Tasmania

DEPARTMENT *of*
PRIMARY INDUSTRY
and FISHERIES

State of River Report on

Water Quality Of Rivers In The Mersey Catchment

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EXECUTIVE SUMMARY

The environmental quality of water in the Mersey catchment was examined in a series of catchment-wide surveys carried out during the spring and summer of 1996-97. The information collected was compared to data collected in the past by a variety of other State agencies. The results showed that conditions in the Mersey River at present and in the recent past are good. Most water quality parameters do show a gradual increase downstream but appear to be adequately diluted by main stream flows.

Compared to the main river, the water quality of tributaries is much more degraded. The worst of these are Coilers Creek and Redwater Creek in the middle of the catchment, and Parramatta and Kings creeks lower down. Nitrogen and phosphorus concentrations in both Coilers and Redwater creeks are very high and during stable hydrological conditions are sufficiently high to cause algal blooms in these creeks. The cause of these elevated concentrations appears to be related to intensive animal industries and wastewater effluent. In Parramatta and Kings creeks, nearer to Latrobe, the causes of water quality degradation are more complex due to the increased variety of catchment activities.

The microbiological quality of rivers in the catchment is variable, but conditions were generally found to be worse in tributaries than the main stream. Of the 18 sites sampled for bacterial quality, 6 exceeded the ANZECC (1992) guidelines for primary contact with water. In a number of instances this pollution may be directly linked to stock access to the river.

Monitoring of turbidity during flood flows in May 1997 showed that the majority of suspended material entering the Mersey River originates from the catchment between Liena and Kimberley. This stretch of river receives inflow from Mole Creek, Lobster Rivulet, the Minnow River and the Dasher River. This indicates the relative severity of erosion and loss of soil occurring in these subcatchments.

Dissolved oxygen levels throughout the catchment are healthy, although large variations were found in Coilers Creek and may be a result of the nutrient load entering this creek. Lowest dissolved oxygen concentrations were measured in Parramatta Creek during a period when flows were extremely low and temperature was very high. During this time fish were seen to be under extreme stress.

While these results show that some deterioration in water quality occurs at sites throughout the catchment, more detailed information is required to determine the main factors causing this degradation and the actions which will be needed to remediate impacted areas. The development of a catchment management plan will provide a suitable mechanism to resolve these problems.

WATER QUALITY OF RIVERS IN THE MERSEY CATCHMENT

This report reviews historical water quality data which has been collected by various interest groups and agencies in the Mersey Catchment and presents current data on the state of the water resources in the catchment as collected by the Department of Primary Industry and Fisheries during the period 1996-97. This information was gathered as part of a study of the environmental condition of rivers in the Mersey Catchment commissioned by the Mersey River Working Group in response to public concern over extremely low flows in the Mersey River.

1. HISTORICAL INFORMATION

In the past, collection of data on water quality of rivers in the Mersey catchment has been intermittent and data is scattered throughout various groups, from Local Government and Community groups to larger State agencies. The following section covers only those groups which were found to have significant amounts of data on ambient water quality in the catchment. In many cases the quality of the data could not be adequately assessed and therefore should be viewed with this in mind.

1.1 Data Extracted from the State Water Quality Database

Interrogation of the State database (HYDROL), which contains past data contributed by the Hydro Electric Corporation (HEC), the Department of Primary Industry and Fisheries (DPIF), the Department of Environment and Land Management (DELM), the Rivers and Waters Supply Commission (RWSC) and the Forestry Tasmania, revealed that the bulk of data collected in the catchment was taken at sites only within the Mersey River. With the exception of the Arm River, very little data from tributaries has been collected and was not considered sufficient to report on here.

The following table shows the sites at which historical data is available, the period over which it was collected and the number of site visits during which data was collected. Although data at some sites was collected on a regular basis for a short period (e.g. Mersey at Kelly Bridge), data at most sites was collected on an infrequent basis. The site associated with the gauging station in the Mersey River u/s Latrobe (Site No. 447) contains the largest dataset, with over 100 records.

TABLE 1. Sites in the Mersey with significant water quality data.

Site Name	No.	Period Containing Data	Sampling Occasions
Arm River u/s Mersey	624	Dec 1974 - Sep 1990	8
Mersey at Liena	640 & 60	May 1977 - Feb 1997	11
Mersey at Union Bridge	1292	Sep 1976 - Sep 1996	9
Mersey at Kelly Bridge	1293	Sep 1976 - Jun 1977	10
Mersey at Kimberley	22	Sep 1976 - Feb 1997	10
Mersey at Merseylea	1288	Sep 1976 - Jun 1977	10
Mersey at Railton Pump Stn.	1289	Sep 1976 - Jun 1977	10
Mersey at Lovetts Flats	1278	Oct 1977 - Jan 1981	23
Mersey at Latrobe	447	Sep 1976 - Mar 1997	101
Mersey at Latrobe d/s Caroline Ck	1280	Sep 1976 - Mar 1997	21
Mersey at Ambleside	1285	Aug 1975 - Jul 1978	10

Site locations are shown on Map 1.

At seven of the main sites routine monitoring appears to have been performed during 1976-77, and some general trends are evident from data collected during this period. At these sites, sufficient data on the following parameters exists to allow interpretation of water quality in the river at that time:

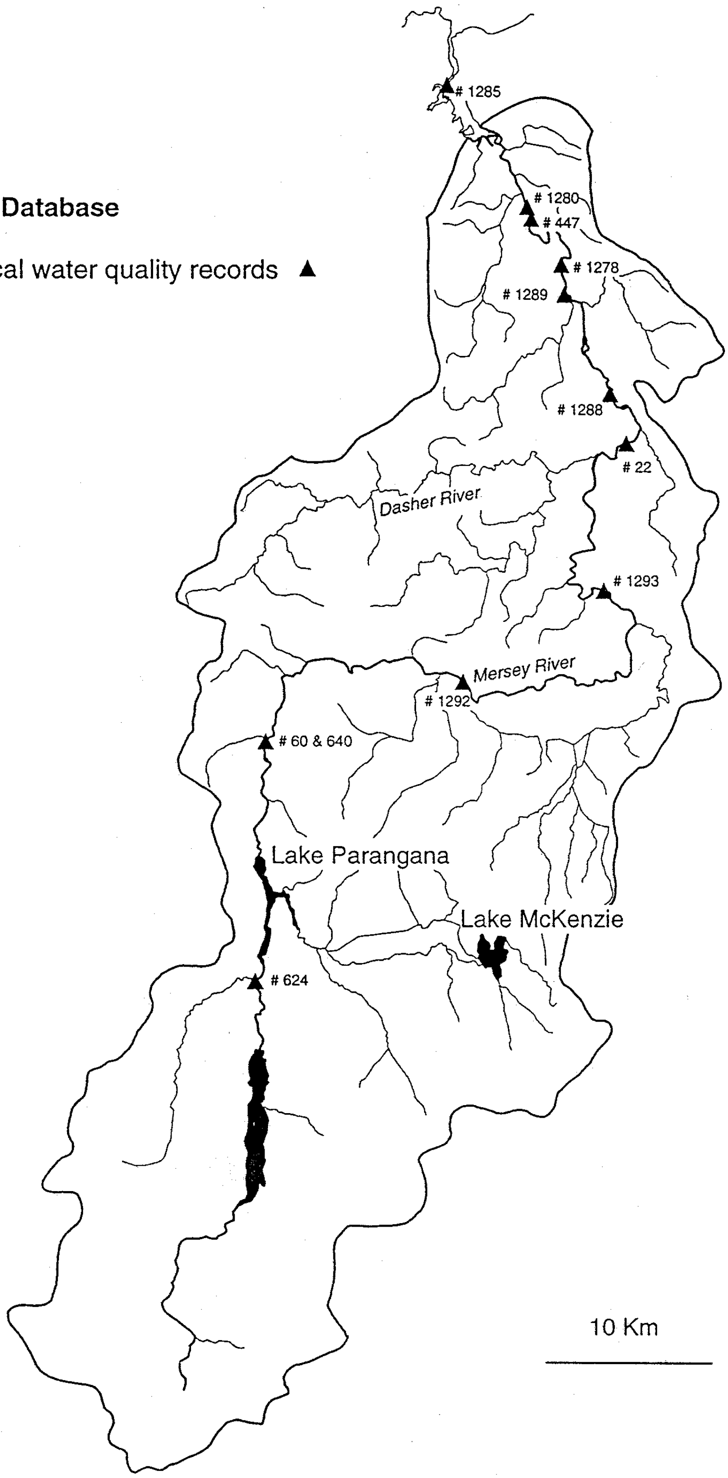
Faecal/Total Coliforms
Apparent Colour
Suspended Solids
Tannins / Lignins
Filterable Residues

Plots showing the average concentrations (and standard error bars) of parameters at sites in the Mersey River are shown in Figures 1 - 5 on the following pages. A common feature of most of these figures is the increase in concentration downstream. The most marked increase is in faecal and total coliforms. Despite a large peak in coliform numbers at Union Bridge, where it appears that contamination was quite high, coliform levels in the river show a gradual increase between the Kellys Bridge site and the lower-most site at Latrobe. It is very likely that the elevated coliform levels at Union Bridge are a result of local access to the river at that site by cattle.

MERSEY RIVER EXPERIMENTAL STUDY

MAP 1. Hydrol Database

Sites with historical water quality records ▲



Overall, this pattern of increasing coliform levels towards the mouth of the river is common in agricultural catchments.

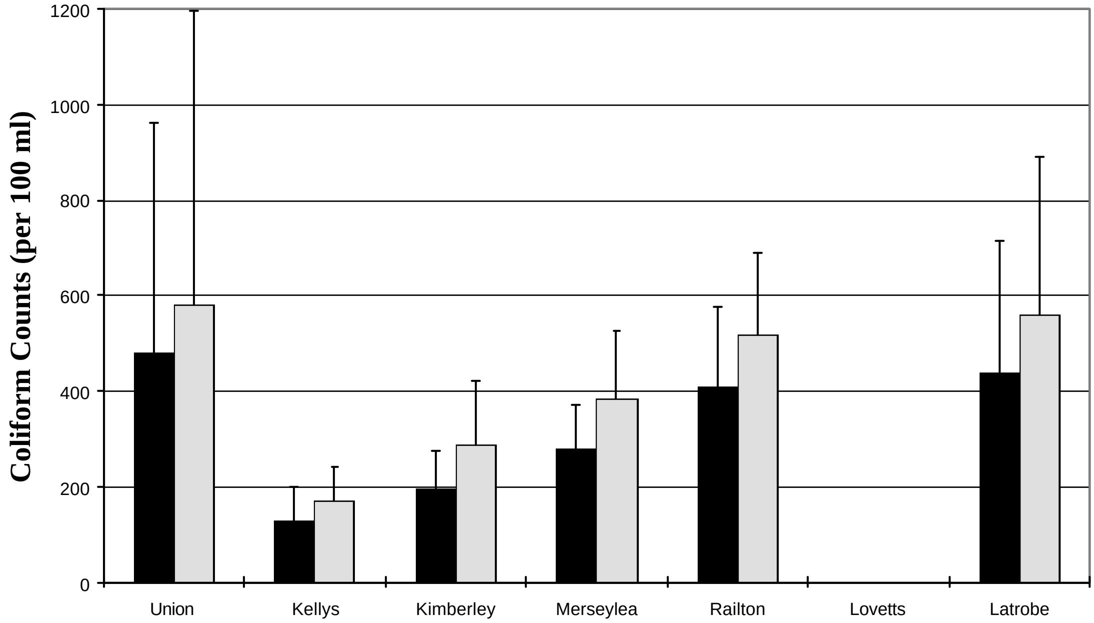


Figure 1 Average (+2 SE) coliform concentrations at sites in the Mersey River using data extracted from the State database. Most data was collected during 1976 - '78. (Solid black columns represent Faecal Coliforms; Shaded columns represent Total Coliforms).

The plots for colour and suspended solids show a similar pattern with a gradual increase in levels downstream. Both plots show a noticeable increase between the Railton and Lovetts Flats sites. The reason for this abrupt increase is most likely a result of the inflow of Redwater Creek between these two sites, implying that at that time Redwater Creek was a significant source of both suspended matter and colour to the Mersey River.

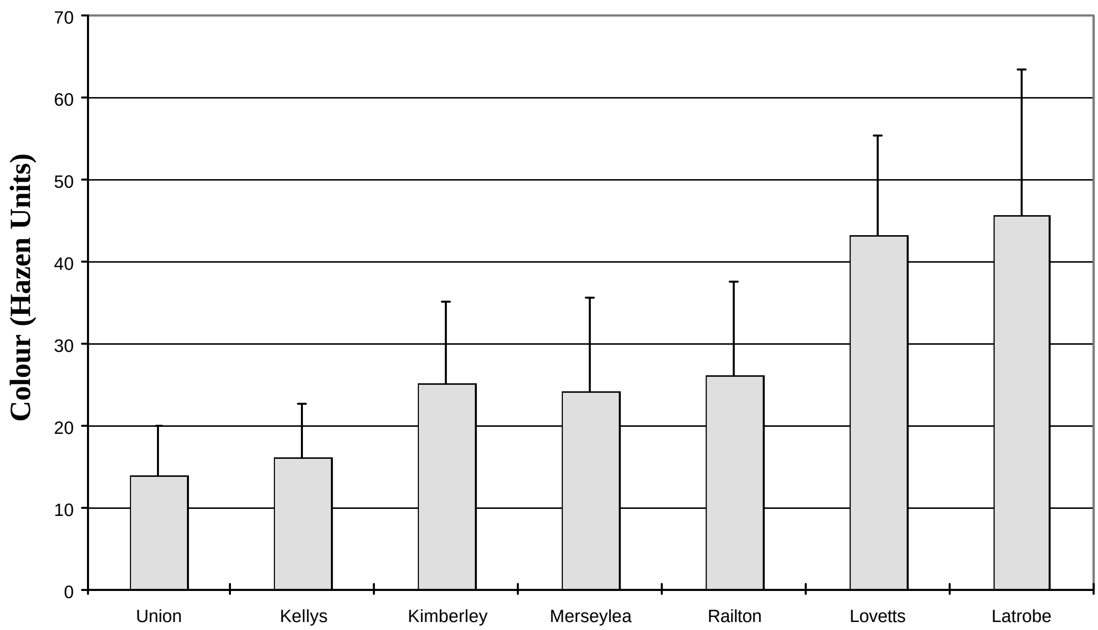


Figure 2 Average (+2SE) colour at sites in the Mersey River using data extracted from the State database. Most data was collected during 1976 - '78.

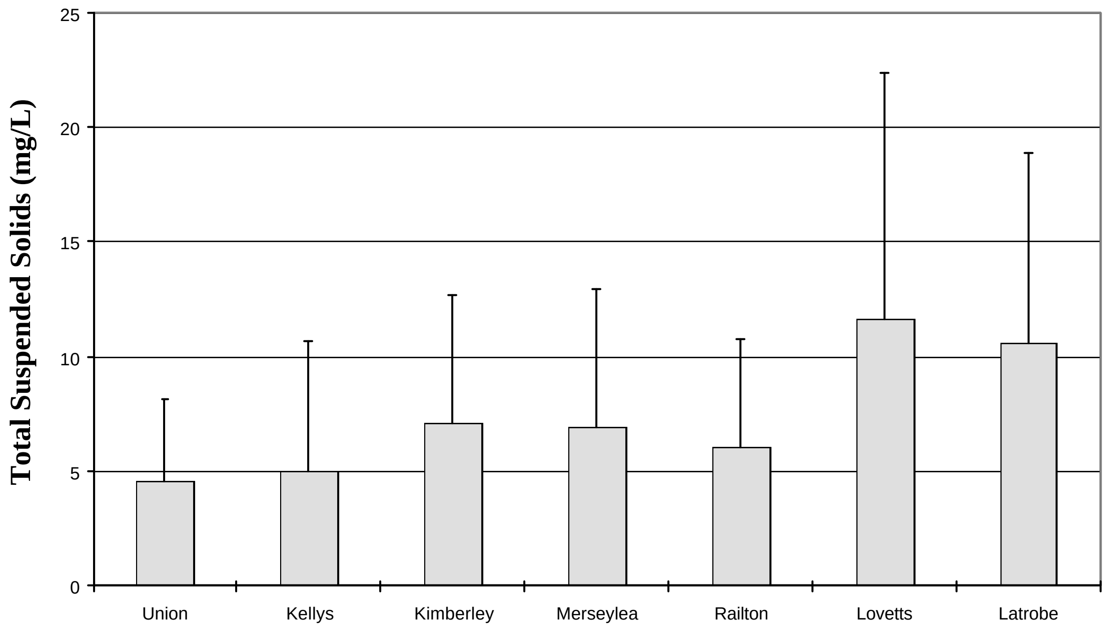


Figure 3 Average (+2SE) suspended solids concentrations at sites in the Mersey River using data extracted from the State database. Most data was collected during 1976 - '78.

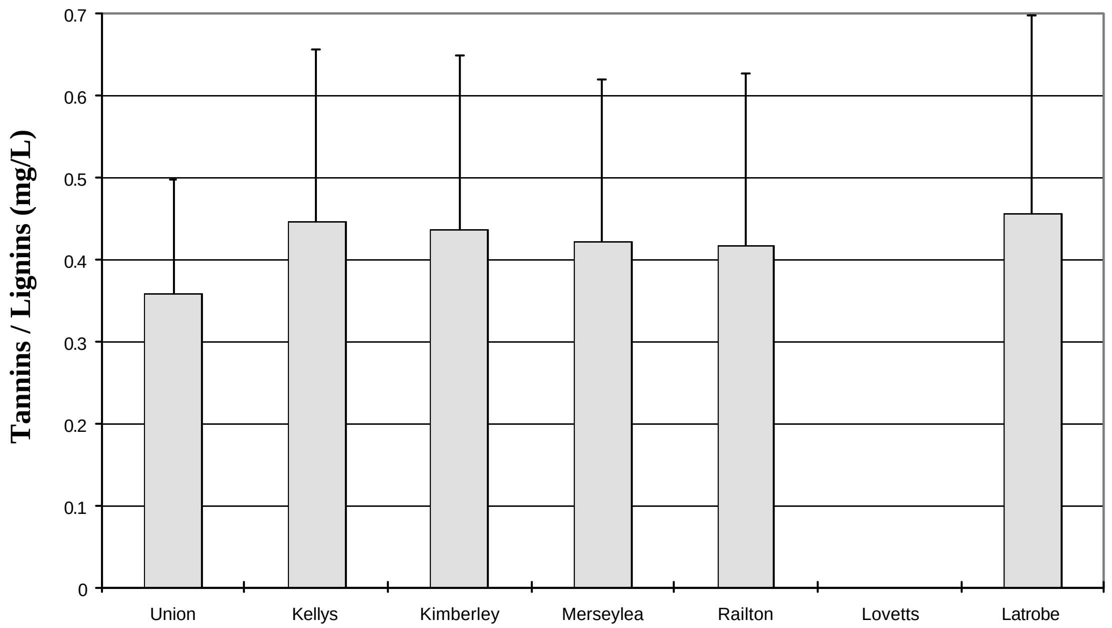


Figure 4 Average concentrations (+2SE) of tannins and lignins at sites in the Mersey River using data extracted from the State database. Most data was collected during 1976 - '78.

Tannins/Lignins show only a very slight increase in concentrations down the length of the river, reaching only 0.5 mg/L at the Latrobe site. While tannins and lignins are normally measured in discharge from paper pulp manufacturing, its presence in water in Tasmania is usually associated with 'tea coloured' waters of button grass areas. In the Mersey River, concentrations of tannins/lignins is low reflecting the lack of influence of these compounds on water colour.

Unlike the other parameters discussed above, filterable residues (which is the equivalent of the more modern measurement 'Total Dissolved Solids'), show a gradual but consistent decrease in concentration from Union Bridge to Latrobe. The reason for this apparent trend is not clear, as the opposite is usually expected. Inflows near the bottom of major river systems generally tend to add water with higher dissolved material. Summary statistics of the data extracted from Hydrol in the Mersey Catchment are given in Appendix 1.

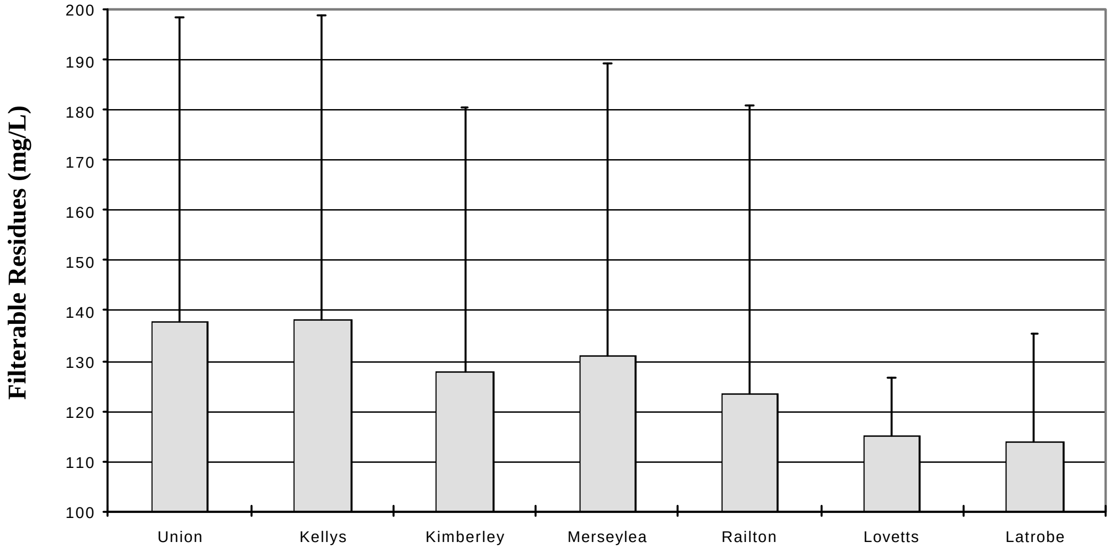


Figure 5 Average concentrations (+2SE) of filterable residue at sites in the Mersey River using data extracted from the State database. Most data was collected during 1976 - '78.

1.2 Inland Fisheries Commission Data

More recent data was obtained from the Inland Fisheries Commission (IFC), who carried out water quality sampling in the Mersey Catchment during the summer of 1993. This short-term program was initiated as a result of concern expressed by the angling community about conditions in the Mersey River and the poor performance of the trout fishery at that time. An internal unpublished report on the results concluded that while water quality in the Mersey River could generally be considered 'good', higher nutrient levels in the lower Mersey appear to result from inflow of nutrient rich water from Coilers and Redwater creeks.

Table 2 lists the sites sampled by the IFC in 1993 and the sites at which water quality was tested during the current study. Most of the sites sampled by the IFC in 1993 have been sampled in the current project.

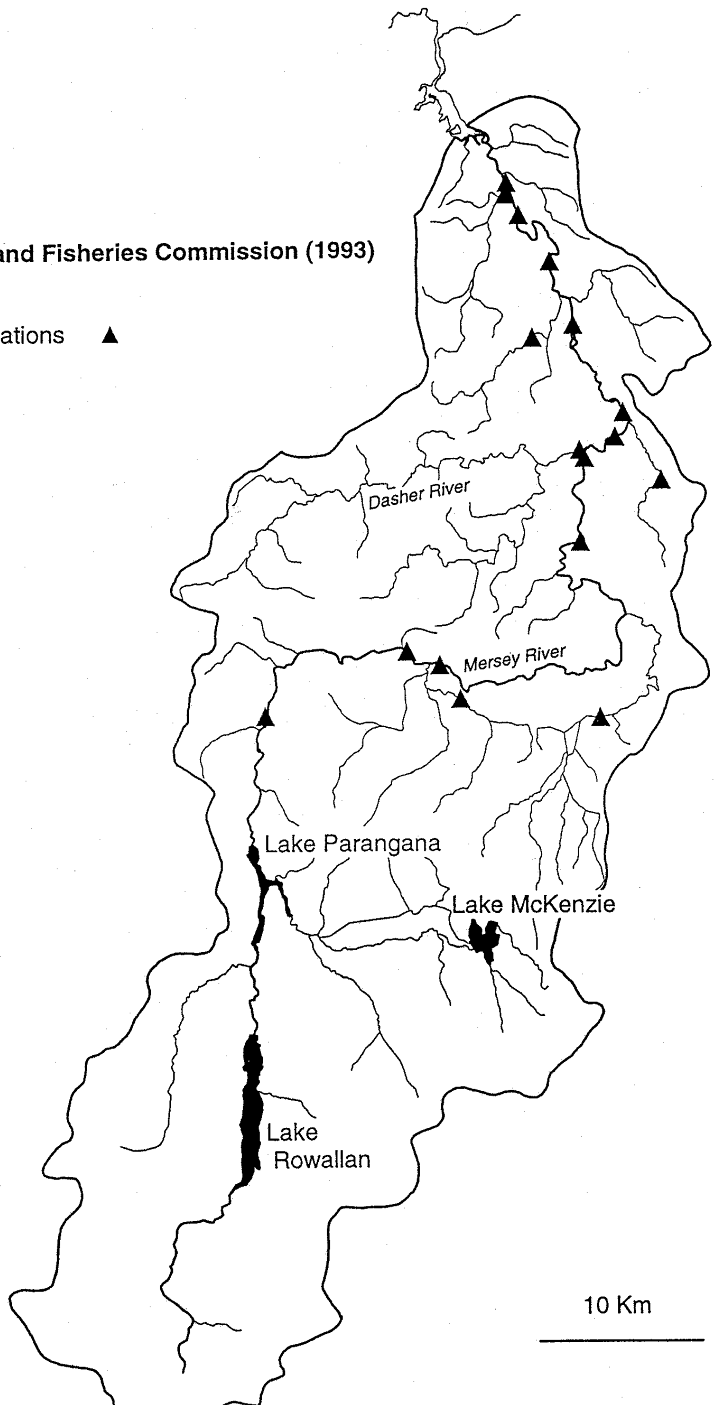
TABLE 2. Sites sampled by the IFC and included in the present study.

IFC Sample Sites (1993)	Sites Included in Present Study
Main River	
Mersey at Liena	Y
Mersey at Union Bridge	Y
Mersey d/s Mole Creek	
Mersey at Dynans Bridge	Y
Mersey at Armistead (u/s Dasher)	
Mersey at Kimberley (u/s Coilers)	Y
Mersey at Kimberley (d/s Coilers)	
Mersey u/s Redwater Creek	Y
Mersey at Lovetts Flats	Y
Mersey at Latrobe (u/s Caroline Ck)	Y
Mersey d/s Caroline Ck (u/s Bonneys)	
Tributaries	
Mole Ck at Moles Creek	Y
Lobster Rivulet at Chudleigh	Y
Dasher River u/s Mersey	Y
Coilers Ck u/s Mersey	Y
Redwater Ck at Native Plains Rd	Y
Caroline Ck on Railton Rd	Y

Site locations are shown on Map 2.

Sampling by the IFC was carried out during summer flows in the period February to March 1993. A check of the hydrological record shows that the three sampling trips were carried out during stable low flows and therefore are a good record of low baseflow conditions in the river at that time. Table 3 (below) summarises the water quality data that was collected. Reference to this table will be made later when discussing the data collected during the present project, as both sets of data were collected during stable, low summer flows and are therefore very comparable.

MERSEY RIVER EXPERIMENTAL STUDY



MAP 2. Inland Fisheries Commission (1993)

Sampling locations ▲

TABLE 3.   Summary of data collected by IFC during low flows of 1993.

	AVERAGE CONCENTRATIONS				
SITE NAME	**Turbidity** (NTU)	**Conductivity** (µS/cm)	**Nitrate-N** (mg/L)	**Total P** (mg/L)	**Total N** (mg/L)
Mersey River					
Liena	0.47	170	0.126	0.010	0.251
Union Bridge	1.24	165	0.132	0.009	0.236
d/s Mole Ck	1.23	244	0.156	0.008	0.294
Dynans Bridge	3.70	204	0.178	0.017	0.313
u/s Dasher Rv	4.29	208	0.144	0.022	0.309
u/s Coilers Ck	4.10	188	0.165	0.019	0.303
d/s Coilers Ck	2.88	202	0.173	0.019	0.295
u/s Redwater Ck	5.45	200	0.175	0.020	0.330
Lovetts Flats	3.70	204	0.175	0.018	0.343
u/s Caroline Ck	3.71	205	0.163	0.016	0.313
d/s Caroline u/s Bonneys Ck	3.87	254	0.167	0.019	0.337
Tributaries					
Mole Ck at Moles Ck	1.32	224	0.464	0.012	0.597
Lobster Rvt at Chudleigh	7.89	127	0.175	0.050	0.425
Dasher River u/s Mersey	3.34	83	0.104	0.028	0.284
Coilers Ck u/s Mersey	7.09	565	0.993	0.074	1.330
Redwater Ck at Native Plains Rd	7.50	150	0.275	0.235	0.732
Caroline Ck on Railton Rd	3.05	353	0.164	0.011	0.331

Average concentrations from 3 sampling occasions.

Some of this data is displayed in Figures 6, 7 and 8 which show the change in turbidity, nitrate-N and phosphorus levels in the Mersey River during the IFC study. In all three figures, the most noteworthy feature is the increase in concentration of all parameters between Site 3 (d/s Mole Ck) and Site 4 (Dynans Bridge), a stretch of river into which the only major inflow is Lobster Rivulet.

The influence of Coilers and Redwater creeks on the quality of water in the Mersey is not apparent. While the quality of these creeks is degraded, inflows from these tributaries are significantly diluted by the higher volume of water in the Mersey during low flow periods.

1.3 Monitoring Riverine Health Initiative (MRHI)

More recently, water quality analyses were performed during ecological sampling in the Mersey catchment as part of the Monitoring Riverine Health Initiative (MRHI), a Federal Government program aimed at assessing rivers using aquatic invertebrates. Water samples were collected at 9 sites in the Mersey catchment during 2 surveys carried out in the spring of 1994 and the autumn of 1995 (Site locations are shown in Map 3). Table 4 gives a summary of all the combined water quality data collected at sites in the Mersey River and its tributaries. All data was collected during periods of stable base flows, although the sampling session of spring 1994 followed a wet period.

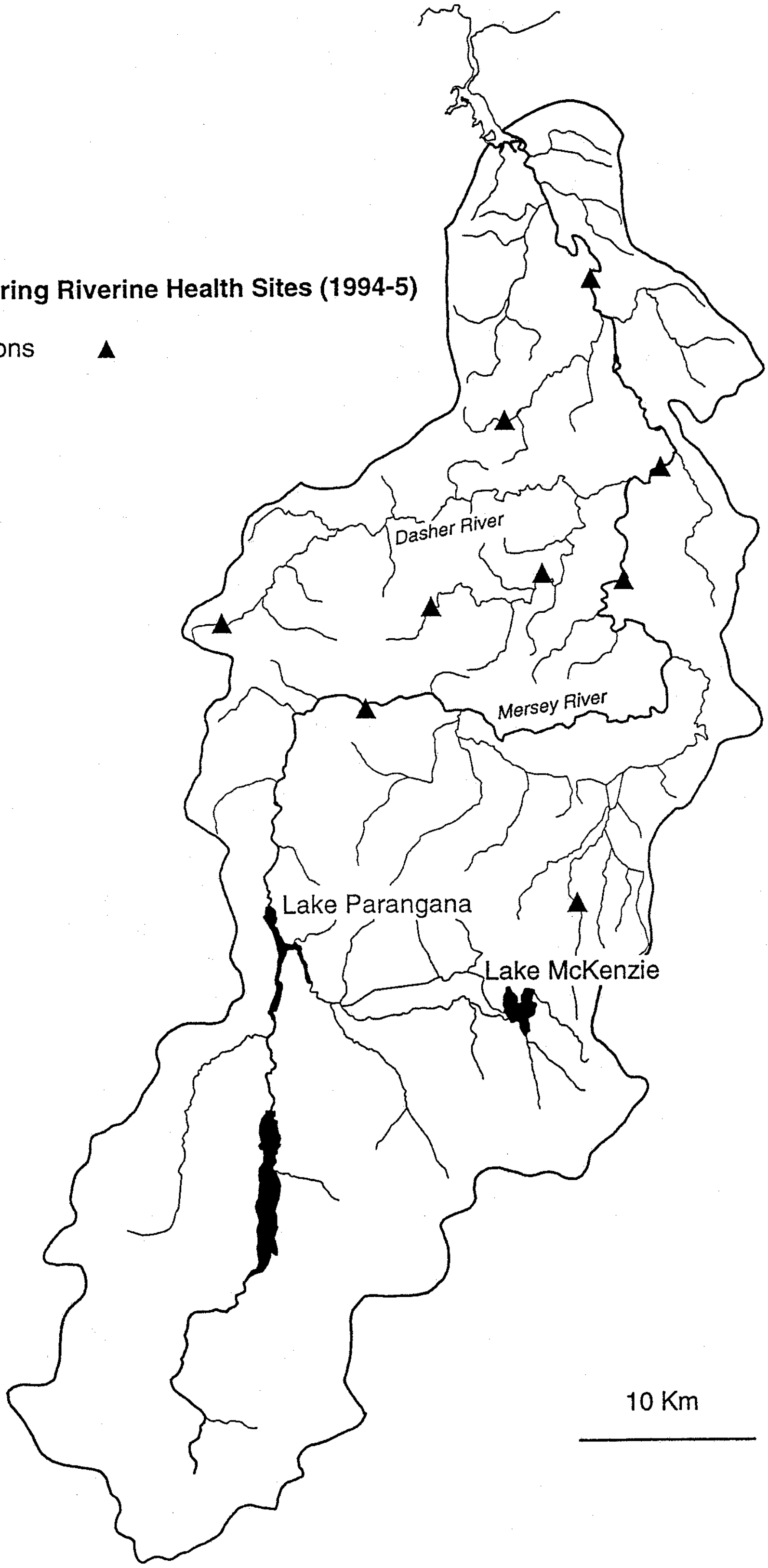
As each of the nine sites was only sampled twice, it is not appropriate to present statistics on the data. However some brief comments can be made:

- Turbidity, although generally low, was highest in the site on the Minnow River, despite this site being located high in the catchment.
- Most sites showed healthy levels of dissolved oxygen with the significant exception of the Lobster Rivulet site which had a low reading of 7.6 mg/L during the autumn 1995 survey.
- Highest dissolved nitrogen (NO_3 + NO_2) concentrations occurred in upper Redwater Creek, especially during the spring 1994 survey. This indicates that this stream may have naturally higher levels of dissolved nitrogen than other streams in the catchment.
- The highest phosphorus (Total P) concentration (0.029 mg/L) was measured in the Dasher River (at Claude Road) during autumn low flows. The next highest TP concentration was in the Mersey at Kimberley which is below the junction of the Dasher River and may be influenced by TP levels in that river.

MERSEY RIVER EXPERIMENTAL STUDY

MAP 3. Monitoring Riverine Health Sites (1994-5)

Sampling locations ▲



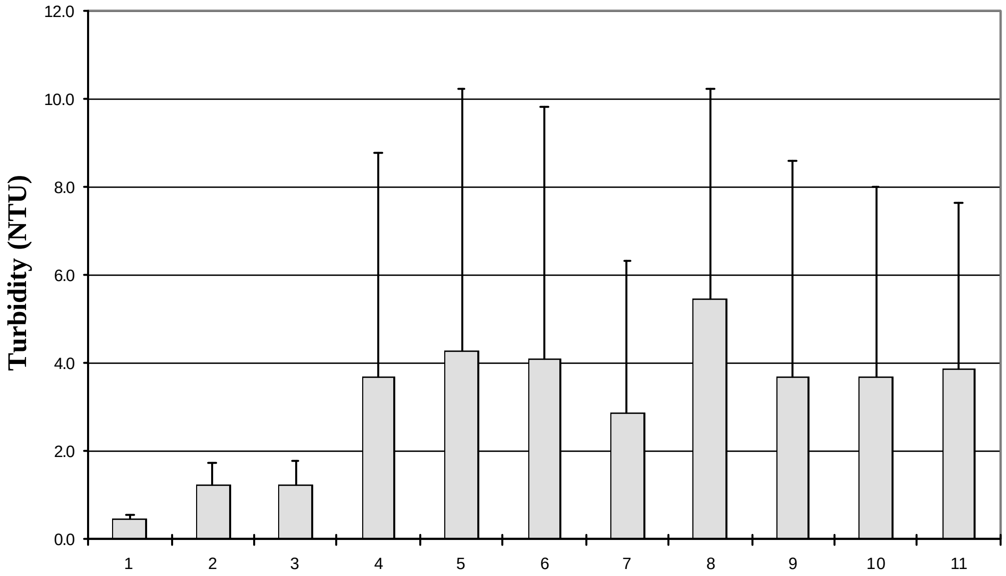


Figure 6 Mean (+ 2SE) turbidity at sites in the Mersey River during the summer - autumn of 1993 measured by the Inland Fisheries Commission. (Site legend on following page).

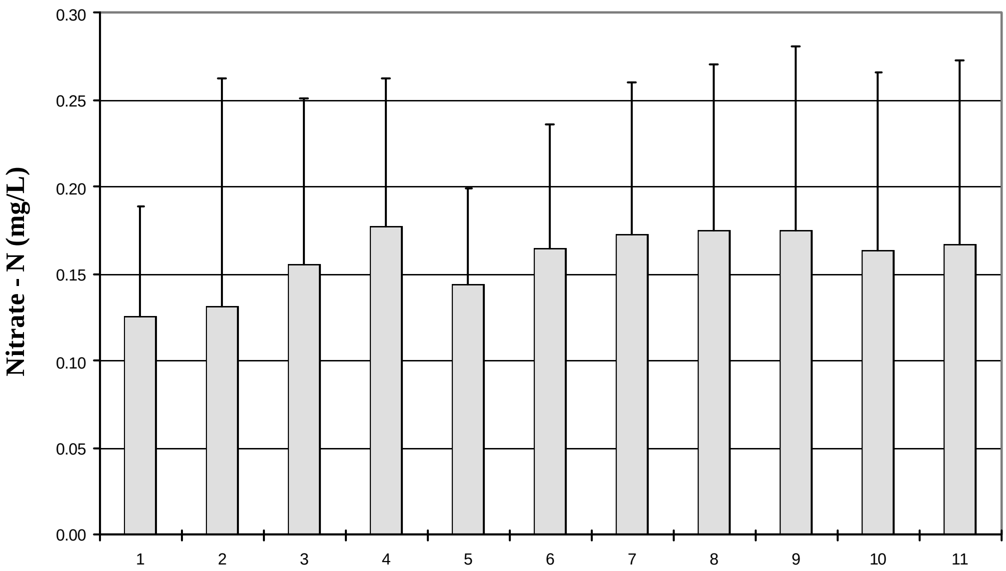
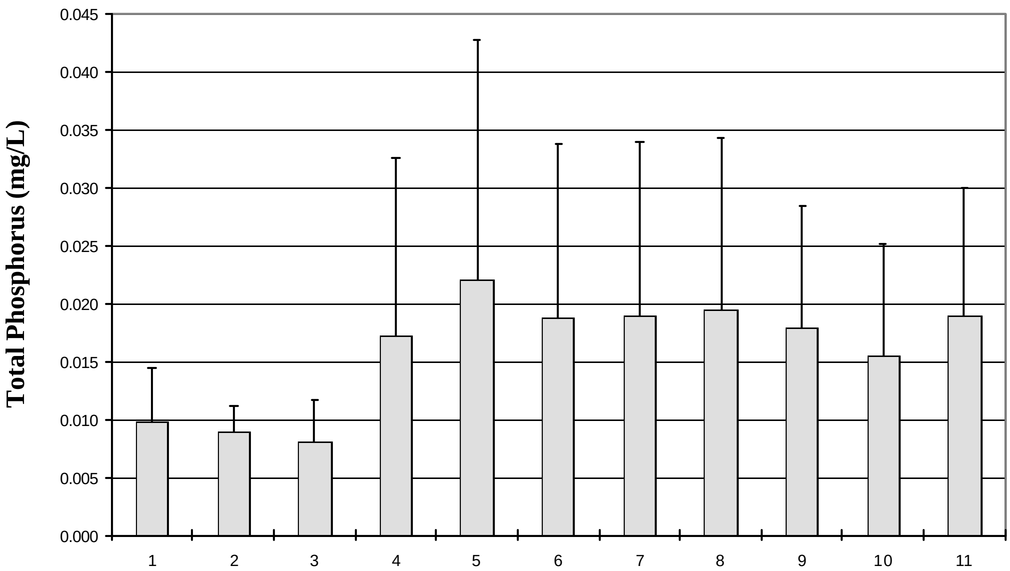


Figure 7 Mean (+2SE) nitrate - N concentrations at sites in the Mersey River during the summer - autumn of 1993 measured by the Inland Fisheries Commission.



LEGEND

1	Liena
2	Union Bridge
3	d/s Mole Ck
4	Dynans Bridge
5	u/s Dasher River
6	u/s Kimberley
7	d/s Coilers Ck
8	u/s Redwater Ck
9	at Lovetts Flats
10	u/s Caroline Ck
11	u/s Bonneys Ck

Figure 8 Mean (+2SE) phosphorus concentrations at sites in the Mersey River during the summer - autumn of 1993 measured by the Inland Fisheries Commission.

TABLE 4 Summary of data collected in the Mersey as part of the MRHI Program.

Parameter	Units	Count	Average	Median	Maximum	Minimum
Field EC @ 25	mS/cm	18	106	71	284	33
Turbidity	NTU	18	2.05	1.69	5.9	0.77
Dissolved Oxygen	mg/L	18	9.9	9.7	11.9	7.6
Temperature		18	12	12	16.5	7.5
NOx - N	mg/L	18	0.136	0.111	0.46	0.037
Ammonia - N	mg/L	15	0.011	0.008	0.066	0.002
Total N	mg/L	18	0.293	0.211	0.814	0.092
Phosphate -P	mg/L	18	< 0.002	< 0.002	< 0.002	< 0.002
Total P	mg/L	18	0.011	0.008	0.029	0.002
Flouride	mg/L	18	< 0.1	< 0.1	< 0.1	< 0.1
Chloride	mg/L	18	6.7	6	12	3
Sulphate	mg/L	18	3.3	4	6	0.6
Alkalinity as $CaCO_3$	mg/L	18	68	39	260	3
Total SS	mg/L	18	3.1	3	6	1
Calcium	mg/L	18	12.7	2.61	57.8	0.52
Magnesium	mg/L	18	2.44	1.94	5.92	0.28
Sodium	mg/L	18	4.87	4.36	8.54	2.08
Potassium	mg/L	18	0.57	0.49	1.53	0.17
Cadmium	mg/L	18	All samples less than 0.001			
Copper	mg/L	18	All samples less than 0.001			
Lead	mg/L	18	All samples less than 0.001			
Zinc	mg/L	18	All samples less than 0.005			

The only other major highlight of this data is that alkalinity is highest in the Mersey River during both surveys and is due to higher calcium levels, reflecting the influence of the limestone geology of the Mole Creek area. Most of the other ions were only found at very low levels. The most dilute waters were those in the Minnow River (u/s Lower Beulah) and upper Redwater Creek (TABLE 5).

TABLE 5. Alkalinity at the nine Mersey sites sampled by the MRHI Program

	ALKALINITY	
Site Name	Spring 1994 (wet)	Autumn 1995 (dry)
Minnow u/s Lower Beulah	3	15
Minnow at Lower Beulah Rd	17	45
Upper Lobster Rivulet	18	34
Mersey u/s Union Bridge	14	75
Mersey at Dynans Bridge	56	260
Mersey u/s Kimberley	48	252
Mersey at Lovetts Flats	71	241
Dasher at Claude Rd	16	44
Upper Redwater Creek	3	10

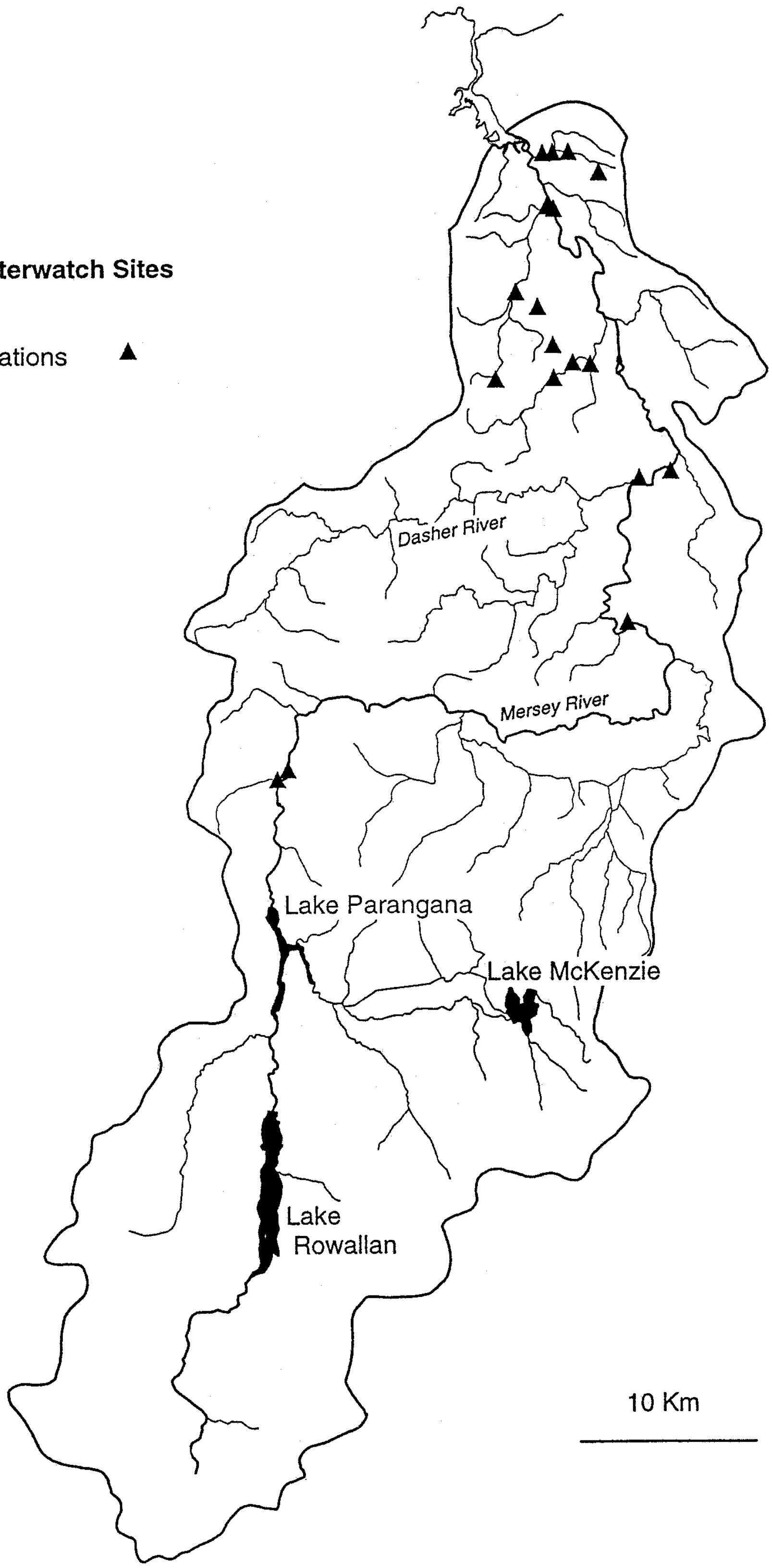
1.4 Waterwatch

Some intermittent Waterwatch data has been collected at several sites throughout the catchment with the large majority of data being collected at sites in and around Latrobe (Refer Map 4). A summary of the data is shown below in Table 6 and at first glance it would appear that nutrient levels at many sites are quite high. Although quality assurance and control procedures are carried out by Waterwatch, some care needs to be taken when interpreting the data. In the measurement of both Nitrate-N (NO_3-N) and orthophosphorus-P (Ortho-P) most of the readings are at or below the lower limit of detection for the kits being used (colour comparator kits which rely on visual colour development). For both NO_3-N and Ortho-P, the measurement techniques employed for analysis are not sufficiently sensitive for the measurement of the naturally low concentrations found in Tasmanian waters.

MERSEY RIVER EXPERIMENTAL STUDY

MAP 4. Waterwatch Sites

Sampling locations ▲



However, when viewed in relative terms, the data suggests that nutrient enrichment occurs at Redwater, Coilers and Kings creeks as well as the Mersey River in the vicinity of Latrobe. High average ortho-phosphorus concentrations are shown in the Mersey above and below Kings Creek. Ortho-P is usually a minor component of Total Phosphorus in water and high values usually indicate organic pollution. The very high average concentrations in the Mersey at these sites may be due to tidal influences in the area, which could be carrying phosphorus rich water upstream from the sewage treatment plant which discharges into the Mersey estuary at Merseylea.

Another interesting result is the low average for dissolved oxygen in the Mersey River upstream of Kings Creek. The data at this site showed levels as low as 3 mg/L, a concentration at which fish cannot survive.

Finally, the data for turbidity shows that levels at sites around Latrobe are very high. The equipment used by Waterwatch to measure turbidity is not sensitive at levels below about 10 NTU, but is useful in identifying areas where there are significant increases in turbidity. The data clearly show that Redwater Creek, Kings Creek and the Mersey River below Kings Creek all have much higher turbidity levels than sites elsewhere in the catchment.

TABLE 6. Summary of data collected by Five Rivers Waterwatch group.

Site Name	**Site Code**	**Samples (n)**	**pH**	**Turb**	**EC**	**DO**	**NO3-N**	**Ortho-P.**
				AVERAGE OF READINGS				
Caroline Creek at Railton Rd	CAR090	2	7.15	20	195			
Mersey at Liena	MER010	2	8.3	12	140	9.5	n.d.#	n.d.
Mersey at Hayward's property	MER040	3	7.15	< 7	230	11	1.05	0.015
Mersey at White Rock swimming hole	MER050	3	6.6	< 7		10.3	1	0.015
Mersey / Shale Rd near Farrell Park	MER065	7	6.4	16	165	9.2	0.8	0.02
Mersey above Caroline Creek	MER070	18	8.16	10	108	9.9	1.1	< 0.015
Mersey below Caroline Creek	MER075	22	7.2	19	161	9.9	1.4	< 0.015
Mersey above Kings Creek	MER080	5	7.55	12		6	1	0.04
Mersey below Kings Creek	MER085	9	7.3	26	280	10.4	1	0.03
Redwater Creek	RED030-050	3	5.5	26	77	10.3	2.3	0.02
Coilers Creek at Kimberly Bridge	COI090	3	7.3	8		11	2	0.025
Kings Creek at old foot bridge	KIN050	15	6.1	47	308		1.1	0.05
Kings Creek at weir	KIN060	13	5.9	38	297		1	0.025

Nitrate-N detection limit of 1 mg/L
Ortho - Phosphate - detection limit of 0.015 mg/L

\# n.d. - not detected.

In summary, while some the nutrient data may lack sensitivity, it appears to show areas of relative water quality degradation. Many of these sites also have higher turbidity compared to levels elsewhere in the catchment, which supports this conclusion.

1.5 Latrobe Council

Water quality data on ambient water quality of rivers in the catchment is not currently collected by the Latrobe Council. However, Council does currently monitor the quality of water leaving sewerage treatment lagoons at Railton and Sheffield. Both these plants discharge treated effluent into the Mersey system, the former to Redwater Creek and the latter into a tributary of the Dasher River. Unfortunately no accurate data is available on the volumes discharged so no estimates of the actual loading to the streams can be made. Data summaries of water quality leaving these plants is presented in Appendix 2.

The main feature of the data are the high nutrient levels in water leaving the treatment ponds. Medians of the common parameters are given in Table 7 below.

TABLE 7. Characteristics of effluent discharged from the Sheffield and Railton sewage treatment plants.

	Conductivity (µS/cm)	**Total SS** (mg/L)	**Phosphorus** (mg/L)	**Nitrogen** (mg/L)	**Nitrate-N** (mg/L)
Sheffield	257	42	1.77	7.16	0.118
Railton	415	2	2.82	8.84	0.28

Conductivity of the effluent from both plants is higher than levels in their respective receiving waters (compare with conductivity of Dasher River and Redwater Creek in Table 3). The treatment plant at Sheffield also discharges much higher concentrations of suspended solids than the plant at Railton, which is essentially clear water. The effluent from both plants is very nutrient enriched, especially in terms of nitrogen. Comparing the Total Nitrogen concentration with Nitrate-N, it is clear that most of the nitrogen leaving the ponds is either bound up in organic matter and other particulates or is in the form of ammonia. The concentration of phosphorus in effluent water is also high, and it is quite likely that effluent from both plants is having some effect on the water quality of their respective receiving waters.

2 WATER QUALITY MONITORING DURING THE PRESENT STUDY

An outline of the sampling strategy proposed during early planning of the Mersey River Experimental Study is presented in a document compiled by the Mersey River Working Group ('Proposal for Experimental Studies, Mersey River') in October, 1996. In section 4.5 of that document, it was proposed that a broad overview of the current water quality ('condition') of rivers of the Mersey Catchment was required and that three 'snapshot' surveys would provide sufficient data to enable this and identify major problem areas. These 'snapshot' surveys were carried out during periods of stable low flow in October 1996, and January and March of 1997. The rationale for this type of sampling is that as long as hydrological conditions during each period of sampling (i.e. each catchment survey) remain stable, sampling will reveal baseline conditions across the catchment and no single tributary will be disproportionately represented.

Each of the surveys were to be carried out over a four-day period, sampling a total of 41 sites. Map 5 shows the locations of all sites visited during the present study (site co-ordinates are given in Appendix 3). At all sites field measurements of physico-chemical parameters were made. These included pH, temperature, electrical conductivity, turbidity and dissolved oxygen. At seventeen of these sites water samples were to be taken for analysis of the chemical and biological parameters listed below.

TABLE 8. Parameters measured during the present study.

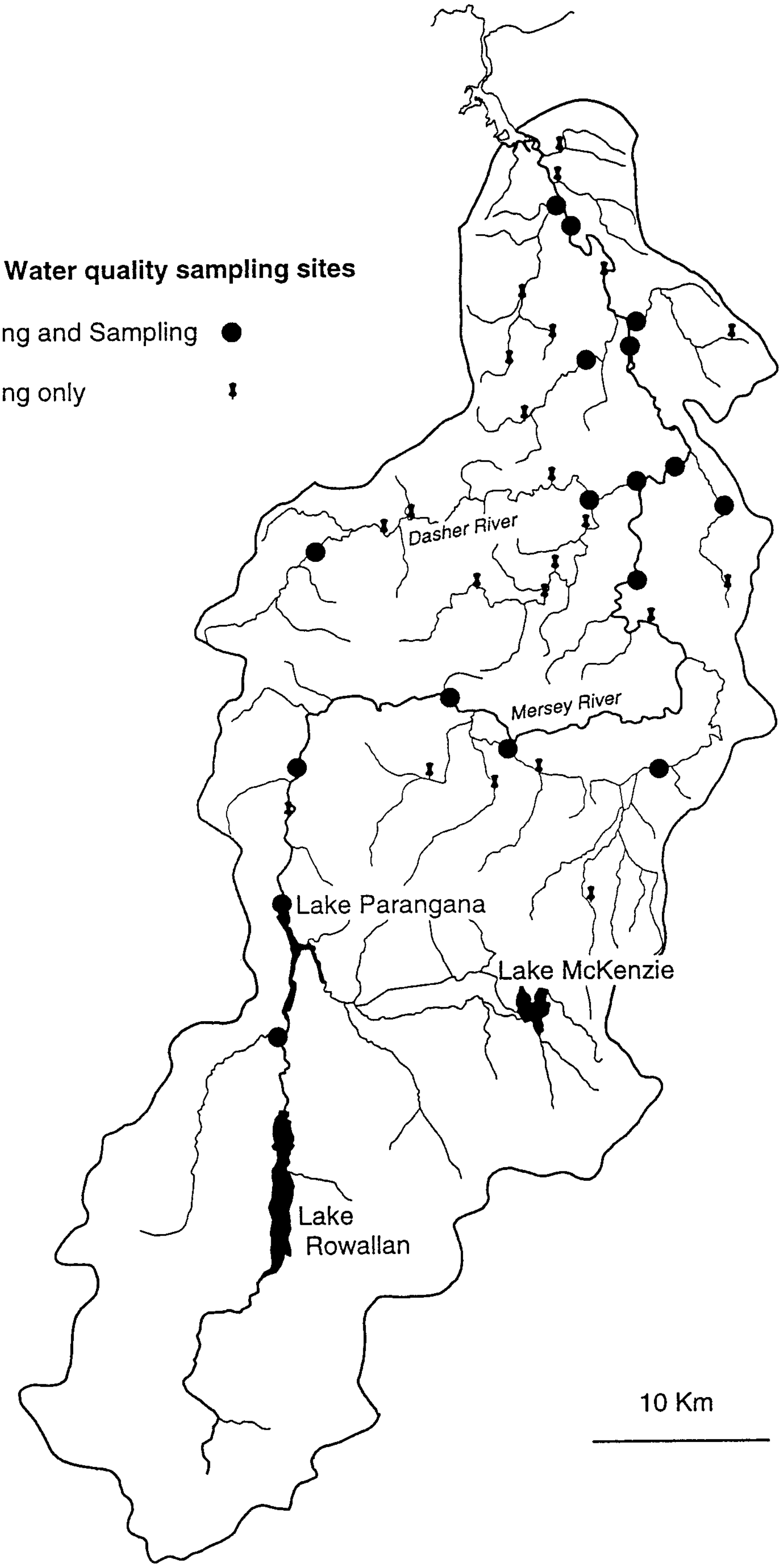
Parameter	Units
Nutrients	
Ammonia - N	mg/L
Total Keldahl Nitrogen	mg/L
Nitrate - N	mg/L
Nitrite - N	mg/L
Dissolved Reactive Phosphorus	mg/L
Total Phosphorus	mg/L
Dissolved Ions	
Lab pH	
Lab Conductivity	µS/cm
Apparent Colour	Hazen Units
Total Dissolved Solids	mg/L
Total Suspended Solids	mg/L
Hardness (as $CaCO_3$)	mg/L
Total Alkalinity	mg/L
Chloride	mg/L
Sulphate	mg/L
Iron	mg/L
Manganese	mg/L
Calcium	mg/L
Magnesium	mg/L
Potassium	mg/L
Sodium	mg/L
Silica	mg/L
Microbiology	
Colony Count (@ 36 ^{o}C)	/100 mL
Colony Count (@ 20 ^{o}C)	/100 mL
Total Coliforms	/100 mL
E. coli colony count	/100 mL
Faecal Streptococci	/100 mL

MERSEY RIVER EXPERIMENTAL STUDY

MAP 5. Water quality sampling sites

Field testing and Sampling ●

Field testing only



Sites where samples were collected were chosen on the basis of both historical data and location with respect to tributary inflows. Many of the sites coincide with sites chosen for sampling by the Inland Fisheries Commission study discussed earlier.

Although this plan was generally adhered to, not all sites were visited during the survey of January ‘97 due to the occurrence of rain on the third day of sampling. This precluded continuation of sampling, as sites visited after the rain event would have appeared more degraded due to the higher flows. As a result some sites were only visited twice during the study.

For ease of presentation and discussion, data from the three catchment surveys have been combined and averages calculated so that data could then be used to generate spatial plots showing areas where relative water quality degradation occurs. In addition, graphs showing changes in water quality down the length of the Mersey River are also presented. These should highlight any major changes in water quality which may occur as a result of tributary inflows.

Also included in the study were a series of specific monitoring events at various sites in the catchment which aimed to collect detailed information on changes in dissolved oxygen levels over 24 to 48 hour periods. Such information is important in determining site condition, as dissolved oxygen is known to reach lowest concentrations during hours of darkness and it is these low levels which are critical to the survival of aquatic organisms. Hydrolab remote data loggers were deployed to collect this information at several sites in the catchment at various times during the summer.

Finally, permanent monitoring stations were set up in the Mersey River both prior to and during the study. Data was collected on water temperature, conductivity and turbidity at three sites; Liena, Kimberley and Latrobe. The site at Latrobe was established prior to the commencement of the study by the DPIF and the other two sites were set up during the study by the HEC. While not of sufficient length for rigorous analysis, data from these sites will be briefly reported.

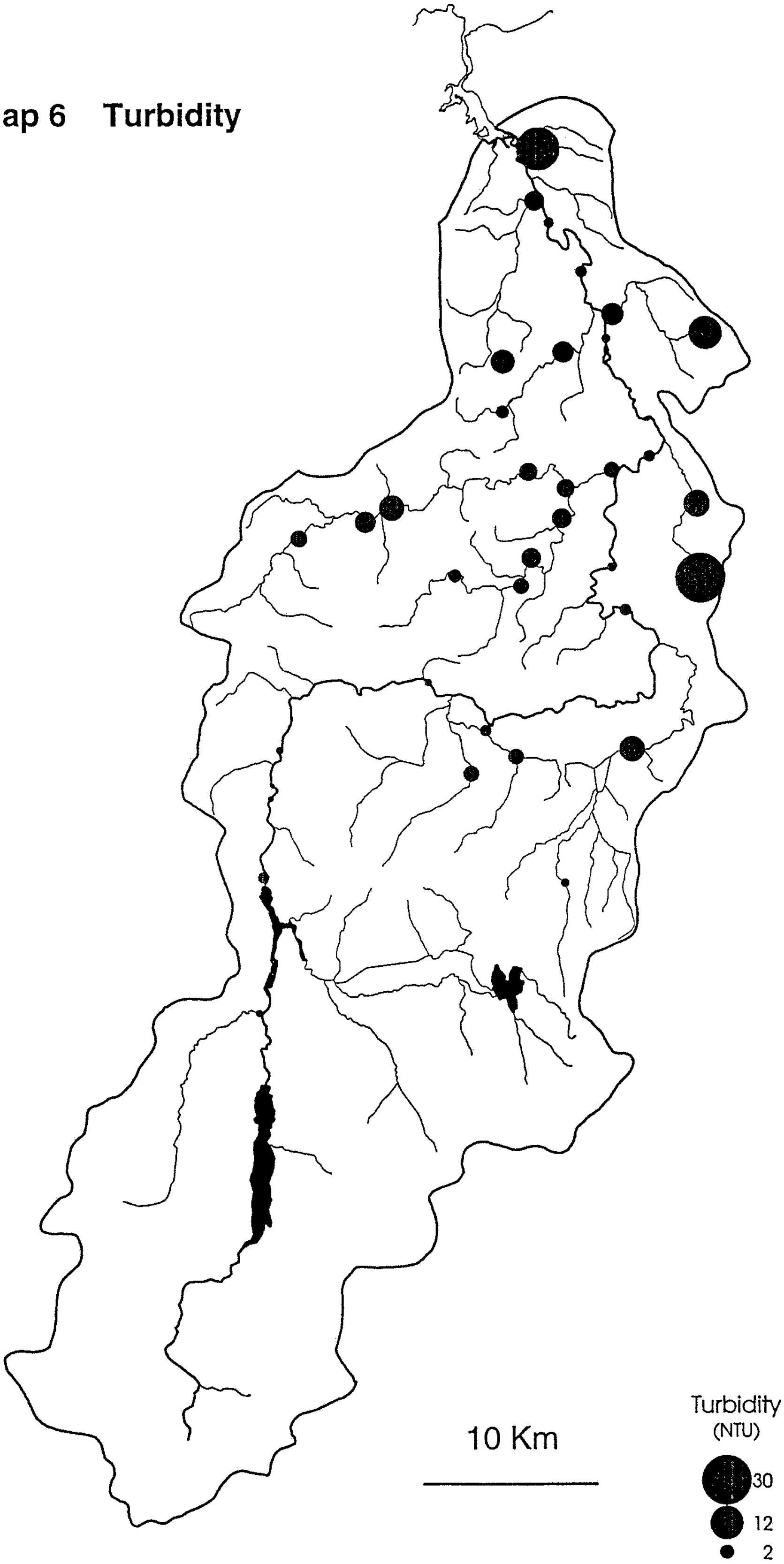
2.1 Catchment Surveys

2.1.1 Physical

Data collected during the surveys is most easily presented as overlays on maps of the Mersey catchment. In the following maps, the size of dots is proportional to the concentration of the parameter measured at that site. This method shows most clearly the sites where water quality is most degraded.

Turbidity levels, as presented in Map 6, are lowest in the Mersey River, with only a very small increase towards the river mouth due to tributary inflows. Highest turbidity was measured in upper Coilers Creek, a site located downstream of a major dairy. Lower in the catchment, elevated turbidity was also recorded at Parramatta and Kings creeks reflecting the intensive nature of activities in both these sub-catchments. It is also noteworthy that turbidity is fairly consistent throughout the Minnow and Dasher sub-catchment, although the site in the Dasher at Claude Road was slightly higher, probably due to cattle access to the river directly upstream.

Map 6 Turbidity



Conductivity (Map 7) shows a slightly different pattern. Highest conductivity is evident in Coilers Creek (500 - 600 µS/cm) and Parramatta Creek (450 µS/cm), on the eastern side of the catchment. Other tributaries with elevated conductivity levels are Caroline Creek and Mole Creek, both of which are influence by groudwater inputs from limestone in the area. The only other site showing elevated conductivity was Kings Creek in Latrobe (350 µS/cm) where water quality is generally degraded (see other parameters). It should be noted that all these levels are within Class 1 & 2 for irrigation water (ANZECC, 1992) which are termed low to moderate salinity.

Dissolved oxygen, which is an indicator of riverine health, was found to be good throughout most the catchment, with levels between 9 and 11 mg/L commonly recorded . However, several sites were found to show unusually high or low values relative to the rest of the catchment. Dissolved oxygen concentrations of 7 mg/L or less were recorded at Kings, Caroline, Coilers and Parramatta creeks. At Coilers Creek, concentrations in excess of 14 mg/L were also measured. The diurnal fluctuation of dissolved oxygen at this site is discussed later in Section 2.3.

2.1.2 Microbiological

E. coli (Map 8) concentrations across the catchment are much more varied, with sites of high counts much more apparent. The three most degraded sites were Lobster Rivulet at Chudleigh, Coilers Creek, and the Dasher River at Claude Road. All three sites are located in areas where there is intensive cattle or dairy farming, the latter two being sites directly downstream of cattle access to streams. Other sites of high *E. coli* levels are at Mole, Redwater and Caroline creeks. ANZECC (1992) guidelines for primary contact (bathing, swimming and other activities involving direct water contact) in freshwater are 150 coliforms per 100 mL. Of the 18 sites sampled, 6 exceed this guideline value.

Unlike *E. coli*, sampling for Faecal Streptococci in river waters gives some indication of whether there is longer term contamination of the stream, as these bacteria can survive for longer periods following input to streams. Streptococci levels at sites throughout the catchment (shown in Map 9) is quite different to that for *E. coli*. The most significant difference was found in the Mersey River at Liena and Union Bridge, where very high streptococci counts occurred while *E. coli* counts were relatively low. This tends to indicate that while there appeared to be relatively little pollution at the time of sampling, there was evidence of longer term faecal pollution at these sites.

2.1.3 Nutrients

Maps 10, 11 and 12 show the variation in concentration of Nitrate Nitrogen (NO_3-N), Total Nitrogen (TN) and Total Phosphorus (TP) across the Mersey catchment. Guideline concentrations for NO_3-N are not given by ANZECC (1992), but guidelines for TN and TP are given for maintaining aquatic ecosystem health. For TP, concentrations at which algal blooms are known to occur are 0.01 - 0.1 mg/L, while for TN it is 0.1 - 0.75 mg/L. However, it is strongly recommended that guideline concentrations should only be set after site specific studies.

In waterways of the Mersey catchment there is a wide variation in the concentration of NO_3-N. Eleven of the 18 sites sampled showed average concentrations below 0.2 mg/L. Sites where relatively high levels occurred (> 0.4 mg/L) are easily seen in Map 10 at Mole Creek and Sassafras Creek in the upper catchment, and at Coilers, Redwater and Parramatta creeks in the lower catchment.

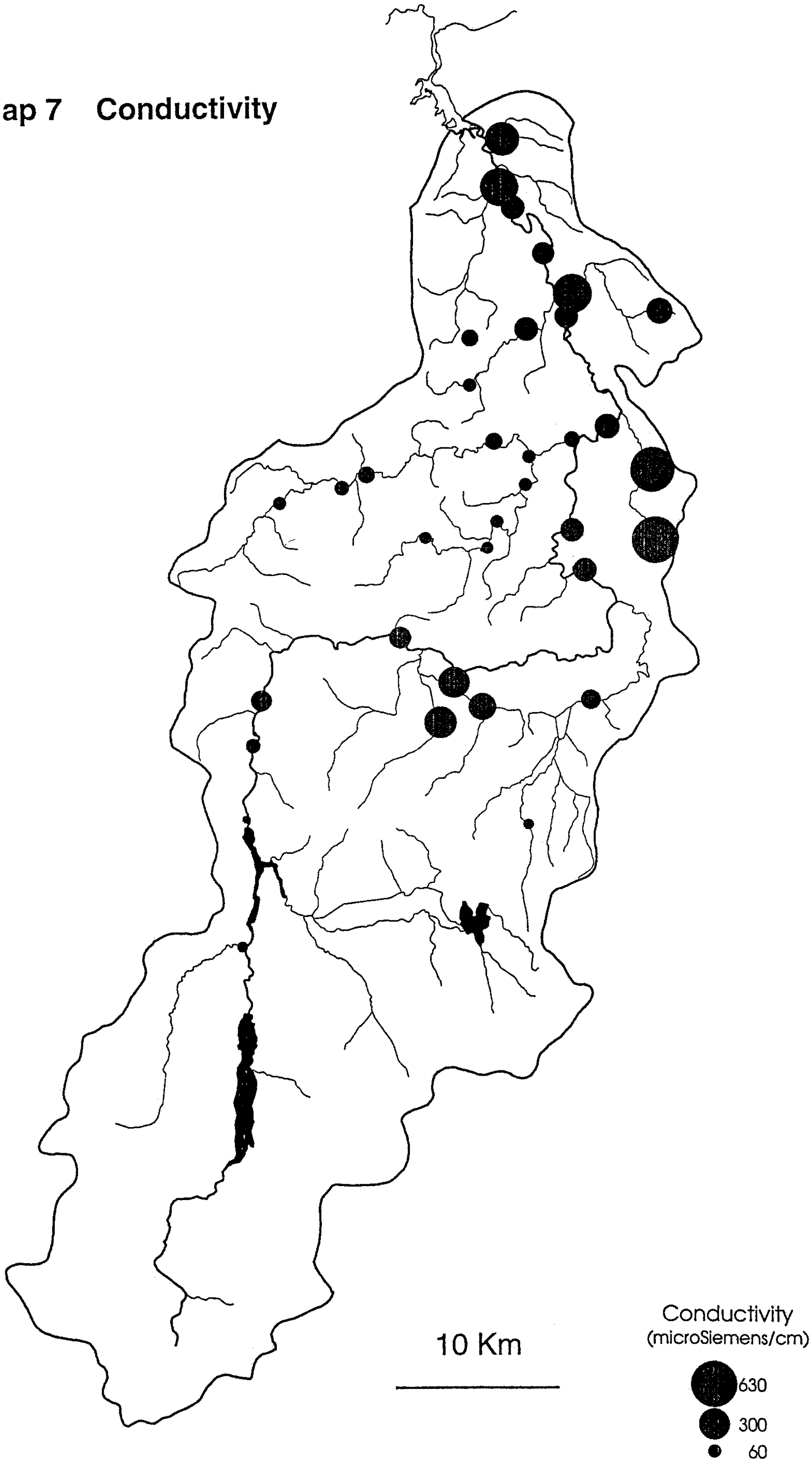
The pattern for TN (Map 11) is similar to that for NO_3-N, however concentrations are much higher due to the added organic nitrogen component. Average TN concentrations above the upper guideline value of 0.75 mg/L set by ANZECC (1992), occur at 4 of the 5 sites mentioned above. These sites showed TN concentrations well above 1 mg/L, the highest being 1.8 mg/L at Coilers Creek. Map 12 shows that an excessive amount of TP is also present at Coilers, Redwater and Parramatta creeks which suggests that these sites are the most nutrient enriched in the catchment and could be expected to be most prone to blooms of algae. The wastewater effluent from sewage treatment ponds in Railton discharges into Redwater Creek and is most likely the reason for the very high average concentration of 0.26 mg/L of TP measured in that stream (See also Section 1.2).

In the Mersey River itself, nutrient concentrations are relatively low, with TP less than 0.01 mg/L and TN less than 0.4 mg/L. While most of the major nutrients are at higher levels lower in the river, there is no obvious pattern to this change down the length of the river.

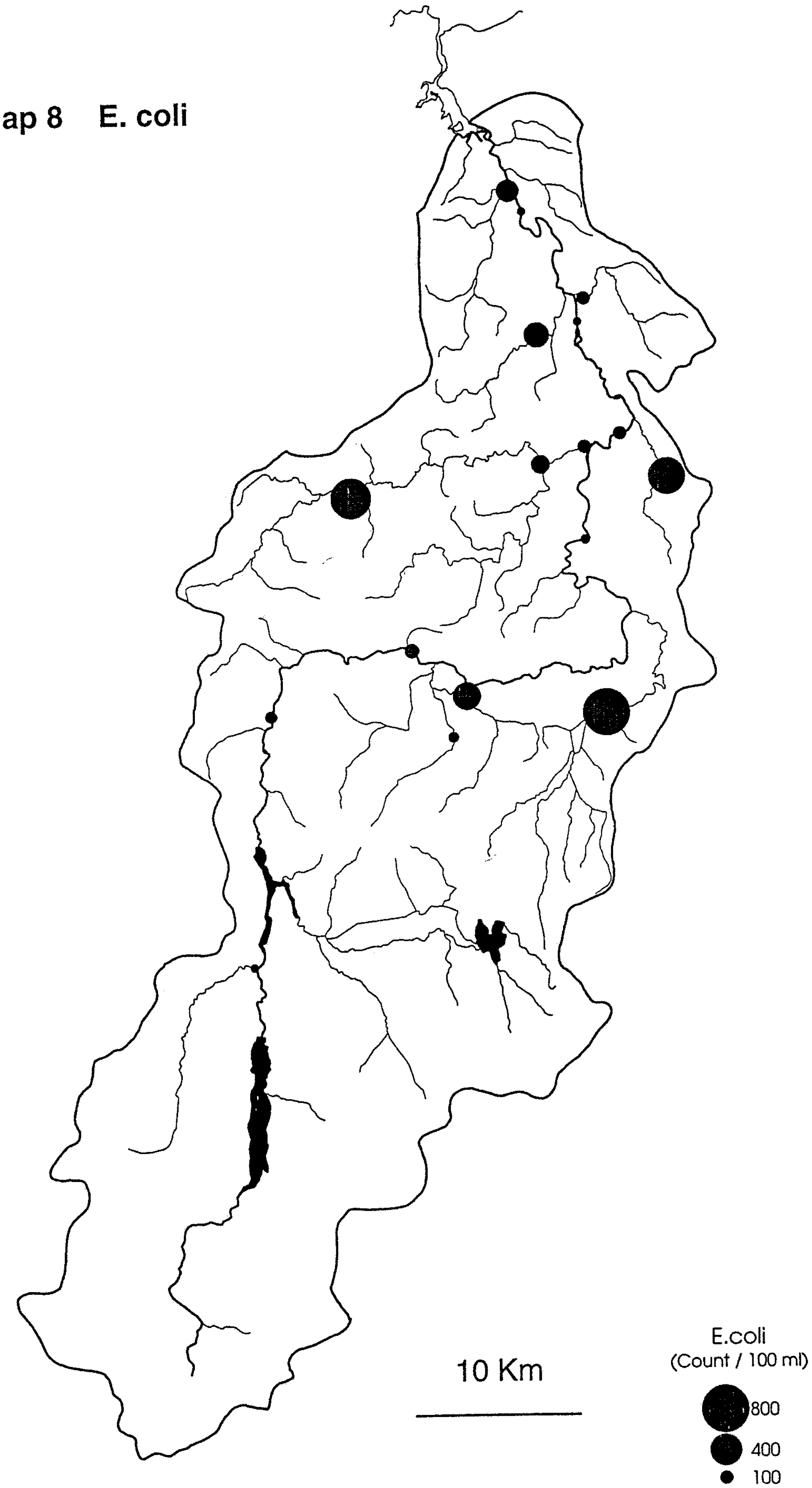
2.1.4 Ionic

A brief mention of the ionic character of waters of the Mersey catchment is useful in demonstrating the influence of the limestone geology of parts of the catchment on the rivers and streams. Map 13 and 14 show the concentrations of alkalinity and total calcium respectively. Alkalinity is a measurement of levels of carbonate and bicarbonate in the water, both of which affect the capacity of water to precipitate soap. The main point of these plots is to show that sites of high alkalinity are largely a result of high calcium concentrations (as calcium carbonate) in waters originating from limestone regions of the catchment. This is particularly evident in the sites near Mole Creek and lower in the catchment at Caroline Creek.

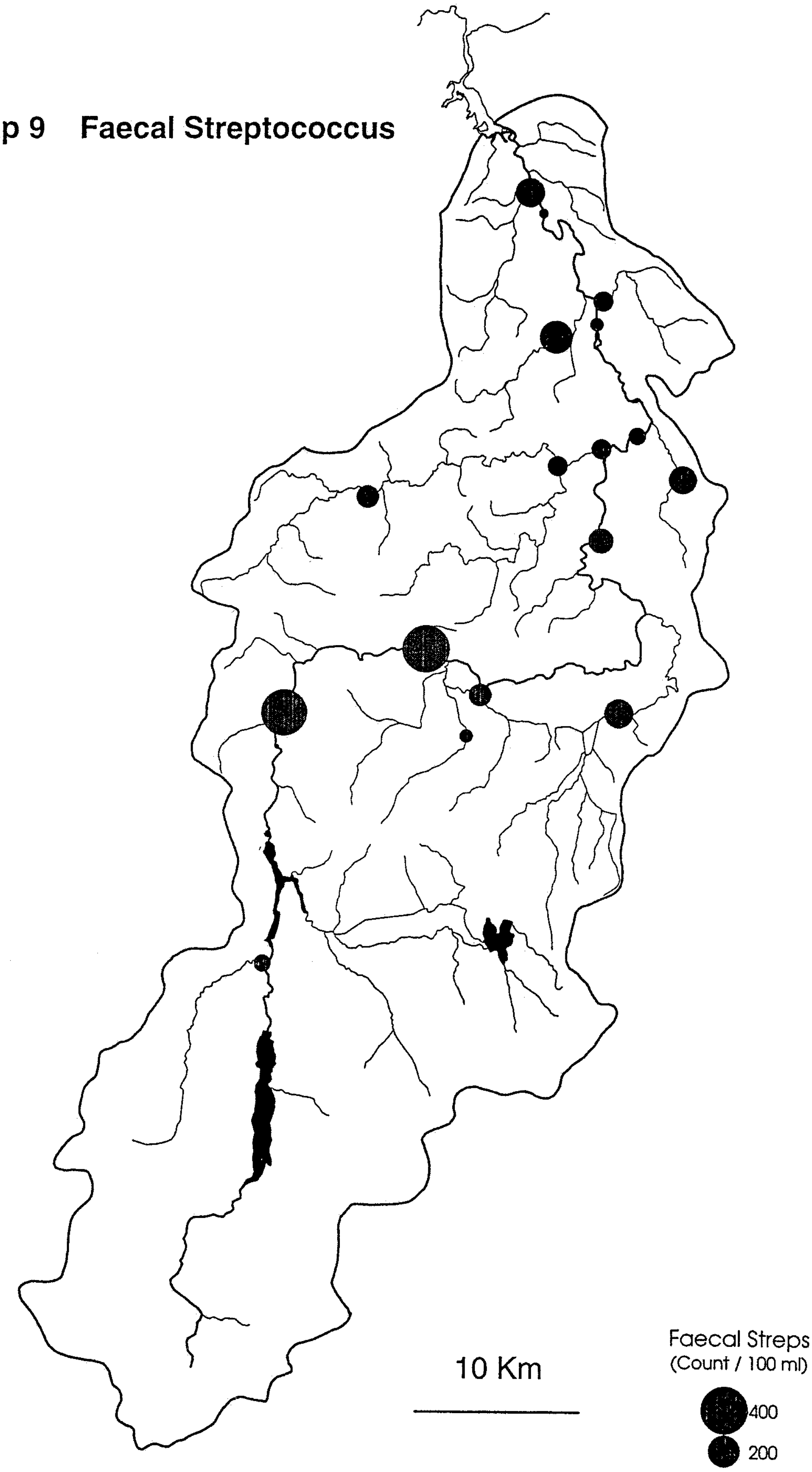
Map 7 Conductivity



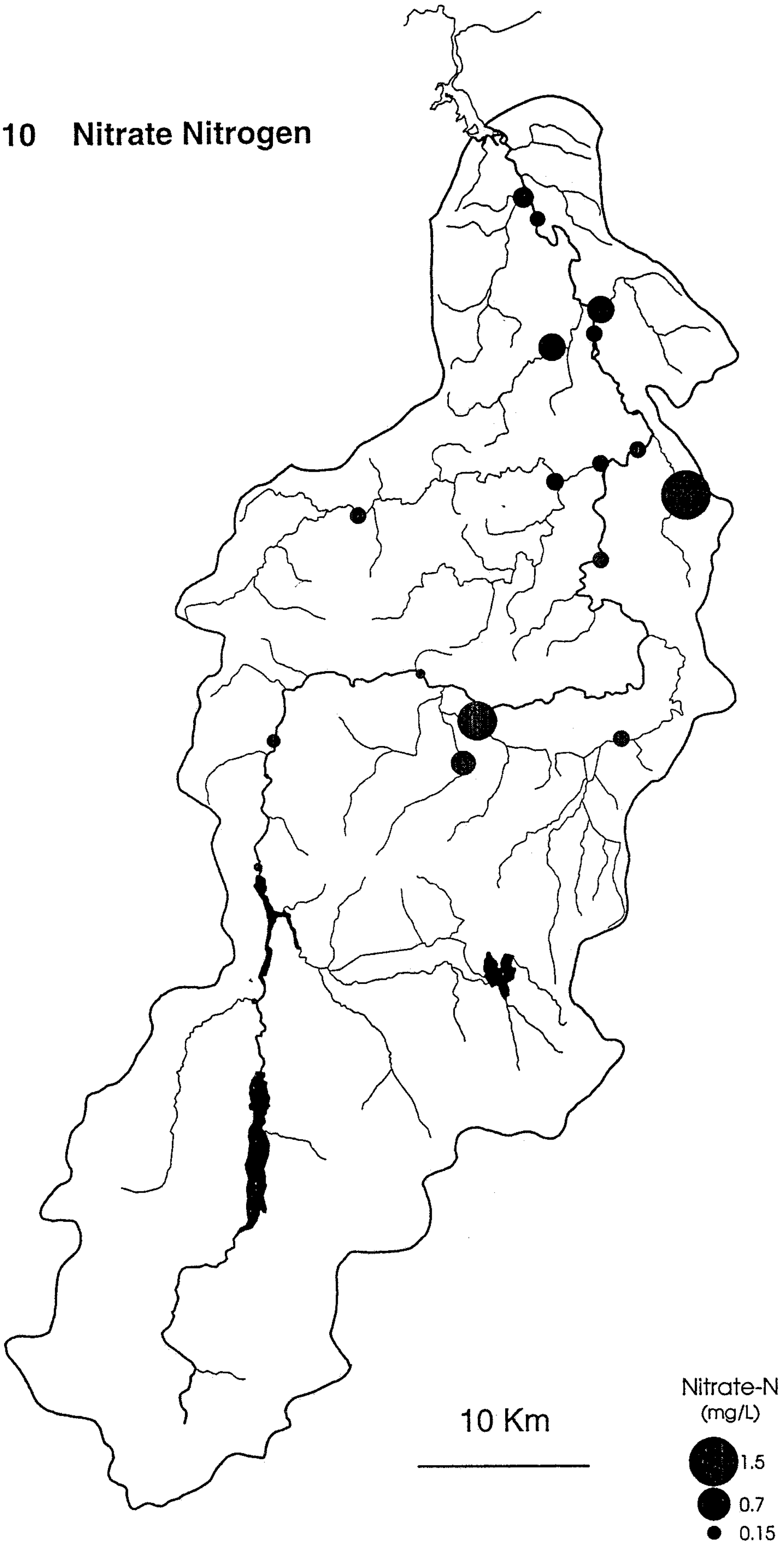
Map 8 E. coli



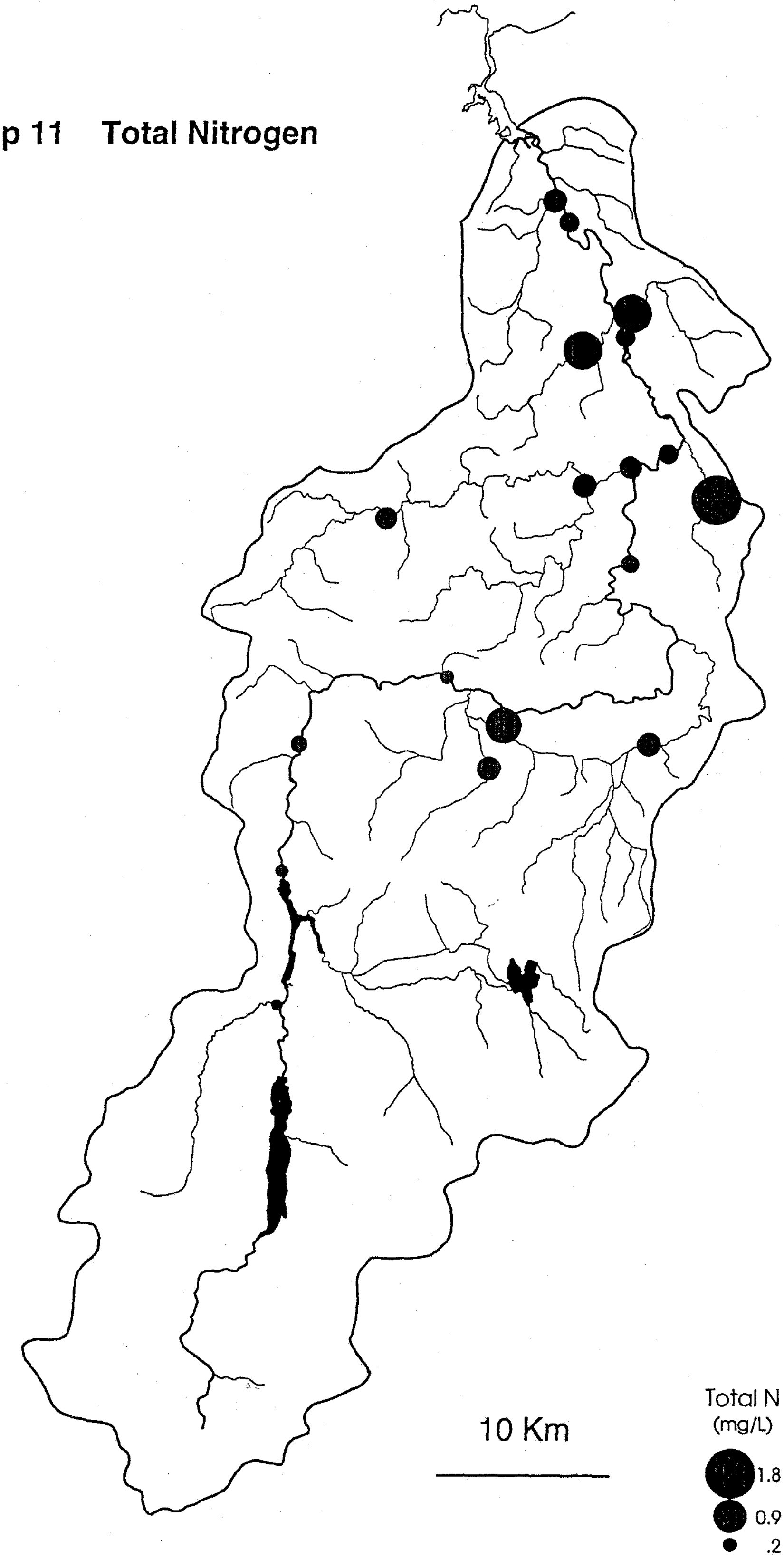
Map 9 Faecal Streptococcus

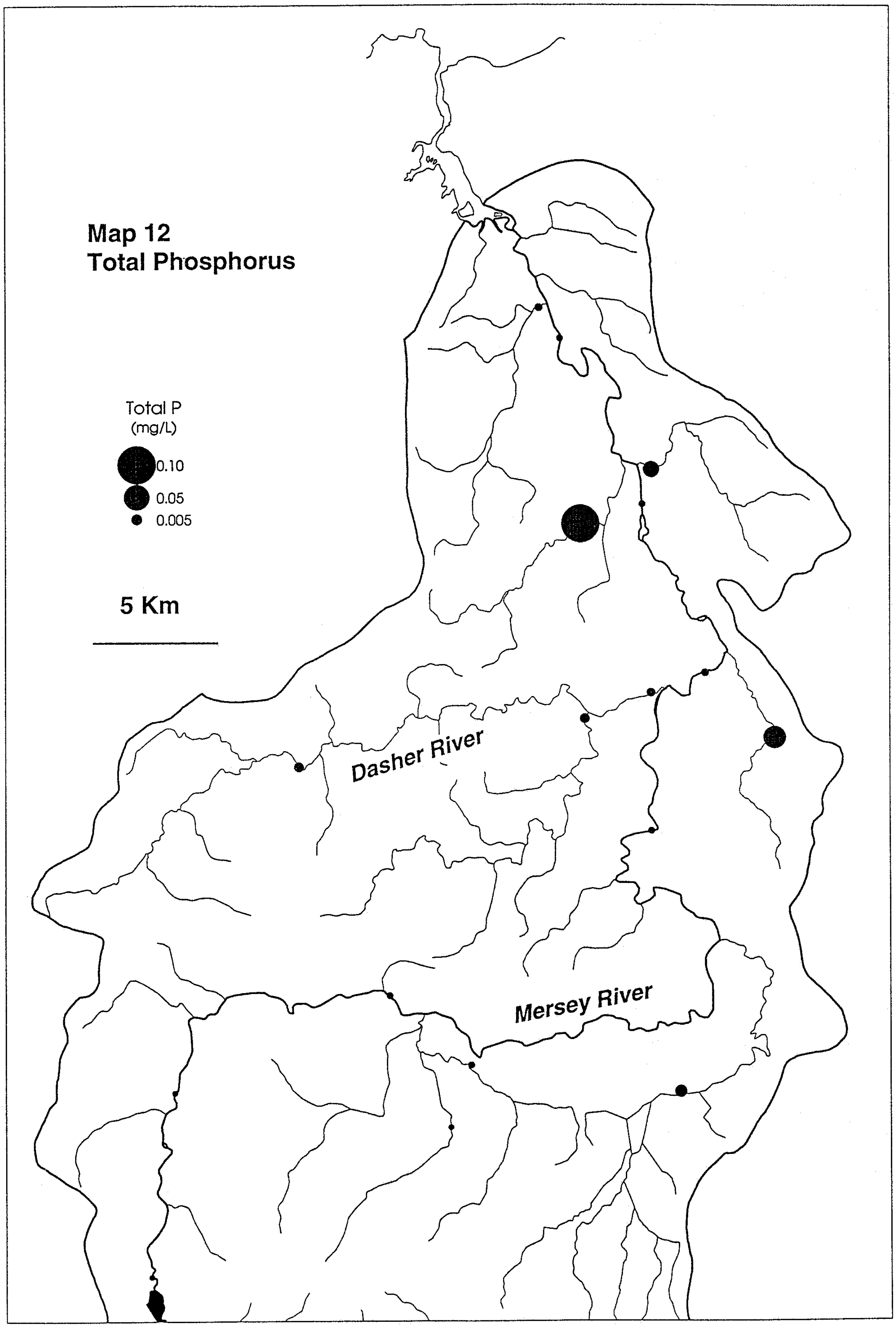


Map 10 Nitrate Nitrogen

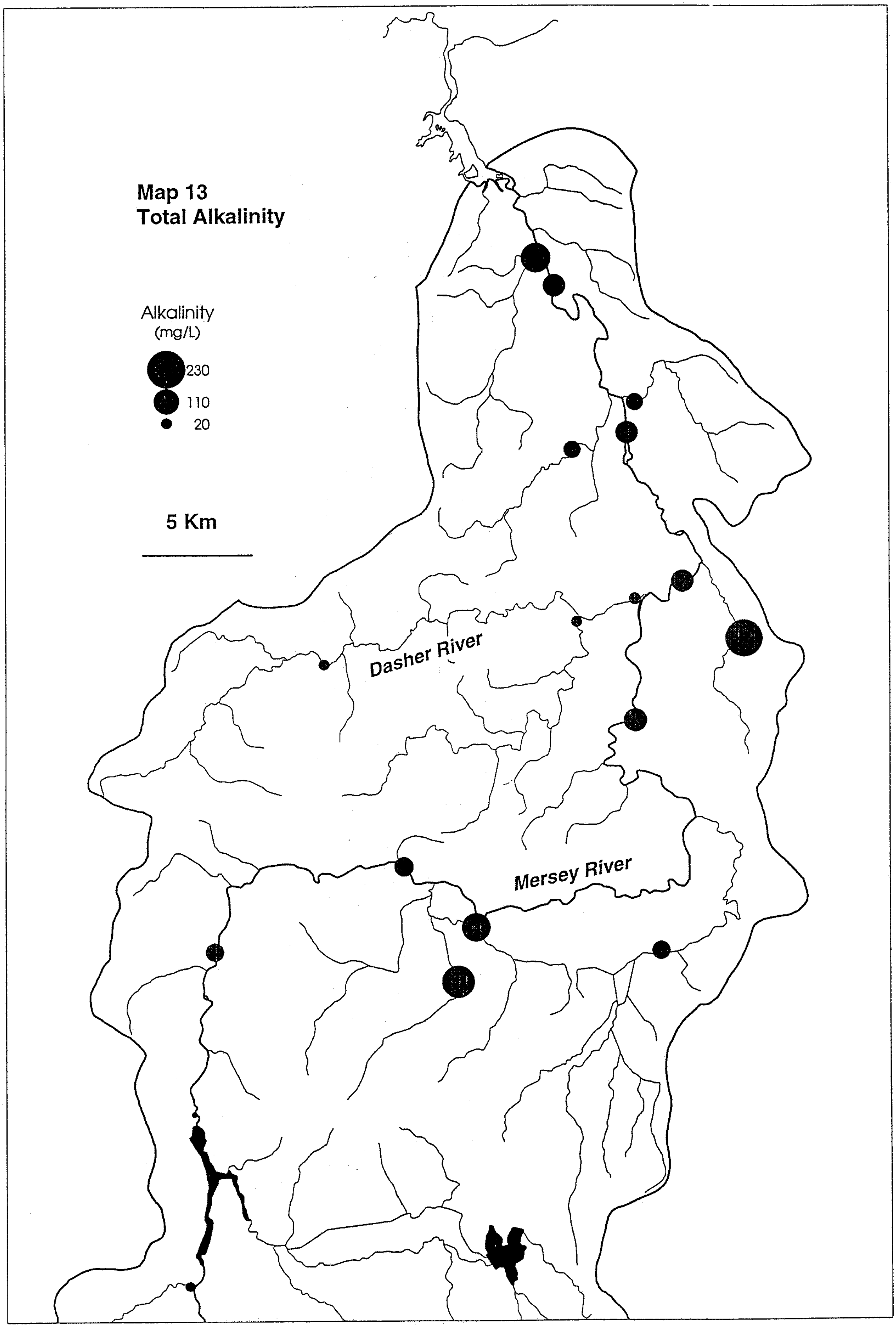


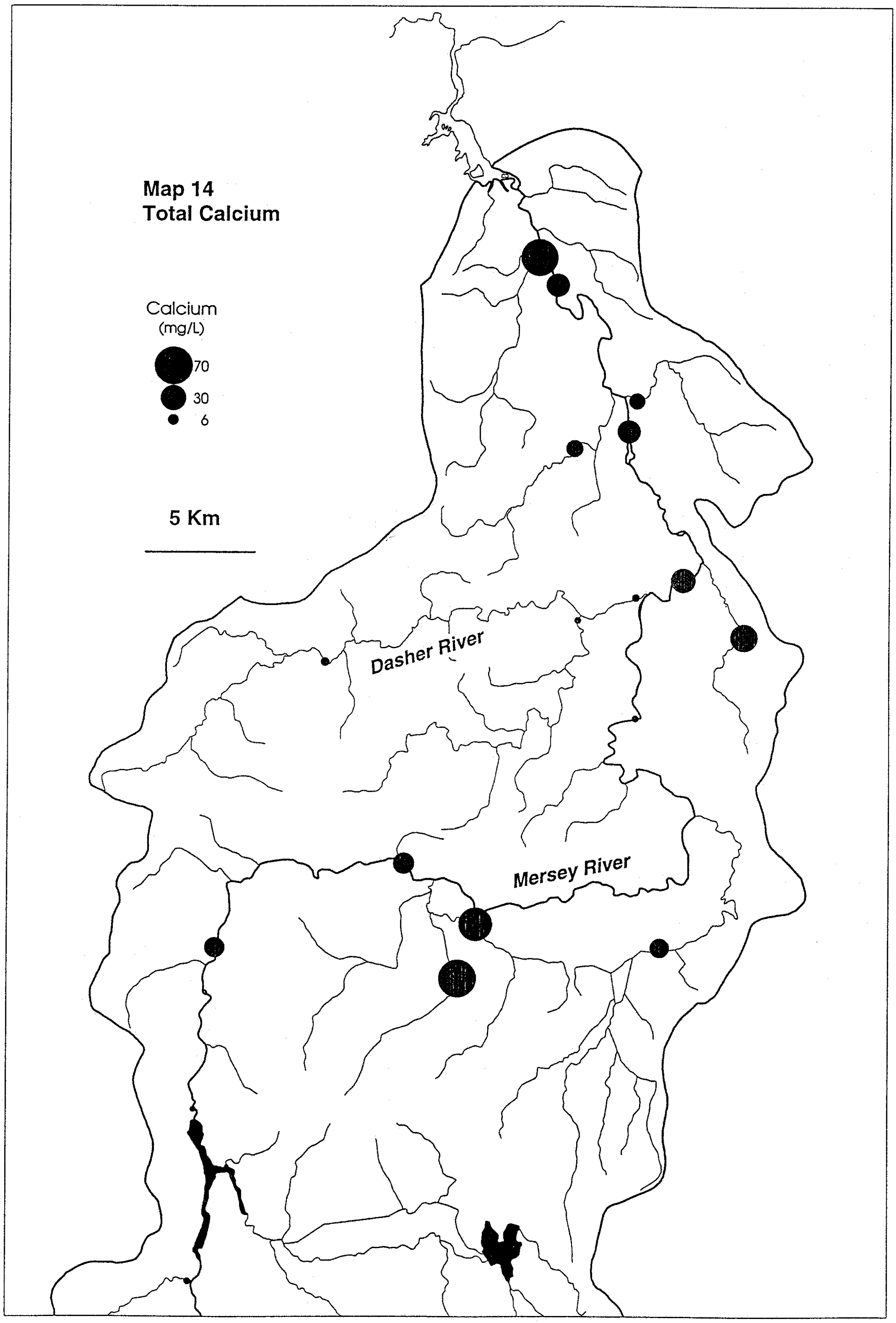
Map 11   Total Nitrogen





Map 12
Total Phosphorus
Total P
(mg/L)
0.10
0.05
0.005
5 Km
Dasher River
Mersey River


Map 13
Total Alkalinity
Alkalinity
(mg/L)
230
110
20
5 Km
Dasher River
Mersey River



Map 14
Total Calcium
Calcium
(mg/L)
70
30
6
5 Km
Dasher River
Mersey River

Highest chloride concentrations were found in Coilers Creek and Parramatta Creek (Map 15), both of which have quite a different chemical character to other streams influenced by limestone geology. These creeks also have higher silica, sodium and potassium concentrations further highlighting the different geology underlying these sub-catchments.

2.2 Longitudinal Mersey Plots

Water quality changes down the Mersey River are given in Figures 9 to 12. For most of the physical and chemical parameters, there is a general increase in concentrations down-river (cf. figures of IFC data). The increase in conductivity is most marked between Lake Parangana and Kellys Bridge (Figure 9), where it appears to stabilise at around 180-200 µS/cm. This pattern is also similar for alkalinity (Figure 10), although the increase between Parangana and Liena is greater (more than a 6-fold increase) reflecting groundwater inputs to the river from the karst area around Mole Creek.

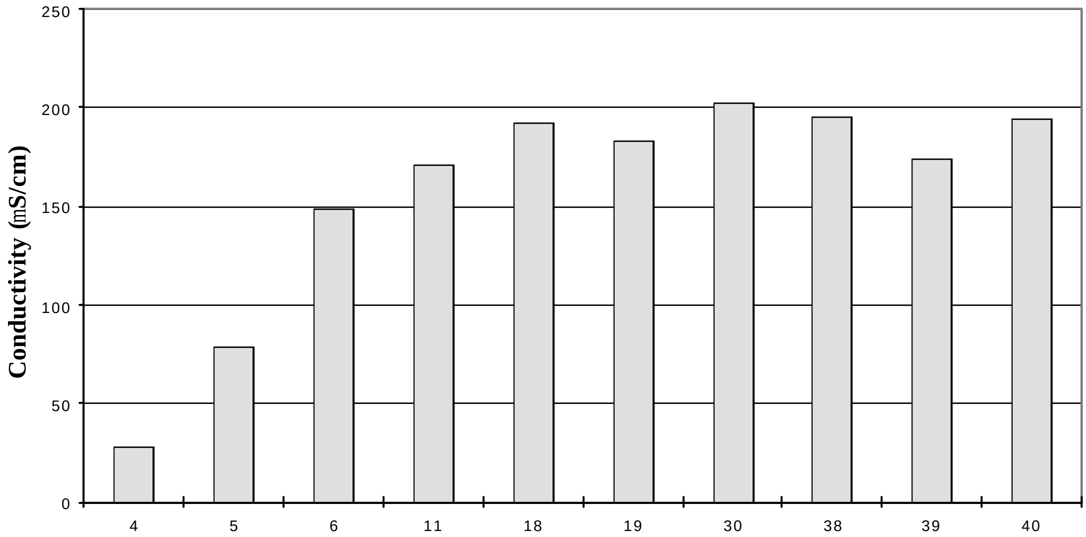


Figure 9 Mean conductivity at sites in the Mersey River monitored during this project.

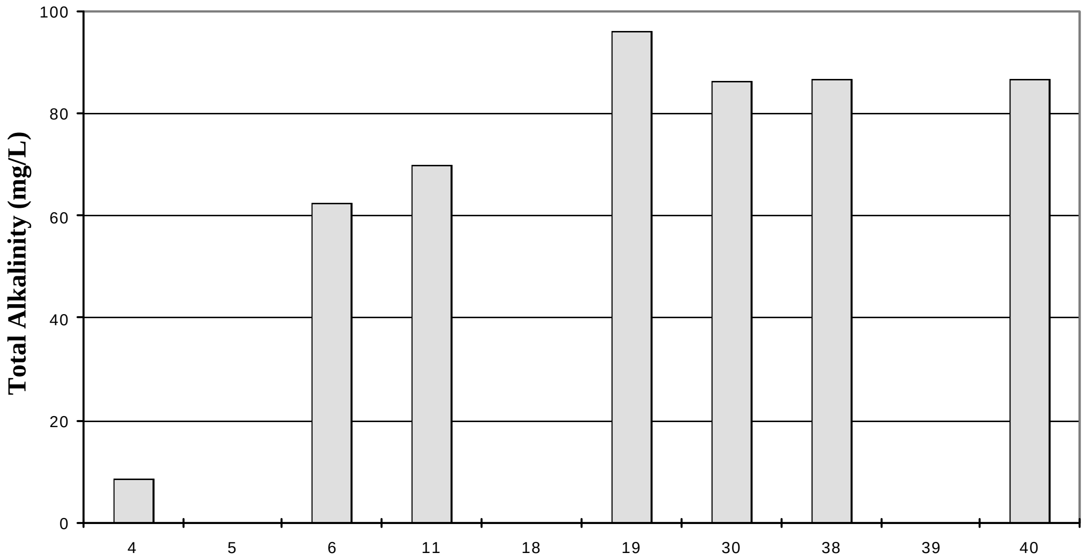
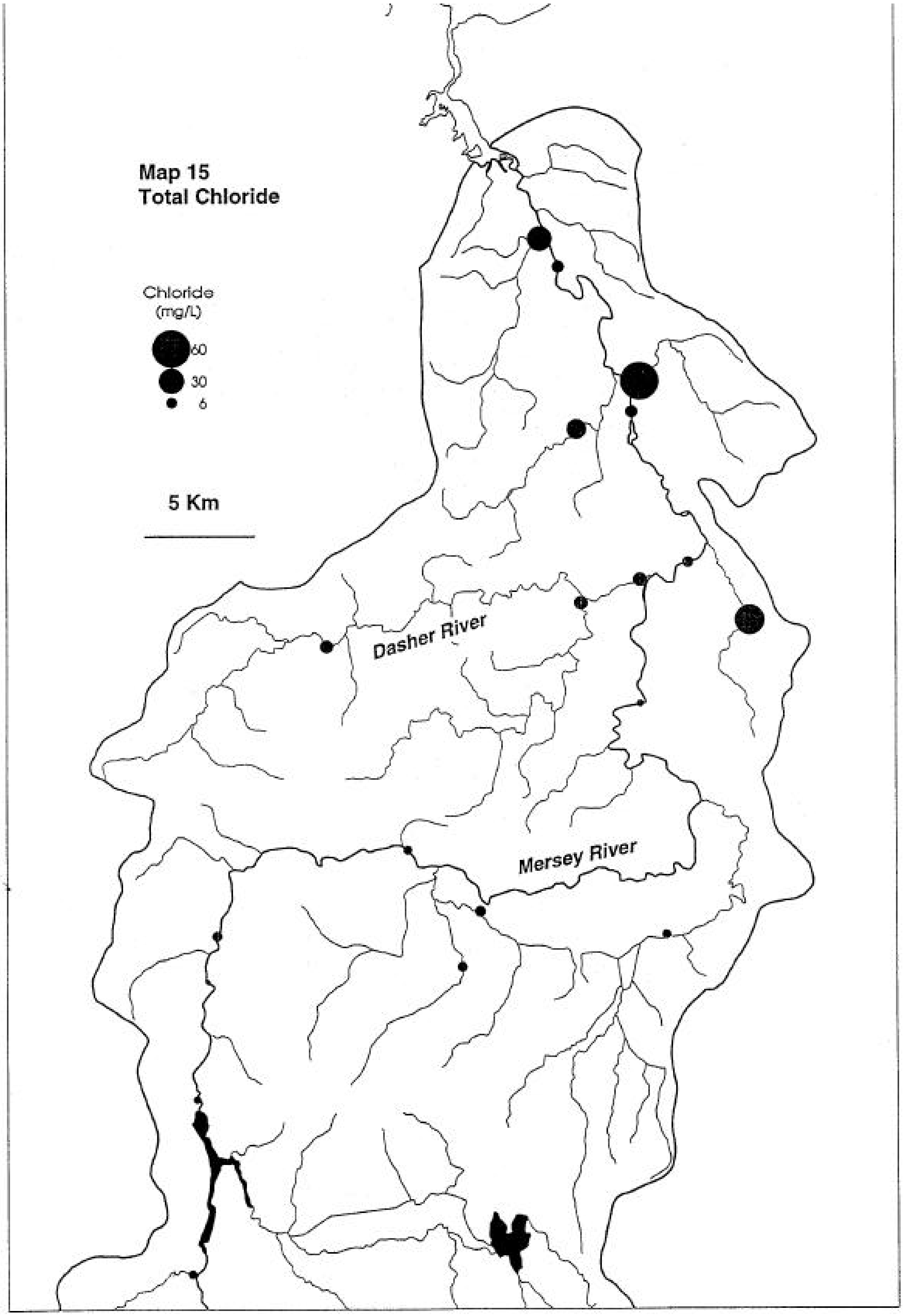


Figure 10 Mean concentration of Total Alkalinity at sites in the Mersey River.

LEGEND		
	4 d/s Parangana	19 Dynans Bridge
	5 d/s Stockroute Ck	30 Kimberley Bridge
	6 Liena Bridge	38 Hoggs Bridge
	11 Union Bridge	39 Lovetts Flats
	18 Kellys Bridge	40 u/s Latrobe



Map 15
Total Chloride
Chloride
(mg/L)
60
30
6
5 Km
Dasher River
Mersey River

Turbidity levels also increase downstream (Figure 11), although a single high measurement at the uppermost site has caused the average at Mersey d/s Parangana to be uncharacteristically high (this was caused by local disturbance in the river nearby). The overall change in turbidity, however, is not great, increasing from around 0.5 NTU in the upper catchment to only about 1.5 NTU at Latrobe. The greatest change is seen between the Site 11 (Union Bridge) and Site 18 (Kellys Bridge), a stretch of the river into which the more turbid Lobster Rivulet flows.

The only other noticeable trend found in the Mersey River was for total chloride, which showed a steady increase in concentration downstream (Figure 12). The levels at all sites are very low and are characteristic of dilute waters. It is to be expected that such a mobile element as chloride should be found in increased concentrations lower in the catchment as it is easily transported in groundwater.

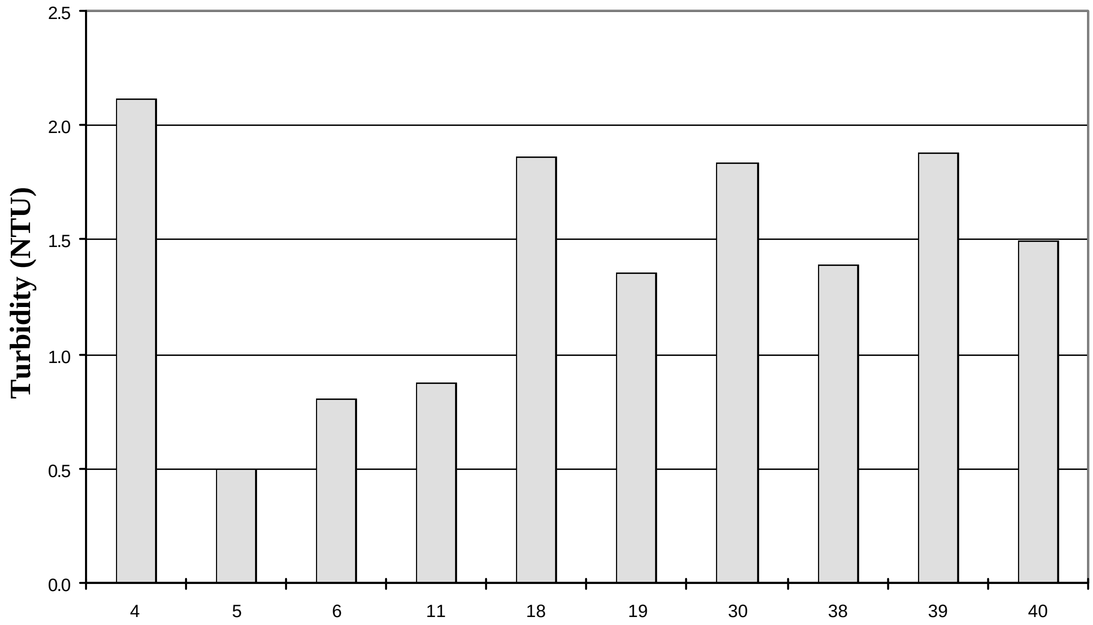


Figure 11 Mean turbidity at sites in the Mersey River monitored during this project.

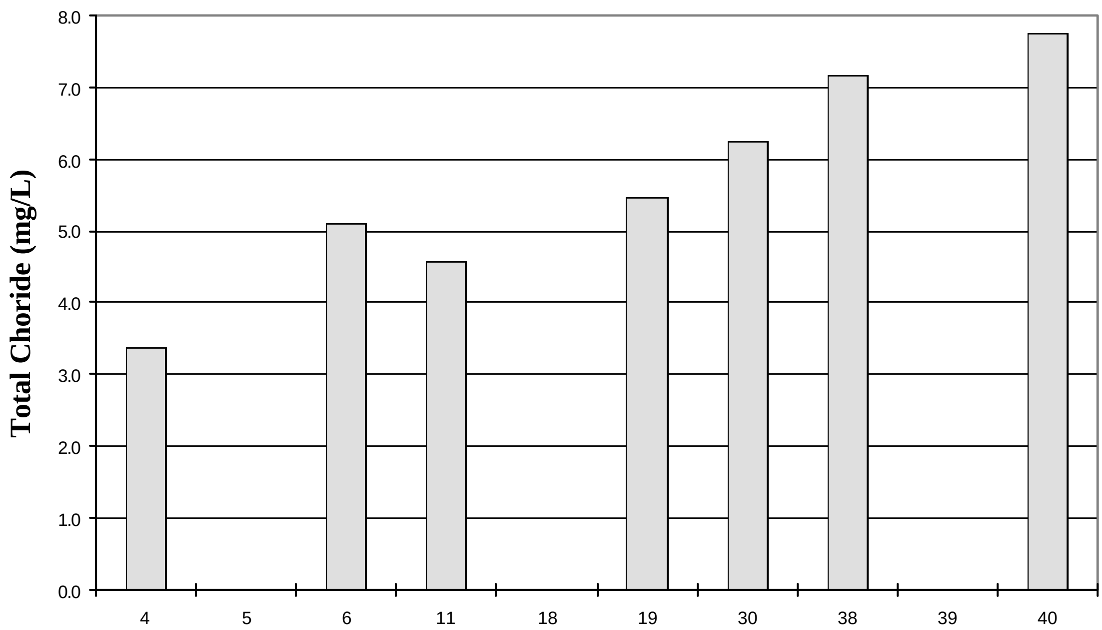


Figure 12 Mean concentration of choride at sites in the Mersey River.

LEGEND		
	4 d/s Parangana	19 Dynans Bridge
	5 d/s Stockroute Ck	30 Kimberley Bridge
	6 Liena Bridge	38 Hoggs Bridge
	11 Union Bridge	39 Lovetts Flats
	18 Kellys Bridge	40 u/s Latrobe

2.3 Hydrolab Logging Runs

Dissolved oxygen was monitored simultaneously at three sites in the Mersey River between 10 - 12 December, 1996 to examine the diurnal change at sites down the length of the river. The time series plots in Figure 13 show the change in dissolved oxygen in the Mersey River just downstream of Mole Creek, at Kimberley Bridge and at a site 2 km upstream of the Latrobe township. The plot clearly shows that oxygen levels in the river are highest in the upper reaches and lowest near the river mouth. The diurnal change is also greatest at the uppermost site and becomes less marked downstream. These data were collected during early summer flows and clearly show that at this time dissolved oxygen levels are very healthy and well above the national guideline of 6 mg/L (ANZECC, 1992).

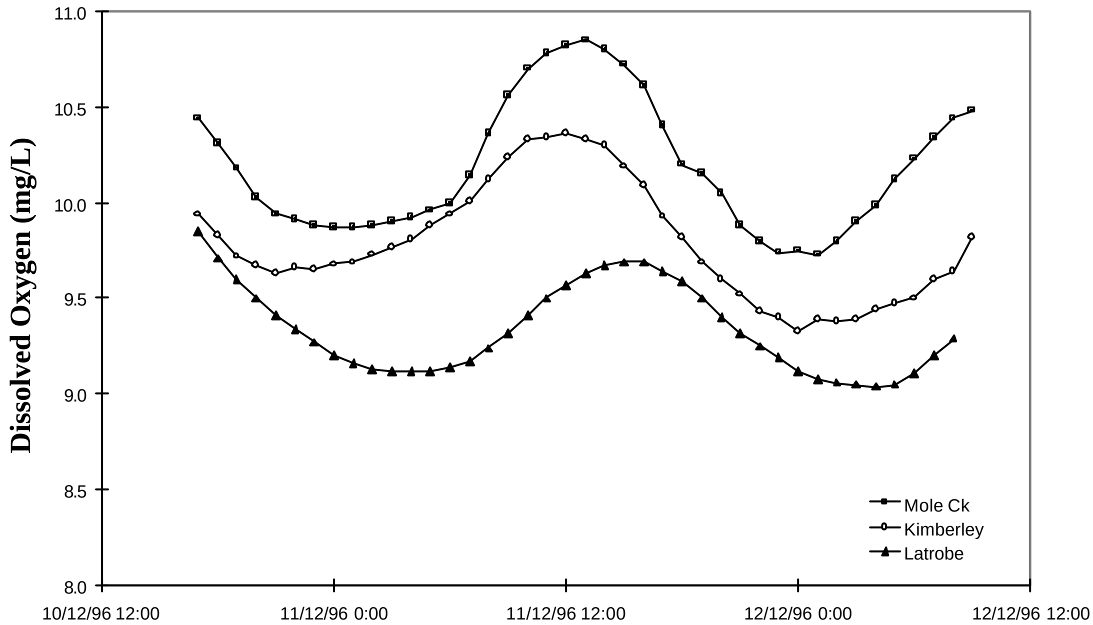


Figure 13 Simultaneous record of dissolved oxygen at three sites in the Mersey River measured from 10/12/97 to 12/12/97.

A similar set of data collected in the Mersey at Kimberley in late January, 1997 shows that oxygen concentrations in the water fluctuate more widely and drop to much lower levels later in summer (Figure 14). A big influence on dissolved oxygen is water temperature which at this time reached close to 27 ^{o}C. Photosynthetic activity during the day is the likely reason for peak dissolved oxygen levels occurring during the middle of the day, however at night the combined effect of aquatic plant respiration and the very high night-time temperature caused oxygen concentrations to drop close to 7 mg/L.

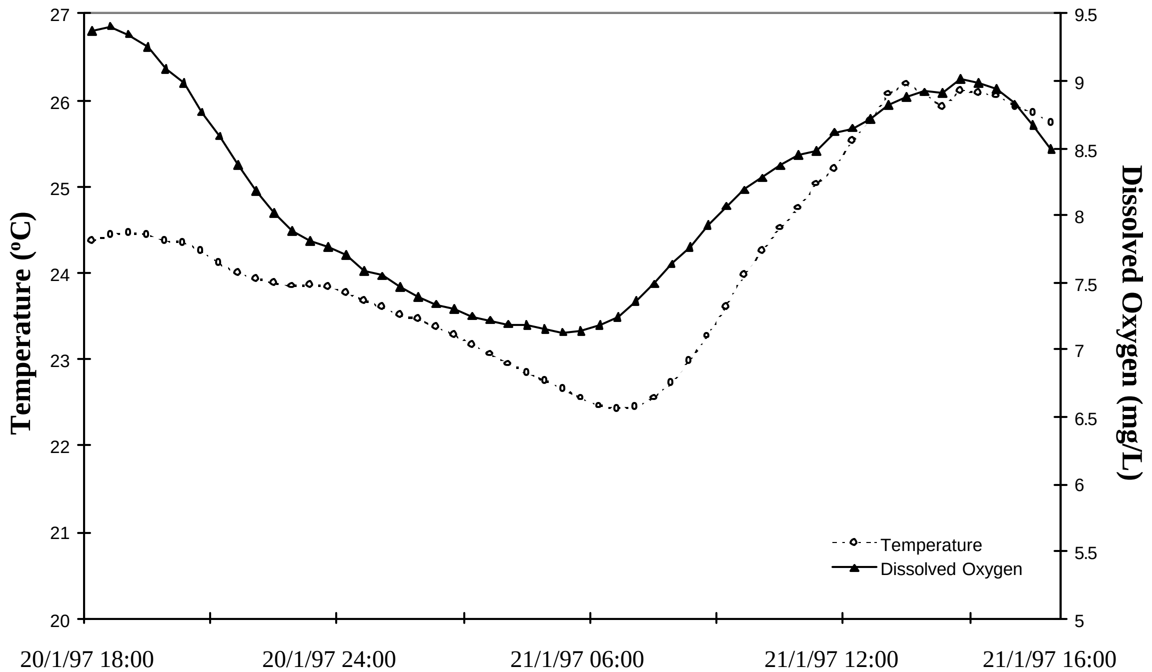


Figure 14 Time series of dissolved oxygen and temperature in the Mersey River at Kimberley 20/1/97 to 21/1/97.

Dissolved oxygen was also monitored at other sites in the catchment later in the program. After communication with Latrobe Waterwatch and examination of data collected by them at a variety of sites, two sites were chosen. These were in lower Coilers Creek and Caroline Creek u/s Mersey River. The plots of dissolved oxygen and temperature at these two sites are given in Figures 15 and 16. They were recorded over several days in mid-April during very calm, settled weather. The two sites show quite different patterns, with dissolved oxygen and temperature at Coilers Creek fluctuating much more dramatically than at Caroline Creek.

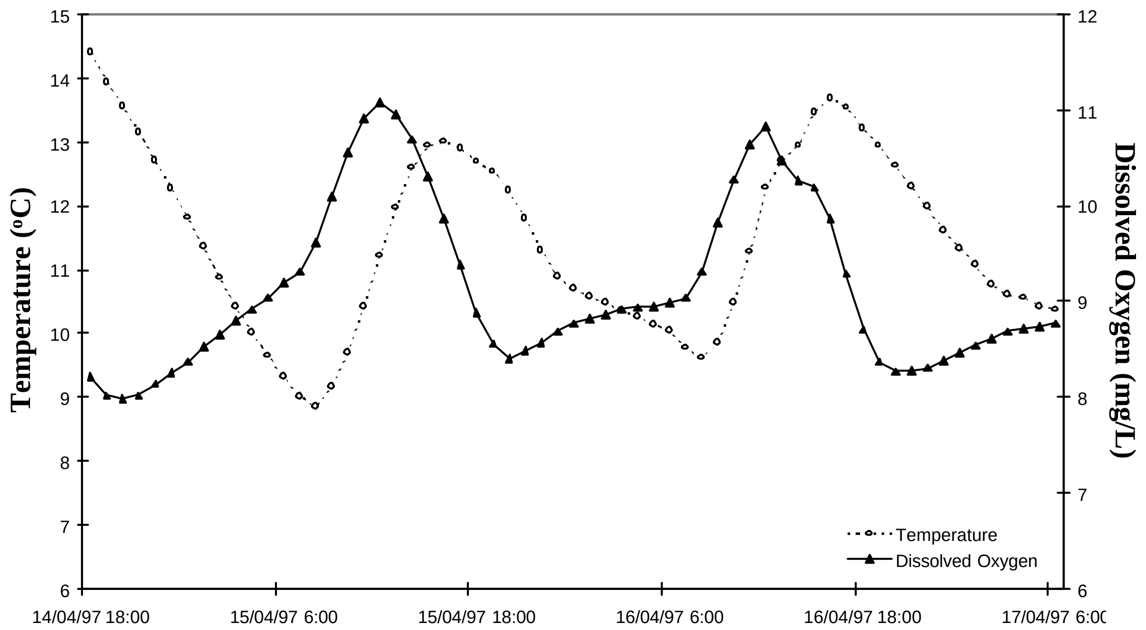


Figure 15 Time series of dissolved oxygen and temperature in Coilers Creek d/s Loafers Creek from 14/4/97 to 17/4/97.

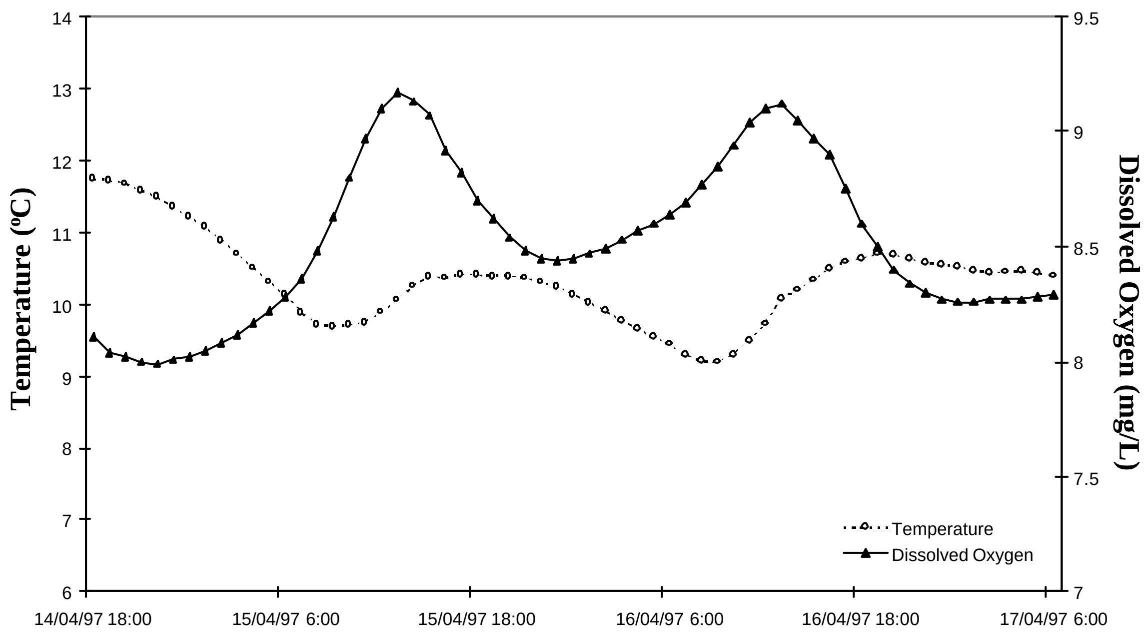


Figure 16 Time series of dissolved oxygen and temperature in Caroline Creek u/s Mersey River from 14/4/97 to 17/4/97.

The scale of change is also much greater at Coilers Creek, where dissolved oxygen ranged from less than 8 mg/L to over 11 mg/L. It is not immediately apparent why this occurs, although the catchment area of Coilers Creek is smaller than Caroline Creek and flow is generally less. It may also be due to the heavier contaminant load of this stream (see Section 2.1.3).

2.4 Dissolved Oxygen Profile

A profile of dissolved oxygen with depth was taken in the Mersey at Union Bridge on 25 February, 1997, prior to the experimental release of water from Parangana Dam (Figure 17). The data show that over the 2.1 m depth of the pond, there was only a very slight stratification in dissolved oxygen (0.55 mg/L). Moreover, most of the change in dissolved oxygen levels occurred in the top 0.3 m of the water column, possibly due to direct diffusion of atmospheric oxygen into the top layer of the water column.

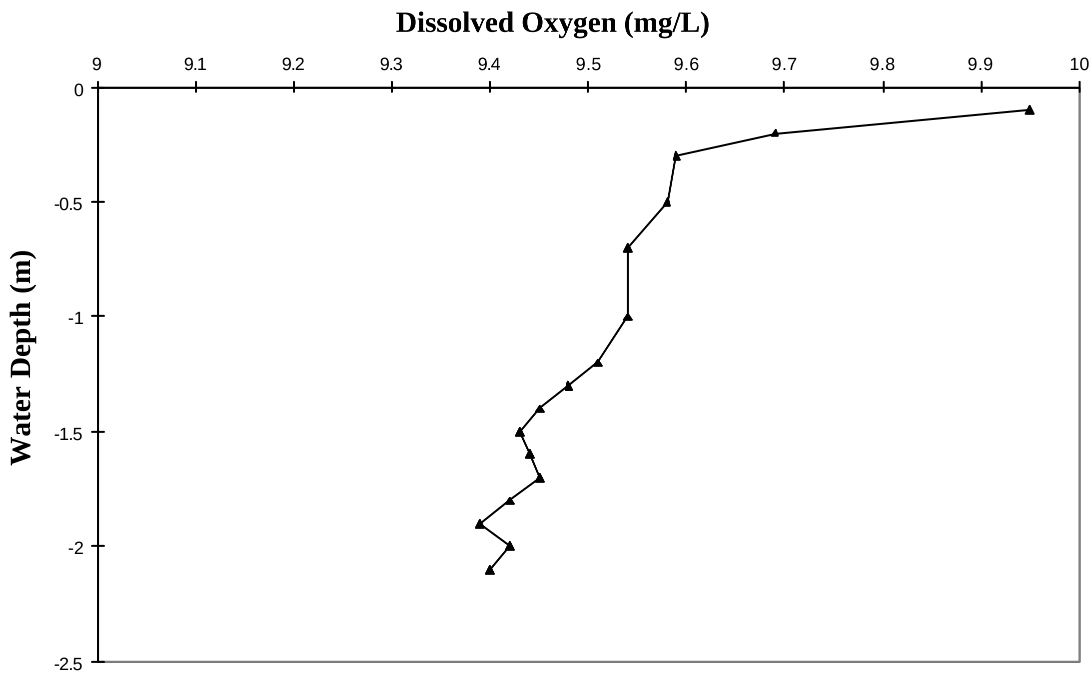


Figure 17 Profile of dissolved oxygen at Union Bridge - 25/2/97

2.5 Continuous Data

Data on water quality was collected at the Liena, Kimberley and Latrobe flow stations using 'in situ' probes which monitored conductivity, temperature and turbidity on a 15 minute time interval. Data is patchy due to intermittent gaps in the record and combined with the very short length of the time series at most sites, make any analysis for trends impossible. However, plots of short term changes in water quality during a minor flood event of May, 1997 show some changes which are of interest. It should be noted that conductivity data presented here is not temperature compensated.

2.5.1 Conductivity

Changes in conductivity are presented in Figures 18 to 20 and all sites show the dramatic decrease in conductivity which occurs during the early stages of a flood. One interesting feature common to all three graphs is the similarity in shape of the drop in conductivity despite the differences in hydrograph shape, particularly between Liena and the other two sites. It is also apparent that the drop in conductivity occurs much earlier in the event at Liena than at Kimberley and Latrobe. This reflects the lack of instream storage and the more immediate impact of precipitation on water quality. The unusual shape of the hydrograph at Liena is due to commencement of spill from Lake Parangana.

At the lower sites in the river, especially at Latrobe, the lag in conductivity change shows the relative increase in water storage within the river. When conductivity finally drops to the baseline level of about 50 μS/cm (which represents runoff water), flood conditions are nearing their peak at Latrobe.

2.5.2 Turbidity

Plots from Liena, Kimberley and Latrobe for the event of early May reveal the origin and fate of suspended material transported during high flows in the Mersey (Figure 21-23). The turbidity data is unconfirmed and has not been checked during higher flows against other instrumentation except at Latrobe where field readings were taken and found to agree with data collected by the 'in situ' probe.

The results show that much of the resulting turbidity in the river arises from tributaries in the middle reaches, between Liena and Kimberley. The data from the Liena station clearly shows that runoff from the upper catchment carries little in the way of suspended material (of which turbidity is largely an indicator). The brief but significant peak at Liena corresponds with the commencement of spill from Lake Parangana. Following this peak, turbidity drops quickly back to the level it was in the river prior to the event.

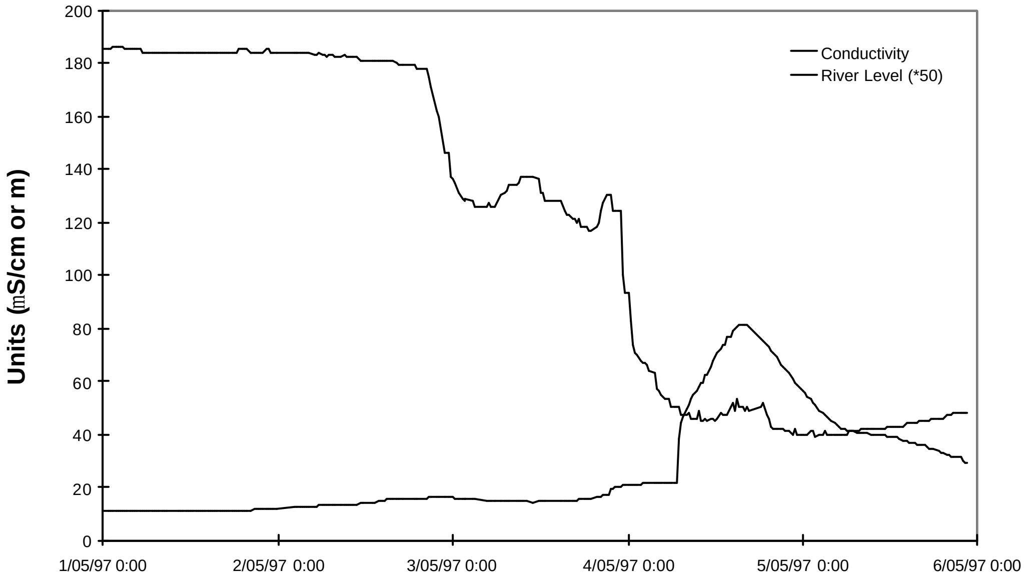


Figure 18 Unconfirmed conductivity at Liena during a high flow event in the Mersey in early May, 1997. (River level has been magnified by 50 for display purposes).

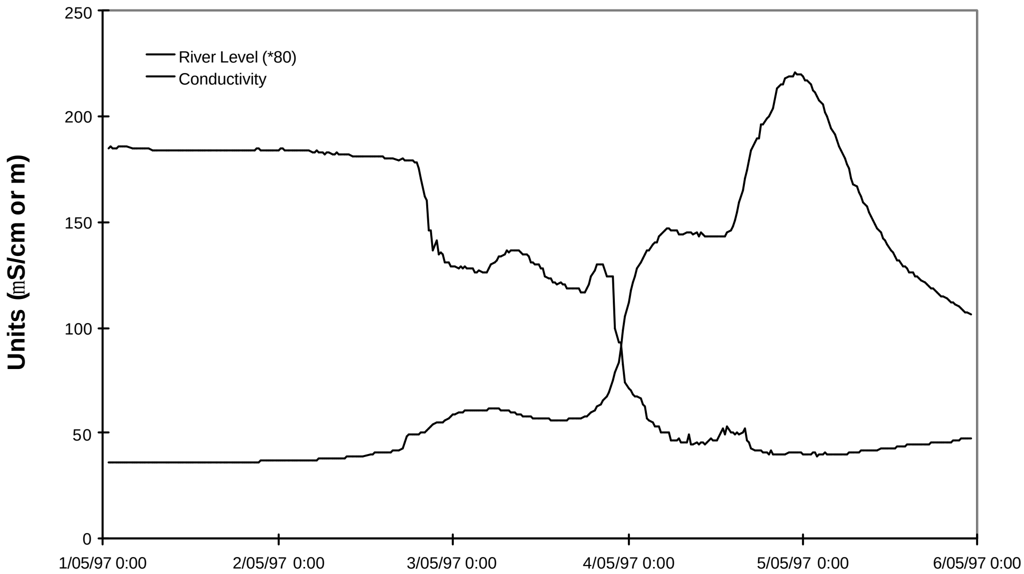


Figure 19 Unconfirmed conductivity at Kimberley during a high flow event in the Mersey in early May, 1997. (River level has been magnified by 80 for display purposes).

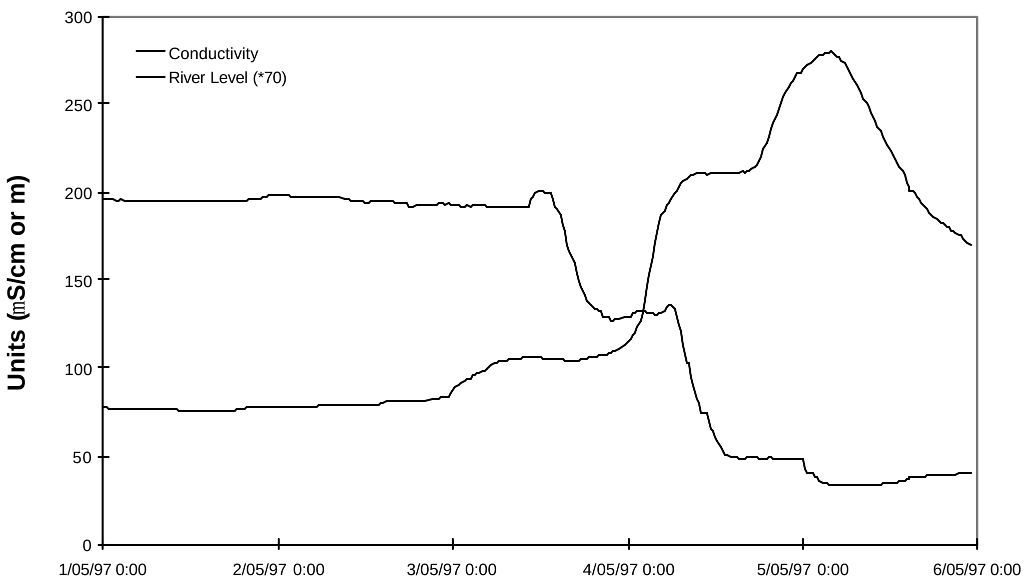


Figure 20 Unconfirmed conductivity at Latrobe during a high flow event in the Mersey in early May, 1997. (River level has been magnified by 70 for display purposes).

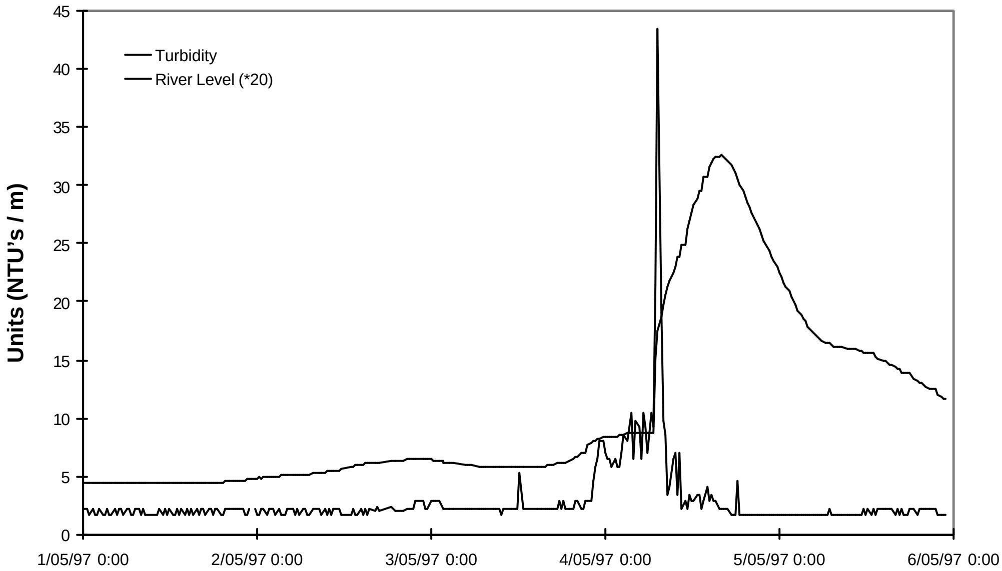


Figure 21 Unconfirmed turbidity at Liena during a high flow event in the Mersey in early May, 1997. (River level has been magnified by 20 for display purposes).

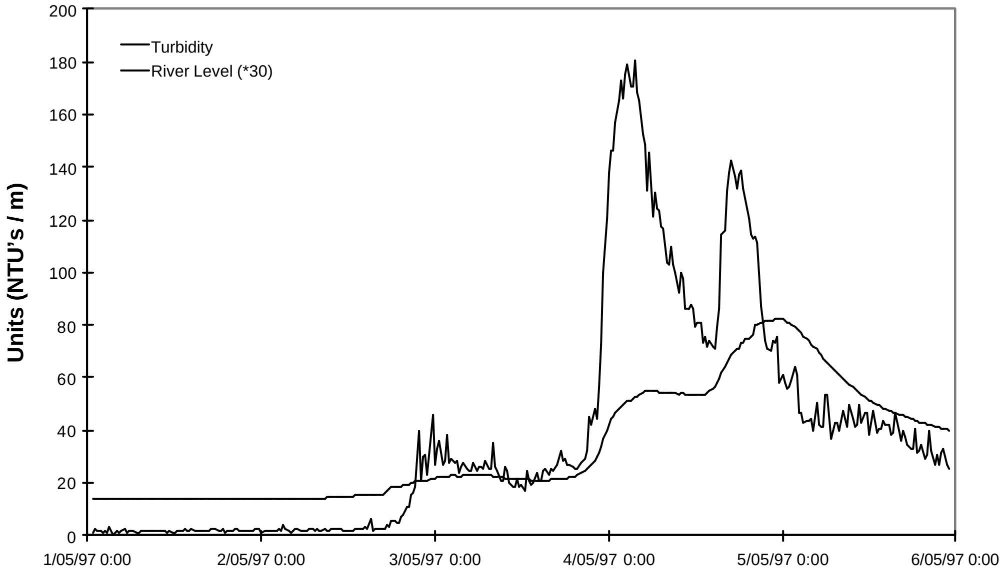


Figure 22 Unconfirmed turbidity at Kimberley during a high flow event in the Mersey in early May, 1997. (River level has been magnified by 30 for display purposes).

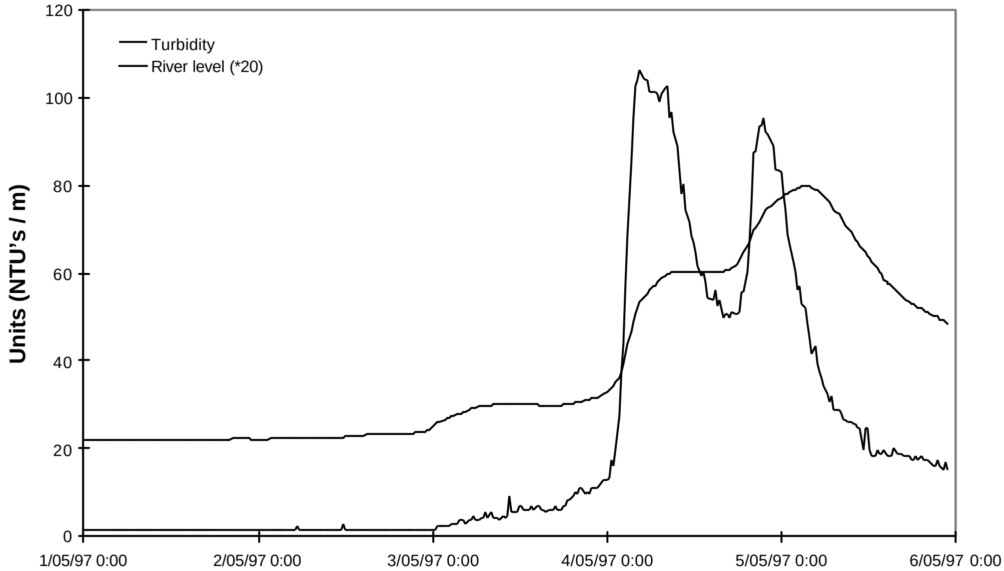


Figure 23 Turbidity at Latrobe during a high flow event in the Mersey in early May, 1997. (River level has been magnified by 20 for display purposes).

At Kimberley, turbidity is much higher during the entire event than at either of the other sites. The record shows three significant events corresponding to the three hydrographic features which are present. Early in the event, there is a distinct jump in turbidity from baseflow levels of about 2 NTU to an unstable 30 NTU which appears to be due to inflows from local tributaries. The next significant peak reaches about 180 NTU and is probably due to flood waters entering the Mersey River from the Minnow and Dasher drainage area. This water obviously carries the bulk of the suspended material. The third peak, which reaches about 150 NTU, appears to correspond to the arrival of flood waters from the upper catchment. This water is probably Parangana spill water which has picked up material from within the river and the small flood plains alongside the river as it travelled downstream.

The trace of turbidity at Latrobe is much less variable than at the other sites, and reflects the more 'sedate' flows characteristic of lower reaches of large rivers. The two significant turbidity peaks in the record at Kimberley are also present in the Latrobe time series, but peak levels are 50 - 60 NTU lower. One of the likely reasons for this decrease between Kimberley and Latrobe may have to do with the decreasing river gradient and the settling out of some of the particulate material. There are also large flood plains in the lower reaches which would also settle out particulates, as flow over these areas is always much slower, encouraging deposition. This is a natural function of significant flood plains and is the reason why they are valuable agricultural areas. Prevention of flooding of such areas results in transport of valuable sediments, and the nutrients they carry, further downstream to be deposited in the estuary, where they may silt up waterways and encourage algal blooms.

Due to the restrictive nature of computer access to the Hydrol database, very little handling of the raw turbidity data was able to be carried out to check on and verify calibration of the record. However, duration analysis of the raw data does summarise some of the basic characteristics of the turbidity data collected at each of the stations. Figures 24 - 26 are duration plots for turbidity at Liena, Kimberley and Latrobe, respectively for the period of record during which all sensors were in operation (11/12/96 to 29/5/97). The figures simply indicate the percentage of time turbidity at each site is within each set of ranges. Each of the range categories is indicated along the X-axis by the mid-point of that range.

The main feature of the duration plots is that turbidity in the Mersey at Liena is below 4 NTU for more than 95% of the record. Most of the existing record from Liena is within the range 1.00 to 4.00 NTU (86%of the time). In comparison with this, turbidity at Kimberley and Latrobe is generally higher. At Kimberley, turbidity levels are mostly between 5 and 25 NTU (62% of the time), while at Latrobe turbidity was between 2 and 5 NTU most of the time (92%). Like the event plots discussed earlier, the data in Tables 10 and 11 also reveal the distinct difference between turbidity levels at Kimberley and Latrobe. The turbidity record at Kimberley clearly spends more time in higher ranges. Between Kimberley and Latrobe suspended material obviously has a chance to settle out of the water column, resulting in lower turbidity in the river by the time water reaches the Latrobe station.

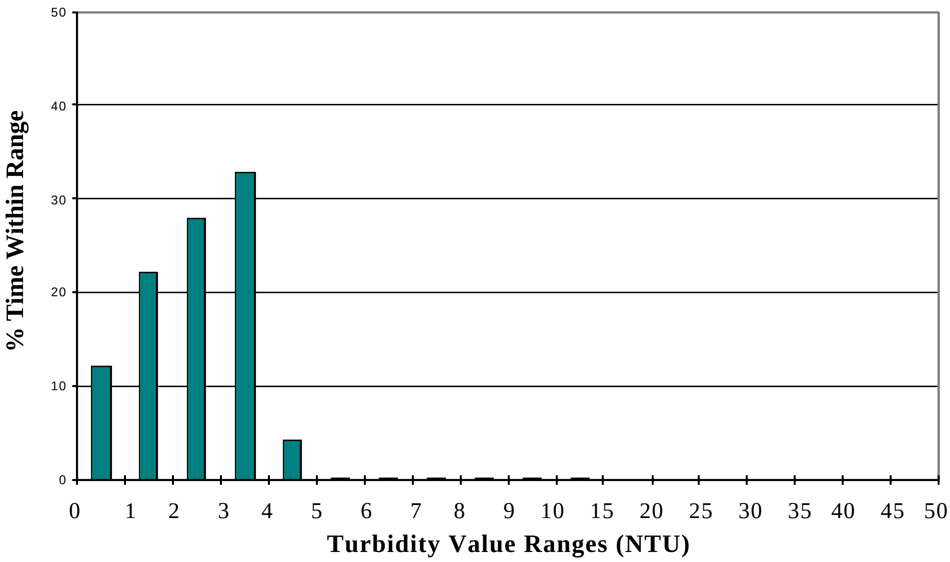


Figure 24 Duration plot for turbidity in the Mersey at Liena.

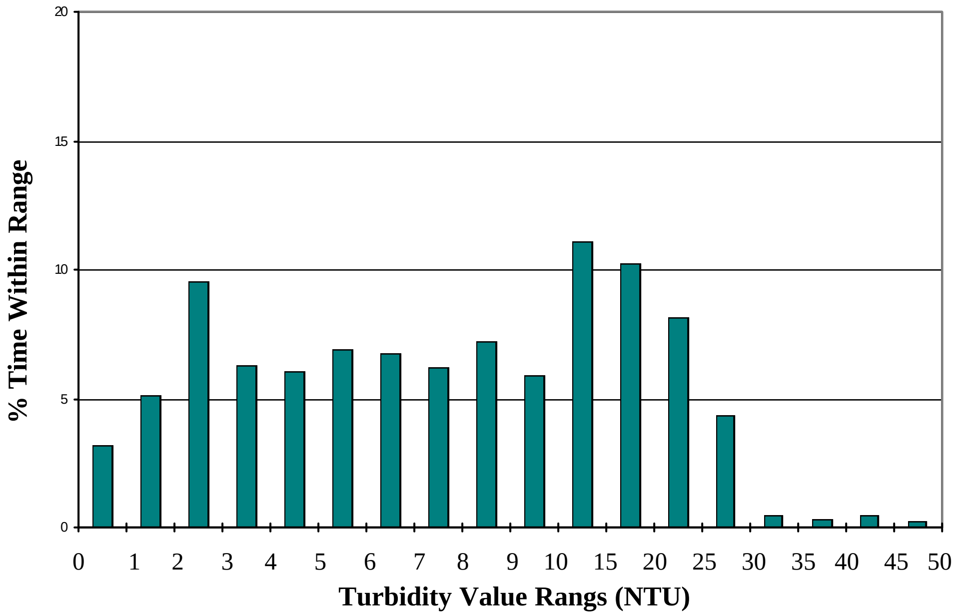


Figure 25 Duration plot for turbidity in the Mersey at Kimberley.

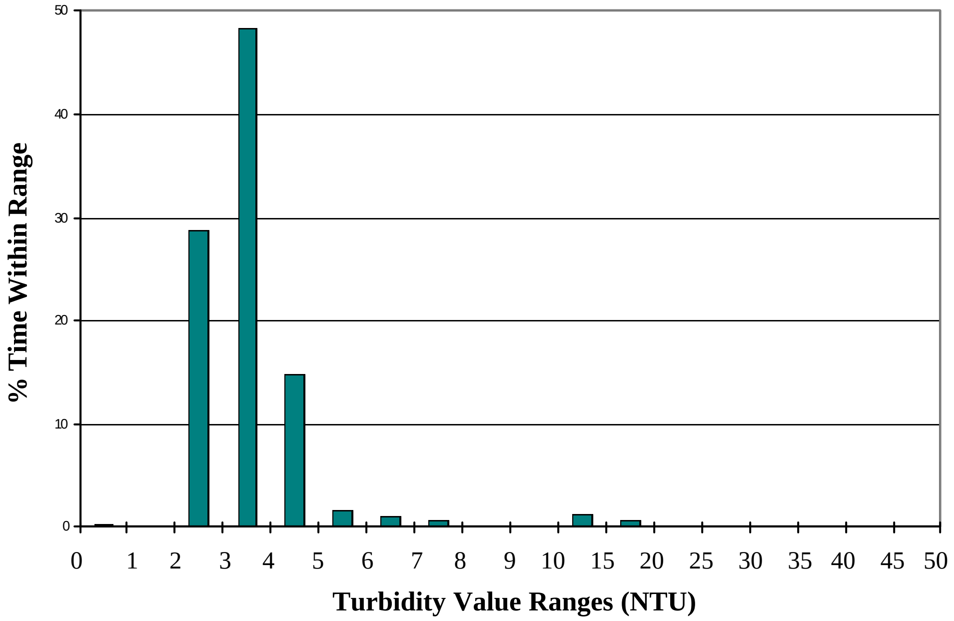


Figure 26 Duration plot for turbidity in the Mersey upstream of Latrobe.

3 Conclusions

In summary, the data collected during the present study confirms much of what has been collected in the past, especially the data collected by the Inland Fisheries Commission during similar low flows. The most prominent feature of both the historical record and data collected during this project, is that water quality in several of the tributaries is much more degraded than that of the Mersey River itself. Coilers Creek and Redwater Creek have significantly higher nutrient concentrations than most of the other sites at which nutrient enrichment was found. During the present study, the inclusion of a site on lower Parramatta Creek has resulted in the identification of this creek as another of the significantly degraded streams in the Mersey. While nutrient sampling of Kings Creek was not carried out, data from Waterwatch combined with the physical data collected during the present study, indicate that it is very likely that this creek is also degraded.

Comparison between the data collected by the Inland Fisheries Commission on the Mersey River with that collected in the present study indicates that turbidity levels at most sites were almost 2 NTU higher in the 1993 study, and that TP (which is often bound to the particulates which cause turbidity) was also higher. Most other parameters are at about the same levels as were measured during the present project.

The microbiological quality of water in the Mersey catchment is variable with water quality in the tributaries much worse than in the main river. In most cases increased coliform counts were attributable to cattle or dairy farming in the area and the resulting movement of cattle in and around streams.

Unusually large fluctuations in dissolved oxygen were also found in Coilers Creek, possibly in response to the high nutrient and microbiological load this tributary receives. Most other sites in the catchment displayed levels indicative of healthy aquatic ecosystems.

Finally, it must be stated that the results dicussed in this report are based on few data and only serve to highlight areas where significant water quality degradation occurs at the present time. The number of sites where chemical and bacterial testing was carried out, while limited to only 18, was considered sufficient to fulfil this purpose. Further monitoring will be needed if answers to the questions of How and Why areas are degraded are required. Answers to these questions were considered beyond the scope of this project.

4 REFERENCES

ANZECC (1992) Australian Water Quality Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council, Canberra.

APPENDIX 1 Summaries of Data extracted from the State Water Quality Database (HYDROL)

Arm River u/s Mersey	**Site No.**	624				
(Dec 1974 - Sept 1990)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Water Temperature	^oC	8	6.5	5.5	11.5	8
Field pH (strip)		6	6.62	6.85	7.4	5

Mersey at Liena	**Site No.**	640 & 60				
(May 1977 - Feb 1997)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Water Temperature	^oC	11	9.9	9	15.9	5
Field pH (strip)		8	7.14	7.25	8.2	5.5
Field EC @ 25	mS/cm	3	99	126	148.7	23.3
Turbidity	NTU	1	2.7	2.7	2.7	2.7

Mersey at Union Bridge	**Site No.**	1292				
(Sept 1976 - Sept 1996)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Water Temperature	^oC	8	14.1	14.7	18.5	8
Apparent Colour	Hazen	4	14	15	20	5
Secchi Depth	m	5	0.20	0.12	0.5	0.12
Turbidity (Hellige)	Hellige	3	1.3	1.2	1.6	1
Turbidity (NTU)	NTU	1	1	1	1	1
Lab pH		9	7.4	7.5	8.2	6.1
Suspended Solids	mg/L	9	4.5	1.7	17	0.8
Filerable Residues	mg/L	9	138	129	345	30
Tannins / Lignins	mg/L	9	0.36	0.31	0.82	0.13
Faecal Coliforms	/100mL	7	481	240	1900	140
Total Coliforms	/100mL	7	579	270	2400	120
Dissolved Oxygen	mg/L	6	10.9	10.8	12	9.8

Mersey at Kellys Bridge	**Site No.**	1293				
(Sept 1976 - Jun 1977)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Water Temperature	^oC	8	14.1	13.8	18.6	8
Apparent Colour	Hazen	5	16	15	25	5
Secchi Depth	m	7	1.2	1.5	1.75	0.25
Turbidity (Hellige)	Hellige	3	2.0	2	2.4	1.5
Lab pH		10	7.6	7.6	8.2	6.5
Suspended Solids	mg/L	10	5.0	1.6	30	0.6
Filerable Residues	mg/L	10	138	118	365	32
Tannins / Lignins	mg/L	10	0.4	0.4	1.3	0.2
Faecal Coliforms	/100mL	7	127	90	260	20
Total Coliforms	/100mL	7	170	160	280	40
Dissolved Oxygen	mg/L	6	9.9	10.0	11	9.6

Mersey at Kimberley **Site No.** 22

(Sept 1976 - Feb 1997)

	Units	Count	Mean	Median	Max	Min
Water Temperature	°C	14	14.4	14.9	19.2	7
Apparent Colour	Hazen	5	25	25	40	10
Secchi Depth	m	7	0.24	0.25	0.3	0.12
Turbidity (Hellige)	Hellige	3	4.2	3.7	7	2
Lab pH		10	7.5	7.6	8	6.4
Suspended Solids	mg/L	10	7.1	4.3	24	0.8
Filerable Residues	mg/L	10	128	110	315	24
Tannins / Lignins	mg/L	10	0.44	0.31	1.3	0.2
Faecal Coliforms	/100mL	8	219	195	370	120
Faecal Streptococci	/100mL	8	38	41	62	10
Total Coliforms	/100mL	8	288	210	580	110
Dissolved Oxygen	mg/L	6	9.7	9.8	10.8	8.5

Mersey at Merseylea **Site No.** 1288

(Sept 1976 - Jun 1977)

	Units	Count	Mean	Median	Max	Min
Water Temperature	°C	8	14.8	15.0	20	8
Apparent Colour	Hazen	5	24	25	40	5
Secchi Depth	m	7	0.22	0.25	0.3	0.12
Turbidity (Hellige)	Hellige	3	2.6	2	4.1	1.8
Lab pH		10	7.55	7.65	8	6.5
Suspended Solids	mg/L	10	6.9	2.1	25	1
Filerable Residues	mg/L	10	131	115	340	16
Tannins / Lignins	mg/L	10	0.4	0.3	1.2	0.2
Faecal Coliforms	/100mL	8	280	295	510	110
Faecal Streptococci	/100mL	8	41	33	92	6
Total Coliforms	/100mL	8	385	385	680	120
Dissolved Oxygen	mg/L	6	10.3	10.1	12	9.4

Mersey at Ambleside **Site No.** 1285

(Aug 1975 - Jul 1978)

	Units	Count	Mean	Median	Max	Min
Water Temperature	°C	10	12.7	10	20	9
Lab pH		9	7.37778	7.4	7.8	7
Suspended Solids	mg/L	9	81.6667	56	236	3
Dissolved Oxygen	mg/L	8	8.5	8.95	10.2	6.1
Chloride	mg/L	7	11158.6	11450	16150	5200

Mersey at Railton Pump Station	**Site No.**	1289				
(Sept 1976 - Jun 1977)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Water Temperature	°C	8	14.6	14.6	19	8
Apparent Colour	Hazen	5	26	30	40	5
Secchi Depth	m	7	1.02	1	1.75	0.12
Turbidity (Hellige)	Hellige	3	2.8	2.1	4.5	1.8
Lab pH		10	7.5	7.55	7.9	6.5
Suspended Solids	mg/L	10	6.1	3.4	24	1
Filerable Residues	mg/L	10	124	111	335	13
Tannins / Lignins	mg/L	10	0.42	0.33	1.3	0.17
Faecal Coliforms	/100mL	8	409	395	840	100
Faecal Streptococci	/100mL	8	37	39	84	4
Total Coliforms	/100mL	8	516	480	910	190
Dissolved Oxygen	mg/L	6	10	9.9	11.2	9.2

Mersey at Lovetts Flats	**Site No.**	1278				
(Oct 1977 - Jan 1981)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Apparent Colour	Hazen	23	43	40	125	5
Turbidity (Hellige)	Hellige	23	6.8	3.1	49	1.2
Lab pH		23	7.6	7.7	8.3	6.8
Suspended Solids	mg/L	22	11.6	5.4	120	0.8
Filerable Residues	mg/L	23	115	113	166	63

Mersey at Latrobe	**Site No.**	447				
(Sept 1976 - Mar 1997)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Water Temperature	°C	101	13.1	12.2	23	4.5
Lab pH		39	7.6	7.6	8.6	6.6
Field EC @ 25	mS/cm	43	156.986	157	255	37
Field EC @ 20	mS/cm	24	166	168	235	96
Field pH (strip)		49	7.1	7	8.6	6.1
Field pH (meter)		3	7.6	7.5	7.8	7.5
Filerable Residues	mg/L	31	114	110	340	27
Tannins / Lignins	mg/L	10	0.5	0.4	1.5	0.2
Suspended Solids	mg/L	32	10.6	3	130	1
Apparent Colour	Hazen	27	46	30	150	5
Faecal Streprococci	/100mL	8	38	20	96	6
Turbidity (Hellige)	Hellige	11	3.7	2.4	11.3	1.4
Turbidity (NTU)	NTU	29	8.1	2.5	34	0.4
Secchi Depth	m	7	0.94	1	1.25	0.75
Faecal Coliforms	/100mL	8	440	295	1210	80
Total Coliforms	/100mL	8	560	375	1460	140
Dissolved Oxygen	mg/L	10	10.3	10	12	9

Mersey at Latrobe u/s Caroline Ck	**Site No.**	1280				
(Sept 1976 - Mar 1997)						
	Units	**Count**	**Mean**	**Median**	**Max**	**Min**
Lab pH		21	7.6	7.6	8.2	7
Filerable Residues	mg/L	21	118	118	149	83
Suspended Solids	mg/L	21	12	6	125	1
Apparent Colour	Hazen	21	44	40	150	5
Turbidity (Hellige)	Hellige	21	7.5	2.7	67	0.6

APPENDIX 2 Summaries of data collected at sewage lagoons by Latrobe Council.

Railton Lagoon						
		Mean	Median	Max	Min	Count
BOD	(mg/l)	3.18	3	5	2	11
NFR-SS	(mg/l)	3.64	2	11	2	11
pH		7.78	7.8	7.9	7.7	6
Total Coliforms	/100 ml	77477	1700	150000	40	11
E Coli Count	/100 ml	556	500	1200	20	10
Faecal Streptococci	Count /100 ml	399	300	1600	5	11
Ca	ppm	42.9	42.1	46.48	40.65	6
Mg	ppm	3.97	4.03	4.81	2.95	6
Hardness	ppm	127	125	136	121	4
Na	ppm	29.7	28.71	45.97	17	6
Cu	ppm	0.013	0.014	0.025	0.025	6
Iron	ppm	0.52	0.53	0.8	0.2	6
Zinc	ppm	0.0125	0.125	0.025	0	6
Mn	ppm	0.238	0.225	0.32	0.2	6
S	ppm	13.88	11.95	24.5	3.83	6
Nitrate	ppm	0.305	0.28	0.731	0.091	6
EC	uS/Cm	430	415	590	340	6
TDS	ppm	306	306	371	240	4
P	ppm	2.75	2.82	4.38	0.97	6
K	ppm	5.53	5.35	6.9	4.61	6
B	ppm	0.041	0.038	0.07	0.025	6
Mo	ppm	0.065	0.013	0.34	0	6
N	ppm	8.84	8.84	8.84	8.84	1

Sheffield Lagoon

		Mean	Median	Max	Min	Count
BOD	(mg/l)	16.9	15	32	5	11
NFR-SS	(mg/l)	45	42	89	8	11
pH		7.5	7.4	7.9	7.2	6
Total Coliforms	/100 ml	84230	49000	280000	5300	10
E Coli Count	/100 ml	4889	3000	15000	700	9
Faecal Streptococci	Count /100 ml	4077	1500	24000	50	11
Ca	ppm	13.34	13.43	14.72	11.77	6
Mg	ppm	5.8	6.98	7.38	0.28	6
Hardness	ppm	64.3	65.31	66.78	59.9	4
Na	ppm	25.49	26.19	44.04	5.67	6
Cu	ppm	0.034	0.0085	0.12	0	6
Iron	ppm	0.98	0.88	1.61	0.44	6
Zinc	ppm	0.022	0.01	0.07	0	4
Mn	ppm	0.165	0.185	0.22	0.03	6
S	ppm	13.98	14.09	19.6	8.99	6
Nitrate	ppm	0.254	0.118	0.699	0.02	6
EC	uS/Cm	257	280	350	70	6
TDS	ppm	215	221	235	183	4
P	ppm	1.86	1.77	3.51	0.24	6
K	ppm	2.93	3.15	4.04	0.68	6
B	ppm	0.037	0.0345	0.05	0.03	4
N	ppm	7.16	7.16	7.16	7.16	1

Latrobe

		Mean	Median	Max	Min	Count
BOD	(mg/l)	47.6	48	72	29	11
NFR-SS	(mg/l)	36.7	36	49	22	11
pH		6.99	7	7.2	6.8	11
Total Coliforms	/100 ml	902000	805000	2E+06	150000	10
E Coli Count	/100 ml	159363	120000	360000	34000	11
Faecal Streptococci	Count /100 ml	25100	24000	52000	3300	11

Port Sorell

		Mean	Median	Max	Min	Count
BOD	(mg/l)	68	70	88	48	11
NFR-SS	(mg/l)	101	92	230	68	11
pH		7.54	7.3	9.3	7	11
Total Coliforms	/100 ml	448181	310000	1E+06	120000	11
E Coli Count	/100 ml	47091	35000	130000	3000	11
Faecal Streptococci	Count /100 ml	9891	1100	21000	400	11

APPENDIX 3 Past and Present Sample Site Locations

Eastng	Nthg	
		Historical Data- Hydrol Sites
434600	5384200	Arm River u/s Mersey
435700	5399700	Mersey at Liena
444475	5403650	Mersey at Union Bridge
456000	5407900	Mersey at Kelly Bridge
457400	5416900	Mersey at Kimberley
456400	5419900	Mersey at Merseylea
446350	5438600	Mersey at Ambleside
453600	5425900	Mersey at Railton Pump Station
453400	5427725	Mersey at Lovetts Flat
453400	5427725	Mersey at Latrobe
451500	5430600	Mersey at Latrobe u/s Caroline Ck
		Inland Fisheries Commission
435700	5399700	Mersey at Liena
444475	5403650	Mersey at Union Bridge
446500	5402800	Mersey d/s Mole Ck
455200	5410400	Mersey at Dynans Bridge
455500	5415600	Mersey at Armistead (u/s Dasher)
457400	5416900	Mersey at Kimberley (u/s Coilers)
457900	5418400	Mersey at Kimberley (d/s Coilers)
454750	5425300	Mersey u/s Redwater Ck
453400	5427725	Mersey at Lovetts Flats
451500	5430600	Merey at Latrobe (u/s Caroline Ck)
450600	5432400	Mersey d/s Caroline Ck u/s Bonneys
449600	5399275	Mole Ck at Mole Ck
456375	5399725	Lobster Rvt at Chudleigh
455200	5416075	Dasher u/s Mersey
460250	5414225	Coilers u/s Mersey
452325	5423000	Redwater at Native Plains Rd
450650	5431875	Caroline Ck on Railton Rd
		Monitoring Riverine Health Initiative
444475	5403650	Mersey at Union Bridge
455200	5410400	Mersey at Dynans Bridge
457400	5416900	Mersey at Kimberley
453400	5427725	Mersey at Lovetts Flats
450550	5410775	Minnow u/s Lower Beulah
444185	5408850	Minnow at Lower Beulah Rd
452450	5391850	Lobster Rvt at Parsons Rd
432185	5408000	Dasher Off Claude Road
448450	5419600	Redwater Ck Off Sheffield Road
		Five Rivers Waterwatch Group
447750	5422010	Caroline Creek above Elliott quarry
451050	5424000	Goliath Creek at Goliath
448900	5427020	NFP (Youngmans Rd)
450150	5426200	Goliath Creek at Youngmans Rd bridge
450700	5431950	Caroline Creek at Railton Rd
435800	5399600	Mersey at Liena
455300	5408100	Mersey at Hayward's property
456000	5416400	Mersey at White Rock swimming hole
451100	5431800	Mersey / Shale Rd near Farrell Park
451100	5422100	Redwater Creek at Dowbiggin, Railton
452200	5423000	Redwater Creek at Native Plains Rd, Railton
453200	5422900	Redwater Ck off Native Plains Rd, blw composting
435200	5399050	Ration Tree Creek at Liena

Eastng	Nthg	
457800	5416800	Coilers Creek at Kimberly Bridge
453700	5433900	Kings Creek at Abey Road
451950	5435050	Kings Creek at Bass Highway
451050	5435000	Kings Creek at old foot bridge
450450	5434950	Kings Creek at weir
		Sites Sampled During this Study
450850	5434875	Kings Creek
450750	5432750	Lower Bonneys Creek
434500	5384250	Arm River u/s Mersey
435200	5391175	Mersey d/s Parangana
435175	5396850	Mersey d/s Stockroute Ck
435700	5399700	Mersey @ Liena
443300	5399000	Marakoopa Ck @ Mayberry Rd
452450	5391850	Lobster Rvt u/s Caveside (MRHI)
449600	5399275	Mole Ck @ Mole Ck
446990	5398275	Sassafras Ck @ Howes Rd
444475	5403650	Mersey @ Union Br
447825	5400800	Mole Ck @ Dens Rd
456375	5399725	Lobster Rvt @ Chudleigh
460400	5409775	Coilers Ck @ Moltema ('The Willows')
460200	5414125	Coilers Ck @ Coilers Crossing
460250	5414225	Coilers Ck d/s Loafers Ck
456000	5407900	Mersey @ Kellys Br
455200	5410400	Mersey @ Dynans Br
449900	5409275	Minnow @ Dawkins Rd
446050	5409900	Minnow @ Beulah Rd (TOP)
442350	5413875	Dasher @ Paradise Rd
450325	5415950	Dasher @ Beulah Rd (mill)
436850	5412100	Dasher @ Patawolongah
440775	5413050	Dasher @ Claude Road
450500	5410925	Minnow Beulah Rd #1
452275	5413250	Minnow Beulah Rd #2
452500	5415000	Minnow u/s Bryans Br
455200	5416075	Dasher u/s Mersey
457400	5416900	Mersey @ Kimberley Br
455225	5425225	Parramatta Ck u/s Mersey
450650	5431875	Caroline @ Railton Rd
448825	5422425	Caroline off New Bed Rd
450650	5424300	Caroline Trib. u/s Discharge
448700	5426425	Caroline @ Dally Rd
452325	5423000	Redwater @ Native Plains Rd
448800	5419475	Redwater Top (MRHI)
454850	5423800	Mersey @ Hoggs Br
453400	5427725	Mersey @ Lovetts Flats
451500	5430600	Mersey @ Latrobe
460700	5424175	Parramatta @ Bass Hwy