3)	31	3.1	30	0.834
EG North (B2-SS3)	21	3.3	21	0.624
EG south (B3-SS3)	24	3.2	25	0.777

Date Start/End Analysis (7/12/2021 - 23/12/2021)

* - Denotes non accredited tests

REMARKS:

Note that general geochem carbon analysis is not performed routinely, and has been done at request using the Leco CHN analyser used for coal ultimate analysis. Calibration curve set up using geo sulphur CRMs which had certified carbon values.
NAG pH for blank was 5.4.

APPLIED METHODS:

ESO_CSA06V: Total sulphur/carbon, LECO Method: SGS Global method

ESO_CLA48V: Determination of ANC, TAP and NAPP of Soils/Rocks: SGS inhouse method

ESO_CLA49V: Net Acid Generation Test: SGS Global method

ANALYSIS REPORT

WP21-09045

Client: Oceana Gold (New Zealand) Ltd
PO Box 190

Waihi 3641 NEW ZEALAND
Attention: Mark Burroughs

Received: 24-Nov-2021
Completed: 23/12/2021
Job Number: WP21-09045
Report Number: 0000019912
Order Reference: 70057883

Signed and dated on 23-Dec-2021

Nick LEES
Operations Manager

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32 Shand Street
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Phone: +61 7 3243 7222 Fax: +61 7 3243 7218
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ALS Brisbane is a NATA Accredited Testing Laboratory. Corporate Accreditation No: 825, Corporate Site No: 818.

To: OCEANA GOLD (NZ) LTD
PO BOX 5442
DUNEDIN 9058
NEW ZEALAND

Page: 1
Total # Pages: 2 (A - D)
Plus Appendix Pages
Finalized Date: 12-FEB-2022
Account: OCEGOL

CERTIFICATE BR21332922

Project: WNP

This report is for 3 samples of Crushed Core submitted to our lab in Brisbane, QLD, Australia on 2-NOV-2021.

The following have access to data associated with this certificate:

CASSIE CRAIG	THOMAS GARDNER	REBECCA HILLYARD

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LEV-01	Waste Disposal Levy
QAR-01	Quarantine Treatment Charge
LOG-22	Sample login - Rcd w/o BarCode
PUL-23	Pulv Sample - Split/Retain
BAG-01	Bulk Master for Storage
PUL-QC	Pulverizing QC Test
TRA-21	Transfer sample

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
F-ELE81a	F by Specific Ion Electrode	TITRATOR
ME-MS61	48 element four acid ICP-MS	
Hg-MS42	Trace Hg by ICPMS	ICP-MS

This is the Final Report and supersedes any preliminary report with this certificate number.Results apply to samples as submitted.All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

Australian Laboratory Services Pty. Ltd.
32 Shand Street
Stafford
Brisbane QLD 4053
Phone: +61 7 3243 7222 Fax: +61 7 3243 7218
www.alsglobal.com/geochemistry
ALS Brisbane is a NATA Accredited Testing Laboratory. Corporate Accreditation No: 825, Corporate Site No: 818.

To: OCEANA GOLD (NZ) LTD
PO BOX 5442
DUNEDIN 9058
NEW ZEALAND

Finalized Date: 12-FEB-2022
Account: OCEGOL

Project: WNP

CERTIFICATE OF ANALYSIS BR21332922

Sample Description	Method Analyte Units LOD	WEI-21 Recvd Wt. kg 0.02	PUL-QC Pass75um % 0.01	F-ELE81a F ppm 20	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05
B1- SS1		1.17	99.1	60	0.61	7.37	134.5	390	0.72	0.04	0.46	0.02	25.0	2.5	9	8.52
B2- SS1		1.98	99.1	30	0.87	5.18	201	600	0.79	0.03	0.18	0.02	31.6	1.3	7	7.46
B3- SS1		2.16	99.2	80	1.05	5.71	228	630	0.98	0.07	0.40	0.03	32.8	2.8	10	8.68

***** See Appendix Page for comments regarding this certificate *****

Sample Description	Method Analyte Units LOD	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	Hg-MS42 Hg ppm 0.005	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1
B1- SS1		12.9	1.33	13.60	0.06	2.5	0.550	0.037	3.10	14.2	102.5	0.12	79	2.00	0.07	6.8
B2- SS1		6.2	1.32	9.00	0.08	1.6	0.076	0.016	4.19	15.6	42.9	0.04	90	1.41	0.15	5.9
B3- SS1		6.5	1.64	10.25	0.08	1.6	0.064	0.014	3.39	16.1	35.6	0.15	216	1.65	0.13	5.4

CERTIFICATE OF ANALYSIS BR21332922

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOD	0.2	10	0.5	0.1	0.002	0.01	0.05	0.1	1	0.2	0.2	0.05	0.05	0.01	0.005
B1- SS1		3.1	90	15.8	185.5	<0.002	1.06	7.60	4.1	<1	3.7	38.0	0.62	<0.05	12.15	0.086
B2- SS1		1.6	50	11.4	250	<0.002	0.75	11.50	3.0	<1	1.7	50.8	0.49	<0.05	10.10	0.065
B3- SS1		2.6	350	10.7	226	<0.002	0.95	9.23	3.9	<1	1.9	60.8	0.47	<0.05	9.50	0.099

***** See Appendix Page for comments regarding this certificate *****

To: OCEANA GOLD (NZ) LTD
PO BOX 5442
DUNEDIN 9058
NEW ZEALAND

Project: WNP

CERTIFICATE OF ANALYSIS BR21332922

Sample Description	Method Analyte Units LOD	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5
B1- SS1		2.04	2.9	38	1.7	10.7	13	67.5
B2- SS1		3.47	1.9	10	1.2	11.1	19	44.5
B3- SS1		3.73	1.8	16	1.5	11.3	32	44.5

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

REEs may not be totally soluble in this method.

Applies to Method: ME-MS61

ACCREDITATION COMMENTS

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist

Applies to Method: ME-MS61

LABORATORY ADDRESSES

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 23 Pineapple Street, Zillmere, QLD, 4034, Australia

Applies to Method:

BAG-01
F-ELE81a
Hg-MS42
LEV-01
LOG-22
ME-MS61
PUL-23
PUL-QC
QAR-01
TRA-21
WEI-21

Appendix C

Particle Size Distribution Analysis

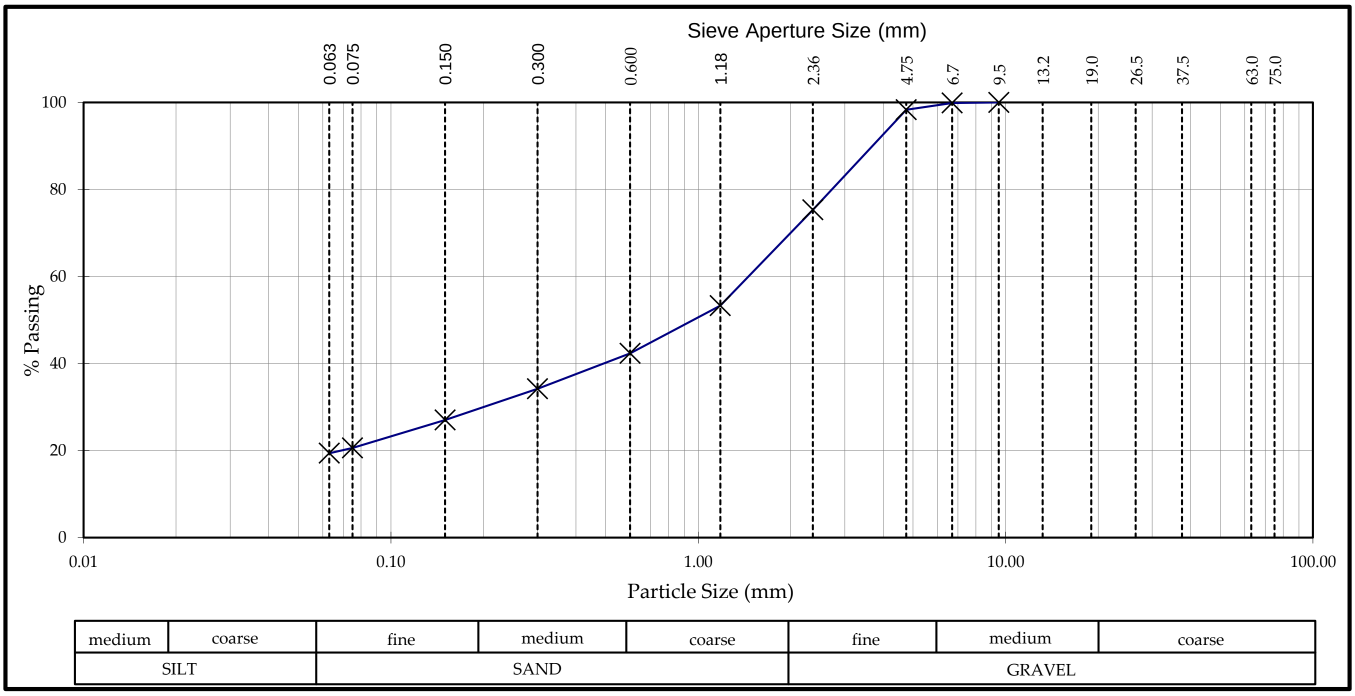
WET SIEVE ANALYSIS
TEST REPORT

Project :	Leach Column WUG
Location :	43, Moresby Avenue, Waihi 2610
Client :	OceanaGold
Contractor :	Rebecca Hillyard
Sampled by :	Rebecca Hillyard
Date sampled :	17/09/2021
Sampling method :	Drill core
Sample description :	Core samples
Sample condition	Crushed
Source	Waihi, T- Stream (B1)
Depth (m) :	n/a

Project No :	5-24G21.67
Lab Ref No :	OR1378A
Client Ref No :	B1-SS2

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	98	0.300	34
63.00	-	13.20	-	2.36	75	0.150	27
37.50	-	9.50	100	1.18	53	0.075	21
26.50	-	6.70	100	0.600	42	0.063	19



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: As received Fraction tested: Whole Dispersant Used: Sodium hexametaphosphate w/ Sodium carbonate All information supplied by Client Sample size is less than specified in NZS4407:2015.

Date tested : 02 - 04/11/2021

Date reported : 09/11/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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IANZ Approved Signatory

Designation : *Laboratory Technician (Z. Francis)*

Date : 09/11/2021

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

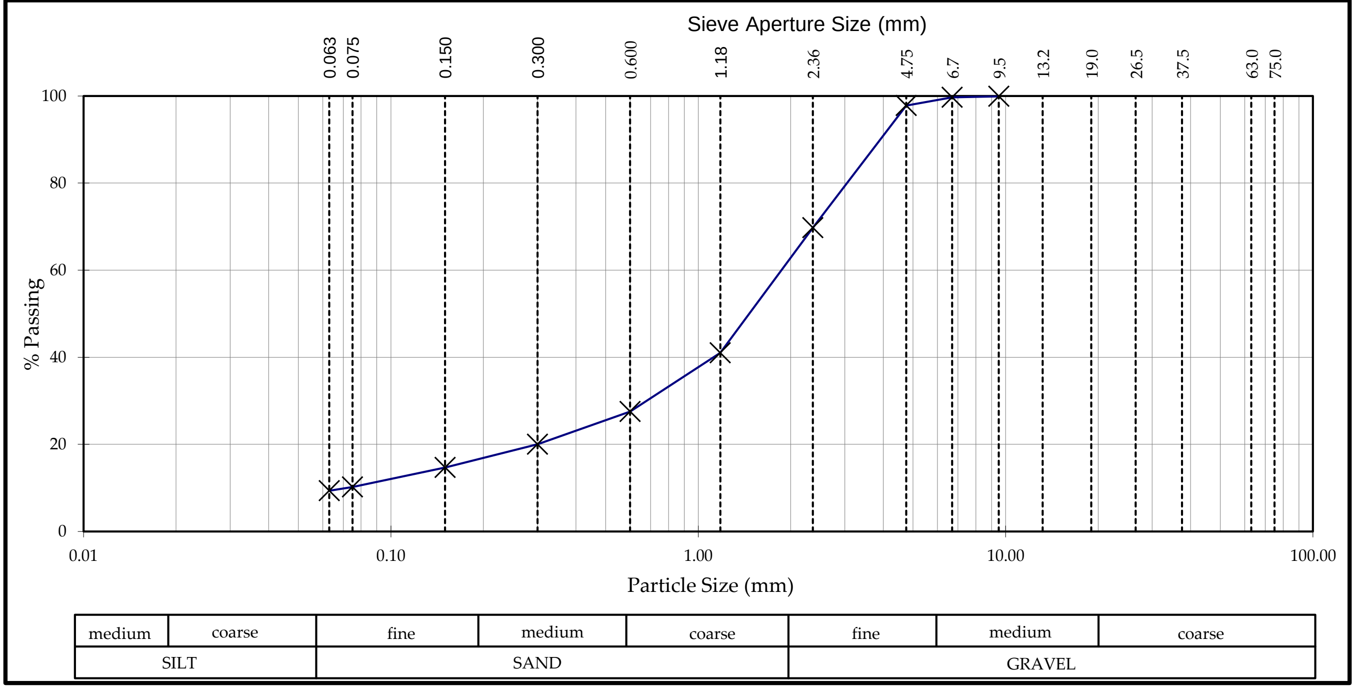
WET SIEVE ANALYSIS
TEST REPORT

Project : Leach Column WUG
Location : 43, Moresby Avenue, Waihi 2610
Client : OceanaGold
Contractor : Rebecca Hillyard
Sampled by : Rebecca Hillyard
Date sampled : 17/09/2021
Sampling method : Drill core
Sample description : Core samples
Sample condition Crushed
Source Waihi, EG North (B2)
Depth (m) : n/a

Project No : 5-24G21.67
Lab Ref No : OR1378B
Client Ref No : B2-SS2

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	98	0.300	20
63.00	-	13.20	-	2.36	70	0.150	15
37.50	-	9.50	100	1.18	41	0.075	10
26.50	-	6.70	100	0.600	28	0.063	9



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: As received Fraction tested: Whole Dispersant Used: Sodium hexametaphosphate w/ Sodium carbonate All information supplied by Client Sample size is less than specified in NZS4407:2015.

Date tested : 02 - 04/11/2021
Date reported : 09/11/2021

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IANZ Approved Signatory

Designation : *Laboratory Technician (Z. Francis)*
Date : 09/11/2021

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

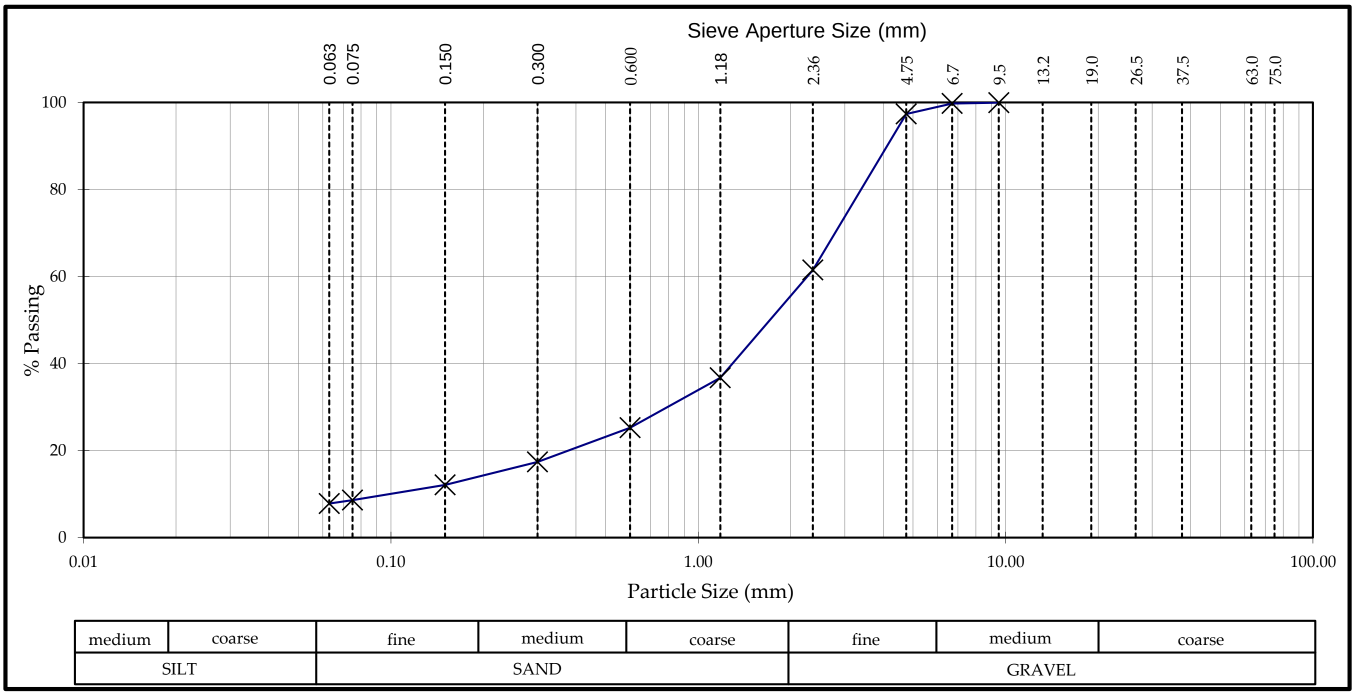
WET SIEVE ANALYSIS
TEST REPORT

Project :	Leach Column WUG
Location :	43, Moresby Avenue, Waihi 2610
Client :	OceanaGold
Contractor :	Rebecca Hillyard
Sampled by :	Rebecca Hillyard
Date sampled :	17/09/2021
Sampling method :	Drill core
Sample description :	Core samples
Sample condition	Crushed
Source	Waihi, EG South (B3)
Depth (m) :	n/a

Project No :	5-24G21.67
Lab Ref No :	OR1378C
Client Ref No :	B3-SS2

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	97	0.300	17
63.00	-	13.20	-	2.36	61	0.150	12
37.50	-	9.50	100	1.18	37	0.075	9
26.50	-	6.70	100	0.600	25	0.063	8



Test Method	Notes	
NZS 4407 : 2015 Test 3.8.1	History:	As received
	Fraction tested:	Whole
	Dispersant Used:	Sodium hexametaphosphate w/ Sodium carbonate
	All information supplied by Client	
	Sample size is less than specified in NZS4407:2015.	

Date tested : 02 - 04/11/2021
Date reported : 09/11/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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IANZ Approved Signatory

Designation : *Laboratory Technician (Z. Francis)*
Date : 09/11/2021

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Appendix D

Leachate Analytical Data

Hill Laboratories
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R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

SPv2

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2763341
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	11-Nov-2021
		Date Reported:	22-Nov-2021
		Quote No:	85959
		Order No:	70056476
		Client Reference:	Extended suite
		Submitted By:	Rebecca Hillyard

Sample Type: Aqueous

	Sample Name:	1836721 09-Nov-2021	1836722 09-Nov-2021	1836723 09-Nov-2021		
	Lab Number:	2763341.1	2763341.2	2763341.3		
Individual Tests						
pH	pH Units	6.0	6.4	5.9	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	3.4	9.4	3.6	-	-
Electrical Conductivity (EC)	mS/m	1.0	3.5	0.8	-	-
Dissolved Aluminium	g/m^3	0.004	0.012	0.003	-	-
Dissolved Antimony	g/m^3	< 0.0002	0.0003	< 0.0002	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	0.35	1.45	0.38	-	-
Dissolved Cobalt	g/m^3	< 0.0002	< 0.0002	< 0.0002	-	-
Dissolved Iron	g/m^3	< 0.02	< 0.02	< 0.02	-	-
Dissolved Magnesium	g/m^3	0.11	0.35	0.10	-	-
Dissolved Manganese	g/m^3	0.0051	0.024	0.0037	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	< 0.0002	< 0.0002	< 0.0002	-	-
Dissolved Potassium	g/m^3	0.17	0.57	0.10	-	-
Dissolved Selenium	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Dissolved Silver	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Dissolved Sodium	g/m^3	0.81	2.6	0.70	-	-
Dissolved Strontium	g/m^3	0.0008	0.0030	0.0010	-	-
Dissolved Uranium	g/m^3	< 0.00002	< 0.00002	< 0.00002	-	-
Dissolved Vanadium	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Sulphate	g/m^3	5	6	5	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.103	0.32	0.0042	-	-
Dissolved Cadmium	g/m^3	< 0.00005	0.00005	< 0.00005	-	-
Dissolved Chromium	g/m^3	0.023	0.071	0.0012	-	-
Dissolved Copper	g/m^3	0.028	0.075	0.0020	-	-
Dissolved Lead	g/m^3	< 0.00010	0.00013	< 0.00010	-	-
Dissolved Nickel	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Zinc	g/m^3	0.065	0.069	0.024	-	-

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**

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m³	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m³ as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m³ as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m³	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m³	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m³	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m³	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m³	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m³	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m³	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m³	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m³	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m³	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m³	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m³	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m³	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m³	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m³	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m³	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m³	1-3

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

Testing was completed between 12-Nov-2021 and 22-Nov-2021. 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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Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2773857 SUPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	20-Nov-2021
		Date Reported:	29-Nov-2021
		Quote No:	85959
		Order No:	70056476
		Client Reference:	Extended suite
		Submitted By:	Mark Burroughs

Sample Type: Aqueous

	Sample Name:	1838000 19-Nov-2021	1838001 19-Nov-2021	1838002 19-Nov-2021	
	Lab Number:	2773857.1	2773857.2	2773857.3	
Individual Tests					
pH	pH Units	6.2 ± 0.2	4.2 ± 0.2	4.1 ± 0.2	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-
Total Alkalinity	g/m^3 as $CaCO_3$	4.30 ± 0.69	< 1.0 ± 0.67	< 1.0 ± 0.67	-
Electrical Conductivity (EC)	mS/m	1.8 ± 0.1	141.8 ± 2.9	352.6 ± 7.1	-
Dissolved Aluminium	g/m^3	0.0088 ± 0.0022	104.7 ± 8.3	234 ± 19	-
Dissolved Antimony	g/m^3	< 0.0002 ± 0.00014	< 0.002 ± 0.00033	< 0.002 ± 0.00033	-
Dissolved Barium	g/m^3	< 0.005 ± 0.00025	0.01560 ± 0.00073	0.0931 ± 0.0044	-
Dissolved Calcium	g/m^3	1.019 ± 0.072	52.5 ± 3.3	530 ± 34	-
Dissolved Cobalt	g/m^3	< 0.0002 ± 0.00014	0.590 ± 0.024	6.35 ± 0.25	-
Dissolved Iron	g/m^3	< 0.02 ± 0.014	71.2 ± 4.9	91.4 ± 6.3	-
Dissolved Magnesium	g/m^3	0.240 ± 0.021	32.1 ± 2.2	483 ± 33	-
Dissolved Manganese	g/m^3	0.00155 ± 0.00036	6.83 ± 0.59	137 ± 12	-
Dissolved Mercury	g/m^3	< 0.00008 ± 0.000054	< 0.00008 ± 0.000054	< 0.00008 ± 0.000054	-
Dissolved Molybdenum	g/m^3	< 0.0002 ± 0.00014	< 0.002 ± 0.00035	< 0.002 ± 0.00035	-
Dissolved Potassium	g/m^3	0.650 ± 0.058	30.8 ± 2.3	376 ± 28	-
Dissolved Selenium	g/m^3	< 0.0010 ± 0.00067	< 0.010 ± 0.0012	0.0858 ± 0.0078	-
Dissolved Silver	g/m^3	< 0.00010 ± 0.000067	< 0.0010 ± 0.00064	< 0.0010 ± 0.00064	-
Dissolved Sodium	g/m^3	1.40 ± 0.15	28.6 ± 3.1	184 ± 20	-
Dissolved Strontium	g/m^3	0.00271 ± 0.00036	0.438 ± 0.023	3.81 ± 0.20	-
Dissolved Uranium	g/m^3	< 0.00002 ± 0.000014	0.0458 ± 0.0052	0.136 ± 0.016	-
Dissolved Vanadium	g/m^3	< 0.0010 ± 0.00067	< 0.010 ± 0.0015	< 0.010 ± 0.0015	-
Sulphate	g/m^3	< 5 ± 0.46	943 ± 57	2,550 ± 160	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn					
Dissolved Arsenic	g/m^3	0.0164 ± 0.0012	0.1625 ± 0.0091	0.426 ± 0.024	-
Dissolved Cadmium	g/m^3	< 0.00005 ± 0.000034	0.0088 ± 0.0013	0.106 ± 0.016	-
Dissolved Chromium	g/m^3	0.00352 ± 0.00043	0.168 ± 0.013	0.0534 ± 0.0042	-
Dissolved Copper	g/m^3	0.00643 ± 0.00068	1.69 ± 0.16	6.01 ± 0.55	-
Dissolved Lead	g/m^3	< 0.00010 ± 0.000067	0.00128 ± 0.00012	0.01321 ± 0.00092	-
Dissolved Nickel	g/m^3	< 0.0005 ± 0.00034	0.2040 ± 0.0072	2.242 ± 0.079	-
Dissolved Zinc	g/m^3	0.0529 ± 0.0050	9.38 ± 0.88	59.5 ± 5.6	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

ilac-MRA

ACCREDITED IANZ TESTING LABORATORY

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 22-Nov-2021 and 29-Nov-2021. 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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Martin Cowell - BSc
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2778761	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	25-Nov-2021	
		Date Reported:	06-Dec-2021	
		Quote No:	85959	
		Order No:	70051933	
		Client Reference:	Extended suite	
		Submitted By:	Rebecca Hillyard	

Sample Type: Aqueous

Sample Name:		1838178 24-Nov-2021	1838179 24-Nov-2021	1838180 24-Nov-2021		
Lab Number:		2778761.1	2778761.2	2778761.3		
Individual Tests						
pH	pH Units	4.1	4.7	7.3	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	-	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	-	-	-
Electrical Conductivity (EC)	mS/m	216	240	2.5	-	-
Dissolved Aluminium	g/m^3	196	70	0.008	-	-
Dissolved Antimony	g/m^3	< 0.0004	< 0.0004	< 0.0002	-	-
Dissolved Barium	g/m^3	0.021	0.026	< 0.005	-	-
Dissolved Calcium	g/m^3	86	162	1.24	-	-
Dissolved Cobalt	g/m^3	1.05	1.84	< 0.0002	-	-
Dissolved Iron	g/m^3	122	26	< 0.02	-	-
Dissolved Magnesium	g/m^3	52	144	0.44	-	-
Dissolved Manganese	g/m^3	11.1	39	0.0060	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	0.00039	-	-
Dissolved Molybdenum	g/m^3	< 0.0004	< 0.0004	< 0.0002	-	-
Dissolved Potassium	g/m^3	58	110	1.10	-	-
Dissolved Selenium	g/m^3	0.013	0.023	< 0.0010	-	-
Dissolved Silver	g/m^3	< 0.0002	< 0.0002	< 0.00010	-	-
Dissolved Sodium	g/m^3	45	57	2.1	-	-
Dissolved Strontium	g/m^3	0.72	1.06	0.0033	-	-
Dissolved Uranium	g/m^3	0.088	0.042	< 0.00002	-	-
Dissolved Vanadium	g/m^3	0.006	0.002	< 0.0010	-	-
Sulphate	g/m^3	1,640	1,540	< 5	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.21	0.40	0.0045	-	-
Dissolved Cadmium	g/m^3	0.0154	0.029	< 0.00005	-	-
Dissolved Chromium	g/m^3	0.29	0.061	0.0014	-	-
Dissolved Copper	g/m^3	3.4	1.95	0.0086	-	-
Dissolved Lead	g/m^3	0.0016	0.0028	< 0.00010	-	-
Dissolved Nickel	g/m^3	0.34	0.64	< 0.0005	-	-
Dissolved Zinc	g/m^3	16.4	16.9	0.027	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 29-Nov-2021 and 06-Dec-2021. 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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2778761	SUPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	25-Nov-2021	
		Date Reported:	06-Dec-2021	
		Quote No:	85959	
		Order No:	70051933	
		Client Reference:	Extended suite	
		Submitted By:	Rebecca Hillyard	

Sample Type: Aqueous

	Sample Name:	1838178 24-Nov-2021	1838179 24-Nov-2021	1838180 24-Nov-2021	
	Lab Number:	2778761.1	2778761.2	2778761.3	
Individual Tests					
pH	pH Units	4.1 ± 0.2	4.7 ± 0.2	7.3 ± 0.2	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0 ± 0.67	< 1.0 ± 0.67	-	-
Electrical Conductivity (EC)	mS/m	216.0 ± 4.4	240.3 ± 4.9	2.5 ± 0.1	-
Dissolved Aluminium	g/m^3	196 ± 16	69.8 ± 5.5	0.0076 ± 0.0021	-
Dissolved Antimony	g/m^3	< 0.0004 ± 0.00015	< 0.0004 ± 0.00015	< 0.0002 ± 0.00014	-
Dissolved Barium	g/m^3	0.02143 ± 0.0010	0.0264 ± 0.0013	< 0.005 ± 0.00025	-
Dissolved Calcium	g/m^3	86.4 ± 5.5	162 ± 11	1.245 ± 0.085	-
Dissolved Cobalt	g/m^3	1.046 ± 0.042	1.840 ± 0.073	< 0.0002 ± 0.00014	-
Dissolved Iron	g/m^3	122.0 ± 8.4	26.3 ± 1.9	< 0.02 ± 0.014	-
Dissolved Magnesium	g/m^3	51.8 ± 3.5	143.5 ± 9.7	0.440 ± 0.033	-
Dissolved Manganese	g/m^3	11.11 ± 0.96	39.2 ± 3.4	0.00598 ± 0.00062	-
Dissolved Mercury	g/m^3	< 0.00008 ± 0.000054	< 0.00008 ± 0.000054	0.000389 ± 0.000071	-
Dissolved Molybdenum	g/m^3	< 0.0004 ± 0.00015	< 0.0004 ± 0.00015	< 0.0002 ± 0.00014	-
Dissolved Potassium	g/m^3	58.0 ± 4.3	110.0 ± 8.0	1.097 ± 0.087	-
Dissolved Selenium	g/m^3	0.0134 ± 0.0014	0.0234 ± 0.0023	< 0.0010 ± 0.00067	-
Dissolved Silver	g/m^3	< 0.0002 ± 0.00013	< 0.0002 ± 0.00013	< 0.00010 ± 0.000067	-
Dissolved Sodium	g/m^3	44.5 ± 4.8	57.1 ± 6.2	2.12 ± 0.23	-
Dissolved Strontium	g/m^3	0.721 ± 0.037	1.060 ± 0.054	0.00334 ± 0.00038	-
Dissolved Uranium	g/m^3	0.0881 ± 0.0099	0.0417 ± 0.0047	< 0.00002 ± 0.000014	-
Dissolved Vanadium	g/m^3	0.0062 ± 0.0011	0.00235 ± 0.00073	< 0.0010 ± 0.00067	-
Sulphate	g/m^3	1,637 ± 99	1,535 ± 93	< 5 ± 0.46	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn					
Dissolved Arsenic	g/m^3	0.212 ± 0.012	0.398 ± 0.023	0.00453 ± 0.00072	-
Dissolved Cadmium	g/m^3	0.0154 ± 0.0022	0.0289 ± 0.0042	< 0.00005 ± 0.000034	-
Dissolved Chromium	g/m^3	0.287 ± 0.023	0.0613 ± 0.0048	0.00135 ± 0.00035	-
Dissolved Copper	g/m^3	3.35 ± 0.31	1.95 ± 0.18	0.00858 ± 0.00085	-
Dissolved Lead	g/m^3	0.00163 ± 0.00014	0.00285 ± 0.00021	< 0.00010 ± 0.000067	-
Dissolved Nickel	g/m^3	0.344 ± 0.013	0.641 ± 0.023	< 0.0005 ± 0.00034	-
Dissolved Zinc	g/m^3	16.4 ± 1.6	16.9 ± 1.6	0.0268 ± 0.0026	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 29-Nov-2021 and 06-Dec-2021. 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

				SPv1
Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2787988	
Contact:	Mark Burroughs	**Date Received:**	03-Dec-2021	
	C/- Oceana Gold (New Zealand) Limited	**Date Reported:**	15-Dec-2021	
	PO Box 190	**Quote No:**	87181	
	Waihi 3610	**Order No:**	70057893	
		Client Reference:	Reduced suite	
		Submitted By:	Rebecca Hillyard	

Sample Type: Aqueous

	Sample Name:	1838286 02-Dec-2021	1838287 02-Dec-2021	1838288 02-Dec-2021		
	Lab Number:	2787988.1	2787988.2	2787988.3		
Individual Tests						
pH	pH Units	4.5	4.5	6.3	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	4.0	-	-
Electrical Conductivity (EC)	mS/m	26.2	107.8	1.8	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Sulphate	g/m^3	114	590	1.9	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.029	0.41	0.0045	-	-
Dissolved Cadmium	g/m^3	0.0083	0.090	< 0.00005	-	-
Dissolved Chromium	g/m^3	0.121	0.039	0.0021	-	-
Dissolved Copper	g/m^3	1.63	5.7	0.0052	-	-
Dissolved Lead	g/m^3	0.00020	0.0102	< 0.00010	-	-
Dissolved Nickel	g/m^3	0.173	1.91	< 0.0005	-	-
Dissolved Zinc	g/m^3	8.5	53	0.026	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 06-Dec-2021 and 14-Dec-2021. 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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2798790 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	14-Dec-2021
		Date Reported:	23-Dec-2021
		Quote No:	85959
		Order No:	70056476
		Client Reference:	Extended suite
		Submitted By:	Rebecca Hillyard

Sample Type: Aqueous

	Sample Name:	1838667 13-Dec-2021	1838668 13-Dec-2021	1838669 13-Dec-2021		
	Lab Number:	2798790.1	2798790.2	2798790.3		
Individual Tests						
pH	pH Units	4.0	4.3	7.1	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	17.6	-	-
Electrical Conductivity (EC)	mS/m	155.9	99.2	8.2	-	-
Dissolved Aluminium	g/m^3	1,280	166	0.010	-	-
Dissolved Antimony	g/m^3	< 0.002	< 0.0010	< 0.0002	-	-
Dissolved Barium	g/m^3	0.012	0.063	< 0.005	-	-
Dissolved Calcium	g/m^3	510	530	1.73	-	-
Dissolved Cobalt	g/m^3	6.5	5.2	< 0.0002	-	-
Dissolved Iron	g/m^3	670	5.7	< 0.02	-	-
Dissolved Magnesium	g/m^3	250	330	0.82	-	-
Dissolved Manganese	g/m^3	67	108	0.0043	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	< 0.002	< 0.0010	< 0.0002	-	-
Dissolved Potassium	g/m^3	310	340	2.5	-	-
Dissolved Selenium	g/m^3	0.11	0.063	< 0.0010	-	-
Dissolved Silver	g/m^3	< 0.0010	< 0.0005	< 0.00010	-	-
Dissolved Sodium	g/m^3	220	145	5.5	-	-
Dissolved Strontium	g/m^3	4.1	3.2	0.0056	-	-
Dissolved Uranium	g/m^3	0.58	0.131	< 0.00002	-	-
Dissolved Vanadium	g/m^3	0.064	< 0.005	< 0.0010	-	-
Sulphate	g/m^3	1,110	520	< 5	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.83	0.22	0.0053	-	-
Dissolved Cadmium	g/m^3	0.115	0.090	< 0.00005	-	-
Dissolved Chromium	g/m^3	2.0	0.023	0.0030	-	-
Dissolved Copper	g/m^3	21	5.2	0.0117	-	-
Dissolved Lead	g/m^3	0.0029	0.0101	< 0.00010	-	-
Dissolved Nickel	g/m^3	2.3	1.80	< 0.0005	-	-
Dissolved Zinc	g/m^3	104	45	0.0190	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 15-Dec-2021 and 23-Dec-2021. 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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2807535 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	21-Dec-2021
		Date Reported:	05-Jan-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Rebecca Hillyard

Sample Type: Aqueous

	Sample Name:	1838692 20-Dec-2021 9:55 am	1838693 20-Dec-2021 10:00 am	1838694 20-Dec-2021 10:10 am		
	Lab Number:	2807535.1	2807535.2	2807535.3		
Individual Tests						
pH	pH Units	-	3.6	4.5	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	-	46	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	-	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	-	520	546	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	0.00017	-	-
Sulphate	g/m^3	-	4,200	3,800	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	4.0	0.75	0.144	-	-
Dissolved Cadmium	g/m^3	0.066	0.082	0.0105	-	-
Dissolved Chromium	g/m^3	2.1	0.047	0.005	-	-
Dissolved Copper	g/m^3	18.2	8.1	2.5	-	-
Dissolved Lead	g/m^3	< 0.0010	0.0060	0.0012	-	-
Dissolved Nickel	g/m^3	1.22	1.55	1.26	-	-
Dissolved Zinc	g/m^3	65	45	4.1	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	2-3
pH	pH meter. 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	2-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	2-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	2-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	2-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	2-3

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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

Testing was completed between 23-Dec-2021 and 05-Jan-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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Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2812321	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	24-Dec-2021	
		Date Reported:	07-Jan-2022	
		Quote No:	85959	
		Order No:	70057893	
		Client Reference:	Extended suite	
		Submitted By:	Kristin Gillard	

Sample Type: Aqueous

	Sample Name:	1838737 22-Dec-2021 3:46 pm	1838738 22-Dec-2021 3:38 pm			
	Lab Number:	2812321.1	2812321.2			
Individual Tests						
pH	pH Units	5.4	3.7	-	-	-
Acidity (pH 3.7)	g/m^3 as CaCO$_3$	< 1.0	32	-	-	-
Total Alkalinity	g/m^3 as CaCO$_3$	2.2	< 1.0	-	-	-
Electrical Conductivity (EC)	mS/m	2.3	318	-	-	-
Dissolved Aluminium	g/m^3	30	230	-	-	-
Dissolved Antimony	g/m^3	< 0.002	< 0.002	-	-	-
Dissolved Barium	g/m^3	0.064	0.044	-	-	-
Dissolved Calcium	g/m^3	560	480	-	-	-
Dissolved Cobalt	g/m^3	2.3	3.0	-	-	-
Dissolved Iron	g/m^3	28	1.0	-	-	-
Dissolved Magnesium	g/m^3	440	200	-	-	-
Dissolved Manganese	g/m^3	12.4	65	-	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	-	-	-
Dissolved Molybdenum	g/m^3	< 0.002	< 0.002	-	-	-
Dissolved Potassium	g/m^3	94	270	-	-	-
Dissolved Selenium	g/m^3	0.126	0.045	-	-	-
Dissolved Silver	g/m^3	< 0.0010	< 0.0010	-	-	-
Dissolved Sodium	g/m^3	175	49	-	-	-
Dissolved Strontium	g/m^3	2.7	1.94	-	-	-
Dissolved Uranium	g/m^3	0.042	0.163	-	-	-
Dissolved Vanadium	g/m^3	< 0.010	< 0.010	-	-	-
Sulphate	g/m^3	4.1	2,400	-	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.096	1.18	-	-	-
Dissolved Cadmium	g/m^3	0.0107	0.062	-	-	-
Dissolved Chromium	g/m^3	0.006	0.075	-	-	-
Dissolved Copper	g/m^3	3.7	7.8	-	-	-
Dissolved Lead	g/m^3	0.0019	0.0073	-	-	-
Dissolved Nickel	g/m^3	1.32	1.11	-	-	-
Dissolved Zinc	g/m^3	4.6	34	-	-	-

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-2
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
pH	pH meter. 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	1-2
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-2
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-2
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-2
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-2
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-2
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-2
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-2
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-2
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-2
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-2
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-2
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-2
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-2
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-2
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-2
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-2
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-2
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-2
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-2

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

Testing was completed between 24-Dec-2021 and 07-Jan-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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Helena Bertram BSc
Client Services Manager - Environmental

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Certificate of Analysis

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2815489
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	31-Dec-2021
		Date Reported:	11-Jan-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Kristin Gillard

Sample Type: Aqueous

Sample Name:		1838748 30-Dec-2021 2:00 pm	1838749 30-Dec-2021 2:00 pm	1838750 30-Dec-2021 2:00 pm		
Lab Number:		2815489.1	2815489.2	2815489.3		
Individual Tests						
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.057	0.153	1.20	-	-
Dissolved Cadmium	g/m^3	0.0064	0.0049	0.055	-	-
Dissolved Chromium	g/m^3	0.006	0.151	0.078	-	-
Dissolved Copper	g/m^3	1.76	1.14	7.2	-	-
Dissolved Lead	g/m^3	0.0014	< 0.0010	0.0083	-	-
Dissolved Nickel	g/m^3	0.70	0.099	1.02	-	-
Dissolved Zinc	g/m^3	2.6	5.0	31	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3

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

Testing was completed between 06-Jan-2022 and 10-Jan-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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Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2823026	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	11-Jan-2022	
		Date Reported:	18-Jan-2022	
		Quote No:	85959	
		Order No:	70057893	
		Client Reference:	Extended suite	
		Submitted By:	Mark Burroughs	

Sample Type: Aqueous

Sample Name:		1838757 06-Jan-2022 10:00 am	1838758 06-Jan-2022 11:40 am	1838759 06-Jan-2022 11:40 am		
Lab Number:		2823026.1	2823026.2	2823026.3		
Individual Tests						
pH	pH Units	2.4	2.4	3.1	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	780	1,110	156	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	259	594	563	-	-
Dissolved Aluminium	g/m^3	290	230	76	-	-
Dissolved Antimony	g/m^3	0.004	< 0.002	< 0.002	-	-
Dissolved Barium	g/m^3	< 0.005	0.050	0.047	-	-
Dissolved Calcium	g/m^3	310	480	520	-	-
Dissolved Cobalt	g/m^3	0.91	2.2	2.4	-	-
Dissolved Iron	g/m^3	1,050	187	34	-	-
Dissolved Magnesium	g/m^3	33	139	440	-	-
Dissolved Manganese	g/m^3	7.5	44	11.4	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00008	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	0.020	< 0.002	< 0.002	-	-
Dissolved Potassium	g/m^3	68	167	91	-	-
Dissolved Selenium	g/m^3	0.019	0.031	0.086	-	-
Dissolved Silver	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Dissolved Sodium	g/m^3	13.0	25	126	-	-
Dissolved Strontium	g/m^3	0.80	1.39	2.6	-	-
Dissolved Uranium	g/m^3	0.104	0.172	0.118	-	-
Dissolved Vanadium	g/m^3	0.24	0.025	0.013	-	-
Sulphate	g/m^3	1,240	5,600	4,700	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	64	6.6	0.119	-	-
Dissolved Cadmium	g/m^3	0.0191	0.047	0.0129	-	-
Dissolved Chromium	g/m^3	1.06	0.21	0.037	-	-
Dissolved Copper	g/m^3	5.4	6.1	6.6	-	-
Dissolved Lead	g/m^3	< 0.0010	0.0153	0.0118	-	-
Dissolved Nickel	g/m^3	0.33	0.81	1.44	-	-
Dissolved Zinc	g/m^3	19.6	26	5.4	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 12-Jan-2022 and 18-Jan-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2825714 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	13-Jan-2022
		Date Reported:	19-Jan-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Kristin Gillard

Sample Type: Aqueous

	Sample Name:	1838824 12-Jan-2022	1838825 12-Jan-2022	1838826 12-Jan-2022		
	Lab Number:	2825714.1	2825714.2	2825714.3		
Individual Tests						
pH	pH Units	1.9	2.4	3.1	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	1,950	1,030	156	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	677	591	523	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Sulphate	g/m^3	3,500	5,300	4,400	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	41	8.9	0.22	-	-
Dissolved Cadmium	g/m^3	0.0073	0.032	0.0124	-	-
Dissolved Chromium	g/m^3	0.46	0.60	0.083	-	-
Dissolved Copper	g/m^3	2.0	5.6	10.5	-	-
Dissolved Lead	g/m^3	< 0.0010	0.0011	0.024	-	-
Dissolved Nickel	g/m^3	0.118	0.58	1.63	-	-
Dissolved Zinc	g/m^3	8.7	24	6.1	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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

Testing was completed between 17-Jan-2022 and 19-Jan-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2836064	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	21-Jan-2022	
		Date Reported:	27-Jan-2022	
		Quote No:	85959	
		Order No:	70057893	
		Client Reference:	Extended suite	
		Submitted By:	Jake Horne	

Sample Type: Aqueous

	Sample Name:	1838923 20-Jan-2022 1:50 pm	1838924 20-Jan-2022 3:10 pm	1838925 20-Jan-2022 3:50 pm		
	Lab Number:	2836064.1	2836064.2	2836064.3		
Individual Tests						
pH	pH Units	2.0	2.5	3.2	-	-
Acidity (pH 3.7)	g/m^3 as CaCO$_3$	2,000	2,100	440	-	-
Total Alkalinity	g/m^3 as CaCO$_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	582	570	511	-	-
Dissolved Aluminium	g/m^3	75	360	131	-	-
Dissolved Antimony	g/m^3	0.002	0.004	< 0.002	-	-
Dissolved Barium	g/m^3	< 0.005	0.012	0.035	-	-
Dissolved Calcium	g/m^3	48	480	510	-	-
Dissolved Cobalt	g/m^3	0.195	1.64	2.2	-	-
Dissolved Iron	g/m^3	440	570	196	-	-
Dissolved Magnesium	g/m^3	8.1	105	430	-	-
Dissolved Manganese	g/m^3	2.6	54	9.5	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	0.005	< 0.002	< 0.002	-	-
Dissolved Potassium	g/m^3	5.2	39	80	-	-
Dissolved Selenium	g/m^3	< 0.010	0.015	0.042	-	-
Dissolved Silver	g/m^3	< 0.0010	0.0019	< 0.0010	-	-
Dissolved Sodium	g/m^3	1.5	8.3	64	-	-
Dissolved Strontium	g/m^3	0.105	0.65	2.5	-	-
Dissolved Uranium	g/m^3	0.0158	0.164	0.125	-	-
Dissolved Vanadium	g/m^3	0.083	0.32	0.066	-	-
Sulphate	g/m^3	2,300	5,500	4,300	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	13.6	6.3	0.28	-	-
Dissolved Cadmium	g/m^3	0.0043	0.033	0.0119	-	-
Dissolved Chromium	g/m^3	0.22	0.60	0.074	-	-
Dissolved Copper	g/m^3	1.09	5.0	9.2	-	-
Dissolved Lead	g/m^3	< 0.0010	< 0.0010	0.0124	-	-
Dissolved Nickel	g/m^3	0.070	0.57	1.47	-	-
Dissolved Zinc	g/m^3	5.3	23	5.7	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 24-Jan-2022 and 27-Jan-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2854592	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	04-Feb-2022	
		Date Reported:	14-Feb-2022	
		Quote No:	85959	
		Order No:	70057893	
		Client Reference:	Extended suite	
		Submitted By:	Jake Horne	

Sample Type: Aqueous

	Sample Name:	1839223 03-Feb-2022	1839224 03-Feb-2022	1839225 03-Feb-2022		
	Lab Number:	2854592.1	2854592.2	2854592.3		
Individual Tests						
pH	pH Units	2.0	2.2	3.3	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,500	3,900	340	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	550	785	534	-	-
Dissolved Aluminium	g/m^3	150	390	123	-	-
Dissolved Antimony	g/m^3	0.0034	0.0050	< 0.0010	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	0.024	-	-
Dissolved Calcium	g/m^3	61	470	500	-	-
Dissolved Cobalt	g/m^3	0.32	1.79	2.3	-	-
Dissolved Iron	g/m^3	1,170	750	141	-	-
Dissolved Magnesium	g/m^3	15.3	121	460	-	-
Dissolved Manganese	g/m^3	4.2	57	9.7	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	0.0128	0.0053	< 0.0010	-	-
Dissolved Potassium	g/m^3	1.2	6.2	78	-	-
Dissolved Selenium	g/m^3	0.008	0.013	0.038	-	-
Dissolved Silver	g/m^3	< 0.0005	0.0010	< 0.0005	-	-
Dissolved Sodium	g/m^3	2.3	8.0	63	-	-
Dissolved Strontium	g/m^3	0.121	0.50	2.5	-	-
Dissolved Uranium	g/m^3	0.029	0.178	0.117	-	-
Dissolved Vanadium	g/m^3	0.23	0.159	0.048	-	-
Sulphate	g/m^3	2,600	7,500	4,200	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	50	30	0.29	-	-
Dissolved Cadmium	g/m^3	0.0072	0.033	0.0122	-	-
Dissolved Chromium	g/m^3	0.46	0.69	0.072	-	-
Dissolved Copper	g/m^3	1.76	5.1	9.3	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	0.0066	-	-
Dissolved Nickel	g/m^3	0.121	0.62	1.49	-	-
Dissolved Zinc	g/m^3	8.4	25	5.5	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 05-Feb-2022 and 14-Feb-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

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2867192
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	12-Feb-2022
		Date Reported:	21-Feb-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Jake Horne

Sample Type: Aqueous

	Sample Name:	1839306 11-Feb-2022 10:00 am	1839307 11-Feb-2022 10:40 am	1839308 11-Feb-2022 11:15 am		
	Lab Number:	2867192.1	2867192.2	2867192.3		
Individual Tests						
pH	pH Units	1.8	2.0	2.4	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	3,800	6,900	2,700	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	798	1,018	811	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00015	-	-
Sulphate	g/m^3	4,200	11,500	8,500	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	50	117	30	-	-
Dissolved Cadmium	g/m^3	0.0053	0.038	0.0150	-	-
Dissolved Chromium	g/m^3	0.35	0.80	0.26	-	-
Dissolved Copper	g/m^3	1.25	4.8	12.5	-	-
Dissolved Lead	g/m^3	0.0006	0.0013	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.081	0.61	1.62	-	-
Dissolved Zinc	g/m^3	7.2	39	7.9	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 15-Feb-2022 and 21-Feb-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2873486 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	16-Feb-2022
		Date Reported:	23-Feb-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Mark Burroughs

Sample Type: Aqueous

	Sample Name:	1839334 15-Feb-2022 10:30 am	1839335 15-Feb-2022 11:10 am	1839336 15-Feb-2022 12:00 pm		
	Lab Number:	2873486.1	2873486.2	2873486.3		
Individual Tests						
pH	pH Units	1.9	2.1	2.3	-	-
Acidity (pH 3.7)	g/m³ as $CaCO_3$	2,900	5,100	2,800	-	-
Total Alkalinity	g/m³ as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	688	844	937	-	-
Dissolved Aluminium	g/m³	95	440	370	-	-
Dissolved Antimony	g/m³	0.0036	0.013	0.004	-	-
Dissolved Barium	g/m³	< 0.005	< 0.005	0.009	-	-
Dissolved Calcium	g/m³	21	350	440	-	-
Dissolved Cobalt	g/m³	0.21	1.52	2.7	-	-
Dissolved Iron	g/m³	960	1,990	1,390	-	-
Dissolved Magnesium	g/m³	11.1	144	480	-	-
Dissolved Manganese	g/m³	3.5	60	16.0	-	-
Dissolved Mercury	g/m³	< 0.00015	< 0.0003	< 0.00015	-	-
Dissolved Molybdenum	g/m³	0.0157	0.016	0.016	-	-
Dissolved Potassium	g/m³	1.5	< 0.5	48	-	-
Dissolved Selenium	g/m³	0.011	0.020	0.018	-	-
Dissolved Silver	g/m³	< 0.0005	0.0035	< 0.0010	-	-
Dissolved Sodium	g/m³	1.58	2.1	18.7	-	-
Dissolved Strontium	g/m³	0.045	0.156	2.5	-	-
Dissolved Uranium	g/m³	0.0155	0.095	0.197	-	-
Dissolved Vanadium	g/m³	0.109	0.73	0.76	-	-
Sulphate	g/m³	3,400	9,500	10,200	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	35	83	31	-	-
Dissolved Cadmium	g/m³	0.0033	0.026	0.0164	-	-
Dissolved Chromium	g/m³	0.22	0.59	0.36	-	-
Dissolved Copper	g/m³	0.94	3.5	13.9	-	-
Dissolved Lead	g/m³	< 0.0005	0.0010	< 0.0010	-	-
Dissolved Nickel	g/m³	0.064	0.53	1.88	-	-
Dissolved Zinc	g/m³	5.1	31	8.1	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 18-Feb-2022 and 23-Feb-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2900847 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	01-Mar-2022
		Date Reported:	09-Mar-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

Sample Name:		1839574 28-Feb-2022	1839575 28-Feb-2022	1839576 28-Feb-2022		
Lab Number:		2900847.1	2900847.2	2900847.3		
Individual Tests						
pH	pH Units	2.1	2.2	2.4	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	4,400	1,060	2,200	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	709	328	895	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00015	-	-
Sulphate	g/m^3	8,100	1,270	9,200	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	51	28	12.4	-	-
Dissolved Cadmium	g/m^3	0.0164	0.0031	0.0169	-	-
Dissolved Chromium	g/m^3	0.33	0.193	0.37	-	-
Dissolved Copper	g/m^3	2.3	0.80	16.0	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.37	0.057	2.0	-	-
Dissolved Zinc	g/m^3	21	4.3	9.3	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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

Testing was completed between 04-Mar-2022 and 09-Mar-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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Carole Rodgers-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2909016 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	09-Mar-2022
		Date Reported:	16-Mar-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Kristin Gillard

Sample Type: Aqueous

Sample Name:		1839844 07-Mar-2022	1839845 07-Mar-2022	1839846 07-Mar-2022		
Lab Number:		2909016.1	2909016.2	2909016.3		
Individual Tests						
pH	pH Units	-	2.1	2.5	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	-	5,400	2,200	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	-	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	-	784	862	-	-
Dissolved Aluminium	g/m^3	127	320	460	-	-
Dissolved Antimony	g/m^3	0.0056	0.0104	0.0027	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	21	220	430	-	-
Dissolved Cobalt	g/m^3	0.26	1.00	3.4	-	-
Dissolved Iron	g/m^3	1,570	1,740	780	-	-
Dissolved Magnesium	g/m^3	14.4	106	630	-	-
Dissolved Manganese	g/m^3	4.5	36	22	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00015	< 0.00015	-	-
Dissolved Molybdenum	g/m^3	0.026	0.0161	0.0018	-	-
Dissolved Potassium	g/m^3	0.4	0.6	22	-	-
Dissolved Selenium	g/m^3	0.020	0.021	0.019	-	-
Dissolved Silver	g/m^3	0.0008	0.0028	< 0.0005	-	-
Dissolved Sodium	g/m^3	1.73	1.08	19.7	-	-
Dissolved Strontium	g/m^3	0.048	0.113	2.8	-	-
Dissolved Uranium	g/m^3	0.0199	0.056	0.27	-	-
Dissolved Vanadium	g/m^3	0.147	0.25	0.88	-	-
Sulphate	g/m^3	-	8,000	8,900	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	61	77	4.9	-	-
Dissolved Cadmium	g/m^3	0.0041	0.0157	0.0199	-	-
Dissolved Chromium	g/m^3	0.28	0.34	0.39	-	-
Dissolved Copper	g/m^3	1.10	2.5	19.4	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0006	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.075	0.53	2.3	-	-
Dissolved Zinc	g/m^3	5.6	22	10.1	-	-

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	2-3
pH	pH meter. 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	2-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	2-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	2-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	2-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	2-3

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

Testing was completed between 10-Mar-2022 and 16-Mar-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2914098 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	12-Mar-2022
		Date Reported:	18-Mar-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

Sample Name:		1839988 10-Mar-2022	1839989 10-Mar-2022	1839990 10-Mar-2022		
Lab Number:		2914098.1	2914098.2	2914098.3		
Individual Tests						
pH	pH Units	2.6	2.0	1.8	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	1,900	7,800	5,500	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	796	977	1,030	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00015	< 0.00015	-	-
Sulphate	g/m^3	10,800	13,900	6,100	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	4.9	114	55	-	-
Dissolved Cadmium	g/m^3	0.0190	0.0152	0.0031	-	-
Dissolved Chromium	g/m^3	0.40	0.39	0.26	-	-
Dissolved Copper	g/m^3	17.3	2.4	0.97	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0011	< 0.0005	-	-
Dissolved Nickel	g/m^3	2.3	0.43	0.187	-	-
Dissolved Zinc	g/m^3	10.0	19.6	4.8	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 15-Mar-2022 and 18-Mar-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2925270	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	22-Mar-2022	
		Date Reported:	30-Mar-2022	
		Quote No:	85959	
		Order No:	70057893	
		Client Reference:	Extended suite	
		Submitted By:	Andrew Bellamy	

Sample Type: Aqueous

	Sample Name:	1840315 18-Mar-2022 3:25 pm	1840316 18-Mar-2022 2:50 pm	1840317 18-Mar-2022 3:10 pm		
	Lab Number:	2925270.1	2925270.2	2925270.3		
Individual Tests						
pH	pH Units	1.7	2.0	2.4	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	6,200	9,200	3,100	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	1,086	987	1,161	-	-
Dissolved Aluminium	g/m^3	109	400	760	-	-
Dissolved Antimony	g/m^3	0.0077	0.020	0.0063	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	15.3	240	410	-	-
Dissolved Cobalt	g/m^3	0.24	1.11	3.3	-	-
Dissolved Iron	g/m^3	1,620	3,000	1,870	-	-
Dissolved Magnesium	g/m^3	11.8	125	660	-	-
Dissolved Manganese	g/m^3	4.3	35	18.8	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00016	-	-
Dissolved Molybdenum	g/m^3	0.030	0.032	0.0029	-	-
Dissolved Potassium	g/m^3	0.5	< 0.3	32	-	-
Dissolved Selenium	g/m^3	0.023	0.045	0.014	-	-
Dissolved Silver	g/m^3	0.0006	0.0013	< 0.0005	-	-
Dissolved Sodium	g/m^3	2.0	1.01	11.3	-	-
Dissolved Strontium	g/m^3	0.044	0.043	2.6	-	-
Dissolved Uranium	g/m^3	0.0193	0.075	0.30	-	-
Dissolved Vanadium	g/m^3	0.134	0.41	1.47	-	-
Sulphate	g/m^3	6,700	11,500	13,500	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	54	125	14.2	-	-
Dissolved Cadmium	g/m^3	0.0031	0.0147	0.024	-	-
Dissolved Chromium	g/m^3	0.25	0.37	0.71	-	-
Dissolved Copper	g/m^3	0.96	2.3	20	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0013	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.098	0.43	2.4	-	-
Dissolved Zinc	g/m^3	4.5	17.0	11.5	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 23-Mar-2022 and 30-Mar-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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Carole Rodgers-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2934532 SPv1
Contact:	Mark Burroughs	**Date Received:**	28-Mar-2022
	C/- Oceana Gold (New Zealand) Limited	**Date Reported:**	06-Apr-2022
	PO Box 190	**Quote No:**	87181
	Waihi 3610	**Order No:**	70057893
		Client Reference:	Reduced suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

Sample Name:		1840620 25-Mar-2022	1840621 25-Mar-2022	1840622 25-Mar-2022		
Lab Number:		2934532.1	2934532.2	2934532.3		
Individual Tests						
pH	pH Units	1.9	2.0	1.8	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,800	5,800	11,400	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 6	< 6	-	-
Electrical Conductivity (EC)	mS/m	677	754	1,608	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00015	< 0.0004	-	-
Sulphate	g/m^3	3,100	7,000	17,900	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	10.3	47	179	-	-
Dissolved Cadmium	g/m^3	0.0010	0.0077	0.0141	-	-
Dissolved Chromium	g/m^3	0.072	0.182	0.70	-	-
Dissolved Copper	g/m^3	0.40	1.44	10.6	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	< 0.002	-	-
Dissolved Nickel	g/m^3	0.034	0.28	1.50	-	-
Dissolved Zinc	g/m^3	1.58	9.3	8.0	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 30-Mar-2022 and 06-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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Carole Rodgers-Carroll

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Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2972202 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	30-Apr-2022
		Date Reported:	09-May-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

	Sample Name:	1841580 28-Apr-2022	1841581 28-Apr-2022	1841582 28-Apr-2022		
	Lab Number:	2972202.1	2972202.2	2972202.3		
Individual Tests						
pH	pH Units	2.0	2.1	1.8	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,200	2,900	11,900	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	595	525	1,569	-	-
Dissolved Aluminium	g/m^3	29	104	540	-	-
Dissolved Antimony	g/m^3	0.0029	0.0050	0.0069	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	3.5	74	420	-	-
Dissolved Cobalt	g/m^3	0.088	0.40	1.10	-	-
Dissolved Iron	g/m^3	470	830	4,900	-	-
Dissolved Magnesium	g/m^3	3.0	40	230	-	-
Dissolved Manganese	g/m^3	0.74	8.7	12.4	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.0004	-	-
Dissolved Molybdenum	g/m^3	0.0056	0.0077	0.139	-	-
Dissolved Potassium	g/m^3	0.3	< 0.3	0.4	-	-
Dissolved Selenium	g/m^3	0.007	0.013	0.030	-	-
Dissolved Silver	g/m^3	< 0.0005	0.0011	< 0.0005	-	-
Dissolved Sodium	g/m^3	2.2	1.15	2.1	-	-
Dissolved Strontium	g/m^3	0.016	0.017	0.84	-	-
Dissolved Uranium	g/m^3	0.0046	0.0137	0.053	-	-
Dissolved Vanadium	g/m^3	0.021	0.096	1.37	-	-
Sulphate	g/m^3	2,300	3,800	22,000	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	7.6	16.9	106	-	-
Dissolved Cadmium	g/m^3	0.0008	0.0025	0.0088	-	-
Dissolved Chromium	g/m^3	0.045	0.059	0.53	-	-
Dissolved Copper	g/m^3	0.30	0.70	5.5	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.029	0.160	0.96	-	-
Dissolved Zinc	g/m^3	0.87	2.9	6.1	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 03-May-2022 and 09-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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Carole Rodger-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

Appendix C

Column Leachate Results

Memorandum

16 June 2021

To	Mark Burroughs, Oceana Gold NZ Ltd.		
Copy to	Thomas Gardner, Oceana Gold NZ Ltd.; Ian Jenkins, AECOM NZ Ltd.		
From	Carlos Hillman, Tim Mulliner	**Tel**	+64 3 378 0900
Subject	WKP Waste Rock Field Column Testing Set-up	**Project no.**	12552081

Introduction and Background

GHD Limited (GHD) has been engaged by Oceana Gold New Zealand Ltd (Oceana Gold) to undertake Geochemical characterisation of the WKP tunnel and mine spoil. This memorandum outlines specifications, set up and operational procedures for the field column tests to aid the geochemical characterisation and assessment.

The purpose of the column tests is to investigate the onset of acid producing leachate and leachate water quality from the waste rock material associated with the WKP Ore Body. Data gathered will enable geochemical characterisation of waste material and its similarity or dissimilarity to waste material currently handled at the existing and proposed Waihi operations. This will then aid methodology for the development of backfill placement and estimating WKP tunnel inflow water quality.

The methodology outlined here is an adaptation of the methodology as outlined in AECOM, 2017[1]

Column Setup and Specification

The existing columns on site (dimensions approximately 800 mm high, 300 mm diameter equalling a total volume of approximately 0.057 m^3 each) will be utilised. The existing columns should be prepared for use by emptying and cleaning, replacing all tubing and buckets (with sealed lids) with food grade plastic and setting up the columns as outlined in Figure 1. Any new or pre-existing equipment should be thoroughly flushed with an acid wash to remove any existing contaminants. It is recommended that if possible, the column cylinders be replaced.

K1 gravel material is recommended at the base of the columns and placed at a thickness that will allow free drainage of leachate to occur (approximately 100 mm). Tubing should be sealed to the base of the columns to collect drainage and avoid any leakage. The length of the tubing should be sufficient so that it can be connected to the collection buckets beneath the columns and long enough so the outlet of the piping can be attached to the side of the column at a height above the maximum level of the waste rock within the column (introducing a head pressure gradient to enable the column to become fully saturated). Tubing should be secured in place (at side of column and top of bucket) in a way that it can easily be released (when sampling) and repositioned when required. Where the tubing connects at the top of the leachate buckets it should be 'sealed' in a manner that avoids water other than leachate entering the buckets and enables the removal of the tubing for sampling during the column operation. An approximate tubing length of 1000 – 2000 mm is therefore recommended.

---

[1] Standard Operating Procedure for PYE Field Columns, Waihi – Set up and sample collection. AECOM, (2017).

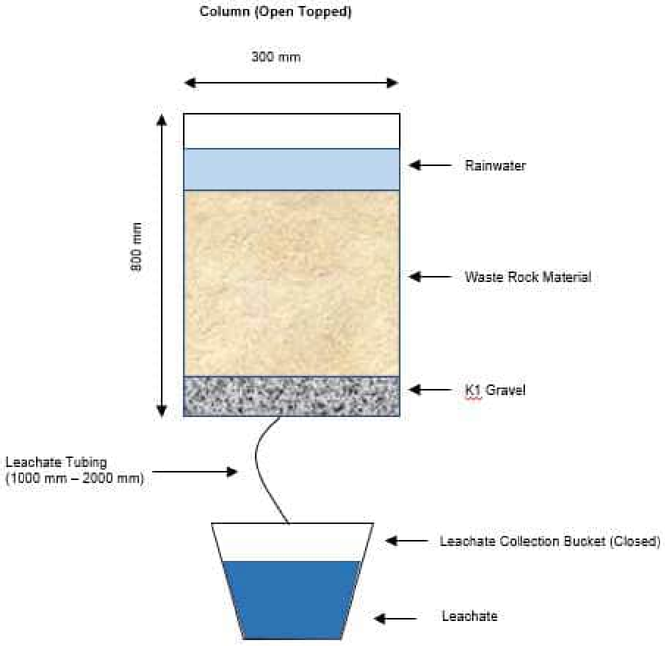


Figure 1 Column Set-up and Specifications

Figure 2 Historical On-site Column Setup (2019)

Waste Rock Selection and Preparation

Three separate columns will be set-up using core material representative of waste spoil and/or tunnel/stope lining material from the WKP Ore body. One column will consist of material surrounding the T-Stream Vein (Drill Site 2) and two columns will exist of material associated with the EG Vein (Drill Site 4 (Northern area) and Drill Site 1 (Southern area)). Each column will contain approximately 60 kg of waste rock representative of the Rhyolitic waste material. Waste rock should be sourced from core material as identified by GHD in the provided spreadsheets (to be provided separately). Appropriate material is selected based on core logs, assay data and photos previously provided to GHD from Oceana Gold.

Once the selected material for each individual column is selected, the material should be fully mixed prior to being crushed (crushing was previously undertaken by the local SGS lab). This will ensure the maximum particle size is not greater than 60 mm or 20% of the column diameter.

Representative samples from each column should be sent for analysis for the parameters detailed in Table 1

The balance of the material should then be placed directly on top of the K1 gravel within the columns. This material should be weighed prior to placing in the column so that total mass of waste within each column is known. A minimum of 150 mm should be maintained between the top of the sample and the top of the column.

Table 1 Recommended Analytical Suite for Column Waste Rock

Required Analytes
PSD (Particle Size Distribution)
NAG pH
Total Sulphur (%)
Total Carbon (%)
ANC (kg $CaCO_3$/tonne)
Aluminium
Iron
Calcium
Magnesium
Sodium
Potassium
Antimony
Arsenic
Barium
Cadmium
Cobalt
Chromium
Copper
Lead
Mercury
Manganese
Molybdenum
Nickel
Selenium
Vanadium
Zinc
Titanium
Tin
Silver
Thallium
Fluoride
Uranium

Column Operation and Sample Procedure

The columns should be left exposed to atmospheric conditions for a minimum of 10 weeks. This initial phase is to ensure that oxidation of the waste rock takes place and becomes acid producing. During this initial phase, leachate generated should be monitored weekly. Depending on the results, the monitoring frequency may be extended with time.

Samples can be obtained by carefully removing the leachate tubing from the bucket and collecting leachate directly from the tubing into laboratory supplied containers suitable for the analysis of the parameters detailed in Table 2 and Table 3.

The expanded and reduced analytical suite should be undertaken on alternate weeks. It is recommended that the expanded suite is utilised for the first flush sample (the first leachate collection event).

Field parameters should be collected utilising a calibrated multi-parameter (or similar individual meters) and the following field parameters recorded:

- pH
- Conductivity
- Temperature

It is recommended that calibration of pH and conductivity is undertaken using appropriate calibration solutions that cover the likely range of measured parameters.

The remaining leachate should be left to drain into the bucket until the tubing runs dry. The volume of leachate within the bucket should be recorded and sampled before reconnecting the tubing to the empty bucket.

If insufficient leachate drains from the tubing and base of column to enable the collection of water samples and/or accurate measurement of field parameters, static water within the bucket should be utilised.

If no leachate water (or insufficient leachate water) is available, a measured volume of 500 mL of de-ionised water should be poured into the column at the top, and the leachate should be collected as described above. Where this is required, it should be recorded on the sampling sheet. In the event that there is frequently not enough leachate to sample within the tubing, a measured volume of deionised water should be added to the top of the column several days before sampling to ensure sufficient water is available. The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommended that field parameters (as above) be recorded prior to the disposal of the leachate water.

The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommended that field parameters (as above) be recorded prior to the disposal of the leachate water.

Table 2 Recommended Analytical Suite for the Leachate Sample Collection – Expanded Suite

Required Analytes
pH
Conductivity
Acidity (mg $CaCO_3$/L)
Alkalinity (mg $CaCO_3$/L)
Sulphate
Dissolved Aluminium
Dissolved Iron
Dissolved Calcium
Dissolved Magnesium
Dissolved Sodium
Dissolved Potassium
Dissolved Antimony
Dissolved Arsenic
Dissolved Barium
Dissolved Cadmium
Dissolved Cobalt
Dissolved Chromium
Dissolved Copper
Dissolved Lead
Dissolved Mercury
Dissolved Manganese
Dissolved Molybdenum
Dissolved Nickel
Dissolved Selenium
Dissolved Vanadium
Dissolved Zinc
Dissolved Titanium
Dissolved Tin
Dissolved Silver
Dissolved Thallium
Dissolved Fluoride
Dissolved Uranium

*It is recommended that samples are field filtered and are analysed at trace level.

*Table 3 Recommended Analytical Suite for the Leachate Sample Collection – Reduced Suite_*

Required Analytes
pH
Conductivity
Acidity (mg $CaCO_3$/L)
Alkalinity (mg $CaCO_3$/L)
Sulphate
Dissolved Arsenic
Dissolved Cadmium
Dissolved Chromium
Dissolved Copper
Dissolved Lead
Dissolved Nickel
Dissolved Zinc

*It is recommended that samples are field filtered and are analysed at trace level.

Results should be forwarded to GHD upon receipt and will be reviewed in terms of the acid generating. Once the columns are verified as being acid producing (generally based on a measured pH <3 and elevated sulphate) GHD will review and advise on requirements for ongoing monitoring.

Regards

Carlos Hillman

Geochemist

Appendix C

Acid Base Accounting Dataset

	SAMPLE	S	C	NAG pH	G kg H2SO	C kg H2SO	CaCO3 Equ	CaCO3 Co	NP	P Correcte	TAP (kg H	MPA	MPA	AP	NAPP	NAPP	MPA	ANC/MPA	NNP	NPR	NPR adjusted ANC
Gladstone Andesite	UW540-0002	0.05	0.17	-	-	-	-	-	-	-		2	0.2	2	-	-		-	-	-	-
Gladstone Andesite	UW540-0003	0.02	0.06	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW540-0004	0.01	0.03	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0006	0.01	0.05	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0007	0.01	0.04	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0008	0.02	0.04	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW540-0009	0.01	0.05	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0011	0.01	0.03	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0012	0.02	0.02	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW540-0013	0.01	0.02	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0014	0.01	0.03	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0016	0.01	0.03	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0017	0.01	0.03	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0021	0.01	0.03	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0022	0.01	0.02	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0024	0.01	0.02	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW540-0025	0.01	0.02	-	-	-	-	-	-	-		0	0.0	0	-	-		-	-	-	-
Gladstone Andesite	UW542-0005	0.03	0.22	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW542-0006	0.03	0.05	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW542-0007	0.11	0.18	-	-	-	-	-	-	-		3	0.3	3	-	-		-	-	-	-
Gladstone Andesite	UW542-0008	4.3	0.03	-	-	-	-	-	-	-		132	13.4	134	-	-		-	-	-	-
Gladstone Andesite	UW542-0009	12.4	0.04	-	-	-	-	-	-	-		379	38.8	388	-	-		-	-	-	-
Gladstone Andesite	UW542-0010	5.46	0.03	-	-	-	-	-	-	-		167	17.1	171	-	-		-	-	-	-
Gladstone Andesite	UW542-0011	5.52	0.02	-	-	-	-	-	-	-		169	17.3	173	-	-		-	-	-	-
Gladstone Andesite	UW542-0012	9.1	0.03	-	-	-	-	-	-	-		278	28.4	284	-	-		-	-	-	-
Gladstone Andesite	UW542-0013	6.68	0.02	-	-	-	-	-	-	-		204	20.9	209	-	-		-	-	-	-
Gladstone Andesite	UW542-0014	6.77	0.02	-	-	-	-	-	-	-		207	21.2	212	-	-		-	-	-	-
Gladstone Andesite	UW542-0015	6.32	0.02	-	-	-	-	-	-	-		193	19.8	198	-	-		-	-	-	-
Gladstone Andesite	UW542-0016	4.58	0.02	-	-	-	-	-	-	-		140	14.3	143	-	-		-	-	-	-
Gladstone Andesite	UW542-0017	7	0.03	-	-	-	-	-	-	-		214	21.9	219	-	-		-	-	-	-
Gladstone Andesite	UW542-0021	5.75	0.02	-	-	-	-	-	-	-		176	18.0	180	-	-		-	-	-	-
Gladstone Andesite	UW542-0022	4.43	0.01	-	-	-	-	-	-	-		136	13.8	138	-	-		-	-	-	-
Gladstone Andesite	UW542-0023	5.4	0.02	-	-	-	-	-	-	-		165	16.9	169	-	-		-	-	-	-
Gladstone Andesite	UW542-0024	4.3	0.02	-	-	-	-	-	-	-		132	13.4	134	-	-		-	-	-	-
Gladstone Andesite	UW542-0025	3.66	0.04	-	-	-	-	-	-	-		112	11.4	114	-	-		-	-	-	-
Gladstone Andesite	UW542-0026	3.65	0.02	-	-	-	-	-	-	-		112	11.4	114	-	-		-	-	-	-
Gladstone Andesite	UW542-0027	3.73	0.02	-	-	-	-	-	-	-		114	11.7	117	-	-		-	-	-	-
Gladstone Andesite	UW542-0028	3.63	0.02	-	-	-	-	-	-	-		111	11.3	113	-	-		-	-	-	-
Gladstone Andesite	UW542-0029	2.64	0.01	-	-	-	-	-	-	-		81	8.3	83	-	-		-	-	-	-
Gladstone Andesite	UW542-0030	3.17	0.01	-	-	-	-	-	-	-		97	9.9	99	-	-		-	-	-	-
Gladstone Andesite	UW542-0031	3.17	0.01	-	-	-	-	-	-	-		97	9.9	99	-	-		-	-	-	-
Gladstone Andesite	UW542-0032	4.13	0.02	-	-	-	-	-	-	-		126	12.9	129	-	-		-	-	-	-
Gladstone Andesite	UW542-0033	3.12	0.02	-	-	-	-	-	-	-		95	9.8	98	-	-		-	-	-	-
Gladstone Andesite	UW542-0034	2.74	0.03	-	-	-	-	-	-	-		84	8.6	86	-	-		-	-	-	-
Gladstone Andesite	UW542-0035	2.23	0.04	-	-	-	-	-	-	-		68	7.0	70	-	-		-	-	-	-
Gladstone Andesite	UW542-0036	3.6	0.04	-	-	-	-	-	-	-		110	11.3	113	-	-		-	-	-	-
Gladstone Andesite	UW542-0037	4.4	0.03	-	-	-	-	-	-	-		135	13.8	138	-	-		-	-	-	-
Gladstone Andesite	UW542-0041	9.17	0.06	-	-	-	-	-	-	-		281	28.7	287	-	-		-	-	-	-
Gladstone Andesite	UW542-0042	4.58	0.04	-	-	-	-	-	-	-		140	14.3	143	-	-		-	-	-	-
Gladstone Andesite	UW542-0043	2.79	0.03	-	-	-	-	-	-	-		85	8.7	87	-	-		-	-	-	-
Gladstone Andesite	UW542-0044	3.14	0.03	-	-	-	-	-	-	-		96	9.8	98	-	-		-	-	-	-
Gladstone Andesite	UW542-0045	3.04	0.04	-	-	-	-	-	-	-		93	9.5	95	-	-		-	-	-	-
Gladstone Andesite	UW542-0046	3.63	0.06	-	-	-	-	-	-	-		111	11.3	113	-	-		-	-	-	-
Gladstone Andesite	UW542-0047	10.85	0.05	-	-	-	-	-	-	-		332	33.9	339	-	-		-	-	-	-
Gladstone Andesite	UW542-0048	3.83	0.04	-	-	-	-	-	-	-		117	12.0	120	-	-		-	-	-	-
Gladstone Andesite	UW542-0049	3.09	0.04	-	-	-	-	-	-	-		95	9.7	97	-	-		-	-	-	-
Gladstone Andesite	UW542-0050	3.74	0.04	-	-	-	-	-	-	-		114	11.7	117	-	-		-	-	-	-
Gladstone Andesite	UW542-0051	4.28	0.04	-	-	-	-	-	-	-		131	13.4	134	-	-		-	-	-	-
Gladstone Andesite	UW542-0052	5.87	0.04	-	-	-	-	-	-	-		180	18.3	183	-	-		-	-	-	-
Gladstone Andesite	UW542-0053	7.17	0.04	-	-	-	-	-	-	-		219	22.4	224	-	-		-	-	-	-
Gladstone Andesite	UW542-0054	6.4	0.04	-	-	-	-	-	-	-		196	20.0	200	-	-		-	-	-	-
Gladstone Andesite	UW542-0055	0.96	0.04	-	-	-	-	-	-	-		29	3.0	30	-	-		-	-	-	-
Gladstone Andesite	UW542-0056	0.05	0.02	-	-	-	-	-	-	-		2	0.2	2	-	-		-	-	-	-
Gladstone Andesite	UW542-0061	0.02	0.01	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW542-0062	0.03	0.02	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW542-0063	0.02	0.01	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW542-0064	0.02	0.01	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW542-0065	0.02	0.01	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-

Gladstone Andesite	UW542-0066	0.03	0.02	-	-	-	-	-	-	-		1	0.1	1	-	-		-	-	-	-
Gladstone Andesite	UW500-0123	2.48	-	2.3	73	9	0.918	0.918	9.18	9.18	76	76	7.8	78	67	68	7.8	0.119	-68.32	0.119	0.119
Gladstone Andesite	UW500-0103	3.55	-	2.2	107	3	0.306	0.306	3.06	3.06	109	109	11.1	111	106	108	11.1	0.028	-107.88	0.028	0.028
Gladstone Andesite	UW505-0033	0.044	-	5.5	2	3	0.306	0.306	3.06	3.06	1	1	0.1	1	-2	-2	0.1	2.227	1.69	2.227	2.227
Gladstone Andesite	UW505-0105	0.021	-	6	2	3	0.306	0.306	3.06	3.06	1	1	0.1	1	-2	-2	0.1	4.665	2.41	4.665	4.665
Gladstone Andesite	UW505-0110	0.145	-	3.8	4	3	0.306	0.306	3.06	3.06	4	4	0.5	5	1	1	0.5	0.676	-1.47	0.676	0.676
Gladstone Andesite	UW540-0001	0.03	0.33	6.4	1	2	0.204	0.204	2.04	2.04		1	0.1	1	-1	1		2.177	-0.73	2.177	2.177
Gladstone Andesite	UW540-0005	0.018	0.04	6.2	2	2	0.204	0.204	2.04	2.04		1	0.1	1	-1	-1		3.628	1.48	3.628	3.628
Gladstone Andesite	UW540-0023	0.019	0.02	6.1	2	2	0.204	0.204	2.04	2.04		1	0.1	1	-1	-1		3.437	1.45	3.437	3.437
Gladstone Andesite	UW540-0026	0.022	0.02	6	2	2	0.204	0.204	2.04	2.04		1	0.1	1	-1	-1		2.969	1.35	2.969	2.969
Gladstone Andesite	UW505-0023	0.042	-	5.7	2	2	0.204	0.204	2.04	2.04	1	1	0.1	1	-1	-1	0.1	1.555	0.73	1.555	1.555
Gladstone Andesite	UW505-0037	0.017	-	6.1	1	2	0.204	0.204	2.04	2.04	1	1	0.1	1	-1	-2	0.1	3.842	1.51	3.842	3.842
Gladstone Andesite	UW505-0072	0.039	-	5.8	2	2	0.204	0.204	2.04	2.04	1	1	0.1	1	-1	-1	0.1	1.675	0.82	1.675	1.675
Gladstone Andesite	UW505-0077	0.096	-	4.5	3	2	0.204	0.204	2.04	2.04	3	3	0.3	3	1	1	0.3	0.680	-0.96	0.680	0.680
Gladstone Andesite	UW505-0096	0.018	-	5.6	3	2	0.204	0.204	2.04	2.04	1	1	0.1	1	-1	-1	0.1	3.628	1.48	3.628	3.628
Gladstone Andesite	UW505-0115	1.83	-	2.6	56	2	0.204	0.204	2.04	2.04	56	56	5.7	57	54	55	5.7	0.036	-55.15	0.036	0.036
Gladstone Andesite	UW507-0137	2.67	-	2.4	78	2	0.204	0.204	2.04	2.04	82	82	8.3	83	80	81	8.3	0.024	-81.40	0.024	0.024
Gladstone Andesite	UW507-0150	8.72	-	2.3	248	2	0.204	0.204	2.04	2.04	267	267	27.3	273	265	270	27.3	0.007	-270.46	0.007	0.007
Gladstone Andesite	UW569-0033	0.396	-	3	2	2	0.204	0.204	2.04	2.04	2	12	1.2	12	10	10	0.2	0.165	-10.33	0.165	0.165
Gladstone Andesite	UW571-0013	0.064	-	5.4	1	2	0.204	0.204	2.04	2.04	2	2	0.2	2	0	0	0.2	1.021	0.04	1.021	1.021
Gladstone Andesite	UW505-0028	0.122	-	4.1	3	1	0.102	0.102	1.02	1.02	4	4	0.4	4	3	3	0.4	0.268	-2.79	0.268	0.268
Gladstone Andesite	UW505-0067	0.061	-	5.2	3	1	0.102	0.102	1.02	1.02	2	2	0.2	2	1	1	0.2	0.535	-0.89	0.535	0.535
Gladstone Andesite	UW507-0051	0.032	-	5.4	1	1	0.102	0.102	1.02	1.02	1	1	0.1	1	0	0	0.1	1.021	0.02	1.021	1.021
Gladstone Andesite	UW507-0077	4.52	-	2.2	122	1	0.102	0.102	1.02	1.02	138	138	14.1	141	137	140	14.1	0.007	-140.23	0.007	0.007
Gladstone Andesite	UW507-0145	3.8	-	2.3	106	1	0.102	0.102	1.02	1.02	116	116	11.9	119	115	118	11.9	0.009	-117.73	0.009	0.009
Gladstone Andesite	UW571-0025	0.104	-	4.7	2	1	0.102	0.102	1.02	1.02	3	3	0.3	3	2	2	0.3	0.314	-2.23	0.314	0.314
Gladstone Andesite	UW574-0007	0.039	-	5.8	3	1	0.102	0.102	1.02	1.02	1	1	0.1	1	0	0	0.1	0.837	-0.20	0.837	0.837
Gladstone Andesite	UW540-0015	0.016	0.02	6.2	2	0	0.000	0.083	0.00	0.83		0	0.1	1	0	1		0.000	-0.50	1.660	1.660
Gladstone Andesite	UW500-0015	0.072	-	6	1	0	0.000	0.083	0.00	0.83	2	2	0.2	2	2	2	0.2	0.000	-2.25	0.000	0.369
Gladstone Andesite	UW500-0023	0.043	-	5.4	2	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-1.34	0.000	0.618
Gladstone Andesite	UW500-0028	7.68	-	2.3	221	0	0.000	0.083	0.00	0.83	235	235	24.0	240	235	240	24.0	0.000	-240.00	0.000	0.003
Gladstone Andesite	UW500-0051	3.82	-	2.2	107	0	0.000	0.083	0.00	0.83	117	117	11.9	119	117	119	11.9	0.000	-119.38	0.000	0.007
Gladstone Andesite	UW500-0129	4.09	-	2.2	120	0	0.000	0.083	0.00	0.83	125	125	12.8	128	125	128	12.8	0.000	-127.81	0.000	0.006
Gladstone Andesite	UW500-0134	2.63	-	2.3	86	0	0.000	0.083	0.00	0.83	80	80	8.2	82	80	82	8.2	0.000	-82.19	0.000	0.010
Gladstone Andesite	UW500-0149	1.57	-	2.5	49	0	0.000	0.083	0.00	0.83	48	48	4.9	49	48	49	4.9	0.000	-49.06	0.000	0.017
Gladstone Andesite	UW505-0085	3.87	-	2.3	108	0	0.000	0.083	0.00	0.83	118	118	12.1	121	118	121	12.1	0.000	-120.94	0.000	0.007
Gladstone Andesite	UW505-0090	0.061	-	5.1	4	0	0.000	0.083	0.00	0.83	2	2	0.2	2	2	2	0.2	0.000	-1.91	0.000	0.435
Gladstone Andesite	UW507-0044	0.04	-	5.6	1	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-1.25	0.000	0.664
Gladstone Andesite	UW507-0066	3.31	-	2.4	93	0	0.000	0.083	0.00	0.83	101	101	10.3	103	101	103	10.3	0.000	-103.44	0.000	0.008
Gladstone Andesite	UW507-0072	4.39	-	2.5	124	0	0.000	0.083	0.00	0.83	134	134	13.7	137	134	137	13.7	0.000	-137.19	0.000	0.006
Gladstone Andesite	UW507-0085	4.18	-	2.1	119	0	0.000	0.083	0.00	0.83	128	128	13.1	131	128	131	13.1	0.000	-130.63	0.000	0.006
Gladstone Andesite	UW507-0126	2.64	-	2.8	76	0	0.000	0.083	0.00	0.83	81	81	8.3	83	81	83	8.3	0.000	-82.50	0.000	0.010
Gladstone Andesite	UW507-0132	1.74	-	2.6	49	0	0.000	0.083	0.00	0.83	53	53	5.4	54	53	54	5.4	0.000	-54.38	0.000	0.015
Gladstone Andesite	UW558-0050	4.52	-	2.4	125	0	0.000	0.083	0.00	0.83	138	138	14.1	141	138	141	14.1	0.000	-141.25	0.000	0.006
Gladstone Andesite	UW563-0037	0.028	-	5.5	7	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-0.88	0.000	0.949
Gladstone Andesite	UW566-0008	0.064	-	5.3	4	0	0.000	0.083	0.00	0.83	2	2	0.2	2	2	2	0.2	0.000	-2.00	0.000	0.415
Gladstone Andesite	UW566-0013	0.027	-	6	2	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-0.84	0.000	0.984
Gladstone Andesite	UW566-0025	0.033	-	5.9	1	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-1.03	0.000	0.805
Gladstone Andesite	UW566-0073	0.049	-	5.6	2	0	0.000	0.083	0.00	0.83	1	1	0.2	2	1	2	0.2	0.000	-1.53	0.000	0.542
Gladstone Andesite	UW566-0083	0.036	-	5.4	1	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-1.13	0.000	0.738
Gladstone Andesite	UW571-0007	0.043	-	5.5	1	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-1.34	0.000	0.618
Gladstone Andesite	UW571-0042	5.45	-	2.4	151	0	0.000	0.083	0.00	0.83	167	167	17.0	170	167	170	17.0	0.000	-170.31	0.000	0.005
Gladstone Andesite	UW571-0050	3.18	-	2.5	88	0	0.000	0.083	0.00	0.83	97	97	9.9	99	97	99	9.9	0.000	-99.38	0.000	0.008
Gladstone Andesite	UW574-0012	2.2	-	2.7	57	0	0.000	0.083	0.00	0.83	67	67	6.9	69	67	69	6.9	0.000	-68.75	0.000	0.012
Gladstone Andesite	UW574-0033	5.81	-	2.3	165	0	0.000	0.083	0.00	0.83	178	178	18.2	182	178	182	18.2	0.000	-181.56	0.000	0.005
Gladstone Andesite	UW574-0041	0.02	-	5.9	2	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-0.63	0.000	1.328
Gladstone Andesite	UW574-0069	1.94	-	2.8	50	0	0.000	0.083	0.00	0.83	59	59	6.1	61	59	61	6.1	0.000	-60.63	0.000	0.014
Gladstone Andesite	UW540-0010	0.022	0.04	6.2	2	-1	-0.102	0.083	-1.02	0.83		1	0.1	1	2	2		-1.484	-1.71	1.207	1.207
Gladstone Andesite	UW500-0037	5.23	-	2.3	160	-1	-0.102	0.083	-1.02	0.83	160	160	16.3	163	161	164	16.3	-0.006	-164.46	-0.006	0.005
Gladstone Andesite	UW500-0076	4.2	-	2.4	132	-1	-0.102	0.083	-1.02	0.83	129	129	13.1	131	130	132	13.1	-0.008	-132.27	-0.008	0.006
Gladstone Andesite	UW500-0085	5.51	-	2.3	170	-1	-0.102	0.083	-1.02	0.83	169	169	17.2	172	170	173	17.2	-0.006	-173.21	-0.006	0.005
Gladstone Andesite	UW500-0091	3.61	-	2.2	117	-1	-0.102	0.083	-1.02	0.83	110	110	11.3	113	111	114	11.3	-0.009	-113.83	-0.009	0.007
Gladstone Andesite	UW500-0095	3.95	-	2.2	121	-1	-0.102	0.083	-1.02	0.83	121	121	12.3	123	122	124	12.3	-0.008	-124.46	-0.008	0.007
Gladstone Andesite	UW558-0036	3.56	-	2.6	100	-1	-0.102	0.083	-1.02	0.83	109	109	11.1	111	110	112	11.1	-0.009	-112.27	-0.009	0.007
Gladstone Andesite	UW558-0055	5.53	-	2.2	154	-1	-0.102	0.083	-1.02	0.83	169	169	17.3	173	170	174	17.3	-0.006	-173.83	-0.006	0.005
Gladstone Andesite	UW566-0053	5.66	-	2.3	161	-1	-0.102	0.083	-1.02	0.83	173	173	17.7	177	174	178	17.7	-0.006	-177.90	-0.006	0.005
Gladstone Andesite	UW566-0064	0.024	-	5.7	3	-1	-0.102	0.083	-1.02	0.83	1	1	0.1	1	2	2	0.1	-1.361	-1.77	-1.361	1.107
Gladstone Andesite	UW569-0026	2.18	-	2.8	2	-1	-0.102	0.083	-1.02	0.83	2	67	6.8	68	68	69	0.2	-0.015	-69.15	-0.015	0.012
Gladstone Andesite	UW569-0041	0.659	-	2.6	2	-1	-0.102	0.083	-1.02	0.83	2	20	2.1	21	21	22	0.2	-0.050	-21.61	-0.050	0.040

Gladstone Andesite	UW569-0002	4.15	-	5.9	2	-1	-0.102	0.083	-1.02	0.83	2	127	13.0	130	128	131	0.2	-0.008	-130.71	-0.008	0.006
Gladstone Andesite	UW571-0029	9.37	-	2.2	265	-1	-0.102	0.083	-1.02	0.83	287	287	29.3	293	288	294	29.3	-0.003	-293.83	-0.003	0.003
Gladstone Andesite	UW571-0054	3.97	-	2.5	115	-1	-0.102	0.083	-1.02	0.83	122	121	12.4	124	122	125	12.4	-0.008	-125.08	-0.008	0.007
Gladstone Andesite	UW571-0067	1.76	-	2.9	49	-1	-0.102	0.083	-1.02	0.83	54	54	5.5	55	55	56	5.5	-0.019	-56.02	-0.019	0.015
Gladstone Andesite	UW574-0017	0.038	-	5.3	2	-1	-0.102	0.083	-1.02	0.83	1	1	0.1	1	2	2	0.1	-0.859	-2.21	-0.859	0.699
Gladstone Andesite	UW574-0029	0.015	-	5.3	3	-1	-0.102	0.083	-1.02	0.83	0	0	0.0	0	1	1	0.0	-2.177	-1.49	-2.177	1.771
Gladstone Andesite	UW574-0097	4.28	-	2.4	121	-1	-0.102	0.083	-1.02	0.83	131	131	13.4	134	132	135	13.4	-0.008	-134.77	-0.008	0.006
Gladstone Andesite	UW500-0065	4.25	-	2.4	132	-2	-0.204	0.083	-2.04	0.83	130	130	13.3	133	132	135	13.3	-0.015	-134.85	-0.015	0.006
Gladstone Andesite	UW500-0071	3.97	-	2.4	124	-2	-0.204	0.083	-2.04	0.83	121	121	12.4	124	123	126	12.4	-0.016	-126.10	-0.016	0.007
Gladstone Andesite	UW507-0103	4.21	-	2.2	114	-2	-0.204	0.083	-2.04	0.83	129	129	13.2	132	131	134	13.2	-0.016	-133.60	-0.016	0.006
Gladstone Andesite	UW507-0113	4.14	-	2.2	117	-2	-0.204	0.083	-2.04	0.83	127	127	12.9	129	129	131	12.9	-0.016	-131.42	-0.016	0.006
Gladstone Andesite	UW507-0121	7.23	-	2.3	214	-2	-0.204	0.083	-2.04	0.83	221	221	22.6	226	223	228	22.6	-0.009	-227.98	-0.009	0.004
Gladstone Andesite	UW558-0044	3.11	-	2.6	85	-2	-0.204	0.083	-2.04	0.83	95	95	9.7	97	97	99	9.7	-0.021	-99.23	-0.021	0.009
Gladstone Andesite	UW563-0193	3.17	-	2.4	90	-2	-0.204	0.083	-2.04	0.83	97	97	9.9	99	99	101	9.9	-0.021	-101.10	-0.021	0.008
Gladstone Andesite	UW566-0021	0.02	-	6	3	-2	-0.204	0.083	-2.04	0.83	1	1	0.1	1	3	3	0.1	-3.266	-2.67	-3.266	1.328
Gladstone Andesite	UW566-0056	0.3	-	3.3	11	-2	-0.204	0.083	-2.04	0.83	9	9	0.9	9	11	11	0.9	-0.218	-11.42	-0.218	0.089
Gladstone Andesite	UW569-0054	4.11	-	2.5	2	-2	-0.204	0.083	-2.04	0.83	2	126	12.8	128	128	130	0.2	-0.016	-130.48	-0.016	0.006
Gladstone Andesite	UW569-0062	4.77	-	2.3	2	-2	-0.204	0.083	-2.04	0.83	2	146	14.9	149	148	151	0.2	-0.014	-151.10	-0.014	0.006
Gladstone Andesite	UW569-0017	3.26	-	2.5	92	-2	-0.204	0.083	-2.04	0.83	100	100	10.2	102	102	104	10.2	-0.020	-103.92	-0.020	0.008
Gladstone Andesite	UW571-0034	5.72	-	2.4	164	-2	-0.204	0.083	-2.04	0.83	175	175	17.9	179	177	181	17.9	-0.011	-180.79	-0.011	0.005
Gladstone Andesite	UW571-0047	4.32	-	2.5	119	-2	-0.204	0.083	-2.04	0.83	132	132	13.5	135	134	137	13.5	-0.015	-137.04	-0.015	0.006
Gladstone Andesite	UW574-0063	3.11	-	2.6	89	-2	-0.204	0.083	-2.04	0.83	95	95	9.7	97	97	99	9.7	-0.021	-99.23	-0.021	0.009
Gladstone Andesite	UW574-0106	3.82	-	2.5	107	-2	-0.204	0.083	-2.04	0.83	117	117	11.9	119	119	121	11.9	-0.017	-121.42	-0.017	0.007
Gladstone Andesite	UW500-0057	3.49	-	2.2	105	-3	-0.306	0.083	-3.06	0.83	107	107	10.9	109	110	112	10.9	-0.028	-112.12	-0.028	0.008
Gladstone Andesite	UW507-0057	4.57	-	2.2	123	-3	-0.306	0.083	-3.06	0.83	140	140	14.3	143	143	146	14.3	-0.021	-145.87	-0.021	0.006
Gladstone Andesite	UW507-0090	4.22	-	2.2	119	-3	-0.306	0.083	-3.06	0.83	129	129	13.2	132	132	135	13.2	-0.023	-134.94	-0.023	0.006
Gladstone Andesite	UW563-0141	5.23	-	2.3	155	-3	-0.306	0.083	-3.06	0.83	160	160	16.3	163	163	166	16.3	-0.019	-166.50	-0.019	0.005
Gladstone Andesite	UW563-0147	4.51	-	2	123	-3	-0.306	0.083	-3.06	0.83	138	138	14.1	141	141	144	14.1	-0.022	-144.00	-0.022	0.006
Gladstone Andesite	UW563-0153	3.82	-	2	109	-3	-0.306	0.083	-3.06	0.83	117	117	11.9	119	120	122	11.9	-0.026	-122.44	-0.026	0.007
Gladstone Andesite	UW563-0162	3.38	-	2	94	-3	-0.306	0.083	-3.06	0.83	103	103	10.6	106	106	109	10.6	-0.029	-108.69	-0.029	0.008
Gladstone Andesite	UW563-0168	2.34	-	2.3	68	-3	-0.306	0.083	-3.06	0.83	72	72	7.3	73	75	76	7.3	-0.042	-76.19	-0.042	0.011
Gladstone Andesite	UW563-0183	4.36	-	2.4	127	-3	-0.306	0.083	-3.06	0.83	133	133	13.6	136	136	139	13.6	-0.022	-139.31	-0.022	0.006
Gladstone Andesite	UW563-0201	6.51	-	2.2	189	-3	-0.306	0.083	-3.06	0.83	199	199	20.3	203	202	206	20.3	-0.015	-206.50	-0.015	0.004
Gladstone Andesite	UW566-0047	3.37	-	2.6	95	-3	-0.306	0.083	-3.06	0.83	103	103	10.5	105	106	108	10.5	-0.029	-108.37	-0.029	0.008
Gladstone Andesite	UW566-0077	0.027	-	5.6	5	-3	-0.306	0.083	-3.06	0.83	1	1	0.084	1	4	4	0.1	-3.628	-3.91	-3.628	0.984
Gladstone Andesite	UW569-0108	4.15	-	2.5	2	-3	-0.306	0.083	-3.06	0.83	2	127	13.0	130	130	133	0.2	-0.024	-132.75	-0.024	0.006
Gladstone Andesite	UW571-0065	4.65	-	2.5	127	-3	-0.306	0.083	-3.06	0.83	142	142	14.5	145	145	148	14.5	-0.021	-148.37	-0.021	0.006
Gladstone Andesite	UW574-0087	3.51	-	2.6	98	-3	-0.306	0.083	-3.06	0.83	107	107	11.0	110	110	113	11.0	-0.028	-112.75	-0.028	0.008
Gladstone Andesite	UW574-0110	4.9	-	2.4	141	-3	-0.306	0.083	-3.06	0.83	150	150	15.3	153	153	156	15.3	-0.020	-156.19	-0.020	0.005
Gladstone Andesite	UW500-0033	8.38	-	2.2	233	-4	-0.408	0.083	-4.08	0.83	256	256	26.2	262	260	266	26.2	-0.016	-265.96	-0.016	0.003
Gladstone Andesite	UW500-0046	5.99	-	2.3	180	-4	-0.408	0.083	-4.08	0.83	183	183	18.7	187	187	191	18.7	-0.022	-191.27	-0.022	0.004
Gladstone Andesite	UW507-0095	6.36	-	2.4	182	-4	-0.408	0.083	-4.08	0.83	195	195	19.9	199	199	203	19.9	-0.021	-202.83	-0.021	0.004
Gladstone Andesite	UW563-0188	4.66	-	2.3	132	-4	-0.408	0.083	-4.08	0.83	143	143	14.6	146	147	150	14.6	-0.028	-149.71	-0.028	0.006
Gladstone Andesite	UW566-0034	4.8	-	2.4	140	-4	-0.408	0.083	-4.08	0.83	147	147	15.0	150	151	154	15.0	-0.027	-154.08	-0.027	0.006
Gladstone Andesite	UW566-0042	4.15	-	2.4	119	-4	-0.408	0.083	-4.08	0.83	127	127	13.0	130	131	134	13.0	-0.031	-133.77	-0.031	0.006
Gladstone Andesite	UW574-0074	4.72	-	2.5	134	-4	-0.408	0.083	-4.08	0.83	144	144	14.8	148	148	152	14.8	-0.028	-151.58	-0.028	0.006
Gladstone Andesite	UW574-0092	4.35	-	2.4	123	-4	-0.408	0.083	-4.08	0.83	133	133	13.6	136	137	140	13.6	-0.030	-140.02	-0.030	0.006
Gladstone Andesite	UW507-0108	7.83	-	2.3	225	-5	-0.510	0.083	-5.10	0.83	240	240	24.5	245	245	250	24.5	-0.021	-249.79	-0.021	0.003
Gladstone Andesite	UW563-0109	3.25	-	2	90	-5	-0.510	0.083	-5.10	0.83	100	99	10.2	102	104	107	10.2	-0.050	-106.67	-0.050	0.008
Gladstone Andesite	UW570-0082	4.47	-	2.4	132	-5	-0.510	0.083	-5.10	0.83	137	137	14.0	140	142	145	14.0	-0.037	-144.79	-0.037	0.006
Gladstone Andesite	UW570-0092	5.05	-	2.4	153	-5	-0.510	0.083	-5.10	0.83	154	155	15.8	158	160	163	15.8	-0.032	-162.92	-0.032	0.005
Gladstone Andesite	UW566-0029	6.2	-	2.3	178	-6	-0.612	0.083	-6.12	0.83	190	190	19.4	194	196	200	19.4	-0.032	-199.87	-0.032	0.004
Gladstone Andesite	UW563-0093	5.64	-	2.1	161	-7	-0.714	0.083	-7.14	0.83	173	173	17.6	176	180	183	17.6	-0.041	-183.39	-0.041	0.005
Gladstone Andesite	UW570-0087	1.85	-	2.5	59	-7	-0.714	0.083	-7.14	0.83	57	57	5.8	58	64	65	5.8	-0.124	-64.96	-0.124	0.014
Gladstone Andesite	UW563-0102	5.37	-	2.3	155	-8	-0.816	0.083	-8.16	0.83	164	164	16.8	168	172	176	16.8	-0.049	-175.98	-0.049	0.005
Gladstone Andesite	UW563-0133	8.72	-	2.2	253	-9	-0.918	0.083	-9.18	0.83	267	267	27.3	273	276	282	27.3	-0.034	-281.68	-0.034	0.003
Gladstone HBX	UW507-0005	0.426	-	5.1	3	28	2.857	2.857	28.57	28.57	13	13	1.3	13	-15	-15	1.3	2.146	15.26	2.146	2.146
Gladstone HBX	UW507-0011	2.21	-	2.6	60	9	0.918	0.918	9.18	9.18	68	68	6.9	69	59	60	6.9	0.133	-59.88	0.133	0.133
Gladstone HBX	UW505-0010	0.076	-	5.4	4	2	0.204	0.204	2.04	2.04	2	2	0.2	2	0	0	0.2	0.859	-0.33	0.859	0.859
Gladstone HBX	UW507-0025	0.016	-	4.8	3	2	0.204	0.204	2.04	2.04	0	0	0.1	1	-2	-2	0.1	4.082	1.54	4.082	4.082
Gladstone HBX	UW505-0005	0.019	-	5.2	4	1	0.102	0.102	1.02	1.02	1	1	0.1	1	0	0	0.1	1.719	0.43	1.719	1.719
Gladstone HBX	UW505-0015	0.033	-	5.5	2	1	0.102	0.102	1.02	1.02	1	1	0.1	1	0	0	0.1	0.990	-0.01	0.990	0.990
Gladstone HBX	UW507-0030	0.014	-	5	5	1	0.102	0.102	1.02	1.02	0	0	0.0	0	-1	-1	0.0	2.333	0.58	2.333	2.333
Gladstone HBX	UW507-0036	0.091	-	3.6	3	1	0.102	0.102	1.02	1.02	3	3	0.3	3	2	2	0.3	0.359	-1.82	0.359	0.359
Gladstone HBX	UW563-0068	0.034	-	4.5	2	1	0.102	0.102	1.02	1.02	1	1	0.1	1	0	0	0.1	0.960	-0.04	0.960	0.960
Gladstone HBX	UW570-0027	0.02	-	5.3	4	1	0.102	0.102	1.02	1.02	1	1	0.1	1	0	0	0.1	1.633	0.40	1.633	1.633
Gladstone HBX	UW507-0001	0.266	-	4.2	14	0	0.000	0.083	0.00	0.83	8	8	0.8	8	8	8	0.8	0.000	-8.31	0.000	0.100
Gladstone HBX	UW507-0016	2.2	-	2.6	64	0	0.000	0.083	0.00	0.83	67	67	6.9	69	67	69	6.9	0.000	-68.75	0.000	0.012
Gladstone HBX	UW563-0063	0.039	-	4.1	2	0	0.000	0.083	0.00	0.83	1	1	0.1	1	1	1	0.1	0.000	-1.22	0.000	0.681

Gladstone HBX	UW563-0070	0.163	-	3.2	4	0	0.000	0.083	0.00	0.83	5	5	0.5	5	5	5	0.5	0.000	-5.09	0.000	0.163
Gladstone HBX	UW569-0011	2.12	-	2.8	61	0	0.000	0.083	0.00	0.83	65	65	6.6	66	65	66	6.6	0.000	-66.25	0.000	0.013
Gladstone HBX	UW569-0071	1.69	-	2.9	49	0	0.000	0.083	0.00	0.83	52	52	5.3	53	52	53	5.3	0.000	-52.81	0.000	0.016
Gladstone HBX	UW570-0037	2.5	-	2.7	66	0	0.000	0.083	0.00	0.83	77	77	7.8	78	77	78	7.8	0.000	-78.13	0.000	0.011
Gladstone HBX	UW563-0045	0.021	-	5	6	-1	-0.102	0.083	-1.02	0.83	1	1	0.1	1	2	2	0.1	-1.555	-1.68	-1.555	1.265
Gladstone HBX	UW563-0050	0.016	-	5.8	4	-1	-0.102	0.083	-1.02	0.83	1	0	0.1	1	1	2	0.1	-2.041	-1.52	-2.041	1.660
Gladstone HBX	UW563-0065	0.033	-	4.2	4	-1	-0.102	0.083	-1.02	0.83	1	1	0.1	1	2	2	0.1	-0.990	-2.05	-0.990	0.805
Gladstone HBX	UW563-0076	0.591	-	3	17	-1	-0.102	0.083	-1.02	0.83	18	18	1.8	18	19	19	1.8	-0.055	-19.49	-0.055	0.045
Gladstone HBX	UW563-0084	0.7	-	2.7	23	-1	-0.102	0.083	-1.02	0.83	21	21	2.2	22	22	23	2.2	-0.047	-22.90	-0.047	0.038
Gladstone HBX	UW569-0007	3.96	-	2.4	107	-1	-0.102	0.083	-1.02	0.83	121	121	12.4	124	122	125	12.4	-0.008	-124.77	-0.008	0.007
Gladstone HBX	UW569-0068	3.3	-	2.6	89	-1	-0.102	0.083	-1.02	0.83	101	101	10.3	103	102	104	10.3	-0.010	-104.15	-0.010	0.008
Gladstone HBX	UW570-0030	3.09	-	2.3	90	-1	-0.102	0.083	-1.02	0.83	95	95	9.7	97	96	98	9.7	-0.011	-97.58	-0.011	0.009
Gladstone HBX	UW563-0047	0.028	-	5.6	6	-2	-0.204	0.083	-2.04	0.83	1	1	0.1	1	3	3	0.1	-2.333	-2.92	-2.333	0.949
Gladstone HBX	UW563-0053	0.008	-	5.3	6	-2	-0.204	0.083	-2.04	0.83	0	0	0.0	0	2	2	0.0	-8.164	-2.29	-8.164	3.320
Gladstone HBX	UW563-0055	0.356	-	2.9	10	-2	-0.204	0.083	-2.04	0.83	11	11	1.1	11	13	13	1.1	-0.183	-13.17	-0.183	0.075
Gladstone HBX	UW563-0073	1.37	-	2.8	44	-2	-0.204	0.083	-2.04	0.83	42	42	4.3	43	44	45	4.3	-0.048	-44.85	-0.048	0.019
Gladstone HBX	UW563-0081	0.84	-	2.6	27	-2	-0.204	0.083	-2.04	0.83	26	26	2.6	26	28	28	2.6	-0.078	-28.29	-0.078	0.032
Gladstone HBX	UW569-0076	2.49	-	2.6	82	-2	-0.204	0.083	-2.04	0.83	76	76	7.8	78	78	80	7.8	-0.026	-79.85	-0.026	0.011
Gladstone HBX	UW569-0083	2.97	-	2.6	86	-2	-0.204	0.083	-2.04	0.83	91	91	9.3	93	93	95	9.3	-0.022	-94.85	-0.022	0.009
Gladstone HBX	UW569-0086	2.93	-	2.6	83	-2	-0.204	0.083	-2.04	0.83	90	90	9.2	92	92	94	9.2	-0.022	-93.60	-0.022	0.009
Gladstone HBX	UW570-0047	4.06	-	2.3	115	-2	-0.204	0.083	-2.04	0.83	124	124	12.7	127	126	129	12.7	-0.016	-128.92	-0.016	0.007
Gladstone HBX	UW570-0051	3.81	-	2.5	110	-2	-0.204	0.083	-2.04	0.83	117	117	11.9	119	119	121	11.9	-0.017	-121.10	-0.017	0.007
Gladstone HBX	UW570-0055	4.98	-	2.4	146	-2	-0.204	0.083	-2.04	0.83	152	152	15.6	156	154	158	15.6	-0.013	-157.67	-0.013	0.005
Gladstone HBX	UW563-0116	2.66	-	2.6	76	-3	-0.306	0.083	-3.06	0.83	81	81	8.3	83	84	86	8.3	-0.037	-86.19	-0.037	0.010
Gladstone HBX	UW563-0123	4.69	-	2.4	138	-3	-0.306	0.083	-3.06	0.83	144	144	14.7	147	147	150	14.7	-0.021	-149.62	-0.021	0.006
Gladstone HBX	UW563-0128	4.28	-	2.4	126	-3	-0.306	0.083	-3.06	0.83	131	131	13.4	134	134	137	13.4	-0.023	-136.81	-0.023	0.006
Gladstone HBX	UW569-0046	3.83	-	2.4	109	-3	-0.306	0.083	-3.06	0.83	117	117	12.0	120	120	123	12.0	-0.026	-122.75	-0.026	0.007
Gladstone HBX	UW569-0074	2.7	-	2.6	65	-3	-0.306	0.083	-3.06	0.83	83	83	8.4	84	86	87	8.4	-0.036	-87.44	-0.036	0.010
Gladstone HBX	UW570-0033	0.582	-	2.8	22	-3	-0.306	0.083	-3.06	0.83	18	18	1.8	18	21	21	1.8	-0.168	-21.25	-0.168	0.046
Gladstone HBX	UW569-0049	5.66	-	2.1	163	-4	-0.408	0.083	-4.08	0.83	173	173	17.7	177	177	181	17.7	-0.023	-180.96	-0.023	0.005
Gladstone HBX	UW569-0089	4.48	-	2.5	118	-4	-0.408	0.083	-4.08	0.83	137	137	14.0	140	141	144	14.0	-0.029	-144.08	-0.029	0.006
Gladstone HBX	UW569-0092	7.03	-	2.2	200	-4	-0.408	0.083	-4.08	0.83	215	215	22.0	220	219	224	22.0	-0.019	-223.77	-0.019	0.004
Gladstone HBX	UW569-0095	5.89	-	2.3	168	-4	-0.408	0.083	-4.08	0.83	180	180	18.4	184	184	188	18.4	-0.022	-188.14	-0.022	0.005
Gladstone HBX	UW570-0061	5.16	-	2.3	150	-4	-0.408	0.083	-4.08	0.83	158	158	16.1	161	162	165	16.1	-0.025	-165.33	-0.025	0.005
Gladstone HBX	UW570-0070	4.05	-	2.4	117	-4	-0.408	0.083	-4.08	0.83	124	124	12.7	127	128	131	12.7	-0.032	-130.64	-0.032	0.007
Gladstone HBX	UW569-0103	5.52	-	2.3	161	-5	-0.510	0.083	-5.10	0.83	169	169	17.3	173	174	178	17.3	-0.030	-177.60	-0.030	0.005
Gladstone HBX	UW563-0061	3.66	-	2.1	104	-6	-0.612	0.083	-6.12	0.83	112	112	11.4	114	118	120	11.4	-0.054	-120.50	-0.054	0.007
Gladstone HBX	UW563-0087	6.03	-	2.2	173	-6	-0.612	0.083	-6.12	0.83	184	185	18.8	188	191	195	18.8	-0.032	-194.56	-0.032	0.004
Gladstone HBX	UW570-0064	6.71	-	2.2	189	-6	-0.612	0.083	-6.12	0.83	205	205	21.0	210	211	216	21.0	-0.029	-215.81	-0.029	0.004
Gladstone HBX	UW570-0073	5.8	-	2.3	171	-7	-0.714	0.083	-7.14	0.83	177	177	18.1	181	184	188	18.1	-0.039	-188.39	-0.039	0.005
Gladstone HBX	UW570-0067	7.06	-	2.4	203	-8	-0.816	0.083	-8.16	0.83	216	216	22.1	221	224	229	22.1	-0.037	-228.79	-0.037	0.004

	SAMPLE	S	Sample Weight	NAG pH	NAG kg H_2SO_4/T	ANC kg H_2SO_4/T	ANC %$CaCO_3$ Equivalent	ANC %$CaCO_3$ Corrected	NP	NP Adjusted	MPA	MPA	AP	NAPP	NAPP	ANC/MPA	NNP	NPR	NPR adjusted
	CORE	%		PH	Kg H_2SO_4/T	Kg H_2SO_4/T	%	%	(kg $CaCO_3$/tonne)	(kg $CaCO_3$/tonne)	Kg H_2SO_4/T	(% $CaCO_3$)	(kg$CaCO_3$/t)	Kg H_2SO_4/T	(kg$CaCO_3$/t)	(%$CaCO_3$)	(kg $CaCO_3$/tonne)	(kg$CaCO_3$/t)	(kg$CaCO_3$/t)
MP4	GT022-0006	3.59	0.2492	10.6	0	104	10.613	10.613	106.13	106.13	110	11.2	112	6	102	0.946	-101.57	0.946	0.966
MP4	GT022-0022	3.46	0.2499	2.8	77	31	3.164	3.164	31.64	31.64	106	10.8	108	75	105	0.293	-104.96	0.293	0.299
MP4	GT022-0026	3.17	0.25	3.2	31	68	6.939	6.939	69.39	69.39	97	9.9	99	29	92	0.701	-92.12	0.701	0.715
MP4	GT022-0027	3.2	0.2501	3.1	35	60	6.123	6.123	61.23	61.23	98	10.0	100	38	94	0.612	-93.88	0.612	0.625
MP4	GT022-0028	2.66	0.2502	3.3	24	65	6.633	6.633	66.33	66.33	81	8.3	83	16	76	0.798	-76.49	0.798	0.815
MP4	GT022-0086	3.93	0.2499	9.4	0	99	10.103	10.103	101.03	101.03	120	12.3	123	21	113	0.823	-112.71	0.823	0.840
MP4	GT022-0087	2.16	0.2501	10.3	0	114	11.634	11.634	116.34	116.34	66	6.8	68	-48	56	1.724	-55.87	1.724	1.760
MP4	GT022-0088	3.73	0.2501	3	50	64	6.531	6.531	65.31	65.31	114	11.7	117	50	110	0.560	-110.03	0.560	0.572
MP4	GT022-0089	3.92	0.2499	9.5	0	108	11.021	11.021	110.21	110.21	120	12.3	123	12	111	0.900	-111.48	0.900	0.919
MP4	GT022-0090	2.86	0.2499	8.9	0	80	8.164	8.164	81.64	81.64	88	8.9	89	8	81	0.913	-81.21	0.913	0.933
MP4	GT022-0091	3.34	0.25	3.3	29	76	7.756	7.756	77.56	77.56	102	10.4	104	26	97	0.743	-96.62	0.743	0.759
MP4	GT022-0092	3.41	0.2501	9.1	0	99	10.103	10.103	101.03	101.03	104	10.7	107	5	96	0.948	-96.46	0.948	0.968
MP4	GT022-0093	3.11	0.2501	2.8	71	24	2.449	2.449	24.49	24.49	95	9.7	97	71	95	0.252	-94.74	0.252	0.257
MP4	GT022-0094	3.27	0.2499	10	0	113	11.532	11.532	115.32	115.32	100	10.2	102	-13	91	1.128	-90.66	1.128	1.152
MP4	GT022-0095	2.95	0.2499	10	0	97	9.899	9.899	98.99	98.99	90	9.2	92	-7	82	1.074	-82.29	1.074	1.097
MP4	GT022-0096	3.43	0.2499	8.1	0	84	8.572	8.572	85.72	85.72	105	10.7	107	21	99	0.800	-98.62	0.800	0.817
MP4	GT022-0097	2.54	0.25	5.6	4	65	6.633	6.633	66.33	66.33	78	7.9	79	13	73	0.836	-72.74	0.836	0.853
MP4	GT022-0098	1.37	0.2499	10.3	0	102	10.409	10.409	104.09	104.09	42	4.3	43	-60	32	2.431	-32.40	2.431	2.483
MP4	GT022-0099	2.96	0.2499	10	0	115	11.736	11.736	117.36	117.36	91	9.3	93	-24	81	1.269	-80.76	1.269	1.296
MP4	GT022-0100	4.66	0.2502	2.5	123	21	2.143	2.143	21.43	21.43	143	14.6	146	122	143	0.147	-143.48	0.147	0.150
MP4	GT022-0101	3.98	0.2511	2.7	78	43	4.388	4.388	43.88	43.88	122	12.4	124	79	120	0.353	-119.99	0.353	0.360
MP4	GT022-0102	3.55	0.25	2.7	94	15	1.531	1.531	15.31	15.31	109	11.1	111	94	109	0.138	-109.41	0.138	0.141
MP4	GT022-0106	3.19	0.2521	10	0	78	7.960	7.960	79.60	79.60	98	10.0	100	20	92	0.798	-91.73	0.798	0.815
MP4	GT022-0107	3.54	0.2506	10.9	0	116	11.838	11.838	118.38	118.38	108	11.1	111	-8	99	1.070	-98.79	1.070	1.093
MP4	GT022-0108	3.18	0.2503	10.4	0	108	11.021	11.021	110.21	110.21	97	9.9	99	-11	88	1.109	-88.35	1.109	1.133
MP4	GT022-0109	3.18	0.2491	3	45	59	6.021	6.021	60.21	60.21	97	9.9	99	38	93	0.606	-93.35	0.606	0.619
MP4	GT022-0110	2.13	0.2468	3.2	33	40	4.082	4.082	40.82	40.82	65	6.7	67	25	62	0.613	-62.48	0.613	0.626
MP4	GT022-0111	2.98	0.2488	2.8	78	23	2.347	2.347	23.47	23.47	91	9.3	93	68	91	0.252	-90.78	0.252	0.257
MP4	GT022-0112	2.86	0.2519	2.8	63	33	3.368	3.368	33.68	33.68	88	8.9	89	55	86	0.377	-86.01	0.377	0.385
MP4	GT022-0113	1.99	0.2525	3	45	29	2.959	2.959	29.59	29.59	61	6.2	62	32	59	0.476	-59.23	0.476	0.486

Appendix D

Kinetic and Column Testing Results

Appendix D – Overburden Kinetic and Column Testing

D1 Introduction

Kinetic and column testing of overburden samples has been undertaken to further refine the assessment of potentially acid generating materials, as well as to characterise the influence of reaction rates.

At the time of kinetic and column test initiation, available overburden was confined to exploratory and / or resource-delineation cores drilled by OGNZL within the vicinity of the projected Gladstone pits.

Overburden was selected with the intention of obtaining samples representative of the overburden material to be excavated from the Gladstone pit. To achieve this, AECOM reviewed the following information provided by OGNZL; lithological drill logs, intercept depths (depth each core entered and exited the future pits' projected boundaries), models of the projected pits' geology, and photos of drill cores. Final material selected for the kinetic and column geochemical testing is outlined in the following sections and focusses on overburden both within and in the area adjoining the proposed Gladstone Pit.

D2 Kinetic Testing

D2.1 Methodology

Kinetic testing of six overburden samples (representative of the Gladstone vent breccias) was undertaken to support findings of the static testing. This was to aid in characterising the acid generating potential, investigate trace element leaching, and to assess the potential rates of acidification in the overburden. Kinetic tests were undertaken using the humidity cell method in general accordance with ASTM:D5744-13e1.*Standard Test Method for Laboratory Weathering of Solid Materials Using a Humidity Cell*.

Approximately 1 kg of sample material was required for each humidity cell. This material was selected based on lithology, extent of alteration, static testing results (net acid generating (NAG) and acid base accounting), and total element analyses. Samples were limited to hydrothermal vent breccias representative of the breccia overburden material within the Gladstone Pit (which compromises approximately 17% of the projected overburden material). The breccia material is the focus of the kinetic tests as it has previously not been widely encountered in existing mining operations.

Sample selection was based on the selection of hydrothermal breccia material which represented a range of the pits' potential chemical variability. To achieve this, only hydrothermal breccia intervals with returned Sulphur, NAG, and ANC data at the time of sample selection were considered. Core intervals from each sample conforming to the selection criteria listed below were plotted on a NPR/NAG pH diagram. Samples spanning the range of the PAF classification were selected and are shown in Figure D1.

The following additional criteria were used where possible to guide selection of kinetic material:

- Core intervals were selected from cores spatially distributed across the projected pits' volume where possible;
- Core intervals with ore-grade concentrations of gold (where existing data was available) and veins or highly silicified zones were excluded;
- Core intervals logged as not having an 'Argillic' or strong clay alteration were excluded;
- Core intervals logged as not having visible Pyrite were excluded; and
- Core intervals logged as weathered or, displaying obvious, pervasive oxidation were excluded.

Based on the stated selection criteria, the resultant selected cores only represent a small portion of the overburden material. However, they represent a 'worse case' sub-set with respect to the acid producing potential and trace element leaching, providing valuable information with regard to the geochemical properties and behaviour of the hydrothermal breccia material. Examples of core intervals selected for kinetic testing are shown in Figure D2. Note, selected core intervals were processed to rock chips by SGS New Zealand Limited. Final samples comprised material where 80% passed through a 3.6 mm sieve opening.

A total of six samples were selected from boreholes UW500, UW507, UW514 and UW533, advanced within or adjacent to the Gladstone Pit. The borehole locations are shown on Figure D3. The selected samples and depth intervals were as follows:

- UW500-0184; 145.5 to 146.5 m
- UW507-0016; 19.9 to 20.7 m
- UW514-0013; 40 to 40.5 m
- UW514-0027; 50 to 51 m
- UW514-0032; 55 to 56 m
- UW533-0052; 50 to 51.2 m

Figure D1 NPR/NAG pH Diagram. Hydrothermal Breccia Samples Selected for Kinetic testing

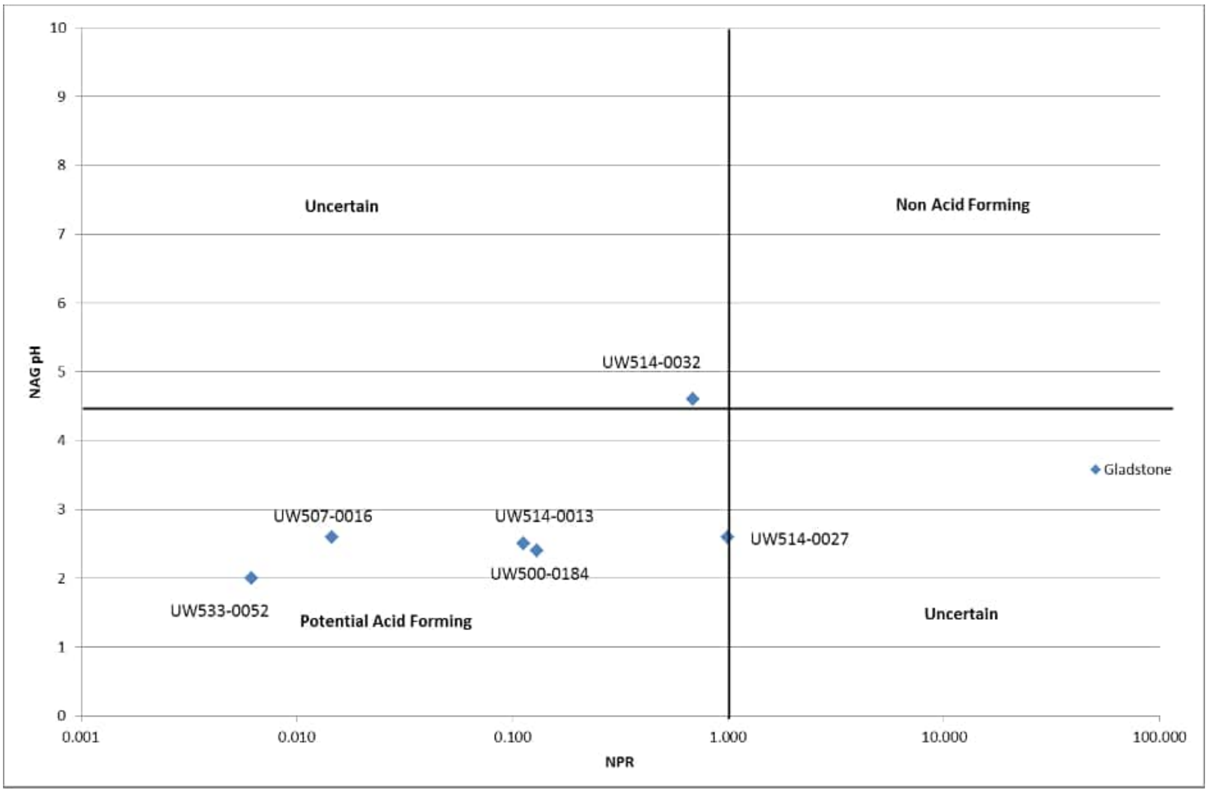
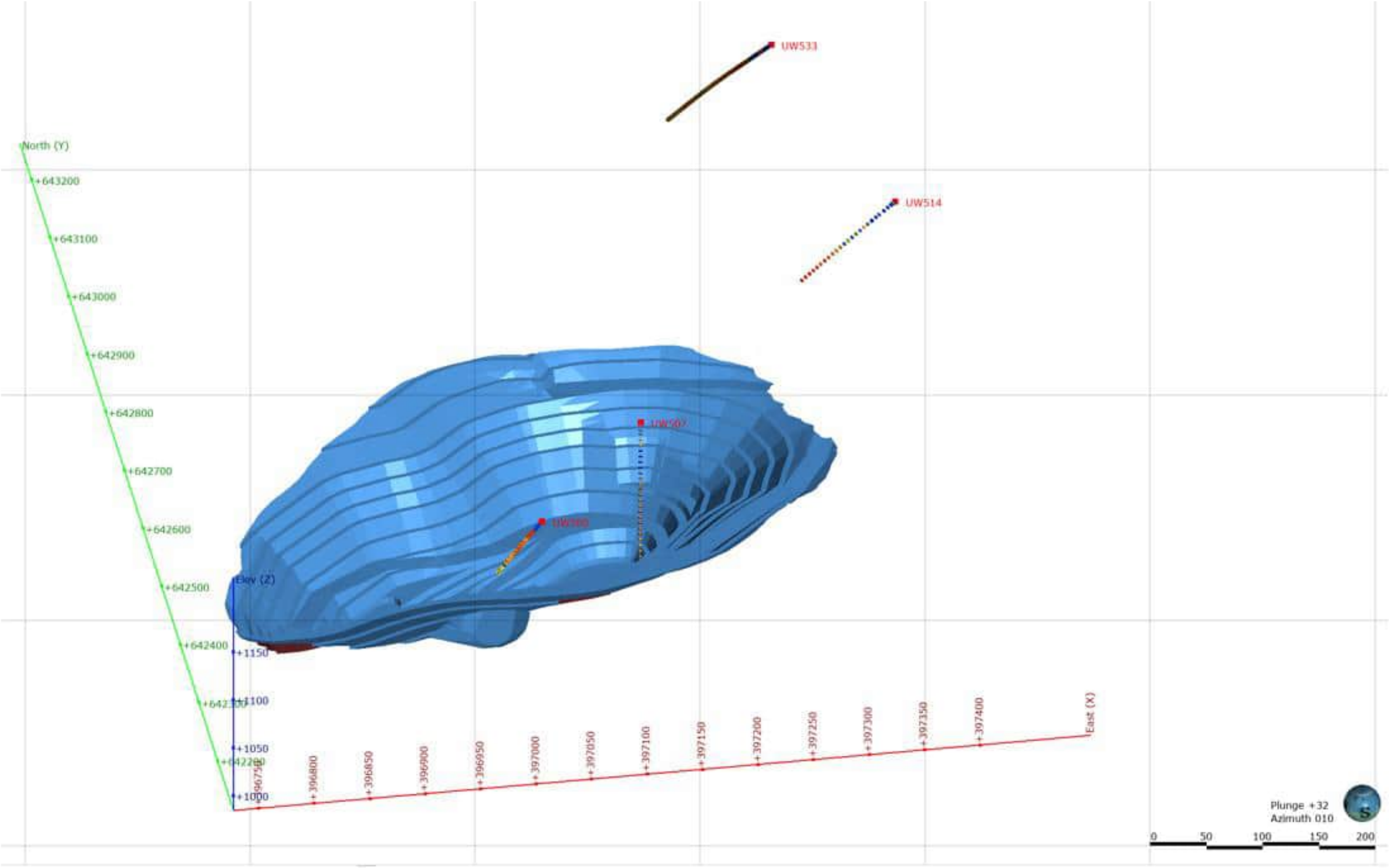


Figure D2 Examples of Core Selected for Kinetic Testing

Hydrothermal Breccia selected from UW507 within the Gladstone Pit void. Intervals selected from 19.9 – 20.35 m. Photo provided by OGNZL.

Hydrothermal Breccia selected from UW533 adjacent to the Gladstone Pit void. Intervals selected from 50.0 – 51.2 m. Photo provided by OGNZL.

Figure D3 Location of Boreholes UW500, UW507, UW514 and UW533 advanced within or adjacent to the Gladstone Pit



2.2 Kinetic Testing Analytical Results

A summary of the kinetic tests is provided in Tables D1 through D7. A visual representation of the results for pH, electrical conductivity, sulphate, and a range of trace elements over the test period for each humidity cell are provided in Figure D4 and Figure D5.

Of note is the depressed pH and elevated trace element concentrations in cells UW507-0016 and UW533-052. This coincides with these cells having the highest acid producing potential (refer to **Figure D1**).

The cell with the highest NAG pH (UW514-0032) exhibited depressed trace element concentrations and a pH similar to the control cell. This sample (UW514-0032) is intensely clay altered and weathered suggesting the sulphides have been fully oxidised and has limited residual acid generating potential.

Mercury (which is elevated in the breccia overburden compared to previous site material) was only detected in three samples over the test period.

Table D1 Summary Kinetic Test Results (Sample Origin: UW514-0032)

Sample Origin		**UW514-0032**												
Sample Name		PYE-01-20170828	PYE-01-20170904	PYE-01-20170911	PYE-01-20170918	PYE-01-20170925	PYE-01-20171002	PYE-01-10102017	PYE-01-20171016	PYE-01-20171023	PYE-01-20171030	PYE-01-20171106	PYE-01-20171113	PYE-01-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1834627.1	1837995.1	1842116.1	1845723.1	1850015.1	1854277.1	1858297.1	1861741.1	1865396.1	1869210.1	1874744.1	1877303.1	1881031.1
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	5.8	5.6	5.7	5.7	5.2	5.9	5.9	5.8	6	5.7	5.8	5.5	5.6
Acidity (pH 3.7)	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	< 1.0	< 1.0
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-	-	2.9	-	-	-	7.3	5	4.9
Total Alkalinity	g/m3 as CaCO3	3.4	2.9	2	2.5	2.3	18	2.2	2.4	2.1	2.4	2.2	2.2	2.2
Electrical Conductivity (EC)	mS/m	5	6.7	5.7	5.8	7.3	6.4	5.5	5.7	4.1	4.7	4.6	4.2	4.2
Major Elements														
Dissolved Aluminium	g/m3	0.013	-	0.014	-	0.017	-	0.097	-	0.013	-	0.011	-	0.008
Dissolved Iron	g/m3	< 0.02	-	< 0.02	-	< 0.02	-	0.03	-	< 0.02	-	< 0.02	-	< 0.02
Dissolved Calcium	g/m3	1.17	-	1.8	-	2.7	-	1.96	-	1.45	-	1.87	-	1.43
Dissolved Magnesium	g/m3	0.7	-	0.94	-	1.33	-	1.03	-	0.76	-	0.96	-	0.81
Dissolved Potassium	g/m3	2.5	-	2.6	-	3.7	-	3.5	-	2.9	-	3.5	-	3.6
Sulphate	g/m3	14	20	18.4	19.5	25	22	18.4	19.9	13.8	15.4	16.6	13.5	12.9
Trace Elements														
Dissolved Antimony	g/m3	0.0006	-	0.0002	-	0.0003	-	0.0003	-	< 0.0002	-	< 0.0002	-	< 0.0002
Dissolved Arsenic	g/m3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Barium	g/m3	0.074	-	0.059	-	0.044	-	0.058	-	0.046	-	0.033	-	0.029
Dissolved Cadmium	g/m3	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Cobalt	g/m3	0.0002	-	0.0004	-	0.0006	-	0.0006	-	0.0004	-	0.0004	-	0.0004
Dissolved Chromium	g/m3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Copper	g/m3	0.0016	0.0035	0.0025	0.0025	0.0074	0.0055	0.0059	0.0036	0.0033	0.0054	0.0038	0.0035	0.0038
Dissolved Lead	g/m3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.0002	0.00011	0.00031	< 0.00010	< 0.00010	0.00029	0.00014	0.0001	0.00022
Dissolved Mercury	g/m3	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	0.00022	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	0.024	-	0.035	-	0.057	-	0.049	-	0.033	-	0.04	-	0.037
Dissolved Molybdenum	g/m3	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002
Dissolved Nickel	g/m3	< 0.0005	0.0026	0.0186	0.02	0.024	0.037	0.0097	0.0059	0.041	0.056	0.026	0.025	0.044
Dissolved Selenium	g/m3	< 0.0010	-	0.0022	-	0.0032	-	0.002	-	0.0014	-	0.0014	-	0.0011
Dissolved Vanadium	g/m3	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010
Dissolved Zinc	g/m3	0.0113	0.03	0.027	0.035	0.082	0.067	0.068	0.05	0.054	0.07	0.074	0.051	0.059
Dissolved Silver	g/m3	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010
Dissolved Strontium	g/m3	0.0108	-	0.014	-	0.02	-	0.0147	-	0.0115	-	0.0137	-	0.0114
Dissolved Uranium	g/m3	< 0.00002	-	< 0.00002	-	< 0.00002	-	< 0.00002	-	< 0.00002	-	< 0.00002	-	< 0.00002
Field Parameters														
pH	pH Units	5.8	5.6	5.8	6.1	6.0	6.3	6.4	6.2	6.1	6.3	6.7	6.2	6.4
Electrical Conductivity (EC)	mS/m	5.2	6.9	5.6	5.9	7.4	6.3	5.8	5.5	4.1	4.3	4.8	4.1	4.1
Temperature	°C	17.5	18.1	16.8	18	19.2	18.2	20	19.2	18.9	20.5	20.3	20.1	21

Table D2 Summary Kinetic Test Results (Sample Origin: UW500-0184)

Sample Origin		**UW500-0184**												
Sample Name		PYE-02-20170828	PYE-02-20170904	PYE-02-20170911	PYE-02-20170918	PYE-02-20170925	PYE-02-20171002	PYE-02-10102017	PYE-02-20171016	PYE-02-20171023	PYE-02-20171030	PYE-02-20171106	PYE-02-20171113	PYE-02-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1834627.2	1837995.2	1842116.2	1845723.2	1850015.2	1854277.2	1858297.2	1861741.2	1865396.2	1869210.2	1874744.2	1877303.2	1881031.2
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	4.4	4.7	4.5	4.4	4.5	4.6	4.5	4.4	4.4	4.5	4.8	4.3	4.6
Acidity (pH 3.7)	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-	-	-	-	-	-	8.1	17	12.2
Total Alkalinity	g/m3 as CaCO3	< 1.0	1.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Electrical Conductivity (EC)	mS/m	107.6	34.7	50.2	75	47.7	38.4	38.1	30.4	34.5	20.3	7.4	33.1	20.9
Major Elements														
Dissolved Aluminium	g/m3	0.84	-	0.51	-	0.36	-	0.19	-	0.187	-	0.028	-	0.138
Dissolved Iron	g/m3	1.45	-	0.6	-	0.55	-	0.69	-	0.94	-	0.29	-	0.87
Dissolved Calcium	g/m3	80	-	32	-	33	-	29	-	20	-	3.3	-	12.3
Dissolved Magnesium	g/m3	62	-	23	-	22	-	14.5	-	14.9	-	3	-	8.7
Dissolved Potassium	g/m3	39	-	13.7	-	15.1	-	16.6	-	17.6	-	3.9	-	7.4
Sulphate	g/m3	560	155	220	360	220	163	165	122	140	78	29	141	81
Trace Elements														
Dissolved Antimony	g/m3	0.001	-	< 0.0002	-	0.0002	-	0.0002	-	0.0003	-	< 0.0002	-	< 0.0002
Dissolved Arsenic	g/m3	0.002	< 0.0010	< 0.0010	< 0.002	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Barium	g/m3	0.043	-	0.0057	-	0.0078	-	0.011	-	0.0188	-	0.0052	-	0.0087
Dissolved Cadmium	g/m3	0.00022	0.00008	0.00014	0.00022	0.00019	0.00017	0.00012	0.00013	0.00014	0.00011	0.00008	0.0002	0.00016
Dissolved Cobalt	g/m3	0.076	-	0.038	-	0.032	-	0.024	-	0.025	-	0.0049	-	0.0146
Dissolved Chromium	g/m3	0.001	< 0.0005	0.0006	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0005	0.0007
Dissolved Copper	g/m3	0.149	0.029	0.044	0.081	0.059	0.057	0.048	0.05	0.086	0.031	0.027	0.133	0.09
Dissolved Lead	g/m3	0.041	0.0134	0.023	0.046	0.027	0.024	0.026	0.02	0.025	0.0095	0.0031	0.025	0.0107
Dissolved Mercury	g/m3	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	0.93	-	0.38	-	0.34	-	0.23	-	0.23	-	0.047	-	0.154
Dissolved Molybdenum	g/m3	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002
Dissolved Nickel	g/m3	0.087	0.07	0.058	0.097	0.09	0.066	0.074	0.075	0.083	0.083	0.099	0.117	0.098
Dissolved Selenium	g/m3	0.026	-	0.0166	-	0.0142	-	0.0085	-	0.0056	-	< 0.0010	-	0.0026
Dissolved Vanadium	g/m3	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010
Dissolved Zinc	g/m3	0.24	0.124	0.22	0.42	0.43	0.35	0.3	0.25	0.41	0.27	0.23	0.71	0.54
Dissolved Silver	g/m3	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010
Dissolved Strontium	g/m3	0.2	-	0.077	-	0.076	-	0.061	-	0.05	-	0.0093	-	0.031
Dissolved Uranium	g/m3	0.00026	-	0.00021	-	0.00018	-	0.00017	-	0.00018	-	0.00003	-	0.00013
Field Parameters														
pH	pH Units	4.4	4.7	4.3	4.2	4.7	4.1	4.2	4.3	4.2	4.2	5	4.4	4.7
Electrical Conductivity (EC)	mS/m	109.6	35.4	50.9	71.7	47.9	37.8	35.4	28.2	33.8	20.3	7.9	32.9	20.7
Temperature	°C	17.5	18.2	16.8	18	19.1	18.1	19.9	19.2	18.9	20.7	20.9	20	20.9

Table D3 Summary Kinetic Test Results (Sample Origin: UW514-0027)

Sample Origin		**UW514-0027**												
Sample Name		PYE-03-20170828	PYE-03-20170904	PYE-03-20170911	PYE-03-20170918	PYE-03-20170925	PYE-03-20171002	PYE-03-10102017	PYE-03-20171016	PYE-03-20171023	PYE-03-20171030	PYE-03-20171106	PYE-03-20171113	PYE-03-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1834627.3	1837995.3	1842116.3	1845723.3	1850015.3	1854277.3	1858297.3	1861741.3	1865396.3	1869210.3	1874744.3	1877303.3	1881031.3
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	4	3.8	3.8	3.5	3.5	3.4	3.3	3.2	3.2	3.1	3.0	3	3
Acidity (pH 3.7)	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	17	21	24	30	45	53	55	78	80	92
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-	-	121	-	-	-	184	210	270
Total Alkalinity	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Electrical Conductivity (EC)	mS/m	40.4	48.1	56.8	63.2	63.1	62.7	66.4	76.4	68.8	76.4	84.7	81.7	89.7
Major Elements														
Dissolved Aluminium	g/m3	1.07	-	4.4	-	3.4	-	3.2	-	3.6	-	5.3	-	5.4
Dissolved Iron	g/m3	10.3	-	5.7	-	11.8	-	16.7	-	29	-	45	-	51
Dissolved Calcium	g/m3	18.7	-	28	-	35	-	27	-	24	-	19.2	-	16.4
Dissolved Magnesium	g/m3	15.1	-	24	-	26	-	18.8	-	17.8	-	15.2	-	11.8
Dissolved Potassium	g/m3	9	-	7.2	-	7.5	-	5.3	-	3.8	-	2.2	-	1.89
Sulphate	g/m3	172	210	240	36	270	240	240	290	230	250	280	260	280
Trace Elements														
Dissolved Antimony	g/m3	0.009	-	0.0021	-	0.0034	-	0.0026	-	0.0028	-	0.0022	-	0.0021
Dissolved Arsenic	g/m3	0.0121	0.009	0.008	0.019	0.019	0.023	0.028	0.041	0.027	0.036	0.042	0.041	0.05
Dissolved Barium	g/m3	0.051	-	0.0196	-	0.0148	-	0.0139	-	0.0109	-	0.0092	-	0.007
Dissolved Cadmium	g/m3	0.00058	0.00088	0.00118	0.00134	0.00125	0.00139	0.00133	0.00139	0.0013	0.00114	0.00133	0.00123	0.00124
Dissolved Cobalt	g/m3	0.113	-	0.196	-	0.21	-	0.21	-	0.168	-	0.199	-	0.144
Dissolved Chromium	g/m3	0.0042	0.0065	0.0148	0.0156	0.037	0.031	0.038	0.103	0.062	0.093	0.083	0.082	0.075
Dissolved Copper	g/m3	0.6	0.6	0.8	0.96	0.9	0.92	1.08	1.28	0.98	1.05	1.39	1.17	1.44
Dissolved Lead	g/m3	0.0029	0.0056	0.00196	0.0072	0.0057	0.0085	0.0084	0.0152	0.0174	0.0148	0.025	0.03	0.044
Dissolved Mercury	g/m3	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	0.3	-	0.62	-	0.68	-	0.57	-	0.55	-	0.52	-	0.47
Dissolved Molybdenum	g/m3	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002
Dissolved Nickel	g/m3	0.062	0.119	0.153	0.31	0.21	0.2	0.25	0.37	0.21	0.32	0.31	0.32	0.31
Dissolved Selenium	g/m3	0.0095	-	0.03	-	0.024	-	0.0166	-	0.011	-	0.0131	-	0.0098
Dissolved Vanadium	g/m3	< 0.0010	-	< 0.0010	-	< 0.0010	-	0.0017	-	0.0034	-	0.0094	-	0.011
Dissolved Zinc	g/m3	0.122	0.198	0.29	0.52	0.46	0.74	0.76	0.79	0.87	0.81	1.15	1.14	1.35
Dissolved Silver	g/m3	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010
Dissolved Strontium	g/m3	0.18	-	0.25	-	0.31	-	0.24	-	0.22	-	0.194	-	0.169
Dissolved Uranium	g/m3	0.00146	-	0.0042	-	0.0048	-	0.0063	-	0.0054	-	0.0055	-	0.0043
Field Parameters														
pH	pH Units	3.9	3.8	3.4	3.4	3.4	3.0	3	2.9	2.9	2.8	2.6	2.8	2.5
Electrical Conductivity (EC)	mS/m	39.7	48.4	57.8	62.6	60.3	78.4	65.2	75.6	67.8	73.9	81.4	77.8	86.3
Temperature	°C	17.6	18.1	16.8	17.9	19.2	18.2	20	19.2	18.9	20.6	20.7	20	20.9

Table D4 Summary Kinetic Test Results (Sample Origin: UW533-0052)

Sample Origin		**UW533-0052**												
Sample Name		PYE-04-20170828	PYE-04-20170904	PYE-04-20170911	PYE-04-20170918	PYE-04-20170925	PYE-04-20171002	PYE-04-10102017	PYE-04-20171016	PYE-04-20171023	PYE-04-20171030	PYE-04-20171106	PYE-04-20171113	PYE-04-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1834627.4	1837995.4	1842116.4	1845723.4	1850015.4	1854277.4	1858297.4	1861741.4	1865396.4	1869210.4	1874744.4	1877303.4	1881031.4
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	3.2	3.3	3.5	3.7	3.3	3.3	3.2	3.0	3.0	3.0	2.8	3	3
Acidity (pH 3.7)	g/m3 as CaCO3	165	46	29	< 1.0	34	34	37	109	81	82	121	-	98
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-	-	210	-	-	-	620	-	490
Total Alkalinity	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 4	< 1.0
Electrical Conductivity (EC)	mS/m	619	223	134.7	49.3	114	80.4	88	180.1	114.8	106.6	174.4	179.4	134.7
Major Elements														
Dissolved Aluminium	g/m3	250	-	19.3	-	15.5	-	6.9	-	11.4	-	18.4	-	14.6
Dissolved Iron	g/m3	660	-	47	-	48	-	43	-	71	-	164	-	141
Dissolved Calcium	g/m3	340	-	104	-	82	-	45	-	48	-	60	-	37
Dissolved Magnesium	g/m3	350	-	37	-	28	-	13.5	-	13.8	-	18	-	12.2
Dissolved Potassium	g/m3	130	-	16.3	-	11.7	-	7	-	9	-	8.9	-	8.3
Sulphate	g/m3	5,700	1,370	780	210	580	340	370	1,000	460	400	790	870	550
Trace Elements														
Dissolved Antimony	g/m3	0.047	-	0.0074	-	0.0046	-	0.0026	-	0.0038	-	0.0089	-	0.0089
Dissolved Arsenic	g/m3	1.73	0.16	0.144	0.041	0.164	0.134	0.2	0.6	0.38	0.59	1.1	0.9	0.88
Dissolved Barium	g/m3	0.064	-	0.0146	-	0.0079	-	0.0057	-	0.0045	-	0.0049	-	0.0121
Dissolved Cadmium	g/m3	0.021	0.0066	0.0033	0.0011	0.002	0.0016	0.0018	0.0034	0.0022	0.00138	0.0023	0.0078	0.004
Dissolved Cobalt	g/m3	2.3	-	0.26	-	0.197	-	0.135	-	0.134	-	0.21	-	0.158
Dissolved Chromium	g/m3	0.69	0.17	0.063	0.0126	0.047	0.025	0.032	0.123	0.045	0.036	0.104	0.122	0.062
Dissolved Copper	g/m3	21	4.8	3.5	1.09	1.91	1.82	2.1	11.9	2.3	2.4	13.5	27	17.4
Dissolved Lead	g/m3	0.46	0.064	0.119	0.058	0.035	0.027	0.036	0.48	0.098	0.114	0.46	1.22	0.71
Dissolved Mercury	g/m3	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	0.00014	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	7.2	-	0.75	-	0.54	-	0.27	-	0.3	-	0.35	-	0.23
Dissolved Molybdenum	g/m3	0.0045	-	0.0004	-	0.0002	-	0.0002	-	0.0004	-	0.0005	-	< 0.004
Dissolved Nickel	g/m3	4	1.54	0.87	0.32	0.54	0.56	0.57	1.15	0.53	0.71	0.68	1.29	0.58
Dissolved Selenium	g/m3	0.043	-	0.0088	-	0.0101	-	0.006	-	0.0057	-	<0.010	-	< 0.02
Dissolved Vanadium	g/m3	0.092	-	0.0088	-	0.01	-	0.0116	-	0.0189	-	0.04	-	0.028
Dissolved Zinc	g/m3	8.4	5.3	2.8	1.96	2.5	3.1	3.9	8.6	6.1	4.4	6.5	26	15.8
Dissolved Silver	g/m3	< 0.0005	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010
Dissolved Strontium	g/m3	2.5	-	0.42	-	0.3	-	0.163	-	0.147	-	0.22	-	0.129
Dissolved Uranium	g/m3	0.0185	-	0.00133	-	0.00093	-	0.00048	-	0.00054	-	0.00064	-	0.00043
Field Parameters														
pH	pH Units	2.9	3.2	3.2	3.6	3.1	3.1	2.9	2.7	2.7	2.5	2.6	2.8	2.4
Electrical Conductivity (EC)	mS/m	559	220	117.6	49.8	112.2	74.9	85.5	170.2	111	102.3	163.5	157.9	125.6
Temperature	°C	17.7	18.2	17	18.1	19.1	18.3	20	19.1	19	20.7	20.8	20.1	21

Table D5 Summary Kinetic Test Results (Sample Origin: UW507-0016)

Sample Origin		**UW507-0016**												
Sample Name		PYE-05-20170828	PYE-05-20170904	PYE-05-20170911	PYE-05-20170918	PYE-05-20170925	PYE-05-20171002	PYE-05-10102017	PYE-05-20171016	PYE-05-20171023	PYE-05-20171030	PYE-05-20171106	PYE-05-20171113	PYE-05-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1834627.5	1837995.5	1842116.5	1845723.5	1850015.5	1854277.5	1858936.1	1861741.5	1865396.5	1869210.5	1874744.5	1877303.5	1881031.5
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	3.1	3.3	3.2	3.1	3	2.9	2.9	3.3	3	2.7	2.7	2.7	2.6
Acidity (pH 3.7)	g/m3 as CaCO3	230	59	66	68	64	97	< 20 #1	26	97	158	126	181	240
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-	-	1,030	-	-	-	390	490	720
Total Alkalinity	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 8 #3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Electrical Conductivity (EC)	mS/m	614	204	208	191.6	156.4	195.6	279	136.9	135.8	192.5	147.9	174.3	234
Major Elements														
Dissolved Aluminium	g/m3	290	-	68	-	30	-	84	-	22	-	11.3	-	33
Dissolved Iron	g/m3	360	-	25	-	28	-	160	-	45	-	68	-	138
Dissolved Calcium	g/m3	220	-	56	-	62	-	128	-	48	-	25	-	48
Dissolved Magnesium	g/m3	540	-	118	-	75	-	151	-	39	-	30	-	55
Dissolved Potassium	g/m3	89	-	5.8	-	4.2	-	4.9	-	3.7	-	2.2	-	3.2
Sulphate	g/m3	5,800	1,410	1,390	1,210	850	1,030	2,000	820	650	810	540	670	960
Trace Elements														
Dissolved Antimony	g/m3	0.02	-	0.003	-	0.0035	-	0.025	-	0.0067	-	0.0046	-	0.0093
Dissolved Arsenic	g/m3	1.25	0.045	0.066	0.118	0.111	0.152	0.27	0.09	0.117	0.22	0.147	0.168	0.34
Dissolved Barium	g/m3	0.0123	-	0.00052	-	0.00065	-	0.0006	-	0.00055	-	0.00052	-	0.0006
Dissolved Cadmium	g/m3	0.131	0.035	0.04	0.03	0.02	0.023	0.046	0.022	0.0169	0.0188	0.0145	0.0174	0.024
Dissolved Cobalt	g/m3	10.9	-	2.5	-	1.38	-	2.3	-	0.71	-	0.51	-	0.91
Dissolved Chromium	g/m3	0.23	0.055	0.057	0.036	0.023	0.028	0.058	0.0195	0.0162	0.022	0.0159	0.023	0.03
Dissolved Copper	g/m3	15.6	2.9	2.9	3	1.96	3.3	49	23	4.2	2.7	2.4	3.2	17
Dissolved Lead	g/m3	0.191	0.036	0.038	0.055	0.05	0.065	1.78	0.44	0.143	0.129	0.133	0.112	0.35
Dissolved Mercury	g/m3	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	0.00023	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	28	-	6.5	-	3.6	-	5.9	-	1.92	-	1.27	-	2
Dissolved Molybdenum	g/m3	0.0018	-	0.0006	-	0.0004	-	< 0.0004	-	< 0.0002	-	< 0.0002	-	< 0.004
Dissolved Nickel	g/m3	14.9	3.4	3.6	3.2	2.4	2.8	4.7	2.3	1.48	2	1.04	1.2	1.75
Dissolved Selenium	g/m3	0.079	-	0.0143	-	0.0056	-	< 0.010	-	0.003	-	<0.005	-	< 0.02
Dissolved Vanadium	g/m3	0.12	-	0.051	-	0.03	-	0.2	-	0.06	-	0.076	-	0.139
Dissolved Zinc	g/m3	16.6	5.2	4.8	3.9	4.6	6.1	38	30	9.3	9.6	12.9	8.5	14.3
Dissolved Silver	g/m3	< 0.0005	-	< 0.00010	-	< 0.00010	-	< 0.0002	-	< 0.00010	-	< 0.00010	-	< 0.00010
Dissolved Strontium	g/m3	0.75	-	0.089	-	0.078	-	0.138	-	0.042	-	0.032	-	0.04
Dissolved Uranium	g/m3	0.048	-	0.005	-	0.0042	-	0.0118	-	0.0045	-	0.0033	-	0.0113
Field Parameters														
pH	pH Units	3.6	3.3	2.8	3	2.8	2.5	2.5	3	2.7	2.4	2.4	2.6	1.9
Electrical Conductivity (EC)	mS/m	606	203	206	189.8	154.6	187.1	267	130	131.8	180	138.7	164.8	216
Temperature	°C	17.5	18.2	16.8	17.9	19.1	18	19.8	19.3	18.9	20.6	20.7	20.1	21

Table D6 Summary Kinetic Test Results (Sample Origin: UW514-0013)

Sample Origin		**UW514-0013**												
Sample Name		PYE-06-20170828	PYE-06-20170904	PYE-06-20170911	PYE-06-20170918	PYE-06-20170925	PYE-06-20171002	PYE-06-10102017	PYE-06-20171016	PYE-06-20171023	PYE-06-20171030	PYE-06-20171106	PYE-06-20171113	PYE-06-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1834627.6	1837995.6	1842116.6	1845723.6	1850015.6	1854277.6	1858297.5	1861741.6	1865396.6	1869210.6	1874744.6	1877303.6	1881031.6
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	4.6	4.7	4.5	4.3	4.4	4.4	4.4	4.4	4.4	4.2	4.2	4.1	4.1
Acidity (pH 3.7)	g/m3 as CaCO3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-	-	14	-	-	-	19	17	15
Total Alkalinity	g/m3 as CaCO3	2.4	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Electrical Conductivity (EC)	mS/m	314	58.7	81.6	89.5	71.5	70.1	58.4	74.9	48.9	54.1	52.3	58.6	48.5
Major Elements														
Dissolved Aluminium	g/m3	1.37	-	0.22	-	0.22	-	0.182	-	0.183	-	0.21	-	0.21
Dissolved Iron	g/m3	4.4	-	0.22	-	0.22	-	0.28	-	0.27	-	0.49	-	0.52
Dissolved Calcium	g/m3	340	-	75	-	66	-	53	-	42	-	45	-	39
Dissolved Magnesium	g/m3	210	-	30	-	30	-	22	-	22	-	25	-	19.5
Dissolved Potassium	g/m3	46	-	12.2	-	11.9	-	12.7	-	10.7	-	11.3	-	10
Sulphate	g/m3	2,100	280	380	440	350	340	280	370	220	250	230	270	210
Trace Elements														
Dissolved Antimony	g/m3	0.0076	-	0.0006	-	0.0005	-	0.0005	-	0.0005	-	0.0005	-	0.0004
Dissolved Arsenic	g/m3	0.014	0.0016	0.0022	0.0025	0.0019	0.0019	0.0023	0.003	0.0019	0.0027	0.0034	0.003	0.0031
Dissolved Barium	g/m3	0.045	-	0.0138	-	0.0124	-	0.0135	-	0.012	-	0.0122	-	0.0123
Dissolved Cadmium	g/m3	0.0064	0.00097	0.00144	0.00186	0.00153	0.00167	0.00153	0.0022	0.00147	0.00173	0.00191	0.0024	0.00195
Dissolved Cobalt	g/m3	0.88	-	0.165	-	0.152	-	0.131	-	0.107	-	0.131	-	0.117
Dissolved Chromium	g/m3	0.0016	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005	0.0005	< 0.0005	< 0.0005	0.0006	0.0006	< 0.0006	0.0005
Dissolved Copper	g/m3	0.62	0.042	0.049	0.059	0.061	0.084	0.081	0.122	0.072	0.099	0.128	0.147	0.14
Dissolved Lead	g/m3	0.0194	0.0018	0.0022	0.0031	0.0028	0.004	0.0041	0.0052	0.003	0.0033	0.0047	0.0064	0.0076
Dissolved Mercury	g/m3	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	0.66	-	0.122	-	0.113	-	0.091	-	0.073	-	0.088	-	0.079
Dissolved Molybdenum	g/m3	< 0.0004	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002	-	< 0.0002
Dissolved Nickel	g/m3	2.1	0.31	0.42	0.48	0.4	0.39	0.4	0.59	0.31	0.38	0.39	0.42	0.36
Dissolved Selenium	g/m3	0.154	-	0.0196	-	0.0126	-	0.0081	-	0.006	-	0.0063	-	0.0043
Dissolved Vanadium	g/m3	< 0.002	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010
Dissolved Zinc	g/m3	0.72	0.167	0.16	0.193	0.3	0.31	0.29	0.27	0.158	0.24	0.35	0.38	0.44
Dissolved Silver	g/m3	< 0.0002	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010	-	< 0.00010
Dissolved Strontium	g/m3	2.7	-	0.51	-	0.44	-	0.35	-	0.3	-	0.32	-	0.29
Dissolved Uranium	g/m3	0.00192	-	0.00061	-	0.00066	-	0.00063	-	0.00065	-	0.0009	-	0.00095
Field Parameters														
pH	pH Units	4.8	4.9	4.5	4.3	4.5	4.3	4.3	4.2	4.1	4.1	3.9	4.3	3.6
Electrical Conductivity (EC)	mS/m	307	59.6	81.8	89.9	65.8	68.1	57.8	74.1	48.3	53.4	52.5	56.7	46.9
Temperature	°C	17.5	18.2	16.8	18	19.1	18.1	19.9	19.1	19	20.5	20.6	20.1	21

Table D7 Summary Kinetic Test Results (Sample Origin: Control)

Sample Origin		**CONTROL**												
Sample Name		PYE-07-20170828	PYE-07-20170904	PYE-07-20170911	PYE-07-20170918	PYE-07-20170925	PYE-07-20171002	PYE-07-10102017	PYE-07-20171016	PYE-07-20171023	PYE-07-20171030	PYE-07-20171106	PYE-07-20171113	PYE-07-20171120
Date		28-Aug-17	4-Sep-17	11-Sep-17	18-Sep-17	25-Sep-17	2-Oct-17	9-Oct-17	16-Oct-17	23-Oct-17	30-Oct-17	6-Nov-17	13-Nov-17	20-Nov-17
Laboratory Reference		1835167.1	-	1842826.1	-	1850095.1	1854277.7	1859068.1	-	1865396.7	1869210.7	1875403.1	1877303.7	1881031.7
Week		0	1	2	3	4	5	6	7	8	9	10	11	12
pH	pH Units	5.7	-	5.5	-	5.8	5.4	5.9	-	5.7	6.2	5.5	5.7	5.8
Acidity (pH 3.7)	g/m3 as CaCO3	< 1.0	-	< 1.0	-	< 1.0	< 1.0	< 1.0	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Acidity (pH 8.3)	g/m3 as CaCO3	-	-	-	-	-		< 1.0	-	-	-	< 1.0	2	< 1.0
Total Alkalinity	g/m3 as CaCO3	2.5	-	2.1	-	2.2	18	1.8	-	1.9	2.4	2.2	1.8	2.2
Electrical Conductivity (EC)	mS/m	0.3	-	0.2	-	0.2	0.2	0.2	-	0.2	0.2	0.3	0.2	0.2
Major Elements														
Dissolved Aluminium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.003
Dissolved Iron	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.02
Dissolved Calcium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	0.05
Dissolved Magnesium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.02
Dissolved Potassium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.05
Sulphate	g/m3	< 0.5	-	1.8	-	< 0.5	< 0.5	< 0.5	-	< 0.5	< 0.5	< 0.5	0.7	< 0.5
Trace Elements														
Dissolved Antimony	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0002
Dissolved Arsenic	g/m3	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Barium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	0.00044
Dissolved Cadmium	g/m3	< 0.00005	-	< 0.00005	-	< 0.00005	-	< 0.00005	-	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Cobalt	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0002
Dissolved Chromium	g/m3	< 0.0005	-	< 0.0005	-	< 0.0005	-	< 0.0005	-	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Copper	g/m3	0.0018	-	0.002	-	0.0023	-	0.0015	-	0.0019	0.0025	0.0026	0.0015	0.0033
Dissolved Lead	g/m3	0.00014	-	0.00016	-	0.00022	-	0.00016	-	0.00018	0.00022	0.00019	0.00015	0.00034
Dissolved Mercury	g/m3	< 0.00008	-	< 0.00008	-	< 0.00008	< 0.00008	< 0.00008	-	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Manganese	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0005
Dissolved Molybdenum	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0002
Dissolved Nickel	g/m3	< 0.0005	-	< 0.0005	-	0.0005	-	< 0.0005	-	< 0.0005	0.0008	< 0.0005	0.0005	0.0011
Dissolved Selenium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0010
Dissolved Vanadium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0010
Dissolved Zinc	g/m3	0.0051	-	0.0096	-	0.0079	-	0.0054	-	0.0058	0.0071	0.0087	0.0043	0.0149
Dissolved Silver	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.00010
Dissolved Strontium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.0005
Dissolved Uranium	g/m3	-	-	-	-	-	-	-	-	-	-	-	-	< 0.00002
Field Parameters														
pH	pH Units	6.9	6.4	6.5	6.2	6.9	6.8	5.8	6.9	6.5	6.9	7	6.9	6.8
Electrical Conductivity (EC)	mS/m	0.3	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.2
Temperature	°C	17.4	18.2	16.8	18	19.1	18	19.9	18.9	18.9	20.5	20.6	20.2	20.9

Figure D4 Weekly measured pH, EC, Sulphate and Arsenic from Kinetics

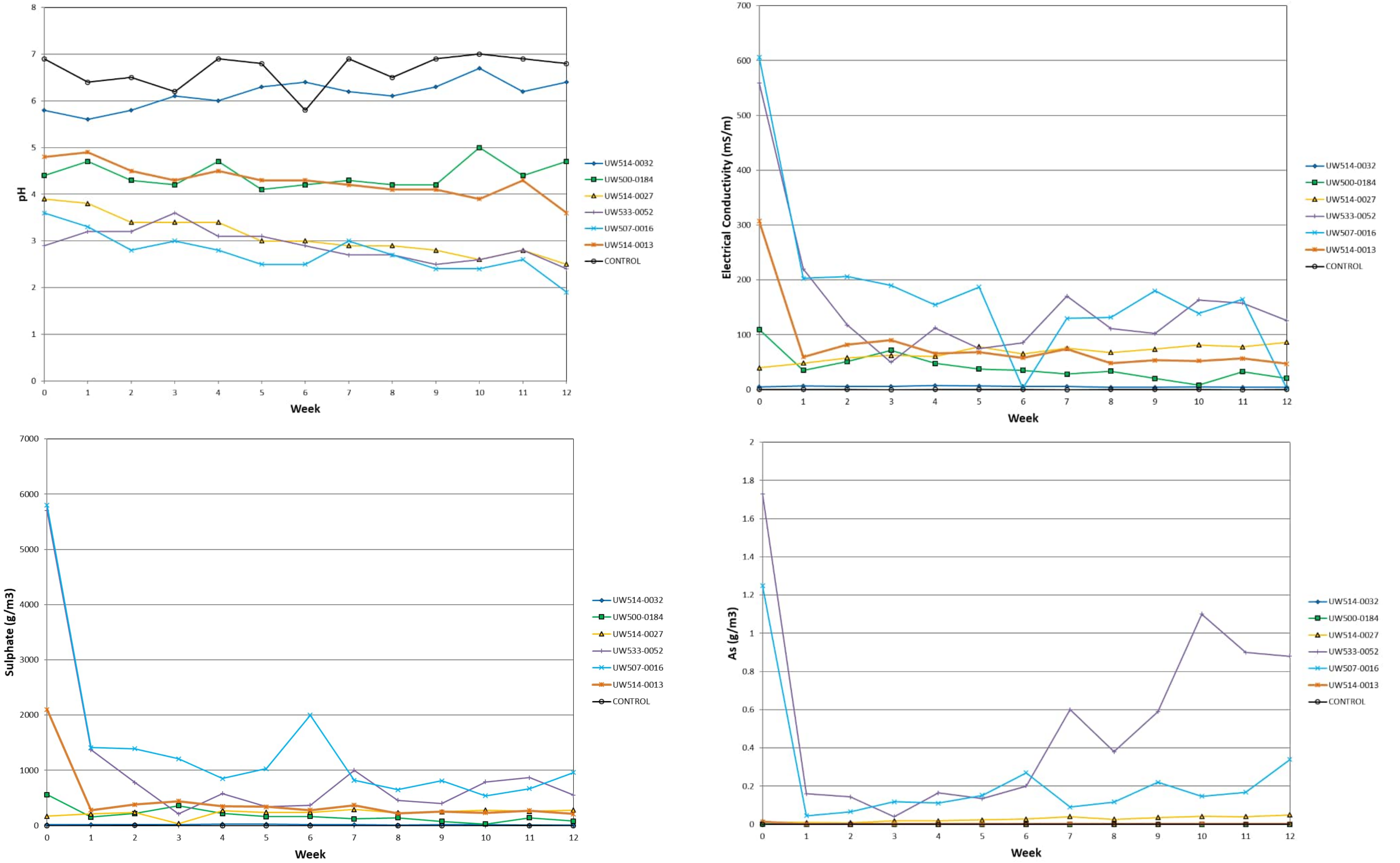
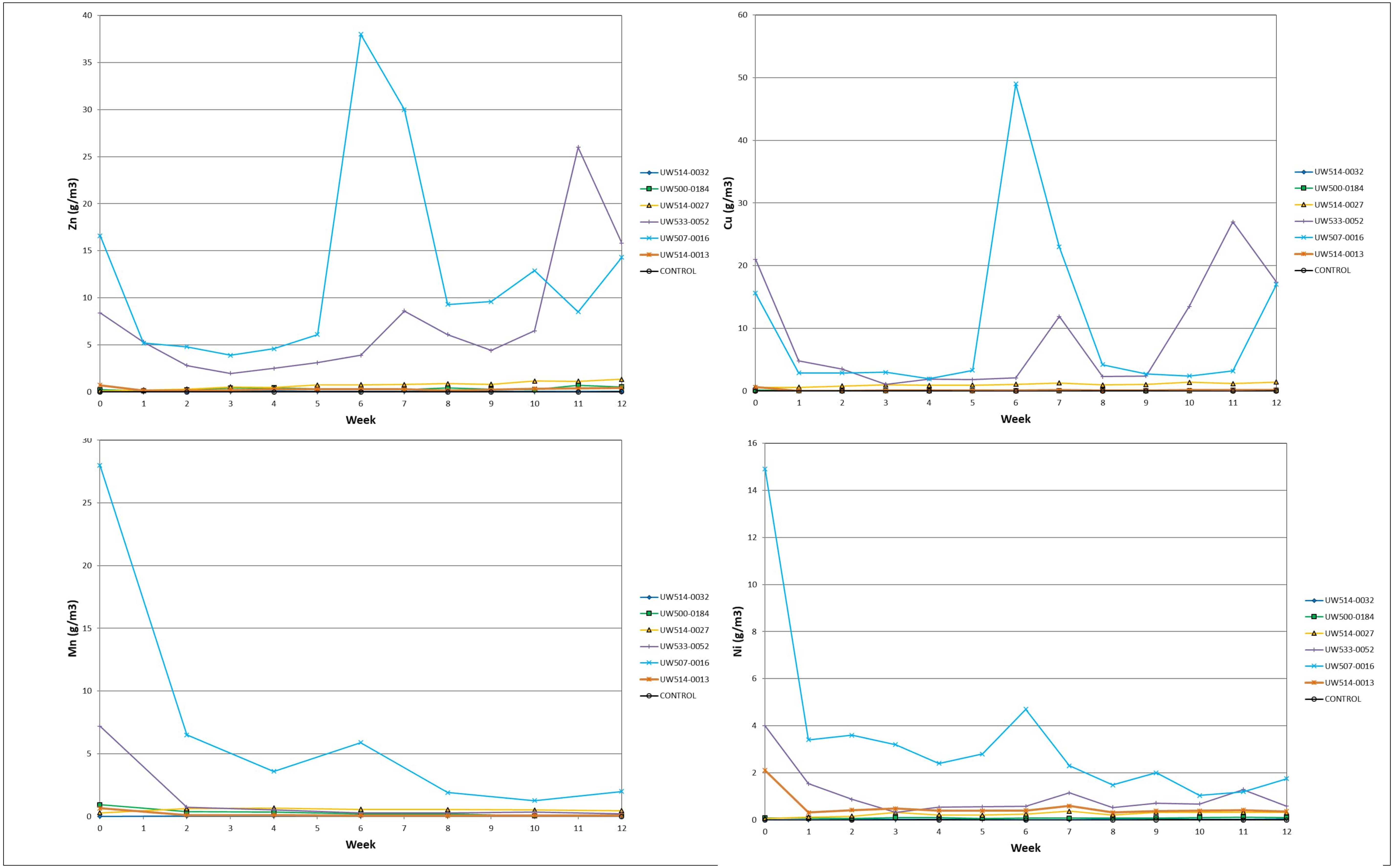


Figure D5 Weekly measured Zinc, Copper. Manganese and Nickel from Kinetics



D3 Column Testing

D3.1 Methodology

Initially, six column tests were undertaken on-site to support and supplement the findings of the kinetic testing to characterise likely trace element loadings and treatment options, and to define a methodology for backfill placement. Three of these columns were subsequently disbanded and replaced with three additional columns. The standard operating procedure for the columns set up and operation is provided in Attachment A. This document refers to Gladstone and Favona rock. The Favona rock is from similar depths to the GOP hydrothermal breccia and andesite materials, so overlying the Favona underground, and is located in an area immediately north of the GOP. The rock sample from outside the GOP void are referred to as "adjacent to GOP" to differentiate between samples that are from within the GOP void and those to the north of the void.

Approximately 60 kgs of overburden was required for each of the nine columns. At the time of selection, samples were selected on the basis of the availability of material, with the volumetric ratios of Andesite and Hydrothermal Breccia encountered in the pit maintained and tested in the columns. These ratios have since been amended within the final pit profile, therefore the ratio of Andesite:Breccia within the columns differ than expected in the balance of overburden material from the Gladstone pit. However, the observed differences are considered insignificant. Refer to Table D8 for a summary of the column setup.

Table D8 Ratio of Andesite to Breccia Material in Column Set Up

Column Name	Treatment Method	Treatment Week	Ratio of PAF Andesite Material	Ratio of PAF Breccia Material
Gladstone Pit Balance	Inclusive of all Overburden Material		38%	13%
Relative Gladstone Pit Balance	Only Andesite / Breccia Material		75%	25%
Col 1	-	-	79%	21%
Col 2	Saturated	Week 11	79%	21%
Col 3	Limestone Dosed	Week 11	79%	21%
Col 4	-		69%	31%
Col 5	Saturated	Week 11	69%	31%
Col 6	Limestone Dosed	Week 11	69%	31%
Col 7	Compacted	Week 0	82%	18%
Col 8	Layered	Week 0	82%	18%
Col 9	Limestone Blended	Week 0	63%	37%
Col 10	Control	-	-	-

The following criteria were used to guide selection:

- Core intervals were selected from cores spatially distributed across the projected pit volume where possible;
- In order for there to be sufficient volume of material, core intervals from a wider area (i.e. outside of the projected pit) have been utilised. Where this has occurred, care has been taken to select material that is considered similar in nature (geologically and geochemically) to overburden material expected from the Gladstone pit.
- Core intervals with ore-grade concentrations of Au (where existing data was available) and veins or highly silicified zones were excluded;

- Core intervals logged as not having an ‘Argillic’ or strong clay alteration were excluded;
- Core intervals logged as not having visible Pyrite were excluded;
- Core intervals logged as weathered or displaying obvious, pervasive oxidation were excluded.

Examples of core intervals selected for Column testing are shown in Figure D6. Note, selected core intervals were processed to rock chips by SGS New Zealand Limited. Final samples comprised material where 80% passed through a 3.6 mm sieve opening.

Figure D6 Examples of Core Selected for Column Testing

Hydrothermal Breccia selected from Gladstone core 1120SP2GR1064. Intervals selected from 114.5-117.5 m. Photo provided by OGNZL.

Andesite selected from core UW531 adjacent to the Gladstone Pit. Intervals selected from 46.3 - 49.7 m. Photo provided by OGNZL.

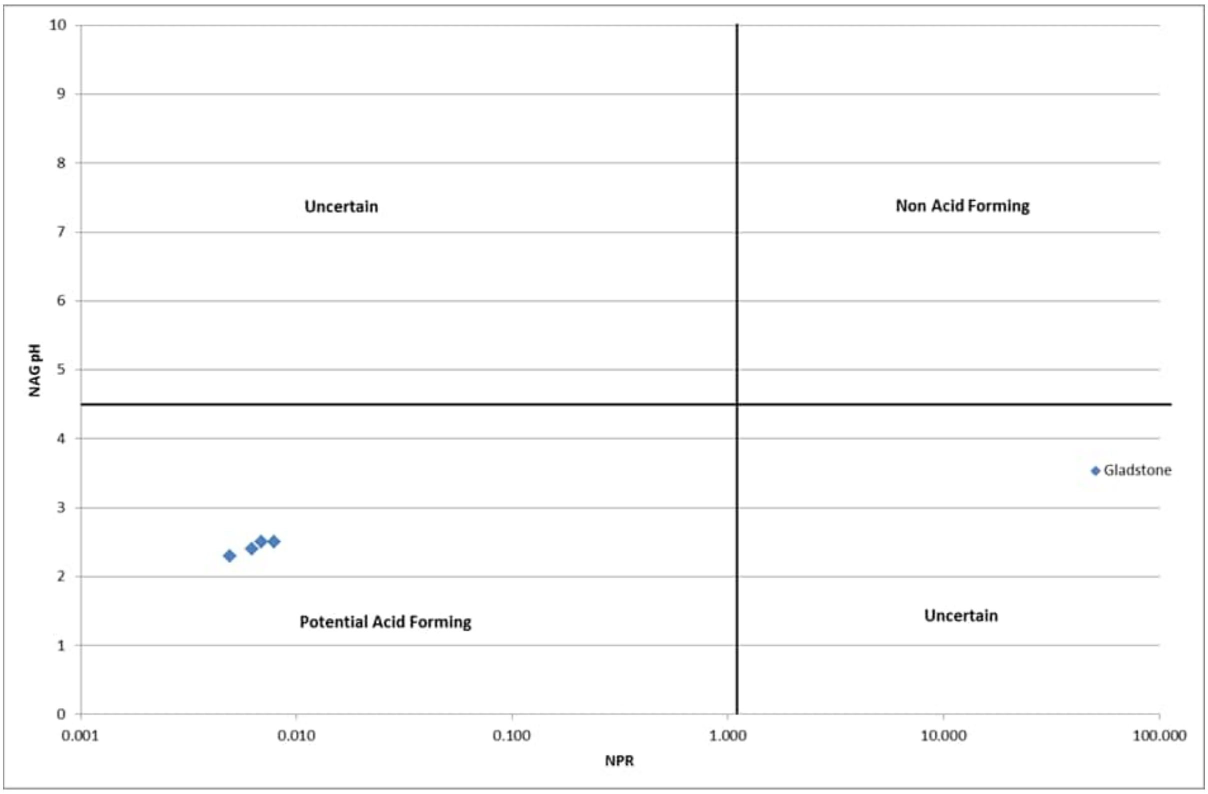
Based on the stated selected criteria, the resultant selected cores only represent a small portion of the overburden material. However, they represent a ‘worse case’ sub-set with respect to the acid producing potential and trace element leaching and provide valuable information in regard to the geochemical properties, behaviour, and treatment of the andesite and hydrothermal breccia material expected.

Each column comprised an approximate 60 kg composite sample. The rock was placed atop a layer of filter material (K1 gravel) in order to aid free drainage of the leachate and all leachate was collected throughout the duration of the field tests into food grade buckets and piping. Photographs of the final column set up are provided as Figure D7 and Figure D8. Acid base accounting characteristics of the columns are shown in Figure D9. All material used within the various column tests show similar acid base accounting characteristics.

Figure D7 On-site Column Setup

Figure D8 On-site Column Setup

Figure D9 NPR/NAG pH diagram for overburden within Columns



D3.2 Column Treatment

A summary of the testing treatment of each column is provided below. Field measurements were taken from the column leachate on a weekly basis by OGNZL staff throughout the column's operation. Leachate was periodically (generally every second or fourth week) collected and sent for analysis to R J Hill Laboratories Limited.

Columns 1 & 4

Columns 1 (adjacent to GOP) & 4 (within GOP void) were not treated and were run under 'optimal' field acid producing conditions. That is no lime dosing and free draining.

Columns 2 & 5 (Saturated)

Columns 2 (adjacent to GOP) & 5 (within GOP void) were initially not treated and were run under 'optimal' field acid producing conditions (free draining), until they had been in operation for an 11 weeks period and until the leachate had a pH < 3. These columns were then saturated to mimic the effect of prolonged exposure followed by groundwater saturation.

Columns 3 & 6 (Limestone Dosed)

Columns 3 (adjacent to GOP) & 6 (within GOP void) were initially not treated and were run under 'optimal' field acid producing conditions (free draining), until they had been in operation for an 11 weeks period and until the leachate had a pH < 3. A volume of limestone ($CaCO_3$) was then calculated based on the exposure period, the leachate sulphate concentration, and mass of rock within the column. This volume of limestone was applied to the top of the columns at week 11. An additional volume of limestone was added at week 30.

Column 7 (Compacted)

Column 7 (adjacent to GOP) was constructed to try and replicate placement of overburden in compacted benches. Compaction was measured based on current density of operating columns and the target dry density of waste rock calculated from a standard compaction test of the selected material. The thickness of the placed material was adjusted so that the material was compacted to 2% wet of optimum at 90% of maximum dry density. When compacting the material into column, the sample was split into four equal masses and constructed in four different 'lifts' based on the mass and the required compaction.

Column 8 (Layered)

Column 8 (adjacent to GOP) involved the reuse of a portion of material from column 3 and is constructed of three layers of overburden – each approximately 150 mm. The bottom two layers consist of fresh overburden material while the top layer is the reused 'oxidised' material. Three kg of limestone was mixed with this top oxidised material prior to placement. The volume of limestone was calculated in order to introduce alkalinity at a rate to extend natural lag (of the fresh material to 210 days) and neutralise the already oxidised material. This column replicates conditions in which overburden is backfilled into the pit in successive layers, with the final (top) layer left to oxidise. Limestone is then placed on top of the final layer at a rate in order to extend the lag period until the material can become saturated.

Column 9 (Limestone Blended - within GOP void*)*

Prior to placement of the waste material within the column, one kilogram of limestone was mixed thoroughly within the material. The quantity of limestone was calculated in order to extend the natural lag period (estimated at 7 weeks) to a period of 210 days by adding sufficient alkalinity (in the form of limestone) to neutralise the predicted sulphate generation throughout this period.

D3.3 Column Testing Analytical Results

Summarised results from the column tests are shown in Figure D10 to Figure D13. Tables outlining all analytical results and figures showing the main elements of concern are provided in Attachment B.

Figure D10 Weekly Column Laboratory pH

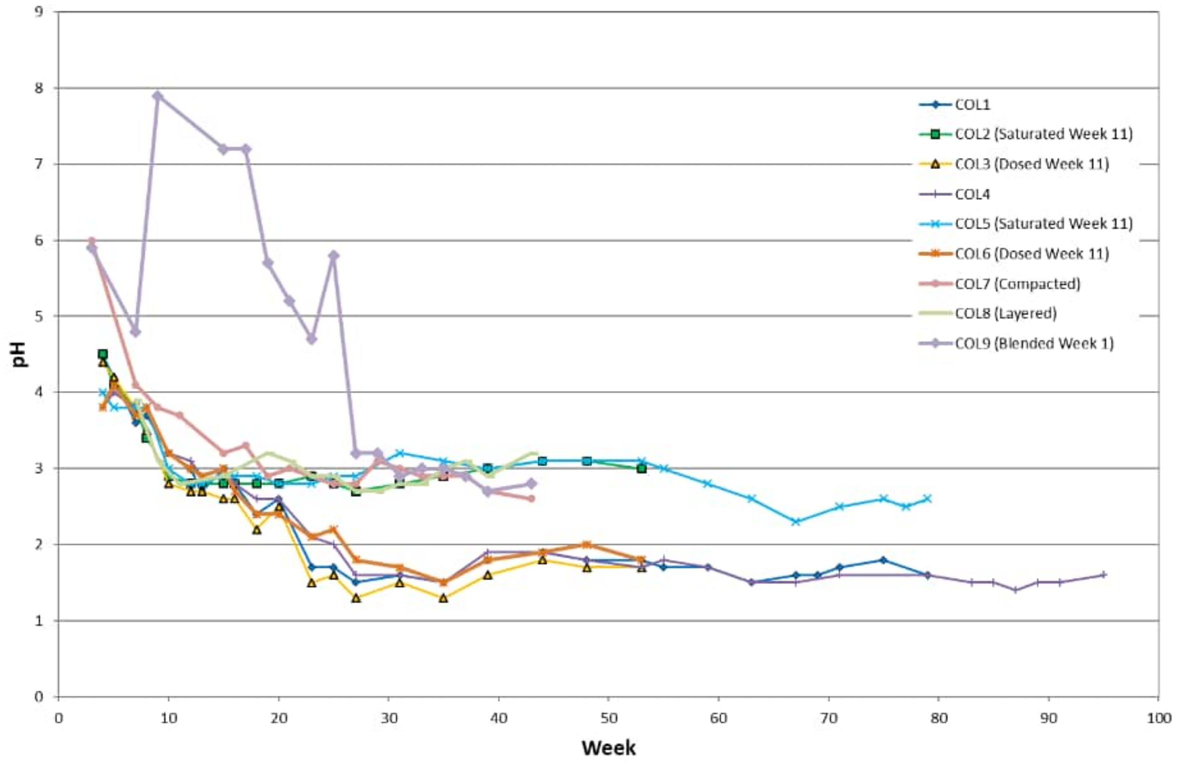


Figure D11 Weekly Column Acidity Concentration

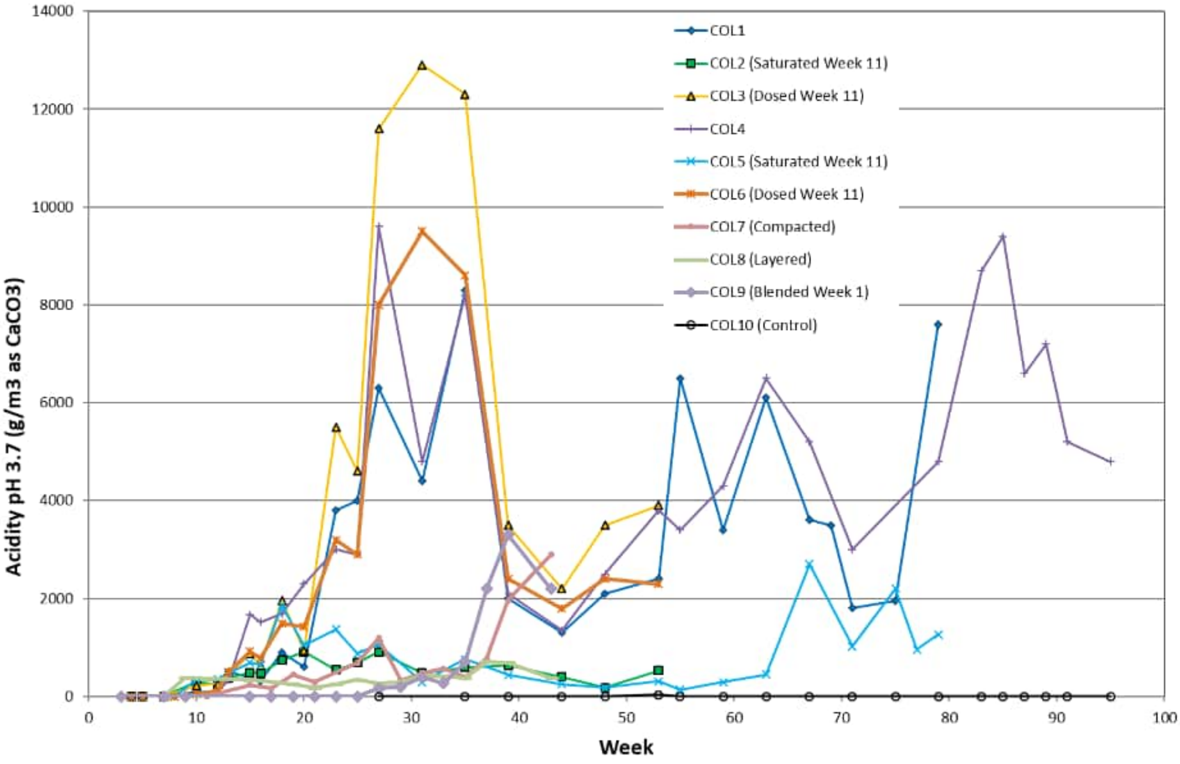


Figure D12 Weekly Column Sulphate Production Rate

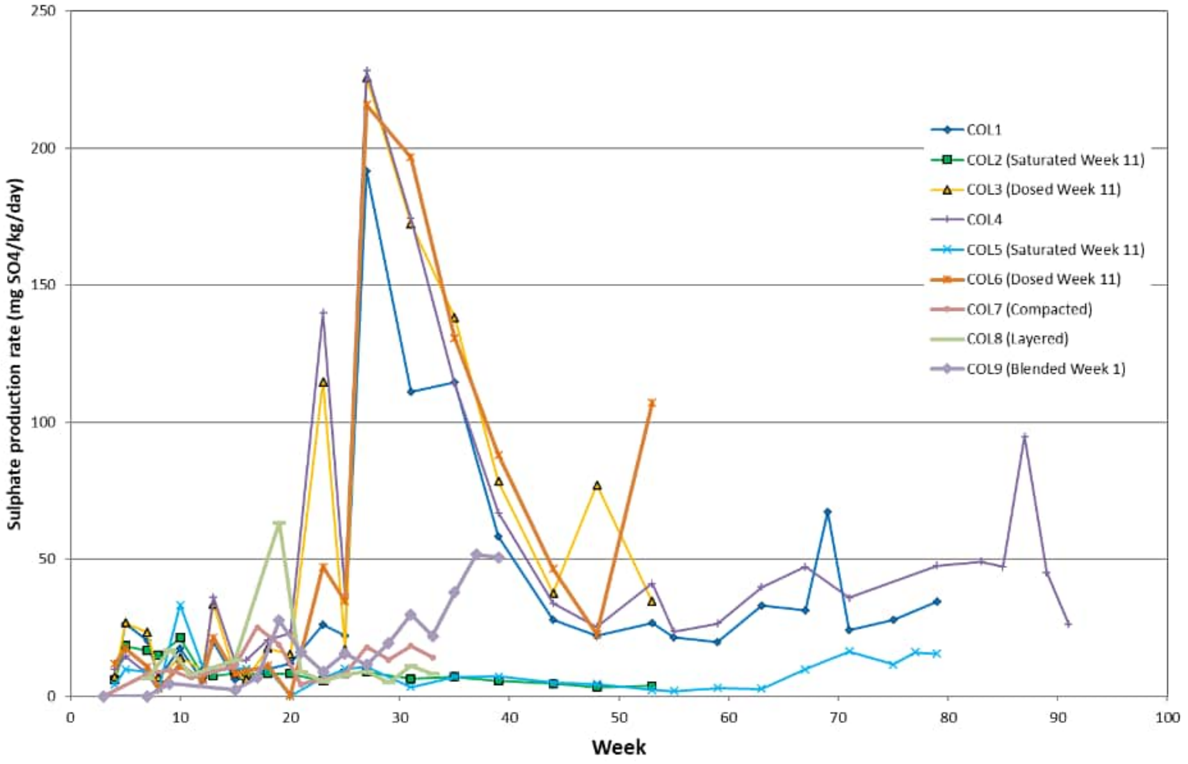
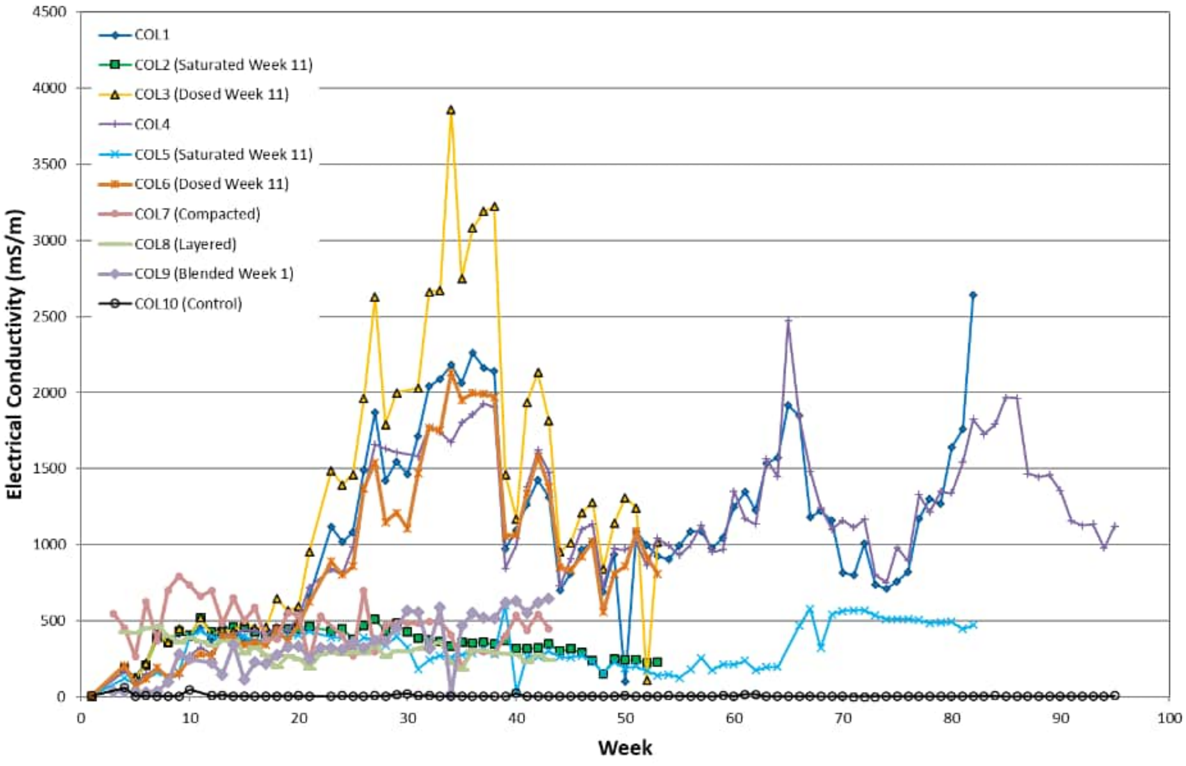


Figure D13 Weekly Column Electrical Conductivity



D3.3 Column Test Results Discussion

In general, columns initially untreated (Col1 - Col6) oxidise rapidly and are characterised by depressed pH (pH < 3.) and elevated acidity (acidity pH 3.7 > 100 mg/L as CaCO3) by week 10. This is also associated with a proportional increase in trace element leaching. This is most noticeable in iron (from week 10), chromium (week 10), lead (week 10), and vanadium (week 15; Figure 1 to 14 of Attachment B).

In Col2 and Col5 (following saturation at week 11), pH, acidity, and sulphate production stabilise whereas Col3 and Col6 (which were limestone dosed) show no change relative to the remaining untreated columns (Col1 and Col4).

At week 21, pH has reduced to ~1.5 in Col and Col4 and a concomitant increase in dissolved metals including arsenic, copper, cadmium, chromium, nickel and zinc occurs. Of note is that mercury does not appear to have mobilised with the other metals and remains at low to negligible levels in the leachate.

For Col1 – Col6, the similar trends of the untreated and limestone-treated columns, and in particular their contrast with trends of the saturated columns, is indicative that the limestone treatment has had limited effect when applied after material is allowed to oxidise and produce acid. It is likely that in-part, this can be attributed to dosing of the columns after they had already reached a highly acidic state. Limestone addition can also have limited efficiency in neutralising acidity when not blended as the amount of alkalinity that will dissolve in infiltrating water is small relative to the alkalinity load. Similarly, if oxidation has resulted in the precipitation of ferric hydroxide on the limestone itself (armouring), this is also known to reduce the effectiveness of limestone addition. These, coupled with ongoing exposure to molecular oxygen (which is expected to be significantly limited in the saturated columns) is a probable cause for the limited effectiveness of limestone addition to the columns.

Very high concentrations of arsenic (> 5 mg/L) are evident in the untreated (Col1 and Col4) and limestone dosed (Col3 and Col6) from week 20 onwards. This increase appears associated with several large flushing events and is likely reflective of arsenates sorbed onto iron hydroxides which have been subject to reducing conditions (< pH 2.5) during the flushing event resulting in speciation to soluble arsenite. It is considered that conditions conducive to these elevated arsenic conditions are unlikely to occur within placed overburden from Project Quattro (refer Section 6.0 of the main report).

In contrast, the columns that have limestone applied at inception (by blending – Col9 and layering – Col8) show that limestone application is an effective measure at preventing / delaying the onset to acidity. This is particularly highlighted in Col9 where the pH remains above pH 4.5 until week 25 of operation, a pH not seen in the other columns since their inception. This is also association with depressed acidity, sulphate and trace element concentrations in the column leachate. The layered column (which includes a layer of blended limestone and oxidised material) exhibits an initial spike in trace element concentrations (associated with the already oxidised material) followed by a general reduction with time.

Like the limestone dosed columns, the compacted column shows depressed long term trace element concentrations when compared to the unmitigated columns. However early ‘spikes’ in copper, molybdenum, nickel and zinc are noticeable and it is likely this is a reflection of the immediate surface on the compacted columns which is exposed to atmosphere and therefore within the zone of oxidation Once sulphate production within this area is exhausted, limited infiltration of oxygen into the compacted mass limits additional sulphide oxidation and associated trace element leaching.

D3 Summary

Refer to Section 4.4 of the main report for an overall summary of kinetic and column testing analysis.

Attachment A – Column Testing Operating Procedure

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Memorandum

To	Kathy Mason	Page	1
CC	Linda Graveson		
Subject	Attachment A – Column Testing Operating Procedure		
From	Tim Mulliner		
File/Ref No.	60544823	Date	09-Jun-2017

1.0 Introduction and Background

The purpose of this memorandum is to outline the specifications, set up and operational procedures for field column tests operated by Oceana Gold at the Martha Mine Site for investigating leachate water quality. Data gathered will aid defining a methodology for backfill placement (including any limestone placement), to mitigate or minimise the groundwater effects that result from inundation of the backfilled Gladstone pit.

2.0 Column Specifications.

Seven existing columns on site (dimensions approximately 800 mm high, 300 mm diameter equalling a total volume of approximately 0.057 m^3 each) will be utilised for the WNP field columns.

The existing columns should be prepared for use by thoroughly emptying and cleaning, replacing all tubing and buckets (with sealed lids) with food grade plastic and setting up the columns as outlined in Figure 1 and specified in this document.

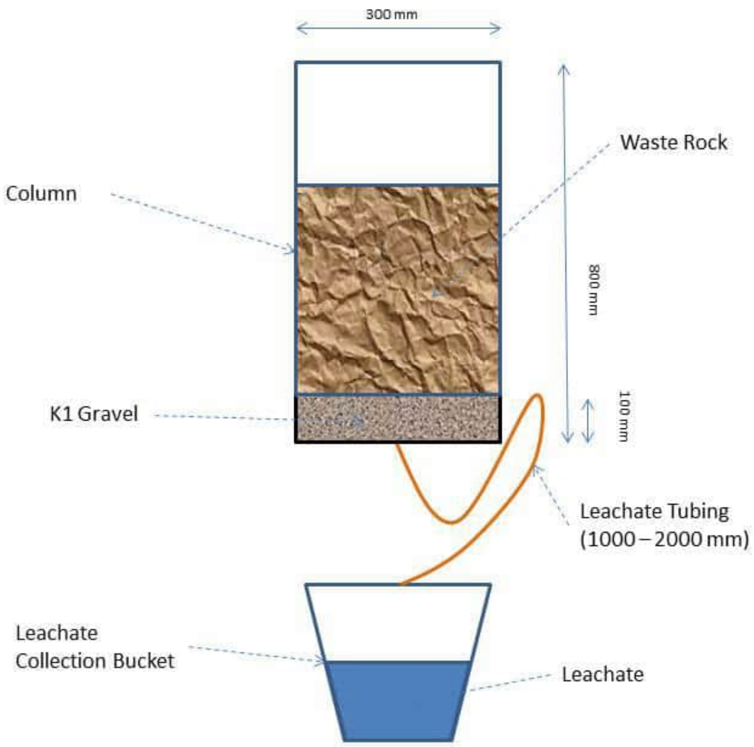

Figure 1. Column Set up (Current / Conceptual).

The base of the columns should be free draining and therefore it is recommended K1 gravel material is placed at a thickness that will allow free drainage of leachate to occur (approximately 100 mm) from the base of the columns.

Tubing should be sealed to the base of the columns to collect drainage and avoid any leakage. The length of the tubing should be sufficient so that it can be connected to the collection buckets beneath the columns and long enough so the outlet of the piping can be attached to the side of the column at a height above the maximum level of the waste rock within the column (introducing a head pressure gradient to enable the column to become fully saturated). An approximate tubing length of 1-2 metres is therefore recommended, however, this may need to be longer depending on the flexibility of the tubing material.

During initial operation, tubing should circulate around the wooden structure holding the columns, above the lowest point of the column (discharge point) to approximately 10 cm above this location, before attaching the draining end to the top of the buckets underneath. This will prevent rapid free drainage of leachate from the columns and introduce a pressure head gradient within the water column. Tubing should be secured in place (at side of column and top of bucket) in a way that it can easily be released (when sampling) and repositioned when required.

Where the tubing connects at the top of the buckets it should be ‘sealed’ in a manner that avoids water other than leachate entering the buckets and enables the removal of the tubing for sampling during the column operation.

3.0 Waste Rock Selection.

Three columns of materials each consisting of approximately 60 kg of waste rock representative of the breccia and andesite waste rock within and adjacent to the Gladstone pit are required. Waste rock should be sourced from core material as identified by AECOM in the provided spreadsheet (to be provided separately) which has been selected based on core logs, assay data and photos previously provided to AECOM from Oceana Gold.

Waste rock should be crushed to ensure the maximum particular size is not greater than 60 mm or 20% of the column diameter.

The selected waste material should be combined (ie. two groups of waste rock totally approximately 180 kg each), mixed and then divided equally between the columns (ie. approximately 60 kg of material per column). Material should then be placed directly on top of the K1 gravel. Representative samples from each column's rock should be sent for analysis for the parameters detailed in **Table 1**. A minimum of 150 mm should be maintained between the top of the sample and the top of the column.

Table 1. Recommended analytical suite for column waste rock

PSD (Particle Size Distribution)
NAG
Total Sulphur (%)
Total Carbon (%)
ANC (kg CaCO3/tonne)
Aluminium
Iron
Calcium
Magnesium
Sodium
Potassium
Antimony
Arsenic
Barium
Cadmium
Cobalt
Chromium
Copper
Lead
Mercury
Manganese
Molybdenum
Nickel
Selenium
Vanadium
Zinc
Titanium
Boron
Strontium
Thorium
Tin
Silver
Thallium
Fluoride
Uranium

Detection limits (where applicable) should be based on previously provided detection limits for samples representative of waste material within and adjacent to the Gladstone pit.

4.0 Initial Column Operation and Sampling

Initially, columns should be left exposed to atmospheric conditions for a minimum of 6 weeks and until they became acid producing. This period ensures that material selected for the columns has time to revert from an unoxidised state at time of placement to an oxidised state.

During this period the leachate should be monitored weekly. During monitoring, it is recommended that the leachate tubing is removed carefully from the bucket and leachate within the tubing and at the base of the column is collected directly from the tubing into laboratory supplied containers suitable for the analysis of the parameters detailed in **Table 2** in week 2, 4 and 6 of operation. Once all containers are full or during weeks 1, 3 and 5 of operation when samples are not required, leachate should be collected directly into a clean beaker.in a clean beaker.

Field parameters should be collected utilising a calibrated multi-parameter (or similar individual meters) and the following field parameters recorded:

- pH
- Conductivity
- Temperature

The remaining leachate should be left to drain into the bucket until the tubing runs dry. The volume of leachate within the bucket should be recorded and sampled before reconnecting the tubing to the empty bucket.

In the event that insufficient leachate drains from the tubing and base of column to enable the collection of water samples and/or accurate measurement of field parameters, static water within the bucket should be utilised.

If no leachate water (or insufficient leachate water) is available, a measured volume of 500 mL of de-ionised water should be poured into the column at the top, and the leachate should be collected as described above. Where this is required it should be recorded on the sampling sheet.

The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommend that field parameters (as above) be recorded prior to the disposal of the leachate water.

5.0 Ongoing Column Operation

Results should be forwarded to AECOM upon receipt and will be reviewed in terms of the acid generating status.

Once the columns are verified as being acid producing (generally based on a measured pH <3 and elevated sulphate) one column comprising material collected adjacent to the Gladstone pit and one column comprising material collected from within the Gladstone pit should be operated as follows:

Column A (Fully Saturated)

These columns should remain fully saturated. The tubing should be attached to a point in the column that is above the placement of the waste rock to ensure that the columns remain saturated. The tubing should then be attached to the leachate collection buckets. The column should then be filled with rainwater so that all of the waste rock within the column is beneath the static water column. The column should then be left exposed to atmospheric conditions to enable a variable unsaturated / saturated cyclic state.

Column B (Limestone Treated)

A layer of limestone should be placed on top of the waste rock. The quantity of limestone introduced will depend on the initial monitoring data and will be calculated by AECOM once the initial operation and sampling has been completed.

The tubing from the column should drain to the collection buckets as per the initial setup and the column should remain exposed at the top to enable a variable unsaturated / saturated cyclic state.

Column C (No Treatment)

The column should remain as per the initial set up with tubing from the column draining to the collection buckets. The column should remain exposed at the top to enable a variable unsaturated / saturated cyclic state.

6.0 Ongoing Column Sample Collection

During this period the leachate should initially be monitored weekly. Depending on the results, the monitoring frequency may be extended with time.

During monitoring, it is recommended that the leachate tubing is removed carefully from the bucket or fastening point to the column. Leachate should be collected directly from the tubing into laboratory supplied containers suitable for the analysis of the parameters detailed in **Table 2**. Once all containers are full, leachate should be collected directly into a clean beaker.

Field parameters should be collected utilising a calibrated multi-parameter (or similar individual meters) and the following field parameters should be recorded:

- pH
- Conductivity
- Temperature

The remaining leachate should be left to drain into the bucket until the tubing runs dry (except in the case of the fully saturated column – refer to comment below). The volume of leachate within the bucket should be recorded and disposed of before reconnecting the tubing to the empty bucket.

In the event that insufficient leachate drains from the tubing and base of column to enable sample collection and the accurate measurement of field parameters, static water within the bucket should be utilised.

If no leachate water (or insufficient leachate water) is available, a measured volume of 500 mL of de-ionised water should be poured into the columns at the top, and the leachate should be collected as described above.

The fully saturated column should be replenished with de-ionised water so that the waste rock remains fully saturated.

The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow.

Samples collected should be stored cold and sent for laboratory analysis for the following parameters.

Table 2. Recommended analytical suite for column sample collection

pH
Conductivity
Acidity (mgCaCO3/L)
Alkalinity (mgCaCO3/L)
Sulphate
Total Organic Carbon (TOC)
Dissolved Aluminium
Dissolved Iron
Dissolved Calcium
Dissolved Magnesium
Dissolved Sodium
Dissolved Potassium
Dissolved Antimony
Dissolved Arsenic
Dissolved Barium
Dissolved Cadmium
Dissolved Cobalt
Dissolved Chromium
Dissolved Copper
Dissolved Lead

Dissolved Mercury
Dissolved Manganese
Dissolved Molybdenum
Dissolved Nickel
Dissolved Selenium
Dissolved Vanadium
Dissolved Zinc
Dissolved Titanium
Dissolved Boron
Dissolved Strontium
Dissolved Thorium
Dissolved Tin
Dissolved Silver
Dissolved Thallium
Dissolved Fluoride
Dissolved Uranium

*It is recommended that samples are field filtered and are analysed at trace level.

Note that depending on the initial static data set (not available at the time of writing) and ongoing analytical data collection from the kinetic and column waste tests, the analytical suite and frequency of sample/data collection may be reduced during the duration of the column operation.

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Attachment B – Column Test Analytical Data and Graphs

Pre Set up

	S	Sample Weight	NAG pH	NAG kg H2SO4/T	NAG-B kg H2SO4/T	ANC kg H2SO4/T	ANC %CaCO3 Equivalent	TAP (kg H2SO4/T)	NAPP
UNITS	%	G	PH	KG/T	KG/T	KG/T	%	KG/T	KG/T
COL1	3.38	0.5004	2.4	93	73	-1	-0.1	103	103
COL2	3.4	0.2013	2.6	94	37	-2	-0.2	104	104
COL3	3.38	0.2004	2.5	94	37	0	0	103	103
COL4	4.22	0.1998	2.5	121	64	0	0	129	129
COL5	4.31	0.5004	2.2	120	100	0	0	132	132
COL6	4.33	0.2007	2.5	123	66	-1	-0.2	132	132
COL7	5.42	0.2509	2.3	149	128	0	0	166	166
COL8	5.45	0.2511	2.3	151	129	0	0	167	167
COL9	3.88	0.2501	2.5	111	90	-3	-0.3	119	119

Post deconstruction

	S	Sample Weight	NAG pH	NAG kg H2SO4/T	NAG-B kg H2SO4/T	ANC kg H2SO4/T	ANC %CaCO3 Equivalent	TAP (kg H2SO4/T)	NAPP
UNITS	%	G	PH	KG/T	KG/T	KG/T	%	KG/T	KG/T
COL1	1.55	0.25	3	46	26	-6	-0.6	47	47
COL2-3	3.22	0.2502	2.5	93	76	-1	-0.1	99	99
COL2-4	3.18	0.2509	2.6	93	76	0	0	97	97
COL3-3	1.89	0.2496	2.8	57	40	-2	-0.2	58	58
COL3-4	0.84	0.2489	9	0	-17	66	6.8	26	-41
COL4	0.971	0.502	2.8	28	13	-5	-0.5	30	30
COL5	3.52	0.2502	2.5	102	82	-5	-0.5	108	108
COL6-3	2.81	0.2484	2.7	71	54	8	0.8	86	78
COL6-4	2.95	0.2481	2.6	78	61	6	0.6	90	85
COL7	4.93	0.2512	2.4	142	112	-3	-0.3	151	151
COL8	2.58	0.252	10.9	0	-30	133	13.6	79	-54
COL9	2.09	0.2514	2.8	55	25	-6	-0.6	64	64

Pre Analysis (prior to column set up):																						
	Au-TL43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-MS43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43
SAMPLE	Au	Bi	Hg	Sb	Se	Sn	Te	Th	Tl	U	W	Ag	Al	As	B	Ba	Be	Ca	Cd	Ce	Co	Cr
DESCRIPTION	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
COL1	0.167	0.17	2.48	11.25	1.6	2.2	0.1	0.51	1.98	0.09	1	1.3	0.31	89.1	<1	16	0.1	0.1	<0.2	3	15.1	5
COL2	0.16	0.15	2.65	11.15	1.5	2	0.09	0.5	2.09	0.08	0.82	1.3	0.3	88.6	<1	15	0.1	0.1	<0.2	3	15.4	5
COL3	0.204	0.13	2.61	11.05	1.4	2.1	0.09	0.47	1.99	0.08	0.8	1.4	0.27	86.9	<1	13	0.1	0.1	<0.2	3	15	4
COL1-3 Average	0.2	0.2	2.6	11.2	1.5	2.1	0.1	0.5	2.0	0.1	0.9	1.3	0.3	88.2	<1	14.7	0.1	0.1	<0.2	3	15.2	4.7
COL4	0.246	0.58	2.17	13	1.7	1.6	0.7	0.44	3.05	0.11	1.09	1.4	0.45	139	<1	10	0.1	0.02	<0.2	2	16.1	5
COL5	0.243	0.54	2.19	13.05	1.7	1.3	0.68	0.43	3.1	0.1	1	1.4	0.44	145	<1	10	0.1	0.02	<0.2	2	16.2	4
COL6	0.243	0.55	2.16	12.95	1.7	1.3	0.7	0.44	3.05	0.1	0.93	1.3	0.42	145	<1	10	0.1	0.02	<0.2	2	16.6	4
COL4-6 Average	0.2	0.6	2.2	13.0	1.7	1.4	0.7	0.4	3.1	0.1	1.0	1.4	0.4	143	<1	10.0	0.1	0.0	<0.2	2	16.3	4.3
COL7	0.16	0.06	4.58	28.4	2.9	1.3	0.1	0.19	2.34	0.12	0.56	0.2	0.32	172	<1	3	0.1	0.09	<0.2	2	24.5	10
COL8	0.154	0.06	4.6	29.5	3	1.2	0.1	0.2	2.3	0.12	0.59	0.2	0.35	174	<1	3	0.1	0.09	<0.2	2	24.3	10
COL9	0.175	1.29	3.76	16.45	3.1	2.1	1.02	0.5	3.15	0.21	0.59	0.7	0.57	150	<1	2	<0.1	0.01	0.2	2	16.8	8
Post Analysis (after column disbandment):																						
COL1-1	0.19	0.03	2.62	8	1	1.9	0.06	0.65	1.36	0.09	0.49	1.2	1.1	30.7	2	25	0.1	0.01	<0.2	5	2.9	11
COL1-2	0.179	0.03	2.55	7.7	0.9	2	0.05	0.58	1.26	0.07	0.51	1.3	0.84	31.2	2	23	0.1	0.01	<0.2	5	2.7	7
COL1 Average	0.18	0.03	2.59	7.9	1.0	2.0	0.06	0.62	1.31	0.08	0.50	1.3	0.97	31.0	2	24	0.1	0.01	<0.2	5	2.8	9
COL2-1	0.185	0.03	2.65	8.44	1.6	2.1	0.09	0.46	1.96	0.1	0.56	1.4	0.83	90.5	<1	8	0.1	0.08	<0.2	4	11.6	9
COL2-2	0.18	0.03	2.51	8.78	1.5	1.9	0.08	0.48	1.78	0.09	0.7	1.3	0.57	85	<1	8	0.1	0.07	<0.2	4	11.6	10
COL2 Average	0.18	0.03	2.58	8.6	1.6	2.0	0.09	0.47	1.87	0.10	0.63	1.4	0.70	87.8	<1	8	0.1	0.08	<0.2	4	11.6	10
COL3-1	0.18	0.03	2.6	5.99	1.1	2.1	0.06	0.46	1.55	0.09	0.35	1.2	0.94	46.8	<1	25	0.1	1.83	0.2	4	4.2	9
COL3-2	0.184	0.03	2.55	6.52	1.1	1.6	0.08	0.44	1.42	0.1	0.38	1.2	1.05	62.2	<1	25	0.1	3.61	0.3	4	4.3	10
COL3 Average	0.18	0.03	2.58	6.3	1.1	1.9	0.07	0.45	1.49	0.10	0.37	1.2	1.00	54.5	<1	25	0.1	2.72	<0.2	4	4.3	10
COL4	0.316	0.47	2.15	7.59	1	1.2	0.38	0.38	1.72	0.06	0.59	1.4	0.48	41.9	1	14	0.1	0.02	<0.2	2	2.7	8
COL5-1	0.257	0.44	2.06	10.25	1.4	1.2	0.54	0.31	2	0.09	0.68	1.3	1.25	95.1	2	7	0.1	0.01	<0.2	2	9.6	12
COL5-2	0.287	0.46	2.24	10.45	1.5	1.2	0.57	0.36	2.03	0.08	0.78	1.4	0.86	101	1	8	0.1	0.01	<0.2	2	10	7
COL5 Average	0.27	0.45	2.15	10.4	1.5	1.2	0.56	0.34	2.02	0.09	0.73	1.4	1.06	98.1	2	8	0.1	0.01	<0.2	2	9.8	10
COL6-1	0.283	0.47	2.27	9.07	1.5	1.5	0.54	0.51	2.79	0.1	0.55	1.3	1.16	76.4	<1	20	0.1	0.63	<0.2	3	7.3	11
COL6-2	0.301	0.47	2.24	9.46	1.4	1.4	0.52	0.47	2.83	0.09	0.6	1.4	0.97	75.2	<1	18	0.1	0.47	<0.2	3	6.8	9
COL6 Average	0.29	0.47	2.26	9.3	1.5	1.5	0.53	0.49	2.81	0.10	0.58	1.4	1.07	75.8	<1	19	0.1	0.55	<0.2	3	7.1	10
COL7	0.176	0.07	5.09	24.8	3	1.1	0.09	0.22	1.91	0.1	0.62	0.1	0.61	145	2	6	0.1	0.05	<0.2	3	16.2	17
COL8	0.163	0.03	2.25	7.75	1.4	1.8	0.07	0.43	1.1	0.1	0.43	1.1	0.78	61.3	2	21	0.1	5.33	<0.2	5	7.9	12
COL9	0.212	1.28	3.95	12.4	2	1.6	0.52	0.53	2.07	0.1	0.6	0.7	0.54	59.7	2	15	<0.1	0.28	<0.2	4	4.3	10

Pre Analysis (prior to column set up):																		
	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43	ME-ICP43
SAMPLE	Cu	Fe	Ga	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sc	Sr	Ti	V	Zn
DESCRIPTION	ppm	%	ppm	%	ppm	%	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm
COL1	25.8	2.78	1	0.13	1	0.04	28	0.7	0.01	14.8	30	4.3	3.25	0.6	17	<0.01	3.9	17
COL2	24.8	2.76	1	0.12	1	0.04	27	0.8	0.01	15	30	4.9	3.25	0.6	18	<0.01	3.8	18
COL3	25	2.75	<1	0.11	1	0.04	27	0.7	0.01	14.7	30	4.2	3.24	0.6	17	<0.01	3.4	17
COL1-3 Average	25.2	2.8	1.0	0.1	1.0	0.0	27.3	0.7	0.0	14.8	30.0	4.5	3.2	0.6	17.3	<0.01	3.7	17.3
COL4	18	3.53	1	0.14	1	0.03	20	0.8	0.01	14.3	20	8.1	4.18	1.4	6	<0.01	6.4	22
COL5	17.2	3.54	1	0.13	1	0.03	18	0.8	0.01	14.4	20	8.2	4.21	1.4	6	<0.01	6.3	23
COL6	17.4	3.55	1	0.12	1	0.03	18	0.8	0.01	14.6	20	7.7	4.22	1.4	7	<0.01	5.9	22
COL4-6 Average	17.5	3.5	1.0	0.1	1.0	0.0	18.7	0.8	0.0	14.4	20.0	8.0	4.2	1.4	6.3	<0.01	6.2	22.3
COL7	70.5	4.4	1	0.08	1	0.03	28	1.5	0.01	21.5	20	7.6	5.36	0.8	16	<0.01	4.9	18
COL8	70.9	4.32	1	0.09	1	0.03	29	1.6	0.01	21.8	20	8	5.23	0.8	17	<0.01	5.4	18
COL9	30.7	3.37	2	0.12	1	0.02	19	1.8	0.01	22.6	40	11.6	3.94	1.9	8	<0.01	8.5	41
Post Analysis (after column disbandment):																		
COL1-1	6	1.73	2	0.3	2	0.03	57	1.1	0.01	4.4	30	6	1.32	1	14	<0.01	16.2	6
COL1-2	6.8	1.67	1	0.25	2	0.03	50	0.8	0.01	4.4	30	6.2	1.31	0.8	13	<0.01	11.5	6
COL1 Average	6.4	1.70	1.5	0.28	2	0.03	54	1.0	0.01	4.4	30	6.1	1.32	0.9	14	<0.01	13.9	6
COL2-1	22.8	2.98	1	0.21	1	0.03	34	0.9	<0.01	13.7	30	4.7	3.38	1.1	16	<0.01	10.8	16
COL2-2	21.7	2.99	1	0.16	1	0.03	46	1	<0.01	13.7	30	5.4	3.23	0.9	15	<0.01	7.2	16
COL2 Average	22.3	2.99	1.0	0.19	1	0.03	40	1.0	<0.01	13.7	30	5.1	3.31	1.0	16	<0.01	9.0	16
COL3-1	7.1	1.76	1	0.24	2	0.04	32	0.8	0.01	4.2	40	5.4	1.55	1	35	<0.01	12.9	9
COL3-2	7.8	1.97	1	0.25	2	0.06	36	0.9	0.03	4.2	70	4.7	1.55	1	56	<0.01	14.8	9
COL3 Average	7.5	1.87	1.0	0.25	2	0.05	34	0.9	0.02	4.2	55	5.1	1.55	1.0	46	<0.01	13.9	9
COL4	3.8	1.53	1	0.21	1	0.03	34	1.1	0.01	3.2	10	8.9	1.22	1	5	<0.01	9.1	6
COL5-1	8.7	3.32	3	0.37	1	0.05	59	1.3	0.01	9.8	20	8.4	3.26	2.2	6	<0.01	21.6	15
COL5-2	9.7	3.32	2	0.28	1	0.04	48	0.9	0.01	9.7	20	8.5	3.39	1.6	6	<0.01	14.1	15
COL5 Average	9.2	3.32	2.5	0.33	1	0.05	54	1.1	0.01	9.8	20	8.5	3.33	1.9	6	<0.01	17.9	15
COL6-1	6.9	2.57	2	0.34	1	0.06	37	1.1	0.01	5.7	20	8.5	2.66	2.1	14	<0.01	19.3	9
COL6-2	6.5	2.47	2	0.3	1	0.05	29	1.1	0.01	6.1	20	9	2.59	1.8	11	<0.01	16.7	10
COL6 Average	6.7	2.52	2.0	0.32	1	0.06	33	1.1	0.01	5.9	20	8.8	2.63	2.0	13	<0.01	18.0	10
COL7	57.9	4.94	1	0.15	1	0.02	62	2.2	0.01	17.8	20	7.5	5.15	0.9	13	<0.01	11.1	14
COL8	13.5	2.94	1	0.22	2	0.08	64	1.2	0.01	16.7	60	4.1	2.58	0.8	62	<0.01	11.9	12
COL9	8.2	2.1	1	0.19	1	0.03	33	1.8	0.01	5.7	20	12.4	1.86	1.3	9	<0.01	10.3	8

AECOM

Quattro Column Testing - Analytical Results (No Treatment)

Sample Origin		**COL1**																				
Sample Name					1772443	1773332		1773974	1774182	1774395	1774632		1775205	1775464		1776280	1776571		1777001		1777531	
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17	16-Nov-17	23-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17	21-Dec-17	28-Dec-17
Laboratory Reference					1835335.1	1839708		1847568	1852490.1		1859544.1		1866803.1	1871033		1878876.1	1882573.1		1892103		1900678.1	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
pH	pH Units				4.5	4.2		3.6	3.7		3.2		3	2.7		3	2.8		2.4		2.6	
Acidity (pH 3.7)	g/m3 as CaCO3				< 1.0	< 1.0		< 1.0	< 1.0		109		93	500		380	320		890		610	
Total Alkalinity	g/m3 as CaCO3				< 1.0	10		< 8 #1	< 8		< 8 #1		< 10 #1	< 10		< 10 #1	< 8 #1		< 8		< 10 #1	
Electrical Conductivity (EC)	mS/m				387	335		396	395		384		376	474		344	357		477		449	
Dissolved Aluminium	g/m3				17.6			29			33			42			18					
Dissolved Antimony	g/m3				0.0029			< 0.0010			0.0008			0.0012			0.0007					
Dissolved Barium	g/m3				0.084			0.046			0.037			0.023			0.0191					
Dissolved Calcium	g/m3				470			500			520			540			350					
Dissolved Cobalt	g/m3				3.3			3.4			3.8			4.1			2.8					
Dissolved Iron	g/m3				50			12.7			55			250			90					
Dissolved Magnesium	g/m3	No Leachate	No Leachate	No Leachate	200			230			250			210			131					
Dissolved Manganese	g/m3				9.1			9.4			10			11.8			6					
Dissolved Mercury	g/m3				< 0.00008	< 0.00008		< 0.00008	< 0.00008		0.00018		< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.0003		< 0.00008	
Acid Soluble Mercury	g/m3																					
Dissolved Molybdenum	g/m3				< 0.0010			< 0.0010			< 0.0004			< 0.0010			< 0.0004					
Dissolved Potassium	g/m3				64			77			67			53			43					
Dissolved Selenium	g/m3				0.24			0.09			0.071			0.032			0.008					
Dissolved Silver	g/m3				< 0.0005			< 0.0005			< 0.0002			< 0.0005			< 0.0002					
Dissolved Sodium	g/m3				143			117			14.4			7			2.7					
Dissolved Strontium	g/m3				2.7			2.9			2.9			3			2.4					
Dissolved Uranium	g/m3				0.014			0.025			0.0169			0.028			0.0169					
Dissolved Vanadium	g/m3				< 0.005			< 0.005			< 0.002			0.065			0.015					
Sulphate	g/m3				2800	2200		2800	2900		2800		2600	3100		2300	2300		3000		3000	
Dissolved Heavy Metals																						
Dissolved Arsenic	g/m3				0.04	0.018		< 0.005	0.011		0.019		< 0.005	0.024		0.032	0.021		0.055		0.034	
Dissolved Cadmium	g/m3				0.0143	0.0116		0.0155	0.0152		0.0147		0.0149	0.0178		0.014	0.0139		0.0121		0.0143	
Dissolved Chromium	g/m3				0.016	0.0075		0.02	0.02		0.055		0.067	0.165		0.083	0.073		0.196		0.175	
Dissolved Copper	g/m3				3.4	2.7		3.6	3.6		4.2		3.1	5.6		3.3	3.3		4.3		3.6	
Dissolved Lead	g/m3				0.001	0.0022		0.0076	0.007		0.0109		0.0103	0.0158		0.0038	0.006		0.0127		0.0024	
Dissolved Nickel	g/m3				1.74	1.34		1.79	1.85		1.95		1.81	2.3		1.55	1.55		1.79		2.1	
Dissolved Zinc	g/m3				1.77	1.5		2.1	1.98		2.6		2.1	3.2		2.3	2.4		2.9		3.0	
Field Parameters																						
pH	pH Units				4.78	4.19	3.73	3.46	3.35	2.75	3	2.38	2.82	2.4	1.98	2.16	2.27	2.16	2.05	2.1	1.94	1.55
Electrical Conductivity (EC)	mS/m				183.2	134.2	227	416.8	356	416	407.1	449	378	467	442	382	358	383	461	451	482	652
Temperature	°C				16.5	15.2	15.8	14.8	11.7	18.3	16	14.6	14.4	18.3	17.5	15.8	20.4	20.6	22.3	23.5	19	16.2
Leachate																						
Volume recovered	mL	5	0	0	600	1000	1000	1000	1000	1000	1000	1000	700	600	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	2500	3500	2200	1250	0	500	4500	0	0	1800	0	0	0	0	500	1000	0	100

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																						
Sample Name			1778161		1778828		1779298				1781502				1782588				178709			
Date		4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18	22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18	3-May-18	10-May-18	17-May-18	23-May-18
Laboratory Reference			1907280.1		1914263.1		1921097				1940132.1				1958862.1				1976201.1			
Week (Relative)		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Week		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
pH	pH Units		1.7		1.7		1.5				1.6				1.5				1.8			
Acidity (pH 3.7)	g/m3 as CaCO3		3800		4000		6300				4400				8300				2000			
Total Alkalinity	g/m3 as CaCO3		< 10 #1		< 10 #1		< 8 #1				< 8 #1				< 8 #1				< 8#1			
Electrical Conductivity (EC)	mS/m		1174		1287		1941				1902				2240				841			
Dissolved Aluminium	g/m3						23															
Dissolved Antimony	g/m3						0.005															
Dissolved Barium	g/m3						0.0056															
Dissolved Calcium	g/m3						360															
Dissolved Cobalt	g/m3						5.1															
Dissolved Iron	g/m3						2700															
Dissolved Magnesium	g/m3						137															
Dissolved Manganese	g/m3						6.9															
Dissolved Mercury	g/m3		< 0.00008		< 0.0015		< 0.002				< 0.00008				< 0.00008				< 0.0003			
Acid Soluble Mercury	g/m3																					
Dissolved Molybdenum	g/m3						0.014															
Dissolved Potassium	g/m3						47															
Dissolved Selenium	g/m3						0.025															
Dissolved Silver	g/m3						< 0.0010															
Dissolved Sodium	g/m3						2.3															
Dissolved Strontium	g/m3						2.7															
Dissolved Uranium	g/m3						0.026															
Dissolved Vanadium	g/m3						0.47															
Sulphate	g/m3		7,200		8,100		15,000				14,400				14,400				3,300			
Dissolved Heavy Metals																						
Dissolved Arsenic	g/m3		5.9		7.6		17.8				19.2				26				2.9			
Dissolved Cadmium	g/m3		0.0122		0.021		0.0187				0.0195				0.009				0.00095			
Dissolved Chromium	g/m3		0.64		0.97		1.08				1.29				0.95				0.100			
Dissolved Copper	g/m3		6.4		11		10.2				14.2				6.4				0.81			
Dissolved Lead	g/m3		0.0075		0.0018		0.003				0.002				0.003				0.0020			
Dissolved Nickel	g/m3		2.5		3.8		3.9				3.9				2.9				0.52			
Dissolved Zinc	g/m3		4.0		6.7		5.6				7.1				4.2				0.46			
Field Parameters																						
pH	pH Units		1.38	1.4	1.45	1.35	1.1	1.12	1.48	1.53	2.55	1.27	1.1	1.28	1.03	0.95	0.93	1.2	2.04	1.64	1.78	1.76
Electrical Conductivity (EC)	mS/m		1117	1020	1083	1488	1871	1420	1545	1460	1710	2040	2090	2180	2060	2260	2160	2140	972.5	1099	1266	1426
Temperature	°C		23.4	20.5	23.1	21.9	20.2	27	21.7	21.9	23.3	15.9	16	16.9	22.1	15.2	15.4	18.9	15.2	15.1	15.8	10.7
Leachate																						
Volume recovered	mL	0	1000	700	1000	1000	1000	500	1000	500	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	2000	250	100	400	6500	8500	500	0	0	1500	2000	2000	2000	750	1750	1000	20000*	500	2500	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																							
Sample Name			1786034				1788478					1790040		1790389								1792713	
Date		30-May-18	8-Jun-18	14-Jun-18	20-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18	27-Sep-18	4-Oct-18	11-Oct-18	18-Oct-18	25-Oct-18
Laboratory Reference			1997135				2010659.1					2029323		2036894								2067567	
Week (Relative)		43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Week		43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
pH	pH Units		1.9				1.8					1.8		1.7				1.7				1.5	
Acidity (pH 3.7)	g/m3 as CaCO3		1300				2100					2400		6500				3400				6100	
Total Alkalinity	g/m3 as CaCO3		< 8 #1				< 1.0					< 8		< 8 #1				< 1.0				< 8	
Electrical Conductivity (EC)	mS/m		626				875					914		1014				1138				1583	
Dissolved Aluminium	g/m3											24											
Dissolved Antimony	g/m3											0.0024											
Dissolved Barium	g/m3											0.009											
Dissolved Calcium	g/m3											79											
Dissolved Cobalt	g/m3											0.51											
Dissolved Iron	g/m3											750											
Dissolved Magnesium	g/m3											1											
Dissolved Manganese	g/m3											0.59											
Dissolved Mercury	g/m3		< 0.00008				< 0.00008					< 0.00008		< 0.00008				< 0.0003				< 0.0003	
Acid Soluble Mercury	g/m3																						
Dissolved Molybdenum	g/m3											0.0048											
Dissolved Potassium	g/m3											8.5											
Dissolved Selenium	g/m3											0.009											
Dissolved Silver	g/m3											< 0.0005											
Dissolved Sodium	g/m3											2.4											
Dissolved Strontium	g/m3											0.28											
Dissolved Uranium	g/m3											0.00093											
Dissolved Vanadium	g/m3											0.024											
Sulphate	g/m3		1,790				3,500					3300		3600				4600				8300	
Dissolved Heavy Metals																							
Dissolved Arsenic	g/m3		1.39				2.9					2.7		2.9				5.5				10.2	
Dissolved Cadmium	g/m3		0.00046				0.0011					0.0010		0.00095				0.0015				0.0020	
Dissolved Chromium	g/m3		0.042				0.116					0.100		0.112				0.149				0.33	
Dissolved Copper	g/m3		0.42				0.88					0.81		0.78				1.05				1.5	
Dissolved Lead	g/m3		0.0021				0.0025					0.0033		0.0026				0.0051				0.0042	
Dissolved Nickel	g/m3		0.30				0.63					0.61		0.55				0.70				1.18	
Dissolved Zinc	g/m3		0.22				0.63					0.51		0.45				0.76				1.10	
Field Parameters																							
pH	pH Units	1.63	2.14	2.19	1.95	2.33	2.39	2.72	2.7	1.36	2.65	1.66	1.73	1.76	1.77	1.92	1.71	1.54	1.85	1.92	1.9	1.96	1.63
Electrical Conductivity (EC)	mS/m	1312	700	808	968	1018	690	933	102	1086	998	923	902	995	1089	1089	976	1044	1247	1346	1227	1535	1573
Temperature	°C	11.6	13	15.7	11.7	8.3	7.2	14.3	9.9	12.1	13.5	11.2	13.9	11.2	13.3	11.3	15.5	19.6	14.5	13.8	15.9	15.4	19.4
Leachate																							
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	500
Volume in bucket	mL	1000	20000*	2000	1000	1500	300	250	3250	1750	1250	4200	1000	1500	1250	1000	0	250	500	1000	500	0	250

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																			
Sample Name				1793482		1794275		1794669				1795856				1798033			
Date		1-Nov-18	8-Nov-18	15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	11-Jan-19	17-Jan-19	24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19	21-Feb-19	28-Feb-19
Laboratory Reference				2081545.2		2089933.2		2097419.3				2107812				2120859			
Week (Relative)		65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Week		65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
pH	pH Units			1.6		1.6		1.7				1.8				1.6			
Acidity (pH 3.7)	g/m3 as CaCO3			3600		3500		1800				1950				7600			
Total Alkalinity	g/m3 as CaCO3			< 8		< 10		< 8				< 8				< 1.0			
Electrical Conductivity (EC)	mS/m			1271		1394		928				956				1525			
Dissolved Aluminium	g/m3																		
Dissolved Antimony	g/m3																		
Dissolved Barium	g/m3																		
Dissolved Calcium	g/m3																		
Dissolved Cobalt	g/m3																		
Dissolved Iron	g/m3																		
Dissolved Magnesium	g/m3																		
Dissolved Manganese	g/m3																		
Dissolved Mercury	g/m3			< 0.00008		< 0.0003		< 0.00008				< 0.00015				< 0.0003			
Acid Soluble Mercury	g/m3															0.0006			
Dissolved Molybdenum	g/m3																		
Dissolved Potassium	g/m3																		
Dissolved Selenium	g/m3																		
Dissolved Silver	g/m3																		
Dissolved Sodium	g/m3																		
Dissolved Strontium	g/m3																		
Dissolved Uranium	g/m3																		
Dissolved Vanadium	g/m3																		
Sulphate	g/m3			4400		9700		2800				3100				8500			
Dissolved Heavy Metals																			
Dissolved Arsenic	g/m3			4.8		6.0		4.8				4.2				13.4			
Dissolved Cadmium	g/m3			0.0010		0.0010		0.00058				0.00067				0.0027			
Dissolved Chromium	g/m3			0.145		0.153		0.062				0.083				0.188			
Dissolved Copper	g/m3			0.74		0.78		0.37				0.43				0.84			
Dissolved Lead	g/m3			0.0058		0.0061		0.012				0.0035				< 0.0010			
Dissolved Nickel	g/m3			0.58		0.65		0.28				0.31				0.79			
Dissolved Zinc	g/m3			0.58		0.68		0.34				0.41				0.96			
Field Parameters																			
pH	pH Units	1.86	1.46	1.54	1.61	1.51	1.57	1.55	1.54	1.75	1.74	1.7	1.72	1.48	1.07	1.58	1.74	1.82	2.07
Electrical Conductivity (EC)	mS/m	1915	1848	1183	1220	1161	813	802	1010	737	711	760	820	1169	1302	1268	1638	1760	2640
Temperature	°C	14	17.3	19.8	18.6	25.4	20.2	23.1	20.9	22.3	23.9	24.2	23.3	21	23	22.5	23.7	23.2	20.1
Leachate																			
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	500	1000	1000	1000	850	1000	1000
Volume in bucket	mL	1000	0	6000	200	3000	4000	500	3000	7000	0	0	0	400	1000	1000	250	0	500

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.
* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Quattro Column Testing - Analytical Results (Saturated from 19 Oct 17)

Treatment

Sample Origin		COL2													
Sample Name					1772444	1773333		1773975	1774183	1774396	1774633		1775206	1775465	
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17
Laboratory Reference					1835335.2	1839708.2		1847568.2	1852490.2		1859544.2		1866803.2	1871033.2	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14
pH	pH Units				4.5	4.1		3.8	3.4		2.9		2.8	2.8	
Acidity (pH 3.7)	g/m3 as CaCO3				< 1.0	< 1.0		< 1.0	-		290		240	370	
Total Alkalinity	g/m3 as CaCO3				< 1.0	< 8#		< 8 #1	< 8 #1		< 8 #1		< 10 #1	< 10	
Electrical Conductivity (EC)	mS/m				374	294		363	400		429		437	439	
Dissolved Aluminium	g/m3				13.7			25			52			39	
Dissolved Antimony	g/m3				0.003			0.0005			0.0015			0.0011	
Dissolved Barium	g/m3				0.076			0.039			0.039			0.0198	
Dissolved Calcium	g/m3				430			450			540			480	
Dissolved Cobalt	g/m3				2.8			3			4.1			3.2	
Dissolved Iron	g/m3				34			0.96			163			210	
Dissolved Magnesium	g/m3		No Leachate	No Leachate	176			188			270			190	
Dissolved Manganese	g/m3				8.6			7.6			11.4			9.4	
Dissolved Mercury	g/m3				< 0.00008	< 0.00008		< 0.00008	< 0.00008		0.00025		< 0.00008	< 0.00008	
Dissolved Molybdenum	g/m3				< 0.0004			< 0.0004			< 0.0010			< 0.0010	
Dissolved Potassium	g/m3				60			69			61			50	
Dissolved Selenium	g/m3				0.3			0.106			0.055			0.032	
Dissolved Silver	g/m3				< 0.0002			< 0.0002			< 0.0005			< 0.0005	
Dissolved Sodium	g/m3				141			89			38			16.3	
Dissolved Strontium	g/m3				2.6			2.6			2.9			2.7	
Dissolved Uranium	g/m3				0.0122			0.024			0.031			0.022	
Dissolved Vanadium	g/m3				< 0.002			< 0.002			0.056			0.049	
Sulphate	g/m3				2600	1980		2400	2900		3200		3000	2800	
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3				0.03	0.011		< 0.010	0.007		0.043		0.01	0.022	
Dissolved Cadmium	g/m3				0.0133	0.0097		0.0138	0.016		0.0162		0.0175	0.0151	
Dissolved Chromium	g/m3				0.0175	0.005		0.0143	0.028		0.117		0.09	0.102	
Dissolved Copper	g/m3				3.5	2.6		3.6	4.4		6.1		4.7	4.8	
Dissolved Lead	g/m3				0.0014	0.0018		0.0047	0.0074		0.0157		0.01	0.0074	
Dissolved Nickel	g/m3				1.47	1.09		1.55	1.87		2.3		2.1	1.86	
Dissolved Zinc	g/m3				1.75	1.25		1.85	2.1		2.9		2.6	2.6	
Field Parameters															
pH	pH Units	7.17			4.81	4.34	3.77	3.59	3.2	2.6	2.7	2.38	2.56	2.43	2.28
Electrical Conductivity (EC)	mS/m	6.47			184.9	121.2	208	388.7	356	434	407.2	520	429	428	458
Temperature	°C	13.6			16.9	15.4	15.9	14.7	11.7	17.2	16	14.9	14.4	18.5	19
Leachate															
Volume recovered	mL	90	0	0	520	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	2800	2500	1800	1400	1200	0	5500	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin															
Sample Name		1776281	1776572		1777002		1777532			1778162		1778829		1779299	
Date		16-Nov-17	23-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17	21-Dec-17	28-Dec-17	4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18
Laboratory Reference		1878876.2	1882573.2		1892103.2		1900678.2			1907280.2		1914263.2		1921097.2	
Week (Relative)		15	16	17	18	19	20	21	22	23	24	25	26	27	28
Week		15	16	17	18	19	20	21	22	23	24	25	26	27	28
pH	pH Units	2.8	2.8		2.8		2.8			2.9		2.8		2.7	
Acidity (pH 3.7)	g/m3 as CaCO3	490	470		740		910			540		690		910	
Total Alkalinity	g/m3 as CaCO3	< 10 #1	< 8 #1		< 8		< 10 #1			< 10 #1		< 10 #1		< 8 #1	
Electrical Conductivity (EC)	mS/m	452	441		427		428			416		411		428	
Dissolved Aluminium	g/m3		41											42	
Dissolved Antimony	g/m3		0.0015											< 0.0010	
Dissolved Barium	g/m3		0.0108											0.0011	
Dissolved Calcium	g/m3		460											410	
Dissolved Cobalt	g/m3		3.1											3.2	
Dissolved Iron	g/m3		350											460	
Dissolved Magnesium	g/m3		210											141	
Dissolved Manganese	g/m3		9.2											7.5	
Dissolved Mercury	g/m3	< 0.00008	< 0.00008		< 0.0003		< 0.00008			< 0.00008		< 0.00015		< 0.002	
Dissolved Molybdenum	g/m3		< 0.0010											< 0.0010	
Dissolved Potassium	g/m3		42											39	
Dissolved Selenium	g/m3		0.021											< 0.005	
Dissolved Silver	g/m3		< 0.0005											< 0.0005	
Dissolved Sodium	g/m3		11.6											6.1	
Dissolved Strontium	g/m3		2.6											2.3	
Dissolved Uranium	g/m3		0.0176											0.0127	
Dissolved Vanadium	g/m3		0.141											0.183	
Sulphate	g/m3	3200	3,100		3100		3100			3,200		3,100		3,100	
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3	0.037	0.066		0.104		0.123			0.13		0.101		0.52	
Dissolved Cadmium	g/m3	0.016	0.0155		0.0146		0.0144			0.0160		0.0152		0.0128	
Dissolved Chromium	g/m3	0.144	0.134		0.163		0.151			0.128		0.118		0.156	
Dissolved Copper	g/m3	5	4.6		4.2		3.8			3.3		3.0		2.9	
Dissolved Lead	g/m3	0.0024	0.0014		0.0008		< 0.0005			0.0008		< 0.0010		< 0.0005	
Dissolved Nickel	g/m3	1.93	1.91		2.1		2.2			2.1		2.1		1.96	
Dissolved Zinc	g/m3	3	3		3.3		3.2			3.3		3.3		2.9	
Field Parameters															
pH	pH Units	2.53	2.7	2.43	2.22	2.32	2.26	2.2		2.47	2.49	2.35	2.14	1.89	2.16
Electrical Conductivity (EC)	mS/m	456	425	416	441	447	450	463		434	447	382	470	512	431
Temperature	°C	17.6	20.9	21	23.7	26	21	16.6		24.3	21	24.5	23.2	21.6	27.1
Leachate															
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	0	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin															
Sample Name				1781503				1782589				1783710			
Date		22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18	3-May-18	10-May-18	17-May-18	23-May-18
Laboratory Reference				1940132.2				1958862.2				1976201.2			
Week (Relative)		29	30	31	32	33	34	35	36	37	38	39	40	41	42
Week		29	30	31	32	33	34	35	36	37	38	39	40	41	42
pH	pH Units			2.8				2.9				3.0			
Acidity (pH 3.7)	g/m3 as CaCO3			480				590				630			
Total Alkalinity	g/m3 as CaCO3			< 8 #1				< 8 #1				< 8#1			
Electrical Conductivity (EC)	mS/m			378				320				312			
Dissolved Aluminium	g/m3														
Dissolved Antimony	g/m3														
Dissolved Barium	g/m3														
Dissolved Calcium	g/m3														
Dissolved Cobalt	g/m3														
Dissolved Iron	g/m3														
Dissolved Magnesium	g/m3														
Dissolved Manganese	g/m3														
Dissolved Mercury	g/m3			< 0.00008				< 0.00008				< 0.0003			
Dissolved Molybdenum	g/m3														
Dissolved Potassium	g/m3														
Dissolved Selenium	g/m3														
Dissolved Silver	g/m3														
Dissolved Sodium	g/m3														
Dissolved Strontium	g/m3														
Dissolved Uranium	g/m3														
Dissolved Vanadium	g/m3														
Sulphate	g/m3			2,500				2,600				2,200			
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3			0.85				0.186				0.113			
Dissolved Cadmium	g/m3			0.0103				0.0104				0.0096			
Dissolved Chromium	g/m3			0.108				0.083				0.067			
Dissolved Copper	g/m3			1.99				2.1				1.30			
Dissolved Lead	g/m3			< 0.0002				< 0.0002				< 0.0002			
Dissolved Nickel	g/m3			1.53				1.59				1.25			
Dissolved Zinc	g/m3			2.4				2.6				2.3			
Field Parameters															
pH	pH Units	2.16	2.6	3.52	2.21	2.29	2.35	2.63	2.15	2.16	2.65	2.86	2.79	2.53	2.69
Electrical Conductivity (EC)	mS/m	484	425	385	372	362	335	359	356	358	346	371	318	316	325
Temperature	°C	21.6	21.8	23.7	16.6	16.5	16.4	21.3	15.5	16.3	20	16.9	15.3	15.8	10.4
Leachate															
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin													
Sample Name			1786035				1788479					1790041	Disbanded 16.08.2018
Date		30-May-18	8-Jun-18	14-Jun-18	20-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	
Laboratory Reference			1997135.2				2010659.2					2029323.2	
Week (Relative)		43	44	45	46	47	48	49	50	51	52	53	
Week		43	44	45	46	47	48	49	50	51	52	53	
pH	pH Units		3.1				3.1					3.0	
Acidity (pH 3.7)	g/m3 as CaCO3		400				176					530	
Total Alkalinity	g/m3 as CaCO3		< 8 #1				< 8 #1					< 8	
Electrical Conductivity (EC)	mS/m		278				205					235	
Dissolved Aluminium	g/m3											14.5	
Dissolved Antimony	g/m3											< 0.0010	
Dissolved Barium	g/m3											< 0.005	
Dissolved Calcium	g/m3											250	
Dissolved Cobalt	g/m3											1.32	
Dissolved Iron	g/m3											178	
Dissolved Magnesium	g/m3											71	
Dissolved Manganese	g/m3											3.0	
Dissolved Mercury	g/m3		< 0.00008				< 0.00008					< 0.00008	
Dissolved Molybdenum	g/m3											,< 0.0010	
Dissolved Potassium	g/m3											22	
Dissolved Selenium	g/m3											< 0.005	
Dissolved Silver	g/m3											< 0.0005	
Dissolved Sodium	g/m3											3.5	
Dissolved Strontium	g/m3											1.14	
Dissolved Uranium	g/m3											0.0044	
Dissolved Vanadium	g/m3											0.043	
Sulphate	g/m3		1,810				1,180					1480	
Dissolved Heavy Metals													
Dissolved Arsenic	g/m3		0.182				0.128					0.069	
Dissolved Cadmium	g/m3		0.0076				0.0047					0.0058	
Dissolved Chromium	g/m3		0.049				0.027					0.041	
Dissolved Copper	g/m3		1.02				0.59					0.73	
Dissolved Lead	g/m3		< 0.0002				< 0.0002					< 0.0005	
Dissolved Nickel	g/m3		1.09				0.68					0.86	
Dissolved Zinc	g/m3		1.77				1.29					1.55	
Field Parameters													
pH	pH Units	2.49	3.19	2.77	3.13	3.52	3.65	3.67	3.49	2.67	3.47	2.81	
Electrical Conductivity (EC)	mS/m	351	300	316	290	240	151	249	243	244	223	230	
Temperature	°C	11.6	13.2	16	11.4	9	7	14.2	10.3	12.2	15	12.3	
Leachate													
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Volume in bucket	mL	0	0	0	0	0	0	0	0	0	0	0	

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Quattro Column Testing - Analytical Results (Limestone treated 19 Oct 17)

Treatment

Sample Origin		COL3													
Sample Name					1772445	1773334		1773976	1774184	1774397	1774634		1775207	1775466	
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17
Laboratory Reference					1835335.3	1839708.3		1847568.3	1852490.3		1859544.3		1866803.3	1871033.3	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14
pH	pH Units		No Leachate	No Leachate	4.4	4.2		3.8	3.5		2.8		2.7	2.7	
Acidity (pH 3.7)	g/m3 as CaCO3				< 1.0	< 1.0		< 1.0			220		260	440	
Total Alkalinity	g/m3 as CaCO3				< 1.0	8		< 8 #1	< 8 #1		< 8 #1		< 10 #1	< 10	
Electrical Conductivity (EC)	mS/m				391	313		386	401		425		415	446	
Dissolved Aluminium	g/m3				19			30			43			34	
Dissolved Antimony	g/m3				0.0027			0.0004			< 0.002			0.0013	
Dissolved Barium	g/m3				0.075			0.045			0.029			0.021	
Dissolved Calcium	g/m3				480			470			540			520	
Dissolved Cobalt	g/m3				3.2			3.3			4			3.7	
Dissolved Iron	g/m3				44			1.38			55			140	
Dissolved Magnesium	g/m3				200			200			270			210	
Dissolved Manganese	g/m3				8.7			8.3			9.5			10.5	
Dissolved Mercury	g/m3				< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.00008		< 0.00008	< 0.00008	
Dissolved Molybdenum	g/m3				< 0.0010			< 0.0004			< 0.0004			< 0.0010	
Dissolved Potassium	g/m3				68			70			61			54	
Dissolved Selenium	g/m3				0.22			0.088			0.071			0.023	
Dissolved Silver	g/m3				< 0.0005			< 0.0002			< 0.0010			< 0.0005	
Dissolved Sodium	g/m3				135			95			30			7.5	
Dissolved Strontium	g/m3				2.8			2.8			3			3	
Dissolved Uranium	g/m3				0.016			0.026			0.023			0.023	
Dissolved Vanadium	g/m3				< 0.005			< 0.002			< 0.002			0.023	
Sulphate	g/m3				2800	2100		2700	2900		3000		2700	2800	
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3				0.03	0.015		< 0.010	< 0.005		< 0.010		< 0.002	0.009	
Dissolved Cadmium	g/m3				0.0144	0.011		0.0151	0.0166		0.0163		0.0152	0.0174	
Dissolved Chromium	g/m3				0.018	0.0069		0.0159	0.03		0.074		0.08	0.106	
Dissolved Copper	g/m3				3.9	2.6		3.5	3.7		4.2		3.4	4.6	
Dissolved Lead	g/m3				0.0009	0.0017		0.0052	0.0059		0.0127		0.0101	0.0107	
Dissolved Nickel	g/m3				1.67	1.22		1.7	1.98		2.1		1.85	2	
Dissolved Zinc	g/m3				1.98	1.44		2.1	2.4		2.8		2.5	2.9	
Field Parameters															
pH	pH Units	7.24			4.74	4.23	3.98	3.55	3.25	2.4	2.6	2.36	2.41	2.37	2.14
Electrical Conductivity (EC)	mS/m	6.66			185.5	122.7	218	410.2	359	450	397.5	519	408	442	432
Temperature	°C	13.6			16.3	14.2	15.8	14.4	11.4	17.2	16.1	14.9	14.5	17.1	15.2
Leachate															
Volume recovered	mL	230	0	0	580	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	2850	3800	2500	2000	0	350	3000	0	700	3500	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin															
Sample Name		1776282	1776573		1777003		1777533			1778163		1778830		1779300	
Date		16-Nov-17	25-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17	21-Dec-17	28-Dec-17	4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18
Laboratory Reference		1878876.3	1882573.3		1892103.3		1900678.3			1907280.3		1914263.3		1921097.3	
Week (Relative)		15	16	17	18	19	20	21	22	23	24	25	26	27	28
Week		15	16	17	18	19	20	21	22	23	24	25	26	27	28
pH	pH Units	2.6	2.6		2.2		2.5			1.5		1.6		1.3	
Acidity (pH 3.7)	g/m3 as CaCO3	870	630		1,960		930			5500		4600		11600	
Total Alkalinity	g/m3 as CaCO3	< 10 #1	< 8 #1		< 8		< 10 #1			< 10 #1		< 10 #1		< 8 #1	
Electrical Conductivity (EC)	mS/m	459	434		625		556			1626		1734		2810	
Dissolved Aluminium	g/m3		34											420	
Dissolved Antimony	g/m3		< 0.0010											0.008	
Dissolved Barium	g/m3		0.0118											0.002	
Dissolved Calcium	g/m3		440											480	
Dissolved Cobalt	g/m3		3.5											8.5	
Dissolved Iron	g/m3		181											4100	
Dissolved Magnesium	g/m3		230											250	
Dissolved Manganese	g/m3		9.6											10.7	
Dissolved Mercury	g/m3	< 0.00008	< 0.00008		< 0.0003		< 0.00008			< 0.00008		< 0.0015		< 0.002	
Dissolved Molybdenum	g/m3		< 0.0010											0.033	
Dissolved Potassium	g/m3		38											63	
Dissolved Selenium	g/m3		0.008											0.04	
Dissolved Silver	g/m3		< 0.0005											< 0.002	
Dissolved Sodium	g/m3		4											2.9	
Dissolved Strontium	g/m3		2.8											4.3	
Dissolved Uranium	g/m3		0.023											0.037	
Dissolved Vanadium	g/m3		0.054											0.72	
Sulphate	g/m3	3100	3000		4600		3800			9,600		11,200		22,000	
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3	0.053	0.013		0.82		0.079			12.2		8.5		32	
Dissolved Cadmium	g/m3	0.0175	0.0162		0.0164		0.023			0.0177		0.04		0.032	
Dissolved Chromium	g/m3	0.152	0.127		0.35		0.27			0.89		1.43		1.96	
Dissolved Copper	g/m3	5.9	5.3		6.7		6.1			9.9		21		20	
Dissolved Lead	g/m3	0.0059	0.0045		0.0036		0.0006			0.0012		< 0.0010		< 0.002	
Dissolved Nickel	g/m3	2	2		3		3			3.6		6.4		6.6	
Dissolved Zinc	g/m3	3.4	3.3		4.3		4.5			5.6		10.7		9.4	
Field Parameters															
pH	pH Units	2.01	2.1	1.97	1.82	1.9	1.88	1.35		1.29	1.32	1.45	1.34	0.96	1.11
Electrical Conductivity (EC)	mS/m	493	453	457	648	567	595	951		1486	1393	1462	1960	2630	1790
Temperature	°C	15.3	18.9	19.3	21.8	24.5	17.4	15.1		22.7	20.9	22	21.9	20.8	27.1
Leachate															
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	0	1000	1000	1000	900
Volume in bucket	mL	0	0	0	450	1000	0	50	0	10400	150	0	150	5000	10000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Additional limestone added 1/3/18

Sample Origin															
Sample Name				1781504				1782590				1783711			
Date		22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18	3-May-18	10-May-18	17-May-18	23-May-18
Laboratory Reference				1940132.3				1958862.3				1976201.3			
Week (Relative)		29	30	31	32	33	34	35	36	37	38	39	40	41	42
Week		29	30	31	32	33	34	35	36	37	38	39	40	41	42
pH	pH Units			1.5				1.3				1.6			
Acidity (pH 3.7)	g/m3 as CaCO3			12900				12300				3500			
Total Alkalinity	g/m3 as CaCO3			< 8 #1				< 8 #1				< 8#1			
Electrical Conductivity (EC)	mS/m			2250				3040				1254			
Dissolved Aluminium	g/m3														
Dissolved Antimony	g/m3														
Dissolved Barium	g/m3														
Dissolved Calcium	g/m3														
Dissolved Cobalt	g/m3														
Dissolved Iron	g/m3														
Dissolved Magnesium	g/m3														
Dissolved Manganese	g/m3														
Dissolved Mercury	g/m3			< 0.00008				< 0.00008				< 0.0003			
Dissolved Molybdenum	g/m3														
Dissolved Potassium	g/m3														
Dissolved Selenium	g/m3														
Dissolved Silver	g/m3														
Dissolved Sodium	g/m3														
Dissolved Strontium	g/m3														
Dissolved Uranium	g/m3														
Dissolved Vanadium	g/m3														
Sulphate	g/m3			20,000				20,000				4,500			
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3			30				34				3.7			
Dissolved Cadmium	g/m3			0.0096				0.007				0.0013			
Dissolved Chromium	g/m3			1.03				0.9				0.164			
Dissolved Copper	g/m3			7				5.2				1.10			
Dissolved Lead	g/m3			< 0.0010				< 0.010				0.0042			
Dissolved Nickel	g/m3			3.6				3.3				0.79			
Dissolved Zinc	g/m3			4.2				3.6				0.65			
Field Parameters															
pH	pH Units	1.19		2.56	1.11	1.11	0.92	0.85	0.94	0.69	1.3	1.91	1.5	1.58	1.63
Electrical Conductivity (EC)	mS/m	1998		2030	2660	2670	3860	2750	3080	3190	3220	1462	1168	1936	2130
Temperature	°C	20.7		23.8	16	16.2	17	21.7	14	14.3	17.2	15	15	15.3	10.7
Leachate															
Volume recovered	mL	1000	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	500	0	0	1500	2000	1000	1500	1100	1000	1000	20000*	1000	2100	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin													
Sample Name			1786036				1788480					1790042	Disbanded 16.08.2018
Date		30-May-18	8-Jun-18	14-Jun-18	20-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	
Laboratory Reference			1997135.3				2010659.3					2029323.3	
Week (Relative)		43	44	45	46	47	48	49	50	51	52	53	
Week		43	44	45	46	47	48	49	50	51	52	53	
pH	pH Units		1.8				1.7					1.7	
Acidity (pH 3.7)	g/m3 as CaCO3		2200				3500					3900	
Total Alkalinity	g/m3 as CaCO3		< 8#1				< 8#1					< 8	
Electrical Conductivity (EC)	mS/m		836				1084					972	
Dissolved Aluminium	g/m3											19.2	
Dissolved Antimony	g/m3											0.003	
Dissolved Barium	g/m3											0.008	
Dissolved Calcium	g/m3											165	
Dissolved Cobalt	g/m3											0.45	
Dissolved Iron	g/m3											950	
Dissolved Magnesium	g/m3											1.6	
Dissolved Manganese	g/m3											0.6	
Dissolved Mercury	g/m3		< 0.00008				< 0.00008					< 0.00008	
Dissolved Molybdenum	g/m3											0.011	
Dissolved Potassium	g/m3											4.6	
Dissolved Selenium	g/m3											0.018	
Dissolved Silver	g/m3											< 0.0010	
Dissolved Sodium	g/m3											2.7	
Dissolved Strontium	g/m3											0.24	
Dissolved Uranium	g/m3											0.0007	
Dissolved Vanadium	g/m3											0.021	
Sulphate	g/m3		2,900				9,600					4700	
Dissolved Heavy Metals													
Dissolved Arsenic	g/m3		1.46				3.6					2.7	
Dissolved Cadmium	g/m3		0.00071				0.0013					0.0007	
Dissolved Chromium	g/m3		0.065				0.15					0.123	
Dissolved Copper	g/m3		0.50				0.95					0.61	
Dissolved Lead	g/m3		0.0043				0.0039					0.0019	
Dissolved Nickel	g/m3		0.42				0.82					0.54	
Dissolved Zinc	g/m3		0.32				0.68					0.49	
Field Parameters													
pH	pH Units	1.5	2.1	2.08	2.04	2.37	2.44	2.7	2.62	1.18	2.53	1.62	
Electrical Conductivity (EC)	mS/m	1812	955	1013	1208	1278	839	1140	1310	1243	109	1017	
Temperature	°C	11.3	12.3	15.5	11.5	7.9	7.5	13.7	10.1	11.9	12.8	11.5	
Leachate													
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Volume in bucket	mL	1000	15000	2000	2000	3000	200	500	3250	2200	2250	1000	

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Quattro Column Testing - Analytical Results

Sample Origin		**COL4**																		
Sample Name					1772446	1773335		1773977	1774185	1774398	1774635		1775208	1775467		1776283	1776574		1777004	
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17	16-Nov-17	23-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17
Laboratory Reference					1835335.4	1839708.4		1847568.4	1852490.4		1859544.4		1866803.4	1871033.4		1878876.4	1882573.4		1892103.4	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
pH	pH Units				3.8	4		3.8	3.8		3.2		3.1	2.9		3	2.8		2.6	
Acidity (pH 3.7)	g/m3 as CaCO3				< 1.0	< 1.0		< 1.0	< 1.0		44		97	330		1,670	1,520		1,690	
Total Alkalinity	g/m3 as CaCO3				< 1.0	< $8^{\#}$		< 8 #1	< 8 #1		< 8 #1		< 10 #1	< 10		< 10 #1	< 8 #1		< 8	
Electrical Conductivity (EC)	mS/m				307	177.4		171.4	144.1		260		275	415		410	421		419	
Dissolved Aluminium	g/m3				197			87			240			480			440			
Dissolved Antimony	g/m3				0.0034			0.0005			0.0005			< 0.0010			< 0.0010			
Dissolved Barium	g/m3				0.049			0.028			0.024			0.0194			0.0154			
Dissolved Calcium	g/m3				176			92			141			181			105			
Dissolved Cobalt	g/m3				3.4			1.86			3.1			4.4			3.1			
Dissolved Iron	g/m3				56			20			25			89			220			
Dissolved Magnesium	g/m3		No Leachate	No Leachate	80			50			80			91			50			
Dissolved Manganese	g/m3				3.7			2.1			2.8			4.5			4.2			
Dissolved Mercury	g/m3				< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.00008		< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.0003	
Acid Soluble Mercury	g/m3																			
Dissolved Molybdenum	g/m3				0.0004			< 0.0002			< 0.0004			< 0.0010			< 0.0010			
Dissolved Potassium	g/m3				72			56			63			60			30			
Dissolved Selenium	g/m3				0.05			0.021			0.036			0.03			0.01			
Dissolved Silver	g/m3				< 0.0002			< 0.00010			< 0.0002			< 0.0005			< 0.0005			
Dissolved Sodium	g/m3				45			24			4.9			4.5			2.2			
Dissolved Strontium	g/m3				1.01			0.51			0.73			1			0.65			
Dissolved Uranium	g/m3				0.025			0.0144			0.025			0.033			0.023			
Dissolved Vanadium	g/m3				0.004			< 0.0010			< 0.002			0.005			0.04			
Sulphate	g/m3				2700	1210		1100	890		2100		2200	3,600		4500	4,600		4100	
Dissolved Heavy Metals																				
Dissolved Arsenic	g/m3				0.027	0.016		0.005	0.0025		0.004		< 0.002	0.006		0.011	< 0.005		0.04	
Dissolved Cadmium	g/m3				0.029	0.0152		0.0155	0.0125		0.02		0.024	0.03		0.02	0.022		0.0159	
Dissolved Chromium	g/m3				0.069	0.023		0.0149	0.0086		0.061		0.066	0.22		0.35	0.34		0.41	
Dissolved Copper	g/m3				3.1	1.58		1.46	1.28		3.4		2.1	4		2.9	3		2.3	
Dissolved Lead	g/m3				0.013	0.0073		0.0102	0.0072		0.0195		0.028	0.032		0.0103	0.0093		0.0032	
Dissolved Nickel	g/m3				2.3	1.25		1.25	1.09		2.2		2.4	3.2		2.1	2.5		2.1	
Dissolved Zinc	g/m3				2.8	1.57		1.62	1.38		3.1		3.1	4.9		5.2	5.4		5	
Field Parameters																				
pH	pH Units	7.45			4.23	4.13	4.01	3.64	3.65	3	3.1	2.57	2.97	2.48	2.33	2.44	2.25	2.14	1.95	1.95
Electrical Conductivity (EC)	mS/m	8.38			169.1	92.8	148.3	181.8	122	140	271.5	324	281	411	416	439	436	409	460	435
Temperature	°C	13.7			18.8	14.5	15.8	15	11.3	18	15.4	14.1	14.3	17.5	17.3	16.6	21.9	20.9	22.8	27
Leachate																				
Volume recovered	mL	480	0	0	830	1000	1000	1000	1000	1000	1000	1000	750	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	3500	3200	1500	1700	0	600	3500	0	0	2500	0	0	0	0	1500	1200

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.
* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																					
Sample Name		1777534			1778164		1778831		1779301				1781505				1782591				1783712
Date		21-Dec-17	28-Dec-17	4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18	22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18	3-May-18
Laboratory Reference		1900678.4			1907280.4		1914263.4		1921097.4				1940132.4				1958862.4				1976201.4
Week (Relative)		20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Week		20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
pH	pH Units	2.6			2.1		2		1.6				1.6				1.5				1.9
Acidity (pH 3.7)	g/m3 as CaCO3	2,300			3000		2900		9600				4800				8200				2100
Total Alkalinity	g/m3 as CaCO3	< 10 #1			< 10 #1		< 10 #1		< 8 #1				< 8 #1				< 8 #1				< 8#1
Electrical Conductivity (EC)	mS/m	485			773		1141		1651				1757				1950				725
Dissolved Aluminium	g/m3								550												
Dissolved Antimony	g/m3								0.003												
Dissolved Barium	g/m3								< 0.0010												
Dissolved Calcium	g/m3								26												
Dissolved Cobalt	g/m3								2.3												
Dissolved Iron	g/m3								3300												
Dissolved Magnesium	g/m3								16.2												
Dissolved Manganese	g/m3								1.90												
Dissolved Mercury	g/m3	< 0.00008			< 0.00008		< 0.0015		< 0.002				< 0.00008				< 0.00008				< 0.0003
Acid Soluble Mercury	g/m3																				
Dissolved Molybdenum	g/m3								0.003												
Dissolved Potassium	g/m3								5.4												
Dissolved Selenium	g/m3								0.016												
Dissolved Silver	g/m3								< 0.0010												
Dissolved Sodium	g/m3								7.2												
Dissolved Strontium	g/m3								0.182												
Dissolved Uranium	g/m3								0.0166												
Dissolved Vanadium	g/m3								0.62												
Sulphate	g/m3	5000			8,200		12,300		15,200				16,100				13,300				3,300
Dissolved Heavy Metals																					
Dissolved Arsenic	g/m3	0.023			2.9		4.2		9.3				16.2				22				2.3
Dissolved Cadmium	g/m3	0.0164			0.0144		0.021		0.015				0.014				0.008				0.0016
Dissolved Chromium	g/m3	0.47			0.83		1.35		0.95				0.91				0.56				0.085
Dissolved Copper	g/m3	1.92			2.9		4.1		4.1				4.9				2.5				0.54
Dissolved Lead	g/m3	0.001			0.0024		< 0.0010		< 0.0010				< 0.0010				< 0.010				0.0049
Dissolved Nickel	g/m3	2.1			1.52		2.4		2.2				2.1				1.65				0.4
Dissolved Zinc	g/m3	5			5.1		8		5.6				6.3				4.1				0.56
Field Parameters																					
pH	pH Units	1.9	1.6		1.58	1.73	1.7	1.54	1.16	1.11	1.33		2.6	1.14	1.19	1.27	1.21	0.83	0.97	1.23	2.03
Electrical Conductivity (EC)	mS/m	526	720		838	806	986	1343	1659	1631	1608		1580	1775	1739	1673	1803	1855	1926	1903	846
Temperature	°C	18.6	15.1		23.6	20.6	22.2	21.8	21.0	28.2	20.7		23.8	16.8	16.4	17.2	22.6	16.1	17.4	20.1	16.6
Leachate																					
Volume recovered	mL	1000	1000	0	1000	800	1000	1000	1000	600	1000	0	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	200	0	15600	300	0	1200	6500	12500	500	0	0	2500	2000	1000	2000	1750	2500	1000	20000*

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																					
Sample Name						1786037				1788481					1790043		1790390				1791724
Date		10-May-18	17-May-18	23-May-18	30-May-18	8-Jun-18	14-Jun-18	20-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18
Laboratory Reference						1997135.4				2010659.4					2029323.4		2036894.2				2052842
Week (Relative)		40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Week		40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
pH	pH Units					1.9				1.8					1.7		1.8				1.7
Acidity (pH 3.7)	g/m3 as CaCO3					1350				2500					3800		3400				4300
Total Alkalinity	g/m3 as CaCO3					< 8#1				< 8 #1					< 8		< 8 #1				< 1.0
Electrical Conductivity (EC)	mS/m					645				983					1040		958				1068
Dissolved Aluminium	g/m3														59						
Dissolved Antimony	g/m3														0.002						
Dissolved Barium	g/m3														0.006						
Dissolved Calcium	g/m3														10.5						
Dissolved Cobalt	g/m3														0.76						
Dissolved Iron	g/m3														1150						
Dissolved Magnesium	g/m3														1.9						
Dissolved Manganese	g/m3														0.53						
Dissolved Mercury	g/m3					< 0.00008				< 0.00008					< 0.00008		< 0.00008				< 0.0003
Acid Soluble Mercury	g/m3																				
Dissolved Molybdenum	g/m3														0.004						
Dissolved Potassium	g/m3														9.2						
Dissolved Selenium	g/m3														< 0.010						
Dissolved Silver	g/m3														< 0.0010						
Dissolved Sodium	g/m3														4.6						
Dissolved Strontium	g/m3														0.087						
Dissolved Uranium	g/m3														0.0015						
Dissolved Vanadium	g/m3														0.063						
Sulphate	g/m3					1,960				3,800					4600		4100				5100
Dissolved Heavy Metals																					
Dissolved Arsenic	g/m3					1.38				4.5							4.8				6.9
Dissolved Cadmium	g/m3					0.00088				0.0019							0.0019				0.0022
Dissolved Chromium	g/m3					0.038				0.083							0.094				0.102
Dissolved Copper	g/m3					0.34				0.64							0.80				0.82
Dissolved Lead	g/m3					0.0080				0.0129							0.0073				0.0038
Dissolved Nickel	g/m3					0.27				0.53							0.55				0.64
Dissolved Zinc	g/m3					0.32				0.74							0.72				0.81
Field Parameters																					
pH	pH Units	1.63	1.67	1.77	1.48	2.24	2.19	2.05	2.3	2.27	2.69	2.71	1.27	2.7	1.63	1.76	1.82	1.84	1.69	1.52	1.52
Electrical Conductivity (EC)	mS/m	999	1379	1621	1476	727	906	1100	1134	722	972	968	1014	864	1040	995	931	1000	1127	953	968
Temperature	°C	15.4	16.8	10.1	11.9	13.9	15.1	11.3	8.9	6.8	14.2	10.1	11.7	13.4	12.2	14.1	11.4	12.8	10.9	15.9	20.1
Leachate																					
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	500	2500	1000	2000	20000*	2000	1000	1500	150	1000	3000	2000	2000	3000	1000	1000	2000	1000	0	250

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																						
Sample Name					1792714				1793484				1794667								1798035	
Date		27-Sep-18	4-Oct-18	11-Oct-18	18-Oct-18	25-Oct-18	1-Nov-18	8-Nov-18	15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	10-Jan-19	17-Jan-19	24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19
Laboratory Reference					2067567				2081545.4				2097419.1								2120859.3	
Week (Relative)		60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Week		60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
pH	pH Units				1.5				1.5				1.6								1.6	
Acidity (pH 3.7)	g/m3 as CaCO3				6500				5200				3000								4800	
Total Alkalinity	g/m3 as CaCO3				< 8				< 8				< 8								< 1.0	
Electrical Conductivity (EC)	mS/m				1636				1664				1280								1597	
Dissolved Aluminium	g/m3																					
Dissolved Antimony	g/m3																					
Dissolved Barium	g/m3																					
Dissolved Calcium	g/m3																					
Dissolved Cobalt	g/m3																					
Dissolved Iron	g/m3																					
Dissolved Magnesium	g/m3																					
Dissolved Manganese	g/m3																					
Dissolved Mercury	g/m3				< 0.0003				< 0.00008				< 0.00008								< 0.0003	
Acid Soluble Mercury	g/m3																				< 0.0003	
Dissolved Molybdenum	g/m3																					
Dissolved Potassium	g/m3																					
Dissolved Selenium	g/m3																					
Dissolved Silver	g/m3																					
Dissolved Sodium	g/m3																					
Dissolved Strontium	g/m3																					
Dissolved Uranium	g/m3																					
Dissolved Vanadium	g/m3																					
Sulphate	g/m3				9900				7300				4900								7100	
Dissolved Heavy Metals																						
Dissolved Arsenic	g/m3				14.4				12.0				8.1								8.7	
Dissolved Cadmium	g/m3				0.0030				0.0021				0.0016								0.0015	
Dissolved Chromium	g/m3				0.21				0.135				0.109								0.24	
Dissolved Copper	g/m3				1.20				0.66				0.47								0.92	
Dissolved Lead	g/m3				0.0053				0.024				0.031								0.0038	
Dissolved Nickel	g/m3				1.06				0.72				0.45								0.74	
Dissolved Zinc	g/m3				1.31				0.83				0.69								0.83	
Field Parameters																						
pH	pH Units	1.69	1.81	1.77	1.98	1.75	1.78	1.45	1.51	1.55	1.65	1.55	1.45	1.52	1.75	1.65	1.8	1.81	1.44	1.22	1.37	1.78
Electrical Conductivity (EC)	mS/m	1352	1171	1134	1563	1448	2470	1844	1481	1243	1102	1158	1113	1166	800	752	980	895	1329	1212	1348	1338
Temperature	°C	14.4	13.2	15.6	15.6	20.1	13.8	17.2	21	20.7	25.7	18.2	22.8	21.3	21.3	23.9	24.5	22.8	21.3	21.2	22.2	24.1
Leachate																						
Volume recovered	mL	1000	0	1000	1000	250	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	500	1000	1000	1000	750
Volume in bucket	mL	1000	600	0	1000	0	2000	250	3500	100	3000	3000	100	2500	7000	200	0	1000	500	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																
Sample Name				1799532		1800052		1800597		1801350		1801895				1802878
Date		21-Feb-19	28-Feb-19	7-Mar-19	14-Mar-19	22-Mar-19	28-Mar-19	4-Apr-19	11-Apr-19	18-Apr-19	24-Apr-19	3-May-19	9-May-19	14-May-19	23-May-19	30-May-19
Laboratory Reference				2138146.1		2147390		2155397		2164341.4		2170480				2185913
Week (Relative)		81	82	83	84	85	86	87	88	89	90	91	40	41	42	43
Week		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
pH	pH Units			1.5		1.5		1.4		1.5		1.5				1.6
Acidity (pH 3.7)	g/m3 as CaCO3			8700		9400		6600		7200		5200				4800
Total Alkalinity	g/m3 as CaCO3			< 8		< 8		< 8		< 10		< 10				< 10
Electrical Conductivity (EC)	mS/m			2030		2270		2170		2120		1722				1443
Dissolved Aluminium	g/m3							100				96				
Dissolved Antimony	g/m3							< 0.004				0.0033				
Dissolved Barium	g/m3							< 0.005				0.007				
Dissolved Calcium	g/m3							17.8				25				
Dissolved Cobalt	g/m3							1.1				0.94				
Dissolved Iron	g/m3							2600				1890				
Dissolved Magnesium	g/m3							2.5				2.7				
Dissolved Manganese	g/m3							0.68				0.61				
Dissolved Mercury	g/m3			< 0.0004		< 0.00016		< 0.00016		< 0.0004		<0.00008				< 0.00008
Acid Soluble Mercury	g/m3					< 0.00016		< 0.00008				< 0.00008				
Dissolved Molybdenum	g/m3							0.008				0.0072				
Dissolved Potassium	g/m3							8.4				10.8				
Dissolved Selenium	g/m3							0.03				0.021				
Dissolved Silver	g/m3							< 0.002				< 0.0005				
Dissolved Sodium	g/m3							5.8				6.3				
Dissolved Strontium	g/m3							0.141				0.138				
Dissolved Uranium	g/m3							0.0042				0.004				
Dissolved Vanadium	g/m3							0.14				0.154				
Sulphate	g/m3			11900		12800		10200		10500		9800				7500
Dissolved Heavy Metals																
Dissolved Arsenic	g/m3			19.9		18.2		12.4		16.9		10.8				7.5
Dissolved Cadmium	g/m3			< 0.005		0.0047		0.0029		0.0033		0.003				0.0022
Dissolved Chromium	g/m3			0.25		0.37		0.181		0.21		0.176				0.087
Dissolved Copper	g/m3			1.02		1.21		0.91		0.72		0.81				0.53
Dissolved Lead	g/m3			< 0.01		0.006		0.022		0.061		0.059				0.054
Dissolved Nickel	g/m3			0.94		1.13		0.98		0.77		0.83				0.53
Dissolved Zinc	g/m3			1.35		1.42		1.03		1.27		0.9				0.78
Field Parameters																
pH	pH Units	1.78	1.91	1.67	1.97	1.81	1.62	1.84	1.6	1.7	1.74	1.85	1.94	2.06	1.94	2.27
Electrical Conductivity (EC)	mS/m	1543	1824	1727	1792	1966	1961	1466	1445	1458	1354	1156	1127	1134	978	1122
Temperature	°C	23	21.8	23	20.4	17.5	19.9	14.7	18.1	17.6	18.1	16.6	14.7	11.5	16.6	9.3
Leachate																
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	1000	500	500	250	500	1000	3000	0	1000	0	0	0	0	0	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.
* Bucket overflowing. Volume assumed to be 20 L.

Quattro Column Testing - Analytical Results (Saturated from 19 Oct 17)

Sample Origin		COL5																				
Sample Name					1772447	1773336		1773978	1774186	1774399	1774636		1775209	1775468		1776284	1776575		1777005		1777535	
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17	16-Nov-17	23-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17	21-Dec-17	28-Dec-17
Laboratory Reference					1835335.5	1839708.5		1847569.5	1852490.5		1859544.5		1866803.5	1871033.5		1878876.5	1882573.5		1892103.5		1900678.5	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
pH	pH Units				4	3.8		3.8	3.8		3		2.8	2.8		2.9	2.9		2.9		2.8	
Acidity (pH 3.7)	g/m3 as CaCO3				< 1.0	< 1.0		< 1.0	< 1.0		340		350	480		690	650		1,860		1,050	
Total Alkalinity	g/m3 as CaCO3				< 1.0	< 8[#]		< 8 #1	< 8 #1		< 8 #1		< 10 #1	< 10		< 10 #1	< 8 #1		< 8		< 10 #1	
Electrical Conductivity (EC)	mS/m				180.1	137.2		151.4	165.1		366		408	406		388	377		363		376	
Dissolved Aluminium	g/m3				80			72			460			420			300					
Dissolved Antimony	g/m3				0.0025			0.0003			0.0012			< 0.0010			< 0.0010					
Dissolved Barium	g/m3				0.043			0.029			0.028			0.0171			0.0135					
Dissolved Calcium	g/m3				99			94			162			173			122					
Dissolved Cobalt	g/m3				1.86			1.58			4			3.6			2.8					
Dissolved Iron	g/m3				37			1.6			128			107			300					
Dissolved Magnesium	g/m3		No Leachate	No Leachate	44			42			95			82			72					
Dissolved Manganese	g/m3				1.89			1.71			4.5			4.4			5.9					
Dissolved Mercury	g/m3				< 0.00008	< 0.00008		< 0.00008	< 0.00008		0.0001		< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.0003		< 0.00008	
Acid Soluble Mercury	g/m3																					
Dissolved Molybdenum	g/m3				< 0.0002			< 0.0002			< 0.0004			< 0.0010			< 0.0004					
Dissolved Potassium	g/m3				57			55			62			58			44					
Dissolved Selenium	g/m3				0.026			0.0164			0.036			0.019			0.006					
Dissolved Silver	g/m3				< 0.00010			< 0.00010			< 0.0002			< 0.0005			< 0.0005					
Dissolved Sodium	g/m3				22			14.9			5.5			4.9			3.9					
Dissolved Strontium	g/m3				0.57			0.49			0.87			0.93			0.69					
Dissolved Uranium	g/m3				0.0116			0.0136			0.029			0.032			0.021					
Dissolved Vanadium	g/m3				0.0015			< 0.0010			0.022			0.011			0.047					
Sulphate	g/m3				1300	860		960	1110		3800		3900	3300		3600	3500		3500		65	
Dissolved Heavy Metals																						
Dissolved Arsenic	g/m3				0.02	0.0092		0.0025	0.001		< 0.010		0.005	0.005		< 0.005	< 0.002		< 0.005		< 0.010	
Dissolved Cadmium	g/m3				0.0161	0.0111		0.0125	0.0138		0.024		0.028	0.028		0.022	0.021		0.021		0.021	
Dissolved Chromium	g/m3				0.026	0.0092		0.0146	0.02		0.182		0.24	0.22		0.24	0.195		0.24		0.26	
Dissolved Copper	g/m3				1.82	1.27		1.21	1.33		3.4		3.4	2.7		2.2	1.83		1.43		1.01	
Dissolved Lead	g/m3				0.0041	0.0036		0.0058	0.0047		0.0182		0.02	0.0164		0.0064	0.0051		0.0036		0.002	
Dissolved Nickel	g/m3				1.25	0.93		1.09	1.26		3		3.1	2.7		2.2	2.2		2.5		2.1	
Dissolved Zinc	g/m3				1.48	1.16		1.36	1.44		4.2		4.4	3.9		3.9	3.9		4.4		4.4	
Field Parameters																						
pH	pH Units	7.1			4.24	3.95	4.11	3.58	3.47	2.85	2.95	2.43	2.43	2.47	2.42	2.65	3.1	2.52	2.43	2.36	2.37	2.1
Electrical Conductivity (EC)	mS/m	7.18			123.4	79.7	117.4	161.2	127	163	397.5	434	395	392	391	397	369	375	393	400	408	430
Temperature	°C	13.7			16.2	13.9	15.5	14.8	11.3	17.4	16.2	13.9	14.5	18.7	19.6	17.3	24.2	20.8	24.4	27.5	20.4	14.7
Leachate																						
Volume recovered	mL	100	0	0	910	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	3400	3000	2000	2400	0	1150	6000	0	0	0	0	0	0	0	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																							
Sample Name			1778165		1778832		1779302				1781505				1782592				1783713				
Date		4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18	22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18	3-May-18	10-May-18	17-May-18	23-May-18	30-May-18
Laboratory Reference			1907280.5		1914263.5		1921097.5				1940132.5				1958862.5				1976201.5				
Week (Relative)		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Week		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
pH	pH Units		2.8		2.9		2.9				3.2				3.1				3.0				
Acidity (pH 3.7)	g/m3 as CaCO3		1370		880		1060				290				760				440				
Total Alkalinity	g/m3 as CaCO3		< 10 #1		< 10 #1		< 8 #1				< 8				< 8 #1				< 8 #1				
Electrical Conductivity (EC)	mS/m		335		354		342				201				250				266				
Dissolved Aluminium	g/m3						240																
Dissolved Antimony	g/m3						< 0.0004																
Dissolved Barium	g/m3						0.0052																
Dissolved Calcium	g/m3						72																
Dissolved Cobalt	g/m3						2.2																
Dissolved Iron	g/m3						550																
Dissolved Magnesium	g/m3						34																
Dissolved Manganese	g/m3						4.1																
Dissolved Mercury	g/m3		< 0.00008		< 0.00015		< 0.002				< 0.00008				< 0.00008				< 0.0003				
Acid Soluble Mercury	g/m3																						
Dissolved Molybdenum	g/m3						< 0.0004																
Dissolved Potassium	g/m3						37																
Dissolved Selenium	g/m3						0.006																
Dissolved Silver	g/m3						< 0.0002																
Dissolved Sodium	g/m3						3.5																
Dissolved Strontium	g/m3						0.51																
Dissolved Uranium	g/m3						0.0147																
Dissolved Vanadium	g/m3						0.079																
Sulphate	g/m3		3,500		3,500		3,500				1,380				2,400				2,600				
Dissolved Heavy Metals																							
Dissolved Arsenic	g/m3		<0.02		< 0.010		0.003				< 0.002				< 0.010				0.003				
Dissolved Cadmium	g/m3		0.0185		0.0173		0.0156				0.0059				0.0075				0.0076				
Dissolved Chromium	g/m3		0.23		0.21		0.175				0.081				0.135				0.118				
Dissolved Copper	g/m3		0.77		0.53		0.27				0.048				0.33				0.194				
Dissolved Lead	g/m3		0.0018		0.0016		0.0009				0.00086				0.0011				0.0003				
Dissolved Nickel	g/m3		2.0		1.9		1.70				0.65				0.85				0.79				
Dissolved Zinc	g/m3		4.2		4.1		3.2				1.70				2.6				2.3				
Field Parameters																							
pH	pH Units		2.34	2.47	2.4	2.4	2.22	2.23	2.44	2.76	4.08	2.46	2.39	2.49	2.79	2.1	2.14	2.79	2.89	2.87	2.49	2.76	2.44
Electrical Conductivity (EC)	mS/m		392	388	333	389	378	338	397	324	183.2	243	272	259	276	285	313	279	601	25.2	266	267	300
Temperature	°C		24.5	22	23.7	23.4	22.4	30.3	20.7	21.7	23.3	17.4	17.3	17.4	20.3	15.1	15.3	18.8	16.3	15.4	15.1	10.1	12.1
Leachate																							
Volume recovered	mL	0	1000	1000	1000	1000	1000	600	1000	900	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																								
Sample Name		1786038				1788482					1790044		1790391				1791725				1792715			
Date		8-Jun-18	14-Jun-18	20-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18	27-Sep-18	4-Oct-18	11-Oct-18	18-Oct-18	25-Oct-18	1-Nov-18	8-Nov-18
Laboratory Reference		1997135.5				2010659.5					2029323.5		2036894.3				2052842				2067567			
Week (Relative)		44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
Week		44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
pH	pH Units	3.1				3.1					3.1		3				2.8				2.6			
Acidity (pH 3.7)	g/m3 as CaCO3	250				180					310		134				290				450			
Total Alkalinity	g/m3 as CaCO3	< 8#1				< 8 #1					< 8		< 8 #1				< 1.0				< 8			
Electrical Conductivity (EC)	mS/m	240				208					150.1		122.5				197.0				177.1			
Dissolved Aluminium	g/m3										65													
Dissolved Antimony	g/m3										< 0.0002													
Dissolved Barium	g/m3										< 0.005													
Dissolved Calcium	g/m3										15													
Dissolved Cobalt	g/m3										0.48													
Dissolved Iron	g/m3										188													
Dissolved Magnesium	g/m3										9.9													
Dissolved Manganese	g/m3										0.37													
Dissolved Mercury	g/m3	< 0.00008				< 0.00008					< 0.00008		< 0.00008				< 0.00008				< 0.00008			
Acid Soluble Mercury	g/m3																							
Dissolved Molybdenum	g/m3										< 0.0002													
Dissolved Potassium	g/m3										13.5													
Dissolved Selenium	g/m3										0.002													
Dissolved Silver	g/m3										< 0.00010													
Dissolved Sodium	g/m3										3.4													
Dissolved Strontium	g/m3										0.123													
Dissolved Uranium	g/m3										0.0031													
Dissolved Vanadium	g/m3										0.0058													
Sulphate	g/m3	1,780				1,470					860		670				1070				980			
Dissolved Heavy Metals																								
Dissolved Arsenic	g/m3	0.003				< 0.002					0.0059		< 0.0010				0.0045				0.0028			
Dissolved Cadmium	g/m3	0.0062				0.0053					0.0040		0.0029				0.0024				0.0030			
Dissolved Chromium	g/m3	0.099				0.072					0.032		0.039				0.073				0.072			
Dissolved Copper	g/m3	0.134				0.076					0.184		0.32				0.5				0.44			
Dissolved Lead	g/m3	0.0003				0.0002					0.00044		0.00030				0.00039				0.00044			
Dissolved Nickel	g/m3	0.65				0.58					0.43		0.29				0.25				0.35			
Dissolved Zinc	g/m3	2.1				1.90					1.38		0.95				1.22				1.25			
Field Parameters																								
pH	pH Units	3.25	2.73	2.86	3.58	3.61	3.52	3.65	2.88	3.47	3	2.95	2.94	2.7	1.24	2.69	2.52	2.6	2.49	2.64	2.45	2.25		2.13
Electrical Conductivity (EC)	mS/m	265	259	272	231	156	228	189	201	170	141	146.5	126	179.8	255	174	214	211	238	174	197	195		467
Temperature	°C	13.4	16.2	11.2	7.8	6	13.9	10.7	10.1	13.6	11.5	14.1	11	14.1	10.2	14.6	19.6	14.8	12.7	15.8	15.6	21.9		17.2
Leachate																								
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	500	0	1000
Volume in bucket	mL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																	
Sample Name		1793483				1794668				1795857		1797638		1798034			
Date		15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	11-Jan-19	17-Jan-19	24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19	21-Feb-19	28-Feb-19
Laboratory Reference		2081545.3				2097419.2				2107812.3		2114738.3		2120859.2			
Week (Relative)		67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
Week		67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
pH	pH Units	2.3				2.5				2.6		2.5		2.6			
Acidity (pH 3.7)	g/m3 as CaCO3	2700				1020				2200		960		1270			
Total Alkalinity	g/m3 as CaCO3	< 8				< 8				< 8		< 1.0		< 1.0			
Electrical Conductivity (EC)	mS/m	624				617				537		587		554			
Dissolved Aluminium	g/m3																
Dissolved Antimony	g/m3																
Dissolved Barium	g/m3																
Dissolved Calcium	g/m3																
Dissolved Cobalt	g/m3																
Dissolved Iron	g/m3																
Dissolved Magnesium	g/m3																
Dissolved Manganese	g/m3																
Dissolved Mercury	g/m3	< 0.00008				< 0.00008				< 0.0003		< 0.0003		< 0.0003			
Acid Soluble Mercury	g/m3													0.0004			
Dissolved Molybdenum	g/m3																
Dissolved Potassium	g/m3																
Dissolved Selenium	g/m3																
Dissolved Silver	g/m3																
Dissolved Sodium	g/m3																
Dissolved Strontium	g/m3																
Dissolved Uranium	g/m3																
Dissolved Vanadium	g/m3																
Sulphate	g/m3	5500				5700				5400		5,200		5400			
Dissolved Heavy Metals																	
Dissolved Arsenic	g/m3	0.25				0.184				0.144		0.21		0.25			
Dissolved Cadmium	g/m3	0.0094				0.0103				0.0096		0.0091		0.0090			
Dissolved Chromium	g/m3	0.53				0.59				0.57		0.56		0.56			
Dissolved Copper	g/m3	3.3				3.7				2.1		2		1.85			
Dissolved Lead	g/m3	< 0.0005				< 0.0005				< 0.0005		< 0.0005		< 0.0005			
Dissolved Nickel	g/m3	1.14				1.19				0.82		0.97		0.88			
Dissolved Zinc	g/m3	4.3				4.6				3.7		4		3.3			
Field Parameters																	
pH	pH Units	2.2	1.74	2.14	2.07	2.05	2.09	2.25	2.22	2.27	2.41	2.4	2.29	2.3	2.45	2.51	2.4
Electrical Conductivity (EC)	mS/m	580	322	544	564	569	570	536	512	512	511	503	486	487	494	446	472
Temperature	°C	21.3	25.8	27.4	18.6	24	21	22.2	24.9	25.2	23.7	22.8	22.9	24.5	24	23.1	22.3
Leachate																	
Volume recovered	mL	1000	1000	1000	1000	1000	1000	100	1000	1000	1000	1000	1000	1000	350	1000	1000
Volume in bucket	mL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Quattro Column Testing - Analytical Results (Limestone treated 19 Oct 17)

Treatment

Sample Origin		**COL6**																		
Sample Name					1772448	1773337		1773979	1774187	1774400	1774637		1775210	1775469		1776285	1776576		1777006	
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17	16-Nov-17	23-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17
Laboratory Reference					1835335.6	1839708.6		1847569.6	1852490.6		1859544.6		1866803.6	1871033.6		1878876.6	1882573.6		1892103.6	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
pH	pH Units				3.8	4.1		3.7	3.8		3.2		3	2.9		3	2.7		2.4	
Acidity (pH 3.7)	g/m3 as CaCO3				< 1.0	< 1.0		< 1.0	< 1.0		39		114	500		920	780		1,490	
Total Alkalinity	g/m3 as CaCO3				< 1.0	< $8^{\#}$		< 8 #1	< 8 #1		< 8 #1		< 10 #1	< 10		< 10 #1	< 8 #1		< 8	
Electrical Conductivity (EC)	mS/m				502	118.2		180.9	168.5		236		272	399		313	365		425	
Dissolved Aluminium	g/m3				490			102			200			460			290			
Dissolved Antimony	g/m3				0.0021			0.0005			< 0.0004			< 0.0010			< 0.0010			
Dissolved Barium	g/m3				0.056			0.028			0.028			0.025			0.0137			
Dissolved Calcium	g/m3				330			96			132			163			163			
Dissolved Cobalt	g/m3				6.2			1.99			2.7			3.9			2.8			
Dissolved Iron	g/m3				77			5.9			15			153			103			
Dissolved Magnesium	g/m3		No Leachate	No Leachate	147			50			74			81			50			
Dissolved Manganese	g/m3				9.6			2			2.7			5.9			2.8			
Dissolved Mercury	g/m3				< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.00008		< 0.00008	< 0.00008		< 0.00008	< 0.00008		< 0.0003	
Dissolved Molybdenum	g/m3				< 0.0010			< 0.0002			< 0.0004			< 0.0010			< 0.0004			
Dissolved Potassium	g/m3				74			55			60			52			31			
Dissolved Selenium	g/m3				0.119			0.022			0.029			0.027			0.012			
Dissolved Silver	g/m3				< 0.0005			< 0.00010			< 0.0002			< 0.0005			< 0.0005			
Dissolved Sodium	g/m3				79			27			7.3			4.4			2.4			
Dissolved Strontium	g/m3				2			0.54			0.63			0.89			0.7			
Dissolved Uranium	g/m3				0.061			0.0176			0.023			0.026			0.0193			
Dissolved Vanadium	g/m3				0.008			< 0.0010			< 0.002			0.016			0.009			
Sulphate	g/m3				5500	700		1240	1110		1830		2100	3400		2900	3200		3400	
Dissolved Heavy Metals																				
Dissolved Arsenic	g/m3				0.02	0.0123		0.006	0.0022		0.002		< 0.002	< 0.005		0.004	0.003		0.107	
Dissolved Cadmium	g/m3				0.051	0.0096		0.0159	0.0145		0.0181		0.022	0.028		0.014	0.02		0.0121	
Dissolved Chromium	g/m3				0.141	0.0106		0.0148	0.0135		0.055		0.078	0.2		0.174	0.182		0.3	
Dissolved Copper	g/m3				4.5	0.86		1.39	1.39		2.6		2.1	3.9		2.2	2.7		2.1	
Dissolved Lead	g/m3				0.0092	0.0034		0.0106	0.0083		0.021		0.029	0.032		0.0105	0.0105		0.0051	
Dissolved Nickel	g/m3				4.3	0.8		1.35	1.35		1.91		2.2	2.9		1.52	2.1		1.54	
Dissolved Zinc	g/m3				5.4	0.99		1.7	1.56		2.6		3	4.5		3	4		3.7	
Field Parameters																				
pH	pH Units	7.3			3.92	4.19	4.11	3.57	3.65	3	3.05	2.6	2.78	2.55	2.35	2.62	2.3	2.1	1.93	2.05
Electrical Conductivity (EC)	mS/m	8.64			209	71.3	117.4	191.7	129	157	250.5	282.1	272	393	394	342	361	342	441	372
Temperature	°C	13.6			17.5	14.7	19.7	15.8	11.5	17.7	15.7	12	14.4	17.5	17.3	16.1	20.9	20.1	22.9	26.8
Leachate																				
Volume recovered	mL	460	0	0	780	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	480	0	0	1200	7700	2500	1500	0	300	4000	0	0	1200	0	0	0	0	300	0

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Additional limestone added 1/3/18

Sample Origin																				
Sample Name		1777536			1778166		1778833		1779303				1781507				1782593			
Date		21-Dec-17	28-Dec-17	4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18	22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18
Laboratory Reference		1900678.6			1907280.6		1914263.6		1921097.6				1940132.6				1958862.6			
Week (Relative)		20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Week		20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
pH	pH Units	2.4			2.1		2.2		1.8				1.7				1.5			
Acidity (pH 3.7)	g/m3 as CaCO3	1,420			3200		2900		8000				9500				8600			
Total Alkalinity	g/m3 as CaCO3	< 10 #1			< 10 #1		< 10 #1		< 8 #1				< 8 #1				< 8 #1			
Electrical Conductivity (EC)	mS/m	440			829		979		1483				1581				2030			
Dissolved Aluminium	g/m3								810											
Dissolved Antimony	g/m3								0.003											
Dissolved Barium	g/m3								< 0.0010											
Dissolved Calcium	g/m3								320											
Dissolved Cobalt	g/m3								3.0											
Dissolved Iron	g/m3								3000											
Dissolved Magnesium	g/m3								24											
Dissolved Manganese	g/m3								3.1											
Dissolved Mercury	g/m3	< 0.00008			< 0.00008		< 0.0015		< 0.002				< 0.00008				< 0.00008			
Dissolved Molybdenum	g/m3								0.003											
Dissolved Potassium	g/m3								3.7											
Dissolved Selenium	g/m3								0.020											
Dissolved Silver	g/m3								< 0.0010											
Dissolved Sodium	g/m3								5.3											
Dissolved Strontium	g/m3								0.46											
Dissolved Uranium	g/m3								0.024											
Dissolved Vanadium	g/m3								0.66											
Sulphate	g/m3	117			8,800		11,100		16,800				21,000				16,700			
Dissolved Heavy Metals																				
Dissolved Arsenic	g/m3	0.134			1.24		1.76		7.8				20				21			
Dissolved Cadmium	g/m3	0.0165			0.0141		0.023		0.022				0.0136				0.010			
Dissolved Chromium	g/m3	0.3			0.67		1.14		1.17				0.93				0.62			
Dissolved Copper	g/m3	1.77			2.7		3.3		4.4				4.8				3.1			
Dissolved Lead	g/m3	0.0016			0.0006		< 0.0010		< 0.0010				< 0.0010				< 0.010			
Dissolved Nickel	g/m3	1.97			1.72		2.7		2.8				2.4				1.95			
Dissolved Zinc	g/m3	4.5			4.9		7.8		6.8				5.8				4.6			
Field Parameters																				
pH	pH Units	1.92	1.45		1.55	1.66	1.85	1.52	1.25	1.26	1.44	1.81	2.84	1.31	1.27	1.09	1	1.05	0.82	1.38
Electrical Conductivity (EC)	mS/m	477	623		889	800	859	1371	1538	1149	1210	1106	1469	1768	1750	2130	1952	1995	1990	1971
Temperature	°C	18.8	14.9		22.7	21.2	23.3	22.1	21.2	29.1	30.2	22	23.5	16.5	16.5	16.7	21.8	14.1	14.6	18.3
Leachate																				
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	0	0	0	2600	150	25	300	6000	9000	500	0	0	1500	2000	1000	2000	1000	2850	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Sample Origin																	
Sample Name		1783714					1786039				1788483					1790045	Disbanded 16.08.2018
Date		3-May-18	10-May-18	17-May-18	23-May-18	30-May-18	8-Jun-18	14-Jun-18	20-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	
Laboratory Reference		1976201.6					1997135.6				2010659.6					2029323.6	
Week (Relative)		39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	
Week		39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	
pH	pH Units	1.8					1.9				2.0					1.8	
Acidity (pH 3.7)	g/m3 as CaCO3	2400					1790				2400					2300	
Total Alkalinity	g/m3 as CaCO3	< 8#1					< 8#1				< 8 #1					< 1.0	
Electrical Conductivity (EC)	mS/m	888					766				704					772	
Dissolved Aluminium	g/m3															27	
Dissolved Antimony	g/m3															0.0016	
Dissolved Barium	g/m3															, 0.005	
Dissolved Calcium	g/m3															147	
Dissolved Cobalt	g/m3															0.36	
Dissolved Iron	g/m3															620	
Dissolved Magnesium	g/m3															1.52	
Dissolved Manganese	g/m3															0.27	
Dissolved Mercury	g/m3	< 0.0003					< 0.00008				< 0.00008					< 0.00008	
Dissolved Molybdenum	g/m3															< 0.0010	
Dissolved Potassium	g/m3															4.5	
Dissolved Selenium	g/m3															0.006	
Dissolved Silver	g/m3															< 0.0005	
Dissolved Sodium	g/m3															2.8	
Dissolved Strontium	g/m3															0.136	
Dissolved Uranium	g/m3															0.00074	
Dissolved Vanadium	g/m3															0.023	
Sulphate	g/m3	4,400					2,800				3,600					3200	
Dissolved Heavy Metals																	
Dissolved Arsenic	g/m3	3.1					4.2				4.1					3.0	
Dissolved Cadmium	g/m3	0.0022					0.00167				0.0014					0.0010	
Dissolved Chromium	g/m3	0.105					0.067				0.073					0.049	
Dissolved Copper	g/m3	0.77					0.68				0.68					0.40	
Dissolved Lead	g/m3	0.0027					0.0172				0.0051					0.0097	
Dissolved Nickel	g/m3	0.47					0.35				0.45					0.31	
Dissolved Zinc	g/m3	0.88					0.61				0.6					0.34	
Field Parameters																	
pH	pH Units	2.04	1.75	1.65	1.75	1.48	1.9	2.09	2.05	2.43	2.59	2.86	2.74	1.1	2.72	1.7	
Electrical Conductivity (EC)	mS/m	1054	1065	1334	1582	1378	851	833	923	1021	556	810	859	1087	919	808	
Temperature	°C	15.3	15.2	15.5	10.3	11.2	11.8	15.4	11.3	7.8	6.4	13.4	9.9	10.1	13.1	11.4	
Leachate																	
Volume recovered	mL	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Volume in bucket	mL	20000*	250	2000	1000	1500	20000*	1000	1000	1900	200	500	45000	2300	2000	5100	

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Quattro Column Testing - Analytical Results (Compacted)

Sample Origin		COL7																							
Sample Name				1790386				1791720		1792086		1792710				1793483		1794274		1794665		1795306			
Date		9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18	27-Sep-18	4-Oct-18	11-Oct-18	18-Oct-18	25-Oct-18	1-Nov-18	8-Nov-18	15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	10-Jan-19	17-Jan-19
Laboratory Reference				2036895.1				2052819.1		2060148.1		2067422.1				2081544.3		2089933.1		2097420.2		2102874.3			
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Week		53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
pH	pH Units			6.0				4.1		3.8		3.7				3.2		3.3		2.9		3			
Acidity (pH 3.7)	g/m3 as CaCO3			< 1.0				< 1.0		< 1.0		< 1.0				234		162		448		290			
Total Alkalinity	g/m3 as CaCO3			20				< 1.0		< 1.0		< 8				< 8		< 10		< 8		< 8			
Electrical Conductivity (EC)	mS/m			4.5				515		840		705				543		407		631		264			
Dissolved Aluminium	g/m3			0.028				49				107				70.7				72.2					
Dissolved Antimony	g/m3			0.0004				0.0029				0.003				0.00211				0.00134					
Dissolved Barium	g/m3			< 0.0005				0.019				0.027				0.01049				< 0.005					
Dissolved Calcium	g/m3			1.00				230				380				324				463					
Dissolved Cobalt	g/m3			0.0005				6.7				15.2				10.07				11.45					
Dissolved Iron	g/m3			0.39				310				780				573				614					
Dissolved Magnesium	g/m3			0.64				250				550				406				485					
Dissolved Manganese	g/m3	No Leachate	No Leachate	0.0182				9.4				16.9				11.6				13.8					
Dissolved Mercury	g/m3			< 0.00008		< 0.00008		< 0.00008		< 0.0003		< 0.0003				< 0.00008		< 0.00008		< 0.00008		< 0.00008			
Acid Soluble Mercury	g/m3																								
Dissolved Molybdenum	g/m3			< 0.0002				0.003				< 0.002				< 0.0010				< 0.0010					
Dissolved Potassium	g/m3			0.57				22				59				47.5				66.4					
Dissolved Selenium	g/m3			< 0.0010				0.163				0.043				0.0160				0.011					
Dissolved Silver	g/m3			< 0.00010				< 0.0005				< 0.0010				< 0.0005				< 0.0005					
Dissolved Sodium	g/m3			4.6				95				198				111				80.8					
Dissolved Strontium	g/m3			0.0043				3.0				6.1				4.08				5.24					
Dissolved Uranium	g/m3			< 0.00002				0.0039				0.081				0.0583				0.0562					
Dissolved Vanadium	g/m3			< 0.0010				< 0.005				0.175				0.167				0.324					
Sulphate	g/m3			5				2900		8000		6800				4460		6300		5150		1630			
Dissolved Heavy Metals																									
Dissolved Arsenic	g/m3			0.025		0.012		0.017		0.031		0.040				0.0283		0.025		0.0272		0.013			
Dissolved Cadmium	g/m3			< 0.00005		0.0117		0.0196		0.048		0.039				0.0283		0.0196		0.0322		0.0109			
Dissolved Chromium	g/m3			0.0103		0.112		0.26		0.87		0.68				0.455		0.28		0.599		0.111			
Dissolved Copper	g/m3			0.0188		2.9		5.7		12.2		8.0				2.99		1.58		1.89		0.54			
Dissolved Lead	g/m3			< 0.00010		< 0.0002		< 0.0005		< 0.0010		0.0015				0.000876		0.0010		< 0.0005		0.0002			
Dissolved Nickel	g/m3			0.0009		2.1		3.4		8.1		7.4				4.67		3.1		5.38		1.77			
Dissolved Zinc	g/m3			0.147		2.6		4.6		10.8		9.3				6.56		4.6		7.84		2.3			
Field Parameters																									
pH	pH Units			4.95	5.44	4.7	4	4.63	3.72	3.9	3.9	3.4	2.7	2.8	3.6	3	3	3.1	2.8	2.5	3.3	3.3	2.8		2.8
Electrical Conductivity (EC)	mS/m			547	451	265	626	367	700	794	732	661	699	483	650	503	586	376	381	552	537	229	531		404
Temperature	°C			11	14.1	11.2	15	19.7	13.8	12.1	16.9	16.3	19.7	13.4	18.6	20.9	20.3	24.8	19.7	25.9	26.7	22.3	26.6		24.8
Leachate																									
Volume recovered	mL			1000	1000	200	300	1000	300	600	500	250	1000	0	200	500	500	1000	1000	1000	200	300	100		200
Volume in bucket	mL		500	500	0	200	500	1000	300	600	500	250	500	500	500	500	500	1000	500	250	500	1000	500		200

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Sample Origin																				
Sample Name		1797635		1798037		1798830		1799530		1800050		1800595		1801348		1801893				1802876
Date		24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19	21-Feb-19	########	7-Mar-19	14-Mar-19	22-Mar-19	28-Mar-19	4-Apr-19	11-Apr-19	18-Apr-19	24-Apr-19	3-May-19	9-May-19	14-May-19	########	30-May-19
Laboratory Reference		2114739.1		2121327		2129265.1		2138147		2147390		2155397		2164341		2170480.1				2185913
Week (Relative)		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Week		77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
pH	pH Units	2.8		2.8		3.1		3		2.9		2.9		2.9		2.7				2.6
Acidity (pH 3.7)	g/m3 as CaCO3	680		1190		330		480		570		390		780		1960				2900
Total Alkalinity	g/m3 as CaCO3	< 1.0		< 8		< 10		< 8		< 8		< 10		< 10		< 10				< 10
Electrical Conductivity (EC)	mS/m	574		550		579		559		535		297		490		555				621
Dissolved Aluminium	g/m3	60		62.7				57				19.8				106				
Dissolved Antimony	g/m3	<0.0010		< 0.001				< 0.0010				< 0.0004				0.001				
Dissolved Barium	g/m3	< 0.005		< 0.005				< 0.0050				< 0.005				< 0.005				
Dissolved Calcium	g/m3	460		456				490				194				360				
Dissolved Cobalt	g/m3	10.2		9.22				8.6				3.9				13.5				
Dissolved Iron	g/m3	460		487				560				148				810				
Dissolved Magnesium	g/m3	430		410				380				133				430				
Dissolved Manganese	g/m3	11.4		11.7				9.8				3.5				10.8				
Dissolved Mercury	g/m3	< 0.00015		< 0.00015				< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00008				< 0.00008
Acid Soluble Mercury	g/m3									< 0.00008		< 0.00008				< 0.00008				
Dissolved Molybdenum	g/m3	< 0.0010		< 0.0010				< 0.0010				< 0.0004				< 0.0010				
Dissolved Potassium	g/m3	54		54.3				67				29				58				
Dissolved Selenium	g/m3	< 0.005		< 0.005				< 0.005				< 0.002				< 0.005				
Dissolved Silver	g/m3	< 0.0005		< 0.0005				< 0.0005				< 0.0002				< 0.0005				
Dissolved Sodium	g/m3	41		36.9				20				7				12.4				
Dissolved Strontium	g/m3	4.8		4.72				4.8				2.2				6				
Dissolved Uranium	g/m3	0.04		0.0465				0.041				0.0125				0.0174				
Dissolved Vanadium	g/m3	0.09		0.188				0.141				0.016				0.27				
Sulphate	g/m3	4500		4890		4500		4600		3800		1910		4000		5300				2600
Dissolved Heavy Metals																				
Dissolved Arsenic	g/m3	0.019		0.01096		< 0.005		0.009		0.006		0.006		0.017		0.136				3
Dissolved Cadmium	g/m3	0.027		0.0303		0.027		0.026		0.025		0.0104		0.023		0.032				0.039
Dissolved Chromium	g/m3	0.3		0.442		0.24		0.4		0.35		0.169		0.35		0.68				0.74
Dissolved Copper	g/m3	0.67		0.485		0.27		0.81		0.149		0.2		0.049		0.043				0.98
Dissolved Lead	g/m3	< 0.0005		< 0.0005		< 0.0005		< 0.0005		< 0.0005		< 0.0002		< 0.0005		< 0.0005				< 0.0005
Dissolved Nickel	g/m3	4.8		4.63		4.3		4		4.1		2		3.2		6.7				5.7
Dissolved Zinc	g/m3	6.6		5.98		6.5		5.5		5.3		2.5		5.3		7.6				10.3
Field Parameters																				
pH	pH Units	2.8	2.3	2.6	2.8	2.89	3.3	2.7	2.6	2.6	2.4	2.6	2.7	3	2.7	2.7	2.75	2.83	2.56	2.66
Electrical Conductivity (EC)	mS/m	269	699	296	471	486	485	483	496	497	406	202	299	298	284	401	536	439	542	448
Temperature	°C	22.3	22.9	24.7	24.5	23.6	21.2	25.3	19.9	17.3	21	13	18.2	18.5	17.2	13.2	15.3	12	14.4	7
Leachate																				
Volume recovered	mL	1000	1000	1000	720	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	750	500	250	500	0	500	500	500	500	500	20000*	1000	1000	500	500	500	250	1000	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Quattro Column Testing - Analytical Results (layered)

Sample Origin		COL8																							
Sample Name								1791721		1792087		1792711				1793479				1794666		1795305		1795860	
Date		9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18	27-Sep-18	4-Oct-18	11-Oct-18	18-Oct-18	25-Oct-18	1-Nov-18	8-Nov-18	15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	11-Jan-19	17-Jan-19
Laboratory Reference								2052819.2		2060148		2067422.2				2081544.2				2097420.3		2102874.2		2107812.1	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Week		53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
pH	pH Units							3.9		3.1		2.8				2.9				3.2		3.1		2.9	
Acidity (pH 3.7)	g/m3 as CaCO3							< 1.0		380		360				340				249		180		250	
Total Alkalinity	g/m3 as CaCO3							< 1.0		< 1.0		< 8				< 8				< 8		< 8		< 8	
Electrical Conductivity (EC)	mS/m							515		381		391				334				304.0		230		318	
Dissolved Aluminium	g/m3							55				38				20.6				5.57				11.4	
Dissolved Antimony	g/m3							0.0033				0.0011				0.00057				< 0.0004				0.0002	
Dissolved Barium	g/m3							0.036				< 0.005				0.00763				0.01702				< 0.005	
Dissolved Calcium	g/m3							450				420				432				525				500	
Dissolved Cobalt	g/m3							7.8				5.4				3.06				0.969				1.11	
Dissolved Iron	g/m3							390				110				106.5				160				85	
Dissolved Magnesium	g/m3							330				220				148				75.9				76	
Dissolved Manganese	g/m3	No Leachate	No Leachate					9.0				7.1				4.30				1.94				2.1	
Dissolved Mercury	g/m3					< 0.00008		< 0.0003		< 0.00008		< 0.00008				< 0.00008				< 0.00008		< 0.00008		< 0.00008	
Acid Soluble Mercury	g/m3																								
Dissolved Molybdenum	g/m3							< 0.0010				< 0.0010				< 0.0004				< 0.0004				< 0.0004	
Dissolved Potassium	g/m3							59				40				38.7				31.4				32	
Dissolved Selenium	g/m3							0.058				0.035				< 0.002				< 0.002				< 0.002	
Dissolved Silver	g/m3							< 0.0005				< 0.0005				< 0.0002				< 0.0002				< 0.00010	
Dissolved Sodium	g/m3							77				15.5				3.70				2.59				3.4	
Dissolved Strontium	g/m3							4.1				3.3				2.55				1.861				2	
Dissolved Uranium	g/m3							0.034				0.0194				0.00465				0.000767				0.0023	
Dissolved Vanadium	g/m3							0.046				0.015				0.0066				0.0068				0.006	
Sulphate	g/m3							4100		2800		2700				2240				2040		1353		2000	
Dissolved Heavy Metals																									
Dissolved Arsenic	g/m3					0.075		0.051		0.015		0.019				0.00670				0.00213		0.004		0.003	
Dissolved Cadmium	g/m3					0.0159		0.023		0.0122		0.0117				0.00502				0.000628		0.00074		0.00112	
Dissolved Chromium	g/m3					0.24		0.26		0.37		0.38				0.166				0.031		0.045		0.110	
Dissolved Copper	g/m3					4.6		6.3		4.0		2.9				0.54				0.0577		0.058		0.061	
Dissolved Lead	g/m3					0.0016		0.0052		0.0047		0.0006				0.00197				0.00131		0.0004		0.0007	
Dissolved Nickel	g/m3					3.5		4.1		2.7		2.3				1.443				0.619		0.54		0.61	
Dissolved Zinc	g/m3					3.9		4.9		3.1		3.1				1.50				0.490		0.40		0.59	
Field Parameters																									
pH	pH Units				4.27	4.39	4	3.84	3.5	3.2	3	2.5	2.5	2.8	2.4	2.8	2.7	2.8	2.7	2.9	3.1	3.4	2.7	2.6	2.7
Electrical Conductivity (EC)	mS/m				428	420	451	471	401	361	390	366	338	369	370	288	327	276	197	269	251	189	279	292	280
Temperature	°C				13.4	11.2	14.8	20.1	14.6	12.9	16.1	16.3	19.9	14.6	17.3	20.7	19.6	24.7	20.7	22.8	24.6	21.9	23.9	27.1	25.3
Leachate																									
Volume recovered	mL					1000	300	500	2500	0	850	250	1000	1000	1000	1000	1000	1000	1000	1000	200	300	1000	200	750
Volume in bucket	mL		100	150	150	1000	500	500	1500	600	850	250	1000	1000	300	2500	500	35000	6000	1250	1500	3000	1000	0	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.
* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Sample Origin																				
Sample Name		1797636		1798039		1798831		1799531		1800051		1800596		1801349		1801894				1802877
Date		24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19	21-Feb-19	28-Feb-19	7-Mar-19	14-Mar-19	22-Mar-19	28-Mar-19	4-Apr-19	11-Apr-19	18-Apr-19	24-Apr-19	3-May-19	9-May-19	14-May-19	23-May-19	30-May-19
Laboratory Reference		2114738.1		2121327.3		2129265.2		2138147.2		2147390		2155397		2164341		2170480				2185913
Week (Relative)		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Week		77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
pH	pH Units	2.9		2.7		2.7		2.8		2.8		3		3.1		2.9				3.2
Acidity (pH 3.7)	g/m3 as CaCO3	340		263		290		430		410		380		710		690				380
Total Alkalinity	g/m3 as CaCO3	< 1.0		< 1.0		< 10		< 8		< 8		< 10		< 10		< 10				< 10
Electrical Conductivity (EC)	mS/m	338		351		364		348		388		258		439		406				344
Dissolved Aluminium	g/m3			13.7				11.6				8.5				10.9				
Dissolved Antimony	g/m3			< 0.0004				< 0.0004				< 0.0010				< 0.0010				
Dissolved Barium	g/m3			0.00578				0.005				< 0.005				< 0.005				
Dissolved Calcium	g/m3			504				590				290				510				
Dissolved Cobalt	g/m3			0.942				0.56				0.44				0.69				
Dissolved Iron	g/m3			65.7				127				240				710				
Dissolved Magnesium	g/m3			76.9				61				45				54				
Dissolved Manganese	g/m3			2.48				2				1.26				1.86				
Dissolved Mercury	g/m3	< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00008				< 0.00008
Acid Soluble Mercury	g/m3			< 0.00008						< 0.00008		< 0.00008				< 0.00008				
Dissolved Molybdenum	g/m3			< 0.0004				< 0.0004				< 0.001				< 0.0010				
Dissolved Potassium	g/m3			32.8				29				14.9				16.9				
Dissolved Selenium	g/m3			< 0.002				< 0.002				< 0.005				< 0.005				
Dissolved Silver	g/m3			< 0.0002				< 0.0002				< 0.0005				< 0.0005				
Dissolved Sodium	g/m3			3.6				5.1				4.1				2.7				
Dissolved Strontium	g/m3			1.93				1.9				1.16				1.77				
Dissolved Uranium	g/m3			0.00323				0.0037				0.0025				0.0036				
Dissolved Vanadium	g/m3			0.00488				0.006				< 0.005				0.017				
Sulphate	g/m3	2,200		2250		2100		2100		2400		1620		3400		4500				2600
Dissolved Heavy Metals																				
Dissolved Arsenic	g/m3	0.003		0.00812		< 0.005		0.007		< 0.005		0.006		< 0.010		< 0.005				< 0.005
Dissolved Cadmium	g/m3	0.00107		0.00096		< 0.0003		0.00081		0.0019		0.0012		0.0026		0.0015				0.0006
Dissolved Chromium	g/m3	0.115		0.1273		< 0.003		0.088		0.122		0.059		0.076		0.056				0.021
Dissolved Copper	g/m3	0.062		0.0686		< 0.003		0.061		0.067		0.048		0.194		0.47				0.162
Dissolved Lead	g/m3	0.0011		0.000968		< 0.0005		0.0009		0.0009		< 0.0005		< 0.0010		< 0.0005				< 0.0005
Dissolved Nickel	g/m3	0.67		0.658		0.62		0.5		0.71		0.47		0.72		0.77				0.43
Dissolved Zinc	g/m3	0.6		0.514		2.9		0.59		0.96		0.66		1.51		1.24				0.87
Field Parameters																				
pH	pH Units	2.8	2.5	2.2	2.6	2.6	2.8	2.5	2.5	2.6	2.4	2.6	3.1	2.9	2.6	2.8	2.78	2.74	3.05	3.03
Electrical Conductivity (EC)	mS/m	296	285	337	266	302	299	318	336	361	224	179	307	305	290	285	280	229	276	244
Temperature	°C	22.3	22.8	23	24.1	23.5	21.8	24.4	20.6	17.6	20.4	13.3	18.9	18.3	19.4	15.7	15.2	15.2	17.3	9.8
Leachate																				
Volume recovered	mL	0	1000	1000	450	850	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	750	250	750	0	500	1000	1000	250	500	1500	1500	1000	1000	0	1000	500	1000	0	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Quattro Column Testing - Analytical Results (limestone Blended)

Sample Origin		COL9																							
Sample Name				1790388				1791722		1792088						1793478		1794276		1794664		1795304		1795861	
Date		9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18	27-Sep-18	4-Oct-18	11-Oct-18	18-Oct-18	25-Oct-18	1-Nov-18	8-Nov-18	15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	11-Jan-19	17-Jan-19
Laboratory Reference				2036895				2052819.3		2060148.3						2081544.1		2089933.3		2097420.1		2102874.1		2107813	
Week (Relative)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Week		53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
pH	pH Units			5.9				4.8		7.9						7.2		7.2		5.7		5.2		4.7	
Acidity (pH 3.7)	g/m3 as CaCO3			< 1.0				< 1.0		< 1.0						< 1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Total Alkalinity	g/m3 as CaCO3			19				2.1		152						102		210		105.0		36		26	
Electrical Conductivity (EC)	mS/m			2.2				26.8		306						119		237		365.0		324		369	
Dissolved Aluminium	g/m3			0.011				1.65								0.025				0.189				0.080	
Dissolved Antimony	g/m3			< 0.0002				0.0003								0.0123				0.0176				0.004	
Dissolved Barium	g/m3			< 0.005				< 0.005								0.01193				0.0304				0.034	
Dissolved Calcium	g/m3			0.36				22								245				651				610	
Dissolved Cobalt	g/m3			0.0002				0.135								0.1092				1.587				1.13	
Dissolved Iron	g/m3			0.07				2.3								1.03				514				610	
Dissolved Magnesium	g/m3			0.31				6.3								14.34				58.2				55	
Dissolved Manganese	g/m3	No Leachate	No Leachate	0.0051				0.149								0.404				1.84				1.77	
Dissolved Mercury	g/m3			< 0.00008		< 0.00008		< 0.00008		< 0.00008						< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00015	
Acid Soluble Mercury	g/m3																								
Dissolved Molybdenum	g/m3			< 0.0002				< 0.0002								< 0.0002				< 0.0010				< 0.0010	
Dissolved Potassium	g/m3			0.21				2.1								17.5				44.2				43	
Dissolved Selenium	g/m3			< 0.0010				0.0079								0.00111				< 0.005				< 0.005	
Dissolved Silver	g/m3			< 0.00010				< 0.00010								< 0.00010				< 0.0005				< 0.002	
Dissolved Sodium	g/m3			2.4				6.7								3.79				2.29				2.1	
Dissolved Strontium	g/m3			0.0016				0.045								0.239				0.856				0.84	
Dissolved Uranium	g/m3			< 0.00002				0.00045								0.000654				0.00145				0.0032	
Dissolved Vanadium	g/m3			< 0.0010				< 0.0010								< 0.0010				< 0.005				< 0.005	
Sulphate	g/m3			< 5				98		1870						585		1280		2710		2400		2800	
Dissolved Heavy Metals																									
Dissolved Arsenic	g/m3			0.0049		0.0073		0.0065		< 0.002						< 0.0010		< 0.002		0.00633		0.006		0.011	
Dissolved Cadmium	g/m3			< 0.00005		0.0042		0.00166		0.0049						0.000546		0.00083		0.0081		0.0006		< 0.0003	
Dissolved Chromium	g/m3			0.0020		0.0032		0.003		< 0.0010						< 0.0005		< 0.0010		< 0.003		< 0.003		< 0.003	
Dissolved Copper	g/m3			0.0058		0.162		0.070		0.031						0.00222		< 0.0010		< 0.003		< 0.003		< 0.003	
Dissolved Lead	g/m3			< 0.00010		0.00016		< 0.00010		< 0.0002						< 0.00010		< 0.0002		< 0.0005		< 0.0005		< 0.0005	
Dissolved Nickel	g/m3			< 0.0005		0.28		0.116		0.52						0.122		0.24		0.451		0.38		0.29	
Dissolved Zinc	g/m3			0.050		0.27		0.122		0.036						0.0240		0.037		1.028		1.17		0.89	
Field Parameters																									
pH	pH Units			5.2	4.88	4.77	4.12	4.65	4.3	6.3	5.8		5.5	6.4	5.9	6	5.9	6.1	5.2	5.3	6.4	6.3	5.3	5.2	4.9
Electrical Conductivity (EC)	mS/m			33	38	30	32	37	97	282	249		225	146	344	115	227	216	275	328	334	252	325	325	311
Temperature	°C			10.9	13.5	11.9	16.7	19.7	15.7	11.8	17.9		19.4	13.1	18.2	22.3	22.6	26.5	17.2	24.1	25.6	21.7	26.6	24.5	23.3
Leachate																									
Volume recovered	mL			1100		100	200	250	500	1000	1000	0	1000	1000	1000	1000	1000	1000	1000	400	300	300	400	200	750
Volume in bucket	mL		500	1100	150	100	0	250	150	200	200	0	1000	1500	300	1000	1000	1000	6000	250	1500	3000	1000	1000	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

Sample Origin																				
Sample Name		1797637		1798038		1798832		1799533		1800053		1800598		1801351		1801896				1802877
Date		24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19	21-Feb-19	28-Feb-19	7-Mar-19	14-Mar-19	22-Mar-19	28-Mar-19	4-Apr-19	11-Apr-19	18-Apr-19	24-Apr-19	3-May-19	9-May-19	14-May-19	23-May-19	30-May-19
Laboratory Reference		2114738		2121327		2129265		2138147		2147390.4		2155397.4		2164341.4		2170480.4				2185913
Week (Relative)		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Week		77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
pH	pH Units	5.8		3.2		3.2		2.9		3		3		2.9		2.7				2.8
Acidity (pH 3.7)	g/m3 as CaCO3	< 1.0		166		193		390		270		710		2200		3300				2200
Total Alkalinity	g/m3 as CaCO3	110		< 1.0		< 8		< 8		< 8		< 8		< 10		< 10				< 10
Electrical Conductivity (EC)	mS/m	399		414		543		642		661		687		899		888				896
Dissolved Aluminium	g/m3			0.467				1.66				105				390				
Dissolved Antimony	g/m3			< 0.001				< 0.004				< 0.004				< 0.002				
Dissolved Barium	g/m3			0.01825				0.012				< 0.005				< 0.005				
Dissolved Calcium	g/m3			590				510				330				480				
Dissolved Cobalt	g/m3			0.899				1.62				2.5				4.5				
Dissolved Iron	g/m3			584				1980				2500				3200				
Dissolved Magnesium	g/m3			68.2				91				55				45				
Dissolved Manganese	g/m3			2.1				2.8				1.69				2				
Dissolved Mercury	g/m3	< 0.00008		< 0.00015		< 0.00016		< 0.0004		< 0.00016		< 0.00016		< 0.0004		< 0.00008				< 0.00016
Acid Soluble Mercury	g/m3			< 0.00015						< 0.00016		< 0.00016				< 0.00008				
Dissolved Molybdenum	g/m3			< 0.0010				< 0.004				< 0.004				< 0.002				
Dissolved Potassium	g/m3			45.5				45				23				13.5				
Dissolved Selenium	g/m3			< 0.005				< 0.02				< 0.02				< 0.010				
Dissolved Silver	g/m3			< 0.0005				< 0.002				< 0.002				< 0.0010				
Dissolved Sodium	g/m3			2.62				2.7				2.4				1.5				
Dissolved Strontium	g/m3			0.84				1.25				1				1.06				
Dissolved Uranium	g/m3			0.00145				0.0039				0.021				0.055				
Dissolved Vanadium	g/m3			< 0.005				< 0.02				< 0.02				< 0.010				
Sulphate	g/m3	2900		3110		4500		5600		5900		6600		9700		10200				12200
Dissolved Heavy Metals																				
Dissolved Arsenic	g/m3	0.016		< 0.005		< 0.005		< 0.02		< 0.010		< 0.02		< 0.10		< 0.010				0.024
Dissolved Cadmium	g/m3	< 0.0003		< 0.0003		< 0.0003		0.0015		0.0083		0.0146		0.047		0.07				0.074
Dissolved Chromium	g/m3	< 0.003		< 0.003		< 0.003		< 0.01		< 0.005		< 0.010		< 0.05		0.071				0.137
Dissolved Copper	g/m3	< 0.003		0.00658		< 0.003		0.012		0.012		< 0.010		< 0.05		< 0.005				0.39
Dissolved Lead	g/m3	< 0.0005		0.000663		< 0.0005		< 0.002		< 0.001		< 0.002		< 0.010		< 0.0010				0.0016
Dissolved Nickel	g/m3	0.29		0.298		0.62		1		1.47		2.3		3.4		5.4				3.9
Dissolved Zinc	g/m3	0.78		0.694		2.9		3.7		4.6		7.5		15.1		15				16.1
Field Parameters																				
pH	pH Units	5.7	3.3	3.1	3	3.1	5.7	2.8	2.5	2.8	3.3	2.6	2.7	2.9	2.8	2.6	2.68	2.8	2.72	2.77
Electrical Conductivity (EC)	mS/m	357	323	370	365	455	569	556	318	586	17.6	468	550	520	514	619	630	552	621	647
Temperature	°C	21.6	22.1	23.5	24.1	23.7	26	29.7	20.9	17.6	20.6	13.4	19	514	16.6	13.4	15.1	11.4	14.5	5.6
Leachate																				
Volume recovered	mL	1000	1000	1000	750	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Volume in bucket	mL	1000	500	250	500	1000	1500	500	500	500	1000	1000	1000	1000	1000	1000	250	500	1000	1000

Due to the nature of sample, a 10 fold dilution was required for the Total Alkalinity analysis. This has resulted in a detection limit greater than that normally achieved.

* Bucket overflowing. Volume assumed to be 20 L.

AECOM

Quattro Column Testing - Analytical Results

Sample Origin		**COL10**																			
Sample Name																					
Date		11-Aug-17	18-Aug-17	24-Aug-17	31-Aug-17	7-Sep-17	14-Sep-17	21-Sep-17	29-Sep-17	5-Oct-17	12-Oct-17	19-Oct-17	26-Oct-17	2-Nov-17	10-Nov-17	16-Nov-17	23-Nov-17	30-Nov-17	7-Dec-17	14-Dec-17	21-Dec-17
Laboratory Reference																					
Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
pH	pH Units		No Leachate	No Leachate																	
Acidity (pH 3.7)	g/m3 as CaCO3																				
Total Alkalinity	g/m3 as CaCO3																				
Electrical Conductivity (EC)	mS/m																				
Dissolved Aluminium	g/m3																				
Dissolved Antimony	g/m3																				
Dissolved Barium	g/m3																				
Dissolved Calcium	g/m3																				
Dissolved Cobalt	g/m3																				
Dissolved Iron	g/m3																				
Dissolved Magnesium	g/m3																				
Dissolved Manganese	g/m3																				
Dissolved Mercury	g/m3																				
Acid Soluble Mercury	g/m3																				
Dissolved Molybdenum	g/m3																				
Dissolved Potassium	g/m3																				
Dissolved Selenium	g/m3																				
Dissolved Silver	g/m3																				
Dissolved Sodium	g/m3																				
Dissolved Strontium	g/m3																				
Dissolved Uranium	g/m3																				
Dissolved Vanadium	g/m3																				
Sulphate	g/m3																				
Dissolved Heavy Metals																					
Dissolved Arsenic	g/m3																				
Dissolved Cadmium	g/m3																				
Dissolved Chromium	g/m3																				
Dissolved Copper	g/m3																				
Dissolved Lead	g/m3																				
Dissolved Nickel	g/m3																				
Dissolved Zinc	g/m3																				
Field Parameters																					
pH	pH Units	7.45			6.45	6.15	7.33	6.58	6.7	5.3	5.6		6.84	6.65	6.35	7.07	6.73	6.7	6.75	7.15	6.59
Electrical Conductivity (EC)	mS/m	7.57			61.6	4.89	6.9	6.57	4.52	4.6	47		6.9	10.9	5.9	4.7	3.9	5.81	5.3	4.6	6.98
Temperature	°C	12.8			15.3	14.4	15.7	15.2	11.3	18.3	15.7		14.5	17.2	17.6	15.9	22.5	20	22.8	26.3	18.6

Sample Origin																						
Sample Name								1779297								1782594				1783715		
Date		28-Dec-17	4-Jan-18	11-Jan-18	18-Jan-18	25-Jan-18	1-Feb-18	7-Feb-18	15-Feb-18	22-Feb-18	1-Mar-18	8-Mar-18	15-Mar-18	22-Mar-18	29-Mar-18	4-Apr-18	12-Apr-18	18-Apr-18	26-Apr-18	3-May-18	10-May-18	17-May-18
Laboratory Reference								1921063.1								1958862.7				1976201.7		
Week		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
pH	pH Units							7								6.4				6		
Acidity (pH 3.7)	g/m3 as CaCO3							<1.0								< 1.0				< 1		
Total Alkalinity	g/m3 as CaCO3							57								28				3.8		
Electrical Conductivity (EC)	mS/m							8.2								4.3				1.9		
Dissolved Aluminium	g/m3																					
Dissolved Antimony	g/m3																					
Dissolved Barium	g/m3																					
Dissolved Calcium	g/m3																					
Dissolved Cobalt	g/m3																					
Dissolved Iron	g/m3																					
Dissolved Magnesium	g/m3																					
Dissolved Manganese	g/m3																					
Dissolved Mercury	g/m3							<0.00008								<0.00008				< 0.00008		
Acid Soluble Mercury	g/m3																					
Dissolved Molybdenum	g/m3																					
Dissolved Potassium	g/m3																					
Dissolved Selenium	g/m3																					
Dissolved Silver	g/m3																					
Dissolved Sodium	g/m3																					
Dissolved Strontium	g/m3																					
Dissolved Uranium	g/m3																					
Dissolved Vanadium	g/m3																					
Sulphate	g/m3							130								7				1.1		
Dissolved Heavy Metals																						
Dissolved Arsenic	g/m3							<0.0010								0.0014				< 0.001		
Dissolved Cadmium	g/m3							<0.00005								< 0.00005				< 0.00005		
Dissolved Chromium	g/m3							<0.0005								0.002				< 0.0005		
Dissolved Copper	g/m3							0.0029								0.0018				0.0008		
Dissolved Lead	g/m3							<0.00010								< 0.00010				< 0.0001		
Dissolved Nickel	g/m3							0.0031								0.0005				< 0.0005		
Dissolved Zinc	g/m3							0.0080								0.0059				0.0029		
Field Parameters																						
pH	pH Units	6.35		6.77	5.45	6.05	5.95	5.62	5.94	3.36	4.75	6.3	5.94	6.33	6.03	5.78	6.15	6.24	6.44	6.38	7.73	5.64
Electrical Conductivity (EC)	mS/m	6.1		4.18	9.2	6.6	2.8	8.6	5.32	16.84	20.00	9.32	10.47	3.95	5.32	4.26	3.2	4.91	4.21	2.13	24.7	2.86
Temperature	°C	13.5		22.6	21.2	21.5	21.9	21.0	27.3	20.6	21.6	22.3	14.6	16	16	19.2	14.4	15.3	17.7	15.2	15.5	14.3

AECOM

Sample Origin																					
Sample Name				1786040				1788484					1790048		1790392				1791726		
Date		23-May-18	30-May-18	8-Jun-18	14-Jun-18	21-Jun-18	27-Jun-18	4-Jul-18	12-Jul-18	19-Jul-18	26-Jul-18	2-Aug-18	9-Aug-18	16-Aug-18	23-Aug-18	30-Aug-18	6-Sep-18	13-Sep-18	20-Sep-18	27-Sep-18	4-Oct-18
Laboratory Reference				1997136				2010659.7					2029323.7		2036894.4				2052842.4		
Week		42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
pH	pH Units			6.3				4					3.6		3.9				5.7		
Acidity (pH 3.7)	g/m3 as CaCO3			< 1.0				< 1.0					34		< 1.0				< 1.0		
Total Alkalinity	g/m3 as CaCO3			21				< 1.0					< 8		12				3.8		
Electrical Conductivity (EC)	mS/m			3.2				9.3					13.4		9.3				22		
Dissolved Aluminium	g/m3												0.24								
Dissolved Antimony	g/m3												< 0.0002								
Dissolved Barium	g/m3												0.011								
Dissolved Calcium	g/m3												0.153								
Dissolved Cobalt	g/m3												0.0037								
Dissolved Iron	g/m3												5.3								
Dissolved Magnesium	g/m3												0.19								
Dissolved Manganese	g/m3												0.0160								
Dissolved Mercury	g/m3			< 0.00008				< 0.00008					< 0.00008		< 0.00008				< 0.00008		
Acid Soluble Mercury	g/m3																				
Dissolved Molybdenum	g/m3												< 0.002								
Dissolved Potassium	g/m3												0.70								
Dissolved Selenium	g/m3												< 0.0010								
Dissolved Silver	g/m3												< 0.00010								
Dissolved Sodium	g/m3												0.96								
Dissolved Strontium	g/m3												0.0037								
Dissolved Uranium	g/m3												0.00002								
Dissolved Vanadium	g/m3												< 0.0010								
Sulphate	g/m3			1.3				17					24		15				2.6		
Dissolved Heavy Metals																					
Dissolved Arsenic	g/m3			< 0.0010				< 0.0010					< 0.0010		0.0026				< 0.0010		
Dissolved Cadmium	g/m3			<0.00005				< 0.00005					< 0.00005		< 0.00005				< 0.00005		
Dissolved Chromium	g/m3			0.0006				0.0009					0.0007		0.0007				< 0.0005		
Dissolved Copper	g/m3			0.0034				0.0074					0.0128		0.045				0.004		
Dissolved Lead	g/m3			< 0.00010				0.00051					0.00084		0.00026				0.00012		
Dissolved Nickel	g/m3			0.0005				0.0045					0.0039		0.0035				0.0012		
Dissolved Zinc	g/m3			0.0				0.0155					0.0164		0.022				0.024		
Field Parameters																					
pH	pH Units	5.57	5.15	6.3	5.22	4.65	6.04	6.53	6.72	6.15	4.4	4.74	6.06	5.3	5.94	7.65	5.8	5.76	4.48	5.03	3.95
Electrical Conductivity (EC)	mS/m	3.13	2.8	3.3	2.46	4.4	5.41	2.75	6.01	11.7	4.13	5.37	2.43	7.3	6.09	5.6	6.5	2.4	11.2	4.8	16.3
Temperature	°C	10.7	10.2	12.9	15.1	11.2	7.9	6.4	13.6	9.6	11.9	13.6	12.4	13.5	11.4	13.6	10.4	15.8	19.9	15.5	12.6

Sample Origin																					
Sample Name			1792716				1793481				1794670				1795855				1798036		
Date		11-Oct-18	18-Oct-18	25-Oct-18	1-Nov-18	8-Nov-18	15-Nov-18	22-Nov-18	29-Nov-18	6-Dec-18	13-Dec-18	20-Dec-18	27-Dec-18	3-Jan-19	11-Jan-19	17-Jan-19	24-Jan-19	31-Jan-19	7-Feb-19	14-Feb-19	21-Feb-19
Laboratory Reference			2067567.4				2081545.1				2097419.4				2107812.1				2120859.4		
Week		62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
pH	pH Units		6.0				6.1				6.1				6.0				5.4		
Acidity (pH 3.7)	g/m3 as CaCO3		< 1.0				< 1.0				< 1.0				< 1.0				< 1.0		
Total Alkalinity	g/m3 as CaCO3		< 8				26				22				30				< 1.0		
Electrical Conductivity (EC)	mS/m		2.4				1.7				1.5				2.2				2.2		
Dissolved Aluminium	g/m3																				
Dissolved Antimony	g/m3																				
Dissolved Barium	g/m3																				
Dissolved Calcium	g/m3																				
Dissolved Cobalt	g/m3																				
Dissolved Iron	g/m3																				
Dissolved Magnesium	g/m3																				
Dissolved Manganese	g/m3																				
Dissolved Mercury	g/m3		< 0.00008				< 0.00008				< 0.00008				< 0.00008				< 0.00008		
Acid Soluble Mercury	g/m3																		< 0.00008		
Dissolved Molybdenum	g/m3																				
Dissolved Potassium	g/m3																				
Dissolved Selenium	g/m3																				
Dissolved Silver	g/m3																				
Dissolved Sodium	g/m3																				
Dissolved Strontium	g/m3																				
Dissolved Uranium	g/m3																				
Dissolved Vanadium	g/m3																				
Sulphate	g/m3		12				< 5				1.7				1.1				< 5		
Dissolved Heavy Metals																					
Dissolved Arsenic	g/m3		< 0.0010				< 0.0010				0.0014				< 0.0010				< 0.0010		
Dissolved Cadmium	g/m3		< 0.00005				< 0.00005				< 0.00005				0.00005				0.00015		
Dissolved Chromium	g/m3		< 0.0005				< 0.0005				0.0007				< 0.0005				0.0007		
Dissolved Copper	g/m3		0.0030				0.0034				0.0048				0.0041				0.0057		
Dissolved Lead	g/m3		< 0.00010				< 0.00010				< 0.00010				< 0.00010				< 0.00010		
Dissolved Nickel	g/m3		0.0007				0.0009				0.0007				0.0010				0.0014		
Dissolved Zinc	g/m3		0.0106				0.01082				0.0096				0.0159				0.015		
Field Parameters																					
pH	pH Units	5.02	4.59	4.53	5.04	5.62	4.9	5.32	5.22	5.77	5.43	5.95	6.41	4.95	5.54	4.92	5.15	5.15	4.03	4.38	4.94
Electrical Conductivity (EC)	mS/m	15.3	2.7	3.2	3	3.4	4.4	4.1	3.5	2.2	1.5	1.6	1.04	1.74	2.2	2.31	3.17	2.07	2.54	2.65	3.15
Temperature	°C	15.8	15	19.2	13	17	18.9	21.1	22.8	17	21.1	21.2	21.3	24	23.5	21.7	19.9	20.6	22.1	22.9	23.2

Sample Origin															
Sample Name			1799534		1800054		1800599		1801352		1801897				1802880
Date		28-Feb-18	7-Mar-19	14-Mar-19	22-Mar-19	28-Mar-19	4-Apr-19	11-Apr-19	18-Apr-19	24-Apr-19	3-May-19	9-May-19	14-May-19	23-May-19	30-May-19
Laboratory Reference			2138146.2		2147390.4		2155397.5		2164341.5		2170480.5				2185913.5
Week		82	83	84	85	86	87	88	89	90	91	92	93	94	95
pH	pH Units		5		5.4		6.9		5.7		4.7				4
Acidity (pH 3.7)	g/m3 as CaCO3		< 1.0		< 1.0		< 1.0		< 1.0		< 1.0				< 1.0
Total Alkalinity	g/m3 as CaCO3		23		24		18		22		22				21
Electrical Conductivity (EC)	mS/m		3.1		2.4		1.9		1.4		4.4				8.7
Dissolved Aluminium	g/m3						0.007				0.033				
Dissolved Antimony	g/m3						< 0.0002				< 0.0002				
Dissolved Barium	g/m3						0.033				0.022				
Dissolved Calcium	g/m3						1.72				1.63				
Dissolved Cobalt	g/m3						0.0009				0.0014				
Dissolved Iron	g/m3						< 0.02				0.8				
Dissolved Magnesium	g/m3						0.33				0.24				
Dissolved Manganese	g/m3						0.047				0.029				
Dissolved Mercury	g/m3		< 0.00008		< 0.00008		< 0.00008		< 0.00008		< 0.00008				< 0.00008
Acid Soluble Mercury	g/m3				< 0.00008		< 0.00015				< 0.00008				
Dissolved Molybdenum	g/m3						< 0.0002				< 0.0002				
Dissolved Potassium	g/m3						0.14				0.11				
Dissolved Selenium	g/m3						< 0.0010				< 0.0010				
Dissolved Silver	g/m3						< 0.00010				< 0.00010				
Dissolved Sodium	g/m3						0.63				0.45				
Dissolved Strontium	g/m3						0.0052				0.004				
Dissolved Uranium	g/m3						< 0.00002				< 0.00002				
Dissolved Vanadium	g/m3						< 0.001				< 0.0010				
Sulphate	g/m3		< 5		6		6		< 5		35				13.1
Dissolved Heavy Metals															
Dissolved Arsenic	g/m3		0.0012		< 0.0010		< 0.0010		< 0.001		< 0.0010				0.0033
Dissolved Cadmium	g/m3		0.00008		0.00005		0.00008		< 0.00005		< 0.00005				0.00008
Dissolved Chromium	g/m3		0.0007		0.0006		< 0.0005		< 0.0005		< 0.0005				0.0005
Dissolved Copper	g/m3		0.0181		0.0093		0.007		0.0051		0.0062				0.0098
Dissolved Lead	g/m3		0.00025		0.00018		0.00019		0.00012		0.00012				0.00049
Dissolved Nickel	g/m3		0.0041		0.0008		0.0012		0.0007		0.0015				0.0026
Dissolved Zinc	g/m3		0.048		0.03		0.024		0.0164		0.02				0.029
Field Parameters															
pH	pH Units	4.9	4.82	4.83	4.64	4.57	4.37	4.25	4.35	4.38	4.48	4.51	4.6	3.38	4.89
Electrical Conductivity (EC)	mS/m	4.4	6.62	7.37	4.08	3.32	2.45	2.35	2.46	1.84	1.96	2.35	2.36	3.15	9.17
Temperature	°C	20.4	24.3	20	17.1	19.8	13.7	17.8	19	17.7	15.5	15.2	9.3	15.8	8.2

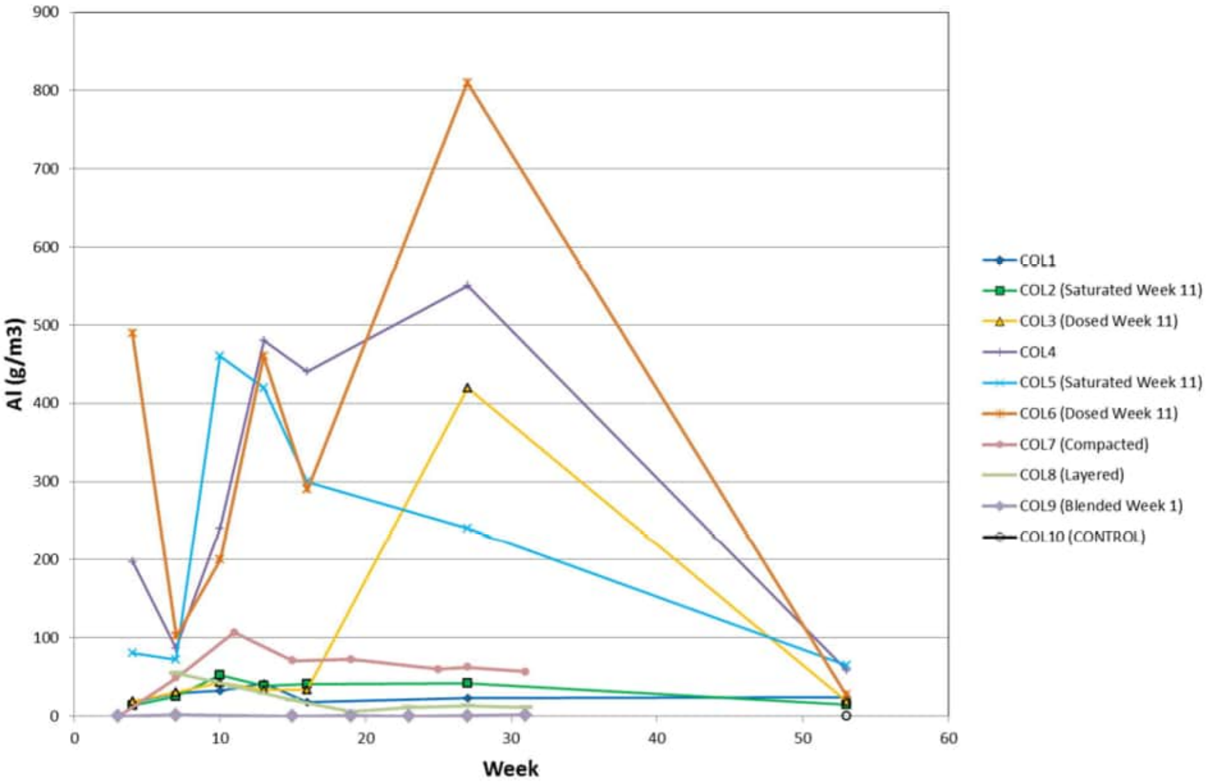

Figure 1 Weekly Column Aluminium Concentration

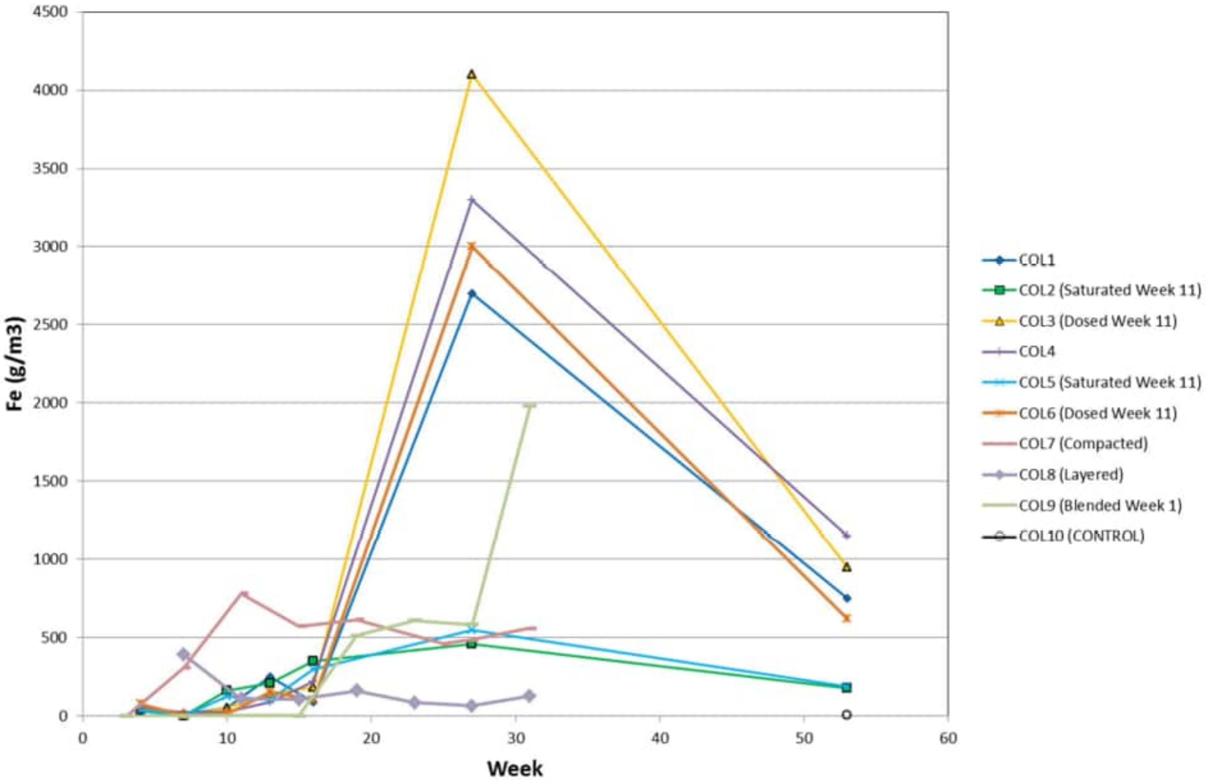

Figure 2 Weekly Column Iron Concentration

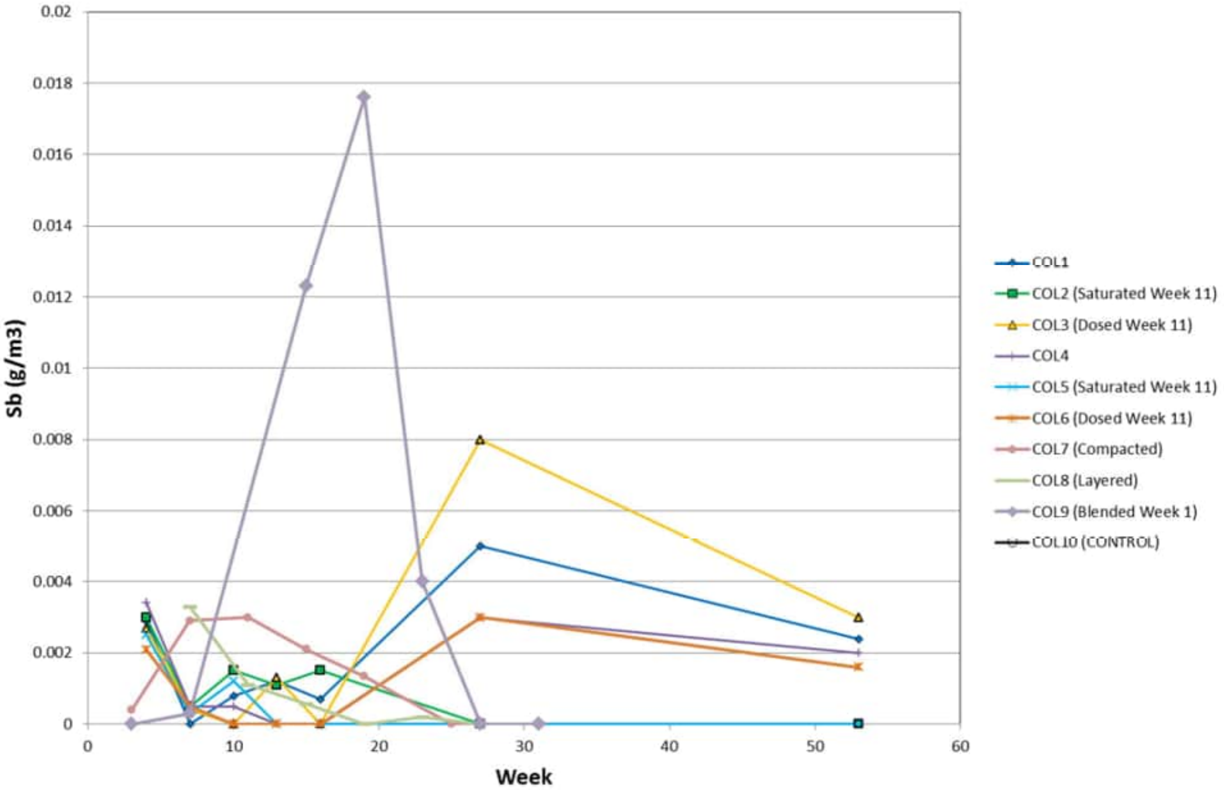

Figure 3 Weekly Column Antimony Concentration

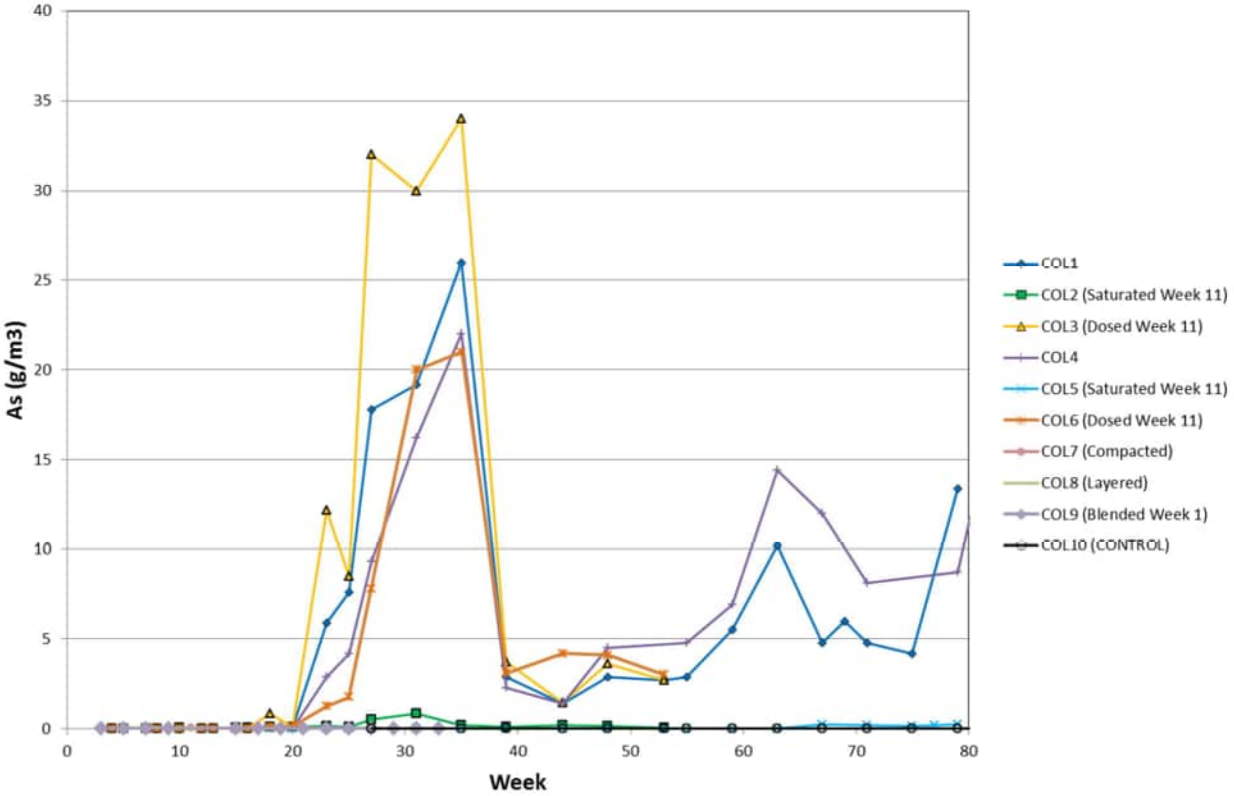

Figure 4 Weekly Column Arsenic Concentration

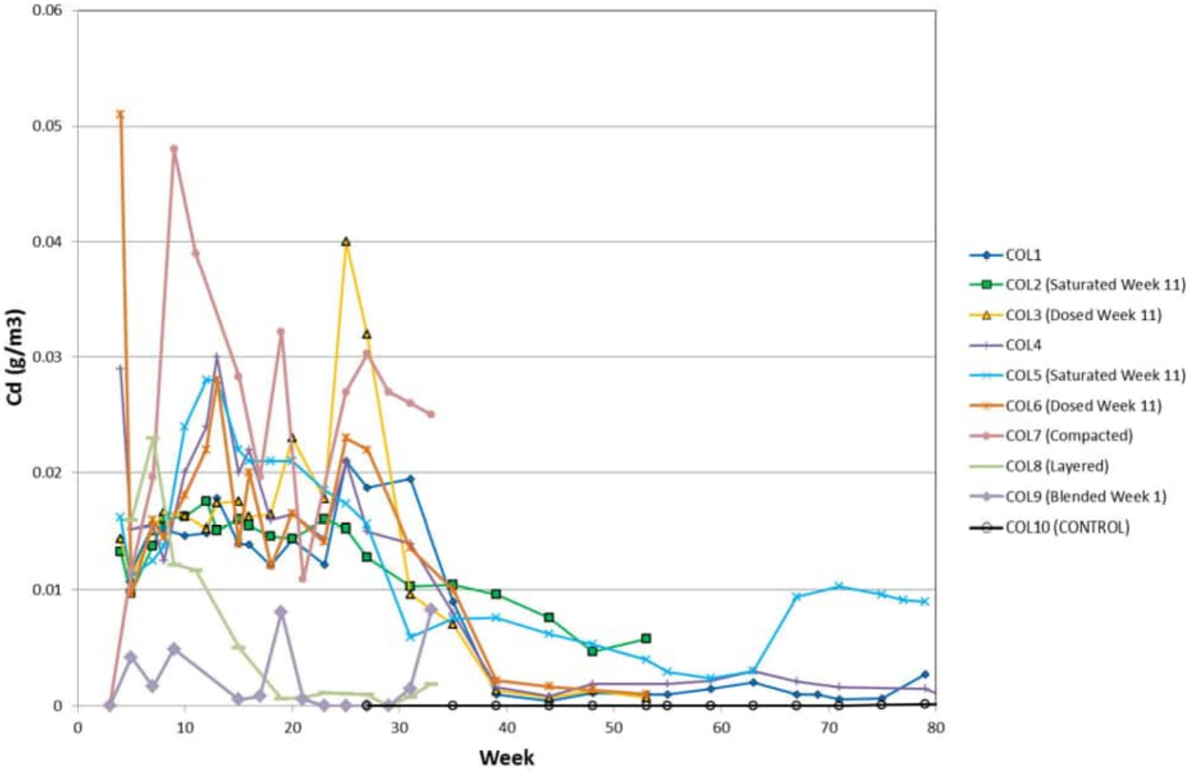

Figure 5 Weekly Column Cadmium Concentration

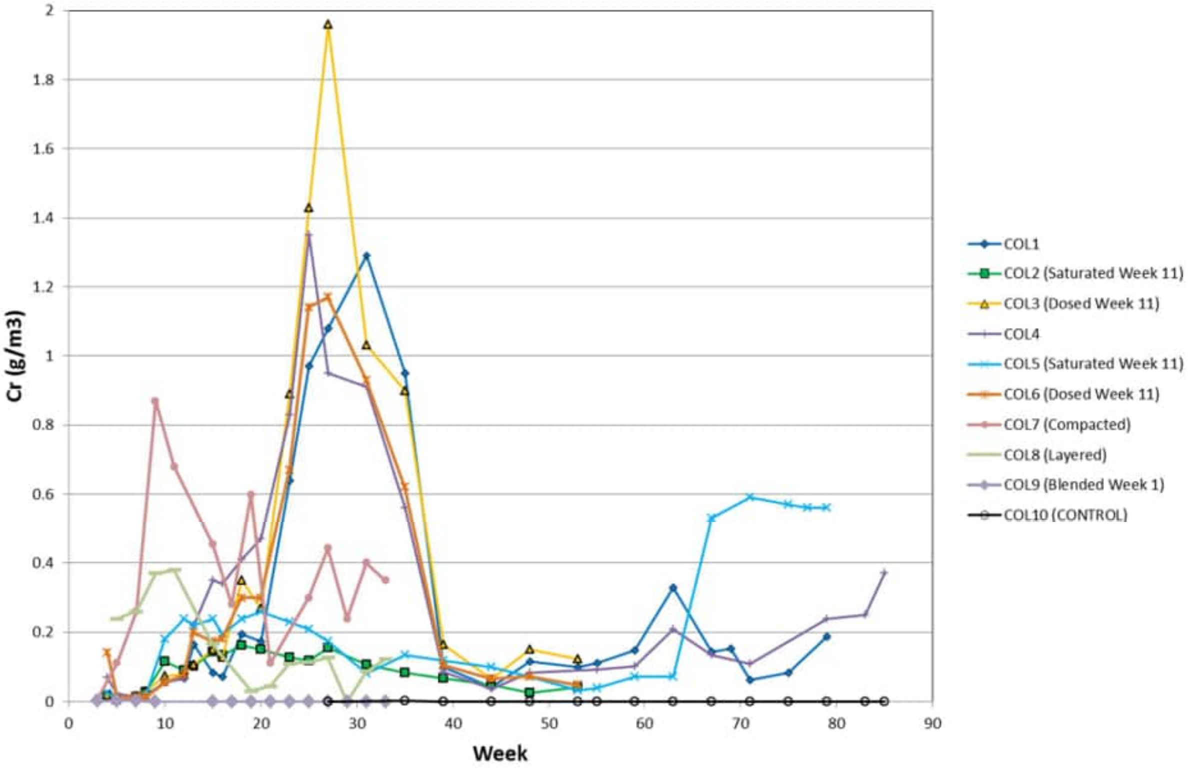

Figure 6 Weekly Column Chromium Concentration

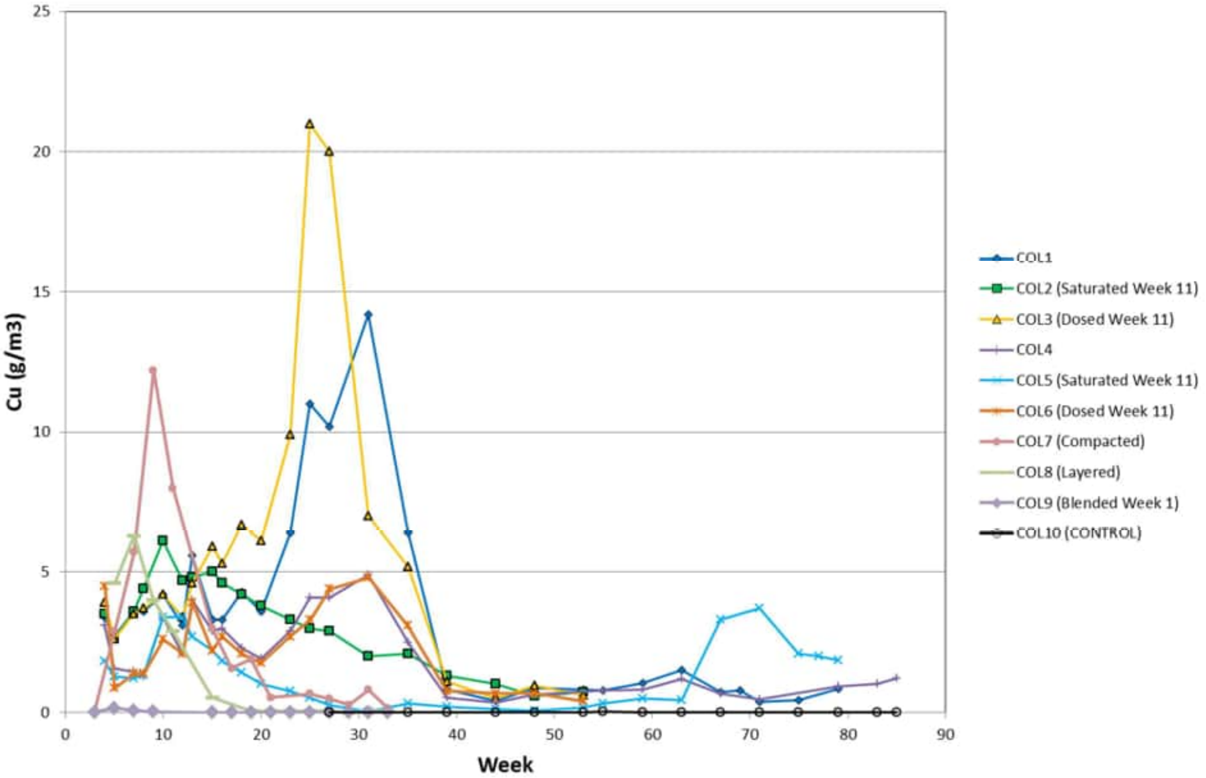

Figure 7 Weekly Column Copper Concentration

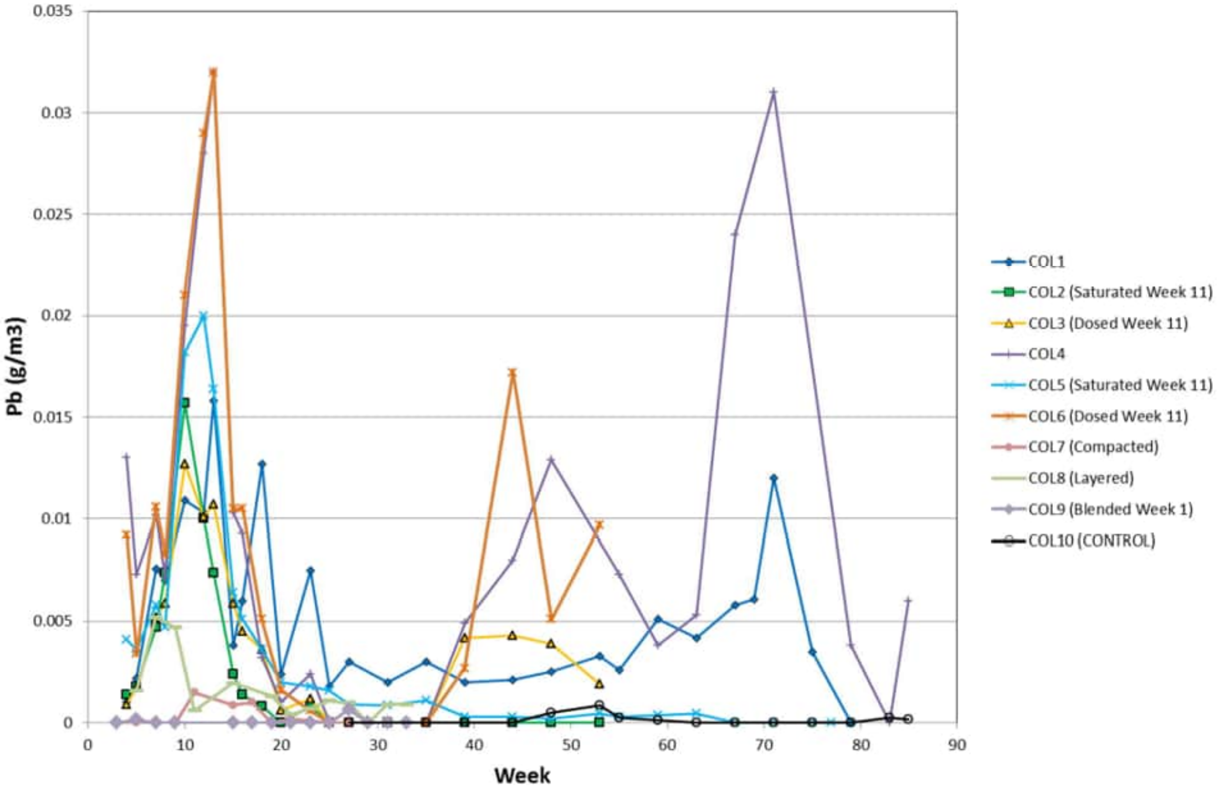

Figure 8 Weekly Column Lead Concentration

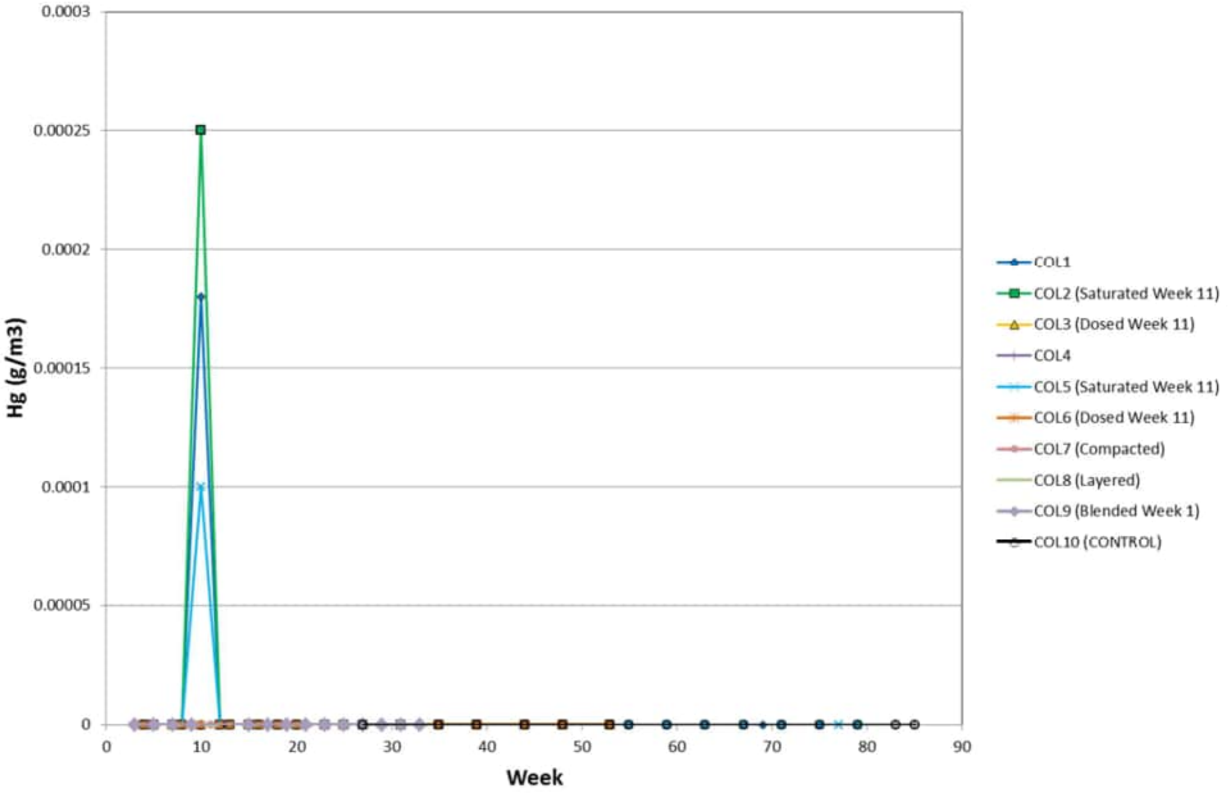

Figure 9 Weekly Column Mercury Concentration

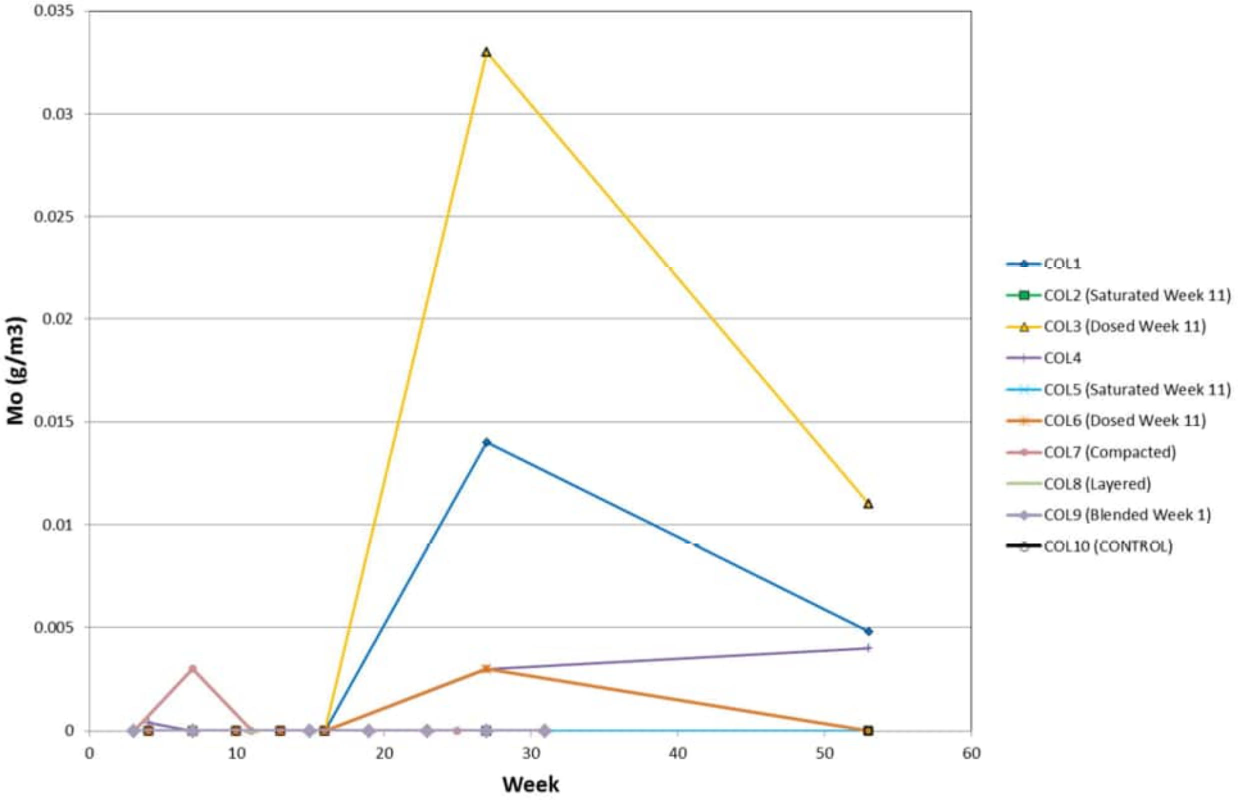

Figure 10 Weekly Column Molybdenum Concentration

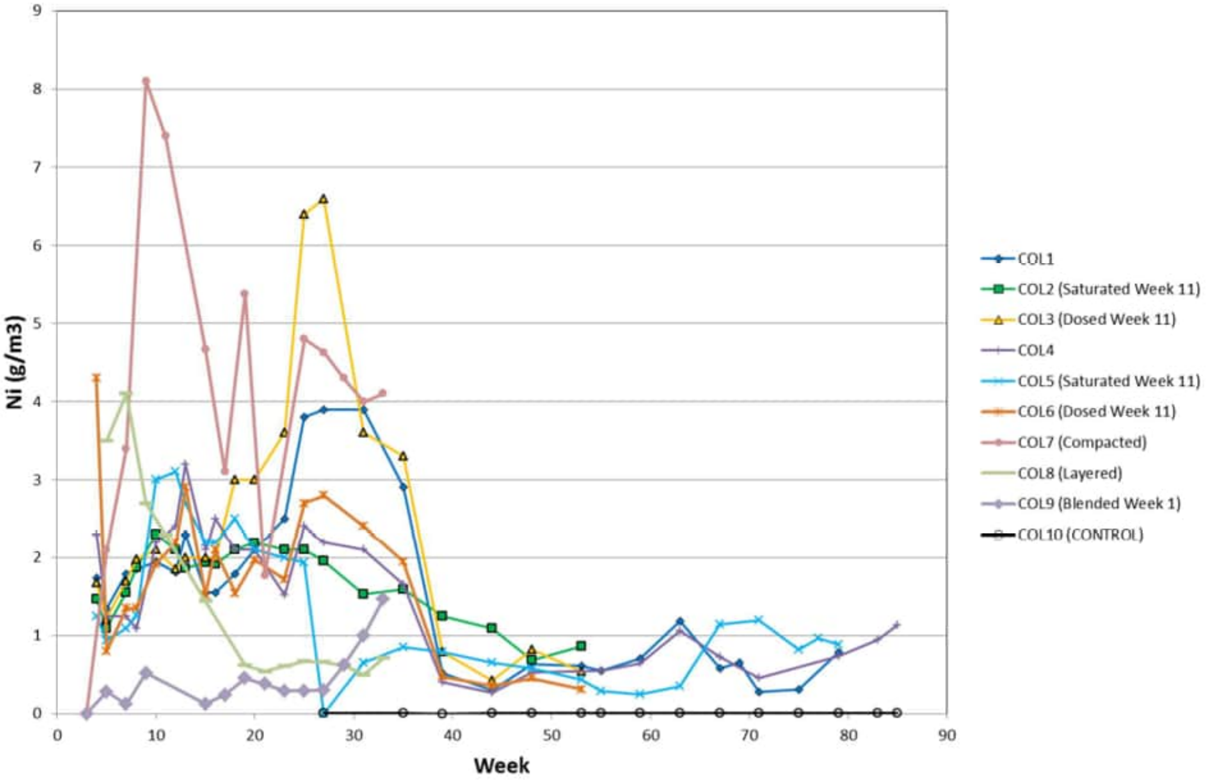

Figure 11 Weekly Column Nickel Concentration

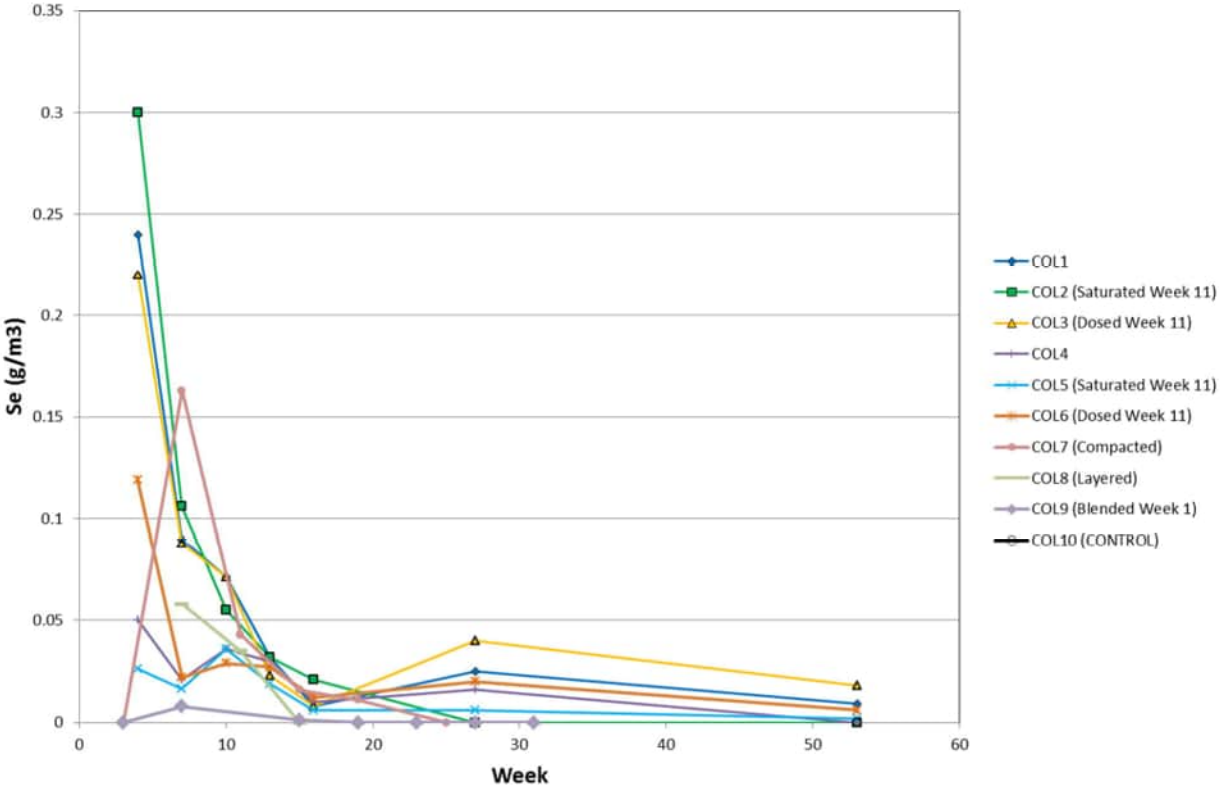

Figure 12 Weekly Column Selenium Concentration

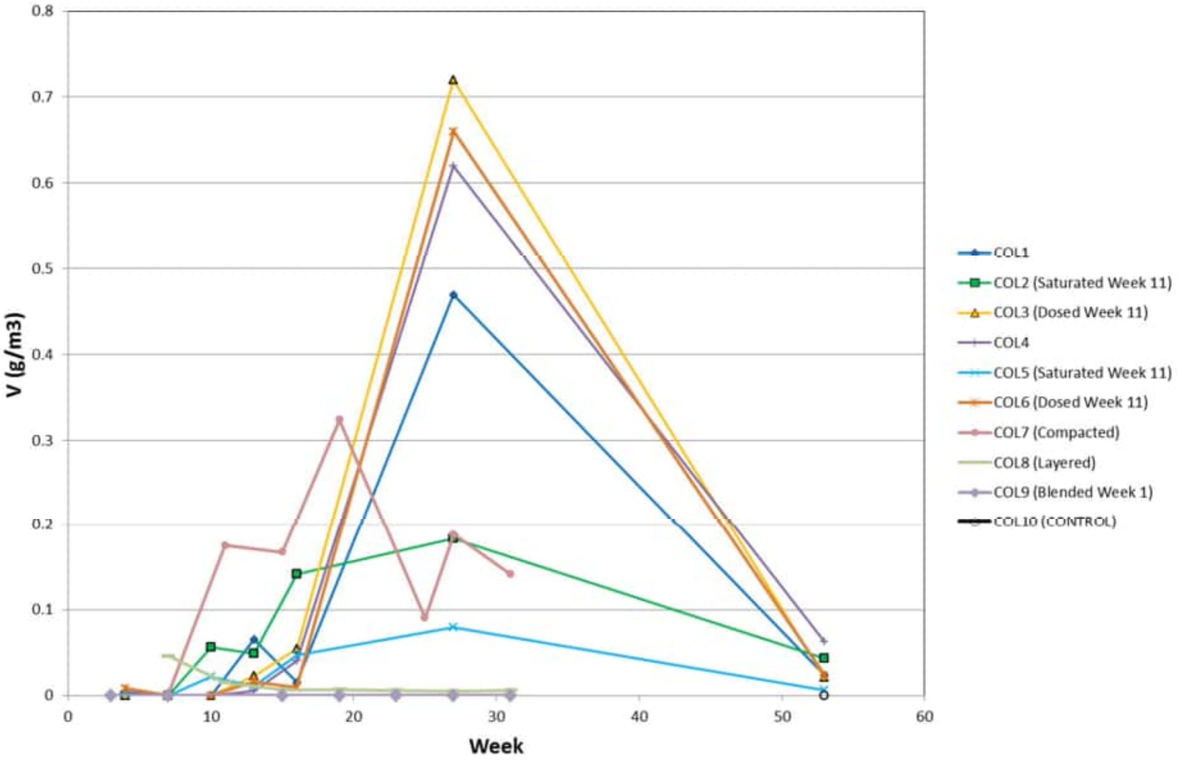

Figure 13 Weekly Column Vanadium Concentration

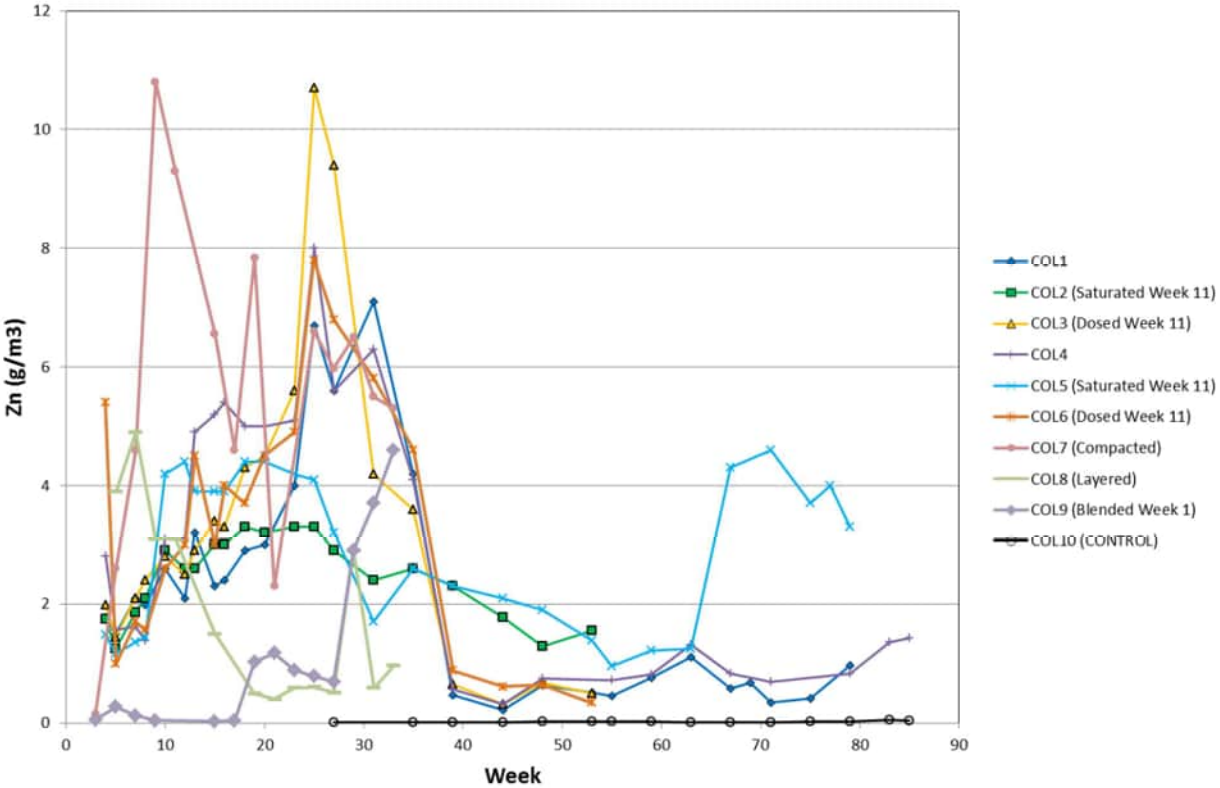

Figure 14 Weekly Column Zinc Concentration

Appendix E

GHD Column Results

May 12, 2022

To	Mark Burroughs, Euan Leslie (Oceana Gold)	**Contact No.**	
Copy to	Ian Jenkins (AECOM)	**Email**	**tim.mulliner@ghd.com**
From	Tim Mulliner	**Project No.**	12552081
Project Name	Waihi North Project		
Subject	Wharekirauponga Column Summary		

1. Introduction

This technical memorandum summarises laboratory analytical acid base accounting (ABA), whole rock geochemistry and leachate data from field columns set up consisting of representative waste rock material associated with the Wharekirauponga Ore Body. The column set up methodology is provided in Appendix A of this document.

2. Column Set up Analysis

Representative sub-samples of the mixed and crushed column material were assessed using multi-element and acid base accounting (ABA) accounting. The collated data is summarised in Table 2.1 and the laboratory data is provided in Appendix B.

In addition, particle size distribution (PSD) analysis was undertaken on the columns. This data is provided in Appendix C.

Before placement in each column, material was weighed so that the total weight of the material in the column was known. This data is summarised and presented in Table 2.2.

Table 2.1 Column Weights

	T-Stream	EG-South	EG-North
Volume of Waste in Column (kg)	63.506	70.106	80.442

Table 2.2 Whole Rock Geochemistry

Sample Origin		**T-Stream**	**EG-North**	**EG-South**
Sample Name		**T-Stream (B1-SS3)**	**EG-North (B2-SS3)**	**EG-South (B3-SS3)**
Date and Time		**11/24/2021**	**11/24/2021**	**11/24/2021**
Laboratory Reference	**Unit**	**WP21-09045**	**WP21-09045**	**WP21-09045**
Total Sulphur (S)	%	1.05	0.77	0.94
Total Carbon (C)	%	0.03	0.02	0.02
Acid Neutralising Capacity (ANC)	kg H_2SO_4/T	2.00	2.00	5.00
Acid Neutralising Capacity (ANC)	% $CaCO_3$ equiv.	0.20	0.20	0.50
Total Acid Producing (TAP)	kg H_2SO_4/T	32.0	24.0	29.0
Total Acid Producing (TAP)	kg $CaCO_3$/T	32.7	24.5	29.6
Acid Producing	kg H_2SO_4/T	32.13	23.56	28.70
Acid Producing	% $CaCO_3$ equiv.	3.28	2.40	2.93
Acid Neutralising Capacity / Total Acid Producing (ANC/PA Ratio)		0.06	0.08	0.17
Net Acid Producing Potential (NAPP)	kg H_2SO_4/T	31.0	21.0	24.0
Net Acid Generation pH (NAG pH)	pH unit	3.10	3.30	3.20
Net Acid Generation (NAG)	kg H_2SO_4/T	30.0	21.0	25.0
NP	kg H2SO4/T	2.33	1.67	1.58
NNP	kg $CaCO_3$/T	-30.32	-22.82	-28.01
NPR Ratio	%	0.07	0.07	0.05
Sulphide Sulphate (S-)	%	0.83	0.62	0.78
S	%	1.06	0.75	0.95
Major Elements				
Al	%	7.37	5.18	5.71
Fe	%	1.33	1.32	1.64
Ca	%	0.46	0.18	0.4
Mg	%	0.12	0.04	0.15
Na	%	0.07	0.15	0.13
K	%	3.1	4.19	3.39
Trace Elements				
Sb	ppm	7.6	11.5	9.23
As	ppm	134.5	201	228
Ba	ppm	390	600	630
Cd	ppm	0.02	0.02	0.03
Co	ppm	2.5	1.3	2.8
Cr	ppm	9	7	10
Cu	ppm	12.9	6.2	6.5
Pb	ppm	15.8	11.4	10.7
Hg	ppm	0.55	0.076	0.064
Mn	ppm	79	90	216
Mo	ppm	2	1.41	1.65
Ni	ppm	3.1	1.6	2.6
Se	ppm	<1	<1	<1
V	ppm	38	10	16
Zn	ppm	13	19	32

This Technical Memorandum is provided as an interim output under our agreement with Oceana Gold NZ Ltd. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

3. Column Leachate Data

Leachate data has been collected throughout the column operation on a weekly basis. Field parameters and measurements taken along with analytical laboratory data are presented for each three columns in Figures 1-3. Leachate analytical data is provided in Appendix D.

Sample Origin		**Figure 1. EG-Vein (Northern Area) Column Results**								
Sample Name		**Column Set-Up**	1836721 09-Nov-2021	1838001 19-Nov-2021	1838178 24-Nov-2021	1838286 02-Dec-2021	1838667 13-Dec-2021	1838692 20-Dec-2021	1838749 30-Dec-2021	1838757 06-Jan-2022
Date and Time		**10/21/2021**	8-Nov-21	19-Nov-21	24-Nov-21	2-Dec-21	13-Dec-21	20-Dec-21	30-Dec-21	6-Jan-22
Laboratory Reference		-	2763341.1	2773857.2	2778761.1	2787988.1	2798790.1	2807535.1	2815489.2	2823026.2
Field Parameters										
FLS Electrical Conductivity	mS/m	-		149.7	225.7	280.9			469.6	991.7
FLS pH	pH Units	-		3.99	3.78	4.77	4.65	4.65	3.51	2.12
FLS Temperature	°C	-		21.3	24.1	19.7	17.7	17.7	24.2	19.2
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	-	1.0	1.0	1.0	1.0	1.0			780
Alkalinity - Total	m^3 as CaC	-	3.4	1.0	1.0	1.0	1.0			1.0
Dissolved Heavy Metals and Trace Elements										
Aluminium-Dissolved	g/m^3	-	0.004	105	196		1,280			290
Antimony-Dissolved	g/m^3	-	0.0002	0.002	0.0004		0.002			0.004
Arsenic-Dissolved	g/m^3	-	0.103	0.162	0.21	0.029	0.83	4	0.153	64
Barium-Dissolved	g/m^3	-	0.005	0.016	0.021		0.012			0.005
Cadmium-Dissolved	g/m^3	-	0.00005	0.0088	0.0154	0.0083	0.115	0.066	0.0049	0.0191
Calcium-Dissolved	g/m^3	-	0.35	52	86	-	510			310
Chromium-Dissolved	g/m^3	-	0.023	0.168	0.29	0.121	2	2.1	0.151	1.06
Cobalt-Dissolved	g/m^3	-	0.0002	0.59	1.05		6.5			0.91
Copper-Dissolved	g/m^3	-	0.028	1.69	3.4	1.63	21	18.2	1.14	5.4
Iron-Dissolved	g/m^3	-	0.02	71	122		670			1,050
Lead-Dissolved	g/m^3	-	0.0001	0.0013	0.0016	0.0002	0.0029	0.001	0.001	0.001
Magnesium-Dissolved	g/m^3	-	0.11	32	52		250			33
Manganese-Dissolved	g/m^3	-	0.0051	6.8	11.1		67			7.5
Mercury-Dissolved	g/m^3	-	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00015
Molybdenum-Dissolved	g/m^3	-	0.0002	0.002	0.0004		0.002			0.02
Nickel-Dissolved	g/m^3	-	0.0005	0.2	0.34	0.173	2.3	1.22	0.099	0.33
Potassium-Dissolved	g/m^3	-	0.17	31	58		310			68
Selenium-Dissolved	g/m^3	-	0.001	0.01	0.013		0.11			0.019
Silver-Dissolved	g/m^3	-	0.0001	0.001	0.0002		0.001			0.001
Sodium-Dissolved	g/m^3	-	0.81	29	45		220			13
Strontium-Dissolved	g/m^3	-	0.0008	0.44	0.72		4.1			0.8
Sulphate	g/m^3	-	5	940	1,640	114	1,110			1,240
Uranium-Dissolved	g/m^3	-	0.00002	0.046	0.088		0.58			0.14
Vanadium-Dissolved	g/m^3	-			0.006		0.064			0.24
Zinc-Dissolved	g/m^3	-	0.065	9.4	16.4	8.5	104	45	5	19.6
Laboratory Field Parameters										
pH(pH units)	pH units	-	6	4.2	4.1	4.5	4			2.4
Electrical Conductivity	(mS/m)	-	1	141.8	216	26.2	155.9			259
Leachate										
Volume in Tubing	mL						80	100	200	200
Volume in Bucket	mL	-					500		40	330
Volume Sampled	mL	-	2,100	1,000	400	350	580	100	240	530

Notes
NES - Not enough to sample
Cells shaded yellow are below the laboratory limit of reporting

Sample Origin										
Sample Name		1838824 12-Jan-2022	1838923 20-Jan-2022	1839223 03-Feb-2022	1839306 11-Feb-2022	1839334 15-Feb-2022	1839575 28-Feb-2022	1839844 07-Mar-2022	1839990 10-Mar-2022	1840315 18-Mar-2022
Date and Time		12-Jan-22	20-Jan-22	3-Feb-22	11-Feb-22	15-Feb-22	28-Feb-22	7-Mar-22	10-Mar-22	18-Mar-22
Laboratory Reference		2825714.1	2836064.1	2854592.1	2867192.1	2873486.1	2900847.2	2909016.1	2914098.3	2925270.1
Field Parameters										
FLS Electrical Conductivity	mS/m	789.3	620	915.9	897.9	821.8		977.1	987.7	1073.7
FLS pH	pH Units	2.1	2.2	2.09	2.08	1.77		1.6	1.65	1.66
FLS Temperature	°C	26.7	21	22.8	21.9	20.6		27.7	24.2	22.5
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	1,950		2,500	3,800	2,900	1060		5,500	6,200
Alkalinity - Total	m^3 as CaC	1.0		1.0	1.0	1.0	1.0		1.0	1.0
Dissolved Heavy Metals and Trace Element										
Aluminium-Dissolved	g/m^3		75	150		95		127		109
Antimony-Dissolved	g/m^3		0.002	0.0034		0.0036		0.0056		0.0077
Arsenic-Dissolved	g/m^3	41	13.6	50	50	35	28	61	55	54
Barium-Dissolved	g/m^3		0.005	0.005		0.005		0.005		0.005
Cadmium-Dissolved	g/m^3	0.0073	0.0043	0.0072	0.0053	0.0033	0.0031	0.0041	0.0031	0.0031
Calcium-Dissolved	g/m^3		48	61		21		21		15.3
Chromium-Dissolved	g/m^3	0.46	0.22	0.46	0.35	0.22	0.193	0.28	0.26	0.25
Cobalt-Dissolved	g/m^3		0.195	0.32		0.21		0.26		0.24
Copper-Dissolved	g/m^3		1.09	1.76	1.25	0.94	0.8	1.1	0.97	0.96
Iron-Dissolved	g/m^3	2	440	1,170		960		1,570		1,620
Lead-Dissolved	g/m^3	0.001	0.001	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005
Magnesium-Dissolved	g/m^3		8.1	15.3		11.1		14.4		11.8
Manganese-Dissolved	g/m^3		2.6	4.2		3.5		4.5		4.3
Mercury-Dissolved	g/m^3	0.00008	0.00015	0.00015	0.00015	0.00015	0.00015	0.00008	0.00015	0.00015
Molybdenum-Dissolved	g/m^3		0.005	0.0128		0.0157		0.026		0.03
Nickel-Dissolved	g/m^3	0.118	0.07	0.121	0.081	0.064	0.057	0.075	0.187	0.098
Potassium-Dissolved	g/m^3		5.2	1.2		1.5		0.4		0.5
Selenium-Dissolved	g/m^3		0.01	0.008		0.011		0.02		0.023
Silver-Dissolved	g/m^3		0.001	0.0005		0.0005		0.0008		0.0006
Sodium-Dissolved	g/m^3		1.5	2.3		1.58		1.73		2
Strontium-Dissolved	g/m^3		0.105	0.121		0.045		0.048		0.044
Sulphate	g/m^3	3,500	2,300	2,600	4,200	3,400	1,270		6,100	6,700
Uranium-Dissolved	g/m^3		0.0158	0.029		0.0155		0.0199		0.0193
Vanadium-Dissolved	g/m^3		0.083	0.23		0.109		0.147		0.134
Zinc-Dissolved	g/m^3	8.7	5.3	8.4	7.2	5.1	4.3	5.6	4.8	4.5
Laboratory Field Parameters										
pH(pH units)	pH units	1.9	2.0	2.0	1.8	1.9	2.2		1.8	1.7
Electrical Conductivity	(mS/m)	677	582	550	798	688	328		1,030	1,086
Leachate										
Volume in Tubing	mL	1,190	1,000	430	1,150	730	420	240	730	400
Volume in Bucket	mL			325	1,050	140	620	0	0	0
Volume Sampled	mL	1,190	1,000	755	2,200	870	1,040	240	730	400

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin							
Sample Name		1840620 25-Mar-2022					1841580 28-Apr-2022
Date and Time		25-Mar-22	31-Mar-22	7-Apr-22	13-Apr-22	21-Apr-22	28-Apr-22
Laboratory Reference		2934532.1					2972202.1
Field Parameters							
FLS Electrical Conductivity	mS/m	454.8					
FLS pH	pH Units	1.77					
FLS Temperature	°C	19.8					
Acidity and Alkalinity							
Acidity (pH 3.7)	m^3 as CaC	2,800					2,200
Alkalinity - Total	m^3 as CaC	1.0					1.0
Dissolved Heavy Metals and Trace Element							
Aluminium-Dissolved	g/m^3						29
Antimony-Dissolved	g/m^3						0.0029
Arsenic-Dissolved	g/m^3	10.3					7.6
Barium-Dissolved	g/m^3						0.005
Cadmium-Dissolved	g/m^3	0.001					0.0008
Calcium-Dissolved	g/m^3						3.5
Chromium-Dissolved	g/m^3	0.072					0.045
Cobalt-Dissolved	g/m^3						0.088
Copper-Dissolved	g/m^3	0.4					0.3
Iron-Dissolved	g/m^3						470
Lead-Dissolved	g/m^3	0.0005					0.0005
Magnesium-Dissolved	g/m^3						3
Manganese-Dissolved	g/m^3						0.74
Mercury-Dissolved	g/m^3	0.00008					0.00008
Molybdenum-Dissolved	g/m^3						0.0056
Nickel-Dissolved	g/m^3	0.034					0.029
Potassium-Dissolved	g/m^3						0.3
Selenium-Dissolved	g/m^3						0.007
Silver-Dissolved	g/m^3						0.0005
Sodium-Dissolved	g/m^3						2.2
Strontium-Dissolved	g/m^3						0.016
Sulphate	g/m^3	3,100					2,300
Uranium-Dissolved	g/m^3						0.0046
Vanadium-Dissolved	g/m^3						0.021
Zinc-Dissolved	g/m^3	1.58					0.87
Laboratory Field Parameters							
pH(pH units)	pH units	1.9					2.00
Electrical Conductivity	(mS/m)	677					595
Leachate							
Volume in Tubing	mL	1,600		100	30	2,000	300
Volume in Bucket	mL			290	0	500	400
Volume Sampled	mL	1,600	550	390	30	2,500	700

Notes
NES - Not enough to sample
Cells shaded yellow are below the laboratory l

Sample Origin		**Figure 2. EG-Vein (Southern Area) Column Results**								
Sample Name		**Column Set-Up**	1836722 09-Nov-2021	1838002 19-Nov-2021	1838179 24-Nov-2021	1838287 02-Dec-2021	1838668 13-Dec-2021	1838693 20-Dec-2021	1838738 - 22-Dec-2021	1838750 30-Dec-2021
Sample Date and Time		**10/21/2021**	8-Nov-21	19-Nov-21	24-Nov-21	2-Dec-21	13-Dec-21	20-Dec-21	22-Dec-21	30-Dec-21
Laboratory Reference		-	2763341.2	2773857.3	2778761.2	2787988.2	2798790.2	2807535.2	2812321.2	2815489.3
Field Parameters										
FLS Electrical Conductivity	mS/m	-		0.3	251.2	65.5			336.9	
FLS pH	pH Units	-		3.96	4.07	4.96	5.09		3.28	
FLS Temperature	°C	-		22.2	23.7	19.8	18.2		25.7	
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	-	1.0	1.0	1.0	1.0	1.0	46	32	
Alkalinity - Total	m^3 as CaC	-	9.4	1.0	1.0	1.0	1.0	1.0	1.0	
Dissolved Heavy Metals and Trace Elements										
Aluminium-Dissolved	g/m^3	-	0.012	230	70		166		230	
Antimony-Dissolved	g/m^3	-	0.0003	0.002	0.0004		0.001		0.002	
Arsenic-Dissolved	g/m^3	-	0.32	0.43	0.4	0.41	0.22	0.75	1.18	1.2
Barium-Dissolved	g/m^3	-	0.005	0.093	0.026		0.063		0.044	
Cadmium-Dissolved	g/m^3	-	0.00005	0.106	0.029	0.09	0.09	0.082	0.062	0.055
Calcium-Dissolved	g/m^3	-	1.45	530	162		530		480	
Chromium-Dissolved	g/m^3	-	0.071	0.053	0.061	0.039	0.023	0.047	0.075	0.078
Cobalt-Dissolved	g/m^3	-	0.0002	6.4	1.84		5.2		3	
Copper-Dissolved	g/m^3	-	0.075	6	1.95	5.7	5.2	8.1	7.8	7.2
Iron-Dissolved	g/m^3	-	0.02	91	26		5.7		1	
Lead-Dissolved	g/m^3	-	0.00013	0.0132	0.0028	0.0102	0.0101	0.006	0.0073	0.0083
Magnesium-Dissolved	g/m^3	-	0.35	480	144		330		200	
Manganese-Dissolved	g/m^3	-	0.024	137	39		108		65	
Mercury-Dissolved	g/m^3	-	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008
Molybdenum-Dissolved	g/m^3	-	0.0002	0.002	0.0004		0.001		0.002	
Nickel-Dissolved	g/m^3	-	0.0005	2.2	0.64	1.91	1.8	1.55	1.11	1.02
Potassium-Dissolved	g/m^3	-	0.57	380	110		340		270	
Selenium-Dissolved	g/m^3	-	0.001	0.086	0.023		0.063		0.045	
Silver-Dissolved	g/m^3	-	0.0001	0.001	0.0002		0.0005		0.001	
Sodium-Dissolved	g/m^3	-	2.6	184	57		145		49	
Strontium-Dissolved	g/m^3	-	0.003	3.8	1.06		3.2		1.94	
Sulphate	g/m^3	-	6	2500	1,540	590	520	4,200	2400	
Uranium-Dissolved	g/m^3	-	0.00002	0.136	0.042		0.131		0.163	
Vanadium-Dissolved	g/m^3	-			0.002		0.005		0.01	
Zinc-Dissolved	g/m^3	-	0.069	59	16.9	53	45	45	34	31
Laboratory Field Parameters										
pH(pH units)	pH units	-	6.4	4.1	4.7	4.5	4.3	3.6	3.7	
Electrical Conductivity	(mS/m)	-	3.5	353	240	107.8	99.2	520	318	
Leachate										
Volume in Tubing	mL	-					50	480	250	60
Volume in Bucket	mL	-					400	550	100	110
Volume Sampled	mL	-	1,200	1,000	350	450	450	1030	350	170

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory limit of reporting

Sample Origin										
Sample Name		1838758 06-Jan-2022	1838825 12-Jan-2022	1838924 20-Jan-2022	1839224 20-Jan-2022	1839307 11-Feb-2022	1839335 15-Feb-2022	1839574 28-Feb-2022	1839845 07-Mar-2022	1839989 10-Mar-2022
Sample Date and Time		6-Jan-22	12-Jan-22	20-Jan-22	3-Feb-22	11-Feb-22	15-Feb-22	28-Feb-22	7-Mar-22	10-Mar-22
Laboratory Reference		2823026.2	2825714.2	2836064.2	2854592.2	2867192.2	2873486.2	2900847.1	2909016.2	2914098.2
Field Parameters										
FLS Electrical Conductivity	mS/m	514.9	626	642	719.6	898.8	982.2		736.4	971.4
FLS pH	pH Units	2.76	2.49	2.6	2.4	2.35	1.92		1.94	1.8
FLS Temperature	°C	25.1	26.8	21.9	21.4	23.1	24		29.1	22.5
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	1,110	1,030	2,100	3,900	6,900	5100	4400	5,400	7,800
Alkalinity - Total	m^3 as CaC	1.0	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Dissolved Heavy Metals and Trace Element										
Aluminium-Dissolved	g/m^3	230		360	390		440		320	
Antimony-Dissolved	g/m^3	0.002		0.004	0.005		0.013		0.0104	
Arsenic-Dissolved	g/m^3	6.6	8.9	6.3	30	117	83	51	77	114
Barium-Dissolved	g/m^3	0.05		0.012	0.005		0.005		0.005	
Cadmium-Dissolved	g/m^3	0.047	0.032	0.033	0.033	0.038	0.026	0.0164	0.0157	0.0152
Calcium-Dissolved	g/m^3	480		480	470		350		220	
Chromium-Dissolved	g/m^3	0.21	0.6	0.6	0.69	0.8	0.59	0.33	0.34	0.39
Cobalt-Dissolved	g/m^3	2.2		1.64	1.79		1.52		1	
Copper-Dissolved	g/m^3	6.1	5.6	5	5.1	4.8	3.5	2.3	2.5	2.4
Iron-Dissolved	g/m^3	187		570	750		1990		1740	
Lead-Dissolved	g/m^3	0.0153	0.0011	0.001	0.0005	0.0013	0.001	0.0005	0.0006	0.0011
Magnesium-Dissolved	g/m^3	139		105	121		144		106	
Manganese-Dissolved	g/m^3	44		54	57		60		36	
Mercury-Dissolved	g/m^3	0.00008	0.00008	0.00015	0.00015	0.00015	0.0003	0.00015	0.00015	0.00015
Molybdenum-Dissolved	g/m^3	0.002	-	0.002	0.0053		0.016		0.0161	
Nickel-Dissolved	g/m^3	0.81	0.58	0.57	0.62	0.61	0.53	0.37	0.53	0.43
Potassium-Dissolved	g/m^3	167		39	6.2		0.5		0.6	
Selenium-Dissolved	g/m^3	0.031		0.015	0.013		0.02		0.021	
Silver-Dissolved	g/m^3	0.001		0.0019	0.001		0.0035		0.0028	
Sodium-Dissolved	g/m^3	25		8.3	8		2.1		1.08	
Strontium-Dissolved	g/m^3	1.39		0.65	0.5		0.156		0.113	
Sulphate	g/m^3	5,600	5,300	5,500	7,500	11,500	9,500	8,100	8,000	13,900
Uranium-Dissolved	g/m^3	0.172		0.164	0.178		0.095		0.056	
Vanadium-Dissolved	g/m^3	0.025		0.32	0.159		0.73		0.25	
Zinc-Dissolved	g/m^3	26	24	23	25	39	31	21	22	19.6
Laboratory Field Parameters										
pH(pH units)	pH units	2.4	2.4	2.5	2.2	2	2.1	2.1	2.1	2
Electrical Conductivity	(mS/m)	594	591	570	785	1018	844	709	784	977
Leachate										
Volume in Tubing	mL	260	1,170	1,160	1,310	1,170	1,140	1,110	770	1100
Volume in Bucket	mL	0	0	0	70	110	170	190	0	0
Volume Sampled	mL	260	1,170	1,160	1,380	1,280	1,310	1,300	770	1100

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory

Sample Origin								
Sample Name		1840316 18-Mar-2022	1840621 25-Mar-2022					1841581 28-Apr-2022
Sample Date and Time		18-Mar-22	25-Mar-22	31-Mar-22	7-Apr-22	13-Apr-22	21-Apr-22	28-Apr-22
Laboratory Reference		2925270.2	2934532.2					2972202.2
Field Parameters								
FLS Electrical Conductivity	mS/m	949.4	795.3					
FLS pH	pH Units	1.86	1.89					
FLS Temperature	°C	23.1	20.2					
Acidity and Alkalinity								
Acidity (pH 3.7)	m^3 as CaC	9,200	5,800					2,900
Alkalinity - Total	m^3 as CaC	1.0	6					1.0
Dissolved Heavy Metals and Trace Element								
Aluminium-Dissolved	g/m^3	400						104
Antimony-Dissolved	g/m^3	0.02						0.005
Arsenic-Dissolved	g/m^3	125	47					16.9
Barium-Dissolved	g/m^3	0.005						0.005
Cadmium-Dissolved	g/m^3	0.0147	0.0077					0.0025
Calcium-Dissolved	g/m^3	240						74
Chromium-Dissolved	g/m^3	0.37	0.182					0.059
Cobalt-Dissolved	g/m^3	1.11						0.4
Copper-Dissolved	g/m^3	2.3	1.44					0.7
Iron-Dissolved	g/m^3	3000						830
Lead-Dissolved	g/m^3	0.0013	0.0005					0.0005
Magnesium-Dissolved	g/m^3	125						40
Manganese-Dissolved	g/m^3	35						8.7
Mercury-Dissolved	g/m^3	0.00015	0.00015					0.00008
Molybdenum-Dissolved	g/m^3	0.032						0.0077
Nickel-Dissolved	g/m^3	0.43	0.28					0.16
Potassium-Dissolved	g/m^3	0.3						0.3
Selenium-Dissolved	g/m^3	0.045						0.013
Silver-Dissolved	g/m^3	0.0013						0.0011
Sodium-Dissolved	g/m^3	1.01						1.15
Strontium-Dissolved	g/m^3	0.043						0.017
Sulphate	g/m^3	11,500	7,000					3,800
Uranium-Dissolved	g/m^3	0.075						0.0137
Vanadium-Dissolved	g/m^3	0.41						0.096
Zinc-Dissolved	g/m^3	17	9.3					2.9
Laboratory Field Parameters								
pH(pH units)	pH units	2	2					2.1
Electrical Conductivity	(mS/m)	987	754					2900
Leachate								
Volume in Tubing	mL	2,000	2,600		680	780	6,710	1,560
Volume in Bucket	mL	0	-		0	0	90	0
Volume Sampled	mL	2,000	2,600	2,100	680	780	6,800	1,560

Notes

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Cells shaded yellow are below the laboratory l

Sample Origin		**Figure 3. T-Stream Vein Column Results**								
Sample Name		**Column Set-Up**	1836721 09-Nov-2021	1838000 19-Nov-2021	1838180 24-Nov-2021	1838288 02-Dec-2021	1838669 13-Dec-2021	1838694 20-Dec-2021	1838737 22-Dec-2021	1838748 30-Dec-2021
Date and Time		**10/21/2021**	8-Nov-21	19-Nov-21	24-Nov-21	2-Dec-21	13-Dec-21	20-Dec-21	22-Dec-21	30-Dec-21
Laboratory Reference		-	2763341.3	2773857.1	2778761.3	2787988.3	2798790.3	2807535.3	2812321.1	281.5489.1
Field Parameters										
FLS Electrical Conductivity	mS/m	-		19.13	2.566	7.8			2.5	
FLS pH	pH Units	-		6.2	6.18	5.57	7.01		5.7	
FLS Temperature	°C	-		22.7	23.5	18.8	18.5		27	
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	-	1.0	1.0		1.0	1.0	1	1	
Alkalinity - Total	m^3 as CaC	-	3.6	4.3		4.0	17.6	1.0	2.2	
Dissolved Heavy Metals and Trace Elements										
Aluminium-Dissolved	g/m^3	-	0.003	0.009	0.008		0		30	
Antimony-Dissolved	g/m^3	-	0.0002	0.0002	0.0002		0.0002		0.002	-
Arsenic-Dissolved	g/m^3	-	0.0042	0.0164	0.0045	0.0045	0.0053	0.144	0.096	0.057
Barium-Dissolved	g/m^3	-	0.005	0.005	0.005		0.005		0.064	-
Cadmium-Dissolved	g/m^3	-	0.00005	0.00005	0.00005	0.00005	0.00005	0.0105	0.0107	0.0064
Calcium-Dissolved	g/m^3	-	0.38	1.02	1.24		1.73		560	
Chromium-Dissolved	g/m^3	-	0.0012	0.0035	0.0014	0.0021	0.003	0.005	0.006	0.006
Cobalt-Dissolved	g/m^3	-	0.0002	0.0002	0.0002		0.0002		2.3	
Copper-Dissolved	g/m^3	-	0.002	0.0064	0.0086	0.0052	0.0117	2.5	3.7	1.76
Iron-Dissolved	g/m^3	-	0.02	0.02	0.02		0.02		28	
Lead-Dissolved	g/m^3	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0015	0.0019	0.0014
Magnesium-Dissolved	g/m^3	-	0.1	0.24	0.44		0.82	-	440	
Manganese-Dissolved	g/m^3	-	0.0037	0.0015	0.006		0.0043	-	12.4	
Mercury-Dissolved	g/m^3	-	0.00008	0.00008	0.00039	0.00008	0.00008	0.00017	0.00008	0.00008
Molybdenum-Dissolved	g/m^3	-	0.0002	0.0002	0.0002		0.0002		0.002	
Nickel-Dissolved	g/m^3	-	0.0005	0.0005	0.0005	0.0005	0.0005	1.26	1.32	0.7
Potassium-Dissolved	g/m^3	-	0.1	0.65	1.1		2.5		94	
Selenium-Dissolved	g/m^3	-	0.001	0.001	0.001		0.001		0.126	
Silver-Dissolved	g/m^3	-	0.0001	0.0001	0.0001		0.0001		0.001	
Sodium-Dissolved	g/m^3	-	0.7	1.4	2.1		5.5		175	
Strontium-Dissolved	g/m^3	-	0.001	0.0027	0.0033		0.0056		2.7	
Sulphate	g/m^3	-	5	5	5	1.9	5	3,800	4.1	
Uranium-Dissolved	g/m^3	-	0.00002	0.00002	0.00002		0.00002		0.042	
Vanadium-Dissolved	g/m^3	-			0.001		0.001		0.01	
Zinc-Dissolved	g/m^3	-	0.024	0.053	0.027	0.026	0.019	4.1	4.6	2.6
Laboratory Field Parameters										
pH(pH units)	pH units	-	5.9	6.2	7.3	6.3	7.1	4.5	5.4	
Electrical Conductivity	(mS/m)	-	0.8	1.8	2.5	1.8	8.2	546	2.3	
Leachate										
Volume in Tubing	mL						0	355	80	10
Volume in Bucket	mL	-					700	600	450	80
Volume Sampled	mL	-	1,800	1,000	200	350	700	955	530	85

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory limit of reporting

Sample Origin										
Sample Name		1838759 06-Jan-2022	1838826 12-Jan-2022	1838925 20-Jan-2022	1839225 03-Feb-2022	1839308 11-Feb-2022	1839336 15-Feb-2022	1839576 28-Feb-2022	1839846 07-Mar-2022	1839988 10-Mar-2022
Date and Time		6-Jan-22	12-Jan-22	20-Jan-22	3-Feb-22	11-Feb-22	15-Feb-22	28-Feb-22	7-Mar-22	10-Mar-22
Laboratory Reference		2823026.3	2825714.3	2836064.3	2854592.3	2867192.3	2873486.3	2900847.3	2909016.3	2914098.1
Field Parameters										
FLS Electrical Conductivity	mS/m	566.9	569	568	558.6	896.4	964.2		906.1	913.9
FLS pH	pH Units	3.43	3.2	3.3	3.09	3.14	2.14		2.36	2.34
FLS Temperature	°C	26.1	29.2	23	22.7	23.6	26.2		26	24.2
Acidity and Alkalinity										
Acidity (pH 3.7)	m^3 as CaC	156	156	440	340	2,700	2800	2200	2,200	1,900
Alkalinity - Total	m^3 as CaC	1.0	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Dissolved Heavy Metals and Trace Element										
Aluminium-Dissolved	g/m^3	76		131	123		370		460	
Antimony-Dissolved	g/m^3	0.002		0.002	0.001		0.004		0.0027	
Arsenic-Dissolved	g/m^3	0.119	0.22	0.28	0.29	30	31	12.4	4.9	4.9
Barium-Dissolved	g/m^3	0.047		0.035	0.024		0.009		0.005	
Cadmium-Dissolved	g/m^3	0.0129	0.0124	0.0119	500	0.015	0.0164	0.0169	0.0199	0.019
Calcium-Dissolved	g/m^3	520		510	0.0122		440		430	
Chromium-Dissolved	g/m^3	0.037	0.083	0.074	0.072	0.26	0.36	0.37	0.39	0.4
Cobalt-Dissolved	g/m^3	2.4		2.2	2.3		2.7		3.4	
Copper-Dissolved	g/m^3	6.6	10.5	9.2	9.3	12.5	13.9	16	19.4	17.3
Iron-Dissolved	g/m^3	34		196	141		1390		780	
Lead-Dissolved	g/m^3	0.0118	0.024	0.0124	0.0066	0.0005	0.001	0.0005	0.0005	0.0005
Magnesium-Dissolved	g/m^3	440		430	460		480		630	
Manganese-Dissolved	g/m^3	11.4		9.5	9.7		16		22	
Mercury-Dissolved	g/m^3	0.00008	0.00008	0.00008	0.00008	0.00015	0.00015	0.00015	0.00015	0.00008
Molybdenum-Dissolved	g/m^3	0.002		0.002	0.001		0.016		0.0018	
Nickel-Dissolved	g/m^3	1.44	1.63	1.47	1.49	1.62	1.88	2	2.3	2.3
Potassium-Dissolved	g/m^3	91		80	78		48		22	
Selenium-Dissolved	g/m^3	0.086		0.042	0.038		0.018		0.019	
Silver-Dissolved	g/m^3	0.001		0.001	0.0005		0.001		0.0005	
Sodium-Dissolved	g/m^3	126		64	63		18.7		19.7	
Strontium-Dissolved	g/m^3	2.6		2.5	2.5		2.5		2.8	
Sulphate	g/m^3	4,700	4,400	4,300	4,200	8,500	10,200	9,200	8,900	10,800
Uranium-Dissolved	g/m^3	0.118		0.125	0.117		0.197		0.27	
Vanadium-Dissolved	g/m^3	0.013		0.066	0.048		0.76		0.88	
Zinc-Dissolved	g/m^3	5.4	6.1	5.7	5.5	7.9	8.1	9.3	10.1	10
Laboratory Field Parameters										
pH(pH units)	pH units	3.1	3.1	3.2	3.3	2.4	2.3	2.4	2.5	2.6
Electrical Conductivity	(mS/m)	563	523	511	534	811	937	895	862	796
Leachate										
Volume in Tubing	mL	170	1,190	1,190	1,150	1,180	1,180	1,100	1,140	820
Volume in Bucket	mL	0	500	0	360	4,300	680	600	0	50
Volume Sampled	mL	170	1,690	1,190	1,510	5,480	1,860	1,700	1,140	870

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

Sample Origin								
Sample Name		1840317 18-Mar-2022	1840622 25-Mar-2022					1841582 28-Apr-2022
Date and Time		18-Mar-22	25-Mar-22	31-Mar-22	7-Apr-22	13-Apr-22	21-Apr-22	28-Apr-22
Laboratory Reference		2925270.3	2934532.3					2972202.3
Field Parameters								
FLS Electrical Conductivity	mS/m	1215.9	1517.1					
FLS pH	pH Units	2.2	1.68					
FLS Temperature	°C	20.5	20.1					
Acidity and Alkalinity								
Acidity (pH 3.7)	m^3 as CaC	3,100	11,400					11,900
Alkalinity - Total	m^3 as CaC	1.0	6					1.0
Dissolved Heavy Metals and Trace Element								
Aluminium-Dissolved	g/m^3	760						540
Antimony-Dissolved	g/m^3	0.0063						0.0069
Arsenic-Dissolved	g/m^3	14.2	179					106
Barium-Dissolved	g/m^3	0.005						0.005
Cadmium-Dissolved	g/m^3	0.024	0.0141					0.0088
Calcium-Dissolved	g/m^3	410						420
Chromium-Dissolved	g/m^3	0.71	0.7					0.53
Cobalt-Dissolved	g/m^3	3.3						1.1
Copper-Dissolved	g/m^3	20	10.6					5.5
Iron-Dissolved	g/m^3	1870						4900
Lead-Dissolved	g/m^3	0.0005	0.002					0.0005
Magnesium-Dissolved	g/m^3	660						230
Manganese-Dissolved	g/m^3	18.8						12.4
Mercury-Dissolved	g/m^3	0.00016	0.0004					0.0004
Molybdenum-Dissolved	g/m^3	0.0029						0.139
Nickel-Dissolved	g/m^3	2.4	1.5					0.96
Potassium-Dissolved	g/m^3	32						0.4
Selenium-Dissolved	g/m^3	0.014						0.03
Silver-Dissolved	g/m^3	0.0005						0.0005
Sodium-Dissolved	g/m^3	11.3						2.1
Strontium-Dissolved	g/m^3	2.6						0.84
Sulphate	g/m^3	13,500	17,900					22,000
Uranium-Dissolved	g/m^3	0.3						0.053
Vanadium-Dissolved	g/m^3	1.47						1.37
Zinc-Dissolved	g/m^3	11.5	8					6.1
Laboratory Field Parameters								
pH(pH units)	pH units	2.4	1.8					1.8
Electrical Conductivity	(mS/m)	1161	1608					1569
Leachate								
Volume in Tubing	mL	2,000	2,900		180	610	4,400	1,850
Volume in Bucket	mL				310	0	3100	500
Volume Sampled	mL	2,000	2,900	2,000	490	610	7,500	2,350

Notes

NES - Not enough to sample

Cells shaded yellow are below the laboratory l

4. Limitations

This report: has been prepared by GHD for Oceana Gold NZ Ltd and may only be used and relied on by Oceana Gold NZ Ltd for the purpose agreed between GHD and Oceana Gold NZ Ltd as set out in section 1 of this report. GHD otherwise disclaims responsibility to any person other than Oceana Gold NZ Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report and in the appendices. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Oceana Gold NZ Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report. Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has not been involved in the preparation of the Assessment of Environmental Effects (AEE), prepared by Mitchell Daysh and has had no contribution to, or review of the AEE other than in this technical report for water management. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the AEE. The GHD document containing the disclaimer is to be included in any other document, the entirety of GHD's report must be used (including the disclaimers contained herein), as opposed to reproductions or inclusions solely of sections of GHD's report.

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Regards

Tim Mulliner
Technical Lead - Environment

This Technical Memorandum is provided as an interim output under our agreement with Oceana Gold NZ Ltd. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

Appendices

Appendix A

Column Set Up Methodology

Memorandum

16 June 2021

To	Mark Burroughs, Oceana Gold NZ Ltd.		
Copy to	Thomas Gardner, Oceana Gold NZ Ltd.; Ian Jenkins, AECOM NZ Ltd.		
From	Carlos Hillman, Tim Mulliner	**Tel**	+64 3 378 0900
Subject	WKP Waste Rock Field Column Testing Set-up	**Project no.**	12552081

Introduction and Background

GHD Limited (GHD) has been engaged by Oceana Gold New Zealand Ltd (Oceana Gold) to undertake Geochemical characterisation of the WKP tunnel and mine spoil. This memorandum outlines specifications, set up and operational procedures for the field column tests to aid the geochemical characterisation and assessment.

The purpose of the column tests is to investigate the onset of acid producing leachate and leachate water quality from the waste rock material associated with the WKP Ore Body. Data gathered will enable geochemical characterisation of waste material and its similarity or dissimilarity to waste material currently handled at the existing and proposed Waihi operations. This will then aid methodology for the development of backfill placement and estimating WKP tunnel inflow water quality.

The methodology outlined here is an adaptation of the methodology as outlined in AECOM, 2017[1]

Column Setup and Specification

The existing columns on site (dimensions approximately 800 mm high, 300 mm diameter equalling a total volume of approximately 0.057 m^3 each) will be utilised. The existing columns should be prepared for use by emptying and cleaning, replacing all tubing and buckets (with sealed lids) with food grade plastic and setting up the columns as outlined in Figure 1. Any new or pre-existing equipment should be thoroughly flushed with an acid wash to remove any existing contaminants. It is recommended that if possible, the column cylinders be replaced.

K1 gravel material is recommended at the base of the columns and placed at a thickness that will allow free drainage of leachate to occur (approximately 100 mm). Tubing should be sealed to the base of the columns to collect drainage and avoid any leakage. The length of the tubing should be sufficient so that it can be connected to the collection buckets beneath the columns and long enough so the outlet of the piping can be attached to the side of the column at a height above the maximum level of the waste rock within the column (introducing a head pressure gradient to enable the column to become fully saturated). Tubing should be secured in place (at side of column and top of bucket) in a way that it can easily be released (when sampling) and repositioned when required. Where the tubing connects at the top of the leachate buckets it should be ‘sealed’ in a manner that avoids water other than leachate entering the buckets and enables the removal of the tubing for sampling during the column operation. An approximate tubing length of 1000 – 2000 mm is therefore recommended.

---

[1] Standard Operating Procedure for PYE Field Columns, Waihi – Set up and sample collection. AECOM, (2017).

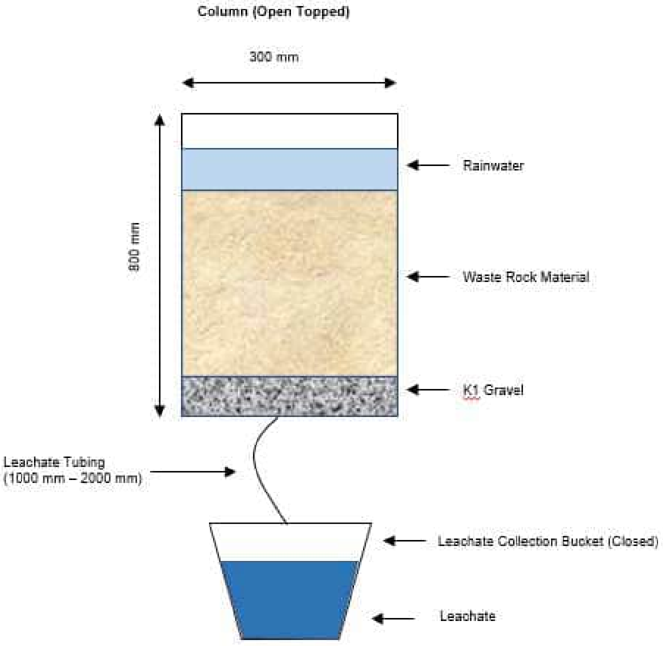

Figure 1 Column Set-up and Specifications

Figure 2 Historical On-site Column Setup (2019)

Waste Rock Selection and Preparation

Three separate columns will be set-up using core material representative of waste spoil and/or tunnel/stope lining material from the WKP Ore body. One column will consist of material surrounding the T-Stream Vein (Drill Site 2) and two columns will exist of material associated with the EG Vein (Drill Site 4 (Northern area) and Drill Site 1 (Southern area)). Each column will contain approximately 60 kg of waste rock representative of the Rhyolitic waste material. Waste rock should be sourced from core material as identified by GHD in the provided spreadsheets (to be provided separately). Appropriate material is selected based on core logs, assay data and photos previously provided to GHD from Oceana Gold.

Once the selected material for each individual column is selected, the material should be fully mixed prior to being crushed (crushing was previously undertaken by the local SGS lab). This will ensure the maximum particle size is not greater than 60 mm or 20% of the column diameter.

Representative samples from each column should be sent for analysis for the parameters detailed in Table 1

The balance of the material should then be placed directly on top of the K1 gravel within the columns. This material should be weighed prior to placing in the column so that total mass of waste within each column is known. A minimum of 150 mm should be maintained between the top of the sample and the top of the column.

Table 1 Recommended Analytical Suite for Column Waste Rock

Required Analytes
PSD (Particle Size Distribution)
NAG pH
Total Sulphur (%)
Total Carbon (%)
ANC (kg $CaCO_3$/tonne)
Aluminium
Iron
Calcium
Magnesium
Sodium
Potassium
Antimony
Arsenic
Barium
Cadmium
Cobalt
Chromium
Copper
Lead
Mercury
Manganese
Molybdenum
Nickel
Selenium
Vanadium
Zinc
Titanium
Tin
Silver
Thallium
Fluoride
Uranium

Column Operation and Sample Procedure

The columns should be left exposed to atmospheric conditions for a minimum of 10 weeks. This initial phase is to ensure that oxidation of the waste rock takes place and becomes acid producing. During this initial phase, leachate generated should be monitored weekly. Depending on the results, the monitoring frequency may be extended with time.

Samples can be obtained by carefully removing the leachate tubing from the bucket and collecting leachate directly from the tubing into laboratory supplied containers suitable for the analysis of the parameters detailed in Table 2 and Table 3.

The expanded and reduced analytical suite should be undertaken on alternate weeks. It is recommended that the expanded suite is utilised for the first flush sample (the first leachate collection event).

Field parameters should be collected utilising a calibrated multi-parameter (or similar individual meters) and the following field parameters recorded:

- pH
- Conductivity
- Temperature

It is recommended that calibration of pH and conductivity is undertaken using appropriate calibration solutions that cover the likely range of measured parameters.

The remaining leachate should be left to drain into the bucket until the tubing runs dry. The volume of leachate within the bucket should be recorded and sampled before reconnecting the tubing to the empty bucket.

If insufficient leachate drains from the tubing and base of column to enable the collection of water samples and/or accurate measurement of field parameters, static water within the bucket should be utilised.

If no leachate water (or insufficient leachate water) is available, a measured volume of 500 mL of de-ionised water should be poured into the column at the top, and the leachate should be collected as described above. Where this is required, it should be recorded on the sampling sheet. In the event that there is frequently not enough leachate to sample within the tubing, a measured volume of deionised water should be added to the top of the column several days before sampling to ensure sufficient water is available. The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommended that field parameters (as above) be recorded prior to the disposal of the leachate water.

The water level of the columns and buckets should be monitoring during and after heavy rainfall events in order to prevent overflow. If leachate buckets need emptying in between the weekly sample cycle, it is recommended that field parameters (as above) be recorded prior to the disposal of the leachate water.

Table 2 Recommended Analytical Suite for the Leachate Sample Collection – Expanded Suite

Required Analytes
pH
Conductivity
Acidity (mg $CaCO_3$/L)
Alkalinity (mg $CaCO_3$/L)
Sulphate
Dissolved Aluminium
Dissolved Iron
Dissolved Calcium
Dissolved Magnesium
Dissolved Sodium
Dissolved Potassium
Dissolved Antimony
Dissolved Arsenic
Dissolved Barium
Dissolved Cadmium
Dissolved Cobalt
Dissolved Chromium
Dissolved Copper
Dissolved Lead
Dissolved Mercury
Dissolved Manganese
Dissolved Molybdenum
Dissolved Nickel
Dissolved Selenium
Dissolved Vanadium
Dissolved Zinc
Dissolved Titanium
Dissolved Tin
Dissolved Silver
Dissolved Thallium
Dissolved Fluoride
Dissolved Uranium

*It is recommended that samples are field filtered and are analysed at trace level.

*Table 3 Recommended Analytical Suite for the Leachate Sample Collection – Reduced Suite_*

Required Analytes
pH
Conductivity
Acidity (mg $CaCO_3$/L)
Alkalinity (mg $CaCO_3$/L)
Sulphate
Dissolved Arsenic
Dissolved Cadmium
Dissolved Chromium
Dissolved Copper
Dissolved Lead
Dissolved Nickel
Dissolved Zinc

*It is recommended that samples are field filtered and are analysed at trace level.

Results should be forwarded to GHD upon receipt and will be reviewed in terms of the acid generating. Once the columns are verified as being acid producing (generally based on a measured pH <3 and elevated sulphate) GHD will review and advise on requirements for ongoing monitoring.

Regards

Carlos Hillman

Geochemist

Appendix B

Whole Rock Laboratory Data

ANALYSIS REPORT

WP21-09045

Client:	Oceana Gold (New Zealand) Ltd PO Box 190 Waihi 3641 NEW ZEALAND Attention: Mark Burroughs	**Received:**	24-Nov-2021
		Completed:	23/12/2021
		Job Number:	WP21-09045
		Report Number:	0000019912
		Order Reference:	70057883

Sample ID	ESO_CSA06V S % LOR 0.01	ESO_CSA06V C % LOR 0.01	ESO_CLA48V ANC H2SO4 KGH2SO4/T LOR -1,000.00	ESO_CLA48V ANC CaCO3 % LOR -100.00	ESO_CLA48V TAP KGH2SO4/T LOR 0.15
T-Stream (B1-SS3)	1.05	0.028	2	0.2	32
EG North (B2-SS3)	0.770	0.020	2	0.2	24
EG south (B3-SS3)	0.938	0.019	5	0.5	29

ANALYSIS REPORT

WP21-09045

Client: Oceana Gold (New Zealand) Ltd
PO Box 190

Waihi 3641 NEW ZEALAND
Attention: Mark Burroughs

Received: 24-Nov-2021
Completed: 23/12/2021
Job Number: WP21-09045
Report Number: 0000019912
Order Reference: 70057883

Sample ID	ESO_CLA48V NAPP KGH2SO4/T LOR -1,000.00	ESO_CLA49V NAG pH pH unit LOR 2.00	ESO_CLA49V NAG KGH2SO4/T	ESO_CSA08V Sulphide S % LOR 0.01
T-Stream (B1-SS3)	31	3.1	30	0.834
EG North (B2-SS3)	21	3.3	21	0.624
EG south (B3-SS3)	24	3.2	25	0.777

Date Start/End Analysis (7/12/2021 - 23/12/2021)

* - Denotes non accredited tests

REMARKS:
Note that general geochem carbon analysis is not performed routinely, and has been done at request using the Leco CHN analyser used for coal ultimate analysis. Calibration curve set up using geo sulphur CRMs which had certified carbon values.
NAG pH for blank was 5.4.

APPLIED METHODS:

ESO_CSA06V: Total sulphur/carbon, LECO Method: SGS Global method

ESO_CLA48V: Determination of ANC, TAP and NAPP of Soils/Rocks: SGS inhouse method

ESO_CLA49V: Net Acid Generation Test: SGS Global method

ANALYSIS REPORT
WP21-09045

Client: Oceana Gold (New Zealand) Ltd
PO Box 190

Waihi 3641 NEW ZEALAND
Attention: Mark Burroughs

Received: 24-Nov-2021
Completed: 23/12/2021
Job Number: WP21-09045
Report Number: 0000019912
Order Reference: 70057883

Signed and dated on 23-Dec-2021

Nick LEES
Operations Manager

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To: OCEANA GOLD (NZ) LTD
PO BOX 5442
DUNEDIN 9058
NEW ZEALAND

Page: 1
Total # Pages: 2 (A - D)
Plus Appendix Pages
Finalized Date: 12-FEB-2022
Account: OCEGOL

CERTIFICATE BR21332922

Project: WNP

This report is for 3 samples of Crushed Core submitted to our lab in Brisbane, QLD, Australia on 2-NOV-2021.

The following have access to data associated with this certificate:

CASSIE CRAIG	THOMAS GARDNER	REBECCA HILLYARD

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LEV-01	Waste Disposal Levy
QAR-01	Quarantine Treatment Charge
LOG-22	Sample login - Rcd w/o BarCode
PUL-23	Pulv Sample - Split/Retain
BAG-01	Bulk Master for Storage
PUL-QC	Pulverizing QC Test
TRA-21	Transfer sample

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
F-ELE81a	F by Specific Ion Electrode	TITRATOR
ME-MS61	48 element four acid ICP-MS	
Hg-MS42	Trace Hg by ICPMS	ICP-MS

This is the Final Report and supersedes any preliminary report with this certificate number.Results apply to samples as submitted.All pages of this report have been checked and approved for release.
***** See Appendix Page for comments regarding this certificate *****

Signature:

Shaun Kenny, Brisbane Laboratory Manager

To: OCEANA GOLD (NZ) LTD
PO BOX 5442
DUNEDIN 9058
NEW ZEALAND

Project: WNP

CERTIFICATE OF ANALYSIS BR21332922

Sample Description	Method Analyte Units LOD	WEI-21 Recvd Wt. kg 0.02	PUL-QC Pass75um % 0.01	F-ELE81a F ppm 20	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05
B1- SS1		1.17	99.1	60	0.61	7.37	134.5	390	0.72	0.04	0.46	0.02	25.0	2.5	9	8.52
B2- SS1		1.98	99.1	30	0.87	5.18	201	600	0.79	0.03	0.18	0.02	31.6	1.3	7	7.46
B3- SS1		2.16	99.2	80	1.05	5.71	228	630	0.98	0.07	0.40	0.03	32.8	2.8	10	8.68

***** See Appendix Page for comments regarding this certificate *****

To: OCEANA GOLD (NZ) LTD
PO BOX 5442
DUNEDIN 9058
NEW ZEALAND

Project: WNP

CERTIFICATE OF ANALYSIS BR21332922

Sample Description	Method Analyte Units LOD	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	Hg-MS42 Hg ppm 0.005	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1
B1- SS1		12.9	1.33	13.60	0.06	2.5	0.550	0.037	3.10	14.2	102.5	0.12	79	2.00	0.07	6.8
B2- SS1		6.2	1.32	9.00	0.08	1.6	0.076	0.016	4.19	15.6	42.9	0.04	90	1.41	0.15	5.9
B3- SS1		6.5	1.64	10.25	0.08	1.6	0.064	0.014	3.39	16.1	35.6	0.15	216	1.65	0.13	5.4

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS BR21332922

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOD	0.2	10	0.5	0.1	0.002	0.01	0.05	0.1	1	0.2	0.2	0.05	0.05	0.01	0.005
B1- SS1		3.1	90	15.8	185.5	<0.002	1.06	7.60	4.1	<1	3.7	38.0	0.62	<0.05	12.15	0.086
B2- SS1		1.6	50	11.4	250	<0.002	0.75	11.50	3.0	<1	1.7	50.8	0.49	<0.05	10.10	0.065
B3- SS1		2.6	350	10.7	226	<0.002	0.95	9.23	3.9	<1	1.9	60.8	0.47	<0.05	9.50	0.099

Sample Description	Method Analyte Units LOD	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5
B1- SS1		2.04	2.9	38	1.7	10.7	13	67.5
B2- SS1		3.47	1.9	10	1.2	11.1	19	44.5
B3- SS1		3.73	1.8	16	1.5	11.3	32	44.5

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

REEs may not be totally soluble in this method.

Applies to Method: ME-MS61

ACCREDITATION COMMENTS

NATA Accreditation covers the performance of this service but does not cover the performance of ALS Brisbane Sample Preparation. Corporate Accreditation No: 825, Corporate Site No: 818. The Technical Signatory is David Jones,ICPMS Supervising Chemist

Applies to Method: ME-MS61

LABORATORY ADDRESSES

Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia. Processed at ALS Brisbane Sample Preparation at 23 Pineapple Street, Zillmere, QLD, 4034, Australia

Applies to Method:

BAG-01
LOG-22
QAR-01
F-ELE81a
ME-MS61
TRA-21
Hg-MS42
PUL-23
WEI-21
LEV-01
PUL-QC

Appendix C

Particle Size Distribution Analysis

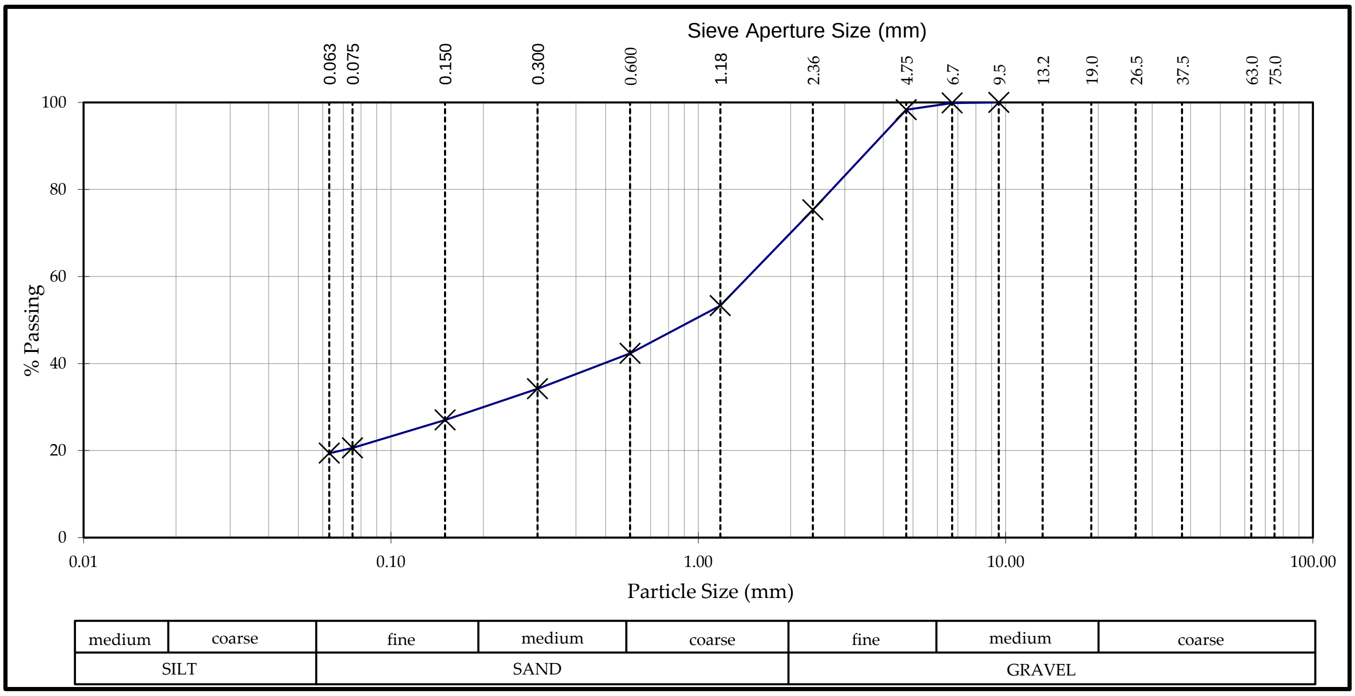
WET SIEVE ANALYSIS
TEST REPORT

Project : Leach Column WUG
Location : 43, Moresby Avenue, Waihi 2610
Client : OceanaGold
Contractor : Rebecca Hillyard
Sampled by : Rebecca Hillyard
Date sampled : 17/09/2021
Sampling method : Drill core
Sample description : Core samples
Sample condition Crushed
Source Waihi, T- Stream (B1)
Depth (m) : n/a

Project No : 5-24G21.67
Lab Ref No : OR1378A
Client Ref No : B1-SS2

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	98	0.300	34
63.00	-	13.20	-	2.36	75	0.150	27
37.50	-	9.50	100	1.18	53	0.075	21
26.50	-	6.70	100	0.600	42	0.063	19



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: As received Fraction tested: Whole Dispersant Used: Sodium hexametaphosphate w/ Sodium carbonate All information supplied by Client Sample size is less than specified in NZS4407:2015.

Date tested : 02 - 04/11/2021
Date reported : 09/11/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

IANZ Approved Signatory

Designation : *Laboratory Technician (Z. Francis)*
Date : 09/11/2021

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

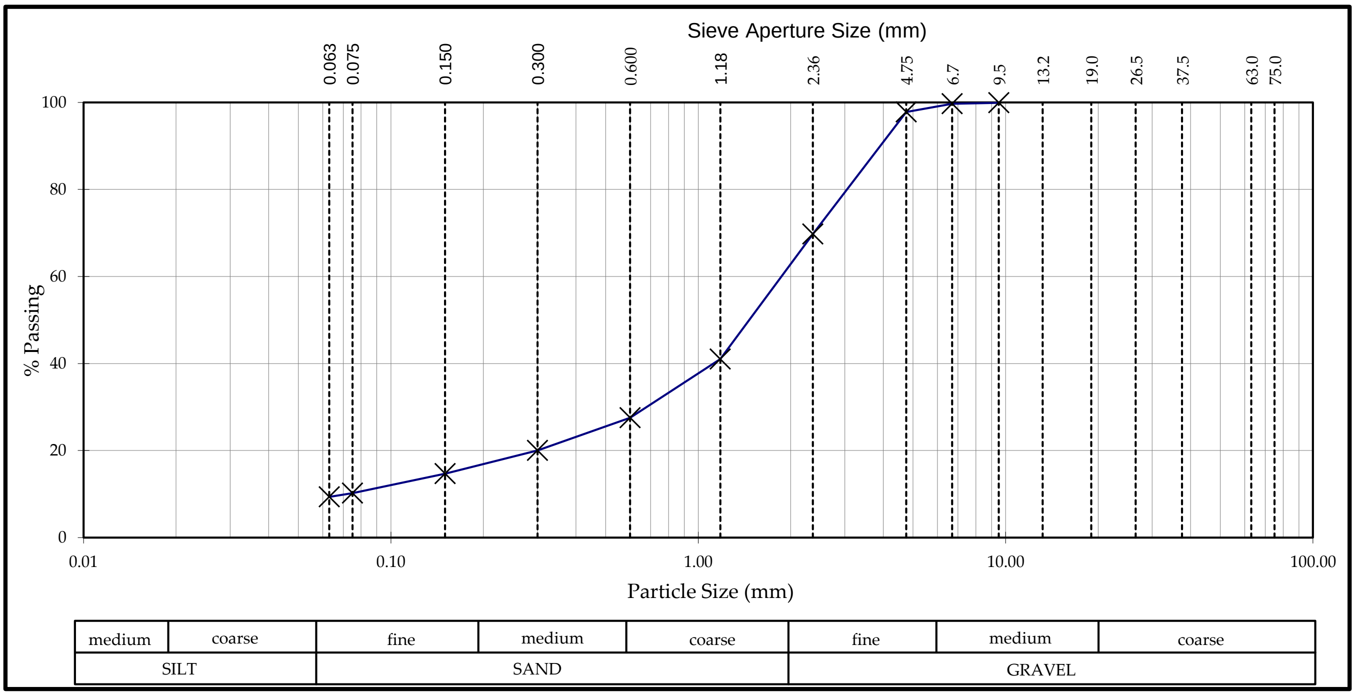
WET SIEVE ANALYSIS
TEST REPORT

Project :	Leach Column WUG
Location :	43, Moresby Avenue, Waihi 2610
Client :	OceanaGold
Contractor :	Rebecca Hillyard
Sampled by :	Rebecca Hillyard
Date sampled :	17/09/2021
Sampling method :	Drill core
Sample description :	Core samples
Sample condition	Crushed
Source	Waihi, EG North (B2)
Depth (m) :	n/a

Project No :	5-24G21.67
Lab Ref No :	OR1378B
Client Ref No :	B2-SS2

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	98	0.300	20
63.00	-	13.20	-	2.36	70	0.150	15
37.50	-	9.50	100	1.18	41	0.075	10
26.50	-	6.70	100	0.600	28	0.063	9



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: As received Fraction tested: Whole Dispersant Used: Sodium hexametaphosphate w/ Sodium carbonate All information supplied by Client Sample size is less than specified in NZS4407:2015.

Date tested : 02 - 04/11/2021
Date reported : 09/11/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

IANZ Approved Signatory

Designation : *Laboratory Technician (Z. Francis)*
Date : 09/11/2021

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

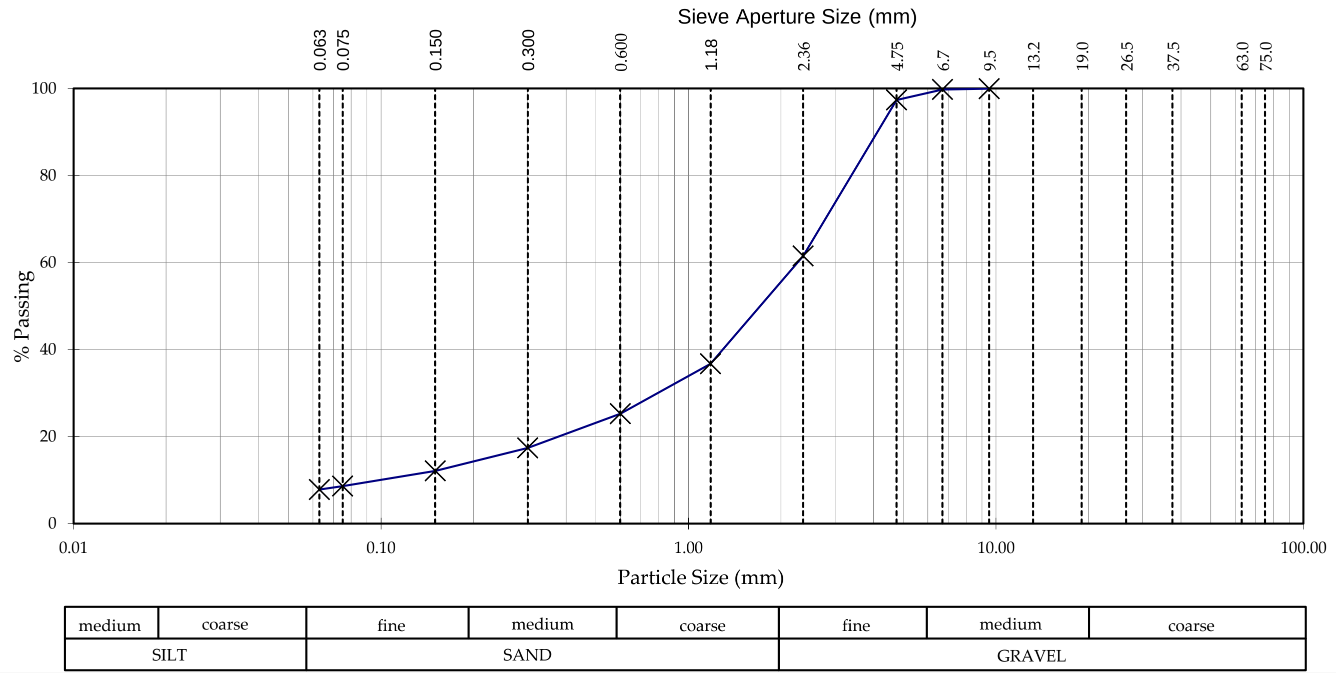
WET SIEVE ANALYSIS
TEST REPORT

Project :	Leach Column WUG
Location :	43, Moresby Avenue, Waihi 2610
Client :	OceanaGold
Contractor :	Rebecca Hillyard
Sampled by :	Rebecca Hillyard
Date sampled :	17/09/2021
Sampling method :	Drill core
Sample description :	Core samples
Sample condition	Crushed
Source	Waihi, EG South (B3)
Depth (m) :	n/a

Project No :	5-24G21.67
Lab Ref No :	OR1378C
Client Ref No :	B3-SS2

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	97	0.300	17
63.00	-	13.20	-	2.36	61	0.150	12
37.50	-	9.50	100	1.18	37	0.075	9
26.50	-	6.70	100	0.600	25	0.063	8



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: As received Fraction tested: Whole Dispersant Used: Sodium hexametaphosphate w/ Sodium carbonate All information supplied by Client Sample size is less than specified in NZS4407:2015.

Date tested : 02 - 04/11/2021
Date reported : 09/11/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

IANZ Approved Signatory

Designation : *Laboratory Technician (Z. Francis)*
Date : 09/11/2021

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Appendix D

Leachate Analytical Data

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2763341 SPv2
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	11-Nov-2021
		Date Reported:	22-Nov-2021
		Quote No:	85959
		Order No:	70056476
		Client Reference:	Extended suite
		Submitted By:	Rebecca Hillyard

Sample Type: Aqueous

Sample Name:		1836721 09-Nov-2021	1836722 09-Nov-2021	1836723 09-Nov-2021		
Lab Number:		2763341.1	2763341.2	2763341.3		
Individual Tests						
pH	pH Units	6.0	6.4	5.9	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	3.4	9.4	3.6	-	-
Electrical Conductivity (EC)	mS/m	1.0	3.5	0.8	-	-
Dissolved Aluminium	g/m^3	0.004	0.012	0.003	-	-
Dissolved Antimony	g/m^3	< 0.0002	0.0003	< 0.0002	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	0.35	1.45	0.38	-	-
Dissolved Cobalt	g/m^3	< 0.0002	< 0.0002	< 0.0002	-	-
Dissolved Iron	g/m^3	< 0.02	< 0.02	< 0.02	-	-
Dissolved Magnesium	g/m^3	0.11	0.35	0.10	-	-
Dissolved Manganese	g/m^3	0.0051	0.024	0.0037	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	< 0.0002	< 0.0002	< 0.0002	-	-
Dissolved Potassium	g/m^3	0.17	0.57	0.10	-	-
Dissolved Selenium	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Dissolved Silver	g/m^3	< 0.00010	< 0.00010	< 0.00010	-	-
Dissolved Sodium	g/m^3	0.81	2.6	0.70	-	-
Dissolved Strontium	g/m^3	0.0008	0.0030	0.0010	-	-
Dissolved Uranium	g/m^3	< 0.00002	< 0.00002	< 0.00002	-	-
Dissolved Vanadium	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Sulphate	g/m^3	5	6	5	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.103	0.32	0.0042	-	-
Dissolved Cadmium	g/m^3	< 0.00005	0.00005	< 0.00005	-	-
Dissolved Chromium	g/m^3	0.023	0.071	0.0012	-	-
Dissolved Copper	g/m^3	0.028	0.075	0.0020	-	-
Dissolved Lead	g/m^3	< 0.00010	0.00013	< 0.00010	-	-
Dissolved Nickel	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Zinc	g/m^3	0.065	0.069	0.024	-	-

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**

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 12-Nov-2021 and 22-Nov-2021. 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

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2773857	SUPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	20-Nov-2021	
		Date Reported:	29-Nov-2021	
		Quote No:	85959	
		Order No:	70056476	
		Client Reference:	Extended suite	
		Submitted By:	Mark Burroughs	

Sample Type: Aqueous

	Sample Name:	1838000 19-Nov-2021	1838001 19-Nov-2021	1838002 19-Nov-2021	
	Lab Number:	2773857.1	2773857.2	2773857.3	
Individual Tests					
pH	pH Units	6.2 ± 0.2	4.2 ± 0.2	4.1 ± 0.2	-
Acidity (pH 3.7)	g/m^3 as CaCO$_3$	< 1.0	< 1.0	< 1.0	-
Total Alkalinity	g/m^3 as CaCO$_3$	4.30 ± 0.69	< 1.0 ± 0.67	< 1.0 ± 0.67	-
Electrical Conductivity (EC)	mS/m	1.8 ± 0.1	141.8 ± 2.9	352.6 ± 7.1	-
Dissolved Aluminium	g/m^3	0.0088 ± 0.0022	104.7 ± 8.3	234 ± 19	-
Dissolved Antimony	g/m^3	< 0.0002 ± 0.00014	< 0.002 ± 0.00033	< 0.002 ± 0.00033	-
Dissolved Barium	g/m^3	< 0.005 ± 0.00025	0.01560 ± 0.00073	0.0931 ± 0.0044	-
Dissolved Calcium	g/m^3	1.019 ± 0.072	52.5 ± 3.3	530 ± 34	-
Dissolved Cobalt	g/m^3	< 0.0002 ± 0.00014	0.590 ± 0.024	6.35 ± 0.25	-
Dissolved Iron	g/m^3	< 0.02 ± 0.014	71.2 ± 4.9	91.4 ± 6.3	-
Dissolved Magnesium	g/m^3	0.240 ± 0.021	32.1 ± 2.2	483 ± 33	-
Dissolved Manganese	g/m^3	0.00155 ± 0.00036	6.83 ± 0.59	137 ± 12	-
Dissolved Mercury	g/m^3	< 0.00008 ± 0.000054	< 0.00008 ± 0.000054	< 0.00008 ± 0.000054	-
Dissolved Molybdenum	g/m^3	< 0.0002 ± 0.00014	< 0.002 ± 0.00035	< 0.002 ± 0.00035	-
Dissolved Potassium	g/m^3	0.650 ± 0.058	30.8 ± 2.3	376 ± 28	-
Dissolved Selenium	g/m^3	< 0.0010 ± 0.00067	< 0.010 ± 0.0012	0.0858 ± 0.0078	-
Dissolved Silver	g/m^3	< 0.00010 ± 0.000067	< 0.0010 ± 0.00064	< 0.0010 ± 0.00064	-
Dissolved Sodium	g/m^3	1.40 ± 0.15	28.6 ± 3.1	184 ± 20	-
Dissolved Strontium	g/m^3	0.00271 ± 0.00036	0.438 ± 0.023	3.81 ± 0.20	-
Dissolved Uranium	g/m^3	< 0.00002 ± 0.000014	0.0458 ± 0.0052	0.136 ± 0.016	-
Dissolved Vanadium	g/m^3	< 0.0010 ± 0.00067	< 0.010 ± 0.0015	< 0.010 ± 0.0015	-
Sulphate	g/m^3	< 5 ± 0.46	943 ± 57	2,550 ± 160	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn					
Dissolved Arsenic	g/m^3	0.0164 ± 0.0012	0.1625 ± 0.0091	0.426 ± 0.024	-
Dissolved Cadmium	g/m^3	< 0.00005 ± 0.000034	0.0088 ± 0.0013	0.106 ± 0.016	-
Dissolved Chromium	g/m^3	0.00352 ± 0.00043	0.168 ± 0.013	0.0534 ± 0.0042	-
Dissolved Copper	g/m^3	0.00643 ± 0.00068	1.69 ± 0.16	6.01 ± 0.55	-
Dissolved Lead	g/m^3	< 0.00010 ± 0.000067	0.00128 ± 0.00012	0.01321 ± 0.00092	-
Dissolved Nickel	g/m^3	< 0.0005 ± 0.00034	0.2040 ± 0.0072	2.242 ± 0.079	-
Dissolved Zinc	g/m^3	0.0529 ± 0.0050	9.38 ± 0.88	59.5 ± 5.6	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

ilac-MRA

ACCREDITED IANZ TESTING LABORATORY

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 22-Nov-2021 and 29-Nov-2021. 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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Martin Cowell - BSc
Client Services Manager - Environmental

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Certificate of Analysis

				SPv1
Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2778761	
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	25-Nov-2021	
		Date Reported:	06-Dec-2021	
		Quote No:	85959	
		Order No:	70051933	
		Client Reference:	Extended suite	
		Submitted By:	Rebecca Hillyard	

Sample Type: Aqueous

Sample Name:		1838178 24-Nov-2021	1838179 24-Nov-2021	1838180 24-Nov-2021		
Lab Number:		2778761.1	2778761.2	2778761.3		
Individual Tests						
pH	pH Units	4.1	4.7	7.3	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	-	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	-	-	-
Electrical Conductivity (EC)	mS/m	216	240	2.5	-	-
Dissolved Aluminium	g/m^3	196	70	0.008	-	-
Dissolved Antimony	g/m^3	< 0.0004	< 0.0004	< 0.0002	-	-
Dissolved Barium	g/m^3	0.021	0.026	< 0.005	-	-
Dissolved Calcium	g/m^3	86	162	1.24	-	-
Dissolved Cobalt	g/m^3	1.05	1.84	< 0.0002	-	-
Dissolved Iron	g/m^3	122	26	< 0.02	-	-
Dissolved Magnesium	g/m^3	52	144	0.44	-	-
Dissolved Manganese	g/m^3	11.1	39	0.0060	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	0.00039	-	-
Dissolved Molybdenum	g/m^3	< 0.0004	< 0.0004	< 0.0002	-	-
Dissolved Potassium	g/m^3	58	110	1.10	-	-
Dissolved Selenium	g/m^3	0.013	0.023	< 0.0010	-	-
Dissolved Silver	g/m^3	< 0.0002	< 0.0002	< 0.00010	-	-
Dissolved Sodium	g/m^3	45	57	2.1	-	-
Dissolved Strontium	g/m^3	0.72	1.06	0.0033	-	-
Dissolved Uranium	g/m^3	0.088	0.042	< 0.00002	-	-
Dissolved Vanadium	g/m^3	0.006	0.002	< 0.0010	-	-
Sulphate	g/m^3	1,640	1,540	< 5	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.21	0.40	0.0045	-	-
Dissolved Cadmium	g/m^3	0.0154	0.029	< 0.00005	-	-
Dissolved Chromium	g/m^3	0.29	0.061	0.0014	-	-
Dissolved Copper	g/m^3	3.4	1.95	0.0086	-	-
Dissolved Lead	g/m^3	0.0016	0.0028	< 0.00010	-	-
Dissolved Nickel	g/m^3	0.34	0.64	< 0.0005	-	-
Dissolved Zinc	g/m^3	16.4	16.9	0.027	-	-

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**

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Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 29-Nov-2021 and 06-Dec-2021. 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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2778761 SUPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	25-Nov-2021
		Date Reported:	06-Dec-2021
		Quote No:	85959
		Order No:	70051933
		Client Reference:	Extended suite
		Submitted By:	Rebecca Hillyard

Sample Type: Aqueous

	Sample Name:	1838178 24-Nov-2021	1838179 24-Nov-2021	1838180 24-Nov-2021	
	Lab Number:	2778761.1	2778761.2	2778761.3	
Individual Tests					
pH	pH Units	4.1 ± 0.2	4.7 ± 0.2	7.3 ± 0.2	-
Acidity (pH 3.7)	g/m^3 as CaCO$_3$	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as CaCO$_3$	< 1.0 ± 0.67	< 1.0 ± 0.67	-	-
Electrical Conductivity (EC)	mS/m	216.0 ± 4.4	240.3 ± 4.9	2.5 ± 0.1	-
Dissolved Aluminium	g/m^3	196 ± 16	69.8 ± 5.5	0.0076 ± 0.0021	-
Dissolved Antimony	g/m^3	< 0.0004 ± 0.00015	< 0.0004 ± 0.00015	< 0.0002 ± 0.00014	-
Dissolved Barium	g/m^3	0.02143 ± 0.0010	0.0264 ± 0.0013	< 0.005 ± 0.00025	-
Dissolved Calcium	g/m^3	86.4 ± 5.5	162 ± 11	1.245 ± 0.085	-
Dissolved Cobalt	g/m^3	1.046 ± 0.042	1.840 ± 0.073	< 0.0002 ± 0.00014	-
Dissolved Iron	g/m^3	122.0 ± 8.4	26.3 ± 1.9	< 0.02 ± 0.014	-
Dissolved Magnesium	g/m^3	51.8 ± 3.5	143.5 ± 9.7	0.440 ± 0.033	-
Dissolved Manganese	g/m^3	11.11 ± 0.96	39.2 ± 3.4	0.00598 ± 0.00062	-
Dissolved Mercury	g/m^3	< 0.00008 ± 0.000054	< 0.00008 ± 0.000054	0.000389 ± 0.000071	-
Dissolved Molybdenum	g/m^3	< 0.0004 ± 0.00015	< 0.0004 ± 0.00015	< 0.0002 ± 0.00014	-
Dissolved Potassium	g/m^3	58.0 ± 4.3	110.0 ± 8.0	1.097 ± 0.087	-
Dissolved Selenium	g/m^3	0.0134 ± 0.0014	0.0234 ± 0.0023	< 0.0010 ± 0.00067	-
Dissolved Silver	g/m^3	< 0.0002 ± 0.00013	< 0.0002 ± 0.00013	< 0.00010 ± 0.000067	-
Dissolved Sodium	g/m^3	44.5 ± 4.8	57.1 ± 6.2	2.12 ± 0.23	-
Dissolved Strontium	g/m^3	0.721 ± 0.037	1.060 ± 0.054	0.00334 ± 0.00038	-
Dissolved Uranium	g/m^3	0.0881 ± 0.0099	0.0417 ± 0.0047	< 0.00002 ± 0.000014	-
Dissolved Vanadium	g/m^3	0.0062 ± 0.0011	0.00235 ± 0.00073	< 0.0010 ± 0.00067	-
Sulphate	g/m^3	1,637 ± 99	1,535 ± 93	< 5 ± 0.46	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn					
Dissolved Arsenic	g/m^3	0.212 ± 0.012	0.398 ± 0.023	0.00453 ± 0.00072	-
Dissolved Cadmium	g/m^3	0.0154 ± 0.0022	0.0289 ± 0.0042	< 0.00005 ± 0.000034	-
Dissolved Chromium	g/m^3	0.287 ± 0.023	0.0613 ± 0.0048	0.00135 ± 0.00035	-
Dissolved Copper	g/m^3	3.35 ± 0.31	1.95 ± 0.18	0.00858 ± 0.00085	-
Dissolved Lead	g/m^3	0.00163 ± 0.00014	0.00285 ± 0.00021	< 0.00010 ± 0.000067	-
Dissolved Nickel	g/m^3	0.344 ± 0.013	0.641 ± 0.023	< 0.0005 ± 0.00034	-
Dissolved Zinc	g/m^3	16.4 ± 1.6	16.9 ± 1.6	0.0268 ± 0.0026	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 29-Nov-2021 and 06-Dec-2021. 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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2787988 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	03-Dec-2021
		Date Reported:	15-Dec-2021
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Rebecca Hillyard

Sample Type: Aqueous

Sample Name:		1838286 02-Dec-2021	1838287 02-Dec-2021	1838288 02-Dec-2021		
Lab Number:		2787988.1	2787988.2	2787988.3		
Individual Tests						
pH	pH Units	4.5	4.5	6.3	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	4.0	-	-
Electrical Conductivity (EC)	mS/m	26.2	107.8	1.8	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Sulphate	g/m^3	114	590	1.9	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.029	0.41	0.0045	-	-
Dissolved Cadmium	g/m^3	0.0083	0.090	< 0.00005	-	-
Dissolved Chromium	g/m^3	0.121	0.039	0.0021	-	-
Dissolved Copper	g/m^3	1.63	5.7	0.0052	-	-
Dissolved Lead	g/m^3	0.00020	0.0102	< 0.00010	-	-
Dissolved Nickel	g/m^3	0.173	1.91	< 0.0005	-	-
Dissolved Zinc	g/m^3	8.5	53	0.026	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 06-Dec-2021 and 14-Dec-2021. 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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2798790	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	14-Dec-2021	
		Date Reported:	23-Dec-2021	
		Quote No:	85959	
		Order No:	70056476	
		Client Reference:	Extended suite	
		Submitted By:	Rebecca Hillyard	

Sample Type: Aqueous

	Sample Name:	1838667 13-Dec-2021	1838668 13-Dec-2021	1838669 13-Dec-2021		
	Lab Number:	2798790.1	2798790.2	2798790.3		
Individual Tests						
pH	pH Units	4.0	4.3	7.1	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	17.6	-	-
Electrical Conductivity (EC)	mS/m	155.9	99.2	8.2	-	-
Dissolved Aluminium	g/m^3	1,280	166	0.010	-	-
Dissolved Antimony	g/m^3	< 0.002	< 0.0010	< 0.0002	-	-
Dissolved Barium	g/m^3	0.012	0.063	< 0.005	-	-
Dissolved Calcium	g/m^3	510	530	1.73	-	-
Dissolved Cobalt	g/m^3	6.5	5.2	< 0.0002	-	-
Dissolved Iron	g/m^3	670	5.7	< 0.02	-	-
Dissolved Magnesium	g/m^3	250	330	0.82	-	-
Dissolved Manganese	g/m^3	67	108	0.0043	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	< 0.002	< 0.0010	< 0.0002	-	-
Dissolved Potassium	g/m^3	310	340	2.5	-	-
Dissolved Selenium	g/m^3	0.11	0.063	< 0.0010	-	-
Dissolved Silver	g/m^3	< 0.0010	< 0.0005	< 0.00010	-	-
Dissolved Sodium	g/m^3	220	145	5.5	-	-
Dissolved Strontium	g/m^3	4.1	3.2	0.0056	-	-
Dissolved Uranium	g/m^3	0.58	0.131	< 0.00002	-	-
Dissolved Vanadium	g/m^3	0.064	< 0.005	< 0.0010	-	-
Sulphate	g/m^3	1,110	520	< 5	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.83	0.22	0.0053	-	-
Dissolved Cadmium	g/m^3	0.115	0.090	< 0.00005	-	-
Dissolved Chromium	g/m^3	2.0	0.023	0.0030	-	-
Dissolved Copper	g/m^3	21	5.2	0.0117	-	-
Dissolved Lead	g/m^3	0.0029	0.0101	< 0.00010	-	-
Dissolved Nickel	g/m^3	2.3	1.80	< 0.0005	-	-
Dissolved Zinc	g/m^3	104	45	0.0190	-	-

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**

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Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 15-Dec-2021 and 23-Dec-2021. 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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Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2807535	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	21-Dec-2021	
		Date Reported:	05-Jan-2022	
		Quote No:	87181	
		Order No:	70057893	
		Client Reference:	Reduced suite	
		Submitted By:	Rebecca Hillyard	

Sample Type: Aqueous

Sample Name:		1838692 20-Dec-2021 9:55 am	1838693 20-Dec-2021 10:00 am	1838694 20-Dec-2021 10:10 am		
Lab Number:		2807535.1	2807535.2	2807535.3		
Individual Tests						
pH	pH Units	-	3.6	4.5	-	-
Acidity (pH 3.7)	g/m³ as $CaCO_3$	-	46	< 1.0	-	-
Total Alkalinity	g/m³ as $CaCO_3$	-	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	-	520	546	-	-
Dissolved Mercury	g/m³	< 0.00008	< 0.00008	0.00017	-	-
Sulphate	g/m³	-	4,200	3,800	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	4.0	0.75	0.144	-	-
Dissolved Cadmium	g/m³	0.066	0.082	0.0105	-	-
Dissolved Chromium	g/m³	2.1	0.047	0.005	-	-
Dissolved Copper	g/m³	18.2	8.1	2.5	-	-
Dissolved Lead	g/m³	< 0.0010	0.0060	0.0012	-	-
Dissolved Nickel	g/m³	1.22	1.55	1.26	-	-
Dissolved Zinc	g/m³	65	45	4.1	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m³	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	2-3
pH	pH meter. 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	2-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m³ as $CaCO_3$	2-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m³ as $CaCO_3$	2-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	2-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m³	2-3

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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

Testing was completed between 23-Dec-2021 and 05-Jan-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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Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2812321 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	24-Dec-2021
		Date Reported:	07-Jan-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Kristin Gillard

Sample Type: Aqueous

Sample Name:		1838737 22-Dec-2021 3:46 pm	1838738 22-Dec-2021 3:38 pm			
Lab Number:		2812321.1	2812321.2			
Individual Tests						
pH	pH Units	5.4	3.7	-	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	< 1.0	32	-	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	2.2	< 1.0	-	-	-
Electrical Conductivity (EC)	mS/m	2.3	318	-	-	-
Dissolved Aluminium	g/m^3	30	230	-	-	-
Dissolved Antimony	g/m^3	< 0.002	< 0.002	-	-	-
Dissolved Barium	g/m^3	0.064	0.044	-	-	-
Dissolved Calcium	g/m^3	560	480	-	-	-
Dissolved Cobalt	g/m^3	2.3	3.0	-	-	-
Dissolved Iron	g/m^3	28	1.0	-	-	-
Dissolved Magnesium	g/m^3	440	200	-	-	-
Dissolved Manganese	g/m^3	12.4	65	-	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	-	-	-
Dissolved Molybdenum	g/m^3	< 0.002	< 0.002	-	-	-
Dissolved Potassium	g/m^3	94	270	-	-	-
Dissolved Selenium	g/m^3	0.126	0.045	-	-	-
Dissolved Silver	g/m^3	< 0.0010	< 0.0010	-	-	-
Dissolved Sodium	g/m^3	175	49	-	-	-
Dissolved Strontium	g/m^3	2.7	1.94	-	-	-
Dissolved Uranium	g/m^3	0.042	0.163	-	-	-
Dissolved Vanadium	g/m^3	< 0.010	< 0.010	-	-	-
Sulphate	g/m^3	4.1	2,400	-	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.096	1.18	-	-	-
Dissolved Cadmium	g/m^3	0.0107	0.062	-	-	-
Dissolved Chromium	g/m^3	0.006	0.075	-	-	-
Dissolved Copper	g/m^3	3.7	7.8	-	-	-
Dissolved Lead	g/m^3	0.0019	0.0073	-	-	-
Dissolved Nickel	g/m^3	1.32	1.11	-	-	-
Dissolved Zinc	g/m^3	4.6	34	-	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-2
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
pH	pH meter. 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	1-2
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-2
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-2
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-2
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-2
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-2
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-2
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-2
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-2
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-2
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-2
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-2
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-2
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-2
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-2
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-2
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-2
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-2
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-2
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-2

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

Testing was completed between 24-Dec-2021 and 07-Jan-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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Helena Bertram BSc
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2815489 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	31-Dec-2021
		Date Reported:	11-Jan-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Kristin Gillard

Sample Type: Aqueous

Sample Name:		1838748 30-Dec-2021 2:00 pm	1838749 30-Dec-2021 2:00 pm	1838750 30-Dec-2021 2:00 pm		
Lab Number:		2815489.1	2815489.2	2815489.3		
Individual Tests						
Dissolved Mercury	g/m³	< 0.00008	< 0.00008	< 0.00008	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.057	0.153	1.20	-	-
Dissolved Cadmium	g/m³	0.0064	0.0049	0.055	-	-
Dissolved Chromium	g/m³	0.006	0.151	0.078	-	-
Dissolved Copper	g/m³	1.76	1.14	7.2	-	-
Dissolved Lead	g/m³	0.0014	< 0.0010	0.0083	-	-
Dissolved Nickel	g/m³	0.70	0.099	1.02	-	-
Dissolved Zinc	g/m³	2.6	5.0	31	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m³	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	1-3

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

Testing was completed between 06-Jan-2022 and 10-Jan-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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Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2823026
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	11-Jan-2022
		Date Reported:	18-Jan-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Mark Burroughs

Sample Type: Aqueous

	Sample Name:	1838757 06-Jan-2022 10:00 am	1838758 06-Jan-2022 11:40 am	1838759 06-Jan-2022 11:40 am		
	Lab Number:	2823026.1	2823026.2	2823026.3		
Individual Tests						
pH	pH Units	2.4	2.4	3.1	-	-
Acidity (pH 3.7)	g/m³ as $CaCO_3$	780	1,110	156	-	-
Total Alkalinity	g/m³ as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	259	594	563	-	-
Dissolved Aluminium	g/m^3	290	230	76	-	-
Dissolved Antimony	g/m^3	0.004	< 0.002	< 0.002	-	-
Dissolved Barium	g/m^3	< 0.005	0.050	0.047	-	-
Dissolved Calcium	g/m^3	310	480	520	-	-
Dissolved Cobalt	g/m^3	0.91	2.2	2.4	-	-
Dissolved Iron	g/m^3	1,050	187	34	-	-
Dissolved Magnesium	g/m^3	33	139	440	-	-
Dissolved Manganese	g/m^3	7.5	44	11.4	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00008	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	0.020	< 0.002	< 0.002	-	-
Dissolved Potassium	g/m^3	68	167	91	-	-
Dissolved Selenium	g/m^3	0.019	0.031	0.086	-	-
Dissolved Silver	g/m^3	< 0.0010	< 0.0010	< 0.0010	-	-
Dissolved Sodium	g/m^3	13.0	25	126	-	-
Dissolved Strontium	g/m^3	0.80	1.39	2.6	-	-
Dissolved Uranium	g/m^3	0.104	0.172	0.118	-	-
Dissolved Vanadium	g/m^3	0.24	0.025	0.013	-	-
Sulphate	g/m^3	1,240	5,600	4,700	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	64	6.6	0.119	-	-
Dissolved Cadmium	g/m^3	0.0191	0.047	0.0129	-	-
Dissolved Chromium	g/m^3	1.06	0.21	0.037	-	-
Dissolved Copper	g/m^3	5.4	6.1	6.6	-	-
Dissolved Lead	g/m^3	< 0.0010	0.0153	0.0118	-	-
Dissolved Nickel	g/m^3	0.33	0.81	1.44	-	-
Dissolved Zinc	g/m^3	19.6	26	5.4	-	-

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**

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 12-Jan-2022 and 18-Jan-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: Oceana Gold (New Zealand) Limited
Contact: Mark Burroughs
C/- Oceana Gold (New Zealand) Limited
PO Box 190
Waihi 3610

SPv1

Lab No: 2825714
Date Received: 13-Jan-2022
Date Reported: 19-Jan-2022
Quote No: 87181
Order No: 70057893
Client Reference: Reduced suite
Submitted By: Kristin Gillard

Sample Type: Aqueous

	Sample Name:	1838824 12-Jan-2022	1838825 12-Jan-2022	1838826 12-Jan-2022		
	Lab Number:	2825714.1	2825714.2	2825714.3		
Individual Tests						
pH	pH Units	1.9	2.4	3.1	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	1,950	1,030	156	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	677	591	523	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.00008	-	-
Sulphate	g/m^3	3,500	5,300	4,400	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	41	8.9	0.22	-	-
Dissolved Cadmium	g/m^3	0.0073	0.032	0.0124	-	-
Dissolved Chromium	g/m^3	0.46	0.60	0.083	-	-
Dissolved Copper	g/m^3	2.0	5.6	10.5	-	-
Dissolved Lead	g/m^3	< 0.0010	0.0011	0.024	-	-
Dissolved Nickel	g/m^3	0.118	0.58	1.63	-	-
Dissolved Zinc	g/m^3	8.7	24	6.1	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 17-Jan-2022 and 19-Jan-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

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2836064
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	21-Jan-2022
		Date Reported:	27-Jan-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Jake Horne

Sample Type: Aqueous

	Sample Name:	1838923 20-Jan-2022 1:50 pm	1838924 20-Jan-2022 3:10 pm	1838925 20-Jan-2022 3:50 pm		
	Lab Number:	2836064.1	2836064.2	2836064.3		
Individual Tests						
pH	pH Units	2.0	2.5	3.2	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,000	2,100	440	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	582	570	511	-	-
Dissolved Aluminium	g/m^3	75	360	131	-	-
Dissolved Antimony	g/m^3	0.002	0.004	< 0.002	-	-
Dissolved Barium	g/m^3	< 0.005	0.012	0.035	-	-
Dissolved Calcium	g/m^3	48	480	510	-	-
Dissolved Cobalt	g/m^3	0.195	1.64	2.2	-	-
Dissolved Iron	g/m^3	440	570	196	-	-
Dissolved Magnesium	g/m^3	8.1	105	430	-	-
Dissolved Manganese	g/m^3	2.6	54	9.5	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	0.005	< 0.002	< 0.002	-	-
Dissolved Potassium	g/m^3	5.2	39	80	-	-
Dissolved Selenium	g/m^3	< 0.010	0.015	0.042	-	-
Dissolved Silver	g/m^3	< 0.0010	0.0019	< 0.0010	-	-
Dissolved Sodium	g/m^3	1.5	8.3	64	-	-
Dissolved Strontium	g/m^3	0.105	0.65	2.5	-	-
Dissolved Uranium	g/m^3	0.0158	0.164	0.125	-	-
Dissolved Vanadium	g/m^3	0.083	0.32	0.066	-	-
Sulphate	g/m^3	2,300	5,500	4,300	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	13.6	6.3	0.28	-	-
Dissolved Cadmium	g/m^3	0.0043	0.033	0.0119	-	-
Dissolved Chromium	g/m^3	0.22	0.60	0.074	-	-
Dissolved Copper	g/m^3	1.09	5.0	9.2	-	-
Dissolved Lead	g/m^3	< 0.0010	< 0.0010	0.0124	-	-
Dissolved Nickel	g/m^3	0.070	0.57	1.47	-	-
Dissolved Zinc	g/m^3	5.3	23	5.7	-	-

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**

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 24-Jan-2022 and 27-Jan-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

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2854592
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	04-Feb-2022
		Date Reported:	14-Feb-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Jake Horne

Sample Type: Aqueous

Sample Name:		1839223 03-Feb-2022	1839224 03-Feb-2022	1839225 03-Feb-2022		
Lab Number:		2854592.1	2854592.2	2854592.3		
Individual Tests						
pH	pH Units	2.0	2.2	3.3	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,500	3,900	340	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	550	785	534	-	-
Dissolved Aluminium	g/m^3	150	390	123	-	-
Dissolved Antimony	g/m^3	0.0034	0.0050	< 0.0010	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	0.024	-	-
Dissolved Calcium	g/m^3	61	470	500	-	-
Dissolved Cobalt	g/m^3	0.32	1.79	2.3	-	-
Dissolved Iron	g/m^3	1,170	750	141	-	-
Dissolved Magnesium	g/m^3	15.3	121	460	-	-
Dissolved Manganese	g/m^3	4.2	57	9.7	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00008	-	-
Dissolved Molybdenum	g/m^3	0.0128	0.0053	< 0.0010	-	-
Dissolved Potassium	g/m^3	1.2	6.2	78	-	-
Dissolved Selenium	g/m^3	0.008	0.013	0.038	-	-
Dissolved Silver	g/m^3	< 0.0005	0.0010	< 0.0005	-	-
Dissolved Sodium	g/m^3	2.3	8.0	63	-	-
Dissolved Strontium	g/m^3	0.121	0.50	2.5	-	-
Dissolved Uranium	g/m^3	0.029	0.178	0.117	-	-
Dissolved Vanadium	g/m^3	0.23	0.159	0.048	-	-
Sulphate	g/m^3	2,600	7,500	4,200	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	50	30	0.29	-	-
Dissolved Cadmium	g/m^3	0.0072	0.033	0.0122	-	-
Dissolved Chromium	g/m^3	0.46	0.69	0.072	-	-
Dissolved Copper	g/m^3	1.76	5.1	9.3	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	0.0066	-	-
Dissolved Nickel	g/m^3	0.121	0.62	1.49	-	-
Dissolved Zinc	g/m^3	8.4	25	5.5	-	-

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**

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 05-Feb-2022 and 14-Feb-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2867192	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	12-Feb-2022	
		Date Reported:	21-Feb-2022	
		Quote No:	87181	
		Order No:	70057893	
		Client Reference:	Reduced suite	
		Submitted By:	Jake Horne	

Sample Type: Aqueous

	Sample Name:	1839306 11-Feb-2022 10:00 am	1839307 11-Feb-2022 10:40 am	1839308 11-Feb-2022 11:15 am		
	Lab Number:	2867192.1	2867192.2	2867192.3		
Individual Tests						
pH	pH Units	1.8	2.0	2.4	-	-
Acidity (pH 3.7)	g/m^3 as CaCO$_3$	3,800	6,900	2,700	-	-
Total Alkalinity	g/m^3 as CaCO$_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	798	1,018	811	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00015	-	-
Sulphate	g/m^3	4,200	11,500	8,500	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	50	117	30	-	-
Dissolved Cadmium	g/m^3	0.0053	0.038	0.0150	-	-
Dissolved Chromium	g/m^3	0.35	0.80	0.26	-	-
Dissolved Copper	g/m^3	1.25	4.8	12.5	-	-
Dissolved Lead	g/m^3	0.0006	0.0013	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.081	0.61	1.62	-	-
Dissolved Zinc	g/m^3	7.2	39	7.9	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as CaCO$_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as CaCO$_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

ilac-MRA

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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

Testing was completed between 15-Feb-2022 and 21-Feb-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2873486 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	16-Feb-2022
		Date Reported:	23-Feb-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Mark Burroughs

Sample Type: Aqueous

	Sample Name:	1839334 15-Feb-2022 10:30 am	1839335 15-Feb-2022 11:10 am	1839336 15-Feb-2022 12:00 pm		
	Lab Number:	2873486.1	2873486.2	2873486.3		
Individual Tests						
pH	pH Units	1.9	2.1	2.3	-	-
Acidity (pH 3.7)	g/m^3 as CaCO$_3$	2,900	5,100	2,800	-	-
Total Alkalinity	g/m^3 as CaCO$_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	688	844	937	-	-
Dissolved Aluminium	g/m^3	95	440	370	-	-
Dissolved Antimony	g/m^3	0.0036	0.013	0.004	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	0.009	-	-
Dissolved Calcium	g/m^3	21	350	440	-	-
Dissolved Cobalt	g/m^3	0.21	1.52	2.7	-	-
Dissolved Iron	g/m^3	960	1,990	1,390	-	-
Dissolved Magnesium	g/m^3	11.1	144	480	-	-
Dissolved Manganese	g/m^3	3.5	60	16.0	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.0003	< 0.00015	-	-
Dissolved Molybdenum	g/m^3	0.0157	0.016	0.016	-	-
Dissolved Potassium	g/m^3	1.5	< 0.5	48	-	-
Dissolved Selenium	g/m^3	0.011	0.020	0.018	-	-
Dissolved Silver	g/m^3	< 0.0005	0.0035	< 0.0010	-	-
Dissolved Sodium	g/m^3	1.58	2.1	18.7	-	-
Dissolved Strontium	g/m^3	0.045	0.156	2.5	-	-
Dissolved Uranium	g/m^3	0.0155	0.095	0.197	-	-
Dissolved Vanadium	g/m^3	0.109	0.73	0.76	-	-
Sulphate	g/m^3	3,400	9,500	10,200	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	35	83	31	-	-
Dissolved Cadmium	g/m^3	0.0033	0.026	0.0164	-	-
Dissolved Chromium	g/m^3	0.22	0.59	0.36	-	-
Dissolved Copper	g/m^3	0.94	3.5	13.9	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0010	< 0.0010	-	-
Dissolved Nickel	g/m^3	0.064	0.53	1.88	-	-
Dissolved Zinc	g/m^3	5.1	31	8.1	-	-

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**

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 18-Feb-2022 and 23-Feb-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

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2900847
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	01-Mar-2022
		Date Reported:	09-Mar-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

	Sample Name:	1839574 28-Feb-2022	1839575 28-Feb-2022	1839576 28-Feb-2022		
	Lab Number:	2900847.1	2900847.2	2900847.3		
Individual Tests						
pH	pH Units	2.1	2.2	2.4	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	4,400	1,060	2,200	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	709	328	895	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00015	-	-
Sulphate	g/m^3	8,100	1,270	9,200	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	51	28	12.4	-	-
Dissolved Cadmium	g/m^3	0.0164	0.0031	0.0169	-	-
Dissolved Chromium	g/m^3	0.33	0.193	0.37	-	-
Dissolved Copper	g/m^3	2.3	0.80	16.0	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.37	0.057	2.0	-	-
Dissolved Zinc	g/m^3	21	4.3	9.3	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 04-Mar-2022 and 09-Mar-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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Carole Rodgers-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2909016	SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	09-Mar-2022	
		Date Reported:	16-Mar-2022	
		Quote No:	85959	
		Order No:	70057893	
		Client Reference:	Extended suite	
		Submitted By:	Kristin Gillard	

Sample Type: Aqueous

Sample Name:		1839844 07-Mar-2022	1839845 07-Mar-2022	1839846 07-Mar-2022		
Lab Number:		2909016.1	2909016.2	2909016.3		
Individual Tests						
pH	pH Units	-	2.1	2.5	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	-	5,400	2,200	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	-	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	-	784	862	-	-
Dissolved Aluminium	g/m^3	127	320	460	-	-
Dissolved Antimony	g/m^3	0.0056	0.0104	0.0027	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	21	220	430	-	-
Dissolved Cobalt	g/m^3	0.26	1.00	3.4	-	-
Dissolved Iron	g/m^3	1,570	1,740	780	-	-
Dissolved Magnesium	g/m^3	14.4	106	630	-	-
Dissolved Manganese	g/m^3	4.5	36	22	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00015	< 0.00015	-	-
Dissolved Molybdenum	g/m^3	0.026	0.0161	0.0018	-	-
Dissolved Potassium	g/m^3	0.4	0.6	22	-	-
Dissolved Selenium	g/m^3	0.020	0.021	0.019	-	-
Dissolved Silver	g/m^3	0.0008	0.0028	< 0.0005	-	-
Dissolved Sodium	g/m^3	1.73	1.08	19.7	-	-
Dissolved Strontium	g/m^3	0.048	0.113	2.8	-	-
Dissolved Uranium	g/m^3	0.0199	0.056	0.27	-	-
Dissolved Vanadium	g/m^3	0.147	0.25	0.88	-	-
Sulphate	g/m^3	-	8,000	8,900	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	61	77	4.9	-	-
Dissolved Cadmium	g/m^3	0.0041	0.0157	0.0199	-	-
Dissolved Chromium	g/m^3	0.28	0.34	0.39	-	-
Dissolved Copper	g/m^3	1.10	2.5	19.4	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0006	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.075	0.53	2.3	-	-
Dissolved Zinc	g/m^3	5.6	22	10.1	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	2-3
pH	pH meter. 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	2-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	2-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	2-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	2-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	2-3

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

Testing was completed between 10-Mar-2022 and 16-Mar-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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Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2914098 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	12-Mar-2022
		Date Reported:	18-Mar-2022
		Quote No:	87181
		Order No:	70057893
		Client Reference:	Reduced suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

	Sample Name:	1839988 10-Mar-2022	1839989 10-Mar-2022	1839990 10-Mar-2022		
	Lab Number:	2914098.1	2914098.2	2914098.3		
Individual Tests						
pH	pH Units	2.6	2.0	1.8	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	1,900	7,800	5,500	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	796	977	1,030	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00015	< 0.00015	-	-
Sulphate	g/m^3	10,800	13,900	6,100	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	4.9	114	55	-	-
Dissolved Cadmium	g/m^3	0.0190	0.0152	0.0031	-	-
Dissolved Chromium	g/m^3	0.40	0.39	0.26	-	-
Dissolved Copper	g/m^3	17.3	2.4	0.97	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0011	< 0.0005	-	-
Dissolved Nickel	g/m^3	2.3	0.43	0.187	-	-
Dissolved Zinc	g/m^3	10.0	19.6	4.8	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

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

Testing was completed between 15-Mar-2022 and 18-Mar-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

SPv1

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2925270
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	22-Mar-2022
		Date Reported:	30-Mar-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

	Sample Name:	1840315 18-Mar-2022 3:25 pm	1840316 18-Mar-2022 2:50 pm	1840317 18-Mar-2022 3:10 pm		
	Lab Number:	2925270.1	2925270.2	2925270.3		
Individual Tests						
pH	pH Units	1.7	2.0	2.4	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	6,200	9,200	3,100	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	1,086	987	1,161	-	-
Dissolved Aluminium	g/m^3	109	400	760	-	-
Dissolved Antimony	g/m^3	0.0077	0.020	0.0063	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	15.3	240	410	-	-
Dissolved Cobalt	g/m^3	0.24	1.11	3.3	-	-
Dissolved Iron	g/m^3	1,620	3,000	1,870	-	-
Dissolved Magnesium	g/m^3	11.8	125	660	-	-
Dissolved Manganese	g/m^3	4.3	35	18.8	-	-
Dissolved Mercury	g/m^3	< 0.00015	< 0.00015	< 0.00016	-	-
Dissolved Molybdenum	g/m^3	0.030	0.032	0.0029	-	-
Dissolved Potassium	g/m^3	0.5	< 0.3	32	-	-
Dissolved Selenium	g/m^3	0.023	0.045	0.014	-	-
Dissolved Silver	g/m^3	0.0006	0.0013	< 0.0005	-	-
Dissolved Sodium	g/m^3	2.0	1.01	11.3	-	-
Dissolved Strontium	g/m^3	0.044	0.043	2.6	-	-
Dissolved Uranium	g/m^3	0.0193	0.075	0.30	-	-
Dissolved Vanadium	g/m^3	0.134	0.41	1.47	-	-
Sulphate	g/m^3	6,700	11,500	13,500	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	54	125	14.2	-	-
Dissolved Cadmium	g/m^3	0.0031	0.0147	0.024	-	-
Dissolved Chromium	g/m^3	0.25	0.37	0.71	-	-
Dissolved Copper	g/m^3	0.96	2.3	20	-	-
Dissolved Lead	g/m^3	< 0.0005	0.0013	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.098	0.43	2.4	-	-
Dissolved Zinc	g/m^3	4.5	17.0	11.5	-	-

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**

ilac-MRA

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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 23-Mar-2022 and 30-Mar-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:	Oceana Gold (New Zealand) Limited	**Lab No:**	2934532 SPv1
Contact:	Mark Burroughs	**Date Received:**	28-Mar-2022
	C/- Oceana Gold (New Zealand) Limited	**Date Reported:**	06-Apr-2022
	PO Box 190	**Quote No:**	87181
	Waihi 3610	**Order No:**	70057893
		Client Reference:	Reduced suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

	Sample Name:	1840620 25-Mar-2022	1840621 25-Mar-2022	1840622 25-Mar-2022		
	Lab Number:	2934532.1	2934532.2	2934532.3		
Individual Tests						
pH	pH Units	1.9	2.0	1.8	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,800	5,800	11,400	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 6	< 6	-	-
Electrical Conductivity (EC)	mS/m	677	754	1,608	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00015	< 0.0004	-	-
Sulphate	g/m^3	3,100	7,000	17,900	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	10.3	47	179	-	-
Dissolved Cadmium	g/m^3	0.0010	0.0077	0.0141	-	-
Dissolved Chromium	g/m^3	0.072	0.182	0.70	-	-
Dissolved Copper	g/m^3	0.40	1.44	10.6	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	< 0.002	-	-
Dissolved Nickel	g/m^3	0.034	0.28	1.50	-	-
Dissolved Zinc	g/m^3	1.58	9.3	8.0	-	-

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, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 30-Mar-2022 and 06-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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Client Services Manager - Environmental

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Certificate of Analysis

Client:	Oceana Gold (New Zealand) Limited	**Lab No:**	2972202 SPv1
Contact:	Mark Burroughs C/- Oceana Gold (New Zealand) Limited PO Box 190 Waihi 3610	**Date Received:**	30-Apr-2022
		Date Reported:	09-May-2022
		Quote No:	85959
		Order No:	70057893
		Client Reference:	Extended suite
		Submitted By:	Andrew Bellamy

Sample Type: Aqueous

Sample Name:		1841580 28-Apr-2022	1841581 28-Apr-2022	1841582 28-Apr-2022		
Lab Number:		2972202.1	2972202.2	2972202.3		
Individual Tests						
pH	pH Units	2.0	2.1	1.8	-	-
Acidity (pH 3.7)	g/m^3 as $CaCO_3$	2,200	2,900	11,900	-	-
Total Alkalinity	g/m^3 as $CaCO_3$	< 1.0	< 1.0	< 1.0	-	-
Electrical Conductivity (EC)	mS/m	595	525	1,569	-	-
Dissolved Aluminium	g/m^3	29	104	540	-	-
Dissolved Antimony	g/m^3	0.0029	0.0050	0.0069	-	-
Dissolved Barium	g/m^3	< 0.005	< 0.005	< 0.005	-	-
Dissolved Calcium	g/m^3	3.5	74	420	-	-
Dissolved Cobalt	g/m^3	0.088	0.40	1.10	-	-
Dissolved Iron	g/m^3	470	830	4,900	-	-
Dissolved Magnesium	g/m^3	3.0	40	230	-	-
Dissolved Manganese	g/m^3	0.74	8.7	12.4	-	-
Dissolved Mercury	g/m^3	< 0.00008	< 0.00008	< 0.0004	-	-
Dissolved Molybdenum	g/m^3	0.0056	0.0077	0.139	-	-
Dissolved Potassium	g/m^3	0.3	< 0.3	0.4	-	-
Dissolved Selenium	g/m^3	0.007	0.013	0.030	-	-
Dissolved Silver	g/m^3	< 0.0005	0.0011	< 0.0005	-	-
Dissolved Sodium	g/m^3	2.2	1.15	2.1	-	-
Dissolved Strontium	g/m^3	0.016	0.017	0.84	-	-
Dissolved Uranium	g/m^3	0.0046	0.0137	0.053	-	-
Dissolved Vanadium	g/m^3	0.021	0.096	1.37	-	-
Sulphate	g/m^3	2,300	3,800	22,000	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	7.6	16.9	106	-	-
Dissolved Cadmium	g/m^3	0.0008	0.0025	0.0088	-	-
Dissolved Chromium	g/m^3	0.045	0.059	0.53	-	-
Dissolved Copper	g/m^3	0.30	0.70	5.5	-	-
Dissolved Lead	g/m^3	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Nickel	g/m^3	0.029	0.160	0.96	-	-
Dissolved Zinc	g/m^3	0.87	2.9	6.1	-	-

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**

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm Filtration, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00005 - 0.0010 g/m^3	1-3
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
pH	pH meter. 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	1-3
Acidity (pH 3.7)	Titration to pH 3.7 with standard sodium hydroxide solution, bromophenol blue indicator. APHA 2310 B 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3
Dissolved Aluminium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.003 g/m^3	1-3
Dissolved Antimony	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	1-3
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Cobalt	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Dissolved Molybdenum	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0002 g/m^3	1-3
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.05 g/m^3	1-3
Dissolved Selenium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Dissolved Silver	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00010 g/m^3	1-3
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	1-3
Dissolved Strontium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0005 g/m^3	1-3
Dissolved Uranium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.00002 g/m^3	1-3
Dissolved Vanadium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0010 g/m^3	1-3
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3

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

Testing was completed between 03-May-2022 and 09-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.

Carole Rodgers-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

Appendix F

PHREEQC Outputs

Appendix F – Raw PHREEQC Data

F1 Introduction

Water quality modelling for the Waihi North Project was completed using the geochemical modelling software PHREEQC Interactive version 3.6.2 and the Minteq.v4-database for modelling completed pre-December 2021 and PHREEQC Interactive version 3.7.3 for modelling post December 2021. The geochemical modelling results are presented in Sections 5 and 6 of the *Waihi North Project Geochemical Assessment* report prepared by AECOM New Zealand Limited. The modelling results presented have been checked and verified as part of AECOM's internal peer review in completing this assessment.

F2 Input Solutions

There are a number of source solution used for modelling the scenarios outlined in Table 3. These include:-

- Gladstone Field Columns
    - Compacted
    - Saturated
    - Limestone Amended
- TSF1a Decant Data 2014 to 2020
- TSF1a Underdrain Data 2014 to 2020
- Martha Pit NAF runoff
- Gladstone Groundwater

Where field columns are used as a source the average concentrations from week 10 to 43 of the leaching test is used. This is inherently conservative in that it uses samples that have become acid generating and thereby introduces a mass of constituents, such as aluminium into the model predictions that are unlikely to be mobilised under typical site operating conditions.

The source terms for pH is calculated by averaging pH results, not the H+ concentrations. Table 1 includes the averages based on corresponding H^+ concentrations. The H^+ concentrations are primarily different for the limestone blended columns that have been sampled beyond the duration of the design lag from limestone amendment. Using the average pH values is therefore considered reasonable and sensitivity testing has shown that using H+ concentrations would not materially influence model predictions.

As presented in Section 5 of our report, sump water quality was estimated using a conservative approach in which two distinctive runoff water qualities were derived and mixed accordingly (refer to Figure 1 below):

- Derived PAF water quality calculated from field column leach data (Table 1) and Gladstone overburden NAPP (Table 2)
- Martha Pit NAF water quality (AECOM 2018; Attachment A)

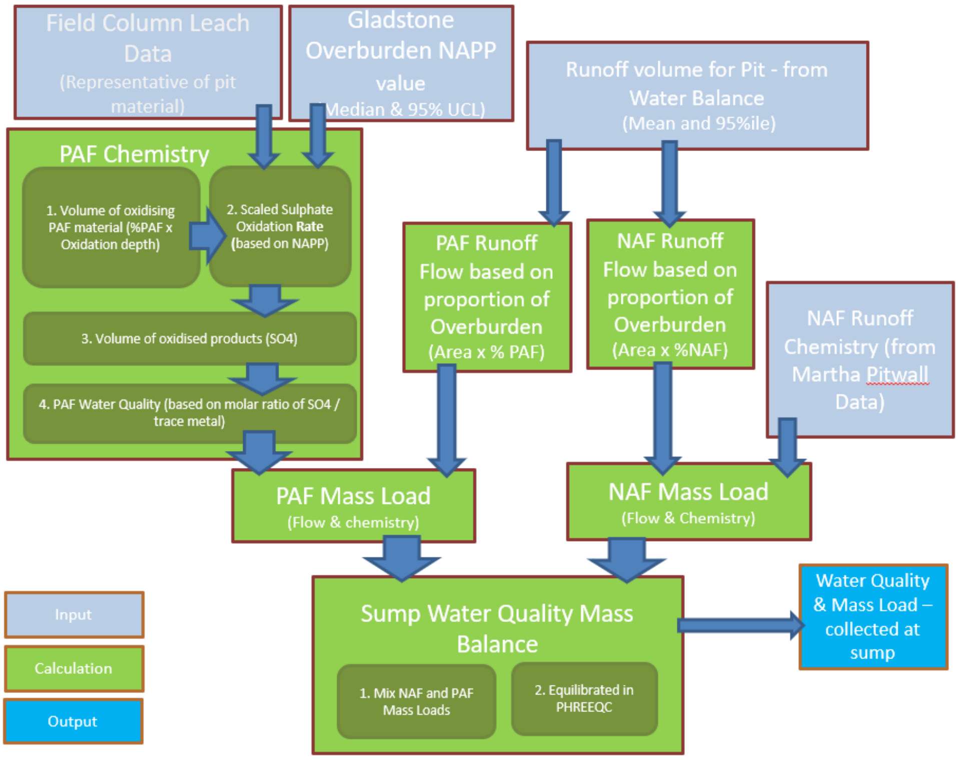


Figure 1 Gladstone Pit – Water Quality reporting to sump

Table 1 Field Column Leach Data

	Gladstone PAF Seepage Limestone Blend Column	Gladstone PAF Seepage Compacted Column	Number of Samples
pH [H$^+$]	4.25 [3.2]	2.99 [2.91]	17
Al	71.060	69.425	9
Ag	<0.001 (n=1) <0.002 (n=3) <0.0001 (n=1) <0.0005 (n=2)	<0.001 (n=1) <0.0002 (n= 1) <0.0005 (n=6)	9
As	0.013	0.257	18
Ba	0.021	0.019	9
Ca	488	390	9
Cd	0.023	0.026	18
Co	1.764	10.268	9
Cr	0.104	0.414	18
Cu	0.085	1.333	18
Fe	1341	554	9
Hg	0.0002	0.000	18
K	33	54	9
Mg	55	403	9

	Gladstone PAF Seepage Limestone Blend Column	Gladstone PAF Seepage Compacted Column	Number of Samples
Mn	1.801	11.188	9
Mo	0.002	0.0004	9
Na	2.4	63	9
Ni	1.440	4.411	18
Pb	0.001	0.001	18
S	5034	4317	9
Sb	0.011	0.002	9
Se	0.001	0.023	9
Sr	0.869	4.743	9
U	0.012	0.044	9
V	0.020	0.171	9
Zn	4.9	6.1	18

All concentrations reported in mg/L except pH which is pH Units

Table 2 Gladstone Overburden NAPP values

Item	Column Test (column 4 Glad 1)	Mean (Gladstone)	95% UCL (Gladstone)
NAPP (kg H_2SO_4/tonne)	129	85	110

F3 Equilibrium Phases

Equilibrium phases in each model run are selected based on the pH and redox condition of the predicted water being modelled, review of the solution chemistry and consideration of whether the predicted water is likely to reach geochemical equilibrium. This is particularly relevant for iron species as multiple iron mineral phases will potentially be over-saturated to varying degrees, however some mineral phases will more rapidly reach equilibrium than others.

Existing porewater data for TSF's have in the past been reviewed using the PHREEQC model which suggested potentially over saturation of lead sulphides (galena) in some strongly reducing tailings porewater samples.

Including species in the equilibrium phase modelling step that are undersaturated has no bearing on the model results as only oversaturated species are allowed to precipitate and no dissolution is simulated.

For low oxygen model scenarios, such as porewater, where these solutions will not be exposed to the atmosphere conditions equilibration with the partial pressure of carbon dioxide or oxygen in the atmosphere is not included as an equilibrium phase.

F4 Adsorption

Adsorption of trace elements onto hydrous ferric oxides (Hfo) is a significant control on trace element levels in modelled solutions. Sensitivity analysis has been completed for selected model runs around the amount of HFo sites made available for adsorption. In all cases where HFo is modelled the sites are limited to the amount of the iron mineral phase oversaturated as defined in section F3 with the ratio of strong to weak sites based on Dzombak and Morel. This is significantly less than the actual amount of hydrous ferric oxides present in the waste materials. Limiting sorption capacity in this way has been found to predict trace element concentrations in water more consistent with actual site data.

The acidifying effect of ferric iron hydolysis is assessed in scenarios where the prediction is assessing a water quality that is exposed to atmospheric conditions, for example NRS embankment predictions in Appendix Table F5-2 (and Table 10 of the report). In these scenarios:-

1. Equilibrium phases are assessed for the mixed solution which provides and mass of sorption sites to the sorption step.
2. Sorption onto hydrous ferric oxides is assessed
3. Equilibrium phases are then reassessed to allow for pH shift as a result of Hfo adsorption

An example of these steps is included in Table 3.

F5 Reported Tables

The following tables have been included in the *Waihi North Project Geochemical Assessment* report prepared by AECOM New Zealand Limited and were generated based on PHREEQC modelling:

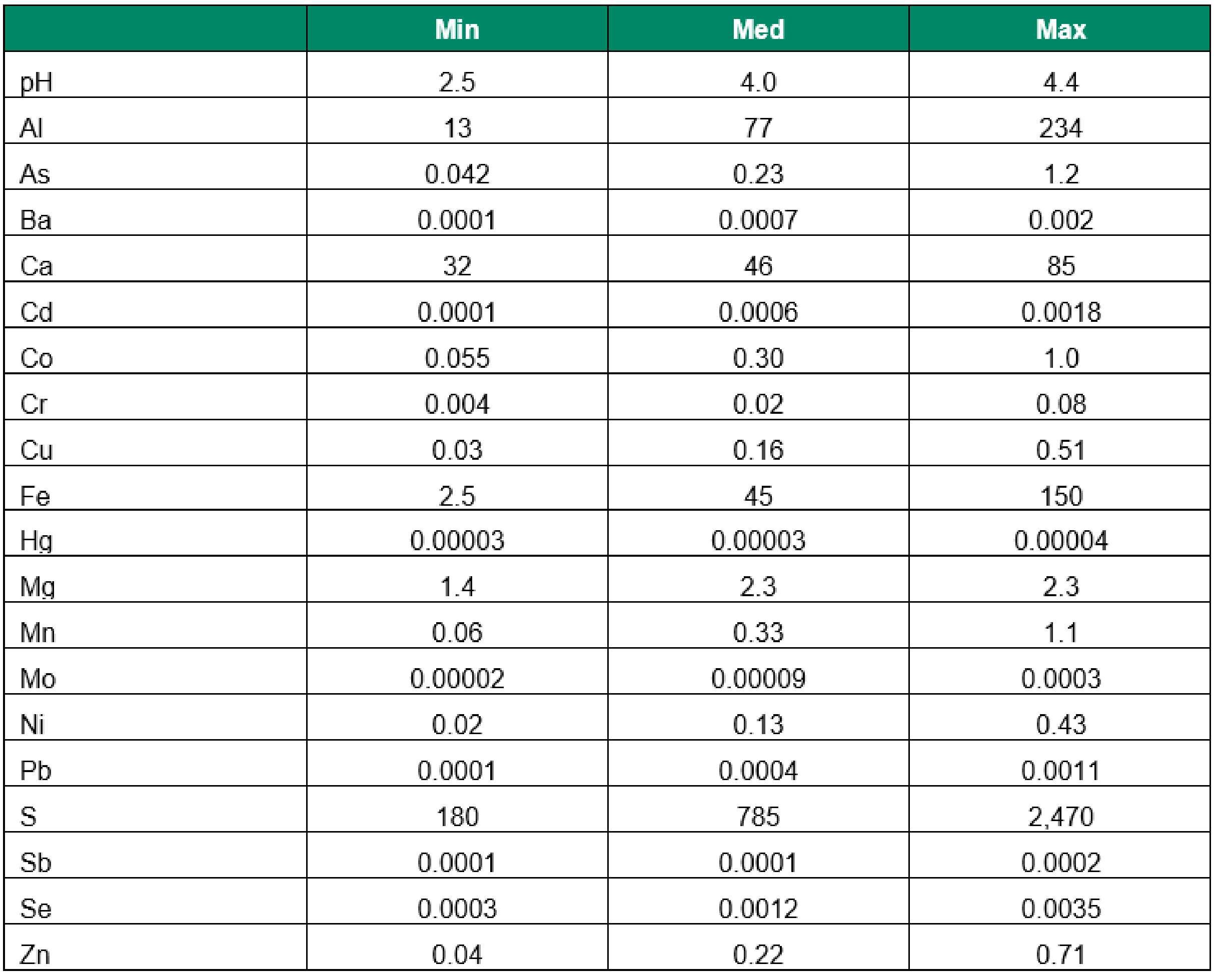
- Table 7: Modelled Sump Water Quality Predictions, Section 5.3
- Table 10: Predicted NRS / Embankment Leachate Water Quality, Section 6.3.2
- Table 16: Gladstone Pit Porewater Quality, Section 6.3.5
- Table 17: Existing Groundwater Quality Within the WUG System, Section 6.4
- Table 24: Predicted TSF1A and TSF2 Pond Water (Decant) Chemistry, Section 7.3.1
- Table 25: Predicted TSF3 and GOP TSF Decant Chemistry, Section 7.3.1
- Table 26: Predicted TSF Porewater Chemistry, Section 7.3.2
- Table 26: Predicted TSF Porewater Chemistry - continued, Section 7.3.2

The details of the model file performed by the PHREEQC modelling software are provided in the sub-sections below.

The model results in these tables summarise multiple modelled scenarios. The minimum pH tabulated is the minimum from across these scenarios. It does not therefore correlate with the minimum concentration of other constituents.

F5-1 Modelled Sump Water Quality Predictions

Table 7 Modelled Sump Water Quality Predictions



	Min	Med	Max
pH	2.5	4.0	4.4
Al	13	77	234
As	0.042	0.23	1.2
Ba	0.0001	0.0007	0.002
Ca	32	46	85
Cd	0.0001	0.0006	0.0018
Co	0.055	0.30	1.0
Cr	0.004	0.02	0.08
Cu	0.03	0.16	0.51
Fe	2.5	45	150
Hg	0.00003	0.00003	0.00004
Mg	1.4	2.3	2.3
Mn	0.06	0.33	1.1
Mo	0.00002	0.00009	0.0003
Ni	0.02	0.13	0.43
Pb	0.0001	0.0004	0.0011
S	180	785	2,470
Sb	0.0001	0.0001	0.0002
Se	0.0003	0.0012	0.0035
Zn	0.04	0.22	0.71

All concentrations reported in in mg/L.

The predicted sump water modelling values are based on six scenarios. The six scenarios had the following parameters:

- Scenario 1 – WQ: Med, Flow: Mean
- Scenario 2 – WQ: 95 % UCL, Flow:0.95
- Scenario 3 – WQ: Med, Flow: 0.95
- Scenario 4 – WQ: 95 % UCL, Flow: Med
- Scenario 5 – WQ: 95 % UCL, Flow: Adjusted
- Scenario 6 – WQ: Med, Flow: Adjusted

The speciation modelling inputs ran the following steps:

1. Mix Solution 1 (PAF Runoff) and Solution 2 (Non PAF Runoff) using a ratio of 0.73:0.27 respectively.
2. Equilibrium phases: CO_2(g), Ferrihydrite, Alunite, K-Jarosite, Gibbsite, $Cu(OH)_2$
3. No Hfo adsorption is modelled.

Note Table 7 presents the range of the 6 model scenario outputs with the minimum and maximum columns not necessarily representing the same model scenario.

F5-2 Predicted NRS / Embankment Leachate Water Quality

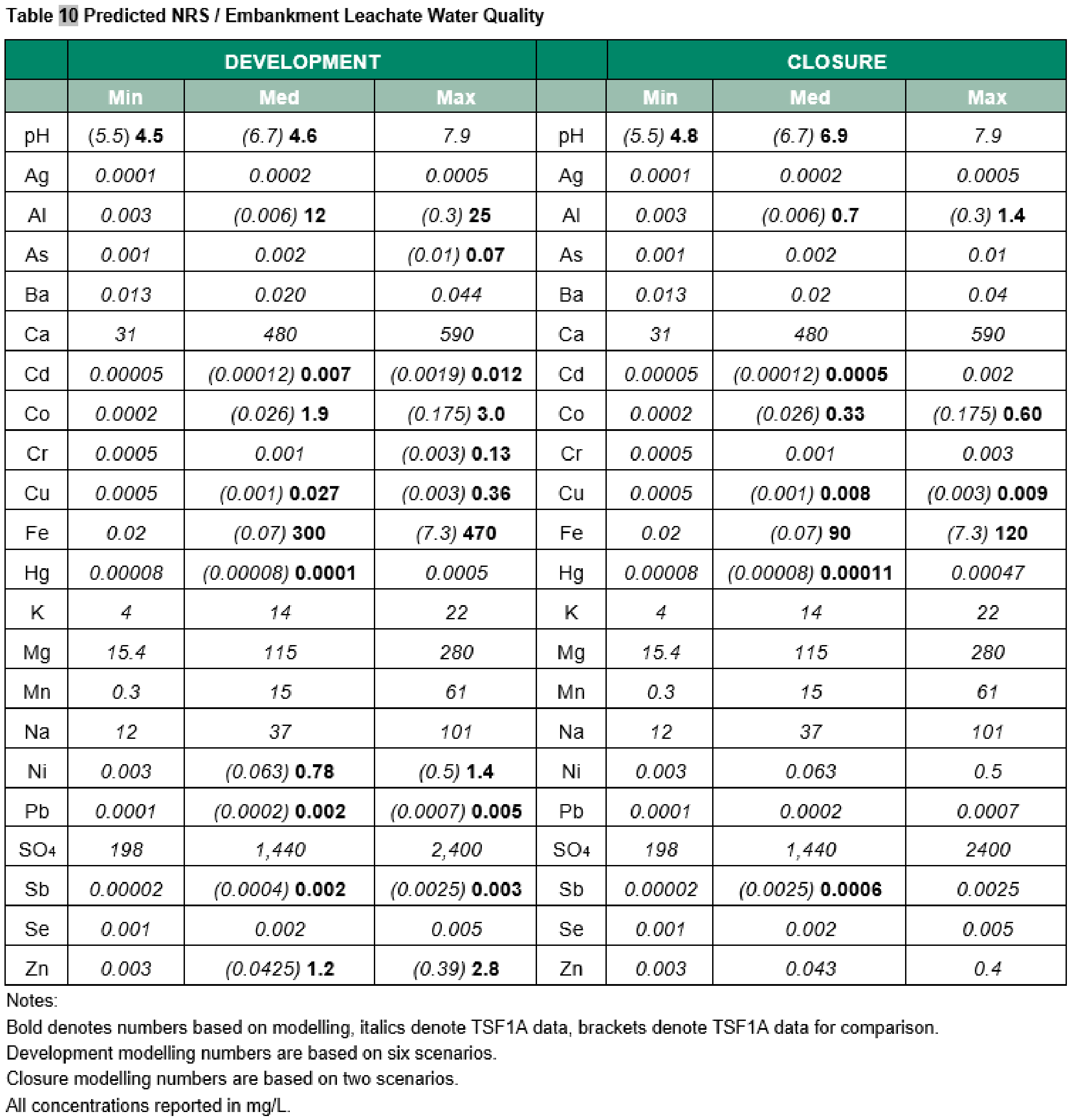


Table 10 Predicted NRS / Embankment Leachate Water Quality

	DEVELOPMENT				CLOSURE		
	Min	Med	Max		Min	Med	Max
pH	*(5.5)* **4.5**	*(6.7)* **4.6**	*7.9*	pH	*(5.5)* **4.8**	*(6.7)* **6.9**	*7.9*
Ag	*0.0001*	*0.0002*	*0.0005*	Ag	*0.0001*	*0.0002*	*0.0005*
Al	*0.003*	*(0.006)* **12**	*(0.3)* **25**	Al	*0.003*	*(0.006)* **0.7**	*(0.3)* **1.4**
As	*0.001*	*0.002*	*(0.01)* **0.07**	As	*0.001*	*0.002*	*0.01*
Ba	*0.013*	*0.020*	*0.044*	Ba	*0.013*	*0.02*	*0.04*
Ca	*31*	*480*	*590*	Ca	*31*	*480*	*590*
Cd	*0.00005*	*(0.00012)* **0.007**	*(0.0019)* **0.012**	Cd	*0.00005*	*(0.00012)* **0.0005**	*0.002*
Co	*0.0002*	*(0.026)* **1.9**	*(0.175)* **3.0**	Co	*0.0002*	*(0.026)* **0.33**	*(0.175)* **0.60**
Cr	*0.0005*	*0.001*	*(0.003)* **0.13**	Cr	*0.0005*	*0.001*	*0.003*
Cu	*0.0005*	*(0.001)* **0.027**	*(0.003)* **0.36**	Cu	*0.0005*	*(0.001)* **0.008**	*(0.003)* **0.009**
Fe	*0.02*	*(0.07)* **300**	*(7.3)* **470**	Fe	*0.02*	*(0.07)* **90**	*(7.3)* **120**
Hg	*0.00008*	*(0.00008)* **0.0001**	*0.0005*	Hg	*0.00008*	*(0.00008)* **0.00011**	*0.00047*
K	*4*	*14*	*22*	K	*4*	*14*	*22*
Mg	*15.4*	*115*	*280*	Mg	*15.4*	*115*	*280*
Mn	*0.3*	*15*	*61*	Mn	*0.3*	*15*	*61*
Na	*12*	*37*	*101*	Na	*12*	*37*	*101*
Ni	*0.003*	*(0.063)* **0.78**	*(0.5)* **1.4**	Ni	*0.003*	*0.063*	*0.5*
Pb	*0.0001*	*(0.0002)* **0.002**	*(0.0007)* **0.005**	Pb	*0.0001*	*0.0002*	*0.0007*
SO_4	*198*	*1,440*	*2,400*	SO_4	*198*	*1,440*	*2400*
Sb	*0.00002*	*(0.0004)* **0.002**	*(0.0025)* **0.003**	Sb	*0.00002*	*(0.0025)* **0.0006**	*0.0025*
Se	*0.001*	*0.002*	*0.005*	Se	*0.001*	*0.002*	*0.005*
Zn	*0.003*	*(0.0425)* **1.2**	*(0.39)* **2.8**	Zn	*0.003*	*0.043*	*0.4*

Notes:
Bold denotes numbers based on modelling, italics denote TSF1A data, brackets denote TSF1A data for comparison.
Development modelling numbers are based on six scenarios.
Closure modelling numbers are based on two scenarios.
All concentrations reported in mg/L.

The development modelling values are based on six scenarios. The six scenarios had the following working and closed area ratios:

- Scenario 1 – 0.6 (working area): 0.4 (closed area)
- Scenario 2 – 0.5 (working area): 0.5 (closed area)
- Scenario 3 – 0.4 (working area): 0.6 (closed area)
- Scenario 4 – 0.3 (working area): 0.7 (closed area)
- Scenario 5 – 0.2 (working area): 0.8 (closed area)
- Scenario 6 – 0.1 (working area): 0.9 (closed area)

The closure modelling values are based on two scenarios. The two scenarios had the following working and closed area ratios:

- Scenario 6 – 0.1 (working area): 0.9 (closed area)

- Scenario 7 – 0.001 (working area): 0.999 (closed area)

The speciation modelling inputs ran the following steps;-

4. Solution 1 (working area) based on the proportions of Martha and Gladstone waste
5. Solution 2 (closed area) based on the proportions of Martha and Gladstone waste and reduced sulphate generation rate
6. Mix using the predefined ratios for the respective scenario listed above
7. Equilibrium phases: CO_2(g), Ferrihydrite, Alunite, K-Jarosite, Gibbsite, $Cu(OH)_2$
8. Sorption onto hydrous ferric oxides
9. Equilibrium phases: CO_2(g), Ferrihydrite, Gibbsite, Calcite

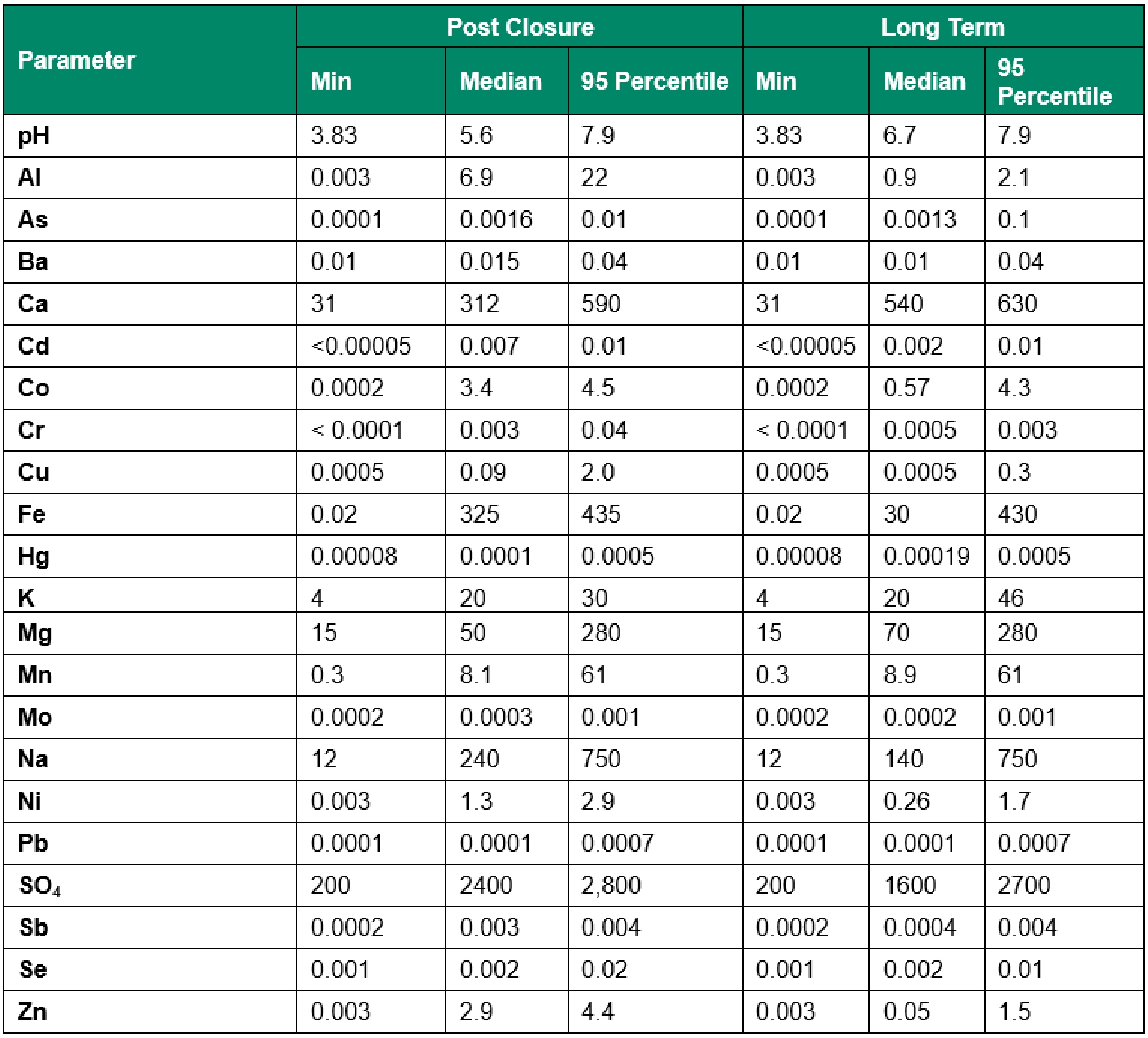
Note Table 10 presents the range of model scenario outputs with the minimum and maximum columns not necessarily representing the same model scenario.

Table 3 Scenario 5 Modelling steps example

Parameter	Step 6 - Mix Output	Step 7 – Equilibrium Phases	Step 8 – Hfo Sorption	Step 9 – Equilibrium Phases
pH	4.2	3.8	6.1	4.7
pe	4.2	4.7	1.1	1.9

F5-3 Gladstone Pit Porewater Quality

Table 16 Gladstone Pit Porewater Quality



Parameter	Post Closure			Long Term		
	Min	Median	95 Percentile	Min	Median	95 Percentile
pH	3.83	5.6	7.9	3.83	6.7	7.9
Al	0.003	6.9	22	0.003	0.9	2.1
As	0.0001	0.0016	0.01	0.0001	0.0013	0.1
Ba	0.01	0.015	0.04	0.01	0.01	0.04
Ca	31	312	590	31	540	630
Cd	<0.00005	0.007	0.01	<0.00005	0.002	0.01
Co	0.0002	3.4	4.5	0.0002	0.57	4.3
Cr	< 0.0001	0.003	0.04	< 0.0001	0.0005	0.003
Cu	0.0005	0.09	2.0	0.0005	0.0005	0.3
Fe	0.02	325	435	0.02	30	430
Hg	0.00008	0.0001	0.0005	0.00008	0.00019	0.0005
K	4	20	30	4	20	46
Mg	15	50	280	15	70	280
Mn	0.3	8.1	61	0.3	8.9	61
Mo	0.0002	0.0003	0.001	0.0002	0.0002	0.001
Na	12	240	750	12	140	750
Ni	0.003	1.3	2.9	0.003	0.26	1.7
Pb	0.0001	0.0001	0.0007	0.0001	0.0001	0.0007
SO_4	200	2400	2,800	200	1600	2700
Sb	0.0002	0.003	0.004	0.0002	0.0004	0.004
Se	0.001	0.002	0.02	0.001	0.002	0.01
Zn	0.003	2.9	4.4	0.003	0.05	1.5

All concentrations reported in mg/L.

The post closure and long term modelling values are based on eight scenarios. The eight scenarios had the same groundwater and backfill area ratio, 0.001:0.999 with different sorptions:

- Scenario 1 – GW0.001: Backfill 0.999:1 Hfo:mean
- Scenario 2 – GW0.001: Backfill 0.999:1 Hfo:95% tile
- Scenario 3 – GW0.001: Backfill 0.999:0.5 Hfo:mean
- Scenario 4 – GW0.001: Backfill 0.999:0.5 Hfo:95% tile
- Scenario 5 – GW0.001: Backfill 0.999:2 Hfo:mean
- Scenario 6 – GW0.001: Backfill 0.999:2 Hfo:95% tile
- Scenario 7 – LongtermGW0.001: Backfill 0.999:1 Hfo:mean
- Scenario 8 – LongtermGW0.001: Backfill 0.999:1 Hfo:95% tile

The post closure speciation modelling inputs ran the following steps,

1. Solution 1 (backfilled porewater) was calculated based on predicted seepage for Martha was and considering saturated column data.

2. Solution 2 (Gladstone groundwater)
3. Sorption of solution 1 to hydrous ferric oxides
4. Mix solution 2 (0.001 %) and 3 (0.999 %)
5. Equilibrium phases: Ferrihydrite, $AlOHSO_4$, Goethite, k-jarosite, Siderite, Gypsum

The long term speciation modelling inputs ran the following steps:

1. Solution 1 (backfilled porewater) was calculated
2. Solution 2 (Gladstone groundwater) was calculated
3. Mix solution 1 (0.999 %) and 2 (0.001 %)
4. Equilibrium phases: Goethite, Gypsum, $AlOHSO_4$, Calcite
5. Sorption of hydrous ferric oxides

F5-4 Existing Groundwater Quality Within the WUG System

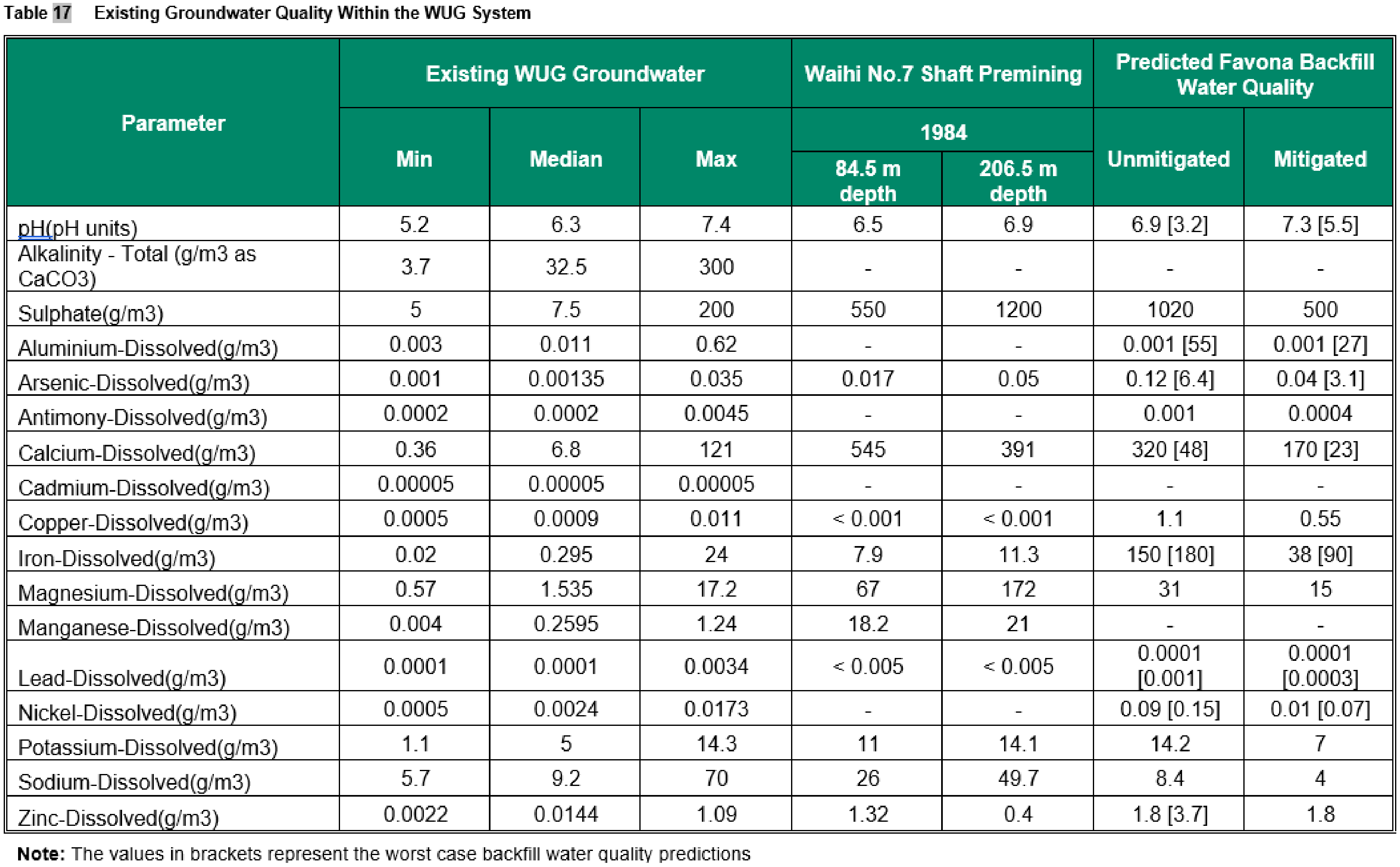


Table 17 Existing Groundwater Quality Within the WUG System

Parameter	Existing WUG Groundwater			Waihi No.7 Shaft Premining		Predicted Favona Backfill Water Quality	
	Min	Median	Max	1984		Unmitigated	Mitigated
				84.5 m depth	206.5 m depth		
pH(pH units)	5.2	6.3	7.4	6.5	6.9	6.9 [3.2]	7.3 [5.5]
Alkalinity - Total (g/m3 as CaCO3)	3.7	32.5	300	-	-	-	-
Sulphate(g/m3)	5	7.5	200	550	1200	1020	500
Aluminium-Dissolved(g/m3)	0.003	0.011	0.62	-	-	0.001 [55]	0.001 [27]
Arsenic-Dissolved(g/m3)	0.001	0.00135	0.035	0.017	0.05	0.12 [6.4]	0.04 [3.1]
Antimony-Dissolved(g/m3)	0.0002	0.0002	0.0045	-	-	0.001	0.0004
Calcium-Dissolved(g/m3)	0.36	6.8	121	545	391	320 [48]	170 [23]
Cadmium-Dissolved(g/m3)	0.00005	0.00005	0.00005	-	-	-	-
Copper-Dissolved(g/m3)	0.0005	0.0009	0.011	< 0.001	< 0.001	1.1	0.55
Iron-Dissolved(g/m3)	0.02	0.295	24	7.9	11.3	150 [180]	38 [90]
Magnesium-Dissolved(g/m3)	0.57	1.535	17.2	67	172	31	15
Manganese-Dissolved(g/m3)	0.004	0.2595	1.24	18.2	21	-	-
Lead-Dissolved(g/m3)	0.0001	0.0001	0.0034	< 0.005	< 0.005	0.0001 [0.001]	0.0001 [0.0003]
Nickel-Dissolved(g/m3)	0.0005	0.0024	0.0173	-	-	0.09 [0.15]	0.01 [0.07]
Potassium-Dissolved(g/m3)	1.1	5	14.3	11	14.1	14.2	7
Sodium-Dissolved(g/m3)	5.7	9.2	70	26	49.7	8.4	4
Zinc-Dissolved(g/m3)	0.0022	0.0144	1.09	1.32	0.4	1.8 [3.7]	1.8

Note: The values in brackets represent the worst case backfill water quality predictions

The predicted unmitigated and mitigated Favona backfill water quality was based two scenarios. The two scenarios were the different backfilled porewater chemistry, one mitigated and one unmitigated based on results from the WUG access tunnel.

- Scenario 1 – Predicted Favona Backfill Water Quality - Unmitigated
- Scenario 2 – Predicted Favona Backfill Water Quality - Mitigated

The modelling inputs ran the following steps,

1. Solution 1 (backfilled porewater) was calculated.
2. Equilibrium batch reaction was completed with Solution 1 and calcite iteratively to achieve pH 6.9
3. Equilibrium of all species: Calcite, Ferrihydrite, $Al(OH)_3$(am), Lepidocrocite, Gypsum, $FeAsO_4{:}2H_2O$, Gibbsite, Manganite, $Zn(OH)_2$
4. Sorption of hydrous ferric oxides

F5-5 Predicted TSF1a and TSF2 Decant Chemistry

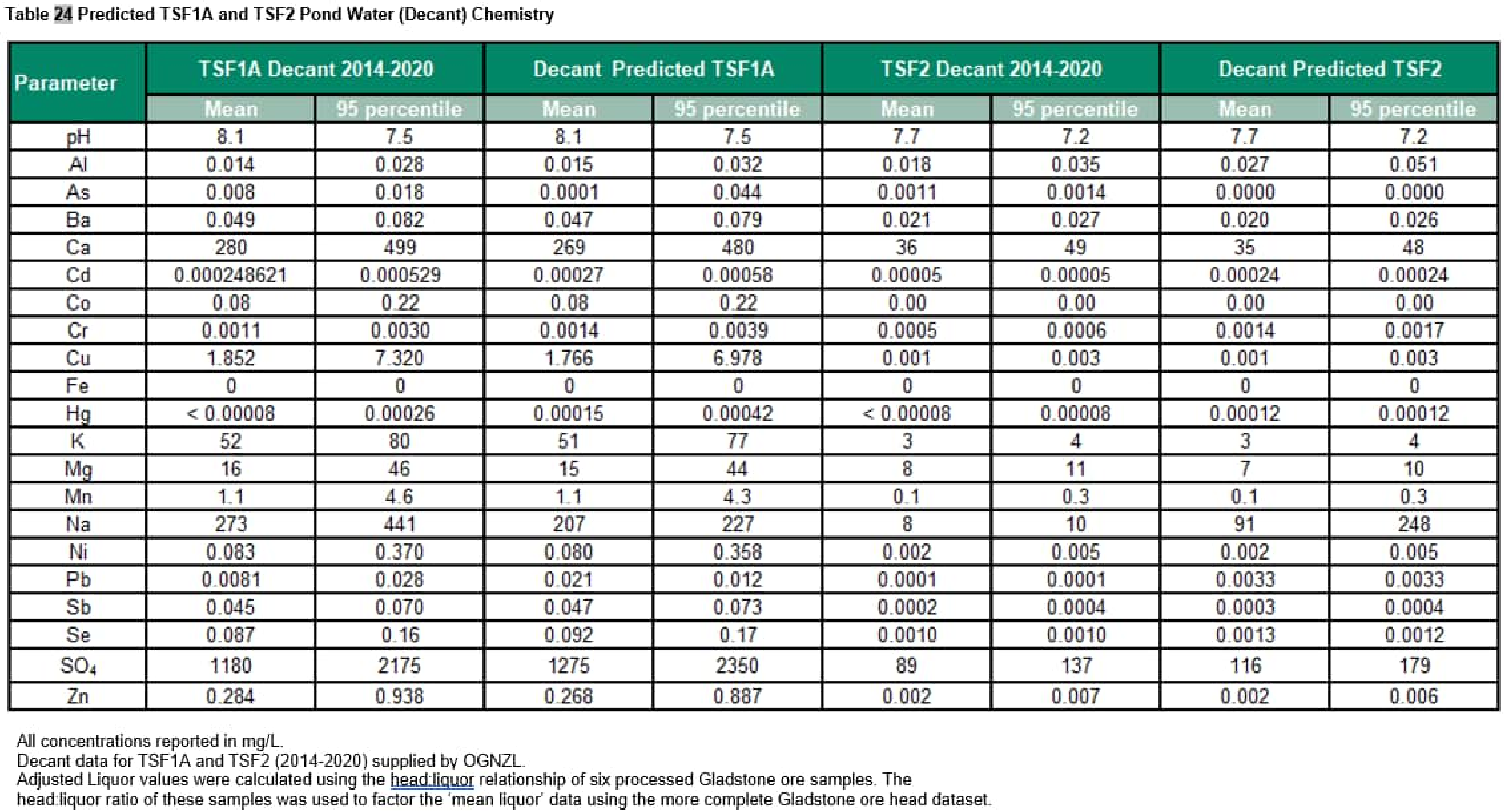


Table 24 Predicted TSF1A and TSF2 Pond Water (Decant) Chemistry

Parameter	TSF1A Decant 2014-2020		Decant Predicted TSF1A		TSF2 Decant 2014-2020		Decant Predicted TSF2	
	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile
pH	8.1	7.5	8.1	7.5	7.7	7.2	7.7	7.2
Al	0.014	0.028	0.015	0.032	0.018	0.035	0.027	0.051
As	0.008	0.018	0.0001	0.044	0.0011	0.0014	0.0000	0.0000
Ba	0.049	0.082	0.047	0.079	0.021	0.027	0.020	0.026
Ca	280	499	269	480	36	49	35	48
Cd	0.000248621	0.000529	0.00027	0.00058	0.00005	0.00005	0.00024	0.00024
Co	0.08	0.22	0.08	0.22	0.00	0.00	0.00	0.00
Cr	0.0011	0.0030	0.0014	0.0039	0.0005	0.0006	0.0014	0.0017
Cu	1.852	7.320	1.766	6.978	0.001	0.003	0.001	0.003
Fe	0	0	0	0	0	0	0	0
Hg	< 0.00008	0.00026	0.00015	0.00042	< 0.00008	0.00008	0.00012	0.00012
K	52	80	51	77	3	4	3	4
Mg	16	46	15	44	8	11	7	10
Mn	1.1	4.6	1.1	4.3	0.1	0.3	0.1	0.3
Na	273	441	207	227	8	10	91	248
Ni	0.083	0.370	0.080	0.358	0.002	0.005	0.002	0.005
Pb	0.0081	0.028	0.021	0.012	0.0001	0.0001	0.0033	0.0033
Sb	0.045	0.070	0.047	0.073	0.0002	0.0004	0.0003	0.0004
Se	0.087	0.16	0.092	0.17	0.0010	0.0010	0.0013	0.0012
SO_4	1180	2175	1275	2350	89	137	116	179
Zn	0.284	0.938	0.268	0.887	0.002	0.007	0.002	0.006

All concentrations reported in mg/L.
Decant data for TSF1A and TSF2 (2014-2020) supplied by OGNZL.
Adjusted Liquor values were calculated using the head:liquor relationship of six processed Gladstone ore samples. The head:liquor ratio of these samples was used to factor the 'mean liquor' data using the more complete Gladstone ore head dataset.

The predicted TSF1A and TSF2 decant modelling values are based on four scenarios. The four scenarios were the known porewater geochemistry with the trace element correction factor applied:

- Scenario 1 – TSF1A – Mean (known pondwater geochemistry) x TSF1A Storage Mean trace element correction factor
- Scenario 2 – TSF1A – 95 %ile (known pondwater geochemistry) x TSF1A Storage Mean trace element correction factor
- Scenario 3 – TSF2 – Mean (known pondwater geochemistry) x TSF2 Storage Mean trace element correction factor
- Scenario 4 – TSF2 – 95 %ile (known pondwater geochemistry) x TSF2 Storage Mean trace element correction factor

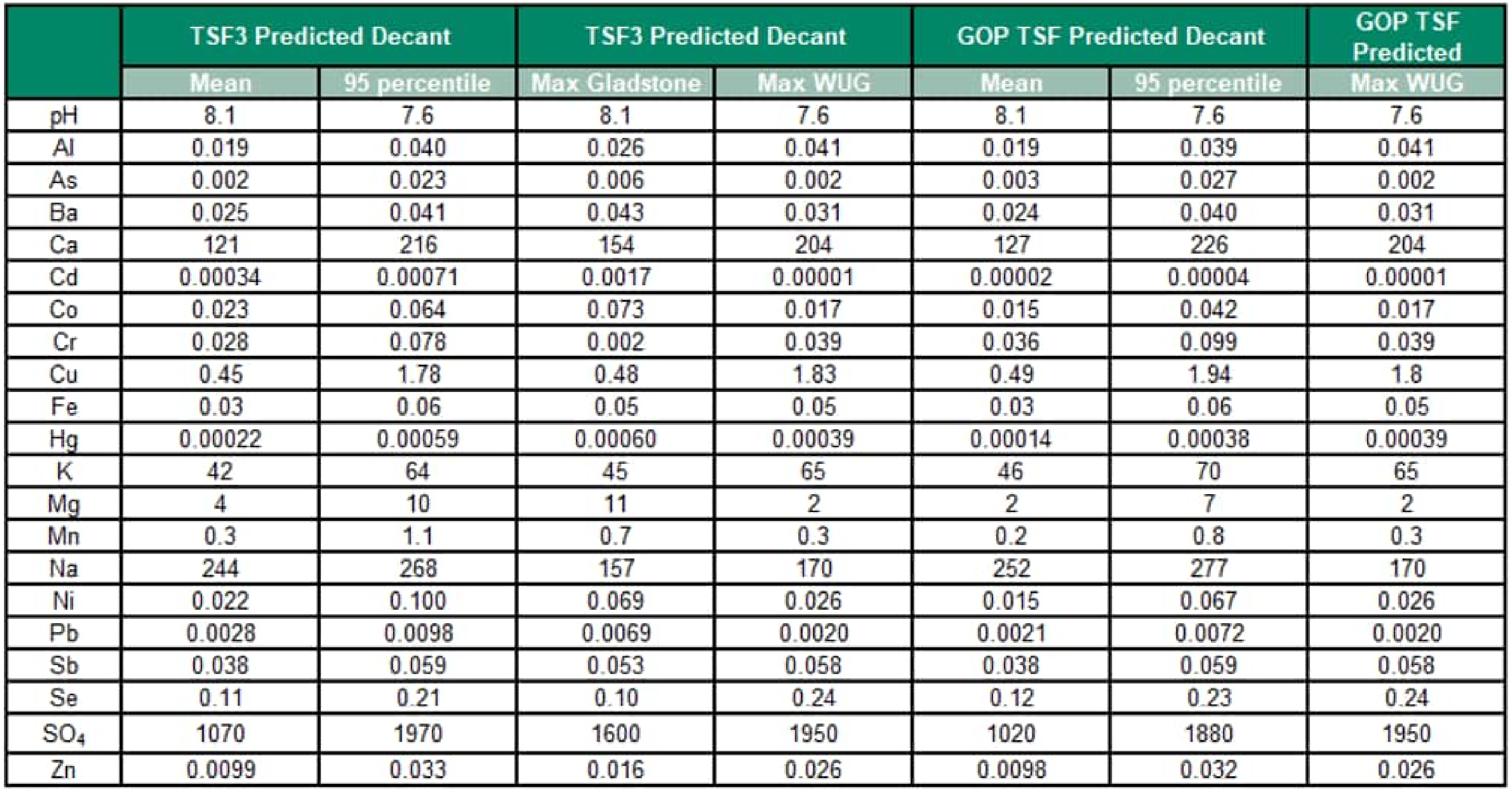
The speciation modelling inputs ran the following steps,

1. Solution 1 was calculated based on factoring existing TSF data by trace element increases in Gladstone and WUG ore and the proportion placed with the respective TSF
2. Equilibrium phases: CO_2(g), Ferrihydrite, Alunite, K-Jarosite, $FeAsO_4{:}2H_2O$, Galena, Gibbsite, $Cu(OH)_2$
3. Sorption of hydrous ferric oxides

The greater of modelled values and existing TSF data is presented.

F5-6 Predicted TSF3 and GOP TSF Decant Chemistry

Table 25 Predicted TSF3 and GOP TSF Decant Chemistry



	TSF3 Predicted Decant		TSF3 Predicted Decant		GOP TSF Predicted Decant		GOP TSF Predicted
	Mean	95 percentile	Max Gladstone	Max WUG	Mean	95 percentile	Max WUG
pH	8.1	7.6	8.1	7.6	8.1	7.6	7.6
Al	0.019	0.040	0.026	0.041	0.019	0.039	0.041
As	0.002	0.023	0.006	0.002	0.003	0.027	0.002
Ba	0.025	0.041	0.043	0.031	0.024	0.040	0.031
Ca	121	216	154	204	127	226	204
Cd	0.00034	0.00071	0.0017	0.00001	0.00002	0.00004	0.00001
Co	0.023	0.064	0.073	0.017	0.015	0.042	0.017
Cr	0.028	0.078	0.002	0.039	0.036	0.099	0.039
Cu	0.45	1.78	0.48	1.83	0.49	1.94	1.8
Fe	0.03	0.06	0.05	0.05	0.03	0.06	0.05
Hg	0.00022	0.00059	0.00060	0.00039	0.00014	0.00038	0.00039
K	42	64	45	65	46	70	65
Mg	4	10	11	2	2	7	2
Mn	0.3	1.1	0.7	0.3	0.2	0.8	0.3
Na	244	268	157	170	252	277	170
Ni	0.022	0.100	0.069	0.026	0.015	0.067	0.026
Pb	0.0028	0.0098	0.0069	0.0020	0.0021	0.0072	0.0020
Sb	0.038	0.059	0.053	0.058	0.038	0.059	0.058
Se	0.11	0.21	0.10	0.24	0.12	0.23	0.24
SO_4	1070	1970	1600	1950	1020	1880	1950
Zn	0.0099	0.033	0.016	0.026	0.0098	0.032	0.026

All concentrations reported in mg/L.
Decant data for TSF1A and TSF2 (2014-2020) supplied by OGNZL.
Adjusted Liquor values were calculated using the head:liquor relationship of six processed Gladstone ore samples. The head:liquor ratio of these samples was used to factor the 'mean liquor' data using the more complete Gladstone ore head dataset.

The predicted TSF3 and GOP TSF decant modelling values are based on seven scenarios:

- Scenario 5 – TSF1A – Mean (known pondwater geochemistry) x TSF3 Mean trace element correction factor
- Scenario 6 – TSF1A – 95 %ile (known pondwater geochemistry) x TSF3 Mean trace element correction factor
- Scenario 7 – TSF1A – Mean (known pondwater geochemistry) x Gladstone Pit Mean trace element correction factor
- Scenario 8 – TSF1A – 95 %ile (known pondwater geochemistry) x Gladstone Pit Mean trace element correction factor
- Scenario 9 – TSF1A – Mean (known pondwater geochemistry) x TSF3 Max Gladstone Tailings trace element correction factor
- Scenario 10 – TSF1A – 95 %ile (known pondwater geochemistry) x TSF3 Max WUG Tailings trace element correction factor
- Scenario 11 – TSF1A – Mean (known pondwater geochemistry) x GOP TSF Max WUG Tailings trace element correction factor

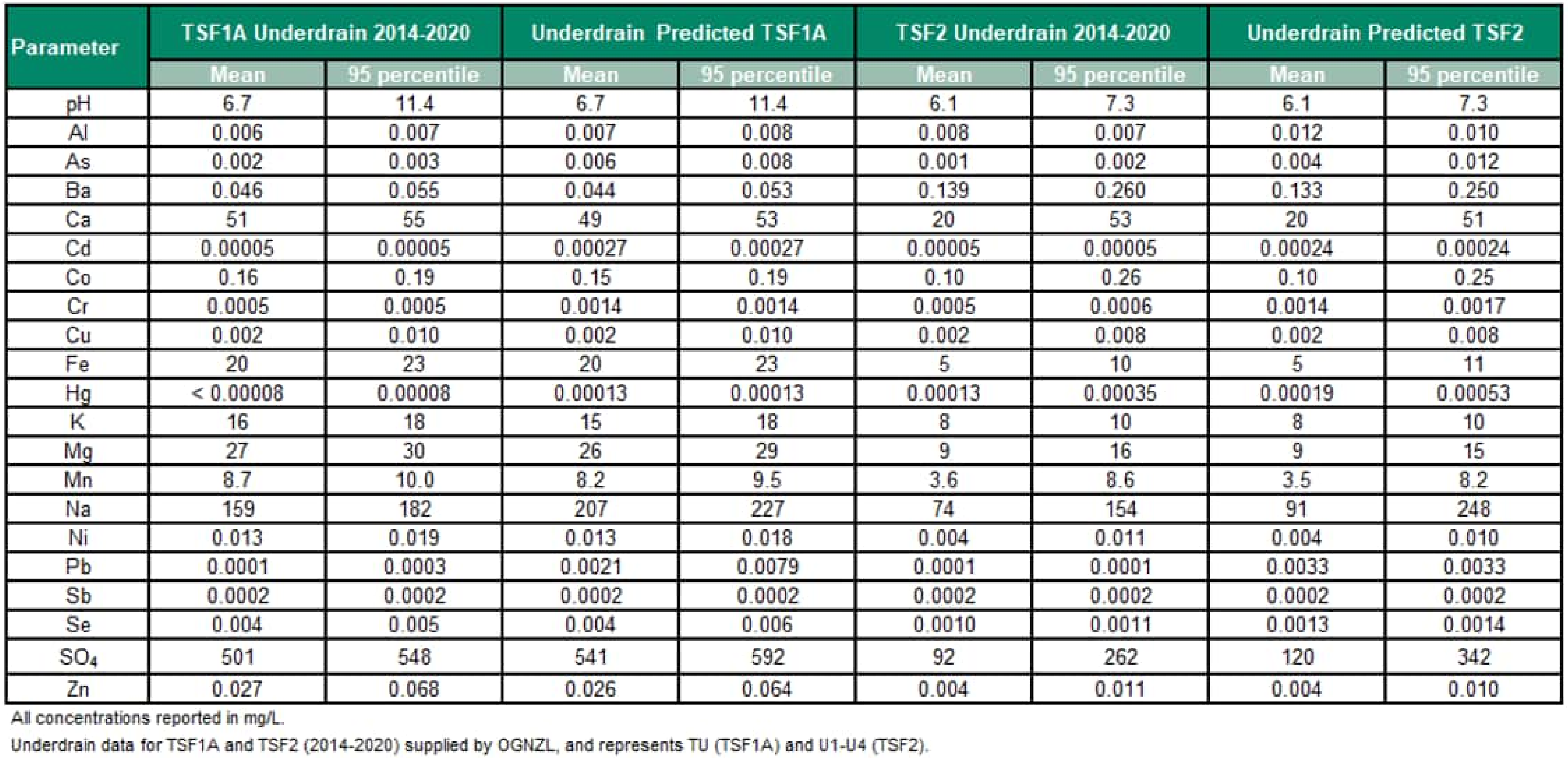
The speciation modelling inputs ran the following steps,

1. Solution 1 was calculated based on factoring existing TSF data by trace element increases in Gladstone and WUG ore and the proportion placed with the respective TSF
2. Equilibrium phases: CO_2(g), Ferrihydrite, Alunite, K-Jarosite, $FeAsO_4{:}2H_2O$, Galena, Gibbsite, $Cu(OH)_2$
3. Sorption of hydrous ferric oxides

The greater of modelled values and existing TSF data is presented

F5-7 Predicted TSF Porewater Chemistry (TSF1A and TSF2)

Table 26 Predicted TSF Porewater Chemistry



Parameter	TSF1A Underdrain 2014-2020		Underdrain Predicted TSF1A		TSF2 Underdrain 2014-2020		Underdrain Predicted TSF2	
	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile	Mean	95 percentile
pH	6.7	11.4	6.7	11.4	6.1	7.3	6.1	7.3
Al	0.006	0.007	0.007	0.008	0.008	0.007	0.012	0.010
As	0.002	0.003	0.006	0.008	0.001	0.002	0.004	0.012
Ba	0.046	0.055	0.044	0.053	0.139	0.260	0.133	0.250
Ca	51	55	49	53	20	53	20	51
Cd	0.00005	0.00005	0.00027	0.00027	0.00005	0.00005	0.00024	0.00024
Co	0.16	0.19	0.15	0.19	0.10	0.26	0.10	0.25
Cr	0.0005	0.0005	0.0014	0.0014	0.0005	0.0006	0.0014	0.0017
Cu	0.002	0.010	0.002	0.010	0.002	0.008	0.002	0.008
Fe	20	23	20	23	5	10	5	11
Hg	< 0.00008	0.00008	0.00013	0.00013	0.00013	0.00035	0.00019	0.00053
K	16	18	15	18	8	10	8	10
Mg	27	30	26	29	9	16	9	15
Mn	8.7	10.0	8.2	9.5	3.6	8.6	3.5	8.2
Na	159	182	207	227	74	154	91	248
Ni	0.013	0.019	0.013	0.018	0.004	0.011	0.004	0.010
Pb	0.0001	0.0003	0.0021	0.0079	0.0001	0.0001	0.0033	0.0033
Sb	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Se	0.004	0.005	0.004	0.006	0.0010	0.0011	0.0013	0.0014
SO_4	501	548	541	592	92	262	120	342
Zn	0.027	0.068	0.026	0.064	0.004	0.011	0.004	0.010

All concentrations reported in mg/L.

Underdrain data for TSF1A and TSF2 (2014-2020) supplied by OGNZL, and represents TU (TSF1A) and U1-U4 (TSF2).

The predicted TSF1A and TSF2 porewater modelling values are based on four scenarios:

- Scenario 1 – TSF1A – Mean (known porewater geochemistry) x TSF1A Storage trace element correction factor
- Scenario 2 – TSF1A –95 %ile (known porewater geochemistry) x TSF1A Storage trace element correction factor
- Scenario 3 – TSF2 – Mean (known porewater geochemistry) x TSF2 Storage trace element correction factor
- Scenario 4 – TSF2 – 95 %ile (known porewater geochemistry) x TSF2 Storage trace element correction factor

The speciation modelling inputs ran the following steps,

4. Solution 1 was calculated based on factoring existing TSF data by trace element increases in Gladstone and WUG ore and the proportion placed with the respective TSF.
5. Equilibrium phases: CO_2(g), Ferrihydrite, Alunite, K-Jarosite, $FeAsO_4{:}2H_2O$, Galena, Gibbsite, $Cu(OH)_2$
6. Sorption of hydrous ferric oxides

The greater of modelled values and existing TSF data is presented.

F5-8 Predicted TSF Porewater Chemistry (TSF3 and GOP TSF)

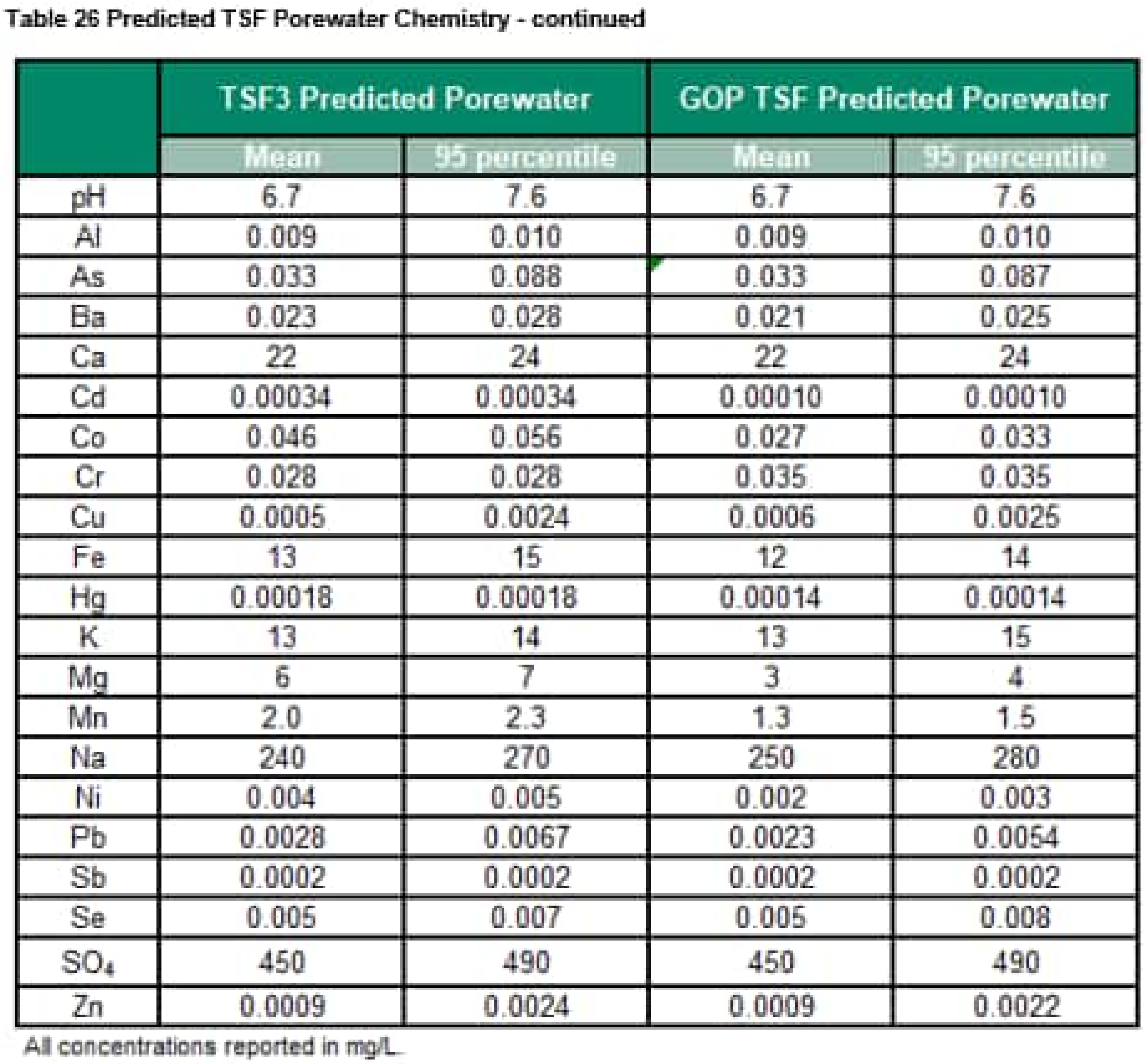


Table 26 Predicted TSF Porewater Chemistry - continued

	TSF3 Predicted Porewater		GOP TSF Predicted Porewater	
	Mean	95 percentile	Mean	95 percentile
pH	6.7	7.6	6.7	7.6
Al	0.009	0.010	0.009	0.010
As	0.033	0.088	0.033	0.087
Ba	0.023	0.028	0.021	0.025
Ca	22	24	22	24
Cd	0.00034	0.00034	0.00010	0.00010
Co	0.046	0.056	0.027	0.033
Cr	0.028	0.028	0.035	0.035
Cu	0.0005	0.0024	0.0006	0.0025
Fe	13	15	12	14
Hg	0.00018	0.00018	0.00014	0.00014
K	13	14	13	15
Mg	6	7	3	4
Mn	2.0	2.3	1.3	1.5
Na	240	270	250	280
Ni	0.004	0.005	0.002	0.003
Pb	0.0028	0.0067	0.0023	0.0054
Sb	0.0002	0.0002	0.0002	0.0002
Se	0.005	0.007	0.005	0.008
SO_4	450	490	450	490
Zn	0.0009	0.0024	0.0009	0.0022

All concentrations reported in mg/L.

The predicted TSF3 and GOP TSF porewater modelling values are based on four scenarios:

- Scenario 5 – TSF1A – Mean (known porewater geochemistry) x TSF3 Mean Storage trace element correction factor
- Scenario 6 – TSF1A –95 %ile (known porewater geochemistry) x TSF3 Mean Storage trace element correction factor
- Scenario 7 – TSF2 – Mean (known porewater geochemistry) x GOP Mean Storage trace element correction factor
- Scenario 8 – TSF2 – 95 %ile (known porewater geochemistry) x GOP Mean Storage trace element correction factor

The speciation modelling inputs ran the following steps,

1. Solution 1 was calculated based on factoring existing TSF data by trace element increases in Gladstone and WUG ore and the proportion placed with the respective TSF
2. Equilibrium phases: CO_2(g), Ferrihydrite, Alunite, K-Jarosite, $FeAsO_4$:$2H_2O$, Galena, Gibbsite, $Cu(OH)_2$
3. Sorption of hydrous ferric oxides

F6 Model Scenarios Summary

A summary of the model scenarios in presented in Table 3.

Table 3 Model Scenarios

Report Table	Table 7	Table 10	Table 16	Table 17	Tables 24 and 25	Table 26
Titles	**Modelled Sump Water Quality Predictions**	**Predicted NRS / Embankment Leachate Water Quality**	**Gladstone Pit Porewater Quality**	**Existing Groundwater Quality Within the WUG System**	**Predicted TSF3 and GOP TSF Decant Chemistry**	**Predicted TSF Porewater Chemistry**
Methodology	PAF runoff water quality is generated by calculating trace elements in molar ratio proportional to sulphide oxidised. Molar ratio based on Gladstone columns. Sulphide oxidised adjusted for NAPP.	Uses the SGR and molar ratios for trace element leaching rates from the Gladstone column tests and Martha PAF in the proportions of waste within the NRS.	Uses the SGR and molar ratios for trace element leaching rates from the Gladstone column tests and Martha PAF in the proportions of waste within the GOP Backfill.	Uses the SGR and molar ratios for trace element leaching rates from the WUG column tests in the proportions of waste within the WUG Backfill.	TSF1a decant chemistry is factored by the difference in total trace element between existing ore and future that will be placed in the TSF. Where leaching tests (SPLP) indicate higher leachability (As, Cd, Cr and Pb) distribution coefficient is used to derive the leaching.	TSF1a underdrain chemistry is factored by the difference in total trace element between existing ore and future that will be placed in the TSF. Where leaching tests (SPLP) indicate higher leachability (As, Cd, Cr and Pb) distribution coefficient is used to derive the leaching.
Source Solutions	Soln 1: Gladstone Columns - Col 1, Soln 2: Martha NAF	Soln 1&2: Gladstone Columns - Compact and Limestone amended	Soln 1: Gladstone Columns - Compacted (for post closure) and Saturated Column for (long term), Soln 2: Gladstone GW	Soln 1: Gladstone Columns - Compacted (for post closure) and Saturated Column for (long term), Soln 2: Gladstone GW	Soln 1: TSF1a Decant Data 2014 to 2020	Soln 1: TSF1a Underdrain Data 2014 to 2020
Input Solutions	Soln 1: PAF Runoff - derived as per flow chart from	Solution 1 (working area) based on the proportions of Martha and Gladstone waste	Solution 1 (backfilled porewater) was calculated based on predicted proportion of waste from Gladstone and Martha.	Solution 1 (backfilled porewater) was calculated based on predicted proportion of waste from WUG.	Soln 1:- TSF1a Decant Data 2014 to 2020 factored by trace element ratio for WUG ore or Kd	Soln 1:- TSF1a Underdrain Data 2014 to 2020 factored by trace element ratio for WUG ore or Kd
Report Table	Table 7	Table 10	Table 16	Table 17	Tables 24 and 25	Table 26

Titles	**Modelled Sump Water Quality Predictions**	**Predicted NRS / Embankment Leachate Water Quality**	**Gladstone Pit Porewater Quality**	**Existing Groundwater Quality Within the WUG System**	**Predicted TSF3 and GOP TSF Decant Chemistry**	**Predicted TSF Porewater Chemistry**
Input Solutions (continued)	Soln 2: Martha NAF	Solution 2 (closed area) based on the proportions of Martha and Gladstone waste and reduced sulphate generation rate	Solution 2 Gladstone groundwater based on monitoring results	None	None	None
Flow (Mix Proportion)	Runoff volumes from GHD Water Balance based on pitwall area of PAF:NAF = 0.61:0.39 Flow:- Mean 711 m3/d, 95 Percentile 3583 m3/d	Proportions as per scenarios below	GW = 0.001, Backfill Porewater = 0.999	None	None	None
PHREEQE Input File	1. Mix Soln 1 and Soln 2 2. Equilibrate oversaturated phases.	1. Mix Soln 1 and Soln 2 2. Equilibrate oversaturated phases 3. Sorption of hydrous ferrioc oxides 4. Equilibrate phases.	*Post Closure* 1. Sorption of hydrous ferric oxides for Solution 1 2. Mix Soln 1 and Soln 2 3. Equilibrate oversaturated phases *Long Term* 1. Mix solution 1 (0.999 %) and 2 (0.001 %) 2. Equilibrium oversaturated phases 3. Sorption of hydrous ferric oxides	1. Solution 1 (backfilled porewater) input 2. Equilibrate with calcite 3. Equilibrate oversaturated phases 4. Sorption of hydrous ferric oxides	1. Solution 1 input 2. Equilibrate oversaturated phases 3. Sorption of hydrous ferric oxides	1. Solution 1 input 2. Equilibrate oversaturated phases 3. Sorption of hydrous ferrioc oxides
Equilibration Phases	Phases 1:- CO_2(g), Ferrihydrite, Alunite, K-Jarosite, Gibbsite, $Cu(OH)_2$	Phases 1:- CO_2(g), Ferrihydrite, Alunite, K-Jarosite, Gibbsite, $Cu(OH)_2$	Phases (post closure):- Ferrihydrite, AlOHSO4, Goethite, k-jarosite, Siderite, Gypsum	Phases 1:- Calcite to GW pH	Phases:- CO_2(g), Ferrihydrite, Alunite, K-Jarosite, $FeAsO_4{:}2H_2O$, Galena, Gibbsite, $Cu(OH)_2$	Phases:- CO_2(g), Ferrihydrite, Alunite, K-Jarosite, $FeAsO_4{:}2H_2O$, Galena, Gibbsite, $Cu(OH)_2$
Report Table	Table 7	Table 10	Table 16	Table 17	Tables 24 and 25	Table 26
Titles	**Modelled Sump Water Quality Predictions**	**Predicted NRS / Embankment Leachate Water Quality**	**Gladstone Pit Porewater Quality**	**Existing Groundwater Quality Within the WUG System**	**Predicted TSF3 and GOP TSF Decant Chemistry**	**Predicted TSF Porewater Chemistry**

Equilibration Phases (continued)	Not applicable	Phases 2:- CO_2(g), Ferrihydrite, Gibbsite, Calcite	Phases (long term):- Goethite, Gypsum, AlOHSO4, Calcite	Phases 2:- Calcite, Ferrihydrite, Al(OH)3(am), Lepidocrocite, Gypsum, FeAsO4:2H2O, Gibbsite, Manganite, Zn(OH)2	Not applicable	Not applicable
Adsorption	None	0.0016 moles oversaturated giving Strong binding sites (Hfo_sOH) = 0.00004046 moles, and weak binding site (Hfo_wOH) = 0.0016 moles. Specific Area of Surface - 600 m2/g. Mass of Solid = 0.09 g (Dzombak and Morel 1990).	Strong binding sites (Hfo_sOH) and weak binding site based on mean and 95 percentile and ratio 0.5, 1.0 and 2.0 for total Hfo moles. Specific Area of Surface - 600 m2/g. Mass of Solid = 0.09 g (Dzombak and Morel 1990).	Strong binding sites (Hfo_sOH) = 0.000013 moles, and weak binding site (Hfo_wOH) = 0.00052 moles. Specific Area of Surface - 600 m2/g. Mass of Solid = 0.09 g (Dzombak and Morel 1990).	Strong binding sites (Hfo_sOH) = 0.2 moles, and weak binding site (Hfo_wOH) = 0.005 moles. Specific Area of Surface - 600 m2/g. Mass of Solid = 0.03 g (Dzombak and Morel 1990).	Strong binding sites (Hfo_sOH) and weak binding site (Hfo_wOH) based on oversaturation. Specific Area of Surface - 600 m2/g. Mass of Solid = 0.09 g (Dzombak and Morel 1990).
Report Table	Table 7	Table 10	Table 16	Table 17	Tables 24 and 25	Table 26
Titles	**Modelled Sump Water Quality Predictions**	**Predicted NRS / Embankment Leachate Water Quality**	**Gladstone Pit Porewater Quality**	**Existing Groundwater Quality Within the WUG System**	**Predicted TSF3 and GOP TSF Decant Chemistry**	**Predicted TSF Porewater Chemistry**
Scenarios	Scenario 1 – WQ: Med, Flow: Mean Scenario 2 – WQ: 95 % UCL, Flow:0.95	*Development models* Scenario 1 – 0.6 (working area): 0.4 (closed area)	*Development models* Scenario 1 – GW0.001: Backfill 0.999:1 Hfo:mean	Unmitigated and Mitigated	*TSF1a & TSF 2* Scenario 1 – TSF1A – Mean (existing decant) x TSF1A Storage Mean trace element correction factor	Scenario 1 – TSF1A – Mean (underdrain chemistry) x TSF1A Storage trace element correction factor

	Scenario 3 – WQ: Med, Flow: 0.95 Scenario 4 – WQ: 95 % UCL, Flow: Med Scenario 5 – WQ: 95 % UCL, Flow: Adjusted Scenario 6 – WQ: Med, Flow: Adjusted	Scenario 2 – 0.5 (working area): 0.5 (closed area) Scenario 3 – 0.4 (working area): 0.6 (closed area) Scenario 4 – 0.3 (working area): 0.7 (closed area) Scenario 5 – 0.2 (working area): 0.8 (closed area) Scenario 6 – 0.1 (working area): 0.9 (closed area) *Closure Models* Scenario 6 – 0.1 (working area): 0.9 (closed area) Scenario 7 – 0.001 (working area): 0.999 (closed area)	Scenario 2 – GW0.001: Backfill 0.999:1 Hfo:95% tile Scenario 3 – GW0.001: Backfill 0.999:0.5 Hfo:mean Scenario 4 – GW0.001: Backfill 0.999:0.5 Hfo:95% tile Scenario 5 – GW0.001: Backfill 0.999:2 Hfo:mean Scenario 6 – GW0.001: Backfill 0.999:2 Hfo:95% tile *Long Term Models* Scenario 7 – LongtermGW0.001: Backfill 0.999:1 Hfo:mean Scenario 8 – LongtermGW0.001: Backfill 0.999:1 Hfo:95% tile		Scenario 2 – TSF1A – 95 %ile (existing decant) x TSF1A Storage Mean trace element correction factor Scenario 3 – TSF2 – Mean (existing decant) x TSF2 Storage Mean trace element correction factor Scenario 4 – TSF2 – 95 %ile (existing decant) x TSF2 Storage Mean trace element correction factor *TSF3 & GOP* Scenario 5 – TSF1A – Mean (existing decant) x TSF3 Mean trace element correction factor Scenario 6 – TSF1A – 95 %ile (existing decant) x TSF3 Mean trace element correction factor Scenario 7 – TSF1A – Mean (existing decant) x Gladstone Pit Mean trace element correction factor Scenario 8 – TSF1A – 95 %ile (existing decant) x Gladstone Pit Mean trace element correction factor Scenario 9 – TSF1A – Mean (existing decant) x TSF3 Max Gladstone Tailings trace element correction factor Scenario 10 – TSF1A – 95 %ile (existing decant) x TSF3 Max WUG Tailings	Scenario 2 – TSF1A –95 %ile (underdrain chemistry) x TSF1A Storage trace element correction factor Scenario 3 – TSF2 – Mean (underdrain chemistry) x TSF2 Storage trace element correction factor Scenario 4 – TSF2 – 95 %ile (underdrain chemistry) x TSF2 Storage trace element correction factor Scenario 5 – TSF1a – Mean (underdrain chemistry) x TSF3 Storage trace element correction factor Scenario 6 – TSF1a – 95 %ile (underdrain chemistry) x TSF3 Storage trace element correction factor Scenario 7 – TSF1a – Mean (underdrain chemistry) x GOP Storage trace element correction factor Scenario 8 – TSF1a – 95 %ile (underdrain chemistry) x GOP Storage trace element correction factor

					trace element correction factor Scenario 11 – TSF1A – Mean (existing decant) x GOP TSF Max WUG Tailings trace element correction factor	
Output File Example (Attachment B)	Scenario 1 – WQ: Med, Flow: Mean	Scenario 1 – 0.6 (working area): 0.4 (closed area)	Scenario 1 – GW0.001: Backfill 0.999:1 Hfo:mean			

F7 Sensitivity Analysis

7.1 Adsorption of Trace element onto Hydrous Ferric Oxides

The sensitivity of PHREEQC model runs has been assessed for a number of input variables. In terms of the modelled geochemical process the values adopted for adsorption on to HFo have the greatest influence on trace elements of environmental concern.

This has been considered for all model scenarios with the model of Gladstone backfill water quality (Table 16) presented as an example where this influence warrants consideration.

The primary variables that influence the model predictions are the input parameters for the site density and mass of solid for adsorption. Both input parameters have the same effect in terms of reduced adsorption sites reducing the amount of trace element adsorbed.

As such the moles of ferrihydrite precipitated is used as a conservative input for the moles available noting other mineral iron minerals (goethite) would remove more as precipitate. Setting the model parameters at a ratio of 0.5, 1 and 2 times the moles available for adsorption gives an indication of the sensitivity to this input parameter. Table 4 and Figure 2 show the effect of these changes noting the effect on trace element concentrations in solution is non-linear for arsenic, copper, chromium and lead.

7.2 Oxidation Depth for Pitwall Runoff

As outlined in Table 5 of the main report (Section 5.1) the oxidation depth of 0.1m and proportion of PAF material is used to assess the volume of material available for oxidation.

The sulphate generation rates used in this calculation are based on column test results from untreated columns containing samples with a maximum particle size of 60mm. As such the surface area and hence sulphide available for oxidation would be greater than would be the case for wall rock insitu. Similarly, the availability of oxygen for sulphide oxidation will be limited relative to a granular porous sample such as tested in columns.

The following summarises the implications on assessed oxidation rates in columns versus wall rock:-

- For this comparison it is assume both media are unsaturated as diffusion in saturated media is negligible in the context of sulphide oxidation. Oxygen flux is therefore controlled by diffusion which is a function concentration gradient and effective diffusion coefficient as defined by Ficks Law.
- Considering the oxygen flux at 0.1m depth in column and wall rock. The concentration gradient at 0.1m depth is the same in both instances so the primary variable is the effective diffusion coefficient. The effective diffusion coefficient is influenced by porosity which for the columns is in excess $n = 0.3$ and for the wall rock is fracture controlled and is expected to be below $n = 0.05$. Modelled gas diffusion coefficients based on Zone D&E materials for these porosities are 5×10^{-4} m^2/sec and 2×10^{-6} m^2/sec respectively.
- Table 5 shows the implications of this in terms of oxygen flux and indicates that SGR based on columns will be highly conservative for wall rock, with oxygen flux at 0.1m depth in wall rock being more than 40 times lower (166/4) than in column data used for the assessment wall quality.

Table 4 Sensitivity Scenarios for HFo

Parameter	Mean Gladstone GW	Calculated Backfill Porewater (model input)	Scenario 3:- GW0.001 :Backfill0.999: 0.5HFo :mean	Scenario 1:- GW0.001 :Backfill0.999: 1 HFo :mean	Scenario 5:- GW0.001 :Backfill0.999: 2HFo :mean
HFo Proportion			0.5	1	2
pH	5.80	3.38	3.84	4.22	6.50
Al	0.0284	26.00	18.9076	7.8809	1.0611
As	0.0084	0.0093	0.0039	0.0004	0.0001
Ba	0.058	0.013	0.0131	0.0130	0.0129
C	14.86	30	5.98	5.98	5.98
Ca	19	256	257	257	256
Cd	0.0001	0.0108	0.0108	0.0102	0.0077
Cl	12	1.00	1.0	1.0	1.0
Co	0.004	4.6	4.6	4.6	4.3
Cr	0.0005	0.1361	0.0114	0.000043	0.000007
Cu	0.0036	0.3089	0.2700	0.0515	0.0407
Fe	0.84	435	436	436	429
Hg	0.0010	0.0001	0.0001	0.0001	0.0001
K	4.3	20	20	20	20
Mg	9.9	31	31	31	31
Mn	0.1	5.7	5.7	5.7	5.7
Mo	4.290	0.0008	0.0005	0.0003	0.0002
Na	20	417	558	558	558
Ni	0.0100	1.82	1.82	1.72	1.26
Pb	0.0001	0.0004	0.0001	0.0000008	0.000000204
S	101	2872.7175	2,816	2,747	2,671
Sb	0.005	0.0034	0.0034	0.0034	0.0034
Se	0.001	0.0028	0.0012	0.0013	0.0016
Sr	0.18	0.4097	0.4112	0.4112	0.4112
U	0.00002	0.0074			
V	0.001	0.2492	0.2500	0.2500	0.2500
Zn	0.01	2.8263	2.83	2.33	1.10

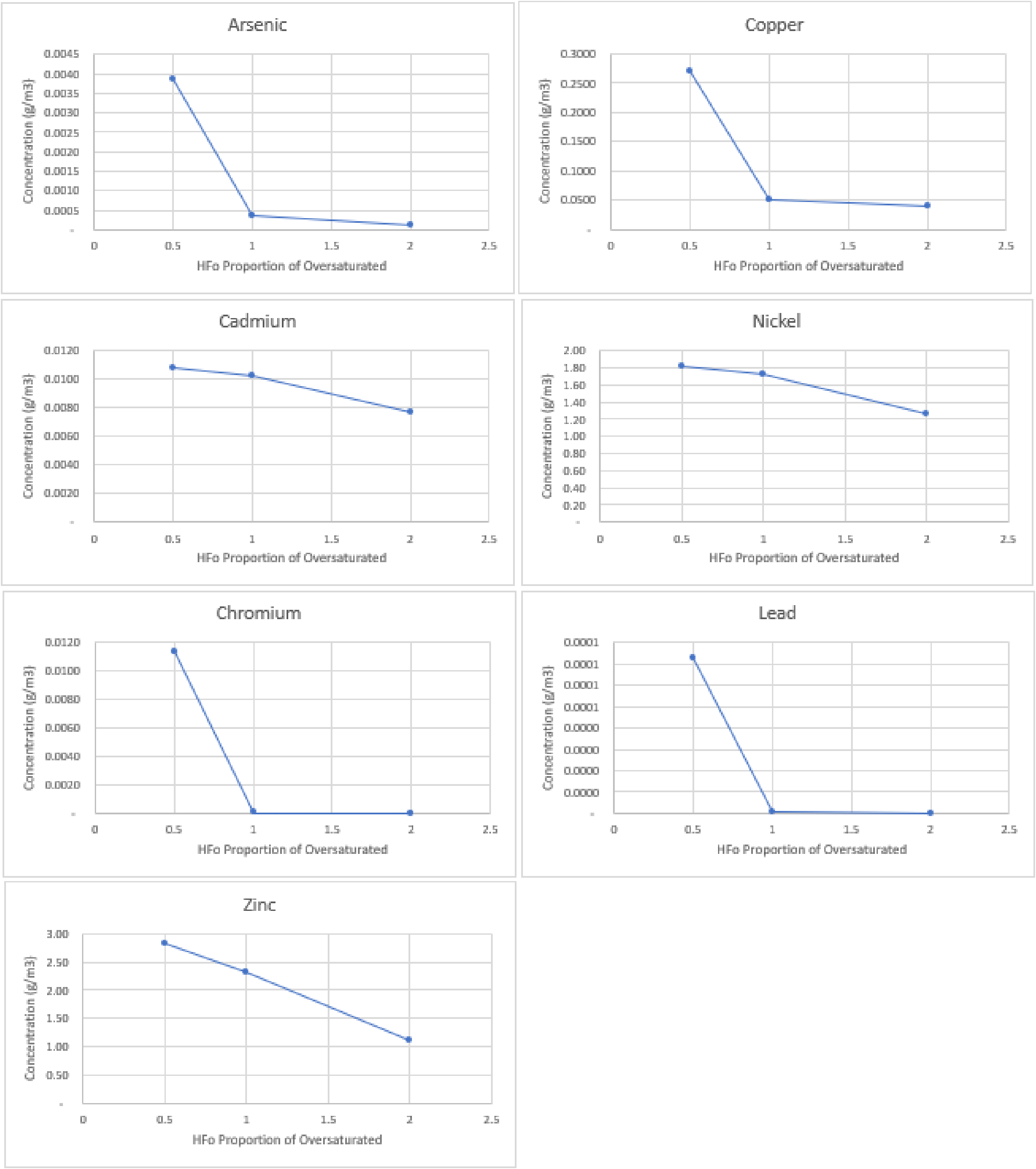


Figure 2 HFo proportion vs Predicted Trace Element Concentration in Solution

Table 5 Oxygen flux column VS wallrock

Scenario	Effective Diffusion coeffient (m2/sec)	Distance (m)	Concentration Gradient (dC/dl)	Oxygen Flux (g/m2/sec)
Column Test	5.00E-04	0.1	2000000	1,000.00
Column Test	5.00E-04	0.6	333333.3333	166.67
Oxidation depth in Pitwall	2.00E-06	0.1	2000000	4.00
Oxidation depth in Pitwall	2.00E-06	0.2	1000000	2.00

Note: Assume oxygen concentration in air of 209,000 g/m3

F8 Water Quality Monitoring

A Tailings and Rock Storage Facility Monitoring Plan is a requirement of the consents for the newer elements of the operation, being TSF3, GOP TSF, NRS and WRS. The monitoring plan is to be updated every two years, or if any significant changes occur in the design or operation of the tailings and rock storage facilities. In the April 2022 Tailings and Rock Storage Facility Monitoring Plan, OceanaGold outlines the parameters to be monitored in:

- the tailings discharge (Table 7-1)
- the collection pond overflow (Table 7-2)
- the underdrain (Table 8-1)

Aluminium is not listed as a water quality monitoring parameter in Tables 7-1 and 7-2 but is included in Table 8-1. Aluminium is unlikely to be found in concentrations that would be of concern as it is strongly pH controlled and within the acceptable pH range for receiving waters. Figure 3 for the existing TSF underdrains and Figure 4 for the column leachate results demonstrate that the dissolved aluminium concentrations are strongly pH controlled with pH range of 6.5-9.5 significantly reducing the concentration of Aluminium in source waters at the site.

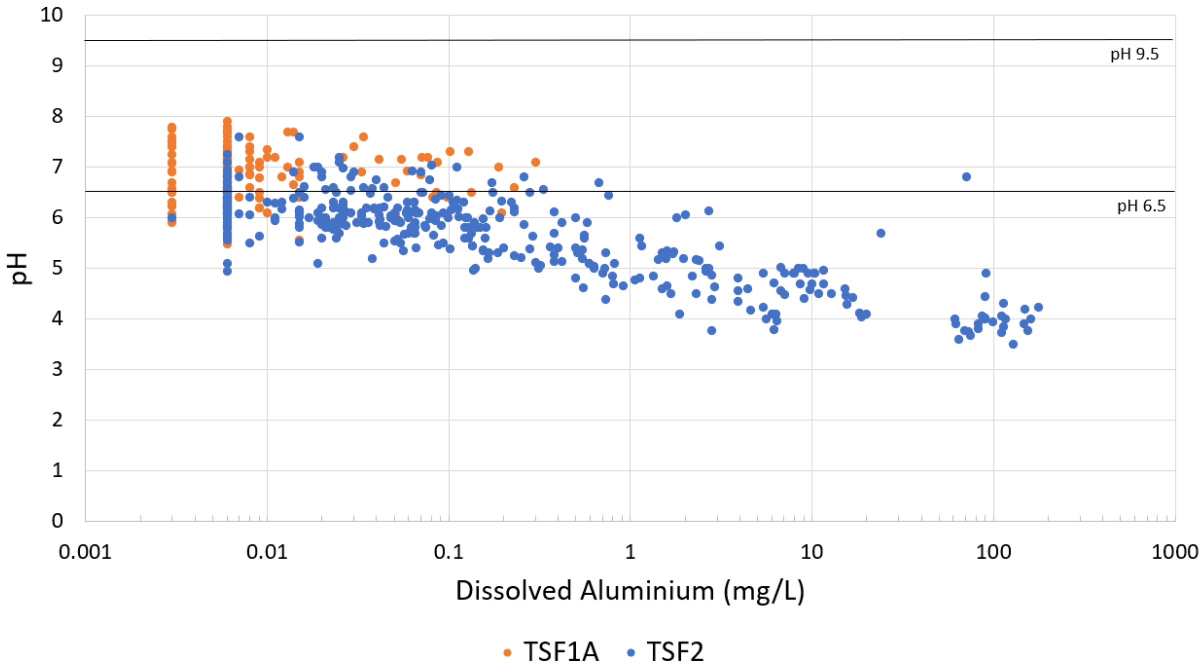


Figure 3 pH/Dissolved Aluminium diagram for TSF Underdrains

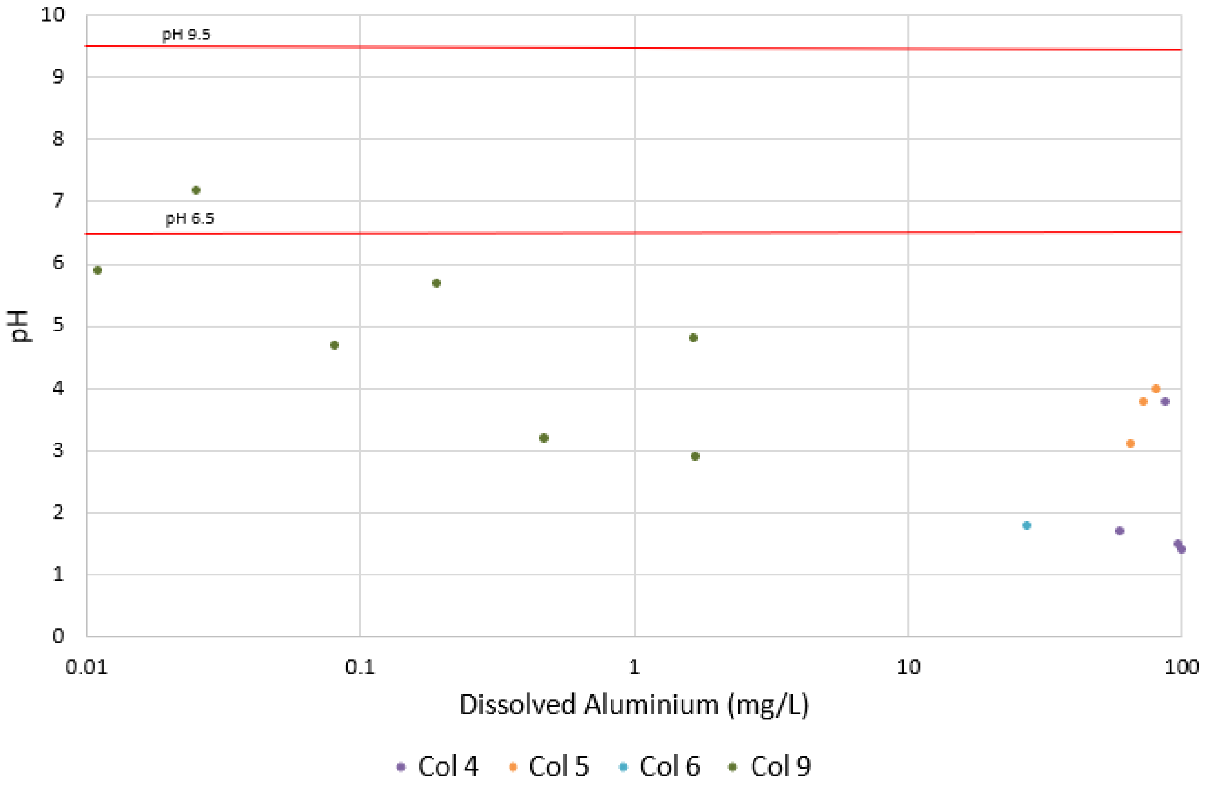


Figure 4 pH/Dissolved Aluminium diagram for column leach results

Appendix G

Waste Classification

Appendix G – Waste Classification Protocol

G1 Introduction

This Appendix details the protocols used to classify waste produced by the Waihi North project.

G2 Definitions

The following analyses are used to characterise waste in terms of acid base accounting:

- Net Acid Generation (NAG): reported as a slurry pH value and kg H_2SO_4/t at slurry pH adjusted to 4.5 and 7.0
- Acid Neutralising Capacity (ANC): reported as %$CaCO_3$ and kg H_2SO_4/t.
- Total Sulphur reported as %S

While Total carbon has been used within the initial phases of this assessment as outlined in Appendix A of our report, to determine whether materials may have some neutralising potential this surrogate analysis is not used as part of waste classification going forward.

These parameters are used to calculate the following:

MPA	Maximum Potential Acidity = %S x 30.6 as kg H_2SO_4/t or %S x 31.25 as kg $CaCO_3$/t
NPR	ANC/MPA
NAPP	Net Acid Producing Potential: calculated as kg H_2SO_4/t, NAPP is calculated as the MPA less the inherent ANC (NAPP = MPA – ANC)

G3 Waste Classification Protocol

Rock material produced by the mining operations are classified in terms of ABA using the flowcharts shown in **Figure G-1**. These criteria are summarised in **Table G-1**. The process outlined in **Figure G-2** is used to define trace elements requiring assessment in terms of potential leaching. It is worth noting that including samples classified as Uncertain as PAF unless shown to be otherwise is conservative with respect to managing rock. Assessment of degree of weathering for any material classified as uncertain that does not meet the definition of LPAF should be considered if extensive areas of uncertain classification are identified as a result of further sampling.

Figure G-2 shows that while there a number of trace elements that are elevated relative to GAI and other materials on site, these are generally correlated with sulphide concentrations and onsite waste practices are therefore appropriate to manage these materials. The only trace element that is classified as PTEL is therefore mercury.

Table G-1 Criteria

Abbreviation	**Definition**	**Criteria**
Total S%	Total Sulphur	Total S <0.02% is NAF
NAF	Non Acid Forming materials	NAG pH > 4.5 NPR > 1
PAF	Potentially Acid Forming materials	NAG pH =< 4.5 NPR =< 1
Uncertain	Manage as PAF or LPAF based on NAG kg H_2SO_4/t (ongoing review)	NAG pH > 4.5 NPR =< 1
Low Capacity PAF/LPAF/PAF-LC	Low capacity - Potentially Acid Forming	NAG 0 to 5 kg H_2SO_4/t
PTEL (High Hg)	Potential for Trace Element Leaching – High Mercury	Hg >3.5 mg/kg – High Hg Hg =<3.5 mg/kg – Low Hg

Figure G-1 Rock Assessment Protocol

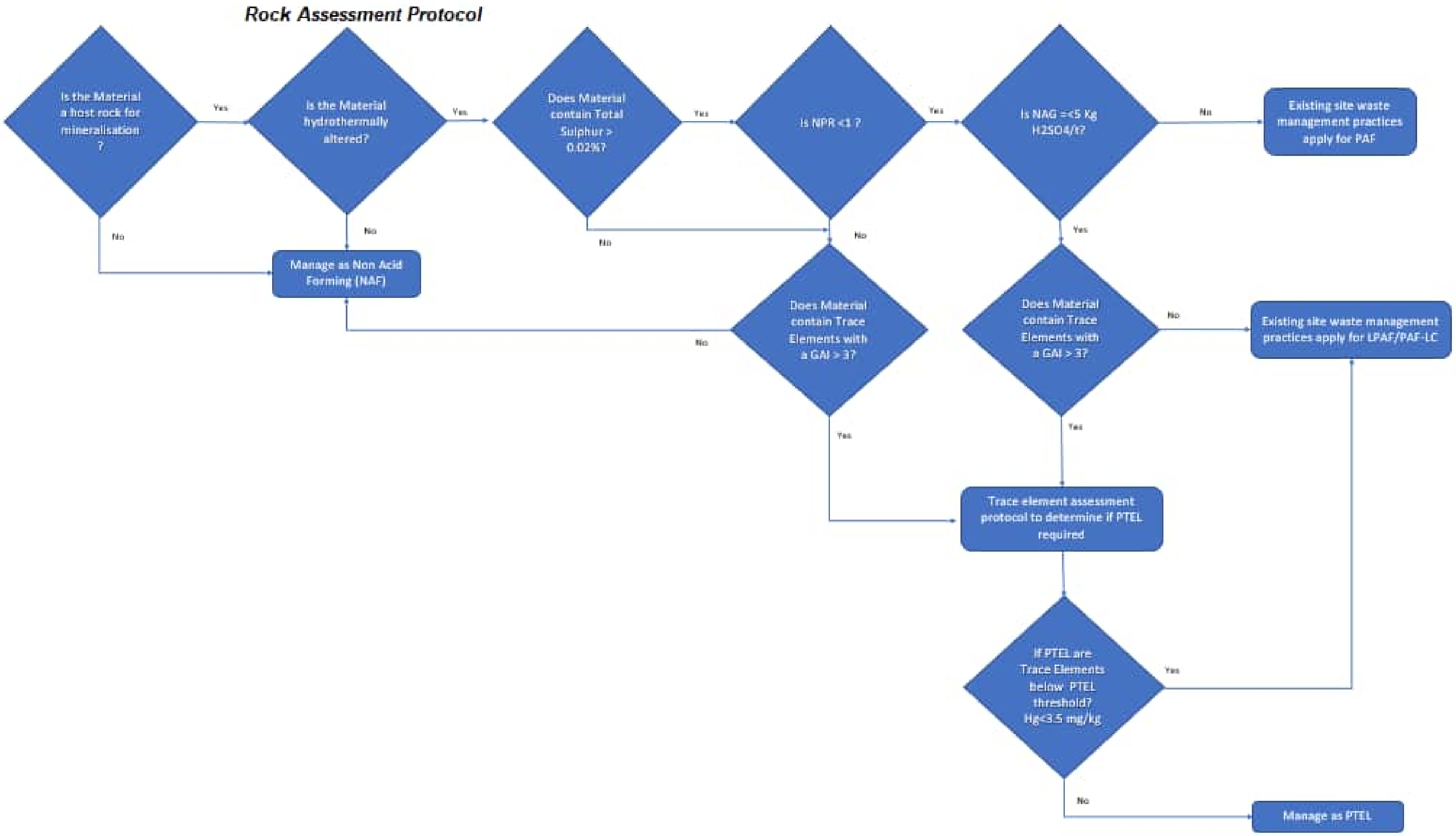
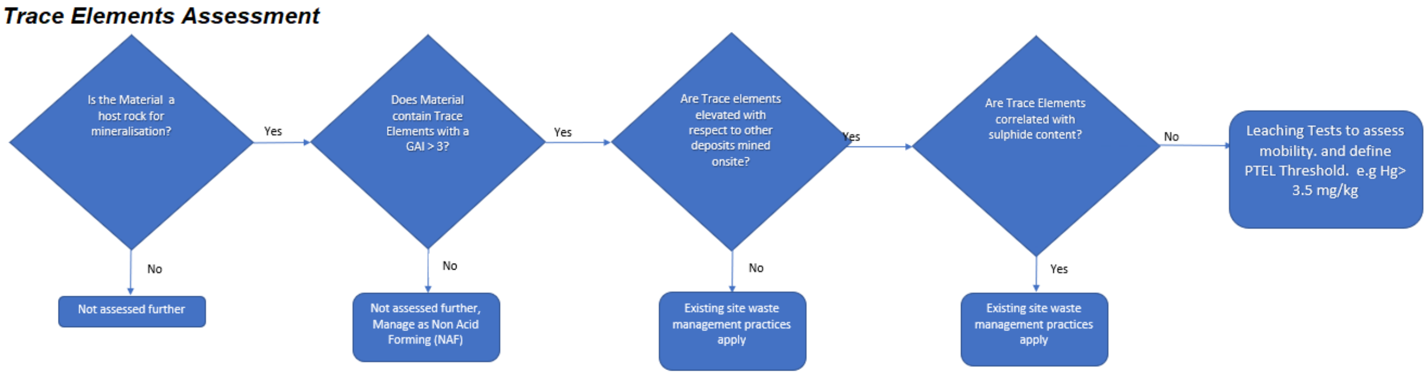
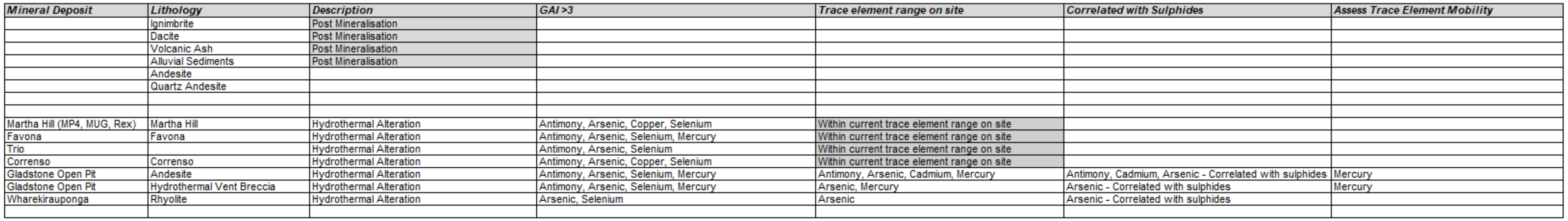


Figure G-2 Trace Elements Assessment





Mineral Deposit	*Lithology*	*Description*	*GAI >3*	*Trace element range on site*	*Correlated with Sulphides*	*Assess Trace Element Mobility*
	Ignimbrite	Post Mineralisation				
	Dacite	Post Mineralisation				
	Volcanic Ash	Post Mineralisation				
	Alluvial Sediments	Post Mineralisation				
	Andesite					
	Quartz Andesite					
Martha Hill (MP4, MUG, Rex)	Martha Hill	Hydrothermal Alteration	Antimony, Arsenic, Copper, Selenium	Within current trace element range on site		
Favona	Favona	Hydrothermal Alteration	Antimony, Arsenic, Selenium, Mercury	Within current trace element range on site		
Trio		Hydrothermal Alteration	Antimony, Arsenic, Selenium	Within current trace element range on site		
Correnso	Correnso	Hydrothermal Alteration	Antimony, Arsenic, Copper, Selenium	Within current trace element range on site		
Gladstone Open Pit	Andesite	Hydrothermal Alteration	Antimony, Arsenic, Selenium, Mercury	Antimony, Arsenic, Cadmium, Mercury	Antimony, Cadmium, Arsenic - Correlated with sulphides	Mercury
Gladstone Open Pit	Hydrothermal Vent Breccia	Hydrothermal Alteration	Antimony, Arsenic, Selenium, Mercury	Arsenic, Mercury	Arsenic - Correlated with sulphides	Mercury
Wharekirauponga	Rhyolite	Hydrothermal Alteration	Arsenic, Selenium	Arsenic	Arsenic - Correlated with sulphides	

G4 Waste Classification Calculation

Table G-2 shows the application of the waste classification protocol with examples.

Table G-2 Application of the waste classification protocol with examples.

Item	Unit	Calculation	Example - PAF	Example Uncertain	Example NAF	Example LPAF
Total S	%	measured	1.83	0.027	0.022	0.061
Acid Neutralising Capacity (ANC as %$CaCO_3$)	%$CaCO_3$	measured	0.2	0.08	2	0.1
Net Acid Generation (NAG)	kg H_2SO_4/t	measured	56	5	2	3
Net Acid Generation pH (NAGpH)	pH units	measured	2.6	5.6	6	5.2
Maximum Potential Acidity (MPA as kg H_2SO_4/t)	kg H_2SO_4/t	MPA = %S x 30.6	56	0.83	0.67	1.9
Maximum Potential Acidity (MPA)	kg $CaCO_3$/t	MPA = %S x 31.25	57	0.84	0.69	1.9
Acid Neutralising Capacity (ANC)	kg $CaCO_3$/t	ANC x 10	20	0.8	20	1
Net Potential Ratio (NPR)	-	ANC/MPA	0.35	0.95	29	0.52
Net Acid Producing Potential (NAPP)	kg H_2SO_4/t	NAPP = MPA -ANC	37	0	-19	1
Criteria - Total S	-	Total S <0.02%	No	No	No	No
Criteria - NPR	-	NPR =< 1	Yes	Yes	No	Yes
Criteria - NAG pH	-	NAG pH =< 4.5	Yes	No	No	No
Criteria - NAG	-	NAG =< 5 H_2SO_4/t	No	No	No	Yes
Classification	-	-	PAF	Uncertain	NAF	Uncertain
Rock Managed as	-	-	PAF	PAF	NAF	LPAF

G5 Sampling Requirements

Sampling of Gladstone Open Pit (GOP) rock will be done as required to increase resolution of the current block model for this pit. This will include definition of PAF and PTEL zones within the GOP. Oceana Gold will develop a standard operating procedure to provide for sampling of drillcore and sampling handling to ensure oxidation of samples is minimised.

Any areas of the Willows Rock Stack (WRS) or Northern Rock Stack (NRS) where rock material has been fully removed will undergo validation sampling of the footprint areas to assess whether insitu material is PAF. Where PAF areas are identified, sufficient lime amendment will be undertaken to achieve an NPR of 1.2 for the upper 0.6 m of insitu material prior to rehabilitation of the area.

G6 Limestone Amendment

As outlined in section 6.2.2 of our report, the limestone amendment required for PAF rock placed within the temporary stockpiles at the Rock and Tailings Storage Area (RTSA) and the WRS will be dependent upon the results of testing of the material prior to it leaving the Gladstone open pit or Wharekirauponga Underground Mine (WUG).

PAF rock placed in temporary storage structures should not be left exposed for a period of more than 30 weeks. This PAF rock should be blended with crushed limestone at a rate designed to provide a lag period appropriate to mitigate generation of Acid and Metalliferous Drainage (AMD) for a 30 week period.

Monitoring of placed rock will ensure these dosing rates are appropriate and enable refinement as part of ongoing operations.

Martha Column tests with Mean NAPP 42 kg H_2SO_4/tonne having a sulphate generation rate (SGR) of 0.023 kg SO_4/tonne/day are the basis for the amendment rate calculated in **Table G-3.** **Table G-4** outlines the NAPP and SGR values used in the derivation of limestone amendment rates presented in Section 6 of our report.

Table G-3 PAF rock Limestone Dosing Requirements – Short Term Exposure

Item	Calculation	Mean (Martha & WUG)
NAPP (kg H_2SO_4/tonne) defined for waste placed	NAPP	48
Sulphate Generation Rate Correction Factor (CF)	NAPP/42 = CF	48/42 = 1.15
Estimated Sulphate Generation Rate (ESGR)	SGR x CF = ESGR	0.023 x 1.15 = 0.027
Factor of Safety (20%)	FoS	1.2
Limestone Neutralisation Required (kg $CaCO_3$/tonne rock) – molar ratio CaCO3/H2SO4 = 100/98	ESGR x FoS x 100/98 = NR	0.027 x 1.2 x 100/98 = 0.032
Lag Required in days (30 weeks)	L_R	210
Natural Lag in days	L_N	140
Additional Lag from Lime Amendment in days (LA)	L_R - L_N = LA	210 – 140 = 70
Limestone Amendment Rate (LAR) (kg $CaCO_3$/tonne rock)	LA x NR = LAR	70 x 0.032 = 2.3
Limestone Amendment Rate (%)	LAR%	0.2 %

It is proposed that no limestone amendment will be required for:

- Gladstone PAF material likely to be exposed for a period of less than 10 weeks
- Martha and WUG PAF material likely to be exposed for a period of less than 30 weeks.

Table G-4 NAPP and SGR values used in the derivation of limestone amendment rates

	NAPP (mean) kg H2SO4/tonne	SGR (mean) kg SO4/tonne/day	Natural Lag - L_N (days)
Martha & WUG (based on EGi columns)	42	0.023	140
GOP (based on kinetic & column tests)	85	0.049	70

G7 Performance Monitoring TSF and NRS

Oceana Gold's standard operating procedure (SOP) for paste pH will be used to monitor the NRS and TSF areas for the onset of acidity. This routine monitoring will be used to verify the adequacy of waste classification and lime amendment of material placed in these areas.

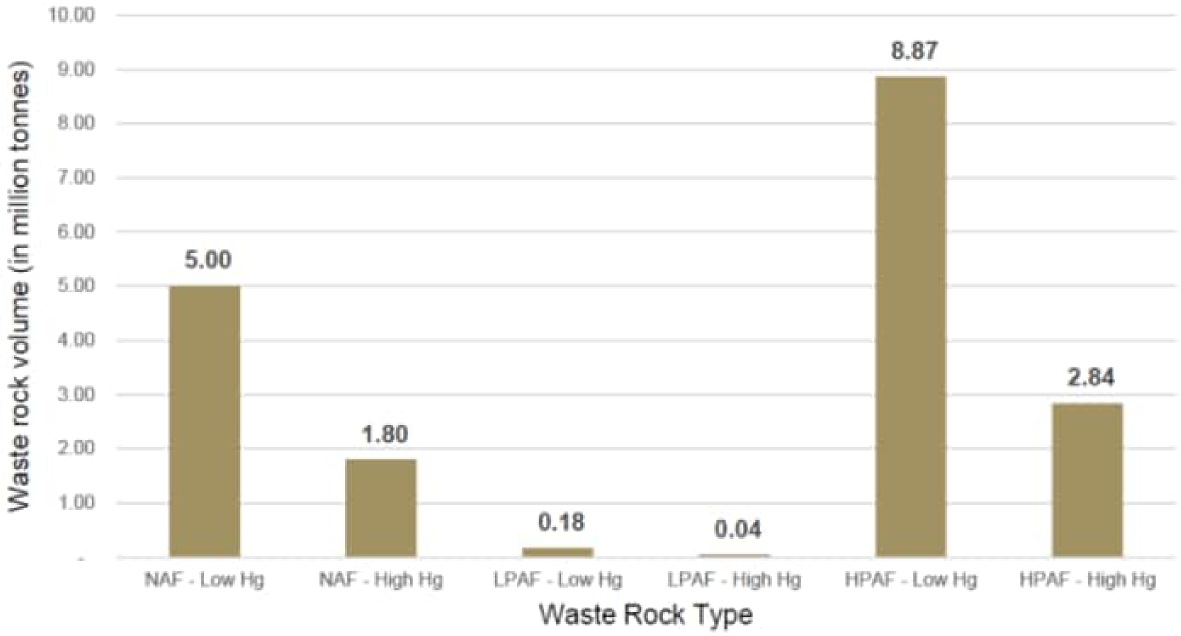
G8 GOP Material Balance

Figure G-3 provides an indication of the expected waste rock volumes from GOP and indicates that there is sufficient NAF based on the current block model to implement the proposed rock management practices.

The current block model has been developed based on drillcore information available to date at the time of report preparation. Ongoing drilling during development will be used to update this model.

Oceana Gold will develop a standard operating procedure for the ongoing sampling of drillcore and open pit materials during mining operation to address any areas inadequately delineation within the block model.

Figure G-3 Expected waste rock volumes from GOP



Appendix H

WUG Post Closure Geochemistry

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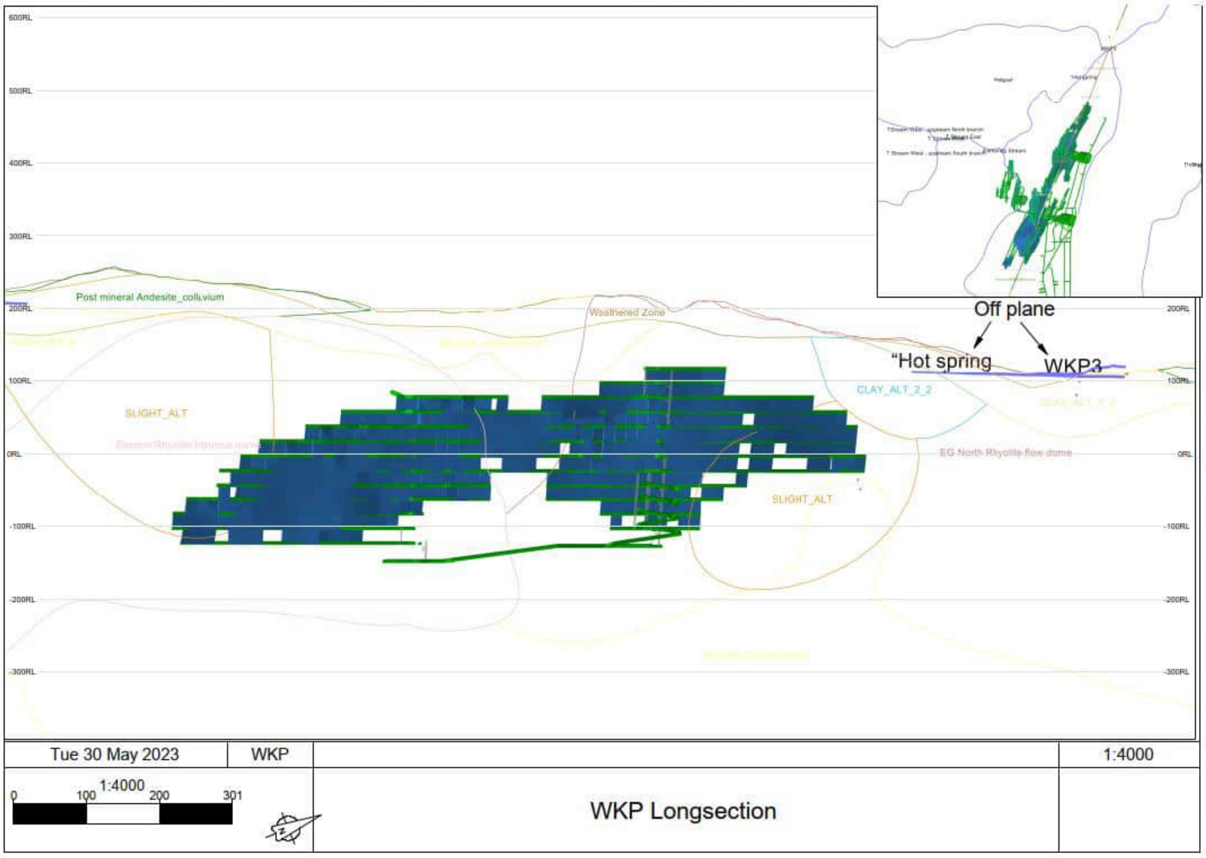
Appendix H – Wharekirauponga Post-Closure Geochemistry Modelling

H1 Introduction

OceanaGold Waihi Operation requested AECOM New Zealand to complete water quality modelling post Wharekirauponga underground mine (WUG) closure to predict the concentrations over time at the warm spring north-west of the pit (refer to long-section in **Figure 1**).

Figure 1 WUG Long-Section



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H2 Methodology

H2.1 Conceptual Geochemical Model

AECOM reviewed available borehole logs, geological models, groundwater and surface water chemistry data and the groundwater flow model developed by FloSolution. We subsequently developed a conceptual geochemical model (CGM) with the following two paths:

1. Warm Spring CGM: between WUG and the warm spring
2. Deep groundwater flow path CGM: between the WUG pit and the deep groundwater within the vein system at the downgradient boundary of FloSolution's groundwater model.

H2.2 Modelling Steps – Warm Spring

The warm spring CGM was developed using the following assumptions:

- Post closure, the backfilled mine will flood with groundwater from the shallow and deep systems.
- Backfill placed within the mine will be comprised of rock stockpiled within the Willows farm, which is lime amended to maintain neutral pH, and rock used as stope backfill directly from the underground mine.
- Once flooded, groundwater from within the backfilled mine moves to the north within the vein system (deep groundwater).
- While no connection to the warm spring is apparent from FloSolution's groundwater model, the warm spring CGM assumed lateral movement within the country rock to the warm spring (point of discharge). This assumption is conservative as it is possible that other mixing is happening or that the vein system is not the source of the warm spring.

To determine water quality of the warm spring, AECOM used the geochemical modelling software PHREEQC Interactive version 3.7.3. The warm spring CGM was used to determine the number of modelling steps which are summarised below and presented in **Table 1** and **Figure 2**.

- The porewater with the mine backfill is determined by mixing the column leachate samples in equal proportions. These samples are then equilibrated with oversaturated phases and calcite to reflect lime amendment.
- Groundwater moves from the WUG domain along the vein about 100m initially. The system is unoxidized (no evidence of oxidation in borehole logs or photos) and will equilibrate with sulphide minerals. These minerals are slow to form (equilibrate) however groundwater model travel times suggest adequate timeframes for these sulphide phases to form. The limited groundwater chemistry data obtained from wells screened within the vein is not sufficient to reliably derive actual redox condition. The currently available data used in the modelling indicates reducing conditions that are not sufficiently reducing to form sulphides. No trace element removal as sulphides is therefore predicted by the current model.
- Groundwater from the vein then moves laterally through country rock about 100m to the warm spring. This is not shown to be the case in FloSolution's groundwater model but is assumed as a conservative measure for the purposes of this CGM. Weathering and associated iron oxides extend to about 100m below ground surface based on the borehole logs. We assumed adsorption onto iron oxides (HFo modelling) with this modelling step to provide significant absorption and trace element removal.

The warm spring CGM assumed limited lateral dispersion between the source and the warm spring.

Table 1 Modelling Steps – Warm Spring

Step	Conceptual Model Stepic	PHrREEQC Model Step	Purpose
1.	Porewater in WUG backfill.	Mix column leachate samples	To determine porewater within flooded backfill
		Equilibrate Porewater	To allow for precipitation of oversaturated species and lime amendment of waste and surface storage
		Adsorption on to iron hydroxides	Allow for trace element adsorption on to oxidation products within backfill
2.		Mix porewater with deep groundwater	Initial saturation of waste will be with deep groundwater
3.		Mix shallow groundwater with other waters	This represents the porewater discharging from the underground mine via the vein system
4a	Groundwater moves from the WUG mine domain along the vein.	Equilibrate water to deep groundwater redox	Determine whether trace elements are removed as sulphides
		Adsorption modelling	Lateral movement via country rock will involve trace element adsorption onto oxidised country rock
		Increase redox conditions to match spring discharge	Inverse modelling used to define redox (pe) to be achieved in the spring discharge. Iteratively modelled this step to calibrate to this pe in the spring discharge
5	Groundwater moves laterally about 100m to the warm spring through country rock.	Increase redox conditions to match spring discharge	Inverse modelling used to define pe to be achieved in the spring discharge. Iteratively modelled this step to calibrate to this pe in the spring discharge
		Adsorption on to iron hydroxides	Allow for trace element adsorption in spring discharge zone
		Equilibrate water	Allow for removal of oversaturated species in spring discharge zone

H2.3 Modelling Steps – Deep Groundwater Flow Path

To determine the water quality of the deep groundwater flow path, AECOM used the geochemical modelling software PHREEQC Interactive version 3.7.3. The deep groundwater flow path CGM was used to determine the number of modelling steps which are summarised below and presented in **Table 2** and **Figure 2**:

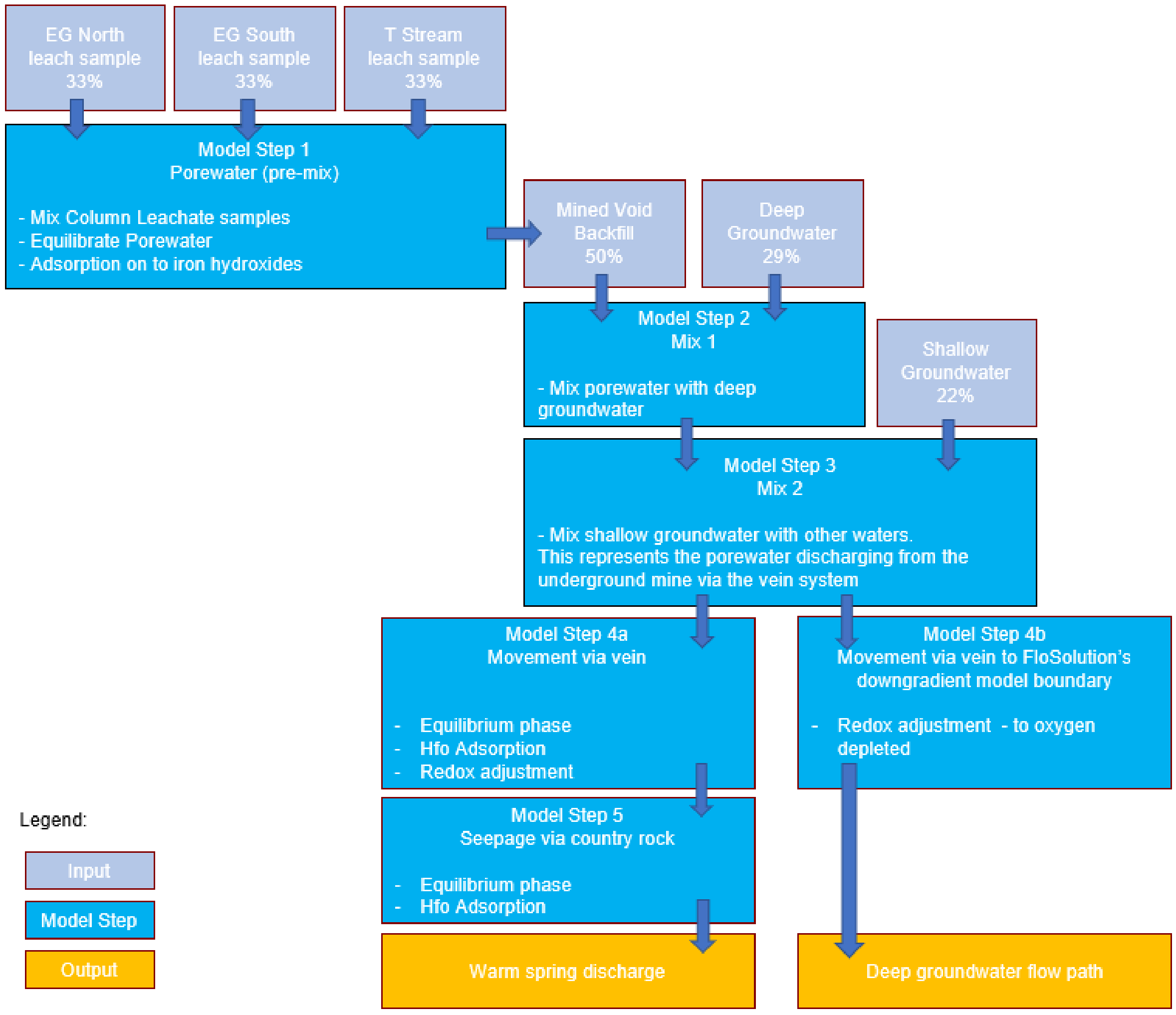
The deep groundwater flow path CGM was developed using the following assumptions:

- Post closure, the backfilled mine will flood with groundwater from the shallow and deep systems.
- Backfill placed within the mine will be comprised of rock stockpiled within the Willows farm, which is lime amended to maintain neutral pH, and rock used as stope backfill directly from the underground mine.
- Once flooded, groundwater from within the backfilled mine moves to the north within the vein system (deep groundwater).

Table 2 Modelling Steps – Deep groundwater flow path

Step	Conceptual Model Stepic	PHREEQC Model Step	Purpose
1.	Porewater in WUG backfill.	Mix column leachate samples	To determine porewater within flooded backfill
		Equilibrate Porewater	To allow for precipitation of oversaturated species and lime amendment of waste
		Adsorption on to iron hydroxides	Allow for trace element adsorption on to oxidation products within backfill
2.		Mix porewater with deep groundwater	Initial saturation of waste will be with deep groundwater
3.		Mix shallow groundwater with other waters	This represents the porewater discharging from the underground mine via the vein system
4b	Groundwater moves from the WUG mine domain along the vein.	Adjust redox in vein to oxygen depleted	Determine deep groundwater chemistry at the downgradient boundary of the FloSolution groundwater model

Figure 2 Conceptual Geochemical Model – WUG Closure



H2.4 Inverse Modelling

The warm spring chemistry data used for the inverse modelling are presented in **Table 3**.This solution was iteratively modelled using PHREEQC model to determine the degree of equilibrium present with respect to atmospheric oxygen and thereby the redox (pe) required to achieve the proportion of iron present in solution. The pe determined from multiple iterations was then used as the target pe for modelling step 5 (refer to **Table 1** for modelling steps).

Table 3 Warm Spring Data

Parameter (mg/L)	Minimum	Maximum	Mean	n
pH	6.5	7.2	6.78	16
Alkalinity	41	46	44.44	16
Bicarbonate	49	56	53.94	8
EC (mS/m)	15.6	16.7	16.15	16
Hardness	39	43	40.25	16
NO_3-N	0.002	0.1	0.008	8
NO_2-N	0.002	0.1	0.008	8
SO_4	13	19	15.38	16
Al - Dissolved	0.003	0.03	0.01	16
As - Dissolved	0.0184	0.03	0.025	8
B - Dissolved	0.01	0.013	0.011	8
Cd - Dissolved	0.00005	0.00005	0.00005	8
Ca - Dissolved	13.3	15	13.94	16
Cr - Dissolved	0.0005	0.0005	0.0005	16
Co - Dissolved	0.0002	0.0002	0.0002	16
Cu - Dissolved	0.0005	0.011	0.002	8
K - Dissolved	6.1	6.6	6.44	7
Hg - Acid Soluble	0.00008	0.00008	0.00008	15
Hg - Dissolved	0.00008	0.00008	0.00008	8
Fe - Dissolved	0.02	1.25	0.77	16
Li - Dissolved	0.033	0.038	0.03	16
Mg - Dissolved	1.27	1.44	1.34	7
Mn - Dissolved	0.17	0.184	0.18	16
Mo - Dissolved	0.0002	0.0002	0.0002	8
Na - Dissolved	11.2	12.6	11.82	16
Ni - Dissolved	0.0005	0.0005	0.0005	16
Pb - Dissolved	0.0001	0.00018	0.0001	8
Sb - Dissolved	0.0002	0.0006	0.0004	8
Sn - Dissolved	0.0005	0.0005	0.0005	16
V - Dissolved	0.001	0.001	0.001	7
Zn - Dissolved	0.001	0.0049	0.002	7

H2.5 Model Input Solutions

To enable modelling, the ion balance of all five input solutions were assessed by entering them in PHREEQC. In all cases, sodium and chloride concentrations were adjusted to balance solutions as these have the least influence on oversaturation of modelled species.

We note that the proportion of trace element leaching as a percentage of total concentration for parameters such as arsenic are unusually high (ranging from 3 to 29%). This suggests that arsenic is present as a discrete mineral rather than present as inclusions within other sulphide minerals. Further data on arsenic distribution within backfill should be considered to assess how representative these leaching columns are for the flooded mine backfill.

The samples used in column leaching are from the immediate vicinity of the vein systems and are therefore considered conservative with regard to trace element leaching expected from backfill, which will be generated from development works largely in the footwall host rock.

The water quality for the input solutions is presented in **Table 4**.

Table 4 Input solutions

	Pre-Mix			Mix 1	Mix 2
Parameter (mg/L)	EG North	EG South	T Stream	Deep Groundwater	Shallow Groundwater
pH	2.550	2.896	4.250	6.700	6.538
Alkalinity	1.096	1.583	2.441	19.600	68.735
Hardness - Total	-	-	-	-	73.338
EC (mS/m)	458.950	635.283	624.670	7.650	27.050
Chloride	-	-	-	9.000	11.071
SO_4	2216.500	5166.783	6427.652	4.150	50.367
Ag - Dissolved	0.00057	0.001091	0.001094	<0.0001	-
Al - Dissolved	125.309	197.776	194.446	0.023	0.183
As - Dissolved	18.613	30.593	18.956	0.00515	0.016
Ba - Dissolved	0.007	0.021	0.015	0.0255	-
Bo - Dissolved	-	-	-	<0.018	0.0383
Cd - Dissolved	64.036	263.966	262.524	<0.00005	0.000058
Ca - Dissolved	0.010	0.033	20.842	4.200	23.987
Co - Dissolved	0.521	1.681	1.313	0.0011	0.020
Cr - Dissolved	0.309	0.239	0.192	<0.0005	0.00095
Cu - Dissolved	2.274	3.543	6.837	0.00225	0.00465
K - Dissolved	22.859	82.216	28.478	1.505	6.579
Hg - Dissolved	0.000102	0.000115	0.000142	<0.00008	<0.00008
Fe - Dissolved	548.728	716.045	957.505	0.575	5.701
Mg - Dissolved	21.497	125.347	252.931	1.225	3.286
Mn - Dissolved	5.663	41.222	8.263	0.102	0.469
Mo - Dissolved	0.00827	0.00659	0.01888	0.01565	0.00301
Na - Dissolved	15.939	30.707	31.131	8.000	20.319
Ni - Dissolved	0.198	0.686	1.057	0.00505	0.012
Pb - Dissolved	0.000686	0.003514	0.003217	0.00039	0.00039
Sb - Dissolved	0.002724	0.004988	0.0033	0.0052	0.001
Se - Dissolved	0.014	0.026	0.014	<0.001	-
Sr - Dissolved	0.313	0.809	0.313	0.019	-
U - Dissolved	0.047	0.079	0.047	<0.00002	-
V - Dissolved	0.062	0.160	0.454	<0.001	0.00108
Zn - Dissolved	9.262	22.823	4.661	0.172	0.306

EG – East Graben

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H3 Results

H3.1 Equilibrium Phases

Equilibrium phases are used for the following conditions:

- In flooded backfill to assess the over saturation of oxidation products.
- In deep groundwater to assess the removal of sulphides. The pe from current modelling suggests conditions within the vein system will approach conditions that are sufficiently reducing to remove sulphides. More complete deep groundwater quality data is required to reliably assess redox conditions post closure.
- Equilibrating with atmospheric oxygen to match warm spring redox conditions.
- In spring discharge to allow for precipitation of species in surface water.

Solution chemistry at each step is reviewed to determine whether the predicted water is likely to reach geochemical equilibrium.

This is particularly relevant for iron species as multiple iron mineral phases will potentially be over-saturated to varying degrees, however some mineral phases will more rapidly reach equilibrium than others.

Similarly, where sulphide species are assessed, the groundwater modelling indicates travel times are sufficiently slow for these equilibrium conditions to be reached.

H3.2 Adsorption

Adsorption of trace elements onto iron hydroxides (HFo) is a significant control on trace element levels in modelled solutions. Sensitivity analysis has been completed for selected model runs around the amount of HFo sites made available for adsorption. In all cases where HFo is modelled, the sites are limited to the amount of the iron mineral phase oversaturated as defined in Section 0 with the ratio of strong to weak sites based on Dzombak and Morel.

H3.3 Model Output

H3.3.1 Warm Spring

The predicted warm spring water quality results generated based on PHREEQC modelling are presented in **Table 5**. The modelled water quality results compared to actual warm spring data are presented in **Table 6**.

Table 5 Modelled Warm Spring Water Quality Predictions

Parameter (mg/L)	Estimated Groundwater Quality in Deep Vein System	Country Rock Shallow Groundwater Quality at Warm Spring Discharge	Warm Spring Discharge
pH	7.25	6.84	7.34
pe	(2.89)	3.13	0.10
C	8.8	7.4	7.4
Al	0.001	0.001	0.001
As	<0.001	<0.001	<0.001
Ba	0.007	0.007	0.007
Ca	244	245	243
Cd	0.229	0.229	0.018
Cl	12	12	12
Co	0.129	0.129	0.033
Cr	<0.001	<0.001	<0.001
Cu	0.45	0.45	0.007
Fe	5.35	<0.01	<0.01
Hg	<0.0001	<0.0001	<0.0001
K	26	26	26
Mg	64	64	60
Mn	9.56	9.56	9.56
Mo	0.003	0.003	0.001
Na	282	282	282
Ni	0.009	0.009	0.001
Pb	<0.0009	<0.0009	<0.0009
S	1,442	1,442	1,418
Sb	0.002	0.002	0.002
Se	0.007	0.007	0.000
Sr	0.4	0.4	0.4
U	0.034	0.034	0.034
V	0.114	0.114	0.112
Zn	0.027	0.027	<0.001
Hardness (mg/L CaCO3)	876	876	857

Table 6 Modelled Water Quality Compared to Actual Warm Spring Data

Parameter (mg/L)	Mean	Range	Modelled Warm Spring Discharge
pH	6.78	6.5 – 7.2	7.34
Al	0.01	0.003 – 0.03	0.001
As	0.025	0.018 – 0.03	<0.001
Ca	13.94	13.3 – 15	243
Cd	0.00005	-	0.018
Co	0.0002	-	0.033
Cr	0.0005	-	<0.001
Cu	0.002	0.0005 – 0.011	0.007
Fe	0.77	0.02 – 1.25	<0.01
Hg	0.00008	-	<0.0001
K	6.44	6.1 – 6.6	26
Mg	1.34	1.27 – 1.44	60
Mn	0.18	0.17 – 0.18	9.56
Mo	0.0002	-	0.001
Ni	0.0005	-	0.001
Pb	0.0001	-	<0.0009
S	19	13 – 19	1,418
Sb	0.0004	0.0002 – 0.0006	0.002
V	0.001	-	0.112
Zn	0.002	0.001 – 0.0049	<0.001
Hardness (mg/L CaCO3)	40	39 – 43	857

H3.3.2 Deep Groundwater Flow Path

The predicted quality of the deep groundwater within the vein system at the downgradient boundary of FloSolution’s groundwater model generated based on PHREEQC modelling is presented in **Table 7**.

The results presented in **Table 7** represent water quality in the vein systems and are therefore comparable to the first column in **Table 5**. We would expect similar attenuation as for the warm spring would be expected for any scenario that could result in discharge to surface waters.

Table 7 Modelled Deep Groundwater Flow Path Quality Predictions

Parameter (mg/L)	Deep Groundwater Flow Path at Downgradient Boundary of FloSolution's Model
pH	7.13
pe	(2.60)
C	8.802
Al	0.001
As	<0.001
Ba	0.007
Ca	244
Cd	0.23
Cl	12
Co	0.129
Cr	<0.001
Cu	0.449
Fe	4.707
Hg	<0.0001
K	26
Mg	64
Mn	9.56
Mo	0.003
Na	282
Ni	0.009
Pb	<0.0009
S	1,441
Sb	0.002
Se	0.007
Sr	0.4
U	0.034
V	0.114
Zn	0.015
Hardness (mg/L CaCO3)	876

H4 Sensitivity Analysis

The sensitivity of PHREEQC model runs has been assessed for a number of input variables. In terms of the modelled geochemical process the degree of lime amendment and thereby iron precipitation in the porewater from mined backfill has the most influence on the mobilisation of trace elements of environmental concern.

While model results for trace elements are influenced by HFo adsorption there is an abundance of iron precipitate within the mined backfill. As such model results are not limited or thereby sensitive to this parameter.

To assess the sensitivity of the model predictions to iron precipitation the amount of oxygen available is varied as shown in **Table 8**.

The process of addition of limestone to maintain neutral pH of backfill in stockpiles will result in exposure atmospheric oxygen levels well in excess of the sensitivity scenario assessed in **Table 8**. The sensitivity analysis therefore demonstrates that provided neutral pH is maintained with lime amendment the storage of stockpiled waste will have sufficient oxygen exposure to ensure iron precipitation and thereby trace element removal.

Table 8 Sensitivity Scenarios for Iron Precipitation

pH	pe	pO2	Mole 02	Iron Concentration
7.2	-0.68	0.0032	-1.94	27.68
7.18	-0.68	0.0033	-1.34	10.693
7.12	-0.68	0.0034	-0.56	3.867
7.03	-0.68	0.0035	13.87	0
7.03	-0.68	0.004	14.36	0
7.03	-0.68	0.005	14.42	0

H5 Conclusions

The following conclusions are presented based on the outcome of the water quality modelling:

- Lime amendment is necessary to prevent high concentrations of trace elements developing in the backfilled mine post flooding.
- Based on the current model predictions and the conservative assumptions that they are based on trace elements are unlikely to be measurably different in the warm spring discharge.
- Elevated sulphate concentrations suggest an increased potential for precipitate deposition in the discharge/mixing zone of the warm spring. These effects would be localised in the oxidising surface water environment immediately downstream of the spring.

All of these findings are highly dependent on the assumptions made in the model setup outlined in Section F2. Recommendations outlined in Section F6 around monitoring should therefore be implemented to address these significant uncertainties.

H6 Recommendations

Several modelling inputs provided are not sufficient to support a robust geochemical model.

The following are recommended to improve the reliability of the current modelling predictions:

- The three columns' leachates results used for this geochemical model are not representative of mine backfill material. The columns are largely of orebody and hanging wall units, whereas the vast majority of backfill will be from within the footwall which are different lithologies. Further column tests should be completed with samples representative of the bulk backfill material and the model rerun. This will help confirm the arsenic leachate results. Once a lime amended leachate is available rerun model predictions with this input.
- Obtain a more comprehensive and reliable deep groundwater chemistry data set.
- Continue to monitor the warm spring to build a more detailed data set that fully assesses seasonal variability.

Obtain temperature measurements as close to possible to the spring discharge point as it is a good indicator of deep groundwater.