DEPARTMENT *of*
PRIMARY INDUSTRIES,
WATER *and* ENVIRONMENT

Tasmania

Water Quality of Rivers in the Coal Catchment

A Report Forming Part of the Requirements for State of Rivers Reporting

PART 4

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The Department of Primary Industries, Water and Environment

The Department of Primary Industries, Water and Environment provides leadership in the sustainable management and development of Tasmania's resources. The Mission of the Department is to advance Tasmania's prosperity through the sustainable development of our natural resources and the conservation of our natural and cultural heritage for the future.

The Water Resources Division provides a focus for water management and water development in Tasmania through a diverse range of functions including the design of policy and regulatory frameworks to ensure sustainable use of the surface water and groundwater resources; monitoring, assessment and reporting on the condition of the State's freshwater resources; facilitation of infrastructure development projects to ensure the efficient and sustainable supply of water; and implementation of the *Water Management Act 1999*, related legislation and the State Water Development Plan.

2.4 Catchment Surveys

Catchment snapshot surveys of the entire drainage system of the Coal River catchment were undertaken in summer (2nd March 2000) and winter (18th July 2000) when river flows were relatively stable. The aim of such sampling is to characterise water quality at a catchment scale, allowing areas where relative degradation occurs to be highlighted. This approach has been employed in studies on the mainland of Australia (Grayson, *et al.*, 1997) and extensively within Tasmania (Bobbi, 1996, 1997, 1998), and has been a valuable tool for water resource management at a catchment level. When using this technique it is important to target stable hydrological conditions and avoid the confounding influences of rain (and runoff) which can make interpretation and comparison difficult and can lead to misleading conclusions.

The aim of the catchment surveys in the Coal Valley was to provide a broad view of water quality across the catchment. All sites were sampled for nutrients, heavy metals and bacteriologicals as well as the collection of data on the more common physio-chemical parameters (ie turbidity, dissolved oxygen, pH, etc). The focus of this section will be placed on those parameters that are not normally sampled for in the monthly sampling program. An analysis and discussion of physio-chemical parameters that are collected on a monthly basis was provided in an earlier section of this report (Section 2.1).

2.4.1 Catchment survey – Nitrogen

The results for both the summer and winter surveys for total nitrogen are graphed in Figure 2.40. There is no clear seasonal difference between the summer and winter nitrogen concentrations at the catchment scale. The summer nitrate concentrations were greater than the winter concentrations at both the top and bottom of the catchment; however, the sites located in the middle of the catchment demonstrated the opposite trend with higher nitrate concentrations recorded in winter. The highest total nitrogen concentration of 4930 µg/L was recorded at White Kangaroo Rivulet (CR6) in winter when there was ponding throughout the river. Seventeen of the 21 sites sampled during the summer survey showed TN concentrations in excess of 500 µg/L, while during winter this dropped to 11. There was also no clear pattern for higher concentrations in any particular area of the catchment, although a number of locations (CR2, CR5, CR10, CR11, CR15 and CR19) did show consistently higher TN levels during both surveys.

White Kangaroo Rivulet had substantially higher TN levels during the winter survey. These results have been discussed in an earlier section (Section 2.3), and there is considerable evidence that domestic waterfowl use of the waterway at this location, particularly during periods of no flow, is contributing to the very high TN and NH_3/N levels. The highest summer TN concentration was recorded at Inverquarity Rivulet (CR5), where once again most of the TN within the river at this site was present as NH_3/N and organic nitrogen, indicating that the biological sources of nitrogen are having a greater impact on the stream at this time.

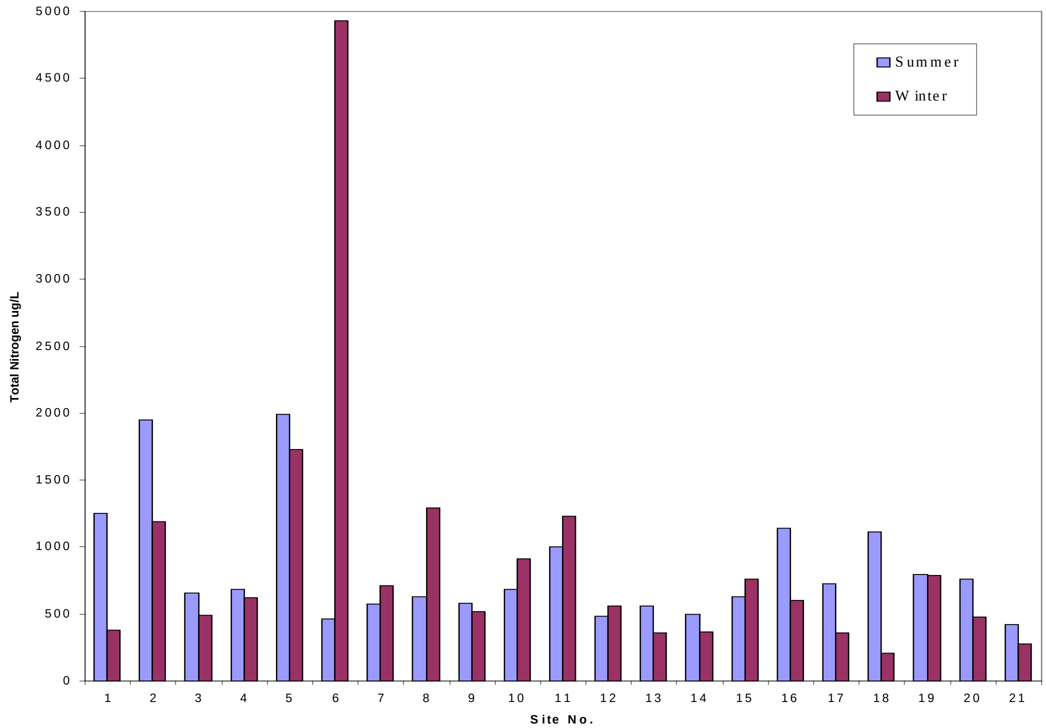

Figure 2.40: Total Nitrogen concentrations during summer 2000 and winter 2000 snapshot surveys.

2.4.2 Catchment Survey –Phosphorus

The maps presenting the survey data for TP concentration (Figures 2.41 and 2.42) show that higher TP concentration was recorded at many sites throughout the catchment during the summer survey. Highest TP concentrations were generally found in tributary sites, particularly at CR1 (Duckhole Rivulet), CR2 (Pages Creek), CR5 (Inverquarity Rivulet) and CR8 (Native Hut Rivulet), in the lower part of the catchment. CR16 (Hunters Swamp Creek) and CR17 (Coal at Wattle Hill Road), in the upper catchment, also showed substantially higher in TP concentration during the summer survey. These sites were all reduced to ponds during the summer month and as such disturbance by stock and wildlife may have contributed to these elevated levels.

High TP concentrations were recorded at Native Hut Rivulet (CR8) during both the winter and summer surveys. Approximately half of the TP concentration at this site was in the dissolved form on both occasions, suggesting that there could be point source contamination of the river at or upstream of this site. For almost all other sites, high TP concentrations were generally linked to suspended material to which TP was bound.

Sediment properties are the key to many physical and chemical changes that occur during drying and re-wetting, as they affect nutrient transformations and exchanges between benthic sediment and the overlying water (Boulten & Brock, 1999). The Coal River and its tributaries are naturally ephemeral, and cyclical drying and re-wetting is a common feature of this system. Drying of the riverbed can increase the crystalinity of mineral phases, reducing the sediment's capacity to absorb nutrients such as phosphorous (Baldwin, 1996). Physico-chemical (primarily adsorption) and biological (microbial) processes appear to be directly involved in increases in nutrients after re-wetting of a site. Microbial action may create conditions at the sediment-water interface that accelerate the release of phosphorous (McComb and Qui, 1998). These processes may at least partly explain some of the patterns of changes in phosphorus concentration at sites in the Coal River catchment.

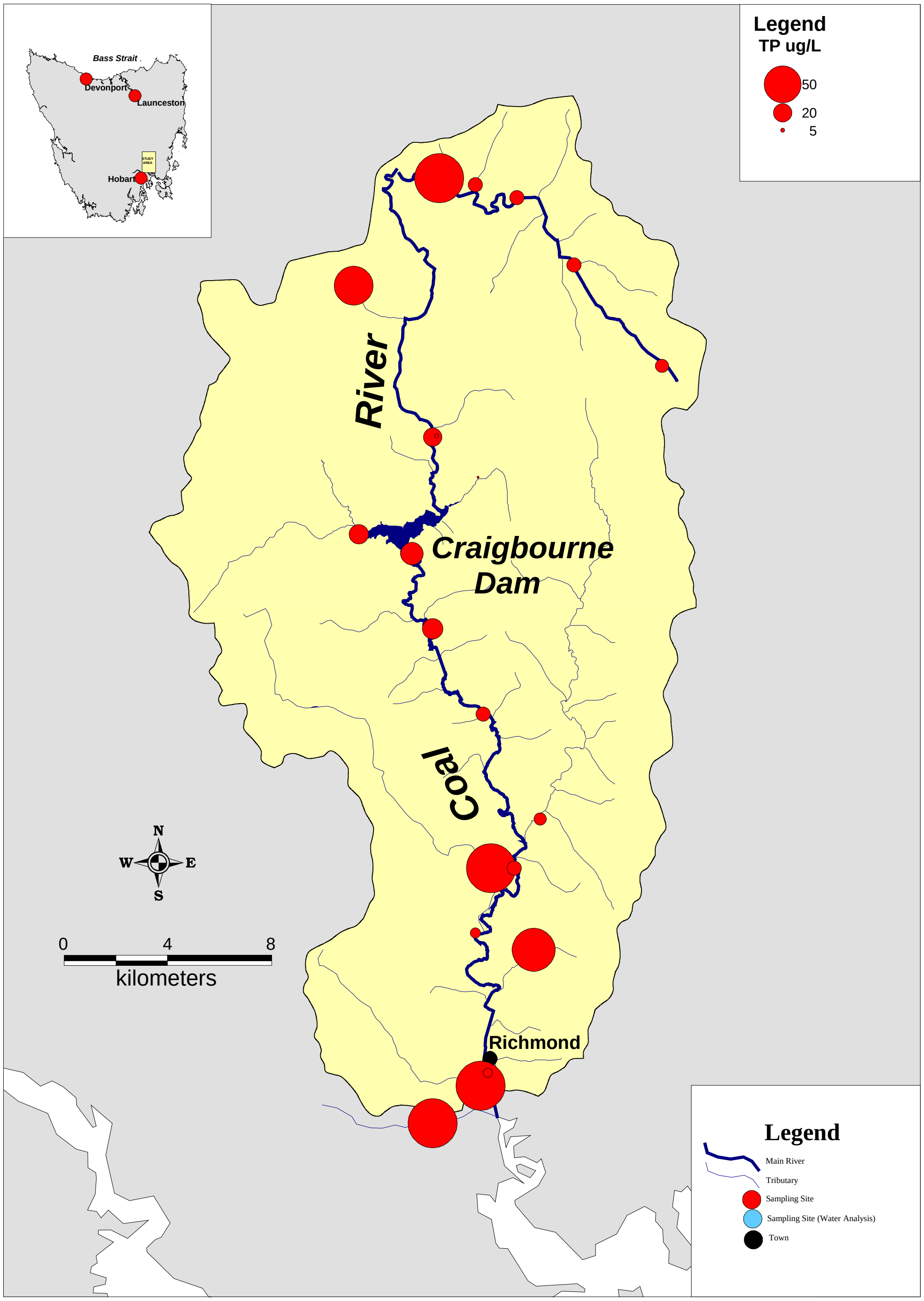

Figure 2.41: Survey of total phosphorous concentrations recorded in the Coal catchment on the 2nd March 2000.

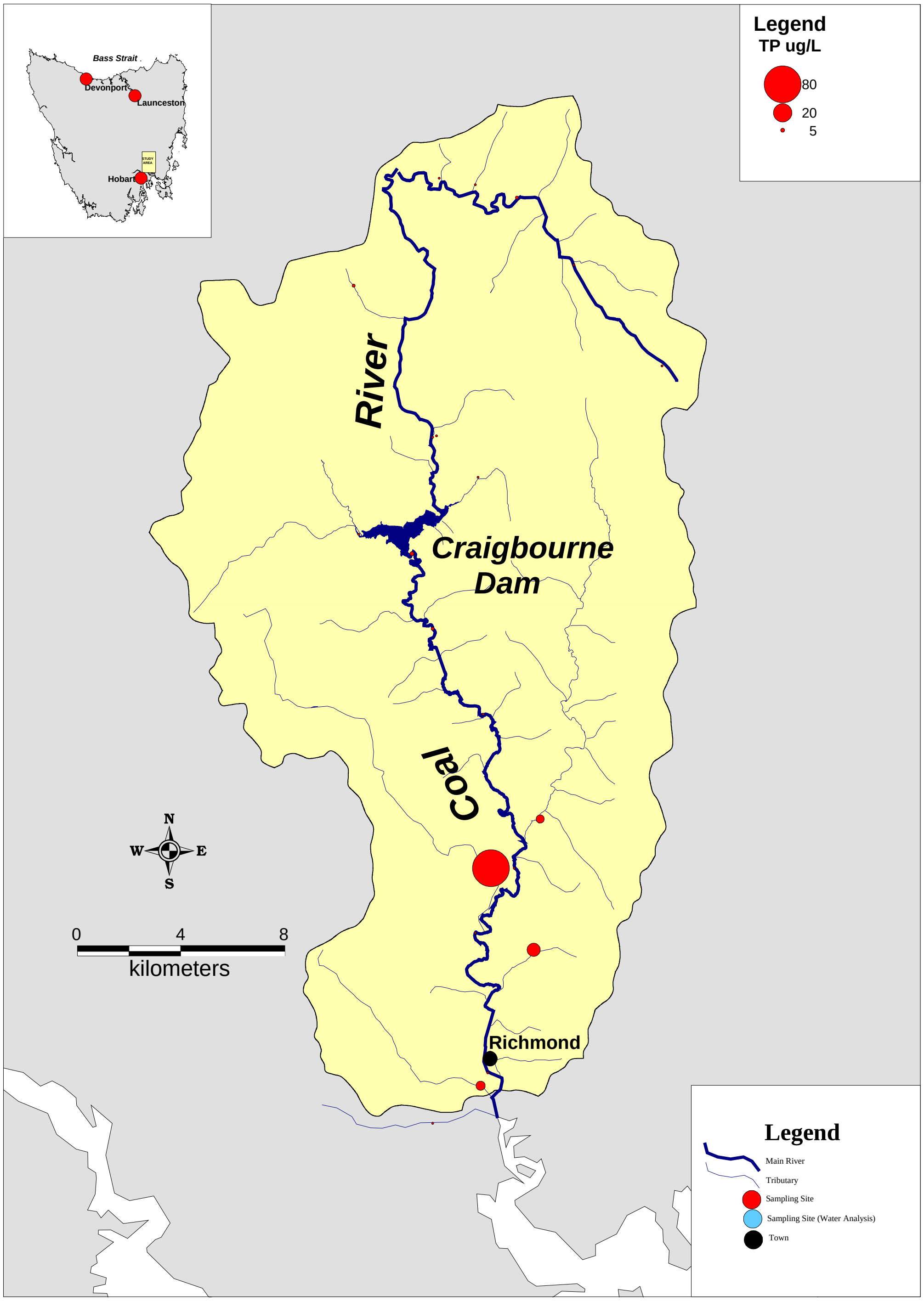

Figure 2.42: Survey of total phosphorous concentrations recorded in the Coal catchment on the 18th July.

2.4.3 Catchment Survey –Metals

Samples taken during the catchment surveys were analysed for some of the main metals commonly found in environmental waters that may pose some risk to aquatic organisms or human health. Due to budget limitation, only total metal concentrations were determined, although it is recognised that it is the dissolved form that generally poses most threat to the environment. The detection limits for those metals analysed are listed below. Detection limits for arsenic changed from <1 μg/L in August 1999 to <5 μg/L in February 2000. This was due to a re-valuation of the laboratory's methods of detection as part of their NATA accreditation methods and procedures.

Metal	Limit of Detection
Aluminium	50μg/L
Arsenic	5μg/L
Cadmium	1μg/L
Copper	1μg/L
Lead	1μg/L
Zinc	1μg/L

As with many other parameters commonly tested for in surface waters, metals can be present in various forms. Trace amounts of some metals are naturally present in surface waters as a consequence of the weathering of rocks and soil. They can be present attached to suspended matter, colloids, or complex organic compounds. Some forms are more toxic to aquatic life than others. Generally the most toxic form to aquatic life is the dissolved form (Dallas and Day, 1993). The relative toxicity of metals is dependant upon the degree of oxidation of the metal ion (UNESCO, 1992), and this can vary depending upon the environment in which it occurs. Acid conditions tend to increase the toxicity of most metals, whilst for others high concentrations of hardness reduce toxicity (ANZECC, 2000).

The recently revised National trigger values for toxicants (ANZECC, 2000) were derived using a statistical distribution method calculated at 4 different protection levels. In the majority of cases the 95% protection level should be used for most ecosystems which can be classified as 'slightly' to 'moderately' disturbed, and is suggested here as the default value (Table 2.6). The general framework for applying levels of protection for toxicants is tabulated in accordance with ANZECC (2000) in Appendix 1.

Table 2.6: Trigger values for observed metals at alternate levels of protection. Values in the grey shaded areas are the trigger values applying to typical *slightly to moderately disturbed* ecosystems (ANZECC, 2000).

Metals	**Trigger Values for freshwater (μg/L)**			
	Level of Protection (% species)			
	99%	95%	90%	80%
Aluminium pH > 6.5	27	55	80	150
Aluminium pH < 6.5	ID	ID	ID	ID
Arsenic (As III)	1	24	94[a]	360[a]
Arsenic (As V)	0.8	13	42	140[a]
Cadmium H	0.06	0.2	0.4	0.8[a]
Copper H	1.0	1.4	1.8[a]	2.5[a]
Lead H	1.0	3.4	5.6	9.4[a]
Zinc H	2.4	8.0[a]	15[a]	31[a]

H = chemicals for which algorithims have been provided to account for the effects of hardness. The values have been calculated using a hardness of 30 mg/L $CaCO_3$.

A summary of the concentrations of metals species assessed during the summer and winter surveys is presented in Table 2.7 & 2.8 respectively. Hardness was measured at a select number of sites every three months, but was not measured during the snapshot surveys. At those sites monitored across the catchment, all rivers were relatively hard, with median hardness (as $CaCO_3$) generally above 200 mg/L.

As can be seen in the tables below, many metals species were found to be near to or below the limit of detection. These include cadmium, copper, arsenic, and to some degree lead. Only aluminium and zinc were found in any amounts, and only the results for these species will be discussed in any detail.

Table 2.7: Summary of the data on total metal concentrations collected during the summer catchment ‘snapshot’ surveys across the Coal River catchment in 2000.

	Aluminium	Cadmium	Copper	Lead	Zinc	Arsenic
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Maximum	1100	<1	3	6	18	<5
Minimum	50	<1	<1	1	1	<5
Median	118	<1	<1	3	4	<5

n = 21 sites across the catchment

Table 2.8 Summary of the data on total metal concentrations collected during the winter catchment ‘snapshot’ surveys across the Coal catchment in 2000.

	Aluminium	Cadmium	Copper	Lead	Zinc	Arsenic
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Maximum	5050	<1	17	<5	37	<5
Minimum	10	<1	<1	<5	1	<5
Median	40	<1	<1	<5	2	<5

n = 21 sites across the catchment

Aluminium

ANZECC (2000) recommends a trigger level of 55 µg/L for aluminium (at pH >6.5) to provide a 95% protection limit for biota inhabiting ‘slightly’ to ‘moderately’ disturbed systems. This guideline is based on absolute bioavailable forms of aluminium. However, the analyses undertaken as part of the winter and summer surveys were for total aluminium concentrations. It must be recognised that as a result, high concentrations that were found during both of these surveys are in fact likely to be bound to particles and thus pose no substantial risk to the aquatic environment.

Aluminium recorded the most significant results out of all the metals tested. The median, minimum and maximum values recorded for both the summer and winter surveys are listed in Tables 2.7 and 2.8 respectively. During the summer survey, aluminium concentration ranged from 50 - 1100 µg/L, with an overall catchment median of 118 µg/L. Summer aluminium concentrations are also represented graphically in Figure 2.44. For the winter survey concentrations ranged from 10 - 5050 µg/L with an overall catchment median of 40 µg/L.

Of the 21 sites sampled during the summer, 9 had concentrations below 55 µg/L. However, significantly higher results were returned from the other 12 sites. A similar trend was observed for the winter survey, with 12 sites below 55 µg/L and the remaining 9 sites significantly higher (Figure 2.43). Figure 2.43 clearly illustrates the extremely high concentrations of aluminium recorded at Pages Creek (CR2). Coal River at Wattle Hill Road also had elevated aluminium concentrations. Further studies would need to be undertaken to determine whether these concentrations were having a detrimental affect on the aquatic environment.

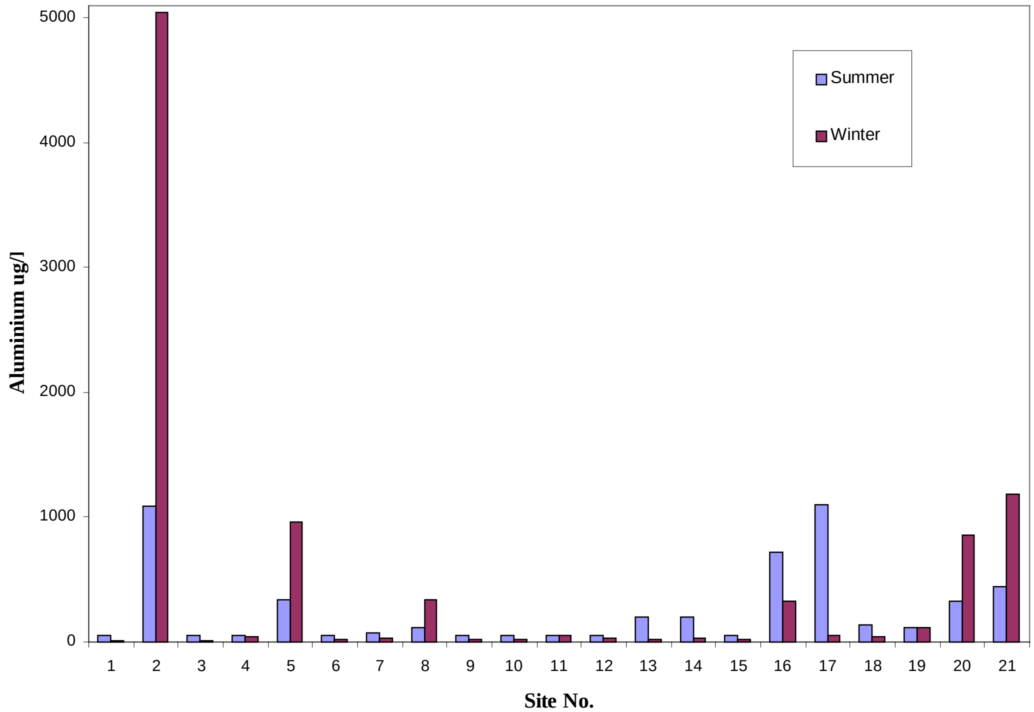

Figure 2.43: Comparison of summer and winter snapshot data for total aluminium concentrations recorded in the Coal catchment on the 20th March 18th July.

Aluminium concentrations at Pages Creek were 1090µg/L and 5050µg/L (summer and winter respectively) and coincided with higher turbidity levels (16.7 NTU and 17.6 NTU respectively). The winter aluminium and turbidity levels for the Coal River at Wattle Hill Road were also high, with aluminium concentrations of 1100µg/L and a corresponding turbidity level of 58 NTU. In winter the aluminium and turbidity levels were substantially lower for the Coal River at Wattle Hill Road, values were 58 µg/L and 3.99 NTU respectively.

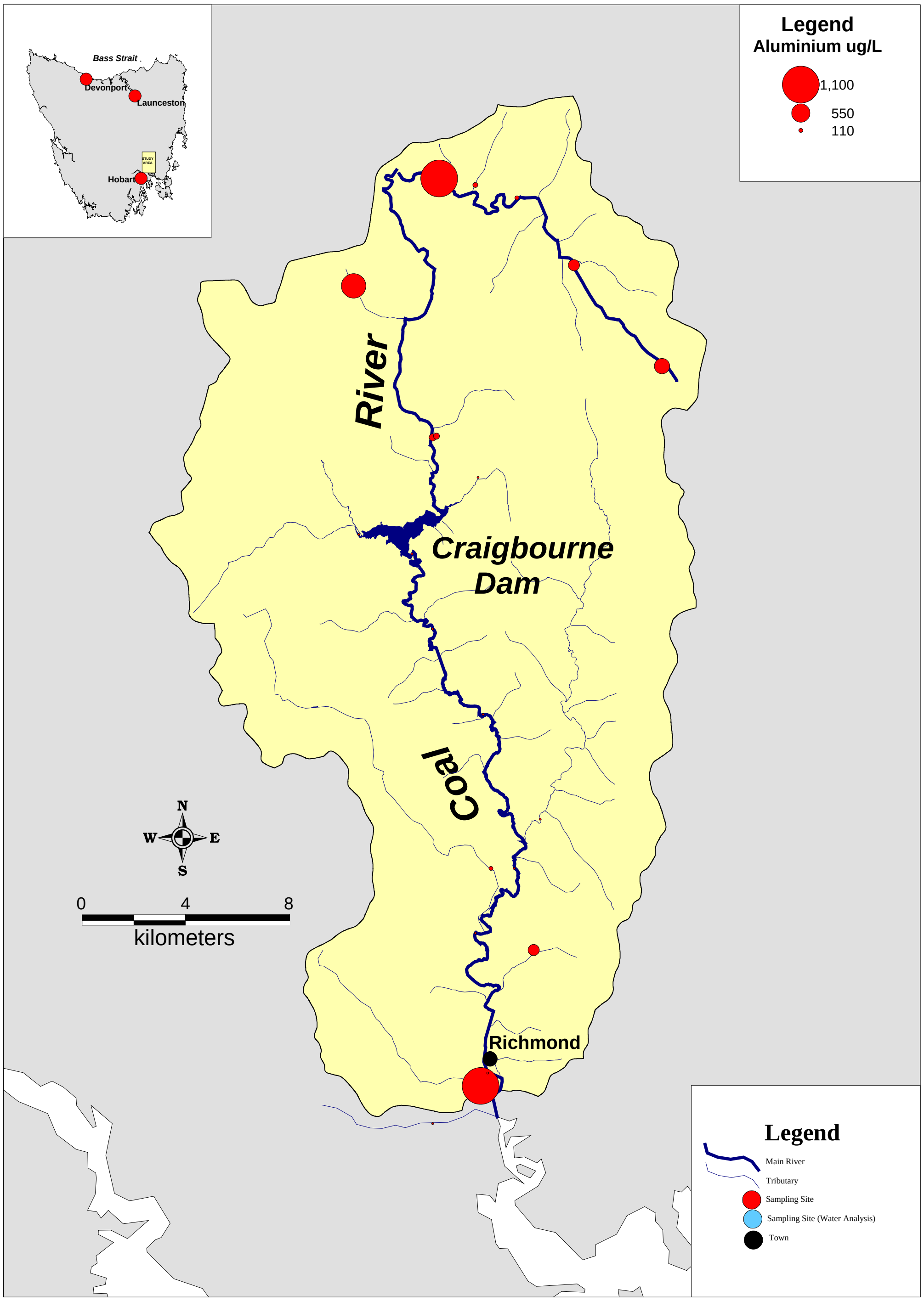

Figure 2.44: Survey of aluminium concentration at sites in the Coal catchment on the 20th March.

A large proportion of the aluminium measured in rivers of the Coal catchment is likely to have been absorbed to suspended particles. As mentioned previously, this could result in a reduction in the potential toxicity of aluminium. The correlation between turbidity levels and aluminium concentration for samples collected in the summer and winter surveys is illustrated in Figure 2.45. There is a broad relationship between turbidity and aluminium concentration. However, there is some variability around this relationship. Although there is a high likelihood that most of the aluminium measured presents no risk to aquatic biota; some sites can be highlighted as having quite elevated aluminium concentrations relative to the rest of the catchment.

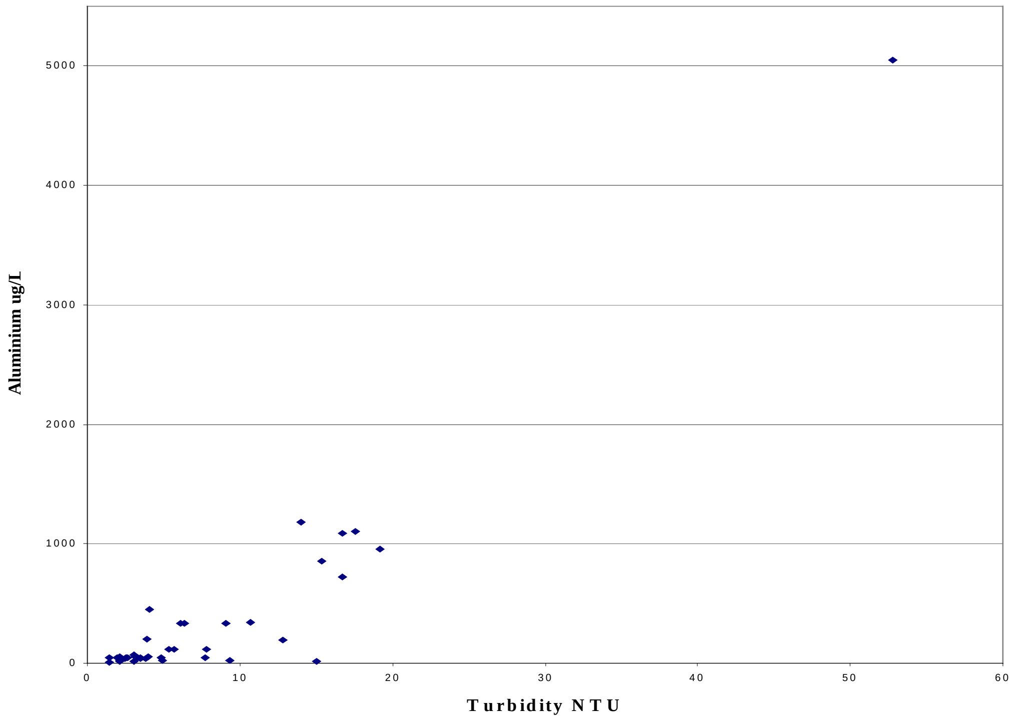

Figure 2.45: Relationship between total aluminium concentrations and turbidity in the Coal River catchment using data collected during 'snapshot' surveys of the catchment conducted in summer and winter.

Previous studies in Tasmania have also referred to a relationship between aluminium concentrations and turbidity, with higher concentrations of aluminium generally detected in turbid waters (Bobbi, 1999). This relationship is also observed in the Coal River catchment. The high aluminium concentrations recorded in the Coal River catchment could pose some risk to the aquatic environment and any further studies in this area should include analysis of the dissolved fraction of aluminium and toxicity studies.

Zinc

Like aluminium, zinc is also found in most natural waters at low concentrations. The toxicity of zinc decreases with increasing hardness and alkalinity and increases where dissolved oxygen is low. Concentrations of total zinc were detected at low concentrations at most sites in the Coal Valley during both the winter and summer surveys. Zinc concentrations during the winter survey were generally slightly higher than those recorded during summer, with a maximum of 37 μg/L detected at Pages Creek. In summer the maximum level recorded was 18 μg/L (also at Pages Creek), and it appears that high turbidity at this site on both occasions may explain the higher zinc concentrations that were detected.

The concentrations of zinc recorded in the winter snapshot are above the concentrations suggested as 'trigger levels' (ANZECC, 2000). However, given the turbidity levels in the catchment it is likely that the zinc is bound to clays and other suspended particulate material in the water column. Further studies into these concentrations would be beneficial for determining higher zinc concentrations.

2.4.4 Catchment Survey – Bacteria

The bacterial condition of the waterways in the Coal River catchment was also assessed in the summer and winter surveys. The results are plotted in Figures 2.46 and 2.47, with sites low in the catchment on the left-hand side and those in the headwaters on the right. The Coal River catchment is highly modified with extensive landclearing and stock access to waterways occurring throughout the catchment. As a result there are often site-specific increases in faceal coliforms. The Coal River at Eldon Road (CR13) had the highest faecal coliform count during the summer survey (>6000 counts/100mL). This site is heavily modified and there is extensive and largely unrestricted access by stock to the river.

There is no clear spatial trend for the winter survey, although sites at the very top and very bottom of the catchment had highest levels of faecal coliforms. Once again it appears that localised effects are responsible for coliform concentrations.

Coliform concentrations across the catchment were generally lower during the winter survey (12 sites with lower faecal coliform counts), although the number of sites with counts in excess of 100 counts/100mL was greater. Higher flows in winter may have been providing an increased source of faecal contamination to the river at these sites. The Coal River at Fingerpost Road (CR4) recorded high coliform concentrations in both summer and winter. This site is home to a large community of birdlife, which may explain the higher faecal coliform concentrations.

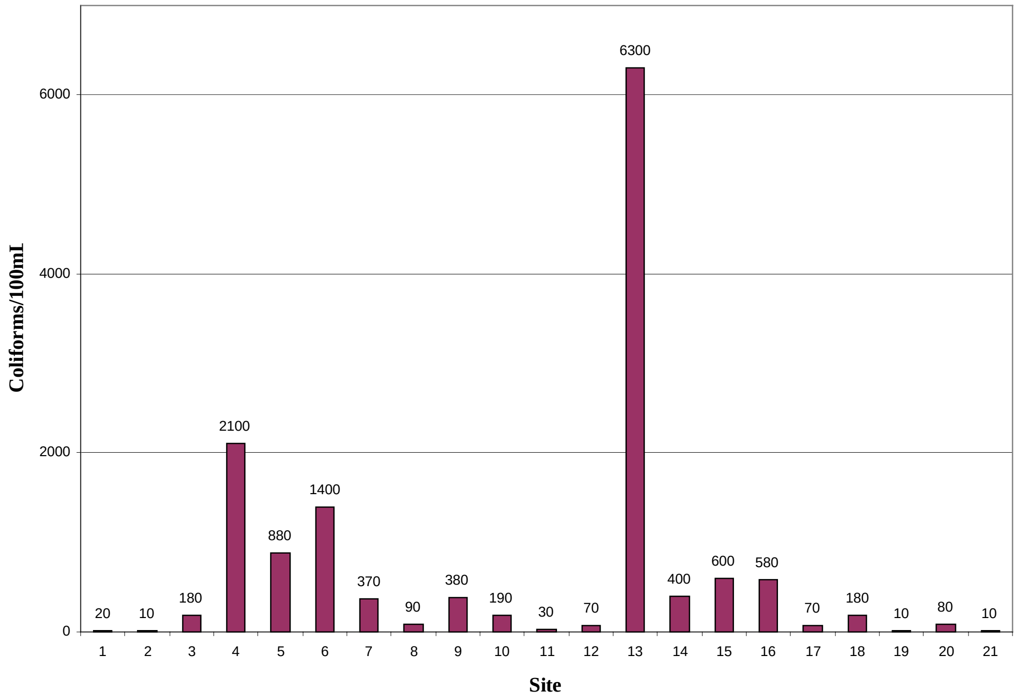

Figure 2.46: Catchment survey for thermotolerant (faecal) coliforms in ambient waters of the Coal River catchment in February 2000.

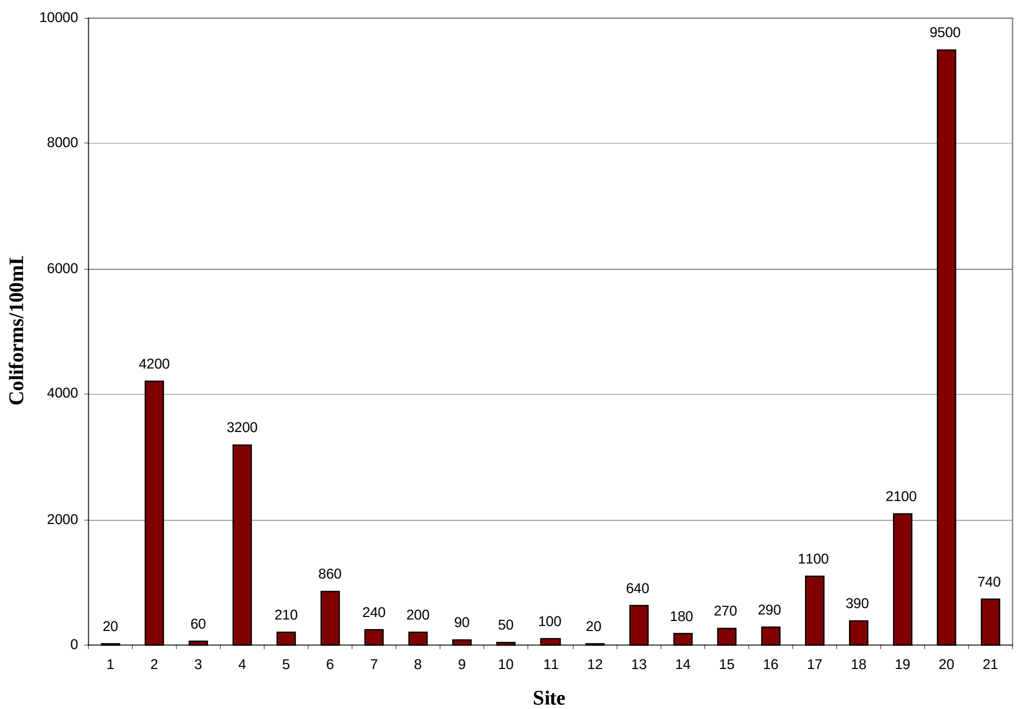

Figure 2.47: Catchment survey for thermotolerant (faecal) coliforms in ambient waters of the Coal River catchment in July 2000.