Evidence to the Commissioners on the proposed Canterbury Land and Water Regional Plan from Orari Flows Steering Committee

The evidence is being presented by five members of the steering committee, although there will be additional members present supporting the evidence and answering questions at the hearing.

1. EVIDENCE BY JUDY BLAKEMORE

1.1. My name is Judy Cassandra Blakemore. I am employed by Timaru District Council within the Drainage and Water Unit and manage the source and treatment of Council water supplies.

1.2. I participated as a member of the community Steering Committee that developed the Pareora Catchment Environmental Flow and Water Allocation Regional Plan between November 2007 and August 2010.

1.3. In my evidence on behalf of the Steering Committee I will cover:

- The process the Steering Committee were involved in.
- Tributaries to the Orari.
- Testing the workability of the plan.
- Additional policy requesting review.

2. The Process the Steering Committee were Involved In

2.1. The Steering Committee is a group of 15 with representatives from the different stakeholder groups in the Orari Catchment. The Steering Committee was established following a number of meetings with a large Orari River community action group. The members are listed in the table below.

Member	**Organisation**
Ad Sintenie	Orari Opihi Pareora (OOP) Zone Committee Orari River Protection Group
Drew Brown	Orari River Protection Group
Bruce Allen	Orari River Protection Group
John Waugh	Orari River Protection Group
Mark Mulligan	Orari Water Inc (Chair)
Hamish McFarlane	Orari Water Inc
George Leslie	Orari Water Inc
Nick Ward	Orari Water Inc
Haidee McCabe	Consultant for Orari Water Inc
Judy Blakemore	Timaru District Council
Mark Webb	OOP Zone Committee Fish& Game
Rosemary Clucas/	Department of Conservation
Nicholas Dunn	Department of Conservation
Mandy Home	Te Runanga o Arowhenua
Karl Russell	Te Runanga o Arowhenua

2.2. Members of the Steering Committee represented a cross section of the local community with interests in the Orari River Catchment. While viewpoints were wide and varying, all members participated in good faith in an endeavour to produce an environmental flow and allocation plan acceptable to the wider residents and visitors to the Orari. Resolution of individual issues was not always to everyone's benefit but when taken as a whole the gains and losses for individuals produced a balanced outcome acceptable to all. A potential weakness in this process is that sectional interests outside the process may highlight the end results that are negative to them without the benefit of knowing how their interests were included and weighted against other interests, and without also acknowledging the positive outcomes. There is no way to avoid this although the regular public forum where the Steering Committee reported back provided opportunities for individual input.

2.3. The Steering Committee meetings were facilitated by ECan staff. There was no chair of the Steering Committee. The role was to gain information from the many presentations, request further information, have discussion and balance the issues on ecological, environmental and economic impacts. Consensus was reached although it is my belief that no committee member achieved the ideal for themselves and all had to compromise.

2.4. The committee would have preferred to have more time to carry out this work but the deadline was set at 6 June 2012 when the plan was presented to the zone committee. Hence the request for ECan to obtain more data and review the river model in 3 years.

2.5. The first Steering Committee Meeting was held on 23 November 2011 in Geraldine. At this meeting the group was provided with a recap of nine Orari River community action group meetings held in 2009-2011. At this meeting it was realised that there were issues related to the hydrology and model of the Orari River and environment. Two technical groups, a hydrological and an environmental group were set up, and included some steering committee members, ECan staff and specialists. Both technical groups met and reported back to the steering committee. Without these technical groups the Steering Committee would not have been able to proceed with determining a future flow regime. For example the hydrological group modified the flow model to ensure it more accurately reflects the Orari River flows.

2.6. A total of eight Steering Committee meetings were held, where information was presented and considerable discussion had on economic environmental and ecological issues, river hydrology, water efficiency, water metering, water allocation, transfer of permits, augmentation, water use restrictions, stream depletion, damming, water yield and water quality. Unfortunately there were some areas where limited information was

available such as Coopers Creek and the cultural report from Te Runanga o Arowhenua, which was never received.

2.7. The Steering Committee set up a number of flow scenarios to be modelled but it was not until the end of May 2012 that the group determined the flow regime that is in this plan which gained consensus of the group.

3. Tributaries to the Orari

3.1. A major issue for the group was a lack of flow data in the Orari system especially relating to the tributaries.

3.2. Within the Coopers Creek catchment there is a number of inconsistencies in water permits, relating to the low flow requirements, causing issues. Some consents have no low flows while others are connected to the Orari River,

3.3. The group followed the recommendation of ECan planning staff for Coopers Creek, a relatively small portion of the Orari catchment, which was to link the low flow to the Orari Main stream, upstream of Ohapi recorder. The group has emphasised to ECan that data must be collected to ensure decisions can be better informed for future reviews of chapter 14.

3.4. The Coopers Creek Ecological Values and Flow Requirements Draft Report was forwarded to the Steering Committee in November 2012, several months after the draft LWRP was notified.

3.5. Rhodes Stream catchment has only two consents with the low flow conditions on Rhodes Stream. Again the group followed the recommendation of ECan planning staff

for Rhodes Stream, a relatively small portion of the Orari catchment, which was to retain the low flow link to the Rhodes stream recorder at Parke Road.

4. Testing the Workability of the Plan

4.1. The Steering Committee submitted that ECan test the wording in the plan to ensure that the wording gave clear information to the ECan staff who process consents. We have not been advised that this has occurred however members of the committee have considered several scenarios and it has become apparent some changes are required to deliver the intent of the steering committee and give certainty to the users of the plan.

4.2. Issues found include no definitions for A permits, B blocks or allocation, an incomplete definition for Orari conjunctive use zone and a change required to policy 14.4.9 as the definition and policy must include surface water.

4.3. Definitions requested are:

- A permit: An existing lawfully consented irrigation take at 11/8/2012.
- B Block: An allocation for storage water from high river flows.
- Allocation: Allocation is the total volume within all the A permits at 11/8/2012.
- Orari conjunctive use zone: All Surface and groundwater takes which are 30m deep or less and are considered to have a direct hydraulic connection with surface water.

4.4. The policy 14.4.9 should be amended to read:

All surface and groundwater takes for irrigation from the Orari catchment within the conjunctive use zone where the screen is less than 30m deep shall have minimum flow conditions consistent with the minimum flow sites and allocations in Table 15.

5. Additional Policy Requesting Review

5.1. As per our submission we requested a review on the plan in three years. We now request this be included as an additional policy to ensure this happens.

5.2. Extensive discussions with DOC including a meeting of representatives on the 3 May 2013 was held to discuss their submission. The outcome of this meeting and further discussions is the agreed proposed policy detailed in the evidence of Mark Webb.

Judy Blakemore

14 May 2013

6. EVIDENCE BY JOHN R WAUGH (HYDROLOGIST, RETIRED)

6.1. My name is John Robert Waugh, I have been employed as an Hydrologist for over 40 years, from 1969 to 2010. From 1982 to 1990 I was employed by the South Canterbury Catchment Board (SCCB) as their Senior Hydrologist, based in Timaru. I am very familiar with the Orari River catchment and carried out numerous flow measurements at Orari Gorge and on Ohapi Creek.

6.2. My evidence will deal with 4 main topics:

- Hydrology.
- Conjunctive use zone.
- Damming.
- Water efficiency for Irrigation
- B Block Allocation

7. Hydrology of the Orari Catchment

7.1. The upper catchment of the Orari River above the gorge is 520km^2 and supplies 74% of the water resource, while rainfall contributes only 20% of the flow. The Coastal Plain of the Orari River, Ohapi Creek and Coopers Creek totals 230km^2, downstream of Orari Gorge.

7.2. Table 1 presents a summary of some flow statistics for the Orari River at the Gorge (1964-2008), which is the only long-term site in this catchment, together with Orari upstream (u/s) of Ohapi and finally Ohapi Creek at the Milford-Clandeboye Road. These sites are in the lower Orari catchment and have relatively short records. The

values quoted in Table 1 are largely based on data from Table 4.1, 4.4 and 4.6 of Burbery and Ritson (2010) and all values are in litres per second.

Table 1. Flow Statistics for the Orari River

Statistic	Orari at Gorge (10/1964 to 5/2008) l/s	Orari u/s Ohapi l/s	Natural Values[1] l/s	Ohapi Creek l/s
Minimum Flow	1560	1300 (natural)	1146	
NES Flow	2244	1197	1197	1286
MALF,7 day	2805	1496	1496	1429
Median Flow	6604	3843	2684	1977
Mean Flow	9492	5561	5791	2819
Maximum Flow	860,000	----	---	---

7.3. The existing minimum flow for the Orari River upstream of Ohapi Creek is set at 200 l/s. This is clearly inadequate and is set so low that it rarely comes into effect and many consents have no minimum flow at all.

7.4. IFIM results for a range of fish species indicate that the lower Orari River u/s of Ohapi Creek needs a minimum flow of at least 500 l/s, with protection of instream flow values up to around 1,000 l/s. Refer to Figure 6, Golders (2013) included as Appendix 1. For Flows greater than 900 l/s many (8) of the habitat curves drop off as flow increases, indicating the instream conditions are less favourable for particular species, e.g. Torrentfish, juvenile Brown Trout, and Upland Bully, or for nominated life stages, e.g. Brown Trout spawning.

7.5. Note that with 1:1 flow sharing above 500 l/s, the total flow in the river reaches 1500 l/s and above this flow all water is available for allocation, while still protecting the instream habitat values.

[1] Ritson, 1 July 2012

7.6. By 2040 (a CWMS date), the minimum flow would be raised to 900 l/s. This is simply a target flow to bear in mind when the Orari catchment water management is reviewed. This value is less than the NES flow value of 1197 l/s(say 1200 l/s), and is based on the instream habitat information in Appendix 1.

7.7. The Steering Committee agreed to base the flow regime and minimum flows on the hydrological site Orari River at Upstream of Ohapi confluence, as this gave the most consistent results in the model studies run by ECan and was also recommended by Golders ecological study. The Burbery and Ritson (2010) report did not manage to establish a reliable relationship between flows at Orari Gorge (1964- 2008) and flows at Orari u/s Ohapi confluence and this precluded using Orari at Gorge as the control site. Burbery and Ritson (2010) suggest that increasing use of groundwater in the catchment has effectively introduced non-linearity to the hydrological system. This affects the historic and modern (2006-2007) streamflow correlations, so they give different results and cannot be relied on.

7.8. Flow Losses: The mean flow of the Orari River at the gorge recorder is 9294 l/s and 7-day MALF of 2805 l/s. Below the gorge a substantial amount of the flow is permanently lost from the Orari River and flows in a SE direction into the Waihi River and its tributaries, and also into spring-fed creeks in the Temuka area, refer Appendix 3 Streamline for shallow groundwater. There is a very simple geomorphic reason for this groundwater flow pattern shown in Appendix 3. In the Pleistocene (Ice Ages) around 50,000 to 20,000 years ago all the rivers flowing into the Opihi River system, including the Orari, were flowing into a deeper valley, considerably entrenched below its present levels. The Opihi River system was flowing out to a lower sea level miles East of the present coastline. This implies that all gravel outwash surfaces laid down

at that time will slope towards the lower Opihi, so it is hardly surprising that groundwater flows in that direction.

7.9. In the lower Orari River water feeds into the Ohapi Creek catchment, refer to Appendix 2, $\delta^{18}O$ Valves measured in surface and groundwater, Figure 4-25 of Burbery and Ritson (2010) to maintain the very steady flows recorded in this catchment. The $\delta^{18}O$ values (blue squares and blue circles on Fig. 4-25) can be thought of as a natural tracer, just like injecting dye into a river. The pattern or distribution of the $\delta^{18}O$ values clearly shows that Ohapi Creek water is the same as Orari River water, it is all part of the same resource. The 2006-2007 study showed that as much as 54% of the flow at Orari Gorge is "lost" from the Orari River over one year, mainly to the Waihi and into Ohapi Creek.

7.10. Water Use: Water use in the Orari catchment , including Ohapi Creek, is one- third from surface water and two-thirds from groundwater, which is unusual compared to other catchments. The shallow aquifer recharges quickly from flow events on the Orari River, but also drains quickly via numerous spring-fed streams.

7.11. Coopers Creek does not feature in this commentary largely because there is very little useful hydrological information available for Coopers Creek. The same applies for Rhodes Stream and Petries Stream in the lower catchment, near Clandeboye. There was simply not sufficient reliable hydrological data available to make sound recommendations on these minor sub-catchments. It was therefore decided that Upper Coopers (with numerous minimum flow consent conditions) and Petries Stream would be managed under the Orari u/s of Ohapi site. While Rhodes Stream would remain under the same (previous) regime consistent with numerous consent

conditions. Further information received since July 2012, has not changed the Steering Committees position.

8. Conjunctive Use Zone

8.1. The Orari River Steering Committee and its technical advisers adopted the notion of using or introducing a "conjunctive use zone" for the whole Orari catchment downstream (d/s) of Orari Gorge. The reasons for this approach are as follows:

- Surface and groundwater are closely linked, refer Appendix 2, $\delta^{18}O$ Valves measured in surface and groundwater Figure 4-25 of Burbery and Ritson (2010), and each affects the other.
- Groundwater use affects river flows and drying of the Orari River. Modelling indicates that the Orari at SH1 was naturally dry for 41 days, and is currently dry for upto 83 days, (2006-07).
- There is a rapid turnover of groundwater. The shallow aquifer does not represent a large long-term store of water. The half-life of recharge water is less than 25 days in the Orari catchment, compared to a half-life of around 400 days in the Selwyn-Waimakariri aquifer, Lee Burbery, presentation on 16 December 2010.
- A conjunctive use zone allows equitable sharing of available water for all water takes.
- A conjunctive use zone treats all water users equally, and this is not the case at present in the Orari catchment.

9. Damming

9.1. Recognition of high naturalness values in the Orari Gorge and in the upper Orari catchment above the Gorge, led the Steering Committee to recommend that damming be prohibited, both in the Orari Gorge and above the Gorge, i.e. in the upper catchments.

9.2. Below the Orari Gorge, the Steering Committee recommended that damming be treated as a non-complying activity, for the Orari River and its tributaries.

9.3. Chapter 14 of the LWRP encourages on-farm storage ponds.

10. Water Efficiency for irrigation

10.1. Minimum water application efficiency should be set at 80%.

10.2. 5 Year target of 85% where possible, i.e. on flatter areas of the Orari catchment.

10.3. The Steering Committee committee recognised that a water efficiency of 90% is too hard to achieve on variable or rolling land

11. B Block Allocation

11.1. The Orari River Steering Committee proposal contains provisions for a B Block Allocation.

11.2. The prime purpose of the B Block Allocation was to make some water available at higher flows to fill storages and thereby raise irrigation reliability to 95%.

11.3. Water from the B Block Allocation needs to be equitably distributed. This might be best achieved via a water users group.

11.4. The B Block Allocation was set so that it still allows floods and freshes in the Orari River to keep the braided channel of the river in a "healthy" state, (see following paragraphs).

11.5. The B Block minimum flow was deliberately set high at 3800 l/s in order to allow for flow variability between the A Block abstractions and the start of B Block takes. The B Block Allocation is recommended to be 1400 l/s.

11.6. Floods and freshes in the Orari River regularly rise to tens of cumecs (50-70 m^3/s), with a maximum recorded flow of 860 cumecs and a Mean Annual Flood of 274 cumecs, so there is plenty of opportunity for higher flows to clean and reshape the braided river channels.

11.7. FRE2 and FRE3 are flows which are used to describe the frequency of floods and freshes in a river. e.g. The number of floods which exceed twice the median flow is a FRE2. For the lower Orari a FRE2 is 5,368 l/s and a FRE3 is 8,052 l/s. These events average around nine per year and are largely controlled by rainfall and climate.

11.8. The full B Block allocation can be taken when flows are above 5200 l/s, with partial restrictions down to a river flow of 3800 l/s. Ritson and Stapleton (2013) note that "there does not appear to be a significant effect on the floods and freshes - even with a B Block". This is hardly surprising given the size of flood events on the Orari River.

12. References

- Burbery L and Ritson J. 2010: Integrated Study of surface water and shallow groundwater resources of the Orari catchment. Report No. R10/36. Environment Canterbury Regional Council.
- Golders Associates, Feb. 22013: Orari River Catchment, Ecological Values and Flow Requirements, 45 pp and Appendices.
- Ritson, J. and Stapleton J. 2013: Memo from Jen Ritson and Jo Stapleton to staff involved in the s.14 LWRP hearings, 2013.
- Ritson, J, July 2012: Orari mainstem modelling final scenarios. ECan report to the Steering Committee.

John R Waugh, Hydrologist (Retired)

14 May 2013

13. EVIDENCE BY MARK WEBB

13.1. My name is Mark Whitby Webb. I am employed as a Fish and Game Officer by Fish and Game New Zealand within the Central South Island Region.

13.2. I participated as a member of the community Steering Committee that developed the Pareora Catchment Environmental Flow and Water Allocation Regional Plan between November 2007 and August 2010.

13.3. I am a community member on the Orari-Opihi-Pareora Zone Committee.

13.4. I have been a member of the Orari Environmental Flow and Allocation Regime Steering Committee since its inception in November 2011, with a role to represent ecological interests.

13.5. In my evidence I will present information on behalf of the Steering Committee on –

- Current positive ecosystem values of the Orari River,
- Important flow characteristics impacting on ecosystem values,
- Flow restoration targets,
- Flow scenario development,

to show the extent to which the ecology of the catchment was considered by the Steering Committee and included in their recommendations to Canterbury Regional Council.

14. Acknowledged Orari Ecosystem Positives

14.1. The river's lower reaches support a diverse and abundant fish community largely due to an open river mouth. The lagoon configuration maintains fish passage to and from the sea and I have never seen it completely blocked. The Orari River is the smallest in New Zealand to sustain a Chinook salmon run.

14.2. The existing wetlands to the north of the river mouth were disconnected from the river when the river mouth was confined to its existing site in the 1950's. The wetlands are largely intact apart from their artificial connection to the river and are a vestige of habitat once common between the Rakaia and Waitaki Rivers. The Steering Committee support the Zone Committee's objective to use the lower Orari River and the coastal wetlands as a foundation project to demonstrate achievement of the Canterbury Water Management Strategy.

14.3. Following a decision in the Environment Court in 1997 that raised the minimum flow of Ohapi Stream at Brown's Road from 570 l/s all year to 730 l/s for February to September and 570 l/s for the remaining months, conditions in the stream for trout and salmon passage and spawning have been satisfactory.

14.4. The Orari River mouth and lagoon support valued and very well used recreational fisheries for whitebait, flounder, sea run trout and salmon.

14.5. The Orari River and its tributaries above and including the gorge are high naturalness waterbodies.

15. Flow Characteristics Impacting on Ecological Values

15.1. The current and probably last opportunity for managing the opposing requirements for retaining water instream for environmental needs, or diverting water out of stream for industry and agriculture, is provided through the Canterbury Water Management Strategy (CWMS). The key strategy is collaboration using local people to solve local problems and avoid the shortcomings of the previous strategy that inevitably lead to experts presenting conflicting opinions in the Environment Court.

15.2. Another failure of the old strategy was implementation of minimum flows as the only requirement for satisfying environmental needs. Almost every river in Canterbury has a minimum flow yet none are the better for it.

15.3. I believe the CWMS recognises the shortcomings of minimum flows by deliberately avoiding use of the words "minimum flow" and their historical connotation. Instead there is emphasis on environmental flows. There are three components to environmental flows –

- Low flow: These are flows that ecosystems can tolerate for short periods but they will decline if frequently experienced.
- Fresh flow: Flows of about three times the mean annual flow that serve to dislodge and prevent build up of algae.
- Flood flow: Flows that occur more than once per year that turn over the bed, reshape channels and maintain channel diversity.

15.4. It is fair to say the low flow issue was the most significant aspect of the catchment plan that the Steering Committee dealt with. Underpinning the evaluation of each low flow scenario assessed was the hydrological model that predicted irrigation reliability and Orari River flow at the lower river site (upstream Ohapi) based on correlation to 40 years of record for flows at the gorge and irrigation demand. To have faith in the

predicted reliability and flow information the hydrological model first had to be accepted by all parties.

15.5. In March 2012 there was agreement that the hydrological model was as reliable as it could be with the information available and testing of flow and reliability scenarios began. The Committee's deadline for the entire plan was June 2012. The Committee submitted that all surface water flow and water metering data in the catchment be reviewed three years after the plan becomes operative to ensure modelled environmental flows and reliability of abstraction used by the Steering Committee reflect reality, and if they do not, that there is a process to address the differences. A suggested additional Policy to reflect the formal review requested by the Steering Committee could be as follows

At three years from the plan becoming operative, the flow regime set out in Table 15 (excluding the Ohapi catchment) will be reviewed, subject to the requirements below. The purpose of the review is to determine whether the predicted modelling outcomes from June 2012 have been achieved and whether the flow regime specified in Table 15 is safeguarding the aquatic ecological values of the catchment.

The outcome of this flow regime review will not provide for the minimum flows identified in Table 15 to be decreased or the allocations limits identified in Table 15 to be increased.

The review will include additional data collected from flow monitoring sites within the Catchment, water metering data, and any other scientific data considered relevant.

The review will consider –

i. the reliability of supply for irrigation currently and in the future

ii. actual water use for irrigation,

iii. effectiveness of the conjunctive use zone for managing surface and shallow groundwater as one,

iv. adverse and/or positive effects on instream values and habitat from current and future water abstractions,.

v. Whether it is necessary to increase instream minimum flows and decrease allocation as per Table 15 to safeguard the aquatic ecological values of the catchment

15.6. In considering where the low flow level should be, the Steering Committee considered the natural flow regime of the river and the hydrology of the catchment provided in reports prepared and agreed to by Canterbury Regional Council and independent hydrologists. These reports were the subject of many technical committee meetings with reporting back to the main committee. The Committee was informed of Tangata Whenua cultural values through Te Runanga O Arowhenua representative attendance however the cultural review of the Orari Catchment due in April 2012, that would have been very valuable to the Committee, was not provided and was not due to be received by Environment Canterbury until April 2013. The ecological needs of wildlife including insects, birds, and fish were presented in draft reports prepared by Golder Associates for Canterbury Regional Council, and discussed at technical committee and full committee level. Current allocation, actual use, and reliability of supply was provided by Canterbury Regional Council hydrologists in consultation with irrigators.

15.7. The CWMS also provided a target for irrigation reliability of supply of 95% by 2040 and the NRRP reliability targets (WQN13) were 75% reliability 9 years in 10 or 95% reliability 6 years in 10. The Committee received a draft report on the economic impact of minimum flow proposals prepared for Canterbury Regional Council by Harris

Consulting. The Steering Committee was also guided by Ministry for the Environment proposed standards for ecological flows of 80% of the mean annual low flow (MALF) and by the final flow regime approved for the nearby Pareora Catchment Environmental Flow and Water Allocation Regional Plan in 2011 of 60% of MALF to apply from 2016.

15.8. During the development of the plan, flow characteristics of significance to environmental values of the Orari River were identified and these were compared with modelled natural flows, where the influence of abstraction could be removed, to indicate possible targets for ecological improvement (Table 2).

Table 2. Key Orari River flows contributing to ecosystem values on an annual basis at the upstream Ohapi flow monitoring site under conditions where there are only natural flows with no abstraction, and the existing situation with abstraction and a 200 l/s minimum flow (CRC modelled statistics for 1972 to 2011).

	Natural	Existing
Mean flow (l/s)	5,790	5,050
Median flow (l/s)	2,680	1,910
MALF (7 day) (l/s)	1,500	780
Days with flow <MALF	31	140
Days of flow > fresh (1.5x median, 4,020l/s)	100	89
Days of flow > flood (3x median, 8,040 l/s)	55	51
A Allocation to abstraction (l/s)		1,800
Lowest daily mean flow (l/s)	1,300	260
Consent minimum flow 100% restriction (l/s)		200
Abstraction reliability		100%
NES proposed low flow (80% MALF)(l/s)	1,200	
Days dry at SH1	44	63

15.9. This assessment indicated that in flows around mean, fresh and flood flows, the existing situation was likely to have little impact on the ecology of the river at upstream Ohapi site. Days when flows could be called either a fresh or a flood were only slightly less in the existing situation than the natural situation.

15.10. Where the flow issues lay were in the low flow range, particularly around MALF and lower. Here the river was much lower than natural with greater than four times more days at flows less than MALF, 31 against 140. It was accepted by all the members of the Steering Committee that of the three components of an Orari River environmental flow, addressing the low flow was the priority. A significant indictment of the existing flow and allocation regime was that despite the river being induced to dry up (days dry at SH1) for 50% more than the natural situation, the minimum flow for consents (200 l/s) remained lower than the lowest daily minimum flow for 40 years of modelled flows and accordingly abstraction had 100% reliability of supply.

16. Flow Restoration Targets

16.1. From information presented to the Steering Committee on ecology, hydrology, irrigation reliability, recreation, and local knowledge, the following targets for flow restoration were agreed.

Restored Habitat for Fish and Birds

16.2. Applying low flow restrictions to abstractors that are not currently limited by low flow, and increasing the low flow at which all abstraction must cease will increase the area of habitat and the diversity of habitat available to fish and birds.

16.3. The key to identifying the flow ranges of significance for fish and other wildlife is the relationship between flow and weighted usable area (WUA) for those species. WUA is an estimate of the area of habitat available for a particular activity or animal at different flows from measurement of the physical characteristics of a stream, commonly water depth, water velocity, and substrate size, and comparing this with the type of habitat needed or habitat preferences of the organism. Habitat modelling for

13 indicator species was undertaken by Golder Associates for Canterbury Regional Council and reported to the Steering Committee in Draft on 8 May 2012 (Appendix 1).

16.4. For most of the 13 indicator species maximum habitat at the u/s Ohapi site was provided in flows of between about 500 l/s and 900 l/s. The exceptions were longfin eel >300mm and adult brown trout. For these species habitat increase with increasing flow beyond 900 l/s was probably due to greater access to berm vegetation cover for eel and more diverse habitat for adult trout that can occupy a wide range of habitat types. The area of habitat available for common and upland bully changed little across the flow range.

16.5. The Steering Committee agreed that the existing 200 l/s minimum flow did not provide an acceptable level of habitat for fish and that the low flow component of the environmental flow should justifiably be set at about 500 l/s in the short term with a longer term objective of 900 l/s.

16.6. The Steering Committee also considered that there should be some measure of environmental restoration as soon as the Plan becomes operative. This scenario is identified as “current” in Table 15. In the Steering Committee’s submissions the “existing” flow regime is the one that has operated for many years and has a 200 l/s minimum flow all year. We considered that raising the minimum flow through winter and in the shoulder months of the irrigation season, the “current” flow regime, reflected the natural hydrograph of the river however to raise the minimum flow over the peak summer months required more advanced notice to abstractors. A significant benefit of the current regime is that all shallow groundwater abstractors will be tied to the monthly low flow levels where in the existing situation most have no minimum flow restriction.

Continuity of Flows for Fish Migration

16.7. Coming out of winter and through spring, natural river flows are generally high with monthly median flows of $3m^3/s$ to $4.5m^3/s$ at upstream Ohapi for September to November. Upstream migrations for juvenile long finned eel and for koaro and torrentfish occur in spring and there is extensive recreational use made of the whitebait run through the river mouth.

16.8. Sea run trout will access the river from November to February and seek spawning grounds in early winter throughout the lower river and higher if flows permit. The additional flow of Ohapi and Rhodes streams maintains satisfactory flows at the river mouth. Chinook salmon are present in the surf around the mouth and in the lower river from November to April for angling. From April to June on average 90% of adult salmon will spawn in the upper reaches of Ohapi Stream.

16.9. Provision of flows in late summer and autumn that enable fish migration between the upper and lower Orari is a requirement for koaro, long finned eel and torrentfish. Abstraction does not greatly affect the size and frequency of fresh and flood flows that provide continuity of flow throughout the river to enable fish migration but may affect the duration of these higher flows. For example comparing natural flows and the existing flows with abstraction, there is little difference in the number of days the river would exceed a fresh or flood flow however there is considerable difference in the number of days the flow at u/s Ohapi is less than MALF or about 1,500 l/s (Table 1). Abstraction increases the extent and duration of dry riverbed through provision for abstraction to continue when the river is at low flows.

16.10. Continuity of flow in Coopers Creek in the 13km of streambed between the permanently flowing upper and lower reaches generally only occurs once or twice a

year, for no more than a week at a time. The flow is so infrequent that the channel in the middle reaches is indistinct from adjoining grazed pasture and identified only by the depression of the bed. The permanently flowing lower reach is about 4km in length and the upper reach varies between 2km and 4km in length depending on summer dry back. In most summers Fish and Game undertake salvage of trout and other fish stranded in pools in the upper reach as flows recede. In the last 40 years salvage has been undertaken on approximately 30 occasions. There is no indication that salvage has been required more frequently in recent years however the number of fish salvaged has become less. For example prior to 1980 up to 450 trout were salvaged while on the last three occasions (2010 to 2012) no more than 20 have been salvaged. In a stream the size of upper Coopers Creek the removal of a significant proportion of the stream's natural trout production over 40 years is likely to be as much a contributor to the current low population status as any decline in habitat quantity or quality.

Environmental Flow Variation

16.11. One of the agreed goals of the Orari flow allocation community process was to consider variable low flows as a way to accommodate critical periods for ecological needs, irrigation demand and recreation. An initial concept was that higher stream flows in spring and autumn would improve fish habitat for migration and spawning, and for recreation, while irrigation demand peaks in mid summer. These conditions are reflected in monthly variations to the low flow in the "current" regime.

16.12. The "3 years after Operative" regime sets a higher minimum flow all year than the "existing" regime and provides for natural variation through a 1:1 sharing regime in flows of 500 l/s to 1,500 l/s.

16.13. The “2040” regime sets a target compatible with timing for achievement of CWMS targets. The Committee acknowledges that this regime is beyond the lifetime of the LWRP and its inclusion is not binding on future plans. The purpose for including the 2040 regime is to signal that environmental restoration is not completed by application of the “3 years after Operative” regime and future flow and allocation plans should continue the stepped restoration of environmental flows.

Allocation Block

16.14. Irrigation reliability is determined by stream flow, the flow at which restrictions on irrigation apply, the level of restriction, and on the size of the allocation to abstraction. ECan’s best advice to the Steering Committee was that approximately 1,520 l/s (1,524 l/s) was consented to allocation in the catchment. Information from metering of water use in a limited trial within the catchment indicated actual monthly water use across the irrigation season averaged 30% of allocation and a maximum of about 40% in February. This information was important for three reasons.

16.15. Firstly, stream flows at which irrigation restrictions are set are based on the sum of the low flow and the total allocation. If the total allocation is not used, then restrictions are probably being applied at higher stream flows than necessary to protect the low flow. Restrictions set at higher stream flows are likely to occur more often as the river spends less time at higher flows and more time at lower flows. Setting the restriction level at the low flow plus actual abstraction reduces the time the trigger flow level is reached and improves the reliability of irrigation. This is achieved without any change to irrigation demand or practices but it does require information on actual use rather then consented take.

16.16. Secondly, actual irrigation use is not constant across the season. Variable monthly demand can be modelled and compared with variable monthly ecological flow needs to identify where these are compatible or where there is conflict.

16.17. Thirdly, the Orari catchment with 1,520 l/s consented allocation for abstraction is almost double the 800 l/s recommended in the Ministry for the Environment proposed National Environmental Standards (NES) for ecological flows for a river the size of the Orari. If actual use of consented allocation is only 40% of 1,540 l/s, or 616 l/s, then reducing the consented take to the level of actual take could allow the Orari to comply with the NES.

17. Flow Scenario Development

17.1. In developing more than 50 environmental flow scenarios the Steering Committee considered the seasonal needs of fish and other fauna, the size of the allocation block and actual use, irrigation reliability, flows needed to support recreation, and signals from other recently adopted regional plans and the proposed NES.

17.2. The first scenarios were broad in their criteria to provide the Steering Committee with a better understanding of the issues having greatest effect on low flow and irrigation reliability. Scenarios compared the effect of the gorge or u/s Ohapi sites, use of current, 60% or 80% of allocation, constant low flow all year at 60% or 80% of MALF, and variable low flow of 13%, 25%, 60% or 80% of MALF including higher spring flows of 25%, 60%, 80% and 120% of MALF.

17.3. These scenarios confirmed the u/s Ohapi site was more responsive to stream flow than the gorge site, and only the current low flow (200 l/s) produced irrigation reliability greater the 90%, all other scenarios had less than 50% reliability. Variable low flows

produced a wide range of irrigation reliabilities giving some indication of potential. The results also showed that November was a critical month for irrigation reliability with potential for irrigation restrictions.

17.4. The second series of flow options further developed variable monthly low flows that were lower in summer and higher in winter and ranged from 200 l/s to 1,800 l/s, and allocation blocks of 800 l/s, 1,200 l/s and 1,500 l/s to assess the effect of the size of the allocation on reliability. The results were promising in that irrigation reliability was better although remained less than 80%. The conclusion was that to achieve reliability of 90%, storage was going to be essential and included in further scenarios. However storage could not be created overnight and it was agreed that a lead in time of three years from when the plan becomes operative was required for irrigators to implement storage.

17.5. The principal components of the final environmental flow and allocation regime to be applied three years from the Operative Plan were –

- The important low flow for ecological values was 500 l/s. At this flow five of the thirteen indicator species were at or near their maximum weighted usable area of habitat. The Steering Committee agreed a low flow of 500 l/s all year was acceptable in the short term.
- In the flow range of 500 l/s to 1000 l/s, eight of thirteen indicator species achieved maximum weighted usable area, the exceptions being common and upland bully, longfin and shortfin eel greater then 300mm, and adult brown trout. The steering committee agreed that ecological flows in this range could be provided by a band of 1:1 flow sharing between the low flow of 500 l/s and 1,500 l/s so that at 1,500 l/s the river would retain 1,000 l/s and 500 l/s would be available for abstraction.

The sharing regime also provided for a proportion of any natural flow variation in that flow range to be retained in the river.

- Above 1,500 l/s the next 900 l/s would be available for abstraction so that maximum allocation of 1,400 l/s for A allocation permits was available in flows of 2,400 l/s and greater. This provides security of supply to abstractors.
- Between 2,400 l/s and 3,800 l/s abstraction is limited to 1,400 l/s and all other natural flow and its variation is retained in the river.
- In flows above 3,800 l/s water may be taken to storage under B allocation permits totalling 1,400 l/s. At 5,200 l/s up to 2,800 l/s could be abstracted equally split between A and B allocation permits and a minimum of 2,400 l/s retained in the river.

17.6. The various components of the proposed 3 years after Operative flow and allocation regime and differences from the existing regime, are best demonstrated in chart form (Figure 1).

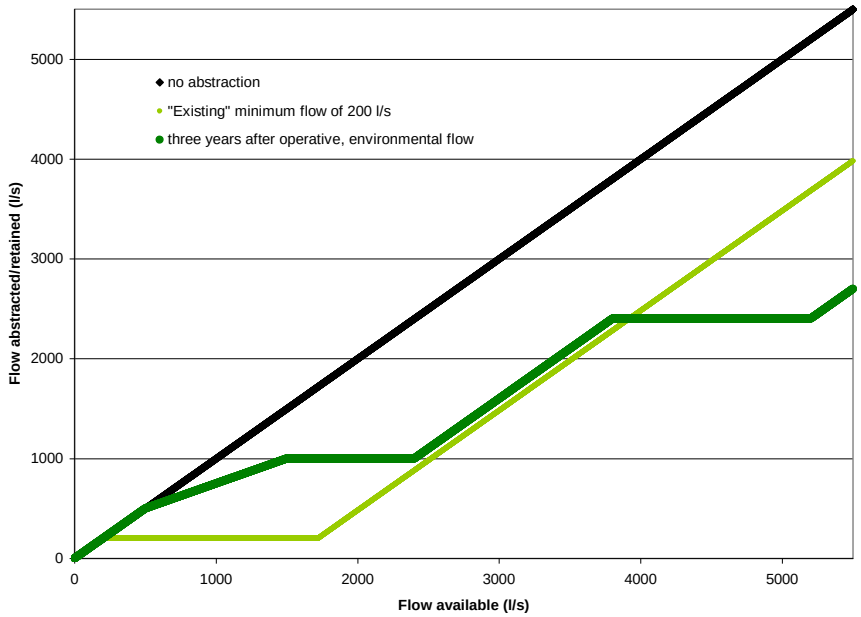


Figure 1. Comparison of the "existing" minimum flow rules and the "three years after Operative" environmental flow rules for the Orari River at u/s Ohapi site.

17.7. In Figure 1 the straight diagonal line represents the naturalised u/s Ohapi flow available for sharing between the environmental flow and abstraction. The lowest and narrower line represents the “existing” flow rules where there was a minimum flow of 200 l/s and an allocation of 1,524 l/s. The middle, wider line represents the proposed environmental flow three years after an Operational Plan. For both of the flow scenarios the flow left in the river is represented by the height of the line from the x-axis to the scenario line and the amount potentially abstracted is represented by the height from the scenario line up to the diagonal naturalised line. For example at a naturalised flow of 1000 l/s the existing rules would provide for a 200 l/s minimum flow and up to 800 l/s for abstraction. At the same naturalised flow the “3-yrs after operative” rules would allow for an environmental flow of 750 l/s and up to 250 l/s for abstraction.

17.8. In the range of flows from 200 l/s to 3,800 l/s the 3-yrs after Operative Plan scenario produces significantly better flows in the river than the existing regime. Above 3,800 l/s the existing regime provides higher flows in the river as there is no provision for B permit allocation. Offsetting this apparent erosion of environmental flows is the reality that Orari River flow at upstream Ohapi is above 3,800 l/s only 23% of the time during the irrigation season so that for the remaining 77% of the irrigation season the river will retain higher flows under the 3 years after Operative scenario.

17.9. The river is in the naturalised flow range from 3,800 l/s to 5,200 l/s for approximately 5% of the time during the irrigation season. In this flow range provision of a B block allocation has the potential to hold the river at the lower flow with the next 1,400 l/s available for storage. Above 5,200 l/s natural flow variation is retained in the river. When considering the size of the B block and the flow range over which it was to operate, the Committee considered it was outside of the priority range for flow

restoration of MALF and less, and that at only 5% occurrence any direct effects on habitat availability in the 3,800 l/s to 5,200 l/s range would be minimal. Any possible negative habitat impacts from provision of the B block were outweighed by the positive benefits of improved low flows in the river that result from abstractors having access to stored water rather than taking from the river.

17.10. In the range of naturalised flows of between 500 l/s and 1,724 l/s occurring during the irrigation season the benefit of the 3 years after Operative scenario over the existing regime is more profound. Flows in this range occur approximately 24% of the time and the 3 years after Operative scenario provides environmental flows two and a half to five times greater than the existing regime. The Steering Committee agreed that in the long term a low flow of 500 l/s was not satisfactory and flows of up to approximately 900 l/s were needed to accommodate invertebrate food producing habitat, and habitat for koaro, torrentfish, common bully, and upland bully. The target date for implementing this condition, together with the reduction in the A allocation to abstraction to 800 l/s was set at 2040 to match the achievement of targets under the CWMS.

17.11. From an ecosystem diversity perspective the Steering Committee did not see the benefit of setting the low flow higher than 900 l/s. Above this level the relationship between flow and weighted usable area presented in the Ecology report and repeated in Figure 1, indicates reduction in habitat for most indicator species at the u/s Ohapi site. As the river rises above about 900 l/s habitat that was formerly ideal for a number of species will become too deep or too fast and the area of new habitat created on the stream margins at higher flows does not replace the area of habitat available at 900 l/s. The benefits of having a higher low flow would be for recreation, particularly whitebaiting and sports fishing, and in provision of habitat further upriver where for a flow of 900 l/s at u/s Ohapi there was none or very little. No information was available

on how much of this new habitat would be created in formerly dry or very low flow reaches compared to the area lost at the upstream Ohapi site in the habitat suitability modelling undertaken there. In developing future LWRP's it is likely this information will be available and the 2040 vision will be more thoroughly scrutinised to justify this environmental flow or alternatives.

18. Summary

18.1. The Steering Committee had a short seven month timeframe for completing the development of a community agreed flow and allocation plan that had started seven years previous. The Committee were still working on the environmental flow and allocation rules for the mainstem Orari River in the week before the Zone Committee were to receive the plan in early June 2012. It is acknowledged that the mainstem low flow had the highest priority in the catchment for its affect on wildlife diversity and abundance and on the greatest number of landowners and other users. Other parts of the Catchment, notably the tributaries, may have suffered from this priority ranking and in the end the absence of sound hydrological information for the tributaries lead to Committee recommendations that current conditions be retained. This was not the case for Upper Coopers Creek. While there was a lack hydrology information this problem was compounded by variable conditions on two take permits and their restriction regimes, within the Upper Coopers Creek Catchment. The Steering Committee recommended provision for Upper Coopers Creek consents to conform with others in the Catchment, being tied to the upstream Ohapi site, to reduce inconsistencies in abstraction rules to assist precision in modelling of Orari hydrology. The Committee, by majority, considered that bringing consent conditions into line would have a likely beneficial long-term outcome for the Orari Catchment as a whole. The Committee was focused on balancing the outcome for all stakeholders, at many levels for the entire Orari Catchment.

18.2. The Steering Committee was unanimous that the existing summer minimum flows in the lower Orari River were not acceptable. It also agreed that any increase in the low flow provisions above the existing 200 l/s minimum flow would have an immediate affect on farm viability. Certainty for environmental improvement and for farming dictated that staged introduction of river flow restoration would provide necessary time for development of irrigation practices, namely access to storage and improved application efficiency, to ensure farm viability and improved environmental conditions and recreation.

M W Webb

14 May 2013

19. EVIDENCE BY HAMISH D MCFARLANE.

19.1. My name is Hamish Donald McFarlane. I am a part owner and manager of our family owned and operated, medium scale, irrigated, crop, horticulture and stock farm in the Orari Groundwater zone.

19.2. I have been involved with the Orari River Flow and Allocation Community Steering Committee since its formation in 2011.

19.3. I am on the steering committee as a farmer representing Orari Water Society (OWS); a Water users group set up to get alignment within the agricultural sector as we proceed through the collaborative planning process, and to administer irrigation water use into the future under the rules of this plan.

19.4. As a (hopefully!) long term member of the community, my role in this process is, and has been throughout, to seek a ecologically and recreationally sustainable flow regime for the river that can be enjoyed for the long term by a stable and prospering community.

19.5. The evidence I present to you now, is as a steering committee member, representing the consensus view of the group. I feel it is important to note that the steering committee is, and has been a disparate group of individuals representing a huge range of conflicting interests both personally and with regard to the management of water resource. Very few of us have technical expertise in this field. There has been a lot of contestable science, untested data and knowledge gaps for the group to deal with in a very tight timeframe. Everyone has had to swallow some bitter pills along the way. In spite of this, I feel that the group has functioned very well and come to remarkably

sensible, future proof recommendations that safeguard the rivers future and allow all stakeholders in the Orari catchment to benefit from the proposed changes.

19.6. It is a key part of this process that decisions are made by local people representing local interests. As you will know there is a high turnover of staff in the ECan technical, planning and science industry. It could be argued that the most reliable expertise in a community is an informed community itself. As such, it is critical that any plan must be robust, simple and clear to deliver the outcomes required by the community.

19.7. I will be commenting on the proposed outcomes delivered to the river and the community in relation to the:

- Flow regimes.
- Allocation.
- Restrictions under flow regimes.
- Reliability of irrigation and mitigation of restrictions.
- Socio economic effects.

19.8. I am not a planner so will not endeavour to relate my points back to specific parts of the plan but hope to reinforce to you the outcomes required by the Steering Committee and the reasons behind these recommendations.

19.9. The flow sharing regime was the best way forward for a number of reasons:

- It ensured that wherever possible the river flow was maintained to provide habitat to the widest range of species for the greatest amount of time.
- It means that no matter the numbers argued regarding allocation, stream depletion etc there is certainty for all parties – the outcome is more important than the numbers.

- It appears to be sound future proof regime for the river, preventing flat lining and outcome based.

19.10. One of the key risks is that no matter what restrictions are put in place, there may be no material change in the rivers' behaviour/ flow. This is because most irrigation takes are from shallow groundwater and most of the rivers behaviour under proposed flow regimes is based on models only.

19.11. Subsequently it is essential the plan is treated as a work in progress – adaptive management – with a review taking place once hard data becomes available. This data should be easily garnered with the metering and telemetry now taking place.

19.12. A number of tools have been put forward to achieve this:

- Conjunctive use has been adopted to deliver equitable abstraction through the shallow groundwater zone.
- OWS has been formed to manage water use and restrictions.
- Provisions for on farm storage, scheme water and B Block are included within plan policies.

19.13. Conjunctive use is a new concept for most of us. The major flaw is that it assumes if a pump stops, the river flow will increase immediately by that amount. This will clearly not be the case for most groundwater takes. However, it does deliver a certain amount of equity between abstractors, the net result being that hopefully 100% of users going on 5% restriction will have a similar net effect to 10% going onto 50% with less impact on the operation. This is a key reason to have the plan reviewed once data becomes available.

19.14. One of the key points the steering committee addressed was allocation. Existing lawful takes need to be capped, so potential over allocation is not exacerbated. It needs to include surface and groundwater takes. There is a lot of debate over the actual volume of allocation – at the end of the day, the proposed flow regime does sidestep this debate by allowing Water User Groups (WUG) to manage abstraction above the flow sharing bands.

19.15. WUG will play a key part in managing restrictions and mitigating the impacts on individual businesses. Incentives in the proposed plan are key to get maximum membership uptake to these, hence the "benefits" around pro rata restrictions for members of WUG as opposed to stepped restrictions for non members. As seen in the Ohapi, WUG work very well and there is no way there would have been the buy in from farmers on the scale we have seen for this process without the existence of OWS. They will be critically important into the future to deliver positive outcomes within catchments.

19.16. The restrictions likely to come into play – modelled only – are dealt with in detail by other submitters.

19.17. Storage will be one of the key tools available for abstractors to reduce reliability risk. Water used to fill this storage will, in the foreseeable future, be from:

- Groundwater A Take.
- Groundwater B Take.
- Scheme water (i.e RSIL).
- Surface water.

19.18. It is difficult to see large uptake of the surface water resource due to current over allocation issues and the general dependence of abstractors on groundwater. If there was a run of river B Block one would anticipate/hope it to be a community based scheme administered by WUG. Again the plan must reflect this.

19.19. You will be aware of the difficulties around setting provision for a B Block of any form. Key for the Steering Committee was that any B Block water was at a level suitable for instream health and was to be shared and accessed equitably between abstractors over the catchment, preferably by WUG.

19.20. At the end of the day, proposed flow changes may result in a large scale shift in the reliability we currently operate under. Most of the farming systems in our region are highly developed and consequently reliability of production is critical to keep the wolf out. Everyone will have different scenarios to work within. But it is imperative that we keep as many options open to ensure reliability is maintained as possible while reaching our objective of sustainable river systems.

19.21. I have included a brief overview of how we might deal with restrictions in our business below.

19.22. Our farm has five shallow groundwater wells. All five of these are likely to come under restrictions, in the conjunctive use zone (one attached to Petries). Due to a mix of deep and shallow water we have had very good reliability at 90 – 100%. This reliability has come at a cost with high levels of investment over the past 40 years.

19.23. Unfortunately in our farming system - growing high value crops on medium to light soils – reliability of anything less than 90% (probably a minimum – gut feel) has an immediate and irreversible impact on our production.

19.24. Action we are taking to mitigate the risk of future restrictions is the uptake of RSIL water to supplement our current supply. We do have the good fortune to be within the command area of this scheme which should start to deliver water this coming summer (2013 – 14).

19.25. Additional cost of this for the 250ha of shares involves:

• Standing charges (yearly)	$125 - 150k	$500 – 600/ha
• On farm storage(one off)	$150 - 200k	$600 – 840/ha
• Pipe and Pump work(one off)	$200 - 250k	$800 – 1000/ha

19.26. There has been an economic report with specifics on the impact of reliability and I will refer you to this (Simon Harris).

19.27. Suffice to say, loss of reliability from increased restrictions will cause economic loss. If predictions are correct and there is a tangible benefit to the catchment then the reduced reliability can be managed given time. If the predictions are incorrect and there is no change to the rivers behaviour in response to restrictions then we need to review the situation promptly.

19.28. Thank you for your time.

HD McFarlane

14 May 2013

20. EVIDENCE BY NICK WARD.

20.1. My name is Nicholas George Ward. I am a arable farmer at Milford, Temuka.

20.2. In my evidence I am going to present the background associated with the Ohapi Water Users Group.

21. Land Use

21.1. Land area within the Ohapi catchment is approximately 4300 hectares. Abstraction from the Ohapi Creek for irrigation covers 2900 hectares at a maximum abstraction rate of 1425 l/s. An additional 1400 hectares is irrigated from groundwater, consented at a maximum of 580 l/s. The shallow groundwater consent holders have agreed to conjunctive use, as part of the development of this plan by the Steering Committee.

21.2. Land use comprises approximately 2000 hectares of dairy farms, 1700 hectares of arable farms and 600 hectares of pastoral farms.

22. Formation of the Group

22.1. The Ohapi Water Users Group has been in operation for some 40 plus years. In 1996 we collectively applied as a group for the renewal of our existing irrigation consents. The hearing process was held during 1997 and the consents were signed off in 1999.

23. Aim of the Group

23.1. The aim of the Ohapi Water Users Group is to minimise any adverse effects of abstraction on the flows and in-stream values within the Ohapi Creek and its' tributaries, especially during periods of low flow and high water demand. In doing so, the group aims to ensure that all abstractive water users are treated equitably, while maintaining minimum flows as determined by Environment Canterbury.

23.2. The group acknowledges that Environment Canterbury has the sole statutory responsibility for the management of the water resource. The Water Users Group role is to assist this by ensuring awareness of flow rates and the rostering of abstractions when needed.

24. Principles of the Group

24.1. To comprise all abstractive water users, both surface and groundwater users. All groundwater users, who are deemed to affect surface water of the Ohapi Creek and its tributaries, are to be active members of the group.

24.2. To minimise the impact of abstraction we adhere to the following low flow restrictions. i.e. the taking of water has to cease whenever the flow falls below:

- 570 l/s between 1 October and 31 January: 50% restriction if flow falls below 1000 l/s during this period.
- 730 l/s between 1 February and 30 September: 50% restriction if flow falls below 1100 l/s during this period.

24.3. We operate a simple and sustainable roster with all members allocated days/hours based on individual allocation. It is a self-policing policy requiring the cooperation of all members. We have never had any issues regarding misuse of the resource.

24.4. In the early years of the group the minimum required flow was 570 l/s all year round. It was subsequently agreed to increase the minimum flow to 730 l/s between February and September when the consents were signed off in 1999. This increase was agreed to by the group due to the importance of the in-stream values, reliable flows and fish spawning in the upper reaches of the catchment.

24.5. The group recognises the importance of the efficient use and management of water for irrigation and are actively attempting to achieve a minimum of 85% efficiency. To do this on farm infrastructure is being improved with the use of irrigation scheduling, monitoring soil moisture levels with the use of data loggers and probes, improved application methods and telemetric recording information at pumping stations.

24.6. The group not only recognises the importance of water quantity but also water quality. The group has encouraged fencing of all streams within the Ohapi catchment and riparian planting.

24.7. To promote and encourage the formation of other water user groups within the Orari catchment and the wider Canterbury region.

25. To The Future

25.1. The Ohapi Water Users Group will continue to:

- Monitor water quantity and quality.

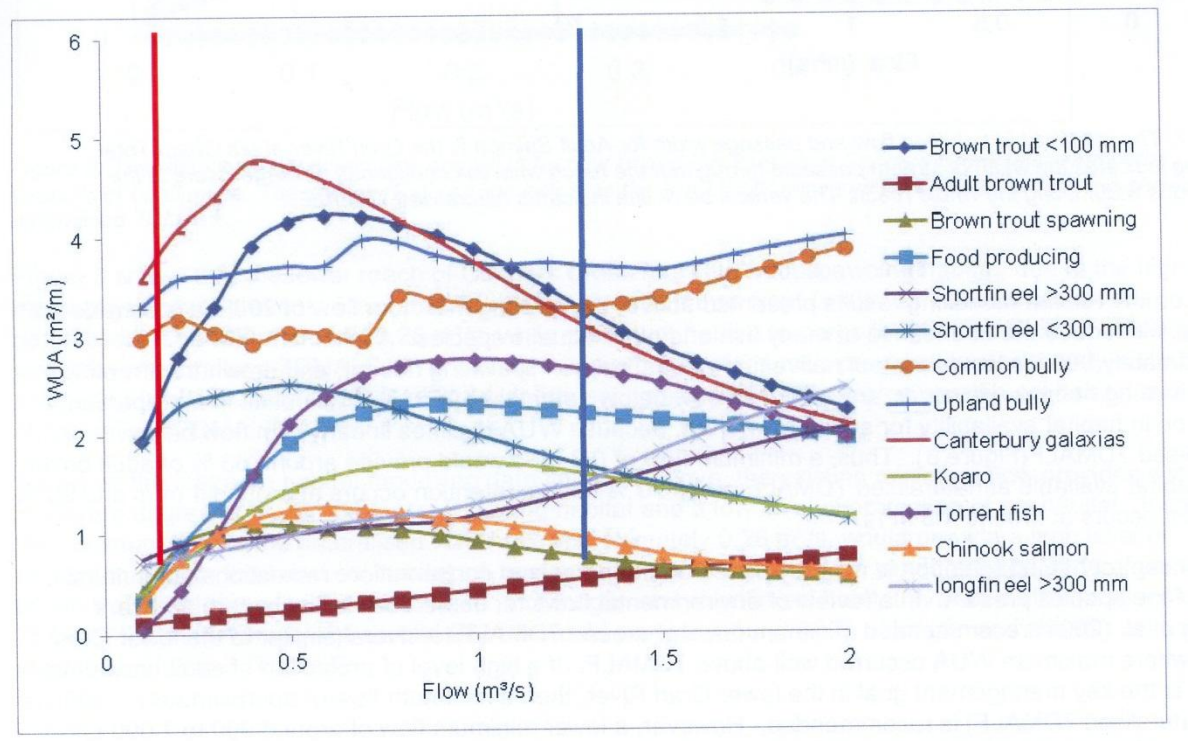
- Encourage improvement in on farm efficiency (to greater than 85% efficiency) with the use of new technology and equipment.
- Ensure sustainability for future generations.

N Ward

14 May 2013

Appendix

Appendix 1: Relationship between flow and weighted usable area for indicator species Orari River upstream of the Ohapi Creek confluence.



The solid vertical red line indicates the pre-2012 minimum flow, while the blue line represents the naturalised 7 day MALF. (Reproduced from Figure 6, Golder Associates report 0978110107-001-R-RevB, to Canterbury Regional Council, February 2013)

Appendix 2: $\delta^{18}O$ Valves measured in surface and groundwater. Reproduced from Burberry and Ritson 2010.

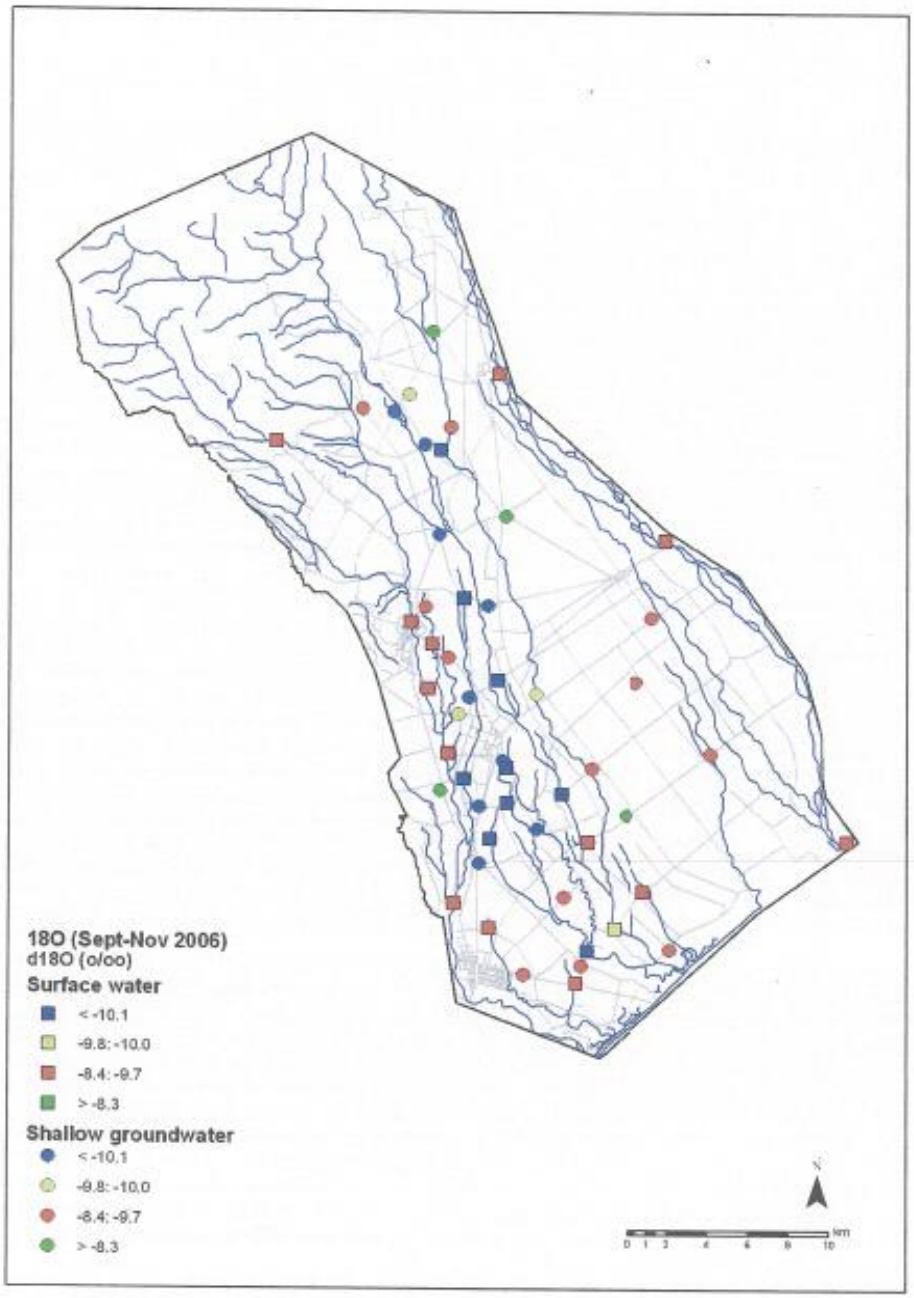


Figure 4-25: $\delta^{18}O$ values measured in surface water and groundwater. With the exception of Rangitata River datapoint, all data relate to samples collected between September and November 2006. Intervals defined by annual range of $\delta^{18}O$ values measured in main river systems: Orari (<-10.1‰); Waihi (-8.4‰ to -9.7‰)

Appendix 3: Streamline for shallow groundwater. Reproduced from Burberry and Ritson 2010.

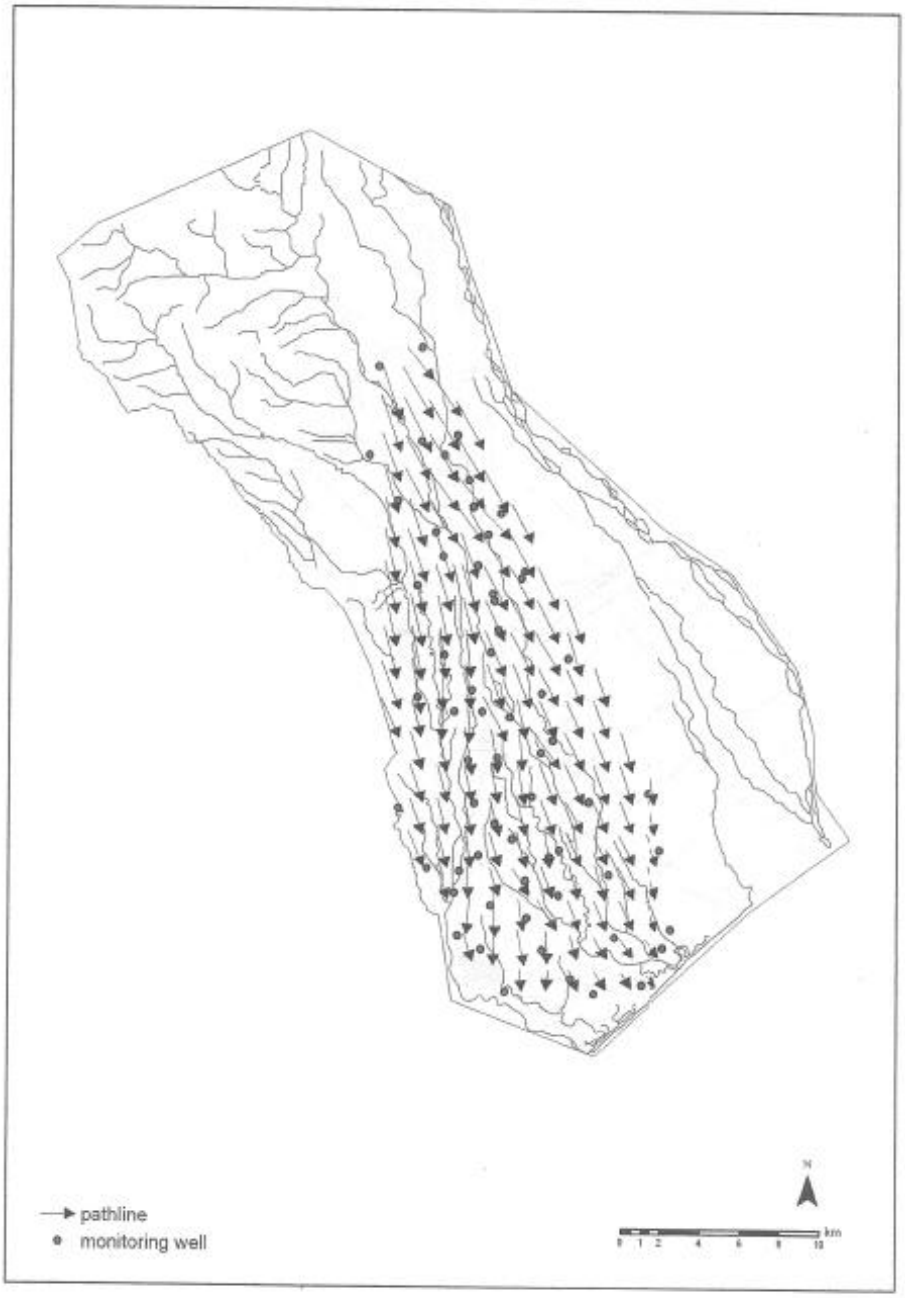


Figure 4-15: Streamlines for shallow groundwater system