

OMAKA RIVER CATCHMENT WATER RESOURCES TECHNICAL REPORT

Marlborough District Council – January 2008



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Executive Summary

- *This report summarises the latest information on the hydrology of the Omaka River Catchment*
- *The Omaka River Catchment forms the most western of the water short Southern Valleys suite of catchments situated south-west of Blenheim*
- *Its elongated shape straddles a range of terrain from mountainous upland to alluvial plains, and presents a unique set of water management issues*
- *Unlike catchments which terminate at the coast, it provides throughflow to recharge downstream aquifers, and influences water resources as far afield as Woodbourne*
- *The Omaka River is naturally ephemeral in its lower reaches, losing a significant proportion of its channel flow to alluvial gravel aquifers beneath the Wairau Plain*
- *The primary source of water for all uses is from underground, although a significant volume is taken from the channel under high flows to be stored in dams for summer use*
- *Groundwater resources are structurally complex. They can be split between 3 zones depending on location, and categorised as either deep or shallow.*
- *In the upper reaches an unconfined aquifer associated with Omaka River channel gravels is underlain by indeterminate deep layers. The unconfined Upper Aquifer is contained in a thin veneer of permeable gravels, has limited storage and is the main source of water for users in this area of the catchment*
- *In the middle reaches around Hawkesbury Road 2 layers exist, comprising the Upper Aquifer overlying a semi-confined Lower Aquifer. The Lower Aquifer is the most common source of water for users but is only actively recharged under higher Omaka River flows*
- *Downstream of Godfrey Road to Woodbourne, the 2 layers converge into a single, medium depth aquifer layer*
- *Across all areas aquifer yield is generally low for deeper layers and variable for the shallow layer associated with the river, depending on flow*
- *All layers primarily rely on recharge from the Omaka River, although the lower reaches near Woodbourne receive a component of Wairau River seepage. Rainfall recharge occurs across the aquifer area, although it is a smaller component than river seepage*
- *A high proportion of the median catchment flow is allocated for out of stream use, mainly for vineyard irrigation*
- *While water is most commonly sourced from underground, it is effectively river water with the catchment being managed as a surface water resource for all intents and purposes during the critical summer period*

- *A review of observed river flow record shows the initial 1994 predictions of flow overestimated the amount of catchment water available for out of stream use, and this has implications for the future reliability of resource consents*
- *The mean annual flow of the Omaka River from late 1993 to 2007 was 1,013 litres per second, however since 2001, mean annual flows have averaged 757 litres per second. It is uncertain whether this represents a long-term trend or a shorter term climatic cycle*
- *The reduction in mean flow is most likely caused by a combination of climate factors and changes in vegetation, although further work is needed to determine the relative contributions*
- *Catchment flow is predicted to be affected by less rainfall from 2050 based on NIWA model predictions*
- *This report can be used as a technical resource in the review of the water allocation framework. A cautious approach to any future allocation is recommended until this reassessment is completed*

1. Introduction

This is a technical report which summarises and updates the hydrological knowledge associated with the Omaka River Catchment. It includes information relating to climate, landforms, geology, surface and groundwater hydrology. It is intended to provide general information to a wide audience.

It is essentially a review of community knowledge and conceptual understanding of the water resources based on the past 13 years of flow record, rainfall observations and targeted studies. It updates the initial series of water resources publications produced by Marlborough District Council and its consultants in 1994. This material formed the basis for much of the existing water management policy and rules in the Proposed Wairau Awatere Resource Management Plan (PWARMPP).

This report identifies water management issues, but its role is not to recommend options or specify courses of action. Rather, its aim was to provide technical support for the process of reviewing the freshwater components of the Proposed Wairau Awatere Resource Management Plan (PWARMPP), for the Council and public alike.

This report has been peer reviewed by staff at the Christchurch office of Pattle Delamore Partners Ltd, who provided the initial hydrogeological advice to Council in 1994. Also by Water Matters Ltd, a Wellington based consulting company with previous experience working in the field of Marlborough hydrogeology.

2. Background

The Omaka River Catchment is located to the south-west of the town of Blenheim. Figure 1 is a plan view showing land surface relief in which the catchment boundary and zone of influence are marked by a yellow line. The Omaka River rises in the mountains and flows out via terraced river valleys onto alluvial plain. It is unique for overlapping the water short Southern Valleys Catchments in the south and the relatively water abundant Wairau Aquifer in its northern reaches.

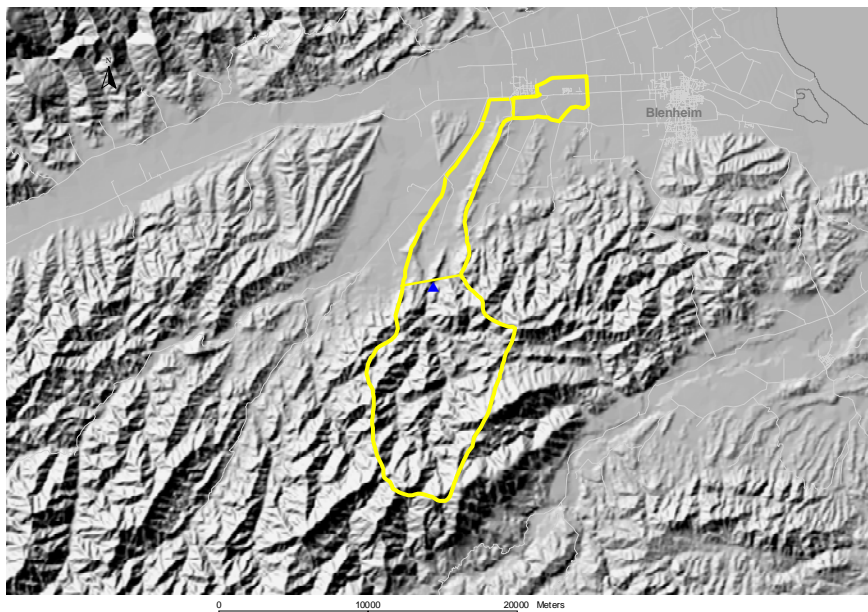


Figure 1 : Catchment Boundary & Topography

This dichotomy between the water resources of the northern and southern Wairau Plain is illustrated by the contrast in aquifer productivity in Figure 2. Higher well yields in blue or green are associated with the more northern area near the Wairau River, with lower yielding Southern Valleys Aquifers or catchments shaded red or brown. Woodbourne in between is often referred to as no-mans-land.

Various names have been used to describe local groundwater resources which can cause confusion. To distinguish it from the Omaka Aquifer in the neighbouring Hawkesbury Valley, the groundwater system associated with the Omaka River has historically been known as the Omaka River Valley Aquifer. This in turn is made up of 2 broad layers.

In this report the shallow, unconfined aquifer will be referred to as the Upper Aquifer; while the lower semi-confined or confined aquifer will be referred to as the Lower Aquifer. These names are synonymous with the shallow aquifer layer and the deep aquifer layer referred to in external publications.

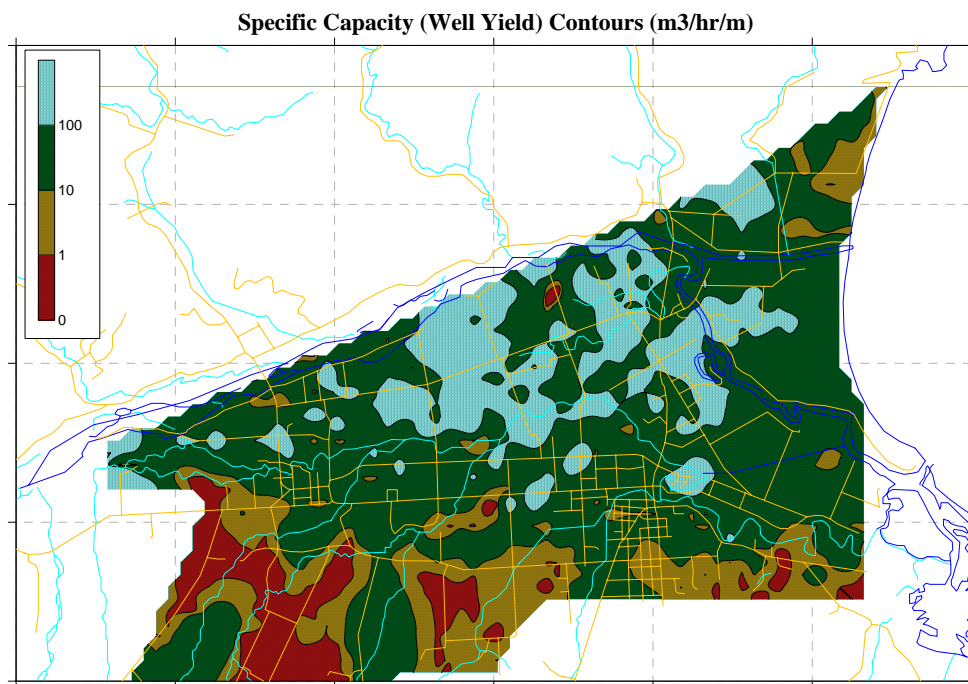


Figure 2 : Wairau Plain Aquifer Productivity

3. Water Management Issues

It is fair to say the Southern Valleys catchments including as far north as Woodbourne, have been a focus of Wairau Plain water management activities since the 1970s in terms of resource consent hearings, water resource investigations and public interest.

The Omaka River is a special case within the Southern Valleys catchment suite due to its potential to generate both local water resource issues within its catchment boundaries, and influence downstream areas like Woodbourne. A frequently used analogy is that of water flowing through a leaky pipe, with downstream users being relatively disadvantaged compared to those upstream, closer to the source of recharge.

An historical issue for Omaka River irrigators since the 1970s has been the difficulty in accessing groundwater from the alluvium for crop irrigation. Marlborough District Council staff attributed this

to a combination of the inefficiency of older wells and the thin nature of the upper aquifer, which limits yield. To most irrigators this is a paradox with regulators describing a relatively abundant water resource which isn't manifested in terms of well productivity.

While stock water use has declined since the late 1980s following the replacement of pastoral holdings with vineyard, there has also been a corresponding increase in demand for domestic water associated with land subdivision throughout the Southern Valleys catchments.

A common pattern is to establish vineyard on the flats or gentle slopes, subdivision of uneconomic pastoral units into residential size lots on spurs, and plantation forestry at higher altitudes or on steeper country. A 2005 review by Marlborough District Council showed the potential exists for domestic water use to rival that of crop irrigation if the full extent of subdivision allowed as controlled activities in the PWARMP were exercised (MDC – 2005).

This water resource has in the past been managed as a river with allocation tied to summer low flows at Tyntesfield Gorge. This was considered a conservative approach at the time, reflecting the limited aquifer storage. In 1994 an initial assessment of water resources by Marlborough District Council was used to set allocation limits based on the annual low flow supplemented by some groundwater storage. In the absence of flow records, an estimate of low flow was made in conjunction with model simulations of the quantum of groundwater.

In numerical terms this consisted of an estimated mean annual Omaka River low flow of 140 litres per second, plus 30 litres per second of groundwater storage, giving a total of 170 litres per second. This was specified as the Omaka River Valley Aquifer allocation limit in the Proposed Wairau Awatere Resource Management Plan (PWARMP).

Once this initial unrestricted allocation block was taken up through the consent process in 1999, further permits were granted allowing harvesting of higher flows. However these flow dependant allocation provisions have yet to be formalised in the district plan.

Flow data collected since late 1993 show the mean annual low flow expected each year is actually slightly lower at 108 litres per second. With the benefit of these measurements, less water than first thought is available for allocation.

Another issue that has also only recently been identified is the decline in mean river flow observed since the late 1990s. Because this is measured upstream of abstractors, it is either a reflection of less rainfall or changes in catchment runoff characteristics, but more record is needed to confirm the causes.

Long-term, less rainfall is likely based on predictions by the National Institute of Water and Atmospheric Science (NIWA). NIWA (2005) predict that between 2030 and 2070, severe droughts will become twice as frequent and the Omaka River will be one of the worst affected catchments. Not only is less rainfall likely to fall, the pattern of river flow is likely to become more variable, which may impact on aquifer recharge processes.

4. Physical Catchment Description

Together with the Fairhall River, Taylor River and Ward/Mill Stream; the Omaka River drains the so called Southern Valleys suite of catchments. A series of aquifer systems also exist within these catchments and rely on river flow for recharge. Water in river channels and aquifers flows northwards, forming part of the larger Wairau Catchment; however there is no direct connection with the Wairau River for much of the year.

Figure 3 is a plan view showing the Omaka River is the western most of the Southern Valley catchments. Rivers are represented by the light blue lines, with the catchment outline in grey and roads in orange. The Omaka Catchment covers an area of 90 square kilometres upstream of the Tyntesfield Gorge, marked by the triangle symbol.

What distinguishes the Omaka River Catchment from its neighbours is its sinuous shape. Consequently activities in the upper reaches can potentially affect downstream water users as far away as Woodbourne or Old Renwick Road. As the river is well to the south of the Richmond Ranges it is less affected by north-west rain than say the Waihopai Catchment. Nonetheless it is prone to heavy north-west rain in part of its catchment area, particularly the western tributary, the Dillon River (MDC -1993).

Although the Omaka River is a Southern Valley catchment, it is situated over 20 kilometres from the coast and as such isn't exposed to the south-easterly weather which brings most of the rainfall to these catchments. (MDC – 1993). In hydrological terms therefore the Omaka River catchment is likely to exhibit a mix of rainfall responses, reflecting some influences from both the north-east and southerly quarters. In other words it is likely to respond in a manner which is related to but not necessarily the same as both the Waihopai and Taylor Rivers (MDC -1993).

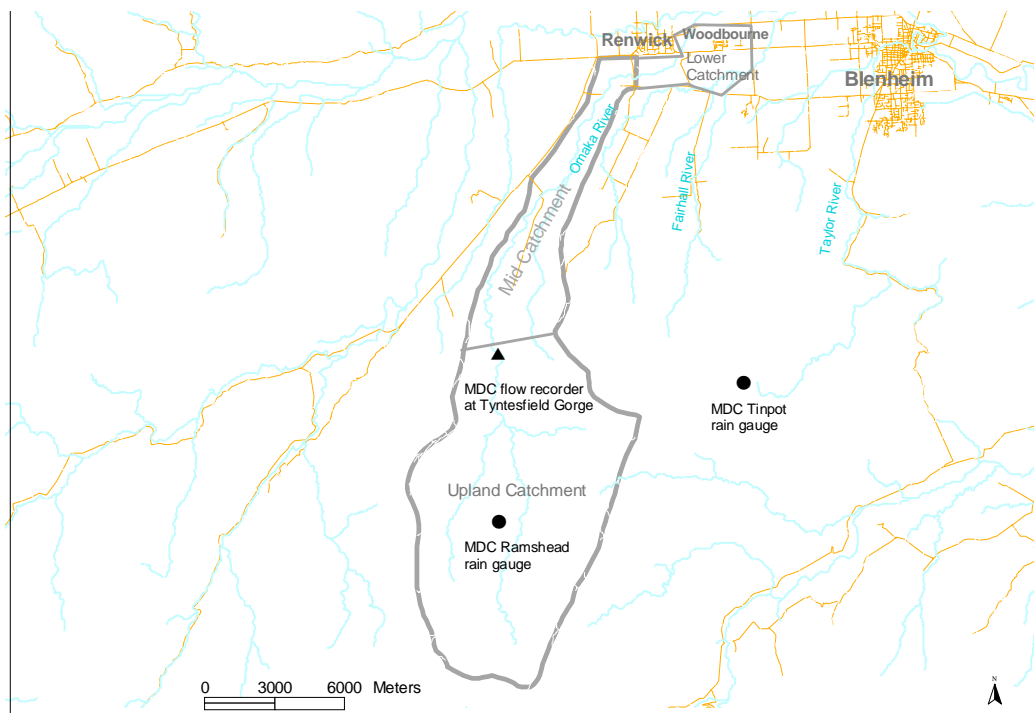


Figure 3 : Omaka River Catchment

Figure 3 splits the Omaka River Catchment into 3 reaches based on a combination of factors including landform, slope, altitude and channel type. This classification reflects the south to north transition from bedrock ranges to alluvial river terraces, and finally an extensive gravel fan deposit that extends as far north as Woodbourne. They will be referred to as the upper, middle and lower reaches heading downstream.

The upper reach represents the primary rainfall catchment area where the majority of runoff is generated. Perennial Omaka River flows only occur in this upper reach of the catchment where the channel is formed of outcropping basement rock which is considered to be impermeable.

Omaka River flow peaks at Tyntesfield Gorge. The reason for this is that downstream of this point the channel cross-section changes in profile from a narrow gorge incised in bedrock, to an alluvial river bed bounded by terraces. These riparian gravels store and release freshwater. It is for this reason that the gorge was specifically chosen by Marlborough District Council for its permanent flow recorder site in 1993. It provides an impermeable section where all catchment runoff can be observed and a summer photo of Tyntesfield Gorge appears as Figure 4.



Figure 4 : Tyntesfield Gorge looking downstream

Not surprisingly the most southerly section of the catchment receives the highest rainfall due to its aspect in relation to weather systems and elevation. These ranges back onto the Awatere Valley and reach elevations of up to 1700 metres above sea level. The primary landform is outcropping greywacke/argillite basement rock, while the vegetation is a mixture of exotic or tussock grassland, scrub and some indigenous forest.

The middle reach is characterised by river terraces and floodplain with the channel constrained within a bed varying in width from 50 to 800 metres. Figure 5 is an oblique aerial view looking north-eastward towards Tyntesfield Road and the Omaka River. The lower plot is a precis showing the main Hawkesbury ridge to the east, a wide flood plain, terraces and a narrow active river channel in the distant tree line.

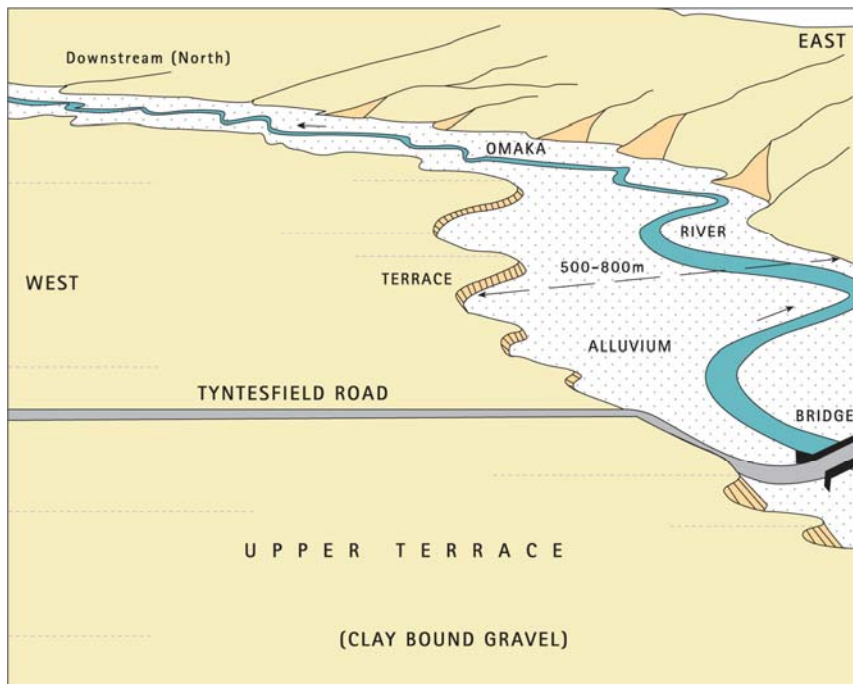


Figure 5 : Aerial & Conceptual Views of Middle Reach

The most northerly section, downstream of Lake Timara/Hawkesbury Road is characterised by a further flattening of the channel grade and the disappearance of river terraces as the Omaka Fan coalesces with the more permeable alluvium deposited by the Wairau River in the vicinity of Old Renwick Road (Figure 6).

The riparian Omaka River gravels have limited storage to buffer variations in channel flow. Because these gravel formations drain quickly, it is sensible for local water users to abstract shallow groundwater when it is available, although this ignores the regional scale picture and the dependence of downstream users.

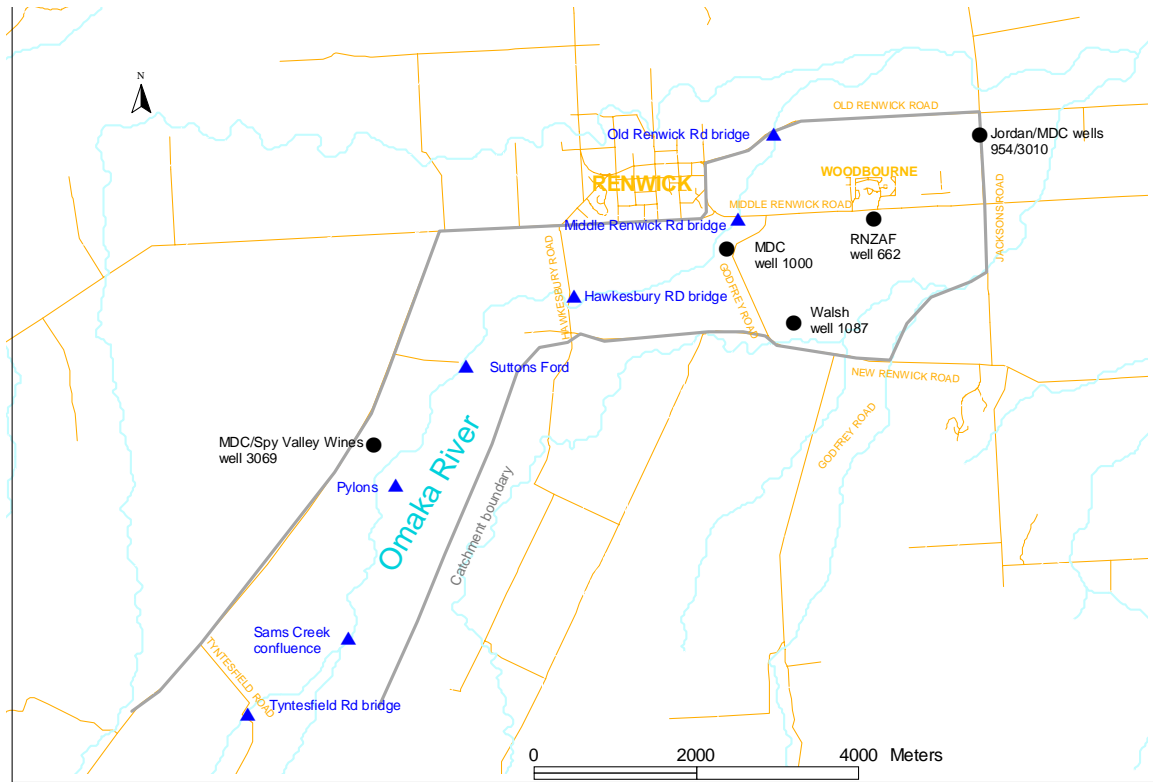


Figure 6 : Lower Catchment

This lower reach is characterised by seasonal ephemeral flow with dry river bed for a high proportion of summer. Figure 7 illustrates the changes in the sedimentary structure of the lower catchment showing surface relief in grey with known faults in red. The dominant land use along the terraces in the middle and throughout the lower section is now vineyard with the exception of the airport and RNZAF Base Woodbourne. Of the faults marked red in Figure 7, only the Wairau Fault (Alpine Fault) is considered active. The Wairau Plain is formed of glacial outwash gravels.

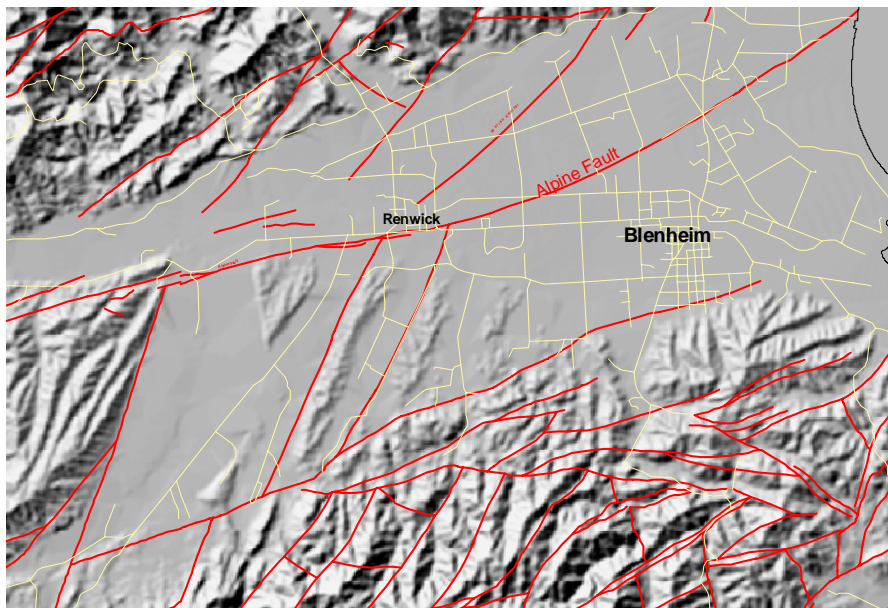


Figure 7 : Catchment Structure

Figure 8 shows a typical stretch of the Omaka River channel in its lower reaches. The so-called wetting front can be seen in the foreground signifying the point at which channel flow disappears into the gravels and becomes groundwater. The point at which this occurs varies seasonally depending on river flow; extending further downstream in winter or spring, and receding in summer or autumn. This pattern is the reverse of that observed for Wairau Plain aquifer fed springs, which increase in flow with increasing distance downstream.



Figure 8 : Lower Reach Channel (November 2006)

The transition from bedrock to alluvium as you move downstream is accompanied by a flattening of the channel grade from around 10 metres per kilometre at Tyntesfield Gorge, to 7 metres per kilometre below Suttons Ford; and around 3 metres per kilometre near Renwick. This is illustrated in Figure 9 by the long section along the Omaka River channel from Tyntesfield Gorge to Jacksons Road.

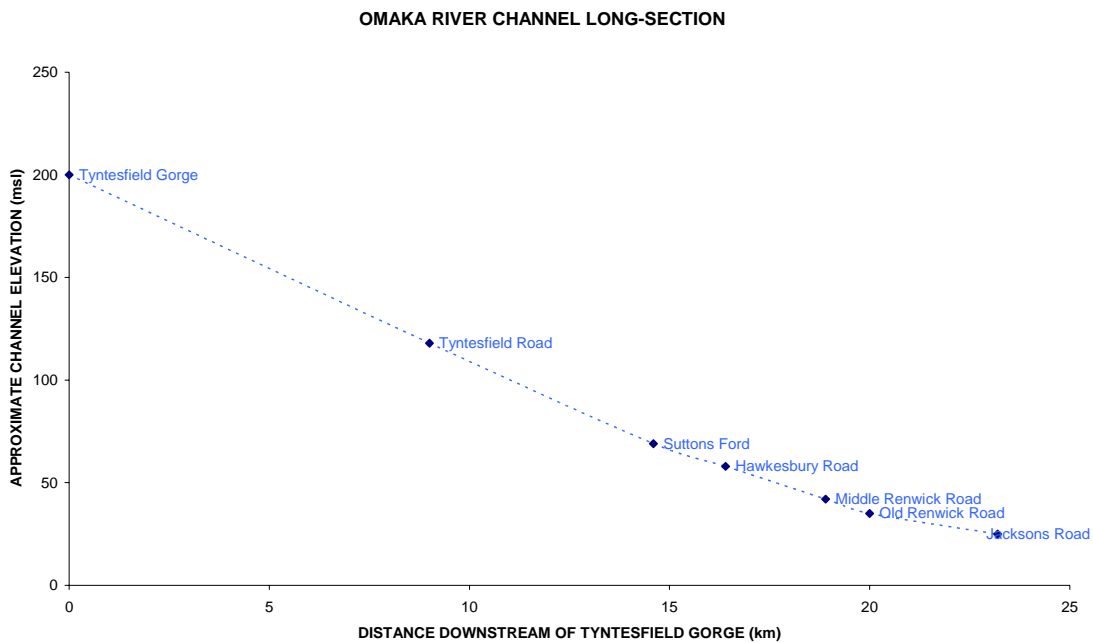


Figure 9 : Omaka River Long Section

Figure 9 illustrates the steepness of the fan deposits emerging from the Southern Valleys catchments. As a consequence water drains more rapidly than would otherwise be the case on the Wairau Plain proper.



Figure 10 : Omaka River at Tyntesfield Road Looking Downstream (June 2006)

Figures 10 to 13 are a series of photos showing the nature of the Omaka River channel and its surroundings at key points from Tyntesfield Road downstream to Old Renwick Road, near the confluence with Gibson Creek when the combined flow becomes the Opawa River system.



Figure 11 : Omaka River Above Hawkesbury Road (June 2006)



Figure 12 : Omaka River Looking Downstream Towards Middle Renwick Road (June 2006)



Figure 13: Omaka River at Old Renwick Road Ford Looking Upstream (June 2006)

5. Omaka River Channel Flow Characteristics

The Omaka River is similar in many respects to the neighbouring Fairhall and Taylor Rivers in that it flows intermittently in its lower reaches and its influence on aquifers to the north is difficult to define. Figure 14 shows the variation in flow along the Omaka River channel for 4 sets of simultaneous gauging surveys from the early 1980s. The key point to note is that channel flow declines with distance downstream from Tynesfield Gorge as water infiltrates into the alluvium. The point of zero flow oscillates between Old Renwick Road and Tynesfield Road, although most frequently it occurs between Hawkesbury and Middle Renwick Road bridges.

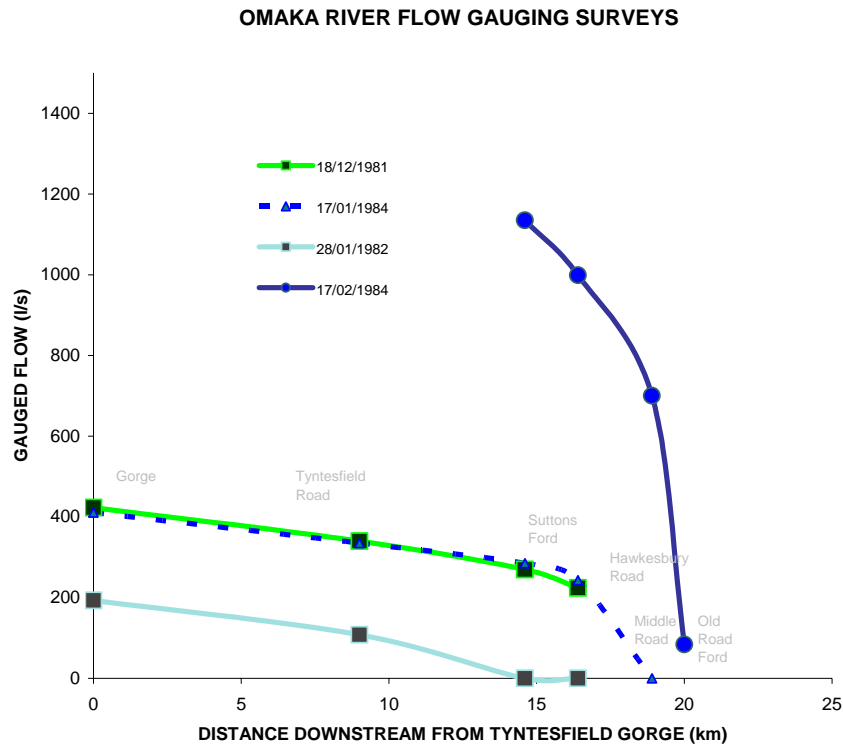


Figure 14 : Omaka River Flow Loss Profile

Flow losses occur all along the river downstream of Tynesfield Gorge, but are largest per unit length of channel downstream of Hawkesbury Road bridge. While a component may remain as underflow, moving beneath the channel, most measured losses represent a permanent seepage to shallow or deep groundwater. This water ultimately flows eastward through Woodbourne towards the coast.

Explanations for the high seepage losses in these lower reaches include a thickening of the alluvium and the presence of more permeable material, although faulting may also be a contributing factor. From late spring onwards all river flow is generally lost to groundwater.

For the 11 month period from November 2006, Marlborough District Council staff surveyed the extent of the Omaka River channel flow downstream of Tynesfield Gorge or its so-called wetted front, at weekly intervals. This information was needed to define the reliability of water permits with flow dependant conditions and to provide an insight into the link between river flow and aquifer response.

Figure 15 shows the cumulative percentage frequency distribution for these observations split between 5 critical reaches. Because the wetted front is not stationary, these discrete observations only approximate the proportion of time the channel is flowing beyond that point. Figure 15 shows that during this period channel flow always extended beyond Suttons Ford and reached the Hawkesbury Road bridge 80% of the time. Flow occurred at Old Renwick Road Ford for only 12% of the time. It is more meaningful to note that flow reached Old Renwick Road on 6 occasions during the 11 month survey. Observations were made during a relatively dry period in terms of rainfall.

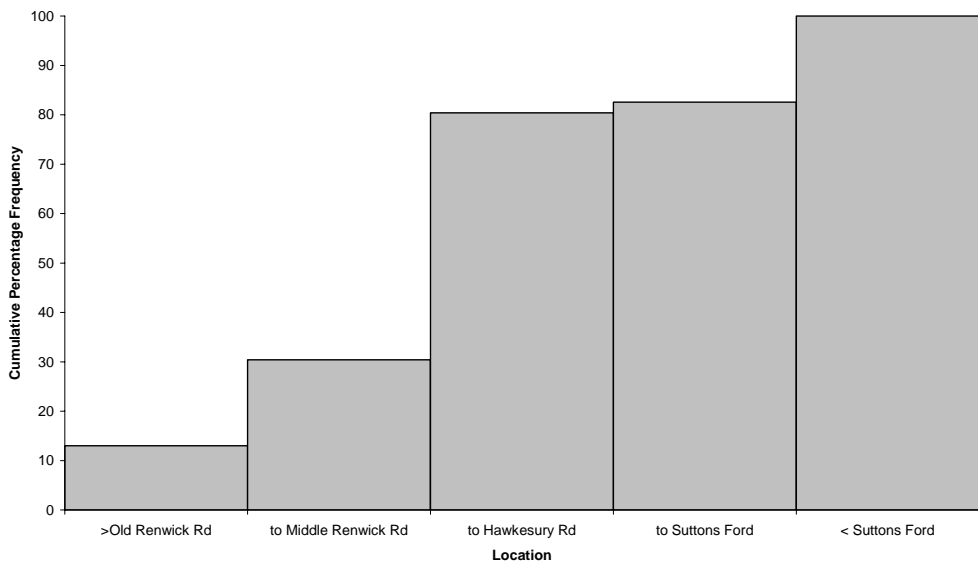


Figure 15 : Wetted Front Frequency Distribution

6. Geology & Aquifer Properties

Aquifer properties and structure vary depending on location within the catchment. To a large extent this reflects changes in geology between the upper, middle and lower catchment reaches. While three main aquifer groupings have been recognised and will be described separately, in general aquifers can be categorised depending on depth as either shallow or deep. Underground water in the middle reaches of the catchment will be discussed first.

Figure 16 is a west to east section through the Omaka River Valley at Spy Valley Wines representing the geological sequence. The unconfined aquifer associated with channel flow or the so-called Upper Aquifer, is shown by the speckled white pattern representing the youngest and most permeable sediments. They are restricted to near the current river channel and are known as riparian gravels.

They are underlain by the Speargrass Formation which are clay bound gravels hosting the so-called Lower Aquifer, marked yellow in Figure 16. The permeability of the material hosting the Upper Aquifer is higher because these gravels have been reworked by fluvial action. The straw shaped objects represent wells with their associated groundwater level marked in blue.

The discontinuity in well water levels in Figure 16 is symptomatic of the multiple layers forming the aquifer with the biggest anomaly being associated with deep well 2449. This indicates a downward flow gradient which is consistent with the observed river flow losses. Locations of the wells used to draw the section are shown in Figure 17.

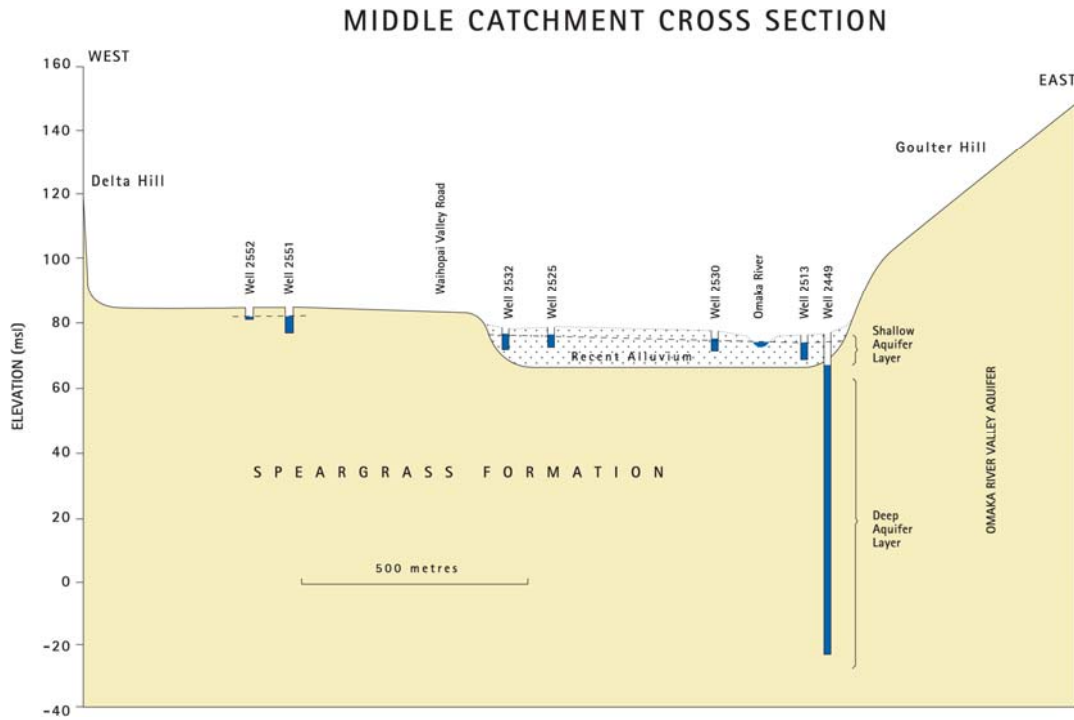


Figure 16 : Geological Section

It is apparent from the records of well 2449 and others, that deeper water bearing layers exist however they don't appear to occur in a single discrete layer. Collectively they are referred to as the Lower Aquifer layer although their occurrence tends to be unpredictable.

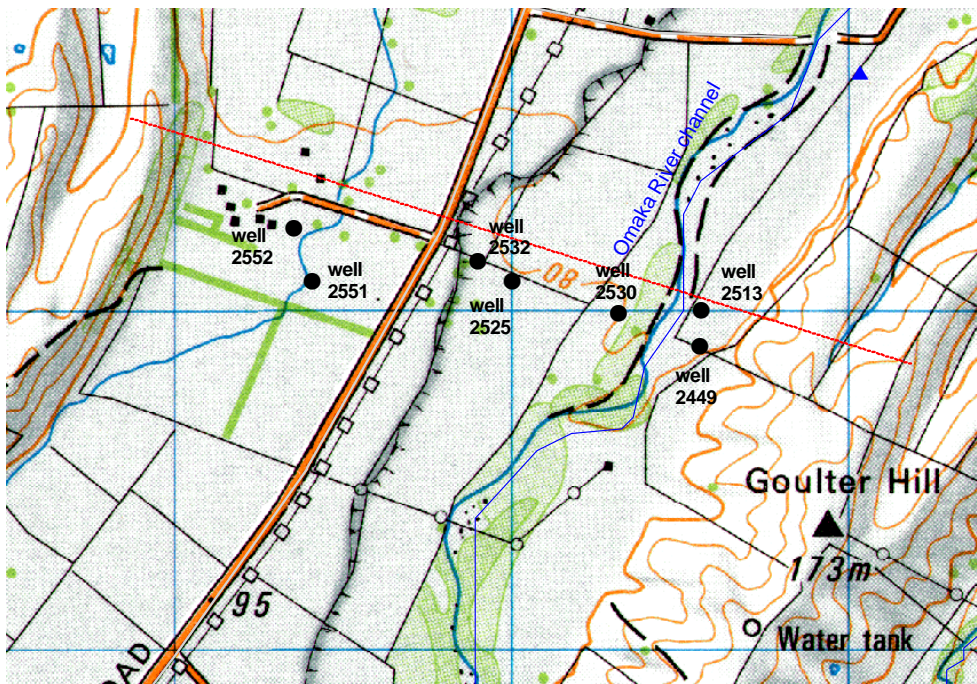
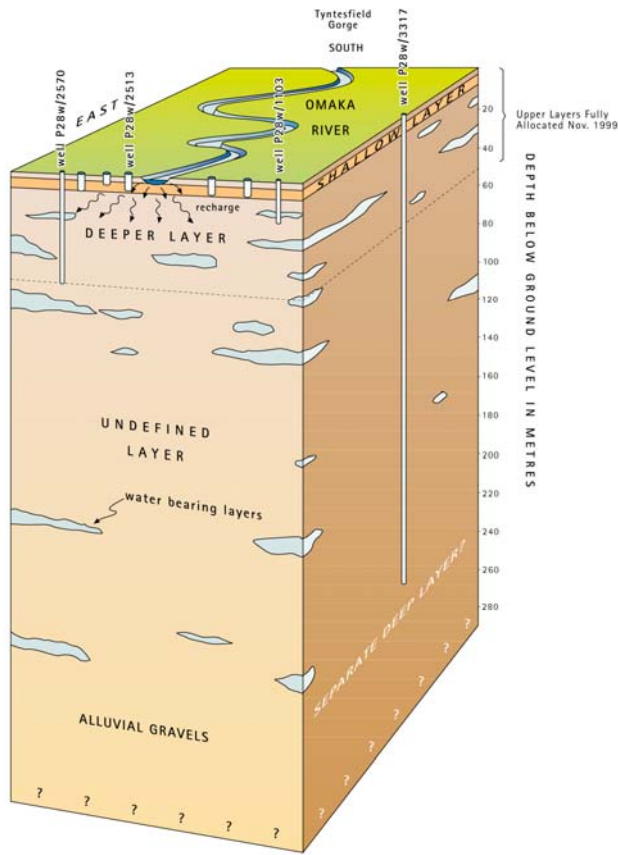


Figure 17 : Cross Section Site Locations

Well productivity is lower than for the Upper Aquifer due to its relative isolation from the Omaka River which provides recharge. These concepts are illustrated in Figure 18 showing an idealised slice through the Omaka River Valley Aquifer in the middle reaches, corresponding with Figure 16.

The grey lenses represent localised aquifers within the orange coloured clay-bound material. This is a simplified picture of a complex system where the extent and degree of river recharge will vary seasonally depending on Omaka River conditions. As a consequence most water is sourced from the Upper Aquifer for all purposes.



OMAKA RIVER VALLEY AQUIFER

Figure 18 : Conceptual Aquifer Model For Middle Reach of Catchment

The sediments forming the Hawkesbury ridgeline to the east of the Omaka River are older and less permeable than the Speargrass Formation material shaded orange in Figure 18. All sediments have originated through glacial processes at the head of the Wairau Valley, and have subsequently been re-deposited by rivers.

The thin veneer of permeable material forming the Omaka River bed represents fluviially reworked Speargrass Formation gravels containing less fine grained material in their matrix. The Upper Aquifer is bounded by terraces at the surface, and at depth by the lower permeability Speargrass Formation sediments.

The water table of the unconfined Upper Aquifer varies in response to fluctuations in Omaka River stage. This in turn determines the saturated thickness of the aquifer and its ability to transmit water otherwise known as transmissivity. Transmissivity values range from about 5 to 2,500 m²/day, depending on the permeability of the strata and its saturated thickness; which fluctuates seasonally. Multiple wells are commonly required by large vineyards to produce the volumes of water required due to the limited available drawdown associated with the upper layer. Values of storage coefficient for the Upper Aquifer range from 0.08 to 0.1, although these results are based on a limited number of

tests. While these channel gravels have good storage characteristics, their limited extent and steep grade restrict their usefulness as water reservoirs over any extended period without regular recharge.

The hydraulic properties of the deeper aquifer layers aren't as well understood as fewer wells and test measurements exist. Two examples involving comprehensive testing and analysis are presented in more detail in the following section. The first involves the testing of well 1263 at Godfrey Road during May 1983, which was preceded by a geophysical survey. Well 1263 taps water bearing layers screened at depths of 22.5 to 24 metres and from 32 to 35 metres.

The test report (Groundwater Consultants N.Z. Ltd – 1983) described the source of groundwater tapped by well 1263 as a leaky channel type aquifer with a transmissivity of 260 to 530 m²/day. As no drawdown effects were observed at neighbouring wells, storativity was estimated at 0.01 or 1%. The transmissivity value is likely to be significantly lower in late summer due to lower groundwater levels.

The second documented test involves well 2577 located near Suttons Ford and screened from a depth of 18 to 62 metres below the surface. However the main water bearing material occurred at 17 and 35 metres depth. A transmissivity value of 22 m³/day per metre width of aquifer was measured in May 1994 using a step drawdown test procedure.

Due to having the same parent material, it is fair to assume these deeper layers behave in a similar manner to the Southern Valleys aquifers, which have been extensively studied. These systems have measured transmissivity values ranging from 5 to 500 m³/day per metre width of aquifer, with storativities of the order of 0.0001. These transmissivity values are consistent with estimates based on the specific capacity of wells in the Lower Aquifer.

7. Aquifer & River Interaction

In its mid to lower reaches around Hawkesbury Road, the Omaka River Valley Aquifer consists of 2 layers. This is an area of high reliance on groundwater which has been studied in detail. The Upper Aquifer associated with the Omaka River overlies a series of dispersed water bearing lenses collectively known as the Lower Aquifer.

The two layers merge together into a deeper layer at the lower end of the catchment around Woodbourne, reflecting changes in geology which will be described in more detail in the following section. The Omaka River is the driving force, providing recharge water to both aquifer layers, and in its absence no economically useful aquifers would probably exist.

The Upper Aquifer is around 10 metres thick and relies on direct recharge from Omaka River channel flow losses. It is underlain by the Lower Aquifer which is tapped by wells of about 30 metres in depth, and physically separated from the shallow aquifer by aquitards.

Of key interest from a water management perspective is the degree of hydraulic interaction between the Omaka River and the Lower Aquifer. While it is relatively easy to track gains or losses in Omaka River channel flow with gaugings, the fate of water once it becomes groundwater is more difficult to track. Surveys of groundwater levels have proved useful in delineating the flow path in some areas, but there are insufficient wells representing deeper aquifer layers.

The key conclusion from the research conducted in this catchment since the early 1980s is that Omaka River flow is central to all water resources management issues within the catchment. Not only to maintain surface flow requirements, but also to recharge groundwater. However recharge of the Lower Aquifer is an indirect process with river losses having to traverse the intermediary gravels

separating the 2 layers. The leakage rate through this aquitard depends on the degree of saturation, which in turn depends on river channel flow.

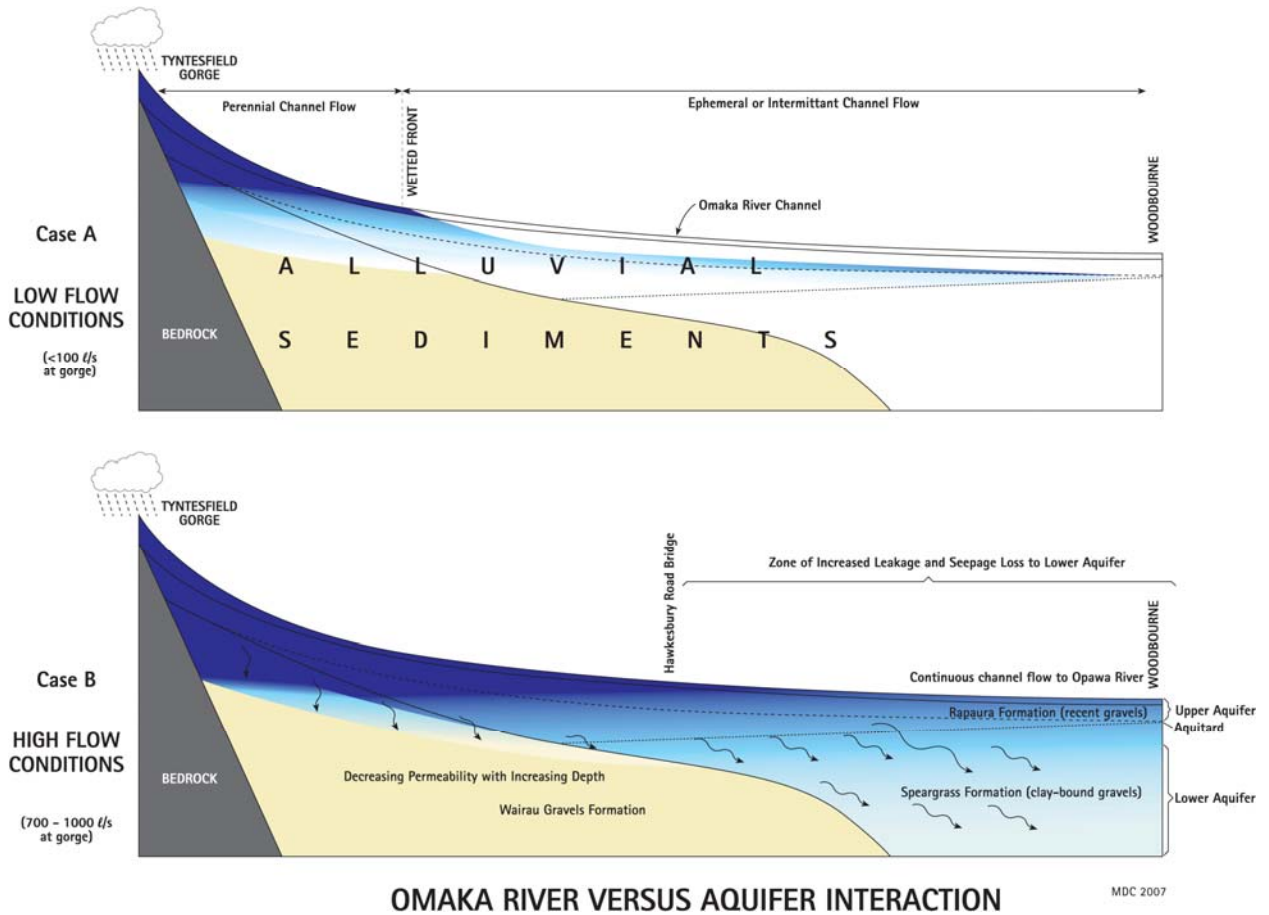


Figure 19 : Omaka River and Aquifer Interaction

The mechanism is summarised in the 1994 PDP report commissioned by Marlborough District Council: “The river seepage into the deeper layer depends on how far down the valley the river flow extends. When the river flow is high, it extends far enough down the valley to enter a zone of increased seepage into the deeper layer and maintain high groundwater pressures. When the river flow is low the surface flow doesn’t extend far enough down the valley to reach the zone of increased seepage loss and the deeper aquifer water levels decline. Furthermore, within the zone of increased river seepage the vertical conductance out of the river bed will be greatest during periods of high river flow, but will reduce during periods of low river flow. This will likely be due to changes in the wetted perimeter of the river bed for varying flows in this stretch of intermittent surface flow”. The deeper aquifer referred to in this excerpt is known as the Lower Aquifer in this report.

This is illustrated conceptually by the longitudinal section in Figure 19 along the Omaka River channel south from the ranges to Woodbourne. The blue shading represents the movement of water along the river channel or underground. Some features of the aquifer conceptual model such as the aquitard may in reality reflect greater heterogeneity with depth, rather than a discrete feature.

From Godfrey Road through to Woodbourne the 2 aquifer layers coalesce to become a single, deeper aquifer. This reflects a thickening of the gravel fan deposited by the Omaka River which hosts the aquifer, and a pinching out of the aquitard (Figure 19). This explains both the seasonal loss of channel flow and the rapid drainage of deeper wells at Woodbourne over summer.

These geological changes are illustrated by Figure 20, which is an extract from the publication entitled: Water and Soil Water Resources of the Wairau, Volume 2. It shows geological units based on drilling records with wells represented by the black vertical lines.

The cross-section represents a line north from Benmorven, to near the Wairau River. The Speargrass Formation shown in orange represents the Omaka River Fan which corresponds with the white shaded region in Figure 19. All the formations shown in Figure 20 represent alluvial deposits whose permeability decreases with depth. For example the Wairau Gravels Formation is the least transmissive unit for groundwater to transit.

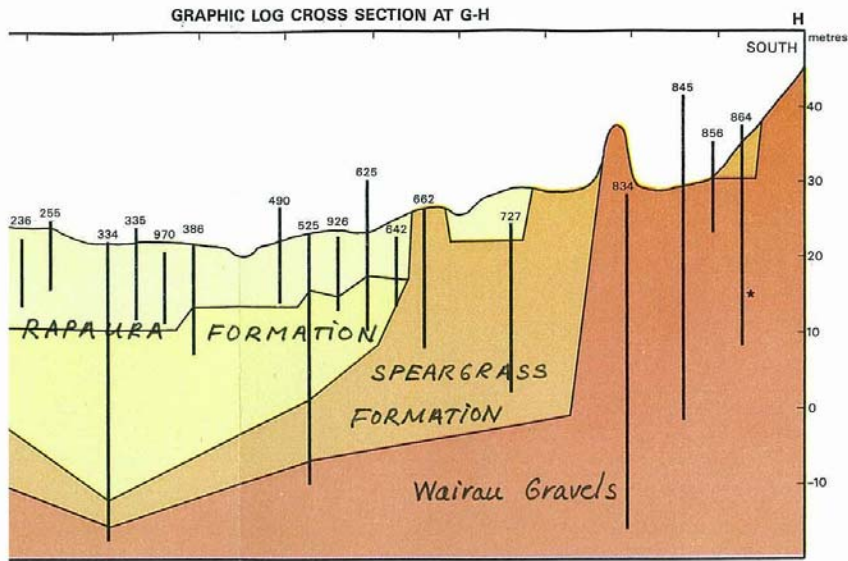


Figure 20 : Omaka River and Aquifer Interaction

Returning to the mechanics of interlayer groundwater flow, Figure 21 is an oblique section through the Omaka River channel in the Hawkesbury Road area showing the likely change in downward seepage under low flows (A) and for higher flow conditions (B).

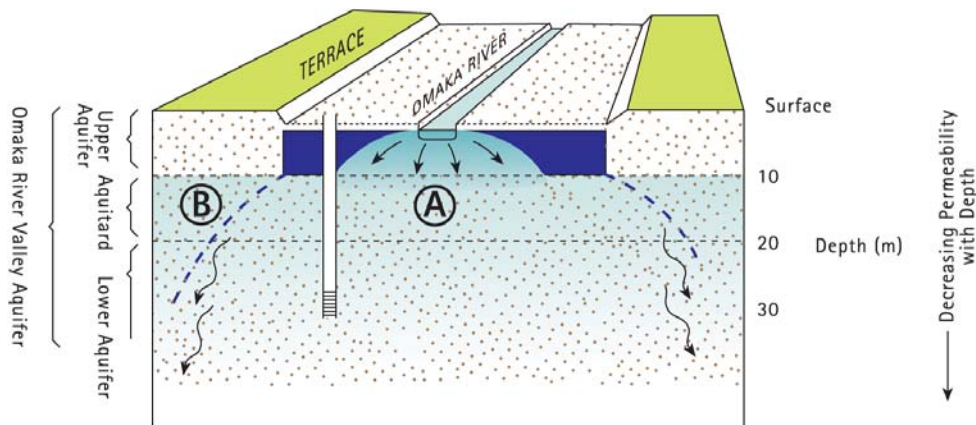
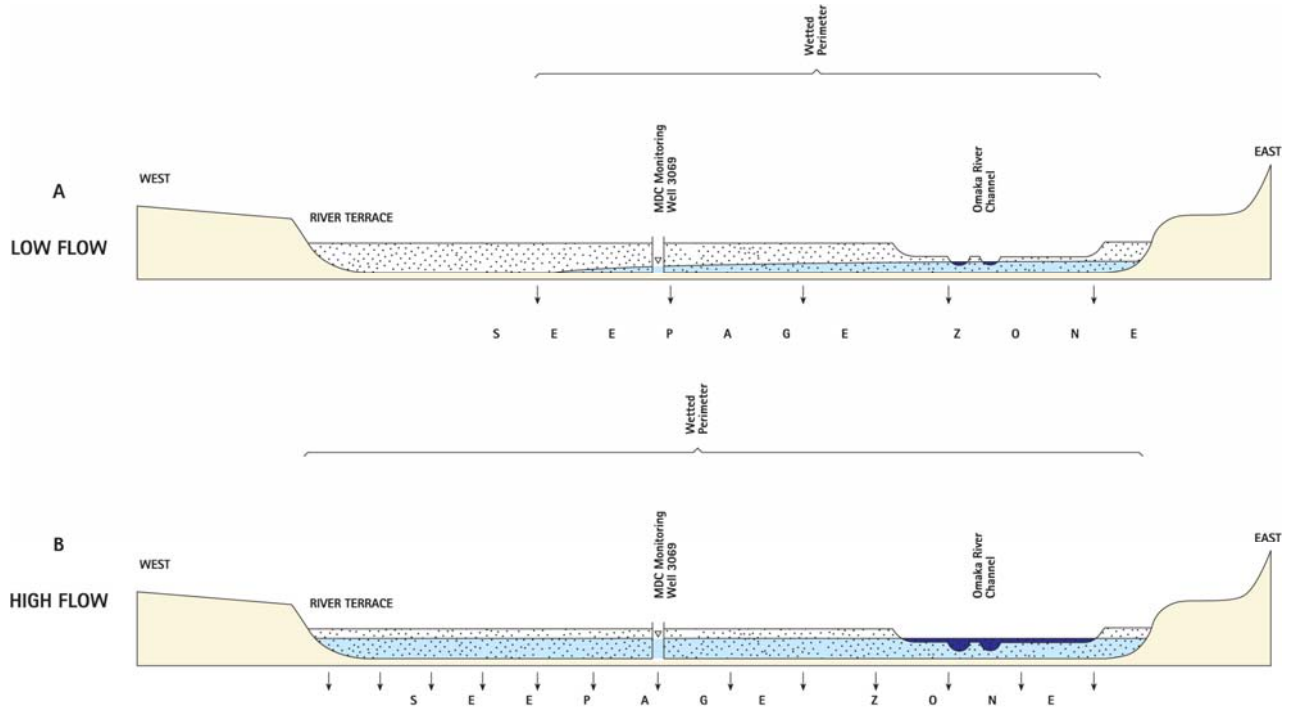


Figure 21 : Aquifer Recharge Model

Interlayer seepage is also likely to be a function of the wetted channel area or perimeter as illustrated in Figure 22 for the same two flow conditions. While these are idealised pictures of reality, they reinforce the fundamental role of Omaka River flow in controlling aquifer status. Figure 22 represents a section through the middle catchment reaches. The channel gravels hosting the Upper Aquifer are represented by the speckled white pattern and bounded by the terraces made up of the less permeable Speargrass Formation gravels.



OMAKA RIVER WETTED PERIMETER VERSUS SEEPAGE RATE

MDC 2007

Figure 22 : Sensitivity of Seepage to Wetted Perimeter

Most importantly this recharge mechanism also explains the characteristically large seasonal variation in well levels experienced at Woodbourne wells of up to 10 metres. Fluctuations of this magnitude don't occur in the Upper Aquifer and reflect the reduction in summer recharge, while drainage rates remain static.

This is a natural process associated with recession of the Omaka River channel southwards over summer as rainfall declines. It is reasonable to assume the majority of the 10 metre fluctuation in Lower Aquifer level at Woodbourne reflects natural variation in Omaka River flow, rather than man-made abstractions.

Even with the benefit of river flow and well records dating from 1993, it remains unclear as to which flow regime or antecedent aquifer state provide the optimum recharge conditions for the Lower Aquifer. This is best illustrated by plotting pairs of groundwater elevation versus Omaka River flow at Tyntesfield Gorge using mean weekly values to allow for the time lag in the process (Figure 23).

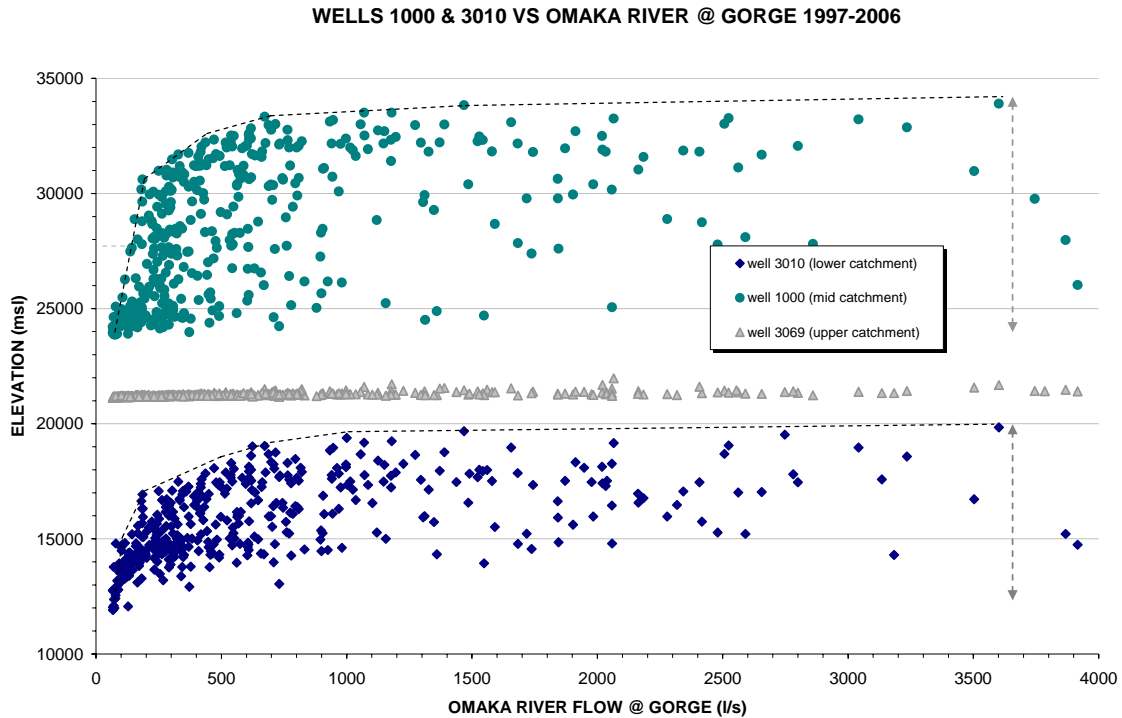


Figure 23 : Aquifer Water Level Variation versus Omaka Flow

Figure 23 shows the variation in weekly level at 3 Marlborough District Council Omaka River Aquifer monitoring wells versus the weekly mean Omaka River flow at Tyntesfield Gorge. Sites include well 1000 representing the Lower Aquifer at Godfrey Road, well 3010 representing the intermediate area bounding the Wairau Aquifer north of Woodbourne in Jacksons Road; and well 3069 at Spy Valley Wines representing the Upper Aquifer in the middle reaches.

The grey triangles representing the Upper Aquifer show little change in aquifer level over time because this site is adjacent to the zone of perennial flow in the Omaka River, whereas there is a large seasonal change at well 1000 in particular, and to a lesser extent at well 3010.

The small variation in well 3069 level reflects the stabilising influence of channel flow. With the exception of flood flows, river channel elevation is reasonably constant and shallow well levels rise and fall in response to fluctuations in river stage. Well 3069 elevations have been reduced by 60 metres to fit on the same vertical scale as the other 2 sites in Figure 23. The smaller variation in groundwater level at well 3010 near Woodbourne can be attributed to its more northerly location, and the stabilising influence of Wairau River recharge in summer.

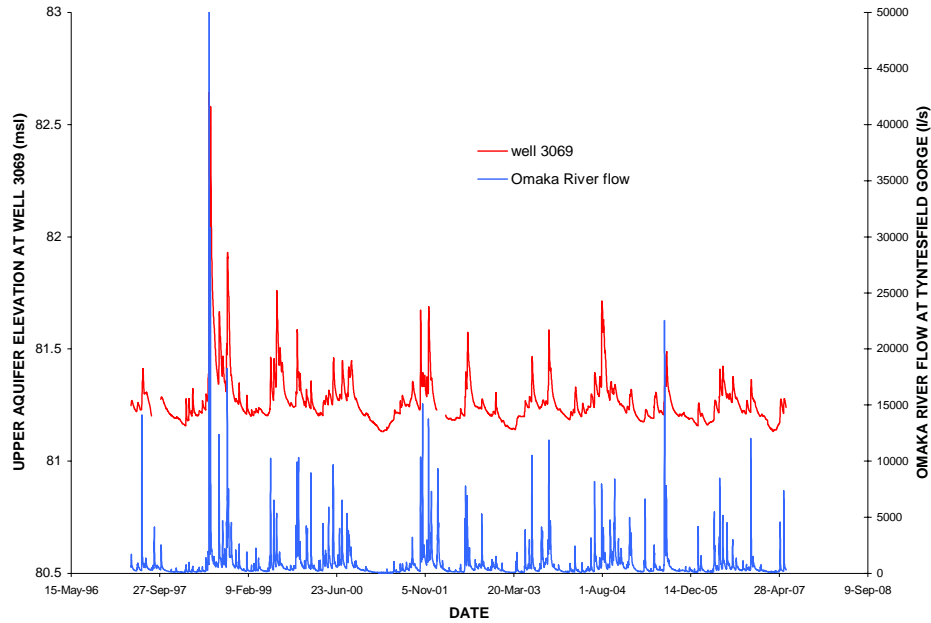


Figure 24 : Omaka River Flow versus Upper Aquifer Level

This moderating influence is illustrated in Figure 24 showing how closely well 3069 level in red mimics Omaka River flow at the Gorge in blue. Generally there is always channel flow opposite this monitoring well or subsurface flow to maintain Upper Aquifer levels.

Conversely the Lower Aquifer is at best only indirectly linked to channel flow and is far less sensitive to changes in river regime, especially under late summer or drought conditions when it becomes isolated from surface processes. An intermediate range in aquifer level at well 3010 can be explained by the buffering effect of groundwater flow originating from the Wairau Aquifer in late summer, when contributions from the Southern Valleys Catchments are limited. This emphasises the regional nature of the Wairau Plain water resource and its blend of recharge influences.

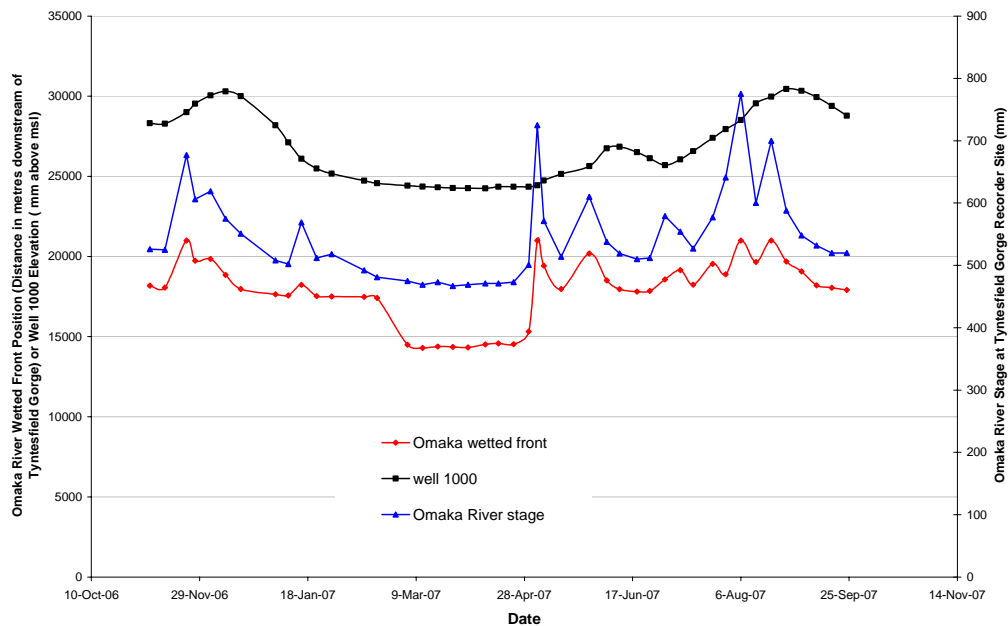


Figure 25 : Well Level versus Omaka River Stage and Channel Extent

While no easily definable relationship exists between Lower Aquifer levels and river flow or stage, there is a close match between Omaka River stage at Tyntesfield Gorge and channel extent downstream of Tyntesfield Gorge. This is based on recent surveys by Marlborough District Council staff and shows Omaka River flow dictates channel extent.

The link between these factors is illustrated by the time series in Figure 25 with the red line showing the extent of the Omaka River wetted front and Omaka River stage at Tyntesfield Gorge in blue. However there is at best a sluggish and delayed response from the Lower Aquifer shown by the black line to these river factors.

A close correlation exists between river stage and channel extent as shown by Figure 26, with 72% of the variation in the wetted front position explained by changes in stage height. Theoretically there should be two separate relationships, depending on whether the Omaka River is in recession or is advancing.

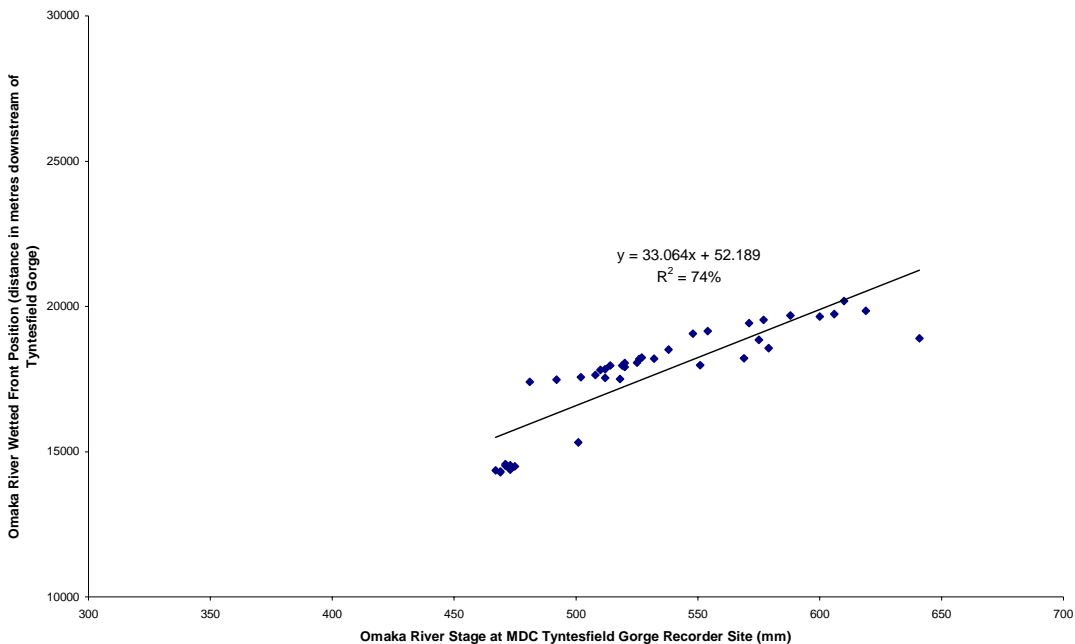


Figure 26 : Omaka River Stage versus Channel Extent

So what is the critical river flow necessary to induce deep aquifer seepage? This is important as it may be necessary to manage river flow to maintain aquifer recharge processes. While we have derived a rule of thumb, the exact relationship may never be known given the number of variables involved, the difficulty in quantifying them and the time delay. But it is likely that no direct relationship exists. A comparison of the response at well 1000 representing the Lower Aquifer to Omaka River floods also suggests the value isn't unique but varies depending on antecedent conditions.

For example, during normal winter or spring conditions when the catchment is saturated and intermediary layers are wetted up, flows in excess of 700 litres per second at Tyntesfield Gorge are sufficient to generate deep seepage. However, flows of 1,000 litres per second or more are necessary under late summer conditions when the aquitard is dry and non-conductive. Flows of this magnitude are only exceeded 20% to 30% of the time, corresponding to the frequency of the channel being fully

extended (Figure 15). Figures 27 and 28 compare the response of well 1000 to river flows at Tyntesfield Gorge for a relatively wet period represented by autumn 2006, and the tail end of the 2001 drought which was a 1 in 30 year event. The blue line shows Omaka River flow with well 1000 elevation in green.

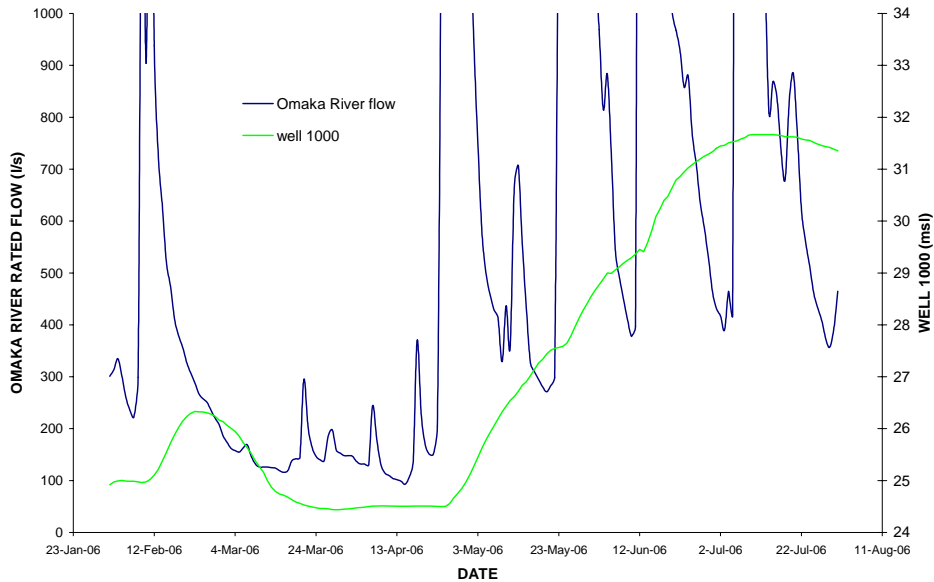


Figure 27 : Wet Autumn 2006 Response

Interestingly, even under relatively wet catchment conditions, Omaka River flows of 200 to 300 litres per second in March or April of 2006 generate no response in Lower Aquifer levels at well 1000 (Figure 27). Subsequently, a series of river flows in excess of 1000 litres per second from early May onwards resulted in Lower Aquifer storage refilling to three quarters full by July 2006.

Lower Aquifer levels had been depleted for an extended period by the end of the 2000/2001 summer irrigation season due to a combination of drought and high demand. Figure 28 shows that under these circumstances even the 1000 litres per second river flow which occurred in early May had a limited rejuvenating effect on Lower Aquifer levels. It is likely that the dry catchment conditions existing at this time soaked up any runoff. Even by August the Lower Aquifer remained in a depleted state with levels only one quarter full, relative to the fill point of around 33 metres elevation on the right hand vertical scale.

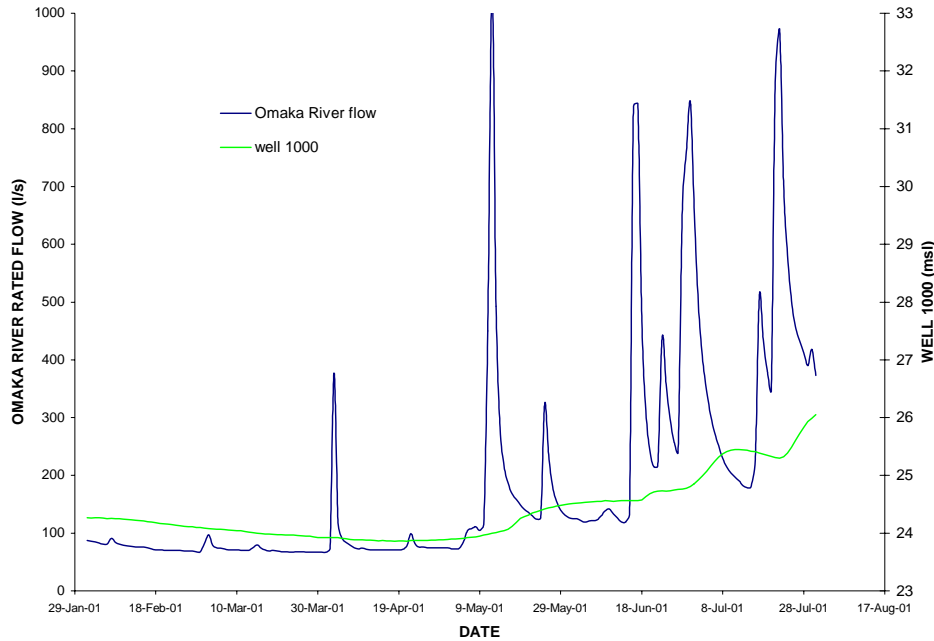


Figure 28 : Dry Autumn 2001 Response

In summary, the lynchpin or key to water resource management in this catchment is the Omaka River. Underground water resources are reliant on Omaka River flows which largely depend on high country runoff.

8. Local Versus Distal Effects

Putting aside variability in catchment yield, the key water management issues for the Omaka River catchment revolve around balancing the needs of local against distant water uses. On the one hand summer low flows provide for downstream water users, whilst winter or spring high flows drive the process of filling groundwater storage.

Because the influence of the Omaka River extends so far beyond its immediate bedrock catchment, there are longstanding environmental considerations and community needs which take priority over discretionary uses such as crop irrigation. Geographically speaking these commitments exist as far north as Old Renwick Road and east to Jacksons Road. While there are exceptions such as very longstanding local water permits, the principle of fulfilling natural downstream requirements first is a sound one.

A consequence of the ephemeral flow regime of the Omaka River is all summer flow ultimately becomes groundwater. It follows from the principle of continuity that intercepting river water will reduce throughflow in downstream aquifers by the same amount. The fundamental question to consider is the relative importance of the Omaka River in maintaining mid plains aquifers, and by implication the benefits of managing flow at Tyntesfield Gorge for downstream well users or ecosystems.

OMAKA RIVER CATCHMENT WATER BUDGET

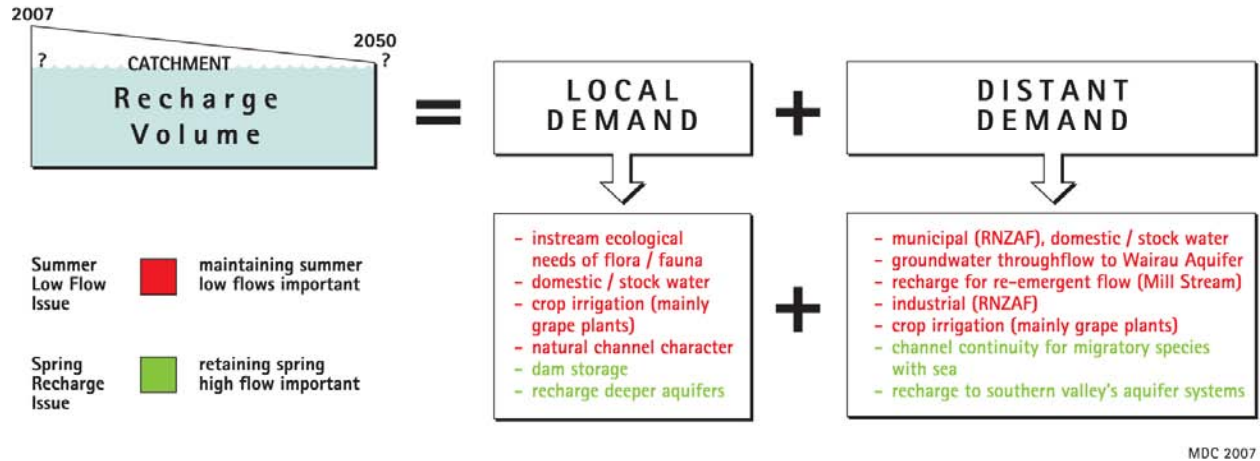


Figure 29 : Water Budget

This question is best addressed using a water balance approach. Figure 29 shows inputs as represented by Omaka River flows on the left hand side of the equation, balanced against demands on the right hand side. We now have a good understanding of the historic frequency of Omaka River flows, although there are indications this may not continue into the future. Putting that issue to one side, uncertainty remains over several of the downstream environmental components on the right hand side of the equation.

For instance how much water is needed to provide an annual connection with the sea for migratory fish species, to allow through-flow of groundwater for Woodbourne Aquifer recharge, or to sustain local ephemeral flows such as Mill Stream. Evaluating the relative importance of each component is complicated by the fact that the zone of influence of the Omaka River downstream of Hawkesbury Road bridge is not clearly defined.

Arguably the most important single downstream consumptive use is the industrial/municipal complex centred on RNZAF Base Woodbourne, which has been in existence since the start of World War 2. There are also many domestic or stock wells servicing the rural hinterland south-east of Renwick, which rely on continued recharge.

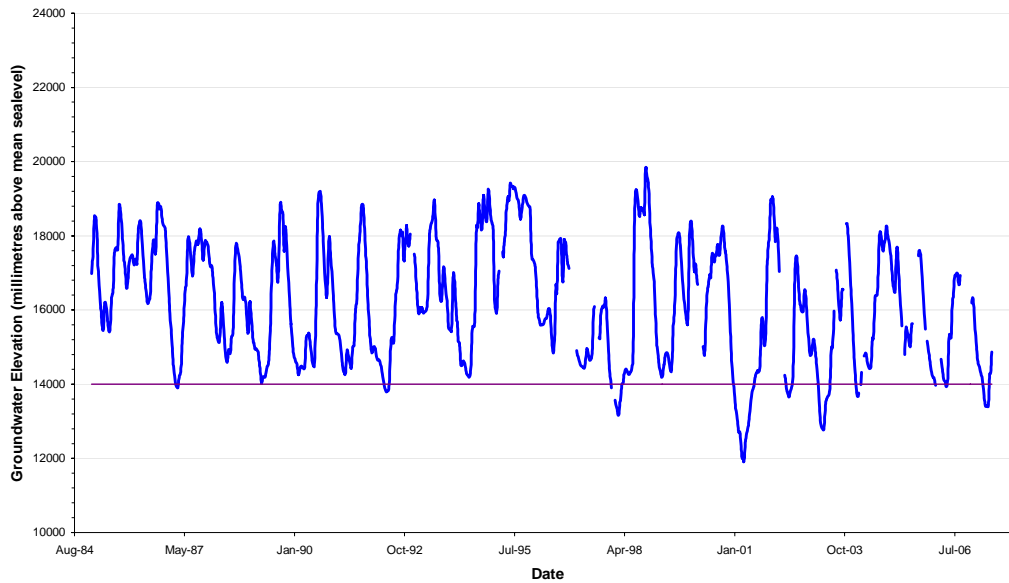


Figure 30 : Woodbourne Aquifer Time Series

Figure 30 is a time series of groundwater elevation at Woodbourne wells in Jacksons Road from 1984 to 2007 and combines record from well 594 prior to 1996, with that from well 3010 through to the present day. This series approximates the behaviour and reliability of RNZAF Base Woodbourne North well 662. The purple horizontal line corresponds to the level in the RNZAF Base Woodbourne North well 662 when it is unable to supply water.

It demonstrates the decline in reliability of well 662 over this period. While there have been interruptions in supply from at least 1982 when well 662 was deepened from its original depth of 17.5 to 24 metres, the average frequency has increased from 20% of summer seasons up to the 1997/98 drought, to 70% since this time. Figure 30 also shows the length of the time the well is inoperative has increased, although at least 2 of these occurrences coincided with severe droughts.

One of the anticipated benefits of re-watering the Gibson Creek/Opawa River system as a by-product of the Southern Valleys Irrigation Scheme was supplementing recharge to Woodbourne Aquifers. As yet the flow regime doesn't appear to be delivering significant benefits based on record from the Marlborough District Council well 3010 in Jacksons Road.

However this initiative does demonstrate the potential for recharge at Woodbourne to originate from a northerly direction, in addition to flows from the Omaka River or other Southern Valleys catchments. Inputs derived from the Wairau River are particularly important over summer when contributions from the Southern Valleys catchments are at a minimum.

While a good understanding exists of seasonal contributions from the Wairau Aquifer as opposed to Southern Valleys catchments, accounting for individual inputs from the Omaka River catchment versus the Omaka-Hawkesbury or Fairhall-Brancott Valleys is complicated by the difficulty in tracking underground flow, and remains unclear.

If we think of Woodbourne as a water convergence zone similar to a railway station with commuters arriving from all directions, how many travellers originate from the Omaka River Catchment? Based on a catchment area of 90 square kilometres, the Omaka River is likely to provide around 50%, with 30% originating from the Omaka-Hawkesbury Valley, and the remaining 20% of Woodbourne water coming from the Fairhall-Brancott Valley. This doesn't take into account the contribution from

Wairau River seepage shown in Figure 12 of the 1988 publication: Water and Soil Resources of the Wairau and Soil Resources of the Wairau, Volume 2. However the influence of this northerly recharge is probably restricted to north of Middle Renwick Road as evidenced by the large seasonal falls in well levels to the south of this location.

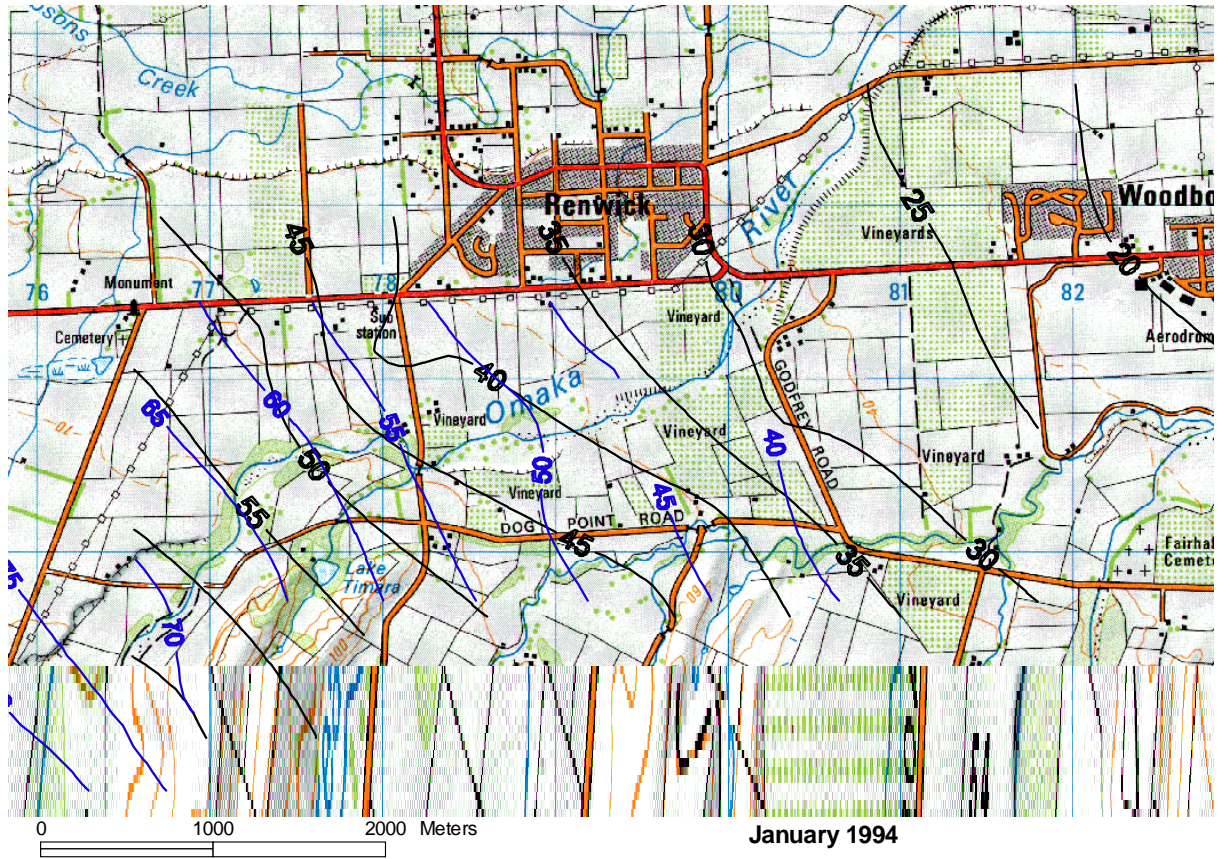


Figure 31 : Aquifer Water Table Under Wet Summer Conditions

What scientific information exists to help define the influence of Omaka River derived subterranean flow? A number of water level surveys have been carried out by the Marlborough District Council in the lower Omaka River Valley Aquifer for the purposes of mapping the groundwater table and identifying the direction of underground flow. These surveys were conducted under a range of seasonal conditions including: January 1994, April 1994, August 1994 and December 1997. Of particular interest are the January 1994 and December 1997 surveys, as they represent wet and dry summer seasons.

Figure 31 is a plan view of the lower reaches of the Omaka River Valley showing contours of Upper (shallow) and Lower (deep) Aquifer groundwater elevations in blue and black lines respectively for the January 1994 survey. The contours were derived from observations of well water levels taken on the same day and converted to elevations in metres above mean sea-level. These were relatively wet catchment conditions with higher than normal Lower Aquifer levels.

Because groundwater flow occurs at right angles to these contours, in early 1994 the direction of lateral groundwater flow was sub-parallel to the Omaka River channel and towards Woodbourne, for both aquifers. This information is also useful for mapping the influence of pumping wells and for inferring zones of greatest interaction between the aquifers. Under these conditions the elevation of groundwater in the Upper Aquifer is around 10-15 metres higher than in the Lower Aquifer at Hawkesbury Road, reducing to 5 metres near Godfrey Road. Further downstream the levels merge.

Discontinuities exist in Lower Aquifer levels as shown by the distortions in the black contours at “Substation”, as a result of well pumping. This compares with the smoother Upper Aquifer surface nearby. These are even more pronounced under the drier conditions shown in Figure 32.

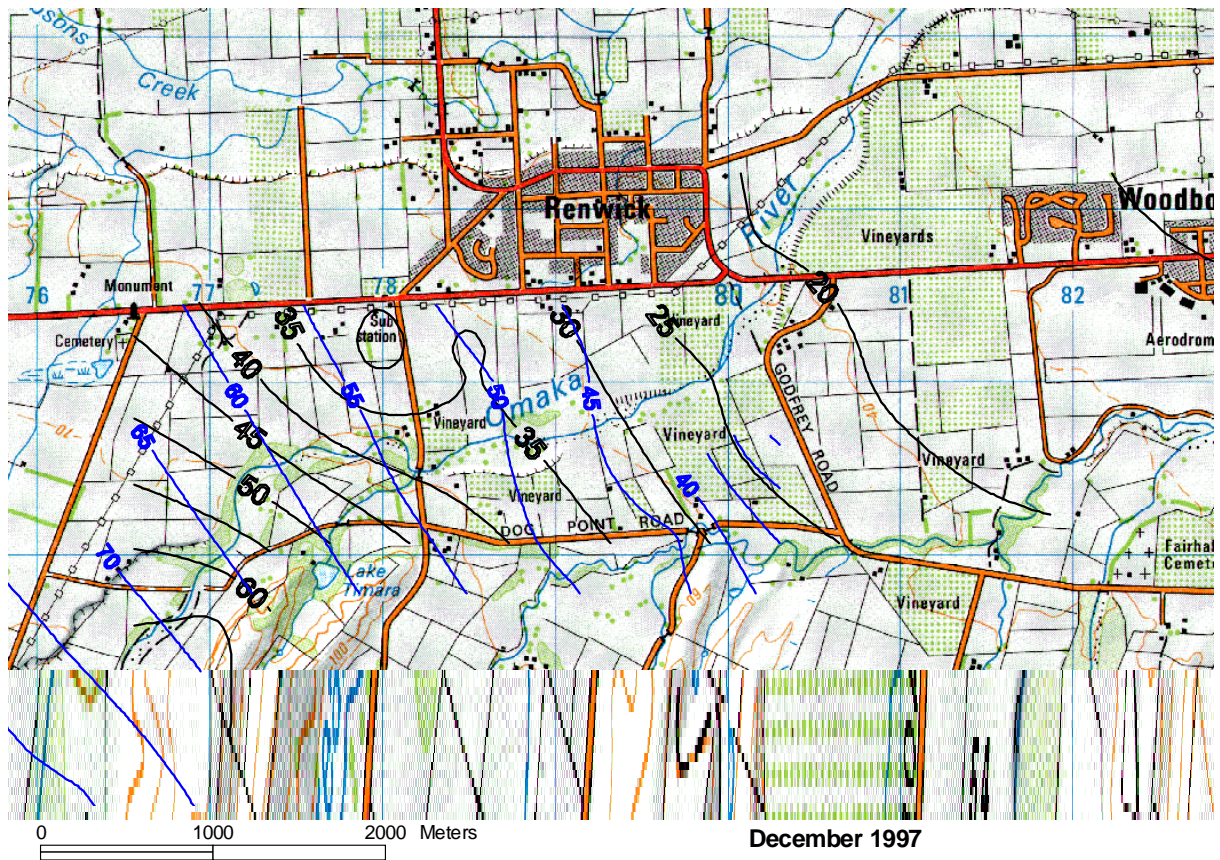


Figure 32 : Aquifer Water Table Under Dry Summer Conditions

Figure 32 shows the equivalent contour map for the dry summer conditions experienced in December 1997, which coincided with the start of the benchmark 1997/98 drought. The major difference between the 2 surveys is that Lower Aquifer levels have fallen relative to the Omaka River or Upper Aquifer, meaning a greater thickness of unsaturated material separates them. As a consequence, downwards flow is likely to slow or cease earlier, and may not occur again until the return of wetter conditions bring sufficiently high flows to reactivate Lower Aquifer recharge.

We have already seen how for perennial stretches of the Omaka River, flow moderates fluctuations in Upper Aquifer level. This pattern is confirmed by the stability of the blue contours between the 2 surveys (Figures 31 and 32). However there are significant seasonal shifts in the contours of the Lower Aquifer layer which is to be expected given the reliance on leakage from the Omaka River and lower yield meaning larger drawdown for the same abstraction rate from wells.

In addition to recharging groundwater systems in the vicinity of Woodbourne, it is possible that some Omaka River water contributes recharge sideways to the confined Brancott, Omaka and Benmorven Aquifers underlying the Southern Valleys catchments further to the east. This finding is based on stable isotopic measurements made during the 1970s and 1980s (Taylor – 1992), although the volumes involved and any relationship between river flow remains inconclusive.

9. Rainfall & Hydrological Information

The long-term mean annual rainfall at the Tinpot and Ramshead rain gauges in the upland catchment areas is 827 and 889 millimetres per year respectively. Rainfall record began at Tinpot in 1963 and at the Ramshead site in 1990. These figures compare with a long term mean annual rainfall for Blenheim of 647 millimetres. Figure 3 shows the location of the Tinpot and Ramshead rain gauge sites.

A good Omaka River flow record now exists with continuous measurements from late 1993 onwards. As mentioned earlier, the channel at Tyntesfield Gorge is formed of bedrock, meaning all runoff exiting the upper catchment area can be measured, unlike further downstream where water disperses within the alluvium. All Omaka River flows are defined in terms of this location in the catchment, although there are small contributions to the channel further downstream such as Sams Creek, but these are of little significance in the overall sense, especially during summer when they typically don't flow.

A distinctive characteristic of rivers draining the Southern Valleys catchments are large seasonal ranges in flow. While for most summer seasons the Omaka River in its lower reaches is ephemeral and typically dries up in the vicinity of the Hawkesbury Road bridge, very large flows can also be generated. For example a rated flow of around 180,000 litres per second was recorded in July 1994.

Figure 33 shows the distribution of Omaka River flows at Tyntesfield Gorge from 1993 to the start of 2007. No floods flows in excess of 50,000 litres per second have occurred since 1998. It is interesting to note a comment in the 1993 Marlborough District Council report to the effect that the planned flow recorder was intended for both flood warning and resource management purposes, although the low flow aspects have certainly had the higher profile since 1997.

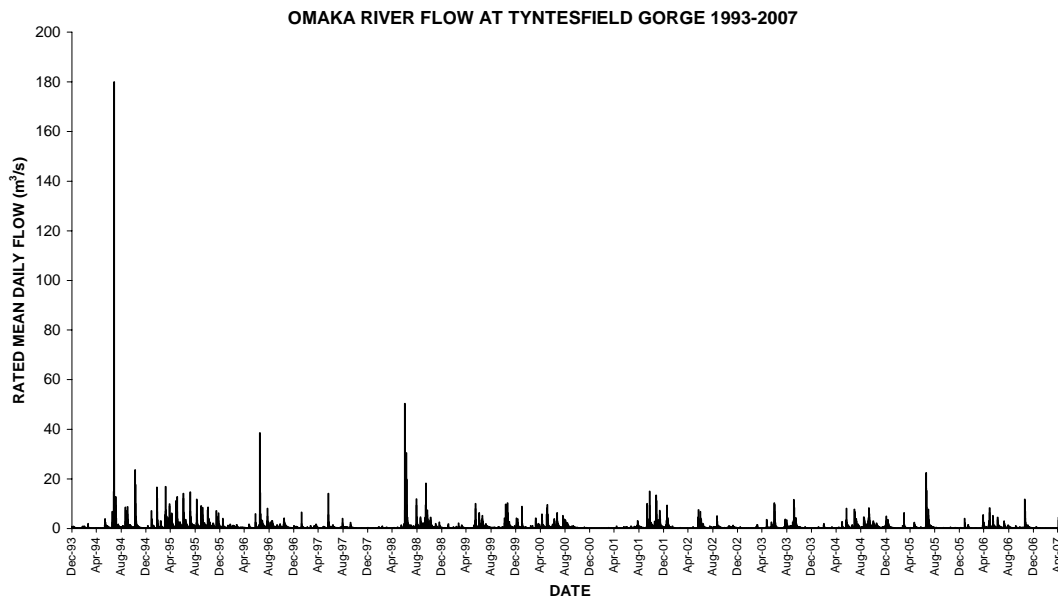


Figure 33 : Omaka River Rated Flow 1993-2007

Flow statistics for the Tyntesfield Gorge site are summarised in Table 1. They show a range of 4 orders of magnitude between the maximum rated and minimum gauged flows for the period from 1993 to 2007. The normal bias associated with flood prone, ephemeral rivers is reflected in the

disparity between the mean rated flow of 1,025 litres per second, and the median rated flow of 440 litres per second. By comparison the Wairau River at Tuamarina has a mean flow of 100 cubic metres per second versus a median flow of 60 cubic metres per second. This compares with Wairau Plain aquifer fed freshwater springs which typically have identical median and mean flows.

The lowest recorded flow of 67 litres per second occurred in March 2001 during a 1 in 30 year return period drought event. A similar flow of 86 litres per second was gauged on the 21st of February 1973 during the benchmark 1973 drought.

Statistic	All Flow Record	Flow Record for: Dec., Jan., Feb. & Mar.
	Flow at Tyntesfield Gorge (litres per second)	
Minimum gauged flows	67 (April 2001) 86 (February 1973)	-
Median flow	440	275
Mean flow	1,025	530
Flow exceeded 80% of time	200	141
Flow exceeded 90% of time	140	108
Maximum rated flow	180,454	-

Table 1 : Observed Omaka River Flow Distribution 1994-2007

For the purposes of defining Omaka River Valley allocation limits during the preparation of the Wairau-Awatere Resource Management Plan in the mid 1990s, Omaka River flow was synthesised and values of the critical low flows were calculated (Lincoln Environmental - 1994) and (Wadsworth - 1993).

Return Period	7 Day (2007 assessment) (litres/second)	7 Day 1993 MDC Predictions (litres/second)
Annual Low Flow	108	138
5 year	82	114
10 year	59	95
20 year	45	77

Table 2 : Derived Omaka River Low Flow Probabilities 1994-2007

Table 2 lists the predicted 7 day low flows based on a Gumbel low flow probability distribution and compares the 2007 values with the 1993 predicted flows. There is a small deficit of about 30 litres per second between the 1993 predicted flows on which the current allocation regime was based, and the flows derived from an analysis of subsequent observed flows. This has implications for water allocation, with less water available for allocation than was first calculated.

Assuming actual use is around 50% of the 170 litre per second unrestricted quota, Table 2 shows that even in a normal season a high proportion of the annual low flow may be used by consent holders; with all Gorge flow consumed in a 1 in 5 year drought event. However it must be remembered that the existing allocation regime differs from that operating elsewhere in Marlborough and reflects the ephemeral nature of the Omaka River with its unique issues.

10. Aquifer Level Trends

A frequently asked water management question is: “what effect does abstraction higher in the catchment have on my well?” It is an important issue and one that isn’t easy to answer, even with the wealth of aquifer level record available in 2008.

Figure 34 is a time series of aquifer level beginning in 1984 for monitoring wells 1000 in Godfrey Road (red), and composite record from wells 594 and 3010 in Jacksons Road (blue). Well 1000 represents the Lower Aquifer in the area where channel losses from the Omaka River reach their peak, while the Jackson Road well pair represent a part of the aquifer that receives recharge from a variety of sources, including the Wairau Aquifer.

The black line is the 50 day moving average which is useful for identifying short term cycles in the record such as the wet series of seasons in the mid 1990s, the 2000/01 or 1997/98 drought events; and the wet spring of 2001. These trends are apparent in both the red and blue traces, suggesting a regional scale climatic influence.

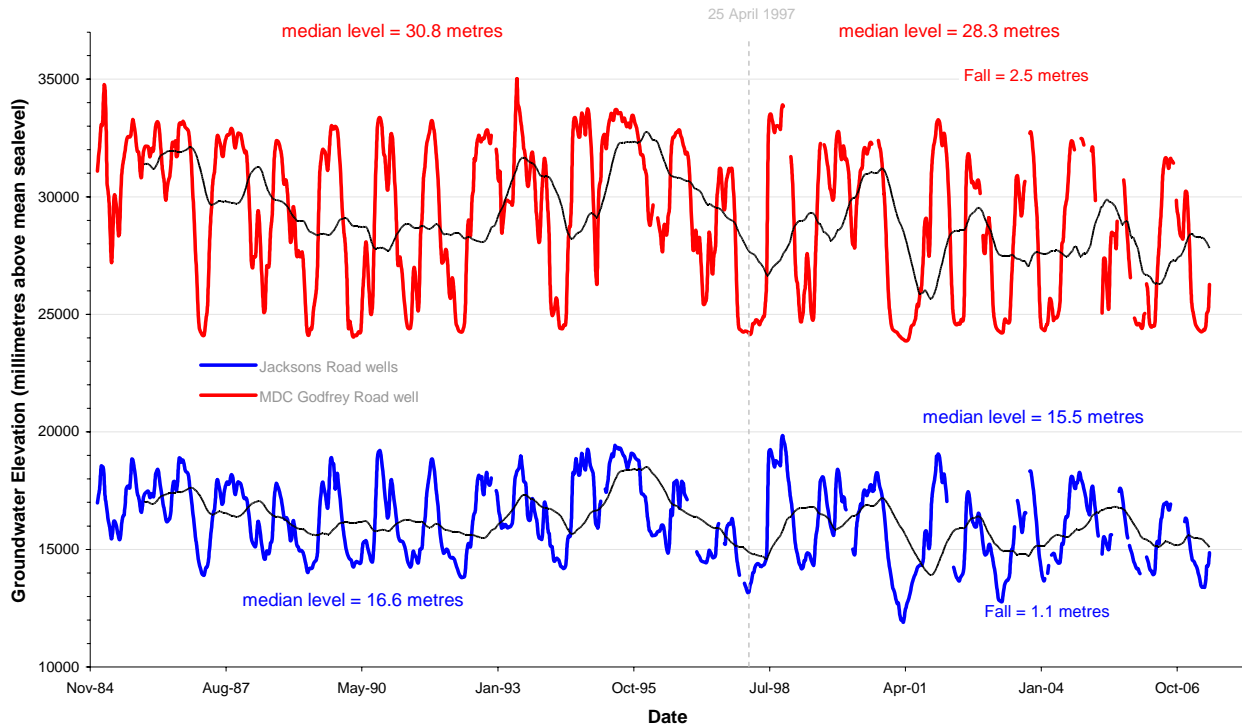


Figure 34 : Long-term Aquifer Trends

Visually speaking the blue trace representing the concatenated record from wells 594/3010 appears to show the most marked decline in aquifer level over time, especially since the late 1990s. However the statistics tell another story. The median level at well 1000 is 2.5 metres lower in 2007, compared with a fall of 1.1 metres in the median level at wells 594/3010 in Jacksons Road over the same period. The explanation lies in the fact that aquifer levels are remaining lower for longer at well 1000, especially during the 1997/98 and 2000/01 droughts.

The difference in shape of the 2 graphs is worth discussing as it provides an insight into aquifer structure and the all important recharge process. Well 1000 levels have a distinctive seasonal shape characterised by a fall in levels associated with aquifer drainage over summer, followed by a rise in levels due to aquifer recharge. The summer drainage cycle reflects disconnection of the Lower Aquifer from Omaka River channel flow, and consequently its recharge source.

This is normal behaviour for alluvial aquifers, but it is unusual that levels fluctuate within such a well defined range that never exceeds a maximum elevation of about 35 metres, nor falls below 24 metres. The consistency of the low level may reflect the presence of an impermeable layer preventing deeper drainage. Alternatively it could represent baseflow from a separate source, although it is thought unlikely that the influence of Wairau River recharge extends this far south. The rise in water level is easier to explain and indicates the Lower Aquifer is being recharged from Omaka River water with the maximum level being controlled by river stage.

This explanation is supported by the fact that a similar cycle occurs elsewhere near Woodbourne including wells: 1087 (Walsh-Woodbourne Farm) located south of the airport runway, and the RNZAF Base Woodbourne wells 661 and 662 near the water tower.

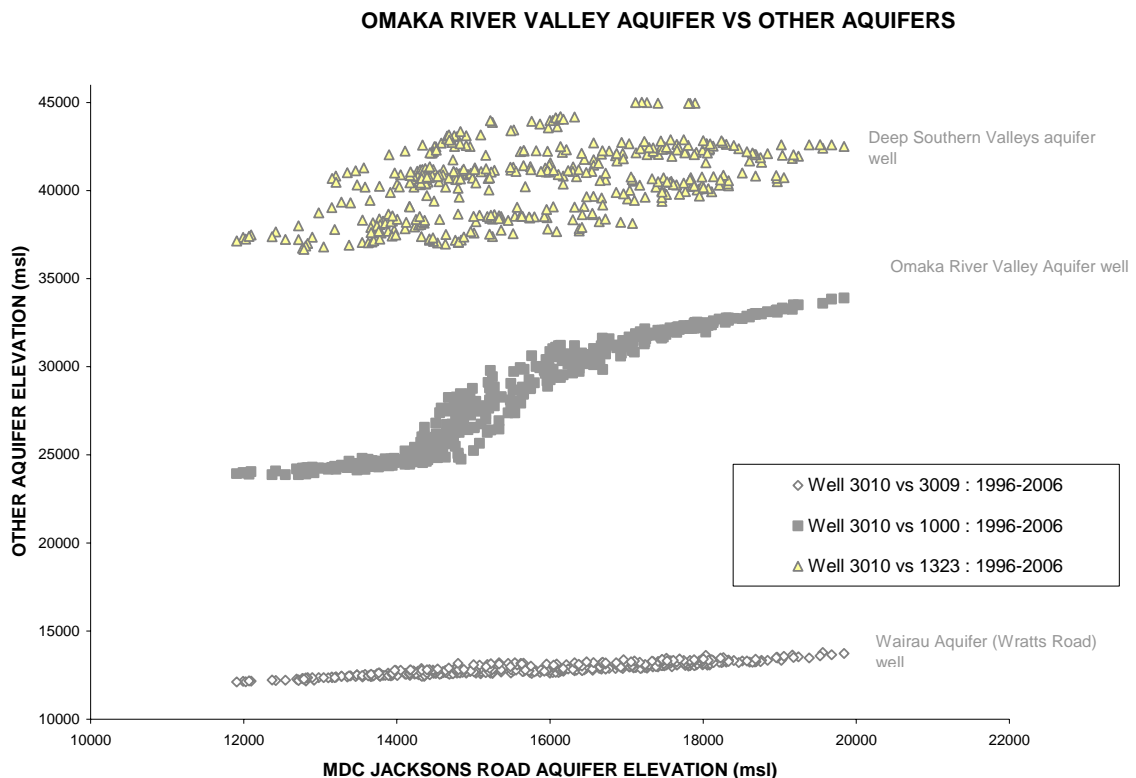


Figure 35 : Inter-aquifer Comparison

It is a useful exercise to compare well records from neighbouring aquifers to see if they display a similar pattern, or whether the cycle is unique to the Omaka River catchment. Figure 35 shows groundwater elevation at the Jackson Road well 3010 along the horizontal axis versus record from

well 1000 representing the Lower Aquifer, Wairau Aquifer well 3009 near the Wairau River and a Southern Valleys aquifer well 1323, representing the Brancott Aquifer. See Figure 6 for well locations.

The Jackson Road wells were used as the basis for the comparison due to their intermediate location between the Wairau Aquifer and Omaka River catchment. What is immediately apparent is the variation in response and large range in aquifer level compared to the 8 metre variation at Jacksons Road. The Wairau Aquifer dataset had the smallest range of 2 metres which was predictable given the influence of perennial Wairau River flows nearby. The middle dataset shows the distinctive seasonal pattern of the Lower Aquifer associated with an ephemeral river. What is interesting is the scatter of points for the Southern Valleys well. This exercise highlights the regional differences caused by structure and recharge regime.

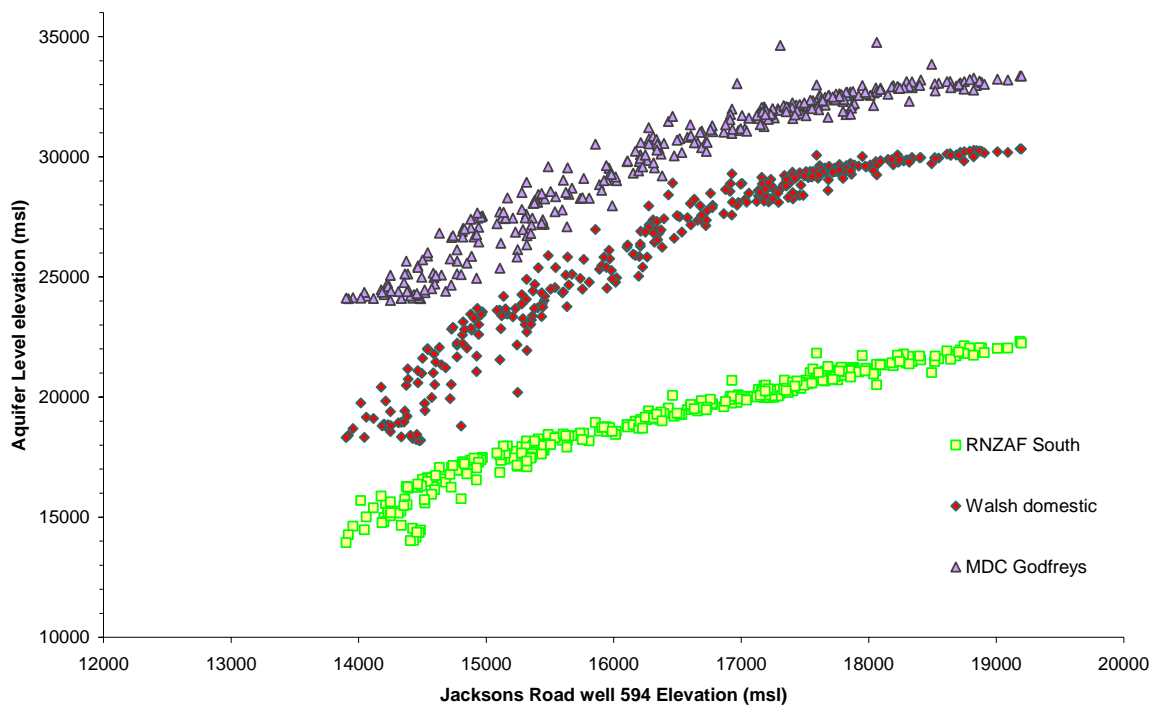


Figure 36 : Woodbourne Comparison

Figure 35 established that Lower Aquifer levels at well 1000 behave in a regionally distinctive manner, but do all wells tapping this aquifer exhibit the same pattern? To answer this question the same approach was used except that well 594 data were substituted for well 3010, representing the aquifer at Jacksons Road to allow comparison with older, historical record. The sites used for the comparison in Figure 36 were well 1000, RNZAF Base well 661 and well 1087 (Walsh domestic) all representing the Lower Aquifer.

All 3 wells show the same pattern, although there is a larger fluctuation at the Walsh domestic well due to pumping. This suggest either the low permeability layer at well 1000 is a widespread feature, or all sites are affected to the same extent by ephemeral river flows. It also suggests that an ephemeral waterway is involved in the recharge, but the proportion of Omaka River water arriving at these wells versus other Southern Valley rivers is less certain.

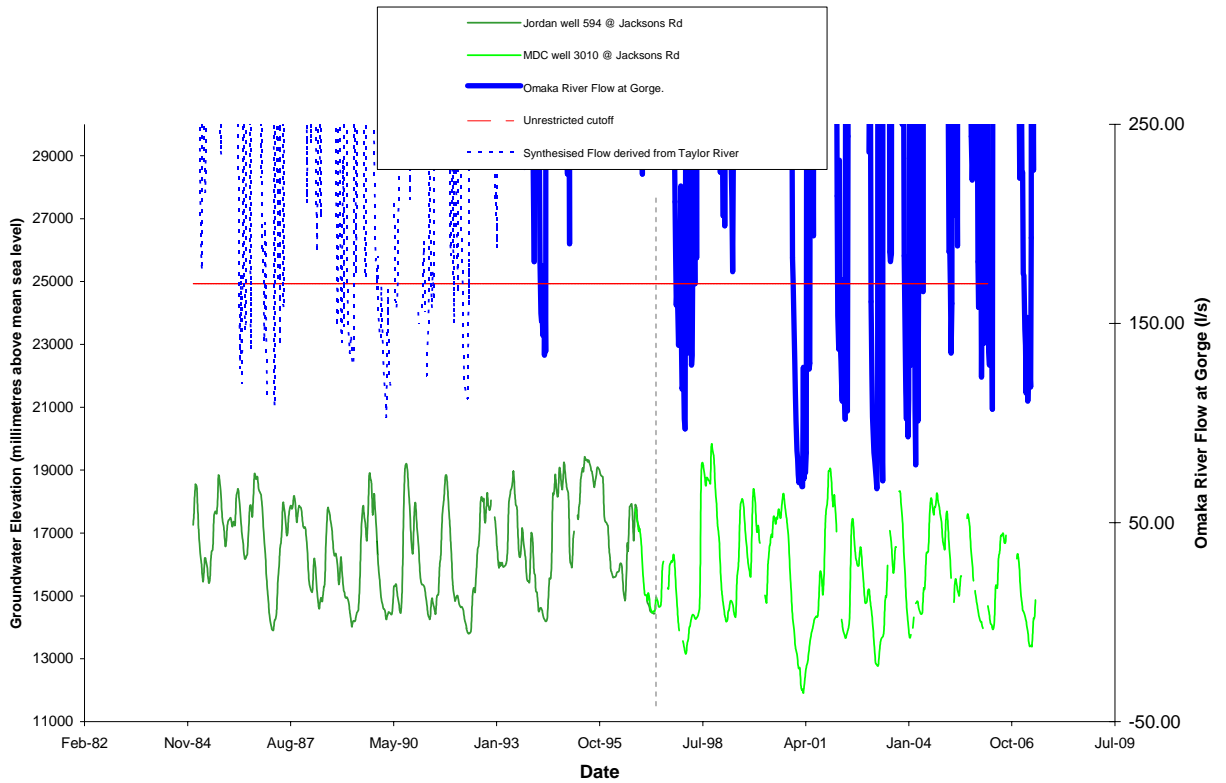


Figure 37 : Long-term Aquifer Trends

Let’s now return to the key question of what is causing the decline in aquifer level and does it represent a long-term trend. The two possible explanations are either reduced recharge or increased water demand. Figure 37 provides an insight into the cause based on the concatenated aquifer level record for the Jacksons Road wells (green), plotted against the variation in Omaka River flow (blue) since 1984. Observed flow is shown by the solid blue line and synthesised flow by the dashed blue line. The method used to derive the synthetic flow record will be described in the following section.

Assuming the synthetic record is an accurate representation of historic Omaka River flows; falls in aquifer level appear to coincide with lower flows. This suggests that reduced catchment runoff is the explanation for the lower well levels, and as a consequence reduced aquifer through-flow arriving at Woodbourne. This conclusion is supported by Figure 38 showing a decline in mean annual Omaka River flow at Tyntesfield Gorge since 2000, where the blue horizontal line indicates the mean flow. In other words there is less water entering the catchment which is upstream and independent of abstraction.

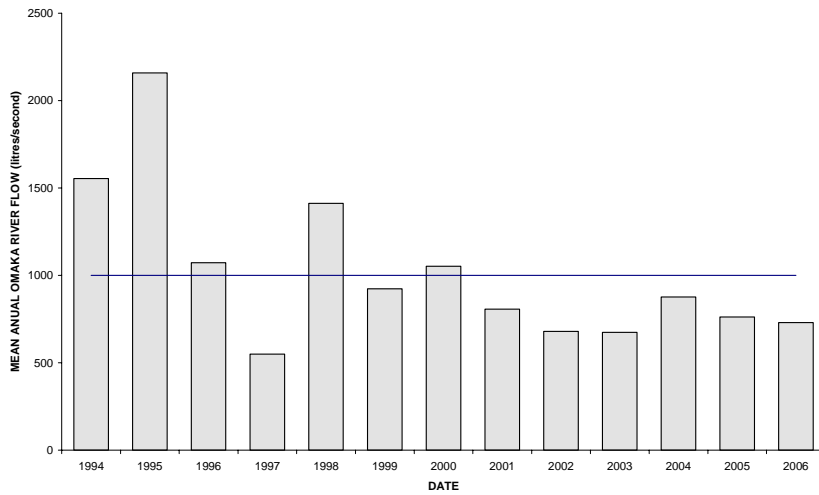


Figure 38 : Mean Omaka River Flow at Tyntesfield Gorge 1994 – 2006

11. Patterns & Trends

So why has catchment runoff declined and is it a short term cycle or part of a longer term trend? Furthermore is it due to reduced rainfall or changes in catchment characteristics? At this stage there is no clear answer based on the information available. Longer rainfall record and detailed analysis of intensity, frequency and duration are needed before reaching a firm conclusion.

A similar declining trend in basin yield has been observed in the neighbouring Taylor River Catchment, however in this case the likely cause is the replacement of tussock grassland with plantation forestry. This trend is illustrated in Figure 39 showing the decline in mean annual flow between 1962 and 2006. There are no restrictions in the district plan on planting commercial forests in these catchments. Negligible exotic plantation forestry exists in the Omaka River catchment although regeneration of native vegetation can have a similar impact on catchment yield.

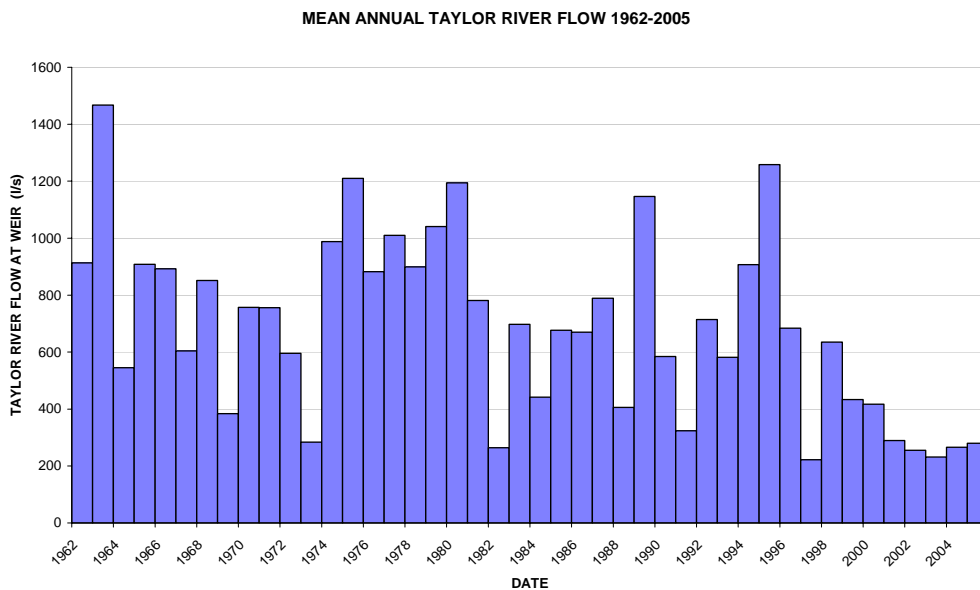


Figure 39 : Taylor River Mean Annual Flow 1962-2005

12. Southern Valley Catchment Comparison

While only 13 years of Omaka River flow data is currently available, we have already seen a much longer record exists for the neighbouring Taylor River Catchment, located closer to the coast and representing the source of the Taylor River running through central Blenheim.

One way of identifying long-term trends in Omaka River flow is by studying the behaviour of nearby catchments with similar rainfall and runoff characteristics. A good candidate for this purpose is the nearby Taylor River Catchment which receives rainfall from the same weather patterns, and most importantly, has had a permanent flow recorder operating since the early 1960s.

A synthetic Omaka River flow record can be derived from the long flow record available for the Taylor River. But first it is important to check the paired catchment method is valid. One difference that may affect the reliability of the estimated flow is the extent of plantation forestry in the Taylor River catchment and its absence in the Omaka River catchment.

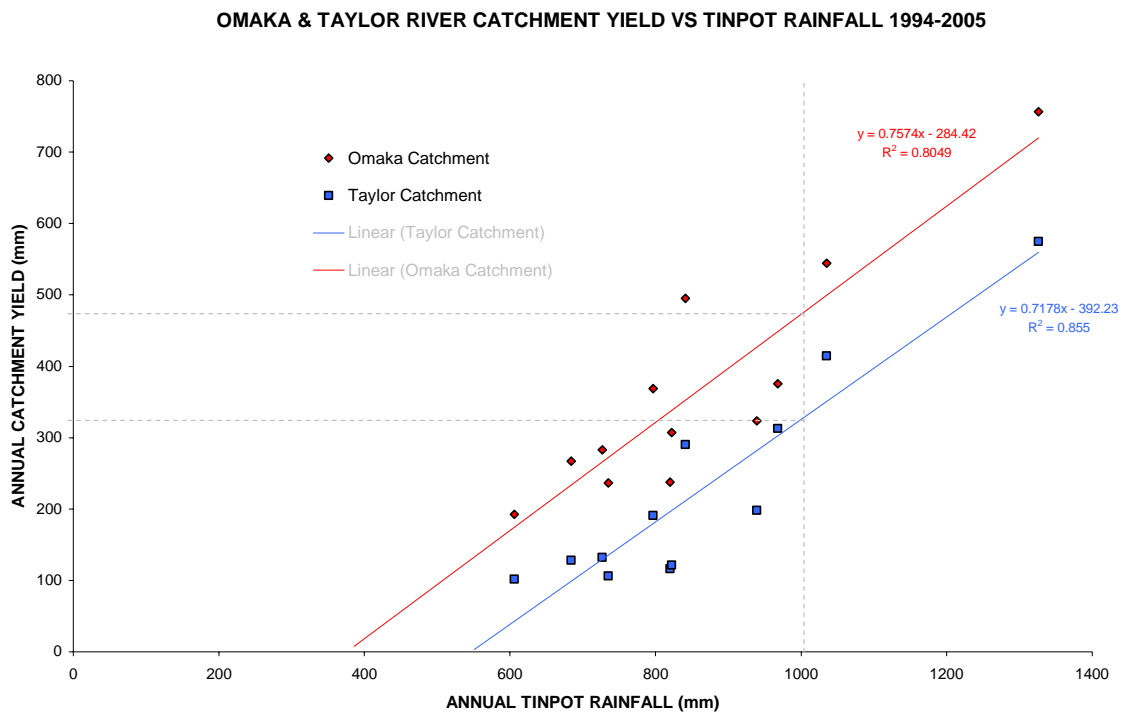


Figure 40 : Catchment Yield Comparison

Firstly lets review what data is available. Figure 40 shows annual rainfall for the Tinpot raingauge in the Taylor River catchment plotted against measured catchment yield, for the 13 seasons of record available at the Omaka River flow recorder site. Yield from both catchments has been converted to a depth of water to allow a direct comparison with rainfall.

This plot tells us a number of things. Firstly, that no runoff occurs in the Omaka catchment unless a minimum of 400 millimetres of rain falls, while 550 millimetres is needed to generate runoff in the Taylor River catchment. The grey lines show an annual rainfall of 1000 millimetres will generate around 330 millimetres of runoff over a year in the Taylor River catchment, and about 470 millimetres in the Omaka River catchment. This is useful background information that demonstrates a good understanding of the hydrology of these catchments, and in particular the relationship between rainfall and runoff.

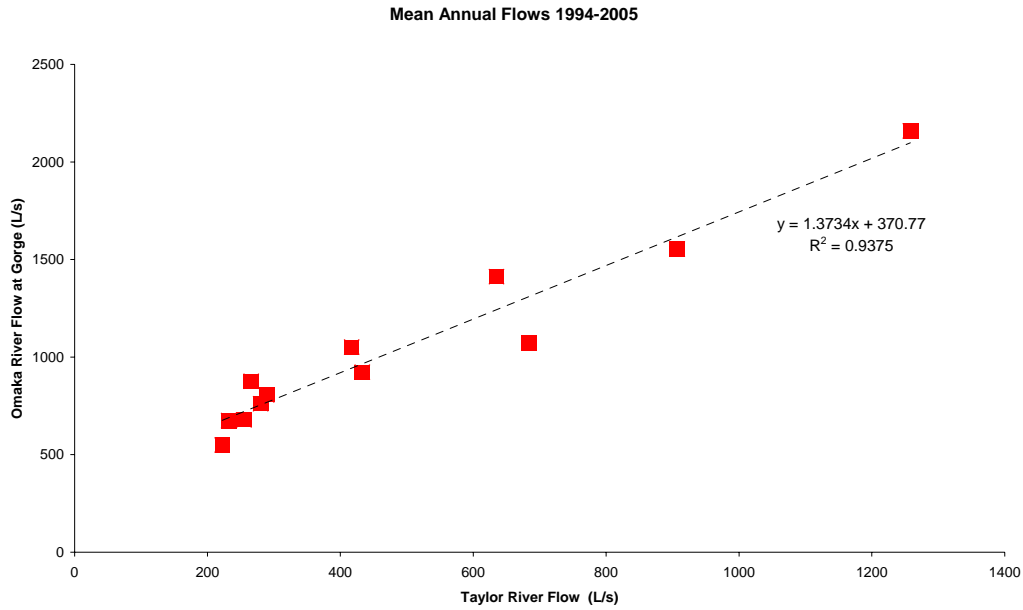


Figure 41 : Catchment Flow Correlation

Figure 41 shows mean annual flow for the Omaka River at the Tyntesfield Gorge site from the first full year of record in 1994 through to 2005, plotted against the corresponding values for the Taylor River at the Borough Weir site. A good straight-line relationship exists between these parameters. Using the mathematical relationship defined in Figure 41 we can derive a synthetic Omaka River annual flow record based on Taylor River records dating back to 1962 (Figure 39).

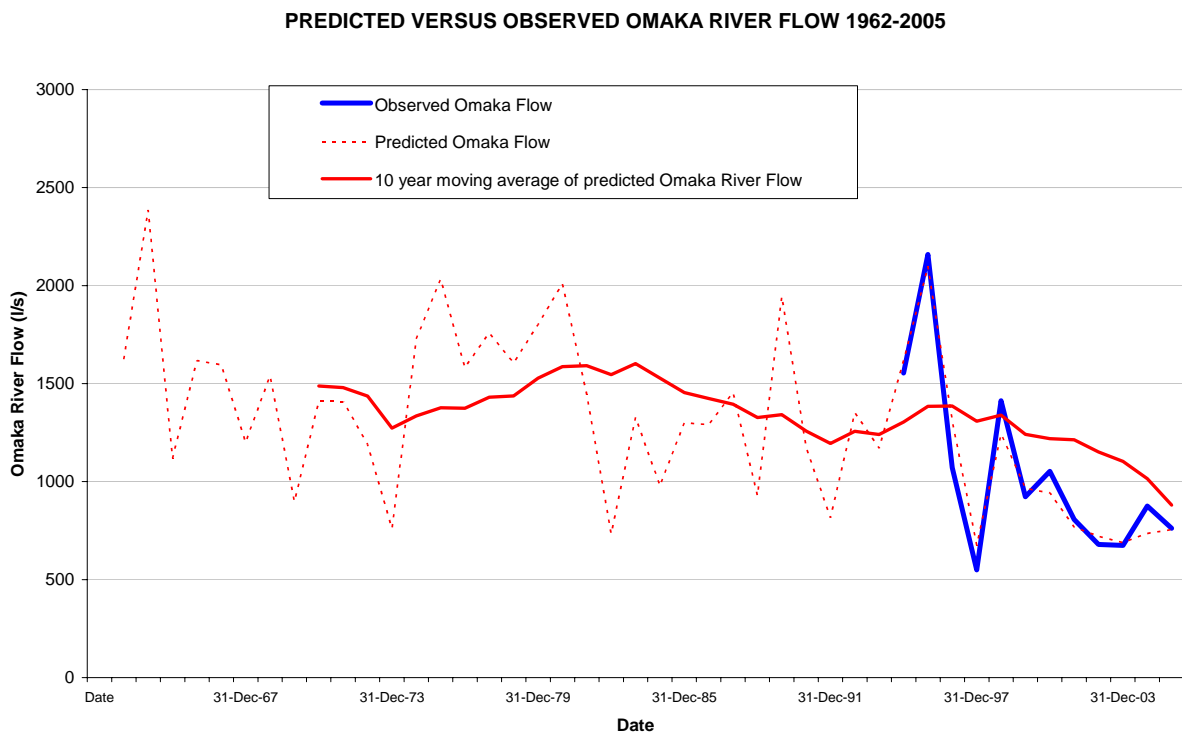


Figure 42 : Predicted Longterm Aquifer Trend

The synthesised annual flow record is represented by the red dashed line in Figure 42 with the 10 year moving average in red and observed Omaka River flows in blue. However the question remains as to whether the times series is stationary with expected low flow frequency unchanged from year, given the cycles in plantation forestry in the Taylor River catchment.

Given this uncertainty, the only reliable method of identifying trends in catchment yield over time is historical record. The synthesised Omaka River flow series in Figure 37 is probably still valid for the shorter time span however.

13. Water Management Rules & Policy

The Omaka River Valley Aquifer has a history of water management problems which culminated in the establishment of a water resource management plan following the extraordinarily dry conditions experienced during the 1982/83 summer. This plan, agreed between the then Marlborough Regional Water Board and water users provided a mechanism whereby the water resource could be managed during drought periods, but did not set a catchment allocation limit. The plan was effectively disestablished as a result of a succession of wet summers until 1993.

Following an application to establish a 40 hectare vineyard in 1993 and in recognition of the water short nature of the Omaka River Catchment, the Hearings Committee of the Marlborough District Council agreed to an interim allocation limit of 170 litres per second in June 1994 based on an intensive assessment of local water resources. The 170 litre per second limit was based on the principle of the bulk of water being supplied by the lowest Omaka River flow that could reliably be expected each summer, plus a subsidiary volume of groundwater.

This allocation category was subsequently formalised in the Proposed Wairau Awatere Resource Management Plan and became fully allocated by 1999. However it proved insufficient to meet demand from irrigators and further water was subsequently allocated with low flow dependant consent conditions. However these arrangements hadn't been formalised in PWARMP at the time of writing.

14. Consented Versus Actual Water Use

Because of its location in what was recognised as early as the 1970s as a water short area, water metering has been mandatory for water permit holders since 1984 when the underground water bylaw was introduced by the then Marlborough Catchment and Regional Water Board.

Marlborough District Council reviewed individual water use in 1996 based on meter records (MDC – 1996). The 1996 report showed that consumption by water permit holders was generally less than 50% of consented allocation. Unfortunately the period reviewed included some of the wettest seasons on record and wasn't representative of average, let alone dry conditions.

A similar Marlborough District Council review in 2007 was invalidated by the lack of continuity and quality of recent records. However based on earlier records from the 1990s, total water use was of the order of 375,000 cubic metres per season. Assuming a 100 day season this averages 3,750 cubic metres per day or an instantaneous pumping rate of 43 litres per second, versus the unrestricted allocation band limit of 170 litres per second.

Taking into account missing record, actual average seasonal water use is probably less than 100 litres per second in most seasons, and under drought conditions, possibly higher. However under extremely

dry conditions, abstraction from the upper aquifer layer will to some extent be self limiting due to its thin nature and the inefficiency of many shallow wells. A similar issue exists for the Rarangi Shallow Aquifer, with both systems reliant on a thin seam of water and older style wells.

15. Current Resource Consents & Allocation Regime

Table 3 lists the details of currently active water permits for the Omaka River Catchment. Out of a total of 48, 35 are unrestricted and shaded black, while a further 13 which are shaded grey, can only be exercised when a certain Omaka River flow is exceeded. Water permits without flow conditions have been granted to irrigate an area of 679 hectares of grape plants, compared with a similar irrigated area of 279 hectares in 1993.

Conditions placed on resource consents by the Marlborough District Council have multiple objectives. These include maintaining Lower Aquifer recharge, providing a seasonal connection for migratory species, preserving groundwater throughflow and protecting existing well users in the Woodbourne area.

The initial conditional water permits could only operate when Omaka River flow at Tyntesfield Gorge exceeded 400 litres per second, which ensured channel flow occurred as far north as Hawkesbury Road. In subsequent consents, successively more restrictive criteria have been adopted by the Marlborough District Council. These were generally defined in terms of continuous channel flow to a certain point, although some also having minimum aquifer levels specified in certain wells.

The most recently granted water permits were conditional upon continuous flow to the Old Renwick Road Ford. The unrestricted quota of 170 litres per second represents 62% of the December to March median Omaka River flow at Tyntesfield Gorge, but there is nothing to stop these permits from operating under drought conditions when flows are as low as 67 litres per second, as in early 2001.

The sum of the instantaneous pumping rate for all flow dependant water permits equals 174 litres per second, bringing the combined rate of abstraction to 344 litres per second compared with the median flow of 440 litres per second. This doesn't include the diversion of flow from Sam's Creek, a tributary of the Omaka River. Of course all these numbers represent the maximum allocations of which only a proportion are likely to actually be used depending on season.

MDC resource consent number	Holder	Allocation class	Crop area (hectares)	Daily volume (m ³ /day)
				Average instantaneous rate (l/s)
U980550	The Bluffs Vineyard Co. Ltd	unrestricted	21	304 (3.5)
U020953	Johnson Estate	unrestricted	124	1761 (20.4)
U960692	Omaka Water Syndicate	unrestricted	103.2	2222 (25,7)
U070048	Isabel Estate	unrestricted	44	324 (3.75)
U000896	Evill-Lawson Partnership	unrestricted	20	260 (3)
U061270	Giesen Wines Ltd	unrestricted	8	177 (maximum of 4.2 l/s)
U010156	Southern Valley Properties	unrestricted	8	15 (0.17)
U970344	Kay Family Trust	unrestricted	11.3	131 (1.5)
U061154	Hagen Family Trust A	unrestricted	8.4	163 (1.9)
U061154	Hagen Family Trust B	unrestricted	11.3	219 (2.5)
U061299	Matua Valley Wines Ltd	unrestricted	8	153 (1.8)
U061299	Matua Valley Wines Ltd	unrestricted	8	153 (1.8)
U060397	Roughan-Lee Family Trust	unrestricted	5.85	16 (0.19)
U070051	Roughan DJ	unrestricted	18	151 (1.75)
U991229	Roughan TJ	unrestricted	20	429 (5)
U061323	Kathy Lynskey Wines Ltd	unrestricted	9.7	200 (2.3)
U070527	Sutherland	unrestricted	14.1	315 (3.6)
U000912	Heritage Estate	unrestricted	54	810 (9.4)
U991205	Woodbourne Farm	unrestricted	11	170 (2)
U070200	Beringer Blass Wines Estate	unrestricted	34	612 (7.1)
U020419	RNZAF Base Woodbourne	unrestricted	-	1500 (17.4)
U011160	Altimarloch	unrestricted	4	50 (0.6)
U000077	Altimarloch	unrestricted	8	20 (0.2)
U011161	Duns	unrestricted	28	450 (5.2)
U030897	Pear Tree & Sorensen	unrestricted	23.5	275 (3.2)
U060535	Pula	unrestricted	4.25	198 (2.3)
U061198	Landon-Lane	unrestricted	7	126 (1.5)
U061144	Rodger	unrestricted	6	45 (0.52)
U010934	Lake Chalice	unrestricted	17	175 (2)
U970882	Tyntesfield Estate	unrestricted	-	518 (6)
U070123	Tyntesfield Estate	unrestricted	28	600 (6.9)
U060628	Altimarloch	unrestricted	- S/D	12.5 (0.14)
U991197	Baxter	unrestricted	- S/D	10 (0.12)
U010935	Ponder	unrestricted	7	167 (1.9)
U060296	Null	unrestricted	4	25 (0.29)
U000356	Donovan	Omaka River flow > 550 l/s	8	177 (2)
U050520	Pear Tree Vineyard	Omaka River flow > Old Renwick Road	22	176 (2)
U050520	Pear Tree Vineyard	Omaka River flow > Old Renwick Road	22	30,000 m ³ /season (30)
U020675	Rannoch Estate	Omaka River flow > Old Renwick Road	12.5	31,600 m ³ /season (20)
U970882	Tyntesfield Estate	Omaka River flow > 400 l/s		518 (6)
U030620	Tyntesfield Estate	Omaka River flow > Old Renwick Road	56	120,000 m ³ /season (7)
U041712	Tyntesfield Estate	Omaka River flow > Old Renwick Road		4320 (50)
U000570	Newman	Sams Creek flow > 162 m ³ /hour	85	1 m ³ /second
U991688	Altimarloch	Omaka River flow > 550 l/s		35,000 m ³ /season (39)
U991352	Waihopai Slopes Vineyard	Omaka River flow > 400 l/s	10	50 (maximum of 2.8)
U011132	Dam Vineyard Co. Ltd	Omaka River flow > 400 l/s	18.2	320 (maximum of 3.7)
U030089	Col Holdings Ltd	Flow downstream of Old Renwick Road	6	13200 (maximum of 10)
U020824	Carreg Vineyard Ltd	Flow downstream of Old Renwick Road	6	132 (1.5)

Table 3 : Active Water Permit Details

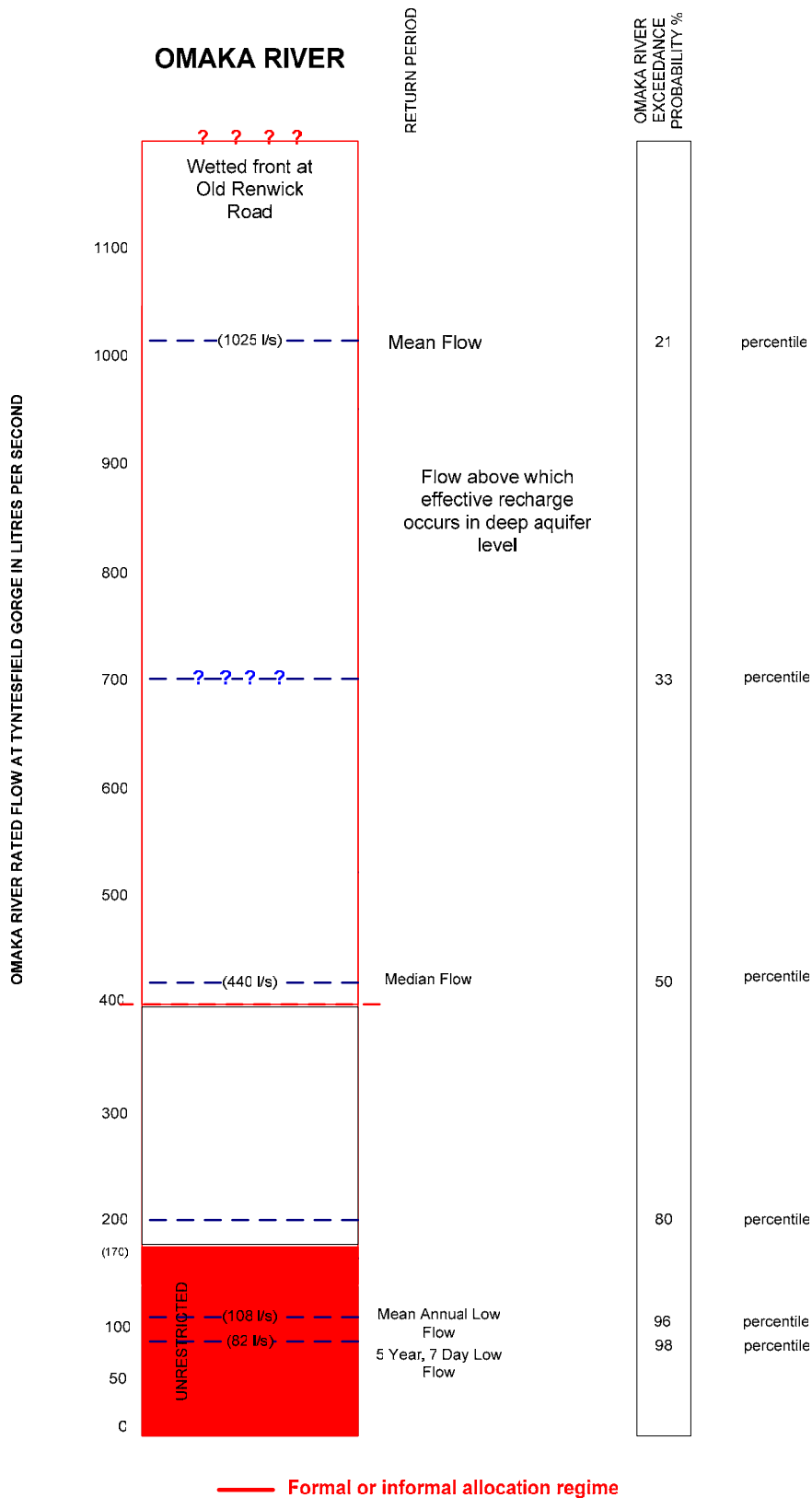


Figure 43 : Omaka River Allocation Practice

Figure 43 describes the current allocation framework for the ephemeral Omaka River Catchment. It can be seen that the Omaka River allocation regime has no low flow restrictions reflecting its ephemeral nature. This is quite a different approach to that adopted for perennially flowing rivers.

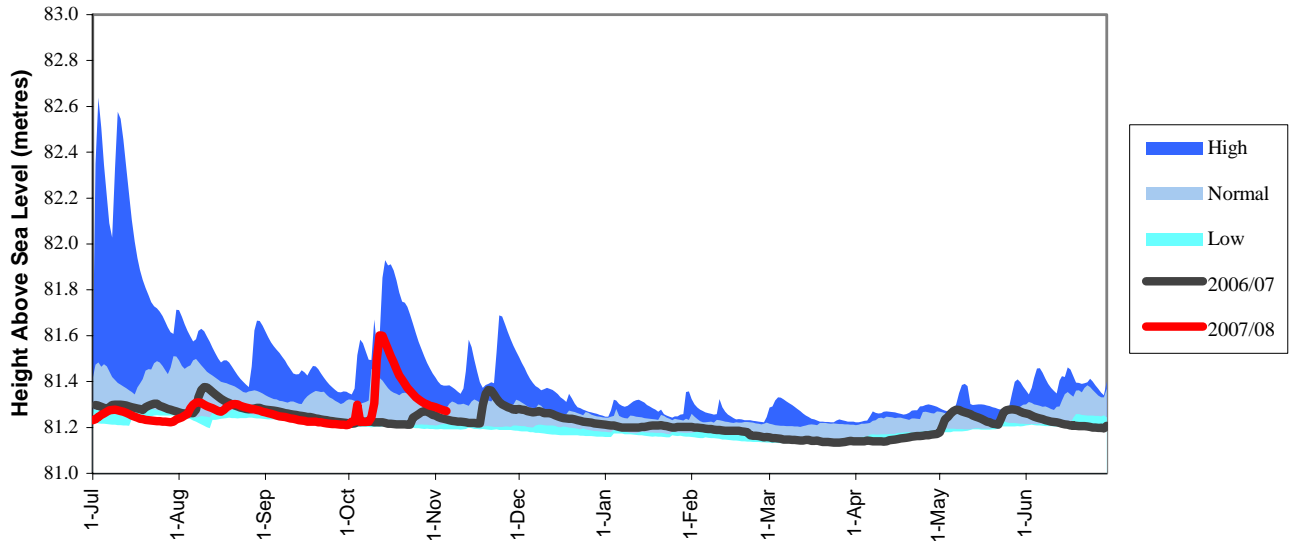


Figure 44 : Omaka River Flow

Figure 44 illustrates the absence of high channel flows between January and June each year, based on 10 seasons of record at well 3069 representing the Upper Aquifer (See Figure 6 for well location). During this 5 month period no recharge of the Lower Aquifer is likely. The different colours reflect the frequency of a particular well level with 60% of observations falling in the middle grey band representing normal conditions, 20% in the high band shown by the bright blue colour or the remaining 20% in the low band denoted by the light blue colour. The red line indicates the current water year starting on the 1st of July with the black line representing the previous 12 month period.

This is the end of the report with the key findings presented in the executive summary at the front.

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