

# GETTING TO ACCEPTABLE - DRINKING WATER SOLUTIONS FOR SMALLER WATER SUPPLIES

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## **ABSTRACT (500 WORDS MAXIMUM)**

The Water Services Act 2021 and the drinking water regulations (standards, compliance rules and aesthetic values) developed by Taumata Arowai, the water services regulator, set new requirements for all drinking water suppliers from 14 November 2022 to ensure safe drinking water. Taumata Arowai is also developing a number of instruments that water suppliers can use to demonstrate that they meet those requirements. Acceptable solutions or verification methods for drinking water (Acceptable Solutions) are one of these instruments and are intended to provide a compliance pathway that is proportionate to the scale, complexity and risk profile of certain, smaller water supplies. Three Acceptable Solutions have been consulted on so far; one for rural agricultural drinking water supplies, one for roof water supplies and one for spring and bore supplies serving up to 500 people.

It is expected that many of the users of these Acceptable Solutions will have limited experience with managing drinking water risks, be unfamiliar with drinking water science and technology, and will be constrained in financial resources, time and expertise. An Acceptable Solution approach improves the provision of safe drinking water by creating an alternative compliance option, but to be effective they need to be simple, affordable, easy to understand, applicable in a wide variety of situations, and practical. A technical approach to drinking water management seeks to minimise the risk of drinking water contamination through strict source water quality requirements, automatic control systems, multiple treatment barriers and providing redundancy for every eventuality. These things add cost and complexity, the opposite of the intention of the Drinking Water Acceptable Solutions.

This paper discusses the development of the Acceptable Solutions, the process of balancing the technical ideals with affordability and practicality by using a public health risk management approach to create a robust method of establishing compliance with legislative requirements. This approach seeks to maximise benefit in an effort to develop a solution that may not please everybody but is ultimately acceptable for everyone.

## **KEYWORDS**

**Drinking Water, Acceptable Solutions, Public Health**

## **INTRODUCTION**

As the new drinking water regulator, Taumata Arowai is aware that there are a large number of smaller water supplies that were not previously regulated, and there is a need to provide a simpler and more cost-effective approach to compliance commensurate to the risks to public health that these supplies present.

An acceptable solutions approach is used in the Building Act 2004 (section 24) to demonstrate compliance, and Taumata Arowai aim to develop similar regulatory tools that will be provide a simplified method of compliance for low risk drinking water supplies.

Taumata Arowai recognises that for this type of approach to be successful, they need to understand the needs and constraints of these new suppliers, in order to develop a practical and low-cost solution that is acceptable to smaller suppliers, as well as a robust and effective system that is acceptable for managing the health risks to drinking water.

This paper sets out the purpose and regulatory function of Acceptable Solutions, who they are aimed at, and discusses the challenge of balancing cost, complexity, and safety to reach a place of acceptability.

## **BACKGROUND**

The Water Services Act places a duty on water suppliers to ensure that the drinking water they supply is safe. Acceptable Solutions are a regulatory tool that Taumata Arowai can use to establish compliance with the legislative requirements of the Water Services Act 2021. Use of an Acceptable Solution replaces some (but not all) of a supplier's obligations under the Water Services Act 2021 and the new drinking water regulations (standards, rules and aesthetic values) developed by Taumata Arowai.

The Acceptable Solutions set out a specific and detailed approach to providing safe drinking water, including testing, maintenance and verification requirements. This gives the water supplier and Taumata Arowai confidence that the supply is effectively managing risks to drinking water safety. They are intended to provide a practical and cost-effective pathway to compliance for smaller water suppliers. Use of an Acceptable Solution is optional, and suppliers may choose to use another method of achieving compliance with legislative requirements.

The Acceptable Solutions are only generally applicable to supplies serving fewer than 500 people (the exception to this is the Acceptable Solution for rural agricultural drinking water supplies which does not have a population limit at the time writing). It is estimated that there could be in the order of 75,000 unregistered supplies which potentially meet the requirements for use of an Acceptable Solution.

Under the previous regulatory system, rural agricultural drinking water supplies were already classed as a special case and an alternative pathway of compliance provided. This alternative pathway is now replaced with the Acceptable Solutions approach (noting that this pathway is still optional). Other water supplies (serving fewer than 500 people) that the Acceptable Solutions may be used for are:

- Commercial premises such as cafes, restaurants, shops, hairdressers, petrol stations, hotels, campgrounds, golf courses, and other businesses
- Community facilities such as town halls, community centres, libraries, sportsgrounds, marae
- Educational facilities such as schools and early childhood education centres
- Groups of houses that share a water supply
- Irrigation schemes where water is used for domestic purposes

Many of these types of supplies were not previously required to be registered or considered water supplies in a regulatory sense. The suppliers are likely to be unfamiliar with the regulations, have limited experience with drinking water principles and technology, a basic understanding about risk, and be unwilling to spend much money on drinking water treatment that they haven't considered necessary until now.

These types of suppliers are sensitive to cost, and would prefer a simple solution that is easy to operate, requires minimal maintenance and paperwork and is widely applicable across a range of situations. The success of the Acceptable Solution approach relies on them being widely and effectively adopted by water suppliers so the Acceptable Solution must be designed with these drivers in mind.

The Water Services Act 2021 requires that Taumata Arowai cannot issue an Acceptable Solution unless satisfied that it is consistent with the purpose of the Act to ensure that drinking water suppliers provide safe drinking water to consumers. From a technical point of view, it is challenging to design an Acceptable Solution to meet the needs of these smaller suppliers whilst still providing a robust and effective treatment solution as there are a number of competing priorities at work – safety, effectiveness, cost, and complexity.

The easiest way to minimise risk for an Acceptable Solution is to limit the situations in which it is applicable to the best quality water supplies. However, this goes against the goal of developing a solution that is widely available to smaller water suppliers.

Generally, designing a solution for a greater variation in water quality requires a higher degree of treatment as a default which adds cost (which smaller water suppliers are very sensitive to), and complexity (which may also make the operation of the solutions more difficult for smaller water suppliers). There is also a tendency to want to add layers of monitoring and automated control to make up for the potential lack of experience of smaller water suppliers, however, this too adds cost and complexity.

In order to reconcile the needs and constraints of suppliers, with technical (and legislative) requirements to provide a robust treatment system, Taumata Arowai have taken a public health risk management approach that seeks to balance the risk to public safety from inadequate treatment of a potable water supply against the cost and complexity of the proposed systems. If the public health risks of a solution can be reduced, for example, by limiting the population potentially affected by that solution, then there is justification for a proportionate reduction in the checks and balances used to manage that risk.

In the context of the Acceptable Solutions, a public health risk management approach considers both the overall risk to public safety from these smaller water suppliers, and the benefit provided by having operational drinking water treatment in place compared to the status quo. A public health risk management approach also considers other means of risk management for example, water quality monitoring and audits, which can provide assurance in the place of physical infrastructure.

It is also worth considering that the adoption of Acceptable Solutions will result in an improvement of the management of drinking risk overall. This is particularly true for water supplies with no existing treatment, but also applies to water supplies that have existing treatment units, but probably not the robust management procedures around operations, maintenance and monitoring that form part of the Acceptable Solutions. From this point of view, it is preferable that the Acceptable Solutions are utilised by suppliers, as opposed to suppliers trying to 'dodge the rules' because the systems are too complex or too costly to run.

## **INITIAL DEVELOPMENT OF ACCEPTABLE SOLUTIONS**

### **APPROACH**

Beca were engaged to assist with the initial development of the Acceptable Solutions. Three Acceptable Solutions were developed: rural agricultural, bore and spring water supplies and roof water.

The approach to the treatment of micro-organisms in drinking water in New Zealand is based on international best practice and relies on the use of multiple barriers to prevent their transmission. The types of barriers used include protection of source water, proper selection and implementation of treatment systems, and management of distribution networks.

This multi-barrier approach also applies to the Acceptable Solutions. The first barrier is the limits of application of the Acceptable Solutions to exclude water suppliers with a risk profile that exceeds the capacity of the standardized treatment solution to adequately remove contaminants from the water.

Treatment equipment technologies provides the next barriers. A combination of cartridge filtration and ultraviolet (UV) disinfection was selected for the Acceptable Solutions. This is a commonly used and proven effective combination of treatment equipment (provided source water quality is kept within appropriate ranges). Cartridge filtration is selected as a pre-treatment unit but can also be an effective method for removal of micro-organisms, solids and the reduction of turbidity. UV disinfection is then used for the inactivation of viruses, bacteria and protozoa. To maintain effective disinfection using UV, turbidity and UV transmissivity must be kept within the operating parameters of the unit.

For the Acceptable Solutions that went for public consultation, where end-point treatment is used, the proximity of the treatment unit to the point of consumption reduces the risk of recontamination in the treated water network. In other situations, residual disinfection via chlorination is required in line with the Drinking Water Quality Assurance Rules 2022.

The Acceptable Solutions are focused on the risks of microbiological contamination and are not suitable for water supplies with chemical or radiological contaminants. Testing is required to show that a supply is low risk for these types of contamination before the Acceptable Solution can be applied. Likewise, the Acceptable Solution is not intended to remove taste or odour from the raw water. Taste and odour in the raw water may make it unpleasant to drink, but do not necessarily indicate the water is unsafe.

## **TECHNICAL STANDARDS FOR EQUIPMENT**

### **CARTRIDGE FILTERS**

Cartridge filters are generally sized based on flow and pore size however, as the 2018 New Zealand Drinking Water Guidelines noted, there is no robust industry standard. This is problematic for establishing design criteria. Previously, cartridge filters could be certified to ASTM F795-88, however this standard was withdrawn in 2002. The Drinking Water Standards for New Zealand 2005 Revised 2018 (DWSNZ) requires cartridges to be certified based on challenge testing to obtain a 2-log removal rating. A survey of the New Zealand market found that although some larger cartridge filters are certified under NSF/ANSI 419 Public Drinking Water Equipment Performance - Filtration, the majority sold in New Zealand do not have any certification.

The Acceptable Solutions do not rely on cartridge filters for protozoa removal. Instead, they are intended to act as pre-treatment for the UV disinfection and hence less stringent validation for the purposes of microbial removal is adequate.

### **UV DISINFECTION**

Under the Drinking Water Quality Assurance Rules 2022, validation of UV disinfection equipment is required to obtain a log removal rating. Acceptable standards for validation include, UV Disinfection Guidance manual (USEPA), DVGW Technical Standard W294, öNORM and NSF/ANSI 55 for Class A systems.

For the Acceptable Solutions, water suppliers are not expected to understand much about drinking water treatment technology and validation is one means of providing assurance, to both the water supplier and Taumata Arowai, that the equipment installed is of good quality and will be effective at inactivating of microorganisms.

The version of the Acceptable Solutions that went for public consultation require that the UV unit must be validated against UV Disinfection Guidance manual (USEPA), DVGW Technical Standard W294, öNORM or NSF/ANSI 55 for Class A systems. In addition, the unit must have:

- A UV Intensity sensor with alarm (audio/visual plus a signal to a solenoid control valve)
- Automatic fixed flow rate control
- Visual means to verify electrical operation of lamps
- Minimum UV dose of 40 mj/cm<sup>2</sup>

## **OTHER CONSIDERATIONS**

### **AFFORDABILITY AND AVAILABILITY**

Affordability was identified as a factor to making the Acceptable Solutions successful in New Zealand, so it was important to understand what sorts of products were already available in the New Zealand market.

A market survey was conducted by placing a notice in the Water New Zealand's Water Journal and reaching out to known suppliers of small drinking water treatment equipment. The survey requested specific information about cartridge filtration and UV disinfection equipment, the makes and models, sizing, validation and certification, and pricing for the units and any consumables.

Responses were received from eight suppliers, some selling only UV units or cartridge filters and some selling both, either individually or as packaged systems. The survey showed that there are a wide range of cartridge filters available in the New Zealand market. Most suppliers did not offer validated cartridge filters, especially at this smaller scale. Nominal pore-size cartridge filters were more common than absolute-rated.

Both validated and non-validated UV units are available. As expected, validated units were more expensive than non-validated units, however suppliers commented that prices for validated units may come down if there was a greater demand for them (since validation is not currently a requirement for a self-supply).

Pricing for packaged cartridge filtration and UV disinfection systems ranged from \$1,000 - \$2,000 for non-validated UV disinfection systems and from \$2,500 - \$7,000 for validated UV disinfection systems.

### **MONITORING AND CONTROL**

The ability to monitor, collect and control water quality data from treatment technologies through manual or automatic process enables both the suppliers and the regulator to prove and monitor compliance, providing a significant step change improvement in the certainty that installed systems are operating correctly.

The ability to store information, transmit data or alarms to a remote location, and control equipment remotely are common features or larger water treatment systems, and as technology advances are increasingly common at a smaller scale.

The Acceptable Solutions do not require remote telemetry but do require the treatment system to stop flow on a UV unit fault, and also consider the level of automated monitoring and control when setting out operator attendance requirements.

### **GENERAL REQUIREMENTS**

All of the Acceptable Solutions require:

- The water supply to have an operation and maintenance manual, standard operating procedures and incident and emergency response plan
- Monitoring of source water, treated water and distribution network

- Regular operator attendance. The frequency is dependent on the availability of remote monitoring of the treatment equipment.
- Self-audits to be completed annually

Adoption of an Acceptable Solution is considered to meet the requirement for a water supply to have a water safety plan, therefore no separate water safety plan is required.

## **ACCEPTABLE SOLUTIONS DEVELOPED FOR CONSULTATION**

Three Acceptable Solutions were initially developed for public consultation based on the general criteria described in the previous section. The first was aimed at rural agricultural drinking water supplies, the second for regulated supplies (i.e. not domestic self-supplies) using roof water as a source, and the third for smaller supplies using bore or spring water as a source. The following sections describe the key characteristics of the Acceptable Solutions that went for public consultation.

### **RURAL AGRICULTURAL WATER SUPPLIES**

Rural (or rural agricultural) water supplies originated from government funding for supplies to improve the quality and reliability of water available to farms and therefore improve farming outcomes. The water provided in rural agricultural supplies is primarily intended for agricultural purposes and is not generally considered safe for people to drink. Taumata Arowai estimates there could be 300-500 rural agricultural water supplies in the country, with each one supplying between 10 to 2,500 people each.

Many of the schemes are constant (trickle) flow and have onsite storage of water. Treatment is often limited, sometimes settling and/or filtration and sometimes chlorination, but generally these types of supplies have not been treated adequately to comply with previous DWSNZ. It is not economic to treat the entire supply to a potable level.

Most of these schemes were inherited by district councils following the 1989 local government reforms and are operated by them often in close partnership with the farmers that use them. Some have been transferred into farmer ownership, and there are schemes operated privately by farmers or irrigation companies.

Source waters for rural agricultural supplies can vary greatly:

- Groundwater from a confined aquifer is usually very good quality, with low levels of microbiological or chemical contamination. However, contamination can occur if the bore or bore head does not prevent surface water or other sources of contaminants from entering the bore and/or the aquifer.
- Groundwater from an unconfined aquifer is generally good quality and may be free from microbiological contaminants. However, water from shallower aquifers (less than 10m depth) can be vulnerable to contamination due to weather events or changes in water quality due to changes in the catchment, particularly if there is high connectivity with nearby surface

water bodies. Water quality in deeper, unconfined aquifers is also vulnerable to contamination, but these changes take longer to manifest.

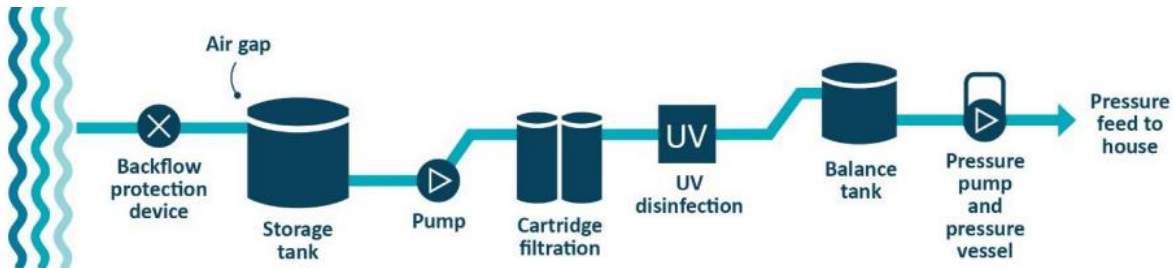
- Lakes and reservoir water sources are variable in quality depending on activities in the catchment and can be susceptible to algal blooms.
- River and stream water sources are variable in quality and are usually affected by rain and flooding which typically causes turbidity in the water to increase....

Because of the agricultural land use, there can be at higher risk of contamination, particularly for surface water sources.

An end-point treatment solution for each domestic user in the rural agricultural water supply is required in the Acceptable Solution. A typical installation of the Acceptable Solution for Rural Agricultural Water Supplies that went for public consultation is shown in Figure 1. The key features of the Acceptable Solution are:

- Source water testing to exclude contaminated catchments
- Limit on turbidity to exclude high risk catchments as well as reduce operational costs and ensure effectiveness of UV disinfection
- 96 hours of raw water storage for resilience, but also to encourage settling of high turbidity water
- End-point treatment consisting of two stage cartridge filtration, validated UV disinfection and automated flow restriction.

Figure 1: Possible Configuration of the Acceptable Solution for Rural Agricultural Water Supplies (with Pressure Pump) (Taumata Arowai, 2022a)



### ACCEPTABLE SOLUTION FOR ROOF WATER SUPPLIES

Rainwater collected from rooftops is a common source of drinking water worldwide. Provided that the roof and collection pipework is kept clean, rainwater is generally considered to be of good quality compared to other natural water sources. The primary sources of contamination for these types of water supply are from animals accessing the roof area and vegetation accumulation in guttering and pipework. Taumata Arowai estimates there are between 10,000 and 30,000 roof water supplies in New Zealand, including many marae.

The size of roof water supplies is limited by the amount of water that can be collected, and typically these sorts of supplies are single buildings with relatively small populations, like household dwellings, or standalone buildings with a commercial function such as a café, office or shop.

Roof water supplies pose a relatively low risk to health due to the self-limiting number of people able to served by a single supply, and the relatively good, and



consistent, quality of the source water, provided some basic maintenance is carried out.

Household and smaller-sized treatment units suitable for roof water supplies are already common in New Zealand. Cartridge filters and UV disinfection are the most common treatment types which are relatively easy to install and maintain for a good quality water source.

An end-point treatment solution is required in the Acceptable Solution. A typical installation of the Acceptable Solution for Roof Water Supplies that went for public consultation is shown in Figure 2. The key features of the Acceptable Solution are:

- 96 hours of storage per treatment unit
- End-point treatment consisting of two stage cartridge filtration, validated UV disinfection and automated flow restriction.

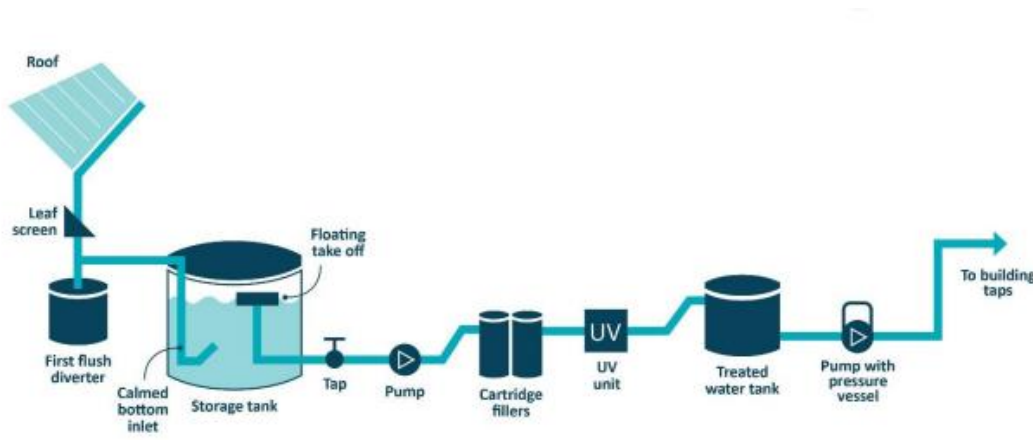


Figure 1: Possible Configuration of the Acceptable Solution for Roof Water Supplies (with Pressure Pump) (Taumata Arowai, 2022b)

### ACCEPTABLE SOLUTION FOR BORE AND SPRING WATER SUPPLIES

As outlined above, bore and spring water is generally considered to be of a more consistent higher quality than surface waters, and groundwater from confined aquifers generally has low levels of microbiological and/or chemical contamination, provided the bore and bore head protect from contamination from the surface. However, this is not universally true. For example, water from geothermal springs is not suitable for drinking, and water from karst/limestone terrain is prone to contamination where there is a reduced amount of filtration from soils and rocks compared to other types of groundwaters. It is uncertain how many of these supplies currently existing in New Zealand.

Some springs may also have a high risk of contamination that other bore waters, particularly where the water is drawn from a spring-fed pool or stream (rather than from the spring itself). In these cases, the source is at higher risk of contamination and water quality may be more like a surface water source.

Interconnectivity with surface water sources can also affect the quality of bore water. Shallow bores or those located close to rivers often exhibit changes in water

quality such as elevated turbidity levels during and after periods of high rainfall. Turbidity is not always a good indicator of contamination for bore water. Groundwater can be contaminated by leaky sewers, intensive farming and other industrial process without a corresponding increase in turbidity.

Groundwater and springs water supplies are common in New Zealand (and overseas), and there is likely to be a wide variety of water suppliers that may be interested in using Acceptable Solutions for compliance with the new regulations. The types of water supplies could include small community networks, commercial enterprises, community centres, marae, campgrounds, and groups of houses.

One of the challenges of developing an Acceptable Solution for bore and spring water supplies is trying to limit the applicability to supplies with low risk of contamination of the source aquifer. This has been doing by excluding bores located too close to sources of contamination (sewage disposal, urban areas, underground storage tanks, waste ponds landfills, offal pits and where pesticides or animal wastes are applied to land). There are also requirements to exclude animals from direct access to the bore head and to regularly check water quality for contamination.

The key features of the Acceptable Solution for Bore and Spring Water Supplies that went for public consultation are:

- Limit on turbidity
- Centralised treatment consisting of 5 micron cartridge filters with differential pressure monitoring, validated UV disinfection and automated flow control.

## **FURTHER DEVELOPMENT OF ACCEPTABLE SOLUTIONS**

At the time of writing, public consultation on the Acceptable Solutions has closed and Taumata Arowai is in the process of reviewing the feedback and refining the Acceptable Solutions.

## **CONCLUSIONS**

The Water Services Act 2021 allows Taumata Arowai to create Acceptable Solutions to establish a method of compliance with legislative requirements that is proportional to the scale, complexity and risk profile of certain, smaller water supplies. Taumata Arowai has developed three Acceptable Solutions to date. Public Consultation on these Acceptable Solutions has closed and Taumata Arowai is in the process of reviewing the feedback and refining the Acceptable Solutions.

The success of the Acceptable Solutions is not only measured in their ability to effectively manage health risks, but also in the successful uptake of them by the potentially large number of inexperienced suppliers that now find themselves subject to drinking water regulation. The Acceptable Solutions must be appealing to these suppliers, which means they must be simple, low maintenance and reasonable in cost.

A public health risk management approach was taken in the development of these Acceptable Solutions so that the need to provide a robust technical solution can be balanced against the cost and complexity. This approach is unlikely to result in

a perfect solution for any one supply, but in contrast is intended to result in (as the name suggests) an acceptable solution for many smaller water supplies.

**REFERENCES**

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