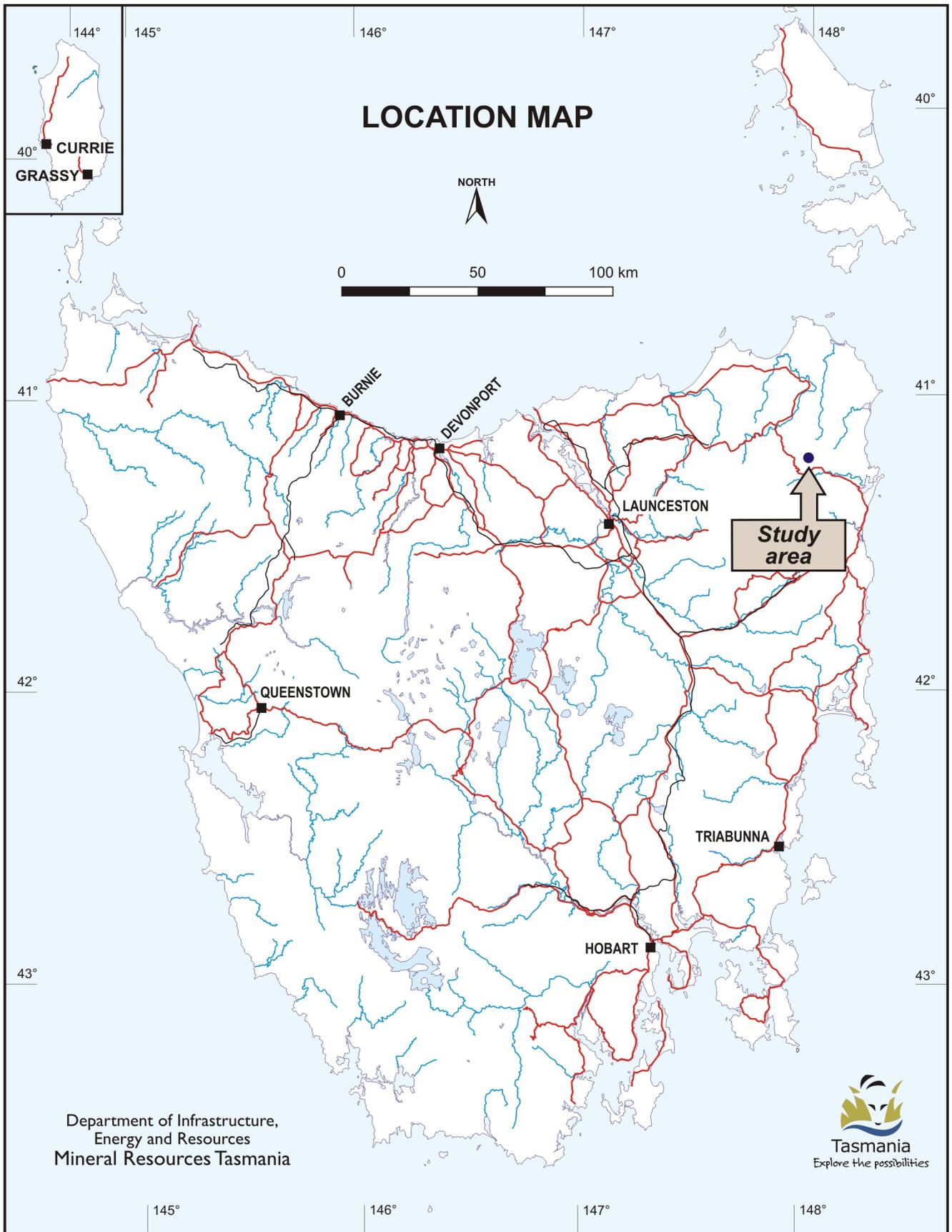


Tasmanian Geological Survey
Record 2011/02

**Anchor mine tailings dam
site investigation, June 2011**

*by Jennifer Parnell, Mine Leasing and Liaison Officer, Mineral Resources Tasmania
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Introduction

Mineral Resources Tasmania (MRT) received several enquiries in May 2011 from concerned residents in Lottah and Goulds Country regarding potential water contamination of the Groom River, downstream of the Anchor mine tailings. The Break O'Day Council also contacted the Environmental Protection Authority (EPA) Division concerned with the potential release of contaminants from the tailings and the integrity of the tailings dam. In response, following discussions between MRT and the EPA Division, an officer from MRT visited the site and collected water samples for analysis in June 2011.

This report was prepared collaboratively by MRT and the EPA Division. The results of the sampling run have been reviewed with regard to the Australian Drinking Water Guidelines (2004) and the Australian Guidelines for Fresh and Marine Water Quality (2000). The key objective of the sampling run was to identify risks to drinking water and the aquatic environment from potential water quality issues arising from releases from the Anchor mine tailings dam.

Location

The Anchor mine is located in northeast Tasmania, approximately seven kilometres north of Pyengana (fig. 1). The mine is situated in a gully between Goughs Hill and Crystal Hill, and is accessed from Anchor Road. The Groom River flows eastward along the floor of this gully and discharges into the Ransom River which flows into the George River near Goshen. The headwaters of the Groom

River are in the Blue Tier, approximately five kilometres northwest of the Anchor mine.

Site history

The Blue Tier region has a rich tin mining history. The prospective tin fields sparked a 'tin rush' in the 1870s and a significant number of people migrated to the area. Once the alluvial deposits were exhausted, new mining methods were employed to target the underlying resource. The Anchor mine was initially developed as an underground operation and then moved to open cut as ore grades diminished. The mining boom of the late 1800s petered out after the turn of the century, with the majority of commercial mining operations closing down. Operations at Anchor ceased in 1913.

The Anchor site was redeveloped in the late 1980s by Spectrum Resources Australia Pty Ltd. Tails from the underground mine were impounded in the valley below the ore processing area. The mine closed in 2000 and some rehabilitation works were completed in the following years including plugging the mine portal, removing infrastructure, tailings stabilisation, drainage controls and revegetation. Unfortunately, revegetation efforts on the tailings dam were largely unsuccessful and the tails remain susceptible to wind and water erosion. The mining lease is currently in the process of being transferred to a new lessee. Any new mine development at Anchor will require a detailed rehabilitation plan for current and future disturbance from mining activities, including the existing tailings dam and polishing pond.



Figure 1. Location map (approximate north to top).

Methodology

Sampling was completed in accordance with the 'Community Water Quality Sampling Protocols and Standards' published by the Department of Primary Industries, Water and Environment (2004). Laboratory prepared single-use containers were used to collect two samples from each sample point. GPS coordinates, photos and a site description were taken of each sample point. Samples were kept in a cool environment during transit and were conveyed to Analytical Services Tasmania (AST) within 48 hours of collection.

Sample locations

A sampling run was conducted on 15 June 2011. Five samples were collected, three on the Groom River and two between the tailings dam wall and the polishing pond. The location of each sample point is shown in Figure 2. The sample points are described in Table 1 and photos of each point are included in Appendix 1.

Analytes

Field measurements of electrical conductivity and pH were taken at sample points 1, 2 and 3 (along the Groom River). The remaining analytes (listed in Table 2) were tested at the AST Laboratories in Hobart.

Water Quality Limits

Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines (ADWG) 2004 were developed by the Australian Government in collaboration with the National Health and Medical Research Council and the Natural Resource Management Ministerial Council. ADWG form part of the National Water Quality Management Strategy and provide the basis for legislative requirements at the State and local level. ADWG are applicable to water intended for drinking at the point of use.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZGFMWQ) 2000

These guidelines, which form part of the National Water Quality Management Strategy, are an authoritative guide for water quality for protecting environmental values for natural and semi-natural water resources. These guidelines provide water quality guidelines for different ecosystem types. Specifically the default values for toxicants, i.e. metals, metalloids and non metals, will be referred to for guidance when considering the risk as a consequence of elevated levels being released from the tailings dam into the receiving waters.

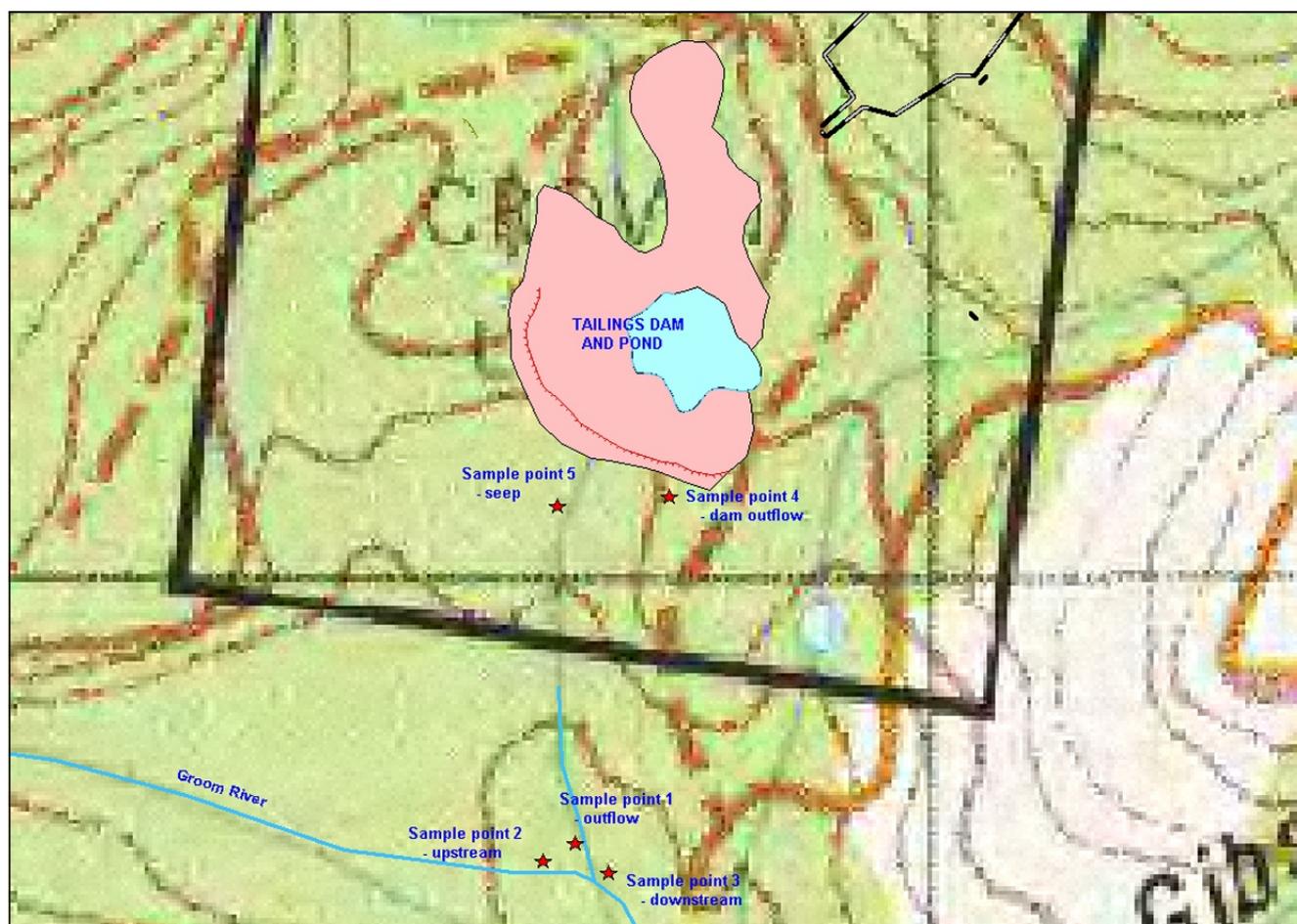


Figure 2

Location map of sample points

(Source: Tasmap — Tasmania 1:100 000 Topographic Survey, edition 3 (2003).

Table 1
Description of sample points

Sample Point	GPS Coordinates	Description
1	584 917 mE 5 435 094 mN	Outflow of discoloured water into Groom River, distinct by the orange hue. The sample was taken approximately 1.5 metres before discharging into the Groom River.
2	584 902 mE 5 435 026 mN	Approximately 19 m upstream of identified discharge point. Sample was taken one metre from stream bank. Water appeared clear with minimal sedimentation.
3	584 937 mE 5 435 016 mN	Approximately 24 metres downstream of identified discharge point. Sample was taken 0.5 m from stream bank, directly downstream of a small rapid. Water appeared clear with minimal sedimentation.
4	584 966 mE 5 435 221 mN	Pipe outflow from tailings dam water collection circuit. Water discharged at this point flows into the polishing pond. Water appeared slightly discoloured.
5	584 908 mE 5 435 215 mN	Seepage point identified down gradient of the tailings dam wall. Water flows from this point into the polishing pond. Water was discoloured with an orange hue.

Table 2
Analytes tested in the laboratory

Metals & metalloids (dissolved and total)	Aluminium, arsenic, barium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, molybdenum, sodium, selenium, nickel, lead, zinc, mercury
Non-metals	Sulphate, chloride, bromide, fluoride

Results

The levels of the analytes and corresponding limits (or trigger values) for further investigation from the ADWG 2004 and ANZGMWQ (2000) are provided in Table 3. The analytical certificate of the results is provided in full in Appendix 2. The Sample ID number corresponds with the sample locations described in Table 3.

Discussion

Risks to drinking water supplies and the environment

The assessment of the water samples collected in the treatment pond system, seeps, the discharge to the Groom River, and upstream and downstream of the discharge indicate typically elevated levels of some metals in the treatment polishing ponds and small seep(s), but no significant impact on the day of sampling in the receiving environment with minimal difference between upstream and downstream values.

The polishing pond (fig. 3), which has developed a wetland plant community, is effectively reducing some of the identified metal pollutants, significantly cadmium, copper and zinc, although some levels, namely iron and to a lesser extent manganese, are elevated at the discharge. The iron is most likely associated with colloidal fluxes and adsorbed to suspended solids, while the manganese is principally in a dissolved form. Depending on the pond residence time some anomalies between input and output, particularly complicated by storm flow events, would be expected to occur.



Figure 3
Polishing pond.

The level of pollutants in the discharge into the Groom River, when compared against the ADWG and ANZFMWQ, does identify certain pollutants of interest, namely aluminium, arsenic, cadmium, iron, lead, manganese and selenium.

Aluminium was identified as a pollutant of interest due to its elevated total level. However it has a low dissolved level in the discharge, which represents a low risk due to the corresponding low level of bio-availability. The dissolved level is also low in the treatment polishing pond system but elevated in the receiving water. The elevated levels in the receiving waters is mostly in the dissolved form or as very fine colloids (<0.45 µm). Some complexing with chemicals such as fluoride, silicates and humic substances will reduce the availability of aluminium to organisms for uptake and will

Table 3
Analytical results

Parameters	ADWG Health Limits	ANZGFMWQ Default Protection of Aquatic Ecosystem Levels	Anchor Site 1	Anchor Site 2	Anchor Site 3	Anchor Site 4	Anchor Site 5
pH	6.5–8.5	6.5–7.5	6.6	6.6	6.6	–	–
EC (S/cm)	750	100	34.4	35.3	35.5	–	–
Al Dissolved (g/L)		55	<20	176	167	<20	39
Al Total (g/L)	200		132	216	212	141	253
As Dissolved (g/L)		24 (As ^(III)) & 13 (As ^(V))	<10	<10	<10	<10	<10
As Total (g/L)	7		<10	<10	<10	<10	<10
Ba Dissolved (g/L)		NA	14	<5	<5	<5	8
Ba Total (g/L)	700		15	<5	<5	<5	10
Bromide (mg/L)	NA		<0.5	<0.5	<0.5	<0.5	<0.5
Ca Dissolved (mg/L)			3.16	0.71	0.69	8.11	26.2
Ca Total (mg/L)			3.21	0.71	0.71	8.27	26.5
Cd Dissolved (g/L)		0.2	<1	<1	<1	11	18
Cd Total (g/L)	2		<1	<1	<1	11	24
Chloride (mg/L)	250		12.6	11.7	11.8	10.3	10.9
Co Dissolved (g/L)		1.4	2	<1	<1	<1	<1
Co Total (g/L)	NA		2	<1	<1	<1	<1
Cr Dissolved (g/L)	Cr ^(VI) 50	3.3(Cr ^(III))&1 Cr ^(VI)	<1	<1	<1	<1	<1
Cr Total (g/L)	NA		<1	<1	<1	<1	<1
Cu Dissolved (g/L)		1.4	<1	<1	<1	19	7
Cu Total (g/L)	1000		<1	1	<1	47	53
Fe Dissolved (g/L)		300	770	78	83	122	38
Fe Total (g/L)	300		8270	124	144	691	17300
Fluoride (mg/L)	1.5		0.17	0.08	0.06	2.54	2.95
Hg Dissolved (g/L)		0.06	<0.05	<0.05	<0.05	<0.05	<0.05
Hg Total (g/L)	1		<0.05	<0.05	<0.05	<0.05	<0.05
K Dissolved (mg/L)			2.11	0.76	0.76	2.81	5.96
K Total (mg/L)	NA		2.1	0.77	0.76	2.92	5.97
Mg Dissolved (mg/L)			2.64	0.84	0.81	4.15	11.2
Mg Total (mg/L)			2.69	0.84	0.83	4.21	11.2
Mn Dissolved (g/L)		1900	1550	23	26	1110	6980
Mn Total (g/L)	100		1590	25	28	1130	7040
Mo Dissolved (g/L)		34	<5	<5	<5	<5	<5
Mo Total (g/L)	50		<5	<5	<5	<5	<5
Na Dissolved (mg/L)			9.54	7.4	7.22	7.58	9.88
Na Total (mg/L)	180		9.5	7.33	7.32	7.7	9.93
Ni Dissolved (g/L)		11	<10	<10	<10	<10	<10
Ni Total (g/L)	20		<10	<10	<10	<10	<10
Pb Dissolved (g/L)		3.4	<7	<7	<7	<7	<7
Pb Total (g/L)	10		<7	<7	<7	<7	<7
Se Dissolved (g/L)		5	<15	<15	<15	<15	<15
Se Total (g/L)	10		<15	<15	<15	<15	<15
Sulphate (mg/L)	500	40	7.5	2	2	14.9	37.7
Zn Dissolved (g/L)		8	4	8	8	1220	2670
Zn Total (g/L)	3000		7	9	9	1340	3120

Anchor Site 1 — discharge point into Groom River

Anchor Site 2 — upstream of discharge point

Anchor Site 3 — downstream of identified discharge point

Anchor Site 4 — outflow from tailings dam into polishing pond

Anchor Site 5 — tailings dam seepage into polishing pond

result in a lower toxicity effect. As aluminium does occur in natural waters from the leaching of soil and rock and the mobilisation of sediments in waterways, the levels detected may reflect normal background levels.

Arsenic is recorded at $<10 \mu\text{g/L}$, which represents a reporting level. This level would be greater than the level of detection and it is reasonable to halve the reporting level when comparing it to the ADWG limit and ANZGFMWQ trigger value. In natural waters arsenic can be introduced into the water body through dissolution of minerals and ores, mostly in the sulfide form.

It is reported that in natural waters arsenic concentrations $<5 \mu\text{g/L}$ are not uncommon. It is considered reasonable that the $<10 \mu\text{g/L}$ level recorded in the treatment system, in the discharge, and upstream and downstream of the outfall reflect background levels and is unlikely to represent a risk to public health (or the receiving environment).

Cadmium does occur at low levels in natural surface waters, i.e. $<1 \text{ g/L}$, which was reported from the samples of the discharge and upstream and downstream of the discharge. Cadmium does complex with inorganic and/or organic agents and adsorb to clay and biotic surfaces. These are important processes for the removal of cadmium from solution and reducing the uptake and toxicity of the metal. The reported less than value for cadmium is less than the ADWG limit and above the ANZGFMWQ level. It is considered reasonable that the reported $<1 \text{ g/L}$ cadmium level represents no risk to public health and is unlikely to represent a risk to the receiving environment. The receiving environment is providing additional dilution and lowering the discharged concentration even further.

Iron is elevated, particularly as a total iron concentration, i.e. $8270 \mu\text{g/L}$. Most is in a suspended solid including colloidal form ($>0.45 \text{ m}$). In water iron is in oxidised forms as ferric ($\text{Fe}^{(III)}$) or ferrous ($\text{Fe}^{(II)}$) compounds and occurs commonly in soil and rocks as the oxide, sulfide and carbonate minerals. As iron concentrations in uncontaminated surface waters are usually less than 1 mg/L this detected level is considerable. In the ADWG it is reported that the taste threshold of iron in water is about 0.3 mg/L , and becomes objectionable above 3 mg/L . If iron at this level is undiluted with receiving waters it would represent a public risk.

Acute toxicity to aquatic insects has been reported at iron concentrations ranging from 320 g/L to $16\,000 \text{ g/L}$. Iron is principally found as colloidal suspensions of ferric hydroxide, and may remain suspended in water or settle and harden. Although elevated levels were not being reflected on the day at the upstream and downstream locations, it is evident from the photos of the treatment system and seeps that suspended colloidal material is causing elevated turbidity and discolouration, noticeable in Figure 4.

In natural waters lead can be introduced into the water body through the dissolution of minerals and ores. Lead is recorded in the samples at $<7 \text{ g/L}$, which is less than the ADWG limit. It is considered reasonable that because the $<7 \text{ g/L}$ lead level is reported in the treatment system, the discharge, and upstream and downstream of the outfall, it reflects background levels and is unlikely to represent a risk to public health or the receiving environment.



Figure 4

Evidence of discolouration around the polishing pond.

Manganese is elevated in the discharge at 1590 g/L with the majority in dissolved form at 1550 g/L . This level should not represent a toxicity risk to the aquatic ecosystem, even though in uncontaminated waterways the level generally ranges from 1 g/L to 600 g/L and the measured background level was 25 g/L .

It is reported in ADWG that, based on aesthetic considerations, the concentration of manganese in drinking water should not exceed 100 g/L and on health consideration should be less than 500 g/L . The discharge level is considerably above this, however with dilution the downstream value has returned to background levels and should not represent either nuisance or a public health concern if downstream users use river water for domestic purposes.

Selenium in the natural waters can be introduced through weathering of rocks and soils. Most toxicity values are based on uptake from the water column but in natural populations this is insignificant compared to uptake through the food chain. A complication with selenium is its potential for bio-accumulation, i.e. concentrations of selenium can build up to toxic levels in higher organisms even when selenium concentrations in the water column are low. It is reported in ANZGFMWQ that several species of crustacean have been toxicologically assessed with 14-d NOEC of $14\text{--}86 \text{ g/L}$ (from LC50) and 21-d NOEC, growth, of 85 g/L .

Selenium, like arsenic, has its measured concentration reported as a less than value. All reported levels for the

polishing pond, discharge and background are <15 g/L, so again the detection limit would be less than this reporting level and the reporting level could be halved when assessing against the ADWG and ANZGFMWQ. The value detected may be less than the 5 g/L protection of aquatic ecosystem trigger value. It is considered that the detected level of <15 g/L represents a low risk to the aquatic ecosystem.

Conclusion and recommendations

The levels detected of the pollutants of interest in the natural environment suggest that there is a very low risk to drinking water and the receiving environment. While some pollutants are elevated in the treatment system and at the discharge point, the levels detected in the receiving

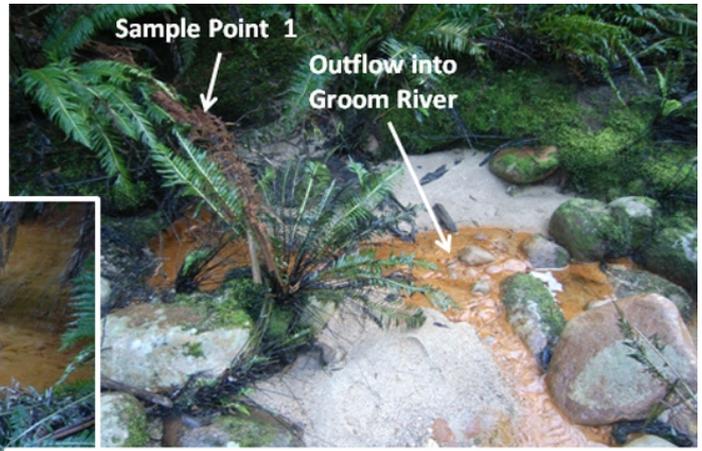
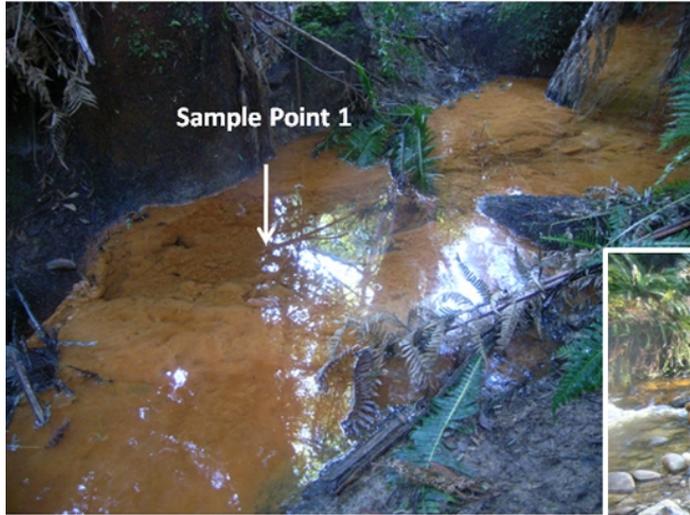
environment represent a low risk to the public, where raw water is used for domestic water supply, and to the protection of the aquatic ecosystem.

Notwithstanding, ongoing monitoring will be undertaken at three sampling points on the Groom River on a quarterly basis. This will provide data for future management directions for the site and enable improved risk assessment for the potential for environmental harm and deleterious effect on public health. In addition to ongoing monitoring, it is also recommended that a dam surveillance report be undertaken to ensure that the integrity of the tailings dam is maintained.

[31 August 2011]

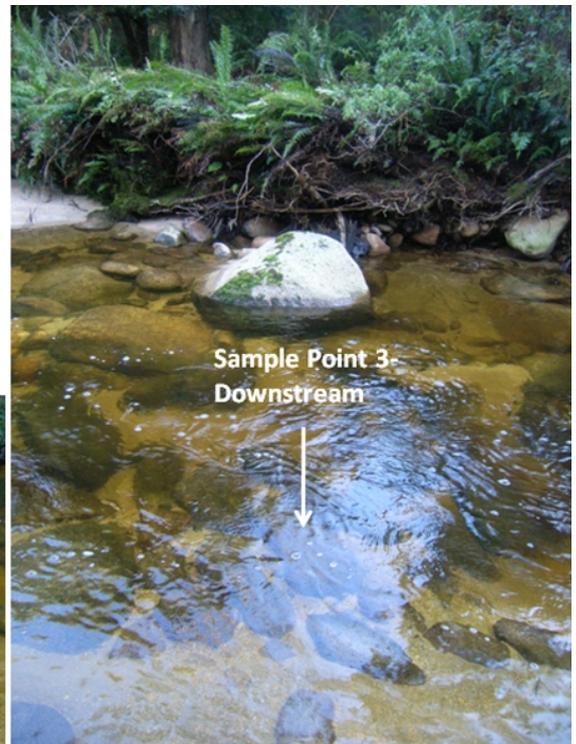
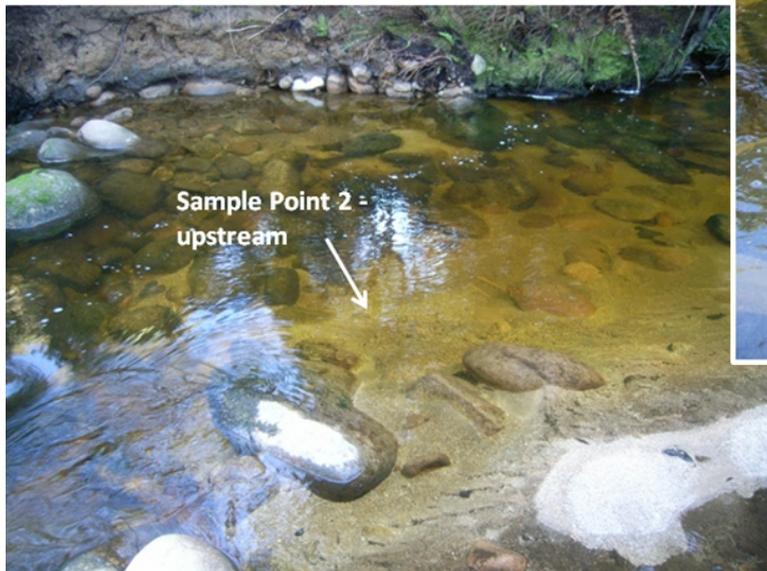
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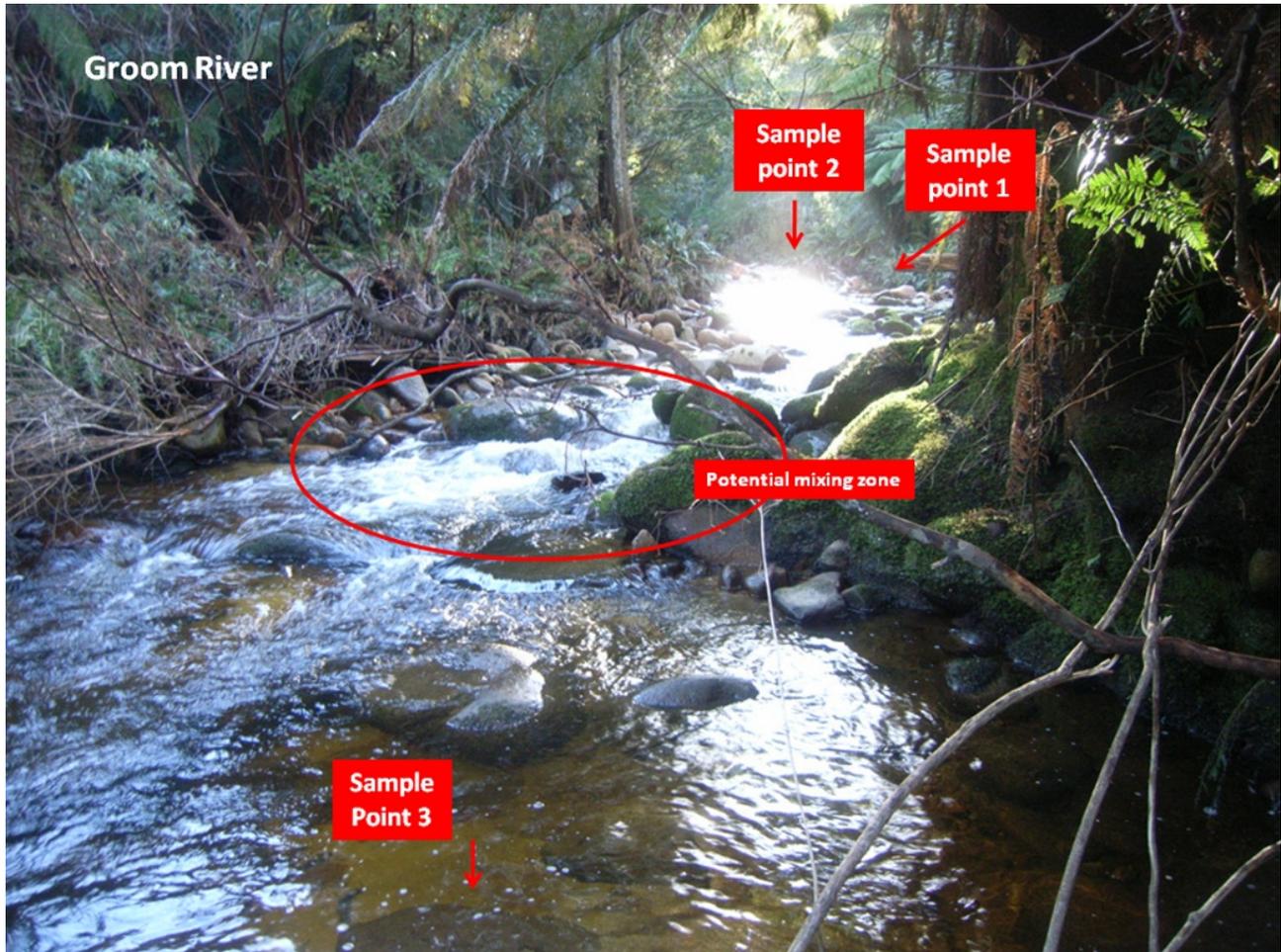
APPENDIX I
Photos of sample points



Sample Point 1 – outflow to Groom River

Sample Points 2 and 3 – Groom River





Sample Points 4 and 5 –
Anchor Mine tailings



APPENDIX B

Water Sample Results, AST — Report No. 49450



ANALYTICAL SERVICES TASMANIA

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Phone: 62338325
Mobile:

Date: 18-Jul-11
Pages: 4 (including this one)
From: Amanda Freeman

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Phone: (03) 6230 7000

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The original was sent to:

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Laboratory Report

Report No: 49450

Issue No: 1

Report Date 18-Jul-2011 16:33

Status: Full Report

Site Description: Anchor Mine

Received: 17-Jun-11

Submitted to: New Town Laboratory

Submitted By: Jen Parnell (Mineral Resources Tasmania)

Client Order No:

Report To: Russell Fulton

Client: TNT Mines Limited

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ANALYTICAL SERVICES TASMANIA

Report No: 49450 Issue No: 1 Report Date: 18-Jul-2011 16:33

Method	Analyte	Units / Sampled On :	Lab.No.: 194647	194648	194649	194650	194651
			Sample Id.: Anchor Site 1	Anchor Site 2	Anchor Site 3	Anchor Site 4	Anchor Site 5
			15/06/11	15/06/11	15/06/11	15/06/11	15/06/11
1103-Water	Bromide	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5
	Chloride	mg/L	12.6	11.7	11.8	10.3	10.9
	Fluoride	mg/L	0.17	0.08	0.06	2.54	2.95
	Sulphate	mg/L	7.5	2.0	2.0	14.9	37.7
1301-Water	Al Dissolved	µg/L	<20	176	167	<20	39
	Al Total	µg/L	132	216	212	141	253
	As Dissolved	µg/L	<10	<10	<10	<10	<10
	As Total	µg/L	<10	<10	<10	<10	<10
	Ba Dissolved	µg/L	14	<5	<5	<5	8
	Ba Total	µg/L	15	<5	<5	<5	10
	Ca Dissolved	mg/L	3.16	0.71	0.69	8.11	26.2
	Ca Total	mg/L	3.21	0.71	0.71	8.27	26.5
	Cd Dissolved	µg/L	<1	<1	<1	11	18
	Cd Total	µg/L	<1	<1	<1	11	24
	Co Dissolved	µg/L	2	<1	<1	<1	<1
	Co Total	µg/L	2	<1	<1	<1	<1
	Cr Dissolved	µg/L	<1	<1	<1	<1	<1
	Cr Total	µg/L	<1	<1	<1	<1	<1
	Cu Dissolved	µg/L	<1	<1	<1	19	7
	Cu Total	µg/L	<1	1	<1	47	53
	Fe Dissolved	µg/L	770	78	83	122	38
	Fe Total	µg/L	8270	124	144	691	17300
	K Dissolved	mg/L	2.11	0.76	0.76	2.81	5.96
	K Total	mg/L	2.10	0.77	0.76	2.92	5.97
	Mg Dissolved	mg/L	2.64	0.84	0.81	4.15	11.2
	Mg Total	mg/L	2.69	0.84	0.83	4.21	11.2
	Mn Dissolved	µg/L	1550	23	26	1110	6980
	Mn Total	µg/L	1590	25	28	1130	7040
	Mo Dissolved	µg/L	<5	<5	<5	<5	<5
	Mo Total	µg/L	<5	<5	<5	<5	<5
	Na Dissolved	mg/L	9.54	7.40	7.22	7.58	9.88
	Na Total	mg/L	9.50	7.33	7.32	7.70	9.93
	Ni Dissolved	µg/L	<10	<10	<10	<10	<10
	Ni Total	µg/L	<10	<10	<10	<10	<10
	Pb Dissolved	µg/L	<7	<7	<7	<7	<7
	Pb Total	µg/L	<7	<7	<7	<7	<7
Se Dissolved	µg/L	<15	<15	<15	<15	<15	
Se Total	µg/L	<15	<15	<15	<15	<15	
Zn Dissolved	µg/L	4	8	8	1220	2670	
Zn Total	µg/L	7	9	9	1340	3120	
1305-Water	Hg Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
	Hg Total	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05

ANALYTICAL SERVICES TASMANIA

Report No: 49450 Issue No: 1 Report Date: 18-Jul-2011 16:33

Test Method(s) :	Test Date
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Inorganic Testing

1103-Water:	Anions in Water by Ion Chromatography Work Conducted at: New Town	04-Jul-2011
1301-Water:	Metals in Water by ICP-AES Work Conducted at: New Town	12-Jul-2011
1305-Water:	Mercury in Water by CVAFS Work Conducted at: New Town	23-Jun-2011

Authorised By:



John O'Reilly
Section Head - Inorganic
(Metals)



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