Lake Ohau Alpine Village Water Supply Upgrading.

Consideration of Design Options

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2 Aug 2019

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1 Executive summary

The Ohau Alpine Village Water Supply is an untreated supply that, in its current form, fails to meet the requirements of the Health Act (and its amendments) and the NZ Drinking Water Standards. Water samples show persistent faecal contamination and the consumers are required to boil all drinking and hygiene water. Health authorities have identified concerns relating to the risk of water borne illness since at least 1994 and source capacity issues were recognised around 2000, leading to multiple start/stop attempts to initiate upgrading works over the preceding two decades.

Council resolved to upgrade the supply in 2008.

Although originally conceived and designed as a very low volume (455L/day) restricted supply, around half of the connected consumers receive an on-demand supply leading to issues around equitability and placing higher demands on the source water.

Extensive engagement was undertaken with the community and representative groups from within the community, ultimately leading to the creation of a Community Task Force who worked with Officers to develop and consider solution options. The engagement process identified a preference among the community for a non-chlorinated, on-demand supply and the transition to on-demand carries the least cost to the community as a whole when compared to transitioning to restricted.

A broad range of solution options were developed and considered with the four most likely options being short-listed and subjected to more detailed consideration. The single most significant difference between the short-listed options was the source of water where one option, favoured by the Task Force, continued to use the existing rock-field gravity surface water with potential for staged supplementation with groundwater, while the balance utilised groundwater alone with the groundwater bore location varying between options.

The existing rock-field source and associated option, preferred by the Task Force, is not considered to have sufficient volume to meet on-demand service levels without supplementation.

The key source water differentiating criteria are volume availability, quality variability and treatability.

The options were evaluated by Officers and their design consultants, and the Task Force representatives and awarded a weighted score. The score considered cost, water safety, location, environment and future proofing/resilience. The highest ranked option was to source and treat groundwater from adjacent to the lake and pump this into the network as an on-demand supply.

The capital cost of options was estimated with the least cost option being the Task Force favoured option retaining the current source, although this option is not able to provide sufficient flows for the future nor on-demand supply. The rate impact was also estimated with a dedicated groundwater source option offering the least rate impact even though its capital cost was estimated to be higher. This is due to the release of depreciation funds from abandoning the existing source and associated infrastructure.

On balance, the preferred option is to:

Abandon the existing rock-field source and gain groundwater adjacent to the lake for treatment and supply to the consumers as an on-demand supply.

2 Introduction.

Constructed in 1981 as a 136-lot subdivision, the Ohau Alpine Village is a settlement of around 70, predominantly holidaymaker, dwellings located adjacent to Lake Ohau at the western-most extremity of the Waitaki District.

The village is serviced with un-treated, reticulated water supplying a mixture of on-demand and restricted supply connections. The supply also services the wastewater plant, adjacent camping area and a small number of nearby users and facilities.

The water supply is registered on the Ministry of Health's register of Drinking Water Supplies as Ohau Alpine Village code OHA005, is currently ungraded, falls below the population threshold for compliance reporting and, as such, does not feature in the Ministries annual report of drinking water quality.

The water supply is subject to the requirements of the Health Act 1956 and its amendments including the Health (drinking-water) Amendment Act 2007. As such the supply is required to meet the requirements of the Act and the Drinking Water Standards for New Zealand.

In its current, un-treated state, the supply satisfies neither the Act nor the Standards and upgrading is required.

The need to upgrade has been long recognised with a "Water Upgrade Group" being formed by permanent residents in the summer of 2000/2001, preliminary proposals to upgrade identified and budgeted from depreciation reserves as early as 2003 and upgrading budget allocation identified in the 2006 draft Waitaki Community Plan. That the need was identified prior to the 2007 amendment to the Health Act reflects the understanding of the constrained yield, poor microbial quality and high health risk associated with the supply.

Council resolved to upgrade the supply in 2008 (resolution 08/543) with upgrading planned for 2012. Due to the high level of public health risk there was no change to the scheduled date following the relaxation of government mandated compliance dates.

3 Drivers for upgrading works.

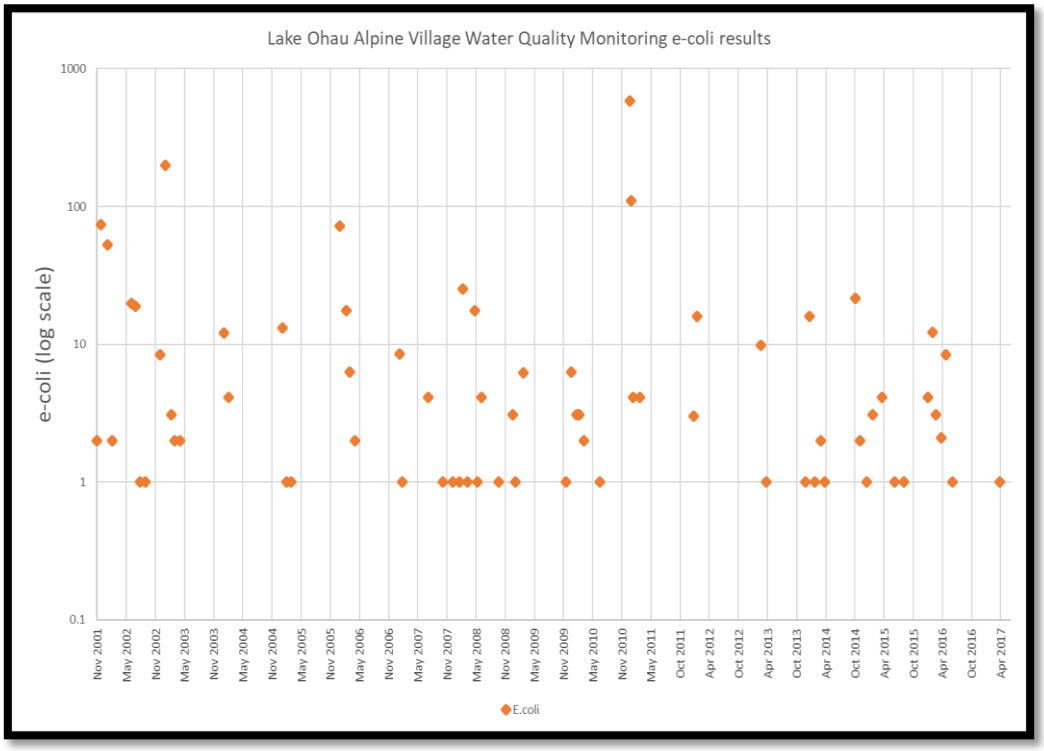
Upgrading is necessary to address water quality concerns. These concerns are:

1. A high prevalence of microbial contamination in the supply.

   The supply is sampled once per month for e-coli. More than one in three (70 of the 188) samples taken between 2001 and 2017 showed faecal contamination in the network drinking-water.

   The e-coli monitoring results are displayed in Figure 1 below. Each orange diamond represents a sample where e-coli was identified by the laboratory. The vertical scale on the chart is logarithmic to more easily display the higher e-coli counts. The e-coli limit in New Zealand Drinking Water Standards is nil detected.

   Figure 1 e-coli monitoring



   Historic sampling results are less easily retrieved than the post 2000 electronically recorded results, however, a cursory review of Councils paper records identified 1994 correspondence from Officers[1] confirming 20 out of 25 samples taken since 1991 failed to comply with the New Zealand Drinking Water Standards.

2. A high risk of microbial contamination linked to the nature of the catchment.

   A Public Health Risk Management Plan (PHRMP) drafted in 2009 identified a requirement for bacterial and 4 log protozoal treatment. A Water Safety Plan (WSP), being the modern

[1] J Dimmendaal 23 June 1994

equivalent of a PHRMP, drafted in 2018 identified a requirement for bacterial and 3 log protozoal treatment.

These assessments identified that the catchment can never be assumed to be free of animal waste contamination and that this contamination is likely to enter the water supply. That this is occurring is demonstrated by the frequency of e-coli detected in the water sampling. This is not to say that the water is of particularly poor quality, rather that it is typical of a surface water where animal contamination can, and does, occur.

3. The existence of a permanent "Boil Water" notice applying to all water used from the supply for drinking, food preparation and oral hygiene.

   Boil water notices require the user to boil all water used for food preparation, drinking and oral hygiene.

   Boil water notices have been identified as being in place since at least 1994[2] and potentially earlier as records show advice from the Public Health Unit at Dunedin Hospital of "serious contamination…… users should be advised of risk"[3] and "shocking result consumers must be advised to boil any drinking water"[4]

   Studies show that over 50% of consumers either ignore advice to boil water or engaged in risky behaviour[5] so it seems entirely unreasonable to expect that all users have always boiled the water since at least the mid 90's, being some 25 years.

   Boil water notices are not a reliable mechanism to ensure public health goals are met and they are not likely to be successful in protecting the community from the risk of water borne illness.

The prevalence of microbial contamination in samples confirms that the current source has consistent and persistent contamination. The PHRMP/WSP assessment of the risk to human health which considered, among other things, the nature of the catchment, identified a high risk to public health. As an untreated supply there are no barriers to contamination in place to protect the public from the contamination and the risk of contamination.

Upgrading of the water supply is necessary to address this contamination and risk of contamination.

[2] J Dimmendaal 18 May 1994
[3] OAHB Dunedin Hospital 23 June 1992
[4] OAHB Dunedin Hospital 16 Nov 1992
[5] C Bergin 26 Sep 2008

4 Impact of the Havelock North water incident

The Havelock North water incident and the resulting governmental enquiry brought sharp focus to the impact unsafe water can have on our communities.

The following May 2017 commentary from the Department of Internal Affairs is useful in outlining the scale of harm that unsafe water can contribute too:

"*Safe drinking water is crucial to public health. The outbreak of gastroenteritis in Havelock North in August 2016 shook public confidence in this fundamental service. Some 5,500 of the town's 14,000 residents were estimated to have become ill with campylobacteriosis. Some 45 were subsequently hospitalised. It is possible that the outbreak contributed to three deaths, and an unknown number of residents continue to suffer health complications.*"[6]

Subsequent to the authoring of the above statement it is now considered that the outbreak contributed to four deaths.

The Government enquiry into the incident identified a raft of failures across many aspects related to the supply of safe drinking water, ranging from governance to regulation to operation and the standards themselves. While the findings of the enquiry were extensive and detailed, perhaps the most useful guiding finding is the need to "**embrace and implement a high standard of care**".

The Havelock North incident has ensured that there is no longer the appetite nationally to permit continued low standards of care. It is difficult to see how it can be argued that the supply of untreated, demonstrably microbially unsafe water from a high-risk source such as the Lake Ohau Alpine Village Water Supply can be deemed to meet a high standard of care.

The Lake Ohau Alpine Village Water Supply must be upgraded to supply safe drinking water.

4.1 Six fundamental principles of drinking-water safety in New Zealand

The enquiry identified six fundamental principles of drinking-water safety in New Zealand[7] and these have been universally accepted by the wider water industry. The six principles are:

Principle 1: A high standard of care must be embraced

> Unsafe drinking-water can cause illness, injury or death on a large scale. All those involved in supplying drinking-water must therefore embrace a high standard of care. Vigilance, diligence and competence are minimum requirements, and complacency has no place.

Principle 2: Protection of source water is of paramount importance

> Protection of the source of drinking-water provides the first, and most significant, barrier against drinking-water contamination and illness. It is of paramount importance that risks to sources of drinking-water are understood, managed and addressed appropriately.

Principle 3: Maintain multiple barriers against contamination

[6] Government Inquiry into Havelock North Drinking Water. 2017. Report of the Havelock North Drinking Water Inquiry: Stage 2. December. Auckland: Department of Internal Affairs

[7] Government Inquiry into Havelock North Drinking Water. 2017. Report of the Havelock North Drinking Water Inquiry: Stage 2. December. Auckland: Department of Internal Affairs

Any drinking-water system must have, and continue to maintain, robust multiple barriers against contamination appropriate to the level of potential contamination. No single barrier is effective against all sources of contamination, and any barrier can fail at any time.

Principle 4: Change precedes contamination

Contamination is almost always preceded by some kind of change, and change must never be ignored. Change of any kind should be monitored for and responded to with due diligence.

Principle 5: Suppliers must own the safety of drinking-water

Drinking-water suppliers must maintain a personal sense of responsibility and dedication to providing consumers with safe drinking-water. Knowledgeable, experienced, committed and responsive personnel provide the best assurance of safe drinking-water.

Principle 6: Apply a preventive risk management approach

A preventive risk management approach provides the best protection against waterborne illness. Once contamination is detected, illness may already have occurred. This requires systematic assessment of risks throughout a drinking-water supply from source to tap; identification of the ways these risks can be managed; and control measures implemented to ensure that management is occurring properly. Adequate monitoring of performance of each barrier is essential.

These six principles set the expectations of government, the community and the water industry and must be used to guide decisions relating to Waitaki District water supplies, including the Lake Ohau Alpine Village water supply.

4.2 The water supplier

Council is the lawful water supplier for the Lake Ohau Alpine Village Water Supply.

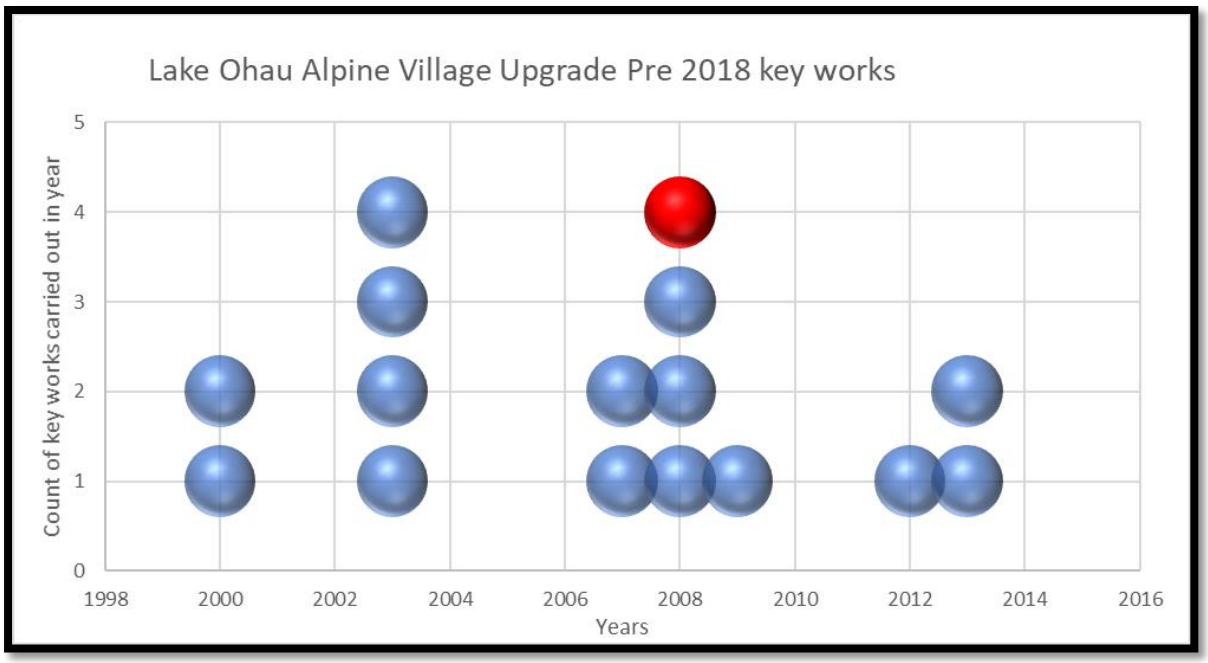
Responsibility for providing safe water and implementing the six principles identified above lay squarely with Council. Further, this responsibility applies equally to all Council Water Supplies.

5 Overview of upgrading history

5.1 2000 to 2018 years

Upgrading of the lake Ohau Water Supply has been mooted since the early 2,000's and budgeted, to some extent, since 2003. Figure 2 shows the concentration of works over the period from 2000 to 2018.

Figure 2 Record of works 2000 to 2018



Each bubble in Figure 2 represents a key body of work or identification of a fundamental upgrade driver. The Red bubble relates to the 2008 Council resolution to upgrade the supply. The following bullet points, identified from Councils records, relate to the bubbles and provide summary information to identify the relevance to the upgrading of the supply:

- **2000 - Insufficient source yield**. 2000/01 "Pump data" report identifies recovery of flows at the source from drought conditions confirming source volume limitations.
- **2000 – Water Upgrade Group established**
- **2003 - Intake relocation and replacement**. 2003/04 Project budget identifies a project to replace and relocate the water intake to ensure secure water supply and improve quality and quantity.
- **2003 - Insufficient source yield**. Memorandum identifies volume limitations causing the supply to "fail".
- **2003 - Supplementary water trench**. Letter identifies the requirement to reinstate a ditch carrying surface water from an adjacent water race to the intake.
- **2003 – Lake water source investigation**. Surface water study using treated lake water as source.
- **2007 – Issues and Options**. Reconsideration of lake water source investigation.
- **2007 – Restricted supply investigation**. Memo identifying connection types and restrictor investigation project.
- **2008 – Resolution to upgrade.**
- **2008 – Scheduled upgrade deferred**. Correspondence identifying deferment of upgrading from 2008 to 2009/10 year.

- **2008 – Property owner survey**. Survey relating to form and volume of supply, source and acceptability of boiling water.
- **2009 – PHRMP**. Draft Public Health Risk Management Plan identifying and assessing supply risks.
- **2009 – Freehold Creek flow**. Flow profile and minimum flow assessment for Freehold Creek.
- **2012 – Issues and Options**. Draft report considering flows and upgrading timeline.
- **2013 – Groundwater source investigation**. Hydrogeologist report on possible groundwater sites.
- **2013 - Issues and Options**. Draft report considering flows, source water upgrading or changing and treatment.
- **2014 – Issues and Options**. Draft report considering flows, source water upgrading or changing and treatment.
- **2014 – Presentation to Residents**. Upgrading presentation to Ohau Village residents and ratepayer's association identifying need and options.

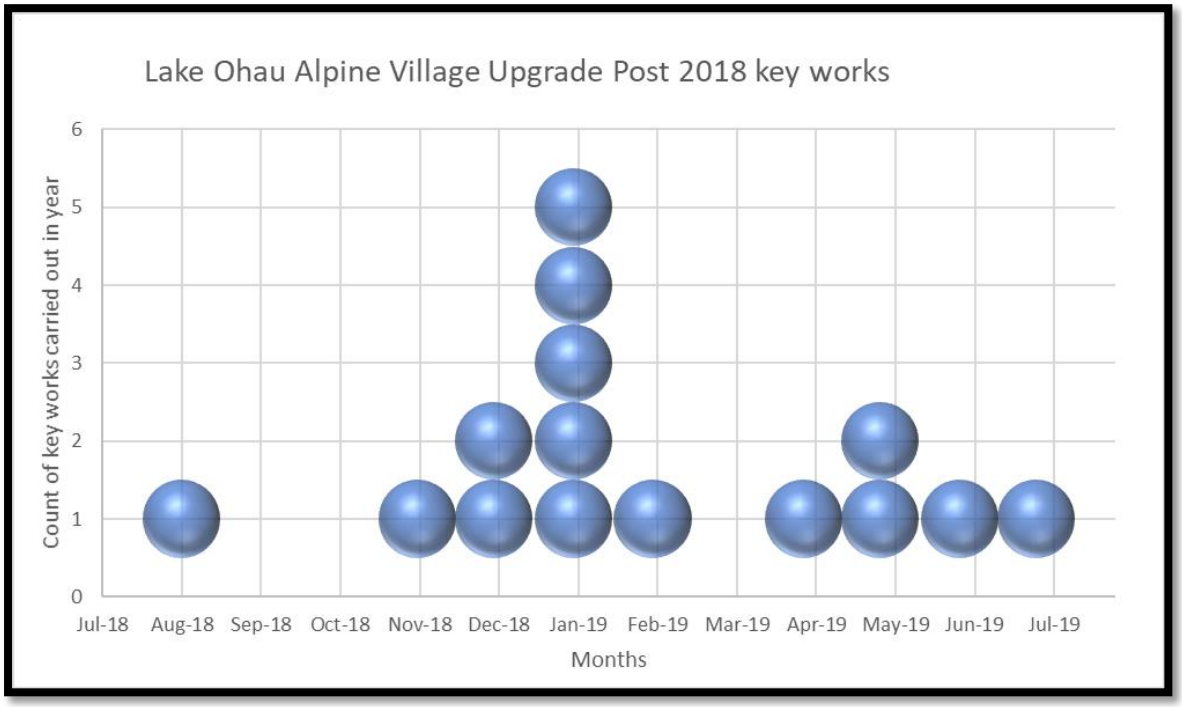
The cluster of works in 2003 relate to a desire to address limitations in source volume. The 2007-09 cluster seek to develop and make real works to upgrade the supply. The 2012-14 works are a further attempt to make real works to upgrade the supply.

5.2 2018 to Present

Efforts over the 2000 to 2018 period failed to gain sufficient momentum as to achieve meaningful upgrade results. The Havelock North water incident provided a strong incentive to revitalise the project and works recommenced in earnest in 2018.

Figure 3 shows the concentration of works over the period from 2018 to present on a monthly basis.

Figure 3 Record of works per month 2018 to present



Each bubble in Figure 3 represents a key body of work or identification of a fundamental upgrade driver. The following bullet points, identified from Councils records, relate to the bubbles and provide summary information to identify the relevance to the upgrading of the supply:

- **Aug 2018 – Issues and Options**. Report considering flows, sources and sub-set of considered upgrading options. This is the output from a substantial block of works looking at preliminary, wide-ranging issues and solutions.
- **Nov 2018 – Stakeholder engagement plan**.
- **Dec 2018 – Upgrade newsletter to residents**. Outlining key issues and pending survey.
- **Dec 2018 – FAQ**. Answers to key questions.
- **Jan 2019 – Public Meeting**. Public meeting to discuss the upgrade project.
- **Jan 2019 – Survey**. Survey of consumer views to chlorine and restricted supply.
- **Jan 2019 – Issues and Options (additional options)**. Memorandum outlining additional options previously considered but not included in the Aug 2018 Issues and Options report.
- **Jan 2019 – Community Task Force created**. Creation of a group of community representatives, who operate separately to the Residents and Ratepayers association, who are the primary contact for discussion on project matters.
- **Jan 2019 – Community Task Force meeting**. Officers meet and discuss option and additional iterations with the Task Force.
- **Feb 2019 – Landowner option.** Landowner identifies option that becomes option 6 and the option is developed.
- **Apr 2019 – Upgrade newsletter to resident's update**. Newsletter providing results of survey.
- **May 2019 – Community Task Force meeting**. Substantial change in Task Force representatives.
- **May 2019 – Issues and Options (additional options)**. Memorandum outlining further additional options.
- **July 2019 – Option evaluation workshop**. Report on evaluation of options by Officers, Advisors and Community Task Force representatives.
- **July 2019 – Issues and Options (community Task Force option)**. Memorandum outlining an option developed by the community Task Force. This option may have been misinterpreted by Officers and resulted in a "RevB" memo.
- **July 2019 – Issues and Options (community Task Force option Augmented)**. Memorandum reconsidering the option developed by the community Task Force to augment the existing source.
- **June 2019 – Alternative option endorsed by landowner**. Correspondence from land-owner outlining preference for no infrastructure on his land, although if no other viable option identified his land could be used subject to constraints.
- **July 2019 – Withdrawal of offer by landowner**. Correspondence from landowner withdrawing previous (June) offer.

The late 2018 works relate to the development of upgrading objectives and measurables, and development and assessment of multiple potential solutions to form the basis of community engagement. The January 2019 works relate to community engagement with the bulk of the balance works being presentation of various iterations of design options in response to community interest, predominantly with the community Task Force.

5.3 Upgrading history conclusion

The project has a long history with the need for upgrading identified through microbial contamination some three decades ago and serious concern relating to yield some two decades ago. Various attempts to progress the project have meet resistance relating to a perception of quality and available yield and suffered from a lack of drive to see the project completed.

An inability to gain sufficient community understanding and support about the substantive issues are the principle reasons behind the protracted, stop/start nature of the project.

This remains an impediment to progressing the project now, although there is a burgeoning understanding of the public health risk associated with the current supply among the community.

6 Community engagement

Attempts over the last two decades to gain traction in upgrading the supply stalled due largely to community resistance. In recognition of this a detailed engagement methodology and plan were set in place to increase the likelihood of successful engagement with the 2018/19 attempt to progress the project. This plan guided engagement activities and has been useful in identifying and clarifying the relatively small range of issues that impede project completion.

6.1 Pre-engagement works

A substantial body of works were completed prior to engaging with the community on the 2018/19 upgrading. These works are summarised below:

1. October 2016. Ohau Water Supply Chronology. Historic works were summarised, and a path forward identified, including the key issues of:
    a. Service level and volume
        i. On-demand
        ii. Restricted and the volume of the restriction
    b. Supply area
        i. Current limitations
        ii. Rural
        iii. Extended to other areas
    c. Source water including;
        i. The current rock-field infiltration source
        ii. Freehold creek
        iii. Lake direct intake
        iv. Lake bank filtration
        v. Lake built filtration
        vi. Groundwater
        vii. Neighbouring supply
        viii. Decision points and engagement

    These works formed the basis for the 2018/19 project development and provided the linkage between historic and current efforts.

1. April to August 2018. Detailed development of issues and options and identification of short-list, most credible, options.
    a. Identification of key decision drivers
    b. Consideration of water sources for volume, flow, treatability, access and risk
    c. Development of flow scenarios
    d. Research and consideration of source options
    e. Preliminary design and costing using a normalised costing basis
    f. Risk assessment
2. August 2018. Issues and options report detailing the best performing technical solution identifying:
    a. Two preferred options (out of more than a dozen preliminary options)
    b. Flow forecasts for on-demand and restricted
    c. Costed options for on-demand and restricted with and without chlorination

These two preferred options formed the basis of the community engagement.

In hindsight, there may have been merit in providing the community with more clarity around the breadth of options considered, and discounted, prior to presenting the two preferred options.

6.2 2018-19 Community engagement

Community engagement has been both proactive and re-active throughout the period that upgrading has been identified as necessary.

Proactive engagement has consisted of; Liaison with the Ahuriri Community Board; Liaison with the Lake Ohau Alpine Village Residents and Ratepayers Association and their appointed spokespeople; Liaison with the community Task Force; Resident and Ratepayer surveys; Newsletters; Public meetings and Task Force meetings. Re-active engagement has consisted of verbal discussion and response to landowner, resident and ratepayer enquiries.

Significant effort has been made in ensuring that information is available to the community through a dedicated web-portal which is updated with pertinent information including a FAQ (Frequently Asked Questions) paper.

6.3 2018/19 Engagement plan

The 2018/19 engagement commenced with the development of an engagement plan aimed to ensure the community understood the reasons for the upgrade, the solution selected and the impact this will have on levels of service and rates and, further, to provide them with an opportunity to influence negotiable aspects of the upgrade, being landscaping and some level of service aspects.

Stakeholders were grouped according to their level of influence on the project with the two highest levels of influence, Collaborate and Empower, being the domain of the Ahuriri Community Board and Council Assets Committee respectively. The Waitaki residents and the Residents and Ratepayers Association were identified as Inform and Consult respectively.

The engagement plan outlined engagement actions and timings and these are summarised in the following table

Table 1 Engagement actions and timing

Timing	Action	Stakeholders	Purpose	Summary of actions
Sept 2018	Email	Ahuriri CB	Provide opportunity to provide feedback on draft engagement plan	Feedback received
Oct 2018	Assets Committee update	Assets Committee	Update on engagement plan	Update completed
Oct 2018	Email	LOAVRRA	Provide opportunity to review draft engagement plan and consultation documents	Feedback received
Nov 2018	Workshop	Assets Committee LOAVRRA	Provide LOAVRRA opportunity to ask questions on draft engagement plan and consultation documents	Feedback received
Nov 2018	Assets Committee update	Assets Committee	Update on engagement plan	Update completed
Dec 2018	Leaflet mail-out	Residents and ratepayers	Provide relevant information regarding upgrading.	Newsletter developed and circulated outlining the preferred options with and without chlorine and on-demand

Timing	Action	Stakeholders	Purpose	Summary of actions
				or restricted. The newsletter provided advance notice of a public meeting to be held in Ohau to discuss the upgrade.
Jan 2019	Public meeting	Residents and ratepayers	Provide opportunity to ask questions and complete survey.	Meeting held on-site Ohau lodge. Community Task Force, representing both the Lake Ohau Alpine Village Residents and Ratepayers Association and the wider community created to work as the contact point for Council Officers for the sharing of information. LOAVRRA remained main distributor of information to the wider community.
Jan 2019	Survey	Residents and ratepayers	Provide opportunity to feedback on levels of service (on-demand vs restricted) and chlorination.	Survey completed. Strong support for on-demand and not chlorinated.
Target Mar 2019	Report	Assets Committee	Gain resolution on project scope	Not yet complete

Note LOAVRRA is the Lake Ohau Alpine Village Residents and Ratepayers Association.

A substantial tract of additional engagement has flowed from the Engagement Plan works with the Task Force being particularly vocal in relation to technical solutions and individual residents providing commentary and input.

6.4 Engagement with the community Task Force

The community Task Force developed from the January public meeting as representatives of residents and of the Lake Ohau Alpine Village Residents and Ratepayers Association. The Task Force purpose was to help Council investigate and assess options and to answer queries from the community.

The Task Force initially comprised eight members being; Belinda Weir, Craig Ovenden, Gary Stitchbury, Kay Lawson, Martin Heal, Pip, Steve Simmons and Phil Driver. Whilst comprising eight members, Officers only met with Belinda Weir, Craig Ovenden, Gary Stitchbury and Kay Lawson.

Council focussed its liaison directly with the Task Force, as was envisaged, and there seemed to be a growing body of understanding of the issues and the offered solutions. Liaison continued through email and telephone discussion and an on-site meeting in May.

Following this meeting Gary Stitchbury resigned and Belinda stepped back. Pip, Phil Driver and Steve Simmons appeared to join the Task Force at this time. Pip and Phil Driver, assisted Council in the assessment and evaluation of shortlist options at a workshop held on24 June 2019 (refer section 15.3 Option evaluation workshop).

Regrettably, the change in Task Force members delayed project progress as understanding and agreed direction was lost and it was necessary for this to be re-built and certain previously agreed matters to be re-discussed.

The Task Force confirmed by email on the 25th July that the Task Force members are; *"Belinda Weir, Kay Lawson, Helen and Bernie White, Jill and David Stone, Craig Ovenden, Barbara and Norman Mackay, and Steve Simmonds. Phil Driver remains an advisor."*

At hand over of the LOAVRRA submission (31st July) Council were advised that the above Task Force was not correct, and that the Task Force was no longer, and to communicate through Elfrida, LOAVRRA chair.

The communication lines adopted by the Task Force are not always fully clear as they currently do not have a designated spokesperson and it can be somewhat difficult to determine if correspondence from individuals, who are Task Force members, is an individual view or that of the Task Force.

These issues aside, liaison with the Task Force has generally been positive and have identified a range of issues that are important to the Task Force, namely:

1. A view that the current source water is of **very high quality**.
2. A view that the **water sampling results** (of the current source water) showing high frequency of bacterial contamination, are invalid.
3. A view that the current source **has sufficient volume** for current and future needs.
4. A view that had residents known, at the time of the survey, that a **change to on-demand** would result in a flow increase and that this flow increase would impact source water options, then the community may have selected differently.
5. A view that **authority to construct or modify** infrastructure on private land will be able to be gained without undue difficulty.
6. A view that sourcing **ground water is not a viable** option as bores have not yet been sunk and thus bores may not yield sufficient, or any, water.

The task Force holds a strong preference to retain the current water source and have promoted a design solution and submission favouring this.

6.4.1 Task Force submission

There was no submission process intended nor sought in the engagement process and no party nor entity were requested to provide, nor did provide (save the Task Force), a submission. Never-the-less the Task Force developed and submitted a submission to Officers on 31 July 2019 and this is included in Appendix A – Task Force Submission.

The submission, in addition to promoting a specific design solution, did not raise any matters not identified through other processes. It did, however, acknowledge that the supply **must be upgraded** and **must be treated**. Both are significant breakthroughs in understanding and go some way to offsetting their view that water sampling is invalid.

The submission also notes a survey conducted by the Task Force that identified 83% support for the Task Force option. It must be stated that the actual question posed in the survey is not known (only the result was provided), the response numbers were low and that the Task Force acknowledges that the costings for the option were incomplete. It is not clear whether the Task Force made the community aware of the cost, risk, flow limitations and potential for subsequent stages and cost in the survey. As such caution is prudent when considering the results of the Task Force survey.

6.4.2 Task Force and LOAVRRA call for donations

A concerned member of the community forwarded to Officers a request from the Task Force and LOAVRRA (Lake Ohau Alpine Village Residents and Ratepayers Association) for donations to raise funds to support advocacy for the Task Force promoted option.

The call for donations, like the Task Force submission and survey, were not anticipated in the engagement process and there exists concern around the impartiality of these works and the completeness of the information provided to consumers in this request for donations.

6.5 Engagement with LOAVRRA

The community Task Force, as the representative body of LOAVRRA (Lake Ohau Alpine Village Residents and Ratepayers Association) provided the primary point of contact for dissemination and discussion of information. However, direct discussion and correspondence with LOAVRRA chairperson and secretary continued in tandem with Task Force communications.

6.6 Engagement with the community

The January Survey, in addition to seeking community views on levels of service (on-demand vs. restricted; chlorinated vs. non-chlorinated) also encouraged comments from survey respondents and a number of respondents made use of this opportunity. Additionally, some members of the community took the opportunity to directly contact Officers, the Chief Executive and the Mayor to express their views. A synopsis of views is summarised below:

1. **Chlorination and restricted supply**. Some respondents noted apparent allergy to chlorine and others raising concerns with potential chemical attack on copper and other metals used in piping and the like. There is a strong community preference to no chlorination. Some respondents expressed concern over the cost, physical workability of siting tanks on properties and potential liability Council may face should they be required to install tanks for restricted supply.
2. **Upgrading is unnecessary or could be addressed individually.** Some respondents maintain the source water is plentiful and safe, "no one has gotten ill". Some respondents maintain that the water sampling showing frequent e-coli (faecal origin) contamination is flawed and thus invalid. Point Of Entry (POE) treatment was raised as a potential solution by some respondents. However, as there is no compliance pathway for POE treatment within the Drinking-water Standards, it is not a valid, compliant treatment technology. POE was eliminated as an option in the earliest stages of the upgrading project. Equally, some respondents identified that upgrading and treatment were both necessary.
3. **Gravity supply was preferred** by some respondents. Some respondents noted power supply reliability issues at the village and felt gravity supply was more secure and thus the existing source should be maintained.
4. **Linkage to development.** Some respondents drew a link, and opposition, to options involving sources other than the current source as a mechanism to improve the development potential of the land upon which the current source and infrastructure is sited.
5. **Access limitations.** Some respondents queried Councils stance relating to access limitations on private property maintaining that existing rights and easements conferred sufficient authority to undertake any necessary works.
6. **Bore water is unknown.** Some respondents noted that the yield and quality of the as yet undrilled groundwater bores was unknown and that this should discount groundwater as an option. Concern was raised around the impact of the wastewater treatment pond discharge on any groundwater bores.
7. **Visual impact and Water conservation.** A strong desire to minimise the visual impact of any works was expressed by some respondents. Promotion of solutions to the south-west ("behind") the village were seen as mitigating potential impacts. Some respondents expressed a desire to ensure water conservation matters were taken into consideration and

that restricted supplies were preferred to achieve this. Some noted that the existing 600L/day was adequate and tended to encourage, what they deemed to be, favourable behaviours. Conversely, some respondents expressed concerns around physical limitations to retrofitting on-site tanks as would be required for a restricted supply whilst others raised concerns with householder costs associated to the same.

8. **Cost, metering and normalised charging.** Some respondents felt that the costs of upgrading were unaffordable and should be spread district wide. Some respondents supported the implementation of water metering for on-demand users.
9. **Project is being rushed.** Some respondents felt that the project was rushed and insufficient information on technical matters and options had been developed or supplied. Some supported delaying the decision until additional information was gained whilst others favoured a staged upgrading approach.
10. **Task Force views not necessarily representative.** Some respondents expressed support for progressing the project and that the views being most strongly advocated may not be representative of their own view.

6.7 Engagement discussion and findings

Community engagement has been extensive, collaborative and thorough. The engagement, in all its forms, has identified a core set of issues that influence progress on this project, namely:

1. Levels of service – On-demand or Restricted Flow and chlorinated or not chlorinated
2. Quantity and Quality of source water – some reluctance to acknowledge the need to upgrade and a strong desire to retain current source

These two over-arching issues are primary considerations relating to the project and are discussed in the following sections. The balance issues are more typical of technical matters that would have differing implication and risk to differing design solutions. That is to say all options would involve a degree of customisation and scope to accommodate specific demands.

7 Level of service

Level of service is the first over-arching issue of importance to the community.

Two key level of service matters were presented to the community by way of the Council survey; whether the supply should be on-demand or restricted; and whether the supply should be chlorinated or not chlorinated. 71 respondents participated with 71% favouring On-demand and 82% favouring not chlorinated.

7.1 On-demand or restricted

There is strong community support for an on-demand supply.

7.1.1 Understanding restricted and on-demand supplies

A restricted supply is a level of service where water is supplied to the consumers on-site storage tank at a pre-set daily volume. In Ohau this volume is currently 600L per day or around two and a half buckets of water an hour. The consumer withdraws water solely from the tank by either having the tank elevated and using this height as a driving force, or by household pumps. In essence, when the consumer turns on a tap the water comes from the consumers own on-site storage tank and the Council network refills that tank slowly over time. The network needs only be capable of meeting the "sold" daily volume as peaks are accommodated by the consumers on-site tank.

The village water supply was established as a restricted flow supply where each lot was allocated a restricted volume of 100 imperial gallons per day (454L/day)[8]. Whilst a restricted volume of 455L/day was the basis for the supply design, it was not captured in the consent conditions and consequently not applied as a service standard[9]. This has resulted in connections being either not restricted or restricted without the actual restrictor device (the unit that physically limits the volume) fitted. As at 2003, Officers believed that no supply was effectively restricted[10]. The 2003 development of the village, being the Stage III subdivision, brought this issue to focus and connections from this period were generally restricted leading to the current mix of restricted flow and on-demand supply and the resultant varying level of service.

At some stage the restricted volume changed from 455L/day to 600L/day. It is not clear exactly when or why this occurred, but it is highly likely that it was to address the potential for restrictor units to block when the restrictor orifice is smaller than the screen protecting the orifice such as is required for a 455L/day restrictor. Generally speaking, any restrictor providing less than 900 or so L/day is vulnerable to blockage by material that is able to pass the protecting screen.

Today, around half of the consumers receive a restricted supply of 600L/day while the balance are on-demand.

An on-demand supply is a level of service where the water is provided at mains pressure. This pressure drives the water through the consumers pipework negating the need for on-site storage tanks and pumps. In essence, when a consumer opens a tap the water is drawn directly from the Council network. The network needs to be capable of meeting the peak demand of multiple consumers simultaneously.

[8] Development Plan Application16 Dec 1980, Johnston Hatfield Anderson & Partners
[9] J Cuthbertson 18 July 2003 letter to Anderson Lloyd Caudwell
[10] J Cuthbertson 18 July 2003 letter to Anderson Lloyd Caudwell

7.1.2 Impact of changing supply level of service

The primary advantage of a restricted supply is the smoothing of flow profiles by removing peak instantaneous demands allowing smaller, less expensive infrastructure. This impact is most significant when considered for reticulation systems where it is simply un-economic to pipe on-demand flows vast distances. The impact on source water and treatment needs, once buffering with reservoirs is included, is significantly reduced but not eliminated.

To maximise this advantage and ensure equitability, all on-demand consumers would need to convert to restricted.

The primary disadvantage of converting the on-demand consumers to a restricted supply is cost, tank siting ability and reasonable enforceability. Requiring consumers to retrofit tanks and pumps would likely meet substantial consumer resistance and is estimated that the physical works to convert the on-demand consumers would cost in the order of $330,000. Costs involved in liaising and enforcing conversion are not estimated but could be substantial and easily push the cost of conversion to $400,000 or more. It has not been confirmed that Council would have sufficient authority to enforce the conversion of an on-demand connection to restricted flow.

The primary advantage of converting the restricted consumers to on-demand is the avoidance of cost involved in physical works, liaison, development of authority should this be lacking, and enforcing he change. Whereas a restricted supply only functions at its design when all consumers are restricted and utilise on-site storage tanks, an on-demand supply will function equally well whether the consumers retain or remove the on-site storage tanks. Conversion is simply a matter of removing the restrictor unit. The consumer would then have the choice to either retain or remove their on-site storage tank.

The primary disadvantage of converting to on-demand is the requirement for the network to meet higher peak demands. This is of most relevance in the reticulation network but does have an impact on source abstraction and treatment. Analysis has identified that the reticulation network has sufficient capacity to accommodate on-demand supply.

7.1.3 Survey result

There is clear support, 71%, for an on-demand supply. This is consistent with a community survey of the same matter in early 2008 where around half favoured on-demand, a quarter restricted, and the balance either status quo (mix of on-demand and restricted) or having no preference.

Considering the impacts of a decision to adopt an on-demand supply we can identify:

Advantages:

1. Is consistent with the communities wishes.
2. The in-equitability of residents receiving different levels of service is eliminated.
3. The cost of converting the on-demand consumers to restricted, estimated as some $330,000 in physical works costs, is avoided.
4. The risks and costs of enforcing conversion are avoided.
5. Property development costs will reduce as on-site tanks and pumping will not be required.
6. Site usage impediments of on-site tanks will be avoided.

Disadvantages:

1. The instantaneous use will increase as the buffering nature of on-site tanks is removed. Design flows will need to increase to accommodate this.

7.1.4 Conclusion - On-demand or restricted

The advantages of adopting an on-demand supply outweigh those of a restricted supply provided that the costs of providing an on-demand supply do not exceed that of a restricted supply by more than, say, $330,000 to $400,000 and the social implication of imposing a change are tolerable.

7.2 Chlorinate of not chlorinate

Chlorine is an effective disinfectant widely used in water treatment. Chlorine offers advantages over other disinfectants in that it maintains a relatively stable residual and is thus available to address contamination that may be present or reintroduced in the network or consumers systems post treatment. However, other treatment technologies are effective at addressing contamination at the treatment plant although they do not offer the residual disinfection benefits.

There is increasing pressure from the Ministry of Health to chlorinate drinking-water, and whilst not mandatory as yet, the Havelock incident and subsequent enquiry may swing the balance in favour of mandatory chlorination.

7.2.1 Impact of adopting chlorination

Chlorination is a relatively straight-forward and, in the context of the project total, low cost treatment technology. The principle costs relate to minor mechanical equipment such as pumps and injectors and housing the gas storage separate from injection.

Chlorine can alter the corrosivity of water and, depending on the source water, create tastes and odours some find objectionable although these effects can be minimised by flushing and, where necessary, stabilisation of the water.

7.2.2 Survey result

Residents strongly oppose chlorination with 82% preferring a not chlorinated supply.

7.2.3 Conclusion - Chlorinate or not chlorinate

On balance and considering the opposing wishes of the community and the Ministry of Health, it seems prudent to install and test chlorination equipment without turning on chlorination.

Should chlorination become mandatory at some stage then it would be easily turned-on.

8 Quantity and quality of source water

Quantity and quality of source water are the second over-arching issue of importance to the community.

Whilst multiple technical options have been considered through the development of the project these distil down to two fundamentally different sources:

1. Surface water
2. Ground water

8.1 Surface water

Various surface water sources are available in the local vicinity with the most likely for consideration being; Lake Ohau, Freehold Creek and minor un-named tributaries to Lake Ohau such as the current source.

8.1.1 Lake Ohau

Lake Ohau is the most obviously abundant source and water could be abstracted by direct take or built filtration or bank filtration. Preliminary assessment carried out in 2018 identified that direct takes of surface water presented greater cost and risk than sourcing Lake influenced groundwater and thus were not considered further.

No specific water quality monitoring has been completed for Lake Ohau for this project, but the water would be expected to be generally stable with potential for low-level contamination, has increased vulnerability to storm induced turbidity and land use changes, and risk of contamination emanating from boating and recreational activities. Department of Conservation lake water sampling supports this view.

Conclusion. Lake Ohau could be a satisfactory source of water for the supply at vast quantities, however lake influenced groundwater is considered to offer multiple advantages and direct lake water was not considered further.

8.1.2 Freehold Creek

Aside from Lake Ohau, Freehold Creek is the most reasonably adjacent, substantial surface water source.

No specific water quality monitoring has been completed for Freehold Creek for this project, but the water, being an open water course in an uncontrolled catchment would be expected to be subject to reasonable variability with persistent, mostly low-level but fluctuating contamination, and increased vulnerability to storm induced turbidity and land use changes.

2009 investigations into Freehold Creek hydrology[11] identified that, whilst not subject to ongoing flow measurements, exhibited a consistent relationship to the Ahuriri River and it was possible to develop a mathematical relationship between the two surface waters.

[11] Boraman Consultants Ltd Jun 2009. Brief Hydrology of Freehold Creek.

The 2009 work identified a Mean Annual Low Flow as 62L/S and, since Freehold Creek falls under the Waitaki Catchment Water Allocation Regional Plan, the total allowed abstraction by all users on the creek is 10% of Mean Annual Low Flow or 6L/S.

Conclusion. Freehold Creek could be a satisfactory, though variable, source of water able to contribute up to 6L/S provided no other user has attained rights to take water. Significant and potentially rapid variability in water quality would be expected and substantial storage or advanced treatment processes would likely be required to accommodate these. The majority of the time, however, the water would be expected to be treatable with readily available treatment technologies.

8.1.3 Rock field (current source)

The current source for the water supply is described in the March 2003 resource consent application to renew the consent for the taking of water from an unnamed creek (tributary to Lake Ohau), as:

"Water is extracted from the base of a terrace some 300m from Freehold Creek. ~ At the base of the terrace there is a section of small to medium size rock (i.e. 20-150mm diameter) which spars some 3-5m wide and in excess of 100m long. It is through this media that water is captured via way of a 100mm diameter field drain and directed into a manhole structure."

The current source is thus a rock-field on an unnamed creek. It is neither a spring nor is it Freehold Creek even though it is sometimes erroneously referred to as such.

There has been long debate relating to the potential yield and quality of the rock-field source.

Quality.

The presence of animals, both wild and farmed in the catchment, ensures that the risk of faecal contamination is always present and the water sampling (refer section 3 Drivers for upgrading works.) identified a clear pattern of faecal contamination extending for decades. Additionally, the previously completed Public Health Risk Management Plan and Water Safety Plan identify the need for no less than 3 log pathogen removal to address microbial risk.

Water from this source does and would require treatment should it be used for the supply of drinking-water. Its current, untreated, use for drinking-water is inappropriate.

Quantity.

There is significant lack of agreement between Officers and the Task Force on the issue of quantity available from the rock-field.

The Task Force maintain a position that the rock-field has, and has always had, sufficient volume whereas Offices consider the source vulnerable to low yields. A search of Councils records identifies that the position of the Task Force is not able to be supported and that the rock-field is documented as having experienced short-falls in volume.

The records identified that, on a site visit undertaken by Environment Canterbury on 28 June 2001, the supply suffered from insufficient water volume to such an extent that un-identified parties constructed a water channel to divert water from a neighbouring water race to supplement the

supply[12]. Environment Canterbury understood that this was remedied at this time and that the works to divert were unauthorised.

Further correspondence identified that a trench diverting water from the water race continued to exist in 2003 as a written instruction to have it "filled in" and further that filling is was to be by "manual shovel; no excavator is to go to site" being issued in May 2003[13], nearly two years after the identification by Environment Canterbury. It is unclear as to whether the trench was re-dug after the 2001 identification or was never actually filled in. The ditch was filled in on 20 May 2003[14].

The search also identified e-mail[15] correspondence from a resident (Barbara Mackay) stating:

"we certainly remember the reduced water flow from our taps, but Freehold itself never dried up completely. It was low. The branch of Freehold that flows out towards our spring intake area did dry up. At that time the trench someone dug was not created so water was from the spring area only."

This view was further reinforced by Barbara MacKay in a letter to Straun Munroe (WDC councillor).[16]

When considering the volume limitations experienced by the users it should be acknowledged that at this time only the on-demand portion of the current consumers were connected to the supply, being 50% of the current consumer count. Further, the water take allowed a volume of around 2L/S be taken and that this was considered satisfactory for the village at this time. To run short of water at this time would suggest that the rock-field yield dropped below 2L/S.

Source water flow has been measured on two occasions, being February 1987 and again in March of the same year with flows measured as 4.2 and 7L/S respectively[17]. The measurements identify a substantial variation in flow across the one-month period and may not represent the lowest, or highest, experienced flow. It can be confirmed that flows dropped to at least 4.2L/S. It is prudent to acknowledge that these flow measurements were taken some 3 years before the 2000/01 water shortages and as such are unlikely to represent the worst-case source yield.

There seems a clear body of evidence that supports the view that the water quantity available from the rock-field is, or has been, insufficient. It has been measured as low as 4.2L/S and may have experienced difficulty in maintaining 2L/S. there are clearly acknowledged times when the source yield failed.

What is unclear is why the issues with volume that occurred in the 2000-2003 period have not resurfaced. There is insufficient information to accurately and unequivocally state why this may be the case, however, when considering the events that are known to have occurred around this period, being the digging of the trench from the water race to supplement the rock-field and the decision to implement restricted connection on all new developments, being subdivision and dwelling, it is possible to infer:

- The trench, even though backfilled, continues to have a positive benefit on the volume available at the rock-field. This is reasonably likely as the backfilling was carried out by

[12] Environment Canterbury 28 March 2003. Lake Ohau Alpine Village Water Supply Resource Consent CRC001915
[13] J Cuthbertson 13 May 2003. Letter to Whitestone Limited.
[14] J Hardy 22 May 2003. Email to J Cuthbertson.
[15] B MacKay 19 Oct 2003. Email to J Cuthbertson, S Munro, S Perrin (WDC), R Halstead, E McRae (Village residents)
[16] B MacKay 13 May 2004. Letter to S Munroe.
[17] March Construction Ltd 11 May 1987. Water supply restrictor valves.

manual shovel and would not be expected to gain the density of the surrounding ground and would thus remain a less resistant flow path than the surrounding ground.

- The imposition of restricted flow curbed volume growth sufficiently that, in combination with the trench, the source remained adequate for the mix of restricted and on-demand users.

Should the above view prove correct there exists a substantial risk in that the rock-field relies on the water race for supplementation and that this water race is privately owned[18] and operated by parties with whom Council has no agreement for supply.

Conclusion. The Rock-field could be a satisfactory, generally stable, source of water able to reliably contribute perhaps 2L/S in the driest years. Variability in water quality would be expected although this would likely be less than a take from Freehold Creek proper and would likely be able to be addressed with readily available treatment technologies. Storage to accommodate quality variability would likely be required.

8.2 Groundwater

Groundwater is known to exist in the area adjacent to Freehold Creek and Lake Ohau by the existence of a small number of water bores. The location of these bores is shown in Figure 4

[18] Environment Canterbury 28 March 2003. Lake Ohau Alpine Village Water Supply Resource Consent CRC001915

Figure 4 Existing groundwater bores

Figure 4 identifies six bores labelled A to F and denotes the relative yield of each.

The tested abstraction flowrate from each bore, including the high and medium yielding bores is low, at no more than 2L/S. This should not be construed to mean that the potential yield is equally low.

The tested bores were assessed as High, Medium or Low yielding by reference to the bores draw-down at the tested flowrate and the bores specific capacity which is a measure of the calculated flow achievable from the bore that would result in a 1m depression in the bore water level. Neither are an exact predictor of sustainable bore yield but do provide useful guidance. The measured performance of the bores is tabled below:

Table 2 Existing groundwater bore flow testing

Bore	Tested flowrate (L/S)	Drawdown at tested flow rate (m)	Specific capacity (L/S/m)	Comment
A	2	Nil	4.5	At 2L/S no measurable drawdown occurred
B	1	14	<0.1	To produce 1L/S the water level in the bore depressed by 14m
C	1	10	<0.1	To produce 1L/S the water level in the bore depressed by 14m
D	2	2	0.7	To produce 2L/S the water level in the bore depressed by 2m

Bore	Tested flowrate (L/S)	Drawdown at tested flow rate (m)	Specific capacity (L/S/m)	Comment
E	1	Nil	9.7	At 1L/S no measurable drawdown occurred
F	nil	-	-	Bore was dry

Bore E, being the bore closest to Lake Ohau, indicates favourable yields. It would be expected that bores at this location would be influenced by lake water to a large degree. Bore A also indicates favourable yields, and this could be due to its siting within the Freehold Creek alluvial outwash. Bore D indicates moderately favourable yields but does incur some drawdown at modest flows.

The balance three bores are either low yielding or failed to find water.

Quantity.

Actual yield from as yet un-drilled bores is unknown and it is necessary to rely on the guidance of hydrogeologists regarding siting and potential yield. Guidance to date indicates that a per bore yield of between 2.5-5L/S should be achievable for carefully sited bores.

It is not possible to guarantee yield until bore(s) are drilled and developed.

Quality.

The groundwater would be expected to have the potential for faecal contamination, much as is expected from the overlaying surface waters. As such it will require similar treatment.

Ground water does not offer a source that can be used as drinking-water without treatment.

Unlike surface waters, groundwater has substantial “inbuilt” quality buffering potential. Where a surface water will show rapid response to storm events with increased turbidity and associated elevated bacterial contamination (due to the run-off picking up faecal matter), groundwater will not exhibit the same rapid response. In most instances the response will be difficult to observe due to the very slow passage of water through the aquifer (surface waters move at metres per second where groundwaters move at metres per day) and the resultant die-off of microbes.

This buffering has significant advantages in the treatability of the water as it is far easier to treat a stable, consistent raw water than a highly variable one.

This buffering effect can be observed in water monitoring results and while no results are available to compare the Ohau surface waters to the Ohau groundwaters directly, the following two figures, kindly provided by the Queenstown Lakes District Council, provide a useful illustration.

Figure 5 Shotover river and Shotover bore e-coli

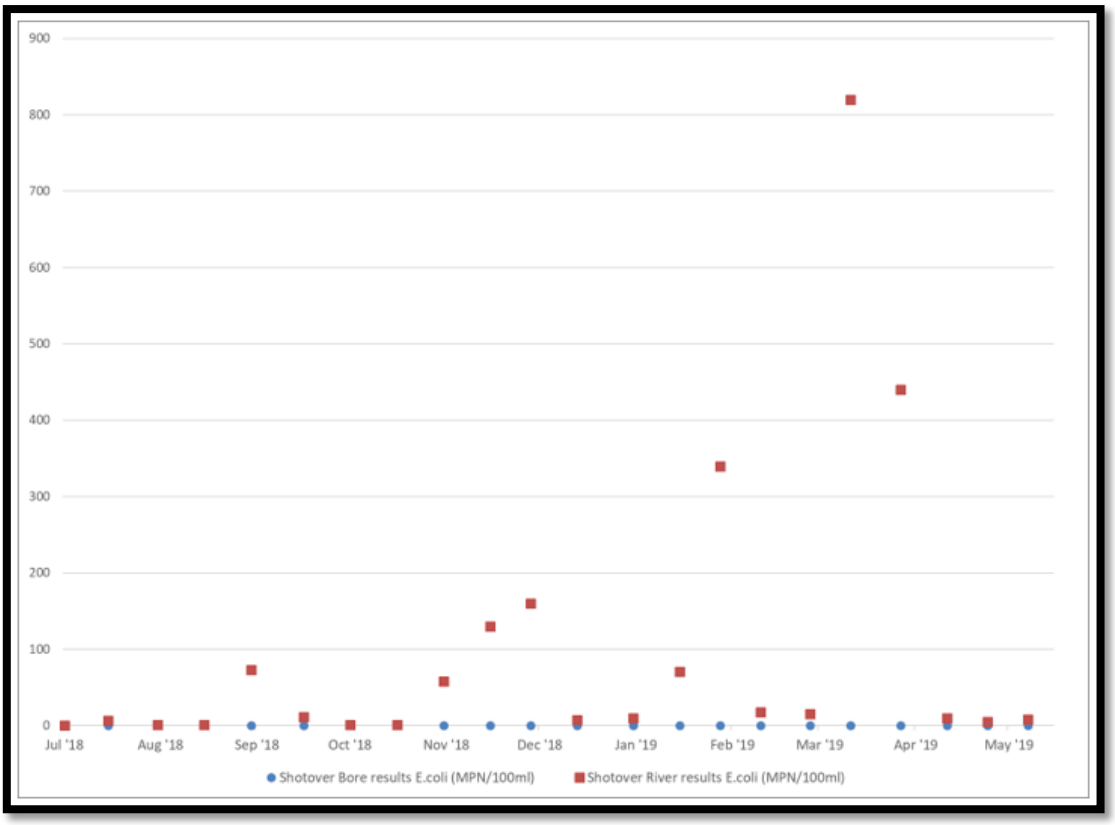


Figure 5 shows, as red squares, variable and often very elevated levels of e-coli in the surface water of the Shotover river between July 2018 and May 2019. The frequency and variability of e-coli in the surface water is readily apparent. Conversely, Figure 5 also shows, as blue dots, stable (nil) e-coli in the ground water of the Shotover bore over the same time period.

Figure 6 Shotover river and Shotover bore turbidity

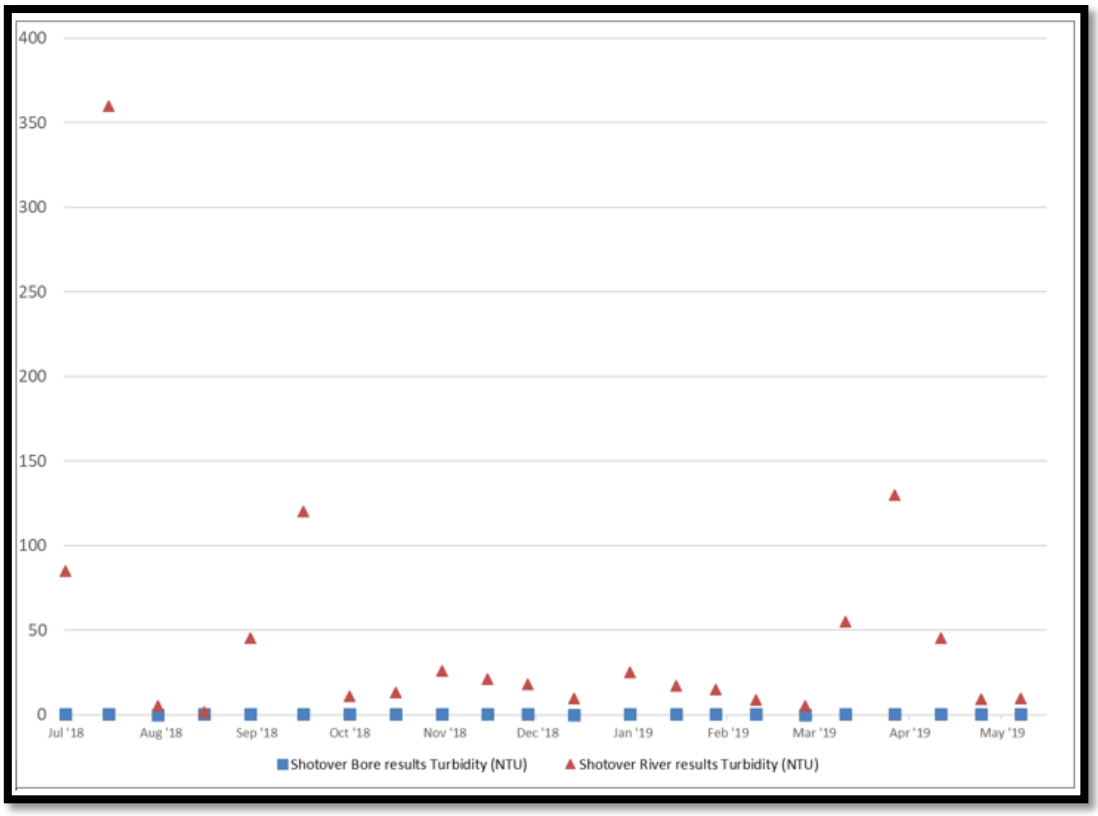


Figure 6 shows a similar relationship between surface and groundwater for turbidity as is evident in Figure 5 for e-coli.

Groundwater provides substantially increased water quality and stability, but the risk of contamination exists, and the water must be treated to address this risk.

Conclusion. Groundwater could be a satisfactory, stable, source of water able to reliably contribute some 2-5L/S per bore. Limited variation in water quality would be expected.

8.3 Quantity and quality discussion

Both surface and ground water sources have the potential to supply useful volumes of treatable water.

Groundwater has the highest potential yield (excepting direct lake water), expected quality and stability but carries a risk associated to exploration and location of a suitable source. This risk can be mitigated by careful bore site selection but is difficult to completely eliminate without encroaching onto the lake itself.

Both surface water sources considered, Freehold Creek and the Rock-field, are impacted by yield limitations and in the case of the Rock-field these limitations are significant. As surface waters the water quality is often low and is subject to a higher degree of variability than that of a groundwater.

8.4 Conclusion - quantity and quality

On balance and considering the existence of functional bores in the general vicinity, the yield and treatment advantages of groundwater make groundwater the preferred water source.

9 Design volume

Design flows have been determined by Fluent Solutions and are included as Appendix C – Design Flow.

Design considered growth impacted future flows for both restricted and on-demand flow scenarios and identified that, adopting a restricted flow of 1,000L/day (increased from the current 600L/day), the design daily flows are:

- Restricted: 188m^3/day being 2.2L/S over 24hours
- On-demand: 352m^3/day being 4.1L/s over 24hours.

Restricted supplies use the consumers on-site storage to smooth out peaks and the 24hour flow, 2.2L/S in this case, can be considered the treatment design instantaneous flow rate although there is merit in allowing water production over less than the full 24hours to accommodate system outages and maintenance.

On-demand supplies, however, experience substantial peaking in flows and these have been estimated to be 12.7L/S as a peak instantaneous flow rate. Typically, peaks are attenuated by treated water storage (a reservoir or collection of tanks functioning as a reservoir) and this returns the treatment design instantaneous flow rate to the 24hour flow or 4.1L/S in this case. Again, there is merit in allowing for outages and repairs.

Without treated water storage (reservoir) the treatment plant must accommodate the peak instantaneous flow, 12.7L/S.

9.1 Conclusion – Design volume

The minimum design flowrate to the water treatment system is:

- Restricted: 2.2L/S
- On-demand: 4.1L/S where treated water (reservoir) storage is provided.
- On-demand: 12.7L/S where treated water (reservoir) storage is not provided.

10 Design Solutions

Multiple design solutions have been developed throughout the course of the project and these are included as Appendix D – Design Reports and Memos.

All options were conceptualised and estimated commensurate with the available detail that is typical for optioneering. Significant "P&G (Preliminary and General) and Contingency costs were allowed in the estimates to reflect not only the design uncertainty, assumptions, engineering and administration necessary to deliver a constructed product, but also to reflect the significant tract of pre-works necessary to identify a preferred option and gain decisions. There is a very high likelihood that these costs are underestimated as project costs have already surpassed $130,000 and no design has yet been agreed.

The objective of costing for optioneering purposes is to provide an even and fair basis for assessment of options for comparison purposes while providing reasonable indication of the completed project cost. For this reason, base assumptions and allowances are applicable across options, that is to say that the confidence and detail of costing for each option is comparable.

From the many design options, four solutions were short-listed and are considered further:

1. Option 2 (revA) – Groundwater adjacent to the lake.
2. Option 6 – Groundwater on Edwards property.
3. Option 8 – Groundwater behind village.
4. Option 9.1 – Existing source with selective abstraction, stage-able.

The four options were assessed for risk at an option evaluation workshop comprising Officers, Fluent Solutions and Task Force representatives and the results were subject to a sensitivity analysis and calibration. This is included as Appendix E – Option evaluation workshop.

11 Option 2 (revA) – Groundwater adjacent to the lake.

This is one of the two options proposed by Officers and advised to the community in January of this year.

This option utilises local groundwater resources and is not substantially different to other groundwater options save the location of the groundwater source and siting of the treatment infrastructure.

In this option the groundwater source is adjacent to the lake and treatment infrastructure is located in the trees behind the campground.

This option broadly consists of:

1. Abandonment of the current source
2. Groundwater bores
3. Water treatment plant
4. Closed pressure pump system
5. Treated water storage
6. Back-up generator
7. On-demand supply

The selection of the site location for this option places the works upon reserve land with easy access and proximity to established infrastructure for construction and operation. Approvals for works within the reserve will be required. The bore site is less secluded than options with siting behind the village although bore infrastructure is predominantly below-ground save the wellhead. The trees and sloping topography will provide screening for the remotely located treatment and storage infrastructure.

The location has a highest likelihood of sourcing the required groundwater volumes.

11.1 Cost

This option has an estimated capital cost of $1.24M.

The abandonment of the current source allows access to depreciation funding which moderates the rate charge impact.

11.2 Source

The water is proposed to be sourced from groundwater from new bores. Siting adjacent to the lake increases the likelihood of sourcing the required volumes.

11.3 Level of service

This option is designed for on-demand supply and as such meets the wishes of the community.

11.4 Staging

No staging is proposed although additional bores could be added over time to accommodate growth (should the yield prove marginal).

12 Option 6 – Groundwater on Edwards property.

This option was promoted by the landowner (Mr Edwards) whose land contains the existing intake, pipeline and water storage.

The option is essentially identical to option 8 except the location of the infrastructure is on Mr Edwards property and thus some small distance further remote from the village.

Mr Edwards has maintained a preference to not having infrastructure on his land and this option was promoted by him as an option he would, were no other options viable, accept.

However, Mr Edwards has now withdrawn this offer and advised that ***"any option to have third party infrastructure on my property will be actively resisted."***[19]

This option has an increased likelihood of failure. The following sections are, however, provided for completeness.

12.1 Cost

This option has an estimated capital cost of $1.43M.

The abandonment of the current source allows access to depreciation funding which moderates the rate charge impact.

12.2 Source

The water is proposed to be sourced from groundwater from new bores. There is increased uncertainty that suitable water volumes will be found at this location.

12.3 Level of service

This option is designed for on-demand supply and as such meets the wishes of the community.

12.4 Staging

No staging is proposed although additional bores could be added over time to accommodate growth (should the yield prove marginal).

[19] D Edwards 23 Jul 2019. Email M Goldingham (WDC)

13 Option 8 – Groundwater behind village.

This option utilises local groundwater resources and is not substantially different to other groundwater options save the location of the groundwater source and siting of the treatment infrastructure.

In this option the groundwater source and treatment infrastructure are located on private property behind the village.

This option broadly consists of:

1. Abandonment of the current source
2. Groundwater bores
3. Water treatment plant
4. Closed pressure pump system
5. Treated water storage
6. Back-up generator
7. On-demand supply

The selection of the site location for this option places the works upon private property with reasonable access and proximity to established infrastructure for construction and operation. Landowner approvals would be required for the works. The site is more secluded reducing visual impact although this carries increased uncertainty that suitable water volumes will be found at this location.

13.1 Cost

This option has an estimated capital cost of $1.09M.

The abandonment of the current source allows access to depreciation funding which moderates the rate charge impact.

13.2 Source

The water is proposed to be sourced from groundwater from new bores. There is increased uncertainty that suitable water volumes will be found at this location.

13.3 Level of service

This option is designed for on-demand supply and as such meets the wishes of the community.

13.4 Staging

No staging is proposed although additional bores could be added over time to accommodate growth (should the yield prove marginal).

14 Option 9.1 – Existing source with selective abstraction.

This is the option promoted by the Task Force and included in their submission, attached as Appendix A – Task Force Submission. In their submission they refer to this option as Option 10 even though there is no apparent difference. For the purpose of maintaining continuity the option is referred to as Option 9.1 throughout this report and appendices.

This option broadly consists of:

1. Selective abstraction from the Rock-field (existing source)
2. Portable, and thus relocatable, water treatment unit
3. Gravity supply through treatment units before pumping
4. Treated water storage
5. Retain current mix of restricted and on-demand
6. Future conversion to on-demand
7. Potential for supplementation with bores in the future
8. Supplementation

The Task Force promotes the benefits of a gravity solution in terms of power saving and resilience to power outage, and the installation of a pump and storage only as required or as an option in their submission. However, the submission clearly references and appends the Apex Environmental solution where pumping and treated water storage is clearly identified. Accordingly, it is assumed that the Task Forces references to the benefits of a gravity supply and the associated power saving benefits are an error, and the option is evaluated on the bases outlined by Apex Environmental.

This option varies from other options in four significant ways:

1. Cost - It appears substantially lower cost
2. Source - It utilises the existing rock-field source
3. Level of service - It retains the mix of restricted and on-demand supply
4. Supplementation – supplementary bores can be added resulting in a dual source supply

14.1 Cost

The Task Force acknowledge that there will be other costs associated with their promoted option but have not provided an indication of the magnitude of these. Fluent Solutions reviewed the option and identified a raft of works not included in the Apex Environmental costing. Estimates were developed by Fluent and discussed and agreed with Apex Environmental[20] to ensure reasonability and to confirm that no omissions or doubling up was occurring.

While estimated costing provided by the Task Force in its submission was $0.47M. Allowing for the excluded items this option, as agreed with Apex Environmental, is estimated to have a project cost of $0.82M excluding any groundwater supplementation.

This option, without supplementation, has insufficient capacity to supply an on-demand level of service.

It should be recognised that this option is identified as being able to be supplemented and that supplementation would attract additional costs estimated to add:

[20] S Kroening 31 Jul 2019. Email response to M Stevenson, Fluent Solutions

- $0.22M to provide supplementary groundwater sourced behind the village, and
- $0.69M to provide supplementary groundwater from adjacent to the lake.

The total project cost is dependent on whether or not supplementation is required.

This is the only option that retains the current intake and infrastructure, and as such does not release depreciation funding to off-set the project costs. This has a significant impact on the rate funded portion of the project.

14.2 Source

This option uses the existing Rock-field water source.

As previously noted, the yield from this source is the most limited of all sources considered. It is unlikely to prove sufficient to meet the needs of an on-demand supply for the current connected users let alone have the capacity for future on-demand growth. There are serious concerns about the ability of this source to satisfy the current mix of on-demand and restricted plus any future growth even if that growth was also restricted.

The source is on private land and whilst Council has sufficient authority to operate and maintain the supply it may not have authority to develop and construct the proposed selective abstraction infrastructure.

14.3 Level of service

This option retains the status-quo mix of on-demand and restricted supply and, due to source yield limitations would not be able to satisfy on-demand flows.

This is inconsistent with the wishes of the community as expressed in the Council survey.

14.4 Supplementation

This option is considered stage-able by the Task Force but in reality, the stages amount to contingency steps in the event identifiable risks eventuate, principally the lack of sufficient yield at the Rock-field source.

There is considered a high likelihood that supplementation will be required within a short period of project completion, especially were the communities wishes to become on-demand actioned.

For consistency in evaluation this option is presented as:

- **9.1 Current source**
- **9.1+GW(i) Current source + groundwater behind village**

The further sub-option **9.1+GW(ii) Current source + groundwater adjacent lake** was not considered further as it does not offer benefits, save reduced risk in sourcing adequate groundwater, over 9.1+GW(i). Additionally, there is no reasonable, cost effective way to allow the two physically separated sources to supply raw water to the treatment plant without extending substantial tracts of pipework. This would obviously add cost further increasing the total project capex.

9.1 relies solely on the current source to meet all current and future needs to the level of service required by the community. This is unlikely to be realisable.

9.1+GW(i) Current source + groundwater behind village is ultimately the same as option 8 but it retains the current source. This involves the development of groundwater bore behind the village to supplement the current source. This offers the "best case" groundwater supplementation of the current source. Both sources would work in parallel to supply the required volume of water. This has the effect of increasing capital cost whilst not releasing deprecation funds. This increases the rates funded portion of the works and thus the users annual charge.

15 Assessing the options

Four options were considered in detail, although one option, being option 6 (and promoted by the landowner) has now had landowner approval withdrawn. As this withdrawal of approval occurred after the assessment and workshop detailed below the option is retained for completeness.

15.1 Summarising the options

The options are discussed briefly in sections 11, 12, 13 and 14 and are tabled below;

Table 3 Summary of options

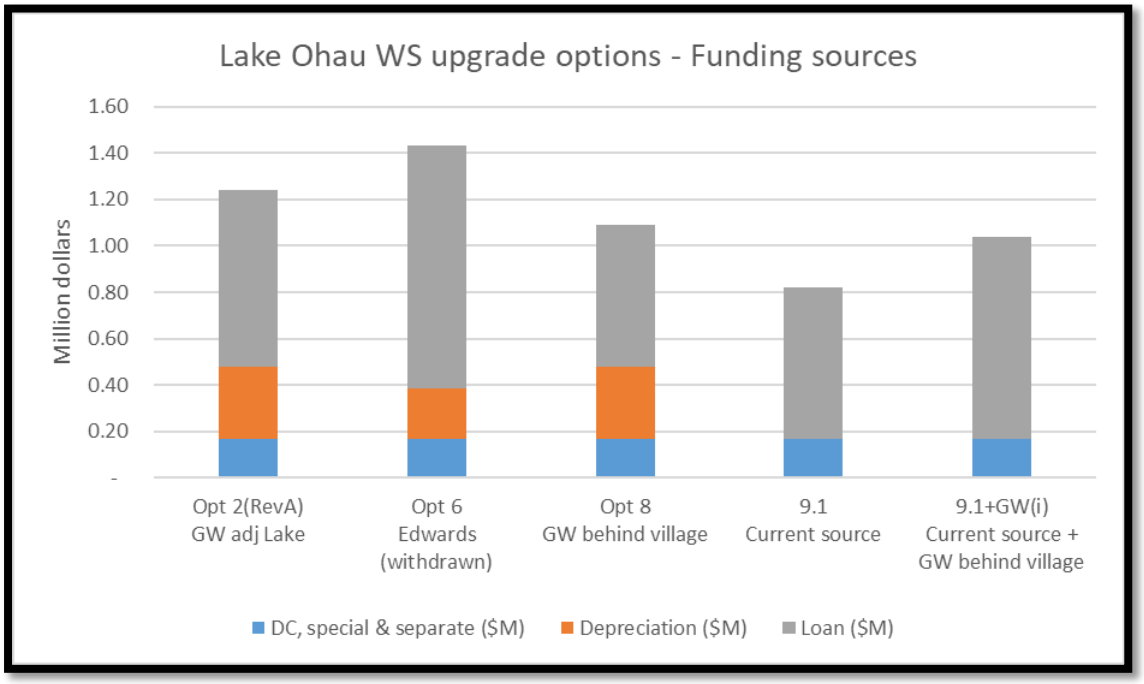
Option	Brief description	Capex (M$)	NPV 20yrs
2(revA)	Groundwater adjacent lake	$1.24M	$1.60M
6	D Edwards option (now withdrawn)	$1.43M	$1.89M
8	Groundwater behind village	$1.09M	$1.51M
9.1	Current source	$0.82M	$1.62M
9.1+GW(i)	Current source + groundwater behind village	$1.04M	$1.47M

Detailed descriptions of the options are included in Appendix D – Design Reports and Memos.

15.2 Funding and rates impact

All options except option 9.1 and its subsequent stages, involve the abandonment of existing infrastructure and this reduces the loan burden as illustrated below:

Figure 7 Summary of funding sources



This has a direct impact on the uniform annual charge as illustrated below:

Figure 8 Summary of rates charge

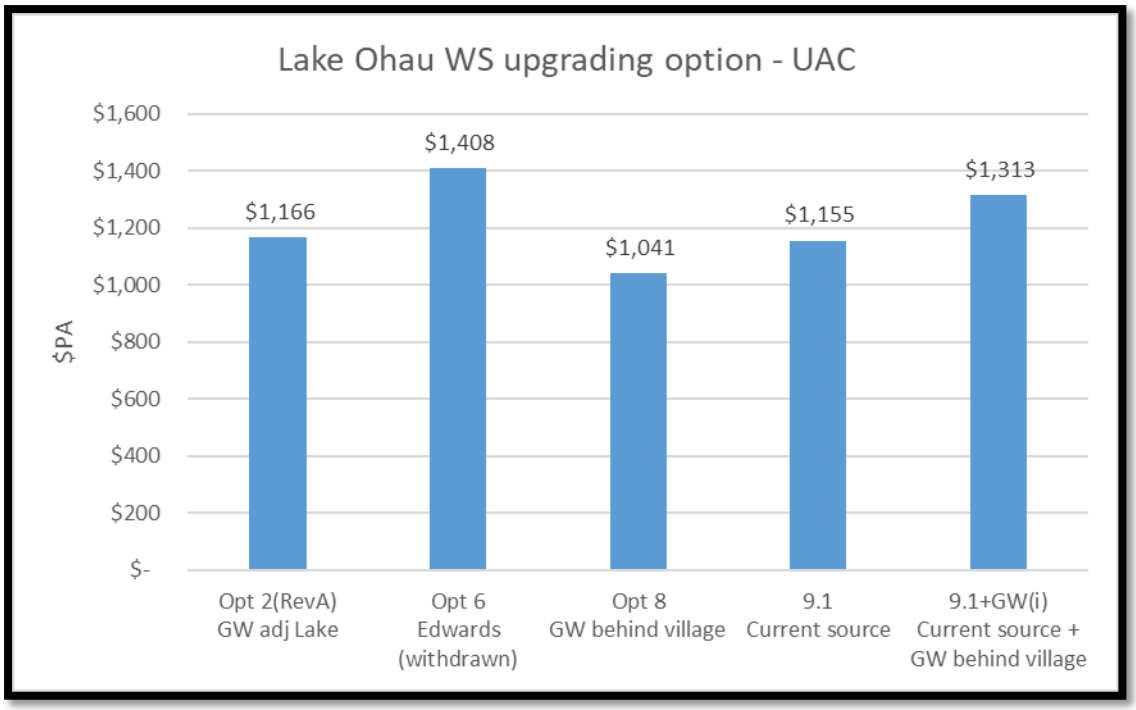


Figure 7 and Figure 8 identify that:

1. Option 9.1 Current source has the least capital cost estimate and the second lowest annual charge. The impact of the additional stage to supplement the supply, Option 9.1 +GW(i) Current source + GW behind village, increases both capital and annual charge costs. Without this supplementation this option does not meet on-demand supply needs.
2. Option 8 is the lowest annual charge option and offers the lowest capital cost for an option that does not retain the current source.
3. Option 6, now withdrawn from consideration by the owner, has capital and annual charge costs higher than the balance options.
4. Option 2(RevA) GW adjacent lake, carries a higher capital and user rate charge than the comparable option 8 GW behind village.

While the current source option is the least capital cost, it does not have the least annual rate impact and it does not meet the on-demand level of service.

15.3 Option evaluation workshop

The four short-listed options were evaluated at an option Evaluation Workshop involving Officers, Fluent Solutions and the Task Force. The Option Evaluation Workshop report is included in Appendix E – Option evaluation workshop.

The Task Force representatives were active participants in the discussion and assessment.

The evaluation considered five criteria; cost, water safety, location, environment and futureproofing/resilience and these were subjected to a structured risk assessment. The five individual criteria were defined, weighted and scored collaboratively by workshop participants and the results were then subjected to a sensitivity analysis and calibration.

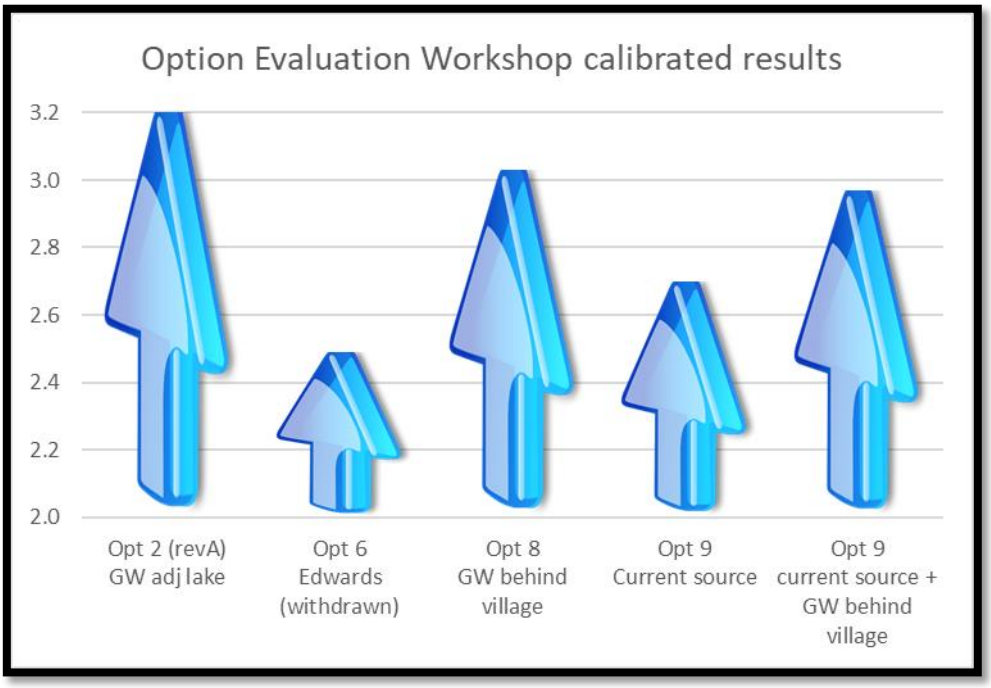
The final agreed weighted scores of the options, taking due consideration of the five criteria and the impact of sensitivity analysis and calibration are:

- Highest ranked with a weighted score of 3.21: Option 2(revA) Groundwater adjacent to lake
- 2nd highest ranked with a weighted score of 3.03: Option 8 Groundwater behind village
- 3rd highest ranked with a weighted score of 2.7: Option 9.1 Current source
- 4th highest ranked with a weighted score of 2.49: Option 6 Edwards (withdrawn)

The ranking of option 9.1 Current Source, when considered as option 9.1(i) Current source + groundwater behind village, improves to a weighted score of 2.97 although this does not improve its ranking.

Graphically the weighted scores of the options are shown in Figure 9 where the **best** performing option has the **taller arrow**.

Figure 9 Weighted scores of options



16 Conclusion and recommended option

Option 2(revA) Groundwater adjacent to the lake is the preferred option.

It offers the best balance between performance, risk and cost, including annual rates cost. This option benefits from increased likelihood of satisfactory yield and stable, treatable water, and satisfies the communities desire for fully on-demand supply.

Option 8 groundwater behind the village is a reasonable performing option but is not preferred as it carries additional risk around sourcing sufficient water for the future and potential security of the water, and this was reflected in the lower weighted score gained at the workshop.

Option 9.1 was a generally low performing option primarily due to concerns around yield and water security. Staged steps to address this improve the option to reasonable performance but have a significant impact on cost. Option 9.1 by utilising surface water is somewhat in tension with **Principle 2: Protection of source water** and **Principle 4: Change precedes contamination** and **Principle 6: Apply a preventive risk management approach** of the fundamental principles of drinking-water safety in New Zealand. More stable and protected sources subject to less change and lower risk are available and the principles would encourage the embracing of these sources.

Option 6 Edwards (withdrawn) was the lowest performing option that has subsequently been withdrawn from consideration.

16.1 Recommendation

Option 2(revA) Groundwater adjacent to the lake is the recommended option.

17 Appendix A – Task Force Submission

18 Appendix B – Task Force call for donations

19 Appendix C – Design Flow

20 Appendix D – Design Reports and Memos

Appendix D includes the following reports and memorandums that relate to this project:

Fluent Solutions documents:

1. 18 Jan 2019 Ohau Water Supply Upgrade – Further Options (DRAFT) memo
2. 17 May 2019 Ohau Water Supply Upgrade – Further Information (DRAFT) memo
3. 21 May 2019 Ohau Water Supply Upgrade – Additional options (DRAFT) memo
4. 1 Jul 2019 Ohau Water Supply Upgrade – Staged Option (Rev A) memo
5. 11 Jul 2019 Ohau Water Supply Upgrade – Staged Option (Rev B) memo
6. Aug 2018 Ohau Village Water Supply Issues and Options Report

21 Appendix E – Option evaluation workshop