Taieri River catchment

Water quality, macroinvertebrates, algae, fish, instream habitat and river flow

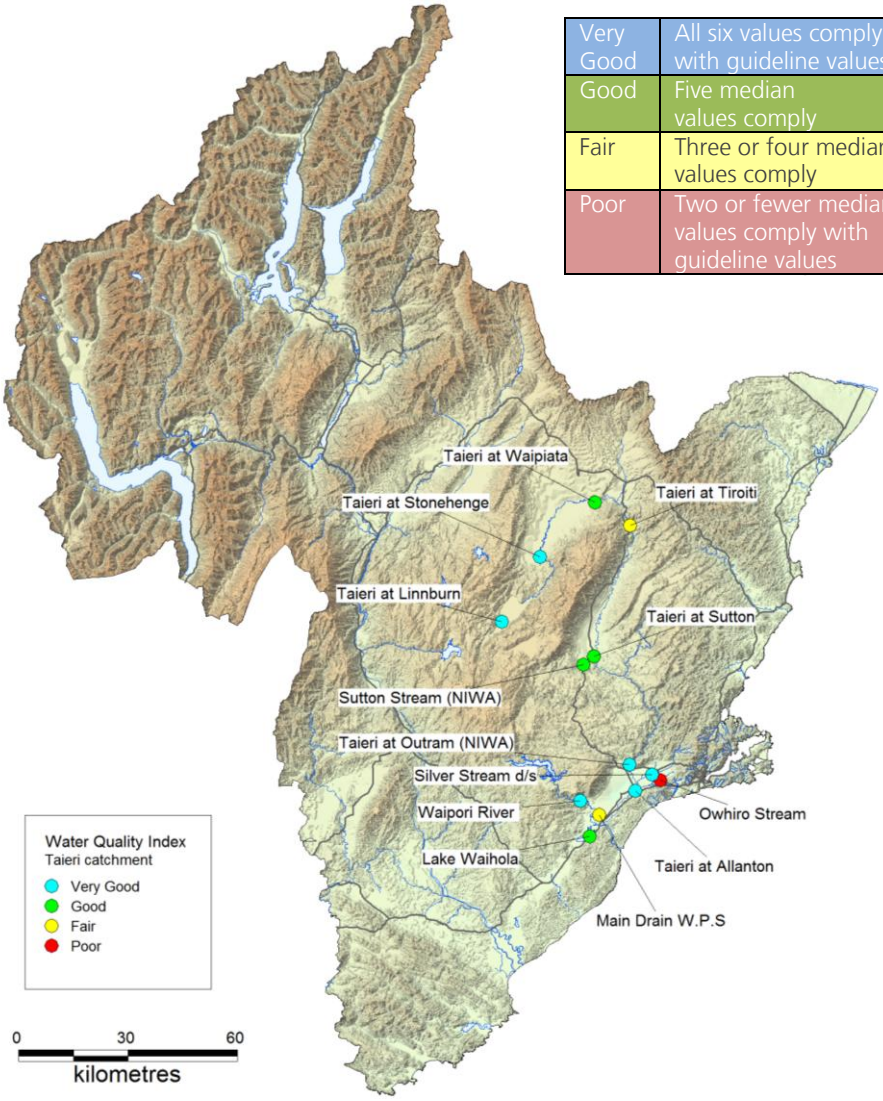
July 2009 to June 2010

Otago Regional Council

Water quality

Between July 2009 and June 2010, the Otago Regional Council (ORC) monitored 13 river and stream sites in the Taieri catchment to assess the current state of water quality. Most sites were monitored bi-monthly, but two further sites (Taieri at Outram and the Sutton Stream) were monitored monthly by NIWA as part of the national river water quality network (NRWQN)

Very Good	All six values comply with guideline values
Good	Five median values comply
Fair	Three or four median values comply
Poor	Two or fewer median values comply with guideline values



Key points

- Half the sites were classified as very good
- Only the Owhiro Stream was classified as poor in 2009
- The upper Taieri had low levels of *E coli,* which increased to above guideline levels at Tiroiti
- Five fish species were found in the Silver Stream which is below the Otago average of 5.96 species
- Macroinvertebrate health in the Waipori River is limited due to the hydro-electric scheme
- Mean annual low flows were up to 64% lower than normal.

Water quality index

ORC uses a water quality index (WQI) to report water quality. The index is derived from median values of six indicator variables: turbidity, dissolved oxygen (% saturation), ammoniacal nitrogen (NH_4), nitrite-nitrate nitrogen (NNN), dissolved reactive phosphorus (DRP), and *Escherichia coli* (*E.coli*) bacteria.

Median values of the six values are compared with ANZECC (2000) and MfE/MoH (2003) guidelines, enabling classification of water quality into one of the four groups.

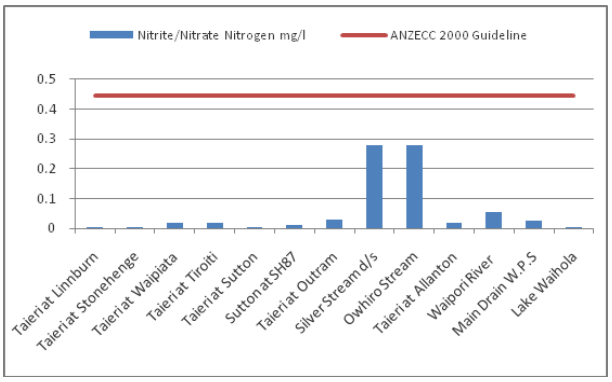
Water quality

Selected water quality indicators are displayed in the graphs and discussed below. Overall, these graphs show that water quality is generally good or very good, but with poorer quality in Mosgiel's urban streams.

Guidelines for nutrients

- Otago's water quality standards are outlined in the Regional Plan: Water (Water Plan), which sets targets to maintain and improve water quality within the region
- The ANZECC (2000) guidelines outline trigger values for lowland watercourses (<150m). The trigger value specifies a level below which the risk of adverse biological effect is low.

Nutrients



Nitrite-nitrate nitrogen (NNN) is a form of nitrogen primarily derived from land drainage. It is an important nutrient for algae and other plant growth, but can be harmful in higher concentrations. None of the sites exceeded the ANZECC 2000 trigger value, which is an improvement on 2008/9 when the Main Drain exceeded the ANZECC trigger value.

Total nitrogen exceeded the guideline value (0.614 mg/l) at two sites, the Main Drain and the Owhiro Stream.

Silver Stream at Riccarton Road

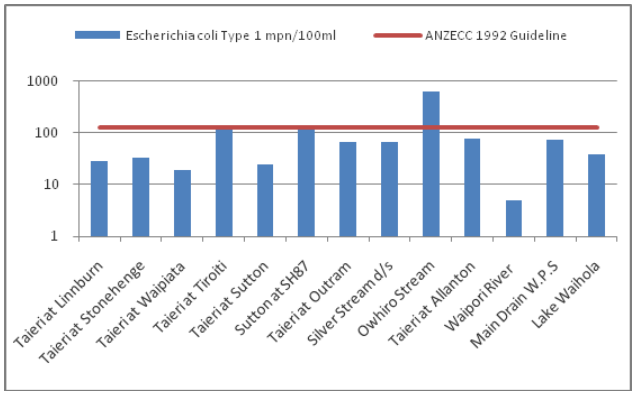
Dissolved reactive phosphorus (DRP) is another important nutrient for plant growth. Concentrations of DRP are affected by wastewater effluent, fertilisers and animal waste. Median DRP concentrations were above the ANZECC trigger value at five of the sites. Sites above Stonehenge have concentrations of DRP well below the guideline, but then concentrations increase downstream. The Taieri at Waipiata, Tiroiti and Sutton all exceed the DRP guideline value

Total phosphorus exceeded the trigger level (0.033 mg/l) at five sites. The Owhiro Stream and Main Drain showed the most significant elevations at 0.15 mg/l and 0.09 mg/l respectively. The Taieri River (Waipiata and Tiroiti) also exceeded the guideline value, as did Lake Waihola.

Bacteria

Guidelines for bacteria

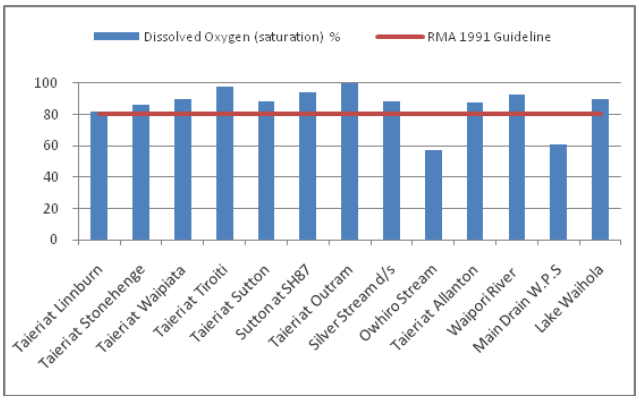
- The 1992 ANZECC guidelines recommend a season median of less than 126 *E.coli*/100ml.
- The Mfe/MoH (2003) guideline recommends that a single sample does not exceed 260 *E.coli*/100ml



Median levels of *E coli* bacteria were above the ANZECC guideline level (126 cfu/100ml) at three of the 13 sites analysed. The main stem Taieri at Tiroiti just exceeded the guideline level; upstream of this site levels were well below the guideline.

The MfE/MoH contact recreation guideline is 260 cfu/100ml for a single sample. The Taieri at Linnburn, Stonehenge, Sutton and Allanton, the Waipori River, and Lake Waihola did not exceed this concentration on any sampling occasion.

Dissolved oxygen



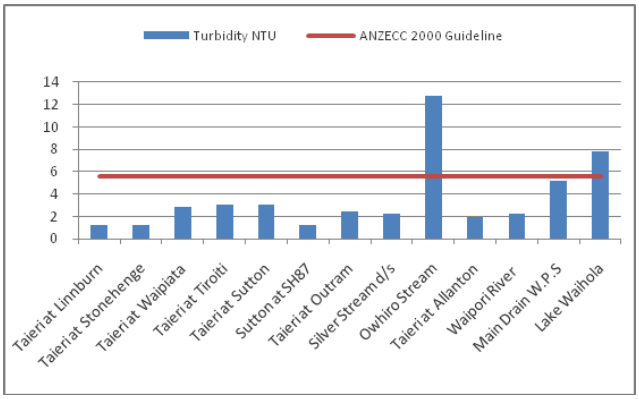
The RMA states that dissolved oxygen saturations should be above 80%, as below this level saturation is considered insufficient for biological health. The median saturation was above this level at all sites other than the Main Drain (a pumped drain on the Taieri plain) and the Owhiro Stream. Low concentrations in the Owhiro Stream are most likely due to excessive macrophyte growth and slow velocities

Water quality references

Australian and New Zealand Environment and Conservation Council (ANZECC). 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Ministry for the Environment, Ministry of Health, 2003. Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment, Wellington.

Turbidity



Turbidity was elevated above the ANZECC trigger value at two sites—Lake Waihola and the Owhiro Stream. As Lake Waihola is shallow it has wind driven re-suspension of sediment, and the very shallow, low flowing Owhiro Stream has sediment disturbed by wildfowl.

Ecosystem health

Ecosystem health takes into account a wide range of inter-linked factors, such as water quality, habitat and instream biota. It is generally assessed using two communities that are important to the food chain in rivers and streams: streambed macro-invertebrates (e.g. insects, crustaceans, snails, worms) and periphyton (e.g. algae). These biological indices put a large amount of information into a compact form. They are therefore inherently coarse tools that give a broad view of general patterns. However, they are useful as the presence or absence, abundance and distribution of species can inform us greatly about the quality and condition of the site at which they live.

Algae (periphyton)

Excessive amounts of periphyton, in particular filamentous algae, can reduce the amenity value of waterways by decreasing their aesthetic appearance, reducing visibility, and being a physical nuisance to swimmers. While algae is a useful tool for monitoring the nutrient conditions in rivers and streams, it is just one method used to get a complete overview of the river system. Factors other than nutrient levels also influence the composition of benthic algal communities. These include substrate character, river flows, the amount of light reaching the river bed, and the water temperature.

Silver Stream algae

Indices to measure macroinvertebrate health

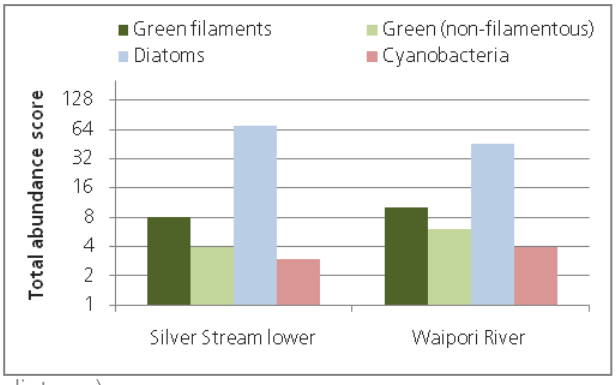
Macroinvertebrate community index (MCI)
The MCI is calculated by adding the pollution tolerance scores of all species found at a site. Species that are very sensitive to pollution score highly whereas the invertebrates suited to muddy/weedy-bedded, pool like habitats are generally the more tolerant, low-scoring taxa that tend to reduce MCI values.

EPT species
EPT richness is a sum of the total number of **E**phemeroptera (mayflies), **P**lecoptera (stoneflies), and **T**richoptera (caddisflies) species collected.

EPT taxa are generally sensitive to a range of pollutants including fine sediment and nutrient enrichment.

Semi-quantitative Macroinvertebrate community index (SQMCI).
The SQMCI is also based on the ratios of sensitive to tolerant taxa, but SQMCI results are primarily determined by the most abundant taxa (unlike the MCI where all taxa are given equal weight in the calculation.

Algal samples were collected at two sites. Algae were given an abundance score ranging from 1 (rare) to 8 (dominant) based on the protocol of Biggs and Kilroy (2000). The abundance scores were added together for four algae types (see figure below). It can be seen that both sites had similar proportions of algae and both were dominated by diatoms.



The Waipori River had dominant *Cladophera* (filamentous green) and abundant *Nitzschia* (diatom) and the Silver Stream had dominant *Cymbella* and abundant *Encyonema* (both diatoms).

Macroinvertebrate health

A key component of the MCI index is the availability of suitable habitat. The MCI index is designed specifically for stony riffle substrates in flowing water. MCI values can vary due to the availability of suitable habitat and not necessarily due to water quality. As substrate type can vary greatly between riffles, it is often more appropriate to compare changes in MCI values at the same site over a period of time rather than between sites throughout the catchment. However, by understanding the limitation of the MCI index it still can be useful for picking up improvements or deterioration in water quality at individual sites over time.

Category	No. of Taxa	EPT richness	MCI	SQMCI
Poor	<10	<5	<80	<4
Average	10 to 20	5 to 15	80 to 100	4 to 5
Good	>20 to 30	>15 to 20	>100 to 120	>5 to 6
Excellent	>30	>20	>120	>6
Site	**No. of Taxa**	**EPT richness**	**MCI**	**SQMCI**
Silver Stream lower	20	7	104	3.8
Waipori River	4	2	95	4

There is no change to previous years. The Silver Stream has good water quality, but marginal habitat due to the modified system (flood banks and straightened channel) The Waipori River is also a modified system. It has good water quality, but macro-invertebrate health can be limited due to the hydro-electric scheme and the rapid rise and fall of water level.

Worm (*Oligochaete*). Source: Stephen Moore

Fish

Electro-fishing was conducted in the summer of 2010 at the Silver Stream site. Results are shown in the table below.

Species	No. fish
Common bully	175
Longfin eel	16
Lamprey (adult)	5
Lamprey (juvenile)	6
Inanga	158
Brown trout	114
Number of species	5
% Exotic	24

Galaxiid (ORC)

Brown trout were the only exotic species observed. The most common native species was the common bully and inanga. The least common was the lamprey. At the Silver Stream site there were five fish species found, which was lower than the Otago average of 5.96 species per site. The percentage of native species was high (76%)

Fish facts

- Fish species diversity is an indicator of stream ecosystem health
- Diversity varies naturally based on a number of factors, including geology, topography, hydrology, groundcover, climate, and altitude
- Streams located near coastal environments often contain relatively high species diversity due to mild climates and the fact that many species spend parts of their lifespan in both fresh and salt water
- Exotic species such as trout are known to limit the range of native species through predation and competition Often streams with large numbers of exotic species show lower densities and diversity among native fish species.

Habitat assessment

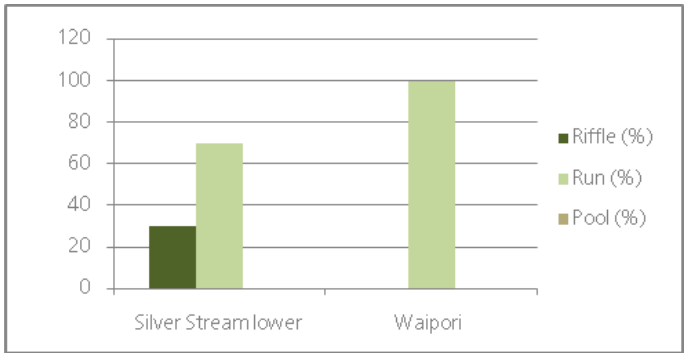
In 2010 ORC undertook stream habitat assessment for the first time. The physical character of a stream determines the quality and quantity of habitat available to biological organisms and the stream's aesthetic and amenity values. Physical habitat is the living space for all in stream flora and fauna, it is spatially and temporally dynamic and its condition and characteristics set the background for any assessment of the health of a waterway.

This section will only focus on three of the parameters analysed, flow type, substrate composition and riparian cover.

Flow type

Flow types are characterised by different mean water velocities and depths. They produce characteristic surface flow patterns and are often associated with different substrate types.

The figure below shows flow type (%) at both ecological monitoring sites



The Waipori River is totally dominated by runs, while the Silver Stream lower has some riffle and run habitat, but no pools.

Flow type

The more diverse the flow types at a site, the more ecological habitat available

Riffle: shallow depth, moderate to fast water velocity with mixed currents, surface rippled but unbroken.

Run: slow with moderate depth and water velocity, uniform to slightly variable current, surface unbroken, smooth to rippled.

Pool: deep, slow flowing with a smooth water surface, usually where the stream widens and/or deepens.

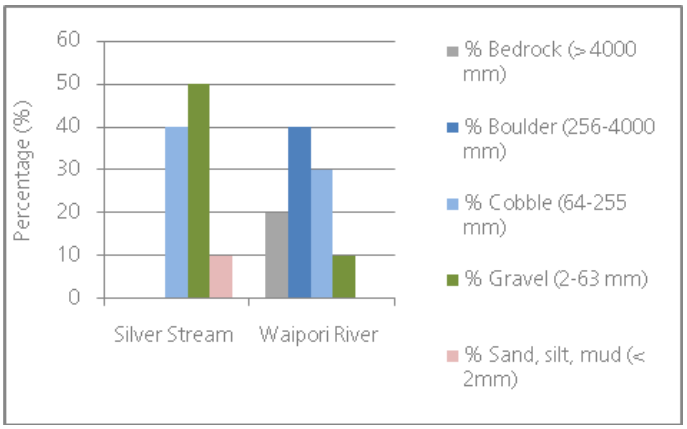
Substrate composition

The size distribution of the stream substrate influences the habitat quality for algae, invertebrates and fish, and determines the quantity and quality of refuge from floods and predators (Harding *et al* 2009[1]).

[1] Harding, J. et al. 2009. Stream Habitat Assessment Protocols for Wadeable Rivers and Streams of New Zealand. University of Canterbury, New Zealand.

Substrate composition

The figure below shows the % substrate size in runs at both ecological monitoring sites.



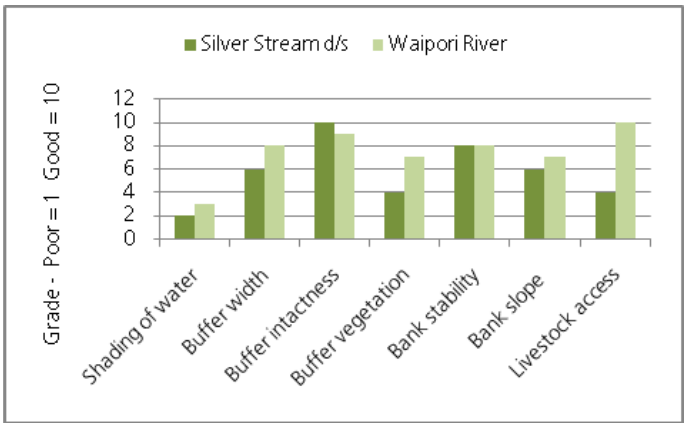
The Waipori River has no fines and a much larger substrate size than the Silver Stream.

Riparian zone

Riparian zones are defined as areas where direct interaction between land and water occur. They have a large influence on stream habitat and water quality relative to their proportion of catchment area. Riparian management usually involves fencing to exclude livestock and planting with native trees and shrubs in a riparian buffer.

Riparian zone

The figure below shows the state of riparian health at both ecological monitoring sites.



Although the sites are very different, there was very little shading at either site. Buffer intactness (an indication of continuous riparian vegetation) was good. Bank stability was generally good although the Silver Stream did allow stock access. The steeper the slope the more runoff. Both sites did not have excessive bank slope.

Electro-fishing in the Silver Stream

River flows

The rate of flow is an important determinant of the biological health of a steam or river, especially the extreme high and low flows. Low and high flow statistics have been calculated for a number of sites throughout the catchment from 1 July 2009 to 30 June 2010.

The Taieri River catchment experienced extreme river flows this year. At the majority of sites, mean annual low flow (MALF) was lower than normal. The Taieri River at Sutton had a MALF that was 60% lower than normal at 0.98 cumecs while at Outram MALF was 64% less than the historical level of 4.42 cumecs. Flood flows were much higher than normal with the Nenthorn Stream at Mt Stoker having a maximum flow of 341 cumecs (compared to the historical average of 85 cumecs). This flow was the second highest on record for the Nenthorn Stream. The Taieri River at Outram reached 1198 cumecs which was the third highest flow since records began in 1968.

Site	7- day low flows			Flood flows	
	2009/ 2010	Historical (MALF)	% change	2009/ 2010	Historical (mean annual flood)
Taieri at Canadian Flat	0.68	0.88	-23	60.8	97.3
Taieri at Waipiata	0.86	1.56	-45	123	59.0
Taieri at Tiroiti	0.86	2.05	-58	130	126
Taieri at Sutton	0.98	2.42	-60	324	167
Taieri at Outram	1.58	4.42	-64	1198	550
Nenthorn at Mt Stoker	0.01	0.03	-33	341	85.0
Silver Stream at Taieri Depot	0.04	0.08	-50	132	68.8

Note: all flows are given in m^3/s

River flow facts

- The 7-day low flow refers to the lowest 7-day average flow for a given year
- The 7-day mean annual low flow (MALF) is the average of all the 7-day low flows over the term of record
- The mean annual flood is the average flood flow expected each year based on the length of the record.

Hydrological monitoring station

Waipori River at Falls Reserve

Owhiro Stream

Otago Regional Council
70 Stafford Street
Private Bag 1954
Dunedin

03 474 0827
0800 474 082

Further information on this and other Otago catchments is available on the ORC website:

www.orc.govt.nz

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