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Ecological Assessments of Spring-fed streams on the Wairau Plain

Prepared for

MARLBOROUGH DISTRICT COUNCIL

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by

Roger Young, Anna Crowe and Rowan Strickland

Cawthron Institute
98 Halifax Street East
Private Bag 2
NELSON
NEW ZEALAND

Phone: +64.3.548.2319
Fax: +64.3.546.9464
Email: info@cawthron.org.nz

Cover Photo: Murphys Creek: Cawthron, March 2002

EXECUTIVE SUMMARY

The freshwater springs of the Wairau Plain constitute an important aesthetic and cultural resource for the local community. However, apart from some recent work on the ecology of Spring Creek, the habitat value and ecology of these springs is not well known. Due to their connection with the underlying Wairau Aquifer, spring flows are remarkably constant although droughts and floods do have a short-term influence. This report is the first step in deriving an ecological assessment of the Wairau Plain springs.

Twenty four sites were sampled as part of this study. Existing information from 10 sites in the Spring Creek catchment was also included. Statistical analysis of the water quality and physical data from each site indicated that there were four groups of springs. Riverlands Industrial was in a group of its own and characterised by severe contamination with bacteria, nutrients and sediment, very low dissolved oxygen, and a weak connection with the aquifer. A second group ('red' sites - Marukoko, Pukaka, Jeffreys, Pipitea Nth, Pipitea Sth) was composed of sites near the coast with tidal influence and thus high conductivity water, high phosphate levels, low bacterial and nitrogen concentrations, and a weak connection with the aquifer. The third group ('blue' sites – Riverlands Co-op, Town Branch, Woolley & Jones, Yelverton) also had a weak connection with the aquifer, but low conductivity and relatively high nitrogen concentrations. The largest group of springs ('green' sites e.g. Spring Creek, Grovetown Springs, Murphys, Fultons, Roberts) had a strong connection with the aquifer, low conductivity, moderate dissolved oxygen concentrations and variable nitrate-nitrogen concentrations.

Seventy three types of macroinvertebrates were collected from the springs. To a large extent the macroinvertebrate communities present in each spring reflected the water quality and physical conditions found. Riverlands Industrial had only very tolerant types of macroinvertebrates, while the 'red' sites had variable, but generally higher quality, macroinvertebrate communities, including some sensitive species such as amphipods. Stream health at the 'blue' sites, as indicated by macroinvertebrate communities, was variable with a high diversity of macroinvertebrate types at three of the four sites, but generally few sensitive species. The coarse gravel substrate at Yelverton, a habitat not normally found in lowland springs, was probably responsible for the high diversity of mayflies and caddisflies found at this 'blue' site. The quality of macroinvertebrate communities at the 'green' sites varied enormously, with relatively poor communities at Sadds and Ganes, and high quality communities at Drain N, Drain Q, Caseys, Kellys, Cravens and the upper reaches of Spring Creek. Amphipods were found at all 'green' sites except Sadds and Ganes. Koura were only found at the 'green' sites, but were not observed at Doctors, Roberts, Sadds, Grovetown Springs, Murphys or Ganes. An ordination of the macroinvertebrate communities using presence/absence data supported our initial site groupings based on the water quality and physical information. The only real exception to this was the invertebrate community at Sadds, which appeared to be different, and of poorer quality, than that at the other 'green' sites.

Forty three different kinds of plants were recorded in, or surrounding, the sites surveyed. Of these, 18 were primarily aquatic, while the remaining 25 were associated with the margins of waterways, or were purely terrestrial plants. Twelve of the aquatic plants were introduced species and included nuisance species such as *Egeria*, *Lagarosiphon* and *Glyceria maxima*.

Six different species of fish were found during our survey of the Wairau Plain springs. These were the native longfin eel, shortfin eel, giant kokopu, inanga and common bully, as well as the introduced brown trout. Lamprey, banded kokopu, yelloweye mullet, giant bully, black flounder and common smelt have also been recorded previously in the Wairau Plain area and may be present in some of the springs. Our observations of two giant kokopu were the first officially recorded

sightings in the Wairau Plain area since 1973. Shortfin eels were the most common species of fish found in the springs. Inanga and common bullies were also widespread, while longfin eels and brown trout were only found occasionally. Fish diversity was generally highest in the 'green' sites, although Sadds was an exception with only two fish species recorded. No fish were found in Riverlands Industrial and, apart from Marukoko, fish diversity at the 'red' and 'blue' sites was generally poor.

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Report reviewed by: Approved for release by:

Dr John Stark, Senior Freshwater Scientist Rowan Strickland, Freshwater Group Manager

1. INTRODUCTION

This report presents the results of an ecological survey of important spring fed streams on the Wairau Plain, and builds on recent studies into the ecology of Spring Creek and its tributaries (Young *et al.* 2000). It documents flora and fauna, along with identifying springs or reaches of springs that are most at risk. Springs are also ranked in terms of their importance and potential habitat value.

A better understanding of spring ecology is needed given increasing pressures that Marlborough District Council have to deal with including: riparian landuses, soil drainage, aquifer effects and consent applications. This is a technical document that will inform the community and enable Marlborough District Council to make management decisions on issues associated with the springs.

The Marlborough Regional Policy Statement recognises the need to maintain or enhance freshwater ecosystems and makes specific reference to the Wairau Plain springs. The Proposed Wairau-Awatere Resource Management Plan controls the damming, taking and diversion of water along with the discharge of contaminants to waterways. It safeguards the natural character of waterways and allows for the maintenance of a network of drains and flood control works.

The Wairau Plain hosts a belt of freshwater springs that represent an important natural and cultural resource for the Marlborough community. These springs appear in various forms from the widely known and appreciated Spring Creek to less well known waterways such as Drain N. Most of these spring-fed waterways rise between the Wairau River and the southern side of Blenheim, in a belt eastward of Hammerichs Road. These springs have generally been modified over the past 150 years to improve agricultural productivity or through urbanisation and today they bear little resemblance to their original natural state. Because the spring belt exists by virtue of the underlying Wairau Aquifer, flows, however, are remarkably constant, although droughts and floods do have a short-term influence. Figure 1 shows a conceptual view of how the hydraulic link between springs and groundwater works.

This report presents detailed ecological assessments for 34 water bodies. This information will provide an essential resource for the community and Council in managing these very special features of the Wairau Plain.

As a result of submissions on the Proposed Wairau-Awatere Resource Management Plan, the Council is committed to developing a riparian management strategy that will integrate issues within the channel and its associated margins.

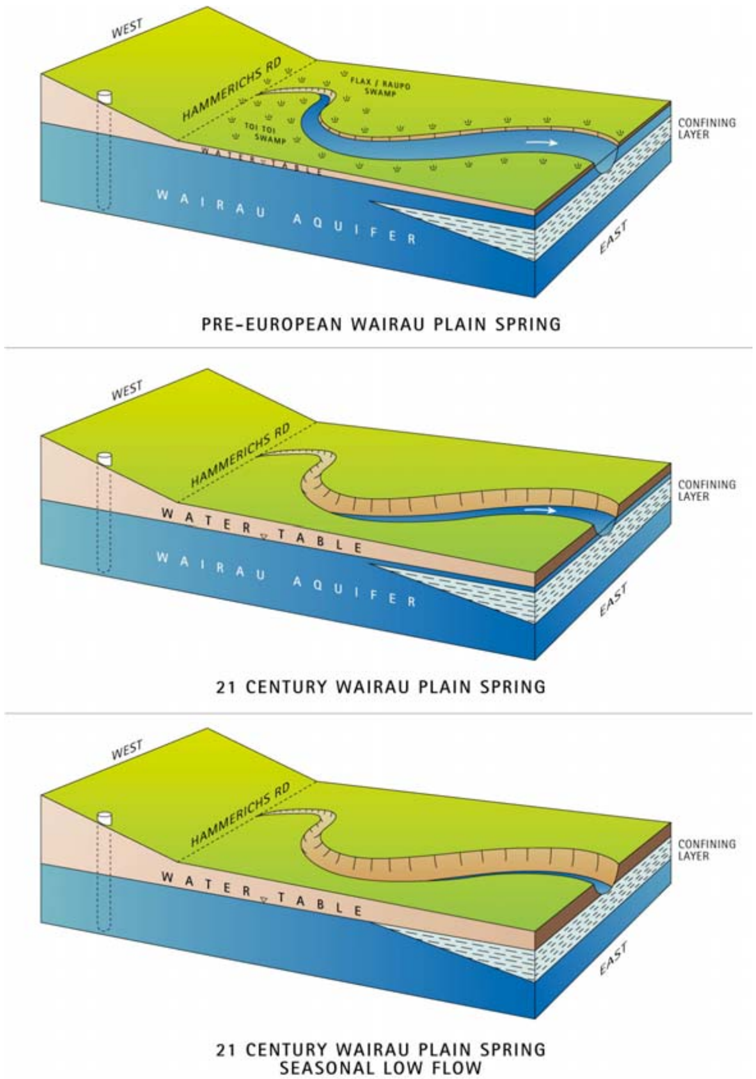

Figure 1 Diagram of the Wairau Plain showing the effect of land modification and droughts on water tables, the Wairau Aquifer and spring flows.

2. METHODS

2.1 Site selection

Seven groups of springs were identified following an initial field tour around the Wairau Plain in January 2002: coastal sand dune springs, large lowland springs, low gradient stagnant springs, Riverlands impacted drains, urban springs flowing into the Taylor/Opawa, rural springs flowing into the Taylor/Opawa, and rural springs flowing into Spring Creek and the Grovetown Lagoon. Representative sites from within each of these groups of springs were chosen and 24 sites were sampled over the week from 18-22 March 2002 (Figure 2). Data reported by Young *et al.* (2000) from 10 additional sites (Tennis Courts, O'Dwyers, Hollis, Ganes, Rapaura, Dentons, Motor Camp, Roses, Collins Bridge, Floodgates) in the Spring Creek catchment were also included in the data analyses (Figure 2). A summary sheet for each site can be found at the end of this report (Appendix 1). Each sheet includes: location map, photo, cross-section diagrams and a brief description of the physical and biological characteristics, as we found them in March 2002.

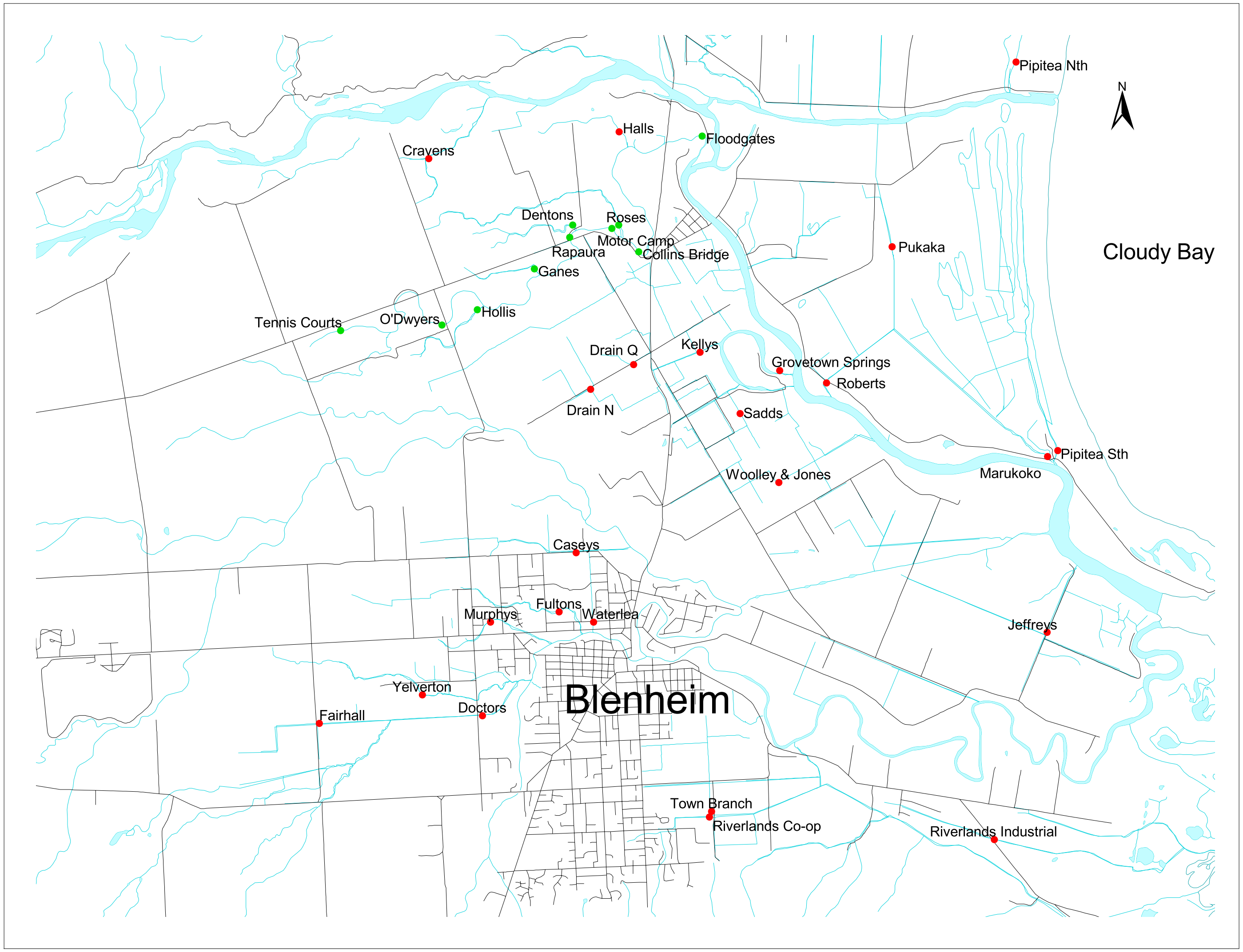

Figure 2 Location of study sites on the Wairau Plain.

2.2 Water quality

At each site water quality samples were collected for analysis of nitrate (NO_3-N), ammonium (NH_4-N), dissolved reactive phosphorus (DRP), total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), inorganic (fixed) suspended solids (FSS), organic (volatile) suspended solids (VSS) and indicator bacteria (*E. coli*). Analyses were undertaken by the Cawthron Institute's IANZ accredited water testing laboratory using appropriate standard methods. Spot measurements of dissolved oxygen, water temperature, turbidity, water clarity, conductivity and pH were measured in the field using standard equipment and techniques. Water quality data used in this report from the 10 additional Spring Creek sites generally were means of 12 monthly samples collected from August 1999 to July 2000 (Young *et al.* 2000). Water temperatures from the additional sites were from spot measurements in February 2000.

2.3 Physical habitat, aquatic plants and riparian condition

At least one representative cross section at each site was surveyed to assess the channel profile, width, depth and the density and diversity of aquatic plants. A tape measure was strung from bank to bank at each cross-section with depth, plant composition, plant density and plant height recorded at 0.2-1.0 m intervals. Species composition and density were determined within a 0.5 m radius of each measurement point. Samples of freshwater algae present were returned to the laboratory for identification.

Cross-section graphs were produced to show the relationship of ground contour and maximum plant height to water surface level. Each cross-section was plotted so that the true left and true right banks correspond with the left and right side of the graph, respectively. Care should be taken interpreting these graphs as they give the impression of continuous plant growth along the cross-section, when in fact there were often height variations and gaps of clean substrate between sample points. Also they give an exaggerated picture of relative plant height because maximum, rather than average, height was used. Nevertheless, the graphs provide a useful baseline for later comparisons and may be particularly useful for weed control monitoring. Cross-section graphs from the additional 10 Spring Creek sites were produced from similar surveys conducted in October 1999 and March 2000 (see Young *et al.* 2000).

Information on shade, riparian land use, surrounding land use, fencing, and stock access at each site was also recorded (Appendix 1).

2.4 Macroinvertebrates

At each site a hand-net was used to sample the range of freshwater insects, crustaceans, worms and snails that were present. These species are known collectively as macroinvertebrates. Macroinvertebrates live almost their entire lives in the water, although many of the insects have aerial adult stages. Some are pollution tolerant whereas others are not. As a result, the presence or absence of some macroinvertebrate species can indicate the ecological health of a stream. Samples were collected by sweeping the hand-net through any aquatic plants present and along the bed and banks of the streams. Samples of this type are not quantitative (*i.e.* you can not get density data from them), but relative abundances of one species versus another at a site can be obtained.

Samples were preserved in 1 litre plastic jars in the field using a mixture of 2 % formalin and 70 % ethanol. In the laboratory, samples were sieved, sorted by eye and identified to the lowest taxonomic level possible using standard keys.

Macroinvertebrate data from the additional 10 Spring Creek sites were obtained from similar hand-net samples collected on 20th October 1999 (Young *et al.* 2000).

Indices used to assist interpretation of macroinvertebrate data included:-

Species richness (or more strictly, taxa richness). This is simply the number of different kinds of animals (= taxa) present. Sometimes the different taxa are resolved down to the species level (*e.g., Austroclima sepia*), but may be at the genera level (*e.g., Austroclima* sp.), or even higher taxonomic level (*e.g.,* Leptophlebiidae), depending upon the practicality of identification.

EPT *taxa.* This is the total number of kinds of mayflies (**E**phemeroptera), stoneflies (**P**lecoptera), and caddisflies (**T**richoptera) found in a sample. These kinds of freshwater insects generally are intolerant of pollution.

Macroinvertebrate Community Index (MCI) values were calculated according to the method of Stark (1985, 1993, 1998). The MCI relies on prior allocation of scores (between 1 and 10) to different kinds of freshwater macroinvertebrates based upon their tolerance to pollution. Types of macroinvertebrates that are characteristic of unpolluted conditions and/or coarse stony substrates score more highly than those found predominantly in polluted conditions or amongst fine organic sediments. In theory, MCI values can range between 200 (when all taxa present score 10 points each) and 0 (when no taxa are present), but in practice it is rare to find MCI values greater than 150. Only extremely polluted or sandy/muddy sites score under 50.

SQMCI (Semi-Quantitative MCI) values were also calculated. Unlike the MCI, which only uses presence-absence data, the SQMCI incorporates relative abundances into the index calculation. SQMCI values, therefore, reflect the abundance and types of macroinvertebrates found at a site.

Although the MCI and SQMCI were developed to assess organic pollution in stony-bottomed streams, they have proven useful in other stream types for assessing habitat quality or environmental health.

2.5 Fish

Where possible, a 50-100 m reach was electric fished at each site using a back-pack electric fishing machine. All fish were identified and released where they had been caught. Many species of fish are more active at night and can be easily seen with a spot-light. Therefore a similar, or longer, length of most springs was spot-lighted at night. Fish were hand netted where possible to verify identification. In addition, fine-meshed fyke nets were set at Pipitea Nth and Marukoko where electric fishing was ineffective because of depth or conductivity. Fyke nets were also set at Drain Q to confirm a spot-light observation of a giant kokopu. The presence and relative abundance of fish species observed at each site using these combined techniques were recorded on NZ Freshwater Fisheries database forms and have subsequently been submitted for inclusion in the database.

3. RESULTS

3.1 Water quality

3.1.1 Site groupings

To identify groups of streams with similar characteristics we used a combination of the physical (width, maximum depth) and water quality variables collected. The majority of these variables were log transformed to improve the normality of the data before analysis. A hierarchical clustering technique based on these combined data identified 4 groups of sites (Figure 3). Riverlands Industrial was placed in a group of its own. The sites nearest to the coast (Jeffreys, Marukoko, Pukaka, Pipitea Nth, Pipitea Sth) were grouped together. The third group consisted of Woolley & Jones, Yelverton, Town Branch and Riverlands Co-op, with the remaining sites in a fourth cluster (Figure 3).

Principal Components Analysis (PCA) was used to help identify the characteristics that separate each site group. PCA is a statistical technique used to condense many variables down to a more manageable number of pseudo-variables (or principal components). Variables that are highly correlated with each other are essentially combined into one principal component. The first principal component (PC1) explained 54% of the total variance in the data and was highly correlated with phosphorus and suspended solids concentrations, turbidity, *E. coli*, and ammonium nitrogen. It was also weakly related with dissolved oxygen and conductivity. The second principal component (PC2) explained 13% of the variance in the data and was highly correlated with nitrate nitrogen and more weakly with water temperature. A plot of the principal component scores for each site is shown in Figure 4. Sites with similar characteristics are plotted closely together, while those with markedly different characteristics are plotted far apart. For further discussion of the characteristics of each site and group see Sections 3.2 and 3.3 below.

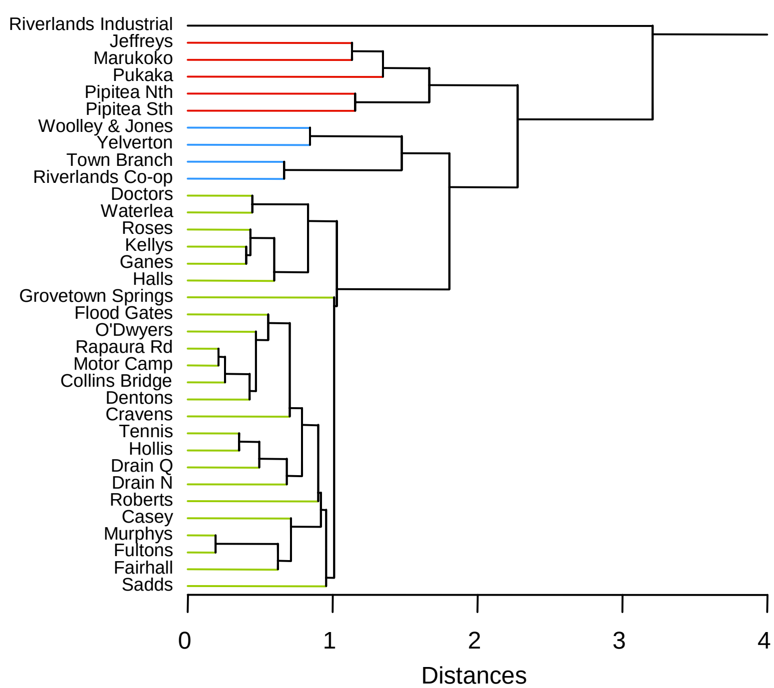

Figure 3 Clustering of the sites based upon physical and water quality variables.

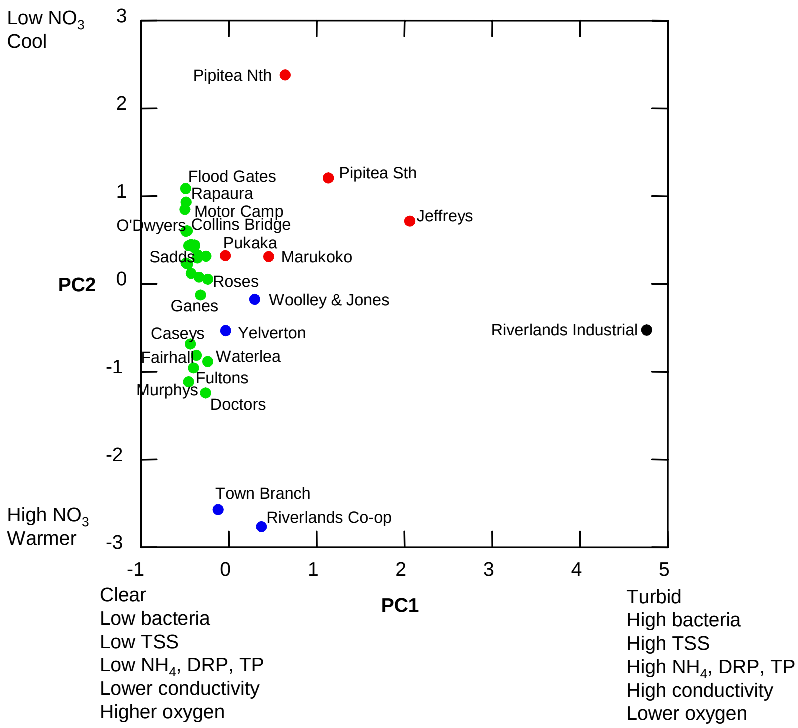

Figure 4 Ordination of sites based upon physical and water quality variables. The colours refer to site groupings identified in Figure 3 above.

3.1.2 Water temperature and connection with the Wairau Aquifer

Temperature measurements of water within, or directly from, the Wairau Aquifer are consistently around 14.0 °C. Therefore our spot measurement of water temperature at each spring-fed stream gave some indication of the likely degree of connection with the aquifer. When water temperature was considerably higher or lower than 14 °C then the connection with the aquifer was *definitely* weak or distant (*i.e.* the temperature of any groundwater that had been on the surface for some time more closely resembled ambient air temperatures). Since we have only single spot measurements for most sites, a reading close to 14 °C does not confirm a close association with aquifer water, however it does indicate that groundwater recently derived from the aquifer *may* provide a considerable portion of the flow.

In general, the 'green' sites appeared to be closely associated with aquifer water, with a few exceptions such as Doctors, Sadds, Fultons, Waterlea, Caseys, Kellys, Murphys, Halls and Ganes (Figure 5). Water temperature at the 'blue' sites indicated a weak or distant connection with the aquifer (Figure 5). Similarly, Riverlands Industrial and the 'red' sites, apart from Pipitea Sth, definitely had weak or distant connections with the aquifer (Figure 5). Pipitea Sth was probably also weakly connected with the aquifer.

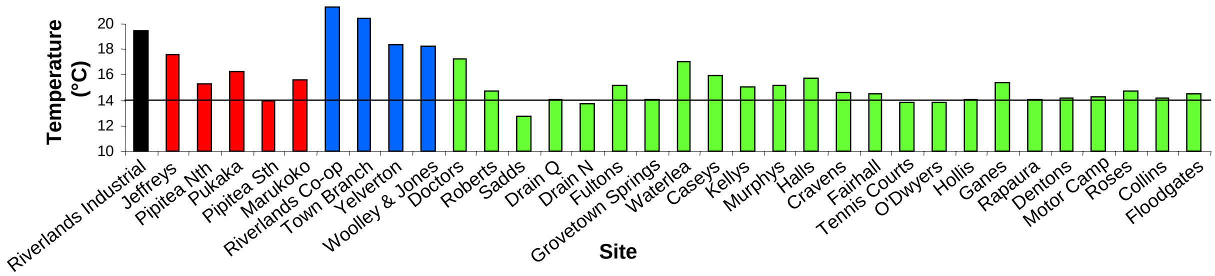

Figure 5 Spot water temperatures measured at each site. The temperature of fresh aquifer water (14 °C) is shown with the horizontal line.

3.1.3 Water quality results

Conductivity at the coastal (red) sites tended to be higher than at the remaining sites (Figure 6). This was particularly the case for Jeffreys, Pipitea Sth and Marukoko, which presumably are influenced by seawater intrusion. Relatively high conductivity at Riverlands Industrial, Riverlands Co-op, Town Branch, Roberts, and Fairhall were likely to be related to inputs of nutrients and other pollutants rather than an influence of seawater (Figure 6).

Dissolved oxygen concentrations were very low at Riverlands Industrial and at all the red sites except Marukoko (Figure 6). Abundant aquatic plant and algae growth, combined with effective tidal flushing, are likely explanations for the very high dissolved oxygen concentrations at Marukoko. Dissolved oxygen concentrations at Yelverton and Woolley & Jones were also relatively low (Figure 6).

Indicator bacteria (*E. coli*) concentrations were extremely high at Riverlands Industrial (20 000 cfu/100ml), and also well above MfE guidelines for swimming and other recreational contact at Riverlands Co-op, Town Branch, Grovetown Springs, Waterlea, Kellys, Halls, Ganes and Roses (Figure 6).

Ammonium nitrogen (NH_4-N) concentrations were relatively high at Riverlands Industrial, Pipitea Sth, Pipitea Nth and at Woolley & Jones (Figure 6). In contrast, nitrate nitrogen (NO_3-N) concentrations were highest at Riverlands Co-op, Town Branch, Doctors, Fultons, Waterlea, Caseys, Murphys, and Fairhall (Figure 6). The high ammonium concentrations and low nitrate concentrations at Riverlands Industrial, Pipitea Nth and Pipitea Sth is probably due to the extremely low dissolved oxygen concentrations which would restrict nitrification - the conversion of NH_4-N to NO_3-N.

Dissolved reactive phosphorus (DRP) concentrations were considerably higher at Riverlands Industrial and the 'red' sites than elsewhere (Figure 6). This phosphorus is likely to come from pollutants at Riverlands Industrial and seawater intrusion at the 'red' sites.

Turbidity was highest at Riverlands Industrial although relatively high turbidities were also observed at the coastal (red) sites and at Riverlands Co-op, Town Branch, Doctors, Sadds, Waterlea and Roses (Figure 6). Drain N, Grovetown Springs, Yelverton, Caseys and Cravens had the lowest turbidity measurements. Very similar patterns were seen with concentrations of suspended solids.

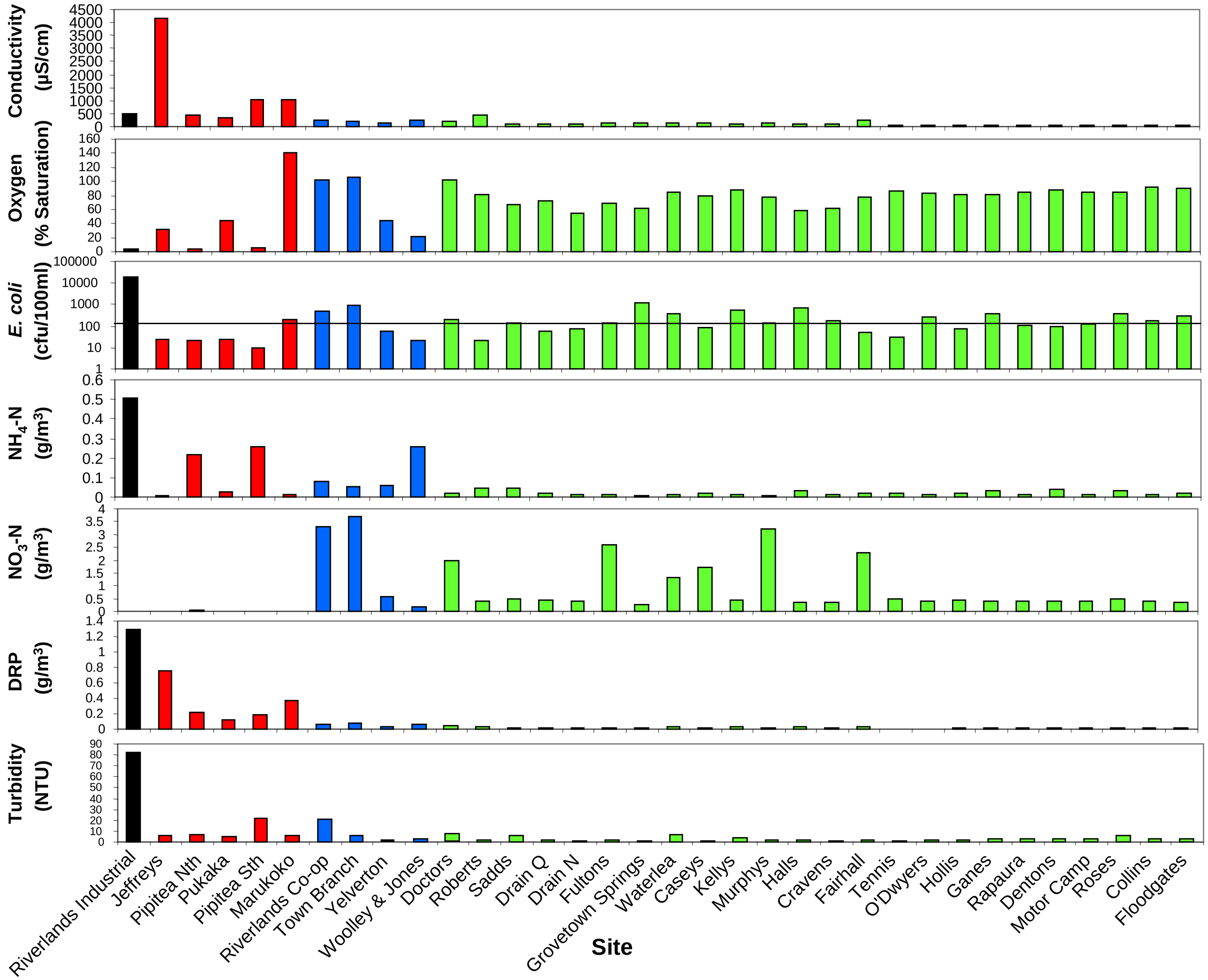

Figure 6 Summary of selected water quality parameters at each of the sites. Note the log scale for *E. coli* and associated contact guideline (126 cfu/100ml).

3.1.4 Water quality summary

In summary, the water quality and physical data indicate that there are four groups of spring-fed streams on the Wairau Plain. The general characteristics of these groups are summarised in Table 1.

Table 1 General description of each site group based on water quality information.

Group	Sites	General characteristics
'Black' sites	Riverlands Industrial	Weak connection with the aquifer, low dissolved oxygen, very high concentrations of bacteria, suspended sediment and nutrients
'Red' sites	Jeffreys, Pipitea Nth, Pukaka, Pipitea Sth, Marukoko	Weak connection with the aquifer, high conductivity indicating seawater influence, variable dissolved oxygen, low bacterial and nitrogen concentrations, high phosphorus concentrations
'Blue' sites	Riverlands Co-op, Town Branch, Yelverton, Woolley & Jones	Weak connection with the aquifer, low conductivity, high nitrogen concentrations
'Green' sites	Doctors, Roberts, Sadds, Drain Q, Drain N, Fultons, Grovetown Springs, Waterlea, Caseys, Kellys, Murphys, Halls, Cravens, Fairhall, Tennis Courts, O'Dwyers, Hollis, Ganes, Rapaura, Dentons, Motor Camp, Roses, Collins, Floodgates	Strong connection with the aquifer, low conductivity, moderate dissolved oxygen concentrations, variable bacterial contamination, low ammonium and phosphorus concentrations, variable nitrate-nitrogen concentrations (high in Taylor/Opawa tributaries, low elsewhere)

3.2 Macroinvertebrates

Seventy-three kinds of macroinvertebrates were identified from 32 spring-fed streams throughout the Wairau Plains (Appendix 2). Pipitea South and Jeffreys were not sampled for macroinvertebrates because of their estuarine nature. The most diverse orders were caddisflies (20 kinds) and true flies (15 kinds), but beetles (9 kinds), molluscs (4 snails and 1 bivalve) and crustaceans (amphipods, shrimp, seed shrimp and koura) were also diverse groups. Mayflies and stoneflies, which are often common in rain-fed, shallow stony streams, were rarely found in these waterways.

Macroinvertebrate indices commonly used to assess stream 'health' are presented in Figure 8, and the dominant macroinvertebrate taxa collected from each site are shown in Table 2. Communities showed considerable variation in quality within each of the groups of streams that were determined using physical and water quality variables (Section 3.1.1), particularly within the large 'green' group where sites ranged from those with diverse assemblages dominated by relatively sensitive amphipods (*e.g.,* Spring Creek sites such as Cravens, O'Dwyers and Motor Camp), to those with low taxa richness and dominance by tolerant annelid worms (*e.g.,* Sadds, Murphys). However, some broad differences could be seen between the four groups, with the "black" (Riverlands Industrial), "red" (Pipitea North, Pukaka, Marukoko) and "blue" (Riverlands Co-op, Town Branch, Yelverton, Woolley & Jones) sites generally having poorer quality macroinvertebrate communities than the good quality sites in the "green" group.

All of the biotic indices suggested that the community at Riverlands Industrial was highly degraded (Figure 8). The macroinvertebrate community was dominated by worms and the snail *Physa* (Table 2). These are both very tolerant taxa, capable of flourishing in the degraded waters at this site (see

Section 3.3). Seed-shrimp (Ostracoda) were the only kind of crustacean present (Table 2), and taxa diversity was low. The sole EPT taxon at the site was a relatively tolerant caddisfly species, *Triplectides cephalotes*. Consequently, the MCI and SQMCI scores were both low.

Figure 7 A large koura from Cravens Creek.

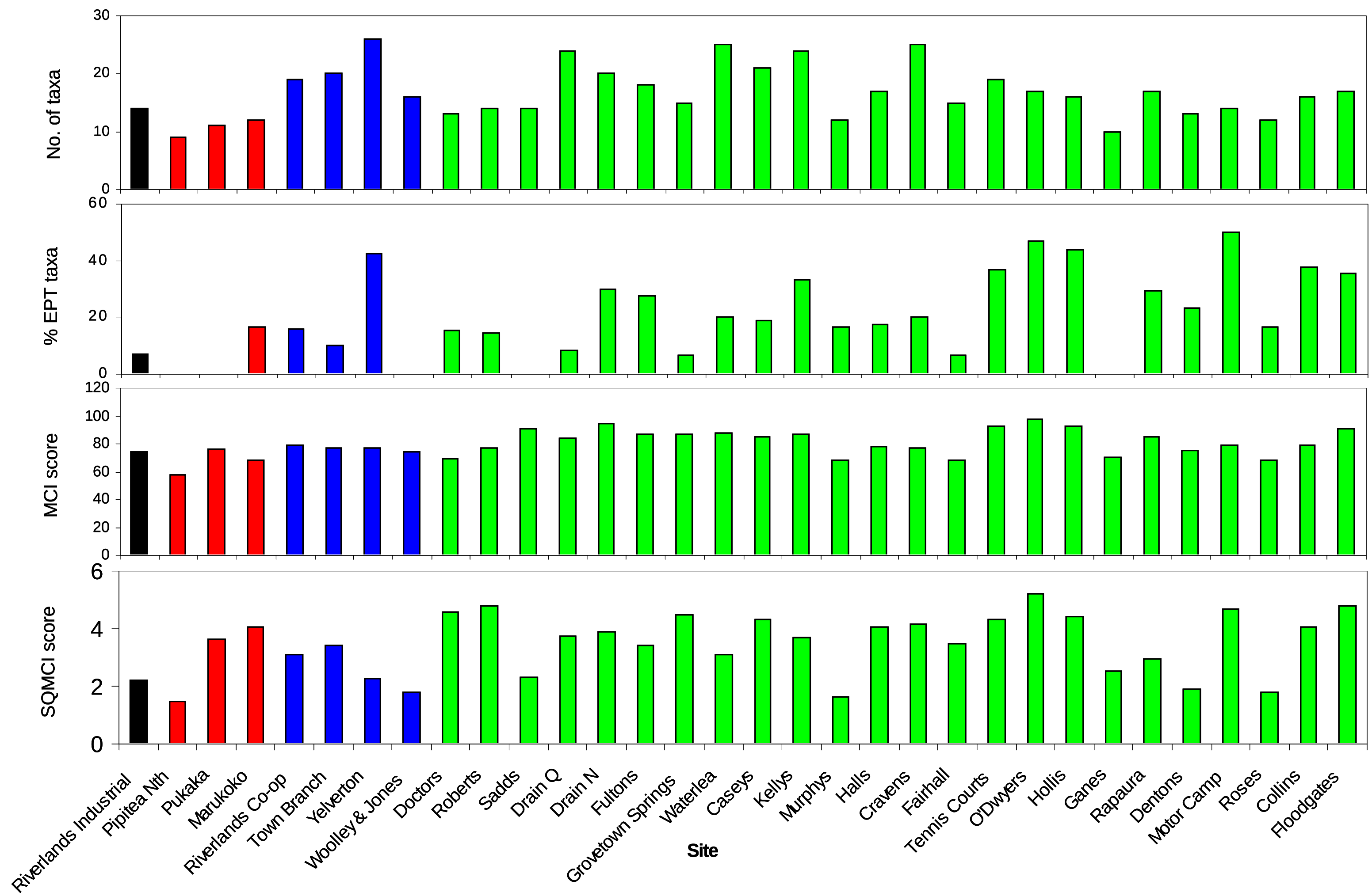

Figure 8 Summary of biotic indices at each of the sites. Colours relate to site groupings identified in Section 3.1.

Table 2 Dominant macroinvertebrate taxa throughout the Wairau Plain Springs. Site colours relate to groupings from Section 3.1.1

Dominant Taxon	**Taxon score**	Riverlands Industrial	Pipitea Nth	Pukaka	Marukoko	Riverlands Co-op	Town Branch	Yelverton	Woolley & Jones	Doctors	Roberts	Sadds	Drain Q	Drain N	Fultons	Grovetown Springs	Waterlea	Caseys	Kellys	Murphys	Halls	Cravens	Fairhall	Tennis Courts	O'Dwyers	Hollis	Ganes	Rapaura	Dentons	Motor Camp	Roses	Collins	Floodgates
Caddisflies																																	
Oxyethira	2					■																											
True Flies																																	
Chironomus	1		■						■																								
Orthocladiinae	2																												■				
Crustacea																																	
Amphipoda	5			■						■	■				■	■		■				■	■	■	■	■		■		■		■	■
Ostracoda	3			■													■						■										
Worms	1	■						■	■			■			■		■			■							■	■	■		■		
Snails																																	
Physa	3	■		■		■																											
Potamopyrgus	4			■	■	■	■						■	■	■	■		■	■		■	■		■			■						

Macroinvertebrate communities at the 'red' sites varied in quality, but all three sites that were sampled had low taxa and EPT diversity. The low MCI and SQMCI scores and dominance by highly tolerant bloodworms (*Chironomus zealandicus*) at Pipitea North indicate that this site is of poorer quality than the other red sites. In addition, no crustacean taxa were found there (Table 3). This probably is a function of the wetland habitat (compared with the channelised morphology of Pukaka and Marukoko), where the lack of flow and low oxygen concentration only allow the most tolerant species to survive. In contrast, SQMCI scores were relatively high at Pukaka and Marukoko. At Pukaka, this was due to dominance by a range of relatively sensitive taxa (amphipods, seed-shrimp/Ostracoda and snails *Physa* and *Potamopyrgus*), whereas at Marukoko only *Potamopyrgus* was dominant, but amphipods also occurred in abundance. The estuarine and anoxic Jeffreys and Pipitea South sites were not sampled for invertebrates but probably supported few freshwater taxa, with only some of the highly tolerant worm, bloodworm or snail taxa likely to inhabit such waters.

There was considerable variation amongst the four 'blue' sites, despite their similarity in water quality/physical variables. Although all four sites had similar MCI scores (which approximated the median value for all of the sites), they were dominated by different taxa, and taxa richness, % EPT taxa and SQMCI varied between the sites. However, Riverlands Co-op and Town Branch were reasonably similar and were both dominated by snails (*Potamopyrgus* and *Physa* at Riverlands Co-op; *Potamopyrgus* at Town Branch), with *Oxyethira* (a tolerant cased-caddis larvae) also dominant at Riverlands Co-op. Both sites had relatively high taxa richness (higher than that at any of the black or red sites, and many of the green sites), but % EPT taxa was low. SQMCI scores were also low, but were higher than those at Yelverton and Woolley & Jones. In contrast, Yelverton had very high taxa richness (26 taxa) and % EPT taxa (42 %) due to the high diversity of caddisflies. This was almost certainly due to the low water level, which had created shallow 'riffles' over the coarse gravel substrate – a habitat that is not normally found in lowland spring-fed systems, but that favors colonisation by caddisflies. Despite this diversity, worms were the dominant taxon and the low SQMCI score was indicative of a poor quality community. Woolley & Jones had the poorest quality macroinvertebrate fauna of the four blue sites. Taxa diversity was relatively low, no EPT taxa were present and the SQMCI score was very low. Worms and bloodworms were the dominant taxa. Shrimp and koura were not observed at any of the 'blue' sites, but amphipods and seed-shrimps were present at all four sites (Table 3).

The quality of macroinvertebrate communities at sites in the 'green' group varied enormously, with taxa richness ranging from 10 (Ganes) to 25 (Cravens & Waterlea), % EPT from 0 (Sadds & Ganes) to 50 (Motor Camp), MCI from 68 (Murphys & Roses) to 98 (O'Dwyers) and SQMCI from 1.64 (Murphys) to 5.20 (O'Dwyers).

The SQMCI index indicated that communities were of poorest quality at Sadds, Fultons, Waterlea, Murphys, Fairhall, Ganes, Rapaura, Dentons and Roses (SQMCI < 3.50). All but one of these sites were dominated or co-dominated by worms (with the exception of Fairhall which was dominated by Crustacea), and almost half of the sites (Sadds, Fultons, Waterlea and Murphys) were denuded of aquatic plants that provide habitat for more sensitive fauna such as amphipods. The highest quality communities occurred at Doctors, Roberts, Grovetown Springs, Caseys, Halls, Cravens, Tennis Courts, O'Dwyers, Hollis, Motor Camp, Collins and Floodgates (SQMCI > 4.00). These sites all supported lush aquatic plant growth, and tended to be dominated by amphipods and/or the snail *Potamopyrgus*. Drain Q, Drain N and Kellys had more intermediate SQMCI scores, ranging from 3.66 – 3.90. Quality of macroinvertebrate communities in these streams is likely to vary temporally and spatially in response to changes in habitat, such as clearance of aquatic plants from in and around the channel. Sampling carried out previously (on three occasions) in Murphys Stream at a different site where aquatic plants had established (downstream near the confluence with the Taylor River), found snail or amphipod-dominated communities (*c.f.* the worm-dominated community in this study) with considerably higher % EPT taxa, MCI and SQMCI scores than were found in this study (Crowe 2002).

MCI scores showed a similar pattern to the SQMCI, but generally showed less variation between sites. In some cases the MCI score was indicative of considerably better quality than the SQMCI score (*e.g.*, Sadds), due to the presence of low numbers of more sensitive taxa (several beetles, waterbugs and damselflies at Sadds). The SQMCI score down-weights rare taxa and places more importance on more abundant/dominant taxa (worms at Sadds), and therefore probably gives a more realistic assessment of the health of a site.

Most sites with high taxa richness and a high proportion of EPT taxa were those with SQMCI scores at the higher end of the range, such as Caseys, Kellys, Cravens, Drain N and Drain Q (high taxa richness), and Tennis Courts, O'Dwyers, Hollis and Motor Camp (high % EPT). However, taxa richness and % EPT taxa did not seem to be strongly linked with SQMCI results, with many of the sites with higher SQMCI scores having relatively low diversity of taxa and % EPT taxa. Furthermore, Waterlea (which had a low SQMCI score) had a very high taxa richness, and Rapaura and Dentons (also with low SQMCI scores) had relatively high proportions of EPT taxa due to presence of mayfly and caddis taxa. Regression analysis indicated that there was a significant relationship between percentage cover by aquatic plants and the proportion of EPT taxa ($F_{1,30}$=10.32, $P<0.005$), with the proportion of EPT taxa increasing as aquatic plant cover increased. In contrast, there was no evidence that streams with a high proportion of aquatic plant cover had higher taxa richness.

Crustacean taxa were found at all of the 'green' sites except Sadds, but Ganes also had a poor crustacean fauna with only low numbers of seed-shrimp present (Table 3). Amphipods were fairly ubiquitous, occurring at all of the sites except Sadds and Ganes, whereas shrimp occurred only at Roberts, Grovetown Springs, Waterlea, Halls, Cravens and Floodgates. Koura were found at 18 of the 24 'green' sites, and in many cases were observed by spotlight or electric-fishing, rather than in hand net samples. Koura were not observed at Doctors, Roberts, Sadds, Grovetown Springs, Murphys and Ganes. Koura have a wide, but patchy, spatial distribution across the Wairau Plain (Figure 9). Waterlea, Halls, Cravens and Floodgates were the only sites at which amphipods, shrimp and koura were all observed. It is interesting that Waterlea supported a diverse crustacean fauna despite the lack of aquatic plant growth in the channel, and it is likely that these taxa would become more dominant if plant biomass (*i.e.,* habitat) increased.

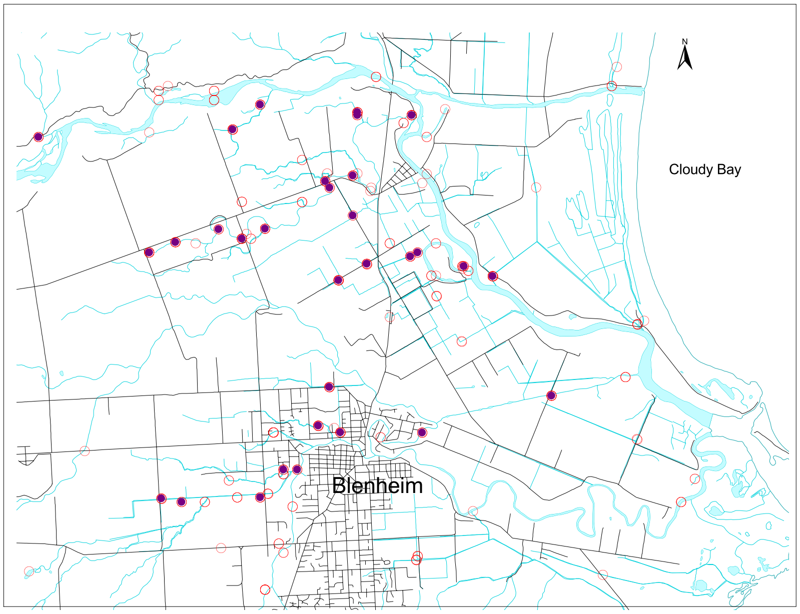

Figure 9 Distribution of koura (*Paranephrops planifrons*) across the Wairau Plains. Open circles are sampling sites, filled circles indicate koura presence.

Table 3 Distribution of Crustacea throughout the Wairau Plain springs. Site colours relate to groupings from Section 3.1.1.

Taxon	Riverlands Industrial	Pipitea Nth	Pukaka	Marukoko	Riverlands Co-op	Town Branch	Yelverton	Woolley & Jones	Doctors	Roberts	Sadds	Drain Q	Drain N	Fultons	Grovetown Springs	Waterlea	Caseys	Kellys	Murphys	Halls	Cravens	Fairhall	Tennis Courts	O'Dwyers	Hollis	Ganes	Rapaura	Dentons	Motor Camp	Roses	Collins	Floodgates
Seed-shrimp																																
Amphipods																																
Shrimp																																
Koura																																

A DECORANA ordination of macroinvertebrate communities using presence-absence data is presented in Figure 10. The separation of sites is proportional to the relative similarity of their macroinvertebrate communities. Sites were colour-coded according to the site groupings identified in Section 3.1.1. Characteristic taxa (from a taxon ordination which is not shown) are plotted near the sites where they were most commonly represented.

Site distribution was remarkably similar to that in the ordination of physical and water quality variables (compare Figure 10 with Figure 4). The 'green' sites were, for the most part, located in a similar location on the left side of the ordination, and were most highly correlated with the occurrence of Crustacea such as amphipods and koura (*Paranephrops*), as well as the more sensitive mayfly (*Austroclima*, *Zephlebia*) and caddisfly (*Pycnocentria*, *Psilochorema*, *Polyplectopus*) taxa. Some lower scoring (less sensitive) taxa were also correlated with these sites, such as blackfly larvae (*Austrosimulium*), freshwater bivalves (Sphaeriidae) and midge larvae (*Tanytarsus*). Sites in the Spring Creek system that were sampled in October 1999 were located in a similar region of the ordination, and were very close to the other 'green' sites considering that they were collected several years earlier, and at a different time of year. Sadds was separated from the other 'green' sites, and was strongly correlated with the presence of "pond-dwelling taxa' such as beetles (Stratiomyidae, *Enochrus*, *Liodessus*), springtails (Collembola), pond-skaters (*Microvelia*), and to a lesser extent, larvae of damselfly *Austrolestes*.

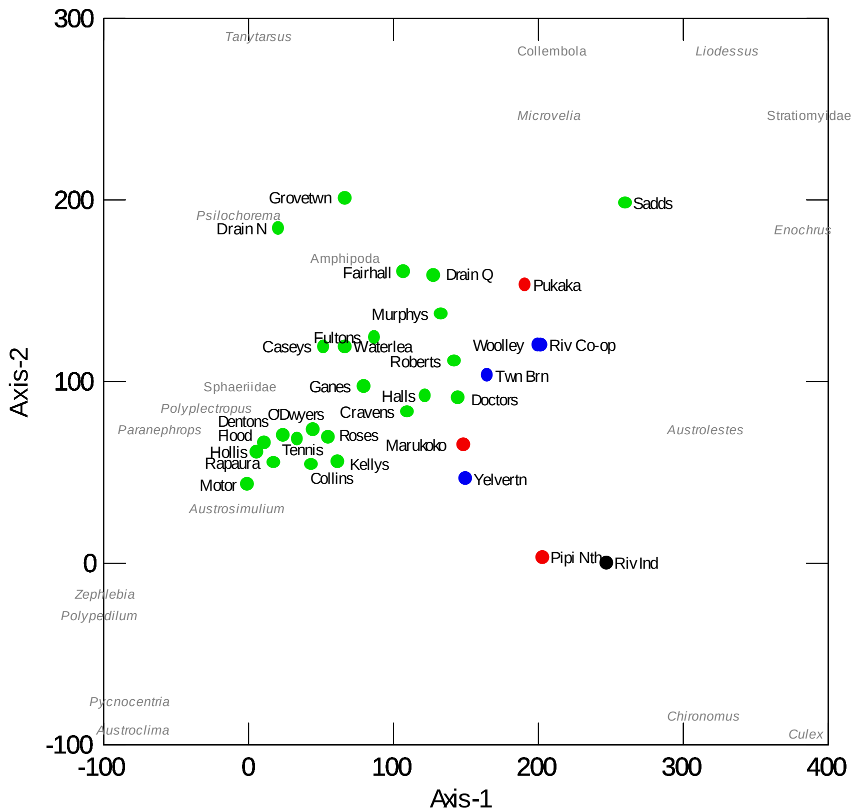

Figure 10 DECORANA ordination of macroinvertebrate communities using presence-absence data. Sites with the most similar macroinvertebrate communities are plotted closest together. Colours relate to site groupings identified in Section 3.1.1.

The 'blue' and 'red' sites had similar site distributions in the central-right region of the ordination, and were more closely correlated with the 'pond-dwelling taxa' (particularly damselfly larvae) than the ‘green’ sites. Pipitea North was positioned close to Riverlands Industrial on the right side of the ordination, and both sites were correlated with the presence of bloodworms (*Chironomus*) and mosquito larvae (*Culex*).

Analysis for correlation of site distributions with environmental variables (physical and water quality data) indicated that site distribution along Axis-1 was positively correlated with ammonia-N, temperature, total, fixed and volatile suspended solids, specific conductivity, dissolved reactive phosphorus, total phosphorus and turbidity. Channel width and volatile suspended solids were negatively correlated with site distribution along Axis-2, but there did not appear to be strong site separation along this axis.

In summary, the macroinvertebrate data supported our initial site groupings based on the water quality and physical information. The only real exception to this was the invertebrate community at Sadds, which appears to be different and of poorer quality than that at the other ‘green’ sites and more similar to that at the ‘blue’ and ‘red’ sites.

3.3 Aquatic plants

Forty-three different kinds of plants were recorded in or surrounding the sites surveyed (Table 4). Of these 18 were primarily aquatic, whereas the remaining 25 were associated with the margins of waterways or were purely terrestrial plants. Twelve of the aquatic plants were introduced species. The most common species recorded were duckweed, mixed pasture grasses, watercress, and swamp willow weed. Nuisance species such as *Egeria* and *Lagarosiphon* were found at Roberts, Kellys, Halls, Marukoko, Riverlands Co-op, Fultons, Waterlea, Caseys, and Murphys. *Glyceria maxima* was found only at Grovetown Springs.

The total number of plant species recorded from the Wairau Plain springs exceeded those found during the Spring Creek study – 20 (Young *et al.* 2000), because a greater number of wetland margin and terrestrial plant species were recorded in this survey.

Most of the streams surveyed are subject to regular aquatic plant control. Control methods vary and include herbicide, mechanical control, hand clearing and combinations of these. Herbicide is also applied to bankside vegetation in some waterways. Recent control work was evident in some of these streams, making an assessment of typical plant assemblage difficult at some sites. Because of the regular control work, species presence and composition will vary markedly over time. Our description of plants is only a “snap shot” and could change dramatically depending on control work.

The positive values of aquatic plants in waterways sometimes are overlooked, particularly when the focus of attention is on the rampant growth of nuisance plants. Under these circumstances, and understandably, any plants growing in the water are perceived as a nuisance. This perception has caused aquatic plants to be most often referred to as weeds and even for many plants to be named as such, *e.g*., Willow weed, Duckweed, Pondweeds *etc*. Because we recognise that these plants can be a useful component of aquatic ecosystems, we have preferred to describe them as “aquatic plants”.

Aquatic plants provide ecological and biological benefits which may include:

- Trapping and stabilisation of sediments
- Uptake and release of nutrients
- Added surface area for algal production, aquatic insects and molluscs
- Shelter and feeding areas for fish
- Provide and host food sources for waterfowl

Some aquatic plants, such as watercress and raupo, are a food source, while these and others have cultural values. For some people, aquatic plants have a pleasing aesthetic value, adding character, texture and visual diversity to the aquatic scene.

It is not possible or necessary to manage aquatic plant growth in the same way for all watercourses. The need for aquatic plant removal can be justified where plant growth affects water levels and properties are at risk or land use is affected because of ineffective drainage. Because of the variety of spring fed watercourses within the Wairau spring belt, there is scope for a variety of approaches to the management of aquatic plants within them. For those watercourses that do not have nuisance plant species and pose less risk of flooding, aquatic plant growth is not an issue. Other watercourses that do have nuisance plant species, but high biological values, require innovative management so that control does not impact on these values.

One of the best techniques that can be used to selectively weed out nuisance aquatic plants and leave behind the more benevolent species is hand clearing. However, wherever examples of hand clearing were found in the Wairau springs, the watercourse had generally been transformed into a relatively sterile habitat with complete plant removal. Selective removal of nuisance aquatic plants may provide a better balance between the drainage and ecosystem values of these springs. Control of plants, particularly along narrow watercourses, can also be achieved by encouraging growth of riparian vegetation, which will shade and suppress aquatic plant growth (Young *et al.* 2000). Even grasses and sedges can fill this role along very narrow watercourses.

CAWTHRON

Table 4 Distribution and percent cover of aquatic plant species in the Wairau Plain springs. Site colours relate to groupings from Section 3.1.1.

Common name	Scientific name	Riverlands Ind	Jeffreys	Pipitea Nth	Pukaka XS1	Pukaka XS2	Pipitea Sth	Marukoko	Riverlands Co-op	Town Branch	Woolley & Jones	Yelverton	Doctors	Roberts XS1	Roberts XS2	Sadds XS1	Sadds XS2	Sadds XS3	DrainQ XS1	DrainQ XS2	DrainQ XS3	DrainN XS1	DrainN XS2	DrainN XS3	Fultons	Grovetown Sp	Waterlea	Caseys	Kellys	Murphys	Halls	Cravens	Fairhall
Alder *	*Alnus glutinosa*																														x		
Cape pondweed *	*Aponogeton distachyus*																													x			
Azolla	*Azolla filiculoides*	4			8	36							1.5				4	5	2														
Beggar's ticks *	*Bidens frondosa*										x																		x				
Starwort *	*Callitriche stagnalis*								0.5	x		4	29															5					x
Unnamed sedges	*Carex* spp.	6	x	0.8	x			4	x	x						6		4								x	4		5	x	x		
Bachelor's button	*Cotula coronopifolia*		29																												3		
Hawthorn *	*Crataegus* spp.										x																						
Egeria *	*Egeria densa*													49															2		15		
Canadian pondweed *	*Elodea canadensis*																								x				3				
Floating sweetgrass *	*Glyceria fluitans*											8											10		x		1					8	14
Reed sweetgrass *	*Glyceria maxima*																									19							
Oxygen weed *	*Lagarosiphon major*							2	24					25											x		1	23	5	x	x		
Duckweed	*Lemna minor*	69		1.3	82	38	64			x	80		4	3		75	70	77	78	3	7	28	37	25		1.5	2	15	0.5		17	14	8
Lilaeopsis	*Lilaeopsis novae-zelandiae*												0.5																				
Primrose willow *	*Ludwigia peploides*																									0.5							
Mint	*Mentha* spp.																													x			
Monkey musk*	*Mimulus guttatus*									x		3														8			1				
Water forget-me-not *	*Myosotis laxa*								6	x			1																		0.5		
Nitella	*Nitella hookeri*							43					5									1	39		x				15		7	24	
Water lily *	*Nymphaea alba*																													x			
Phalaris *	*Phalaris spp.*										x																						
NZ Flax	*Phormium tenax*			10																										x			
Pittosporum	*Pittosporum* spp.																																x
Broad-leaved plantain*	*Plantago major*				x																												
Willow weed *	*Polygonum persicaria*																												53				
Swamp willow weed	*Polygonum salicifolium*								2	x		15	8				7			81		30		25		46		36	13	x	29	0.5	7

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Table 4 cont.

Common name	Scientific name	Riverlands Ind	Jeffreys	Pipitea Nth	Pukaka XS1	Pukaka XS2	Pipitea Sth	Marukoko	Riverlands Co-op	Town Branch	Woolley & Jones	Yelverton	Doctors	Roberts XS1	Roberts XS2	Sadds XS1	Sadds XS2	Sadds XS3	DrainQ XS1	DrainQ XS2	DrainQ XS3	DrainN XS1	DrainN XS2	DrainN XS3	Fultons	Grovetown Sp	Waterlea	Caseys	Kellys	Murphys	Halls	Cravens	Fairhall
Curly pondweed *	*Potamogeton crispus*							1	50	x			2																		15	23	
Blunt pondweed	*Potamogeton ochreatus*																														0.5		
Water buttercup *	*Ranunculus trichophyllus*							2					47																		3		
Riccia *	*Riccia fluitans*																											4.5		x			
Watercress *	*Rorippa nasturtium-aquaticum*				3.5				7	x		69	2	1						3	74		2	5	x	23		18		x	10	11	49
Marsh yellow cress	*Rorippa palustris*											1																					
Horse's mane weed	*Ruppia polycarpa*		71																														
Crack willow *	*Salix fragilis*			88																									x				
Raupo	*Typha orientalis*				6	26	29	8																									
Gorse *	*Ulex europaeus*				x	x																											
Algae								7																									
Blackberry *				x												x																	
Manuka				x																													
Mixed pasture grasses		19	x		x	x	7	7	10	x	20	x	x	23		19	19	14	20	13	19	41	13	45		2	54		2	x		20	22
Tree Lucerne *																												x					
Unnamed native shrubs																																	x
Unnamed rushes		2	x	0.5	0.5			26	0.5				x													x			2	x	x		
% instream plant cover		100	12	100	91	86	100	57	89	0	100	92	73	92	0	100	94	100	100	100	100	100	74	100	0	100	17	14	82	0	86	54	79
total species		5	2	5	6	3	3	9	8	7	2	6	10	5	0	3	4	4	3	4	3	4	5	4	5	7	5	6	11	9	11	7	6

Shaded common names indicate aquatic plants. * = introduced species x = present but not recorded in the cross-section.

3.4 Fish

Six different species of fish were found during our survey of the Wairau Plain springs. These include the native longfin eel (*Anguilla dieffenbachii*), shortfin eel (*Anguilla australis*), giant kokopu (*Galaxias argenteus*), inanga (*Galaxias maculatus*) and common bully (*Gobiomorphus cotidianus*), as well as the introduced brown trout (*Salmo trutta*). Yelloweye mullet (*Aldrichetta forsteri*), a largely estuarine/marine species, were seen at the confluence of the Pipitea Sth/Marukoko and the Wairau River. In addition to the above species, lamprey (*Geotria australis*) and black flounder (*Rhombosolea retiaria*) have been recorded in the Spring Creek catchment (Young *et al.* 2000). A large bodied galaxiid, thought to be a banded kokopu (*Galaxias fasciatus*) was also observed by spot-light at the Tennis Courts site on Spring Creek (Young *et al.* 2000). Giant bully (*Gobiomorphus gobioides*) and common smelt (*Retropinna retropinna*) have been recorded in the NZ freshwater fisheries database from the Roses Overflow and may also be found in some of the spring-fed streams where access to and from the sea is easy.

Shortfin eels were the most common species of fish found in the springs (Figure 12, Table 5). Inanga (Figure 13) and common bullies (Figure 15) were also widespread, while longfin eels (Figure 11) and brown trout (Figure 14) were only found occasionally. Only two individual giant kokopu were seen -- in Drain N and Drain Q (Figure 16). These are the first officially recorded sightings of giant kokopu in the Wairau Plain area since 1973, although Mr R. Winter reported the capture of a giant kokopu in Spring Creek in 1985 (see Young *et al*. 2000). The only other record of giant kokopu from the Wairau River catchment is a 1988 record from the Onamalutu River. We also saw an unidentified galaxiid in Roberts but it was not possible to confirm whether this was a banded or giant kokopu.

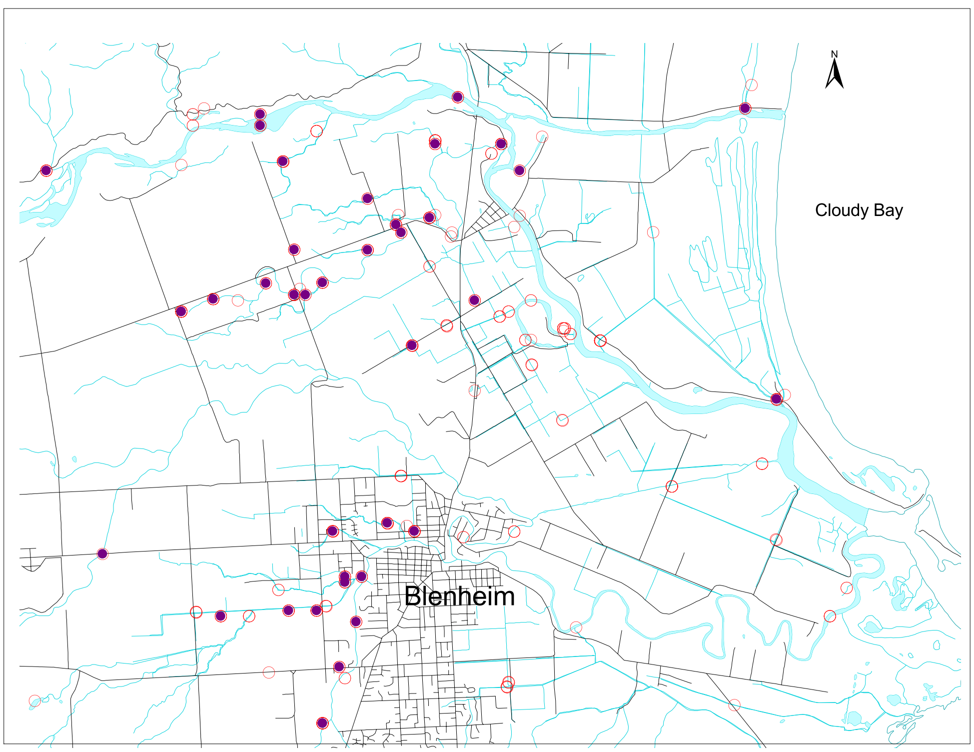

Figure 11 Distribution of longfin eels (*Anguilla dieffenbachii*) across the Wairau Plain. Fish survey sites are shown with open circles, longfin eel presence is shown with filled circles.

Figure 12 Distribution of shortfin eels (*Anguilla australis*) across the Wairau Plain. Fish survey sites are shown with open circles, shortfin eel presence is shown with filled circles.

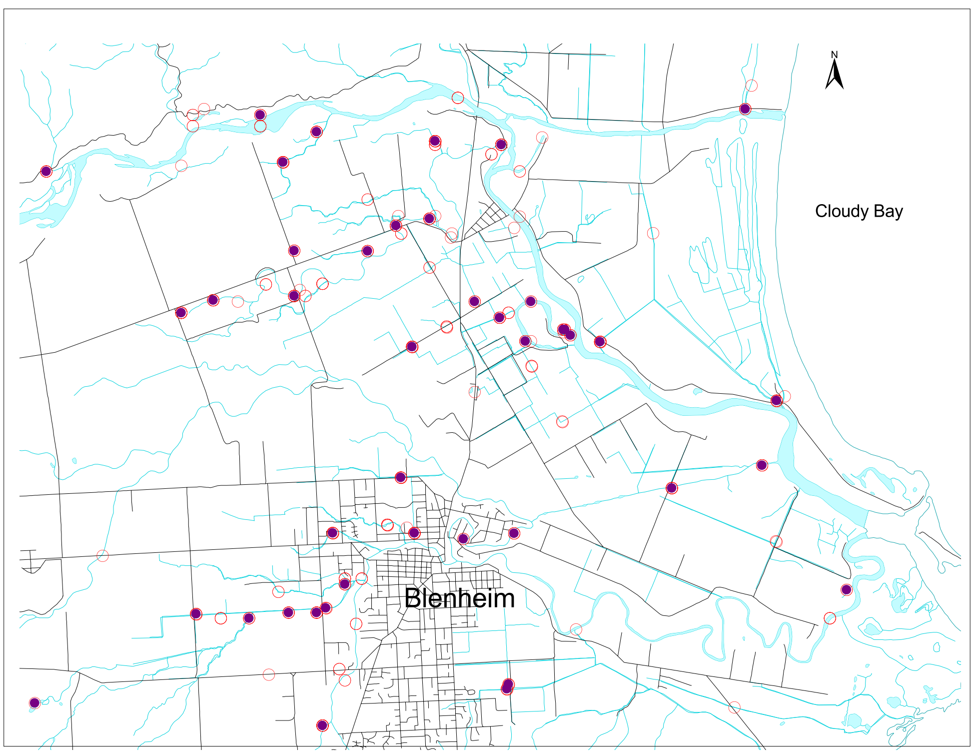

Figure 13 Distribution of inanga (*Galaxias maculatus*) across the Wairau Plain. Fish survey sites are shown with open circles, inanga presence is shown with filled circles.

Figure 14 Distribution of brown trout (*Salmo trutta*) across the Wairau Plain. Fish survey sites are shown with open circles, brown trout presence is shown with filled circles.

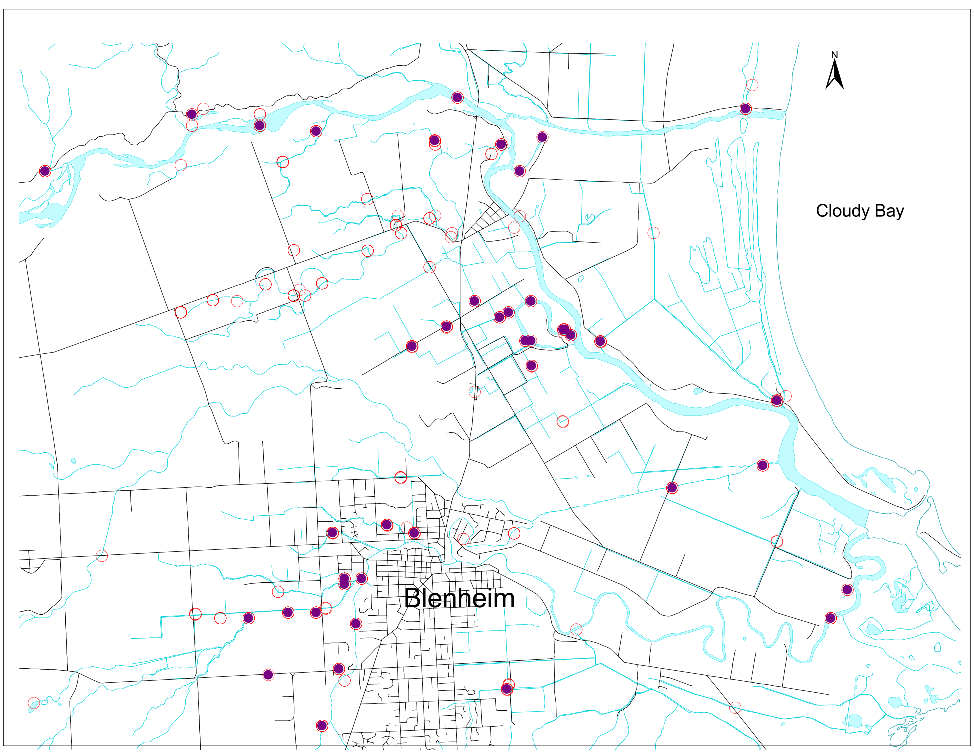

Figure 15 Distribution of common bully (*Gobiomorphus cotidianus*) across the Wairau Plain. Fish survey sites are shown with open circles, common bully presence is shown with filled circles.

Figure 16 Giant kokopu (*Galaxias argenteus*) found at Drain Q

The distribution of fish species was consistent with the site groupings based on water quality and physical variables developed in Section 3.1.1. Fish diversity generally was high at the 'green' sites, although Sadds was perhaps an exception with only two fish species recorded and thus was more closely aligned with a 'red' or 'blue' site. No fish were found in Riverlands Industrial ('black' site) and, apart from Marukoko, fish diversity at the 'red' sites was very poor also (Table 5).

Although water quality and physical conditions at sites determine their suitability for fish, the key aspect governing the presence of fish at any of these sites is access. For example, Pipitea South was sampled just upstream of its lower floodgate and no fish were found there. In contrast, yelloweye mullet and inanga were abundant immediately below the floodgate. If fish passage could be improved through the floodgate more habitat would be made available to these species.

Table 5 Distribution of all fish species throughout the Wairau Plain springs. Unconfirmed sightings are shown with cross-hatching. Site colours relate to groupings from Section 3.1.1.

Species	Riverlands Industrial	Jeffreys	Pipitea Nth	Pukaka	Pipitea Sth	Marukoko	Riverlands Co-op	Town Branch	Woolley & Jones	Yelverton	Doctors	Roberts	Sadds	Drain Q	Drain N	Fultons	Grovetown Springs
Lamprey																	
Longfin eel						X					X				X	X	
Shortfin eel		X	X			X	X	X	X	X	X	X	X	X	X	X	X
Giant kokopu												(X)		X	X		
Banded kokopu																	
Inanga						X	X	X			X	X			X	X	X
Brown trout												X			X	X	
Common bully						X	X				X	X	X	X	X	X	X
Black flounder																	

Species	Waterlea	Caseys	Kellys	Murphys	Halls	Cravens	Fairhall	Tennis Courts	O'Dwyers	Hollis	Ganes	Rapaura	Dentons	Motor Camp	Roses	Collins	Floodgates
Lamprey																	X
Longfin eel	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Shortfin eel	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Giant kokopu									X								
Banded kokopu								(X)									
Inanga	X	X	X	X	X	X	X	X	X		X			X			X
Brown trout		X	X	X	X	X		X	X	X		X	X	X	X	X	X
Common bully	X		X	X	X	X											X
Black flounder					X				X								X

4. DISCUSSION

4.1 Flow limits and habitat protection

4.1.1 Relationships between habitat and flow

One of the aims of this study was to determine the relationship between habitat and flow so that limits on abstraction could potentially be set to maintain habitat integrity in the Wairau Plain springs. Habitat quality for aquatic organisms can depend on a wide range of variables including water quality, cover, substrate type, freedom of access to the sea, flow variability and hydrological variables such as water depth, velocity and wetted width. Only the latter hydrological variables are potentially influenced by spring flows. For example, at Waterlea Creek where there is a good record of multiple flow gaugings, average water depth and width on any particular occasion were closely related with flow (Figure 17). Surprisingly, average water velocity was not related with flow (Figure 17).

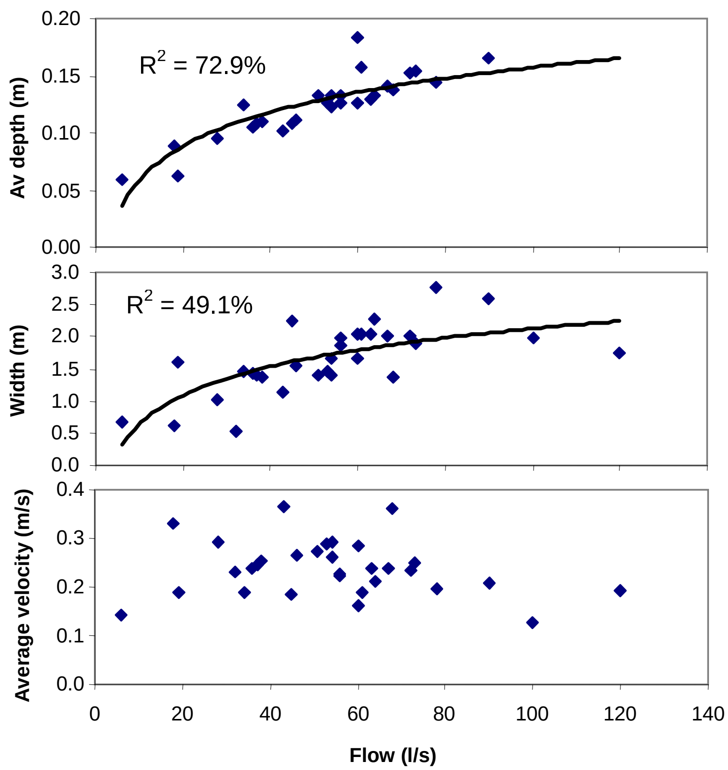

Figure 17 Relationships between flow and hydrological habitat variables at Waterlea Creek.

Flows, however, may not be the only thing controlling water depth, width and velocities. For example, water levels at the Motor Camp site on Spring Creek are thought to be largely dependent on the growth and density of aquatic plants downstream, rather than flow. This is demonstrated in Figure 18 where there was actually a tendency for average depth and width to decrease with flow, rather than increase as would first be expected. It appears that as flow increases in a channel with dense aquatic plant growth the first effect is an increase in water level until eventually the plants are toppled over and water depth decreases. From then on depth slowly increases again with increasing flows. Tidal fluctuation is another factor, independent of flow, which primarily controls water level in the springs near the coast. Similarly, due to the low gradient of many spring-fed streams, water levels may be controlled by the level of the rivers that they flow into rather than their own flows.

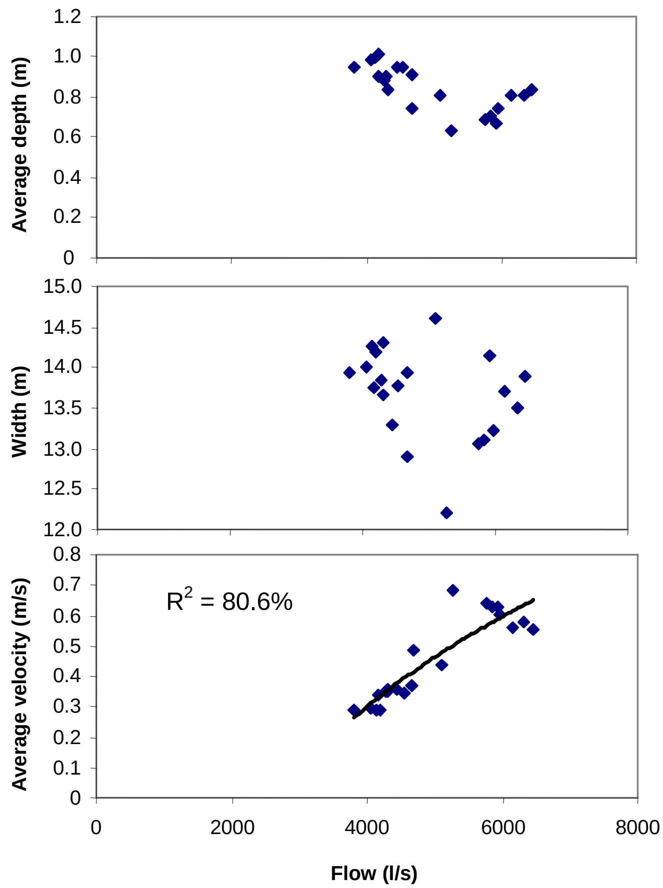

Figure 18 Relationships between flow and hydrological habitat variables at the Motor Camp site on Spring Creek.

4.1.2 Habitat preferences for aquatic organisms

The notion of habitat preference is based upon the idea that species are adapted to a limited range of habitat or environmental conditions. Where habitat or environmental conditions are highly suitable for a particular organism, that organism will often be found in abundance. Hydrological habitat preferences for a variety of species have been defined both in New Zealand and overseas. Relevant suitability curves for fish found in the Wairau Springs are shown in Figure 19 (Hayes & Jowett 1994; Jowett 1995; Bonnett & Sykes 2002). Suitability curves have been developed for some species of macroinvertebrates (Jowett & Richardson 1990), but unfortunately these have concentrated on species that are found in rain-fed gravel-bottomed rivers and can not be applied to species commonly found in spring-fed streams. Most macroinvertebrates that colonise spring-fed streams are those that prefer relatively shallow to moderate depths and slow water velocity.

Most of the fish species found in the Wairau Plain springs prefer slow to intermediate water velocity (0-0.4 m/s) and shallow (10-20 cm) water (Figure 19). Longfin and shortfin eels are habitat generalists and find a variety of environmental conditions to their liking (Figure 19). Giant kokopu tend to like very slow moving water but will occur over a wide depth range. Inanga and common bully prefer shallow water with intermediate water velocity. The suitability curves for adult brown trout shown in Figure 19 are based on measurements from trout feeding on drifting invertebrates and may not be totally appropriate in spring-fed streams where alternative food sources and feeding strategies are probably more important. Nevertheless the curves indicate a preference by adult brown trout for relatively deep water and moderate water velocity (Figure 19).

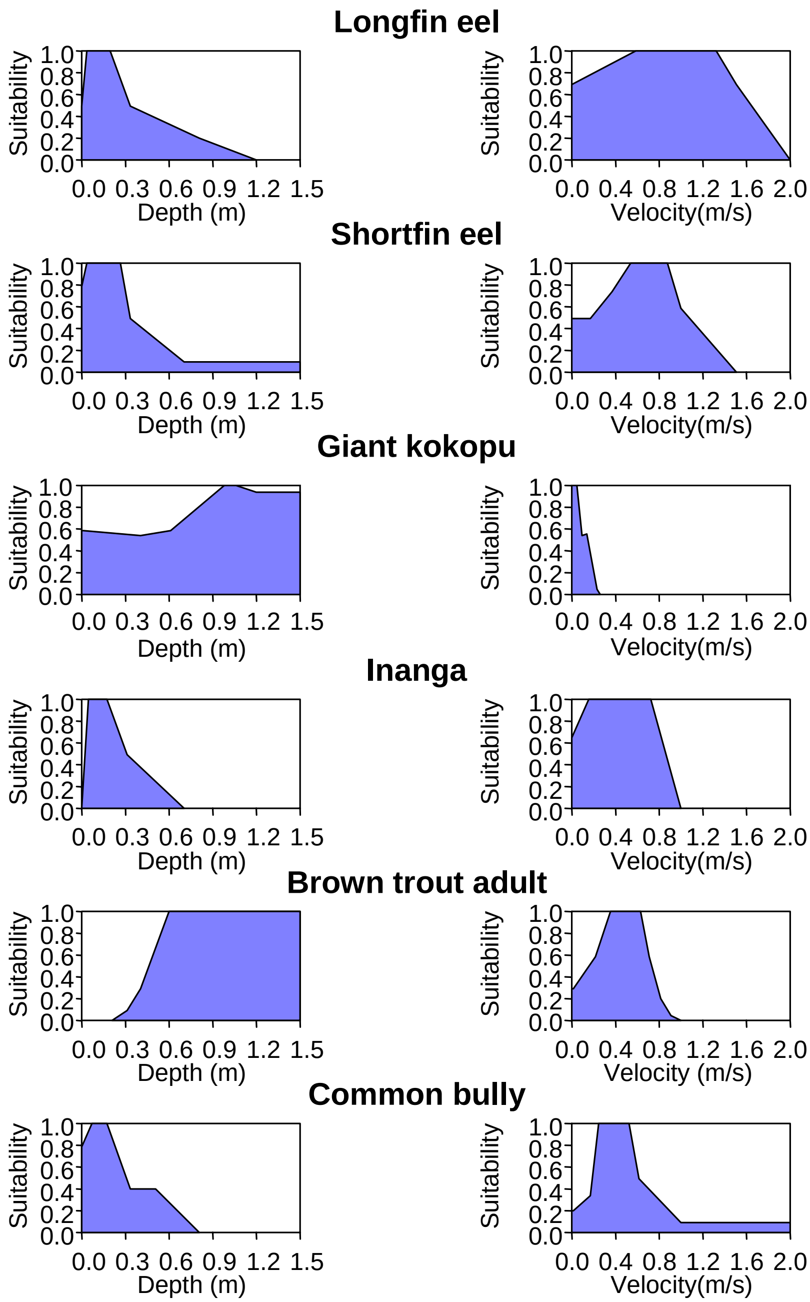

Figure 19 Depth and velocity suitability curves for the main fish species found in the Wairau Plain springs. Suitability is ranked on a scale from 0 to 1.

4.1.3 Historical occurrence of spring drying

Limited available flow data indicated that Doctors, Fairhall and Yelverton dried up during summer 2000/2001. Waterlea may also have dried up (still only 6 l/s in November 2001). The upper reaches of Spring Creek near the Tennis Court were almost dry during early 2001 (R. Young & R.

Strickland, personal observations), whereas water levels in the upper reaches of Murphys were also reported to fluctuate with irrigation pumping. The upper reaches of Caseys, Fultons and the smaller Spring Creek tributaries probably are also threatened by increased groundwater abstraction, along with the upper Grovetown Lagoon tributaries. The upper reaches of Pipitea Nth may also be threatened by abstraction from the shallow Rarangi aquifer if major landuse changes occur there.

4.1.4 Potential strategy on setting limits for habitat protection

Given the data available, the most sensible option for setting limits to protect the habitat in the Wairau Plain spring-fed streams would be to use the flow/habitat relationships from Waterlea Creek (Figure 17) to come up with a trigger level below which irrigation could be restricted. The sheer size of Spring Creek at either the Motor Camp or Gainsford Bridge recording sites, along with the confounding effects of aquatic plant growth on water levels, makes these two sites impractical as potential triggers for managing spring flows.

Once flows in Waterlea drop below 10 l/s, average depth and width are predicted to decline sharply (Figure 17). Presumably water velocity would also decline at about this level although there is insufficient data at low flow to confirm this. As width declines the total area of habitat available will decline, even if the remaining habitat is suitable. At a flow of 10 l/s average depth in Waterlea is predicted to decline to about 5 cm, well below the preferred depth for adult brown trout and in the range of rapid decline in habitat suitability for the other species (Figure 19). Similarly, average velocities at a flow of 10 l/s in Waterlea are probably around 0.15 m/s, which is in the range of declining habitat suitability for all the fish species except shortfin eels and giant kokopu (Figure 19).

The key assumption required in using flows at Waterlea as a trigger to restrict irrigation would be that Waterlea needs to be hydrologically representative of other spring-fed streams threatened by irrigation. Ideally, more flow data from a range of the spring-fed streams would be required to confirm whether this assumption is a good one. However, it may be possible to determine whether this is the case by looking at the relative elevation of each spring-fed stream. Presumably, 'high' elevation spring-fed streams would run dry before 'lower' elevation ones if groundwater levels are relatively consistent across the Wairau Plain. If Waterlea has a similar or higher elevation to the other threatened springs then it would be a suitable representative. If not then perhaps another spring, such as Yelverton that is likely to dry up first, would be a better 'early warning' indicator for abstraction restrictions.

If the above options are unsuitable, or impractical, then another alternative could be to use groundwater levels at Wratts Road Well as a trigger for protection of Spring Creek/Grovetown Lagoon tributaries, while groundwater levels at the Athletic Park Well could be used for protecting the rural and urban Taylor/Opawa spring-fed streams. Relationships between groundwater levels and spring flows would have to be developed before this latter option could be implemented.

4.2 Site rankings

Another aim of this report was to rank the sites in terms of their importance. This is not a simple task since a variety of values must be considered. For example, the urban springs (Murphys, Fultons, Caseys and Waterlea) have considerable aesthetic value, while Drain N & Drain Q have a high biodiversity value due to the presence of giant kokopu. The relative weights to be given to factors such as these really need input from the whole community.

In terms of ecological values, the springs can be ranked as shown in Table 6. These rankings are based on the site groups developed from the water quality and physical data (see section 3.1.1) with some modifications related to the macroinvertebrate and fish communities present at each site. For example, Marukoko is one of the 'red'sites, which generally have poor quality fish and invertebrate communities. However, presumably due to the large amount of flow and easy fish access in Marukoko, biodiversity and ecological values were considered to be good.

Table 6 Ranking of the Wairau Plain springs in terms of their current ecological value. Site colours refer to the groupings from Section 3.1.1.

Ranking	Sites
Good	Drain N, Drain Q, Marukoko, Cravens, Halls, Tennis Courts, O'Dwyers, Hollis, Floodgates
Medium-Good	Kellys, Rapaura, Motor Camp, Collins, Murphys
Medium	Roberts, Grovetown Springs, Fultons, Doctors, Fairhall, Dentons, Caseys, Roses, Waterlea, Pukaka, Yelverton
Medium-Poor	Sadds, Ganes, Woolley & Jones, Town Branch, Riverlands Co-op
Poor	Pipitea Nth, Jeffreys
Very Poor	Riverlands Industrial, Pipitea Sth

5. ACKNOWLEDGEMENTS

We thank Peter Hamill, Ally Jerram and Mike Ede for assistance with the field work and collection of the flow data. Discussions with Peter, Mike and Peter Davidson were also helpful in regard to flow management options. Karen Shearer assisted with the macroinvertebrate sample processing and identification and Aaron Quarterman helped with the report preparation.

6. REFERENCES

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Appendix 1

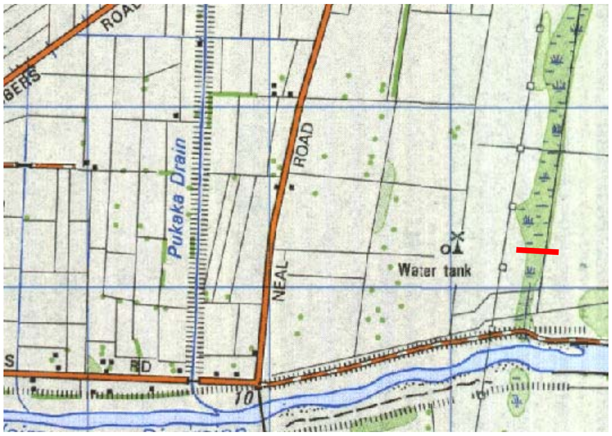
Site Summary Sheets

In this section a short summary of the habitat, water quality and ecology of each site is provided. The location of the cross-section(s) are shown on each map with a red line. The summary sheets are listed in the order we sampled the sites, which is as follows:

Site 1 – Pipitea Nth
Site 2 – Pukaka
Site 3 – Roberts
Site 4 – Sadds
Site 5 – Drain N
Site 6 – Drain Q
Site 7 – Pipitea Sth
Site 8 – Marukoko
Site 9 – Grovetown Springs
Site 10 – Kellys
Site 11 – Waterlea
Site 12 – Fultons
Site 13 – Caseys
Site 14 – Woolley & Jones
Site 15 – Murphys
Site 16 – Doctors
Site 17 – Yelverton
Site 18 – Riverlands Industrial
Site 19 – Riverlands Co-op
Site 20 – Town Branch
Site 21 – Jeffreys
Site 22 – Fairhall
Site 23 – Cravens
Site 24 – Halls

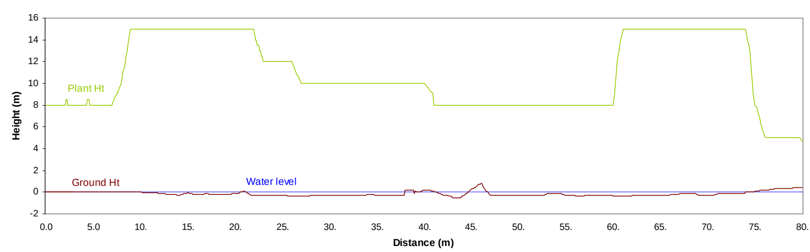
ECOLOGICAL ASSESSMENT - SITE 1 18 March 2002

PIPITEA North



Amongst willows upstream of bridge to new subdivision

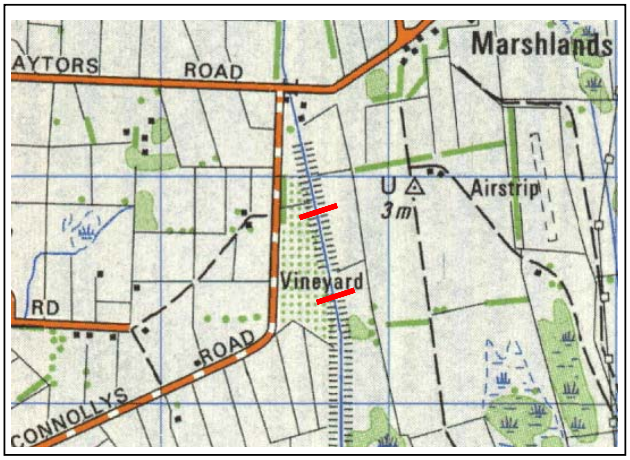
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Wetland with shallow stagnant water and dominated by willows	Lack of flow Dense willow growth suppressing establishment of a diverse under storey	Enhanced through flow to improve water quality and removal of some willows to enhance diversity of plant growth is likely to attract a more diverse fauna	
FISH	Shortfin eels	Anoxic conditions provide limited habitat for fish	Improved water quality and access will increase fish utilisation of this habitat	
AQUATIC PLANT SPECIES	Willow dominated with sparse under storey of flaxes sedges and rushes	Dense willow growth	Diversity of plants on fringe of wetland indicate the potential for more diverse range of plants to establish throughout the wetland with some management of the willows	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 58 SQMCI index = 1.49 EPT taxa = 0 % Species Richness = 9 Dominant taxon = midge larvae (*Chironomus*) Crustacea = not observed	Anoxic conditions and lack of flow restrict the macroinvertebrate fauna to an assemblage of highly tolerant, pond-dwelling taxa.	Improved water quality (particularly DO) may allow more sensitive invertebrates (such as pond-dwelling caddisflies) to inhabit the wetland	
RIPARIAN & BANK PLANT SPECIES	Native shrubs, sedges and variety of weed species		Well stock proofed but some fire damage from surrounding land use	

INSTREAM MICROBIOLOGICAL	*E. coli* = 20 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 441µS/cm pH = 6.8 Dissolved Oxygen = 0.44mg/l (4% saturation) Total Nitrogen = 1.9g/m^3 Ammonium-N = 0.22g/m^3 Nitrate-N = 0.064g/m^3 Total Phosphorus = 0.24g/m^3 Dissolved P = 0.22g/m^3		Removal of some willows may allow growth of more aquatic plants, which will help to oxygenate the water	
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.3 °C Turbidity = 6.9 NTU Black Disc = 0.9m Total Suspended sediment = 9 g/m^3 (3 inorganic; 6 organic)			
WATER FLOW	Ungauged – appears to be little water movement			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Rarangi Dune wetland near coast – NZMS 260 P28 955743			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill, Ally Jerram & Mike Ede on 18 March 2002. Fyke nets set overnight. Access from new subdivision road.			

OVERALL ECOLOGICAL ASSESSMENT	**POOR**

ECOLOGICAL ASSESSMENT - SITE 2 18 March 2002

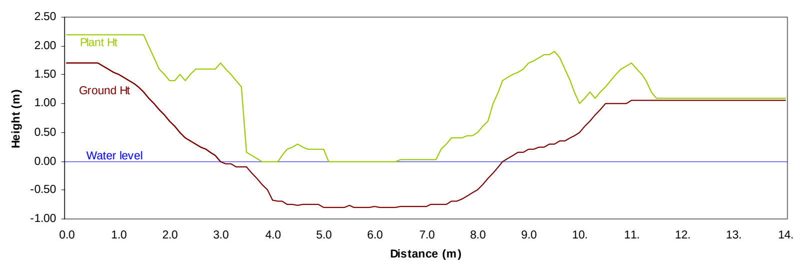
PUKAKA

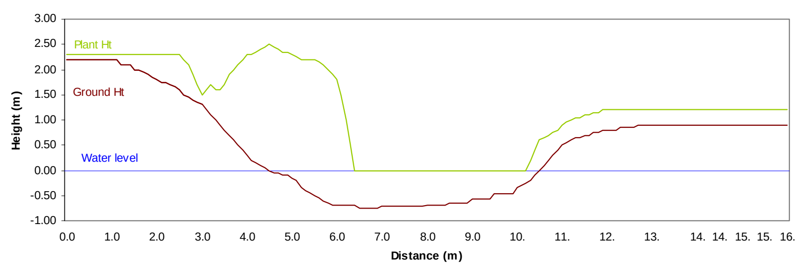


DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Highly modified and managed waterway with little water movement	Lack of flow and riparian vegetation	Stream shading and check on means for flow improvement	Surrounding land use may limit opportunities for riparian planting
FISH	Not sampled, but providing there is suitable access, shortfin eels, inanga & common bully should be present	Lack of flow & shade		Fish access should be checked
AQUATIC PLANT SPECIES	Raupo, water cress and duckweed Algae (*Spirogyra* spp.) common	Duckweed suppressing other aquatic plant growth	Increased flow would thin out duckweed and possibly allow establishment of a more diverse range of plants	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 76 SQMCI index = 3.61 EPT taxa = 0 % Species Richness = 11 Dominant taxa = seed shrimps, amphipods, snails Crustacea = seed shrimp & amphipods	Lack of flow, low dissolved oxygen, possible salt water intrusion	Increased flow and dissolved oxygen may allow a more sensitive community to develop, but tidal influxes of salt water may prevent colonisation by EPT taxa	Koura and shrimp have been found in Pukaka Drain on the north side of the Wairau diversion (*i.e.* not connected to this waterbody), just upstream of the floodgates (SoE monitoring site)
RIPARIAN & BANK PLANT SPECIES	Rough pasture, sedges & weed species	No trees		Fenced on LB and no stock access on RB due to vineyards
INSTREAM MICROBIOLOGICAL	*E. coli* = 23 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 342µS/cm pH = 6.9 Dissolved Oxygen = 4.4mg/l (45% saturation)			

<table>
<tr><td></td><td>Total Nitrogen = 0.6g/m^3
Ammonium-N = 0.029g/m^3
Nitrate-N = 0.005g/m^3
Total Phosphorus = 0.16g/m^3
Dissolved P = 0.12g/m^3</td><td></td><td></td><td></td></tr>
<tr><td>INSTREAM PHYSICAL PROPERTIES</td><td>Temperature = 16.3 °C
Turbidity = 4.7 NTU
Black Disc = 2.2m
Total Suspended sediment = 4 g/m^3 (3 inorganic; 1 organic)</td><td></td><td></td><td></td></tr>
<tr><td>WATER FLOW</td><td colspan="4">Not gauged - water movement appears to be controlled by tidal movement</td></tr>
<tr><td>CROSS-SECTION & SUBSTRATE

Cross-section 1 at : 2593758 E 5971514 N

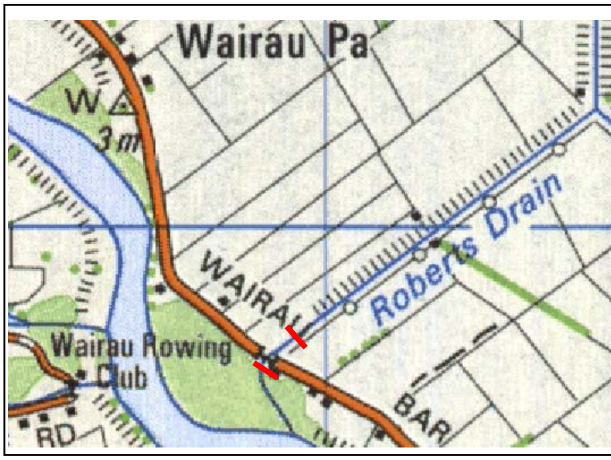
Cross-section 2, upstream</td><td colspan="4">


</td></tr>
<tr><td>LOCATION & ZONE</td><td colspan="4">Lower Wairau Plain – large coastal waterway with tidal influence – NZMS 260 P28 937717</td></tr>
<tr><td>SITE VISIT DETAILS & PERSONNEL</td><td colspan="4">Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill, Ally Jerram & Mike Ede on 18 March 2002. Access through Chaytors vineyard off Connellys Road</td></tr>
</table>

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

ECOLOGICAL ASSESSMENT - SITE 3 18 March 2002

ROBERTS

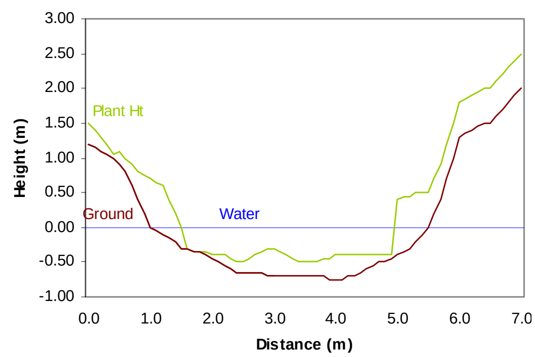


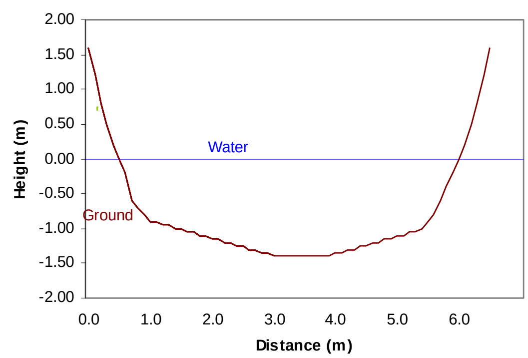
View upstream from bridge

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Good flowing water in a modified waterway with intensive dairy farming in immediate surrounds	Lack of shading, vegetative cover or riparian protection	Bank protection and riparian improvement would enhance fish and wildlife habitat values	
FISH	Good fish habitat because of water quality and includes: shortfin eels, brown trout, inanga, common bully &*Galaxias* spp. (probably giant kokopu)	Lack of riparian protection limits spawning habitat for inanga and general fish habitat	Increased numbers of whitebait and other species possible with better riparian protection	Less intensive aquatic and bankside plant control will increase habitat potential for fish
AQUATIC PLANT SPECIES	Dominated by *Egeria* & *Lagarosiphon* Algae (*Rhizoclonium*)	Intensive control removes all plants	Tree planting may assist in control of nuisance aquatic plant growth	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 77 SQMCI index = 4.80 EPT taxa = 14 % Species Richness = 14 Dominant taxon = amphipods Crustacea = koura, shrimp & amphipods	This good quality macroinvertebrate community was found in a reach with a high density and diversity of aquatic plants. Upstream, the macroinvertebrate community was probably poorer due to removal of all aquatic plants	A good quality macroinvertebrate fauna (as described here) could be present throughout Roberts Drain	Macroinvertebrates were sampled near the floodgates where aquatic plants had not been cleared from the channel
RIPARIAN & BANK PLANT SPECIES	Pasture grasses	Not fenced and stock have unlimited access to stream	Aesthetic and biological gains to be had from stock exclusion and riparian planting	
INSTREAM MICROBIOLOGICAL	*E. coli* = 20 cfu/100 ml			

<table>
<tr><td>INSTREAM CHEMICAL PROPERTIES</td><td>Conductivity = 439µS/cm
pH = 7.0
Dissolved Oxygen = 8.2mg/l (80% saturation)
Total Nitrogen = 0.63g/m^3
Ammonium-N = 0.046g/m^3
Nitrate-N = 0.39g/m^3
Total Phosphorus = 0.024g/m^3
Dissolved P = 0.022g/m^3</td><td></td><td></td><td></td></tr>
<tr><td>INSTREAM PHYSICAL PROPERTIES</td><td>Temperature = 14.7 °C
Turbidity = 2.4 NTU
Black Disc = 2.4 m
Total Suspended sediment = 1 g/m^3 (0.9 inorganic; 0.1 organic)</td><td></td><td></td><td></td></tr>
<tr><td>WATER FLOW</td><td colspan="4">Not gauged – large spring flow going through floodgates or pumped into lower Wairau River</td></tr>
<tr><td>CROSS-SECTION & SUBSTRATE

Cross-section 1: 2592828 E 5969588 N

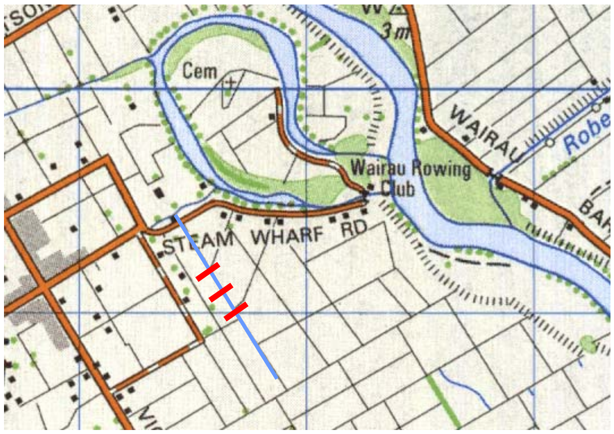
Cross-section 2, upstream of road bridge</td><td colspan="4">


</td></tr>
<tr><td>LOCATION & ZONE</td><td colspan="4">Lower Wairau Plain – large spring-fed rural waterway – NZMS 260 P28 928696</td></tr>
<tr><td>SITE VISIT DETAILS & PERSONNEL</td><td colspan="4">Main survey carried out by Roger Young, Anna Crowe, and Rowan Strickland on 18 March 2002. Spotlight fish survey that night. Access from Wairau Bar Road.</td></tr>
</table>

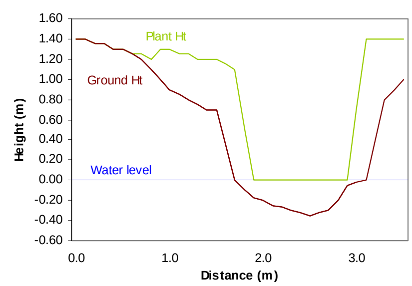
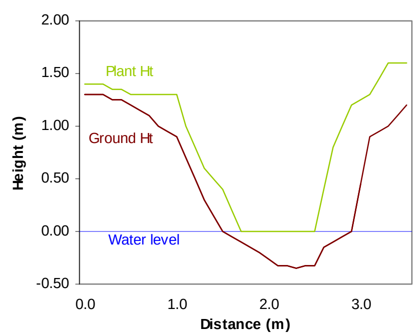
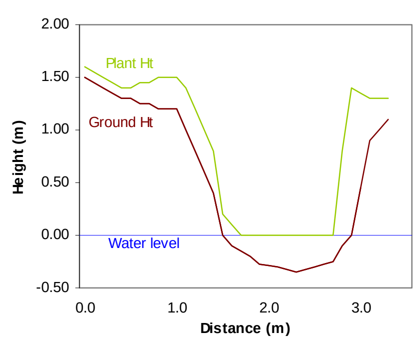
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

ECOLOGICAL ASSESSMENT - SITE 4 19 March 2002

Sadds



DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Highly modified and unattractive waterway	Intensive surrounding land use, lack of character and riparian protection	Moderate improvement possible with riparian protection	
FISH	Shortfin eels Common bully	As above	As above, but use of this habitat by fish is also very dependant on access	
AQUATIC PLANT SPECIES	Duckweed	Lack of flow prevents dispersal of floating plants and the establishment of other plants		Dense growth of duckweed helps suppress growth of nuisance plants
MACROINVERTEBRATES & CRUSTACEA	MCI index = 91 SQMCI index = 2.30 EPT taxa = 0 % Species Richness = 14 Dominant taxon = worms Crustacea = not observed	Lack of flow limits macroinvertebrate fauna to 'pond-dwelling' taxa High turbidity, low dissolved oxygen	Increases in flow will improve habitat for EPT and crustacean taxa	
RIPARIAN & BANK PLANT SPECIES	Fenced TR bank with grasses and sedges, but stock access on TL with bare soil and grazed pasture	No protection on TL bank	Fencing and planting	Shading and cover provided by grasses and sedges on fenced TR bank
INSTREAM MICROBIOLOGICAL	*E. coli* = 140 cfu/100 ml	No protection on TL bank	Fencing and planting	Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 103µS/cm pH = 6.4 Dissolved Oxygen = 7.1mg/l (67% saturation) Total Nitrogen = 0.81g/m^3			

<table>
<tr><td></td><td>Ammonium-N = 0.044g/m^3
Nitrate-N = 0.48g/m^3
Total Phosphorus = 0.038g/m^3
Dissolved P = 0.013g/m^3</td><td></td><td></td><td></td></tr>
<tr><td>INSTREAM PHYSICAL PROPERTIES</td><td>Temperature = 12.8 °C
Turbidity = 5.6 NTU
Total Suspended sediment = 2 g/m^3 (1 inorganic; 1 organic)</td><td></td><td></td><td></td></tr>
<tr><td>WATER FLOW</td><td colspan="4">Not gauged – water levels probably linked with levels in Grovetown Lagoon.</td></tr>
<tr><td>CROSS-SECTION & SUBSTRATE
Cross-section 1: 2591610 E 5969157 N (up stream)</td><td colspan="4">
</td></tr>
<tr><td>Cross-section 2 (middle site)</td><td colspan="4">
</td></tr>
<tr><td>Cross-section 3 (down stream)</td><td colspan="4">
</td></tr>
<tr><td>LOCATION & ZONE</td><td colspan="4">Lower Wairau Plain – small rural waterway – NZMS 260 P28 916691</td></tr>
<tr><td>SITE VISIT DETAILS & PERSONNEL</td><td colspan="4">Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 19 March 2002. Access off Steam Wharf road.</td></tr>
</table>

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM-POOR**

ECOLOGICAL ASSESSMENT - SITE 5 **19 March 2002**

DRAIN N

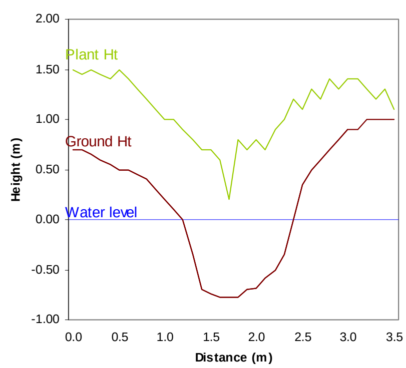
View downstream from road

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Highly modified waterway with intensive surrounding land use, but good flow	Surrounding land use and close proximity to public road	Good wildlife and fish habitat but requires careful management of riparian zone	
FISH	Giant kokopu, Longfin eels, Shortfin eels, Common bully, Brown trout, Inanga	As above and lack of habitat diversity		Already used by greater range of species than most other sites, but habitat could be better managed
AQUATIC PLANT SPECIES	Duckweed Willow weed Watercress			Encouragement of overhanging pasture grasses and planting of shrubs would help shade drain and control aquatic plants
MACROINVERTEBRATES & CRUSTACEA	MCI index = 94 SQMCI index = 3.90 EPT taxa = 29 % Species Richness = 21 Dominant taxon = snails (*Potamopyrgus*) Crustacea = koura and amphipods			Good quality macroinvertebrate community was present Encouragement of overhanging pasture grasses would provide good habitat for Crustacea
RIPARIAN & BANK PLANT SPECIES	Bound by vineyards and road with very small riparian zone of mown and un mown grasses	Small riparian zone and land use limits planting opportunity	Flaxes and low shrubs would provide good riparian protection and stream shade.	Indiscriminate use of herbicides and mowing of riparian zone
INSTREAM MICROBIOLOGICAL	*E. coli* = 70 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 90µS/cm pH = 6.5			

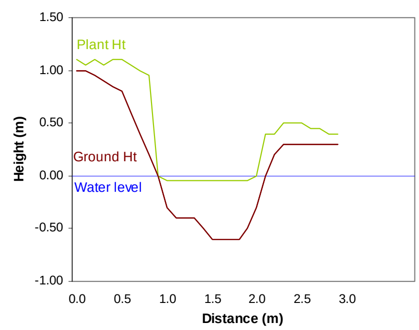
	Dissolved Oxygen = 5.6mg/l (54% saturation) Total Nitrogen = 0.75g/m^3 Ammonium-N = 0.011g/m^3 Nitrate-N = 0.38g/m^3 Total Phosphorus = 0.022g/m^3 Dissolved P = 0.01g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 13.7 °C Turbidity = 0.8 NTU Total Suspended sediment = 0.6 g/m^3 (0 inorganic; 0.6 organic)			
WATER FLOW	Flow gauged by Mike Ede on 19 March 2002= 30 l/s			

CROSS-SECTION & SUBSTRATE

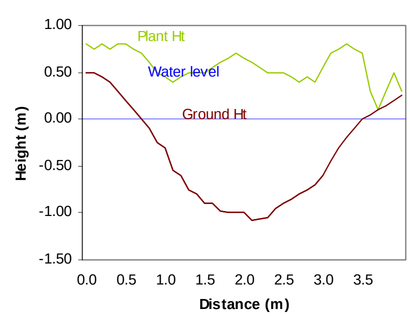
Cross-section 1: 2589492 E 5969500 N (Northern side of road)



Cross-section 2



Cross-section 3 : 2589527 E 5969468 N (down stream site)



LOCATION & ZONE	Upper Grovetown Lagoon tributary – small rural spring - NZMS 260 P28 895695
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 19 March 2002. Spotlight fish survey carried out that night. Access from Mills & Ford road

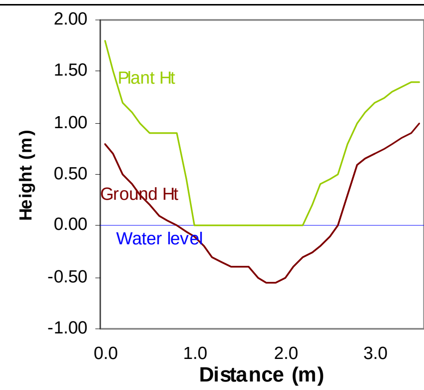
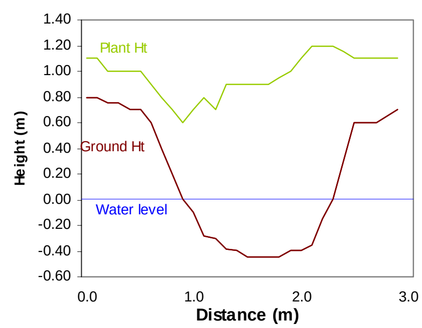
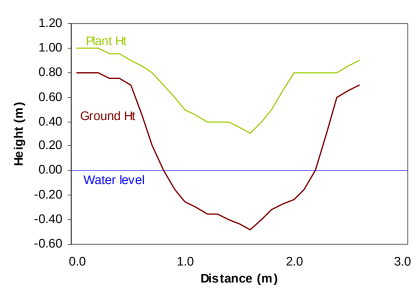
OVERALL ECOLOGICAL ASSESSMENT	**GOOD**

ECOLOGICAL ASSESSMENT - SITE 6 **19 March 2002**

DRAIN Q

View looking back towards road

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Small modified waterway with good flow	Surrounding land use and close proximity to public road	Good fish habitat but requires careful management of riparian zone	
FISH	Giant kokopu, Shortfin eels, Common bully	Habitat diversity lacking in reach alongside road	As above	
AQUATIC PLANT SPECIES	Duckweed Watercress	Regular control	Diversity of good aquatic plants possible without becoming a nuisance	Requires shade plantings to reduce the need for control and habitat disturbance
MACROINVERTEBRATES & CRUSTACEA	MCI index = 83 SQMCI index = 3.72 EPT taxa = 8 % Species Richness = 24 Dominant taxon = snails (*Potamopyrgus*) Crustacea = koura, amphipods and seed shrimp	Habitat diversity lacking in reach alongside road, regular aquatic plant control	Further colonisation by EPT taxa as seen in Drain N, particularly mayflies and increased diversity of caddisfly species	
RIPARIAN & BANK PLANT SPECIES	Mix of horticulture, mown lawn and mown road verge	Residential and road verge	Enhancement of some portions of riparian zone possible through planting shrubs	Mowing and herbicide control of riparian vegetation reduces shading potential
INSTREAM MICROBIOLOGICAL	*E. coli* = 55 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 86µS/cm pH = 6.4 Dissolved Oxygen = 7.3mg/l (71% saturation) Total Nitrogen = 0.68g/m^3			

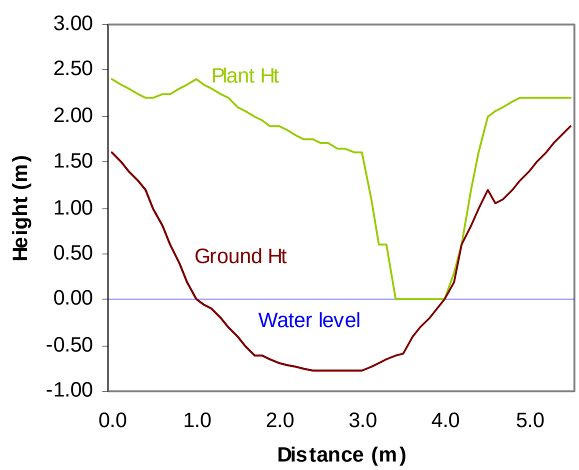
	Ammonium-N = 0.021g/m^3 Nitrate-N = 0.46g/m^3 Total Phosphorus = 0.019g/m^3 Dissolved P = 0.016g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 14.1 °C Turbidity = 1.7NTU Black Disc = 3.5m Total Suspended sediment = 1 g/m^3 (0.6 inorganic; 0.4 organic)			
WATER FLOW	Flow gauged by Mike Ede on 19 March 2002= 6 l/s			
CROSS-SECTION & SUBSTRATE Cross-section 1: 2590103 E 5969853 N (down stream site)				
Cross-section 2 : 2590052 E 5969907 N (middle site)				
Cross-section 3, 5 m upstream				
LOCATION & ZONE	Upper Grovetown Lagoon tributary – small rural spring - NZMS 260 P28 901699			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 19 March 2002. Spotlight fish survey carried out that night. Access from Mills & Ford road			
OVERALL ECOLOGICAL ASSESSMENT	**GOOD**			

ECOLOGICAL ASSESSMENT - SITE 7 **19 March 2002**

PIPITEA South

View upstream from floodgate

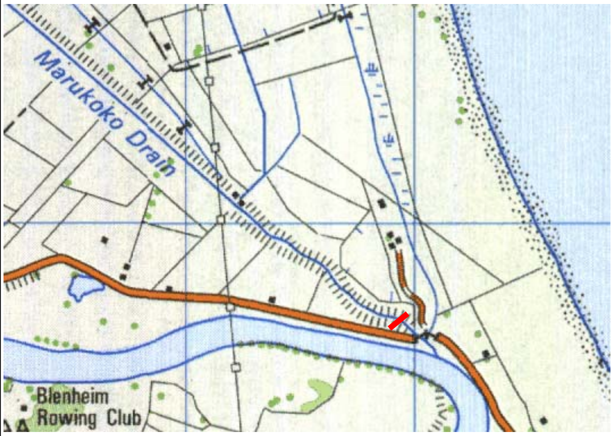
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified and deep waterway with very little flow	Floodgate prevents adequate flushing of the waterway	Very good potential to improve the biological value of this site by different management of floodgate	
FISH	No fish at sample site, but Yelloweye mullet and inanga observed below floodgate	Floodgate prevents access and its closure creates anoxic conditions upstream	Unique habitat for inanga and other migratory species if continuous access from Wairau River was made available	Small change in floodgate management has potential for significant enhancement of whitebait numbers
AQUATIC PLANT SPECIES	Duckweed Raupo	Inadequate flow and flushing	More diversity of plant species with better flow and less duckweed	Nuisance plant growth in lower reaches would be limited if more saltwater intrusion was allowed
MACROINVERTEBRATES & CRUSTACEA	Not sampled but impoverished fauna observed	Inadequate flow and flushing creates anoxic conditions	Healthy estuarine community would develop with increased flushing / saltwater intrusion	
RIPARIAN & BANK PLANT SPECIES	Grazed pasture to crest of waterway on both banks	No permanent stock exclusion	Potential for riparian management and planting	
INSTREAM MICROBIOLOGICAL	*E. coli* = 10 cfu/100 ml			

INSTREAM CHEMICAL PROPERTIES	Conductivity = 1050µS/cm pH = 6.4 Dissolved Oxygen = 0.5mg/l (6% saturation) Total Nitrogen = 1.3g/m^3 Ammonium-N = 0.26g/m^3 Nitrate-N = 0.014g/m^3 Total Phosphorus = 0.28g/m^3 Dissolved P = 0.18g/m^3	Little flow	Increased flushing would help by improving oxygen levels	
INSTREAM PHYSICAL PROPERTIES	Temperature = 14 °C Turbidity = 22 NTU Total Suspended sediment = 20 g/m^3 (11 inorganic; 9 organic)			
WATER FLOW	Not gauged – water level controlled by tidal fluctuation and Wairau River levels. Flushing restricted by floodgate.			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Lower Wairau Plain – near coast with tidal influence - NZMS 260 P28 961687			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 19 March 2002. Access through farm off Wairau Bar Road.			

OVERALL ECOLOGICAL ASSESSMENT	**VERY POOR**

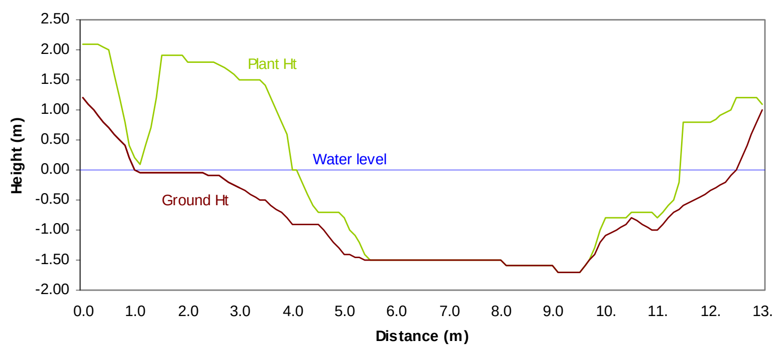
ECOLOGICAL ASSESSMENT - SITE 8 19 March 2002

MARUKOKO



View upstream from Wairau Bar Road

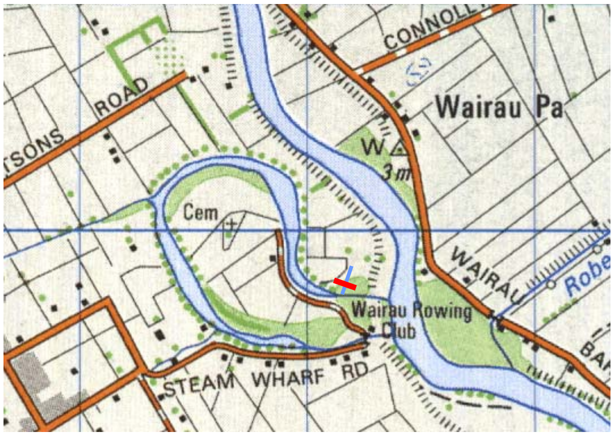
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Larger of the spring fed waterways, providing good wildlife and fish habitat	Flap gate control and lack of riparian management	Habitat enhancement opportunities	
FISH	Longfin eels Shortfin eels Inanga Common bully	As above and stock exclusion	Unique habitat for inanga, but would benefit from riparian management and continuous access from Wairau River	
AQUATIC PLANT SPECIES	*Nitella* and mixed aquatic plant species Algae (*Enteromorpha*) common	Saltwater intrusion, but controls nuisance species in lower reaches		
MACROINVERTEBRATES & CRUSTACEA	MCI index = 68 SQMCI = 4.04 EPT taxa = 17 % Species Richness = 12 Dominant taxon = snails (*Potamopyrgus*) Crustacea = amphipods present	Saltwater intrusion limits colonisation by some of the more sensitive freshwater macroinvertebrates		
RIPARIAN & BANK PLANT SPECIES	Pasture, sedges, scrub and raupo	No stock exclusion	Fencing and planting	Plenty of scope for enhancement
INSTREAM MICROBIOLOGICAL	*E. coli* = 210 cfu/100 ml Above contact guidelines		Restrict stock access and runoff	
INSTREAM CHEMICAL PROPERTIES	Conductivity = 1018µS/cm pH = 8.0			

	Dissolved Oxygen = 13.5mg/l (141% saturation) Total Nitrogen = 0.71g/m^3 Ammonium-N = 0.012g/m^3 Nitrate-N = 0.004g/m^3 Total Phosphorus = 0.44g/m^3 Dissolved P = 0.37g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.6 °C Turbidity = 6.3 NTU Total Suspended sediment = 20 g/m^3 (16 inorganic; 4 organic)			
WATER FLOW	Not gauged – large spring flow influenced by tidal fluctuations and river levels			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Lower Wairau Plain – large waterway near coast with tidal influence - NZMS 260 P28 959686			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 19 March 2002. Spotlight fish survey carried out that night. Fyke nets also set. Access from Wairau Bar road.			

OVERALL ECOLOGICAL ASSESSMENT	**GOOD**

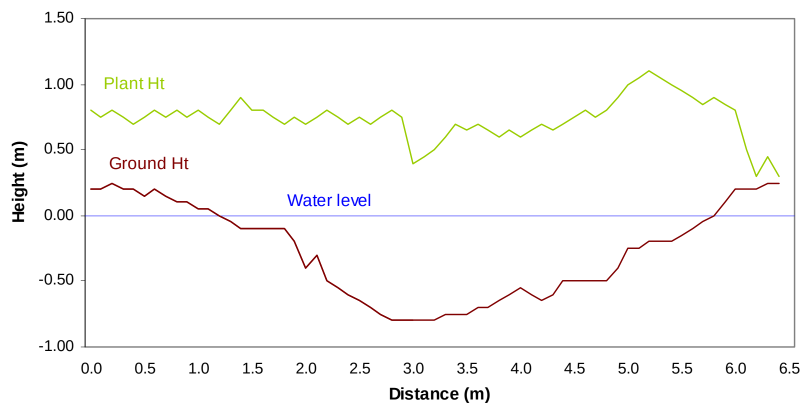
ECOLOGICAL ASSESSMENT - SITE 9 20 March 2002

GROVETOWN LAGOON SPRINGS



Looking back towards the lagoon

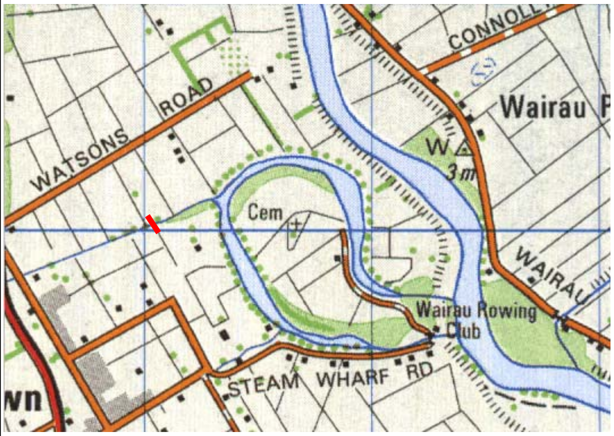
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Manmade waterway for intercepting small springs draining into lower end of Grovetown lagoon	Short course, grazed on both sides, prolific aquatic plant growth	Shade trees may assist in control of excessive aquatic plant growth	Shade experiment being conducted in lower end by MDC
FISH	Shortfin eel Inanga Common bully	As above	Enhancement of habitat possible through riparian planting and natural control of plants	Good fish habitat but in the absence of riparian cover, aquatic plants are an essential component of the habitat
AQUATIC PLANT SPECIES	*Glyceria maxima* Willow weed Watercress Algae (*Spirogyra*; *Vaucheria*)			Potentially good local source of watercress depending on controls implemented, although bacterial levels are of concern
MACROINVERTEBRATES & CRUSTACEA	MCI index = 87 SQMCI index = 4.46 EPT taxa = 7 % Species Richness = 15 Dominant taxa = snails (*Potamopyrgus*), amphipods Crustacea = amphipods & shrimp present			Aquatic plant growth provides good habitat for freshwater shrimp
RIPARIAN & BANK PLANT SPECIES	Rough pasture, rushes and sedges	Not stock proofed and no trees	Fencing, planting and reversion to a more natural wetland	
INSTREAM MICROBIOLOGICAL	*E. coli* = 1200 cfu/100 ml	Stock access	Restrict stock access and any runoff	Well above contact guidelines

INSTREAM CHEMICAL PROPERTIES	Conductivity = 150µS/cm pH = 6.6 Dissolved Oxygen = 6.3mg/l (61% saturation) Total Nitrogen = 0.48g/m^3 Ammonium-N = 0.008g/m^3 Nitrate-N = 0.25g/m^3 Total Phosphorus = 0.019g/m^3 Dissolved P = 0.012g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 14.1 °C Turbidity = 0.9 NTU Total Suspended sediment = 0.8 g/m^3 (0.3 inorganic; 0.5 organic)			
WATER FLOW	Not gauged moderate spring flow. Water levels probably controlled by level of Grovetown Lagoon.			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Grovetown Lagoon tributary – small rural spring - NZMS 260 P28 922698			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 20 March 2002. Access from Steam Wharf road.			

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

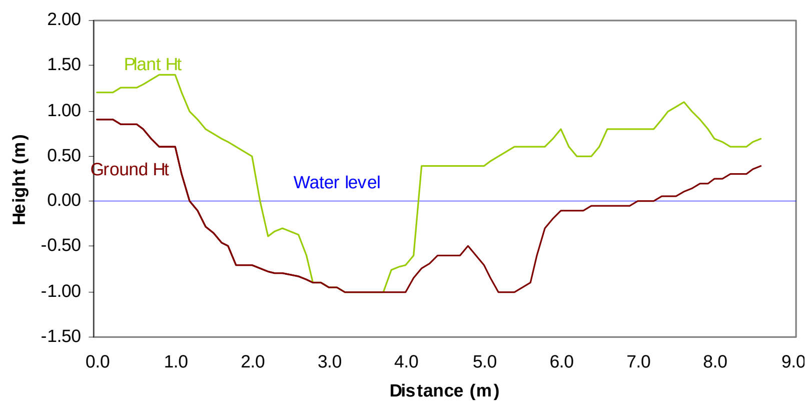
ECOLOGICAL ASSESSMENT - SITE 10 20 March 2002

KELLYS



Looking downstream

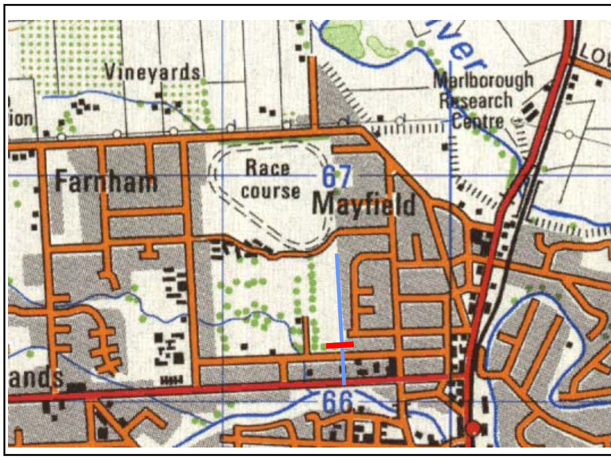
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Good flow and clear water	Unfenced and shaded on North side	Scope for enhancement	
FISH	Shortfin eel Common bully Inanga Brown trout	Access controlled by floodgate operation in lagoon downstream	Good fish habitat if riparian zone is managed carefully	Fish use is likely to increase with improved access and minimised control disturbance
AQUATIC PLANT SPECIES	Willow weed, *Egeria*, *Elodea*, *Lagarosiphon* Algae (*Spirogyra*; *Oscillatoria*)	Controlled from north side	Shade trees on north side would decrease the necessity for control works	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 87 SQMCI index = 3.66 EPT taxa = 33 % Species Richness = 24 Dominant taxon = snails (*Potamopyrgus*) Crustacea = koura, amphipods & seed shrimp present			
RIPARIAN & BANK PLANT SPECIES	Dairy grazing to stream side on TL bank, but fenced with overhanging willows on TR	Stock access	Enhancement and aquatic plant control potential with fencing and riparian planting	
INSTREAM MICROBIOLOGICAL	*E. coli* = 540 cfu/100 ml	Stock access and perhaps septic tanks	Requires improvements in restriction of stock access throughout this relatively large catchment Checks on septic tank inputs.	Above contact guidelines

INSTREAM CHEMICAL PROPERTIES	Conductivity = 117µS/cm pH = 6.9 Dissolved Oxygen = 8.8mg/l (88% saturation) Total Nitrogen = 0.77g/m^3 Ammonium-N = 0.016g/m^3 Nitrate-N = 0.46g/m^3 Total Phosphorus = 0.037g/m^3 Dissolved P = 0.027g/m^3	Stock access	Riparian fencing and planting	
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.1 °C Turbidity = 4.1 NTU Black Disc = 2.5 m Total Suspended sediment = 3 g/m^3 (2 inorganic; 1 organic)			
WATER FLOW	Gauged on 19th July 1991 = 280 l/s			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Main Grovetown Lagoon tributary – large rural spring - NZMS 260 P28 910700			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 20 March 2002. Access through farm off Steam Wharf road.			

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM-GOOD**

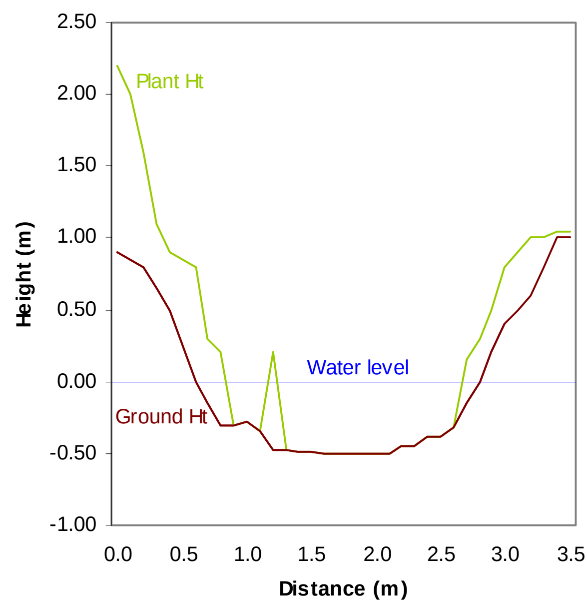
ECOLOGICAL ASSESSMENT - SITE 11 20 March 2002

WATERLEA



View upstream alongside golf course

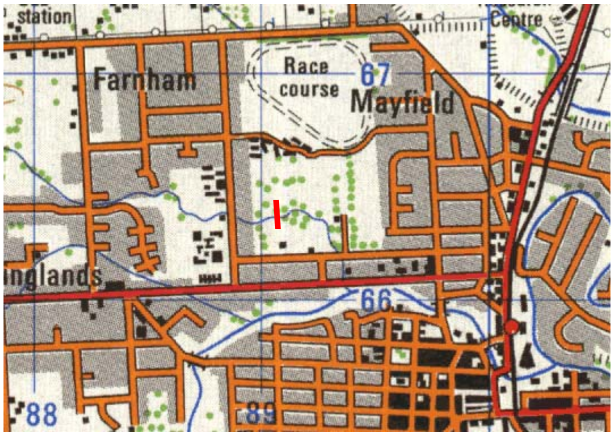
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified urban stream with fish access problems	Surrounding land use, lack of character and riparian protection	Habitat enhancement and improved fish access	
FISH	Shortfin eels only at this site, but shortfin eels, inanga, common bully and longfin eels downstream	Waterway upstream of road culvert, weir and flap gate inaccessible to some species	As above	
AQUATIC PLANT SPECIES	*Lagarosiphon* and other plants hand weeded	Regular indiscriminate control	More habitat would be provided by selective control of aquatic plants	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 88 SQMCI index = 3.08 EPT taxa = 20 % Species Richness = 25 Dominant taxa = seed shrimp & worms Crustacea = koura, shrimp, amphipods & seed shrimp	Aquatic plant removal High turbidity	Selective control of aquatic plants and encouragement of overhanging riparian plantings would increase habitat for the diverse crustacean fauna	Species richness, crustacean and EPT taxa diversity was high
RIPARIAN & BANK PLANT SPECIES	Mown lawn to waterway crest and some residential fencing with occasional shrubs	Surrounding land use	More bankside shrub species for shade and cover could be planted	Any planting will enhance the aesthetics of this waterway
INSTREAM MICROBIOLOGICAL	*E. coli* = 380 cfu/100 ml	Leaky septic tanks? Urban runoff		Above contact guidelines

INSTREAM CHEMICAL PROPERTIES	Conductivity = 130µS/cm pH = 6.8 Dissolved Oxygen = 8.2mg/l (85% saturation) Total Nitrogen = 1.9g/m^3 Ammonium-N = 0.012g/m^3 Nitrate-N = 1.3g/m^3 Total Phosphorus = 0.034g/m^3 Dissolved P = 0.024g/m^3	High groundwater nitrate		High nitrogen levels
INSTREAM PHYSICAL PROPERTIES	Temperature = 17.0 °C Turbidity = 7.4 NTU Black Disc = 1.4 m Total Suspended sediment = 4 g/m^3 (3 inorganic; 1 organic)			
WATER FLOW	Flow gauged by Mike Ede = 54 l/s Weekly gauging carried out here since October 2001- range 6-120 l/s			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Springlands urban spring-fed stream - NZMS 260 P28 895662			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 20 March 2002. Access beside golf course.			

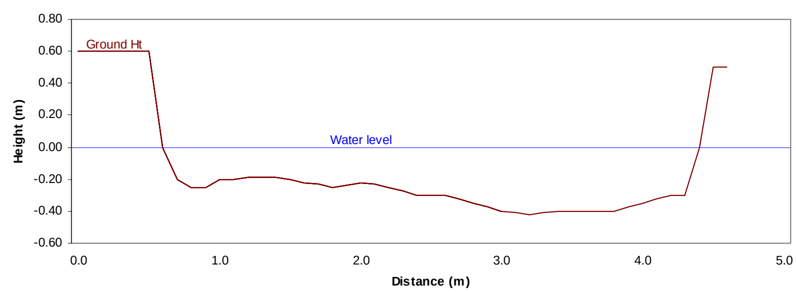
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

ECOLOGICAL ASSESSMENT - SITE 12 **20 March 2002**

FULTONS



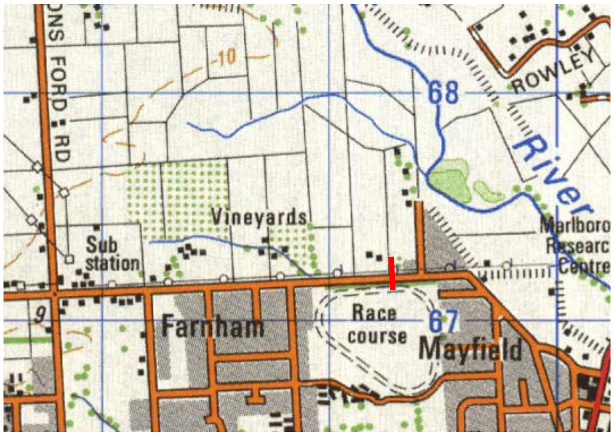
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Urban watercourse modified as a park feature	Managed as a water feature rather than for biodiversity	Aesthetics and habitat values could be enhanced	
FISH	Longfin eels, Shortfin eels, Common bully, Brown trout, Inanga	Instream cover	Better instream habitat could be provided by fostering some aquatic plants	
AQUATIC PLANT SPECIES	Only remnants of *Elodea*, *Lagarosiphon, Glyceria, Nitella* and watercress	Indiscriminate hand weeding of entire watercourse through park	Selective hand weeding of nuisance plants only would improve the aesthetic and habitat values of this stream	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 87 SQMCI = 3.40 EPT taxa = 28 % Species Richness = 18 Dominant taxa = amphipods, worms, snails (*Potamopyrgus*) Crustacea = koura, amphipods & seed shrimp	As above	Better instream habitat could be provided by fostering some aquatic plants	
RIPARIAN & BANK PLANT SPECIES	Mown lawns to concrete and rock bank lining	Park management objectives	Additional values possible with enhancement programme	
INSTREAM MICROBIOLOGICAL	*E. coli* = 140 cfu/100 ml	Urban runoff		Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 145µS/cm pH = 6.3 Dissolved Oxygen = 6.9mg/l (69% saturation)	High groundwater nitrate		High nitrogen levels

	Total Nitrogen = 3.6g/m^3 Ammonium-N = 0.01g/m^3 Nitrate-N = 2.6g/m^3 Total Phosphorus = 0.016g/m^3 Dissolved P = 0.015g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.2 °C Turbidity = 1.7 NTU Black Disc = 5.0m Total Suspended sediment = 2 g/m^3 (1 inorganic; 1 organic)			
WATER FLOW	Gauged on 22 March 2002 by Mike Ede = 299 l/s Also gauged 3 December 1999 (272 l/s) and 14 June 2001 (230 l/s)			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Springlands large urban spring-fed stream - NZMS 260 P28 890664			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 20 March 2002. Spotlight fish survey carried out that night. Access through park.			

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

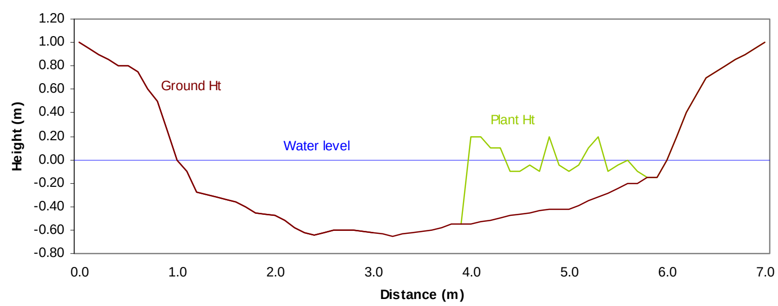
ECOLOGICAL ASSESSMENT - SITE 13 20 March 2002

Caseys



Looking south along Old Renwick road

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified watercourse with good flow and clear water	Surrounding land use and close proximity to public road	Habitat enhancement planting on roadside	
FISH	Shortfin eels Brown trout Inanga	Road verge management and removal of bankside vegetation	Increase cover through provision of bankside vegetation	
AQUATIC PLANT SPECIES	*Lagarosiphon*, Willow weed, Duckweed, Water cress	Control	Control reduction possible with more bankside shading	Shading on TL is already effective in reducing aquatic plant growth
MACROINVERTEBRATES & CRUSTACEA	MCI index = 85 SQMCI index = 4.33 EPT taxa = 19 % Species Richness = 21 Dominant taxa = amphipods, snails (*Potamopyrgus*) Crustacea = koura, amphipods & seed shrimp	Removal of bankside vegetation	Encouragement of overhanging bankside vegetation would increase habitat for Crustacea	
RIPARIAN & BANK PLANT SPECIES	Mown grass verge on TR and hedge and shelter belt plantings along TL	Road verge management	Low shrubs for bankside cover	Discourage use of herbicide control of bankside vegetation
INSTREAM MICROBIOLOGICAL	*E. coli* = 80 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 129µS/cm pH = 6.3 Dissolved Oxygen = 7.9mg/l (80% saturation)	High groundwater nitrate levels		

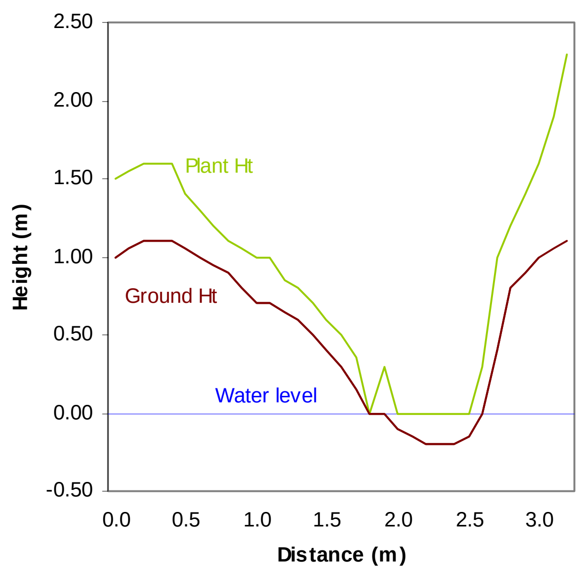
	Total Nitrogen = 2.4g/m^3 Ammonium-N = 0.02g/m^3 Nitrate-N = 1.7g/m^3 Total Phosphorus = 0.015g/m^3 Dissolved P = 0.015g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.9 °C Turbidity = 1.4 NTU Black Disc = 5.0m Total Suspended sediment = 1 g/m^3 (0.9 inorganic; 0.1 organic)			
WATER FLOW	Not gauged			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Springlands urban spring-fed stream - NZMS 260 P28 893672			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 20 March 2002. Spotlight fish survey carried out that night. Access from Old Renwick road			

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

ECOLOGICAL ASSESSMENT - SITE 14 21 March 2002

WOOLLEY & JONES

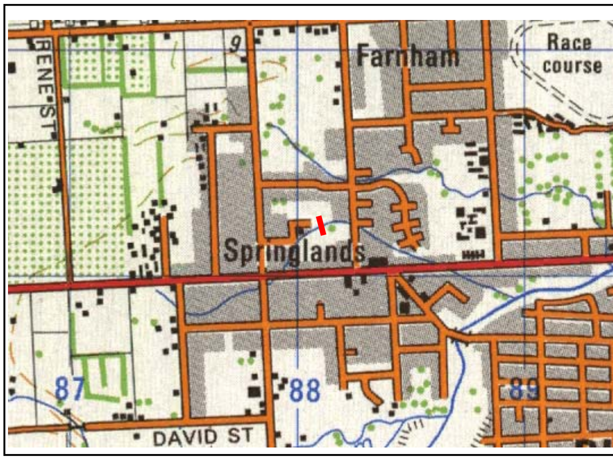
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Small spring flow contained within farm drainage system	Size	Habitat enhancement opportunity by fencing and planting	
FISH	Shortfin eels Good eel cover provided by overhanging bankside vegetation	Access for other species dependant on floodgate operation		
AQUATIC PLANT SPECIES	Almost 100% cover of duckweed	Small flow		
MACROINVERTEBRATES & CRUSTACEA	MCI index = 74 SQMCI = 1.77 EPT taxa = 0 % Species Richness = 16 Dominant taxa = worms, midge larvae (*Chironomus*) Crustacea = amphipods & seed shrimp	Low flow velocity, low dissolved oxygen, little aquatic plant diversity	Any increases in flow will improve DO and quality of the macroinvertebrate community Increased aquatic plant diversity would increase macroinvertebrate habitat	Overhanging bankside vegetation provides some habitat for macroinvertebrates
RIPARIAN & BANK PLANT SPECIES	Rough pasture in immediate riparian zone with fenced TR bank and hedge of macrocarpa, hawthorn etc	Surrounding land use		In the absence of riparian tree planting on TL bank, overhanging vegetation is important habitat
INSTREAM MICROBIOLOGICAL	*E. coli* = 20 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 249µS/cm pH = 6.7 Dissolved Oxygen = 2.0mg/l (22% saturation)	Little flow Agricultural runoff Stock access	Riparian fencing and planting	

	Total Nitrogen = 1.3g/m^3 Ammonium-N = 0.26g/m^3 Nitrate-N = 0.19g/m^3 Total Phosphorus = 0.16g/m^3 Dissolved P = 0.054g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 18.2 °C Turbidity = 2.7 NTU Total Suspended sediment = 5 g/m^3 (4 inorganic; 1 organic)	Little shade on north bank Weak connection with the aquifer	Plantings	
WATER FLOW	Not gauged			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Lower Wairau Plain – small rural waterway - NZMS 260 P28 922682			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 21 March 2002. Access through farm off Jones road.			

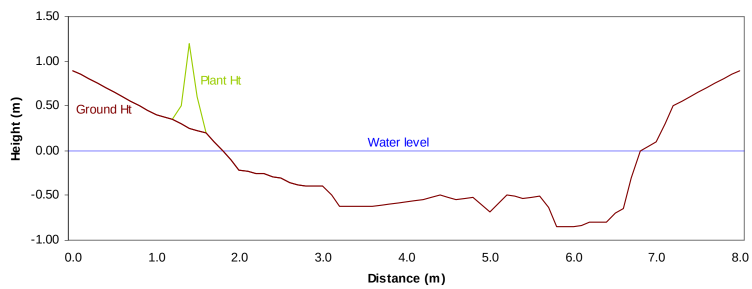
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM-POOR**

ECOLOGICAL ASSESSMENT - SITE 15 21 March 2002

MURPHYS



DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	One of the larger urban spring fed streams	Close proximity of residential properties and possible riparian rights		Aesthetic values important to the many residential properties developed to incorporate the stream in their development
FISH	Brown trout Common bully Longfin eels Shortfin eels Inanga	Good fish habitat but would be improved with less disturbance from aquatic plants control	Better instream habitat could be provided by selective hand weeding of aquatic plants	In settings such as the park and retirement village opposite, viewing and feeding platforms could be made where eels, other fish or waterfowl could be tamed as a feature
AQUATIC PLANT SPECIES	*Lagarosiphon*, Watercress, *Glyceria*	Indiscriminate control Perception of all aquatic plants as nuisance	Aesthetic and habitat values could be enhanced by allowing non-nuisance plants to establish	Scope for aquatic plant growth to become a feature
MACROINVERTEBRATES & CRUSTACEA	MCI index = 68 SQMCI = 1.64 EPT taxa = 17 % Species Richness = 12 Dominant taxon = worms Crustacea = amphipods & seed shrimp present	Indiscriminate control of aquatic plants Little overhanging streamside vegetation	Increased aquatic plant growth would improve habitat for macroinvertebrates, and would allow more sensitive taxa to inhabit and dominate the community	Koura have been found in low abundance near confluence with the Taylor River (at the SoE monitoring site)
RIPARIAN & BANK PLANT SPECIES	Some bankside trees and natural low vegetation such as sedges and willow weed, but mostly made up of mixed garden styles and mown lawns	Land ownership Differing views on aesthetics	Recommend streamside planting regimes for more effective habitat enhancement	

INSTREAM MICROBIOLOGICAL	*E. coli* = 140 cfu/100 ml	Urban runoff		Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 155µS/cm pH = 6.0 Dissolved Oxygen = 8.1mg/l (78% saturation) Total Nitrogen = 4.6g/m^3 Ammonium-N = 0.007g/m^3 Nitrate-N = 3.2g/m^3 Total Phosphorus = 0.016g/m^3 Dissolved P = 0.015g/m^3	High groundwater nitrate levels		
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.2 °C Turbidity = 1.6 NTU Black Disc = 3.8m Total Suspended sediment = 2 g/m^3 (1 inorganic; 1 organic)			
WATER FLOW	Flow gauged on 21 March 2002 by Mike Ede = 432 l/s			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Springlands large urban spring-fed stream - NZMS 260 P28 881662			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill, Ally Jerram & Peter Davidson on 21 March 2002. Spotlight fish survey carried out that night. Access through old fruit orchard.			

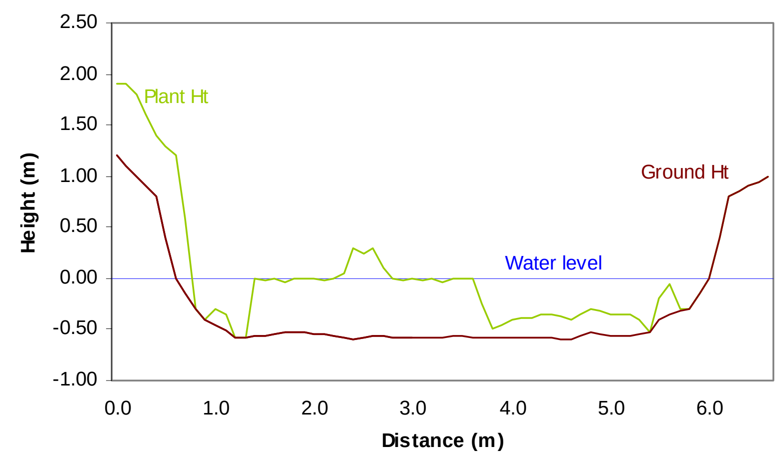
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM-GOOD**

ECOLOGICAL ASSESSMENT - SITE 16 21 March 2002

DOCTORS

Looking downstream from Battys Road

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified rural watercourse with good flow and clear water	Surrounding land use and ownership	Could be utilised more with fish habitat enhancement due to proximity to Taylor River	
FISH	Inanga, Shortfin eels, Longfin eels, Common bully	Continual modification of habitat	Provision of stable habitat through enhancement	
AQUATIC PLANT SPECIES	Starwort, *Nitella*, Willow weed, Duckweed, *Ranunculus*, Watercress Algae (*Vaucheria*)	Control	Modify control methods to suit enhancement of habitat	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 69 SQMCI = 4.58 EPT taxa = 15 % Species Richness = 13 Dominant taxon = amphipods Crustacea = amphipods & seed shrimp	Aquatic plant control Runoff from surrounding landuse, high turbidity	Increased species richness	Good quality community but species richness poor
RIPARIAN & BANK PLANT SPECIES	TL bank fenced with rough pasture bankside vegetation, but no fencing on TR and unstable banks	Land use	Stream shading and habitat enhancement programme worth considering	
INSTREAM MICROBIOLOGICAL	*E. coli* = 210 cfu/100 ml	Agricultural runoff Stock access	Fencing and riparian planting	Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 212µS/cm pH = 6.6 Dissolved Oxygen = 9.9mg/l (103% saturation)	High groundwater nitrate levels		

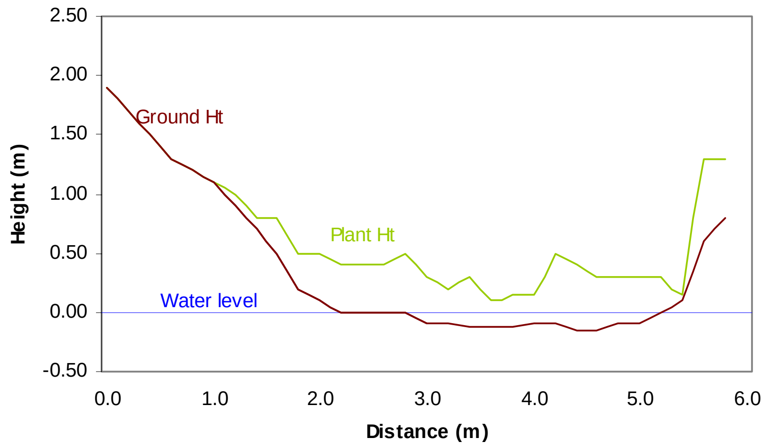
	Total Nitrogen = 3.4g/m^3 Ammonium-N = 0.017g/m^3 Nitrate-N = 2.0g/m^3 Total Phosphorus = 0.074g/m^3 Dissolved P = 0.048g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 17.3 °C Turbidity = 6.8 NTU Black Disc = 1.2 m Total Suspended sediment = 4 g/m^3 (3 inorganic; 1 organic)			
WATER FLOW	Flow gauged on 22 March 2002 by Mike Ede = 333 l/s Also gauged on 27 July 1994 (3919 l/s), 23 January 1997 (214 l/s), 27 March 2001 (0 l/s), 7 June 2001 (55 l/s), 3 September 2001 (233 l/s), and 5 September 2001 (250 l/s).			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Rural Taylor/Opawa River spring-fed tributary - NZMS 260 P28 879649			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 21 March 2002. Access from Battys road.			

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

ECOLOGICAL ASSESSMENT - SITE 17 21 March 2002

YELVERTON

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Small rural stream prone to drying up	Flow	With regular flow would offer good habitat	
FISH	Shortfin eels	Flow	Diversity of habitat features and close to Taylor River offer potentially good fish habitat	Whitebait reported running up this stream when it flowed more regularly 16 years prior
AQUATIC PLANT SPECIES	Watercress, Willow weed, Monkey musk, *Glyceria*			
MACROINVERTEBRATES & CRUSTACEA	MCI index = 77 SQMCI = 2.26 EPT taxa = 42 % Species Richness = 26 Dominant taxon = worms Crustacea = amphipods & seed shrimp	Lack of flow and low dissolved oxygen Further flow reductions will reduce habitat for macroinvertebrates, and may lower species richness and % EPT taxa	Increased flow and dissolved oxygen levels may allow more sensitive crustacean taxa to dominate	High species richness and % EPT taxa, but community dominated by tolerant taxa
RIPARIAN & BANK PLANT SPECIES	Mix of fenced and unfenced with pasture and some shrubs	Surrounding land use	Riparian shade planting will control aquatic plant growth and provide some bank stability	
INSTREAM MICROBIOLOGICAL	*E. coli* = 60 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 161µS/cm pH = 6.4 Dissolved Oxygen = 4.0mg/l (43% saturation) Total Nitrogen = 1.3g/m^3	Lack of flow		

	Ammonium-N = 0.061g/m^3 Nitrate-N = 0.58g/m^3 Total Phosphorus = 0.044g/m^3 Dissolved P = 0.028g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 18.4 °C Turbidity = 1.4 NTU Total Suspended sediment = 4 g/m^3 (2 inorganic; 2 organic)	Little flow Weak connection with the aquifer		
WATER FLOW	Flow gauged on 3 September 2001 = 1 l/s			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Small rural Taylor/Opawa River spring-fed tributary - NZMS 260 P28 871652			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 21 March 2002. Access from David Street.			

OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

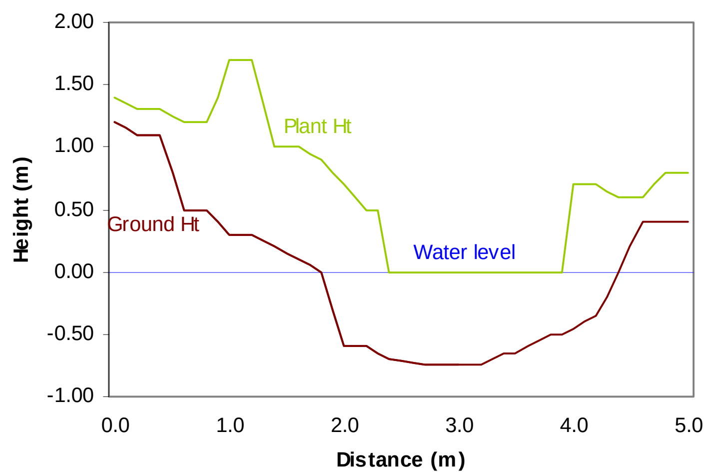
ECOLOGICAL ASSESSMENT - SITE 18

21 March 2002

RIVERLANDS INDUSTRIAL

Looking downstream from SH1

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Highly modified and stagnant rural drain	Lack of flow and elevation		
FISH	No fish	Lack of flow and access difficulty	Major water quality change needed	
AQUATIC PLANT SPECIES	Duckweed Algae (*Spirogyra*) present			
MACROINVERTEBRATES & CRUSTACEA	MCI index = 74 SQMCI index = 2.23 EPT taxa = 7 % Species Richness = 14 Dominant taxa = worms, snails (*Physa*) Crustacea = seed shrimp	Lack of flow, poor water quality and low dissolved oxygen	Quality of the macroinvertebrate community would improve with increased flow, but any change is likely to be limited by poor water quality	
RIPARIAN & BANK PLANT SPECIES	Fenced both sides and good bankside growth of rough pasture and sedges. Some shading provided by hedge of pines on north side		Further riparian planting potential in fenced off sections	
INSTREAM MICROBIOLOGICAL	*E. coli* = 20 000 cfu/100 ml Extremely high	Serious industrial contaminant input	Contaminant control	A long way above guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 496µS/cm pH = 6.3 Dissolved Oxygen = 0.37mg/l (4% saturation) Total Nitrogen = 3.6g/m^3	Serious industrial contaminant input High groundwater nitrate	Contaminant control Increased tidal flushing??	

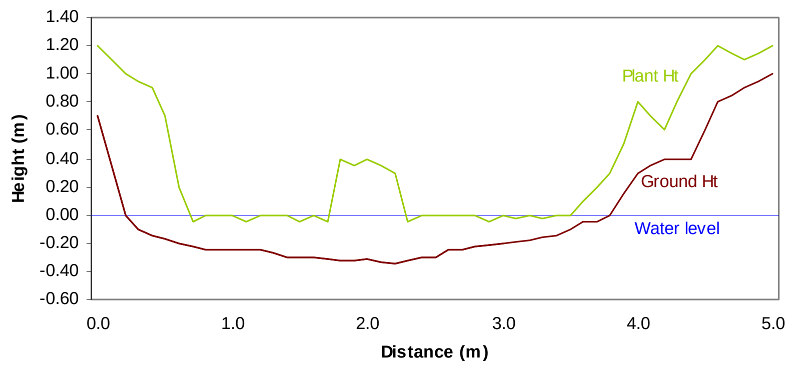
	Ammonium-N = 0.51g/m^3 Nitrate-N = 0.01g/m^3 Total Phosphorus = 1.9g/m^3 Dissolved P = 1.3g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 19.5 °C Turbidity = 82.4 NTU Black Disc = 0.1m Total Suspended sediment = 54 g/m^3 (42 inorganic; 12 organic)	Serious industrial contaminant input Weak connection with the aquifer	Contaminant control	
WATER FLOW	Not gauged			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Impacted Riverlands drain - NZMS 260 P28 952631			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 21 March 2002. Access from SH1.			

OVERALL ECOLOGICAL ASSESSMENT	**VERY POOR**

ECOLOGICAL ASSESSMENT - SITE 19 21 March 2002

RIVERLANDS CO-OP

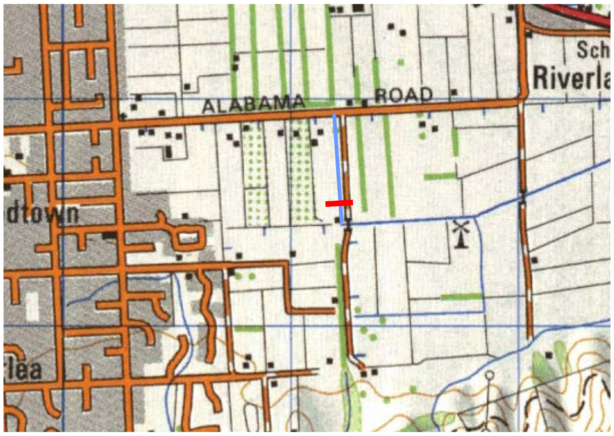
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Highly modified urban waterway	Featureless and subject to machine clearing	Habitat enhancement opportunities	
FISH	Shortfin eels Common bully Inanga	As above	As above and through disturbance reduction with less control activities	
AQUATIC PLANT SPECIES	*Lagarosiphon, Potamogeton*, Watercress	Regular control	Shading with riparian planting to reduce need for regular control	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 79 SQMCI index = 3.13 EPT taxa = 15 % Species Richness = 20 Dominant taxa = *Oxyethira* (cased-caddis), snails (*Physa* & *Potamopyrgus*) Crustacea = amphipods & seed shrimp	Regular control of aquatic plants High turbidity, poor water quality	Improved water quality / clarity would allow more sensitive taxa to colonise.	
RIPARIAN & BANK PLANT SPECIES	LB fenced and vineyards, RB grazed to stream bank	Surrounding land use	Fencing and planting for shade and habitat	
INSTREAM MICROBIOLOGICAL	*E. coli* = 480 cfu/100 ml	Urban runoff	Contaminant control	Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 250µS/cm pH = 6.9 Dissolved Oxygen = 9.0mg/l (102% saturation)	High groundwater nitrate Urban runoff		

	Total Nitrogen = 5.3g/m^3 Ammonium-N = 0.077g/m^3 Nitrate-N = 3.3g/m^3 Total Phosphorus = 0.099g/m^3 Dissolved P = 0.058g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 21.3 °C Turbidity = 21 NTU Black Disc = 0.35m Total Suspended sediment = 16 g/m^3 (14 inorganic; 2 organic)	Weak connection with the aquifer Large inorganic sediment input	Minimise sediment input and bed disturbance	
WATER FLOW	Not gauged			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Riverlands urban waterway - NZMS 260 P28 911635			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 21 March 2002. Spotlight fish survey carried out that night. Access from new lifestyle development road.			

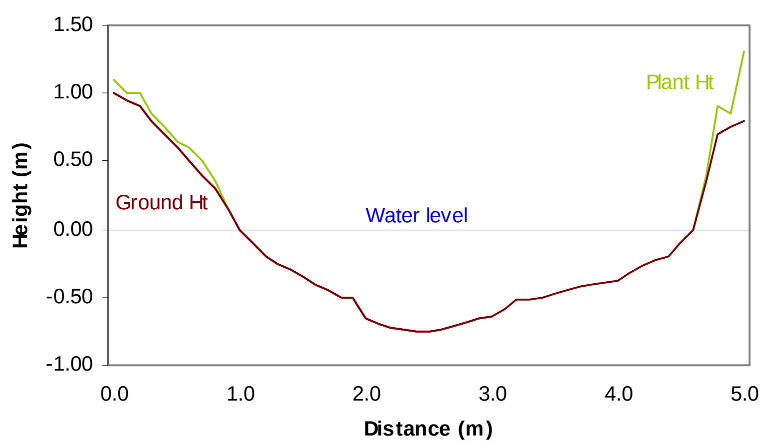
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM-POOR**

ECOLOGICAL ASSESSMENT - SITE 20 21 March 2002

TOWN BRANCH



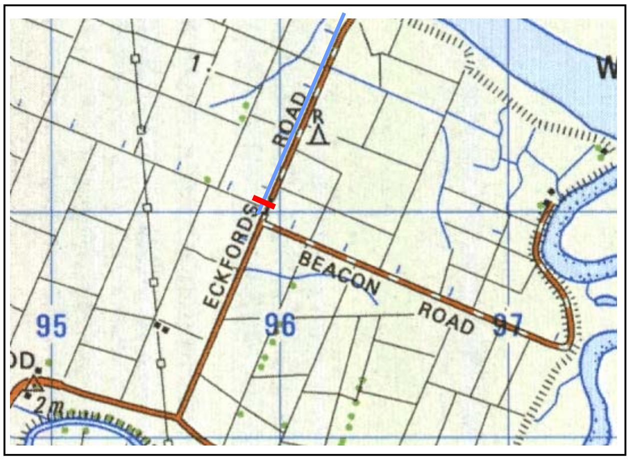
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified urban watercourse	Surrounding land use		
FISH	Inanga Shortfin eels	Featureless and no habitat diversity	Habitat enhancement opportunities	
AQUATIC PLANT SPECIES	Recently cleared and only remnants of Willow weed, Watercress, *Potamogeton* Algae (*Vaucheria*; *Oedogonium*) present	Regular control		
MACROINVERTEBRATES & CRUSTACEA	MCI index = 77 SQMCI index = 3.44 EPT taxa = 10 % Species Richness = 20 Dominant taxon = snails (*Potamopyrgus*) Crustacea = amphipods & seed shrimp	Regular control of aquatic plants and lack of overhanging streamside vegetation High turbidity, poor water quality	Growth of overhanging streamside vegetation and aquatic plants would provide habitat for macroinvertebrates Improved water quality / clarity would allow more sensitive taxa to colonise.	
RIPARIAN & BANK PLANT SPECIES	Mown road verge on TL bank and fenced TR with rank pasture	Road verge and land ownership	Bankside shrub species for shade and cover needed	
INSTREAM MICROBIOLOGICAL	*E. coli* = 980 cfu/100 ml	Urban runoff		Well above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 217µS/cm pH = 7.1 Dissolved Oxygen = 9.6mg/l (106% saturation)	High groundwater nitrate Urban runoff		

	Total Nitrogen = 5.5g/m^3 Ammonium-N = 0.051g/m^3 Nitrate-N = 3.7g/m^3 Total Phosphorus = 0.095g/m^3 Dissolved P = 0.072g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 20.4 °C Turbidity = 6.2 NTU Black Disc = 1.4m Total Suspended sediment = 5 g/m^3 (4 inorganic; 1 organic)	Weak connection with the aquifer		
WATER FLOW	Not gauged			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Riverlands urban waterway - NZMS 260 P28 912635			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, & Rowan Strickland on 21 March 2002. Spotlight fish survey carried out that night. Access from new lifestyle development road.			

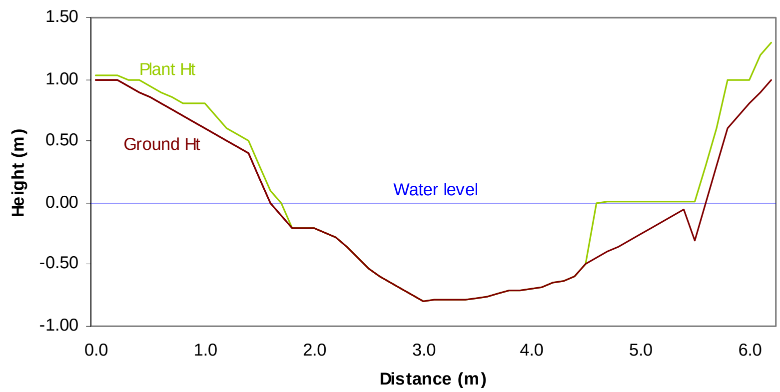
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM-POOR**

ECOLOGICAL ASSESSMENT - SITE 21 **22 March 2002**

JEFFREYS



DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified rural watercourse	Semi estuarine and flow restricted by control gates Low elevation		Possibly too low in elevation for significant improvement
FISH	Shortfin eels	Access and water quality	Gate operation to allow more regular flushing and access	
AQUATIC PLANT SPECIES	*Ruppia* Algae (*Enteromorpha* spp.; *Lyngbya*; *Cladophora*) common	Estuarine		
MACROINVERTEBRATES & CRUSTACEA	Not sampled Estuarine fauna	Estuarine, low dissolved oxygen and lack of flushing		
RIPARIAN & BANK PLANT SPECIES	Rank pasture within fenced TL bank and TR road verge	Road verge	North bank (TL) needs shrubs for shade and cover	
INSTREAM MICROBIOLOGICAL	*E. coli* = 25 cfu/100 ml			
INSTREAM CHEMICAL PROPERTIES	Conductivity = 4170µS/cm pH = 7.7 Dissolved Oxygen = 2.5mg/l (31% saturation) Total Nitrogen = 1.0g/m^3 Ammonium-N = 0.009g/m^3 Nitrate-N = <0.002g/m^3 Total Phosphorus = 0.81g/m^3 Dissolved P = 0.75g/m^3	Little flow	More water movement through improved tidal flushing	Maybe too low lying to allow tidal fluctuations

INSTREAM PHYSICAL PROPERTIES	Temperature = 17.6 °C Turbidity = 6.0 NTU Black Disc = 1.1m Total Suspended sediment = 40 g/m^3 (31 inorganic; 9 organic)	Weak connection with the aquifer		
WATER FLOW	Not gauged – water level controlled by tidal fluctuation. Flushing restricted by floodgates.			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Lower Wairau Plain – strongly influenced by tides - NZMS 260 P28 959660			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe & Rowan Strickland on 22 March 2002. Spotlight fish survey carried out the previous night. Access from Eckfords road.			

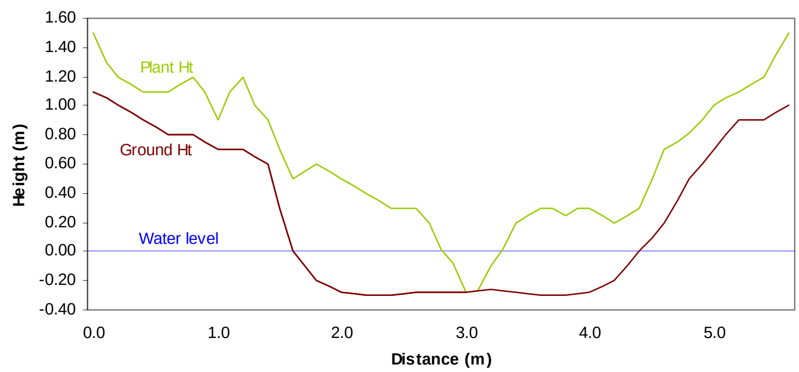
OVERALL ECOLOGICAL ASSESSMENT	**POOR**

ECOLOGICAL ASSESSMENT - SITE 22 **22 March 2002**

FAIRHALL

Looking downstream from Bells Road

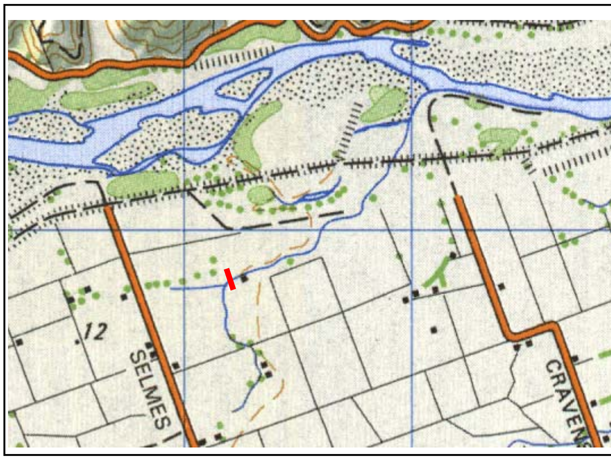
DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Modified rural watercourse	Surrounding land use		
FISH	Inanga Shortfin eels	Good fish habitat while sufficient aquatic plants present	Habitat would improve with less disturbance due to aquatic plants control	
AQUATIC PLANT SPECIES	Watercress, Willow weed, *Glyceria* Algae (*Eunotia*) present	Control	Shrubs on north side for shade will reduce the frequency for control	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 69 SQMCI = 3.45 EPT taxa = 7 % Species Richness = 15 Dominant taxa = amphipods, seed shrimp Crustacea = koura, amphipods & seed shrimp	Enriched runoff may promote occurrence of more tolerant taxa		
RIPARIAN & BANK PLANT SPECIES	Fenced and mixed native shrubs planted on TR and electric fence on TL with rank pasture	Cattle race on TL	Low shrubs similar to TR need planting on North side (TL) Maintain rank pasture for filtering nutrient input from race	
INSTREAM MICROBIOLOGICAL	*E. coli* = 50 cfu/100 ml			Effective stock exclusion
INSTREAM CHEMICAL PROPERTIES	Conductivity = 262µS/cm pH = 6.7 Dissolved Oxygen = 7.9mg/l (78% saturation)	High groundwater nitrate Agricultural runoff	Maintain rank pasture for filtering nutrient input from race	

	Total Nitrogen = 3.4g/m^3 Ammonium-N = 0.019g/m^3 Nitrate-N = 2.3g/m^3 Total Phosphorus = 0.045g/m^3 Dissolved P = 0.033g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 14.5 °C Turbidity = 2.4 NTU Black Disc = 3.1m Total Suspended sediment = 3 g/m^3 (2 inorganic; 1 organic)			
WATER FLOW	Flow gauged on 23 January 1997 (52 l/s) and 3 September 2001 (12 l/s)			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Rural Taylor/Opawa River spring-fed tributary - NZMS 260 P28 857648			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 22 March 2002. Access from Bells road.			

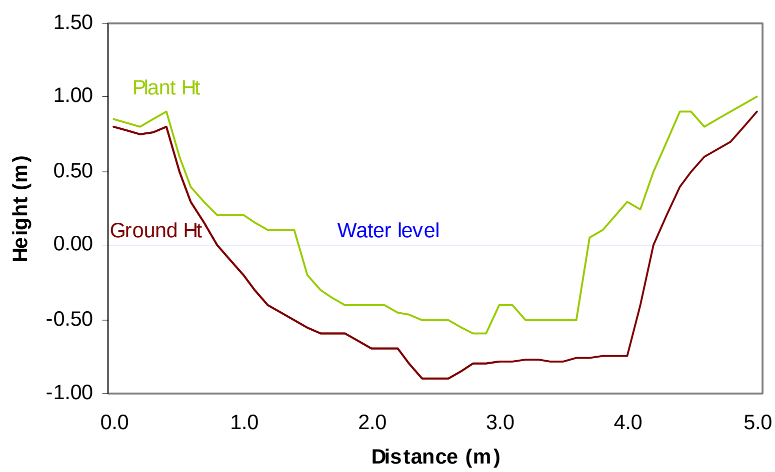
OVERALL ECOLOGICAL ASSESSMENT	**MEDIUM**

ECOLOGICAL ASSESSMENT - SITE 23 22 March 2002

CRAVENS



DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Good flow in modified rural setting	Land use	Habitat enhancement	
FISH	Brown trout, Inanga, Longfin eel, Shortfin eel	Land use and threat to instream habitat via control	Riparian management and habitat enhancement	Potential for greater use by fish with habitat enhancement, given close proximity to Wairau
AQUATIC PLANT SPECIES	Watercress, *Potamogeton, Nitella* Algae (*Palmella mucosa*) present	Control	Stream shading may reduce the need for frequent control and habitat disturbance	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 78 SQMCI = 4.17 EPT taxa = 20 % Species Richness = 25 Dominant taxa = amphipods, snails (*Potamopyrgus*) Crustacea = koura, amphipods & seed shrimp present			
RIPARIAN & BANK PLANT SPECIES	Unfenced on both sides with grazed pasture to stream banks	Land use	Habitat improvement potential and stream shading with fencing and planting	
INSTREAM MICROBIOLOGICAL	*E. coli* = 180 cfu/100 ml	Stock access	Fencing	Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 105µS/cm pH = 6.7 Dissolved Oxygen = 6.3mg/l (62% saturation) Total Nitrogen = 0.52g/m^3			

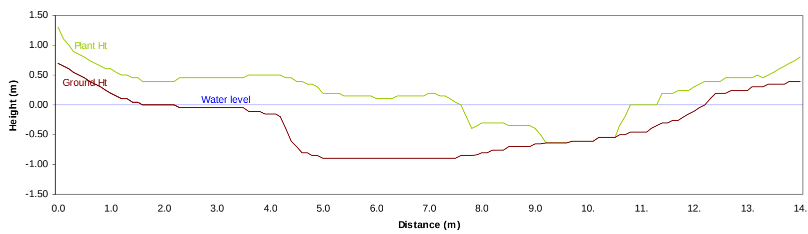
	Ammonium-N = 0.016g/m^3 Nitrate-N = 0.35g/m^3 Total Phosphorus = 0.019g/m^3 Dissolved P = 0.017g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 14.6 °C Turbidity = 1.1 NTU Black Disc = 6.4m Total Suspended sediment = 3 g/m^3 (3 inorganic; 0 organic)			
WATER FLOW	Not gauged – large spring flow - NZMS 260 P28 872728			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Large rural spring-fed stream – Spring Creek zone			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Anna Crowe, Rowan Strickland, Peter Hamill & Ally Jerram on 22 March 2002. Spotlight fish survey carried out the previous night in the lower reaches of Cravens Creek. Access through farm off Selmes road.			

OVERALL ECOLOGICAL ASSESSMENT	**GOOD**

ECOLOGICAL ASSESSMENT - SITE 24 22 March 2002

HALLS

DESCRIPTION	EXISTING	LIMITATIONS	POTENTIAL	COMMENTS
GENERAL	Rural stream with less modified course than others	Subject to runoff from dairy farm activities	Management of runoff and better riparian management	
FISH	Longfin eel, Shortfin eel, Inanga, Common bully, Black flounder, Brown trout		Habitat enhancement potential	
AQUATIC PLANT SPECIES	*Egeria*, *Lagarosiphon*, Watercress, Willow weed		Possible control of nuisance species with stream shading	
MACROINVERTEBRATES & CRUSTACEA	MCI index = 78 SQMCI = 4.04 EPT taxa = 18 % Species Richness = 17 Dominant taxon = snails (*Potamopyrgus*) Crustacea = koura, shrimp, amphipods & seed shrimp	Enriched runoff may promote colonisation by more tolerant taxa		
RIPARIAN & BANK PLANT SPECIES	Fenced on both sides with riparian wetland on TR and tall alders shading TL		Further shading possible with TR bank planting	
INSTREAM MICROBIOLOGICAL	*E. coli* = 680 cfu/100 ml	Stock crossing Agricultural runoff	Bridge stock crossing Restrict stock access	Above contact guidelines
INSTREAM CHEMICAL PROPERTIES	Conductivity = 95µS/cm pH = 6.6 Dissolved Oxygen = 5.8mg/l (59% saturation)			

	Total Nitrogen = 0.69g/m^3 Ammonium-N = 0.034g/m^3 Nitrate-N = 0.34g/m^3 Total Phosphorus = 0.052g/m^3 Dissolved P = 0.033g/m^3			
INSTREAM PHYSICAL PROPERTIES	Temperature = 15.7 °C Turbidity = 1.9 NTU Black Disc = 3.6m Total Suspended sediment = 1.8 g/m^3 (0.8 inorganic; 1 organic)			
WATER FLOW	Flow gauged on 19 July 1991 = 242 l/s			
CROSS-SECTION & SUBSTRATE				
LOCATION & ZONE	Large rural spring-fed stream – Spring Creek zone - NZMS 260 P28 899732			
SITE VISIT DETAILS & PERSONNEL	Main survey carried out by Roger Young, Rowan Strickland, Peter Hamill & Ally Jerram on 22 March 2002. Access through Hall's farm off Hillocks road.			

OVERALL ECOLOGICAL ASSESSMENT	**GOOD**

Appendix 2

Relative abundance of macroinvertebrates

Site no:		1	2	3	4	5	6
Site name:	Taxon	Pipi Nth	Pukaka	Roberts	Sadds	Drain N	Drain Q
Date:	score	3/18/02	3/18/02	3/18/02	3/19/02	3/19/02	3/19/02
Mayflies							
Austroclima jollyae	9	-	-	-	-	-	-
Austroclima sepia	9	-	-	-	-	-	-
Zephlebia versicolor	7	-	-	-	-	C	-
Stoneflies							
Megaleptoperla sp.	9	-	-	-	-	-	-
Odonata							
Damselflies (Zygoptera)	5	-	-	R	C	-	C
Austrolestes colensonis	6	-	-	R	C	-	C
Xanthocnemis zelandica	5	R	R	C	-	R	C
Water Bugs							
Anisops sp.	5	C	-	R			
Microvelia sp.	5	-	-	-	R	R	R
Sigara sp.	5	-	-	R	-	C	C
Dobsonflies							
Archichauliodes diversus	7	-	-	-	-	R	-
Beetles							
Antiporus sp.	5	-	-	-	-	-	-
Dyticidae	5	-	-	-		-	-
Enochrus sp.	5	-	-	-	R	-	-
Enochrus tritus	5	-	-	-		-	-
Hydrophilidae	5	-	-	-		-	-
Liodessus deflectus	5	-	R	-	R	-	-
Liodessus sp.	5	-	-	-	R	-	-
Rhantis pulverosus	5	-	R	-		-	R
Scirtidae	8	-	-	-	R	-	-
True Flies							
Anthomyiidae	3	-	-	-	-	-	-
Austrosimulium spp.	3	-	-	-	-	-	-
Chironomus sp. A	1	C	-	-	-	-	-
Chironomus zelandicus	1	VA	-	-	-	-	-
Corynoneura sp.	2	-	-	-	-	A	R
Culex sp.	3	C	-	-	-	-	-
Ephydrella sp.	4	-	-	-	-	-	-
Orthocladiinae	2	R	-	-	-	A	A
Paradixa sp.	4	-	-	-	-	-	-
Paralimnophila skusei	6	-	-	-	-	-	R
Polypedilum spp.	3	-	-	-	-	-	-
Sciomyzidae	3	-	-	-	-	-	-
Stratiomyidae	5	-	-	-	R	-	-
Tanypodinae	5	-	-	-	-	C	R
Tanytarsus vespertinus	3	-	-	-	-	C	R
Caddisflies							
Hudsonema alienum	6	-	-	-	-	-	-
Hudsonema amabile	6	-	-	-	-	-	-
Hydrobiosis budgei	5	-	-	-	-	-	-
Hydrobiosis copis	5	-	-	-	-	-	-
Hydrobiosis parumbripennis	5	-	-	-	-	-	-
Hydrobiosis umbripennis	5	-	-	-	-	-	-
Hydrobiosis spp.	5	-	-	-	-	-	-
Oecetis unicolor	6	-	-	-	-	-	-
Olinga feredayi	9	-	-	-	-	R	-
Hydroptilidae	2	-	-	-	-	-	-

Site no:		1	2	3	4	5	6
Site name:	Taxon	Pipi Nth	Pukaka	Roberts	Sadds	Drain N	Drain Q
Date:	score	3/18/02	3/18/02	3/18/02	3/19/02	3/19/02	3/19/02
Oxyethira albiceps	2	-	-	C	-	C	A
Paroxyethira eatoni cmplx	2	-	-	-	-	-	-
Paroxyethira hendersoni	2	-	-	R	-	-	-
Polyplectropus puerilis	8	-	-	-	-	R	C
Psilochorema bidens	8	-	-	-	-	R	-
Psilochorema nemorale	8						
Psilochorema spp.	8	-	-	-	-	R	-
Pycnocentria evecta	7	-	-	-	-	-	-
Pycnocentrodes sp.	5	-	-	-	-	-	-
Triplectides cephalotes	5	-	-	-	-	-	-
Triplectides obsoletus	5	-	-	-	-	-	-
Moths							
Hygraula nitens	4	-	-	-	-	-	-
Crustacea							
Amphipoda	5	-	A	VVA	-	A	C
Ostracoda	3	-	A	-	-	-	VA
Paranephrops planifrons	5	-	-	-	-	-	-
Paranephrops sp.	5	-	-	-	-	-	-
Paratya curvirostris	5	-	-	C	-	-	-
Annelida	1	A	C	R	VA	C	VA
Platyhelminthes	3	R	R	A	A	-	R
Nematoda	3	-	-	-	-	R	-
Hirudinea	3	-	-	-	-	-	R
Acarina	5	-	R	-	-	-	R
Collembola	6	-	-	-	R	-	VA
Mollusca							
Ferrissia sp.	3	-	-	-	-	-	-
Gyraulus sp.	3	-	C	A	A	-	R
Physa sp.	3	A	A	C	A	A	A
Potamopyrgus antipodarum	4	-	A	C	A	VVA	VVA
Sphaeriidae	3	-	-	-	-	R	C
Number of taxa		9	11	14	14	20	24
MCI		58	76	77	91	94	83
SQMCI		1.49	3.61	4.80	2.30	3.90	3.72
% EPT_{taxa}		0.0	0.0	14.3	0.0	30.0	8.3

Site no:		8	9	10	11	12	13
Site name:	Taxon	Marukoko	Grovetwn	Kellys	Waterlea	Fultons	Caseys
Date:	score	3/19/02	3/20/02	3/20/02	3/20/02	3/20/02	3/20/02
Mayflies							
Austroclima jollyae	9	-	-	R	-	-	-
Austroclima sepia	9	-	-	-	-	-	-
Zephlebia versicolor	7	-	-	R	-	-	-
Stoneflies							
Megaleptoperla sp.	9	-	-	-	-	R	R
Odonata							
Damselflies (Zygoptera)	5	C	R	R	R	-	-
Austrolestes colensonis	6	-	-	R	-	-	-
Xanthocnemis zelandica	5	C	-	C	R	-	R
Water Bugs							
Anisops sp.	5	R	-	R	R	-	-
Microvelia sp.	5	-	A	-	R	-	-
Sigara sp.	5	R	-	R	R	-	R
Dobsonflies							
Archichauliodes diversus	7	-	-	-	-	-	-
Beetles							
Antiporus sp.	5	-	-	-	-	-	-
Dyticidae	5	-	R	-	-	-	-
Enochrus sp.	5	-	-	-	-	-	-
Enochrus tritus	5	-	-	-	-	-	-
Hydrophilidae	5	-	-	-	-	-	-
Liodessus deflectus	5	-	-	-	-	-	-
Liodessus sp.	5	-	-	-	-	-	-
Rhantis pulverosus	5	-	-	-	-	-	-
Scirtidae	8	-	-	-	-	-	-
True Flies							
Anthomyiidae	3	-	-	-	-	-	-
Austrosimulium spp.	3	-	R	A	R	R	-
Chironomus sp. A	1	R	-	-	-	-	-
Chironomus zelandicus	1	-	-	-	-	-	-
Corynoneura sp.	2	-	C		R	-	-
Culex sp.	3	-	-	-	-	-	-
Ephydrella sp.	4	-	-	-	-	-	R
Orthocladiinae	2	R	C	A	C	R	R
Paradixa sp.	4	-	R	R	R	-	-
Paralimnophila skusei	6	-	-	-	R	-	-
Polypedilum spp.	3	-	-	-	-	-	R
Sciomyzidae	3	-	-	R	-	-	-
Stratiomyidae	5	-	-	-	-	-	-
Tanypodinae	5	-	-	-	A	R	C
Tanytarsus vespertinus	3	-	R	-	-	-	R
Caddisflies							
Hudsonema alienum	6	-	-	-	-	-	-
Hudsonema amabile	6	-	-	-	-	C	-
Hydrobiosis budgei	5	-	-	-	-	-	-
Hydrobiosis copis	5	-	-	R	-	-	-
Hydrobiosis parumbripennis	5	-	-	-	-	-	-
Hydrobiosis umbripennis	5	-	-	-	-	-	-
Hydrobiosis spp.	5	-	-	R	R	-	-
Oecetis unicolor	6	-	-	-	-	-	-
Olinga feredayi	9	-	-	-	-	-	-
Hydroptilidae	2	R	-	-	-	-	-

Site no:		8	9	10	11	12	13
Site name:	Taxon	Marukoko	Grovetwn	Kellys	Waterlea	Fultons	Caseys
Date:	score	3/19/02	3/20/02	3/20/02	3/20/02	3/20/02	3/20/02
Oxyethira albiceps	2	-	-	C	C	-	-
Paroxyethira eatoni cmplx	2	-	-	-	-	-	-
Paroxyethira hendersoni	2	R	-	R	-	-	-
Polyplectropus puerilis	8	-	-	-	A	-	R
Psilochorema bidens	8	-	R	-	C	R	R
Psilochorema nemorale	8						
Psilochorema spp.	8	-	-	R	R	R	R
Pycnocentria evecta	7	-	-	R	-	-	-
Pycnocentrodes sp.	5	-	-	-	-	-	-
Triplectides cephalotes	5	-	-	-	-	-	-
Triplectides obsoletus	5	-	-	-	-	R	-
Moths							
Hygraula nitens	4	R	-	-	-	-	-
Crustacea							
Amphipoda	5	A	VA	A	A	VA	VVA
Ostracoda	3	-	-	C	VA	A	C
Paranephrops planifrons	5	-	-	-	R	R	
Paranephrops sp.	5	-	-	-	R	-	R
Paratya curvirostris	5	-	R	-	R	-	-
Annelida	1	R	-	R	VA	VA	R
Platyhelminthes	3	-	-	-	-	C	R
Nematoda	3	-	-	-	-	-	-
Hirudinea	3	-	-	-	-	R	-
Acarina	5	-	-	-	-	-	-
Collembola	6	-	C	-	-	R	-
Mollusca							
Ferrissia sp.	3	-	R	C	-	-	C
Gyraulus sp.	3	-	-	A	-	-	A
Physa sp.	3	-	R	A	C	R	VA
Potamopyrgus antipodarum	4	VVA	VA	VA	C	VA	VVA
Sphaeriidae	3	-	-	-	A	C	C
Number of taxa		12	15	24	25	18	21
MCI		68	87	87	88	87	85
SQMCI		4.04	4.46	3.66	3.08	3.40	4.33
% EPT_{taxa}		16.7	6.7	33.3	20.0	27.8	19.0

Site no:		14	15	16	17	18	19
Site name:	Taxon	Woolley	Murphys	Doctors	Yelvertn	Riv Ind	Riv Co-op
Date:	score	3/21/02	3/21/02	3/21/02	3/21/02	3/21/02	3/21/02
Mayflies							
Austroclima jollyae	9	-	-	-	-	-	-
Austroclima sepia	9	-	-	-	-	-	-
Zephlebia versicolor	7	-	-	-	-	-	-
Stoneflies							
Megaleptoperla sp.	9	-	-	-	-	-	-
Odonata							
Damselflies (Zygoptera)	5	C	-	C	R	-	-
Austrolestes colensonis	6	-	-	-	-	R	R
Xanthocnemis zelandica	5	C	-	R	R	C	A
Water Bugs							
Anisops sp.	5	-	-	-	-	-	-
Microvelia sp.	5	C	-	-	-	-	R
Sigara sp.	5	R	-	C	VA	-	A
Dobsonflies							
Archichauliodes diversus	7	-	-	-	-	-	-
Beetles							
Antiporus sp.	5	-	-	-	R	R	-
Dyticidae	5	-	-	-	-	-	-
Enochrus sp.	5	-	-	-	-	-	-
Enochrus tritus	5	R	-	-	-	R	R
Hydrophilidae	5	-	-	-	-	R	-
Liodessus deflectus	5	-	-	-	-	R	-
Liodessus sp.	5	-	-	-	-	-	-
Rhantis pulverosus	5	-	R	-	-	-	R
Scirtidae	8	-	-	-	-	-	-
True Flies							
Anthomyiidae	3	-	-	-	R	-	-
Austrosimulium spp.	3	-	-	-	C	-	-
Chironomus sp. A	1	-	-	R	A	-	-
Chironomus zelandicus	1	VA	-	-	R	A	-
Corynoneura sp.	2	-	-	-	-	-	-
Culex sp.	3	-	-	-	-	R	C
Ephydrella sp.	4	-	-	-	-	-	-
Orthocladiinae	2	R	VA	R	A	C	A
Paradixa sp.	4	-	-	-	-	-	-
Paralimnophila skusei	6	-	-	-	-	-	-
Polypedilum spp.	3	-	-	-	-	-	-
Sciomyzidae	3	-	-	-	-	-	-
Stratiomyidae	5	C	-	-	-	-	R
Tanypodinae	5	-	R	-	-	-	-
Tanytarsus vespertinus	3	-	-	-	-	-	-
Caddisflies							
Hudsonema alienum	6	-	-	-	R	-	R
Hudsonema amabile	6	-	-	-	R	-	-
Hydrobiosis budgei	5	-	-	-	-	-	-
Hydrobiosis copis	5	-	-	-	R	-	-
Hydrobiosis parumbripennis	5	-	-	-	R	-	-
Hydrobiosis umbripennis	5	-	-	-	C	-	-
Hydrobiosis spp.	5	-	-	-	R	-	-
Oecetis unicolor	6	-	-	R	-	-	-
Olinga feredayi	9	-	-	-	-	-	-
Hydroptilidae	2	-	-	-	-	-	-

Site no:		14	15	16	17	18	19
Site name:	Taxon	Woolley	Murphys	Doctors	Yelvertn	Riv Ind	Riv Co-op
Date:	score	3/21/02	3/21/02	3/21/02	3/21/02	3/21/02	3/21/02
Oxyethira albiceps	2	-	A	C	VA	-	VVA
Paroxyethira eatoni cmplx	2	-	-	-	-	-	R
Paroxyethira hendersoni	2	-	-	-	A	-	-
Polyplectropus puerilis	8	-	-	-	-	-	-
Psilochorema bidens	8	-	-	-	R	-	-
Psilochorema nemorale	8						
Psilochorema spp.	8	-	-	-	-	-	-
Pycnocentria evecta	7	-	-	-	-	-	-
Pycnocentrodes sp.	5	-	-	-	R	-	-
Triplectides cephalotes	5	-	-	-	R	R	-
Triplectides obsoletus	5	-	R	-	-	-	-
Moths							
Hygraula nitens	4	R	-	-	-	-	-
Crustacea							
Amphipoda	5	C	C	VVA	VA	-	VA
Ostracoda	3	A	C	A	VA	C	A
Paranephrops planifrons	5	-	-	-	-	-	-
Paranephrops sp.	5	-	-	-	-	-	-
Paratya curvirostris	5	-	-	-	-	-	-
Annelida	1	VA	VVA	A	VVA	VA	A
Platyhelminthes	3	A	-	-	-	-	-
Nematoda	3	-	-	-	-	-	-
Hirudinea	3	C	R	-	-	-	-
Acarina	5	-	-	-	-	-	-
Collembola	6	-	-	-	-	-	R
Mollusca							
Ferrissia sp.	3	-	-	-	-	-	-
Gyraulus sp.	3	-	R	R	R	-	VA
Physa sp.	3	C	R	A	A	VA	VVA
Potamopyrgus antipodarum	4	R	VA	VA	R	A	VVA
Sphaeriidae	3	-	-	-	-	-	-
Number of taxa		16	12	13	26	14	19
MCI		74	68	69	77	74	79
SQMCI		1.77	1.64	4.58	2.26	2.23	3.13
% EPT_{taxa}		0.0	16.7	15.4	42.3	7.1	15.8

Site no:		20	22	23	24	SPC4	SPC3
Site name:	Taxon	Twn Brn	Fairhall	Cravens	Halls	Tennis	O'Dwyers
Date:	score	3/21/02	3/22/02	3/22/02	3/22/02	20/10/99	20/10/99
Mayflies							
Austroclima jollyae	9	-	-	-	-	-	-
Austroclima sepia	9	-	-	-	-	R	C
Zephlebia versicolor	7	-	-	-	-	R	A
Stoneflies							
Megaleptoperla sp.	9	-	-	-	-	-	-
Odonata							
Damselflies (Zygoptera)	5	C	-	R	C	-	-
Austrolestes colensonis	6	R	-	R	R	-	-
Xanthocnemis zelandica	5	A	-	C	A	C	-
Water Bugs							
Anisops sp.	5	-	-	-	-	-	-
Microvelia sp.	5	R	-	R	-	-	R
Sigara sp.	5	A	-	A	C	C	C
Dobsonflies							
Archichauliodes diversus	7	-	-	-	-	-	-
Beetles							
Antiporus sp.	5	-	-	-	-	-	-
Dyticidae	5	-	-	-	-	-	-
Enochrus sp.	5	-	-	-	-	-	-
Enochrus tritus	5	-	-	-	-	-	-
Hydrophilidae	5	-	-	-	-	-	-
Liodessus deflectus	5	-	-	-	-	-	-
Liodessus sp.	5	-	R	-	-	-	-
Rhantis pulverosus	5	R	-	-	-	-	-
Scirtidae	8	-	-	-	-	-	-
True Flies							
Anthomyiidae	3	-	R	-	-	-	-
Austrosimulium spp.	3	-	A	-	-	-	A
Chironomus sp. A	1	C	-	R	-	-	-
Chironomus zelandicus	1	R	-	R	R	-	-
Corynoneura sp.	2	-	R	-	-	-	-
Culex sp.	3	-	-	-	-	-	-
Ephydrella sp.	4	-	-	-	-	-	-
Orthocladiinae	2	A	A	C	R	A	A
Paradixa sp.	4	-	-	-	-	-	-
Paralimnophila skusei	6	-	-	-	-	-	-
Polypedilum spp.	3	-	-	-	-	-	-
Sciomyzidae	3	-	-	R	-	-	-
Stratiomyidae	5	-	-	-	-	-	-
Tanypodinae	5	R	C	R	R	R	R
Tanytarsus vespertinus	3	-	R	-	-	-	-
Caddisflies							
Hudsonema alienum	6	-	-	-	-	-	R
Hudsonema amabile	6	-	-	-	-	-	C
Hydrobiosis budgei	5	-	-	-	-	-	-
Hydrobiosis copis	5	-	-	-	-	-	-
Hydrobiosis parumbripennis	5	-	-	-	-	-	-
Hydrobiosis umbripennis	5	-	-	-	-	-	-
Hydrobiosis spp.	5	-	-	R	-	R	-
Oecetis unicolor	6	-	-	-	-	-	-
Olinga feredayi	9	-	-	-	-	-	-
Hydroptilidae	2	-	-	-	-	-	-

Site no:		20	22	23	24	SPC4	SPC3
Site name:	Taxon	Twn Brn	Fairhall	Cravens	Halls	Tennis	O'Dwyers
Date:	score	3/21/02	3/22/02	3/22/02	3/22/02	20/10/99	20/10/99
Oxyethira albiceps	2	R	A	R	R	A	C
Paroxyethira eatoni cmplx	2	-	-	-	-	-	-
Paroxyethira hendersoni	2	-	-	R	-	-	-
Polyplectropus puerilis	8	-	-	C	R	R	C
Psilochorema bidens	8	-	-	R	-	-	-
Psilochorema nemorale	8					R	R
Psilochorema spp.	8	-	-	-	-	-	-
Pycnocentria evecta	7	-	-	-	-	C	VA
Pycnocentrodes sp.	5	-	-	-	-	-	-
Triplectides cephalotes	5	C	-	-	R	-	-
Triplectides obsoletus	5	-	-	-	-	-	-
Moths							
Hygraula nitens	4	-	-	-	-	-	-
Crustacea							
Amphipoda	5	A	VA	VVA	VA	VVA	VVA
Ostracoda	3	VA	VA	A	C	C	R
Paranephrops planifrons	5	-	-	-	-	-	-
Paranephrops sp.	5	-	-	-	-	-	-
Paratya curvirostris	5	-	-	-	-	-	-
Annelida	1	VA	A	A	A	A	C
Platyhelminthes	3	-	R	C	A	-	-
Nematoda	3	-	-	-	-	-	-
Hirudinea	3	-	-	R	-	-	-
Acarina	5	R	-	-	-	-	-
Collembola	6	-	R	-	-	-	-
Mollusca							
Ferrissia sp.	3	-	-	R	-	R	-
Gyraulus sp.	3	VA	-	VA	-	A	-
Physa sp.	3	A	C	VA	A	A	R
Potamopyrgus antipodarum	4	VVA	R	VVA	VVA	VVA	C
Sphaeriidae	3	A	-	A	R	A	-
Number of taxa		20	15	25	17	19	17
MCI		77	69	78	78	93	98
SQMCI		3.44	3.45	4.17	4.04	4.29	5.2
% EPT_{taxa}		10.0	6.7	20.0	17.6	36.8	47.1

Site no:		SPC10	SPC9	SPC2	SPC8	SPC7	SPC6
Site name:	Taxon	Hollis	Ganes	Rapaura	Dentons	Motor	Roses
Date:	score	20/10/99	20/10/99	20/10/99	20/10/99	20/10/99	20/10/99
Mayflies							
Austroclima jollyae	9	-	-	-	-	-	-
Austroclima sepia	9	R	-	R	-	-	-
Zephlebia versicolor	7	R	-	R	C	C	R
Stoneflies							
Megaleptoperla sp.	9	-	-	-	-	-	-
Odonata							
Damselflies (Zygoptera)	5	-	-	-	-	-	-
Austrolestes colensonis	6	-	-	-	-	-	-
Xanthocnemis zelandica	5	R	R	R	-	-	R
Water Bugs							
Anisops sp.	5	-	-	-	-	-	-
Microvelia sp.	5	-	-	-	-	-	-
Sigara sp.	5	-	-	-	-	-	-
Dobsonflies							
Archichauliodes diversus	7	-	-	-	-	-	-
Beetles							
Antiporus sp.	5	-	-	-	-	-	-
Dyticidae	5	-	-	-	-	-	-
Enochrus sp.	5	-	-	-	-	-	-
Enochrus tritus	5	-	-	-	-	-	-
Hydrophilidae	5	-	-	-	-	-	-
Liodessus deflectus	5	-	-	-	-	-	-
Liodessus sp.	5	-	-	-	-	-	-
Rhantis pulverosus	5	-	-	-	-	-	-
Scirtidae	8	-	-	-	-	-	-
True Flies							
Anthomyiidae	3	-	-	-	-	-	-
Austrosimulium spp.	3	-	R	R	R	A	R
Chironomus sp. A	1	-	-	A	-	-	-
Chironomus zelandicus	1	-	-	-	-	-	-
Corynoneura sp.	2	-	-	-	-	-	-
Culex sp.	3	-	-	-	-	-	-
Ephydrella sp.	4	-	-	-	-	-	-
Orthocladiinae	2	VA	C	A	VVA	A	R
Paradixa sp.	4	-	-	-	-	-	-
Paralimnophila skusei	6	-	R	-	-	-	-
Polypedilum spp.	3	R	-	R	R	R	-
Sciomyzidae	3	-	-	-	-	-	-
Stratiomyidae	5	-	-	-	-	-	-
Tanypodinae	5	R	R	R	-	-	-
Tanytarsus vespertinus	3	-	-	R	-	-	-
Caddisflies							
Hudsonema alienum	6	-	-	-	-	-	-
Hudsonema amabile	6	-	-	-	-	-	-
Hydrobiosis budgei	5	-	-	-	-	R	-
Hydrobiosis copis	5	-	-	-	-	-	-
Hydrobiosis parumbripennis	5	-	-	-	-	-	-
Hydrobiosis umbripennis	5	-	-	-	-	-	-
Hydrobiosis spp.	5	-	-	-	-	R	-
Oecetis unicolor	6	-	-	-	-	-	-
Olinga feredayi	9	-	-	-	-	-	-
Hydroptilidae	2	-	-	-	-	-	-

Site no:		SPC10	SPC9	SPC2	SPC8	SPC7	SPC6
Site name:	Taxon	Hollis	Ganes	Rapaura	Dentons	Motor	Roses
Date:	score	20/10/99	20/10/99	20/10/99	20/10/99	20/10/99	20/10/99
Oxyethira albiceps	2	C	-	-	C	C	R
Paroxyethira eatoni cmplx	2	-	-	-	-	-	-
Paroxyethira hendersoni	2	R	-	R	-	R	-
Polyplectropus puerilis	8	A	-	C	C	R	-
Psilochorema bidens	8	-	-	-	-	-	-
Psilochorema nemorale	8	C	-	-	-	-	-
Psilochorema spp.	8	-	-	-	-	-	-
Pycnocentria evecta	7	VA	-	R	-	C	-
Pycnocentrodes sp.	5	-	-	-	-	-	-
Triplectides cephalotes	5	-	-	-	-	-	-
Triplectides obsoletus	5	-	-	-	-	-	-
Moths							
Hygraula nitens	4	-	-	-	-	-	-
Crustacea							
Amphipoda	5	VVA		VA	VA	VVA	R
Ostracoda	3	A	C	A	C	R	A
Paranephrops planifrons	5	-	-	-	-	-	-
Paranephrops sp.	5	-	-	R	R	-	-
Paratya curvirostris	5	-	-	-	-	-	-
Annelida	1	VA	VVA	VA	VVA	A	VVA
Platyhelminthes	3	-	-	-	-	-	R
Nematoda	3	-	-	-	-	-	-
Hirudinea	3	-	-	-	-	-	-
Acarina	5	-	-	-	-	-	-
Collembola	6	-	-	-	-	-	-
Mollusca							
Ferrissia sp.	3	-	-	-	-	-	R
Gyraulus sp.	3	-	-	-	-	-	-
Physa sp.	3	-	R	R	R	-	-
Potamopyrgus antipodarum	4	A	VVA	-	A	A	VA
Sphaeriidae	3	A	C	-	R	C	VA
Number of taxa		16	10	17	13	14	12
MCI		93	70	85	75	79	68
SQMCI		4.4	2.51	2.94	1.92	4.66	1.77
% EPT_{taxa}		43.8	0.0	29.4	23.1	50.0	16.7

Site no:		SPC5	SPC1
Site name:	Taxon	Collins	Flood
Date:	score	20/10/99	20/10/99
Mayflies			
Austroclima jollyae	9	-	-
Austroclima sepia	9	-	R
Zephlebia versicolor	7	R	C
Stoneflies			
Megaleptoperla sp.	9	-	-
Odonata			
Damselflies (Zygoptera)	5	-	-
Austrolestes colensonis	6	-	-
Xanthocnemis zelandica	5	C	-
Water Bugs			
Anisops sp.	5	-	-
Microvelia sp.	5	C	-
Sigara sp.	5	-	R
Dobsonflies			
Archichauliodes diversus	7	-	-
Beetles			
Antiporus sp.	5	-	-
Dyticidae	5	-	-
Enochrus sp.	5	-	-
Enochrus tritus	5	-	-
Hydrophilidae	5	-	-
Liodessus deflectus	5	-	-
Liodessus sp.	5	-	-
Rhantis pulverosus	5	-	-
Scirtidae	8	-	-
True Flies			
Anthomyiidae	3	-	-
Austrosimulium spp.	3	R	A
Chironomus sp. A	1	R	-
Chironomus zelandicus	1	-	-
Corynoneura sp.	2	-	-
Culex sp.	3	-	-
Ephydrella sp.	4	-	-
Orthocladiinae	2	A	A
Paradixa sp.	4	-	-
Paralimnophila skusei	6	-	-
Polypedilum spp.	3	-	-
Sciomyzidae	3	-	-
Stratiomyidae	5	-	-
Tanypodinae	5	-	-
Tanytarsus vespertinus	3	-	-
Caddisflies			
Hudsonema alienum	6	-	-
Hudsonema amabile	6	-	-
Hydrobiosis budgei	5	R	-
Hydrobiosis copis	5	-	-
Hydrobiosis parumbripennis	5	-	-
Hydrobiosis umbripennis	5	-	-
Hydrobiosis spp.	5	-	R
Oecetis unicolor	6	-	-
Olinga feredayi	9	-	-
Hydroptilidae	2	-	-

Site no:		SPC5	SPC1
Site name:	Taxon	Collins	Flood
Date:	score	20/10/99	20/10/99
Oxyethira albiceps	2	C	A
Paroxyethira eatoni cmplx	2	-	-
Paroxyethira hendersoni	2	R	-
Polyplectropus puerilis	8	C	-
Psilochorema bidens	8	-	-
Psilochorema nemorale	8	-	R
Psilochorema spp.	8	-	-
Pycnocentria evecta	7	C	A
Pycnocentrodes sp.	5	-	-
Triplectides cephalotes	5	-	-
Triplectides obsoletus	5	-	-
Moths			
Hygraula nitens	4	-	-
Crustacea			
Amphipoda	5	VA	VVA
Ostracoda	3	-	-
Paranephrops planifrons	5	-	-
Paranephrops sp.	5	-	R
Paratya curvirostris	5	-	C
Annelida	1	A	R
Platyhelminthes	3	-	-
Nematoda	3	-	-
Hirudinea	3	-	-
Acarina	5	-	-
Collembola	6	-	-
Mollusca			
Ferrissia sp.	3	R	R
Gyraulus sp.	3	-	-
Physa sp.	3	A	R
Potamopyrgus antipodarum	4	R	R
Sphaeriidae	3	-	R
Number of taxa		16	17
MCI		79	91
SQMCI		4.06	4.81
% EPT_{taxa}		37.5	35.3