BEFORE THE CANTERBURY REGIONAL COUNCIL

In the Matter of	The Resource Management Act 1991
Between	CANTERBURY REGIONAL COUNCIL
And	GREENSTREET IRRIGATION SOCIETY LIMITED Submitter

EVIDENCE OF RICHARD TREVOR de JOUX – HEARING THREE
ASHBURTON RIVER (SECTION 13)

Introduction

1. My name is Richard de Joux. I am a hydrologist and geohydrologist, and hold the qualifications of Bachelor of Science (Geology) and New Zealand Certificate of Engineering (Civil). I presently manage a Consultancy specialising in measuring and monitoring river flows, groundwater, irrigation abstractions, hydrological investigations and modelling, and preparation of resource consent applications. I have had 40 years' experience in surface water and groundwater hydrology, and prior to setting up my own business in 1994 was employed by Environment Canterbury and by the South Canterbury Catchment Board.

2. During my employment with the South Canterbury Catchment Board I collected, processed and analysed hydrological data and participated in the formulation of water management regimes during the preparation of Water Management Plans for the Ashburton River. Between 1973 and 1983 I was a field hydrologist and carried out many of the flow measurements and hydrological investigations within the Ashburton Catchment. Over time I have developed an understanding of the complex hydrology of the Ashburton Catchment.

3. Although this is a regional council plan hearing, I have complied with the code of conduct for expert witnesses contained in the Environment Court's Practice Note dated 1 November 2011 when preparing this evidence

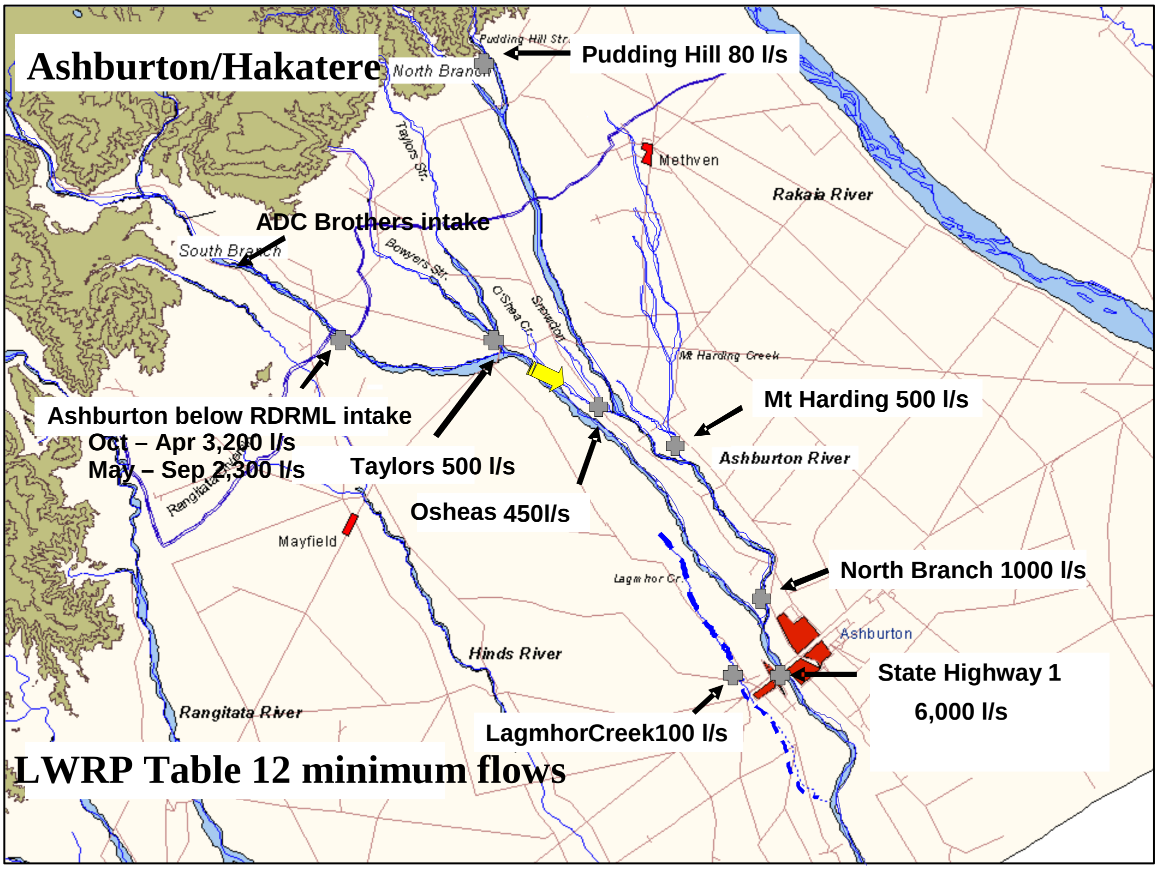
Scope of evidence

4. I have been asked by Greenstreet Irrigation Society Ltd (GISL) to review and present information in relation to the flow modelling carried out for ECan to compare water management scenario modelling, and to provide comments on relevant policies and rules that affect GISL's reliability of supply.

Background

5. For the sake of clarity, I have included Figure 1 in my evidence to show the location of the various tributaries and minimum flow sites within the Ashburton Catchment. The figure has been modified from that provided by Environment Canterbury during a public presentation of the minimum flow regime proposed in the Natural Resources Regional Plan (NRRP) held in Ashburton in June 2008.

FIGURE 1 : Location of Ashburton Catchment minimum flow sites



6. The hydrology of the Ashburton catchment is extremely complex. There are 4 main tributaries (South Branch, Taylors, Bowyers, North Branch) and a number of smaller springfed tributaries (Mt Harding Creek, O'Sheas Creek, Laghmor Creek). Each tributary has a distinct hydrological regime and different flow pattern. The South Branch has considerable hydrological storage within the upper Ashburton Lakes, the North Branch has proportionally more of its catchment in the sub alpine zone, the smaller creeks are fed from groundwater. Each tributary has different reliabilities of supply.

7. The proposed minimum flow regime within section 13 of the proposed Canterbury Land and Water Regional Plan (LWRP) is based on previous work by Horrell hydrological modelling and Ashburton River low flow regime (Horrell, 2001, 2004, 2009, 2012). The proposed flow regime is predicated on the following:

7.1 That the naturally occurring flows within the Ashburton River tributaries are those provided in table 4.3 of Horrell (2004). This includes estimated 7 Day Mean Annual Low

Flows of 4210 l/s for South Ashburton at Valetta, 1080 l/s for Taylors Stream, 9170 l/s for South Ashburton above North confluence, and 3870 l/s for North Ashburton above South confluence.

7.2 That the North Ashburton River (North Ashburton) rarely if ever goes dry "naturally", rather it is dry only because of abstractions. Horrell (2004) states "In conclusion naturally occurring low flows in the foothills do not necessarily equate to zero flow at Digby's Bridge, owing to the high influence groundwater levels on tributary flow in the middle reaches of the North Branch, during these periods."

8. I have previously provided Environment Canterbury with a review and comment on that analysis and remain unconvinced of the dependability of the conclusions. A major concern that I had about the calculation of "naturalised" flows was the practise of adding all of the upstream abstractions back into the measured flow at specified downstream reaches. Many of the reaches lose surface flow to the surrounding groundwater, therefore a portion of any abstracted water would either be permanently lost and would not have remained within the river, or would be intercepted by springs and re-enter the river at a downstream location. This fact has been recognised by other authors. Scarf (2003) noted that *"clearly a portion of that water would be permanently lost to adjacent unconfined groundwater and springfed streams"*. Scarf used proportional corrections to account for abstractions within the Orari, Temuka and Ohapi Stream catchments.

9. Scarf's reference to permanent loss to groundwater is particularly relevant to the Ashburton River. Piezometric contours prepared by Environment Canterbury staff clearly show a strong flow of groundwater away from the North Ashburton to the surrounding aquifer. Losses occur continuously from Thompsons Track to below Digby's Bridge. These flows are permanently lost from the River, however this has not been taken into account in the modelled "naturalised" flows presented by Horrell (2001, 2004).

10. Mosley (2001) referred to the 2001 Horrell report, stating "This table [appendix 3, table 5 of Horrell (2001)] is based on some quite severe assumptions, and should only be taken as indicative of the "median" effect of abstractions on the natural flow regime."

11. The North Ashburton minimum flow of 1000 l/s was set on the assumption that the 7DMALF was estimated to be 3870 l/s. In August 2012, I attended a meeting in Ashburton between myself, Graeme Horrell and Tim Davies to discuss my concerns regarding the modelling of flow

regimes undertaken at that time. I attach a copy of note prepared by Tim Davie outlining the matters discussed as appendix A of this submission. Following that meeting, the model used to predict surface flows was revised and updated (Horrell 2012). The resulting revised regression for the North Ashburton provided an estimated 7DMALF of 2020 l/s. This is similar to the value calculated by Young (1992). This dramatic reduction in estimated 7DMALF for the North Ashburton River has not been highlighted in either the section 32 report or in the section 42A report prepared by the officer and introduces considerable uncertainty on the efficacy of the model.

12. On 11th April 2013 I sent an email to Dr Tim Davie which in part stated "Given this large reduction in estimated MALF, has there been any intention to re-visit what the North Branch minimum flow should be? I would have thought that if the 1000l/s minimum flow was based on an estimated MALF of 3870 l/s, then surely the minimum flows needs to be re-visited." Dr Davie responded on 2nd May 2013 that "I don't see any need for looking at them again in light of a revised MALF."

13. It is my opinion that the significant change in estimated 7DMALF for the North Ashburton River warrants a re-assessment of the proposed flow regime "package", which is predicated on maintaining a minimum flow of 1000 l/s in the North Ashburton upstream of the South Ashburton confluence.

Proposed flow regime for GISL

14. GISL hold a suite of consents to take and use water for irrigation. Water can be taken (CRC921547C) from the South Ashburton River at a maximum rate of 990 l/s to augment the flow of O'Sheas Creek. The take is restricted in accordance with existing minimum flows at State Highway 1 Bridge. Water is also taken from a pond at the confluence of O'Sheas and Snowdens Creek (CRC921547F.2) for irrigation at a rate of 1200 l/s. This take is subject to State Highway 1 minimum flows plus a minimum flow of 50 l/s to be maintained within O'Sheas Creek below the intake..

15. The implementation strategy proposes that GISL abstract all of their 1200 l/s from the South Ashburton River, foregoing the use of O'Sheas and Snowden Creeks. The latter requirement will cause an increase in abstraction by GISL from the South Ashburton River from 990 l/s to 1200 l/s. GISL will be subject to the State Highway 1 minimum flows specified in table 12.

Comments on the hydrological model and flow sharing regimes

16. The minimum flows at various sites rely significantly on the presumption that a continuous flow can be achieved within the North Ashburton. Based on my personal knowledge of the hydrology of the Catchment, and in combination with my reservations over the irreversible hydrological impacts of land use change and river control works, I do not believe that permanent continuous flow can be achieved within the North Ashburton River – especially during summer months.

17. I believe that the "naturalised" hydrology presented in the modelling work gives an unrealistically high expectation that continuous flow will be restored to the North Ashburton River.

18. From personal observations, there have been numerous occasions when the North Ashburton River has been dry at Digby's Bridge for long periods of time even during winter months when there are no irrigation abstractions occurring. Mr Bryan Lawn of GISL will provide his personal observations of previous times when the total flow of O'Sheas Creek was discharged in to the dry North Ashburton River with little or no effect on flows downstream of O'Sheas Creek.

19. The modelling of reliability carried out by Horrell is based on the flow distribution for each of the tributaries. I do not believe that this provides a realistic estimate of reliability because it does not look specifically at the flow rates in the various tributaries in every year. The analysis is based solely on the flow frequency distribution for the entire record.

20. This approach may be adequate in the catchment where all the tributaries have similar flow patterns, but the differing flow regimes within the Ashburton Catchment means that while one tributary might be at (for example) its 80 percentile flow on a certain day there is no guarantee that a different tributary will also be at its 80 percentile flow on the same day. The flow distributions don't account for timing of flows, but the modelling assumes that this will happen.

21. A more reasonable approach would have been to model the daily time series for the record so that a better assessment of reliability can be attained.

22. The modelled results are an amalgam of the entire record period. As such, the reported reliabilities are averages. The analysis does not identify the number of consecutive days when restrictions would be required; the time of year when restrictions will occur; the number of days

between successive periods of restriction; or the reliability during dryer years when impacts on reliability will be greater. All of the above are essential when attempting to describe the impacts on reliability of supply.

Flow within the North Ashburton River

23. My previous submission to the Ashburton Zone Committee referred to observations within the North Ashburton River at times when GISL ceased taking water, allowing the full flow of O'Sheas Creek to enter the North Ashburton River. The consequence of discharging the additional 817 l/s flow of O'Sheas Creek into the North Ashburton for a period of 2.75 days resulted in surface flow being maintained for an additional 657 metres downstream of where it was previously dry. The River remained dry upstream of Digby's Bridge. Given that there was continuous flow upstream of O'Sheas Creek at the time of this exercise, the discharging of equivalent rates of water at times when the river is dry upstream of O'Sheas will result in those flows being lost over shorter distances.

24. Section 5.2(ii) of Horrell (2004) refers to the fact that the North Branch loses approximately 700 l/s naturally from the river between O'Sheas Creek to the confluence. It is suggested that if the river were dry for 6 months then this equates to a groundwater deficit of 11 million cubic metres. It is then commented that the discharge of water from O'Sheas and Snowdens Creeks, when on restriction, would never satisfy the needs of the underground system, resulting in no surface flow throughout the reach to Digby's Bridge for months until a major rainfall event occurred. This appears to be in conflict with the proposed sharing regime.

25. In essence, Horrell suggests that surface flow in the lower river cannot occur until at least the groundwater deficit (11 million cubic metres) is replaced through prolonged higher river flows. Horrell also noted that 3 freshes recorded between February and March 1999 discharged 8 million cubic metres of water into the river but the north branch remained dry at Digby's Bridge.

26. Between 17th February and 7th May 2012 RDRML continuously discharged water into the North Ashburton at the RDRML Siphon. A summary of this data is provided in Appendix B of this evidence. The average flow rate for this 81 day period was 5645 l/s which equates to a volume of 39,502,858 m3. The flow rate exceeds the sum of consented abstractions from the North Ashburton River (3874 l/s, Appendix A, Horrell 2012 or 2734 l/s from Table 12, Chapter pLWRP), therefore the additional water far exceeds the amount of water that would be retained within the North Ashburton River during total irrigation restrictions.

27. In combination with the estimated natural flow at the RDRML Siphon (average flow of 3142 l/s), the average flow downstream of the Siphon was 8786 l/s with a total volume of 61,490,454 m^3 . To keep this in perspective, a volume of 61,490,454 m^3 exceeds the annual allocation limits for the Cust, Loburn Fan and Rangitata-Orton groundwater zones and is only 12% less than the 69,700,000 m^3 allocation for the Ashburton/Hakatere "A" groundwater allocation limit.

28. If Horrell's (2004) assumption were correct, then the North Ashburton River should have had continuous flow after (approximately) 11 million cubic metres of water had been discharged to the River. A volume of 11 million cubic metres of spill (as distinct from total flow) occurred 25 days after the start of spill on 17th February (ie 12nd March).

29. Despite the large volume of water discharged, the river was still noted to be dry at Digby's Bridge. The volume of water spilt between 17th February and 11th April was 25,248,067 m^3. Although no "official" records were kept, Mr Bryan Lawn noted that the river was dry between the 5th and 11th April. It is likely that the river was dry continuously for a significant period prior to that time, despite the large volumes of water being discharged since mid-February. The river flowed at Digby's Bridge following rainfall of 41mm about the 13th April but was noted to be dry again on 4th May 2012.

30. This event demonstrates that the natural flow losses within the North Ashburton River are not retained within the riverbed (as underflow) but are lost permanently into the surrounding groundwater. There is therefore considerable doubt and disbelief by many people that the requirement to discharge water from O'Sheas Creek into a dry North Ashburton Riverbed will provide any environmental benefit to that Riverbed.

31. It is my opinion that the requirement for Greenstreet Irrigation to take all of their consented water from the South Ashburton will only add more pressure on the flow in the South Ashburton without providing the modelled improvement in flow in the North Ashburton. The end result will be that the Ashburton River at SH1 minimum flow will be triggered earlier and the reliability to irrigators will be less than modelled.

32. In my experience of the river, and in discussions with others who have a long history of living alongside the river, I do not share the enthusiasm of Mr Horrell that a continuous flow can be maintained within the North Ashburton River.

Impact of proposed flow regime on the GISL intake

33. The introduction section of Chapter 13 of the pLWRP states that "In achieving these outcomes changes are to occur over time so as to have minimal impact on existing activities."

34. The impact of the proposal to require GISL to take all of their water from the South Ashburton River (Scenario 3 of Horrell 2012) is shown in Table 6.1 of Horrell (2012). Scenario 3 increases the time when GISL are on partial restriction from 2% (Scenario 2) to 30% of the time, and reduces the reliability of full restriction from 93% of the time (Scenario 2) to 68% of the time. Bearing in mind that the numbers represent the "average" reliability, this is a drastic reduction in reliability. Mr Hugh Eaton will make comment on the economic and farming impact of this.

35. The reduction in reliability is in stark contrast to the statement made in section 9.2 of the S42A report which states that modelling undertaken by Graeme Horrell (2012) indicates that the increase in flows will work **to maintain or, in some cases improve** [my emphasis] the existing reliability.

Possible Alternative Options to improve residual flows

36. I consider that there may be other options available to help improve residual flows within the River, and that those options could be investigated in more detail.

37. The possible use of the RDR to distribute stock drinking water has been raised in the past. This would obviously require co-operation between RDRML, Ashburton District Council and ECan, but should result in a reduction of existing ADC abstractions from the River, while providing improved residual flows in all tributaries.

38. It should be possible for Greenstreet Irrigation Society to discharge the full O'Sheas Creek flow into the lower North Ashburton River at Rawles Crossing Road rather than into the North Ashburton river (which is usually dry downstream of the Creek confluence). This would ensure that the full flow of O'Sheas Creek would enter the North Ashburton immediately upstream of the North/South Confluence rather than being lost to groundwater.

Summary

39. In summary, I conclude that:

39.1 There is considerable doubt whether the proposed minimum flow regimes will maintain a continuous flow in the North Ashburton River, or that the implementation strategy will achieve the desired minimum flows at SH1 Bridge.

39.2 The proposal to make Greenstreet Irrigation Society Limited to forego O'Sheas Creek and to take their full 1200 l/s abstraction from the South Ashburton River will lead to an increase in demand from the South Ashburton River with no guarantee that the discharge of water from O'Sheas creek into the North Ashburton will provide a continuous flow in that water body. If this is true, then restrictions on abstractions from the South Ashburton River, and the frequency of lower flows at State Highway 1 Bridge will be greater than those modelled.

39.3 The modelling carried out by Horrell shows that despite comments made in the S42A report that there would be no reduction in reliability, the average reliability for GISL to take their full allocation will reduce from 93% to 68%. The modelling does not provide sufficient detail to be able to determine the number of consecutive days when restrictions may occur, or at what time of year they will occur.

39.4 Any changes to the existing flow regime should be staged over periods of time to allow careful monitoring to ensure that the predicted benefits in flows are actually achieved. Advancing to the next stage of restrictions should only occur once the benefits have been proven.

39.5 There may be other opportunities to provide higher flows within the River. These include RDRML to provide stock water that is presently supplied by Ashburton District Council stock water races, and the discharging of O'Sheas Creek directly into the North Ashburton River via the Greenstreet Irrigation Society discharge race below Rawles Crossing Road.

References:

de Joux, R T; Young J R; 2002: *Review: Horrell G A 2001 Ashburton River Low Flow Regime.*

Duncan, M. J; 2009: Review of the science supporting the proposed minimum flow regime for the Ashburton River.

Environment Canterbury; 2009: NRRP hearing stage 31, Officer report no. 31 chapter 5 WQN13 on proposed variation 1 of the Proposed Canterbury Natural Resources Regional Plan. prepared by Anna Veltman and Malcolm Miller

Horrell, G A; 2012: Ashburton/Hakatere River flow and allocation regimes: Update of modelling results. Niwa Client Report No. CHC2012-140 prepared for Environment Canterbury, November 2012

Horrell, G A; 2009: Ashburton River/Hakatere flow and allocation regimes: Review and update of options. Environment Canterbury report R09/9 ISBN: 978-1-86937-92. February 2009.

Horrell, G A; 2004: Ashburton River Low Flow Regime – Review and Update. Environment Canterbury report U04/20. April 2004

Horrell, G A; 2001: *Ashburton River Low Flow Regime.* Environment Canterbury report U01/26.

Mosley, M P: 2001: *Ashburton River: Instream and amenity values, and flow management regime.* Environment Canterbury report U01/16, June 2001

Scarf, F: 2003: *Low flows of the main stem and tributaries of the Orari and Temuka Rivers and Ohapi Stream.* Environment Canterbury report U03/38. May 2003

Young, J R; 1992: Rainfall and River Flows in the Ashburton Catchment. In Environment Canterbury Report R92(36) “Natural Resources of the Ashburton River and Catchment Volume One.

Appendix A : Ashburton surface water flow modelling meeting

Notes prepared by Tim Davie, 23 August 2012

Ashburton surface water flow modelling meeting

Present: Richard de Joux (ECS), Graeme Horrell (NIWA), Tim Davie (Environment Canterbury)
Date: 21/8/2012
Background

In developing the Ashburton River Flow Plan with the community, Environment Canterbury has commissioned NIWA to provide the hydrological modelling work to assess impacts of any proposed changes. Prior to a Section 32 report being prepared it was agreed that it would be worthwhile having an informal peer review of the model structure by an external hydrologist who knows the area well. The aim of the peer review was to have agreement on the structure of the model so that any hearing process is able to concentrate on impacts of proposed plan changes rather than details of how the hydrology was assessed.
Richard de Joux agreed to fulfil the peer review role and this meeting is the first step in the peer review. A second step is for Richard to have a copy of the model and the hydrology part of the section 32 report (as prepared by Graeme Horrell).
The model

The model used by Graeme Horrell is that used in Horrell (2001) and Horrell (2004). The model takes measured flows in the Ashburton River (both branches) and predicts the flow regime at specific points in the catchment based on gauged differences between the points. The output of the model is a distribution of flows (usually expressed as a flow duration curve) rather than hydrographs (see below for discussion on this).
Agreements

The following was agreed at the start of the meeting.
No model is a perfect representation of the real world hydrology but it is important to try and capture as much as possible of what we know about surface water – groundwater interactions.

The hydrology in the South Branch of the Ashburton River as far as Valetta is adequately represented. The model has been revised since Horrell (2001) to include average abstraction rates (rather than maximum) and using a flow loss calculation across the reach as suggested by Richard de Joux and John Young (described in Horrell, 2004).

The model has been improved through use of actual measured data for Taylors Stream (flow recorders on Taylors and Bowyers Stream were installed in December 2004). This replaces regression models for these flows. There was enough data to allow distribution curves to be drawn for Taylors Stream.

The modelling of the South Branch from Valetta to the confluence with the North Branch is adequately represented in the current model (including the changes to Taylors Stream inputs described above.

Areas of contention and agreements reached

The main area of contention was in the modelling of the North Branch, particularly from Thompsons Track to the confluence with the South Branch. The current model has flow losses incorporated within it (as calculated from gaugings) but assumes that if a hypothetical 1 cumec of water was added at the top it would all reach the confluence. This assumption relies on all the flow losses being fed from the river already and that the river is in some kind of steady state. Richard believes that this is an unreasonable assumption and that some of the hypothetical cumec will be lost to groundwater. Graeme agrees that this may be the case but does not have a way of calculating how much would be lost.

It was agreed that Graeme would perform a sensitivity analysis within the model. This would start by assuming the losses to any "new water" released through the plan would be at the proportion shown through gauging loss (when accounting for abstractions and inflows).

The sensitivity analysis would demonstrate whether this is a significant impact on the modelled scenarios. If it is a significant impact then this will be presented with the scenarios.

The second area of contention was in the use of distributions for the model. It was agreed that we did not have enough information or understanding to model satisfactorily as a daily time series. The current model has flow distributions for the whole year and also distributions for the irrigation season only. The scenarios are based on the irrigation season distributions. The issue of contention is that the South and North Branch flow in different ways and distributions don't account for timing of flows. The South Branch comes from the mountains where snowmelt becomes significant and also has a significant lake-fed component. The North Branch comes from the foothills that is more rainfall driven. Therefore the timings of the different distributions probably won't match (ie high flows in the South Branch may not occur at the same time as high flows in the North Branch but using distributions will assume they do.

It was agreed that a way forward was to use monthly flow duration curves (distributions) rather than the whole season altogether. This gives a better allowance for timing differences but maintains the integrity of distribution approach.

References

Horrell GA (2001) *Ashburton low flow regime*. Environment Canterbury report U01/26.
Horrell GA (2004) *Ashburton River low flow regime – review and update*. Environment Canterbury report U04/20

APPENDIX B : North Ashburton river flow below RDRML siphon

Spill data supplied by RDRML (via Boraman Consultants Ltd)
North Ashburton flow at Old Weir supplied by ECan
Thompson Track (“T Track”) flow derived by : T Track = 3989.4 * Ln(Old Weir) – 30270 l/s

~~~ PDAY ~~~
Source is C:\RDRML\LWRP\RDR at Nth Ashburton Sp
From 1-Jan-2012 00:00:00 to 13-Feb-2013 08:15:00
24 hour periods ending at midnight each day.
Daily means, 2012, Flow(l/s) at RDR at Nth Ashburto

Day	Feb	Mar	Apr	May
1	0	7253	6292	5134
2	0	6356	5353	8854
3	0	3559	4970	7390
4	0	3408	4857	10
5	58	3421	4036	12
6	0	3881	1461	12
7	0	4970	1801	7
8	0	5575	714	0
9	0	7154	1830	0
10	0	6962	1036	0
11	0	6754	3519	0
12	0	7085	5959	0
13	0	7523	7413	0
14	0	7408	9173	0
15	0	7555	8650	0
16	0	7783	8420	0
17	1121	7747	9007	0
18	4550	7806	9429	0
19	2955	7410	8743	0
20	2287	6320	7787	0
21	4110	7336	8169	0
22	4563	7422	8584	0
23	6447	7448	7925	0
24	7205	5000	7795	0
25	7615	5000	7586	0
26	6951	5000	7756	0
27	6588	5000	5770	0
28	6694	4184	5133	0
29	6816	3473	5134	0
30		6203	5134	0
31		6456		0
Min	0	3408	714	0
Mean	2343	6239	5981	691
Max	7615	7806	9429	8854
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	RDRML Spill		T Track flow	Total flow T Track
Mean flow - 17 February to 7th May 2012	5645	l/s	3142	8786
Total Volume - 17 February to 7th May 2012	39,502,858	m3		61,490,458