MARLBOROUGH
DISTRICT COUNCIL

Aquifer Safe Yield Review 2012

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Executive Summary

As part of the review of freshwater policy in Marlborough, levels of allocation were compared with plan limits, safe yield and actual rates of use for each of the main aquifer systems

All aquifers are over-allocated relative to plan limits and most are over-allocated compared with safe yield. However actual abstraction from wells is generally less or close to the safe yield in most summer seasons

If all of the allocation were used the effects would be unsustainable based on the latest research. With the exception of drought seasons there have been no adverse effects except in the heavily committed Southern Valleys Aquifers

The lack of recent issues will also partly reflect uninterrupted supplementary recharge from the Gibson Creek/Opawa River system, the wetter than normal climate phase since 2008 and correspondingly lower demand

Volumetric safe yields in the plan were reviewed as part of this report and where none existed a limit was defined based on modelling or water balance approaches for all Wairau Plain aquifers. Existing allocations were mostly revised downwards

A stock take of actual groundwater use and demonstration of the effects of pumping under drought conditions would enable further refinement of safe yields

Current groundwater controls are generally inadequate to manage the potential effects of consented groundwater in most areas relative to national guidelines or standards

Contents

1. Introduction

Most of Marlborough's groundwater resources are concentrated beneath the Wairau Plain where the largest deposits of aquifer forming gravels are located. Localised aquifers occur elsewhere, but they have limited storage and surface water is more often the primary source of supply.

The Wairau Plain area of Marlborough is highly dependant on its underground water resources. From the basics of day to day life to underpinning our economic and ecological wealth, they make the Blenheim hinterland the favoured place it is to live for humans and other species alike.

The primary nature of the local economy makes it reliant on groundwater for the irrigation and processing of agricultural crops. In most places it is reliably available in some shape or form during the driest weather, and its high quality makes it ideal for drinking with minimal treatment.

The natural availability of large volumes of groundwater close to the surface is responsible for upwelling springs. These springs are ecologically important and give the Lower Wairau Plain and the waterways that meander through Blenheim their unique character.

Compared to other alluvial aquifers around the country, the Wairau Aquifer is relatively simple in terms of its structure and flow dynamics. This makes it easier to understand hydrologically and for water management decision making purposes than either the Southern Valleys or Deep Wairau Aquifer.

Ground and surface waters are commonly interconnected to the extent that it makes sense to manage them as a single water body. This is particularly so as demand grows and matches natural rates of flow or aquifer storage. The main components of this cycle involve Wairau River channel losses to the Wairau Aquifer north and west of Renwick which in turn supplies the mid plain springs.

Groundwater provides the baseflow for all of the Lower Wairau Plain streams. This means if it hasn't rained for a while, then most channel flow is originating from underground. In this way groundwater helps regulate fluctuations in flow or temperature of streams and provides a unique habitat compared to conventional catchments fed by rainfall or runoff.

It is no exaggeration to say that groundwater maintains the biodiversity of Marlborough's lowland flood plain habitats. The makeup of the word wetland says it all. Without the buffering effect of these underground reservoirs, Marlborough wetlands and springs would alternate between being either too wet or too dry. Managing river and aquifer allocation or activities has broader benefits in space and time for nature and the community.

Most Marlborough rivers and streams have an element of groundwater associated with them stored in the gravels of the channel. Where this is a small fraction of the catchment water budget or where its proportion is uncertain, the conservative approach is taken and the water resource is managed as a river.

There are major differences in the natural functioning of rivers and groundwater systems which affect their management here in Marlborough. Aquifers store water in time and space. Water may enter an aquifer at one point and flow 30 kilometres before it is pumped from a well. Some Marlborough groundwater is tens of thousands of years old meaning it fell that long ago as rain and has been trapped underground ever since.

Aquifers are natural reservoirs meaning they smooth out imbalances between inputs and outputs. It is for this reason that we talk in terms of average rates of pumping instead of instantaneous ones as is the case with riverflow management.

Aquifers are hidden unlike rivers meaning that knowledge of their behaviour, hydraulic properties, boundaries and limits is gained through using groundwater. Refining understanding takes time and in some cases decades to accumulate.

For these reasons and a lack of issues in recent times, MDC hasn't rigidly adhered to the 1998 plan limits for abstraction, particularly for the Wairau Aquifer. This contrasts with the practice for the major perennial rivers where allocation matches policy based on the certainty that 50 years of flow record gives.

2. Purpose and Format

The aim of this report is to provide Marlborough District Council with safe yields for the main groundwater resources of Marlborough. This involves reassessing existing limits and establishing new ones where they do not exist. As part of this process the following questions were addressed:

- *How much groundwater has MDC allocated & where?*
- *How much of this consented allocation is used?*
- *Are current levels of use causing problems?*

What is missing is a complete picture of water use by aquifer and season, but it is being worked on and is expected to be available within 5 years. Average rates of abstraction where they are known have been used in this report or alternatively, estimated consumption based on modelling by Plant and Food Research limited.

Each aquifer system was then described in detail and its water management discussed under the following headings:

- *Where is the aquifer located and what is its capacity?*
- *What are the actual or potential water management issues?*
- *Is groundwater abstraction close to any limits?*
- *What state is the aquifer currently in?*

Imbalances between allocation, plan limits, actual use and safe yields are explained for each individual aquifer system or layer.

3. Determining Safe Yield

A central concept of this report is safe yield which refers to the long-term natural replenishment rate of a particular aquifer system. If abstraction is kept to within this rate then there are unlikely to be long lasting issues. Safe yield is not a static figure however, but varies from season to season as rates of recharge and demand fluctuate.

There are challenges determining the safe yield of some Marlborough aquifers because their full water balance is not precisely known yet. In the case of the Southern Valleys aquifers this value was defined by stressing these systems during the 1997/98 and 2000/01 droughts for known rates of abstraction while observing the effects.

The Wairau Aquifer has not been stressed to the same extent yet and MDC rely on model studies to forecast the rate at which groundwater can be withdrawn without causing problems. Models are useful for setting broad targets, but the best measure of the safe yield of an aquifer is through demonstrated use and effect.

The reliability of model forecasts of safe yield for the Wairau Aquifer is limited by uncertainty over how much groundwater is being pumped. MDC have a comprehensive monitoring network to measure the response of aquifers to pumping, but don't yet have a full appreciation of how use varies.

Enough is now known about the hydrology of most Wairau Plain aquifers to set volumetric limits and avoid regional scale issues such as seawater intrusion or spring depletion from occurring. The exceptions are the recharge and springs areas of the Wairau Aquifer where due to its dynamic relationship with the Wairau River, the range in safe yield is still being refined.

Limits for these sectors were derived by ramping up current rates of groundwater use in relation to changes in groundwater level or spring flow for acceptable levels of reliability. However they will need to be further refined based on known rates of abstraction.

In addition to these volumetric limits, local controls have evolved as part of the resource consent process to manage local issues such as seawater intrusion or interference between neighbouring wells. A multitude of different thresholds exist and an aim of the current plan review process is to standardise them to provide uniformity for compliance staff and improve certainty for water users.

A comparison of existing plan limits and the proposed safe yields are shown in Table 1 below.

Table 1: Current Limits Versus Safe Yield

Aquifer or management sector	Existing WARMP Safe Yield (m^3/s)	Proposed Safe Yield (m^3/s)
Wairau Aquifer recharge sector	4.0	0.75
Wairau Aquifer springs sector		0.25
Lower Wairau Aquifer & Coastal sector		0.7
Riverlands Aquifer		0.1
Southern Springs sector		0.13
Benmorven Aquifer	0.02	0.012
Brancott Aquifer	0.035	0.023
Omaka Aquifer	0.022	0.023
Omaka River Aquifer and Woodbourne sector	0.172*	0.12**
Rarangi Shallow Aquifer	0.012	0.020
Fairhall River Gravels Aquifer	0.009	0.005

* Existing WARMP safe yield for Omaka River Aquifer, Woodbourne sector is currently within Wairau Aquifer safe yield

** Provisional

4. Individual Aquifer and Sector Reviews

4.1. Wairau Aquifer

Background

The Wairau Aquifer underlies the northern Wairau Plain and benefits from a perennial source of recharge from Wairau River losses in conjunction with a large area of porous gravels that store a massive volume of water.

By contrast the Southern Valleys Aquifer suite which occupy the southern half of the Wairau Plain consist of clay-bound gravels and rely on intermittent recharge from ephemeral rivers. These two main groups are separated by the intermediate yielding Woodbourne and Southern Springs sectors.

The relatively groundwater abundant northern areas associated with the Wairau Aquifer are shaded light yellow while the heavily committed Southern Valleys Aquifer suite are marked in brighter colours (Figure 1). These were the aquifer boundaries back in the mid 1990s when the WARMP was drafted, but those of the Wairau Aquifer in particular have changed significantly since then.

Interestingly because of the longstanding aquifer management issues associated with the Southern Valleys Aquifers, there is a long history of water metering dating back to the mid 1980s whereas the absence of pressing issues has meant there hasn't been the same emphasis for the Wairau Aquifer until recently.

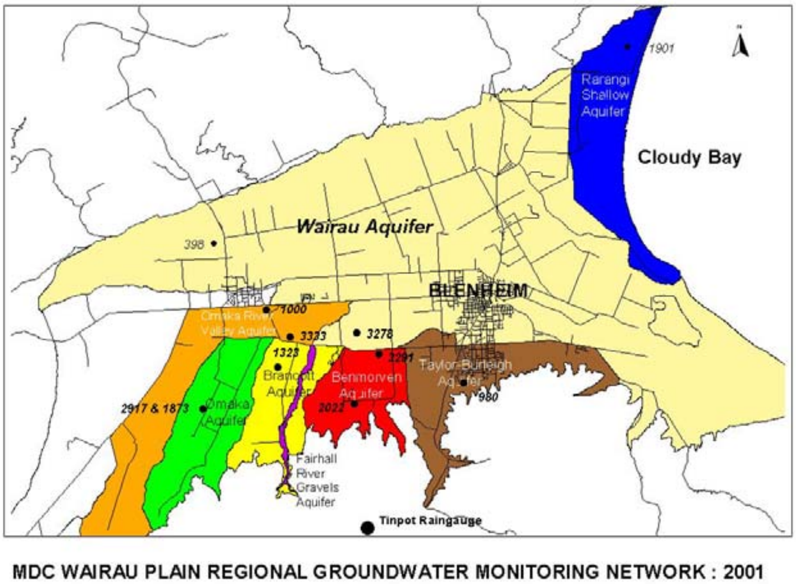

Figure 1: Wairau Plain Aquifer Boundaries 1995

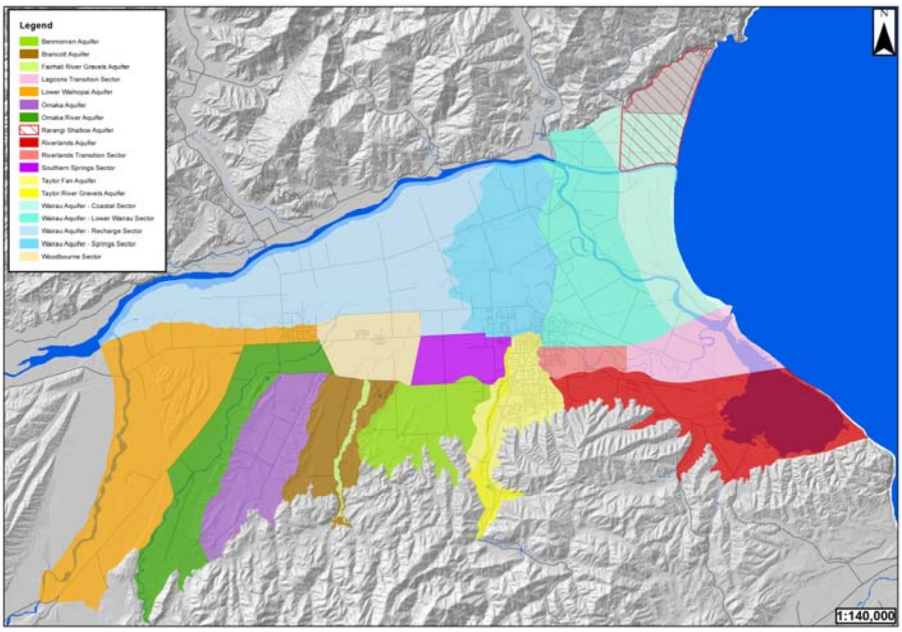

Figure 2: Wairau Plain Aquifer Boundaries 2012

Boundary adjustments since 1995 have affected the Wairau Aquifer the most. It has been subdivided into sectors to recognise local hydrological features or properties as understanding of its hydrology has improved. Originally it was defined as those areas recharged by losses of Wairau River flow.

The area of the Wairau Aquifer is smaller now than when it was defined in the district plan back in the mid 1990s. The Woodbourne and Southern Springs groundwater resources have been split off because they receive a high proportion of Southern Valleys recharge water.

The Riverlands area has been given separate aquifer status to recognise the unique management issues associated with what is effectively a backwater area (Figure 2). It has effectively been aligned with the Southern Valleys Aquifer suite in recognition of its naturally low storage capacity.

The Wairau Aquifer is the most important natural resource of the Wairau Plain economically, ecologically and for the everyday existence of all its inhabitants. Maintaining access to its groundwater into the future currently relies on a single control in the district plan in the form of a maximum cumulative pumping rate (4 m^3/second).

This was adequate a decade ago when demand wasn't close to sustainable limits, but no longer provides enough certainty to users or to protect the natural environment because of the growth in consents.

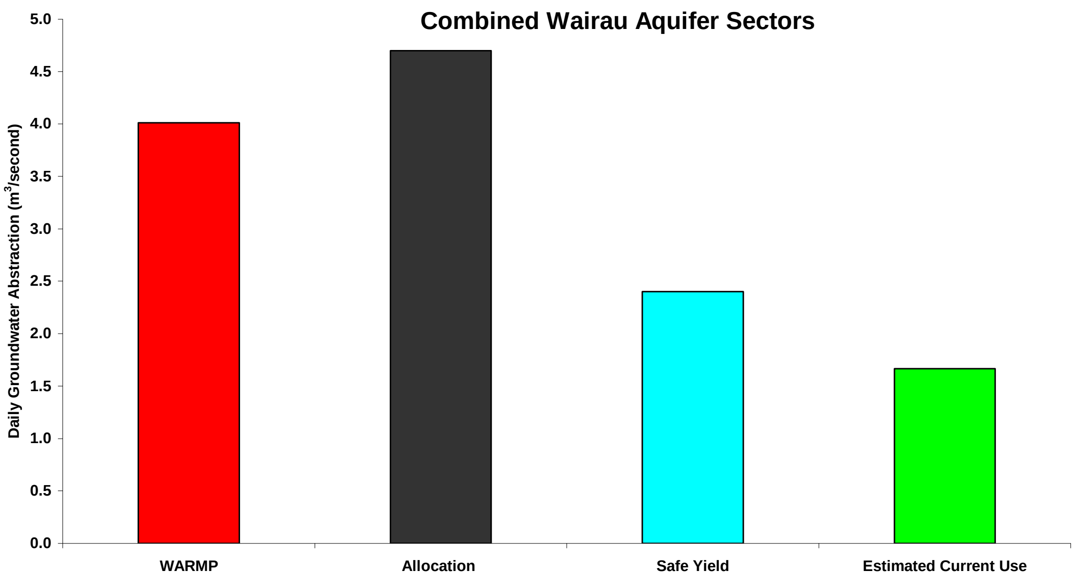

Figure 3: Safe Yield, Water Allocation and Use - Combined Wairau Aquifer

What has also changed since the WARMP water plan was first written 15 years ago also is that the safe yield of the Wairau Aquifer has been refined downwards. Recent modelling results show the current plan limit of 4 m^3/second may not be available under all seasonal conditions, and if all the consented water were pumped there would be unacceptable effects, particularly on groundwater fed springs (Figure 3). Based on this work the long-term average safe yield is probably closer to 2.5 m^3/second.

This combined with the allocation of water beyond the WAMP limits means the resource has effectively become 50% overallocated. Since consented levels of abstraction passed the 4 m^3/second level in 2001, the reliability of supply has decreased with each extra user drawing on the same sized pool of water. MDC decided to continue to allocate past the 4 m^3/second limit on the premise that there was no adverse effects.

A global, volumetric limit such as this can't control local issues if they develop and doesn't provide an adequate framework for managing a resource that affects all Wairau Plain residents and life to some extent. Neither does a static rate account for the natural variability in recharge or demand. In short it is a very blunt instrument.

It has long been known that abstraction from the Wairau Aquifer is ultimately limited by maintaining acceptable minimum flows in the groundwater fed springs. This was recognised by the 1995 Regional Policy Statement, but no ecological thresholds have been set in the resource management plans yet. These springs act as overflows for the Wairau Aquifer and spill groundwater just like a dam when the system can't transmit all of the Wairau River recharge to the coast (Figure 4).

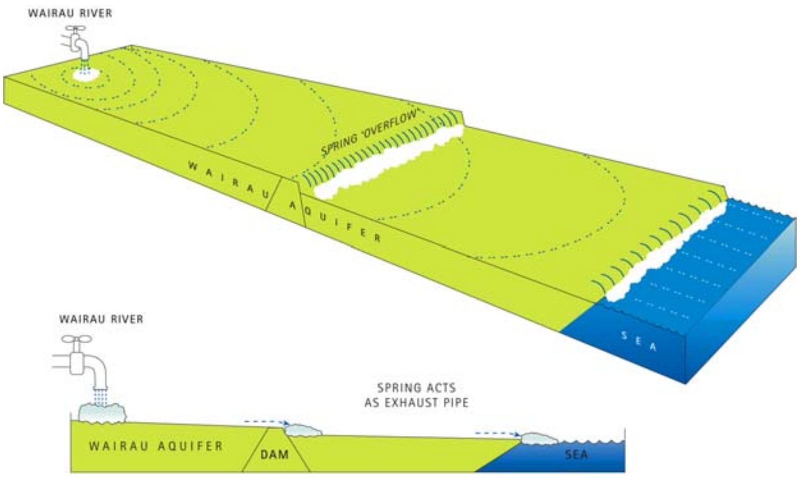

Figure 4: Conceptual Model of Groundwater Spring Overflow

They would take precedence over all other uses just like minimum flows in perennial rivers such as the Wairau, and are intended to provide certainty for both water users and the environment. Environmental requirements need access to the most reliable band of water and no-one wants to dry up the springs in mid summer.

There is considerable latitude in where these thresholds are set short of drying up the springs entirely which isn't acceptable. In all cases it is the headwaters of springs that are most vulnerable to pumping and recede most when affected by low groundwater levels. The lower reaches will always have flow and fish can migrate downstream for refuge as the headwaters recede (Figure 5).

Because the water table is almost flat, small drops in groundwater generate large shifts in the position of springs. This explains why spring headwater recession is the limiting control on Wairau Aquifer abstraction rather than the drop in the groundwater levels relative to well depth. The saturated aquifer thickness is tens of metres meaning aquifer levels have to fall a long way below current levels before wells dry up.

Modelling has shown that springs around Blenheim are more susceptible to overpumping or low rates of recharge because they are further from the Wairau River where most groundwater originates from. Springlands is aptly named and home to many springs which are valued by residents and there is a limit to how much of their headwaters could be dried up and for how long each summer. However it is important to reiterate that at present flows are acceptable, except for severe droughts when a high proportion of the fall may be natural.

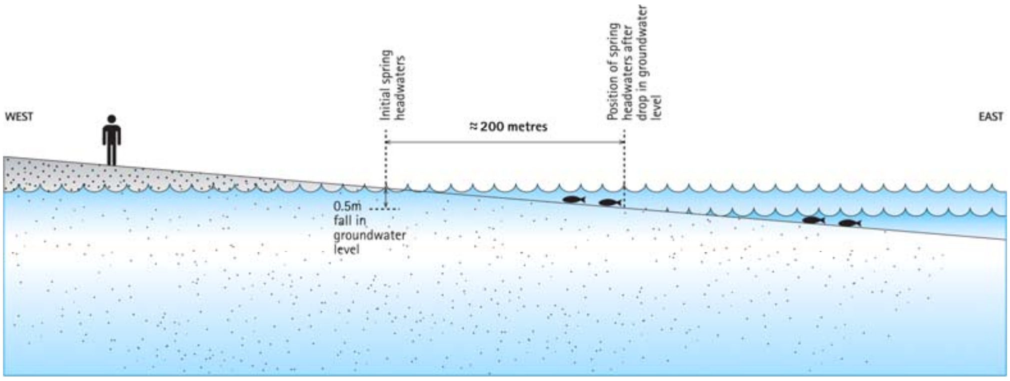

Figure 5: Effect of Spring Headwater Recession on Habitat

Part of the reason why no minimum flows have been set is there have been no significant impacts from current levels of groundwater abstraction. There are a number of reasons why the full effects of abstraction haven't been observed.

Firstly, there have been a series of wet seasons since 2008 meaning water demand has been low and recharge relatively high. As a result the cumulative impact of all irrigators pumping hasn't been fully tested since the 2001 summer drought and since then a significant number of new consents have been issued.

Secondly, the generous nature of the MDC allocation guideline for grape plants means there is universal underuse of irrigation water, especially on heavier soils or in higher rainfall areas. The final factor which may mask the full effects of pumping is the rewatering of the Gibson Creek/Opawa River system since 2004 with aquifer levels having been boosted by supplementary recharge, but this source of water won't be available in a significant drought event for up to 3 months.

The risks of MDC continuing to allocate past the safe yield are:

- *actual use will approach sustainable limits more often and there are inadequate controls to manage adverse effects on springs or public water supplies*
- *a fixed limit that doesn't reflect the variable state of local groundwater resources meaning water will be locked up in some seasons and overallocated in others*
- *the reliability of existing consent holders falls as the resource is split between more users*
- *it is not ideal practice to keep allocating groundwater indefinitely until there is a problem as the experience in the Southern Valleys up to the year 2000 showed*
- *if more intensive landuses replace significant areas of vineyard in the future, demand would increase by 5 times in real terms and this rate of abstraction would be unsustainable*

Notwithstanding these liabilities the community is in a good position to review its freshwater plan right now. This is because there are no regional scale crises associated with current levels of pumping and the predominant grape crop has sufficient water in most summer seasons.

4.1.1. Wairau Aquifer - Recharge Sector

Introduction

The hydrology of the recharge sector is reasonably well understood with Wairau River flow being lost to the Wairau Aquifer. What isn't precisely quantified yet is how aquifer recharge varies depending on flow or other river characteristics such as channel location, degree of braiding or wetted area, porosity of the channel bed or silt build-up and whether the bed is degraded or aggraded relative to the neighbouring groundwater table.

The recharge sector is virtually an extension of the Wairau River and opportunities are being explored by MDC for managing groundwater abstraction in the future in ways that compliment surface water management and variations in its natural flow regime.

Separate sectors were defined for the recharge area, where most groundwater enters the Wairau Aquifer and the springs sector where it leaves the system because both are important functions in their own right and have management implications. The 2 sectors should be managed in tandem because of their mutual dependence on a common flow of groundwater that originates as recharge from the Wairau River.

Hydrology

Wairau Aquifer recharge relies on flow losses from the Wairau River in the channel reach north-west of Renwick from the Waihopai River confluence to about opposite Wratts Road. Wells as far away as Riverlands and the Cloudy Bay coast depend on a continual throughflow of groundwater that originates from this area. The time taken for groundwater to travel to these distant boundary areas is of the order of decades.

Wells in the recharge area have first access to the newly recharged groundwater but they can’t take it all. A residual of around 7.3 m^3/second has to be set aside for a number of purposes including:

- *providing groundwater for downstream well users and the Blenheim public water supply*
- *keeping the seawater interface in a safe position away from wells*
- *maintaining acceptable flows in groundwater fed springs*
- *maintaining a natural gradient to drive groundwater flow from west to east*

For a given rate of recharge from the Wairau River how much groundwater is available to be pumped from wells will depend on the size of this residual. Maintaining spring flows at acceptable levels to the community forms the largest component of the water that needs to be set aside. The higher the minimum spring flow the less groundwater can be pumped for consumptive uses such as crop irrigation and vice versa.

The Wairau River largely controls inputs to the Wairau Aquifer and evidence of this is easy to see in wells which respond almost immediately to changes in river flow. Hydrographs are a subdued version of what is happening in the nearby channel.

Each Wairau River flood generates a larger than normal pulse of recharge which passes through the aquifer as a wave and as a consequence well levels close to the channel are constantly changing. By contrast flow in the confined aquifer further east is very sluggish because only a small fraction of the original Wairau River recharge water gets this far and fluctuations are dampened by the friction effects of the confined structure.

In western parts of the Wairau Aquifer groundwater throughflow is a highly dynamic process because of the influence of Wairau River floods on recharge rates. The aquifer receives higher volumes of river recharge each time a large flood occurs compared to the base recharge rate. Most of this water exits the aquifer within a short space of time via the mid plains spring belt however.

Natural drainage from these springs is a large and continuous process whose importance to the overall Wairau Aquifer water budget is often underestimated. There is a fine balance between river recharge and spring losses with summer pumping of groundwater occurring at the expense of lower spring flows or the drawing down of water stored in the aquifer.

The importance of drainage losses is illustrated by the fact that some of the lowest observed well levels occurred in winter 1991 and 1992 when there would have been limited pumping from wells. These low levels were presumably caused by recharge rates being less than spring losses draining the aquifer which in turn reflected low river flows and the lack of medium sized flood events. It appears that regular Wairau River flood flows of greater than 500 m^3/second are needed to boost levels as shown conceptually by Figure 6.

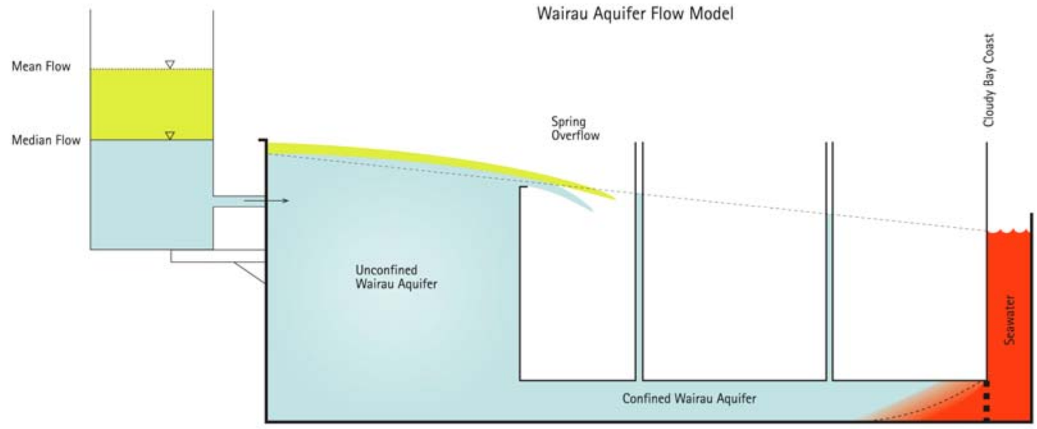

Figure 6: Wairau Aquifer-River Recharge Conceptual Model

Well levels and spring flows don't fall permanently for a number of reasons. Firstly, groundwater recession rates slow as the gradient between groundwater and spring levels drops over time. Secondly, there is likely to always be a minimum river recharge rate of 5 m^3/second maintaining groundwater levels even at the lowest Wairau River flows.

The last factor moderating groundwater levels is groundwater storage which sustains aquifer throughflow until the arrival of the next Wairau River flood event. The interval between these events is normally no more than 3 months.

The volume of groundwater is not as large as perceived over and above that required to maintain spring flows or provide for the natural functioning of the aquifer. Its contribution to the safe yield is unlikely to exceed 1 m^3/second and not for more than several months on end.

The opposite process occurs under high river flows when recharge rates exceed spring losses. More water enters the aquifer than leaves it causing well levels to rise. This raises the question of what is the maximum rate of aquifer recharge and under what Wairau River flow conditions does it occur?

Losses can be directly gauged at low flows but this is impractical for bigger floods because the small differences being lost to groundwater are within the measurement error of the gauging method. Maximum recharge rates have been estimated at 20 m^3/second by numerical models of the Wairau Aquifer (*AQUALINC RESEARCH 2005*). The upper rate is probably closer to 15 m^3/second based on the logic that most of the recharge water has to exit the aquifer via the spring-belt and this is the sum of all flows during wetter seasons (Figure 7).

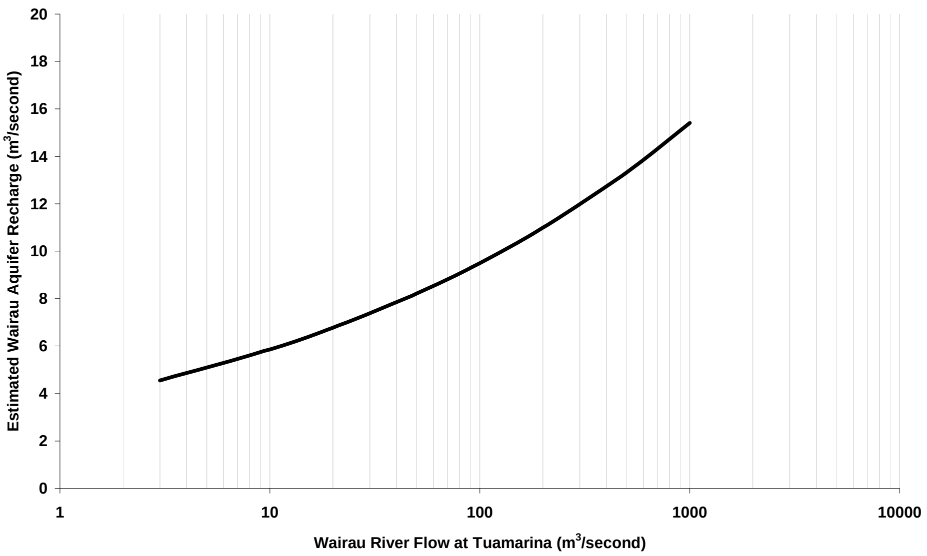

Figure 7: Postulated Aquifer Recharge Versus Wairau River Flow

Aquifer management issues

The primary limitation on abstraction from the recharge and springs sectors of the Wairau Aquifer is retaining sufficient groundwater throughflow to provide for downstream users and maintain summer spring flows at acceptable levels.

We know from experience that interference between pumping wells is generally not a big issue because the Wairau Aquifer is high yielding. Furthermore, modelling has shown that groundwater levels at the coast are relatively insensitive to groundwater abstraction in the recharge and spring sectors 15 kilometres to the west. This is because increased groundwater abstraction will draw-down spring flow first before affecting coastal levels.

Safe Yield, Current Allocation and Water Use

We know intuitively from the acceptable state of Wairau Plain spring flows over the past 15 years or so that current actual rates of groundwater use are within the safe yield (Figure 8). What is uncertain is how much is being abstracted and MDC won't have a complete picture for several more years until more meter readings are available. In fact more can be taken than is currently pumped, except in drier periods. Once these figures are known for a range of seasons, MDC can confidently relate the effect of different levels of pumping.

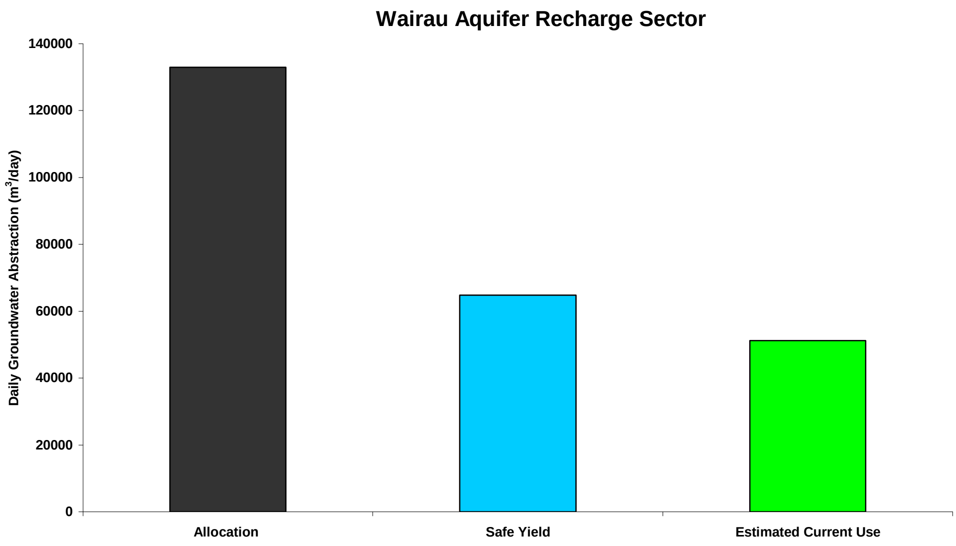

Figure 8: Safe Yield, Water Allocation and Use - Recharge Sector

New safe yields were developed for each of the newly defined Wairau Aquifer sectors. They were lower than expected at 0.25 m^3/second for the springs sector and 0.75 m^3/second for the recharge sector, and smaller than the current plan limit of 4 m^3/second for the entire system.

These volumetric limits were revised using a computer model of the Wairau Aquifer based on the criteria that consent holders would have reliable access to water without springs falling below their proposed minimum flows more than 1 year in every 5.

The details of this work are described in more detail in the following springs sector chapter and form part of ongoing research commissioned or carried out by MDC to fine tune regional scale limits since the early 1990s.

Forecasts of aquifer behaviour have not been as definitive as hoped, mainly due to technical difficulties calibrating the computer models and the limitations of using estimated rather than measured abstraction rates. A pre-requisite for refining the Wairau Aquifer model in the future are sufficient water use records to allow it to be calibrated based on the distribution of actual pumping in time and space.

Groundwater use in the recharge sector is overwhelmingly for irrigating grape plants. Due to the shallow and free draining nature of soils in the recharge sector, rates of irrigation are likely to be slightly higher than elsewhere and estimated to average 1.5 mm/day based on experience. This translates to an average abstraction rate of about 0.7 m^3/second by applying this application rate over the known mapped vineyard area.

4.1.2. Wairau Aquifer - Springs Sector

Introduction

A belt of groundwater fed springs rise in the mid and lower Wairau Plain east of about Hammerichs Road. These springs are highly prized for the ecological habitat they provide and their aesthetic qualities. Residents in both the country and towns appreciate the visual appeal of continuously running water, and land values are enhanced when they flow past houses.

Being groundwater fed they have a steady flow and don't flood. Their waters are cooler and have more stable temperatures than river waters, especially in summer. This provides a unique habitat which supports a different range of plants and fish to the Wairau River for example.

However pumping groundwater from wells can reduce spring flow. Generally speaking the more groundwater that is pumped, or the closer the well is to the spring, the greater the depletion effect. One of the reasons for defining a separate springs sector was to manage the direct effects of groundwater pumping near springs.

There is no physical boundary separating the springs sector from the upstream recharge sector of the Wairau Aquifer, with a continuous flow of groundwater traversing both areas. Because they share the same body of groundwater, pumping from the recharge sector upstream of the springs will deplete the springs sector by an equal amount. The effect is indirect and delayed in time because of the separation distance and the high storage properties of the recharge area.

One of the complications of its large size is that for water management purposes the Wairau Aquifer can't be dealt with as a fixed storage system like a dam. Time dependant factors have to be accounted for and it needs to be treated as a dynamic storage system.

Aquifer management issues

The limiting factor on how much groundwater can be pumped is maintaining acceptable spring flows. Pumping from wells lowers aquifer levels which in turn reduces the rate of groundwater contributing to spring flow.

Spring headwaters are the most sensitive part of the springs to well abstractions because their flows are the lowest. The headwaters of Spring Creek, Doctors Creek, Murphys Creek and Fulton Creek were noticeably affected by the 2000/01 drought for example with their headwaters receding eastwards by between 50 and several hundreds of metres as groundwater levels fell.

Spring depletion can be caused by the direct effect of wells pumping close to the spring headwaters, or the indirect effect of many upstream wells intercepting groundwater that would otherwise contribute to downstream flow.

Direct pumping effects develop quickly and spring flows are correspondingly fast to recover once pumping stops. Indirect pumping effects are slower acting and the benefits of rejuvenating spring flow by switching off pumps in distant wells are less.

A question mark remains over how much pumping contributed to the low flows experienced by springs in the 2000/01 drought versus the naturally low rates of Wairau River recharge. During the 1997/98 drought, which the Wairau River catchment didn't experience to the same extent as elsewhere in the province, groundwater use was high but Spring Creek wasn't drastically affected.

This suggests that natural factors play a major role with pumping reducing spring flows by only around 150 l/s based on modelling (*AQUALINC 2011*). However it isn't straightforward to isolate the effects of pumping from natural climate variability. Clear cut evidence of well pumping affecting spring flow exists for Doctors Creek, but it isn't as definitive elsewhere yet.

The interdependence of spring flow, aquifer level and Wairau River processes means it is likely that whether there is pumping or not, spring recession would happen naturally. However there is no doubt based on a preliminary modelling study of the interaction between groundwater and Spring Creek that current levels of consented allocation could potentially reduce flows significantly and cause headwaters to recede (*Water Matters Ltd 2010*).

Modelling studies by MDC staff in the early 1990s first identified that springs furtherest from the Wairau River source of recharge are the most vulnerable to headwater recession. The largest springs in this category include Fulton Creek and Murphys Creek in Blenheim which together contribute most of the summer baseflow of the Taylor River. These results were incorporated in the original Regional Policy Statement issued by MDC in 1995.

Influences on spring flow have changed a lot over the past 2 decades. One of the major differences in the Wairau Plain water balance was the artificial rewatering of the Opawa/Gibson Creek system in 2004 which has increased the flows of central and southern springs at the expense of flows in the lower Wairau River.

Aquifer limits

The regional scale effects of pumping or drought result in lower groundwater levels or spring flows in areas further away from the recharging effect of the Wairau River. Just like rivers, the spring belt can be grouped together as catchments although boundaries aren't as clear cut because the plains are flat. The 4 main spring catchments that drain to the Wairau River are: Spring Creek, Grovetown Lagoon, Opawa River and the Taylor River (Figure 9).

Cravens Creek is treated differently because its flow returns to the main channel of the Wairau River upstream of the Tuamarina recorder. Another set of springs are the Cloudy Bay coastal system which drain the Riverlands Aquifer, lower Wairau and coastal sectors of the Wairau Aquifer.

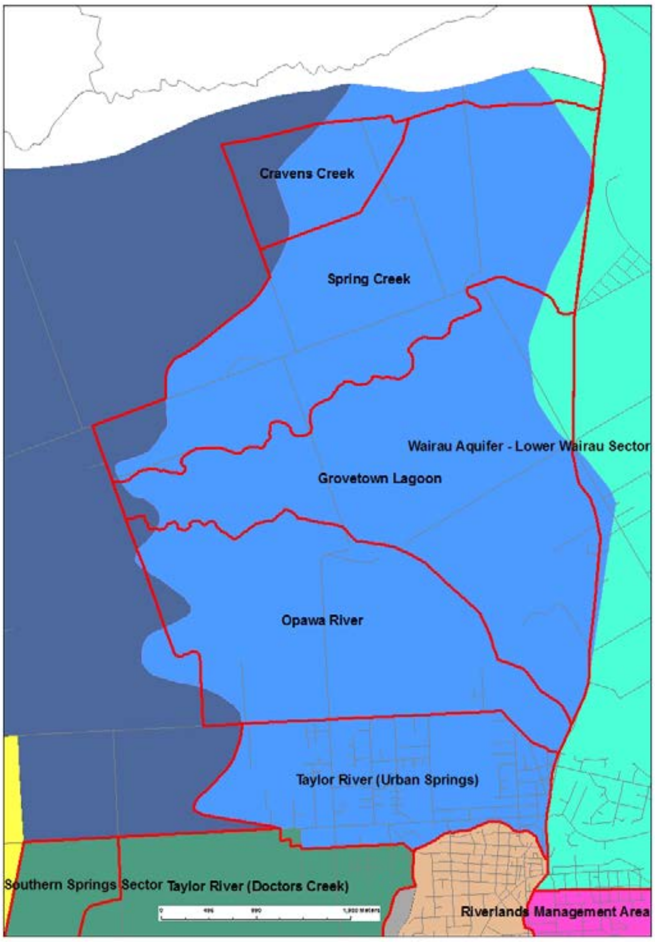

Figure 9: **Spring Catchments**

The safe yield of the springs sector depends on what the community decide is an acceptable minimum flow in springs. Because all springs gain flow in a downstream direction and the quantum of flow is generally much larger than the depletion effect generated by well pumping, headwater recession is the limiting factor on groundwater abstraction.

As explained earlier, abstraction from the recharge and spring sectors needs to be jointly managed to preserve minimum spring flows because the same water passes through both areas and can't be allocated twice.

Northerly springs

Spring Creek has the largest flow of the northern springs by far and is the most studied hydrologically. The lowest recorded flow of 2.95 m^3/second occurred during the 2001 summer drought. As discussed earlier, naturally low rates of Wairau River recharge to the aquifer were likely to account for most of this extreme event, but consented abstraction will have contributed to the fall.

Site visits by MDC staff and complaints from the public show that when Spring Creek flow is less than about 3 m^3/second at the motorcamp site, headwater recession upstream near Hammerichs Road becomes a significant issue for the local landowner and this is likely to be the case for the headwaters of tributary springs like Ganes Creek.

It is likely based on the severity of the 2000/01 drought that this is the lowest flow that any of the Wairau Plain springs will experience. The question is how frequently is it acceptable to the community for these low flows to occur and what groundwater abstraction rate does this lowest flow equate to?

The computer model of the Wairau Aquifer was used to answer this question but because it isn't accurately calibrated it can't be used to directly predict the recurrence intervals of certain pumping rates across both sectors. However it is able to reliably predict relative changes in groundwater levels for different pumping rates but relies on knowing the current level of pumping.

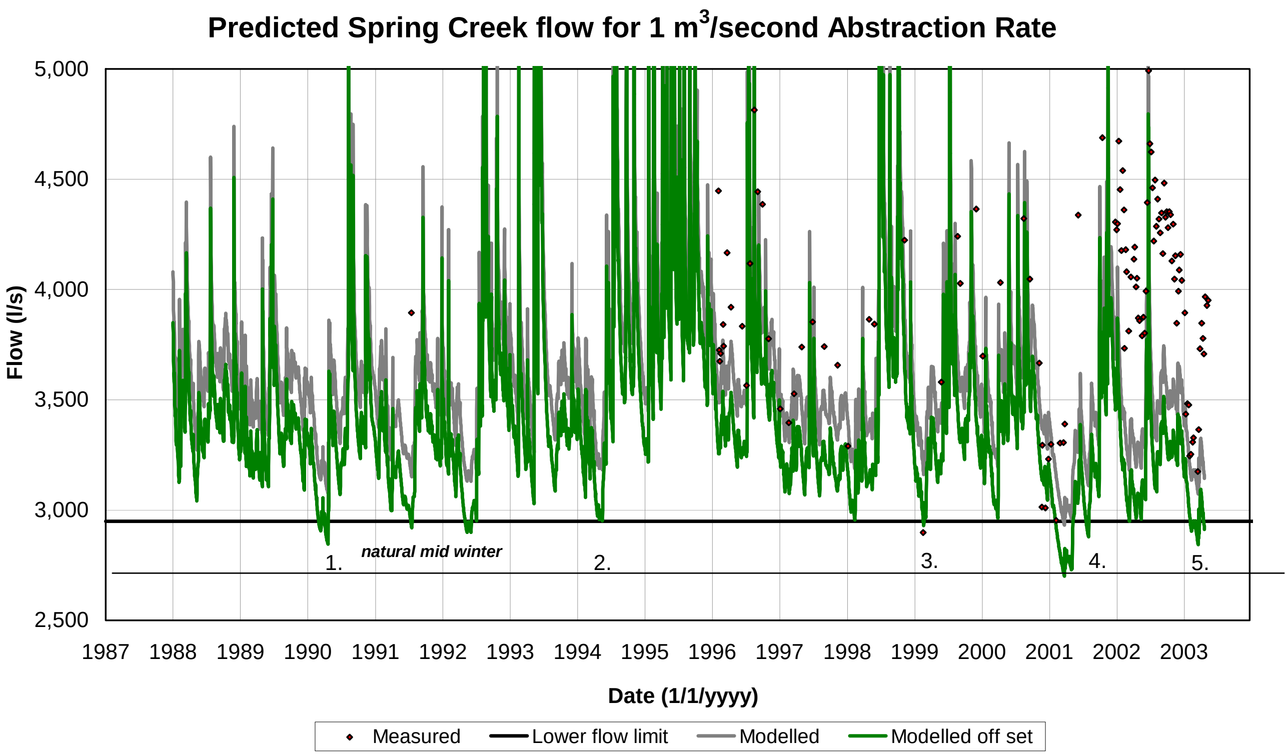

Figure 10: Predicted Transgressions of Spring Creek Low Flow

To characterise the variation in groundwater level which drives spring flows, the computer model generated a long time series for the MDC well 3009 in Wratts Road in response to the assumed average current combined pumping rate from 1988 to 2003. This is shown by the grey line in Figure 10. The pumping rate was then adjusted based on the observed relationship between gauged Spring Creek flow at the motorcamp and groundwater levels at well 3009 for predicted pumping generated declines in groundwater level (Figure 11).

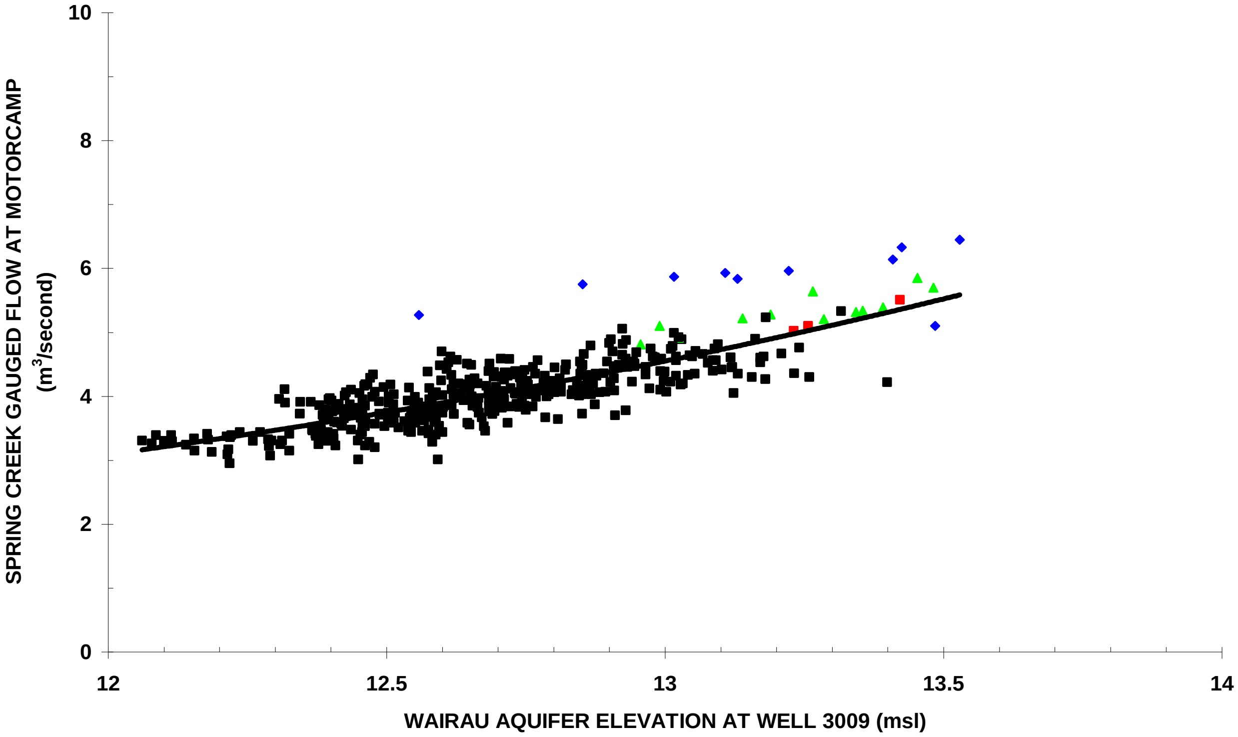

Figure 11: Observed Relationship between Wairau Aquifer Level and Spring Creek Flow

The hypothetical pumping rate was increased until the reliability target of being interrupted not more often than once every 5 years on average was met and is shown by the green line (Figure 10). It corresponds to a combined pumping rate across both sectors of 1 m^3/second.

This compares with an estimated actual average summer pumping rate across the recharge and springs sectors of about 0.9 m^3/second over this period and supports the conclusion that more groundwater can be pumped than is currently the case if the minimum Spring Creek flow were set at 2.95 m^3/second.

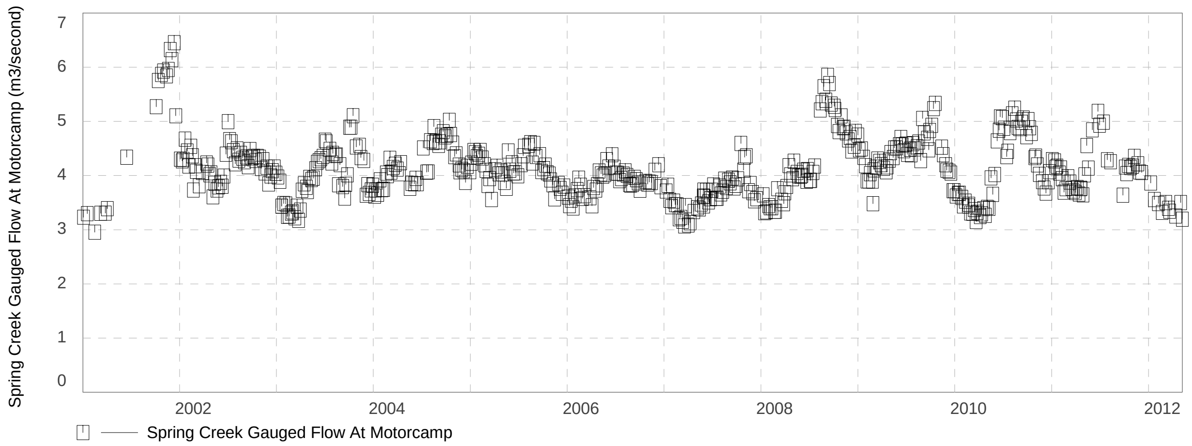

Figure 12: Spring Creek Gauged Flow 2001-2012

This is consistent with what we are seeing in the real world with severe headwater recession in Spring Creek having only occurred once since gauging records began in 1996 (Figure 12). In other words low flows of less than 3 m^3/second are a relatively infrequent event in response to current patterns of groundwater use.

Caution is needed applying these results as they are based on ramping up estimated groundwater pumping rates and have only been applied to Spring Creek flows. Spring Creek was the obvious choice as it has more flow and well level record, but there is a question over how representative the results are of springs further from the Wairau River recharge source.

Southerly springs

The Blenheim urban springs which include Murphys Creek, Fulton Creek and many small un-named upwellings provide the baseflow of the Taylor River through Blenheim. Doctors Creek also contributes flow, although a high proportion of its water originates from the Southern Valleys Catchments and is less influenced by the Wairau River or Wairau Aquifer well pumping.

The flow of Fulton Creek is measured weekly by MDC upstream of its confluence with the Taylor River (Figure 13), whereas Spring Creek flows are measured in its middle reaches. The headwater channels of springs in the western suburbs of Blenheim are commonly more modified than Spring Creek and the effect on flows or headwater recession of pumping is less predictable.

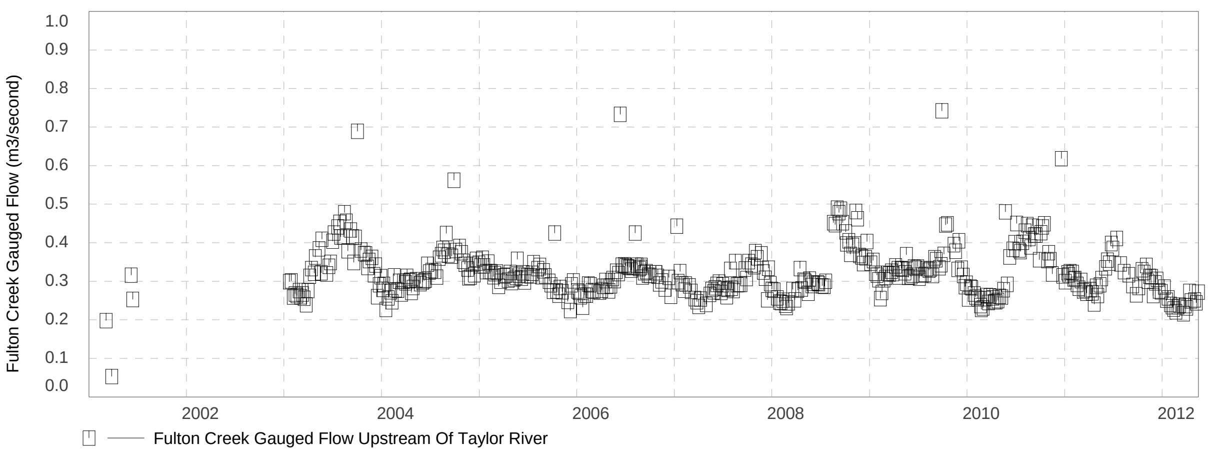

Figure 13: Fulton Creek Gauged Flow 2001-2012

Based on feedback to MDC staff, current flows of springs are acceptable to most residents except during severe drought conditions. The urban springs are appreciated by more people than those in rural areas because they are more accessible and close to a large population.

They are also more vulnerable to headwater recession than Spring Creek because of the longer distance that recharge water has to travel from the Wairau River source and urbanisation reducing local infiltration of groundwater. This means that increases in groundwater abstraction will have a proportionately greater effect.

Minimum flows are recommended for Murphys Creek and Fulton Creek which would in turn maintain other springs in an acceptable state. Minimum flows are necessary to preserve habitat, maintain land values for houses with a spring vista, and keep the spectacle they provide to thousands of Wairau Plain residents every day.

The proposed low flows were derived based on the formula in the Proposed National Environmental Standard on Ecological Flows and Water Levels 2008 (Table 2). However not all sites had sufficient flow information to derive this threshold or no observations under drought conditions and an estimate has been made. In general the cutoffs are similar to the lowest flows that have been gauged to date and will not significantly interfere with current water use patterns.

The nominal total of low flows across the 5 spring catchments is 6 m^3/second. Obviously this isn't a comprehensive inventory of all groundwater losses from the Wairau Aquifer as most aren't measured and there will be diffuse leakage of groundwater that can't be seen. If a variable allocation approach were adopted this groundwater flow would be set aside along with downstream water use, and the difference with estimated Wairau River recharge would be available for allocation.

Because of these uncertainties estimating and applying volumetric limits, local controls are also needed to fine tune or balance the method. They regulate the direct effects of pumping from wells near springs. These are the same thresholds used to derive the volumetric limits in Table 2 and are specified on springs that MDC monitor on a weekly basis.

These local flow limits wouldn't be as effective in the upstream recharge area because they are too far away from the springs. The volumetric safe yield is used to maintain springs by restricting long-term groundwater use. If none of these measures arrest the fall in groundwater levels or spring flows, then emergency measures would be used. A consequence of these proposals is that spring flows would be lower for longer periods.

Table 2 : Proposed Minimum Spring Flows

Groundwater fed spring catchment	Individual spring	Gauging Site	Proposed minimum flow (m^3/second)	Grounds for minimum flow
Spring Creek	Spring Creek	Motorcamp	**2.95**	Lowest recorded flow during benchmark 2000/01 drought
Mid plain drains /Grovetown Lagoon	Grovetown Lagoon	Drain Y	**0.5**	Estimated natural low flow
Opawa River	Opawa River	SH1	**1.2**	Estimated natural low flow
Taylor River	Murphys Creek	Upstream of confluence	**0.5**	Lowest recorded flow during benchmark 2000/01 drought
	Fulton Creek	Upstream of confluence	**0.2**	
	Miscellaneous	Upstream of confluence	**0.5**	
Coastal Springs	-	-	**0.2**	Estimated natural low flow
TOTAL			**6.05**	

Safe Yield, Current Allocation and Water Use

With the exception of the Blenheim municipal supply, current levels of pumping are low relative to consented rates and are unlikely to change unless crop types do. In part this reflects the heavy soil types forming the springs sector. The area is well suited soil-wise to more intensive landuses and supports pip-fruit, dairying and cropping, or has done in the recent past.

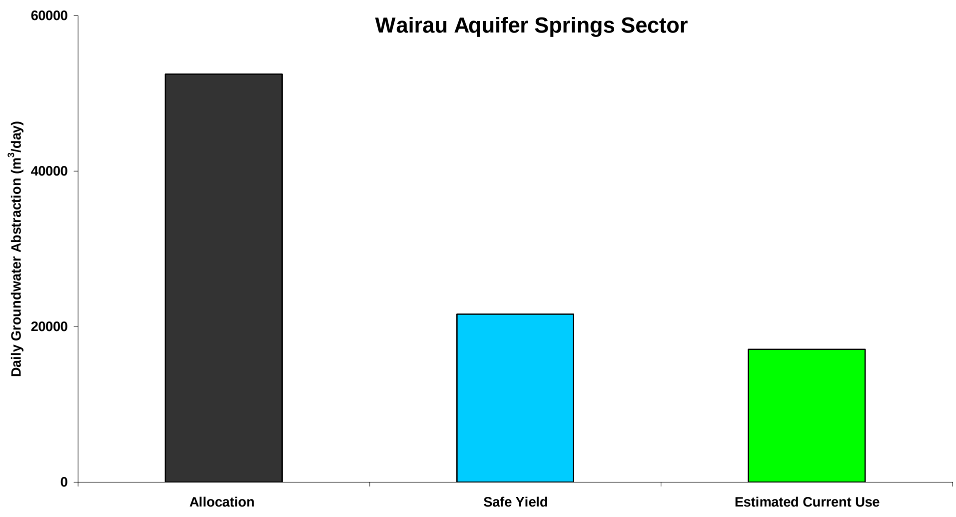

Figure 14: Safe Yield, Water Allocation and Use - Springs Sector

Spring flows are currently at acceptable levels, but modelling shows they would fall to unacceptably low levels if all of the consented allocation was used and the Blenheim public water supply would be affected (Figure 14). However more water than is currently being pumped can be taken.

4.1.3. Wairau Aquifer - Urban Springs (Blenheim) Sector

Introduction

Blenheim forms part of the springs sector but is treated as a separate management area because of the large volumes of groundwater that are pumped for municipal supply all year round. Outside of the summer irrigation season, groundwater for public water supply use is the largest demand placed on the underground resource. Public water supplies can't be interrupted, although in times of natural drought the reasonable needs of urban dwellers might be reduced.

Aquifer management issues

The same issues apply as elsewhere within the spring sector except that springs are more visible because their channels are near roads or in parks that are accessible to the public. There would be an outcry from residents whose houses back onto springs or people in the CBD if Taylor River flows were unacceptably low for very long.

Aquifer limits

A limit of 0.5 m^3/second is set for the Blenheim urban area equal to how much the Marlborough District Council is entitled to pump under their current water permit for municipal supply (Figure 15). There are several other minor groundwater permits in the Blenheim area, mostly to water school grounds in summer.

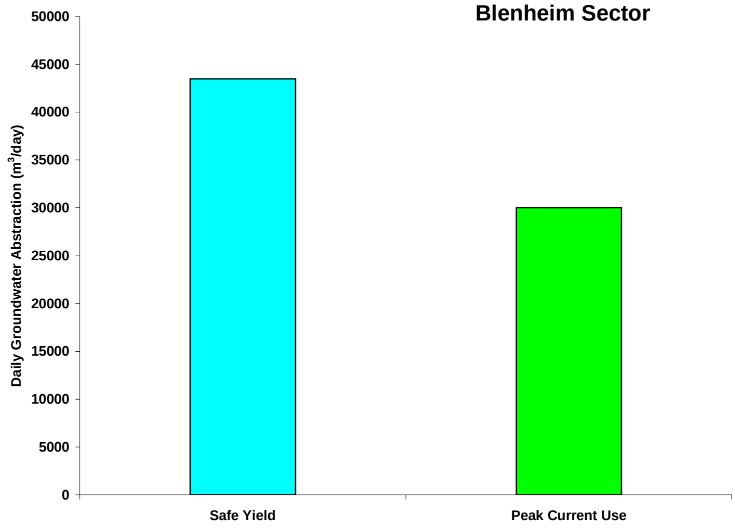

Figure 15: Safe Yield, Water Allocation and Use - Blenheim Sector

Whether the safe yield is appropriate is best demonstrated by spring response to full demand under drought conditions. MDC have weekly gaugings of spring flows dating back to 2001 in some cases which provide a very good record for identifying trends and the effects of abstraction.

Current and future pumping effects

Current levels of pumping from the MDC municipal wellfields at Middle Renwick Road and Grove Road aren't causing any apparent problems on spring headwaters in a normal summer season despite pumping at very high rates and using a high proportion of their consented volume at 74% (Figure 16). This level of utilisation is far higher than that of the typical grape irrigation consent on the Wairau Plain.

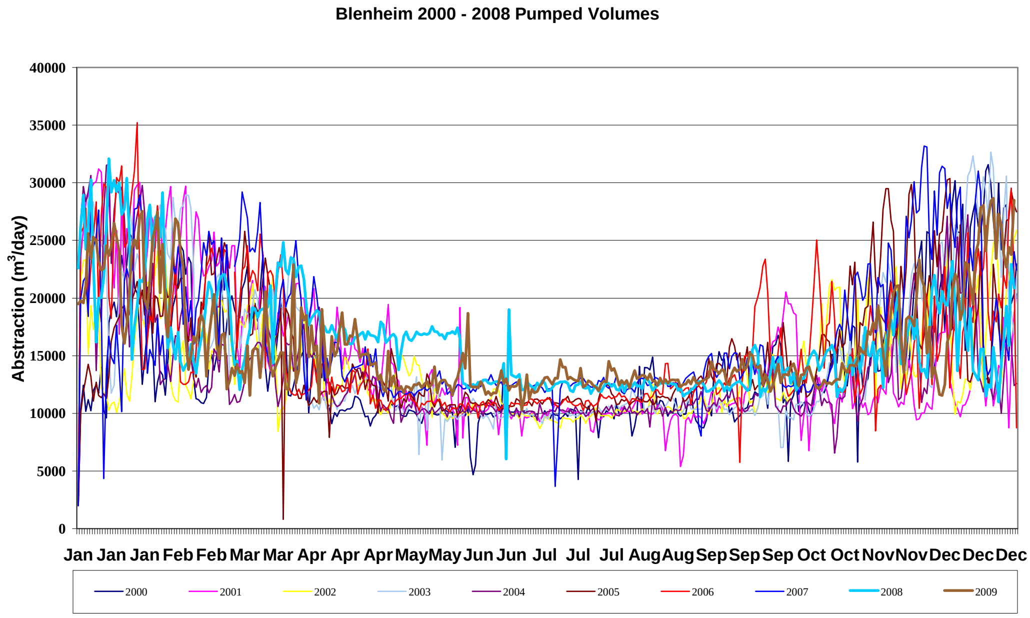

Figure 16: MDC Municipal Water Supply Pumping Rates 2000-2008

This means that most of the effects of pumping on spring headwaters will already be apparent in MDC hydrological monitoring records or visible to residents in their everyday activities. MDC staff received a number of complaints from people living near spring headwaters in the western suburbs during the 2000/01 drought.

To what extent municipal pumping contributes to this effect versus natural factors remains uncertain. Modelling studies suggest a high proportion of groundwater pumped from the second largest municipal wellfield located at Springlands comes from Murphys Creek or intercepts groundwater that would otherwise contribute to channel flow (*PDP – 2004*).

Future expansion of the municipal supply should consider water security and environmental factors when selecting where new pumping capacity is sited. Distributing the effects of pumping by locating wells across the northern Blenheim area and further east will minimise the impacts on surface flows and in particular the headwaters of springs.

Siting new wells further east has the added advantage of reducing the risk from microbial contamination because they die off more quickly in the confined part of the Wairau Aquifer. However this approach is at odds with the need to centralise wellfields to minimise the cost of water treatment.

4.1.4. Wairau Aquifer – Lower Wairau Sector & Coastal Sector

Introduction

Deeper groundwater underlying the land area north from the Riverlands Aquifer to Rarangi Road and forming a corridor 2 kilometres inland from the sea is known as the Wairau Aquifer Coastal Sector (WACS). Abstractions within this area are likely to have a direct effect on groundwater levels at the Cloudy Bay coast and pumping rates are restricted when salinity levels are high and aquifer levels are low relative to sea-level.

Table 3: Wairau Aquifer Coastal Sector Sentinel Well Thresholds

Site	Minimum WACS elevation (msl)	WACS conductivity when pumping restricted by ½ of actual rate (mS/m)	WACS conductivity when pumping stops (mS/m)
well 1733	1.25	40 - 60	> 60
well 3667	1.25	70 - 90	> 90

The thresholds to manage these local pumping effects are listed in Table 3. While there is a common minimum elevation for deeper groundwater of 1.25 metres above mean sea-level at Rarangi and opposite the central plain, multiple conductivity thresholds are needed to reflect the different ambient values. For example the average conductivity at well 3667 north of the Diversion channel is 35 mS/m compared to around 20 mS/m at central and southern coastal wells (Figures 17 & 18).

The sensitivity of these thresholds to changes in the position of the seawater interface have yet to be tested under full demand and drought conditions and are deliberately conservative at this stage. Restrictions on water users would only apply when both levels are low and conductivities are high. Low groundwater levels would indicate an increased risk of seawater intrusion requiring extra vigilance. Only after conductivity levels have exceeded the thresholds would restrictions be applied.

Experience in other coastal aquifer areas of New Zealand show that especially in free flowing aquifers, groundwater levels can even fall below sea-level for short periods without problem or irreversible conditions developing.

Minimum groundwater elevations are based on the Ghyben-Herzberg equation for the deeper, confined aquifers addressed in this chapter, or the Glover equation for the unconfined Rarangi Shallow Aquifer (Section 4.1.6). Defining appropriate conductivity values is more difficult because models don't exist to evaluate them and more knowledge of aquifer structure is needed than currently exists to the detail required.

To a large extent conductivity criteria have been constrained by what is specified in resource consents. The interim values in this report were based on the rule of thumb of doubling the long-term average value for restricting actual use by half, and stopping abstraction completely when conductivity increased by a further 20 mS/m.

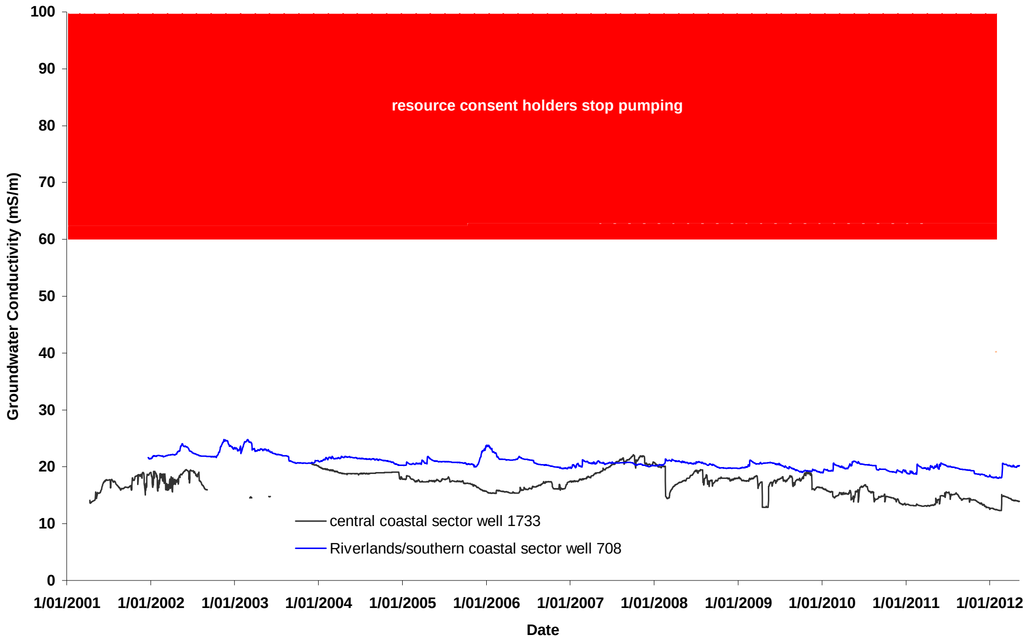

Figure 17*:* Central and Southern Coastal Aquifer Conductivity and Restrictions

In 2011 modelling of aquifer behaviour showed that consents located further inland can also potentially contribute to the lowering of coastal aquifer levels (*Water Matters Ltd 2010*). This is due to the cumulative effect of many wells pumping together. Because these indirect effects weren't addressed by conditions on individual consents, a separate management sector was defined seawards of SH1 and named the Wairau Aquifer Lower Wairau Sector (Figure 2).

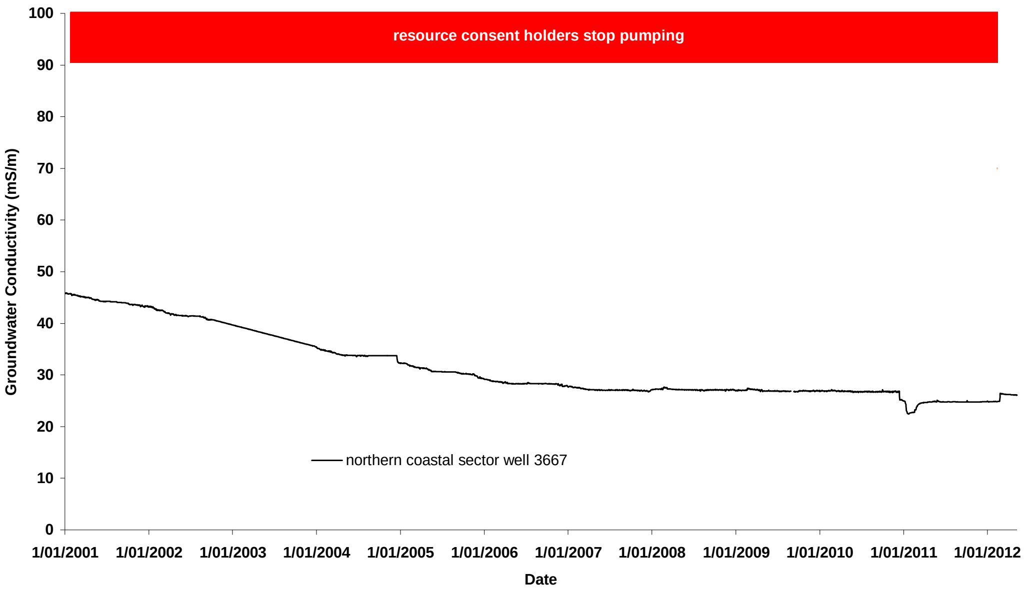

Figure 18: Northern Coastal Aquifer Conductivity and Restrictions

Aquifer management issues

Potential groundwater management issues for this area are similar to those for the related coastal parts of the Riverlands Aquifer and include:

- *loss of long-term artesian pressure in wells over summer*
- *seawater intrusion of coastal wells*
- *reduced base-flow of coastal springs*
- *irrigating with old, evolved groundwater causing soil salinity issues*

Aquifer limits

A volumetric pumping limit of 60,500 m^3/day was defined in 2010 based on the results of model forecasts of aquifer behaviour. Limiting well pumping to this daily volume should maintain groundwater elevations at a safe minimum level and avoid seawater intrusion. This is a high level target intended to manage regional scale effects. Local issues may still occur depending on the distribution of pumping wells and would be managed by cutoff thresholds at the nearest sentinel well.

This safe yield is based on preliminary simulations and monitoring observations will be used to verify it. A clearer picture of cause and effect will emerge as more information becomes available from the MDC monitoring network in relation to metered groundwater use.

Safe Yield, Current Allocation and Water Use

Consents have been issued for a combined daily take of 100,000 m^3/day of groundwater (Figure 19). Actual pumping rates are estimated to be around 35,000 m^3/day based on applying known rates of irrigation from meter readings to mapped crop areas. Rates of pumping near the coast are better documented than elsewhere on the Wairau Plain because consents have a longer history of metering due to the potential for seawater intrusion.

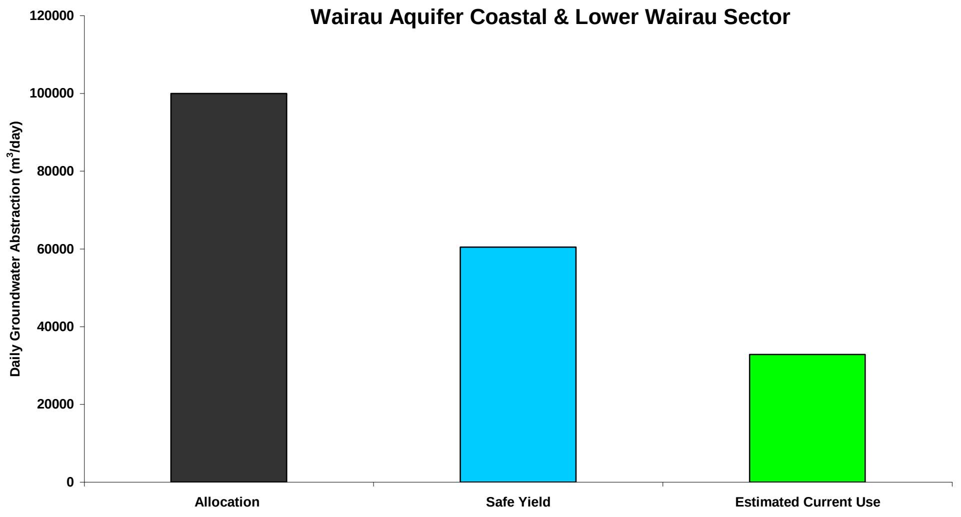

Figure 19: Safe Yield, Water Allocation and Use - Wairau Aquifer Lower Wairau Sector & Coastal Sector

Irrigation water use on the free draining sandy soils forming the isthmus south of Rarangi to the Wairau Bar commonly use 100% of their allocation and can probably justify rates higher than the MDC guideline. However for the majority of the area formed by heavy soils, grape plants are irrigated at low rates compared to the MDC guideline. Pasture and other crops are likely to be taking at their full rate but this is offset by land being fallowed in alternate years.

The variation in irrigation and as a consequence groundwater pumping rates between the 2010 and 2011 summer seasons shows that demand isn't static and justifies the need for continuous monitoring given the potential for issues to develop quickly in these low storage coastal aquifers (Figure 20).

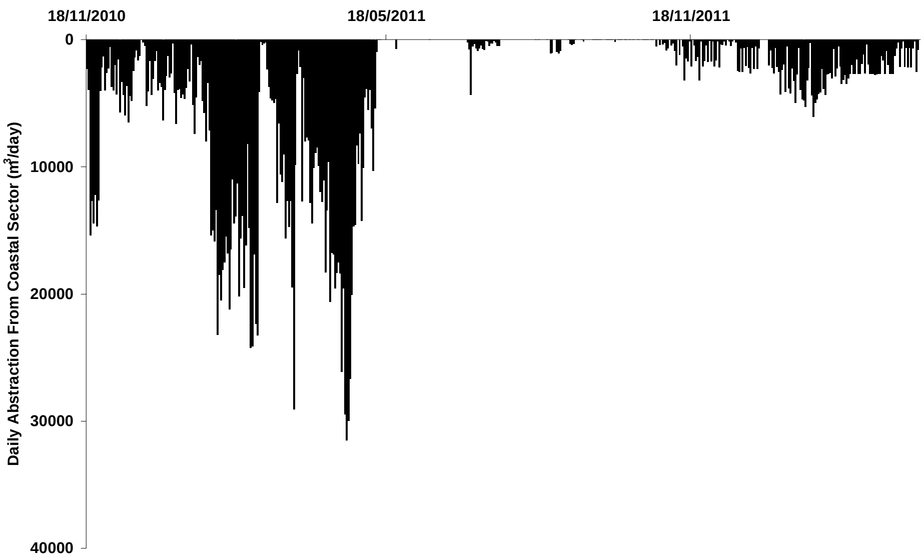

Figure 20: Variation in Wairau Aquifer Coastal Sector Groundwater Pumping 2010-2011

Each of the black lines represents the total daily volume pumped by many water consent holders in the coastal area based on automated water use information. Water use varies during the summer and from season to season in relation to demand and climate.

The current MDC aquifer surveillance system is evolving to mirror the longstanding flood warning system, but applies to low flows and water shortages over longer time frames. Alarms are set to alert MDC staff of low groundwater levels or elevated conductivity. The Cloudy Bay coastal aquifer systems are a focus of MDC monitoring because their response to full demand remains uncertain and is currently based on model results alone.

Current and future pumping effects

Monitoring results from the sentinel well network show current levels of well pumping are not causing any water management problems, but this has to be seen in the context of the relatively wet conditions since 2008 that keep aquifers full and demand low.

Most importantly, seawater intrusion hasn't occurred to date with average groundwater levels above the 1.25 metres elevation threshold (Figure 21). Current levels of pumping in the Wairau Aquifer Coastal Sector are likely to be lowering groundwater levels at the coast by the order of 0.5 metres.

This is based on the gap between the black line in Figure 21 representing the northern area where demand has increased since 2000, and the relatively stable levels in red representing wells opposite the Wairau River mouth where demand is lower and aquifer yield higher. In 2000 the lines coincided when demand was probably at a similar low level in both areas.

Reliability is currently high with no restrictions or interruptions to pumping from wells to date. Future water demand is likely to increase slightly with several large vineyards or pastoral farms still being developed and their water permits have yet to be fully taken up.

Once these consents come on line groundwater levels are likely to fall by a further 0.5 metres. Changes in position of the seawater interface will be more sensitive to new demand closer to the coast compared to wells further inland.

The effect on aquifer levels if the full safe yield of 60,500 m^3/day were to be pumped is more difficult to predict because wells are located at different distances from the coast and pumping at varying rates. Extrapolating existing effects of pumping suggests aquifer levels will approach the minimum threshold in some seasons.

The potential for new wells drilled close to and directly affecting levels at monitoring wells is further justification for restricting water users only when both groundwater level and conductivity criteria are met.

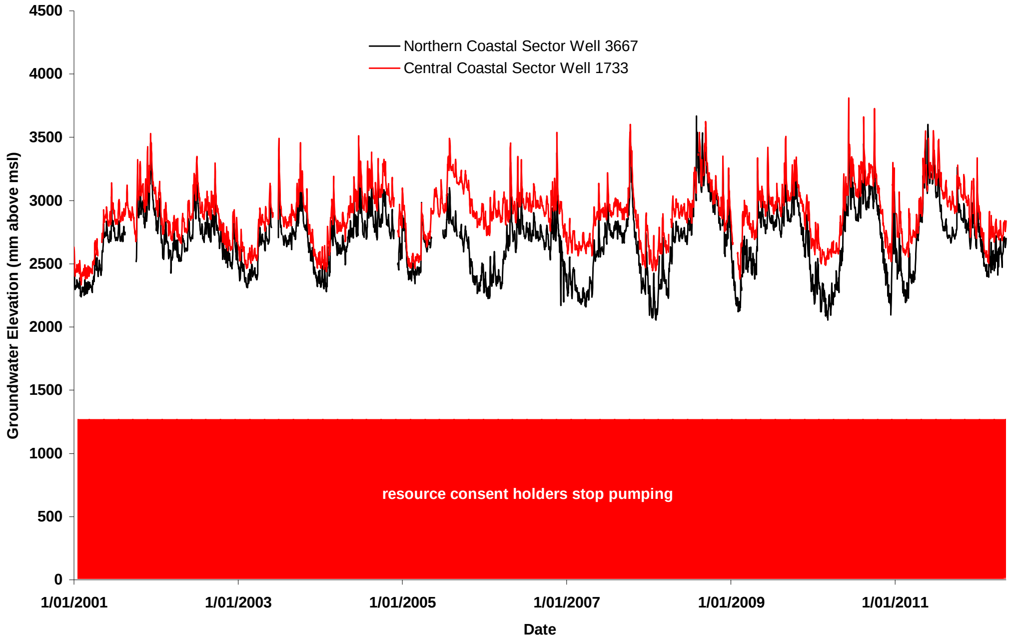

Figure 21: **Central and Northern Coastal Aquifer Elevation and Restrictions**

The aquifer can sustain higher rates of pumping than is currently the case in some seasons and this is reflected in the fact that aquifer levels are above the critical environmental thresholds. However as the safe yield is approached more active management is likely to be needed to balance inputs and outputs.

There are 3 sentinel wells representing the deeper groundwater resources beneath the Cloudy Bay coast and used to regulate underground abstraction in specified areas (Figure 22). Abstractions from the northern Coastal Sector of the Wairau Aquifer are tied to monitoring information from well 3667 north of the Wairau Diversion.

Consented abstractions from central coastal areas are guided by measurements at the bar well 1733. Well 708 provides early warning of a landwards move of the seawater interface for the southern flank of the Cloudy Bay coastline formed by coastal parts of the Riverlands Aquifer. The management boundaries are marked red in Figure 22.

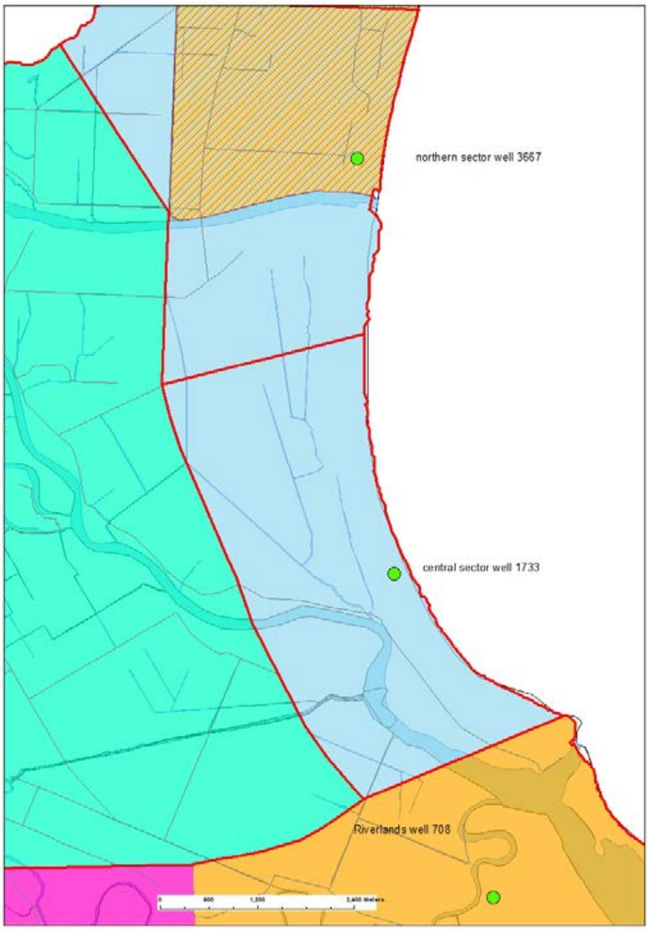

Figure 22: **Sentinel Wells and Management Areas**

4.1.5. Riverlands Aquifer (including Lagoons and Riverlands Transition Sectors)

Introduction

The Riverlands Aquifer is essentially an extension of the low yielding Southern Valleys suite of groundwater systems although it is largely recharged by Wairau River losses in common with the Wairau Aquifer. It is vulnerable to over-pumping because of its isolation from the recharge source and low storage capacity in the confined aquifer, however no problems have been observed to date.

This aquifer is located on the edge of the main groundwater resource beneath the Wairau Plain. Its confined structure makes it a closed system meaning it can only store small volumes of groundwater compared to the unconfined Wairau Aquifer and naturally recharges at a slow rate.

Well records show that groundwater elevations are some of the lowest anywhere on the Wairau Plain and lie close to sea-level over the drier months of the year. Furthermore, well levels in inland areas can remain subdued long after summer pumping has ceased.

The likely explanation is the isolating effect of its confined structure with very low permeability boundaries on 3 sides which create a natural backwater. This is exacerbated by a reliance on recharge water that has to travel up to 15 kilometres from the Wairau River near Renwick.

Large parts of the coastal Riverlands area have poor or saline soils which limit their usefulness for growing crops. As a consequence there is unlikely to be large increases in irrigated area, or growth in new groundwater demand.

Aquifer management issues

Potential groundwater management issues for the Riverlands Aquifer are:

- *loss of long-term artesian pressure in wells over summer*
- *seawater intrusion of coastal wells*
- *reduced base-flow of coastal springs or Opawa River channel flows*
- *irrigating with old, evolved groundwater causing soil salinity issues*

To date the only actual water management issue is the loss of artesian pressures in some seasons or specific areas. This limits traditional methods of filling stock troughs and may require a change in pumping systems to access deeper groundwater for some well owners.

It is likely that the same drop in artesian pressure will cause lower rates of spring flow or leakage of groundwater to the Opawa River. The most serious risk to the groundwater resource is the potential for over-pumping to induce seawater to move inland and contaminate wells.

Because of the serious consequences of seawater intrusion and uncertainty over its exact safe yield in some seasons, the Riverlands Aquifer should be managed cautiously. The naturally low storage of the Riverlands Aquifer means pumping can induce rapid changes in groundwater levels and for this reason they are closely monitored by MDC staff on a day by day basis.

Groundwater is used for a wider variety of end uses at Riverlands than elsewhere on the Wairau Plain and not just in summer, but throughout the year. For example groundwater is used for food processing and manufacturing at the Riverlands Industrial Estate or Cloudy Bay Business Park, and for rural community supply or stock water. Much of this groundwater is supplied by MDC from two wellfields located at Malthouse Road and Hardings Road.

A higher percentage of allocation is actually used for these purposes compared to crop irrigation. Groundwater is also used for irrigating pasture and field crops which have higher irrigation requirements than grape plants, but are watered for shorter seasons and won't be grown or irrigated every year.

Grape growers at Riverlands have some of the lowest metered rates of water use of anywhere on the Wairau Plain. This reflects the heavy, poorly drained soils which can store water between rainfall events. In a normal season grape plants require little or no supplementary watering.

Rates of groundwater use for agricultural purposes are not expected to rise significantly unless there are widespread changes in crop type. This is more likely than western areas of the Wairau Plain because soils are more versatile at Riverlands. Replacing vineyard with irrigated pasture or field crops would significantly increase irrigation rates and actual rates of groundwater pumping.

Aquifer limits

The prime management objective for the Riverlands Aquifer is to maintain sufficiently high aquifer pressures so as to keep the seawater interface at a safe distance from inland wells. This in turn should provide sufficient baseflow to the Opawa River and other spring fed streams over summer via upwards leakage of groundwater through the base of their channels. Once these requirements are provided for, remaining groundwater can be allocated for other end uses.

Table 4: Riverlands Sentinel Well Thresholds

Site	Minimum elevation when pumping ceases (msl)	Conductivity when pumping restricted by ½ of actual use (mS/m)	Conductivity when pumping ceases (mS/m)
well 708	1.5	40 - 60	> 60

The position of the seawater interface isn't precisely known and in lieu of this uncertainty a minimum elevation of 1.5 metres was selected to stabilise its position based on a model of aquifer behaviour (Table 4). The 1.5 metre elevation threshold is marked by the top of the red shaded area in relation to historical groundwater levels at the two MDC monitoring wells in the area which are 4402 and 708 (Figure 23).

Well 708 is the main sentinel well located close to the coast at the lagoons (Figure 22). Well 4402 is located further inland, just east of the tight bend on Alabama Road. Levels at both MDC monitoring wells have transgressed the minimum threshold of 1.5 metres elevation for short periods, however there has been no sign of increasing groundwater salinity or well issues.

At this stage restrictions on consents are based only on levels at the more coastal well 708 as this is the best indicator of the risk of seawater intrusion. The reason for including groundwater levels at well (4402) in Figure 23 is to show that during summer levels in the more coastal well 708 are usually higher than those of inland wells. This is because of the greater concentration of pumping around SH1, Malthouse Road and Alabama Road and as a result there is limited offshore flow of groundwater for much of the year.

The 1.5 metre elevation is slightly higher than that specified for deep groundwater further north opposite the Bar or Rarangi. This reflects the more inland location of sentinel well 708, the sluggish recovery of aquifer levels following pumping at Riverlands since the late 1970's, and uncertainty as to the minimum groundwater pressure needed to maintain the seawater interface in a safe position. The boundary between seawater and freshwater is a natural phenomena and is only a water management issue when it moves too far inland and affects wells.

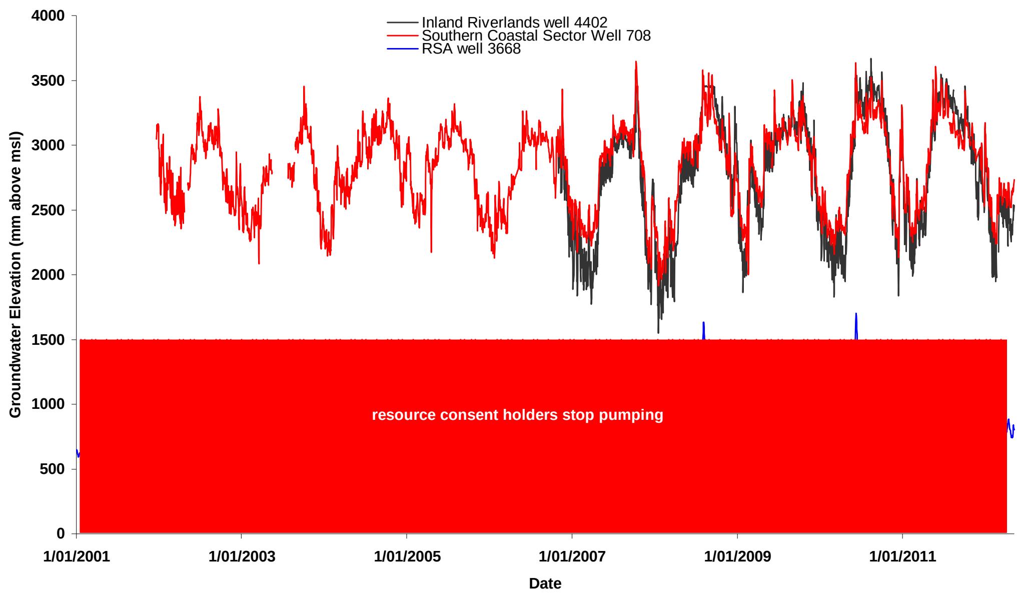

Figure 23: Riverlands Aquifer Groundwater Elevation Variation (2002-2012)

A volumetric safe yield of 8,640 m^3/day corresponds to the 1.5 metre groundwater elevation threshold based on modelling studies of Riverlands Aquifer behaviour. This withdrawal rate is intended to maintain sufficient groundwater pressure to avoid seawater intrusion and other issues from developing.

Modelling the Riverlands Aquifer was a very comprehensive exercise. The model incorporated all of the known hydrological science and applied this to forecasting the aquifer response to different levels of pumping. This safe yield figure was defined in 2008 and the findings are documented in the report entitled: *Riverlands Groundwater Model And Aquifer Sustainability Assessment* by Water Matters Ltd.

The current seasonal fall in aquifer levels due to pumping will vary from place to place, but is estimated to be of the order of 0.5 metres based on MDC monitoring since 2001. Changes in groundwater level at the coast are of most interest from an aquifer management point of view because they determine the risk of seawater intrusion. Falls will be larger near pumping wells and smaller further away from their influence.

This is not a large decline compared with other areas of the Wairau Plain or the depth of Riverlands wells of around 30 metres. However it is significant when the average elevation of groundwater levels at the MDC Alabama Road well (4402) is only 2.5 metres above mean sea-level, 5 kilometres inland from the coast (Figure 23). In other words there is not a lot of free board to play with.

Safe Yield, Current Allocation and Water Use

Estimated actual use is a high proportion of the safe yield but a low proportion of allocation (Figure 24). Demand will vary from year to year and also within an individual summer season. The largest uncertainty for the future is how much of the outstanding allocation will be taken up, and depending on the location of pumped wells, whether this will cause problems.

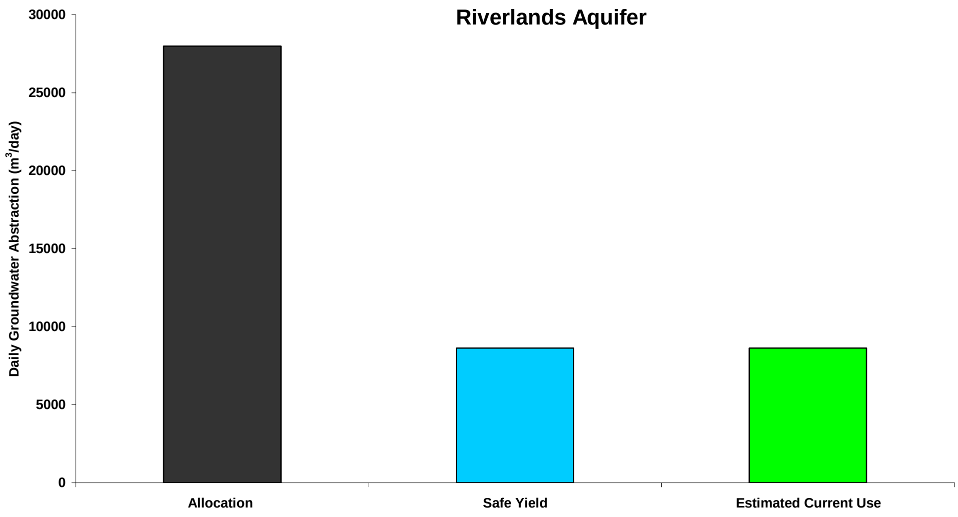

Figure 24: Safe Yield, Water Allocation and Use - Riverlands Aquifer (including Lagoons and Riverlands Transition Sectors)

Tracking the effects of future pumping relies on results from the MDC sentinel well network in conjunction with meter readings of groundwater use. Over time the relationship between well pumping and the fall in aquifer level will allow the safe yield to be revised up or down. This information will identify those areas most vulnerable to pumping.

An idea of the likely future fall in well levels for varying levels of demand can be extrapolated from the current effects. If current rates of pumping estimated at 9,000 m^3/day generate drawdowns of the order of 0.5 metres, predicted future increases up to a total abstraction of about 15,000 m^3/day will cause well levels to fall by another 0.3 metres.

But much depends on the location of wells with localised effects being difficult to predict with the regional scale tools that have been used to set the interim allocation limit. If all of the consented demand were pumped, coastal well levels are likely to fall to near sea-level. The Riverlands Aquifer may not sustain large increases in actual use otherwise problems are likely to develop.

4.1.6. Rarangi Shallow Aquifer

Introduction

The small size of the Rarangi Shallow Aquifer (RSA) limits its capacity to store large volumes of water. It also has seawater forming two of its boundaries with the potential for seawater intrusion of coastal wells to occur. These natural characteristics make it vulnerable to over-pumping. From a supply perspective it is the only reliable source of drinking water for local residents north of Rarangi Road and provides summer baseflow to ecologically important fen wetlands.

Aquifer management issues

Potential groundwater management issues are:

- *seawater intrusion of coastal wells*
- *seasonal drying up of ecologically important groundwater fed wetlands*
- *seasonal loss or limitations on domestic water supply*

- *decline in groundwater quality due to less dilution and groundwater throughflow*

All of these issues can be avoided if sufficient natural flows of groundwater towards the coast and to a lesser extent vertically upwards from the Wairau Aquifer are maintained.

Aquifer limits

The potential for issues to develop and uncertainty as to their consequences means a more comprehensive management system has been developed than elsewhere in Marlborough. A volumetric limit is proposed later in this report to complement the local controls based on environmental thresholds at the sentinel wells.

These dedicated MDC sentinel wells provide early warning of seawater intrusion and most have been operating for over a decade now. They make the RSA the most intensively monitored groundwater resource in Marlborough with continuous measurements at these wells used to manage any adverse effects generated by pumping on the seawater interface or groundwater fed wetlands.

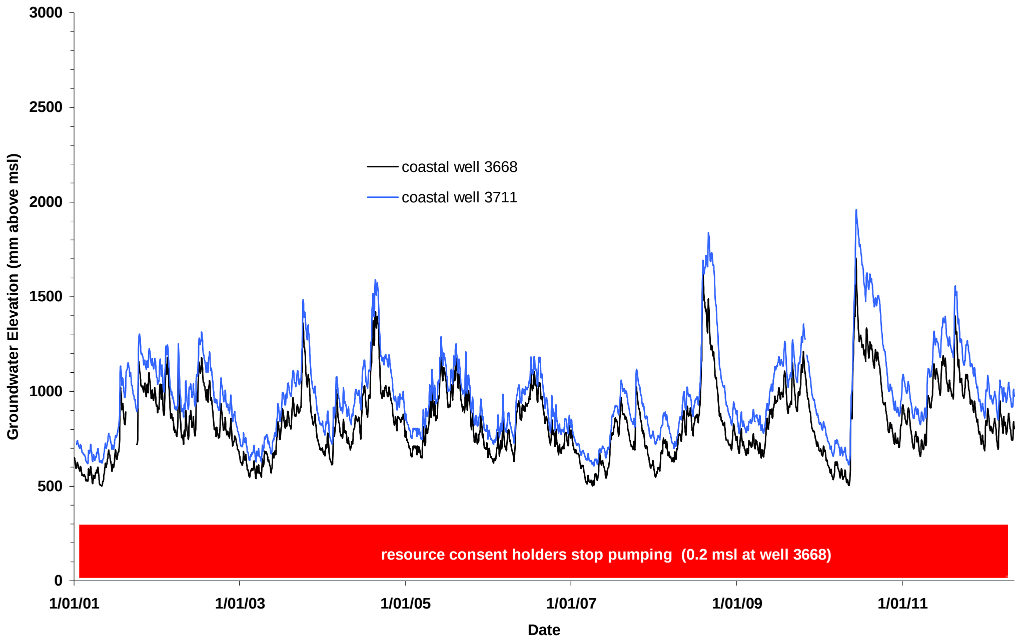

Figure 25: Coastal RSA Groundwater Elevations 2001-2012 and Restrictions

A review of the past decade of monitoring shows that RSA level and conductivity values have settled down and there is now a clear picture of the ambient variation. Coastal groundwater elevations have varied by only 1.5 metres since records started in 2001 (Figure 25).

Conductivity values average 35 mS/m and vary from 15 to 55 mS/m (Figure 26). A review of the entire record shows conductivity values peak in spring and decline in summer when water demand is highest, indicating that until now the variation is caused mainly by natural leaching of sea salts. This supports the approach of not restricting water use unless both conductivity and groundwater level thresholds are transgressed.

Several groundwater level thresholds are needed for triggering restrictions because of different background values depending on distance from the coast.

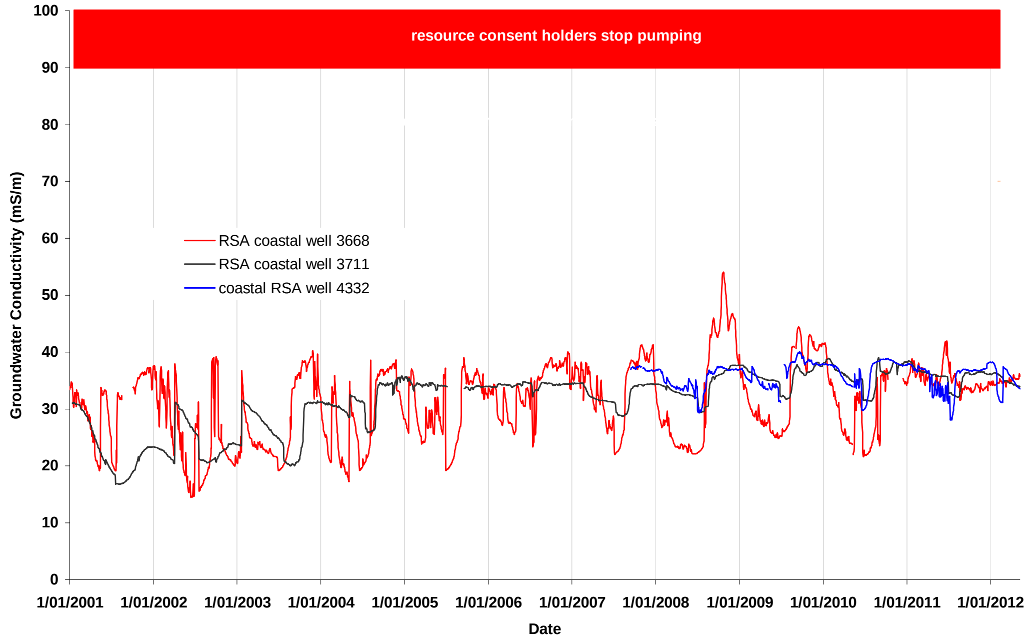

Figure 26: **Coastal RSA Conductivity 2001-2012 and Restrictions**

The management aim is to maintain groundwater conductivity below 70 mS/m and groundwater levels at above either 0.2 or 0.3 metres elevation at the MDC sentinel well sites depending on location (Table 5). A further threshold at the inland well 4331 regulates the effects of direct pumping effects on the wetlands by restricting RSA water use when elevations are less than 1.2 metres at Rarangi Road.

Table 5: RSA Sentinel Well Thresholds

Site	Minimum RSA elevation when pumping ceases (msl)	RSA conductivity when pumping restricted by ½ of actual rate (mS/m)	RSA conductivity when pumping ceases (mS/m)
Wells 4349 & 3668	0.2*	70 - 90	> 90
Wells 4332 & 3711	0.3*	70 - 90	> 90
Wetland well 4331	1.2*	-	-

** S. Wilson/MDC - 2004*

There have been no restrictions based on these conductivity thresholds since the sentinel well network was established in 2001 and no interruptions to supply (Figure 26). The elevation cutoff of 1.2 metres at the inland well has been breached in the past, but with only the Rarangi Golf Club currently operating a large consent, this is likely to happen less frequently (Figure 27).

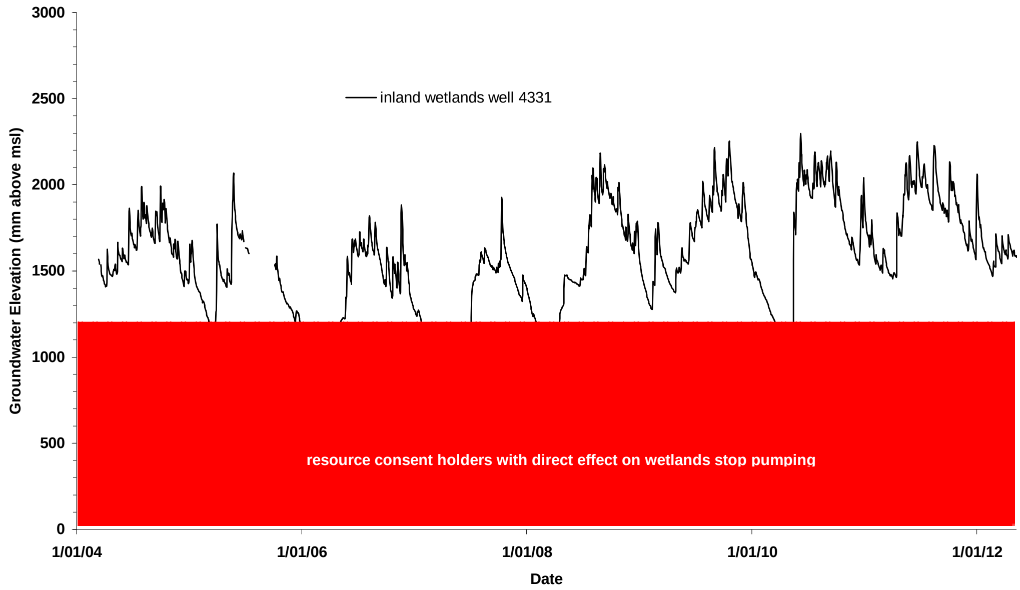

Figure 27: Inland RSA Groundwater Elevation 2004-2012 and Restrictions

Other thresholds exist to manage specific resource consent activities such as irrigation water use by the Rarangi Golf Club. These may be applied universally in the future, but need to be tested under drought conditions first to verify that they are appropriate.

Because it represents a small groundwater reservoir that is potentially prone to overpumping, local controls at the coastal sentinel wells may not always be adequate to avoid issues from developing, especially in some drier seasons that can extend into May.

For example a situation could develop whereby more groundwater is pumped at inland sites than is naturally recharged under typical summer conditions and the sentinel wells may not provide enough warning to manage the consequences, especially if there was limited rainfall in the meantime.

For these reasons a volumetric limit is recommended in addition to the sentinel well system to guide the quantum of allocation. This would provide certainty for existing and future users. A safe yield of 1,761 m^3/day is proposed based on 15% of the average annual recharge.

This approach was described in the proposed National Environmental Standard on Ecological Flows and Water Levels. The average annual recharge to the RSA was calculated using a soil moisture budget model (*Water Matters Ltd 2011*). This proposed limit can be compared with the current allocation limit of 1,200 m^3/day from the RSA including domestic use.

Pumping from deeper wells tapping the Wairau Aquifer which partially underlie the southern half of the RSA is likely to reduce the rate of upwards groundwater flow to the Rarangi wetlands. Maintaining Wairau Aquifer levels at 1.25 metres elevation or more is likely to maintain a 0.5 metre upwards gradient between the two groundwater systems which in turn would preserve a minimum rate of groundwater upflow (Figure 23).

A minimum elevation of 1.25 metres is recommended to avoid seawater from affecting the Wairau Aquifer, although lower values exist as conditions on individual consents. A cut off of 1.25 metres elevation would achieve both management objectives. Based on record at MDC well 3667 dating back to late 2000, deep aquifer elevations have never fallen below this mark.

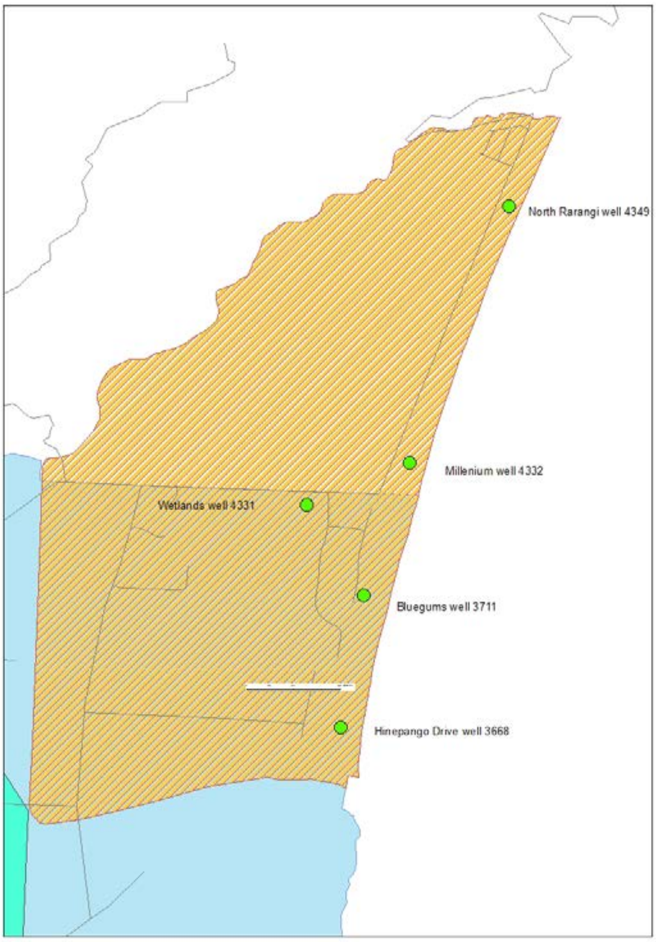

Figure 28: **Sentinel or Wetland Wells and Management Areas**

There are 4 coastal sentinel and 1 wetland monitoring wells regulating RSA water use (Figure 28). A simple approach is to say that a transgression at any of the sentinel wells affects the operation of all resource consent holders drawing on RSA groundwater because it is such a small aquifer. In the case of small domestic takes, it would make sense to split the aquifer into coastal sectors with each assigned to the nearest sentinel well.

Safe Yield, Current Allocation and Water Use

Demand is likely to have peaked as there are few areas of flat land that have not been developed. There is the potential for future changes in irrigation regimes or crop types and groundwater use, but agricultural intensification is less likely than elsewhere on the Wairau Plain because the sandy soils aren't suited to many crops.

No incidences of seawater intrusion are known to MDC staff and there have been no signs of it occurring since the sentinel well network was established in 2001. However over this period there have been no severe droughts to test aquifer response.

Further allocation is available but RSA levels would be lower for longer as a result (Figure 29). This in turn is likely to affect the health of the wetlands and productivity of domestic wells. If further water were allocated by MDC, the effects would be sensitive to the location of the pumping wells.

Domestic use has been included in the allocation component of Figure 29 because it is so important to local residents and for many it is the only source of water available. Limits on all coastal aquifers have been defined as daily totals to match current resource consent practice. This is a conservative approach because changes in the position of the seawater interface generally take longer to develop in response to pumping.

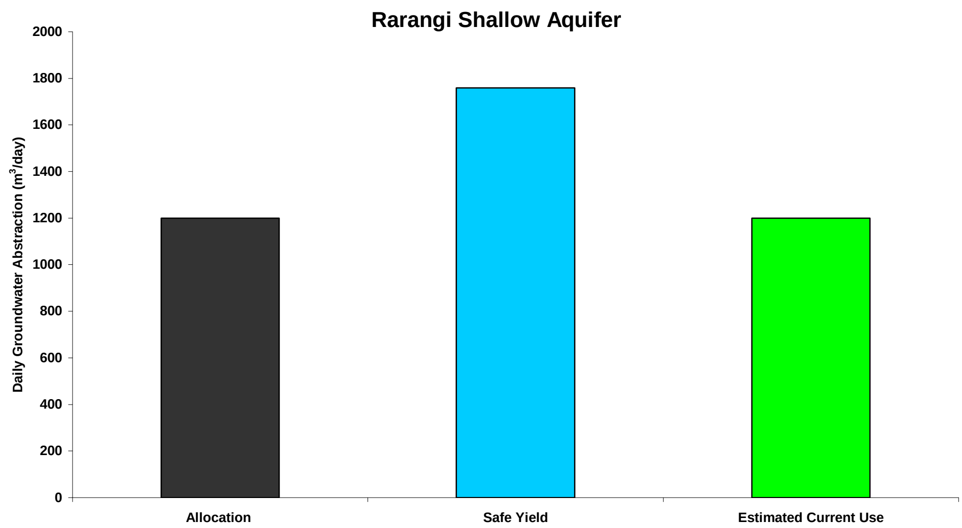

Figure 29: Safe Yield, Water Allocation and Use - Rarangi Shallow Aquifer

4.1.7. Omaka River Aquifer and Woodbourne sector

Introduction

The Omaka River forms part of the water short Southern Valleys catchments. Seasonal water shortages for irrigation, community water supply at RNZAF base Woodbourne and some domestic or stock wells are nothing new and have been experienced since at least the early 1970s.

Because both the Omaka River Aquifer and the downstream Woodbourne Sector groundwater system rely for most of their recharge on Omaka River flow, it makes sense to combine them for management purposes. However there are local differences which is why separate aquifer zones exist. For example northern parts of Woodbourne receive some recharge from the Wairau River depending on seasonal conditions whereas the area around Godfrey Road depends entirely on Omaka River flow arriving from the hill catchment to the south-west.

While groundwater occurs in the shallow gravels surrounding the river, it is limited in volume and drains quickly when there are lower Omaka River flows over summer. Deeper groundwater is more reliable under drier conditions, but both sources have limited storage and without regular top-ups of recharge water, can't sustain high pumping rates from wells.

Aquifer management issues

Water use issues include:

- *summer availability of domestic, community, industrial and irrigation groundwater*
- *potential for climate variability or vegetation change to reduce catchment runoff and downstream groundwater recharge*

There are few ecological issues to consider because of the ephemeral nature of the Omaka River flow regime. This means that all catchment runoff naturally seeps into the gravels and most can be allocated for consumptive uses in summer.

The elongated shape of the Omaka River channel complicates water allocation because upstream water users intercept groundwater first and have an advantage over downstream users. Between 1994 and 2007 the mean flow of the Omaka River catchment was showing a decreasing trend, but in recent seasons this pattern has reversed (Figure 30). This rapid turn around in catchment yield suggests climate is the key driver rather than re-vegetation or a reduction in runoff in recent times.

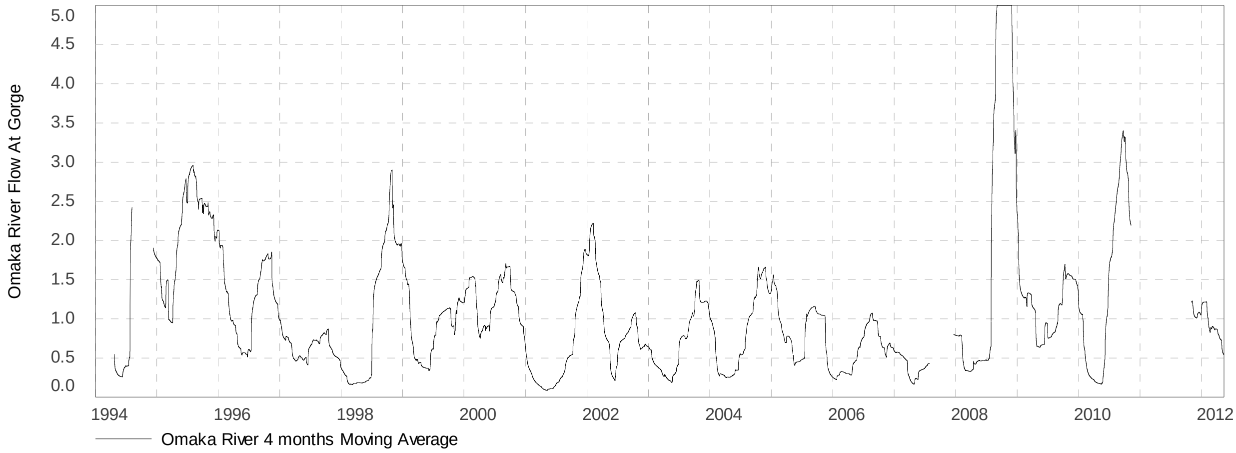

Figure 30*:* Omaka River Flow 4 Month Moving Average

Aquifer Limits

The existing daily allocation limit of 14,688 m^3/day for the Omaka River Aquifer (WARMP) was set in the mid 1990s based on limited hydrological information. This volumetric limit is made up of a surfacewater component and a groundwater component.

At that time the annual low flow of the Omaka River at Tyntesfield Gorge was estimated to be 140 l/s. Modelling showed that groundwater stored in the underlying gravels could supply a further 30 l/s, making a total of 170 l/s (14,688 m^3/day). There is no new information to show the value of the groundwater component isn't still valid.

However considerably more is now known about the flow regime of the Omaka River by virtue of 18 years of Omaka River flow record. For example the average annual 7 day low flow of the Omaka River is 115 l/s compared with the 1994 estimate of 140 l/s. While the record is still relatively short, it provides a clearer picture of river flows and the availability of water.

Predicted Omaka River flows and their average recurrence interval are listed in Table 6. The flow that is selected will be a trade-off between reliability and having as much water as possible to share between water users.

For instance a flow of 80 l/s would be available in a reasonably severe drought that would occur on average once every 20 years. A higher flow of 95 l/s could be shared amongst more users, but would be interrupted more frequently and on average once every 5 years.

Table 6: Omaka River Flows and Allocations

Average 7 day Omaka River low flow at Tyntesfield Gorge (l/s)	Average return period	Total allocation including groundwater storage component of 30 l/s
80	20 years	110
85	10 years	115
95	5 years	125
115	1 year	145

Safe Yield, Current Allocation and Water Use

The daily volume of groundwater available for a drought event that occurs on average once every 10 years has been selected to show the reliability of current levels of allocation and use (Figure 31). These values include groundwater storage plus Omaka River catchment runoff. Under dry conditions pumping is likely to exceed these limits.

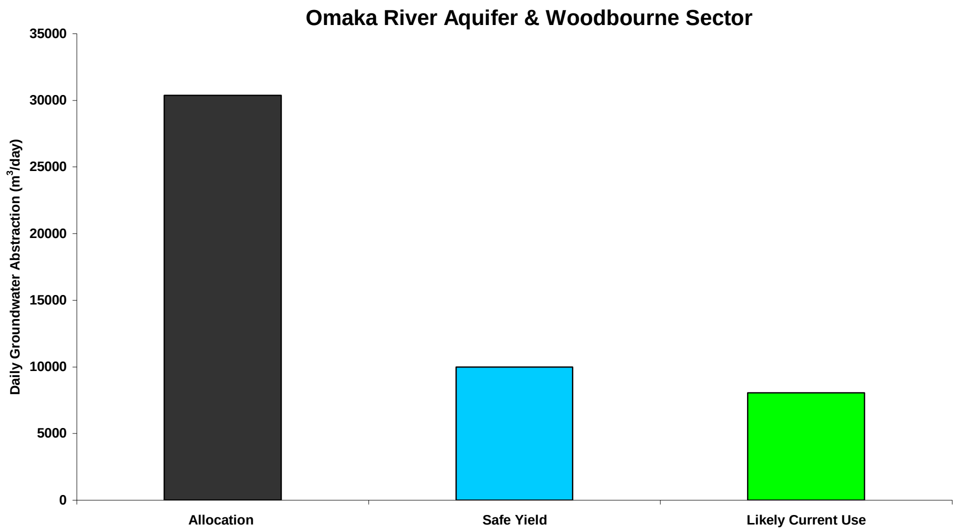

Figure 31: Safe Yield, Water Allocation and Use - Omaka River Aquifer and Woodbourne sector

As is common with most grape growing areas of Marlborough, actual irrigation water use is low compared to consented rates. Actual water use has been calculated based on the area planted in grapes and the rule of thumb daily irrigation application rate of 1 millimetre/day. This is likely to reflect an average rate of use.

Another class of consents exists allowing harvesting of Omaka River water at high flows of greater than 400 l/s. However these are already severely restricted meaning this category of water is approaching the limits of its usefulness.

4.1.8. Southern Springs Sector

Introduction

The Southern Springs Sector is an area of groundwater fed springs on the south-western outskirts of Blenheim. Its boundaries extend from Woodbourne to the Taylor River and from Middle Renwick Road through to New Renwick Road (Figure 32).

The Southern Springs are managed separately from the neighbouring urban springs such as Murphys Creek or Fulton Creek because they behave differently and a high proportion of their recharge water comes from the water short Southern Valleys catchments rather than the more reliable Wairau River. Another distinction is that Southern Springs flows are more variable than true groundwater fed springs because they are subject to floods generated in the Benmorven hill catchment.

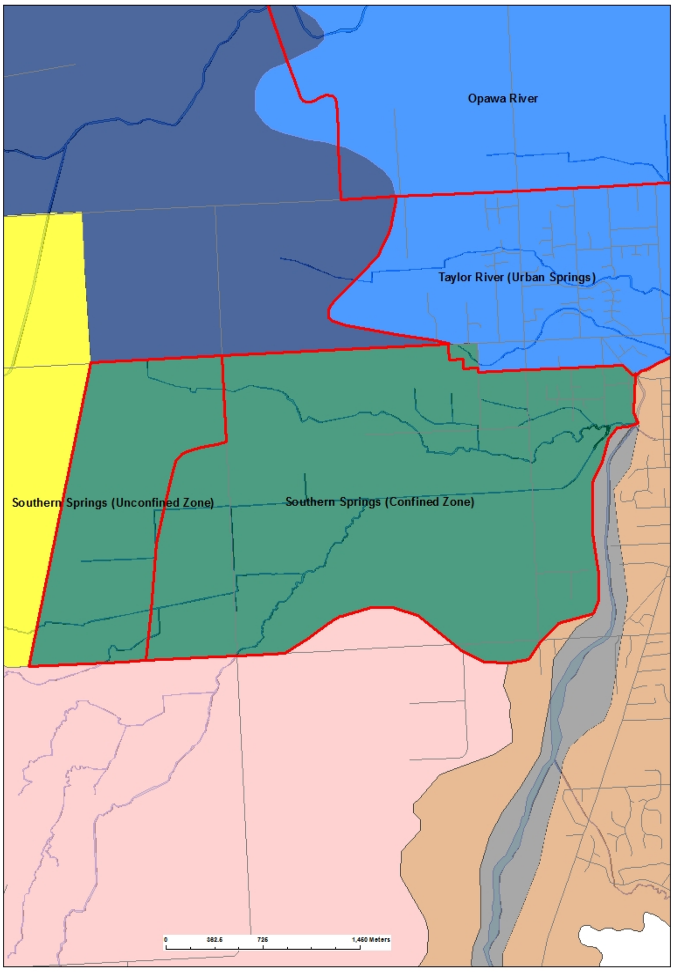

Figure 32: Southern Springs Sector and Structure

There are a series of springs which makeup the Southern Springs with the largest being Doctors Creek/Fairhall Co-op Drain. They all drain into the Taylor River and during summer most of the flow through Blenheim is supplied from groundwater. Perennial flows only begin where Doctors Creek joins the Taylor River upstream of the High Street bridge. Above this point Taylor River flow is ephemeral and depends on rainfall in the hill catchments to the south.

While there is an excess of water for agriculture in winter or spring which is managed via a network of artificial drains, in summer or autumn there are commonly low spring flows which can affect the health of plant and fish life.

Springs rely on groundwater for their baseflow during the driest period of the year and pumping from wells can indirectly affect flows. A large volume of groundwater has been allocated and this is affecting spring flow in some summer seasons.

Over time the actual rate of both surface and groundwater use is likely to have fallen because historic high water users such as the Korere Farms dairy unit have been subdivided into rural residential blocks whose water use is significantly less. This is balanced by increased use of frost protection in spring and expansion of the Villa Maria winery.

Aquifer management issues

Water management issues are:

- *under dry catchment conditions groundwater pumping can indirectly lead to unacceptably low Doctors Creek and Taylor River flows upstream of Murphys Creek*
  - *This can degrade aquatic habitat and channel aesthetic qualities for Blenheim residents*

Aquifer limits

Since 2004 a minimum Doctors Creek flow of 150 l/s at a point upstream of the confluence with the Taylor River has been commonly applied as a condition on water permits having a significant effect on channel flow. A significant effect is defined as a reduction in Doctors Creek channel flow by 2 l/s or more.

Some wells are located a large distance from the spring channels or are drilled in low permeability material and pumping at low rates. The combination of these factors means they have a limited effect on spring flow. In particular wells tapping the unconfined portion of the aquifer have a small effect on Doctors Creek flow because this part of the aquifer becomes hydraulically disconnected from the springs in late summer (Figure 32).

The 150 l/s threshold upstream of the Taylor River is similar to 90% of the mean annual low flow threshold specified in the proposed National Environmental Standard (NES) on Ecological Flows and Water Levels of 170 l/s. This threshold has not been transgressed for an extended period since the 2002/03 summer season based on weekly flow gauging of Doctors Creek (Figure 33).

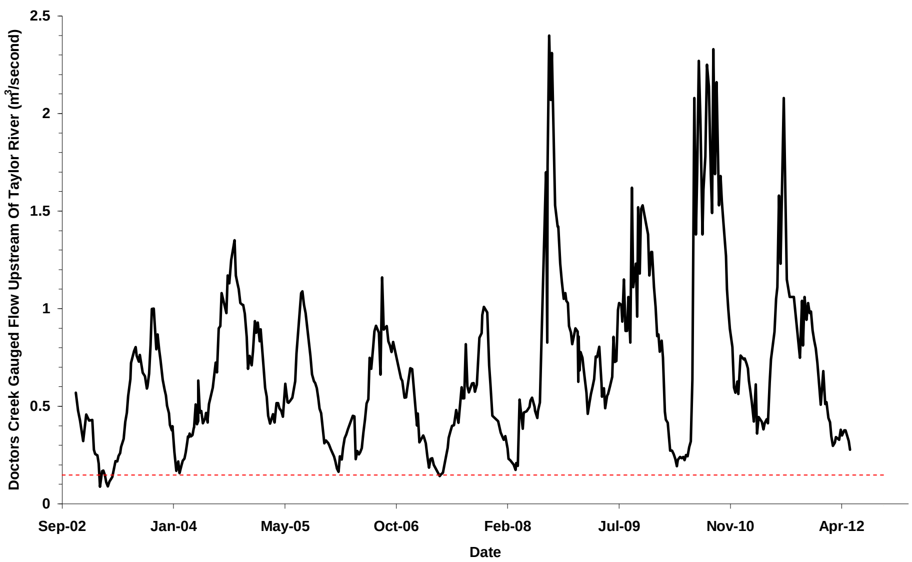

Figure 33: Doctors Creek Gauged Flow 2002-2012 And Restriction

Maintaining a minimum Doctors Creek flow is important because it is a major source of Taylor River baseflow. There is currently no volumetric limit on abstraction from the Southern Springs water resource but one is recommended for two reasons. Firstly we know from plotting the predicted effects of pumping on Doctors Creek low flows that the high reliability water (90-95% available) needed for summer crop irrigation is overallocated.

This is the category of water required for crop irrigation at the driest time of the year when stream flows are at their lowest. Granting new permits will reduce the reliability of existing water permits by causing flows to reach the threshold of 150 l/s sooner in the season and stay lower for longer.

Secondly there are many groundwater abstractions that aren't subject to the low flow cutoff because in isolation they have a minor effect on channel flow. But their cumulative effect on spring flow may be significant in some seasons by intercepting throughflow that would otherwise end up supplying the springs several months later. There is little point in limiting direct pumping effects on spring low flows if upstream groundwater use is uncontrolled.

Current actual use is estimated at 5,600 m^3/day, but in the past is likely to have been higher because of irrigated cropping and dairying with an estimated average use of about 10,000 m^3/day. The explanation for the fall in water use is that grape plants have replaced irrigated pasture or crops and require little watering because of the heavy soils.

This compares with a total consented allocation of 57,415 m^3/day for both surface and groundwater use (665 l/s). Confirming actual groundwater use for different seasonal conditions is a priority so that a realistic volumetric limit can be set.

But not all of this water has a direct effect on spring flow because in summer groundwater beneath the area west of Bells Road becomes disconnected from the springs and the confined aquifer feeding them. The total consented allocation for this more sensitive area is 418 l/s of which 333 l/s is calculated to originate from the springs or groundwater that would otherwise end up there. However the actual depletion effect on spring flow will be much less than this after allowing for how much consented groundwater is actually used.

Southern Springs allocation is inflated by the large rates of groundwater used in spring for protecting grapes from frost and the irrigation of crops closer to Woodbourne that have a lesser effect on spring flow. In most seasons this water is probably replaced before the height of summer when demand in the sensitive confined aquifer area peaks, and is less relevant to the low spring flows that are typically experienced after Christmas.

Safe Yield, Current Allocation and Water Use

The Southern Springs are overallocated on paper (Figure 34) in terms of the highest reliability water but more water could be allocated for storage. The volume of consented allocation is very large and unlikely to be available in typical summer conditions without unacceptably affecting Doctors Creek flows.

In terms of the effects of current levels of abstraction, a combination of higher rainfall since 2008 together with lower water demand due to changes to lower irrigation demand crops has meant that spring flows have generally been acceptable since 2002. This shows that more water could be pumped under current weather conditions, but less in a drier season.

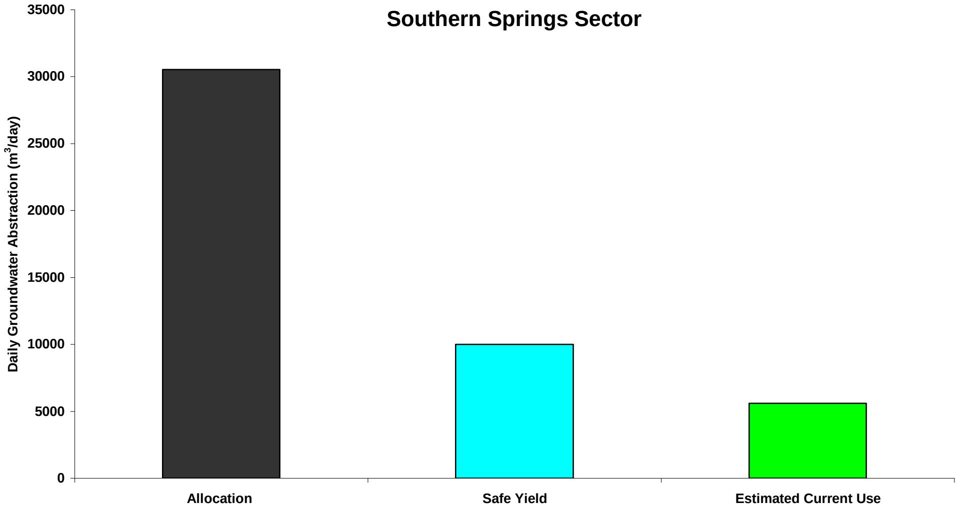

Figure 34: Safe Yield, Water Allocation and Use - Southern Springs Sector

4.2. Southern Valleys Aquifers

Introduction

The Southern Valleys suite of groundwater systems are the lowest yielding of the aquifers underlying the Wairau Plain. They are associated with the ephemeral river catchments draining the southern margin of the Wairau Plain.

Their water short nature has been a generally accepted fact since the 1970s and is reflected in lower agricultural land values. Grapes are the main irrigated crop today and are well suited to the area because of their low water demand.

Two types of aquifers exist. First of all shallow, localised riparian aquifers which have limited storage and rely on continual top-ups of recharge water from either Wards/Mill Stream in the Omaka-Hawkesbury Valley or the Fairhall River in the Fairhall-Brancott Valley. There is no equivalent river system for the hill catchment of the Benmorven Aquifer because Doctors Creek flows so infrequently and is isolated from direct contact with the aquifer by the capping layer.

These aquifers are underlain by a series of deeper water bearing layers which have greater storage and provide most of the consented groundwater. The deeper aquifers are more sensitive to pumping than recharge because they are closed systems and slow to replenish.

For example pumping can cause well levels to fall by 10 metres or more over a single summer season. There is no guarantee that well levels in these deeper aquifers will recover by the following spring if river flows or rainfall is low and draw-off high.

Because aquifer status is primarily driven by pumping and not natural processes, it isn't straightforward to predict its behaviour. Well levels can fall rapidly so allocation limits can't be set to match a certain historical reliability or river flow pattern. This applies to all the deep Southern Valleys Aquifers, but particularly the more isolated Benmorven Aquifer.

A bulk seasonal allocation is best suited to these sluggish aquifer systems which don't have a distinct recharge or wet season. The combined safe yield of all 3 Southern Valleys Aquifers will vary seasonally but is known to be about 500,000 m^3/season based on the analysis of pumping versus the change of aquifer levels over the past 20 years, and in particular their response to the 2000/01 drought.

While groundwater levels can be lowered further than the minimums experienced during the 2000/01 drought, there is an increased risk of subsidence and the drying up of wells along the southern margin which can't be deepened because bedrock is close to the surface. Minimum levels have been adopted based on consultation with local water users of all descriptions following the 2000/01 drought.

This is not to say the management aim should be to return levels to those experienced during the 1980s. The target lies somewhere in between these extremes by minimising restrictions while avoiding locking up groundwater.

A further implication for these low storage and sluggishly recharging aquifers is that all of the available groundwater can potentially be pumped in a single season. Inter-seasonal issues could coincide with droughts that last for 3 or more successive years. As such there is less certainty for consent holders than for those pumping from the higher yielding Wairau Aquifer which can be recharged by the river at any time.

Historically the deeper aquifers have been considered hydrologically isolated from surface wetlands and aquifers to the north at Woodbourne or the Southern Springs. New information suggests that groundwater does contribute to downstream processes such as replenishing the wetlands in the lower reaches of the Omaka Aquifer at Dog Point Road, and providing throughflow to Woodbourne or Southern Springs areas. The degree to which groundwater is preserved for these purposes depends on their relative ecological worth versus the economic importance to the community.

The Deep Wairau Aquifer was discovered only as recently as 1998 and because its boundaries remain poorly defined it has been managed as part of the adjoining Southern Valleys Aquifer which it underlies and is effectively an extension of.

4.2.1. Benmorven Aquifer

Introduction

The Benmorven Aquifer is the lowest yielding of the 3 deep Southern Valleys Aquifer systems. It experienced the largest decline in levels of any groundwater system in the district of 15 metres between 1997 and 2001. This was caused primarily by over-pumping, exacerbated by drought.

Groundwater is used for a wider range of end uses than elsewhere in the Southern Valleys Catchments. These include individual domestic well or centralised rural residential schemes, winery wash-down, golf course or vineyard irrigation.

The confined structure of the Benmorven Aquifer has a major influence on its safe yield because it regulates how quickly it recovers from pumping. This is because it is a closed system and relies on a trickle of recharge all year round rather than during a specific wet period as is the case for the Wairau Aquifer. This means there is little benefit to pumping in the wetter months as it is the same body of water that will be resident until the next summer.

There is a single MDC monitoring well (2022) to characterise 3 known sub-aquifer layers. The results from this well may not be representative of each aquifer pocket in all seasons. Furthermore the influence of localised pumping on well 2022 is likely to be growing as consented demand is taken up. This means that levels will appear lower than they are likely to be across the greater Benmorven Aquifer.

Aquifer management issues

Current groundwater resource management issues are:

- *uncertainty of supply for consented and permitted uses under drought conditions*
- *potential for subsidence of the aquifer forming clay beds if levels fall below 20 metres elevation*
- *drying up the southernmost wells which can't be deepened because of bedrock close to the surface*

Pumping demonstrated that the Benmorven Aquifer can't sustain the consented volumes withdrawn during the 1997/98 or 2000/01 droughts and is slow to recover. This conclusion was based on an analysis of measured groundwater use versus the fall in aquifer levels since the mid 1980s.

Aquifer limits

The lowest aquifer elevation experienced at well 2022 was 20 metres during summer 2001 (Figure 35). If levels fall below this point there is an increasing risk of land settlement and it was decided by local water users following the drought in late 2001 that levels should not be allowed to go lower.

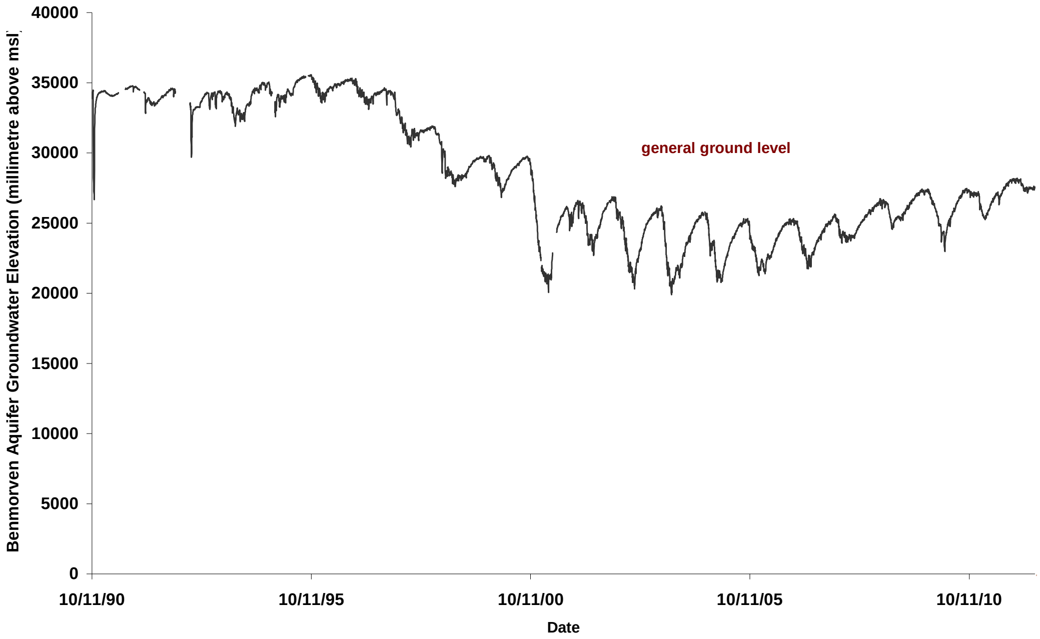

Figure 35: Benmorven Aquifer Levels 1990-2012

On this basis the safe yield is defined as the volume of groundwater stored in the aquifer above this minimum elevation each spring prior to the next summer irrigation season. Safe yield has to account for the possibility of dry conditions being experienced in successive summers. Not all of the water in storage can be taken in a single season as there is no guarantee it will be replaced over winter or spring before the next summer.

Safe Yield, Current Allocation and Water Use

Levels in the Benmorven Aquifer have stabilised, but have not recovered to the same extent as the neighbouring Brancott or Omaka Aquifers.

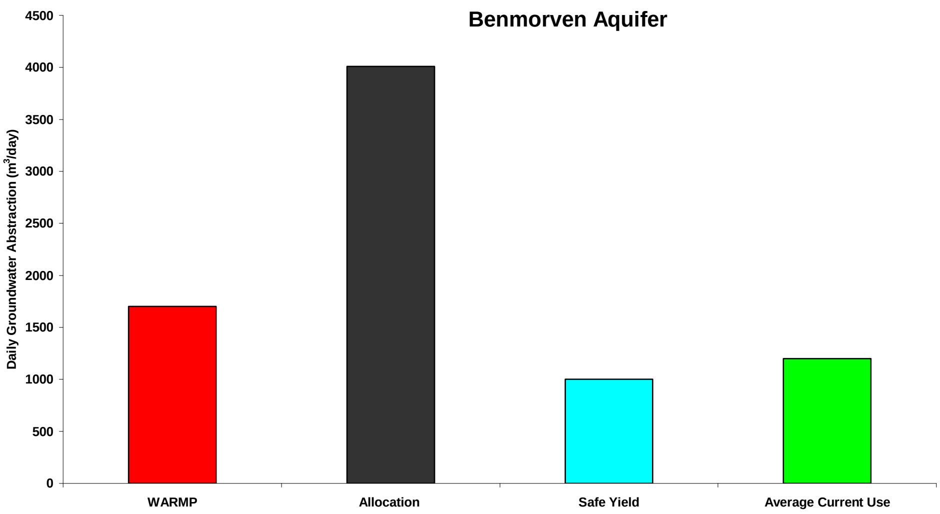

Figure 36: Safe Yield, Water Allocation and Use - Benmorven Aquifer

The aquifer is overcommitted during dry conditions with current pumping rates being greater than the long-term safe yield of 100,000 m^3/season which explains why levels haven't fully recovered (Figure

36). It is likely that the full effects of this pumping are being offset by slightly higher recharge rates since 2008.

Some users such as the Villa Maria winery do not have the option of using SVIS water because it is not suitable for food processing and Benmorven Aquifer water is unavailable whenever water levels fall below 20 metres elevation.

The effects of groundwater pumping for residential supply have been studied and shown to be significant. The reasons for this are they operate all year round, they are numerous and their combined drawoff is of the same magnitude as that used for summer irrigation pumping. It follows that the combined effect on the resource can be the same as irrigation pumping when taken over an entire year.

4.2.2. Brancott Aquifer

Introduction

The Brancott Aquifer is composed of more permeable sediments and has a more open structure than the Benmorven Aquifer. This means it not only stores more water, but also recovers faster from summer pumping by virtue of a faster recharge rate. However large flows in the Fairhall River are needed to recharge the deeper aquifer layers and they do not occur every year.

The state of the Brancott Aquifer is permanently measured by well 1323 sited in the middle of the valley. As is the case with all of the Southern Valleys Aquifers, their natural inhomogeneity makes it difficult to place too much weight on the representativeness of results from a single monitoring well. Over time however the record it provides is a good relative indicator of aquifer state.

Aquifer management issues

Current management issues are:

- *uncertainty of supply for consented and permitted uses under drought conditions*
- *drying up the southernmost wells which can't be deepened because of bedrock close to the surface*
- *potential for subsidence of the aquifer forming clay beds if levels fall below 36 metres elevation*

Aquifer limits

The lowest aquifer elevation experienced at well 1323 was 36 metres during summer 2001 (Figure 37). If levels fall below this point there is an increasing risk of land settlement. On this basis the safe yield is defined as the volume of groundwater stored in the aquifer above this minimum elevation each spring prior to the next summer irrigation season.

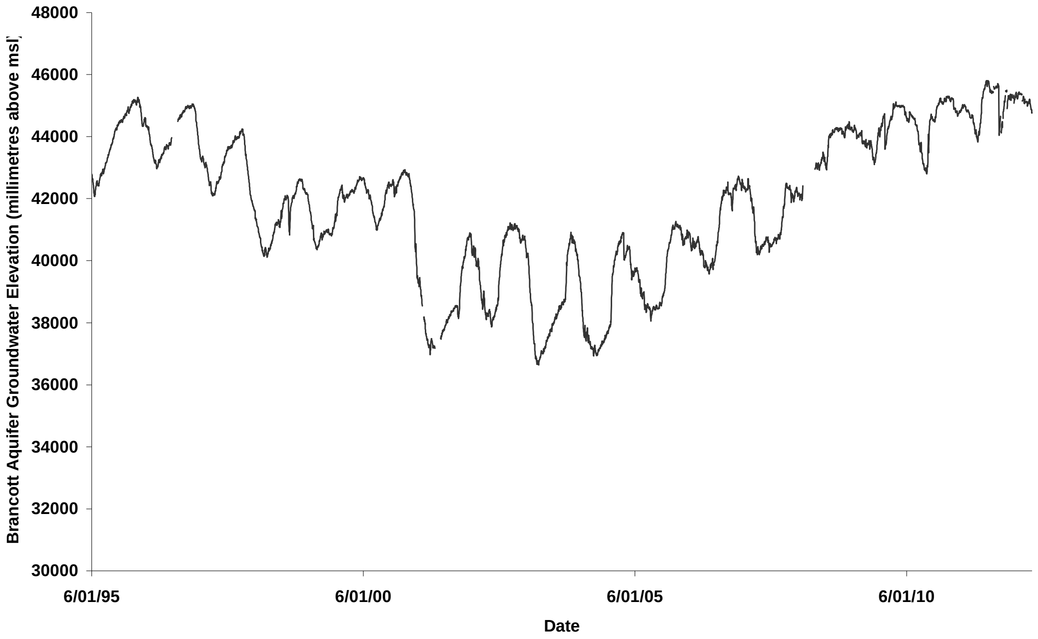

Figure 37: **Brancott Aquifer Levels 1995-2012**

Brancott Aquifer groundwater levels have recovered from the low levels experienced during the 2000/01 drought and are currently the highest since records started in early 1995, but they can quickly fall to below the minimum thresholds within the space of a season because the pore spaces that store water are small and the rate to refill these interstices is slow.

Safe Yield, Current Allocation and Water Use

Aquifer and well levels have recovered from the minimums experienced during the 2000/01 drought. This has happened earlier than was predicted by modelling and reflects the wetter conditions experienced since 2008 together with SVIS water being used instead of local groundwater.

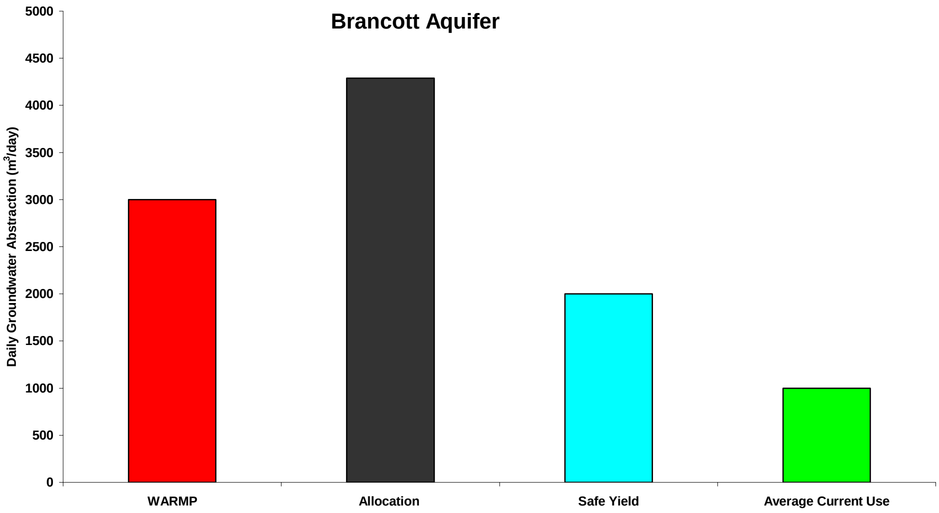

Figure 38: Safe Yield, Water Allocation and Use - Brancott Aquifer

More groundwater can be pumped than is currently being used, although in common with the other Southern Valleys aquifers the potential issue of over-pumping remains (Figure 38).

4.2.3. Omaka Aquifer

Introduction

The Omaka Aquifer has similar characteristics in terms of reservoir capacity and rate of recharge as the Brancott Aquifer. This is demonstrated by the way it has recovered from heavy groundwater use during the 2000/2001 drought.

It makes sense to manage the Omaka Aquifer in a similar way to the Brancott Aquifer and this is reflected in larger safe yields than for the Benmorven Aquifer. Both systems are not as highly confined as the Benmorven Aquifer, while Wards/Mill Stream flows at sufficiently high rates in most seasons to recharge most Omaka Aquifer layers.

Aquifer management issues

Current management issues are:

- *uncertainty of supply for consented and permitted uses under drought conditions*
- *drying up of wetlands in northern areas*
- *potential for subsidence of the aquifer forming clay beds if levels fall below 73 metres elevation*

Aquifer limits

The minimum elevation level is higher because the Omaka Aquifer is naturally elevated above the Brancott and Benmorven Aquifers. The equivalent minimum level for the Omaka Aquifer is 73 metres above mean sea-level based on the medium depth well record (Figure 39).

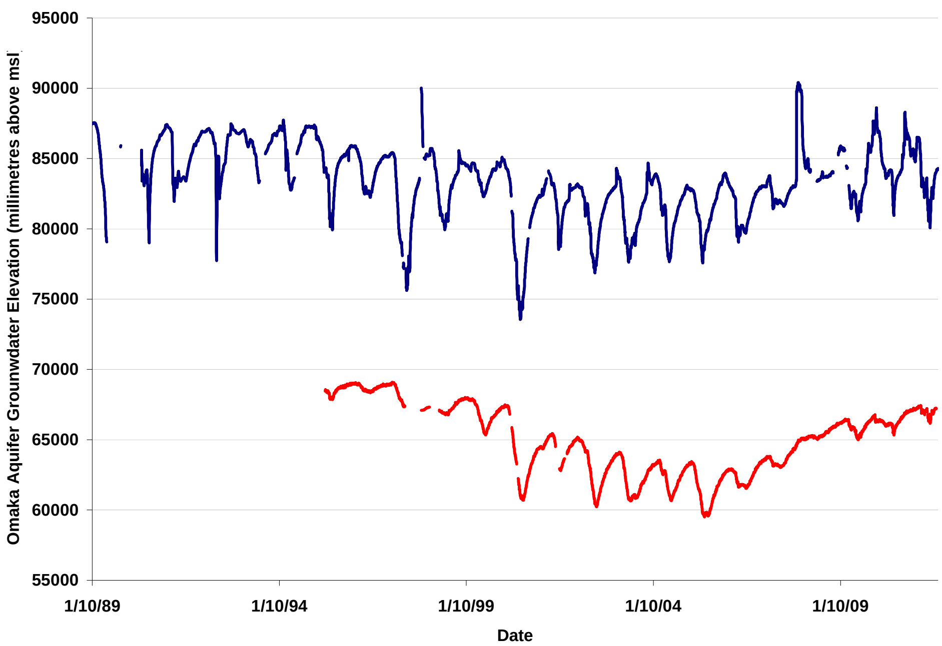

Figure 39: **Omaka Aquifer Deep and Medium Depth Levels 1989-2012**

Safe Yield, Current Allocation and Water Use

The Omaka Aquifer is not as overallocated as the other two Deep Southern Valleys Aquifer systems but exceeds safe yield (Figure 40). The levels of both aquifer layers fell by around 10 metres as a result of heavy demand and low recharge following the 1997/98 and 2000/01 summer droughts. Aquifer and well levels have recovered from the minimums experienced during these drought events and there are currently no problems for well users.

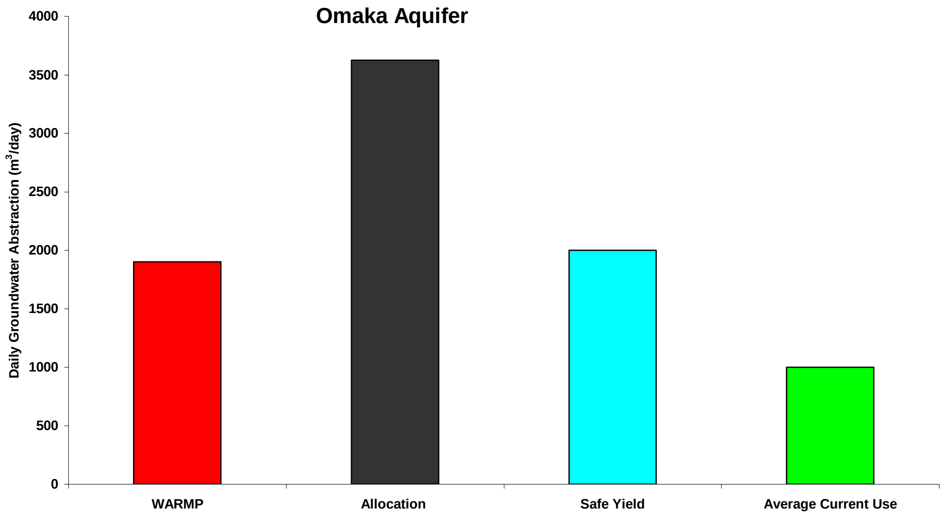

Figure 40: Safe Yield, Water Allocation and Use - Omaka Aquifer

While aquifer levels have now recovered to their pre-drought state, this reflects the relatively wet conditions experienced since 2008 and a greater reliance on Southern Valleys Irrigation Scheme water (SVIS) instead of local groundwater from the Omaka Aquifer.

The potential remains for significant falls in well levels in the future based on the forecast unavailability of SVIS irrigation water for 90 days in conjunction with the known low storage capacity of the Omaka Aquifer.

Strategic aquifer management should plan for a series of droughts in successive summer seasons last seen in the hydrologic record in the early to mid 1930s, which would compound the sluggish recharge process with use not being replaced each spring or winter.

Summary

Wairau Plain groundwater resources are overallocated on paper but underutilised in practice. Depending on location, anywhere between 5% and 90% of consented groundwater is not used and potentially locked up which is inefficient.

In practice, when averaged across all aquifers, consent holders can only access 50% of the allocated water before there will be adverse effects on the environment. In the case of the Wairau Aquifer as new allocations continue to be granted by MDC, the reliability of existing water permits is being eroded as more water is allocated from a finite resource.

If more intensive landuses replaced significant areas of vineyard in the future, irrigation demand would increase by 5 times in real terms. Even high yielding systems such as the Wairau Aquifer could not sustain these levels of pumping and there would be adverse effects on spring flows in particular.

Because groundwater is hidden, knowledge accumulates slowly and accompanies its development. Just like the rest of New Zealand groundwater management in Marlborough has followed an adaptive management approach and will continue to do so by following the science.

The limits of a newly exploited aquifer are never known up front. Interim limits were set in the District Plan in the mid 1990s for some resources where information existed, or where there were significant risks from over pumping.

Significantly more is now known about groundwater resources in Marlborough than when the first generation water plan was written 1995. In the mean time aquifer safe yields have been refined and in most cases allocations have been revised downwards.

Most Marlborough aquifers currently have no plan limits because either the hydrological science wasn't adequate at the time the plan was written, or controls weren't considered necessary because of high rainfall or low anticipated demand.

Knowledge of the balance between inputs and pumping takes time and is an iterative process. Major advances do occur during droughts which stress the system, but these are rare events. In the case of the Southern Valleys Aquifers, more water was allocated than was reliably available and this was highlighted by the experiences of the 2000/01 drought.

Alternative approaches such as using models to forecast aquifer behaviour have been used by MDC for setting limits, but to be precise they require levels of water use information that is not yet available in Marlborough.

Interim allocation limits have been proposed in this report for all of the major aquifer systems. The aim of these safe yields is to provide certainty to existing and potential water users, and to protect the environment.

The criteria used for setting these limits varies from aquifer to aquifer and is tailored to meet the unique mix of issues associated with each. They potentially form the starting point for a more comprehensive allocation framework.

Two of the biggest limitations on improved understanding of underground water resources are not driving aquifers hard enough to demonstrate cause and effect, and having inadequate water use information. Water meters are necessary tools for day to day restrictions and for irrigators to plan seasonal use, but their greatest worth to MDC are for regional or catchment scale planning.

There are currently no management crises which shows that demand is generally within safe limits. Furthermore, with the exception of the Southern Valleys Aquifers or under severe drought conditions, most water users have had uninterrupted access to groundwater over the past 3 decades.

If current crop types continue to be grown and irrigated at historical rates, there should be no change in the effects generated by pumping except those associated with severe drought, long-term climate variability or sea-level rise.

Groundwater is valued in not only monetary terms. Currently there is little formal recognition of the importance of groundwater fed springs to the Wairau Plain community or fish, plants or animals that live in them.

Groundwater resources haven't been set aside for ecological purposes to the same extent as has been standard practice for Marlborough rivers. The risk is that once all the water is allocated there won't be sufficient left in the environment for springs. These uses require the most reliable groundwater which is available under all conditions.

One of the advantages of adopting minimum spring flows is that at a regional Wairau Plain scale it would also regulate rates of groundwater pumping at safe levels. There will always be local groundwater management issues, but these are easier to manage.

While there is no unique formula for setting minimum spring flows, it is recommended that MDC maintain them above the minimums experienced during the 2000/01 drought on the grounds that this is likely to be the lowest they will fall to naturally in the absence of pumping.

As a word of caution, if minimum flows were adopted by MDC along with the safe yield rates of abstraction in Figure 2, spring flows would fall to these low levels once every 5 years on average. This is more frequent than is now the case and may not be acceptable to everyone. Consultation is needed as to what is an acceptable flow.