Chapter 37: Marlborough Sounds/Rai/Pelorus River Valley

Introduction

Historically the Marlborough Sounds Catchments have been less reliant on groundwater as surface flows have been available. Water is more readily accessed from large, perennially flowing rivers such as the Rai/Pelorus River system and other smaller streams than from groundwater.

Geological setting

The Marlborough Sounds are a very dynamic part of New Zealand. During the Quaternary Period over the last 1.8 million years, the world's climate fluctuated between glacial and warm periods. During glacial periods the sea level was considerably lower than it is now. At the peak of the last ice age 14,000 years ago the sea level was 140 metres lower than it is today (Gibb - 1986).

During these glacial periods the North and South Islands were connected by an isthmus extending north from the Marlborough Sounds. This land bridge was last severed when sea-levels rose following the last glaciation and Cook Strait was formed (Morgenstern et al - 2009).

Originally the Marlborough Sounds consisted of a series of narrow river valleys, similar to the present day Kaituna or Pelorus River Valleys. Since the Pliocene Period the Marlborough Sounds has been tectonically tilted northwards from the Wairau Fault. This tilting has resulted in uplift of the Richmond Range, and regional subsidence in the Marlborough Sounds area.

This subsidence together with sea-level rise has resulted in these valleys becoming drowned by the sea to form Queen Charlotte, Kenepuru and Pelorus Sounds (Fig. 37.1).

Submergence of the Marlborough Sounds has taken place relatively recently in terms of geological time.

Figure 37.1: Marlborough Sounds drowned valleys

According to radiocarbon dating of fragments of Matai wood from an ancient forest buried on the seabed east of the present day Maud Island, the shoreline was this far north 12,550 years ago (Singh - 2001).

Seismic reflection profiles of the seabed in Pelorus Sound show that it was a flat-floored valley and pollen extracted from the samples show that podocarp forests dominated.

A hydrological consequence of the northern tilting of the Marlborough Sounds block has been a reversal of the ancient river drainage pattern somewhere between 120,000 and 70,000 years ago (Craw et al 2007 & Mortimer et al - 1997).

Apart from the outer Pelorus Sound area, all rivers that drained the ancient Marlborough Sounds valleys flowed south towards the Wairau River or Cloudy Bay (Fig. 37.2).

Geologists have shown that the present day Kaituna and Pelorus Rivers were once tributaries of the Wairau River. The geologists also discovered Pelorus Gravels with their distinctive mineralogy in two wells at Okaramio, and in a well on the north bank of the Wairau River (Mortimer & Wopereis - 1997).

Groundwater systems

Relatively little is known about the groundwater resources associated with the Rai or Pelorus River valleys. Groundwater investigations tend to be driven by demand, and until recently water use was low in these areas. In recent years, demand for groundwater has increased especially in areas associated with dairy farming and pasture irrigation.

The scale of groundwater resources are small and localised in nature due to the mountainous topography. Groundwater systems in this area are riparian type aquifers, formed by the alluvial gravels which fill the base of the river valleys. Their narrow extent means they have limited storage and they rely on continual recharge water from the associated river or stream, and rainfall to sustain pumping from wells during summer. It is likely that water moves backwards and forwards between the aquifer and rivers or streams, depending on the nature of the sediments and the gradient in a particular reach.

With the exception of the Linkwater area, the only significant groundwater resources in the Marlborough Sounds catchments occur in the Rai-Pelorus River Valley. Significantly more information is available on the hydrogeology of the upstream Rai/Ronga River compared to the downstream Pelorus or Wakamarina River Valleys.

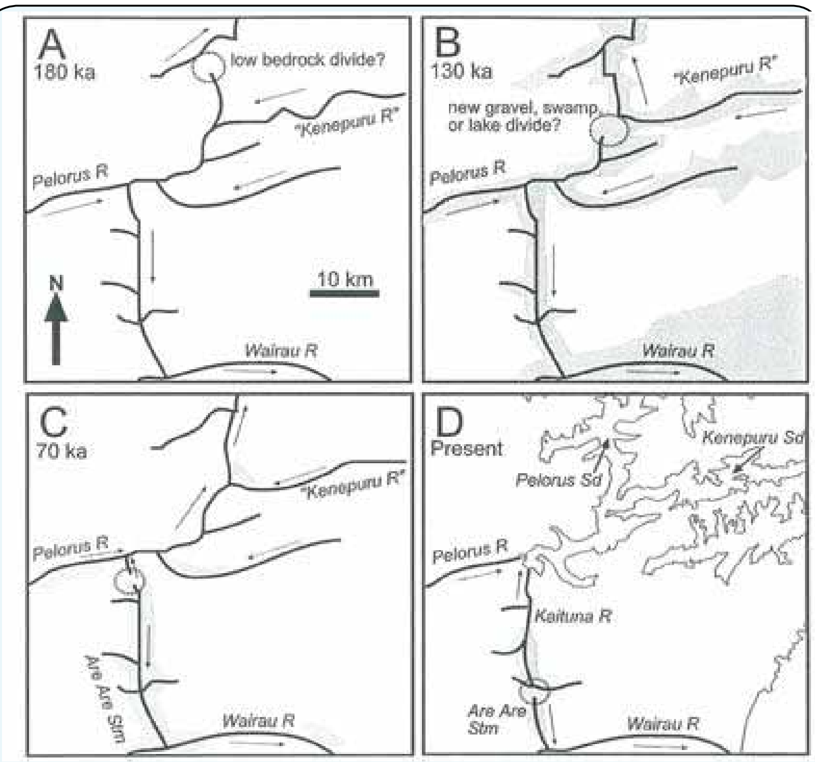

Figure 37.2: Ancient drainage pattern changes (Craw et al - 2007). The ka represents 1,000 years so in B the time is 130,000 years before present.

The Rai Valley was formed by the Ronga Fault which is why the valley is so straight and narrow. Movement on fault lines shatter the adjacent basement rocks, forming weaknesses in the earths surface. Water percolating through these fractures weathers the basement rock, allowing these areas to be preferentially eroded by rivers and streams. The Rai River has followed the Ronga Fault because this is the path of least resistance.

The geological profile of Rai Valley is not well defined due to the small number of deep wells reaching the base of the gravels.

The depth to basement rock in Rai Valley varies from over 30 metres in the north of the catchment, to less than 10 metres in the south. At the township the basement is thought to be at 15 to 20 metres depth below the surface (Fig. 37.4).

The depth of alluvium in the middle to upper part of the valley is uncertain because there are no wells in the MDC database that have reached basement rock. Some bores drilled along the valley margins have intercepted basement at shallower depths. For example, well O27w/0093 intercepted greywacke at 1.8 metres, and well O27w/0102 near Bryant Road intercepted "green rock" at 15 metres depth.

Regional scale tectonic subsidence in the Marlborough Sounds has gradually dropped the surface of the basement in the northern part of the Rai catchment. As a result of this subsidence, the northern part of the catchment in the Ronga Road area has seen a buildup of sediments.

Sediments in this area are known to be over 30 metres thick, and the Rai River is continuing to deposit alluvium in this area today. Deeper sediments in the Ronga Road area are below the elevation of the basement downstream, so it is likely that deeper groundwater in these sediments is relatively old.

Alluvial deposits at Rai Valley are dominated by Q2-Q4 gravels, equivalent to the Havelock Formation in the Kaituna Valley, and the Speargrass Formation on the Wairau Plain. Lithologically the alluvium consists of a mixture of gravels and predominantly yellow clay, with minor amounts of sand.

To the south of Rai Valley township the Rai River has eroded away older gravel deposits and bedrock is

Ronga-Rai River Valley groundwater resources

Historically most wells in this area have provided small amounts of water for domestic or stock supply, and for washing down milking sheds. Residents of Rai Valley township have always relied upon individual water wells for domestic supply. The mussel factory at the north end of the town also used freshwater from a well for processing while it was operating.

The Rai Valley consists of a narrow strip of alluvial sediments bounded by greywacke basement rocks of the Pelorus Group. The width of the valley floor sediments is generally less than one kilometre, and it is likely that a strong hydraulic connection exists with the local river system (Fig. 37.3).

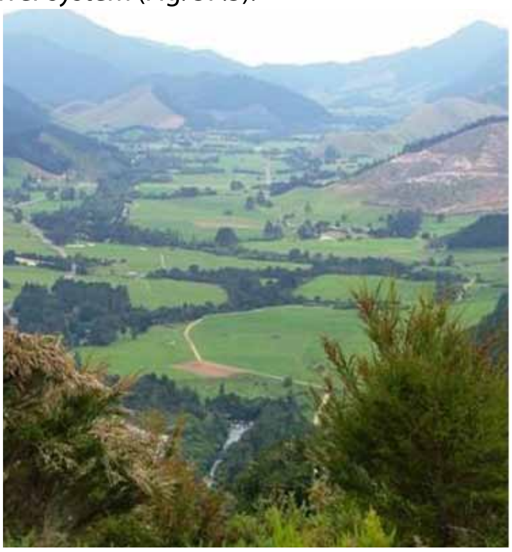

Figure 37.3: Rai River Valley alluvial floodplain

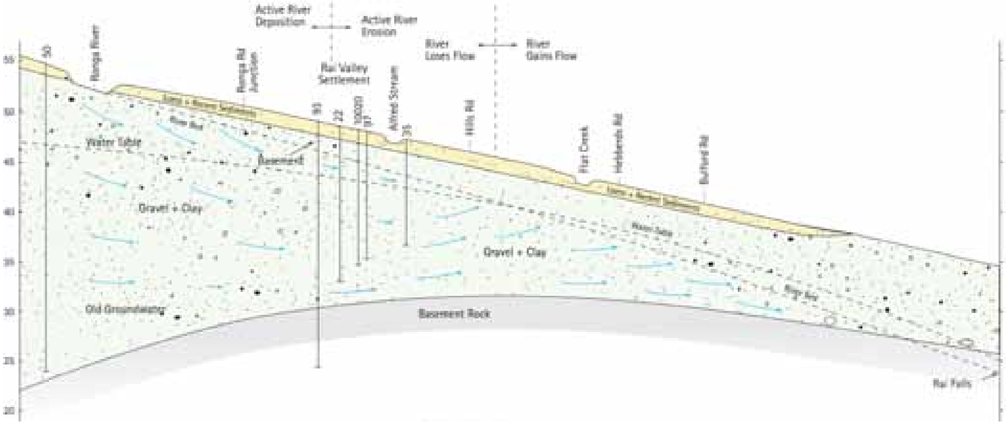

Figure 37.4: Rai Valley geological section

exposed in the channel at Rai Falls. Gravel deposits older than the last glacial period (Q6, Q8) are not clearly present in well logs, and appear to have been completely eroded away by the river. These deposits are only found as terrace remnants along the margins of the valley.

A distinctive yellow clay layer is recorded near the surface in most bore logs from the township area and is interpreted to be postglacial outwash deposits or possibly wind-blown clay (loess). The clay layer is typically two metres thick, and may be sufficiently impermeable to act as a confining layer for the underlying gravels.

Recharge and flow patterns

The majority of groundwater at Rai Valley is expected to be very young because of its close connection to the river. Sounds riparian aquifers are characteristically narrow and have limited storage. This means that wells pumped at high rates are reliant on continuous recharge. Water pumped from bores is considered to be effectively surface water because most wells are shallow and located close to rivers or streams.

Anecdotal reports of a rapid rise in well levels following rain suggest the aquifer has a low storage coefficient. This means that the aquifer is at least partially confined, and is recharged mainly by river and tributary stream losses rather than land surface recharge. The relationship between river flow and groundwater level has not been studied in detail.


Figure 37.5: Rai Falls looking upstream with MDC flow recorder at top left

In the upper terraced part of the catchment groundwater levels are lower than the riverbed, and the Rai River is expected to lose flow to the aquifer. In the lower part of the catchment, south of about Hills Road, the reverse is true and groundwater is lost to the river as the gravel deposits gradually become thinner. When the river first crosses bedrock just upstream of the Rai Falls it has captured almost all of the groundwater held within the Rai Valley.

The MDC river flow recorder at Rai Falls (Fig. 37.5) records all of the groundwater flow as it leaves the Rai catchment. The lowest observed flow of 580 l/s occurred in March 2001. The river recession curve at the time was essentially flat, indicating that the Rai River was being sustained entirely by groundwater storage. Flow in the Ronga River at Ronga Road at the time was only 4 l/s.

Hydraulic properties

Most wells in the Rai Valley are shallow compared to the rest of the district. This reflects the availability of sufficient water for domestic supply close to the surface. Irrigation wells are generally slightly deeper, although those located close to streams can be very shallow too.

The permeability of the aquifer forming gravels at Rai Valley is very high, indicating that the river has historically been a high energy environment. There is a large range in estimated transmissivity values from 120 to 2,800 m^2/day, with a median of 1,400 m^2/day. Higher values tend to be recorded at shallower depths, and most of the bores with transmissivities greater than 1,500 m^2/day are likely to be influenced by recharge from a nearby stream or river channel.

An aquifer test conducted on behalf of Pacifica Seafoods in July 1995 determined aquifer transmissivity to be within the range from 1,000 to 5,000 m^2/day, which is consistent with estimated values. Aquifer storage was estimated at 0.001, although there is doubt over the reliability of these values due to rainfall during testing.

An aquifer test was carried out at well O27w/0065 at Bulford Road near Rai Valley in May 2002. The well was pumped at a rate of 14.5 l/s for 24 hours (Fig. 37.6). A flattening of the rate of drawdown indicated that a recharge source was intercepted by the expanding cone of depression after 30 minutes of pumping.

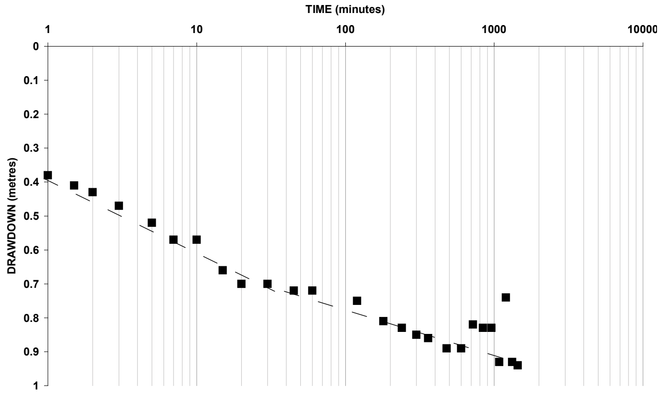

Figure 37.6: Well O27w/0065 aquifer test results

A very high transmissivity value of 13,800 m^2/day corresponds with the initial drawdown response, which is much higher than that indicated from the specific capacity test. The high transmissivity indicates extremely permeable gravels and the decrease in slope of the curve indicates an additional source of recharge nearby.

The narrow nature of Rai Valley and the high transmissivity of the gravels means that the upper 10-15 metres of the aquifer is essentially an extension of the river, and behaves in a similar way. Deeper groundwater is likely to be more sluggish because of lower gravel permeabilities, particularly to the north of Rai Valley township.

Pelorus River Valley groundwater resources

Very little is known about the hydrogeology of the Pelorus River Valley. Demand for groundwater has historically been low, with most bores being drilled for domestic supply. More recent demand for summer dairy pasture irrigation water has prompted an increase in well drilling and groundwater use.

The Pelorus Valley is typically less than a kilometre in width, but widens around major stream confluences. The valley consists of a narrow strip of alluvium bounded by Pelorus Group greywacke basement rock forming the hills.

Like the Rai Valley catchment, groundwater in the Pelorus catchment is likely to be hydraulically connected to flows in the nearby river.

The Havelock Gravels are the main water bearing sediments in the Pelorus Valley. These gravels are intercepted at about six metres depth in the Daltons Road-Canvastown area, and are 3.5 to 6 metres thick. Depth to the basement is unknown as all of the bores in the valley are less than 17 metres deep.

Water levels in well logs around Dalton's Bridge are above the main water bearing gravels. This indicates that the aquifer is at least partially confined by overlying terrestrial clays in this area. Fine blue clays start to appear in bore logs downstream of Canvastown, and the aquifer is confined between here and the sea. These clays are probably of marine origin and are found to a depth of around 12 metres.

Transmissivity values of known wells in the Pelorus Valley estimated from specific capacity tests, range from 2 to 640 m^2/day, with a median of 61 m^2/day. These values are considerably lower than in the Rai Valley indicating the lower Pelorus was an area of comparatively low energy during the deposition of the Havelock Gravels.

References

Craw, D., Anderson, L., Rieser, U. and Waters, J. 2007. Drainage reorientation in Marlborough Sounds, New Zealand, during the Last Interglacial. New Zealand Journal of Geology and Geophysics 2007, Vol. 50: 13-20

Gibb, J.G. 1986: A New Zealand regional Holocene eustatic sea-level curve and its application for determination of vertical tectonic movements. Royal Society of New Zealand bulletin 24: 377-395.

Morgenstern, U. Brown, L.J. Daughney, C. Begg, J. and Davidson P. 2009. Linkwater catchment groundwater residence time, flow pattern, and hydrochemistry trends, GNS Science Report 2009/08, May 2009

Mortimer, N., and Wopereis, P. 1997. Change in direction of the Pelorus River, Marlborough, New Zealand: evidence from composition of Quaternary gravels. New Zealand Journal of Geology and Geophysics 1997, Vol. 40: 307-313

Royds Consulting 1995. Pump Test: Pacifica Seafoods Ltd

Singh, L. J., 2001. Late Quaternary Sea Level and Tectonic History of Marlborough Sounds, PhD thesis, Victoria University of Wellington.

Johnston, M.R. 1993. Geology of the Rai Valley area, Institute of Geological and Nuclear Sciences Ltd, 1:50,000 scale geological map