Surface Water

Key Information	Why is this Useful?	What is Happening?
Microbiological water quality in waterways.	Faecal coliform concentrations are used to indicate whether waterways are safe to use for particular activities such as contact recreation eg swimming.	↑ The median faecal coliform values sampled in the City generally increased between 1995 and 1999.
Nutrient levels in waterways.	Large levels of nutrients such as nitrogen and phosphorus can lead to excessive growth of waterway plants and algae, which can produce undesirable aquatic conditions.	↓ Dissolved nitrogen levels have generally declined since 1991, however they are above the recommended guideline. ↑ Generally, median dissolved phorphorus levels increased between 1995 and 1999.
Biological oxygen demand (BOD) in waterways.	BOD is a measure of the potential for the chemical and organic contaminants in water to reduce the dissolved oxygen in the water body, which in turn could impact on aquatic organisms.	↓ Generally, BOD levels in the City's waterways decreased between 1996 and 1999.
Birdlife on the City's waterways.	Birdlife provides a indicator of the sustainablility of the City's waterways for natural communities. Birdlife relies on the presence of lesser fauna and vegetation to exist.	↑ Birdlife on the Avon River (the number of birds and bird species) increased between 1993/94 and 1998/99.

Other Related Sections: Population Growth, Health, Weather and Climate, Land Use, Groundwater, Coastal Environment, Open Space and Natural Ecosystems, Built Environment, Urban Amenity, Waste Management, Businesses, Employment and Unemployment.

Waterway Characteristics

Christchurch's waterways, wetlands and drainage system is an important part of the City's environment. It is made up of natural assets such as:

- Rivers (90 kilometres)
- Environmental asset waterways (125 kilometres)
- Hill waterways (16 kilometres)
- Wetlands (69 hectares)

and man-made infrastructural assets such as:

- Stormwater pipes (504 kilometres)
- Utility waterways (130 kilometres)
- Drainage structures (stopbanks, stormwater retention and soakage basins and Woolston tidal barrage).

The main waterway catchments in the City are the Avon, Heathcote, Styx and Halswell Rivers, and Otukaikino Creek (south branch of the Waimakariri River). Both the Avon and Heathcote Rivers flow into the Avon-Heathcote Estuary. The Styx River and Halswell Rivers flow into Brooklands Lagoon and Lake Ellesmere respectively, while the Otukaikino flows into the Waimakariri River at the motorway bridge. The Waimakariri River forms the northern boundary of the City and is a large, braided river fed predominantly by rainfall in the Southern Alps.

Although the rivers that originate within the Christchurch City boundary are all spring-fed, there are distinct differences in the landuse of individual rivers. (The catchment land uses for the three main rivers are shown in Table 2.10.) Variation in catchment land use can have significant influences on the water quality in each catchment.

The Avon River originates from the spring-fed Avon, Waimairi and Wairarapa Streams in north-west Christchurch. It drains a highly modified urban

Table 2.10 Zoned Land Use for the Main River Catcments in Christchurch [20]

Landuse Zoning	Avon Catchment		Heathcote Catchment		Styx Catchment	
	ha	%	ha	%	ha	%
Living	5,465	63	3,816	39	983	20
Commercial	209	2	65	1	15	0
Cultural	353	4	151	1	52	1
Industrial	382	4	979	10	167	3
Rural	1,045	12	2,833	29	3,513	71
Conservation	335	4	1,013	10	89	2
Open Space	749	9	495	5	80	2
Special	192	2	532	5	19	0
Total	**8,730**	**100**	**9,884**	**100**	**4,918**	**100**

Source: Christchurch City Council.

[20] It should be noted these areas are based on the proposed zoning in the City of Christchurch City Plan. Because an area is in a particular zone the land use is not necessarily the same as the zoning.

catchment, with up to 73 per cent of its 8.730 hectare catchment zoned for urban land uses.

The Heathcote River drains a semi-urban catchment of around 10,000 hectares in area. Its catchment lies entirely within the City boundary and drains rural land on the Port Hills and the urban suburbs in southern Christchurch. Ten per cent of the Heathcote's catchment is zoned for industrial use.

As a result of City Plan decisions in June 1999, 550 hectares of rural land in the Heathcote catchment were rezoned. Of this, 380 hectares were rezoned residential, with the remaining 170 hectares going to conservation (76 hectares), open space (28 hectares) and special purpose zones (49 hectares).

The Styx River flows through a predominantly rural catchment. As a result of City Plan decisions in June 1999, an additional 150 hectares of rural land were rezoned residential. This represented a 18 per cent increase in residential-zoned land, bringing the proportion of urban-zoned land to 25 per cent of the catchment.

Both the Halswell River and the Otukaikino Creek have predominantly non-urban catchments.

Pressures on Surface Waters

The greatest impacts on surface water in the City come not from water use but from land use. Significant pressures on waterways are:

- Sedimentation and nutrient enrichment (eutrophication) of surface waters by agricultural run-off and urban stormwater; and
- Point source pollution in some lower reaches of streams and rivers.

Examples of agricultural pressures are land clearance, land drainage and channelling, draw off for irrigation and stock watering, and run-off and waste discharges from farms and agricultural processing facilities.

Urban pressures on waterways result from sewage and industrial waste, stormwater run-off, water being drawn off for household and industrial uses, and urban expansion into wetlands and estuaries. Urban pressures tend to fall into two main types: point source discharge of sewage and non-point source discharge of stormwater run-off.

Stormwater run-off pollution comes from substances that are washed off the street and adjacent surfaces, and also from accidental mixing of stormwater and sewage. Contaminants include sediments, organic matter, nutrients, disease-causing organisms and toxic substances ranging from oil products and contaminated dust from vehicle exhausts to industrial chemicals.

Stormwater run-off is also a major source of marine debris, such as floating plastic, which is both unsightly and hazardous to marine mammals and birds.

Urban stormwater is often similar in quality to secondary-treated sewage. Stormwater that runs off construction sites can carry very high levels of sediment, particularly where the vegetation and topsoil are stripped beforehand. Sediment loss from catchments undergoing urban development is up to 15 times greater than the sediment loss from equivalent non-urban catchments.

Water Quality

Water quality is generally defined by various parameters which measure the microbiological, physical and chemical nature of a waterway. Each of these parameters can impact on the waterway or its use in different ways. Impact of water quality parameters are outlined with the recommended guidelines in Table 2.11.

Spatial Variation in Water Quality Parameters

Monitoring results show water quality in Christchurch rivers appears to be dependent on the nature of surrounding land use, the flow regime and the influence tributary streams have on the main rivers.

Microbiological water quality is measured by the median concentration of faecal coliforms[21] in the water. This gives an indication of the safety of water used for recreational activities such as swimming. It also provides a measure of the contamination of waterways from agricultural land uses or sewage discharge.

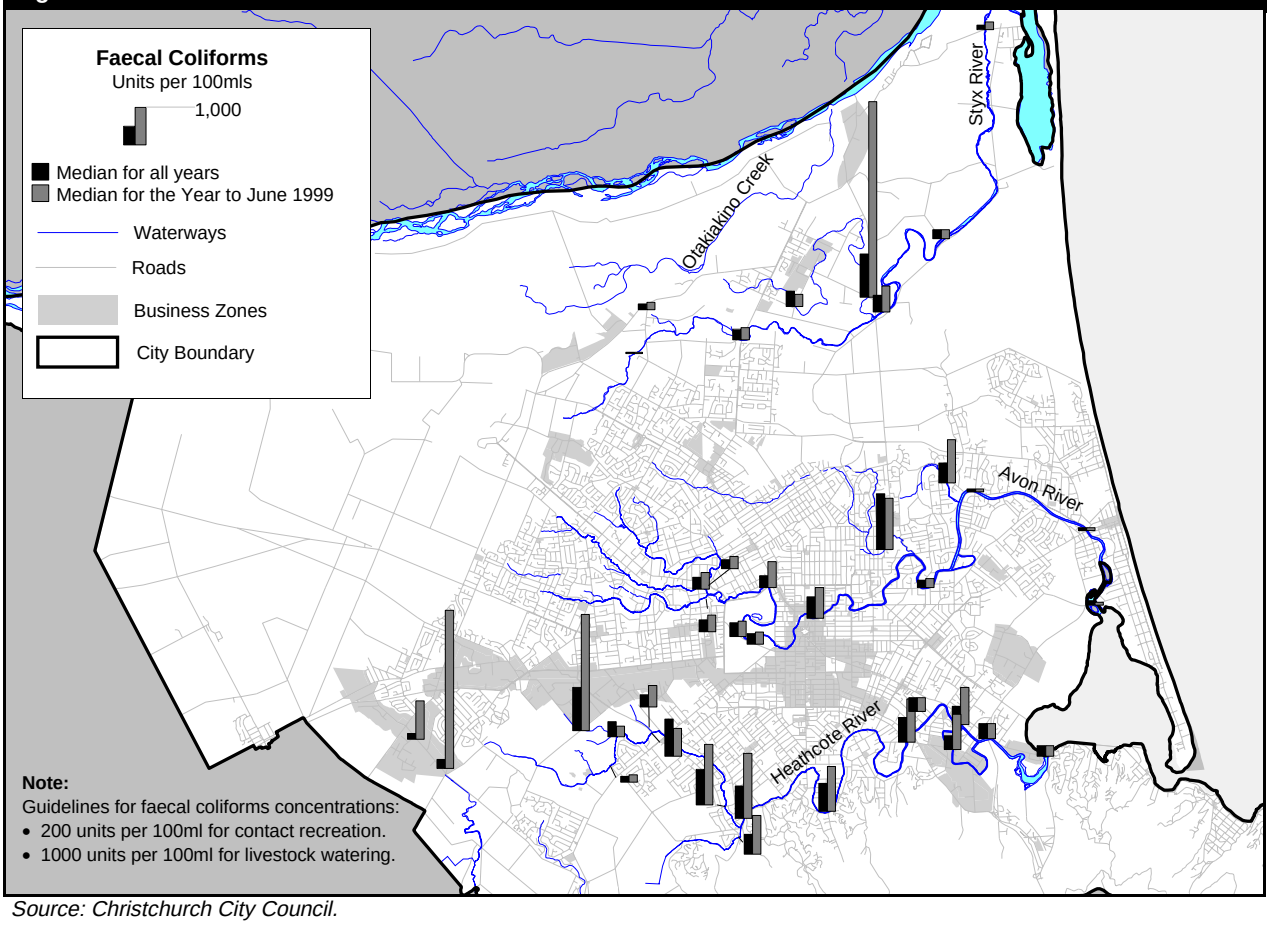
Faecal coliform concentrations were sampled at 42 river and stream sites in the City. The drains which flow directly into the Estuary were also sampled but the results are not presented in this report. Coastal bathing information is in the Coastal section of this report.

River sites in Christchurch City which met the guidelines for swimming (200 faecal coliforms per 100 millilitres) during the year to June 1999 were in the upper Styx River, the Otukaikino Creek above the outlet of the Belfast waste water treatment plant, the source of Cashmere Stream, and lower tidal reaches of the Avon River (Figure 2.15).

Seven sites have long-term medians which exceed the livestock watering guideline of 1,000 faecal coliforms per 100 millilitres. They are in the upper Heathcote from Haytons Drain down to below the confluence with

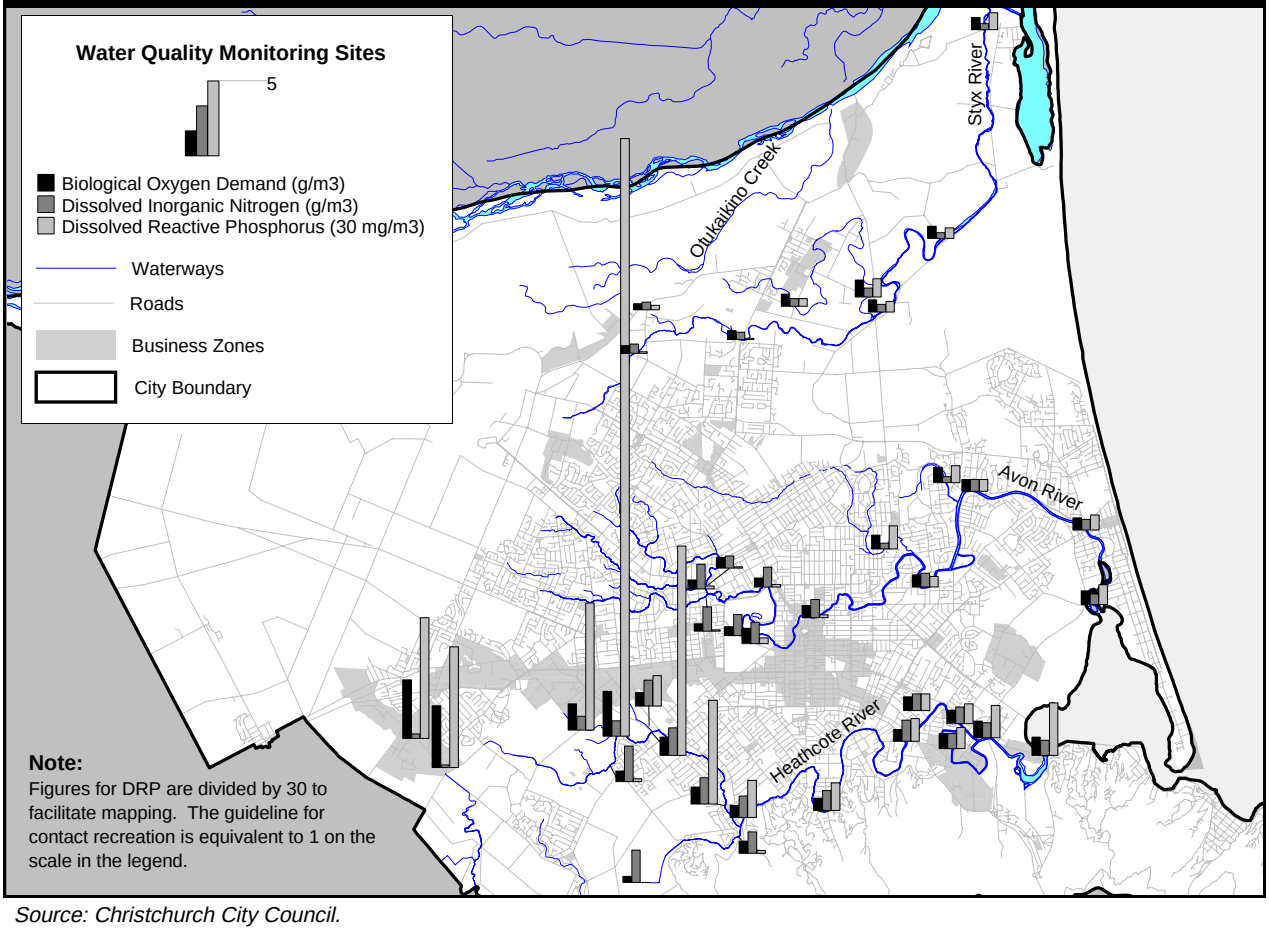
[21] It is not practical to monitor water for all harmful micro-organisms. Instead the common bacteria faecal coliforms have been monitored on the assumption that were there are high concentrations of these, there is the possibility of more harmful micro-organisms. If these bacteria are present at all, water is classified as unfit for human consumption. As bacterial density increases, water is progressively classed as unfit for shellfish harvesting, contact recreation and livestock consumption.

Fig 2.15 Median Faecal Coliforms Concentrations



Source: Christchurch City Council.

Fig 2.16 Median Values of Selected Water Quality Parameters for the Period from 1989 to 1999.



Source: Christchurch City Council.

Table 2.11 Physio - Chemical Water Quality Guidelines

Parameter	Suitability Thresholds for Particular Uses	
Biochemical oxygen demand (BOD_5)	1-2gm^{-3}	Contact recreation Aesthetics
Dissolved reactive phosphorus (DRP)	no more than 15 - 30mgm^{-3}	Contact recreation Aesthetics Preventing algal growth
Dissolved inorganic nitrogen (DIN)	No more than 40 - 100 mgm^{-3}	Contact recreation Aesthetics Preventing algal growth
Ammonia	Suitability varies with temperature and pH	Aquatic ecosystems
Dissolved oxygen (DO)	No less than 80 per cent	Aquatic ecosystems

Source: Ministry for the Environment, The State of New Zealand's Environment 1997.

Cashmere Stream at Fernihurst Street, Dudley Stream which flows into the Avon River, and Kaputone Stream in the Styx catchment. During the year to June 1999, 14 sites exceeded this guideline. The high faecal coliform levels of the Heathcote River extended downstream to Garlands Road, excluding the Mackenzie Street site which had levels below the guideline. The Avon at Manchester St, Horseshoe Lake, Dudley Stream, Kaputone Stream and the outlet to the Halswell retention basin also exceeded the guideline.

Higher concentrations of faecal coliforms during the year to June 1999 may have been partially caused by lower flows in the waterways as a consequence of the drought during 1998 and 1999. Lower flows can reduce the dispersion or dilution of micro-organisms, especially if the source is in-stream wildlife.

The same river and stream sites tested for microbiological indicators were sampled for physical and chemical water quality parameters. Physical and chemical water quality indicators include dissolved oxygen, pH, turbidity, biological oxygen demand (BOD_5), ammonia, temperature, nutrients including, dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP)) and suspended solids.

Nutrients levels are important as they influence the level of eutrophication and growth of slimes and water weeds. Ammonia can be very toxic to aquatic life depending on the pH and temperature of the water body. Turbidity and suspended solids provide a measure of the clarity of a water body, which effects recreational and aesthetic values more than biological ones. Biological oxygen demand provides a measure of the potential for chemical and organic contaminants in water to reduce the level of dissolved oxygen available in the water body.

Nutrient concentrations in the tributaries were generally higher than in the main rivers. Figure 2.16 shows results of BOD and nutrients measured as dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) at most of the monitoring sites in the City. Median values for the year to June 1999 were similar to long-term medians and did not vary as much as the faecal coliform values.

Generally, Christchurch waterways show spring sources have dissolved reactive phosphorus (DRP) levels well below guidelines. Tributary streams are the main contributors of phosphorus; subsequently concentrations increase with distance downstream. Haytons Drain had high median DRP values of around 900 micrograms per cubic metre for the whole monitoring period and 1500 micrograms per cubic metre during the year to June 1999. This is between 30 to 50 times the recommended guideline. The main source of the phosphorus is the fertiliser industry in Hornby[22]. The nutrient-rich environment of Haytons Drain appears to have a detrimental impact on the water quality of the Heathcote River down to its confluence with Cashmere Stream. Nutrient levels remain relatively constant from this point before increasing again as the Heathcote comes under tidal influences.

Dissolved inorganic nitrogen at all sites in the City was higher than the Ministry for the Environment guidelines. The spring sources of Cashmere Stream, Avonhead, Waimairi and Wairarapa Streams have DIN levels greater than the guideline. Generally, DIN concentrations decrease with distance downstream, with most tributaries having little effect on the main rivers.

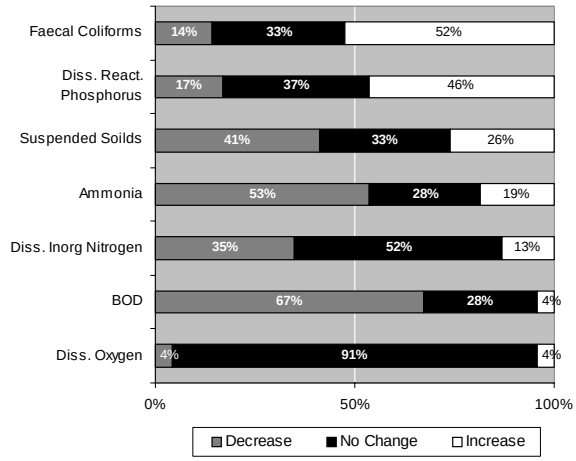
Biological oxygen demand (BOD_5) guidelines were exceeded at sites close to the industrial areas of Haytons Drain and Curletts Drain, and the Halswell Retention Basin. Although sites in the main rivers downstream of the confluences of these tributaries showed high BOD_5 concentrations, only the Heathcote River below the confluence with Haytons Drain approached the guideline.

Trends in surface water quality parameters

Trends in individual water quality parameters aggregated for all the water quality monitoring sites in Christchurch are shown in Figures 2.17 to 2.21. Figure 2.17 shows the difference between the median value for the year to June 1999 and the long-term median for selected parameters for all monitoring sites. The upward trend indicates an increase in the median concentration of a particular parameter compared with its long-term median concentration, while a downward

[22] Christchurch City Surface Water Quality Data 1995 – 97, Water Quality Trends 1986 – 97, Christchurch City Council, Waste Management Unit Laboratory, 1999.

Fig 2.17 Trends in Surface Water Quality by Indicator



Note: The presence of an upward trend indicates an increase in the median concentration of a particular constituent while a downward trend indicates a decrease in the median concentration. No trend was defined as plus or minus 20% from the median long term value for each indicator.

Source: Christchurch City Council.

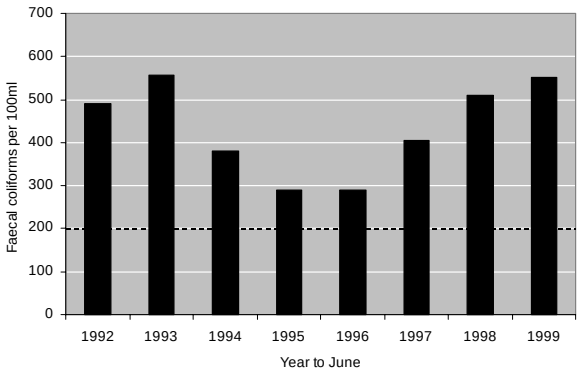
trend indicates a decrease in the median concentration. It should be noted that, for dissolved oxygen, a decrease in concentration results in reduced water quality as opposed to increased water quality for other indicators.

Trends in water quality parameters show most of the median concentrations for the year to June 1999 remained unchanged or decreased for the majority of sites compared with the long-term median concentration. Only faecal coliforms at more than half the monitoring sites have increasing concentrations. This means that increasing faecal coliforms is a widespread occurrence throughout most of the waterways in the Christchurch rather than a local or site-specific problem. This is confirmed by Figure 2.18 which shows the annual median values of faecal coliforms for all sites monitored. The annual trend shows that since 1995 faecal coliform levels in the City's waterways have been increasing. This may be related to changes in rainfall during these periods or the increase in birdlife which is a main source of faecal coliforms in waterways.

Just under half the sites in Figure 2.17 also show an increasing trend in dissolved reactive phosphorus. Figure 2.19 shows median values from all sites have more than doubled since 1992. In 1998 and 1999 the median for all sites was above the Ministry for the Environment guideline of 30 micrograms per cubic metre. This means that over half the sites monitored in the City exceeded the guideline.

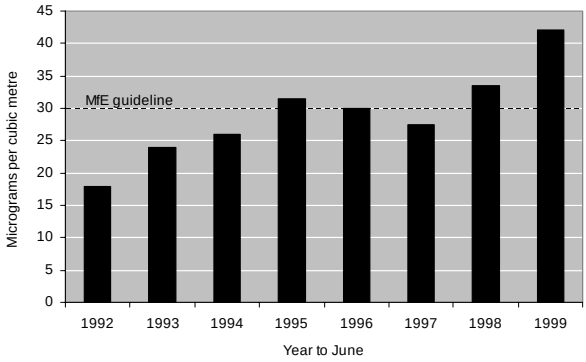
Figure 2.20 shows a 33 per cent decrease in the levels of dissolved inorganic nitrogen (DIN) between 1991 and 1999. However all sites in the City were still well above the guideline. Dissolved organic nitrogen measures the combined effect of nitrate and ammonia

Fig 2.18 Median Faecal Coliform Conc for all Sites



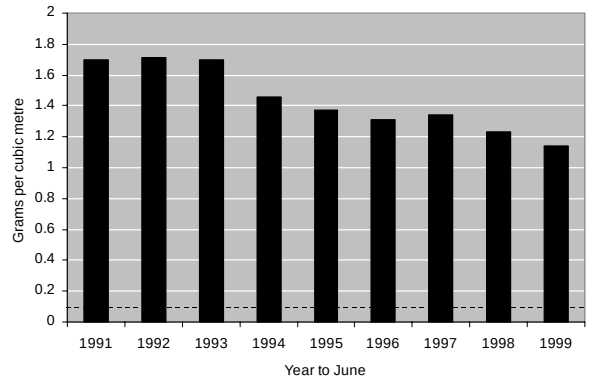
Source: Christchurch City Council.

Fig 2.19 Median DRP Concentrations for all Sites



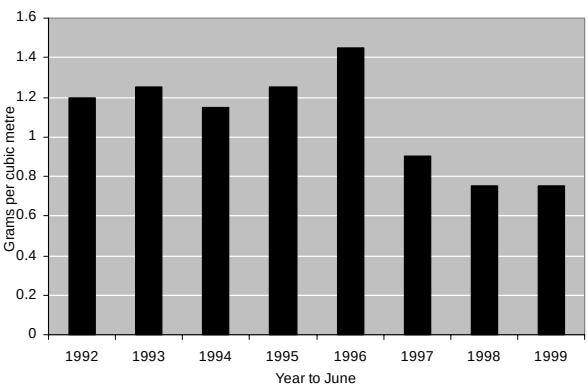
Source: Christchurch City Council.

Fig 2.20 Median DIN Concentrations for all Sites



Source: Christchurch City Council.

Fig 2.21 Median BOD Concentrations for all Sites



Source: Christchurch City Council.

levels in a waterway. Christchurch waterway DIN levels are dominated by nitrates. Fifty three per cent of sites showed decreasing ammonia levels in the year to June 1999, which is consistent with decreasing DIN values.

Sixty seven per cent of sites showed a decrease in BOD levels in the year to June 1999. The median value for all sites (Figure 2.21) shows decreasing levels of BOD since 1996.

Waterway Management

In the past waterway management in Christchurch aimed to create fast draining water channels, which were straight and had few obstructions. This type of management affected natural ecosystems in and along Christchurch's streams, often transferring pressures on the waterway network to different parts of the system.

Waterway management has changed to a more integrated approach which focuses on a range of values including ecology, landscape, recreation, cultural, heritage, drainage and flood control. Outcomes of this change in management are to:

- Protect and improve the natural character of waterways;
- Restore natural waterway function;
- Restore habitat for birds, fish and insects;
- Create green linkages and corridors;
- Restore waterways for their value to local communities; and
- Retain a natural buffer between waterways and development.

By June 1999 waterway enhancement projects had resulted in 1,700 metres of waterway margin being planted. Waterway views were enhanced at Jacksons Creek, Bells Creek at Mary Dixon Park, Dudley Creek at McFaddens Road and Halswell Junction Road wetland.

Eleven hundred metres of waterway or wetland margin was protected through the use of covenants, road stopping, reserve acquisition or land purchase. This included reserve creation on Marshland Road, road stopping by Thorrington School and the purchase of river bank on Nottingham Stream and Smacks Creek.

Birdlife on the City's Waterways[23]

The state of the City's waterways can be assessed using the number, diversity and distribution of natural wildlife, such as waterway birdlife. Birds are high up the food chain and therefore dependent on the condition of lesser fauna and vegetation of a waterway to sustain them.

In 1993/4 a series of bird surveys was carried out for the City Council on a number of Christchurch waterways. The aim of these surveys was to provide some baseline information about the wetland bird populations in the City. These surveys were repeated five years later in 1998/99 and the results for the Avon River are presented below.

Initial conclusions show an increase in bird numbers between 1993/4 and 1998/9. The number of native birds more than doubled from an average of 174 birds in 1993/4 to an average of 380 in 1998/9. The number of native wetland bird species also increased from 11 to 15. This increase in native birds was spearheaded by the New Zealand scaup. Seen only seen once in 1993/4, the New Zealand scaup was recorded on all counts in the 1998/99 survey, with a maximum of 172 birds in July.

These increases in bird numbers on the Avon River have taken place across the range of guilds and feeding groups. This suggests that the cause of the change lies within rather than outside the Avon River ecosystem. A tentative but logical conclusion is that bird numbers and species richness increased partly in response to habitat enhancement and improved feeding, roosting and nesting opportunities.

Birdlife of Natural Waterways[24]

An investigation of birdlife along small natural waterways (streams) was carried out in July and August 1997. The following eleven streams were surveyed:

- Nottingham Stream, Halswell
- Hoon Hay Valley Stream, Port Hills
- Jacksons Stream, Sydenham
- Steamwharf Stream, Woolston
- Avoca Valley Stream, Port Hills
- Old Lake Outlet, Horseshoe Lake
- Upper tributaries, Horseshoe Lake
- Wairarapa Stream, Fendalton
- Papanui Stream, Papanui
- Kaputone Stream, Belfast
- Smacks Stream, Belfast

Twenty two species of wetland bird probably inhabited Christchurch streams when European settlement began in the 1850s. Of these, at least six subsequently became extinct locally (brown teal, buff weka, banded rail, spotless crake, black stilt and South Island fernbird) and most of the others are now seldom recorded on streams.

Despite this decrease in native species, the actual number of wetland bird species that could potentially occur on Christchurch streams is 28 on coastal and peri-urban streams, and 21 on urban streams. The

[23] Information in this section is based on the report for the Water Services Unit, CCC, by Andrew Crossland: The Avon River – Wetland Birdlife Monitoring the first five years: 1993/94 – 1998/99. Preliminary Update February 1999.

[24] Information in this section is based on the report for the Water Services Unit, CCC, by Andrew Crossland: The Birdlife of Christchurch's Natural Waterways.

potential species diversity has probably decreased due to many of the new birds having similar or overlapping niches, while the diverse niches of extinct species are no longer occupied.

Linwood Avenue Canal has the greatest species diversity supporting up to 20 wetland birds, including eight which regularly nest there. However, most City streams currently attract less than 10 species, and some less than five.

Approximately six species of native bush bird may occur in wooded stream-side habitats along Christchurch waterways. These include the common silvereye, grey warbler and South Island fantail, as well as the less common bellbird, kereru (NZ pigeon) and shining cuckoo. In addition, streams which pass through native bush remnants on the Port Hills may also occasionally be visited by vagrant tomtits, tuis and long-tailed cuckoos.