AQUENAL

PTY LTD

Aquatic Environmental Investigation
at
Proposed Tamar River Crossings
for
Gunns Pulp Mill Water Supply Pipeline

Prepared for

Gunns Limited

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1 INTRODUCTION AND PROJECT BRIEF

Gunns Limited propose to cross the Tamar River with a water supply pipeline for their proposed pulp mill and have identified two potential sites. The proposed installation technology involves a jetting machine which is typically 4-6m long, weighs 3 to 9 tonnes and requires a pulling force of 1 to 5 tonnes. It rolls along the pipeline stabilised by buoyancy tanks, excavating by jetting away the riverbed sediments to form a trench into which the pipeline settles. Gunns Limited contracted Aquenal Pty Ltd to conduct a limited environmental investigation within specified areas surrounding the two sites and conduct a literature review. The specific brief was

1. To film the riverbed along two transects in each area.
2. To collect 6 benthic infauna grab samples from each area.
3. To conduct a literature review of previous water quality/biological surveys in the vicinity to generate typical background levels for pH, suspended solids and heavy metals.

The proposed sites are in the upper reaches of the Tamar River estuary (Figure 3.1-1) where the waters are subject to tidal influences including water level variation in excess of 3 metres and strong tidal flows. This causes extensive mud banks to be exposed at both sites at low tide with those at the northern (downstream) site being several hundred metres in width. River flows are also influenced by occasional floods although the frequency and magnitude of these is greatly reduced by water management practices and hydro-electric power stations in the upper Tamar and its tributaries (Pirzl and Coughanowr 1997). The upper reaches of the Tamar River estuary are subject to heavy silt loadings resulting in heavy deposition of silt requiring ongoing dredging to maintain navigable water depths in the navigation channels and reduce the risk of serious flooding during periods of high river flow. Tidal flows constantly resuspend and transport the silt resulting in permanently high turbidity levels in much of the upper estuary (Pirzl and Coughanowr 1997). Both crossing sites are located within 1 kilometre of each other on the outskirts of suburban Launceston where residential development gives way to agricultural and grazing land (Figure 3.1-2 and Figure 3.1-3). The tailrace from the Trevallyn Dam hydroelectric power station discharges into the river 2 kilometres above the sites.

The crossing sites are at the upper limits of the introduced Rice Grass (*Spartina anglica*) infestation of the estuary (Hedge 1997) and the introduced eastern mosquito fish (*Gambusia holbrooki*) has been recorded in the Tamar Estuary in the vicinity of the crossings.

2 MAPS

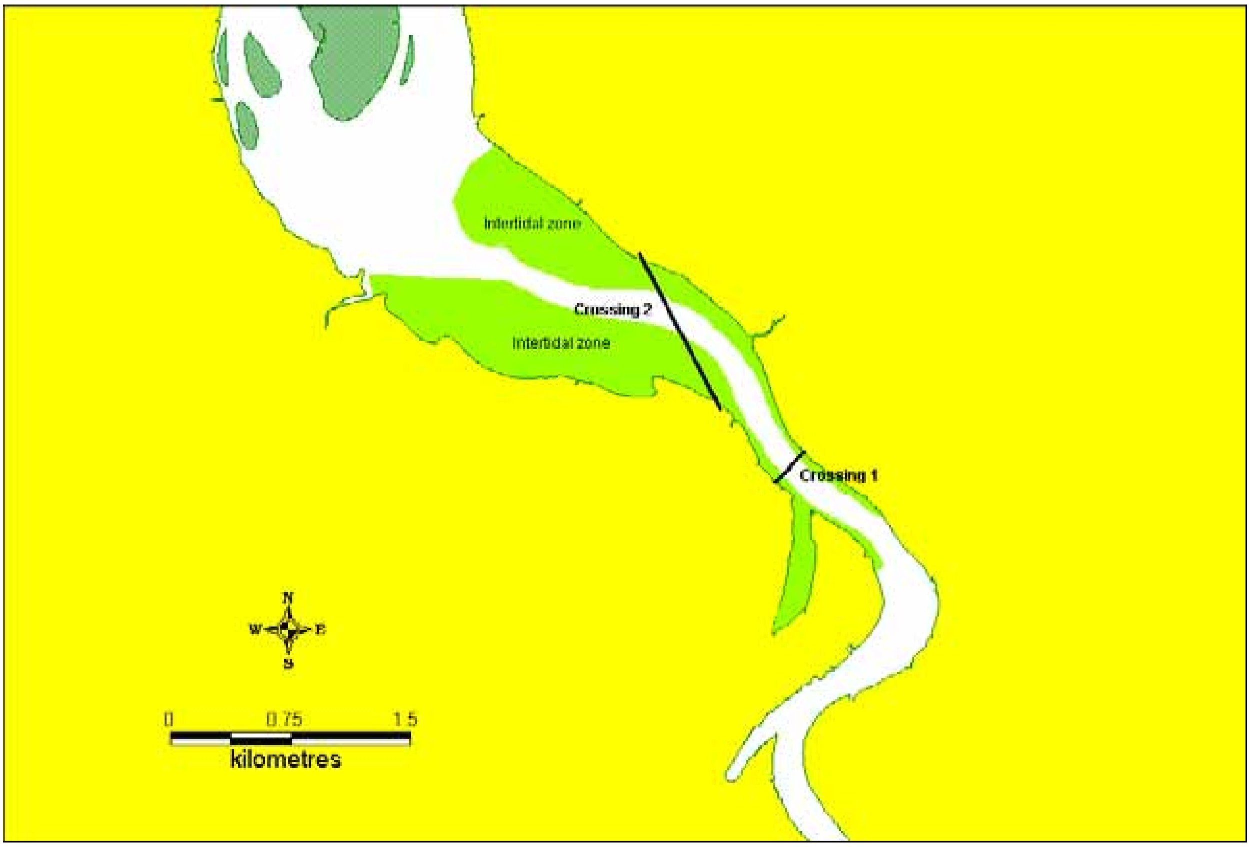

Figure 3.1-1 General location map showing the Tamar River in the vicinity of the proposed crossings and intertidal mud flats.

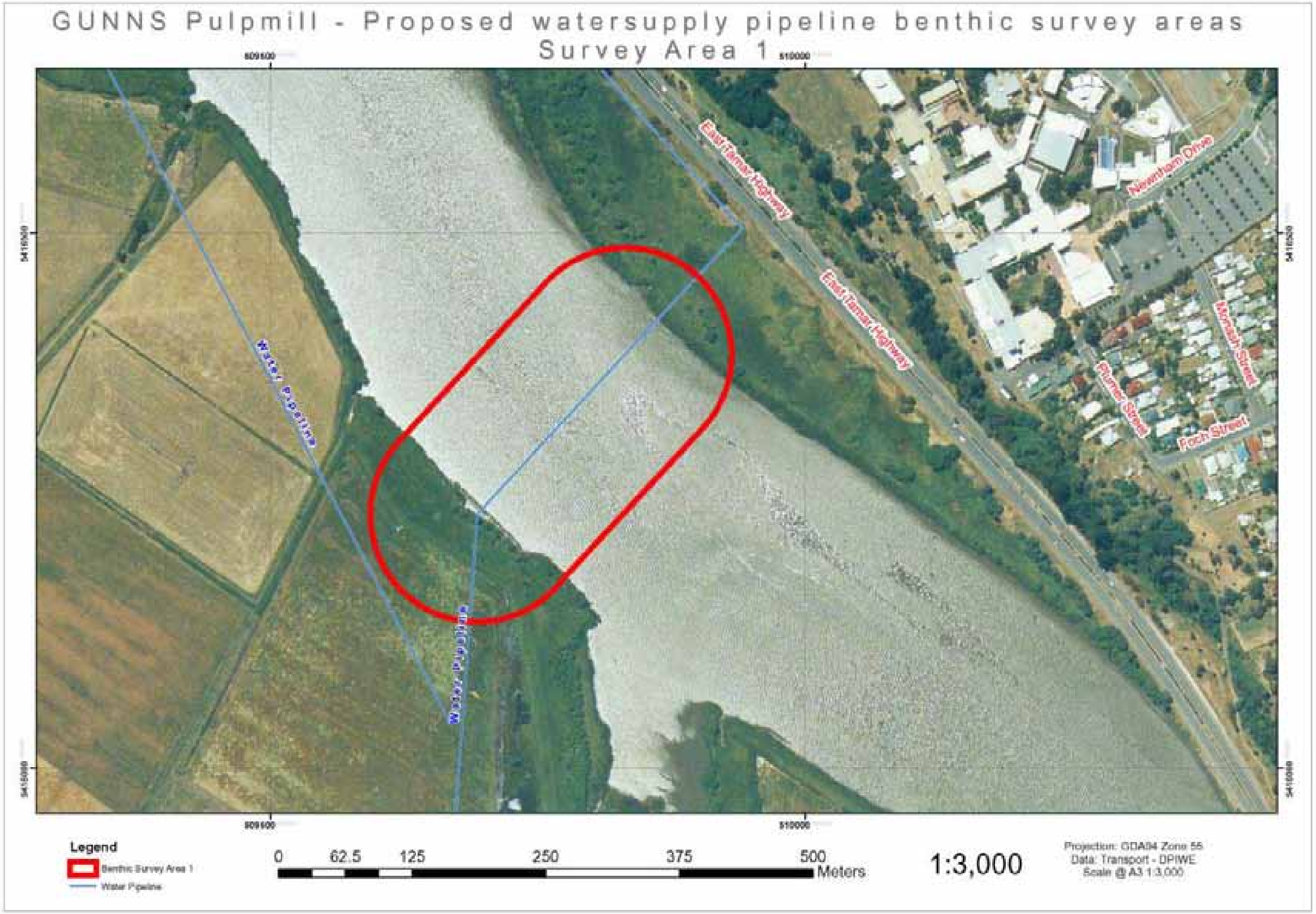

Figure 3.1-2 Southern crossing site and benthic survey Area 1 (Courtesy Pitt and Sherry)

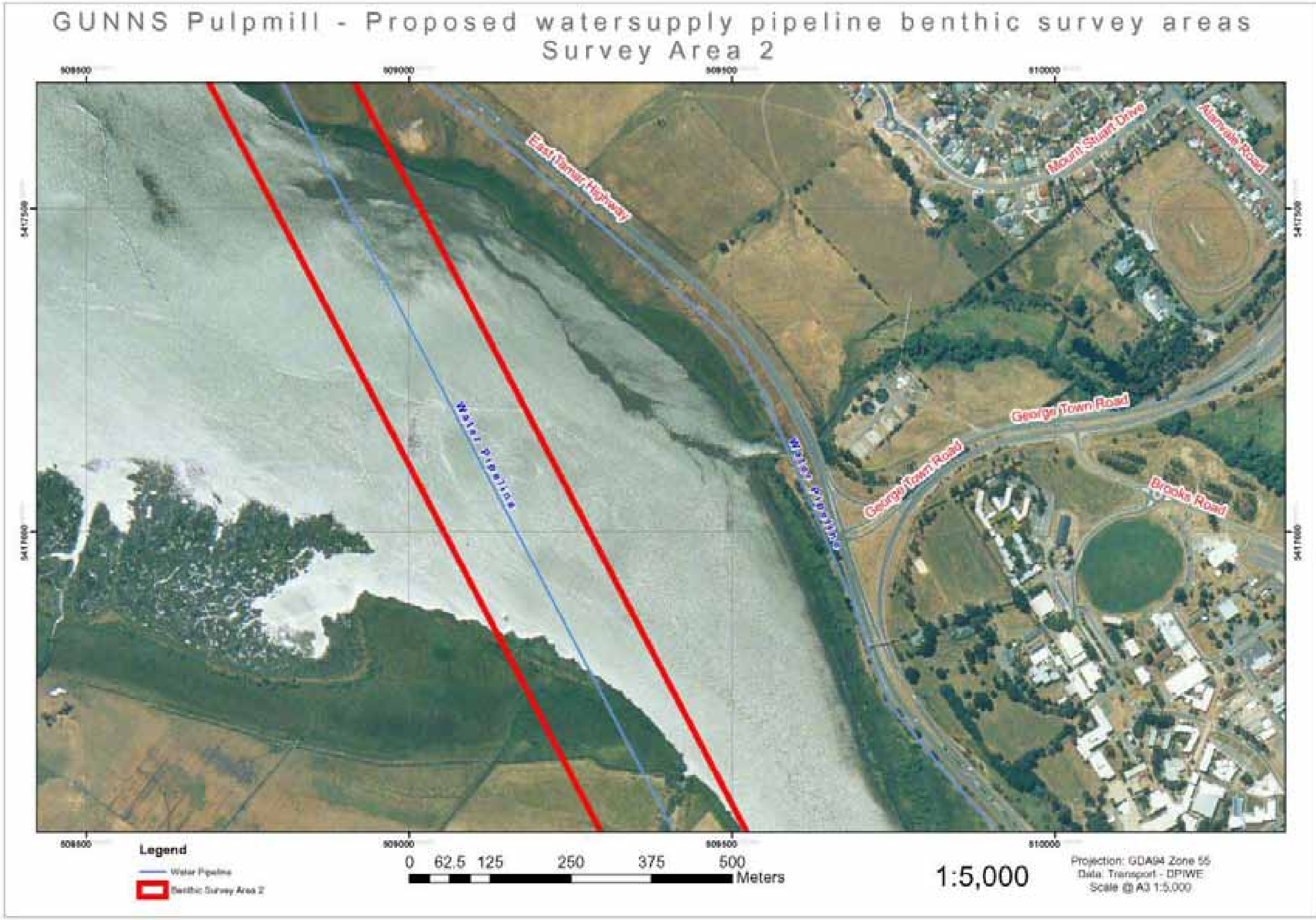

Figure 3.1-3 Northern crossing site and benthic survey Area 2 (Courtesy Pitt and Sherry)

3 METHODS

3.1 Overview

Maps of the two areas and GPS coordinates of the pipeline crossings were supplied by Gunns Limited and Pitt and Sherry (Figure 3.1-2 and Figure 3.1-1. Based on these it was proposed to conduct a bathymetric survey of the proposed pipeline routes to gain an understanding of the river profile, collect benthic infauna grab samples from each side of the river at 1m depth and from mid-river and to film the riverbed along lines parallel to and 25m distant from the proposed pipeline routes. Due to the turbidity in the river normally being too high for video filming, the fieldwork was carried out around the low tide of 1st June 2006 when most of the intertidal mud flats were exposed. Although this was a period of probably higher than average turbidity, the benefits of being able to inspect and record the sediments of the extensive intertidal mudflats were considered greater than the prospects of possibly recording some low visibility video of the river channel at high tide.

3.2 Bathymetric survey

The two areas were initially surveyed using a Garmin GPS depth sounder system with bottom hardness sensing function. The colour and thickness of the riverbed reflection were observed while steaming slowly back and forth across the survey areas. The river profile was recorded along the pipeline using the Garmin to record position and depth.

3.3 Benthic infauna survey

Benthic samples were collected on the falling tide using a Van Veen grab which sampled an area of 0.07 m2 to a depth of 100 mm. Locations of sample sites are shown in Figure 4.1-1 and Figure 4.1-2. Samples were washed into polypropylene mesh bags with a mesh size of 0.8 mm. These were tied closed then the bulk of fine sediments washed out by dunking the bags in the river. The washed samples in their bags were labelled and placed into 20 L drums of 10% buffered formalin for a minimum of 3 days. In the laboratory the remaining material was described qualitatively, washed through a 1 mm sieve and the retained material was sorted under a dissecting microscope to separate fauna from other material. All fauna was subsequently counted and identified to family level with the exception of any introduced marine pests which were identified to species level. In addition, the number of species present per family was counted for each sample, without actually allocating names to the species. No cross checks were made between samples for this parameter and hence data on number of species per family is only available at the level of sample, and not at site or area levels. Therefore, data generated for each sample included: a) number of families, b) abundance of each family and c) number of species present. All specimens were placed in labelled vials and preserved in 70% alcohol for longer term storage.

3.4 Visual survey

Filming the riverbed proved to be problematic and eventually the appearance was recorded by photographing the exposed mud flats and a series of Van Veen grab samples. Due to the expected high turbidity levels several apparatus were employed to film and photograph the riverbed. To ensure being able to view and record the appearance of the extensive intertidal mud flats the survey was timed for a low low tide of 0.64 m. As the tide flow ceased a video camera mounted on a weighted hydrofoil with attached light were lowered to the riverbed. This was unable to distinguish between the river water and the riverbed due to the high turbidity of the water. Next a Video Ray ROV was deployed. This has two 50 Watt lights and a manipulator claw positioned 50 mm from its camera lense which can be used to provide a scale as well as pick up items of interest. Once the ROV reached a depth of 300 mm the claw could only be seen as a faint shadow and long before it reached the riverbed the claw had disappeared from view entirely, indicating the visibility was less than 50 mm. The final solution was to bring samples of the riverbed to the surface where they could be inspected and photographed. This was done using the Van Veen grab and dumping the relatively intact samples into a Tote box where they were photographed using a Canon Powershot 3.2 Mega pixel digital camera. Samples were collected from 6 sites which in combination with the 6 benthic sample grabs were distributed within each area to give a good indication of the riverbed appearance and sediment type at all depths. Locations of the riverbed habitat grab samples are shown in Figure 4.1-1 and Figure 4.1-2.

4 RESULTS

4.1 Bathymetric survey

This showed the riverbed in both areas to be uniform unvegetated, smooth, soft mud. A similar echo sounder signal was generated by the submerged intertidal mud flats at mid tide and the subtidal riverbed indicating the entire riverbed consists of the same habitat type, i.e. unvegetated soft mud. Tide corrected depths along the pipeline routes are shown in Figure 4.1-1 and Figure 4.1-2. Note that tide corrections applied were those for George Town as no local correction factors were available. These were sourced from the Australian Bureau of Meteorology web site http://www.bom.gov.au/cgi-bin/oceanography/tides/ .

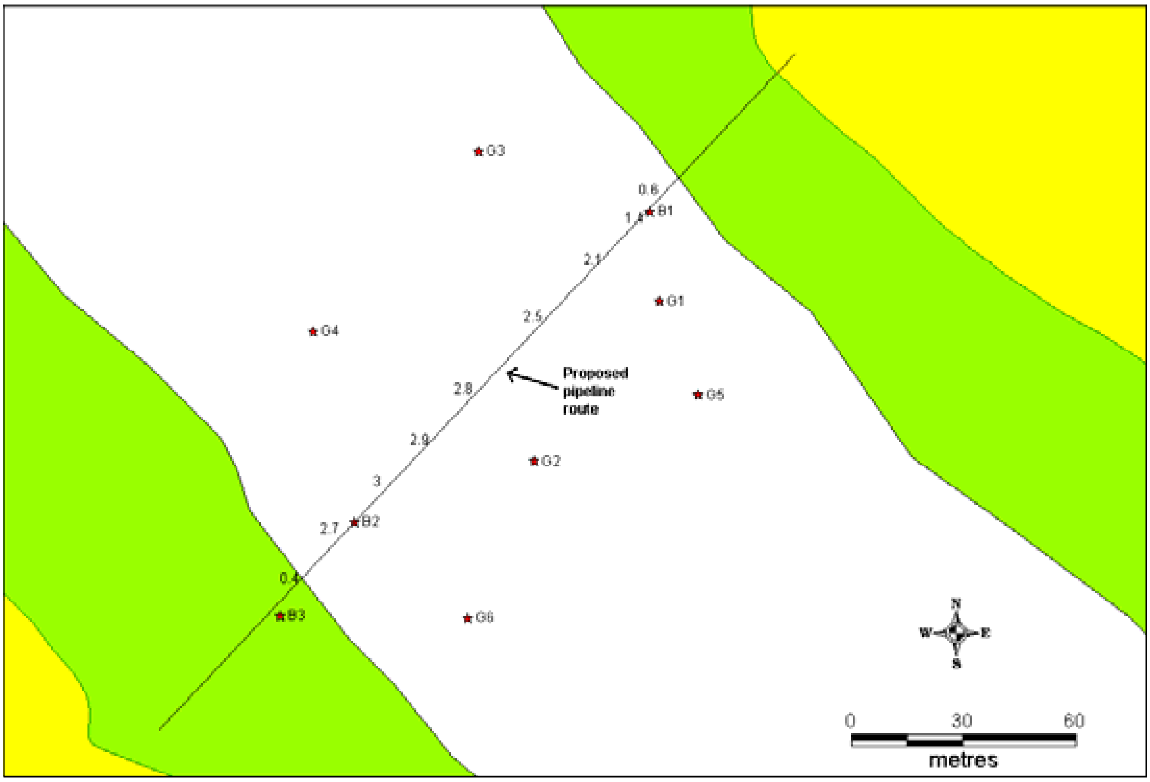

Figure 4.1-1 Riverbed depths (m) along the pipeline route at the southern crossing with locations of benthic sample sites (B) and habitat grab sites (G). Intertidal areas are shown in green. Tide corrections applied were those for George Town.

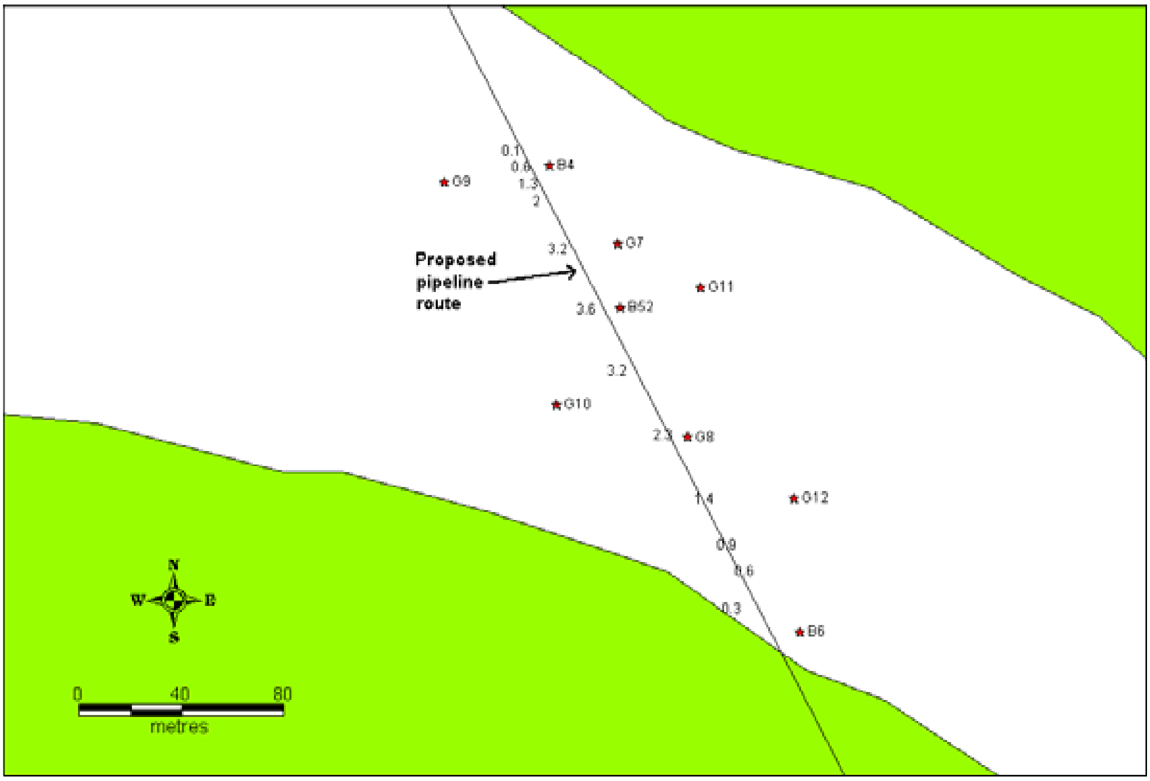

Figure 4.1-2 Riverbed depths (m) along the pipeline route at the northern crossing with locations of benthic sample sites (B) and habitat grab sites (G). Intertidal areas are shown in green. Tide corrections applied were those for George Town.

4.2 Benthic infauna survey

A total of ten species comprising 672 individuals was collected from benthic samples deployed in the Tamar River (Table 4.2-1). The species consisted of three crustaceans, four molluscs, two annelids and a single insect larva. The crustaceans were the dominant group, with a single species of Corophiid amphipod contributing ~70% of all individuals collected (469 individuals). Other crustaceans contributed only 5 individuals while Mollusca contributed 120 individuals (~18%), Annelids 77 (~11%) and a single chironomid insect larva was collected. These proportions are typical of the communities associated with subtidal estuarine mudflats with a strong freshwater influence. A single cryptogenic species, the gastropod *Potamopyrgus antipodarum,* was collected from all sites except 1-E1.

Table 4.2-1 Number of individuals recorded in each sample.

		1-E1	1-E2	1-M1	1-M2	1-W1	1-W2	2-E1	2-E2	2-M1	2-M2	2-W1	2-W2
Amphipoda	*Corophium sp.*	1	3	87	86	134	11	6	8	11	63	16	43
Amphipoda	*Aorid sp.*	0	0	0	0	1	0	0	0	0	0	0	0
Decapoda	*Amarinus laevis*	0	0	0	2	0	0	0	1	0	0	0	1
Insecta	*Chironomid sp.*	0	0	1	0	0	0	0	0	0	0	0	0
Gastropoda	*Potamopyrgus antipodarum*	0	1	24	6	15	13	2	7	3	8	6	3
Gastropoda	*Tatea rufilabrus*	0	0	1	0	0	1	0	0	1	2	0	0
Gastropoda	*Ascorhis victoriae*	1	0	1	0	2	2	3	1	1	1	1	1
Bivalvia	*Montacuta dromaensis*	0	0	0	0	5	1	1	1	0	0	2	3
Polychaeta	*?Barantolla lepte*	4	8	15	9	8	1	2	0	8	6	5	4
Polychaeta	*Neanthes vaalii*	0	0	0	2	0	1	0	0	0	0	2	2
	TOTAL	6	12	129	105	165	30	14	18	24	80	32	57

The results of MDS analysis are presented in Figure 4.2-1. The low stress statistic associated with the MDS plot (0.13) indicates an accurate depiction of relationships among locations. The primary difference highlighted by the MDS is the separation of the eastern sites of Crossing 1 (1-E1, 1-E2) from the remaining sites. Other sites clustered in a single loose group with samples from east and west tending to fall at the top of the plot while samples from the middle tend to lie at the bottom.

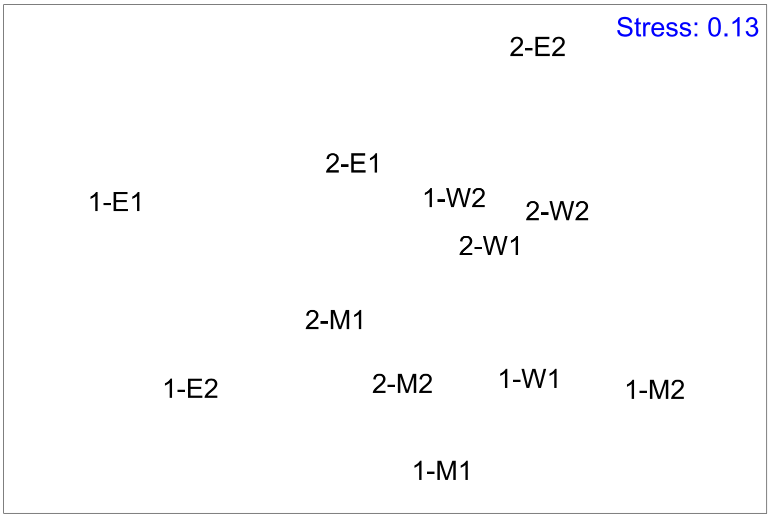

Figure 4.2-1 MDS plot depicting patterns of benthic infaunal similarity.

SIMPER analysis demonstrated that the abundance of the dominant species of Corophiid amphipod was the primary factor contributing to the observed differences between sites. Values for diversity indices are illustrated graphically in Figure 4.2-2 in conjunction with data on total abundance. High abundances in the middle and western portion of Crossing 1 (1-M1, 1-M2, 1-W1) were a result of a large number of Corophiid amphipods, which also occurred at site 2-M2. Likewise, the absence of this single species is responsible for the low (1-E1, 1-E2, 2-E1, 2-E2) to moderate (1-W2, 2-W1, 2-W2) abundances recorded elsewhere.

Shannon-Wiener diversity index values were notably reduced at sites strongly affected by the dominant species (1-M1, 1-M2, 1-W1), and also at the eastern sites of Crossing 1 which generally had a lower abundance of all species (1-E1, 1-E2). Thus Crossing 1 tended to have lower levels of diversity than Crossing 2 with the exception of site 1-W2 which possessed a reduced abundance of *Corophium sp.*. This difference is also evident in the graph depicting the Inverse Simpson's dominance index, which measures of 'evenness' of the community and shows a more uniform community in sites from Crossing 2, and in the graph of Margalf's richness which demonstrates an elevated richness at sites within Crossing 2.

In general, the infauna described from this survey represents a typical, low diversity community from a shallow mudflat environment with a strong freshwater influence. Differences between sites were attributable to the abundance of a single species of Corophiid amphipod which occurred in grater abundance over Crossing 1 than 2. Sites within Crossing 1 are further differentiated by a low overall abundance of all species from samples collected from the eastern bank of the river (1-E1, 1-E2). In comparison the eastern bank of Crossing 2 yielded a uniform community similar to other sites within this transect. Little differentiation is apparent between sites from the middle of the river and those in the shallow water adjacent to the banks reflecting the strong tidal influence and uniform benthic habitat of this portion of the river.

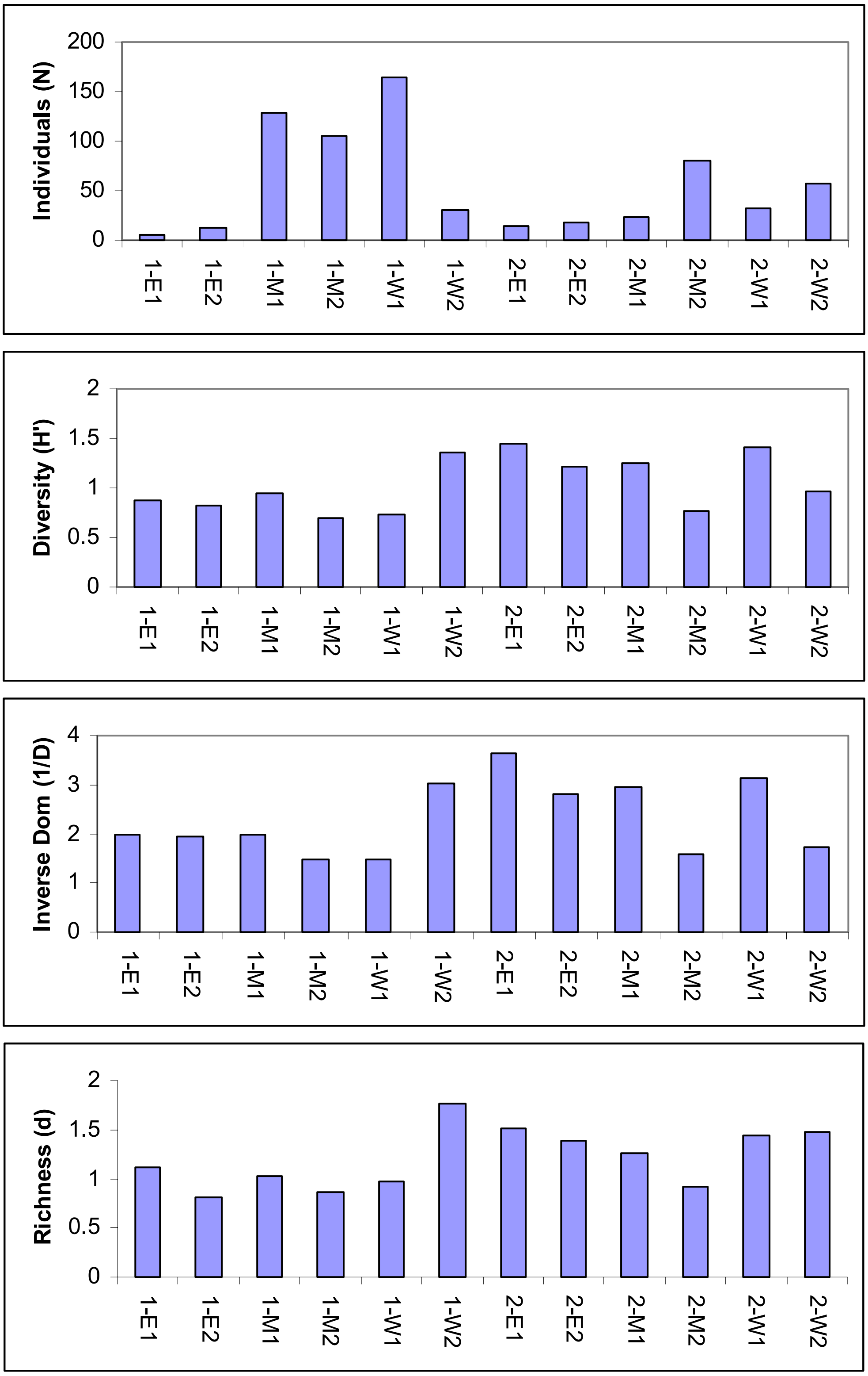

Figure 4.2-2 Benthic infauna data: N = Number of individuals, H' = Shannon-Wiener diversity index, 1/D = inverse Simpson's dominance index, d = Margalef's richness index.

4.3 Visual survey

The upper margins of the intertidal zones on both sides of both crossings were fringed with mixed riparian vegetation consisting mainly of reeds, predominantly *Phragmites australis*, and tussock including *Apodisma brownii* and *Poa poifomis*. Willows and New Zealand flax were also present. The surface of the remainder of the intertidal zone consisted of unvegetated, soft grey-brown mud. Photos showing the exposed intertidal mud flats on the proposed pipeline routes are presented in Figures 4.4-2 to 4.4-13. Grab samples of the riverbed were all very similar in appearance regardless of location or depth. They were all unvegetated, soft grey-brown mud over darker brown to black, soft mud. No burrows or evidence of macro flora or fauna were observed. Photos showing a selection of the grab samples are presented in Figures 4.4-14 and 4.4-15.

Figure 4.3-1 Typical vegetation found at the crossing sites.

Figure 4.3-2 Crossing 1 east bank upper intertidal margin

Figure 4.3-3 Crossing 1 east bank intertidal mudflat close up

Figure 4.3-4 Crossing 1 east bank view of intertidal zone at low tide

Figure 4.3-5 Crossing 1 west bank upper intertidal margin

Figure 4.3-6 Crossing 1 west bank intertidal mudflat close up

Figure 4.3-7 Crossing 1 west bank view of intertidal zone at low tide

Figure 4.3-8 Crossing 2 east bank upper intertidal margin

Figure 4.3-9 Crossing 2 east bank intertidal mudflat close up

Figure 4.3-10 Crossing 2 east bank view of intertidal zone at low tide

Figure 4.3-11 Crossing 2 west bank upper intertidal margin

Figure 4.3-12 Crossing 2 west bank intertidal mudflat close up

Figure 4.3-13 Crossing 2 west bank view of intertidal zone at low tide

Figure 4.3-14 Crossing 1 typical subtidal riverbed sample – G5

Figure 4.3-15 Crossing 1 typical subtidal riverbed sample – G11

4.4 Literature review

Very few aquatic environmental studies have been carried out in the vicinity of the proposed river crossings in the upper Tamar Estuary. Those carried out prior to 1997 have been reviewed and summarised in the 1997 State of the Tamar Estuary report (Pirzl and Coughanowr 1997). These show the Tamar Estuary to experience high sedimentation rates although this is mainly due to hydrological processes resuspending previously deposited silts rather than sediment input which is considered to be relatively low. Variations in fresh water input (riverine and run-off) throughout the year, in wind generated wave action on the mud banks and in tidal flow at differing stages and heights of the tides resuspend different quantities of riverbed sediments. In general floods scour out the upper reaches of the estuary and tidal flows carry the sediments back again during periods of low flow. However intertidal mud flats show a high resistance to scouring and are not considered a major sediment source except under conditions of severe wave action. Mud flat sediments probably serve as an effective trap for heavy metals and other contaminants with high levels of metals recorded in sediments from the upper reaches. In 1986 the Department of the Environment surveyed cadmium, lead, mercury and zinc concentrations and found slightly elevated levels of cadmium and highly elevated levels of zinc in the sediments of Home Reach (Pirzl and Coughanowr 1997).

Very little published data is available relating to the flora and fauna of the intertidal and subtidal zones of the estuary. There are no known areas of vegetated riverbed in the upper estuary other than the upper intertidal zone where reed and rush communities occur. These are dominated by *Phagmites australis, Juncus krausii* and *Schoenoplectus pungens*. Studies in 1997 by the Rice Grass Advisory Group of the Department of the Environment surveyed the extent of the introduced weed rice grass, *Spartina anglica,* found its upper limit to extend to the site of Gunns proposed northern crossing. The mud flats of the upper estuary provide breeding habitat and feeding grounds for over 20 species of water birds and waders. 110 fin-fish species have been documented in the Tamar Estuary with distributions tolerance to salinity changes and available habitat. The introduced eastern mosquito fish *Gambusia holbrooki* has been recorded from the vicinity of the proposed crossings (Keane and Neira 2004).

The most recent and relevant study of water quality in the upper Tamar is the Environment Division of Department of Primary Industry, Water and Environment (ED DPIWE) study which monitored a range of parameters at selected sites within the Tamar Estuary from December 2003 to March 2005 (ED DPIW 2006 unpub.). One of the sites in that study, Site 5, is situated midstream in Home Reach off the Trevallyn power station tailrace 2 km upstream of the proposed crossing site 1. It should be noted that water depths at this site are 10 m compared to the depths of 3 m at crossing 1 and 3.6 m at crossing 2. A summary of data collected during that study is given in Table 4.4-1 and Table 4.4-2. This data was collected in the case of pH and turbidity by profiling the water column and in all other parameters from top and bottom samples. The metals data has been sorted by depth, further analysed and annotated in tables presented in Appendix 1. A spreadsheet containing the original and processed data has been submitted with this report to further analysis.

Analysis of the 2003 – 2005 data shows pH decreased slightly with depth, was relatively constant throughout the recording period and the mid water mean was 7.24.

Mean turbidity increased with depth in general however there were large variations between records and very high peak values were encountered at all depths. Increase in sediment load with depth and a generally high sediment load were apparent in the total suspended solids (TSS) data with mean values of 41 and 64.5 mg/L recorded in surface and bottom waters respectively and values up to 277 mg/L recorded in bottom waters (Table 4.4-1).

Metals analysis of surface and bottom samples from the Home Reach site reported dissolved and total concentrations of 11 metals sampled on 15 occasions over the 2003 – 2005 survey period. Ten of the 22 parameters measured failed to return values above detection threshold for the tests used. The remaining parameters; dissolved and total aluminium, total chromium, total cobalt, dissolved and total copper, dissolved and total iron, total manganese, total manganese and dissolved and total zinc were all present in measurable concentrations. ANZECC & ARMCANZ (2000) guidelines have not been determined for dissolved metals (cf total metals), aluminium or iron. Of the remaining analytes total cobalt, dissolved and total copper and total zinc were the only ones to be recorded in values above the ANZECC & ARMCANZ (2000) 95% trigger value for slightly to moderately disturbed systems. Of these, total copper and total zinc were recorded in levels above the 90% trigger levels (10 and 7 records out of 30 respectively) and above the 80% trigger levels (3 and 2 records respectively). These trigger levels refer to the percent of species expected to be protected at that concentration of contaminant.

Mean values for all metals detected showed higher concentrations in bottom waters than surface waters and all records exceeding the 80% trigger levels occurred in bottom water samples. The Environment Division analysis of percentile values for heavy metals in Table 4.4-2 is based on surface and bottom sample records combined. Therefore higher and lower percentiles generally reflect conditions prevalent at either the surface or riverbed with the less extreme percentiles and median values more often reflecting mid-water values.

Table 4.4-1 Summary of water quality data collected by ED DPIWE from 2003 to 2005. Units as pH field - sensor TC, Turbidity Hydrolab NTU, Total suspended solids (0.45um) mg/L.

	pH	Turbidity	TSS
Surface (<1.0m)			
Mean	7.39	45.97	41
Max	8.32	135.4	87
Min	6.76	3	1
SD	0.47	37.51	26.12
Midwater (1.0m - 9.0m)			
Mean	7.24	71.27	
Max	8.24	409.9	
Min	6.8	8.5	
SD	0.34	64.28	
Bottom (>9.0m)			
Mean	7.08	97.65	64.5
Max	7.52	414.8	277
Min	6.81	11	7
SD	0.18	100.04	65.34

Table 4.4-2 Summary of heavy metals and water quality data collected by ED DPIWE from 2003 to 2005. Percentile calculations have been done on surface and bottom data combined. Shading of cells reflects the ANZECC & ARMCANZ 2000 trigger values for level of protection as percent species likely to be protected.

PARAMETER	95th Percentile	90th Percentile	80th Percentile	20th Percentile	10th Percentile	5th Percentile	Median	No of Samples	Mean surface	Mean bottom
pH field - sensor TC	7.966	7.8	7.5	6.97	6.896	6.814	7.18	249	7.39	7.08
Turbidity Hydrolab NTU	208.24	139.81	101.6	21.04	11	9.3	55.75	198	45.97	97.65
Total suspended solids (0.45um) mg/L	85.4	81.4	70.4	22.6	8.6	6.4	41	29	41.00	64.50
Aluminium (Dissolved) as Al ug/L	217.55	198.6	121	20	20	20	31	28	63.54	82.43
Aluminium (Total) as Al ug/L	3376	2920	1794	326	186.4	151.6	850	29	973.36	1628.14
Cadmium (Dissolved) as Cd ug/L	1	1	1	1	1	0.82	1	29	0.98	0.98
Cadmium (Total) as Cd ug/L	1	1	1	1	1	0.82	1	29	0.98	0.98
Chromium (Dissolved) as Cr ug/L	1	1	1	1	1	0.88	1	29	0.99	0.99
Chromium (Total) as Cr ug/L	6	4.4	3.4	1	1	0.88	2	29	1.91	3.20
Cobalt (Dissolved) as Co ug/L	1	1	1	1	1	1	1	29	1.00	1.00
Cobalt (Total) as Co ug/L	3.6	2.2	1	1	1	1	1	29	1.14	1.57
Copper (Dissolved) as Cu ug/L	2	2	1	1	1	1	1	29	1.14	1.29
Copper (Total) as Cu ug/L	10.4	7.2	4.4	1	1	1	2	29	2.79	4.36
Filt Mercury as Hg ug/l	0.05	0.05	0.05	0.05	0.05	0.05	0.05	29	0.05	0.05
Iron (Dissolved) as Fe ug/L	249.2	238	143.8	24	20	20	54	29	90.43	97.21
Iron (Total) as Fe ug/L	3488	3334	2430	584.4	297.8	102.8	1210	29	1292.07	2200.86
Lead (Dissolved) as Pb ug/L	8	5	5	5	5	5	5	29	5.36	5.36
Lead (Total) as Pb ug/L	10	6.8	5	5	5	5	5	29	5.36	6.07
Manganese (Dissolved) as Mn ug/L	5	5	5	5	5	2.6	5	29	4.73	4.71
Manganese (Total) as Mn ug/L	246.4	198.4	142.2	38.2	17.6	9.4	76	29	78.67	128.50
Mercury (Total) as Hg ug/L	0.074	0.05	0.05	0.05	0.05	0.05	0.05	29	0.05	0.05
Nickel (Dissolved) as Ni ug/L	2	1.2	1	1	1	1	1	29	1.13	1.07
Nickel (Total) as Ni ug/L	4.6	3.2	2	1	1	1	1	29	1.40	2.21
Zinc (Dissolved) as Zn ug/L	4.6	3.2	3	1	1	1	2	29	2.27	2.57
Zinc (Total) as Zn ug/L	46.8	37.4	23.4	8	5.2	1.4	14	29	14.13	22.86
		95%		90%		80%				

5 CONCLUSIONS

Riverbed habitat at the two proposed crossing sites consists of reed and rush communities in the upper intertidal margins and unvegetated, grey-brown over black silts over the remaining intertidal and subtidal regions. The river channel at both sites is of similar width while the intertidal mudflats are several hundred metres wider at the northern crossing than the southern crossing. The intertidal mudflats are relatively stable while the channel sediments are more mobile being resuspended and transported during periods of high tidal or river flow.

Benthic infauna samples were collected from both crossing sites. Crustaceans were the dominant group present, with a single species of Corophiid amphipod contributing ~70% of all individuals collected. Molluscs contributed ~18%, Annelids ~11% and a single chironomid insect larva was collected. These proportions are typical of the communities associated with subtidal estuarine mudflats with a strong freshwater influence. A single cryptogenic species, the gastropod *Potamopyrgus antipodarum,* was collected from all sites except 1-E1.

The intertidal mudflats provide breeding and foraging habitat for over 20 species of birds and the Tamar Estuary supports over 100 species of fish. Introduced pest species in the vicinity of the crossings included rice grass and the eastern mosquito fish.

Turbidity and suspended solids are very variable and frequently high, ph is relatively constant and within the range of 6.8 to 8.3. Cadmium, copper and zinc have been recorded in levels exceeding the ANZECC & ARMCANZ 2000 95% trigger values and copper and zinc concentrations in bottom water samples have exceeded the 80% trigger values.

Jetting the trench to contain the water pipe will cut into the intertidal mudflats potentially mobilising sediments with high concentrations of contaminants, particularly cadmium, copper and zinc. Although this may be rapidly dispersed by the high water flow there is a potential for significant danger to species locally during trenching and for a more extended period should disturbing the mudflats weaken their resistance to scouring. Prevailing high sedimentation rates will probably rapidly fill the trench where it crosses the channel although the potential for erosion of the sides of the trench should be investigated.

Equipment to be used for the trenching should be cleaned prior to deployment to reduce the likelihood of introducing any pest species. It should also be cleaned and inspected at the conclusion of operations to prevent the transportation of either rice grass or mosquito fish away from the site.

When setting compliance levels for water quality with relation to the proposed trenching the variation in parameters with depth should be considered. Also the effect on flow rates and consequent background water quality in the shallower river profiles at the crossing sites compared to the Home Reach monitoring site should be estimated.

6 REFERENCES

ANZECC & ARMCANZ (2000) *Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy.* Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand.

Department of the Environment 1986. *Tamar River Report; a water, sediment, bacteriological and oyster survey.* Department of the Environment, Hobart, Tasmania.

Environment Division 2006. Unpublished data from 2003 to 2005 Tamar Estuary monitoring program. Courtesy M Rushton, Environment Division, Department of Primary Industries, Water and Environment, Hobart, Tasmania

Hedge P 1997. *Strategy for the management of rice grass (*Spartina anglica*) in Tasmania, Australia (draft for public comment).* Report to Rice Grass Advisory Group, DPIF

Keane, JP, Neira, FJ, 2004 *'First record of mosquitofish,* Gambusia holbrooki*, in Tasmania, Australia: stock structure and reproductive biology'*, New Zealand Journal of Marine and Freshwater Research 2004, **38** 857-867 (2004) [A1]

Pirzl, Helga & Coughanowr, Christine 1997. *State of the Tamar Estuary, a review of environmental quality data to 1997.* Supervising Scientist Report 128, Supervising Scientist, Canberra.

7 APPENDIX 1

Site Tamar River Home Reach-midstream, off HEC t-race (5) (ALL)

	Aluminium (Dissolved) as Al ug/L	Aluminium (Total) as Al ug/L	Cadmium (Dissolved) as Cd ug/L	Cadmium (Total) as Cd ug/L	Chromium (Dissolved) as Cr ug/l	Chromium (Total) as Cr ug/L	Cobalt (Dissolved) as Co ug/L	Cobalt (Total) as Co ug/L
95th Percentile	217.6	3376	1	1	1	6	1	3.6
90th Percentile	198.6	2920	1	1	1	4.4	1	2.2
80th Percentile	121	1794	1	1	1	3.4	1	1
20th Percentile	20	326	1	1	1	1	1	1
10th Percentile	20	186.4	1	1	1	1	1	1
5th Percentile	20	151.6	0.82	0.82	0.88	0.88	1	1
Median	31	850	1	1	1	2	1	1
Sample Numbe	28	29	29	29	29	29	29	29
Mean Surface	63.54	973.4	0.979	0.9786	0.99	1.9143	1	1.1429
Mean Bottom	82.43	1628	0.979	0.9786	0.99	3.2	1	1.5714

DATEANDTIME	DEPTH	COMMEN'	Qualifier for Aluminium (Dissolved) as Al ug/L	Aluminium (Dissolved) as Al ug/L	Qualifier for Aluminium (Total) as Al ug/L	Aluminium (Total) as Al ug/L	Qualifier for Cadmium (Dissolved) as Cd ug/L	Cadmium (Dissolved) as Cd ug/L	Qualifier for Cadmium (Total) as Cd ug/L	Cadmium (Total) as Cd ug/L	Qualifier for Chromium (Dissolved) as Cr ug/l	Chromium (Dissolved) as Cr ug/L	Qualifier for Chromium (Total) as Cr ug/L	Chromium (Total) as Cr ug/L	Qualifier for Cobalt (Dissolved) as Co ug/L	Cobalt (Dissolved) as Co ug/L	Qualifier for Cobalt (Total) as Co ug/L	Cobalt (Total) as Co ug/L
12/12/2002 9:30	0.1	Surface		80		802	<	1	<	1	<	1		1	<	1	<	1
23/01/2003 16:15	0.1	Surface	<	20		958	<	1	<	1	<	1		1	<	1	<	1
27/02/2003 11:15	0.1	Surface	<	20		1680	<	1	<	1	<	1		3	<	1	<	1
27/03/2003 9:35	0.1	Surface	<	20		38	<	1	<	1	<	1	<	1	<	1	<	1
27/03/2003 16:30	0.1	Surface		28		775	<	1	<	1	<	1		2	<	1	<	1
15/05/2003 15:10	0.1	Surface	<	20		1690	<	1	<	1	<	1		3	<	1	<	1
26/06/2003 14:30	0.1	Surface				942	<	1	<	1	<	1		2	<	1	<	1
24/07/2003 10:30	0.1	Surface		200		2820	<	1	<	1	<	1		4	<	1		3
21/08/2003 9:45	0.1	Surface		37		195	<	1	<	1	<	1	<	1	<	1	<	1
5/11/2003 13:50	0.1	Surface		72		353	<	1	<	1	<	1	<	1	<	1	<	1
26/11/2003 10:10	0.1	Surface		34		1330	<	1	<	1	<	1		3	<	1		1
21/04/2004 8:30	0.1	Surface	<	20		350	<	0.7	<	0.7	<	0.8	<	0.8	<	1	<	1
25/08/2004 9:50	0.1	Surface		255		850	<	1	<	1	<	1		2	<	1	<	1
16/12/2004 8:00	0.11	Surface	<	20		844	<	1	<	1	<	1		2	<	1	<	1
17/03/2005 9:45	0.1	Surface	<	20		160	<	1	<	1	<	1	<	1	<	1	<	1
12/12/2002 9:30	13.9	Bottom		118		2860	<	1	<	1	<	1		6	<	1		1
23/01/2003 16:15	7.2	Bottom	<	20		861	<	1	<	1	<	1		1	<	1	<	1
27/02/2003 11:15	8.6	Bottom		123		3520	<	1	<	1	<	1		6	<	1		1
27/03/2003 9:35	7	Bottom	<	20		290	<	1	<	1	<	1	<	1	<	1	<	1
15/05/2003 15:10	9	Bottom	<	20		1800	<	1	<	1	<	1		3	<	1	<	1
26/06/2003 14:30	11	Bottom		198		1790	<	1	<	1	<	1		4	<	1		2
24/07/2003 10:30	13	Bottom		180		3160	<	1	<	1	<	1		4	<	1		4
21/08/2003 9:45	12	Bottom		38		193	<	1	<	1	<	1	<	1	<	1	<	1
5/11/2003 13:50	10	Bottom		75		440	<	1	<	1	<	1		1	<	1	<	1
26/11/2003 10:10	9	Bottom		75		5450	<	1		1	<	1		11	<	1		5
21/04/2004 8:30	11	Bottom	<	20		395	<	0.7	<	0.7	<	0.8		0.8	<	1	<	1
25/08/2004 9:50	13	Bottom		227		815	<	1	<	1	<	1		2	<	1	<	1
16/12/2004 8:00	11	Bottom	<	20		1060	<	1	<	1	<	1		3	<	1		1
17/03/2005 9:45	10	Bottom	<	20		146	<	1	<	1	<	1	<	1	<	1	<	1

Below threshold 95% 90% 80%

Table 4.4-1 Sorted data from ED DPIWE monitoring 2003 to 2005

Site Tamar River Home Reach-midstream, off HEC t-race (5) (ALL)

	Copper (Dissolved) as Cu ug/L	Copper (Total) as Cu ug/L	Filt Mercury as Hg ug/l	Iron (Dissolved) as Fe ug/L	Iron (Total) as Fe ug/L	Lead (Dissolved) as Pb ug/L	Lead (Total) as Pb ug/L
95th Percentile	2	10.4	0.05	249.2	3488	8	10
90th Percentile	2	7.2	0.05	238	3334	5	6.8
80th Percentile	1	4.4	0.05	143.8	2430	5	5
20th Percentile	1	1	0.05	24	584.4	5	5
10th Percentile	1	1	0.05	20	297.8	5	5
5th Percentile	1	1	0.05	20	102.8	5	5
Median	1	2	0.05	54	1210	5	5
Sample Numbe	29	29	29	29	29	29	29
Mean Surface	1.1429	2.786	0.05	90.4286	1292.1	5.3571	5.3571
Mean Bottom	1.2857	4.357	0.05	97.2143	2200.9	5.3571	6.0714

DATEANDTIME	DEPTH	COMMEN	Qualifier for Copper (Dissolved) as Cu ug/L	Copper (Dissolved) as Cu ug/L	Qualifier for Copper (Total) as Cu ug/L	Copper (Total) as Cu ug/L	Qualifier for Filt Mercury as Hg ug/l	Filt Mercury as Hg ug/l	Qualifier for Iron (Dissolved) as Fe ug/L	Iron (Dissolved) as Fe ug/L	Qualifier for Iron (Total) as Fe ug/L	Iron (Total) as Fe ug/L	Qualifier for Lead (Dissolved) as Pb ug/L	Lead (Dissolved) as Pb ug/L	Qualifier for Lead (Total) as Pb ug/L	Lead (Total) as Pb ug/L
12/12/2002 9:30	0.1	Surface	<	1		1	<	0.05		58		906	<	5	<	5
23/01/2003 16:15	0.1	Surface	<	1		2	<	0.05		43		1080	<	5	<	5
27/02/2003 11:15	0.1	Surface		2		2	<	0.05		21		1760	<	5	<	5
27/03/2003 9:35	0.1	Surface	<	1		3	<	0.05	<	20		137	<	5	<	5
27/03/2003 16:30	0.1	Surface	<	1		3	<	0.05		45		1810	<	5	<	5
15/05/2003 15:10	0.1	Surface	<	1		3	<	0.05		54		1540	<	5	<	5
26/06/2003 14:30	0.1	Surface		1		2	<	0.05		196		1010	<	5	<	5
24/07/2003 10:30	0.1	Surface		2		7	<	0.05		257		2700	<	5	<	5
21/08/2003 9:45	0.1	Surface	<	1	<	1	<	0.05		109		377	<	5	<	5
5/11/2003 13:50	0.1	Surface	<	1	<	1	<	0.05		107		957	<	5	<	5
26/11/2003 10:10	0.1	Surface	<	1		4	<	0.05		40		2200	<	5	<	5
21/04/2004 8:30	0.1	Surface	<	1		2	<	0.05		24		662	<	10	<	10
25/08/2004 9:50	0.1	Surface		1		4	<	0.05		254		1260	<	5	<	5
16/12/2004 8:00	0.11	Surface	<	1		4	<	0.05		38		1690	<	5	<	5
17/03/2005 9:45	0.1	Surface	<	1	<	1	<	0.05	<	20		80	<	5	<	5
12/12/2002 9:30	13.9	Bottom	<	1		5	<	0.05		89		3500	<	5	<	5
23/01/2003 16:15	7.2	Bottom		3		1	<	0.05		49		944	<	5	<	5
27/02/2003 11:15	8.6	Bottom	<	1		4	<	0.05		88		3300	<	5	<	5
27/03/2003 9:35	7	Bottom	<	1		1	<	0.05		24		468	<	5	<	5
15/05/2003 15:10	9	Bottom	<	1		2	<	0.05		34		1580	<	5	<	5
26/06/2003 14:30	11	Bottom		1		6	<	0.05		242		3280	<	5		6
24/07/2003 10:30	13	Bottom		2		8	<	0.05		237		3470	<	5		6
21/08/2003 9:45	12	Bottom	<	1	<	1	<	0.05		103		338	<	5	<	5
5/11/2003 13:50	10	Bottom	<	1	<	1	<	0.05		105		1150	<	5	<	5
26/11/2003 10:10	9	Bottom	<	1		13	<	0.05		67		8580	<	5		13
21/04/2004 8:30	11	Bottom	<	1		12	<	0.05	<	20		662	<	10	<	10
25/08/2004 9:50	13	Bottom		2		2	<	0.05		233		1210	<	5	<	5
16/12/2004 8:00	11	Bottom	<	1		4	<	0.05		50		2250	<	5	<	5
17/03/2005 9:45	10	Bottom	<	1	<	1	<	0.05	<	20		74	<	5	<	5

Below threshold 95% 90% 80%

Table 4.4-2 Sorted data from ED DPIWE monitoring 2003 to 2005

Site Tamar River Home Reach-midstream, off HEC t-race (5) (ALL)

	Manganese (Dissolved) as Mn ug/L	Manganese (Total) as Mn ug/L	Mercury (Total) as Hg ug/L	Nickel (Dissolved) as Ni ug/L	Nickel (Total) as Ni ug/L	Zinc (Dissolved) as Zn ug/L	Zinc (Total) as Zn ug/L
95th Percentile	5	246.4	0.074	2	4.6	4.6	46.8
90th Percentile	5	198.4	0.05	1.2	3.2	3.2	37.4
80th Percentile	5	142.2	0.05	1	2	3	23.4
20th Percentile	5	38.2	0.05	1	1	1	8
10th Percentile	5	17.6	0.05	1	1	1	5.2
5th Percentile	2.6	9.4	0.05	1	1	1	1.4
Median	5	76	0.05	1	1	2	14
Sample Numbe	29	29	29	29	29	29	29
Mean Surface	4.73	78.67	0.054	1.13	1.4	2.27	14.1
Mean Bottom	4.71	128.5	0.053	1.07	2.21	2.57	22.9

DATEANDTIME	DEPTH	COMMENT	Qualifier for Manganese (Dissolved) as Mn ug/l	Manganese (Dissolved) as Mn ug/L	Qualifier for Manganese (Total) as Mn ug/L	Manganese (Total) as Mn ug/L	Qualifier for Mercury (Total) as Hg ug/L	Mercury (Total) as Hg ug/L	Qualifier for Nickel (Dissolved) as Ni ug/L	Nickel (Dissolved) as Ni ug/L	Qualifier for Nickel (Total) as Ni ug/L	Nickel (Total) as Ni ug/L	Qualifier for Zinc (Dissolved) as Zn ug/L	Zinc (Dissolved) as Zn ug/L	Qualifier for Zinc (Total) as Zn ug/L	Zinc (Total) as Zn ug/L
12/12/2002 9:30	0.1	Surface	<	5		37		0.11		2		1		2		7
23/01/2003 16:15	0.1	Surface	<	5		47	<	0.05	<	1		1		3		11
27/02/2003 11:15	0.1	Surface	<	5		48	<	0.05	<	1		1		2		12
27/03/2003 9:35	0.1	Surface	<	5		16	<	0.05	<	1	<	1		2		2
27/03/2003 16:30	0.1	Surface	<	5		135	<	0.05	<	1		1		1		20
15/05/2003 15:10	0.1	Surface	<	5		84	<	0.05	<	1		2		3		15
26/06/2003 14:30	0.1	Surface	<	5		60	<	0.05	<	1		1		7		18
24/07/2003 10:30	0.1	Surface	<	5		189	<	0.05		1		4		3		37
21/08/2003 9:45	0.1	Surface	<	5		23	<	0.05	<	1		1		2		6
5/11/2003 13:50	0.1	Surface	<	5		63	<	0.05	<	1	<	1	<	1		12
26/11/2003 10:10	0.1	Surface	<	5		190	<	0.05	<	1		1		1		23
21/04/2004 8:30	0.1	Surface	<	1		92	<	0.05	<	2		3		3		13
25/08/2004 9:50	0.1	Surface	<	5		76	<	0.05	<	1	<	1		2		17
16/12/2004 8:00	0.11	Surface	<	5		115	<	0.05	<	1	<	1		1		18
17/03/2005 9:45	0.1	Surface	<	5	<	5	<	0.05	<	1	<	1	<	1	<	1
12/12/2002 9:30	13.9	Bottom	<	5		130		0.09		1		3		3		26
23/01/2003 16:15	7.2	Bottom	<	5		39	<	0.05	<	1		2		3		10
27/02/2003 11:15	8.6	Bottom	<	5		100	<	0.05	<	1		2		3		20
27/03/2003 9:35	7	Bottom	<	5		51	<	0.05	<	1	<	1		3		8
15/05/2003 15:10	9	Bottom	<	5		90	<	0.05	<	1		2		4		14
26/06/2003 14:30	11	Bottom	<	5		232	<	0.05	<	1		2		5		39
24/07/2003 10:30	13	Bottom	<	5		256	<	0.05		1		5		3		52
21/08/2003 9:45	12	Bottom	<	5		18	<	0.05	<	1	<	1		2		8
5/11/2003 13:50	10	Bottom	<	5		80	<	0.05	<	1		2		1		14
26/11/2003 10:10	9	Bottom	<	5		518	<	0.05	<	1		6		2		83
21/04/2004 8:30	11	Bottom	<	1		57	<	0.05	<	2	<	2		2		10
25/08/2004 9:50	13	Bottom	<	5		70	<	0.05	<	1	<	1		3		11
16/12/2004 8:00	11	Bottom	<	5		153	<	0.05	<	1	<	1		1		24
17/03/2005 9:45	10	Bottom	<	5	<	5	<	0.05	<	1	<	1	<	1		1

Below threshold 95% 90% 80%

Table 4.4-3 Sorted data from ED DPIWE monitoring 2003 to 2005