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Twizel Drinking Water Safety Plan

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Mackenzie District Council

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Contents

List of Figures

List of Tables

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1 Revision Details

Version control

Version No	Description
V1	Prepared and approved by DWA in 2012.
V2	Prepared by Jim Graham, Principal Environmental Scientist, Opus International Consultants Ltd. Approved by DWA September 2017.
V3	Draft prepared by WSP NZ Ltd, June 2022.
V4	Final copy submitted to MDC, November 2022.

Document review and approval

Role	Name	Signature	Date
Authors	Nicole Hunter (Engineer – Water, WSP)		12/10/2022
	Lachlan Donaldson (Engineer – Water, WSP)		12/10/2022
Reviewers	Bridget O'Brien (Technical Principal – Water & Wastewater, WSP)		12/10/2022
	Geoff Horler (3 Waters Manager, MDC)		9/11/2022
Approver	John Mackie (Acting Engineering Manager, MDC)		

The Water Services Act 2021 requires Taumata Arowai to maintain a register of drinking-water suppliers. The Twizel drinking water supply is owned by Mackenzie District Council, PO Box 52, Fairlie 7925 or 53 Main Street, Fairlie 7925. The operation and maintenance is undertaken by Whitestone Contracting Limited on behalf of Mackenzie District Council.

For the purposes of clarity:

- The Acting Engineering Manager, John Mackie, is the person responsible for the supply.
- 3 Waters Manager, Geoff Horler, is the primary contact for the supply.

Assessment of the performance of the plan

Assessment of the performance of this drinking water safety plan will be undertaken annually, under the authority of the Chief Executive, and completed by the 3 Waters Manager. The assessment will consider any events, non-compliances, near misses and unexpected situations that have occurred during the past year, progress against the improvement schedule and any changes to any of the supply elements. Any matters requiring attention will be included into the Annual Plan, the Three Waters Asset Management Plan and if requiring significant capital funding, the Council Long Term Plan.

Reporting of the plan

A brief report on the performance of the plan, including information from the assessment of the plan will be completed and reported to the Engineering Manager annually on the anniversary of finalisation of the plan.

The report will cover the items listed above in the assessment of the performance of the plan. The 3 Waters Manager will be responsible for ensuring that any matters requiring attention will be appropriately included into the Annual Plan or the Asset Management Plan. If significant capital funding is required, the matter will be included into the Long Term Plan process (reviewed every three years).

Links to other quality systems

This drinking water safety plan will be linked to the Council's Water Supply Asset Management Plan, Activity Plan for Water Supply, Long Term Plan and Annual Plan.

2 About this Drinking Water Safety Plan

This drinking water safety plan has been prepared for the Twizel drinking water supply to identify potential events that present public health risks and reliability of supply to consumers. Mackenzie District Council (MDC) is committed to the principles of drinking water safety planning and to the supply improvements that have been identified in this drinking water safety plan.

Supply governance is in accordance with the statutory provisions and obligations of the Local Government Act 2002. Supply delivery falls within the expressed purpose of local government namely: *to enable democratic local decision-making and action by, and on behalf of, communities; and to promote the social, economic, environmental, and cultural well-being of communities in the present and for the future*.

The drinking water safety plan is aligned to national best practice and strengthens the focus on preventive measures across the whole drinking-water supply system, moving away from a reliance on after-the-event endpoint water quality testing. It promotes a multi-barrier approach to managing risks, which safeguards against the failure of any one barrier. It was prepared in accordance with the New Zealand Drinking-water Safety Plan Framework (Ministry of Health, 2018) and to meet the requirements of the Water Services Act 2021, including the requirement for a source water risk management plan. Taumata Arowai has advised that it is up to water suppliers to determine the format of their drinking water safety plan and that using the Ministry of Health framework is acceptable.

The Twizel supply has a base population of 1,300 which swells to as many as 11,000 over the summer holiday period and during the Maadi Cup rowing tournament. The supply was constructed in 1969 when the township was established as a camp for workers constructing the Upper Waitaki Hydroelectricity Scheme in the region. Since that time Twizel has become established with a permanent population and a number of holiday homes. The community has the normal social infrastructure of a community of this size with a school, Council Office, cafes, Holiday Park and service station. Twizel also supports local outdoor recreational activities and businesses.

The Twizel drinking water supply is classified as a large drinking-water supply under the Drinking Water Quality Assurance Rules (Taumata Arowai, 2022) and provides water to a total population of approximately 1300 people. There are 1402 connections and 368 sections in the Twizel water supply area.

The water is sourced from three shallow bores and is treated with cartridge filtration, UV disinfection and chlorination before being distributed to consumers.

The maintenance and operation of the supply is undertaken by Whitestone Contracting Ltd under contract to MDC. Both are based in Fairlie. The key persons responsible for management, maintenance and operation of the Twizel water supply scheme are:

- Acting Chief Executive – Angela Oorsthuizen
- Acting General Manager, Operations, Planning and Regulatory Services – David Adamson
- Acting Engineering Manager – John Mackie
- 3 Waters Manager – Geoff Horler
- Treatment Plant Operator – John Wilson (Whitestone Contracting).

Preparation of the plan

The drinking water safety plan was prepared by Nicole Hunter (Engineer – Water) and Lachlan Donaldson (Engineer – Water), overseen by Bridget O'Brien (Technical Principal – Water & Wastewater, CPEng), with significant input from MDC staff via weekly meetings, site visits and a risk workshop.

WSP staff undertook a site visit of the water supply escorted by Geoff Horler (3 Waters Manager) on 16 November 2021. A risk workshop was held on 10 December 2021 via Microsoft Teams, facilitated by WSP and attended by Geoff Horler, Joni Johnson (former Engineering Manager), Tim Scott (Project Manager) and David Adamson.

The pre-circulated draft risk register was discussed with a focus on unmitigated risks that were rated high or extreme. Further information about the water supply was obtained from MDC staff by phone and email, and through weekly meetings. Sections of the draft drinking water safety plan were submitted progressively to MDC for review between January and June 2022 and comments were received from Geoff Horler and Joni Johnson. These comments were incorporated into the final drinking water safety plan.

3 Commitment to Drinking Water Quality Management

3.1 Relationship of the Drinking Water Safety Plan to Organisational Policy and Strategy

Mackenzie District Council is committed to the six guiding principles for safe drinking-water as described in in Taumata Arowai's Guidance on Drinking Water Safety Planning[1]:

- A high standard of care must be embraced
- Protection of source water is of paramount importance
- Maintain multiple barriers against contamination
- Change precedes contamination
- Suppliers must own the safety of drinking-water
- Apply a preventive risk management approach

The community outcomes that the Council's water supplies contribute to are 'a treasured environment', 'resilient successful communities', 'a strong and innovative economy' and to 'embrace heritage and diversity'. These community outcomes are described in the Council's 30 year infrastructure strategy and align with their vision statement 'to empower our communities and treasure our environment'.

3.1.1 Legislative Requirements

The responsibility of providing drinking water by Council is undertaken in accordance with:

- Drinking-water Standards for New Zealand 2005 (revised 2018)
- Water Services Act 2021
- Resource Management Act 1991
- Local Government Act 2002
- Health and Safety at Work Act 2015
- Civil Defence and Emergency Management Act 2002
- National Policy Statement for Freshwater Management 2020
- National Policy Statement on Urban Development 2020
- Mackenzie District Council Water Supply, Wastewater and Stormwater Bylaw 2021

The Council must deliver the water supply service to comply with:

Safe drinking water standards: The Water Services Act, supported by the Drinking-water Standards for New Zealand (DWSNZ), specifies standards for drinking water quality and securing a safe supply. This will be replaced by the Drinking Water Quality Assurance Rules, Water Services (Drinking Water Standards for New Zealand) Regulations 2022 and the Aesthetic Values 2022 on 14 November 2022[2].

Drinking water safety plan: Under the Water Services Act, a drinking water safety plan must be prepared for each of the Council's water supplies. The Council must manage and operate each water supply in accordance with the relevant drinking water safety plan.

Abstraction of raw water: The Council is consented in terms of the Resource Management Act 1991 on the volume of water which it may take from a given water resource.

[1] https://www.taumataarowai.govt.nz/for-water-suppliers/drinking-water-safety-planning/guidance-for-drinking-water-safety-planning/#e636
[2] Taumata Arowai, New Standards, Rules and Aesthetic Values: https://www.taumataarowai.govt.nz/for-water-suppliers/new-compliance-rules-and-standards/

Water services assessments: The Local Government Act 2002 requires a territorial authority to assess, from a public health perspective, the adequacy of its water supply in light of health risks, quality of service, current and future demand and regulatory compliance with drinking water standards.

Fire flow: Although the New Zealand Fire Service Firefighting Water Supplies Code of Practice is not mandatory, the Council provides fire hydrants as part of its urban water reticulation system. The Council endeavours to provide water for firefighting but does not guarantee a constant flow of water or any maximum or minimum pressure.

Development capacity to meet demand: The National Policy Statement on Urban Development 2020 directs local authorities to enable sufficient supply of land for houses and businesses and ensure that planning is responsive to changes in demand, while seeking to ensure that new development capacity enabled by Councils is of a form and in locations that meet the diverse needs of communities and encourages well-functioning, liveable urban environments.

Emergency preparedness and response: Under the Civil Defence and Emergency Management Act 2002, the Council as a local authority is required to plan and provide for civil defence emergency management in its district. It must be part of a Civil Defence Emergency Management Group and must provide suitably trained and competent personnel for effective civil defence emergency management in its area. As a lifeline utility, the Council as a water supplier must ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency. It must also participate in the development of the national civil defence emergency management strategy and civil defence emergency management plans.

3.1.2 Long Term Plan and Annual Plan

The Long Term Plan (2021 – 2031, adopted 14 December 2021) provides a 10-year plan for the Council. It is supported by the 30-year Infrastructure Strategy, Activity Plans, Asset Management Plans and a Financial Strategy. The purpose of the Long Term Plan is to:

- Describe outcomes the Council aims to achieve
- Specify the services, projects and budgets that will enable those outcomes
- Provide integrated decision-making and coordination of resources, as per section 93(6)(c) of the Local Government Act
- Provide a long-term focus
- Demonstrate transparency and accountability
- Provide an opportunity for participation by the public in Council decision-making processes.

The development of the Long Term Plan is supported by the preparation of the Water Supply Activity Management Plan. The Revenue and Financing Policy describes the revenue sources, the Financial Strategy sets out capital and operational expenditure for the next 10 years and the Infrastructure Strategy identifies the significant issues for the Council over the next 30 years, the options and planned approach for dealing with those issues and forecast capital and operational expenditure.

The draft Long Term Plan is released for public consultation, providing the Council's stakeholders (including the public) an opportunity to provide direct feedback on the Council's proposed priorities and associated budgeting. The Council took the feedback into account before finalising the Long Term Plan 2021 – 2031 on 14 December 2021.

The Long Term Plan is updated every three years. In the intervening two years, the Council undertakes an Annual Plan process. The plan for the coming year as set out in the Long Term Plan is reviewed, released for public consultation as a draft Annual Plan, and then finalised before the start of the financial year on 1 July.

Budgets for the water supply programme are determined through the Council's Long Term Plan and Annual Plan processes. This includes budgets for work relating to water safety.

3.1.3 Documents related to the Twizel Water Supply

The documents related to the Twizel water supply are listed in Table 3-1.

Table 3-1 Documents related to the Twizel water supply

Name	Description	Location
Twizel Water Treatment Plant Operational Manual	Describes Twizel water supply operation and maintenance	A hardcopy is stored at the Twizel water treatment plant and at Council offices.
Twizel Water Supply Standard Operating Procedures	Describes how the Twizel water supply should be operated and maintained.	Whitestone have electronic copies of SOPs. There is an improvement action in Section 8.2 for SOPs that are missing.
MDC Long Term Plan 2021 - 2031	Documents outlining the Council's priorities, activities, services, capital programme and operational expenditure and how the Council proposes to pay for it.	https://www.mackenzie.govt.nz/council/strategies-plans-and-reports/long-term-plan-2021-2031
Mackenzie District Plan	Document provides zonings and rules for Mackenzie District's land	https://www.mackenzie.govt.nz/council/strategies-plans-and-reports/district-plan
MDC Annual Report 2020/21	Report on the performance of the Council, including water supply services	https://www.mackenzie.govt.nz/__data/assets/pdf_file/0010/512668/2019-2020-Annual-Report-Full.pdf
MDC Water Supply, Wastewater and Stormwater Bylaw 2021	Bylaws for the Mackenzie District, including a bylaw for water supply.	https://www.mackenzie.govt.nz/__data/assets/pdf_file/0009/589806/Water-Supply-Wastewater-and-Stormwater-Bylaw-2021.pdf
Activity Management Plan for Water Supply 2021-2031	Outlines Council's long-term asset management approach for the provision and intergenerational management of water throughout the district	https://www.mackenzie.govt.nz/__data/assets/pdf_file/0007/596104/Mackenzie_DC__Water_AMP_2021_4.pdf
Mackenzie District Council Map Viewer	Online GIS database showing locations of water supply assets	https://mapviewer.canterburymaps.govt.nz/?webmap=cdc3592cd33341fd9efe89361f754b59&extent=1399870,5067900,1485000,5190500,2193
Canterbury Civil Defence Emergency Management Group Plan 2018	Describes how the group will manage and respond to emergencies and sets out the operational arrangements of the group. MDC is a member of the group.	https://www.cdemcanterbury.govt.nz/media/bxwhxjcm/canterbury-cdem-group-plan-updated-june-2018.pdf
Mackenzie District Council	Describes how Council plans to manage its infrastructure (including water supply) over	https://www.mackenzie.govt.nz/__data/assets/pdf_file/0

Name	Description	Location
Infrastructure Strategy 2021 - 2051	the next 30 years, taking into account issues facing the Mackenzie District. Capital and operating expenditure forecasts are included.	008/596123/Infrastructure_Strategy_2021_-_Final_4_October_2021.pdf

3.2 Engaging Stakeholders and the Community

3.2.1 Key Stakeholders:

MDC maintains active working relationships with several key organisations and stakeholders. This allows for the ongoing management and operation of the supply, including emergency events or response to incidents relating to drinking water safety, quality, or continuity. Table 3-2 lists the key stakeholders for the Twizel drinking water supply. Figure 3-1 shows the MDC organisation chart for staff that have responsibility for three waters (water supply, wastewater, and stormwater).

Table 3-2 Key stakeholders

Stakeholder	Description/Relationship to supply management and operation	Contact Position	Contact Details
Taumata Arowai	Regulatory functions under the Water Services Act	Compliance Officer	https://www.taumataarowai.govt.nz/
Regional Public Health	Public health services and regulatory functions under the Health Act.	Medical Officer of Health	https://www.cph.co.nz/
Mayor and Councillors	Exercises drinking water supply decision-making responsibilities in a transparent, inclusive and lawful manner in accordance with the Local Government Act.	Mayor Graham Smith, Council Chairman	https://www.mackenzie.govt.nz/council/mayor-and-councillors
MDC Executive Leadership Team	Council's operational structure is divided into multiple groups responsible for council functions.	Angela Oosthuizen, CEO	https://www.mackenzie.govt.nz/council/executive-team
Canterbury Region Civil Defence Emergency Management Group	MDC is a member of the Canterbury Region CDEM which provides leadership and support to the community in a drinking water emergency and subsequent recovery.	Joe Rush, Emergency Operations Controller, MDC	https://www.cdemcanterbury.govt.nz/canterbury-cdem/governance-strategies-and-plans/
Environment Canterbury	Management and enforcement of RMA provisions in relation to water abstraction and allocation.	Resource Management Officer – Monitoring and Compliance	www.ecan.govt.nz; 0800 324 636

Stakeholder	Description/Relationship to supply management and operation	Contact Position	Contact Details
Fire and Emergency NZ	Response agency for CDEM events relating to drinking water. Major water user (flow and volume) during fire/emergency management incident response.	Carrie Lakin, Mackenzie Fire and Emergency Group Manager	027 405 9091
NZ Police	Response agency for CDEM events relating to drinking water.	Brad Morton, Senior Constable, Tekapo Police	021 191 2805
		Les Andrew, Senior Constable, Twizel Police	021 191 2324
		Russell Halkett, Senior Constable, Fairlie Police	03 685 8400
Alpine Energy	Operates and maintains the electricity distribution network serving treatment plants and related pump stations.	NA	https://www.alpineenergy.co.nz/
Whitestone Contracting Limited	Operation and Maintenance Contractor for the Twizel water supply reticulation network	Padraic Lawless	https://www.whitestone.co.nz/contact/
Hills Laboratory	Provides IANZ and Taumata Arowai accredited water testing services	Craig Radford	https://www.hill-laboratories.com/
Arowhenua via Aoraki Consultant Services	Arowhenua is the principal Māori kainga of South Canterbury.	Treena Davidson, Senior Policy Advisor	https://arowhenua.org/
Cone Peaks Farm Ltd	Registered water carrier available if required – not under contract to MDC	Raymond Wallace Harrington	027 435 9632

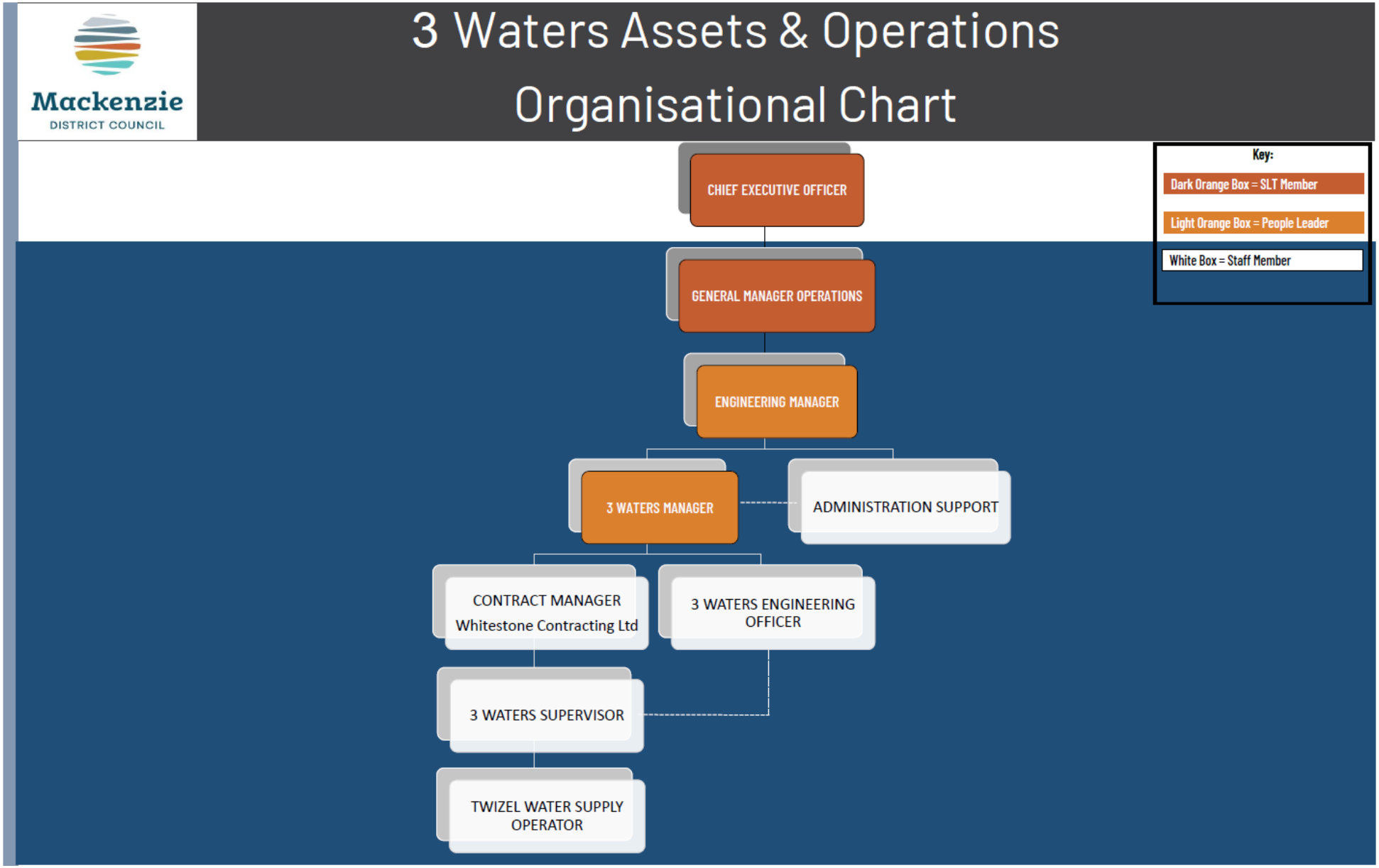


Figure 3-1 Mackenzie District Council organisational chart

3.2.2 Maintenance Contractor

Whitestone Contracting Ltd is the operations and maintenance contractor for the Twizel water supply.

3.2.3 Public Consultation

Public consultation on the water supply is primarily through the Long Term Plan and Annual Plan process.

3.2.4 Incidents and Emergencies

Mackenzie District Council is a member of the Canterbury Region Civil Defence Emergency Management (CDEM) Group, which includes all local authorities in the Canterbury Region. The Canterbury region CDEM Group Plan was developed to provide effective and efficient management of significant hazards and risks and sets out the operational arrangements of the group. The Canterbury Region CDEM Group Public Information Team is responsible for providing accurate and timely communications to the public in the event of an emergency.

3.2.5 Customer Complaints

Customer complaints regarding water can be lodged on the Council website, email, post, free-call and in person at the Fairlie office or the Twizel office. Whitestone Contracting Ltd contact information is also provided on the council website.

3.3 Te Mana o te Wai

Policy 1 of the National Policy Statement for Freshwater Management is that freshwater is managed in a way that gives effect to Te Mana o te Wai. Te Mana o te Wai sets outs to achieve the following:

- Recognise that protecting the health of freshwater (te hauora o te wai) protects the health and well-being of the wider environment (te hauora o te taiao) and of people (te hauora o te tangata)
- Protects the mauri of the wai

Giving effect to Te Mana o te Wai requires:

- Prioritising first the health and well-being of water bodies and freshwater ecosystems
- Active involvement of tangata whenua in freshwater management and decision-making
- An integrated approach recognising the interconnectedness of the whole environment, ki uta ki tai (from the mountains to the sea).

All elements of te taiao (the environment) possess their own mauri or life force.

Hauora is a holistic understanding of health and wellbeing:

- Te hauora o te taiao (the health of the environment), te hauora o te wai (the health of the waterbody) and te hauora o te tangata (the health of the people) are interconnected
- The state of health and wellbeing of te wai and te taiao is seen as a reflection on the mana, health and wellbeing of mana whenua
- Decline in te hauora o te wai and te hauora o te taiao is also understood to impact the health and well-being of the wider community

Ki uta ki tai is the concept used to describe holistic natural resource management, recognising all environmental elements are interconnected and must be managed as a whole. It is a way of understanding the natural environment, including how it functions, how people relate to it and how it can be looked after appropriately. Ki uta ki tai:

- Reflects mātauranga (indigenous knowledge) that all environmental elements are interconnected and must be managed as such
- Includes connections throughout a freshwater system, and also the relationships between air, land, freshwater and coastal waters
- Is concerned with each of the part of the system, and also the sum of the parts
- Requires holistic management.

Te Mana o te Wai approach does not ask, "Are the adverse effects within acceptable limits?" but rather it asks, "How are we supporting the health and wellbeing of the water body?" This affects system planning in the following ways.

- Respect the mauri of each water body:
    - Mauri is distinctive for each water body, reflecting whakapapa
    - Reflect natural form and function – letting the river be itself
    - The baseline for evaluating effects should be what happens naturally
    - Unnatural mixing of the mauri of different water bodies is not appropriate.
- Enable exercise of Kaitiakitanga:
    - Do not draw down "environmental capital", but protect and sustain the water body for current and future generations
    - Do not manage to just meet bottom lines, but provide for healthy resilience, and do not rely on assimilative capacity; prevent contamination instead
- Mana whakahaere:
    - Partnership and active involvement of mana whenua in decision-making
    - Sustain iwi relationships with water bodies and provide for customary associations and uses – recognise wāhi tūpuna, avoid discharge of waste to water
    - Incorporate mātauranga
- Integrated management / ki uta ki tai:
    - Sustain and restore connections throughout catchment
    - Recognise connections between water body and coast
    - Sustain and restore habitats of mahinga kai and indigenous species
    - Consider relationships between land use and water use
    - Have regard to cumulative effects and climate change risks

Examples of how water supply takes, and associated infrastructure can support or be inconsistent with Te Mana o te Wai are summarised in Table 3-3.

Table 3-3 Te Mana o te Wai and water supply takes and infrastructure

Supports Te Mana o Te Wai	Inconsistent with Te Mana o Te Wai
Intake designed to allow natural flow to continue around it	Intake disrupts/diverts natural flow
Abstraction proportionate to natural flow	Abstraction takes all or most of natural flow
Maintains connections between surface water and groundwater	Treats surface water and groundwater as different resources
Ensures continuity of flow from mountains to sea	Considers only flow at point of take
Considers habitat needs holistically	Considers habitat factors narrowly

Supports Te Mana o Te Wai	Inconsistent with Te Mana o Te Wai
Intake designed to allow natural flow to continue around it	Intake disrupts/diverts natural flow
Structures located away from sensitive areas	Structures located close to mahinga kai or areas of dynamic river/coastal processes
Riparian buffers established and maintained	Structures built right next to river/ coastal margin
Fish are able to migrate naturally	Structures interrupt natural migration
Built-in resilience in terms of capacity and safeguards against overflows/leakage	Accepting a degree of overflow/failure as inevitable
Design for changing environment (especially due to climate change)	Reliance on structures/system designs that are no longer fit for purpose
Structures located away from sensitive areas	Structures located close to mahinga kai or areas of dynamic river/coastal processes

MDC gives effect to Te Mana o te Wai in the following ways:

- Engaging with mana whenua to understand the values they hold for the water bodies that MDC uses for its drinking water supplies.
- Resource consent applications for water takes have considered the wider effects on the water bodies that they draw from.
- There are no discharges of waste or chemicals to the environment from any of the water treatment plants.
- Dangerous chemicals are handled with care and measures are in place to contain spills.
- All water intake structures allow fish passage.
- Water from high quality sources is used, which results in higher quality drinking water, less waste and lower treatment costs.
- The source water risk management plans in this drinking water safety plan take an holistic view of the catchments.

MDC aims to improve how it gives effect to Te Mana o te Wai in the following ways:

- Increase water efficiency through installing smart meters on all water supply connections
- Continuing to improve water efficiency and reduce leakage in its water networks.

4 Description of the Twizel Drinking Water Supply

4.1 Overview

The Twizel drinking water supply was established in 1969 to accommodate workers on the Upper Waitaki Hydroelectricity Scheme. The town has grown and now supports a range of tourist activities. The drinking-water supply originally included fluoridation and chlorination however these were removed at the end of the hydroelectricity project. Water was then supplied untreated until Council re-installed chlorine dosing equipment in 2011. Since then, the supply was upgraded in 2017 to include cartridge filtration, UV disinfection and chlorination.

The supply abstracts water from three shallow bores in alluvial gravel just outside the Twizel township on the northern side of Glen Lyon Road and adjacent to Fraser Stream. Abstracted water is stored in a raw water reservoir which is covered and lined with high density polyethylene (HDPE) before undergoing treatment at the neighbouring water treatment plant. A covered reinforced concrete reservoir, located partly under the water treatment plant building, stores water following treatment.

Treated water is then pumped to customers throughout the distribution network. There are two booster pump stations other than the pumps servicing the treatment plant, one boosts supply to The Drive subdivision, the other supplies water to Pukaki Airport.

Raw, filtered and bore water turbidity, UV intensity, UV transmissivity, free available chlorine (FAC) and flow are measured continuously at the treatment plant and the data is reported back to the operator and the Council office through the SCADA system. Samples are collected and analysed for *E. coli* twice weekly from the treatment plant and the distribution zone. Free available chlorine (FAC) is tested weekly in the distribution system.

The maintenance and operation of the supply is undertaken by Whitestone Contracting Ltd under contract to MDC. Operators visit the treatment plant at least weekly to check the operation of treatment devices, the level in the sodium hypochlorite tank and test the FAC.

A catchment risk assessment was prepared in October 2011 and identified that the source water has a low to moderate risk of protozoal contamination and requires 4-log protozoa treatment under section 5 of the DWSNZ. A sampling programme identified that 3-log protozoa removal was more appropriate for the Twizel drinking water supply. This was reviewed as part of the source water risk assessment in Section 6 of this drinking water safety plan and 4-log protozoal removal is considered appropriate. The treatment plant is capable of providing 5-log protozoal removal but currently achieves no log credits as the monitoring frequency is too low.

A map of the water supply scheme is shown in Figure 4-1 and the details of the scheme summarised in Table 4-1.

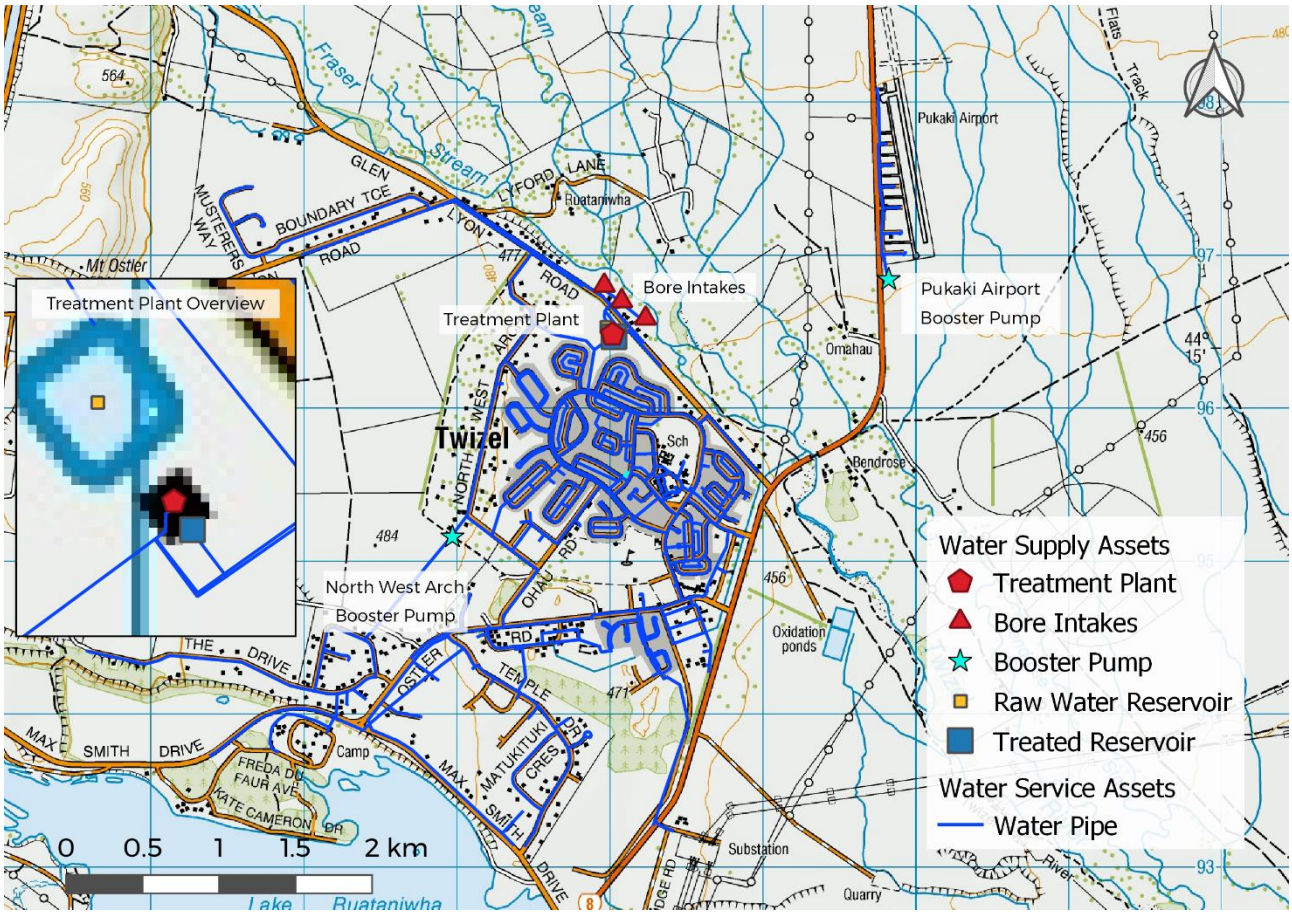


Figure 4-1 Twizel water supply sources and treatment plant

Table 4-1 Twizel water supply scheme summary

Supply Management and Operation		
Supply Name	Twizel	
Hinekōrako Code	TWI001	
Population Served by Supply	1300	
Local Authority / Supply Owner	Mackenzie District Council	
Acting Engineering Manager	John Mackie	
3 Waters Manager	Geoff Horler	
Water Supply Operator	John Wilson (Whitestone Contractors Ltd)	
Source Details		
Source Name	Twizel Wells	
Source DWO Community Code	G00247	
Type of Source	Groundwater	
Resource Consent No.	CRC042741	
Consent Expires	20 August 2047	
Maximum Consented Water Take:	130 L/s. Maximum rate of 39,000 m^3/day with maximum of 10,000 m^3/day for no more than 3 consecutive days. 1,440,000 m^3/yr.	
Grid Reference of Source (NZTM)	Easting: 1368077	Northing: 5096705
Treatment		

Plant Name	Twizel	
Plant Code	TP00368	
Location	Glen Lyon Road	
Grid Reference of Source (NZTM)	Easting: 1368017	Northing: 5096484
Treatment Processes	Filtration, UV disinfection, chlorination	
Average Daily Volume	3,000 m^3/day	
Peak Daily Volume	6,000 m^3/day	
Distribution		
Distribution Zone Name	Twizel	
Distribution Zone Code	TWI00TW	
Distribution Zone Population	1300	

4.1.1 System Flow Diagrams

Figure 4-2 and Figure 4-3 show the water supply system, from source to reticulation, including the treatment. Figure 4-2 shows the barriers to contamination, critical points and critical control points which are described in Section 9.6.

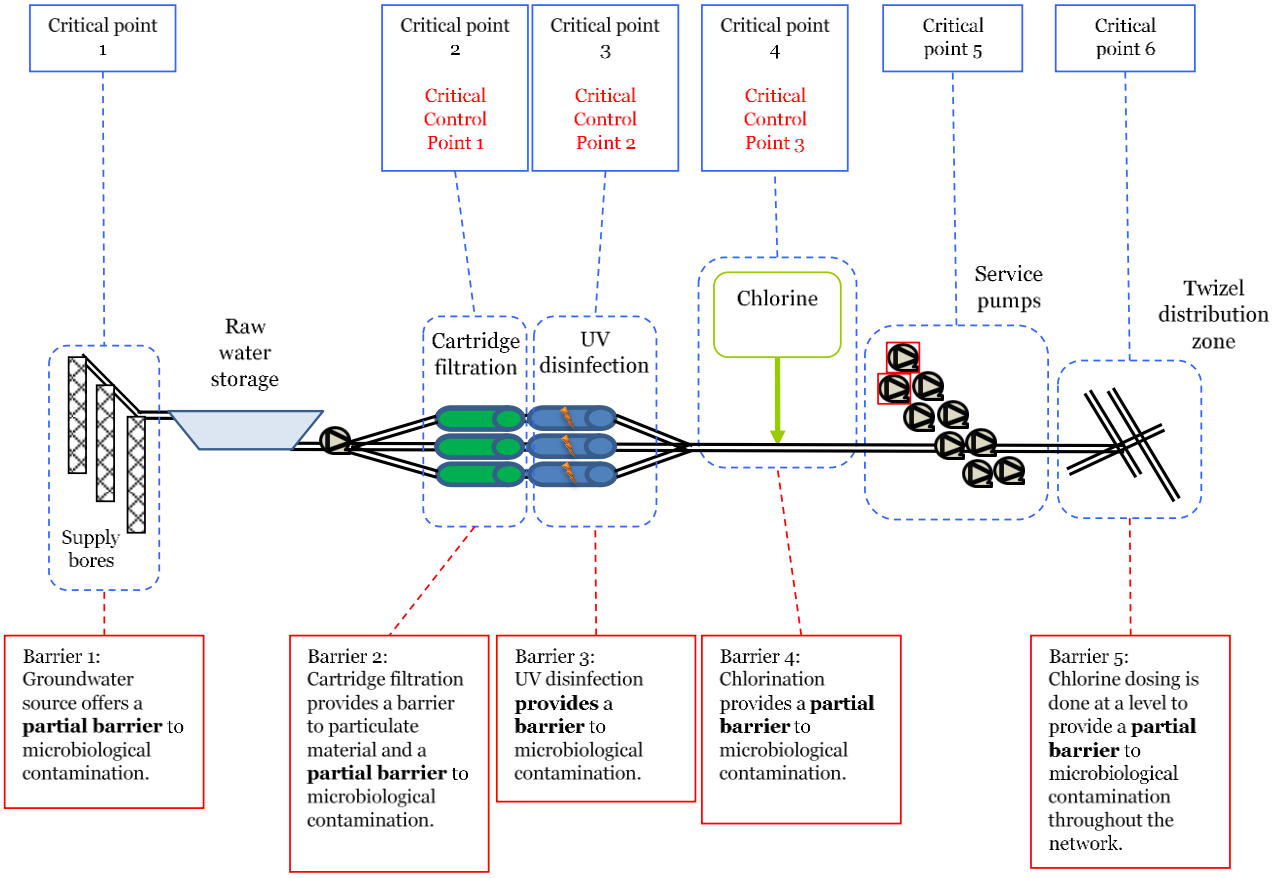


Figure 4-2 Twizel water supply schematic showing barriers, control points and critical control points

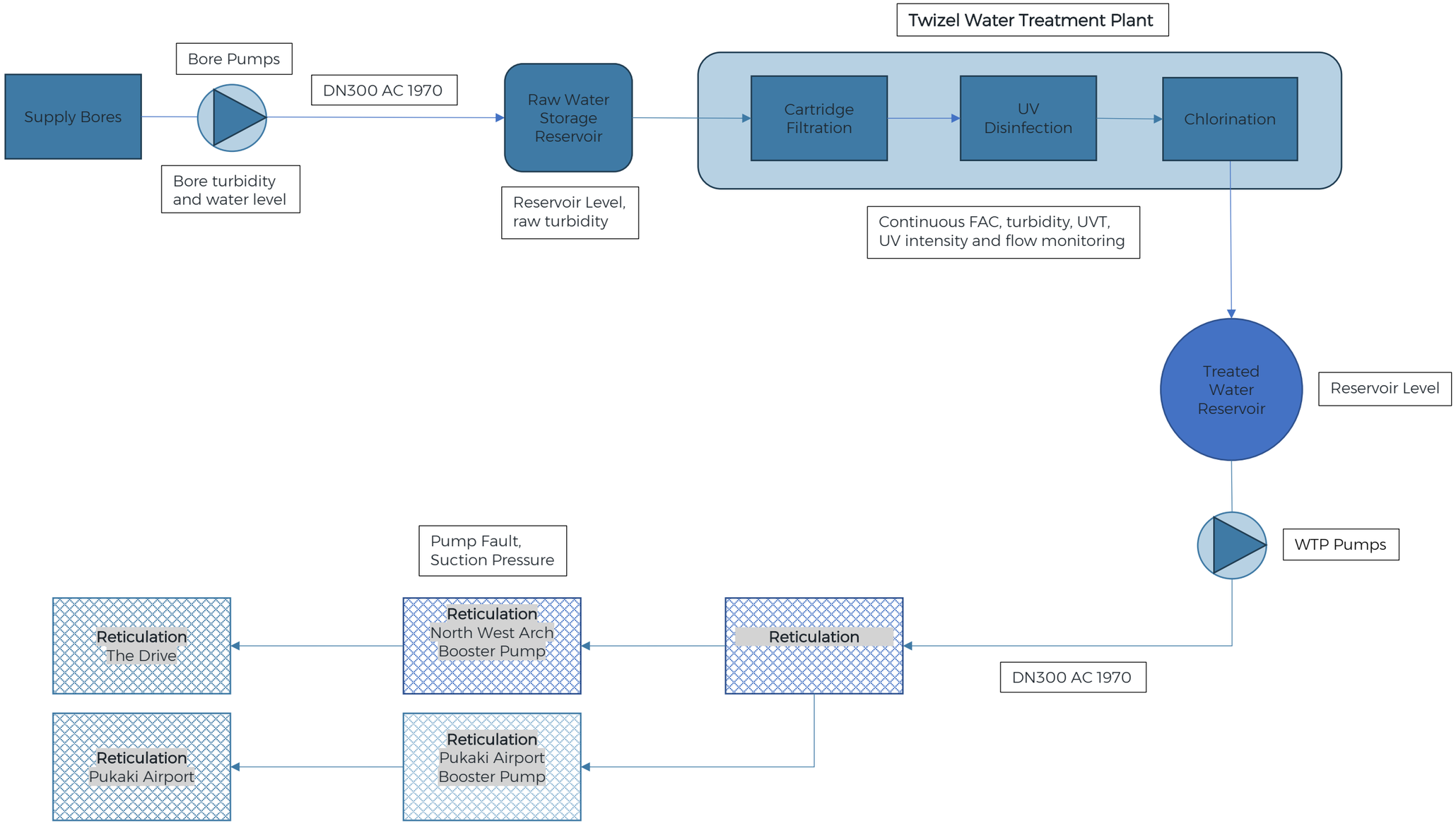


Figure 4-3 Twizel water supply schematic, including flow and water quality monitoring

The draft Mackenzie District Council Water Activity Management Plan 2021 – 2031 states that population growth projections in the district "predict a relatively static population growth over the period of this asset management plan" and "there will not be a significant increase or decrease in demand for Council services based on change in population" (over the next 30 years). The available quantity of the source meets the required needs of the current and future population, even during times of drought. There are no significant economic developments planned in the Twizel area in the near future.

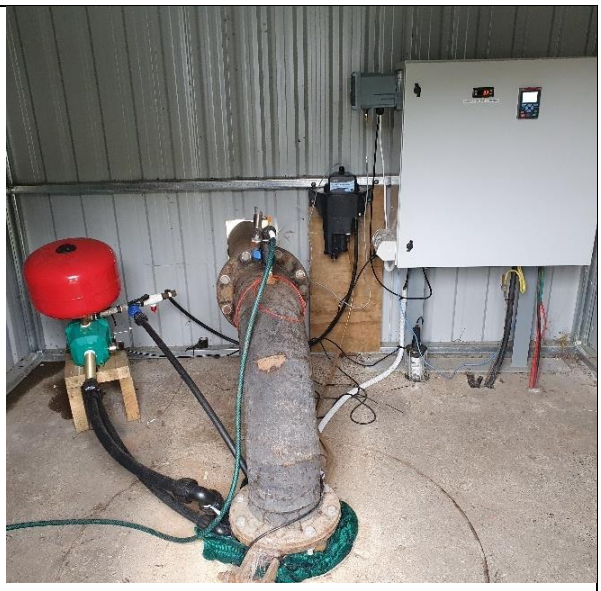
4.2 Water Source and Water Quality

4.2.1 Intake Details

Three bores drilled to 21.5 m and screened to 9.5 m draw water from a shallow unconfined aquifer next to Fraser Stream. The bores consist of DN 200 pipe placed within 1200 mm bores filled with washed gravels and were installed in 1969. Two of the bores are generally used over summer and on an alternate basis during winter. The third bore is retained as a backup.

There is public access to the land surrounding the bores; however, the bores are secured in locked sheds and vandalism has not been an issue in the past. Figure 4-4 shows an internal and external view of one of the bore sheds.

Source water bore shed



One of the three source water bores

Figure 4-4 Twizel water supply bore intake photos

4.2.2 Raw Water Quality

The raw water quality from the bores is good. The turbidity can increase slightly after rainfall but has not been monitored above 2 NTU in the past five years. However, the annual compliance report notes several instances when the treated water turbidity has exceeded 2 NTU, indicating that the raw water turbidity is higher than this at times, or that sediment is being resuspended in the raw water reservoir.

In addition to continuous monitoring at the treatment plant, turbidity is monitored at the bores and raw water reservoir (Table 4-2). Raw water quality is also monitored annually for the Twizel drinking water supply. Table 4-3 summarises the raw water quality results.

Interpretation of the raw water analysis below include:

- None of the determinands exceed the DWSNZ maximum acceptable values (MAV) or half the MAV.
- Alkalinity is consistently below the DWSNZ guideline value (GV) and should be corrected to prevent metals leaching from plumbing and fittings.
- pH was below the DWSNZ guideline value once in 2016, 2018 and 2020 but was within the guideline range when measured in 2021.
- Iron exceeded the DWSNZ guideline value once in 2021 but was below the detection limit on other occasions.
- Microbiological analysis of the source water is not routinely undertaken, but it is expected that low levels of faecal contamination would be present, requiring disinfection in the treatment process.

Table 4-2 Bore and combined raw water turbidity monitoring

Parameter	DWSNZ GV	Minimum	Average	Maximum
Turbidity – bore (NTU)	2.5	0.03	0.21	1.56
Turbidity – raw (NTU)	2.5	0.02	0.18	1.59

Table 4-3 Raw water quality data

		DWSNZ		Measured Concentration			
Parameter	**Units**	Guideline Value (GV)	Maximum Acceptable Value (MAV)	29/11/2016	4/10/2018	9/09/2020	13/09/2021
Total Alkalinity	g/m³ as $CaCO_3$	100 - 300		15.2	17.9	15.2	16.6
pH	-	7.0-8.5		6.5	6.8	6.7	7.1
Free Carbon Dioxide	g/m³ at 25°C			10	6.1	6.1	2.9
Total Hardness	g/m³ as $CaCO_3$	< 200		9.4	13.6	12.1	14.5
Electrical Conductivity	µS/cm			30	38	35	41
Total Dissolved Salts	g/m³			20	26	23	27
Total Arsenic	g/m³		0.01			< 0.0011	< 0.0011
Total Boron	g/m³		1.4	< 0.0053	< 0.0053	< 0.0053	< 0.0053
Total Calcium	g/m³			3.1	4.5	4.1	5
Total Copper	g/m³	< 1	2	0.003	0.00064	0.0035	0.0068
Total Iron	g/m³	< 0.2		< 0.021	< 0.021	0.023	0.22
Total Lead	g/m³		0.01			0.00053	0.0022
Total Magnesium	g/m³			0.39	0.59	0.40	0.53
Total Manganese	g/m³	< 0.04 Stain < 0.10 Taste	0.4	0.0021	< 0.00053	< 0.00053	0.0088
Total Potassium	g/m³			0.29	0.49	0.40	0.43
Total Sodium	g/m³	< 200		2.2	2.6	2.3	2.3
Total Zinc	g/m³	< 1.5		0.064	< 0.0011	0.0072	0.0046
Chloride	g/m³	< 250		< 0.5	0.5	0.6	1.1
Nitrate-N	g/m³		11.3	0.15	0.38	0.22	0.36
Sulphate	g/m³	< 250		< 0.5	0.7	1.1	1.5
			Key:	Less than MAV and GV	Exceeds GV or half the MAV	Exceeds the MAV	

4.3 Treatment Plant and Water Storage

The Twizel water treatment plant was upgraded in 2017. It includes cartridge filtration, UV disinfection and chlorination. No protozoal log credits are is achieved through the treatment process, as the water quality monitoring frequency is too low. However, cartridge filtration followed by UV disinfection has the potential to provide 5-log credits. There is an improvement item in Section 8 to address this.

4.3.1 Raw Water Storage

Raw water is pumped from the bores to a 7,000 m^3 HDPE covered and lined raw water storage reservoir. The reservoir cover was replaced in 2016. A level control switch turns the bores on and off when the reservoir level reaches predetermined levels. At least 80% capacity is typically maintained in the reservoir to ensure 3 days of storage during peak demand. Surface water can be pumped from the reservoir cover when ponding occurs.

Water from the raw water reservoir generally flows under gravity through the treatment processes. Two process pumps with VSD controls can facilitate flow through the system if there is increased headloss through the cartridge filters. The raw water storage reservoir is shown in Figure 4-5.

Figure 4-5 Raw water storage pond with HDPE liner and cover

4.3.2 Cartridge Filtration

Flow from the raw water pond is split across three process chains, each with a cartridge filter followed by a UV reactor. The cartridge filters are used to remove turbidity from the raw water and have a 5-micron pore size (Figure 4-6). Differential pressure is measured across each of the filters to indicate when replacement is required. The filters do not currently provide protozoa log credits, but could provide 2 log credits with increased water quality monitoring.

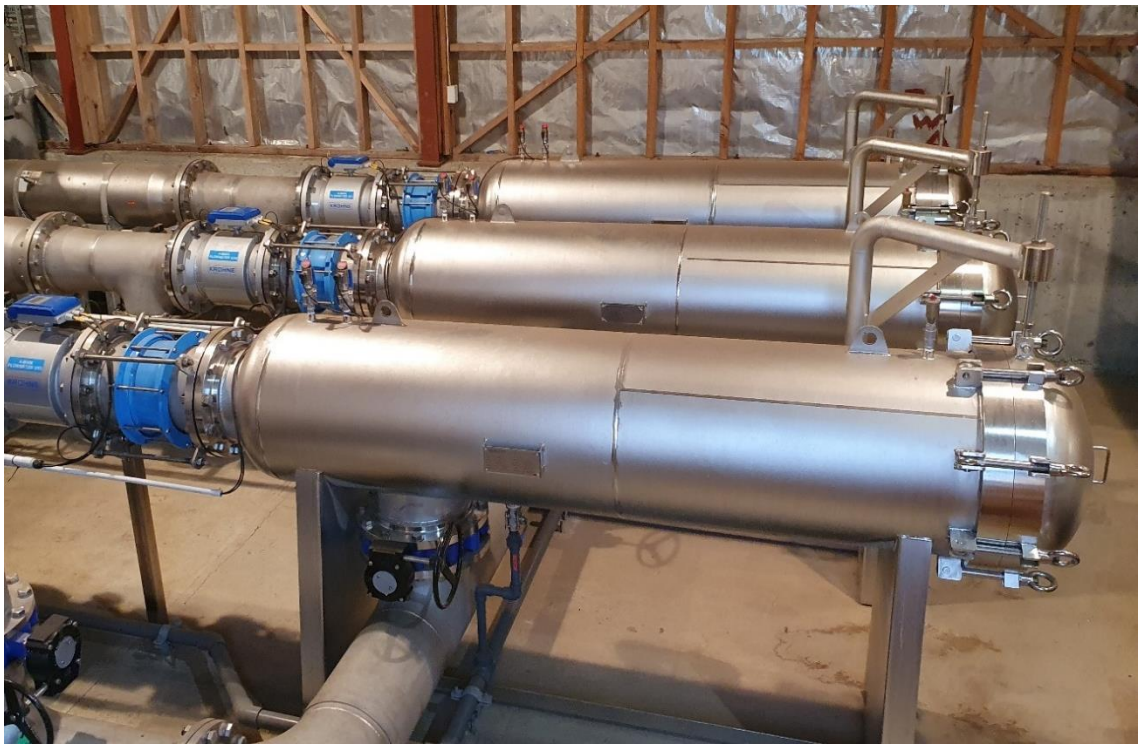


Figure 4-6 Twizel water treatment plant cartridge filters

4.3.3 UV treatment

Following filtration, the water passes through one of three UV reactors (see Figure 4-7). The UV reactors are six lamp Wedeco Spektron 350e models that are certified to the German DVGW standard. UV intensity (UVI), UV transmissivity (UVT) and turbidity are monitored at the reactors with data telemetered via SCADA to the operators and the Council office. Actuators control the flow of water through the UV reactors. The reactors are used to provide disinfection and have the potential to provide 3-log protozoa treatment credits if the frequency of water quality monitoring is increased.

Figure 4-7 Twizel water treatment plant UV disinfection reactors

4.3.4 Chlorination

Prior to being discharged into the treated water reservoir, sodium hypochlorite is dosed to the water. Sodium hypochlorite is stored in a bunded plastic tank and dosed via a metered pump (see Figure 4-8). The dosing rate is flow proportional and adjusted automatically based on the FAC concentration. The small chlorine dosing shed is located outside the main water treatment plant building.

Chlorination is used as a secondary disinfectant to provide a disinfection residual in the distribution system.

Figure 4-8 Twizel treatment plant hypochlorite dosing system

4.3.5 Treated Water Reservoir

Following disinfection, treated water is stored in a 500 m^3 concrete reinforced reservoir (see Figure 4-9). This is mostly beneath the water treatment plant building with the remainder roofed with corrugated iron. The maintenance contractor confirmed in March 2022 that all gaps between the roof and the top of the reservoir are sealed to prevent vermin access.

The reservoir is difficult to access for internal inspection / condition assessment and cannot be taken offline as there is no bypass in place to supply water directly to the reticulation. A potential improvement action is included in this drinking water safety plan for five yearly treated water reservoir checks, refer Section 0. This could be completed by using a Remotely Operated Vehicle (ROV).

Figure 4-9 Twizel underground treated water reservoir

4.3.6 Treatment Plant Pumps and Pump Stations

From the treated water reservoir, nine pumps provide water to the distribution zone (see Figure 4-10). A small priming pump ensures the main pumps have a positive operating pressure. Two of the pumps are 11 kW jockey pumps, while the others are 22 kW booster pumps. The pumps respond to the pressure in the distribution zone and a pressure relief valve is installed to reduce water hammer. The two process pumps ramp up and down based on the water level in the treated water reservoir and are generally only required during high demand periods or when the filters begin to clog.

There are also two booster pump stations located in the distribution system (see Figure 4-10). One boosts supply to The Drive subdivision, the other boosts supply to Pukaki Airport.

Twizel water treatment plant reticulation pressure pumps

North West Arch pumps (boosting supply to The Drive subdivision)

Pukaki Airport pumps

Figure 4-10 Twizel treatment plant and distribution network booster pumps

4.3.7 Power Supply

The treatment plant is connected to mains power. An emergency backup generator automatically starts in the event of a power outage and battery backup is in place to supply power to the instruments and communications equipment. The backup generator is wired to the intake bores and has the capacity to run the entire plant. The generator is test run once a month from October to April and the fuel supply winterized in May.

4.4 Plant Control Measures and SCADA

Raw, filtered and bore water turbidity, UV intensity, UV transmissivity, FAC and flow are measured continuously at the treatment plant. FAC monitoring results are used to control the chlorine dosing upstream.

The treatment plant has alarms for low UV intensity, low and high FAC, turbidity and pump faults.

There are auto shutdowns at the treatment plant for UV disinfection faults or if power failure occurs and alarms in place for a generator fault or low fuel warning.

4.5 Treated Water Quality Characteristics

4.5.1 Treated Water Quality

The water quality monitoring results at the treatment plant for Twizel from the last 5 years is summarised in Table 4-4.

Table 4-4 Treated water quality data (treatment plant)

Parameter	DWSNZ GV	DWSNZ MAV	Minimum	Average	Maximum
Total Coliforms (MPN/100mL)			< 1	< 1	1
E. coli (MPN/100mL)		<1	< 1	< 1	< 1
Turbidity – filtered (NTU)	2.5		0.01	0.17	3.39
FAC (mg/L)		5.0	0.20	0.42	1.36

Interpretation of the treated water analysis include:

- Turbidity is normally below the DWSNZ GV, but in 2021/22 there were 3 days where it exceeded 2.5 NTU
- *E. coli* has not been detected
- pH is not monitored in the treated water; therefore, it is unclear if the DWSNZ GV has been met.

The water quality monitoring data in the Twizel distribution system over the last five years is summarised in Table 4-5.

Table 4-5 Treated water quality data (distribution)

Parameter	DWSNZ MAV	Minimum	Average	Maximum
Total Coliforms (MPN/100mL)		< 1	< 1	1
E. coli (MPN/100mL)	<1	< 1	< 1	1
FAC (mg/L)	5.0	0.15	0.35	0.68

Interpretation of the water analysis in the distribution system include:

- *E. coli* is generally below the DWSNZ MAV except for one transgression in 2017. Compliance criterion 6A was still met that year due to the number of samples taken.
- FAC is generally above 0.2 mg/L and was consistently below the MAV of 5 mg/L.

Disinfection by-products have not been monitored for the Twizel drinking water supply; therefore, it is unclear if there are any exceedances of the MAVs. There is an improvement action in Section 8.1 to address this unacceptable risk.

4.5.2 Water Quality Incidents and Responses

There has been one transgression recorded in the Twizel distribution zone in the last five years on 19 October 2017 when 1 MPN/100 mL of *E. coli* was measured. The transgression was investigated and noted as a potential operator error.

4.6 Distribution System

4.6.1 Asset Characteristics

The Twizel distribution system consists of 71.4 km of pipe. Water is pumped directly from the bores to the raw water reservoir via a DN 300 asbestos cement (AC) pipe installed in 1970. Condition assessment of an AC raw water main pipe sample assessed the sample as 'Grade 1 – Very Good Condition' in 2015. Above ground sections of the raw water main are spiral wound steel pipe.

The initial pipework installed in the 1970s is predominately AC pipe (21.9 km) which is due for replacement as part of the pipeline renewal programme of works. All DN 100 and DN 150 AC pipe is scheduled for replacement during 2021 / 2022 as part of the accelerated renewal programme under the COVID 19 recovery stimulus funding. Rider mains in the reticulation network are PVC pipe and are in good condition.

Overall, the Twizel reticulation is made up of 46% PVC, 31% AC and 23% PE pipe. The AC pipe is reaching its end of useful life within the next 10 years. 11 km of PVC will reach the end of its expected useful life within 26 to 30 years. The remainder of the network is in good condition and is not expected to reach its end of useful life for over 50 years.

4.6.2 System Water Loss and Leakage

The average daily consumption of 1720 L/person/day[3] in the Mackenzie district far exceeds the average in New Zealand of 280 L/person/day[4]. MDC is currently rolling out smart water metering of its water supplies as a demand management strategy to identify high water users and provide more detailed information on where leakage is occurring. Water metering is intended to drive a behavioural change where both the supplier and user are more likely to fix leaks once the quantity of water being lost is identified.

Leaking supply points are also an ongoing issue in the Twizel reticulation. These are replaced as they are identified.

4.7 SCADA Control Measures and Alarms

The treatment plant is monitored online using SCADA. All data in SCADA is stored every 15 minutes. The SCADA alarm set points for the plant are shown in Table 4-6. SCADA alarms are also raised in the event of a power outage, pump fault or generator issue. The alarms are displayed on the screens in the treatment plant, as well as in SCADA and are alerted to operators' via text messages to their mobile phone. The duty operator monitors and responds to alarms 24/7.

[3] Mackenzie District Council 2020/21 Annual Report: /https://www.mackenzie.govt.nz/__data/assets/pdf_file/0005/629474/2020-2021-Annual-Report-Full.pdf
[4] Water NZ National Performance Review 2020/2021: https://www.waternz.org.nz/resourceuseefficiency

Table 4-6 SCADA alarm set points

Parameter	Low Alarm	High Alarm
FAC	0.5 mg/L leaving WTP	5.0 mg/L leaving WTP
UV Intensity	100 mJ/cm^2	N/A
Turbidity	N/A	> 2 NTU
Raw Water Reservoir Level	60%	N/A
Treated Water Reservoir Level	60%	N/A

5 Hazards and Hazardous Event Identification and Risk Assessment

5.1 Risk Assessment Methodology

Each element of the water supply is exposed to risk events of varying likelihood and consequence. In establishing a management plan, the level of risk to public health and operations within the water supply needs to be understood, quantified, and managed.

The risk assessment includes identifying hazardous events and their likely causes. Hazardous events are defined as events that introduce hazards, or fail to remove them, from the water supply. The events and causes listed in the risk register were discussed and agreed upon in the risk assessment workshop held on MS Teams with MDC staff on 9 December 2021. Likelihood and consequence scoring was done by means of expert judgement by workshop attendees (see Section 2 for a list of attendees).

A risk rating for each possible hazardous event has been estimated based on the likelihood of the event occurring and the consequences if it does occur (Table 5-1 and Table 5-2). The matrix is based on five categories of likelihood and five categories of consequence (Table 5-3) which were discussed and agreed at the risk workshop.
The New Zealand Drinking-water Safety Plan Framework (Ministry of Health, 2018)[5] allows a water supplier to establish its own approach to hazard identification and risk assessment methodology. The Handbook for Preparing a Water Safety Plan (Ministry of Health, 2019)[6] provides examples of likelihood and consequence ratings. The Council developed its own risk assessment methodology taking into account the examples given in the handbook and the World Health Organisation Water Safety Plan Manual 2009, which says that the aim of the risk assessment should be to distinguish between significant and less significant risks.

Table 5-1 Risk assessment – likelihood

Likelihood Frequency	*Score*	Likelihood Description
Almost Certain	5	Is expected to occur (more often than once per week)
Likely	4	Will probably occur (more often than once per month and up to once per week)
Possible	3	Might occur at some time (more often than once per year and up to once per month)
Unlikely	2	Could occur at some time (more often than once every 5 years and up to once per year)
Rare	1	Expected to occur only in exceptional circumstances (greater than once every 5 years)

[5] Ministry of Health, 2018: New Zealand Drinking-water Safety Plan Framework: https://www.health.govt.nz/publication/new-zealand-drinking-water-safety-plan-framework
[6] Ministry of Health, 2019: Handbook for Preparing a Water Safety Plan: https://www.health.govt.nz/publication/handbook-preparing-water-safety-plan

Table 5-2 Risk assessment – consequence

Consequence Ranking	Score	Description
Catastrophic	5	Major impact on most of the population, complete failure of systems, requirement for high level of monitoring and incident management. Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected
Major	4	Major impact on a sub-population, significant compromise of systems and abnormal operation, requirement for high level of monitoring and incident management. Potential acute harm to people, declared outbreak or widespread illness expected.
Moderate	3	Minor impact on most of the population, significant (but manageable) disruption to normal operation, requirement for increased monitoring. Potential widespread aesthetic issues, or repeated breach of maximum acceptable value (MAV).
Minor	2	Minor impact on a sub-population, some manageable disruption to normal operation. Potential local aesthetic issues, isolated exceedance of MAV.
Insignificant	1	Insignificant impact, little disruption to normal operation. Isolated exceedance of aesthetic parameter.

A semi-quantitative risk prioritisation approach was used where each likelihood and consequence category received a score between 1 and 5 as detailed above, and the combined risk score determines the overall risk rating as per Table 5-3 and Table 5-4.

Table 5-3 Risk assessment – scoring matrix

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Score		1	2	3	4	5
Rare	1	1	2	3	4	5
Unlikely	2	2	4	6	8	10
Possible	3	3	6	9	12	15
Likely	4	4	8	12	16	20
Almost Certain	5	5	10	15	20	25

Table 5-4 Risk assessment – risk rating

Risk Score	1 - 4	4- 9	10 - 16	20 - 25
Risk Rating	Low	Medium	High	Extreme

Risk Assessment, Uncertainty and Acceptability

A range of factors contribute to the consequence of an event, including economic, environmental, public health, and operational impacts. This document only considers public health and operations effects, with emphasis placed on public health risks.

The Risk Table gives details of the maximum risk and residual risk i.e. without any measures in place and barriers failed, and with existing preventive measures in place respectively.

Hazard identification and risk assessment are activities of informed judgement and contain uncertainty and limitations. Uncertainty arises from factors such as lack of or variability in data and/or information. These uncertainties and limitations need to be understood and taken into consideration when determining acceptability of risks. Risk uncertainty descriptors are provided in Table 5-5. In general, an uncertain or estimated risk elevates the risk acceptability and requires further investigation.

Table 5-5 Risk Assessment – uncertainty

Level of Certainty	Description
Certain	At least five years of:
	Continuous data (e.g. FAC), or
	Monitoring data (e.g. *E. coli* monitoring), or
	Monthly monitoring data (chemical), or
	Inspection records which have been collated and analysed, and variability is predictable
	At least five years of continuous/daily/monthly monitoring/inspection data for the duration of seasonal events which have been collated and analysed, and variability is predictable.
	The hazardous event and preventive measures/processes involved are thoroughly understood.
Confident	At least two years of:
	Continuous data (e.g. FAC), or
	Daily monitoring data (*E. coli* monitoring), or
	Monthly monitoring data (chemical), or
	Inspection records which have been collated and analysed, and variability is predictable.
	At least two years of continuous/daily/monthly monitoring/inspection data for the duration of seasonal events, which have been collated and analysed, and variability is predictable.
	There is a good understanding of the hazardous event and preventive measures/processes involved.
Reliable	At least one year of:
	Continuous data (e.g. FAC), or
	Daily monitoring data (*E. coli* monitoring), or
	Monthly monitoring data (chemical), or
	Inspection records which have been collated and analysed, and variability is predictable.
	At least two years of continuous/daily/monthly monitoring/inspection data for the duration of seasonal events have been collated and analysed, but variability is not predictable.

	There is a good understanding of the hazardous event and preventive measures/processes involved.
Estimate	There are limited monitoring data available.
	There is a reasonable understanding of the hazardous event and preventive measures/process involved.
Uncertain	There are limited or no monitoring data available.
	The hazardous events or preventive measures/processes are not well understood.

Table 5-6 outlines the levels of risk considered:

- Acceptable risk – no further actions required to reduce the risk
- Unacceptable risk – additional actions / improvements to be taken

Table 5-6 Risk assessment – acceptability

Risk Level	Certainty	Acceptability	Management Actions
Low	Certain	Acceptable	Manage within existing processes, adopting continuous improvement.
	Confident		
	Reliable		
	Estimate		
	Uncertain		
Medium	Certain	Acceptable	Implement short-term measures, and plan and implement longer-term risk reduction measures within x-year timeframe.
	Confident		
	Reliable		
	Estimate	Unacceptable	Implement short-term measures and investigate measures to reduce level of uncertainty as soon as possible.
	Uncertain		
High	Certain	Unacceptable	Implement short-term measures immediately and prioritise longer-term risk reduction measures.
	Confident		
	Reliable		
	Estimate	Unacceptable	Implement short-term measures immediately and investigate measures to reduce level of uncertainty as soon as possible.
	Uncertain		
Extreme	Certain	Unacceptable	Implement short-term measures immediately, put emergency plans on stand-by and give longer-term risk reduction measures top priority.
	Confident		
	Reliable		
	Estimate	Unacceptable	Implement short-term measures immediately, put emergency plans on stand-by and immediately investigate measures to reduce level of uncertainty.
	Uncertain		

The Council has determined that a medium risk where the level of Uncertainty is classified as 'Certain', 'Confident', or 'Reliable' is an acceptable risk, as illustrated in Table 5-6. This is in line with the World Health Organisation Water Safety Plan Manual 2009, which says that the aim of the risk assessment should be to distinguish between significant and less significant risks.

Unacceptable risks requiring improvements have been identified in the respective capital, operational and procedural improvement tables. The responsibility for ensuring progress on the improvement, the timeframe for the improvement, and possible practical steps to carry out the improvement are also included in the tables.

To ensure that the work is undertaken, responsibilities have been assigned to the relevant Council staff. Roles and responsibilities are likely to change and therefore are required to be checked as part of the annual internal drinking water safety plan review process.

5.2 Risk Assessment Table

The Twizel drinking water supply risk assessment table is provided in Appendix A.

5.3 Unacceptable Risks

The assessment of risk acceptability and level of uncertainty in Appendix A has identified three risks that are considered unacceptable which is listed in Table 5-7. Existing programmes and measures are described in this section, and additional improvements to address this risk outlined in Section 8.1.

Table 5-7 Unacceptable risks

Supply Element	Event Description	Cause No.	Possible Causes
Source	Microbiological contamination due to surface runoff from catchment, community wastewater systems, dairy effluent ponds or septic tank systems	1.01	Contamination from human or animal activity in catchment, unmonitored permitted activities, consent conditions not followed, or potential impact not considered.
Source	Cyanotoxin contamination	1.06	Cyanobacteria growth in source water
Reticulation	Chemical/Microbiological Contamination	5.08	Backflow from consumer connections

5.3.1 Risk 1.01 – Microbiological contamination due to surface runoff into surface water source

Microbiological contamination of the source water has the potential to cause a repeated breach of MAVs. This is considered possible due to on-site wastewater systems in the community drinking water protection zone and high-producing grassland in the catchment, and a treatment plant which provides no protozoal log credits due to insufficient data. The likelihood and potential consequence correspond to a High risk that is classified as unacceptable.

The improvement actions to mitigate this risk are:

- Increase the logging frequency for turbidity (raw and filtered), differential pressure across the cartridge filters, flow through the cartridge filters, flow through the UV units and UV intensity/dose so that the separation between data records is no more than 1 minute
- Continuously monitor cartridge filter service state (separation between data records no more than 1 minute)
- Obtain a validation certificate from Filtec to demonstrate that it meets one of the approved standards in DWSNZ and the Rules

5.3.2 Risk 1.06 - Cyanobacteria growth in source water

Release of cyanotoxins from cyanobacteria growing in the stream is a contamination hazard for the shallow groundwater used to supply Twizel. WSP completed a cyanobacteria risk assessment for the Twizel drinking water supply in July 2022 which assigned a moderate to high cyanobacteria risk to the drinking water source.

The improvement actions to reduce this risk are:

- Monitor the source water for phosphorous, turbidity, pH and temperature quarterly during the year and monthly over the summer period.
- Undertake further investigations into the type and locations of cyanobacterial species within the Fraser Stream, in particular above the Twizel bore intake structures.
- Consider implementing riparian management or upstream waste discharge management/control to at least 1 km upstream of the intake.
- As there is a moderate to high risk of cyanobacteria formation, a cyanobacteria/cyanotoxin response plan will need to be prepared (Rule S2.5 in the Drinking Water Quality Assurance Rules).

5.3.3 Risk 5.08 – Backflow from consumer connections

Contaminants entering the drinking water supply due to backflow or back siphonage poses a contamination hazard to the distribution system. A lack of backflow prevention devices (as well as inadequate, faulty, or incorrectly installed backflow devices) means that there is insufficient protection to reduce the likelihood of contaminants entering the drinking water supply.

The improvement actions to reduce this risk are:

- Undertake a survey of commercial customers to determine backflow hazard (complete)
- Install backflow prevention devices on high and medium hazard connections.
- Test all testable backflow prevention devices annually
- Create and maintain a backflow register
- Undertake assessment of backflow risk for residential connections.

.

6 Source Water Risk Management Plan

Source water risk management plans are a new requirement in the Water Services Act 2021. MDC has chosen to include a source water risk management plan as part of this drinking water safety plan. It is considered that the requirements of the Water Services Act are met as follows:

- This section of the WSP meets the requirements of section 43(1)
- The risk assessment, preventive measures and improvement plan in sections 5, 7 and 8 of the WSP meet the requirements of sections 43(2)a – c.
- The consideration of values identified by local authorities in section 6.4 of the WSP meets the requirements of section 43(2)d.
- Information about land use activities, potential sources of contamination, other water users and water quality data is included in section 4.2 of the WSP and meets the requirements of section 43(4)a(i-ii)
- The risk assessment in section 5 of the WSP meets the requirements of section 43(4)(a)(iii)
- The improvement actions agreed to by the local authority in section 8 meet the requirements of section 43(4)(b).

A catchment risk assessment was prepared in 2017 detailing the catchment delineation, characteristics and risks. This has been reviewed as part of the source water risk management plan.

6.1 National Environmental Standards for Sources of Human Drinking Water

The current National Environmental Standards for Sources of Human Drinking Water 2007 (NES-DW) forms part of the multiple barrier approach applied in New Zealand ensure safe drinking water is supplied to customers.

The existing NES-DW requires regional councils to identify certain activities within a source water catchment and determine if they will have an adverse effect on source water quality (resulting in MAVs in excess of DWSNZ limits following treatment). The Ministry for the Environment's draft consultation document on updating the NES-DW[7] proposes defining three source water risk management areas (SWRMAs) as defined below and depicted on Figure 6-1 (for river sources) and Figure 6-2 (for aquifer sources).

- SWRMA 1 is the immediate area around the source water take where there is an immediate risk of contamination because there is very little time to respond to any contamination before it enters the water supply.
    - For aquifers, it encompasses land within a 5-metre radius around the intake (bore head).
    - For rivers, it encompasses the river and its bed 1,000 m upstream and 100 m downstream of the intake, extending 5 m into land from the river edge.
- SWRMA 2 is a larger area where activities need to be managed, to mitigate more medium-term risks of contamination, particularly microbiological risks. The size will vary because it is based on the time it takes for water to flow to the source.
    - For aquifers, it is the land area above where groundwater travels to the intake (bore) within a 1-year period, to a maximum of 2.5 kilometres.
    - For rivers, it is the river and bed from where water travels to the intake within an 8-hour period.

[7] https://environment.govt.nz/assets/publications/nes-dw-consultation-document.pdf

- SWRMA 3 is the entire catchment area for the source water. Persistent contaminants and cumulative effects of all activities within the catchment are the management focus in this area, and they are considered to be appropriately managed under the RMA. The proposed amendments to the NES-DW aim to clarify that consenting decisions must address source water risks.

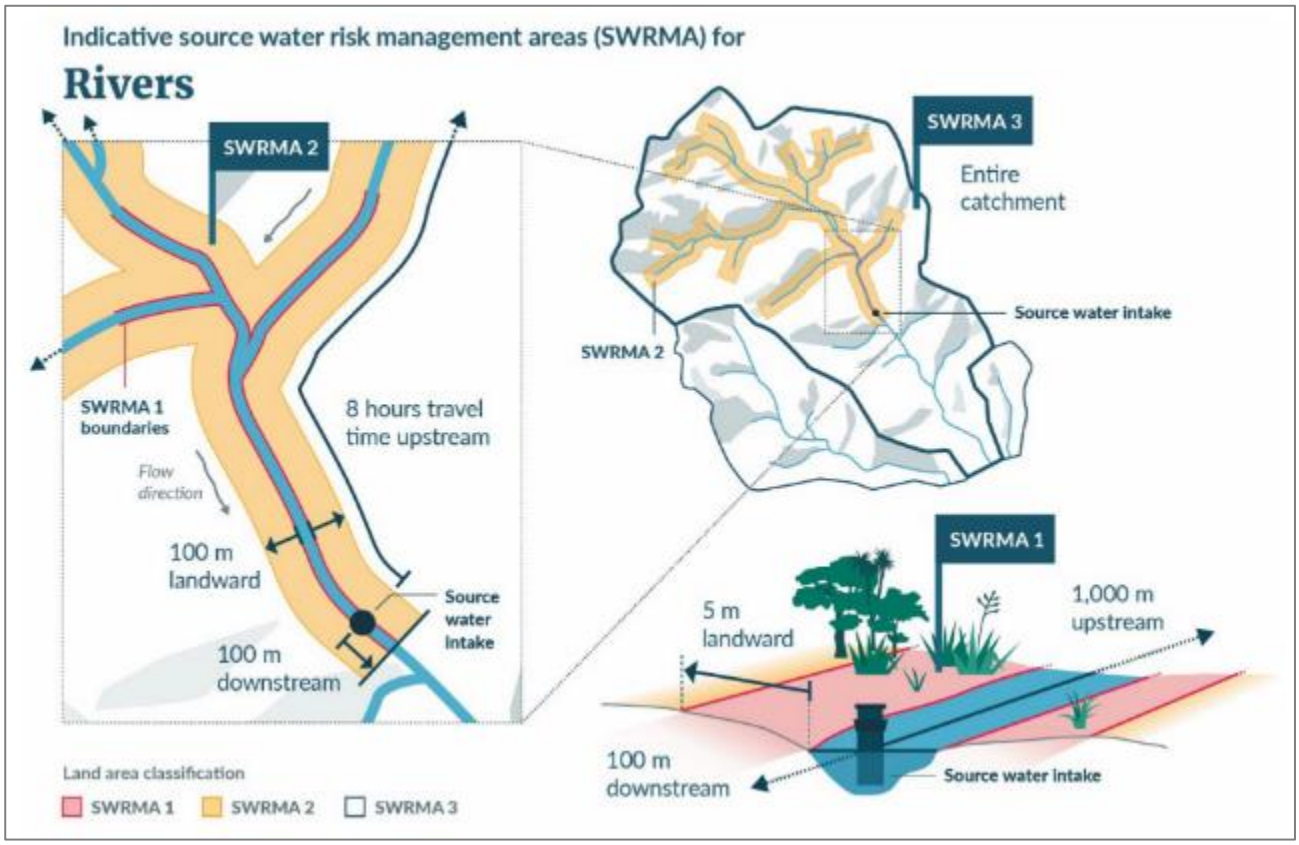


Figure 6-1 Draft NES Source Water Risk Management Areas for River Sources (Ministry for the Environment, 2021)

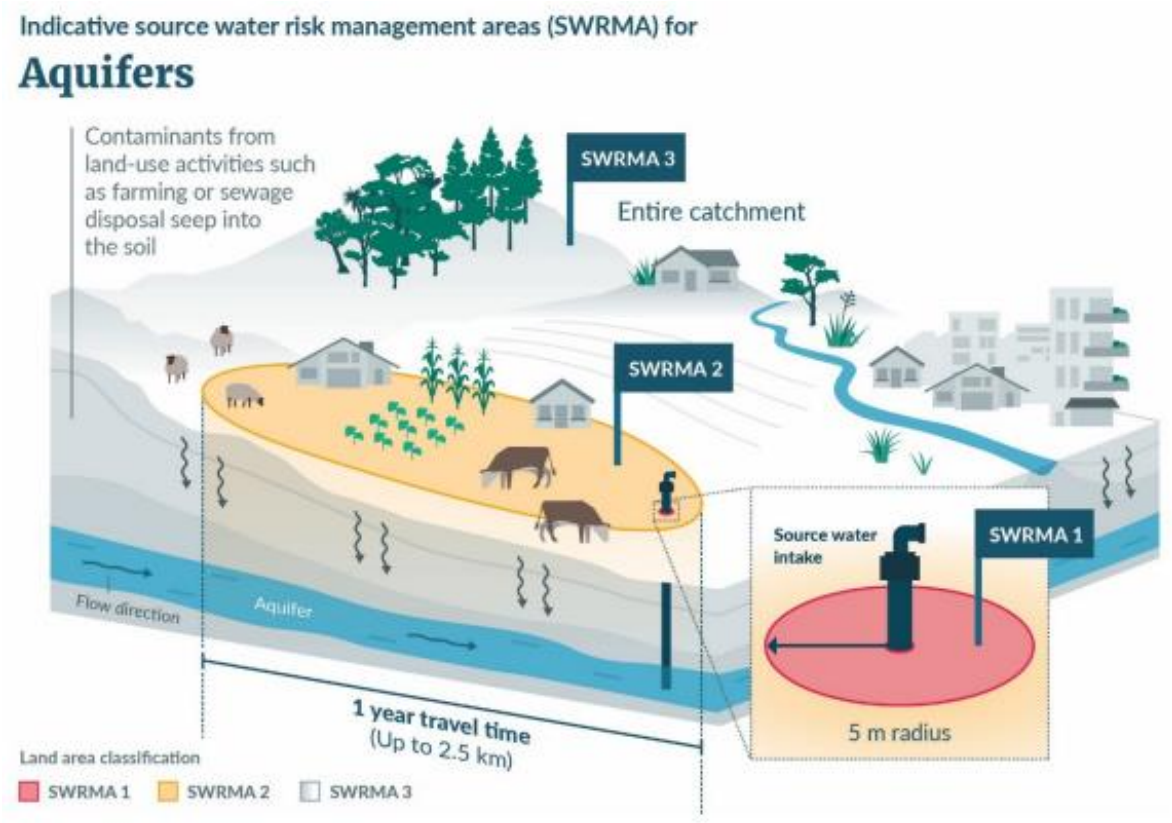


Figure 6-2 Draft NES Source Water Risk Management Areas for Aquifer Sources (Ministry for the Environment, 2021)

For the purposes of this assessment, we have assumed that the total catchment for the bores (SWRMA Zone 3) includes the surface water catchments of the Fraser Stream and Twizel River at their confluence, in addition to a 2.5 km radius circle around the bores used to represent the possible additional groundwater catchment.

6.2 Catchment Description

The supply abstracts water from three shallow bores in alluvial gravel just outside the town on the northern side of Glen Lyon Road adjacent to the Fraser Stream. Two bores are generally used over summer and on an alternate basis during winter. The third bore is retained as a backup.

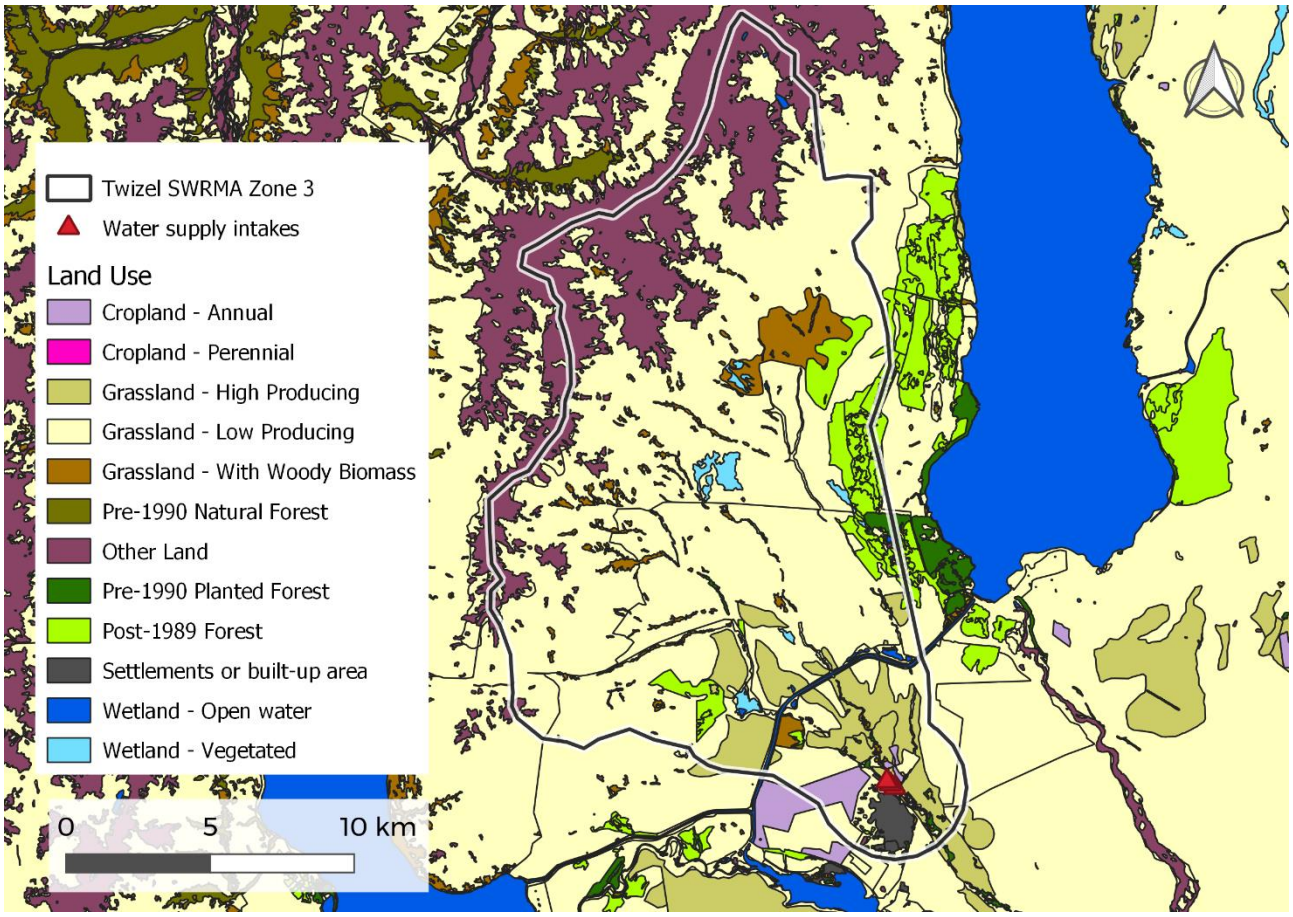


Figure 6-3 Twizel water source whole catchment land use

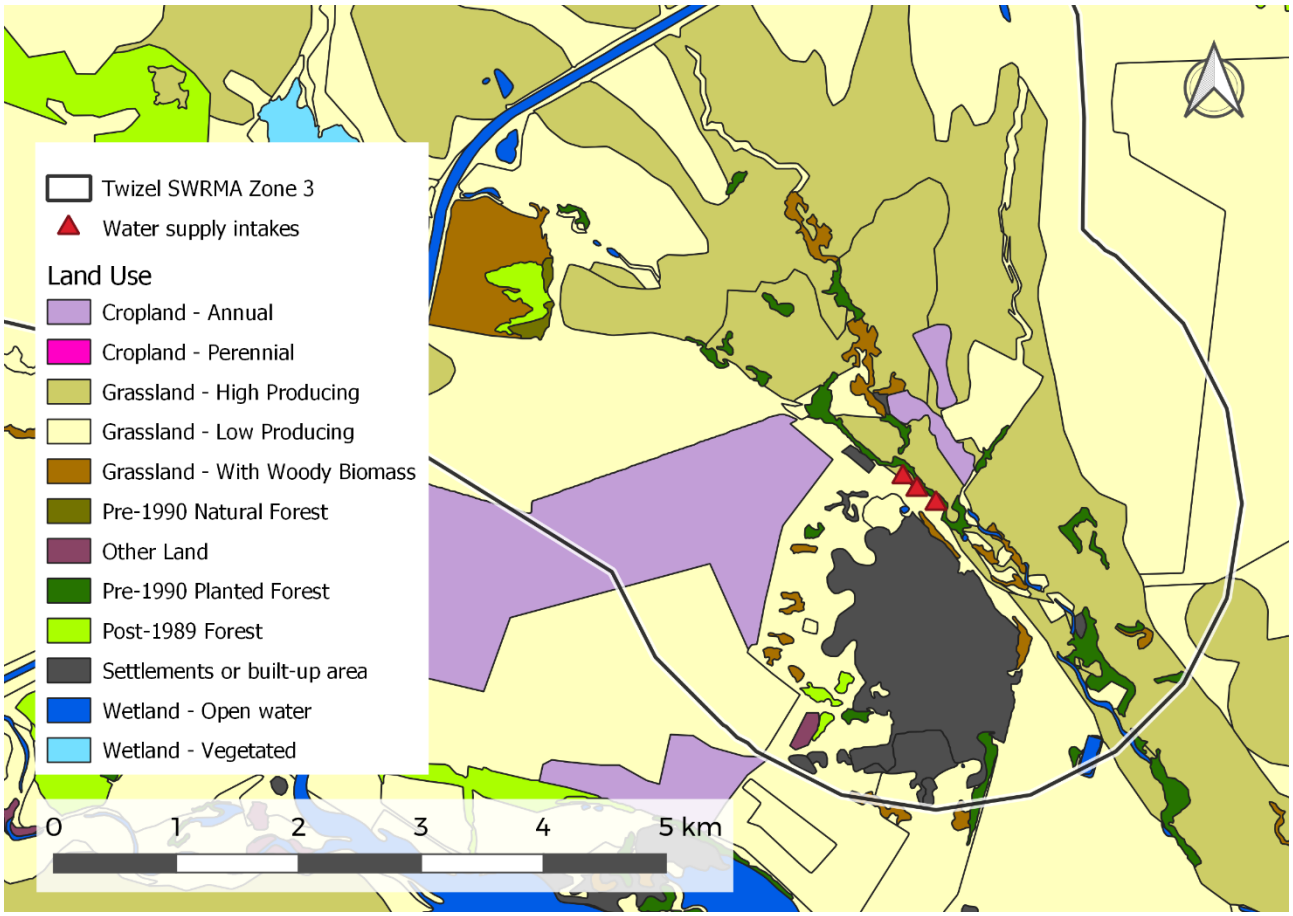


Figure 6-4 Twizel water source land use – showing detail closer to bores

6.2.1 Other Water Takes

There are 15 resource consents to take water in the Twizel catchment. These are shown in Figure 6-5 and summarised in Table 6-1.

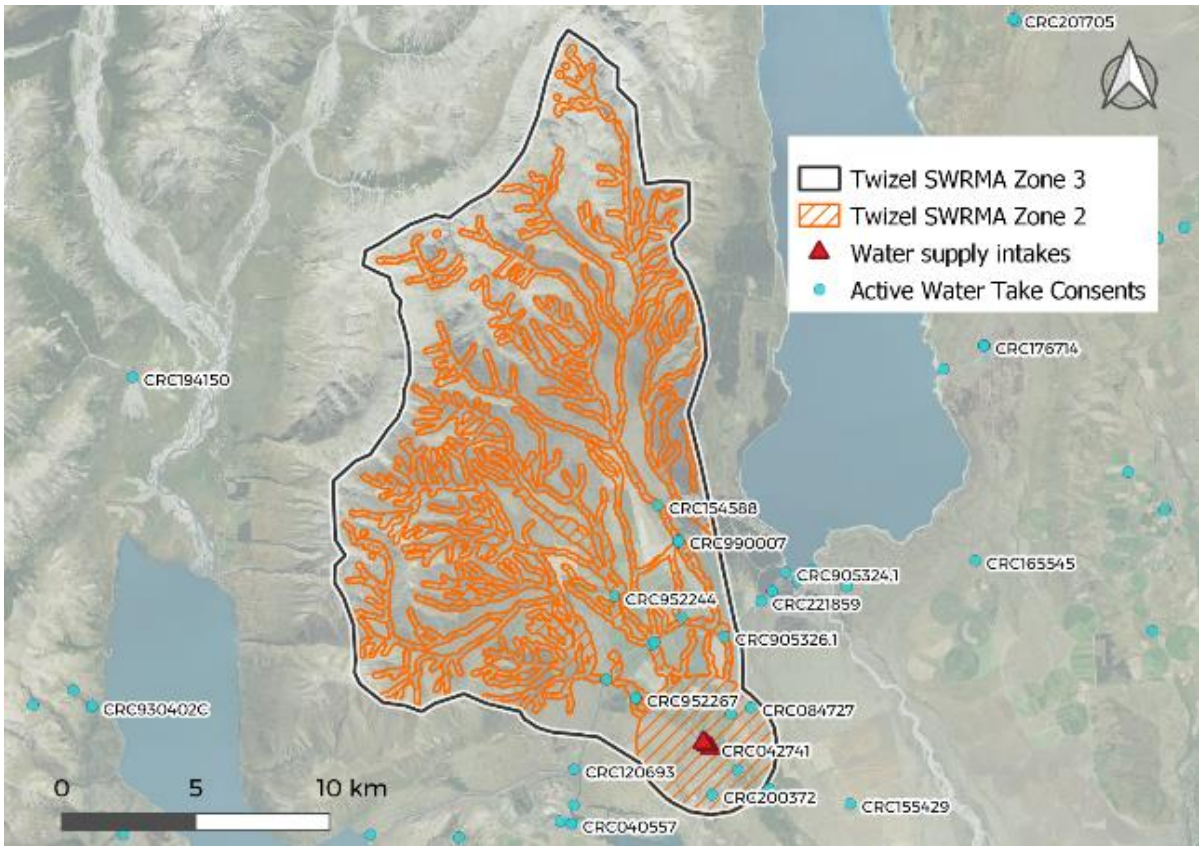


Figure 6-5 Water take consents in the vicinity of the Twizel water supply bores (in progress and active resource consents)

Table 6-1 Summary of water take consents within the Twizel catchment (within SWRMA 3)

Consent Number	Consent Holder	Location	Consent Type	Expiry Date	Volume or Flow Limits
CRC952267	Simon John Cameron	Rhoboro Downs Rd, RHOBORO DOWNS	Water Permit (s14)	29/09/2030	315 l/s
CRC174163	Bendrose Farm 2014 Limited	Old Glen Lyon Road, State Highway 8, Twizel	Water Permit (s14)	24/08/2052	Diversion
CRC952269	Simon John Cameron	Rhoboro Downs Rd, RHOBORO DOWNS	Water Permit (s14)	29/09/2030	230 l/s
CRC952244	Simon John Cameron	Rhoboro Downs Rd, RHOBORO DOWNS	Water Permit (s14)	29/09/2030	40 l/s

Consent Number	Consent Holder	Location	Consent Type	Expiry Date	Volume or Flow Limits
CRC154589	Mr D R McIntyre & Waitaki Trustees (Golden Acres) Limited.	Twizel River, Rhoboro Down Road, PUKAKI	Water Permit (s14)	31/01/2036	50 l/s
CRC154588	Rhoborough Downs Station Limited	Twizel River, Rhoboro Down Road, PUKAKI	Water Permit (s14)	31/01/2036	45 l/s
CRC991808	Department of Conservation, Twizel Area Office	Rhoborough Downs Road, TWIZEL	Water Permit (s14)	5/08/2033	20 l/s
CRC990007	Department of Conservation, Twizel Area Office	Rhoborough Downs Road, TWIZEL	Water Permit (s14)	5/08/2033	500 l/s maintained in Twizel River
CRC200372	Ben Ohau Golf Club Incorporated	1 Mackenzie Drive, Twizel	Water Permit (s14)	5/09/2034	10.5 l/s and 53,100 m^3/annum
CRC905328.1	Meridian Energy Limited	FRASER STREAM	Water Permit (s14)	30/04/2025	Diversion
CRC905329.1	Meridian Energy Limited	Lake Pukaki	Water Permit (s14)	30/04/2025	Diversion
CRC905326.1	Meridian Energy Limited	PUKAKI-OHAU CANAL	Water Permit (s14)	30/04/2025	Diversion
CRC905327.1	Meridian Energy Limited	DRY STREAM	Water Permit (s14)	30/04/2025	Diversion
CRC169360	New Zealand Transport Agency	Tekapo Twizel Road (SH8), Twizel	Water Permit (s14)	26/08/2051	Diversion
CRC084727	MacKenzie Holdings Limited	Twizel Road, PUKAKI AIRPORT	Water Permit (s14)	7/08/2027	5 l/s and 50,198 m^3/annum

6.2.2 Wastewater and Stormwater Discharges

There are 40 consents to discharge wastewater and stormwater in the SWRMA zone 2 for Twizel (see Figure 6-5 and Table 6-2). Many of the discharge consents are located near Glen Lyon Road and Pukaki-Twizel Airport and are related to the discharge of stormwater.

There is only one permitted wastewater activity listed within the SWRMA zone 2 catchment (CRC160781). This site is approximately 8 km upstream of the Twizel water take bores.

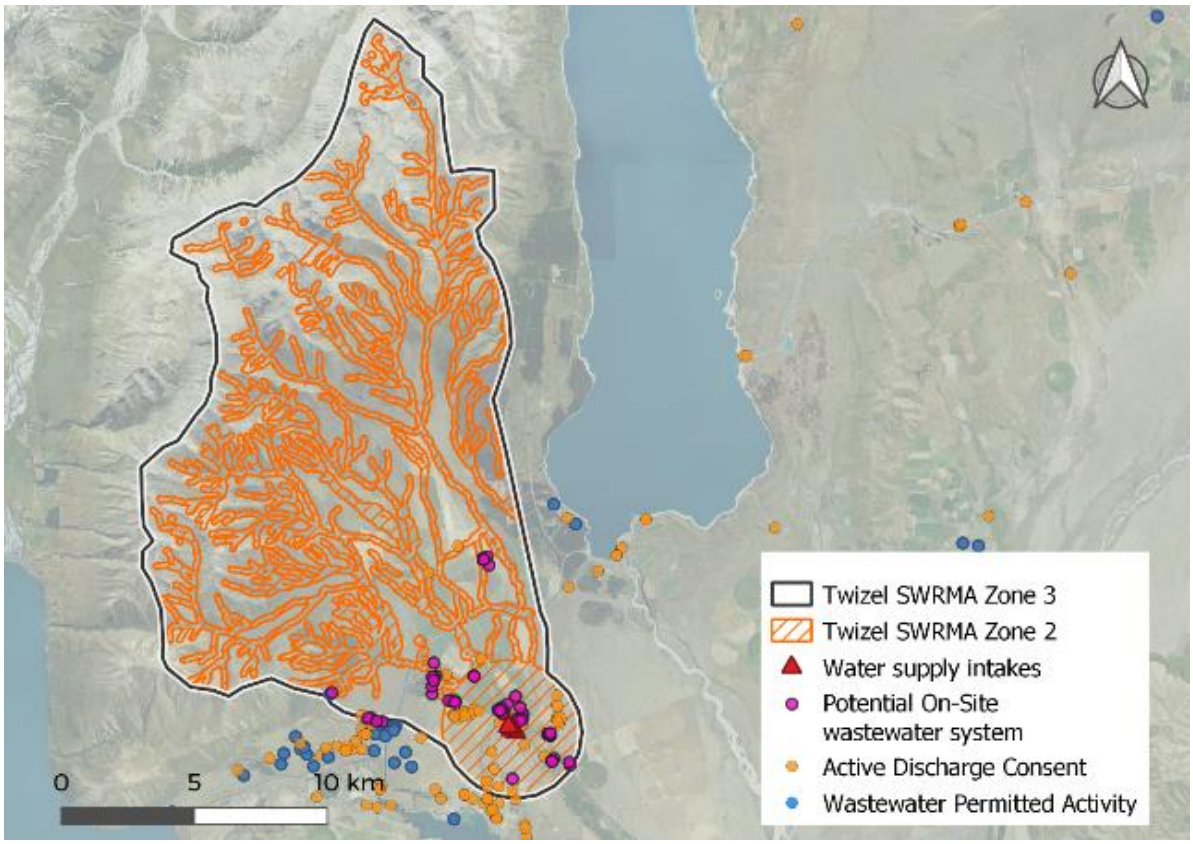


Figure 6-6 Discharge consents and wastewater permitted activity sites around the Twizel water supply bores

Table 6-2 Summary of wastewater and stormwater consents within the Twizel SWRMA 2

Consent Number	Consent Holder	Location	Consent Purpose	Expiry Date
CRC091502	Mackenzie District Council (Pukaki Airport Board)	Pukaki Aerodrome, Tekapo Twizel Road (State Highway 8), TWIZEL	SW	9/09/2043
CRC064322	N & C Lyons Family Trust	Omahau Downs, State Highway 8, TWIZEL	WW	31/08/2041
CRC084700	Mr D J & Mrs J L Rayner	Hocken Lane, TWIZEL	WW	24/06/2043
CRC042742	Mackenzie District Council	Streets and Roads within the Twizel Township, TWIZEL TOWNSHIP	SW	18/02/2040
CRC952029	Mackenzie District Council	Twizel Landfill, Ostler Road, TWIZEL	Landfill	25/07/2031

Consent Number	Consent Holder	Location	Consent Purpose	Expiry Date
CRC084922	Mackenzie District Council (Pukaki Airport Board)	Pukaki Aerodrome, Tekapo Twizel Road (State Highway 8), TWIZEL	SW	9/09/2043
CRC084233	Mr SJ Cameron & Mr RJ Preston	Corner Rhoboro Downs Road and Old Glen Lyon Road, TWIZEL	SW	9/09/2043
CRC081120	MacKenzie Holdings Limited	Pukaki Airport, TWIZEL	SW	7/12/2042
CRC991881	Geoffrey Alexander Talbot Hemm	Glen Lyon Road, TWIZEL	WW	4/03/2034
CRC063888.1	Mr B R Irvine & Mr D A & Mrs J L Symon	Crn Glen Lyon Roand & Old Glen Lyon Road, TWIZEL	SW	9/05/2041
CRC091497.1	Aoraki Helicopters Limited	Pukaki Aerodrome, Tekapo Twizel Road (State Highway 8), TWIZEL	SW	9/09/2043
CRC147635	Mr P T Chapman & Mrs H L Cox	Crn Glen Lyon Road & Old Glen Lyon Road, TWIZEL	SW	9/05/2041
CRC091495.1	Mark David Stagg	Pukaki Aerodrome, Tekapo Twizel Road (State Highway 8), TWIZEL	SW	9/09/2043
CRC091498.1	Getaway Recreational Vehicles Limited	Pukaki Aerodrome, Tekapo Twizel Road (State Highway 8), TWIZEL	SW	9/09/2043
CRC145566	Mr C R W & Mrs R A Horsley & Ellice Tanner Trustees No.2 Limited	Cnr Glen Lyon Road & Old Glen Lyon Road, TWIZEL	SW	9/05/2041
CRC163566	The Alpine Group Limited	Pukaki Aerodrome, Tekapo Twizel Road (State Highway 8), TWIZEL	SW	9/09/2043
CRC091292.1	Mr T & Mrs A Spearing	Corner Rhoboro Downs Road and Old Glen Lyon Road, TWIZEL	SW	9/09/2043
CRC091296.1	Mr B J & Mrs J F Hill	Corner Rhoboro Downs Road and Old Glen Lyon Road, TWIZEL	SW	9/09/2043

Consent Number	Consent Holder	Location	Consent Purpose	Expiry Date
CRC091206	Rob-Brooks Forest Limited	Manuka Terrace & Ben Ohau Road, TWIZEL	WW	4/09/2043
CRC091288.2	Mr W J & Mrs S A Spry	Corner Rhoboro Downs Road and Old Glen Lyon Road, TWIZEL	SW	9/09/2043
CRC154502	Mr T A & Mrs R S Sheridan	Corner Rhoboro Downs Road and Old Gleyn Lyon, TWIZEL	SW	9/09/2043
CRC091040.2	Mr K D Morgan & Ms K M Henderson & Race & Donald Trustees Ltd	Corner Rhoboro Downs Road and Old Glen Lyon Road, TWIZEL	SW	9/09/2043
CRC091293.1	Tonio De Bono	Corner Rhoboro Downs Road and Old Glen Lyon Road, TWIZEL	SW	9/09/2043
CRC183787	Andrew Hocken	140D Hocken Lane, Twizel	WW	12/05/2044
CRC133981	Mr R W Parker & Ms S M Corcoran & Albert Alloo & Sons Trustee Company (2007) Limited	Hocken Lane, TWIZEL	WW	12/05/2044
CRC181861	Andrew James Reid	Hocken Lane, TWIZEL	WW	12/05/2044
CRC192198	Mackenzie Properties Limited	Grandvue Drive, Twizel	SW	19/12/2023
CRC084741.1	BP Oil New Zealand Limited	State Highway 8, TWIZEL	SW	7/10/2043
CRC202549	Mr T M & Mrs R H Silva & RMF Trustees One Limited	Corner Rhoboro Downs Road and Old Gleyn Lyon Road, TWIZEL	SW	9/09/2043
CRC156739	Jobert 2013 Limited	395 Glen Lyon Road, Twizel	WW	5/05/2030
CRC191730	Payne Developments Limited	Corner of Ohau Road & North West Arch, Twizel	SW	30/01/2024
CRC063935.1	Mr A G Weekes & Ms P A Prior	Glen Lyon Road, TWIZEL	SW	12/05/2041

Consent Number	Consent Holder	Location	Consent Purpose	Expiry Date
CRC160781	Mr M Lindsay & Mrs E Lindsay	Omahau Hill Station, Ben Ohau Road, Section 6 SO 20051, Twizel	WW	None

A desktop assessment was carried out to identify the sites of potential on-site wastewater systems within the SWRMA zone 2. All buildings larger than 100 m^2 and more than 200 m from the public wastewater network were selected as possibly needing an on-site wastewater system. This method is intended to be used as a first cut to identify locations that require further investigation; further work would be needed to confirm this. There are 55 potential on-site wastewater systems identified within the SWRMA zone 2 of the Twizel bores as seen in Figure 6-7. Note that some of the sites identified are likely to be farm sheds so the actual number of on-site wastewater systems could be lower than 55. The closest on-site wastewater system (CRC133981) is 375 m from the nearest bore used for the Twizel supply.

The vast majority of the potential on-site wastewater systems identified do not have a resource consent to discharge wastewater. As seen Figure 6-7 there are a number of potential on-site wastewater systems within the existing Community Drinking Water Protection Zones for the water intake bores. Of these, only two have a corresponding discharge consent (CRC183787 and CRC133981) which are both consents to discharge domestic wastewater to land. MDC is committed to connecting these properties to the reticulated wastewater system and are conducting a study to assess the cost of this (improvement item in Section 8.1).

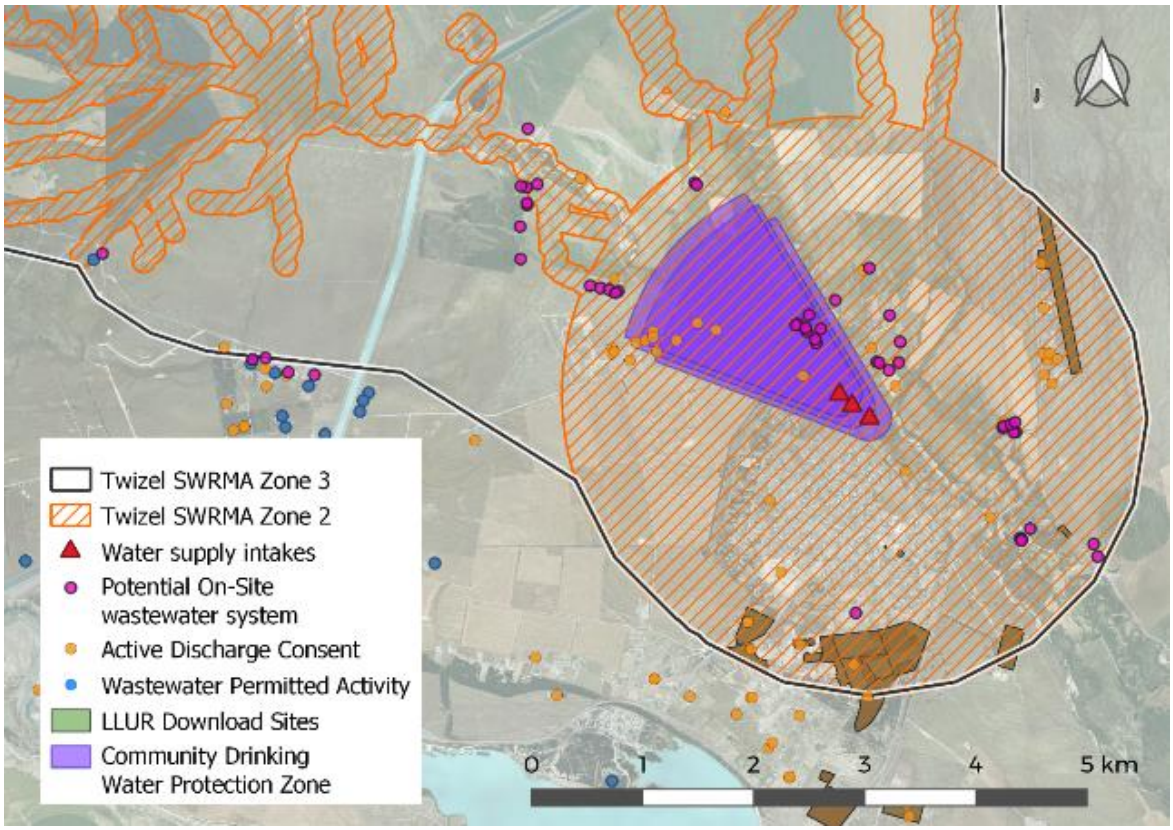


Figure 6-7 Discharge consents, wastewater permitted activity sites and potential on-site wastewater systems around the Twizel water supply bores

6.3 Climatic Features

Climate related factors influencing catchment conditions and demand for water include rainfall and temperature. Median annual total rainfall in the Twizel catchment is 600 - 700 mm/year and the median temperature is 9 – 10 °C (See Figure 6-8 and Figure 6-9).

NIWA Future Climate Predictions anticipate an increase in mean temperature of 2.0 – 3.0 ˚C by 2090, with 0 – 5% less precipitation in the Mackenzie area and up to 15 fewer wet days – based on RCP8.5 scenarios (https://ofcnz.niwa.co.nz/#/nationalMaps). This increased temperature and lowered rainfall is likely to increase demand for water use and affect the rate of groundwater recharge available for abstraction.

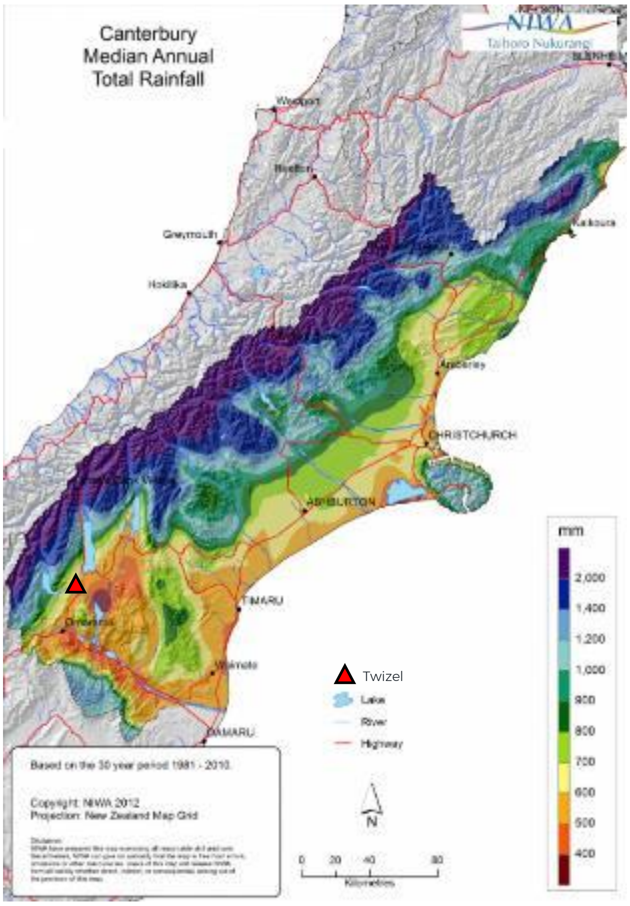


Figure 6-8 Canterbury region median annual total rainfall

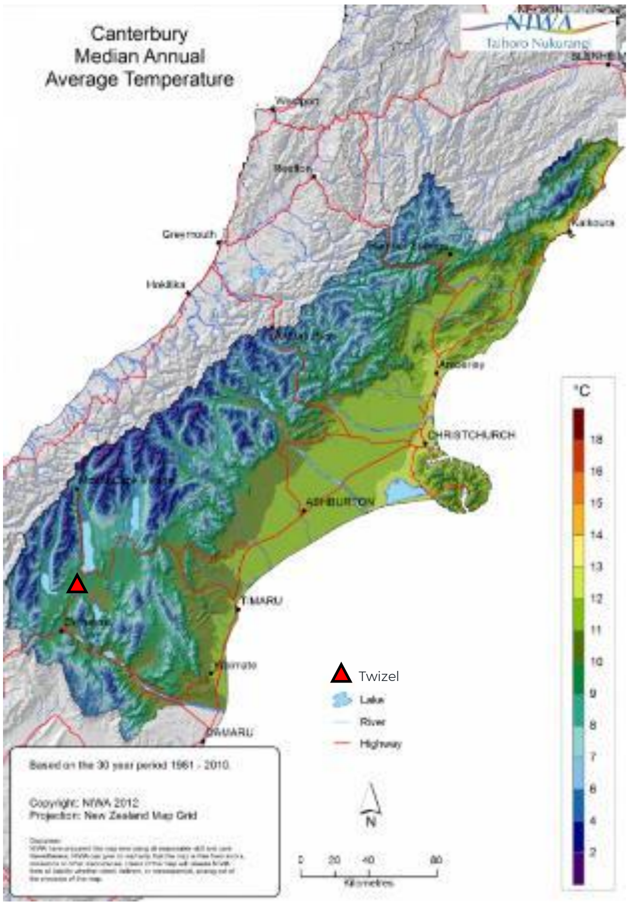


Figure 6-9 Canterbury region median annual temperature

6.4 Impacts of Catchment Activities on Water Quality

A summary of catchment impacts is outlined in Table 6-3. The majority of the catchment is alpine or low producing grasslands which are of low risk to the source water. There are however areas of more intensive agriculture and residential development close to the bores which pose a higher risk to the source water due to the higher density of domestic, feral and stock animals.

Table 6-3 Catchment impacts

Land Use	Percentage of Catchment Area	Comment
Cropland - Annual	<1%	Cropland is likely to be lightly grazed or not grazed at all. Cropland represents a low to moderate risk to the source water. This is due to the low to moderate density of domestic and feral animals which will produce low level of faecal contamination.
Grassland – High Producing	7%	High producing grassland is likely to be heavily grazed and represents a high risk to the source water.
Grassland – Low Producing	67%	Low producing grassland is likely to be lightly grazed and represents a low to moderate risk to the source water. This is due to the low to moderate density of domestic and feral animals which will produce low level of faecal contamination.
Grassland – With Woody Biomass	4%	Forest areas are likely to contain a low number of wild and feral animals and represents a low risk to the source water.
Pre – 1990 Nature Forest	<1%	
Pre – 1990 Planted Forest	<1%	
Post – 1989 Forest	5%	
Other Land	14%	The “Other” land use in the catchment consists of the alpine environment in the northern reaches of the catchment. It is expected that this area presents a low risk to the source water, due to the presence of the low density of feral animals. In addition, the Twizel Resource Recovery Park within the SWRMA zone 3. This activity poses a high risk to water quality but the position of the site with respect to the intake bores lowers the risk to the source water.
Settlement or built-up area	<1%	Built up areas are likely to represent a high risk to the source water. This is due to sources of pollution from human activities (particularly on-site wastewater systems in unreticulated areas) and the high density of domestic and feral animals.
Wetland	1%	The main area of open water within the SWRMA zone is the wastewater treatment pond. This site is just within the 2500 m groundwater SWRMA zone 3 boundary and is towards the downstream end of the catchment. This activity poses a high risk to water quality but the position of the site with respect to the intake bores lowers the risk to the source water.

6.5 Cyanobacteria

A cyanobacteria risk assessment found that there is a moderate to high risk of cyanobacteria formation (WSP, 2022). The assessment recommended that MDC:

- Monitor the source water for phosphorous, turbidity, pH and temperature quarterly during the year and monthly over summer period.
- Monitor for the presence of cyanobacteria in Fraser Stream over the period from November to March.
- Consider fencing and riparian planting around the intake and for 1 km upstream to keep stock out of the water and to minimise run off.

As there is a moderate to high risk of cyanobacteria formation, a cyanobacteria/cyanotoxin response plan will need to be prepared (Rule S3.8 in the Drinking Water Quality Assurance Rules).

6.6 Protozoa Log Removal Level

Section 5.2.1.2 of DWSNZ states that "The default requirement for protozoa in surface waters is 3-log inactivation or removal. Drinking water safety plans include an assessment of the catchment; if this indicates that 4-log credits may be required, Cryptosporidium monitoring is needed. Cryptosporidium monitoring is not required if the water supplier elects to provide 4-log credits."

Based on the moderate risk of microbial contamination identified in the catchment, a treatment process which provides 4-log protozoal removal is considered appropriate.

6.7 Values Identified by Local Authorities Under the National Policy Statement for Freshwater Management

A summary of the national requirements for the National Policy Statement for Freshwater Management 2020 (NPSFM) and the relevant objectives and policies of the Canterbury Land and Water Regional Plan (CLWRP) and Opihi River Regional Plan as they relate to this water supply are included in Appendix A.

6.7.1 Values of the water sources

The Twizel water take is from three groundwater bores. The CLWRP (including Plan Change 7 Decisions dated 17 November 2021) contains the following notations for Twizel in the vicinity of the drinking water takes:

- Schedule 1: Community Drinking-water Protection Zone
- Schedule 17: Salmon Spawning Sites
- Twizel groundwater quality zone
- Critical habitat
- Nearby is a tributary that flows into the Twizel River, both of which the surface water bodies are an Alpine Upland Water Quality Management Class.
- Nutrient Allocation Zone – At risk classification

It needs to be noted the CLWRP does not map ecosystems however the Biodiversity Projects – Ecosystem Type layer in Canterbury Maps contains a braided river notation approximately 1 kilometer downstream of the drinking water takes.

Furthermore, it needs to be noted the CLWRP does not map cultural values however the New Zealand Archaeological Association contains an archaeological site notation downstream of the drinking water takes.

6.7.2 *Arowhenua Engagement*

A meeting was held with Arowhenua on 22 June 2022 to discuss the values of the water bodies that MDC uses for its water supply. Arowhenua advised that as a tributary of the Waitaki River, Fraser Stream is of immense cultural significance to Arowhenua.

6.7.3 *Implications of the values*

A source water risk management plan must have regard to any values identified by local authorities under the NPSFM that a supplier uses as a source of drinking water. The NPSFM contains policy direction related to protecting the values of freshwater that are to be implemented by the Regional Council through the PNRP. Values that have been identified for the Twizel water source are summarised in Table 6-4.

Table 6-4 Values Identified for the water sources

	Cultural	Contact Recreation	Biodiversity Values	Ecosystem Values	Trout Fishery and Spawning	Wetlands
Twizel	✓		✓	✓	✓	

'Having regard to' requires consideration of the values and what they seek to protect alongside other factors. In developing the source water risk management plan regard has been given to the values by understanding of the catchment from which drinking water is taken.

7 Existing Preventive Measures and Barriers to Contamination

7.1 Introduction

Multi-barrier risk management is considered the best practice approach to supply drinking water as it identifies barriers that prevent contamination from entering the water at every step from catchment to tap. The quality of water supplied by the Council to consumers is secured through the use of multiple barriers to the entry of contaminants. Barriers to contamination considered in this plan extend from catchment to the end supply to consumers.

The four types of barriers are:

- Preventing hazards entering the raw water
- Removing particles, pathogens, and chemical and radiological hazards from the water
- Killing or inactivating pathogens in the water
- Maintaining the quality of the water in the distribution system.

In addition to considering barriers at each step in the physical supply chain (source, treatment, distribution, reticulation) barriers have also been considered for each step in the supply management process.

7.2 Preventing Hazards Entering the Raw Water

Raw water is sourced from three shallow bores drilled to about 20 m and screened to about 10 m that are 50 m – 100 m away from Fraser Stream. The bores are housed in locked sheds to prevent public access and are within the Twizel Community Drinking Water Protection Zone (Environment Canterbury Land and Water Regional Plan) and the Twizel Water Supply Protection Area (Mackenzie District Plan).

Total coliforms and *E. coli* have been detected in the raw water historically and the lack of information about the source of the groundwater means that the bores are not considered to provide a barrier to bacterial and chemical contamination.

7.3 Removing Particles, Pathogens, and Chemical and Radiological Hazards from the Water

The Twizel water treatment plant uses cartridge filtration to remove particles from the water and improve the efficiency of the UV disinfection and chlorination processes. This is considered to provide a complete barrier to particles.

However, as the treatment plant does not currently achieve any protozoal log credits, the treatment barrier is considered to be partially effective. There is an improvement action in Section 8.1 to address this.

As there are no known chemical or radiological hazards present, there is no need to remove these hazards from the water.

7.4 Killing or Inactivating Pathogens in the Water

Disinfection is used to eliminate the risk of bacteria and viruses contaminating the water supply. The water supply is disinfected with UV disinfection. While this is capable of providing 3-log inactivation of protozoa, the monitoring frequency is too low to demonstrate this so this barrier is considered to be partially effective. There is an improvement action in Section 8.1 to address this.

7.5 Maintaining the Quality of the Water in the Distribution System

The treated water reservoir is covered to prevent ingress of rainwater or contaminants and all gaps are sealed to prevent vermin access. The reservoir and pipe network are relatively new and are in good condition.

Sodium hypochlorite is dosed following UV disinfection. The water supply targets a free available chlorine residual of 0.3 mg/L in water leaving the treatment plant (before the treated water reservoir) and no less than 0.2 mg/L in the distribution zone. The chlorine residual in the network provides a partial barrier to re-contamination.

Backflow prevention is a crucial part of maintaining the quality of water in the distribution system. Backflow prevention is required for all high and medium hazard connections to prevent contaminants entering the distribution network. There is an improvement action to install backflow prevention devices at the boundary of properties with high and medium hazard activities (see Section 8.1).

It is considered that the chlorine residual, the good condition of the distribution infrastructure and continuous positive pressure in the reticulation provides a partial barrier to maintain the quality of water in the distribution system. Once backflow prevention is in place and all gaps are sealed on the treated water reservoir, this will be a complete barrier.

7.6 Additional Mitigation Measures

In addition to the considerations above, the following measures also assist in providing barriers in the distribution network:

MDC employs a dedicated maintenance contractor to provide services to the water supply network. Whitestone is the only contractor licensed by MDC that is permitted to work on the network and must follow Standard Operating Procedures (SOPs) and best-practice approaches. Other contractors may be permitted to work on the network with Council approval.

The option of providing water via tanker is a fall-back preventive measure to ensure the community continues to be provided with safe drinking water in the event of source, treatment or distribution quality and/or quantity issues. MDC can engage Cone Peak Farms Ltd for water delivery services in case of emergencies, who deliver potable water from Twizel and are a registered water carrier.

7.7 Summary of Existing Preventive Measures

The existing preventive measures for hazards and hazardous events are listed in the risk assessment table.

7.8 Effectiveness of Preventive Measures

Based on the information presented in the risk assessment table (Appendix A) and in Sections 7.2 to Section 7.6, it is considered that there are adequate preventive measures in place that contribute to the effectiveness of each of the four barrier types.

Table 7-1 Summary of effectiveness of preventive measures

Type of Barrier	Statement on Effectiveness of Existing Preventive Measures
Preventing hazards entering the raw water	Existing bore water provides a fairly consistent quality of source water. Turbidity levels are known to increase following rain events and total coliforms and *E. coli* have been detected historically in the source water. Comprehensive source water quality monitoring shows that there are no other contaminants of major concern.
Removing particles and hazardous chemicals from the water	Cartridge filtration demonstrates an effective barrier to particles is in place.
Killing or inactivating pathogens in the water	UV disinfection within specified ranges and no *E. coli* detected at the treatment plant. However, no protozoal log credits are achieved so this is a partial treatment barrier.
Maintaining the quality of the water in the distribution system	FAC levels are within specified ranges. *E. coli* was detected once during 2017/2018 monitoring. Investigation did not identify a cause and the transgression was attributed to the sampling process. An additional barrier in the reticulation is needed to reduce the risk to an acceptable level. An improvement to add backflow prevention devices to high and medium risk connections is included in this drinking water safety plan which addresses the unacceptable risk.

The Council has identified several areas for improvement which are outlined in Section 8.

8 Identification of Additional Preventive Measures and Improvement Plan

8.1 Improvements to Address Unacceptable Risks

The risk assessment table in Appendix A includes an assessment of each risk's acceptability in light of the associated uncertainty. An improvement plan has been developed that includes several improvements which will address the unacceptable risks and help deliver a safer and more robust water supply.

Table 8-1 describes improvement actions discussed in the risk workshop, to mitigate risks deemed unacceptable. Those items that address a high risk are assigned the highest priority (1) and those that address a medium risk are the next priority (2).

The responsibility for ensuring progress on the improvement item, the timeframe for the improvement, and estimated cost are also included in the table. To ensure that the work is undertaken, responsibilities have been assigned to the relevant Council staff. Roles and responsibilities are likely to change and therefore are required to be checked as part of the annual internal drinking water safety plan review process. Senior management has endorsed these improvements approving the full drinking water safety plan, reflected in the signatures provided on page 2.

Table 8-1 Improvement actions – unacceptable risks

Improvement Number	Improvement Action	Mitigates Risk No(s)	Role Responsible	Estimated Cost	Timeframe	Priority 1 = High 2 = Medium 3 = Low
1	• Increase the logging frequency for turbidity (raw and filtered), differential pressure across the cartridge filters, flow through the cartridge filters, flow through the UV units and UV intensity/dose so that the separation between data records is no more than 1 minute • Continuously monitor cartridge filter service state (separation between data records no more than 1 minute) • Obtain a validation certificate from Filtec to demonstrate that it meets one of the approved standards in DWSNZ and the Rules	1.01	3 Waters Manager	Staff time	14 November 2022	1
2	• Undertake a survey of commercial customers to determine backflow hazard (complete) • Install backflow prevention devices on high and medium hazard connections. • Test all testable backflow prevention devices annually • Create and maintain a backflow register • Undertake an assessment of backflow risk for residential connections.	5.08	Engineering Manager	$50,000	End June 2023	1

Improvement Number	Improvement Action	Mitigates Risk No(s)	Role Responsible	Estimated Cost	Timeframe	Priority 1 = High 2 = Medium 3 = Low
3	• Monitor the source water for phosphorous, turbidity, pH and temperature quarterly during the year and monthly over the summer period. • Undertake further investigations into the type and locations of cyanobacterial species within the Fraser Stream, in particular above the Twizel bore intake structures. • Consider implementing riparian management or upstream waste discharge management/control to at least 1 km upstream of the intake. • Develop a cyanobacteria/cyanotoxin response plan.	1.06	Engineering Manager	$5,000	End June 2023	2

8.2 Potential Additional Improvements

The Council continuously works to improve water supply delivery and during the risk workshops additional areas where improvements could be implemented were identified (see Table 8-2). These items have a lower priority (3) than those in Table 8-1 and will be addressed when and if staff resources and funding are available. The timeframes presented are estimates only.

Table 8-2 Additional improvement actions

Improvement Number	Improvement Action	Mitigates Risk No(s)	Role Responsible	Estimated Cost	Timeframe	Priority 1 = High 2 = Medium 3 = Low
4	Extend the wastewater reticulation so that septic tanks can be removed from the drinking water protection zone	1.01	Engineering Manager	$250,000	End June 2024	3
5	Programme five yearly treated water reservoir checks	4.01 4.03	3 Waters Manager	$10,000	End June 2024	3
6	Monitor disinfection by-products (6-monthly monitoring has commenced)	3.12	3 Waters Manager	$5,000	End of 2022	3
7	Set up SCADA alarm for the smoke detector at the treatment plant	3.13	3 Waters Manager	Staff time	End June 2024	3
8	Consider installing a bypass for the treated water reservoir	4.01 4.03 4.04	3 Waters Manager	$100,000	End of 2026	3
9	Install water meters on customer connections	5.09	3 Waters Manager	$320,000	End of 2026	3

Improvement Number	Improvement Action	Mitigates Risk No(s)	Role Responsible	Estimated Cost	Timeframe	Priority 1 = High 2 = Medium 3 = Low
10	Install continuous pH monitoring at the treatment plant	5.12	3 Waters Manager	$5,000	End of 2023	3
11	Adjust alkalinity and pH so that they are within the guideline values	5.12	3 Waters Manager	$5,000	End of 2023	3
12	Review operations and maintenance manual	6.04	3 Waters Manager	Staff time	End of 2022	3
13	Develop emergency response plan and business continuity plan	6.10	Engineering Manager	Staff time	End of June 2023	3
14	Prepare standard operating procedures for maintaining the cartridge filter and UV disinfection unit, reticulation maintenance and replacement, and contamination event response.	All treatment risks	3 Waters Manager	Staff Time	End of 2023	3

9 Operational Procedures

9.1 Operational Staff Training

MDC and Whitestone Contracting Ltd staff managing and operating the Twizel drinking water supply have the following training certificates and qualifications (see Table 9-1).

Table 9-1 Staff training certificates and qualifications

Role / Position	Training Certificate	Qualification
Water Supply Operator – Whitestone Contracting Ltd	Drinking Water – Water Treatment – Level 4	National Certificate
Water Supply Operator – Whitestone Contracting Ltd	Drinking Water – Water Treatment – Level 4	National Certificate (currently training)
3 Waters Manager – Mackenzie District Council	Drinking Water – Water Treatment – Level 4 & Level 5	Training completed but qualification / certificate not held

9.2 Operations and Maintenance Manual

The Twizel Water Operational Manual describes how the Twizel drinking water supply should be operated and maintained. The manual was prepared, reviewed, and approved in 2019. There is a potential additional improvement action to review and update the existing Operations Manual on a regular basis to maintain its currency.

9.3 Standard Operating Procedures

Whitestone Contracting Ltd have a list of SOPs for the Twizel water treatment plant and for potable water sampling techniques. The Operations and Maintenance Management Procedures detail routine maintenance required at the treatment plant, pump stations, and reticulation and whose responsibility it is. This also specifies training and certificates required from maintenance staff, and the programmed maintenance checks in place.

The SOP for the water treatment plant details the responsibility of the operator, health and safety requirements, and processes and timeframes for checks. A list of SOPs for the Twizel water treatment plant is provided in Table 9-2.

Table 9-2 Twizel water treatment plant standard operating procedures

Procedure No.	Version No.	Operations Instructions
SOP-OPS-007	Revision 03	Chlorine Handling & Storage 1
SOP-OPS-008	Revision 04	Potable Water Sample Testing
SOP-OPS-034	Revision 03	Pump Maintenance

Document/version control is in place to ensure SOPs are reviewed every two years. The document revision number, approval date, review date and authorising party are documented in the SOP header. SOPs are authorised by the Whitestone Contracting Ltd Chief Executive Officer.

The following SOPs have been added to the improvement programme:

- Maintenance of cartridge filters
- Maintenance of UV disinfection units
- UV sensor calibration
- Reticulation maintenance and replacement

- Contamination event response
- Installing and testing backflow prevention devices.

9.4 Operations and Maintenance Activities

There is a list of monitoring and inspections that the maintenance contractor needs to conduct daily, weekly and monthly in the Twizel Water Operational Manual. Maintenance tasks that need to be undertaken bi-monthly, six-monthly and annually are also listed. The Twizel Water Data Recording Sheet template is in Appendix A of the operational manual.

Regular operations and maintenance activities are scheduled by MDC for Whitestone Contracting Ltd. These activities are recorded and saved in Laserfiche.

9.5 Operational Monitoring and Inspection

The monitoring and inspection plans are described in the maintenance contract MDC have in place with Whitestone Contracting Ltd. The monitoring and inspection plans for the Twizel water supply are:

- Part 9.2.1 – Levels of Service
- Part 9.3 – Monitoring Inspection Duties
- Part 9.7 – Routine Maintenance

These are saved in Laserfiche (MDC's document management system). Geoff Horler and Bernie Haar (former MDC Engineering Manager) were involved in revising the existing contract in 2019/2020.

Water quality monitoring records are stored in Council's SCADA system (for parameters measured continuously) and in Laserfiche (for grab samples e.g. reticulation monitoring data). Historical data previously stored in Drinking Water Online is now stored in Laserfiche as Taumata Arowai's Hinekōrako replaced Drinking Water Online on 30 November 2021. A more limited set of data is reported in Hinekōrako. MDC uses Lutra Infrastructure Data for storing its water quality data.

Records of contractor inspections are supplied to MDC weekly and stored in Laserfiche.

9.6 Critical Control Points

A Critical Control Point (CCP) is a point, step or procedure at which controls can be applied and a drinking water safety hazard can be prevented, eliminated or reduced to acceptable (critical) levels. The most common critical control points in a water supply where water suppliers designate critical limits, are disinfection and filtration processes.

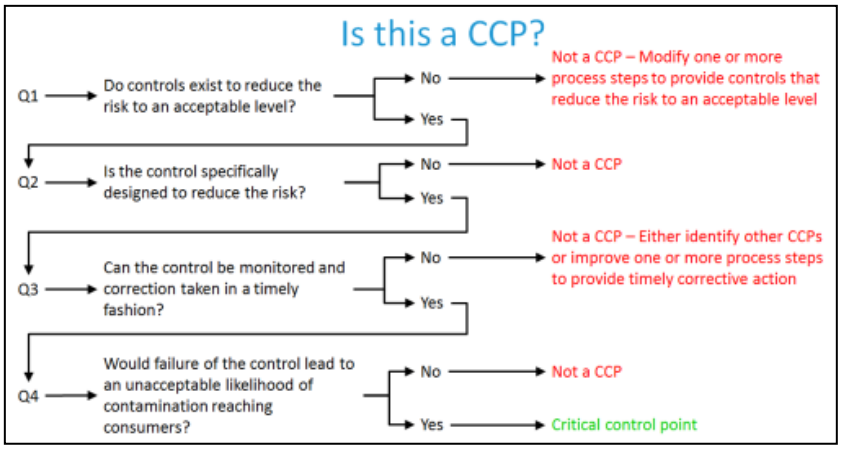


Figure 9-1 Flowchart to help distinguish a CCP, taken from the Handbook for Preparing Drinking Water Safety Plans

The Twizel water supply has cartridge filtration, UV disinfection and chlorination as critical control points over which process controls can be made.

Table 9-3 Critical points and critical control points

	Critical Point	Description
1	Supply bores	Possible access point for contamination due to source water contamination.
2	*Critical Control Point* Cartridge filtration	Cartridge filtration removes particulate material and failure may affect protozoa removal, the performance of the UV reactors and chlorination treatment processes.
3	*Critical Control Point* UV disinfection	UV reactors disinfect the water of all micro-organisms and failure removes a protozoa barrier in the treatment process.
4	*Critical Control Point* Chlorine dosing	Chlorination controls bacterial and viral pathogens and failure reduces the number of treatment barriers and removes the residual disinfectant provided in the distribution zone. Overdosing may exceed the chemical MAV.
5	Service pumps	Pump failure may result in loss of supply pressure.
6	Distribution system	Possible recontamination of the treated water in the distribution system. A chlorine residual provides a partial barrier to recontamination throughout the distribution system. Possible access point for contamination due to backflow.

9.6.1 Cartridge Filtration – CCP1

Cartridge filtration provides the **primary particle removal CCP** to separate material that will compromise the efficacy of subsequent disinfection barriers. It also provides a protozoa barrier.

Table 9-4 Twizel filtration critical control point process objectives

OPERATIONAL DAY-TO-DAY MONITORING OF CONTROL PROCESSES		
What	Turbidity.	
When	Continuously monitored.	
Where	In the main plant building, before and after treatment.	
How	Continuous online monitoring analysers with alarms to the operators if measurement approaches designated parameters.	
Who	Results are telemetered to the duty operator.	
Records	All data is recorded digitally to the Mackenzie District Council SCADA system.	
Process performance criteria at the operational monitoring point.		Correction required if performance criteria are not met.
Target Range	Turbidity < 1.0 NTU	Perform routine plant/supply assessment and maintenance.
Action Limits	Turbidity 1.0 NTU – 2.0 NTU	• On call operator receives alarm to notify that filtered water is at high turbidity. • Operator to assess and dial in to review SCADA. • Visit site and conduct the following checks and remedial actions: • Check raw water turbidity/condition using portable HACH meter. • Check differential pressure across filters. • Replace cartridge filters if necessary. • If raw water turbidity is high, inspect source to determine possible cause. • Record cause of failure and corrective steps taken. • Once situation corrected, monitor turbidity until it is below 1.0 NTU consistently.
Critical Limits	Turbidity ≥ 2.0 NTU	Continue with Action Limit response and: • Operator to change filter cartridges. • Duty Operator notifies Taumata Arowai if inadequately treated water needs to be supplied or has been supplied to the community and determines with the Taumata Arowai Compliance Officer the need to issue a boil water notice and/or provide tankered water. • In consultation with the Taumata Arowai Compliance Officer, follow the relevant procedures in DWSNZ Fig 5.1 (plant). • The Duty operator notifies the MDC 3 Waters Manager. • Operator to complete an investigation into the failure and record the results of the investigation and any improvement actions.

9.6.2 UV Disinfection – CCP2

UV treatment provides the primary **disinfection CCP** to inactivate bacterial, viral and protozoan pathogens that may have entered the water supply upstream of the system.

Table 9-5 Twizel UV critical control point process objectives

OPERATIONAL DAY-TODAY MONITORING OF CONTROL PROCESSES		
What	UV intensity and UV transmittance.	
When	UV intensity is continuously monitored. UV transmittance is measured weekly.	
Where	In the treatment plant, after water is filtered and prior to chlorine disinfection (at the UV reactor)	
How	Continuous online monitoring analysers with alarms to the operators. Automatic plant shutdown if UV disinfection fault occurs	
Who	Results are telemetered to the duty operator.	
Records	All data is recorded digitally to the Mackenzie District Council SCADA system.	
Process performance criteria at the operational monitoring point.		Correction required if performance criteria are not met.
Target Range	UV intensity ≥ 140 mJ/cm^2 UV transmittance > 95%	Normal operating range for UV disinfection. No action required. Conduct normal checks/calibrations on reactor.
Action Limits	UV intensity 100 mJ/cm^2 – 140 mJ/cm^2 UV transmittance 80% – 95%	• If there is a UV fault, on-call operator receives an alarm. • The UV unit that has faulted automatically shuts down and the plant continues to run on the remaining UV units. • If all three UV units fault, the treatment plant automatically shuts down. Treated water storage is now being relied on to supply the community. • Operator to visit the plant to check situation and repair/rectify. UV visual alarms at plant, lights are displayed to diagnose the fault type. • Record cause of failure and corrective steps taken.
Critical Limits	UV intensity <100 mJ/cm^2 UV transmittance < 80%	Continue with Action Limit response and: • Duty Supervisor notifies Taumata Arowai if inadequately treated water needs to be supplied or has been supplied to the community and considers with the Taumata Arowai Compliance Officer the need to issue a boil water notice and/or provide tankered water. • The Duty operator notifies the MDC 3 Waters Manager. • In consultation with the Taumata Arowai Compliance Officer follow the relevant procedures in DWSNZ Fig 5.2 (plant). • Operator to complete an investigation into the failure and record the results of the investigation and any improvement actions.

9.6.3 Chlorine Disinfection – CCP3

Chlorine disinfection provides secondary **disinfection CCP** to inactivate bacterial and viral pathogens that may have entered upstream in the system.

This also provides a **residual disinfection quality control point** to help inactivate pathogens entering downstream of the dosing point.

Table 9-6 Twizel chlorine disinfection critical control point process objectives

OPERATIONAL DAY-TODAY MONITORING OF CONTROL PROCESSES		
What	FAC concentration.	
When	Continuously monitored online at the treatment plant. Monitored weekly in the distribution.	
Where	Designated sampling point in the distribution zone. Post UV disinfection, prior to the treated water reservoir.	
How	Portable spectrophotometer for weekly sampling. Continuous online monitoring analysers with alarms to the operators if measurement approaches designated parameters.	
Who	Sampling undertaken by the duty operator. Results are telemetered to the duty operator.	
Records	All data is recorded digitally to the MDC SCADA system and Laserfiche.	
Process performance criteria at the operational monitoring point.		Correction required if performance criteria are not met.
Target Range	• > 0.3 mg/L in water leaving the treatment plant • > 0.2 mg/L in the distribution zone	• Perform routine plant/supply assessment, checks, calibration, and maintenance. • Chlorine dose is automatically controlled by chlorine dosing control system, controlled by a FAC setpoint reading on the post-filtration chlorine analyser, set by the Operator. • Operator to check FAC concentration and if necessary, change dosing rate to ensure the target range is maintained. • Operator to perform routine treatment plant and chemical supply assessment and checks.
Action Limits	Low Limit: • 0.2 mg/L – 0.3 mg/L in water leaving the treatment plant • < 0.2 mg/L in the distribution zone High Limit: • 2.0 mg/L – 5.0 mg/L in water leaving the treatment plant	• Chlorine Low Alarm, or Chlorine High Alarm are initiated, going to SCADA and Operator pager system. • Operator to visit site and check calibration of chlorine analyser and pH meter. • Operator to check supplies of hypochlorite and dosing systems. • Operator to adjust sodium hypochlorite dosing to within target limits. • Operator to record cause of failure and corrective steps taken. • Operator to advise 3 Waters Manager of incident and corrective actions taken.
Critical Limits	Low Limit: • 0.2 mg/L – 0.3 mg/L in water leaving the treatment plant • < 0.2 mg/L in the distribution zone High Limit: • > 5.0 mg/L in water leaving the treatment plant	Continue with Action Limit response and: • Operator to go to site to investigate the cause of the problem and rectify. • Operator to notify the 3 Waters Manager and Engineering Manager. • Operator to notify the Taumata Arowai Compliance Officer if FAC > 5 mg/L in water leaving the treatment plant or in the distribution zone. • If FAC in water from treated water storage reservoir < 0.2 mg/L, discuss with Taumata Arowai Compliance Officer about the need to issue a boil water notice and/or provision of tankered water. • Operator to complete an investigation into the failure and record the results of the investigation and any improvement actions.

10 Verification Monitoring Programme

The effectiveness of the drinking water safety plan is determined by verification monitoring, which assesses the drinking water quality at the point at which it is supplied to a consumer's property. The assessment makes use of water quality testing and consumer complaints. The latter provides an important source of information about the aesthetic properties of the water.

10.1 Drinking Water Quality Compliance Monitoring

Compliance monitoring requirements for the Twizel drinking water supply are flow based. Flow data is sent directly to Taumata Arowai and ECan from the SCADA system. Compliance monitoring results are stored in SCADA, on the MDC computer servers (Laserfiche) and Hinekōrako.

10.2 Microbial Reduction from Water Treatment Processes

This section describes the measures in place to comply with DWSNZ.

10.2.1 Protozoal and Bacterial Compliance

While the treatment plant is capable of achieving 5-log protozoa inactivation, currently no log credits are achieved due to insufficient monitoring.

Bacterial compliance was not achieved at the treatment plant in 2021/22 as none of the possible bacterial compliance criteria were met.

The water in the distribution system is monitored in accordance with compliance criterion 6A in section 4.3.1 of the DWSNZ.

10.2.2 Treated Water Quality

Table 10-1 shows the required water quality standards and where this is sampled.

Table 10-1 Treated water quality specifications

Parameter	Compliance Range	Sampling Point
E. coli	< 1 per 100 mL	WTP post treatment
Treated water turbidity	Target < 2.0 NTU	WTP post treatment
UV intensity	Target > 100 mJ/cm^2	WTP post treatment
UV transmittance	Target > 80%	WTP post treatment
Treated water FAC target	Target > 0.2 mg/L	Reticulation network

10.2.3 Compliance with DWSNZ – Treated Water Quality Monitoring

The Twizel drinking water supply is subject to the various performance criteria detailed in the DWSNZ. The drinking water compliance monitoring regime is carried out in accordance with the requirements set out in DWSNZ. Continuous monitoring data is stored in SCADA as part of the water treatment plant operation.

Table 10-2 provides a summary of the protozoal compliance monitoring with the DWSNZ.

Table 10-2 DWSNZ compliance – protozoal monitoring

Twizel Treatment Plant	Control	Frequency
Flow	Flow restrictor	Permanent installation
Turbidity	Treated water turbidimeter	Continuous
UV intensity	UVI meter	Continuous
UV transmittance	UVT meter	Weekly
Lamp replacement	Lamp replacement hour meter	Continuous
Lamp outage	Lamp outage sensor	Continuous

Table 10-3 DWSNZ compliance assessment [8]

Standards Compliance Assessed Against	DWSNZ 2005 (revised 2018)
Bacterial compliance criteria used for water leaving the treatment plant	Criterion 5. Not achieved due to insufficient continuous flow monitoring at the UV disinfection unit.
Protozoa log removal requirement for the supply	3-log
Protozoa treatment process	Cartridge filtration and UV disinfection (potential for 5-log protozoa inactivation but no log credits currently achieved)
Compliance criterion 6A is used for water in the distribution zone	Minimum of 13 *E. coli* samples collected per quarter (maximum interval of 11 days between samples, minimum of 5 different days of the week used, zero permitted exceedances)
Bacterial compliance for water leaving the treatment plant has been achieved for the last 4 quarters	No
Protozoa compliance for water leaving the treatment plant has been achieved for the last 4 quarters	No
Bacterial compliance for water in the distribution zone has been achieved for the last 4 quarters	Yes
P2 determinands allocated to supply	No, as plumbosolvency notification requirements were not met.
Chemical compliance achieved for the last 4 quarters	N/A
Cyanobacteria identified in the supply	N/A
Cyanobacterial compliance has been achieved for the last 4 quarters	N/A

Annual compliance with the DWSNZ requirements for the Twizel water supply are stored in Hinekōrako. Compliance survey results with the Health Act for the past 5 years are shown in Table 10-4.

[8] Annual Drinking Water Compliance Report: 1 July 2021 – 30 June 2022 (WSP, 2022)

Table 10-4 Annual Health Act compliance survey results

Compliance Survey	2017/18	2018/19	2019/20	2020/21	2021/22
Supplier Complied with Duty to:					
Provide Drinking Water (69S)	Yes	Yes	Yes	Yes	Yes
Take Steps to Protect Source (69U)	Yes	Yes	Yes	Yes	Yes
Duty to Monitor Drinking Water (69Y)	Yes	Yes	Yes	Yes	Yes
Duty to Prepare and Implement water safety plan (69Z)	-	-	Yes	Yes	Yes
Keep Records and make them Available (69ZD)	Yes	Yes	Yes	Yes	Yes
Investigate Complaints (69ZE)	Yes	Yes	Yes	Yes	Yes
Duty to Take Remedial Actions (69ZF)	No	-	Yes	Yes	Yes
Bacterial Compliance	No	Yes	Yes	Yes	No
Protozoal Compliance	No	No	No	No	No

Note: The sections referred to in this table relate to the Part 2A of the Health Act 1956, which has now been replaced by the Water Services Act.

The compliance report said that protozoal compliance with the DWSNZ was not met due to insufficient monitoring at the UV disinfection unit. Bacterial compliance with the DWSNZ was not achieved due to insufficient pH and FAC monitoring data and elevated turbidity.

10.3 Consumer Satisfaction

10.3.1 Customer Satisfaction

MDC carries out a 'Residents Opinion Survey' each year, to seek feedback from residents on their satisfaction with services like water supplies, roads, community facilities and rubbish collection. Satisfaction surveys have been carried out annually every year for over 10 years. The information is gathered to provide a robust measure of satisfaction with service delivery, determine performance drivers and identify the best opportunities for improving performance, and to measure progress towards long-term objectives.

The most recent survey (2020) was conducted via telephone interviews with resident and non-resident ratepayers that reside in the Mackenzie district. Key findings of the survey were:

- 80% of respondents were satisfied with the water supply and quality.
- The performance target of 80% satisfaction was met.
- Satisfaction levels were similar to the previous year (83% in 2019).
- Concerns causing dissatisfaction were in relation to chlorine content, poor taste/appearance/quality content and water supply issues.

Data collection was randomised to ensure the sample included a range of respondents based on age, location, and gender, with a quota system in place to ensure the sample was representative of the population in line with 2018 Census results. Surveyees were asked their opinion on a wide range of Council issues and the services it delivers to residents.

Residents are also encouraged to provide feedback through the Council's Consultation webpage or in person at the customer services desk.

Responses from the Community Satisfaction Survey form part of the results for Council's Annual Report.

10.3.2 Customer Service Requests and Complaints

Customers are able to lodge service requests or notify the Council of water problems at any time via:

Customer Contact Centre, by phone or in person. This is the Council's main number, and it is available in the White Pages or on the Council's website under 'Contact Us'.

Online via the 'Contact us, 'Ask a question' or the 'Report an issue' forms, these forms are available on the Council's website under the 'Contact Us' webpage.

Staff in the Customer Contact Centre record all calls, complaints and letters. Service requests are tracked in MAGIQ Software called NCS. Anything that requires an action is logged and forwarded to the appropriate team for resolution. The time taken to respond and resolve the issue is recorded.

10.4 Short-term Evaluation of Results

Assessment of the performance of this drinking water safety plan is undertaken annually. This includes a review of the operational and verification monitoring and inspection results. If necessary, the drinking water safety plan will be updated in response to this annual review. This provides an early warning for any problems that may occur and allows MDC to monitor how well the plan and activities are working.

MDC holds weekly meetings with the maintenance contractor to discuss compliance data and incidents. Critical issues are reported to MDC on the day of occurrence.

Short term evaluation of results is undertaken monthly by the Council's water team as part of a routine reporting cycle to identify trends or issues at the supply and confirm whether compliance requirements have been met.

The level of compliance of the applicable water supplies is reported to the Community Boards bi-monthly.

11 Management of Incidents and Emergencies

11.1 Previous Incidents and Emergencies

The Twizel drinking water supply has never achieved protozoal compliance with the DWSNZ. MDC is attempting to find a method of providing data in a way that can prove compliance.

E. coli has been detected once in the last five years during the 2017/2018 monitoring period. An investigation did not identify a cause and the transgression was attributed to the sampling process. A boil water notice was temporarily issued. The supply therefore failed to comply with the Health Act or the DWSNZ between 1 July 2017 to 30 June 2018[9]. The Drinking Water Assessor noted that "Twizel did not take enough *E. coli* samples, failed other monitoring requirements and did not take appropriate action to protect public health after an issue was discovered". The supply failed to comply with sections 69Y and 69ZF of the Health Act and bacterial compliance was not met.

11.2 Incident and Emergency Response Plan

11.2.1 Levels of emergency

Defining and assigning a level of emergency to each type of possible incident/emergency assists with clear internal communication of the hazard threat level. Table 11-1 defines the emergency descriptors used by MDC during incident/emergency responses. Each emergency response plan indicates the range of emergency levels that may apply, which will depend on the specific event.

Table 11-1 Emergency / incident level descriptor

Incident/emergency level	Description of level
Level 5	Widespread outbreak of waterborne disease
	Declared civil defence natural disaster
	Water supply unable to be maintained
	Gross exceedance of one or more chemical MAVs (e.g. more than 5x MAV, including cyanotoxins)
Level 4	*E. coli* >10 cfu/100 mL or any pathogen detected at the treatment plant or in reticulation
	Failure of infrastructure resulting in water outages for consumers lasting > 8 hours
	Alert from District Health Board that surveillance information suggests cases of illness in the community are drinking water related
Level 3	Detection of *E. coli* (<10 cfu/100 mL) in reticulation
	Exceedance of one or more chemical MAVs
Level 2	Preventive measure failure in combination with corrective action failure
	One or more chemicals at greater than 50% of MAV
Level 1	Exceedance of a DWSNZ aesthetic guideline (GV), possibly resulting in customer complaints
	Water restrictions required to enable supply continuity

[9] Annual Report on Drinking-Water Quality 2017 – 2018 Appendix 1 (Ministry of Health, 2019) https://www.health.govt.nz/system/files/documents/publications/drinking-water-annual-report-appendix-1-revised-aug2019.pdf

11.2.2 Emergency Response Plan

MDC is a member of the Canterbury Region CDEM Group, which includes all local authorities in the Canterbury Region. The Canterbury Region CDEM Group are responsible for developing the recovery arrangements for their group area. CDEM Groups must state and provide strategic planning for recovery from the hazards and risks identified in their CDEM Group plan.

The Canterbury Region CDEM Group Plan describes how the group will manage and respond to emergencies and sets out the operational arrangements of the group.

MDC does not currently have an emergency response plan in place for the Twizel drinking water supply. There is a potential improvement action in Section 0 to develop an emergency response plan for the plant's operation, principally for response to natural disasters in particular after a major earthquake disrupts the water supply (level 5 event – see Table 11-1).

11.2.3 Incident Response Plan

Implementation of the contingency plan actions when there is an indication of poor water quality is the responsibility of the 3 Waters Manager. These actions are detailed in Table 11-2.

Table 11-2 Twizel water supply incident response plan

Type of Event	Required Actions
Microbiological contamination of the abstracted source water (such that treatment is ineffective) Indicators: • A contamination event in the bore water recharge zone may be observed by or reported to MDC staff • High levels of E. coli or total coliforms measured in raw water • E. coli detected in distribution system • Total coliforms > 10 cfu/mL detected in distribution system • Reports of illness in the community	• Notify Taumata Arowai and the 3 Waters Manager. • Issue boil water notice to consumers in conjunction with Taumata Arowai and following Council response plans. • Commence daily E. coli testing at WTP and in the distribution system, use an enumeration test method for both. • Inspect area around bore water source and surrounding areas to identify source of contamination and rectify problem as quickly as possible. • Super chlorinate the reservoir and distribution system and flush mains if they contain contaminated water. • Keep customers informed and advise once regular supply is restored. • Consider providing potable drinking water from alternative sources such as bottled water or tankered water.
Elevated turbidity of the abstracted source water and/or high turbidity in water in distribution system Indicators: • Highly turbid water identified in treated water turbidimeter or handheld meter in zone • Taste, odour, or visual complaints from consumers	• Advise the 3 Waters Manager. • Investigate the source of the elevated turbidity. • Assess the performance of the treatment processes in place to reduce turbidity at the treatment plant. • Where elevated turbidity compromised the plant's ability to adequately disinfect the drinking water, issue a boil water notice to consumers in conjunction with Taumata Arowai and follow Council response plans. • Commence daily E. coli testing. • Monitor source water turbidity. • Keep customers informed and advise once regular supply is restored.
Chemical contamination of source water Indicators: • A contamination event in the bore water recharge zone observed by or reported to MDC staff. • Taste, odour, or visual complaints from consumers • Reports of illness in the community	• Notify Taumata Arowai and the 3 Waters Manager. • Advise consumers not to drink the water supply in conjunction with Taumata Arowai and follow the Council response plans. • Assess situation and advise customers regarding use/treatment/disposal of contaminated water. • Inspect area around intake to identify source of contamination and rectify problem as quickly as possible. • Consider mains isolation to avoid spread of chemical contaminants. • Flush reservoir and mains. • Arrange emergency water supply (tankers/bottles) if necessary. • Keep customers informed and advise once regular supply is restored.

Type of Event	Required Actions
Insufficient water available for abstraction or loss of ability to take water from the bores Indicators: • Observed or reported low abstraction levels • Low reservoir levels	• Notify Taumata Arowai and the 3 Waters Manager. • Advise customers to conserve water. • Implement demand management strategies as outlined in Council response plans as required. • Arrange emergency water supply (tankers/bottles) if necessary. • Investigate and resolve any intake or pipeline issues. • Refer to business continuity plan and emergency response plans once they have been developed, refer Section 0for improvement action. • Keep customers informed and advise once regular supply is restored.
***E. coli* transgression in water in distribution zone** Indicators: • Positive E. coli monitoring results • Reports of illness in the community	• Follow transgression response procedure in DWSNZ. • Advise Taumata Arowai and the 3 Waters Manager. • Commence daily E. coli testing at WTP and in the distribution system, use an enumeration test method for both. • Investigate cause, inspect plant and source. • Take remedial action. • Continue to sample for E. coli until 3 consecutive samples are free of E. coli. • If E. coli is found in any of the repeat samples, consult with Taumata Arowai, intensify remedial action, increase disinfection, issue 'Boil Water' notice.
Inadequate FAC residual in water post treatment enters distribution system Indicators: • FAC of 0.2 mg/L cannot be maintained in distribution system despite primary corrective actions • Reports of illness in the community • E. coli or total coliforms are detected in the network	• Advise the 3 Waters Manager. • Inspect treatment plant to identify cause of problem and rectify as quickly as possible. • Check quality of chlorine, quantity of chlorine and dosing equipment of levels and faults. • Hand dose sodium hypochlorite into the treated water reservoir. • Double check FAC levels in the distribution zone with calibrated equipment. • Investigate contaminant entry at the source, reservoirs and reticulation (including backflow and mains break). • Discuss the need to issue a boil water notice to consumers with Taumata Arowai and follow Council response plans. • Keep customers informed and advise once regular supply is restored.

Type of Event	Required Actions
Excessive FAC residual in water post treatment enters distribution system Indicators: • FAC >5 mg/L is measured in treated water or in distribution system • Taste and odour complaints from consumers • Reports of illness in the community	• Notify Taumata Arowai and the 3 Waters Manager. • Advise consumers not to drink the water supply in conjunction with Taumata Arowai. • Arrange emergency water supply (tankers/bottles) if necessary. • Assess situation and advise customers regarding use/treatment/disposal of contaminated water. • Identify reason for chlorine limit breach and rectify problem as quickly as possible. • Flush storage tanks and mains and advise consumers to flush taps. • Keep customers informed and advise once regular supply is restored.
Earthquake, flood or other natural disaster	Refer to the Canterbury Region Civil Defence Emergency Management Group Plan.

12 Documenting and Reporting

12.1 Management of Documentation and Records

MDC uses Laserfiche for its document management system. Key documents relating to the water supply system including water quality monitoring reports and maintenance records are stored in Laserfiche. All MDC staff have access to Laserfiche and receive training in its use.

All data that is measured continuously (e.g. treated water turbidity, FAC and pH) is stored in the Council's SCADA system historian, which is accessible to operators and MDC staff.

Lutra Infrastructure Data software is used to store monitoring data via a secure online dashboard. The software stores all SCADA data and directly uploads monitoring results processed by the lab.

Water supply staff are trained in the use of these systems and in how to fill out records properly.

Hinekōrako is used for compliance reporting to Taumata Arowai.

12.2 Reporting

Drinking water supply quality, compliance and water supply performance are reported, and publicly available online, to external stakeholders, consumers and other agencies through:

- The Annual Report on Drinking-water Quality by the Ministry of Health. The Council contributed information annually for these reports focussed on bacteriological, protozoal and chemical compliance with DWSNZ, the status of drinking water safety plans, and meeting legislative requirements. Now that Taumata Arowai has taken over from the Ministry of Health as the regulator, MDC commissioned WSP to prepare the 2021/22 annual compliance report.
- MDC Annual Report: This report is focused on MDC's performance against levels of service and provides insight into the final financial and performance results including DWSNZ compliance and Department of Internal Affairs mandatory non-financial performance measures.
- Compliance updates are reported to the three MDC Community Boards on a monthly basis.
- The Council website and social media platform Facebook are used to communicate boil water notices to the public.
- Resource consent compliance: flow data is sent directly to ECan and Taumata Arowai from SCADA.

13 Investigations

13.1 Investigative Studies

Investigations can be triggered by an incident or customer complaints. Customer complaints are loaded into the Council's MAGIQ Software NCS system by the Customer Contact Centre to be triaged and actioned by the 3 Waters Manager. All complaints are investigated with the outcome and actions taken recorded once a job is resolved. If there is a cluster of complaints, a wider investigation is undertaken.

MDC are planning investigative studies to assess the unusually high quantity of water consumed by the Twizel and Tekapo water supplies. It is expected that irrigation is a contributing factor. The smart water meter roll out for each supply will help to identify high volume users.

MDC have also engaged WSP to complete the following work during 2022 to address improvement actions, all of which are complete:

- Undertake a cyanobacteria risk assessment for the Twizel drinking water supply
- Develop backflow prevention policy and conduct backflow prevention surveys
- Complete an annual compliance report for the monitoring period between 1 July 2021 and 30 June 2022.

13.2 Validation of Equipment, Processes and Practice

Validation collects evidence to establish that preventive measures can perform at the expected level. The regular re-validation of procedures, treatment processes and associated controls ensures their effective operation and adequate control, especially if a process or component has been physically changed or an operational setting changed.

All new equipment is required to be validated by the supplier to confirm that it meets the specifications and is operating correctly.

Routine revalidation of equipment is undertaken by the operators. There is an improvement item to update the SOP that describes the calibration and maintenance requirements for the Twizel drinking water supply.

14 Oversight, Review and Continual Improvement

14.1 Long-term Evaluation of Results

The Council's long-term evaluation of results is focused on water quality monitoring and system performance.

As well as monitoring for the water take consent for the drinking water supply, the Council monitors and reviews its performance against its levels of service described in the Long Term Plan and Annual Plan. Annual reports identify areas needing immediate attention with a full review every three years as part of the Long Term Plan process contributes to the funding and development of the water supply network over a ten year period.

The results for water supply levels of service for 2020/21 are summarised in the Mackenzie District Council 2020/21 Annual Report[10]. Of the seven levels of service, three were achieved (fault response times, number of complaints and customer satisfaction). The exceptions were:

Provide safe drinking water:

- 25% of MDC drinking water supplies achieved bacterial compliance in accordance with DWSNZ, compared with a target of ≥ 95%.
- 0% of MDC drinking water supplies achieved protozoal compliance in accordance with DWSNZ. MDC aims to have 3 of 5 supplies compliant by 2023/2024.

Provide demand management of water supply services:

- The average consumption of drinking water per day per resident within the district was 1.72 m^3, compared with a target of ≤ 1.2 m^3.
- 26% water loss, compared with a target of <25%.

The maintenance contractor is required to report any defects observed during day to day duties. There is an ongoing inspection and maintenance regime under the routine maintenance contract and information recorded is used to inform the condition of assets. Almost 90% of water supply assets are estimated to be in good condition and only 3% assumed to be in poor condition. The overall performance of water supply assets is adequate. The primary concern is achieving DWSNZ compliance.

The Council also records information relating to DWSNZ compliance and transgression information. This was provided annually for the Ministry of Health's annual report on drinking water quality. Historical information on the Twizel water supply can be evaluated from the Ministry of Health's Annual Review of Drinking-water Quality in New Zealand. Reporting is now to Taumata Arowai.

Section 17A of the Local Government Act 2002 requires the Council to carry out service delivery reviews. These reviews are a method of determining whether the existing means for delivering a service remain the most efficient, effective, and appropriate means for delivering that service. The most recent review for three waters was carried out in 2019/2020. Reviews are required to be carried out no later than six years following the last review.

14.2 Audit of Drinking Water Quality Management

An annual review is undertaken to assess compliance with the DWSNZ and the Water Services Act. An annual review of the water safety plan is also completed to ensure improvement actions are implemented within the agreed timeframes. Lutra Infrastructure Data software is used to store

[10] https://www.mackenzie.govt.nz/__data/assets/pdf_file/0005/629474/2020-2021-Annual-Report-Full.pdf

monitoring data via a secure online dashboard. The software stores all SCADA data and directly uploads monitoring data processed at the lab.

14.3 External Audit of Drinking Water Quality Management

External audits of the water supply are undertaken by Taumata Arowai. These were previously undertaken by the Drinking Water Assessor, including a three-yearly review of compliance with the drinking water safety plan. The most recent external audit was carried out in 2020.

Appendix A

Twizel Drinking Water Supply – Risk Assessment Table

Twizel Water Supply - Risk Assessment Table

	Hazardous Event			Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)							RESIDUAL Risk (with existing preventive measures)								LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY				
Supply Element	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Aesthetics	Disruption to Supply	Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Likelihood	Consequence of the HAZARD	Assessment Rationale - Consequence	MAX L	MAX C	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Modified Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Modified Likelihood	Modified Consequence of the HAZARD	Assessment Rationale - Modified Consequence	MOD L	MOD C	Residual Risk	Level of Uncertainty	Residual Risk Score	Risk Acceptability	Additional Preventive Measure Required?	Improvement Plan Reference
Source - Bore Recharge Zone	Microbiological contamination due to surface runoff from catchment, community wastewater systems, dairy effluent ponds or septic tank systems	1.01	Contamination from human or animal activity in catchment, unmonitored permitted activities, consent conditions not followed, or potential impact not considered.	☑	☑			Almost Certain	Assumes no land use controls	Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	5	4	Extreme	• Continuous turbidity monitoring in raw water • Continuous turbidity and FAC monitoring in treated water • pH grab samples • FAC and E. coli monitoring in distribution system • SCADA controls and alarms • Building consents • Resource consents • Illness in community	• Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Groundwater source • Community drinking water protection zone in Land and Water Regional Plan • Twizel water supply protection area in Mackenzie District Plan • Raw and treated water storage • Use of tankered water	Likely	Septic tanks and grazing are in the catchment / community drinking water protection zone Protozoa testing showed nothing	Moderate	Treatment reduces consequence but insufficient water quality monitoring frequency means that no protozoal log credits are achieved	4	3	High	Uncertain	12	Unacceptable	Yes	1, 4
Source - Bore Recharge Zone	Chemical contamination from surface runoff containing chemical contaminants from agricultural activities. (e.g. pesticides, fertilisers etc)	1.02	Poor fertiliser / pesticide application practices, landowners in catchment unaware of drinking water catchment area			☑		Possible	Assumes no land use controls	Major	Potential repeated exceedance of MAV	3	4	High	• Taste and/or odour complaints • Complaints or information provided by the public about activities in the bore recharge zone • Source water chemical suite is analysed annually	• Groundwater source • Community drinking water protection zone in Land and Water Regional Plan • Twizel water supply protection area in Mackenzie District Plan • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Raw and treated water storage • Use of tankered water • small / lifestyle rural blocks with no dairy farming and low stock	Rare	Groundwater source and protection zone reduces likelihood	Major	PMs don't reduce consequence	1	4	Medium	Reliable	4	Acceptable	No	
Source - Bore Recharge Zone	Chemical contamination due to naturally occurring chemical contaminants or land use intensification	1.03	Naturally occurring chemical contaminants from local geology or from land use intensification			☑		Unlikely		Moderate	Potential widespread aesthetic issues, or repeated breach of maximum acceptable value (MAV)	2	3	Medium	• Taste and/or odour complaints • Source water chemical suite is analysed annually	• Groundwater source • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination)	Unlikely	Source water monitoring shows no contaminants of concern other than iron in one sample (0.22 mg/L compared with GV of 0.2 mg/L)	Moderate	PMs don't reduce consequence	2	3	Medium	Reliable	6	Acceptable	No	
Source - Bore Recharge Zone	Chemical contamination	1.04	Chemical spill in water upstream of bore recharge zone			☑		Unlikely		Major	Potential repeated exceedance of MAV	2	4	Medium	• Taste and/or odour complaints • Chemical spill is reported	• Groundwater source • Community drinking water protection zone in Land and Water Regional Plan • Twizel water supply protection area in Mackenzie District Plan • Few chemicals used in recharge zone by farmers who are aware they operate in a protected recharge area for the Twizel drinking water supply • No bulk storage of chemicals in the bore recharge area • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Raw and treated water storage • Use of tankered water	Rare	Groundwater source and protection zone reduces likelihood	Major	PMs don't reduce consequence	1	4	Medium	Reliable	4	Acceptable	No	
Source - Bore Recharge Zone	Increased sediment load in source water	1.05	Heavy rainfall, fire in catchment			☑		Possible	Can get over 10 NTU when it rains	Moderate	Potential widespread aesthetic issues	3	3	Medium	• Continuous turbidity and pH monitoring in raw water • Continuous turbidity and FAC monitoring in treated water • SCADA controls and alarms • Visual observation	• Groundwater system naturally filters sediment • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Raw and treated water storage • Use of tankered water	Possible	Turbidity is consistently below 2 NTU at WTP.	Minor		3	2	Medium	Reliable	6	Acceptable	No	
Source - Catchment	Cyanotoxin Contamination	1.06	Cyanobacteria growth in source water	☑		☑		Unlikely	No indication of cyanobacteria	Moderate	Potential widespread aesthetic issues	2	3	Medium	• Taste and/or odour complaints • ECan report cyanobacteria in area	• ECan has observed cyanobacteria downstream of the confluence with the Twizel river. Cyanobacteria has not been observed in Fraser Stream • Flowing catchment system • Use of tankered water	Unlikely		Moderate	PMs don't reduce consequence	2	3	Medium	Estimate	6	Unacceptable	Yes	3
Source - Bore Recharge Zone	Loss of Supply	1.07	Drought reduces quantity of water that can be abstracted				☑	Unlikely		Major	Significant compromise of systems and abnormal operation	2	4	Medium	• Bore water level indicator • Flow meter • Reservoir level indicator • SCADA controls and alarms • Low flows from bores • Prolonged drought or low rainfall conditions	• Water restrictions • Use of tankered water • Restrictions on take when river level low	Rare		Moderate	PMs don't reduce consequence	1	3	Low	Estimate	3	Acceptable	No	
Source - Bore Recharge Zone	Loss of supply	1.08	Consent to take water is not renewed or is declined by the Regional Council				☑	Possible		Major	Significant compromise of systems and abnormal operation	3	4	High	• Regional Council raises issues about water consents prior to consent application	• Current consent expires in 2047 • Community drinking water protection zone in Land and Water Regional Plan • NPS Freshwater Management prioritises drinking water over other consumptive uses	Rare		Major	PMs don't reduce consequence	1	4	Medium	Reliable	4	Acceptable	No	
Source - Bores	Loss of supply	1.09	Intentional vandalism or accidental damage to the bores or associated equipment				☑	Possible		Major	Significant compromise of systems and abnormal operation	3	4	High	• Flow meter • Reservoir level indicator • SCADA controls and alarms • Obvious signs of damage to structure • Reports from nearby residents	• Three bores provide redundancy (normally one bore required to meet demand) • Bore heads are in locked sheds • 2 days of raw water storage at average demand • Raw and treated water storage • Use of tankered water	Possible		Moderate		3	3	Medium	Reliable	9	Acceptable	No	
Source - Bores	Loss of supply	1.10	• Mechanical or electrical failure of bore pumps • Failure of bore pump due to power outage • Bore screens become clogged with fine particles				☑	Possible		Moderate	Significant compromise of systems and abnormal operation	3	3	Medium	• Flow meter • Reservoir level indicator • SCADA controls and alarms	• Three bores provide redundancy • 2 days of raw water storage at average demand • Duty standby generator at WTP wired to bores, autostart • Raw and treated water storage • Use of tankered water • Electrical testing of bore pumps annually	Possible		Minor		3	2	Medium	Reliable	6	Acceptable	No	
Source - Bores	Microbiological contamination	1.11	• Flooding of the bore chambers • Bore casing or bore head failure	☑	☑			Possible		Major	Significant compromise of systems and abnormal operation	3	4	High	• Continuous turbidity and pH monitoring in raw water • Continuous turbidity, pH and FAC monitoring in treated water • FAC and E. coli monitoring in distribution system • Flow meter • Ponding of water visible near bores • SCADA controls and alarms	• Three bores provide redundancy • Bores raised above ground, elevated from surrounding area • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Pump maintenance programme in place • Raw and treated water storage	Unlikely		Moderate	Treatment reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	

Twizel Water Supply - Risk Assessment Table

	Hazardous Event			Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)							RESIDUAL Risk (with existing preventive measures)								LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY				
Supply Element	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Aesthetics	Disruption to Supply	Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Likelihood	Consequence of the HAZARD	Assessment Rationale - Consequence	MAX L	MAX C	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Modified Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Modified Likelihood	Modified Consequence of the HAZARD	Assessment Rationale - Modified Consequence	MOD L	MOD C	Residual Risk	Level of Uncertainty	Residual Risk Score	Risk Acceptability	Additional Preventive Measure Required?	Improvement Plan Reference
Source - Bores	Loss of supply	1.12	Earthquake damage to bore				☑	Rare		Major	Significant compromise of systems and abnormal operation	1	4	Medium	• Seismic event • visible signs of damage • SCADA monitoring	• three bores provide redundancy • Raw and treated water storage	Rare		Moderate	Storage reduces consequence	1	3	Low	Reliable	3	Acceptable	No	
Source - Raw Water Pipeline	Loss of supply	1.13	• Raw water pipeline failure between intake and treatment plant • Damage to pipeline by landowner/contractor				☑	Possible		Major	Significant disruption to normal operation	3	4	High	• Flow meter • SCADA controls and alarms • Condition and type of materials of pipeline • Records of pipeline failures and repairs • Reduced / no flow to treatment plant	• Most breaks can be repaired quickly by the maintenance contractor • Whitestone contract requires rapid response to repair failures (KPIs) • Spare pipes and couplings stored at contractor yard • Pipe condition assessment of raw water main • Raw and treated water storage • Water use restrictions • Use of tankered water, pump direct from bores to tanker	Unlikely	Pipe sample recovered in 2015, assessed as Grade 1 - Very Good condition. Unlikely to be at risk of failure until 2090	Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Source - Raw Water Pipeline	Inadequate quantity of water supplied	1.14	Size of raw water pipeline is inadequate				☑	Possible		Moderate	Significant disruption to normal operation	3	3	Medium	• Flow meter • Hydraulic calculations, modelling • Customer complaints • SCADA controls and alarms	• Calculations show that pipeline is correctly sized	Rare	No issues meeting peak demand	Moderate		1	3	Low	Estimate	3	Acceptable	No	
Storage - Raw Water	Microbiological or chemical contamination	2.01	Vandalism to reservoir	☑	☑	☑		Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• Continuous turbidity and pH monitoring in raw water • Continuous turbidity, pH and FAC monitoring in treated water • Visual evidence of damage to reservoirs • Complaints from consumers about loss of supply • Reports of unauthorised access to site • Operator visits the plant 1-2 times weekly • Regular inspections of treatment plant and reservoir site	• Locked gate and site fencing	Rare		Major		1	4	Medium	Reliable	4	Acceptable	No	
Storage - Raw Water	Loss of supply	2.02	Reservoirs out of service due to earthquake damage or structural failure				☑	Possible		Major		3	4	High	• Flow meter • Complaints from consumers about loss of supply • Change in flow or pressure in reticulation	• Raw water reservoir is PE lined and in good condition. cover replaced in 2016	Rare		Major		1	4	Medium	Reliable	4	Acceptable	No	
Storage - Raw Water	Contamination of water supply	2.03	Animal or bird access to reservoir	☑	☑			Possible		Major		3	4	High	• Visual evidence • Taste or odour complaints by customers	• Raw water reservoir cover is sealed and in good condition, replaced in 2016 • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • flap on overflow pipe	Rare		Minor	Treatment reduces consequence	1	2	Low	Estimate	2	Acceptable	No	
Storage - Raw Water	Contamination of water supply	2.04	Sludge build up in reservoir				☑	Possible		Moderate		3	3	Medium	• Visual checks • Customer complaints • Compromised water quality when reservoir level is low • turbidity data	• Groundwater source is generally good quality • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Sludge build-up in raw water reservoir checked 10 yearly, reservoir cleaned out if required • Use of tankered water	Unlikely	elevated turbidity in groundwater	Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Treatment - Cartridge Filtration	Failure of the cartridge filter / particles not removed	3.01	• Damage to the seal or filter casing • Failure of cartridge	☑	☑			Possible		Moderate		3	3	Medium	• Visual inspections • Filter pressure differential • Continuous turbidity and pH monitoring in raw water • Continuous turbidity, pH and FAC monitoring in treated water • SCADA controls and alarms • Reports of illness	• UV disinfection and chlorination • full set of spare cartridge on site • Trained operators • Standard operating procedures • cartridge filter serviced as required by Whitestone • weekly site visit by operator • Raw and treated water storage	Unlikely	Source groundwater has low turbidity, trained operators and regular maintenance reduce likelihood	Minor	Multi-stage treatment system and chlorine residual reduces consequence	2	2	Low	Reliable	4	Acceptable	No	
Treatment - UV disinfection	Inadequate disinfection	3.02	UV intensity insufficient due to build-up of deposits on sleeve	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• Visible build-up of deposits on sleeve • UV intensity sensor • SCADA controls and alarms	• Sleeve has automatic cleaning mechanism installed • Sleeve can be manually cleaned if UV intensity drops • Source water is stable with low turbidity • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Weekly site visits by operator • Operations and maintenance manual • Standard operating procedures • Trained and experienced operations staff • Treated water storage • Use of tankered water • Servicing of UV by Wedeco as required	Unlikely		Minor	Multi-stage treatment system and chlorine residual reduces consequence	2	2	Low	Reliable	4	Acceptable	No	
Treatment - UV disinfection	Inadequate disinfection	3.03	Excessive turbidity in water decreases the effectiveness of the treatment	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• Continuous turbidity and FAC monitoring in treated water • FAC and E. coli monitoring in distribution system • SCADA controls and alarms • Illness in the community	• Source water is stable with low turbidity • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Treated water storage • Use of tankered water	Unlikely		Moderate	Multi-stage treatment system and chlorine residual reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	

Twizel Water Supply - Risk Assessment Table

	Hazardous Event			Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)							RESIDUAL Risk (with existing preventive measures)							LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY				
Supply Element	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Aesthetics	Disruption to Supply	Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Likelihood	Consequence of the HAZARD	Assessment Rationale - Consequence	MAX L	MAX C	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Modified Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Modified Likelihood	Modified Consequence of the HAZARD	Assessment Rationale - Modified Consequence	MOD L	MOD C	Residual Risk	Level of Uncertainty	Residual Risk Score	Risk Acceptability	Additional Preventive Measure Required?	Improvement Plan Reference
Treatment - UV disinfection	Inadequate disinfection	3.04	Flow rate through UV unit too rapid for effective treatment	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• Flow rate through plant greater than UV unit maximum	• Actuated valves limits flow through UV unit • Treatment systems are designed to an optimal flow rate for the UV unit • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination)	Rare		Moderate	Multi-stage treatment system and chlorine residual reduces consequence	1	3	Low	Reliable	3	Acceptable	No	
Treatment - UV disinfection	Inadequate disinfection	3.05	UV lamp failure	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• UV lamp failure alarm • UV intensity sensor and alarm • Lamp hour meter • SCADA controls and alarms	• UV system is maintained at regular intervals and lamps replaced after 10,000 hours • Spare lamps and sleeves kept on-site • Weekly site visits by operator • Operations and maintenance manual • Standard operating procedures • Maintenance contract KPIs • Trained and experienced operations staff • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Treated water storage • Use of tankered water	Unlikely		Moderate	Multi-stage treatment system and chlorine residual reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	
Treatment - UV disinfection	Inadequate disinfection	3.06	UV intensity sensor failure	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• UV intensity sensor and alarm • SCADA controls and alarms	• UV systems are maintained at regular intervals with sensor checked or replaced annually • UVI calibrated as per manufacturer recommendation • Spare UVI sensor kept on-site • Weekly site visits by operator • Operations and maintenance manual • Standard operating procedures • Maintenance contract KPIs • Trained and experienced operations staff • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Treated water storage • Use of tankered water	Unlikely		Moderate	Multi-stage treatment system and chlorine residual reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	
Treatment - UV disinfection	Inadequate disinfection	3.07	Power failure resulting in UV unit being unable to operate	☑	☑			Likely		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	4	4	High	• Notice of power failure • SCADA controls and alarms	• Duty standby generator provides power to treatment plant • Treated water storage • Use of tankered water • Auto shutdown of plant	Unlikely		Moderate	Chlorination reduces consequence of bacterial or viral contamination but not protozoal	2	3	Medium	Reliable	6	Acceptable	No	
Treatment - Chlorination	Inadequate Chlorination	3.08	Inadequate contact time	☑	☑			Likely		Moderate	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	4	3	High	• Calculation of contact time • Continuous turbidity and FAC monitoring in treated water • SCADA controls and alarms	• Sufficient contact time is provided in the treated water reservoir • Chlorine dose leaving the treatment plant is 0.3 mg/L • UV disinfection	Rare	Ample contact time in reservoir	Moderate	UV treatment reduces consequence	1	3	Low	Reliable	3	Acceptable	No	
Treatment - Chlorination	Inadequate Chlorination	3.09	• Sodium hypochlorite supply exhausted • Dosing system failure • Chlorine dose rate incorrect • Chlorine demand exceeds chlorine dose due to high raw water turbidity • Dosing line failure or leak • Power failure • Freezing temperatures	☑	☑			Likely	Assumes inexperienced operators and no O&M procedures	Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	4	4	High	• Illness in community • Continuous turbidity and FAC monitoring in treated water • FAC and E. coli monitoring in distribution system • SCADA controls and alarms	• Operator visits the plant 1-2 times weekly to check supply of sodium hypochlorite • Sodium hypochlorite filled by tanker when supply is low • Chlorine dose rate automatically adjusts (flow paced and FAC) • SCADA alarms for FAC • Chlorine dosing pump checked weekly and serviced as required • Operations and maintenance manual • Standard operating procedures • Spare dosing pump available • Trained and experienced operations staff • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Heaters in treatment plant building and checked weekly in winter	Unlikely	O&M procedures and trained staff reduce likelihood	Moderate	UV treatment reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	
Treatment - Chlorination	Inadequate Chlorination	3.10	pH too high or low for chlorination to be effective	☑	☑	☑		Unlikely		Moderate	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	2	3	Medium	• Illness in community • Continuous turbidity and FAC monitoring in treated water • FAC and E. coli monitoring in distribution system • SCADA controls and alarms	• pH is generally between 6.0 - 7.0 • UV disinfection	Unlikely		Moderate	UV treatment reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	10, 11
Treatment - Chlorination	Over-chlorination	3.11	Chlorine dose rate incorrect			☑		Likely	Assumes inexperienced operators and no O&M procedures	Moderate	Repeated breach of MAV	4	3	High	• Continuous turbidity and FAC monitoring in treated water • FAC and E. coli monitoring in distribution system • SCADA controls and alarms • Odour and taste complaints	• Chlorine dose rate automatically adjusts (flow paced and FAC) • Check valve on dosing line to prevent hypochlorite siphoning • Operator visits the plant at least weekly to check operation of chlorination system • Operator checks FAC in distribution system daily • Chlorine dosing pump checked weekly and serviced as required • Operations and maintenance manual • Standard operating procedures • Trained and experienced operations staff	Unlikely		Moderate	PMs don't reduce consequence	2	3	Medium	Reliable	6	Acceptable	No	

Twizel Water Supply - Risk Assessment Table

	Hazardous Event			Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)							RESIDUAL Risk (with existing preventive measures)								LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY				
Supply Element	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Aesthetics	Disruption to Supply	Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Likelihood	Consequence of the HAZARD	Assessment Rationale - Consequence	MAX L	MAX C	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Modified Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Modified Likelihood	Modified Consequence of the HAZARD	Assessment Rationale - Modified Consequence	MOD L	MOD C	Residual Risk	Level of Uncertainty	Residual Risk Score	Risk Acceptability	Additional Preventive Measure Required?	Improvement Plan Reference
Treatment - Chlorination	Production of disinfection by-products	3.12	Organic material in raw water results in the production of disinfection by-products			☑		Likely		Moderate	Repeated breach of MAV	4	3	High	• High organic loading in source water	• Groundwater source has low level of particulate matter • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination)	Unlikely	DBPs have been tested for and none found	Moderate	PMs don't reduce consequence	2	3	Medium	Reliable	6	Acceptable	No	6
Treatment	Fire within treatment plant building	3.13	• Faulty switchboard or other malfunction • Vandalism or sabotage • inappropriate welding				☑	Possible		Major		3	4	High	• Obvious signs of damage to structure • Reported by residents	• Surge protection • Yearly electrical inspection • Site securely fenced with locked gate • tankered water	Rare		Major		1	4	Medium	Reliable	4	Acceptable	No	7
Treatment	Malfunction of controls systems	3.14	• rodents affecting WTP equipment				☑	Possible		Moderate		3	3	Medium	• SCADA controls and alarms	• regular checks of treatment plant • bait stations • seal building as best as possible	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Post-Treatment - Storage	Microbiological Contamination	4.01	• Access by birds or vermin • Leakage through reservoir roof or other parts of structure	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• Visual evidence of leakage • Condition assessment • FAC and E. coli monitoring in distribution system • Monthly inspection of reservoir by Contractor	• Reservoir is covered and all entry hatches are secured and locked against unauthorised access • Regular visual inspection of the outside of reservoir is carried out • Chlorine residual	Unlikely	Gaps in the corrugated roof have been checked to ensure vermin cannot access the reservoir	Major	Chlorine residual reduces consequence of bacterial or viral contamination but not protozoal contamination	2	4	Medium	Reliable	8	Acceptable	No	5, 8
Post-Treatment - Storage	Microbiological or chemical contamination	4.02	Vandalism to reservoir	☑	☑	☑		Possible		Moderate	Potential repeated exceedance of MAV	3	3	Medium	• FAC and E. coli monitoring in distribution system • Reports from the neighbour or the public	• Reservoir is covered by the treatment plant and all entry hatches are secured and locked against unauthorised access • Site is securely fenced with locked gate • Chlorine residual	Rare	Reservoir security reduce likelihood	Major	Chlorine residual reduces consequence of bacterial or viral contamination but not protozoal contamination	1	4	Medium	Reliable	4	Acceptable	No	
Post-Treatment - Storage	Microbiological Contamination	4.03	Sediment accumulation and release from reservoir			☑		Possible		Moderate	Potential widespread aesthetic issues	3	3	Medium	• Visible suspended matter in water exiting reservoir • FAC and E. coli monitoring in distribution system • Customer complaints	• Source has very low sediment load and low turbidity • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • minimum operating level 70%	Unlikely	Low turbidity in source water reduces likelihood	Moderate	PMs don't reduce consequence	2	3	Medium	Reliable	6	Acceptable	No	5, 8
Post-Treatment - Storage	Loss of Supply	4.04	Failure of reservoir e.g. due to earthquake				☑	Unlikely		Catastrophic	Major impact on most of the population, complete failure of systems, requirement for high level of monitoring and incident management	2	5	High	• Customer complaints • Obvious signs of leakage or failure at reservoir site • Monthly visual inspections • Reservoir level indicator • SCADA controls and alarms	• Reservoir is constructed of concrete (1970) with 1ft thick walls • Water restrictions • Use of tankered water	Rare	Reservoir condition reduces likelihood	Major		1	4	Medium	Reliable	4	Acceptable	No	8
Post Treatment Storage	Loss of Supply	4.05	Insufficient storage for peak demand				☑	Likely		Major	Significant compromise of systems and abnormal operation	4	4	High	• Customer complaints • Reservoir level indicator • SCADA controls and alarms • Resource consent peak draw exceeded in summer	• About 2 days of raw water storage available • Water restrictions • Use of tankered water	Possible	No issues meeting peak demand	Moderate		3	3	Medium	Reliable	9	Acceptable	No	
Post Treatment Service Pumps	Loss of Supply	4.06	Pump failure due to power outage. Mechanical or electrical failure of service pumps				☑	Possible		Moderate		3	3	Medium	• Flow meter • SCADA controls and alarms • Customer complaints	• Generator automatically starts when mains power fails • Nine pumps provide redundancy • Regular maintenance regime in place • Replacement pumps can be readily sourced • Use of tankered water	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Post Treatment - Service Pumps	Loss of Supply	4.07	Demand exceeds pumping capacity				☑	Possible		Moderate		3	3	Medium	• Flow meter • Low pressure in reticulation • SCADA controls and alarms • Customer complaints	• Nine pumps installed to provide sufficient capacity and redundancy • Water restrictions • Use of tankered water	Unlikely		Minor		2	2	Low	Reliable	4	Acceptable	No	
Post Treatment - Service Pumps	Loss of Supply	4.08	Water hammer damages pumps or piping				☑	Likely		Moderate		4	3	High	• Damage to pumps or pipes / damage observed • SCADA controls and alarms • Customer complaints	• Pressure valve installed at the treatment plant • Two jockey pumps and seven booster pumps all have slow starts and VSDs • Pipe failures are repaired as a priority by maintenance contractor • Maintenance contract KPIs • Pipe renewals programme • Use of tankered water	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Reticulation	Loss of Supply	5.01	Failure of critical supply main from reservoir to town break, structural failure, contractor damage				☑	Possible		Catastrophic	Major impact on most of the population, complete failure of systems, requirement for high level of monitoring and incident management	3	5	High	• Customer complaints • Change of flow or pressure in reticulation • Pipeline condition assessment • Reservoir level indicator • SCADA controls and alarms	• Pipe failures are repaired as a priority by maintenance contractor • Maintenance contract KPIs • Pipe renewals programme • Pipe location, material and age on Canterbury Maps • Water restrictions • Use of tankered water	Rare	Pipe sample recovered in 2014, assessed as Grade 1 - Very Good condition. Unlikely to be at risk of failure until 2080	Catastrophic		1	5	Medium	Reliable	5	Acceptable	No	
Reticulation	Loss of Supply	5.02	• Excessive demand in the network • Inadequate distribution system capacity • Failure of booster pump stations				☑	Possible		Moderate		3	3	Medium	• Customer complaints • Reservoir level indicator • SCADA controls and alarms	• Pipe renewals programme • Water restrictions • Use of tankered water • duty / standby pumps at booster stations	Rare	No issues meeting peak demand	Moderate		1	3	Low	Reliable	3	Acceptable	No	
Reticulation	Microbiological Contamination	5.03	• Inadequate controls on maintenance and construction work • Contractors other than the nominated maintenance contractors carry out work on the water supply network	☑	☑			Possible		Moderate		3	3	Medium	• Complaints from consumers about taste or odour • FAC and E. coli monitoring in distribution system • Contractor or staff notification	• Maintenance and replacement work is undertaken by trained qualified and experienced contractors • Only Council approved contractors can work on the water supply network. Other contractors require Council approval on basis they are qualified • Chlorine residual	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	

Twizel Water Supply - Risk Assessment Table

	Hazardous Event			Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)							RESIDUAL Risk (with existing preventive measures)								LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY				
Supply Element	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Aesthetics	Disruption to Supply	Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Likelihood	Consequence of the HAZARD	Assessment Rationale - Consequence	MAX L	MAX C	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Modified Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Modified Likelihood	Modified Consequence of the HAZARD	Assessment Rationale - Modified Consequence	MOD L	MOD C	Residual Risk	Level of Uncertainty	Residual Risk Score	Risk Acceptability	Additional Preventive Measure Required?	Improvement Plan Reference
Reticulation	Microbiological Contamination	5.04	Contaminants permeate from pipeline installed in contaminated land			☑		Unlikely		Moderate	Repeated breach of maximum acceptable value	2	3	Medium	• Customer complaints • Water quality monitoring	• HAIL (hazardous activities and industries list) sites checked when building new subdivisions • Resource consents for contaminant plumes - monitoring wells	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Reticulation	Microbiological Contamination	5.05	Standard hygiene practices not adhered to or inadequate flushing and disinfection practices during repairs or commissioning of new mains and new connections	☑		☑		Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• FAC monitoring • Contractor reports breach of disinfection procedure	• Chlorine residual • Only Council approved contractors can work on the water supply network. Other contractors require Council approval on basis they are qualified • Maintenance contractor follows 'chain of cleanliness' • Water main disinfection and water quality testing after mains repairs • Maintenance contractor follows contractor plans and uses disinfection when carrying out repairs	Possible		Moderate	Chlorine residual reduces consequence	3	3	Medium	Reliable	9	Acceptable	No	
Reticulation	Microbiological Contamination	5.06	Breaks / leaks due to pipe condition or significant flow and pressure fluctuations, or accidental damage to watermains	☑	☑			Possible		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	3	4	High	• Visual inspection • Water quality monitoring • Customer complaints • Reports from contractors • Reports of illness	• Only Council approved contractors can work on the water supply network. Other contractors require Council approval on basis they are qualified • Pipe location on Canterbury Maps • Maintenance contractor follows 'chain of cleanliness' • Pipe failures are repaired as priority • Asset knowledge is held on pipe ages, material and condition • Failures, maintenance and renewals are recorded in Council asset management system • Pipeline renewals programme • Raw and treated water storage • Chlorine residual • Use of tankered water	Unlikely	Contractor processes and audits Mostly new PE and PVC network	Moderate	Chlorine residual reduces consequence	2	3	Medium	Reliable	6	Acceptable	No	
Reticulation	Microbiological Contamination	5.07	Cross contamination from WW and WS sampling	☑	☑			Likely	Assumes no sampling controls	Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	4	4	High	• Contaminants identified in the reticulation system. • Taste or odour complaints from consumers.	• Chlorine residual • Water supply samples are taken on separate rounds to wastewater samples • Trained and experienced water sampling staff • Backup trained water sampling staff • Standard operating procedures	Unlikely		Minor	Chlorine residual reduces consequence	2	2	Low	Estimate	4	Acceptable	No	
Reticulation	Chemical/Microbiological Contamination	5.08	Backflow from consumer connections.	☑	☑			Likely		Major	Potential acute harm to people, declared outbreak or widespread illness and possible deaths expected	4	4	High	• Contaminants identified in the reticulation system. • Taste or odour complaints from consumers.	• Chlorine residual • Building consent process requires a backflow prevention device if there is a backflow hazard • Non-testable double check valves in manifolds for most connections	Unlikely		Major	Chlorine residual reduces consequence of microbial contamination but not chemical contamination	2	4	Medium	Estimate	8	Unacceptable	Yes	2
Reticulation	Loss of water	5.09	Unidentified leakage or illegal connections				☑	Likely		Moderate		4	3	High	• Consumption exceeds calculated expectation	• Known breaks and leaks repaired as a priority. • Repair leaks as priority • Disconnect or legitimise illegal connections • Estimated 20% leakage, minimum overnight flow ~10 l/s	Possible	Leakage ~20%	Minor		3	2	Medium	Reliable	6	Acceptable	No	9
Reticulation	Supply of Turbid Water	5.10	Silt build up within reticulation pipes.			☑		Possible		Minor		3	2	Medium	• Reduced flows in reticulation. • Complaints from consumer about quality of water	• Low turbidity source water • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Flushing undertaken in response to complaints • Very few dead ends in network	Rare	No complaints	Minor		1	2	Low	Estimate	2	Acceptable	No	
Reticulation	Inadequate Supply of Water	5.11	Poor quality workmanship or inappropriate materials used for reticulation pipes and fittings			☑		Possible		Moderate	Significant disruption to normal operation	3	3	Medium	• Contaminants identified in the reticulation system. • Taste and odour complaints from consumers • Reduced FAC in water	• Council requires all work and materials used in reticulation to meet standard specifications • Best practice reticulation approach taken to reticulation work	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Reticulation	Loss of water	5.12	Corrosive or scale forming water causes damage to pipes, fittings and consumers hot water cylinders				☑	Possible		Moderate	Significant disruption to normal operation	3	3	Medium	• Rate of pipe failures is higher than expected • Complaints about hot water cylinder failures • Water pH, alkalinity and hardness Langelier saturation index of water	• pH and alkalinity of source water is analysed annually • Monitoring shows that pH is generally stable	Possible	Source water alkalinity and pH consistently monitored below the guideline value	Moderate		3	3	Medium	Reliable	9	Acceptable	No	10, 11
Systems and Processes	Sampling failure	6.01	Inadequate sampling programme or sample collection error.	☑	☑			Likely		Moderate		4	3	High	• DWSNZ compliance failure due to days of week, days between samples, insufficient samples, information gaps, positive results or sampling error	• Sampling programme prepared and checked against standards	Possible		Moderate		3	3	Medium	Reliable	9	Acceptable	No	
Systems and Processes	Incorrect or inadequate water quality data used for water supply management	6.02	Not enough sampling points	☑	☑			Likely		Insignificant		4	1	Medium	• Drinking water compliance audits identify missing or incorrect sample results	• Sufficient sampling points at the WTP and at booster stations in the reticulation network	Possible		Minor		3	2	Medium	Reliable	6	Acceptable	No	
Systems and Processes	Unidentified Operational Failure	6.03	Insufficient monitoring and alarming of key operational data	☑	☑	☑	☑	Possible		Moderate		3	3	Medium	• SCADA controls and alarms	• Continuous monitoring of turbidity and FAC • Continuous monitoring and SCADA	Unlikely		Major		2	4	Medium	Reliable	8	Acceptable	No	
Systems and Processes	Failure of supply	6.04	Insufficient, inadequate, out of date or incorrect manual of operational procedures.					Almost Certain		Moderate		5	3	High	• Operational Manuals not up to date / require review	• O&M manual updated in 2019 • Standard operating procedures	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	12

Twizel Water Supply - Risk Assessment Table

	Hazardous Event			Hazards (associated with the hazardous event)				MAXIMUM Risk (with no preventive measures in place and all barriers failing)							RESIDUAL Risk (with existing preventive measures)								LEVEL OF UNCERTAINTY AND RISK ACCEPTABILITY				
Supply Element	Event Description	Cause No.	Possible Causes	Bacteria / Viruses	Protozoa	Chemicals / Aesthetics	Disruption to Supply	Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Likelihood	Consequence of the HAZARD	Assessment Rationale - Consequence	MAX L	MAX C	Maximum (unmitigated) Risk	Existing Measures to Identify the Hazard	Existing Preventive measures	Modified Likelihood of HAZARDOUS EVENT occurring	Assessment Rationale - Modified Likelihood	Modified Consequence of the HAZARD	Assessment Rationale - Modified Consequence	MOD L	MOD C	Residual Risk	Level of Uncertainty	Residual Risk Score	Risk Acceptability	Additional Preventive Measure Required?	Improvement Plan Reference
Systems and Processes	Failure due to Inadequate Maintenance	6.05	Supply equipment fails due to inadequate asset information and inadequate maintenance planning	☑	☑	☑	☑	Almost Certain		Moderate		5	3	High	• Unexpected plant equipment failure. • Not having an asset register and maintenance programme	• Council and contractor have a good understanding of water supply assets allowing maintenance to be planned and undertaken • Failures are attended as a priority (maintenance contract KPIs) • Asset knowledge is held on pipe ages, material and condition • Water supply renewals programme in Long Term Plan	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Systems and Processes	Operator Error or Mismanagement	6.06	• Insufficient qualified and experienced operators to operate and manage the water treatment plant to meet DWNZS compliance requirements • Inadequate training, professional development and up-skilling of	☑	☑	☑	☑	Almost Certain		Major		5	4	Extreme	• Poor operation of plant. • Plant compliance failure. • Loss of supply. • Audits • DWSNZ compliance • Operational issues	• Operator has Level 4 Water Treatment qualification and one other is in training for Level 4 Water Treatment • Provide in-house training where abilities are in deficit • Operations and maintenance manual • Standard operating procedures • Maintenance contract has requirement for qualified staff	Possible		Moderate		3	3	Medium	Reliable	9	Acceptable	No	
Systems and Processes	Water treatment technician error or mismanagement	6.07	Loss of staff, inability to attract and retain staff				☑	Possible		Major		3	4	High	• Resignations / staff turnover • Poor operation of plant • Plant compliance failure • Loss of supply	• Automated treatment processes • Standard operating procedures • Succession planning • On-going training and up-skilling is provided for Water Treatment Technicians	Unlikely		Major		2	4	Medium	Reliable	8	Acceptable	No	
Systems and Processes	Failure to Provide Safe Water	6.08	Inadequate data collection, reporting and control systems	☑	☑			Likely		Moderate		4	3	High	• Information about how the supply is operating is not available • Continuous monitoring + manual sampling	• FAC and turbidity results • Recording of manual sampling results • Sample schedule is prepared in accordance with DWSNZ	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Systems and Processes	Failing to meet the requirements of the DWSNZ	6.09	Treatment processes are not sufficient to comply with the requirements of the DWSNZ	☑	☑			Almost Certain		Major		5	4	Extreme	• Treatment processes comply with DWSNZ requirements	• Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Continuous monitoring • Protected drinking water zone in District Plan • Low turbidity source water	Rare		Moderate		1	3	Low	Reliable	3	Acceptable	No	
Systems and Processes	Civil emergency	6.10	Catastrophic natural disaster or failure including earthquake, flooding etc.	☑	☑	☑	☑	Unlikely		Catastrophic		2	5	High	• Major natural disaster occurs • Intense sustained weather • Land slide, flooding, volcanic eruption • Total plant failure is evident • Warnings from Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police	• Prior warning from Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police • Robust secure plant structures and buildings • Implement all measures necessary to ensure plant continues to operate in a natural disaster • Multi stage treatment system (cartridge filtration, UV disinfection and chlorination) • Chlorine residual • Treated water storage • Use of tankered water	Rare		Major		1	4	Medium	Reliable	4	Acceptable	No	13
Systems and Processes	Operator, contractor and other management issues	6.11	Inadequate QA / management systems	☑	☑			Possible		Minor		3	2	Medium	• Third party audits	• Contract audits and QA • Laboratory is IANZ accredited and MoH approved	Unlikely		Minor		2	2	Low	Reliable	4	Acceptable	No	
Systems and Processes	Operator, contractor and other management issues	6.12	Inadequate supply planning and management	☑	☑			Possible		Major		3	4	High	• Third party audits • DWSNZ compliance • Operational issues • Budgets exceeded due to unplanned reactive work	• Asset management plan • Infrastructure strategy • Long Term Plan • Suitably qualified and experienced staff at Council	Unlikely		Moderate		2	3	Medium	Reliable	6	Acceptable	No	
Systems and Processes	Operator, contractor and other management issues	6.13	Not updating/reviewing risks in the water safety plan following incidents or major changes to the water supply	☑	☑		☑	Likely		Minor		4	2	Medium	• Water safety plan audits	• Incident response procedure includes reviewing and updating water safety plan • Continual tracking of progress against improvement actions in water safety plan	Possible		Moderate		3	3	Medium	Reliable	9	Acceptable	No	
Systems and Processes	Disruption to operation of water treatment processes or SCADA	6.14	Cyber security attack				☑	Rare		Moderate		1	3	Low	• IT security reviews • Disruption to supply management systems	• Running two systems, SCADA and Industrial Control (one system would flag issues with the other) • Can manually operate plant if required • SCADA is read-only so if unauthorised access occurs the impact would be minimal	Rare		Minor		1	2	Low	Reliable	2	Acceptable	No	

Appendix B
National Policy Statement for Freshwater Management 2020 (NPSFM) and Canterbury Land and Water Regional Plan Requirements

National Requirements

The National Policy Statement for Freshwater Management 2020 (NPSFM) contains an objective and policies relating to safeguarding New Zealand's freshwater values. These impose directions primarily on Regional Councils who then need to ensure that regional plans to give effect to those directions.

The following objective of the NPSFM is relevant to protecting drinking water supplies.

1. *The objective of this National Policy Statement is to ensure that natural and physical resources are managed in a way that prioritises:*
    a. *first, the health and well-being of water bodies and freshwater ecosystems*
    b. *second, the health needs of people (such as drinking water)*
    c. *third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.*

The following policies give effect to the above objective and are considered relevant to protecting the Twizel drinking water supply:

Policy 1	*Freshwater is managed in a way that gives effect to Te Mana o te Wai.*
Policy 3	*Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.*
Policy 5	*Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.*
Policy 7	*The loss of river extent and values is avoided to the extent practicable.*
Policy 11	*Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.*
Policy 12	*The national target (as set out in Appendix 3) for water quality improvement is achieved.*
Policy 13	*The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends.*
Policy 14	*Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.*

The following specific requirements of the NSPFM are relevant to the management of freshwater and must also be implemented by Regional Councils.

3.24 Rivers[11]

1. *Every regional council must include the following policy (or words to the same effect) in its regional plan(s):*
    "The loss of river extent and values is avoided, unless the council is satisfied:
        (a) that there is a functional need for the activity in that location; and
        (b) the effects of the activity are managed by applying the effects management hierarchy."
2. *Subclause (3) applies to an application for a consent for an activity:*
    a. that falls within the exception to the policy described in subclause (1); and

[11] A river is defined in the Resource Management Act 1991 as a continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal).

b. *would result (directly or indirectly) in the loss of extent or values of a river.*

3. *Every regional council must make or change its regional plan(s) to ensure that an application referred to in subclause (2) is not granted unless:*
   a. *the council is satisfied that the applicant has demonstrated how each step in the effects management hierarchy will be applied to any loss of extent or values of the river (including cumulative effects and loss of potential value), particularly (without limitation) in relation to the values of: ecosystem health, indigenous biodiversity, hydrological functioning, Māori freshwater values, and amenity; and*
   b. *any consent granted is subject to conditions that apply the effects management hierarchy.*
4. *Every regional council must:*
   a. *develop and undertake a monitoring plan that:*
      i. *monitors the condition of its rivers; and*
      ii. *contains sufficient information to enable the council to assess whether its policies, rules, and methods are ensuring no loss of extent or values of the rivers; and*
   b. *have methods to respond if loss of extent or values is detected.*

Canterbury Land and Water Regional Plan

The Canterbury Land and Water Regional Plan (CLWRP) contains a number of objectives and policies that are relevant to protecting the values of the Twizel drinking water supply.

Objective 3.2	Water management applies the ethic of ki uta ki tai – from the mountains to the sea – and land and water are managed as integrated natural resources recognising the connectivity between surface water and groundwater, and between fresh water, land and the coast.
Objective 3.6	Water is recognised as essential to all life and is respected for its intrinsic values.
Objective 3.7	Fresh water is managed prudently as a shared resource with many in-stream and out-of-stream values.
Objective 3.8	The quality and quantity of water in fresh water bodies and their catchments is managed to safeguard the life-supporting capacity of ecosystems and ecosystem processes, including ensuring sufficient flow and quality of water to support the habitat and feeding, breeding, migratory and other behavioural requirements of indigenous species, nesting birds and, where appropriate, trout and salmon.
Objective 3.12	When setting and managing within limits, regard is had to community outcomes for water quality and quantity.
Objective 3.13	Groundwater resources remain a sustainable source of high quality water which is available for abstraction while supporting base flows or levels in surface water bodies, springs and wetlands and avoiding salt-water intrusion.
Objective 3.16	Freshwater bodies and their catchments are maintained in a healthy state, including through hydrological and geomorphic processes such as flushing and opening hāpua and river mouths, flushing algal and weed growth, and transporting sediment.
Objective 3.23	Soils are healthy and productive, and human-induced erosion and contamination are minimised.
Objectives 3.24	All activities operate at good environmental practice or better to optimise efficient resource use and protect the region's fresh water resources from quality and quantity degradation.

Policy 4.1

Lakes, rivers, wetlands and aquifers will meet the fresh water outcomes set in Sections 6 to 15 within the specified timeframes. If outcomes have not been established for a catchment, then each type of lake, river or aquifer should meet the outcomes set out in Table 1 by 2030.

Policy 4.2

The management of lakes, rivers, wetlands and aquifers will take account of the fresh water outcomes, water quantity limits and the individual and cumulative effects of land uses, discharges and abstractions will meet the water quality limits set in Sections 6 to 15 or Schedule 8 and the individual and cumulative effects of abstractions will meet the water quantity limits in Sections 6 to 15.

Policy 4.4

Groundwater is managed so that:

(a) groundwater abstractions do not cause a continuing long-term decline in mean annual groundwater levels or artesian pressures;

(b) the individual and cumulative rate, duration and volume of water pumped from bores is controlled so as to prevent seawater contamination;

(c) the rate and duration of individual abstractions is controlled to ensure that individually or cumulatively, localised pressure reversal does not result in the downward movement of contaminants;

(d) in any location where an overall upwards pressure gradient exists, restrict the taking of groundwater so that at all times the overall upward pressure difference is maintained between any one aquifer and the next overlying aquifer;

(e) overall water quality in aquifers does not decline; and

(f) the exercise of customary uses and values is supported.

Policy 4.5

Water is managed through the setting of limits to safeguard the life-supporting capacity of ecosystems, support customary uses, and provide for community drinking-water supplies and stock water, as a first priority and to meet the needs of people and communities for water for irrigation, hydro-electricity generation and other economic activities and to maintain river flows and lake levels needed for recreational activities, as a second priority.

Policy 4.7

Resource consents for new or existing activities will not be granted if the granting would cause a water quality or quantity limit set in Sections 6 to 15 to be breached or further over allocation (water quality and/or water quantity) to occur or in the absence of any water quality standards in Sections 6 to 15, the limits set in Schedule 8 to be breached. Replacement consents, or new consents for existing activities may be granted to:

(a) allow the continuation of existing activities at the same or lesser rate or scale, provided the consent contains conditions that contribute to the phasing out of the over allocation (water quality and/or water quantity) within a specified timeframe; or

(b) exceed the allocation limit (water quality and/or water quantity) to a minor extent and in the short-term if that exceedance is part of a proposal to phase out the overallocation within a specified timeframe included in Sections 6 to 15 of this Plan.

Policies 4.12-22, 24-69 & 75-98	Seeks to protect the environment by managing how the following activities are undertaken: - Discharge of contaminants to land or water - Stormwater and community wastewater systems - Earthworks, land excavation and deposition of material into land over aquifers - Soil stability - Hazardous substances and hazardous activities - Livestock exclusion from waterways - Discharges of collected animal effluent - Nutrient management - Damming and diversion of water bodies - Abstraction and efficient use of water - Flow sensitive catchments - Site dewatering - Hydrocarbon exploration or production, including 'fracking' - Fine sediment removal and habitat restoration - Gravel extraction
Policy 4.23	Any water source used for drinking-water supply is protected from any discharge of contaminants that may have any actual or potential adverse effect on the quality of the drinking-water supply including its taste, clarity and smell and community drinking water supplies are protected so that they align with the CWMS drinking-water targets and meet the drinking-water standards for New Zealand.
Policy 4.23A	The quality of water abstracted from community drinking-water supply sources is protected through: (a) the application of a provisional protection zone around the source of any existing community drinking-water supply, unless a specific protection zone is included as a condition in the permit to take or use water; and (b) requiring applications for new or replacement permits to take or use water for community drinking-water supply to include an assessment of the specific protection zone required, taking into account the factors set out in Schedule 1; and (c) providing, by way of resource consent, for the replacement of provisional protection zones with specific protection zones which reflect the level of protection required for that supply.

Policy 4.23B	In considering resource consent applications to take or use water for a community drinking water supply, the consent authority shall have regard to: (a) the factors set out in Schedule 1; and (b) the extent to which the application reflects those factors set out in Schedule 1 when establishing the extent of the proposed protection zone; and (c) the level of additional restriction the proposed protection zone will impose on land users within the proposed protection zone.
Policy 15B.4.2	Protect wāhi tapu and wāhi taonga values in the Waitaki by avoiding or mitigating the adverse effects of land use intensification on wāhi tapu or wāhi taonga.
Policy 15B.4.7	Water quality is maintained by: (a) restricting any discharge of sewage sludge, bio-solids or treated sewage effluent from a community wastewater treatment system to the relevant nitrogen load limit in Table 15B(h), unless the exceedance is less than the nitrogen load contribution from the aggregation of on-site domestic wastewater treatment systems that would be replaced by the community wastewater system; and (b) adoption of the best practicable option to treat and manage the discharge.
Policies 15B.4.11-13 & 16-17	Seeks to manage nutrient discharges from farming activities.

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