OPUS

Ashburton District Council

Water Investigation Project

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Executive Summary

Whilst addressing increasing demand on limited resources, improvements in water efficiency in mid Canterbury are identified in the Canterbury Water Management Strategy (2009) as a key project to aid in meeting community needs and deliver substantially more water for productive purposes. Ashburton District Council's network of stockwater races is identified as both a key issue and an opportunity for the District in the Ashburton Zone Implementation Programme.

Against a background of a changing regulatory environment and to assist the work of the Ashburton Zone committee, Council has investigated whether any unrequired water could be made available through water efficiency improvements and how that water could be used elsewhere within the District to help achieve the objectives of the Ashburton Zone Implementation Programme. The study does not consider the current need for stockwater nor the need to maintain an open race stockwater scheme.

Replacement resource consents were granted in February 2012 with a 20 year duration.

The proposed LWRP proposes a new flow and allocation regime for the Hakatere/Ashburton River with a number of methods to achieve this, including the decrease in stockwater abstraction from the river.

The study confirms that stock consume 4% of the water abstracted for the network and an additional 5% is used for domestic purposes with approximately 745 L/s across the network and 480 L/s for the Hakatere/Ashburton River catchment.

The mean abstraction rate for each of the main intakes ranges between approximately 50% to 70% of the maximum consented historical rate. The total combined abstraction represents 60% of the current consented maximum for both the monitored takes and those abstractions just from the Hakatere/Ashburton River catchment.

The study finds that generally less water is taken than actually consented. Therefore, reducing the maximum consented abstraction to reflect actual abstraction would effectively release only 'paper water' - water which is not actually being abstracted and is already available at source. The exception would be for short periods during the summer months when abstraction is at the maximum consented rate due to high stockwater demand. Therefore, gains at source will only be achieved if consented limits are reduced below actual abstraction rates.

For the Hakatere/Ashburton River catchment, 1,785 L/s of the current consented rate of take is, on average across the year, not being abstracted from the catchment, being paper water already available at source. It is noted that this figure does not account for seasonal variations where less water is likely to be available at source during the peak summer period due to higher abstraction rates.

Provided stockwater and domestic uses can be delivered by another means with 100% efficiency, approximately 60% of the water currently abstracted is potentially available with 95% reliability. An analysis of the largest abstractions shows that 3,670 L/s is potentially available for other uses and 2,450 L/s from the Hakatere/Ashburton River catchment.

Consistent with previous studies, only small gains in efficiency are possible without converting the open races to a piped network.

Integrating stockwater with irrigation networks is worth considering. However, there are some constraints in doing so.

Low flow trials show that the open race network is not viable at reduced flow as water will not make it to the extremities of the network and service will be lost.

Irrigation use is the only use with potential to generate revenue to offset the costs of piping the network. A transfer of water for irrigation use is possible. However, given proposed Rule 5.107 of the LWRP, ADC would need to consider 'gifting' something back to environmental needs as a first order priority. An analysis of the conditions of Rule 5.107 and the matters to which the Regional Council has restricted its discretion, is set out in the report.

Alternative sources of water are explored. However, groundwater is the only alternative that would be able to supply the required quantity and provide a reliable and clean supply for both stockwater and potable supply. An analysis of the rules and policies relevant to the abstraction of groundwater is then provided.

Potential impacts of closing the races for a piped network are considered with likely effects arising from the loss of groundwater recharge on shallow bores and surface water, and potential effects on aquatic and terrestrial species.

A number of potential uses of the available water are considered. Subject to preliminary designs and the ability to transfer the quantities needed, the economic analysis suggests, using conservative estimates, that piping the network is viable if water can be transferred for irrigation uses to offset the costs of piping the network.

Decreasing the stockwater abstraction to leave water in the Hakatere/Ashburton River is one of several measures aimed at increasing flows in the River. Surrendering water back to the River would align with gifting something back to the environment.

The Ashburton ZIP identifies and recognises the need to manage the water races for a multiple of uses including for biodiversity opportunities. It is recommended that ADC continue to pursue the recommended actions in the ZIP and comply with conditions of their consent to undertake ecological assessments to identify any areas of high biodiversity value within the races.

Set against a background of the existence of this 100 year activity, and a continuing trend of dairy conversions with farmers resorting to accessing groundwater, there may be a middle ground that can be reached. Races are continuing to be closed with approximately one third of the scheme closed over the last eight years. Assuming this trend continues, this leads to consideration as to whether the network can be rationalised and the network progressively piped.

A balance needs to be found with some of the water being released back to the rivers and/or provided for community benefit to assist the regional environmental objectives, and a reduced amount made available for irrigation, but still adequate to fund an alternative stockwater scheme and irrigation network. Further work and negotiation is required to establish where the appropriate balance lies.

1 Introduction

1.1 Introduction

Water is vital to the Ashburton District's economic, social and environmental wellbeing. Agriculture and associated support services and industry are a major contributor to the primary sector and economy of the Ashburton District, as well as the wider Canterbury region and at the national level in general. Access to, security of supply and the wise use of water resources is essential for continued sustainable development.

The Ashburton District Council (ADC) operates and maintains an extensive open stockwater race network of 2,400km, supplying approximately 233,000 hectares (ha) of land and approximately 1,800 properties within the District. The network is the largest stockwater network in Canterbury. ADC further provides 14 potable water supplies serving over 10,000 properties.

Improvements in water efficiency in mid Canterbury are identified in the Canterbury Water Management Strategy (2009) (CWMS) as a key project, in combination with others, to aid in meeting community needs and deliver substantially more water for productive purposes.

Priority outcomes of the District as identified in the Ashburton Zone Implementation Programme (ZIP) (n.d.) include the Hakatere/Ashburton River, ecosystem health and biodiversity, water quality and water quantity. ADC's network of stockwater races is identified both as a key issue and as an opportunity for the District and consequently is a recommended action for investigation. The Ashburton ZIP states the future of the stockwater schemes '*will depend on the necessity of the supply, affordability of alternative means of supply and the extent of the network's contributions to the CWMS goals and targets.*' (p.10).

1.2 Context to the Study

There are three key documents concerning water management in Canterbury. The CWMS takes a collaborative and integrated approach providing long term direction for the management of Canterbury water and is a strategic response to increasing demand on limited resources. The Strategy has led to the need for local decision making to address local land and water management issues culminating in Zone Implementation Programmes or ZIPs. These local programmes identify environmental outcomes which can be achieved in part by the setting of sub-regional rules and policies in the recently notified proposed Land and Water Regional Plan (LWRP).

Canterbury Water Management Strategy

Over the last decade, water quantity has been a primary concern for water management in Canterbury with increased groundwater abstractions following farm conversions to dairying and groundwater zones reaching sustainable limits in quantity terms, presenting challenges for lowland streams and ecosystems. More recently, water quality of both ground and surface water resources has been a significant and pressing issue and this is firmly addressed in the Canterbury Regional Council's (the Regional Council) proposed LWRP.

The CWMS is a non-statutory leadership document published in November 2009. Under the ECan Act (2012), the Regional Council is required to have regard to the vision and principles of the CWMS with respect to its regional plans and policy statements.

The CWMS sets the vision for Canterbury water and forges a paradigm shift in water management focussed on integrated management with a holistic approach to land and water management. Responsibility to improve how water is used falls to both existing and new users. The vision of the CWMS is *"to enable present and future generations to gain the greatest social, economic, recreational and cultural benefits from Canterbury's water resources within an environmentally sustainable framework"* (p6).

Underpinning the Strategy are fundamental principles to ensure the water resource is managed sustainably. Environment, customary use, community supplies and stockwater are identified as first order priorities within this set of principles. Other uses are identified as second order priorities: irrigation, renewable electricity generation, recreation and amenity.

Implementation of the Strategy will be measured by progress against identified targets relating to:

- drinking water
- irrigated land area
- energy security and efficiency
- ecosystem health/biodiversity
- water use efficiency
- kaitiakitanga
- regional and national economic growth
- natural character of braided rivers
- recreational and amenity opportunities.

The CWMS has created ten water management zones and established working committees for each zone comprising key stakeholders and community representatives. The purpose of these committees is to develop non-statutory implementation plans, called a Zone Implementation Programme (ZIP) to address local environmental concerns, including *inter alia* ecosystem protection and restoration, investment in new infrastructure, water allocation, land management practices and water use efficiency. The committees are tasked with identifying and recommending actions and approaches for integrated water management solutions to achieve the CWMS. Recommendations will inform the proposed LWRP.

In addition to the zones, a regional level of integrated management called a Regional Implementation Programme (RIP) ensures regional issues common across Canterbury are captured and addressed. This level of management has vertical relationship with central government by way of the National Land and Water Forum and the National Policy Statement for Freshwater Management (2011). The RIP identifies four regional priority issues: kaitiakitanga, ecosystem health and biodiversity, land use and water quality, and regional infrastructure. The RIP identifies a forward work programme providing advice and guidance to the development of the proposed LWRP.

Both the RIP and ZIPs are living documents.

Asbhurton Zone Implementation Programme

The Ashburton zone covers the area between the Main Divide and the coast with the Rakaia River forming the northern boundary and the Rangitata River to the south. The Ashburton ZIP was completed in late 2011 and is recognised as a 'first cut' in prioritising CWMS targets relevant to the zone. The implication of the ZIP to ADC will need to be considered through future long term plan and annual plan development. Recommendations of the ZIP will inform the proposed LWRP.

The ZIP identifies outcomes, priorities and recommended actions for local water management and in particular, the management of flows in the Ashburton and Hinds River catchments and of water quality. The ZIP seeks to achieve four priority outcomes:

- Hakatere/Ashburton River – improved and protected natural character and mauri
- Ecosystem health and biodiversity – protected and improved
- Water quality – protected and improved
- Water quantity – efficiently used, and secure and reliable supply of water.

The ZIP (n.d.) notes that in 2007, 37% of Ashburton's GDP was from agriculture and meat and vegetable processing industries. Changes to farming practices with increased irrigation in recent years has led to dairy farm conversions and to increases in the growing of vegetables and seeds, all of which require high quality water.

Land and Water Regional Plan

The Regional Council has prepared a new regional plan. The LWRP was notified in August 2012 and will replace Chapters 1 and 4 to 8 of the Natural Resources Regional Plan (NRRP). It provides a framework enabling implementation of the CWMS and decisions on the proposed Plan must have particular regard to the vision and principles of the Strategy. The proposed LWRP provides an integrated approach to the management of land and water resources, providing greater direction on appropriate resource management outcomes.

The proposed LWRP provides a two tier approach to water management in Canterbury. It sets out region wide objectives, policies and rules with linkages to the RIP. It then sets out sub-regional policies and rules providing catchment specific rules linked to the relevant ZIP as the foundation document. The sub-regional chapters of the proposed LWRP will be added to the Plan over time as work on each ZIP is completed. The region wide policies and rules are applicable until such time as the sub-regional policies and rules are included in the Plan.

The Ashburton sub-regional chapter introduces increased minimum flows for the Hakatere/Ashburton River and a water allocation regime to achieve the priority outcomes identified in the ZIP, with benefits for in-stream values, water efficiency and reliability of supply. It is proposed that the changes in the flow regime occur over time so that the impact on existing activities is minimal.

Purpose of the study

Against this background of a changing regulatory environment and to assist the work of the Ashburton Zone committee, Opus has investigated whether any water could be made available primarily within the stockwater network. The purpose of this study is as follows:

1. Identify any unrequired water within ADC's existing water services that could be made available for ZIP targets and/or other productive purposes.
2. Identify physical works and cost estimates that can reduce the amount of water required for ADC's services.
3. Investigate combining stockwater with irrigation schemes as an example of achieving water efficiency.
4. Identify impacts on groundwater from race closures and potential piping of races.
5. Explore water trading and revenue opportunities any unrequired water may provide.
6. Identify environmental or biodiversity benefits in the Ashburton ZIP that could be achieved by application of any identified unused water.

This study does not consider the current need for stockwater nor the need to maintain an open race stockwater scheme. Therefore, surveys of those who currently source water from the network have not been undertaken as part of this study. The primary purpose of the study is to identify any unrequired water that could be made available through water efficiency improvements and how that water could be used elsewhere within the District to help achieve the objectives of the ZIP.

2 Background

2.1 History of Water Races in Canterbury

Much of the history of the stockwater races is documented elsewhere within numerous reports. A good summary is provided in ADC's resource consent application (Opus, 2001) for replacement consents for the stockwater race network. The consent application states that details of the history of the races are largely sourced from a Canterbury University thesis prepared in 1952 by B.W. Leadley, entitled *"Stock Water Races in Ashburton County: Their Contribution to Development"*. As the history provides a context for this study, a summary from the consent application is provided below.

For the early settlers of Canterbury in the 1840-50's, the Canterbury setting translated to a vast, dry and largely barren land. Due to a lack of access to water, settlement based around intensive agriculture was not possible. Early run-holders ran very little stock over large areas of land, and wool was the only viable product from the land in these initial years.

As more settlers arrived and different markets opened up, expansion into the meat and wheat markets occurred. These more intensive forms of farming required a ready source of water. The very first races were constructed in the early to mid 1860's. As individual races began to appear, run-holders collaborated and began to connect and expand their races, forming race schemes.

The races heralded a new change in farming practice in Canterbury, with a shift from extensive pastoralism to arable forms of farming. The intensity of farming increased and subdivision of the larger runs occurred. By about 1915, the main sections of the stockwater race network across Canterbury were significantly finished. Such is the age of some of the races that the Historic Places Act (1993) has relevance to their modification as a pre-1900 structure.

The stockwater races now form an established part of the Canterbury Plains, both in geographic/landscape sense and in an economic/land use sense. In the Report and Final Decision (2009) for the replacement stockwater consents, Hearing Commissioner Bob Batty concluded (para 4.9) *'that the ADC stockwater scheme was an 'embedded' part of the existing environment in terms of its relationship and effects upon the social and economic characteristics of the communities it serves as well as the nature of the water, soil and ecosystems that have developed in consequence of its operations'*.

The network today faces increased pressure from other resource users including recreational, cultural, fisheries and wildlife interests (ADC, 2008).

2.2 General Overview of the Races Today

The stockwater network is primarily a gravity fed open race system, although there are a number of areas serviced by piped systems. This network services an area of the Canterbury plains that extends from the Rakaia River in the north to the Rangitata River in the south (Figure 2.1). The Council also provides stockwater via two piped schemes in Methven/Springfield and Montalto areas. These schemes are also used for household purposes and are treated to provide potable water.

The network of water races comprises five separate schemes (Figure 2.2) which service a combined gross area of approximately 233,000 ha. The five schemes are:

- Methven/Lauriston - located in the northwest part of the District.
- Winchmore/Rakaia - located northeast of the Ashburton township and at the "bottom" of the ADC race water network.
- Mount Somers/Willowby - located in the centre of the District.
- Montalto/Hinds - located to the south of Mt Somers/Willowby.
- Acton - located south of the Rakaia River and east of Winchmore/Rakaia.

Collectively these five schemes serve approximately 1,800 individual properties.

The ADC network is the largest stockwater network in Canterbury. It consists of approximately 2,400 km of water races (472 km of main races and 1,927 km of minor races) with ADC responsible for maintaining the majority of the main races. There are 27 intakes, including one from the Rangitata Diversion Race (RDR) at Klondyke and the Acton intake which is operated and managed by Acton Irrigation Ltd. Ten of these 27 abstractions are from Hakatere/Ashburton River system.

The Mt Somers/Willowby scheme has the greatest number of intakes and accounts for the largest percentage of the overall water taken. There is limited connectivity between the schemes except for the Methven/Lauriston scheme which discharges into the Winchmore/Rakaia scheme through the network of races in its lower reaches. Stockwater in the Montalto/Hinds scheme is also augmented by water from the RDR via the Klondyke intake (Opus, 2011). Table 2.1 sets out the total rates of abstraction for each water source. The total abstraction is 8,281 L/s. Consent conditions allow the intake at Methven Auxilliary to increase by 500 L/s provided the Pudding Hill tributary intake is reduced accordingly by the same amount. The Cracroft intake also allows a higher flow for a period not exceeding 14 days, otherwise there are no conditions restricting the abstractions at any of the intakes.

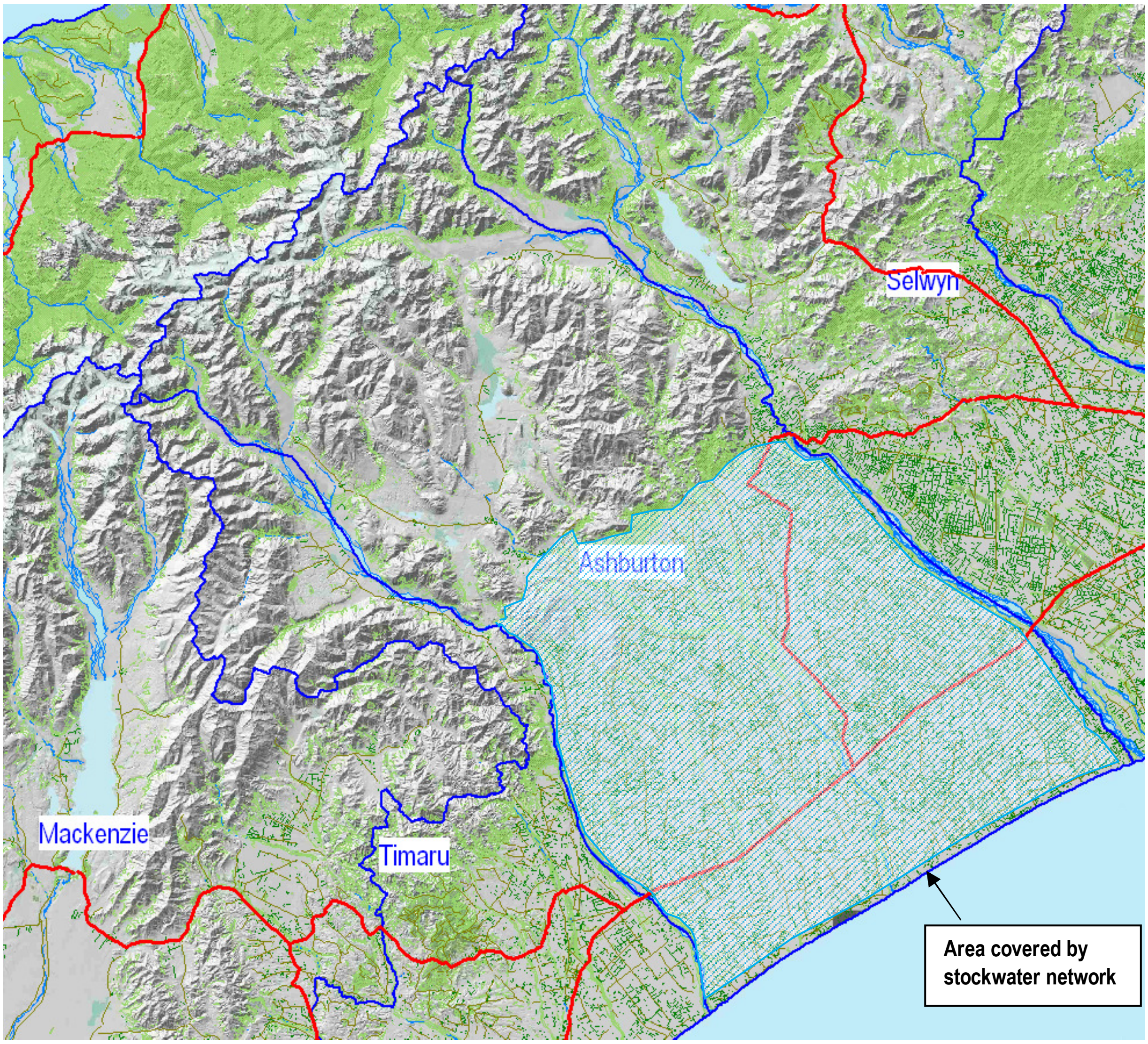

Figure 2.1: Location of the Ashburton District stockwater race network

Source: Opus (2011)

Figure 2.2: Components and boundaries of the major schemes within the ADC stockwater race network

Source: Opus (2011)

Table 2.1: Stockwater sources

Water Source	Rate (L/s)
Ashburton River North Branch	1300 (or 1800)
Ashburton River South Branch	1955
Ashburton River tributaries	1310 (or 810)
Winchmore (Ashburton River springs)	790
Total abstractions from Ashburton catchment	**5355**
Rangitata River and catchment	1115/849
Limestone Creek (Hinds River catchment)	50
Acton Irrigation Scheme (Rakia River)	680
RDR	230
Springs	160
Drains	691
Total of all abstractions	**8281**

There are also some 100 discharge points into river beds, drains, soak pits and the coastal marine area at the distal end of the various race networks. The discharges of unused water are commonly for a maximum rate of 10 L/s.

Approximately 449 km of main race is operated and maintained by ADC and a further 23 km is operated by Acton Irrigation Ltd. The remaining minor races are operated by ADC, but maintenance is the responsibility of the property owners. ADC's requirements with respect to the maintenance of the races is supported by the Ashburton District Council Bylaws (n.d.) and the Water Race Management Plan (2008). Figure 2.3 shows the scheme as it is today with approximately one third of the network closed over recent years.

The day to day management of each of the schemes is carried out by four water rangers. Each ranger is responsible for organising maintenance and capital work, monitoring flows, enforcing stockwater bylaws and managing the overall operation of their scheme (Opus, 2011).

ADC is actively pursuing race network rationalisation and improved hydraulic management within the stockwater network. Until recently ADC had a target of reducing the length of the stockwater races by 100 km per year. This target has been removed in ADC's Long Term Plan 2012-2022 to consider race closure on a case by case basis. In 2004, ADC's submission on the Regional Council's NRRP (2012), reported that the network comprised 3,600km of races. Today, this has reduced to 2,400km, a reduction of 1,200km over eight years.

A continued reduction in races is likely as more properties convert to dairy farming requiring higher quality water due to access to the races by dry stock areas and dairy support farms, and the desire to remove races from paddocks for management requirements. However, it is noted that it is becoming more difficult to close large sections of the network with many of the closures to date being considered as the 'low hanging fruit'.

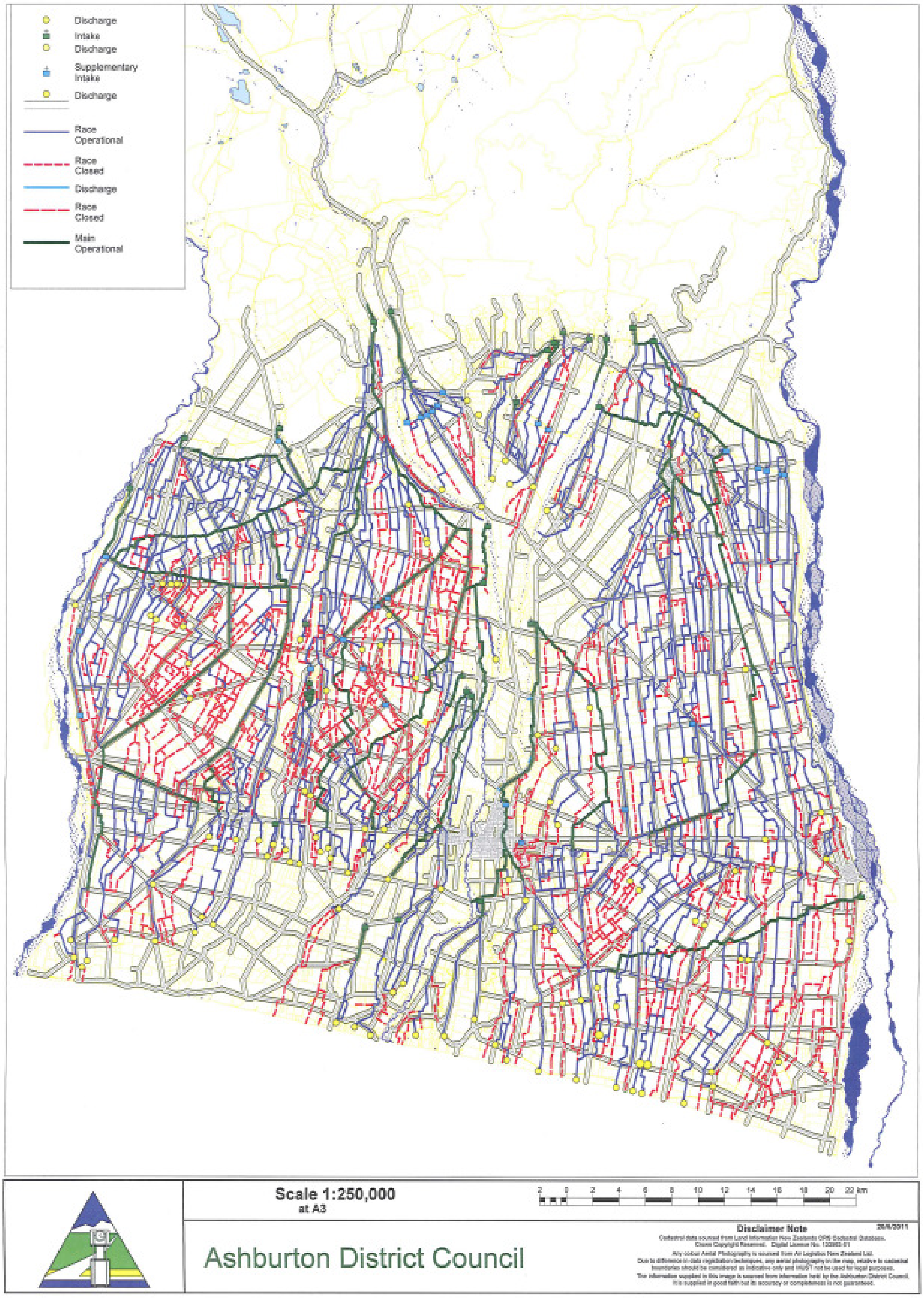

Figure 2.3: Map of the network

Source: ADC (2012)

2.3 Existing Water Usage of the Races

Data from Statistics NZ (2004) showed that the 'plains' area of Ashburton District supported around 1 million sheep, 90,000 beef cattle, and a lesser number of other livestock. Dairy cows were not included in the study but likely now make up a significant number of stock units. ADC's State of the Community Report (2009) states that between 2002 and 2007, there was an increase of 28% in the number of dairy cows in the District. The stockwater race system also provides domestic water supplies in some areas, water for firefighting and some household garden supply.

The 2009 Hearing Decision stated that a 2002 survey found that 74% of 1,370 surveyed customers of the stockwater scheme used the water for its primary purpose as stockwater and 17% for household use. It was noted that the open races are susceptible to contamination and the quality of the water was therefore not suitable for domestic purposes.

The stockwater network also provides instream values and a contribution to amenity values of the area. The races provide a strip of greenery and biodiversity in what would otherwise be a dry and waterless area.

In considering the stockwater race system, the reliability of supply is of primary importance. Farmers are legally required to maintain '*proper and sufficient*' water for animals by the Animal Welfare Act (1999). Livestock farms have animals on them throughout the year and therefore need access to a continuous supply of water. Consequently, the supply of stockwater is distinctly different to irrigation water supplies which require a greater volume of water but generally only for a relatively short irrigation season.

2.4 Resource Consents

The Water and Soil Conservation Act (1967) gave priority to domestic supply, stockwater and water for fire-fighting. These provisions were carried over into the Resource Management Act (1991) (RMA) where Section 14(3)(b)(ii) states "*the reasonable needs of an individual's animals for drinking water*" can be taken without the need for resource consent. Section 7(b) of the RMA states that all persons exercising functions and powers under the Act shall have particular regard to "*the efficient use and development of natural and physical resources*". While the stockwater scheme is a technically inefficient mechanism for delivering water, it is considered by ADC to be economically efficient for end users of the scheme.

As the abstraction of water serves a stockwater scheme rather than an individual, resource consent from the Regional Council is required. Applications to replace the original resource consents for the stockwater network were lodged in March 2001. Resource consents were granted in February 2012 for a total take of 8,281 L/s recognising additional flow in the races during river freshes and the delay in manually adjusting the gates to the network. However, since these applications were lodged (over ten years ago), some of the races and therefore abstraction points have closed or are due to close, including:

- Russells Drain (Dawsons Road) 20 L/s
- McFarlanes Terrace (North Ashburton River) 100 L/s
- Clearwell Springs West and East Intake (springs of the Ashburton River) 100 L/s.

The resource consents were granted for a duration of 20 years. This was considered an incentive to secure more efficient use of the water resource and an overall reduction in the volume of water utilised by the scheme. A 20 year timeframe was considered of sufficient duration to plan for any replacement infrastructure and to identify areas where the races might be the only practicable option to deliver stockwater.

Although considered part of the existing environment and the recognition of the economic significance to the District, the Commissioner cautioned that under the current environment of water shortage, the scheme '*would be most unlikely to be adopted as being an acceptable or environmentally sustainable method for the longer term*' (Batty, 2009, para 4.11).

2.5 Potable Water Supply

There are 14 potable water supplies in the Ashburton District serving approximately 10,000 homes and businesses. These schemes obtain water from a variety of surface (five schemes) and groundwater (nine schemes) sources, provide treatment where necessary and distribute the water through a piped network to customers. Montalto, Winchmore and Dromore also provide stockwater. Approximately 1,500 households, predominantly in rural areas, obtain their water from other sources including private community schemes, private wells, stockwater races or rain water tanks.

ADC maintains the supply networks and facilities to ensure they are reliable, available and provide an acceptable level of service. The potable water supplies serve the following properties:

Table 2.2: Potable supply

Scheme	Properties Served
Ashburton	8,150
Methven	916
Rakaia	434
Lake Hood	140
Hinds	115
Mt Somers	95
Methven/Springfield	68
Chertsey	68
Fairton	67
Mayfied	62
Hakatere	58
Dromore	36
Montalto	34
Winchmore	20

Source: ADC Long Term Plan 2012-2022

The Ashburton ZIP notes that water quality of potable supply in the urban area is high. Most rural supplies have had recent upgrades except Mt Somers, Chertsey, Methven/Springfield and Montalto. These remaining supplies are proposed to be upgraded in the future.

Rural properties that cannot presently access good quality domestic supplies could in some cases be connected to one of the existing potable schemes. However, some are likely to be located where there is no nearby potable scheme or other sufficient source available. For these cases, a point-of-use treatment system may be the most cost-effective and appropriate option.

It is unlikely that any significant quantities of water could be saved from ADC's potable schemes in the rural areas. Generally, these schemes are piped and are small - most with capacity of 30 L/s or less each. Potable supply within the District is formally managed and upgraded parallel with development. Many of these supplies are operated with little margin during the summer. Leakage is often of more operational concern in these schemes as a small leak (e.g. 0.5 L/s) can still be significant and be enough to run a smaller scheme out of water. For these reasons, potable supply is considered to be efficient and not investigated further within this study with respect to water efficiency.

2.6 Water Resources of the Ashburton Zone

A comprehensive description of the Ashburton zone is provided in the Ashburton ZIP. A summary of the main points are:

Rivers, hapua and wetlands
The Rakaia, Ashburton and Rangitata Rivers provide outstanding habitat for rare birds, fish, plants and recreational values. A number of foothill streams with associated bush remnants provide valuable recreational and ecological opportunities. The Ashburton Lakes Basin, Hakatere Conservation Park and mid to upper Rangaitata and Rakaia Valleys contain nationally significant wetlands, high country lakes, intermontane streams, braided river and dryland habitats and provide a highly unmodified landscape. Hapua/Coastal lagoons, springs and streams provide native fish and bird habitat, and native saltmarsh and freshwater vegetation.

Birds, Fish Invertebrates and Plants
The rivers and lakes provide the largest habitat for aquatic birdlife in New Zealand with over 70,000 ha and 40,000 birds. The Hakatere/Ashburton River catchment supports the threatened Canterbury mudfish and the koura. The Rakaia River is recognised as a 'Waters of National Importance for Biodiversity'. Lowland streams, irrigation canals, stockwater raceways and drainage networks provide important habitat for remaining native fish, invertebrate and bird populations, and plant species.

Kaitiakitanga
All the waterways and associated tributaries, wetlands and springs are considered significant resources of cultural, spiritual and historical importance to Ngai Tahu.

Recreation
Rivers and lakes in the zone provide recreational opportunities, enabling enjoyment, healthy exercise, educational experiences and positive economic benefits, including both instream and out of stream activities. The rivers and lakes also provide scenic and landscape values adding quality to recreational experiences. River flows, accessibility and water quality are important issues.

Water quality
Water quality throughout the zone is variable. The Rakaia and Rangitata Rivers and foothill streams generally have high quality water. The Hakatere/Ashburton River has high quality water in the upper North and South Branches. However, the lower North Branch and the mainstem downstream of the SH1 Bridge are unsafe for swimming. Stockwater races are noted to be highly enriched with nutrients and faecal contamination but do support a fairly healthy aquatic ecology and fish habitat. Groundwater in the northern coastal part of the zone is enriched with nitrate-nitrogen from various discharge sources and intensified land uses.

Water quantity

Parts of the Ashburton zone have exceeded or are close to reaching the limits of sustainable water use. Further irrigation is dependent on increasing water efficiency, redistribution of water where there is ample supply, water harvesting and storage, and tapping into out of district water resources.

The Ashburton zone is also subject to two water conservation orders: Rakaia River (1988) and Rangitata River (2006 and as amended 2012). The orders require that certain specified flows are maintained. The Hakatere/Ashburton River is also a Statutory Acknowledgement Area under the Ngai Tahu Claims Settlement Act (1998).

The ZIP notes that the rivers and wetlands, and associated groundwaters have been seriously altered by abstraction. Of the ten water management zones across Canterbury, the Ashburton zone has the greatest daily groundwater and surface water allocation. The groundwater allocation is equivalent to 40% of the total volume of water allocated in the region, and surface water allocation is equivalent to 39% of the total allocated volume of water in Canterbury (Tricker, et.al., 2012).

The proposed LWRP states that most rivers in Canterbury are at or near full allocation for reliable 'run of river' takes. Many groundwater zones are also at or over allocation limits for abstraction. With the exception of the Mayfield Hinds area, the groundwater resource in the remainder of the Ashburton District is a red zone (see Figure 2.4 below) where abstractions exceed resource availability. Surface water abstraction is also limited with no new abstractions to be granted from the Hakatere/Ashburton River until the minimum flow at the SH1 Bridge is 10,000 L/s.

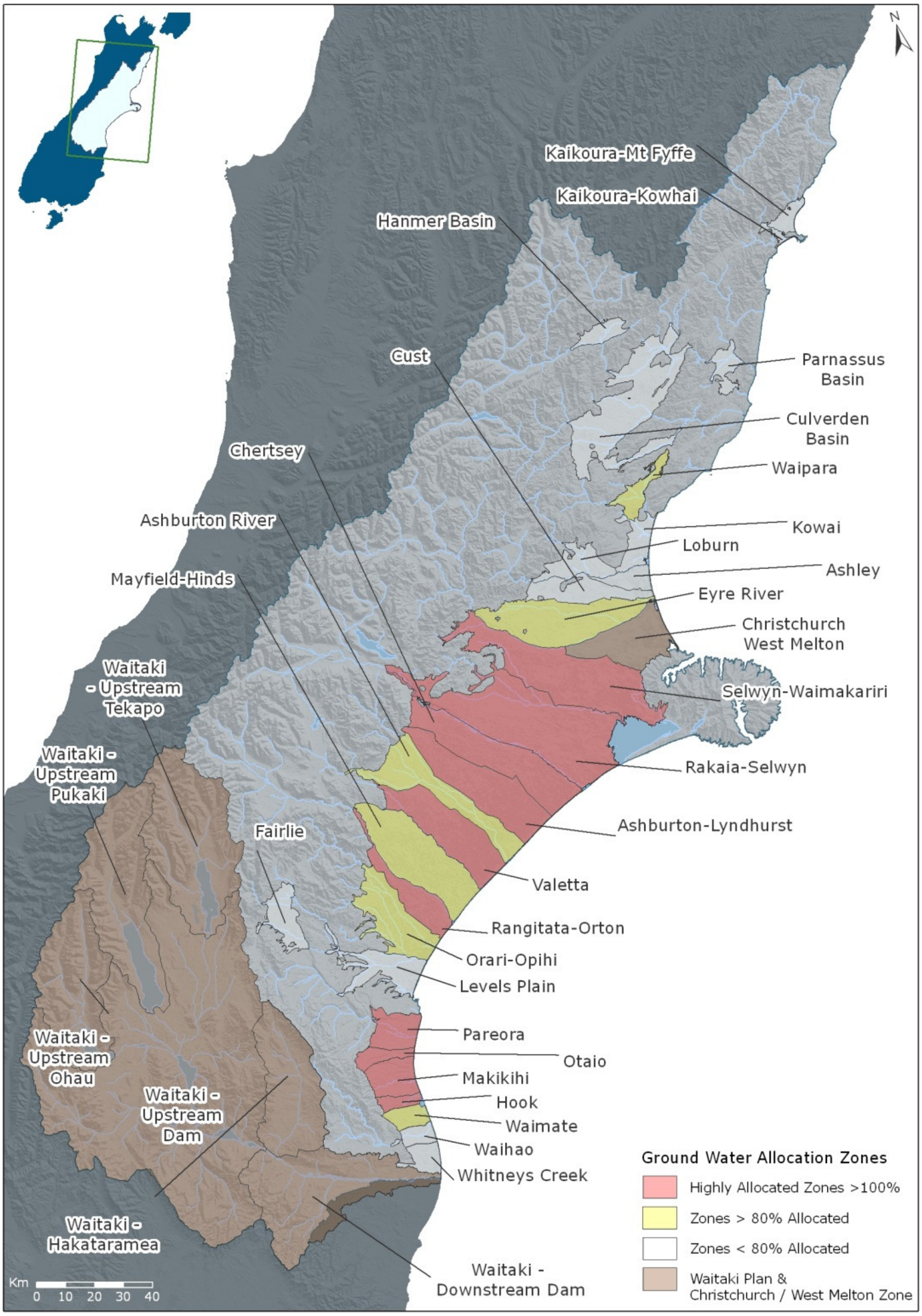

Figure 2.4: Canterbury groundwater zones

Source: ECan (n.d.)

Ashburton River water allocation regime

The sub-regional section of the proposed LWRP for the Ashburton zone specifies under Policy 13.4.1 that no new surface water permits will be granted from the Hakatere/Ashburton River catchment except for the replacement of existing water permits that expire. Therefore, any new applications for surface water abstraction would be considered by the Regional Council for decline under this rule. However, the new plan will allow for more allocation of water under 'B' block when the 'A' block minimum flow is increased to 10,000 L/s in 2022.

Differences between existing minimum flows under the operative NRRP and proposed minimum flows set out in the proposed LWRP are set out in Table 2.3.

Table 2.3: Ashburton River minimum flows (m^3/s)

Month	Existing 50% Reduction in Allocation	Existing Minimum Flow (NRRP)	Proposed Minimum Flow (LWRP)	
			2012	2022
January	5.0	4.5	6.0	10.0
February	4.0	3.5	6.0	10.0
March	4.0	3.5	6.0	10.0
April	5.5	5.0	6.0	10.0
May	5.5	5.0	6.0	10.0
June	5.5	5.0	6.0	10.0
July	5.5	5.0	6.0	10.0
August	7.0	6.5	6.0	10.0
September	8.5	8.0	6.0	10.0
October	8.5	8.0	6.0	10.0
November	7.0	6.5	6.0	10.0
December	5.5	5.0	6.0	10.0

The NIWA report setting out the basis for the proposed Hakatere/Ashburton River flow regime was unavailable at the time of writing this report. However, it is understood that the proposed minimum flows are based on a study by Todd (1992) in which it was found that northward displacement of the river mouth often led to prolonged periods of mouth closure and therefore, prolonged restriction of fish passage, a sizeable beach barrier with subsequent flooding of adjacent lower river channels during high river flows, and accelerated erosion of coastal cliffs. It was suggested that river flows may be critical for mouth closure. Conclusions of that study showed, *inter alia*, that an open mouth can be maintained if river flows are continually above $6m^3/s$ and that flows of $10m^3/s$ are required if extreme northward mouth migration is to be avoided for the reasons noted.

Todd (1992) considered that flow restrictions on water users or flow enhancement would be required to achieve these flows but advised that these measures may not necessarily ensure that natural flows would be maintained above the levels stated.

The Hakatere/Ashburton River is a key issue for the Ashburton Zone Committee and they have identified three priority outcomes for the River:

- The 'natural' character and mauri of the River is improved and protected to ensure its long term health.
- Key features of the river are protected: the hapua, lagoon, headwaters and spring fed streams are alive, productive and active.
- Sufficient and secure river flows and high quality water is available for recreation, mahinga kai, farming, and instream habitat and species, and to ensure the river mouth is open at key times for fish passage.

Critical periods for spawning and migration of fish including glass eels, whitebait, mahinga kai and sports fisheries are September to November and January to April, although it is noted that at times the river mouth will close naturally. The ZIP also considers it important to protect flows in the North Branch from September/October to mid December.

To achieve these outcomes for the Hakatere/Ashburton River, the proposed LWRP flow and allocation regime introduces a minimum flow of 6,000 L/s at SH1, and in the longer term a minimum flow of 10,000 L/s. Other outcomes to be achieved by the flow regime include the protection of the North Branch flows and in stream habitats, facilitation of alternative water use to reduce pressure of river flows (e.g. groundwater abstractions in exchange for releasing surface water, water harvesting and storage, water sharing), efficient use of water, improved reliability of supply and management of water permits that are transferred.

Obviously not all of these outcomes would be achieved in the short term, but the increase of the current minimum flow to 6,000 L/s across the year is a stepping stone to a longer term goal. It is noted that the proposed year round minimum flow of 6,000 L/s is lower than existing minimum flows from August to November when it would be advantageous to harvest and store spring freshes.

In achieving this long term goal, it is expected that in the short term some surface water abstractors will switch to groundwater, that water sharing will occur and that increasingly in the longer term, new storage projects will assist (e.g., Ashburton Lyndhurst Irrigation Scheme, Mayfield Hinds, Valetta and Barrhill-Chertsey via the RDR).

In addition to this desire to increase the minimum flow of the Hakatere/Ashburton River, Policy 13.4.1 of the proposed LWRP states that: *The taking of water for community stockwater supplies from the Hakatere/Ashburton River from 1 July 2015 will not exceed 2,900 L/s in total.*

Hence, the decrease in stockwater abstraction from the river is seen as an additional tool to increase flows in the river alongside the measures mentioned above. The Regional Council recognises that policies will not be given effect to overnight given that the life of a plan is ten years, but the policies will guide future decision making.

3 Stockwater Use of the Races

While the open water race network is designed to supply stockwater throughout the District, there is no data relating to the actual demand or usage of this water by stock. Little is known of stock numbers, or the mix of stock which are supported by the water race network (note that these numbers are constantly changing as landowners vary their landuse for a variety of reasons). This lack of information acts as a major constraint on the level of analysis and reliability of results relating to the efficiency and effectiveness of the water race network.

The only data available relates to the primary surface flows into and out of the various race networks. All other 'water transactions' relating to the water races are unknown.

At a general level, the stockwater network supplies water to approximately 233,000 ha. The maximum consented take across all 27 intakes is 8,281 L/s. However, the actual amount of water used by stock is significantly less than this as:

- The maximum combined consented rate of abstraction is rarely taken; and
- The stockwater race network is not 100% efficient.

While it is possible to quantify the actual rate of abstraction, quantifying the efficiency of the race network is problematic. Losses from the races vary both spatially and temporally, and so are not constant.

3.1 Stockwater Balance

Opus (2011) attempted to quantify a water balance for the Ashburton stockwater race network. The key elements of that water balance are discussed below.

Water used by livestock

A typical allowance for stockwater is between 72 and 230 L/ha/day depending on stocking rates. An overall estimate of approximately the average of this range i.e. 120 L/ha/day, has been used for the area serviced by the Ashburton stockwater race network.

Domestic uses

Water from the races is also used for domestic irrigation, although the exact volume of water has never been quantified. ADC (2008) recognise that some water race customers are reliant on the races for domestic use. However, domestic use is not a key objective of the water race network and stockwater is not intended for human consumption. Five percent of the total take has been allowed for this domestic usage.

Losses

Evaporation Losses

Evaporation losses to the atmosphere occur from the surface area of all water races. In Ashburton District, the 2,400km of races have an assumed average width of 0.5m, providing an estimate of average evaporation losses of 5 mm/day and peak instantaneous losses of 12 mm/day. These evaporation rates are equivalent to a sustained water loss of 69 L/s, and a peak instantaneous flow loss of 210 L/s over the entire network.

Transpiration

Transpiration occurs when plants, hedges and trees alongside the water races draw water from the race and transpire it into the atmosphere. Over the entire Ashburton District stockwater race network the transpiration loss has been assessed at 278 L/s under normal conditions.

Discharges

Water is also discharged from the water race system directly into surface streams, drains, rivers and to the sea. For most of the discharges this is a relatively small volume (up to 10 L/s) but during wet weather these may increase significantly as the races receive surface runoff. Discharges from the water race network have previously been assessed to be approximately 8% of the total water abstracted. However, discharges are thought to have been lowered to 3-5% since the last assessment.

Infiltration Losses

Water is lost to groundwater by seepage from the races. Water is also discharged directly to the ground at the ends of small distributor races. Few field measurements of infiltration losses along the races have been carried out. Such losses are likely to vary both spatially and temporally and so a high degree of scatter would likely be found in any field sampling programme.

The calculation provided in Opus (2011) and summarised in Table 3.1 and Figure 3.1, indicates that approximately 82% of the abstracted water is lost to infiltration. This figure is consistent with 80-90% losses reported by de Joux (2000a & b), and in previous reports where flow measurements were carried out in the Ashburton and Selwyn Districts. Further examination of other studies is set out later in this report. Table 3.1 also sets out the pro-rata consumption figures relevant to abstractions from the Hakatere/Ashburton River catchment.

Table 3.1: Water balance for the stockwater race network

Water Use	Consumption (L/s)	
	Total Network	Ashburton River
Stock Use	330	215
Evaporation	69	45
Transpiration	278	178
Discharges to Drains/Rivers/Sea	414	268
Domestic Uses	414	268
Total Water Used/Discharged	1,505	974
Total Take	8,281	5,355
Infiltration	6,776	4,381

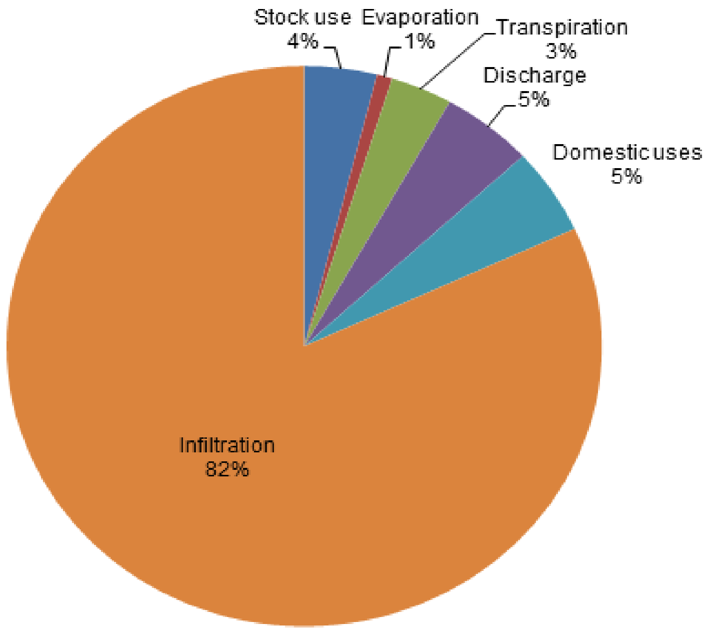

Figure 3.1: Summary of the overall water balance for the stockwater race network

Therefore, despite being a stockwater race network, only about 4% of the water passing into the scheme is actually used as stock drinking water and another 5% for domestic uses. The bulk of the water in the race network is lost to infiltration.

Assuming that this water balance is reasonably representative of average conditions, it suggests that the actual water needs of stock and domestic requirements within the network area could be met with a flow of approximately 745 L/s and 485 L/s for the Hakatere/Ashburton River catchment, provided this water could be delivered with 100% efficiency.

Table 3.2 shows that if the stock drinking water could be delivered with 100% efficiency and the network was limited to only providing for stockwater and water for domestic uses, this would 'free up' approximately 7,540 L/s of water across the entire network and 4,870 L/s from the Hakatere/Ashburton River. This water could then potentially be used for other purposes.

Table 3.2: Potentially available water

Water use	Total Network (L/s)	Ashburton River (L/s)
Total Abstraction	8281	5355
Stock Use	330	215
Domestic Use	414	268
Potentially available water	7,537	4,872

4 Water Abstraction

4.1 Flow Monitoring

Of the 27 abstractions, the largest eight intakes are monitored and recorded. Of these, the Klondyke intake is managed and supplied to ADC by RDR under private agreement. For this reason, the following analysis only considers the seven main abstractions excluding the Klondyke intake. These seven intakes account for approximately 73% (6,045 L/s) of the total maximum consented take. It is noted that the total consented take may reduce slightly in the near future as a result of the small intake and race closures highlighted in Section 2.4 of this report.

The seven main abstractions are:

- Brothers (1,955 L/s)
- Methven Auxilliary (1,200 L/s)
- Cracroft (849 L/s)
- Winchmore (790 L/s)
- Acton (680 L/s)
- Pudding Hill (500 L/s)
- Bushside (71 L/s)

ADC has also recently installed telemetered flow monitoring structures or meters at 14 of the smaller intakes as part of the requirements of the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010. The remaining intakes are expected to have flow monitoring structures and equipment installed in the next year. There is little or no water use data available from these sites at present.

4.2 Flow Data

The flow series for the monitored abstractions, were obtained from Environmental Quality Services Ltd (EQS), ADC's consultant hydrologist and from NIWA (Graeme Horrell, *pers com.*), however, there are differences between the two flow series. It appears that different rating curves have been used by NIWA for certain periods of the record to those provided by EQS and to date no explanation for the adjustment by NIWA has been provided.

As EQS have primary responsibility for the collection of water level data, maintenance of the various flow monitoring sites, flow gauging and of accurate rating curves, and quality assurance, this study has assumed that the data provided by EQS is the more reliable and consistent.

4.3 Individual Abstractions

Appendix I shows the actual volume of water abstracted at each of the main intakes, together with the current maximum consented take. In all cases the mean amount of water abstracted from each site is significantly less than the maximum permitted (noting that some of the consented limits have changed recently). This reflects the nature of water permits when applied to stockwater and irrigation. The maximum consented take reflects the maximum amount of water that will be required under the most extreme circumstances. The need for security of supply, while avoiding breaching consent conditions, requires that the peak demand be sought even if it will only be used on rare occasions and for short durations.

Table 4.1 summarises the amount of water actually abstracted from each of the mainwater takes, together with the current (as of February 2012) maximum consented take at each site. The previously consented abstraction rates are shown in brackets. Increases in abstraction rates were sought in the recent replacement consents to avoid breaching resource consents at times when races carry flash flood flows and there is a time lag to manually adjust the intake gates.

Table 4.1: Actual abstraction rates

Site	Consented maximum (Prior to 2012)	Minimum		Mean		Maximum	
		L/s	%	L/s	%	L/s	%
Brothers	1955 (1699)	154	8 (9)	1222	63 (72)	2645	135 (156)
Methven	1200 (1133)	131	11 (12)	742	62 (65)	1471	123 (130)
Pudding Hill	500 (509)	14	3 (3)	334	67 (66)	642	128 (126)
Bushside	70 (141)	3	4 (2)	69	99 (49)	638	911 (452)
Winchmore	790 (566)	0	0 (0)	395	50 (70)	614	78 (108)
Total for Ashburton River catchment	**4515 (4048)**	**302**	**8 (9)**	**2762**	**61 (68)**	**6010**	**133 (149)**
Cracoft	849 (849)	0	0 (0)	530	62 (62)	1125	133 (133)
Acton*	680 (680)	0	(0)	324	(48)	709	(104)
Total for all takes	**6044 (5577)**	**302**	**5 (5)**	**3616**	**60 (65)**	**7844**	**130 (141)**

* Data not available post March 2010

While the maximum consented abstraction has been exceeded at all sites, these breaches are of short duration. In general, less water is abstracted to support the stockwater race network than is consented. The currently consented maximum abstraction rates have only taken effect since February this year. When compared to the authorised rates of the now expired consents relevant for the monitoring period, the mean abstraction rate for each intake ranges between approximately 50% to 70% of the maximum consented rate.

Most of the occasions when abstraction exceeds the consented amount occur during high flow conditions when the river level rises rapidly and additional water flows into the stockwater intake until the gate is adjusted. Since a manual response is required as there are no automated intake structures on the schemes, this can take some time.

4.4 Combined Abstractions

The total amount of water actually abstracted across all seven monitored intakes compared to the current (6,044 L/s) and historical (5,577 L/s) combined maximum consented rate of those abstractions is shown in Figure 4.1. The actual rate of abstraction for those takes from the Hakatere/Ashburton River catchment is shown in Figure 4.2. Where there is an incomplete set of data across the seven abstractions, the remaining flow records are shown in red on these graphs.

Generally, the total combined abstraction represents 60% of the current consented maximum for both the seven monitored takes (3,738 L/s) and those monitored abstractions only from the Hakatere/Ashburton River catchment (2,730 L/s). Alternative histogram representations are set out in Appendix II. Figure 4.3 represents the seasonal variation in abstraction across all seven intakes in relation to the historical consented flow, i.e., prior to February 2012. Less water is generally taken in winter when demand falls, with peak periods in January, February and March.

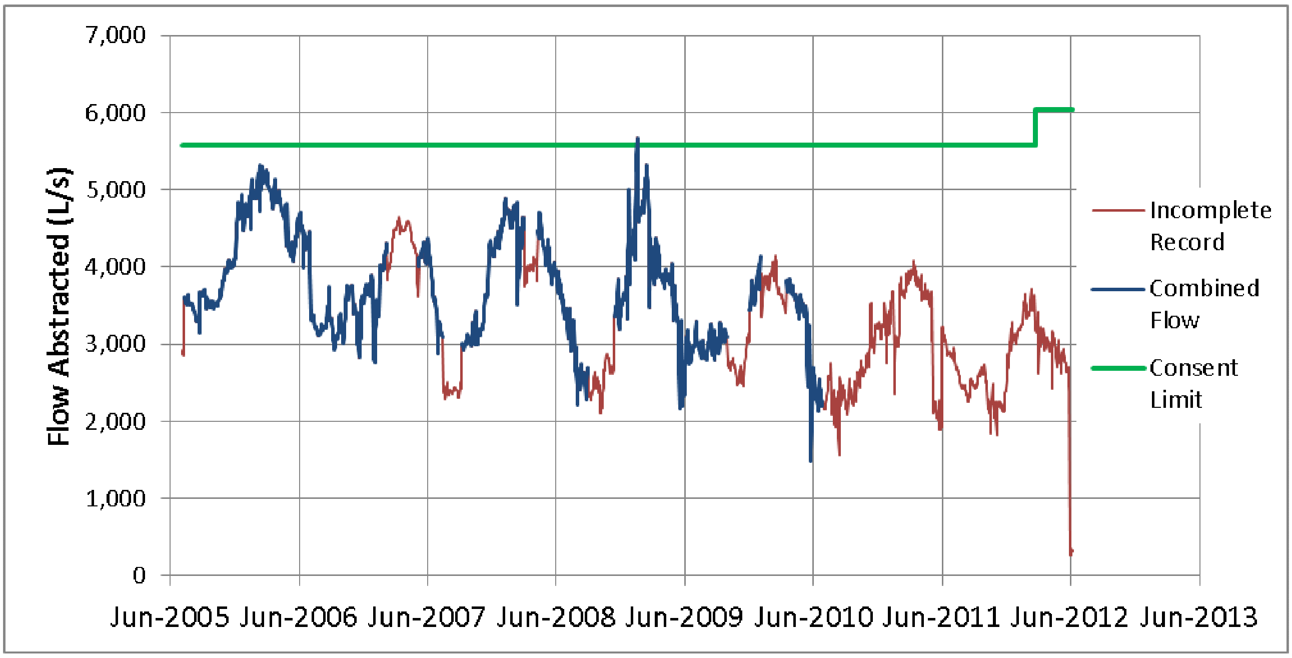

Figure 4.1: Daily abstraction rate across the race network 2005-2012

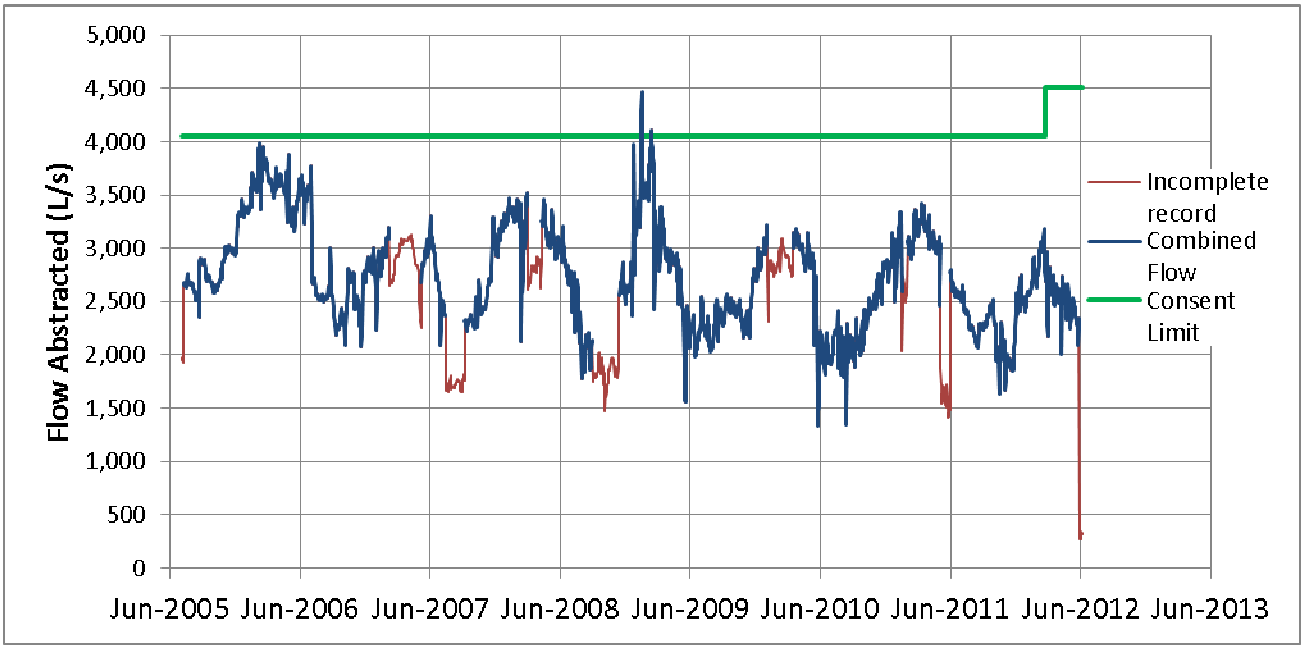

Figure 4.2: Daily abstraction rate from the Ashburton River catchment 2005-2012

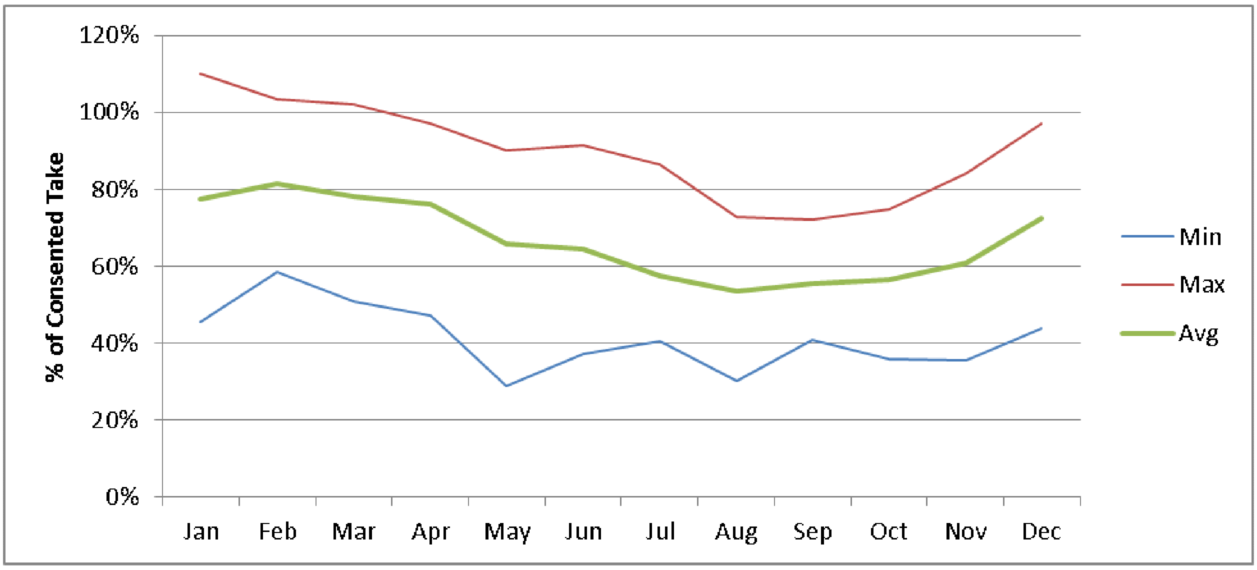

Figure 4.3: Seasonal variation of abstraction rate 2005 - 2012

Since there are limited data available for the other intakes, it is difficult to determine how representative these abstractions are of the total network. If the other intakes are similar in their manner of water supply and operation, the results of this analysis can be simply up-scaled. However, it is more likely that the small intakes have distinctive characteristics and behaviour and are likely to be less reliable during dry periods. Irrespective of the relationship between these intakes and the entire scheme, since these monitored abstractions are the largest takes, they are where changes in operation and efficiency would have the greatest potential impact.

As can be seen in Figures 4.1 and Figure 4.2, generally less water is taken than actually consented. Therefore, reducing the maximum consented abstraction to reflect actual abstraction would not result in a significant change in the amount of water remaining in the various rivers and streams. Such a change would effectively release only 'paper water': water which is only available on paper. This water is not actually being abstracted at present for the majority of the time. Therefore, the water is already available at source except for those short periods when abstraction is at the maximum consented rate due to high stockwater demand. Any increase in the actual amount of water remaining in the rivers and streams should consented rates be reduced, would only occur over those occasional short periods when abstraction is at its maximum consented rate, i.e. gains at source will only be achieved if consented limits are reduced below actual abstraction rates.

With respect to the abstractions from the Hakatere/Ashburton River catchment, the data shows that the actual average take from the monitored sites is 2,730 L/s or 60% of the consented limit of 4,515 L/s for those abstractions from the catchment. This means that 1,785 L/s of the consented rate of take is, on average, not being abstracted from the Hakatere/Ashburton River catchment and is essentially paper water already available at source. However, it is noted that this figure is an average across the year and does not account for seasonal variations where less water is likely to be available at source during the peak summer period due to higher abstraction rates.

4.5 Water Surplus to Stockwater Demand

While a considerable volume of water is abstracted to support the stockwater race network, about 330 L/s is actually required by the stock and a further 400 L/s assumed to be taken for domestic uses. The rest is 'lost' throughout the system. Assuming that the delivery of water was 100% efficient and only stock drinking water and domestic water was provided, then approximately only 565 L/s would need to be abstracted (on a peak day) to meet the domestic and stockwater demand from the 76% of the race network supplied by the seven intakes reviewed. Monitored abstractions from the Hakatere/Ashburton River catchment represent 55% of the overall network and require approximately 410 L/s to provide stockwater and domestic water.

Since the existing abstraction is significantly greater than the amount required only to support stock, there is actually water available which could support alternative activities if the stockwater could be delivered more efficiently. The seasonal variation of the water potentially available to meet other needs based on historical consumption data is shown in Figure 4.4.

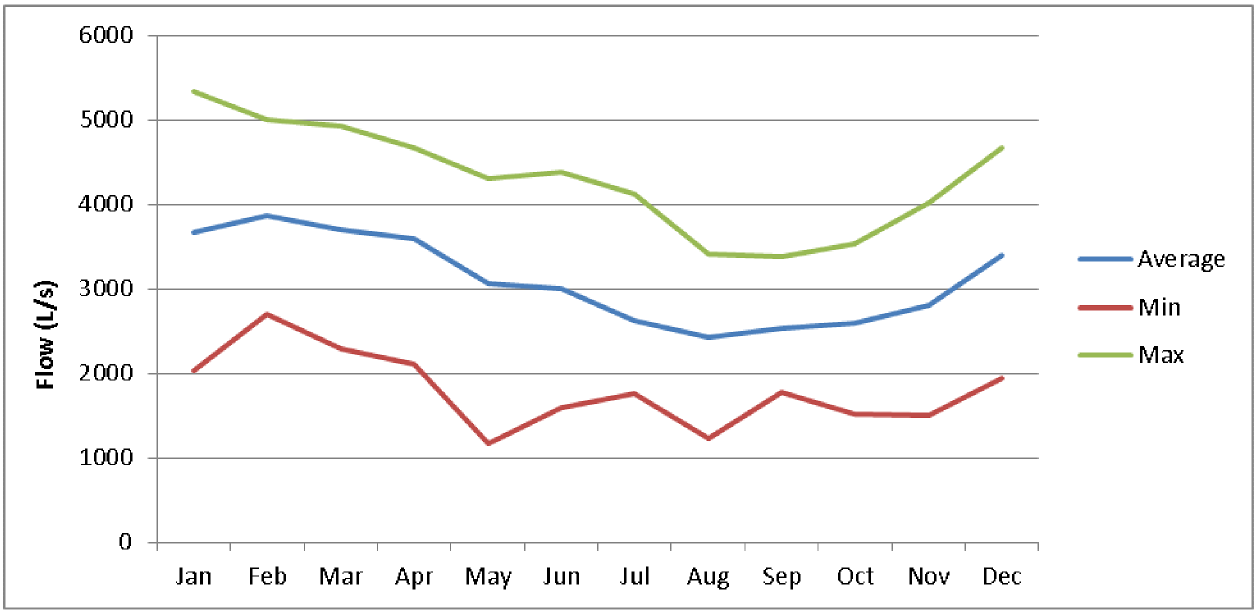

Figure 4.4: Available water relative to actual abstraction 2005-2012

However, more water could actually be available than shown in Figure 4.4 as many of the sources should be able to sustain high abstractions throughout the summer months. The Klondyke abstraction of 230 L/s provided by RDR and not previously included in this analysis would also increase the amount of water potentially available.

Consideration of the 100-year 7-day low flow data (Waugh, 2008) as set out in Table 4.2 for each of the source rivers shows that some of these sources are highly reliable.

Table 4.2: Consented flow compared to 100 year 7 day river low flow

River	River Low Flow (m^3/s)	Consented Flow (m^3/s)	Consent relative to River Flow (%)
North Ashburton (Old Weir)	1.69	1.3	77
South Ashburton (Mt Somers)	2.7	2	74
Rakaia (Fighting Hill)	58	0.7	1
Rangitata (Upstream of RDR take)	32	0.85*	3

* Total abstraction by RDR is approximately 35 m^3/s subject to water restriction levels and minimum flow provisions

The flow data suggests that there would be no shortage of water even in an extremely dry summer for stockwater use as the 100 year river low flows are higher than the water taken by the stockwater intakes for each of those sources; these abstractions currently being unrestricted with respect to minimum flows. It is noted that the flow regimes of the Rakaia River and Rangitata River are usually lowest in late winter as these are fed from the main divide, and do not reduce over summer to the same extent of rivers from the foothills.

A study of the flow reliability records during the peak of the dry season of the sources that supply these main intakes, show that flows are at their highest over the summer months when stockwater scheme demand is highest. During this period, these main abstractions are often operated near to their consented limits (bearing in mind that the limits were lower for most of the intakes until February 2012 when the new consent limits took effect). In winter, the intakes are generally throttled back significantly as the same quantities of water are not required. This suggests that the water sources of the main abstractions generally do not constrain the quantity of water able to be taken up to the maximum consented flow and further reinforces that these intakes could reliably supply water near to their consented flows throughout summer. However, it is noted that significant and/or more frequent instream works may be required to get the water into the stockwater network to obtain these maximum flows.

A qualitative assessment of the water available within the network at 95% reliability has been made incorporating the historical data and the statistics relating to the river flows as set out in Table 4.3. This table considers the seven main monitored takes and the Klondyke abstraction.

Table 4.3: Available water within the network at 95% reliability

Intake	Source	Consented Flow (L/s)	Assessed Available Flow for stockwater (L/s)
Brothers	South Ashburton	1,955	1,200
Methven Auxilliary	North Ashburton	1,200	900
Pudding Hill	Pudding Hill Stream	500	300
Bushside	Taylors Stream	70	60
Winchmore	Springs	790	400
Total for Ashburton Catchment		**4515**	**2860**
Acton	Rakaia	680	550
Klondyke	RDR	230	200
Cracroft	Rangiata	849*	800
Total of all flows		**6,274**	**4,410**

* Rate of flow continuously available under consent; maximum abstraction of 1115 L/s authorised for limited periods

Subtracting 744 L/s for stockwater demand and domestic use across the network assuming provision by another delivery system, means that 3,666 L/s of 6,274 L/s (i.e. 58%) is potentially available from the main takes with 95% reliability for other uses. For the Hakatere/Ashburton catchment, the assessed available water less 483 L/s for stockwater and domestic use, means that 2,377 L/s is available for other uses. These are conservative figures as water that may be available from the other 19 smaller intakes is excluded. Without any flow data from these, it is difficult to quantify availability as many of the sources of these smaller abstractions are expected to be unreliable during the summer months. These figures are further considered conservative given the historical flow data for the main intakes was predominantly obtained when most of the resource consent limits were lower and the intakes operated accordingly.

5 Potential Improvements to the Stockwater Network

5.1 General

There has been considerable discussion in the past regarding the apparent 'inefficiency' of the stockwater race system in delivering water to meet the needs of stock. At the basic level of simply delivering 744 L/s required by stock and domestic uses throughout the area serviced by the network, the race system is inefficient i.e. only about 9% of the water abstracted is actually used. However, the stockwater race system can be considered economically efficient and can serve as an opportunity to provide a wide range of environmental benefits, including habitat diversity and groundwater recharge.

A number of previous studies have investigated options for improving the efficiency of the stockwater race network (Beca, 1994; Opus, 2008; Opus, 2011). These studies have generally concluded that only small gains in efficiency are possible without converting the open races to a piped network. Any gains resulting from increased efficiency are likely to be very small and within the margins of error inherent in current data and information relating to the stockwater race network.

The following options consider improvements based on retention of an open channel scheme.

5.2 Options

As a gravity-fed, open-channel water conveyance system, the stockwater race network is less efficient than a piped system, primarily due to losses resulting from evapotranspiration and infiltration. In addition, the races must follow the hydraulic grade line and this limits the layout efficiency and flexibility. These features which reduce efficiency are common to all open-channel water reticulation systems.

The majority of the 'loss' of water in the system is through infiltration (i.e. 82%). Consequently, the greatest gains in efficiency would come through reducing these infiltration losses. Other potential areas of improvement include decreasing the amount of water discharged at the distal end of the network by controlling the intakes more closely; and reducing the scale of the network (Opus, 2011).

Physical / Design improvements

Reducing infiltration losses

There are several potential means of reducing infiltration losses. These include:

- Reducing the permeability of the channel by installing clay, bentonite or concrete lining;
- Converting the open races to a pipe system in areas of high loss; and
- Increasing the flow velocity in the races by keeping them cleaner (i.e. removing weeds and other growth) and improving their hydraulic efficiency.

Large scale lining of the channels presents a number of problems. These include:

- Capital cost: If concrete is used and only the main races were lined, the capital cost would be in excess of $6 million (depending on method used and assuming average race wetted perimeter of 1m).
- Operational issues: The races will continue to silt up as a result of sediment transported into and through the races. If clay or bentonite lining is used, removing the silt without damaging the lining would be difficult.
- Effectiveness: ADC only manages 449km of the 2,400km network directly. Lining only the main races would therefore only address a small portion of the overall infiltration losses throughout the network. Losses could still potentially occur in the lined sections as a result of leaks through cracks etc. Infiltration losses may therefore still be significant even after lining.

Identifying high loss areas is difficult because it requires detailed and accurate flow gauging at regular intervals along all of the races. Any flow gauging would also have to be completed under stable flow conditions so that any changes in flow can be related solely to infiltration losses. Such an exercise would be extremely time consuming and expensive, and given the inherent accuracy of flow gauging i.e. ±8%, it may not be particularly effective. Given the size of the network, the flows involved and the continually changing nature of flows within the system, such an exercise is not really practical.

Increasing the flow velocity within the races by keeping them clear of vegetation and other obstacles would reduce infiltration losses. However, there is a practical limit to maintenance of these higher velocities as weeds and other obstructions will return relatively quickly. Furthermore, if the velocity is too high the flow will scour and remove any fine sediment or silt which has been deposited within the channel. This fine material helps to decrease the permeability of the bed of the race and therefore reduces infiltration losses (Opus, 2011).

Reducing distal discharges

There are over 100 discharge points at the distal end of the stockwater race network. The long distance between the head of the race and the various discharge points means that any change in the conditions at the intake or upstream may take days to affect the discharge throughout the network. Also, because of the way that stockwater race systems operate, a 10% change to the flow rate in the headwater race may equate to a 50% change in flow within a minor race at the distal end of the network towards the coast.

Rainfall and stormwater runoff interception also mean that discharge flows can fluctuate regardless of the intake flows or conditions further upstream.

Reducing distal discharges is therefore problematic and may not result in any increase in the overall efficiency of the stockwater race network.

RATIONALISATION

As land use in the District has changed, and large irrigation schemes are developed, the requirement for stockwater is decreasing. Dairy farms require water of higher quality, than can be provided by the existing stockwater network. Consequently, alternative water sources have been developed to meet the specific needs of individual water users, including private wells.

Until recently, ADC has implemented a programme aimed at closing at least 100 km of stockwater races each year. Maps of the location of closed races show that these are widely scattered throughout the five stockwater schemes. Because of the dispersed nature of race closures to date, this process is unlikely to have had any noticeable effect on the flows required to operate the stockwater network (Opus, 2008), but would likely increase reliability of supply to remaining users of the network.

Closing races that are no longer required, and focusing on maintaining and improving the remainder of the network would be beneficial but the potential effect on efficiency difficult to quantify (Opus, 2011).

CONTROL IMPROVEMENTS

ADC is currently in the process of installing additional flumes and flow recorders at their intakes. This is part of the requirements of the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.

While flow monitoring systems are presently installed on the major intakes, these devices are not used to automatically control the scheme intakes. There may be some benefit obtained by automating the key intakes. The feasibility of intake automation depends on particular conditions of each site and the ability to provide power. Any potential gains may be relatively small. However, such an automated system would improve the rangers' ability to effectively manage flows in a timely manner (Opus, 2011).

MANAGEMENT IMPROVEMENTS

As mentioned in the previous paragraph, additional control automation may increase the management efficiency of the scheme, although it is unlikely to result in more than a small improvement (Opus, 2011).

5.3 Low Flow Trials

Optimal efficiency could be perceived as ensuring that the intake of water is such that flow only just reaches the furthest part of the scheme i.e. there is no discharge at the distal end of the network.

A 'base minimum flow' is therefore the flow needed to keep the water race system operating under hot and dry summer conditions. If flows are cut back to this level, as a result of water shortage or other restrictions, it is usually possible to maintain flow in the races for around two to three weeks.

When sections of a race are dry for any period of time, the base of the race is prone to cracking. Once this happens it can subsequently take longer to 're-wet' and seal the race. This means that reducing race flows even temporarily can be potentially counter-productive (Opus, 2008).

In really dry summers (e.g., 1998, 1999, 2004 and 2008), flows fall away in the headwater streams and the volume of water able to be abstracted for the stockwater network falls well below the "base minimum flow". During dry periods, spring-fed areas have dried up and springs which formerly added flow to the water races have disappeared (Opus, 2008). stockwater races go dry under these conditions.

In an attempt to establish the minimum amount of water necessary to sustain the stockwater race network, a series of low flow trials were conducted in 2003 (Opus, 2008). The results from the low flow trials indicate that it is possible to operate ADC's four stockwater schemes (i.e. not Acton) in the "base minimum flow" mode using 5,187 L/s with major reductions in abstraction of around 1000 L/s from consented flows in both:

- The Methven–Lauriston scheme where the base minimum flow is 1,501 L/s; and
- The Mt. Somers–Willowby scheme where the base minimum flow is 1,676 L/s.

While these are significant reductions in water abstraction, it is only possible to maintain the delivery of stockwater throughout the network for two to three weeks when operating at the "base minimum flow". Longer periods of abstraction below the "base minimum flow" result in flows reducing and the stockwater races going dry (Opus, 2008). This leads to a loss of service to some scheme users.

5.4 Conclusions

The only effective alternative for eliminating water losses is to pipe the entire network. Without piping, potential efficiency gains are very small.

6 Combining Stockwater with Irrigation Schemes

6.1 General

Using irrigation networks for stockwater are a possible alternative solution to achieving water efficiency and making available water taken and not used by stock for other purposes. This section analyses this potential opportunity using the Ashburton Lyndhurst Irrigation Scheme (ALIS) as an example and identifies potential constraints.

A proposal is being developed to upgrade the ALIS scheme with the view of enhancing its level of service to shareholders and improving water efficiency. ALIS has already converted 25% of their races to a gravity-fed pressure pipe network and are currently determining the viability of piping the remaining 75% of the races. The drive behind the upgrade has been primarily to utilise the available water more efficiently and it avoids the need to pump water.

ALIS covers an area of approximately 28,000 ha and services around 250 individual properties. The system originally delivered water through a race system for flood irrigation.

The drive towards the development of large community or district-based irrigation schemes is typical of recent moves in major rural infrastructure. Such developments would appear to be supported by government policy and funding initiatives.

Within the project area of ALIS there are two open race networks; one to support irrigation and the other, the ADC stockwater race network. Integration of the two networks during any upgrading process would therefore seem logical.

The most obvious and cost effective way to improve the efficiency of the stockwater race network may be to incorporate them within future piped irrigation schemes. The four major schemes where such an approach would be worth considering are: Valletta; Mayfield-Hind; Ashburton-Lyndhurst and Barhill-Chertsey.

6.2 Stockwater Race and Irrigation Networks

As can be seen from Figure 6.1 and Figure 6.2 both the existing stockwater races and the proposed pipe network within the Ashburton Lyndhurst project area follow more or less the same routes. Therefore, there is potential to integrate the water demands from the two systems to improve overall efficiency.

In general terms, for most large scale irrigation projects the associated stockwater demand is negligible i.e. probably within the measurement resolution of the irrigation scheme.

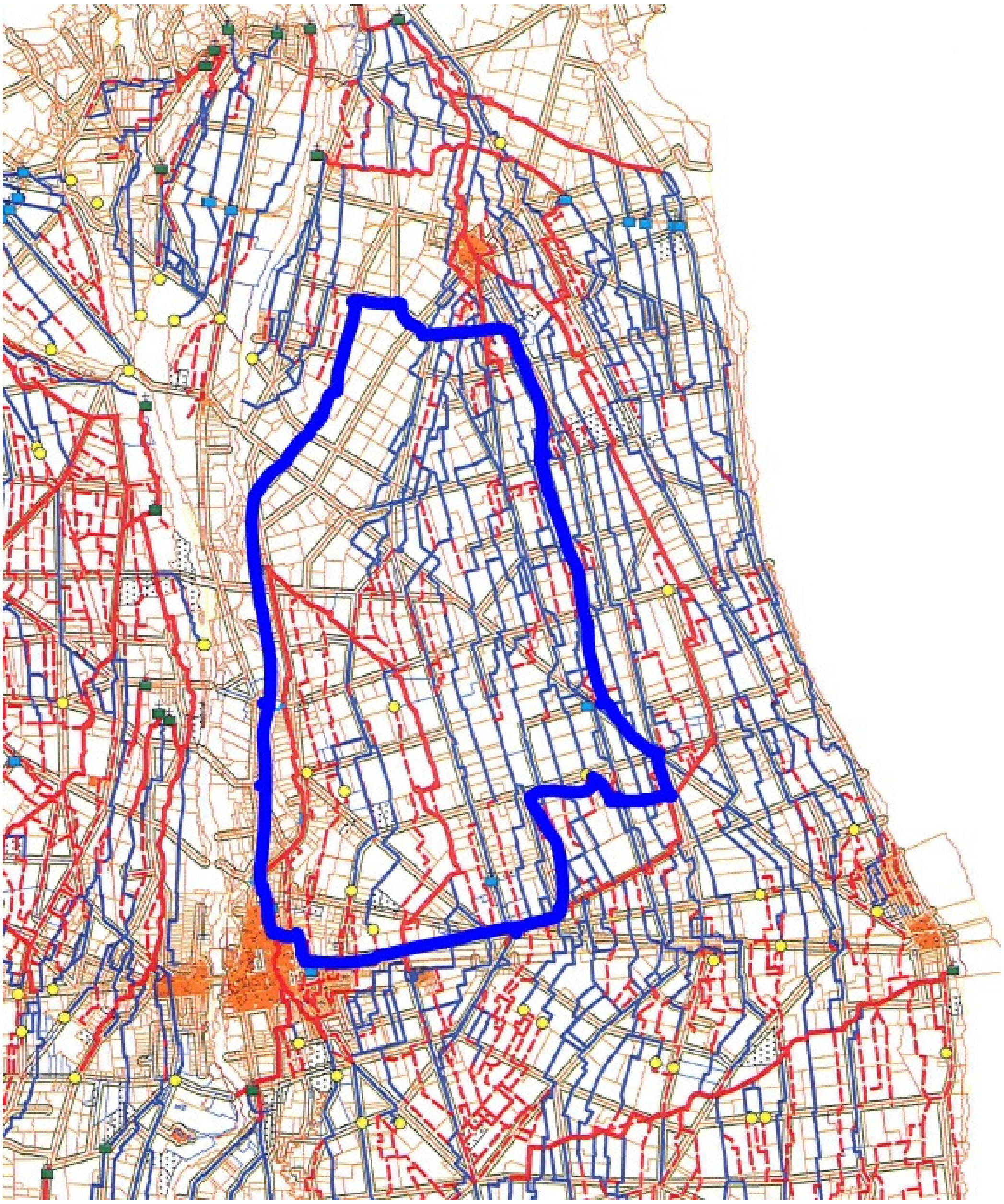

Figure 6.1: Stockwater race network maintained by ADC in the ALIS project area

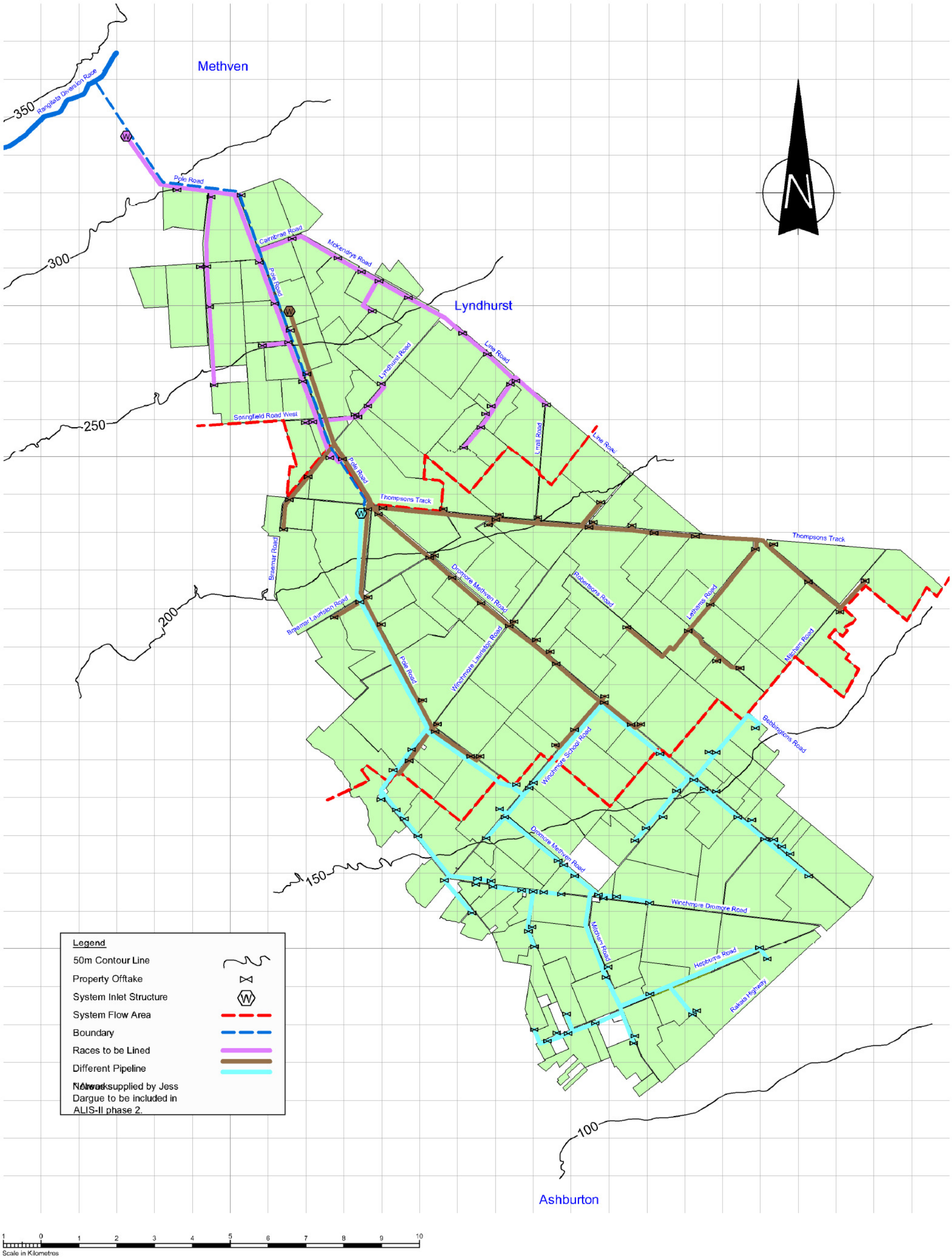

Figure 6.2: Proposed pipe network for ALIS

6.3 Integrating Stockwater and Irrigation

ALIS makes up approximately 12% of the area serviced by the stockwater race system. The ALIS area requires 995 L/s of the consented stockwater abstractions (i.e. 8281 L/s) to deliver approximately 90 L/s of water actually consumed by stock and used for domestic purposes.

Supplying 90 L/s over an area of 28,000 ha is the equivalent of irrigating 0.028 mm/day. This represents only 0.007% of an irrigation demand of 4 mm/day. Consequently, the marginal cost of adding the stockwater component of water demand to the irrigation scheme is negligible. For example, at a cost of providing piped irrigation of $4000-$6500/ha, this additional flow would only add from $28-$45.50/ha to the total cost. Such an integration of the two water resource networks would potentially allow 905 L/s to be 'returned' to the rivers and streams, or to be used for other productive or community purposes.

If the 'losses' in the current allocation to support the stockwater network within the ALIS project area (i.e. 905 L/s or 78,192 m^3/day) could be put to alternative uses, this water could irrigate approximately 1,955 ha at a rate of 4 mm/day. Using current estimates of the cost of providing piped irrigation infrastructure (i.e. $4,000-$6,500/ha) it would cost from $7.82M to $12.7M, not including on-farm costs, to fully utilise the 'saved' water.

The low volumes of water required for stockwater mean that system capacity is unlikely to be a constraint. However, there are some constraints with integrating stockwater and irrigation networks, particularly with respect to the timing of when water is required. While stockwater is required year-round, irrigation systems generally only supply water over part of the year i.e. the irrigation season. The need to continually supply water at low rates for stockwater when the system is not being used for half the year to meet the needs of irrigation would have to be considered during the design stage with respect to flow control and pressure ratings, and there may be practical difficulties in overcoming this.

The issue of water quality, and difference in the requirements of stock and irrigation water, would also need to be considered. There are likely to be technical difficulties in piping small stockwater flows with silty irrigation water and likely higher bacterial content, which can cause maintenance problems in small on farm pipes and valves. In addition, ADC would still need to be able to serve those properties beyond the boundary of the irrigation scheme area.

In some areas integration may not be feasible or practical but it is worth consideration during the conceptual and design stages of any large-scale irrigation scheme.

7 Legislation and Transfer of Water

7.1 Legislative Constraints

The Water and Soil Conservation Act (1967) gave priority regarding the allocation of water to domestic supply, stockwater and firefighting. These provisions were carried over into the RMA (1991) which allows the taking and using of water for domestic purposes or for stock drinking purposes, without the need for resource consent. Specifically, Section 14(3)(b) of the RMA allows the taking and using of water for an individual's reasonable domestic needs; or the reasonable needs of an individual's animals for drinking water as long as there is no adverse effect on the environment.

As the stockwater network is a '*scheme*', the water is not being taken for an individual's animal's needs. As such, the network cannot be provided for under Section 14(3)(b) and resource consent is required for the network.

The policies of the proposed LWRP provide for stock drinking water supplies as a priority.

Strategic Policy 4.3: Water is managed to maintain the life-supporting capacity of ecosystems, support customary uses, and provide for community and stock drinking water supplies, as a first priority; and to meet the needs of people and communities for water for irrigation, hydro-electricity generation and other economic activities and to maintain river flows and lake levels needed for recreational activities, as a second priority.

The use of ADC's existing water permits for the network are limited to stockwater and although the majority of the water is used to convey the stockwater, it cannot be used for a purpose different to that for which its abstraction has been authorised. However, any other alternative use of that water could be the subject of a resource consent application.

It is a moot point whether the water which has been taken for stockwater can be used for other purposes. At the very least a change in use would require a new consent. In addition, some or all of the water that could be used for 'other purposes' and which do not have priority, is likely to be restricted (particularly during summer). This has significant implications for both the efficient and alternative use of water which is abstracted to supply the stockwater race network. This is explored further below.

7.2 Challenges and Implications

The following discussion sets out the challenges of transferring stockwater for irrigation use as this is likely to be the only use with potential to generate revenue to offset the costs of piping the network.

If ADC were to transfer water, they or another party would first need to apply for a separate or new resource consent for a new activity, being for irrigation purposes, as this activity or purpose for the use of water sits outside the realm of the current water permits. Accordingly, ADC would need to formally transfer the water to the new user and reduce their existing consents by the same volume or that needed for stock drinking water. Pre-application discussions between ADC and the Regional Council are fundamental in reaching any agreement around a framework to realise this opportunity.

As part of the Regional Council's discretion, consideration must be given to the intended use of the water and an assessment of the volume of water allocated to irrigation as a second order priority in the CWMS against the provision for first order priorities of providing for the environment alongside customary use, and community and stockwater needs. In other words, the Regional Council might consider it appropriate to only allocate a portion of the water for irrigation use in consideration of the need to also provide for first order priority uses – there would need to be recognition of the priorities set in the CWMS and a balancing act achieved.

In particular, Strategic Policy 4.8 clearly states that the harvest and storage of water for irrigation schemes contribute to or do not frustrate the attainment of the regional concept for water harvest, storage and distribution set out in Schedule 16 of the proposed LWRP, or the priority outcomes expressed in the relevant ZIP. Schedule 16 refers to the CWMS which recognises the benefits and constraints of new water supply and the potential for more efficient use of water for new or existing users, and for environmental enhancement or restoration. There is a desire to increase irrigated land but with an integrated approach to supporting priority outcomes and ZIPs.

The value of that water in terms of first and second order priority will be a major consideration of any potential transfer of water between stockwater and irrigation water. The Commissioner's decision (2009) for the replacement stockwater consents noted that environmental standards are increasingly more demanding. Given proposed Rule 5.107 of the LWRP, ADC would need to consider 'gifting' or giving something back to environmental needs as a first order priority. Consultation on behalf of ADC with key stakeholders including Ngai Tahu would be imperative in defining where such a line should be drawn.

It is noted that any consent application to transfer water for irrigation purposes is likely to be publicly notified given the quantities to be transferred and the effects of potentially returning water to the environment.

7.3 Transfer of Water Permits

Assuming a new permit is obtained for irrigation use, a transfer of that water to another user can be sought. An analysis of the relevant transfer rules provide an insight into the relevant assessment matters for a resource consent to transfer water to another user.

The recently notified proposed LWRP is likely to be operative by the end of 2013. Although it has yet to be challenged through the submission and hearing process, the rules in the proposed LWRP now have legal effect and therefore must be considered going forward. The Regional Council has given clear guidance that an application will be assessed against the more stringent rule between the operative NRRP and the proposed LWRP. With respect to the transfer of water permits, the proposed LWRP contains the more stringent rule. Therefore, as from the date of notification of the Plan (11 August 2012), a proposal to transfer water must comply with the rules of the proposed LWRP. The relevant rule is Rule 5.107.

The activity to transfer a water permit other than to the new owner of the site and to which the location of the take and the use does not change, alters from a controlled activity under the NRRP to a restricted discretionary activity in the proposed LWRP. There are five conditions that a proposed transfer must satisfy as a restricted discretionary activity and there are several matters to which the Regional Council has restricted its discretion.

Failing to meet any one of these conditions, results in the transfer becoming a non-complying activity under Rule 5.108. The Regional Council has clearly indicated that a proposal for a non-complying activity will be generally considered as inappropriate, such that it will be difficult to obtain resource consent unless the applicant can demonstrate that there are exceptional circumstances that warrant the granting of the application. The nature and scale of the stockwater network with the potential to make available substantial amounts of water through piping of the races and the opportunity to return water to the environment or meeting ZIP targets might be considered one of exceptional circumstances should consent for a non-complying activity be sought.

The following analysis only considers the transfer of surface water taken to supply the stockwater races on the assumption that there is an opportunity to make water available under existing resource consents if the water actually used for stockwater and any domestic uses was supplied by other means i.e. a piped supply. As stated earlier in this report, there is no opportunity within existing potable supplies to transfer water as there is no surplus of provision within these schemes.

The following assessment assumes ADC is successful in obtaining a new water permit to use water for irrigation purposes. The conditions provide an analysis under which a consent may be granted as a restricted discretionary activity pursuant to Rule 5.107:

Table 7.1: Analysis of Conditions for Rule 5.107

	Condition	Analysis
1	The reliability of supply for any other lawfully established water take is not reduced.	The reliability of supply would remain the same. Water for irrigation purposes would be subject to minimum flow restrictions to ensure stockwater remained the priority use.

2	The seasonal or annual volume of take after the transfer is less than or equal to the volume of take prior to the transfer, or if no seasonal or annual volume has been applied, a seasonal or annual volume is applied in accordance with Schedule 10.	Any transfer of water for irrigation purposes would be subject to a seasonal or annual volume in accordance with Schedule 10: Reasonable Use Test.
3	In the case of surface water, the point of take remains within the same surface water allocation zone and the take complies with the limits set in Sections 6-15.	The abstraction point for the transferred water will need to remain within the Ashburton zone and the transferred water will need to comply with minimum flows.
4	In the case of groundwater…	This condition relates to existing takes for groundwater and is therefore not relevant here.
5	In a catchment where the surface water and/or groundwater allocation limits set out in Rule 5.96 or sections 6-15 are exceeded, any transferred water is surrendered in the following proportions: (a) 0% in the case of transferring surface water to an irrigation scheme which includes a storage component; (b) 25% in the case of transferring surface water from down-plains to up-plains; (c) 25% in the case of transferring groundwater from up-plains to down-plains; and (d) 50% in all other cases.	The Ashburton surface water allocation is over-allocated and otherwise known as a red zone. Therefore, in the case of a transfer of surface water: (a) the transferred water can be transferred in whole provided that water was transferred to an irrigation scheme with storage; (b) this option is not relevant as the stockwater scheme does not take water in the down-plains area (i.e. below SH1); (c) this option is not relevant as the existing take is not groundwater; (d) in all other circumstances, 50% of the transferred water must be surrendered back to the Hakatere/Ashburton River, the source of the original abstraction.

Therefore, a full or partial transfer of water without any partial surrendering of water is possible provided water is transferred to an irrigation scheme with water storage and subject to seasonal/annual volume and minimum flow restrictions. The rule encourages the harvesting and storage of water during river freshes so that further demand is not placed on over allocated resources while also meeting irrigation demand when need is highest.

Recognising that abstraction points for the stockwater network are across the District, storage would also need to be spread across the District to be of use to all users.

Provided the proposed transfer can satisfy each of the conditions of Rule 5.107, the application to transfer water will be assessed by the Regional Council against the following matters to which it has restricted its discretion and without public or limited notification (except where relevant under section 95(B)(3) of the RMA with respect to affected order holders (section 95F)). These matters will need to be set out and addressed in any application for a full or part transfer of a water permit:

1. The nature of the transfer, whether short term, long term, partial or full and the apportioning of the maximum rate and seasonal or annual volume in the case of a partial transfer;

2. The appropriateness of existing conditions, including conditions on minimum flow, seasonal or annual volume and other restrictions to mitigate effects;

3. The reasonable need for the quantities of water sought, the intended use of the water and the ability of the applicant to abstract and use those quantities;

4. The efficiency of the exercise of the resource consent;

5. The reduction in the rate of take in times of low flow; and

6. The method of preventing fish from entering any water take.

These matters are required in general to determine the relevant conditions for both the original permit (e.g., reduced rate of take) and the new permit to which water has been transferred, for example, rate of take, seasonal/annual volume, minimum flow restriction, fish screen, etc.

Efficiency of the exercise of the proposed intended use of water will also be assessed. A transfer of water from an open race scheme to a piped scheme would be viewed positively as the use of the water would be considered technically efficient.

Reasonable need is dictated by the intended use, so in the example of irrigation, site demand will need to be assessed to show that the quantity of water needed is reasonable. The policy also allows for an assessment of the priority of certain abstracted uses in accordance with Policy 4.4 of the proposed LWRP which provides for community and stock drinking water supplies as a first priority.

An application would need to demonstrate the ability to abstract and use the water to be transferred. This could be possible if maximum consented rates and volumes were abstracted in the winter months and stored for use in the summer peak demand as that water may not be available in the source rivers during the driest period when demand is highest, given the need to comply with minimum flows.

8 Alternative Sources of Water

8.1 Alternative Sources

Alternative options to sourcing water for stockwater and domestic supply and in particular to support the current network are limited. Assuming the retention of the quantities as that currently consented, there are no realistic alternatives than to abstract water under the status quo as no other source will be able to yield the quantities sought to keep the network running.

If the network is piped, then obviously continued abstraction from existing sources will no longer be an issue from a water allocation perspective. Reducing abstractions from the Hakatere/Ashburton River in particular, will aid to reduce its current over allocation of water. Reducing or ceasing abstraction from the Hinds River catchment, although noting current authorised abstraction is limited at 50 L/s (Limestone Creek), would also aid the south branch of the Hinds River which is identified as a flow sensitive catchment in the proposed LWRP.

Possible alternatives include other surface water sources, spring fed streams, groundwater or water storage. A number of options have been previously explored by others.

Previously investigated alternatives

Beca (1995) considered three alternative sources of supply in light of the existing open race channels: Valetta Springs, Westerfield Springs and groundwater.

Below Valetta Springs, works were undertaken to feed the race network with water supply boosts to reduce the abstraction from the Brothers intake. At that time, the reliability of the boost was uncertain as improvements to increase the boost had only recently been completed.

There was considered to be little reserve capacity from the excess of Westerfield, Remmingtons and Blairs Springs from which water was taken and then discharged back to the river. Natural springs and some tail end race flow contributed a discharge of 270 L/s.

River water losses along an 11km stretch of the South Branch between the RDR and the Valetta Bridge were also considered. However, a significant portion of this river loss was thought to reappear along the river terrace below Valetta and in a number of springs while also feeding deeper confined aquifers. It was concluded that to secure a reasonable supply would be highly impractical and very expensive.

Other groundwater reserves were considered but in light of an open race system it was considered to be of limited benefit, unless the supply could be piped.

Opus (2001) considered alternative surface water supplies as part of the latest replacement consent application for the stockwater network but noted that most of the existing surface water resources within the District were already committed to water restrictions and minimum flows, and discounted a number of sources for these reasons.

Several constraints were identified with the potential to abstract additional water from the Rangitata River: an application for a Water Conservation Order on the river, technical feasibility and costs of a siphon to carry water under the Hinds River; and cultural issues with the mixing of waters from different catchments. The River became subject to an Order in 2006 placing restrictions on river flows to ensure the characteristics of the braided river are maintained and with limited availability for further abstractions.

A potential dam at Blowing Point was too early in its stage of development to be considered further as a practical source although it was thought it could provide a more reliable supply of stockwater. Investigation of this dam has not revealed any further progress of its development.

Other potential sources of water

Other possible alternatives not previously explored include spring fed surface water including Winchmore and Langdons Springs (although Langdons Springs dry up during summer months). Springs typically provide better water quality but are limited in yield and therefore only feasible if conveyance of the water was piped.

Storage of water is another option during high flow periods, allowing a reduction in the quantities abstracted from surface water during peak times. Storage ponds could operate in conjunction with the existing race system to convey the water to storage but would require significant investment and land.

The only other alternative source is groundwater, although the quantities able to be pumped would require piping of the conveyance network. Groundwater is generally of better quality than surface water and therefore more suitable for stock drinking water, particularly dairy stock and domestic water. In addition, the taking of groundwater, unless hydraulically connected, avoids the need to consider Water Conservation Orders such as those for the Rakaia River (1988) and the Rangitata River (2006). However, consideration should be given to the cost of sinking a well and operation or maintenance costs. To obtain good-quality water suitable for domestic and stock use usually requires a relatively deep well – most of the potable wells drilled recently in the District are 60-120m deep. The cost of these when constructed for potable supply is typically $90,000 per well. Wells for other uses are usually less expensive (approximately $60,000). For a District-wide network such as this, it is likely that 6-10 wells would be required.

The aquifers of the Ashburton area are semi-confined or unconfined. Depth to the aquifers vary, with increasing groundwater levels towards the coast due to river and land based recharge. Groundwater becomes deeper inland due to natural deep hydraulic gradients (Thorley, et. al., 2010). Opus (2001) states that the area east of SH1 has readily accessible groundwater at shallow depths of 20-50m. This is evident in the growth of irrigation bores in this area over recent years. However, west of SH1, reliable groundwater supplies tend to be located below 80m, substantially increasing drilling costs.

Essentially, if the existing open race network is to be maintained, there are no reasonable alternatives to provide the quantities needed to run the network. Therefore, possible alternatives for supply can only be considered if the network was piped to reduce the quantities needed to that only required for stock drinking water. Having considered a number of options, groundwater is the only alternative that would be able to supply the required quantity and provide a reliable and clean supply for both stockwater and potable supply. Household drinking water standards would need to be complied with for shared supply schemes.

If the scheme was piped and abstractions accordingly reduced, water could potentially still be sourced from existing surface water resources, although water quality will not be as high as that sourced from groundwater. Therefore water would need to be obtained from higher quality sources such as springs or storage ponds to prevent silty water entering the piped network where it will reduce capacity and create maintenance problems. There would be no need to take groundwater and therefore no need to bear the costs of drilling a well. However, this is provided that the abstraction is supported by a Water Supply Strategy pursuant to proposed Rule 5.88 of the LWRP setting out flow reductions at times when river levels are low.

The only potable supplies that don't already source groundwater are Montalto, Methven/Springfield and Mt Somers. The ADC Long Term Plan 2012-2022 states that upcoming upgrades or reticulation are due for Mt Somers and Methven/Springfield.

8.2 Regulatory Requirements for the Abstraction of Groundwater

If groundwater is the only practical alternative to sourcing water for the network to that from current surface water sources, then due consideration needs to be given to the consenting requirements around the abstraction of water particularly in light of the Regional Council's new plan.

It is unlikely that an application for groundwater abstraction from ADC would be forthcoming prior to the proposed LWRP becoming operative towards the end of 2013. Therefore, only the policies and rules of the proposed LWRP are considered here rather than the operative NRRP. Relevant policies of the proposed LWRP, and against which an application for groundwater would be assessed, are:

Policy 13.4.4(b): To avoid over-allocation of the Ashburton River Groundwater Allocation Zone, 35 million m^3 per annum is available for applicants who surrender surface water and/or stream depleting groundwater takes in accordance with Policies 13.4.5 and 13.4.6.

Policy 13.4.5: To address over-allocation of surface water in the Hakatere/Ashburton catchment, enable an applicant to take deep groundwater provided the applicant holds a lawfully established surface water take or stream depleting groundwater take for an equal or greater rate and volume than is sought and the take is surrendered.

Clearly the taking of groundwater within an over-allocated 'red' zone is provided for where:

- that water is not stream depleting;
- the abstraction is the same or lesser rate and volume of a surface water abstraction; and
- the existing surface water abstraction is surrendered.

Hence, the taking of groundwater can be offset by the return or surrendering of water to surface water resources. ADC explored an early concept of 'gifts and gains' with the Regional Council in early 2011 by investigating the abstraction of groundwater from an over-allocated resource in return for a discharge from the stockwater network to the shallow aquifer via soakpits in a location separate to the abstraction bore. The proposal would achieve multiple benefits including enhancement of the Hakatere/Ashburton River base flows. Effectively, the shallow aquifer would be recharged from a consented allocation of water to allow the abstraction of groundwater within an over allocated catchment. The ultimate aim of this recharge would be to create a wetland for biodiversity purposes. ADC was successful with this concept and accordingly granted resource consent.

The abstraction of groundwater for stockwater and domestic uses would be considered against Rule 5.88 which provides for community water takes. It is noted that there is no relevant sub-regional rule and the default therefore is to refer to the regional rules in Section 5. The rule states that the taking and using of water is a restricted discretionary activity provided it can meet one condition: there is an operative water supply strategy. A water supply strategy would need to set out strategies to reduce water demand during times when minimum flow (surface water abstractions) or water level (groundwater abstractions) restrictions are in effect. A water supply strategy might exist within existing bylaws or asset management plans.

If this one condition for a water supply strategy cannot be met, the abstraction is treated the same as for any other groundwater abstraction by which further conditions would need to be met before being considered a non-complying activity.

It is noted that proposed Rule 5.88 does not require that abstractions cease but that there is a reduction in use providing some equity with reductions for other out of stream uses. Obviously, in the case of stockwater or potable water supplies, a reduction in water taken or supplied would not be reasonable but a case for reduction in use can be made for water taken for domestic purposes including the watering of gardens. However, this needs to be balanced against the health and well-being effects that gardens provide for individuals and for the community.

As a restricted discretionary activity, the matters of discretion for the Regional Council when considering an application to take groundwater are limited to:

1. The reasonable demand for water, taking into account:
    - the size of the community or group
    - the number of properties and stock that are to be supplied
    - the uses that are to be supplied
    - the potential growth in demand for water;
2. The effectiveness and efficiency of the distribution network;
3. The adequacy of the water supply strategy;
4. The effect on other water takes, including reliability of supply;
5. Any beneficial effects form the use of water; and
6. Compliance with any relevant Water Conservation Order.
7. The extent to which the proposed activity is inconsistent with, the Strategic Policies of this Plan.

The abstraction would need to show that other groundwater users were not adversely affected and demonstrate that the method by which stockwater is distributed will be in a water efficient manner.

The proposed LWRP sets out eight strategic policies which must be read and considered together. An abstraction of groundwater must not be inconsistent with these policies. In summary, these policies seek to:

- meet specified freshwater outcomes
- take account of the cumulative effects of land uses, discharges and abstractions
- not diminish values of cultural significance to Ngai Tahu
- manage water in accordance with first and second order priorities
- limit the use of high naturalness waterbodies
- not grant resource consents where set water limits would be breached or further over-allocation would occur
- establish a regime to eliminate over-allocation
- the harvest and storage of water contribute to or do not frustrate the attainment of the regional concept for water harvest, storage and distribution or the priority outcomes expressed in the relevant ZIP.

Surrendering surface water in exchange for the abstraction of groundwater for stockwater and domestic purposes would, in general, comply with the strategic policies of the proposed LWRP.

There are also an additional 17 policies specific to the activity of water abstraction. These policies generally relate to how water is taken and how applications should be treated in relation to priority, replacement of existing consents, effects of taking water, conditions of consent and use of wells.

An application for groundwater requires a bore permit to drill the well and a water permit to take and use groundwater. Water permit applications must be supported by an aquifer test to confirm the yield and likely drawdown effects on other users.

9 Potential Impacts of Race Closure

There are a number of potential impacts arising from race closure and these should be considered should any attempt be made to convert the stockwater races to a piped network. The likely impacts can be defined as:

- reduction of aquifer recharge from loss of seepage with potential effects on shallow bores and surface water
- loss of habitat within the races for fauna and flora
- loss of visual amenity.

Seepage through races is known to help sustain groundwater levels, support flows in spring fed streams and provide localised benefits not only to those that access shallow groundwater, but also for biodiversity – fauna and flora that inhabit the races. The closure of races will reduce this recharge and the ecological environments they support.

9.1 Loss of Seepage to the Aquifer

A piped system will minimise water losses resulting from inaccurate delivery, leakage and to some extent evaporation of traditional open race channels. Leakage from open water races contribute to aquifer recharge and the closure of these races will significantly reduce these 'losses'.

To understand the implications arising from the closure and/or piping of stockwater races on groundwater it is necessary to understand the contribution of seepage from the races to groundwater.

The contribution of seepage to the aquifer

The stockwater races as an open-channel scheme are inherently inefficient in terms of the amount of water used for its primary purpose compared to the amount of water taken from its various intakes (termed technical efficiency). This inherent inefficiency is largely due to the losses from seepage along races, and to a lesser degree from losses due to evaporation, evapotranspiration and discharges at the terminal points of the scheme. It is also affected by the need for races to follow ground contours which may not necessarily result in the most direct route from the intake to any given user. With the closure and/or piping of, the groundwater recharge contribution is reduced.

Water being distributed in an open channel will seep out from the sides and base of the channel. The rate of seepage is determined by:

- The wetted perimeter of the water race channel;
- The depth and elevation of water within the channel;
- The elevation of the groundwater table in the ground adjacent to, or underneath, the channel; and
- the hydraulic conductivity of the strata comprising the water race channel and the surrounding ground.

In addition to seepage from the sides and base of the channel, many water race systems also terminate in soakholes where the surplus water that is required to keep water moving along the water race is discharged directly into the groundwater. Piping the network will remove these discharges.

A review of studies undertaken to quantify the seepage shows that:

- Scott & Thorpe (1986) estimated that stockwater races contributed 3.67 m^3/s of recharge to the groundwater resources between the Rakaia and Ashburton Rivers. Over an annual basis, they reported a contribution of 123 million m^3 from stockwater races compared to a total groundwater recharge from all sources of 866 million m^3. Therefore, the stockwater race system contributes 14% of the total inflow to this groundwater resource.

- Beca (1994) estimated seepage of 75% of the water taken for the Ashburton South Main Race.

- Taylor (1996) undertook an assessment of the groundwater balance for the catchment contributing seepage to Te Waihora/Lake Ellesmere estimating water race seepages at 92 million m^3 per annum. This was compared to a total estimated recharge from all sources of 840 million m^3 per annum. Therefore, the stockwater race network contributes 11% of the estimated recharge to this groundwater system.

- Agriculture New Zealand Ltd (1997) estimated 80-90% seepage for the Paparua scheme based on flow measurements. Indicating recharge at a rate of around 0.7 m^3/s into the Christchurch and Selwyn groundwater systems. A numerical modelling estimate indicated that if this recharge was not occurring, groundwater levels within the area would drop by as much as 1.5 m.

- De Joux (2000a) provides various estimates and measurements of stockwater systems that show 75%-90% of their flow as recharge into the groundwater system. The same report describes gauging surveys on water races with the Orari-Rangitata and Orari-Waihi stockwater systems where the race designs provide groundwater recharge at a rate of around 1.8-2 L/s per kilometre. These rates of seepage will vary depending on the composition of the race channel, the build up of silt within the race and the effects of race cleaning, which typically increase seepage rates.

- Davey (2005) summarises work undertaken looking at the recharge from stockwater and irrigation races in the Waimakariri-Ashley Plains and other studies resulting in a recommendation that a loss of 80% be used.

- Waugh (2007) considers that near point discharges to ground (as occurs at soakhole discharges) water levels may be increased by around 1 m over a limited recharge “mound”.

- Brough (2008) and Steffens et. al. (2011) carried out Ashburton specific work. Estimates show that the Ashburton race systems recharge 85% of the total take with an annual recharge of 280.7 x 10^6 m^3/yr.

- Scott (2004) estimated the irrigation and rainfall recharge of the aquifers in the Ashburton area at 1,176 10^6 m^3/yr excluding recharge from the stockwater races. However, Steffens et. al. (2011) calculated that the stockwater race system could provide up to an extra 19% recharge to the groundwater system.

Within this study, a loss of stockwater to groundwater has been estimated at 82% and this is consistent with these previous investigations.

It is understood that the Regional Council has not included the seepage from stockwater races to groundwater in their estimate of the water available for allocation from groundwater as *“this is primarily because it is anticipated that the longevity of these networks is strictly limited”* (ECan, 2008, p.16). However, excluding the seepage in the allocation limit does not mean the seepage does not have some benefit.

The impact of the loss of race seepage on aquifers

Groundwater is primarily recharged from river leakage and secondly from land surface drainage due to rainfall and irrigation. There is a contribution of potentially up to 19% of the recharge from the stockwater race meaning the seepage helps to support groundwater levels. In contrast to other sources of land based recharge, for example, irrigation, seepage from stockwater races occurs throughout the year and over the entire Ashburton District and is therefore, more consistent.

Seepage should not necessarily be considered as losses as they are often reported given the recharge that occurs. Seepage through races:

- has been occurring for more than a century so are an established component of the groundwater system
- helps to sustain groundwater levels
- supports flow in spring fed streams; and
- provides localised benefits to bore owners in the vicinity of soakpit discharges.

The groundwater seepages have been occurring for many decades and in many cases over 100 years meaning historic measurements of shallow groundwater levels will have already included any recharge contribution from the stockwater races. These seepage losses make a positive contribution to the recharge of the groundwater resources of the Ashburton District and removing this seepage as a source of groundwater recharge would mean that wells could be adversely affected (Brough, 2008).

The Regional Council has identified a significant increase in groundwater abstractions (to 40m depth) in the Ashburton catchment, particularly over the last ten years increasing from an equivalent total irrigation rate of 480 L/s in 2000 to 2,800 L/s in 2012. Figure 9.1 shows the significant increase in shallow accessed groundwater over recent years.

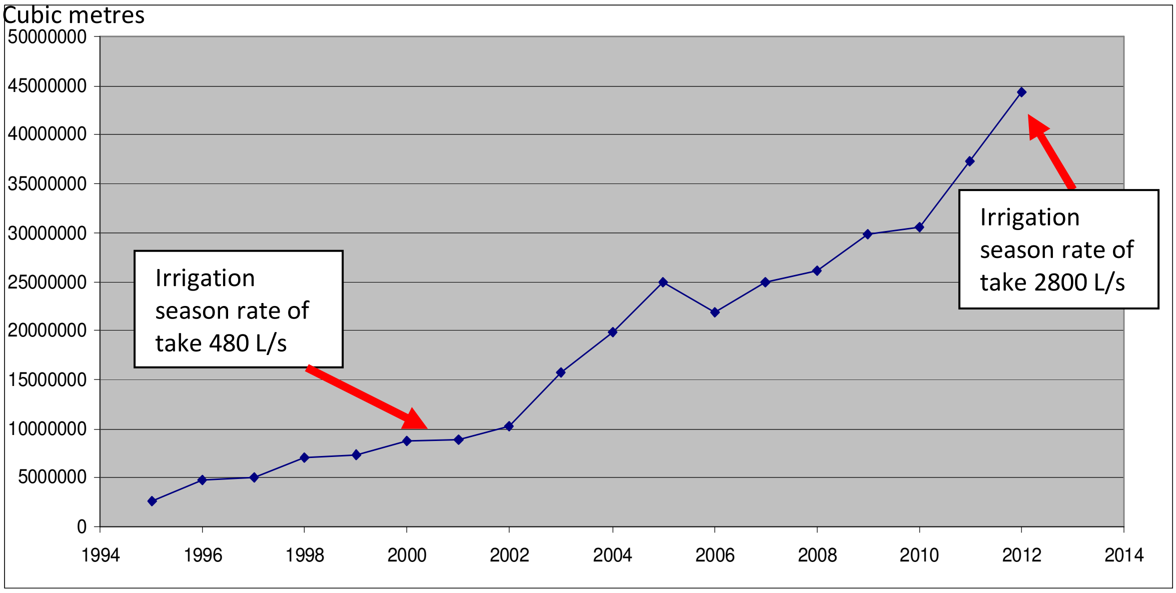

Figure 9.1: Volume of consented groundwater takes to 40m depth in the Ashburton Catchment

Source: Smith (n.d.)

It is difficult to quantify with any certainty the exact impacts removing this recharge would have on individual bores. Given the above information, there will definitely be some impact. Previous studies suggest seepage could result in raising groundwater levels by one metre. Waugh (2007) estimates groundwater levels may be increased by one metre in the vicinity of soakpit discharges with localised benefits to bore owners. There has also been some anecdotal evidence (Andrew Guthrie, pers comm.) of shallow household bores being influenced by the discharge of tail end race water into soakholes. Impacts are likely to relate to the lowering of groundwater levels on existing users with reduced reliability of supply, or users being unable to obtain their permitted or consented abstractions, and the need, and consequently, the cost to access deeper groundwater through:

- lowering the abstraction pump
- changing from a surface to a submersible pump
- using more electricity to abstract water; and

- drilling a deeper bore.

It is noted that there will be some compensation for this loss of recharge with the Regional Council's direction to increase irrigated land across Canterbury including the Ashburton District, in accordance with the regional concept plan of the CWMS. However, it may be some time before this is realised.

The relationship of ground and surface water resources

Race closure is also likely to impact on surface water flows through a loss of groundwater recharge. A gross simplification of the interaction between surface and groundwater is that (PDP *et. al.* 2000):

- Streams gain water from groundwater through the streambed when the elevation of the water table adjacent to the streambed is greater than the water level in the stream.
- Streams lose water to groundwater by outflow through the streambed when the elevation of the water table is lower than the water level in the stream.
- At times of low groundwater levels, surface flow may only occur due to surface flows in the upper catchment or from runoff. This flow will contribute seepage through the streambed to the underlying water table.
- Seasonal fluctuations in groundwater occur due to rainfall recharge fluctuations, fluctuations in river flows, ground and surface water abstractions and irrigation recharge.

In addition, the interaction between surface water and groundwater is extremely complex, as it is recognised that river losses and gains to groundwater vary considerably, both spatially and temporally.

A number of studies into Canterbury's water resources have been undertaken, along with technical evidence presented as part of resource consent hearings. Water models have been developed to predict the response of systems to changes in land use and abstraction. However, as is the case with modelling there are always differences of opinion about the validity of the model whether it be the input parameters, data used or the applicability of the model to specific scenarios.

One of the major findings of the Canterbury Strategic Water Study (Morgan, et. al., 2002) was that river recharge provides a large component of the Canterbury Plains groundwater. For the area between the Rakaia and Rangitata River river recharge was calculated to be at least 63% of total recharge. Aqualinc's (2007) regional tool, the Canterbury Groundwater model covering the aquifer system between the Waimakariri and Rangitata Rivers, has an overall mass balance of:

Inflows (approximately):
- 57% of the aquifer system's gross inflow is sourced from surface water (streams and

Outflows (approximately):
- 41% to surface water
- 52% to Te Waihora/Lake Ellesmere

rivers)
- 36% from land surface drainage (rainfall and irrigation)
- 7% from other inflows (leakage from the RDR scheme and stockwater races)[1]
- 7% groundwater extraction

What is generally agreed by the experts is that: river recharge provides a significant component of the plains groundwater; the variation in groundwater levels and springfed stream flows are very largely attributable to the variation in land surface recharge; and there is a good relationship between the flow in Canterbury's spring-fed streams and the water levels in the region's groundwater systems.

The Hakatere/Ashburton River and Valetta groundwater allocation zone hearings of 2010 involved the presentation of evidence from a large number of experts on the interaction between surface and groundwater, with the focus on the effects of abstraction. The Commissioners' decision notes:

- that there is a high degree of connection between the Hakatere/Ashburton River and the groundwater system, and
- there is an extensive open race stockwater system that effectively transfers surface water from the Ashbruton River (as a point of take) to groundwater and drains.

The impact of the loss of race seepage on spring fed streams

A high degree of connection means that both surface water and groundwater need to be considered together and that any change in the groundwater system will have either a direct or cumulative effect on surface water base flows.

The ADC Biodiversity Action Plan (n.d.) states that most of the lowland streams in the District are spring-fed and provide valuable fish and invertebrate habitats, as well as wildlife corridors, including small ephemeral streams running through farm land.

A study of springs in the Hakatere/Asbhurton River system (Aitchison-Earl, 2000) found that springs were likely to occur in:

- areas of shallow groundwater or a high water table
- areas where the Hakatere/Ashburton River is losing water
- areas where low permeability layers force groundwater to the surface; and
- in old abandoned river channels.

[1] Groundwater recharge from stockwater has been incorporated in the model (pg 32) with the main takes summed and distributed evenly over the land surface. A recharge rate of 0.142mm/day was used for the Rakaia-Ashburton zones and 0.103mm/day for the Ashburton-Rangitata zones. The recharge has been assumed to occur all year round.

Springs occur as distinct point sources, seepage areas, channels, or flow from terrace edges (Aitchison-Earl, 2000). It was identified that most springs associated with the Hakatere/Ashburton River are permanent with year round flows but with some variation. Intermittent springs tend to occur in the upper headwaters. Rainfall recharged groundwater or flow losses from river systems appear to be key criteria for these springs. Stockwater races were noted to have had some impact on headwaters and to supplement flows in creeks (e.g., Mt Harding Creek and Mill Creek).

Given the earlier assessment of the contribution of race seepage to the underlying aquifer and the relationship between shallow groundwater and surface water flows, there is likely to be some impact from the removal of stockwater races on spring fed flows but again, this would be difficult to quantify. However, an assessment of the impact can be measured through effects on ecosystems as discussed in the following section.

9.2 Ecosystems

Race closure will also have impacts for biodiversity, not only for instream values but for fauna and flora in the vicinity of the discharge points and the groundwater fed springs.

Instream and Riparian Habitat

Hearing evidence of Dr Roper-Lindsay (2008) for the replacement consent applications for the stockwater network outlined the instream and riparian habitat of the stockwater races. Although various studies have been undertaken on discrete areas of the stockwater network, Dr Roper-Lindsay states that there has been no comprehensive ecological survey and in the absence of this, could not identify specific places or reaches that were of particularly high or low ecological value. Her evidence relied on previous studies and anecdotal evidence of local residents and scientists.

Dr Roper-Lindsay refers to a report commissioned by ADC and RDR Limited by Pak and Ward (1998) which provides an ecological survey and assessment of the stockwater races in the District. Ecological values were identified although no threatened or endangered species were noted.

The following findings are from a number of studies, the resource consent application for ADC's replacement stockwater and supporting hearing evidence:

- Water races provide diverse aquatic and terrestrial habitats not commonly associated with the District's larger river systems.
- Native plants and animals use both the margins and aquatic habitats along the races as a source of food and shelter.
- Margin vegetation cover is generally dominated by introduced species of herbs, shrubs, trees, gorse hedges, pine and macrocarpa shelter trees and rough grasses.
- Instream vegetation cover is not common due to regular race cleaning operations.

- There are both native and introduced species: the common bully, upland bully, eel, brown trout and one record of salmon.
- Freshwater mussels and crayfish are present, particularly in the lower plains.
- Various birds have been observed using the races and their edges including ducks, pukeko, seagulls, domestic geese, kingfishers and herons.
- Dragonflies, damselflies, butterflies and other insects have been observed.

The native Canterbury mudfish is only found on the Canterbury Plains and is a nationally endangered species. It is considered to be the second rarest, and therefore, threatened, native fish in New Zealand and is regarded as taonga species for iwi (Department of Conservation, n.d.). Dr Roper-Lindsay (2008) notes that mudfish habitat falls into the Government's National Priority 4 for protection on private land.

O'Brien (n.d.) notes that the water races north of the Hakatere/Ashburton River and south of the Hinds River are unlikely to contain the Canterbury mudfish. These are areas where there has been no record and no expectation that mudfish occur. However, mudfish have been recorded in pockets between the Ashburton River and the Hinds River and in some areas they are expected to occur more widely. Dr Roper-Lindsay (2008) also states: *"Leanne O'Brien (pers comm.) also reports mudfish habitat in the lower spring-fed parts of the Ashburton race system and groundwater-fed streams east of State Highway 1. Mudfish habitat restoration is being undertaken as part of the Synlait development."* (p.10).

Instream vegetation including exotic aquatic plants is a key habitat for mudfish survival, particularly during spawning periods. Water race operation and management practices can have a detrimental effect on ecological values, and it is recommended that vegetation, where it does not impede water flow, should be retained.

Effects on Aquatic and Terrestrial Environments

None of the intakes are currently subject to a fish exclusion device although they are required to do so under the recently granted resource consents. It is understood, that this requirement for their installation is currently on hold in agreement with the Regional Council while trials are undertaken in consultation with the Fish and Game New Zealand.

Therefore, fish are free to enter the race network. Clearly, should the races be closed, habitat would be immediately lost for any instream life and physical relocation to an appropriate environment would be essential. Vegetated margins will also be lost as a result of race closure and similarly, the habitat for birds and insects will be reduced by the absence of water.

As stated earlier, there has been no comprehensive ecological survey of the stockwater races. However, it is evident that any closure of the races is likely to have some impact. The recently granted resource consents stipulate a requirement to undertake an assessment of the ecological values of the stockwater network as part of a two year review of the Stockwater Network Management Plan. The consent conditions effectively treat the water races as waterways. As part of this assessment, ADC is required *inter alia* to:

- identify management objectives that address those ecological values and their enhancement
- a strategy, plan and/or programme for management of ecological values
- operational guidelines or procedures to manage ecological values throughout the race system; and
- a monitoring programme for ecological values, including water quality.

ADC are also required to take into account potential adverse effects on ecological and amenity values, and opportunities for their enhancement when making any change to the network including race closure and to implement any recommendations of an ecological assessment.

An ecological assessment is imperative as it will highlight any races deemed to have high ecological value and any recommendation as to their retention or otherwise. ADC's Biodiversity Action Plan (n.d.) is likely to assist in meeting these consent conditions.

9.3 Visual Amenity

The races contribute to the aesthetic values of the region bringing social enjoyment and wellbeing to communities. They are considered by many to provide green corridors of plant life and aquatic habitat in an otherwise dry region.

Undertaking an ecological assessment as required by the resource consent conditions will identify those races which have high ecological value. Enhancement of these races will enable their contribution to visual amenity be retained.

10 Potential Uses of the Water

A key output of this study is to identify potential uses of any unrequired water than can be made available. As previously identified, water can only be made available if the current network is piped. There are a range of possible uses and these can be summarised as:

- irrigation use
- leaving or returning water to its original source
- biodiversity initiatives or enhancements; or
- a combination of the above.

These potential uses of water are consistent with the objectives of the CWMS and the recommended actions of the Ashburton ZIP.

10.1 Economic analysis for irrigation use

The possible transfer of water for irrigation use would be consistent with the strategic aim of the Regional Council, in line with the CWMS to increase the irrigable area and therefore, productivity across the region while also enhancing environmental flows and increasing reliability of supply.

The ability for ADC to transfer unrequired water to an irrigation scheme to generate revenue, would allow the costs of piping the network to be offset. This is essential if a piped network is to be realised and it would mean that the users of the piped stockwater scheme do not absorb the associated high costs of delivering such an upgrade.

The following economic analysis assumes that water can be transferred for other irrigation purposes including that water supplied under private agreement by the RDR at the Klondyke intake. An economic analysis was undertaken to determine the value of the water that could be made available for irrigation purposes. The full analysis is set out in Appendix III. The analysis is based on 95% reliability of water and within the stockwater scheme this is estimated to be at least 3,666 L/s provided the stockwater and domestic requirement is delivered with 100% efficiency. The rate of 3,666 L/s is a conservative estimate based on the eight largest takes of the scheme. This volume of water is sufficient to irrigate 7,920 ha at an application rate of 4mm/ha, a generally accepted minimum for irrigated agriculture.

For abstractions from the Hakatere/Ashburton River catchment, a 95% reliable abstraction of 2,860 L/s less stockwater provision of 215 L/s and domestic uses of 268 L/s, allows 2,377 L/s potentially available for irrigation purposes, assuming the stockwater is delivered with 100% efficiency. This volume of water will irrigate approximately 5,135 ha based on an application rate of 4mm/day, as set out in Table 10.1 below.

Table 10.1: Potentially irrigable area

Use of Water	Total Network	Ashburton River Catchment
Assessed available water (L/s)	4,410*	2,860
Stockwater requirement (L/s)	330	215
Domestic requirement (L/s)	414	268
Unrequired water (L/s)	3,666	2,377
Irrigable area (ha)**	7,920	5,135

* Based on the eight main/monitored abstractions

** Based on 4mm/day

Over the potentially irrigable area of 7,920 ha based on the eight monitored takes, the net present value of the unrequired water is approximately $129m and potentially up to $252m, depending on the interest and discount rates utilised and the project life time (refer Appendix III). Table 10.2 sets out the cost and benefit of making water available for irrigation with pro rata values for abstractions from the Hakatere/Ashburton River catchment.

On a per hectare basis, the value of the unrequired water is estimated at $2,100/ha/annum in terms of the average increase in net farm income. The net present value of this is $16,000/ha, with a best case of $32,000/ha (for the more favourable discount rate/lifetime analysis). These figures represent the maximum that a farmer might be expected to be willing to pay for water delivered to the farm gate free of any other charge. Conversion would not be worthwhile at values above these figures.

The cost of piping irrigation water is estimated to be $6,500/ha, considerably less than the calculated value of water for any land use (refer Appendix III). The cost for piping water to 7,920 ha is hence $51m and $33m for abstractions from the Hakatere/Ashburton River catchment. Consideration must also be given to the cost of continuing to provide stockwater and domestic water to all non-irrigated properties which are currently supplied by the scheme, and in not having water lost in that provision. This cost has been estimated at $56m for the network and $36m for the Hakatere/Ashburton River catchment.

The total costs of making water available for irrigation, that is, the cost for piping irrigation water and supplying an alternative stockwater scheme, are $107 million including on farm costs for the network and $69 million for the Hakatere/Ashburton River catchment, considerably less than the financial benefits estimated. However, these figures are based on providing a replacement network over the entire scheme area. It is noted that the races have reduced in length by approximately one third over the last eight years. If race closures continue at the same rate, costs to provide a replacement network are unlikely to be as high as those set out in Table 10.2 below.

Table 10.2: Cost and benefit of making water available for irrigation

Cost and Benefit	Total Network[1]	Ashburton River[2] Catchment
Unrequired water (L/s)	3,666	2,377
Potentially irrigable area (ha)	7,919	5,134
Conservative Scenario		
Value of water[3] ($m)	129	83
Cost to pipe irrigation ($m)	51	33
Cost to pipe stockwater[4] ($m)	56	36
Total Benefit to ADC ($m)	22	14
Best Case Scenario		
Value of water[3] ($m)	252	163
Cost to pipe irrigation ($m)	52	33
Cost to pipe stockwater[4] ($m)	56	36
Total Benefit to ADC ($m)	144	94

[1] Based on the eight monitored abstractions

[2] Based on all abstractions from the catchment

[3] Net present value

[4] Costs include on farm costs

With respect to abstractions from the Hakatere/Ashburton River, Table 10.2 suggests that the cost of piping stockwater for those abstractions is $36m. In section 4 of this report, it was identified that 1,785 L/s of the currently authorised abstraction is, on average, already in the river and not currently abstracted. If this water was used for irrigation, then the economic return should exceed the cost of piping this part of the network, so this would be economically viable, even at a conservative level.

If ADC was required to return 2,455 L/s to the Hakatere/Ashburton River (i.e. a total take of 5,355 L/s less Policy 13.4.1 requirement to reduce abstraction to 2,900 L/s), based on a conservative scenario, the stockwater network would be economically unviable.

The total benefits of providing irrigation water are hugely affected by the irrigable area. The above calculations are also based on estimates of water availability for 95% of the time with respect to the eight main abstractions and in relation to the historical consent limits for rates of abstraction, as established in Section 4 of this report. It is acknowledged that this data would benefit from more detailed analysis, particularly, the inclusion of data from the supplies for which flow measurements have only just begun. A storage scheme would also obviously greatly increase the irrigable area, albeit at a financial and environmental cost which has not been calculated but which may be significant.

Subject to preliminary designs and the ability to transfer the quantities needed, the economic analysis suggests, using conservative estimates, that piping the network is certainly viable.

An interesting element not factored into the above exercise, is a value that one might place on the water, beyond any assessed economic value and which cannot be defined within the scope of this study. The Commissioner for the replacement stockwater consents alluded to this point in his decision (2009) referring to the:

'…transfer of the rights to the use of that water from public to private 'benefit' by means of some form of 'saleable water rights' scheme – also implying a water valuation process.' (Para 4.13).

The Hakatere/Ashburton River is over-allocated and under Policy 13.4.2 of the proposed LWRP, no more water can be allocated from the Hakatere/Ashburton River until 2022 when it is intended to increase the minimum flow from 6,000 L/s to 10,000 L/s. Only at this time when the minimum flow is increased, can additional water for out of stream uses be released from the River from the 'B' permit allocation i.e. in ten years time.

The stockwater is an existing abstraction and under Policy 13.4.1 of the proposed LWRP, 2,900 L/s of the take from the Haktere/Ashburton River is included as part of the 'A' Permit allocation of the proposed Plan, although not subject to water flow restrictions. As the proposed LWRP currently stands, there is no ability for ADC to transfer water from the Hakatere/Ashburton River to another user above 2,900 L/s. As the 'A' Permit allocation is full, any new abstractions from the river will be subject to a 'B' Permit status. Therefore, any transfer of water within 2,900 L/s to another user may potentially retain the same 'A' permit priority. Given this and that no additional water can be abstracted from the river, there must be a price that someone would be willing to pay to obtain that water, should ADC wish to transfer water within the next ten years. The alternative would otherwise be to wait ten years until the Hakatere/Ashburton River minimum flow was raised before being able to abstract water and if obtaining a new allocation of water (i.e. not currently abstracted or allocated), would likely be subject to a 'B' permit minimum flow of 14,000 L/s.

10.2 Returning water to the source

The Hakatere/Ashburton River is over-allocated. The consented allocation is thought to be in the order of 18,000 L/s for 'A' permit allocation (Don Vattala, pers com.), considerably more than the 11,800 L/s set out in the NRRP. There is also an additional 1,340 L/s consented as 'B' permits.

The proposed LWRP proposes an 'A' permit allocation of 15,100 L/s and a 'B' permit allocation of 5,000 L/s – an increase on existing limits set out in the NRRP. As it currently stands under the proposed LWRP, the 'A' permit allocation is full and there is only 1,660 L/s remaining in the 'B' permit allocation (existing allocation of 1,340 L/s plus the proposal to increase the minimum flow to 10,000 L/s for 2,000 L/s of the RDR abstraction).

Likewise, the minimum flows in the proposed LWRP are a substantial increase on existing restrictions, stepping up from 6,000 L/s in 2012, to 10,000 L/s in 2022 for the main stem river. The reasons for increasing minimum flows in the catchment were set out in Section 2 of this report.

The Regional Council proposes a number of measures to achieve the increased minimum flows in the Hakatere/Ashburton River mainstem, while also allowing for an increase in irrigated land:

- revised allocation limits
- water permit transfers
- water sharing
- water harvesting and storage
- allowing users to resort to the taking of groundwater in surrender of an equivalent surface or hydraulically connected water permit
- increasing minimum flows on tributaries, including Taylor's Stream from 300 L/s to 500 L/s, O'Shea Creek from 50 L/s to 450 L/s and Lagmhor Creek from 25 L/s to 100 L/s
- reallocating 2,000 L/s of the RDR abstraction from an 'A' permit status to a 'B' permit with subsequent higher minimum flow restrictions
- removing the option for Greenstreet Irrigation Society to abstract water at a rate of 1,200 L/s from O'Shea Creek (a tributary of the North Branch)
- reducing ADC's stockwater abstraction from the Hakatere/Ashburton River from 5,355 L/s to 2,900 L/s from 1 July 2015 (Policy 13.4.1).

These initiatives will be implemented progressively from the proposed LWRP becoming operative in late 2013, including a review of the conditions of existing water permits. The proposed minimum flows will only be attainable if all of these measures are implemented, allowing the river to no longer be over-allocated. Until these minimum flows are enforced, it is not considered that there is any spare capacity in the river to allocate water to out of stream users.

Hence, the decrease in stockwater abstraction from the river is seen as an additional tool to increase flows in the river alongside the measures mentioned above. Enforcement of Policy 13.4.1 on its own will not achieve the objectives of the proposed Plan. The allocation limits set out in the proposed LWRP, and in particular, the 'A' allocation limit, are based on ADC reducing their abstraction 'from the River' to 2,900 L/s. As a fundamental report behind the modelling of the River is as yet unavailable, it is unknown whether the reduction is related to the entire catchment or just from the north and south branches of the River. The Policy suggests leaving 2,455 L/s in the river from a current allocation of 5,355 L/s, although it is noted that the abstraction of 100 L/s at McFarlanes Terrace may soon close. The structure of the proposed water allocation regime is such that any volume of water above 2,900 L/s could not be transferred to another user or used for any other purpose – it would have to be surrendered back to the river.

Replacement resource consents were granted to ADC in February 2012 for a 20 year duration. The Regional Council could give effect to Policy 13.4.1 under the following circumstances:

(1) A replacement application for an expired consent.

(2) The consent holder seeking to alter their consent, for example, a transfer of consent, or seeking an alternative groundwater abstraction.

(3) The Regional Council initiates a review of the conditions of a consent as provided for in that consent.

When reviewing conditions of a resource consent, Section 131(1)(a) of the RMA states that Councils *"shall have regard to the matters in section 104 and to whether the activity allowed by the consent will continue to be viable after the change"*. Section 104 includes relevant provisions of a plan or proposed plan (i.e. Policy 13.4.1). Therefore, consideration will need to be given as to whether any change to the conditions of the consent arising from a review will be such that the consent can no longer be exercised.

This study has shown that the stockwater network as an open race scheme will not be viable at a reduced flow as water will not make it to the extremities of the network and service will be lost. ADC will not be able to effectively operate the existing network on a substantially reduced flow as proposed in the LWRP, without losing service to parts of the scheme. Therefore, the only viable option of reducing the abstraction rate will be for ADC to pipe all or part of the network, the costs of which were set out in the preceding section.

Policy 13.4.1 seeks a desired end state and has the support of the Ashburton Zone committee. The risk is that if the balance of the abstraction (potentially up to 2,455 L/s) is used for other purposes, the environmental objectives of the Plan will not be realised. However, surrendering this water back to the River would align with gifting something back to the environment. Given that the activity and the stockwater races have formed part of the environment for over the last 100 years or more, careful consideration needs to be given to how these objectives can be realised.

If consent limits were reduced by 2,455 L/s to return water to the river in line with the proposed policy, this water would be unavailable for other uses, namely, it would be unavailable to be transferred for irrigation purposes to generate revenue – increased irrigation and productivity also being a regional objective. The economic viability would be significantly impacted as the same costs would need to be met but by greatly diminished benefits (as the irrigable area would be much less).

A balance needs to be found. The ADC abstraction forms part of a bigger picture and the Regional Council are seeking new and existing users of the resource to play their part in achieving the proposed objectives. Piping the network to achieve the Plan's environmental objectives will have a number of positive effects (leaving water in the river, achieving biodiversity objectives, and increased irrigation and productivity). However, not being able to transfer or sell the required quantities from the Hakatere/Ashburton catchment means that costs will not be able to be reasonably offset and someone will have to bear the cost of implementing a water efficient network.

The alternative is that the environment continues to bear the cost and the proposed allocation regime is not realised. The Regional Council are working to a long term plan to achieve the environmental objectives – they note that changes to the flow regime need to occur over time to ensure minimal impact on existing activities. Set against a background of the existence of this 100 year activity, and a continuing trend of dairy conversions with farmers resorting to accessing groundwater, there may be a middle ground that can be reached. Races are continuing to be closed with approximately one third of the scheme closed over the last eight years. Assuming this trend continues, this leads to consideration as to whether the network can be rationalised and the network progressively piped starting with a part of the network served by the Hakatere/Ashburton River. Certainly the costs of providing a replacement piped scheme will reduce over time as the area requiring service reduces.

10.3 Biodiversity initiatives

The Ashburton ZIP takes a catchment approach to achieving the protection and improvement of waterways and accordingly states that *"none of the priority outcomes can be considered in isolation and the integration of all aspects of water management is needed to achieve the Zone Committee's priority outcomes"*. These actions have been set in the CWMS including the efficient use of water and increasing irrigated land area and reliability.

A part of this study includes an assessment of the ZIP recommendations and whether available water can be utilised to achieve any of these targets.

Only those priority outcomes and actions for which ADC has specific responsibility (as opposed to part of the Zone committee) as a leader or partner have been considered and are set out in Appendix IV. However, there are a number of other recommendations for which ADC has no direct responsibility (other than as part of the Zone committee) but which may have an impact on the stockwater network, for example, recommended action 4.2.1. This action seeks to *"identify and support activities and strategies to improve and optimise rural water-use efficiency in the zone. This will include how to provide reliable stock water across the zone…"*(p.36). The full ZIP can be found on the Regional Council's website.

The ZIP identifies multiple actions including the provision of green corridors from the hills to the sea and increasing flows in the Ashburton River. It recognises the need to manage the water races for multiple uses including for biodiversity opportunities. Mainline races can also provide an opportunity as an artificial waterway to provide a green corridor through the District. The ZIP recommends identification, mapping and subsequent prioritisation of biodiversity areas with high values. This recommendation is consistent with the requirements of ADC's resource consents.

The existing resource consents for the water races provide for ecological assessments to be undertaken and to enhance those water races that are identified as having high value. There is an inherent expectation that the races should provide optimal habitat during the term of their consent and provide appropriate management in the operation of or change in the network. There is potential conflict here with the measures proposed in the proposed LWRP as it currently stands.

Piping the network might be considered to be inconsistent with the biodiversity targets set out in the ZIP but there is provision both within the ZIP and the consents for the closure of races and their appropriate management with respect to the translocation of species and mitigation through appropriate enhancement or restoration initiatives.

Given the policies and the rules in the proposed LWRP as they currently stand (and in particular, Policy 13.4.1), it is unlikely that ADC would be able to transfer the quantities of water needed to offset the cost of implementing a water efficient piped scheme. It is acknowledged that the proposed regulations may change following further river modelling work and the hearing process.

It is accepted by many that given the long existence of the races that they do form part of the existing environment. The Commissioner for the hearing of the replacement consents referred to the race network as "*…an 'embedded' part of the existing environment in terms of its relationship and effects upon the social and economic characteristics of the communities it serves as well as the nature of the water, soil and ecosystems that have developed in consequence of its operations.*" (para 4.9). Some may argue that on the basis of this, today's environmental baseline for assessing potential effects includes the existing races and the consented abstractions.

However, set against a background of national policy to address water quantity and water quality issues and the increased pressure on resources, it is also widely accepted that such a system would be unlikely to be considered environmentally acceptable or sustainable today. In the current climate, there is a responsibility on all users of the resource to use water more wisely and an approach that is fair is one that applies to both existing and new users.

Given the timeframe to achieve the objectives in the proposed plan and that these are as of yet uncontested, it is recommended that ADC continue to pursue the recommended actions in the ZIP and comply with conditions of their consent to undertake ecological assessments to identify any areas of high biodiversity value within the races. Given the current trend for dairy conversions and a likely continuing decline in the need for the water races, there is a need in the meantime to more seriously consider rationalisation of the races. What will the need be to service the network upon consent expiry in 20 years' time?

However, if piping the network is to be realised, ADC would need to transfer the required amounts of water to generate revenue to offset the costs of such a scheme. Irrigation is the only use that would provide this need. Under these circumstances, it would be appropriate for ADC to gift something back to the river. The proposed flow regime in the LWRP and the identified measures to implement the regime should reflect this need.

11 Potential Risks and Barriers

There are a number of potential risks and barriers for ADC with respect to their current stockwater resource consents and for the future, should a transfer of water be pursued. Outlined below is a summary of those challenges set out within the body of this report. In setting out this summary, it is noted that the environment today is different to that considered at the time the replacement applications were first lodged ten years ago and it will be more challenging again in 20 years time upon expiry of ADC's existing consents.

- The resource consents were granted for a duration of 20 years. This timeframe was considered sufficient to plan for any replacement infrastructure and to identify areas where the races might be the only practicable option to deliver stockwater. These aspects will need to be given due consideration in any replacement consent application in 20 years time.
- Approximately one third of the race network has closed over the last eight years (refer Figure 2.3). A continued reduction in races is likely over the duration of the existing resource consents as more properties convert to dairy farming requiring higher quality water and the desire to remove races from paddocks. This raises issues about the future of the stockwater network given expected land use changes over the foreseeable future. A survey of users should be undertaken at regular intervals to ensure accurate usage data and to identify any end users of the scheme.
- Race closures may be subject to the requirement of an archaeological authority under the Historic Places Act (1993) for pre 1900 structures.
- Only small gains in efficiency are possible without converting the open races to a piped network.
- There may be technical and practical difficulties in piping small stockwater and domestic flows with irrigation water if a combined scheme were considered. This may make such a scheme infeasible.
- If a transfer of water is pursued, ADC or the party seeking water, would first need to apply for a new resource consent for irrigation purposes (i.e. create a new use), followed by a transfer in name. Any consent for irrigation purposes is likely to be publicly notified.
- The Regional Council might allocate a portion of any transferred water to first order priority uses (i.e. the environment) in accordance with the CWMS.
- ADC would need to negotiate with RDR to change the use of water supply of 230 L/s from stockwater to irrigation.

- A transfer of water must satisfy all conditions as a 'restricted discretionary' activity, otherwise a transfer would be considered a 'non-complying' activity for which consent will only be granted under exceptional circumstances.

- A transfer of water without any partial surrendering of water is possible provided water is transferred to an irrigation scheme with water storage and subject to seasonal/annual volume and minimum flow restrictions.

- Groundwater is the only reasonable alternative to current sources of abstraction, although the cost of accessing large volumes and the requirement to show efficient use would necessitate piping of the network. Consideration should be given to the cost of sinking wells and operation or maintenance costs.

- If the network was piped and abstraction reduced to that only necessary for stock drinking and domestic purposes, surface water is still a possible source of abstraction, but only from higher quality sources or via storage ponds to prevent silty water entering the piped network where it will reduce capacity and create maintenance problems.

- Abstraction of surface water may be subject to restrictions during low flows.

- ADC need to undertake an ecological assessment in accordance with resource consent conditions to highlight any races deemed to have high ecological value and any recommendation as to their retention or otherwise.

- ADC's existing consents are likely to be subject to a review of the conditions by the Regional Council upon the proposed LWRP becoming operative and to address any adverse effects on the environment. However, ADC will not be able to effectively operate the existing network on a substantially reduced flow without losing service to parts of the scheme. The only viable option of reducing the abstraction rate will be for ADC to pipe all or part of the network.

- Policy 13.4.1 of the proposed LWRP states that water taken from the Hakatere/Ashburton River will not exceed 2,900 L/s from 1 July 2015. This requires a reduction in abstraction of 2,455 L/s to be returned to the River – water that would be required to offset the costs of implementing water efficiency initiatives.

12 Conclusions

The purpose of this report is to:

- Review the water use and availability of the Ashburton District stockwater scheme.
- Identify means whereby additional water could be left in the rivers supplying the scheme.
- Consider what other uses could be made of the water and the costs and benefits relating to this.
- Identify risks and barriers to implementing changes in the network that would allow either less water to be used and/or water to be used for other purposes.

The report has been prepared against a backdrop of changing regulatory and landuse context, i.e. the proposed LWRP and an increase in dairy farming in the District.

Network analysis

The total consented abstraction rate for the 27 stockwater intakes is 8,281 L/s, while the actual stock and domestic demand is estimated to be approximately 745 L/s. For the Hakatere/Ashburton River, the total take is 5,355 L/s delivering stockwater and domestic provision at a pro rata rate of 483L/s. Aside from the maximum flow limits, the resource consents for stockwater are almost entirely unrestricted.

Records for each of the seven main consented intakes show that the mean abstraction rate typically ranges between approximately 50 to 70% of the maximum consented rate, but during a particularly dry summer the maximum consented rate may be exceeded. The scheme is operated according to demand, so reducing the maximum consented abstraction would effectively release only 'paper water' and may result in loss of service during a dry summer.

If the estimated 745 L/s required for actual stock consumption and domestic uses could be delivered with 100% efficiency this would make available up to 7,540 L/s of water across the network or 4,870 L/s for the Hakatere/Ashburton River catchment which could potentially be used for other purposes. However, many intakes (especially the smaller abstractions) are unable to yield their full consented flow all the time and our assessment of the larger intakes (based on historical records and derived river statistics) is that 3,666 L/s for the network or 2,377 L/s for the Hakatere/Ashburton River catchment is reliably available at 95% of the time for other uses. This is considered to be conservative as it excludes water that may be available from the other 19 smaller intakes. Some of the historical records may also be skewed as the consent limits prior to February 2012 were generally lower for the main intakes which probably influenced the way they were operated (i.e. the operators operated them within the limits at the time), adding conservatism to the estimate of available flow.

The general consensus from this and previous work is that only small gains in efficiency are possible without converting the open races to a piped network.

The possibility of combining a piped stockwater and irrigation network (using the Ashburton Lyndhurst Irrigation Scheme as an example) has been investigated. Although the cost of 'tagging on' the stockwater network would be small, the different requirements of stock and irrigation water mean there are technical and practical difficulties for a combined scheme. This may make such a scheme infeasible.

Regulatory requirements

If ADC wish to pursue a transfer of water from stock to irrigation purposes, a new resource consent would be required. Under the proposed rules, a transfer can occur without surrendering any part of that water, provided water is transferred to an irrigation scheme with water storage. Water used for irrigation purposes will also be subject to water restrictions and seasonal or annual volumes. However, as part of this process and given the transfer rule in the proposed LWRP, ADC would need to consider 'gifting' or giving something back to environmental needs as a first order priority.

If the existing open race network is to be maintained, there appear to be no reasonable alternative sources of water to provide the quantities needed to run the network. Therefore, possible alternatives for supply can only be considered if the network was piped to reduce the volumes needed to only that required for stock drinking water. The relatively small diameter pipes required for a domestic and stockwater only scheme require relatively good quality water to prevent maintenance issues and/or loss of capacity. This can only be practicably provided by either groundwater or higher quality surface sources (e.g. springs) or via storage ponds.

The taking of groundwater would be considered favourably by the Regional Council provided it was offset by the equivalent return of water to surface water resources (since most of the District is red-zoned with respect to groundwater).

Potential impacts of race closure

There are a number of potential impacts from race closures including a reduction in groundwater recharge with potential effects on shallow bores and surface flows; loss of habitat within the races for fauna and flora; and loss of visual amenity. However, recharge from seepage has not been included in the Regional Council's assessment of water available for allocation and increased irrigation may compensate in part for the loss of recharge. An ecological assessment would be required to highlight any races deemed to have high ecological value and any recommendation as to their retention or otherwise.

Alternative uses of the water

In consideration of the larger abstractions, the volume of water of 3,666 L/s estimated to be available for other uses is sufficient to irrigate 7,920 ha at an application rate of 4mm/ha over the entire network. For the Hakatere/Ashburton River catchment, 2,377 L/s will irrigate an area of 5,135 ha based on the same application rate. Over this potentially irrigable area, the productive value of the water has been assessed as $129m for the for the network and $83m for water obtained from the Hakatere/Ashburton River catchment, assuming the unavailable water can be transferred for irrigation use. The cost of supplying an alternative stockwater scheme is estimated to be $56m for the network and $36m for the Hakatere/Ashburton River catchment component. Subject to preliminary designs and more detailed analysis, and the ability to transfer the quantities needed, economic analysis suggests that the benefit from this water (if used for irrigation) is sufficient to fund an irrigation scheme and replacement (piped) stockwater scheme.

Policy 13.4.1 of the proposed LWRP states that water taken from the Hakatere/Ashburton River will not exceed 2,900 L/s from 1 July 2015. The policy seeks a desired end state and has the support of the Ashburton Zone committee. The Ashburton ZIP also identifies and recognises the need to manage the water races for a multiple of uses including for biodiversity opportunities.

If the balance of the abstraction (potentially up to 2,455 L/s) is used for other purposes, the environmental objectives of the Plan will not be realised. Surrendering the water back to the River means that water would not be available to generate revenue to offset the costs of implementing a more efficient stockwater scheme. The proposed flow regime in the LWRP and the identified measures to implement the regime should reflect this need and it is acknowledged that proposed regulations may change following further river modelling work and the plan hearing process.

Summary

There appears to be three potential ways forward:

1. The status quo remains in regards of the stockwater schemes and ADC will face increasing regulatory pressure to reduce flows.
2. ADC attempt to transfer all of the reliably available water (3,666 L/s) from stockwater to irrigation purposes. It seems very unlikely that this could occur given current proposed regulations.
3. A win/win situation is agreed with some of the water being released back to the rivers and/or provided for community benefit to assist the regional environmental objectives, and a reduced amount made available for irrigation, but still adequate to fund an alternative stockwater scheme and irrigation network.

We believe that the intent of the regulations clearly favours option three to best meet the District's long-term interests. Further work and negotiation is required to establish where the appropriate balance lies.

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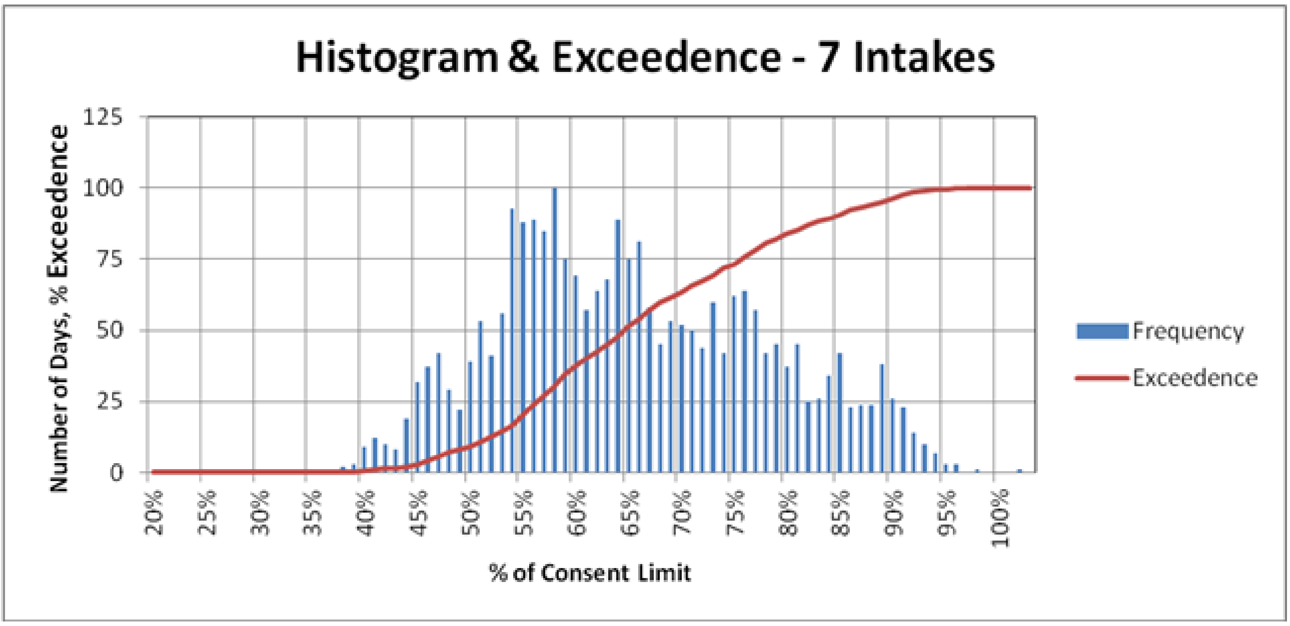
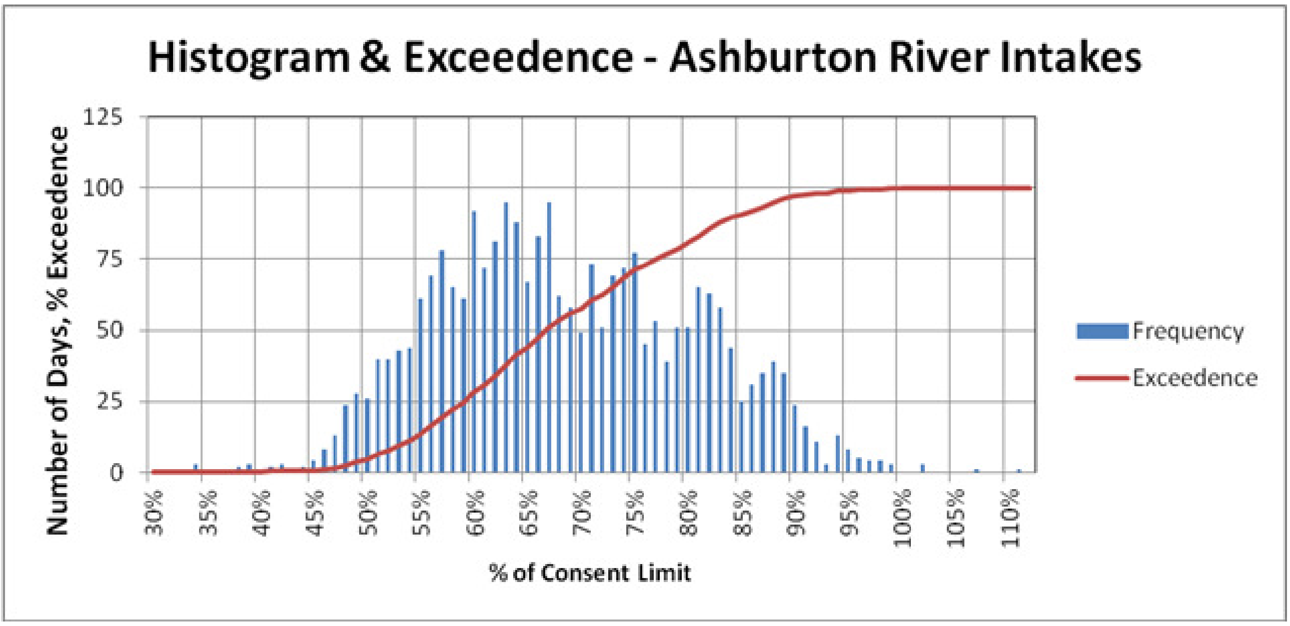
Appendix I

Ashburton Stockwater Network, Water Use and Availability

Appendix II

Alternative histogram representations of combined abstractions





Appendix III

Irrigation Water in Ashburton District: The Economic Value of Water at the Farm Gate

Appendix IV

Ashburton ZIP Recommended Actions

The rows unshaded in the following tables below are those outcomes or actions where the use of water from the stockwater races may have some beneficial impact. Those rows shaded are outcomes or actions where the taking or use of water will not have an impact.

Hakatere/Ashburton River

	Aspect	Summary of Recommendation	Level of Responsibility	Analysis
1.2.4	Enhancing recreation, education and biodiversity opportunities	Undertake feasibility study to investigate opportunities to enhance educational, recreational and biodiversity values.	Party to	The recommendation relates to an investigation of opportunities towards which water will have some beneficial impact.
		Enhance foot access.	ADC	Not relevant.
1.2.6	Investigating ways of increasing flows	ECan to provide a report on flows in the North Branch and impacts of abstraction; history of river flows and under different operating regimes; and related environmental, economic and cultural impacts of flow regimes.	Partner with ECan	To date this report is not completed and therefore not available. ADC has a role as a key contributor to ECan's report and the work behind this subject report will assist in this.
		Investigate flows in the north branch to reduce dry periods.	Partner with ECan	ECan proposes to increase flows in the North Branch by a combination of increasing the minimum flow and a reduction in ADC's stockwater abstraction. ADC's existing resource consents expire 2032. ADC proposes to review and rationalise the network in response to applications for race closure.
		Explore alternative	Partner with	As stated above, ADC

		methods for getting the flow of 6 cumecs at SH1. Including the using of unrequired stockwater from stockwater races.	ECan	has resource consents to abstract stockwater until 2032 and the newtowrk cannot operate at a reduced flow. This report considers whether water could be made available for a number of potential users including returning water to the river.
1.2.7		Investigate gravel excavation in the North Branch.	Partner with Ecan	Not relevant.
1.2.8	Ensuring the Hakatere/Ashburton sub-regional chapter (of the LWRP) provides for important values	The chapter must include flow and allocation regimes for the Hakatere/Ashburton River providing for a number of outcomes.	Partner with ECan	ADC and Ecan are to work together as part of the planning process to consider how these outcomes can be achieved and in particular, preparing a flow regime for abstractions. The work behind this subject report will assist Ecan in finalising the proposed LWRP.

Ecosystem Health and Biodiversity

2.2.1	Prioritising Immediate Steps Biodiversity Funding	Target immediate Steps Biodiversity funding to priority areas.	Party to	Not relevant. Priority for funding is for fencing of areas of high value. Secondary priority includes infill planting.
2.2.2	Integrating biodiversity into the working landscape and all new/reconfigured developments	Identify opportunities for biodiversity enhancements to be integrated into working and urban landscapes.	Party to	This action relates to an investigation to identify opportunities for biodiversity enhancement to which the taking and use of water may assist.
2.2.4	Protecting wetlands	Identify and assess the significance of existing wetlands in the zone. Identify options for improved management and protection of wetlands in the zone.	Party to	Identification and assessment of existing wetlands for ecological significance is required. The action relates to improved management and protection to which the taking and use of water may assist.
2.25	Supporting rules for ecosystem protection	Review of ADC plan to ensure adequate protection for native dryland plants.	ADC	Not relevant.

2.2.6	Increasing community understanding of biodiversity values	Investigate opportunity's to raise communities understanding of biodiversity, taonga species, mahinga kai and ecosystem services.	Party to	Not relevant. This action is an educational exercise.
2.2.7	Developing a biodiversity corridor from the mountains to the sea	Identify opportunities to enhance existing waterway corridors to provide a green corridor from the hills to the sea.	Party to	Waterway corridors can be either natural or artificial. ADC races have existed for over 100 years and have some instream values. The races are an example of the potential to provide a green corridor from the hills to the sea.
2.2.9	Identifying and monitoring of indigenous biodiversity values	Support ADC biodiversity action plan.	ADC	ADC are required to review and provide an update on the Biodiversity Action Plan to identify areas of value.
2.2.10	Protecting remaining biodiversity	Identify and prioritise indigenous biodiversity values in lowland streams, waterways, wetlands and hapua; Develop and implement strategies to protect and enhance values; Identify fence and control weeds.	Party to	This action relates to identification and the implementation of strategies to protect, maintain and enhance biodiversity values. The taking and use of water may assist.
		Extend survey of dryland biodiversity.	ADC	Not relevant.
2.2.12	Improving drainage management	Implement drain management techniques and timing to reduce the impact of drain cleaning	Party to	Not relevant.
2.2.14	Managing stock water races for multiple values	Implement management recommendations for races with existing high biodiversity values which are to remain open, Mitigate effects of closing open channel stock water races. Educate landowners.	Party to/lead	Those races with existing high biodiversity and/or mahinga kai values need to be identified. Effects on biodiversity by the closure of races should be mitigated.
2.2.15	Establishing a biodiversity	Investigate opportunities to provide	Party to	ADC races have existed for over 100 years and

	corridor in Ashburton town	a green corridor through Ashburton town focusing on waterways.		have some instream values. The races are an example of the potential to provide a biodiversity corridor.
2.2.16	Protecting remaining biodiversity	Identify key dryland remnants and develop options to protect and enhance them.	Party to	Not relevant.
2.2.18	Protecting remaining indigenous biodiversity	Engage and develop an action plan with landowners on the impact of development on water quality, quantity and biodiversity downstream.	Party to	Not relevant. This action appears to be more educational in nature to understand areas of biodiversity and impacts of development. Requires an action plan.
2.2.19	Controlling weeds in foothills streams	Undertake weed control.	Party to	Not relevant.
2.2.21	Controlling wilding trees	Investigate options to eradicate Wilding trees.	Party to/Lead	Not relevant.
2.2.22	Protecting remaining indigenous biodiversity	Work with landowners to prevent stock access and vegetation clearance of waterways, wetlands & lakes.	Party to	Not relevant.
2.2.23	Managing landuse intensification, irrigation and nutrients	Through planning rules, nutrient load limits and consent conditions ensure no impacts on significant biodiversity.	Party to	Not relevant. Relates to planning rules.
2.2.25	Controlling wilding trees	ADC to remove source trees for Wildings at Lake Clearwater. Eradicate Wildings spread in the basin.	Party to/lead	Not relevant.
2.2.30	Protecting habitat of braided river nesting birds	Ensure riverbed nesting birds are protected from human disturbance during breeding season.	Party to	Not relevant.
2.2.32	Protecting wetlands and native vegetation	Identify threatened native vegetation sites and support programmes to provide protection and enhancement.	Party to	Not relevant. Relates to identification of threatened native vegetation sites.
		Enforce existing rules for vegetation clearance and wetland drainage.	Partner with ECan	Not relevant. Regulation and enforcement.

Water Quality

3.2.1	Setting water quality monitoring priorities	Identify areas where water quality is under threat and declining; data is insufficient; the need for a new monitoring site.	Partner with ECan	Not relevant. This action is an identification exercise.
3.2.2	Developing and implementing a comprehensive and consistent monitoring and reporting programme	Monitor water quality focussing on Hakatere, Hinds River Catchment and Pudding Hill Stream. Identify critical issues and 'hot spots' and undertake actions.	Party to/Lead?	Not relevant. This action is an identification, mapping and monitoring exercise.
3.2.4	Ensuring good water quality for recreational opportunities	ECan and ADC to identify and map additional recreational sites for water quality monitoring.	Partner with ECan/lead	Not relevant. This action is an identification and mapping exercise.
3.2.5	Ensuring high quality drinking water	Support ADC initiatives to improve community water supplies and and protect domestic water supplies.	ADC	Not relevant. Relates to protection of supply from contamination and for, example, securing high quality water (e.g., groundwater)
		Identify opportunities to provide domestic water supplies currently sourced from stock water races with alternative water sources.	Party to/Lead	It is preferred to source groundwater for potable supply but any scheme would need to comply with the drinking water standards. Otherwise individual point-of-use treatment may be appropriate.
		Identify: catchments or areas where groundwater quality is poor or deteriorating and current domestic drinking supplies are at risk of reduced reliability; areas where further groundwater monitoring is required; opportunities and strategies to reverse deteriorating quality trends.	Party to/lead	Not relevant. Relates to water quality and domestic drinking water.
3.2.6	Managing urban stormwater for improved water quality in	Identify current threats to water quality. Encourage businesses to minimise water use and their contribution	Partner with ECan/Lead	Not relevant. Relates to stormwater management.

	receiving streams	to stormwater runoff.		
		ECan runs 'Improving Urban Waterway Health Programme' in towns where stormwater enters waterways.	Partner with ECan	Not relevant. Aims to target and therefore manage stormwater to improve water quality.
		Work with industry to ensure management of water use and discharges to best practise standards.	Partner with ECan	Not relevant. Relates to management of industry stormwater.

Water Quantity

4.2.2	Using water efficiently in urban areas	Support strategies to improve urban water-use efficiency.	ADC	Not relevant. Relates to urban water use efficiency.
4.2.3	Encouraging water users to meet water metering regulations as soon as possible	Ensure water metering regulations are complied with in a timely manner.	Party to	ADC will encourage compliance with water metering regulations.
4.2.7	Managing groundwater levels	Manage groundwater so that any increased irrigation upcountry will not negatively impact on surface water east of State Highway 1.	Party to	Relates to the impact of up-country irrigation to water levels in lowland streams; and management of allocation regimes and limit setting in the Plan.
4.2.8	Investigating issues and opportunities around stock water races	Identify key issues, opportunities, concerns and management options for stockwater races. Protect water availability for smaller land-holders.	Party to/lead	This study contributes to this action.
4.2.9	Increasing water reliability and irrigated land area	Encourage collaboration to identify options for optimising water supply and use. Investigate potentially irrigable land area; and difference between consented and actual take water take.	Party to	This study contributes to this action.
4.2.11	Involving Ashburton Zone Committee in regional 'water security' work	Involve the Ashburton Zone Committee in regional work programmes.	Party to	This action relates to region wide water projects. This study will contribute to this action.

	programmes			
4.2.15	Encouraging innovation and investment in our zone	Encourage/develop: a research and development project or centre of excellence; local development of water-related technology; local training opportunities; existing innovative groups; industries to develop a 'clean green image'.	Party to/Lead?	Not relevant. Relates to training and support.

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