IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	applications for Resource Consents to Abstract water from
	Station Stream (CRC071786), Cass River (CRC052502) Scrubby Creek (CRC020584) East Branch, Ahuriri River (CRC042020) Manuka Creek (CRC063564) Otamatapaio River (CRC012047 & CRC012019) Corbies Creek (CRC012017) Glen Bouie Stream(CRC041033) Sutton Stream (CRC030944) Gibson Stream (CRC030944) Black Jack Stream (CRC072363)
BY	Applicants
	Lilybank Station Holdings Limited Glenmore Station Limited Totara Farming Co Limited Maree Horo Twin Peaks Station Limited Otamatapaio Station Bogroy Station Limited Otematata Station Rostreiver Station Waitangi Station Te Akatarawa Station
TO	Canterbury Regional Council

EVIDENCE OF DAVID JOHN BORAMAN IN SUPPORT OF THE ABOVE MENTIONED APPLICANTS

INTRODUCTION

1.1. My Name is David John Boraman. I am a hydrological Consultant and a Director of Boraman Consultants Limited (BCL). I am a current member of the New Zealand Hydrological Society.

1.2. I hold a New Zealand Certificate in Engineering (Civil Option) I have been working in the field of Hydrology since 1986. I was employed by the South Canterbury Catchment Board, and by the Canterbury Regional Council (ECan) as a Hydrological Officer. I was later employed as the Hydrological Team Leader of the Southern (Timaru) Office, reporting directly to the Hydrologist.

1.3. In 1997 I was employed as the Field Hydrologist for Environmental Consultancy Services. (ECS) My work at ECS generally involved monitoring of irrigation abstractions and monitoring of flows for investigations for resource consent applications.

1.4. I am currently a Managing Director of Boraman Consultants Limited (formed in 2005). BCL monitor a proportion of South and Mid-Canterbury's irrigation takes and related minimum flow sites. BCL are currently involved in many investigations relating to resource investigations.

1.5. I am familiar with the hydrology and have been involved with monitoring flows in the Upper Waitaki Basin since the amalgamation of the Waitaki Catchment Commision and the South Canterbury Catchment Board into the Canterbury Regional Council in 1989.

1.6. Although this is a Regional Council hearing, I have prepared my evidence in compliance with the Code of Conduct for Expert Witnesses set out in the Environment Court's consolidated Practice Note dates 31 July 2006. I confirm that my evidence is within my area of expertise.

2.0. SCOPE OF EVIDENCE

My evidence will provide the following

a. Introduction
b. Flow data Summary for each of the subject waterways
c. Analysis for each of the Subject waterways
d. Conclusions and proposed minimum flows based on Mean Annual Low Flows for the Rivers with High natural Character and five year seven day low flows for all other rivers

   My Flow reports are attached as appendices to this evidence

3.0 BACKGROUND

3.1. Boraman Consultants Limited was commissioned to determine the Mean Annual Low Flow measurement for Rivers/ Streams of High Natural Character, and five year seven day low flows for all other rivers this measurement being a key statistic for these waterways under the Waitaki Catchment Water Allocation Regional Plan.

3.2. A report produced by Environment Canterbury in 2005 titled "Seven Day mean annual low flow mapping of the Waitaki River" by Graeme Horrell and Suzanne Gabites is referred to in my evidence and has been the basis for much of my analysis.

3.3. Prior to this hearing, Mr Dave Stewart (consultant Hydrologist to ECan), Mr Richard DeJoux (Environmental Consultancy Services), Mr Frank Scarf (Hydrologist to Fish and Game) and I had agreed to work together until we agreed on the hydrological information. The information provided in my reports has been scrutinized, and used by Mr Dave Stewart in his Section 42A report.

3.4. Many of the rivers and streams in the MacKenzie Basin had very little information, with most flow measurements carried out by the Ministry of Works prior to the power development projects, and then the Waitaki catchment commission in the 1970's and 1980's. Several of my clients contacted me as early as 2005 to gather background information, on the subject catchments.

4.0 COMMENTS ON SECTION 42A Report 2A

4.1. I have reviewed the Section 42A report2A, specifically in terms of 'Flow sharing regime' and related mitigation. I have found several inconsistencies when comparing Report 2A with the individual Section 42A reports that should be bought to attention. These relate in general to whether the minimum flow site is upstream or downstream of the abstraction point(s). The conditions specific to the individual consent, relate back to the flow graph in the Section 42A report 2A without distinguishing between upstream and downstream abstraction points.

4.2. The minimum flow site location has been a key factor in how several of the minimum flow conditions will operate therefore I refer to this now as it will clarify matters when I refer to individual subject catchments.

4.3. These points have been discussed with Claire Penman, Author of Section 42A report 2A and she was verbally in agreement at the time of writing this evidence, that the annexed flow graph will unnecessarily restrict abstraction from streams and rivers earlier than that is required by the WCWARP where the minimum flow site is below the point of abstraction. [verbally discussed but yet to confirmed by Claire]

4.4. "The WCWARP specifies in Table 3 xxii (All other rivers and streams)

> A minimum flow of the 5 year 7 day low flow, as assessed by the CRC at the downstream end of the catchment: and a 1:1 flow sharing threshold above the mean flow."

4.5. From a hydrology perspective I interpret this rule to meant there is no water allocation limit, and water can be allocated below mean flow, however, when the flow is above mean flow (flow sharing threshold) water is allocated with the proviso that it is shared 1:1 with the river (B permit.)

4.6. Section42A Para 145 states: "For all abstractions, a condition will be required on the consents in that catchment to ensure that no more water than is available above the minimum flow is abstracted. For example, minimum flow + abstraction = minimum flow condition trigger. This is consistent with the requirement of policy 25 of the WCWARP. This will ensure that the minimum flow will be retained at the downstream end of the catchment as far as possible. An example of what this would entail is in Box 1 below, using a site where the minimum flow monitoring location is upstream of the abstractions. However, the same approach would apply to any river."

4.7. In general I also consider this methodology for minimum flow conditions will work when the minimum flow site is above the abstraction point. However the same condition has been applied to all consents, including those with the minimum flow site below the abstractions which I do not consider to work or practical. Example: Benmore catchments

4.8. I have included two examples, one with the minimum flow site above the abstraction point and one with the minimum flow sites below the abstraction point

Minimum Flow Site Above Abstractions:

4.9. For Scrubby Creek, the minimum flow site has been chosen to be above the abstraction point H39:866-356. This is a very steep catchment on the eastern side of the Benmore Range. It was not practical to install an open channel site at the lower end of the catchment.

4.10. Minimum flow condition for Scrubby Creek. Section 42A report 2A:

"15. Whenever the flow (expressed in Litres per second) in Scrubby Creek, as estimated by the Canterbury Regional Council at Map reference NZMS 260 H39:855-440:

(a) is equal or greater than 80 litres per second the maximum rate at which water is taken, shall not exceed 50 Litres per second.

(b) falls below the flow shown on the horizontal axis of the annexed graph, then the rates of the abstraction permitted in terms of this permit shall not exceed those shown as corresponding on the vertical axis of the annexed graph.

[see example – graph to show a straight line reduction in abstraction from 50 litres per second to zero when flows reduce between 80 litres per second and 30 litres per second]

(c) falls below 30 litres per second, the taking of water in terms of this permit shall cease".

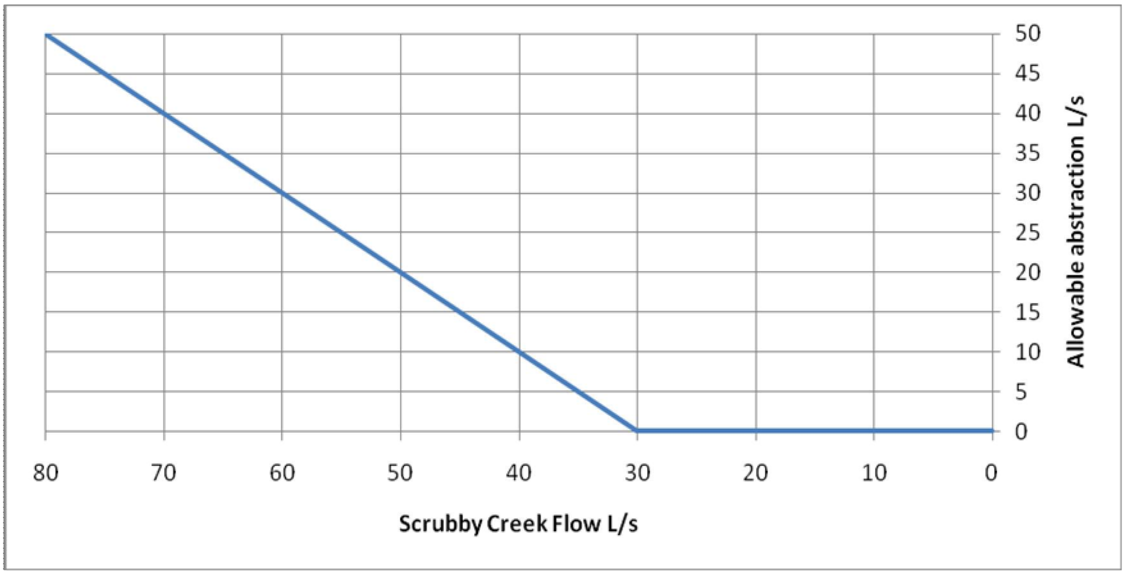

Figure 1:Scrubby Creek abstraction regime

4.11. My interpretation of this is that this scenario works, and it protects the minimum flow to the lower end of the catchment as shown in Table 1 which is consistent with the Section 2 report .

Scrubby Creek at minimum flow site (above abstraction)	*Allowable Abstraction*	*Residual (Lower catchment)*	*Natural Flow above abstraction*
>80	*50*	*>30*	*>80*
80	*50*	*30*	*80*
70	*40*	*30*	*70*
60	*30*	*30*	*60*
50	*20*	*30*	*50*
40	*10*	*30*	*40*
30	*0*	*30*	*30*
<30		*<30*	*<30*

Table 1:CRC020584 abstraction regime as per S42A report 2A

<u>Minimum Flow Site Below Abstractions</u>

4.12. Minimum flow condition for Shepherds Creek. Section 42A report 2A

"14. Whenever the flow (expressed in Litres per second) in Shepherds Creek, as estimated by the Canterbury Regional Council at Map reference NZMS 260 H39:866-356:

(a) is equal or greater than 74 litres per second the maximum rate at which water is taken, shall not exceed 14 Litres per second.

(b) falls below the flow shown on the horizontal axis of the annexed graph, then the rates of the abstraction permitted in terms of this permit shall not exceed those shown as corresponding on the vertical axis of the annexed graph.

[see example – graph to show a straight line reduction in abstraction from 14 litres per second to zero when flows reduce between 74 litres per second and 60 litres per second]

(c) falls below 30 litres per second, the taking of water in terms of this permit shall cease".

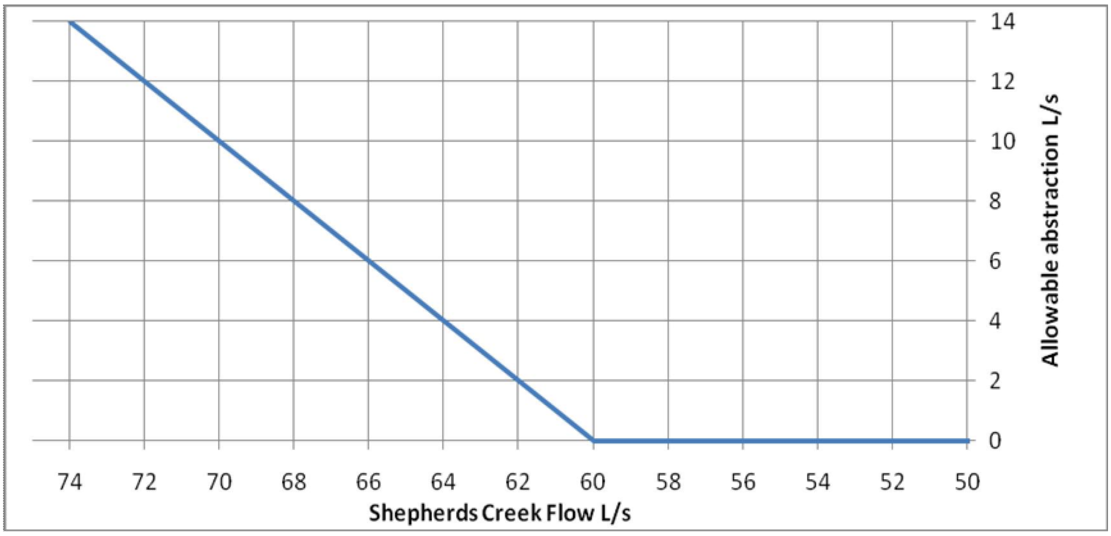

Figure 2: Shepherds Creek abstraction regime

4.13. I do not consider that this scenario will work as intended, as the minimum flow site is below the point of abstraction, this requires the abstractor to be restricted early when flow is just above the minimum flow, this was not the intention of the WCWARP and is incorrect. (see table 2)

Shepherds Creek at minimum flow site (below abstraction)	*Allowable Abstraction*	*Residual (Lower catchment)*	*Natural flow above abstraction*
>74	*14*	*>74*	*>88*
72	*12*	*72*	*84*
70	*10*	*70*	*80*
68	*8*	*68*	*76*
66	*6*	*66*	*72*
64	*4*	*64*	*68*
62	*2*	*62*	*64*
60	*0*	*60*	*60*
<60	*0*	*<60*	*<60*

Table 2 CRC060253 abstraction regime as per S42A report 2A

4.14. The above information also conflicts with Section 42A Report 12 which States

Mitigation		
6	WP07 modified as only the applicant is abstracting water from both creeks, so delete (b) of this condition.	*Tributary name:* Shepherds Creek *Grid reference of recorder site:* H39:866-356 *Minimum flows apply to both creeks:* *"B" Minimum flow:* 74 l/s *Rate of take:* 14 l/s *Daily volume:* 1,209.6 cubic metres *Annual volume for each creek:* 178,000 cubic metres *"A" Minimum flow:* 60 l/s

There is no 'B' water for this permit, yet correctly states that the minimum flow is 60 litres per second.

Conclusion:

4.15. The primary concern is that the generic approach may apply unnecessary restrictions on several of the applications (applications CRC042020, CRC060253, CRC991473, CRC991474, CRC991475, CRC012290 and CRC012291) where the minimum flow site is below the point(s) of abstraction.

4.16. Consequently I have included the annexed graph specific to the consent where the minimum flow site is above the abstraction point in my evidence specific to each applicants and consent . Similarly where the minimum flow site is below the abstraction point, I have re-drafted and included consent conditions that I would recommend to be compliant with the WCWARP.

5.0 HYDROLOGY TEKAPO CATCHMENTS

Background

5.1. The statistics derived from the Gabites and Horrell report, for Station Stream and the Cass River have been derived from measurements in the Jollie River recorded by NIWA. I obtained copies of this information and applied nationally recognized audit procedures to the datasets. The results of the audit checks showed the data did not meet NIWA standards, and I requested a revision of data to NIWA. Due to time constraints this not able to be carried out. I suggested several data processing changes to the Jollie River data to improve the quality and submitted these to NIWA. The data processing changes were checked and accepted by NIWA and the original data was over-written and archived.

5.2. As my Analysis was carried out with a revised dataset, my results necessarily differ from those set out in the Gabites and Horrell report. Mr Graeme Horrell was unable to revise his analysis using the updated dataset however, my analysis has been submitted to Mr. David Stewart who has checked my analysis and accepted the revisions.

5.3. Previous information for the statistics for the Jollie River were extracted from the Gabites and Horrell report and the validity of the statistics checked. The results listed in Table 3. The results of the statistics did not vary greatly. However the revised dataset did affect the accuracy of the correlations with each of the two subject catchments.

Statistic	Ecan	Niwa Revised (BCL)
Period	7/12/64 to Not Specified	7/12/64 to 16/4/07
7DMALF	2843 L/s	2936 L/s
5Y7dLF	2350 L/s	2379 L/s
Mean Flow	8242 L/s	8211 L/s

Table 3: Jollie River Statistics

STATION STREAM

5.4. PREVIOUS INFORMATION

Environment Canterbury derived flow record for Station Stream in the Gabites/Horrell report utilizing a correlation with 8 flow measurements carried out relating to their analysis (only 7 could be located) and the Forks River. Specific values and dates relating to actual flow measurements were not included in their report.

STATION STREAM ANALYSIS

5.5. ADDITIONAL INFORMATION

In 2005 I commenced a study into the hydrology of Station Stream, between September 2005 and March 2007 a further 12 flow measurements were taken and a water level recorder was installed between April 2006 and March 2007.

I derived a flow record utilizing a linear correlation with the measured instantaneous values of Station Stream and the Daily mean recorded value for the Jollie River. The calculated R2 for the correlation was 0.95 indicating a very good reliability.

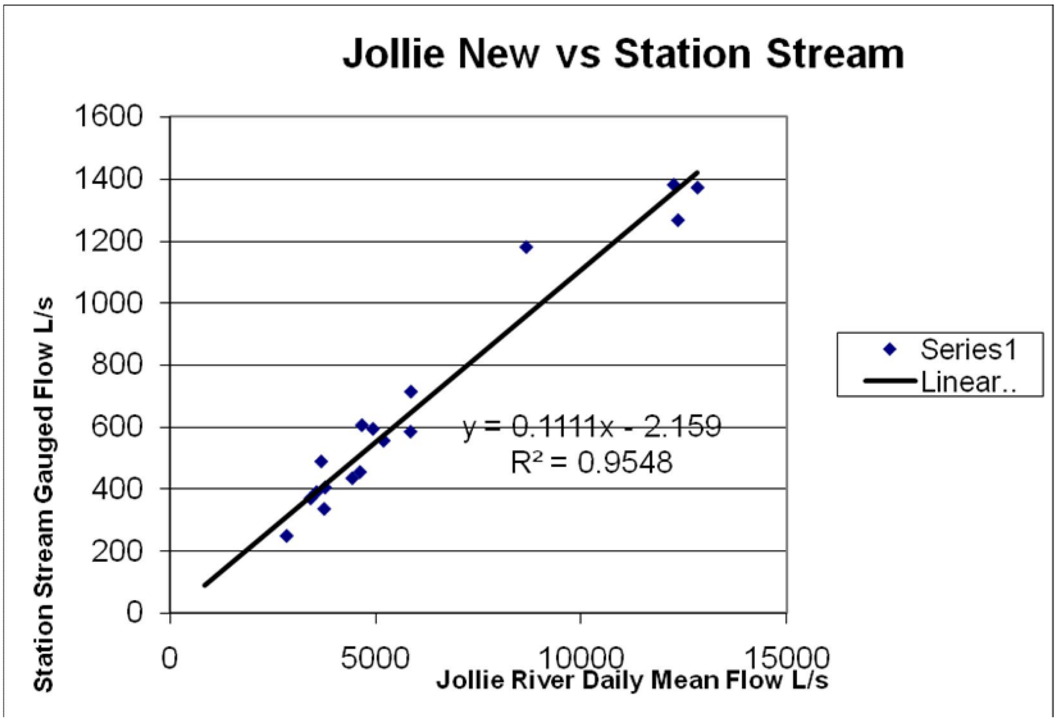

Figure 3: Station Stream Gaugings vs Jollie River Daily Mean Flows (L/s)

5.6. The derived flow for Station Stream utilises the equation

Station Stream = 0.1111x Jollie – 2 Litres per second.

5.7. From my analysis I consider that the statistics for Station Stream to be:

Statistic	Jollie River	Station Stream
Period	7/12/64 to 16/4/07	7/12/64 to 16/4/07
MALF	2834 L/s	312 L/s
7DMALF	2936 L/s	324 L/s
5Y7dLF	2379 L/s	262 L/s
Mean Flow	8211 L/s	910 L/s

Table 4: Station Stream Statistics

STATION STREAM CONCLUSIONS:

5.8. My analysis supports the contention that the figure for Mean Annual Low Flow for Station Stream is 312 Litres per second.

5.9. After consultation with both ECan and Fish and Game agreement was reached that the mean annual low flow be rounded to a more conservative 320L/s and that this be adopted as a minimum flow. It is proposed that 100L/s can be abstracted until the flows in Station Stream at the minimum flow site reaches 420L/s. Below 420L/s the flows will be managed in 25L/s steps (see table 5) to mitigate against 'flat-lining' and provide for flow variability. The risk of flat lining is considered to be low as the stream has natural variability and is statistics show that Station stream is in the 320L/s to 420L/s flow range approximately 2.5% of the time during the irrigation season.

5.10. Due to remoteness and to provide transparency it is proposed these minimum flows and abstractions will be carefully monitored and managed utilising water level recording and flow meters with telemetry capability.

5.11. It is proposed to manage the flows in accordance with the table 5, note that the Station Stream Flows indicated in Table 5 are the Natural flows, that is the combined flow of Station Stream at recorder site, map reference NZMS 260 I36:126-212 and the abstraction under CRC071786.

Natural Station Stream Flows	Abstraction
Above 420 L/s	100 L/s
396 L/s to 420 L/s	75 L/s
371 L/s to 395 L/s	50 L/s
346 L/s to 370 L/s	25 L/s
321 L/s to 345 L/s	Managed minor take
320 L/s and Below	0 L/s

Table5 : Proposed management of Station Stream

5.12. There are some inconsistencies in the conditions of the S42A report 24A proposed flow reduction set out in para 16 (b-d), consequently the Recommended conditions, 5 WP07, is also incorrect. This is in part due to the minimum flow site being below the abstraction point.

5.13. The objective of the proposed flow reduction is to maintain a residual flow below the point of abstraction in Station Stream of 320 litres per second, and provide a small variation in flows above 320 litres per second.

5.14. Recommended conditions:

Whenever the combined flow (expressed in litres per second) of Station Stream as estimated by the Canterbury Regional Council from measurements at the Station Stream recorder site, map reference NZMS 260 I36:1259-2119 and the abstracted flow relating to CRC071786:

a) is equal to or greater than 420 litres per second, the maximum rate at which water is taken shall not exceed 100 litres per second;

b) is equal to or less than 420 litres per second, and greater than 395 litres per second, the maximum rate at which water is taken shall not exceed 75 litres per second;

c) is equal to or less than 395 litres per second, and greater than 370 litres per second, the maximum rate at which water is taken shall not exceed 50 litres per second;

d) is equal to or less than 370 litres per second, and greater than 345 litres per second, the maximum rate at which water is taken shall not exceed 25 litres per second;

e) is equal to or less than 320 litres per second, abstraction shall cease.

6. CASS RIVER

6.1. PREVIOUS INFORMATION

Environment Canterbury derived flow record for Cass River in the Gabites/Horrell report utilizing a correlation with 10 flow measurements carried out relating to their analysis and the Forks River. The derived record was generated from an exponential equation, which is not always desirable for predicting low flows. Specific values and dates relating to actual flow measurements were not included in their report.

CASS RIVER ANALYSIS

6.2. ADDITIONAL INFORMATION

I was asked to review the current information, no further flow measurements were carried out. However in light of the Jollie data being revised, particularly in 1975 and 1976 when many of the Cass measurements were taken, the derived correlations were reviewed. I was able to utilise 14 of the 20 flow measurements, explanations for exclusions can be found in my report.

I derived a flow record utilizing a linear correlation with the measured instantaneous values of Cass River and the Daily mean recorded value for the Jollie River. The calculated R2 for the correlation was 0.87 indicating good reliability.

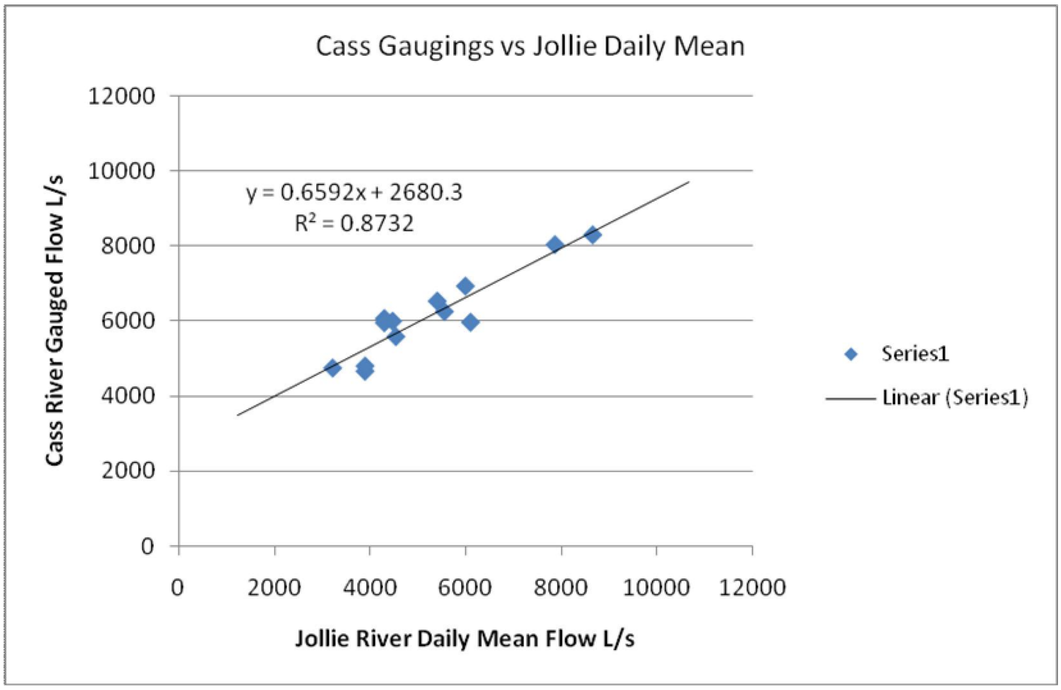

Figure 4: Cass River Gaugings vs Jollie River Daily Mean Flows (L/s)

6.3. The derived flow for Cass River utilises the equation

Cass River = 0.6592 x Jollie – 2680 Litres per second.

6.4. From my analysis I consider that the statistics for the Cass River to be:

Statistic	Jollie River	Cass River
Period	7/12/64 to 16/4/07	7/12/64 to 16/4/07
MALF	2834 L/s	4548 L/s
7DMALF	2936 L/s	4615 L/s
5Y7dLF	2379 L/s	4248 L/s
Mean Flow	8211 L/s	8093 L/s

Table 6: Cass River Statistics

CASS RIVER CONCLUSIONS

6.5. My analysis supports the contention that the figure for Mean Annual Low Flow for Cass River is 4548 Litres per second.

6.6. It is not recommended to continuously monitor the Cass River as CRC052501 is the only current application to abstract water from the Cass catchment. This application equates to less than 3% of the mean flow, therefore continuous monitoring is not required unless further applications are received to abstract from the Cass River.

7.0 HYDROLOGY SCRUBBY CREEK

Background

7.1. The information available at time of writing my reports was correlated with many catchments. Many of these are in the region but not neighbouring catchments. Attempts to correlate with the Twizel River and Maryburn River provided very poor relationships. A correlation with the long term ECan site Rocky Gully at Rockburn (Site 69621) provided the best results for all three catchments

Statistic	Ecan
Period	15/1/64 to Not Specified (Gabites and Horrell)
7DMALF	78 L/s
5Y7DLF	64 L/s
Mean Flow	312 L/s

Table 7: Rocky Gully at Rockburn Statistics

7.2. Scrubby Creek runs through Totara Peaks Station directly into Lake Benmore.

PREVIOUS INFORMATION

7.3. There is no known previous information on Scrubby Creek

SCRUBBY CREEK ANALYSIS

7.4. In February 2009 Boraman Consultants commenced a study into the hydrology of Scrubby Creek, between February 2009 and May 2009, 5 flow measurements were carried out and a water level recorder was installed on 24 February 2009.

7.5. I derived a flow record utilizing a correlation with the measured instantaneous values of Scrubby Creek and the Daily mean recorded value for the Rocky Gully Stream. The calculated R2 for the correlation was 0.99 indicating good reliability. The correlation 'best fit' utilised and 'Power' trend line which is less desirable than the usual linear trend line. However given the limited dataset the 'power' equation was accepted.

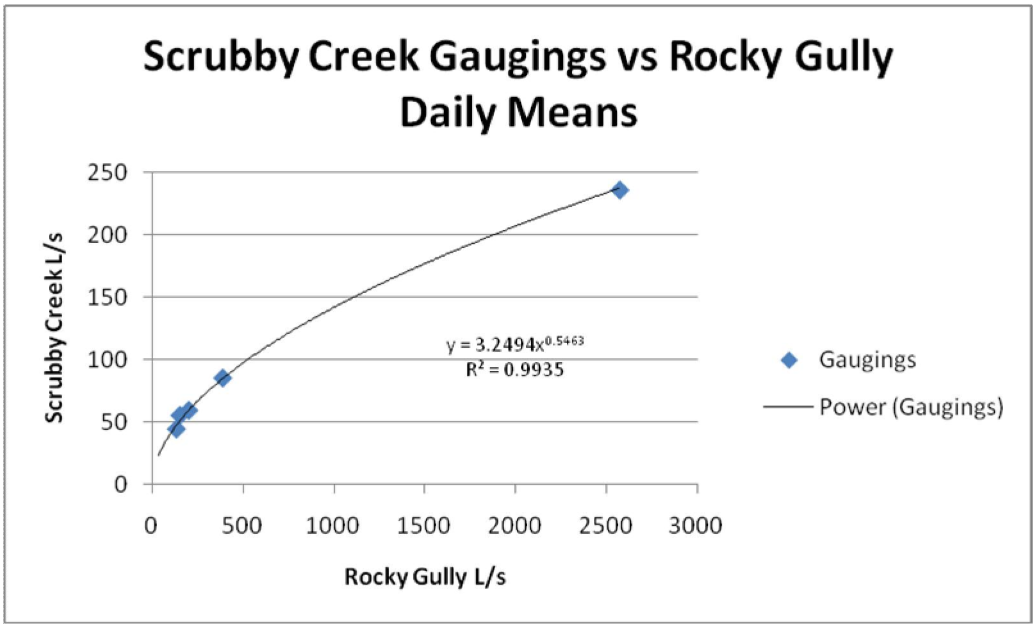

Figure 5: Scrubby Creek Gaugings vs Rocky Gully Daily Means Flows (L/s)

7.6. The derived flow for Scrubby Creek utilises the equation

Scrubby Creek = 3.2494 (Rocky Gully)$^{0.5463}$.

7.7. From my analysis I consider that the statistics for Scrubby Creek are:

Statistic	Rocky Gully Stream	Scrubby Creek
Period	15/1/1964 to not specified (Gabites Horrell)	15/1/1964 to not specified
7DMALF	78 L/s	35 L/s
5Y7dLF	64 L/s	32 L/s
Mean Flow	312 L/s	75 L/s

Table 8: Scrubby Creek Statistics

7.8. A site was selected to monitor the flows above the abstraction points due to the very steep nature of the catchment. Therefore the flow at Scrubby Creek monitoring site less the abstraction must be greater than the minimum flow.

SCRUBBY CREEK CONCLUSIONS

7.9. My analysis supports the contention that the figure for 5 Year Seven Day Low Flow for Scrubby Creek is 32 Litres per second. In accordance with the WCWARP the proposed interim minimum flow should be 30 L/s.

7.10. The above figure should be treated as interim and a flow measurement program set up to further the dataset. The statistics and analysis should be reviewed when a season where the interim 5y7dlf has been surpassed.

SCRUBBY CREEK MITIGATION

7.11. I have reviewed the mitigation relating to minimum in the section 42A Officers report by Elizabeth Vesey (report 36A). See table 9.

Mitigation		
6	WP07	*Name of Water Body*: Scrubby Creek
		Map Reference: NZMS 260 H39:855-440 *Minimum Flow*: 30 litres per second *Flow graph*: see Report 2A

Table 9: CRC020584 Scrubby Creek Mitigation

This is acceptable and complying with the WCWARP as the minimum flow site is above the point of abstraction.

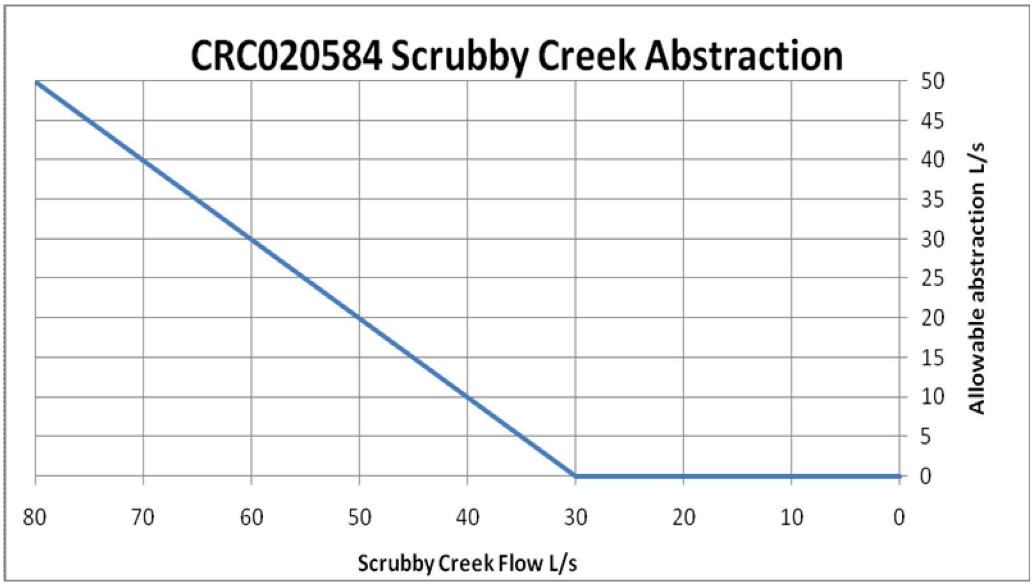

Figure 6: Scrubby Creek reduced flow.

8.0 HYDROLOGY EAST BRANCH AHURIRI RIVER

Background

8.1. I was informed of this investigation late in March 2009, significant rainfall had occurred in the catchment earlier in the month, thwarting any possibility of monitoring any low flows. 16 existing flow measurements were used to derive flow record for the east Ahuriri.

8.2. The information available at the time of writing my reports was correlated with several catchments. Initially it was attempted with the Main Branch Ahuriri, this did not correlate very well due to the North-West rainfall influence.

8.3. It was then correlated with the Lindis River, which is on the southern side of the main Ahuriri branch, but is a similar distance from the divide.

8.4. The figures provided by ECan in the report 'Seven day mean annual low flow mapping of the Waitaki River Tributaries' were checked by BCL. Table 10, shows the statistics that were derived for the Lindis River by ECan. Column 3 shows the figures arrived at by BCL, which clearly shows a different data set was used, the dataset used was the latest up to date information provided by NIWA

8.5. Lindis at Lindis Peak Statistics

Statistic	ECan	BCL
Period	25/9/76 to Not specified	25/9/76 to 28/4/08
7DMALF	1620 L/s	1566 L/s
5Y7DLF	1110 L/s	1029 L/s
Mean Flow	6463 L/s	6264 L/s

Table 10: Lindis River at Lindis Peak Statistics

PREVIOUS INFORMATION

8.6. Analysis on the East Ahuriri was provided by ECan for checking, I checked the methodology used and found that usual procedures to naturalise flows by ECan were not followed, the total allocation of 570 L/s was added to all flow measurements regardless to the time of year. Usual procedure by ECan is to add 50% allocation to flow measurements during the irrigation season as described on page 18 of the Gabites/ Horrell report "Seven Day mean annual low flow mapping of the Waitaki River".

EAST BRANCH AHURIRI RIVER ANALYSIS

8.7. I used the same East Ahuriri dataset as ECan and the updated Lindis data. There is little information on the East Ahuriri abstractions other than 570L/s is allocated for irrigation and stock water.

8.8. To naturalized flows I added 50% maximum allocation (285L/s) during irrigation season and assumed a 10 % stock water component of 57L/s which is to be allocated outside irrigation season.

8.9. I derived a flow record utilizing a correlation with the adjusted instantaneous values of East Ahuriri and the Daily mean recorded value for the Lindis River at Lindis Peaks.

8.10. Initially the entire dataset was used, 11 of the 16 flow measurement were above mean flow. It was decided to truncate the data at mean flow leaving 5 flow measurements for comparison.

8.11. The calculated R2 for the correlation was 0.996 indicating excellent reliability.

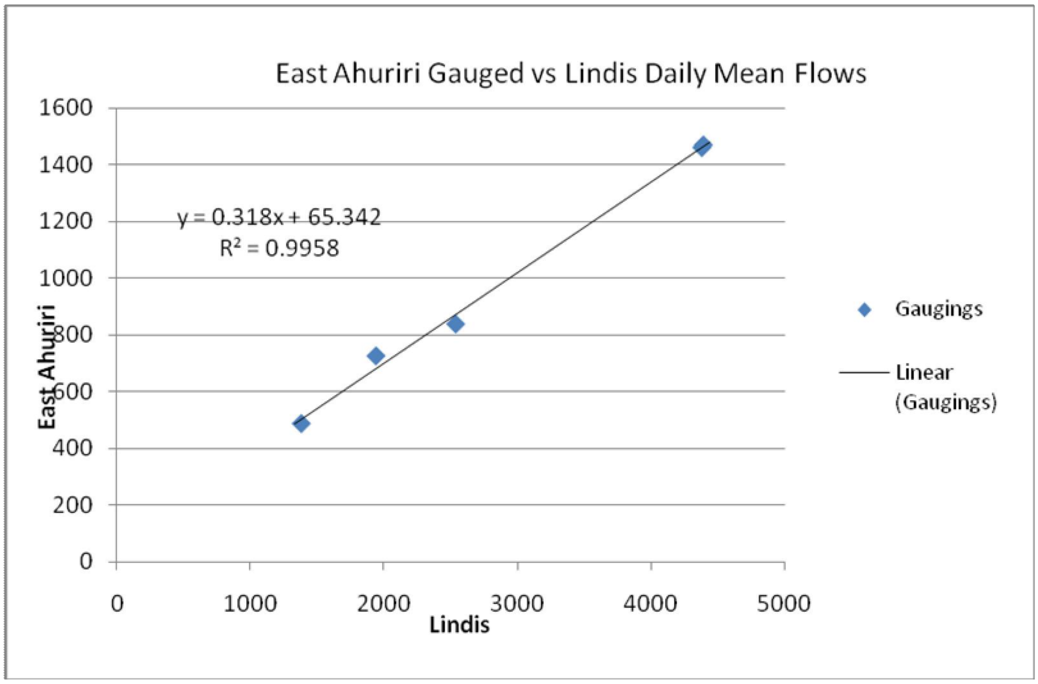

Figure 7: East Ahuriri gauged flow vs Lindis River Daily Mean flow

8.12. The derived flow for East Ahuriri utilises the equation

East Ahuriri = 0.318x (Lindis) + 65 L/s

8.13. From this the Statistics for East Ahuriri are:

Statistic	Lindis River (BCL)	East Ahuriri
Period	25/9/76 to 28/4/08	25/9/76 to 28/4/08
7DMALF	1566 L/s	562 L/s
5Y7dLF	1029 L/s	392 L/s
Mean Flow	6264 L/s	2056 L/s

Table 11: East Ahuriri Statistics

EAST BRANCH AHURIRI RIVER CONCLUSIONS

8.14. My anaylsis supports the contention that the figure for 5 Year Seven Day Low Flow for East Ahuriri is 392 Litres per second. In accordance with the WCWARP the proposed interim minimum flow should be set at 400 L/s.

8.15. The above figure should be treated as interim and a flow measurement program set up to further the dataset. The statistics and analysis should be reviewed once a season where the interim 5y7dlf has been surpassed.

EAST BRANCH AHURIRI RIVER MITIGATION

8.16. I have reviewed the mitigation relating to minimum flow in the section 42A Officers report of Claire Penman (report 21B). See table 12.

4	WP07	*Name of Water body:* East Branch Ahuriri River *Map Reference:* NZMS 260 G39:483-355 *Minimum flow:* 400 litres per second *Flow Graph:* See report 2A

Table 12: CRC042020 East Branch Ahuriri River Mitigation

This is regime is not the intention of the WCWARP table 3,xxii, a, the use of flow graph 2 is incorrect as it restricts the applicant above the minimum flow because the Minimum flow site is below the point of abstraction.

8.17. Therefore suggested Mitigation Condition CRC042020:

Rate and Volume

No.	Condition Code	Details
2		Whenever the flow (expressed in litres per second) in East Branch Ahuriri River as estimated by the Canterbury Regional Council at map reference NZMS 260 G39:483-355; a) Is greater than 400 litres per second, the maximum rate at which water is taken shall not exceed 174 litres per second. b) is equal or less than 400 litres per second, the taking of water in terms of this permit for irrigation purposes shall cease.

		water may be diverted taken and used; a) with a volume not exceeding 15,033 cubic metres per day b) with a volume not exceeding 1,455,080 cubic metres between 1 July and the following 30 June

Table 13: CRC042020 East Branch Ahuriri River suggested mitigation

9.0 HYDROLOGY MANUKA CREEK

Background

9.1. Work Began on this investigation initially for Twin Peaks Station in 2006, Killermont station later become involved. A water level recorder was installed in September 2007 and operated until May 2008.

9.2. Data available on the Manuka Creek was attempted to correlate with the Omarama Stream, however results were poor, however it did correlate well with the Lindis River,

9.3. The figures of the Lindis differed from those used by ECan see 8.4 and 8.5

PREVIOUS INFORMATION

9.4. There was no previous flow measurements carried out on the Manuka Creek

MANUKA CREEK ANALYSIS

9.5. Flow record was derived by correlating daily mean flows from prolonged recession recorded at Manuka Creek and comparing it with Daily mean flows at Lindis River at Lindis Peak. The recession was from 1 November 2007 to 22 January 2008 and incorporated the lowest flows from the Manuka Creek recorder.

9.6. The calculated R2 for the correlation was 0.982 indicating excellent reliability.

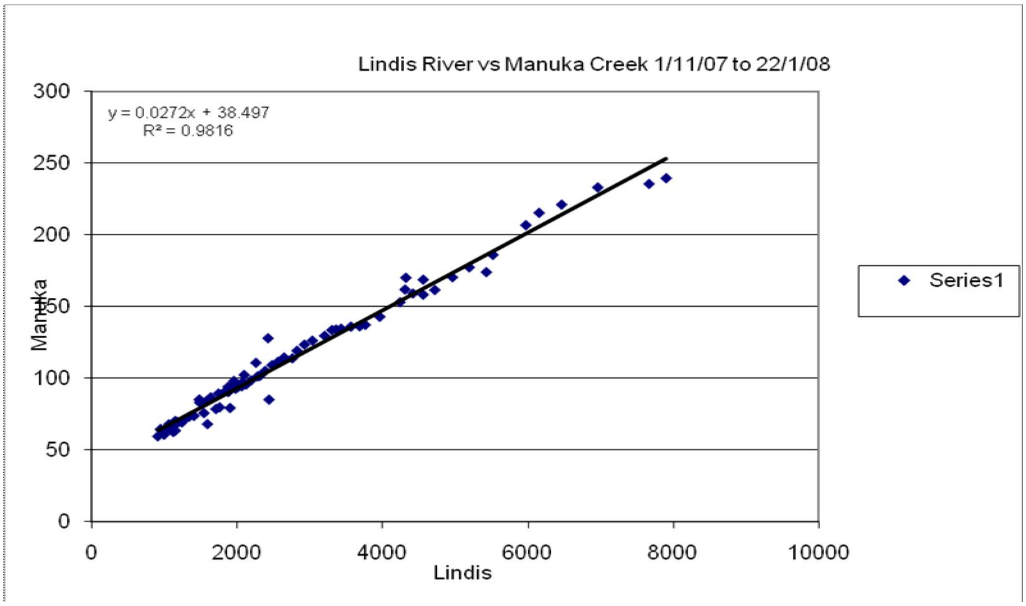

Figure 8: Lindis River vs Manuka Creek Daily Mean Flows L/s 1/11/07 to 22/1/08

9.7. The derived flow for Manuka Creek utilises the equation

Manuka = 0.0272x (Lindis) + 38 L/s

R2 = 0.982

9.8. From this the Statistics for Manuka Creek are:

Statistic	Lindis River (BCL)	Manuka Creek
Period	25/9/76 to 28/4/08	25/9/76 to 28/4/08
7DMALF	1566 L/s	81 L/s
5Y7dLF	1029 L/s	66 L/s
Mean Flow	6264 L/s	208 L/s

Table 14: Manuka Creek Statistics

9.9. Existing Consent CRC00002.1 is held by Killermont Station to Abstract 23 L/s from Manuka Creek. The proposed minimum flow will not effect this consent. There was a flow loss survey carried out by Boraman Consultants Limited on 1 April 2009. The flow at the proposed minimum flow site and two sites in between. There was a nett gain of 5 L/s second between the sites.

MANUKA CREEK CONCLUSIONS

9.10. My analysis supports the contention that the figure for 5 Year Seven Day Low Flow for Manuka Creek is 66 Litres per second. In accordance with the WCWARP the proposed interim minimum flow should be set at 65 L/s.

9.11. Other submitters have/ will argue that the Manuka Creek falls under the Ahuriri Conservation Order, there is no evidence of this because at times of average flow the water has disappeared to ground 300 metres below Killermont intake. This has also been agreed in Mr. Dave Stewarts Section 42A report. Locals have made comment, that they cannot recall when then Manuka Creek has reached the Omarama Stream.

9.12. The above figure should be treated as interim and a flow measurement program set up to further the dataset. The statistics and analysis should be reviewed once a season where the interim 5y7dlf has been surpassed.

MANUKA CREEK MITIGATION

9.13. Mitigation covered by condition 6, WP07 in S42A and report 23A CRC041798 and condition 6, WP07 report 37A CRC063564 are consistent with the proposed application and consistent with Rule 2,Table 3, xxii

10.0 HYDROLOGY OTAMATAPAIO RIVER

Background

10.1. investigation into the minimum flow for the Otamatapaio River began in 2007, initially a few flow measurement were taken, it was decided to install a water level recorder in September 2007, it is still in operation today

10.2. Data available on the Otamatapaio River was initially correlated with the Manuherikia River, this site was decommissioned on 2004, and therefore could not be used with the added data. The new data did correlate well with the Lindis River,

10.3. The figures of the Lindis differed from those used by ECan see paragraph 8.4 and 8.5

10.4. Manuherikia at Downstream Forks Statistics

Statistic	ECan
Period	28/5/75 to 14/4/04
7DMALF	940 L/s
5Y7DLF	725 L/s
Mean Flow	3051 L/s

Table 14: Manuherikia at Downstream Forks Statistics

OTAMATAPAIO RIVER PREVIOUS INFORMATION

10.5. There were 33 flow measurements carried out during 1975 to 1978, of these 20 overlap with Manuherikia at Downstream Forks Data. In the Gabites and Horrell report a record for Otamatapaio was derived using the instantaneous gauged flow and the Manuherikia daily mean flow. A reasonable correlation was established with and R2 of 0.90

10.6. The statistics for the Otamatapaio from this analysis are:

Statistic	ECan
Period	28/5/75 to 14/4/04
7DMALF	283 L/s
5Y7DLF	199 L/s
Mean Flow	1118 L/s

Table 15: Otamatapaio at Footbridge Statistics (Gabites/ Horrell)

OTAMATAPAIO RIVER ANALYSIS

10.7. Due to the Manuherikia site being closed we were unable to add to the Gabites / Horrell dataset with our additional flow measurements.

10.8. Flow record was derived by correlating daily mean flows from a recession recorded at the Otamatapaio Footbridge daily mean flows and comparing it with daily mean flows at Lindis River at Lindis Peak. The recession was from 30 December 2007 to 21 January 2008 and incorporated the lowest flows on record from the Otamatapaio water level recorder.

10.9. The calculated R2 for the correlation was 0.970 indicating excellent reliability.

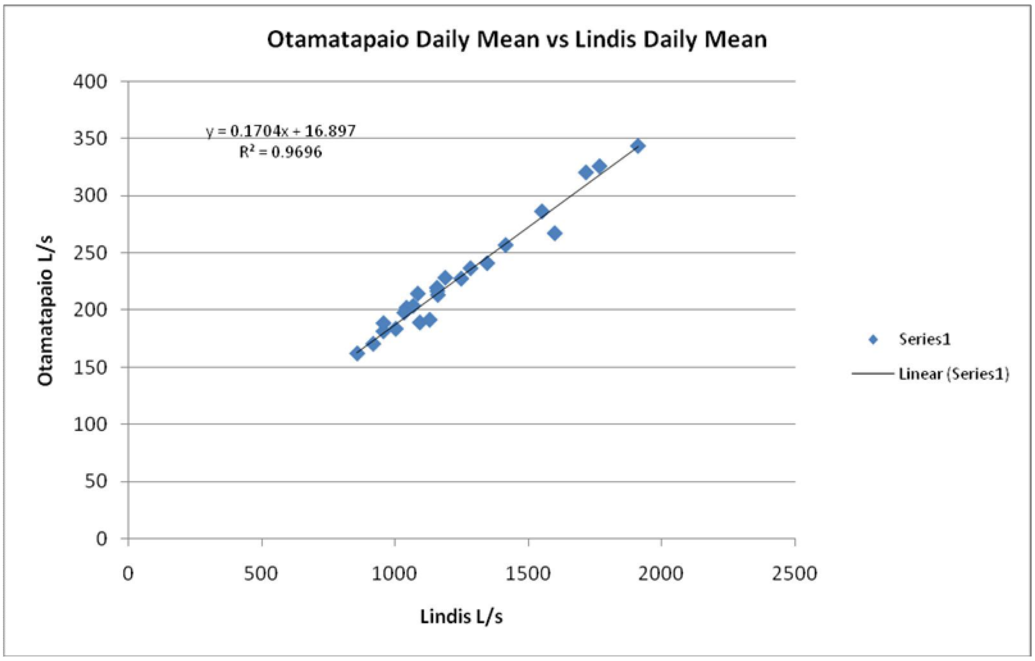

Figure 9: Otamatapaio River vs Lindis River Daily Mean Flows L/s 30/12/07 to 21/1/08

10.10. The derived flow for Otamatapaio River utilises the equation

Otamatapaio = 0.1704 x (Lindis) + 17 L/s

10.11. From this the Statistics for Otamatapaio River are:

Statistic	Lindis River (BCL)	Otamatapaio
Period	25/9/76 to 28/4/08	25/9/76 to 28/4/08
7DMALF	1566 L/s	283 L/s
5Y7dLF	1029 L/s	192 L/s
Mean Flow	6264 L/s	1084 L/s

Table 16: Otamatapaio River Statistics

10.12. The statistics produced by Boraman consultants concur with those in the Gabites /Horrell report with the figures being within 4% i.e 7 L/s for the 5 year 7 day low flow.

10.13. The site selected for the minimum flow site was selected because of the historical flow measurements. The site has a small gorge section and is suitable for a flow monitoring site as it has continuous flow all season where reaches of the lower catchment are subject to drying up.

10.14. To maintain continuous flow in the Otamatapaio my calculations estimate 300 Litres per second is required at the 'Footbridge' site therefore sites lower in the catchment would not offer reliable year round monitoring

10.15. As agreed with Mr. Dave Stewart, Mr. Frank Scarf and the ECan investigating officers the monitoring site known as 'Otamatapaio at Footbridge' will become the trigger point for all abstractions in the Encompassing Otamatapaio Catchment

10.16. As the monitoring site is above all abstraction points, the catchment will be monitored using modern telemetry and reporting systems. The applicants will manage the abstractions by commencing restrictions at flow equating to the minimum flow added to the abstractions on the main stem Otamatapaio.

10.17. The restrictions will be set as a percentage of available water based on the usual maximum abstraction. All other abstractions in the Corbies catchment will be placed on the same percentage restriction.

10.18. Flow losses are significant in the Otamatapaio River and have caused some contention between the irrigators at times of low flow. I have been working with both Bogroy and Otamatapaio to come up with a user group agreement that will satisfy both parties and satisfy the environemtal requirements by abiding to the 5 year seven day low flow.

CORBIES STREAM

10.19. There have 24 flow measurement made on the Corbies at Old Gorge Bridge. These have been correlated with concurrent flow measurements at the footbridge.

10.20. The calculations show that Corbies Stream supplies approximately 25% of the flow to the Otamatapaio Main stem.

10.21. At times of very low flow the contribution of Corbies Stream to the Otamatapaio River is nil.

GLEN BOUIE STREAM

Background

Previous information

10.22. A water level recorder was installed in February 2002 by Environmental Consultancy Services, it was operated until September 2004, during this period there were 17 flow measurements, the lowest instantaneous flow being an estimated flow of 4 Litres per second.

GLEN BOUIE STREAM ANALYSIS

10.23. A flow record was derived by correlating a recession period between 20 February 2003 and 29 March 2003 of the daily mean Manuherikia flows against the daily mean Glen Bouie flows. This record covers the lowest flow on record for Glen Bouie Creek.

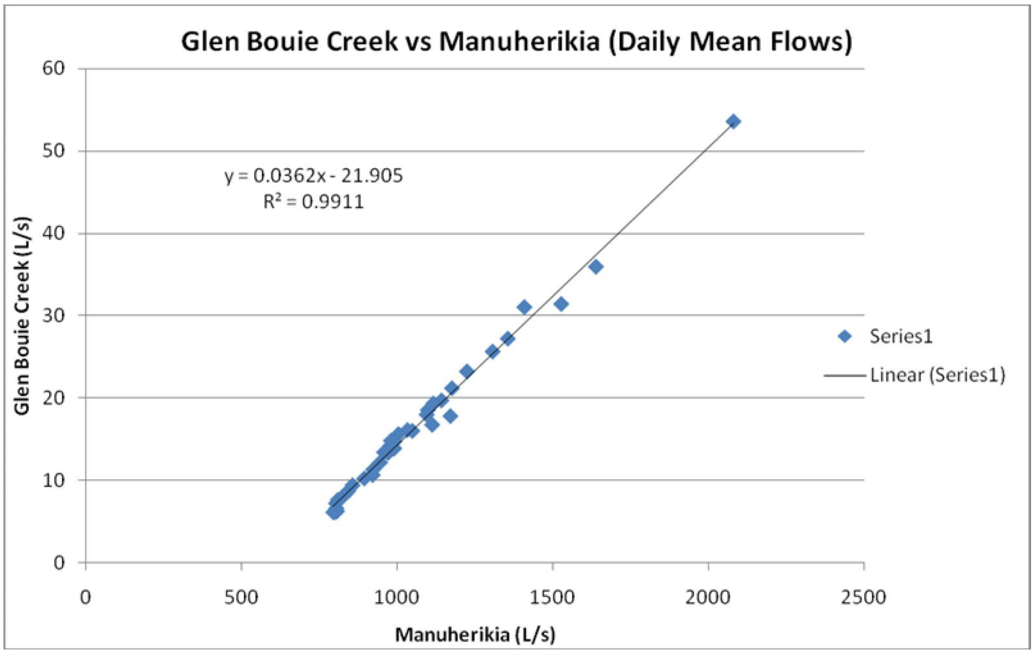

Figure 10: Glen Bouie Creek vs Manuherikia Daily Mean Flows L/s 20/2/03 to 29/3/03

10.24. The derived flow for Glen Bouie Creek utilises the equation

Glen Bouie Creek = 0.0.0362 x (Manuherakia) - 22 L/s

R2 = 0.99

10.25. From this the Statistics for Glen Bouie Creek are:

Statistic	Manuherikia River	Glen Bouie Creek
Period	28/5/75 to 14/4/04	28/5/75 to 14/4/04
7DMALF	940 L/s	12 L/s
5Y7dLF	725 L/s	4 L/s
Mean Flow	3051 L/s	88 L/s

Table 17: Glen Bouie Creek Statistics

OTAMATAPAIO CATCHMENT CONCLUSIONS

10.26. My analysis supports the contention that the figure for 5 Year Seven Day Low Flow for the Otamatapaio River is 192 Litres per second. In accordance with the WCWARP the proposed interim minimum flow should be set at 200 L/s.

10.27. My analysis supports the contention that the figure for 5 Year Seven Day Low Flow for the Glen Bouie Creek is 4 Litres per second. After consultation with Fish and Game it was agreed that the minimum flow for Glen Bouie Creek be set at 10 Litres per second.

10.28. With consultation with the applicants I have drafted a flow management scenario for the user group, a user group regime with online information is the most effective way to manage the river and abstractions at times of low flows.

OTAMATAPAIO CATCHMENT MITIGATION

10.29. I have reviewed the mitigation relating to minimum flow in the section 42A Officers reports of Claire Penman (report 29A,6A,6B,30B,). See table 18.

No.	Condition Code	Details
7	WP07	Name of waterbody: Otamatapaio River Map Reference: NZMS 260 H40:759-168 Minimum Flow: 200 Litres per second Flow graph: See report 2A

Table 18: CRC012047, CRC012017, CRC012019, CRC041033 Mitigation

10.30. The flow graph in report 2A, does not reflect the ‘usual’ abstraction of Otamatapaio Station of which the combined flow of CRC012047 and CRC012019 are the basis of all flow reductions in the greater Otamatapaio catchment. The ‘usual’ (‘A’ block) abstraction for Otamatapaio Station as defined in a user group arrangement between all users is 140 litres per second. Therefore under the annexed graph referred to by Ms Penman in Report 2A the reduction threshold flow sharing between the users should commence when the flow in the Otamatapaio River is reduced to 450 litres per second.

10.31. CRC012047and CRC012019 are abstracted directly from the Otamatapaio River and are collectively added to the minimum flow.

10.32. Suggested Mitigation Conditions CRC012047: Otamatapaio Station, Otamatapaio River.

Rate and Volume

No.	Condition Code	Details
2		Water may be diverted , taken and used as follows: a) At a rate not exceeding 30 litres per second at any flow in the Otamatapaio River; b) At a rate not exceeding 200 litres per second when river flows in the Otamatapaio River are greater than 600 litres per second; and c) At a rate not exceeding 140 litres per second when flows in the Otamatapaio River is equal or less than 600 litres per second but greater than 450 litres per second d) at a rate not exceeding 140 litres per second when river flows in the Otamatapaio River are equal or less than 450 litres per second but greater than 200L/s; and a sharing regime that limits the combined rate of abstraction to ensure that the flow in the Otamatapaio River at Footbridge less the combined flow of CRC012047 (Otamatapaio) and CRC012019 (Bogroy), is equal to or greater than 200 litres per second e) when the flow in the Otamatapaio River is equal to or Less than 200 litres per second taking of water in terms of this permit for irrigation purposes shall cease. f) With a volume not exceeding 2,442,080 cubic metres between 1 July and the following 30 June

Table 19: CRC012047 Suggested mitigation.

10.33. Suggested Mitigation Conditions CRC012019: Bogroy Station, Otamatapaio River

Rate and Volume

No.	Condition Code	Details
2		Water may be diverted, taken and used as follows: a) At a rate not exceeding 10 litres per second at any flow in the Otamatapaio River; b) at a rate not exceeding 110 litres per second when river flows in the Otamatapaio River are less than 450 litres per second but greater than 200L/s; and a sharing regime that limits the combined rate of abstraction to ensure that the flow in the Otamatapaio River at Footbridge less the combined flow of CRC012047 (Otamatapaio) and CRC012019 (Bogroy) is equal to or greater than 200 litres per second c) At a rate not exceeding 110 litres per second when river flows in the Otamatapaio River are greater than 450 litres per second; and d) when the flow in the Otamatapaio River is equal to or Less than 200 litres per second taking of water in terms of this permit for irrigation purposes shall cease. e) With a volume not exceeding 1,820,016 cubic metres between 1 July and the following 30 June

Table 20: CRC012019 Suggested mitigation

10.34. Otamatapaio River Mainstem operational guidelines for sharing regime CRC012047 and CRC012019

Restriction Level	Footbridge Flow	Otamatapaio Mainstem						Otamatapaio Irr CRC012047		Bogroy Irr. CRC012019	
		Total Abstraction	Stock water	% S/W	Irrigation	% Avail	Mainstem Residual	Irrigation	S/W	Irrigation	S/W
	800	310	40	100	270	100	490	170	30	100	10
B Permit	600	310	40	100	270	100	290	170	30	100	10
	599	250	40	100	210	100	349	110	30	100	10
A	450	250	40	100	210	100	200	110	30	100	10
B	400	200	40	100	160	80	200	83	30	76	10
C	350	150	40	100	110	60	200	58	30	52	10
D	300	100	40	100	60	40	200	31	30	28	10
E	250	50	40	100	10	20	200	5	30	5	10
F	200	40	40	100	0	0	160	0	30	0	10
	100	40	40	100	0		60	0	30	0	10

Table 21: Operational guidelines for CRC012047 and CRC012019

10.35. All other abstractions on the tributaries of the Otamatapaio will utilise the Otamatapaio minimum flow site as a trigger. The flows will be reduced at the same percentage as the combined flow of the 'A' block water abstraction of CRC012047 and CRC012019.

10.36. Suggested Mitigation Conditions CRC012017, Bogroy, Rostriever, Otematata, Corbies Creek

Rate and Volume

No.	Condition Code	Details
2		Water may be diverted, taken and used as follows: a) With a volume not exceeding 9504 cubic metres per day b) With a volume not exceeding 1,062,996 cubic metres between 1st July and the following 30^{th} June Whenever the flow of the Otamatapaio River as estimated by the Canterbury Regional at Map Reference NZMS 260 H40:759-168: c) Is equal or greater than 450 litres per second the maximum rate of take must not exceed 110 litres per second, and; d) Falls below the flow shown on the horizontal axis of 'Figure 11', then the rate of abstraction permitted in terms of this permit shall not exceed those shown as corresponding flows on the vertical axis. e) At a rate not exceeding 10 litres per second at any flow in the Otamatapaio River;

Table 22: CRC012017 Suggested mitigation

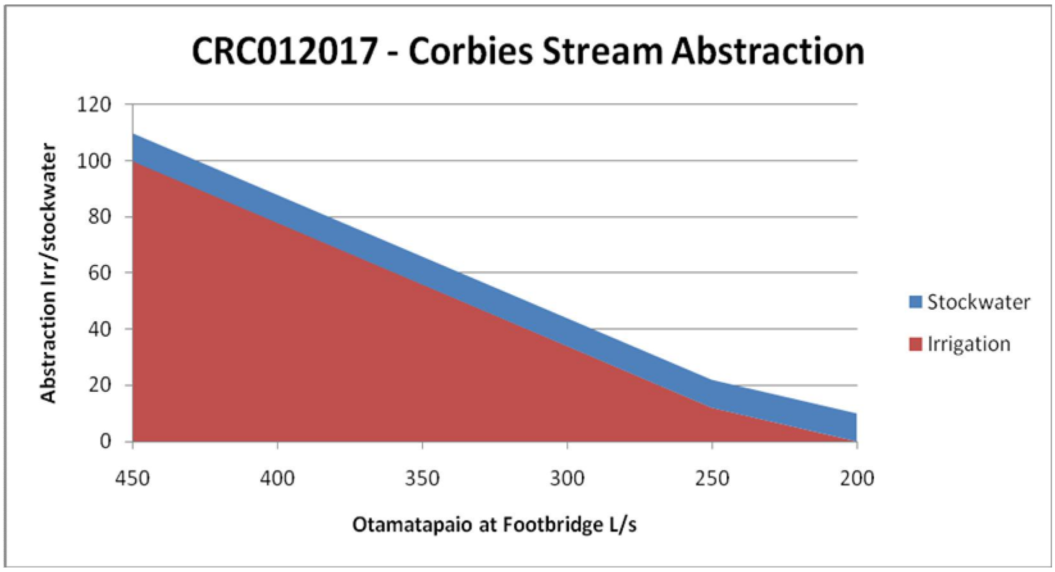

Figure 11: Bogroy, Rostriever, Otemetata (CRC012017) as proposed by table 23

Restriction Level	Otamatapaio at Footbridge L/s	% Available	Total Corbies Abstraction	Corbies Irrigation CRC012017	Corbies Stock water CRC012017
A	450	100	110	100	10
B	400	80	88	78	10
C	350	60	66	56	10
D	300	40	44	34	10
E	250	20	22	12	10
F	200	0	10	0	10

Table 23, Abstraction Regime for CRC012017

10.37. Mitigation for CRC041033, requires a local minimum flow above the abstraction point and also must be complying with the minimum flow on the Otamatapaio River utilizing the Otamatapaio as a trigger site. Abstractions on the 'A' block water will be reduced at the same percentage as the rest of the catchment. It is proposed to take 'B' block water for storage when the both Otamatapaio River is above 600L/s and Glen Bouie Stream is above 70L/s.

10.38. Suggested Mitigation Conditions CRC041133

Rate and Volume

No.	Condition Code	Details
2		Water may be diverted, taken and used as follows: a) With a volume not exceeding 8640 cubic metres per day b) With a volume not exceeding 660,000 cubic metres between 1st July and the following 30th June. c) At a Rate not exceeding 200 litres per second when Glen Bouie Stream as estimated by the Canterbury Regional Council at Map Reference NZMS 260 is at or above 410 litres second reducing to 70 litres per second (1:1 flow sharing) when Glen Bouie Stream is at 70 litres per second, and; when the Otamatapaio River is at or above 600 Litres per second. (Abstraction as defined as 'B' block in Figure 12) and; d) At a rate not exceeding 30 litres per second when Glen Bouie Stream is at or above 40 Litres per second, and when the Otamatapaio River is at or above 450 Litres per second. (Abstraction as defined as 'A' block in Figure 13) e) Falls below the flow shown on the horizontal axis of 'Figure 13' (Glen Bouie Stream), then the rate of abstraction permitted in terms of this permit shall not exceed those shown as corresponding flows on the vertical axis. f) Falls below the flow shown on the horizontal axis of 'Figure 13' (Otamatapaio River), then the rate of abstraction permitted in terms of this permit shall not exceed those shown as corresponding flows on the vertical axis.

Table 24: CRC012017 Suggested mitigation

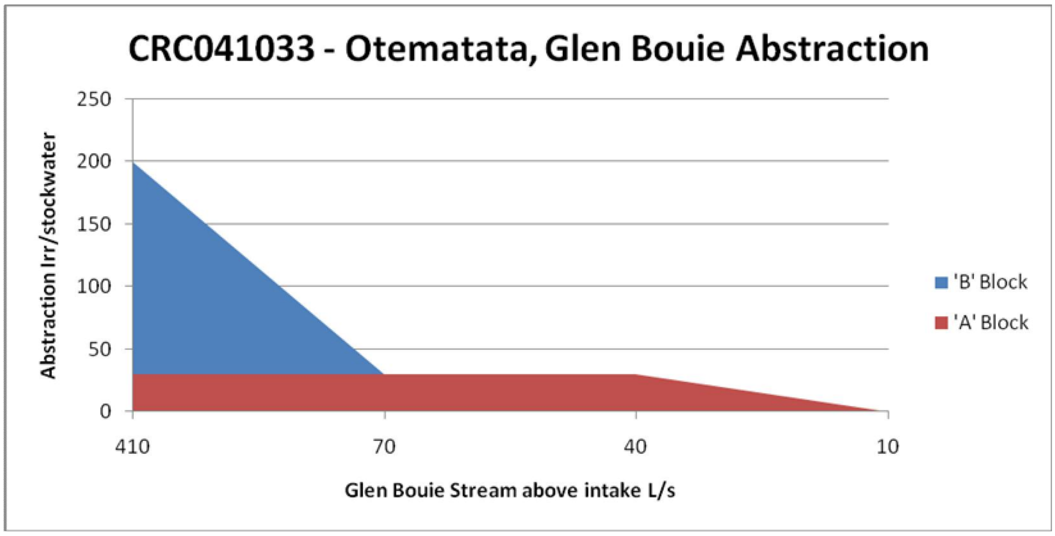

Figure 12: Otematata flow regime in relation to Glen Bouie Stream

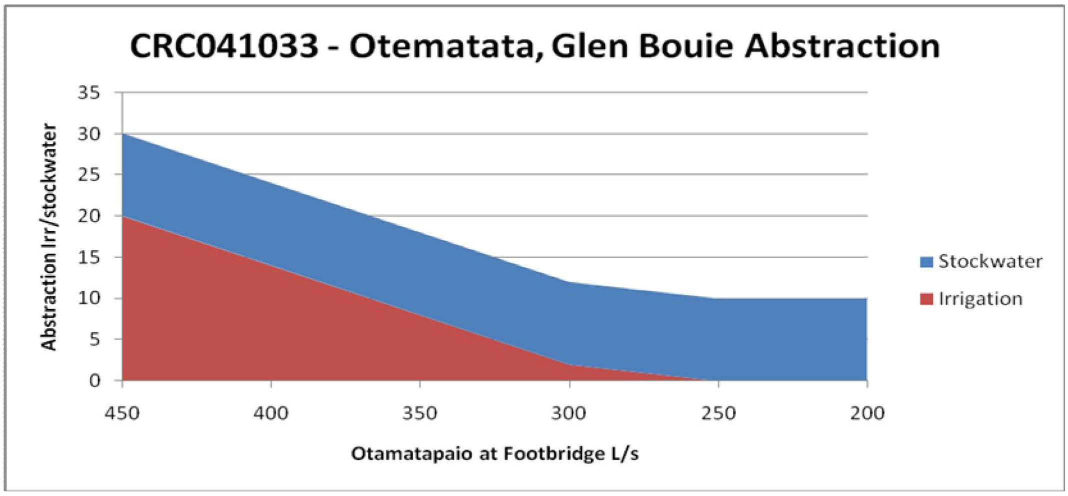

Figure 13: Otematata Station (CRC041033), flow regime in relation to Otamatapaio River

Restriction Level	Otamatapaio at Footbridge L/s	% Available	Glen Bouie above intake	Total Glen Bouie Abstraction CRC041033	Otemetata Irrigation CRC041033	Otematata Stock water CRC041033
B permit	600		410	200	190	10
B permit	600		70	30	20	10
A	450	100		30	20	10
B	400	80		24	14	10
C	350	60		18	8	10
D	300	40		12	2	10
E	250	20		10	0	10
F	200	0		10	0	10

Table 25, Abstraction Regime for CRC041033

11.0 HYDROLOGY SUTTON STREAM

Background

11.1. investigation into the minimum flow for the Sutton Stream began in 2007, initially a few flow measurement were taken, it was decided to install a water level recorder in December 2007 at a location known as Homestead Bridge this recorder was operated until 17 May 2008.

11.2. Original analysis for Sutton stream was carried out above the Sutton stream intake, this was to avoid any naturalizing of flows. The flow measurements were correlated with the Naturalised Hakataramea at MH Bridge flows. Giving an average result

11.3. Hakataramea at MH Bridge Flows Naturalised.

Statistic	ECan
Period	26/11/1963 to Not specified
7DMALF	1126 L/s
5Y7DLF	780 L/s
Mean Flow	5872 L/s

Table 26: Hakataramea at MH Bridge Statistics

PREVIOUS INFORMATION

11.4. There were 15 flow measurements carried out during 1976 to 1978, and a further 8 flow measurements carried out in 2003 and 2004. Record was derived for Sutton Stream by correlating the daily mean naturalized flows of the Hakataramea,

11.5. The equation for the Hakataramea generated by Gabites / Horrell is

Sutton = 0.1137 x Haka – 47 Litres per second.

The adjusted R2 for this correlation is 0.79

11.6. From this the Sutton Stream above Waitangi Station Intake Statistics are

Statistic	ECan
Period	26/11/1963 to Not specified
7DMALF	81 L/s
5Y7DLF	42 L/s
Mean Flow	620 L/s

Table 27: Sutton Stream Statistics

11.7. The analysis within the Gabites/ Horrell report came with a cautionary warning due to the poor correlation and the limited dataset.

SUTTON STREAM ANALYSIS

11.8. Boraman Consultants carried out three more flow measurements above the Waitangi intake on Sutton Stream. These were added to the dataset and the data was tried with several other streams and rivers in the region for correlation.

11.9. All attempts to correlate with other catchments were not of the accuracy achieved by Gabites/ Horrell. When attempting to correlate with Hakataramea using the expanded dataset, the correlation was still not as good as the original

11.10. The correlations did not improve, therefore it was agreed between Mr. Dave Stewart, Mr. Frank Scarf and myself, that the figures establish in the Gabites/ Horrell report be accepted as an interim. We also agreed that the figures are not robust and more research is required to establish the statistics. We also agreed that the 5 year 7 day low flow was provided in the report appeared to be on the low side, and mutually accepted that the 7 day mean annual low flow should be the interim minimum flow until enough data has been collected to established to a reliable 5 year seven day low flow.

11.11. A water level recorder was installed at a location known as Homestead Bridge and operated from 26 December 2007 to 17 May 2008 and is below all abstraction points.. Statistics could not be provided as we were unable to naturalise the flows as not all abstraction points could be monitored due to their intake setup. ‘Homestead Bridge’ site was selected as it was suitable as an ongoing minimum flow site, statistics and abstraction monitoring need to be established before this site can be utilised.

11.12. As the proposed minimum site is tributary of the greater Sutton stream catchment it is suggested this site acts as a trigger for the other abstractions in the catchment.

SUTTON STREAM CONCLUSIONS

11.13. I could not improve on the Gabites/ Horrell figure for the 5 year day low flow, and therefore it was agreed between Mr. Dave Stewart, Mr. Frank Scarf that we should establish an interim minimum flow until more data was collected.

11.14. We should adopt the 7 Day Mean Annual Low Flow, calculated using the Gabites / Horrell equation as the Minimum flow until the dataset is improved.

11.15. The interim Minimum flow for Sutton Stream should be adopted as 80L/s above the Waitangi Intake. To mitigate an environmental flow in Sutton stream the abstractions from the catchment should be managed by a user group.

SUTTON STREAM MITIGATION

11.16. The draft conditions for Sutton Stream in section 42A Report 38A are consistent with consistent with the proposed application and meet the requirements of the WCWARP. That is Sutton Stream intake will reduce flows to maintain the minimum flow below the point of Abstraction. Abstractions from adjacent catchments or catchments where the confluence is below the minimum flow site will take a reduction in flow at an equivalent percentage to the Sutton Stream Abstraction.

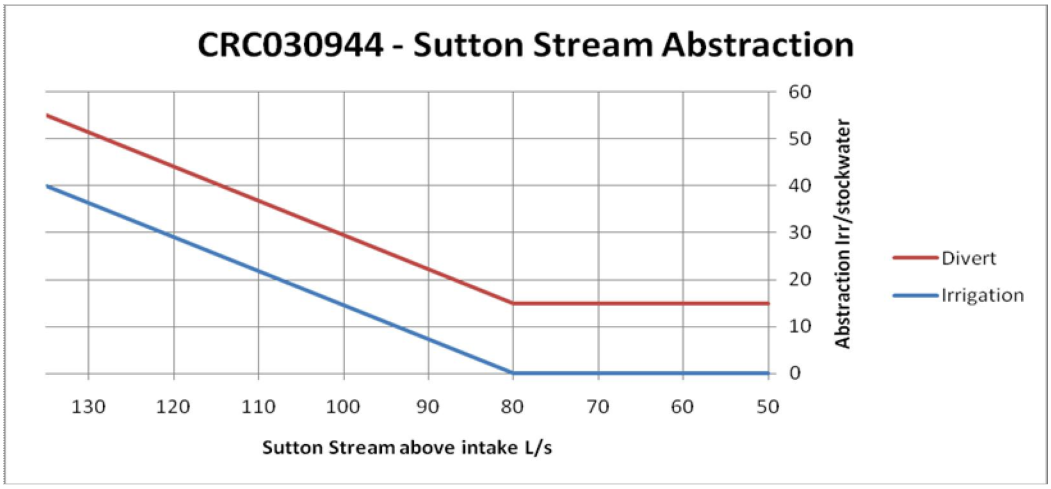

Figure 14: Flow regime Sutton Stream Intake CRC030944

11.17. Gibson Stream intake will reduce at the same rate as the Sutton Stream abstraction.

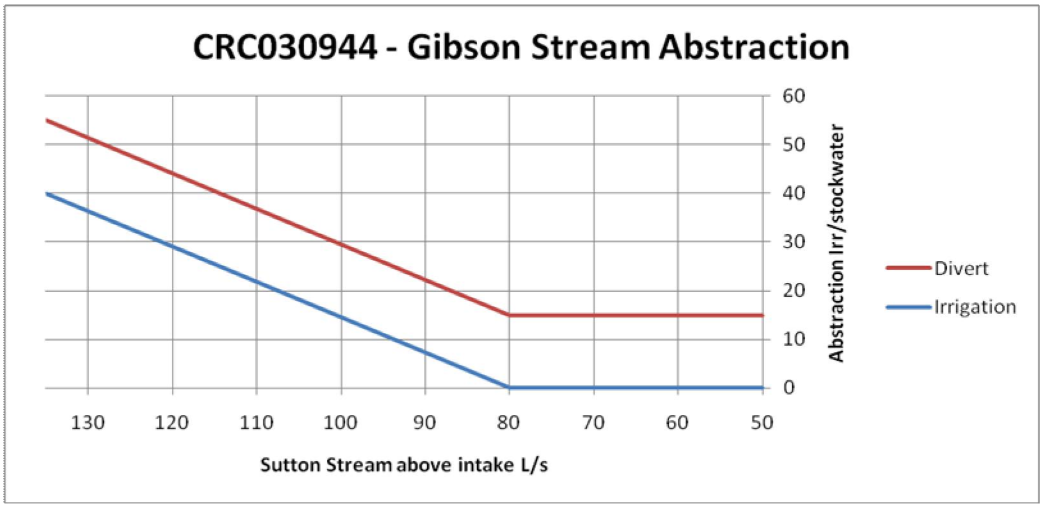

Figure 15: Flow regime Gibson Stream Intake CRC030944

11.18. Black Jack Stream intake will reduce at the same percentage rate as the Sutton Stream Intake.

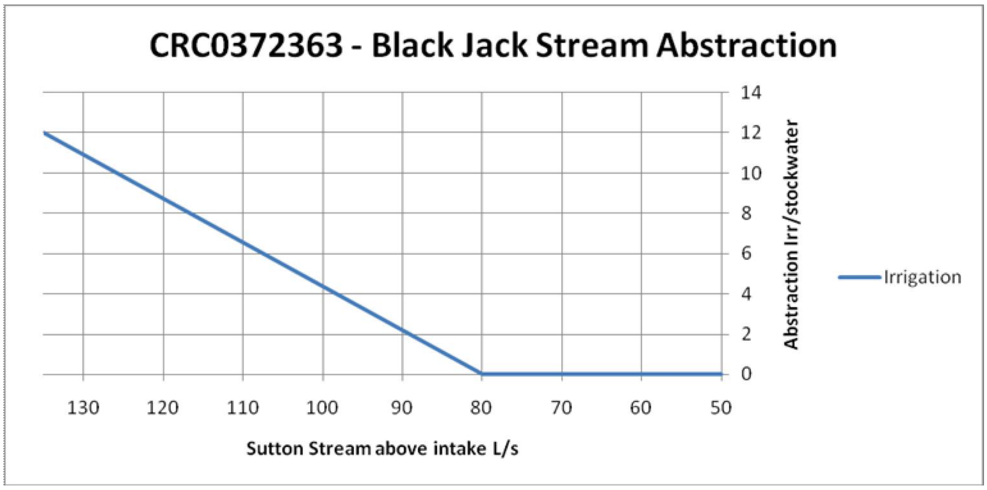

Figure 16: Flow regime Black Jack Stream Intake CRC030944