Chapter 40: Havelock Aquifer And Kaituna River

Introduction

Havelock's estuarine location at the head of Pelorus Sound and its proximity to seawater has complicated the search for a secure and reliable supply of groundwater. Accordingly, Havelock has a long history of water supply issues and much of our groundwater knowledge of the area has come from water supply investigations. Groundwater below Havelock township is either hosted by poor yielding clay rich gravels, or has high salinity.

Groundwater has been used to supplement the public water supply since 1974, when well P27w/0149 was drilled at Havelock Domain (the Motor Camp) (Fig. 40.1). This well was abandoned in 1989 when the screen collapsed and was replaced by an adjacent well P27w/0114.

Water quality in well P27w/0114 deteriorated over time as salinity levels increased in response to higher rates of pumping. The groundwater supply was subsequently moved to well P27w/0124 adjacent to the Kaituna River in 1993. Well P27w/0508 was commissioned in 2007 as a backup to supplement the supply from well P27w/0124. An initial backup well (P27w/0497) drilled to a depth of 62 metres proved to be low yielding and was abandoned (PDP - 2008).

Figure 40.2: Kaituna Estuary and valley looking south

All groundwater north of the catchment divide located just north of Okaramio at Mount Riley Road, flows towards Havelock and discharges into Pelorus Sound.

The valley that contains the Kaituna River is oversized for the current Kaituna River (Fig. 40.2). This is because the valley once carried the ancient Pelorus River, which once flowed south to join the Wairau River (Craw et al - 2007). While the Pelorus River no longer follows this path, it has played an important role in depositing the sediments that host groundwater in the Havelock area.

The sediments beneath Havelock can broadly be divided into as those deposited by the Pelorus River during the Pleistocene, which have good water-bearing potential, and those deposited during the Holocene which have poor water bearing potential.

Groundwater systems

Groundwater in the Kaituna Valley is hosted by a narrow lense of alluvial gravel beneath the valley floor.

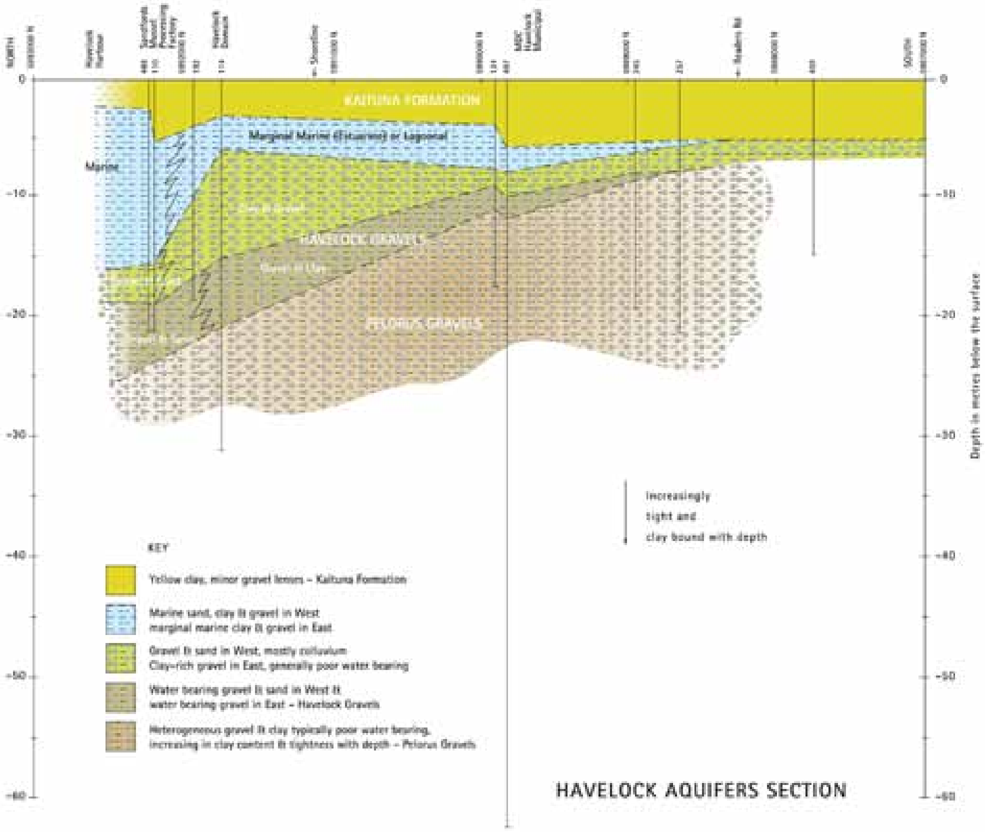

Figure 40.1: Havelock geological cross section

Pleistocene sediments

Most of the gravels forming the Kaituna Valley floor were deposited by the Pelorus River when it flowed southward into the Wairau Valley. Sediments deposited by the Pelorus River are known as the Pelorus Gravels.

The Pelorus Gravels are 26 metres thick at the Kaituna-Okaramio saddle, and at least 52 metres thick at the MDC municipal supply well-field near Havelock. They are heterogeneous with sub-rounded to rounded pebbles and cobbles. They are often clay bound and poor producers of groundwater.

Figure 40.3: Havelock municipal supply wellfield

Water bearing layers seem to be more common within 20 metres of the surface and consist of discontinuous seams of cleaner gravels within predominantly clay or clay-bound gravel. This is the opposite to what was found at Okaramio where the Pelorus Gravels were higher yielding than shallower material.

The Pelorus Gravels directly overlie the schist bedrock that bounds the catchment. Weathered schist basement has been intercepted at a depth of 71 metres near Okaramio (Mortimer & Wopereis - 1997). Sediments of angular, locally derived schist fragments in a clay matrix have also been deposited along the margins of the valley.

Sediments originating from the surrounding bedrock comprises much of the well logs for wells P27w/0114 and P27w/0192 at the Havelock Campground. The presence of these sediments at the valley margins restricts the extent of water bearing gravels, which are only found within the middle of the valley.

The Pelorus Gravels are overlain by locally derived clay-rich gravel, and a deeper gravel and clay layer, which is water-bearing. The upper clay-rich gravel is called the Kaituna Formation. This formation is poor water bearing and most likely to have been deposited by the Kaituna River towards the end of the Pleistocene prior to encroachment of the sea.

The deeper, water-bearing gravel layer is most likely to consist of fluvially reworked Pelorus Gravels that have been deposited by the Pelorus River.

Almost all of the production wells in the Havelock area are screened in the deeper gravel layer which is about five metres thick at Havelock. This layer is known as the Havelock Gravels.

Well logs indicate that the Havelock Gravels are laterally extensive from the MDC supply wells northwards (Fig. 40.3). They are however not always productive. The tidal response and water quality results differ between wells in close proximity (Royds Garden -1994) and this suggests that the aquifer consists of localised lenses of more and less permeable material.

Holocene sediments

Logs from wells adjacent to the Havelock Estuary record a succession of Holocene sediments that overlie the Pleistocene gravels. These sediments represent a period of climatic warming and on-lapping of the sea as global sea-levels rose between 120 and 130 metres due to melting of the continental ice caps. This succession is apparent in the MDC supply wells as a two to five metre thick layer of estuarine blue clay and gravel which forms a confining layer. The clay thickens towards the coastline and reaches a depth of 15 metres of marine clay and sand at Havelock Wharf.

Sediments at the base of the marine unit at Havelock are thought to be about 14,000 years old (Singh - 2001). Recent studies of microfossils (Foraminifera) in shallow marine sediments have provided strong evidence that Havelock and the Marlborough Sounds have been subsiding at a rate of 0.7 to 0.8 metres per thousand years over the last 7,000 years (Hayward et al. - 2009).

Both the Pelorus Gravels and Holocene marine sediments are overlain by yellow clay which has some minor gravel lenses. These sediments were deposited by the Kaituna River in the last 7,000 years and are typically not water-bearing. These sediments are about five metres thick in the Havelock area, but may be much thicker southwards beneath the Kaituna Valley.

Exploration wells drilled near the Kaituna saddle encountered 40 metres of clay-bound, angular schist gravels with silt and clay lenses (Mortimer & Wopereis - 1997), although, it is likely that much of the material has been derived from the hillside rather than fluvial material.

Recharge and flow patterns

Groundwater in the Kaituna Valley is predominantly recharged by rainfall infiltration and streams. Annual rainfall in the catchment varies from 1200 millimetres to over 1600 millimetres at higher elevations.

Figure 40.4: Lower Kaituna Valley and estuary

Groundwater flow is driven down the valley towards Pelorus Sound by the topographic gradient. The rate of flow is likely to be greater in the centre of the valley where sediments are more permeable.

Groundwater levels have been observed to decrease with depth. The static water level in exploration well P27w/0497 decreased with depth from 1.6 metres near the surface, to 5.2 metres at 50 metres depth. This indicates that groundwater is moving downwards through the sedimentary sequence as the sea is approached. The most likely reason for this is that the Pelorus Gravels thicken to the north. It is expected that groundwater eventually moves upwards again and is discharged offshore into Pelorus Sound, although groundwater springs have yet to be identified.

Water levels are continuously monitored at the MDC supply well P27w/0124 and this monitoring record does not show any long term decline in water levels (PDP - 2008). Water levels have also been recorded at wells P27w/0114 and P27w/0245 from September 2005 to August 2007 (PDP - 2008). These records show that water levels are lowest from March to May, following the drier summer period.

Groundwater levels in the Havelock and MDC supply wells are influenced by tidal fluctuations. Because the aquifer is confined and the sea is close, there is no time lag between tides and the response of wells. A tidal response at P27w/0124 is only apparent for three hours either side of high tide, suggesting that tidal loading only occurs when the tidal flats north of Havelock are being covered (PDP - 2002) (Fig. 40.4).

Hydraulic properties

Pumping tests have been carried out on three wells in the Havelock area, two at the new MDC wellfield and one at Havelock Wharf. All three tests were carried out on wells screened in the Havelock Gravels and returned very high transmissivity values between 2218 m^2/day and 7200 m^2/day.

Storativity and aquitard leakage coefficient values are identical for the two MDC tests. The storativity value

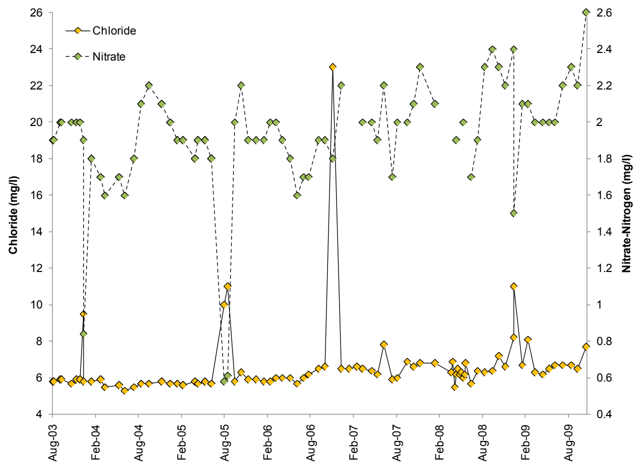

Figure 40.6: Former Havelock public water supply wellfield groundwater quality trends

is typical for a confined aquifer, although the leakage coefficient is indicative of a leaky aquifer. Pelorus Gravels are locally more permeable than the Havelock gravels and support higher well yields.

Groundwater chemistry

The main groundwater quality issue affecting Havelock wells has historically been seawater intrusion. Microbial contamination of the town water supply from upstream dairy and sheep farming is also a potential risk for the municipal water supply wellfield near the Kaituna River. Monitoring of the MDC supply well P27w/0124 however, has not detected the presence of microbes to date.

A sample of groundwater from the old public water supply well P27w/0114 in December 1989 had a moderately high chloride concentration of 270 g/m^3 (Fig. 40.6). The major element composition at that time was dominated by sodium and chloride (Fig. 40.5). These are the key salts in seawater, which demonstrates that the aquifer boundary with the estuary is nearby.

Chloride levels at this well and its predecessor well have varied significantly as a direct result of pumping inducing seawater to migrate inland or upwards through the confining layer into groundwater.

Recent monitoring at well P27w/0114 shows that chloride now averages 6.5 g/m^3, which is lower than that measured in groundwater from the new public

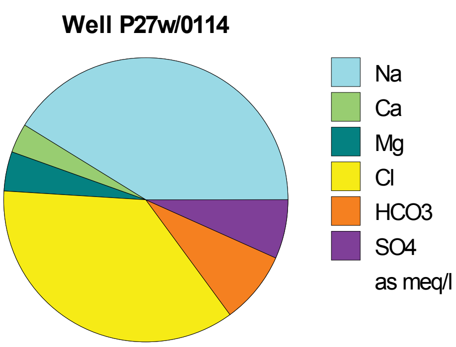

Figure 40.5: Well P27w/0114 groundwater composition

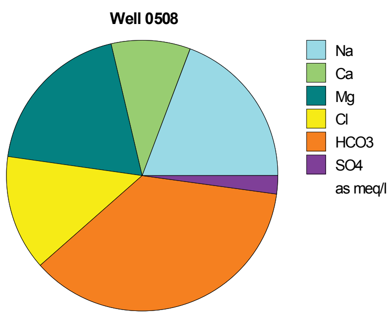

Figure 40.7: Well P27w/0508 groundwater composition

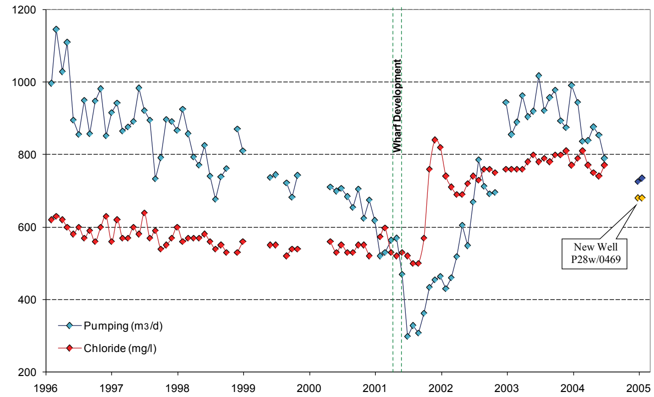

Figure 40.8: Pumping versus chloride trends at Sanford production wells

water supply wells, and significantly less than the 1989 level. Historically, salinity levels were observed to increase in both of the now obsolete camping-ground public water supply wells in response to higher pumping rates.

Unfortunately few of the historic records prior to 2003 are available, but salinity levels in well P27w/0114 have declined since pumping ceased while nitrate-nitrogen and chloride concentrations have varied between 2003 and 2009. Chloride concentrations shown in orange have increased slightly from 6 g/m^3 in 2003 to about 8 g/m^3 in 2009. Nitrate-nitrogen concentrations have increased over time from 1.9 to 2.6 g/m^3. This may indicate that a higher proportion of younger water is being drawn into the aquifer over time and may follow a seasonal cycle.

The chemical composition of groundwater from the MDC public water supply well P27w/0508, is quite different to that of the saline affected well P27w/0114. Well P27w/0508 intercepts dilute water that reflects a combination of rainfall or Kaituna River water (Fig. 40.7). This is similar in composition to most young, dilute type groundwaters in Marlborough.

Chloride at well P27w/0508 averages 11.2 g/m^3 and has increased slightly over time (PDP - 2008). Occasional increases in chloride concentration have occurred at the new well-field after prolonged periods of higher groundwater demand. For example chloride reached a peak level of 28 g/m^3 in April 2007. Nitrate-nitrogen averages 0.7 g/m^3 at the new supply well, and has remained steady since 2002.

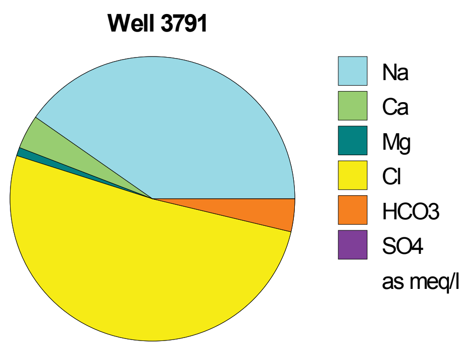

Figure 40.9: Well 3791 groundwater composition

At the Sanford wells on the Havelock Wharf, chloride concentrations are much higher than the drinking water standard, but are suitable for mussel processing.

During April to June 2001, the Sanford wharf was re-piled and this work appears to have increased the permeability of the confining layer in the vicinity of the Sanford wells. Chloride concentrations averaged 560 g/m^3 prior to October 2001 and rose sharply to an average of 765 g/m^3 following wharf development (Fig. 40.8).

Oxygen isotope samples from well P27w/0149 indicate that groundwater is derived from local rainfall (Royds Garden - 1994). Samples from well P27w/0124 give a mean age of 24 years and contain no water less than a year old (PDP - 2002a).

One interesting and as yet unexplained phenomenon in this area is the presence of salty groundwater originating from a 20 metres deep well 3791, in the upper reaches of Kenningtons Road. The explanation for its salty nature is unclear, but it may be linked to older, evolved water or a localised mineral deposit. The water from this well is dominated by sodium and chloride (Fig. 40.9). The concentration of chloride is around 10% that of sea-water and tastes very salty to the tongue. Other salts also exist in this groundwater at levels which can affect human health, including boron and manganese. The water is very hard due to high levels of calcium and magnesium. High levels of ammoniacal nitrogen indicate advanced reducing conditions which in turn explain the presence of other dissolved chemicals such as iron and manganese in the water. The level of silica is possibly the highest observed in Marlborough and is often an indicator of very old groundwater. The existence of this type of water demonstrates the unpredictable nature of groundwater chemistry and the potential influence of geology.

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