State of the Environment Surface Water Quality Monitoring Report, 2011

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Executive Summary

There are 54 river and stream sites that are monitored to assess the state of water quality in Marlborough's surface waters. Of these 34 are monitored on a monthly basis for a variety of physical/chemical parameters and 51 are monitored annually for macroinvertebrates. Twenty of the sites have a telemeted flow station either at the site or in the near vicinity, such that flow data can be used to interpret the results of the physical, chemical and biological data. The catchment in which the sites are located range from 100% indigenous forest to 100% urban environment.

Water quality results from 2007-10 are analysed to assess the current state of water quality at each of the sites. Sites are compared using box plot analyses and are compared against relevant guideline values. Water quality from each site is summarised and a water quality index and/or biotic index is calculated. A water quality grade is then determined based on the calculation for each site. Sites are graded along a continuum of: Excellent-Good-Fair-Poor-Very Poor.

Water quality is assessed against various catchment characteristics as described in the Freshwater Ecosystems of New Zealand (FENZ) Geodatabase (Leathwick *et al.*, 2010). Poor water quality was found to be highly correlated with the increasing percentage of pastoral land in the catchment, in addition water quality deterioration was shown to accelerate when more than a quarter of the catchment was in pastoral land. Springs such as Spring Creek, Murphys Creek and Mill Stream have better water quality than would be expected given the surrounding land use because of the buffering effect from groundwater. However these streams are still susceptible to deterioration in water quality from the input of sediment from stream bank erosion and/or runoff from the surrounding land and *E. coli* where stock have from direct access to the waterway. Promoting riparian management in the form of fencing and/or planting is a common and known way to improve water quality and may be especially beneficial to spring fed streams.

Contents

1. Introduction

Surface water sampling of rivers and streams is carried out in order to assess the current state of water quality in our surface waters and to allow for changes or trends in water quality to be detected over time. Monitoring water quality for the region is a requirement of the Resource Management Act (RMA) 1991. Regional Plans must be consistent with the RMA. Monitoring and reporting on water quality for the region helps inform our Regional Policy Statement and Resource Management Plans. Our policy and Plans serve to manage our water resources in a sustainable way. Monitoring and reporting on our water quality also allows us to: 1) assess the effectiveness and efficiencies of our plans and policies; 2) to identify degraded water bodies which require active management; 3) to identify rivers and streams at risk of deterioration and 4) to ensure water quality is maintained in a 'good' state where appropriate. Currently there are three monitoring programmes which assess surface water quality in Marlborough, these are;

1. State of the Environment (SoE) surface water quality monitoring
2. Recreational water quality monitoring
3. Clean streams accord water quality monitoring.

Each of these programmes have been set up with specific objectives. These objectives determine the frequency, type and location of monitoring that is required. This report discusses the objectives and analyses the results of the State of the Environment (SoE) surface water quality monitoring programme. Details of the recreational water quality monitoring programme and the clean streams accord water quality monitoring programme can be found in the reports 'Marlborough's Freshwater Recreational Water Quality 2009-10' and 'Rai River Catchments Monitoring Report for the Dairying and Clean Streams Accord, 2008'. The two core objectives of SoE monitoring are:

1. to define the state of water quality for the region
2. to detect changes in water quality for the region.

SoE monitoring of surface water in the region is based on a catchment approach. It is unfeasible and desirable to monitor every catchment and therefore the region has been divided into a number of units broadly representative of catchments in the region (MDC, 2010). Seventy two water resource units (WRU) have been identified in the region (Appendix 1). These units are based primarily on the hydrological catchment areas (MDC, 2010). Water quality is monitored for 55 WRU's, covering a broad range of catchment types and developments, from pristine native bush catchment to 100% urbanised catchments. Monitoring consists of monthly monitoring of physical/chemical parameters at 34 sites and annual monitoring of macroinvertebrates at 51 sites. Where possible, monitoring of biological, physical and chemical components are carried out at the same site.

Monitoring of the WRU's started in 2007 for 19 WRU's. Additional sites were added from 2007 to 2009. Two of the sites (on the Wairau River) are monitored by NIWA. This report analyses the results of monitoring from February 2007 to December 2010. Trend analysis has not been carried out on data as it is recommended that five years of data is used to analyse for trends (Scarsbrook and McBride, 2007). Monitoring results are assessed against the relevant guidelines to determine the current state of water quality for the region. The water quality index (MDC, 2010) is updated for 2011.

2. Sites Monitored

Monitoring occurs monthly for physical/chemical parameters and annually for biological (macroinvertebrate) parameters.

2.1. Marlborough's Water Resource Units

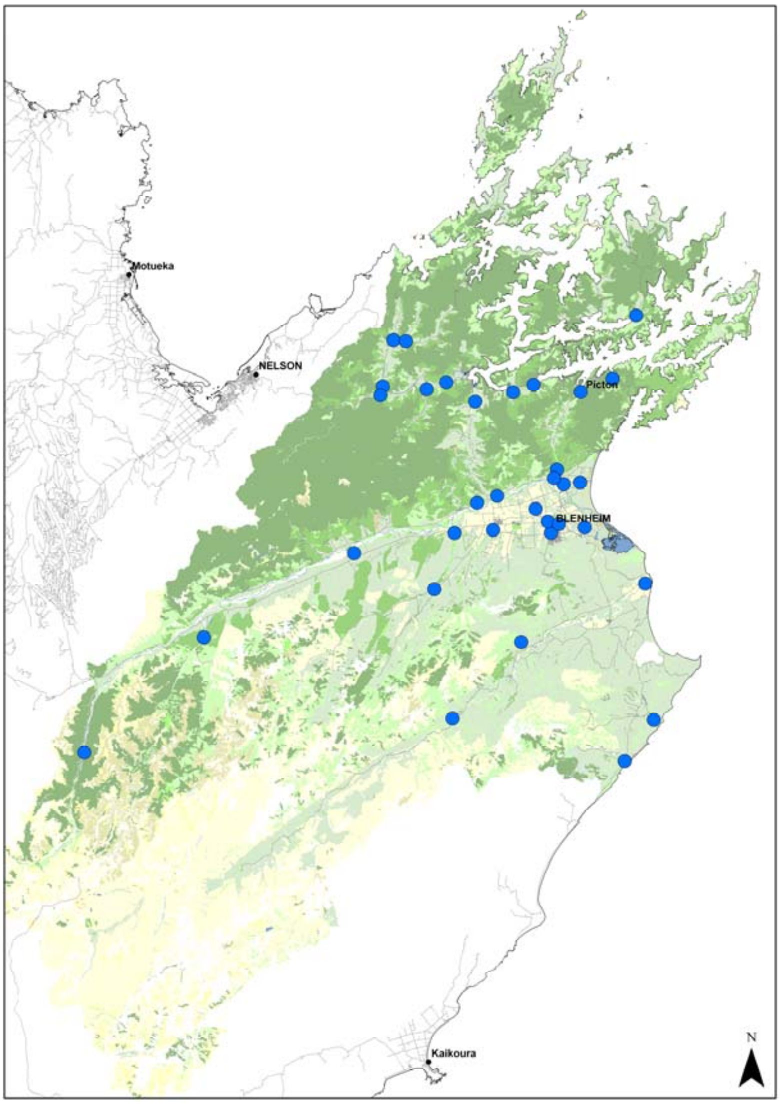
There are 72 water resource units (WRU's) used to assess surface water quality for the region. Appendix 1 lists each of the water resource units, the monitoring site associated with them and the characteristics of the catchment upstream of the monitoring site. These WRU's fall into nine geographical regions as shown in Table 1 and Appendix 1.

Table 1: Geographical regions of Marlborough based on water resource units.

Geographic Region	Description
Pelorus	High rainfall area, large areas of native forest. Dairying is main land use activity.
Marlborough Sounds	High rainfall, small order streams. Large areas of native forest. Pastoral and exotic forests.
Wairau	High rainfall and large areas of native forest in upper catchment. Pastoral farming, exotic forests and vineyards.
Waihopai	Dry, hill country, predominance of pastoral farmland, viticulture increasing in the region.
Omaka	Dry lowland area, dominated by vineyards.
Awatere	Dry mountain and hill country. Pastoral farming predominates.
South East Marlborough	Dry lowland areas, low order streams, sparse vegetation.
Clarence	Mountainous area, pastoral farming.
Small Coastal Catchments	No water catchments have been described in NIWAs database. Most likely ephemeral waterways predominate.

2.2. Monthly Monitoring

There are 34 sites that are monitored on a monthly basis (figure 1). A water sample is taken each month which is then analysed for its physical and chemical properties. Where possible these sites are located at the bottom of catchments and/or where flow monitoring is carried out. Flow information is central when interpreting water quality data, particularly when analysing trends over time and relative loads of contaminants. Two of the sites are monitored by NIWA; the Wairau at Dip Flat (WRR-6) and the Wairau at State Highway 1 (WRR-2). Data from the NIWA sites are supplied to the Council on an annual basis.



Site ID	Site Name	Easting (NZTM)	Northing (NZTM)
ARE-3	Are Are Creek	1668891	5409150
AWR-1	Awatere (lower)	1695945	5393096
AWR-3	Awatere at Awapiri	1660707	5368307
BBS-001	Black Birch Stream	1673268	5382346
BNR-1	Branch River upstream of Hydroelectric dam	1615310	5383200
CUL-3	Cullens Creek	1671802	5428178
DNC-002	Duncan Stream (Linkwater)	1675552	5429552
DRC-1	Doctors Creek	1678538	5403700
FLX-1	Flaxbourne at limestone quarry	1697479	5368033
GRR-001	Graham River at road bridge	1689949	5430629
KNR-1	Kenepuru upstream of NIWA flow site	1694287	5442220
KTR-005	Kaituna at Readers Road	1664877	5426463
MST-21	Mill Stream at flow site	1642747	5398630
MUR-1	Murphys Creek	1678585	5404340
OMR-1	Omaka River at Hawkesbury Road	1668150	5402871
ONR-1	Onamalutu	1665221	5407894
OPO-1	Opouri	1652204	5437502
OPR-1	Opawa at Swamp Road	1684887	5403319
OPR-3	Opawa at Hammerichs Road	1675898	5406769
PLR-4	Pelorus at Fishermans Flat	1659571	5430016
PLR-5	Pelorus at Kahikatea Flat	1647585	5427613
RAR-1	Rai at Rai Falls	1648018	5429266
RON-4	Ronga	1649966	5437711
SPC-1	Spring Creek at flood gates	1681052	5411335
TMR-1	Tuamarina at Wairau confluence	1680588	5412144
TYR-1	Taylor River at Riverside	1680148	5403948
WaiM	Waima upstream of SH bridge	1692178	5360509
WDV-1	Wairau Diversion at Neals Road	1684047	5411651
WHR-1	Waihopai at SH bridge	1661086	5402329
WHR-5	Waihopai at flow site	1657397	5392054
WKR-1	Wakamarina upsteam of SH bridge	1656011	5428720
WRR-2	Wairau at SH1 Bridge	1680623	5412041
WRR-6	Wairau at Dip Flat	1593486	5362089
WTS-009	Waitohi at SH1 bridge	1684133	5428227

Figure 1: State of the Environment surface water quality (physical/chemical parameters) monitoring sites.

2.3. Annual Monitoring

There are 51 sites that are monitored on an annual basis (figure 2). A macroinvertebrate sample and a habitat assessment are carried out at each of the sites at the time of monitoring.

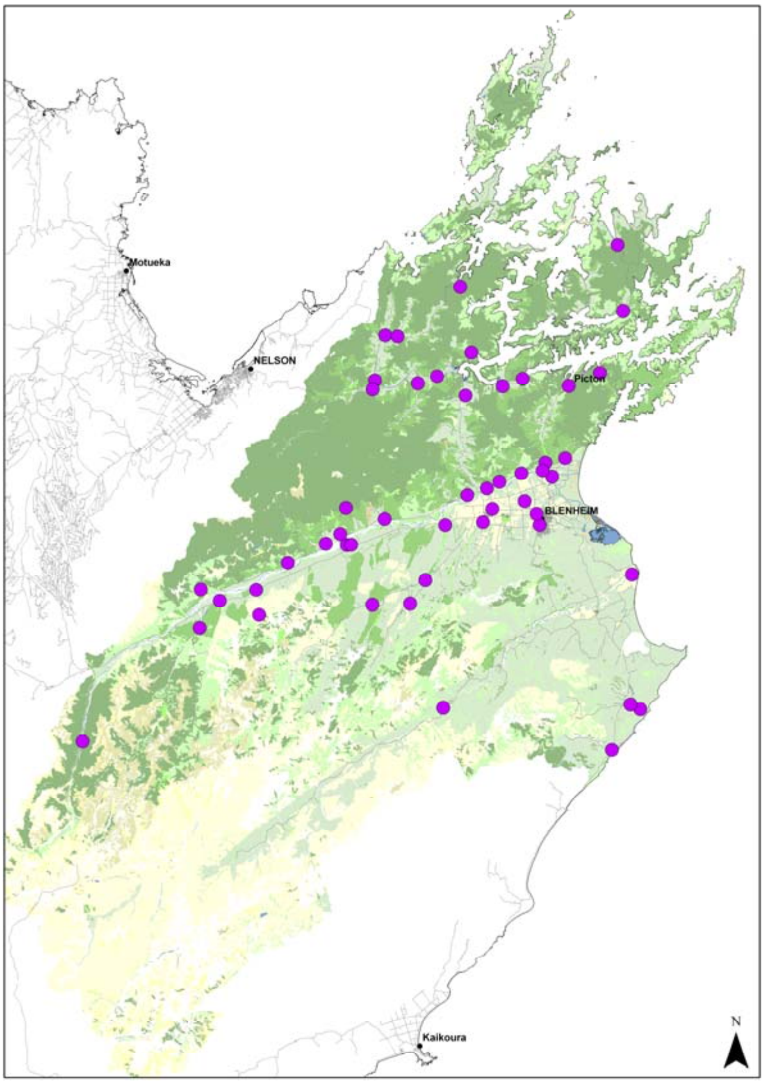


Figure 2: State of the Environment monitoring sites sampled annually. A macroinvertebrate sample and a habitat assessment are carried out at each site.

Site ID	Site Name	Easting (NZTM)	Northing (NZTM)
ANS-1	Anakoha Stream	1693260	5454525
ARE-3	Are Are Creek	1668891	5409150
AVR-1	Avon River	1654552	5387697
AWR-1	Awatere (lower)	1685073	5401815
AWR-3	Awatere at Awapiri	1660707	5368307
BBS-001	Black Birch Stream Cullens Creek	1673268	5382346
BNR-1	Branch River upstream of Hydroelectric dam	1615310	5383200
BRC-1	Bartletts Creek	1649816	5403453
CTG-1	Cabbage Tree Gully Stream	1625856	5390229
CUL-3	Cullens Creek	1671802	5428178
DNC-002	Duncan Stream (Linkwater)	1675552	5429552
DNC-1	Duncan Bay Stream	1663894	5446691
DRC-1	Doctors Creek	1678538	5403700
ENS-1	Enchanted Stream	1631755	5395282
FLX-1	Flaxbourne at limestone quarry	1697479	5368033
GBC-1	Gibsons Creek	1669880	5405340
GLT-1	The Goulter River	1615505	5390310
GRR-001	Graham River at road bridge	1689949	5430629
KNR-1	Kenepuru upstream of NIWA flow site	1694287	5442220
KTR-005	Kaituna at Readers Road	1664877	5426463
KUS-1	Kaiuma Bay Stream	1665963	5434503
MST-21	Mill Stream at flow site	1642747	5398630
MUR-1	Murphys Creek	1678585	5404340
NED-3	Spring Creek at flood gates	1695638	5368880
OMR-1	Omaka River at Hawkesbury Road	1668150	5402871
ONR-1	Onamalutu Taylor River at Riverside	1665221	5407894
OPO-1	Opouri	1652204	5437502
OPR-3	Opawa at Hammerichs Road	1675898	5406769
PLR-4	Pelorus at Fishermans Flat	1659571	5430016
PLR-5	Pelorus at Kahikatea Flat	1647585	5427613
PNV-01	Pine Valley Stream	1642598	5405503
PUK-5	Pukaka Stream	1683488	5414797
RAR-1	Rai at Rai Falls	1648018	5429266
RON-4	Ronga	1649966	5437711
SPC-1	Spring Creek	1681052	5411335
SWC-1	Salt Water Creek	1619068	5388223
SYC-1	Storeys Creek	1671220	5410389
TMC-1	Timms Creek	1641504	5400735
TMR-1	Tuamarina at Wairau confluence	1680588	5412144
TVR-1	Top Valley Stream	1638848	5398855
WaiM	Waima upstream of SH bridge	1692178	5360509
WHR-1	Waihopai at SH bridge	1661086	5402329
WHR-2	Waihopai River above Dam	1647510	5387498
WHR-5	Waihopai at flow site	1657397	5392054
WKK-1	The Waikakaho	1675301	5411934
WKR-1	Wakamarina upsteam of SH bridge	1656011	5428720
WRR-2	Wairau at SH1 Bridge	1680623	5412041
WRR-6	Wairau at Dip Flat	1593486	5362089
WST-5	Walkers Stream	1643573	5398609
WTS-009	Waitohi at SH1 bridge	1684133	5428227
WYE-1	Wye Creek	1626403	5385627

3. Results

A set of water quality parameters which best define waterways and the health of waterways and which reflect human influence on water quality have been chosen for analysis. A full list of the parameters analysed for on a routine basis is shown in appendix 2. Temperature and dissolved oxygen measurements are carried out on site at all sites using a YSI meter. The YSI meter is calibrated prior to use on site on all occasions. A core set of water quality parameters (numbers 1 – 11, Appendix 2) are measured at all sites whist a sub-set (numbers 12 – 17, Appendix 3) are measured at a selection of sites where the risk of contamination is seen as moderate to high. Twenty of the 34 monthly monitored sites also have flow measured at the site or in the vicinity of the site such that flow measurements can be used when assessing flow adjusted data for trends.

3.1. Physical/Chemical Parameters

Water quality data for 34 SoE sites from 2007 to 2010 (inclusive) was analysed using STATISTICA 7.0. Summary statistics for each parameter measured at each site are shown in Appendix 3. The number of samples per site range from 15 to 48; this is due to the addition of new sites since the revision of the SoE monitoring strategy in 2007. Some parameters, at some sites e.g. *E. coli* at Rai Falls have >48 samples due to the increased frequency of sampling associated with other programmes (e.g. bathing water sampling). The greater the number of samples available the greater the confidence in the results. In the absence of water quality standards the results are compared with various appropriate guidelines (Table 2) in order to place the results in context.

Table 2: Guideline values used to assess the state of surface water quality in Marlborough.

Parameter	Guideline Value	Purpose	Reference
Nitrate	1.7mg/L	Aquatic ecosystem toxicity	Hickey and Martin (2009)
	0.444mg/L	Prevent nuisance algal growth in lowland rivers	ANZECC (2000)
	0.167mg/L	Prevent nuisance algal growth in upland rivers	ANZECC (2000)
DRP	0.01mg/L	Prevent nuisance algal growth in lowland rivers	ANZECC (2000)
	0.009mg/L	Prevent nuisance algal growth in upland rivers	ANZECC (2000)
Ammonia	0.9mg/L*	Aquatic ecosystem toxicity	ANZECC (2000)
	0.021mg/L**	Lowland river ecosystem health	ANZECC (2000)
	0.01mg/L**	Upland river ecosystem health	ANZECC (2000)
E. coli	550 n/100mL	Contact recreation (action level)	MfE (2003)
	260 n/100mL	Contact recreation (alert level)	MfE (2003)
	126 n/100mL	Contact recreation (median level for surface waters)	McBride *et al*. (1991)
Turbidity	5.6 NTU	Lowland rivers	ANZECC (2000)
	4.1 NTU	Upland rivers	ANZECC (2000)
Suspended Solids	10 mg/L	Ecological guideline	CCREM (1991)
Copper	0.0014mg/L	95% protection of freshwater aquatic life (slightly to moderately disturbed systems)	ANZECC (2000)
Zinc	0.008mg/L	95% protection of freshwater aquatic life (slightly to moderately disturbed systems)	ANZECC (2000)
Arsenic	0.013mg/L	95% protection of freshwater aquatic life (slightly to moderately disturbed systems)	ANZECC (2000)

* The ANZECC guidelines specify a toxic guideline level of 0.9mg/L for total ammonia (NH_3 plus NH_4^+)

** In addition the guidelines give a limit for ionised ammonia ($NH4^+$) of 0.01mg/L for upland rivers and 0.021mg/L for lowland rivers for the protection of ecosystem health

An exceedance of a guideline does not always imply an effect; rather they are thresholds at which management options need to be considered to prevent further degradation of water quality.

3.1.1. Nitrate

Nitrogen is found in several different forms in surface waters, one of which is nitrate. Nitrate is a compound of nitrogen and oxygen ($NO3^-$). In well oxygenated waters nitrate is the dominant form of nitrogen. Nitrate concentrations in rivers typically show strong seasonal trends, being low in summer and high in winter.

Nitrogen is an important nutrient for plant growth and nitrate is the form in which it is most readily available to plants. This can be a problem when excess nitrate enters waterways causing excessive plant and algae growth. The ANZECC guidelines identify 0.167mg/L as the concentration above which nuisance plant growth will occur in upland rivers and 0.444mg/L as the concentration above which nuisance plant growth will occur in lowland rivers. Recent research has shown that nitrate toxicity for aquatic organisms can occur at levels above 1.7mg/L (Hickey and Martin, 2009).

The median, interquartile range, non-outlier range[1], outliers and extremes[2] for nitrate are shown in Figure 3. The relevant guideline values are shown to the right of the boxplot.

Doctors Creek and Mill Stream have the highest nitrate concentrations. Mill Stream and Doctors Creek are also two of the longest spring fed streams in Marlborough. Nitrate concentrations at these sites are consequently heavily influenced by groundwater nitrate concentrations. Groundwater in the Wairau Plains is important as a drinking water supply and thus must comply with the New Zealand Drinking Water Standards (NZDWS, 2005). The drinking water standard for nitrate is 11.3mg/L; the groundwaters of the Wairau plains generally comply with this standard. Groundwater nitrate concentrations within the drinking water standards but above the threshold for ecological toxicity (1.7mg/L) (Hickey and Martin, 2009) are a concern where groundwater quality determines the water quality of spring fed streams thereby influencing their life supporting capacity. Spring fed streams support a sensitive ecological community as water quality (in particular temperature and conductivity) tends to remain very stable; small changes in water quality can stress the aquatic life of spring fed streams.

Nitrate concentrations are also elevated in some agricultural catchments e.g. Are Are Creek, Kaituna, Rai and Ronga Rivers. The lowest nitrate concentrations are found in the Branch River, the Awatere at Awapiri, Black Birch Stream and the Wairau at Dip Flat.

[1] The non-outlier range is the range of values that fall below the upper outlier limit and above the lower outlier limit

[2] Values that are "far" from the middle of the distribution are referred to as outliers and extreme values. Outliers are atypical, infrequent observations; data points which do not appear to follow the characteristic distribution of the rest of the data. These may reflect genuine properties of the variable, or be due to measurement errors or other anomalies which should not be modelled. Typically, outliers represent a random error. Outliers not only artificially increase the value of a correlation coefficient, but they can also decrease the value of a "legitimate" correlation. The calculation is further defined in Statistica 7.0.

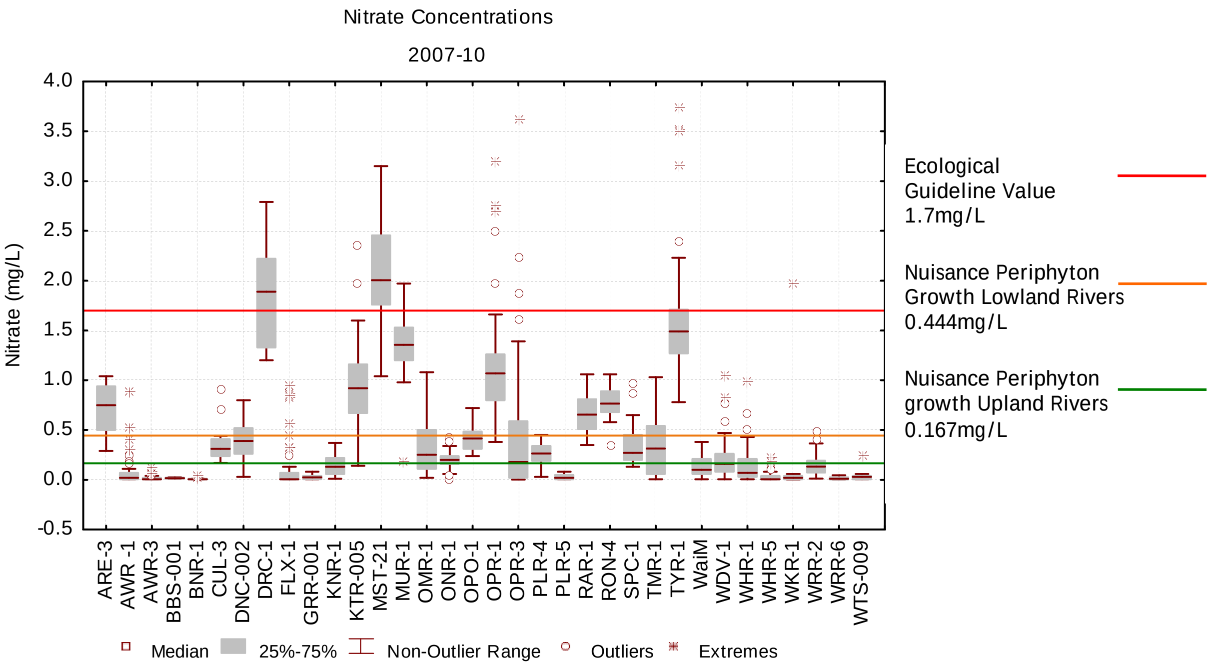
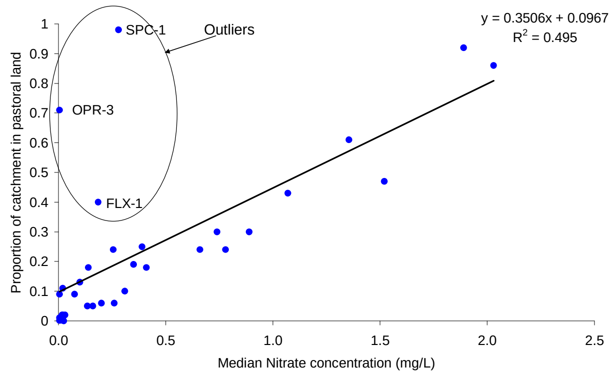


Figure 3: Boxplot showing the summary statistics for nitrate for the 34 monthly monitored SoE sites in relation to the relevant guideline values. Figure 1 gives the reference for each of the site ID's.

Median nitrate concentrations are highly correlated with the percentage of pastoral land in the catchment. The higher the proportion of pastoral land in the catchment the higher the nitrate concentrations (Figure 4).

(a) **(b)**



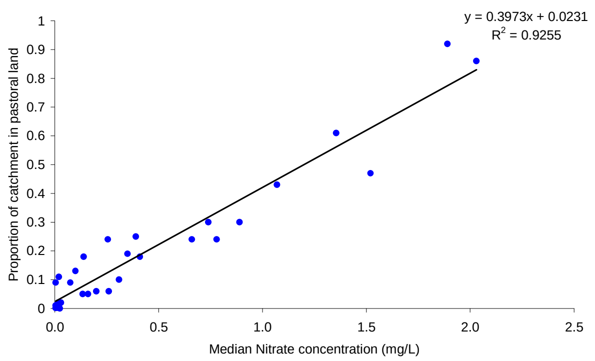


Figure 4: (a) Median nitrate concentrations (2007-10) for the 34 sites versus the proportion of the catchment in pastoral land. (b) Median nitrate concentrations (2007-10) the SoE sites with the outliers removed versus the proportion of the catchment in pastoral land.

There are three distinct outliers when looking at the relationship between increasing nitrate concentrations and increasing percentage of pastoral land in the catchment (Figure 4(a)). Spring Creek (SPC-1) has lower nitrate concentrations than expected; this is most probably due to the influence of the Wairau River on water quality in Spring Creek. It is likely that changes in water quality of the Wairau River will have the biggest influence on water quality in Spring Creek rather than land use practices in the immediate catchment. The reason for lower nitrates in the Opawa at Hammerichs Road and the Flaxbourne is less clear but may be a result of uptake from plants and algae.

3.1.2. Dissolved Reactive Phosphorus (DRP)

In rivers and streams dissolved reactive phosphorus (DRP) is the most bioavailable form of phosphorus available to plants and algae and is the dominant form of phosphorus found in the water column. Whilst phosphorus is an essential nutrient for plant growth, an excess of it will lead to increased plant growth which can lead to algal blooms and eutrophication.

The amount of phosphorus in a riverine system is largely determined by the geology of the area. Rock weathering produces most of the natural phosphorus entering waterways. In soils, phosphorus will sorb to clay particles and organic material, thereby slowing its movement through the subsurface. Phosphorus enrichment of rivers and streams commonly occurs through diffuse sources such as fertiliser runoff from agricultural land and point sources such as wastewater treatment works and stormwater runoff.

The median, interquartile range, non-outlier range, outliers and extremes for DRP are shown in Figure 5. The relevant guideline values are shown to the right of the boxplot.

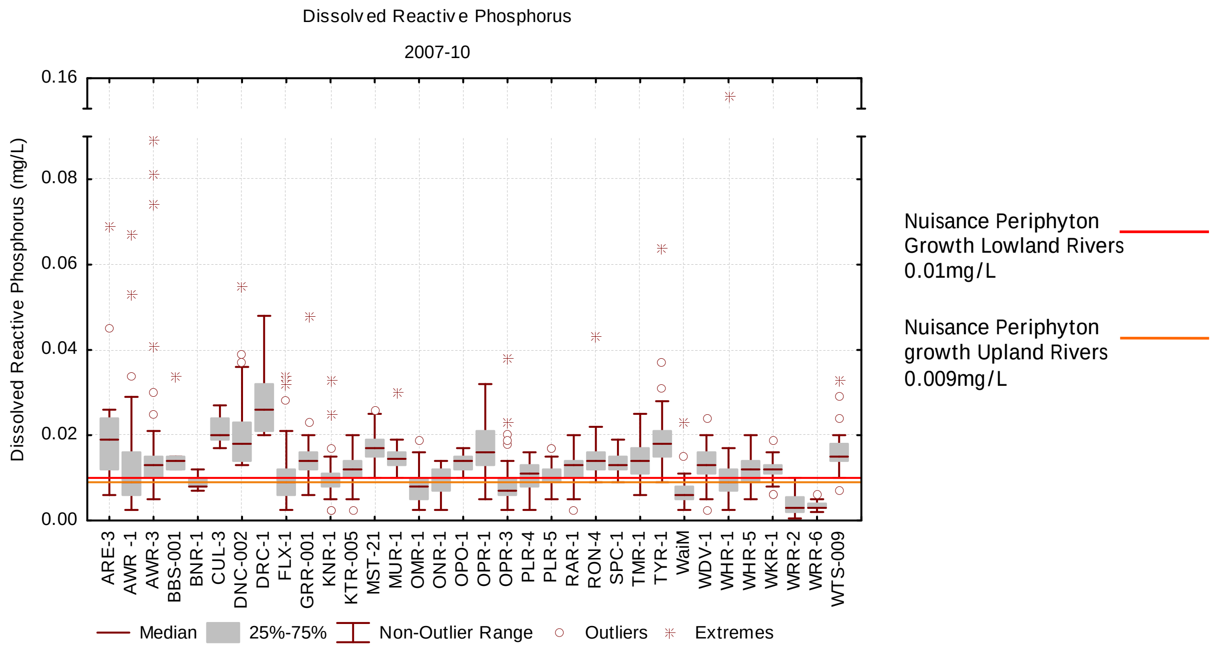


Figure 5: Boxplot showing the summary statistics for DRP for the 34 monthly monitored SoE sites in relation to the relevant guideline values. Figure 1 gives the reference for each of the site ID's.

Doctors Creek has the highest DRP concentration, followed by Cullens Creek, Duncan Stream (Linkwater), Are Are Creek, Opawa River at Hammerichs Road and the Taylor River. Extreme concentrations are recorded in the Awatere at Awapiri and the Waihopai. The extreme values at the Awatere at Awapiri do not coincide with extreme values in the lower Awatere or with rainfall/flow. The extreme value recorded at the Waihopai at SH63 does not coincide with an extreme value further upriver but does coincide with heavy rainfall and high flows, the highest for nearly 10 years recorded for the site.

Twenty nine of the thirty five sites had median concentrations above one or both of the guideline values (0.01mg/L and 0.009mg/L). Despite this it is difficult to say if all of these rivers experience nuisance algal growth as a result of elevated phosphorus levels. Lack of instream shading allowing more sunlight on the streams will also help drive plant and algal growth and therefore nutrient (nitrate and DRP) concentrations need to be correlated with other factors that contribute to algal growth (such as sunlight) in order to determine the real impact of elevated DRP concentrations at over 80% of monitored sites. As with nitrate, the lowest DRP concentrations are measured in the upper Wairau at Dip Flat (WRR-6).

3.1.3. Ammonia Nitrogen

The term 'ammonia' or 'total ammonia' refers to two chemical forms of ammonia that are present in water; the un-ionised ammonia (NH_3) form and the ionised ammonium form (NH_4^+). The ratio of the two forms is determined by temperature and pH, however the ionised form is generally the dominant form (figure 6). River waters typically have a stable pH range of 6.5 to 8.5 whilst temperature increases from winter to summer and can range from 2°C to 22°C. The un-ionised form is the form which is more toxic to aquatic life. In well oxygenated waters ammonia is quickly converted by nitrifying bacteria to nitrite and nitrate, nitrate is the dominant form of nitrogen in surface waters. Ammonia is excreted by animals and is produced during the decomposition of plants and animals. Ammonia is also present in sewage, agricultural fertilisers, landfill leachate, storm water runoff, industrial wastewaters and runoff from animal feed areas.

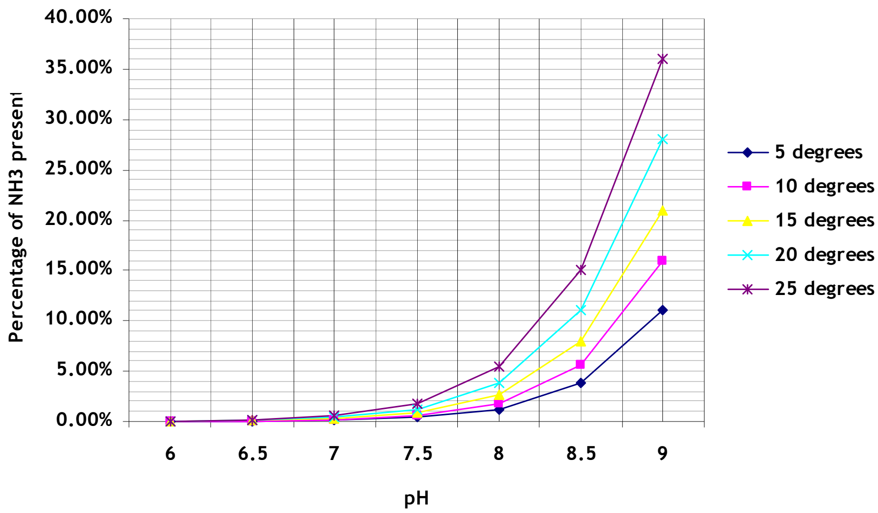


Figure 6: Percentage of un-ionised ammonia (NH_3) present at varying temperatures (°C) and pH, (USEPA, 1987).

The ANZECC guidelines specify a toxic guideline level of 0.9mg/L (95% protection level) for total ammonia (NH_3 plus NH_4^+). In addition the guidelines give a limit for ionised ammonia ($NH4^+$) of 0.01mg/L for upland rivers and 0.021mg/L for lowland rivers for the protection of ecosystem health. At normal river pH and temperature the majority of total ammonia will be in the ionised ($NH4^+$) form of ammonia and thus these upland and lowland river levels can be used for state of the environment purposes when assessing rivers against guideline values for the protection of aquatic life. The median, interquartile range, non-outlier range, outliers and extremes for ammonia are shown in Figure 7. The relevant guideline values are shown to the right of the boxplot.

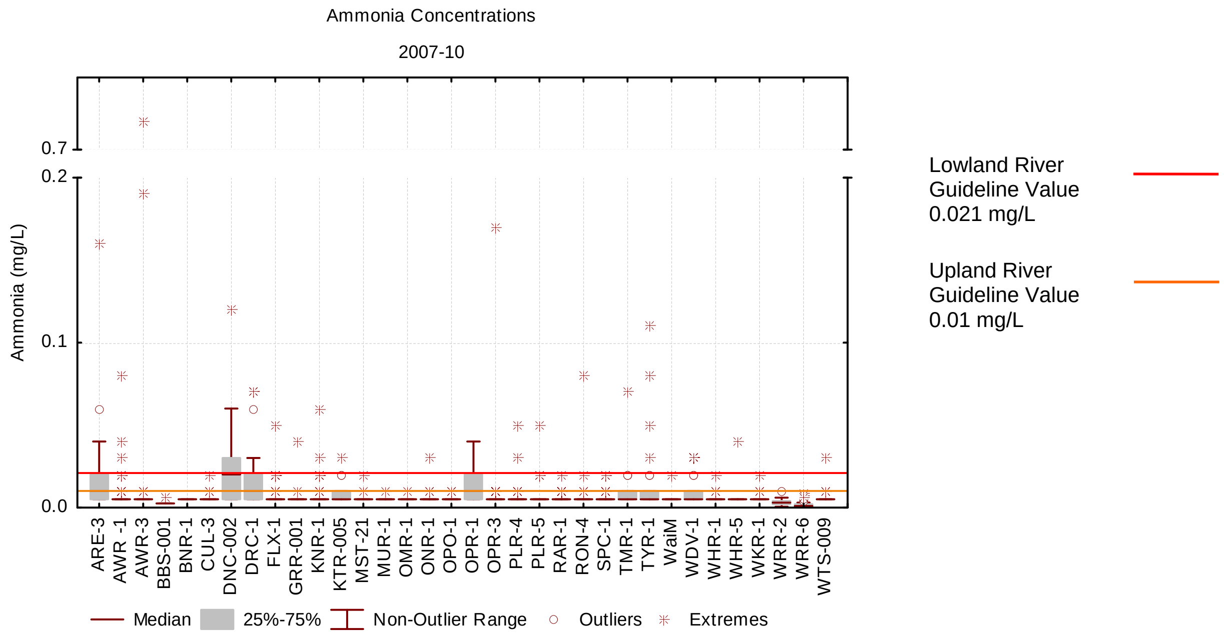


Figure 7: Boxplot showing the summary statistics for total ammonia for the 34 monthly monitored SoE sites in relation to the relevant guideline values. Figure 1 gives the reference for each of the site ID's.

Ammonia concentrations are low throughout the region and rarely exceed the relevant guideline standards. In most cases ammonia concentrations are recorded as being below the detection limit. This is a consequence of there being very few point source effluent discharges of effluent to rivers and streams and a result of its rapid degradation in the environment generally as a result of well oxygenated waters. The lowland river guideline (0.021mg/L) is rarely exceeded. Higher than average ammonia concentrations have been recorded from the Awatere at Awapiri, Duncan Stream, Doctors Creek and the lower Opawa.

3.1.4. E. coli

E. coli is a bacterium found in the gut of all warm blooded animals (including humans, mammals and birds). Its presence in water indicates the recent contamination of the water by faecal matter. *E. coli* will survive for a period of time outside the gut of warm blooded animals but cannot multiply in numbers, UV rays from sunlight will reduce their numbers over time.

The median, interquartile range, non-outlier range, outliers and extremes for *E. coli* are shown in Figure 8. The relevant guideline values are shown to the right of the boxplot.

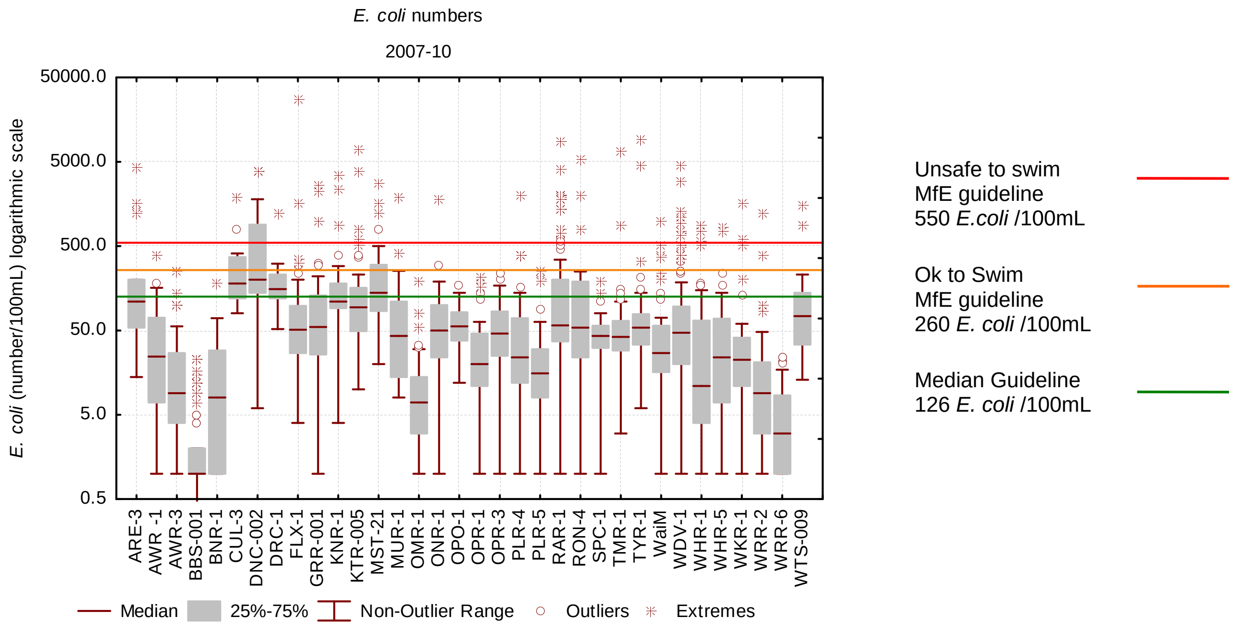


Figure 8: Boxplot showing the summary statistics for *E. coli* for the 34 monthly monitored SoE sites in relation to the relevant guideline values. Figure 1 gives the reference for each of the site ID's.

Rivers in lowland farmed areas and urban areas have the poorest water quality in terms of bacteria numbers, with numbers being particularly high during and after heavy rainfall (MDC, 2008, 2009). Rivers that exceed the median guideline of 126 *E. coli*/100mL include: Cullens Creek, Duncan Stream (Linkwater), Doctors Creek and Mill Stream. Rivers with the lowest numbers include the Awatere River, the Omaka River and the Wairau.

3.1.5. Turbidity

Turbidity is an optical property that shows the amount in which light is scattered and absorbed by particles in the water. Turbidity is a good measure of water clarity with low levels reflecting good water clarity and higher levels indicating poor water clarity. Turbidity in rivers can result from the input of fine sediments as a result of stream bank erosion, algal blooms and glacial/snow melt. Some rivers have naturally high turbidity e.g. rivers draining alpine or glacial wash areas, where large amount of fine sediment is eroded from the land and washed into the river. The Awatere River has naturally high levels of suspended sediment which results in high turbidity levels.

The median, interquartile range, non-outlier range, outliers and extremes for turbidity are shown in Figure 9. The relevant guideline values are shown to the right of the boxplot.

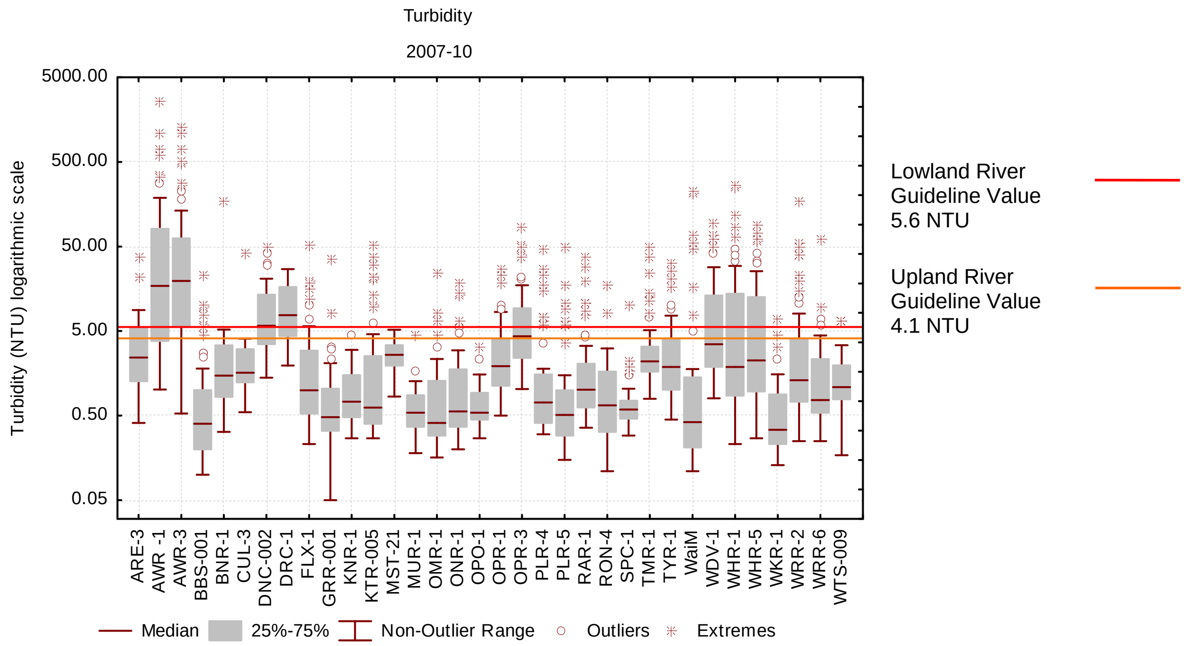


Figure 9: Boxplot showing the summary statistics for turbidity for the 34 monthly monitored SoE sites in relation to the relevant guideline values. Figure 1 gives the reference for each of the site ID's.

Rivers and streams in Marlborough generally have low levels of turbidity and consequently very good clarity (Photo 1) with median levels for nearly 90% of monitored sites within the ANZECC guidelines for upland rivers.

The highest median turbidity levels (excluding the Awatere River) are recorded at Duncan Stream (Linkwater) and Doctors Creek. The lowest (90%ile < 2NTU) turbidity levels have been recorded from the Opouri River, the Wakamarina River, Spring Creek and Murphys Creek.

Photo 1: Wakamarina River with high visual clarity as a result of low turbidity levels.

3.1.6. Suspended Solids

Total suspended solids (TSS) are a measure of the mass of suspended material in a given volume of water. It is can be comprised of mineral matter (sediment or soil), phytoplankton, plant and animal debris. Suspended solids can transport contaminants, such as metals, toxicants and pathogens in rivers. High concentrations of suspended solids will absorb light and consequently increase water temperature. The higher the water temperature the less oxygen it can hold.

The median, interquartile range, non-outlier range, outliers and extremes for total suspended solids concentrations are shown in Figure 10. The relevant guideline values are shown to the right of the boxplot.

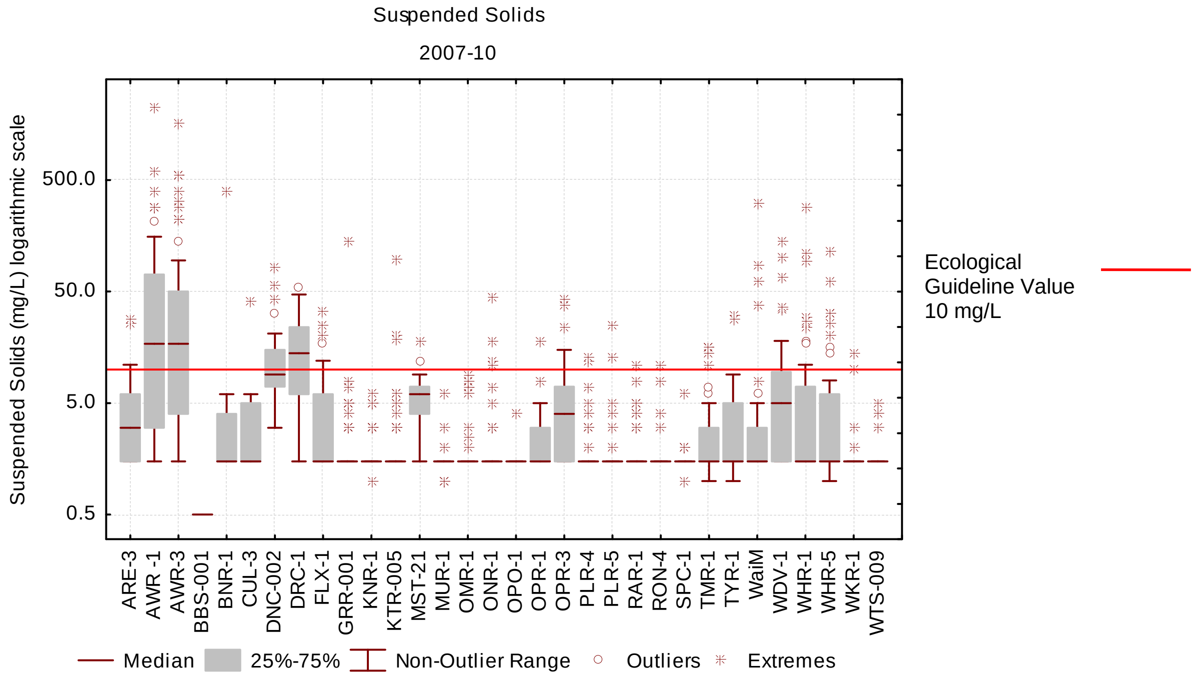


Figure 10: Boxplot showing the summary statistics for total suspended solids for 32 of the monthly monitored SoE sites in relation to the relevant guideline values. Total suspended solids are not routinely monitored by NIWA and therefore there is no data for suspended solids for the Wairau at Dip Flat (WRR-6) or State Highway 1 (WRR-2). Figure 1 gives the reference for each of the site ID's.

Suspended solids concentrations are generally low in the rivers and streams of Marlborough, with the exception of the Awatere, where levels are naturally high due to the geology of the catchment. Suspended solids concentrations are relatively high for Doctors Creek. Doctors Creek has a highly modified and cultivated catchment. There is little or no riparian vegetation along its length which makes it prone to bank erosion and sediment run-off from the surrounding land. Flooding in July 2008 would have resulted in large amounts of fine sediment entering the waterway. The creek has little flushing capacity and so much of this sediment will remain in-situ, being periodically re-suspended resulting in poor visual clarity.

3.1.7. pH

Stream water usually ranges from a pH of 6.5 to a pH of 8 (ANZECC, 2000); this range is considered to be an optimal range for most aquatic life. The natural pH of a river will vary from river to river but the pH range of a river will generally remain stable. The ANZECC guidelines state that pH limits for individual rivers and streams should be set using the 20th and 80th percentiles based on seasonal medians of reference sites; changes of more than 0.5 from the seasonal minimum and maximums should be investigated (ANZECC 2000). The natural pH range of a river is largely determined by the geology and soils of the area, for example limestone areas will result in rivers and streams having naturally higher pH levels and peat areas will have naturally low pH levels. pH has a diurnal cycle i.e. it fluctuates between night and day as a result of plant respiration and photosynthesis.

The median, interquartile range, outliers and extremes for pH are shown in Figure 11. Guideline values for pH have not been shown on the plot as guidelines for pH are specific to individual water bodies i.e. some water bodies have a naturally high pH e.g. the Waima, Awatere and Flaxbourne rivers due to the geology of the area, whilst other water bodies can have a low pH e.g.

some areas of the west coast have naturally low pH values, as low as 4 due to humic acids or young sedimentary geologies with a pyrite component (WCRC, 2005).

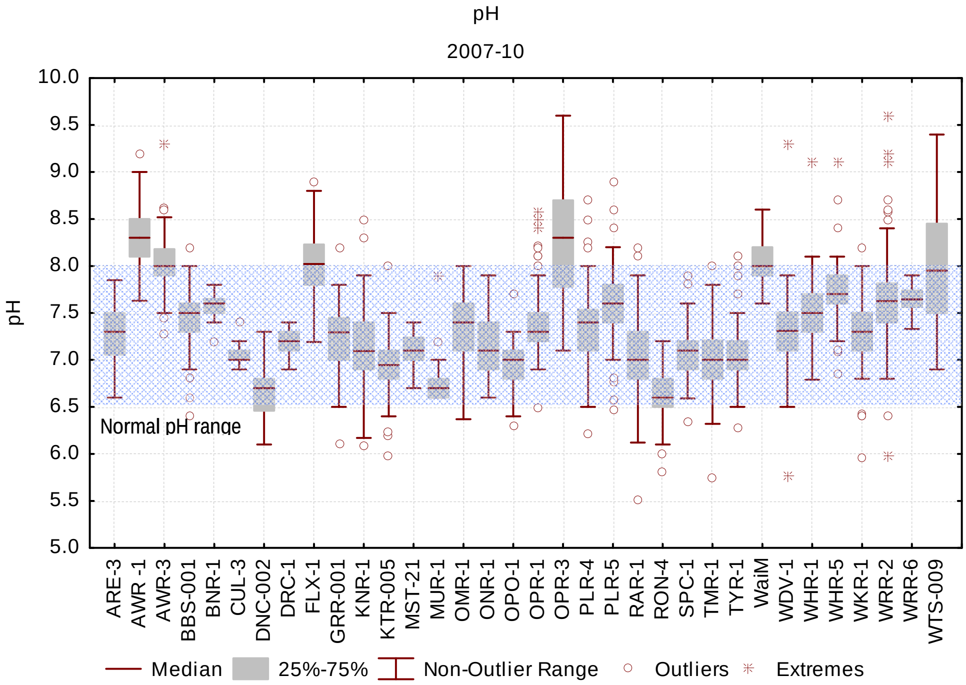


Figure 11: Boxplot showing the summary statistics for pH for the 34 monthly monitored SoE sites. Figure 1 gives the reference for each of the site ID's. The blue band depicts the 'normal' range for rivers as defined by the ANZECC guidelines.

High pH values recorded from the Opawa and the Waitohi can not be completely explained by the underlying geology and anthropogenic influences may be influencing the pH of these rivers. In addition these rivers have the largest pH range of the 34 monitored sites.

3.1.8. Specific Conductivity

Specific conductivity is conductivity measured at 25°C. Conductivity is a measure of the ability of water to conduct an electrical current. The temperature of water influences the conductivity values with warmer waters having lower conductivity values; this is why conductivity is commonly measured at a standard temperature of 25°C; to allow for comparisons throughout the year and between different water bodies. Conductivity gives an estimate of the amount of dissolved inorganic solids such as chloride, sulphate, sodium, calcium etc. present in the water. The conductivity of a river will principally be determined by the geology and soils of the catchment through which the river flows. Catchments comprised of 'hard' rocks such as granite will have rivers with low conductivity values whilst catchments with 'soft' rocks such as limestone and clay soils will have higher conductivity values. The conductivity of a river will tend to remain within a specified range. Conductivity is often used as a surrogate for water pollution as a gradual increase in conductivity over time can be an indication of pollution. Urban runoff and industrial pollution are characterised by high conductivity. Organic compounds such as oil are not good electrical conductors and thus oil spills will tend to lower the conductivity of water. The median, interquartile range, non-outlier range, outliers and extremes for specific conductivity are shown in Figure 12. Figure 12 shows that the lower Opawa and the Wairau Diversion have the highest variability in conductivity, this is due to the sites being influenced by the saline water from the coast.

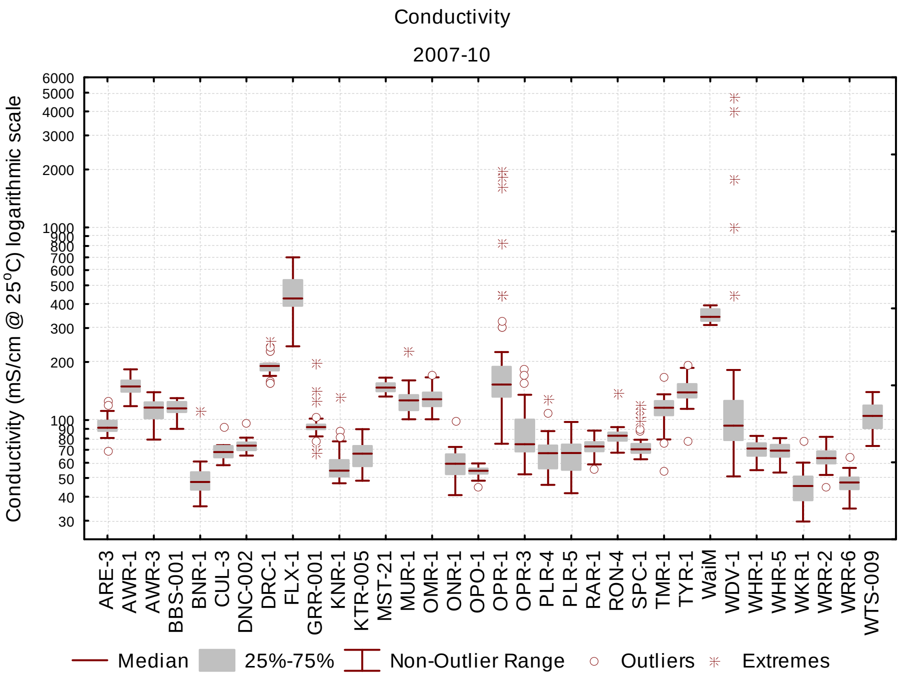


Figure 12: Boxplot showing the summary statistics for specific conductivity for the 34 monthly monitored SoE sites. Figure 1 gives the reference for each of the site ID's.

3.1.9. Dissolved Oxygen

Healthy aquatic ecosystems depend on a good supply of oxygen being dissolved in the water column. Faster flowing sections of rivers and streams will have better oxygenated waters than slow flowing sections of rivers or rivers that have been modified as straight channels. The amount of dissolved oxygen in the water is also dependent on temperature, with cooler waters having more dissolved oxygen than warmer waters. Spring fed streams will often have lower oxygen levels as the amount of oxygen dissolved in groundwaters will be less than that of surface waters. Aquatic plants will add oxygen to the water but their overabundance can lead to oxygen super saturation during the day and consequently very low levels at night when photosynthesis ceases but respiration (which uses oxygen) continues. This fluctuation in oxygen can stress the aquatic communities living there. A common cause of low oxygen waters is where organic material (from wastewater treatment works, agricultural runoff etc.) is added to the water. Bacteria break down this material and in so doing use up the available oxygen in the water to the extent that waters can become severely depleted of oxygen or anoxic. Whilst most species require well oxygenated waters in order to survive e.g. stoneflies are only found in cool, well oxygenated waters, some species thrive in low oxygen waters. The presence or the abundance of these species can be an indicator of organic enrichment.

The median, interquartile range, non-outlier range, outliers and extremes for dissolved oxygen are shown in Figure 13. The normal range for dissolved oxygen in healthy ecosystems lies between 80 and 120%. Surface waters in Marlborough are predominately within this range, however some sites fall outside this range. The Tuamarina shows the largest dissolved oxygen range. Factors such as salinity, temperature, groundwater inflow, the presence of organic matter and plant life all have an influence on dissolved oxygen concentrations. Dissolved oxygen exhibits diurnal and seasonal variations in concentrations. In order to accurately assess the health of a river with regard to dissolved oxygen, continuous monitoring during the critical summer months when dissolved oxygen is likely to be at its lowest, should be carried out. Spot measurements, such as those carried out for the analysis in Figure 13 are a useful way of identifying where dissolved oxygen levels are likely to have a detrimental effect on aquatic life and where further more intensive monitoring can be carried out.

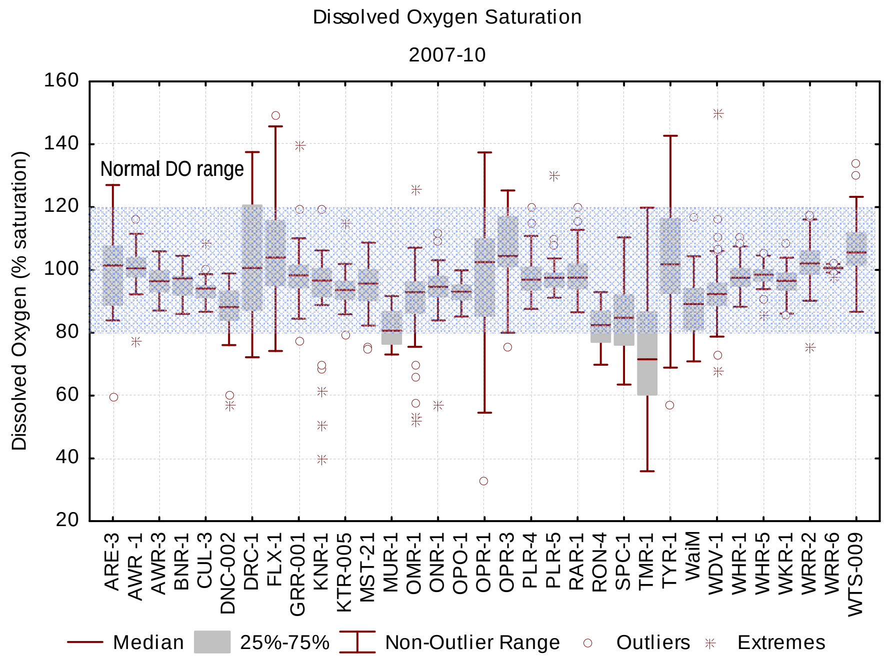


Figure 13: Boxplot showing the summary statistics for dissolved oxygen for 33 monthly monitored SoE sites. Figure 1 gives the reference for each of the site ID's. The blue band depicts the dissolved oxygen range expected for normal healthy rivers.

A narrow dissolved oxygen range such as that seen for the Waihopai River, the Wairau, the Wakamarina and the Opouri is a good indication that oxygen levels within the river are stable and thus unlikely to have a negative impact on aquatic life. Large dissolved oxygen ranges as seen for Doctors Creek, the Opawa, the Flaxbourne and the Taylor for example indicate the potential for the ecosystem to become stressed due to low oxygen levels, eventhough for the most part the concentrations lie within the normal range.

3.1.10. Temperature

The median, interquartile range, non-outlier range, outliers and extremes for temperature are shown in Figure 14. Temperature changes from season to season with warmer temperatures occurring in the summer months and colder temperatures during the winter months. Some of the factors that influence the degree to which temperatures increase in surface waters during the summer months include:

- Altitude; upland rivers and streams are generally cooler than lowland rivers and streams
- Degree of shading e.g. from riparian vegetation, cliffs, tall buildings etc.
- Groundwater inflow
- Substrate type and degree of exposure to sunlight e.g. gravels within a braided rivers system absorb and retain heat thereby acting as radiators heating up the surrounding water, fine sediment within a river or stream will act in much the same way.

The narrowest temperature range is observed in spring fed system where the temperature of the water largely reflects the temperature of groundwater e.g. Murphys Creek and Spring Creek. Some aquatic organisms such as stone flies, some mayflies and trout are sensitive to elevated temperatures and can become stressed or disappear completely where elevated temperatures persist. Elevated temperatures (above 20^{o}C) are generally not a problem in Marlborough's rivers and streams.

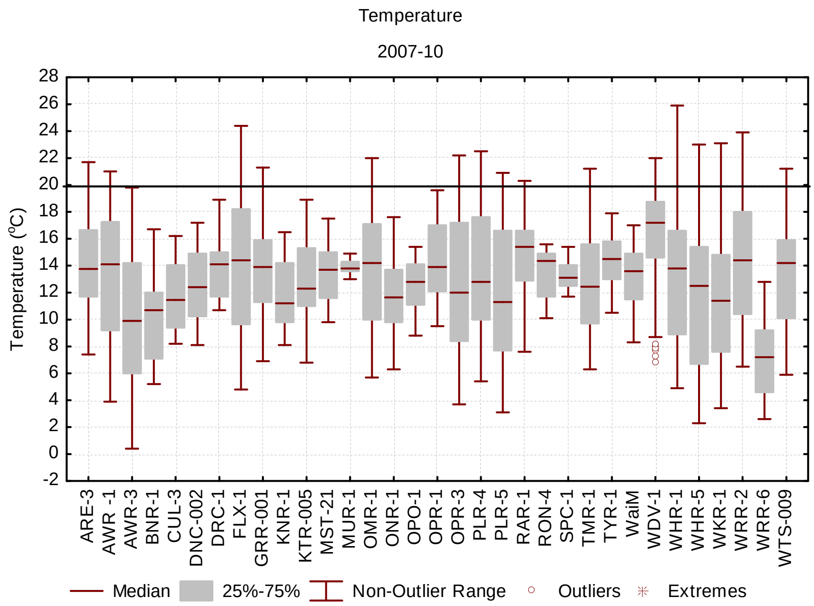


Figure 14: Boxplot showing the summary statistics for temperature for 33 monthly monitored SoE sites. Figure 1 gives the reference for each of the site ID's.

3.1.11. Metals

Copper, lead and zinc are three of the most common metal pollutants from runoff in urban areas of New Zealand (Zander, 2005), however lead concentrations are in decline due to the phasing out of lead based paints and petrol (Suren and Elliott, 2004). Vehicle brake emissions and buildings account for sources of copper whilst tyre wear and catchment roof run-off are common sources for zinc. Copper is also commonly used in horticulture as a pesticide. Arsenic has been found in some groundwaters in the Wairau plains and is mainly associated with current or historic wetlands where redox conditions cause it to become soluble. These same reducing conditions exist in deep aquifer systems beneath the Wairau Plains and it is likely that arsenic exists naturally in these groundwaters (Callander and Loomer, 2002; Robinson *et al.*, 2004). Arsenic is also commonly used for the treatment of vineyard posts. Vineyards now account for just less than 24,000 hectares of the Marlborough region. Copper, zinc and arsenic are analysed for at the following surface water monitoring sites:

- Are Are Creek ARE-3
- Doctors Creek DRC-1
- Murphys Creek MUR-1
- Opawa (upper) OPR-3
- Opawa (lower) OPR-1
- Taylor River TYR-1
- Waitohi River WTS-009

Both total and dissolved metals are analysed for completeness. The ANZECC guidelines do not specify the form (whether dissolved or total) to which the guidelines refer to, commonly it is the dissolved phase of a metal which can have the greater ecological impact, however measuring the total metal concentration gives a more complete picture of metal concentrations.

Results are shown in Appendix 5. Arsenic has not been recorded above the guidelines at any of the sites. Low concentrations of arsenic have been recorded from the Taylor River; the upper and lower Opawa; Are Are Creek and Murphys Creek.

Zinc has been recorded above the guideline at all monitored sites. Copper has been recorded above the guideline at all monitored sites with the exception of Murphys Creek. Figures 15 and 15 compare zinc and copper concentrations at the Blenheim sites.

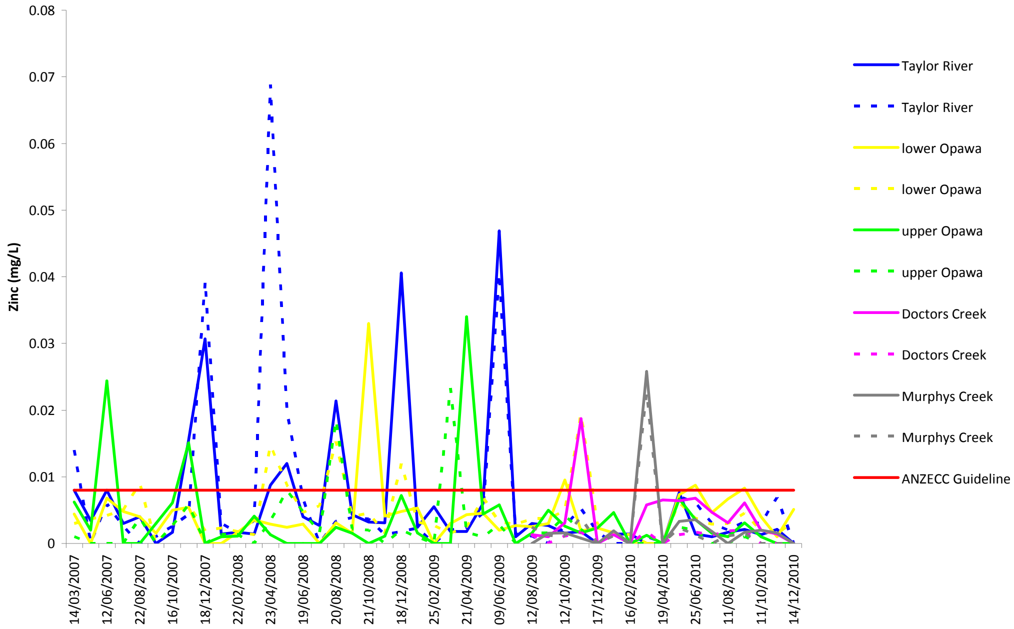


Figure 15: Zinc concentrations for the Blenheim sites. Total concentrations are shown as continuous lines and dissolved concentrations are shown as broken lines.

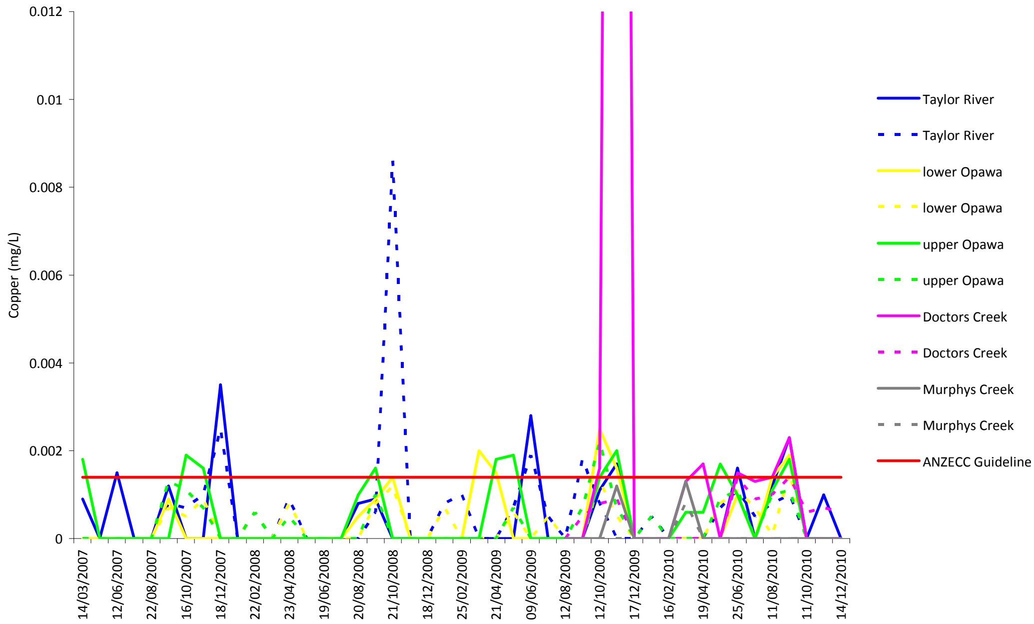


Figure 16: Copper concentrations for the Blenheim sites. Total concentrations are shown as continuous lines and dissolved concentrations are shown as broken lines.

The highest recorded copper concentration (0.064mg/L) was from Doctors Creek on the 17th November 2009 (Figure 16). This coincided with a peak in zinc concentrations. The zinc guidelines are regularly exceeded in the Taylor River, the upper and lower Opawa and the Waitohi. Doctors Creek, Murphys Creek and Are Are Creek have exceeded the guideline on one occasion. On occasion the dissolved metal concentration is higher than the total metal concentrations. In most cases this is due to the different detection limits for the two test methods (detailed in Appendix 3) and the error associated with each test (approx. ± 10%). However there are occasions when the dissolved concentrations are significantly higher than the total concentrations. Due to the very low concentrations of metals in the water samples, it is possible that the samples could have been contaminated somewhere between taking the sample and analysing the sample at the laboratory. Filtering during the testing for dissolved metal concentrations can contaminate samples and may have been responsible for some of the anomalous results.

3.2. Water Quality Index (WQI)

A water quality index is a way of summarising differing amounts and types of water quality data into a simple, single score. For example, the calculation of a single score can be based on results from 180 samples. By its nature the score is somewhat subjective but the derivation of the score is based on actual data and assessed against known quality criteria (guidelines). An index is most useful for comparisons, communications and general questions. More specific questions and decisions should be made based on the analysis of the original water quality data. The water quality index (WQI) presented here is unitless and ranges from 1 to 5. A higher number is indicative of poorer water quality. Limitations with using a WQI are 1) the index is based on a set of predefined water quality parameters and thus poor water quality as a result of a parameter that is not measured (or not incorporated into the index) will not be reflected in the WQI score and 2) because the score is an aggregation of data it can either mask or over emphasise short-term water quality problems. The derivation of the WQI is shown in Appendix 6.

Figure 17 shows the water quality index scores for the 34 sites and the corresponding category into which they fall. Nearly half fall into the 'Good' or 'Excellent' categories, whilst about a quarter are classed as 'Poor' or 'Very Poor'. Water quality data from 2007 onwards has been used in the derivation of the scores. In order to make comparisons between sites the number of samples per site must be comparable, therefore scores have been defined as complete or incomplete depending on the number of samples used to derive the score. A score is complete when at least 30 samples have been collected over a three year period. The calculation of the scores is shown in Appendix 7. Sites marked in grey (figure 17) have insufficient data to calculate a complete score; these scores are classed as interim until at least 30 samples over a 3 year period have been collected.

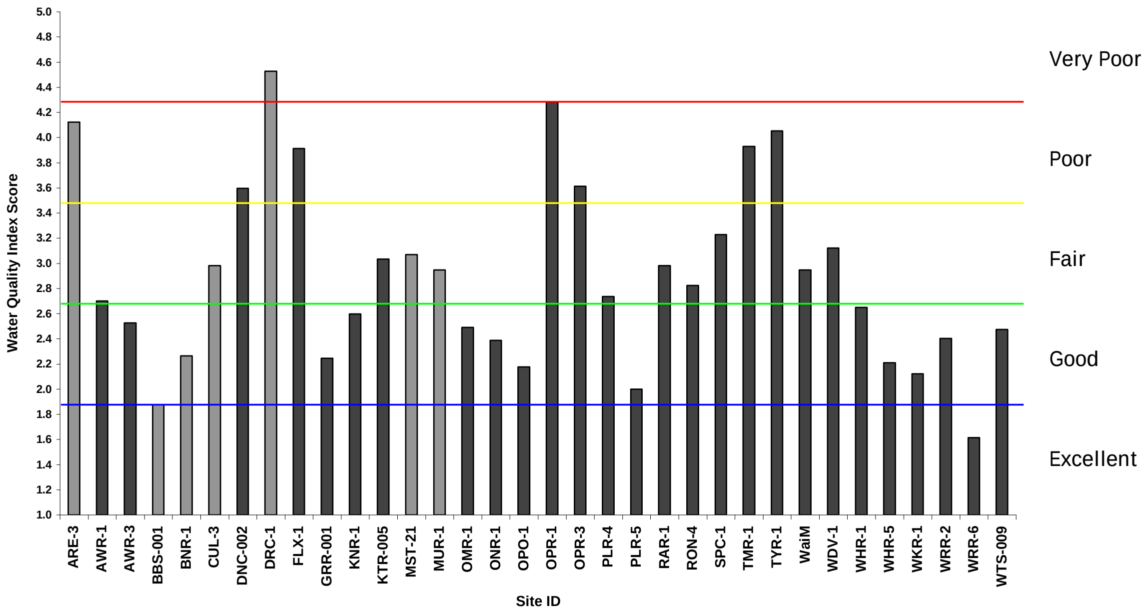


Figure 17: Water Quality Index scores for the 34 SoE sites.

Doctors Creek has the poorest water quality. The Opawa (both upper and lower sites), the Taylor, Tuamarina, Flaxbourne, Duncan Stream (Linkwater) and Are Are Creek are all classed as poor. Table 3 compares the water quality index scores calculated in 2010 (MDC, 2010) using data from 2007-09 with this years scores, using data from 2007-10.

Table 3: WQI scores calculated in 2010 and 2011

Site ID	WQI Score 2010	WQI Score 2011	Score Change	Grade Change
ARE-3	3.7	4.1	0.4	No change
AWR-1	2.7	2.7	0.0	No change
AWR-3	2.3	2.5	0.3	No change
BBS-001	n/a	1.9	n/a	n/a
BNR-1	2.8	2.3	-0.5	**Fair → Good**
CUL-3	2.6	3.0	0.4	**Good → Fair**
DNC-002	3.6	3.6	0.0	No change
DRC-1	4.1	4.5	0.4	**Poor → Very Poor**
FLX-1	3.4	3.9	0.6	**Fair → Poor**
GRR-001	2.4	2.2	-0.1	No change
KNR-1	2.9	2.6	-0.4	**Fair → Good**
KTR-005	3.1	3.0	-0.1	No change
MST-21	3.1	3.1	-0.1	No change
MUR-1	3.3	2.9	-0.3	No change
OMR-1	2.5	2.5	0.0	No change
ONR-1	2.1	2.4	0.3	No change
OPO-1	2.2	2.2	0.0	No change
OPR-1	4.0	4.3	0.3	No change
OPR-3	3.6	3.6	0.0	No change
PLR-4	2.8	2.7	-0.1	No change
PLR-5	2.3	2.0	-0.3	No change
RAR-1	3.0	3.0	0.0	No change
RON-4	2.8	2.8	0.0	No change
SPC-1	3.0	3.2	0.3	No change
TMR-1	3.9	3.9	0.0	No change
TYR-1	4.3	4.1	-0.3	**Very Poor → Poor**
WaiM	2.6	2.9	0.3	**Good → Fair**
WDV-1	3.4	3.1	-0.3	No change
WHR-1	2.6	2.6	0.0	No change
WHR-5	2.2	2.2	0.0	No change
WKR-1	2.1	2.1	0.0	No change
WRR-2	2.4	2.4	0.0	No change
WRR-6	1.2	1.6	0.4	No change
WTS-009	2.2	2.5	0.3	No change

The change in water quality grade should be compared with statistical trends in water quality data for the site in order to correctly interpret the results. It is recommended that fives years worth of data is collected for carrying out trend analysis. Comprehensive trend analysis will be carried out at selected sites in 2012.

3.3. Aquatic Macroinvertebrates

Aquatic macroinvertebrates are used worldwide for assessing water quality in rivers and streams. Their usefulness lies in the variety of species found and the relative tolerance of each species to different forms of disturbance, such as organic enrichment. Macroinvertebrates have relatively short life cycles and are relatively immobile and are therefore a good indicator of localised disturbance.

3.3.1. Sampling Methods

Aquatic macroinvertebrates are sampled annually at 51 sites in Spring/early Summer. Sampling occurs under stable flows, high and low flows are avoided. Sampling is carried out in stony riffle areas where possible. The substrate is disturbed upstream of the D-net for a period of 3 minutes. Samples are taken using Protocol C1 and analysed in the lab using Protocol P1 (Stark *et al*., 2001). The sample is then washed and sorted and stored in 95% ethanol before being transported to Stark Environmental Ltd for analysis.

3.3.2. Macroinvertebrate Indices

The Macroinvertebrate Community Index (MCI) and its quantitative variant (QMCI), used to assess organic enrichment in wadeable stony streams, was first proposed in the early 1980's (Stark, 1985). Later work looked at the performance and precision of the indices (Stark 1993) where a national dataset was used to investigate the influence of sampling method, water depth, current velocity and substrate on the MCI and QMCI. The results showed that the indices were independent of depth, velocity and substrate; attributes necessary when assessing water pollution. Stark later developed a more cost-effective variant of the QMCI called the Semi-Quantitative Macroinvertebrate Community Index, or SQMCI (Stark 1998). The SQMCI uses a five-point scale of coded abundances (i.e. Rare, Common, Abundant, Very Abundant, Very Very Abundant). This index produces values very similar to the QMCI, but at a much reduced cost.

3.3.3. Calculating the MCI and SQMCI

The MCI is calculated from **presence-absence** data as follows:

$$\mathrm{MCI} = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$$

S = the total number of taxa in the sample
a_i = the pollution tolerance value for the ith taxon (i.e 10 = highly intolerant, 1= highly tolerant).

The SQMCI is calculated from the **abundance** of various taxa, coded abundances are used i.e. R = Rare; C = Common; A = Abundant; VA = Very Abundant; VVA = Very Very Abundant. The score is calculated as follows:

$$\mathrm{SQMCI} = \sum_{i=1}^{i=S} \frac{(n_i \times a_i)}{N}$$

S = the total number of taxa in the sample
a_i = the pollution tolerance value for the ith taxon (see above)
n_i = the coded abundance for the ith scoring taxon (i.e. R = 1, C = 5, A = 20, VA = 100, VVA = 500)
N = the total of the coded abundances for the entire sample.

MCI values range from 0 to 200 (Stark 1985) whilst SQMCI values range from 0 to 10 (Stark 1998). However most MCI values are in the range of 50 – 150 and most SQMCI values are in the range of 2.5 to 7.5. Values of zero indicate that no macroinvertebrates are present, the higher the score the better the water quality.

3.3.4. Interpretation of the biotic indices scores

The interpretation of biotic index scores was initially based on levels of enrichment or pollution (Stark, 1998) as shown in Table 4. However it is now widely recognised that biotic indices respond to a number of environmental variables, including, but not limited to enrichment. This has led to the descriptors Excellent, Good, Fair, Poor as shown below (Stark and Maxted, 2004, 2007).

Table 4: Interpretation of the biotic indices scores (Stark (1998); Stark and Maxted (2007))

Interpretation	Class	MCI score	SQMCI score
Clean Water	Excellent	> 119	> 5.99
Doubtful quality or possible mild pollution	Good	100 – 119	5 – 5.99
Probable moderate pollution	Fair	80 - 99	4 – 4.99
Probable severe pollution	Poor	< 80	< 4

The MCI and SQMCI have an accuracy of approximately ±10% from a single hand-net sample (Stark, 1998). For example, an MCI score of 105 taken at face value would assign a site to the "good" quality class, but given the ±10% error associated with the sampling method, the actual MCI could range from 95 to 115, however the balance of probability is such that the true MCI class would lie in the "good" class, but it could also possibly be classified as "fair". The MCI is less sensitive to subtle changes in community composition than the SQMCI as it is principally a tool to assess changes in community composition (i.e. presence/absence of taxa) and not numerical (or abundance) composition. Stressors in an environment (such as organic enrichment) will often lead to a change in community structure with regard to the relative abundance of taxa, if the stressors persists then eventually the community structure will change with regard to the presence/absence of taxa.

3.3.5. Macroinvertebrate Results

The full results from the macroinvertebrate sampling are shown in Appendix 7. The MCI scored 76% of sites in the Good to Excellent category whilst the SQMCI scored 70% of sites in the Good to Excellent category. Figures 18 and 19 show each of the sites and the Quality Class into which they fall.

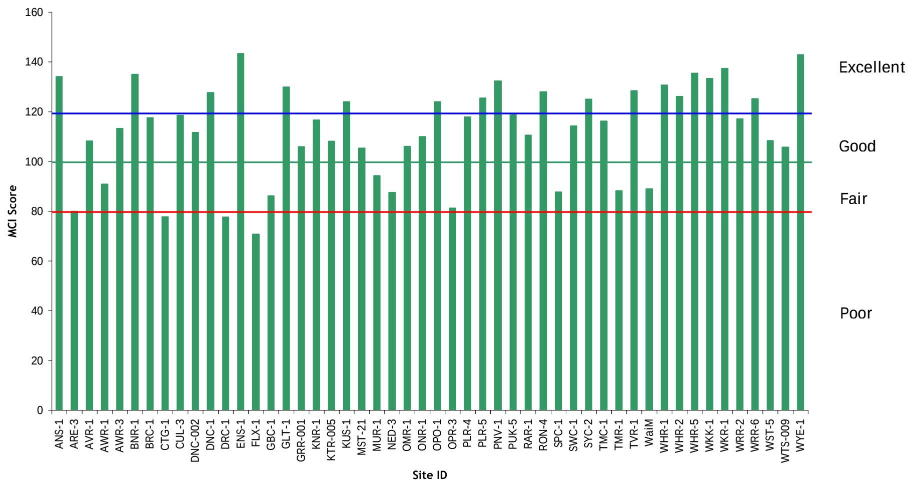


Figure 18: MCI scores for macroinvertebrate samples taken in 2010.

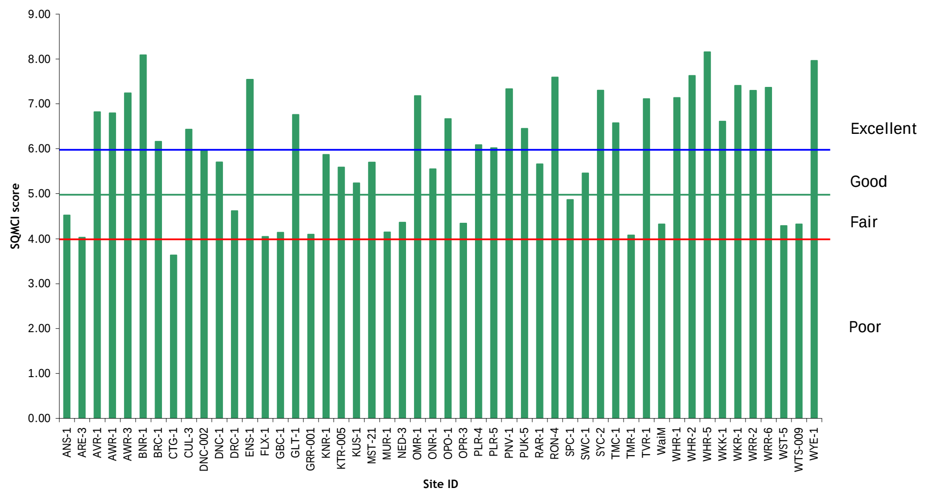


Figure 19: SQMCI scores for macroinvertebrate samples taken in 2010.

Anakoha Stream (Photo 2), despite a high MCI score (134 = excellent) shows signs of localised pollution as its SQMCI score is only 4.52, which classes it as Fair. This is due to the abundance of pollution sensitive species present in the sample, particularly the true fly *Maoridiamesa* spp. Anakoha Stream is located in the outer Marlborough Sounds. 80% of the catchment is in indigenous forest, with the remaining being predominately comprised of scrub and pastureland. Stock (cattle and sheep) access to the stream was noted at the time of sampling causing minor erosion of both sides of the stream bank.

Photo 2: Anakoha Stream (ANS-1)

The Avon River (Photo 3) scores lower on the MCI than with the SQMCI. The SQMCI score classes it as excellent (SQMCI=6.82), whilst the MCI only classes the river as good (MCI=108), even taking into account an accuracy of ±10% the MCI still classes the site as good and not excellent. The Avon River site is located in a catchment which is predominately scrub and tussock (>50%), with the remaining land divided between indigenous forest and pastoral land. Organic enrichment is unlikely to be a problem, hence the high SQMCI score but disturbance from flash floods and stream bank erosion may have an effect on the overall macroinvertebrate composition. Reference conditions for this catchment would need to be assessed before a judgement could be made about the quality class for the MCI value.

Photo 3: The Avon River (AVR-1). **Photo 4: The Awatere River at Awapiri (AWR-3)**

The MCI values for the Awatere River (AWR-1 and AWR-3) are both lower than the SQMCI. The SQMCI classes the waters as Excellent whilst the MCI only classes the waters as Fair or Good. Again, similar to the Avon River, this may have more to do with assigning appropriate quality classes to the Awatere River based on reference conditions for the catchment. The characteristics of the river (high suspended solids, flash flows) (Photo 4) may mean that the best MCI score for the river may only be classed as Good.

The Graham River (GRR-001) is classed as good according to the MCI (MCI=106) and Fair according to the SQMCI (SQMCI=4.09). Indigenous forest and scrub account for more than 95% of the catchment land use, pastoral land accounts for only 2%. The disparity between the water quality classes based on the macroinvertebrate assemblages and catchment land cover suggests that there are other factors affecting the macroinvertebrate assemblages found at this site. The stream banks are steep and highly eroded in the lower reaches and may be a factor in the poor macroinvertebrate fauna at this site. Two pollution tolerant taxa (*Maoridiamesa* spp. and Orthocladinae) were found to be abundant at this site and may suggest localised organic enrichment.

Photo 5: The Graham River (GRR-001)

Kaiuma Bay Steam (KUS-1) is classed as Excellent using the MCI score and only Good when using the SQMCI score. The catchment is comprised of 57% indigenous forest, 18% exotic forest, 15% pastoral land with the remainder mainly comprised of scrub. There was a distinct lack of mayflies and stoneflies at the site with only two species of mayflies being recorded. The two mayfly species were described as Rare in the sample.

The Omaka River (OMR-1) is classed as Excellent using the SQMCI score (SQMCI=7.18) and Good using the MCI score (MCI=106). The river in its lower reaches often runs dry over the summer months and this may lead to repetitive stress on the macroinvertebrates assemblages. This may account for the poorer MCI score in relation to the SQMCI score.

All of the other sites sampled showed MCI scores and SQMCI scores in the same Quality class, taking into account an accuracy of approximately ±10% for the sampling methodology. In the long term it may be more appropriate to assess quality classes for rivers and streams in Marlborough based on reference site data, particularly for the Awatere and East coast catchments where MCI and SQMCI scores showed significant differences.

It is important to identify the natural distribution of macroinvertebrate communities for particular catchments/geographic regions i.e. the natural reference conditions, in order to accurately assess stream health and to establish stream rehabilitation programmes (Weigel *et al*. 2003). The MCI scores can then be 'benchmarked' against the relevant reference condition scores.

4. Land Use Effects

Table 5 below shows the correlation between the various indices and a number of catchment characteristics as defined by Leathwick *et al.* (2010). Spearman rank correlations (r_s) were calculated using STATISTICA 7. The WQI and the MCI are highly correlated (r_s=-0.78) as are the MCI and SQMCI (r_s=0.82). The correlation between the MCI and the SQMCI compares favourably with those made by Wright-Stow and Winterbourn (2003) where 230 sites in Canterbury were analysed giving an r_s=0.86. The WQI shows a better correlation with the MCI than with SQMCI. Weigel *et al*. (2003) studied the influence of environmental variables on macroinvertebrate assemblages at different spatial scales i.e. catchment, reach and riparian spatial scales. They found that whilst the catchment and reach variables were equally influential in defining the macroinvertebrate composition, the reach scale (more local scale) was more influential in determining relative abundance and presence/absence of taxa. The appropriateness of the index being used should account for the scale at which the analysis is being done. The SQMCI is commonly used to assess localised or short term effects on water quality e.g. for compliance monitoring. Stark and Maxted (2007) recommend the use of the MCI for SoE reporting.

Both the MCI and WQI show a greater correlation with land use in the catchment than the SQMCI. These indices are particularly highly correlated with the percentage of indigenous forest in the catchment and with the percentage of pastoral land in the catchment indicating that these two land uses have the greatest impact (positively and negatively respectively) on water quality.

Table 5: Correlation between the water quality index (WQI) and the macroinvertebrate indices (SQMCI and MCI) with catchment characteristics as defined by Leathwick *et al*. (2010). Statistically significant correlations (p<0.05) are marked in red.

	WQI	Number of taxa	MCI	SQMCI	EPT^{taxa} (excluding *Oxyethira)*
WQI	1.00				
Number of taxa	-0.40	1.00			
MCI	-0.78	0.43	1.00		
SQMCI	-0.63	0.28	0.82	1.00	
EPT^{taxa} (excluding *Oxyethira)*	-0.73	0.32	0.88	0.77	1.00
CATCHMENT CALCIUM	0.32	-0.17	-0.54	-0.59	-0.49

CATCHMENT HARDNESS	-0.49	0.33	0.41	0.41	0.37
CATCHMENT PHOSPHOROUS	0.12	-0.14	-0.29	-0.22	-0.16
CATCHMENT PROPORTION ALLUVIUM	0.43	-0.10	-0.42	-0.35	-0.38
CATCHMENT PROPORTION BARE LAND	-0.43	-0.20	0.30	0.56	0.31
CATCHMENT PROPORTION EXOTIC FOREST	0.37	-0.01	-0.11	-0.21	-0.27
CATCHMENT PROPORTION INDIGENOUS FOREST	-0.48	0.48	0.51	0.10	0.37
CATCHMENT PROPORTION MISCELLANEOUS LANDCOVER	-0.08	0.08	0.05	0.01	0.01
CATCHMENT PROPORTION PASTORAL FARMING	0.66	-0.09	-0.63	-0.46	-0.50
CATCHMENT PROPORTION SCRUB	-0.01	-0.27	-0.09	0.07	0.05
CATCHMENT PROPORTION TUSSOCK	-0.31	-0.26	0.16	0.47	0.22
CATCHMENT PROPORTION URBAN	0.02	-0.31	-0.15	-0.27	-0.09
CATCHMENT RAINFALL VARIABILITY	0.38	-0.18	-0.52	-0.34	-0.53
DISTANCE TO COAST (m)	-0.41	0.25	0.39	0.52	0.38
FLOW	-0.26	-0.35	0.19	0.43	0.43
LOW FLOW	-0.30	-0.28	0.27	0.41	0.52
NUMBER OF CATCHMENT RAINDAYS > 25mm	-0.28	0.48	0.52	0.18	0.36
SEGMENT MAXIMUM ELEVATION (m)	-0.44	0.13	0.38	0.49	0.31
SEGMENT MINIMUM ELEVATION (m)	-0.44	0.11	0.37	0.48	0.31
SEGMENT SINUOSITY	0.08	0.26	-0.08	0.04	-0.10
SEGMENT SLOPE	-0.35	0.11	0.42	0.44	0.33
TEMPERATURE SUMMER	0.45	-0.08	-0.31	-0.38	-0.20
TEMPERATURE WINTER	0.27	-0.22	-0.34	-0.48	-0.38

The WQI was graphed against the proportion of catchment in pastoral land to determine the spread of results (Figure 20). Three distinct outliers are observed. These sites were Murphys Creek, Mill Stream and Spring Creek (MUR-1, MST-21 and SPC-1). It would appear that Spring Creek, Murphys Creek and Mill Stream all have better water quality that what could be expected given the proportion of pastoral land in the catchment.

(a) **(b)**

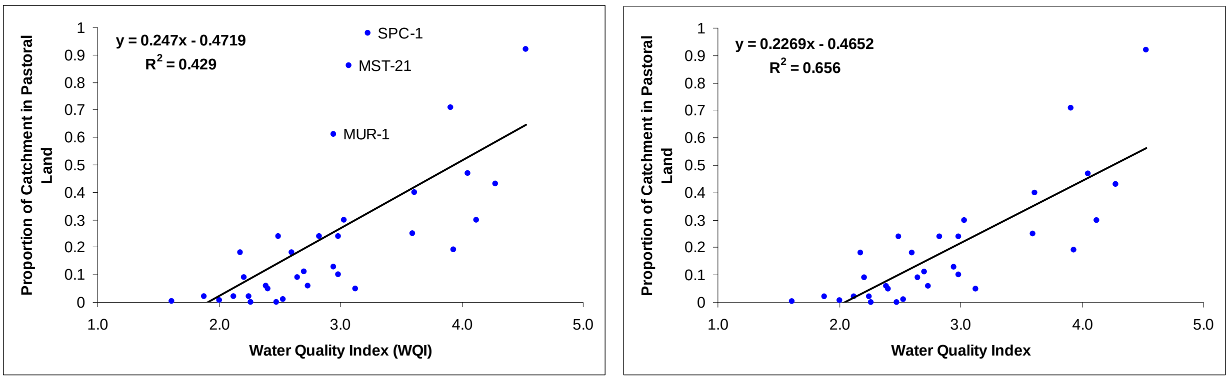


Figure 20: (a) Scatter diagram showing the relationship between the WQI and pastoral land (b) Scatter diagram showing the relationship between the WQI and pastoral land, excluding the outlier sites i.e. spring sites (SPC-1, MUR-1 and MST-21)

The three outlier sites are all located on spring fed streams. These streams are highly valued from an ecological point of view and from an aesthetics (high visual clarity) point of view. Water in the streams is derived directly from groundwater and may be anything from years to decades old. Groundwater can act to buffer water quality to some degree from any deterioration that might be expected to result from land use within the catchment as there can be significant lag times between the rainfall hitting the land surface, percolating through the soils and entering the groundwater table and returning to the surface. In addition, water in spring fed streams is often derived from outside of the hydrological catchment i.e. it may originate in alpine or native forest catchments and appear as surface water in an urban catchment and thus the water quality would not be expected to correlate with land use within the hydrological catchment. Water in Murphys Creek and Spring Creek is derived from the Wairau aquifer which originates from the Wairau River, the origin of water in Mill Stream is less well understood but likely to derive from the Southern foothills of the Wairau as far west as Boundary Creek. Fitting a Generalised Additive Model (GAM) to the data using TimeTrends[3] gives a better indication of the relationship between water quality and land use. Figure 21 shows that 72% of the variation about the mean is explained by GAM. When more than approximately 25% of the catchment is in pastoral land water quality deterioration is shown to accelerate i.e. water quality can be expected to deteriorate more quickly when pastoral land in catchments increases to greater than 25%.

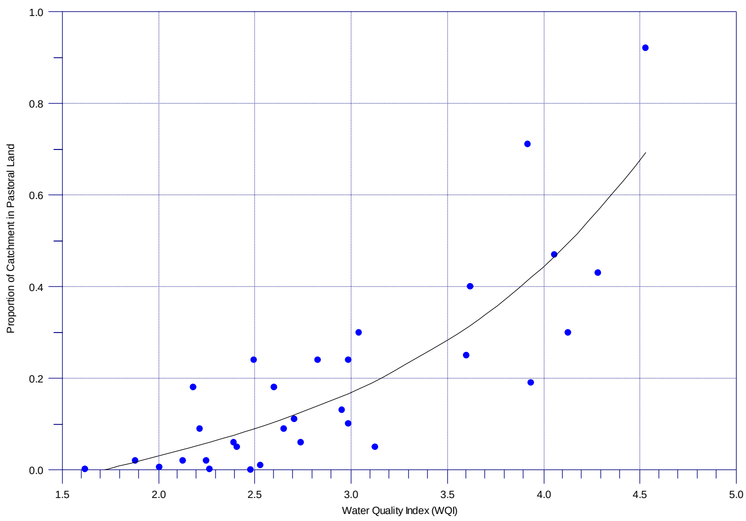


Figure 21: Scatter diagram with a GAM fitted showing the correlation between the WQI and the proportion of the catchment in pastoral land.

Figure 22 shows the relationship between increasing pastoral land and the macroinvertebrate community index (MCI). Sites have been grouped according the percentage of pastoral land in the catchment. Median MCI scores remain in the Excellent or Good classes when pastoral land is <30%.

[3] Time Trends. Analysis of trends and equivalence in water quality data. Version 3.2, 2011. Prepared by NIWA, Ian Jowett.

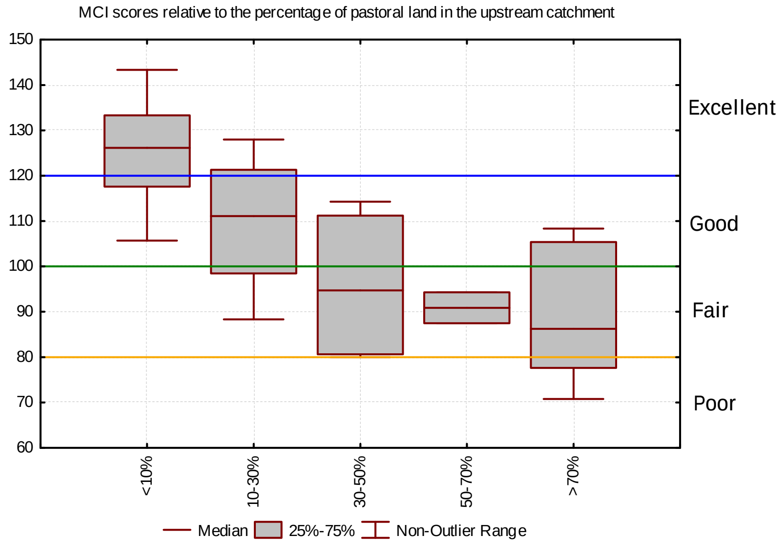


Figure 22: Boxplots showing the MCI scores for the sites in Marlborough in relation to the percentage of land in the catchment in pastoral cover.

5. Discussion

State of the Environment reporting requires that the state and trends of surface waters are assessed on a timely basis. Comprehensive State of the Environment reports are produced by Council at 5 year intervals. The frequency of monitoring and the longevity of monitoring need to be considered in order to satisfy the requirements of state of the environment reporting. Three years of monthly monitoring is considered a minimum to assess the state or baseline water quality. Five years of monthly monitoring is considered the minimum to detect trends in water quality. Taking a catchment management approach to water quality management allows for the ability to assess land use and land use change with water quality trends over time. There are very few point source discharges to surface waters in Marlborough and thus the biggest threat to surface water quality comes from diffuse pollution from land use, including urban development. The ability to track changes in water quality with changes in land use is essential in order to allow for the development of appropriate land management practices to prevent degradation of water bodies and to enhance and maintain water bodies where appropriate.

Water quality in Marlborough's rivers and streams is generally good. Water quality is seen to deteriorate in agricultural and urban areas, particularly where there has been little or no riparian management and/or where there are extensive pastoral areas. Nitrate levels are of most concern in the spring fed streams (e.g. Mill Stream and Doctors Creek) where median levels exceed the threshold for ecological toxicity (Hickey and Martin, 2009). The sensitivity of these waterways and their reliance on groundwater quality is an indication of the need to manage groundwater quality for the protection of aquatic life in spring fed streams. Ammonia concentrations are generally very low or non-detectable in most sites sampled. This is predominately a reflection of the absence of point source discharges. Median *E. coli* numbers are generally good with the exception of Cullens Creek, Duncan Stream (Linkwater) Doctors Creek and Mill Stream. Extreme high numbers (>500 cfu/100mL) are recorded for almost 70% of sites. These extremes numbers are mainly (but not always) attributed to rainfall events. Water clarity is generally very good as indicated by low turbidity levels. Notable exceptions where water clarity is poor include: the Awatere, Duncan Stream (Linkwater) and Doctors Creek. The Awatere has naturally high turbidity levels but it is likely that the poor clarity for Duncan Stream and Doctors Creek is due to poor riparian management resulting in sediment input from eroding stream banks. Arsenic is not of concern for any of the waterways sampled; however copper and zinc frequently exceed the ANZECC guidelines at the sites sampled.

A water quality index (WQI) is a way of summarising differing amounts and types of water quality data into a single score. Deriving water quality indices for river sites help to summarise a vast amount of data collected over time for a range of parameters. The water quality index (WQI) used here correlates well with established biotic indices used in New Zealand indicating that the WQI is an appropriate measure of river water quality in Marlborough. The WQI scores calculated in 2010 are compared with those calculated in 2011. The calculations are for information only and do not necessarily reflect a changing trend as the 2011 scores incorporate an extra years worth of data whilst still retaining all of the data used in the 2010 calculation. Where there is a change in the water quality grade calculated this is mainly attributed to the fact that more data has been collected and is not necessarily a change in water quality status. Complete grades for 31 of the 34 sites will be possible in 2012 and near complete grades will be possible for a further 2 sites in 2012. Changes in the water quality grade should be interpreted alongside trend analysis for the sites, this will allow for a more complete and accurate interpretation of the results. The values of Marlborough's surface waters need to be accurately defined to allow for appropriate water quality standards to be set, from which to assess the status of surface water bodies. These standards can then be incorporated into the calculation of water quality grades and reported on, on an annual basis.

Land use (in particular pastoral land use) shows a significant correlation with water quality indicating that diffuse pollution is the main problem for Marlborough's rivers and streams. Improvements in land use practices such as fencing and riparian planting along with better management of farm effluent in rural pastoral areas amongst other measures (McKergow *et al*., 2007) and improved stormwater management in urban areas will go a long way to significantly improving water quality throughout Marlborough. Combining water quality, water flow, biological sampling and habitat assessments at the same site improves the analysis and interpretation of data that can be made. The ability to assess the effectiveness of land management practices and/or water quality management initiatives is essential in order to ensure that resources and funds are managed in a sustainable way.

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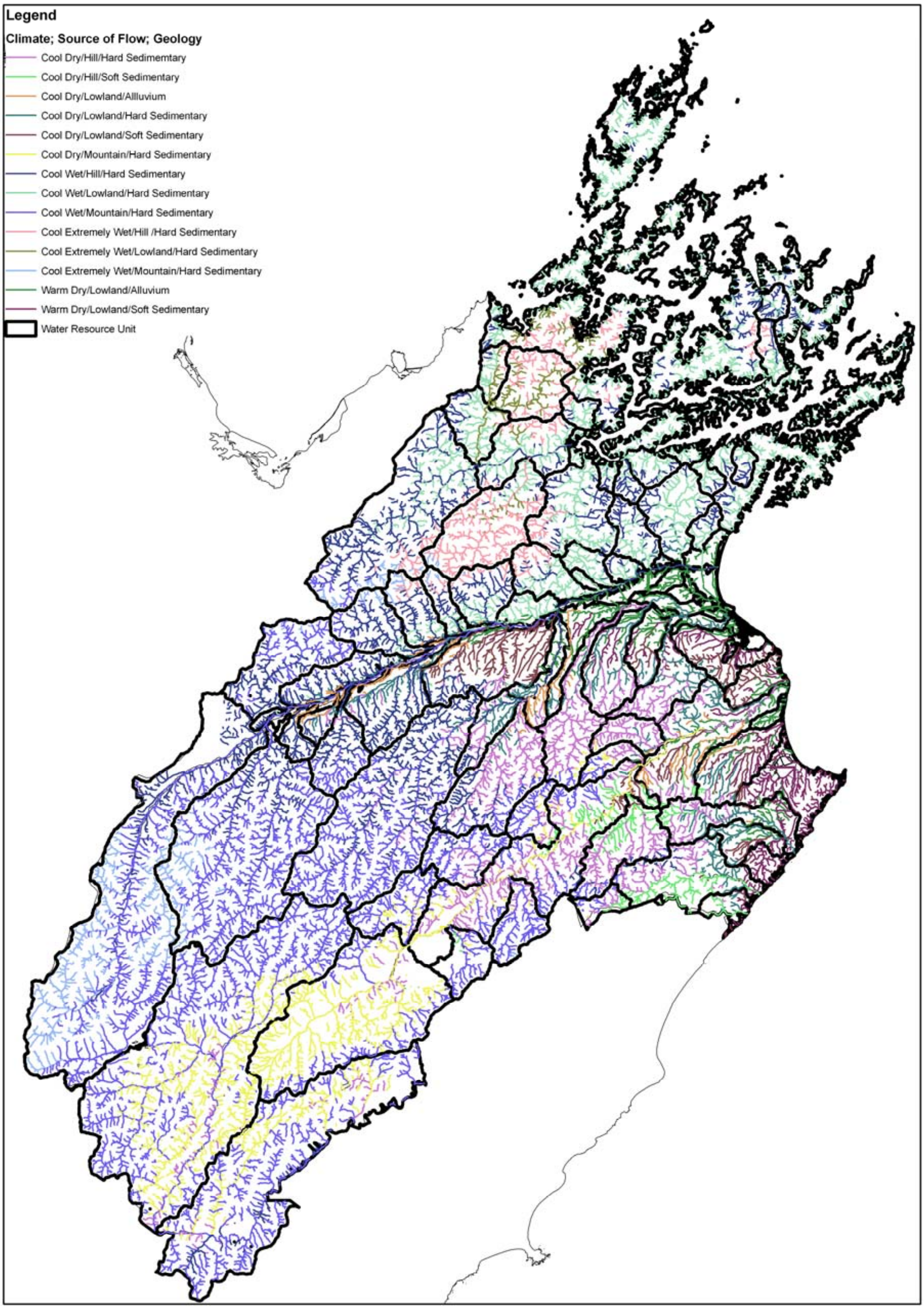
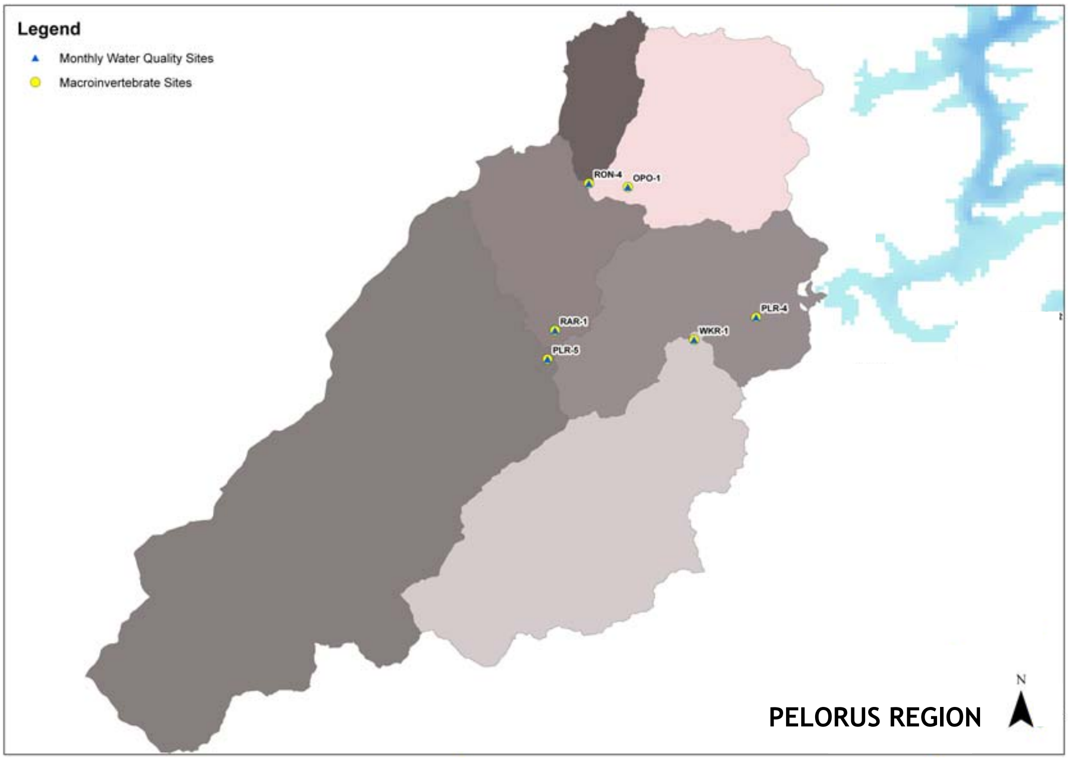
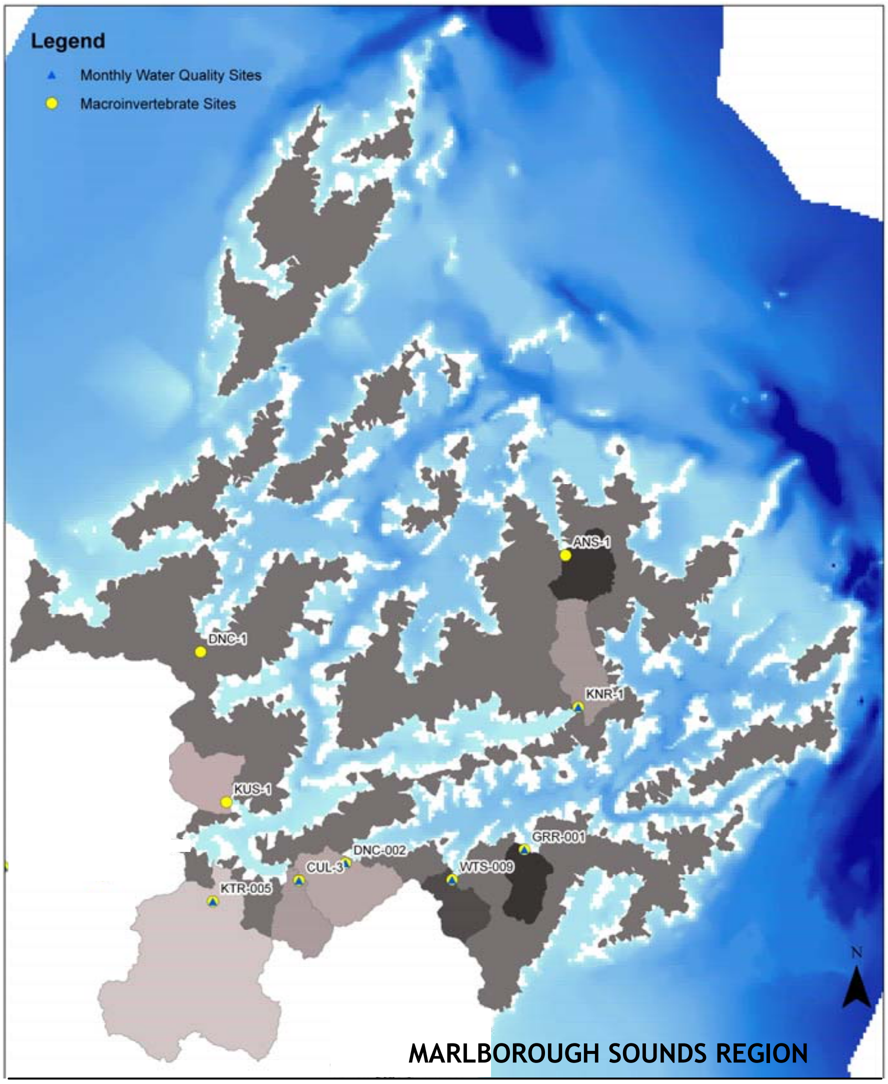
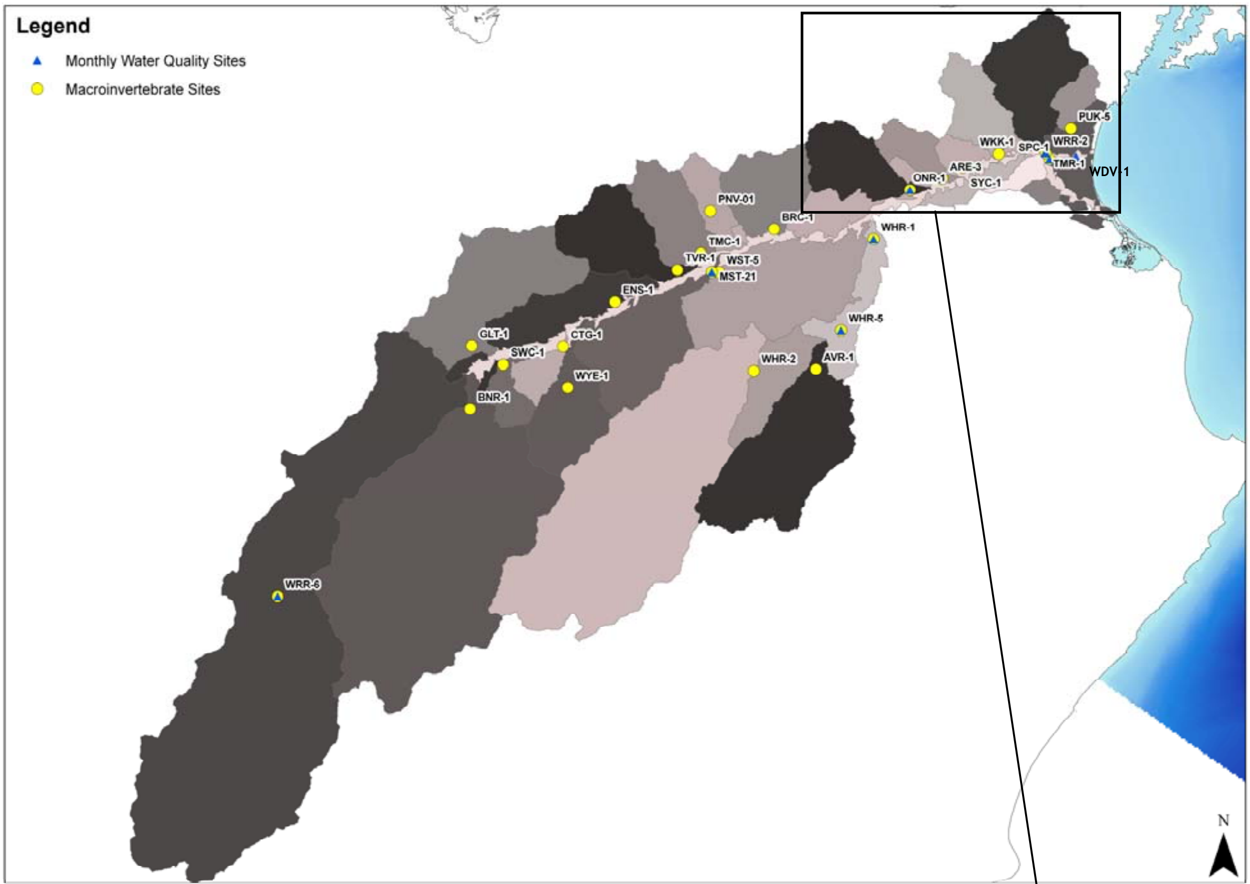
Appendix 1: River 'types' in Marlborough according to the River Environment Classification (Snelder *et al*,2004). Water Resource Units boundaries are shown in black and listed in the following table along with information on the catchment characteristics according to Leathwick *et al*. (2010).



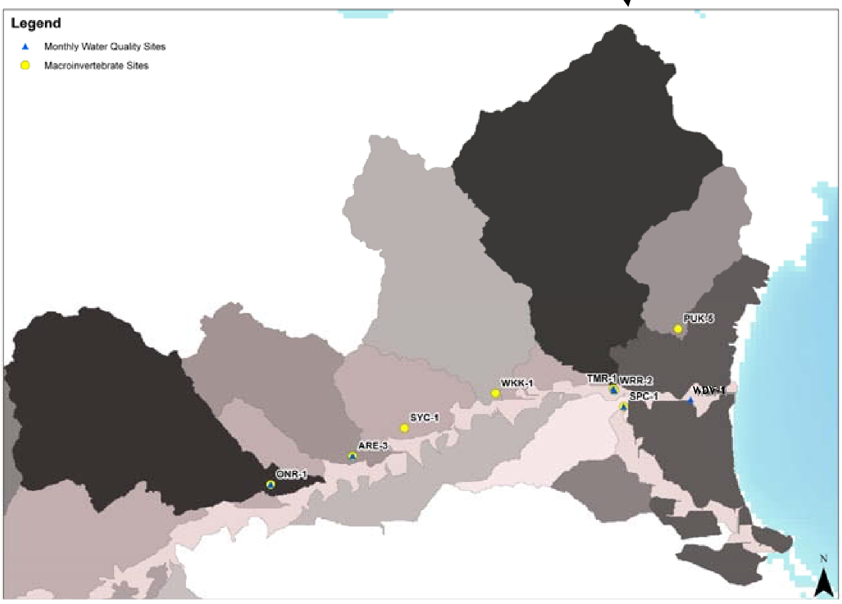
Region	Water Resource Unit	Monitoring Site	River Name	NZ Reach Number	Catchment Area (km^2)	% Bare Land	% Exotic Forest	% Indigenous Forest	% Pastoral Land	% Scrub	% Tussock	% Urban	Low Flow (l/s)	Elevation (m)
Pelorus	Ronga	RON-4	Ronga River	11009511	32.98	0.2	7.0	62.0	24.0	4.0	0.4	0.1	140.64	48.555
Pelorus	Opouri	OPO-1	Opouri River	11009660	70.40	0.6	11.0	60.0	18.0	8.0	0.0	0.0	226.25	43.725
Pelorus	Rai	RAR-1	Rai River	11011511	209.03	0.5	12.0	54.0	24.0	8.0	0.1	0.0	947.45	35.485
Pelorus	Upper Pelorus	PLR-5	Pelorus River	11011819	378.96	0.6	2.0	93.0	0.6	2.0	0.9	0.0	2747.47	36.725
Pelorus	Wakamarina	WKR-1	Wakamarina	11011667	186.51	0.4	9.0	81.0	2.0	5.0	0.1	0.0	1016.4	3.645
Pelorus	Lower Pelorus	PLR-4	Pelorus River	11011349	863.60	0.6	7.0	79.0	6.0	5.0	0.5	0.0	5829.23	0
Marlborough Sounds	Small Sounds streams	DNC-1	Duncan Bay Stream	11007732	5.02	0.0	0.0	98.0	0.0	1.0	0.0	0.0	11.52	34.47
Marlborough Sounds	Anakoha	ANS-1	Anakoha Stream	11006296	20.72	0.0	0.0	80.0	3.0	16.0	0.0	0.0	21.81	6.68
Marlborough Sounds	Kenepuru	KNR-1	Kenepuru River	11008643	27.30	0.4	14.0	47.0	18.0	19.0	0.0	0.0	30.22	2.9
Marlborough Sounds	Kaiuma	KUS-1	Kaiuma Bay Stream	11010162	21.97	0.0	18.0	57.0	15.0	8.0	0.1	0.0	53.3	7.265
Marlborough Sounds	Kaituna	KTR-005	Kaituna River	11012276	135.54	0.3	19.0	32.0	30.0	17.0	0.0	0.0	356.24	0
Marlborough Sounds	Cullens Creek	CUL-3	Cullens Creek	11011611	20.25	0.0	37.0	43.0	10.0	8.0	0.0	0.0	36.67	7.89
Marlborough Sounds	Ada Creek 'complex'	DNC-002	Duncan Stream	11011436	8.38	0.0	39.0	16.0	25.0	18.0	0.0	0.0	15.54	6.94
Marlborough Sounds	Waitohi	WTS-009	Waitohi Stream	11011673	15.24	0.0	0.1	77.0	0.0	17.0	0.0	4.0	21.12	8.36
Marlborough Sounds	Graham River	GRR-001	Graham River	11011033	16.80	0.0	0.4	76.0	2.0	20.0	0.0	0.0	17.73	7.21
Wairau	Upper Wairau	WRR-6	Wairau River	11029639	518.04	48.0	0.0	19.0	0.2	5.0	26.0	0.0	6041.79	673.53
Wairau	Branch River	BNR-1	Branch River	11024066	551.62	32.0	0.3	24.0	0.1	28.0	14.0	0.0	4890.17	381.375
Wairau	Goulter	GLT-1	Goulter River	11022457	145.59	5.0	0.0	66.0	0.0	27.0	0.5	0.0	1155.35	340.575
Wairau	Patriarch 'complex'	ENS-1	Enchanted Stream	11021363	7.41	3.0	0.0	61.0	1.0	33.0	0.0	0.0	60.91	253.785
Wairau	Argyle Pond													
Wairau	Saltwater Stream	SWC-1	Saltwater Stream	11022769	23.77	0.0	30.0	0.0	46.0	1.0	21.0	0.0	208.82	323.29
Wairau	Cabbage Tree Gully Stream	CTG-1	Cabbage Tree Gully Stream	11022082	23.98	0.3	3.0	0.0	87.0	3.0	6.0	0.0	171.16	274.97
Wairau	Wye River	WYE-1	Wye River	11023508	66.37	10.0	2.0	18.0	3.0	36.0	27.0	0.0	497.37	352.015
Wairau	Top Valley Stream	TVR-1	Top Valley Stream	11020463	88.78	2.0	11.0	84.0	0.4	1.0	0.7	0.0	678.2	187.34
Wairau	Boundary Creek 'complex'	MST-21	Mill Stream	11019999	31.94	2.0	0.5	0.0	86.0	1.0	8.0	0.0	206.43	155.07
Wairau	Timms Creek	TMC-1	Timms Creek	11019990	67.58	2.0	8.0	78.0	3.0	1.0	6.0	0.0	480.49	165.57
Wairau	Centre Valley Stream 'complex'	WST-5	Walkers Stream	11020308	1.80	0.0	4.0	0.0	95.0	0.0	0.0	0.0	11.02	160.6
Wairau	Pine Valley Stream	PNV-01	Pine Valley Stream	11018517	20.60	6.0	0.0	93.0	0.0	0.0	0.0	0.0	143.58	236.81
Wairau	Bartletts Creek	BRC-1	Bartletts Creek	11019171	71.60	0.4	15.0	72.0	3.0	8.0	0.0	0.0	351.88	112.09
Wairau	North Bank 'complex'	SYC-1	Storeys Creek	11017194	7.83	0.0	64.0	0.0	6.0	29.0	0.0	0.0	12.02	26.46
Wairau	Onamalutu	ONR-1	Onamalutu River	11017762	71.70	0.0	39.0	46.0	6.0	7.0	0.0	0.0	235.24	45.16
Wairau	Are Are Creek	ARE-3	Are Are Creek	11017507	31.12	0.0	62.0	0.2	30.0	6.0	0.0	0.0	71.8	30.565
Wairau	Waikakaho	WKK-1	Waikakaho River	11016590	57.89	0.0	21.0	47.0	5.0	25.0	0.0	0.0	101.4	9.7
Wairau	Tuamarina	TMR-1	Tuamarina River	11016362	102.04	0.1	34.0	30.0	19.0	15.0	0.0	0.0	147.77	1.955
Wairau	Pukaka Stream	PUK-5	Pukaka Stream	11015643	22.43	0.8	27.0	60.0	0.3	8.0	1.0	0.0	26.4	11.155
Wairau	Spring Creek	SPC-1	Spring Creek	11016829	13.55	0.0	0.0	0.0	98.0	0.0	0.0	0.7	16.34	1.06
Wairau	Grovetown Lagoon													
Wairau	Coastal Wairau 'complex'	WDV-1	Wairau Diversion	11016737	3569.59	22.0	5.0	31.0	5.0	18.0	17.0	0.0	26159.7	0.365
Wairau	Wairau River	WRR-2	Wairau River	11016544	3518.43	22.0	5.0	31.0	5.0	18.0	17.0	0.0	26002.36	0.23
Wairau	Lower Wairau Trib 'complex'													
Waihopai	Upper Waihopai	WHR-2	Waihopai River	11023053	486.71	17.0	1.0	6.0	5.0	28.0	40.0	0.0	2795.06	261.435
Waihopai	Avon	AVR-1	Avon River	11022862	182.52	2.0	0.2	25.0	23.0	37.0	11.0	0.0	622.64	209.845
Waihopai	Mid Waihopai	WHR-5	Waihopai River	11022016	738.55	14.0	1.0	9.0	9.0	29.0	35.0	0.0	3709.35	173.465
Waihopai	Lower Waihopai	WHR-1	Waihopai River	11019403	782.31	14.0	1.0	9.0	9.0	29.0	35.0	0.0	3861.21	83.865
Omaka	Omaka River	OMR-1	Omaka River	11019336	120.44	0.2	0.0	9.0	24.0	49.0	15.0	0.0	235.49	69.25
Omaka	Gibsons Creek	GBC-1	Gibsons Creek	11018540	52.65	0.0	5.0	0.1	92.0	1.0	0.0	0.3	102.38	33.315
Omaka	Fairhall River													
Omaka	Doctors Creek	DRC-1	Doctors Creek	11019119	48.05	0.0	0.0	0.0	92.0	7.0	0.0	0.2	55.22	7.065
Omaka	Blenheim Springs	MUR-1	Murphys Creek	11018883	2.37	0.0	0.0	0.0	61.0	1.0	0.0	36.0	1.71	7.63
Omaka	Taylor River	TYR-1	Taylor River	11019007	145.63	0.1	6.0	0.0	47.0	34.0	9.0	1.0	139.23	3.14
Omaka	Opawa River	OPR-3	Opawa River	11018115	287.21	0.2	0.8	6.0	40.0	38.0	11.0	0.3	504.6	13.25
Omaka	Lower Opawa	OPR-1	Opawa River	11019373	460.18	0.2	2.0	5.0	43.0	36.0	11.0	0.9	600.26	1.845
Omaka	Seventeen Valley Stream 'complex'													
Omaka	Wairau Lagoon 'complex'													
Awatere	Upper Awatere													
Awatere	Castle River													
Awatere	Winterton River													
Awatere	Grey River													
Awatere	Mid Awatere	AWR-3	Awatere	11028051	984.33	41.0	0.0	1.0	1.0	13.0	43.0	0.0	3219.87	341.22
Awatere	Hodder River													
Awatere	Penk River													
Awatere	Medway River													
Awatere	Black Birch Stream	BBS-001	Black Birch Stream	11024343	29.93	2.0	0.0	0.8	2.0	55.0	39.0	0.0	39.51	223.7
Awatere	Blairich Stream													
Awatere	Lower Awatere	AWR-1	Awatere River	11021862	1571.69	31.0	0.5	1.0	11.0	17.0	38.0	0.0	3957.92	11.07
South Marlborough	Blind River													
South Marlborough	East Coast 'complex'													
South Marlborough	Flaxbourne	FLX-1	Flaxbourne River	11027969	150.52	0.0	0.3	0.0	71.0	23.0	4.0	0.0	70.87	7.875
South Marlborough	Needles/Tachalls	NED-3	Needles Creek	11027907	41.81	0.0	0.1	0.0	66.0	32.0	0.3	0.0	18.6	26.98
South Marlborough	Waima	WaiM	Waima River	11030093	152.46	4.0	0.0	12.0	13.0	39.0	29.0	0.0	97.4	4.74
Clarence	Acheron													
Clarence	Upper Clarence													

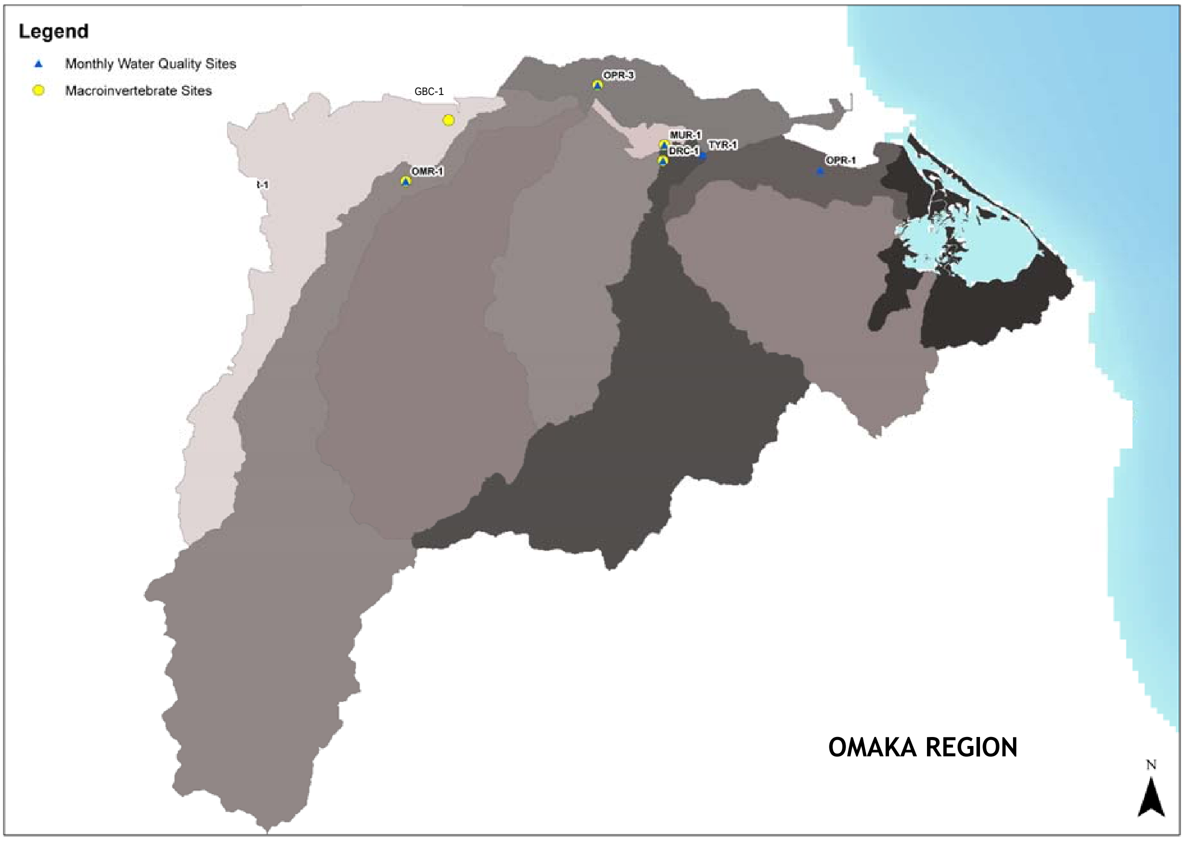

Legend
Monthly Water Quality Sites
Macroinvertebrate Sites
RON-4
OPO-1
RAR-1
PLR-5
WKR-1
PLR-4
N
PELORUS REGION

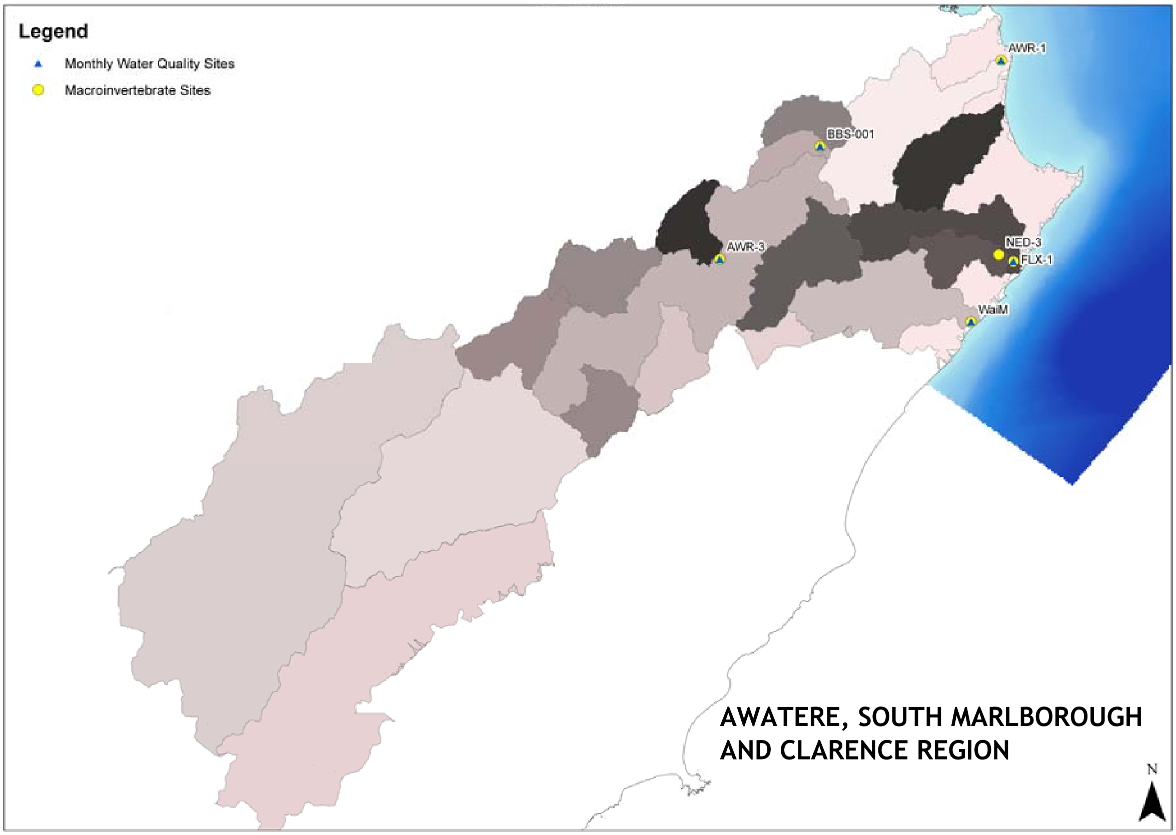

Legend
Monthly Water Quality Sites
Macroinvertebrate Sites
ANS-1
DNC-1
KNR-1
KUS-1
GRR-001
DNC-002
CUL-3
WTS-009
KTR-005
N
MARLBOROUGH SOUNDS REGION



WAIRAU AND WAIHOPAI REGIONS




Legend
Monthly Water Quality Sites
Macroinvertebrate Sites
GBC-1
OPR-3
MUR-1
DRC-1
TYR-1
OPR-1
OMR-1
OMAKA REGION
N


Legend
Monthly Water Quality Sites
Macroinvertebrate Sites
AWR-1
BBS-001
AWR-3
NED-3
FLX-1
WaiM
AWATERE, SOUTH MARLBOROUGH AND CLARENCE REGION
N

Appendix 2: Water quality parameters measured for state of the environment surface water monitoring; the test method used for analysis and the detection limit for each parameter. Analysis is carried out by Environmental Laboratories Services (ELS) Ltd to IANZ accredited standards at all but the two sites on the Wairau which are sampled and analysed by NIWA.

No.	Test Code	Test Name	Test Method	Detection Limits
1	1	pH	Dedicated pH meter following APHA 21st Edition Method 4500 H. LAS official test 5.03.	<0.1
2	2	Suspended Solids - Total	APHA 21st Edition Method 2540 D	<3 g/m³
3	55	Conductivity at 25°C	APHA 21st Edition Method 2510 B. LAS official test 5.02.	<0.1 mS/m
4	84	Turbidity	Turbidity Meter following APHA 21st Edition Method 2130 B. LAS official test 5.04.	<0.01 NTU
5	89	Faecal Coliforms	Membrane Filtration following APHA 21st Edition Method 9222 D	<1 cfu/100mL
6	98	*E. coli*	APHA 21st Edition 9222 G.	<1 cfu/100mL
7	125	Inorganic Nitrogen	By Calculation - NNN plus Ammonia	<0.01 g/m³
8	515	Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 21st Edition Method 4500-NO3 I. LAS official tests 5.13 and 5.14.	<0.005 g/m³
9	605	Nitrate - Nitrogen	Ion Chromatography following USEPA 300.0 (modified). LAS official test 5.13.	<0.01 g/m³
10	760	Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 21st Edition Method 4500 NH3 H. LAS official test 5.10.	<0.01 g/m³
11	2088	Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 21st Edition Method 4500-P G. Official LAS test 5.15.	<0.005 g/m³
12	6603	Arsenic - Total	ICP-MS following APHA 21st edition method 3125 (modified)	<0.002 g/m³
13	6613	Copper - Total	ICP-MS following APHA 21st edition method 3125 (modified)	<0.002 g/m³
14	6638	Zinc - Total	ICP-MS following APHA 21st edition method 3125 (modified)	<0.005 g/m³
15	6703	Arsenic - Dissolved	ICP-MS following APHA 21st edition method 3125 (modified). LAS official test 5.18	<0.001 g/m³
16	6713	Copper - Dissolved	ICP-MS following APHA 21st edition method 3125 (modified). LAS official test 5.23	<0.0005 g/m³
17	6738	Zinc - Dissolved	ICP-MS following APHA 21st edition method 3125 (modified). LAS official test 5.33	<0.002 g/m³
18	P1855	Aqueous Total Metal Digestion	Follows APHA 21st Edition Method 3030E (modified) using nitric acid.	
19	P1859	Sample Filtration	Sample filtered through 0.45 micron filter following APHA 21st Edition Method 3030B.	

‘<’ means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m^3 is the equivalent to mg/L and ppm

Appendix 3: Summary statistics for each water quality parameter for the 34 state of the environment (SoE) water quality monitoring sites.

Descriptive Statistics Ammonia (mg/L) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	19	0.021684	0.010000	0.005000	0.160000	0.005000	0.020000	0.005000	0.060000	0.036370
AWR -1	46	0.009130	0.005000	0.005000	0.080000	0.005000	0.005000	0.005000	0.020000	0.012706
AWR-3	47	0.037553	0.005000	0.005000	0.720000	0.005000	0.005000	0.005000	0.010000	0.122824
BBS-001	6	0.003083	0.002500	0.002500	0.006000	0.002500	0.002500	0.002500	0.006000	0.001429
BNR-1	16	0.005000	0.005000	0.005000	0.005000	0.005000	0.005000	0.005000	0.005000	0.000000
CUL-3	15	0.006667	0.005000	0.005000	0.020000	0.005000	0.005000	0.005000	0.010000	0.004082
DNC-002	31	0.021452	0.020000	0.005000	0.120000	0.005000	0.030000	0.005000	0.040000	0.023209
DRC-1	18	0.020000	0.010000	0.005000	0.070000	0.005000	0.020000	0.005000	0.070000	0.022752
FLX-1	47	0.007553	0.005000	0.005000	0.050000	0.005000	0.005000	0.005000	0.020000	0.007652
GRR-001	41	0.005976	0.005000	0.005000	0.040000	0.005000	0.005000	0.005000	0.005000	0.005502
KNR-1	43	0.008256	0.005000	0.005000	0.060000	0.005000	0.005000	0.005000	0.020000	0.009691
KTR-005	46	0.007717	0.005000	0.005000	0.030000	0.005000	0.010000	0.005000	0.020000	0.005548
MST-21	25	0.005800	0.005000	0.005000	0.020000	0.005000	0.005000	0.005000	0.005000	0.003122
MUR-1	18	0.005278	0.005000	0.005000	0.010000	0.005000	0.005000	0.005000	0.005000	0.001179
OMR-1	46	0.005109	0.005000	0.005000	0.010000	0.005000	0.005000	0.005000	0.005000	0.000737
ONR-1	47	0.005745	0.005000	0.005000	0.030000	0.005000	0.005000	0.005000	0.005000	0.003756
OPO-1	37	0.005270	0.005000	0.005000	0.010000	0.005000	0.005000	0.005000	0.005000	0.001146
OPR-1	47	0.013511	0.010000	0.005000	0.040000	0.005000	0.020000	0.005000	0.030000	0.010157
OPR-3	47	0.009468	0.005000	0.005000	0.170000	0.005000	0.005000	0.005000	0.010000	0.024007
PLR-4	41	0.007195	0.005000	0.005000	0.050000	0.005000	0.005000	0.005000	0.010000	0.007988
PLR-5	46	0.006630	0.005000	0.005000	0.050000	0.005000	0.005000	0.005000	0.005000	0.007231
RAR-1	63	0.009603	0.005000	0.005000	0.240000	0.005000	0.005000	0.005000	0.010000	0.029598
RON-4	37	0.007703	0.005000	0.005000	0.080000	0.005000	0.005000	0.005000	0.010000	0.012505
SPC-1	47	0.006064	0.005000	0.005000	0.020000	0.005000	0.005000	0.005000	0.010000	0.003286
TMR-1	47	0.009574	0.005000	0.005000	0.070000	0.005000	0.010000	0.005000	0.020000	0.010469
TYR-1	47	0.012872	0.005000	0.005000	0.110000	0.005000	0.010000	0.005000	0.020000	0.019553
WaiM	39	0.005385	0.005000	0.005000	0.020000	0.005000	0.005000	0.005000	0.005000	0.002402
WDV-1	41	0.010732	0.005000	0.005000	0.030000	0.005000	0.010000	0.005000	0.020000	0.008258
WHR-1	48	0.017083	0.005000	0.005000	0.560000	0.005000	0.005000	0.005000	0.005000	0.080065
WHR-5	39	0.005897	0.005000	0.005000	0.040000	0.005000	0.005000	0.005000	0.005000	0.005604
WKR-1	47	0.005532	0.005000	0.005000	0.020000	0.005000	0.005000	0.005000	0.005000	0.002385
WRR-2	48	0.002896	0.003000	0.000500	0.010000	0.002000	0.004000	0.001000	0.006000	0.001845
WRR-6	48	0.001990	0.001000	0.000500	0.009000	0.001000	0.002000	0.000500	0.005000	0.001764
WTS-009	42	0.005833	0.005000	0.005000	0.030000	0.005000	0.005000	0.005000	0.005000	0.003969

Descriptive Statistics Dissolved Oxygen (% saturation) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	21	101.3381	101.5000	59.50000	127.0000	88.9000	107.5000	84.50000	122.9000	16.23094
AWR -1	35	100.5229	100.5000	77.20000	116.0000	98.0000	103.8000	93.70000	108.8000	6.61007
AWR-3	35	96.1629	96.4000	87.10000	105.9000	93.2000	99.6000	91.30000	100.3000	4.28383
BBS-001	15	95.7000	97.3000	86.00000	104.5000	92.1000	97.8000	88.30000	102.7000	5.20961
BNR-1	16	94.2750	94.1000	86.70000	108.7000	91.2500	94.8500	88.60000	100.5000	5.16791
CUL-3	31	86.7710	88.2000	56.80000	98.9000	84.1000	93.2000	77.90000	95.6000	9.31186
DNC-002	18	103.6000	100.6000	72.20000	137.5000	87.2000	120.5000	78.80000	134.7000	20.13577
DRC-1	38	107.6053	104.0000	74.20000	149.5000	95.1000	115.6000	88.70000	135.6000	17.42862
FLX-1	40	98.7525	98.3000	77.20000	139.7000	94.4000	101.4000	89.65000	105.2500	9.58837
GRR-001	40	92.9875	96.6500	39.90000	119.0000	91.6000	100.3000	68.80000	104.4500	15.09393
KNR-1	41	93.6805	93.6000	79.10000	114.8000	90.8000	96.3000	88.70000	98.4000	5.42163
KTR-005	25	94.9560	95.7000	74.60000	108.7000	90.3000	100.0000	82.30000	106.2000	9.10298
MST-21	18	81.6389	80.6500	73.10000	91.7000	76.5000	86.7000	73.70000	88.5000	5.82178
MUR-1	41	89.7073	92.9000	51.90000	125.8000	86.3000	96.1000	69.40000	100.8000	14.07664
OMR-1	43	94.3558	94.6000	56.80000	111.5000	91.6000	97.8000	88.40000	102.7000	8.12709
ONR-1	36	92.9556	93.1000	85.20000	99.9000	90.6500	95.1000	88.70000	97.8000	3.55234
OPO-1	41	98.3951	102.5000	32.50000	137.4000	85.4000	109.8000	80.30000	122.1000	20.52715
OPR-1	42	106.8714	104.4500	75.40000	125.3000	101.2000	116.8000	99.10000	119.8000	10.57434
OPR-3	41	98.1024	96.9000	87.60000	119.8000	93.7000	100.7000	91.50000	106.2000	6.65505
PLR-4	42	98.0357	97.5000	91.10000	130.0000	94.6000	98.9000	92.30000	101.6000	6.39691
PLR-5	95	98.6189	97.6000	86.50000	120.0000	94.2000	101.8000	92.30000	107.8000	6.13000
RAR-1	38	81.6895	82.4000	69.80000	92.9000	77.1000	86.8000	74.50000	88.7000	5.74215
RON-4	41	84.1049	84.7000	63.50000	110.4000	76.2000	92.0000	70.90000	97.3000	11.04205
SPC-1	41	72.6049	71.5000	35.90000	119.8000	60.3000	86.5000	47.50000	96.4000	20.19286

TMR-1	39	104.6128	101.8000	56.70000	142.7000	92.6000	116.3000	79.90000	132.7000	18.85553
TYR-1	34	88.3382	89.1500	70.90000	116.4000	81.1000	94.0000	78.10000	95.3000	8.72964
WaiM	75	93.1147	92.3000	68.00000	149.8000	88.8000	95.7000	83.00000	104.8000	10.27125
WDV-1	43	98.2767	97.5000	88.30000	110.7000	94.9000	100.3000	93.50000	107.0000	4.66434
WHR-1	39	98.1718	98.5000	85.70000	105.5000	96.6000	100.0000	94.50000	104.1000	3.70540
WHR-5	42	96.1381	96.5500	85.60000	108.7000	93.7000	98.9000	91.60000	100.1000	4.52656
WKR-1	70	102.4443	102.0000	75.60000	117.5000	98.8000	105.9000	93.60000	112.1500	6.97406
WRR-2	49	100.5143	100.6000	97.50000	102.3000	100.2000	100.9000	99.40000	101.5000	0.84385
WRR-6	43	107.2279	105.6000	86.70000	134.1000	101.6000	111.7000	97.80000	120.4000	9.54210
WTS-009	21	101.3381	101.5000	59.50000	127.0000	88.9000	107.5000	84.50000	122.9000	16.23094

Descriptive Statistics Dissolved Reactive Phosphorus (% saturation) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	18	0.021556	0.019000	0.006000	0.069000	0.012000	0.024000	0.011000	0.045000	0.014521
AWR -1	45	0.013478	0.009000	0.002500	0.067000	0.006000	0.016000	0.006000	0.026000	0.012299
AWR-3	46	0.018087	0.013000	0.005000	0.089000	0.010000	0.015000	0.009000	0.030000	0.017999
BBS-001	6	0.016833	0.014000	0.012000	0.034000	0.012000	0.015000	0.012000	0.034000	0.008519
BNR-1	16	0.008688	0.008000	0.007000	0.012000	0.008000	0.010000	0.007000	0.011000	0.001493
CUL-3	15	0.020800	0.020000	0.017000	0.027000	0.019000	0.024000	0.018000	0.024000	0.002757
DNC-002	31	0.020645	0.018000	0.013000	0.055000	0.014000	0.023000	0.013000	0.036000	0.009580
DRC-1	18	0.027778	0.026000	0.020000	0.048000	0.021000	0.032000	0.020000	0.043000	0.008272
FLX-1	47	0.011106	0.009000	0.002500	0.034000	0.006000	0.012000	0.005000	0.021000	0.007457
GRR-001	41	0.014659	0.014000	0.006000	0.048000	0.012000	0.016000	0.009000	0.019000	0.006522
KNR-1	43	0.010244	0.010000	0.002500	0.033000	0.008000	0.011000	0.005000	0.013000	0.005240
KTR-005	46	0.011902	0.012000	0.002500	0.020000	0.010000	0.014000	0.008000	0.016000	0.003486
MST-21	25	0.017720	0.017000	0.010000	0.026000	0.015000	0.019000	0.014000	0.024000	0.003588
MUR-1	18	0.015444	0.014500	0.010000	0.030000	0.013000	0.016000	0.012000	0.019000	0.004301
OMR-1	45	0.008156	0.008000	0.002500	0.019000	0.005000	0.010000	0.002500	0.014000	0.003785
ONR-1	47	0.009266	0.010000	0.002500	0.014000	0.007000	0.012000	0.006000	0.013000	0.002939
OPO-1	37	0.013649	0.014000	0.010000	0.017000	0.012000	0.015000	0.012000	0.016000	0.001783
OPR-1	47	0.017277	0.016000	0.005000	0.032000	0.013000	0.021000	0.010000	0.025000	0.006272
OPR-3	47	0.008851	0.007000	0.002500	0.038000	0.006000	0.010000	0.002500	0.018000	0.006487
PLR-4	41	0.010159	0.011000	0.002500	0.016000	0.008000	0.013000	0.006000	0.014000	0.003103
PLR-5	46	0.010457	0.010000	0.005000	0.017000	0.009000	0.012000	0.007000	0.014000	0.002754
RAR-1	63	0.012071	0.013000	0.002500	0.020000	0.010000	0.014000	0.008000	0.016000	0.003263
RON-4	37	0.014676	0.014000	0.009000	0.043000	0.012000	0.016000	0.010000	0.018000	0.005533
SPC-1	47	0.013511	0.013000	0.009000	0.019000	0.012000	0.015000	0.011000	0.017000	0.002215
TMR-1	47	0.014298	0.014000	0.006000	0.025000	0.011000	0.017000	0.008000	0.021000	0.004477
TYR-1	47	0.019447	0.018000	0.009000	0.064000	0.015000	0.021000	0.013000	0.026000	0.008387
WaiM	39	0.006872	0.006000	0.002500	0.023000	0.005000	0.008000	0.002500	0.011000	0.003745
WDV-1	41	0.013261	0.013000	0.002500	0.024000	0.011000	0.016000	0.009000	0.017000	0.004146
WHR-1	47	0.012319	0.009000	0.002500	0.154000	0.007000	0.012000	0.005000	0.014000	0.021409
WHR-5	39	0.011667	0.012000	0.005000	0.020000	0.009000	0.014000	0.007000	0.016000	0.003579
WKR-1	47	0.011809	0.012000	0.006000	0.019000	0.011000	0.013000	0.009000	0.015000	0.002437
WRR-2	48	0.004052	0.003000	0.000500	0.010000	0.002000	0.005500	0.002000	0.007000	0.002114
WRR-6	48	0.003375	0.003000	0.002000	0.006000	0.003000	0.004000	0.002000	0.005000	0.000981
WTS-009	42	0.015905	0.015000	0.007000	0.033000	0.014000	0.018000	0.011000	0.020000	0.004663

Descriptive Statistics *E. coli* (cfu/100mL) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	18	540.2778	110.0000	14.00000	4400.00	54.0000	200.0000	16.00000	1600.000	1083.285
AWR -1	46	49.8696	24.5000	1.00000	390.00	7.0000	71.0000	3.00000	120.000	69.228
AWR-3	47	26.1064	9.0000	1.00000	250.00	4.0000	27.0000	1.00000	56.000	44.241
BBS-001	88	2.7841	1.0000	0.00000	23.00	1.0000	2.0000	0.00000	9.000	4.652
BNR-1	16	25.5000	8.0000	1.00000	180.00	1.0000	29.0000	1.00000	70.000	45.968
CUL-3	15	353.5333	180.0000	80.00000	1900.00	120.0000	370.0000	83.00000	800.000	466.974
DNC-002	31	673.4839	200.0000	6.00000	3900.00	140.0000	900.0000	70.00000	1800.000	1013.645
DRC-1	18	213.3889	155.0000	52.00000	1200.00	120.0000	230.0000	53.00000	310.000	255.434
FLX-1	47	705.1064	51.0000	4.00000	28000.00	27.0000	98.0000	10.00000	300.000	4074.815
GRR-001	41	214.2683	55.0000	1.00000	2600.00	26.0000	130.0000	15.00000	300.000	528.394
KNR-1	42	285.0000	110.0000	4.00000	3500.00	92.0000	180.0000	50.00000	290.000	631.335
KTR-005	46	367.7826	94.0000	10.00000	7000.00	49.0000	160.0000	25.00000	500.000	1146.909
MST-21	25	391.1600	140.0000	20.00000	2800.00	85.0000	300.0000	36.00000	1200.000	630.896
MUR-1	19	170.5789	43.0000	8.00000	1900.00	14.0000	110.0000	10.00000	410.000	430.763
OMR-1	45	16.4444	7.0000	1.00000	190.00	3.0000	14.0000	2.00000	31.000	30.573

ONR-1	47	104.6170	50.0000	1.00000	1800.00	24.0000	100.0000	5.00000	170.000	259.990
OPO-1	37	62.6757	56.0000	12.00000	170.00	38.0000	82.0000	22.00000	110.000	35.237
OPR-1	46	39.1739	20.0000	1.00000	210.00	11.0000	46.0000	7.00000	120.000	47.473
OPR-3	46	59.3478	46.0000	1.00000	240.00	25.0000	84.0000	8.00000	130.000	51.666
PLR-4	41	103.9268	24.0000	1.00000	2000.00	12.0000	70.0000	8.00000	140.000	315.942
PLR-5	44	34.6136	15.5000	1.00000	250.00	8.0000	30.0000	5.00000	63.000	53.106
RAR-1	152	296.0789	57.5000	1.00000	8900.00	37.0000	200.0000	20.00000	560.000	881.663
RON-4	37	301.7027	54.0000	1.00000	5300.00	24.0000	190.0000	10.00000	250.000	910.744
SPC-1	47	48.7872	43.0000	1.00000	190.00	31.0000	57.0000	21.00000	71.000	32.070
TMR-1	47	206.7447	42.0000	3.00000	6700.00	29.0000	65.0000	11.00000	120.000	976.225
TYR-1	46	364.7609	54.0000	6.00000	9400.00	34.0000	78.0000	16.00000	150.000	1511.614
WaiM	39	95.2821	27.0000	1.00000	1000.00	16.0000	57.0000	3.00000	370.000	188.563
WDV-1	128	185.2656	47.0000	1.00000	4600.00	20.0000	96.0000	7.00000	480.000	519.007
WHR-1	48	86.9167	11.0000	1.00000	880.00	4.0000	65.5000	2.00000	180.000	190.367
WHR-5	39	83.9487	24.0000	1.00000	831.00	7.0000	69.0000	3.00000	170.000	176.286
WKR-1	46	86.5870	22.5000	1.00000	1600.00	11.0000	41.0000	6.00000	130.000	254.481
WRR-2	76	34.6632	9.0000	1.00000	1203.30	3.0000	21.0000	1.00000	36.900	143.481
WRR-6	45	5.8489	3.0000	1.00000	24.00	1.0000	8.5000	1.00000	17.100	6.563
WTS-009	42	138.4286	74.0000	13.00000	1500.00	34.0000	140.0000	24.00000	200.000	256.528

Descriptive Statistics Nitrate (mg/L) 2007-2010

	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	19	0.714737	0.740000	0.290000	1.040000	0.500000	0.940000	0.410000	1.010000	0.234055
AWR -1	46	0.081304	0.020000	0.005000	0.880000	0.005000	0.070000	0.005000	0.250000	0.163746
AWR-3	47	0.020319	0.005000	0.005000	0.120000	0.005000	0.030000	0.005000	0.060000	0.025139
BBS-001	6	0.017167	0.017000	0.010000	0.026000	0.012000	0.021000	0.010000	0.026000	0.005981
BNR-1	16	0.010313	0.005000	0.005000	0.040000	0.005000	0.010000	0.005000	0.030000	0.010562
CUL-3	15	0.376000	0.310000	0.170000	0.910000	0.240000	0.410000	0.200000	0.710000	0.198954
DNC-002	31	0.388387	0.390000	0.030000	0.800000	0.250000	0.520000	0.080000	0.640000	0.198832
DRC-1	18	1.852222	1.890000	1.200000	2.790000	1.330000	2.220000	1.260000	2.300000	0.446431
FLX-1	47	0.128298	0.005000	0.005000	0.940000	0.005000	0.080000	0.005000	0.570000	0.260258
GRR-001	41	0.028293	0.030000	0.005000	0.080000	0.010000	0.040000	0.005000	0.060000	0.020694
KNR-1	43	0.146047	0.140000	0.010000	0.370000	0.060000	0.220000	0.020000	0.270000	0.097788
KTR-005	46	0.950000	0.890000	0.140000	2.360000	0.670000	1.160000	0.470000	1.520000	0.423698
MST-21	25	2.108800	2.030000	1.040000	3.150000	1.780000	2.460000	1.260000	2.980000	0.577114
MUR-1	18	1.334444	1.355000	0.180000	1.970000	1.200000	1.530000	0.980000	1.750000	0.386967
OMR-1	46	0.318696	0.255000	0.020000	1.080000	0.110000	0.500000	0.040000	0.710000	0.264538
ONR-1	48	0.205677	0.200000	0.002500	0.420000	0.160000	0.240000	0.120000	0.340000	0.083940
OPO-1	37	0.411892	0.410000	0.240000	0.720000	0.320000	0.480000	0.260000	0.560000	0.117871
OPR-1	47	1.171702	1.070000	0.380000	3.190000	0.800000	1.320000	0.620000	1.970000	0.594717
OPR-3	48	0.474844	0.185000	0.002500	3.610000	0.020000	0.590000	0.005000	1.390000	0.700133
PLR-4	41	0.261220	0.260000	0.030000	0.450000	0.190000	0.340000	0.150000	0.380000	0.095294
PLR-5	46	0.027065	0.020000	0.005000	0.080000	0.005000	0.050000	0.005000	0.060000	0.022175
RAR-1	63	0.680317	0.660000	0.350000	1.060000	0.510000	0.810000	0.470000	0.920000	0.175820
RON-4	39	0.793077	0.780000	0.340000	1.060000	0.680000	0.910000	0.600000	0.970000	0.152801
SPC-1	47	0.333404	0.280000	0.130000	0.960000	0.200000	0.450000	0.150000	0.540000	0.185499
TMR-1	47	0.354468	0.350000	0.005000	1.030000	0.060000	0.580000	0.020000	0.780000	0.296168
TYR-1	47	1.642340	1.520000	0.780000	3.740000	1.270000	1.720000	1.070000	2.390000	0.665322
WaiM	39	0.130641	0.100000	0.005000	0.380000	0.060000	0.210000	0.005000	0.280000	0.097550
WDV-1	41	0.223780	0.160000	0.005000	1.050000	0.080000	0.250000	0.030000	0.470000	0.228863
WHR-1	48	0.151354	0.075000	0.005000	0.990000	0.030000	0.220000	0.005000	0.400000	0.193747
WHR-5	39	0.032692	0.005000	0.005000	0.220000	0.005000	0.040000	0.005000	0.110000	0.053174
WKR-1	48	0.062323	0.020000	0.002500	1.980000	0.005000	0.040000	0.005000	0.050000	0.283252
WRR-2	48	0.149125	0.134500	0.012000	0.483000	0.074500	0.192000	0.035000	0.283000	0.105379
WRR-6	48	0.015875	0.011000	0.002000	0.048000	0.005000	0.025500	0.003000	0.038000	0.012995
WTS-009	42	0.028571	0.025000	0.005000	0.240000	0.005000	0.040000	0.005000	0.050000	0.037209

Descriptive Statistics pH 2007-2010

	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	24	7.288167	7.300000	6.600000	7.850000	7.055500	7.500000	6.900000	7.700000	0.316756
AWR -1	62	8.335000	8.300000	7.630000	9.200000	8.100000	8.500000	8.000000	8.750000	0.308899
AWR-3	63	8.013016	8.000000	7.280000	9.300000	7.900000	8.180000	7.700000	8.270000	0.293272
BBS-001	69	7.437681	7.500000	6.400000	8.200000	7.300000	7.600000	6.900000	7.800000	0.323174
BNR-1	16	7.562500	7.600000	7.200000	7.800000	7.500000	7.650000	7.400000	7.800000	0.154380
CUL-3	15	7.060000	7.000000	6.900000	7.400000	7.000000	7.100000	6.900000	7.200000	0.124212

DNC-002	37	6.677838	6.700000	6.100000	7.300000	6.460000	6.800000	6.300000	7.000000	0.279862
DRC-1	18	7.183333	7.200000	6.900000	7.400000	7.100000	7.300000	7.000000	7.400000	0.158114
FLX-1	63	8.030159	8.020000	7.190000	8.900000	7.800000	8.230000	7.500000	8.500000	0.367513
GRR-001	52	7.230654	7.295000	6.100000	8.200000	7.000000	7.450000	6.890000	7.700000	0.361496
KNR-1	56	7.134607	7.095000	6.080000	8.500000	6.900000	7.400000	6.618000	7.800000	0.468282
KTR-005	64	6.929219	6.945000	5.980000	8.000000	6.800000	7.100000	6.600000	7.280000	0.315335
MST-21	28	7.110357	7.100000	6.700000	7.400000	7.000000	7.240000	6.800000	7.320000	0.183373
MUR-1	18	6.794444	6.700000	6.600000	7.900000	6.600000	6.800000	6.600000	7.200000	0.315244
OMR-1	62	7.342726	7.400000	6.370000	8.000000	7.100000	7.600000	6.800000	7.900000	0.381727
ONR-1	63	7.153492	7.100000	6.600000	7.900000	6.900000	7.400000	6.730000	7.600000	0.310422
OPO-1	41	6.933610	7.000000	6.300000	7.700000	6.800000	7.100000	6.600000	7.200000	0.270422
OPR-1	61	7.407213	7.300000	6.490000	8.570000	7.200000	7.500000	7.020000	8.100000	0.401859
OPR-3	61	8.267049	8.300000	7.100000	9.600000	7.780000	8.700000	7.500000	9.000000	0.615097
PLR-4	56	7.383750	7.400000	6.220000	8.700000	7.100000	7.535000	7.000000	7.860000	0.422114
PLR-5	65	7.570123	7.600000	6.470000	8.900000	7.400000	7.800000	7.100000	8.000000	0.417709
RAR-1	106	7.014981	7.000000	5.520000	8.200000	6.800000	7.300000	6.600000	7.400000	0.387053
RON-4	41	6.613805	6.600000	5.800000	7.200000	6.500000	6.800000	6.300000	7.000000	0.295325
SPC-1	62	7.085484	7.100000	6.350000	7.900000	6.900000	7.200000	6.700000	7.400000	0.288471
TMR-1	62	7.009274	7.000000	5.740000	8.000000	6.800000	7.210000	6.600000	7.540000	0.389727
TYR-1	61	7.059508	7.000000	6.270000	8.100000	6.900000	7.200000	6.700000	7.400000	0.337656
WaiM	50	8.051000	8.000000	7.600000	8.600000	7.900000	8.200000	7.790000	8.300000	0.228993
WDV-1	72	7.290417	7.310000	5.770000	9.300000	7.100000	7.505000	6.750000	7.700000	0.440820
WHR-1	62	7.523306	7.500000	6.790000	9.100000	7.300000	7.700000	7.140000	7.900000	0.361156
WHR-5	49	7.740102	7.700000	6.860000	9.100000	7.600000	7.900000	7.200000	8.100000	0.384765
WKR-1	65	7.226000	7.300000	5.950000	8.200000	7.100000	7.500000	6.800000	7.600000	0.381800
WRR-2	92	7.657174	7.625000	5.980000	9.600000	7.400000	7.815000	7.200000	8.310000	0.522718
WRR-6	48	7.658333	7.645000	7.330000	7.900000	7.565000	7.740000	7.510000	7.840000	0.125008
WTS-009	54	7.997222	7.950000	6.900000	9.400000	7.500000	8.450000	7.300000	8.840000	0.587073

Descriptive Statistics Suspended Solids (mg/L) 2007-2010										
	Valid Number	**Mean**	**Median**	**Minimum**	**Maximum**	**Lower Quartile**	**Upper Quartile**	**10%ile**	**90%ile**	**Standard Deviation.**
ARE-3	18	6.2222	3.00000	1.500000	28.000	1.500000	6.00000	1.500000	26.0000	8.0700
AWR -1	45	115.8667	17.00000	1.500000	2270.000	3.000000	71.00000	1.500000	282.0000	349.6429
AWR-3	46	108.4674	17.00000	1.500000	1630.000	4.000000	50.00000	1.500000	328.0000	267.7972
BBS-001	6	0.5000	0.50000	0.500000	0.500	0.500000	0.50000	0.500000	0.5000	0.0000
BNR-1	16	26.8438	1.50000	1.500000	394.000	1.500000	4.00000	1.500000	6.0000	97.9198
CUL-3	15	5.1000	1.50000	1.500000	41.000	1.500000	5.00000	1.500000	6.0000	10.0538
DNC-002	29	15.3448	9.00000	3.000000	84.000	7.000000	15.00000	5.000000	42.0000	17.6519
DRC-1	18	18.1389	14.00000	1.500000	54.000	6.000000	24.00000	3.000000	47.0000	15.7273
FLX-1	47	5.0106	1.50000	1.500000	33.000	1.500000	6.00000	1.500000	12.0000	6.7256
GRR-001	41	5.6220	1.50000	1.500000	141.000	1.500000	1.50000	1.500000	5.0000	21.7289
KNR-1	43	1.8605	1.50000	1.000000	6.000	1.500000	1.50000	1.500000	3.0000	1.0484
KTR-005	45	4.9556	1.50000	1.500000	98.000	1.500000	1.50000	1.500000	6.0000	14.6949
MST-21	25	5.8000	6.00000	1.500000	18.000	4.000000	7.00000	1.500000	9.0000	3.5414
MUR-1	18	1.8056	1.50000	1.000000	6.000	1.500000	1.50000	1.000000	3.0000	1.1264
OMR-1	46	2.2065	1.50000	1.500000	9.000	1.500000	1.50000	1.500000	6.0000	1.8844
ONR-1	46	3.5000	1.50000	1.500000	45.000	1.500000	1.50000	1.500000	7.0000	7.0364
OPO-1	37	1.5676	1.50000	1.500000	4.000	1.500000	1.50000	1.500000	1.5000	0.4110
OPR-1	47	2.5532	1.50000	1.500000	18.000	1.500000	3.00000	1.500000	4.0000	2.6524
OPR-3	46	6.7283	4.00000	1.500000	42.000	1.500000	7.00000	1.500000	14.0000	8.4437
PLR-4	41	2.4024	1.50000	1.500000	13.000	1.500000	1.50000	1.500000	4.0000	2.5623
PLR-5	46	2.4348	1.50000	1.500000	25.000	1.500000	1.50000	1.500000	3.0000	3.8451
RAR-1	63	1.9921	1.50000	1.500000	11.000	1.500000	1.50000	1.500000	3.0000	1.6001
RON-4	37	2.0405	1.50000	1.500000	11.000	1.500000	1.50000	1.500000	3.0000	1.9017
SPC-1	47	1.6064	1.50000	1.000000	6.000	1.500000	1.50000	1.500000	1.5000	0.6671
TMR-1	47	3.1383	1.50000	1.000000	16.000	1.500000	3.00000	1.500000	7.0000	3.7018
TYR-1	47	4.1170	1.50000	1.000000	31.000	1.500000	5.00000	1.500000	9.0000	5.9071
WaiM	39	14.5513	1.50000	1.500000	309.000	1.500000	3.00000	1.500000	37.0000	51.3135
WDV-1	40	13.9750	5.00000	1.500000	144.000	1.500000	9.50000	1.500000	35.0000	28.5296
WHR-1	47	15.2234	1.50000	1.500000	282.000	1.500000	7.00000	1.500000	27.0000	45.0489
WHR-5	39	9.8974	1.50000	1.000000	114.000	1.500000	6.00000	1.500000	32.0000	21.1225
WKR-1	46	2.0000	1.50000	1.500000	14.000	1.500000	1.50000	1.500000	1.5000	2.2086
WRR-2	42	1.6786	1.50000	1.500000	5.000	1.500000	1.50000	1.500000	1.5000	0.6881
WRR-6	18	6.2222	3.00000	1.500000	28.000	1.500000	6.00000	1.500000	26.0000	8.0700
WTS-009	45	115.8667	17.00000	1.500000	2270.000	3.000000	71.00000	1.500000	282.0000	349.6429

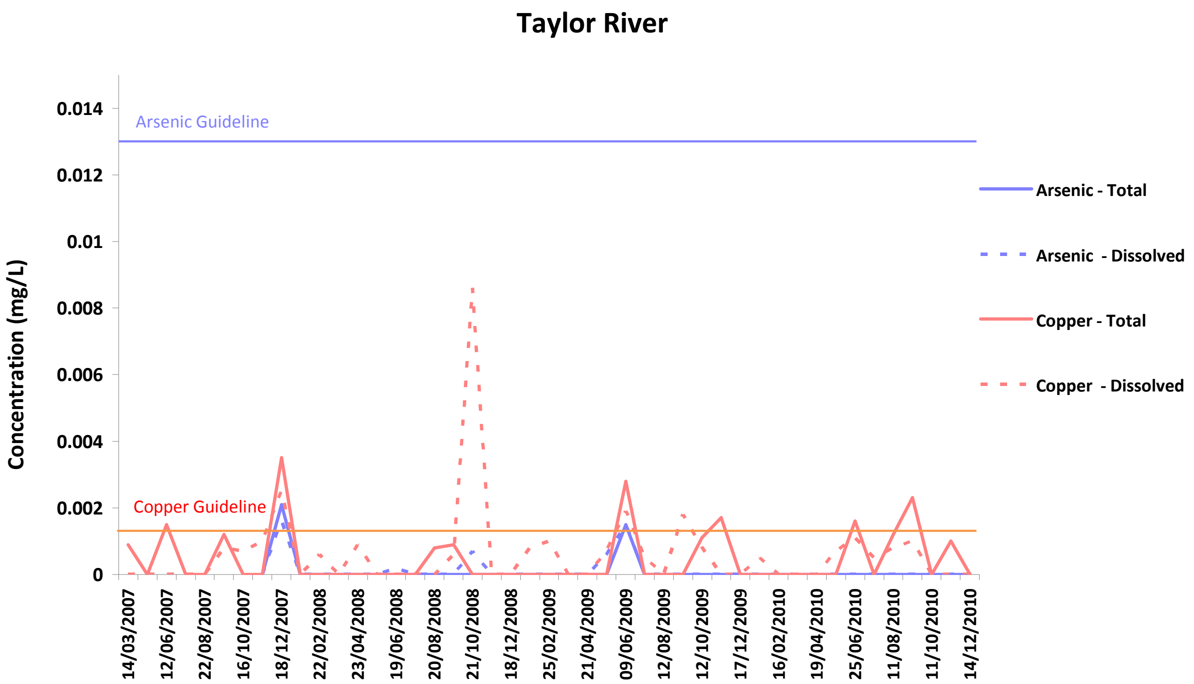
Descriptive Statistics Temperature (°C) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	24	14.13750	13.75000	7.40000	21.70000	11.70000	16.65000	10.20000	20.70000	3.753469
AWR -1	44	13.26136	14.10000	3.90000	21.00000	9.20000	17.25000	7.00000	19.20000	4.917279
AWR-3	45	10.07556	9.90000	0.40000	19.80000	6.00000	14.20000	3.60000	17.40000	5.340929
BBS-001	17	10.22353	10.70000	5.20000	16.70000	7.10000	12.00000	5.70000	16.10000	3.577452
BNR-1	16	11.86875	11.45000	8.20000	16.20000	9.40000	14.05000	9.00000	14.90000	2.543153
CUL-3	32	12.59063	12.40000	8.10000	17.20000	10.25000	14.90000	9.20000	16.70000	2.832229
DNC-002	19	13.93158	14.10000	10.70000	18.90000	11.70000	15.00000	11.10000	17.70000	2.279389
DRC-1	44	14.20909	14.40000	4.80000	24.40000	9.65000	18.20000	7.60000	20.90000	5.017867
FLX-1	42	13.82381	13.90000	6.90000	21.30000	11.30000	15.90000	9.70000	17.30000	3.138495
GRR-001	43	11.90930	11.20000	8.10000	16.50000	9.80000	14.20000	9.40000	15.40000	2.397897
KNR-1	45	12.67333	12.30000	6.80000	18.90000	11.00000	15.30000	8.10000	16.80000	3.116044
KTR-005	26	13.42692	13.70000	9.80000	17.50000	11.60000	15.00000	10.80000	15.60000	1.971306
MST-21	19	13.95263	13.80000	13.00000	14.90000	13.60000	14.30000	13.40000	14.90000	0.492576
MUR-1	45	13.62444	14.20000	5.70000	22.00000	10.00000	17.10000	7.10000	19.10000	4.433660
OMR-1	46	11.75870	11.65000	6.30000	17.60000	9.80000	13.70000	7.70000	16.10000	2.972958
ONR-1	36	12.60556	12.80000	8.80000	15.40000	11.10000	14.10000	10.50000	14.70000	1.748623
OPO-1	43	14.28605	13.90000	9.50000	19.60000	12.10000	17.00000	9.80000	18.70000	3.201754
OPR-1	45	12.58667	12.00000	3.70000	22.20000	8.40000	17.20000	5.50000	20.20000	5.171891
OPR-3	42	13.45238	12.80000	5.40000	22.50000	10.00000	17.60000	7.30000	19.80000	4.712373
PLR-4	47	11.72553	11.30000	3.10000	20.90000	7.70000	16.60000	5.70000	18.00000	4.772406
PLR-5	143	14.76154	15.40000	7.60000	20.30000	12.90000	16.60000	11.50000	17.80000	2.504220
RAR-1	38	13.40526	14.35000	10.10000	15.60000	11.70000	14.90000	10.50000	15.40000	1.854425
RON-4	44	13.25227	13.10000	11.70000	15.40000	12.50000	14.05000	12.10000	14.60000	0.927484
SPC-1	44	12.71591	12.45000	6.30000	21.20000	9.70000	15.60000	8.20000	17.60000	3.738794
TMR-1	43	14.42791	14.50000	10.50000	17.90000	13.00000	15.80000	11.80000	17.00000	1.908418
TYR-1	38	13.21053	13.60000	8.30000	17.00000	11.50000	14.90000	9.60000	16.30000	2.373023
WaiM	128	16.14766	17.20000	6.80000	22.00000	14.60000	18.75000	10.40000	19.80000	3.615343
WDV-1	45	13.32444	13.80000	4.90000	25.90000	8.90000	16.60000	5.80000	20.60000	5.455862
WHR-1	39	11.67949	12.50000	2.30000	23.00000	6.70000	15.40000	3.70000	18.90000	5.586788
WHR-5	46	11.38043	11.40000	3.40000	23.10000	7.60000	14.80000	6.30000	17.80000	4.465802
WKR-1	73	14.36986	14.40000	6.50000	23.90000	10.40000	18.00000	8.80000	20.30000	4.630385
WRR-2	49	7.34490	7.20000	2.60000	12.80000	4.60000	9.20000	3.50000	11.90000	3.052189
WRR-6	43	13.40698	14.20000	5.90000	21.20000	10.10000	15.90000	8.30000	18.70000	3.948381
WTS-009	24	14.13750	13.75000	7.40000	21.70000	11.70000	16.65000	10.20000	20.70000	3.753469

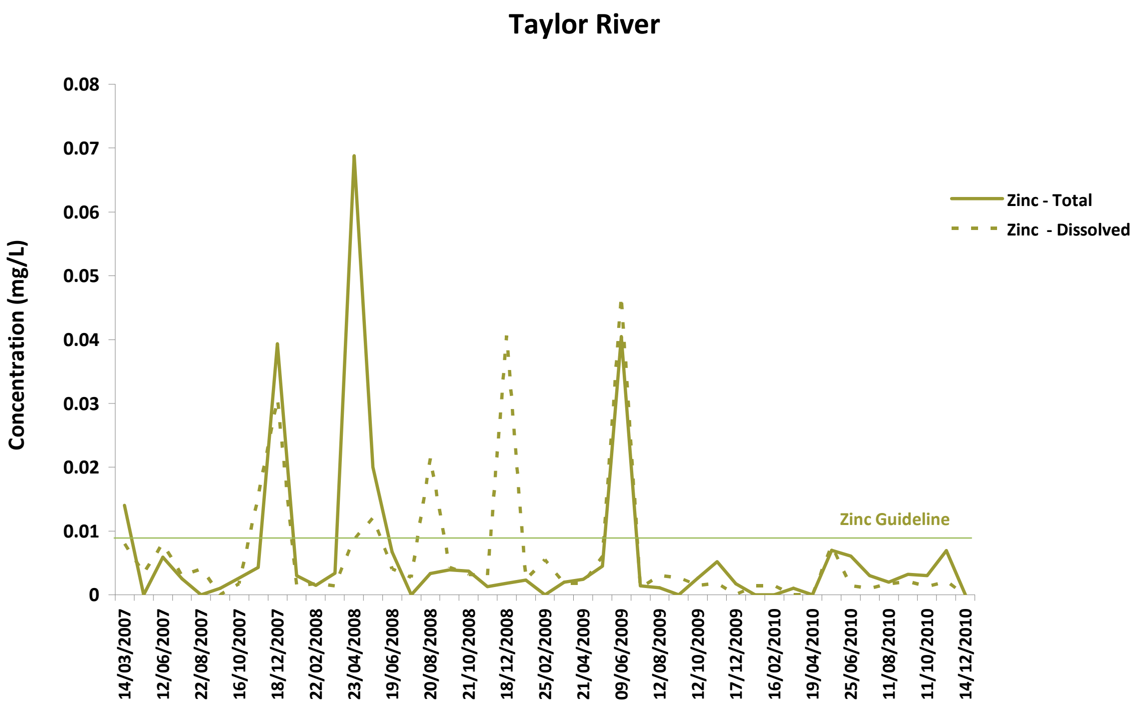
Descriptive Statistics Turbidity (NTU) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	18	5.9483	2.42500	0.410000	37.000	1.280000	5.49000	0.810000	21.1000	9.1642
AWR -1	59	131.3441	17.10000	1.020000	2600.000	3.830000	80.80000	1.720000	338.0000	378.8968
AWR-3	61	105.6130	19.60000	0.530000	1320.000	5.620000	62.30000	1.740000	270.0000	245.7453
BBS-001	70	1.4914	0.40000	0.100000	23.000	0.200000	1.00000	0.150000	3.7000	3.3256
BNR-1	16	12.6819	1.48500	0.320000	174.000	0.830000	3.38000	0.400000	5.2200	43.0433
CUL-3	15	4.4880	1.61000	0.550000	42.600	1.240000	3.05000	0.730000	4.0600	10.5898
DNC-002	32	11.0084	5.79500	1.410000	49.300	3.505000	13.45000	1.830000	30.5000	11.9398
DRC-1	18	10.3650	7.73500	1.960000	27.000	4.370000	16.60000	3.710000	23.5000	7.6926
FLX-1	52	3.6813	0.99500	0.230000	52.300	0.530000	2.93500	0.310000	10.0000	8.1909
GRR-001	44	1.7498	0.48000	0.050000	35.900	0.330000	1.04000	0.240000	2.3000	5.4338
KNR-1	47	1.0311	0.73000	0.270000	4.500	0.480000	1.51000	0.350000	2.0800	0.8569
KTR-005	53	4.9189	0.62000	0.270000	51.300	0.400000	2.52000	0.320000	20.7000	10.2369
MST-21	26	2.7331	2.61500	0.840000	5.180	1.950000	3.40000	1.370000	4.9200	1.1659
MUR-1	18	0.8400	0.54000	0.180000	4.540	0.370000	0.87000	0.200000	1.6600	1.0026
OMR-1	49	1.5384	0.41000	0.160000	24.000	0.290000	1.29000	0.200000	3.1600	3.6349
ONR-1	50	1.9492	0.56000	0.200000	18.200	0.370000	1.76000	0.280000	5.1550	3.6634
OPO-1	37	0.7630	0.54000	0.270000	3.290	0.450000	0.93000	0.370000	1.4000	0.6008
OPR-1	57	3.9735	1.92000	0.500000	26.500	1.130000	4.05000	0.760000	9.0100	5.2104
OPR-3	58	9.8019	4.34000	1.030000	86.500	2.410000	9.30000	1.660000	22.3000	15.1509
PLR-4	46	3.9937	0.71500	0.300000	47.400	0.410000	1.53000	0.340000	15.0000	8.7932
PLR-5	52	2.5575	0.51000	0.150000	50.400	0.290000	0.99500	0.210000	6.0000	7.4800
RAR-1	72	2.8736	1.01000	0.360000	38.400	0.625000	2.05000	0.530000	4.5800	6.0011
RON-4	37	1.5757	0.66000	0.110000	17.800	0.320000	1.66000	0.200000	2.7100	3.0965
SPC-1	49	0.8941	0.59000	0.290000	10.300	0.460000	0.75000	0.380000	1.5000	1.4281
TMR-1	52	5.2083	2.19000	0.790000	48.200	1.660000	3.26000	1.310000	12.7000	8.7437
TYR-1	55	4.1213	1.88000	0.450000	32.100	1.010000	3.96000	0.650000	8.9000	6.1222
WaiM	43	15.1593	0.42000	0.110000	224.000	0.210000	1.42000	0.160000	47.5000	47.4975

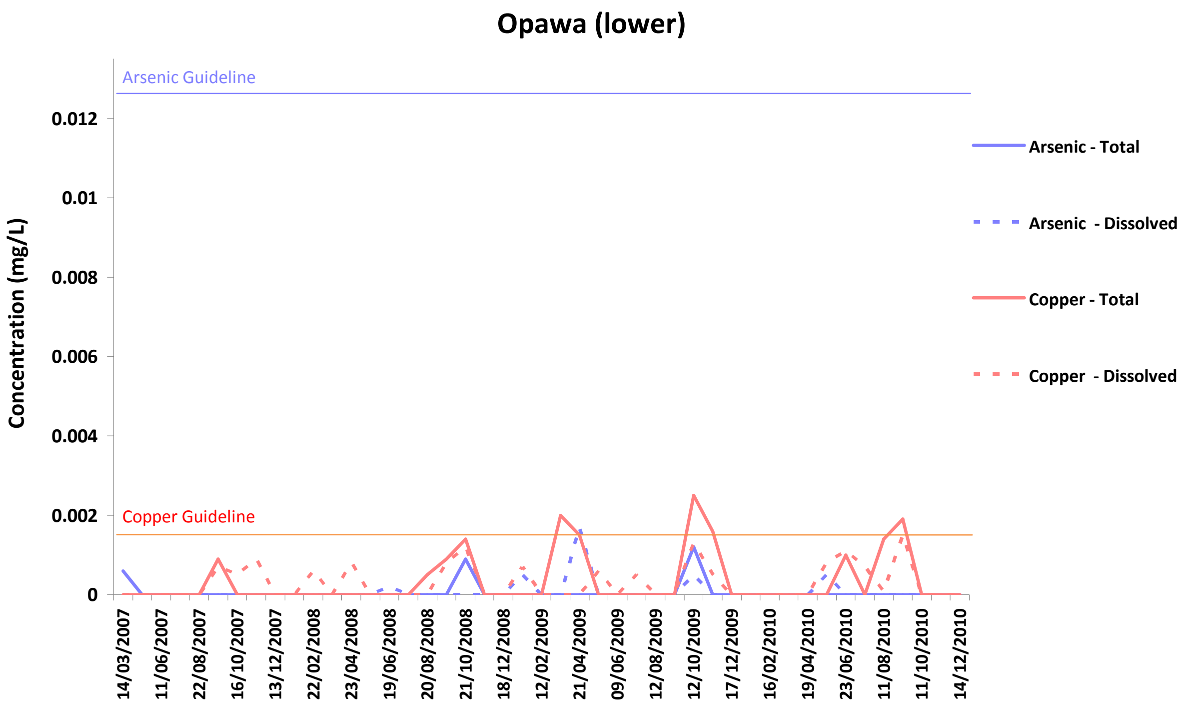
WDV-1	48	12.8381	3.48500	0.800000	92.800	1.895000	13.16500	1.170000	48.0000	20.9062
WHR-1	53	21.2596	1.88000	0.230000	260.000	0.860000	13.80000	0.680000	47.6000	52.2512
WHR-5	44	12.3186	2.25000	0.270000	91.300	0.965000	12.59000	0.670000	41.3000	21.3021
WKR-1	50	0.7896	0.34000	0.130000	7.090	0.230000	0.89000	0.175000	1.5200	1.2053
WRR-2	81	7.1263	1.31000	0.250000	174.000	0.730000	4.05000	0.530000	12.5000	21.4478
WRR-6	48	2.9804	0.76500	0.250000	62.000	0.540000	2.32500	0.370000	6.0000	8.9320
WTS-009	44	1.5725	1.09000	0.170000	6.510	0.780000	1.96500	0.620000	3.1300	1.3646

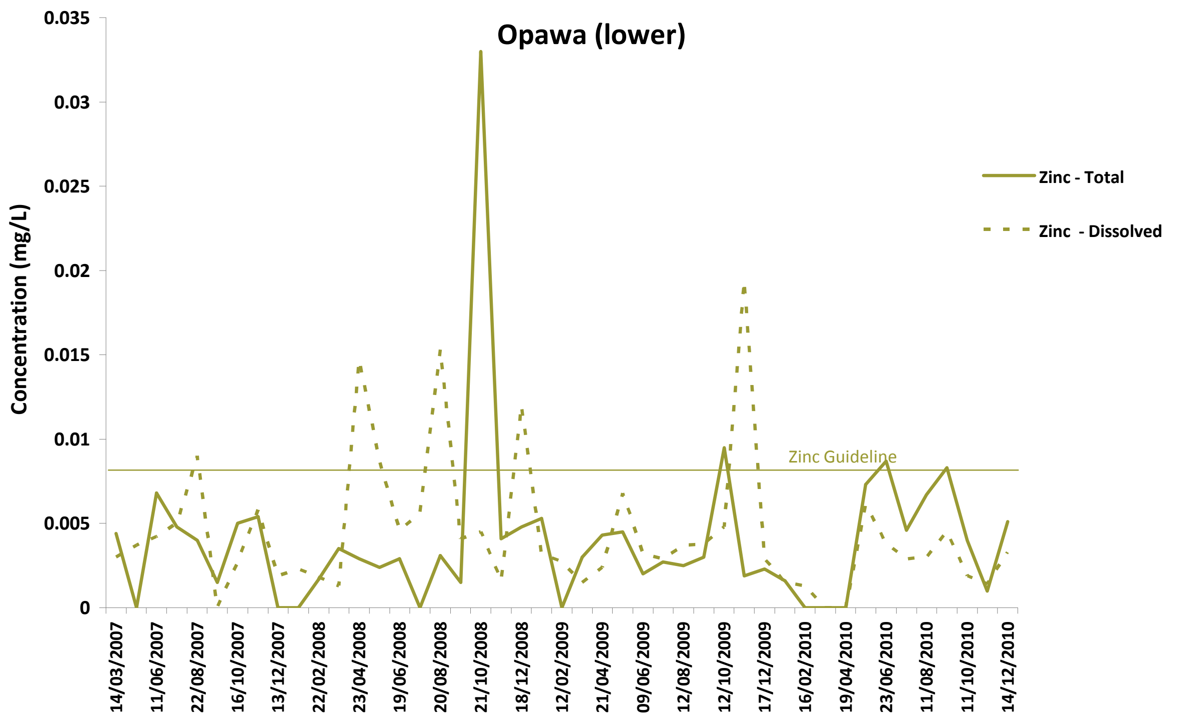
Descriptive Statistics Specific Conductivity (μS/cm) 2007-2010										
	Valid Number	Mean	Median	Minimum	Maximum	Lower Quartile	Upper Quartile	10%ile	90%ile	Standard Deviation.
ARE-3	18	94.9556	91.1500	68.1000	124.000	87.7000	99.3000	80.7000	119.2000	13.8084
AWR -1	44	149.6341	149.5500	118.0000	183.300	140.2000	160.3000	129.1000	166.4000	14.9929
AWR-3	45	112.8356	116.1000	79.2000	139.600	102.2000	123.6000	90.2000	132.9000	16.3128
BBS-001	10	114.3000	115.0000	90.0000	130.000	110.0000	124.0000	94.5000	130.0000	13.0473
BNR-1	18	51.3389	47.7000	35.6000	111.300	43.5000	53.6000	41.3000	60.9000	16.3058
CUL-3	15	69.0400	68.2000	58.3000	90.700	64.0000	73.3000	61.7000	74.0000	7.6588
DNC-002	30	73.5967	73.5500	65.3000	95.100	69.8000	76.4000	67.8000	77.7000	5.5931
DRC-1	17	193.9647	190.7000	153.7000	256.000	180.9000	196.0000	154.3000	236.0000	28.9465
FLX-1	47	451.3617	428.0000	241.0000	699.000	391.0000	532.0000	337.0000	568.0000	94.5296
GRR-001	41	95.3122	91.8000	67.2000	194.800	89.5000	94.7000	83.0000	101.6000	19.9001
KNR-1	43	59.3860	54.7000	47.0000	130.800	50.8000	61.9000	49.2000	74.1000	14.5841
KTR-005	47	66.0809	66.9000	48.4000	89.500	57.6000	73.3000	50.4000	77.6000	10.3952
MST-21	26	148.1769	147.1500	132.4000	165.800	140.9000	155.0000	138.5000	163.7000	9.0209
MUR-1	17	130.9647	126.4000	100.9000	228.000	112.6000	134.7000	106.3000	160.7000	28.9711
OMR-1	44	128.7273	128.2500	100.9000	170.200	118.0500	138.8000	106.1000	148.0000	15.7033
ONR-1	47	59.7936	59.3000	40.8000	99.200	52.3000	66.3000	47.6000	70.5000	10.1869
OPO-1	37	53.9568	54.5000	44.9000	59.600	52.7000	56.0000	48.6000	57.3000	3.1847
OPR-1	46	293.3891	152.7000	75.3000	1953.000	132.1000	189.0000	120.9000	440.0000	419.9797
OPR-3	47	86.6404	74.9000	52.2000	182.800	68.7000	100.6000	62.9000	128.9000	29.7393
PLR-4	41	67.7195	67.3000	46.1000	128.500	56.1000	73.8000	50.8000	82.8000	15.8538
PLR-5	47	66.4362	67.4000	41.7000	97.800	55.1000	74.7000	48.1000	81.0000	12.7103
RAR-1	57	72.2842	72.9000	55.7000	88.100	68.8000	76.8000	62.3000	79.1000	6.5753
RON-4	37	83.6703	82.9000	67.7000	136.300	78.1000	86.2000	76.9000	90.8000	10.5968
SPC-1	47	74.0191	70.4000	62.5000	119.200	67.5000	75.1000	65.3000	88.7000	12.1904
TMR-1	47	114.0766	115.6000	54.7000	167.100	105.8000	125.4000	88.3000	131.3000	18.1939
TYR-1	46	142.9804	139.0500	78.2000	192.600	130.9000	153.5000	122.5000	175.0000	20.8719
WaiM	39	350.1538	343.0000	311.0000	394.000	327.0000	376.0000	315.0000	379.0000	25.6685
WDV-1	40	384.3075	93.4000	51.0000	4730.000	78.6000	125.7500	67.8000	723.5000	979.7642
WHR-1	48	70.6458	71.0500	54.9000	82.700	65.2000	75.7000	61.9000	78.8000	6.6441
WHR-5	37	68.7784	69.3000	53.4000	80.600	64.5000	74.3000	57.2000	76.8000	7.2278
WKR-1	47	45.3681	45.5000	29.7000	77.300	38.4000	50.8000	35.6000	54.3000	8.6755
WRR-2	48	63.6313	63.3500	45.1000	81.800	59.5000	68.9000	55.3000	71.6000	6.7495
WRR-6	48	47.2313	47.4000	34.7000	64.300	43.7500	50.3000	41.7000	53.1000	4.9592
WTS-009	41	104.8366	105.1000	73.3000	139.800	90.7000	118.9000	81.9000	129.8000	18.1491

Appendix 4: Arsenic, copper and zinc concentrations for selected rivers. Both total and dissolved concentrations are measured. The guidelines refer to the ANZECC trigger values for slightly to moderately disturbed systems for the protection of 95% of species in freshwater. The ANZECC guidelines do not differentiate between total and dissolved concentrations.






Opawa (lower)
Arsenic Guideline
Copper Guideline
Concentration (mg/L)
0.012
0.01
0.008
0.006
0.004
0.002
0
Arsenic - Total
Arsenic - Dissolved
Copper - Total
Copper - Dissolved
14/03/2007
11/06/2007
22/08/2007
16/10/2007
13/12/2007
22/02/2008
23/04/2008
19/06/2008
20/08/2008
21/10/2008
18/12/2008
12/02/2009
21/04/2009
09/06/2009
12/08/2009
12/10/2009
17/12/2009
16/02/2010
19/04/2010
23/06/2010
11/08/2010
11/10/2010
14/12/2010


Opawa (lower)
Zinc Guideline
Concentration (mg/L)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Zinc - Total
Zinc - Dissolved
14/03/2007
11/06/2007
22/08/2007
16/10/2007
13/12/2007
22/02/2008
23/04/2008
19/06/2008
20/08/2008
21/10/2008
18/12/2008
12/02/2009
21/04/2009
09/06/2009
12/08/2009
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16/02/2010
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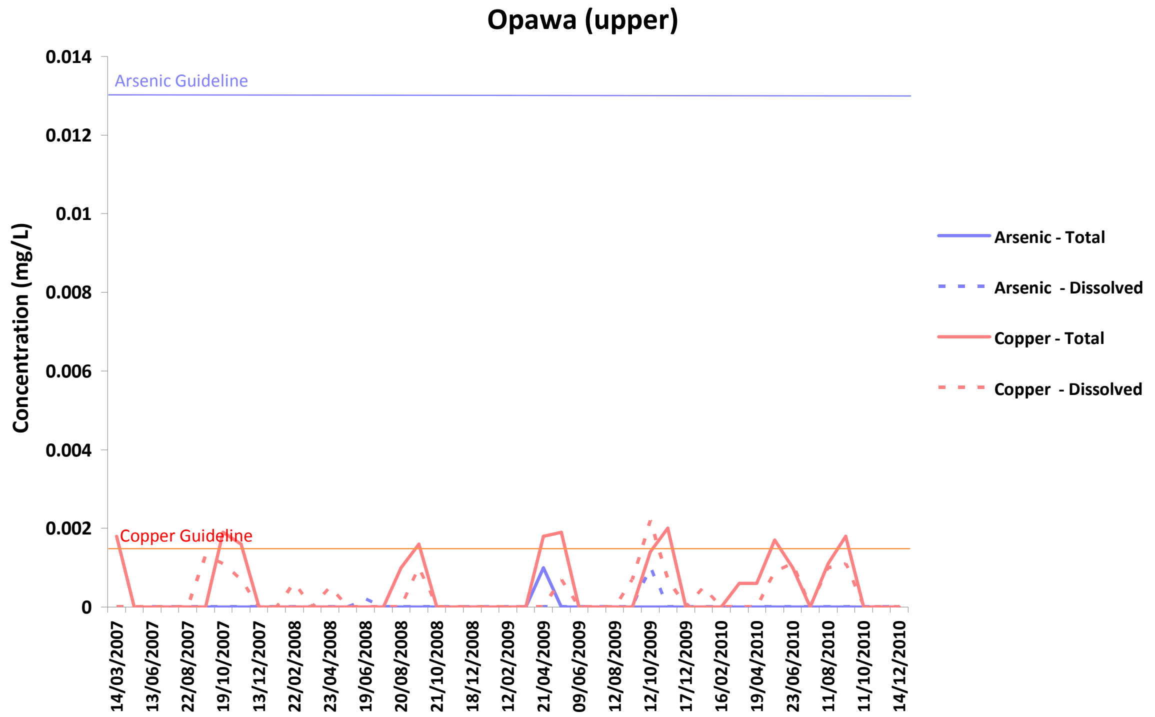
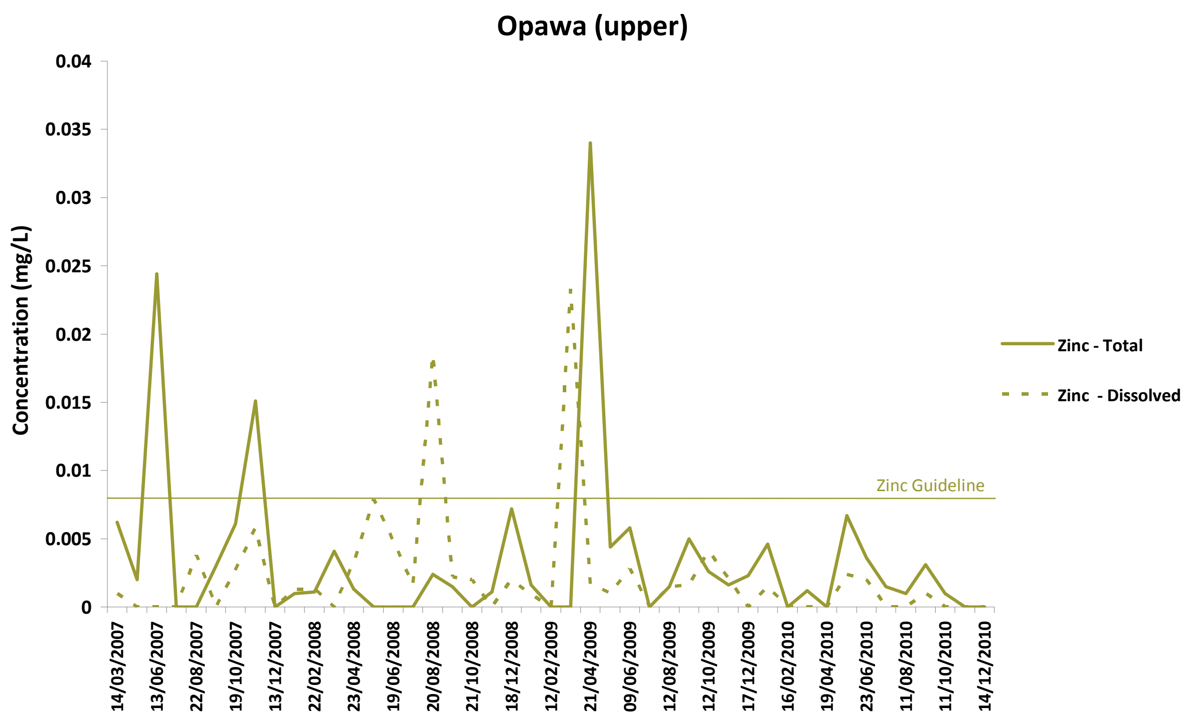
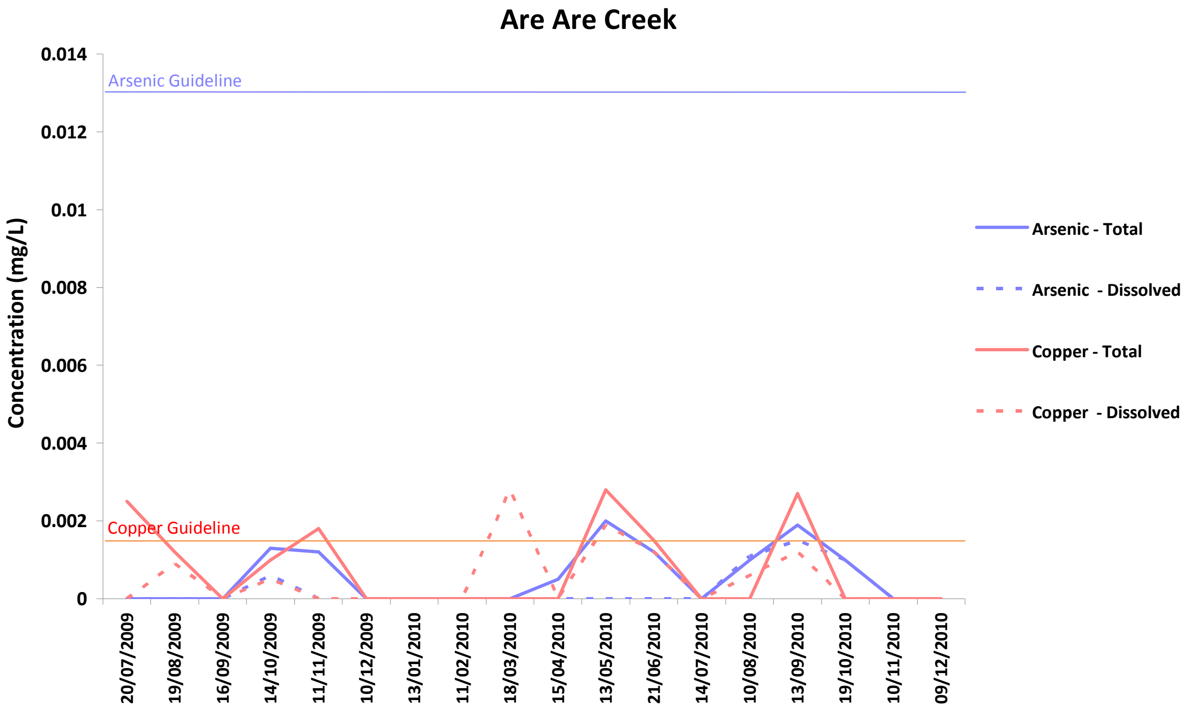
11/08/2010
11/10/2010
14/12/2010



Opawa (upper)
Concentration (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Arsenic Guideline
Copper Guideline
Arsenic - Total
Arsenic - Dissolved
Copper - Total
Copper - Dissolved
14/03/2007
13/06/2007
22/08/2007
19/10/2007
13/12/2007
22/02/2008
23/04/2008
19/06/2008
20/08/2008
21/10/2008
18/12/2008
12/02/2009
21/04/2009
09/06/2009
12/08/2009
12/10/2009
17/12/2009
16/02/2010
19/04/2010
23/06/2010
11/08/2010
11/10/2010
14/12/2010



Opawa (upper)
Concentration (mg/L)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Zinc Guideline
Zinc - Total
Zinc - Dissolved
14/03/2007
13/06/2007
22/08/2007
19/10/2007
13/12/2007
22/02/2008
23/04/2008
19/06/2008
20/08/2008
21/10/2008
18/12/2008
12/02/2009
21/04/2009
09/06/2009
12/08/2009
12/10/2009
17/12/2009
16/02/2010
19/04/2010
23/06/2010
11/08/2010
11/10/2010
14/12/2010


Are Are Creek
Arsenic Guideline
Copper Guideline
Concentration (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Arsenic - Total
Arsenic - Dissolved
Copper - Total
Copper - Dissolved
20/07/2009
19/08/2009
16/09/2009
14/10/2009
11/11/2009
10/12/2009
13/01/2010
11/02/2010
18/03/2010
15/04/2010
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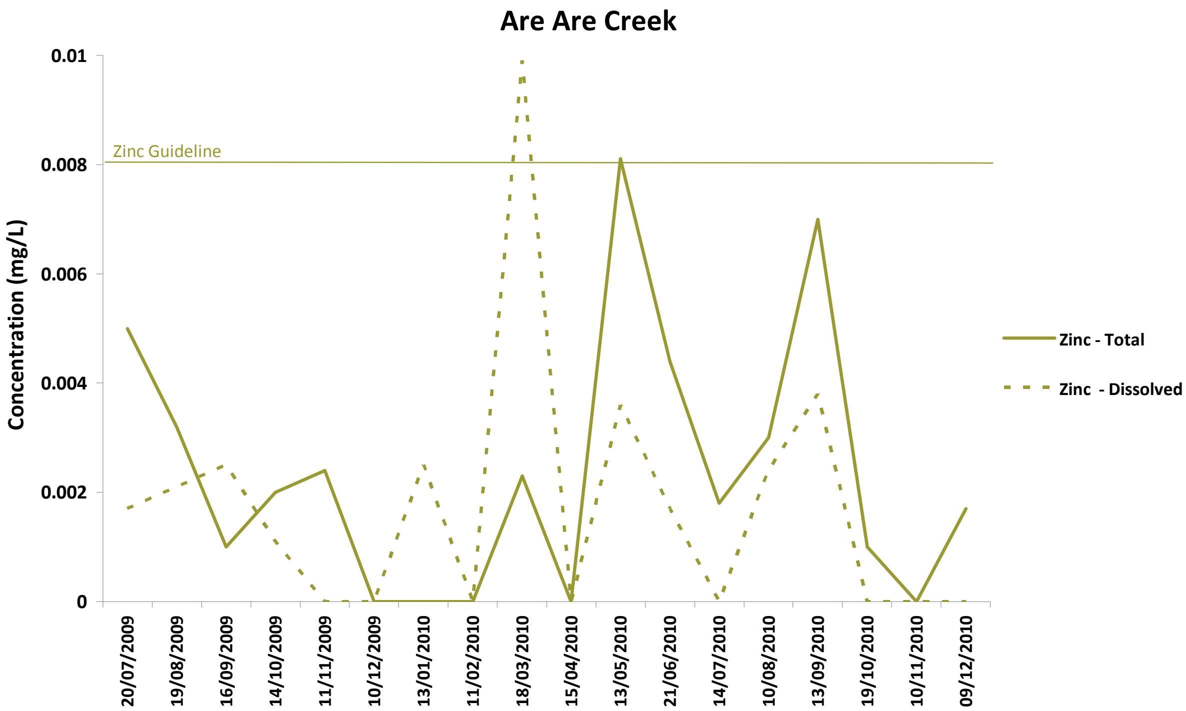
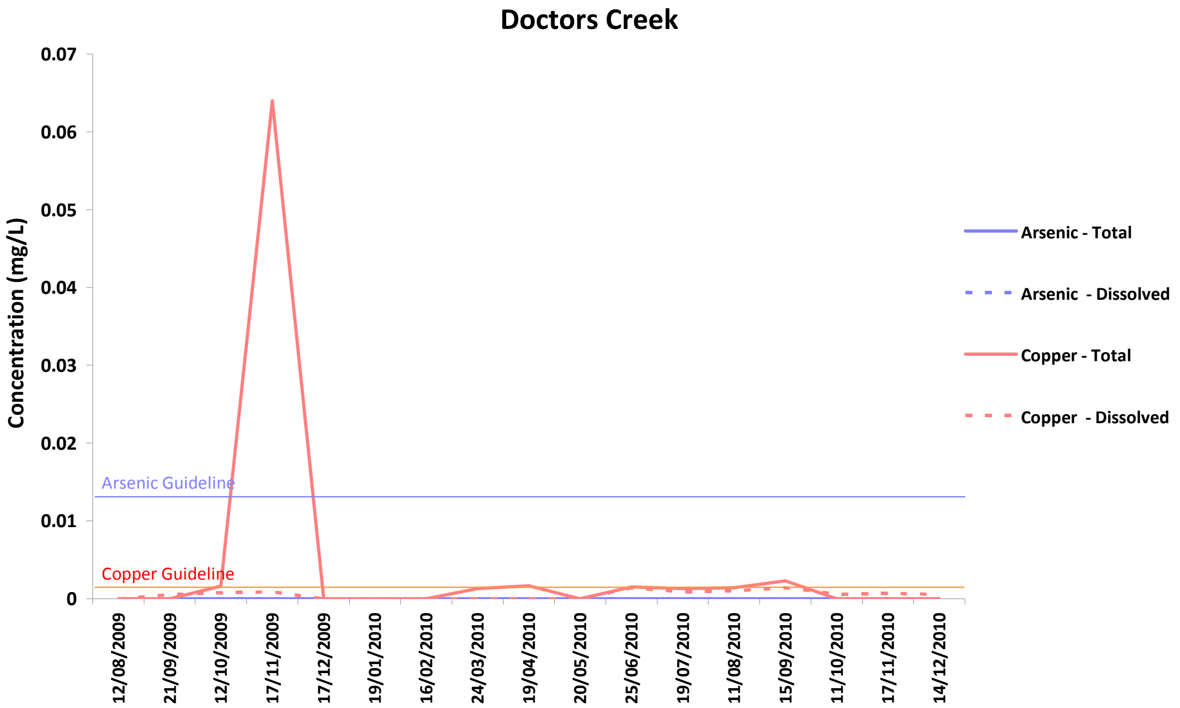
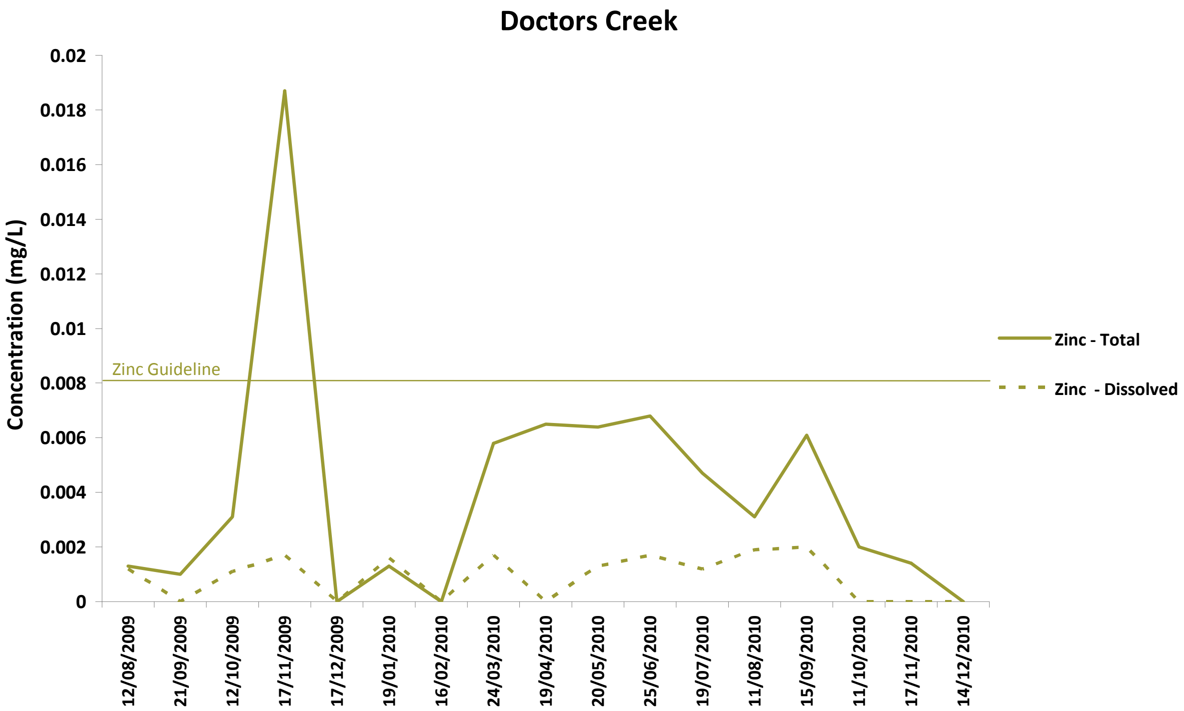
13/09/2010
19/10/2010
10/11/2010
09/12/2010


Are Are Creek
Zinc Guideline
Concentration (mg/L)
0.01
0.008
0.006
0.004
0.002
0
Zinc - Total
Zinc - Dissolved
20/07/2009
19/08/2009
16/09/2009
14/10/2009
11/11/2009
10/12/2009
13/01/2010
11/02/2010
18/03/2010
15/04/2010
13/05/2010
21/06/2010
14/07/2010
10/08/2010
13/09/2010
19/10/2010
10/11/2010
09/12/2010


Doctors Creek
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Concentration (mg/L)
Arsenic Guideline
Copper Guideline
12/08/2009
21/09/2009
12/10/2009
17/11/2009
17/12/2009
19/01/2010
16/02/2010
24/03/2010
19/04/2010
20/05/2010
25/06/2010
19/07/2010
11/08/2010
15/09/2010
11/10/2010
17/11/2010
14/12/2010
Arsenic - Total
Arsenic - Dissolved
Copper - Total
Copper - Dissolved


Doctors Creek
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Concentration (mg/L)
Zinc Guideline
12/08/2009
21/09/2009
12/10/2009
17/11/2009
17/12/2009
19/01/2010
16/02/2010
24/03/2010
19/04/2010
20/05/2010
25/06/2010
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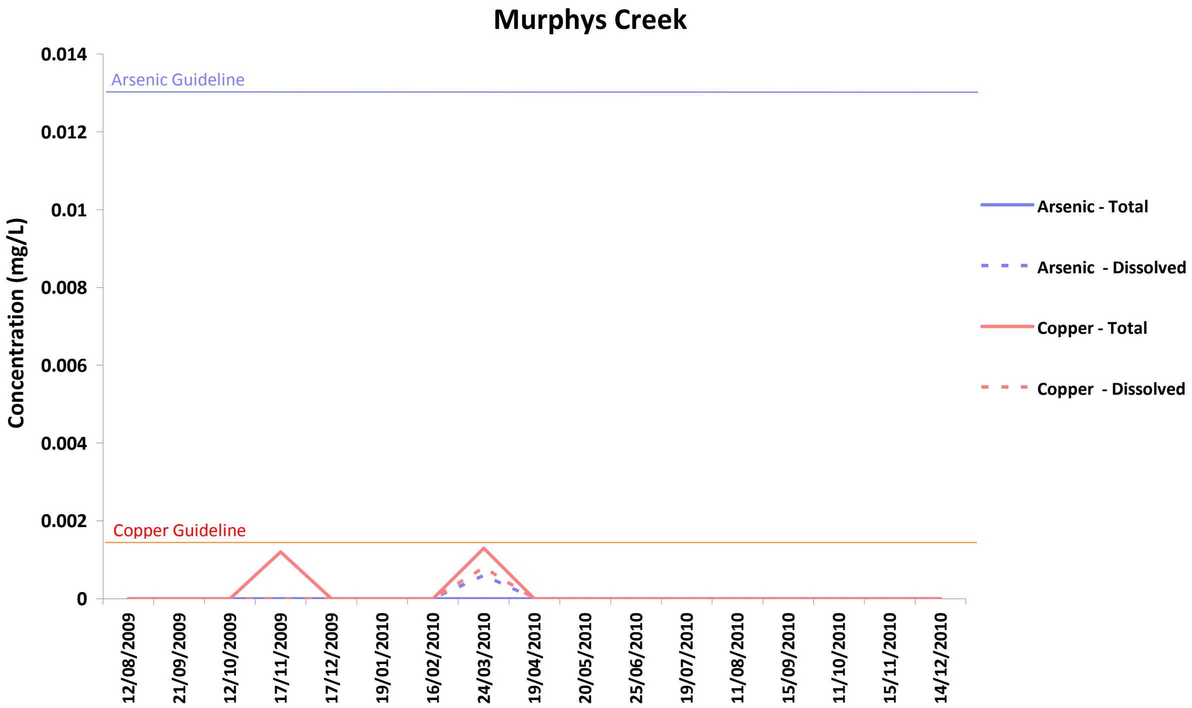
17/11/2010
14/12/2010
Zinc - Total
Zinc - Dissolved


Murphys Creek
Concentration (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Arsenic Guideline
Copper Guideline
Arsenic - Total
Arsenic - Dissolved
Copper - Total
Copper - Dissolved
12/08/2009
21/09/2009
12/10/2009
17/11/2009
17/12/2009
19/01/2010
16/02/2010
24/03/2010
19/04/2010
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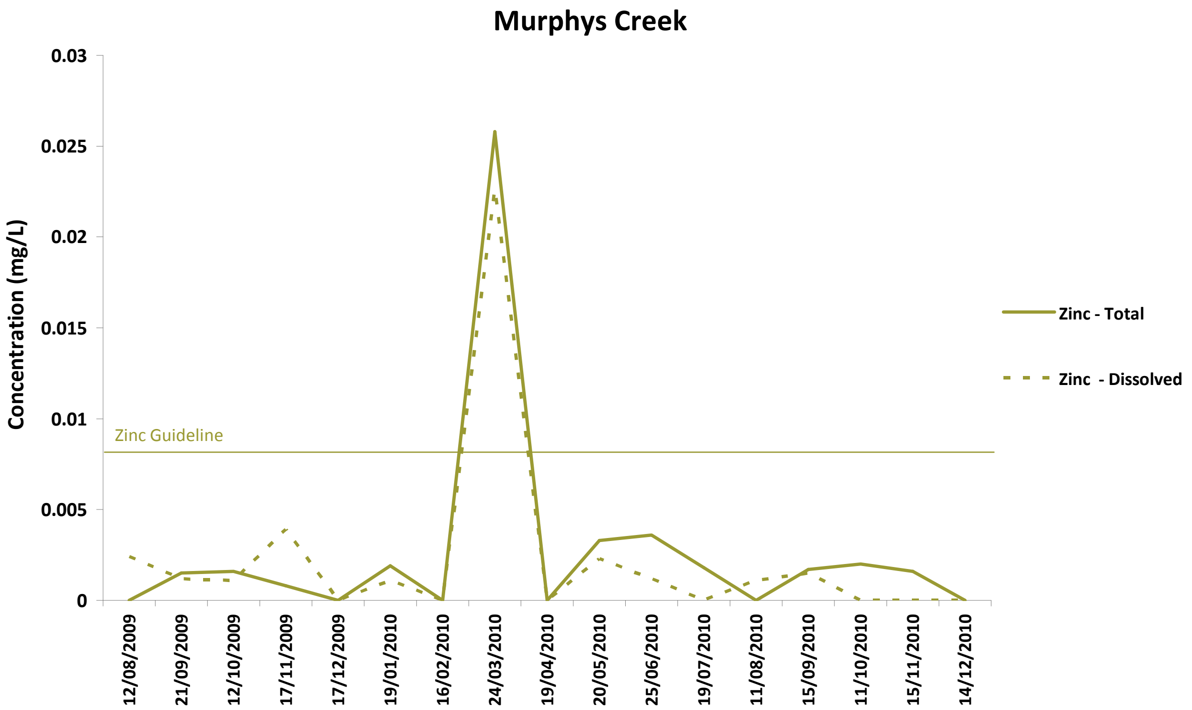
11/10/2010
15/11/2010
14/12/2010


Murphys Creek
Concentration (mg/L)
0.03
0.025
0.02
0.015
0.01
0.005
0
Zinc Guideline
Zinc - Total
Zinc - Dissolved
12/08/2009
21/09/2009
12/10/2009
17/11/2009
17/12/2009
19/01/2010
16/02/2010
24/03/2010
19/04/2010
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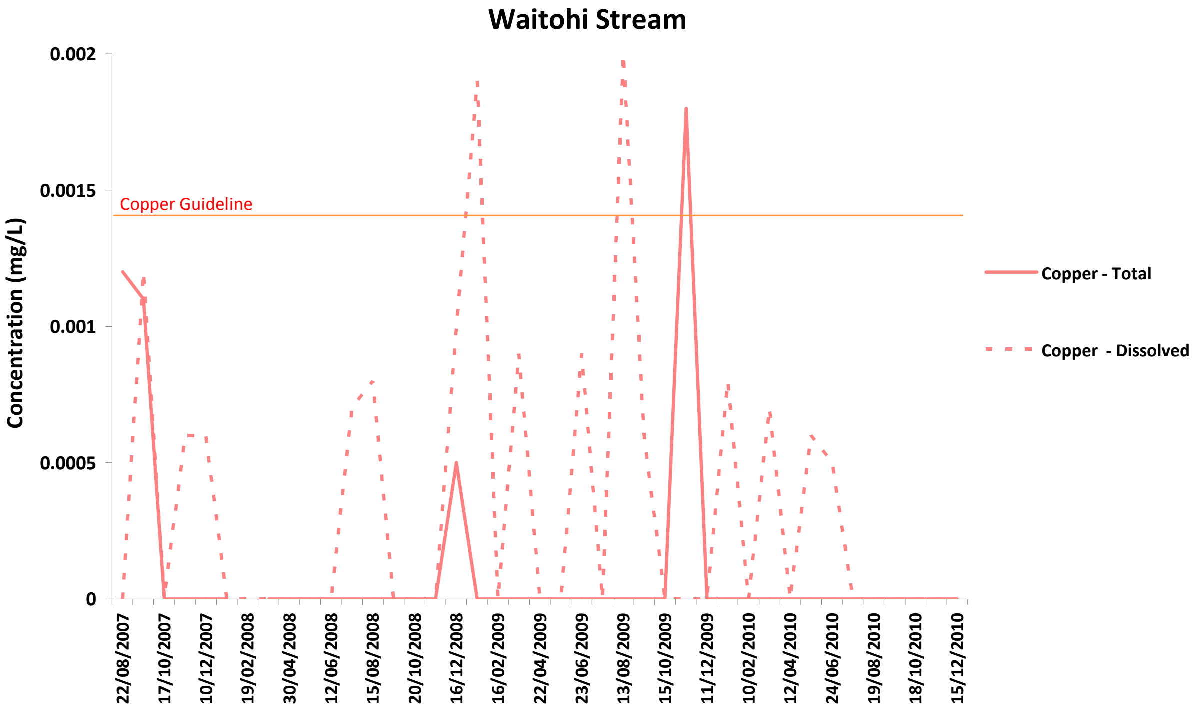
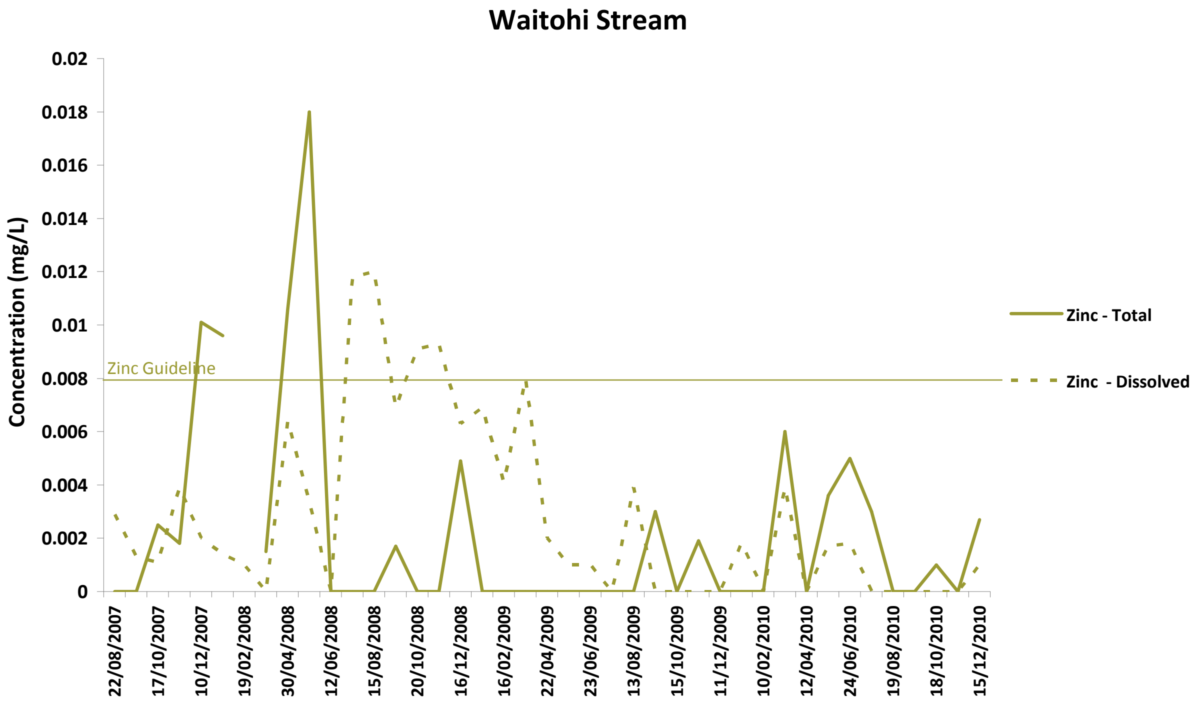
15/11/2010
14/12/2010


Waitohi Stream
Concentration (mg/L)
0.002
0.0015
0.001
0.0005
0
Copper Guideline
Copper - Total
Copper - Dissolved
22/08/2007
17/10/2007
10/12/2007
19/02/2008
30/04/2008
12/06/2008
15/08/2008
20/10/2008
16/12/2008
16/02/2009
22/04/2009
23/06/2009
13/08/2009
15/10/2009
11/12/2009
10/02/2010
12/04/2010
24/06/2010
19/08/2010
18/10/2010
15/12/2010


Waitohi Stream
Concentration (mg/L)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Zinc Guideline
Zinc - Total
Zinc - Dissolved
22/08/2007
17/10/2007
10/12/2007
19/02/2008
30/04/2008
12/06/2008
15/08/2008
20/10/2008
16/12/2008
16/02/2009
22/04/2009
23/06/2009
13/08/2009
15/10/2009
11/12/2009
10/02/2010
12/04/2010
24/06/2010
19/08/2010
18/10/2010
15/12/2010

Appendix 5: Derivation of the water quality index scores and assessment of water quality grades.

Water Quality Weighting

Ammonia	DO	Nitrate	DRP	Turbidity	E. coli
1.5	1.5	1	1	0.5	0.2

Water Quality Guidelines

WQ Class	*Ammonia*	*DO*	*Nitrate*	*DRP*	*Turbidity*	*E. coli*	*SCORE*
Very Poor	0.9	20	1.7	0.05	5.6	550	5
Poor	0.021	15	0.444	0.021	4.1	260	4
Fair	0.01	10	0.167	0.01	2	126	3
Good	0.005	5	0.05	0.005	1	50	2
Excellent	<.005	<5	<0.05	<.005	<1	<50	1

Water Quality Grades

5.7	The lowest possible score if all parameters scored '1' according to their water quality assessed against the guidelines
28.5	The highest possible score if all parameters scored '5' according to their water quality assessed against the guidelines

The difference between 28.5 and 5.7 is **22.8**

22.8 divided by 5 WQ classes is 4.56
The lowest score (5.7) plus the difference between classes (4.56) gives the width band for the excellent class and so forth for the 5 classes

All scores are subsequently divided by 5.7 to give a band width from 1 to 5.

A	Excellent	1 - 1.8
B	Good	1.9 - 2.6
C	Fair	2.7 - 3.4
D	Poor	3.5 - 4.2
E	Very Poor	4.3 - 5

Appendix 6: Summary statistics for the water quality parameters used to calculate the water quality score and assess the water quality grade.

WATER QUALITY GRADE CALCULATIONS 2007-10

Site ID	Ammonia (90%ile)	DO (Quartile Range)	Nitrate (90%ile)	DRP (90%ile)	E. coli (90%ile)	Turbidity (mean)	Number of Samples	WQ Score	WQ Grade	Grade Status
ARE-3	0.060	18.6	1.01	0.05	1600	5.95	19	4.1	Poor	Interim
AWR-1	0.020	5.8	0.25	0.03	120	127.04	46	2.7	Fair	Complete
AWR-3	0.010	6.4	0.06	0.03	56	102.26	47	2.5	Good	Complete
BBS-001	0.006	4	0.03	0.03	9	1.49	6	1.9	Excellent	Interim
BNR-1	0.005	5.7	0.03	0.01	70	12.68	16	2.3	Good	Interim
CUL-3	0.010	3.6	0.71	0.02	800	4.49	15	3.0	Fair	Interim
DNC-002	0.040	9.1	0.64	0.04	1800	10.67	31	3.6	Poor	Complete
DRC-1	0.070	33.3	2.30	0.04	310	10.37	18	4.5	Very Poor	Interim
FLX-1	0.020	20.5	0.57	0.02	300	3.14	47	3.9	Poor	Complete
GRR-001	0.005	7	0.06	0.02	300	1.51	41	2.2	Good	Complete
KNR-1	0.020	8.7	0.27	0.01	290	0.88	43	2.6	Good	Complete
KTR-005	0.020	5.5	1.52	0.02	500	4.27	46	3.0	Fair	Complete
MST-21	0.005	9.7	2.98	0.02	1200	2.37	25	3.1	Fair	Interim
MUR-1	0.005	10.2	1.75	0.02	410	0.84	18	2.9	Fair	Interim
OMR-1	0.005	9.8	0.71	0.01	31	1.30	46	2.5	Good	Complete
ONR-1	0.005	6.2	0.34	0.01	170	1.57	48	2.4	Good	Complete
OPO-1	0.005	4.45	0.56	0.02	110	0.71	37	2.2	Good	Complete
OPR-1	0.030	24.4	1.97	0.03	120	3.60	47	4.3	Poor	Complete
OPR-3	0.010	15.6	1.39	0.02	130	9.02	48	3.6	Poor	Complete
PLR-4	0.010	7	0.38	0.01	140	3.40	41	2.7	Fair	Complete
PLR-5	0.005	4.3	0.06	0.01	63	2.18	46	2.0	Good	Complete
RAR-1	0.010	7.6	0.92	0.02	560	2.38	63	3.0	Fair	Complete
RON-4	0.010	9.7	0.97	0.02	250	1.46	39	2.8	Fair	Complete
SPC-1	0.010	15.8	0.54	0.02	71	0.72	47	3.2	Fair	Complete
TMR-1	0.020	26.2	0.78	0.02	120	4.44	47	3.9	Poor	Complete
TYR-1	0.020	23.7	2.39	0.03	150	3.60	47	4.1	Poor	Complete
WaiM	0.005	12.9	0.28	0.01	370	13.04	39	2.9	Fair	Complete
WDV-1	0.020	6.9	0.47	0.02	480	11.20	41	3.1	Fair	Complete
WHR-1	0.005	5.4	0.40	0.01	180	18.78	48	2.6	Good	Complete
WHR-5	0.005	3.4	0.11	0.02	170	10.84	39	2.2	Good	Complete
WKR-1	0.005	5.2	0.05	0.02	130	0.65	48	2.1	Good	Complete
WRR-2	0.006	7.1	0.28	0.01	37	6.41	48	2.4	Good	Complete
WRR-6	0.005	0.7	0.04	0.01	17	2.98	48	1.6	Excellent	Complete
WTS-009	0.005	10.1	0.05	0.02	200	1.28	42	2.5	Good	Complete

Number of complete grades = 27

Turbidity results for AWR-1 and AWR-3 excluded from calculations

Appendix 7

Results of the Macroinvertebrate Analysis

Site	MCI Score	Doctors Ck	Omaka	mid Awatere	upper Opawa	lower Awatere	Murphys Ck	Kaituna	lower Opouri	lower Pelorus	upper Pelorus	Rai Falls	lower Ronga	Wakamarina	Graham	Flaxbourne	Needles	Waima	Anakoha	Kenepuru	Waitohi	Enchanted S	Goulter	Timms Ck	Top Valley	Are Are Ck	Wakakho	Cullens Ck	Duncan S	Kaiuma S	Bartletts Ck	Onamalutu	Pine Valley S	Duncan Bay S	Avon	lower Waihopai	upper Waihopai	mid Waihopai	Branch	Cabbage Tree Gully	Pukaka S	Spring Ck	Saltwater S	Storeys Ck	Tuamarina	lower Wairau	upper Wairau	Wye	Mill Str	Walker S	Gibsons Ck	Number of sites taxa present at
Site ID		DRC-1	OMR-1	AWR-3	OPR-3	AWR-1	MUR-1	KTR-005	OPO-1	PLR-4	PLR-5	RAR-1	RON-4	WKR-1	GRR-001	FLX-1	NED-3	WaiM	ANS-1	KNR-1	WTS-009	ENS-1	GLT-1	TMC-1	TVR-1	ARE-3	WKK-1	CUL-3	DNC-002	KUS-1	BRC-1	ONR-1	PNV-1	DNC-1	AVR-1	WHR-1	WHR-2	WHR-5	BNR-1	CTG-1	PUK-5	SPC-1	SWC-1	SYC-2	TMR-1	WRR-2	WRR-6	WYE-1	MST-21	WST-5	GBC-1	
Sample ID		20095422	20095424	20095449	20095448	20095450	20095423	20100105	20100100	20100103	20100102	20100101	20100099	20100104	20100111	20100243	20100245	20100244	20100241	20100107	20100110	20100326	20100325	20100331	20100330	20100336	20100337	20100108	20100109	20100242	20100333	20100335	20100332	20100106	20100163	20100162	20100160	20100161	20100324	20100327	20100339	20100340	20100328	20100334	20100338	20100341	20100323	20100329	20100342	20100547	20100548	
Date		25/11/2009	25/11/2009	26/11/2009	26/11/2009	27/11/2009	27/11/2009	7/01/2010	7/01/2010	7/01/2010	7/01/2010	7/01/2010	7/01/2010	7/01/2010	14/01/2010	15/01/2010	15/01/2010	15/01/2010	26/01/2010	26/01/2010	26/01/2010	27/01/2010	27/01/2010	27/01/2010	27/01/2010	8/02/2010	8/02/2010	10/02/2010	10/02/2010	10/02/2010	19-Feb-10	19-Feb-10	19-Feb-10	21/03/2010	8-Jul-10	8-Jul-10	8-Jul-10	8-Jul-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	8-Oct-10	14-Oct-10	14-Oct-10	27-Oct-10	
Easting		1678538	1668150	1660707	1675898	1685071	1678585	1664877	1652204	1659571	1647585	1648018	1649966	1656011	1689949	1697479	1695638	1692178	1693260	1694287	1684133	1631755	1615505	1641504	1638848	1668891	1675301	1671802	1675552	1665963	1649816	1665221	1642598	1663894	1654552	1661086	1647510	1657397	1615310	1625856	1683488	1681052	1619068	1671220	1680588	1680623	1593486	1626403	1642747	1643573	1669880	
Northing		5403700	5402871	5368307	5406769	5401815	5404340	5426463	5437502	5430016	5427613	5429266	5437711	5428720	5430629	5368033	5368880	5360509	5454525	5442220	5428227	5395282	5390310	5400735	5398855	5409150	5411934	5428178	5429552	5434503	5403453	5407894	5405503	5446691	5387697	5402329	5387498	5392054	5383200	5390229	5414797	5411335	5388223	5410389	5412144	5412041	5362089	5385627	5398630	5398609	5405340	
Mayflies																																																				
Ameletopsis perscitus	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Austroclima jollyae	9	-	-	-	-	-	-	R	R	-	R	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	R	-	R	C	-	-	-	-	R	-	-	A	-	-	-	-	-	R	-	-	-	-	10
Austroclima sepia	9	R	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	A	-	C	6
Atalophlebioides cromwelli	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Coloburiscus humeralis	9	-	R	-	-	-	-	R	A	R	-	R	C	A	-	-	-	-	C	A	-	A	-	-	A	-	R	R	-	R	C	C	C	A	R	-	-	R	-	-	-	-	R	C	-	-	-	-	R	-	-	24
Deleatidium sp.	8	-	VVA	VA	C	VA	-	VA	VA	VA	A	A	VVA	VVA	C	-	R	A	A	A	C	A	A	VA	VA	R	A	A	C	-	VA	VA	VA	A	VA	VA	VA	VA	VA	C	A	R	A	VA	R	VA	VA	VVA	A	R	C	47
Ichthybotus bicolor	6	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Neozephlebia scita	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	R	-	-	C	-	C	R	-	-	-	-	C	-	-	8
Nesameletus sp.	9	-	-	-	-	-	-	R	A	R	A	R	C	C	-	-	-	-	-	-	-	-	R	-	R	-	C	C	-	-	-	-	A	-	-	-	R	R	A	-	-	-	-	R	R	-	A	R	-	-	-	19
Oniscigaster wakefieldi	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Rallidens mcfarlanei	9	-	-	-	-	-	-	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Zephlebia versicolor	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	R	R	-	4
Stoneflies																																																				
Acroperla trivacuata	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Austroperla cyrene	9	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	R	-	-	C	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	6
Megaleptoperla diminuta	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Spaniocerca zelandica	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Stenoperla prasina	10	-	-	-	-	-	-	-	C	-	R	-	C	C	-	-	-	-	R	-	-	C	C	-	C	-	-	-	-	-	-	-	C	R	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	11
Stenoperla spp.	10	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	5
Taraperla ancilis	7	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Zelandobius confusus group	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Zelandobius furcillatus group	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	R	-	C	A	A	R	-	-	R	R	R	-	R	A	-	-	-	-	12
Zelandobius sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Zelandoperla decorata	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	C	-	-	-	-	-	-	-	R	R	C	C	-	R	A	VA	C	-	-	-	-	-	-	-	C	R	-	-	-	13
Zelandoperla fenestrata	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Zelandoperla sp.	10	-	-	-	-	-	-	-	R	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Odonata																																																				
Austrolestes colensonis	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Xanthocnemis zealandica	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	A	-	-	-	-	-	-	2
Water Bugs																																																				
Microvelia macgregori	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	1
Saldula sp.	5	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sigara sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Dobsonflies																																																				
Archichauliodes diversus	7	-	C	-	-	-	-	C	A	R	C	C	C	C	C	-	-	-	C	A	C	-	R	R	C	C	-	C	C	C	C	-	A	C	C	-	-	R	-	-	R	-	A	C	-	-	C	-	-	-	-	29
Beetles																																																				
Antiporus strigosulus	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Antiporus sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Berosus sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Elmidae type A	6	-	A	R	A	C	-	VA	VA	A	A	A	A	VA	R	R	-	C	R	-	C	A	A	A	A	A	A	A	C	C	VA	A	A	-	C	R	-	R	R	-	R	-	R	-	-	-	C	R	-	-	C	37
Elmidae type B	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Enochrus sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Hydraenidae	8	-	R	-	-	-	-	A	A	-	-	-	A	A	-	-	-	-	-	R	R	R	-	C	R	-	R	C	-	-	C	A	A	C	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	17
Ptilodactylidae	8	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Scirtidae	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
True Flies																																																				
Anthomyiidae	3	-	-	-	-	-	-	-	-	-	C	-	-	-	C	R	R	C	-	-	-	-	R	R	-	R	-	-	-	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Aphrophila neozelandica	5	-	-	R	-	R	-	R	C	-	C	R	-	C	-	-	-	R	-	-	R	C	A	A	C	-	C	-	-	R	R	R	A	R	-	-	-	R	-	-	-	-	R	R	-	-	C	-	-	-	-	23
Austrosimulium spp.	3	R	A	R	R	-	-	C	C	-	R	C	A	C	C	-	A	-	C	A	-	R	C	A	R	A	C	-	R	C	C	A	-	A	C	-	-	-	-	A	C	C	A	C	-	-	C	C	C	R	R	37
Ceratopogonidae	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	1
Chironomus sp. A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Chironomus zelandicus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Empididae	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Ephydrella sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Eriopterini	9	-	-	R	-	-	-	-	R	R	C	-	R	R	-	-	-	-	R	R	-	R	R	C	C	-	R	-	-	-	C	R	-	-	-	-	R	R	R	-	-	-	-	-	-	-	C	-	-	-	-	20
Harrisius pallidus	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Hexatomini	5	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Lobodiamesa sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Maoridiamesa spp.	3	-	C	C	R	R	-	-	C	-	A	C	-	-	A	-	R	A	VA	R	C	-	R	C	C	R	-	C	-	-	R	R	C	R	-	-	-	-	-	VA	-	-	A	R	-	-	-	R	A	-	C	28
Molophilus sp.	5	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Neocurupira campbelli	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Neocurupira hudsoni	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Nothodixa sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Orthocladiinae	2	A	R	C	A	A	-	A	C	C	C	R	R	R	A	A	R	A	-	C	A	-	C	C	R	C	-	R	C	R	C	A	A	R	R	-	-	-	-	C	R	R	-	C	-	-	-	-	R	R	A	38
Paradixa sp.	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	2
Paralimnophila skusei	6	R	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	6
Parochlus sp.	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Polypedilum spp.	3	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	R	-	R	6
Stictocladius sp.	5	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	2
Stratiomyidae	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Tabanidae	3	-	-	-	-	-	-	R	A	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	R	C	-	-	R	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	8
Tanyderidae	4	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Tanypodinae	5	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	R	R	-	C	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	7
Tanytarsus spp.	3	C	R	R	R	R	-	R	R	R	C	R	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	A	A	C	C	-	-	-	-	R	R	-	R	-	-	-	-	-	-	C	-	C	21
Zelandotipula sp.	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Caddisflies																																																				
Aoteapsyche colonica	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Aoteapsyche raruraru	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	1
Aoteapsyche tepoka	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Aoteapsyche spp.	4	-	C	C	A	R	-	VA	C	A	C	C	R	A	VA	-	-	A	-	C	VA	C	A	C	C	VA	-	C	-	C	A	VA	A	VA	A	A	C	C	R	-	R	-	C	C	-	-	C	C	R	-	C	39
Beraeoptera roria	8	-	-	-	-	-	-	-	-	R	-	-	-	R	-	-	-	-	-	-	-	-	C	-	R	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Confluens olingoides	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	R	-	-	-	-	-	-	-	-	-	R	-	-	-	-	3
Costachorema psaropterum	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Costachorema xanthopterum	7	-	-	R	-	-	-	-	R	-	R	R	C	R	-	-	-	-	R	-	-	-	R	-	R	R	-	-	-	R	-	-	R	-	-	-	R	R	-	-	-	-	-	-	-	-	R	-	-	-	-	15
Costachorema spp.	7	-	R	R	-	-	-	-	-	-	-	-	C	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	R	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	9
Helicopsyche sp.	10	-	-	-	-	-	-	-	C	-	-	-	C	R	-	-	-	-	-	-	-	R	A	-	R	-	-	-	-	R	-	-	A	C	-	-	-	-	-	-	R	-	-	-	-	-	-	R	R	A	-	14
Hudsonema alienum	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	1
Hudsonema amabile	6	C	R	-	-	-	-	-	-	-	-	-	-	-	-	R	C	-	-	-	-	-	-	-	-	-	-	-	R	-	R	R	-	-	R	-	-	R	-	-	-	-	-	R	-	-	-	-	R	R	-	12
Hydrobiosella mixta	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Hydrobiosella stenocerca	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	2
Hydrobiosis chalcodes	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Hydrobiosis charadraea	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	1
Hydrobiosis clavigera	5	-	R	-	-	-	-	R	C	R	-	R	C	C	-	-	-	-	-	-	-	R	C	C	R	-	C	-	-	-	R	R	R	-	-	-	R	-	-	-	-	-	-	R	-	R	-	-	-	-	-	18
Hydrobiosis copis	5	-	R	-	-	R	-	C	R	-	-	-	C	R	R	-	-	-	-	C	C	-	R	C	A	-	C	-	-	-	C	C	-	-	-	-	-	-	-	A	-	-	C	-	-	-	-	-	R	-	R	20
Hydrobiosis frater	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Hydrobiosis gollanis	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	2
Hydrobiosis parumbripennis	5	C	-	-	C	-	R	R	R	-	R	R	R	R	-	-	-	-	C	R	-	R	R	-	-	-	-	R	-	R	R	-	C	R	-	-	-	R	-	-	-	-	R	-	-	-	-	-	-	-	R	22
Hydrobiosis umbripennis	5	-	-	-	-	-	-	R	-	-	R	-	-	-	R	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	6
Hydrobiosis spp.	5	R	-	-	R	-	-	C	C	R	C	R	A	C	C	-	C	-	C	C	-	R	R	C	C	-	-	-	R	C	C	C	C	C	R	R	-	R	-	A	R	-	C	-	-	R	R	-	R	-	R	34
Hydrochorema crassicaudatum	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Neurochorema forsteri	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	5
Neurochorema confusum	6	-	R	-	R	-	-	R	-	R	C	C	-	-	C	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	C	C	R	R	R	-	-	R	-	-	R	-	R	-	-	R	-	-	-	-	R	18
Oecetis unicolor	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Oeconesus similis	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Oeconesus sp.	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	1
Olinga spp.	9	-	-	R	-	-	-	R	A	C	C	C	VA	VA	R	-	-	-	-	-	R	-	A	A	A	-	C	-	-	R	A	A	VA	A	C	R	R	C	R	-	R	-	C	R	-	-	C	A	C	-	-	31
Oxyethira albiceps	2	A	-	-	C	-	R	R	-	-	-	-	-	-	R	C	-	R	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	C	-	-	R	-	-	-	R	R	R	14
Paroxyethira eatoni	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Paroxyethira hendersoni	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Philorheithrus sp.	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Plectrocnemia maclachlani	8	-	R	R	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	R	-	-	R	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Plectrocnemia sp.	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Polyplectropus puerilis	8	-	-	-	-	-	-	-	-	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Psilochorema bidens	8	-	R	-	-	-	-	C	R	-	-	-	R	-	C	-	R	-	-	C	C	-	C	C	-	-	C	-	C	R	C	C	-	-	-	-	-	R	-	C	-	-	R	R	-	-	-	-	R	-	-	21
Psilochorema leptoharpax	8	-	R	R	-	R	-	-	-	C	C	-	-	C	-	-	-	-	R	-	-	-	R	C	R	-	-	R	-	-	R	-	-	-	R	R	-	-	R	-	-	-	-	-	-	-	-	C	-	-	-	16
Psilochorema macroharpax	8	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	5
Psilochorema nemorale	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	2
Psilochorema tautoru	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Psilochorema spp.	8	-	R	-	-	-	-	C	C	R	-	-	C	-	R	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	R	-	-	R	R	-	-	R	-	-	-	R	R	-	R	R	-	-	-	-	16
Pycnocentria evecta	7	-	-	-	C	-	A	-	R	-	-	C	R	-	-	-	-	-	-	-	R	-	-	-	R	-	C	-	-	-	C	A	-	-	A	R	-	R	-	-	A	R	A	R	-	-	R	-	C	-	-	20
Pycnocentrodes sp.	5	C	VA	-	VA	-	-	VA	A	VA	A	A	A	VA	R	-	-	-	R	C	A	-	C	A	A	-	C	R	-	A	VA	VA	-	C	A	C	R	A	R	-	-	-	C	R	-	A	R	R	R	-	A	36
Triplectides cephalotes	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Triplectides obsoletus	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	R	-	-	2
Zelolessica cheira	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Moths																																																				0
Hygraula nitens	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Crustacea																																																				
Amphipoda	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Gammaridae	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Hemigrapsus crenulatus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Orchestia sp.	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Ostracoda	3	R	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Paracalliope fluviatilis	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VA	-	-	C	-	-	-	A	C	R	5
Paracalliope sp.	5	VVA	-	-	-	-	A	-	-	-	-	-	-	-	-	VA	VA	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Paracorophium lucasi	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Paranephrops planifrons	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Paratya curvirostris	5	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	R	C	-	-	-	-	R	-	-	-	-	-	-	-	C	-	-	C	-	-	-	-	-	-	7
Phreatogammarus fragilis	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Phreatogammarus helmsii	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Talitridae	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	1
Worms	1	A	C	-	R	R	A	C	R	R	-	-	R	-	-	R	C	-	-	-	R	-	-	-	-	C	R	-	-	-	-	R	-	-	R	-	R	-	-	C	C	R	R	-	R	-	-	-	R	-	C	25
Flatworms	3	-	-	-	-	-	-	-	C	-	-	R	R	-	-	-	R	-	-	-	R	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	7
Horsehair worms	3	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	R	-	-	3
Roundworms	3	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Leeches	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Proboscis worms	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Springtails	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	1
Snails																																																				
Ferrissia dohrnianus	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Ferrissia neozelanica	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	R	-	-	2
Gyraulus sp.	3	R	R	-	R	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	C	-	-	-	-	-	-	6
Lymnaea columella	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Melanopsis trifasciata	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Physa acuta	3	R	-	-	A	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	5
Potamopyrgus antipodarum	4	A	R	-	VA	-	VA	A	A	A	-	A	C	R	A	VA	A	-	A	A	C	C	C	-	-	VA	-	C	C	C	R	A	-	C	-	-	-	-	-	-	A	C	A	-	VA	C	-	-	A	VVA	C	34
Sphaeriidae	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	1
Mites	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Oribatidae	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Number of taxa		18	23	16	17	11	7	27	34	21	24	21	32	27	20	13	16	11	21	20	21	20	27	20	29	14	16	14	12	16	29	33	33	30	18	15	13	23	13	11	16	18	25	24	12	8	25	14	27	12	18	
MCI		78	106	113	81	91	94	108	124	118	125	111	128	137	106	71	88	89	134	117	106	143	130	116	128	80	133	119	112	124	118	110	132	128	108	131	126	135	135	78	119	88	114	125	88	117	125	143	105	108	86	
SQMCI		4.62	7.18	7.24	4.35	6.80	4.15	5.59	6.67	6.09	6.02	5.66	7.60	7.41	4.09	4.05	4.36	4.32	4.52	5.87	4.32	7.54	6.76	6.58	7.11	4.03	6.61	6.43	5.98	5.24	6.16	5.55	7.33	5.71	6.82	7.13	7.63	8.16	8.09	3.63	6.45	4.87	5.46	7.30	4.08	7.30	7.37	7.96	5.70	4.29	4.14	
EPT_{taxa} (excluding *Oxyethira*)		27.78	56.52	43.75	41.18	36.36	42.86	55.56	58.82	57.14	62.50	57.14	65.63	66.67	55.00	7.69	25.00	27.27	71.43	55.00	42.86	70.00	66.67	55.00	65.52	21.43	62.50	50.00	41.67	62.50	58.62	48.48	66.67	66.67	61.11	80.00	76.92	73.91	76.92	45.45	62.50	27.78	64.00	75.00	16.67	87.50	64.00	71.43	55.56	41.67	44.44	

Added to reference collection

Samples processed by Yvonne Stark & Anne Biggs (Stark Environmental Ltd)

Data entry and index calculation by John Stark (Stark Environmental Ltd)