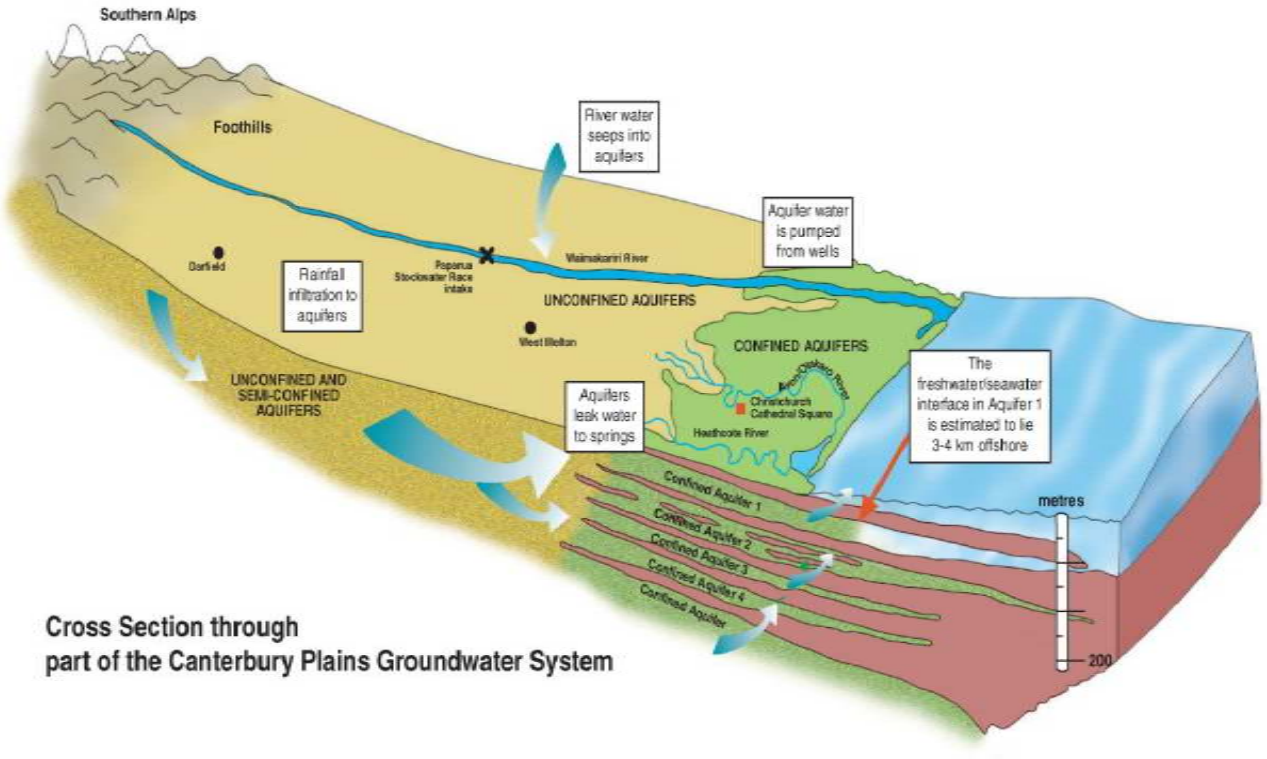
The Fate of Christchurch’s Drinking Water

What effect might CPW have if they 're-plumb' Canterbury’s plains?

The conventional model for the Canterbury Plains



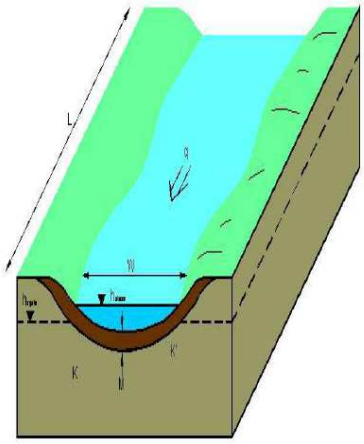
Underneath the alluvial plains of Canterbury, it is believed there are beds of river stones down to a depth of 350 meters which allow the passage of water more or less freely. Water is able to pass effectively downhill or traversing a gradient of pressure. Hindrances to this flow exist in the form of lenses of finer material, sand and clays or old bench debris. Such lenses may form layered galleries of aquifers which may impede water from rising to the surface under pressure; these are termed confined aquifers.
Conventionally it is considered the resource of water available under Christchurch originates in leakage from the Waimakariri river (50%), rain recharge falling on the plains, and water from further west and the foothills. Water is considered to be lost from this system by abstractions for irrigation, industry and public water supply, springs which collectively feed the cities streams, and outlets to the sea including possible resurgence offshore.

In this circumstance it is hoped Christchurch's aquifers may be protected from farm fouling (nitrates, phosphates and pathogens) by the creation of a land use controlled area to its west and bounded by the South Waimakariri river bank.

By extracting water from the Rakaia and Waimakariri rivers, CPW propose to allow intensive irrigation of 65,000 hectares of arable land.

In order to allay concerns over the threat to environment from farm runoff, CPW defended its position in Resource Consent hearings (2008,09). It maintained nitrates would be contained by best practices, phosphates would not be a problem as the ground was flat, and other contaminates would

be only in shallow ground water. The hearing commissioners where shown hydrological modelling



$$\lambda = \frac{\Delta q}{L \Delta h} = \frac{-KW}{M}$$

Gauging and Piezometric surveys

Infiltration/Seepage measurements

of various types and were inclined to accept the work done by **Aqualinc consultant, J. Weir.**

By taking inputs of leakage from the Waimakariri and Rakaia, rainfall recharge and other sources, assessed by groundwater measurements from a range of wells across the plains, Aqualinc attempted to describe the flow regimes for ground water under the influence of development by CPW. Points of interest were;

- Water mounding or lifting the background water table level under the influence of applied irrigation water.
- The degree of leakage reduction into aquifers from the Waimakariri after the river is reduced by abstraction.
- Whether Christchurch's western buffered land use area could come under the influence of farm runoff from the CPW command area.

The numerical modelling, based on inputs of 7 to 8 cumecs leakage from the Waimakariri to aquifers and best practise intensive application of irrigation water, was able to show Christchurch would receive a lift in shallow ground water flow which would support its streams, and not come under the influence of serious contaminate plumes.

Areas south and east of Christchurch will however experience water mounding and contamination plumes into groundwater.

However this model was based on questionable assumptions.

There is no conclusive study of plains plumbing to determine either the quantity of water leaking from the Waimakariri bed, nor its place of leakage. A 7 to 8 cumec flow is assumed for the model. Nor is the assumption of a 1 cumec reduction of loss to the Christchurch aquifers as a result of abstraction from the upper river able to be justified by research. Further more, studies published since the CPW hearings, and supported by a number of Canterbury’s foremost hydrologists conclude that so called impervious layers making up the aquifer cake are not as leak proof as may have previously been thought.

What are the implications for a critical analysis of the modelling as CPW commissioners understood it?

- Assumptions of inputs may be too wide of the mark to create a reliable picture.
- Assumptions of protection by confinement of aquifers may be false and have implications for the plains other than just in vicinity of Christchurch.
- Reduction of loss from the Waimakariri may have a critical bearing upon Christchurch aquifers ability to resist contamination. Something which has not been considered by the modelling, nor the commissioners.

To calculate the likely contribution from the river, Darcy's equation for flow through a membrane may be adopted.

Aqualinc adopted Darcy's model but imposed assumptions upon the inputs. The model was 'calibrated' (or fiddled) to give an input into the greater computation of the old assumption of 7 - 8 cumecs. This in the face of no satisfactory assessment of the actual flow loss from the river. The Aqualinc model then produced a 1 cumec reduction in flow after CPW's intended take.
Actually the critical variable W or width of river was taken as 50 meters, when the rivers' width is more like double this at stable flows. Factor K is unknown for Canterbury river beds and may be highly variable along the river and may also vary considerably where the river bed is being churned over in flood events.

So a guess has been made to supply a computer model, whereupon decisions were taken.

Using Darcy's law as a rule of thumb and taking more likely inputs from observation and comparisons made from elsewhere, a good case can be made for a 40% reduction in leakage from the Waimakariri as a result of abstraction. With this effect a threat from other surface contaminates far worse than farm pollutants, becomes likely. If pressures of resurgent flow are reduced west and under Christchurch then contamination plumes are enabled to penetrate deeper. We are considering dump materials, hydrocarbons, and urban runoff. The confined aquifer system may not be entirely impervious.
Not only are we likely to see a reduction of positive pressure but there is likely to be a shouldering aside of these clean inflows by the water mounding effects from irrigation. The modelled trend in ground water flows may swing a little north on its path to the sea. It may find a reduced flow equilibrium.

Further more the effect of more stable river bed conditions as the river slows its churning through river bed shingles, may decrease the permeability of the river bed, furthering aquifer depletion.
So what we have is a situation which many of us find unacceptable. Most likely there will be trace pollution reaching our public water supply. There is an outright loss of water for people south of the city. Water mounding delivers severe drainage problems for good land east of CPW. And there is the continued degradation of lowland streams and Lake Ellesmere.

So, too bad, those affected didn't squeal loud enough when the consents were being dished out, or didn't have an economic imperative. But what of Christchurch's drinking water remaining fit to drink within acceptable standards? Christchurch's drinking water gazumps, economically speaking, anything farmers can cook up on the plains, and decisions are being made without an understanding of the rate of flow into it's aquifer nor the conditions under which it occurs.

Edward Snowdon