Otago Regional Council

Surface Water Quality in South West Otago

June 2004

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Executive Summary

Water quality monitoring in the Wairuna Stream, Waipahi River, Heriotburn and Crookstonburn began in 1996 as part of the state of environment monitoring programme. In response to concerns that water quality may be deteriorating, a more intensive six month surface water quality monitoring programme commenced on the Wairuna Stream in April 2000. Poor water quality results from this programme led to the Waipahi/Clydevale monitoring programme, which encompassed a larger catchment, this ran from October 2002 to October 2003. The third water quality monitoring programme began in May 2000 in the Heriotburn and Crookstonburn catchments. Otago Regional Council has also been working with landowners and farmers in the area to minimise the potential impacts of high density farming in an area which is predominantly tile drained.

Water quality monitoring focused on six sites in the Wairuna Stream, ten sites in the Waipahi/ Clydesvale and 14 sites in the Heriotburn and Crookstonburn. Spot water sampling was conducted at all sites with water samples tested for a range of physico-chemical and microbiological parameters. Periphyton and macroinvertebrate sampling was also conducted.

The monitoring results indicate that water quality in all three catchments is poor with a deterioration in water quality with distance downstream. For example there was a marked increase in *Eschericia coli* with distance downstream in all watercourses other than the Kaihiku and Waipahi. In addition, the Heriotburn and Wairuna catchments had extremely high median concentrations of indicator bacteria, all sites exceeding MfE/MoH action/red mode levels (550 *E.coli*/100ml).

Nutrient concentrations were also found to be high, nitrite-nitrate nitrogen exceeds Australia and New Zealand Environment and Conservation Council (ANZECC) 2000 default trigger values at all monitoring sites other than the headwaters in the Crookstonburn, Wairuna and Kahiku Stream. Nutrient enrichment is of concern as at many sites both median dissolved phosphorus and median dissolved inorganic nitrogen concentrations exceed the ANZECC 2000 default trigger values for lowland river ecosystems, suggesting that excessive weed growth or algal blooms are likely to occur.

Macroinvertebrate values followed the same trend as water quality, showing a decline with distance downstream, although differences in physical habitat may be a contributing factor rather than a decline in water quality.

Poor water quality at most monitoring sites is attributed to various factors, one being tile drains, which are widespread throughout South Otago, these rapidly remove excess surface water to provide better conditions for grass, however they also quickly and efficiently convey farm surface runoff to receiving watercourses. Allowing stock access to water and riparian margins will also degrade water quality through deposition of sediment (bank erosion), increased nutrient input, increased faecal contamination and reduced water clarity. Otago Regional Council's Land Resource section are working closely with farmers and landowners to improve water quality. Field days, catchment group meetings and sampling at property boundaries all play a part in encouraging landowners to adopt best management practices. On the other hand the Compliance section ensure that breaches of Council rules are investigated and appropriate measures taken.

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1 Introduction

The 2003-2004 Annual Plan required that water quality in the Waipahi and Pomahaka River catchments be investigated. The Heriotburn, Crookstonburn, Lower Kaihiku Stream and lower Wairuna Stream are also listed as waterbodies in need of enhancement under Policy 7.6.2 of the *Regional Plan: Water*.

This report presents the results and findings of three water quality monitoring programmes undertaken in the Waipahi and Pomahaka catchments[1] between April 2000 and May 2003.

- The Wairuna Catchment Monitoring Programme (April 2000 to February 2002).
- The Waipahi-Clydevale Catchment Monitoring Programme (October 2002 to October 2003).
- The Heriotburn/Crookstonburn Catchment Monitoring Programme (May 2000 to May 2002).

1.1 Aims and Objectives

The principal aim of the monitoring programmes was to assess water quality in the catchments. Specific objectives included:

- To determine the state (health) of water quality through comparison of water quality data against the Australia and New Zealand Conservation Council Water Quality Guidelines (2000).
- To examine spatial and temporal trends in water quality.
- To identify sites of poor water quality and attempt to identify the causes of water quality problems.

1.2 Background Information

The three monitoring programmes focus on catchments which, during the last ten to fifteen years, have undergone an enormous change in landuse practice. The changing predominant land use, dairying, is likely to have more of an impact on water quality than the former sheep grazing as the nutrient loading on the land is higher. South Otago is also extensively tile drained, these drains are able to transport contaminants such as excess effluent and discharge it directly to the local watercourse. Finally there is also a history of a lack of appropriate riparian management in the catchments i.e; allowing bankside grazing which promotes bank erosion.

Council staff have been working with landowners, Department of Conservation, Fish and Game and local iwi to improve water quality in these catchments. Community catchment programmes aim to encourage the adoption of good landuse management practices and Otago Regional Council staff have organised field days, sub-catchment group meetings and newsletters to promote awareness. The Otago Regional Council's Compliance section also have a role to play through the inspection of dairy farms, consented activities and follow up of pollution complaints and ensuring that breaches of Council rules are investigated and appropriate measures taken.

[1] In the context of this report the Pomahaka catchment also incorporates the Waiwera and Kaihiku catchments.

1.3 Physico-chemical, Microbiological and Biological Monitoring

The Otago Regional Council has monitored physico-chemical and microbiological water quality in the Pomahaka catchment since 1997. Monitoring is typically carried out at bi-monthly intervals with samples tested for a range of physico-chemical parameters including dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, suspended solids, nutrients and faecal bacteria. Biological monitoring of riverbed periphyton and macroinvertebrate communities is undertaken annually.

1.4 Sampling Methods

Spot sampling was conducted at all sites (Figure 1.1). Water samples were stored on ice upon collection and transported to the Otago Regional Council's contracted laboratories for analysis within 24 hours of collection. Field measurements (dissolved oxygen, temperature and conductivity) were taken using approved water quality meters.

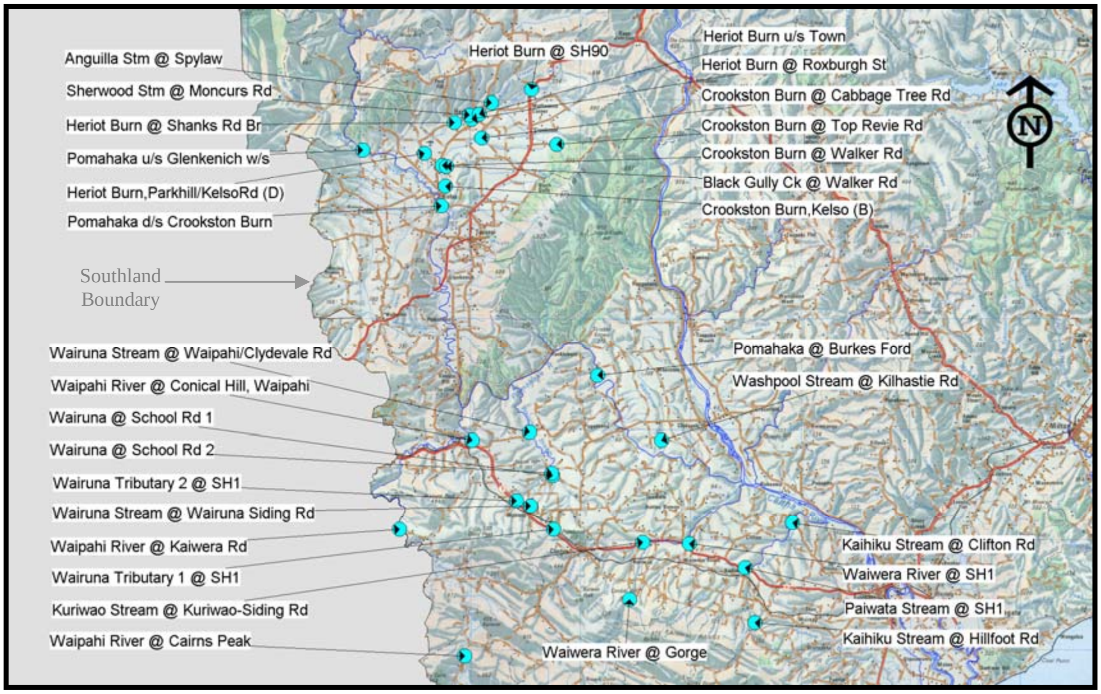

Figure 1.1 Location of physico-chemical and microbiological water quality monitoring sites sampled between April 2000 and October 2003

Periphyton sampling was conducted by pooling the scrapings from three randomly selected cobbles of approximately 5 cm^2 in area. Samples were identified and the relative abundance of each different taxa assessed using methodology developed by Biggs and Kilroy (2000). Macroinvertebrate samples were collected and processed in accordance with Protocols C1 and P1 of the Ministry for the Environment's Protocol for Sampling Macroinvertebrates in Wadeable Streams (Stark *et al*. 2001). This involved kick-net sampling 0.6-1.0 m^2 of substrate from a riffle habitat at each monitoring site.

1.5 Monitoring Analytes

Water samples were tested for a range of physico-chemical and microbiological parameters. These included dissolved oxygen (DO), temperature, conductivity, pH, visual clarity, suspended solids (SS), turbidity, faecal coliforms (FC), *Escherichia coli* (*E. coli*), 5-day biochemical oxygen demand (BOD), ammoniacal nitrogen (NH_4), nitrite-nitrate nitrogen (NNN), total nitrogen (TN), dissolved reactive phosphorus (DRP) and total phosphorus (TP).

1.6 Data Analysis

Summary statistics were tabulated for all water quality data with non-detect values taken as being half the detection limit (e.g. a result reported as <0.1 mg/l is taken as 0.05 mg/l).

Raw data has been summarised in box plot format, the box plot is used as it gives a quick impression of the magnitude of data, the amount of spread and the symmetry. A box encloses the middle 50% of data. The median is drawn as a vertical line inside the box. The mean is drawn as a cross, which tends to occur inside the box. Horizontal lines, known as whiskers extend from each end of the box. The left (or lower) whisker is drawn from the first quartile to the smallest point within 1.5 interquartile ranges from the lower quartile. The other whisker is drawn from the upper quartile to the largest point within 1.5 interquartile ranges from the upper quartile. Any individual values that fall beyond the whiskers, (outliers) are shown as small squares

Median results were graphed by site for selected water quality analytes and time series plots were used to illustrate the results over the course of the monitoring programmes.

1.7 Results

A summary of the physico-chemical and microbiological water quality results for the three catchment programmes are shown in both tabular and graphical form. Periphyton and macroinvertebrate sampling results are also shown.

Minimum, *median* and maximum results of key water quality analytes are compared against the Australian and New Zealand Guidelines for Fresh Water Quality (ANZECC 2000). The guidelines set default trigger values for slightly disturbed (modified) lowland (<150m altitude) river ecosystems in New Zealand. It should be noted that exceedances of these values does not necessarily mean adverse effects would occur, but that the exceedance should “trigger” further investigation which may or may not result in the need for remedial action (ANZECC 2000).

The ANZECC 2000 Guidelines emphasise that the best reference conditions are set by locally appropriate data. The guidelines therefore recommend deriving *site-specific* trigger values for different catchments, this has not been possible for the three catchments as there are no long-term monitoring sites in the upper reaches of any of these streams.

2 Wairuna Catchment Surface Water Quality Monitoring

2.1 Catchment Description

The Wairuna Stream rises in the Kaihuku Range to the north-west of Clinton and its upper catchment is characterised by light grazing by sheep and cattle, tussock grasslands surround most of the upper reaches. Further downstream, the intensity of land use increases with smaller farms, smaller paddocks and more stock. Dairy farming has expanded rapidly over the last 5-10 years.

2.2 Water Quality Monitoring:

Routine State of the Environment (SOE) water quality monitoring began in mid 1997. The principal monitoring site was located at Waipahi-Clydevale Road towards the bottom of the catchment. Additional monitoring was carried out between 6 April 2000 and 11 February 2002 as part of the Land Resource Section's *Wairuna Catchment Programme*. Water quality was monitored at six sites:

- Wairuna Tributary 1 at State Highway 1
- Wairuna Tributary 2 at State Highway 2
- Wairuna Stream at Siding Road
- Wairuna Stream at School Road 1
- Wairuna Stream at School Road 2
- Wairuna Stream at Waipahi/Clydevale Road

Figure 2.1 Location of physico-chemical, microbiological and biological water quality monitoring sites. Tributaries 1 and 2 and School Road 1 and 2 were sampled for physico-chemical parameters only

Sampling varied from approximately three-monthly intervals in the early stages of the programme to monthly intervals over the period September 2001 to February 2002 inclusive.

2.3 Monitoring Results

A summary of the water quality results for the Wairuna catchment is shown in Table 2.1. Full results are located in Appendix 2.

Table 2.1 Median water quality results for the Wairuna catchment, April 2000-February 2002 (n=5-12), with long term median values (July 1997-May 2002) for the baseline site at Waipahi-Clydevale Road indicated in brackets and exceedances of relevant guideline values indicated in bold type.

Parameter	Wairuna Catchment Sampling Sites						
	Trib. 1 @ SH1	**Trib. 2 @ SH1**	**Siding Road**	**School Road 1**	**School Road 2**	**Waipahi/ Clyde. Rd**	**ANZECC 2000*** **
Conductivity (mS/cm)	0.1125	0.109	0.124	0.1785	0.1605	0.172 (0.166)	None
Dissolved Oxygen (mg/l)	10.6	10	11.05	10.2	10.35	10.4 (11.3)	None
Diss. Reac.Phosphorus (mg/l)	0.006	**0.022**	0.008	**0.059**	**0.029**	**0.02 (0.026)**	0.010
E. coli (n/100ml)	**645**	**1400**	**860**	**1450**	**1650**	**665 (460)**	550*
Faecal Coliforms (cfu/100ml)	**365**	**600**	**260**	**1000**	**580**	**510 (425)**	100**
Ammoniacal Nitrogen (mg/l)	0.02	0.02	0.021	**0.22**	**0.08**	**0.05 (0.05)**	0.021
Nitrite Nitrate Nitrogen mg/l	0.37	0.44	**0.94**	**1.04**	**0.99**	**0.97 (0.97)**	0.444
PH	7.2	7.05	6.9	7.15	7.2	7.4 (7.4)	7.2-7.8
Suspended Solids (mg/l)	3.5	8	8	15	18	8 (11.0)	None
Total Nitrogen (mg/l)	0.595	**0.725**	**1.4**	**1.9**	**1.65**	**1.5 (1.5)**	0.614
Total Phosphorus (mg/l)	0.0295	**0.059**	0.033	**0.187**	**0.143**	**0.133 (0.129)**	0.033
Turbidity (NTU)	**5.785**	**7.395**	**6.7**	**13**	**16.75**	**11.35 (11.8)**	5.6

*Action/Red Mode – Ministry of Environment/Ministry of Health (2003) Recreational Water Quality Guidelines
**Median default trigger value – ANZEEC 2000 Stockwater Drinking Guidelines
*** ANZECC 2000 default trigger values for lowland streams

It should be noted that monitoring parameters changed during the course of the programme, with some analytes (i.e., FC, SS) being dropped after five sampling rounds and others (i.e., *E. coli*, TN, TP) being added.

From Table 2.11 it can be seen that water quality is highest at the top of the catchment (Tributaries 1 and 2 at SH1), although Tributary 2 has elevated TN, TP, DRP and *E.coli*. The Wairuna Stream at Wairuna Siding Road is comparable to the two tributaries, although TN and NNN are found at higher concentrations at this site. The mid catchment area sampling sites (School Roads 1 and 2) show a deterioration in water quality, in particular TP, TN, SS, NNN and NH_4. At the downstream site (Waipahi/Clydevale Road) water quality has improved, although this may be a factor of dilution as flows are higher at this site.

At all sites the median bacteria concentrations exceed the ANZECC 2000 stockwater drinking guidelines (100 FC/100ml). The Ministry of Environment/Ministry of Health (MfE/MoH) Recreational Water Quality Guideline values are also exceeded (action red mode is 550 *E. coli/100ml)*, however these guidelines were devised for recreational waters and it should be stressed that the streams being monitored are not used for recreational activities.

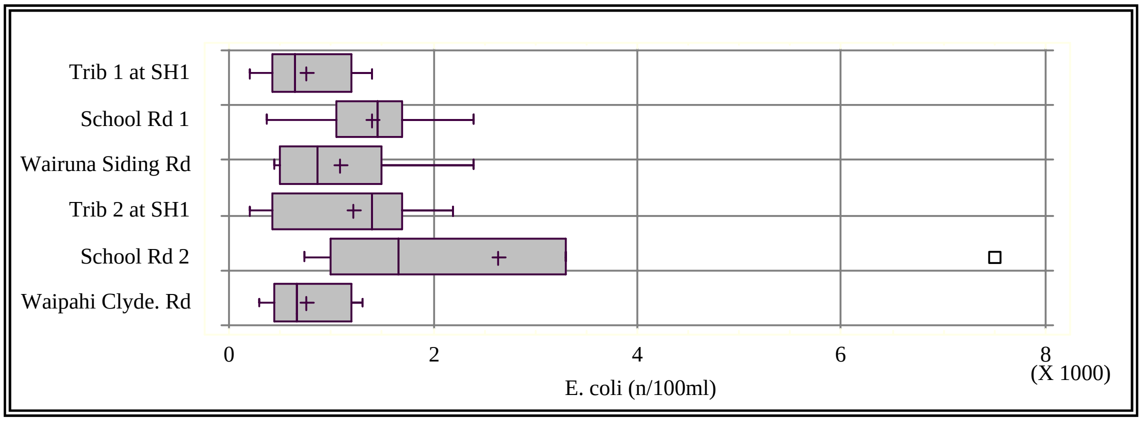

Figure 2.2 Box and whisker plot of *E. coli* concentrations at various sites in the Wairuna catchment between April 2000 and February 2002

Figure 2.2 clearly shows that median *E. coli* bacteria concentrations were highest at School Road 2 (1650 *E. coli*/100ml), however at all sites the median concentrations are significantly higher than the Action/Red Mode of the MfE/MoH 2003 Recreational Water Quality Guidelines. Figure 2.3 shows the same pattern with an elevated mean concentration of *E. coli* at School Road 2.

Figure 2.4 shows that there was no clear correlation between *E. coli* concentration and flow in the Waipahi River, or *E. coli* concentration and rainfall (measured at Warepa over the previous 48 hours). Elevated *E. coli* concentrations in these streams is likely to be due to variables such as stock in stream or intermittent discharges from tile drains.

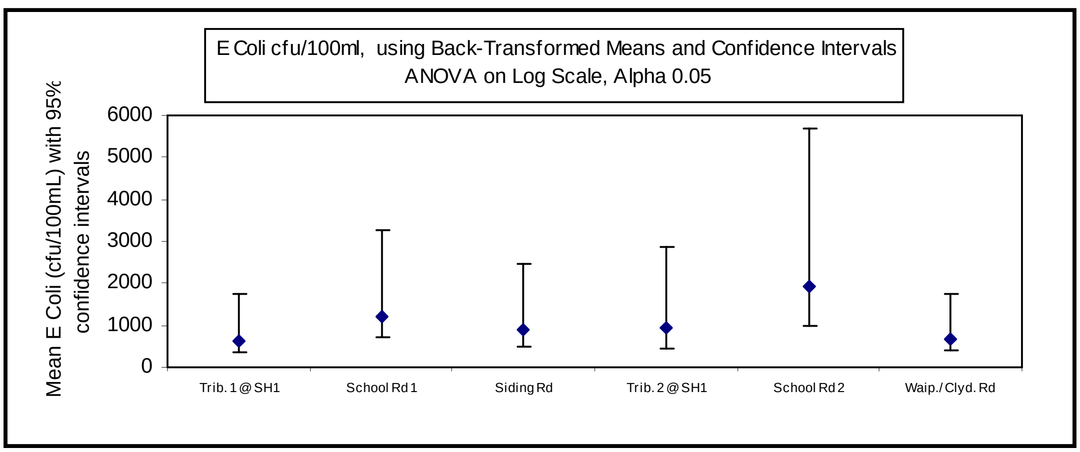

Figure 2.3 *E. coli* bacteria concentrations (back transformed means and confidence intervals, using ANOVA on log scale, alpha 0.05) recorded at various locations in the Wairuna between April 2000 and February 2002

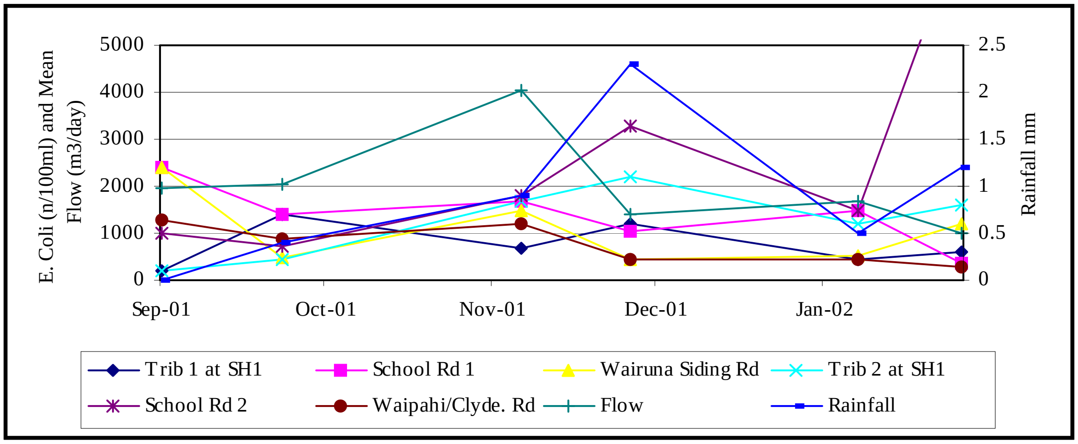

Figure 2.4 E*. coli* bacteria concentrations recorded at various locations in the Wairuna between April 2000 and February 2002, total rainfall mm recorded at Warepa over the preceding 48 hours and total mean flow recorded in the Waipahi River at Waipahi

Table 2.1 and Figure 2.5 show that median turbidity exceeds the ANZECC 2000 default trigger value (5.6 NTU) at all of the sampling sites. School Road 2 has the poorest clarity, being more than three times the ANZECC 2000 default trigger value.

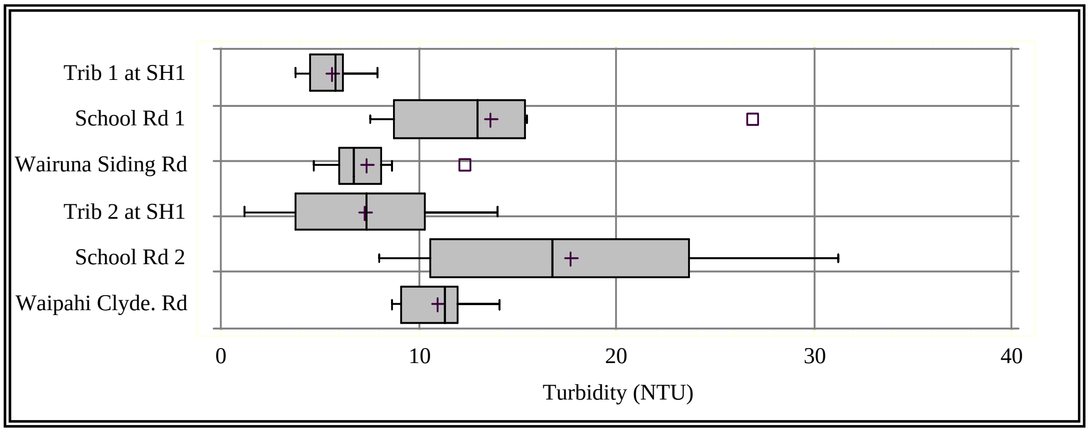

Figure 2.5 Box and whisker plot of median turbidity concentrations recorded in the Wairuna catchment between April 2000 and February 2002

Figure 2.6 and Figure 2.8 show that water quality in Wairuna Stream at Wairuna Siding Road has high nitrite-nitrate nitrogen (NNN) and total nitrogen (TN) concentrations, otherwise water quality in this stream is similar to the two tributaries.

Table 2.1 and Figure 2.6 to Figure 2.10 indicate that median nutrient concentrations i.e., NNN, NH_4, TN, DRP and TP exceed the ANZECC 2000 default trigger values at School Road 1, School Road 2 and the downstream site at Waipahi/Clydevale Road.

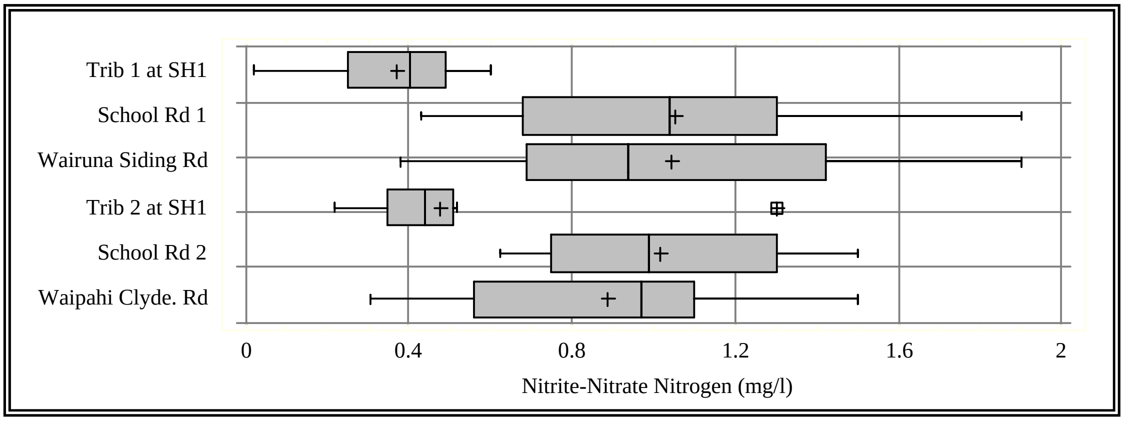

Figure 2.6 Box and whisker plot of median nitrite-nitrate nitrogen concentration in the Wairuna catchment between April 2000 and February 2002

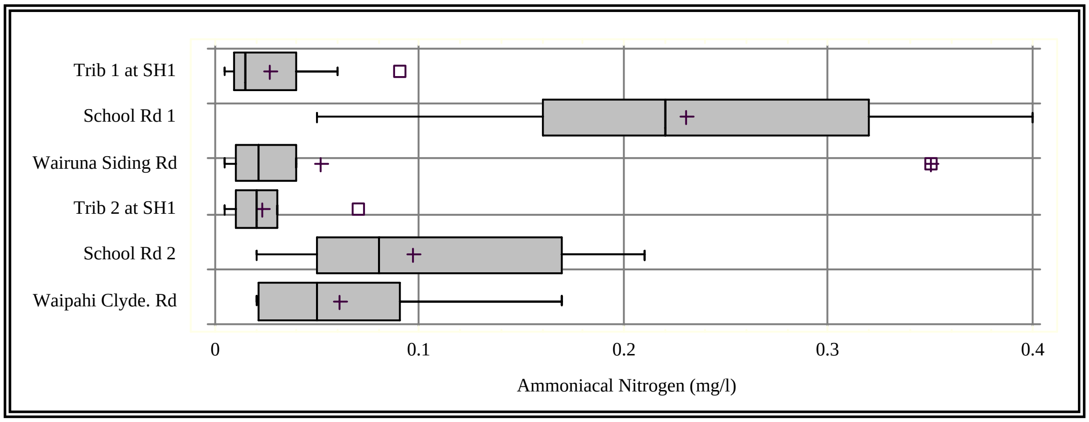

Figure 2.7 Box and whisker plot of median ammoniacal nitrogen concentrations in the Wairuna catchment between April 2000 and February 2002

Figure 2.7 shows that School Road 1 has extremely high NH_4 concentrations compared to the other sites, the lower concentration found at School Road 2 is due to the influence of the Wairuna Stream and Tributary 2 both of which have relatively low concentrations of NH4.

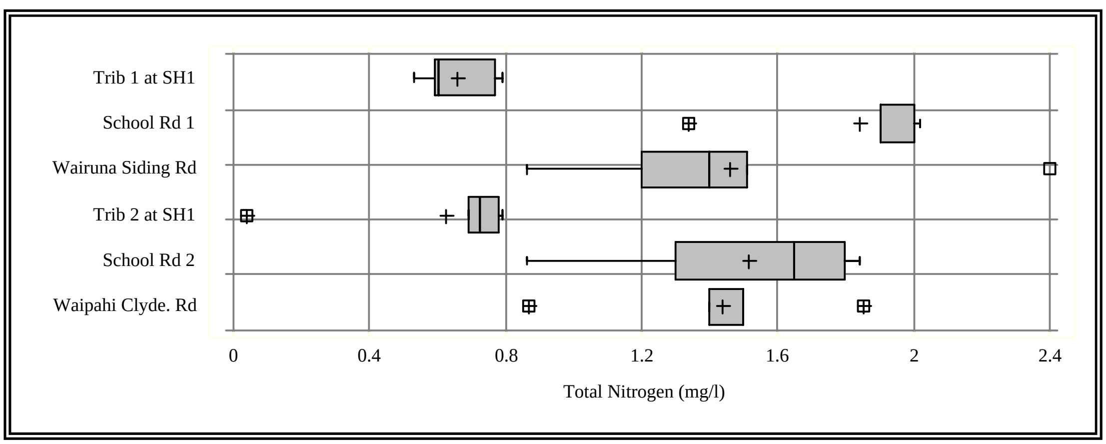

Figure 2.8 Box and whisker plot of median total nitrogen concentration in the Wairuna catchment between April 2000 and February 2002

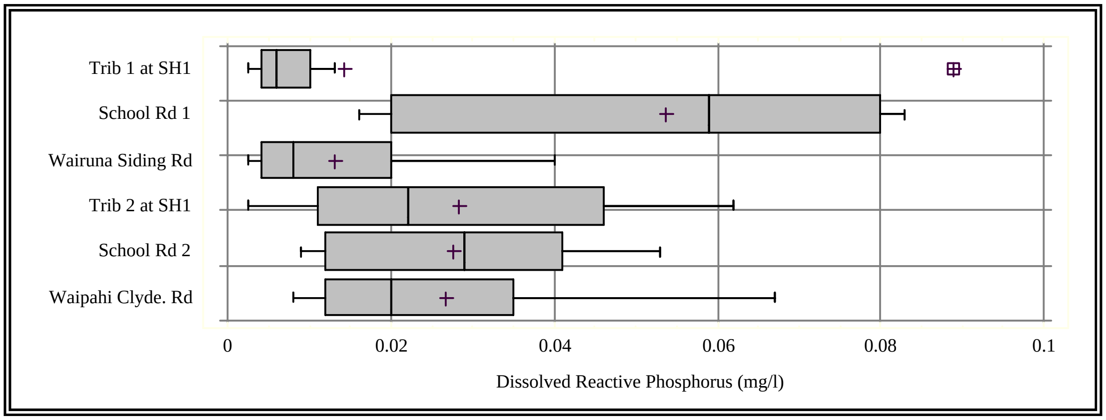

Figure 2.9 Box and whisker plot of median dissolved reactive phosphorus concentration recorded in the Wairuna catchment between April 2000 and February 2002

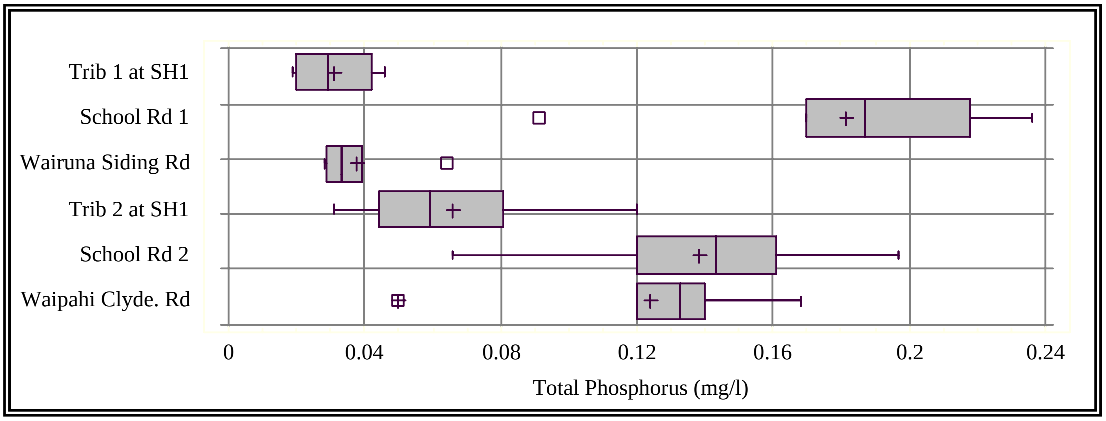

Figure 2.10 Box and whisker plot of median total phosphorus concentration recorded in the Wairuna catchment between April 2000 and February 2002

Figure 2.9 and Figure 2.10 show that School Road 1 has the most elevated median dissolved reactive phosphorus (DRP) and total phosphorus (TP) concentrations, however all sites other than Tributary 1 and Siding Road exceed ANZECC 2000 default trigger values.

2.4 Biological Sampling

In addition to water quality sampling, the macroinvertebrate and periphyton communities are also monitored on an annual basis at two sites in the Wairuna. The March 2002 macroinvertebrate results support the physico-chemical sampling results, i.e, that water quality in Wairuna Stream is poor towards the bottom of the catchment. At the upstream site (Wairuna-Siding Road) pollution sensitive mayflies (*Deleatidium* sp*p.)* and caddisflies (*Psilochorema* spp.) were very abundant indicating that the upper reaches of the stream offer reasonable water quality and habitat for aquatic biota. The downstream site at Waipahi-Clydevale Road was dominated by snails and oligochaete worms, which reflects not only the poor water quality at this site, but also the poor habitat (the stream is muddy bottomed and channelised). The periphyton community was dominated at Wairuna Siding Road by *Navicula avenacea, which* is widespread and common, at Waipahi-Clydevale Road the community is dominated by *Oedogonium* which is normally associated with fairly enriched conditions.

Table 2.2 Periphyton abundance values for samples taken from the Wairuna Stream, 2001 to 2002

		2001	2001	2002
River/Site Code		**WA1**	**WA2**	**WA2**
Genus list				
	Cladophora			1
	Mougoetia		4	
	Oedogonium			8
Red/Brown Algae	*Audouinella*	5		
Non-filamentous	*Closterium*	1		
	Achnanthidium linearis	3	4	2
Diatoms	*Cocconeis placentula*		8	
	Cocconeis spp.			2
	cf. *Diatoma*		3	
	Fragilaria (small)			1
	Gomphoneis spp			2
	Gomphonema spp (small)	4	8	6
	Gomphonema cf. *truncatum*			2
	Melosira varians		6	7
	Navicula avenacea	8		4
	Navicula spp. (small)		4	
	Nitzschia spp. (skinny)	4		3
	Nitzschia spp. (needle shape)			4
	Rhoicosphenia	4	5	1
	Surirella cf brebissonii			2
	Synedra ulna	4		3
Cyanobacteria	*Phormidium*	2	3	
WA1 – Wairuna at Wairuna Siding Rd, WA2 - Wairuna at Waipahi/Clydevale Rd				

Table 2.3 Species richness, macroinvertebrate community index (MCI) and semi quantitative macroinvertebrate community inded (SQMCI) values for invertebrate samples collected from Wairuna Stream in March 2002

Biological Index	Wairuna-Siding Rd (riffle/run)	Waipahi-Clydevale Rd (run)
***Species Richness*:** number of taxa present	19	24*
MCI: a sensitivity score based solely on the number of different taxa present	91.6	76.7*
***SQMCI*:** a sensitivity score based on the number of different taxa present and the relative abundance of each taxon.	5.39	3.89*
Interpretation of Scores (Stark 1998): • MCI>120 o SQMCI>6 = clean water • MCI>100-120 or SQMCI 5-6 = doubtful quality or possible mild pollution • MCI 80-100 or SQMCI 4-5 = probable moderate pollution • MCI <80 or SQMCI <4 = probable severe pollution		

* Based on a grab sample only (i.e., not a truly representative sample) and collected from a run (rather than a riffle for which these biological indices were designed)

2.5 Discussion

Water quality in the Wairuna catchment is poor. From Table 2.1 it can be seen that at all six locations ANZECC default trigger values are breached and median bacteria concentrations exceed the recommended stockwater and MfE/MoH action/red mode recreational water quality guideline values (550 *E.coli*/100ml).

The upper catchment sites of the Wairuna Stream (Tributaries 1 and 2) had the best water quality, however both tributaries had elevated concentrations of bacteria and Tributary 2 had elevated concentration of TP. Water quality in the Wairuna Stream at Wairuna Siding Road had high NNN and TN concentrations, otherwise the water quality is similar to the two tributaries.

The two School Road sites have the poorest water quality, the water is turbid and bacteria, suspended solids, phosphorus and nitrogen concentrations are all very high, particularly at School Road 1. At this site nutrient concentrations were particularly high when compared to ANZECC 2000 default trigger values. The upstream site (Wairuna Tributary 1) had no nutrient exceedences therefore there is a large input between these two sites.

Total phosphorus concentrations follow the same pattern, increasing by more than six times between the Tributary 1 site and School Road 1. The increase in nutrients is likely to be due to a combination of management practices in terms of effluent disposal, exacerbated by the tile drain network, which acts as a conduit, discharging directly into the watercourse.

Water quality also decreases between Tributary 2/Siding Road and School Road 2. However it should be noted that School Road 1 will also have a significant effect on the water quality at School Road 2. Water quality in Wairuna Stream at Waipahi/Clydevale Road is also poor with elevated nitrogen, phosphorus and turbidity levels.

Possible causes for poor water quality are discussed in detail in section 5.0.

Almost all streams and rivers deteriorate in invertebrate community 'richness' with distance downstream, this is commonly attributed to stream warming, nutrient enrichment, decreasing current velocity as gradient declines, decreasing dissolved oxygen and decreasing substrata particle sizes. The diversity of the macroinvertebrate community of the Wairuna Stream at Wairuna-Siding Road is higher than at Waipahi-Clydevale Rd however at both sites diverse invertebrate communities are limited by habitat.

The MCI was developed for stony streams, the habitat represented at the Waipahi-Clydevale Road sampling site is soft bottomed and samples are taken from a run/pool, therefore it is not entirely surprising that the MCI index at this site is low.

Tributary 1 at State Highway 1

Tributary 2 at State Highway 2

Wairuna Stream at Waipahi/Clydesvale Rd

Wairuna Stream at Wairuna Siding Rd

Wairuna Stream at School Rd 2

Figure 2.11 Photographs taken at various locations in the Wairuna catchment

3 Waipahi/Clydevale Catchment Monitoring Programme

3.1 Catchment Description

The Waipahi River rises in the Kaihiku and Wisp Ranges to the southwest of Clinton discharging into the Pomahaka to the south of Conical Hill. The upper Waipahi catchment is characterised by extensive sheep and cattle grazing amongst areas of improved pastoral development which are intermingled with patches of remnant red tussock grasslands and wetlands and the occasional patch of beech forest. Several smaller waterways including the Wairuna, Kuriwao, Waiwera, Kaihiku and Washpool dissect the rolling downlands that make up the bulk of the Clydevale- Waipahi area west of the Kaihiku Range. The Wairuna and the Washpool discharge to the Pomahaka River and the remainder direct to the Clutha River. Landuse through the downland areas is generally more intensive than in the upland areas and includes sheep and beef, dairy, deer and cropping units.

3.2 Water Quality Monitoring:

Routine State of the Environment (SOE) water quality monitoring began in 1997. The principal monitoring sites were the Kaihiku Stream at Clifton Road and Waipahi at Conical Hill. Additional monitoring was carried out between October 2002 and October 2003 as part of the Land Resource section's Waipahi-Clydevale Catchment Programme. Water quality was monitored at ten sites:

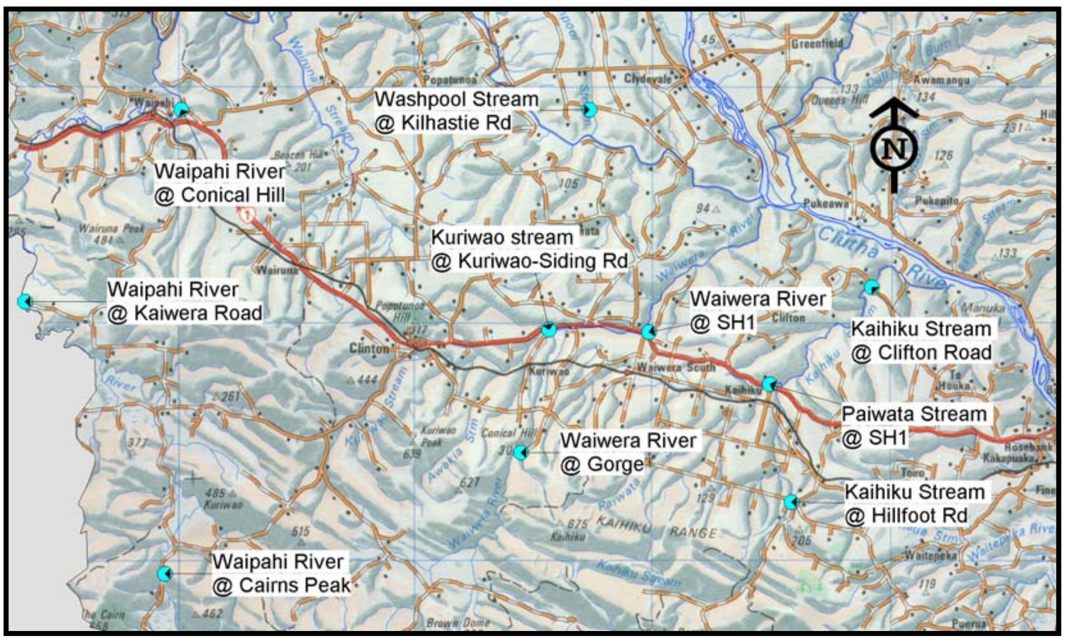

Figure 3.1 Location of physico-chemical, microbiological and biological water quality monitoring sites. The Washpool, Paiwata Stream, Kuriwao Stream and Waipahi at Conical Hill were sampled for physico-chemical parameters only.

- **Kaikihu Catchment**: Kaikihu Stream at Clifton Rd (SOE site), Kaikihu Stream at Hillfoot Rd, Paiwata Stm at SH1.
- **Waiwera Catchment**: Waiwera River at Gorge, Waiwera River at SH1 (SOE site), Kuriwao Stream at Kuriwao-Siding Rd.

- **Waipahi Catchment**: Waipahi River at Cairns Peak, Waipahi River at Kaiwera Rd, Waipahi River at Conical Hill, Waipahi (SOE site).
- **Washpool Catchment**: Washpool Stream at Kilhastie Rd.

Sampling was undertaken monthly from October 2002 to October 2003, apart from January 2003 during which two complete sampling runs were organised (15th and 30th).

3.3 Monitoring Results

A summary of the water quality results for the Waipahi-Clydevale area is given in Table 3.1. Full results are shown in Appendix 2.

Table 3.1 Median water quality results for the Waipahi/Clydevale catchment, October 2000-October 2002 (*n*=14), with longterm medians for the two baseline sites indicated in brackets and exceedances of the ANZECC 2000 default trigger values for lowland rivers figures indicated in bold type

Site	Turbidity (NTU)	*E. coli* (n/100ml)	Ammonia N (mg/l)	Nitrite-Nitrate N (mg/l)	Total N (mg/l)	Dissolved Reactive P (mg/l)	Total P (mg/l)
*ANZECC 2000**	5.6	550†	0.021	0.444	0.614	0.010	0.033
Waipahi River							
Cairns Peak	3.7	240	0.01	**0.579**	0.93	0.003	0.029
Kaiwera Rd	3.8	130	0.015	**0.899**	**1.375**	0.007	0.025
Conical Hill	3.15 (3.7)	130 (330)	0.02 (0.02)	**1.065 (0.960)**	**1.455 (1.4)**	0.006 (0.008)	0.021 **(0.037)**
Waiwera River and Tributaries							
Gorge	3.05	110	0.02	**0.794**	**1.105**	0.009	0.029
Kuriwao Stream u/s Waiwera Conflu.	3.6	260	0.02	**0.869**	**1.37**	**0.017**	**0.05**
SH1	3.55	340	**0.025**	**0.764**	**1.21**	**0.011**	**0.044**
Kaihiku Stream and Tributaries							
Hillfoot Rd	2.65	270	0.015	0.157	0.395	0.003	0.018
Paiwata Stream at SH1	5.55	500	**0.03**	**0.811**	**1.405**	**0.018**	**0.066**
Clifton Rd	3.2 (3.6)	250 (275)	0.02 **(0.023)**	**0.537 (0.495)**	**1.04 (0.78)**	**0.019 (0.015)**	**0.055 (0.051)**
Washpool							
Kilhastie Rd	**13**	440	**0.09**	**1.062**	**2.44**	**0.052**	**0.281**

† Action/Red Mode - Ministry for Environment/Ministry of Health 2003 Recreational Water Quality Guidelines
*Default Trigger Value for Lowland Rivers

It should be noted that faecal coliform data has not been presented due to sporadic sampling at limited locations.

3.4 Waipahi River

Table 3.1 shows that median *E. coli* bacteria concentrations were highest at the uppermost site at Cairns Peak, concentrations then decreased with distance downstream. Median values are significantly lower than the Action/Red Mode of the MfE/MoH 2003 Recreational Water Quality Guidelines and mean concentrations show the same pattern

(Figure 3.2, sites 1, 2 and 3). Figure 3.2 shows that the high concentrations of *E. coli* on the 12th December coincided with the highest flows in the Waipahi River, however this pattern was not repeated during the next high flow period (9th July).

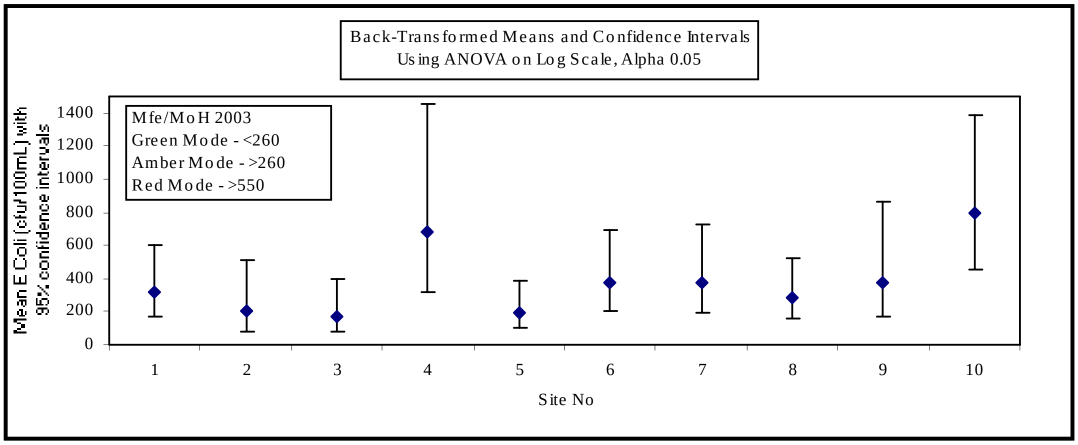

Figure 3.2 ***E. coli* bacteria concentrations (back transformed means and confidence intervals, using ANOVA on log scale, alpha 0.05) recorded at various locations in the Waipahi-Clydevale catchment (see Table 3.2) between May 2000 and May 2002**

Table 3.2 Site numbers and associated site names

Site Number	Site Name
1	Waipahi River at Cairns Peak
2	Waipahi River at Clement Road
3	Waipahi River at Waipahi
4	Washpool Stream
5	Waiwera River at Gorge
6	Kuriwao Stream upstream of Waiwera
7	Waiwera River at State Highway 1
8	Kaihiku Stream at Hillfoot Road
9	Paiwata Stream at State Highway 1
10	Kaihiku Stream at Clifton Road

Note: Site numbers are used rather than site names in some graphs

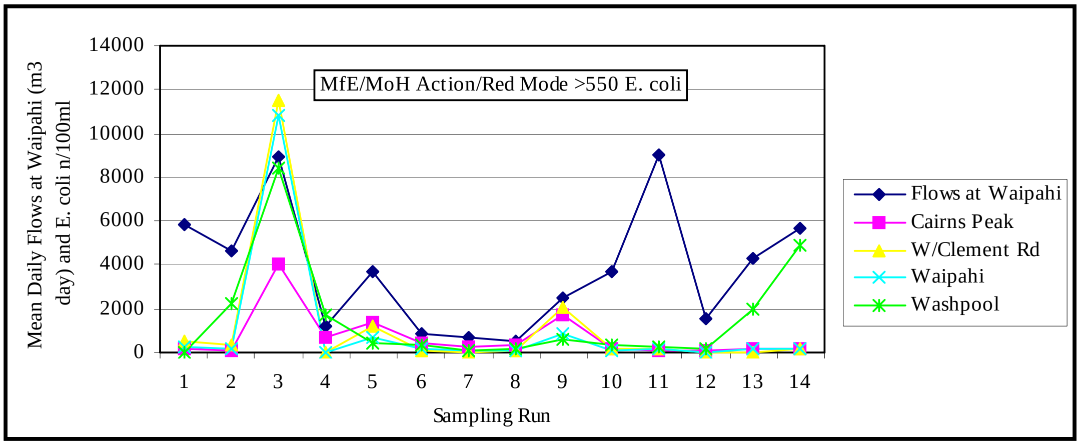

Figure 3.3 Mean river flows in the Waipahi River at Waipahi and *E. coli* bacteria concentrations (see Table 3.3) in the Waipahi, Waiwera, Kaihiku and Washpool between October 2002 and October 2003

Table 3.3 Rainfall data at the Warepa Gauge and flows in the Waipahi River at Waipahi

Sample Run	Date	Rainfall mm at Warepa		Flows in Waipahi at Waipahi (m^3/day)
		Preceding 48 hours	Preceding 10 days	
1	21 October 2002	6.9	26.2	5870
2	19 November 2002	6.2	50.9	4667
3	16 December 2002	19.8	65.6	8925
4	15 January 2003	2.9	27.2	1206
5	30 January 2003	6.1	31	3701
6	13 February 2003	0.5	3.3	883
7	18 March 2003	0	5.7	680
8	9 April 2003	0.5	31.9	499
9	21 May 2003	7.9	19.5	2451
10	10 June 2003	0.6	21.3	3705
11	9 July 2003	1.6	28.6	8976
12	13 August 2003	1.4	4.2	1575
13	10 September 2003	11.2	24.7	4270
14	9 October 2003	0.1	41.3	5640

Note: Various graphs use the sample run rather than the date

Table 3.1 shows that water quality is highest at the uppermost site (Cairns Peak) and deteriorates with increasing distance downstream. This trend is most evident in the median nitrite-nitrate nitrogen, ammoniacal nitrogen and total nitrogen concentrations recorded at each site. (Figure 3.4, 3.5, and Figure 3.6 respectively).

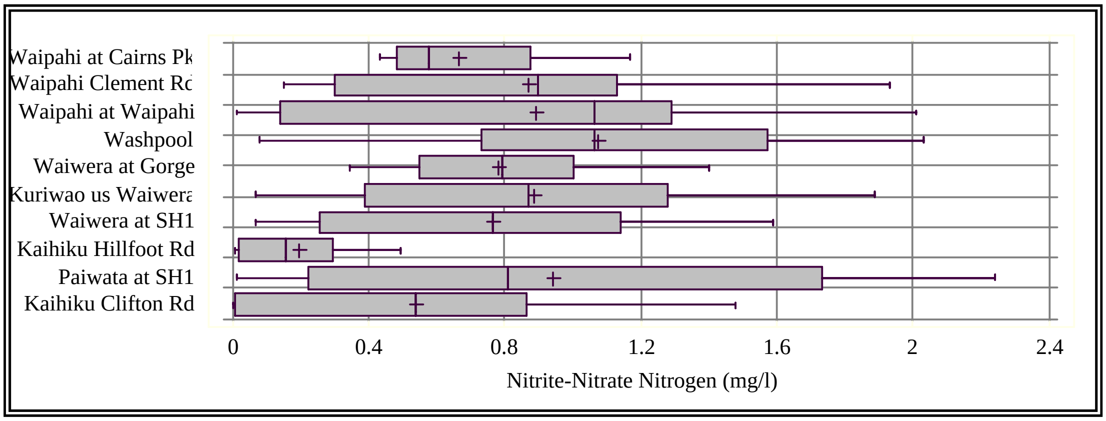

Figure 3.4 Box and whisker plot of nitrite-nitrate nitrogen concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

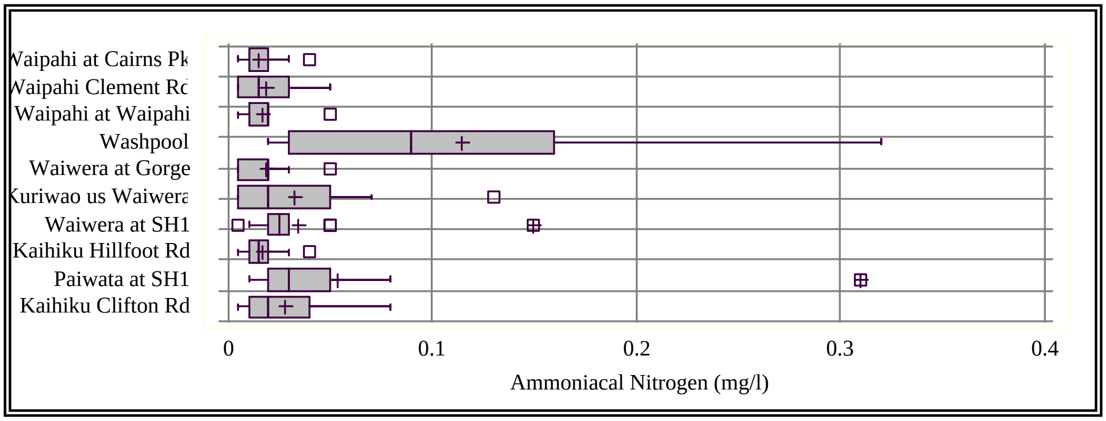

Figure 3.5 Box and whisker plot of ammoniacal nitrogen concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

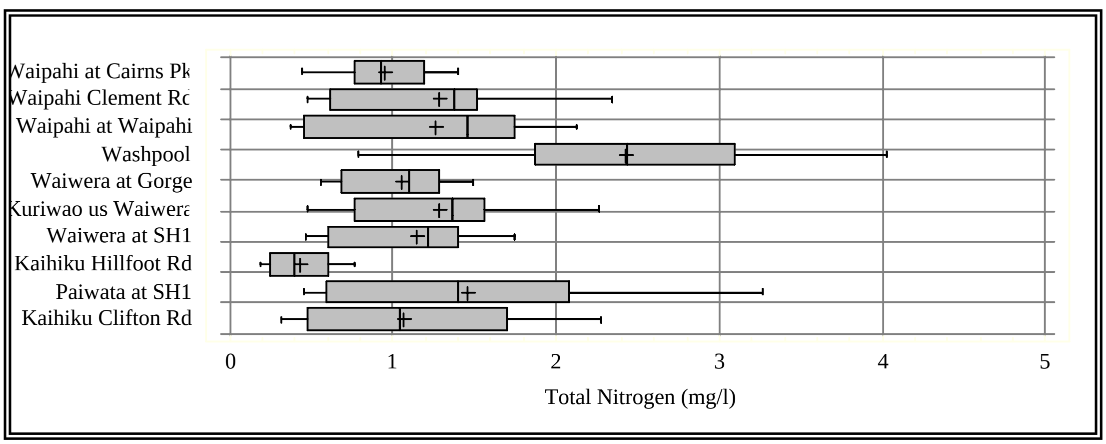

Figure 3.6 Box and whisker plot of total nitrogen concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

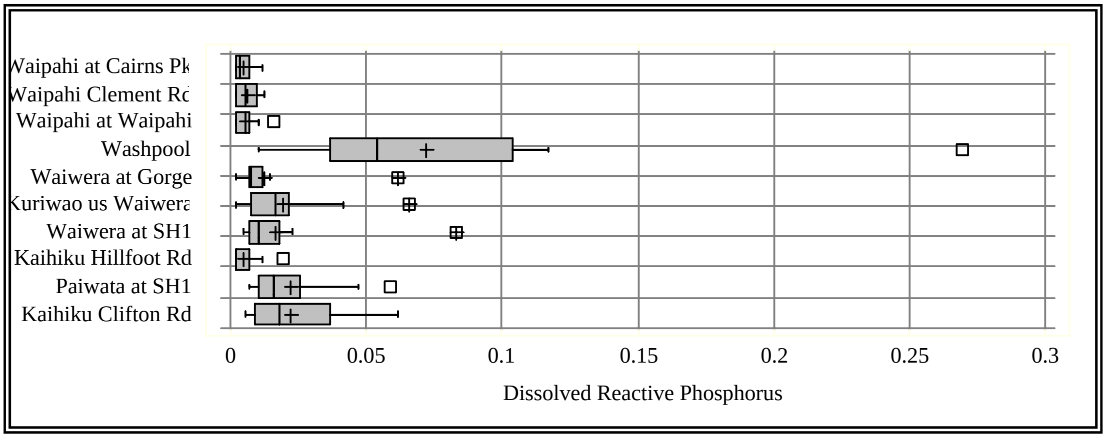

Figure 3.7 Box and whisker plot of dissolved reactive phosphorus concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

Phosphorus concentrations in the Waipahi were consistently below ANZECC default trigger values (DRP 0.010 mg/l and TP 0.033 mg/l) at all the sites, other than the long term monitoring site at Conical Hill (Waipahi at Waipahi). The median at this site just exceeded the trigger value for TP (0.037 gm/l).

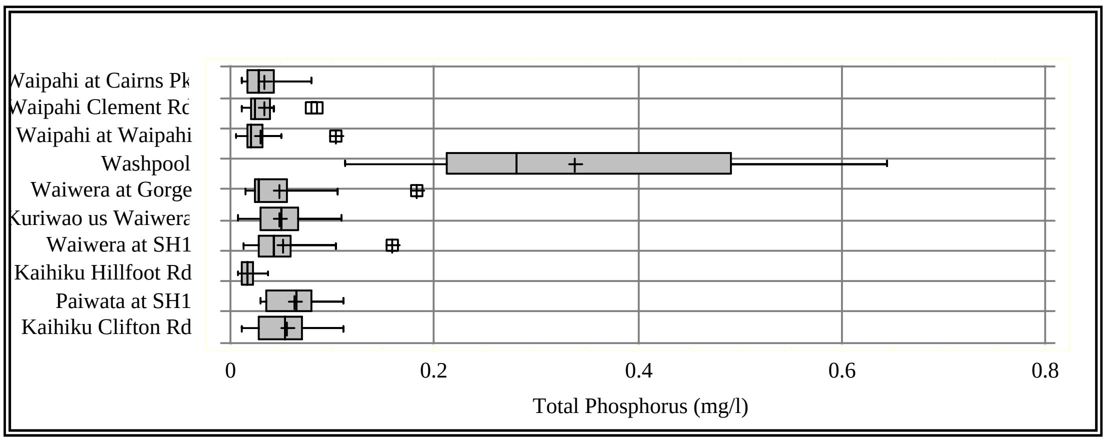

Figure 3.8 Box and whisker plot of total phosphorus concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

3.5 Waiwera River and Tributaries

Figure 3.9 shows that *E. coli* concentrations are below the MfE/MoH Action/Red Mode level of the recreational water quality guideline at all sites (500 n/100ml). However the median level of *E. coli* in the downstream site (SH1) is over three times the median concentration found at the upstream site. Figure 3.2 shows that there is a marked increase in the mean concentration of *E. coli* between sites five (Waiwera at Gorge) and site seven (Waiwera at SH1), the Kuriwao recording a mean concentration at a similar level to the SH1 site. Figure 3.10 indicates that *E.coli* concentrations in the Waiwera catchment closely follow the rainfall recorded at Warepa during the previous 48 hours.

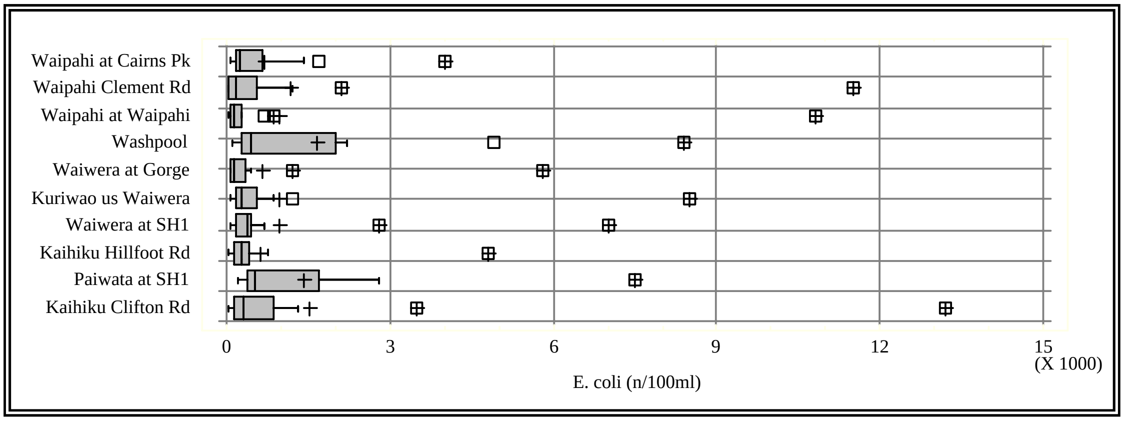

Figure 3.9 Box and whisker plot of *E. coli* concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

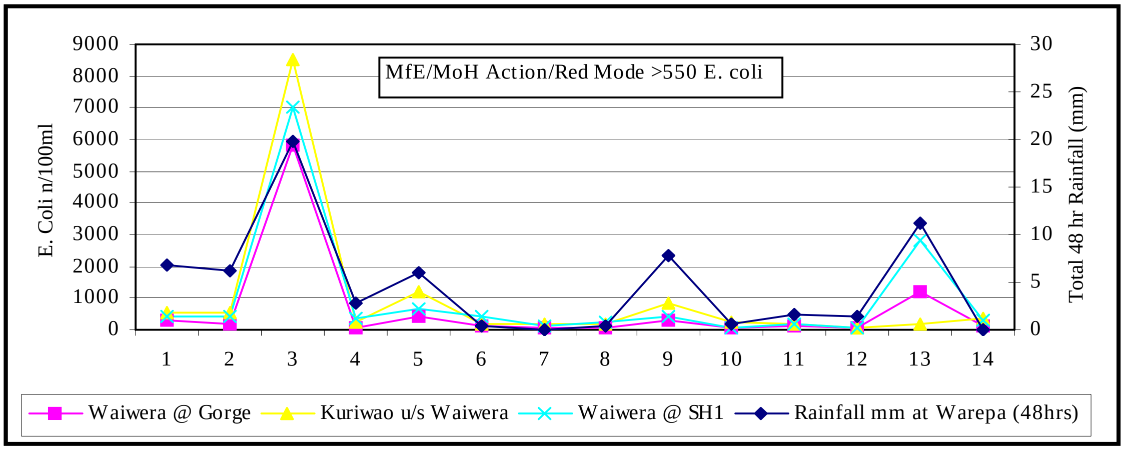

Figure 3.10 Rainfall (mm) recorded during the previous 48 hours at Warepa and E. coli bacteria concentrations recorded in the Waipahi catchment between October 2002 and October 2003 (see Table 3.3). The 2003 MfE/MoH Action/Red Mode Recreational Water Quality Guideline is also shown

Table 3.1 indicates that at the downstream site (Waiwera at SH1) median nutrient concentrations (NNN, TN, NH4, TN, TP and DRP) exceed the ANZECC 2000 default trigger values, whilst at the upstream site (Waiwera at Gorge) only NNN and TN exceed these trigger values. Figure 3.4 to Figure 3.8 clearly show this increase. However the concentrations recorded at the downstream site may be influenced by the Kuriwao Stream. This stream has the greatest median turbidity and the most elevated nutrient concentrations. In this stream the levels of all nutrients other than ammoniacal nitrogen exceed the ANZECC 2000 default trigger values.

3.6 Kaihiku Stream and Tributaries

Again, there is a marked decrease in water quality from the upstream site (Hillfoot Road) to the downstream site (Clifton Road). The Paiwata Stream shows the poorest water quality in this catchment.

Table 3.1 shows that that water quality at Clifton Road exceeds the ANZECC 2000 default trigger values for NNN, TN, DRP and TP, whilst at the upstream site no analytes exceeded these default trigger values. Figure 3.4 to Figure 3.9 show the decrease in water quality. The Paiwata Stream at SH1 will influence the water quality at Clifton Road. This stream has poor water quality with the concentrations of all analytes exceeding the ANZEEC default trigger values. Figure 3.11 shows that the Paiwata stream has elevated turbidity levels

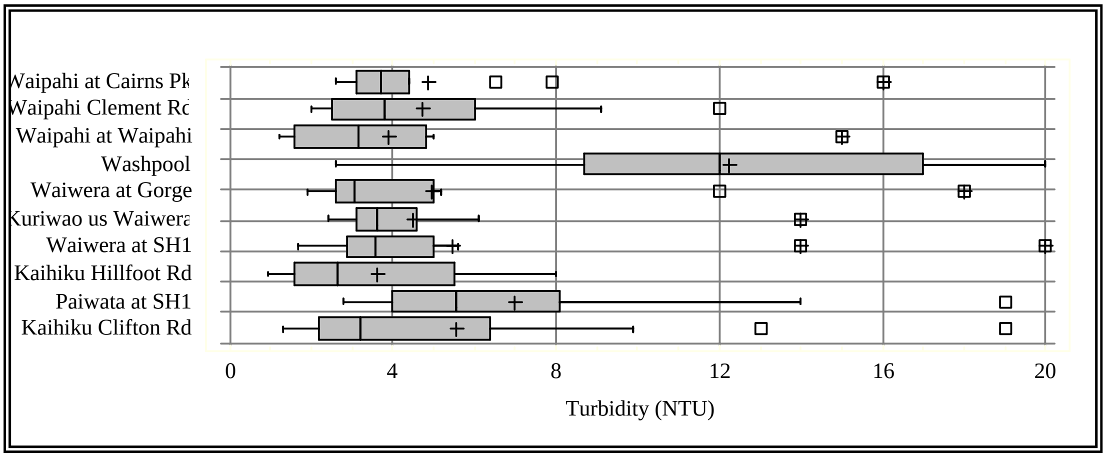

Figure 3.11 Box and whisker plot of turbidity concentrations recorded at various locations in the Waipahi, Waiwera, Kaihiku and Washpool between October 2000 and October 2002

Figure 3.9 shows that median E. coli concentrations in the Kaihiku catchment decrease with distance downstream and are below the MfE/MoH Action/Red Mode level of the recreational water quality guideline, the Paiwata stream records a high median value of 500 *E. coli*/100ml (the highest recorded in the monitoring programme). However Figure 3.2 shows that *E. coli* concentrations increase significantly in the Kaihiku catchment between site eight (Hillfoot Road) and site ten (Clifton Road). Figure 3.12 indicates that *E.coli* concentrations in the Kaihiku catchment closely follow the rainfall recorded at Warepa during the previous 48 hours.

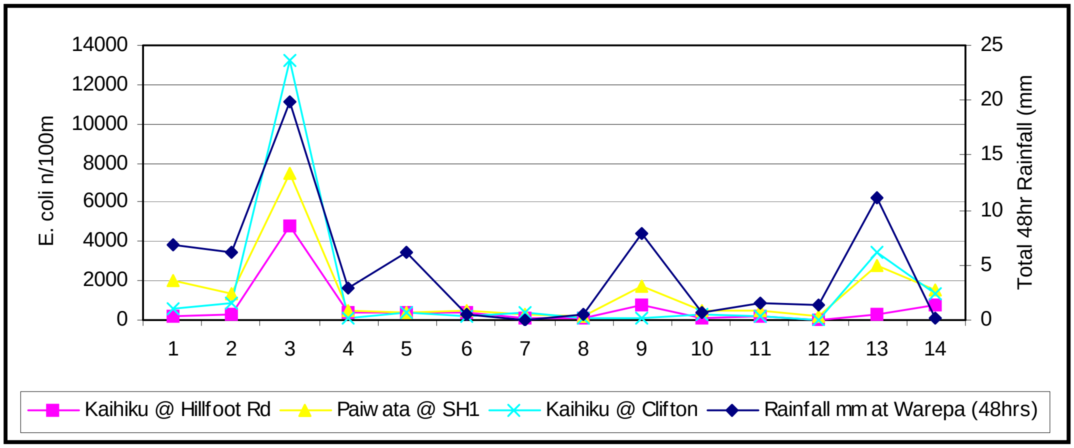

Figure 3.12 Rainfall (mm) recorded during the previous 48 hours at Warepa and E. coli bacteria concentrations recorded in the Waiwera catchment between October 2002 and October 2003 (see Table 3.3)

3.7 Washpool

Water quality in the Washpool Stream is extremely poor. Figure 3.4 to Figure 3.9 clearly show that of all the streams monitored in the Waipahi-Clydevale area the Washpool is the most degraded.

Table 3.1 shows that median concentrations of all analytes exceed the ANZECC 2000 default trigger values. Figure 3.9 shows that the median *E. coli* concentration is below the MfE/MoH Action/Red Mode level of the recreational water quality guideline at all sites, however Figure 3.1 shows an elevated mean concentration of *E. coli* at site 4 (Washpool). Figure 3.13 and Figure 3.14 indicate that total nitrogen and nitrite-nitrate nitrogen concentrations in the Washpool are closely linked to the total rainfall recorded at Warepa during the ten days prior to the sample being taken.

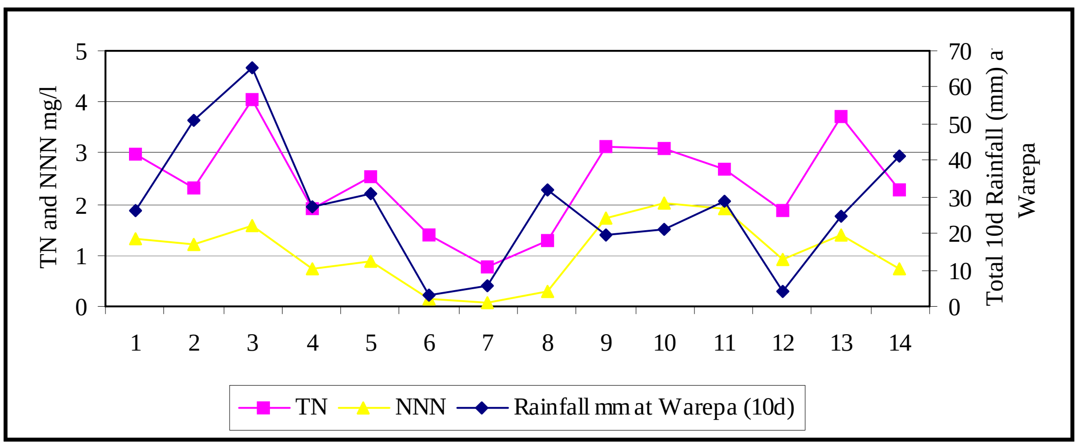

Figure 3.13 Rainfall (mm) recorded during the previous 10 days at Warepa and total nitrogen and nitrite-nitrate nitrogen concentrations recorded in the Waiwera catchment between October 2002 and October 2003 (See Table 3.3)

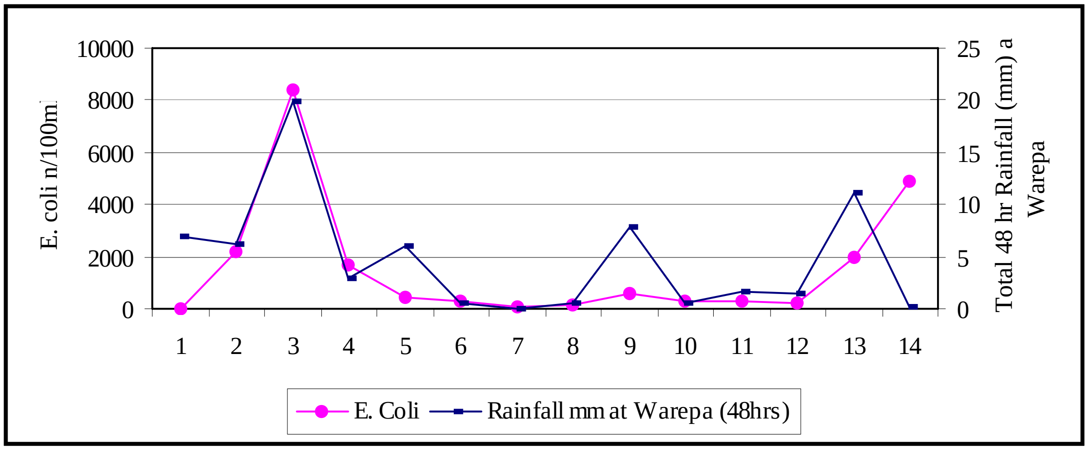

Figure 3.14 Rainfall (mm) recorded during the previous 10 days at Warepa and E. coli concentrations recorded in the Waiwera catchment between October 2002 and October 2003 (See Table 3.3)

3.8 Biological Monitoring

In addition to water quality sampling, the macroinvertebrate and periphyton communities are also monitored on an annual basis at selected sites on the Wairuna, Waiwera, Waipahi, Kaihiku and Pomahaka. The 2003 macroinvertebrate results support the physico-chemical sampling results in that they indicate water quality in the catchment is nutrient-enriched (Table 3.4).

Both the Waipahi at Cairns Peak and the Waiwera at the Gorge have a decreased SQMCI compared to sites further downstream, but Cairns Peak has an abundance of *microspora* (Appendix 3) which often indicates clean, gently flowing conditions and the Waipahi at Waipahi has an abundance of *Gomphoneis*, which often dominates periphyton communities in moderately enriched to enriched waters. Pollution-sensitive *Deleatidium*, were abundant at all sites other than Waipahi at Cairns Peak (rare) and Kaihiku at Clifton Road (common). *Pycnocentria* species which are also pollution sensitive were absent at Kaihiku at Clifton Road, Waipahi at Waipahi and the Waipahi at the Gorge.

Table 3.4 Species richness, macroinvertebrate community index (MCI) and semi-quantitative macroinvertebrate community index (SQMCI) values for invertebrate samples collected from the Waiwera, Waipahi, Kaihiku and Pomahaka in 2003

Sample Location	Total Richness	% EPT Richness	MCI Score	SQMCI Score
Waiwera River at Gorge	19	10	103.16	4.63
Waiwera River at SH1	18	9	108.89	5.60
Waipahi River at Cairns Peak	17	8	97.65	**3.93**
Waipahi River at Kaiwera Rd	19	10	104.21	5.70
Waipahi River at Waipahi	19	9	90.53	**3.47**
Kaihiku Stream at Hillfoot Rd	17	10	109.41	5.64
Kaihiku Stream at Clifton Rd	11	2	78.18	4.31
Pomahaka River at Glenken	16	10	123.75	6.56
Pomahaka River at Burkes Ford Rd	18	8	94.44	**3.28**

interpretation of Scores (Stark 1998):

- MCI >120 or SQMCI >6 = clean water
- MCI 100-120 or SQMCI 5-6 = doubtful quality or possible mild pollution
- MCI 80-100 or SQMCI 4-5 = probable moderate pollution
- MCI <80 or SQMCI <4 = probable severe pollution

Table 3.5 Periphyton abundance values for samples taken from the Waipahi-Clydevale catchment in 2003

River/Site Code	WP 2	WP 3	WP 1	WW 1	WW 3	PR 1	PR 2	KA 2	KA 1
Genus list									
Cladophora		1							
Microspora	8								
Oedogonium	7	4	1				8	5	
Spirogyra				2					1
Stigeoclonium		3		2					
Audouinella	6				8	8			
Ankistrodesmus		1					2		
Closterium		3							
Protoderma			7					2	
Pediastrum	1	2							
Scenedesmus	2	2		2					
Achnanthidium lin.	4	4					3		
Cocconeis spp.	4	4	3				3		2
Cocconeis spp. (large)							1	1	
Cymbella kappii		7				1	3		1
Encyonema cf. *minu.*		5	2		3		5		
Epithemia cf. *adnata*							1		
Fragilaria (small)	2	2					1		
Gomphoneis spp	2	8	5	8	6	3	8		
Gomphonema spp		5		3	5	4	4		4
Gomphonema cf. *tru.*								1	3
Melosira varians	5	4		3	2		7		
Navicula avenacea	6	2		4	5		4	1	
Navicula cryptoceph.	4							2	
Navicula spp. (small)		1						3	
Nitzschia palea	2						2	2	
Nitzschia spp. (thin)				2			3		
Nitzschia spp. (small)	4			2			2		
Nitzschia spp (needle)							4		
Rhoicosphenia	2				4		1		
Surirella cf brebisso.									
Synedra ulna									2
Synedra ulna cf.							2		
Oscillatoria/Phormid.	3	1	8	3		1	2		
cf. *Coleodesmium*								4	8

WP2 – Waipahi at Cairns Peak, WP3 – Waipahi Clement Rd, WP1- Waipahi at Waipahi, WW1 – Waiwera at Gorge Road, WW3 – Waiwera at SH1, PR1 – Pomahaka at Glenken, PR2 – Pomahaka at Burkes Ford, KA2 – Kaihiku at Clifton Rd, KA1 – Kaihiku at Hillfoot Rd

3.9 Discussion

There is a general increase in the median concentrations of contaminants with distance downstream in the Waipahi River, Waiwera River and Kaihiku Stream.

With the exception of the upper reaches of the Kaihiku Stream (i.e., Hillfoot Rd), all sites show elevated levels of NNN and other than the upper reaches of the Kaihiku Stream and Waipahi River (i.e., Hillfoot Rd and Cairns Peak) all sites show elevated levels of TN mg/l. NH_4 is elevated in the lower reaches of the Waiwera River, Kaihiku Stream and the Washpool Streams). The landuse map (Figure 5.1) shows a number of dairy units in the area, therefore there is a potential risk of dairy effluent entering the drainage systems causing elevated NNN concentrations in watercourses, however, other farming activities such as cropping and grazing also generate NNN. The highest NNN concentrations was recorded in the Washpool Stream.

Concentrations of analytes show a close correlation with rainfall, for example on 16 December 2002, 19.8 mm had fallen at Warepa during the previous 48 hours. This resulted in elevated TN and NNN nitrogen concentrations (Figure 3.13), elevated *E coli* concentrations (Figure 3.14) and raised concentrations of total phosphorus, dissolved reactive phosphorus, ammoniacal nitrogen and turbidity throughout the catchment. The increase in contaminants in the river following rainfall implies that tile drains may be responsible as the drains rapidly convey excess effluent off the waterlogged land and discharge it directly to the watercourses.

Dissolved reactive phosphorus and total phosphorus are elevated at all sites other than the Waipahi and the upper reaches of the Kaihiku and Waiwera.

The Washpool has very poor water quality with median concentrations of at least eight times the default trigger value for total phosphorus mg/l and of at least five times the default trigger value for dissolved reactive phosphorus mg/l. The Washpool exceeds ANZECC 2000 default trigger values for all contaminants, as well as recording a high median concentration of *E. coli* n/100ml.

Surprisingly, *E. coli* is consistently below the action/red mode Ministry of Environment (MfE) Ministry of Health (MoH) 2003 Recreational Water Quality Guideline (550 *E. coli*/100ml) at all monitoring sites. The Waiwera River below SHI which is on the list of water bodies in need of enhancement (to become suitable to support primary contact recreation) under Policy 7.6.1 of the Regional Plan: Water, recorded a median *E. coli* count of 350 *E.coli*/100ml (exceeding the MfE/MoH alert/amber mode value of >260 *E. coli*/100ml). The median value of turbidity is consistently below the default trigger value of 5.6 NTU, the exception being the Washpool Stream which recorded a median value of 13 NTU.

The biological sampling shows that the Kaihiku Stream at Clifton Road has a low MCI score. Again this is not surprising because the samples are taken from a run rather than a riffle and the substrate is dominated by mud and weed.

Waiwera River at Gorge

Waipahi River at Waipahi

Kaihiku Stream at Clifton Road

Waipahi River at Cairns Peak

Washpool at Kilhastie Road

Paiwata Stream at State Highway 1

Figure 3.15 Photographs taken at various locations in the Waipahi-Clydevale area

4 Heriotburn / Crookstonburn Catchment Monitoring Programme

4.1 Catchment Description

The Heriotburn and Crookstonburn, including Black Gully Creek are tributaries of the Pomahaka River, and rise in the foothills of the Blue Mountains, the Heriotburn discharges into the Pomahaka to the north west of Kelso and the Crookstonburn enters the Pomahaka south of Kelso.

The upper catchments are characterised by light grazing by sheep and cattle. Native and exotic forestry surround most of the upper reaches of the Crookstonburn, Black Gully Creek and one branch of the Heriotburn, tussock grasslands are found in the upper reaches of the other branch of the Heriotburn. Substantial areas of exotic forestry are found in the Dusky and Blue Mountains. The mid and lower catchments of all three areas comprise intensive stocking systems, dairy farms, sheep/beef farms and a small number of deer units. Dairy farming has expanded rapidly over the last 10 years.

4.2 Water Quality Monitoring

Routine water quality monitoring in these catchments began in early 1996. The principal monitoring sites on the Heriotburn were located at Shanks Road and Parkhill-Kelso Road and the Crookstonburn was monitored above Kelso. In addition to these three sites, monitoring has also been undertaken on the Pomahaka River at the Glenkenich Water Treatment Plant intake, approximately 7.5 km above the confluence with the Heriotburn and at Burkes Ford towards the bottom of the catchment.

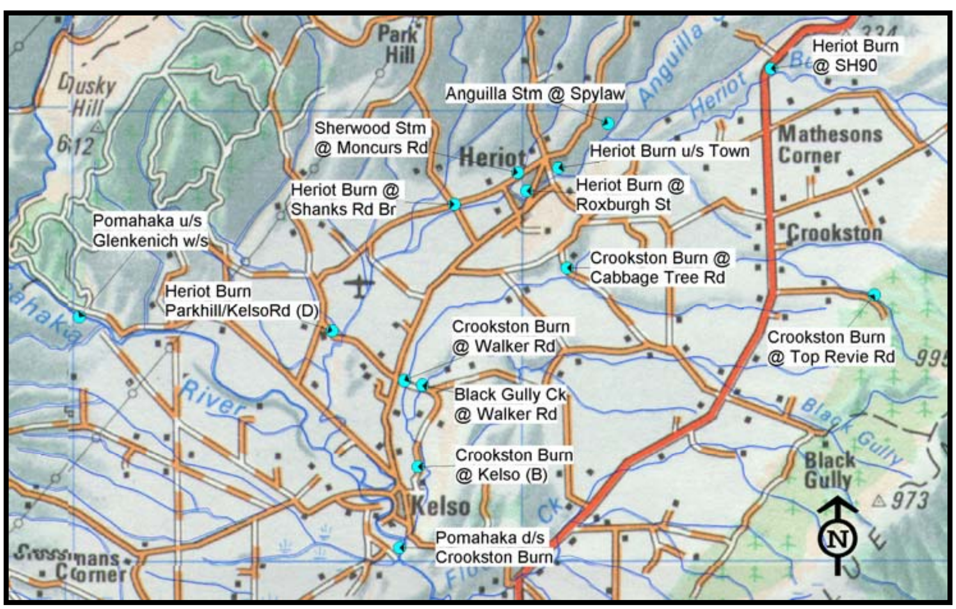

Figure 4.1 Location of physico-chemical water quality monitoring sites in the Heriotburn (HB) and Crookstonburn (CB) catchments. HB at SH90, HB at Parkill/Kelso Road and CB above Kelso were also monitored for macroinvertebrates and periphyton

As part of the Land Resource section's *Heriotburn-Crookstonburn Catchment Programme*, monitoring was undertaken at additional sites within the Heriotburn and Crookstonburn catchments between 24 May 2000 and 7 May 2002.

This monitoring incorporated:

- Five sites on the Heriotburn: State Highway 90, Upstream Town, Roxburgh Street, Shanks Road Bridge and Parkhill/Kelso Road (baseline site)
- Four sites on the Crookstonburn: Top Levie Road, Cabbage Tree Road, Walker Road and Kelso (baseline site)
- Three tributary sites: Sherwood Stream, Black Gully Creek and the Anguilla Stream (limited sampling)
- Two sites on the Pomahaka River. Glenkenich (baseline site) and a site approximately 300 m below the confluence with the Crookstonburn.

The locations of these monitoring sites are shown in Figure 4.1. Sampling was carried out at approximately three-monthly intervals in the early stages of the programme to monthly intervals between September 2001 and May 2002.

Table 4.1 Median water quality results for the Heriotburn-Crookston catchment, May 2000-May 2002 (*n*=8-12), with longterm medians for the four baseline sites indicated in italics and exceedances of the ANZECC 2000 default trigger values for lowland rivers figures indicated in bold type

Site	Turbidity (NTU)	*E. coli* (n/100ml)	Ammonia N (mg/l)	Nitrite-Nitrate N (mg/l)	Total N (mg/l)	Dissolved Reactive P (mg/l)	Total P (mg/l)
*ANZECC 2000 ***	5.6	550†	0.021	0.444	0.614	0.010	0.033
Heriotburn							
SH 90	1.5	**800**	0.014	**0.502**	0.550	0.007	0.027
Spylaw	3.6	**770**	0.020	**1.670**	**1.520**	0.008	**0.042**
Above town	2.7	**620**	0.020	**0.962**	**1.100**	0.008	**0.050**
Roxburgh St	3.2	**910**	**0.030**	**0.875**	**1.500**	**0.012**	**0.056**
Shanks Rd	3.6 *(4.2)*	**840** ***(530)***	**0.030** ***(0.034)***	**0.839** ***(1.000)***	**1.170** ***(1.300)***	**0.018** ***(0.020)***	**0.078** ***(0.068)***
Parkhill-Kelso Rd	5.0 *(5.3)*	**990** ***(850)***	0.020 ***(0.029)***	**0.710** ***(0.990)***	**1.300** ***(1.400)***	**0.016** ***(0.019)***	**0.063** ***(0.075)***
Crookstonburn							
Top Levie Rd	0.7	4	0.005	0.164	0.260	**0.012**	0.021
Cabbage Tree Rd	2.1	410	0.010	**1.900**	**1.600**	**0.015**	0.027
Walker Rd	4.1	**690**	**0.030**	**1.042**	**1.500**	**0.016**	**0.050**
Above Kelso	3.65 *(4.3)*	**910** ***(820)***	**0.050** ***(0.036)***	**0.584** ***(0.970)***	**1.600** ***(1.500)***	**0.017** ***(0.021)***	**0.047** ***(0.044)***
Tributaries							
Sherwood Stream	**8.1**	**1,400**	**0.040**	0.202	**0.920**	**0.011**	**0.099**
Black Gully Creek	4.2	**1,500**	0.020	**0.596**	**1.200**	**0.014**	**0.050**
Anguilla Stream*	2.9	-	0.010	0.021	0.370	**0.011**	**0.042**
Pomahaka River							
Glenkenich	1.6 *(2.2)*	225 *(245)*	0.005 *(0.013)*	0.026 *(0.039)*	0.210 *(0.210)*	0.003 *(0.005)*	0.021 *(0.021)*
D/s Crookstonburn	2.0	340	0.010	0.163	0.385	0.006	0.024
Burkes Ford	*(3.0)*	*(115)*	*(0.020)*	*(0.410)*	***(0.730)***	*(0.008)*	***(0.034)***

† Action/Red Mode - Ministry for Environment/Ministry of Health 2003 Recreational Water Quality Guidelines

* Based on 5-6 sets of results only, with insufficient *E. coli* data to derive a median value

** Default Trigger Value for Lowland Rivers

4.3 Monitoring Results

A summary of the water quality results for the Heriotburn-Crookstonburn catchments and receiving waters are shown in Table 4.1. Full results are located in Appendix 2.

It should be noted that changes in monitoring frequency and parameters have created inconsistent data sets and, in many cases limited data. Faecal coliform data has not been used due to limited sampling, and unequal data sets have resulted in some median nitrite-nitrate nitrogen (NNN) concentrations being higher than median total nitrogen (TN) concentrations. This is due to TN being introduced on the fourth sampling run and high NNN results being recorded early in the programme.

4.4 Heriotburn

From Table 4.1 it can be seen that water quality is highest at the uppermost site in the catchment (State Highway 90) and deteriorates over the 12km to the downstream site at Parkhill/Kelso Road.

E. coli bacteria concentrations were elevated at all sites with the highest concentrations recorded on 18 September and 11 December 2001 and 12 February 2002 (Figure 4.2). This coincided with or immediately followed significant rainfall and subsequent high flows (Table 4.2).

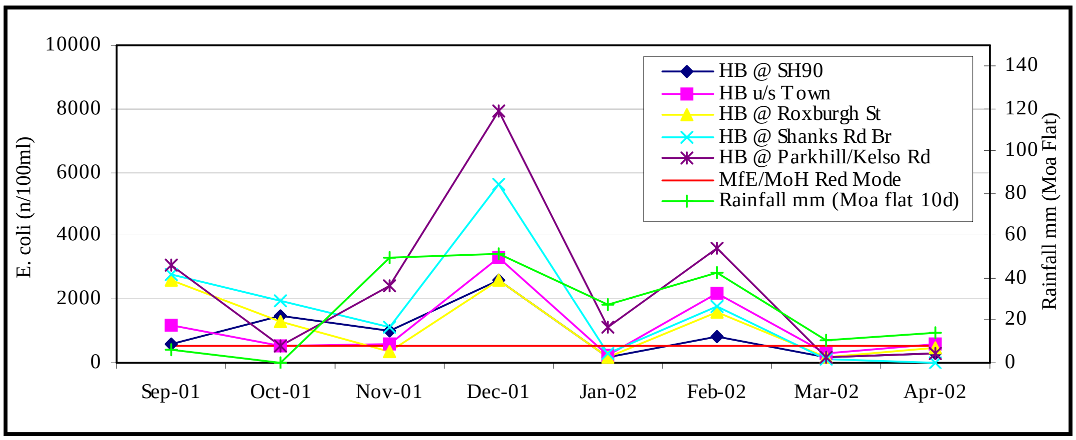

Figure 4.2 *E. Coli* bacteria concentrations recorded at various locations in the Heriotburn between May 2000 and May 2002, total rainfall mm recorded at Moa Flat over the previous 10 days. The 2003 Ministry of Environment MfE/MoH Action/Red Mode Recreational Water Quality Guidelines are noted.

Table 4.2 Rainfall data in neighbouring catchment areas and flows in the Pomahaka River at Glenkenich during in 2001 and 2002

Date	Rainfall (mm) at Moa Flat (upper catchment)		Rainfall (mm) at Waikoikoi (lower catchment)		Flows in Pomahaka River at Glenkenich (m^3/day)
	Preceding 48 hours	Preceding 10 days	Preceding 48 hours	Preceding 10 days	
24 May 00	1	41.5	0	54.2	872
11 Jul 00	1	2	1.8	1.8	815
26 Sep 00	4.5	7.5	5.2	12.9	872
1 Mar 01	17.5	47	0	6.9	703
18 Sep 01	5.5	6.0	13.6	13.6	908
10 Oct 01	0	0	0	6.7	782
21 Nov 01	0.5	49.5	6.6	61.1	1034
11 Dec 01	10	51.5	4.8	28.2	1016
21 Jan 01	0.5	27.5	0	45.5	862
12 Feb 02	16.5	43	36.4	54.1	No data
19 Mar 02	4.5	11	8.2	23.3	697
10 Apr 02	No data	14.5	0	49.7	835
7 May 02	5.5	88.5			1128

The median values significantly exceed the Action/Red Mode of the Mfe/MoH 2003 Recreational Water Quality Guidelines (Figure 4.2). Figure 4.3 shows the mean E. coli concentrations with 95% confidence intervals, concentrations increase downstream, the highest mean recorded at Parkhill/Kelso Road, Figure 4.4 also confirms high concentrations at this site.

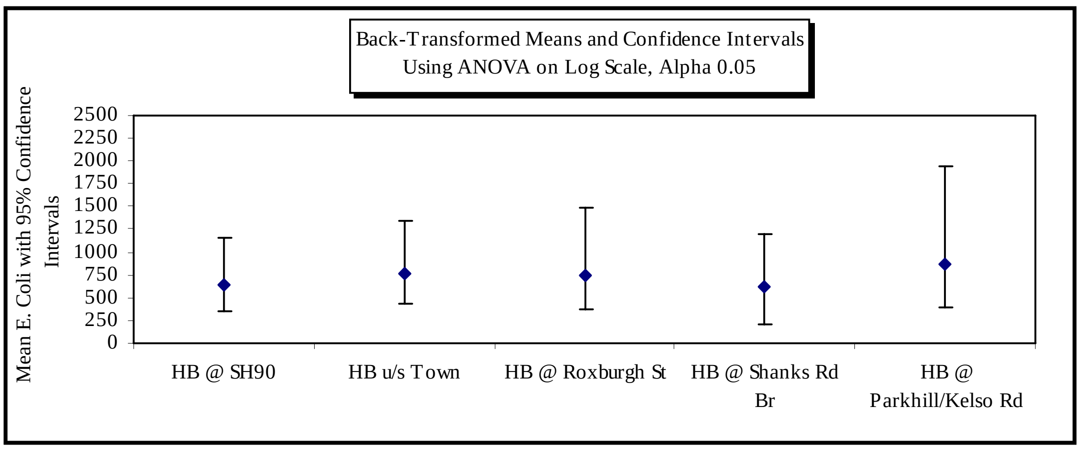

Figure 4.3 *E. coli* bacteria concentrations (back transformed means and confidence intervals, using ANOVA on log scale, alpha 0.05) recorded at various locations in the Heriotburn between May 2000 and May 2002

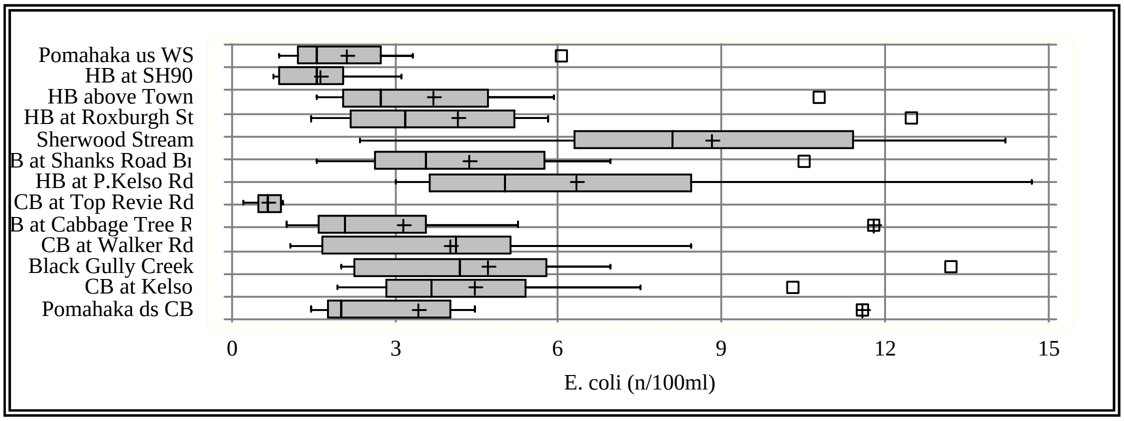

Figure 4.4 Box and whisker plot depicting *E. coli* concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002

This trend for decreasing water quality with increasing distance downstream is most evident in the median turbidity and phosphorus concentrations recorded at each site (Figure 4.5 and Figure 4.6 respectively).

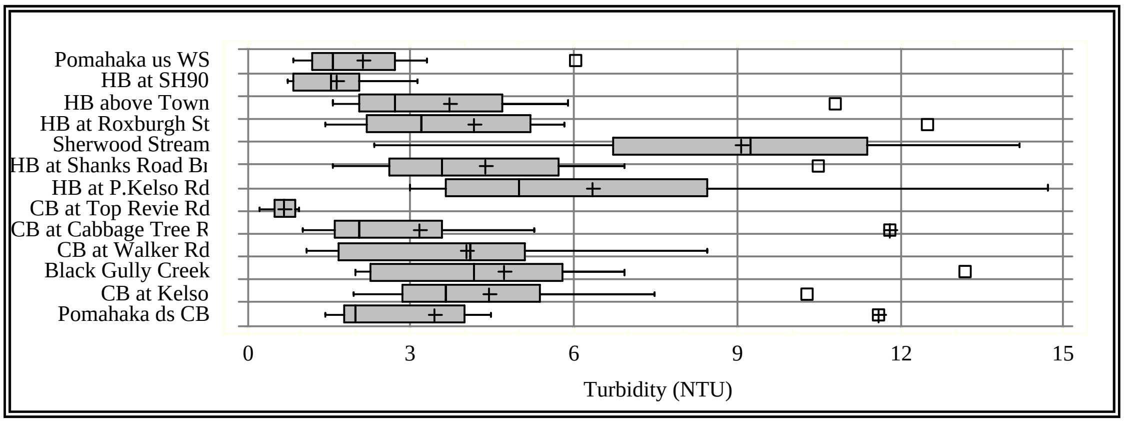

Figure 4.5 Box and whisker plot of turbidity concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002.

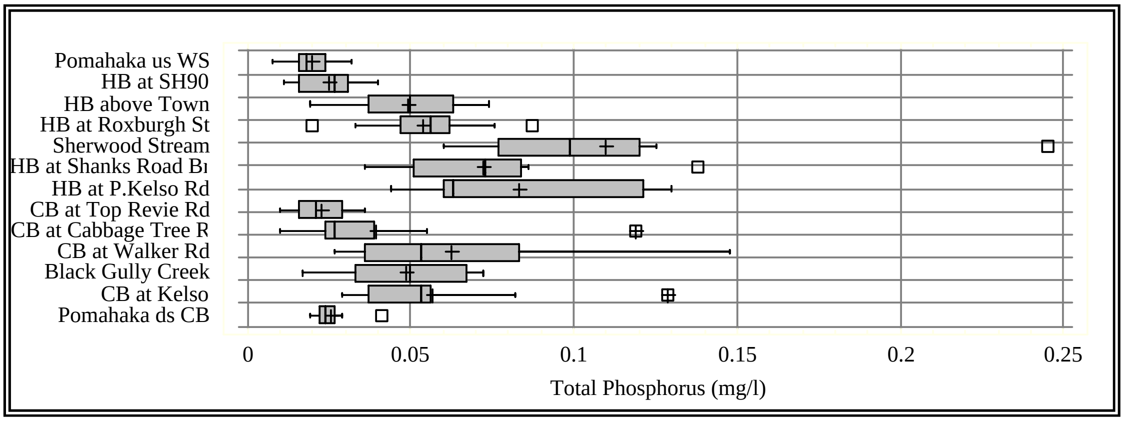

Figure 4.6 Box and whisker plot of total phosphorus concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002

The highest turbidity and total phosphorus concentrations were also recorded during rainfall events (Figure 4.7 and Figure 4.8 respectively).

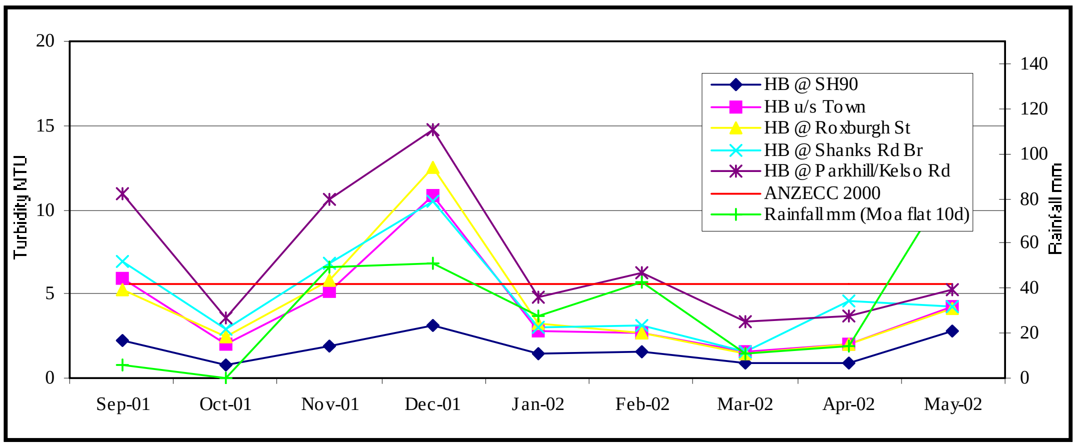

Figure 4.7 Turbidity levels recorded at various locations in the Heriotburn between September 2001 and May 2002 and rainfall mm recorded at Moa Flat (10 day total prior to sampling). The ANZECC 2000 default trigger value for turbidity in slightly disturbed New Zealand lowland rivers is noted

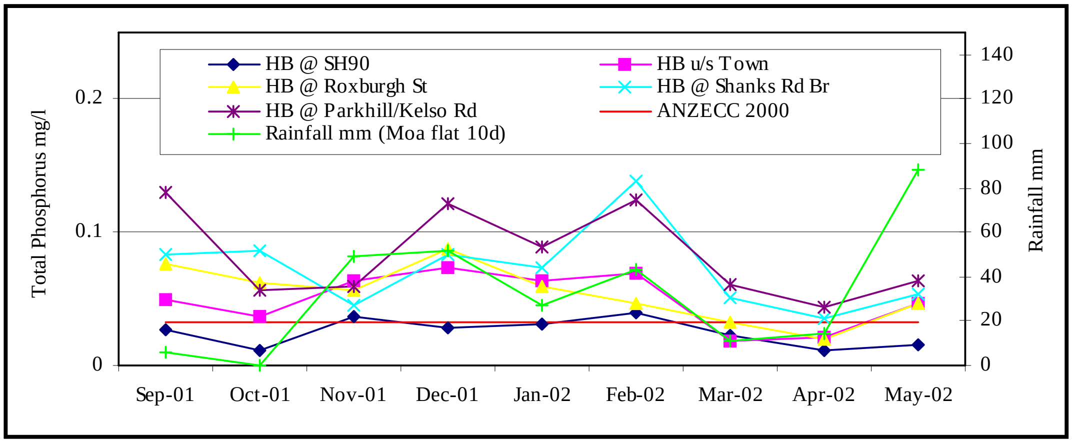

Figure 4.8 Total phosphorus concentrations recorded at various locations in the Heriotburn between May 2000 and May 2002, and rainfall mm recorded at Moa Flat (10 day total prior to sampling). The ANZECC 2000 default trigger value for phosphorus in slightly disturbed New Zealand lowland rivers is noted

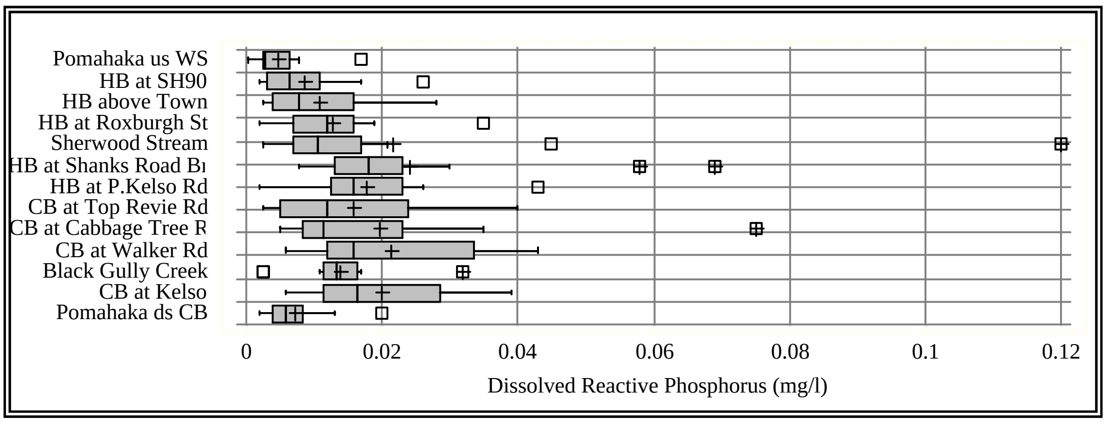

Figure 4.9 Box and whisker plot of dissolved reactive phosphorus concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002

Table 4.1 indicates that median nutrient concentrations, notably nitrite-nitrate nitrogen (NNN), total nitrogen (TN) and total phosphorus (TP) exceed the ANZECC 2000 default trigger values at the majority of sampling sites. The TN and NNN concentrations are very high at all sites below SH90 (Figure 4.10 and Figure 4.11). DRP and NH4 concentrations only exceeded the default trigger values at and below the Heriot township (Figure 4.9 and Figure 4.12).

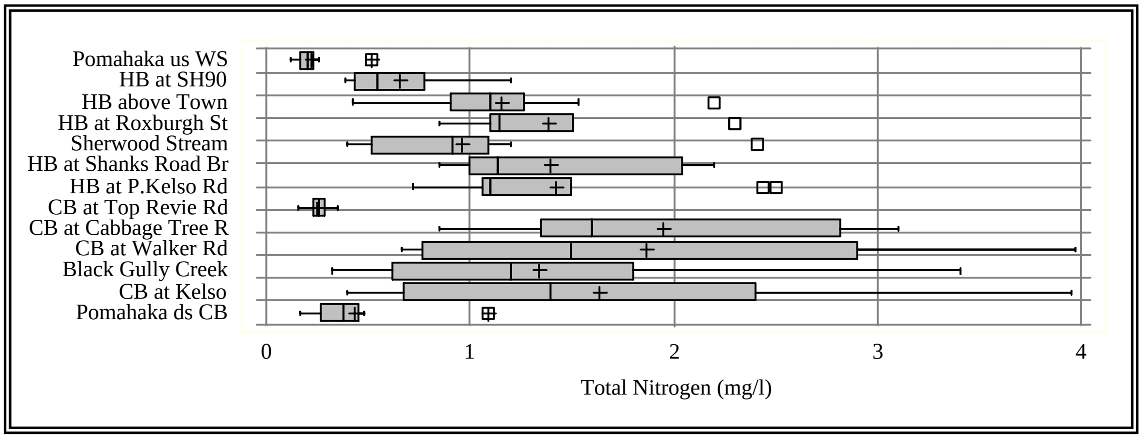

Figure 4.10 Box and whisker plot of total nitrogen concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002

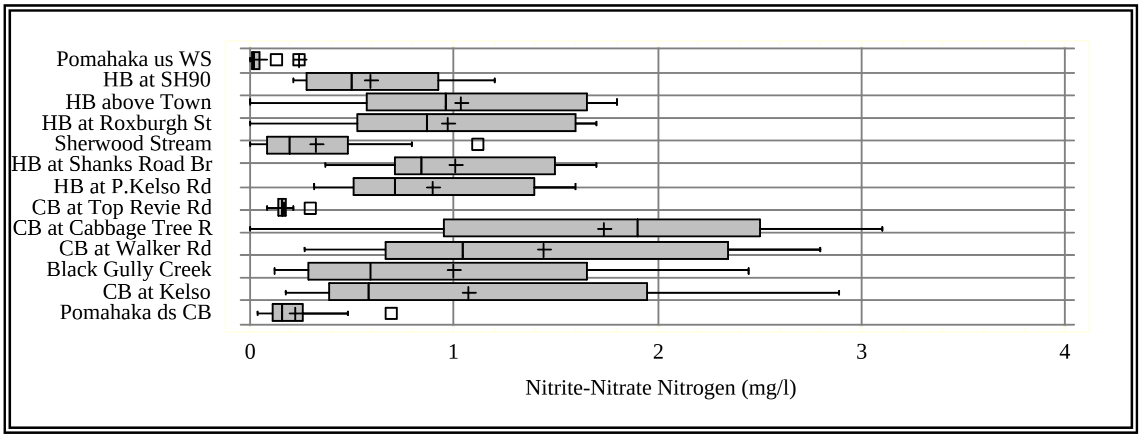

Figure 4.11 Box and whisker plot of nitrite-nitrate nitrogen concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002

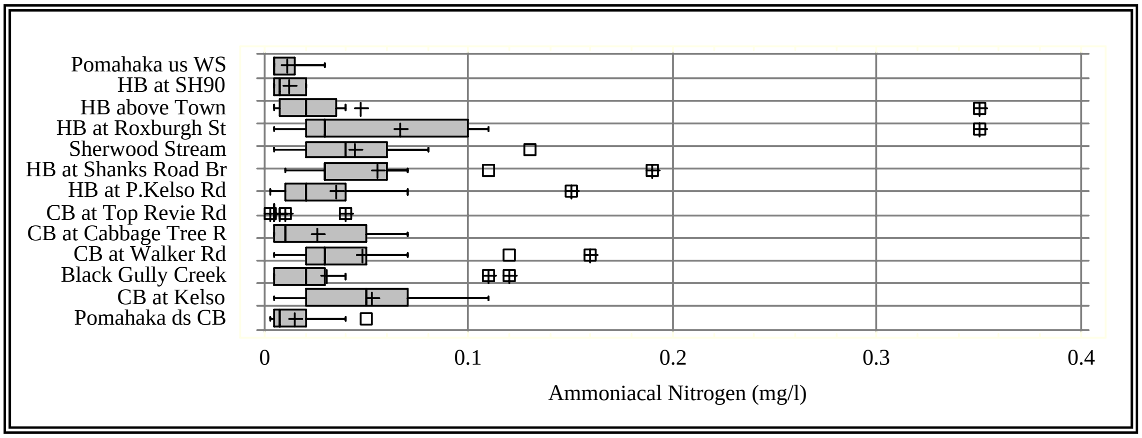

Figure 4.12 Box and whisker plot of ammoniacal nitrogen concentrations recorded at various locations in the Heriotburn and Crookstonburn between May 2000 and May 2002

4.5 Crookstonburn

Like the Heriotburn, water quality in the Crookstonburn is highest in the uppermost site (Top Levie Road) and generally deteriorates with distance downstream. This trend is clear with *E. coli* concentrations. Figure 4.4 and Figure 4.13 show that only the site at Top Revie Road is consistently safe for contact recreational activities such as swimming.

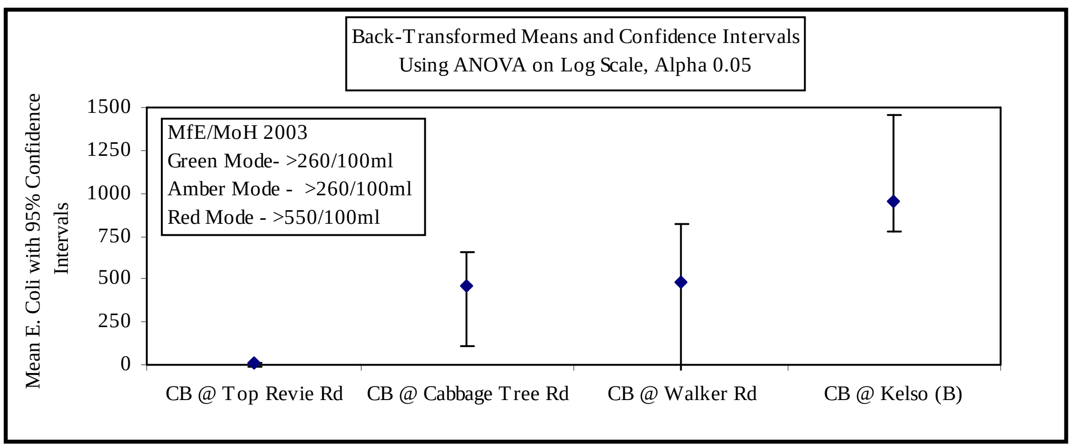

Figure 4.13 *E. coli* bacteria concentrations (back transformed means and confidence intervals, using ANOVA on log scale, alpha 0.05) recorded at various locations in the Crookstonburn between May 2000 and May 2002

All four sites on the Crookstonburn recorded median DRP concentrations above the ANZECC 2000 default trigger value of 0.010 mg/l (Figure 4.9) while median TP concentrations were significantly above the default trigger level of 0.033 mg/l at Walker Road and Kelso (Figure 4.6). The Crookstonburn also recorded very high NNN and TN concentrations below Top Levie Road, with the median NNN result for Cabbage Tree Road being more than four times the ANZECC 2000 default trigger value of 0.444 mg/l

(Figure 4.11). NH4 concentrations were elevated lower in the catchment at Walker Road and Kelso.

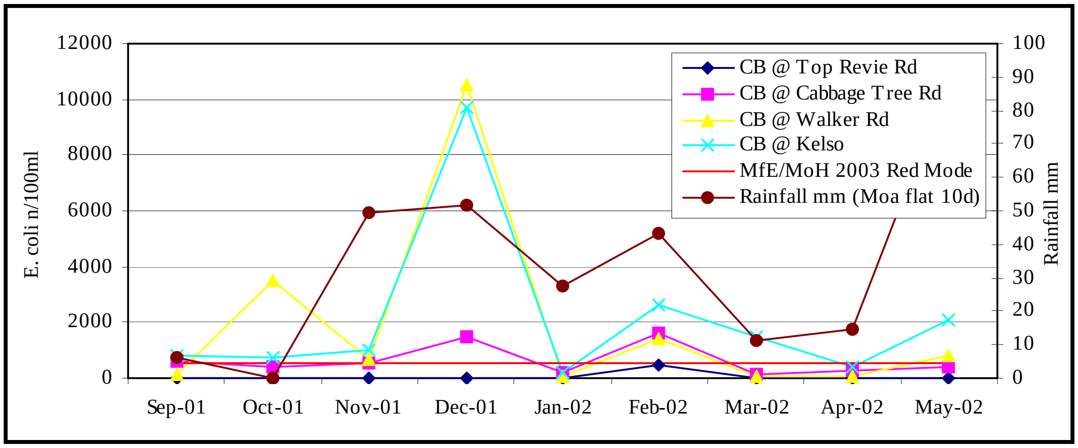

Figure 4.14 *E. coli* concentrations recorded at various locations in the Crookstonburn between May 2000 to May 2002. The 2003 MfE/MoH Action/Red Mode Recreational Water Quality Guidelines are also noted

As with the Heriotburn, the highest turbidity, bacteria and nutrient concentrations in the Crookstonburn tended to be recorded following high rainfall and subsequent high flows The exception was on 11 October 2001 when high *E. coli* concentrations were recorded in the stream despite less than 3.5 mm of rainfall in the 10 days prior to sampling (Figure 4.14).

4.6 Key Tributaries

Of the three tributaries monitored over May 2000 to May 2002, most data exists for Sherwood Stream and Black Gully Creek, the former being a tributary of the Heriotburn and the latter a tributary of the Crookstonburn. Sherwood Stream has the poorer water quality of the two tributaries, with elevated turbidity (Figure 4.15), DRP, TP (Figure 4.16), NH4, TN and *E. coli* concentrations (Table 4.1). Black Gully Creek and Sherwood Stream recorded the highest median *E. coli* concentrations (1,400/100ml and 1,500/100 ml respectively). However, Black Gully Creek recorded higher median NNN and TN concentrations and also had elevated phosphorus concentrations.

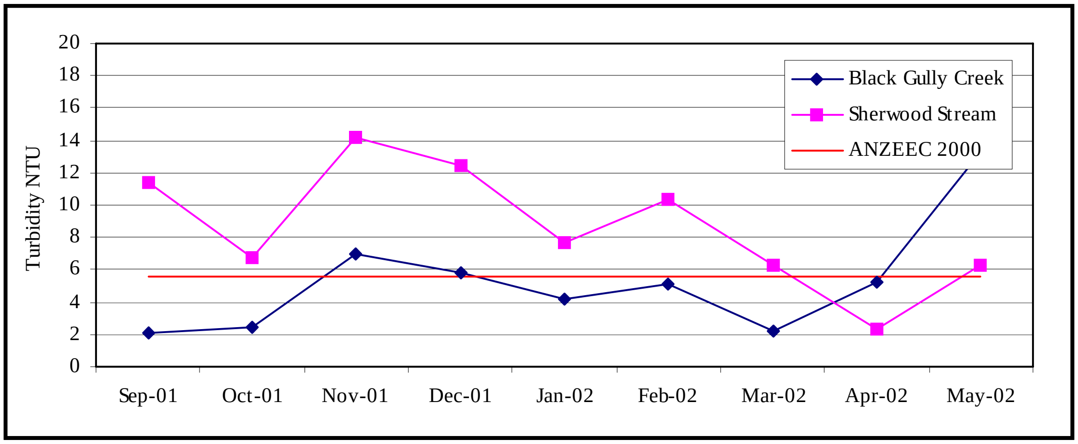

Figure 4.15 Turbidity levels recorded in Sherwood Stream and Black Gully Creek between May 2000 to May 2002. The relevant ANZECC 2000 default trigger value for slightly disturbed New Zealand lowland rivers are also noted

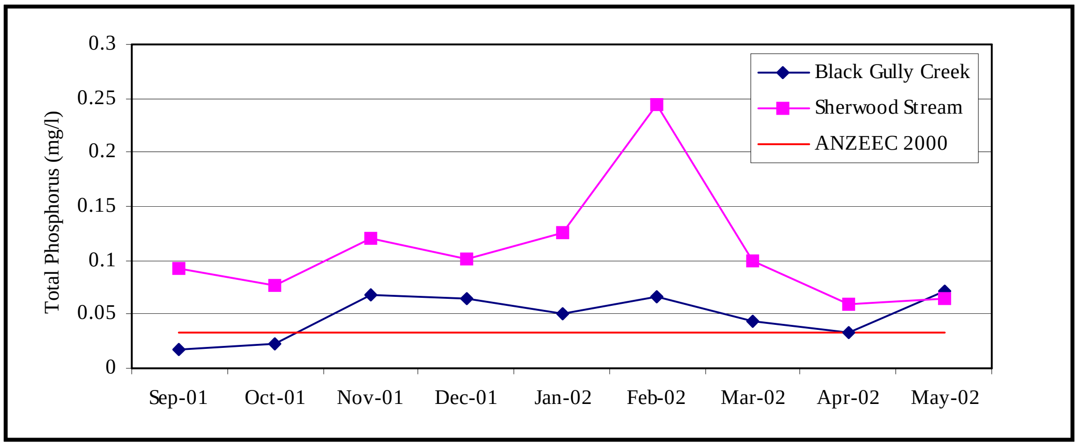

Figure 4.16 Total phosphorus concentrations recorded in Sherwood Stream and Black Gully Creek between May 2000 to May 2002. The relevant ANZECC 2000 default trigger value for slightly disturbed New Zealand lowland rivers are also noted

4.7 Pomahaka River

The median water quality data presented in Table 4.1 indicate there is a clear decline in water quality between the Glenkenich Water Treatment Plant intake and below the confluence with the Crookstonburn. This is most apparent in the downstream nutrient concentrations, notably NNN (Figure 4.17) and TP (Figure 4.18). Despite this, the median results for all physico-chemico water quality analytes are below the relevant ANZECC 2000 default trigger values for both sites.

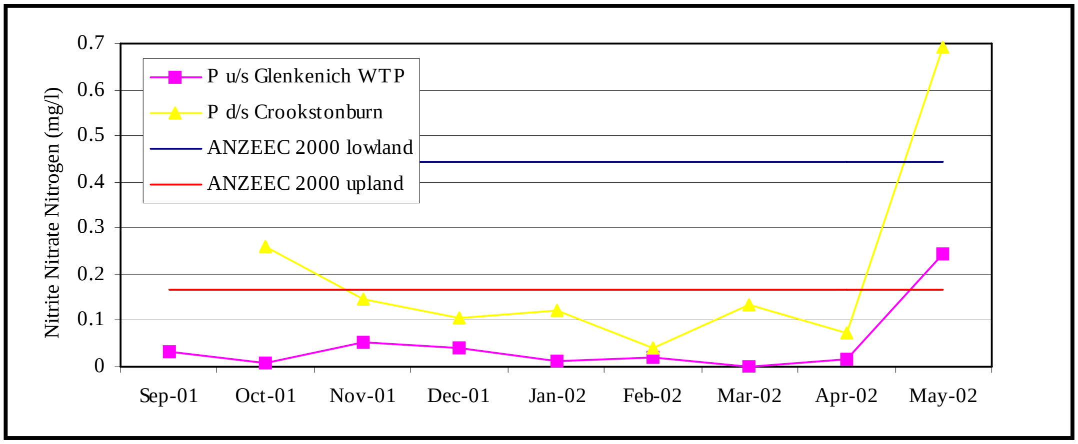

Figure 4.17 Nitrite-nitrate nitrogen concentrations recorded in the Pomahaka River between May 2000 to May 2002. The relevant ANZECC 2000 default trigger values for slightly disturbed New Zealand upland and lowland rivers are also noted

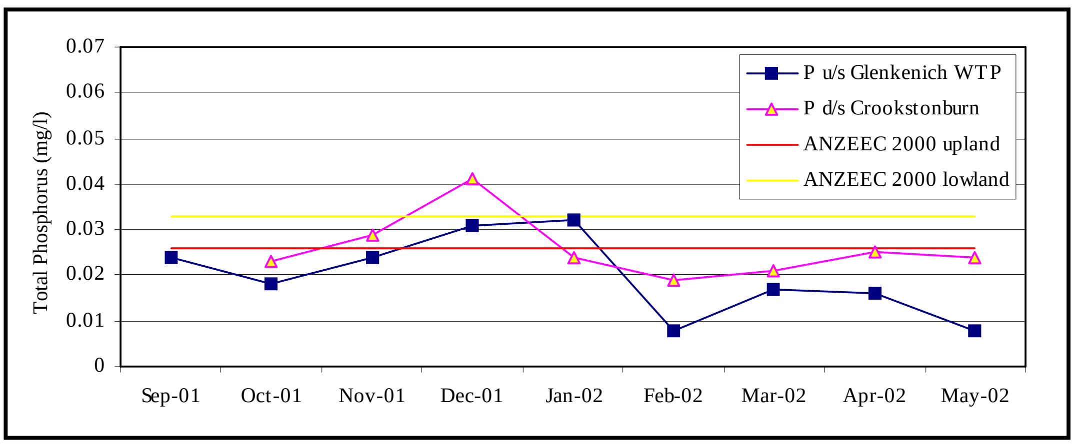

Figure 4.18 Total phosphorus concentrations recorded in the Pomahaka River between May 2000 and May 2002. The relevant ANZECC 2000 default trigger values for slightly disturbed New Zealand upland and lowland rivers are also noted.

As with the Heriotburn and Crookstonburn, turbidity, *E. coli* bacteria and nutrient concentrations were highest in the Pomahaka River following significant rainfall events and subsequent high river flows (Figure 4.19).

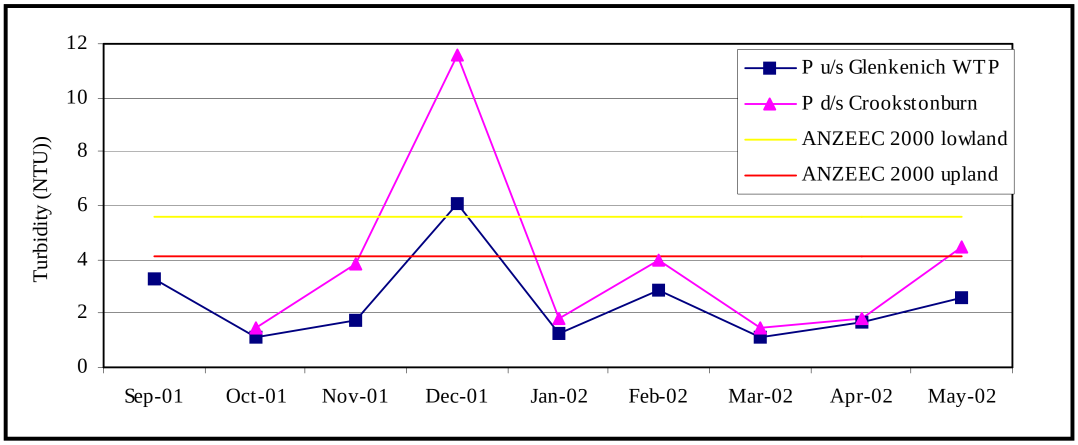

Figure 4.19 Turbidity levels recorded in the Pomahaka River between May 2000 and May 2002. The relevant ANZECC 2000 default trigger values for slightly disturbed New Zealand upland and lowland rivers are also noted

4.8 Biological Monitoring

In addition to water quality sampling, the macroinvertebrate and periphyton communities are also monitored on an annual basis at selected sites on the Heriotburn, Crookstonburn (and Pomahaka River).

Table 4.3 Species richness, macroinvertebrate community index (MCI) and semi-quantitative macroinvertebrate community index (SQMCI) values for invertebrate samples collected from the Heriotburn and Crookstonburn in February 2001 and March 2002

Site	Heriotburn @ SH90		Heriotburn @ Parkhill/Kelso Rd		Crookstonburn above Kelso	
Year	2001	2002	2001	2002	2001	2002
Species Richness: number of taxa present	11	21	10	20	8	16
EPT Richness	6	10	7	10	4	7
% EPT Richness	54.5	47.62	70	50.00	50	43.75
MCI: a sensitivity score based solely on the number of different taxa present	112.73	91.43	110	102.00	110	98.75
SQMCI: a sensitivity score based on the number of different taxa present and the relative abundance of each taxon	5.97	6.67	5.93	6.41	5.73	3.89

Interpretation of Scores (Stark 1998):

- MCI >120 or SQMCI >6 = clean water
- MCI 100-120 or SQMCI 5-6 = doubtful quality or possible mild pollution
- MCI 80-100 or SQMCI 4-5 = probable moderate pollution
- MCI <80 or SQMCI <4 = probable severe pollution

The 2001/2002 macroinvertebrate results support the physico-chemical sampling results in that they indicate water quality in the Heriotburn and Crookstonburn is nutrient-enriched (Table 4.3). Despite this pollution-sensitive *Deleatidium* mayflies (and slightly less sensitive *Pycnocentria evecta* caddisflies) were very abundant in the Heriotburn at both SH90 and at Parkhill-Kelso Road towards the bottom of the catchment. This is an indication of good habitat (although barrier structures prevent fish access at present). The periphyton community was dominated by *Stigioclonium* at

SH90 which prefers moderate-fast flowing streams from clean to enriched waters and *Ulothrix* at the lower sites which is widespread under low stable flows (Appendix 3).

Table 4.4 Periphyton abundance values for samples taken from the Heriotburn and Crookstonburn in February 2001 and March 2002

	2001	2002	2001	2002	2001	2002
River/Site Code	**HB1**		**HB 2**		**CB 2**	
Stigeoclonium	4	8				
Ulothrix				8		8
Ankistrodesmus	3					
Scenedesmus	2					
Achnanthidium		3				6
Cocconeis placentula		5	2			6
Cymbella kappii	3					
Encyonema minutum	8	4				4
Gomphoneis spp.	3	3	8	2	1	
Gomphonema parvulum	7	4	3	6	8	6
Melosira varians			2			8
Navicula avenacea				7		4
Navicula cryptocepha.		1		7		
Navicula spp.	4	4	7			5
Nitzschia spp. (small)	5	3		3		
Rhoicosphenia curvata						5
cf. Sellaphora		1				
Synedra rumpens	1					
Synedra ulna		4				1
Synedra spp. (short)	2					
Phormidium		7				
HB1 – Heriotburn at SH90, HB2 – Heriotburn at Parkhill/Kelso Rd, CB2 – Crookstonburn at Kelso						

4.9 Discussion

Despite a decline in water quality at the downstream site, the median results for the Pomahaka River downstream of the Crookstonburn confluence meet all ANZECC 2000 default trigger values for lowland rivers. Although not specifically monitored in this catchment programme, the results of baseline water quality testing further downstream at Burkes Ford were also included in Table 4.1. The results indicate a further decline in water quality relative to the two upstream sites.

Water quality is poor in both the Heriotburn and Crookstonburn, particularly in the lower reaches. With the exception of the headwaters of the Crookstonburn, which reflects the absence of agricultural activity in this area, water in these streams is characterised by high nutrient and *E. coli* bacteria concentrations. The Heriotburn and Crookstonburn are on the list of water bodies in need of enhancement (to become suitable to support primary contact recreation) under Policy 7.6.1 of the Regional Plan: Water. Median concentrations of E. coli and faecal coliforms in these rivers are extremely high, most sites in the Heriotburn and Crookstonburn recorded median values greater than the MfE/MoH action red mode (>550 *E.coli*/100ml).

NNN is especially high in both streams as well as DRP concentrations being elevated at many sites (relative to the ANZECC 2000 default trigger values). However the forested uppermost site in the Crookstonburn (Top Levie Road) has a median DRP concentration slightly above the ANZECC 2000 trigger level, suggesting that this stream may carry naturally high concentrations. The highest NNN concentrations were recorded in the middle of the catchment (Heriotburn above Town and Crookstonburn at Cabbage Tree Road).

On several occasions during the monitoring period, spikes in ammoniacal nitrogen concentrations were recorded, notably on 11 December 2001 and 7 May 2002 (Figure 4.20). In most cases these spikes also coincided with high turbidity, total phosphorus and *E. coli* concentrations (Figure 4.1, Figure 4.7, Figure 4.8, Figure 4.14 and Appendix 2).

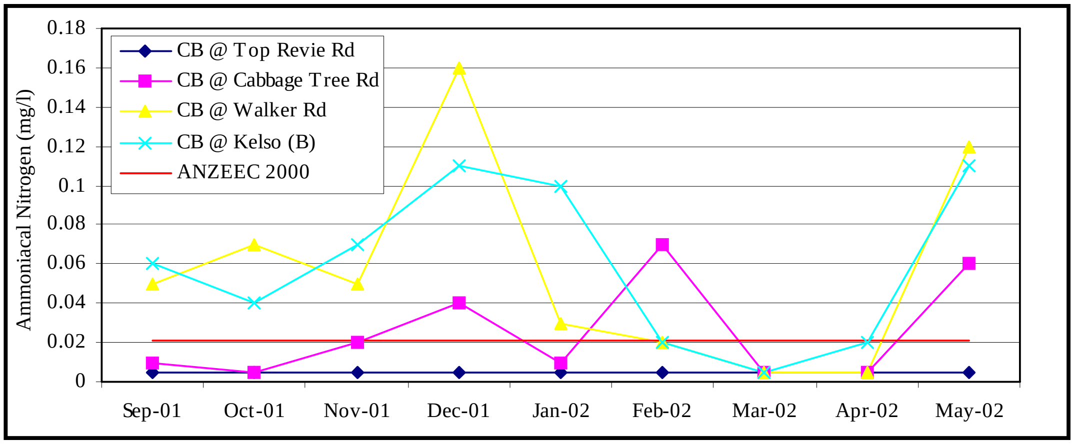

Figure 4.20 Ammoniacal nitrogen concentrations recorded at various locations in the Crookstonburn between September 2001 to May 2002. The relevant ANZECC 2000 default trigger value for slightly disturbed New Zealand lowland rivers is also noted.

These spikes are can generally be linked to elevated rainfall and subsequent high stream flows in the catchment. On 11 December 2001, 51.5 mm of rain had fallen at Moa Flat during the previous 10 days, including 10 mm on the day prior to sampling, as a result high concentrations of NH4, turbidity, TP and *E. coli* were recorded in both the Heriotburn and Crookstonburn.

The elevated turbidity and total phosphorus concentrations recorded during wet weather events are probably due to direct stream bank and channel erosion, this is common throughout both the Heriotburn and Crookstonburn and is mainly due to stock access to the watercourses, although there is some natural erosion in times of flood.

Figure 4.22 where it can be seen that the highest *E. coli* concentrations were recorded over the warmer months of November 2001 to March 2002 inclusive (although high rainfall on two of the sampling occasions will also have influenced instream concentrations). This may be due to stock having access to the stream for drinking water.

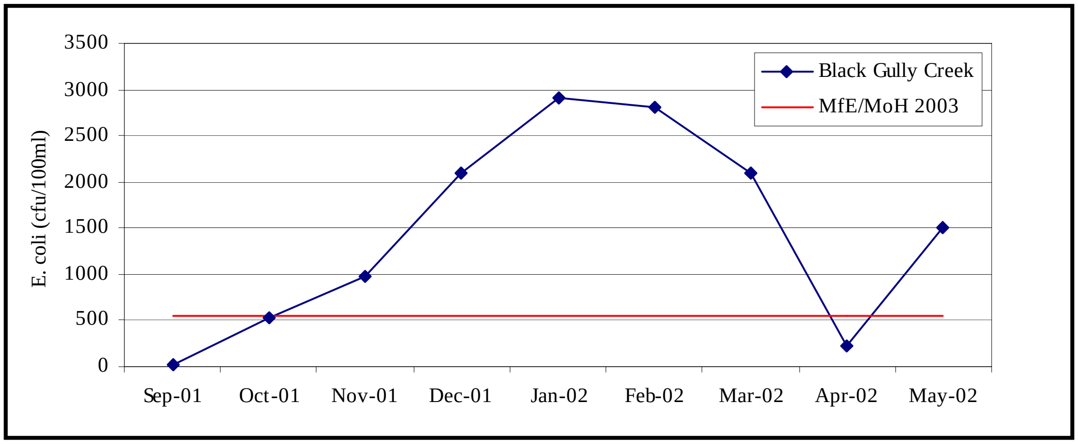

Figure 4.21 ***E. coli*** **concentrations recorded in Black Gully Creek at Walker Rd between May 2000 to May 2002. The 2003 Mfe/MoH Action/Red Mode Recreational Water Quality Guideline is also noted.**

Water quality in the Pomahaka River is clearly poorer below the confluence with the Crookstonburn when compared to the upstream site at Glenkenich (Table 4.1). The Pomahaka River dilutes the poorer water quality of the Heriotburn and Crookstonburn so that the median turbidity and nutrient concentrations in the Pomahaka River are below the ANZECC 2000 default trigger values.

Water quality at the downstream site is influenced by what is happening higher up in the river catchment, particularly with respect to *E. coli* concentrations. The downstream concentrations closely mirror those recorded upstream, irrespective of the flow in the river (Figure 4.22). The situation is similar for turbidity, TP, NNN, NH4 and TN although the downstream concentrations tend to be higher, particularly during high flow events such as 11 December 2001 and 12 February 2002 (refer to Figure 4.17, Figure 4.18 and Figure 4.19). This probably reflects the elevated sediment and nutrients from the Heriotburn and Crookstonburn during periods of wet weather.

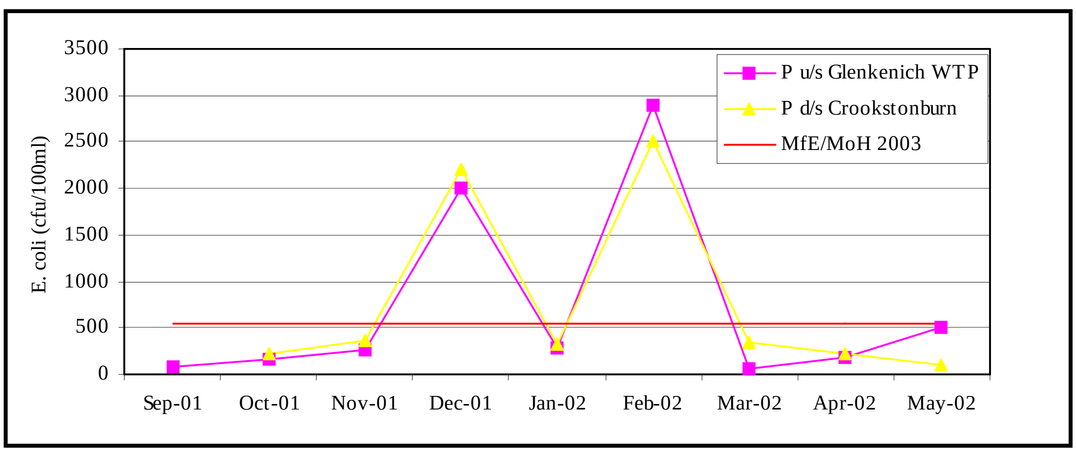

Figure 4.22 ***E. coli*** **concentrations recorded in the Pomahaka River at Glenkenich and downstream of the Crookstonburn confluence between May 2000 and May 2002. The 2003 MfE/MoH Action/Red Mode Recreational Water Quality Guidelines are also noted**

Crookstonburn at Walker Road

Black Gully Creek at Walker Rd

Crookstonburn at Cabbage Tree Road

Crookstonburn at Kelso

Figure 4.23 Photographs taken at various locations in the Crookstonburn catchment

Heriotburn at Parkhill/Kelso Rd

Heriotburn at Shanks Road Bridge

Heriotburn at Roxburgh Street

Sherwood Stream at Moncurs

Heriotburn at SH90

Figure 4.24 Photographs taken at various locations in the Heriotburn catchment

5 General Discussion

Tile drainage systems are in place throughout much of south west Otago. The high nutrient and *E. coli* concentrations recorded in the majority of catchments are likely to be a result of these drains carrying contaminated surface water runoff to the nearest watercourse. For example on 17 February 2001 at the Wairuna Stream School Road 2, field notes taken at the time of sampling indicate that there was a '*Tile discharging just upstream'*.

The landuse maps (Figure 5.1 and Figure 5.2) indicate the abundance of dairy farms in the catchments, and therefore the potential for dairy effluent to effect watercourses. The nitrogen component of dairy effluent comprises largely of ammoniacal nitrogen which when applied to land, enters the soil and, under normal conditions, converts to nitrate nitrogen. Nitrates are very mobile in soil and can easily pass into the tile drainage system which discharge into adjacent streams. Rainfall resulting in saturated soils reduces the conversion of ammonia to nitrate nitrogen, meaning that a considerable amount of the nitrogen on the farm paddocks can drain straight down into the tile drainage system and out into the streams as ammonia (Figure 4.20).

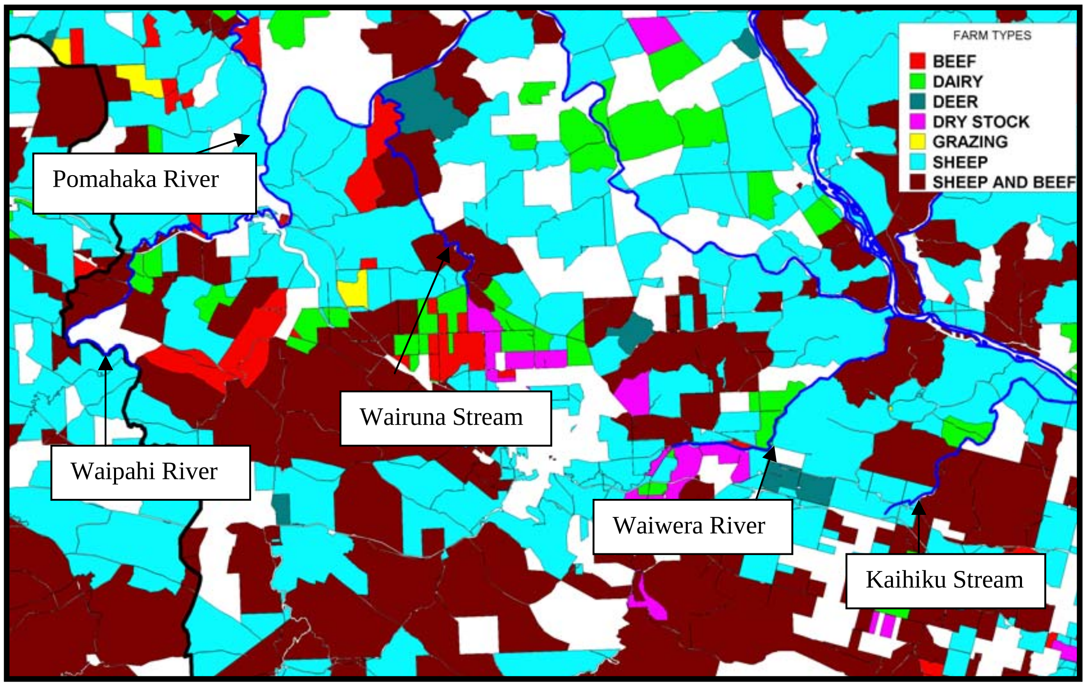

Figure 5.1 Landuse in the Waipahi/Wairuna catchments. (Landuse database *Agribase,* AgResearch 2001)

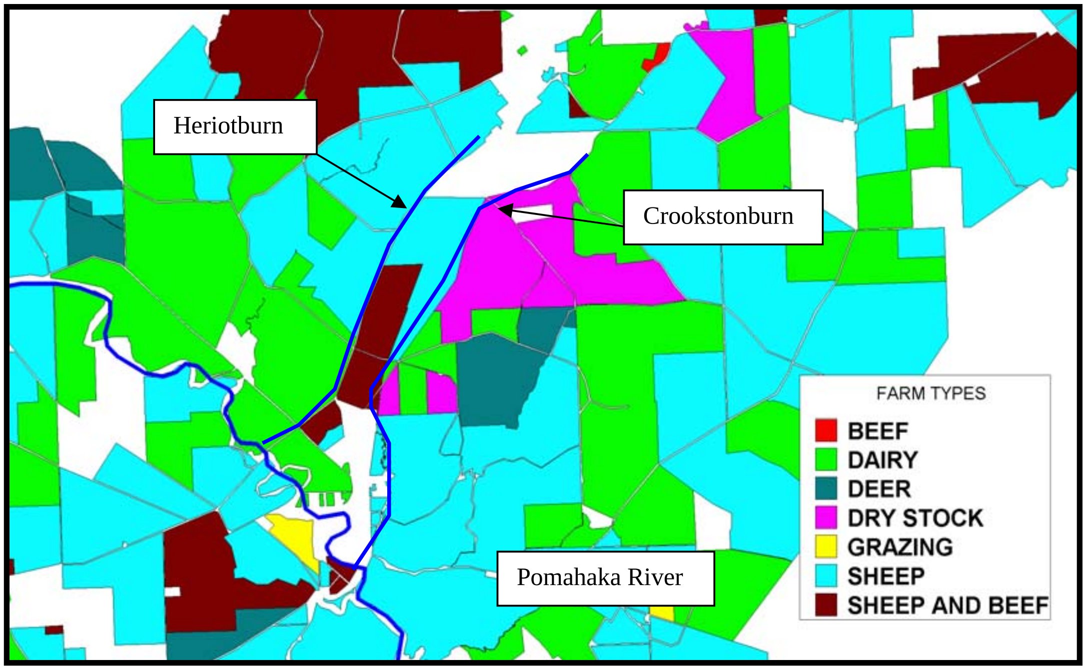

Figure 5.2 Landuse map in Crookstonburn/Heriotburn catchments. (Landuse database *Agribase*, AgResearch 2001)

The proliferation of dairy conversions in south Otago is demonstrated by the number of consents issued for dairy shed water bores. Figure 5.3 shows that 60.7% of the total number of consents issued for dairy shed bores between 1994 and 2003 were issued between 1998 and 2000. As consents are generally sought before conversion, it can be assumed that the majority of conversions occurred after 2000.

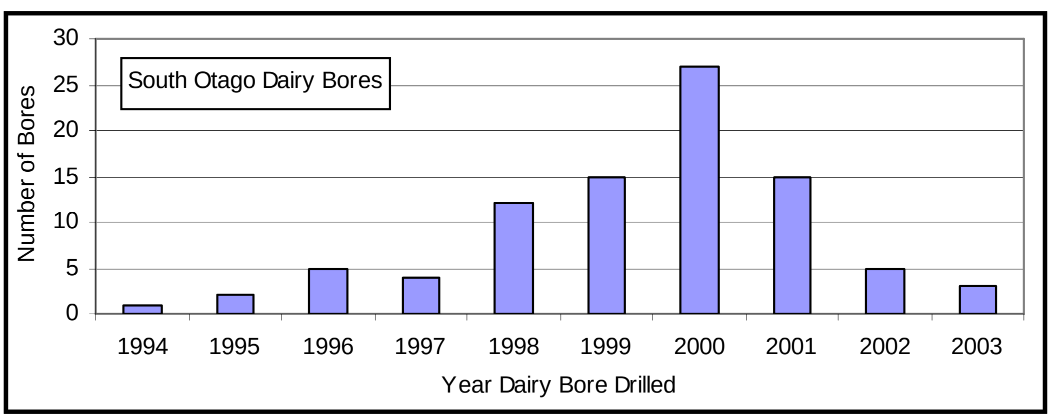

Figure 5.3 Number of consents issued for dairy shed bores between 1994 and 2003

The impacts of landuse on water quality are not limited to the tile drainage systems and dairy conversions. Stock access to sections of some streams is also likely to be a factor influencing water quality, this is most likely to occur in the warmer summer months when stock need water to drink. For example at Kaihiku Stream, Clifton Road on 19 November 2002 field notes taken at the time of sampling indicated that there were*'stock on banks everywhere'*.

Stream bank and channel erosion is common throughout the catchment, during rainfall the exposed soil erodes quickly leading to elevated turbidity and total phosphorus concentrations in the watercourses. Field staff regularly noted discoloured, silt-laden water when sampling during or following significant rainfall. This problem has been addressed in the Black Gully Creek where some sections of the stream banks have been regraded and planted in an attempt to reduce erosion.

Catchment Programmes are an opportunity for Otago Regional Council staff to work closely with landowners and farmers. The aim being to improve water quality by developing farming practices better suited to local conditions.

- In south west Otago the soils are generally heavy and are prone to saturation, because of this dairy farmers are being encouraged to increase effluent storage facilities. Farmers are advised to have at least one months storage, as with any less there is a risk of having to apply effluent to land when conditions are unsuitable.
- A combined Otago Regional Council and Fonterra initiative involves trialing soil moisture probes. The Washpool has been chosen for the trial, real time telemetry will give farmers precise knowledge of soil moisture content and therefore when and when not to irrigate. The farmers will also benefit from knowing when the soils are at the optimum temperature and moisture content for fertiliser application.
- The proliferation of tile drains is considered a major problem in terms of effluent management. Otago Regional Council published a booklet in 2004 entitled 'Environmental Considerations for Managing Dairy Effluent Application to Land in Otago'. This publication arose as a consequence of a tile drain workshop in April 2003, to which 60 people attended. The booklet contains detailed technical information to manage effluent in such a way as to minimise adverse environmental impacts.
- Although most dairy farms have fenced off watercourses, in some instances stock had free access to the water and banks. It is well known that water quality is adversely affected by stock access, but it is permitted under Section 13.5.1.8 of the Regional Plan: Water (conditions apply). In 2003 the Otago Regional Council adopted an initiative to exclude all dairy cows from waterways in Otago by December 2005. Through the catchment programmes, Council land resources staff are working with farmers to promote the use of temporary or permanent fencing, the latest survey (Land Resources 2004) show that 91.9% of waterways on south Otago farms have been fenced to exclude stock, and 86.2% of streams on west Otago farms have been fenced.
- In addition to stock access to waterways, most farming activites have the potential to adversely effect water quality. The Otago Regional Council has held workshops, field days and discussion groups on a range of land management issues. The aim being to address issues, give appropriate advice and discuss options available.

- In selected catchments, including the Washpool and Kaihiku, farmers have been asked to make a record of all activities taking place on their farm (such as effluent application, stock location, stock numbers etc.). During this period the Land Resource section have organised water quality surveys with samples being taken at property boundaries. The water quality results can often be linked back to farm management practices.

In addition to the work of the Land Resource section, Otago Regional Council's Compliance section enforce the Regional Plan: Water. Appendix 4 lists relevant complaints of pollution since 1996, along with the 17 infringement notices issued. Of the eighty seven complaints received in south west of Otago, forty were due to dairy effluent discharging to water and fourteen were due to stock in water.

6 Conclusions

The results of the water quality monitoring programmes indicate that water quality in south west Otago is relatively poor, with elevated nutrient and bacteria concentrations. The Otago Regional Council has recently produced two Taieri River water quality reports and Table 6.1 compares water quality in the Upper and Lower Taieri to the South Otago Rivers. Even though the two areas are not directly comparable, and degradation in water quality is expected in lowland catchments, it does put into context that water quality in South Otago is much poorer than that of the Taieri River.

Table 6.1 Comparison of Upper Taieri River (ORC 2003), Lower Taieri River (ORC 2004) and South Otago River median water quality results

	Upper Taieri River		South Otago Rivers and Lower Taieri River					
	AZ 2000*	Upper Taieri Waipiata	AZ 2000†	Lower Taieri SH1	Wairuna at Waipahi/ Clyde. Rd	Waipahi Conical Hill	Heriotburn Parkhill-Kelso Rd	Crookston-burn u/s Kelso
$NH4^+$/ $NH3^-$	0.010	0.01	0.021	0.020	0.05	0.020	0.020	0.050
NNN	0.167	0.012	0.444	0.041	0.97	1.065	0.710	0.584
TN	0.295	0.365	0.614	0.315	1.5	1.455	1.300	1.600
DRP	0.009	0.010	0.010	0.006	0.02	0.006	0.016	0.017
TP	0.026	0.043	0.033	0.019	0.133	0.021	0.063	0.047
E. coli	260‡	305	260‡	110	665	130	990	910

*ANZECC 2000 default trigger values for upland rivers
†ANZECC 2000 default trigger values for lowland rivers
‡Acceptable/Green Mode- MfE/MoH (2003) Recreational Water Quality Guidelines

South Otago has seen a large number of dairy farm conversions since the late 1990's, this type of farming requires more nutrient input onto the land, in the form of manufactured fertilisers and as manure and dairy shed effluent, and as a consequence local watercourses are more vulnerable to pollution. The Otago Regional Council is encouraging farmers to adopt good farm management practices to minimise the impact of higher density farming on the local watercourses.

Bank and channel erosion is also a problem in South Otago Rivers and needs to be reduced if instream habitat values for sensitive macroinvertebrate species are to be protected. Such measures should include reducing sedimentation (bank protection works, fencing) and riparian planting. These issues have been addressed at field days run by the Land Resource section of Otago Regional Council.

The main findings from the surveys are that:

- Other than the head waters, water quality in the catchments is poor. Overall there is a trend of increasing concentrations downstream and a noted deterioration in water quality in times of rainfall.
- Median concentrations of *E. coli* in these rivers are extremely high. The Heriotburn, Crookstonburn and Waiwera River below SHI are on the list of water bodies in need of enhancement (to become suitable to support primary contact recreation) under Policy 7.6.1 of the Regional Plan: Water. However, it is unlikely that these watercourses will ever reach such a high bacteriological standard as their catchments are tile drained and mainly agricultural.

- *E. coli* and nutrient concentrations in South Otago watercourses are particularly elevated after rainfall, due to tile drains facilitating fast land drainage of farm surface runoff to receiving waters.
- Median concentrations of NNN are elevated, usually exceeding ANZECC 2000 default trigger values by a considerable margin, TN concentrations are correspondingly high. Although dairy farming is undoubtedly a source of NNN and TN, cropping and sheep farming also contribute to these elevated nitrogen concentrations.
- Other than in the Waipahi River, median DRP and TP concentrations are elevated at the lower sites in all the catchments, again usually exceeding ANZEEC 2000 default trigger values by a considerable margin.
- Turbidity in the Wairuna catchment consistently breaches ANZECC 2000 default trigger values, and the median turbidity of the Washpool is also extremely elevated.
- The diversity of macroinvertebrates needed to achieve high MCI values relies not only on water quality, but also on instream habitat and substrate, which is not present in the Kaihiku Stream below Clifton Road and in the Wairuna Stream at Waipahi-Clydevale Road

The Land Resource section will continue to run Catchment Programmes in the Waipahi/ Clydevale catchments and are striking a fine balance between ensuring landowners comply with Council rules whilst striving to be innovative in their methods to encourage farmers to adopt good farming practices. However the Heriotburn and Crookstonburn Catchment Programme is due to finish in June 2004 although water quality will still be monitored through the SOE monitoring programme.

The role that farmers play today is vitally important for the long term maintenance of good quality water, not only in their immediate catchment, but also in the Pomahaka River. As pressure on water resources increases, and the Pomahaka River becomes increasingly allocated, these small tributaries will contribute a greater percentage of flow to the main stem. This report shows that tributary waters are already enriched and having an adverse effect on water quality of the Pomahaka River. It is also known that enriched waters are more sensitive to flow abstraction (i.e., become more degraded) (Suren *et al.* 2003), it is therefore likely that the Pomahaka River will require higher minimum flows to maintain river health, than if it were in a pristine state.

It is also likely that if water is available for irrigation, further dairy conversions and an associated increase in agricultural intensity will occur in the Pomahaka catchment. This will result in additional surface water runoff, which, due to the presence of tile drains throughout the Pomahaka catchment, is likely to further degrade water quality.

Water abstraction and lower flows can also significantly increase stream temperature in New Zealand rivers (Hockey *et al.* 1982), which may result in the optimum temperature for fish also being exceeded. It is particularly important to safeguard water quality of the Pomahaka River as it is a regionally significant recreational fishery in the Otago Fish and Game Region.

7 References

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Appendix 1

SITE_ID	SOURCE	SITE_NAME	SAMPLE_ID	DATE	TIME	BY	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1000465	06-Apr-00	11:15	AS			0.011		260	0.021	0.38		8				
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1000866	13-Jul-00	1155	AHJ			0.01		81	0.01	1.3	7	6	5.1			
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1001085	21-Sep-00	10.50	AS			0.0025		740	0.005	1.3	6.9	9	7.3			
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1001279	01-Nov-00	11:05	AS			0.006		260	0.01	0.94	7.2	5				6.5
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1010002	04-Jan-01	11:05	AS			0.04		680	0.04	1.9	6.8	12	13.2			6.9
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1010853	17-Sep-01	11:20	CAM	0.124	12.2	0.02	2400		0.04	0.83	6.5		10.8	1.2	0.029	6.48
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1011193	09-Oct-01	09:38	CAM	0.128	12.2	0.0025	500		0.01	0.69	6.9		8.2	1.3	0.028	7.58
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1011435	22-Nov-01	12:15	CAM	0.116		0.004	1500		0.03	1.49	**6.9**		10.9	2.4	0.031	12.3
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1011552	12-Dec-01	09:08	CAM	0.135	9.9	0.035	440		0.02	0.737	7.5		12.5	1.5	0.064	8.62
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1020038	23-Jan-02	11:14	CAM			0.008	520		0.03	1.42	6.6			1.51	0.039	4.7
OTA7520520	Wairuna Stream	Wairuna Siding Rd	OTA1020054	11-Feb-02	10:00	CAM	0.124	8.9	0.006	1200		0.35	0.498	7.1		15.8	0.86	0.035	5.55
			3			**Median**	**0.124**	**11.05**	**0.008**	**860**	**260**	**0.021**	**0.94**	**6.9**	**8**	**10.85**	**1.4**	**0.033**	**6.7**
						No	**5**	**4**	**11**	**6**	**5**	**11**	**11**	**10**	**5**	**8**	**6**	**6**	**8**
						Mean	**0.13**	**10.80**	**0.01**	**1093.33**	**404.20**	**0.05**	**1.04**	**6.94**	**8.00**	**10.48**	**1.46**	**0.04**	**7.33**
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1000466	06-Apr-00	12:20	AS			0.02		56	0.021	0.66		3				
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1000870	13-Jul-00	1310	AHD			0.018		9	0.14	1.5	7.3	8	4.5			
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1001089	21-Sep-00	12.00	AS			0.016		1400	0.09	1.4	7	8	8.4			
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1001283	01-Nov-00	12:45	AS			0.023		510	0.05	0.97	7.6	10				12
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1010006	04-Jan-01	14:00	AS			0.033		700	0.03	1	7.7	8	17.6			11
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1010856	17-Sep-01	12:55	CAM	0.181	13.1	0.012	1300		0.05	0.56	7		12.2	1.5	0.14	14.1
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1011196	09-Oct-01	11:20	CAM	0.179		0.008	870		0.03	0.53	7.9		9.6	1.4	0.12	11.9
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1011432	22-Nov-01	11:00	CAM	0.143	14.94	0.012	1200		0.05	1	**7.01**		11.5	1.5	0.05	8.67
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1011551	12-Dec-01	10:15	CAM	0.194	10.4	0.035	440		0.02	0.737	7.5		15.8	1.5	0.136	8.62
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1020035	23-Jan-02	10:07	CAM	0.159	8.9	0.067	460		0.17	1.1	6.9		16.2	1.85	0.168	9.47
OTA7520541	WAIRUNA STREAM	Waipahi/Clydevale Road	OTA1020057	11-Feb-02	11:30	CAM	0.165	10	0.05	300		0.02	0.304	7.7		18.9	0.87	0.129	11.7
			6			**Median**	**0.172**	**10.4**	**0.02**	**665**	**510**	**0.05**	**0.97**	**7.4**	**8**	**12.2**	**1.5**	**0.1325**	**11.35**
						No	**6**	**5**	**11**	**6**	**5**	**11**	**11**	**10**	**5**	**9**	**6**	**6**	**8**
						Mean	**0.17**	**11.47**	**0.03**	**761.67**	**535.00**	**0.06**	**0.89**	**7.36**	**7.40**	**12.74**	**1.44**	**0.12**	**10.93**
OTA7520905	Wairuna Trib1	SH 1	OTA1000461	06-Apr-00	11:05	AS			0.004		500	0.009	0.019		2				
OTA7520905	Wairuna Trib1	SH 1	OTA1000865	13-Jul-00	1140	AHJ			0.01		69	0.01	0.6	7.3	3	5			
OTA7520905	Wairuna Trib1	SH 1	OTA1001084	21-Sep-00	10.40	AHS			0.006		17	0.02	0.47	7.2	4	6.3			
OTA7520905	Wairuna Trib1	SH 1	OTA1001278	01-Nov-00	10:55	AS			0.01		230	0.02	0.25	7.5	4				5
OTA7520905	Wairuna Trib1	SH 1	OTA1010001	04-Jan-01	10:48	AS			0.089		620	0.04	0.49	7.2	6	12.2			5.7
OTA7520905	Wairuna Trib1	SH 1	OTA1010851	17-Sep-01	10:20	CAM	0.116	11.3	0.006	210		0.06	0.37	6.6		9.4	0.59	0.028	6.02
OTA7520905	Wairuna Trib1	SH 1	OTA1011191	09-Oct-01	08:45	CAM	0.11	12.6	0.0025	1400	1400	0.01	0.35	7.2	3	7.6	0.6	0.02	5.87
OTA7520905	Wairuna Trib1	SH 1	OTA1011436	22-Nov-01	12:35	CAM	0.0908		0.004	670		0.005	0.437	**6.92**		10.46	0.79	0.031	7.94
OTA7520905	Wairuna Trib1	SH 1	OTA1011553	12-Dec-01	08:50	CAM	0.115	10.6	0.005	1200		0.005	0.199	7.2		12.4	0.53	0.042	6.26
OTA7520905	Wairuna Trib1	SH 1	OTA1020040	23-Jan-02	12:00	CAM	0.11	10.2	0.013	430		0.09	0.505	6.9		15	0.77	0.046	3.98
OTA7520905	Wairuna Trib1	SH 1	OTA1020052	11-Feb-02	09:25	CAM	0.115	9.6	0.007	620				7.4		16.1		0.019	3.77
			1			**Median**	**0.1125**	**10.6**	**0.006**	**645**	**365**	**0.015**	**0.4035**	**7.2**	**3.5**	**10.46**	**0.6**	**0.0295**	**5.785**
						No	**6**	**5**	**11**	**6**	**6**	**10**	**10**	**10**	**6**	**9**	**5**	**6**	**8**
						Mean	**0.11**	**10.86**	**0.01**	**755.00**	**472.67**	**0.03**	**0.37**	**7.14**	**3.67**	**10.50**	**0.66**	**0.03**	**5.57**

SITE_ID	SOURCE	SITE_NAME	SAMPLE_ID	DATE	TIME	BY	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520906	Wairuna Trib2	SH 1	OTA1000462	06-Apr-00	11:20	AS			0.046		1400	0.021	0.22		4				
OTA7520906	Wairuna Trib2	SH 1	OTA1000867	13-Jul-00	1230	AHJ			0.022		219	0.01	0.52	7.2	8	5.3			
OTA7520906	Wairuna Trib2	SH 1	OTA1001086	21-Sep-00	11.00	AS			0.011		46	0.01	0.51	7	21	7.5			
OTA7520906	Wairuna Trib2	SH 1	OTA1001280	01-Nov-00	11:15	AS			0.062		600	0.03	1.3	7.3	6				4.2
OTA7520906	Wairuna Trib2	SH 1	OTA1010003	04-Jan-01	11:19	AS			0.038		2200	0.02	0.35	7	30	13.6			14
OTA7520906	Wairuna Trib2	SH 1	OTA1010852	17-Sep-01	10:43	CAM	0.113	11.2	0.056	210		0.03	0.44	6.2		9.8	0.69	0.12	9.32
OTA7520906	Wairuna Trib2	SH 1	OTA1011192	09-Oct-01	09:10	CAM	0.109	12.5	0.0025	430		0.03	0.35	7.4		7.5	0.79	0.031	8.99
OTA7520906	Wairuna Trib2	SH 1	OTA1011437	24-Nov-01	09:00	CAM	0.36		0.011	1700		0.01	0.444	7.1			0.75	0.059	1.21
OTA7520906	Wairuna Trib2	SH 1	OTA1011554	12-Dec-01	10:55	CAM	0.109	10	0.02	2200		0.07	0.255	6.9		13	0.7	0.081	11.2
OTA7520906	Wairuna Trib2	SH 1	OTA1020039	23-Jan-02	11:39	CAM	0.1	9.7	0.021	1200		0.02	0.47	6.7		15.8	0.78	0.059	3.36
OTA7520906	Wairuna Trib2	SH 1	OTA1020053	11-Feb-02	09:46	CAM	0.103	9.4	0.023	1600		0.005	0.382	7.1		15	0.04	0.044	5.8
			4			**Median**	**0.109**	**10**	**0.022**	**1400**	**600**	**0.02**	**0.44**	**7.05**	**8**	**11.4**	**0.725**	**0.059**	**7.395**
						No	**6**	**5**	**11**	**6**	**5**	**11**	**11**	**10**	**5**	**8**	**6**	**6**	**8**
						Mean	**0.15**	**10.56**	**0.03**	**1223.33**	**893.00**	**0.02**	**0.48**	**6.99**	**13.80**	**10.94**	**0.63**	**0.07**	**7.26**
OTA7520907	Wairuna	School Rd 1	OTA1000463	06-Apr-00	11:40	AS			0.08		2300	0.4	1.3		24				
OTA7520907	Wairuna	School Rd 1	OTA1000868	13-Jul-00	1240	AHJ			0.054		760	0.32	1.9	7.2	15	3.2			
OTA7520907	Wairuna	School Rd 1	OTA1001087	21-Sep-00	11.20	AS			0.06		1300	0.39	1.5	7	15	6.8			
OTA7520907	Wairuna	School Rd 1	OTA1001281	01-Nov-00	12:00	AS			0.019		840	0.18	0.43	7.2	16				15
OTA7520907	Wairuna	School Rd 1	OTA1010004	04-Jan-01	11:38	AS			0.081		1000	0.16	0.68	7.1	7	15.2			11
OTA7520907	Wairuna	School Rd 1	OTA1010854	17-Sep-01	11:42	CAM	0.192	10.6	0.059	2400		0.26	1.2	6.7		9.9	2	0.19	26.9
OTA7520907	Wairuna	School Rd 1	OTA1011194	09-Oct-01	10:05	CAM	0.182	12.6	0.02	1400		0.16	0.99	7.5		8.5	1.9	0.17	15.5
OTA7520907	Wairuna	School Rd 1	OTA1011434	22-Nov-01	11:49	CAM	0.147	14.1	0.016	1700		0.22	0.648	**7.03**		11.3	1.9	0.091	7.57
OTA7520907	Wairuna	School Rd 1	OTA1011555	12-Dec-01	09:24	CAM	0.205	9.6	0.073	1050		0.15	1.04	7.2		14	1.9	0.218	8.36
OTA7520907	Wairuna	School Rd 1	OTA1020037	23-Jan-02	10:58	CAM	0.145	9.8	0.044	1500		0.25	1.14	6.7		16.1	2.02	0.184	9.1
OTA7520907	Wairuna	School Rd 1	OTA1020055	11-Feb-02	10:30	CAM	0.175	9.15	0.083	360		0.05	0.731	7.4		17.2	1.34	0.236	15.3
			2			**Median**	**0.1785**	**10.2**	**0.059**	**1450**	**1000**	**0.22**	**1.04**	**7.15**	**15**	**11.3**	**1.9**	**0.187**	**13**
						No	**6**	**6**	**11**	**6**	**5**	**11**	**11**	**10**	**5**	**9**	**6**	**6**	**8**
						Mean	**0.17**	**10.98**	**0.05**	**1401.67**	**1240.00**	**0.23**	**1.05**	**7.10**	**15.40**	**11.36**	**1.84**	**0.18**	**13.59**
OTA7520908	Wairuna	School Rd 2	OTA1000464	06-Apr-00	11:50	AS			0.034		2300	0.17	0.71		18				
OTA7520908	Wairuna	School Rd 2	OTA1000869	13-Jul-00	1300	AHJ			0.013		169	0.05	1.5	7.2	14	4.2			
OTA7520908	Wairuna	School Rd 2	OTA1001088	21-Sep-00	11.30	AS			0.01		230	0.03	1.3	7.2	19	7.2			
OTA7520908	Wairuna	School Rd 2	OTA1001282	01-Nov-00	12:15	AS			0.041		580	0.02	1	7.4	12				11
OTA7520908	Wairuna	School Rd 2	OTA1010005	04-Jan-01	11:48	AS			0.027		1300	0.05	1.3	7.1	47	15.3			24
OTA7520908	Wairuna	School Rd 2	OTA1010855	17-Sep-01	12:18	CAM	0.172	10.8	0.029	1000		0.18	0.99	6.7		11.1	1.7	0.15	31.2
OTA7520908	Wairuna	School Rd 2	OTA1011195	09-Oct-01	10:25	CAM	0.165	12.5	0.009	730		0.08	0.75	7.3		8.7	1.6	0.12	19.6
OTA7520908	Wairuna	School Rd 2	OTA1011433	22-Nov-01	11:30	CAM	0.136	11.44	0.012	1800		0.06	0.972	**7**		10.9	1.8	0.066	13.9
OTA7520908	Wairuna	School Rd 2	OTA1011556	12-Dec-01	09:35	CAM	0.178	9.9	0.045	3300		0.1	0.895	7.2		14.6	0.86	0.161	10.1
OTA7520908	Wairuna	School Rd 2	OTA1020036	23-Jan-02	10:47	CAM	0.134	9.7	0.031	1500		0.21	1.13	6.8		15.9	1.84	0.136	8
OTA7520908	Wairuna	School Rd 2	OTA1020056	11-Feb-02	10:50	CAM	0.156	8.3	0.053	7500		0.11	0.624	7.3		17.5	1.3	0.197	23.3
			5			**Median**	**0.1605**	**10.35**	**0.029**	**1650**	**580**	**0.08**	**0.99**	**7.2**	**18**	**11.1**	**1.65**	**0.143**	**16.75**
						No	**6**	**6**	**11**	**6**	**5**	**11**	**11**	**10**	**5**	**9**	**6**	**6**	**8**
						Mean	**0.16**	**10.44**	**0.03**	**2638.33**	**915.80**	**0.10**	**1.02**	**7.12**	**22.00**	**11.71**	**1.52**	**0.14**	**17.64**

Appendix 2

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520186	WAIWERA RIVER	Gorge	21-Oct-02	09:50	JRM		0.5	0.11	11.4	0.0025	280	290	0.01	0.616	7.61	8	9.5	1.05	0.028	4.5
OTA7520186	WAIWERA RIVER	Gorge	19-Nov-02	09:22	CAM	0.85	0.5	0.096	11.82	0.006	190		0.02	0.903	7.76		9.27	1.11	0.015	3.4
OTA7520186	WAIWERA RIVER	Gorge	16-Dec-02	10:00	MJT	0.4	0.5	0.107	10.8	0.007	5800		0.03	0.972	7.41	24	10.1	1.41	0.071	12
OTA7520186	WAIWERA RIVER	Gorge	15-Jan-03	09:38	CAM	1.55	0.5	0.161	11.1	0.01	63	140	0.005	0.548	8.14	4	12	0.68	0.029	2.6
OTA7520186	WAIWERA RIVER	Gorge	30-Jan-03	09:30	MJT	0.8	1	0.122	11.8	0.012	450	500	0.02	0.685	7.71	11	13	1.1	0.041	5
OTA7520186	WAIWERA RIVER	Gorge	13-Feb-03	09:34	CAM	1.2	0.5	0.118	10.54	0.007	150	180	0.02	0.347	7.69	5	14.31	0.63	0.048	2.6
OTA7520186	WAIWERA RIVER	Gorge	18-Mar-03	10:20	WJT	0.9	0.5	0.155	11.4	0.009	64		0.03	0.37	8.02	3	10.5	0.67	0.024	2.2
OTA7520186	WAIWERA RIVER	Gorge	9-Apr-03	10:30	CAM	1.35	0.5	0.16	11.8	0.007	88		0.02	0.43	7.92	3	7.2	0.56	0.024	2.1
OTA7520186	WAIWERA RIVER	Gorge	21-May-03	10:21	CAM	0.85	0.5	0.107	11.5	0.011	330		0.02	0.602	7.4	9	8.8	0.86	0.184	4.4
OTA7520186	WAIWERA RIVER	Gorge	10-Jun-03	10:25	CAM	1.15	0.5	0.107	12.4	0.015	72		0.005	1.11	7.69	3.9	4.8	1.28	0.024	2.6
OTA7520186	WAIWERA RIVER	Gorge	9-Jul-03	10:33	CAM	0.9	0.5	0.088	13.2	0.006	99		0.05	1.4	7.52	5	3.3	1.48	0.016	2.7
OTA7520186	WAIWERA RIVER	Gorge	13-Aug-03	10:22	CAM	0.9		0.114	13.8	0.062	58		0.005	1	7.79	3	2.5	1.24	0.057	1.9
OTA7520186	WAIWERA RIVER	Gorge	10-Sep-03	10:23	CAM	0.3		0.091	11.9	0.015	1200		0.02	0.91	7.48	30	5.4	1.49	0.105	18
OTA7520186	WAIWERA RIVER	Gorge	9-Oct-03	09:05	CAM	0.8		0.105	13	0.007	110		0.005	1.07	7.69	11	8	1.23	0.023	5.2
				5	**Median**	**0.9**	**0.5**	**0.107**	**11.8**	**0.009**	**110**	**235**	**0.02**	**0.794**	**7.69**	**5**	**9.035**	**1.105**	**0.029**	**3.05**
					n	**13**	**11**	**14**	**14**	**14**	**14**	**4**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					Mean	**0.919**	**0.545**	**0.117**	**11.89**	**0.013**	**639.571**	**277.5**	**0.019**	**0.783**	**7.702**	**9.223**	**8.477**	**1.056**	**0.049**	**4.943**
OTA7520187	KURIWAO STREAM	Above Waiwera River	21-Oct-02	10:45	JRM		0.5	0.133	11.1	0.008	550	550	0.02	0.807	7.38	11	10.35	1.54	0.035	6.1
OTA7520187	KURIWAO STREAM	Above Waiwera River	19-Nov-02	10:12	CAM	0.65	0.5	0.117	11.63	0.008	520		0.02	1.01	7.36		10.34	1.34	0.037	5
OTA7520187	KURIWAO STREAM	Above Waiwera River	16-Dec-02	10:40	MJT	0.25	0.5	0.13	8.9	0.014	8500		0.05	1.79	7.06	26	11.2	2.26	0.074	14
OTA7520187	KURIWAO STREAM	Above Waiwera River	15-Jan-03	10:30	CAM	1.7	0.5	0.189	11.4	0.019	260	530	0.005	0.259	8.11	3	14.2	0.56	0.06	3.6
OTA7520187	KURIWAO STREAM	Above Waiwera River	30-Jan-03	10:30	MJT	0.62	0.5	0.138	10.9	0.025	1200	1600	0.02	1.14	7.5	6	14.8	1.7	0.07	4.6
OTA7520187	KURIWAO STREAM	Above Waiwera River	13-Feb-03	10:27	CAM	1.05	1	0.135	9.96	0.022	170	350	0.03	0.102	7.31	4	15.58	0.51	0.068	3.6
OTA7520187	KURIWAO STREAM	Above Waiwera River	18-Mar-03	11:00	WJT	0.75	0.5	0.148	11.2	0.017	210		0.05	0.066	7.63	3	10.5	0.48	0.057	3.1
OTA7520187	KURIWAO STREAM	Above Waiwera River	9-Apr-03	11:15	CAM	1.4	0.5	0.198	11.2	0.066	200		0.04	0.39	7.71	3	8.1	0.76	0.11	2.7
OTA7520187	KURIWAO STREAM	Above Waiwera River	21-May-03	11:00	CAM	1.2	0.5	0.14	11	0.017	870		0.13	0.677	7.14	4	8.8	1.3	0.043	3.4
OTA7520187	KURIWAO STREAM	Above Waiwera River	10-Jun-03	11:10	CAM	1.3	0.5	0.128	13.4	0.018	270		0.005	1.28	7.5	2	4.9	1.56	0.031	2.7
OTA7520187	KURIWAO STREAM	Above Waiwera River	9-Jul-03	11:15	CAM	1.6	0.5	0.103	12.6	0.0025	180		0.005	1.89	7.33	4	3.1	1.98	0.019	3.4
OTA7520187	KURIWAO STREAM	Above Waiwera River	13-Aug-03	11:08	CAM	1.3		0.126	14.6	0.008	68		0.005	0.758	7.85	2	2.9	1.03	0.009	2.4
OTA7520187	KURIWAO STREAM	Above Waiwera River	10-Sep-03	11:10	CAM	0.9		0.123	13.2	0.042	180		0.07	0.931	7.94	4	6.3	1.4	0.06	3.9
OTA7520187	KURIWAO STREAM	Above Waiwera River	9-Oct-03	08:39	CAM	0.8		0.121	10.8	0.009	370		0.01	1.32	7.38	6	9.3	1.54	0.022	4.2
				6	**Median**	**1.05**	**0.5**	**0.13**	**11.2**	**0.017**	**260**	**540**	**0.02**	**0.869**	**7.44**	**4**	**9.82**	**1.37**	**0.05**	**3.6**
					n	**13**	**11**	**14**	**14**	**14**	**14**	**4**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					Mean	**1.04**	**0.545**	**0.138**	**11.564**	**0.02**	**967.714**	**757.5**	**0.033**	**0.887**	**7.514**	**6**	**9.312**	**1.283**	**0.05**	**4.479**
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	21-Oct-02	10:20	JRM		0.5	0.128	11.05	0.005	440	440	0.02	0.601	7.29	10	10.1	1.23	0.019	5.6
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	19-Nov-02	09:42	CAM	0.7	0.5	0.11	11.1	0.008	410		0.03	0.956	7.36		9.98	1.19	0.042	4.7
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	16-Dec-02	10:30	MJT	0.28	0.5	0.135	8.5	0.014	7000	7000	0.05	1.54	7.13	24	11	1.65	0.076	14
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	15-Jan-03	10:10	CAM	1.1	0.5	0.166	10	0.014	340	400	0.02	0.258	7.78	6	14.8	0.55	0.049	3.7
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	30-Jan-03	10:00	MJT	0.68	0.5	0.138	10.9	0.011	690	820	0.03	0.778	7.44	8	15	1.4	0.057	4.5
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	13-Feb-03	10:03	CAM	1.4	1	0.126	9.26	0.018	440	780	0.15	0.17	7.33	4	16.27	0.61	0.06	3.1
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	18-Mar-03	10:40	WJT	0.8	0.5	0.158	11.5	0.019	120	190	0.03	0.065	7.65	1	11	0.47	0.031	1.7
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	9-Apr-03	10:50	CAM	1.3	0.5	0.17	10.5	0.01	240		0.02	0.244	7.54	3	8.6	0.55	0.046	2.2
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	21-May-03	10:40	CAM	1.25	0.5	0.124	11.2	0.007	400	390	0.02	0.524	7.2	4	8.8	0.96	0.028	3
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	10-Jun-03	10:50	CAM	1.1	0.5	0.12	12.6	0.01	79		0.01	1.17	7.47	2.8	4.7	1.4	0.034	2.9
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	9-Jul-03	10:55	CAM	0.9	0.5	0.1	12.9	0.005	170	140	0.03	1.59	7.36	5	3.1	1.71	0.013	3.4
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	13-Aug-03	10:46	CAM	1.05		0.117	13.8	0.083	57	130	0.01	0.902	7.72	3	2.7	1.17	0.104	2.9
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	10-Sep-03	10:50	CAM	0.3		0.106	11.8	0.023	2800		0.05	0.75	7.38	32	5.9	1.75	0.16	20
OTA7520188	WAIWERA RIVER	State Highway 1 bridge	9-Oct-03	08:50	CAM	1		0.115	10.9	0.007	280	520	0.005	1.14	7.45	9	9.4	1.34	0.024	5
				7	**Median**	**1**	**0.5**	**0.124**	**11.1**	**0.011**	**340**	**420**	**0.025**	**0.764**	**7.41**	**5**	**9.69**	**1.21**	**0.044**	**3.55**
					n	**13**	**11**	**14**	**14**	**14**	**14**	**10**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					Mean	**0.912**	**0.545**	**0.13**	**11.144**	**0.017**	**961.857**	**1081**	**0.034**	**0.763**	**7.436**	**8.6**	**9.382**	**1.141**	**0.053**	**5.479**

Otago Regional Council

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520516	Kaihiku Stream	Hillfoot Rd	21-Oct-02	09:10	JRM		0.5	0.0969	12.05	0.0025	200	220	0.005	0.165	7.25	11	8.1	0.46	0.011	5.1
OTA7520516	Kaihiku Stream	Hillfoot Rd	19-Nov-02	08:47	CAM	1.05	0.5	0.082	13.6	0.0025	270		0.02	0.206	7.25		8.21	0.47	0.009	3.5
OTA7520516	Kaihiku Stream	Hillfoot Rd	16-Dec-02	09:30	MJT	0.43	0.5	0.098	10.9	0.0025	4800		0.02	0.426	7.2	18	10	0.7	0.038	7.5
OTA7520516	Kaihiku Stream	Hillfoot Rd	15-Jan-03	09:10	CAM	1.65	0.5	0.148	10.8	0.0025	400	600	0.01	0.02	7.67	2	9.9	0.19	0.014	1.6
OTA7520516	Kaihiku Stream	Hillfoot Rd	30-Jan-03	09:00	MJT	0.95	1	0.101	11.5	0.0025	400	620	0.03	0.014	7.36	4	12	0.39	0.029	2.3
OTA7520516	Kaihiku Stream	Hillfoot Rd	13-Feb-03	08:50	CAM	1.2	0.5	0.105	10.24	0.0025	410	460	0.005	0.005	7.24	1		0.2	0.018	1.6
OTA7520516	Kaihiku Stream	Hillfoot Rd	18-Mar-03	10:00	WJT	1.45	0.5	0.13	10.2	0.007	130		0.02	0.009	7.6	0.5	8.9	0.25	0.015	0.95
OTA7520516	Kaihiku Stream	Hillfoot Rd	9-Apr-03	09:55	CAM	1.25	0.5	0.135	11.6	0.02	79		0.03	0.054	7.51	4	5.9	0.21	0.018	1.6
OTA7520516	Kaihiku Stream	Hillfoot Rd	21-May-03	09:50	CAM	0.65	0.5	0.098	11.8	0.007	770		0.005	0.149	7.2	6	8.7	0.37	0.023	6.1
OTA7520516	Kaihiku Stream	Hillfoot Rd	10-Jun-03	09:55	CAM	1.5	0.5	0.094	12.6	0.012	120		0.01	0.274	7.43	5.6	3.6	0.4	0.017	3
OTA7520516	Kaihiku Stream	Hillfoot Rd	9-Jul-03	10:04	CAM	1.7	0.5	0.078	13.3	0.0025	190		0.04	0.495	7.28	2	2.7	0.6	0.008	1.9
OTA7520516	Kaihiku Stream	Hillfoot Rd	13-Aug-03	09:45	CAM	1.85		0.099	14.4	0.0025	37		0.01	0.133	7.54	1	1	0.28	0.012	1.7
OTA7520516	Kaihiku Stream	Hillfoot Rd	10-Sep-03	09:55	CAM	0.35		0.086	12.1	0.0025	250		0.02	0.294	7.3	19	5.3	0.75	0.024	8
OTA7520516	Kaihiku Stream	Hillfoot Rd	7-Oct-03	08:52	CAM	0.6		0.076	14.7	0.0025	770		0.01	0.472	6.7	13	5.57	0.76	0.018	5.5
				8	**Median**	**1.2**	**0.5**	**0.098**	**11.8**	**0.003**	**270**	**530**	**0.015**	**0.157**	**7.29**	**4**	**8.1**	**0.395**	**0.018**	**2.65**
					n	**13**	**11**	**14**	**14**	**14**	**14**	**4**	**14**	**14**	**14**	**13**	**13**	**14**	**14**	**14**
					Mean	**1.125**	**0.545**	**0.102**	**12.128**	**0.005**	**630.429**	**475**	**0.017**	**0.194**	**7.324**	**6.7**	**6.914**	**0.431**	**0.018**	**3.596**
OTA7520540	WAIPAHI RIVER	Waipahi	21-Oct-02	13:35	JRM		1			0.006	270	370	0.02	1.24	8.11	9		1.9	0.031	5
OTA7520540	WAIPAHI RIVER	Waipahi	19-Nov-02	12:00	CAM	0.8	0.5	0.111	10.94	0.008	130		0.02	1.31	7.46		12.16	1.46	0.03	4.8
OTA7520540	WAIPAHI RIVER	Waipahi	16-Dec-02	12:30	MJT	0.32	2	0.118	8.9	0.0025	10800	10900	0.05	1.06	7.26	36	12.5	1.74	0.104	15
OTA7520540	WAIPAHI RIVER	Waipahi	15-Jan-03	12:35	CAM	3.1	0.5	0.161	12.7	0.0025	19	52	0.005	0.011	9.29	1	18.3	0.38	0.017	1.4
OTA7520540	WAIPAHI RIVER	Waipahi	30-Jan-03	12:30	MJT	0.55	1	0.117	9.2	0.007	670	950	0.02	0.91	7.49	9	16.3	1.5	0.051	5
OTA7520540	WAIPAHI RIVER	Waipahi	13-Feb-03	12:22	CAM	1.85	0.5	0.115	11.04	0.011	200	300	0.02	0.105	8.58	1	19.3	0.46	0.039	1.6
OTA7520540	WAIPAHI RIVER	Waipahi	18-Mar-03	13:00	WJT	1.55	0.5	0.133	12.8	0.006	75	50	0.005	0.012	8.86	0.5	14.5	0.37	0.02	1.2
OTA7520540	WAIPAHI RIVER	Waipahi	9-Apr-03	13:00	CAM	2.7	3	0.174	11	0.007	53		0.01	0.138	8.16	0.5	10	0.37	0.021	1.6
OTA7520540	WAIPAHI RIVER	Waipahi	21-May-03	12:55	CAM	1.3	0.5	0.124	11.9	0.006	870		0.02	0.747	7.24	3	8.2	1.45	0.021	1.7
OTA7520540	WAIPAHI RIVER	Waipahi	10-Jun-03	12:50	CAM	1.4	0.5	0.123	13.2	0.016	87		0.02	1.53	7.39	3.3	5.4	1.82	0.021	3
OTA7520540	WAIPAHI RIVER	Waipahi	9-Jul-03	13:20	CAM	0.7	0.5	0.105	12	0.0025	190	120	0.01	2.01	7.33	6	3.7	2.12	0.032	4
OTA7520540	WAIPAHI RIVER	Waipahi	13-Aug-03	13:18	CAM	1.2		0.119	12.9	0.0025	21	16	0.02	1.07	7.7	3	4	1.27	0.013	2.5
OTA7520540	WAIPAHI RIVER	Waipahi	10-Sep-03	13:17	CAM	1.05		0.125	12.1	0.0025	130		0.01	1.07	7.54	5	6.9	1.34	0.007	3.3
OTA7520540	WAIPAHI RIVER	Waipahi	9-Oct-03	10:55	CAM	1.15		0.119	10.8	0.0025	140	200	0.01	1.29	7.48	6	9.6	1.5	0.013	4.5
				3	**Median**	**1.2**	**0.5**	**0.119**	**11.9**	**0.006**	**130**	**200**	**0.02**	**1.065**	**7.515**	**3.3**	**10**	**1.455**	**0.021**	**3.15**
					n	**13**	**11**	**13**	**13**	**14**	**14**	**9**	**14**	**14**	**14**	**13**	**13**	**14**	**14**	**14**
					Mean	**1.359**	**0.955**	**0.126**	**11.498**	**0.006**	**975.357**	**1439.7**	**0.017**	**0.893**	**7.849**	**6.408**	**10.835**	**1.263**	**0.03**	**3.9**
OTA7520646	Kaihiku Stream	Clifton Road	21-Oct-02	08:00	JRM		0.5	0.14	9.7	0.009	610	860	0.02	0.527	7.17	6	10.7	1.03	0.029	5.8
OTA7520646	Kaihiku Stream	Clifton Road	19-Nov-02	08:00	CAM	0.6	0.5	0.141	9.55	0.011	870		0.02	0.632	7.17		10.69	1.05	0.045	6.4
OTA7520646	Kaihiku Stream	Clifton Road	16-Dec-02	08:00	MJT	0.35	0.5	0.183	8.5	0.02	13200	13200	0.08	1.43	7.05	14	12	1.98	0.085	13
OTA7520646	Kaihiku Stream	Clifton Road	15-Jan-03	08:10	CAM	1.55	0.5	0.232	14.7	0.037	64	80	0.005	0.006	8.62	1	14.7	0.59	0.071	2.2
OTA7520646	Kaihiku Stream	Clifton Road	30-Jan-03	08:00	MJT	0.75	1	0.199	7.2	0.019	350	700	0.005	0.006	7.3	3	15	0.48	0.065	3.3
OTA7520646	Kaihiku Stream	Clifton Road	13-Feb-03	08:00	CAM	2.1	1	0.153	6.55	0.062	160	260	0.02	0.007	7.16	0.5	18.6	0.53	0.108	1.6
OTA7520646	Kaihiku Stream	Clifton Road	18-Mar-03	09:00	WJT	1.5	0.5	0.185	8.4	0.042	430	430	0.02	0.0025	7.34	0.5	12.8	0.32	0.066	1.3
OTA7520646	Kaihiku Stream	Clifton Road	9-Apr-03	09:05	CAM	1.4	0.5	0.205	9.6	0.04	90		0.005	0.014	7.08	2	9.1	0.48	0.069	2.2
OTA7520646	Kaihiku Stream	Clifton Road	21-May-03	09:00	CAM	2.2	0.5	0.137	10.7	0.018	130	150	0.01	0.138	6.9	0.5	7.94	0.38	0.022	2.7
OTA7520646	Kaihiku Stream	Clifton Road	10-Jun-03	09:05	CAM	1.4	0.5	0.162	11.8	0.014	250		0.03	0.841	7.4	1.9	4.2	1.08	0.028	3
OTA7520646	Kaihiku Stream	Clifton Road	9-Jul-03	09:05	CAM	0.75	0.5	0.152	13	0.008	190	170	0.02	1.48	7.29	5	2.6	1.77	0.011	4.5
OTA7520646	Kaihiku Stream	Clifton Road	13-Aug-03	09:00	CAM	1.05		0.18	12.2	0.006	46	40	0.04	0.547	7.61	3	3.2	1.19	0.023	3.1
OTA7520646	Kaihiku Stream	Clifton Road	10-Sep-03	09:04	CAM	0.3		0.193	10.2	0.021	3500		0.08	0.864	7.18	23	5.8	2.28	0.111	19
OTA7520646	Kaihiku Stream	Clifton Road	7-Oct-03	08:05	CAM	0.4		0.126	12.74	0.008	1300	1300	0.04	1.07	6.38	17	6.4	1.7	0.04	9.9
				9	**Median**	**1.05**	**0.5**	**0.18**	**10.2**	**0.019**	**250**	**345**	**0.02**	**0.537**	**7.175**	**3**	**9.895**	**1.04**	**0.055**	**3.2**
					n	**13**	**11**	**14**	**14**	**14**	**14**	**10**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					Mean	**1.104**	**0.591**	**0.171**	**10.346**	**0.023**	**1513.571**	**1719**	**0.028**	**0.54**	**7.261**	**5.954**	**9.552**	**1.061**	**0.055**	**5.571**

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520998	WAIPAHI RIVER	Cairns Peak	21-Oct-02	12:05	JRM		0.5	0.091	11.15	0.005	180	200	0.01	0.498	6.94	6	9.9	0.76	0.019	3.1
OTA7520998	WAIPAHI RIVER	Cairns Peak	19-Nov-02	10:52	CAM	0.63	0.5	0.0803	11.26	0.005	84		0.005	0.539	6.92		10.12	0.81	0.018	3.2
OTA7520998	WAIPAHI RIVER	Cairns Peak	16-Dec-02	11:20	MJT	0.46	0.5	0.09	9.8	0.0025	4000		0.03	0.907	6.69	24	12	1.3	0.053	6.5
OTA7520998	WAIPAHI RIVER	Cairns Peak	15-Jan-03	11:15	CAM	1	0.5	0.131	10.4	0.0025	660	650	0.005	0.481	7.27	4	12.6	0.68	0.03	3.9
OTA7520998	WAIPAHI RIVER	Cairns Peak	30-Jan-03	11:20	MJT		0.5			0.0025	1400	1500	0.02	0.914	6.78	13		1.4	0.043	4.2
OTA7520998	WAIPAHI RIVER	Cairns Peak	13-Feb-03	11:10	CAM	1.1	0.5	0.088	9.73	0.0025	400	380	0.01	0.462	6.94	2	12.9	0.66	0.029	2.8
OTA7520998	WAIPAHI RIVER	Cairns Peak	18-Mar-03	11:40	WJT	0.65	0.5	0.113	10.5	0.007	240		0.02	0.454	7.15	3	9.2	0.44	0.029	3.9
OTA7520998	WAIPAHI RIVER	Cairns Peak	9-Apr-03	11:55	CAM	0.95	0.5	0.14	10.6	0.009	330		0.01	0.494	7.2	3	7.5	0.85	0.062	3.5
OTA7520998	WAIPAHI RIVER	Cairns Peak	21-May-03	11:35	CAM	0.4	0.5	0.08	10.47	0.005	1700		0.04	0.433	6.7	12	9.04	0.97	0.037	7.9
OTA7520998	WAIPAHI RIVER	Cairns Peak	10-Jun-03	11:48	CAM	1	0.5	0.09	12.1	0.012	200		0.02	0.804	7	3.2	5	1.06	0.012	2.6
OTA7520998	WAIPAHI RIVER	Cairns Peak	9-Jul-03	11:55	CAM	1.15	0.5	0.079	12	0.0025	86	120	0.01	1.17	7.21	6	4	1.28	0.012	3.2
OTA7520998	WAIPAHI RIVER	Cairns Peak	13-Aug-03	11:44	CAM	1.05		0.093	12.8	0.0025	72		0.01	0.618	7.13	3	2.4	0.89	0.024	2.9
OTA7520998	WAIPAHI RIVER	Cairns Peak	10-Sep-03	11:45	CAM	0.25		0.09	12	0.008	190		0.01	0.66	7.11	36	5	1.19	0.08	16
OTA7520998	WAIPAHI RIVER	Cairns Peak	9-Oct-03	09:48	CAM	1		0.096	11.3	0.0025	160		0.005	0.878	7.04	8	7.8	1.06	0.016	4.4
				1	**Median**	**0.975**	**0.5**	**0.09**	**10.93**	**0.003**	**240**	**380**	**0.01**	**0.579**	**7.02**	**6**	**9.04**	**0.93**	**0.029**	**3.7**
					n	**12**	**11**	**13**	**13**	**14**	**14**	**5**	**14**	**14**	**14**	**13**	**13**	**14**	**14**	**14**
					Mean	**0.803**	**0.5**	**0.097**	**11.085**	**0.005**	**693**	**570**	**0.015**	**0.665**	**7.006**	**9.477**	**8.266**	**0.954**	**0.033**	**4.864**
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	21-Oct-02	13:00	JRM		0.5	0.118	12.75	0.005	550	550	0.02	0.816	7.84	12	11.8	1.51	0.024	5.1
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	19-Nov-02	11:25	CAM	0.55	0.5		11.56	0.007	310		0.02	1.12	7.32		11.8	1.35	0.029	5.3
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	16-Dec-02	12:00	MJT	0.3	1	0.115	9.8	0.0025	11500		0.05	1.13	7.12	31	11.9	1.96	0.085	12
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	15-Jan-03	12:50	CAM	1.51	1	0.159	12.4	0.0025	34	100	0.005	0.235	8.85	1	16.5	0.51	0.023	2
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	30-Jan-03	11:45	MJT	0.61	1	0.111	11.3	0.007	1200	1300	0.03	0.88	7.4	7	14.8	1.4	0.043	3.9
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	13-Feb-03	11:45	CAM	1.5	1	0.115	10.16	0.01	110	140	0.03	0.249	7.84	2	17.24	0.62	0.039	2.2
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	18-Mar-03	12:20	WJT	0.65	0.5	0.128	10.4	0.012	32		0.01	0.151	8.18	2	13	0.52	0.022	2.5
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	9-Apr-03	12:30	CAM	1.45	0.5	0.152	11.8	0.011	64		0.03	0.3	7.77	3	8	0.48	0.025	2.5
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	21-May-03	12:15	CAM	0.9	0.5	0.12	11.87	0.008	2100		0.04	0.928	7.13	7	8.46	1.4	0.024	6
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	10-Jun-03	12:18	CAM	1.1	0.5	0.115	13.4	0.013	130		0.01	1.38	7.42	4.1	4.9	2.35	0.081	2.9
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	9-Jul-03	12:45	CAM	0.75	0.5	0.1	12	0.0025	180		0.005	1.93	7.25	5	3.7	2.1	0.03	9.1
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	13-Aug-03	12:43	CAM	1.1		0.113	14	0.0025	31		0.005	0.892	8.12	2	3.7	1.19	0.016	2.9
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	10-Sep-03	12:40	CAM	0.45		0.111	13.4	0.0025	40	70	0.005	0.905	8.23	7	6.8	1.17	0.013	6
OTA7520999	WAIPAHI RIVER	Kaiwera Rd/Clement	9-Oct-03	10:15	CAM	1		0.115	11.4	0.0025	180		0.005	1.23	7.49	6	9	1.41	0.011	3.7
				2	**Median**	**0.9**	**0.5**	**0.115**	**11.8**	**0.007**	**130**	**140**	**0.015**	**0.899**	**7.63**	**5**	**10.4**	**1.375**	**0.025**	**3.8**
					n	**13**	**11**	**13**	**14**	**14**	**14**	**5**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					Mean	**0.913**	**0.682**	**0.121**	**11.874**	**0.006**	**1175.786**	**432**	**0.019**	**0.868**	**7.711**	**6.854**	**10.114**	**1.284**	**0.033**	**4.721**
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	21-Oct-02	14:30	JRM		4	0.203	10.05	0.063			0.16	1.34	7.4	26	15.3	2.97	0.492	20
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	19-Nov-02	12:36	CAM	0.28	3	0.189	9.64	0.059	2200		0.07	1.21	7.33		15.8	2.33	0.335	17
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	16-Dec-02	14:00	MJT		7	0.27	8.4	0.056	8400		0.17	1.57	7.32	23	15.7	4.03	0.507	20
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	15-Jan-03	13:15	CAM	0.4	3	0.288	11.9	0.104	1700	2400	0.03	0.735	8.26	19	19.8	1.9	0.593	18
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	30-Jan-03	13:10	MJT	0.45	4	0.235	11.1	0.117	440	630	0.04	0.894	7.78	14	17.8	2.55	0.468	14
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	13-Feb-03	13:08	CAM		2	0.238	11.91	0.269	310	370	0.03	0.138	8.4	5	23.3	1.39	0.645	8.4
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	18-Mar-03	13:45	WJT		2	0.247	12.2	0.106	99		0.03	0.077	8.54	5	16	0.79	0.294	8.7
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	9-Apr-03	13:55	CAM		2	0.318	10.9	0.031	160		0.02	0.311	7.56	5	9.3	1.3	0.228	7
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	21-May-03	13:30	CAM		2	0.236	10.3	0.052	580		0.15	1.73	7	9	9.53	3.14	0.17	12
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	10-Jun-03	13:30	CAM		1	0.239	12.5	0.031	320		0.1	2.03	7.38	9	5.4	3.09	0.158	8.7
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	9-Jul-03	14:00	CAM		0.5	0.179	12.8	0.011	280		0.08	1.93	6.88	12	2.2	2.68	0.114	2.6
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	13-Aug-03	13:50	CAM			0.207	13.6	0.037	210		0.15	0.914	7.49	11	3.6	1.87	0.213	9.7
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	10-Sep-03	13:48	CAM			0.259	11.7	0.042	2000		0.26	1.4	7.43	24	7.5	3.71	0.268	18
OTA7521000	WASHPOOL STREAM	Kilhastie Rd	9-Oct-03	11:29	CAM			0.196	10.7	0.037	4900		0.32	0.732	7.37	15	9.8	2.28	0.241	15
				4	**Median**	**0.4**	**2**	**0.238**	**11.7**	**0.052**	**440**	**630**	**0.09**	**1.062**	**7.415**	**12**	**12.55**	**2.44**	**0.281**	**13**
					n	**3**	**11**	**14**	**14**	**14**	**13**	**3**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					Mean	**0.377**	**2.773**	**0.236**	**11.264**	**0.073**	**1661.462**	**1133.3**	**0.115**	**1.072**	**7.581**	**13.61**	**12.216**	**2.431**	**0.338**	**12.793**

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7521002	PAIWATA STREAM	SH1	21-Oct-02	08:30	JRM		0.5	0.18	10.9	0.012	2000	3200	0.03	0.722	7.28	10	9.2	1.3	0.052	7.7
OTA7521002	PAIWATA STREAM	SH1	19-Nov-02	08:22	CAM	0.55	0.5	0.175	10.61	0.013	1300		0.02	0.899	7.14		9.3	1.51	0.081	8.1
OTA7521002	PAIWATA STREAM	SH1	16-Dec-02	09:00	MJT	0.34	0.5	0.17	9.4	0.018	7500		0.08	1.89	6.84	23	12	2.23	0.096	14
OTA7521002	PAIWATA STREAM	SH1	15-Jan-03	08:40	CAM	1.5	0.5	0.278	10.5	0.023	500	500	0.01	0.164	7.62	3	11.7	0.57	0.064	3.5
OTA7521002	PAIWATA STREAM	SH1	30-Jan-03	08:45	MJT	0.9	1	0.218	10.5	0.04	370	700	0.03	0.228	7.33	6	13.5	0.87	0.081	5.2
OTA7521002	PAIWATA STREAM	SH1	13-Feb-03	08:25	CAM	1.75	0.5	0.205	7.86	0.023	440	490	0.01	0.015	7.08	3	12.8	0.45	0.067	4.4
OTA7521002	PAIWATA STREAM	SH1	18-Mar-03	09:30	WJT		0.5	0.245	9.3	0.008	330		0.02	0.01	7.46	2	9.2	0.58	0.031	2.8
OTA7521002	PAIWATA STREAM	SH1	9-Apr-03	09:30	CAM		0.5	0.268	10	0.059	200		0.02	0.224	7.36	3	6.5	0.59	0.082	2.9
OTA7521002	PAIWATA STREAM	SH1	21-May-03	09:26	CAM		2	0.199	8.86	0.047	1700		0.07	0.465	6.9	7	8.71	1.06	0.08	5.9
OTA7521002	PAIWATA STREAM	SH1	10-Jun-03	09:30	CAM		0.5	0.196	11.8	0.026	490		0.05	1.44	7.3	3.4	4	1.78	0.036	4
OTA7521002	PAIWATA STREAM	SH1	9-Jul-03	09:40	CAM		0.5	0.162	12.5	0.007	520		0.04	2.24	7.12	6	2.8	2.53	0.043	5.2
OTA7521002	PAIWATA STREAM	SH1	13-Aug-03	09:26	CAM			0.213	12.8	0.009	230		0.03	1.27	7.48	7	2	1.65	0.036	6.2
OTA7521002	PAIWATA STREAM	SH1	10-Sep-03	09:30	CAM			0.206	11	0.014	2800		0.31	1.86	7.02	29	5.9	3.27	0.111	19
OTA7521002	PAIWATA STREAM	SH1	7-Oct-03	08:30	CAM			0.147	13.7	0.011	1500		0.03	1.73	6.47	19	6.1	2.08	0.035	9
				10	**Median**	**0.9**	**0.5**	**0.205**	**10.5**	**0.018**	**500**	**600**	**0.03**	**0.811**	**7.21**	**6**	**8.955**	**1.405**	**0.066**	**5.55**
					n	**5**	**11**	**14**	**14**	**14**	**14**	**4**	**14**	**14**	**14**	**13**	**14**	**14**	**14**	**14**
					mean	**1.008**	**0.682**	**0.204**	**10.695**	**0.022**	**1420**	**1222.5**	**0.054**	**0.94**	**7.171**	**9.338**	**8.122**	**1.462**	**0.064**	**6.993**

Appendix 3

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520099	HERIOT BURN	Shanks Rd bridge	24-May-00	12.35	AM	0.95	0.5	0.1068	13.3	0.03	580	580	0.025	0.79	7.5	7	7.5	1.4	0.082	4
OTA7520099	HERIOT BURN	Shanks Rd bridge	11-Jul-00	1255	A					0.018		62	0.03	1.7		5				
OTA7520099	HERIOT BURN	Shanks Rd bridge	26-Sep-00	14:15	BM					0.02		62	0.01	1.5		2				2.4
OTA7520099	HERIOT BURN	Shanks Rd bridge	01-Mar-01	13:55	BRM					0.069		380	0.05	1.1		4				2.3
OTA7520099	HERIOT BURN	Shanks Rd bridge	18-Sep-01	11:15	CAM	0.7	2	0.117		0.022	2800	2900	0.19	1.7	7.4	10	8	2.1	0.083	6.94
OTA7520099	HERIOT BURN	Shanks Rd bridge	10-Oct-01	11:40	CAM			0.112		0.017	1960		0.11	1.6	7.4		9.3	2.2	0.086	2.85
OTA7520099	HERIOT BURN	Shanks Rd bridge	21-Nov-01	10:44	CAM	0.89	0.5	0.083	11.32	0.008	1100	1300	0.03	0.751	7.3	12	11.98	1	0.045	6.86
OTA7520099	HERIOT BURN	Shanks Rd bridge	11-Dec-01	10:41	CAM			0.107	10	0.01	5650		0.05	0.369	7.6		14.1	1.2	0.084	10.5
OTA7520099	HERIOT BURN	Shanks Rd bridge	21-Jan-02	10:36	CAM	1.3	0.5	0.109	10.4	0.017	280	320	0.06	0.625	7.3	2	16.6	1.03	0.073	3.04
OTA7520099	HERIOT BURN	Shanks Rd bridge	12-Feb-02	10:52	CAM			0.1	9.7	0.058	1800		0.07	0.839	7.5		17.3	1.14	0.138	3.12
OTA7520099	HERIOT BURN	Shanks Rd bridge	19-Mar-02	12:00	CAM	1.9	1	0.1	10.6	0.023	110	200	0.03	0.715	7	2	14.3	0.97	0.051	1.57
OTA7520099	HERIOT BURN	Shanks Rd bridge	10-Apr-02	11:05	CAM				12	0.013	16		0.03	0.484	7		9	0.85	0.036	4.61
OTA7520099	HERIOT BURN	Shanks Rd bridge	07-May-02	11:00	CAM	0.8	0.5	0.11	11.2	0.008	530	2600	0.03	0.957	6.8	10	9.2	2.04	0.053	4.23
					Median	***0.92***	***0.5***	***0.107***	***10.9***	***0.018***	***840***	***380***	***0.03***	***0.839***	***7.35***	***5***	***10.64***	***1.17***	***0.0775***	***3.56***
					n	***6***	***6***	***9***	***8***	***13***	***10***	***9***	***13***	***13***	***10***	***9***	***10***	***10***	***10***	***12***
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	24-May-00	10:10	AM							250	0.06			4				
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	11-Jul-00	1230	AM	1.05	0.5	0.1271	11.4	0.016	130	158	0.03	2.5	7.3	8	6.4	3.1	0.033	6.1
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	26-Sep-00	10:30	BM					0.031		250	0.05	2.1		5				4.4
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	01-Mar-01	10:20	BRM					0.039		480	0.005	0.61		4				2.9
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	18-Sep-01	13:30	CAM	1.1	0.5	0.149	12.8	0.01	820	960	0.06	0.21	7.4	5	10.4	2.6	0.053	3.96
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	11-Oct-01	09:42	CAM			0.134	12.1	0.006	770		0.04	1.8	7.5		8.4	2.4	0.033	2.78
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	22-Nov-01	08:55	CAM			0.1089	10.62	0.012	1000		0.07	0.699	**6.92**		11.56	1.4	0.053	4.67
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	11-Dec-01	10:43	CAM			0.152	10	0.026	9700		0.11	0.557	7.5		16	1.8	0.129	7.49
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	21-Jan-02	12:10	CAM		0.5	0.114	11.2	0.017	210	240	0.1	0.505	7.7	2	18.2	0.89	0.056	1.95
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	12-Feb-02	12:12	CAM			0.109	9.9	0.024	2600		0.02	0.424	7.6		17.2	0.68	0.04	3.31
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	19-Mar-02	13:27	CAM			0.099	11.4	0.011	1500		0.005	0.181	7.8		15.2	0.4	0.029	2.28
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	10-Apr-02	12:00	CAM				11.6	0.015	430		0.02	0.359	7		8.5	0.58	0.037	3.35
OTA7520371	CROOKSTON BURN	Crookston Burn,Kelso (B)	07-May-02	12:10	CAM			0.18	10.6	0.032	2100		0.11	2.89	6.7		10	3.95	0.082	10.3
					Median	***1.075***	***0.5***	***0.1271***	***11.3***	***0.0165***	***910***	***250***	***0.05***	***0.5835***	***7.45***	***4.5***	***10.98***	***1.6***	***0.0465***	***3.655***
					n	***2***	***3***	***9***	***10***	***12***	***10***	***6***	***13***	***12***	***10***	***6***	***10***	***10***	***10***	***12***
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	24-May-00	11.35	AM	0.8	0.5	0.1125	13.4	0.016	270	270	0.0025	0.71	7.4	10	6.4	1.3	0.067	
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	11-Jul-00	1105	Ali	0.85	0.5	0.1078	12.2	0.013	120	124	0.02	1.5	7.2		4.8	2	0.052	5.9
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	26-Sep-00	09:30	BM					0.34		270	0.005	1.4		5				3.9
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	01-Mar-01	09:40	BRM					0.043		550	0.01	0.84		6				3
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	18-Sep-01	13:10	CAM	0.7	1	0.1309	12.7	0.026	3100	4100	0.15	1.6	7.4	22	10	2.5	0.13	11
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	10-Oct-01	12:10	CAM			0.115		0.006	520		0.02	1.4	7.3		10.2	1.5	0.057	3.54
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	21-Nov-01	11:40	CAM	0.61	1	0.091	11.5	0.002	2400	2900	0.04	0.526	7.3	14	12.99	1.1	0.06	10.6
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	11-Dec-01	09:55	CAM			0.117	9.9	0.012	7900		0.06	0.319	7.2		14.9	1.4	0.121	14.7
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	21-Jan-02	11:14	CAM	0.9	1	0.117	9	0.016	1100	1200	0.02	0.54	7.1	6	17	1.01	0.089	4.79
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	12-Feb-02	11:16	CAM			0.107	8.9	0.022	3600		0.04	0.481	7.2		16.8	1.07	0.124	6.29
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	19-Mar-02	12:38	CAM	1.3	1	0.106	10.2	0.015	190	260	0.02	0.515	7.3	7	14.6	1.06	0.061	3.4
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	10-Apr-02	11:22	CAM				11.7	0.024	280		0.005	0.378	7		8.9	0.72	0.044	3.72
OTA7520372	HERIOT BURN	HeriotBurn,Parkhill/KelsoRd(D)	07-May-02	11:27	CAM	0.55	0.5	0.14	11	0.019	990	2800	0.07	1.45	6.7	9	9.4	2.44	0.063	5.23
					Median	***0.8***	***1***	***0.11375***	***11.25***	***0.016***	***990***	***550***	***0.02***	***0.71***	***7.2***	***8***	***10.2***	***1.3***	***0.063***	***5.01***
					n	***7***	***7***	***10***	***10***	***13***	***11***	***9***	***13***	***13***	***11***	***8***	***11***	***11***	***11***	***12***

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
	Heriot Burn	SH90	24-May-00																	
OTA7520512	Heriot Burn	SH90	11-Jul-00	1030	AM					0.012		97	0.01	1.2		0.5				1.8
OTA7520512	Heriot Burn	SH90	26-Sep-00	14:50	BM					0.017		117	0.005	1.1		3				1.5
OTA7520512	Heriot Burn	SH90	01-Mar-01	14:40	BRM					0.026		470	0.005	0.61		0.5				0.84
OTA7520512	Heriot Burn	SH90	18-Sep-01	09:20	CAM			0.0796		0.0025	570		0.02	0.99	7.3		6	1.2	0.027	2.21
OTA7520512	Heriot Burn	SH90	10-Oct-01	09:20	CAM			0.084		0.0025	1500		0.005	0.86	7.3		8.3	0.89	0.011	0.75
OTA7520512	Heriot Burn	SH90	21-Nov-01	08:38	CAM			0.058	11.4	0.002	1000		0.02	0.217	7.3		10.2	0.44	0.037	1.91
OTA7520512	Heriot Burn	SH90	11-Dec-01	08:15	CAM			0.072	10	0.004	2600		0.02	0.256	7.1		12	0.55	0.028	3.11
OTA7520512	Heriot Burn	SH90	21-Jan-02	08:48	CAM			0.079	10.7	0.005	180		0.02	0.299	7.3		13	0.39	0.031	1.42
OTA7520512	Heriot Burn	SH90	12-Feb-02	08:17	CAM			0.078	9	0.009	800		0.02	0.509	7		15	0.73	0.04	1.59
OTA7520512	Heriot Burn	SH90	19-Mar-02	10:25	CAM			0.076	10.8	0.007	200		0.005	0.343	7		11.2	0.5	0.022	0.84
OTA7520512	Heriot Burn	SH90	10-Apr-02	09:34	CAM				11.7	0.01	270		0.005	0.22	6.6		7.3	0.43	0.012	0.87
OTA7520512	Heriot Burn	SH90	07-May-02	09:30	CAM			0.07	11.2	0.006	950		0.005	0.495	6.9		8.5	0.78	0.016	2.82
					Median			***0.077***	***10.8***	***0.0065***	***800***	***117***	***0.0075***	***0.502***	***7.1***	***0.5***	***10.2***	***0.55***	***0.027***	***1.545***
					n	***0***	***0***	***8***	***7***	***12***	***9***	***3***	***12***	***12***	***9***	***3***	***9***	***9***	***9***	***12***
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	24-May-00																	
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	11-Jul-00	1050	PJS	2	1.1	0.032	14.2	0.008	55	64	0.01	0.13	7.4	0.5	0.2	0.36	0.036	1.5
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	26-Sep-00	09:10	BM					0.017		68	0.005	0.044		3				1.3
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	01-Mar-01	09:10	BRM					0.0025		270	0.005	0.0025		6				0.86
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	18-Sep-01	12:45	CAM	0.9	0.5	0.0353		0.007	75	130	0.005	0.031	7.3	7	7.3	0.21	0.024	3.31
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	11-Oct-01	09:00	CAM					0.001	170		0.005	0.009	7.4			0.13	0.018	1.15
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	22-Nov-01	09:58	CAM	1.53	0.5	0.04	12.22	0.003	260	260	0.02	0.051	**7.2**	2	11.1	0.21	0.024	1.76
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	11-Dec-01	11:00	CAM			0.05	10.2	0.006	2000		0.03	0.04	7.5		13.8	0.23	0.031	6.04
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	23-Jan-02	08:45	CAM	2	0.5	0.046	10.2	0.003	280	300	0.005	0.013	7.1	2	15	0.21	0.032	1.26
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	13-Feb-02	09:48	CAM			0.043	10.6	0.006	2900		0.005	0.021	6.5		13	0.26	0.008	2.83
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	20-Mar-02	11:00	CAM	3.4	0.5	0.049	10.6	0.0005	58	210	0.005	0.0015	7.2	0.5	10.6	0.12	0.017	1.11
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	10-Apr-02	12:28	CAM				12.6	0.003	190		0.005	0.015	7		7.4	0.17	0.016	1.65
OTA7520628	POMAHAKA RIVER	U/S GLENKENICH W/S	07-May-02	12:54	CAM	0.95	0.5	0.03	11.7	0.0025	500	520	0.005	0.245	7.1	6	8.8	0.52	0.008	2.61
					Median	***1.765***	***0.5***	***0.0415***	***11.15***	***0.003***	***225***	***235***	***0.005***	***0.026***	***7.2***	***2.5***	***10.6***	***0.21***	***0.021***	***1.575***
					n	***6***	***6***	***8***	***8***	***12***	***10***	***8***	***12***	***12***	***10***	***8***	***9***	***10***	***10***	***12***
OTA7520909	Pomahaka	d/s Crookstonburn	24-May-00	9.50	AM					0.009		270	0.0025	0.27		5				
OTA7520909	Pomahaka	d/s Crookstonburn	11-Jul-00	1205	A					0.013		148	0.01	0.48		3				
OTA7520909	Pomahaka	d/s Crookstonburn	26-Sep-00	10:00	BM					0.006		49	0.005	0.23		3				2
OTA7520909	Pomahaka	d/s Crookstonburn	01-Mar-01	10:00	BRM					0.006		380	0.005	0.18		9				2
	Pomahaka	d/s Crookstonburn	18-Sep-01																	
OTA7520909	Pomahaka	d/s Crookstonburn	11-Oct-01	08:24	CAM					0.002	220		0.01	0.26	7.1			0.43	0.023	1.45
OTA7520909	Pomahaka	d/s Crookstonburn	22-Nov-01	09:20	CAM			0.047	11.05	0.02	370		0.02	0.146	**6.94**		11.77	0.42	0.029	3.83
OTA7520909	Pomahaka	d/s Crookstonburn	11-Dec-01	11:30	CAM			0.057	9.9	0.005	2200		0.05	0.107	7.4		14.5	0.48	0.041	11.6
OTA7520909	Pomahaka	d/s Crookstonburn	23-Jan-02	09:22	CAM			0.054	9.7	0.004	330		0.02	0.124	6.7		16	0.17	0.024	1.78
OTA7520909	Pomahaka	d/s Crookstonburn	13-Feb-02	09:15	CAM			0.048	10	0.006	2500		0.005	0.04	6.4		14	0.35	0.019	4
OTA7520909	Pomahaka	d/s Crookstonburn	20-Mar-02	10:30	CAM			0.05	9.7	0.004	350		0.005	0.136	6.7		12	0.29	0.021	1.47
OTA7520909	Pomahaka	d/s Crookstonburn	10-Apr-02	12:50	CAM				12	0.004	220		0.005	0.073	6.6		8.2	0.26	0.025	1.78
OTA7520909	Pomahaka	d/s Crookstonburn	07-May-02	12:27	CAM			0.08	11.1	0.008	98		0.04	0.692	6.8		9.3	1.09	0.024	4.47
					Median			***0.052***	***10***	***0.006***	***340***	***209***	***0.0075***	***0.163***	***6.75***	***4***	***12***	***0.385***	***0.024***	***2***
					n	***0***	***0***	***6***	***7***	***12***	***8***	***4***	***12***	***12***	***8***	***4***	***7***	***8***	***8***	***10***
OTA7520910	Crookston Burn	Walker Rd	24-May-00	10.45	BM							280	0.05			4				
OTA7520910	Crookston Burn	Walker Rd	11-Jul-00	1125	A					0.017		75	0.03	2.8		6				
OTA7520910	Crookston Burn	Walker Rd	26-Sep-00	10:40	BM					0.031		99	0.02	2.3		5				3.7
OTA7520910	Crookston Burn	Walker Rd	01-Mar-01	10:35	BRM					0.036		960	0.02	1.2		4				1.6
OTA7520910	Crookston Burn	Walker Rd	19-Sep-01	12:45	CAM			0.14		0.015	140		0.05	2.4	7.4		12.9	2.9	0.048	4.55
OTA7520910	Crookston Burn	Walker Rd	11-Oct-01	10:05	CAM			0.144	11.4	0.013	3500		0.07	2.3	7.8		9.2	3.1	0.053	4.11
OTA7520910	Crookston Burn	Walker Rd	21-Nov-01	12:05	CAM			0.116	10.9	0.007	690		0.05	0.884	7.2		13.8	1.5	0.054	5.11
OTA7520910	Crookston Burn	Walker Rd	11-Dec-01	10:13	CAM			0.148	9.3	0.025	10500		0.16	0.641	7		15.7	2.1	0.148	8.44
OTA7520910	Crookston Burn	Walker Rd	21-Jan-02	11:37	CAM		0.5	0.123	11	0.015	80	110	0.03	0.701	7.5	2	18	0.77	0.036	2.88

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520910	Crookston Burn	Walker Rd	12-Feb-02	11:34	CAM			0.122	9.9	0.039	1400		0.02	0.777	7.4		16.7	1.12	0.083	4.65
OTA7520910	Crookston Burn	Walker Rd	19-Mar-02	12:56	CAM			0.111	10.4	0.006	70		0.005	0.274	7.3		14.2	0.67	0.027	1.07
OTA7520910	Crookston Burn	Walker Rd	10-Apr-02	11:38	CAM				10.9	0.011	58		0.005	0.492	6.9		9	0.7	0.03	1.66
OTA7520910	Crookston Burn	Walker Rd	07-May-02	11:40	CAM			0.19	10.4	0.043	830		0.12	2.54	6.7		10	3.97	0.084	6.55
					Median		***0.5***	***0.1315***	***10.65***	***0.016***	***690***	***110***	***0.03***	***1.042***	***7.3***	***4***	***13.8***	***1.5***	***0.053***	***4.11***
					n	***0***	***1***	***8***	***8***	***12***	***9***	***5***	***13***	***12***	***9***	***5***	***9***	***9***	***9***	***11***
OTA7520911	Crookston Burn	Cabbage Tree Rd	24-May-00	11.30	BM							150	0.05			4				
OTA7520911	Crookston Burn	Cabbage Tree Rd	11-Jul-00	1315	BM					0.026		400	0.05	2.8		27				11.8
OTA7520911	Crookston Burn	Cabbage Tree Rd	26-Sep-00	11:30	BM					0.02		90	0.01	2.5		2				1.7
OTA7520911	Crookston Burn	Cabbage Tree Rd	01-Mar-01	11:15	BRM					0.035			0.005	2		6				2
OTA7520911	Crookston Burn	Cabbage Tree Rd	18-Sep-01	10:00	CAM			0.14	12.8	0.009	630		0.01	3.1	7		9.2	3.1	0.024	2.14
OTA7520911	Crookston Burn	Cabbage Tree Rd	11-Oct-01	10:55	CAM			0.137	11	0.005	390		0.005	2.5	7.3		9.7	2.9	0.022	1.89
OTA7520911	Crookston Burn	Cabbage Tree Rd	22-Nov-01	08:25	CAM			0.104	13	0.007	540		0.02	1.09	**6.8**		10.56	1.6	0.027	2.2
OTA7520911	Crookston Burn	Cabbage Tree Rd	11-Dec-01	08:45	CAM			0.137	9.9	0.012	1450		0.04	0.821	7.6		13	1.6	0.055	3.74
OTA7520911	Crookston Burn	Cabbage Tree Rd	21-Jan-02	09:27	CAM			0.114	11.1	0.011	210		0.01	1.1	7.2		13.9	1.28	0.039	1.24
OTA7520911	Crookston Burn	Cabbage Tree Rd	12-Feb-02	09:00	CAM			0.122	9.2	0.075	1600		0.07	1.8	6.9		14.9	2.08	0.119	3.38
OTA7520911	Crookston Burn	Cabbage Tree Rd	19-Mar-02	11:04	CAM			0.109	11.9	0.017	110		0.005	0.004	6.7		12.8	1.35	0.027	1.02
OTA7520911	Crookston Burn	Cabbage Tree Rd	10-Apr-02	10:11	CAM				11.4	0.008	300		0.005	0.63	6.5		8.6	0.85	0.01	1.48
OTA7520911	Crookston Burn	Cabbage Tree Rd	07-May-02	10:00	CAM			0.13	11.1	0.011	410		0.06	2.45	6.7		9	2.82	0.033	5.26
					Median			***0.126***	***11.1***	***0.0115***	***410***	***150***	***0.01***	***1.9***	***6.9***	***5***	***10.56***	***1.6***	***0.027***	***2.07***
					n	***0***	***0***	***8***	***9***	***12***	***9***	***3***	***13***	***12***	***9***	***4***	***9***	***9***	***9***	***12***
OTA7520912	Crookston Burn	Top Revie Rd	24-May-00	12.20	BM					0.022		18	0.0025	0.17		1				
OTA7520912	Crookston Burn	Top Revie Rd	11-Jul-00	1150	BM					0.04		1	0.01	0.3		3				0.58
OTA7520912	Crookston Burn	Top Revie Rd	26-Sep-00	12:20	BM					0.032		2	0.005	0.2		0.5				0.5
OTA7520912	Crookston Burn	Top Revie Rd	01-Mar-01	12:00	BRM					0.028		56	0.04	0.18		1				0.51
OTA7520912	Crookston Burn	Top Revie Rd	19-Sep-01	11:52	CAM			0.13	12	0.0025	4		0.005	0.12	7.5		7	0.26	0.019	0.63
OTA7520912	Crookston Burn	Top Revie Rd	10-Oct-01	08:45	CAM			0.138		0.0025	10		0.005	0.14	7.6		6.4	0.2	0.021	0.7
OTA7520912	Crookston Burn	Top Revie Rd	21-Nov-01	08:10	CAM			0.122	11.66	0.004	6		0.005	0.09	7.4		7.26	0.16	0.036	0.92
OTA7520912	Crookston Burn	Top Revie Rd	11-Dec-01	08:00	CAM			0.108	11	0.005	12		0.005	0.088	7.5		8.5	0.23	0.016	0.95
OTA7520912	Crookston Burn	Top Revie Rd	21-Jan-02	08:34	CAM			0.113	11.2	0.012	1		0.005	0.164	7.5		9	0.23	0.029	0.87
OTA7520912	Crookston Burn	Top Revie Rd	12-Feb-02	08:00	CAM			0.12	10.3	0.024	500		0.005	0.215	7.6		11	0.3	0.035	0.48
OTA7520912	Crookston Burn	Top Revie Rd	19-Mar-02	10:00	CAM			0.116	11.4	0.015	2		0.005	0.182	7.3		8	0.27	0.027	0.22
OTA7520912	Crookston Burn	Top Revie Rd	10-Apr-02	09:02	CAM			0.1091	12.9	0.012	4		0.005	0.158	6.9		6.9	0.35	0.012	0.83
OTA7520912	Crookston Burn	Top Revie Rd	07-May-02	09:10	CAM			0.07	11.9	0.006	4		0.005	0.153	7.2		7.3	0.29	0.01	0.91
					Median			***0.116***	***11.53***	***0.012***	***4***	***10***	***0.005***	***0.164***	***7.5***	***1***	***7.3***	***0.26***	***0.021***	***0.665***
					n	***0***	***0***	***9***	***8***	***13***	***9***	***4***	***13***	***13***	***9***	***4***	***9***	***9***	***9***	***12***
OTA7520913	Black Gully Ck	Walker Rd	24-May-00	10.50	BM							260	0.12			6				
OTA7520913	Black Gully Ck	Walker Rd	11-Jul-00	1135	A					0.016		280	0.01	2.3		7				
OTA7520913	Black Gully Ck	Walker Rd	26-Sep-00	10:50	BM					0.014		110	0.005	1.9		4				2
OTA7520913	Black Gully Ck	Walker Rd	01-Mar-01	10:50	BRM					0.032		6300	0.005	0.36		6				2.6
OTA7520913	Black Gully Ck	Walker Rd	19-Sep-01	12:25	CAM			0.1015		0.0025	27		0.005	1.4	7.8		11.8	2.3	0.017	2.14
OTA7520913	Black Gully Ck	Walker Rd	11-Oct-01	10:23	CAM			0.117		0.0025	520		0.005	1.4	8.6		9.2	1.8	0.023	2.5
OTA7520913	Black Gully Ck	Walker Rd	21-Nov-01	12:20	CAM			0.192	10.75	0.013	980		0.02	0.807	7.3		13.84	1.3	0.068	6.94
OTA7520913	Black Gully Ck	Walker Rd	11-Dec-01	10:21	CAM			0.107	9.8	0.011	2100		0.04	0.336	6.8		16.2	1.2	0.065	5.78
OTA7520913	Black Gully Ck	Walker Rd	21-Jan-02	11:53	CAM		0.5	0.101	9.8	0.017	2900	3000	0.03	0.384	7.3	8	19	0.68	0.05	4.18
OTA7520913	Black Gully Ck	Walker Rd	12-Feb-02	11:49	CAM			0.094	9.5	0.017	2800		0.02	0.252	7.4		17.5	0.62	0.067	5.09
OTA7520913	Black Gully Ck	Walker Rd	19-Mar-02	13:08	CAM			0.082	9.9	0.012	2100		0.02	0.12	7.1		16.1	0.33	0.043	2.25
OTA7520913	Black Gully Ck	Walker Rd	10-Apr-02	11:43	CAM				11.9	0.013	230		0.005	0.235	7		8.5	0.46	0.033	5.25
OTA7520913	Black Gully Ck	Walker Rd	07-May-02	11:57	CAM			0.15	11.3	0.016	1500		0.11	2.45	6.8		9.5	3.41	0.072	13.2
					Median		***0.5***	***0.10425***	***9.9***	***0.0135***	***1500***	***280***	***0.02***	***0.5955***	***7.3***	***6***	***13.84***	***1.2***	***0.05***	***4.18***
					n	***0***	***1***	***8***	***7***	***12***	***9***	***5***	***13***	***12***	***9***	***5***	***9***	***9***	***9***	***11***

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520916	Heriot Burn	Roxburgh St	24-May-00	13.00	AM							340	0.35			5				
OTA7520916	Heriot Burn	Roxburgh St	11-Jul-00	1345	A					0.013		98	0.01	1.7		8				
OTA7520916	Heriot Burn	Roxburgh St	26-Sep-00	14:10	BM					0.012		60	0.02	1.6		4				4.1
OTA7520916	Heriot Burn	Roxburgh St	01-Mar-01	13:35	BRM					0.035		320	0.1	1.2		3				2.2
OTA7520916	Heriot Burn	Roxburgh St	18-Sep-01	10:30	CAM			0.1094		0.019	2600		0.11	1.7	7.4		7.3	2.3	0.076	5.2
OTA7520916	Heriot Burn	Roxburgh St	10-Oct-01	10:45	CAM			0.109		0.012	1300		0.11	1.6	7.4		9.1	2.3	0.062	2.45
OTA7520916	Heriot Burn	Roxburgh St	21-Nov-01	10:00	CAM			0.079	10.86	0.002	370		0.03	0.533	7.3		11.47	1.1	0.056	5.83
OTA7520916	Heriot Burn	Roxburgh St	11-Dec-01	10:18	CAM			0.104	10.1	0.007	2600		0.04	0.259	7.4		13.2	1.2	0.087	12.5
OTA7520916	Heriot Burn	Roxburgh St	21-Jan-02	10:05	CAM			0.105	10.6	0.011	200		0.03	0.734	7.4		15.2	1.1	0.059	3.2
OTA7520916	Heriot Burn	Roxburgh St	12-Feb-02	10:15	CAM			0.096	9.3	0.014	1600		0.02	0.962	7.4		17	1.15	0.047	2.71
OTA7520916	Heriot Burn	Roxburgh St	19-Mar-02	11:34	CAM			0.096	10.6	0.018	150		0.005	0.008	7.2		13	1.01	0.033	1.45
OTA7520916	Heriot Burn	Roxburgh St	10-Apr-02	10:37	CAM				11.8	0.007	500		0.005	0.528	6.8		8.3	0.85	0.02	2.06
OTA7520916	Heriot Burn	Roxburgh St	07-May-02	10:30	CAM			0.11	11.3	0.0025	910		0.04	0.788	6.9		9	1.51	0.047	4.08
					Median			***0.1045***	***10.6***	***0.012***	***910***	***209***	***0.03***	***0.875***	***7.4***	***4.5***	***11.47***	***1.15***	***0.056***	***3.2***
					n	***0***	***0***	***8***	***7***	***12***	***9***	***4***	***13***	***12***	***9***	***4***	***9***	***9***	***9***	***11***
OTA7520919	Anguilla Stream	Spylaw	24-May-00	14.15	AM							230	0.05			5				
OTA7520919	Anguilla Stream	Spylaw	11-Jul-00	1400	BM					0.011		82	0.01	0.77		4				3.6
OTA7520919	Anguilla Stream	Spylaw	26-Sep-00	13:20	BM					0.013		16	0.005	0.068		3				2.9
OTA7520919	Anguilla Stream	Spylaw	01-Mar-01	13:00	BRM					0.063		300	0.005	0.021		2				3.4
OTA7520919	Anguilla Stream	Spylaw	18-Sep-01																	
OTA7520919	Anguilla Stream	Spylaw	10-Oct-01																	
OTA7520919	Anguilla Stream	Spylaw	21-Nov-01																	
OTA7520919	Anguilla Stream	Spylaw	11-Dec-01																	
OTA7520919	Anguilla Stream	Spylaw	21-Jan-02																	
OTA7520919	Anguilla Stream	Spylaw	12-Feb-02																	
OTA7520919	Anguilla Stream	Spylaw	19-Mar-02	10:45	CAM			0.119	11.3	0.011	210		0.005	0.011	7.6		12.6	0.34	0.05	2.54
OTA7520919	Anguilla Stream	Spylaw	10-Apr-02	09:54	CAM				12.6	0.011	200		0.005	0.0015	7.1		8	0.4	0.034	2.16
OTA7520919	Anguilla Stream	Spylaw	07-May-02																	
					Median			***0.119***	***11.95***	***0.011***	***205***	***156***	***0.005***	***0.021***	***7.35***	***3.5***	***10.3***	***0.37***	***0.042***	***2.9***
					n	***0***	***0***	***1***	***2***	***5***	***2***	***4***	***6***	***5***	***2***	***4***	***2***	***2***	***2***	***5***
OTA7520921	Sherwood Stream	Moncurs Rd	24-May-00	12.55	AM							200	0.13			3				
OTA7520921	Sherwood Stream	Moncurs Rd	11-Jul-00	1315	A					0.012		75	0.04	0.8		3				
OTA7520921	Sherwood Stream	Moncurs Rd	26-Sep-00	14:30	BM					0.021		126	0.06	0.48		8				8.1
OTA7520921	Sherwood Stream	Moncurs Rd	01-Mar-01	14:05	BRM					0.12		1500	0.02	0.12		7				11.3
OTA7520921	Sherwood Stream	Moncurs Rd	18-Sep-01	10:55	CAM			0.1413		0.006	2200		0.04	0.48	7.2		7	1	0.093	11.4
OTA7520921	Sherwood Stream	Moncurs Rd	10-Oct-01	11:10	CAM			0.15		0.0025	980		0.02	0.1	7.2		9	0.52	0.077	6.71
OTA7520921	Sherwood Stream	Moncurs Rd	21-Nov-01	10:22	CAM			0.128	9.56	0.003	1400		0.07	0.213	7.1		11.76	0.92	0.12	14.2
OTA7520921	Sherwood Stream	Moncurs Rd	11-Dec-01	09:30	CAM			0.144	8.8	0.008	6900		0.04	0.191	7.5		13.2	1.2	0.102	12.4
OTA7520921	Sherwood Stream	Moncurs Rd	21-Jan-02	10:19	CAM			0.149	9.1	0.009	230		0.02	0.083	7.1		14.4	0.62	0.125	7.69
OTA7520921	Sherwood Stream	Moncurs Rd	12-Feb-02	10:37	CAM			0.131	5.9	0.045	2500		0.08	0.274	7		16.9	1.09	0.245	10.4
OTA7520921	Sherwood Stream	Moncurs Rd	19-Mar-02	11:47	CAM			0.145	8.7	0.012	120		0.005	0.01	7.2		11.8	0.4	0.099	6.29
OTA7520921	Sherwood Stream	Moncurs Rd	10-Apr-02	10:52	CAM				9.6	0.013	380		0.005	0.008	7		8.5	0.49	0.06	2.34
OTA7520921	Sherwood Stream	Moncurs Rd	07-May-02	10:45	CAM			0.17	9.9	0.008	2100		0.05	1.12	6.6		9.2	2.41	0.064	6.29
					Median			***0.1445***	***9.1***	***0.0105***	***1400***	***163***	***0.04***	***0.202***	***7.1***	***5***	***11.76***	***0.92***	***0.099***	***8.1***
					n	***0***	***0***	***8***	***7***	***12***	***9***	***4***	***13***	***12***	***9***	***4***	***9***	***9***	***9***	***11***
OTA7520922	Heriot Burn	above Town	24-May-00	14.00	AM							230	0.35			8				
OTA7520922	Heriot Burn	above Town	11-Jul-00	1440	BM					0.013		106	0.01	1.7		8				3.2
OTA7520922	Heriot Burn	above Town	26-Sep-00	13:50	BM					0.026		58	0.01	1.6		4				2.3
OTA7520922	Heriot Burn	above Town	01-Mar-01	13:20	BRM					0.028		300	0.04	1.3		2				1.8
OTA7520922	Heriot Burn	above Town	18-Sep-01	10:15	CAM			0.1074		0.0025	1200		0.02	1.8	7.3		7	2.2	0.05	5.9
OTA7520922	Heriot Burn	above Town	10-Oct-01	10:20	CAM			0.107		0.0025	550		0.005	1.8	7.3		8.7	0.43	0.037	2.05
OTA7520922	Heriot Burn	above Town	21-Nov-01	09:30	CAM			0.0788	11.02	0.003	620		0.04	0.583	7.3		11.18	1.1	0.063	5.13
OTA7520922	Heriot Burn	above Town	11-Dec-01	09:00	CAM			0.104	10.2	0.006	3300		0.03	0.317	7.5		13.1	1.1	0.074	10.8

SITE_ID	SOURCE	SITE_NAME	DATE	TIME	BY	BLKDK	BOD5	COND	DO	DRP	EC	FCC	NH4	NNN	PH	SS	TEMP	TN	TP	TURB
OTA7520922	Heriot Burn	above Town	21-Jan-02	09:48	CAM			0.105	10.6	0.011	260		0.03	0.808	7.4		14.3	0.82	0.063	2.79
OTA7520922	Heriot Burn	above Town	12-Feb-02	09:20	CAM			0.096	9.4	0.019	2200		0.02	1.05	7.1		16.8	1.27	0.069	2.66
OTA7520922	Heriot Burn	above Town	19-Mar-02	11:19	CAM			0.095	11	0.005	280		0.005	0.006	6.8		12	1.02	0.019	1.56
OTA7520922	Heriot Burn	above Town	10-Apr-02	10:26	CAM				11.8	0.008	570		0.005	0.571	6.8		8.1	0.91	0.021	2.05
OTA7520922	Heriot Burn	above Town	07-May-02	10:15	CAM			0.11	11.4	0.008	800			0.873	6.9		9	1.53	0.046	4.25
					Median			***0.1045***	***11***	***0.008***	***620***	***168***	***0.02***	***0.9615***	***7.3***	***6***	***11.18***	***1.1***	***0.05***	***2.725***
					n	***0***	***0***	***8***	***7***	***12***	***9***	***4***	***12***	***12***	***9***	***4***	***9***	***9***	***9***	***12***

Appendix 4

	Date	General Location	Problem	Major Stream
4278	1-Nov-96	Clinton-Clydevale	dairy effluent discharge to water	Pomahaka River
4316	26-Nov-96	Tapanui	dairy effluent discharge to water	Pomahaka River
4312	26-Nov-96	Tapanui	dairy effluent discharge to water	Pomahaka River
4377	29-Nov-96	Tapanui	dairy effluent discharge to water	Pomahaka River
4360	25-Dec-96	Wairepa	dairy effluent discharge to water	Kaihiku Stream
4388	15-Jan-97	Conical, Tapanui	dairy effluent overflow from pond	Pomahaka River
4629	16-Jan-97	Heriot	piggery effluent discharge to water	Sherwood Stream
4507	7-Mar-97	Waipahi	Truck wash	Waipahi River
4628	23-Apr-97	Heriot	dairy effluent discharge to water	Crookston Burn
4642	27-Jul-97	Waiwera	dairy effluent discharge to water	Waiwera River
4780	29-Jul-97	Kelso	silage leachate to water	Black Gully Creek
4901	28-Oct-97	Wairepa	dairy effluent discharge to water	Kaihiku Stream
5069	9-Feb-98	Tapanui	discharge of contaminants to water	Trib. of Pomahaka River
5235	8-Apr-98	Kelso	Trees fallen in river	Pomahaka River
5385	1-Jul-98	Tapanui	stock in water	Pomahaka River
5500	19-Sep-98	Clydevale	stock grazing in water	Pomahaka River
5593	27-Oct-98	Waipahi	silage effluent to water	Waipahi River
5596	28-Oct-98	Wairepa	dairy effluent discharge to water	Kaihiku Stream
5618	3-Nov-98	Tapanui	dairy effluent discharge to water	Pomahaka River
5621	12-Nov-98	Wairuna	leachate from silage pad	Trib.of Wairuna Stream
5669	27-Nov-98	Wairepa	dairy effluent discharge to water	Kaihiku Stream
5968	27-Mar-99	Waikerikeri	dredging in spawning area	Waikerikeri Stream
6288	10-Jun-99	Clydevale	dairy effluent discharge to water	Washpool Creek
6290	10-Jul-99	Clydevale	dairy effluent discharge to water	Washpool Creek
6157	13-Jul-99	Wairepa	effluent from stock track top water	Kaihiku Stream
6167	5-Aug-99	Tapanui	leachate from silage pad	Pomahaka River
6814	11-Aug-99	Tapanui	hardner in unnamed due to fire	Trib. of Pomahaka River
5744	11-Nov-99	Crookston	dairy effluent to water	Black Gully Stream
6346	12-Nov-99	Clydevale	Dairy effluent discharge to water	Washpool Creek
6433	17-Dec-99	Clydevale	Dairy effluent discharge to water	Washpool Creek
6447	5-Jan-00	Kelso	stock in water	Pomahaka River
6499	28-Jan-00	Waiwera	unknown discharge to water	Waiwera River
6602	20-Mar-00	Kelso	Dairy effluent discharge to water	Pomahaka River
6606	21-Mar-00	Crookston	stock in water	Crookston Burn
6625	29-Mar-00	Wairepa	Dairy effluent discharge to water	Kaihiku Stream
6653	14-Apr-00	Kelso	Dairy effluent discharge to water	Pomahaka River
6740	25-May-00	Clydevale	Dairy effluent discharge to water	Washpole Creek
6814	13-Jul-00	Black Gully	diesel spill in creek	Black Gully Creek
6831	13-Jul-00	Black Gully	1800 litres of diesel into stream	Black Gully Creek
6846	31-Jul-00	Kelso	diesel spill in creek	Trib. of Pomahaka River
6907	4-Sep-00	Clydevale	creek running dirty	Washpole Creek
6951	27-Sep-00	u/k	bright green colouring in water	Pomahaka River
6972	9-Oct-00	Tapanui	Dairy effluent discharge to water	Pomahaka River
7006	29-Oct-00	Wairepa	Dairy effluent discharge to water	Kaihiku Stream
7013	2-Nov-00	Mill Road, Wairepa	dairy effluent discharge to water	Waikihu Stream
7012	2-Nov-00	Wairepa	dairy effluent discharge to water	Kaihiku Stream
7084	4-Nov-00	Waipahi	dairy effluent to water	Waipahi River
7039	13-Nov-00	Waipahi-Clydevale Road	discoloured water and smell	Trib. of Wairuna River
7064	27-Nov-00	Mill Rd, Wairepa	runoff – effluent irrigator	Kaihiku River
7083	30-Nov-00	Popotonoa	Discharge to water	Trib. of Wairuna River
7361	28-Jan-01	Clydevale	stock in water	Washpool Creek

	Date	General Location	Problem	Major Stream
7393	4-Feb-01	Clydevale	stock in water	Washpool Creek
7531	5-Mar-01	Clydevale	stock in water	Washpool Creek
7744	1-May-01	Heriot	effluent pond overflow	Heriot Burn
7746	5-May-01	Heriot	stock effluent to water	Heriotburn
7750	5-May-01	Glenkenrich Road, Kelso	dairy effluent discharge to water	Pomahaka River
7752	11-May-01	Clydevale	dairy effluent into tributary	Trib. of Pomahaka River
7779	28-May-01	Crookston of SH90	stock in water	Trib. of Pomahaka River
7805	21-Jun-01	Mill Road, Wairepa	effluent off stock track	Waikihu Stream
7985	7-Aug-01	Black Gully Road	stock in water	Black Gully Creek
7932	2-Sep-01	Junc.Poma. & Clutha	dead cows in Rankleburn	Pomahaka
7944	5-Sep-01	Mill Rd, Waiwera	dairy effluent runoff in water	Kaihiku River
7971	21-Sep-01	Trib. of Pomahaka Rr	dairy effluent from land	Trib. of Pomahaka River
7976	25-Sep-01	Koi Flat Rd	White foam in water	Waikoikoi Stream
8183	20-Dec-01	Heriot	discoloured water	Tributary of Heriot Burn
8181	15-Jan-02	Clydevale	dairy effluent to water	Washpool Creek
8547	19-May-02	Clinton	milk tanker overturned	Kauwoa Stream
8602	11-Jun-02	Athurton	stock in water	Trib. of Pomahaka River
8875	23-Aug-02	Merino Downs	dairy effluent discharge to water	Trib. of Pomahaka River
8799	2-Sep-02	Papatunoa	stock in water	Pomahaka River
8939	5-Sep-02	Waipahi	stock in water	Waipahi River
8847	8-Sep-02	Papatonoa	dairy effluent discharge to water	Trib. of Wairuna Stream
8940	12-Sep-02	Merino Downs	dairy effluent discharge to water	Trib. of Pomahaka River
8833	16-Sep-02	Merino Downs	dairy effluent discharge to water	Trib. of Pomahaka River
8941	17-Sep-02	Merino Downs	effluent to water	Trib. of Pomahaka River
8891	19-Sep-02	Clydevale	dairy effluent discharge to water	Washpool Creek
9002	15-Oct-02	Merino Downs	dairy effluent discharge to water	Trib. of Pomahaka River
9016	16-Oct-02	Merino Downs	discoloured stream	Trib. of Pomahaka River
9044	19-Oct-02	Clydevale	discharge of silage to water	Washpool Creek
9091	27-Oct-02	Clydevale	dairy effluent on side of road	Washpool Creek
9133	13-Nov-02	Clydevale	discharge of contaminants to water	Washpool Creek
9277	14-Jan-03	Kelso	stock in water	Pomahaka River
9912	23-Jun-03	Tapanui	discharge of contaminants to water	Trib. of Pomahaka River
9975	7-Sep-03	Waipahi	well contaminated	Waipahi River
10389	20-Dec-03	Glenkenrich Road, Kelso	dairy effluent discharge to water	Trib. of Pomahaka River
10347	5-Jan-04	Waipahi	sewage to water	Waipahi River

INFRINGEMENT NOTICES

12/02/01	Kelso	7-Feb-02	Waiwera	14-Nov-03	Clinton
12-Feb-02	Wairepa	7-Oct-02	Papatunoa	22-Dec-03	Kelso
6-Nov-02	Tapanui	2-Oct-03	Waipahi	20-Dec-03	Marino Downs
3-Dec-02	Clydevale	29-Oct-03	Wairuna		
4-Dec-02	Kelso	23-Oct-03	Wairuna		
13-Dec-02	Tapanui	5-Nov-03	Clydevale		
13-Dec-02	Tapanui	3-Nov-03	Tapanui		