

Ok Birim Tailings Storage Facility Project

Environmental and Social Impact Assessment

Appendix A

Geochemical characterisation results





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Geochemical characterisation of TPP tailings

Ok Tedi Mine

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Geochemical characterisation of TPP tailings

OK TEDI MINE

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LIST OF ABBREVIATIONS

ABBREVIATIONS USED IN GEOCHEMICAL ASSESSMENT

ARD	Acid Rock Drainage
AMD	Acid, Metalliferous and Saline Drainage
NMD	Neutral and Metalliferous Drainage
ABA	Acid Base Account
pH_{1:2}	pH of a sample slurry with a solid to water ratio of 1:2 (by weight)
EC_{1:2}	Electrical Conductivity of a sample slurry with a solid to water ratio of 1:2 (by weight)
ESP	Exchangeable Sodium Percentage
ECEC	Effective Cation Exchange Capacity
S	Sulphur
CRS	Chromium Reducible Sulphur
KCl	Potassium Chloride
H₂SO₄	Sulphuric Acid
SO₄	Sulphate
CaCO₃	Calcium Carbonate
ANC	Acid Neutralising Capacity in kg H ₂ SO ₄ /t
ANC_{ABCC}	Acid Neutralising Capacity in kg H ₂ SO ₄ /t estimated from ABCC testing
CNV	Carbonate Neutralising Value in kg H ₂ SO ₄ /t
MPA	Maximum Potential Acidity, calculated from total S in kg H ₂ SO ₄ /t
NAPP	Net Acid Producing Potential, calculated from ANC and total S (or MPA) in kg H ₂ SO ₄ /t.
NAG	Net Acid Generation (test)
NAG_{pH}	pH of NAG solution before titration
NAG_(pH4.5)	NAG acidity titrated to pH 4.5 in kg H ₂ SO ₄ /t
NAG_(pH7.0)	NAG acidity titrated to pH 7.0 in kg H ₂ SO ₄ /t
ABCC	Acid Buffering Characteristic Curve
GAI	Geochemical Abundance Index based on multi-elements of solids
PAF	Potentially Acid Forming
PAF-LC	Potentially Acid Forming - Low Capacity
NAF	Non-Acid Forming
UC	Uncertain
AC	Acid Consuming

UNITS OF MEASUREMENTS

%	Percentage
°C	Degrees Celsius
dS	Deci Siemen
µm	Micrometre
mm	Millimetre
m	Metre
mg	Milligram
g	Gram
kg	Kilogram
t	Tonne
L	Litre
ml	Millilitre

OTHER ABBREVIATIONS

ALS	Australian Laboratory Services
EGi	Environmental Geochemistry International Pty Ltd
EAL	Environmental Analysis Laboratory
Project	Ok Birim Tailings Storage Facility Project
OTML	Ok Tedi Mining Limited
TPP	Tailings Pyrite Plant
TSF	Tailings Storage Facility
SOC	Sulphide Oxidation Consumption

EXECUTIVE SUMMARY

Ok Tedi Mining Limited (OTML) currently discharges process tailings from their Tailings Pyrite Plant (TPP) into the Ok Tedi. The lowland tailings storage facility (TSF) project aims to limit riverine discharge of tailings, with most tailings planned to be placed in a TSF located at the confluence of the Ok Birim and Ok Tedi, some 60 km downstream of the mine. The proposed TSF will feature a ring-dyke (paddock) impoundment design with two cells to store tailings. An on-site cyclone house will separate piped tailings into fines and coarse sands prior to TSF disposal, with coarse sands used for embankment construction, and fines deposited in the TSF cells.

Cyclone fractionation of tailings to produce a sand fraction for embankment construction and a fines fraction for disposal could potentially result in fractionation of sulphides and/or carbonates which could alter the AMD potential of the fractionated tailings.

To investigate the AMD properties of both bulk and fractionated tailings that will be deposited in the lowlands TSF, a test program was designed to produce materials representative of tailings for TSF disposal to life of mine (LOM) and detailed geochemical characterisation of these materials undertaken. This study included:

- Samples of TPP feed and tailings were collected over several weeks and screened for basic Acid-Base Accounting (ABA) parameters (Total S and Total C) to ascertain the range of ABA properties of TPP tailings available at the time of sampling.
- A sub-set these materials were characterised in more detail to confirm AMD characteristics.
- TPP tailings samples were selected and combined to generate a bulk tailings sample with properties likely representative of the TPP tailings expected to LOM (Total S = 0.72%, NAPP = -53 kg H₂SO₄/t).
- The bulk tailings sample was size fractionated using wet screening and the properties of the size fractions compared with cyclone overflow and underflow samples produced for geotechnical studies as a part of the broader TSF studies.
- The bulk and size fractionated tailings have been geochemically characterised to understand their AMD potential.
- The bulk and size fractionated tailings are undergoing kinetic leach column testing (using both free draining and saturated conditions) to simulate the range of conditions likely to be found in the TSF cells and embankments.

This report describes results of static tests to characterise the AMD potential of tailings materials to be deposited in the lowlands TSF cells and embankments. It also provides preliminary results from on-going kinetic testing.

Results from geochemical characterisation of size fractionated TPP tailings can be summarised as follows:

- The bulk TPP tailings sample, composited from selected daily composite tailings slurries collected during June 2025, provided a sample with a Total S content of 0.72% and a NAPP of -53 kg H₂SO₄/t, which was within the target range (Total S ≈ 0.7%, NAPP < -30 kg H₂SO₄/t) to represent potential future TPP tailings that will be deposited in the proposed TSF.
- Compared to the tailings used in cyclone trials (as a part of the broader TSF studies), the bulk tailings used for fractionation in this study contained a lower proportion of particles >200 µm. However, the particle size distribution of the cyclone overflow and the -75 µm fraction obtained by wet sieving were similar.
- Sulphide S (pyrite) was preferentially deported to smaller size fractions with 66% and 56% of the sulphide S mass deporting to the -75 µm and -38 µm fractions respectively. As a consequence of preferential deportment of sulphur to the smaller size fractions, Total S in the -75 µm fraction was enriched to 1.03% from 0.72% in the bulk sample and depleted in the +75 µm fraction to 0.38%.
- Similar Total S deportment was found with cyclone fractionation, with most S (typically 75 – 85%) reporting to the overflow.
- Preferential deportment of inorganic C (shown to be mostly calcite) to smaller particles was less pronounced than for sulphide S (52% and 37% to -75 µm and -38 µm fractions respectively). However, calcite followed pyrite to a

sufficient degree during size fractionation such that all fractions remained strongly NAF (as determined by negative NAPP and neutral NAGpH).

Results from kinetic testing of size fractionated TPP tailings can be summarised as follows:

- Tailings oxidation rates are moderate (10^{-7} kg O₂/m³/s) for the tested -75 µm and bulk tailings and about an order of magnitude higher than the +75 µm tailings under free draining column test conditions.
- Tailings oxidation rates are reduced by one to two orders of magnitude (10^{-8} and 10^{-9} kg O₂/m³/s for -75 µm and bulk tailings respectively) when saturated, suggesting on average TSF tailings oxidation rates are likely to be relatively low.
- Leachate pH for all samples under both free draining and saturated conditions remained neutral through the first 4 months of testing, consistent with the NAF AMD classification of these materials.
- Leachate chemistry for all samples under both free draining and saturated conditions are dominated by Ca and SO₄, consistent with on-going sulphide oxidation and concomitant calcite dissolution and acid neutralisation, albeit at a much reduced rate in saturated columns.
- Metal(loid)s concentrations in leachates for all samples under both free draining and saturated conditions are very low, except for Mn which is likely associated with calcite. Metal(loid) concentrations in free draining column leachates albeit low, are generally higher than in saturated column leachates consistent with higher sulphide oxidation rates under free draining conditions.
- Leachate Cu concentrations are similar for saturated and free draining columns in contrast to apparent dissimilar sulphide oxidation rates. This suggests that copper is not readily mobilised from these tailings, even under the oxidising conditions of the free draining columns.

In an accompanying study, a geochemical water quality model was developed to model and predict potential effects on water quality in the Ok Tedi and Fly River system because of future tailings deposition in the lowland TSF rather than into the Ok Tedi. An important source term for this model is TSF beach run-off and decant water which will discharge to the Ok Tedi. At the time of undertaking the water quality modelling project, data were not available for the required water quality parameters for tailings run-off/seepage, and so source terms were developed using results from previous kinetic leach column testing involving riverine sediments and various tailings samples.

Comparison of results from the initial stages of leach column testing using size fractionated TPP tailings and TSF beach run-off water quality assumed for the water quality model shows:

- Many of the source terms for TSF run-off used in water quality modelling appear to be in the range of measured values for the initial stages of column testing (IOR, Al, Cd, Fe, Zn), while some were lower than measured values (saturation, pH, alkalinity, Mn) and others higher (Ca (saturated columns only), SO₄ (saturated and free draining +75 µm fraction) and Cu).
- Sulphide Oxidation Consumption (SOC) measurements confirm that the modelled oxidation rate for tailings is towards the upper end of measured oxidation rates from column testing.
- In general, the derived water quality parameters used for water quality modelling are in the range of those measured during kinetic (saturated and free draining) leach column testing, confirming the TSF beach run-off source term used in the model provides a suitable facsimile of what can be expected from bulk and cyclone overflow tailings on an exposed TSF beach.

Kinetic testing of TPP tailings is on-going and the results from these tests will be provided in an updated report in the future. In addition to kinetic testing, selective extractions using the various tailings size fractions, together with aqueous portioning experiments using various river water samples are being conducted to provide data to model metal partitioning between tailings and river water.

BACKGROUND AND APPROACH

This report describes the results of the geochemical characterisation study required to support an ESIA being prepared for the proposed Ok Birim Tailings Storage Facility Project (the project) in the Western Province of Papua New Guinea (PNG).

Ok Tedi Mining Limited (OTML) currently discharges process tailings from their Tailings Pyrite Plant (TPP) directly into the Ok Kumiup near the mine which subsequently flows into the Ok Tedi and downstream to Bige, where sediment is dredged and placed in engineered stockpiles on the riverbanks. This project aims to limit direct riverine discharge of tailings, with most tailings planned to be placed in a tailings storage facility (TSF) located at the confluence of the Ok Birim and Ok Tedi, some 60 km downstream of the mine.

The proposed TSF will feature a ring-dyke (paddock) impoundment design with two cells to store tailings. An on-site cyclone house will separate piped tailings into fines and coarse sands prior to TSF disposal, with coarse sands used for embankment construction, and fines deposited in the TSF cells. The current design also includes drainage of tailings decant water from the TSF with transfer of supernatant to the Ok Tedi via siphon pipelines.

These changes to the practice of tailings disposal will not only have an impact on sediment loads in the river but may also impact the acid and metalliferous drainage (AMD) properties (including neutral and saline drainage) of riverine sediments. Any changes to the AMD characteristics of the riverine sediments, including variations in tailings AMD properties arising from a change from sub-aqueous (river) to sub-aerial (TSF) disposal, could potentially have flow-on effects to surface and groundwater quality.

Furthermore, cyclone fractionation of tailings to produce a sand fraction for embankment construction and a fines fraction for disposal could potentially result in fractionation of sulphides and/or carbonates which could alter the AMD potential of the fractionated tailings. If sulphides preferentially report to the cyclone overflow, this could result in finer particles (higher surface area, higher reactivity) reporting to the TSF beaches. Alternatively, if sulphides were to preferentially report to the cyclone underflow, this may result in embankment sand which, with likely low water retention (lower saturation) and high oxygen ingress, has the potential for increased sulphide oxidation rates.

To investigate the AMD properties of both bulk and fractionated tailings that will be deposited in the lowlands TSF, EGI designed a program to produce materials which would be representative of tailings for TSF disposal to life of mine and undertook detailed geochemical characterisation of these materials. As a first step, samples of TPP feed and tailings were collected over several weeks and screened for basic Acid-Base Accounting (ABA) parameters (Total S and Total C) to ascertain the range of ABA properties of TPP tailings at the time of sampling. Some of these materials were characterised in more detail to confirm AMD characteristics. In a second stage, TPP tailings samples were collected as slurries and combined to generate a bulk tailings sample with properties likely representative of the TPP tailings to LOM. The bulk tailings sample was size fractionated using wet screening and the properties of the size fractions compared with cyclone overflow and underflow samples produced for geotechnical studies as a part of the broader TSF studies. The bulk and size fractionated tailings have been geochemically characterised using both static and kinetic methods.

In an accompanying study¹, a geochemical water quality model was developed to model and predict potential effects on water quality in the Ok Tedi and Fly River system with future tailings deposition in the lowland TSF rather than into the Ok Tedi. An important source term for this model is TSF beach run-off and decant water that will discharge to the Ok Tedi. At the time of undertaking the water quality modelling project, data were not available for the required water quality parameters for tailings run-off/seepage, and so source terms were developed using results from previous kinetic leach column testing involving riverine sediments and various tailings samples. The current leach column test program is designed to validate the source terms for TSF run-off used in the model.

¹ EGI 2026, Ok Birim Tailings Storage Facility: Hydrogeochemical Assessment and Implications for River Water Quality, Doc. No. J000926/R1788 – Final Rev1, 27 May 2026



Part 1 of this report describes results of static tests to characterise the AMD potential of tailings materials to be deposited in the lowlands TSF. Part 2 reports preliminary results from on-going kinetic testing. Longer-term kinetic test results will follow in an updated report at the end of 2026.

PART 1 – STATIC GEOCHEMICAL TESTING

1. METHODOLOGY

1.1. Sample collection

1.1.1. Composite samples for characterisation of TPP feed and tailings

Based on the LOM2050 mine plan, it is anticipated TPP tailings should have a Total S content below 1% and on average below 0.7% into the future, i.e. a Total S content of around 0.7% will likely represent a typically upper limit. Consequently, it was decided to use (if possible) TPP tailings with a Total S content around 0.7% for the current test program.

To determine if TPP tailings being produced by the processing plant at the time of sampling could provide samples with the desired Total S content, and to understand variations in both feed (Cu flotation plant tailings) and TPP tailings, a sampling campaign was undertaken over several weeks in June 2025. This campaign built on standard plant procedures where daily composite tailings samples are collected, a split of the tailings slurry dried and analysed to provide data for metals accounting, including Total S content. However, in a variation to the standard protocol, the plant was requested to keep the remaining slurry samples so that, if screening assay results (Total S and Total C) suggest that the sample met the required criteria (Total S $\approx$ 0.7%), or could be composited to meet the required criteria, this sample could be retained for the test program. In addition to screening assays (Total S and Total C), a subset of samples were selected to undergo more detailed geochemical testing. These tests were conducted to confirm the preliminary AMD classification (NAF or PAF) indicated from Total S and Total C analyses.

Daily composite samples of Feed and Tailings were collected from Unit 1 and Unit 2 of the TPP over the period of 7 June 2025 to 23 June 2025 (Table 1. 1). On three of these days (18, 20, and 21 June 2025), two composite samples were taken. These samples were processed and analysed for Total S and Total C at the OTML Environment Laboratory. These results are shown in Table A 1. (and further considered in Section 2.1).

Fifteen samples (5 TPP feed and 10 TPP tailings) were selected for detailed geochemical characterisation by EGi (Table 1. 1). The dried samples were shipped to Steritech in Brisbane for gamma irradiation treatment, before release from biosecurity control and shipment to ALS Laboratory in Brisbane and EGi Laboratory in Sydney for geochemical testing.

Table 1. 1: Schedule of composite sample collection from Unit 1 and Unit 2 of the TPP. The green fill represents the selected samples for detailed geochemical characterisation.

Date	Time	Unit 1		Unit 2	
		Feed	Tails	Feed	Tails
7 June 2025	-	✓	✓	✓	✓
8 June 2025	-	✓	✓	✓	✓
9 June 2025	-	✓	✓	✓	✓
10 June 2025	-	✓	✓	✓	✓
11 June 2025	-	✓	✓	✓	✓
13 June 2025	-	✓	✓	✓	✓
14 June 2025	-	✓	✓	✓	✓
15 June 2025	-	✓	✓	✓	✓
16 June 2025	-	✓	✓	✓	✓
17 June 2025	-	✓	✓		✓
18 June 2025	06:00	✓	✓	✓	✓
	18:00	✓	✓	✓	✓
19 June 2025	-	✓	✓	✓	✓
20 June 2025	06:00	✓	✓	✓	✓
	18:00	✓	✓	✓	✓
21 June 2025	06:00	✓	✓	✓	✓
	17:00	✓	✓	✓	✓
23 June 2025	-			✓	✓

1.1.2. TPP tailings slurries

Eighteen of the composite TPP tailings slurries from Unit 1 and Unit 2 sampled between 7 June 2025 and 29 June 2025 were selected for compositing to produce a tailings sample for size fractionation and kinetic leach column testing. These slurry samples were analysed for Total S, Total C, and metals (Table A 1) at the OTML Environment Laboratory and then shipped to Steritech in Brisbane for gamma irradiation treatment, before release from biosecurity control and shipment to Indicum Laboratory in Brisbane for size fractionation.

1.2. Fractionation of slurries

The eighteen slurry samples were provided to Indicum Laboratory in Brisbane in 25 x 1 L containers, which were subsequently combined to form a single sample. Tailings were size fractionated according to the procedure illustrated diagrammatically in Figure 1. 1.. Samples were taken from the various size fractions for either characterisation or for kinetic leach column testing. Samples for characterisation, except particle sizing, were dried in a low temperature oven (40°C) under a nitrogen atmosphere to eliminate sulphide oxidation. Size fractionated samples (dried and slurries) were sent to EGi for testing (including routine analyses at ALS Geochemistry in Brisbane). Wet and dry



weights were recorded for mass balance calculations and calculation of moisture contents and solids densities. Samples for particle sizing were shipped as slurries.

The final size fractions resulting from processing were:

- Bulk tailings
- +75 μm fraction
- -75 μm fraction
- +38 -75 μm fraction
- -38 μm fraction

Fractions used for kinetic column testing included Bulk, +75 μm fraction, and -75 μm fraction.

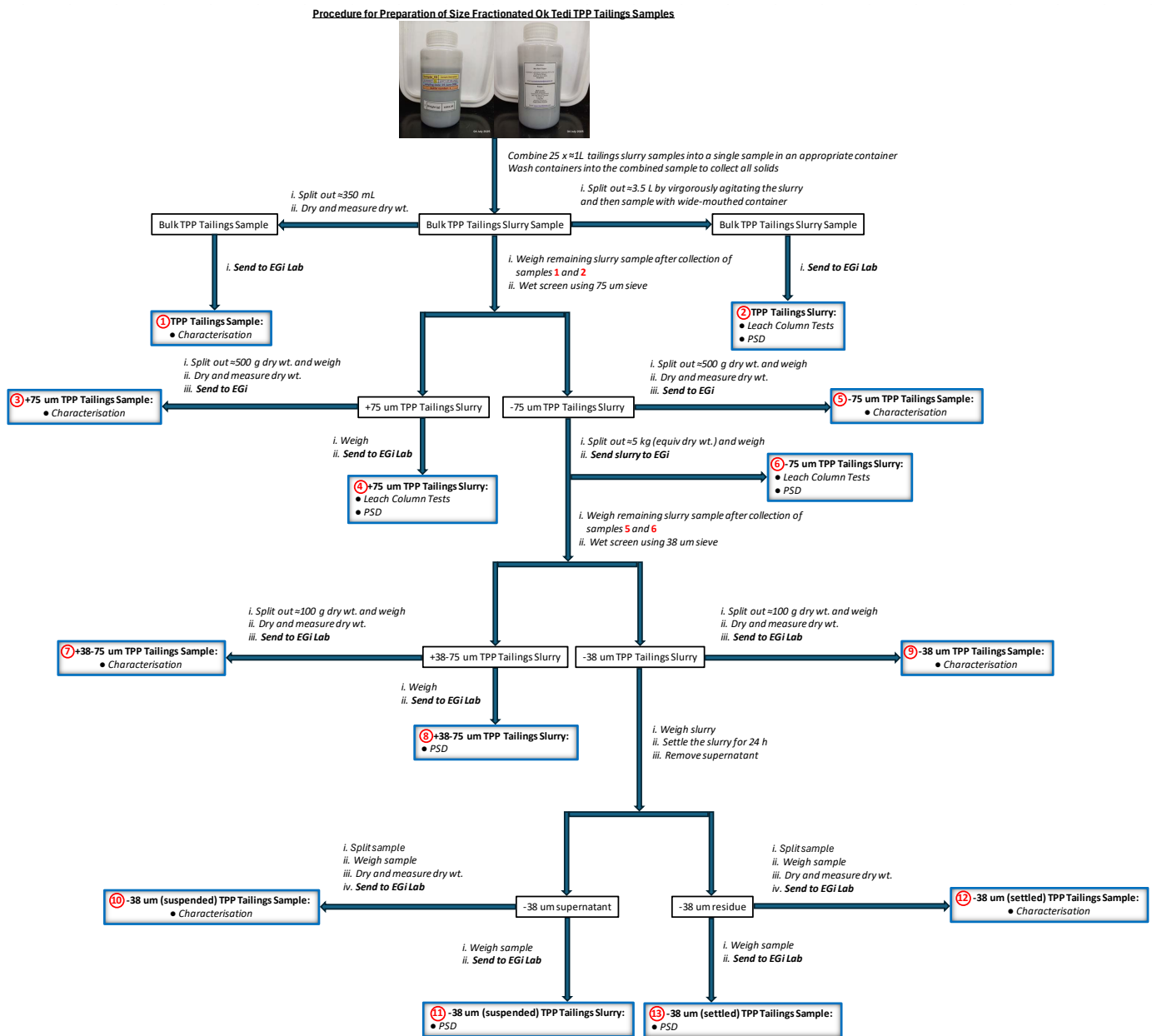


Figure 1. 1: Procedure for preparation of size fractionated Ok Tedi TPP tailings samples.

1.3. Geochemical characterisation of collected samples

1.3.1. Selected composite feed and tailings samples

The selected (5 feed and 10 tailings) samples were analysed at the ALS laboratory for routine analyses and at the EGi laboratory for specialised analyses (Table 1. 2).

1.3.2. Slurries

The results for Total S, Total C, and metals contents of the 18 collected slurries are shown in Table A 3. Slurries were composited to create a bulk tailings slurry which was subsampled to create fractionated samples by wet sieving (undertaken at Indicum Laboratory). Representative samples of the bulk and fractionated samples (+75 μm , -75 μm , +38 -75 μm , and -38 μm) were analysed at the ALS laboratory for routine analyses and at the EGi laboratory for specialised analyses (Table 1. 2).

Table 1. 2: Measured and calculated parameters used for geochemical characterisation.

Analysis	Description	Purpose of test	Lab	Selected composite samples	Representative Slurries	Cyclone samples
Total S	Total sulphur by Leco furnace	To estimate Maximum Potential Acidity (MPA).	ALS	15	5	11
Sulphate	Sulphate sulphur by HCl digest, ICP-AES finish	To provide a measure of sulphur present as sulphate, including acidic sulphate	ALS	15	5	-
Total C	Total carbon by furnace	To provide a measure of all carbon in the sample	ALS	15	5	-
Organic C	Total carbon of acidified sample	To provide a measure of non-carbonate carbon	ALS	15	5	-
CRS	Chromium reducible sulphur	Measure of sulphides	ALS / EAL	15	5	-
ANC	Acid neutralising capacity – Modified Sobek titration	To provide an indication of solid phase neutralising capacity (i.e. ANC provided by both carbonate and some silicate minerals).	EGi	15	5	-
Single addition NAG	pH and acidity of NAG solution produced by oxidation of sample by peroxide	To provide a more definitive Acid-Rock Drainage (ARD) classification.	EGi	-	5	-

Sequential NAG	Repeated NAG test on solid residue until complete oxidation	To provide a more definitive ARD classification for samples that have reported a single addition NAG pH greater than 4.5 but contain greater than 0.5% total sulphur.	EGi	15	-	-
ABCC	Acid Buffering Characteristic Curve – pH evolution during acid titration of sample.	Provides a measure of Effective ANC. Buffering mineralogy indicated by comparison to curve shapes of reference minerals.	EGi	-	5	-
Multielement analyses	Elemental content determined by 4-acid digest and ICP-OES and ICP-MS finish.	Provides an indication of elemental enrichment and potential for environmental concern.	ALS	-	5	-
QXRD	Semi-quantitative X-ray diffraction.	Estimate mineral content.	McKnight Mineralogy	-	5	-
Particle size distribution	Particle size distributions determined by laser diffraction ¹ .	Quantify particle size distributions	Microanalysis	-	5	-
MPA	Maximum Potential Acidity	Provide acid generation potential of a sample based on sulphide oxidation: MPA (kg H ₂ SO ₄ /t) = Total S x 30.6	Calculated value	15	5	-
NAPP	Net Acid Producing Potential	Provide the balance between acid generation and neutralisation potential of a sample: NAPP (kg H ₂ SO ₄ /t) = MPA - ANC	Calculated value	15	5	-

1. Laser diffraction particle size analysis was undertaken using a Malvern Mastersizer 3000. The slurry was dispersed by addition of sodium hexametaphosphate solution followed by a short period of sonication prior to analysis to ensure agglomerated particles were dispersed to produce primary particles only.

2. RESULTS

2.1. Daily composite TPP feed and tailings samples analysed at OTML Environment Laboratory

Median Total S of the TPP feed samples collected between 7 and 23 June 2025 was 2.47%, which was reduced to 0.67% in the tailings (Figure 1. 2). 75% of tailings contained Total S of <1.05%. Total C content was unchanged by TPP processing with median values of 1.12%. Full test results are shown in Table A 1.

When ANC_{TC}^2 was calculated from Total C, most feed samples had $NAPP > 0$ and almost all had $ANC_{TC}/MPA < 2$, indicating significant potential for acidification (Figure 1. 3). In contrast, all tailings had $NAPP < 0$ (average -77 kg H_2SO_4/t) and almost all tailings samples had $ANC_{TC}/MPA > 2$, indicating minimal risk of acidification, due to sulphide removal in the TPP.

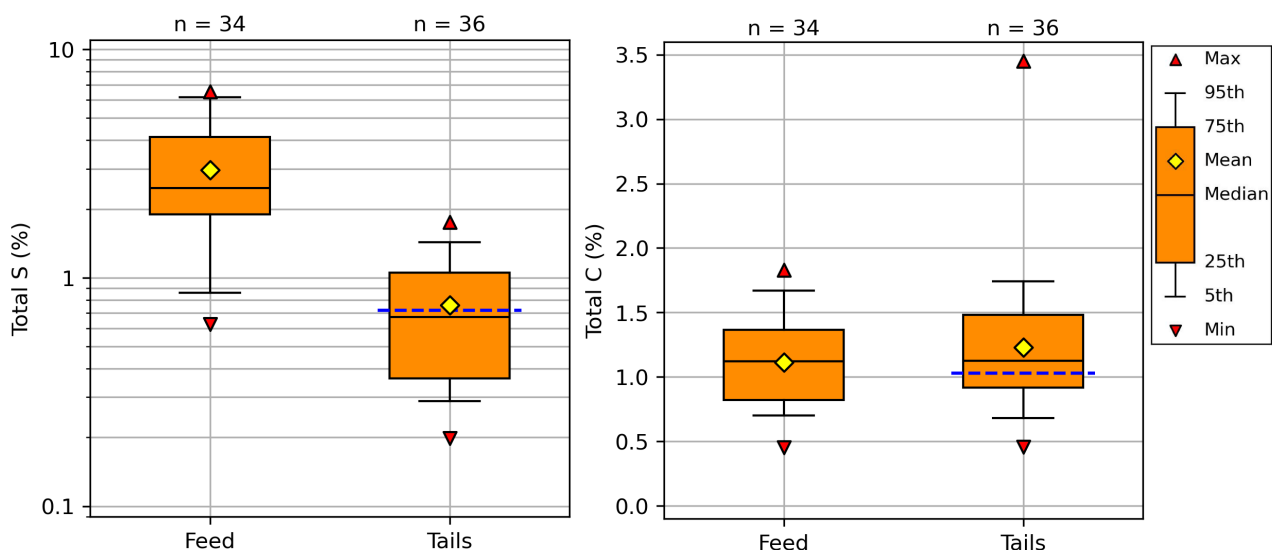


Figure 1. 2: Total S and Total C of composite TPP feed and tailings samples collected between 7 June 2025 and 23 June 2025. The Blue dashed lines represent the Total S and Total C concentrations of the composited bulk tailings sample used for fractionation and column studies.

² ANC_{TC} (kg H_2SO_4/t) = Total C (%) x 81.7

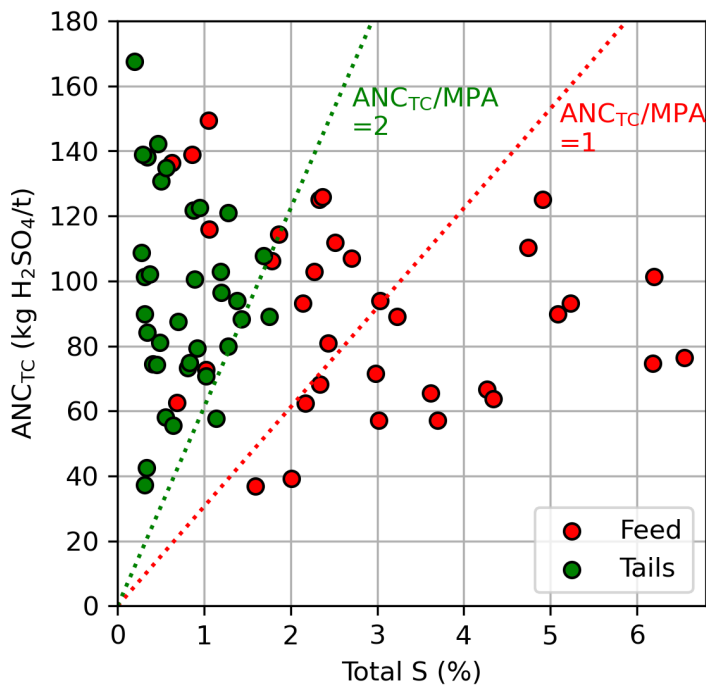


Figure 1. 3: ANC_{TC} vs Total S of TPP feed and tailings samples collected between 7 June 2025 and 23 June 2025. ANC_{TC} was calculated from Total C. $ANC_{TC}/MPA = 1$ represents NAPP of 0 kg H_2SO_4/t . Samples with $ANC_{TC}/MPA > 2$ are considered to have minimal potential of acidification.

2.2. Geochemical testing of selected TPP feed and tailings samples

Five feed samples and ten tailings samples were selected for detailed geochemical characterisation (Table 1. 1 and Table 1. 2). The acid forming characteristics of these samples have been tabulated in Table 1. 3.

Table 1. 3: Acid forming characteristics of selected TPP feed and tails samples

EGi Code	Sample Description	Total S	SO ₄ - S	Sulphide S ¹	CRS	Total C	Org C	MPA	MPA* ²	ANC	NAPP	NAPP* ³	ANC/MPA*	NAGpH ⁴	ARD Class
			%					kg H ₂ SO ₄ /t							
28168	TPP Feed 10/06/2025_Unit 2	6.53	0.08	6.45	6.36	0.91	0.03	200	197	60	140	137	0.3	2.3	PAF
28167	TPP Feed 11/06/2025_Unit 2	2.45	0.06	2.39	2.30	0.90	0.03	75	73	62	13	11	0.8	2.8	PAF
28164	TPP Feed 13/06/2025_Unit 1	4.47	0.09	4.38	4.17	0.82	0.03	137	134	59	78	75	0.4	2.5	PAF
28165	TPP Feed 21/06/2025 06:00_Unit 2	0.67	0.03	0.64	0.62	1.64	0.03	21	20	128	-107	-108	6.5	7.5	NAF
28166	TPP Feed 21/06/2025 17:00_Unit 2	1.88	0.05	1.83	1.87	1.39	0.04	58	56	70	-12	-14	1.3	7.6	NAF
28170	TPP Tails 07/06/2025_Unit 1	1.01	0.05	0.96	1.01	1.53	0.04	31	29	91	-60	-62	3.1	7.6	NAF
28173	TPP Tails 09/06/2025_Unit 1	2.19	0.09	2.10	2.26	1.04	0.04	67	64	79	-12	-15	1.2	8.0	NAF
28171	TPP Tails 10/06/2025_Unit 1	1.10	0.06	1.04	1.06	0.93	0.02	34	32	61	-27	-29	1.9	7.8	NAF
28178	TPP Tails 10/06/2025_Unit 2	0.97	0.05	0.92	0.85	0.88	0.03	30	28	57	-27	-29	2.0	7.8	NAF
28169	TPP Tails 14/06/2025_Unit 1	0.73	0.04	0.69	0.72	0.70	0.02	22	21	53	-31	-32	2.5	7.3	NAF
28175	TPP Tails 18/06/2025 06:00_Unit 2	0.37	0.04	0.33	0.34	0.45	0.02	11	10	38	-27	-28	3.8	7.8	NAF
28172	TPP Tails 20/06/2025 06:00_Unit 1	0.69	0.04	0.65	0.53	1.53	0.04	21	20	106	-85	-86	5.3	8.0	NAF
28177	TPP Tails 20/06/2025 18:00_Unit 2	0.35	0.03	0.32	0.30	0.88	0.03	11	10	66	-55	-56	6.7	8.7	NAF
28176	TPP Tails 21/06/2025 17:00_Unit 2	0.38	0.03	0.35	0.38	1.22	0.02	12	11	71	-59	-60	6.6	8.4	NAF
28174	TPP Tails 23/06/2025_Unit 2	0.23	0.02	0.21	0.14	1.96	0.03	7	6	119	-112	-113	18.5	8.4	NAF

¹Sulphide S = Total S - SO₄-S

²MPA* = Sulphide S x 30.6

³NAPP* = MPA* - ANC

⁴Lowest NAGpH during Sequential NAG test

2.2.1. Sulphur

Median Total S values for the selected feed and tailings samples (Figure 1. 4) were very similar to those measured for all the collected samples (Figure 1. 2), although the variability was lower. Total S was shown to be a good measure of sulphide S content in these samples by comparison with sulphide S estimated from either Total S minus sulphate S or CRS (Figure 1. 5). The maximum potential acidity of TPP feed and tailings samples has been subsequently calculated as MPA* using sulphide S as Total S minus sulphate S.

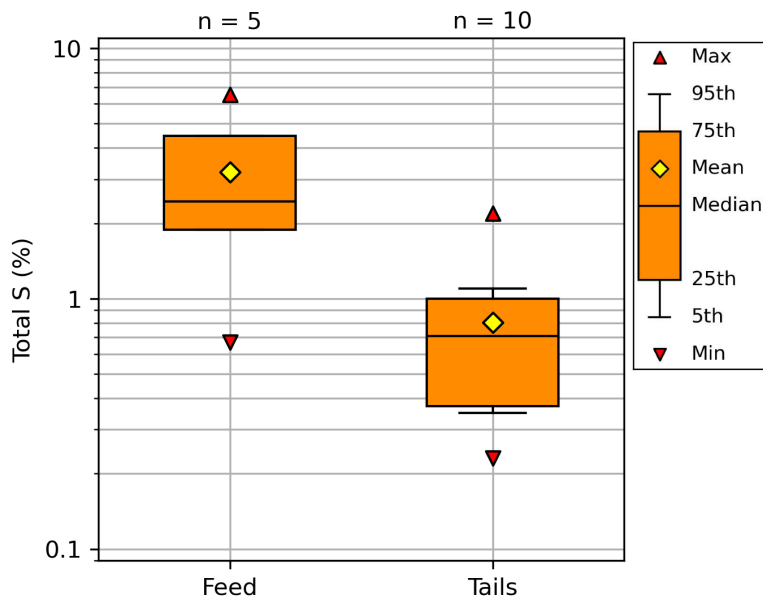


Figure 1. 4: Total S of selected TPP feed and tailings samples.

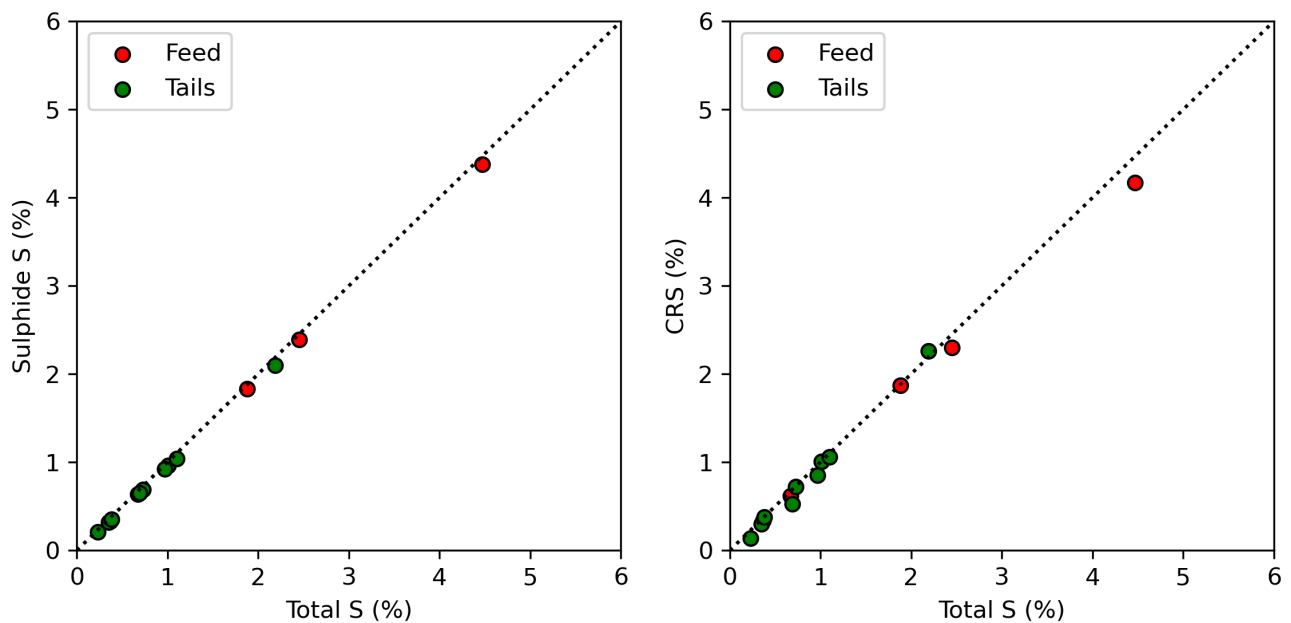


Figure 1. 5: Sulphide S vs Total S and CRS vs Total S for selected feed and tailings samples.

2.2.2. ANC

Average ANC was similar for feed and tailings samples (Figure 1. 6), although the median value was slightly higher in the tailings, suggesting that some minerals contributing to ANC in the TPP feed preferentially report to the tailings during flotation. Tailings ANC varied between 40 and 120 kg H₂SO₄/t. CNV (calculated from inorganic C) was equal to or greater than ANC (Figure 1. 7) indicating the presence of non-neutralising carbonates such as siderite (FeCO₃) and suggesting ANC_{TC} or CNV may overestimate neutralising capacity of TPP tailings. It is also worth noting that ABCC testing of bulk and size fractionated tailings samples (Section 2.4.2) indicated that modified Sobek ANC may overestimate effective ANC by 30 to 40% (Table 1. 5).

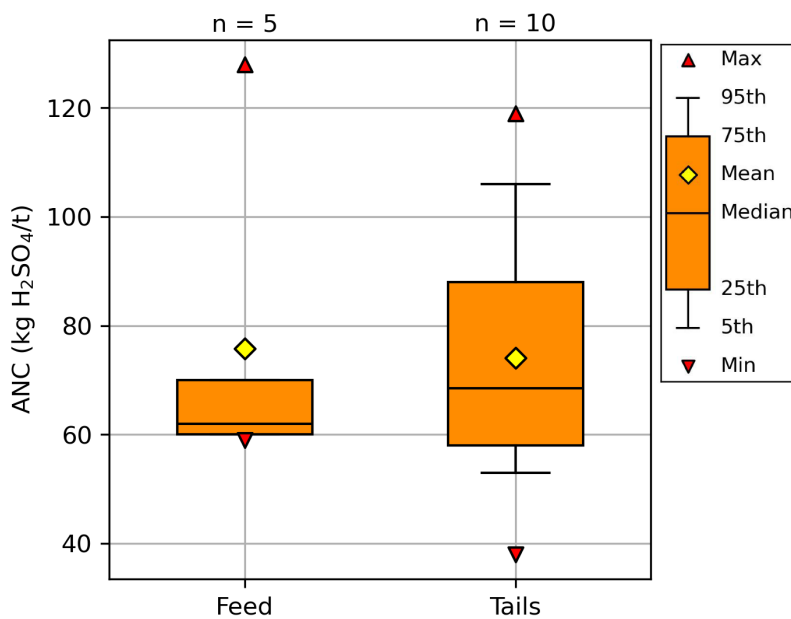


Figure 1. 6: ANC of selected TPP feed and tailings samples.

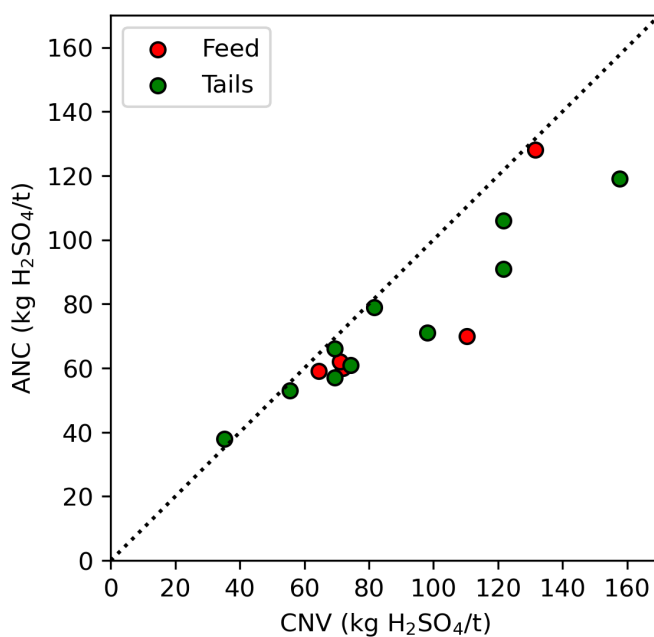


Figure 1. 7: ANC vs CNV for selected feed and tailings samples

2.2.3. NAPP

NAPP* was calculated as MPA* minus ANC, where MPA* was calculated using sulphide S (Total minus sulphate S). MPA* is only slightly lower than MPA since sulphate contents are very low (Table 1. 3). Sulphide removal in the TPP reduced median NAPP* from 11 kg H₂SO₄/t in the feed to -44 kg H₂SO₄/t in the tailings (Figure 1. 8). Importantly, all except one tailings sample gave a NAPP value of equal to or less than -30 kg H₂SO₄/t, the maximum average quarterly NAPP target for tailings riverine discharge. Similarly, all except one tailings sample had ANC/MPA ratio of 2 or greater (Figure 1. 9), indicating minimal potential for acidification.

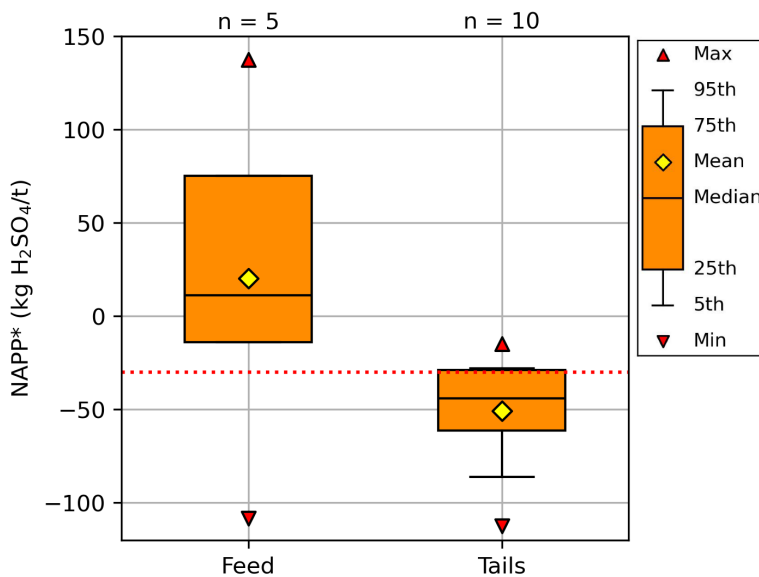


Figure 1. 8: NAPP* (calculated using MPA*) of selected TPP feed and tailings samples. Red dashed line shows NAPP = -30 kg H₂SO₄/t, the target maximum NAPP of tailings.

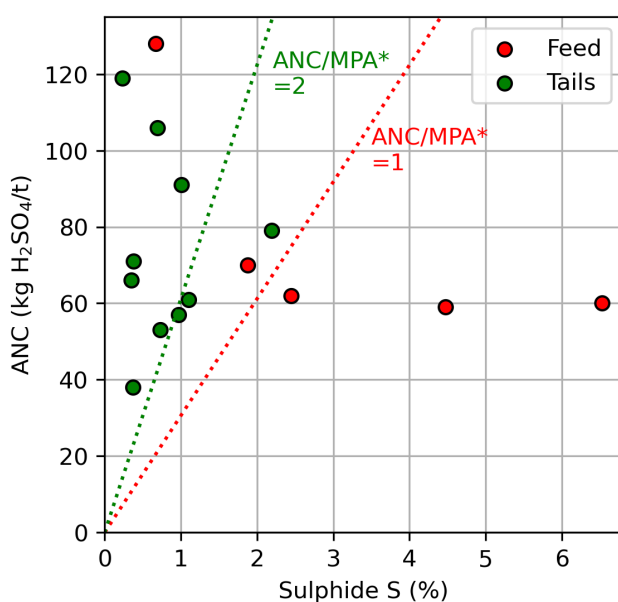


Figure 1. 9: ANC vs Total S of selected feed and tailings samples. ANC was calculated from Total C. ANC/MPA = 1 represents NAPP of 0 kg H₂SO₄/t. Samples with ANC/MPA > 2 are considered of minimal potential of acidification.

2.2.4. NAG – single stage and sequential

Single stage NAGpH values for feed and tailings samples were all >pH 7 (Table A 2). However, sequential NAG testing showed that three of the feed samples acidified after up to 4 stages of testing, as already indicated by the positive NAPP values (Table 1. 3). Acidity generated during sequential NAG testing confirmed the acidity potential indicated by NAPP. None of the tailings samples acidified with up to 4 stages of peroxide treatment (Table A 2), confirming excess neutralising capacity as indicated by calculated NAPP values.

2.2.5. ARD classification

ARD classification using NAGpH and NAPP* confirmed that all tailings were NAF (Non-Acid Forming) and three feed samples were PAF (Potentially Acid Forming), conforming with NAPP* values (Figure 1. 10).

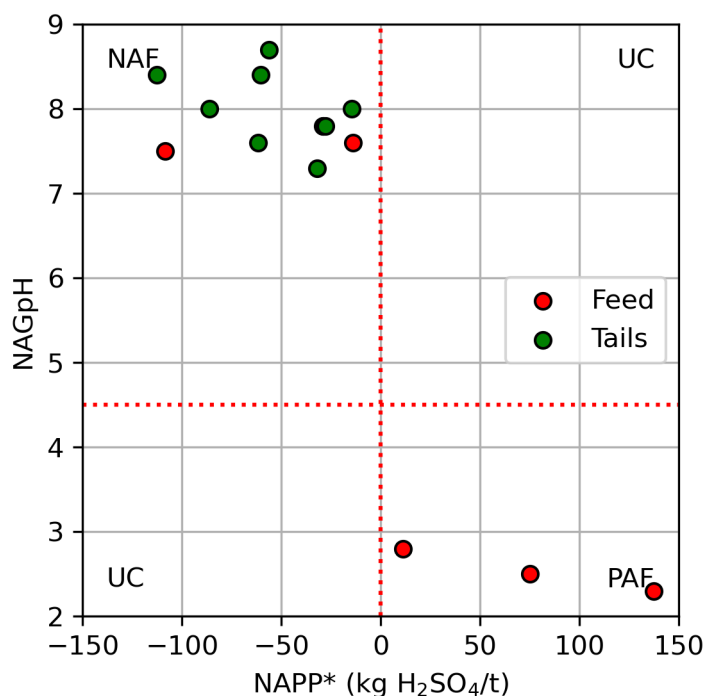


Figure 1. 10: ARD classification of selected feed and tailings samples using NAGpH and NAPP* (calculated using MPA* based on sulphide content).

2.3. Comparison of analyses from OTML Environment Laboratory and ALS

The selected samples sent to ALS for Total S and Total C analyses (Table 1. 3) were tested prior to selection in the OTML Environment laboratory (Figure A 1). Comparison of these analyses for the selected samples are shown in Figure 1. 11 and Figure 1. 12. These samples showed good agreement between the two sets of analyses, with only one tailings sample showing substantial deviance. This indicates a lack of variation effects due to mixing and subsampling techniques, and analytical procedures.

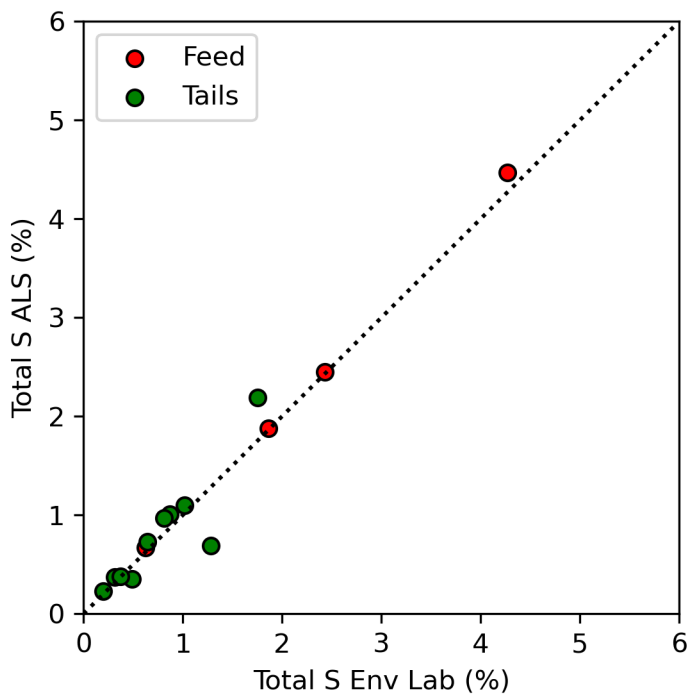


Figure 1. 11: Comparison of Total S for selected feed and tailings samples analysed in the ALS and OTML Environment laboratories.

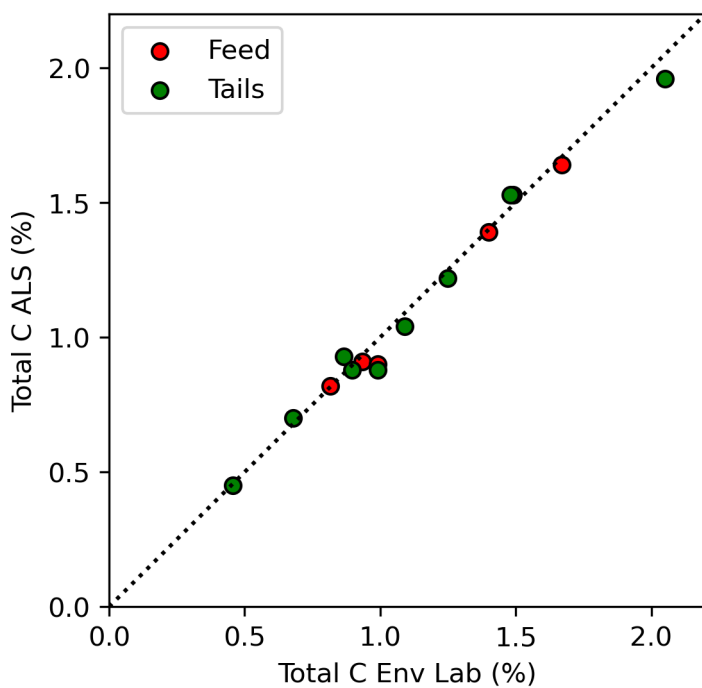


Figure 1. 12: Comparison of Total C for selected feed and tailings samples analysed in the ALS and OTML Environment laboratories.

2.4. Size fractionation of tailings

2.4.1. Size distributions

The bulk tailings slurry sample was fractionated by wet sieving. Initial sieving was at 75 μm followed by sieving of the - 75 μm fraction at 38 μm . This process produced four fractions plus the original bulk tailings sample:

- Bulk tailings
- +75 μm fraction
- -75 μm fraction
- +38 -75 μm fraction
- -38 μm fraction

Particle size analysis by laser diffraction showed that the +75 μm fraction comprised 28% of particles by volume that were <75 μm , while the -75 μm fraction comprised 4% of particles by volume that were >75 μm (Figure 1. 13). The P80 values of the two fractions were 191 μm and 42 μm respectively (Table 1. 4).

The +38 -75 μm fraction comprised 32% of particles <38 μm and 12% of particles >75 μm , while the -38 μm fraction comprised 3% of particles >38 μm (Figure 1. 14). The P80 values of the two fractions were 66 μm and 21 μm respectively (Table 1. 4).

Based on particle size distributions of the fractions resulting from wet sieving, the fractionation process appears to have produced reasonable separation of the particles into the desired size fractions. These fractions were compared to those produced by cyclonic separation in Section 2.4.6.

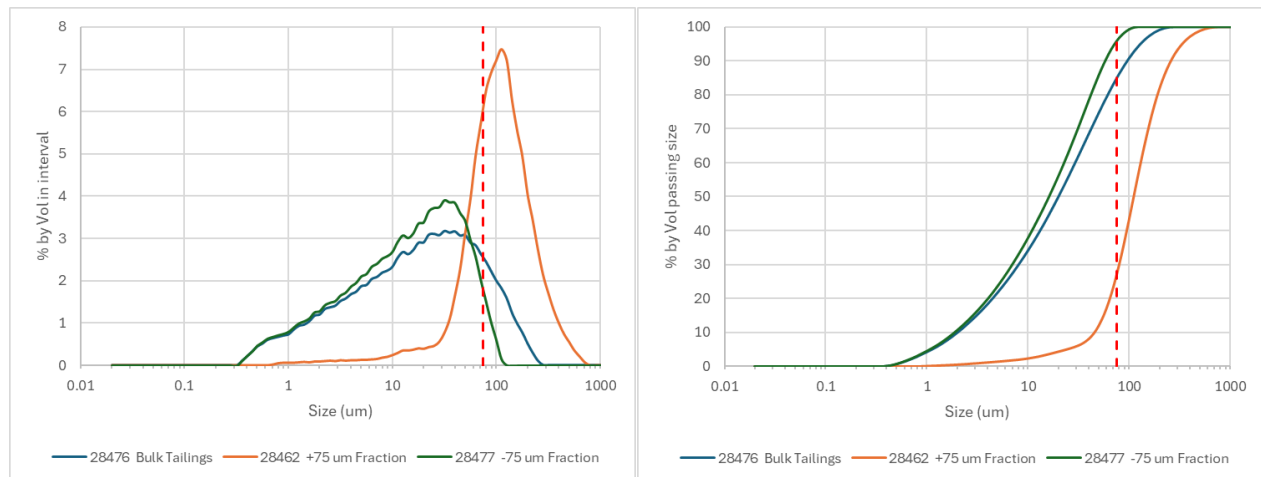


Figure 1. 13: Frequency and Cumulative size distributions determined by laser diffraction of Bulk tailings and +75 μm and -75 μm fractions produced by wet sieving. The red vertical dashed line shows 75 μm .

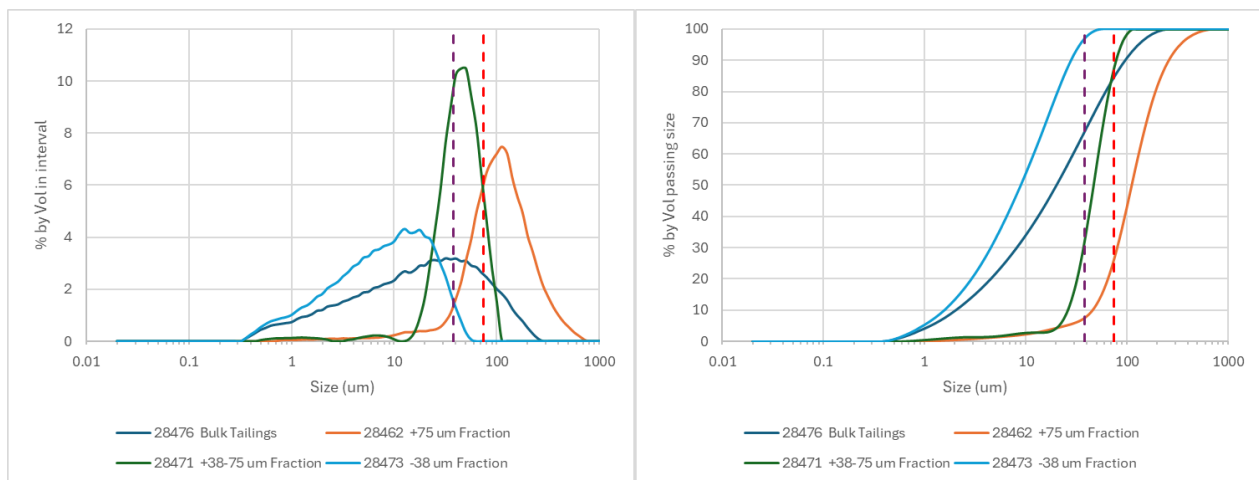


Figure 1. 14: Frequency and Cumulative size distributions determined by laser diffraction of Bulk tailings and +75 µm, 38 to 75 µm, and -38 µm fractions produced by wet sieving. The vertical dashed lines show 38 and 75 µm.

Table 1. 4: Particle size cut-offs from the cumulative distribution curves for tailings fractions.

Size Fraction	Particle size cutoffs (percentiles)			
	D_{10} (µm)	D_{50} (µm)	D_{80} (µm)	D_{90} (µm)
Bulk Tailings	2	20	62	98
+75 µm	46	111	191	260
-75 µm	2	16	42	58
+38 -75 µm	26	47	66	78
-38 µm	2	9	21	28

2.4.2. AMD characteristics of tailings fractions

The AMD characteristics of the tailings fractions resulting from wet sieving are shown in Table 1. 5. The -38 µm fraction contained the highest concentrations of sulphide and had the highest NAPP* value. However, there were only small differences in NAPP* between the fractions since ANC tended to deport with sulphide.

ABCC testing indicated that effective ANC was less than Modified Sobek ANC and was very similar between the fractions. However, even if the lower effective ANC as measured by ABCC is used to calculate the NAPP for each of the size fractions, all samples are NAPP negative and, combined with high NAGpH, all size fractions of the TPP tailings can be classified as NAF.

Table 1. 5: Acid forming characteristics of tailings fractions obtained by wet sieving of the bulk tailings.

EGi Code	Sample Description	Total S	SO ₄ - S	Sulphide S	CRS	Total C	Org C	MPA	MPA* ¹	ANC	ABCC	NAPP	NAPP* ²	ANC/MPA*	NAGpH	ARD Class
		%						kg H ₂ SO ₄ /t								
28476	Bulk tailings	0.72	0.06	0.66	0.68	1.03	0.02	22	20	75	53	-53	-55	3.7	8.2	NAF
28461	>75 um tailings	0.38	0.02	0.36	0.42	0.83	0.04	12	11	69	54	-57	-58	6.3	8.4	NAF
28477	<75 um tailings	1.03	0.09	0.94	1.17	1.18	0.03	32	29	76	53	-44	-47	2.6	8.3	NAF
28470	>38 um & <75um tailings	0.68	0.02	0.66	0.75	1.03	0.02	21	20	67	52	-46	-47	3.3	8.2	NAF
28472	<38 um tailings	1.30	0.08	1.22	1.23	1.29	0.05	40	37	79	56	-39	-42	2.1	8.1	NAF

¹MPA* = Sulphide S x 30.6

²NAPP* = MPA* - ANC

2.4.3. Mineral content of tailings fractions

Mineralogy of the tailings fractions resulting from wet sieving was determined using QXRD. The mineral contents are shown below in Table 1. 6. The department of the various minerals to the fractions are shown Figure 1. 15. The key points to note relating to mineral department to the various size fractions are:

- Pyrite deported to the smaller particle size fraction, with greater content in the -75 μm compared to the +75 μm fraction and in the -38 μm fraction compared to the +38 -75 μm fraction.
- Pyrrhotite was also detected by XRD, but the amounts are too low to provide accurate size-by-size content.
- In the -75 μm fraction, calcite deported preferentially to the -38 μm fraction compared to the +38 -75 μm fraction.
- Siderite was also detected by XRD and, like calcite, appears to have higher content in the smaller size fractions. In all size fractions, siderite content is substantially less than calcite content, but its presence supports the findings that effective ANC measured by ABCC testing is less than CNV across all size fractions.

Table 1. 6: Mineral content of tailings fractions by wet sieving measured by QXRD.

Phase	28476 Bulk	28461 >75 μm	28477 <75 μm	28470 38 to 75 μm	28472 <38 μm
Quartz	10.4	12.4	9.5	12.2	8.5
Orthoclase	19.3	24.5	19.2	21.9	20.5
Albite-Ca	40.8	39.1	39.5	46.3	40.1
Phlogopite-2M	5.8	2.8	6.3	3.3	5.8
Magnetite	4.8	3.3	4.6	5.6	5.0
Calcite	6.8	5.2	6.3	2.7	5.5
Garnet	3.9	4.9	2.9	3.3	3.3
Muscovite	0.2	0.4	0.9	0.1	0.3
Pyrite	1.8	1.3	1.9	1.3	2.0
Siderite	2.0	1.3	2.4	1.5	2.2
Diopside-Fe	0.7	2.8	2.1	0.7	1.4
Kaolinite	0.7	0.4	1.2	0.1	1.1
Chalcopyrite	0.3	0.1	0	0	0.1
Ilvaite	0.8	0.7	0.9	0.7	1.3
Pyrrhotite	0.2	0.3	0.2	0.1	0.1
Ferro-actinolite	0.6	0.2	0.5	0.1	0.4
Fluorapatite	0.4	0.1	0.4	0.1	1.6
Montmorillonite	0.1	0	0.3	0	0.3
Talc-1A	0.1	0	0.3	0	0.2
Hematite	0.3	0	0.6	0	0.3
Chalcocite	0	0.2	0	0	0
Sum of Input	100	100	100	100	100

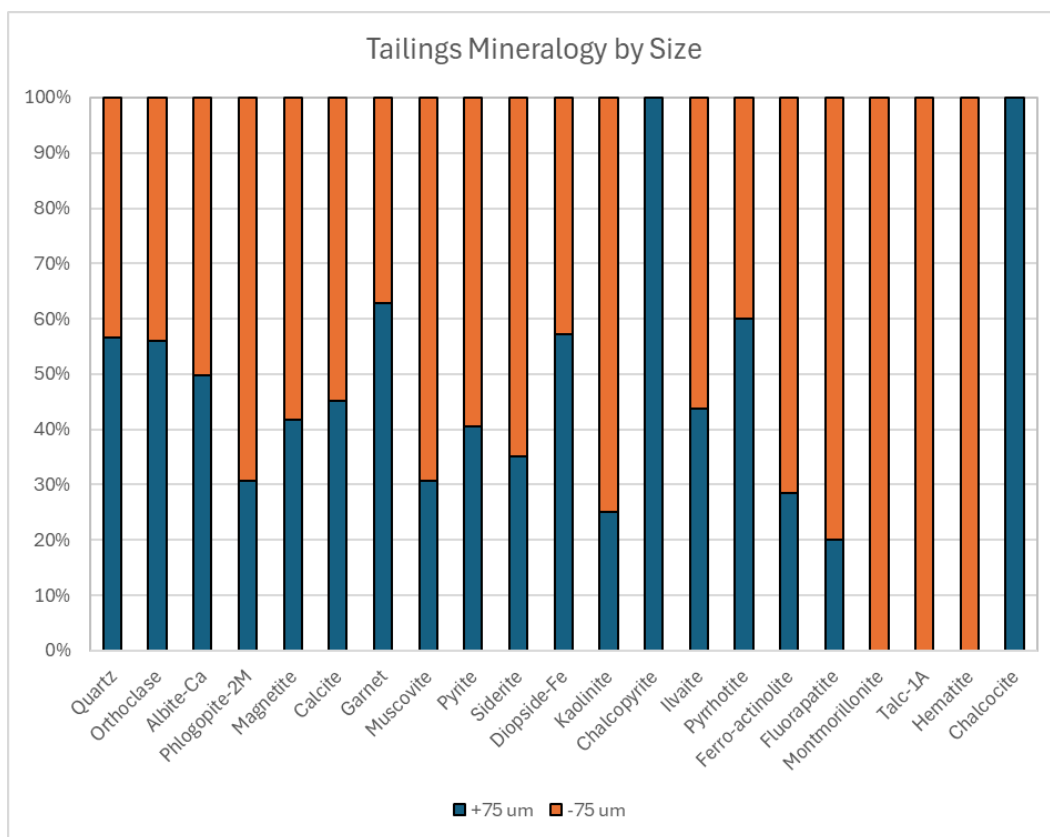
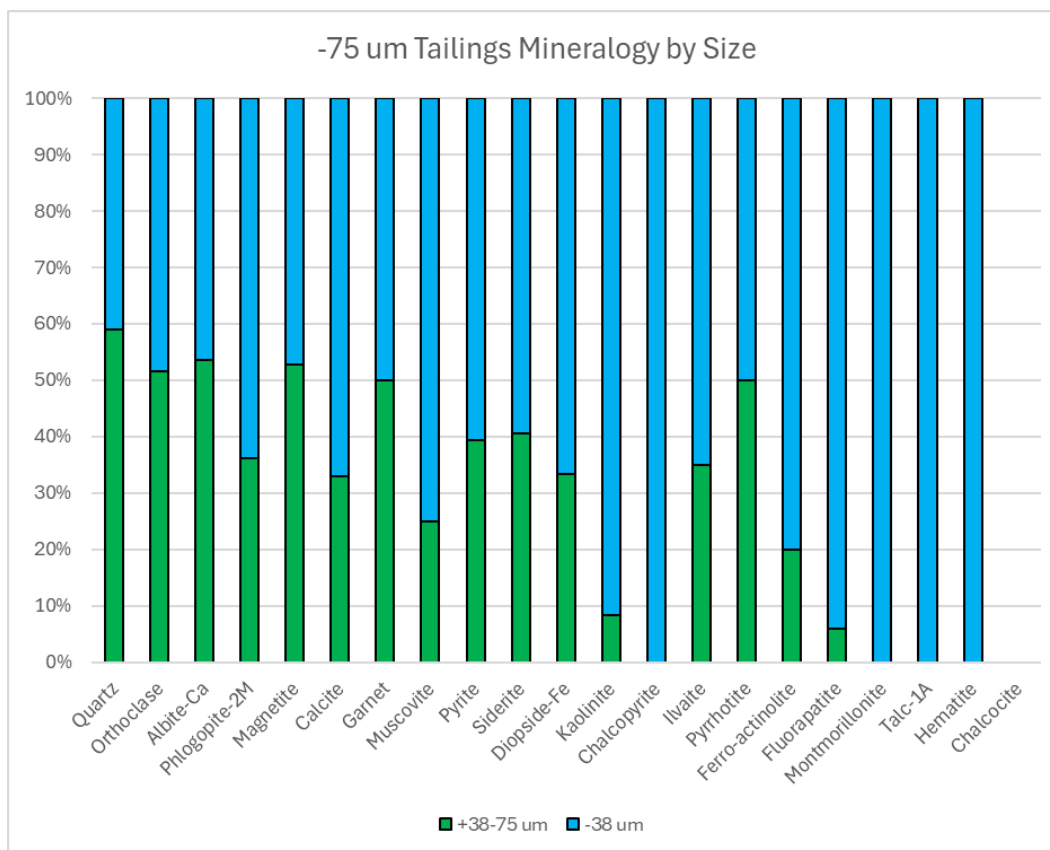


Figure 1. 15: Fractionation effects on mineralogy of tailings fractions.

2.4.4. Department of sulphur and carbon

Department of the total mass of sulphur and carbon was calculated using the size fraction masses and mineral element contents (sulphides for S and carbonates for C) determined from S and C assays. The elemental concentrations of each fraction following either one stage (+75 μm and -75 μm) or two stage (+75 μm , +38 -75 μm , and -38 μm) fractionation are compared to the bulk sample concentrations in Figure 1. 16. The amounts of sulphide S and inorganic C in each size fraction expressed as fractions of the total mass in the bulk sample are shown in Table 1. 7.

Sulphides have preferentially deported to smaller particle sizes. The -75 μm fraction and the -38 μm fraction contain 66% and 56% of the bulk tailings sulphide S respectively. Since most of the Total S is sulphide S (Table 1. 5) and most of the sulphide S is pyrite (Table 1. 6), pyrite in these tailings appears to be mainly found as smaller particles.

Similarly, inorganic C content is slightly higher in the finer fractions (52% reporting to -75 μm of which 37% is < 38 μm), albeit not to such an extent as sulphide S. Effective ANC has been shown to be due mainly to calcite content (Table 1. 6) and so effective ANC is likely to be higher in the finer size fractions of these tailings, although this is not quite borne out by the ABCC results (Table 1. 5). Nevertheless, the fact that calcite tends to follow pyrite to a certain extent within the size fractions means that all size fractions remain NAF despite increased pyrite content in the smaller size fractions.

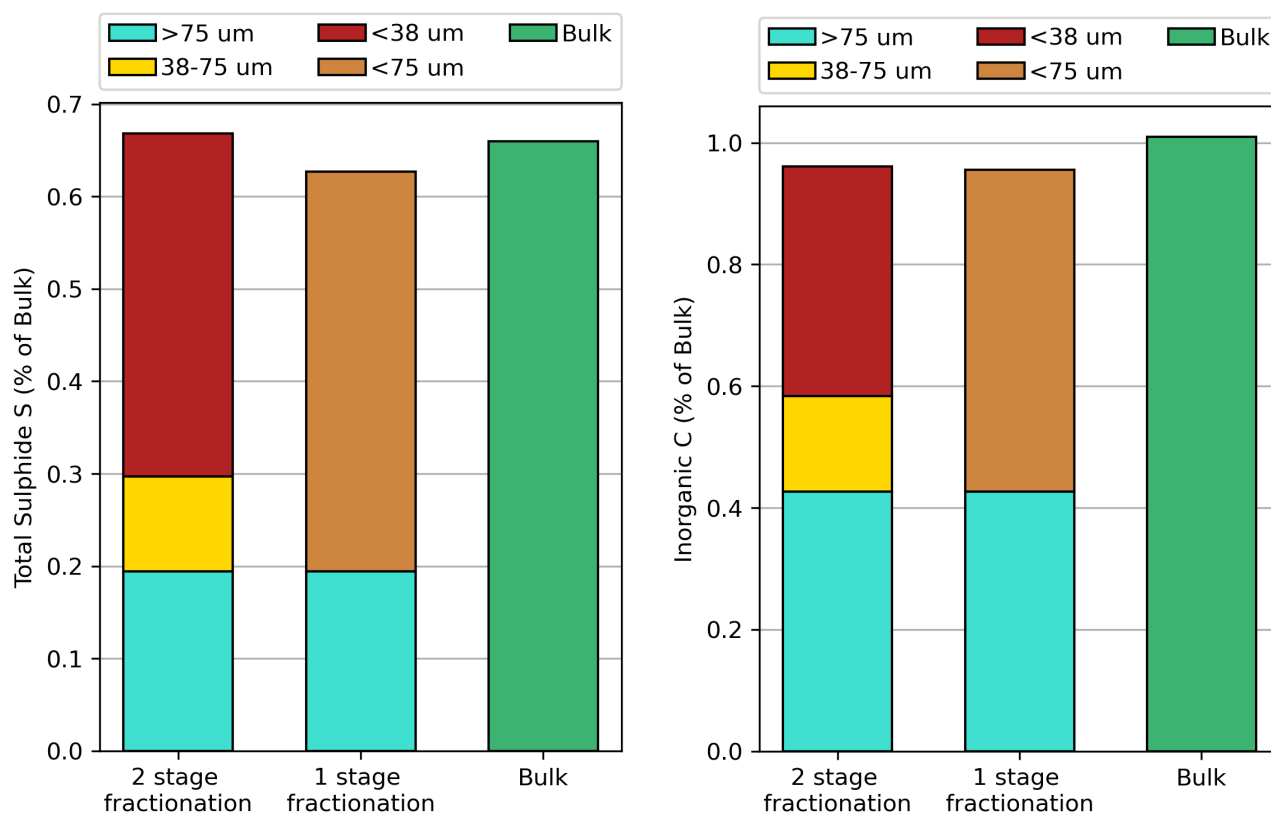


Figure 1. 16: Department of sulphur and carbon to tailings fractions resulting from wet-sieving calculated using either elemental assay results or mineral contents by QXRD.

Table 1. 7: Deportment of sulphide S and inorganic C as fractions of the mass contained in the bulk sample.

Fraction of Bulk Sulphide S or Inorganic C	Bulk	>75 μm	<75 μm	38-75 μm	<38 μm
Sulphide S	1	0.29	0.66	0.16	0.56
Inorganic C	1	0.42	0.52	0.16	0.37

2.4.5. Deportment of metals

Fractionation of some metals (As, Co, Ni, and Zn) was similar to that of sulphide S with 61 to 65% of metal mass deporting to the -75 μm fraction and 49 to 52% deporting to the -38 μm fraction (Table 1. 8). This suggests that these metals are likely associated with pyrite, and should pyrite undergo oxidative dissolution, these metals will be solubilised, and subsequent mobilisation will be determined by solubility control at circum-neutral to slightly alkaline pH and/or metal sorption by precipitated iron (oxy)hydroxides.

Cu does not follow S deportment, with close to a 50:50 split between the +75 and -75 μm fractions. This is reflected in mineralogical assay (XRD) with equal amounts of chalcopyrite reporting to the -75 μm and +75 μm fractions. Note the amounts of chalcopyrite in these samples is low ($\approx 0.1 - 0.2\%$) meaning XRD results are not to be considered quantitative. Results do, however, suggest Cu in tailings is likely associated with chalcopyrite.

Mn deportment to the various size fractions is almost identical to the deportment of carbonate C, suggesting that Mn is closely associated with carbonates, most likely as manganous calcite/siderite.

Mass balance for most metals between the size fractions and the bulk sample was mostly $\sim 100\%$, supporting the validity of the calculated deportment values.

Elemental contents of bulk tailings and fractions are provided in Table A 4.

Table 1. 8: Deportment of metals to tailings fractions resulting from wet sieving. Recovery was calculated by comparing the summed elemental masses in the fractions to the bulk elemental mass.

	28476	28461	28477	28470	28472	Recovery 75 µm	Recovery 38 µm
	Bulk tailings	>75 µm Fraction	<75 µm Fraction	38 to 75 µm Fraction	<38 µm Fraction		
As (mg/kg)	6.9	4.9	10.7	6.9	13.1	110%	112%
Co (mg/kg)	11	7.1	15.6	12.2	17.2	100%	100%
Cu (mg/kg)	512	491	607	184	832	106%	107%
Mn (mg/kg)	1425	1185	1680	1485	1800	99%	100%
Ni (mg/kg)	6.6	5.4	9.8	6.1	12.4	112%	116%
Sr (mg/kg)	653	759	593	647	560	105%	104%
Zn (mg/kg)	92	63	128	78	160	101%	103%
Mass fraction As (%)	1	0.35	0.65	0.14	0.52	-	-
Mass fraction Co (%)	1	0.35	0.65	0.17	0.48	-	-
Mass fraction Cu (%)	1	0.49	0.51	0.05	0.46	-	-
Mass fraction Mn (%)	1	0.45	0.55	0.16	0.39	-	-
Mass fraction Ni (%)	1	0.39	0.61	0.12	0.49	-	-
Mass fraction Sr (%)	1	0.60	0.40	0.15	0.25	-	-
Mass fraction Zn (%)	1	0.37	0.63	0.13	0.51	-	-

2.4.6. Comparison of KCB cyclone trial fractions and wet sieved fractions

The proposed lowlands TSF will use cyclone technology to produce a sand fraction from the TPP bulk tailings for embankment construction, with the overflow to be deposited in the TSF. The purpose of creating +75 μm and -75 μm fractions by wet sieving for geochemical testing was to represent the cyclone underflow and overflow tailings fractions, respectively. Subsequent to EGi producing and testing size fractionated tailings produced by wet sieving, KCB undertook cyclone trials on TPP tailings to assess and characterise separation into underflow (to be used to form TSF embankments) and overflow fractions (to be deposited in the TSF).

It was felt expedient to compare the size fractionated tailings used for geochemical testing with the cyclone underflow and overflow materials to ensure that the size fractions used for geochemical analysis were representative of cyclone tailings generated during cyclone trials and potentially those that will be generated during operation of the TSF. Consequently, EGi received samples of underflow and overflow slurries generated from several cyclone trials. Results from PSD analysis using laser diffraction for the various samples were also provided by KCB. EGi conducted Total S analysis on each of the cyclone trial fractions for comparison with the results from Total S analysis of the size fractionated tailings used for geochemical testing.

Comparison of the size distributions (also generated using laser diffraction) of the Bulk Tailings (EGi Code 28476, P80 = 63 μm) used in wet-sieving and the Raw Feed (EGi Code 28741) to the cyclone (Figure 1. 17) showed that the Raw Feed included a population of larger particles, 200 to 500 μm (P80 = 220 to 250 μm). Consequently, the cyclone underflow comprised larger particles compared to the +75 μm fraction (Figure 1. 18). However, it is important to note that size distributions of the cyclone overflow and the -75 μm fraction were mostly very similar, providing confidence that the two fractions are directly comparable.

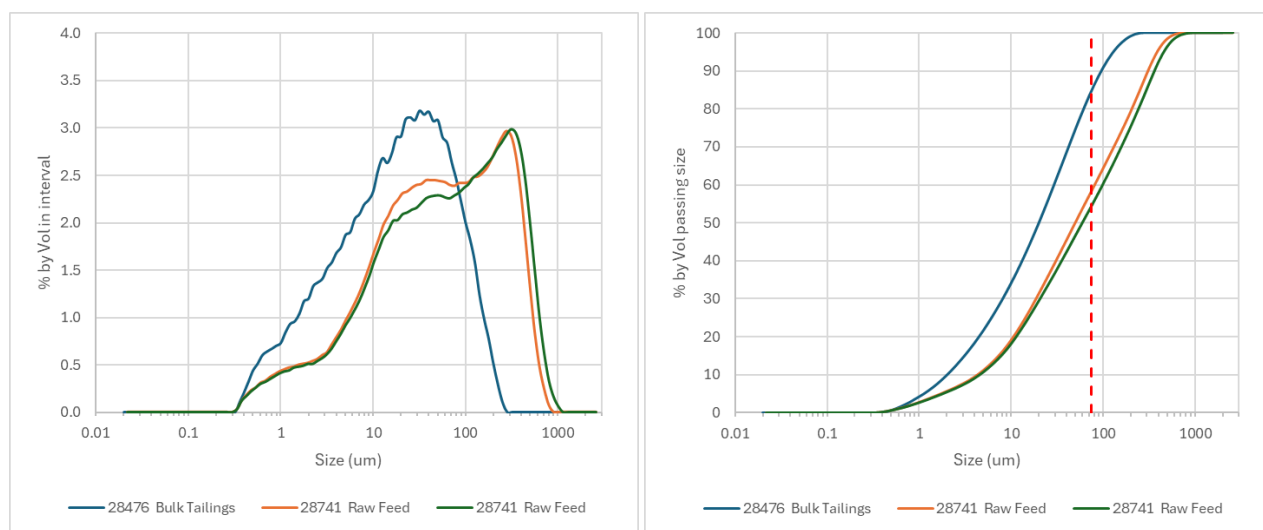


Figure 1. 17: Frequency and Cumulative size distributions determined using laser diffraction of Bulk Tailings used for fractionation by wet sieving and the Raw Feed sample (duplicate analyses) used as feed for cyclone trials. The vertical dashed line shows 75 μm .

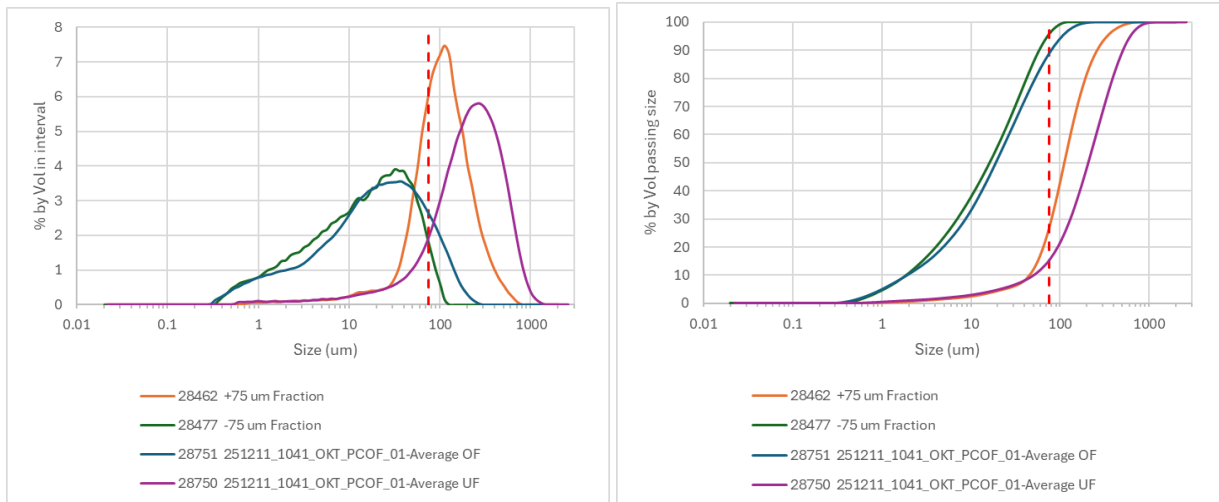


Figure 1. 18: Frequency and Cumulative size distributions determined by laser diffraction of +75 µm and -75 µm fractions by wet sieving and representative cyclone underflow (UF) and overflow (OF). The vertical dashed line shows 75 µm. (Three other runs from the cyclone trials, with mostly similar distributions, are shown in Figure A1.)

The results of Total S analysis of the various overflow and underflow samples from the cyclone trials are presented in Table 1. 9. Assuming quantitative mass recovery, the relative mass of tailings reporting to the underflow and overflow fractions were calculated and from these the fraction of Total S reporting to each fraction calculated. These results are also provided in Table 1.9. Note that the raw tailings sample used for the cyclone trials (Total S = 0.39%) has a significantly lower S content than the bulk tailings sample used for the geochemical studies (Total S = 0.72%). Consequently, direct comparison of Total S content between the cyclone underflow and overflow samples with the +75 µm and -75 µm tailings obtained by wet sieving is not possible, however comparison of the relative percent deportment of S to each size fraction is informative.

As shown above (Section 2.4.4), ~70% of sulphide S (equivalent to Total S) in Bulk Tailings deported to the -75 µm fraction during wet sieving. This is roughly in line with S deportment during cyclone treatment of TPP tailings, where in several trials the majority (75 – 85%) of S reported to the overflow

The similarity of the PSD for the -75 µm fraction from wet-sieving and the cyclone underflow PSD, together with the similar S deportment results, suggest that the use of the -75 µm fraction as a surrogate for cyclone overflow tailings to be deposited in the TSF should provide reliable results.

The -75 µm fraction and the bulk tailings when compared with the cyclone UF and raw tailings samples indicates that the sample used for geochemical analysis may lack some of the larger particles in comparison with the sample used for the cyclone trials, and that the sample used for geochemical testing is not quite “typical” of the plant tailings in the higher particle size range³. But since this material (+75 µm or cyclone UF) is significantly depleted in S and in the high particle size range less reactive, the lack of higher particle size material for geochemical testing is unlikely to have any significant effect on results.

A generally favourable comparison between size fractionated tailings obtained through wet sieving and cycloning has been demonstrated, and so the results obtained for the fractionated tailings used for geochemical testing should be applicable to tailings fractionated with a cyclone.

³ PSD analysis (conducted by the Ok Tedi Processing Technical Services using screening) during the first three months of 2026, showed TPP tailings had an average P80 value of 177 µm (range 133 – 228 µm).

Table 1. 9: Deportment of sulphur resulting from cyclone separation.

EGi Code	Sample ID	Sample	Total S%	Total mass fraction ¹	S mass fraction
28741	Raw Feed Tailings	Raw Feed	0.39	1.00	1.00
28744	251209_1300_OKT MHC100FB-VF40StdS15 P200	Underflow	0.33	0.77	0.65
28745	251209_1300_OKT MHC100FB-VF40StdS15 P200	Overflow	0.59	0.23	0.35
28746	251210_1106_OKT MHC100FB-VF40StdS15 P100	Underflow	0.24	0.25	0.15
28747	251210_1106_OKT MHC100FB-VF40StdS15 P100	Overflow	0.44	0.75	0.85
28748	251210_1402_OKT MHC100CB-VF40StdS20 P200	Underflow	0.24	0.00	0.00
28749	251210_1402_OKT MHC100CB-VF40StdS20 P200	Overflow	0.39 ²	1.00	1.00
28750	251211_1041_OKT MHC100CB-VF40StdS20 P100	Underflow	0.23	0.47	0.28
28751	251211_1041_OKT MHC100CB-VF40StdS20 P100	Overflow	0.53	0.53	0.75

¹Calculated from Total S values assuming 100% recovery.

²Since the overflow of this trial has not been enriched in S according to this total S content, calculation of total mass fractions is invalid. Appears to be a problem with the Total S analysis here.

3. SUMMARY

Key points to note from geochemical characterisation of TPP feed and tailings are:

- The bulk TPP tailings sample, composited from selected daily composite tailings slurries collected over June 2025, provided a sample with a Total S content of 0.72% and a NAPP of -53 kg H₂SO₄/t, which was within the target range (Total S ≈0.7%, NAPP <-30 kg H₂SO₄/t) to represent potential future TPP tailings that will be deposited in the proposed TSF.
- Compared to the tailings used in the KCB cyclone trials, the bulk tailings used for fractionation in this study contained a lower proportion of particles >200 µm. However, the particle size distribution of the cyclone overflow and the -75 µm fraction obtained by wet sieving were similar. This is important since there was preferential deportment of pyrite and, to a lesser extent, calcite to smaller particles.
- Sulphide S (pyrite) was preferentially deported to smaller size fractions with 66% and 56% of the sulphide S mass deporting to the -75 µm and -38 µm fractions respectively. Because of preferential deportment of sulphur to the smaller size fractions, Total S in the -75 µm fraction was enriched to 1.03% from 0.72% in the bulk sample and depleted in the +75 µm fraction to 0.38%.
- Similar Total S deportment was found with cyclone fractionation, with most S (typically 75 – 85%) reporting to the overflow.
- Preferential deportment of inorganic C (shown to be mostly calcite) to smaller particles was less pronounced than for sulphide S (52% and 37% to -75 µm and -38 µm fractions respectively). However, calcite followed pyrite to a sufficient degree during size fractionation such that all fractions remained strongly NAF (as determined by negative NAPP and neutral NAGpH following sequential stages of peroxide oxidation).

PART 2 – KINETIC GEOCHEMICAL TESTING

1. METHODOLOGY

1.1. Free draining leach columns

EGi's standard free-draining column leach method was used for leach column testing, as described in the ARD Test Handbook⁴. The columns were set-up and maintained at EGi's specialised geochemical laboratory in Sydney. Each column comprised approximately 1.8 to 2.0 kg (dry weight) of tailings housed within a plastic Buchner funnel measuring 170 mm internal diameter and 100 mm in height. The funnel configuration provided a free-draining condition and a relatively high exposure area per unit mass of sample, thereby providing conditions amenable to sulphide oxidation should it occur. For tailings deposited in a TSF, this would most closely represent tailings at the surface of the deposited material which has dried sufficiently to be unsaturated for most of the time.

Immediately following setup, the samples were flushed with 400 mL/kg of deionised water and initial flush (week 0) leachates were collected for analysis. Thereafter, samples were subjected to cyclic wetting and drying on a weekly basis over a four-week leach cycle. During the first three weeks of each cycle the samples were moistened by a once weekly addition of water at a rate of 100 mL/kg (typically on Friday). On the fourth week the samples were flushed by addition of 400 mL/kg, with the leachates collected in plastic containers positioned immediately beneath the funnel spouts. Typically, around 500 mL of leachate was collected from each column per cycle. Heat lamps positioned above the columns were operated for 8 hours per day for 4 days during each week of the four-weekly cycle (typically Monday to Thursday) to allow drying of the samples. Under this regime, surface temperatures are typically around 30°C during the heating cycle, simulating drying of the TSF beaches and enhancing oxidation throughout the column sample.

Leachates from the columns were assayed for pH, EC, alkalinity/acidity, and a suite of elements that includes Ag, Al, As, B, Ba, Be, Ca, Cd, Cl, Co, Cr, Cu, Cs, F, Fe, Hg, Li, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, Si, Sn, Sr, Th, Tl, U and Zn.

1.2. Saturated leach columns

Saturated column testing was used to investigate the leaching characteristics of tailings under conditions where saturation of the tailings bed limits the ingress of oxygen and the oxidation of pyritic minerals. This test provides an understanding of the longer-term potential of these materials to release metals and metalloids via very low rates of oxidation and solubility-controlled mechanisms.

The experimental setup used for the saturated leach column test is shown in Figure 2. 1. Sample masses of approximately 1700 g were placed on a bed of acid-washed sand, with filter paper (30 µm) separating the two layers, and submerged beneath a head of distilled water, maintained throughout the test at 100 mm depth (1.54 L). The depth of the sample layers were 74 and 95 mm for the Bulk and -75 µm tailings respectively. Approximately 300 mL of leachate was drained from the columns every 4 weeks. This represents approximately 0.6 and 0.4 pore volumes for the Bulk and -75 µm tailings respectively. 300 mL of the overlying water (sample referred to as supernatant below) was also sampled every 4 weeks at the same time as leachate was sampled. After sampling, DI water was replenished to maintain a 100 mm head of overlying water, with care taken to minimise disturbance to the tailings surface. Leachates and supernatants were analysed for the same suite of analyses as per the free draining columns.

⁴ EGi and IWRI, 2002. ARD Test Handbook, AMIRA International, May 2002.

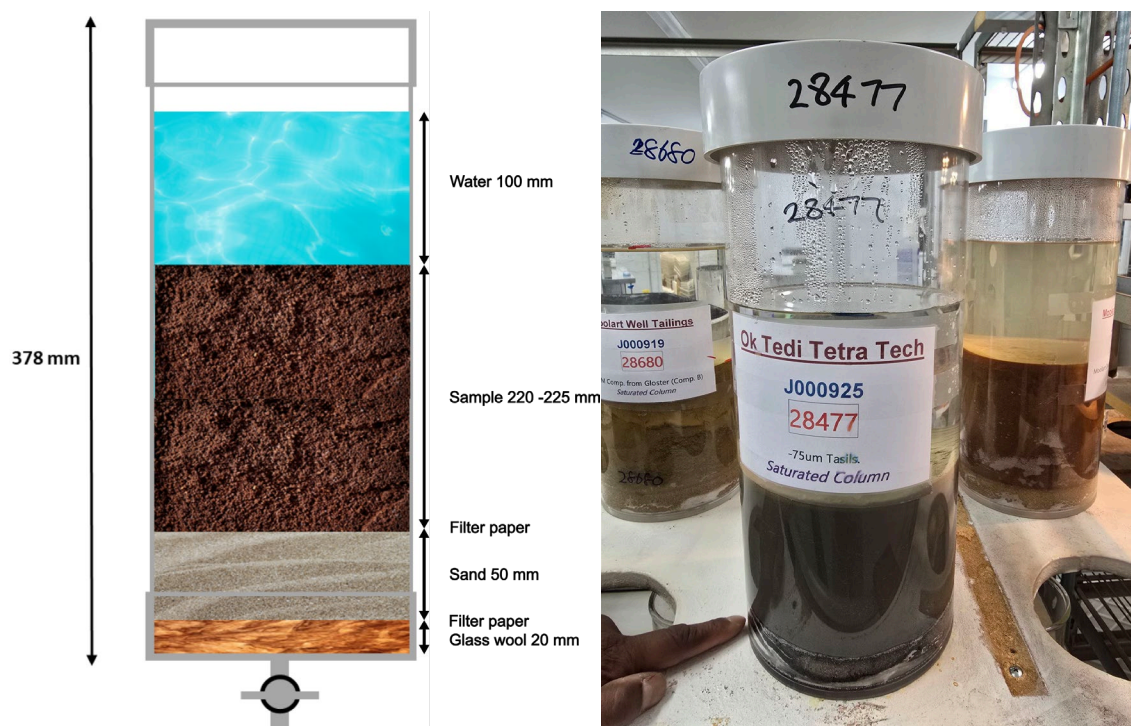


Figure 2. 1: Saturated column setup (not to scale) and operating columns.

1.3. Sulphide oxidation consumption experiments

The bulk and -75 μm tailings fraction samples were subject to sulphide oxidation consumption (SOC) testing during the fifth wetting and drying cycle of the free draining columns. SOC testing provides direct measurement of oxygen consumption, and can be used to calculate sulphide oxidation rates, assuming oxygen consumption is according to the stoichiometric reaction of oxygen with pyrite, and that other pathways of oxygen consumption, e.g., microbial respiration, are negligible.

The experimental setup for the SOC test is shown in Figure 2. 2. Samples were adjusted to approximately 70% saturation by addition of DI water prior to placement in the SOC and oxygen consumption measured for a period of around 10 days. The SOC experiments were conducted in a constant temperature lab maintaining a temperature of 23 ± 0.5 °C. Oxygen consumption was converted to an average oxidation rate over the period of the measurement, and the measured rates at a saturation level (≈ 0.7) intermediate between free draining and saturated column tests compared with oxidation rates calculated from column leachate sulphate concentrations.

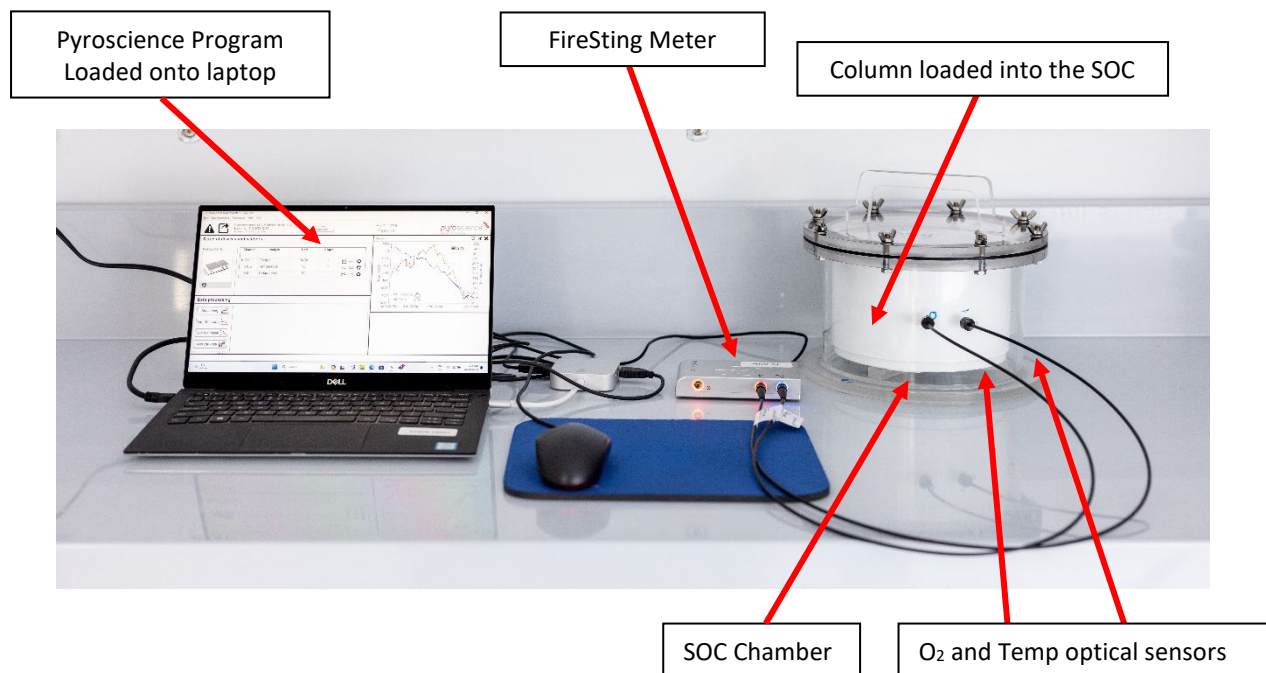


Figure 2. 2: SOC setup showing sample loaded into the chamber and connected FireSting meter.

2. RESULTS

2.1. Free draining columns

Three free draining leach columns were established. These included:

- Bulk tailings (TPP final tails)
- +75 μm size fraction of TPP final tails
- -75 μm size fraction of TPP final tails

The +75 μm size fraction column is designed to provide leachate data which can be used as a source term for modelling seepage from the TSF embankments which are to be constructed using sand from the cyclone underflow. It is expected that the TSF embankments will remain largely unsaturated, with infiltrating water freely draining from the structure. This behaviour is reflected in the operating conditions of the free draining leach column.

The -75 μm size fraction represents cyclone overflow which will be deposited in the TSF and bulk TPP final tails sample represents tailings which will be deposited when the cyclones are not operational. It is expected that these materials will be subject to varying degrees of saturation from fully saturated (e.g. beneath the decant water pond) to unsaturated for near surface tailings on the TSF beaches. This latter condition is reflected in the operating conditions of the free draining leach column.

Key AMD properties of the three tailings samples used in free draining leach column testing are shown in Table 2. 1.

Table 2. 1: Key AMD properties of tailings samples used for free draining leach column testing

EGi Code	Description	Total S (%)	ANC (kg H ₂ SO ₄ /t)	P80 (µm)	AMD Class
28476	Bulk tailings	0.72	75	62	NAF
28461	+75 µm tailings	0.38	69	191	NAF
28477	-75 µm tailings	1.03	76	42	NAF

Table 2. 2 shows average saturation levels across the first four wetting-drying cycles of the free draining leach columns. Each column was subject to the same water addition rates and heating cycles during these periods. Despite this, there is a clear difference between the average saturation levels of each sample and particularly in the case of the +75 µm fraction, where water retention was significantly reduced in comparison to the bulk and -75 µm size fraction.

Also shown in Table 2. 2 are average intrinsic oxidation rates (IOR) across the same period calculated from sulphate concentrations measured in the leachates. The calculation of IOR based on leachate sulphate concentrations assumes that oxygen consumption is according to the stoichiometric reaction of oxygen with pyrite, and that all product sulphate is flushed from the column. Results from solution speciation calculations suggest that leachates are not saturated with respect to any sulphate containing phases (e.g., gypsum, jarosite) and consequently it is likely that the second assumption is valid. Mineralogy determined by XRD analysis (Table 1. 6) demonstrates that pyrite is by far the dominant sulphide in these tailings, supporting the first assumption.

The calculated IOR values show that oxidation rates during the first few months of free draining column leach tests for the bulk and -75 µm size fraction tailings are essentially the same, and pyrite is oxidising at a moderate rate. In contrast the oxidation rate of pyrite in the +75 µm fraction is slow at about an order of magnitude less than the bulk and finer size fraction tailings. These results suggest that oxidation rate is largely controlled by the sulphide content and surface area (particle size) rather than saturation level under the conditions of the free draining leach column test. Despite the lower saturation level of the +75 µm tailings fraction, the lower sulphide content and larger particle size appears to significantly reduce the oxidation rate in comparison to the bulk and -75 µm tailings fraction. Results indicate that despite the likely lower saturation levels of the coarser tailings in the TSF embankment, which will likely lead to greater oxygen ingress than in finer tailings on the TSF beaches, reduced pyrite content and surface area will potentially lead to reduced sulphide oxidation in embankment materials.

It is noted that despite the enrichment of Total S (principally as pyrite) in the -75 µm tailings fraction relative to the bulk tailings, this material remains NAF (as are all the tailings fractions tested). While initial oxidation rates measured for the bulk and -75 µm tailings fraction can be considered moderate, low pH conditions are unlikely to occur in the longer term, with sufficient readily available neutralising capacity, principally as calcite, to ensure circumneutral conditions will be maintained. Under these conditions it is likely that oxidation rates in the longer term will be significantly attenuated⁵ and pyrite oxidation rates in the finer tailings fractions will approach those of the coarser tailings fraction.

⁵ Fan, et al. 2017. The formation of silicate-stabilized passivating layers on pyrite for reduced acid rock drainage, *Environ. Sci. Technol.* 51, 11317-11325, DOI: <http://dx.doi.org/10.1021/acs.est.7b03232>

Table 2. 2: Average saturation levels and IOR for free draining leach column tests during the first four flush cycles (Flush at week 0 excluded)

EGi Code	Description	Saturation	IOR (kg O ₂ /m ³ /s)
28476	Bulk tailings	0.35	1.5×10^{-7}
28461	+75 um tailings	0.15	1.5×10^{-8}
28477	-75 um tailings	0.44	1.7×10^{-7}

2.1.1. Free draining column leachate chemistry

Free draining leach column tests have been operated for a period of four wetting-drying cycles (five flushes including week 0) at the time of reporting. Testing is ongoing. Full leachate analysis results for free draining columns are provided in Appendix B.

The main conclusions to be drawn from the initial period of free draining leach column testing of TPP tailings can be summarised as follows:

- All column leachates remained circumneutral throughout the first 16 weeks (Figure 2.3).
- Major cation and anions, and metal(loid)s concentrations are generally in the order -75 um tailings > Bulk tailings >> +75 um tailings (Figure 2. 3 and Figure 2. 4).
- Major cations and anions in leachates are dominated by Ca and SO₄ which are essentially constant and present at approximately 1:1 mol ratio (Figure 2. 3). This is consistent with on-going sulphide oxidation and acidification together with neutralisation by calcite dissolution.
- Leachate metal(loid) concentrations are generally very low, some decreasing in concentration (Ni, U), some with relatively constant concentrations (Cu, Se, Zn) (Figure 2. 4), and some increasing in concentration (Mo).
- Leachate Cu concentrations are similar for all columns (Figure 2. 4) consistent with similar Cu content of all tailings samples (Table A 4) and in contrast to apparent sulphide oxidation rates. This may reflect greater retention of Cu through more secondary mineral precipitation/sorption in the more reactive -75 um and Bulk tailings, or that copper sulphide oxidation rates are similar for all samples.
- Leachate Mn concentrations are generally higher than other metals and similar trends to Ca suggests Mn is likely associated with calcium carbonates (Figure 2. 4).

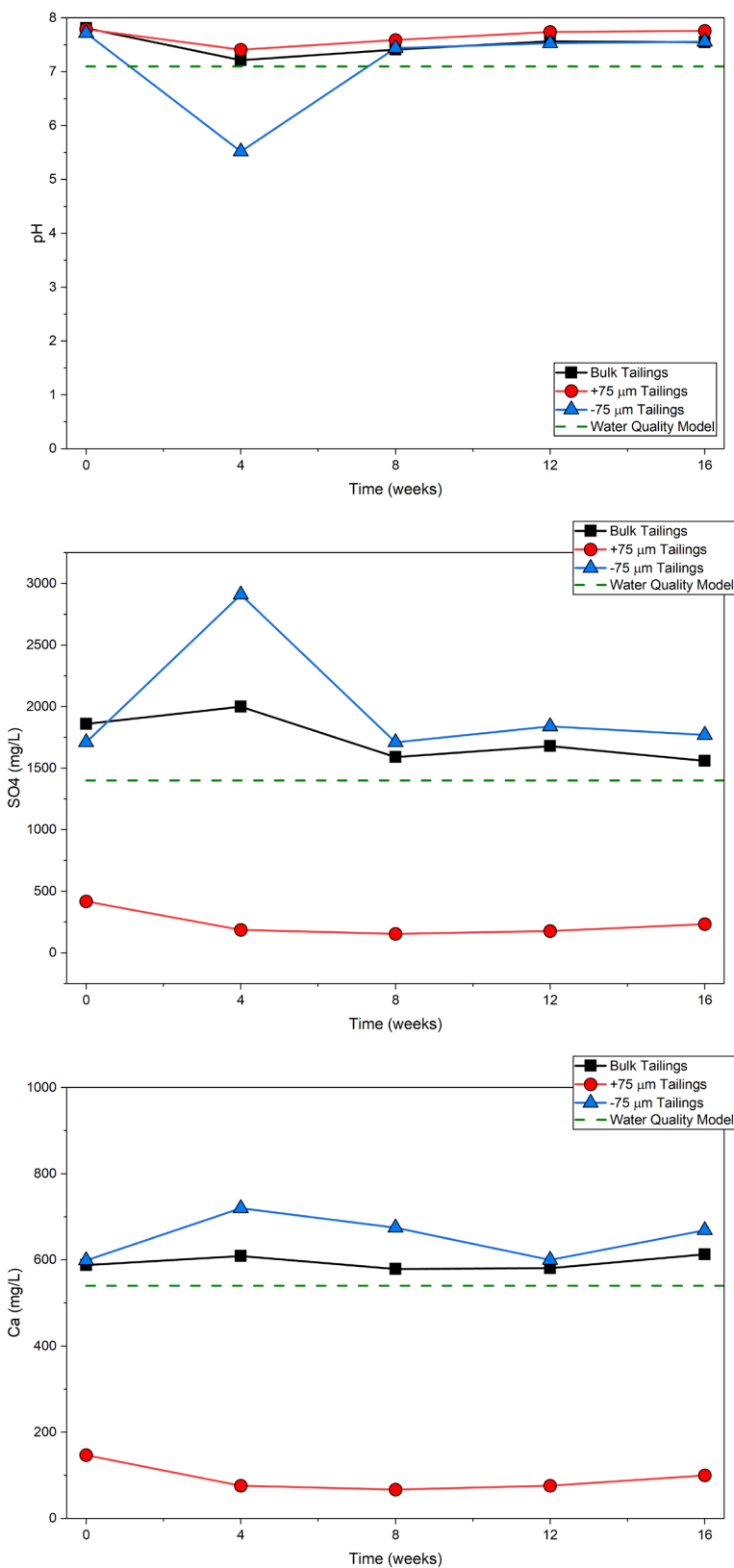


Figure 2. 3: Leachate chemistry for free draining columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

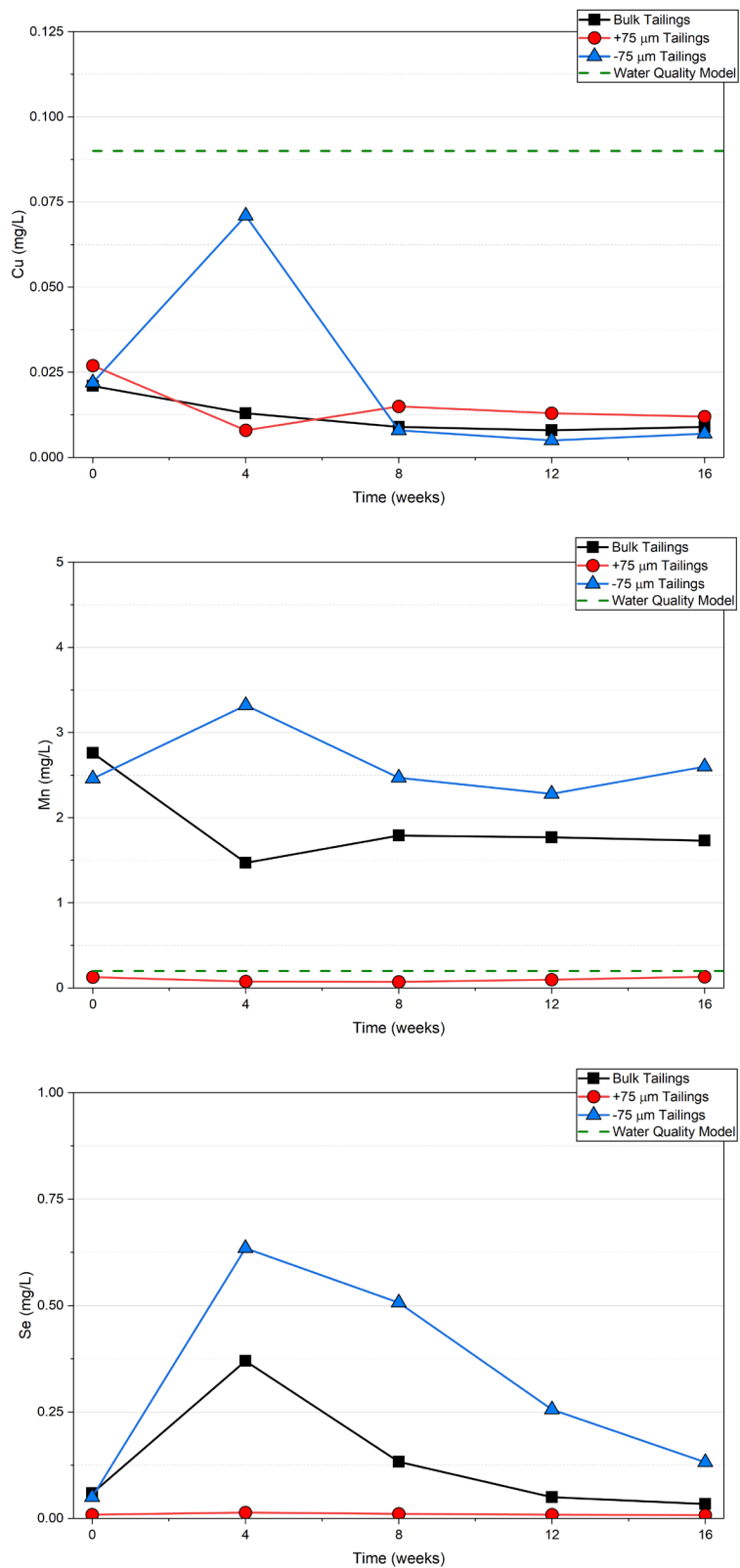


Figure 2. 4: Metal concentrations in leachates for free draining columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

2.2. Saturated columns

Two saturated leach columns were established. These included:

- Bulk tailings (TPP final tails)
- -75 µm size fraction of TPP final tails

The +75 µm size fraction column was not included in the saturated leach column test set as it is expected that the TSF embankments constructed from cyclone underflow (+75 µm size fraction) will remain largely unsaturated.

A portion of the -75 µm size fraction representing cyclone overflow that will be deposited in the TSF and bulk TPP final tails that will be deposited in the TSF when the cyclones are not operational are expected to remain fully saturated (e.g. beneath the decant water pond). Therefore, these materials were included in saturated leach column testing. Full analysis results for both leachates and supernatants from saturated column tests are provided in Appendix C.

As for the free draining columns, sulphate concentrations in leachates from saturated leach columns were used to calculate oxidation rates (Table 2. 3). In the case of saturated columns, samples were placed into the columns as slurries, containing some process water. The presence of process water is evident from chloride and (to a lesser extent) sodium concentrations in leachates (Figure 2. 5). Chloride is likely only sourced from process water and not from mineral dissolution, and can therefore be used to give an indication of when all process water is flushed from the tailings and thereafter leachate solutes likely originate from mineral reaction/dissolution. Figure 2. 5 indicates that almost all chloride has been flushed from the tailings after 1 – 2 pore volumes of flush water has passed through the tailings bed, or 8 to 12 weeks of operation, with leachate concentrations approaching that of supernatant after this. Leachate concentrations of sodium show similar behaviour, albeit Na concentrations level out at a slightly higher concentration than in supernatants, suggesting some ongoing equilibrium with a sodium-containing phase(s) in the tailings. Nevertheless, these results suggest that process water is effectively flushed from the tailings bed after around 1 to 2 pore volumes of DI water have been flushed through the column.

Assuming this to be the case, it was presumed that sulphate in leachates from flushes 2 to 3 onwards (weeks 8 to 12) is derived from sulphide oxidation rather than from entrained process water. Consequently IOR shown in Table 2. 3 were derived from leachate sulphate concentrations from week 8 onwards (Bulk tailings) or week 12 onwards (-75 µm size fraction).

Table 2. 3: Average IOR for saturated leach column tests

EGi Code	Description	IOR (kg O ₂ /m ³ /s)
28476	Bulk tailings	1 x 10 ⁻⁹
28477	-75 um tailings	9 x 10 ⁻⁹

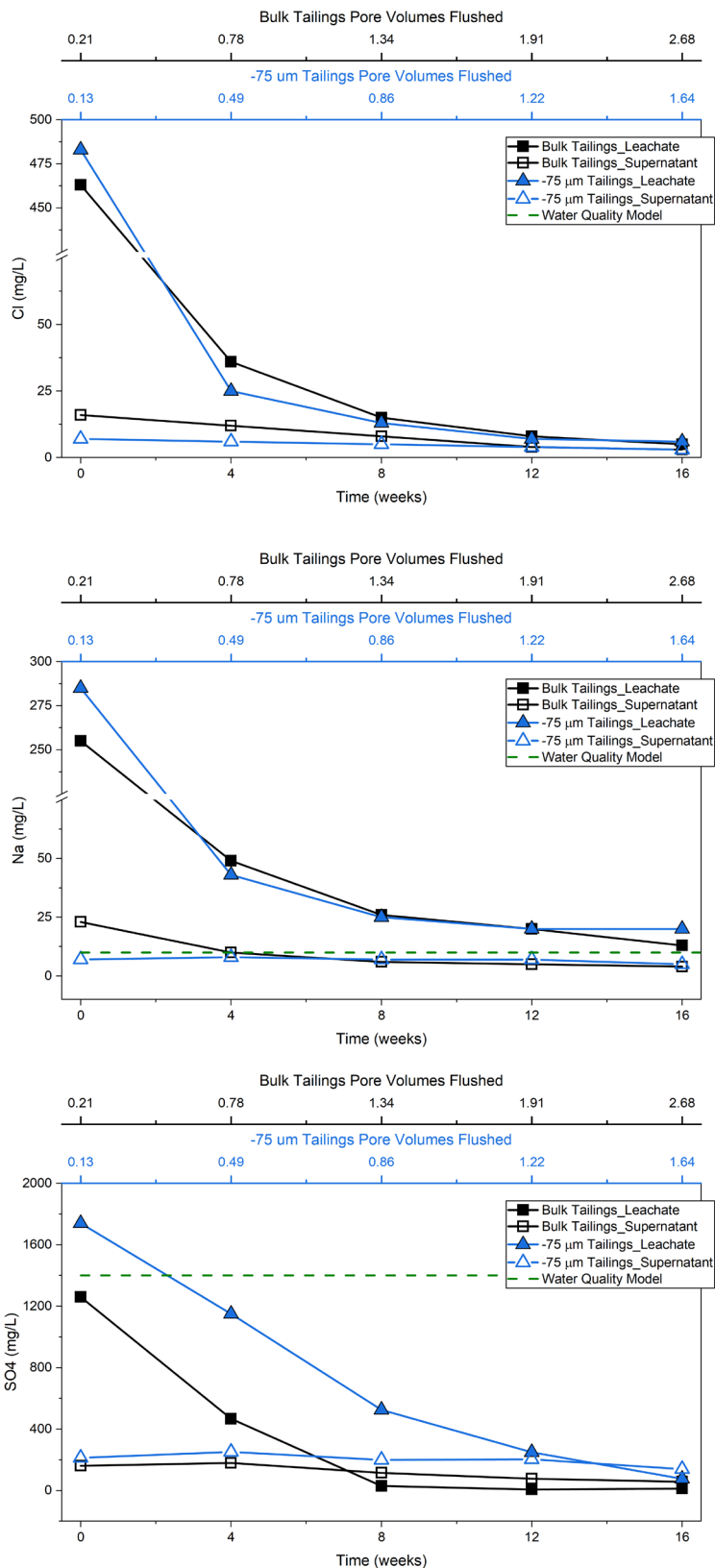


Figure 2. 5: Major cation and anion concentrations in leachates for saturated columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

2.2.1. Saturated column leachate chemistry

Saturated leach column tests have been operated for a period of four cycles (five flushes including week 0) at the time of reporting. Testing is ongoing. Full leachate analysis results for free draining columns are provided in Appendix C.

The main conclusions to be drawn from the initial period of saturated leach column testing of TPP tailings can be summarised as follows:

- Tailings supernatant waters are alkaline (pH $\approx$ 8, Alkalinity $\approx$ 90 mg CaCO₃/L) (Figure 2. 6) and appear to be in equilibrium with calcite and air.
- The tailings leachates from the -75 μ m tailings fraction are alkaline (pH $\approx$ 8, Alkalinity $\approx$ 200 mg CaCO₃/L) (Figure 2. 6) and appear to be in equilibrium with calcite.
- The tailings leachates from the bulk tailings displayed similar chemistry to the -75 μ m tailings fraction for approximately 1 pore volume flush, after which the pH decreased to around 7 and alkalinity and Ca concentrations increased suggesting increased calcite dissolution as the pH dropped (Figure 2. 6). The reasons for these changes are not clear at this stage.
- Metal concentrations in leachates and supernatant waters are generally very low, with concentrations in leachates slightly higher than in supernatant waters (Figure 2. 7).
- Copper concentrations in leachates and supernatants are very low, reflecting very low sulphide oxidation rates and Cu retention through secondary mineral precipitation and/or sorption.
- Leachate Mn concentrations are generally higher than other metals and similar trends to Ca suggests Mn is likely associated with calcium carbonates (Figure 2. 7).

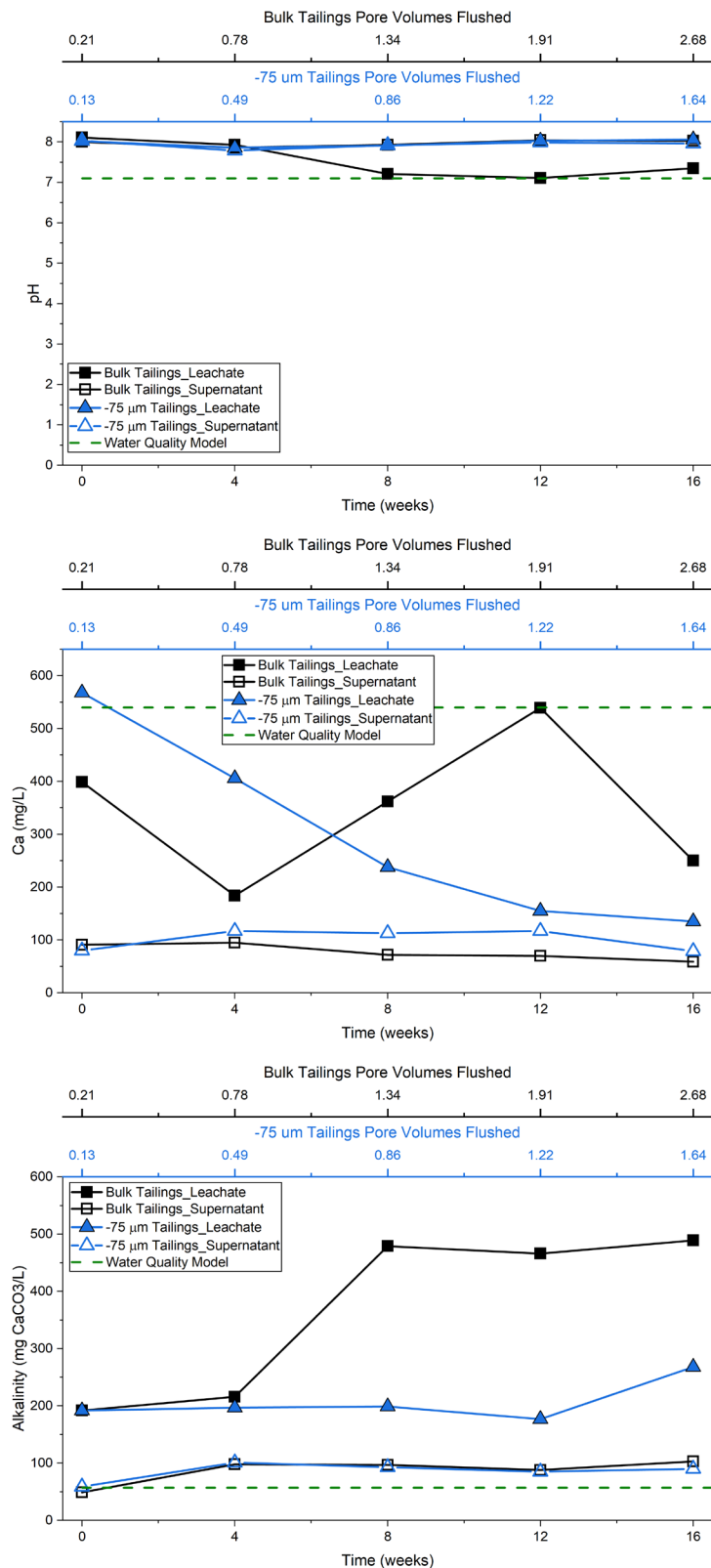


Figure 2. 6: Leachate chemistry for saturated columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

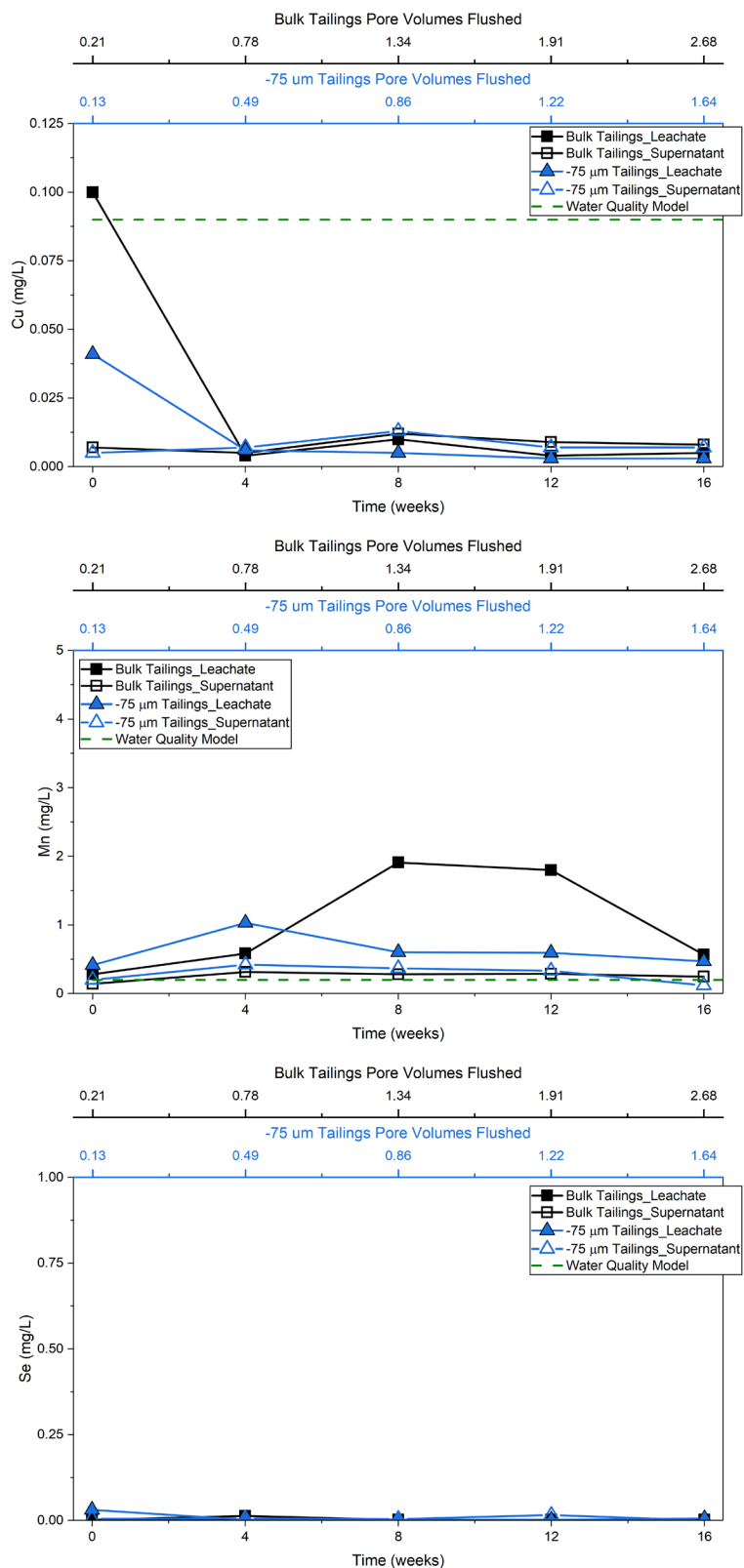


Figure 2. 7: Metal concentrations in leachates for saturated columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model. Note concentrations scales in this figure are the same as those used for free draining column leachates (Figure 2.4) to facilitate comparison.

2.3. Comparison of free draining and saturated columns

The free draining and saturated column leach tests were designed to understand the leaching behaviour of TPP tailings to be placed in the lowlands TSF over the range of water content of deposited tailings. These results therefore represent the extremes of leaching behaviour and TSF beach run-off and seepage will likely fall somewhere between the two extremes. Comparison of saturated and free draining column leachates provides a picture of the expected chemistry of TSF run-off/seepage.

The main conclusions to be drawn from comparison of leachate chemistries during the initial period of leach column testing of TPP tailings can be summarised as follows:

- Na and Cl concentrations are similar in free draining and saturated column leachates (after the initial flush) consistent with their source as entrained process water (Figure 2. 8).
- Sulphate concentrations in free draining column leachates are significantly higher than in saturated column leachates (after the initial flush), consistent with significantly higher sulphide oxidation rates under free draining column conditions (Figure 2. 8).
- Leachate pH is slightly lower and Ca concentrations slightly higher in saturated leach column tests than would be expected for a closed calcite – water system (Figure 2. 9), possibly consistent with limited acid generation through sulphide oxidation even under saturated conditions, but very low sulphate concentrations (Figure 2. 8) show that saturation has substantially reduced oxidation rates (Table 2. 3).
- Leachate pH is lower and Ca concentrations much higher in free draining leach column tests than would be expected for an open calcite – water system (Figure 2. 9), possibly consistent with on-going acid generation through sulphide oxidation under free draining conditions. This supports elevated leachate sulphate concentrations (Figure 2. 8) result from sulphide oxidation with associated acid generation rather than soluble sulphate salt dissolution.
- Metal concentrations in free draining column leachates are generally higher than in saturated column leachates (Figure 2. 10) consistent with higher sulphide oxidation rates under free draining conditions. However, metal(loid) concentrations generally decrease with each flush (see e.g., Se concentrations, Figure 2. 10) despite apparent on-going sulphide oxidation. This suggests that as oxidation proceeds, increased formation of iron oxyhydroxides results in increasing metal(loid) adsorption and reduced leachate concentrations.
- Leachate Cu concentrations are similar for saturated and free draining columns (Figure 2. 10) in contrast to apparent dissimilar sulphide oxidation rates. This suggests that copper is not readily mobilised from these tailings, even under the oxidising conditions of the free draining columns.
- Mn concentrations in leachates are the highest of leachate metals and appear not to be attenuated by precipitation/sorption as are other metals.

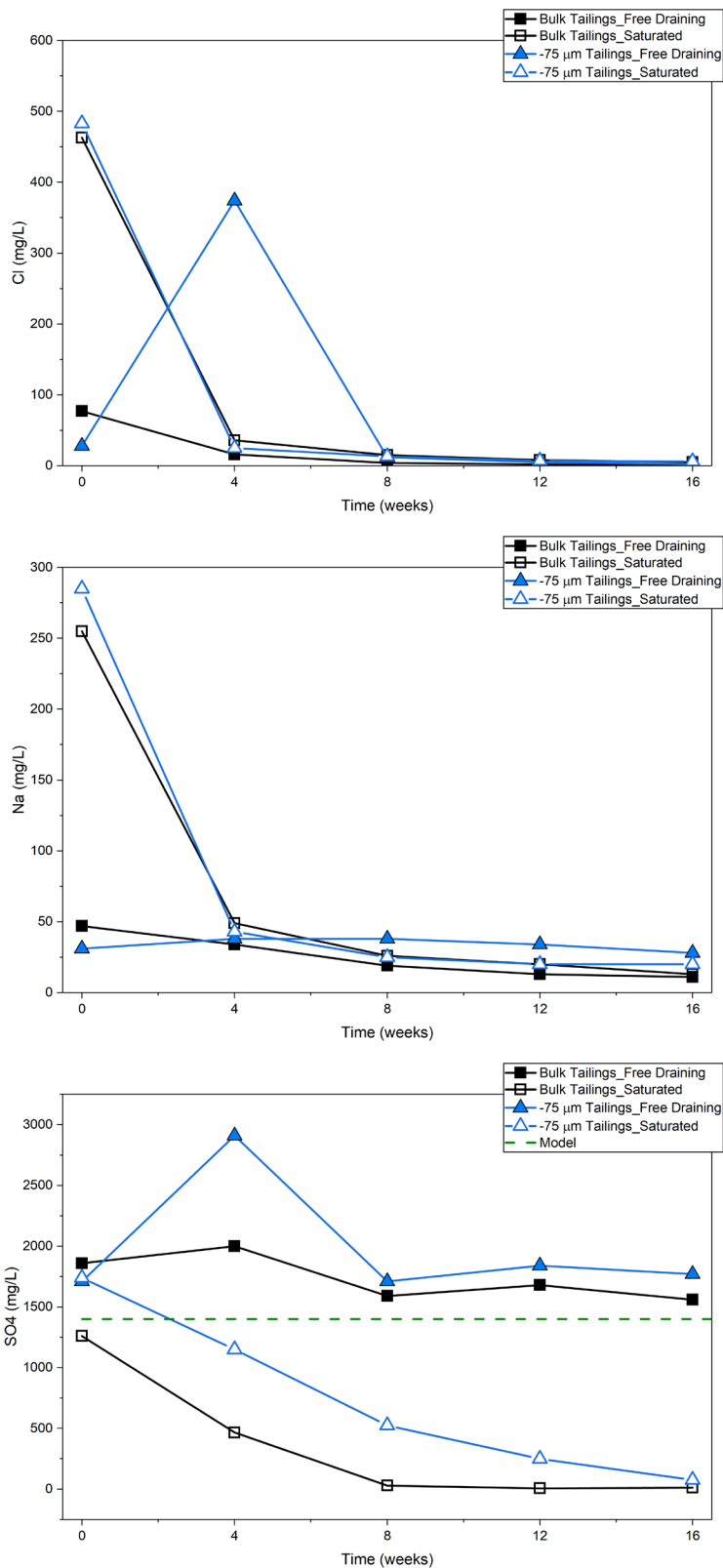


Figure 2. 8: Major cation and anion concentrations in leachates for free draining and saturated columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

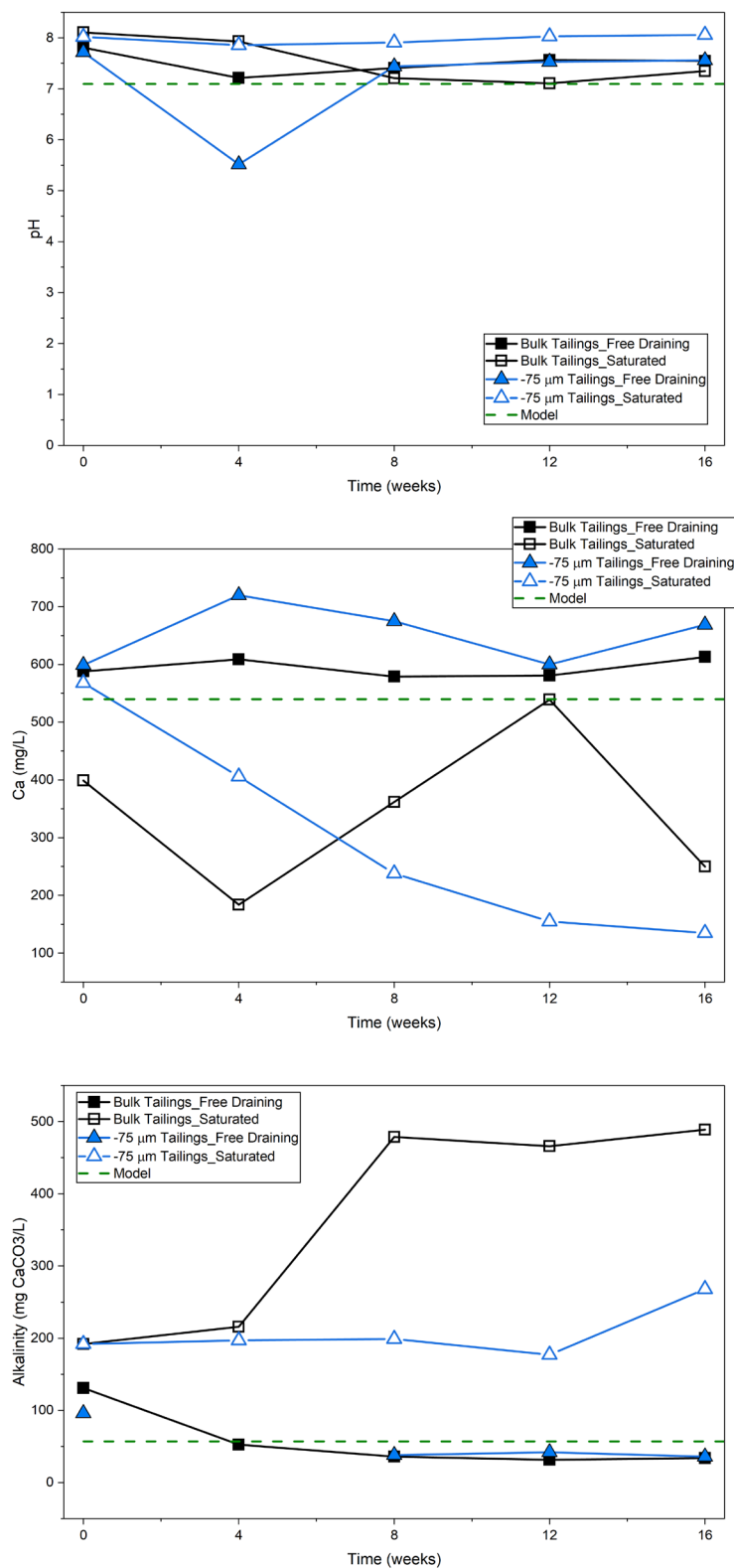


Figure 2. 9: Leachate chemistry for free draining and saturated columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

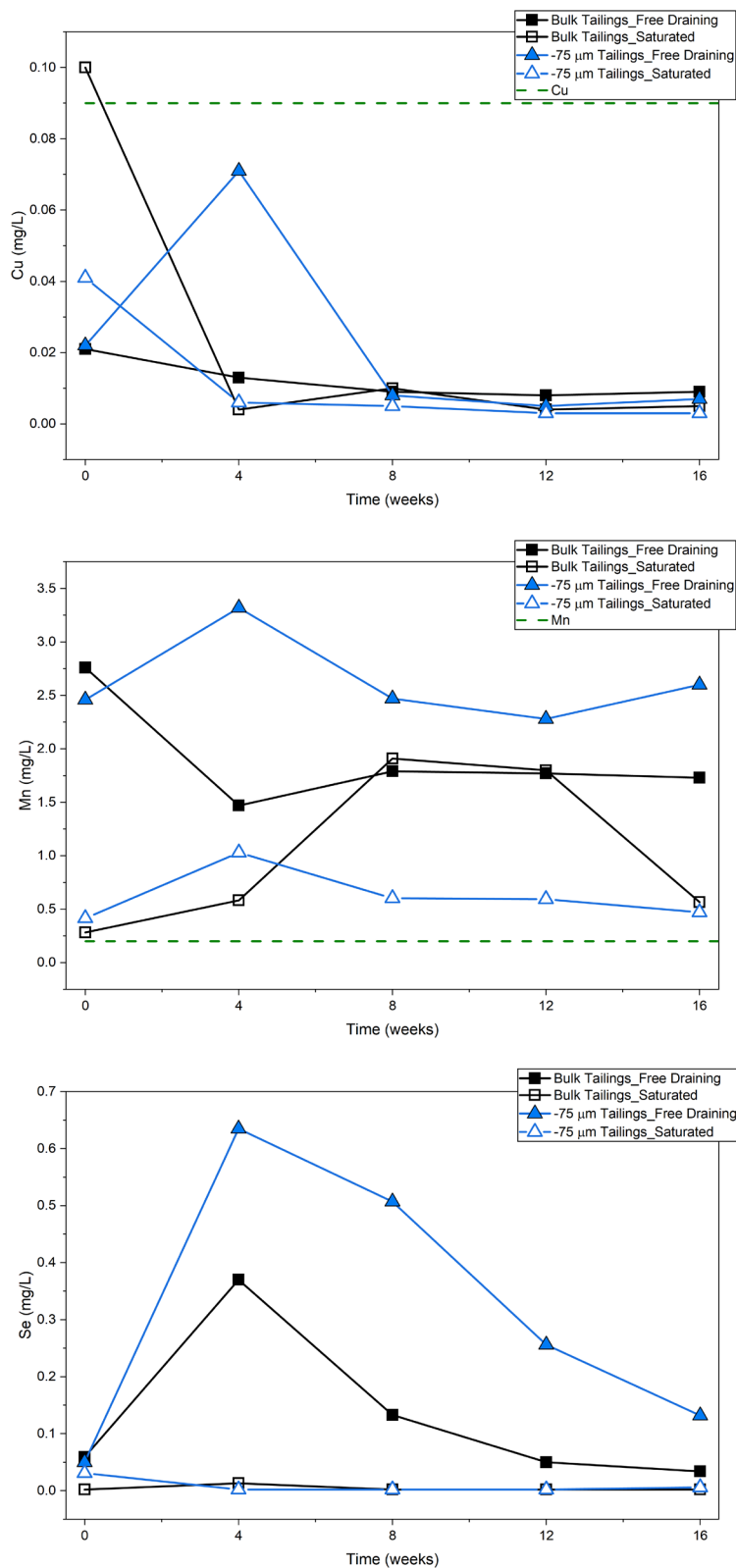


Figure 2. 10: Metal concentrations in leachates from free draining and saturated columns containing TPP tailings. The green dotted line shows the value used for TSF beach and embankment source terms in the preliminary WQ model.

2.4. Comparison of column leachate chemistry with water quality model source terms

A geochemical water quality model has recently been developed to model and predict potential effects on water quality in the Ok Tedi and Fly River system as a result of future tailings deposition in the lowlands TSF rather than into the Ok Tedi. At the time of undertaking the water quality modelling, data were not available for the required water quality parameters for tailings run-off/seepage, and so source terms were developed using results from previous kinetic leach column testing involving riverine sediments and various tailings samples. The current leach column test program is designed to validate the source terms for TSF run-off used in the model.

Preliminary results from the current kinetic tests conducted using size fractionated TPP tailings, including oxidation rates and seepage and supernatant water quality, are compared with source terms used for TSF run-off in the water quality model in Table 2. 4.

Many of the source terms used in the preliminary modelling appear to be in the range of measured values for the initial stages of column testing (IOR, Al, Cd, Fe, Zn), while some were lower than measured values (saturation, pH, alkalinity, Mn) and others higher (Ca in saturated columns only, SO₄ in saturated and free draining +75 µm fraction, and Cu).

In general, the parameters used for water quality modelling are in the range of those measured during kinetic (saturated and free draining) leach column testing, confirming the TSF beach run-off source term used in the model provides a suitable facsimile of what can be expected from bulk and cyclone overflow tailings on an exposed TSF beach. However, further leach column testing is required to understand the influence of longer-term leaching on tailings leachate quality, and the results will be checked against those used in the water quality modelling to confirm the appropriateness of the model source terms.

Table 2. 4: Comparison of TSF water quality source terms used for preliminary WQ modelling and measured values from column leach testing

Parameter	Column Type	Tailings Type	Leach Column	TSF Component	Model	Comments
Saturation	Free Draining	+75 um	0.05 - 0.28	Embankment	0.13	Modelled value in the range of FD +75 um column, but modelled value lower than FD bulk and -75 um tailings, indicating modelling is conservative.
		-75 um	0.42 - 0.48	Tailings beach	0.13	
		Bulk	0.26 - 0.49			
	Saturated	-75 um Bulk	1 1		- -	
IOR (kg O ₂ /m ³ /s)	Free Draining	+75 um	1.2 - 1.9E-8	Embankment	5.0E-08	Modelled value intermediate between measured IOR for FD and saturated columns, indicating model value is appropriate.
		-75 um	1.4 - 2.5E-7	Tailings beach	5.0E-08	
		Bulk	1.4 - 1.8E-7			
	Saturated	-75 um Bulk	0.5 - 6.3E-8 0.03 - 3.7E-8		- -	
pH	Free Draining	+75 um	7.4 - 7.8	Embankment	7.1	Modelled value in general lower than measured for both FD and saturated columns, suggesting that the lower model pH may have resulted in conservative metal concentrations.
		-75 um	7.4 - 7.7	Tailings beach	7.1	
		Bulk	7.2 - 7.8			
	Saturated	-75 um Bulk	7.9 - 8.1 7.1 - 8.1		- -	
Alkalinity (mg CaCO ₃ /L)	Free Draining	+75 um	44 - 68	Embankment	57	Modelled value similar to measured values for FD columns but lower than measured values in saturated columns.
		-75 um	36 - 96	Tailings beach	57	
		Bulk	32 - 131			
	Saturated	-75 um Bulk	177 - 268 192 - 489		- -	
Ca (mg/L)	Free Draining	+75 um	67 - 147	Embankment	540	Modelled value similar to measured values for FD columns but higher than measured values in saturated columns.
		-75 um	599 - 720	Tailings beach	540	
		Bulk	579 - 613			
	Saturated	-75 um Bulk	135 - 568 184 - 539		- -	
SO ₄ (mg/L)	Free Draining	+75 um	154 - 418	Embankment	1400	Modelled value in the range of FD bulk and -75 um tailings, but higher than FD +75 um tailings and generally higher than measured values for saturated columns. Modelled embankment run-off/seepage will be conservative, as will TSF beach run-off/seepage where saturation levels are >0.5.
		-75 um	1710 - 2910	Tailings beach	1400	
		Bulk	1560 - 2000			
	Saturated	-75 um Bulk	76 - 1740 6 - 1260		- -	
Na (mg/L)	Free Draining	+75 um	2 - 6	Embankment	10	Modelled value in general lower than measured for both FD and saturated columns.
		-75 um	31 - 38	Tailings beach	10	
		Bulk	11 - 47			
	Saturated	-75 um Bulk	20 - 285 13 - 255		- -	
Al (mg/L)	Free Draining	+75 um	<0.01 - 0.02	Embankment	0.05	Modelled value slightly higher than measured column concentrations, but this difference is not significant.
		-75 um	<0.01 - 0.01	Tailings beach	0.05	
		Bulk	<0.01 - 0.01			
	Saturated	-75 um Bulk	<0.01 <0.01		- -	
Cd (mg/L)	Free Draining	+75 um	0.0001	Embankment	0.0003	Modelled value is in the range of column concentrations.
		-75 um	0.0001 - 0.0003	Tailings beach	0.0003	
		Bulk	0.0001 - 0.0005			
	Saturated	-75 um Bulk	0.0001 - 0.0004 0.0001 - 0.0004		- -	
Cu (mg/L)	Free Draining	+75 um	0.008 - 0.027	Embankment	0.09	Modelled value higher than measured column concentrations, suggesting modelling results will be conservative.
		-75 um	0.005 - 0.020	Tailings beach	0.09	
		Bulk	0.008 - 0.021			
	Saturated	-75 um Bulk	0.003 - 0.04 0.004 - 0.1		- -	
Fe (mg/L)	Free Draining	+75 um	<0.05	Embankment	0.08	Modelled value is in the range of column concentrations.
		-75 um	<0.05	Tailings beach	0.08	
		Bulk	<0.05			
	Saturated	-75 um Bulk	<0.05 - 0.06 <0.05 - 0.68		- -	
Mn (mg/L)	Free Draining	+75 um	0.07 - 0.13	Embankment	0.2	Modelled value in the range of measured FD +75 um tailings but lower than measured FD bulk and -75 um tailings, and generally lower than measured values for saturated columns. Modelled TSF run-off/seepage will likely underestimate actual concentrations under most saturation levels. However, this is unlikely to have any significant impact on modelled river water concentrations.
		-75 um	2.5 - 3.3	Tailings beach	0.2	
		Bulk	1.5 - 2.8			
	Saturated	-75 um Bulk	0.42 - 1.0 0.28 - 1.9		- -	
Zn (mg/L)	Free Draining	+75 um	<0.005 - 0.008	Embankment	0.025	Modelled value slightly higher than measured column concentrations, but this difference is not significant.
		-75 um	<0.005 - 0.015	Tailings beach	0.025	
		Bulk	<0.005 - 0.016			
	Saturated	-75 um Bulk	<0.005 - 0.007 <0.005 - 0.007		- -	

2.5. SOC testing

Bulk and -75 μm tailings fraction samples were subject to sulphide oxidation consumption (SOC) testing during the fifth wetting and drying cycle of the free draining column tests. Samples were adjusted to approximately 70% saturation by addition of DI water prior to placement in the SOC chamber and oxygen consumption measured for a period of around 10 days. Oxygen consumption was converted to an average oxidation rate over the period of the measurement, and the measured rates at a saturation level (≈ 0.7) intermediate between free draining and saturated column tests compared with oxidation rates calculated from column leachate sulphate concentrations.

The measured IOR determined from the SOC tests (Flush cycle 5) are compared with IOR calculated from leachate sulphate concentrations in the free draining and saturated column tests (Flush cycle 4) in Figure 2. 11. Oxidation rates vary across the range of measured saturation ($\approx 0.4 - 1$) between about 10^{-7} to 10^{-9} and 10^{-7} and 10^{-10} $\text{kg O}_2/\text{m}^3/\text{s}$ for -75 μm and bulk tailings respectively. The influence of saturation level on IOR appears to be dominated by the oxygen diffusion coefficient, with the general trend having a similar trend to the relationship between saturation and gas diffusion in a non-reactive porous material (shown by green broken line in the figure).

Also shown in Figure 2. 11 is the IOR used for TSF tailings in preliminary water quality modelling. The modelled oxidation rate is toward the upper end of the measured tailings oxidation rates, representing the fraction of tailings which have dried to a significant extent on TSF beaches. This suggests that derived source terms used for seepage/run-off from the TSF based on the IOR used for water quality modelling will be relatively conservative, with overall oxidation rates and subsequent sulphate and metal release rates likely to be lower than modelled. Consequently, impacts on receiving river water quality will likely be less than water quality model results.

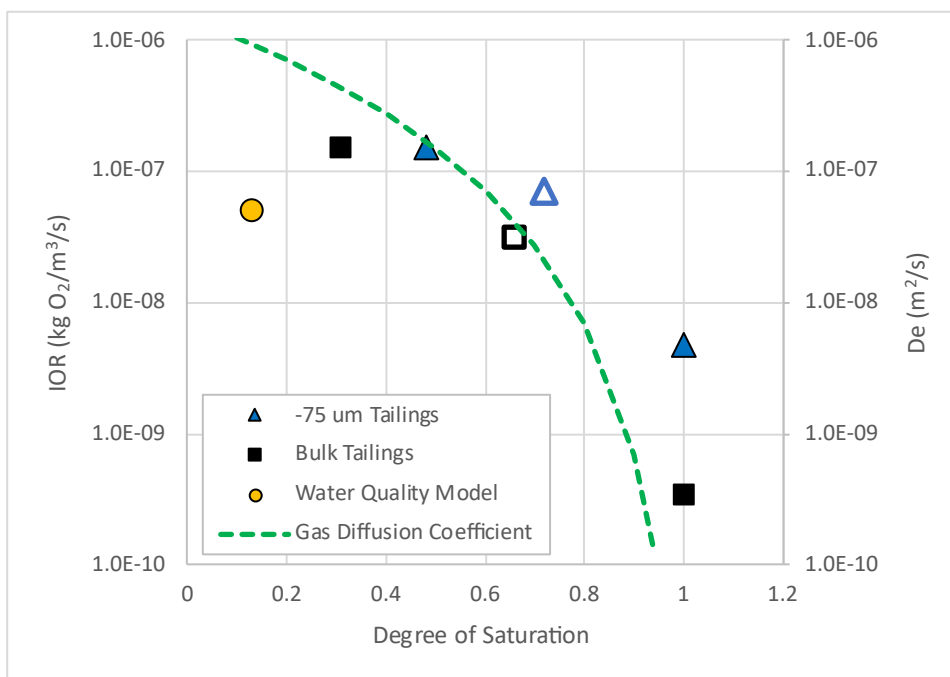


Figure 2. 11: IOR from bulk and -75 μm TPP tailings column tests as a function of saturation. The open symbols represent IOR measured using SOC testing, and closed symbols IOR calculated from leachate sulphate concentrations.

3. SUMMARY

Key points to note from kinetic leach column testing of TPP tailings are:

- Tailings oxidation rates are moderate (10^{-7} kg $O_2/m^3/s$) for the tested -75 μm and bulk tailings and about an order of magnitude higher than the +75 μm tailings under free draining column test conditions.
- Tailings oxidation rates are reduced by one to two orders of magnitude (10^{-8} and 10^{-9} kg $O_2/m^3/s$ for -75 μm and bulk tailings respectively) when saturated, suggesting on average TSF tailings oxidation rates are likely to be relatively low.
- Leachate pH for all samples under both free draining and saturated conditions remained neutral through the first 4 months of testing, consistent with the NAF AMD classification of these materials.
- Leachate chemistry for all samples under both free draining and saturated conditions are dominated by Ca and SO_4 , consistent with on-going sulphide oxidation and concomitant calcite dissolution and acid neutralisation, albeit at a much reduced rate in saturated columns.
- Metal(loid)s concentrations in leachates for all samples under both free draining and saturated conditions are very low, except for Mn which is likely associated with calcite and/or siderite. Metal(loid) concentrations in free draining column leachates albeit low, are generally higher than in saturated column leachates consistent with higher sulphide oxidation rates under free draining conditions.
- Leachate Cu concentrations are similar for saturated and free draining columns in contrast to apparent dissimilar sulphide oxidation rates. This suggests that copper is not readily mobilised from these tailings, even under the oxidising conditions of the free draining columns.
- Many of the source terms for TSF run-off used in preliminary water quality modelling appear to be in the range of measured values for the initial stages of column testing (IOR, Al, Cd, Fe, Zn), while some were lower than measured values (saturation, pH, alkalinity, Mn) and others higher (Ca in saturated columns only, SO_4 in saturated and free draining +75 μm fraction, and Cu).
- Sulphide Oxidation Consumption (SOC) measurements confirm that the modelled oxidation rate for tailings is towards the upper end of measured oxidation rates from column testing.
- In general, the derived water quality parameters used for water quality modelling are in the range of those measured during kinetic (saturated and free draining) leach column testing, confirming the TSF beach run-off source term used in the model provides a suitable facsimile of what can be expected from bulk and cyclone overflow tailings on an exposed TSF beach.

Appendix A

TPP TAILINGS STATIC GEOCHEMICAL TEST RESULTS

Table A 1: Total sulphur and carbon of feed and tails composite samples

Sample Description	Sample Date	Sample ID	Sample Wt.	Total S	Total C	ANC _{TC} ¹	NAPP ²
			g	%		kg H ₂ SO ₄ /t	
TPP Feed Unit 1	07-June-2025	1FT 07.06.2025_202506-001	110	4.91	1.53	125	25
TPP Feed Unit 1	08-June-2025	1FT 08.06.2025_202506-005	145	3.02	0.70	57	35
TPP Feed Unit 1	09-June-2025	1FT 09.06.2025_202506-009	107	5.23	1.14	93	67
TPP Feed Unit 1	10-June-2025	1FT 10.06.2025_202506-013	142	5.09	1.10	90	66
TPP Feed Unit 1	11-June-2025	1FT 11.06.2025_202506-017	189	2.14	1.14	93	-28
TPP Feed Unit 1	13-June-2025	1FT 13.06.2025_202506-021	134	4.27	0.82	67	64
TPP Feed Unit 1	14-June-2025	1FT 14.06.2025_202506-025	142	2.17	0.76	62	4
TPP Feed Unit 1	15-June-2025	1FT 15.06.2025_202506-029	96	2.34	0.83	68	3
TPP Feed Unit 1	16-June-2025	1FT 16.06.2025_202506-033	104	3.23	1.09	89	10
TPP Feed Unit 1	17-June-2025	1FT 17.06.2025_202506-037	243	6.20	1.24	101	88
TPP Feed Unit 1	18-June-2025	1FT 18.06.2025_(06:00)_202506-040	233	1.59	0.45	37	12
TPP Feed Unit 1	18-June-2025	1FT 18.06.2025_(18:00)_202506-042	146	2.51	1.37	112	-35
TPP Feed Unit 1	19-June-2025	1FT 19.06.2025_202506-048	144	1.78	1.30	106	-52
TPP Feed Unit 1	20-June-2025	1FT 20.06.2025_(18:00)_202506-054	275	0.68	0.77	63	-42
TPP Feed Unit 1	20-June-2025	1FT 20.06.2025_(06:00)_202506-052	305	1.06	1.42	116	-84
TPP Feed Unit 1	21-June-2025	1FT 21.06.2025_(06:00)_202506-060	254	0.86	1.70	139	-113
TPP Feed Unit 1	21-June-2025	1FT 21.06.2025_(17:00)_202506-062	439	2.37	1.54	126	-53
TPP Feed Unit 2	07-June-2025	2FT 07.06.2025_202506-002	111	4.74	1.35	110	35
TPP Feed Unit 2	08-June-2025	2FT 08.06.2025_202506-006	132	3.70	0.70	57	56
TPP Feed Unit 2	09-June-2025	2FT 09.06.2025_202506-010	137	6.18	0.91	75	115
TPP Feed Unit 2	10-June-2025	2FT 10.06.2025_202506-014	176	6.55	0.94	76	124
TPP Feed Unit 2	11-June-2025	2FT 11.06.2025_202506-018	216	2.43	0.99	81	-7
TPP Feed Unit 2	13-June-2025	2FT 13.06.2025_202506-022	135	4.34	0.78	64	69
TPP Feed Unit 2	14-June-2025	2FT 14.06.2025_202506-026	120	3.62	0.80	66	45
TPP Feed Unit 2	15-June-2025	2FT 15.06.2025_202506-030	103	2.98	0.88	71	20
TPP Feed Unit 2	16-June-2025	2FT 16.06.2025_202506-034	97	3.03	1.15	94	-1
TPP Feed Unit 2	18-June-2025	2FT 18.06.2025_(06:00)_202506-041	258	2.01	0.48	39	22
TPP Feed Unit 2	18-June-2025	2FT 18.06.2025_(18:00)_202506-043	136	2.70	1.31	107	-24
TPP Feed Unit 2	19-June-2025	2FT 19.06.2025_202506-049	106	2.27	1.26	103	-33
TPP Feed Unit 2	20-June-2025	2FT 20.06.2025_(18:00)_202506-055	235	1.02	0.89	73	-41
TPP Feed Unit 2	20-June-2025	2FT 20.06.2025_(06:00)_202506-053	369	2.33	1.53	125	-54
TPP Feed Unit 2	21-June-2025	2FT 21.06.2025_(06:00)_202506-061	250	0.63	1.67	136	-117
TPP Feed Unit 2	21-June-2025	2FT 21.06.2025_(17:00)_202506-063	452	1.86	1.40	114	-57
TPP Feed Unit 2	23-June-2025	2FT 23.06.2025_202506-068	148	1.05	1.83	150	-117
TPP Tails Unit 1	07-June-2025	1PFT 07.06.2025_202506-003	125	0.87	1.49	122	-95
TPP Tails Unit 1	08-June-2025	1PFT 08.06.2025_202506-007	100	0.92	0.97	79	-51

Sample Description	Sample Date	Sample ID	Sample Wt.	Total S	Total C	ANC _{TC} ¹	NAPP ²
			g	%		kg H2SO4/t	
TPP Tails Unit 1	09-June-2025	1PFT 09.06.2025_202506-011	121	1.75	1.09	89	-36
TPP Tails Unit 1	10-June-2025	1PFT 10.06.2025_202506-015	143	1.02	0.87	71	-40
TPP Tails Unit 1	11-June-2025	1PFT 11.06.2025_202506-019	186	0.34	1.03	84	-74
TPP Tails Unit 1	13-June-2025	1PFT 13.06.2025_202506-023	103	1.28	0.98	80	-41
TPP Tails Unit 1	14-June-2025	1PFT 14.06.2025_202506-027	157	0.64	0.68	55	-36
TPP Tails Unit 1	15-June-2025	1PFT 15.06.2025_202506-031	91	0.41	0.91	74	-62
TPP Tails Unit 1	16-June-2025	1PFT 16.06.2025_202506-035	86	1.20	1.18	96	-60
TPP Tails Unit 1	17-June-2025	1PFT 17.06.2025_202506-038	261	1.19	1.26	103	-67
TPP Tails Unit 1	18-June-2025	1PFT 18.06.2025_(06:00)_202506-044	71	0.33	0.52	42	-32
TPP Tails Unit 1	18-June-2025	1PFT 18.06.2025_(18:00)_202506-046	148	0.50	1.60	131	-115
TPP Tails Unit 1	19-June-2025	1PFT 19.06.2025_202506-050	101	0.31	1.24	101	-92
TPP Tails Unit 1	20-June-2025	1PFT 20.06.2025_(18:00)_202506-058	164	0.45	0.91	74	-60
TPP Tails Unit 1	20-June-2025	1PFT 20.06.2025_(06:00)_202506-056	177	1.28	1.48	121	-82
TPP Tails Unit 1	21-June-2025	1PFT 21.06.2025_(17:00)_202506-066	284	0.28	1.33	109	-100
TPP Tails Unit 1	21-June-2025	1PFT 21.06.2025_(06:00)_202506-064	251	0.34	1.69	138	-128
TPP Tails Unit 2	07-June-2025	2PFT 07.06.2025_202506-004	123	0.95	1.50	123	-94
TPP Tails Unit 2	08-June-2025	2PFT 08.06.2025_202506-008	94	0.70	1.07	87	-66
TPP Tails Unit 2	09-June-2025	2PFT 09.06.2025_202506-012	172	1.38	1.15	94	-52
TPP Tails Unit 2	10-June-2025	2PFT 10.06.2025_202506-016	148	0.81	0.90	73	-48
TPP Tails Unit 2	11-June-2025	2PFT 11.06.2025_202506-020	187	0.55	0.71	58	-41
TPP Tails Unit 2	13-June-2025	2PFT 13.06.2025_202506-024	139	1.43	1.08	88	-44
TPP Tails Unit 2	14-June-2025	2PFT 14.06.2025_202506-028	143	1.14	0.71	58	-23
TPP Tails Unit 2	15-June-2025	2PFT 15.06.2025_202506-032	83	0.83	0.92	75	-49
TPP Tails Unit 2	16-June-2025	2PFT 16.06.2025_202506-036	95	0.89	1.23	100	-73
TPP Tails Unit 2	17-June-2025	2PFT 17.06.2025_202506-039	273	1.69	1.32	108	-56
TPP Tails Unit 2	18-June-2025	2PFT 18.06.2025_(06:00)_202506-045	89	0.32	0.46	37	-28
TPP Tails Unit 2	18-June-2025	2PFT 18.06.2025_(18:00)_202506-047	121	0.56	1.65	135	-118
TPP Tails Unit 2	19-June-2025	2PFT 19.06.2025_202506-051	105	0.32	1.10	90	-80
TPP Tails Unit 2	20-June-2025	2PFT 20.06.2025_(06:00)_202506-057	163	0.46	1.74	142	-128
TPP Tails Unit 2	20-June-2025	2PFT 20.06.2025_(18:00)_202506-059	232	0.49	0.99	81	-66
TPP Tails Unit 2	21-June-2025	2PFT 21.06.2025_(06:00)_202506-065	273	0.29	1.70	139	-130
TPP Tails Unit 2	21-June-2025	2PFT 21.06.2025_(17:00)_202506-067	362	0.37	1.25	102	-91
TPP Tails Unit 2	23-June-2025	2PFT 23.06.2025_202506-070	116	0.20	2.05	167	-161
TPP Tails Unit 2	23-June-2025	2PFT 23.06.2025_202506-069	120	0.80	3.45	282	-257

¹ANC_{TC} calculated from Total C

²NAPP calculated using Total S and ANC_{TC}

Table A 2: Sequential NAG results for selected Feed and Tails

EGi Sample Code	Sample Description	Total S (%)	ANC	NAPP	STAGE 1			STAGE 2			STAGE 3			STAGE 4			Cumulative NAG	
					NAGpH	NAG _(pH4.5)	NAG _(pH7.0)	NAGpH	NAG _(pH4.5)	NAG _(pH7.0)	NAGpH	NAG _(pH4.5)	NAG _(pH7.0)	NAGpH	NAG _(pH4.5)	NAG _(pH7.0)	NAG _(pH4.5)	NAG _(pH7.0)
					(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)	(kg H ₂ SO ₄ /t)
28168	TPP Feed 10/06/2025_Unit 2	6.53	60	140	7.8	0	0	2.4	40	56	2.3	59	64	2.6	10	13	109	132
28167	TPP Feed 11/06/2025_Unit 2	2.45	62	13	9.2	0	0	7.8	0	0	5.3	0	1	2.8	11	14	11	14
28164	TPP Feed 13/06/2025_Unit 1	4.47	59	78	7.7	0	0	2.5	30	41	2.6	25	28	3.3	2	4	58	73
28165	TPP Feed 21/06/2025 06:00_Unit 2	0.67	128	-107	9.1	0	0	7.5	0	0	8.1	0	0	8.3	0	0	0	0
28166	TPP Feed 21/06/2025 17:00_Unit 2	1.88	70	-12	8.3	0	0	7.6	0	0	7.9	0	0	7.8	0	0	0	0
28170	TPP Tails 07/06/2025_Unit 1	1.01	91	-60	8.3	0	0	7.6	0	0	7.8	0	0	8.3	0	0	0	0
28173	TPP Tails 09/06/2025_Unit 1	2.19	79	-12	8.2	0	0	8.1	0	0	8.7	0	0	8.0	0	0	0	0
28171	TPP Tails 10/06/2025_Unit 1	1.10	61	-27	8.8	0	0	7.8	0	0	8.9	0	0	8.2	0	0	0	0
28178	TPP Tails 10/06/2025_Unit 2	0.97	57	-27	8.9	0	0	7.8	0	0	8.4	0	0	8.4	0	0	0	0
28169	TPP Tails 14/06/2025_Unit 1	0.73	53	-31	8.7	0	0	7.3	0	0	7.3	0	0	7.6	0	0	0	0
28175	TPP Tails 18/06/2025 06:00_Unit 2	0.37	38	-27	8.6	0	0	8.3	0	0	8.1	0	0	7.8	0	0	0	0
28172	TPP Tails 20/06/2025 06:00_Unit 1	0.69	106	-85	8.6	0	0	8.0	0	0	9.5	0	0	9.3	0	0	0	0
28177	TPP Tails 20/06/2025 18:00_Unit 2	0.35	66	-55	9.4	0	0	8.7	0	0	8.7	0	0	8.9	0	0	0	0
28176	TPP Tails 21/06/2025 17:00_Unit 2	0.38	71	-59	9.1	0	0	8.4	0	0	8.9	0	0	8.7	0	0	0	0
28174	TPP Tails 23/06/2025_Unit 2	0.23	119	-112	8.4	0	0	8.6	0	0	8.5	0	0	9.4	0	0	0	0

Table A 3: Elemental analyses of TPP tailings slurries collected in June 2025.

Sample ID	Sampling Date	Sampling Point	Sample Wt. (g)	Total S Eltra (%)	Al ₂ O ₃ (%)	As (ppm)	Bi (ppm)	CaO (%)	Cu XRF (%)	Fe (%)	K ₂ O (%)	MgO (%)	Mo (ppm)	Ni (ppm)	Pb (ppm)	SiO ₂ (%)	TiO ₂ (ppm)	Zn (ppm)	Ca (%)	ANC_Ca (kg H ₂ SO ₄ /t)	NAPPCa (kg H ₂ SO ₄ /t)	Total C (%)	ANC_TC (kg H ₂ SO ₄ /t)	NAPP_TC (kg H ₂ SO ₄ /t)
TPP Tails Unit 1	07-June-2025	1PFT 07.06.2025_C24 SLURRY	1640.26	0.92	12.1	<20	<10	7.18	0.05	9.00	3.8	1.34	<80	<50	<80	50.4	5520	140	5.1	126	-98	1.49	122	-94
TPP Tails Unit 1	08-June-2025	1PFT 08.06.2025_C24 SLURRY	1208.21	1.04	14.0	<20	<10	5.07	0.04	5.89	4.7	1.07	<80	<50	<80	56.3	5160	140	3.6	89	-57	0.97	79	-48
TPP Tails Unit 1	09-June-2025	1PFT 09.06.2025_C24 SLURRY	2350.12	2.23	13.4	<20	<10	6.97	0.03	6.76	4.7	1.40	<80	61	<80	54.6	4940	100	5.0	122	-54	1.09	89	-21
TPP Tails Unit 1	10-June-2025	1PFT 10.06.2025_C24 SLURRY	1281.3	1.29	13.6	80	<10	5.97	0.07	7.57	4.7	1.53	<80	<50	<80	52.4	4900	80	4.3	105	-65	0.87	71	-31
TPP Tails Unit 1	11-June-2025	1PFT 11.06.2025_C24 SLURRY	2055.55	0.31	13.5	80	<10	6.65	0.05	6.18	4.7	1.40	<80	<50	<80	52.6	4760	60	4.8	116	-107	1.03	84	-75
TPP Tails Unit 1	26-June-2025	1PFT 26.06.2025_C24 SLURRY	2047.51	0.19	12.4	<20	<10	10.60	0.07	9.64	3.5	1.54	<80	1777	<80	51.3	3880	80	7.6	186	-180	2.08	170	-164
TPP Tails Unit 1	27-June-2025	1PFT 27.06.2025_C24 SLURRY	990.84	0.24	12.3	<20	17	8.26	0.17	7.99	3.8	1.29	<80	218	<80	52.1	3720	60	5.9	145	-137	1.51	123	-116
TPP Tails Unit 1	28-June-2025	1PFT 28.06.2025_C24 SLURRY	1858.34	0.25	13.5	<20	<10	9.38	0.06	7.20	3.7	1.36	<80	<50	<80	56.2	4980	80	6.7	164	-157	1.78	146	-138
TPP Tails Unit 1	29-June-2025	1PFT 29.06.2025_C24 SLURRY	1162.27	0.09	13.3	<20	<10	15.40	0.04	7.73	2.4	2.55	<80	<50	<80	48.4	4980	100	11.0	270	-267	3.24	265	-262
TPP Tails Unit 2	07-June-2025	2PFT 07.06.2025_C24 SLURRY	1491.54	0.92	12.2	<20	13	7.64	0.06	8.82	3.9	1.35	<80	<50	<80	51.2	5520	120	5.5	134	-106	1.50	123	-94
TPP Tails Unit 2	08-June-2025	2PFT 08.06.2025_C24 SLURRY	2086.49	0.65	14.0	<20	<10	6.21	0.05	8.03	4.5	1.19	<80	<50	<80	57.0	5760	100	4.4	109	-89	1.07	87	-68
TPP Tails Unit 2	09-June-2025	2PFT 09.06.2025_C24 SLURRY	2506.83	1.38	13.8	<20	<10	7.37	0.04	6.34	4.8	1.05	<80	<50	<80	56.9	4920	100	5.3	129	-87	1.15	94	-52
TPP Tails Unit 2	10-June-2025	2PFT 10.06.2025_C24 SLURRY	2993.62	1.02	13.4	60	<10	6.31	0.08	7.60	4.8	1.54	<80	<50	<80	52.0	4520	80	4.5	110	-79	0.90	73	-42
TPP Tails Unit 2	11-June-2025	2PFT 11.06.2025_C24 SLURRY	3032.17	0.62	14.8	20	<10	5.61	0.06	7.71	4.7	1.64	<80	<50	<80	55.1	5340	60	4.0	98	-79	0.71	58	-39
TPP Tails Unit 2	26-June-2025	2PFT 26.06.2025_C24 SLURRY	3182.0	0.27	12.1	<20	22	9.67	0.09	9.27	3.4	1.47	<80	196	<80	50.7	3780	80	6.9	169	-161	1.85	151	-143
TPP Tails Unit 2	27-June-2025	2PFT 27.06.2025_C24 SLURRY	1889.0	0.46	12.7	<20	<10	8.21	0.07	8.37	3.8	1.24	<80	107	<80	54.2	3820	60	5.9	144	-130	1.50	122	-108
TPP Tails Unit 2	28-June-2025	2PFT 28.06.2025_C24 SLURRY	2115.1	0.43	13.0	<20	<10	8.42	0.05	7.21	3.7	1.16	<80	<50	<80	55.9	4680	60	6.0	147	-134	1.55	127	-114
TPP Tails Unit 2	29-June-2025	2PFT 29.06.2025_C24 SLURRY	2072.8	0.39	12.9	20	37	16.60	0.06	8.12	2.2	2.46	<80	<50	<80	46.9	4960	100	11.9	291	-279	3.53	288	-277

Table A 4: Elemental contents and GAI (Global Abundance Index) values of composited tailings sample and fractions obtained by wet sieving. GAI values ≥ 3 indicate significant enrichment.

Element	Detection Limit	Sample Number					Element	Median Soil Abundance*	Sample Number				
		Sample 3 +75 μm pulp	Sample 7 +38- 75 μm pulp	Sample 9 -38 pulp	Mix 1 Bulk tailings	Mix 2 -75 μm tailings			Sample 3 +75 μm pulp	Sample 7 +38- 75 μm pulp	Sample 9 -38 pulp	Mix 1 Bulk tailings	Mix 2 -75 μm tailings
Ag	0.01	0.27	0.24	1.2	0.52	0.84	Ag	0.05	2	2	4	3	3
Al	0.01%	7.34%	6.38%	7.11%	6.98%	6.83%	Al	7.1%	-	-	-	-	-
As	0.2	4.9	6.9	13.1	6.9	10.7	As	6	-	-	1	-	-
Ba	10	520	380	380	430	380	Ba	500	-	-	-	-	-
Be	0.05	2.1	2.12	2.63	2.22	2.43	Be	0.3	2	2	3	2	2
Bi	0.01	0.62	0.62	3.35	1.39	2.87	Bi	0.2	1	1	3	2	3
Ca	0.01%	6.10%	6.57%	5.63%	6.03%	5.88%	Ca	1.5%	1	2	1	1	1
Cd	0.02	0.11	0.11	0.31	0.18	0.24	Cd	0.35	-	-	-	-	-
Ce	0.01	102.5	116	121	100	119.5	Ce	50	-	1	1	-	1
Co	0.1	7.1	12.2	17.2	11	15.6	Co	8	-	-	1	-	-
Cr	1	86	25	127	53	89	Cr	70	-	-	-	-	-
Cs	0.05	1.92	1.78	5.81	3	4.34	Cs	4	-	-	-	-	-
Cu	0.2	491	184	832	512	607	Cu	30	3	2	4	4	4
Fe	0.01%	5.99%	10.70%	10.50%	8.27%	10.30%	Fe	4.0%	-	1	1	-	1
Ga	0.05	20.6	19.25	23.3	20.6	22.1	Ga	20	-	-	-	-	-
Ge	0.05	0.13	0.16	0.2	0.14	0.18	Ge	1	-	-	-	-	-
Hf	0.01	1.3	1.3	1.1	1.3	1.2	Hf	6	-	-	-	-	-
Hg	0.005	<0.005	0.009	0.028	0.015	0.016	Hg	0.06	-	-	-	-	-
In	0.005	0.345	0.406	0.523	0.395	0.471	In	1	-	-	-	-	-
K	0.01%	3.68%	3.19%	3.55%	3.41%	3.44%	K	1.4%	1	1	1	1	1
La	0.5	69.4	77.8	74.1	64.8	77.3	La	40	-	-	-	-	-
Li	0.2	10.8	12.7	20.5	13.9	17.8	Li	25	-	-	-	-	-
Mg	0.01%	0.92%	1.04%	1.23%	1.03%	1.17%	Mg	0.5%	-	-	1	-	1
Mn	5	1185	1485	1800	1425	1680	Mn	1000	-	-	-	-	-
Mo	0.05	21.8	8.09	26.6	13.85	21.1	Mo	1.2	4	2	4	3	4
Na	0.01%	2.11%	1.77%	1.55%	1.84%	1.62%	Na	0.5%	1	1	1	1	1
Nb	0.1	7.5	7.6	7.8	7.2	8	Nb	10	-	-	-	-	-
Ni	0.2	5.4	6.1	12.4	6.6	9.8	Ni	50	-	-	-	-	-
P	10	800	1020	970	880	970	P	800	-	-	-	-	-
Pb	0.5	10.1	10.1	41	19.4	31.1	Pb	35	-	-	-	-	-
Rb	0.1	122	108.5	139.5	116	130	Rb	150	-	-	-	-	-
S	0.01%	0.44%	0.74%	1.40%	0.77%	1.15%	S	0.07%	2	3	4	3	3
Sb	0.05	0.27	0.3	0.46	0.3	0.41	Sb	1	-	-	-	-	-
Sc	0.1	5.8	6	8.8	6.8	8.1	Sc	7	-	-	-	-	-
Se	1	1	1	3	1	2	Se	0.4	1	1	2	1	2
Sn	0.2	7.6	10.1	9.9	8.3	9.7	Sn	4	-	1	1	-	1
Sr	0.2	759	647	560	653	593	Sr	250	1	1	1	1	1
Ta	0.05	0.42	0.4	0.43	0.39	0.42	Ta	2	-	-	-	-	-
Th	0.2	7.24	8.16	10.05	7.91	11.15	Th	9	-	-	-	-	-
Ti	0.005%	0.25%	0.25%	0.27%	0.24%	0.26%	Ti	0.50%	-	-	-	-	-
Tl	0.02	0.61	0.53	0.98	0.69	0.82	Tl	0.2	1	1	2	1	1
U	0.1	6.1	6.7	11	7.7	10	U	2	1	1	2	1	2
V	1	117	135	200	149	176	V	90	-	-	1	-	-
W	0.1	8.5	11.2	18.1	11.6	15	W	1.5	2	2	3	2	3
Y	0.1	14	16.1	18.4	15.5	17.6	Y	40	-	-	-	-	-
Zn	2	63	78	160	92	128	Zn	90	-	-	-	-	-
Zr	0.5	42.4	42.2	42	40.4	42	Zr	400	-	-	-	-	-

< element at or below analytical detection limit.

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

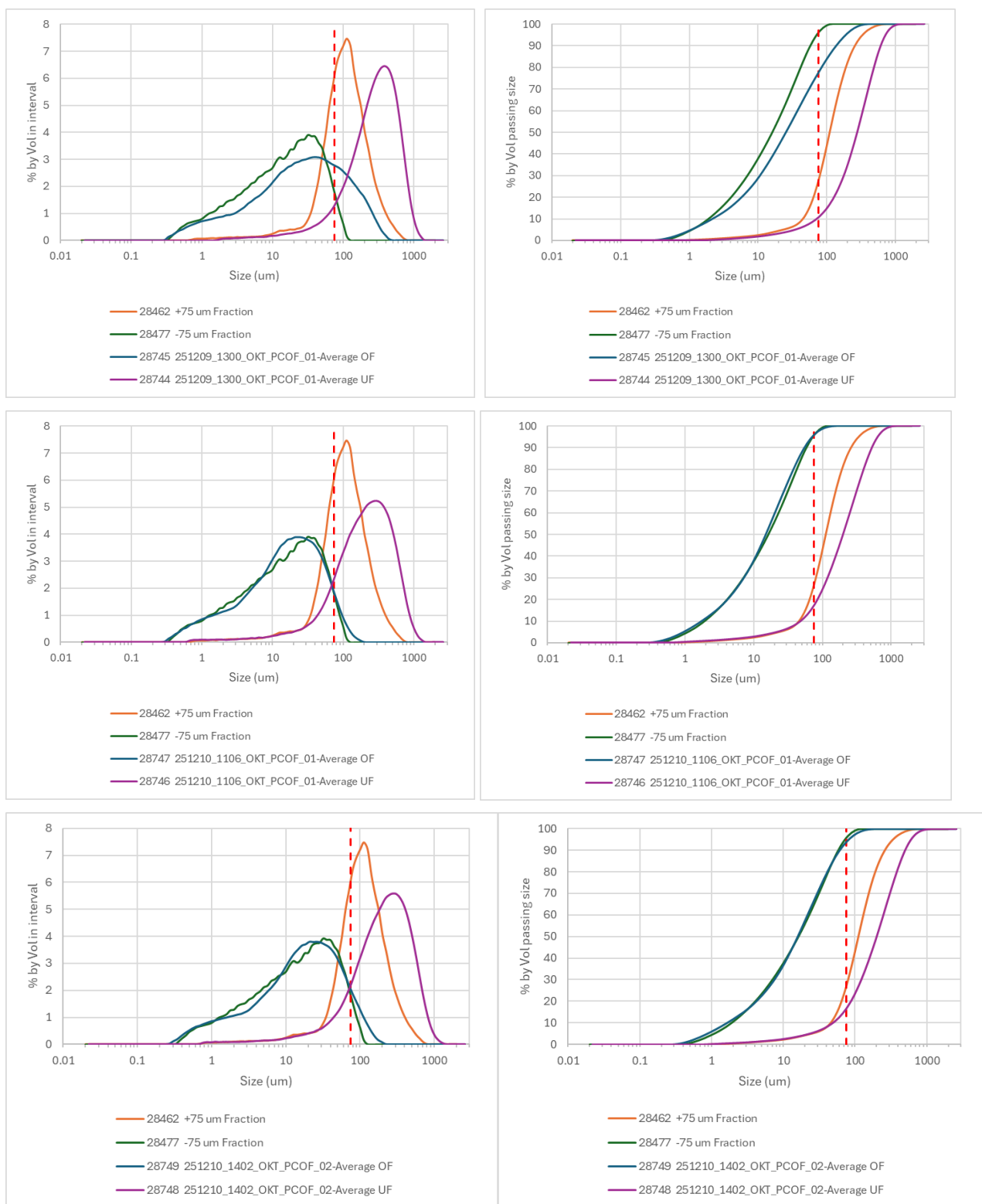


Figure A 1: Frequency and Cumulative size distributions of +75 μm and -75 μm fractions by wet sieving and additional replicates of cyclone underflow (UF) and overflow (OF). The vertical dashed line shows 75 μm .

Appendix B

TPP TAILINGS FREE DRAINING LEACH COLUMN TEST RESULTS

Table B 1: Column leach test results of Bulk Tailings - Free Draining Column Leachate

		Sample Characteristics								
		Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start	Sample
		%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date	Code
		0.72	75	-53	0	0	8.2	1714	10/11/25	28476

Parameters		Week								
		0	4	8	12	16	20	24	28	32
		24-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26	13-Apr-26			
		28476-Initial	28476-1	28476-2	28476-3	28476-4	28476-5	28476-6	28476-7	28476-8
Volume	ml	552	499	492	486	489				
pH	-	7.8	7.2	7.4	7.6	7.6				
EC	dS/m	2.32	2.41	2.29	2.19	2.11				
Alkalinity	mg/l	131	52	36	32	34				
Acidity	mg/l	-	-	-	-	-				
Ag	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Al	mg/l	<0.01	<0.01	<0.01	<0.01	0.01				
As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
B	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Ba	mg/l	0.04	0.04	0.03	0.03	0.03				
Be	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Ca	mg/l	588	609	579	581	613				
Cd	mg/l	0.0003	<0.0001	<0.0001	0.0001	0.0005				
Cl	mg/l	77	16	4	2	<1				
Co	mg/l	0.01	0.003	0.003	0.002	0.002				
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cu	mg/l	0.021	0.013	0.009	0.008	0.009				
F	mg/l	0.8	2.0	2.0	2.4	2.4				
Fe	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
K	mg/l	49	46	43	34	31				
Mg	mg/l	38	48	46	38	29				
Mn	mg/l	2.76	1.47	1.79	1.77	1.73				
Mo	mg/l	0.064	0.151	0.122	0.112	0.216				
Na	mg/l	47	34	19	13	11				
Ni	mg/l	0.01	0.00	0.001	0.001	<0.001				
P	mg/l	<1	<1	<1	<1	<1				
Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Sb	mg/l	0.001	<0.001	<0.001	<0.001	<0.001				
Se	mg/l	0.059	0.37	0.13	0.05	0.03				
Si	mg/l	7.1	3.8	3.6	3.5	3.6				
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
SO ₄	mg/l	1860	2000	1590	1680	1560				
Sr	mg/l	4.08	4.51	3.97	3.35	3.38				
Th	mg/l	0.003	<0.001	<0.001	<0.001	<0.001				
Tl	mg/l	0.001	<0.001	<0.001	<0.001	<0.001				
U	mg/l	0.010	0.002	0.001	<0.001	0.001				
Zn	mg/l	0.01	<0.005	<0.005	0.01	0.02				

Table B 2: Column leach test results of +75µm Tailings - Free Draining Column Leachate

		Sample Characteristics								
		Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start	Sample
		%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date	Code
		0.38	69	-57	0	0	8.4	2000	10/11/25	28462
Parameters		Week								
		0	4	8	12	16	20	24	28	32
		24-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26				
		28462-Initial	28462-1	28462-2	28462-3	28462-4	28462-5	28462-6	28462-7	28462-8
Volume	ml	513	492	486	488	491				
pH	-	7.8	7.4	7.6	7.7	7.8				
EC	dS/m	0.812	0.38	0.34	0.38	0.43				
Alkalinity	mg/l	68	44	60	56	51				
Acidity	mg/l	-	-	-	-	-				
Ag	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Al	mg/l	0.01	0.02	0.02	<0.01	0.01				
As	mg/l	<0.001	0.001	0.001	0.001	0.001				
B	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Ba	mg/l	0.01	0.01	0.01	0.04	0.01				
Be	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Ca	mg/l	147	76	67	76	100				
Cd	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
Cl	mg/l	22	2	<1	2	1				
Co	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cu	mg/l	0.027	0.008	0.015	0.013	0.012				
F	mg/l	0.8	1.1	0.8	0.8	0.7				
Fe	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
K	mg/l	11	8	7	7	8				
Mg	mg/l	7	4	4	4	6				
Mn	mg/l	0.128	0.08	0.07	0.10	0.13				
Mo	mg/l	0.037	0.076	0.110	0.141	0.192				
Na	mg/l	6	3	2	5	3				
Ni	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
P	mg/l	<1	<1	<1	<1	<1				
Pb	mg/l	0.002	<0.001	<0.001	<0.001	<0.001				
Sb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Se	mg/l	0.009	0.01	0.01	0.01	0.01				
Si	mg/l	4.9	7.3	6.4	5.4	6.4				
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
SO ₄	mg/l	418	186	154	177	233				
Sr	mg/l	0.89	0.51	0.44	0.49	0.67				
Th	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Tl	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
U	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Zn	mg/l	0.01	<0.005	<0.005	<0.005	<0.005				

Table B 3: Column leach test results of -75µm Tailings - Free Draining Column Leachate

Sample Characteristics								
Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start	Sample
%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date	Code
1.03	76	-44	0	0	8.3	1779	10/11/25	28477

Parameters		Week								
		0	4	8	12	16	20	24	28	32
		24-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26	13-Apr-26			
		28477-Initial	28477-1	28477-2	28477-3	28477-4	28477-5	28477-6	28477-7	28477-8
Volume	ml	542	497	485	481	487				
pH	-	7.7	5.5	7.4	7.5	7.6				
EC	dS/m	2.07	2.74	2.42	2.36	2.31				
Alkalinity	mg/l	96	-	38	42	36				
Acidity	mg/l	-	25	-	-	-				
Ag	mg/l	<0.001	0.002	<0.001	<0.001	<0.001				
Al	mg/l	<0.01	0.01	<0.01	<0.01	<0.01				
As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
B	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Ba	mg/l	0.07	0.08	0.06	0.05	0.06				
Be	mg/l	<0.001	<0.001	<0.001	<0.001	0.003				
Ca	mg/l	599	720	675	600	669				
Cd	mg/l	0.0002	0.0003	0.0001	0.0001	0.0002				
Cl	mg/l	28	374	12	5	2				
Co	mg/l	0.007	0.008	0.005	0.003	0.004				
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cu	mg/l	0.022	0.071	0.008	0.005	0.007				
F	mg/l	0.8	1.3	1.9	2.4	2.4				
Fe	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
K	mg/l	40	42	47	41	45				
Mg	mg/l	37	62	63	60	62				
Mn	mg/l	2.46	3.32	2.47	2.28	2.600				
Mo	mg/l	0.064	0.092	0.107	0.128	0.174				
Na	mg/l	31	38	38	34	28				
Ni	mg/l	0.007	0.004	0.001	0.001	0.002				
P	mg/l	<1	<1	<1	<1	<1				
Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Sb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Se	mg/l	0.05	0.64	0.51	0.26	0.13				
Si	mg/l	11.9	7.5	4.5	4.0	3.7				
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
SO ₄	mg/l	1710	2910	1710	1840	1770				
Sr	mg/l	3.76	5.30	4.94	4.01	4.73				
Th	mg/l	0.002	<0.001	<0.001	<0.001	<0.001				
Tl	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
U	mg/l	0.009	0.003	0.002	0.001	0.001				
Zn	mg/l	0.01	0.01	0.02	0.01	<0.005				

Appendix C

TPP TAILINGS SATURATED LEACH COLUMN TEST RESULTS

Table C 1: Column leach test results of Bulk Tailings - Saturated Column Leachate

		Sample Characteristics								
		Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start	Sample
		%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date	Code
		0.72	75	-53	0	0	8.2	1716	10/11/25	28477Sat

Parameters		Week								
		0	4	8	12	16	20	24	28	32
		25-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26	13-Apr-26			
		28476Sat-Init	28476Sat-1	28476Sat-2	28476Sat-3	28476Sat-4	28476Sat-5	28476Sat-6	28476Sat-7	28476Sat-8
Volume	ml	311	310	310	311	422				
pH	-	8.1	7.9	7.2	7.1	7.4				
EC	dS/m	2.86	1.03	1.34	1.88	0.92				
Alkalinity	mg/l	192	216	479	466	489				
Acidity	mg/l	-	-	-	-	-				
Ag	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Al	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01				
As	mg/l	0.011	0.007	0.014	0.006	0.007				
B	mg/l	0.31	0.17	0.14	0.09	0.05				
Ba	mg/l	0.19	0.11	0.28	0.22	0.10				
Be	mg/l	0.002	<0.001	<0.001	<0.001	0.002				
Ca	mg/l	399	184	362	539	250				
Cd	mg/l	0.0004	<0.0001	<0.0001	<0.0001	<0.0001				
Cl	mg/l	463	36	15	8	5				
Co	mg/l	0.001	<0.001	0.002	<0.001	0.001				
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cu	mg/l	0.1	0.004	0.010	0.004	0.005				
F	mg/l	0.3	0.8	0.6	0.6	0.9				
Fe	mg/l	<0.05	<0.05	0.68	0.21	0.06				
Hg	mg/l	0.0003	<0.0001	<0.0001	<0.0001	<0.0001				
K	mg/l	51	30	36	31	24				
Mg	mg/l	65	20	24	29	16				
Mn	mg/l	0.282	0.58	1.91	1.80	0.57				
Mo	mg/l	0.069	0.108	0.020	0.009	0.021				
Na	mg/l	255	49	26	20	13				
Ni	mg/l	0.002	0.001	<0.001	<0.001	0.002				
P	mg/l	<1	<1	<1	<1	<1				
Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Sb	mg/l	0.001	<0.001	<0.001	<0.001	<0.001				
Se	mg/l	<0.004	0.01	<0.004	<0.004	<0.004				
Si	mg/l	9.2	9.7	11.7	12.4	12.5				
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
SO ₄	mg/l	1260	467	29	6	12				
Sr	mg/l	2.93	1.45	3.19	4.12	2.15				
Th	mg/l	0.001	<0.001	<0.001	<0.001	<0.001				
Tl	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
U	mg/l	0.002	<0.001	<0.001	<0.001	<0.001				
Zn	mg/l	0.01	<0.005	0.01	0.01	<0.005				

Table C 2: Column leach test results of Bulk Tailings - Saturated Column Supernatant

		Sample Characteristics								
		Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start	Sample
		%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date	Code
		0.72	75	-53	0	0	8.2	-	-	28476SatSup

Parameters		Week								
		0	4	8	12	16	20	24	28	32
		25-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26	13-Apr-26			
		28476Sup-Init	28476Sup-1	28476Sup-2	28476Sup-3	28476Sup-4	28476Sup-5	28476Sup-6	28476Sup-7	28476Sup-8
Volume	ml	300	301	301	301	301				
pH	-	8.0	7.9	7.9	8.0	8.0				
EC	dS/m	0.371	0.41	0.36	0.34	0.29				
Alkalinity	mg/l	49	98	97	88	103				
Acidity	mg/l	-	-	-	-	-				
Ag	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Al	mg/l	0.02	0.01	0.01	<0.01	<0.01				
As	mg/l	0.001	<0.001	<0.001	<0.001	<0.001				
B	mg/l	0.09	0.06	<0.05	<0.05	<0.05				
Ba	mg/l	0.02	0.02	0.02	0.01	0.02				
Be	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Ca	mg/l	91	95	72	70	59				
Cd	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
Cl	mg/l	16	12	8	4	3				
Co	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Cu	mg/l	0.007	0.005	0.012	0.009	0.008				
F	mg/l	0.3	0.6	0.6	0.7	0.7				
Fe	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05				
Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
K	mg/l	15	14	11	11	10				
Mg	mg/l	8	6	4	4	4				
Mn	mg/l	0.142	0.32	0.28	0.29	0.25				
Mo	mg/l	0.023	0.032	0.024	0.023	0.031				
Na	mg/l	23	10	6	5	4				
Ni	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
P	mg/l	<1	<1	<1	<1	<1				
Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Sb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Se	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004				
Si	mg/l	2.3	4.0	3.7	3.7	3.9				
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
SO ₄	mg/l	161	179	115	77	57				
Sr	mg/l	0.63	0.65	0.47	0.44	0.42				
Th	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
Tl	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001				
U	mg/l	0.001	0.001	<0.001	<0.001	<0.001				
Zn	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005				

Table C 3: Column leach test results of -75µm Tailings - Saturated Column Leachate

		Sample Characteristics							
		Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start
		%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date
		1.03	76	-44	0	0	8.3	1756	10/11/25
		28477Sat							

Parameters		Week							
		0	4	8	12	16	20	24	28
		25-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26	13-Apr-26		
		28477Sat-Init	28477Sat-1	28477Sat-2	28477Sat-3	28477Sat-4	28477Sat-5	28477Sat-6	28477Sat-7
Volume	ml	308	312	313	312	362			
pH	-	8.0	7.9	7.9	8.0	8.1			
EC	dS/m	3.34	1.66	1.14	0.82	0.55			
Alkalinity	mg/l	192	197	199	177	268			
Acidity	mg/l	-	-	-	-	-			
Ag	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Al	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01			
As	mg/l	0.009	0.008	0.008	0.011	0.013			
B	mg/l	0.39	0.17	0.10	0.10	0.08			
Ba	mg/l	0.19	0.13	0.10	0.07	0.28			
Be	mg/l	<0.001	<0.001	<0.001	<0.001	0.001			
Ca	mg/l	568	406	238	155	135			
Cd	mg/l	0.0004	<0.0001	<0.0001	<0.0001	<0.0001			
Cl	mg/l	483	25	13	7	6			
Co	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Cu	mg/l	0.041	0.006	0.005	0.003	0.003			
F	mg/l	0.2	0.5	0.7	0.9	0.9			
Fe	mg/l	<0.05	0.06	<0.05	<0.05	<0.05			
Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			
K	mg/l	50	35	30	23	25			
Mg	mg/l	93	38	23	16	16			
Mn	mg/l	0.415	1.03	0.60	0.59	0.47			
Mo	mg/l	0.041	0.070	0.058	0.035	0.028			
Na	mg/l	285	43	25	20	20			
Ni	mg/l	0.002	0.001	<0.001	<0.001	0.001			
P	mg/l	<1	<1	<1	<1	<1			
Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Sb	mg/l	0.001	<0.001	<0.001	<0.001	<0.001			
Se	mg/l	0.031	<0.004	<0.004	<0.004	0.01			
Si	mg/l	16.4	17.0	13.1	11.7	13.0			
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
SO ₄	mg/l	1740	1150	525	249	76			
Sr	mg/l	3.80	2.87	1.65	1.12	1.14			
Th	mg/l	0.001	<0.001	<0.001	<0.001	<0.001			
Tl	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
U	mg/l	0.003	0.005	0.004	0.002	<0.001			
Zn	mg/l	0.01	<0.005	<0.005	<0.005	<0.005			

Table C 4: Column leach test results of -75µm Tailings - Saturated Column Supernatant

		Sample Characteristics							
		Sulphur	ANC	NAPP	NAG _{4.5}	NAG _{7.0}	NAGpH	Weight	Start
		%S	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t	kgH ₂ SO ₄ /t		g	Date
		1.03	76	-44	0	0	8.3	-	-
		28477SatSup							

Parameters		Week							
		0	4	8	12	16	20	24	28
		25-Nov-25	22-Dec-25	19-Jan-26	16-Feb-26	16-Mar-26	13-Apr-26		
		28477Sup-Init	28477Sup-1	28477Sup-2	28477Sup-3	28477Sup-4	28477Sup-5	28477Sup-6	28477Sup-7
Volume	ml	301	301	301	300	301			
pH	-	8.0	7.8	7.9	8.0	8.0			
EC	dS/m	0.431	0.55	0.49	0.46	0.39			
Alkalinity	mg/l	59	101	93	85	90			
Acidity	mg/l	-	-	-	-	-			
Ag	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Al	mg/l	0.03	<0.01	<0.01	<0.01	<0.01			
As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
B	mg/l	0.06	<0.05	<0.05	<0.05	<0.05			
Ba	mg/l	0.01	0.02	0.01	0.01	0.01			
Be	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Ca	mg/l	80	117	113	117	79			
Cd	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			
Cl	mg/l	7	6	5	4	3			
Co	mg/l	<0.001	0.001	<0.001	<0.001	<0.001			
Cr	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Cu	mg/l	0.005	0.007	0.013	0.007	0.007			
F	mg/l	0.4	0.6	0.7	0.9	0.8			
Fe	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05			
Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			
K	mg/l	11	13	14	13	10			
Mg	mg/l	5	7	7	8	5			
Mn	mg/l	0.2	0.42	0.37	0.33	0.12			
Mo	mg/l	0.013	0.030	0.024	0.032	0.037			
Na	mg/l	7	8	7	7	5			
Ni	mg/l	<0.001	0.00	<0.001	<0.001	<0.001			
P	mg/l	<1	<1	<1	<1	<1			
Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Sb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Se	mg/l	0.005	0.01	0.00	0.02	<0.004			
Si	mg/l	3.7	5.4	5.0	4.4	4.2			
Sn	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
SO ₄	mg/l	213	251	199	203	139			
Sr	mg/l	0.50	0.74	0.68	0.71	0.48			
Th	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
Tl	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001			
U	mg/l	<0.001	0.002	0.002	0.001	<0.001			
Zn	mg/l	<0.005	<0.005	<0.005	0.01	<0.005			



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