Appendix E Acid and Metalliferous Drainage Studies (GHD and Graeme Campbell and Associates Pty Ltd)

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1412/2

COMPANY:	Talison Lithium Australia Pty Ltd
ATTENTION:	Steve Green
FROM:	Graeme Campbell
SUBJECT:	Greenbushes Mine: Appraisal of Drainage-water Quality from Floyd's Dump and Implications for Future Mine-waste Management

NO. PAGES (including this page): 20 DATE: 17th February 2014

Steve,

My appraisal of the monitoring results for drainage-water quality for Floyd’s Dump, and implications for the proposed future dumping of mine-wastes (i.e. waste-dump extension), are outlined below.

Implications for on-going management of Floyd's dump are also highlighted.

It is noted that the 24/7 generation of drainage-water by Floyd’s dump is a rare occurrence at hard-rock mines in Western Australia.

Furthermore, the monthly monitoring of drainage-water quality over a 16 year period of record enables a first-hand assessment of the integrated dynamics of weathering at "whole-dump-scale".

1.0 QUALITY OF DRAINAGE-WATER FROM FLOYD’S DUMP

Time-series plots for selected parameters over the period 1997-2013 are shown on Figures 1-5.[1]

1.1 pH, Alkalinity and Elution of "Connate-salts"

The drainage-water has consistently been neutral-to-alkaline (viz. pH 7+) [Figure 1], and is well-buffered by carbonate species (chiefly HCO_3) [Figure 2], due to dissolution of calcite in the amphibolites (see below).

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[1] The plots shown on Figures 1-5 are derived from the site's Environmental Database for water-quality monitoring.

The electrical-conductivity (EC) values are within the range 2,500-3,500 µS/cm seasonally, and reflect sulphates dominating over chlorides.

Variations in the Na and Cl concentrations are seasonally "in-phase" (Figure 3), and reflect varying contributions from:

(a) "matrix-porefluids" (i.e. porefluids flowing through finer-pore pathways) which contribute most to drainage-water during the summer (= 'base-flow') months; and,

(b) "macropore-flow" during winter/spring which predominate when recharge rates peak.

The "NaCl" flushed from the dump represents elution of solutes present in mine-waste *in situ* (cf. solutes [e.g. sulphates] generated through weathering after mine-wastes have being placed on the waste-dump). The seasonal maxima and minima in the Na and Cl concentrations are accordingly coincident.

The HCO_3 concentrations within the broad range 50-150 mg/L exceed the *c.* 20-30 mg/L typical of calcite solubility under ambient conditions in equilibrium with atmospheric-CO_2 (Figure 2). Such elevated HCO_3 concentrations reflect circum-neutral buffering via calcite dissolution arising from the slow oxidation of trace-sulphides in the mine-wastes.

Although difficult to quantify *a priori*, the HCO_3-enriched porefluids must promote formation of Fe(III)-oxyhydroxide phases (e.g. ferrihydrite-type phases) as armouring deposits (likely of colloidal dimensions) on reactive sites of sulphide-grain surfaces, thereby reducing the rate of oxidation of the trace-sulphides (e.g. Huminicki and Rimstidt 2009; Miller *et al.* 2003).[2]

1.2 Oxidation of Trace-sulphides and Fate of Sulphate

The temporal trends in the Cl and SO_4 concentrations are seasonally "out-of-phase" (Figure 4), viz.

- <u>winter/spring</u>
    - maxima in SO_4 concentration, due to flushing of SO_4 produced by sulphide-oxidation in macropore pathways during the preceding summer
    - minima in Cl concentration, due to loss of Cl from historic flushing of macropore pathways (i.e. no generation of "new" Cl through geochemical weathering)

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[2] <u>References</u>:
Huminicki DMC and Rimstidt JD, 2009, "Iron oxyhydroxide coating of pyrite for acid mine drainage control", *Applied Geochemistry*, <u>24</u>:1626-1634
Miller S, Smart R, Andrina J, Neale A and Richards D, 2003, "Evaluation of limestone covers and blends for long-term acid rock drainage control at the Grasberg Mine, Papua Province, Indonesia", pp. 133-141 in the "6th International Conference on Acid Rock Drainage", Cairns, Queensland, 12-18 July 2003

- summer

  - minima in SO_4 concentration, due to constrained sulphide-oxidation in (chiefly saturated) the finer-pore pathways associated with matrix-flow

  - maxima in Cl concentration, due to matrix-flow domination

Since about 2004, the seasonal maxima and minima for SO_4 and Cl concentrations have been stable, and indicate the establishment of steady-state dynamics in terms of:

(a) dumping of "new" (typically dry) mine-waste which needs to be first "wetted-up" from infiltration before contributing to weathering and solute transport;

(b) net rainfall infiltration (as influenced by partial capping works with clayey strata); and,

(c) sulphide-oxidation within, and flushing of solutes from, "historical" and "new" (from recently dumped mine-wastes) flow pathways.

The peak SO_4 concentrations of *c.* 1,200-1,300 mg/L fall just shy of the 1,600 mg/L typically observed for gypsum equilibrium solubility in dilute systems. The fact that the SO_4 concentrations exhibit a sharp peak at their maxima reflects the oxidation of "minute/trace" amounts of sulphides being the chief source of the SO_4.

1.3 Lithium

The temporal trends in the Li and SO_4 concentrations are seasonally "in-phase" (Figure 5), though the Li concentrations of *c.* 1-2 mg/L are *c.* 1,000-fold lower than the SO_4 concentrations.

The close correlation between the Li and SO_4 concentrations indicates a dependence of Li solubility on sulphide-oxidation. One possibility is the release of Li (as well as Na, K, Mg, and Ca) from "near-silicates" in contact with pyrite grains as oxidation proceeds (i.e. release of Li from acidic "micro-sites" [viz. an ensemble of sulphide- and silicate-grains] associated with sulphide-oxidation). In this type of weathering mechanism, Li release to solution should decrease over time as trace-sulphides decompose.

In the GCA (2002) study (see reference in footnote 4), there was also evidence of a close correlation between leachate-Li and leachate-SO_4 concentrations for the granofels sample tested. Holmquistite (i.e. a Li-inosilicate) was one of the Li-minerals in the granofels sample.

2.0 GEOCHEMISTRY AND MINE-WASTE MANAGEMENT

Information on the nature of the future mine-wastes (viz. amphibolites, dolerites and granofels) to be placed in the extension to Floyd's dump is presented in Attachment I.

This information is also applicable to the waste-bedrocks placed on Floyd's dump, since in terms of waste-rock types and production schedules, future mining corresponds to "doing more of the same thing", as carried out at the Greenbushes Operations over the past several years.

2.1 Floyd's Dump

2.1.1 Conceptual Weathering Model

Geochemical Structure of Waste-dump Profile

Key points pertinent to the quality of drainage-water produced by Floyd's dump are that:

(a) occurrences of sulphide-minerals (e.g. pyrrhotite) in the pit waste-zone are sporadic in distribution, and where found, sulphide-minerals invariably occur as trace components (e.g. Sulphide-S values typically less than 0.2-0.3 % at "metre-scale" in drillcore [i.e. at the "bcm-scale" following excavation]);

(b) the volume of the "High-S" lithotypes in (a) are estimated to constitute less than *c.* 1 % of the total volume of waste-bedrocks (i.e. an approximate 1:100 dilution); and,

(c) the amphibolites comprise about half of the total mine-waste volume, and about half of the amphibolites is characterised by calcites in veined forms.[3]

In terms of assessing sulphide-oxidation at the dump-scale, "Oxidation-Zones" (likely at spatial-scales of 10-100 bcm) are taken as being randomly scattered throughout a profile of Bulk-Rock (devoid of sulphide-minerals) of which about one-quarter is calcareous (chiefly the calcite-bearing amphibolites). Geometrically, the Oxidation-Zones would typically occur as inclined layers resulting from end-tipping at angle-of-repose dumping with ensuing segregation of rock-flour, gravels, cobbles, boulders, etc.

Preliminary Assessment of Reaction Kinetics in Oxidation-Zones

As part of previous investigations on mine-waste geochemistry for the Greenbushes Operations, kinetic testing employing weathering-columns was undertaken on a -5mm fraction (viz. pea-gravel grading) of a granofels sample from the Cornwall Pit with a Sulphide-S value of 0.15 % (GCA 2002).[4] The suite of "trace-sulphides" comprised pyrite, marcasite, pyrrhotite, and arsenopyrite.

Acidification, corresponding to leachate-pH values of *c.* 4, developed after about 30 weekly-weathering-cycles. During this period of lag-phase weathering, the Sulphide-Oxidation Rate (SOR) was *c.* 5 mg SO_4/kg/day, corresponding to the time (about 3 days each week) when the moisture content of the rock-bed in the column was within the Least-Limiting-Water Range (LLWR). The LLWR corresponds to optimum conditions for sulphide-oxidation (i.e. neither too wet where O_2-diffusion supply limits reaction, nor too dry where 'unbound-H_2O' supply limits reaction). Given the Initial-Sulphide-S value of 0.15 %, the above SOR_{pH6+} value indicates that the trace-sulphides in the

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[3] The recent in-pit survey using the "fizz" test with HCl provides decisive first-hand evidence of the common occurrence of calcites within the amphibolites (Attachment I).

[4] Reference:
Graeme Campbell and Associates Pty Ltd, 2002, Greenbushes Operations: Weathering & Solubility Behaviour of Waste-Rock Samples from Cornwall Pit ('Kinetic-Testwork') - Implications for Waste-Rock Management", unpublished report prepared for Sons of Gwalia Ltd.

granofels sample include reactive varieties, as expected from the occurrence of marcasite in particular.

If a SOR_{pH6+} value of 5 mg SO_4/kg/day was maintained 24/7, then it would take up to *c.* 5 years for 0.3 % of Sulphide-S to be fully decomposed. In the first instance, this provides an indication of the "decomposition-time, t_D" for the complete-oxidation of the trace-sulphides in Oxidation-Zones with average Sulphide-S values of 0.3 %.

However, this treatment is overly simplistic, since:

(a) "part" of the Sulphide-S value of an Oxidation-Zone overall will be both occluded within the matrix of rock-clasts, and so not available for reaction, and in pockets of rock-fines (viz. clay/silt-sized) which will remain saturated (once wetted-up), and so sulphide-oxidation stifled by O_2-diffusion;

(b) the SOR_{pH6+} itself will reduce with progressive depletion of the trace-sulphides through decomposition (though likely not appreciably until at least about half of the trace-sulphides are decomposed); and,

(c) HCO_3 in the "incoming" porefluids (from calcite-bearing amphibolites up-flowpath) will promote surface-armouring of the trace-sulphides, and so reduce the SOR_{pH6+} value (possibly by several-fold [e.g. SOR_{pH6+} value reduced to 1 mg SO_4/kg/day]).[5]

In the above, (a) would act to decrease t_D, whereas (b) and (c) would act to increase t_D. Based on the available information, it is not possible to accurately quantify (a) to (c).

Nonetheless, intuitively, it is considered that t_D corresponds to decadal time-scales.

2.1.2 Management and Closure of Floyd's Dump

As discussed above for Floyd's dump, a steady-state situation has prevailed over the last several years in terms of the seasonal variation in drainage-water quality, and its year-to-year relative stability.

There is no reason to believe that the *status quo* should change substantially in the foreseeable future.

It is understood that dumping of mine-wastes to Floyd's dump is to continue after dumping to the waste-dump extension (see below) commences, though at a reduced rate compared with that in recent years. The amount of mine-waste to be placed on Floyd's dump will closely depend on the tantalum and lithium markets.

Based on the information reviewed herein it is deemed environmentally sound to leave the uncapped portion of Floyd's dump as it is currently (i.e. essentially free-draining), even if some years are to elapse between active dumping.

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[5] In the GCA (2002) study, the granofels sample in the column was flushed with deionised-water as conventionally undertaken in kinetic-testing programmes. However, flushing of the (sporadically distributed) trace-sulphides within Floyd's dump would typically occur by porefluids with HCO_3 concentrations of 20-30+ mg/L (due to the buffering action of the calcite-bearing amphibolites).

2.2 Waste-dump Extension

Information on the nature of the future mine-wastes (viz. amphibolites, dolerites and granofels) to be placed in the extension to Floyd's dump is presented in Attachment I. It is understood that, like Floyd's dump itself, drainage produced by the waste-dump extension will report to the downstream environs from the mine, and ultimately reach the Blackwood River.

The conceptual geochemical model for the internal structure of Floyd's dump applies to the waste-dump extension, since the latter constitutes essentially "more of the same thing" as far as mine-waste production and dumping are concerned.

However, in the case of Floyd's dump, the "travel path" of porefluids prior to exiting as drainage-water is hundreds of metres in length, and has been so for many years. The same will not apply to the waste-dump extension until this new facility is well advanced. It is therefore recommended that consideration be given to constructing the first lift of the waste-dump extension (at the toe of the ridge which the dump will be built onto) from the amphibolites which are at least partly calcareous. This measure is intended to ensure that the geochemical benefit of calcite dissolution to drainage-water chemistry occurs even when dumping to the waste-dump extension is in its infancy.

3.0 RECOMMENDATIONS

Based on the findings of this study, it is recommended that:

(a) monitoring of drainage-water quality for Floyd's dump (i.e. at the gauging station at the dump toe on Floyd's Gully) be continued as in previous years;

(b) related monitoring as in (a) is undertaken for the waste-dump extension which is understood to also straddle a gully;

(c) further work is undertaken to quantify the abundance of calcite in the amphibolites (and other rock types), and so extend the in-pit survey carried out recently (Attachment I);

(d) additional kinetic testing is undertaken on representative samples of "trace-sulphide-lithotypes" to allow a better estimation of SOR_{pH6+} values applicable to weathering within the Oxidation-Zones of the waste-dumps; and,

(e) focused geochemical modelling is undertaken to allow better estimation of the likely range in t_D values, and ensuing implications for closure strategies and targets.

It should be noted that the investigatory work in (c), (d) and (e) should not be seen as demanding immediate attention. Rather, such work should be progressed over time in line with closure-planning timeframes.[6]

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[6] It is noted that the nature of kinetic testing is such that item (d) would likely take some time to complete.

4.0 CLOSURE

Management of mine-wastes containing trace-sulphides at hard-rock mines in the south-west is not unique to the Greenbushes Operations, since this also applies at the Boddington Gold Mine (Campbell *et al.* 2012).[7] However, in the case of the Greenbushes site, buffering by the calcite-bearing amphibolites through the generation of HCO_3-enriched porefluids has the dual benefit of curtailing sulphide-oxidation rates (via promoting surface-armouring), and instantly neutralising the acidity generated from sulphide-oxidation which does take place. In essence, "microsite-acidity" associated with trace-sulphide oxidation is "swamped" by the flowing HCO_3-enriched porefluids produced by the "bulk-rock-matrix" overall.

Finally, the detailed monitoring of drainage-water quality for Floyd's dump provides invaluable insight – rare for mine-sites in Western Australia – into the integrated geochemical dynamics operative at the "whole-dump-scale".

I trust that the above is useful to your current needs.

Regards,

Dr GD Campbell
Director

encl. Figures 1-5 (6 pages)
Attachment I (7 pages)

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[7] Reference:
Campbell G, Haymont R and Amoah N, 2012, "A testing approach to assess the weathering behaviour of lithotypes characterised by a trace-sulphide/carbonate-deficient mineralogy: application to the altered andesites/dolerites at the Boddington Gold Mine, Western Australia", pp. 950-960 in "9th International Conference on Acid Rock Drainage", Ottawa, Ontario, May 20-26 2012.

FIGURES

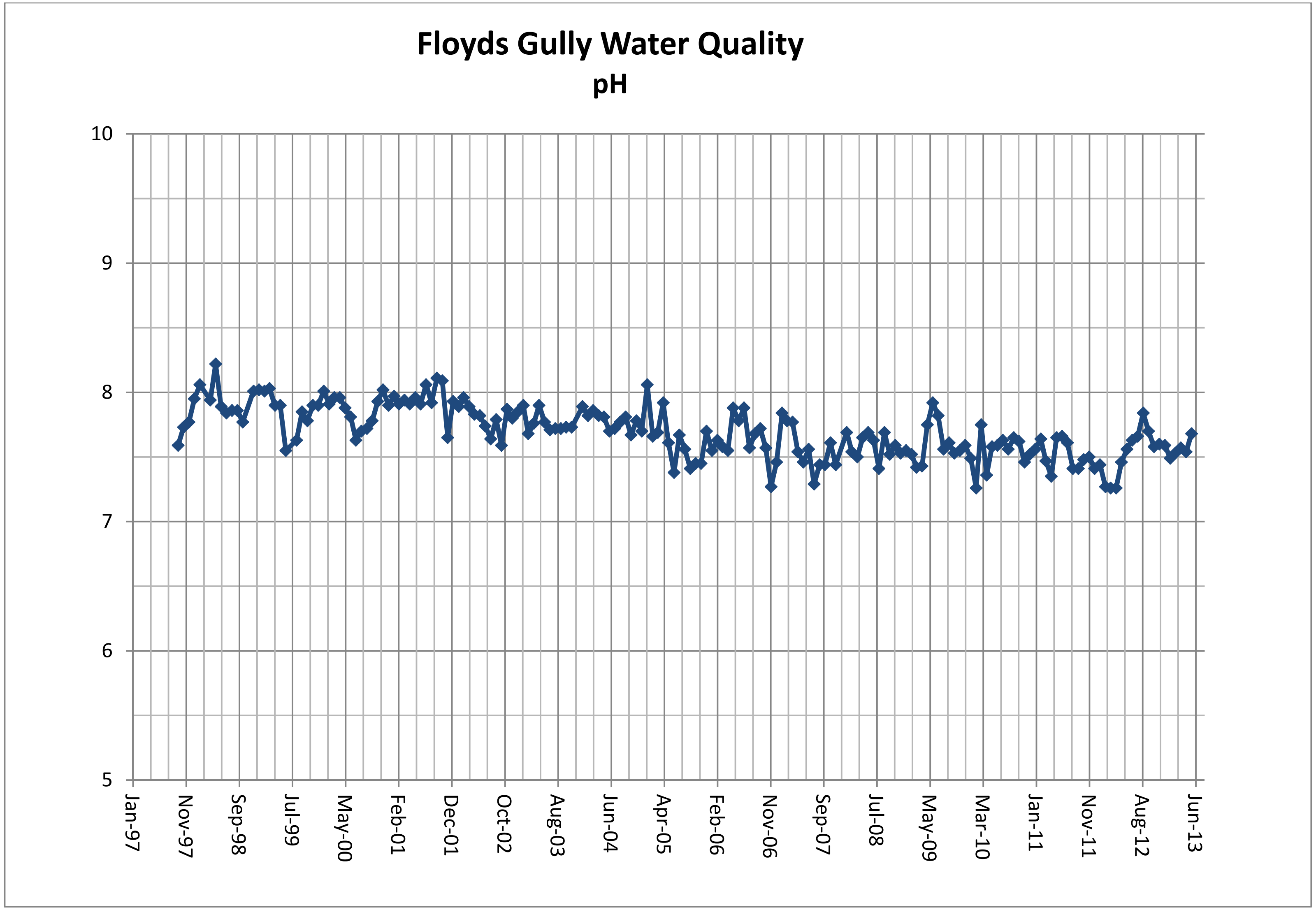


Figure 1: Variation in pH values for drainage-water from Floyd's dump

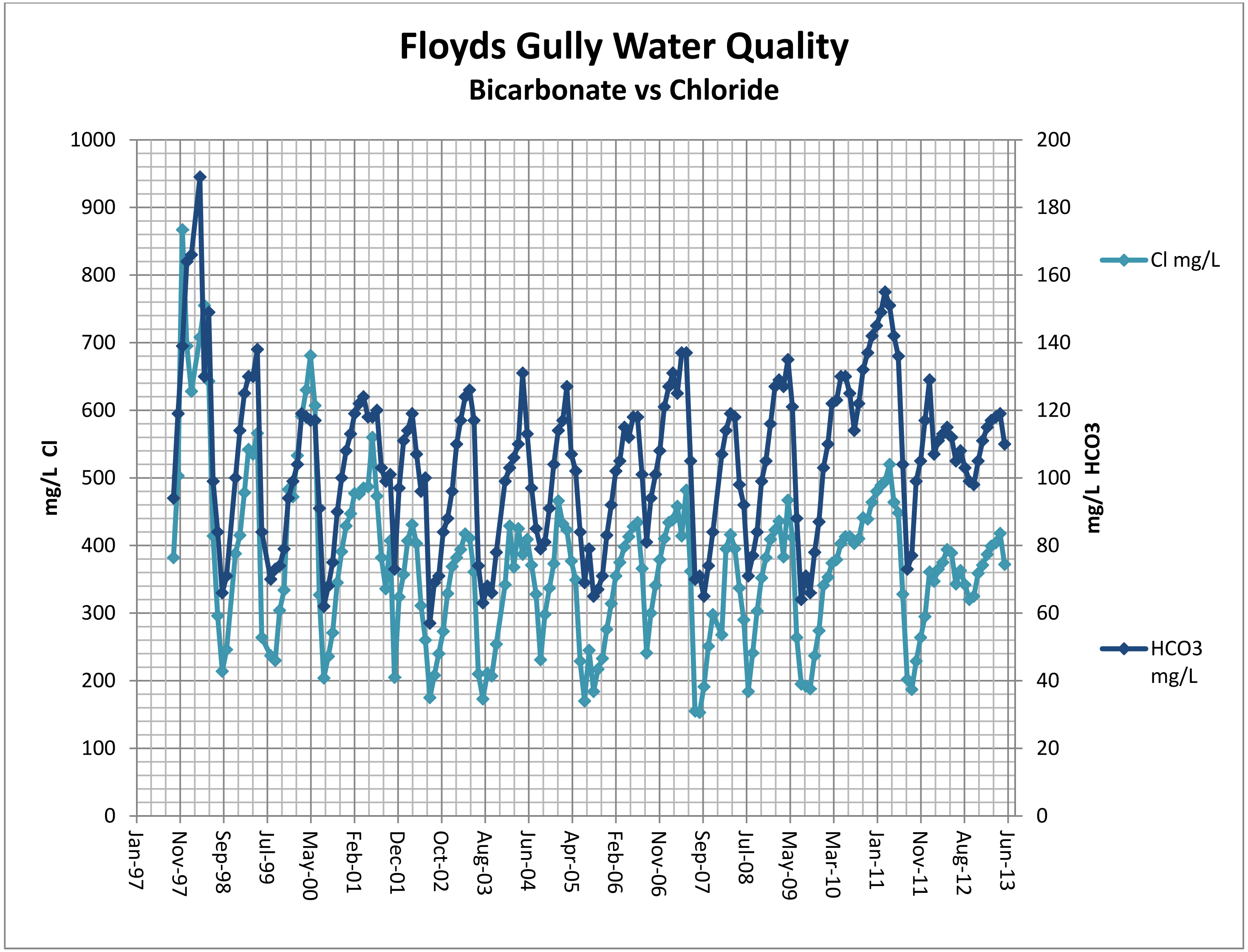


Figure 2: Variation in bicarbonate and chloride concentrations for drainage-water from Floyd’s dump

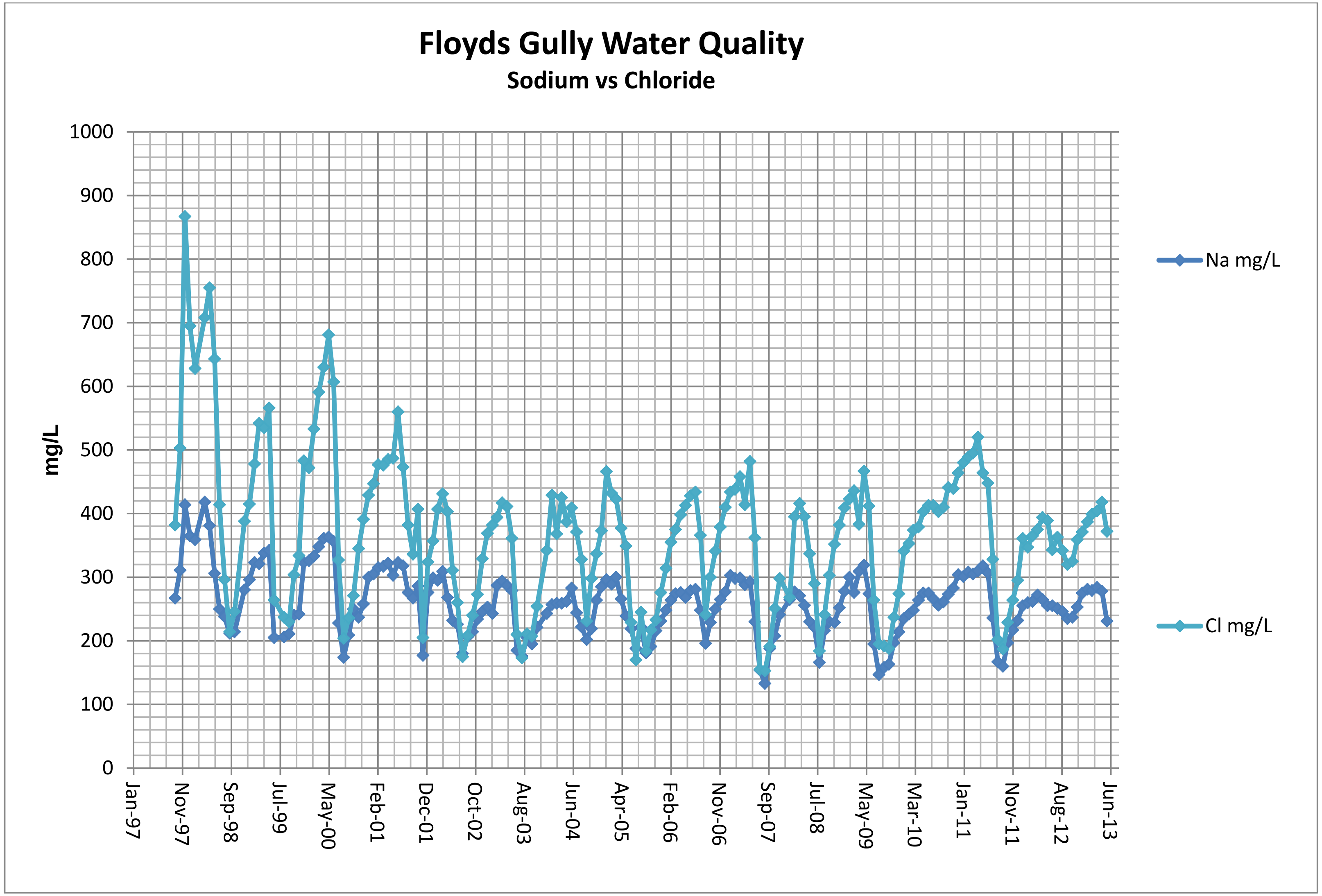


Figure 3: Variation in sodium and chloride concentrations for drainage-water from Floyd’s dump

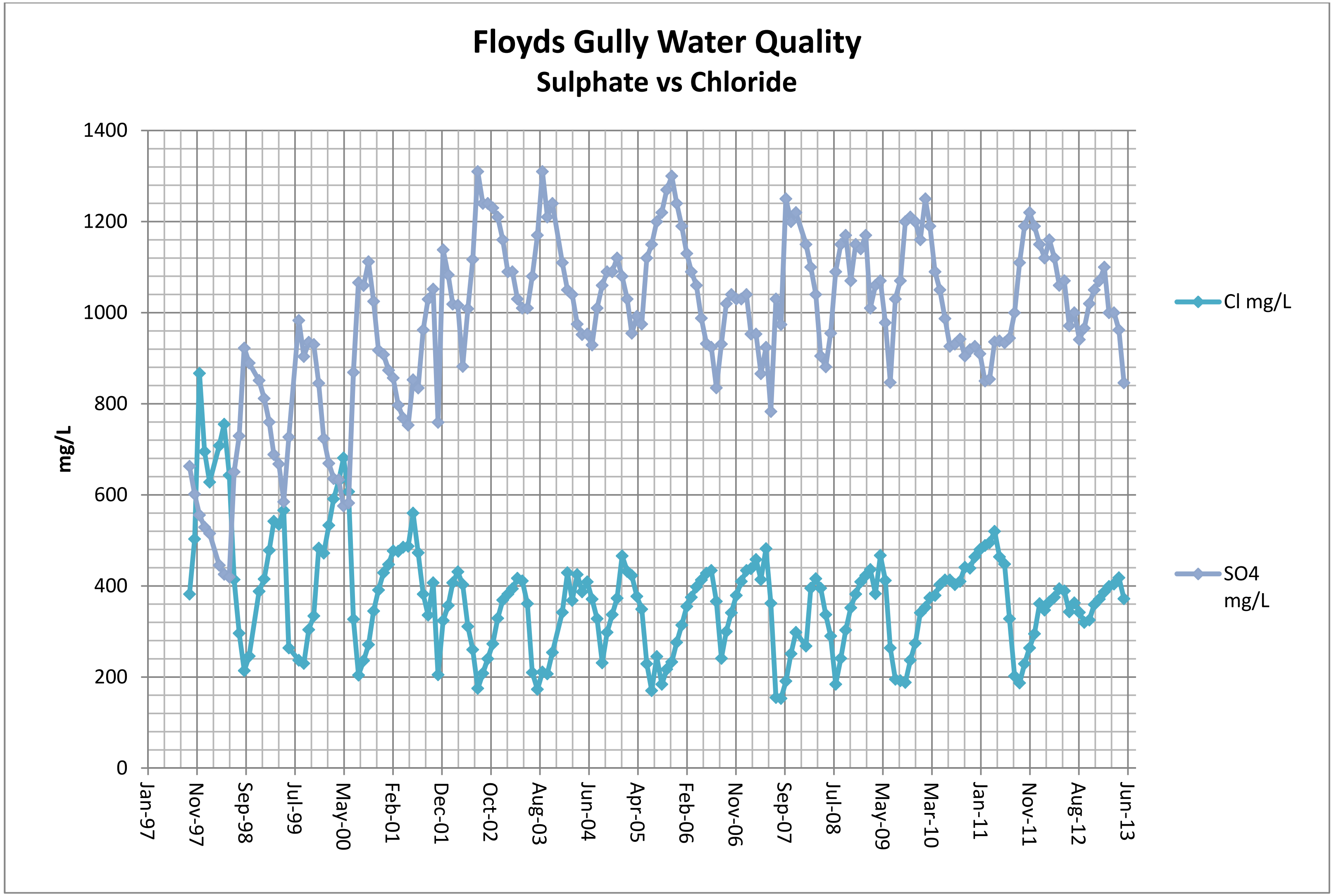


Figure 4: Variation in sulphate and chloride concentrations for drainage-water from Floyd's dump

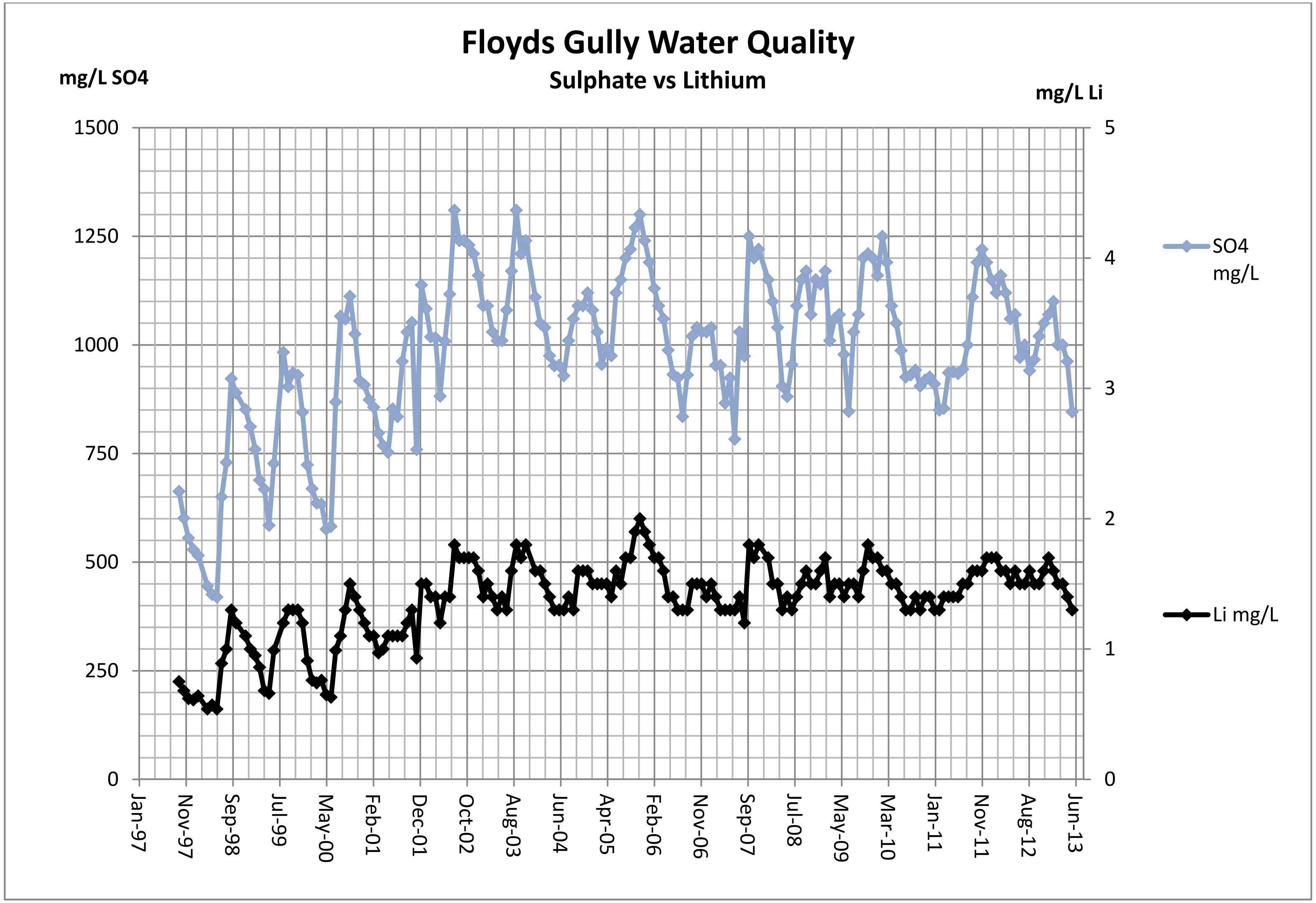


Figure 5: Variation in lithium and sulphate concentrations for drainage-water from Floyd's dump

ATTACHMENT I

GEOLOGICAL INFORMATION

Talison Lithium Limited
GREENBUSHES OPERATIONS

MEMORANDUM

Memo to: Graeme Campbell
From: Daryl Baker
Date: October 16, 2013
Subject: Fizz testing pit walls
cc: Steve Green, Clark Ward
Ref:

Projected waste mining Central Lode

Three types of waste rock Amphibolite, Dolerite and Granofels will be sent to the Floyds waste dump. The current (2012) Greenbushes open pit design is expected to generate the waste volumes shown in table 1 with the ratio between rock types remaining close to the splits shown in the table throughout mining.

Waste Types	Grand Total Volumes m^3	% Volume to Dump
Amphibolite	21,971,000	57%
Dolerite	14,350,500	37%
Granofels	2,163,250	6%
Grand Total	38,484,750	

Table 1 Waste Volumes to Floyds 2012 Design

Distal-Proximal relationship of S

Stepping through drill holes coloured by geology and S assays, elevated sulphur levels are most likely to occur in order of likelyhood:

1. In waste internal to the pegmatite (small volumes)
2. In the immediate hanging wall or footwall to the pegmatite
3. In waste intersected by random centimetre scale minor pegmatite or quartz veins (small volume)
4. In monotonous rock logged as dolerite
5. In monotonous rock logged as amphibolite
6. In monotonous rock logged as granofels
7. In monotonous rock logged as pegmatite

Plan and typical section view of the rock types in the final pit design are shown in the images following.

Talison Lithium Limited
GREENBUSHES OPERATIONS

MEMORANDUM

Memo to: Steve Green
From: Daryl Baker
Date: February 12, 2014
Subject: SO3 Assay History in C3
cc: Clark Ward
Ref:

Historical waste mining Central Lode

Three types of waste rock Amphibolite, Dolerite and Granofels have been sent to the Floyds waste dump historically from the Cornwall and more recently from the C3 pit. In addition negligible amounts of pegmatite where it contacted and mixed with the waste rock to become uneconomic has been sent to Floyds dump.

All hard rock is drilled and blasted, and for grade control representative blast holes containing pegmatite are sampled and assayed. In addition approximately six holes in each waste blast are sampled and assayed for waste rock management purposes. Additionally reverse circulation holes are drilled for grade control and all intervals assayed. All blast and RC grade control holes drilled in the C3 pit have a “C3” hole prefix and have had for years of excavation.

The mine has a Waste Management Plan document *Waste Management Plan MIN-11000* introduced in 2004 and revised from time to time which stipulates waste with sulphide content greater than 0.25% S shall be designated high sulphide waste and given special treatment.

Note that 0.25% S is equivalent to the S contained in 0.62% SO_3

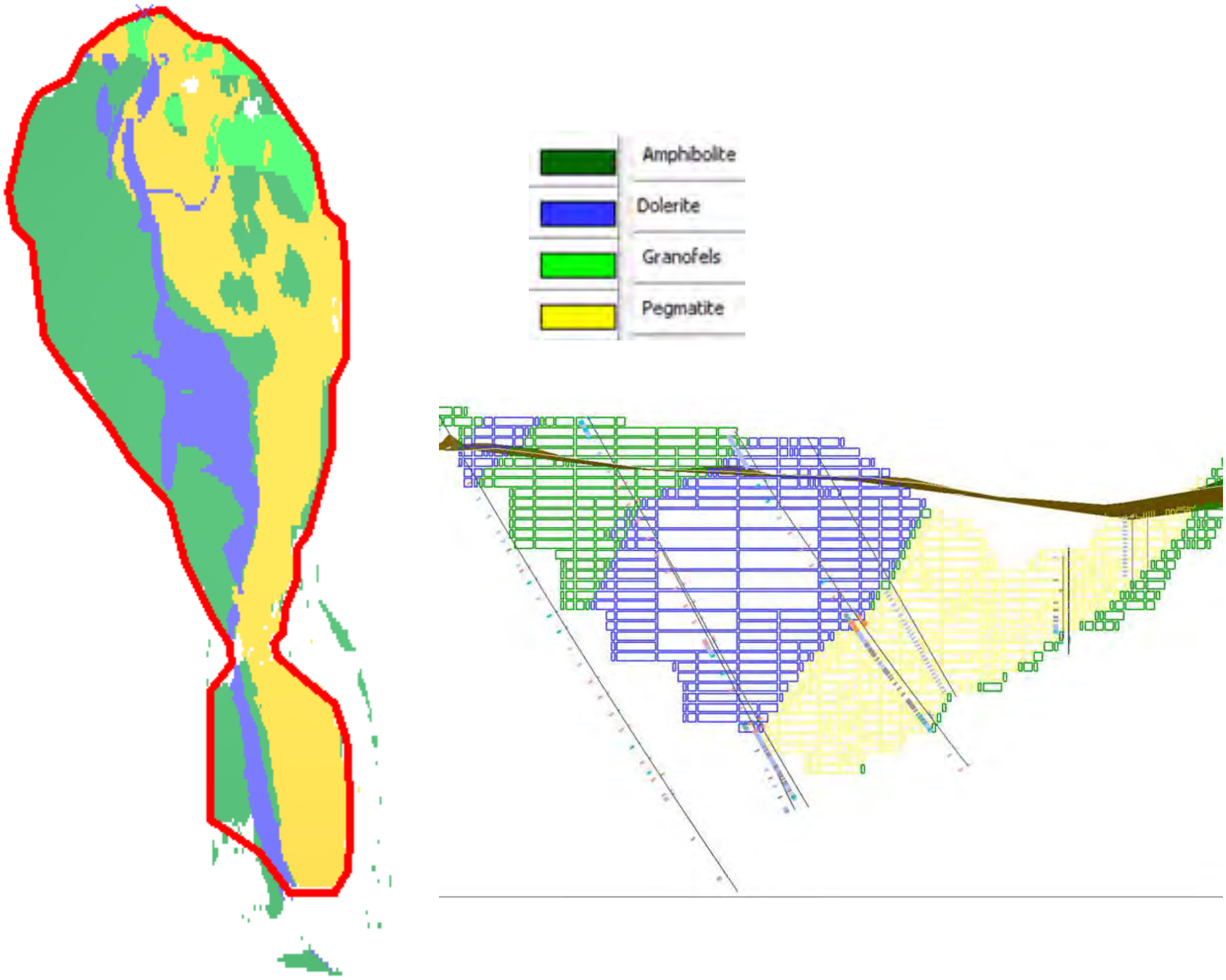
The geology department has Work Procedure *Environmentally Hazardous Waste Rock Management MIN-2024* introduced in 2003 and revised from time to time to outline how the Geology department adheres to MIN-11000. The laboratory reports sulphur content as the oxide SO_3 and therefore MIN-2024 stipulates SO_3 >= 0.6% is treated as high sulphide waste.

- The database contains 84633 assays for C3 prefix grade control holes and of these there are 77 or 0.1% that have SO3>=0.6%.

- There are 6116 samples not logged as pure pegmatite. These are waste samples and mixed waste/pegmatite and those not logged. The 77 assays with SO_3>=0.6% would account for 1.3% of this subset.

Based on the assayed intervals the dilution of high sulphide waste is approximately 1:99 which supports co-disposal.

There was a period of misunderstanding when the 0.25% was applied to the SO_3 assay and this material was treated as high sulphide. Had the misunderstanding not occurred it is unlikely any material would have been treated as high sulphide from the C3 pit.



Summary statistics for sulphur (S) in different rock types taken from exploration drill hole sampling are shown in the table below.

S	*Amphibolite*	*Dolerite*	*Granofels*	*HW Contact*
Mean	0.068	0.092	0.053	0.089
Median	0.068	0.098	0.024	0.079
Mode	0.026	0.004	0.004	0.046
Standard Deviation	0.045	0.072	0.064	0.059
Sample Variance	0.002	0.005	0.004	0.004
Kurtosis	0.492	7.456	0.012	1.554
Skewness	0.690	1.907	1.309	0.996
Range	0.217	0.443	0.181	0.334
Minimum	0.001	0.001	0.001	0.001
Maximum	0.218	0.444	0.182	0.335
Count	114	159	25	108

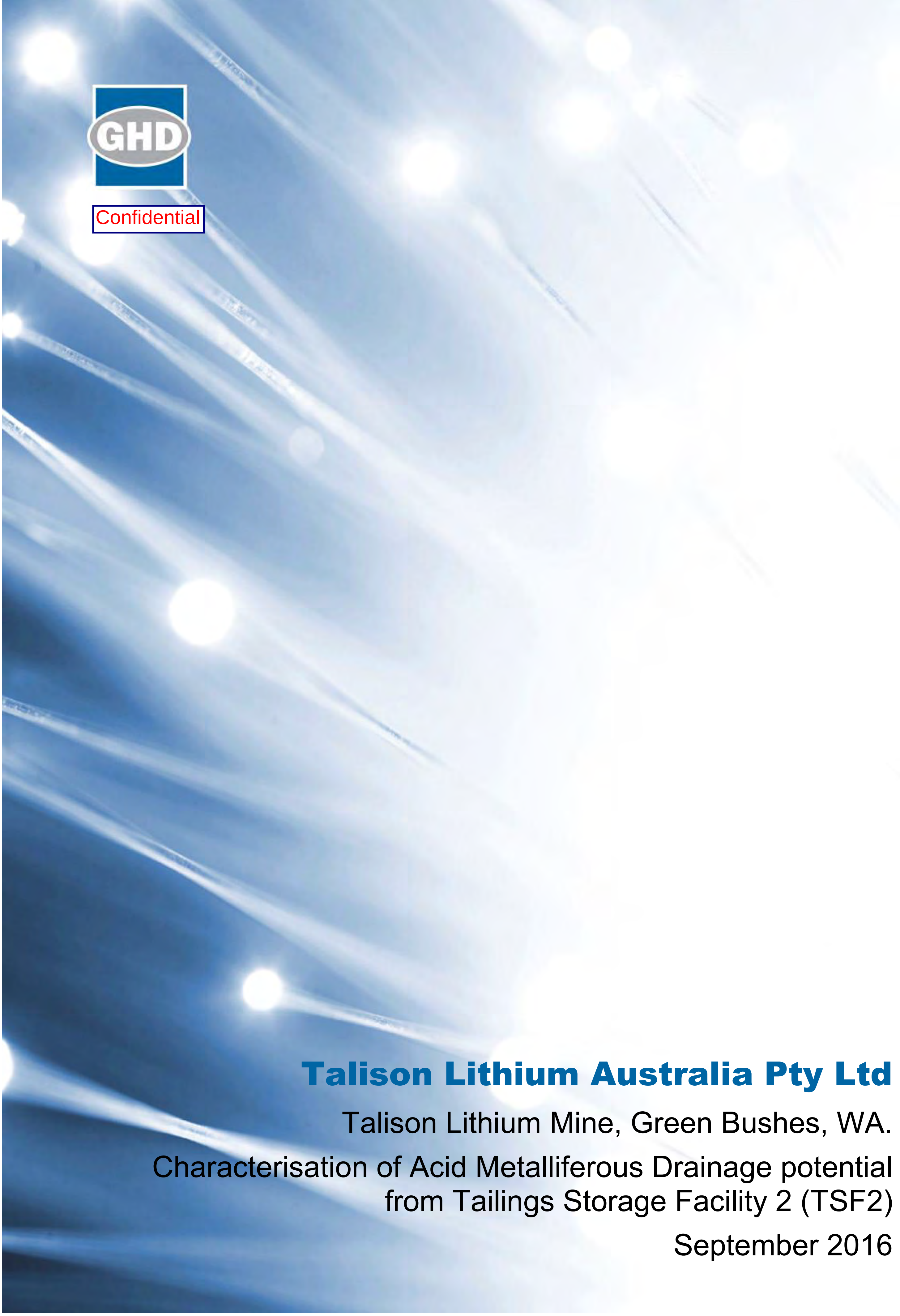
Traverses were made along berms of the west wall squirting 10% HCL solution onto the wall to fizz test for the presence of calcite. A map of the outcome is shown below. No dolerite, which is concentrated at the south end of the exposed pit responded to the test. Approximately 50% of the amphibolite fizzed in response to the test.

The amphibolite fizzed in areas cut by thin frequent calcite veining. The calcite veins are typically 1 to 10cm wide and 30 to 50cm apart and fizz vigorously when sprayed with 10% HCL solution. The fines in crevices in the Amphibolite in these areas fizzed moderately and the amphibolite surrounding the calcite veins weakly fizzed. In areas without calcite veins the amphibolite did not fizz.

Thin frequent calcite veins throughout Amphibolite
Veins are 1-10cm thick and 30cm apart.

Large joint planes in the amphibolite are filled by a 2~3mm layer that fizzed vigorously in response to the 10% HCL solution.

Approximately 57% of the waste rock removed to Floyds from the 2012 open pit design will be amphibolite. If the wall mapping to date is representative then half of this amphibolite will be crosscut with thin frequent calcite veining that reacts to 10% HCL solution.



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Talison Lithium Australia Pty Ltd

Talison Lithium Mine, Green Bushes, WA.

Characterisation of Acid Metalliferous Drainage potential from Tailings Storage Facility 2 (TSF2)

September 2016

Executive summary

GHD were engaged by Talison Lithium Pty Ltd to undertake a preliminary Acid Metalliferous Drainage (AMD) assessment of the leaching potential from the Tailings Storage Facility (TSF2), located at the Talison Lithium Mine, Greenbushes Western Australia.

The scope of works for this desk-top study comprised:

- collation of the geochemical data sets (tailings and ore assay data),
- review of the mineralogical data,
- geo-statistical analysis of the geochemical data and assessment of AMD potential
- provision of recommendations required to complete the AMD assessment.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.2 and the assumptions and qualifications contained throughout the Report.

Based on the preliminary AMD assessment, the following summary is presented:

- The data assessed indicates that the tailings and ore body has a low acid producing potential with low concentrations of sufides (and sulfur), and a theoretical maximum potential acidity of 0.12 kg (H_2SO_4).
- Given the very low sulfur values (close to zero), the classification of the ore and tailings is considered reflective of a “Non-Acid Forming” despite the absence of buffering capacity (carbonates not identified).
- The ore assay (No. 591), and elemental statistical analysis results indicate, of the 36 elements analysed, a total of 10 metals (As, Al, Bi Co, Cs, Hf, Li, Nb, Pb, Rb, Sb, Sn, Ta, Th, Ti, U and W) were relatively enriched compared to the benchmark of average crustal abundance. Five of these metals also exceeded the available regulatory trigger values (As, Cs, Cr, Ni and Sn).
- The tailings assay (No. 1932), and elemental statistical analysis results indicate that of the 14 elements analysed a total of five metals were relatively enriched in compared to the average crustal abundance (As, Cs, Li, Rb, and W). Arsenic was also detected at concentrations that exceeded the regulatory trigger values.
- The laboratory information indicates metals at concentrations elevated above that deemed to represent the average crustal abundance within the ore and tailings, which if liberated or leached from the tailings storage facilities may be also deemed “metals of concern”. It is noted, that two metals of concern (Co and W) are likely derived from the ore grinding media.
- A former assessment of the tailings drainage waters (GHD 2014) indicates that the drainage waters are neutral and are moderately buffered (bicarbonate). The tailings circuit waters are actively managed to pH 8-8.5 with addition of sodium bicarbonate to prevent metal mobilisation. From the limited laboratory analysis, restricted to selected metals - a total of five metals appear elevated (e.g. arsenic, lithium, boron, nickel and zinc). The presence of these elevated metals in the tailings drainage and circuit waters indicates that either leaching is occurring from the tailings during weathering processes, and/or liberation of the metals from the ore during processing.

Although the acid producing potential tailings (and ore) appears negligible, given the relatively large number of metals identified (elevated above the average crustal abundance), and elevated metals observed within the tailings drainage waters, GHD consider that further laboratory analysis is warranted to assess the metal leaching potential, as follows:

- Elemental and metals laboratory analysis of tailings and/or ore for a comprehensive metals suite including metals which have not formerly been analysed (e.g. Ag, B, Be, Cd, Ga, Hg, Lanthanides (Ln), Mo, Re, Sc, Se, Te, and the compound carbonate).
- Selected column leach testing using leach waters comprising: 1) process water; 2) rain water/deionised water; and 3) acidic solutions, to provide for current operational and future closure scenarios.
- Laboratory analysis of leach waters derived from the column leach testing for metals, considered elevated (above the average crustal abundance), carbonate, sulfate (acid production/buffering) and major-ions (salinity potential).

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Appendices

1. Introduction

1.1 Purpose of this report

GHD were engaged by Talison Lithium Pty Ltd to undertake an assessment of the leaching potential from the Tailings Storage Facility (TSF2), located at the Talison Lithium Mine, Greenbushes Western Australia.

The purpose of this report is to present the findings of a desktop review of geochemical data (supplied by Talison) and the risk that acid, metalliferous or saline drainage may leach from the existing TSF, currently and into the future.

1.2 Scope and limitations

The scope of works for this study included:

- collation of the geochemical data-sets;
- review of the mineralogical data;
- undertake geo-statistical analysis of the geochemical data, and
- provision of recommendations based on the AMD assessment.

This report does not include assessment of TSF1 or the Waste Rock Dump (WRD). It is understood that assessment of the WRD has been assessed separately.

This report has been prepared by GHD for Talison and may only be used and relied on by Talison for the purpose agreed between GHD and Talison as set out in this report.

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

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

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

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1.3 Data sources

The following key data sources were used in this assessment:

- *Talison geochemical assay data noted in Section 4.1.*

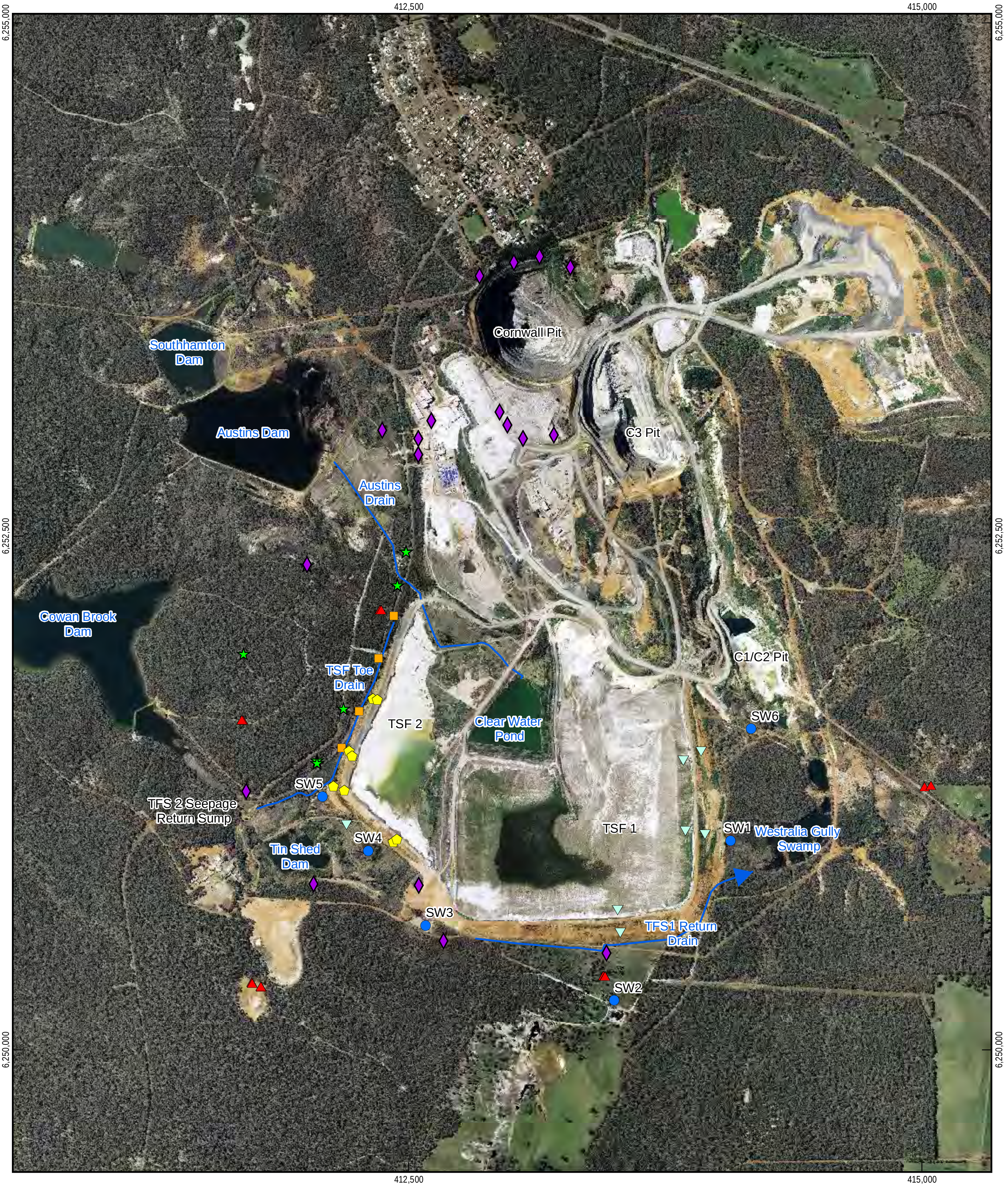
- *GHD 2014, Stage 3 Integrated Geophysics and Hydrogeological Investigation (GHD 2014).*
- *Discussions with mine geologist, Daryl Baker.*
- *Behre Dolbear, NI 43-101 Technical Report, June, 2011, Talison Lithium Limited – Greenbushes Lithium Operations.*

1.4 Mining overview

The Talison mine site is located approximately 250 km south, south-east of Perth immediately adjacent to the town of Greenbushes. The mine site is presented in Figure 1. The project comprises:

- The mining of a pegmatite ore-body, mineralised with tantalum (currently sub economic) and lithium (currently economic) in open cut and underground excavations.
- Processing of the ore on site to produce a Lithium concentrate.
- Storage of the waste product at an onsite TSF.
- Transport of the Lithium ore concentrate to Bunbury Port for export

Given the significant ore reserves, the projected mine life is expected to continue into the foreseeable future (20 years).



LEGEND

Bore Location

- ▲ MB01, 1 to 14
- ■ MB05, 1 to 4
- ▽ MB07, 1 to 7
- ⬠ MB13, 1 to 8
- ★ MB97, 1 to 6
- ◆ MBxx, 1 to 12
- ● Stormwater feature
- — Drain

1: 25,000 (at A4)

0 100 200 400 600 800 1,000
Metres
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Talison Lithium Limited
Characteristion of AMD
potential from Talings (TSF2).

Talison Lithium Mine Plan

Job Number	61-33295
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Date	20 July 2016

Figure 1

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999 Hay Street Perth WA 6004 Australia **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: Talison Lithium Limited: Overall Greenbushes Mine MGA50 - -2013; GHD: Monitoring Bore Location - 20140116, Extent of Inferred Sand - 20140116, Section Line - 20140110. Created by: jrutherford

2. Project setting

2.1 Climate

The Greenbushes area has a temperate climate that is described as mild Mediterranean. There is a distinct rainfall pattern for winter, with most of the rain occurring between May and October. The area averages about 970 mm per annum with an evaporation rate for the area, recognised as similar to rainfall at approximately 1,190 mm per annum.

The mean minimum temperatures range from 4°C to 12°C, while the mean maximum temperatures range from 16°C to 30°C.

2.2 Regional geological setting

The Greenbushes pegmatite intrudes the granitic rocks located on the western margin of the Yilgarn Craton – which is recognised as a regionally extensive granitic and greenstone metamorphic terrain. The regional geology is presented as Figure 2.

The Greenbushes pegmatite lies within a 15 to 20 km wide, north to north-west trending lineament within the Yilgarn Craton, known as the Donnybrook-Bridgetown Shear Zone. A sequence of sheared gneiss, orthogneiss, amphibolite and migmatite outcrops along the shear zone lineament together with syntectonic granitoid intrusives.

The Greenbushes pegmatites were recorded as have been dated at approximately 2,525 million years (Ma) and appear to have been intruded during shearing. However, the pegmatites have been affected by subsequent deformation and/or hydrothermal recrystallisation, the last episode dated at around 1,100 Ma (Behre Dolbear June, 2011).

2.3 Local geology and overview of ore mineralogy

The mineralogy of the pegmatite orebody is well documented and much of what follows is derived from a Technical Report (Behre Dolbear 2011) and conversations with Daryl Baker – Talison Mine Geologist.

The Greenbushes pegmatite body is approximately 100 to 250 meters in width and strikes in a north to north-westerly direction and dips moderately to steeply towards the west-southwest (Figure 3 and Figure 4).

The main pegmatite is bounded by granofels - which forms the footwall; and amphibolite - which forms the hanging wall.

The pegmatite has been intruded by Proterozoic dolerite dykes and sills which trend east-west and vary in width from a few centimetres to tens of metres.

The pegmatite bodies of the Greenbushes deposit are generally lenticular in nature and inter-finger along strike and down dip and are mineralogically zoned as follows:

- The Lithium or Spodumene Zone: enriched in the lithium-bearing silicate mineral spodumene.
- Sodium or Albite Zone: characterized by albite (Na-plagioclase), tourmaline, muscovite and tantalite and cassiterite mineralization.
- Potassium feldspar Zone: contains concentrations of microcline and accessory minerals such as apatite, minor beryl and garnet.

In addition, within the amphibolites and dolerites (generally referred to locally as “greenstones”) contain occasional stringers and pods of sulfides such as pyrite, pyrrhotite and chalcopyrite.

Arsenopyrite and arsenolamprite (native arsenic) are ubiquitous in some areas, particularly within granofelsic and amphibolitic inliers in the main pegmatite. In addition, within the ore native arsenic is present (Daryl Baker pers.com).

2.4 Detail on ore mineralogy

In general, the full width of the pegmatite ore body is excavated and processed, given that the pegmatite comprises economical grades of lithium.

Within the hosting pegmatite there are a number of cross-cutting dykes, which range in width from a few centimetres to a few metres. The dykes have substantially different chemistry to the pegmatites and are basic in composition. Lithium values in the mafic dykes are relatively low and the dykes are identified by significantly higher calcium oxide (“CaO”) and Fe_2O_3 values.

As a rule of thumb, given the chemical contrasts of Fe_2O_3 and CaO between pegmatite and dyke material, a 1 m RC interval with >= 0.5% CaO or >=1.5% Fe_2O_3 is likely to contain >10 cm of basic dyke. The dyke material is manually separated from lithium pegmatite during mining to avoid contamination of the final lithium products.

Major minerals and approximate abundances in pegmatite are quartz 28%, spodumene 26%, albite 23%, K-feldspar 20%, tourmaline 1%, mica 1% and apatite 0.5%. The chemical formulae of the major minerals and secondary minerals are presented in Table 2-1.

Table 2-1 Pegmatite body minerals and chemical formulae

Mineral	*Chemical Formulae*
Major pegmatite minerals	
Quartz	SiO_2
Spodumene [1]	$LiAl(SiO_3)_2$
Muscovite	$KAl_2(AlSi_3O_{10})(F,OH)_2$
Albite[2]	$NaALSi_3O_8$
Microcline [2]	$KALSi_3O_8$
Perthite [2]	$KALSi_3O_8$ and $NaALSi_3O_8$
Secondary pegmatite minerals	
Lithiophilite	$Li(Mn^{2+} Fe^{2+)}O_4$
Amblygonite	$(Li, Na) AlPO_4(F,OH)$
Holmquisite	$Li(Mg, Fe^{2+)3}Al_2 Si_6 O_{22}(OH)_2$
Lepidolite	$K(Li, Al)^3(Si, Al)^4O^{16}(OH)^2$
Tourmaline	$(Ca,K,Na,)(Al,Fe,Li,Mg,Mn)^3(Al,Cr, Fe,V)^6(BO^3)^3(Si,Al,B)^6O^{18}(OH,F)^4$
Columbo-Tantalite	$(Mn,Fe,Mg)(Nb,Ta)_2O_6$
Cassiterite	SnO_2
Fluorapatite	$Ca_5(PO_4)_3F$

[1] includes varieties of Spodumene: kunzite and hiddenite (Fe, Mn and Cr inclusions in Spodumene)

[2] may contain up to 10% anorthite ($Ca,ALSi_3O_8$)

2.5 Ore processing

During ore processing the ore is treated with the addition of sulfuric acid (H_2SO_4), and following the removal of lithium, the pH is adjusted with the addition of sodium carbonate ($NaHCO_3$) to increase the residue to a pH of about 8 before being deposited as a slurry in the tailings dams.

The ore is separated into two grades for processing:

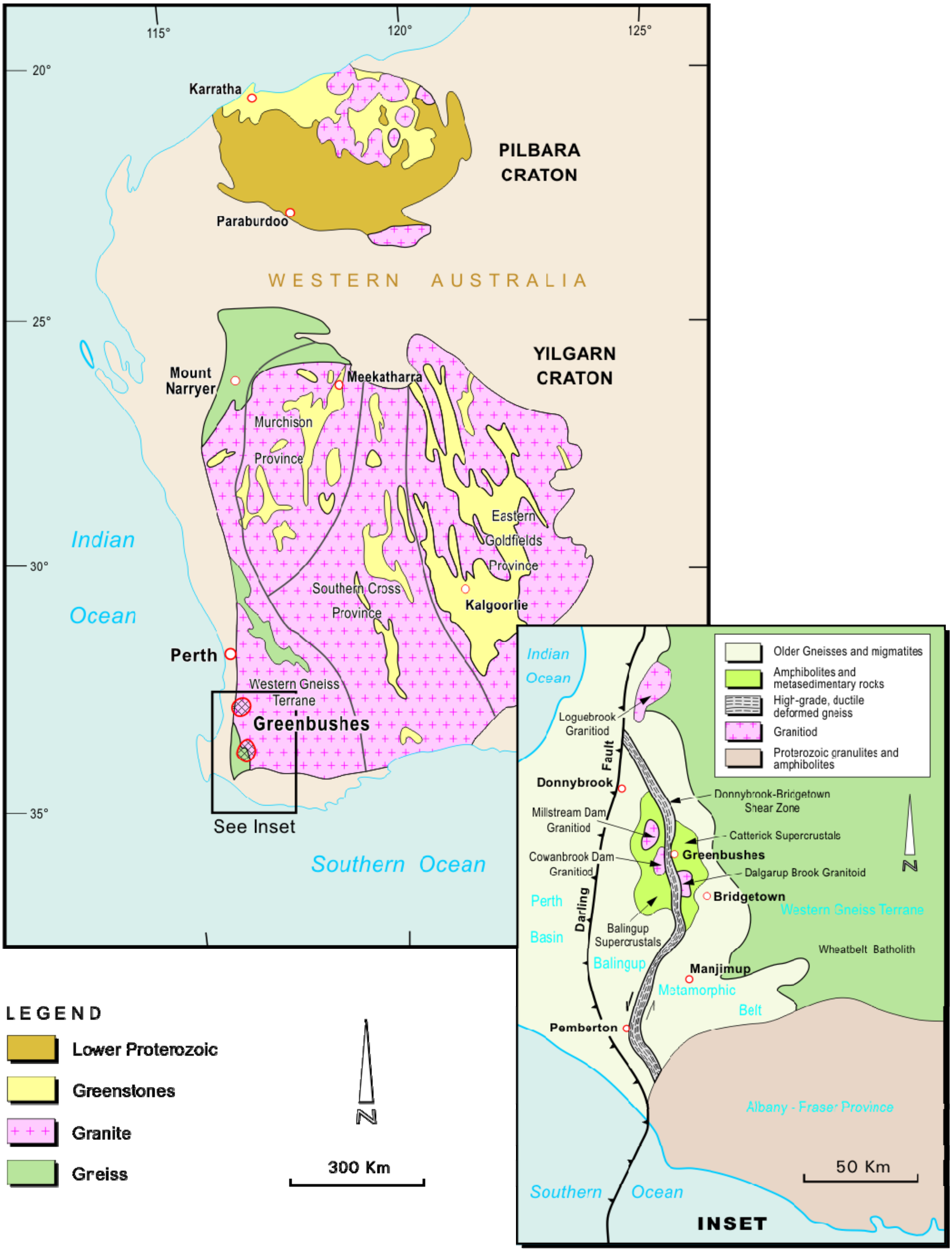
- Technical grade plant, comprising >3.8% Li_2O (i.e. >47% spodumene) makes a variety of products for ceramic and glass manufacturing applications.
- Chemical grade plant, comprising >0.7% Li_2O (i.e. >8% spodumene) and typically 2% Li_2O concentrate feedstock for battery manufacture.

The processes are similar for both the Technical and the Chemical Grade – and both tails contain Na_2CO_3, oleic acid, and frother as part of fatty acid flotation process.

Given that tailings are co-disposed within the TSF2, for the purposes of this AMD assessment the technical and the chemical grade tailings are characterised together. The tonnages of Tailings disposal is presented in Table 2-2.

Table 2-2 Tailings disposal at TSF2

Year	*Total Tailings disposal (tonnes)*
2004/2005	161,136
2005/2006	175,854
2006/2007	511,027
2007/2008	435,622
2008/2009	398,152
2009/2010	331,076
2010/2011	350,892
2011/2012	430,626
2012/2013	640,897
2013/2014	511,835
2014/2015	799,489
Total	**4,746,606 Tonnes**



Simplified Regional Geology

(Reproduced from Ingham et al, 2011)

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potential from Talings (TSF2).

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Figure 2

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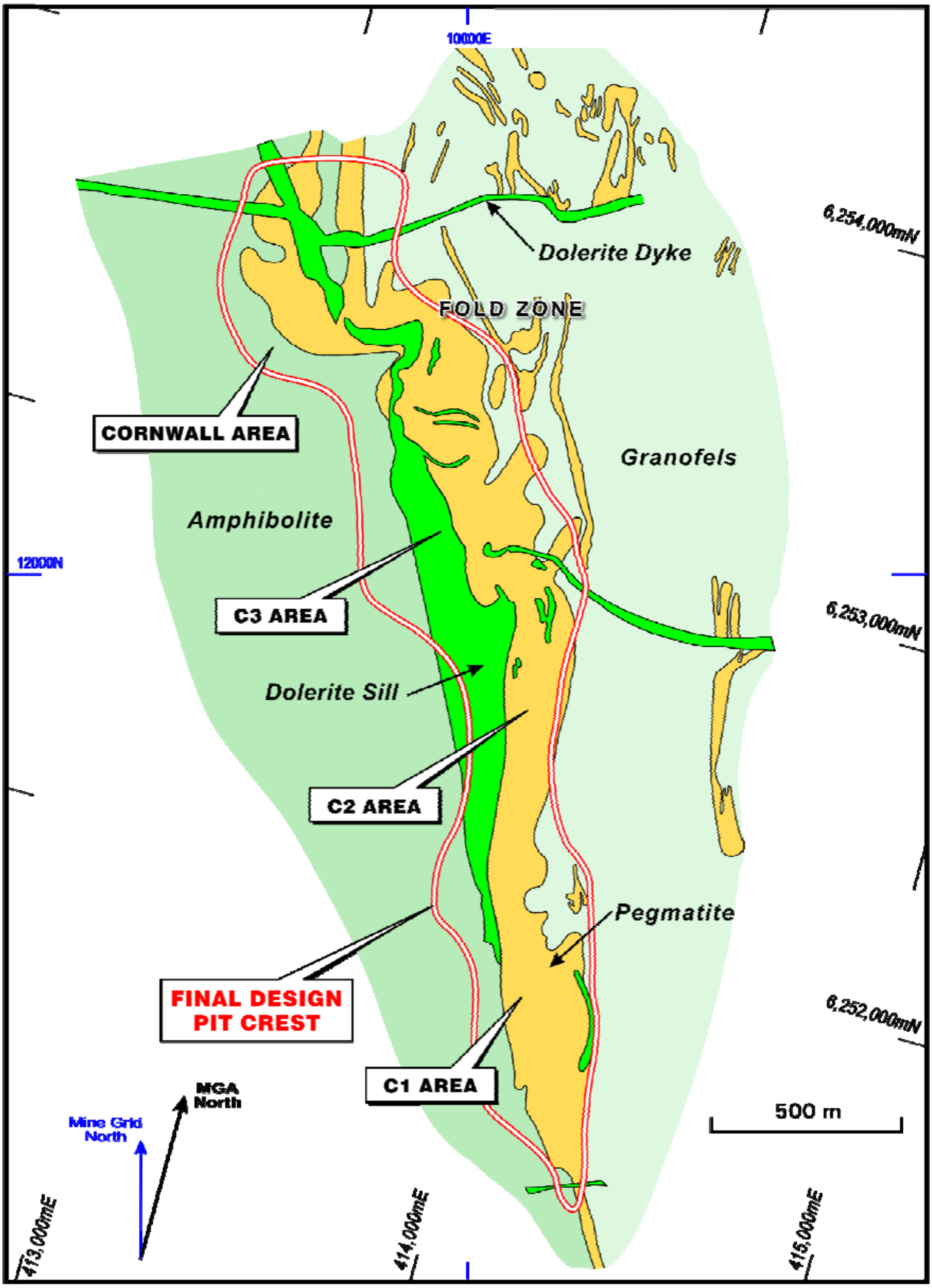
999 Hay Street Perth WA 6004 Australia **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au



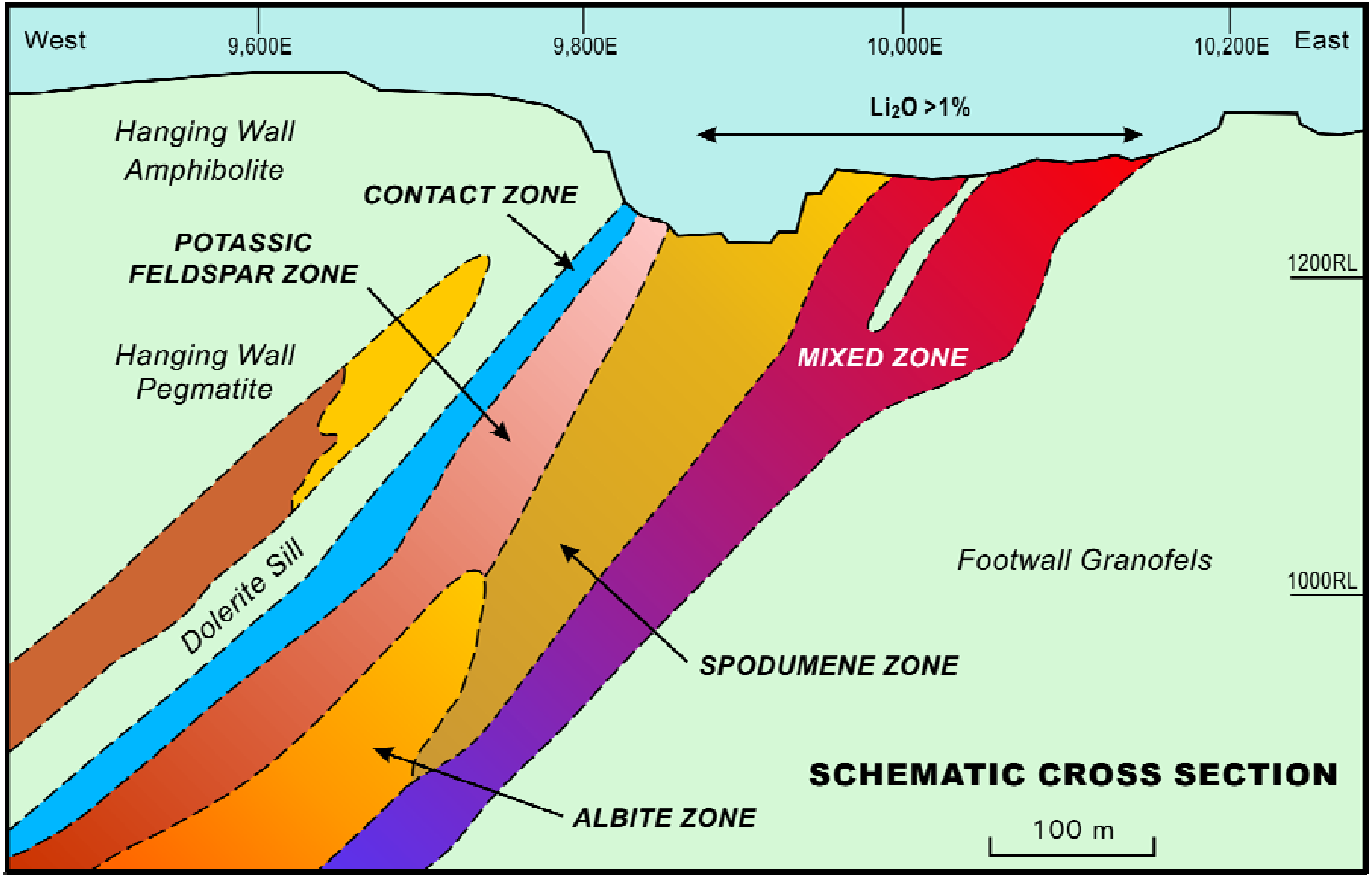
Simplified Local Geology

(Reproduced from Ingham et al, 2011)

Talison Lithium Limited
Characteristion of AMD
potential from Talings (TSF2).

Job Number	61-33295
Revision	0
Date	20 July 2016

Figure 3



Schematic Cross Section
(reproduced from Ingham et al, 2011)

Talison Lithium Limited
Stage 3, Integrated Geophysics
& Hydrogeology Assessment.

Job Number	61-33295
Revision	0
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Figure 4

3. AMD assessment methodology

3.1 Background to AMD assessment methods

In undertaking this assessment GHD are drawing on the following relevant guidelines:

1) *National guidelines on Acid Metalliferous Drainage (DITR 2007)*

2) *The Global Acid Rock Drainage Guide (GARD Guide), the International Network for Acid Prevention (INAP 2009).*

The above guidelines indicate methods to assess the risk of generating the following potential leachate types from tailings, ore and waste rock:

- acid generation;
- metalliferous leaching; and
- saline drainage.

Acid generation assessment methods:

The assessment of acid generation comprises the theoretical capacity of tailings (or ore) to produce and neutralise acid, based on the assay data and ratios of the following:

- sulfur content (as total sulfur)
- carbonate content (e.g: Ca + Mg)

By subtracting the theoretical acid neutralising capacity, or ANC of a sample (CaO + MgO in this instance), from the maximum potential acidity (MPA) of a sample (total S in this instance), a value of Net Acid Potential (NAPP) is derived which is a theoretical net acid producing (or consuming) value of a sample.

The calculation provides an overall indication of the potential for acid generation from the tailings and ore at the Talison Lithium mine. The classification scheme adopted for the preliminary geochemical assessment is provided in Table 3-1. The NAPP value was calculated using Equation 1.

Table 3-1 NAPP classification categories

AMD classification	NAPP* value (kg H_2SO_4/tonne)
Potentially Acid Forming (PAF)	≥ 10
Uncertain (UC)	0 -10
Non-Acid Forming (NAF)	-50 to 0
Acid Consuming Material (AC)	< -50

** Equation 1:**NAPP** (kg H_2SO_4 / tonne) = **MPA** [% Total S * 30.6] – **ANC** [(%CaO * 17.5) + (%MgO * 24.3)]*

Metalliferous drainage assessment methods:

The assessment of metalliferous drainage is based on two aspects:

- an assessment of the metals concentration within the tailings (or ore) against the average crustal abundance.
- Leachable concentrations of metals emanating from the tailings or ore.

With respect to the average crustal abundance, as the abundance of elements varies significantly, a log base 2 index has been historically developed to simplify comparison of measured values with average abundance. The index, called the global, or Geochemical Abundance Index (GAI), and the method is documented in INAP (2009).

INAP (2009) describes the Geochemical Abundance Index (GAI) as a measure to compare the elemental concentration in a sample to the median abundance in the most relevant media (soils, crustal abundance etc.). The purpose is to provide a relative indication of any elemental enrichment that may be of environmental importance. The GAI for an element is calculated by:

Equation 2: $GAI = \log_2 [C / (1.5 * S)]$

Where: C is the elemental concentration in a sample; and S is the median content for that element in the reference material.

The GAI is measured on a scale of 0 to 6; whereby 0 indicates the element is present at a concentration equal to median global abundance, and 6 indicates an approximate 100 fold, or greater, enrichment above global abundance. As a general guide, a GAI of 3 or above is considered significant, and such enrichment may warrant further investigation.

It is important to note that the GAI only considers total concentration and does not take in to account solubility/mobility or bioavailability in the environment nor does it take in to account the toxicity of the element. Consequently, some elements that are highly elevated but immobile may not represent a risk of environmental harm, whereas other more soluble or toxic metals at much lower concentrations may present a risk. The GAI is only considered as an indicator of elements to be assessed in more detail.

Saline drainage assessment methods:

Saline drainage can occur under the following scenarios:

- Contribution of soluble minerals, such as gypsum, halite, carbonates and other readily dissolvable minerals or mineral salts.
- Acid drainage which is completely neutralised by carbonate resources, has potential to comprise elevated salinity - primarily as a consequence of elevated sulfate.
- metals which have dissolved during the acidification/neutralising process, and which remain in solution at neutral pH.

Methods to estimate or measure saline drainage include, mineralogical assessment, acid base accounting and column leach and laboratory testing of the dissolved constituents.

4. AMD assessment results

4.1 Geochemical data inputs and source

The geochemical assessment was undertaken on review of assay information supplied by Talison.

The Talison laboratory analysis was undertaken using XRF and Atomic Absorption Spectroscopy (AAS) methods, and the concentrations were reported in their oxide form as percent, with limits of detection, ranging from 0.002 to 0.005%.

Talison supplied the following data:

1. A total of **1932 tailings samples** (selected analytes were restricted to 493 samples). Elements included Al, As, Ca, Co, Cs, Fe, K, Li, Mg, Mn Na, P, Rb, S, Si, Ti, W
2. A total of **591 ore samples**. Elements included Al, As, Ba, Bi,Ca, Ce, Co, Cs, Cu Fe, Hf, K, La, Li, Mg, Mn Na, Nb, Ni, P, Pb, Rb, S, Sb, Si, Sn, Sr, Ta, Th, Ti, V, W, Y, Zn, Zr.

The TSF2 tailings data (**1932)** is reported by Talison as derived from laboratory analysis of tails from the years 2013 to 2015.

The ore body data **(591**) comprises laboratory analysis of drill hole information, completed along the strike length and depth of ore body to accommodate a projected mine duration of 20 years.

The following AMD assessment is based upon a statistical assessment of the laboratory data sets derived from tailings deposited in TSF2(1932) and drilling information of the ore body (591). The original laboratory data has not been re-presented herein.

4.2 Acid generation and buffering capacity

4.2.1 Sulfide occurrence

The mineralogy of the ore is presented in Section 2.4. The ore mineralogy indicates that sulfur is not present within the ore as potentially acid generating minerals (sulfides within pyrite) and sulfur is not present as non-acid generating sulfur minerals (e.g. gypsum). Sulfides are however, noted where inclusions of footwall dolerite occur as pods within the pegmatite material (Behre Dolbear, 2011).

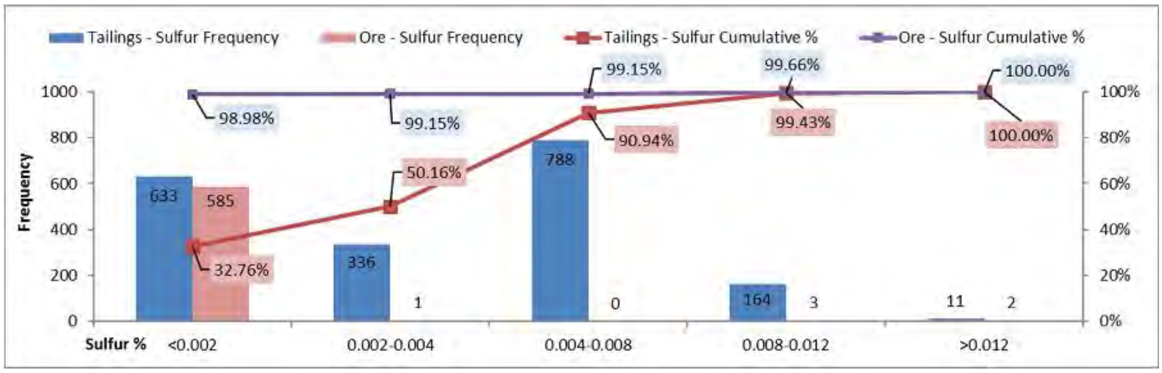
The ore and tailings assay data have been presented as a statistical summary in Appendix A. In addition, a cumulative frequency histogram for sulfur (as S% values) for the ore and tailings is presented below as Figure 5.

Data for the ore (Appendix A and Figure 5) indicates that sulfur is detected at concentrations generally below detection (0.001%), with an average concentration of 0.001%. Of the 591 samples with sulfur data, 99% were measured below the detection limit of 0.001%.

Data for the tailings (Appendix A and Figure 5) indicates that sulfur is detected at concentrations slightly more elevated than the ore, at concentrations from below detection (0.001%) to a maximum of 0.015%, and with an average concentration 0.004%. Of the 1932 tailings samples with sulfur data, over 90% were less than 0.008%. The slightly elevated sulfur content within the tailings material is considered to reflect the residual sulfur (as sulfate) following the addition of sulfuric acid during ore processing.

The tabulated data presented as Appendix A indicate that the concentrations of sulfur are an order of magnitude lower in the ore (0.001%) and tailings (0.004%), in comparison to the average crustal composition of 0.035, and as a consequence do not exceed the GAI index.

Figure 5 Sulfur content (%) Ore and Tailing's



4.2.2 Carbonate occurrence

The mineralogy (Section 2.4) indicates that carbonate minerals have not been identified within the ore as primary or secondary minerals (e.g. calcium carbonate and/or dolomite). Anecdotal evidence (Daryl Baker Pers.com) supports the occurrence of carbonates within some fractures and joints within the ore body, but carbonate is not considered associated with the major deformation and mineralisation event and as a consequence, is considered of minor relevance.

4.2.3 Acid base accounting

The acid base accounting is based upon the methods presented in Section 3.1 and Table 3-1.

The mineralogical information indicates that carbonates are not observed, and given the lack of carbonate assay data, the concentrations of carbonate are for the purposes of this study deemed as negligible. With respect to the calculated neutralising capacity, the neutralising capacity (ANC) is deemed as zero (see equation 1).

The tabulated data presented as Appendix A indicate that the concentrations of sulfur are relatively low with concentrations within the ore (0.001%) and tailings (0.004%), an order of magnitude lower in comparison to the average crustal composition of 0.035%.

Based on the statistical average of sulfur concentrations (99%UCL), the calculated values of Maximum Potential Acid (MPA) are as follows:

- Tailings: 0.12 kg H_2SO_4 / tonne *(based on 1932 samples)*
- Ore: 0.04 kg H_2SO_4 / tonne *(based on 591 samples)*

Based on Equation 1 (below), and given that the neutralising capacity is deemed zero, the Net Acid Production Potential (NAPP) ranges from 0.12 to 0.04 kg H_2SO_4/tonne for the Talings and Ore respectively.

Comparison of the values of the Net Acid Production Potential (0.12 to 0.04 kg H_2SO_4/tonne) with reference to Table 3-1, indicates that the AMD classification is indicated as “Uncertain”. However, given the very low sulfur values (approximately zero), the classification is considered more reflective of a “Non-Acid Forming” classification.

Equation 1: ***NAPP*** *(kg H_2SO_4 / tonne) =* ***MPA*** *[% Total S * 30.6] –* ***ANC*** *[(%CaO * 17.5) + (%MgO * 24.3)]*

4.3 Metalliferous drainage assessment

4.3.1 Metal assay and Geochemical Abundance Index (GAI)

The laboratory analysis results of the tailings and ore, undertaken using XRF and Atomic Absorption Spectroscopy (AAS), were converted from their oxide form as percent, to the elemental forms and expressed as percent or ppm - subject to common reporting convention.

Statistics were subsequently completed on each element (count, minimum, median, mean, maximum, 99% UCL - assumes normal distribution), the results of which have been presented in Appendix A. To assess and compare the statistics for the elemental data has been presented in Appendix A, together with the following:

- calculated Global Abundance Index (GAI);
- the average crustal abundance; and
- a selection of regulatory guidelines (WA DER, QLD EPA).

The ore assay and elemental results in Appendix A show the following:

- Of the 36 elements analysed, a total of 10 metals were relatively enriched in concentrations and were detected above the average shale crustal abundance and with an elevated GAI (=>3), and include: As, Bi, Cs, Li, Rb, Sb, Sn, Ta, Ti, and W.
- The following metals were detected at concentrations that exceeded the regulatory trigger values: As, Cs, Cr, Ni and Sn.
- The following metals were detected at concentrations that exceeded the average crustal abundance but were below the GAI (=3): Al, Co, Hf, Nb, Pb, Th and U.
- A total of 13 elements were not analysed and the concentrations of these elements within the ore is not determined (*Ag, B, Be, Cd, Ga, Ge, Hg, lanthanides (ln), Mo, Re, Sc, Se, Te*).

The tailings assay and elemental results in Appendix A show the following:

- Of the 14 elements analysed, As, Cs, Li, Rb, and W, were relatively enriched in concentrations and were detected above the average shale crustal abundance and with an elevated GAI (=>3).
- Arsenic was also detected at concentrations that exceeded the regulatory trigger values (no trigger values for other metals Cs, Li, Rb, and W).
- A total of 35 elements were not analysed in the tailings and the concentrations of these elements within the tailings is not determined (*Ag, B, Be, Bi, Ce, Co, Cr, Cd, Cu, Ga, Ge, Hg, Hf, La, lanthanides (ln), Mo, Nb, Ni, Pb, Re, Sb, Sc Se, Sn, Sr, Te Ta, Th, U, V, Y Zn, Zr*).

GHD understand, that elevated Co and W, identified within the tailings and ore laboratory analysis, are likely to be derived from the ore grinding media. Tungsten carbide is used to grind and mill the ore samples (Carbide comprises Co fused with W).

The statistical analysis indicates that the concentrations of sulfur are an order of magnitude lower in the ore (0.001%) and tailings (0.004%), in comparison to the average crustal composition of 0.035% and supports the low acid generation potential (Appendix A).

4.4 Existing tailings drainage data

GHD formerly undertook an assessment of information obtained from the laboratory analysis of drainage derived from the existing TSF 1 and TSF2 tailings storage facility's (GHD 2014).

Interception drains are installed in areas surrounding tailings dams (TSF1 and TSF2) to collect seepage at the banks and foot of the tailings (the TSFs are generally unlined). The interception drain waters are directed towards collection sumps, and the water circuit is completed by pumping of the sumps to the water storage dams (Austin and Southampton dams).

Given the closed nature of the water circuit system, the water quality of the tailings dams, interception drains/sumps and storage dams are considered as a single water body.

A summary and interpretation of the major ion chemistry of the water quality of the tailings waters measured from decant ponds and drainage sumps is presented in GHD 2014.

Typical concentrations of the tailings waters, summarised from 2011 to 2014 data (GHD 2014) and presented as Table 4-1 and indicates the tailings water quality is slightly basic, with a dissolved salt content of between 800 and 11200 mg/L. The waters appear to be moderately buffered (bicarbonate) although, a number of metals appear elevated (e.g. arsenic, lithium, boron, nickel and zinc). The tailings circuit waters are actively managed to pH 8-8.5 with addition of sodium carbonate to prevent metal mobilisation.

The presence of these elevated metals in the tailings drainage and circuit waters (arsenic, lithium, boron, nickel and zinc) indicates that either leaching is occurring from the tailings during weathering processes, and/or liberation of the metals is occurring from the ore during ore processing.

Table 4-1 Representative tailings waters (2011-2014)

Analyte	Concentration range (mg/L)
Major Ions + general	
TDS	800 - 1200
pH	7.6 – 8.3
Sulfate	150 - 350
Chloride	200 – 350
Bi-carbonate (+ carbonate)	100 - 250
Potassium	8 - 13
Magnesium	20 - 45
Sodium	180 - 310
Phosphorus	0.01 - 0.14
Nutrients	
Phosphate	0.2 – 0.6
Nitrate	1 - 2
Metals	
Lithium	6 - 18
Arsenic	0.1 – 0.6
Boron	0.1 – 0.35*
Beryllium	<0.005*
Cadmium	<0.005
Chromium	<0.001*
Cobalt	<0.005 – 0.04
Copper	<0.01
Fluoride	0.09 – 1.2*
Iron	0.001 – 0.7
Manganese	1 – 1.5
Mercury	<0.0001*
Lead	<0.05
Nickel	0.01- 0.02
Selenium	<0.002
Thorium	<0.0005
Tin	0.02*
Uranium	<0.0001
Zinc	0.02 – 0.04

* Limited to Clear Water Pond data only.

5. Summary and recommendations

Based on the above preliminary AMD assessment, the following comments and recommendations are made:

- The data assessed indicates that the tailings and ore body is very low in acid producing potential with low concentrations of sulfides (and sulfur), with a theoretical maximum potential acidity of 0.12 kg (H_2SO_4).
- Given the very low sulfur values (close to zero), the classification of the ore and tailings is considered reflective of a "Non-Acid Forming" despite the absence of buffering capacity (carbonates not identified).
- The ore assay (**No. 591**), and elemental statistical analysis results indicate, of the 36 elements analysed, a total of 10 metals (As, Al, Bi, Co, Cs, Hf, Li, Nb, Pb, Rb, Sb, Sn, Ta, Th, Ti, U and W) were relatively enriched in compared to the average crustal abundance. Five of these metals also exceeded the available regulatory trigger values (As, Cs, Cr, Ni and Sn).
- The tailings assay (**No. 1932**), and elemental statistical analysis results indicate that of the 14 elements analysed a total of five metals were relatively enriched in compared to the average shale crustal abundance (As, Cs, Li, Rb, and W). Arsenic was also detected at concentrations that exceeded the regulatory trigger values.
- The laboratory information indicates metals at concentrations elevated above that deemed to represent "average crustal abundance" within the ore and tailings, which if liberated or leached from the tailings storage facilities at significant concentrations may be also deemed "metals of concern". It is noted, that two metals of concern (Co and W) are likely derived from the ore grinding media.
- A former assessment of the tailings drainage waters (GHD 2014) indicates that the drainage waters are neutral and are moderately buffered (bicarbonate). The tailings circuit waters are actively managed to pH 8-8.5 with addition of sodium bicarbonate to prevent metal mobilisation. From the limited laboratory analysis, restricted to selected metals - a total of five metals appear elevated (e.g. arsenic, lithium, boron, nickel and zinc). The presence of these elevated metals in the tailings drainage and circuit waters indicates that either leaching is occurring from the tailings during weathering processes, and/or liberation of the metals from the ore during processing.

Although the acid producing potential and associated metal leachability of the ore and tailings appears negligible, given the relatively large number of metals identified (elevated above the average crustal abundance), GHD consider that further laboratory analysis is warranted to assess the metal leaching potential, as follows:

- Elemental and metals laboratory analysis of tailings and/or ore for a comprehensive metals suite including metals which have not formerly been analysed (e.g. Ag, B, Be, Cd, Ga, Hg, lanthanide (Ln), Mo, Re, Sc, Se, Te, and the compound carbonate).
- Selected column leach testing using leach waters comprising: 1) process water; 2) rain water/deionised water; and 3) acidic solutions, to provide for operational and future closure scenarios.
- Laboratory analysis of leach waters derived from the column leach testing for metals, considered elevated (above the average crustal abundance), carbonate, sulfate (acid production/buffering) and major-ions (salinity potential).

6. References

Behre Dolbear June, 2011., Talison Lithium Limited – Greenbushes Lithium Operations, Ni 43-101 Technical Report, report prepared for Talison Lithium Limited.

GHD 2014, Stage 3 Integrated Geophysics and Hydrogeological Investigation, Interpretation of Geochemical Data. Report for Talison Lithium Australia (61/30220)

National guidelines on Acid Metalliferous Drainage (DITR 2007),

The Global Acid Rock Drainage Guide (GARD Guide), the International Network for Acid Prevention (INAP 2009).

Appendices

Appendix A

Ore and Tailings geochemical summary statistics

Assay Summary Table for Ore and Tailings

			TAILINGS							ORE							GUIDELINES			
Metal	**Units**	**LOR**	Count	Min	Median	mean	Max	99%UCL (assume norm. dist.)	GAI Index	Count	Min	Median	mean	Max	99%UCL (assume norm. dist.)	GAI Index	**QLD EPA Env Trigger Value**	**DER EIL - Areas of Ecological Significance**	**DER EIL - Commerical and Industrial**	**Avg Shale/Crustal Abundance**
Al	%	*0.005*	493	2.7	6.8	6.6	9.2	6.77	-0.5	591	7.66	8.95	8.94	10.72	9	-0.5	**-**	**-**	**-**	**8.23**
As	ppm	*38*	1932	19	19	48	333	**50**	3.7	590	19	53	100	1242	**111**	4.4	**20**	**40**	**160**	**2**
Ba	ppm	*45*	0	-	-	-	-	-	-	591	22	22	23	81	23	-4.9	**-**	**-**	**-**	**425**
Bi	ppm	*45*	0	-	-	-	-	-	-	591	22	22	23	152	24	6.4	**-**	**-**	**-**	**0.17**
Ca	%	*0.004*	1932	0.01	0.08	0.12	0.83	0.13	-6.2	591	0.01	0.10	0.22	2.30	0.24	-5.7	**-**	**-**	**-**	**4.2**
Ce	ppm	*41*	0	-	-	-	-	-	-	591	20	20	21	65	22	-2.2	**-**	**-**	**-**	**60**
Co	ppm	*40*	0	-	-	-	-	-	-	591	20	20	52	267	56	0.0	**-**	**-**	**-**	**25**
Cr	ppm	*34*	0	-	-	-	-	-	-	591	17	89	101	431	108	-1.2	**50**	**60**	**310**	**100**
Cs	ppm	*47*	1932	24	660	644	1707	657	6.8	567	47	330	429	2933	462	6.1	**-**	**-**	**-**	**3**
Cu	%	*39.00*	0	-	-	-	-	-	-	591	20	20	21	176	22	-2.1	**60**	**20**	**140**	**55**
Fe	%	*0.003*	1932	0.02	0.10	0.19	5.87	0.20	0.0	591	0.018	0.358	0.370	1.879	0.390	-6.7	**-**	**-**	**-**	**20**
Hf	ppm	*43*	0	-	-	-	-	-	-	591	21	21	21	21	21	2.2	**-**	**-**	**-**	**3**
K	%	*0.004*	1932	0.24	1.28	1.46	5.42	1.50	-1.4	591	0.03	0.87	1.45	9.43	1.57	-1.9	**-**	**-**	**-**	**2.1**
La	ppm	*43*	0	-	-	-	-	-	-	591	21.3	21.3	21.5	68.2	21.7	-1.1	**-**	**-**	**-**	**30**
Li	ppm	*46*	1,932	1,403	10,408	10,035	23,446	10335	8.0	591	2,383	16,743	15,230	26,355	15,686	8.8	**-**	**-**	**-**	**20**
Mg	%	*0.003*	1919	0.00	0.04	0.06	0.43	0.06	-6.3	567	0.00	0.04	0.07	0.79	0.08	-6.2	**-**	**-**	**-**	**2.3**
Mn	ppm	*39*	1918	39	213	221	1355	227	-3.0	591	116	356	406	2602	424	-2.0	**500**	**-**	**-**	**950**
Na	%	*0.004*	1932	0.23	0.73	0.85	2.59	0.87	0.0	591	0.10	0.75	1.03	5.84	1.10	-2.3	**-**	**-**	**-**	**2.4**
Nb	ppm	*13*	0	-	-	-	-	-	-	591	7	20	37	223	40	-0.4	**-**	**-**	**-**	**20**
Ni	ppm	*39*	0	-	-	-	-	-	-	591	20	20	27	967	31	-2.3	**60**	**5**	**55**	**75**
P	ppm	*22*	1932	65	445	524	1916	539	-1.9	576	22	642	758	6804	807	-1.4	**-**	**-**	**-**	**1050**
Pb	ppm	*46*	0	-	-	-	-	-	-	591	23	23	23	56	23	0.2	**300**	**470**	**1800**	**12.5**
Rb	ppm	*45*	1773	649	2,835	3,215	12,500	3299	4.3	591	46	1,655	2,453	22,760	2691	3.5	**-**	**-**	**-**	**90**
S	%	*0.001*	1932	0.001	0.004	0.004	0.015	0.004	-4.2	591	0.001	0.001	0.001	0.014	0.001	-5.7	**-**	**-**	**-**	**0.035**
Sb	ppm	*45*	0	-	-	-	-	-	-	591	21	21	21	74	21.4	6.1	**20**	**-**	**-**	**0.2**
Sn	ppm	*15*	0	-	-	-	-	-	-	591	8	65	125	1820	**138**	3.1	**50**	**-**	**-**	**6**
Sr	ppm	*40*	0	-	-	-	-	-	-	591	21	21	61	1742	71	-4.0	**-**	**-**	**-**	**375**
Ta	ppm	*8*	0	-	-	-	-	-	-	585	8	53	67	267	71.1	4.1	**-**	**-**	**-**	**2**
Th	ppm	*44*	0	-	-	-	-	-	-	591	22.0	22.0	22.0	22.0	22	0.5	**-**	**-**	**-**	**10**
Ti	%	*29*	1932	0.00	0.01	0.01	0.11	0.01	-6.8	591	15	30	78	1912	92.2	5.5	**-**	**-**	**-**	**0.57**
U	ppm	*17*	0	-	-	-	-	-	-	591	8	8	9	31	9	1.0	**-**	**-**	**-**	**2.7**
V	ppm	*28*	0	-	-	-	-	-	-	591	14	14	14	67	14	-3.9	**-**	**-**	**-**	**135**
W	ppm	*39*	1773	87	507	549	9333	565	7.7	591	20	20	352	2276	389.7	5.4	**-**	**-**	**-**	**1.5**
Y	ppm	*39*	0	-	-	-	-	-	-	591	20	20	24	157	26	-1.1	**-**	**-**	**-**	**30**
Zn	ppm	*40*	0	-	-	-	-	-	-	591	20	20	40	281	43	-1.7	**200**	**50**	**360**	**70**
Zr	ppm	*37*	0	-	-	-	-	-	-	591	19	19	19	19	19	-3.8	**-**	**-**	**-**	**165**

111	Exceeds GAI of 3, and EIL Trigger Values
24	Exceeds GAI of 3
108	Exceeds Trigger values
23	At or marginally above Average Crustal abundance

No data for : Ag, B, Be, Cd, Ga, Ge, Hg, In, Mo, Re, Sc, Se, Te, U

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