

Remarkables Ski Area Expansion Project

Potable Water Supply Infrastructure Concept Report

Prepared for:
NZSki Limited

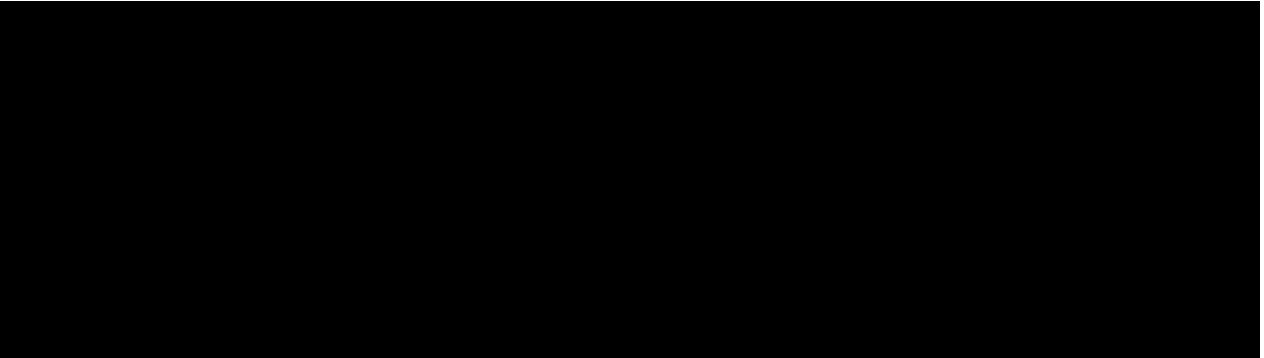
Date: 23 April 2026

Prepared by:
Stantec New Zealand

Project/File:
310104671



Revision Schedule



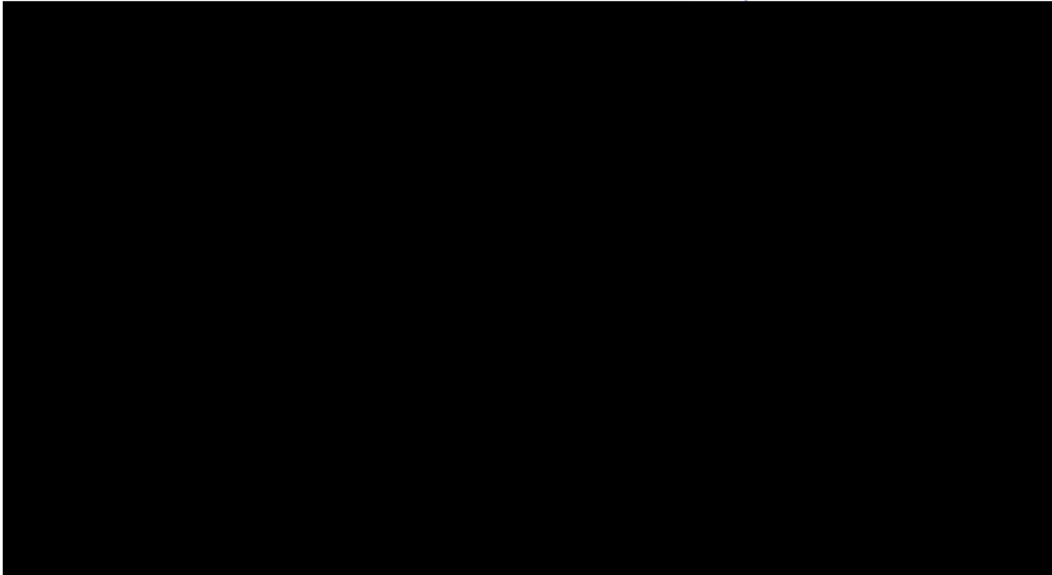
Disclaimer

The conclusions in the Report titled Upper Doolans Creek Right Branch Potable Water Supply Infrastructure Concept Report Assessment are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorised use or reliance is at the recipient's own risk.

Stantec has assumed all information received from NZSki Limited (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein. This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided by the Client to applicable authorities having jurisdiction and to other third parties in connection with the project, Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any third party, and will not be liable to such third party for any damages or losses of any kind that may result.

Stantec acknowledges that this Report is intended to be provided to, and may be relied upon by, a Panel appointed under the Fast Track Approvals Act 2024 solely for the purpose of determining the relevant application under that Act. Other than the reliance expressly permitted above, this Report may not be relied upon by any other person or for any other purpose. Stantec does not accept or assume any duty, responsibility, or liability to any person other than the Client or the Panel for that limited statutory purpose. Any use of or reliance on this Report by any other person or for any other purpose is at that person's own risk.





Code of Conduct

The author of the drinking water aspects of this report is Andrew Wong. I am a Chartered Professional Engineer (CPEng) in drinking water treatment based in Stantec's Dunedin office, with technical experience in drinking water treatment design, and construction. I have been responsible for process design, optioneering, operation, troubleshooting, optimisation, construction monitoring, contract management, and peer reviews of drinking water treatment facilities and systems. I hold a BSc in Chemical Engineering (Queen's University, Kingston, Canada) and a MASc in Civil and Environmental Engineering (University of Waterloo, Canada).

The authors of the Firefighting Water Supply (FFWS) aspects of this report are Brady Cosgrove & Artem Chensky. Brady is a Chartered Professional Engineer (CPEng) & International Professional Engineer (IntPE) in fire safety engineering and a Fellow of Engineering New Zealand (FEng) based in Stantec's Christchurch office. Brady has over 30 years of experience within the New Zealand ski environment, including design involvement with the Rastus Burn Day Lodge. Artem is a Member of Engineering New Zealand (MEng) and is based in Stantec's Queenstown office. Artem has over 4 years of experience within the New Zealand Construction Industry as a fire engineer and holds a BE(Hons) in Civil Engineering (University of Canterbury, Christchurch).

We confirm that we have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. This report has been prepared in compliance with that Code, as if it was expert evidence presented in proceedings before the Environment Court. Unless we state otherwise, the drinking water aspects & firefighting water supply of this report are within our areas of expertise, and we have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this report.



Table of Contents

Executive Summary	v
Acronyms / Abbreviations.....	8
1 Introduction	8
1.1 Current site assets.....	8
1.2 Issues to be Addressed.....	10
1.3 Assumptions	11
1.3.1 General notes	11
1.3.2 Source water quality assumptions:	11
1.3.3 Source water volume assumptions.....	12
1.3.4 Treatment and demand assumptions	12
2 Background	15
2.1 Population Staging	15
2.2 Water Quality and Quantity	15
2.3 Supply Categorisation	17
2.4 Source (S3) and Treatment (T3) Requirements	17
2.4.1 Current Requirement to Chlorinate.....	17
2.5 Existing Rastus Burn Water Supply System.....	19
3 Firefighting Water Supply (FFWS).....	22
3.1 Rastus Burn Base Building.....	22
3.2 Gondola Mid and Return Stations	22
3.3 Doolans Gondola Carrier Stacking/Café Building	23
4 Rastus Burn Base Buildings Potable Water System.....	25
4.1 Potable Water Demand at the Rastus Burn Base Facilities.....	25
4.2 Pipeline Rastus Burn to Tank Farm to Base Facilities.....	26
4.2.1 Raw Water Pipeline Design Parameters	26
4.3 Rastus Burn Potable Water Treatment	27
4.3.1 Rastus Burn Raw Water Filtration.....	28
4.3.2 Rastus Burn UV Disinfection	30
4.3.3 Rastus Burn Chlorine Dosing.....	31
4.3.4 Rastus Burn Treated Water Storage	31
4.3.5 Network Distribution Booster Pumping.....	32
4.3.6 Summary of Upgrade and Recommended Options.....	32
5 Doolans Creek Right Branch Gondola Carrier Stacking Building/Café Potable Water Supply	34
5.1 Doolans Potable Water Demand.....	34
5.2 Doolans Raw Water Supply Assets.....	35
5.2.1 Doolans Raw water demand and new assets required	35
5.2.2 Doolans Raw Water Pipeline Intake – Facilities.....	36
5.3 Doolans Creek Right Branch Right Branch Potable Water Treatment.....	37
5.3.1 Filtration	37
5.3.2 UV Disinfection.....	39
5.3.3 Chlorine Dosing	39
5.3.4 Treated Water Storage.....	40
5.3.5 Distribution Booster Pumping.....	41
5.3.6 Recommended Option.....	41
6 Recommendations and Next Steps	43
6.1 Rastus Burn Water Supply high level summary.....	43
6.2 Doolans Water Supply high level summary	43
6.3 Firefighting summary	44

List of Tables

Table 1:	Expected population (NZSki, 2025)
Table 2:	Expected population (NZSki, 2025)
Table 3:	Existing water take permits in the Rastus Burn
Table 4:	Expected Rastus Burn occupancy figures (NZSki, 2025)



Remarkables Ski Area Expansion Project Water Supply Infrastructure

- Table 5: Filtration Option 1 benefits and disadvantages summary
- Table 6: Filtration Option 2 benefits and disadvantages summary
- Table 7: UV Option 1 benefits and disadvantages summary
- Table 8: UV Option 2 benefits and disadvantages summary
- Table 9: Expected population (NZSki, 2025)
- Table 10: Filtration Option 1 benefits and disadvantages summary
- Table 11: Filtration Option 2 benefits and disadvantages summary
- Table 12: UV Option 1 benefits and disadvantages summary
- Table 13: UV Option 2 pros and cons

List of Figures

- Figure 1. Rastus Burn area major facilities layout diagram
- Figure 2 Existing water treatment system with two filters at lower left and dual UV disinfection
- Figure 3. Location of potable water intake in the Rastus Burn and tank farm lids
- Figure 4. Installation of potable water tank farm in 2014 involving five 24,750 litre tanks
- Figure 5. Elements of the existing water treatment plant with filtration and UV disinfection
- Figure 6. Firefighting flow for FW2 from SNZ PAS 4509:2008
- Figure 7. Water Supply Classification FW2 for a sprinklered building
- Figure 8. Requirement for 45m³ sprinkler storage for the Chair Stacking/Cafe building
- Figure 10: High level process diagram of preferred option for Rastus Burn catchment WTP
- Figure 10: Preliminary Rastus Burn WTP general arrangement sketch
- Figure 11. Nominal route for rising main between intake and Doolans facilities
- Figure 11: High level process diagram of preferred option for Doolans Creek Right Branch catchment WTP
- Figure 12: Preliminary Doolans Creek Right Branch WTP general arrangement sketch



Executive Summary

This report covers the water supply elements for the proposed upgrading of the existing base facilities within the Rastus Burn area and expansion of the Remarkables Ski Area into Doolans Creek Right Branch Basin. The sites require treated potable water for drinking, food preparation, and sanitary requirements, and untreated water for fire supply.

Potable Water Treatment

Both the Rastus Burn Base Building and Doolans Basin Carrier Stacking/Café are classified as large supplies as they will serve more than 500 people per day¹. Our recommendations regarding water supply and treatment in association with the Project are summarised as follows.

Rastus Burn Water Supply System

The recommended alterations and upgrades to the existing Rastus Burn water supply is as follows:

- The existing 160mm pipe between the intake and tank farm does not require upgrading,
- The existing tank farm (consisting of five 24,000 litre tanks) does not require upgrading,
- The existing falling main from the tank farm to the existing base building does not require upgrading,
- A new filtration system is recommended (see Section 4.3, Option 2) as the existing system requires too much manual intervention. The new system includes:
 - 100 µm automatic disc filters for removal of larger particles
 - 5 µm automatic disc filters for removal of small particles and compliance
- An additional UV Reactor is recommended (see Section 4.3.2, Option 1), to address required capacity, operator familiarity, and equipment commonality. This will result in:
 - 3 x UV disinfection units in total (one in addition to the existing) units plumbed in parallel with inline flow restrictors,
- Chlorine dosing of the water is required under the current Drinking Water Quality Assurance Rules, for a large 'self-supplied building'. Additionally, the provision of chlorine reduces the risk of bacterial contamination and growth in the network and is effective at inactivating viruses which may be present in the source water. The provision of chlorination with 1% sodium hypochlorite (NaOCl) has been proposed upstream of the treated water storage tank to meet compliance requirements and to provide a multi barrier approach to contamination.
- A new 30,000 litres treated water storage tank is recommended to buffer high demand flows and to allow contact time for the chlorine dosing to inactivate viruses,
- New treated water booster pumping into the network from the treated water holding tank to provide pressure to the network. A pressure vessel surge attenuator may be required, and this is to be addressed at the detailed design stage.

¹ Refer to Clause 1.5 Categories of drinking water supply of the 'Drinking Water Quality Assurance Rules' issued by Taumata Arowai.



Remarkables Ski Area Expansion Project Water Supply Infrastructure

Gondola Return Station Doolans

No potable water facilities are proposed at the Gondola Mid Station location at Helicopter Ridge.

Doolans Facilities Water Supply System

The following new water supply system is recommended for the Doolans facilities

- Raw Water Booster at the intake location pumping to the facilities at the Gondola Return Station
- Raw water storage tanks at the base facilities will also provide firefighting storage. This requires 45,000 litres of storage.
- Pumping from the raw water storage tanks to the treatment system,
- Filtration is included to remove particles in the raw water to achieve both UV and chlorination compliance requirements (see Section 5.3.1, Option 2), which includes:
 - 5 µm automatic disc filters with air compressor
- A UV Reactor for disinfection (see Section 5.3.2, Option 1), with inline flow restrictor
- Dosing of chlorine is not specifically required by the Drinking Water Quality Assurance Rules currently as the system proposed will have no 'network', however the rules could change in the future. As with Rastus Burn, chlorination is effective at reducing the risk of visitor or staff illness and is part of the multi barrier approach to contamination. Thus, it is recommended that the chlorination system is installed upstream of treated water storage tank.
- A new 5,000 litre tank for treated water storage within the Gondola Carrier Stacking/Café building,
- Treated water booster pumping to provide pressure to the network. Note, a surge attenuation pressure vessel may be required to achieve this outcome.

Firefighting

Extension to existing Rastus Burn Base Building

The existing Rastus Burn base building is sprinkler protected. Therefore, the firefighting water required from SNZ PAS 4509:2008 is FW2 which is a stored volume of 45,000 litres. The proposed extension to the Base Building will not increase the firefighting demand or the fire sprinkler demand.

The ability to use the firefighting water should be discussed with Fire and Emergency NZ (FENZ) during the design phase so they are comfortable with the available firefighting water (accessible building hydrants), the attendance points and associated systems with regards to their standard operating procedures.

Gondola Mid Station at Helicopter Ridge

No firefighting water provisions are required at the Gondola Mid Station.

Carrier Stacking/Cafe Building

The proposed Carrier Stacking/Café building is intended to be sprinkler protected. Therefore, the firefighting water required from SNZ PAS 4509:2008 is FW2 which is a stored volume of 45,000 litres.

The ability to use the firefighting water should be discussed with Fire and Emergency NZ (FENZ) during the design phase so they are comfortable with the available firefighting water and associated systems with regards to their standard operating procedures. We note that access to the Doolans Creek Right



Remarkables Ski Area Expansion Project Water Supply Infrastructure

Branch basin Carrier Stacking/Café Building is challenging for FENZ, as there is currently no road access for their appliances.

Gondola Return Station Doolans

For the Doolans Gondola Return Station it is expected that either a fire separation is provided between the Station & Carrier Stacking/Café building or the sprinkler system will be extended into adjoining return Gondola station.



Acronyms / Abbreviations

Acronym / Abbreviation	Full Name
DWQAR	Drinking Water Quality Assurance Rules (updated 2024)
DWSNZ	Water Services (Drinking Water Standards for New Zealand) Regulations 2022
FAC	Free Available Chlorine
NaOCI	Sodium Hypochlorite
UVT	Ultraviolet Transmittance
WSA	Water Services Act 2021
WTP	Water Treatment Plant

1 Introduction

The purpose of this report is to provide a concept level design to provide potable water supply and firefighting for the proposed Remarkables Ski Area Expansion Project. This involves the Remarkables Base Building in the Rastus Burn Catchment and expansion of the existing ski field area into the adjacent Doolans Creek Right Branch Basin. The development includes the following elements:

- Construction of a new gondola from the existing base area, over Helicopter Ridge to the upper Doolans Creek Right Branch basin.
- Construction of a new water intake structure and pump station in Doolans Creek Right Branch, with rising mains for potable water, firefighting, and snow making.
- Supply and treatment of potable water to the new Carrier Stacking/Café building in the Doolans Creek Right Branch.
- Supply of fire sprinkler water to the new Carrier Stacking/Café building in the Doolans Creek Right Branch.
- Expansion of the existing Remarkables base building facilities in the Rastus Burn catchment including upgrading of the existing potable water supply system at this location.

This report deals only with the supply and treatment of potable water and the supply of firefighting water and does not cover water required for snow making.

1.1 Current site assets

The Rastus Burn facilities include the following elements.

- Three conveyor lifts in the learners' area
- Four chairlifts arranged in an approximately radial pattern from the base building area
- Rastus Burn base building containing guest services, public toilets, food and beverage, staff offices staff facilities, standby power generators, power transformers, lower snow making pumps, snow making air compressors



Remarkables Ski Area Expansion Project Water Supply Infrastructure

- 11 kV underground power supply in the road for approximately 4km below the base facilities and above ground lines on poles, parallel to the Rastus Burn creek below that
- Wastewater treatment facilities consisting of septic tanks within Car Park 1 immediately below the base building. Infiltration ponds for primary treated wastewater located approximately 1km down the Rastus Burn stream from the base infrastructure
- Medical services and ski patrol building in the upper parking area adjacent to the base building
- Plant maintenance building located below and adjacent to the base building
- Three raw water intake locations.
 - intake in Lake Alta supplying the snow making pump shed at the top of the Alta Chairlift,
 - potable and firefighting water intake from the Rastus Burn adjacent the lower service road crossing over the Rastus Burn,
 - A second snow making intake (supplying the snow making pumps in the base building) in the Rastus Burn adjacent to the top of the learners' slopes.
- Buried raw water tank farm at the top of the learners slope adjacent to the potable water intake which supplies potable water and firefighting reserve to the base building
- Snow making pump shed at the top of the Alta Chairlift

The location of major facilities in the Rastus Burn basin is shown in the figure below.



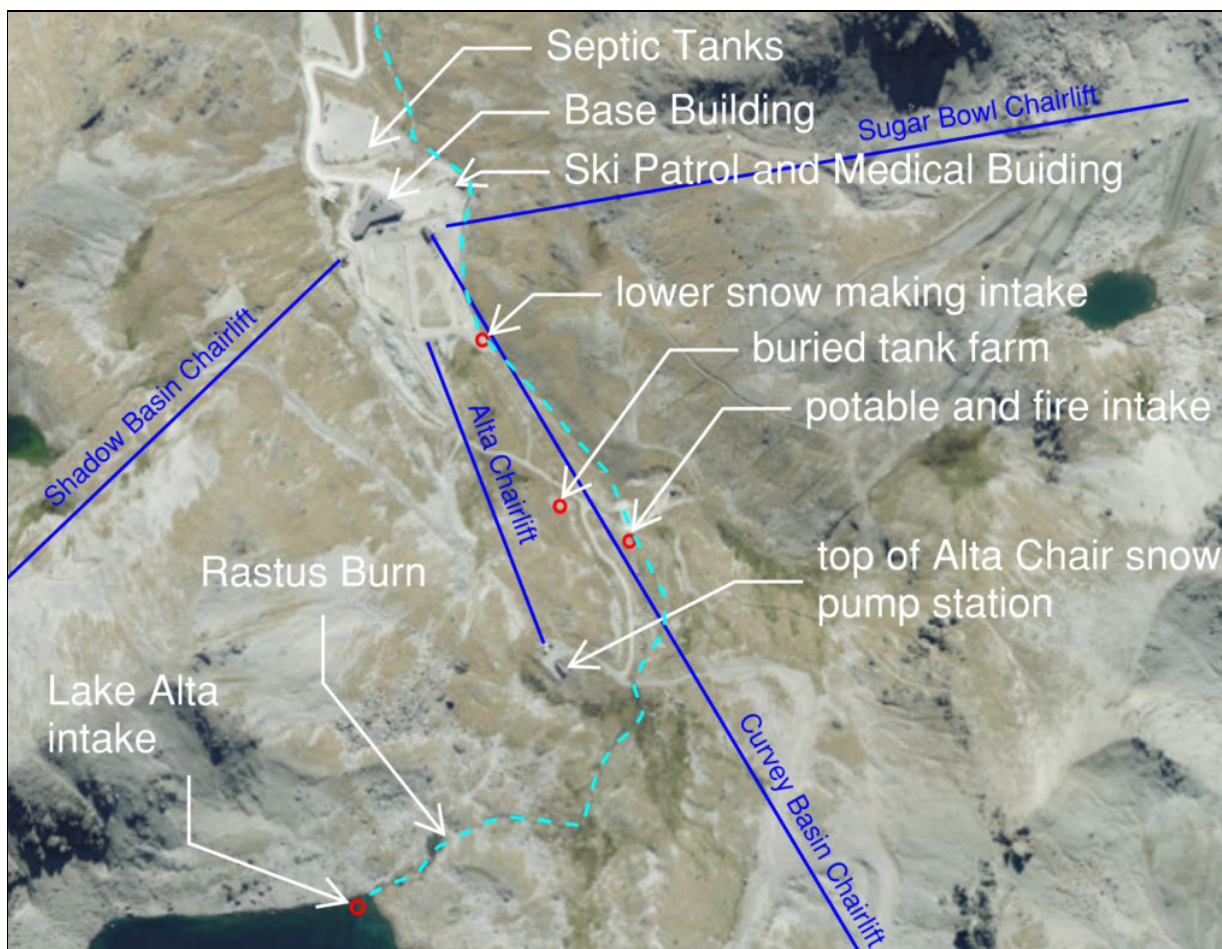


Figure 1. Rastus Burn area major facilities layout diagram

1.2 Issues to be Addressed

Key issues to be addressed in this report and the associated upgrade requirements are summarised below:

- Provide compliant² potable water to meet the required demand at the expanded Rastus Burn Base Building noting that the current potable water system at the Rastus Burn Base Building system is unable to meet the current peak demand.

² 'Compliant' drinking water means it must meet the requirements of the Water Services (Drinking Water Standards for New Zealand) Regulations 2022 (DWSNZ), the Drinking Water Quality Assurance Rules 2022 (DWQAR), and Water Services Act

Remarkables Ski Area Expansion Project Water Supply Infrastructure

- Provide compliant³ potable water to meet the required demand the Doolans Carrier Stacking/Café building,
- Provide appropriate firefighting supply for the Rastus Burn Base Building,
- Provide appropriate firefighting supply for the proposed Doolans Carrier Stacking/Café building,
- Ensure water supply system is sized to meet all peak potable water demand instantaneous flow rates (e.g., increase system size, treated water storage),
- Ensure fire supply system is sized to meet the requirements of the new buildings, including consultation and approval from the necessary authorities,
- Reduce the flow variability through the existing water treatment equipment,
- Provide water supply systems that limit the amount of manual operator input required (i.e., cartridge filter maintenance) and provide a filtration technology that can be automatically backwashed.

1.3 Assumptions

1.3.1 General notes

A list of assumptions made to enable the development of this concept design is summarised below. It is expected that this list of assumptions is reviewed when new information becomes available, or design parameters change. Some assumptions provided herein are based on information provided by NZSki (e.g., water take metering, visitor numbers).

As limited water quality testing has been undertaken of either the existing or the proposed sources, some assumptions have been made about the source waters. It has been assumed that the source water in both The Doolans Creek Right Branch and the Rastus Burn Creek is free from detrimental quantities of organic material, turbidity, arsenic, manganese, heavy metals, nitrates and other similar undesirable constituents. This is believed to be a reasonable assumption given the alpine nature of the source water. If these assumptions are not correct, additional treatment processes may be required, treatment units may need to be upsized, or the proposed processes changed for a different one. This would likely add capital and operational costs to the project, as it could require additional pipework, specialist treatment devices, a larger building, and could create additional waste streams which may impact the wastewater system.

1.3.2 Source water quality assumptions:

- The levels and character of organic matter present in the source water in the Rastus Burn and Doolans Creek Right Branch do not require treatment and will not result in the formation of

2021 (WSA). The DWSNZ states a list of chemical and bacteriological parameters and their allowable limits. The DWQAR, provides rules on the required treatment for different sized supplies and supplies of varying risks. The WSA provides general overarching supplier obligations but also includes the specific requirement to chlorinate networks.

³ 'Compliant' drinking water means it must meet the requirements of the Water Services (Drinking Water Standards for New Zealand) Regulations 2022 (DWSNZ), the Drinking Water Quality Assurance Rules 2022 (DWQAR), and Water Services Act 2021 (WSA). The DWSNZ states a list of chemical and bacteriological parameters and their allowable limits. The DWQAR, provides rules on the required treatment for different sized supplies and supplies of varying risks. The WSA provides general overarching supplier obligations but also includes the specific requirement to chlorinate networks.



Remarkables Ski Area Expansion Project Water Supply Infrastructure

disinfection by-products with the chlorination or negatively impact the performance of UV disinfection.

- The levels and character of colour causing compounds (e.g., organics, iron, manganese) in the source water in the Rastus Burn and Doolans Creek Right Branch do not require treatment and will not result in customer complaints or negatively impact the performance of chlorination or UV disinfection.
- The levels of nitrogen-based compounds (i.e., ammonia, nitrate) do not require treatment. The alpine conditions and lack of upstream land uses (such as farming) suggests that this is likely.
- The levels of other chemical determinants (i.e., arsenic, boron, hardness) do not require treatment. These are not known to be chemicals of concern in other local water supplies.
- Algae and cyanobacteria are not a risk in the source water due to the cold temperatures and constant flowing water of the creeks (the lakes would be a higher risk).
- The UV transmittance (UVT) of the filtered water is a minimum of 95%. This is reliant on the water quality assumptions listed above.

NB: one grab sample result is available for Doolans Creek Right Branch, taken by e3Scientific in May 2025. Iron and manganese were below the limit of detection and turbidity was 0.06 NTU on the day. UVT – a key parameter for UV disinfection was not measured. The source water comes from steep alpine streams which become turbid during storms or during significant snow melt in spring/early summer. When the source water becomes turbid the intake is closed and buffer storage used until the stream has cleared. This is an existing standard operating procedure.

1.3.3 Source water volume assumptions

- There is enough water available in both the Rastus Burn to meet the required water demand and comply with the existing water take consents.
- At least 30 L/s of flow is available for abstraction in Doolans Creek Right Branch during winter. Limited flow monitoring from Doolans Basin is available. Initial remote flow monitoring equipment was installed at two sites in Doolans Creek Right Branch by e3Scientific in 2025, and a spot informal gauging was undertaken by Stantec Staff in November 2025.
- The required water demand can be consented.

1.3.4 Treatment and demand assumptions

- The potable water system at the existing Base Building provides safe drinking water that is or could become 'compliant' with minor changes.
- The potable water treatment plant operating period is between 7 am and 5 pm (10 hours/day).
- The total abstraction rate from Doolans Creek Right Branch is 30 L/s.
- Required potable water demand is 50 litres/person/day.
- The existing potable water supply system relies on gravity flow only. There is no booster pumping upstream of downstream of the WTP.
 - If booster pumping is needed/ and existing system requires upgrading, this will require additional design, as well as capital and operational costs
- The peak instantaneous flow rate to which each respective water supply system will be designed to produce is based on the maximum building occupancy. The volume of potable water required to meet the building occupancy demand will be produced within one hour to



Remarkables Ski Area Expansion Project Water Supply Infrastructure

account for visitor cycling through the buildings (e.g., breakfast, morning tea, lunch, afternoon tea). NZSki have reported the following occupancy figures.

Table 1: *Expected population (NZSki, 2025)*

Location	Current Occupancy	Ultimate Development
Site Wide	3,500 people/day	6,000 people/day
Rastus Burn total occupancy	3,500 people/day	3,500 people/day
Rastus Burn Base Building	1,526 people	3,052 people

- Treated water storage to be provided to buffer short-term instantaneous demand peaks (e.g. the peak flow across both the existing Rastus Burn base building and the Doolans Return Station facilities (i.e., at morning teatime or lunch time) and provide chlorine contact time. However, the selected storage volumes do not provide system resilience during an extended water supply system outage.
- WTP redundancy:
 - Pumps: Duty / Standby at Doolans facilities
 - Filtration: Duty only – minimum 120% of maximum design capacity
 - UV reactors: Duty only
 - Chlorination: Duty only
 - Treated water storage sized for peak flow buffering only
- For both the upgrade of the existing Rastus Burn and new Doolans Creek Right Branch water supply infrastructure, it is anticipated that there will be no benefits to staging the installation works. Given the scale of the proposed system, the remote location, and challenge to install equipment in alpine conditions, the concept designs are based on the ultimate development populations.
- The existing TrojanUV Pro50 units are certified to NSF/ANSI 55 Class A and provide 4-log protozoal treatment.



Remarkables Ski Area Expansion Project Water Supply Infrastructure



Figure 2 Existing water treatment system with two filters at lower left and dual UV disinfection



2 Background

2.1 Population Staging

A summary of the existing and expected population numbers, as identified by NZSki, is summarised in Table 2.

Table 2: *Expected population (NZSki, 2025)*

Location	Current Occupancy	Ultimate Development
Site Wide	3,500 people/day	6,000 people/day
Rastus Burn total occupancy	3,500 people/day	3,500 people/day
Rastus Burn Base Building	1,526 people	3,052 people
Doolans Creek Right Branch Right Branch Basin Ski Area	-	2,500 people/day
Doolans Creek Right Branch Right Branch Basin Cafe Building	-	450 people

2.2 Water Quality and Quantity

The existing water quality in both the Rastus Burn and in Doolans Creek Right Branch is assumed to be suitable, and our specific assumptions are listed in Section 1.3.

One set of lab results is currently available from Doolans Creek Right Branch and aligns with some of the listed assumptions. Previous water quality testing undertaken in the Rastus Burn indicates that it may be suitable for treatment for the existing and proposed treatment process. These are however unsecure surface water takes and may, from time to time, contain contaminants such as animal droppings, protozoa, dead animals, and other pathogens.

One risk with the raw water is turbidity associated with flood flow and spring/summer snow melt. Significant flood flows are not anticipated to coincide with high visitor occupancy. Floods are more likely to occur outside the ski season when precipitation falls as rain; high visitor numbers are unlikely during a significant rainfall. Depending on the amount of turbidity, the proposed filtration system may be sufficient to achieve compliant drinking water or may need to be temporarily halted and the buffer storage used until such time as the raw source water returns to an acceptable level of quality. One winter season of flow monitoring is available for the Doolans Creek Right Branch at a site upstream of the proposed intake location. This indicates that flows greater than 66 L/s were available during winter. Informal gauging undertaken by Stantec Staff indicated that the flow of Doolans Creek Right Branch in November, during a period of fine weather and upstream of the proposed intake site was in excess of 100 L/s.

The Rastus Burn is a significant creek and has permanent flow year-round. There are three existing water take permits for the Rastus Burn and these are sufficient. These consents are summarised in Table 3



Remarkables Ski Area Expansion Project Water Supply Infrastructure

Table 3: Existing water take permits in the Rastus Burn

number	Description	Pertinent Conditions	Expiry date
RM11.368.04 2013	to take and use water as a supplementary allocation from Lake Alta and the Rastus Burn for the purposes of snow making	<ul style="list-style-type: none"> Maximum abstraction rate 51 L/s RM11.368.03 does not exceed 400,000 m³ annually Residual flow in Rastus Burn to exceed 15 L/s No abstraction from Lake Alta when the level is lower than 1799.4m 	23 January 2043
RM11.368.03 2013	to take and use water as a primary allocation from Lake Alta and the Rastus Burn for the purposes of snow making	<ul style="list-style-type: none"> Maximum abstraction rate 74 L/s RM11.368.04 does not exceed 400,000 m³ annually Residual flow in Rastus Burn to exceed 15 L/s No abstraction from Lake Alta when the level is lower than 1799.4m 	23 January 2043
RM16.115.01 2017	To take water from Rastus Burn Stream for the purpose of constant flow water supply to the Remarkables Ski field complex	<p>The abstraction rate shall not exceed.</p> <ul style="list-style-type: none"> 5.2 L/s 450 m³ day A consumptive take of no more than 320.4 m³/day 151,200 m³/year 	16 December 2031

The maximum total visitor occupancy has been identified as 6,000 people per day. The historical visitor water usage was estimated to be 45 litres per person per day (see Section 4.1). This figure includes toilets, food and beverage preparation and other water demands. Thus, a conservative estimate of the maximum daily potable water consumption is: 6,000 guests x 50 L/person/d = 300 m³/d. This figure is less than the 320.4 m³ consumptive daily maximum figure stated in RM16.115.01 2017.



2.3 Supply Categorisation

Categorisation of drinking water supplies in the Drinking Water Quality Assurance Rules 2022 (DWQAR) (Section 1.5) is based on population served, as follows:

- Small (26-100 people),
- Medium (101-500 people), and
- Large (>500 people).

Both the Rastus Burn Base Building and Doolans Base Building are classified as large supplies as they will serve more than 500 people per day, as outlined in Table 1. Furthermore, the Remarkables Ski Area water supply is currently registered in Hinekōrako (the Water Services Authority database) with a population served of 1,000 people (Supply ID: REM001).

The DWQAR have a compliance option called ‘*Self-supplied Buildings*’. The existing Remarkables Ski Area water supply is classified as a self-supplied building, and which the upgraded supply and new Doolans Creek Right Branch supply are expected to fall under. Self-supplied Buildings are defined as water supplies that provide drinking water to up to ten buildings / structures on one site and provide water to more than 25 people. In the event that more than 10 buildings are supplied in the future, the supply will need to be registered as a large network supply.

Using this compliance option, both the Rastus Burn Base Building and Doolans Basin Base Building Carrier Stacking/Café must comply with the following rule modules for the Large Self-supplied Building Rules, as outlined in the DWQAR (Section 2): G, S3, T3⁴. It is noted that there is no requirement to follow any distribution rules (D3).

2.4 Source (S3) and Treatment (T3) Requirements

The raw water for both the Rastus Burn and Doolans Creek Right Branch are surface water sources. The default protozoa and bacteria treatment target is 4-log (99.99%) inactivation or removal. If the raw water quality is good, this will be achieved by using a combination of filtration, UV disinfection, and chlorination. All process equipment will be appropriately sized, rated, and / or certified for the application.

2.4.1 Current Requirement to Chlorinate

Section 2 of the DWQAR, in relation to footnote 4 (of the self-supplied buildings option), states that “where more than one building is supplied, chlorine must be used to demonstrate bacterial compliance”. For the Rastus Burn Base Building, it is understood that potable water is currently and will continue to be supplied to more than one building in the existing ski area (i.e., Base Building, Maintenance Workshop, Medical Facility / Patrol Building); therefore, chlorination must be provided.

If the Doolans Creek Right Branch supply will only provide water to the Doolans Base Building, and no other building or structure, there may be an opportunity to remove the chlorine dosing requirements.

⁴ When more than one building is supplied, chlorine must be used to demonstrate bacterial compliance. It is noted that NZSki may be eligible to apply for a chlorine exemption.



Remarkables Ski Area Expansion Project Water Supply Infrastructure

However, chlorination has been included at this concept level for commonality and consistency of operation. In addition to this, a change to this requirement may occur in the future, making chlorination mandatory. Thus, provision of this infrastructure at this time provides for future proofing, allows for chlorination to be undertaken should it be required in the future, plus the cost of such infrastructure is not expected to be onerous.

The Water Services Authority released proposed changes to Level 3 rules in November 2025⁵. These include a proposed change to remove the requirement to chlorinate self-supplied building water supplies with more than one building. These proposed changes are out for public consultation and may not be promulgated. Changes to the Level 3 rules following the consultation period are expected to be published by mid-2026.

Where treated water tanks exist, the provision of chlorination is recommended even if it is not required for compliance. Following the 'multi barrier approach' to prevent contamination, chlorination is a key risk reduction measure for both at the water treatment plant and the network. The purpose of the multi barrier approach is to provide more than one barrier to protect the public from a contamination event that may result in illness. If one barrier were to fail and goes unnoticed, the other barriers will still provide safe drinking water. If there is only one barrier in place, there is a significant risk of supplying unsafe water, should that single barrier fail and goes unnoticed. Barriers at the ski field sites may include protecting the catchment, abstracting the cleanest water possible, sedimentation in raw water tanks, filtration, UV disinfection, chlorination, and protection of the network to backflow.

The site will require a Drinking Water Safety Plan to be produced, and in this plan, the source, treatment and distribution risks will be assessed. A distribution system (especially one which includes a treated water tank) with no residual chlorine will most likely have risks scored as unacceptably high.

However, handling and dosing of chlorine by untrained staff can increase risks. It's uncertain at this stage how the treatment systems will be maintained and how quickly they will be fixed if a fault occurs. This will likely be part of a later risk assessment when the detailed design is undertaken.

Based on the availability of information, status of the current legislation, uncertainty of future changes to the compliance rules, and for the purpose of commonality and consistency of operation, chlorination has been included in the concept design of both the Rastus Burn and Doolans Creek Right Branch water supplies.

⁵ [Proposed changes to the Drinking Water Quality Assurance Rules for supplies serving 501 or more people - Taumata Arowai - Citizen Space](#)



2.5 Existing Rastus Burn Water Supply System

The Remarkables Ski Area abstracts raw water for both the potable water supply and firefighting from the Rastus Burn Creek, via weir approximately 400 m from the Base Building. Downstream of the weir are two in ground chambers that contain bypass valving and flow metering, which are accessed by manholes. The location of the weir and tank farm is shown in the figure below.



Figure 3. Location of potable water intake in the Rastus Burn and tank farm lids

From the below ground chambers, the water flows by gravity through five 24 m³ in ground concrete tanks approximately 300m from the Base Building. The installation of the tank farm is shown in the figure below.

Remarkables Ski Area Expansion Project Water Supply Infrastructure



Figure 4. Installation of potable water tank farm in 2014 involving five 24,750 litre tanks

These tanks provide sufficient storage for firefighting for the Base Building sprinkler system.

The falling main from the tanks is a 160mm 16 bar PE100 pipe. The tank farm includes a 110mm diameter PE80 overflow return pipe to the Rastus Burn and a similar 110mm diameter inlet pipe from the Rastus Burn. From May to November 2025, the water take data provided indicates that the peak water take rate did not exceed 2 L/s and the daily water take did not exceed 155 m³/d. The accuracy of the flow meter was not verified.

From May to November 2025, the peak water take rate from the lake did not exceed 12 L/s and the daily water take did not exceed 800 m³/d.

The existing Base Building Water Treatment Plant (WTP) operates on demand, and consists of the following elements:

- Two cartridge filter housings plumbed in parallel each equipped with seven Pentek Polydepth polypropylene cartridge filters with a nominal 5 µm rating. Each cartridge filter housing has a rated capacity of 4 L/s, for a total filtration capacity of 8 L/s.
- Two Trojan UV Pro50 UV reactors plumbed in parallel. Each UV reactor has a rated capacity of 3.2 L/s, for a total UV disinfection capacity of 6.4 L/s. It is assumed that both UV reactors operate 100% of the time (i.e., a duty / duty arrangement) with flow restrictors.
- The maximum treatment capacity of the existing plant is 6.4 L/s



Remarkables Ski Area Expansion Project Water Supply Infrastructure

The elements of the water treatment plant are shown in the figure below.



Figure 5. Elements of the existing water treatment plant with filtration and UV disinfection

Treated potable water is distributed throughout the Base Building, to the Maintenance Workshop, and to the Medical Facility / Patrol Building. There are no existing treated water tanks in the water supply system.



3 Firefighting Water Supply (FFWS)

3.1 Rastus Burn Base Building

The existing base building is sprinkler protected. The SNZ PAS 4509:2008 Firefighting Classification is FW2 and requires a minimum storage volume of 45,000 litres for a non-reticulated supply. The requirement from this standard is shown in the figure below.

SNZ PAS 4509:2008					
Table 2 – Method for determining firefighting water supply					
Fire water classification	Reticulated water supply			Non-reticulated water supply	
	Required water flow within a distance of 135 m	Additional water flow within a distance of 270 m	Maximum number of fire hydrants to provide flow	Minimum water storage within a distance of 90 m (see Note 8)	
				Time (firefighting) (min)	Volume (m ³)
FW1	450 L/min (7.5 L/s) (See Note 3)	–	1	15	7
FW2	750 L/min (12.5 L/s)	750 L/min (12.5 L/s)	2	30	45
FW3	1500 L/min (25 L/s)	1500 L/min (25 L/s)	3	60	180
FW4	3000 L/min (50 L/s)	3000 L/min (50 L/s)	4	90	540
FW5	4500 L/min (75 L/s)	4500 L/min (75 L/s)	6	120	1080
FW6	6000 L/min (100 L/s)	6000 L/min (100 L/s)	8	180	2160
FW7	As calculated (see Note 7)				

Figure 6. Firefighting flow for FW2 from SNZ PAS 4509:2008

The volume provided in the below ground tank farm is 5 x 24m³ = 120,000 litres. The proposed extension to the Base Building will not increase the firefighting demand or the fire sprinkler demand.

The firefighting water demand assessment is described below for both the Gondola Return Station and the Day Lodge. These buildings will ultimately need to be designed to meet minimum NZ Building Code requirements, including life safety. The firefighting water supply provisions will form part of the protection and compliance strategy for these buildings.

Currently the Gondola Base Station will be included with the fire protection facilities in the Rastus Burn Base Building.

3.2 Gondola Mid and Return Stations

Sprinklers are not considered to be required at the Gondola Mid Station. For the Doolans Gondola Return Station it is expected that either a fire separation is provided between the Station & Carrier



Remarkables Ski Area Expansion Project Water Supply Infrastructure

Stacking/Café building or that the sprinkler system will be extended into the station given that it is adjoining the sprinkler protected Carrier Stacking/Café building.

For the Mid station sprinkler protection & firefighting water supplies are not considered necessary for the following reasons:

- It's a standalone building with limited occupancy,
- People are transient through the facility,
- The facility is primarily items of mechanical plant and contain steel and concrete structures and are largely constructed from non-combustible materials,
- Typically, gondola and chairlifts do not require, and have not obtained, a building consent as they are elements of mechanical plant and are covered by Pressure Equipment, Cranes and passenger Ropeways Regulations 1999,
- Consultation with both the Territorial Authority and FENZ is part of the consenting process for buildings to confirm the building requirements, including sprinkler protection & FFWS. This will be discussed at the time of preparation of overall designs, but we do not anticipate the requirement for sprinklers or specific firefighting water supplies in the mid station.

The Rastus Burn gondola base station will be considered as part of the main base facility, and again, for this reason, we expect this gondola base station building to be sprinkler protected to comply with the New Zealand Sprinkler standard given that it is adjoining an existing sprinkler protected building. Due to this base station being part of the main base building facility, the FFWS for FENZ will be adequate. The only aspect to resolve is the location of the fire hydrant outlet locations for FENZ use.

3.3 Doolans Gondola Carrier Stacking/Café Building

The Doolans Gondola Carrier Stacking Building/Café will require fire sprinklers and greater than 45m³ of firefighting water storage. Either a fire separation is provided between the Station & Carrier Stacking/Café building or the sprinkler system will be extended into adjoining return Gondola station with suitable freeze protection provided.

Storage can be achieved by external below ground storage tanks (similar to those in the Rastus Burn). Firefighting flow can be achieved with booster pumps within the building adjacent to the sprinkler system pump and valve set.

The Carrier Stacking/Café building is approximately 1,100m² (62m x 17.8m) and may accommodate as many as 350 people.



Remarkables Ski Area Expansion Project Water Supply Infrastructure

For a Sprinklered building the Water Supply Classification is FW2 as per the table from SNZ PAS 4509:2008 as below.

Sprinklered structures	
Category	Water supply classification (see table 2)
Single family homes with a sprinkler system installed to an approved Standard	FW1
All other structures (apart from single family homes) with a <u>sprinkler system</u> installed to an approved Standard	FW2

Figure 7. Water Supply Classification FW2 for a sprinklered building

The volume of storage required for a non-reticulated building with FW2 classification is 45m³. This requirement is identified in the table from SNZ PAS 4509:2008 below. By comparison a non-sprinklered building with Fire Hazard Category 2 (>100 people), with 1,100m² fire cell floor area, would be water supply classification FW5. FW5 classification for a non-sprinklered building requires approximately 1,100m³ of firefighting storage.

This requirement is not directly applicable as this firefighting storage volume required for a non-sprinklered building and is intended to allow FENZ to fight the fire. In the case of the Doolans Creek Right Branch basin Carrier Stacking/Café Building there is no road access for FENZ appliances. It is impractical for the proposed Carrier Stacking/Café building to not be sprinkler protected, noting that a non-sprinkler protected design would need to be addressed as an alternative fire engineering solution.

Fire water classification	Reticulated water supply			Non-reticulated water supply	
	Required water flow within a distance of 135 m	Additional water flow within a distance of 270 m	Maximum number of fire hydrants to provide flow	Minimum water storage within a distance of 90 m (see Note 8)	
				Time (firefighting) (min)	Volume (m ³)
FW1	450 L/min (7.5 L/s) (See Note 3)	–	1	15	7
FW2	750 L/min (12.5 L/s)	750 L/min (12.5 L/s)	2	30	45

Figure 8. Requirement for 45m³ sprinkler storage for the Chair Stacking/Cafe building



4 Rastus Burn Base Buildings Potable Water System

The recommended potable water system at the Rastus burn is as described below

- Retain the existing intake in the Rastus Burn but throttle flow to achieve a maximum flow of 5.2 L/s in accordance with the consent RM16.115.01 2017
- Retain the existing 160mm raw water supply pipeline between the intake weir and the Rastus Burn Tank Farm
- Retain the existing Tank Farm
- Retain the existing 160mm falling main between the Tank Farm and the Rastus Burn Base facilities
- Install new water filtration system
- Install additional UV disinfection capacity
- Install new chlorination system
- Install a treated water tank to provide chlorine contact tank time and flow buffering of peak demand
- Install booster pump to pump water from the treated water tank

4.1 Potable Water Demand at the Rastus Burn Base Facilities

Based on the current daily average visitor numbers of 3,500 people per day and a maximum daily use of 155 m³/d from the 2025 ski season, the per capita potable water demand is estimated to be an average of 44 litres/person/d. A conservative figure of 50 litres/person/day has been used. This figure is supported by NZSki's own analysis. The occupancy figures for the Rastus Burn Facilities are reproduced below for reference.

Table 4: *Expected Rastus Burn occupancy figures (NZSki, 2025)*

Location	Current Occupancy	Ultimate Development
Site Wide	3,500 people/day	6,000 people/day
Rastus Burn total occupancy	3,500 people/day	3,500 people/day
Rastus Burn Base Building	1,526 people	3,052 people



Remarkables Ski Area Expansion Project Water Supply Infrastructure

- Daily Demand based on maximum area occupancy of 6,000 people and a per capita demand of 50 L/person: 300 m³/d
 - This falls within the limits of the current consumptive water take consent of 320.4 m³/d
- Maximum WTP design flow rate:
 - Ultimate occupancy maximum Base Building occupancy: 3,052 people
Peak hourly water demand:
$$\frac{3,052 \text{ people}}{1 \text{ h}} \times 10 \frac{\text{L}}{\text{person}} \times \frac{1 \text{ m}^3}{1,000 \text{ L}} = 30.5 \frac{\text{m}^3}{\text{h}}$$

Where, 10 litres per capita estimate is based on 6 litres for toilet flushing and 4 litres for handwashing.
 - Peak daily water demand:
$$30.5 \frac{\text{m}^3}{\text{h}} \times 10 \text{ h} = 305 \frac{\text{m}^3}{\text{d}}$$
 - Where, 10 h is the operating period of the ski field. The estimated 305 m³/d is less than a consumptive water take consent limit of 320.4 m³/d
 - Plant instantaneous flow rate:
$$30.5 \frac{\text{m}^3}{\text{h}} \times \frac{1,000 \text{ L}}{\text{m}^3} \times \frac{\text{h}}{3,600 \text{ s}} = 8.5 \frac{\text{L}}{\text{s}}$$
 - The 8.5 L/s is rounded up to 9 L/s and is selected as the design basis for the WTP.

4.2 Pipeline Rastus Burn to Tank Farm to Base Facilities

4.2.1 Raw Water Pipeline Design Parameters

The following calculations demonstrate that the existing pipe between the Rastus Burn Tank Farm and the base facilities is sufficient for the upgraded site. .

The consent RM16.115.01 2017 requirements for abstraction from the Rastus Burn for the Base Building facilities are a maximum of:

- 5.2 L/s
- 320.4 m³/day

The predicted maximum daily occupancy of the Rastus Burn facilities is 3,500 guests.

- If each guest has a daily water demand of 50 litres, then the total daily demand is 175m³. This is less than the daily maximum allowed in consent RM16.115.01 2017
- If the water take from the Rastus Burn is spread evenly over 12 hours and the peaks are balanced by the tank farm, and the base building treated water storage tank, then the maximum abstraction rate from the Rastus Burn is expected to be 4 L/s. This is lower than the maximum abstraction rate allowed in the consent RM16.115.01 2017. However, management of the rate of abstraction is required to stay below the maximum consented limit.

The flow velocity in the pipeline between the tank farm and the Rastus Burn Base facilities has excess capacity as the 160mm diameter pipeline is designed for firefighting flow which is greater than the potable water demand.



4.3.1 Rastus Burn Raw Water Filtration

Option 1: Replicate Existing

Add an additional cartridge filter housing with seven 5 µm Pentek Polydepth cartridge filters to increase the filtration capacity to 12 L/s.

Table 5: Filtration Option 1 benefits and disadvantages summary

Benefits	Disadvantages
Simple and familiar for staff	Manual cleaning required, increasing staff time to disassemble, clean, and reassemble the additional cartridge filter housing Note: While removing and manually cleaning cartridge filters with a hose may be standard practice for industrial or irrigation applications this is not typical practice for potable water treatment. Pathogens or contaminants can be transferred to the filtered, or clean side, of the cartridge during the cleaning process. Replacement of dirty cartridges with new- and disposal of the old ones is normal practice.
Small footprint	No automation
Low cost	While the rated capacity may be 4 L/s per cartridge vessel, as material accumulates on the cartridge filters the filtration capacity decreases.
	Does not address operational concerns / constraints

Option 2: Backwashable Filtration System

Replace filtration system with a different unit with the same degree of filtration as the existing cartridge filters (5 µm) but can be automatically backwashed.

Table 6: Filtration Option 2 benefits and disadvantages summary

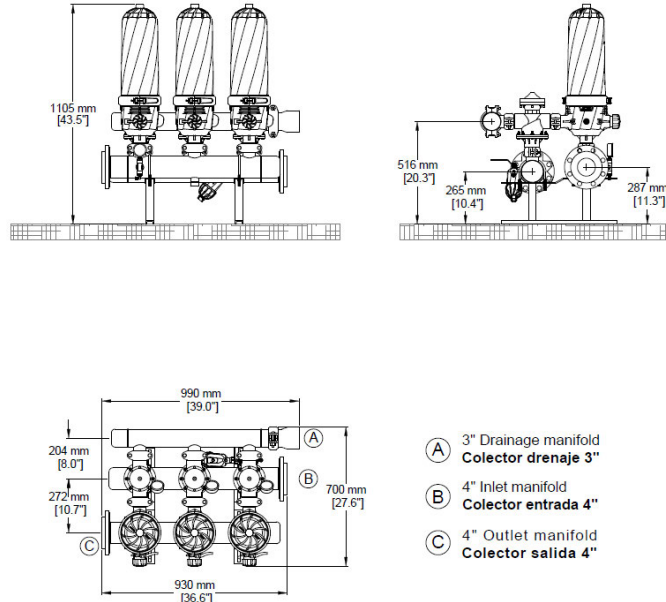
Benefits	Disadvantages
Fully automated backwash system based on time and / or differential pressure	Larger footprint
Maintenance does not require special tools	Increased process complexity (automation)
The existing cartridge filters could be retained and installed downstream of the backwashable filters, to provide an additional barrier, but is not necessarily required.	Higher cost
No backwash pump required – clean water produced from the other filters is used to backwash the filtering element. Note: Compressed air can be added during the backwashing stage for a more aggressive backwash but not expected to be required.	Produces a backwash stream that needs to be disposed of to a stormwater or wastewater system
Less waste (i.e., cartridge filters to landfill) and ongoing OPEX costs than Option1	May increase the required water take due to the production of a waste stream) 100 µm filter required to remove larger particles to reduce backwashing frequency and protect the downstream 5 µm filter.

Filter configuration:

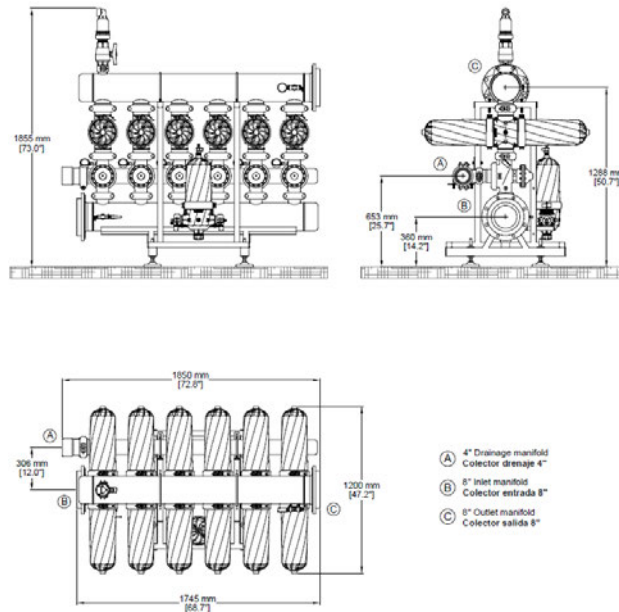


Remarkables Ski Area Expansion Project Water Supply Infrastructure

- 100 µm Azud Helix Automatic FT203/4F with HDPE disks
 - Includes three filtration pods
 - Backwash requirements: 2 bar_(g) at 2.8 L/s for 30s = 84 litres per filtration pod = 252 litres per backwash for the system.
 - Footprint: 1 m x 1 m plus working space and piping: See picture below



- 5 µm Azud Helix Automatic FT4DCL6 with HDPE disks
 - Includes 6 double filter pods
 - Backwash requirements: 2 bar_(g) at 5.6 L/s for 30s = 168 litres per filtration pod = 1,010 litres per backwash for the system
 - Footprint: 2 m x 1.2 m plus working space and piping: see picture below



4.3.2 Rastus Burn UV Disinfection

UV disinfection will inactivate bacteria and protozoa in the source water, but typical UV dose rates are insufficient to inactivate viruses. Bacteria, viruses and protozoa may originate from human activities in the catchment and from feral animals and birds. Compliance requires treatment for surface water even if the source has a low risk of contamination.

Two options are presented below: adding additional UV reactors to the existing or replacing the existing with a single larger unit. Having one unit means that maintenance only needs to be done to a single device and the pipework, valving and controls can be simpler. This option, however, has low resiliency if the UV device faults and a specialist may be required to attend the site to fix it, causing unacceptable water outages. The options to add additional (smaller units) means that if one fails, the other two can continue to supply water whilst maintenance occurs.

Option 1: Add in a third identical UV Reactor to existing treatment plant

Install a third TrojanUV / Viqua Pro50 UV reactor to increase the WTP UV disinfection capacity to 9.6 L/s with an appropriately sized flow restrictor. The two existing UV reactors may be due for replacement due to age and serviceability.

Table 7: *UV Option 1 benefits and disadvantages summary*

Benefits	Disadvantages
Simple and familiar for staff	3 units in parallel – additional unit to service and maintain
Small footprint – can be wall mounted	No operational flexibility, such as variable power, automatic switching, duty / standby functionality, auto shutdown, automatic isolation during fault
Low CAPEX option	
Three separate units allows water to be treated at a lower flow rate if one faults	

Option 2: Replace existing UV reactor capacity with a single larger unit

Replace existing UV reactors with a single larger unit, such as a TrojanUV SwiftSC D03, or equal

Table 8: *UV Option 2 benefits and disadvantages summary*

Benefits	Disadvantages
Single unit	Larger footprint – floor mounted
Fully automated control	Higher cost (CAPEX / OPEX)
N+0.5 redundancy	Higher complexity – could not be maintained by existing staff
Same number of lamps	Higher capacity than required (14 L/s)
More operational flexibility such as variable power, automatic switching, duty / standby functionality, auto shutdown, automatic isolation during fault	



4.3.3 Rastus Burn Chlorine Dosing

Chlorine dosing of the water is required as the Drinking Water Quality Assurance Rules require chlorination for supplies covering multiple buildings. Plus, chlorine reduces the risk of bacteria growth in the network and bacterial contamination in the network from backflow from mechanical damage or other sources. Chlorination is effective at inactivating viruses which may be present in the source water. One potential source of viruses is faecal contamination from camping areas at Lake Alta.

Chlorine gas is difficult to manage so dosing with 1% NaOCl is recommended upstream of treated water storage tank. The chlorination system has been designed to meet the DWQAR. The system would dose chlorine continuously to provide a constant chlorine residual in the network. Sizing and assumptions of the chlorine dosing system are summarised below:

- Assume 1% sodium hypochlorite (NaOCl).
 - This concentration of NaOCl is not considered a hazardous substance by Worksafe / HSNO so would be more suitable for a site where less trained staff may be required to handle it. A lower concentration would, however, mean that a larger volume is required to be stored at site and delivered more regularly to the site by vehicle
- Assume a treated water flow rate of 9 L/s and plant operation period of 12 hours per day
- Assume a maximum dose of 0.9 mg/L FAC
- Required dosing rate of 3 L/h of NaOCl
- Based on a NaOCl dosing rate of 3 L/h and an operational period of 12 hours per day, the selected storage volume is a 1,000 litres (IBC) of 1% NaOCl. This provides 29 days of storage.
 - A higher concentration of NaOCl could be used to reduce the storage volume and room footprint required. However, this would introduce more health and safety and chemical compliance requirements. There is also a higher risk of overdosing into the water supply system by using a stronger strength NaOCl solution.

It is recommended that chlorine is included in design.

4.3.4 Rastus Burn Treated Water Storage

A minimum of one 30,000 litre treated water storage tank is required at the Rastus Burn site to provide flow balancing and chlorine contact time. The treated water storage tank was sized to provide adequate chlorine contact time and to buffer peak hourly flows through the treatment system. This allows for smaller and more economical treatment equipment and allows for limited downtime for an operator to complete minor maintenance.

The treated water tank will be located within the building in order to avoid the issues associated with an external tank such as freezing, mechanical damage or contamination. The treated water storage tank will also be used to provide chlorine contact time (C.t) and enable compliance with the bacterial rules of the DWQAR. The required target C.t is 15 min.mg/L. Assuming a standard circular plastic 30 m³ tank, with a top entry and bottom exit installed on opposite sides of the tank, and the tank remains 100% full, the chlorine contact time (C.t) is calculated as follows:



$C.t = [FAC] \times \text{retention time} \times \text{baffle factor}$

$$C.t = 0.9 \frac{mg}{L} \times 30 m^3 \times \frac{1}{32.4 \frac{m^3}{h}} \times \frac{60 min}{h} \times 0.3 = 15 \frac{min mg}{L}$$

The concept design can achieve the required C.t of 15 min.mg/L.

4.3.5 Network Distribution Booster Pumping

The distribution network (the pipework in and between the buildings) need to be pressurised to an acceptable level.

The distribution booster pumping will match the raw water booster pumping of 9 L/s at 3 bar. A pressure vessel is recommended to mitigate start / stop frequency, especially during off peak times or when only staff are on site.

It is normal to have more than one pump to ensure continuous operation if one pump fails or to boost flows during peak demand periods. Pump sizing and number will be confirmed during detailed design.

4.3.6 Summary of Upgrade and Recommended Options

The recommended option for the Rastus Burn catchment potable water treatment system at the Base Building is summarised as follows and shown in the schematic below:

- Raw Water Booster pumping
 - Filtration Option 2 (automated filtration)
 - 3 x 100 µm automatic disc filters
 - 12 x 5 µm automatic disc filters
 - UV Reactor Option 1 (addition of another UV unit to existing)
 - 3 x TrojanUV / Viqua Pro50 in parallel with flow restrictors
 - 1% NaOCl dosed upstream of treated water storage tank
 - 30,000 litres of treated water storage
 - Treated water booster pumping – pressure vessel may be required
- NB: Water quality monitoring, flow, and pressure instrumentation not shown in the schematic



Remarkables Ski Area Expansion Project Water Supply Infrastructure

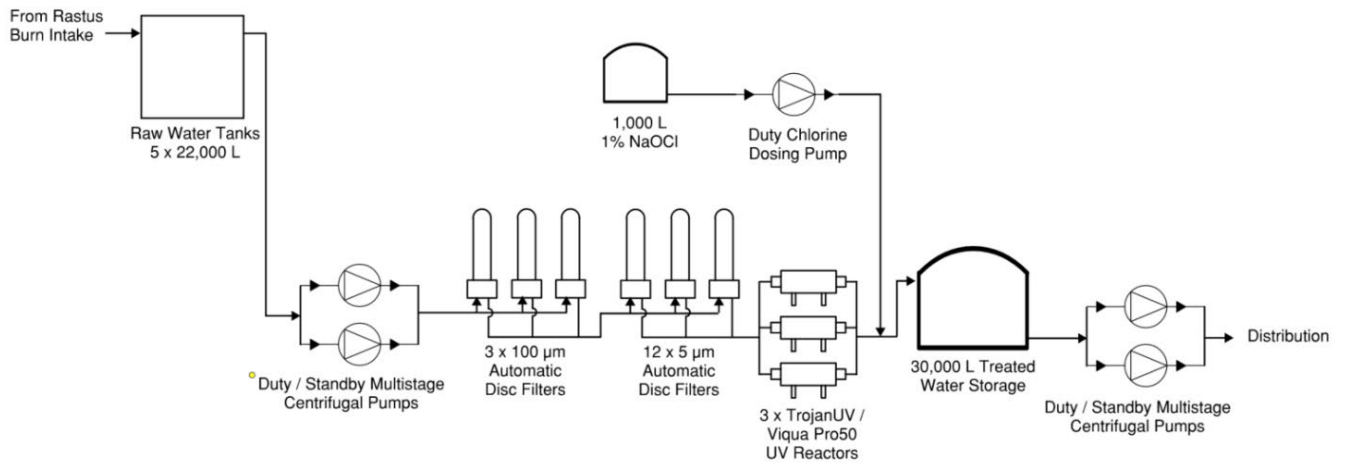


Figure 9: High level process diagram of preferred option for Rastus Burn catchment WTP

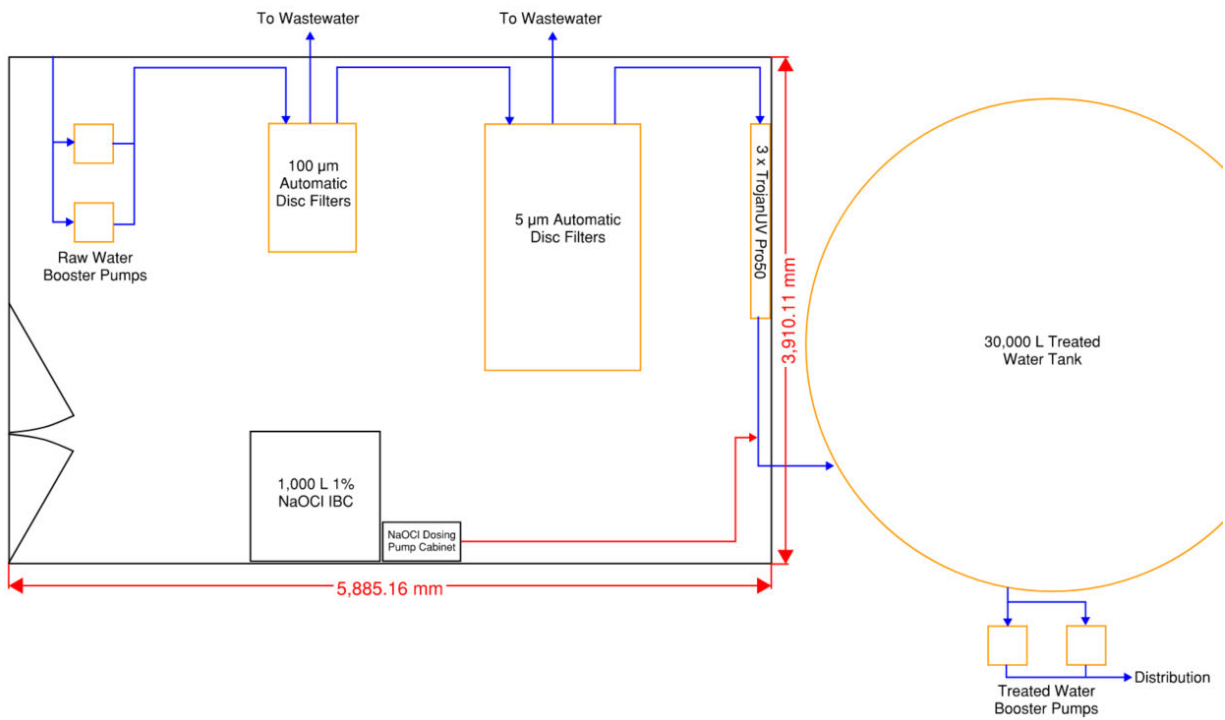


Figure 10: Preliminary Rastus Burn WTP general arrangement sketch



5 Doolans Creek Right Branch Gondola Carrier Stacking Building/Café Potable Water Supply

5.1 Doolans Potable Water Demand

NZSki identify the following visitor numbers in the Doolans Basin.

Table 9: Expected population (NZSki, 2025)

Location	Current Occupancy	Ultimate Development
Site Wide	3,500 people/day	6,000 people/day
Doolans Creek Right Branch Right Branch Basin Ski Area	-	2,500 people/day
Doolans Creek Right Branch Right Branch Basin Cafe Building	-	450 people

Based on the projected development ultimate visitor numbers of 2,500 people per day for the Doolans Creek Right Branch Basin the estimated potable water demand is as follows:

- Daily Demand based on maximum area occupancy of 2,500 people and a per capita demand of 50 L/person: 125 m³/d. Flow monitoring undertaken by e3 over the 2025 winter identified that the flow in Doolans Creek Right Branch was greater than 66L/s and thus a flow rate of up to 30 L/s could be taken. If the 125 m³/day is taken from the creek flow over a period of 12 hours this equates to an abstraction rate of 3 L/s.
- Maximum WTP design flow rate:
 - Ultimate building occupancy: 450 people
 - Peak hourly water demand:

$$\frac{450 \text{ people}}{h} \times 10 \frac{L}{\text{person}} \times \frac{1 \text{ m}^3}{1,000 L} = 4.5 \frac{\text{m}^3}{h}$$
 - Where, 10 litres per capita estimate is based on 6 litres for toilet flushing and 4 litres for handwashing.
 - Peak daily water demand:

$$4.5 \frac{\text{m}^3}{h} \times 10 h = 45 \frac{\text{m}^3}{d}$$
 - Where, 10 h is the operating period of the ski field. The estimated 45 m³/d is less than the estimated daily demand of 125 m³/d
 - Plant instantaneous flow rate:

$$4.5 \frac{\text{m}^3}{h} \times \frac{1,000 L}{\text{m}^3} \times \frac{h}{3,600 s} = 1.3 \frac{L}{s}$$
 - The 1.3 L/s is rounded up to 1.5 L/s and is selected as the design basis for the WTP.



5.2 Doolans Raw Water Supply Assets

5.2.1 Doolans Raw water demand and new assets required

The proposed Raw water system at the Doolans Facilities includes the following elements:

- Raw Water Booster at the intake location pumping to the facilities at the Gondola Return Station
- Raw water storage tanks at the base facilities which will serve a dual purpose as firefighting storage. This requires 45,000 litres of storage.
- Pumping from the raw water storage tanks to the treatment process
- Filtration (Option 2), including:
 - 3 x 5 µm automatic disc filters with air compressor
- A UV Reactor to deactivate protozoa and bacteria (Option 1), including
 - 1 x UV disinfection unit with flow restrictor
- Dosing of 1% NaOCl is not specifically required by the Drinking Water Quality Assurance Rules currently, but a change to this requirement is anticipated. Thus, it is recommended that chlorine dosing upstream of treated water storage tank is provided.
- A new 5,000 litres of treated water storage

Treated water booster pumping to provide pressure to the network. Note, a surge attenuation pressure vessel may be required to achieve this outcome.

- A dedicated rising main from the new / proposed intake site on Doolans Creek Right Branch to NZSki's identified 'Option 1 reservoir site' for snow making. This would require dedicated pumps at the intake site. There is a rise of approximately 270 m between intake and reservoir site. This lift is achievable with multistage pumps.
- A separate dedicated rising main and smaller pumps from the Doolans Creek Right Branch intake site to the firefighting storage tanks located above the Doolans Carrier Stacking/Cafe area, this is a rise of approximately 200 m.
- A tank / chamber will be required at the intake site for these pumps to abstract from. A control building with motor control centre will be required.
- Dedicated firefighting pumps within the Carrier Stacking/Cafe/ gondola terminal, these are likely to be diesel for reliability if there is a power outage.
- A Falling man from the firefighting storage to a filter and UV disinfection system which discharge into treated water holding tank(s) and is then pumped from the treated tanks to maintain constant supply pressure within the building.



5.2.2 Doolans Raw Water Pipeline Intake – Facilities

The pipeline between the Doolans Creek Right Branch intake pump building and the Doolans Facilities is anticipated to be laid along the general alignment shown below. Where the pipeline is outside the road formation the vegetation will be removed, stored and replaced as the pipe installation occurs. This is similar to other underground services in the Rastus Burn area. The pipe is small, only approximately 30mm in diameter, and it does not require a large excavator to excavate and backfill the trench.

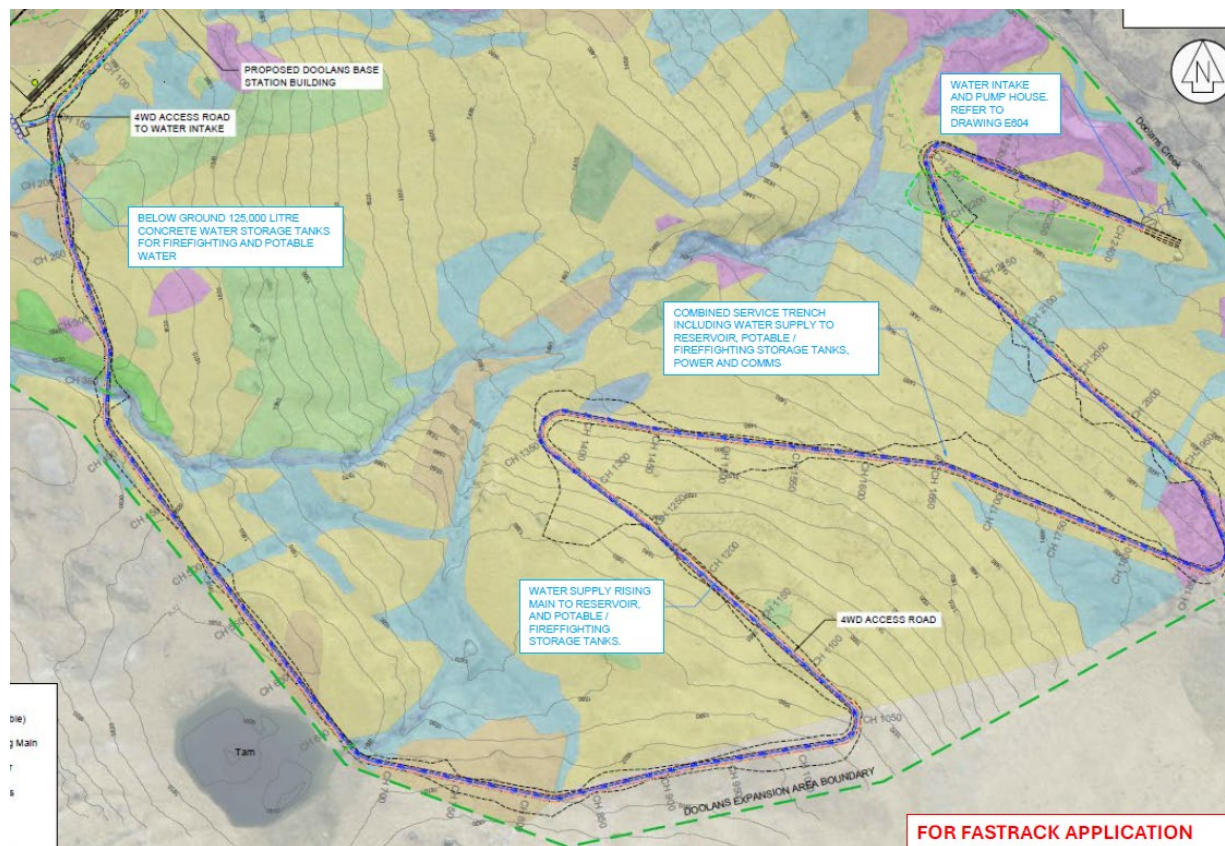


Figure 11. Nominal route for rising main between intake and Doolans facilities

Approximate sizing of the rising main is given as follows.

- Maximum fluid velocity (ignoring head loss): 1.2 m/s.
- Required diameter to achieve a flow of 1.5 L/s:

$$\text{Pipe diameter} = \frac{2}{\pi} \sqrt{\frac{0.0015 \text{ m}^3/\text{s}}{1.2 \text{ m/s}}} = 22 \text{ mm}$$

- The nearest nominal pipe size is DN25 (ignoring head loss).
- Refill existing raw water tanks at maximum consented flow rate of (TBC).
- Raw water booster pumping to feed WTP expected to be required.

A high head multistage pump will be required to lift water between the intake at approximately 1,360m altitude and the facilities at approximately 1,600m. This is a significant height gain and is beyond the

capacity of a single stage centrifugal pump. Multistage pumps are available which are capable of this head. The snow making pumps are required to pump against a significantly higher head than this.

5.3 Doolans Creek Right Branch Right Branch Potable Water Treatment

5.3.1 Filtration

As per Section 4.3, two options have been described: a cheaper more manual option (cartridge filters) and a more expensive automated option. For the same reasons described in Section 4.3 the automated option is preferred. Also, given that there is no history of water abstraction from this stream, there could be a sediment load that is higher than Rastus Burn which could block the cartridge filters at a rate which is unacceptable (i.e. require changing every couple of weeks). As there are no existing treatment system or buildings at this site, and there are no existing assets to re-use.

Option 1: Replicate Rastus Burn Cartridge Filter

Provide a cartridge filter housing with seven 5 µm Pentek Polydepth cartridge filters with a filtration capacity of 4 L/s.

Table 10: *Filtration Option 1 benefits and disadvantages summary*

Benefits	Disadvantages
Simple and familiar for staff	Manual cleaning required, increasing staff time to disassemble, clean, and reassemble the additional cartridge filter housing Note: assume the cartridge filter needs to be disposed of when it becomes blocked and not washed at site. Cost of replacement cartridge filters.
Small footprint	No automation
Low cost to install	While the rated capacity may be 4 L/s per cartridge vessel, as material accumulates on the cartridge filters the filtration capacity decreases.

Option 2: Backwashable Filtration System

Provide a filtration system a 5 µm particle size cut off that can be backwashed.

Table 11: *Filtration Option 2 benefits and disadvantages summary*

Benefits	Disadvantages
Fully automated backwash system based on time and / or differential pressure	Larger footprint
Maintenance does not require special tools	Increased process complexity (automation)
The existing cartridge filters could be retained and installed downstream of the backwashable filters, to provide an additional barrier, but necessarily required	Higher cost
No backwash pump required	Produces a backwash stream

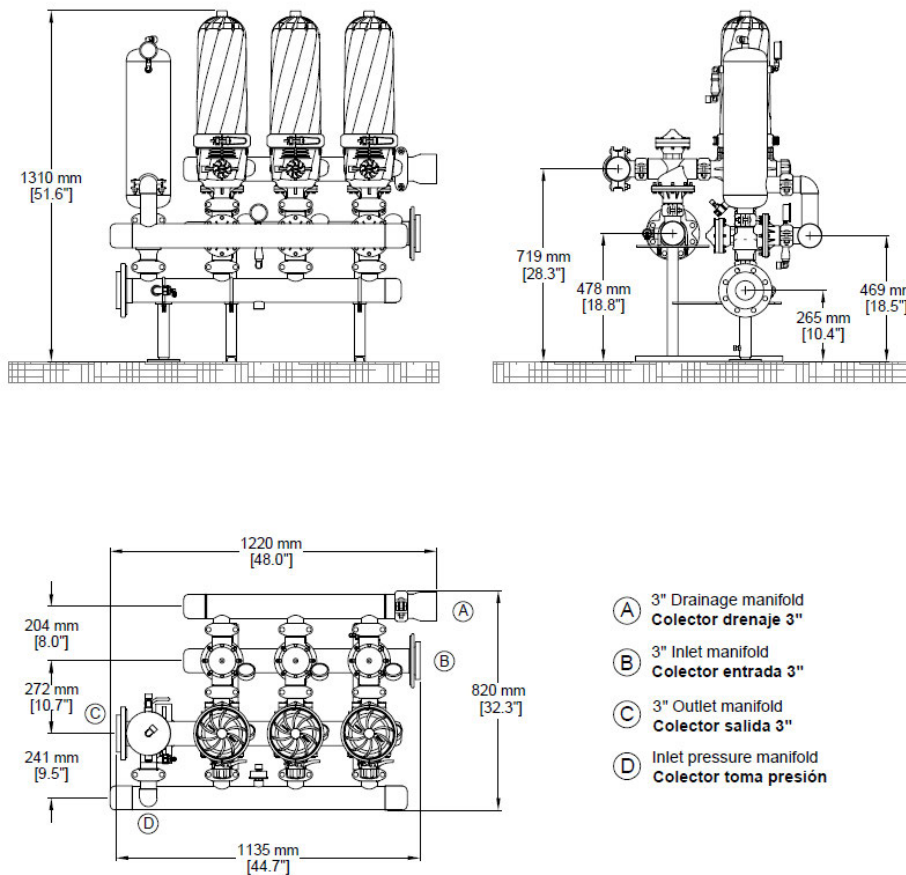


Remarkables Ski Area Expansion Project Water Supply Infrastructure

100 µm filter to remove larger particles to reduce backwashing frequency of the 5 µm filter.

Compressed air required – Instantaneous design flow rate is inadequate to backwash without air.

- 5 µm Azud Helix Automatic FT203 AA DLP with HDPE disks
Backwash requirements: 8 bar air compressor with 90L tank, 30 litres of wastewater for a full backwash
Footprint: 1.2 m x 1 m plus working space and piping. See below for standout set out and compressor example



5.3.2 UV Disinfection

As per Section 4.3, two options have been presented. This site is different to the Rastus Burn facilities in that there are no existing assets to re-use. Option 1 is to install a single reactor to treat the full flow. As this site (and water demand) is much smaller than the Rastus Burn facilities only one unit is required to treat the full flow. There is no larger unit that is suitable for this application, and there are no anticipated major savings by purchasing two smaller units and splitting the flow between them. For this reason, Option 1 has been recommended with one unit with capacity to treat the full design flow rate; however, if more resilience were preferred, a second UV reactor could be installed in the future. As they can be wall mounted, they do not require additional floor space or a larger building area.

Option 1: One single UV Reactor

Install one Trojan UV / Viqua Pro50 UV reactor to provide a WTP UV disinfection capacity of 3.2 L/s with an appropriately sized flow restrictor installed in line. There is an opportunity here to install valving and tees to be able to install a second reactor easily in the future. Provision of one unit with additional valving is the preferred option at this stage

Table 12: UV Option 1 benefits and disadvantages summary

Benefits	Disadvantages
Simple and familiar for staff	only one unit- no backup
Small footprint	
Low cost	

Option 2: as per Option 1, but with an additional UV Reactor as a backup (duty/standby)

Install two TrojanUV / Viqua Pro50 UV reactor to provide a WTP UV disinfection capacity of 3.2 L/s with an appropriately sized flow restrictor installed in line.

Table 13: UV Option 2 pros and cons

Benefits	Disadvantages
Simple and familiar for staff	An additional unit to operate and maintain
Small footprint	
Additional backup / capacity	

5.3.3 Chlorine Dosing

The chlorination system has been designed to meet the DWQAR. The system would dose chlorine continuously to provide a constant chlorine residual in the network. Sizing and assumptions of the chlorine dosing system are summarised below:

- Assume 1% sodium hypochlorite (NaOCl).
 - This concentration of NaOCl is not considered a hazardous substance by Worksafe / HSNO so would be more suitable for a site where less trained staff may be required to handle it. A lower concentration would mean that a larger volume is required to be stored at site and delivered more regularly to the site by vehicle.



Remarkables Ski Area Expansion Project Water Supply Infrastructure

The chlorination system sizing and summarised below. The dosing system proposed for Rastus Burn Base Building, along with its design basis, is replicated at Doolans Basin Day Lodge:

- Assume 1% NaOCl
 - The concentration of NaOCl is not considered a hazardous substance by Worksafe / HSNO
- Assume a treated water flow rate of 1.5 L/s and operation for 12 hours per day
- Assume a maximum dose of 0.9 mg/L FAC
- Required dose rate of 0.7 L/h NaOCl
- Based on an NaOCl dosing rate of 0.7 L/h and an operational period of 12 hours per day, the selected storage volume is a 250 litres tank of 1% NaOCl. This provides 32 days of storage.
 - A higher concentration of NaOCl could be used to reduce the storage volume and room footprint required. However, this would introduce more health and safety and chemical compliance requirements. There is also a higher risk of overdosing into the water supply system by using a stronger strength NaOCl solution.

It is recommended that chlorine is included in design at this stage.

5.3.4 Treated Water Storage

A minimum of 5,000 litres is required for the treated water storage tank to allow for adequate chlorine contact time for microbiological deactivation and to buffer peak hourly flows through the treatment system. This tank will be located within the water treatment area in the lower level of the Gondola Carrier Stacking/Café Building.

Having a tank allows for smaller and more economical treatment equipment and allows for some downtime for an operator to complete minor maintenance. Storage is not sized for longer outages, especially during peak demand periods. If a higher level of system resiliency is required to ensure business continuity, a larger tank or more tanks will be needed.

The treated water tank will need to be designed so that the water does not freeze. This may include careful choice of tank material, burying the tank, including a mixer, installing it indoors, or under a building so that it is adequately insulated. This smaller tank may fit within a shipping container or similar sized building. This will be investigated further during detailed design.

The treated water storage tank will also be used to provide chlorine contact time (C.t) and enable compliance with the bacterial rules. The required target C.t is 15 min.mg/L (refer to footnote 4). Assuming a standard circular plastic 5 m³ tank, with a top entry and bottom exit installed on opposite sides of the tank, and the tank remains 100% full, the chlorine contact time (C.t) is calculated as follows:

$$C.t = [FAC] \times \text{retention time} \times \text{baffle factor}$$
$$C.t = 0.9 \frac{mg}{L} \times 5 m^3 \times \frac{1}{5.4 \frac{m^3}{h}} \times \frac{60 min}{h} \times 0.3 = 15 \frac{min mg}{L}$$

The concept design can achieve the required C.t of 15 min.mg/L.



5.3.5 Distribution Booster Pumping

The distribution network (the pipework in and between the buildings) need to be pressurised to an acceptable level to operate sinks and toilets etc.

The distribution booster pumping will match the raw water booster pumping of 1.5 L/s at 3 bar. A pressure vessel is recommended to mitigate start / stop frequency, especially during off peak times or when only staff are on site.

It is normal to have more than one pump to ensure continuous operation if one pump fails or to boost flows at peak time. Pump sizing and number will be confirmed during detailed design.

5.3.6 Recommended Option

The recommended option for the Doolans Creek Right Branch catchment potable water treatment system at the Doolans Creek Right Branch Carrier Stacking/Café is summarised as follows and shown in the schematic:

- Raw Water Booster pumping to storage tanks
- Falling main to treatment facility
- Filtration Option 2
 - 3 x 5 µm automatic disc filters with 90 litres air compressor
- UV Reactor Option 1
 - 1 x TrojanUV / Viqua Pro50 with flow restrictor with tees and valving for a second reactor in the future.
- 1% NaOCl dosed upstream of treated water storage tank
- 5,000 litres of treated water storage
- Treated water booster pumping – pressure vessel may be required
- NB: Water quality, flow and pressure instrumentation not shown in schematic

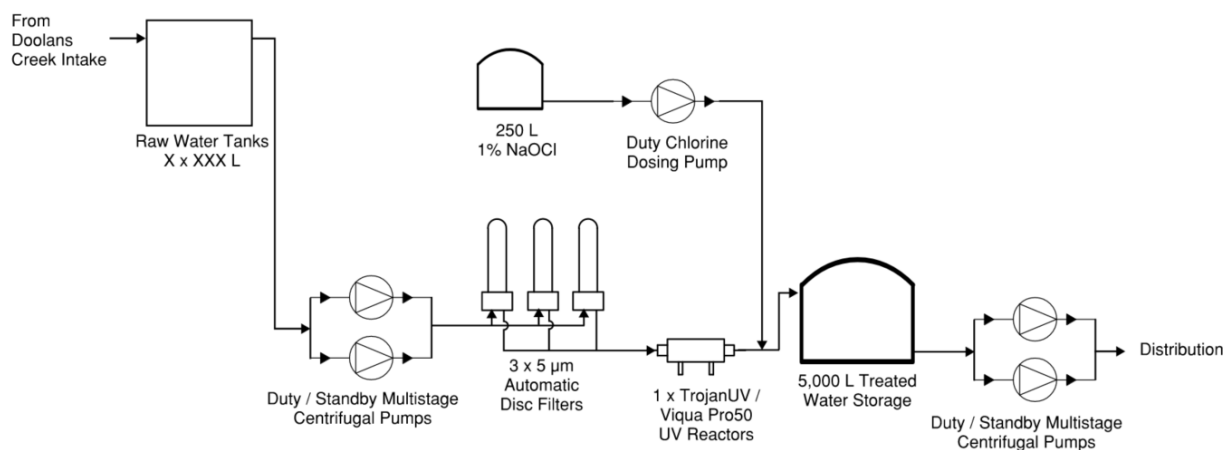


Figure 12: High level process diagram of preferred option for Doolans Creek Right Branch catchment WTP



Remarkables Ski Area Expansion Project Water Supply Infrastructure

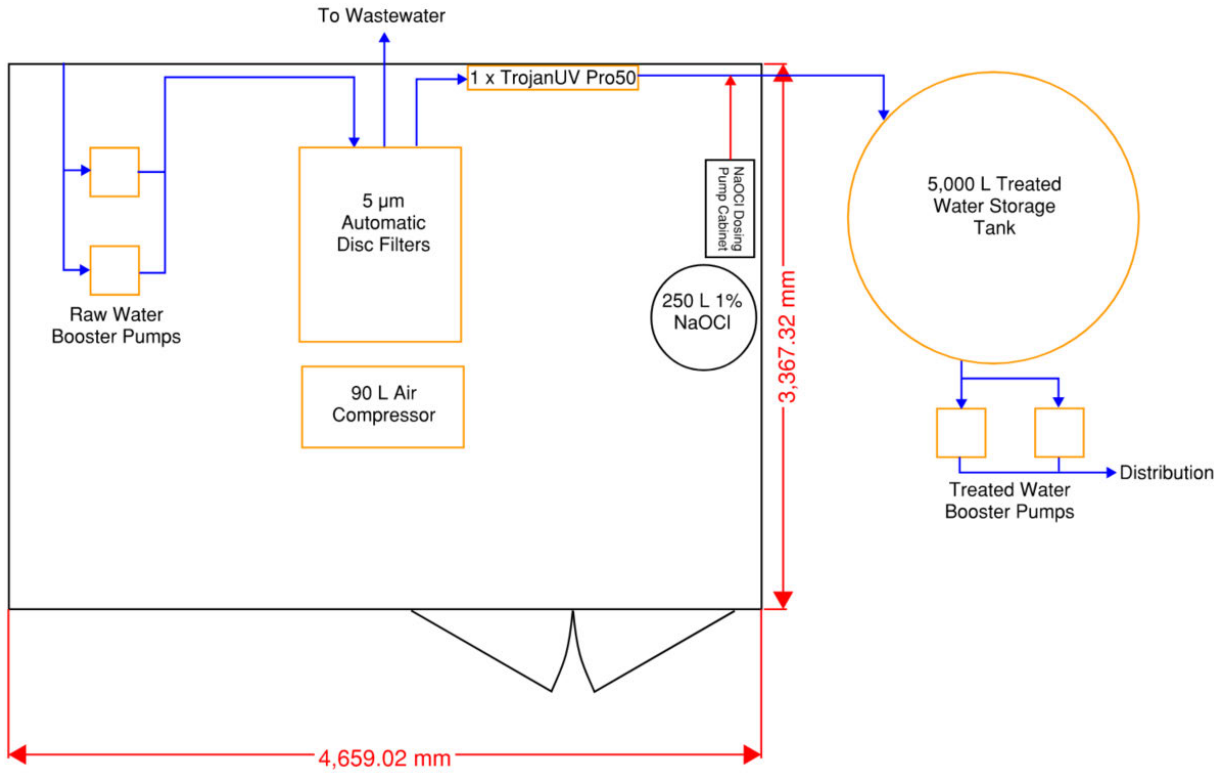


Figure 13: Preliminary Doolans Creek Right Branch WTP general arrangement sketch



6 Recommendations and Next Steps

The Rastus Burn water supply needs to be upgraded to provide additional capacity and to improve operability.

The new water facilities to be implemented in the Doolans require a new treatment plant and associated tanks, pumps and pipework

Our recommendation for the upgrades relating to potable water and fire supply are summarised as follows. The intake structure is covered in other reports and is excluded from consideration here.

6.1 Rastus Burn Water Supply high level summary

Rastus Burn: existing site to be upgraded with reuse of some existing assets

- Filtration Option 2
 - 3 x 100 µm automatic disc filters
 - 12 x 5 µm automatic disc filters
- UV Reactor Option 1
 - 3 x UV disinfection units in parallel with flow restrictors
- 1% NaOCl dosed upstream of treated water storage tank
- A minimum of 30,000 litres of treated water storage
- Treated water booster pumping – pressure vessel may be required

6.2 Doolans Water Supply high level summary

Doolans Facilities: new site to be constructed

- Raw Water Booster pumping to storage/sprinkler tanks
- booster pumping to filters
- Filtration Option 2
 - 3 x 5 µm automatic disc filters with air compressor
- UV Reactor Option 1
 - 1 x UV disinfection unit with flow restrictor with additional valving to accommodate a second reactor.
- 1% NaOCl dosed upstream of treated water storage tank
- A minimum of ,000 litres of treated water storage
- Treated water booster pumping – pressure vessel may be required



6.3 Firefighting summary

Extension to existing Rastus Burn Base Building

The extension to the Rastus Burn Base Building will require an extension to the sprinkler system. The existing intake and holding tanks are sufficient for this expansion.

Gondola Mid Station

No sprinklers or fire hydrants will be provided at the Gondola Mid Station

Gondola Return Station Doolans

No sprinklers or fire hydrants will be provided at the Gondola Mid Station

Doolans Carrier Stacking/Café building

Sprinklers will be provided in the Carrier Stacking/Café building. A minimum of 45 m³ of firefighting storage is required on site and this can be in external buried tanks. Booster pumps will be required.







Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

Stantec New Zealand

Unit D1-03, 19 Grant Road

Frankton

Queenstown 9300

NEW ZEALAND

Mail to: PO Box 13052, Christchurch 8140

stantec.com

