

Healthy Estuary and Rivers of the City

*Water quality and ecosystem health
monitoring programme of Ihutai*

Water quality of the Avon and Heathcote rivers

Summary report on data collected in 2010

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1 Introduction

The Healthy Estuary and Rivers of the City: Water quality and ecosystem health monitoring programme of Ihutai was initiated in 2006¹. It includes monitoring programmes for four environmental values; safe for contact recreation, healthy ecosystems, food gathered is safe to eat, and culturally acceptable mahinga kai values. This report summarises data collected in 2010 from the Avon and Heathcote rivers as part of Value B – Healthy Ecosystems – water quality. Other parts of this value include water quality of the estuary and beyond, river habitat and its biota, and the soft sediments of estuary and tidal reaches. These aspects are covered by separate summary reports².

The Avon and Heathcote rivers drain a large part of the city of Christchurch and flow to the Avon-Heathcote Estuary/Ihutai. Both rivers are spring-fed and slow-flowing and have a number of tributaries that include both natural streams and man-made drains. The quality of the water in these rivers is influenced by both the quality of groundwater in the shallow aquifers that feed the springs and the quality of stormwater that runs off the land into the rivers and tributaries when it rains. Stormwater quality is strongly influenced by land use in the river catchment. Other factors that can affect water quality in these urban rivers include catchment geology, point source discharges from industrial sites, infrequent sewage overflows, and the presence of large numbers of waterfowl. In the lower reaches of the rivers water quality is also influenced by the quality of water in the estuary due to tidal flows extending up the rivers. Estuary water quality was strongly affected by the discharge of treated wastewater up until the commissioning of the ocean outfall in March 2010. The removal of the wastewater discharge from the estuary can therefore be expected to have affected the water quality at tidal sites on the rivers.

An additional factor likely to have influenced water quality in 2010 was the 4 September earthquake which resulted in damage to sewerage infrastructure and the discharge of untreated sewage to the Avon River for a period of around two months. Additional monitoring was undertaken during this time and is discussed in this report.

Good water quality is required for the plants and animals that live in the water, and on the bed of the rivers, to function normally. For the water to be of good quality it should not contain unnaturally high concentrations of nutrients or sediment and must contain sufficient oxygen for living things. High concentrations of nutrients and sediment and low concentrations of oxygen can be detrimental to the plants and animals that live in the water, and on the river bed. Some contaminants from the urban environment, such as ammonia and heavy metals, can be toxic to aquatic life even at low concentrations.

Water quality is monitored³ at sites on both the Avon and Heathcote rivers as well as some of their tributary streams in the upper parts of their catchments. This is a summary report of the water quality data collected at these sites and an overall evaluation of their water quality in 2010. This is the fourth annual summary report to be produced. A report including more detailed analysis, such as analysis of trends over time, will be produced following five years of data collection at these sites.

¹ Batcheler, L., Bolton-Ritchie, L., Bond, J., Dagg, D., Dickson, P., Drysdale, A., Handforth, D and Hayward, S. 2009. Healthy Estuary and Rivers of the City: Water quality and ecosystem health monitoring programme of Ihutai. Environment Canterbury Report No RO9/8. 60pp.

² See all summary reports from this year and previous years at www.ecan.govt.nz search: Ihutai

³ Monitoring is the routine collection of data over time in order to assess the state of the environment and identify changes over time.

2 Sampling

2.1 Sampling sites

The sites sampled are shown in Figure 2-1. These sites remained consistent with those sampled throughout 2009. Water samples were collected once a month by staff of the City Water and Waste Unit, Christchurch City Council.

Following the 4 September earthquake water samples were collected weekly for a month at a subset of sites across the city to determine the effects of the earthquake, including sewage and industrial discharges, on water quality. On the Avon River the sites were at Mona Vale (the railway line), Manchester Street and Pages Road and the Heathcote River sites were at Templetons Road, Rose Street, Tunnel Road and Cashmere Stream. These additional data are not included in the analysis and graphs presented in this report but comments are made in the text for selected parameters where relevant.

2.2 Water quality parameters

The water samples were analysed for a range of water quality parameters including:

- Dissolved oxygen
- Biochemical oxygen demand
- Total suspended solids
- Turbidity
- *Escherichia coli*
- Ammonia nitrogen
- Nitrate-nitrite nitrogen
- Dissolved reactive phosphorus
- Heavy metals – total zinc, copper, lead, cadmium, mercury

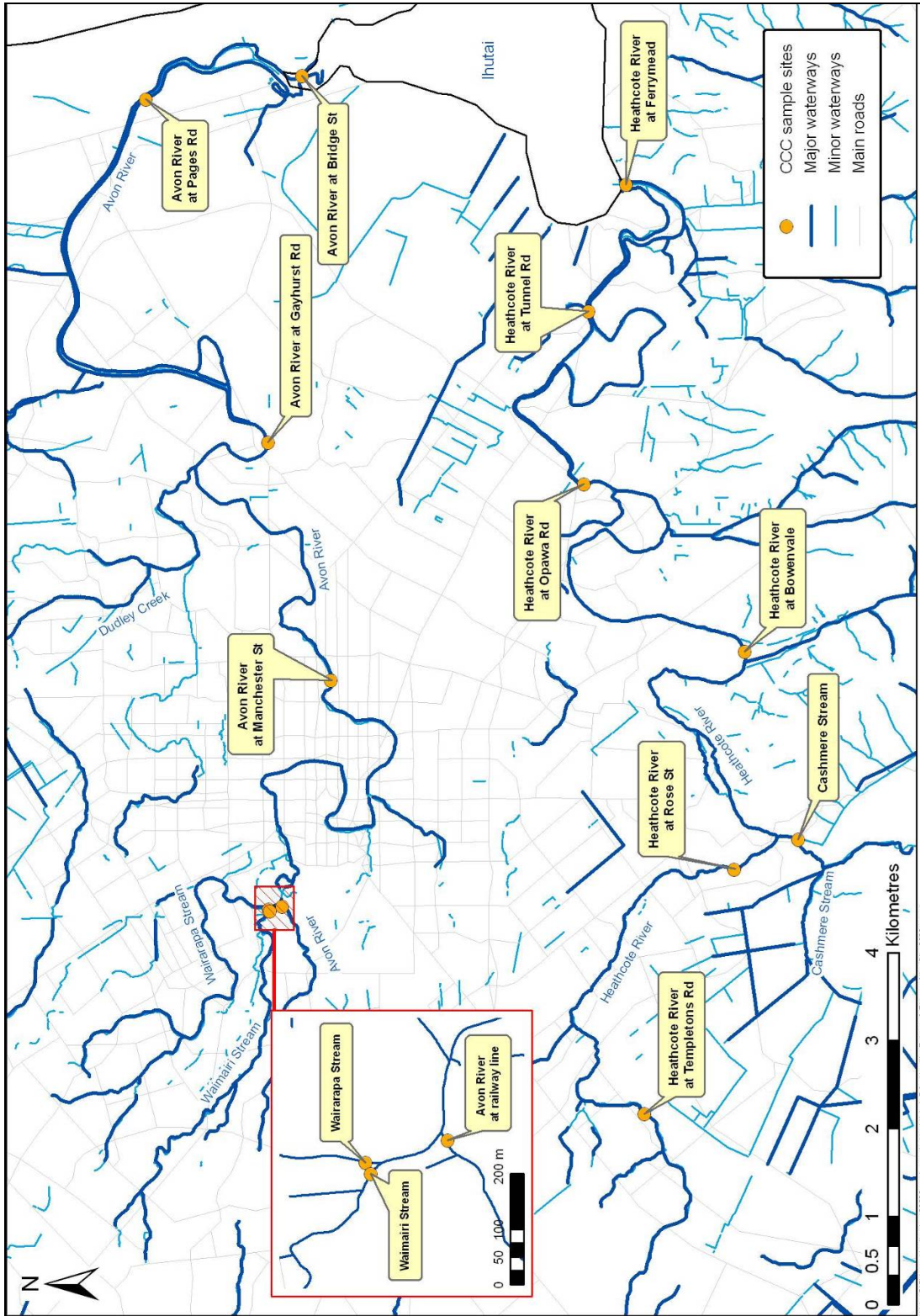


Figure 2-1: The location of the water quality sampling sites in 2010

3 Results

The results are presented on the following pages. The data are presented as bar graphs. The height of the bar depicts the median⁴ value from the samples taken at a site. The bars have been positioned on a map and below each bar are the minimum and maximum values recorded at the site. This form of presentation makes it easy to see the similarities and differences between sites.

3.1 Guidelines and trigger values

Guidelines are established to protect different waterway values, such as ecosystem health and suitability for contact recreation. Comparison of water quality results with relevant guidelines is useful to determine whether the water quality may be impacting on the values that a community considers are important for a waterway.

The ANZECC (2000)⁵ guidelines specify trigger values for nutrients, turbidity and toxic chemicals in fresh water. Where concentrations are below these trigger values there is a low risk of impacts on aquatic life occurring. Where the trigger values are exceeded this does not necessarily mean that an environmental problem exists but indicates that there is a potential risk. The trigger values used here are those that apply to slightly-moderately disturbed freshwater ecosystems, and in the case of toxicants (ammonia-nitrogen and heavy metals) provide for protection of 95% of species.

3.2 Nitrate-nitrite nitrogen

Nitrate is the common form of nitrogen found in natural waters. It is changed by biochemical processes to nitrite when there is no oxygen; when oxygen is present the nitrite quickly forms nitrate. Nitrate and nitrite are formed during the biochemical breakdown of ammonia-nitrogen. Fertilisers that are applied to land to promote plant growth are often a significant source of nitrate and nitrite.

Nitrate-nitrite nitrogen (NNN) represents the majority of nitrogen in waters that is immediately available to plants and elevated concentrations can result in excessive growth of aquatic plants or algae.

⁴ The median is the middle number when all numbers are ordered from lowest to highest. When there is an even number of numbers it is the average of the middle two numbers.

⁵ ANZECC 2000. Australia and New Zealand guidelines for fresh and marine water quality, Volume 1, The guidelines. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

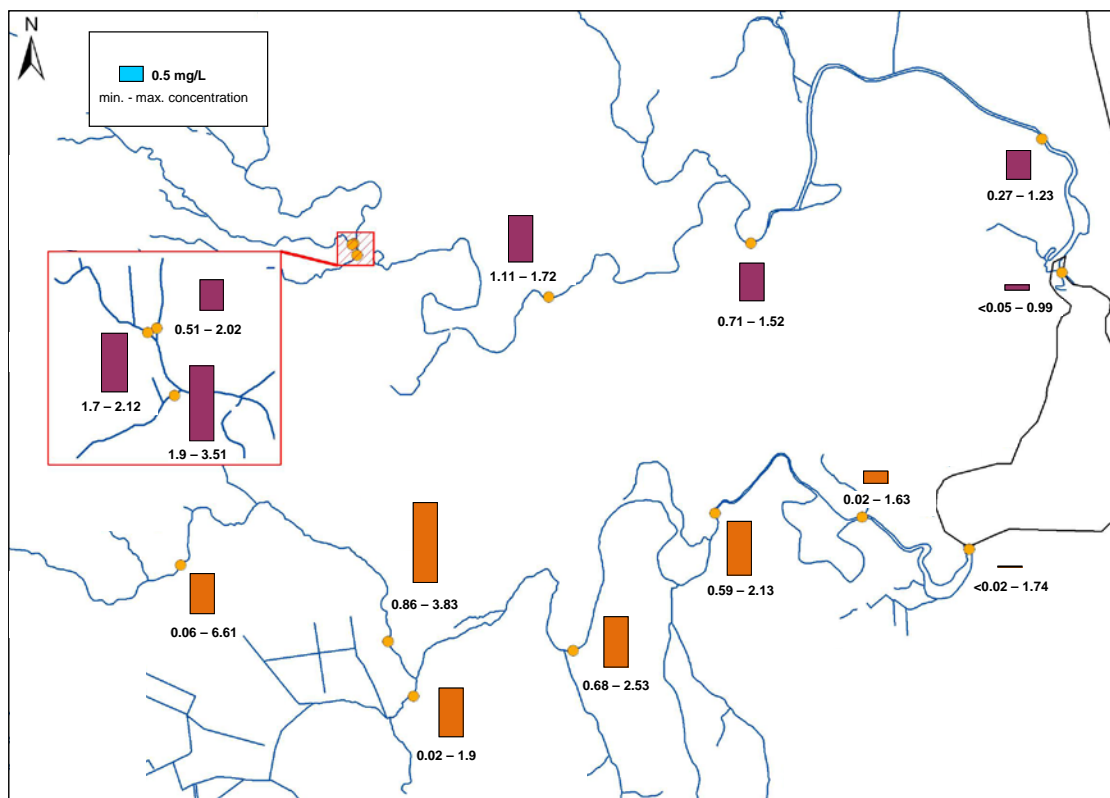


Figure 3-1: Nitrate-nitrite nitrogen concentrations in 2010

In both the Avon and Heathcote rivers, as in previous years, the concentrations of NNN were highest near the headwater springs and decreased downstream towards the estuary (Figure 3-1). This is due to the high nitrate concentrations that are found in groundwater in the shallow aquifers of the Christchurch-West Melton area, which are the source of flow from the springs. As the rivers flow through the urban area of Christchurch the NNN concentrations decrease due to dilution by water from other sources, such as tributaries and stormwater, that have lower NNN concentrations.

The ANZECC (2000) trigger value for NNN in lowland rivers is 0.444 mg/L. The majority of samples taken at all sites were greater than this value. This indicates that there is potential for excessive plant and algal growth in these rivers. Other conditions required for growth include sufficient phosphorus, light and temperature.

The results of the additional weekly sampling in September and October indicate that NNN concentrations in the rivers did not deviate beyond the typical range of values for sampled sites as a result of the 4 September earthquake.

3.3 Dissolved reactive phosphorus

Dissolved reactive phosphorus (DRP) is the dissolved form of phosphorus that is available for plant growth. Phosphorus naturally occurs in water with the concentrations typically reflecting the concentrations in the surrounding soil and rock. Phosphorus occurs in fertilisers applied to land to enhance plant growth. However in contrast to nitrate, the concentrations in groundwater are generally low as soils are good at absorbing excess phosphorus. Phosphorus is also a constituent of detergents and washing powders and hence is present in wastewater.

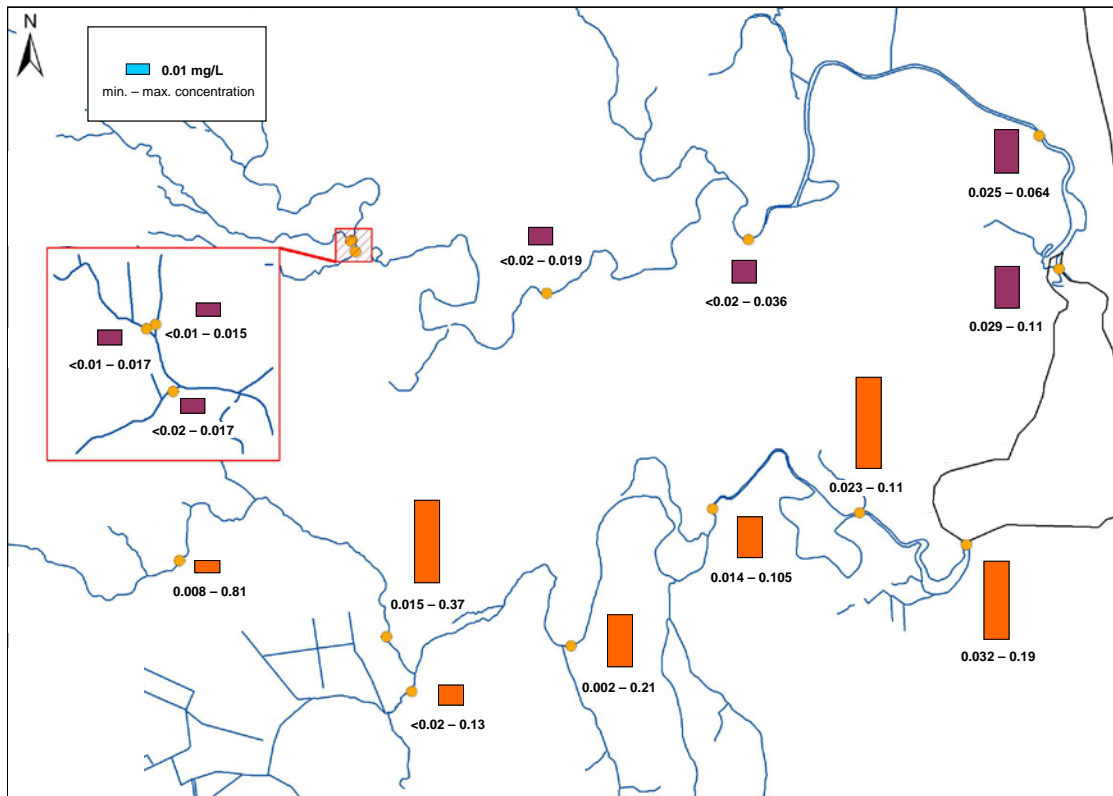


Figure 3-2: Dissolved reactive phosphorus concentrations in 2010

In the Avon River DRP concentrations were relatively low, with the highest concentrations occurring at the downstream sites (Figure 3-2). The same pattern was found on the Heathcote River with high median concentrations at the tidal sites. Concentrations of DRP were generally higher in the Heathcote River than in the Avon River, which is likely to be due to the high phosphorus content of Port Hills loess soils. High DRP concentrations were frequently found at the Rose Street site, which is immediately downstream of the Haytons and Curletts Road tributaries. These tributary streams have known sources of DRP in their industrial catchments and work is ongoing with industry to reduce the input from these sources. The highest DRP concentration measured was at Templetons Road on the Heathcote River and results for other parameters indicate that rainfall runoff may have been an influencing factor on this sampling occasion.

The trend for higher DRP concentrations at the downstream sites is most likely due to estuarine water containing effluent from the wastewater discharge brought up the river by tides. With the cessation of the wastewater discharge in March 2010 the DRP concentrations at the Pages Road and Bridge Street sites on the Avon and the Ferrymead site on the Heathcote have gradually decreased (Figures 3-3 and 3-4) but for the lower Avon sites concentrations still remain higher than those at sites further upstream. This may be due to a legacy effect of phosphorus that is bound to sediments on the riverbed which can be released to the water column under certain environmental conditions. Slightly elevated concentrations at these sites towards the end of the year may be related to the discharge of raw sewage to the lower reaches of the Avon River following the September earthquake, but a higher peak at Pages Road was observed in June which can not be explained (Figure 3-3). Results from the additional weekly sampling post-earthquake were not outside the typical range for these sites. The lower Heathcote River sites do not show such a marked

difference to the upstream sites on a monthly basis (Figure 3-4) and this is due to the other sources of DRP in the catchment, namely industrial inputs and loess soils.

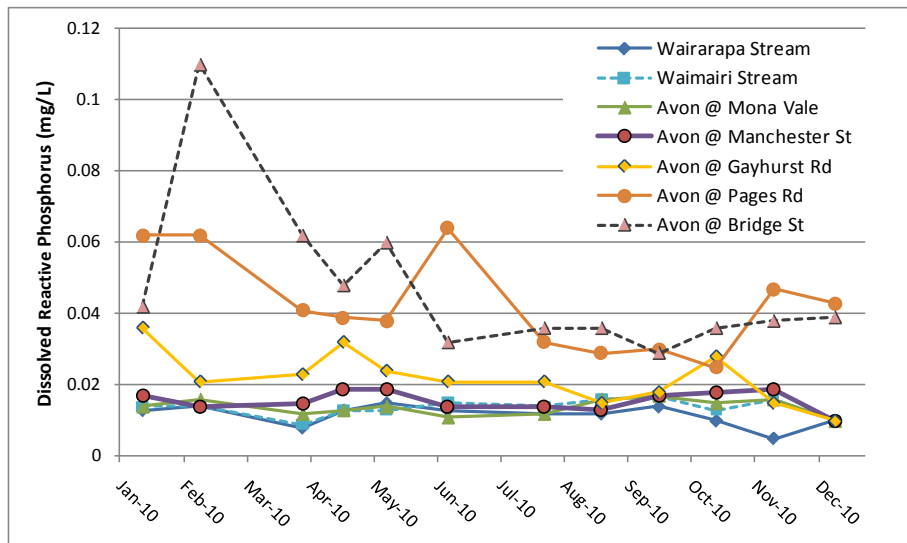


Figure 3-3: Monthly DRP concentrations at the Avon catchment sites

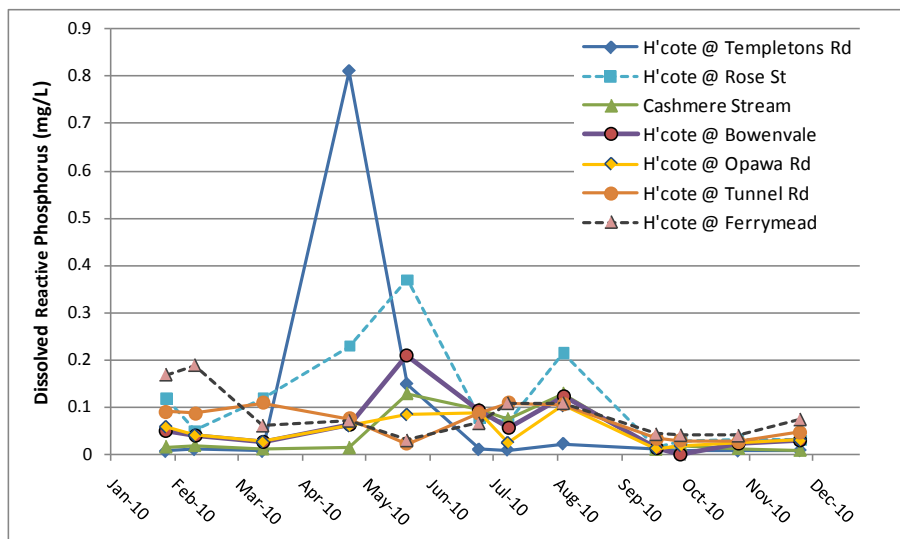


Figure 3-4: Monthly DRP concentrations at the Heathcote catchment sites (note the difference in scale on the y-axis compared to Figure 3-3)

3.4 Ammonia-nitrogen

The ammonia-nitrogen (NH_3N) that occurs naturally in water is from the breakdown of once living and non-living nitrogen-based matter and from gas exchange with the atmosphere. The main concern with ammonia-nitrogen (NH_3N) concentrations in waterways is its toxicity effects on aquatic ecosystems and the large amount of oxygen used when ammonia breaks down to nitrate.

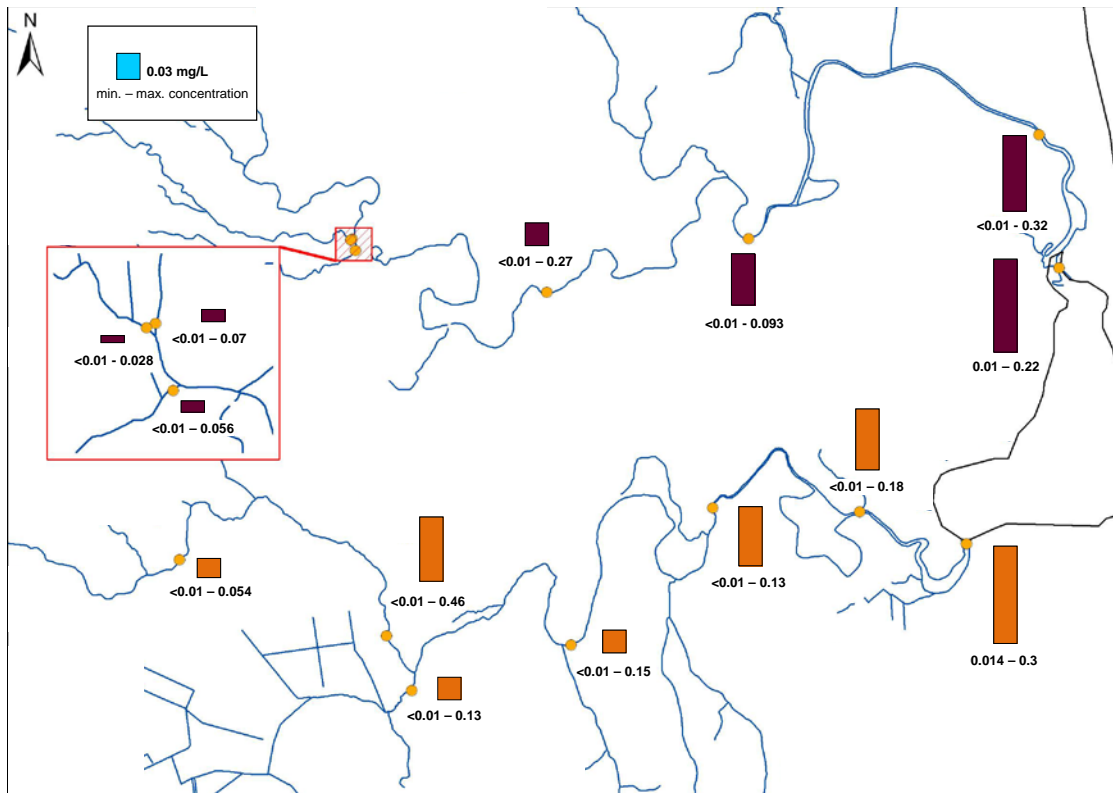


Figure 3-5: Ammonia-nitrogen concentrations in 2010

The Avon River had low concentrations of NH_3N at the upstream sites, with the highest concentrations occurring at the sites nearest the estuary (Figure 3-5). While treated wastewater was being discharged to estuary this would have been a major source of NH_3N to the tidal sites. However, as indicated by Figure 3-6, concentrations at these sites did not decrease markedly after March 2010 when the ocean outfall became operational and wastewater discharge to the estuary ceased. This may be due to the timing of sampling, which coincides with low tide to ensure that the influence of estuarine water is minimal. Further examination of such trends will be possible following five years of data collection.

The same trend for increasing NH_3N concentrations with distance downstream was seen on the Heathcote River, although elevated concentrations were also detected at the Rose Street site. This site is influenced by inputs from the Haytons and Curletts Road tributaries, which receive stormwater runoff from a mix of industrial, commercial and residential land use. In this case chemicals involved in industrial processes, such as refrigerants or cleaning products, are a likely source.

The ANZECC (2000) toxicity trigger value for NH_3N is 0.9 mg/L at pH 8, however the toxicity decreases with decreasing pH. The Rose Street site had the highest NH_3N concentration

(0.46 mg/L) but this was still well below the threshold likely to result in toxic effects on aquatic life. Despite the spatial trends described above and elevated concentrations at tidal sites the NH₃N concentrations measured are not within a range that would cause concern with regard to chronic toxic effects on ecosystems.

The results from additional weekly sampling following the September earthquake were within the typical range for the sites sampled. Elevated concentrations at the Pages Road and Bridge Street sites in December (Figure 3-6) may be related to sewage leakage; while direct discharges ceased in early November the potential for sewage inputs to the river remained, particularly following rainfall.

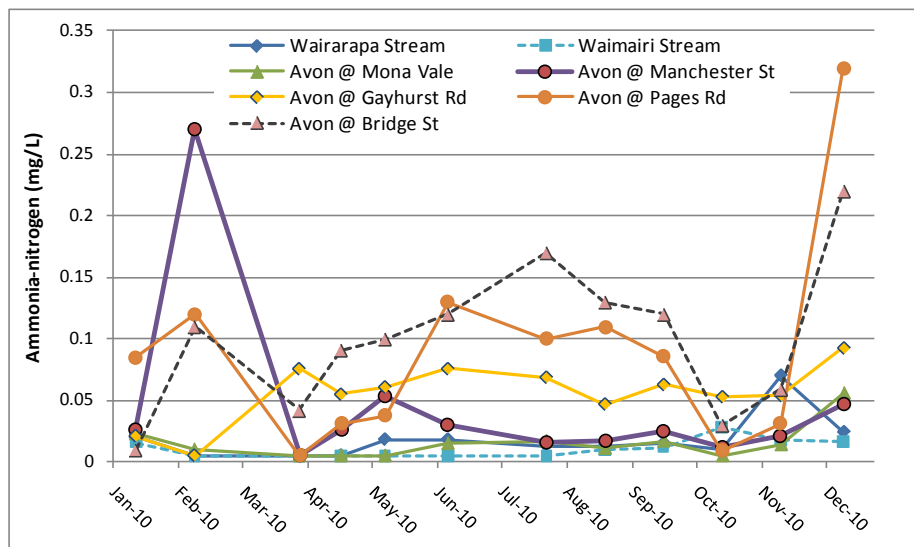


Figure 3-6: Monthly NH₃N concentrations at the Avon catchment sites

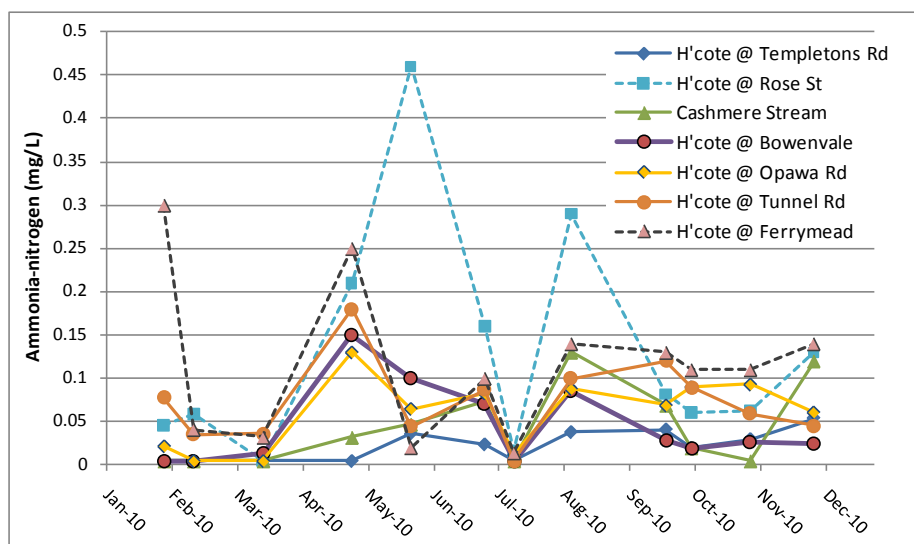


Figure 3-7: Monthly NH₃N concentrations at the Heathcote catchment sites

3.5 Dissolved oxygen and biochemical oxygen demand

Adequate dissolved oxygen (DO) concentrations are essential for aquatic animals and a reduction in DO in water reduces the physiological efficiency of fish and non-air breathing invertebrates. Usually it is not the concentration of DO as such that is important but the percentage of oxygen saturation, which varies with water temperature and is highly variable throughout the day. The percent saturation affects the ease with which aquatic animals respire and a general guideline provided by the Resource Management Act is that oxygen saturation should exceed 80% saturation.

Biochemical oxygen demand (BOD₅) is a measure of the oxygen consumed by micro-organisms, such as bacteria, as they degrade organic material in the water. High amounts of organic material, such as from a wastewater discharge or decaying aquatic plants, result in high BOD₅ concentrations. High BOD₅ concentrations cause decreased dissolved oxygen in the water.

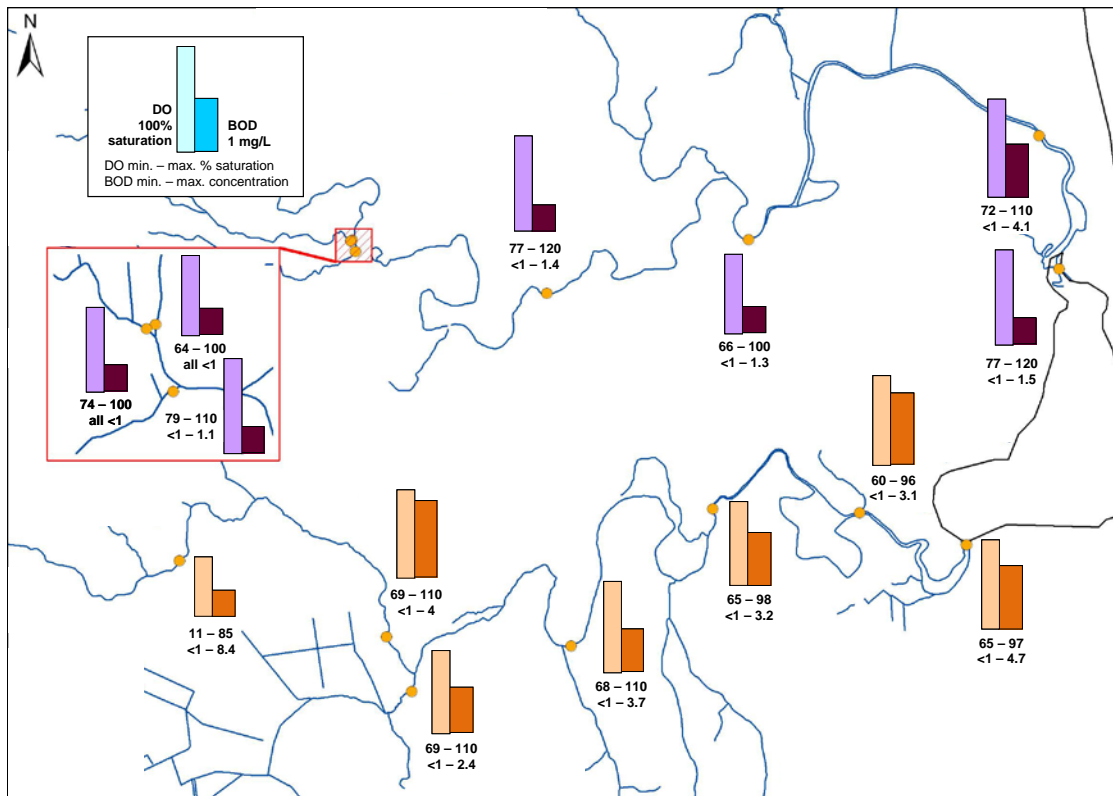


Figure 3-8: Dissolved oxygen saturation and biochemical oxygen demand concentrations in 2010

Overall, at many of the sites on both the Avon and Heathcote rivers the majority of BOD₅ concentrations were less than the limit of detection, particularly at the upper sites (Figure 3-8). This indicates that organic matter decay is not a significant issue in these areas. The Heathcote River had overall higher BOD₅ concentrations than the Avon River. The highest median concentration was at the Rose Street site while the highest maximum concentration was at the uppermost site at Templetons Road, which may be a result of sluggish flows and decaying plant matter in autumn.

The spot measurements of DO indicate that oxygen conditions at most sites may negatively affect aquatic life at times (Figure 3-8). Median saturation results were below 80% at a number of sites. The Templetons Road site on the Heathcote River had the lowest measured DO saturation, likely related to lower flows. Aquatic species are likely to find these conditions highly stressful and may avoid this upper part of the river in response. High biomass of aquatic plants (macrophytes) in many reaches of the rivers is likely to result in large daily variations in DO as the plants cycle between photosynthesis (generating oxygen) and respiration (using oxygen). The spot measurements reported here are not likely to have detected the lowest DO conditions that are experienced through the day due to the time of sampling, so oxygen conditions may be a factor limiting the health of ecosystems in these rivers.

The sewage discharges into the Avon River following the September earthquake can be expected to have resulted in elevated BOD₅ concentrations due to high organic matter inputs and consequently low DO conditions. However, the results of additional weekly sampling did not detect particularly high BOD₅ or low DO at lower river sites. This suggests that either the discharge volumes were low enough to be easily assimilated and diluted by the river flows or that the sampling did not detect contamination from the discharges due to variability in discharge flow and timing of sampling.

3.6 Total suspended solids

Total suspended solids (TSS) are sediment particles of all sizes that are washed into waterways during rainfall or are eroded from the bed or banks of the river channel. Factors that can contribute to high TSS concentrations include bank erosion due to lack of vegetation and/or trampling by animals, soil erosion due to vegetation clearance, and earthworks during construction.

Fine sediments that are carried in the water column affect the clarity of the water. Water clarity is important for aesthetic and safety aspects of recreational use of waterways. Reduction in clarity can also affect the behaviour of fish and macroinvertebrates, especially the migratory and predatory species, and primary production, such as algal growth.

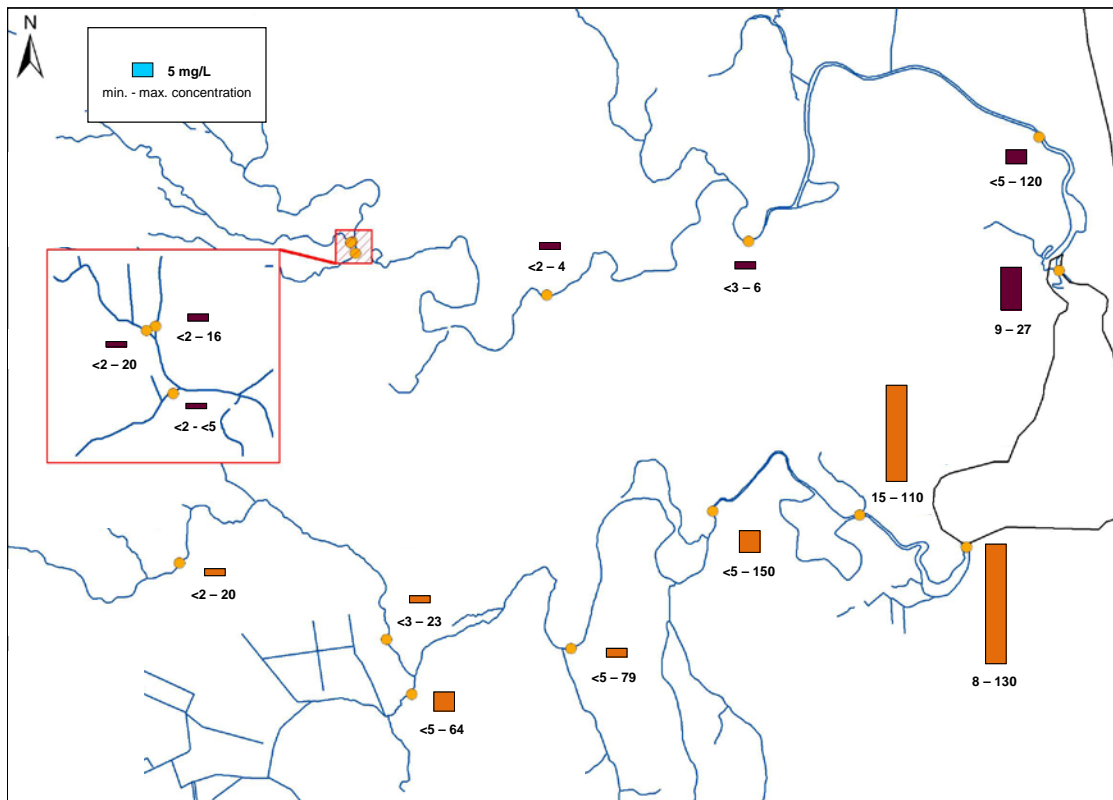


Figure 3-9: Total suspended solids concentrations in 2010

Larger sediment particles settle to the river bed and can smother habitats for aquatic life including spawning areas for fish. Fine sediments also settle out in areas of low flow such as pools and estuaries. Contaminants such as nutrients and heavy metals attach to sediment particles and are washed into waterways where they settle with the sediment or detach and become soluble in the water column.

TSS concentrations measured in the Avon River were generally low, with the exception of sites in lower, tide-influenced reaches (Figure 3-9). The highest concentrations were found at the tidal sites, which is probably due to the re-suspension of fine bed sediments with tidal flows. On the Heathcote River a similar pattern was seen. Low TSS concentrations were found at the Templetons Road site near the springs and median concentrations increased at sites downstream, with the highest concentrations at the tidal sites. Occasional high concentrations at Cashmere Stream, Bowenvale and Opawa Road are likely to be due to sediment-laden runoff from the easily eroded loess soils during rainfall.

TSS concentrations measured by additional weekly monitoring were not outside of normal ranges following the September earthquake.

3.7 Turbidity

Turbidity is a measure of the degree to which light travelling through water is scattered by the suspended particles present. Turbidity measurements are therefore strongly related to suspended solids concentrations, although the relationship differs depending on the properties of the particles. Increased water turbidity can affect the healthy growth of plants and algae on the river bed by reducing light penetration through the water. High turbidity also infers the same effects as high suspended solids concentrations, such as impairment of

fish that feed visually, smothering of habitats and spawning areas, and reduced amenity values.

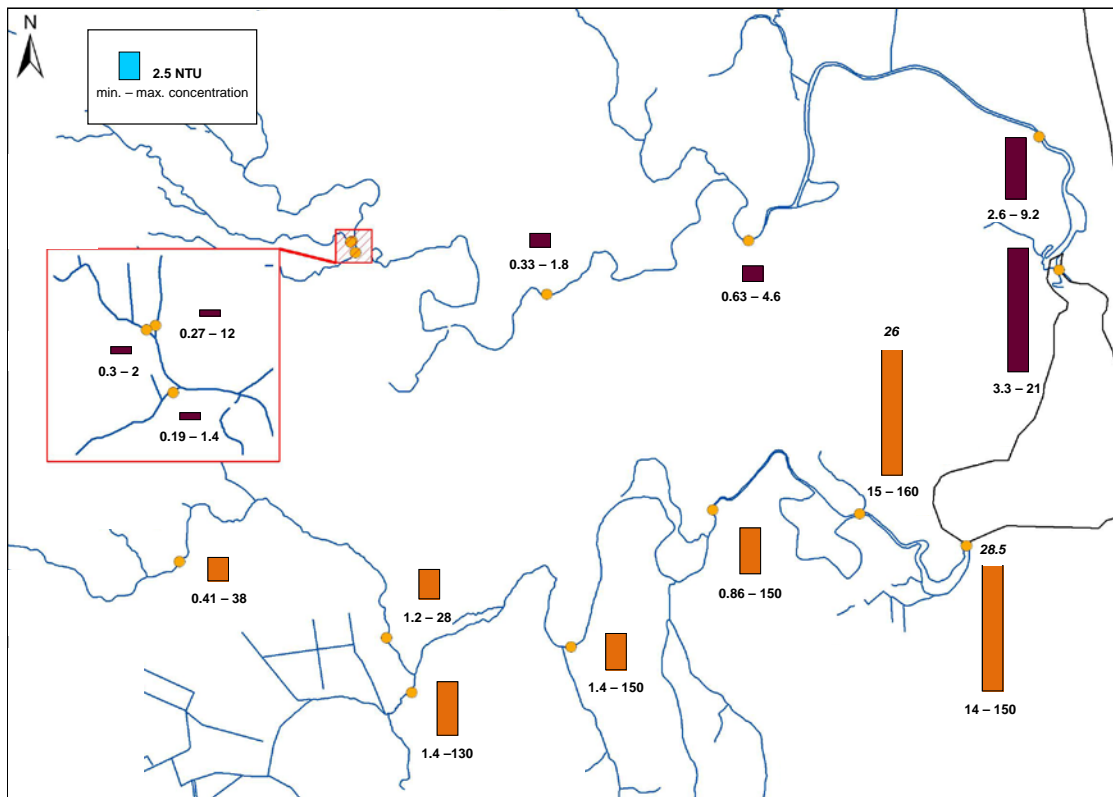


Figure 3-10: Turbidity measurements in 2010

The patterns in measured turbidity at the sample sites on the Avon and Heathcote rivers were very similar to those for total suspended solids (Figure 3-10). Turbidity values were highest at the downstream tide-influenced sites due to accumulation of fine sediments in these slow-flowing areas and re-suspension of these deposited sediments with tidal flows.

The range of turbidity values measured in the Heathcote River was much greater than in the Avon River. This is due to the fine sediment particles that are generated from loess soils in the catchment, which remain suspended in the water column for long distances and, once settled on the bed, are easily re-suspended by high flows and tidal movement. The increased range in turbidity between Rose Street and Bowenvale is an indication of the influence of Cashmere Stream inflows, which are often observed to be more turbid than the upper Heathcote flows where the two converge.

ANZECC (2000) provides a trigger value for turbidity of 5.6 NTU (nephelometric turbidity units). The majority of sites had median turbidity measurements lower than this value, with the exception of the tidally-influenced sites. Occasions when turbidity measurements were greater than the trigger value at other sites are likely to be related to rainfall and high flow events.

3.8 *Escherichia coli*

Escherichia coli (*E. coli*) is a bacterium found in high numbers in the stomachs and intestines of warm-blooded animals (including birds and people). The presence of high concentrations of *E. coli* in water indicates the likely presence of faecal material and, with it, the possibility that other disease-causing organisms may be present. Faecal contamination of waters can occur through inadequately treated sewage, stormwater inputs, septic tanks, runoff from pastoral farm land, and from wildlife such as waterfowl living in and around waterways. *E. coli* concentrations in fresh water are used to determine if water quality is suitable for contact recreation or as a source of drinking water.

E. coli concentrations sampled in the Avon and Heathcote rivers were highly variable across the year (Figure 3-11). All sites had low bacteria concentrations at times as well as some very high concentrations. High concentrations indicate that there is likely to have been recent faecal contamination of the water and the occasional low concentrations show that contamination events are not constant. High concentrations may also arise from the re-suspension of bacteria that have settled with sediment on the river bed, where they can survive for long periods of time.

Guidelines from the Ministry for the Environment and Ministry of Health (MfE/MoH 2002⁶) suggest that median concentrations of *E. coli* greater than 126 cfu/100 mL are a potential risk to the health of people that come into contact with the water. Based on the results presented here the Avon and Heathcote rivers are not considered to be suitable for contact recreation.

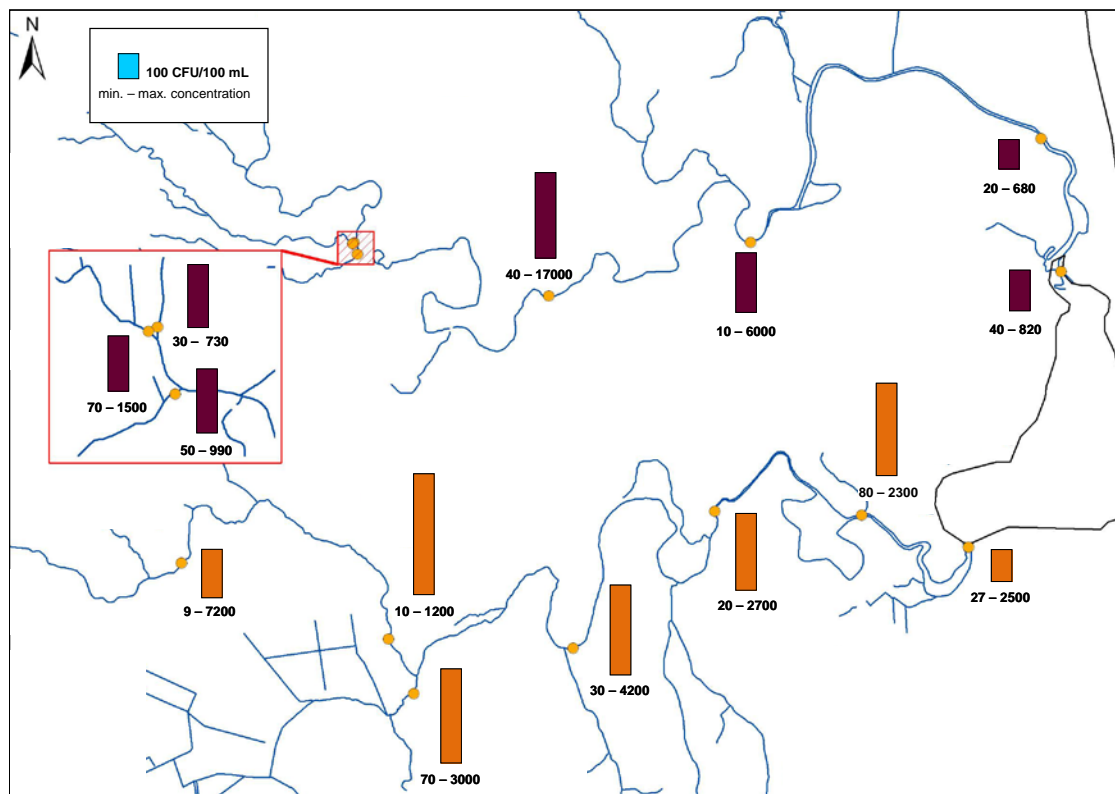


Figure 3-11: *E. coli* concentrations in 2010

⁶ MfE/MoH 2002. Microbiological water quality guidelines for marine and freshwater recreational areas. Ministry for the Environment, Wellington

During the summer months Environment Canterbury samples weekly at Kerrs Reach on the Avon River and at Catherine Street on the Heathcote River as part of its recreational water quality monitoring programme. Based on a risk assessment and the last five years of monitoring results, both sites have Suitability for Recreation Grades of 'Very Poor' in accordance with the latest national guidelines⁷. The reader can access the 'Water quality for contact recreation'⁸ annual summary report for more information on this monitoring programme.

Christchurch City Council and Environment Canterbury undertook additional monitoring for *E. coli* following the September earthquake to determine the effects of sewage discharges to the Avon River and to assess when microbial water quality had returned to normal levels. A range of sites were sampled weekly until soon after the sewage discharges ceased, which coincided with the start of the summer recreational water quality monitoring season in mid-November. In addition, Kerrs Reach was sampled daily for two weeks in late October-early November to provide a finer-scale picture of the variability in microbial concentrations during that time.

The additional monitoring showed that despite the known presence of human faecal contamination in the lower Avon River there was still a high degree of variability in *E. coli* results. Sampling sites downstream of the Fitzgerald Ave bridge (at Gayhurst Road, Kerrs Reach and Pages Road) had extremely high concentrations on occasion with concentrations returning to within the typical range in early November. Concentrations of *E. coli* in the Heathcote River were not affected by sewage discharges.

⁷ MfE/MoH 2003. Microbiological water quality guidelines for marine and freshwater recreational areas. Ministry for the Environment, Wellington

⁸ Bolton-Ritchie, L. 2011. Healthy Estuary and Rivers of the City: Water quality for contact recreation – Summary report on data collected in 2010. Environment Canterbury unpublished report.

3.9 Heavy metals

Heavy metals are those metals with high atomic weights (e.g. lead and zinc) that can be toxic to plant and animal life even at low concentrations. The metals copper, chromium, cadmium, lead, nickel and zinc are used in a wide range of industrial processes and some are also used in motor vehicle components and building materials, e.g. roofs and pipes. Metals are added to waterways via stormwater and accidental spills and can be a particular problem in urban waterways.

Heavy metals are easily bound to sediment and settle to the river bed so results from water samples are often below laboratory detection limits. Table 3-1 summarises the results for heavy metals from samples collected at the Avon and Heathcote river sites in 2010.

Table 3-1: Summary of heavy metal concentrations in 2010

	Total number of samples	Laboratory detection limit (mg/L)	Number of sample results greater than or equal to detection limit	ANZECC (2000) trigger value for fresh water	Sites with results greater than trigger value*	Maximum concentration detected (mg/L)
Cadmium	168	0.0007 ¹	1	0.0002	none	0.0001 (at H6)
Copper	168	0.001 ²	78	0.0014	all except A1	0.011 (at H2, H5, H6, H7)
Lead	168	0.001 ³	66	0.0034	H1 – H7	0.012 (at H6)
Mercury	168	0.0002	5	0.0006	H2, H5	0.001 (at H2, H5)
Zinc	168	0.001	159	0.008	all	0.22 (at H2)

* Where trigger values are less than the laboratory detection limit there may be some samples with concentrations that are greater than the trigger value that are not able to be reported.

¹ The reported laboratory detection limit for cadmium varied between 0.0001 mg/L and 0.0007 mg/L.

² The reported laboratory detection limit for copper varied between 0.001 mg/L and 0.0015 mg/L.

³ The reported laboratory detection limit for lead varied between 0.001 mg/L and 0.0017 mg/L.

A1 – Wairarapa Stream

A2 – Waimairi Stream

A3 – Avon River at railway line

A4 – Avon River at Manchester St

A5 – Avon River at Gayhurst Rd

A6 – Avon River at Pages Rd

A7 – Avon River at Bridge St

H1 – Cashmere Stream

H2 – Heathcote River at Templetons Rd

H3 – Heathcote River at Rose St

H4 – Heathcote River at Bowenvale

H5 – Heathcote River at Opawa Rd

H6 – Heathcote River at Tunnel Rd

H7 – Heathcote River at Ferrymead

The most frequently detected metals were zinc, copper and lead. These contaminants are commonly associated with stormwater runoff from roads and roofs. The ANZECC (2000) trigger values for the protection of aquatic ecosystems were exceeded at the majority of sites for copper and zinc and all of the Heathcote River sites for lead. The sampled concentrations of zinc in both the Avon and Heathcote rivers, and of copper and lead in the Heathcote River in particular, indicate a potential risk to the health of aquatic life.

Additional sampling following the September earthquake did not detect metal contamination beyond the ranges typically found at these sites.

4 Conclusion

The quality of the water within the Avon and Heathcote Rivers is affected by the quality of the water that flows from the springs in their headwaters, the quality of the stormwater that flows from the land during rainfall and, in the lower tidal reaches, the quality of water in the estuary.

The water that flows from the springs at the headwaters of the rivers is high in nitrate-nitrite nitrogen. This is due to high nitrate concentrations in groundwater in the shallow aquifers in the Christchurch-West Melton area. The water quality at upper catchment sites was otherwise relatively good, with low concentrations of dissolved reactive phosphorus (DRP), ammonia-nitrogen (NH₃N) and total suspended solids (TSS), and high dissolved oxygen (DO).

Sites further downstream were increasingly influenced by urban land use and stormwater. This was shown by higher concentrations of NH₃N, DRP, TSS and heavy metals. Other factors that may have affected water quality as the rivers flowed through the urban area include point source discharges from industrial sites, sewage overflows and waterfowl.

Concentrations of indicator bacteria were variable throughout the year at all sites and contact recreation is not recommended in the Avon and Heathcote rivers due to the risk to public health.

Effects of tributary water quality

Some river sites in particular clearly showed the influence of poor quality tributary inflows. The Heathcote River at Rose Street had elevated DRP and NH₃N concentrations compared to other sites. This can be linked to inputs from the Haytons Stream and Curletts Road Drain tributaries that enter the river between Templetons Road and Rose Street. Peaks in concentrations of those parameters coincided in May and August. These events are likely to be related to inputs from industrial land use upstream, which may be a result of direct spills of chemicals or contamination of stormwater at an industrial site.

The Bowenvale site on the Heathcote River had high TSS and turbidity compared to the Rose Street site further upstream. This can be attributed to the inflow of turbid water from Cashmere Stream, which has issues with poor water clarity due to a range of sediment sources within its catchment (James & McMurtrie 2010⁹).

Wastewater discharge to estuary

The quality of water in the estuary has historically been strongly influenced by the discharge of treated wastewater, with high NH₃N and DRP concentrations and reduced DO concentrations. In March 2010 the discharge ceased due to the commissioning of the ocean outfall. Water quality in the estuary has improved as a result with reductions in NH₃N and DRP of up to 90% at some sites (Bolton-Ritchie 2011¹⁰). A consistent spatial trend of higher concentrations of DRP and NH₃N at lower river sites compared to those upstream has previously been attributed to the influence of estuarine water carried up the rivers by tidal flows. However, the 2010 data did not show the significant reductions in DRP and NH₃N concentrations that would be expected after March if this was the case. Concentrations of DRP did gradually decrease but remained higher than at upstream sites, while there were no

⁹ James A, McMurtrie S, 2010. Sources of sediment input into Cashmere Stream. Prepared for Environment Canterbury by EOS Ecology. Environment Canterbury Report No. R10/6.

¹⁰ Bolton-Ritchie, L. 2011. Healthy Estuary and Rivers of the City: Water quality of the Avon-Heathcote Estuary/Ihutai – Summary report on data collected in 2010. Environment Canterbury unpublished report.

apparent reductions in NH₃N concentrations after March. The lower river sites are sampled around low tide to minimise the influence of estuarine water. It is possible that accumulation of contaminants down the rivers, combined with the deep, slow-flowing conditions in the lower rivers with heavily silted substrates that are likely to be low in oxygen, may account for the higher DRP and NH₃N concentrations in these parts of the rivers. More detailed analysis of trends in future reporting (see below) will provide further assessment of these patterns.

The September 2010 earthquake

The Canterbury earthquake on 4 September 2010 caused damage to sewerage infrastructure that resulted in the discharge of raw sewage to the lower Avon River for a period of around two months. Additional weekly sampling at a subset of sites showed that microbial concentrations were elevated in the lower river below Fitzgerald Ave bridge, although significant variability was still apparent. For other parameters, including DRP, NH₃N and BOD₅ which are associated with sewage inputs, the additional sampling did not show an increase beyond the ranges typically found at these sites. Some of the results from the monthly monitoring towards the end of the year did show slight increases in DRP and NH₃N which may be a result of direct sewage discharges or subsequent leakage from pipes during rainfall. However, the absence of an obvious measured change in concentrations of these parameters indicates that the volumes of sewage discharged at that time did not have a major effect on water quality in the rivers.

Future work

We will undertake more detailed analysis, including analysis of trends over time, in 2012 following five years of data collection. This will allow more detailed assessment of the effects of the cessation of the wastewater discharge to the estuary, the September 2010 earthquake and subsequent damaging aftershocks that have occurred in February and June 2011. The February and June aftershocks caused more extensive damage to the sewerage infrastructure in Christchurch than the September earthquake, resulting in large quantities of raw sewage being discharged to the Avon and Heathcote rivers, the estuary and the sea for many months. Consequently the effects of these events on water quality measured by the Healthy Estuary and Rivers monitoring programme are expected to be much greater in 2011.

