Improving security of groundwater supplies

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Groundwater is a nationally critical resource and there are nearly 1500 registered water supplies in this country, with a good proportion of those taking from groundwater bores. Groundwater has many advantages over sourcing drinking water from rivers and lakes, as the water has been naturally filtered and stored away from the various activities at surface; yet only a small proportion of the population understand bores or even recognise where their water comes from.

People generally want clean fresh drinking water. However, funding the infrastructure required is usually the challenge. Drinking water contamination in the Havelock North water supply in August 2016 highlighted the importance of secure bore water. Many in the industry are now asking if our drinking water supplies are as secure as they could be and what constitutes a secure bore water?

Bores are our gateway to vast underground stores of drinking water. Bores need to be designed, installed and operated in such a way that the quality of the groundwater is maintained from source through to its delivery point.

If we think of a bore as delivering a food grade product, then logically a bore and the bore-head should be clean and form a tightly fitting seal into the underground reservoir from which it draws. Ideally it should be sited away from sources of contaminants although in some cases this is not possible and treatment processes are needed to clean it up and/or reduce the risk to an acceptable level.

Generally, the most vulnerable part of a bore to contamination is the bore head because it provides the physical connection between the land surface and the underlying well. A bore head can be a hive of componentry with pipes, valves, cables, joints, access points and connections to pumps.

It's a challenging multi-disciplinary design question as the bore head brings together elements from nearly all of the engineering disciplines (mechanical, electrical, structural, civil, and environmental).

Traditionally, wells were placed into underground

chambers. Ironically this was thought to protect the well head when in fact it is now recognised these structures can create both a hazard to the bore from contamination, and, a hazard to operators due to the confined space access. Following the Christchurch earthquakes, some of these heavy concrete structures caused damage to water supply bores and hindered the reinstatement of the water supply. A more secure, resilient and efficient approach to bore heads is to install them above ground, allow for movement through flexible connections, and locate them so potential sources of runoff and contaminants are excluded.

An air vent acts like a snorkel for a well. Each time a well is pumped, the water level inside the bore is drawn down which inevitably displaces the air sitting inside the well. If no vent is provided, then the air and/or water can be drawn in across openings or gaps in the bore head or casing. A vent provides a controlled conduit for the well to "breathe". Ideally bores should be sited outside of areas that can be flooded, but this is not always possible, and a vent will assist in preventing flood water entering the bore if it becomes submerged so that the supply can continue during such events.

Cement grout seals are also an area for improvement in secure drinking water bores. Historically, grout sealing of the space left between the bore casing and the strata was not always done. This leaves a potential pathway open at the bore allowing water to preferentially migrate down the outside of the casing and into the screen.

Many supply bores that were drilled 20-plus years ago are still in service and many do not meet the criterion for secure bore-head status under the Drinking Water Standards for New Zealand (DWSNZ). While it is difficult to retrofit grout seals, it is relatively straightforward to install them during the construction of a new bore and should be included for any new drinking water supply bore, particularly one for which secure status is sought.

Action is required to improve the consistency and quality of bore design and construction. The authority over how bores are designed and constructed usually sits with the regional councils, however many do not have specific rules or standards for drinking water bores or perhaps the rules have not taken into account the requirements in the DWSNZ.

Regional councils could readily raise the bar for drinking water bores and play a more active role in improving good practice across the industry.

Improving aquifer security

Some aquifer systems are more resistant to contamination than others, depending on the hydrogeological conditions found in the wellfield itself and also the up-gradient recharge area.

Some aquifers are shallow, thin and close to rivers and act as an extended river braid with a strong, direct connection to the surface water, whilst others are deep and may receive their recharge water from many kilometres away and over a long duration.

These factors, combined with how an aquifer is tapped, will determine how secure a supply is and how much additional treatment is required to make it safe as a water supply.

Similarly, discharges into or onto the ground can affect groundwater quality; ensuring a "safe" distance is maintained between our bores and the discharges is a very important step in managing the first line of defence for our drinking water quality.

Bores are stationary objects, but the activities around them are not, especially when you consider the life of a bore is normally 20-30 years.

As many in the industry will know, what can be the edge of town can rapidly become a very different place over the course of 30 years. What may have been a low risk site and a reliable source of clean drinking water can over time become affected by changing land use: septic tanks, ditches, agriculture, urban sprawl, and abandoned bores all increase the risk profile of a drinking water bore to potential contamination. Ongoing vigilance and management is required.

Groundwater age is an important indicator of flow paths and risk; but on its own should not be given too much emphasis when determining if a drinking water source is "secure".

Just because an aquifer contains "older" groundwater doesn't necessarily mean it is not vulnerable to contamination, and conversely, younger groundwater may be more "secure" if its source catchment doesn't contain sources of contaminants that can affect human health, and providing that appropriate land use controls are in place.

It is important that ongoing monitoring of water quality continues and is regularly reviewed and tailored to the specific catchment contamination risks.

The role of vertical leakage in delivering water to a bore is important when considering where the water is coming from.

Models of aquifer systems readily demonstrate that after relatively short time periods, most of the flow to a well can occur as leakage into the pumped layer from the overlying layer. Initially the pumped layer will drawdown laterally, but once a wide enough area is drawn from, the overlying layers start dewatering. If pumped long enough, the vertical flow can reach the surface and thus can draw in any surface or shallow contamination that is present.

The degree of this vertical leakage varies from one aquifer to another.

This has implications for the risk of contaminants migrating through the ground and to a drinking water bore. Those bores which show high rates of vertical leakage, which can only be assessed via robust pumping testing, should be treated as more vulnerable to local sources of contamination at the surface. The Havelock North contamination event has demonstrated just how quickly and severely contamination can reach a bore in a semi-confined aquifer setting, and why more thorough assessments of localised flow patterns and leakage is required. The assessment of 'semi-confined', or 'leaky-confined', aquifers in the DWSNZ needs further clarification.

Secure bores need thorough design and planning, and are more likely to be successful when there is collaboration between a skilled hydrogeologist or engineer and an experienced drilling contractor. The role of a recognised "expert" in the planning, design and installation of a drinking water bore is important in maintaining standards and assessing contamination risks to a water supply, as is identified in the DWSNZ.

Such specialist knowledge should be more routinely included in water safety plans and the auditing by Drinking Water Assessors.

Improving bore and groundwater source security is an important step towards achieving meaningful change and protecting the health of all New Zealanders.

Getting the basics right in bore design and construction is critical to delivering clean and safe water. Our underground reservoirs are vulnerable to contamination and robust assessments of the hydrogeological conditions assist in understanding the first line of defence.

Vigilance around land use activities around drinking water sources is required by councils, planners and community health agencies.

We owe it to the people of Havelock North and the New Zealand community to improve the quality of infrastructure and ensure our drinking water resources are safe and secure. **WNZ**