Challenges of Small Town Water Supply Upgrades: The Reefton Experience

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Abstract

Aurecon was engaged by the Buller District Council to upgrade the drinking water supply for the township of Reefton, after it failed to meet the *Drinking Water Standards New Zealand* (DWSNZ), as required by the *Health (Drinking Water) Amendment Act 2007* by 2014.

Upgrades required to meet the DWSNZ criteria included, amongst others, installing a cap around the existing supply well; installing a water treatment plant as there is currently no water treatment and lining the existing ageing open concrete reservoir and installing a covered roof over top of the reservoir.

An application was made for a subsidy from the Ministry of Health under the Capital Works Assistance Programme. However the approved amount was around 25% less than expected. This was due to discrepancies in population records and differing interpretations of what represents a capital component of a project.

This lower than expected funding was significant for this community, who have previously made it very clear the project should not proceed if it would result in a significant cost to the community. To deliver improvements to the water supply, our design approach had to be modified and compromises made in order to proceed in a manner affordable to Reefton.

Keywords:

Potable, Water, Treatment, Reefton, Drinking, Upgrade, Funding, Aurecon

1 Introduction

Following the Health (Drinking Water) Amendment Act 2007, which required all water supplies providing for over 500 people to comply with the Drinking Water Standards New Zealand (DWSNZ) by 2014, an investigation was carried out on the water supply of the town of Reefton, on the West Coast of the South Island.

The investigation found that the existing water supply was not secure under the criteria of the DWSNZ, and would need upgrades to meet the standard. To assist water supply network owners and operators to meet the criteria in the DWSNZ, the Ministry of Health introduced the Drinking Water Assistance Programme (DWAP) Capital Assistance Programme (CAP), allowing upgrade schemes to obtain large subsidies for the funding of capital works. This subsidy was applied for to fund the upgrades proposed for the Reefton water supply.

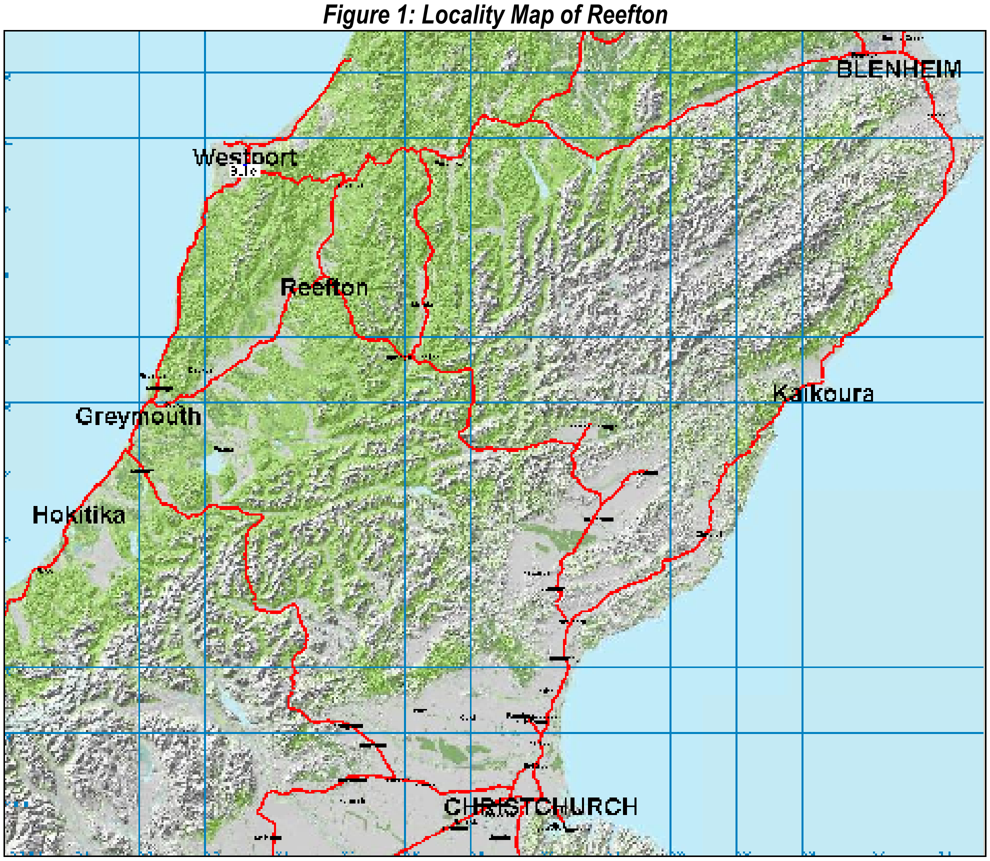
This paper discusses our experiences in working on a financially constrained project that would not have been able to proceed without the large subsidy on offer, and our experiences on this project with the DWAP. The Reefton community is not wealthy, and significant upgrades are required to bring the project up to standard. Small changes in the allocated funding therefore had large impacts on the outcomes of the project, the response from the Reefton community and how the project was funded.

2 Reefton

Reefton is a small township on the West Coast, which originated in the mid-late 1800's after the discovery of a gold bearing quartz reef in 1870 (hence the name Reefton). From 1872 until the mine closed in 1951, over 4 million tonne of quartz was mined from the Reefton area, producing a total of 64,700 kg of gold. Reefton also boasts the record of becoming the first town in the Southern Hemisphere to get electric street lighting, in 1888.

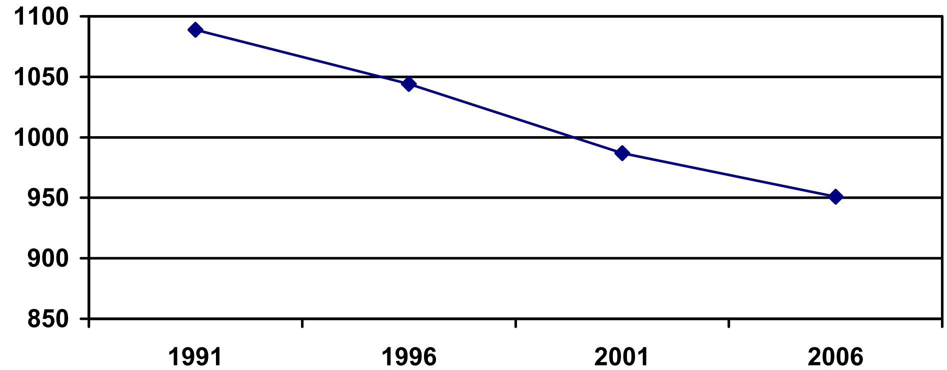
Figure 1 presents a locality map of Reefton.

Figure 1: Locality Map of Reefton



The halt of gold mining in the Reefton area saw decline in Reefton's population and economy. The town currently has a population of 951 residents (2006 Census) and a median income of $16,800 per annum. Census data, since 1991, shown in *Figure 2: Population decline in Reefton*

Figure 2: Population decline in Reefton



3 Reefton Existing Water Supply

3.1 Water Source

The existing Reefton water supply is sourced from a shallow well adjacent to the Inangahua River. The well is 14 metres deep (*Photograph 1*), extracting water from the alluvial gravels adjacent to the riverbed.

Photograph 1: Water supply well

Water is abstracted from the well using surface mounted pumps, which are housed in a pump station adjacent to the well, next to a public reserve. There are two pumps, once of which is relatively modern (2007) and used as the duty pump. The other pump is very old and remains only as a backup standby pump, which is currently not used in the day to day running of the pump station.

The pump station has no generator or back-up electricity source, SCADA or telemetry systems. Pump on/off operation is controlled by the water level in the reservoir, with the levels relayed to the pump station via a cable.

Water samples collected directly from the well show that the water is of relatively good quality. All chemical determinants are below the Minimum Acceptable Value in the DWSNZ. A full table of contaminants compared to maximum acceptable values is provided in Appendix A**Error! Reference source not found.**. However, there is farming in the upstream catchment and while water is not taken directly from the Inangahua River, the close proximity of the well to the river affords very little protection against contamination. *E. coli* has previously been detected in the water.

3.2 Water Reticulation

There is currently no water treatment. Water is pumped from the well directly into the town reticulation. The town reticulation is connected to an open reservoir above the town via a single rising/falling main, therefore when the pump is off the reservoir feeds the town supply, while the pumps feed the town directly when on.

The reservoir is an open concrete structure measuring approximately 45m long x 15m wide x 1.75m deep, and was constructed in 1959-1960. Due to exposure to sunlight, the reservoir is prone to high algal growth, and provides habitat for insects, frogs and tadpoles. An open drain approximately 1 metre deep was originally constructed around the back of the reservoir, however it is suspected that the hill above the reservoir has subsided and filled this in. It has been reported that one time a slip from the hill above caused material to enter the reservoir. The state of the water in the reservoir can be observed in *Photograph 2*.

Photograph 2: Reefton water supply reservoir

Construction of the reservoir was undertaken using a gantry crane to transport materials to the reservoir site due to difficult access by truck. The site access currently consists of a steep, narrow gravelled track that would be unsuitable for large trucks or crane trucks to navigate.

The town reticulation contains some very old galvanised steel and cast iron pipes, in much deteriorated condition. Leakage from the Reefton reticulated network is significant. Average daily water usage is well over 1,500 m^3, which is a lot considering the population and the relatively low demand for garden irrigation.

4 Health (Drinking Water) Amendment Act 2007 and Drinking Water Assistance Programme

The *Health (Drinking Water) Amendment Act 2007* introduced the requirement that towns with populations in the range of 501 to 5000 must comply with the *Drinking Water Standards New Zealand* (DWSNZ) from the 1st of July, 2011 (this was subsequently amended to 1 July 2014 for Minor Drinking Water Suppliers).

The purpose of the *Health (Drinking Water) Amendment Act 2007* is to secure the water supply and prevent unusual or unexpected circumstances in the supply's contributing catchment contaminating the water source and causing a large public health crisis. Such events have occurred previously overseas, such as in Walkerton, Canada in May 2000. Heavy rain caused animal faecal matter to get washed into the town's water supply's catchment. The water supply was not well monitored and subsequently not sufficiently treated. 2,321 of the towns 4000 residents became sick, 65 were hospitalised, 7 died and 30 are on kidney dialysis for the remainder of their lives (www.moh.govt.nz).

The catchment contributing to the Inangahua River currently contains or has previously contained agricultural, residential, and forestry land uses, as well as containing a busy state highway, all of which could contribute to contamination of the water supply. At present there are no safety barriers to prevent contamination of Reefton's water supply from causing an outbreak of illness in the community.

While Reefton's water is sourced from a relatively clean source, the supply is not secure. The supply does not comply with the DWSNZ criteria, as the 14 metre deep well cannot be given a secure status if it is in an unconfined aquifer and between 10-30 metres deep until it can be demonstrated that:

- Surface or climatic influences cannot have any significant effect on the groundwater
- The bore head is satisfactorily protected
- No *Escherichia Coli* (E Coli) has been detected in the water for a five year period.

The existing well currently does not meet any of these criteria. *E. Coli* has already been observed in the water supply, and even if improvements are made to the well head, it is unlikely that no *E. Coli* will be detected in the future.

Also it is expected that water quality at the tap will be worse than a sample directly from the well due to the age of the reticulated network, the open nature of the reservoir and the time that water spends in the network without treatment and disinfection.

It is clear that significant and costly upgrades will be required to bring Reefton's water supply up to current drinking water standards.

The Central Government subsidy under the Drinking Water Assistance Programme (DWAP) introduced the possibility that these upgrade requirements could be made affordable for the community. For a population of fewer than 1000 people and a deprivation index of 8, a DWAP subsidy of up to 95% of the construction cost appeared to be available. Due to the prospect of securing such a large subsidy, the project seemed a certainty and a necessity.

5 Proposed Upgrades

5.1 Overview

Aurecon was engaged by the Buller District Council (BDC) to investigate upgrading the Reefton water supply in 2008. Investigations and concept design of the project were undertaken, with the concept design report issued in March 2008.

When assessing the upgrades required to the water supply, several key outcomes were identified; the need for either a new reservoir or a cover and lining on the existing reservoir, back-up pump and electricity source, protection of well from possibility of contamination, filtration and disinfection.

BDC had also been advised that the DWAP subsidy could also be extended to upgrades to the reticulation, where a public health issue existed. However, it was decided that upgrading the reticulation system would need to be diferred until another time due to a shortage of council funds.

It is also important to remember that while the aim of the project is to secure capital funding from the Government to reduce the cost of the project on Reefton ratepayers, the final system needs to have low maintenance costs in order to not be an ongoing financial burden on residents. Therefore, while it is tempting to install a very advanced, high tech system, the lifespan and replacement costs of the components of the water supply and treatment system need to be considered.

5.2 Water Source

The possibility of sourcing the water supply from an alternative secure aquifer was investigated. However, there was very little data on groundwater around the Reefton area, as there are only three existing bores in the basin. The option of a round of exploratory drilling would have been relatively expensive for this community, with no guarantee that a suitable aquifer would be found. Given this, combined with the fact that the water quality of the water from the existing well has historically been of suitable quality for treatment and supply, it was decided to continue sourcing the water from the well in the river bed.

It was identified that the well would require a cap to prevent any contamination of the well source from surface water and any spills running down the sides of the well chamber. It was decided that a concrete cap measuring approximately 2.35m x 2.49m would sufficient. In addition, existing penetrations through the wall of the well need to be made water proof.

Installing water level measurement within the well will enable help to safeguard the pumps against damage from over pumping. It will also indicate over time whether the well needs maintenance.

5.3 Pump Station

The existing pump station building was found to be satisfactory, but does require some minor improvements to make it vermin proof. The back-up pump however is old and no longer suitable. Current pump operation sees the main pump as the sole operating pump. A replacement back up pump was proposed to be installed to allow alternate operational duty of both pumps to ensure a more robust and reliable system. New pumps were also considered necessary because the addition of the treatment plant would provide additional head loss through the pumped main, which would reduce the output of the existing pumps.

The electrical controls are also very old and their reliability is questionable. Only the newer pump is operated through a soft starter and ideally VSDs should be provided to enable the pumps to be ramped up and down gently enough to prevent surges through any filtration system that might be installed as part of the treatment process. Also, as a result of the proposed water treatment, the operation of the pumps will need to be changed to permit the delay required for the UV lamp to come up to operational status, prior to the starting of the pumps. The pumps will need to be able to be automatically shut down as well, if a fault with the treatment system occurs.

A telemetry system is needed to relay pump station operation and flow data back to the BDC offices in Westport. Installing a continuously monitored flow meter will allow BDC to track pump performance, while water level measurement of the well and reservoir should be installed to allow BDC to better monitor performance. Installing a flow meter also will allow the Council to better record and monitor water demand.

5.4 Treatment

Treatment is required to primarily remove Priority 1 contaminants bacteria (such as *E. coli*) and protozoa (such as *cryptosporidium* and *giardia*).

Based on an assessment of the catchment land use, treatment will be required to meet 4 log protozoa removal (99.99%), in accordance with the criteria presented in Table 5.1a of the DWSNZ (i.e. surface water with a pastoral catchment with low concentrations of cattle, sheep, horses or humans).

Treatment options consisted of the following:

- Option 1: Cartridge filtration and UV disinfection
- Option 2: Cartridge filtration, UV disinfection and chlorination
- Option 3: Cartridge filtration and chlorine dioxide disinfection.
- Option 4: Membrane filtration
- Option 5: Membrane filtration and chlorine disinfection
- Option 6: Granular media filtration and UV disinfection

Membrane filtration was ruled out early on due to the operational requirements. Membrane filtration relies on cleaning chemicals which need to be neutralised and disposed of to the foul sewer network. One of the key requirements of Reefton's water treatment system is cost effective maintenance and operation due to the socio-economic background of the community and its relative remoteness from main service centres.

Chlorination, or other such treatment that provides a residual, is desirable in order to prevent re-growth of bacteria and protozoa while water is being transported around the reticulated network. However, the community expressed strong opposition to chlorination of the water supply due to the taste it can impart on drinking water, leaving UV disinfection as the strongest candidate for disinfection.

UV disinfection requires turbidity to be removed from the water supply to ensure the water is of sufficient clarity for the UV rays to fully penetrate through the water and kill pathogens. The water supply has historically had low levels of recorded suspended solids; however there is not sufficient data to rule out the need for filtration as part of the overall treatment process.

Cartridge filtration and granular media filtration are both considered to be sufficiently effective methods of filtration. Cartridge filtration has a much lower initial capital cost, but potentially higher ongoing operation and maintenance costs if the cartridge filters end up needing to be frequently replaced. As the majority of the capital works is to be funded by the Central Government, and Reefton's ratepayers are going to have to pay for the ongoing maintenance and operational costs, it was considered that granular media filtration is the optimal solution for filtration.

Continual monitoring of quality of the water supply at outlets in the township is required if chlorination is not used. If the water quality standards are not met then chlorination will need to be introduced, however this is only considered a last resort. It is hoped that improvements to the reticulated network and reservoir, should be sufficient to minimise the chances of bacterial re-growth.

5.5 Backup Power Generation

There is currently no backup power supply, nor the provision to connect a portable generator. Given Reefton's remote location and the potential for failures in the reticulated power supply, the provision for backup power generation was considered necessary to provide more security to the supply.

A single generator capable of operating the pumps and the treatment process was proposed.

5.6 Reservoir

The options of either upgrading the existing reservoir or replacing it were considered. Following the consideration of these options, it was decided that the most cost effective approach would be to upgrade the existing reservoir. The upgrades required included constructing a cover to prevent animals using the reservoir as habitat, and to prevent infection of the water supply from dead animals in the reservoir. A cover over the reservoir is required to prevent algal growth and reduce the risk of contamination from external water sources.

It was also decided that further water proofing of the old concrete was required to prevent treated water leaking from the reservoir, and to prevent contaminants entering the reservoir through the concrete.

Options for the cover over the reservoir consisted of a solid roof, a floatable cover or a completely enclosed synthetic bladder. The solid roof option was chosen over a floatable roof or enclosed bladder due to durability and ease of future access to the reservoir for maintenance purposes.

Site access is by a steep, narrow and winding four-wheel drive track that would be unsuitable for access by any kind of crane truck. A section of the track can be seen in *Photograph 3*. Due to very difficult access to the site, different material options for the solid roof were considered, based on their ability to be either constructed on site or lifted to site with a helicopter. A steel frame solution was ultimately adopted.

Photograph 3: Section of access track to reservoir

Options were considered to water proof the concrete reservoir, including the installation of an impermeable liner or having a waterproof coating applied. Following investigation the preferred option was an impermeable liner that could be welded together.

The reservoir will need to be drained to enable placement of the impermeable liner and construction of the roof. It is proposed that two 30,000 litre plastic storage tanks are installed on site as temporary storage during construction. The tanks will remain in place on completion of construction and will be connected to the reservoir. This will enable future maintenance on the reservoir to be carried out in a much more trouble free manner.

6 Community Consultation

The poor condition and performance of Reefton's water supply has been well known for many years and intentions to upgrade this supply had been communicated to the community on numerous occasions in the past. Reefton's water supply is entirely funded by the residents of Reefton, so proposed upgrades with significant cost implications to the community had never been warmly received in the past. The potential for a 95% government subsidy had livened the debate on this issue and given BDC the mandate to proceed with the concept design for the upgrades.

The most meaningful community consultation took take place at the point where the concept designs for the upgrades were near completion and the upgrade cost (around one million dollars) had been accurately estimated.

An evening meeting was held with the Reefton community to outline the proposed upgrades and seek community input. This meeting was chaired by BDC's Operation Manager, with Aurecon presenting the technical aspects of the proposed upgrades and the DWAP Technical Assistance Programme Facilitator presenting information about the drivers behind the latest drinking water legislation and the government funding available.

Based on the general mood of the meeting, it would be fair to say that there was still no general buy in to the idea that their water supply required any upgrade. There were many examples cited by individuals where the quality of the tap water in other locations in New Zealand did not seem as good as Reefton. The notion that there were unacceptably high risks associated with drinking Reefton water did not correspond well to the experiences of many of the long-term residents.

When broken down to its various components, the improvements around the well and the covering of the reservoir were eventually accepted as reasonable upgrades. The water treatment was the most difficult issue, with opinions ranging from fierce opposition to an attitude of; if such a large subsidy is available it may as well be taken advantage of. Residents expressed strong and unanimous opposition to the idea of chlorination of the water supply as they didn't want water treatment to affect the taste of the water.

At the conclusion of the meeting, there was a general mandate for BDC to proceed with the detailed design and tendering of proposed upgrades. However, it would be more accurate to describe this outcome as 'reluctant acceptance', rather than full endorsement, and it was clear that further consultation was expected if the costs to the community were likely to differ from that outlined.

What became very apparent from this experience was how crucial the offer of a significant government subsidy is, when trying to win over the community.

7 DWAP Funding

Based on the outcomes of the meeting with the community, Aurecon finalised the concept design of the project. We managed to trim around $110,000 from our initial estimates in order to make the project as affordable as possible. The final cost estimates for construction were around $100,000 for the well, pumping and back up power generation, around $630,000 for the treatment and around $390,000 for the reservoir upgrades (including GST, but excluding design costs).

The BDC then made the application for DWAP funding, based on our estimates, as part of the March 2008 round. The total project costs included in the application were $1,056,425 at 95% subsidy, which means the amount of funding applied for was $1,003,604.

In November 2008 the BDC were advised that their funding application was successful, but the value of the approved funding was only $754,210.75. This was $249,393.25 less than expected. The reasons for the lower than expected funding are stated as follows:

- The claim for the 95% subsidy was based on the population being below 1,000. If you refer back to the census data, this has been the case since 2001. However, the WINZ population figure is stated as being 1044 (i.e. it had not been updated since the 1996 census). Since BDC had not previously attempted to correct the WINZ population, this higher population was adopted for the funding assessment, meaning that only a 90% subsidy could be claimed.
- The pumps and VSDs were considered to be replacement costs and therefore considered to be ineligible for subsidy funding.
- The cost estimated included within the Aurecon concept design report included a 15% contingency amount, to account for unknowns. Contingency was not considered to be a capital cost and so was considered to be ineligible for subsidy.
- The cost estimated included within the Aurecon concept design report included a 5% amount, to account for BDC's cost associated with tendering and managing the construction contract. This cost was not considered to be a capital amount and so considered to be ineligible for subsidy.

This unanticipated shortfall in funding expectations represents a cost of over $260 per Reefton resident. Given the socio-economic background of Reefton and the nature of Reefton residents demands that the project has minimal community financial input, this issue is significant.

The whole upgrade project was placed on hold, between November 2008 until June 2010, while BDC considered its options. Aurecon assisted in this process, by undertaking a more detailed assessment of the total costs associated with this project and identifying if savings are possible.

According to our estimates, when design and other administrative costs are included, the total amount that will need to be funded by the Reefton community will be around $470,000 excluding GST. If this is loan funded over a 25 year period this amounts to around $6,000 pa. This alone represents a 3% increase in rates.

In addition to the capital cost there is the ongoing operation and depreciation requirements. If depreciation is fully funded, this would amount to an increase of over $40,000 pa. This depreciation is required to be prevented from ending up as additional cost to ratepayers. This will involve making direct use of the depreciation collected on the treatment upgrades to fund the renewal work required within the reticulation.

Increases to operational costs are difficult to estimate at this stage, until the final treatment process is determined. However, given the need for the community to fund a larger proportion of the capital upgrades, extra effort is going in to finding savings in the expected operational costs.

8 Current Design Direction

The funding shortfall resulted in us having to reduce the scope of the project in order to reduce the financial impact on the community. As consultant's fees are not covered under the subsidy scheme, one of the most direct means to reduce the cost to the community is to minimise our input as consulting engineers as much as possible.

To reduce the consultant fee component of the project, we suggested to break the project into a number of smaller projects and get the BDC staff to undertake as much of the work as possible.

The provision of the well cap, for example, has entirely been left to BDC to organise. We have been forced to resist the urge to tidy up the pipework within the pump shed, instead we proposed to simply size a pump and leave BDC staff to engage a local contractor to find a place for it. A similar approach will be taken with the generator and the upgrade of the electrical controls.

With regard to the water treatment, the emphasis has moved to finding a design/build solution. The intention is that the prospective supplier will carry most of the costs associated with the selection of the treatment equipment.

There are a lot of compromises associated this current design direction. To compensate for the risk that a reduced design component could increase construction costs beyond original estimates, BDC is accepts that there could be compromises necessary to the final quality and design life expectations.

However, this region has a long tradition of making do with what's available and the removal of a few fancy bits is likely to be far more acceptable to the community than requesting more funding from them.

9 Conclusions

The drinking water subsidy scheme was put on hold in September 2009, pending a review of the scheme's ability to fund those communities in the most need first and foremost. While we were able to secure significant funding for this project before the moratorium was put in place, we also learnt a number of lessons that should still be relevant when the subsidy scheme is revived in the future.

Firstly, the importance of the DWAP funding for small high deprivation communities should not be underestimated. There is often no public outcry to make their water supplies safer, therefore the prospect of gaining a large subsidy can be the critical incentive required to convince a small community to upgrade their water supply.

When reviewing this project there are several aspects we would have done differently or advised our clients to do differently when applying for DWAP funding. These are summarised as follows:

- The population recorded within the WINZ database is obviously very important. Ensuring it is up to date can have a significant effect.

- Once the application for the subsidy was submitted to the MoH, there was virtually no dialogue over the details of why certain items were included. If we had made it clearer that the VSDs were important to reduce surges through the treatment plant, or that the new pumps were required to compensate for the additional head losses caused by the treatment plant, then it is far more likely that these would not have been removed from the approved funding. In reality a reliable and resilient pumping system does play an important public heath role.

- The subsidy does not make allowance for contingencies as expected with the majority of engineering projects. We thought that a 15% allowance was very modest and within the realms of normal engineering practice. However, when undertaking another project under the drinking water assistance scheme, rather than list contingencies separately, we would simply inflate our estimated cost to provide some buffer for contingencies.

The purpose of the subsidy is to enable small communities such as Reefton to bring their water supply up to the standard required in the DWSNZ. Even with such a large subsidy, it was difficult for Reefton to be able to afford the upgrades required to meet the DWSNZ. It was found that decisions made during concept design could easily be influenced by what we could get funded under the assistance scheme, rather than what was simply the best technical solution.

An important consideration was ongoing maintenance costs. When the subsidy is available it is tempting for the designer to not worry about capital cost and purchase a technologically top of the line system, however the subsidy will not cover ongoing maintenance and operation. For this reason membrane filtration was ruled out early on in the project. Also for this reason, granular media filtration was selected ahead of cartridge filters despite the higher capital cost of a granular media filtration system.

In conclusion, the DWAP subsidy is considered to be absolutely necessary for towns such as Reefton to be able to gain access to a safer drinking water supply. However, we would suggest that a more pragmatic approach is required in order to get the best from the process. By entering into greater dialogue between the applicant and the assessor, we consider that more suitable and cost effective solutions for the community can be obtained in a more efficient manner.

Acknowledgments

- Steve Griffin, Martin Dobson and other staff at the Buller District Council

- Paul Stephenson and the chemical and processes group in Aurecon Wellington
- David Ward, Aurecon Auckland

References

The following websites were referenced when researching this paper:

http://www.drinkingwater.co.nz/supplies/supplycomplyforcy.asp?ccode=REE001

http://www.beehive.govt.nz/release/drinking+water+subsidy+scheme+hold

http://www.moh.govt.nz/moh.nsf/indexmh/drinking-water-proposed-legislation

Figure 1 was sourced from Quickmap.

Appendix A: Contaminant levels compared to maximum allowable values (MAV) from Reefton water source

Determinand	MAV	Unit	Date Sampled							
			December 2008				January 2009			
			5	15	23	29	5	13	21	29
E. coli at Pumphouse	<1	per 100 ml	ND[5]	ND	D[5]	ND	ND	ND	ND	ND
E. coli in distribution zone	<1	per 100 ml	ND	ND	ND	ND	D	ND	ND	ND
Antimony	0.02	mg/l	0.007	-	-	-	0.006	-	-	-
Lead	0.01	mg/l	<0.003	-	-	-	<0.003	-	-	-
Arsenic	0.01	mg/l	-	<0.01	<0.01	-	-	-	-	-
Boron	1.4	mg/l	-	<0.05	<0.05	-	-	-	-	-
Cadmium	0.004	mg/l	<0.0005	-	-	-	<0.0005	-	-	-
Calcium	(Note 1)	mg/l	-	3.4	3.0	-	-	-	-	-
Chromium	0.05	mg/l	-	<0.001	<0.001	-	-	-	-	-
Copper	2	mg/l	-	0.009	0.003	-	-	-	-	-
Iron	0.2[2]	mg/l	-	0.009	0.019	-	-	-	-	-
Magnesium	(Note 1)	mg/l	-	2.4	2.3	-	-	-	-	-
Manganese	0.4	mg/l	-	<0.001	<0.001	-	-	-	-	-
Potassium	(Note 3)	mg/l	-	<0.5	<0.5	-	-	-	-	-
Sodium	200[2]	mg/l	-	3.4	3.2	-	-	-	-	-
Zinc	1.5[2]	mg/l	-	<0.01	<0.01	-	-	-	-	-
Total suspended solids	(Note 3)	mg/l	<1[4]	<1	<1	-	<1	<1	<1	<1
Free carbon dioxide	(Note 3)	mg/l	-	23	24	-	-	-	-	-
Alkalinity	(Note 3)	mg/l as $CaCO_3$	-	28	29	-	-	-	-	-
Chloride	250[2]	mg/l	-	-	3.0	-	-	-	-	-
Nitrate-N	50	mg/l as NO_3	1.2	1.2	1.1	-	1.0	0.9	0.8	.09
Sulphate	250[2]	mg/l	-	3.9	3.8	-	-	-	-	-
Conductivity	(Note 3)	mSm^{-1}	-	5.8	5.6	-	-	-	-	-
Hardness	200	mg/l as $CaCO_3$	-	18	17		-	-	-	-

Notes:
1. Total hardness is (Ca + Mg) as $CaCO_3$.
2. Guideline value only.
3. No MAV or Guideline value.
4. After heavy rain.
5. ND = Not detected, D = Detected.