
**Storys Creek Water Quality
Monitoring Results**

10 August & 1 September 2005

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A Report to Mineral Resources Tasmania

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Technical Advice on Water



1 Introduction

Mineral Resources Tasmania (MRT) has implemented large-scale remediation works at the historic Storys Creek mine site in eastern central Tasmania, including the removal of the contents of a precipitation dam, closure of adits, removal of some tailings and implementation of an anoxic limestone drain. A 3-year water quality monitoring program was initiated in September 2003 to determine the concentrations and fluxes of pollutants leaving the site and evaluate the efficacy of the remediation works.

This report summarises the results from the eighth and ninth water quality-monitoring runs completed on August 10th, 2005 and September 1st 2005 and compares results to previous findings. These monitoring runs corresponded to high flow events in the catchment.

2 Sampling details

Water quality and flow monitoring was completed on August 10th and September 1st, 2005 by L. Koehnken of Technical Advice on Water. In August, all sites in Table 1 were visited; in September, the sites in the lower Storys Creek catchment (Storys above Aberfoyle, Aberfoyle above Storys and Storys below Aberfoyle) were not able to be monitored due to flooding in the South Esk River which prevented access to the area. At each site pH, conductivity and temperature was measured *in situ* and a water sample was collected for subsequent analysis of metals, sulphate, fluoride and alkalinity.

During both monitoring runs, flow measurements were obtained at the following sites: Storys below Precipitate Dam, Storys below Nisbet Creek, and Storys at Managers. During the August monitoring flow measurements were also completed at Storys above Aberfoyle and Aberfoyle above Storys. For each flow measurement the dimensions of the channel were measured (width, depth at various points) and flow measurements were made using a flow-meter at 3-7 points across a transect at a depth of 0.6 of the water depth (from the surface). The flow estimates were used to estimate fluxes at each of the sites. The 'Storys below Precipitation Dam' site flow measurement was used in the flux calculations for three sites (Storys Creek above mine, Storys below PPT dam, and Storys above Side Creek) because flow varies little between the sites and the site yields the most accurate flow estimate due to the presence of bedrock, resulting in a stable channel with confined flow.

Flow from the ALD was estimated using the flow meter and dimensions of the channel. During the August monitoring, there was considerable surface flow entering the ALD channel from the marshy area upstream. At the Precipitate dam outflow, flow was visually estimated during both monitoring runs because the flow is no longer confined to the pipe and cascades over the dam wall (Photo 1).



Photo 1. Discharge from Precipitate dam flowing over dam wall. Photo taken on 10 August 2005. Note no flow is exiting pipe in center of photo.

Flow from Eastern Adit was determined using the height of the water in the V-notch weir, and a generalised USGS equation for calculating V-notch flow. Sedimentation of iron floc in the portal of the Eastern Adit is presently affecting the accuracy of the V-notch.

Conditions during sampling on August 10th were fine, and followed a large but relatively isolated rainfall event in the upper catchment, with 42 mm falling in the previous 48 hours at Powranna, but only 9.7 mm at Fingal. The September sampling followed a wide-spread high rainfall event which resulted in flooding in the South Esk catchment. In the three days prior to monitoring, a total of 77.4 mm of rain was recorded at Powranna, and 54.4 mm at Fingal. Rainfall was higher in the headwaters of the South Esk, with 104 mm falling over the same period at the Launceston airport. This resulted in a flood peak in the South Esk River which passed through Avoca on the sampling day and prevented access to the lower Storys Creek catchment.

Table 1. Site number and location of monitoring points.

Site Number	Site Location	Justification
ALD	Anoxic Drain outflow at Storys Creek	Provide indication of alkalinity input to underground workings
2	Storys Cr above mine workings	Provides background water quality and indication of upstream changes
5	Storys Cr below Precipitation Dam	Provide record of changes since dam removal – should continue to change as groundwater ‘flushes’ through system
7	Storys above Side Creek	Indicate pollutant load from tailings deposit located upstream Side Cr
8	Storys Cr below Side Creek	Significant pollutant load enters via Side Creek
10	Eastern Adit outflow	Adit plugged, monitoring of pH indicates effectiveness of works
13	Storys below Nisbet	Indicates inputs from diffuse sources downstream of Side Creek and dilution from entrance of Nisbet Cr
14	Storys at Managers*	Continue best long-term data collection point; indicates diffuse load entering between Nisbet and Pumphouse
21	Storys Above Aberfoyle	Final measurement of pollutant load in Storys Creek
23	Storys below Aberfoyle	Indicative of water entering South Esk
22	Aberfoyle Creek	Has elevated zinc levels and contributes to loads entering S. Esk
24	South Esk above Storys	‘Background’ water quality in South Esk River
25	South Esk d/s Storys	Estimate of Storys Creek impact on S. Esk
4	Precip. dam outflow	Historic pollutant source
6	Side Creek	Historic pollutant source

*This site has been referred to as both Storys below Pumphouse and Storys at Manager’s. In this and subsequent reports ‘Storys at Manager’s’ will be used.



Photo 2. Flooding of the South Esk in the Fingal valley. Photo taken at South Esk crossing near Aberfoyle property (September 1, 2005).



Photo 3. South Esk crossing on Henbury Road. Bridge creating rapid in river (1 September 2005).

3 Results and discussion

Water quality results for August and September 2005 are presented in Table 2, and Table 3. Table 2 contains the water quality results from the regular monitoring sites on Storys Creek, Aberfoyle Creek and the South Esk River. Table 3 shows the pH, conductivity and temperature data collected in the field, and an estimate of metal and sulphate fluxes for each of the regular monitoring sites.

3.1 Flows

Flows in Storys Creek during the August and September sampling runs are presented in Table 2, and are the highest recorded since monitoring began in September 2003. Photo 4 through 7 show flow conditions at the Storys at Managers monitoring site. Photo 8 shows flow conditions in May 2005, the lowest flow monitored, for comparison. Although water levels were similar during the August and September monitoring runs, flow velocities were greater in September, leading to higher river discharge. In August and September, flow at the Managers site was ~1400 l/s and ~1,900 m³/s, respectively.

Flow in lower Storys Creek and Aberfoyle Creek were only able to be measured in August. With ~2 m³/s discharged from Storys Creek above Aberfoyle Cr, and an additional 1 m³/s entering from Aberfoyle Creek.



Photo 4. & Photo 5 Storys Creek at Managers Residence, view downstream (left) and upstream (right) on August 10, 2005.



Photo 6 & Photo 7 Storys Creek at Managers Residence, view downstream (left) and upstream (right) on 1 September 2005.



Photo 8. Storys Creek at Managers May 19th 2005, showing lowest flow monitored during Story Creek monitoring period.

3.2 Anoxic Limestone Drain (ALD)

During both monitoring periods there was a relatively large flow in the ALD drain, with much of the water derived from surface flow. As shown in Figure 3.1, alkalinity concentrations in August were similar to previous levels, but in September, the lab result indicates there was no alkalinity in the water. Because the EC value of the sample (172 $\mu\text{S}/\text{cm}$) was quite elevated compared to Storys above the minesite (26 $\mu\text{S}/\text{cm}$), and there was no alkalinity detected in any of the water samples submitted to the lab, it is possible that the laboratory result is an error.

Alkalinity flux from the drain in August was within the range of previous results. No flux is shown for the September sample.

The recent surface drainage works near the ALD continue to direct the ALD outflow towards the Side Creek catchment, rather than into the underground workings.

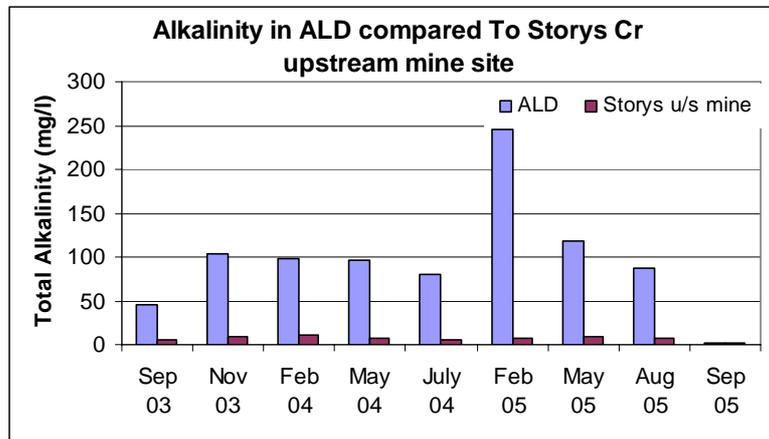


Figure 3.1. Alkalinity levels in water from the ALD compared to alkalinity levels in Storys Creek above the mine site.

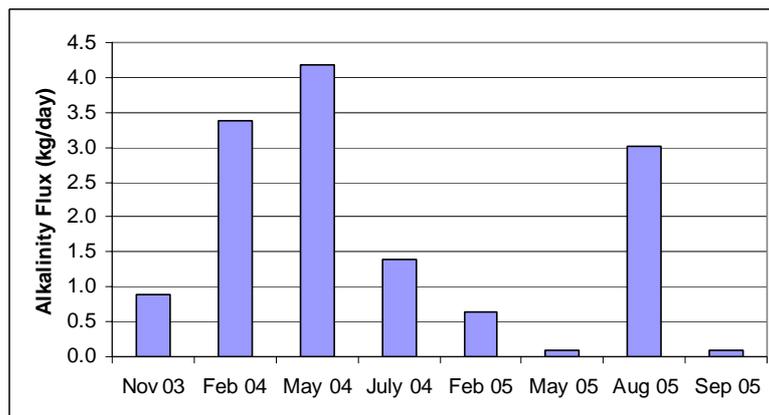


Figure 3.2 Alkalinity flux from ALD at Storys Creek township.

Table 2. Water quality results and flow for Storys Creek monitoring, August 10, 2005. All units µg/L except Fluoride, Sulphate and Alkalinity, which are mg/l.
*Flow calculated by adding Storys above Aberfoyle, and Aberfoyle Creek flows

		Storys Ab Mine	Precip Dam Outflow	Storys Bel Precip	Storys Ab Side Cr	Storys Bel Side Cr	Storys Bel Nisbet	Storys at Manage r	Storys Ab Aber	Storys Bel Aber	Aber Ab Storys	S. Esk Ab Storys	S. Esk Bel Storys
Date		10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05
Alkalinity Total	mg/l CaCO ₃	8	7	7	2	4	6	5	4	7	10	7	7
Fluoride	mg/l	<0.03	0.25	<0.03	0.34	0.18	0.12	0.12	0.14	0.19	0.26	<0.03	0.05
Sulphate	mg/l	0.45	27	1.7	16	9.3	6.9	8	8.4	8.8	9.4	1.5	2.7
Al Dis	µg/l	83	295	57	82	208	171	208	229	100	72	186	178
Al Total	µg/l	379	1410	253	1270	576	586	707	849	1060	1360	508	634
As Dis	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
As Total	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	7	16	<5	<5
Cd Dis	µg/l	1	67	4	68	33	20	22	21	15	9	<1	3
Cd Total	µg/l	1	69	4	69	34	21	24	22	19	16	<1	4
Co Dis	µg/l	<1	3	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
Co Total	µg/l	<1	4	<1	2	<1	<1	<1	<1	2	3	<1	<1
Cr Dis	µg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cr Total	µg/l	<1	2	<1	<1	<1	<1	<1	1	1	2	<1	<1
Cu Dis	µg/l	<1	16	1	226	79	43	50	49	38	33	<1	10
Cu Total	µg/l	<1	23	2	335	117	62	71	66	89	125	<1	16
Fe Dis	µg/l	68	250	36	<20	70	115	127	144	96	151	156	160
Fe Total	µg/l	370	843	142	282	235	456	420	586	1470	2760	444	625
Mn Dis	µg/l	<5	252	11	71	51	46	43	34	78	106	<5	11
Mn Total	µg/l	8	264	14	75	53	51	49	41	245	534	11	47
Ni Dis	µg/l	<2	5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ni Total	µg/l	<2	8	<2	3	<2	<2	<2	<2	3	5	<2	<2
Pb Dis	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Pb Total	µg/l	<5	<5	<5	<5	<5	<5	<5	<5	9	21	<5	<5
Zn Dis	µg/l	23	1680	93	1470	719	432	499	476	361	260	1	78
Zn Total	µg/l	30	1850	108	1520	755	479	562	546	578	645	5	100
Flow	l/s	970	20	970	970	1400	1400	1410	2110	3103	993		

Table 2 (continued) Water quality results and flow for Storys Creek monitoring, September 1, 2005. All units µg/L except Fluoride, Sulphate and Alkalinity, which are mg/l/.

		Storys Ab Mine	Precip Dam Outflow	Storys Bel Precip	Storys Ab Side Cr	Storys Bel Side Cr	Storys Bel Nisbet	Storys at Manager	Storys Ab Aber	Storys Bel Aber	Aber Ab Storys	S. Esk Ab Storys	S. Esk Bel Storys
Date		1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05
Alkalinity Total	mg/l CaCO ₃	<2	<2	<2	<2	<2	<2	<2	Not able to be accessed due to high flows			<2	<2
Fluoride	mg/l	<0.025	0.2	0.026	0.38	0.2	0.16	0.11				0.037	0.049
Sulphate	mg/l	0.3	21.4	1.8	19	11.2	10.2	7.9				1.8	2
Al Dis	µg/l	75	216	56	245	149	171	200				342	374
Al Total	µg/l	322	1470	296	1410	680	639	707				3610	3820
As Dis	µg/l	<5	<5	<5	<5	<5	<5	<5				<5	<5
As Total	µg/l	<5	<5	<5	<5	<5	<5	<5				<5	<5
Cd Dis	µg/l	<1	54	4	99	44	37	25				<1	<1
Cd Total	µg/l	<1	55	4	100	44	37	25				<1	<1
Co Dis	µg/l	<1	3	<1	3	1	1	<1				<1	<1
Co Total	µg/l	<1	4	<1	3	1	1	<1				1	1
Cr Dis	µg/l	<1	<1	<1	<1	<1	<1	<1				<1	<1
Cr Total	µg/l	<1	2	<1	<1	<1	<1	<1				4	4
Cu Dis	µg/l	2	7	1	435	105	80	56				<1	3
Cu Total	µg/l	3	11	2	511	158	115	72				1	5
Fe Dis	µg/l	76	168	39	42	69	79	102				316	373
Fe Total	µg/l	232	779	176	379	345	310	386				2280	2480
Mn Dis	µg/l	<5	243	14	93	96	84	43				10	13
Mn Total	µg/l	10	250	16	96	98	85	47				58	65
Ni Dis	µg/l	<2	4	<2	3	<2	<2	<2				<2	<2
Ni Total	µg/l	<2	5	<2	3	<2	<2	<2				<2	<2
Pb Dis	µg/l	<5	<5	<5	<5	<5	<5	<5				<5	<5
Pb Total	µg/l	<5	<5	<5	<5	<5	<5	<5				<5	<5
Zn Dis	µg/l	<1	1390	94	2140	984	852	563				<1	12
Zn Total	µg/l	2	1500	101	2180	999	846	593				8	23
Flow	l/s	1300	30	1300	1300	1700	1700	1920					

Table 2 (continued) Water quality results from Side Creek, August and September 2005.

		Side Cr	Side Cr
Date		10 August 05	1 Sep 05
Alkalinity Total	mg/l CaCO ₃	<2	<2
Fluoride	mg/l	1	1.18
Sulphate	mg/l	31	38.5
Al Dis	µg/l	701	880
Al Total	µg/l	906	1370
As Dis	µg/l	<5	<5
As Total	µg/l	<5	<5
Cd Dis	µg/l	33	40
Cd Total	µg/l	34	40
Co Dis	µg/l	1	3
Co Total	µg/l	2	3
Cr Dis	µg/l	<1	<1
Cr Total	µg/l	<1	<1
Cu Dis	µg/l	72	70
Cu Total	µg/l	73	71
Fe Dis	µg/l	235	443
Fe Total	µg/l	377	988
Mn Dis	µg/l	110	175
Mn Total	µg/l	111	177
Ni Dis	µg/l	4	5
Ni Total	µg/l	5	6
Pb Dis	µg/l	<5	<5
Pb Total	µg/l	<5	<5
Zn Dis	µg/l	949	1010
Zn Total	µg/l	947	1010
Flow	l/s	1	2

Table 3. Flow, pH conductivity and temperature results collected *in situ*, August 10, 2005 and flux calculations based on flows and analytical results.

*Flow estimate from Storys below Precip dam used to estimate fluxes.

#Calculated based on Storys above Aberfoyle & Aberfoyle above Storys

**Visually estimated due to unchannelised flow

		Storys Ab Mine*	Precip Dam Outflow	Storys Bel Precip	Storys Ab Side Cr*	Storys Bel Side Cr*	Storys Bel Nisbet	Storys at Manager	Storys Ab Aber	Storys Bel Aber	Aber Ab Storys#	S. Esk Ab Storys	S. Esk Bel Storys
Parameter	Unit	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05	10 Aug 05
Flow	l/s	970	20	970**	970	1400	1400	1410	2110	3103	993		
pH (field)	pH units	6.90	6.47	6.94	5.84	6.02	6.66	6.48	6.57	6.47	6.65	6.45	6.48
EC	µS/cm	26.5	88.3	25.2	30.0 - 53.8	38.4	38.5	39.9	45.3	85.1	61.0	43.4	49.2
Temp	°C	4.4	5.3	4.4	4.6	5.9	5.5	5.9	5.1	5.4	5.8	7.2	7.0
TSS	mg/l							5	9	30	59		
Zn tot flux	kg/d	0.04	3.20	9.05	127.39	91.32	57.94	68.47	99.54	154.96	55.34		
Cd tot flux	kg/d	0.04	0.12	0.34	5.78	4.11	2.54	2.92	4.01	5.09	1.37		
Mn tot flux	kg/d	<0.03	0.46	1.17	6.29	6.41	6.17	5.97	7.47	65.68	45.81		
Fe tot flux	kg/d	<0.12	<0.01	11.90	23.63	28.43	<0.05	51.17	106.83	394.11	236.79		
SO₄ flux	kg/d	37.7	3.5	142.5	1341	1125	834.6	974.6	1531	2359	806.5		

		ALD	Side Creek	Eastern Adit
Date		10 Aug 05	10 Aug 05	10 Aug 05
Flow	l/s	0.4	1	0.1
pH (field)	pH units	7.29	3.82	5.67
EC	µS/cm	171.6	87.0	327
Temperature	°C	4.0	5.6	6.9

Table 3 (continued) Flow, pH conductivity and temperature results collected in situ, September 1, 2005 and flux calculations based on flows and analytical results.

		Storys Ab Mine*	Precip Dam Outflow	Storys Bel Precip	Storys Ab Side Cr*	Storys Bel Side Cr*	Storys Bel Nisbet	Storys at Manager	Storys Ab Aber	Storys Bel Aber	Aber Ab Storys#	S. Esk Ab Storys	S. Esk Bel Storys
Parameter	Unit	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05	1 Sep 05
Flow	l/s	1300	30	1300	1300	1700	1700	1920	Not sampled due to high flows in South Esk River				
pH (field)	pH units	7.02	6.51	6.77	5.65-5.80**	5.82	5.90	6.04				6.39	6.40
EC	µS/cm	26.0	101.2	32.0	37 – 83.5**	55.7	57.8	49.5				66.9	69.6
Temp	°C	5.1	8.0	5.6	5.8	6.2	6.3	7.0				8.8	8.9
TSS	mg/l											36	45
Zn tot flux	kg/d	0.06	3.89	11.34	244.86	146.73	124.26	98.37					
Cd tot flux	kg/d	0.06	0.14	0.45	11.23	6.46	5.43	4.15					
Mn tot flux	kg/d	<0.03	0.65	1.80	10.78	14.39	12.48	7.80					
Fe tot flux	kg/d	<0.12	<0.01	19.77	42.57	50.67	<0.05	64.03					
SO₄ flux	kg/d	34	56	202	2134	2061	1877	1842					

**Range of values collected from transect across channel.

		ALD	Side Cr	Eastern Adit
Date		1 Sep 05	1 Sep 05	1 Sep 05
Flow	l/s	0.5	2	0.2
pH (field)	pH units	6.27	4.09	5.87
EC	µS/cm	119.2	118.0	288
Temperature	°C	8.8	8.7	8.4

3.3 Water quality trends in Storys Creek

The water quality trends from August and September 2005 differ from results obtained under low flow conditions, in that under high flow, the majority of metals and sulphate enter the river upstream of Side Creek. Under low flow conditions, the Side Creek area adds a substantial percentage of the metals and sulphate. The increase upstream of Side Creek is attributable to the draining/leaching of the tailings deposits on the steep bank of the river at the historic mine site. There was an EC gradient, ranging from 30-54 $\mu\text{S}/\text{cm}$ (August) and 37 – 84 $\mu\text{S}/\text{cm}$ (September) across the river upstream of Side Creek, with maximum values present at the toe of the tailings deposit. In spite of the high flows, there was a white precipitate on the bed of Storys Creek near the toe of the deposits, similar to the floc observed in May 2005 during very low flows. This input of contaminants upstream of Side Creek is evident in Figure 3.3 - Figure 3.5, where concentrations of zinc, cadmium and sulphate are compared to previous monitoring results. In the three graphs concentrations 'peak' upstream of Side Creek, and decrease with distance downstream. This is strong evidence that input from the tailings deposits is a sporadic event associated with high rainfall.

Other water quality trends include:

- Dissolved arsenic and lead are present at below detection levels at monitoring sites within Storys Creek, but are present in Aberfoyle Creek and Storys Creek below Aberfoyle Creek;
- Dissolved cobalt and nickel are below detection limits except for the outflow from the Precipitate Dam and Side Creek;
- Dissolved chromium is below detection limits for all sites;
- There is a decrease in pH and alkalinity through the mine site, with the largest decrease occurring between the Downstream of the Precipitate Dam site and Upstream of Side Creek site;
- Sulphate, aluminium, iron and manganese concentrations are consistent with the pH and alkalinity trend, and increase substantially between the Above Side and Below Side Creek sites;
- The highest concentrations of iron, manganese and aluminium all occur at upstream of Side Creek. Concentrations of iron and aluminium decrease downstream presumably due to precipitation, while manganese levels remain relatively constant. Some of the variability may also be attributable to the variability across the transect at the Upstream of Side Creek site. Although the water sample for analysis was collected from across the transect, it may not be representative of the cross-section.
- Zinc, copper and cadmium concentrations also peak upstream of Side Creek and decrease downstream;
- In the lower catchment, Total Suspended Solids were elevated in both Aberfoyle and Storys Creek, with Aberfoyle returning the highest value (Table 3);

- Aluminium, cadmium, copper and zinc levels exceed ANZECC trigger values for the protection of aquatic ecosystems (95th percentile) at the Managers Residence monitoring site in both August and September. In August, the same metals exceed trigger values at the Storys below Aberfoyle site, just upstream from where the river enters the South Esk. No results from the lower catchment are available for September.

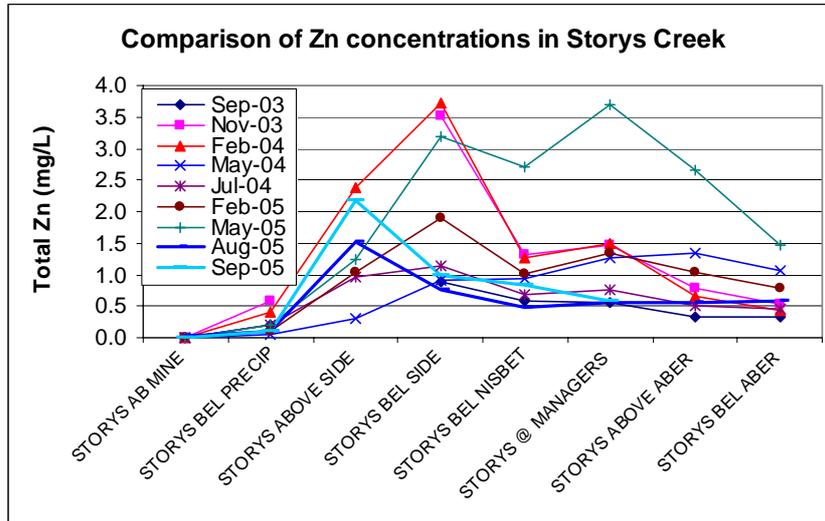


Figure 3.3. Total zinc concentrations at monitoring sites in Storys Creek by date.

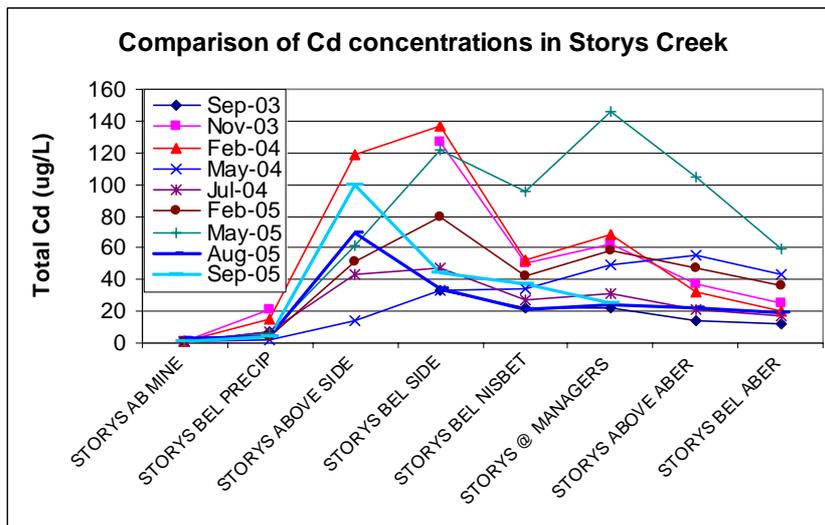


Figure 3.4. Total cadmium concentrations at monitoring sites in Storys Creek by date.

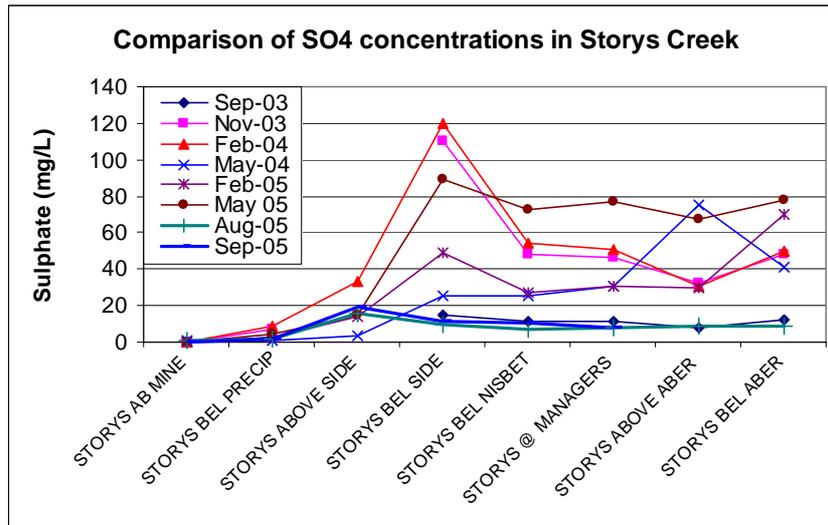
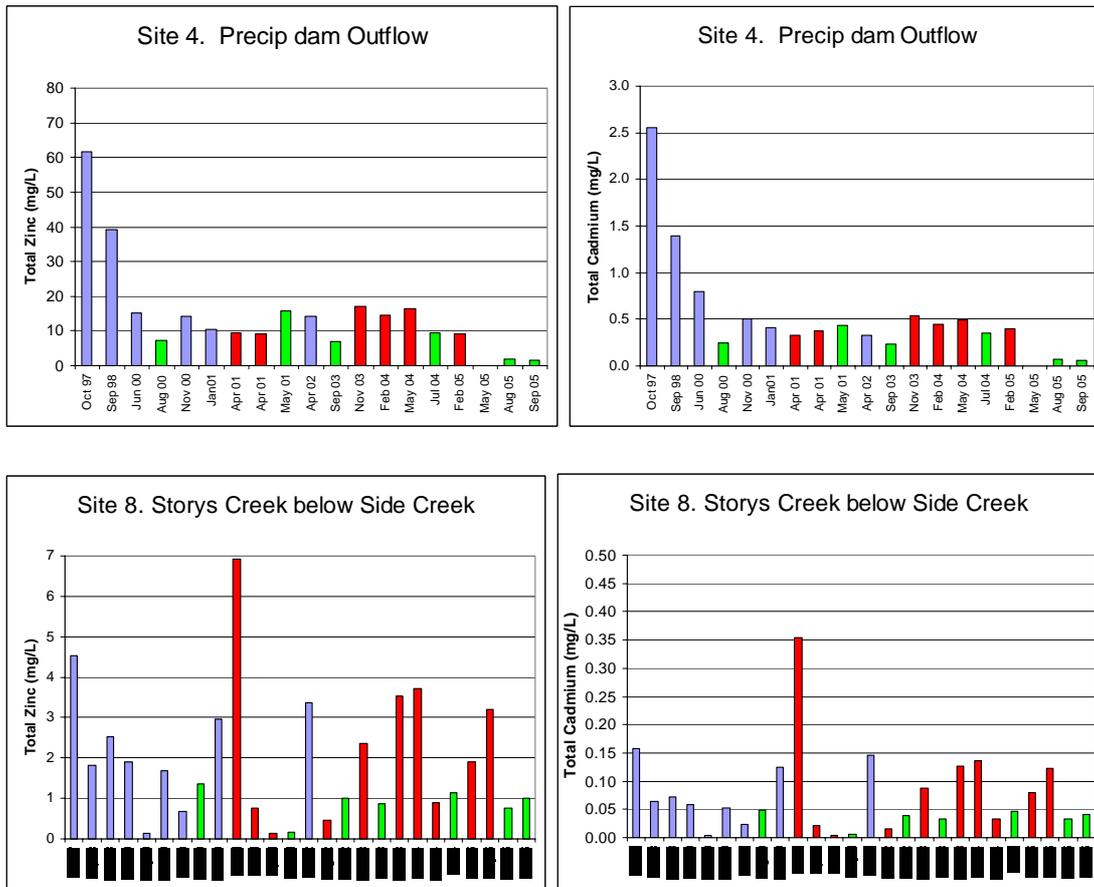


Figure 3.5. Sulphate concentrations at monitoring sites in Storys Creek by date

The zinc and cadmium concentrations measured in August and September 2005 are compared with previous zinc results for the Precipitate Dam, Storys below Side Creek and Storys at the Managers Residence in Figure 3.6. The graphs show that concentrations are very low compared to previous results obtained under lower flow condition.



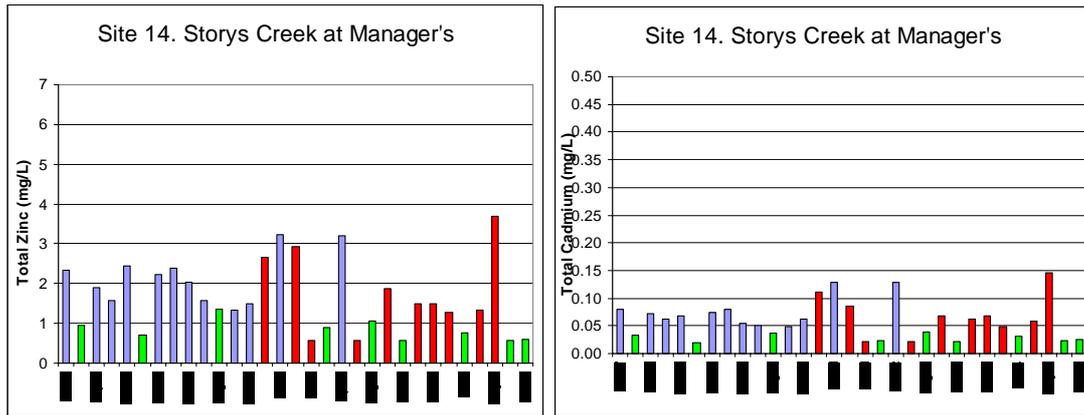


Figure 3.6 . Total zinc (left) and total cadmium (right) graphs comparing the August 2005 and September 2005 results with previous monitoring results. Red bars denote low flow (<250 L/s), blue bars denote medium flows (250 – 350 L/s), and green bars denote high flow (>350 L/s). Note different scale for the Precipitate dam results. No results shown for Precip Dam indicates no flow from dam at time of sampling.

The zinc load from Storys Creek increased zinc concentrations in the South Esk from 5 µg/L to 100 µg/L in August, and from 8 µg/L to 23 µg/L in September (Table 2). The greater influence of Storys Creek on the South Esk in August is attributable to the relatively higher flow in Storys Creek as compared to the South Esk due to the localized nature of the August rainfall event. In contrast, the 8 – 23 µg/L increase in September is relatively small compared to previous monitoring due to the relatively greater rainfall in the upper South Esk catchment as compared to Storys Creek. During both monitoring runs, zinc levels in the South Esk were increased to above ANZECC (2000) trigger levels for the protection of aquatic ecosystems, but still well below irrigation or stock watering guidelines.

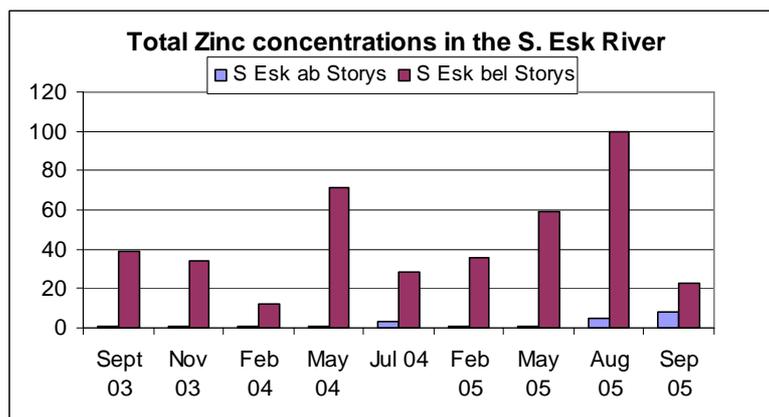


Figure 3.7. Comparison of total zinc concentrations in the South Esk River upstream and downstream of the confluence with Storys Creek.

3.4 Water quality – fluxes

Using the flow estimates and water quality results, fluxes for zinc, cadmium, iron, manganese and sulphate were determined, and are presented in Table 3. Figure 3.8, Figure 3.9 and Figure 3.10 show zinc, cadmium and sulphate fluxes at each of the

monitoring sites in Storys Creek compared to previous results since September 2003. Figure 3.11 compares the fluxes from August and September 2005 with results between 1997 and the present. The fluxes show the following characteristics and trends:

- The August and September 2005 fluxes are the highest fluxes measured at any site since monitoring began in September 2003 (Figure 3.8-Figure 3.10), and for zinc and cadmium, are the highest fluxes recorded at the Manager's Residence site since monitoring began in 1997;
- Of the two monitoring periods, the September fluxes are higher, attributable to higher flows yet similar metal and sulphate concentrations in September as compared to August. In September, it is likely there was a higher contribution of groundwater to the creek, due to the sampling occurring during a receding hydrograph, and following a generally wetter period as compared to August;
- The largest source of metal to Storys Creek was the river reach between the 'Below Precipitate Dam' monitoring site, and the 'Above Side Creek' monitoring site. The strong east (low) to west (high) EC gradient across the river, and presence of white amorphous metal hydroxides along the western bank strongly suggests that the remaining tailings deposits on the steep bank of the river are the major source of these metals. The associated reduction in pH and increase in sulphate in the same river reach is consistent with on going sulphide oxidation in the dumps, with the released metals stored in the tailings deposit until flushed during large rain events. The importance of large rain events is evident when results are compared to low-flow monitoring trends, which do not show a decrease in pH in this same river reach;
- The metal fluxes appear to decrease with distance downstream from the tailings deposits, which probably indicates there was incomplete mixing at the sampling sites;
- Metal fluxes from the lower catchment are only available for August. The fluxes show that Storys above Aberfoyle contributes about twice the total zinc, cadmium and sulphate flux to lower Storys Creek as compared to Aberfoyle Creek.

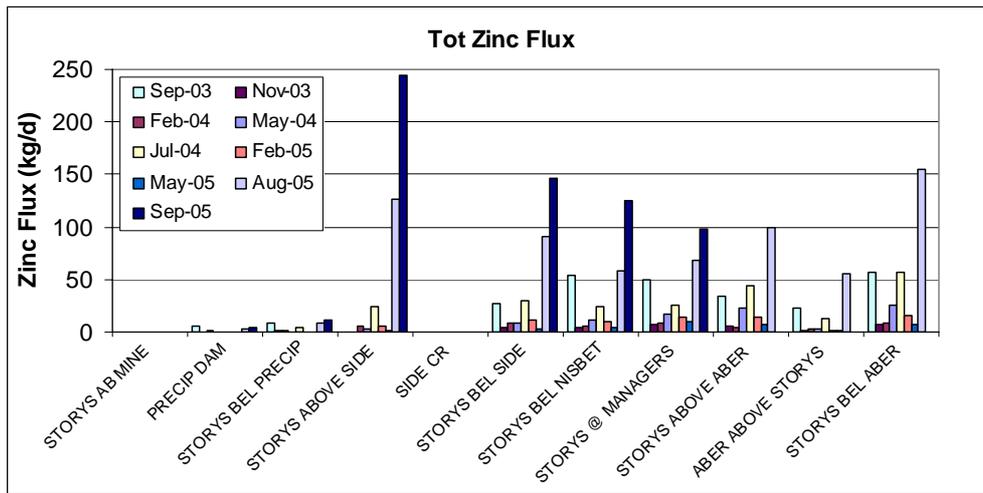


Figure 3.8. Total zinc fluxes for sites in Storys Creek for all sampling runs since September 2003. Note, Storys above Side Creek was not monitored in September 2003.

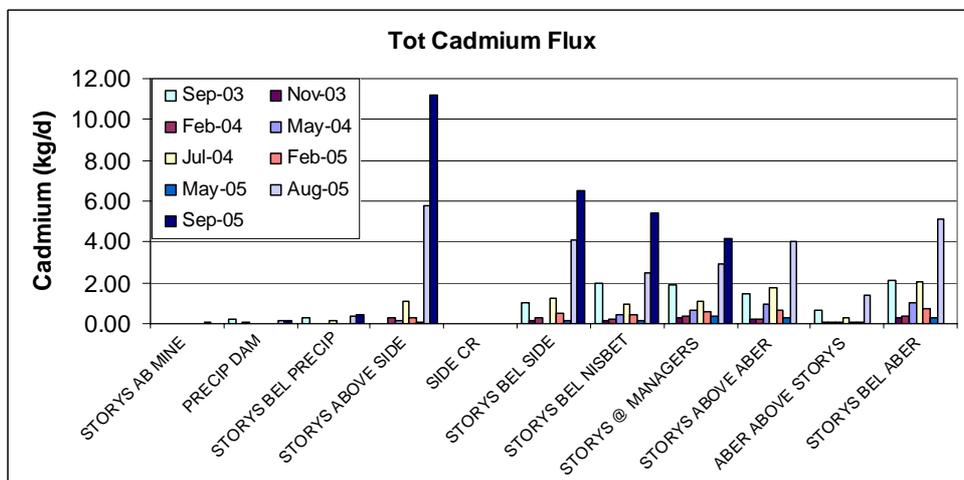


Figure 3.9. Total cadmium fluxes in Storys Creek since September 2003.

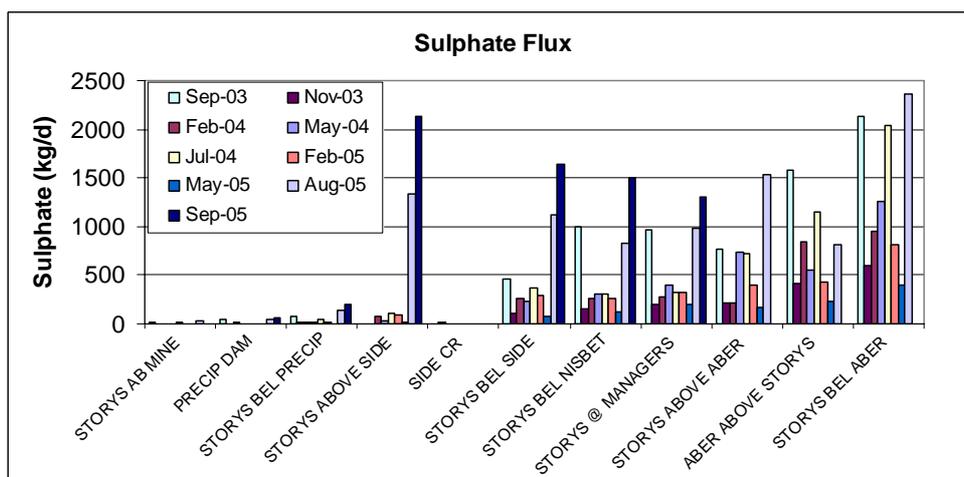


Figure 3.10. Sulphate fluxes in Storys Creek since September 2003. Storys above Side Cr was not monitored in September 2003.

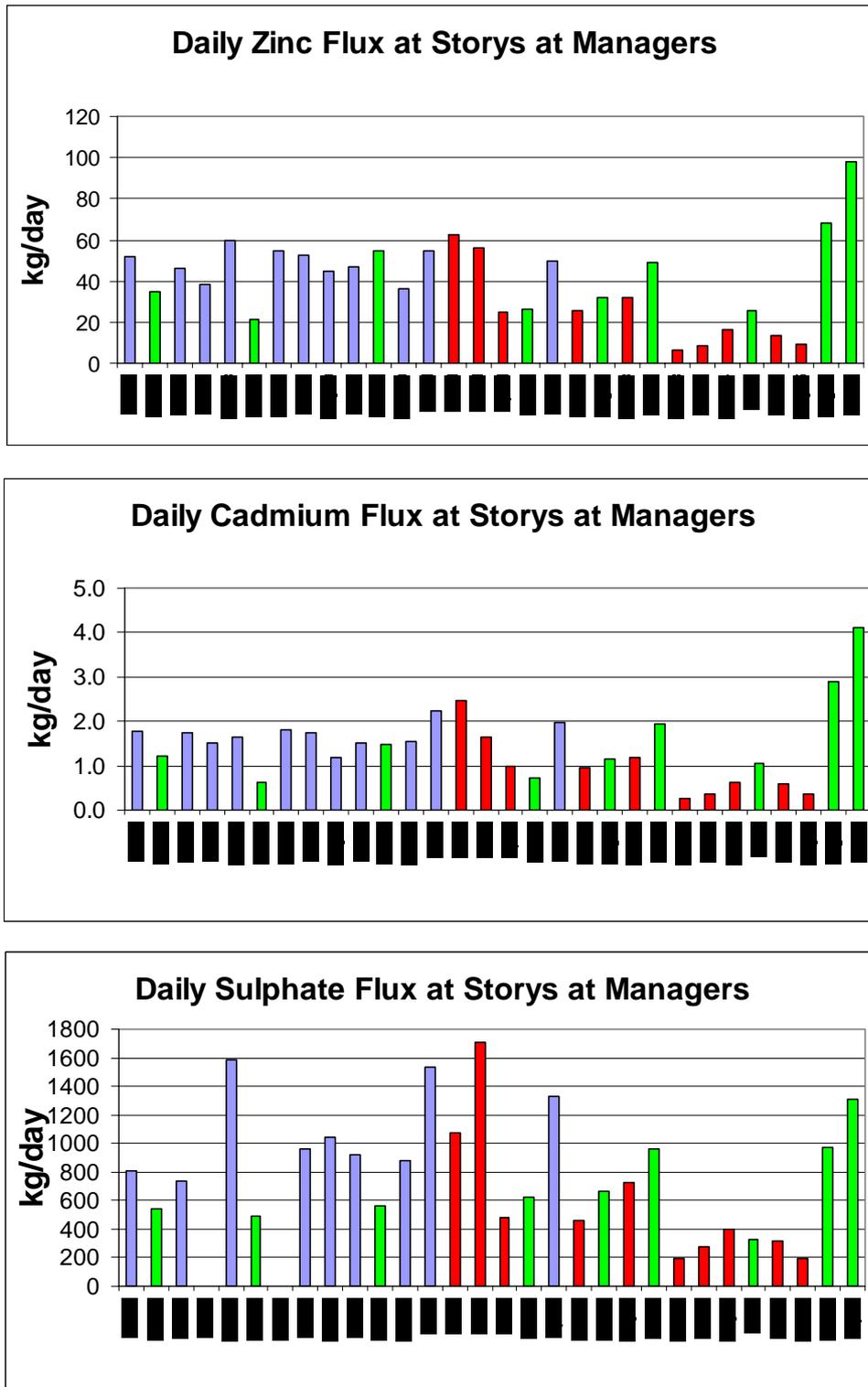


Figure 3.11. Daily total zinc, total cadmium and sulphate fluxes at Managers Site. Red denotes low flow (<250 l/s); blue denotes moderate flow (250 -350 l/s) and green denotes high flow (>350 l/s)

3.5 Present distribution of metal sources in Storys Creek

Comparing the present high flow results with the May 2005 results demonstrates how the primary pollutant sources on the mine site vary with flow in Storys Creek.

In May 2005, water levels were extremely low. The main metal source to the river was groundwater entering from near the tailings deposits (Storys above Side Creek) and from the Side Creek catchment (Storys below Side Creek), resulting in very high zinc and cadmium concentrations in the river, although overall relatively low fluxes.

In August and September 2005, the very high rainfall resulted in the tailings deposit located upstream of Side Creek becoming the primary metal source to the river, with additional inputs from Side Creek resulting in a reduction in metal concentrations, rather than an increase. Under these conditions, the metal concentrations in the river are much lower but fluxes are much greater as compared to low flow. The strong EC gradient across the river in August and September suggests the tailings, rather than the sediments in the river are the primary source of metals and sulphate.

3.6 Impact of remediation works

It is difficult to assess the impact of the remediation works on Storys Creek during very high flows, as there are no pre-remediation monitoring results reflecting these flow conditions. Given the high metal and sulphate fluxes entering the river from the remaining tailings deposits on the mine site, it is likely that the removal of some of the tailings has reduced pollutant inputs following high rain fall events. It is also evident that remediation of the Precipitation Dam has decreased metal input into the creek; in August and September, in spite of very high flows from the Precipitate Dam, zinc and cadmium concentrations and fluxes continue to be low.

The remediation works require some maintenance if meaningful monitoring is to be continued over the next year, as it is presently not possible to obtain good flow estimates at the ALD, Precipitate Dam, or Eastern Adit. At the ALD and Precipitate Dam, water no longer flows through the established discharge pipe. At Eastern Adit, the accumulation of iron hydroxide floc restricts water flow through the V-notch

3.7 Future monitoring

It is recommended that an additional high flow monitoring run be completed towards the end of Spring 2005, followed by a low flow monitoring during the Summer of 2005/2006. An additional high flow monitoring will show whether the tailings deposits are always a major pollutant source during high flows, or, if after an initial big flush, pollutant loads decrease. A summer, low flow monitoring run will confirm our understanding of the importance of groundwater inputs during the long dry periods in the catchment.

4 Related References

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