MOUNT GARNET TAILINGS STORAGE FACILITY 2

HYDROGEOLOGICAL REVIEW

CONSOLIDATED TIN MINES LTD
Table of Contents

1.0 INTRODUCTION .................................................................................................................. 3

2.0 HYDROGEOLOGY .................................................................................................................. 3

2.1 Groundwater Monitoring Bore Suite .................................................................................. 3

2.2 2015 Groundwater Investigations ...................................................................................... 6

3.0 GROUNDWATER LEVELS .................................................................................................. 8

3.1 Groundwater Flow Directions ............................................................................................ 12

3.2 Hydraulic Conductivity Distribution .................................................................................... 14

4.0 GROUNDWATER QUALITY ............................................................................................... 16

4.1 Electrical Conductivity ........................................................................................................ 16

4.2 Sulphate ................................................................................................................................ 21

5.0 INITIAL PREDICTIONS OF IMPACTS OF THE PROPOSED TSF2 ON THE HYDROGEOLOGICAL REGIME ................................................................................................. 25

APPENDIX 1 : HYDROGEOLOGICAL INVESTIGATIONS TECHNICAL REPORT ........ 27
1.0 INTRODUCTION

Consolidated Tin Mines Ltd (CSD) engaged Rob Lait and Associates Pty Ltd (RLA) to undertake a desktop groundwater assessment and field investigations, use all existing baseline and bore data, and to provide a report on existing groundwater environmental values, potential impacts and mitigation measures, for submission with the initial application for a new tailings storage facility (TSF), at the Mount Garnet mine site, to the Queensland Department of Environment and Heritage Protection (EHP). The new facility will be known as the proposed TSF2.

This document presents a review of aspects of the groundwater data that have been collected at the Mount Garnet site for over a decade. It also incorporates results of recent drilling of dedicated groundwater monitoring bores targeted specifically at a greater understanding of the hydrogeological regime surrounding the proposed TSF2.

2.0 HYDROGEOLOGY

RLA has undertaken a number of previous groundwater investigations in regard to tailings storage facility 1 (TSF1) at the Mount Garnet site1 and two progress reports on a transitional environmental program (TEP)2. Those reports detail the hydrogeological regime associated with TSF1.

2.1 Groundwater Monitoring Bore Suite

A comprehensive suite of groundwater bores exists on the Mt Garnet mine site. The groundwater bores have been installed in stages as the infrastructure of the site has developed over the last 12 years.

RLA undertook further hydrogeological investigation between and 25th March and 1st April 2015 in association with a geotechnical assessment of the proposed TSF2 for the Mount Garnet site which was carried out, and will be reported by, ATC Williams Pty Ltd. This work undertaken included drilling and construction of one test bore and three groundwater monitoring bores, and falling head tests on each to assess the hydraulic conductivity of the aquifer they are intended to monitor. The results of the 2015 hydrogeological investigation are presented in Appendix 1.

---

1 Rob Lait and Associates Pty Ltd, September 2012. KAGARA LIMITED (ADMINISTRATORS APPOINTED) MOUNT GARNET OPERATION REVIEW OF TAILINGS STORAGE DAM IMPACTS ON HYDROGEOLOGICAL REGIME

2 Rob Lait and Associates Pty Ltd, December 2012. MOUNT GARNET TAILINGS STORAGE FACILITY LEACHATE RECOVERY STRATEGY KAGARA LIMITED (ADMINISTRATORS APPOINTED)

3 Rob Lait and Associates Pty Ltd, March 2013. PROGRESS REPORT ON DEWATERING AND RECOVERY OF POTENTIAL SEEPA GE MOUNT GARNET SNOW PEAK MINING PTY LTD

4 Rob Lait and Associates Pty Ltd, August 2013. PROGRESS REPORT ON DEWATERING AND RECOVERY OF POTENTIAL SEEPA GE - AUGUST 2013 MOUNT GARNET SNOW PEAK MINING PTY LTD
Table 1 shows the locations of all the Mount Garnet mine site groundwater monitoring bores and the type of bore that each is. The full designation of the six groundwater monitoring bores specified in Environmental Authority EPML00974913 (dated 16 December 2013) is MTG GWB02, MTG GWB03 through to MTG GWB07, as shown in Table 1, where the first three letters refer to the Mount Garnet site, and the last five letters and numerals refer to the particular groundwater bore. Throughout this document the first four letters of the designation will be omitted for ease of presentation in maps and charts.

<table>
<thead>
<tr>
<th>Environmental Authority Bore_ID</th>
<th>Easting MGA94</th>
<th>Easting MGA94</th>
<th>Elevation of Measuring point (m AHD)</th>
<th>Bore_ID (this report)</th>
<th>Bore Type*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTG GWB02</td>
<td>299613</td>
<td>8044517</td>
<td>643.77</td>
<td>WB02</td>
<td>M, Site</td>
</tr>
<tr>
<td>MTG GWB03</td>
<td>299832</td>
<td>8044246</td>
<td>656.70</td>
<td>WB03</td>
<td>M, Site</td>
</tr>
<tr>
<td>MTG GWB04</td>
<td>300026</td>
<td>8042831</td>
<td>680.70</td>
<td>WB04</td>
<td>M, Site</td>
</tr>
<tr>
<td>MTG GWB05</td>
<td>299357</td>
<td>8043202</td>
<td>673.93</td>
<td>WB05</td>
<td>M, Site</td>
</tr>
<tr>
<td>MTG GWB06</td>
<td>299134</td>
<td>8044257</td>
<td>648.35</td>
<td>WB06</td>
<td>M, Site</td>
</tr>
<tr>
<td>MTG GWB07</td>
<td>299340</td>
<td>8043573</td>
<td>659.35</td>
<td>WB07</td>
<td>M, Site</td>
</tr>
<tr>
<td>Not specified</td>
<td></td>
<td></td>
<td></td>
<td>WB08</td>
<td>M, Site</td>
</tr>
<tr>
<td>Not specified</td>
<td></td>
<td></td>
<td></td>
<td>WB09</td>
<td>M, Site</td>
</tr>
<tr>
<td>Not specified</td>
<td>299950</td>
<td>8042442</td>
<td>670.38</td>
<td>WB10</td>
<td>M, Site</td>
</tr>
<tr>
<td>Not specified</td>
<td>299064</td>
<td>8043924</td>
<td>653.53</td>
<td>WB12</td>
<td>M, Site</td>
</tr>
<tr>
<td>Not specified</td>
<td>299854</td>
<td>8042940</td>
<td>686.12</td>
<td>MGP1A</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>299853</td>
<td>8042938</td>
<td>686.17</td>
<td>MGP1B</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>299856</td>
<td>8042937</td>
<td>686.07</td>
<td>MGP1C</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>299980</td>
<td>8042759</td>
<td>679.73</td>
<td>MGP2A</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>299985</td>
<td>8042761</td>
<td>679.70</td>
<td>MGP2B</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>299987</td>
<td>8042766</td>
<td>679.90</td>
<td>MGP2C</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>300532</td>
<td>8042387</td>
<td>661.89</td>
<td>MGP3</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>300977</td>
<td>8042063</td>
<td>643.66</td>
<td>MGP4</td>
<td>M, TSF1</td>
</tr>
<tr>
<td>Not specified</td>
<td>299979</td>
<td>8043106</td>
<td>692.55</td>
<td>MGPZ1A</td>
<td>M, Piezo</td>
</tr>
<tr>
<td>Not specified</td>
<td>299980</td>
<td>8043108</td>
<td>692.60</td>
<td>MGPZ1B</td>
<td>M, Piezo</td>
</tr>
<tr>
<td>Not specified</td>
<td>299840</td>
<td>8042999</td>
<td>692.36</td>
<td>MGPZ2A</td>
<td>M, Piezo</td>
</tr>
<tr>
<td>Not specified</td>
<td>299843</td>
<td>8043000</td>
<td>692.44</td>
<td>MGPZ2B</td>
<td>M, Piezo</td>
</tr>
<tr>
<td>Not specified</td>
<td>299728</td>
<td>8042976</td>
<td>692.77</td>
<td>MGPZ3A</td>
<td>M, Piezo</td>
</tr>
<tr>
<td>Not specified</td>
<td>299730</td>
<td>8042977</td>
<td>692.80</td>
<td>MGPZ3B</td>
<td>M, Piezo</td>
</tr>
<tr>
<td>Not specified</td>
<td>299950</td>
<td>8042442</td>
<td>680.85</td>
<td>WB04P</td>
<td>P</td>
</tr>
<tr>
<td>Not specified</td>
<td>299966</td>
<td>8042464</td>
<td>670.47</td>
<td>WB10P</td>
<td>P</td>
</tr>
<tr>
<td>Not specified</td>
<td>299709</td>
<td>8042518</td>
<td>680.07</td>
<td>WB11R</td>
<td>P</td>
</tr>
<tr>
<td>Not specified</td>
<td>299965</td>
<td>8042753</td>
<td>680.00</td>
<td>WB13</td>
<td>P</td>
</tr>
<tr>
<td>Not specified</td>
<td>299867</td>
<td>8042682</td>
<td>680.00</td>
<td>WB14</td>
<td>P</td>
</tr>
<tr>
<td>Not specified</td>
<td>299790</td>
<td>8042584</td>
<td>680.00</td>
<td>WB15</td>
<td>P</td>
</tr>
<tr>
<td>Not specified</td>
<td>299062**</td>
<td>8043737**</td>
<td>Not required to be surveyed</td>
<td>WB16 test hole</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 1: LOCATION AND TYPE OF CSD MT GARNET GROUNDWATER BORES

<table>
<thead>
<tr>
<th>Environmental Authority Bore_ID</th>
<th>Easting MGA94</th>
<th>Easting MGA94</th>
<th>Elevation of Measuring point (m AHD)</th>
<th>Bore_ID (this report)</th>
<th>Bore Type*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not specified</td>
<td>299082</td>
<td>8043717</td>
<td>665.903</td>
<td>WB16</td>
<td>M, proposed TSF2</td>
</tr>
<tr>
<td>Not specified</td>
<td>298983</td>
<td>8042942</td>
<td>688.116</td>
<td>WB17</td>
<td>M, proposed TSF2</td>
</tr>
<tr>
<td>Not specified</td>
<td>298730</td>
<td>8043296</td>
<td>653.083</td>
<td>WB18</td>
<td>M, proposed TSF2</td>
</tr>
</tbody>
</table>

Notes: *
M, Site = groundwater monitoring bore for Mine Site;
M, TSF1 = groundwater monitoring bore specifically for tailings storage facility 1;
M, TSF2 = groundwater monitoring bore specifically for tailings storage facility 2;
M, Piezo = groundwater monitoring bore and piezometer within tailings storage facility dam wall;
P = Production Bore
** Handheld GPS coordinates only

For the purposes of this review report only, RLA has allotted the groundwater monitoring bores into four precincts, namely:

- The northern indicator bores;
- The western TSF indicator bores;
- The TSF seepage management bores; and
- The Wurruma Swamp indicator bores.

Only one groundwater monitoring bore is excluded from these precincts and that is WB03, which has been dry for several years as a result of a local depression in the water table following deepening of the Mount Garnet open pit.

Figure 1 shows the locations of the Mount Garnet groundwater monitoring bores and their precincts.
2.2 2015 Groundwater Investigations

Drilling and construction of one test bore and three groundwater monitoring bores (WB16 test hole, WB16, WB17 and WB18) occurred in March 2015. The drilling and construction logs of these bores are presented in Appendix 1.

The aquifers below the proposed TSF2 occur in slightly to moderately fractured metasediments. No colluvial material is present to the west of TSF1.

Only two of the monitoring bores drilled intersected free groundwater (WB16 test hole, and WB18). The airlift yield from WB16 test hole was 1L/s and that from WB18 was 0.2L/s.
Monitoring bores WB16 and WB17 drilled dry and ‘made water’ slowly (this is not unusual in many of the bores to the west of TSF1, for example, WB05 and WB07 originally drilled dry and have been subsequently key groundwater monitoring bores in the Mount Garnet groundwater suite). Therefore, the ‘drilled dry’ observations in WB16 and WB17 will not diminish their use as effective groundwater monitoring bores.

The electrical conductivity and pH of the groundwater were measured where groundwater was encountered at time of drilling. Table 2 shows the results of those measurements.

<table>
<thead>
<tr>
<th>Bore_ID</th>
<th>Electrical Conductivity (µS/cm)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB16 test hole</td>
<td>794</td>
<td>7.68</td>
</tr>
<tr>
<td>WB18</td>
<td>1,160</td>
<td>7.54</td>
</tr>
</tbody>
</table>

This electrical conductivity of the groundwater in WB05 is of the order of 900 to 1,000 µS/cm. This compares well with the electrical conductivity of the groundwater in WB18.

Hydraulic conductivity (or permeability) values were calculated for the three recently constructed groundwater monitoring bores, from falling head tests undertaken in March 2015.

The standing water level was measured and recorded prior to each test. A Solinst automatic groundwater level data logger was emplaced below the standing water level in the bore. The data logger was set to capture water level and water temperature variations at two second intervals to ensure that valid hydraulic conductivity testing data could be obtained.

A ‘slug’ of clean water was then introduced into each of the bores tested. The slug of water raised the groundwater level in the bore above the standing water level and, following introduction of the clean water, the groundwater level declined.

The data from the loggers were downloaded and stored in the form of Microsoft Excel data files, and analysed using a proprietary software program, according to the Bouwer-Rice\(^5\) analytical method. Appendix 2 contains the graphical solutions of the data analysis from the falling head tests. Table 3 shows the calculated hydraulic conductivity from those tests.

<table>
<thead>
<tr>
<th>Bore_ID</th>
<th>Hydraulic Conductivity (m/d)</th>
<th>Hydraulic Conductivity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB16</td>
<td>5.73 x 10(^{-3})</td>
<td>6.63 x 10(^{-8})</td>
</tr>
<tr>
<td>WB17</td>
<td>2.69 x 10(^{-5})</td>
<td>3.11 x 10(^{-10})</td>
</tr>
<tr>
<td>WB18</td>
<td>1.14 x 10(^{-1})</td>
<td>1.32 x 10(^{-6})</td>
</tr>
</tbody>
</table>

\(^5\) Bouwer, Herman and Rice, R.C., 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research 12(3) 423–428.
The calculated hydraulic conductivity results in Table 3 show that the median aquifer permeability beneath the proposed TSF2 is $6.63 \times 10^{-8}$ m/s which is quite low.

3.0 GROUNDWATER LEVELS

Figure 2 shows a chart of historical groundwater level in the northern indicator bore precinct. Groundwater levels in these bores respond ‘normally’ to seasonal conditions (i.e. their groundwater level rises after rainfall recharge and declines during the dry season). They are not impacted by any anthropogenic influences.

![Figure 2: Groundwater Levels in the Northern Indicator Bore Precinct](image)

Groundwater levels in bores WB05 and WB07 do not respond ‘normally’ to seasonal conditions and in fact show a continually rising trend since the end of 2005. They are impacted by an anthropogenic influence and that is the current TSF. The hydraulic conductivity of the aquifer sequences in these two bores is very low and the groundwater level in both is greater than 10m below ground surface so there is no threat to the hydrogeological regime as a result of rising groundwater level in this area.
Figure 4 shows a chart of historical groundwater level in the TSF seepage management bore precinct. These bores have been impacted by TSF1, as was addressed by the actions implemented by previous TEP MAN15860, with the leachate recovery infrastructure continuing to be maintained by CSD. The details of the leachate recovery program were reported in RLA (December, 2012).
Figure 5 shows groundwater level trends in WB04, WB08 and WB10 within the TSF seepage management precinct. These bores are located to the east, west and south of the current TSF respectively. For the purposes of this review they are regarded as key performance indicator bores of the leachate recovery program.
The impact of the leachate recovery program on groundwater levels in this province is well illustrated by Figures 4 and 5. It is obvious that groundwater levels have been lowered by at least 10m and up to 20m by dewatering. The rising groundwater level trend has been reversed and groundwater levels are now at pre-2008 conditions. Groundwater at a depth of 15m below ground level in this province does not represent an environmental threat.

Figure 6 shows the groundwater levels in the two Wurruma Swamp indicator bores to the south east of the Mount Garnet mine site. The groundwater levels in these two bores show a gradual rising trend but this is not attributed to seepage from TSF1 as the leachate management program would have lowered the groundwater level in these bores if they were impacted by TSF1.
FIGURE 6: GROUNDWATER LEVELS IN THE WURRUMA SWAMP BORE PRECINCT
(vertical axis shows depth to groundwater in metres below measuring point)

3.1 Groundwater Flow Directions

Figure 7 shows the December 2005 (pre-TSF1) groundwater monitoring bores and groundwater flow directions at the Mount Garnet mine site. In 2005 groundwater flow was dominated by dewatering of the Mount Garnet open pit with groundwater flow directions predominantly towards the pit.
Figure 8 shows the December 2014 flow directions at the Mount Garnet mine site. TSF1 and the leachate recovery borefield currently dominate currently groundwater flow directions at the Mount Garnet mine site.

The success of the leachate recovery program can be seen in the contours to the south of TSF1, where a trough in the potentiometric surface has been created by dewatering, thus reversing groundwater flow direction towards the dewatering bores (WB13, WB14 and WB15).
The impacts of TSF1 must also be considered with regard to both the hydraulic conductivity of the aquifer sequences at Mount Garnet mine site and water quality impacts. These will be discussed later in this report.

### 3.2 Hydraulic Conductivity Distribution

Figure 9 shows the distribution of measured hydraulic conductivity in (in m/day) in the fractured rock basement aquifers at Mount Garnet. Recent groundwater monitoring bore drilling (WB16, WB17 and WB18) show that there is no colluvial aquifer to the west of TSF1 i.e. underlying the proposed TSF2. Therefore hydraulic conductivity measurements for the colluvial aquifer to the south of TSF1 are not pertinent to this review. They have been fully discussed in RLA (December 2012).
The important points that are illustrated by Figure 9 are that the hydraulic conductivity of the only aquifer sequence underlying the proposed TSF2 is very low to the north and south of the proposed TSF2 and is comparable to measured basement aquifer hydraulic conductivity to the west of the proposed TSF2. This means that high groundwater flow velocities will not occur to the north and south of the proposed TSF2 and that groundwater flow velocities to the west of the proposed TSF2 will be only slightly higher than to the north and south.

**FIGURE 9:** BASEMENT AQUIFER HYDRAULIC CONDUCTIVITY DISTRIBUTION (in m/day)
(Orange outline is the proposed TSF2 wall, blue outline is the proposed TSF2 inundated area)
4.0 GROUNDWATER QUALITY

For the purposes of this review of the hydrogeological regime associated with both the existing and proposed TSFs two groundwater quality parameters – electrical conductivity (EC), and sulphate concentration of the groundwater have been selected as general indicators of the groundwater quality at Mount Garnet mine site.

This is not to diminish the importance of the other groundwater quality parameters that are measured at the site but detailed discussions of these have been provided in the previously mentioned TEP reports (refer to previous references 3 and 4) and in an SPM Annual Groundwater Review Reports\(^6\), and they need not be repeated in this review.

4.1 Electrical Conductivity

Figures 10 to 13 show the historical EC of the groundwater in the groundwater monitoring bores in each of the precincts at Mount Garnet mine site.

---

\(^6\) Rob Lait and Associates Pty Ltd, June 2014. TAILINGS STORAGE FACILITY BOREFIELD REVIEW MOUNT GARNET SNOW PEAK MINING PTY LTD
Figure 10 shows that the EC in the northern indicator bores is reasonably low (generally below 1,000 µS/cm). These bores are considered to be representative of background EC for the groundwater in the Mount Garnet area. Despite the groundwater flow directions shown in Figure 8, there is no evidence of impacts of saline water that has resided in TSF1 impacting on the groundwater in these three bores. No change to this situation is expected when the proposed TSF2 comes in to operation.

Figure 11 shows the EC in the western TSF bores. Note that groundwater monitoring bores WB16, WB17 and WB18 have only been recently installed and do not have historical groundwater EC measurements yet. They are, therefore, not included in Figure 11.

It is apparent from Figure 11 that the EC in WB05 shows no increases in the period since TSF1 has been in operation. This is ascribed to the very low hydraulic conductivity of the basement aquifer in this groundwater monitoring bore (1 x 10⁻⁵ m/day). As the measured hydraulic conductivity of the basement aquifer in groundwater monitoring bore WB17 is almost the same as that in WB05, similar groundwater EC behavior may be expected in that bore.

The groundwater EC in WB07 shows a considerably rising trend since TSF1 commenced operation. This is attributed to the locally higher hydraulic conductivity of the basement aquifer and previous seepage from TSF1 slowly reporting to this groundwater monitoring bore.

No change to this situation is expected when the proposed TSF2 comes in to operation.
Figure 12 shows the groundwater EC in the three directional indicator bores in the TSF seepage management precinct. As previously discussed, WB04, WB08 and WB10 are located to the east, west and south of the current TSF respectively and for the purposes of this review they are regarded as key performance indicator bores of the leachate recovery program. Therefore, the EC data from only these three bores are shown below.

![Groundwater EC in the TSF seepage management indicator bores](image)

**FIGURE 12: GROUNDWATER EC IN THE TSF SEEPAGE MANAGEMENT INDICATOR BORES**
*(EC on the vertical axis is in µS/cm)*

It is readily apparent from Figure 12 that the EC in WB04 shows a similar trend to that in WB07, discussed above. The groundwater EC in WB08 shows a rising trend owing to its proximity to TSF1. At these sites the hydraulic conductivity of the basement aquifer is locally quite high. As discussed previously in this report, the groundwater level in all three of these bores has been lowered so that groundwater flow is towards the leachate recovery bores. Therefore the high EC in the groundwater in WB04 and WB08 cannot present an environmental threat.

There is no evidence of high EC groundwater in WB10 so there is no impact of stored water in TSF1 on groundwater EC at this location.

Figure 13 shows the groundwater EC in the Wurruma Swamp indicator bores. The groundwater EC in these two bores has remained steady since these bores were installed. There is no impact on groundwater EC in this area as a result of stored water in TSF1.
Figure 14 is a distribution map of groundwater EC at the Mount Garnet mine site. The data set includes the EC measurements from two of the recently installed western TSF bores, WB16 and WB18.

The EC distribution in Figure 14 show that high EC water is largely confined to TSF1 itself, and to the groundwater in a halo to the west and south of TSF1.

There are no impacts on groundwater EC to the north of TSF1. Thus, high EC groundwater is essentially constrained to the mining leases. This is considered to be a manageable situation and it is not expected to change once the proposed TSF2 comes into operation.
FIGURE 14: GROUNDWATER EC DISTRIBUTION
(EC shown in red in μS/cm)
4.2 Sulphate

Figures 15 to 18 show the historical sulphate concentration of the groundwater in the groundwater monitoring bores in each of the precincts at Mount Garnet mine site.

Groundwater monitoring bores WB16, WB17 and WB18 have only been recently installed and do not have historical groundwater sulphate measurements yet. They are, therefore, not included below.

As previously discussed, WB04, WB08 and WB10 are located to the east, west and south of TSF1 respectively and, for the purposes of this review, they are regarded as key performance indicator bores of the leachate recovery program. Therefore, the sulphate concentration data from only these three bores are shown below.

![Graph showing sulphate concentration over time for WB02, WB06, and WB12.]

**FIGURE 15: GROUNDWATER SULPHATE CONCENTRATION IN THE NORTHERN INDICATOR BORES**
(Sulphate concentration on the vertical axis is in mg/L)
FIGURE 16: GROUNDWATER SULPHATE CONCENTRATION IN THE WESTERN TSF INDICATOR BORES
(Sulphate concentration on the vertical axis is in mg/L)

FIGURE 17: GROUNDWATER SULPHATE CONCENTRATION IN THE TSF SEEPAGE MANAGEMENT INDICATOR BORES
(Sulphate concentration on the vertical axis is in mg/L)
The comments that apply to groundwater EC also apply to groundwater sulphate concentration in the groundwater monitoring bores at Mount Garnet mine site i.e.

- The groundwater sulphate concentration in the northern indicator bores is representative of background groundwater quality conditions;
- Rising groundwater sulphate conditions in WB07 and WB04 are attributable to the storage of water in TSF1, but the situation is manageable;
- The groundwater sulphate concentration in the Wurruma Swamp indicator bores is low and is expected to remain that way; and
- High sulphate groundwater to the south of TSF1 is being managed by the leachate recovery program.

Figure 19 is a distribution map of groundwater sulphate concentration at the Mount Garnet mine site.

Groundwater with a sulphate concentration of less than 1,000 mg/L is considered suitable for stockwatering.

The sulphate distribution in Figure 19 shows that high sulphate concentration water is also largely confined to TSF1 itself, and to the groundwater in a halo to the west and south of TSF1.
There are no impacts on groundwater sulphate concentration to the north of TSF1. Thus, high sulphate concentration groundwater is essentially constrained to the mining leases. This is considered to be a manageable situation and it is not expected to change once the proposed TSF2 comes into operation.

**FIGURE 14: GROUNDWATER SULPHATE CONCENTRATION DISTRIBUTION**
(Sulphate concentration shown in red in mg/L)
5.0 INITIAL PREDICTIONS OF IMPACTS OF THE PROPOSED TSF2 ON THE HYDROGEOLOGICAL REGIME

When considering the potential hydrogeological impacts of the proposed TSF2 a number of factors are pertinent, namely:

- Whether the proposed TSF2 will be lined or unlined. The conceptual design for the proposed TSF2 indicates that it will be clay lined;
- The strata sequence is generally massive in nature and therefore rapid infiltration from any recharge source is not expected;
- There is a considerable difference in groundwater occurrence within short distances. This is demonstrated by the fact that free groundwater was obtained in WB16 test hole but no free groundwater was obtained in WB16, some 20m away. The fractured rock aquifer in the area is therefore inhomogeneous;
- Standing water levels in the groundwater monitoring bores are in excess of 10m below ground level; and
- There are differences in hydraulic conductivity between individual groundwater monitoring bores sites of four orders of magnitude.

Taking these factors into consideration, it is predicted that:

1. Assuming that the proposed TSF2 is lined and operated properly with the designed seepage system, groundwater mounding beneath the proposed TSF2 should not be an issue;
2. No impact on groundwater level is expected in the northern indicator bores WB02, WB06 and WB12, as the proposed TSF2 will be lined and should provide no recharge contribution to the hydrogeological regime to its north;
3. There should be no impact of the proposed TSF2 on WB08, as the proposed TSF2 will be lined. Groundwater levels in WB08 are managed by the TSF seepage dewatering program that is both currently in place and is effectively lowering groundwater levels south of TSF1;
4. No local increases in EC and sulphate concentration in the groundwater in WB16, WB17 and WB18 are expected to occur as a result of the proposed TSF2 containing saturated tailings as the proposed TSF2 will be lined.
The factors listed above suggest that lining of the proposed TSF2 and properly managed deposition and storage of tailings will not impact on the hydrogeological regime.

Rob Lait and Associates Pty Ltd

[Signature]

ROB LAIT
Principal Hydrogeologist

Attachments:
Appendix 1: Hydrogeological Investigations Technical Report
Appendix 1: Hydrogeological Investigations Technical Report
MOUNT GARNET TAILINGS STORAGE FACILITY 2
HYDROGEOLOGICAL INVESTIGATIONS TECHNICAL REPORT
CONSOLIDATED TIN MINES LTD
Table of Contents

1.0 INTRODUCTION .................................................................................................................. 3

2.0 SCOPE OF WORK .................................................................................................................. 3

3.0 HYDROGEOLOGY ............................................................................................................... 3
   3.1 Strata Sequence ............................................................................................................. 4
   3.2 Aquifer Occurrence and Extent .................................................................................... 9
   3.3 Field Groundwater Quality .......................................................................................... 9
   3.4 Aquifer Hydraulic Conductivity ................................................................................... 9

4.0 RECOMMENDATIONS ...................................................................................................... 10
1.0 INTRODUCTION

Consolidated Tin Mines Ltd (CSD) is investigating hydrogeological and geotechnical conditions associated with a proposed new tailings storage facility (TSF) at the Mt Garnet mine site. When constructed this will be known as TSF2.

Rob Lait and Associates Pty Ltd (RLA) undertook a hydrogeological investigation between 24th March and 3rd April 2015 in association with a geotechnical assessment of TSF2 for the Mount Garnet mine site which was carried out and will be reported by ATC Williams Pty Ltd.

2.0 SCOPE OF WORK

The scope of the work undertaken included:

- Drilling and construction of three groundwater monitoring bores according to the Minimum Construction Requirements for Water Bores in Australia;
- Falling head tests on each to assess the hydraulic conductivity of the aquifer they are intended to monitor; and
- A report on the findings of the hydrogeological investigation.

3.0 HYDROGEOLOGY

Four groundwater monitoring bore sites were drilled. The first borehole drilled near MTGGWB16 could not be cased owing to collapsing strata. This borehole was named MTGGWB16 test hole.

TSF2 will inundate MTGGWB05. MTGGWB05 is considered to be vital for the overall assessment of groundwater level and groundwater quality behaviour at the Mount Garnet site. As such, new bore MTGGWB18 will eventually replace MTGGWB05.

The locations and brief details of the three recently constructed groundwater monitoring bores are shown in Table 1.

---

1 Australian Government, National Water Commission, National Uniform Drillers Licensing Committee. February 2012. MINIMUM CONSTRUCTION REQUIREMENTS FOR WATER BORES IN AUSTRALIA Third edition
TABLE 1: BRIEF DETAILS OF 2015 GROUNDWATER MONITORING BORES

<table>
<thead>
<tr>
<th>Bore_ID</th>
<th>Easting MGA94</th>
<th>Northing MGA94</th>
<th>Depth cased (m)</th>
<th>Perforated Interval (m)</th>
<th>Standing Water Level (metres below top of monitoring pipe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTGGWB16 test hole</td>
<td>299062</td>
<td>8043737</td>
<td>Not cased</td>
<td>N/A</td>
<td>15.5</td>
</tr>
<tr>
<td>MTGGWB16</td>
<td>299082</td>
<td>8043717</td>
<td>49</td>
<td>37-49</td>
<td>20.7</td>
</tr>
<tr>
<td>MTGGWB17</td>
<td>298983</td>
<td>8042942</td>
<td>59</td>
<td>47-59</td>
<td>58.0</td>
</tr>
<tr>
<td>MTGGWB18</td>
<td>298730</td>
<td>8043296</td>
<td>37</td>
<td>25-37</td>
<td>11.44</td>
</tr>
</tbody>
</table>

3.1 Strata Sequence

The strata encountered in each of the groundwater monitoring bores consisted of fine grained metasediments, mostly metapelite. The strata are essentially slightly to moderately blocky and are fractured at depth (i.e. deeper than 30m, well below TSF2 proposed excavation depth).

The drilling and construction logs for the groundwater monitoring bores are shown in Figures 1 to 4.
Figure 1: Drilling and Construction Log – MTGGWB16 test hole
Figure 2: Drilling and Construction Log – MTGGWB16
Figure 3: Drilling and Construction Log – MTGGWB17
Figure 4: Drilling and Construction Log – MTGGWB18
3.2 Aquifer Occurrence and Extent

The aquifers below TSF2 occur in slightly to moderately fractured metasediments. Only two of the monitoring bores drilled interested free groundwater (MTGGWB16 test hole, and MTGGWB18). Monitoring bores MTGGWB16 and MTGGWB17 drilled dry and ‘made water’ slowly (this is not unusual in many of the bores to the west of TSF1, for example, WB05 and WB07 originally drilled dry and have been subsequently key groundwater monitoring bores in the Mount Garnet groundwater suite). Therefore, the ‘drilled dry’ observations in WB16 and WB17 will not diminish their use as effective groundwater monitoring bores.

The airlift yield from MTGGWB16 test hole was 1L/s and that from MTGGWB18 was 0.2L/s.

3.3 Field Groundwater Quality

The electrical conductivity and pH of the groundwater were measured where groundwater was encountered at time of drilling. Table 2 shows the results of those measurements.

<table>
<thead>
<tr>
<th>Bore_ID</th>
<th>Electrical Conductivity (µS/cm)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTGGWB16 TEST HOLE</td>
<td>794</td>
<td>7.68</td>
</tr>
<tr>
<td>MTGGWMB18</td>
<td>1,160</td>
<td>7.54</td>
</tr>
</tbody>
</table>

This electrical conductivity of the groundwater in MTGGWB05 is of the order of 900 to 1,000 µS/cm. This compares well with the electrical conductivity of the groundwater in MTGGWB18, which will replace it.

It is recommended that CSD purges the recently installed groundwater monitoring bores and obtains groundwater samples for full chemical analyses at its earliest opportunity. The results from those analyses can then be compared with those from pre-existing groundwater monitoring bores in the vicinity.

3.4 Aquifer Hydraulic Conductivity

Hydraulic conductivity (or permeability) values were calculated for all the recently constructed groundwater monitoring bores, from falling head tests undertaken in March 2015.

The standing water level was measured and recorded prior to each test. A Solinst automatic groundwater level data logger was emplaced below the standing water level in the bore. The data logger was set to capture water level and water temperature variations at two second intervals to ensure that valid hydraulic conductivity testing data could be obtained.
A ‘slug’ of clean water was then introduced into each of the bores tested. The slug of water raised the groundwater level in the bore above the standing water level and, following introduction of the clean water, the groundwater level declined.

The data from the loggers were downloaded and stored in the form of Microsoft Excel data files, and analysed using a proprietary software program, according to the Bouwer-Rice\(^2\) analytical method. The graphical solutions of the data analysis from the falling head tests are included in this technical report. Table 3 shows the calculated hydraulic conductivity from those tests.

<table>
<thead>
<tr>
<th>Bore_ID</th>
<th>Hydraulic Conductivity (m/d)</th>
<th>Hydraulic Conductivity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTGGWB16</td>
<td>5.73E-03</td>
<td>6.63E-08</td>
</tr>
<tr>
<td>MTGGWB17</td>
<td>2.69E-05</td>
<td>3.11E-10</td>
</tr>
<tr>
<td>MTGGWB18</td>
<td>1.14E-01</td>
<td>1.32E-06</td>
</tr>
</tbody>
</table>

The calculated hydraulic conductivity results in Table 3 show that the median aquifer permeability beneath the proposed TSF2 is \(6.63 \times 10^{-8}\) m/s which is, in general, quite low.

### 4.0 RECOMMENDATIONS

It is recommended that:

1. CSD purges the recently installed groundwater monitoring bores and obtains groundwater samples for full chemical analyses at its earliest opportunity;

2. Groundwater levels should be measured at monthly intervals prior to construction of TSF2;

3. Groundwater quality should be measured at monthly intervals prior to construction of TSF2; and

4. When deposition of tailings commences in TSF2, samples of groundwater should be measured for electrical conductivity and pH at monthly intervals. This will permit CSD to gauge whether any changes to background groundwater quality is occurring.

---

\(^2\) Bouwer, Herman and Rice, R.C., 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research 12(3) 423–428.
Rob Lait and Associates Pty Ltd

ROB LAIT
Principal Hydrogeologist