



# Cardrona catchment

Information sheet    June 2013

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## LOCATION

Situated between Arrowtown and Wanaka, the Cardrona catchment (Figure 1) is located in the upper Clutha River/Mata-Au valley, east of Wanaka, west of Cromwell, north of Arrowtown and south of Albert Town. The catchment covers approximately 340 km<sup>2</sup> and is bounded on the west and south by the Crown Range, on the east by the Criffel Range, and on the north by the Cardrona River's confluence with the Clutha River/Mata-Au.

The Cardrona River flows in a north-north-easterly direction, 32 km down the Cardrona valley. Its headwaters originate at Mt Scott on the Crown Range, draining the western flanks of the Criffel Range, and from the eastern side of the Crown Range north to mount Alpha.

Some of the tributaries include Boundary Creek, Little Meg Creek, Pringle Creek, Spotts Creek, Stoney Creek, and Timber Creek. At the end of the valley at "The Larches" (otherwise known as Mt Barker), the river crosses about 7 km of relatively flat plains south-east of Wanaka, before discharging into the Clutha River/Mata-Au at Albert Town. The Cardrona River experiences low flows in its lower catchment and most years flows dry up in some sections of the river, particularly downstream of The Larches flow recorder site.

The Wanaka Basin-Cardrona gravel aquifer is located between Lake Wanaka, the Upper Clutha River/Mata-Au, the Criffel Range and Mount Roy. This aquifer is responsible for the flow of Bullock Creek through Wanaka township, and ensures the availability of groundwater in the rural areas. The aquifer also contributes to the periodic drying-up of sections of the Cardrona River during summer due to infiltration.

The Cardrona alluvial ribbon aquifer comprises the river flats which extend from Little Meg Creek in the south to The Larches in the north.

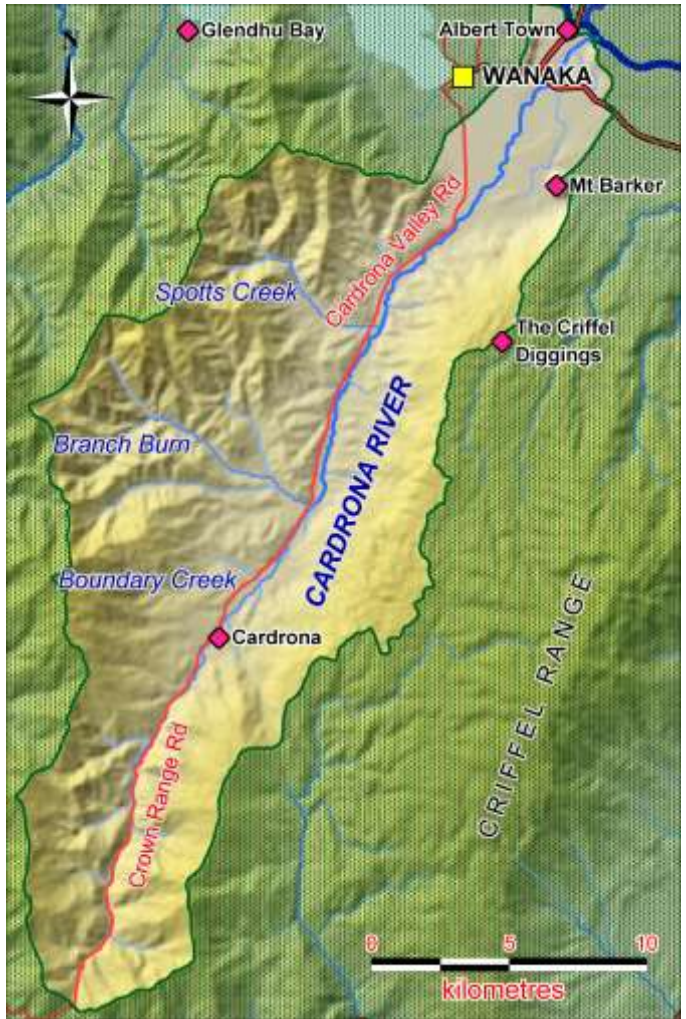


Figure 1. Cardrona catchment



# NATURAL VALUES

## Topography, geology and soils

Topography varies from river flats in the lower reaches to the short steep slopes of the Criffel Range, to the higher undulating hills on the western side of the valley. The river valley has an elevation range of approximately 300 m at the confluence with the Clutha River/Mata-Au, and 1000 m at the top of the Crown Range. Some of the river terrace faces are eroded and modified from early gold workings.

The Kaikoura orogeny formed the characteristic Central Otago basin and range topography, as some parts of the landscape were pushed up faster than others. The Haast schist bedrock of the Cardrona valley floor is covered with a thick alluvial mantle, while the ancient alluvial gravels present on ridge tops predate the Kaikoura orogeny. It is in these gravels that gold was discovered and subsequently mined.

The Wanaka Basin consists of glacial deposits and glacial outwash gravels which cover most of the intermediate lignite-bearing sediments and underlying schist basement rock.

Soils in the valley are low-fertility pallic soils. On the lower plains, they are brown, melanic (darkened), and recent soils, with low-to-moderate fertility.



Figure 2. Soils in the Cardrona catchment

## Climate and rainfall

The climate within the catchment is characterised by cold winters and warm summers. Temperatures across the seasons range from an average of 6degC in winter to an average of 26degC in summer (depending on the altitude). Much of the moisture received in the higher areas during winter is in the form of snow, some of which can persist in shady areas through summer. Snow cover on the Criffel Range tends to be shallower and less frequent than the Pisa Range.

The median annual rainfall ranges from 650-700 mm on the lower flats, to 1250-1500 mm on the tops of the Crown and Criffel Ranges. A severe rainfall deficit occurs during summer, with typical January - February rainfall totals approximately half of the potential evapotranspiration rate, leading to a high demand for irrigation water.

The Cardrona township, West Wanaka, and Wanaka Airport rainfall gauges show a downward trend in annual rainfall since the late 1990s. The five-year moving average at West Wanaka has fallen approximately 300 mm since 1995, while Wanaka Airport has dropped 120 mm since 1998.

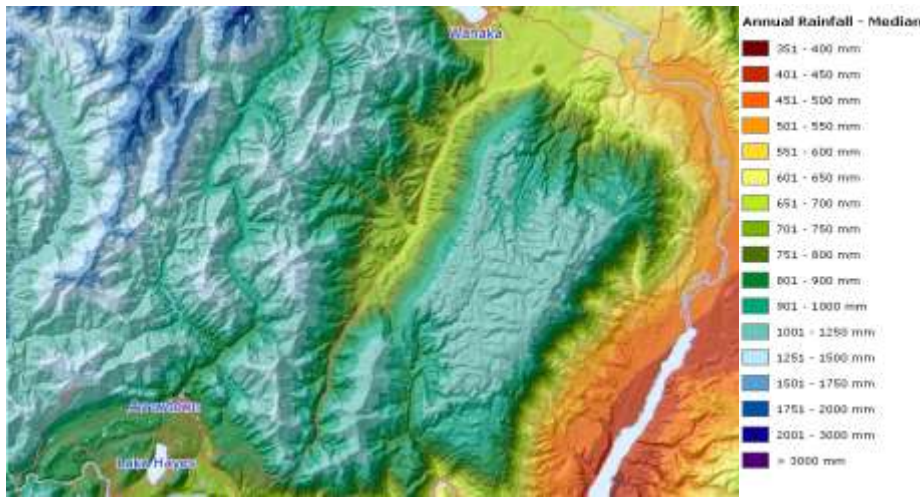


Figure 3. Modelled median rainfall in the Cardrona catchment

## Surface water hydrology and river flow data

The Otago Regional Council (ORC) and the National Institute of Water and Atmosphere (NIWA) have collected continuous hydrological information from The Larches flow recorder since the mid-1970s. ORC installed a second flow recorder on the Cardrona River in 2008 at the confluence with the Clutha River/Mata-Au. A summary of the flow statistics for these sites is given in Table 1.

Table 1. Flow statistics for the Cardrona River at The Larches and at the Clutha confluence (litres per second)

Site	Min (l/s)	Max (l/s)	Mean (l/s)	Median (l/s)	MALF (l/s)
Cardrona at The Larches	308	145,299	3,137	2,306	1,057
Cardrona at Clutha confluence	253	33,445	1,980	1,489	348

The river downstream of The Larches commonly dries up during summer, as surface flows are lost to groundwater, and many abstractions occur. There is some recovery of flow by the time the river reaches Albert Town, as groundwater and excess irrigation water re-enter the river.

Flows in the Cardrona River are generally higher in the spring due to snow melt, and reduced over the summer, although low flows can occur during winter due to much of the catchment being locked up in ice.

The Cardrona River can experience extreme low flows during summer with some tributaries running dry during this period. However, the high-yielding upper catchment provides stable base flows in the main stem in the absence of abstraction.

Flow monitoring has shown that the Cardrona River loses approximately 400-600 l/s to the underlying aquifer between The Larches and SH6. Between SH6 and Clutha confluence the river gains approximately 300 l/s as groundwater re-enters the river.

Based on the loss of surface flow in the lower reaches, and our knowledge of current irrigation practices, it is possible that the river may naturally dewater between The Larches and SH6 in an extremely dry year, even in the absence of irrigation.

### **Flooding**

Flooding has had a significant impact on the catchment and its community. During the past 35 years, flood flow levels have been experienced in 1980, 1984, 1994, 1995, 1999 and 2002.

### **Water quality**

Between July 2011 and June 2012 the water quality in the Cardrona River was classified as 'excellent'. This means that ANZECC (2000) guidelines were met for turbidity, dissolved oxygen, ammoniacal nitrogen (NH<sub>4</sub>), nitrite-nitrate-nitrogen (NNN) and dissolved reactive phosphorus (DRP). The ANZECC (1992) guidelines were met for *Escherichia coli* (*E.coli*).

Over a longer period (July 2006 to June 2011) the Cardrona River ranked 18th in Otago for water quality (out of 62 water bodies). This period has seen a significant improvement in *E.coli* concentrations and suspended solid concentrations.

Macroinvertebrates are an important component of streams and rivers, as they aid ecosystem processes, and provide food for fish. Macroinvertebrates have a relatively long life span, and as such, are good indicators of environmental conditions over a prolonged period. The main measure of macroinvertebrate communities is the Macroinvertebrate Community Index (MCI). Between 2006 and 2011 the average MCI score for the Cardrona River was 102. This indicates that water quality is good.<sup>[1]</sup>

## Groundwater hydrology

### *Aquifer recharge and flow patterns*

Water from the Cardrona River infiltrates the Wanaka-Cardrona aquifer between The Larches flow recorder site and Ballantyne Road crossing. Excess soil water from rainfall and irrigation water also contributes to aquifer recharge.

While river water infiltrates the aquifer upstream of Ballantyne Road, the Cardrona River downstream of State Highway 6 receives a steady augmentation from the aquifer of approximately 0.3m<sup>3</sup>/s. Other discharge sites where the groundwater leaves the aquifer include Bullock Creek, Lakeside Drive, and Ripponlea springs in Wanaka township, the lower Cardrona River and the Cameron Creek tributary of the river, Lake Wanaka, Clutha River/Mata-Au, and various springs scattered within Albert Town.

The pattern of recharge and discharge to a variety of sites results in a splitting of the groundwater flow in the Mount Barker area, between water flowing in the direction of Bullock Creek and Lake Wanaka, and water destined for the lower Cardrona River or Clutha River/Mata-Au. Overall, Bullock Creek is the largest recipient of groundwater by volume.

## Catchment ecology

### *Flora*

The catchment was historically covered with predominantly tussock grassland. Cultivation and burning practices have modified parts of this landscape to what it is today.

Tussock and low-producing grassland dominate in the upper catchment with the ridges and outcrops covered with bracken, silver tussock, and hawkweed (*Hieracium lepidulum*).

The slopes of the Criffel Range are covered with pasture species, fescue tussock (*Festuca novae-zelandiae*) and silver tussock (*Poa cita*) while the lower-mid slopes contain shrublands and bracken fern. Criffel front faces and Pringle Creek contain some remnants of native shrubland.

The valley floor and lower terraces are now dominated by high-producing exotic grassland and forestry, and tussock.

### *Invertebrates*

The catchment contains a range of invertebrates (especially in the mid-to-upper reaches, including a number of rare invertebrates. Species known to be present include mayflies, native wood borer, anthribid, grasshopper, praying mantis, dragonflies, damselflies, blue butterfly, and tussock butterfly.

### *Reptiles*

McCanns lizard, common skink and Cromwell Gorge gecko can be found within the catchment.

### *Birds*

A variety of birds have been observed in the catchment area, including: California Quail, Chukor Partridge, Paradise Shelducks (putangitangi), Australasian Harrier (kahu), Pipit (pihoihoi), Blackbacked Gull (karoro) and the New Zealand Falcon (karearea). The New Zealand Falcon is a category B (second priority) threatened species in gradual decline.

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[1] The MCI categories are: Poor: less than 80, Fair: 80-99, Good: 100-119, Excellent: greater than 119.

### *Fish*

The catchment has been identified as providing significant habitat for Clutha flathead galaxias, although these occur almost exclusively in small tributaries in areas unsuitable for trout. Several of the larger tributaries and the main stem of the Cardrona provide important spawning areas for rainbow trout migrating from the upper Clutha River. The lower reaches of the Cardrona River and some tributaries provide significant habitat for juvenile trout, and an important source of trout recruitment for the upper Clutha River. Koaro and longfin eels are also present, although eel numbers have been greatly reduced by downstream barriers to migration.

## **Schedule 1A natural values**

Schedule 1A of the Water Plan identifies the Cardrona River and its tributaries as having a high degree of naturalness above 900 metres and providing habitat for native fish. A summary of the natural values supported by the Cardrona and its tributaries is given in Table 2.

Table 2: Natural values of the Cardrona River and its tributaries

Water body	Natural value
Cardrona River	Provides habitat and bed composition for biota and juvenile fish – and is free of aquatic weeds. It contains trout, eel and rare fish with rare invertebrates in the mid to upper reaches.
Spotts Creek, Timber Creek, Boundary Creek, Branch Burn, Wrights Gully	Is weed free and provides habitat for indigenous fish species such as Koaro.

## **COMMERCIAL, SOCIAL, AND CULTURAL VALUES**

### **Historical value**

Historically, the Cardrona catchment supported Maori transport/trade routes (see iwi values, below) and has supported gold mining and agricultural endeavours.

The catchment has its roots in the gold mining past. Cardrona came into its own in November 1862 with the discovery of gold in the valley. The remains of some of the Cardrona diggings can still be found along the Cardrona Valley Road. Hundreds of settlers came to stake their claim and over the next three decades the Cardrona township prospered and developed to the point that it supported four hotels (the Cardrona Hotel remains one of NZ's oldest hotels), three European stores, three Chinese stores, four butcheries, a blacksmith, and a baker. By 1871 the township had become the centre of the butchery trade in Central Otago. The town prospered until the end of the gold rush in approximately 1914. The Cardrona Hall and Church, and the Cardrona Hotel facade are listed in the Queenstown Lakes District Plan's inventory of protected features.

### **Land use**

The upper catchment is dominated by sheep and beef farming, while deer are farmed in the lower catchment. Pastoral farming has been and continues to be an integral part of the fabric of the community. The availability of water for irrigation has been fundamental to this and ongoing development. Within the catchment are a number of past and present Crown pastoral leases, including Hillend, The Larches, Spotts Creek, Avalon, Branch Creek, Robrosa and Waiorau.

Ski-fields and snow parks have been more recent additions to the landscape and are now dominant features providing recreational opportunities throughout the year.

There has been a significant increase in the development of lifestyle blocks and residential use in both Cardrona Village, and the lower catchment toward Wanaka and Albert Town.

The Pisa Ecological District (PED) covers 84.75 ha of land bounded in the north and east by the Clutha River/Mata-Au, in the west by Lake Wanaka and the Cardrona River, and in the south by the Kawarau River.



The Cardrona River and tributaries support a range of agricultural, tourism and recreational uses, all of which play an important part in the overall character of the community and the region.

## Commercial value

The Clutha River was identified in the Water Programme of Action: potential Water Bodies of National Importance - Technical Working Paper (July 2004) as being one of the most valuable rivers for recreation purposes, irrigation, and existing and potential energy production. Reflective of this are the many commercial activities that rely on the Cardrona's physical, historical and aesthetic qualities, including:

*Pastoral farming* – see also 'Land use'

Agriculture has been an important part of the catchment since the Gold Rush, and has helped to form the aesthetic landscape which so many people recognise and associate with, and value. The agricultural operations contribute economically to the region through on farm employment on farm, and by supporting downstream industries such as agricultural contractors and other local businesses.

The reliance of pastoral farming operations: including sheep (merino wool and meat), deer and crops; on water for irrigation is very important.

Many farming operations have diversified and are making the most of the increase in tourism in the region and the expansion opportunities that come with this.

*Tourism* - see also 'Recreational values'

The growth of tourism in the region, and Central Otago in general, has led to an increase in visitor numbers. The number of outdoor pursuits and other recreational activities available to visitors in the Cardrona/Wanaka region continues to expand, thereby growing the economic value of tourism and its importance to the local community and Otago in general. Many tourism enterprises in the area are founded on, and continue to promote, the quality and beauty of the landscape, continuing the theme promoted by Tourism New Zealand and the 100% Pure New Zealand advertising campaign.

The popularity of Central Otago for local and overseas film production in the region has also contributed to tourism growth e.g. Lord of the Rings and the Hobbit. The increasing visitor numbers continue to justify the need for accommodation and associated hospitality operations, such as pubs and restaurants.

## Iwi values

Water occupies a significant role in the spiritual beliefs and cultural traditions of Kai Tahu, and the health of water bodies and the condition of water is of particular consideration

Schedule 1D of the Water Plan and the Kai Tahu ki Otago Natural Resource Management Plan 2005 identify the spiritual or cultural beliefs, values, or uses associated with water bodies of significance to Kai Tahu. The Cardrona catchment is important for:

- Kaitiakitanga and mauri
- Waahi tapu and/or Waiwhakaheke – sacred places i.e. urupa; sites, areas and values associated with water bodies that hold spiritual values of importance.
- Waahi taoka – treasured resource; values, sites and resources that are valued and reinforce the special relationship Kai Tahu has with Otago's water resources.
- Mahika kai – places where food is procured or produced.
- Kohanga – important nursery/spawning areas for native fisheries.
- Trails – sites and water bodies which formed part of traditional routes.
- Cultural materials – water bodies that are sources of traditional weaving materials (such as raupo and paru) and rongoa (medicines).

Lakes Wanaka and Hawea were occupied by Waitaha up until the Maori wars whereupon the families left the area. It was occupied during the 19<sup>th</sup> century by families of Kati Mamoe and Kai Tahu, who came for seasonal visits of several months at a time or even years.

The Clutha River / Mata-au was used as a highway into the interior of Otago, and the Cardrona catchment forms part of the ara tawhito (old trails) across to Tai Poutini (West Coast) and Te Koroka (Dart River/Te Awa Whakatipu) for gathering pounamu (greenstone). The trails are an indicator of how Kai Tahu ki Otago used the river. The valley still provides access to many of the old pathways.

The valley was part of the region relied upon heavily for seasonal mahinga kai – tuna (eel) and koaro. The places where tuna were harvested are important to whanau and hapu and the Wanaka area was known to have teemed with the fish.

## Recreational value

The predominant recreational uses within the catchment include:

Snow sports (Cardrona Alpine Resort, Snow Farm and Snow Park NZ), mountain biking, 4-wheel driving, quad biking, hunting (e.g. Cardrona Safaris), horse trekking, fishing (in particular fly-fishing trout), walking / walkways, swimming / informal water play, gold panning, picnicking, camping, photography and painting.

Although angler numbers are not particularly high compared to some other upper Clutha rivers, the Cardrona River does support a healthy early season fishery that occurs mainly in November before post-spawning adult trout return to the Clutha River. An angler survey undertaken in 2007/08 (Unwin, April 2009) has shown that in the Cardrona angler numbers amounted to 30 angler days. All angler numbers were recorded in the months of December and January. The numbers of anglers recorded fishing the Clutha River from Wanaka to Lake Dunstan has increased from 2710 (2001/2002) to 5150 (2007/2008). These results show that fishing in the area is continuing to grow in popularity and remains an important recreational pursuit within the region.



Figure 4. Mount Cardrona Station



# WATER TAKES WITHIN THE CATCHMENT

## Permitted surface water takes

Under the Resource Management Act (RMA) and the Water Plan, water is able to be taken from the Cardrona River and its tributaries for an individual's reasonable household and stock drinking-water needs, and for fire-fighting purposes. The Water Plan permits smaller water takes subject to meeting the standards specified. ORC does not hold information on permitted water takes.

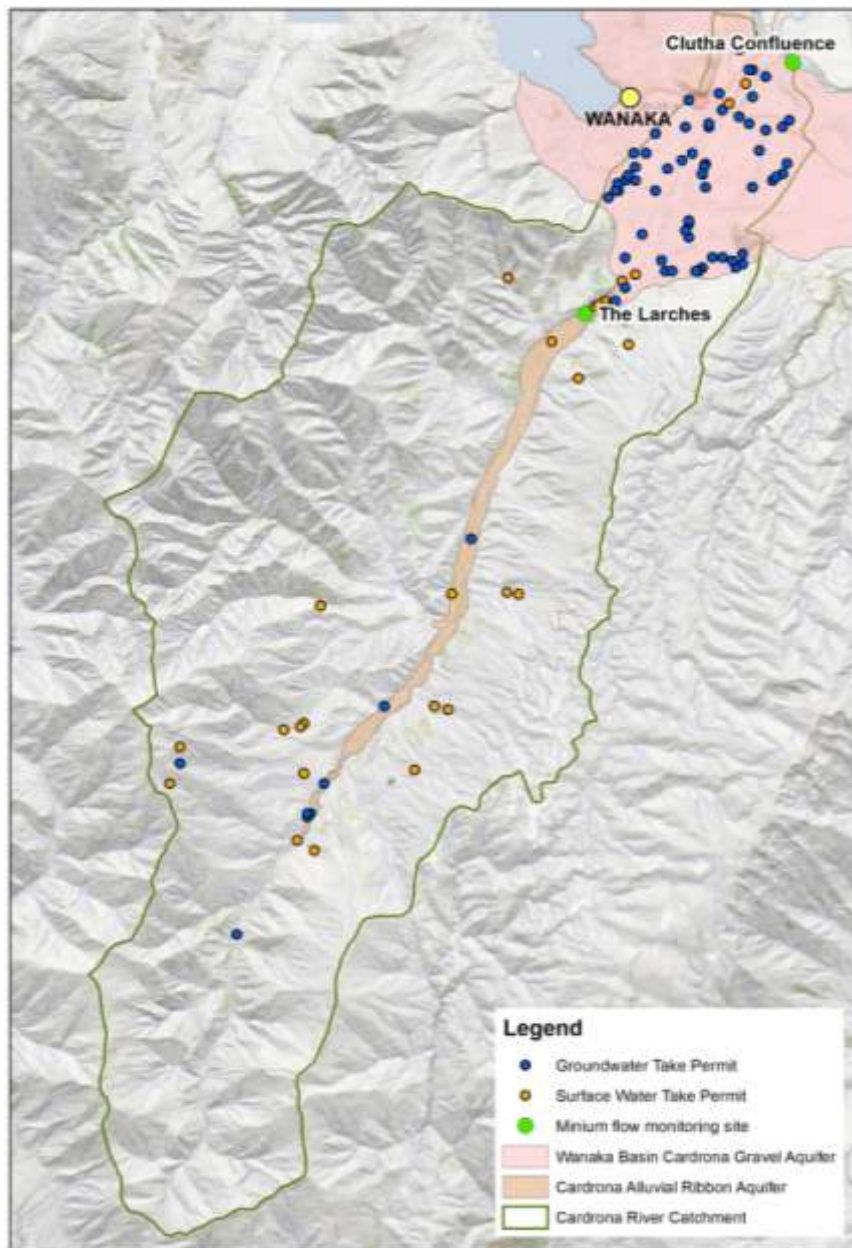


Figure 5. Map of catchment depicting points of abstraction

## Consented surface water takes

There are 41 consented surface water takes from the Cardrona River and its tributaries. Of these, 19 are deemed permits (see explanation below) and of the remaining 22 consented water takes, twenty are primary allocation and two are supplementary allocation takes. Table 3 shows the current situation in the catchment. The catchment has an overall consented primary instantaneous water take of 2440.45 l/s and a 50% MALF of 528.5 l/s, therefore, no new primary allocation is currently available.

Table 3: Consented Surface Water Takes within the Cardrona catchment (as at 10 January 2012)

Permit Type	Number of consents	Combined instantaneous take rate (l/s)	Combined monthly volume (m <sup>3</sup> )	Water source	Purpose
Deemed permits (primary)	19	1620.3	3,957,252	Cardrona River, Boundary Creek, Camerons Creek, Claybank Creek, Clearwater Creek, MacDonalds Creek, Shepherds Creek, Welshes Creek	Irrigation, stockwater, domestic
Primary surface water permits	20	820.15	942,553	Cardrona River, Camerons Creek, Deep Creek, Foxes Creek, German Gully Creek, Little Meg Creek, Pringles Creek, Spotts Creek, Timber Creek, Tuohys Creek, unnamed tributary	Communal supply, irrigation, ski resort, stockwater
<b>Total primary permits</b>	<b>39</b>	<b>2440.45</b>	<b>4,899,805</b>		
Supplementary surface water permits	2	10.8	1,744	Little Meg Creek, Pringles Creek	Communal supply, irrigation, ski resort

Recent work undertaken by the ORC and local irrigators has shown that the actual peak take from the Cardrona catchment is 1,160 l/s. Of this total take, it is estimated that 620 l/s is taken from the catchment above The Larches, and 540 l/s is taken downstream. In the latter parts of the irrigation season it is likely that the total take drops well below 1,160 l/s as tributary and main stem flows decrease.

## Deemed permits

Deemed permits (also known as “mining privileges”) were issued under very early mining legislation, including the Mining Act 1926, and allowed the taking, damming, and discharging of water. As gold mining declined, this water was increasingly used for irrigation. The Crown acquired a number of the significant, higher priority mining privileges which were used for irrigation schemes, and these were then transferred to community irrigation groups. The Cardrona River is used as a source of water for one large irrigation scheme in the Wanaka Basin. Up to 500 l/s is taken from the river at The Larches and transported via an open race network to the greater Wanaka Basin. This is the largest single consented take from the Cardrona River.

In 1991, under the RMA, every mining privilege was deemed to become a water permit for the taking or damming of water on the same terms and conditions as the original mining privilege. Deemed permits expire on 1 October 2021 (RMA Section 413(3)) at which time water permits in replacement of the deemed permit will need to be sought if water is to be taken or dammed after that time.

## Consented groundwater takes

### *Consented groundwater takes*

Eighty-one groundwater take consents have been issued in the Cardrona catchment under the RMA. A further five non-consumptive groundwater take consents have been issued since 2006 for construction dewatering.

Groundwater takes can be divided into two groups: groundwater takes from within the Cardrona alluvial ribbon aquifer which comprises the river flats extending from Little Meg Creek in the south to The Larches in the north, and groundwater takes from within the much larger Wanaka Basin-Cardrona gravel aquifer.

### *Cardrona alluvial ribbon aquifer*

Groundwater takes from within this aquifer are managed as surface water, subject to the surface water allocation regime, and any minimum flow. Water from within this aquifer is currently taken by two consented groundwater takes. Use of groundwater within the aquifer is currently confined to communal water supply, commercial water supply and water for irrigation of consented 0.21 million m<sup>3</sup>/y.

*Wanaka Basin -Cardrona gravel aquifer*

Water from within this aquifer is currently taken by approximately 290 registered bores and 55 consented consumptive groundwater takes. The current aquifer allocation of groundwater by resource consents is estimated to be around 4.2 million m<sup>3</sup>/y.



## FURTHER INFORMATION

growOTAGO (2004)	growOTAGO project. <a href="http://www.growotago.orc.govt.nz">www.growotago.orc.govt.nz</a>
Otago Regional Council (2011)	Integrated Water Resource Management for the Cardrona River
Otago Regional Council (2007)	The Water Resources of the Cardrona River
Otago Regional Council (2004)	Regional Plan: Water for Otago
Kai Tahu ki Otago (2005)	Natural Resource Management Plan
LINZ (1999)	Crown Pastoral Lease Tenure Review Eastburn and Waitiri – Fish and Game Report
LINZ (October 2002)	Crown Pastoral Lease Tenure Review Waitiri Station – Conservation Resources Report
LINZ (October 2002)	Crown Pastoral Lease Tenure Review The Larches – Conservation Resources Report
Ngai Tahu ki Murihiku (2008)	Natural Resource and Environmental Iwi Management Plan
MAF (April 2004)	The Economic Value of Irrigation in New Zealand. MAF Technical Paper No. 04/01
MAF (July 2004)	Water Programme of Action: Potential Water Bodies of National Importance for Recreational Value - Technical Working Paper
Unwin, M. (April 2009)	Angler usage of lakes and river fishers managed by Fish and Game New Zealand: Results from the 2007/00 National Angling Survey. NIWA Client Report CHC2009-046