Memo

Date	29 June 2018
To	OTOP Zone Committee
CC	
From	Craig Davison and Dan Clark

Stream Depletion in the Opihi and Temuka Catchments

Purpose

The purpose of this paper is to:

a. Provide the Orari-Temuka-Orari-Pareora (OTOP) Zone Committee (ZC) with an overview of stream depleting groundwater theory and assessment methodologies;

b. Highlight the differences between the current methodology for assessing a stream depletion effect under the Opihi River Regional Plan (ORRP) and the Land and Water Regional Plan (LWRP);

c. Advise the ZC on the number of consents that will be affected by adopting the methodology in the LWRP for assessing a stream depletion effect as recommended in the Draft Zone Implementation Programme Addendum (dZIPA)[1], and which allocation block these abstractions would be factored into;

d. Advise the ZC on the feedback received on Recommendation 4.9.2 and provide suggested amendments to this recommendation for finalisation in the dZIPA.

What is stream depleting groundwater?

Surface water bodies and the surrounding groundwater are often seen to be different resources. However, nearly all surface water bodies interact with surrounding groundwater. Surface water bodies can naturally lose flow to groundwater (recharge) or gain flow from groundwater. This interaction can vary down the length of a river, Figure 1 shows examples these interactions. Abstraction of groundwater can impact on this interaction.

[1] Recommendation 4.9.2 of the Orari-Temuka-Orari-Pareora Draft Zone Implementation Addendum

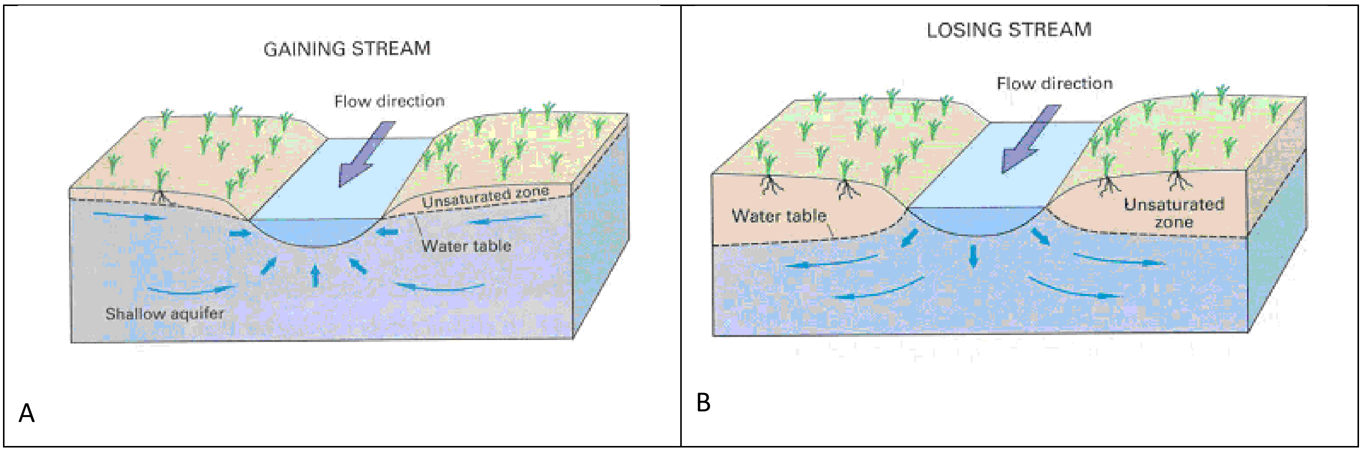

Figure 1 Example of a stream gaining from groundwater (A) and losing to groundwater (B) (from USGS 1998)

As groundwater is pumped the water level surrounding the bore is reduced, described as drawdown. This drawdown is influenced by the pump rate, depth, stream bed and aquifer characteristics. When abstraction occurs the pumping of groundwater can reduce flows in waterbodies. Figure 2 provides a simplified conceptual diagram of a bore pumping a flow (Q) at a distance of (L) from a waterbody. This diagram highlights how drawing down groundwater adjacent to a stream can influence flow in a the stream. Stream depletion includes both; intercepting groundwater that would have ended up in the waterbody and inducing loses of water that is already in the waterbody.

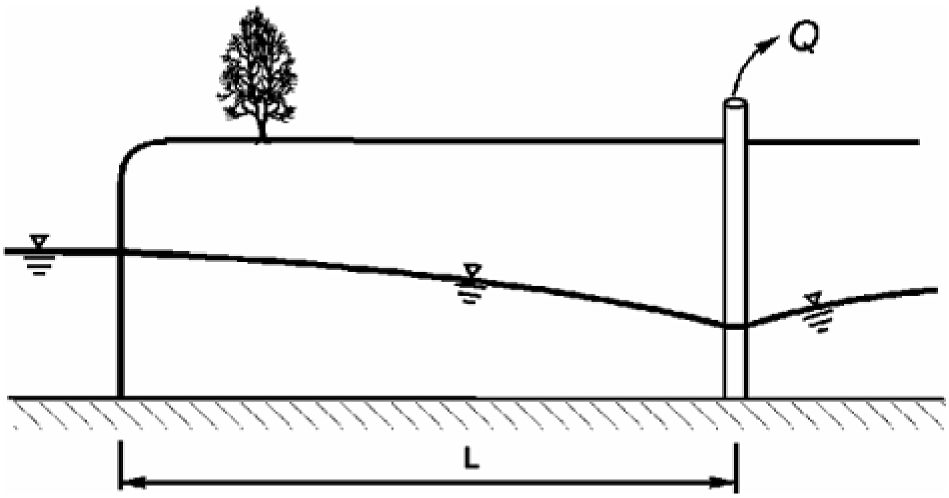

Figure 2 Conceptual diagram of a stream depleting groundwater take in an unconfined aquifer (from Hunt 1999)

How is a stream depletion effect of a groundwater abstraction assessed?

It is difficult to observe or physically measure the interaction between surface water and groundwater. However, given there is a clear interaction between surface and groundwater, it is necessary to establish an effects based regime to manage the effects that shallow groundwater abstraction has on surface water, and to account for these abstraction within allocation blocks.

Given the difficulty that exists to observe or physically measure a stream depletion effect, modelling approaches have been developed to estimate these effects. These modelling approaches consider key hydrogeological components including the duration and rate of abstraction, aquifer transmissivity, stream bed characteristics and the distance from the point of abstraction to a surface water body.

The ORRP defines a methodology to calculate stream depletions using a threshold of 5 L/s stream depletion effect calculated over 30 days of pump. If this threshold is breached, the groundwater abstraction is treated as if it is surface water abstraction, and managed with a minimum flow condition. The method assumes that groundwater is pumped at the peak rate for 30 days..

The relationship between the point of abstraction, the distance of surface waterways from the point of abstraction, and the duration of pumping has been explored further in Smith (2000). The potential magnitude of a stream depletion effect as a result of a groundwater abstraction is significantly influenced by these variables. As the distance between the point of abstraction and a surface water body increases, the magnitude of the stream depletion effect decreases. This demonstrates that there is a lag time between the effects on that surface water body and the point of abstraction, and that to observe the maximum stream depletion effect, a long pumping duration is required. This infers that timing is a key variable required to determine a stream depletion effect.

When the Natural Resources Regional Plan (NRRP) was developed, it introduced a framework for stream depletion management that required a stream depletion effect to be calculated as a percentage over 7 and 150-day periods. Depending on the percentage, an abstraction was afforded a classification of a low, moderate, high, or direct degree of connection to surface water. This framework for assessing a stream depletion effect was carried over into the LWRP (Appendix Two), and applies across Canterbury except in the areas covered by the ORRP, the Waimakariri River Regional Plan (WRRP).

Part of the LWRP methodology assesses pumping occurring at the average rate of take for a duration of 150 days to allow slower developing stream depletion effects to be captured. It is considered to be a more appropriate method to better reflect the effects of longer term cumulative abstraction on surface water bodies. The 150-day period as a trigger was based on irrigation surveys completed by Sanders (2003), which concluded that irrigation in Canterbury commonly occurs for more than 150 days. Therefore, in order to determine the stream depletion effect, the methodology should take into account abstraction that could occur over the course of the irrigation season.

Stream depletion classifications

The LWRP regime for managing stream depleting groundwater abstractions has two components; managing the abstraction with a minimum flow condition, and accounting for it within the relevant surface water and groundwater allocation blocks. Table 1 sets out how stream depleting groundwater abstractions are managed depending on its classification.

Table 1 – Management Framework for Stream Depletion under the LWRP

Stream depletion effect	Amount to be included in the surface water allocation limit	Amount allocated from the groundwater zone	Pumping schedule	Subject to surface water minimum flow restrictions
Direct	Maximum daily rate of take[1] (the rate at which water can be continuously taken to abstract the maximum daily volume that is to be taken), and 100% of the annual volume	None	Not applicable	Yes
High	The stream depletion effect[1] estimated using the *pumping schedule*; and 75% of the annual volume	25% of the annual volume	150 days continuous steady pumping required to deliver the annual volume	Yes if above 5 L/s
Moderate	The stream depletion effect[2] estimated using the *pumping schedule*; and 50% of the annual volume	50% of the annual volume	150 days continuous steady pumping required to deliver the annual volume	No
Low	None	100% of the annual volume	Not applicable	No

Methodology used for estimating stream depletion in the Opihi and Temuka catchments

As part of the Resource Consent Inventory (RCI) for the Healthy Catchments Project, an assessment has been undertaken to estimate the potential stream depletion effect from all bores in the OTOP Zone screened at a depth of less than 30 metres. This assessment was required to identify the number of consents that may be affected by the change in methodology across the zone in terms of future minimum flow requirements, and to quantify the stream depletion effect for inclusion in surface water allocation blocks.

Due to a lack of site specific testing across the zone, a desktop analysis was undertaken using the Theis (1941) stream depletion model as it requires the least number of input parameters. Its assumptions therefore are considered conservative for surface waterbodies, and are likely to have overestimated the stream depletion effect. Where any bores had site specific testing available, those inputs were used for estimating the potential stream depletion effect from those bores. A consequence of this assessment it that the surface water allocation blocks are shown to be more allocated than is the case in reality. However, it is likely to have captured all potential stream depletion effect across the zone.

Newly Identified Stream Depleting Groundwater Abstractions in the Opihi Catchment

Table 1 (Appendix One) sets out the newly identified stream depleting groundwater abstractions in the Opihi catchment, and which allocation block these abstractions would be factored into based on Recommendation 4.9.2 of the dZIPA. In summary, there are 62 affected consents in the Opihi Catchment as follows:

- There are nine affected consents in the Upper Opihi River catchment[2], with a total stream depletion effect of 49 L/s (BN Block)
- There are 41 affected consents in the Opihi River catchment[3], with a total stream depletion effect of 499 L/S (230 L/s AN Block and 269 L/s BN Block)
- There are eight affected consents in the Te Ana Wai River catchment[4], with a total stream depletion effect of 10 L/s (BN Block)
- There are two affected consents in the Station Creek sub catchment, with a total stream depletion effect of 20 L/s (8.5 L/s A Block and 12 L/s B Block).
- There are two affected consents in the Deep Creek sub catchment, with a total stream depletion effect of 5 L/s (BN Block)

Newly Identified Stream Depleting Groundwater Abstractors in the Temuka Catchment

Table 2 (Appendix 1) sets out the newly identified stream depleting groundwater abstractions in the Temuka catchment, and which allocation block these abstractions would be factored into based on Recommendation 4.9.2 of the dZIPA.

In summary there are 47 affected consents in the Temuka River Catchment as follows:

- There are 13 affected consents in the Temuka River, with a total stream depletion effect of 117 L/s (85 L/s A Block and 32 L/s B Block);
- There is one affected consent in Raupo Creek, with a stream depletion effect of 32 L/s (A Block);
- There are 28 affected consents in the Waihi River, with a total stream depletion effect of 211 L/s (141 L/s A Block and 70 L/s B Block)
- There are five affected consents in the Hae Hae Te Moana River, with a total stream depletion effect of 20 L/s (8.5 L/s A Block and 12 L/s B Block).

Impact of Recommendation 4.9.2 across the Opihi and Temuka catchments

Tables 1 and 2 (Appendix One) highlight that, irrespective of Recommendation 4.9.2, there 42 and 27 consents in the Opihi and Temuka catchments respectively that may require a minimum flow in the

[2] Including Stoneleigh Stream

[3] Including Milford Lagoon / Clandeboye Drainage Area, and German and Pleasant Point Creeks

[4] Including Totara Creek

future. In other words, if the current 30 day methodology were to remain. Therefore, the net effect of Recommendation 4.9.2 in terms of consents that may require minimum flows in the future is considered to be 22 in the Opihi catchment, and 20 in the Temuka catchment. However, all 62 consents in the Opihi catchment and 47 in the Temuka catchment may be impacted by changes to minimum flows. The full economic implications of Recommendation 4.9.2 will be presented in the economic evaluation of the dZIPA currently being completed and will be available by 6 August.

As previously mentioned, a conservative desktop assessment has predominantly been used to estimate the current stream depletion effect from all bores shallower than 30 metres in these catchments. The actual stream depletion effect, and whether those consents will require a minimum flow definitively in the future is yet to be determined. This can only be determined through site specific bore testing that will be required on renewal of consent as part of the consent application. The onus for demonstrating an actual stream depletion effect lies with the consent holder and/or consent applicant. However, the assessment that as been undertaken is considered appropriate for the current limit setting process.

Feedback received on Recommendation 4.9.2 – Stream Depletion Methodology

The feedback received on Recommendation 4.9.2 was substantial and ranged from strong support to strong opposition given the impact this recommendation may have on some consent holders' reliability of supply. Suggested amendments included clarifying which allocation block new stream depleters affected by the change in methodology would be in using the actual dates from the Opihi River Regional Plan (ORRP), and including in the narrative of the DZIPA how many consent holders this recommendation may affect. Other feedback suggested that there be a ten-year lead in period before this recommendation comes into force. It is noted that in accordance with recommendation 4.9.7 (Resource Consent Reviews) the changes to stream depletion methodology would apply when water permits in the Opihi and Temuka FMUs are reviewed.

Options for Amending Recommendation 4.9.2 – Stream Depletion Methodology

1. Retain Recommendation 4.9.2 in its current form; or
2. Amend Recommendation 4.9.2 as follows:

Suggested Amendments to Recommendation 4.9.2

I. The methodology in the Land and Water Regional Plan for estimating the stream depletion effect of shallow groundwater abstractions applies zone wide.

II. The allocation block for newly identified stream depleting groundwater abstractions is to be determined by the date the original consent was granted **in accordance with the priority for abstraction as set out in the Opihi River Regional Plan**.

III. **In the Opihi Freshwater Management Unit, water permits** ~~Consents~~ granted prior to **30 July 1994** ~~the notification of the Opihi River Regional Plan~~ are **AN consents**. **Water permits granted subsequent to this date are BN consents.** ~~while those that were granted subsequent to the notification of the Opihi River Regional Plan will be B block.~~

IV. **In the Temuka Freshwater Management Unit, water permits granted prior to 1 January 1991 are A Permit consents. Water permits granted subsequent to this date are B Permit consents.**

References

Hunt, B; 1999; Unsteady Stream Depletion from Ground Water Pumping; Ground Water, Vol 37, No. 1, pp 98-102.

Scott, D; 2003; Management of the stream depletion effects of groundwater abstraction. Ecan internal memorandum. File IN6C-0011

Sanders, R.A. (2003): Irrigation water use survey: Report on the 2002/2003 irrigation season. Environment Canterbury Report U03/30.

Smith, M. (2000): Techniques for evaluating stream depletion effects: A supplement to the guidelines for the assessment of groundwater abstraction effects on stream flow. Environment Canterbury Report R09/53.

United States Geological Survey; 1998; “Ground Water and Surface Water A Single Resource”; US Geological Survey Circular 1139.

Appendix One – Newly Identified Stream Depleting Groundwater Abstractions in the Opihi and Temuka Catchments

For the purposes of Tables 1 and 2:

- Where a consent is listed as requiring a minimum flow under the ORRP and the LWRP (i.e. "Yes" "Yes"), those consents are **not** considered to be affected by Recommendation 4.9.2 as those abstractions may require minimum flow in the future notwithstanding Recommendation 4.9.2.

- Where a consent is listed as not requiring a minimum flow under the ORRP and the LWRP (i.e. "No" "No"), those consents are **not** considered to be affected by Recommendation 4.9.2, but the stream depletion effect from those abstractions is required to be factored into the relevant allocation block (i.e. these abstractions are below the 5L/s threshold over 30 days as specified in the ORRP, and are considered to have a "high" degree of stream depletion effect under the LWRP, but that effect is below the 5 L/s threshold over 150 days; or those abstractions are considered to have a "moderate" degree of stream depletion effect;

- Where a consent is listed as not requiring a minimum flow under the ORRP but requiring one under the LWRP (i.e. "No" "Yes"), those consents **are** considered to be affected by Recommendation 4.9.2 (i.e. these abstractions are below the 5 L/s threshold over 30 days, but are considered to have either a high degree of stream depletion effect (greater than 5 L/s over 150 days) or are considered to have a direct connection to surface water).

- Where a consent is listed as requiring a minimum flow under the ORRP, but not requiring one under the LWRP (i.e. "Yes" "No"), those consents are **not** considered affected by Recommendation 4.9.2 (i.e. these abstractions are estimated to exceed the 5 L/s threshold over 30 days, but have a high degree of stream depletion effect that does not exceed 5 L/s over 150 days under the LWRP.

Table 1 – Newly Identified Stream Depleting Groundwater Consents in the Opihi Catchment

Catchment	Consent Number	Date of Original Grant	Permit Type	Depletion Effect (L/s)	Minimum Flow (ORRP)?	Minimum Flow (LWRP)?
Upper Opihi	CRC136765	15/12/2003	BN	5	Yes	Yes
	CRC001034	9/02/2000	BN	3.37	No	No
	CRC147469	2/11/2005	BN	3.88	No	No
Total BN				12.25		
Total Number of Consents Affected by Rec 4.9.2				0		
Stoneleigh Stream (Upper Opihi)	CRC062731	12/04/2006	BN	2.00	No	Yes
	CRC136325	16/08/1995	BN	1.59	No	No
	CRC000596.2	9/03/2000	BN	15.00	Yes	Yes
	CRC171794	5/06/1998	BN	3.21	No	No

	CRC020347	3/12/2001	BN	7.26	No	Yes
	CRC021200	14/02/2002	BN	7.60	Yes	Yes
Total BN				36.65		
Opihi Mainstem	CRC991954	8/02/1989	AN	1.9	No	No
	CRC153090	9/08/1989	AN	4.06	No	No
	CRC992480	2/11/1990	AN	19	Yes	Yes
	CRC153110	4/02/1992	AN	4.75	No	No
	CRC000349.1	23/12/1991	AN	5.47	Yes	Yes
	CRC952585.2	12/06/1991	AN	8	No	Yes
	CRC133569	6/05/1992	AN	3.84	No	No
	CRC951595.1	12/06/1991	AN	11.91	No	Yes
	CRC156464	12/06/1991	AN	14.29	No	Yes
	CRC121509.1	12/06/1991	AN	14.29	No	Yes
	CRC960510.1	14/08/1986	AN	22.39	Yes	Yes
	CRC001348.1	18/09/2002	BN	1.03	No	No
	CRC090125.1	13/10/2008	BN	1.06	No	No
	CRC981064	8/09/1999	BN	1.45	No	No
	CRC960666.3	10/11/1995	BN	1.85	No	No
	CRC080638	2/04/2008	BN	25	Yes	Yes
	CRC991671.1	9/03/1999	BN	15.2	Yes	Yes
	CRC174439	20/12/2004	BN	5.86	Yes	Yes
	CRC011715	10/10/2001	BN	7.14	No	Yes
	CRC961386.2	28/02/1996	BN	7.82	No	Yes
	CRC992481	22/10/1997	BN	10.46	No	Yes
	CRC980250	30/08/1999	BN	10.49	No	Yes
	CRC952556.2	2/08/1995	BN	20	Yes	Yes
	CRC103999	28/09/2006	BN	18.56	No	No
	CRC136256	27/07/2007	BN	37.21	No	No
	CRC981246.1	13/10/1999	BN	30.89	No	Yes
Total AN				109.9		
Total BN				194.02		
Total Number of Consents Affected by Rec 4.9.2				11		
Milford Lagoon (Opihi)	CRC992275	13/09/1989	AN	6.6	No	Yes
	CRC962522.1	23/10/1991	AN	14.35	No	Yes
	CRC150514	14/08/1986	AN	36.03	Yes	Yes
	CRC140633	15/04/1996	BN	36.65	No	Yes
Total AN				56.98		
Total BN				36.65		
Total Number of Consents Affected by Rec 4.9.2				3		
German Creek (Opihi)	CRC132937	12/07/1989	AN	2.46	No	No
	CRC155646	11/12/1989	AN	6.95	No	Yes
	CRC162762	16/12/2011	BN	0.58	No	No
	CRC000345.1	23/09/1999	BN	1.33	No	No
	CRC091762	2/12/2008	BN	11.01	No	Yes

Total AN				9.42		
Total BN				12.92		
Total Number of Consents Affected by Rec 4.92				2		
Pleasant Point Creek (Opihi)	CRC153938	26/11/1992	AN	0.86	No	No
	CRC992573	13/09/1989	AN	1.04	Yes	No
	CRC991559	14/06/1989	AN	10.00	Yes	Yes
	CRC132938	12/06/1989	AN	19.00	Yes	Yes
	CRC166536	29/01/1992	AN	23.00	Yes	Yes
	CRC012098.2	23/05/2001	BN	25.00	Yes	Yes
Total AN				53.91		
Total BN				25		
Total Number of Consents Affected by Rec 4.9.2				0		
Te Ana Wai	CRC992794	10/05/1989	AN	7.08	No	Yes
	CRC020046.1	10/10/2001	BN	28.00	Yes	Yes
	CRC164167	10/10/2001	BN	30.00	Yes	Yes
	CRC020220.2	10/10/2001	BN	13.95	Yes	Yes
Total AN				7.08		
Total BN				71.95		
Total Number of Consents Affected by Rec 4.9.2				1		
Totara Creek (Te Ana Wai)	CRC175624	2/04/1993	AN	21.10	No	Yes
	CRC151726	25/09/2014	BN	4.90	No	Yes
	CRC082990	12/11/2008	BN	13.80	Yes	Yes
	CRC084866	11/09/2008	BN	1.70	No	No
Total AN				21.10		
Total BN				20.4		
Total Number of Consents Affected by Rec 4.92				2		
Station Stream	CRC081654	10/04/2008	BN	5.00	No	Yes
	CRC093760	14/08/2009	BN	5.00	No	Yes
Total BN				10		
Total Number of Consents Affected by Rec 4.92				2		
Deep Creek	CRC153922	12/01/2009	BN	4.5	No	Yes
	CRC169703	17/12/2007	BN	0.74	No	No
Total BN				5.24		
Total Number of Consents Affected by Rec 4.92				1		

Table 2 – Newly Identified Stream Depleting Groundwater Consents in the Temuka Catchment

Catchment	Consent Number	Date of Original Grant	Permit Type	Depletion Effect L/s	Minimum Flow (ORRP)?	Minimum Flow (LWRP)?
Temuka River	CRC991606	26/03/1993	A	0.64	No	No
	CRC012876	8/10/2001	B	0.99	No	No
	CRC950343	7/11/1994	A	4	No	Yes
	CRC040758	25/03/2004	B	7	Yes	Yes
	CRC084774	30/09/2008	B	3.5	No	Yes
	CRC992551	13/09/1989	A	3.66	Yes	No
	CRC084587	20/08/2008	B	3.78	Yes	No
	CRC030505	19/11/2002	B	5.5	Yes	Yes
	CRC030508	19/11/2002	B	5.5	Yes	Yes
	CRC030818	27/01/2003	B	6	Yes	Yes
	CRC991570	14/08/1986	A	15.02	No	Yes
	CRC161313	30/11/1998	A	23.21	No	Yes
	CRC962541	19/04/1991	A	38.48	No	Yes
Total A				85.01		
Total B				32.27		
Total Number of Consents Affected by Rec 4.9.2				5		
Raupo Ck	CRC991957	13/09/1989	A	32	Yes	Yes
Total A				32		
Total Number of Consents Affected by Rec 4.92				0		
Waihi River	CRC960347.1	21-Sep-95	A	3.00	No	Yes
	CRC133082	13-Sep-89	A	17.93	Yes	Yes
	CRC992248	13/09/1989	A	1.50	No	No
	CRC020518.1	21/11/2001	B	1.83	No	No
	CRC142152	11/10/1989	A	11.10	Yes	Yes
	CRC141350	20/10/1999	B	8.00	Yes	Yes
	CRC040688	22/01/2004	B	5.00	No	Yes
	CRC166441	11/10/1989	A	11.00	Yes	Yes
	CRC042916.1	20/09/2004	B	5.00	No	Yes
	CRC161677	13/09/2003	B	2.80	No	No
	CRC032274	13/08/2003	B	3.50	No	Yes
	CRC071059	7/03/2007	B	3.17	No	No
	CRC173562	17/09/1998	A	4.90	No	Yes
	CRC991836.1	2/12/1991	A	3.40	No	No
	CRC164628	26/06/2006	B	3.53	No	No
	CRC157408	13/09/2003	B	3.54	No	No
	CRC011826	24/04/2001	B	4.80	No	Yes
	CRC992638	11/10/1989	A	3.70	No	No
	CRC980055	5/12/1997	A	20.00	Yes	Yes
	CRC012560	9/07/1969	A	4.38	No	No

	CRC041689	9/06/2004	B	5.00	No	Yes
	CRC992439	25/09/1992	A	5.64	No	Yes
	CRC980854	31/03/1999	B	6.09	Yes	Yes
	CRC000449.2	11/10/1989	A	8.28	No	Yes
	CRC153535	13/09/1989	A	31.00	Yes	Yes
	CRC060740.2	2/11/2005	B	12.77	Yes	Yes
	CRC992497.2	13/09/1989	A	15.02	No	Yes
	CRC174006	21/02/2007	B	4.90	No	Yes
Total A				140.86		
Total B				69.93		
Total Number of Consents Affected by Rec 4.92				11		
Hae Hae Te Moana	CRC050248	24/10/2004	B	1.71	No	No
	CRC081917	17/04/2008	B	5.00	No	Yes
	CRC992165	13/09/1989	A	3.50	No	Yes
	CRC166228	13/09/1989	A	5.00	No	Yes
	CRC041121	12/03/2004	B	5.00	No	Yes
Total A				8.50		
Total B				11.71		
Total Number of Consents Affected by Rec 4.92				4		

Appendix Two – Schedule 9 Land and Water Regional Plan

The degree of stream depletion effect shall be determined as follows:

A **direct degree of stream depletion effect** is where the modelled effect of seven days of steady continuous groundwater abstraction on the surface waterbody is equal to or greater than 90% of that abstraction rate.

A **high degree of stream depletion effect** is where the modelled effect of seven days of steady continuous groundwater abstraction on the surface waterbody is less than 90% of that abstraction rate but the effect of 150 days of steady continuous groundwater abstraction is greater than or equal to 60% of that abstraction rate.

A **moderate degree of stream depletion effect** is where the effect of 150 days of steady continuous groundwater abstraction on the surface waterbody is less than 60% but greater than or equal to 40% of that abstraction rate, or the effect of 150 days of continuous steady groundwater abstraction on the surface waterbody is less than 40% of that abstraction rate but pumping the proposed annual volume over 150 days at a continuous steady rate exceeds 5 L/s unless a greater or lesser rate is specified for the catchment in Sections 6 to 15.

A **low degree of stream depletion effect** is where the effect of 150 days of steady continuous groundwater abstraction on the surface waterbody is less than 40% of that abstraction rate and the effect of pumping the proposed annual volume over 150 days at a continuous steady rate is less than 5 L/s unless a greater or lesser rate is specified for the catchment in Sections 6 to 15.

Borefields

Where there is more than one bore on a property abstracting water that is hydraulically connected to a stream, the stream depletion effect for each bore shall be determined independently, and where the bores have the same stream depletion effect, the stream depletion effect of the bores shall be determined in combination as a borefield. The combined stream depletion effect shall be determined evaluating the maximum possible stream depletion effect that may develop as a result of operating under the proposed consent conditions.

Inclusion in surface and groundwater allocations

Table S9.1: Stream depletion effect to be included in the surface and groundwater allocations

Stream depletion effect	Amount to be included in the surface water allocation limit	Amount allocated from the groundwater zone	Pumping schedule	Subject to surface water minimum flow restrictions
Direct	Maximum daily rate of take[1] (the rate at which water can be continuously taken to abstract the maximum daily volume that is to be taken), and 100% of the annual	None	Not applicable	Yes

Stream depletion effect	Amount to be included in the surface water allocation limit	Amount allocated from the groundwater zone	Pumping schedule	Subject to surface water minimum flow restrictions
	volume			
High	The stream depletion effect[1] estimated using the *pumping schedule*; and 75% of the annual volume	25% of the annual volume	150 days continuous steady pumping required to deliver the annual volume	Yes if above stream depletion effect cut-off.
Moderate	The stream depletion effect[2] estimated using the *pumping schedule*; and 50% of the annual volume	50% of the annual volume	150 days continuous steady pumping required to deliver the annual volume	No
Low	None	100% of the annual volume	Not applicable	No

Notes:

1. This effect will be included in the surface water allocation irrespective of the rate of take
2. This effect will be included in the surface water allocation if the stream depletion effect exceeds the stream depletion effect cut-off in Sections 6 to 15, or where none has been set in Sections 6 to 15, 5 L/s