Remarkables Ski Area Upgrade and Doolans Expansion -Doolans Creek Water Take Assessment of Effects

e3 Scientific
Raranga toru taiao
Te Ao, Te Wai, Te Moana

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Executive Summary

NZSki is proposing to expand the Remarkables Ski Area into the Doolans Creek Right Branch Catchment. The Doolans Creek Catchment is undeveloped and is of steep alpine terrain. To supply snow making and potable water demand, a surface water take from the Doolans Creek Right branch is proposed at the maximum rate of water take of 30 litres per second (L/s), and 41,240 cubic metres per year (m^3/yr). Water will be piped to a 19,000 m^3 reservoir so that water can be taken at the higher rate required for snow-making, without causing adverse effects on Doolans Creek Right Branch.

The Doolans Creek Right Branch (hereafter called the Doolans Creek) flows downstream to join the Left Branch and then on to the Nevis River just before it connects to the Kawarau River within the Kawarau Gorge above Lake Dunstan. The preferred intake location was identified based on flow monitoring within the creek and both terrestrial and freshwater ecological studies.

The catchment above the intake site is 568 ha and is 0.8 % of the overall Nevis River catchment. The mean annual low flow at the intake site is modelled to be 67 L/s, relative to the Nevis River mean annual low flow of 4,790 L/s. Water level and flow monitoring was conducted to verify the availability of flow at the intake site. This indicates that flow in Doolans Creek is unlikely to decrease below 65 L/s for extended periods during the snow-making season and therefore the proposed maximum take of 30 L/s would result in 54% of the flow at this location remaining in the creek under low flow conditions.

The take is 1% of the allocation available within the Nevis River catchment and representative of approximately 0.6% of the Nevis River MALF. The proposed rates of take are considered to be reasonable and efficient for the proposed uses of potable water supply and snow-making, with the demand buffered by appropriate water storage. Given the take will be operational during the winter months when downstream irrigation takes are dormant, there will be no adverse effects on downstream water users or flows. A proposed condition of consent is to retain a residual flow of 20 L/s in the creek at the intake location at all times to guarantee sustained flow within the creek downstream of the take. The wetlands present within the catchment are elevated above the creek within the steep sided valley. Minor lowering of the water level within the creek will not alter the hydraulic gradient to the creek and therefore will not impact on water levels within these wetlands.

To summarise, the effects of the water take on Doolans Creek will be mitigated by only taking the water quantities required for outlined activities, storing water to buffer the water demand and maintaining flow during low flow periods. To understand the ecological effects of this take, this assessment should be read in conjunction with the following ecological impact assessments:

- e3Scientific, (2026b). *Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment*. March 2026.
- e3Scientific, (2026c). *Remarkables Skifield Expansion Project Ecological Impact Assessment*. March 2026

1 Introduction

NZSki Limited (The Applicant) are planning to extend the Remarkables Ski field into the Doolans Valley (The Project) to increase capacity and improve resilience to the effects of climate change and variable weather patterns.

A water supply is needed for snowmaking and potable water for the base building, with some storage for fire-fighting. Potable water uses include food and beverage operations, and provision of water for visitors and on-site staff. The proposed intake site (Figure 1) is from the Doolans Creek Right Branch (hereafter referred to as Doolans Creek) at an approximate altitude of 1,370m.

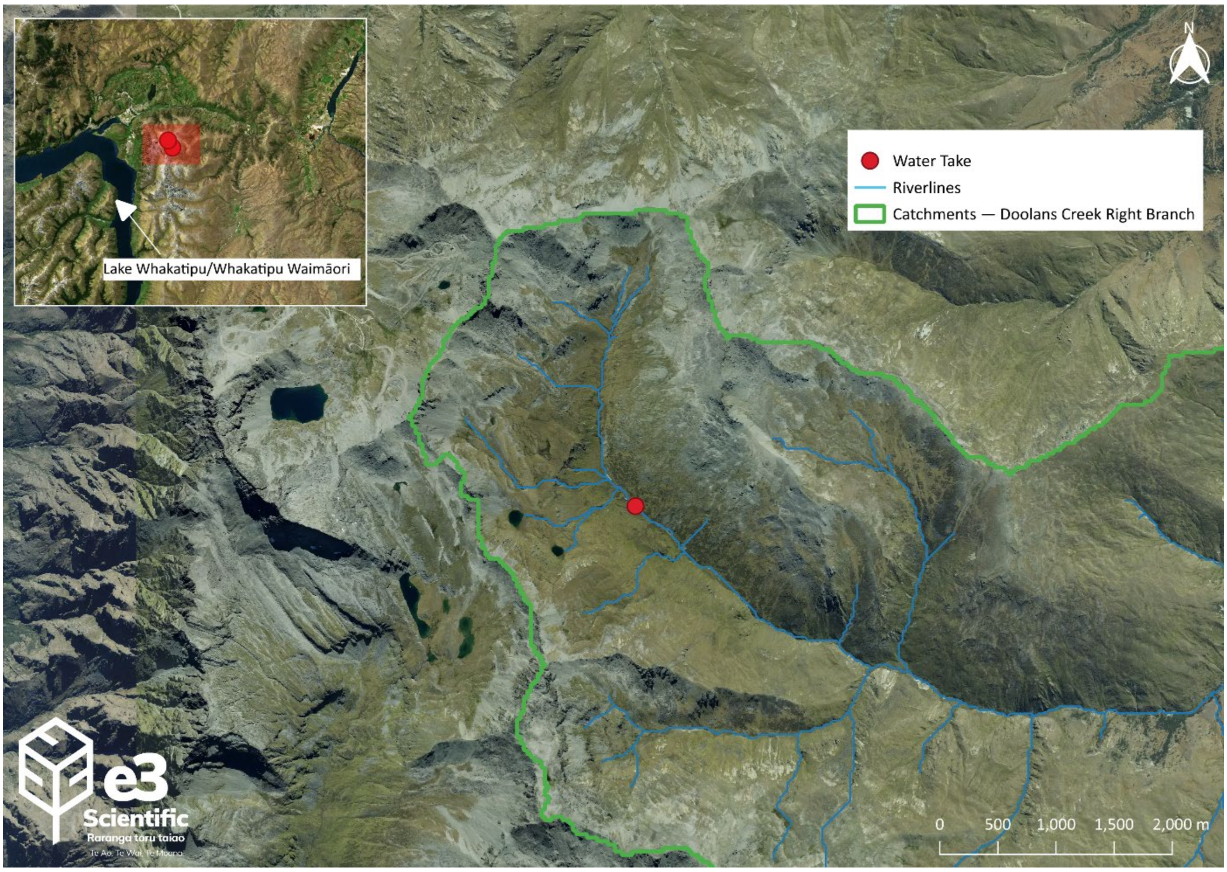

Figure 1: Site Location

1.1 Code of Conduct

The author of this report is Alexandra Badenhop. I am the Technical Director of Water & Environmental Management at e3Scientific Ltd and hold a Bachelor of Engineering (Environmental) (Hons) (1999) and a Masters of Engineering Science (Groundwater Studies) (2008) from the University of New South Wales (UNSW). The subjects completed for my Masters also fulfilled the criteria for Master of Engineering Science (Water Quality).

I am a member of the International Association of Hydrogeologists and New Zealand Hydrological Society. I have over 20 years experience working in the water industry in Australia and New Zealand. As the Technical Director - Water & Environmental Management team at e3Scientific, I am responsible for groundwater and surface water supply and water quality assessments, technical reviews for regional councils, assessing and reviewing discharges to land, assessment of environmental effects, project management and contributes my hydrological and water quality expertise to multidisciplinary assessments across the business. I have acted as an Expert Witness in in consent hearings in New Zealand for the past ten years in Otago and Southland, providing expertise in the fields of hydrogeology, groundwater and surface water quality and environmental monitoring plan design.

I confirm that I 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 I state otherwise, this report is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this report.

1.2 Scope of Work

e3Scientific (e3s) was contracted by NZSki to determine whether adequate water supply is available from Doolans Creek for the Project and to assess the effects of the water take.

To assess the available water supply, e3s has completed the following works:

- Field investigations of flow within Doolans Creek
- Desktop review of site environmental context, including geology, hydrology, allocations and wetlands

- Assessment of water demand
- Assessment of effects of taking water from Doolans Creek.

This assessment should be read in conjunction with the following ecological impact assessments:

- e3Scientific, (2026b). *Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment*. March 2026.
- e3Scientific, (2026c). *Remarkables Skifield Expansion Project Ecological Impact Assessment*. March 2026

1.3 Limitations

The findings of this report are based on the Scope of Work outlined above. e3Scientific Limited (e3s) performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental science profession. No warranties, express or implied, are made. The confidence in the findings is limited by the Scope of Work.

The results of this assessment are based upon field investigations conducted by e3s personnel, and information provided in other reports. All conclusions and recommendations regarding the properties are the professional opinions of e3s personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, e3s assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside e3s, or developments resulting from situations outside the scope of this project.

2 Proposed Water Take

NZSki Limited are proposing to take water for snowmaking and potable water from the Doolans Creek Right Branch at the following rates:

- Maximum rate of take: 30 litres per second (L/s)
- Maximum daily take: 2,592 cubic metres per day (m^3/day)
- Maximum monthly take: 38,872 m^3/month
- Maximum annual take: 41,240 m^3/year

This take allows for taking at the maximum rate of take over a full day, and for 16 days of take at the maximum rate within one month as needed for snowmaking and potable supply. In reality, the take is more likely to be spread out over the snowmaking months of May – October. The take will be metered to ensure compliance with the proposed rates of take. Further information regarding the water use requirements are provided in Section 5.3.

Water will be taken using a Tyrolean weir situated within the river (Stantec New Zealand, Remarkables Ski Area Doolans Expansion Water Intake Concept Report, 2025) with a piped connection to a sediment exclusion overflow/flushing chamber (Figure 2). Water intake pumps will be sized for a maximum take of 30 L/s, though they will be on variable speed drives to enable flow reduction if required. Water will be pumped to up to 4 x 30 m^3 tanks. A reservoir with 19,000 m^3 storage is planned to buffer the snowmaking needs of the site (Stantec New Zealand, 2025). Snow production requires a high rate of take (see snowmaking calculations in Appendix B) which could not be supported solely by taking directly from Doolans Creek. With snowmaking using up to 104 L/s, the reservoir provides capacity for 51 hours of snowmaking. With the reservoir filling concurrently, snowmaking can be maintained for 71 hours straight, or 10 sequential 12 hour nights of snow making before the reservoir is emptied.

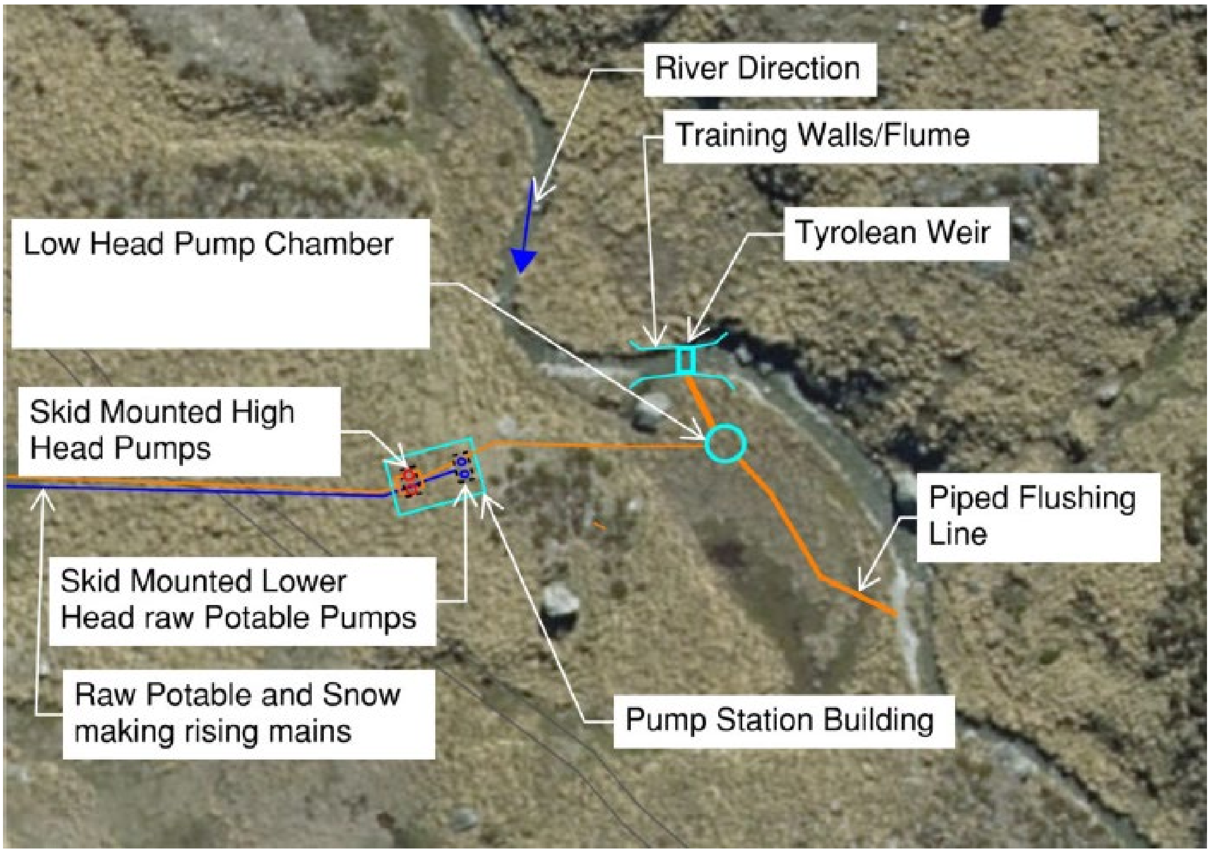

Figure 2: Proposed arrangement at intake site (Stantec New Zealand, 2025)

2.1 Regulatory Context

A full consideration of policies related to the project is provided in the substantive assessment of environmental effects prepared by Mitchell Daysh Limited (2026). A brief summary of aspects of the water take with respect to regional and national policy are provided here for context:

2.1.1 Regional Water Plan

Under Rule 12.1.4.6 of the Regional Water Plan (Otago Regional Council, 2025), the proposed water take would be considered restricted discretionary activity:

12.1.4.6 Taking and use of surface water as a new primary allocation take in catchment areas not listed in Schedule 2A:

(i) This rule applies to the taking of surface water as primary allocation in catchment areas not listed in Schedule 2A, and not subject to Rule 12.1.4.5.

(ii) Unless covered by Rule 12.1.1A.1, the taking and use of surface water to which this rule applies is a *restricted discretionary* activity. The matters to which the Otago Regional Council has restricted the exercise of its discretion are set out in Rule 12.1.4.8.

(iv) Minimum flows for catchments not listed in Schedule 2A will be set on a case-by-case basis such that any minimum flow set will allow the taking of water, while providing for the aquatic ecosystems and natural character of the catchment water bodies and the taking to be subject to Rule 12.1.4.9.

(v) The minimum flows set on a case-by-case basis will continue to apply until investigations have established the appropriate minimum flow. The new minimum flow will be added to Schedule 2A by a plan change and Rule 12.1.4.2 or Rule 12.1.4.4 will then apply.

2.2 National Policy for Freshwater Management 2020. Amended 2025

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.

Policies 1 to 3 and 11 are of particular relevance to the consideration of the proposed water take. A full evaluation of this water take and the wider project against the wider National Policy Statement for Freshwater Management is provided in the substantive assessment of environmental effects prepared by Mitchell Daysh Limited (2026).

2.3 Resource Management (National Environmental Standards for Freshwater) Regulations 2020

The standards contain regulations for activities within wetlands and within 100 m of wetlands that may cause drainage of the wetlands, for reclamation of rivers and maintenance of fish passage. The water take activity and associated reservoir storage will not cause any drainage of wetlands, result in reclamation of river or impede fish passage.

3 Site Environmental Context

The Doolans Basin is an alpine environment located to the east of the existing Remarkables Ski Field and is crown land administered by the Department of Conservation (DOC). The catchment is undeveloped, with the area upstream remaining largely free of anthropogenic influences. Several alpine tarns and creeks with ephemeral headwaters flow throughout the basin which drain towards Doolans Creek at the valley floor. The tussock covered basin is buried by snow in winter and experiences hot dry summers, and the waterways are largely fed by snow meltwater. Vegetation in the area ranges from alpine tussock grasslands within the higher elevation to subalpine shrublands at lower elevations.

3.1 Climate

The Regional Climate of Otago in which the site lies is strongly influenced by the main divide of the Southern Alps/Ka Tiritiri-o-te-Moana. They act as a barrier, separating the wettest region in the country (West Coast) from the driest region (Central Otago). This overall gives the region a semi-arid 'continental' climate (Macara, 2015).

The closest rainfall station is at Queenstown Airport and this measures an average annual rainfall of 757 mm making it the third wettest area in the region and on par with Balclutha and Dunedin (Musselburgh) (Macara, 2015). There is no weather station at the Remarkables, therefore climate data has been sourced from Queenstown Airport Data, National Institute of Water and Atmospheric Research (NIWA) Virtual Climate Station Network (VCN) data and Mt Larkins records. The VCN data was found to be unrealistically similar to Queenstown airport given the expected effect of elevation on rainfall totals. Review of this data provided annual rainfall estimates ranging from 754mm to 1634mm. Annual median rainfalls mapped on the Grow Otago website ranged from 1000-1250 mm in the valley and up to 1500 mm on the ridge[i].

3.1.1 Climate change

Climate change risk has not been assessed, however information has been gathered from the Climate Projections Map produced by the Ministry for the Environment[ii]. This has been generated to a 5 km resolution. The site falls under the Central Otago District,

[i] https://maps.orc.govt.nz/OtagoViewer232/?map=a3d75c9e135142e68f4e02b6fb64eaf7, accessed 4/03/2026
[ii] https://map.climatedata.environment.govt.nz/ , accessed 26/02/26

which has a comparison base period of 1995-2014 under a climate change scenario of SSP1 – 2.6, SSP2-4.5 AND SSP3-7.0 and a future period of 2021-2040 looking at annual variables. The climate change scenario of SSP1–2.6 is considered a 'sustainability' scenario, SSP2-4.5 A 'Middle of the road' and SSP3-7.0 'Regional Rivalry'. This data has been downscaled, therefore while it can be used as an indication of what may happen, it has not been modelled specifically for the site. While this data can be used as an indication, it is not appropriate to be used as a definite analysis.

Table 1: Climate Change Scenarios

Climate Change Scenario	Mean Daily Air Temp. (°C)	Mean Daily Minimum Temp. Increase (°C)	Total Rainfall (%)	No. Rainy Days <1mm	No. very Rainy Days >25mm	Mean Wind Speed (%)	Number of windy days >10m/s (days)	Potential Evapo-transpiration Deficit (PED) (mm) – Drought Exposure
SSP1-2.6	+0.4	+0.4	+0.1	-1.3	+0.5	+0.6	+2.5	+4.2
SSP2-4.5	+0.6	+0.5	-2.9	-3.5	+0.3	-0.8	-1.1	+14.6
SSP3-7.0	+0.7	+0.6	-4.9	-3.9	+0.2	-0.7	-0.6	+26.0

In summary, the site is projected to experience varying increases in temperature, rainfall and higher rainfall events, wind and windy days and drought exposure.

3.2 Geology

Based on the 1:250,000 Geological Map of New Zealand most of the site is situated on Aspiring Lithologic Association TZIV greyschist (Rakaia Terrane) of interlayered psammitic and pelitic greyschist and minor greenschist (Heron, D.W. 2020). The area is classed as having hard sedimentary geology (Snelder, et al., 2010). Doolans Creek is characterised by steep slopes, shallow soils and schist bedrock with the geomorphology undergoing both glacial and fluvial processes. Moraine remnants are visible on site, with active scree zones and confined channel forms.

Specific soil data for the site is limited though, using Manaaki Whenua 'Soil Map Viewer', soil in the area is generally 'Brown Soil'. This is classified as being a mature soil with distinct dark grey-brown topsoil, and a brown or yellow-brown subsoil (Button, 2024). Brown soils make up 50% of soil types in Otago. Mostly occurring on hilly to steep landscapes these soils generally have good drainage and structure with low fertility.

3.3 Hydrogeology

The site does not sit over any groundwater protection zones. The closest groundwater protection zone is the Wakatipu Basin Aquifer located north of the site (ORC, 2022).

Groundwater conditions beneath the site are unknown, however it is expected that any resource would be low yielding within the low permeability schist bedrock. The water table would be expected to be a subdued reflection of the local topography with low flows but steep gradients towards Doolans Creek. Groundwater storage within the catchment is important for maintaining baseflows to the wetlands, tarns, tributaries and to Doolans Creek.

3.4 Hydrology

Doolans Creek is a steep alpine stream which flows north-south along the eastern edge of the proposed Doolans expansion area and is fed by several small tributaries, some of which feed, and are fed by tarns (
Figure 6 & Figure 3). It is a high gradient valley landform with an elevation of 1380-1750m a.s.l. across the site, with visible moraine remnants, active scree zones and confined channel forms. Field observations concluded the main stem of the creek exhibits a steep-pool morphology, coarse bed material and a flashy hydrological regime indicating high sediment potential during storm events and snowmelt periods. Hydrological features in the catchment are shown in Figure 3.

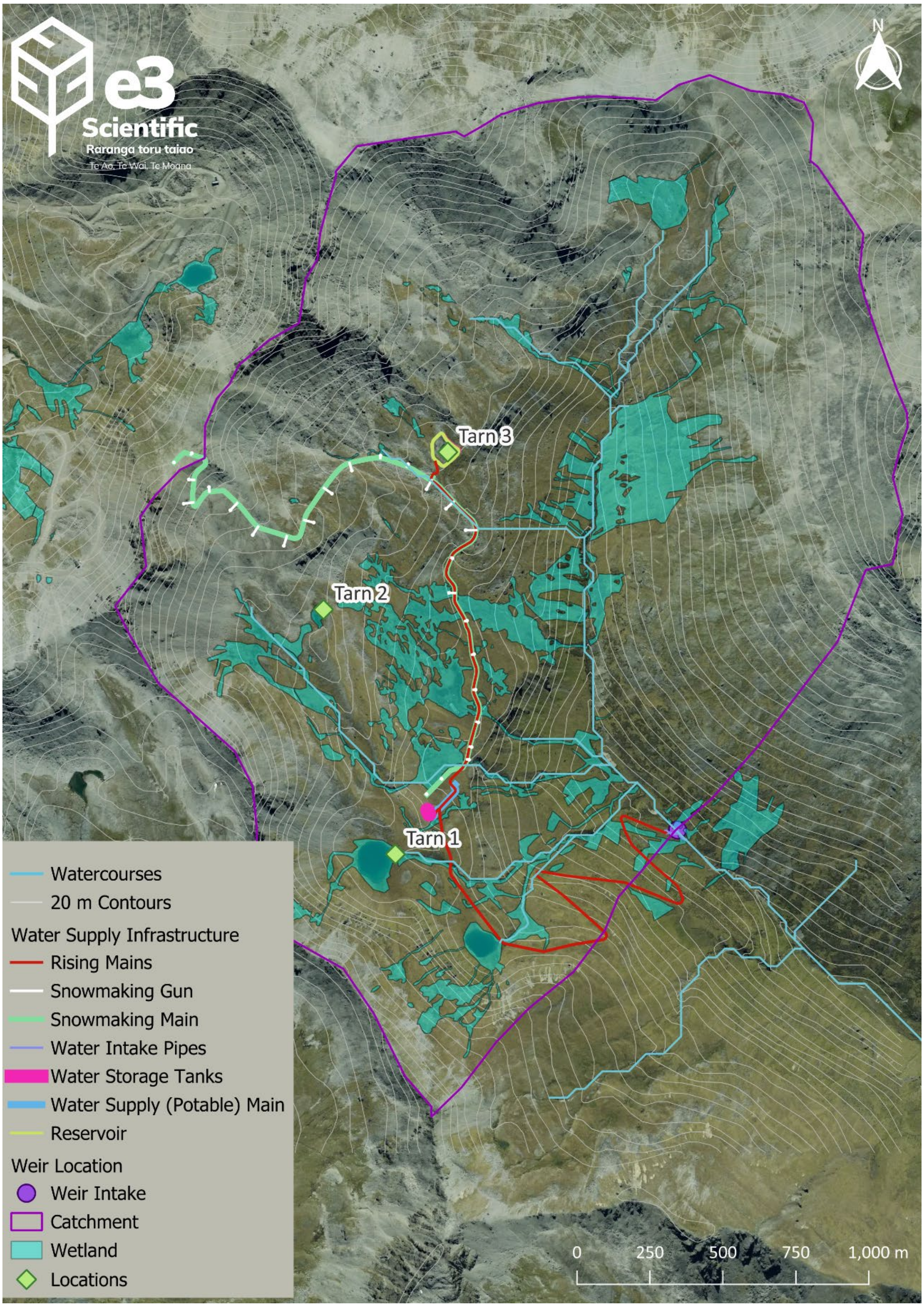

Figure 3: Hydrological Features within the Proposed Take Area

The Doolans Creek Right Branch flows downstream to join the Left Branch and then on to the Nevis River just prior to its confluence with the Kawarau River within the Kawarau Gorge above Lake Dunstan and the Clyde Dam. No regional council nor Land Air Water Aotearoa (LAWA) water quality sites are nearby (within 20 km), however there is a flow monitoring site (Nevis River at Wentworth Station) managed by Contact Energy just upstream of its confluence with the Kawarau River (see Figure 4).

Modelled flow estimates for the intake location are summarised in Table 2, relative to the flows in the Nevis River. The intake catchment is 0.8 % of the Nevis River catchment. To confirm that there is flow available for the proposed take, further field investigations and flow measurements were conducted, which are summarised in Section 4.

Table 2: Modelled Flows

	Intake Location	Nevis River
Catchment (ha)	568	70 368
Median flow[1] (L/s)	132	11 400
Mean Annual Low Flow[1] (MALF) (L/s)	67	4 960

[1] Sourced from NIWA (2025)

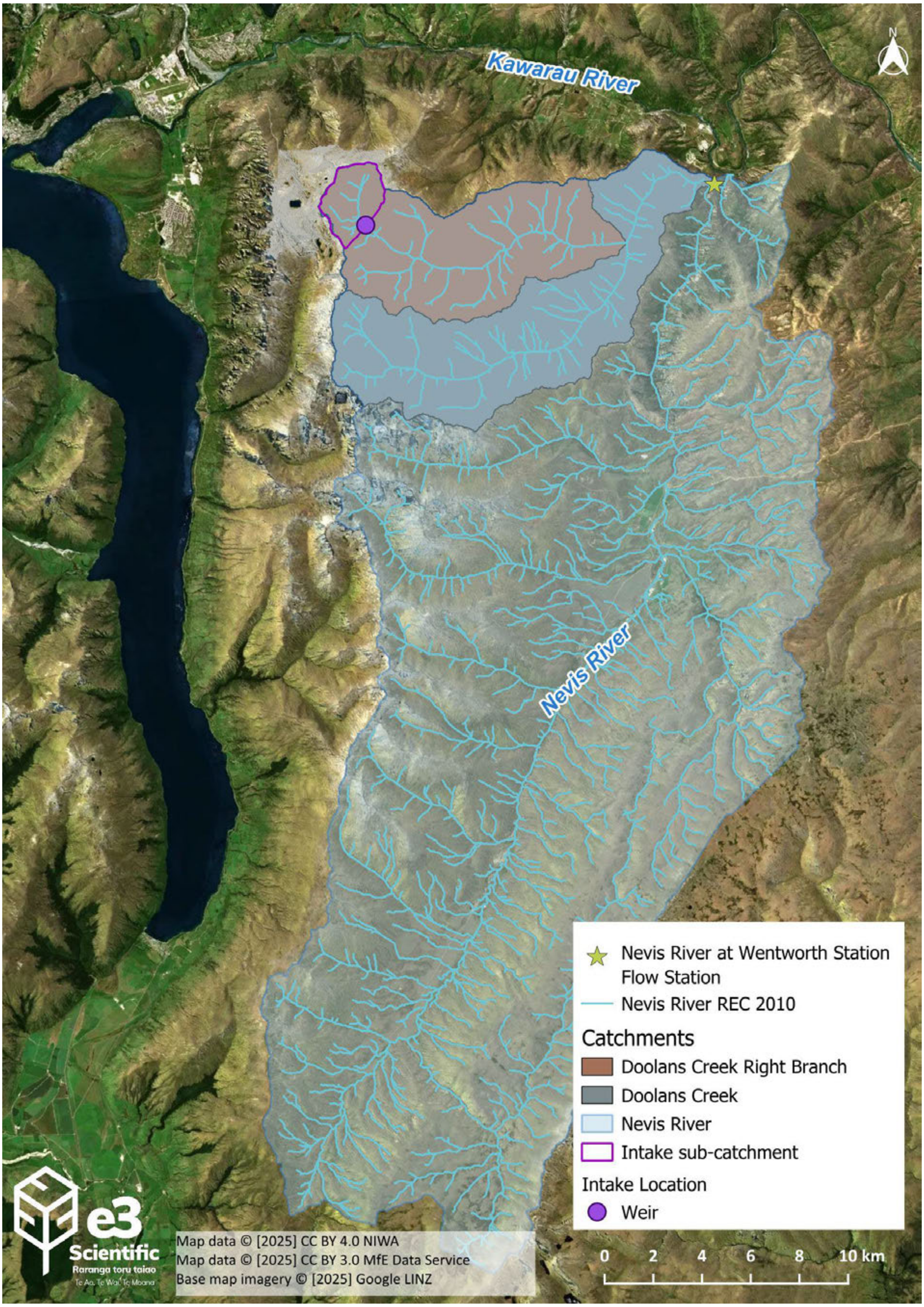

Figure 4: Nevis River Catchment

3.4.1 Tarns

There are several large tarns within the catchment areas of the take. The tarns are described further in e3Scientific, (2026b). Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment. March 2026. Tarn 3 (Figure 3) is to be expanded and lined to create the reservoir for snow-making water supplies and thus is discussed in more detail for this report.

Tarn 3 differs from the other tarns as its water storage is more seasonal – filled after snow melt and slowly declining during the summer season such that the areal extent and volume are greatly decreased, indicating that it does not receive consistent groundwater fed baseflows. For example, whilst the maximum extent of Tarn 3 was ~ 4450 m^2 in January 2026, with depths of ~1.5 m around the tarn edge and up to 3 m in the centre, the maximum water level was only 1.5 m in the centre during the April 2025 site visit, with an approximate area of 2300 m^2. The smaller areal extent equates to ~25% storage of the maximum extent.

The tarn is fed by a small catchment that is part of a glacially formed basin (Figure 5). There are seepage wetlands feeding a small surface water inflow into the tarn, with the closest wetlands 39 m upgradient of the tarn. There is no flow out of the tarn, with the downgradient edge bunded by glacial moraine sediments. The flow to the south of the tarn is fed by a larger catchment area within the basin to the west and goes to ground at the terminus of the basin. Based on this geological setting, the tarn is less likely to be a flow-through system as observed in the other Tarns.

Unlike the other Tarns, Tarn 3 does not have wetlands directly downstream; the closest downgradient wetlands are 260 m to the east (Figure 5). Seepage wetlands downstream of Tarn 3 occur at the break in slope above Doolans Creek and are not in obvious connection to the tarn. They are likely sourced from a much larger catchment area than the tarn. If losses from the tarn were feeding downgradient wetlands, they would be expected to present at the break in slope directly south-east below the tarn, however there are no wetlands present in this area. This is in contrast to the other studied tarns which have permanent areal extent and are inferred to be in connection with groundwater and hence downgradient wetlands. Wetlands downstream of Tarn 2 are approximately 28 m from the Tarn and joined by a water way, while Tarn 1 is adjacent to downstream wetlands (Figure 3).

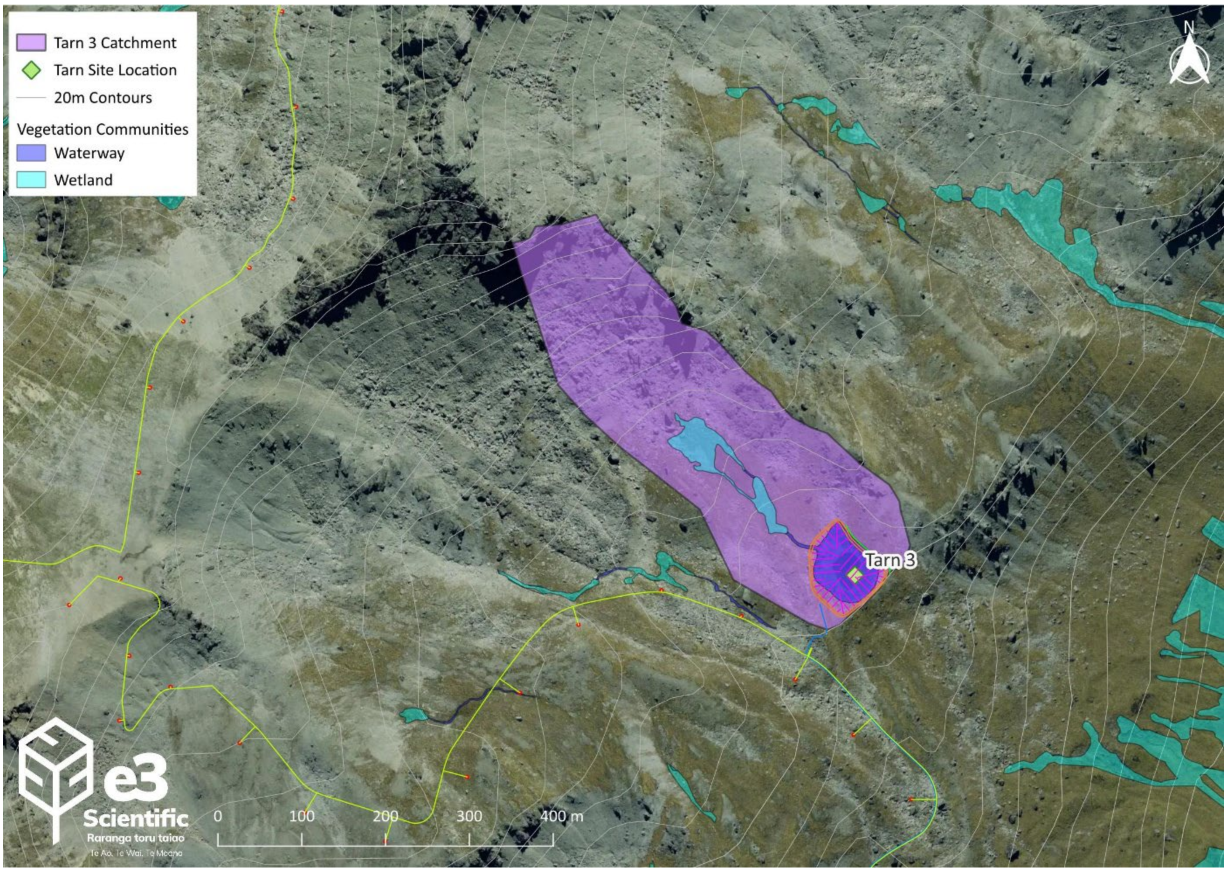

Figure 5: Tarn 3 Hydrology

3.4.2 Wetlands

Wetlands in the study area have been mapped by e3Scientific (Figure 3) and are further described e3Scientific, (2026c) along with an assessment of effects. The wetlands are present on the steep sided slopes of the Doolans valley and are both fed by and provide base flow to tributaries of Doolans Creek.

An assessment of the Manaaki Whenua Wetland Database showed that there are no mapped wetland extents downstream of the proposed development site in the Doolans Creek catchment. Due to the small take relative to the overall catchment flow (the catchment above the take is less than 1 % of the overall Nevis River catchment), and the numerous tributary inflows into the Doolans Creek Right Branch below the take along the almost 12 km reach to its confluence with the Left Branch (see Figure 4) it is not considered necessary to describe wetlands outside of the Doolans Creek Right Branch catchment.

3.5 Freshwater Ecology

Freshwater ecological values have been characterised by e3Scientific and are detailed in the report e3Scientific, (2026b). Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment. March 2026.

4 Field Investigations

4.1 Flow Monitoring

4.1.1 Methodology

Initial site investigations were undertaken in conjunction with the freshwater ecologists in April 2025 to determine whether adequate flow was available in Doolans Creek for a surface water take. Flow was measured at several locations within the upper catchment using a FlowTracker flow meter, which indicated that it was unlikely that adequate flow would be available above the location of the proposed intake (see e3Scientific, 2026c for further information). Based on this initial assessment, detailed water level and flow investigations were conducted at two sites labelled DC2 and DC3 (Figure 6). Capacitance probes logging water levels at hourly interval were installed at these two locations on the 27th May 2025, prior to the site becoming inaccessible due to snowfall (Figure 7).

Flow measurements were collected at the site on three occasions in order to be able to interpret the water level data collected using the capacitance probe during the winter season (one in November 2025, and 12th and 25th in February 2026. Due to snow cover on the site, no flow measurements could be made over the winter season and the first time that the site could be accessed to download the water level data was in November 2025, when flows were high (1042 L/s) due to snowmelt. The aim of the flow gauging events was to determine a rating curve for the site (i.e. to relate recorded water level to flows for the water levels recorded), in order to confirm whether 30 L/s could be sustainably taken at the site. Therefore, the priority was for accuracy at low flows and hence to obtain flow measurements during low flow periods.

Flows were measured in accordance with National Environmental Monitoring Standards for Open Channel Flow Measurement (NEMS, 2026), using either a SonTek FlowTracker 2 (handheld acoustic doppler velocimeter) or NivuFlow Stick, (ultrasonic cross-correlation of flow velocity) and input of depth measurements to integrate flow across the channel cross-section. On each occasion:

- The site for water level monitoring and therefore flow gauging was located 3 - 5 times the channel width downstream of any bends in the creek or significant surface turbulence to increase the portion of laminar flow at the site.
- A total of 20-25 measurements were taken across the creek ensuring depth and velocity measurements were taken at no greater than1/20th of the width.
- The Nivu Flow Stick measures depth using highly accurate pressure transducers.
- Each velocity measurement was recorded after the meter had stabilised at the vertical and for a minimum 40 seconds.
- Care was taken to stand 0.5 m downstream and away from the flow stick when measurements were taken to avoid disturbance.
- At each vertical, the flow meter was aligned with the direction of flow.
- The Nivu Flow Stick was calibrated to meet ISO 748:2021 standards and was transported with care to ensure no damage to the device.
- At each flow measurement, water level sensor data was also downloaded and additional measurements including depth of water at the sensor, stream width, depth and bank height were recorded. The sensor was reset, the sensor housing was checked for debris build up surrounding it and the sensor was reinstalled.

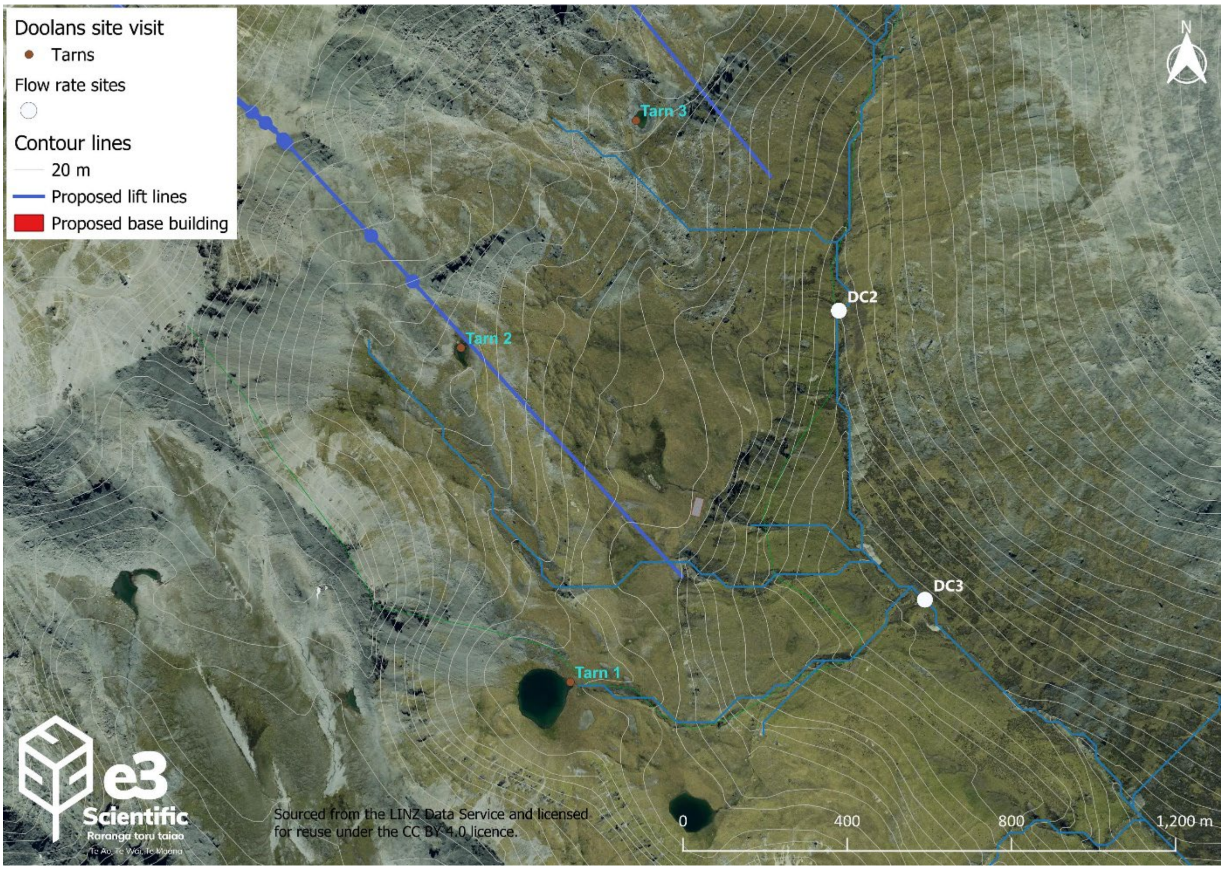

Figure 6: Doolans Creek water level monitoring site locations

Figure 7: DC3 located in the Doolans Creek at 1370 m ASL

4.1.2 Results

As it was apparent from flow gauging that there was unlikely to be adequate water available at site DC2, the discussion in this section focusses on the results from DC3. The proposed intake weir is located 100 m from the original DC3 site due to the requirement to have an area of flat land elevated above high flow levels to site the pump house and access track, whilst avoiding significant ecological areas. However, there are no other tributary inflows between the two locations (DC3 and the actual intake site) and the difference in catchment area is minor due to the topography, therefore the results from DC3 are considered representative of the intake location.

The flow readings collected in February 2026[iii] at low stage (water level) heights are presented in Table 3, and compared with the modelled flows for the site that were provided in Section 3.4.

Table 3: Summary Flow Measurements

Information source	Stage (m)	Flow rate (L/s)	Uncertainty (%)	Flow +/- (L/s)
Flow measurement 19.11.2025	0.390	1042	3.4	35.4
Flow measurement 11.02.2026	0.247	98	4.4	4.3
Flow measurement 25.02.2026	0.207	65	4.0	2.6
Median flow[1]		132		
Mean Annual Low Flow (MALF)[1]		67		

[1]NIWA. NZ River Maps. Retrieved from River Maps: https://shiny.niwa.co.nz/nzrivermaps/, accessed 29/07/2025

The water level measurements recorded at site DC3 from 27th May 2025 till 25th February 2026 are presented in

Figure 8. Water levels were lowest during February, May and June. The two flow readings taken in February at low stage heights are represented by the red and green

[iii] While additional measurements were taken at this site, one flow reading was well above the desired low flow range, therefore not helpful for defining low flows. Velocity measurements were also made on other dates without a flow meter, have lower level of accuracy and are not included here although they do broadly concur with the flow readings obtained using the flow meter.

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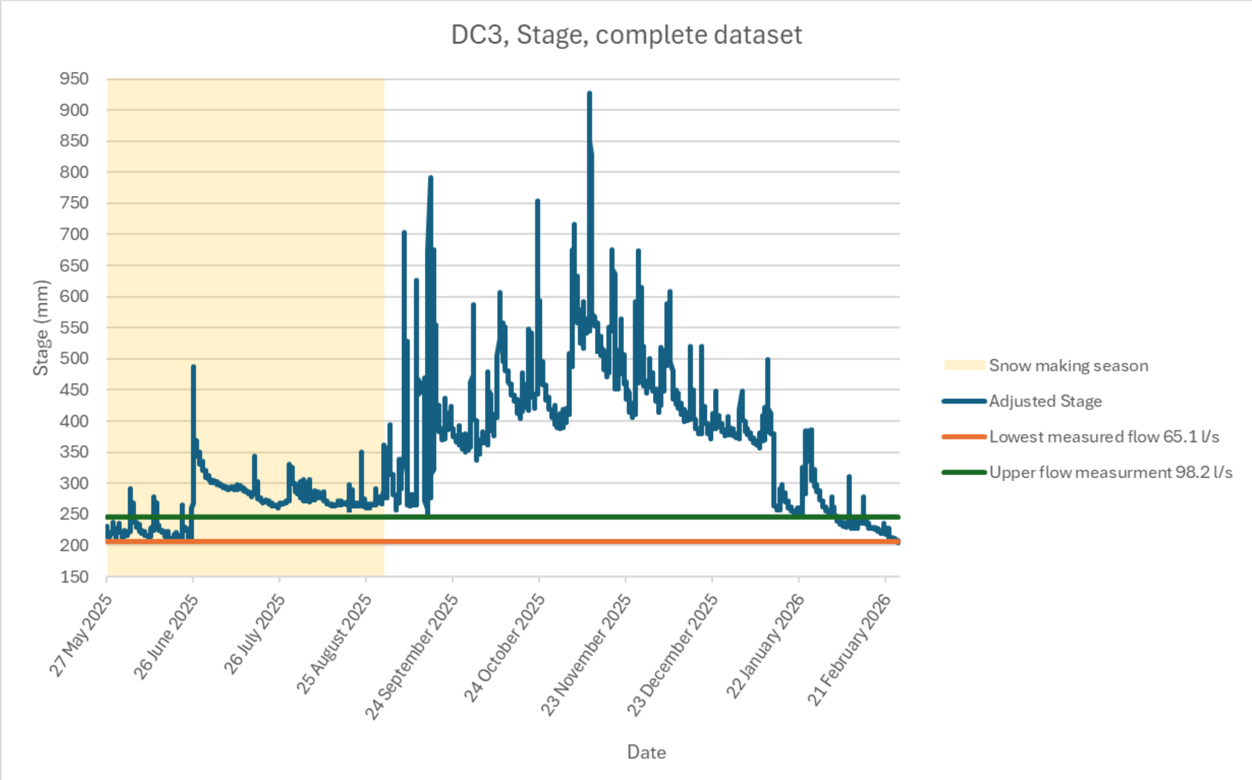

Figure 8. The lowest water level recorded was 207 mm (0.207 m) on the 25th February 2026 and corresponded to a 65.1 ± 2.6 L/s flow rate. Flow gauging on the 12th February 2026 occurred when the water level was 246 mm (0.246 m) and corresponded to a 98.2 ± 4.3 L/s flow rate.

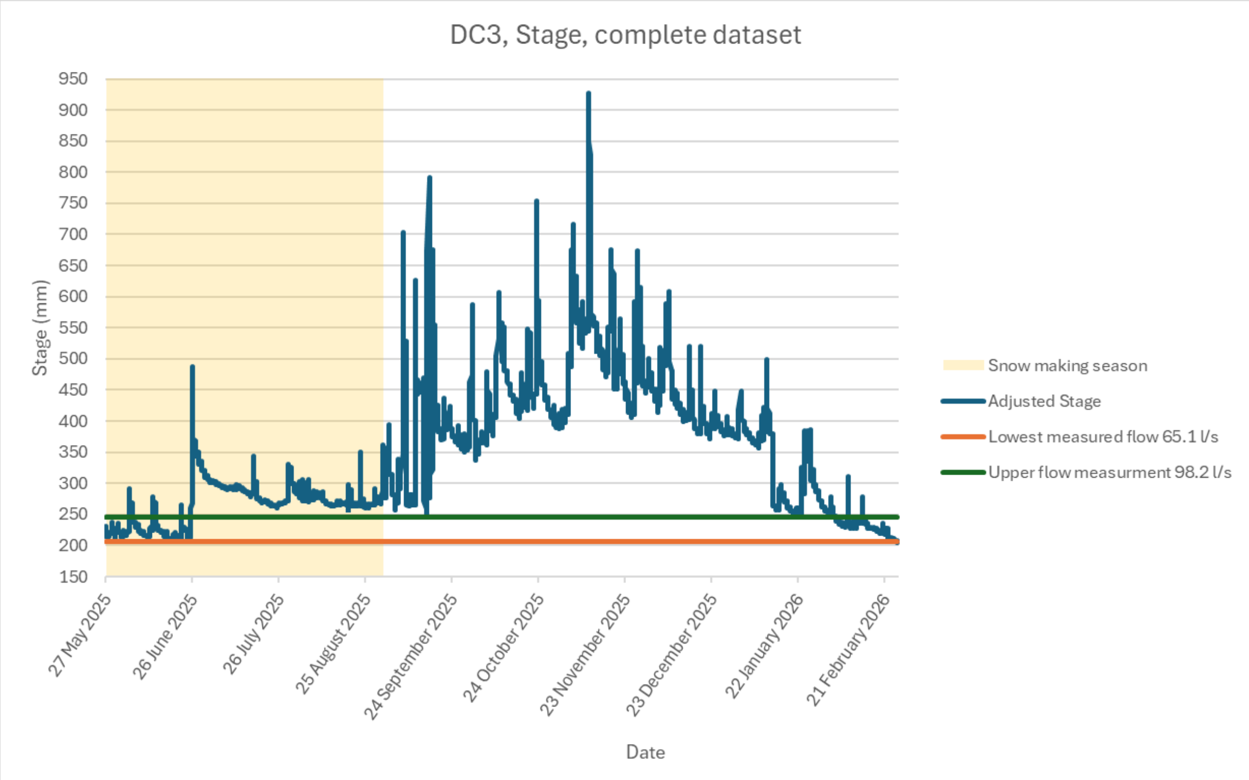

Figure 8: Stage (mm) at DC3 throughout the monitoring period

Figure 9 shows the average daily stage heights over the snow making period. Stage heights lowered to 207 mm for one day in June; suggesting the lowest flow for the snowmaking period was also 65.1 L/s. The modelled MALF previously obtained from NIWA (2025) was 67 L/s, which shows good agreement based on the data collected. Obtaining sufficient data points to confirm a low flow rating curve was not possible at this site given access to the site during winter and the large range in flows across seasons. However, the information obtained is sufficient to establish that flows during the snow making period are unlikely to decrease below 65 L/s for extended periods and therefore the proposed maximum take of 30 L/s would result in 54% of the flow remaining in the creek below the intake point.

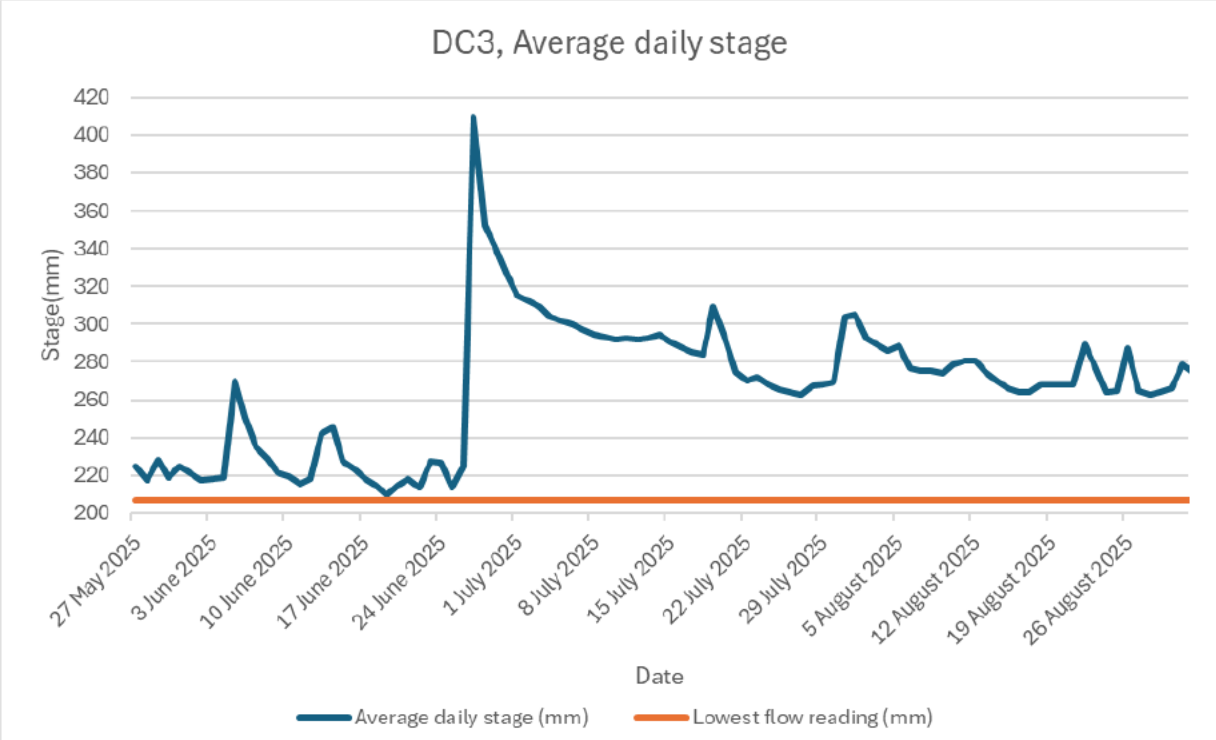

Figure 9: Average daily stage values during the snowmaking season

4.1.3 Discussion

Flow data was obtained by approval from Contact Energy for the Nevis River downstream of the junction with the Doolans Creek for the period 1978-2025 (Nevis River at Wentworth Station – see Figure 4). The low flow readings measured at DC3 in February 2026 were compared to the Nevis River flows on the same day in Table 4. Flows at DC3 contributed 0.93% and 0.85% of Nevis River flows at the two low flow readings.

Table 4: Comparison between Nevis River and DC3 flow rates

	Catchment area	Flow 11/02/2026	Flow 25/02/2026
Nevis River catchment	70,368 ha	10,600 L/s	7,650 L/s
DC3 catchment	568 ha	98.2 L/s	65.1 L/s
DC3 Flow contribution to Nevis River Flow	0.8%	0.93%	0.85%

Nevis River data (47 years) was analysed to compare the median monthly flows during the 2025 snowmaking season to historic data for May – August inclusive, presented in Table 5. The flow in the Nevis River on the day the water level monitoring site at DC3 was installed, 27th May 2025, was **5,590 L/s**. This flow is within the lowest 10% of historic Nevis River flows recorded for May. The median flows for May – August in 2025 were within the 10th percentile of historic Nevis River flows, except for July which was within the 30th percentile. This indicates that the water levels measured at DC3 during the 2025 snow making months are representative of a low flow year, i.e in most years, flow at the intake site during the snowmaking season will be higher than that measured in 2025.

Table 5: Flow Statistics for Nevis River flow (1977-2025) compared to median flows for 2025

Month	Percentile Flows (L/s) (1977 - 2025)										Median flows (L/s) 2025
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
May	5971	6871	7838	8993	10274	11740	13539	16200	20908	87396	**6449**
Jun	7075	8045	8927	9840	10839	12390	14068	16552	20743	123476	**6708**
Jul	6288	6958	7692	8370	9227	9982	10928	12255	14321	72065	**8310**
Aug	6121	7198	8148	9019	9840	10677	12012	13446	16281	84062	**6020**

Median flow for the Nevis River is displayed in Figure 10, it can be seen that between the seasons of May-August that 2025 experienced lower flows than other years between 2015-2025. The seasons of May to August were used to display the main timeframe of expected snow making. Therefore,

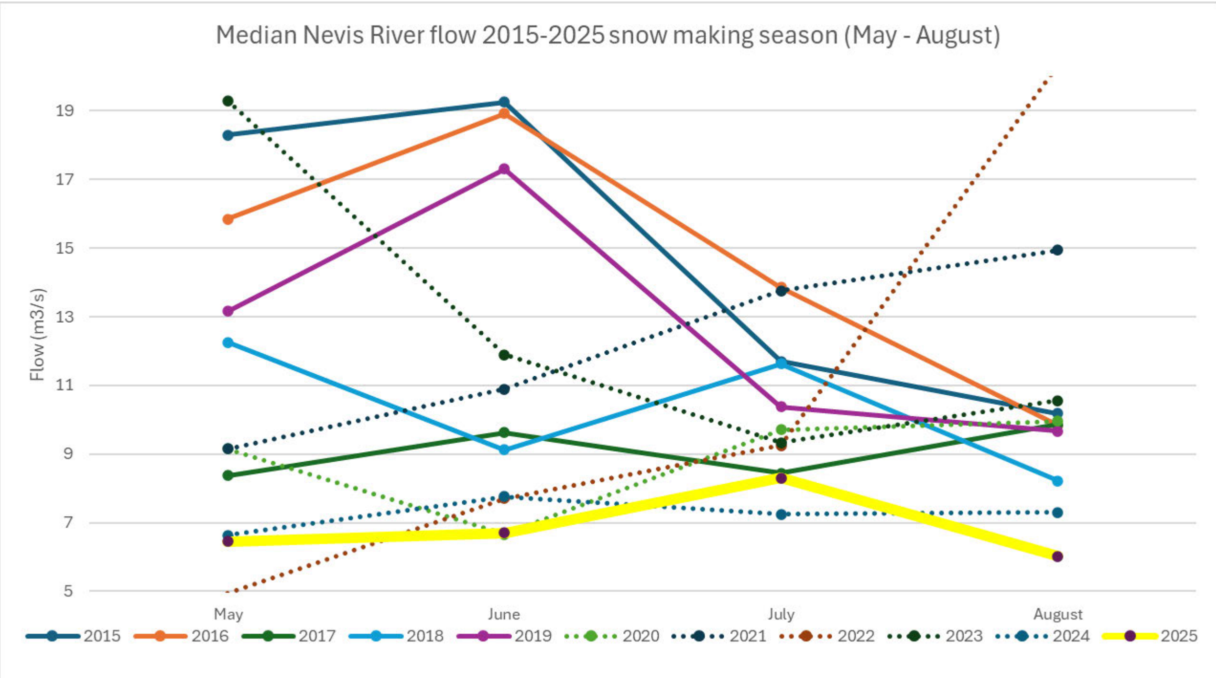

Figure 10: Nevis River Median Flow between 2015-2025 for the snow making season (May-August)

4.2 Water Quality

4.2.1 Methodology

A water quality sample was collected from Doolans Creek at DC3 on 27 May 2025 to confirm whether the Doolans Creek water is suitable for drinking water supply. The field QA/QC procedures performed during the water sampling are listed as follows:

- Use of standardised field sampling forms and methods;
- Field personnel wore a fresh pair of nitrile gloves between sampling events;
- Water samples were transferred to plastic sample bottles as supplied by Analytica Laboratories;
- Samples were transferred under chain of custody procedures;
- All samples were labelled to show point of collection, project number, and date;
- Headspace in sample bottles was avoided;
- The threads on the sampling bottles were cleaned to avoid VOC loss;
- All samples were stored in a cooled chilly bin containing ice while in the field to reduce the potential for volatilisation and/or precipitation.

Field parameters were measured on site using a calibrated YSI ProDSS Multiparameter meter that measured water temperature, dissolved oxygen, conductivity, pH and turbidity. The meter was deployed mid water and allowed to stabilise for 1 minute before the readings were recorded.

All water samples were couriered to Hill Laboratories within a day of collection. Hill Laboratories have IANZ accreditation for the water quality analysis completed and conduct internal QA/QC in accordance with IANZ requirements.

Following the receipt of laboratory data, a detailed review of the data was performed to determine its accuracy and validity. All laboratory data were checked for analytical and typographical errors.

4.2.2 Results

Water quality at DC3 was very high quality, with low total dissolved salts, and concentrations of heavy metals, *E.coli* and nutrients below detection levels. Water quality was well below the Maximum Acceptable Values (MAV)[iv] for drinking water based on the Drinking Water Standards for New Zealand Regulations for 2022, and are

[iv] https://www.legislation.govt.nz/secondary-legislation/pco-drafted/2022/168/en/latest/#LMS698021

considered well within aesthetic values. The full laboratory analysis is found in Appendix A.

Note that this sample may not indicate the full range of quality at the site; however given the high elevation and that there are no anthropogenic influences in the catchment, it is likely that this sample is representative of the water quality during low flows.

5 Assessment of Effects

5.1 Allocation

Doolans Creek lies within the Nevis River catchment, Otago Regional Council identifies as having 2554 L/s of water that may be allocated as 'primary allocation' water allocation. Primary allocation is the first amount of water that can be allocated for taking and using by resource consents. Currently, 418 L/s is allocated to water take consents, leaving 2135 L/s of available allocation[v]. The requested take of 30 L/s is only 1% of the available allocation and, therefore, can be taken as primary allocation, leaving a further 2105 L/s for allocation within the catchment. Furthermore, the take for snow-making will only be taken during the winter months, when irrigation takes are not operational. Water use consents are discussed further in Section 5.4.

5.2 Effects on Flows

The water take of 30 L/s is 46% of modelled Mean Annual Low Flow (MALF) at the intake location. A consent condition is proposed to maintain a residual flow of 20 L/s in the creek at this location at all times.

The effect on flows is considered low for the following reasons:

a) The overall volume of the take is low – equivalent to 16 days of take at the maximum rate. The take will only operate to fill the available storage, and will

[v] https://maps.orc.govt.nz/OtagoViewer232/?map=2b72476ec76446cf8270dad325952215, accessed 10/03/2026

otherwise be dormant. If the storage was completely empty (which would be extremely unlikely), it would be filled in 7.3 days. The take would not be expected to run continuously. Snowmaking will only occur when it is required and when conditions are suitable. Ten hours of snowmaking overnight would use 3,528 m^3 from the available storage, which would subsequently be replaced over a period of 33 hours.

b) The take is situated high within the catchment (see Figure 4) and additional tributaries join the flow within 500 m of the intake location. Figure 11 displays the increase in modelled MALF along Doolans Creek below the intake. This demonstrates that based on the additional flows to the creek, the take is equivalent to 30% of MALF 600 m downstream of the take, and 18% of MALF within 2.5 km of the take. In addition the snowline at 1100m elevation can be seen, below which precipitation is expected to fall as rain and contribute more to streamflow rather than being stored in the snowpack.

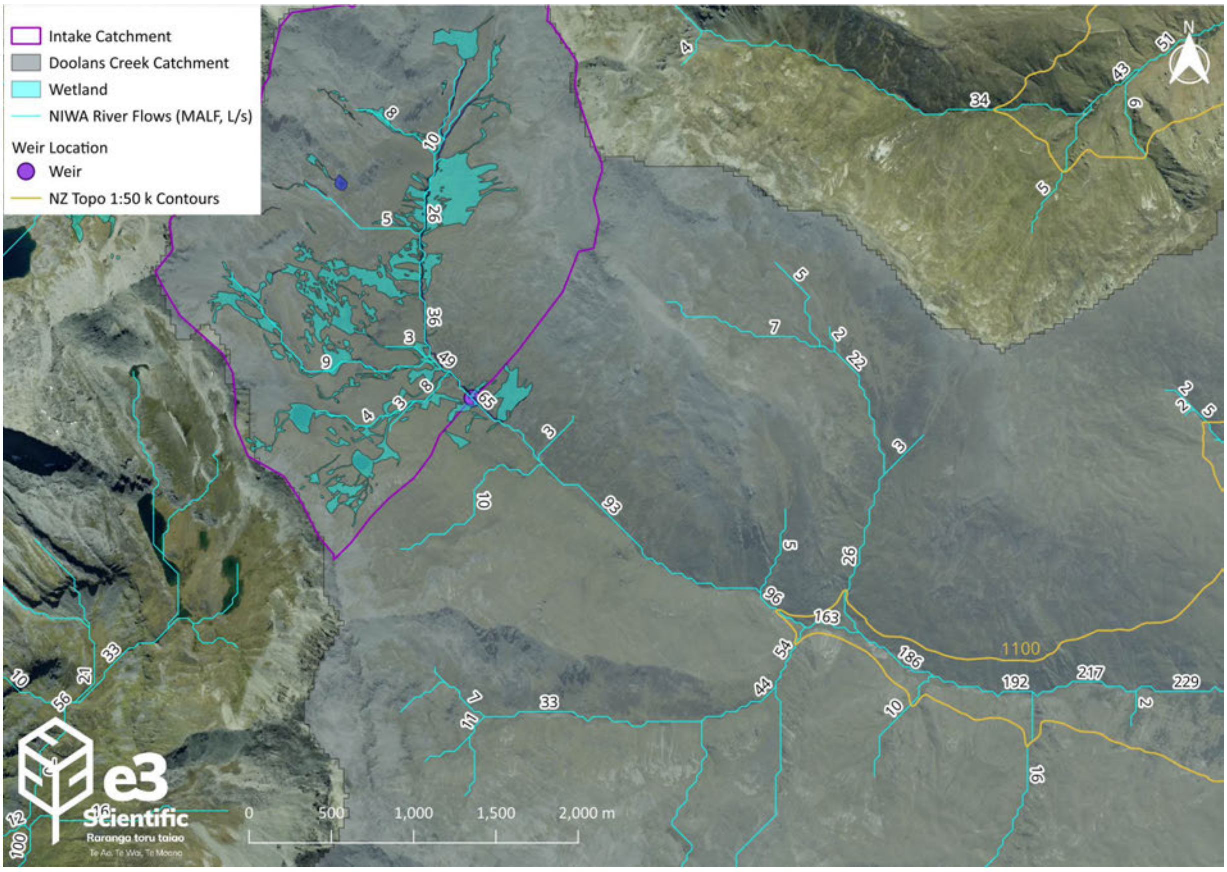

Figure 11: Catchment Hydrology including elevation and MALF

c) In terms of the wider catchment, the amount of flow being extracted from Doolans Creek is representative of approximately 0.5% of the Nevis River MALF as displayed within Table 2, and is therefore not significant, particularly as more than 92% of the take will be during the winter months when there is no soil moisture deficit, and irrigation takes are dormant.

It should also be noted that the majority of the water will be returned to the catchment as snow on the planned trails (the snow-making calculations consider that 15% is lost due to wind transport and evaporation). Snowmelt from this area will therefore return the water to Doolans Creek upstream of the water take (see Figure 12 for the location of snow-making relative to the water take). During spring snowmelt, flows are greatly increased (see

Figure 8 plot of water level fluctuations), and the snowmelt from the snow-making is not expected to measurably affect the measured flows within the creek[vi].

5.3 Efficiency of water use

The water take will be limited to supply the needs of the site and is summarised in Table 6, with the water infrastructure proposed for the site shown in Figure 12. The water take will cease when storage capacity is reached at 19,000 m³, with the total annual take requested equivalent to pumping 16 days at the maximum requested rate of take.

Table 6: Site Water Demand

Summary	Daily rate (m^3)	Monthly take (m^3/month)	Annual Take (m^3/year)
Snowmaking	2,592[1]	38,134	38,134
Potable Water	24	738	2986
Additional Storage			120
Total	2592	38,872	41,240

[1] The maximum daily rate taken for snow-making is not reduced to account for potable water as there may be some days when the potable storage is full and the snow-making is not. However, the maximum daily rate of take will not be exceeded regardless of whether it is allocated to snow-making or potable supply.

[vi] Note the area of trails over which snow is to be made is ~8.3 ha (or 1.5 % of the intake catchment). When snowmelt occurs, there would be expected to be snow coverage over a large proportion of the catchment.

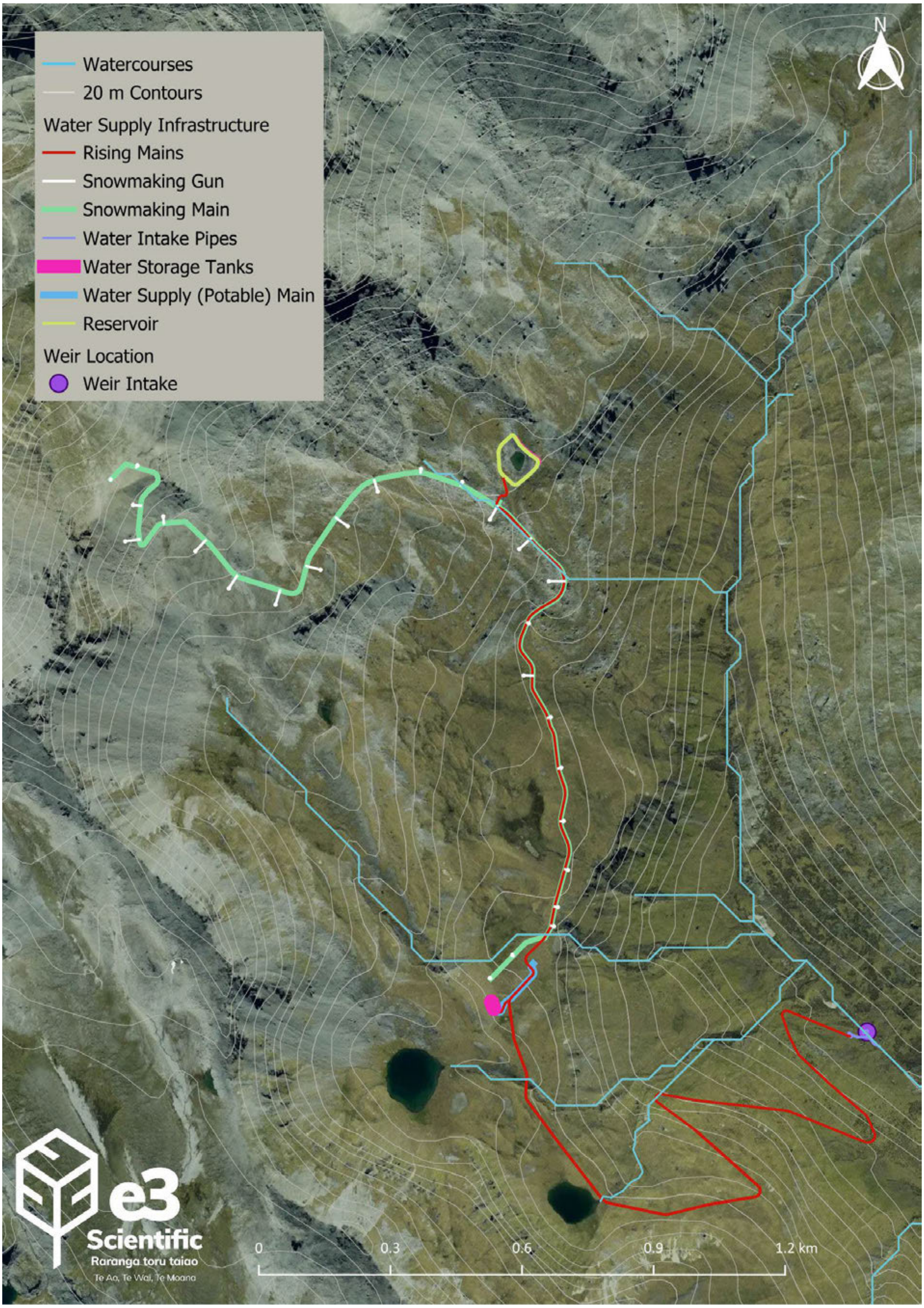

Figure 12: Proposed Water Infrastructure

5.3.1 Potable Water

Potable water will be held in three or four 30 m³ tanks storage tanks. Based on approximations by Wyatt + Gray Architects, the base building is designed for 946 pax per day (18 back of house and front of house kitchen staff, 10 staff above the number working in the kitchen and 918 visitors). The water demand for the base building is provided in Table 7.

Table 7: Potable Water Demand During Winter

Category	No. People/Covers	L/pp	Day (L/day)
BOH and FOH Staff	18	30	540
Additional Staff	10	30	300
Visitors	918	25	22,950
Total	946		23,790

Over the ski season (June-September), the potable water demand is expected to be 2,950 m³. With an additional amount for reduced crew (nominally 5 people) over summer months, the annual potable water requirements are expected to be ~2,986 m³/year.

5.3.2 Snow-making

Snow making volumes are based on a requirement to provide 0.5 m base and 0.5 m of conditioning snow on the two planned snow trails within the Doolans Stage 1 Development. The main trail will have an area of 76,500 m², with the learners trail having an area of 6400 m². The location of the snowmaking guns is found in Figure 12. The total volume of water supply required for these trails is 38,134 m³. Detailed calculations are provided in Appendix B. It is assumed that snow making activities will occur between the months of June to September.

Note that while all snow making from this water take is intended to be used within the Doolans Creek catchment, snow-making will occur at the top of the ridge to ensure safe snow levels at the top base cut into the ridge line. Snow made in this area may fall in either the Doolans Creek or Rastas Burn catchment depending on the wind direction, however, it is considered that this mimics the natural processes that occur on the ridge line, with snow blown over the ridge on windy days.

5.3.3 Fire-fighting

Limited firefighting storage will be provided; due to the building access limitations, the fire service is unable to reach the site and firefighting rate of take does not require inclusion. Due to the base building location, it will not be able to be reached by fire-fighting services in the event of a fire. No sprinkler storage will be supplied; instead safe escape paths will be prioritised. Limited fire-fighting supplies will, therefore, be made available from the storage tanks planned for the base-building (see next section). The use of water for fire-fighting is expected to be a limited amount (Table 6) and only on an as required basis (refer to water storage discussion below for further information).

5.3.4 Water Storage

A reservoir with 19,000 m^3 storage is planned to buffer the snowmaking needs of the site (Stantec New Zealand, 2025). Snow production requires a high rate of take (see snowmaking calculations in Appendix B) which could not be supported solely by taking directly from Doolans Creek. With snowmaking using up to 104 L/s, the reservoir provides capacity for 51 hours of snowmaking, and would take 176 hours (7.3 days) to fill completely. With the reservoir filling concurrently, snowmaking can be maintained for 71 hours straight, or 10 sequential 12 hour nights of snow making before the reservoir is emptied.

Up to four x 30 m^3 storage tanks are planned for potable water and fire-fighting supply next to the base building. An additional amount of water has been added to the water demand calculations to keep these storage tanks full at the end of the season.

5.4 Water Users

Otago Maps layer 'Consents in Otago'[vii] and 'Water Allocation Catchment' was assessed to understand if other water users would be affected by the proposed water take. There is only one water take consent downstream of the site – RM21.351.01.V1 – to take and use water from Doolans Creek to irrigate 80 ha of land. As this is an irrigation take, the take will not be exercised during the snowmaking season during which period crops are not growing and there is no soil moisture deficit. It should also be noted that the total annual volume requested is only equivalent to 16 days of take at the proposed maximum rate. There are therefore no lawful downstream waters users that will be affected by this take.

[vii] https://maps.orc.govt.nz/OtagoViewer232/?map=2b72476ec76446cf8270dad325952215, accessed 4/03/26

5.5 Freshwater Ecology

Freshwater ecological effects have been assessed in an Ecological Impact Assessment (FEcIA) that will assess affects from the weir install, water abstraction and reservoir (tarn loss) (e3Scientific, Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment. March 2026., 2026b).

5.6 Wetlands & Tarns

Wetlands may affected by changing water levels. The water level in Doolans Creek at the intake point was only 0.207 m when the flows were 65 L/s, and therefore the reduction in water level in the creek due to the take of 30 L/s would be no more than 0.1 m at the full rate of take.

The majority of wetlands identified in Section 3.4.2 are seepage wetlands which provide baseflow to Doolans Creek and are located on the steep sides of the valley, therefore minor lowering of the water levels within Doolans Creek will not change the groundwater gradient to the creek and will, therefore, not impact on the hydrological functioning of any of these wetlands.

Riparian wetlands may be present downgradient of the take that could be affected by lowering the water levels by 0.1 m, however as the take can only operate at the maximum rate of take for the equivalent of 16 days, lower water levels would not be sustained over a long enough period to have any effects. It should also be noted that more than 92% of the take will occur during winter when there is no soil moisture deficit. Furthermore, as seen by the water level monitoring detailed in Section 4.1.2, the site is naturally subject to large seasonal fluctuations in water level, and flows will greatly increase during snowmelt.

The reservoir is to be constructed in the location of an existing tarn. The flow into the tarn is to be diverted into an armoured swale around the northern side of the tarn which will also prevent any upgradient flows directly entering the reservoir. This will allow the water that previously fed the tarn to infiltrate to ground in close proximity to the existing tarn.

There are no downgradient wetlands that will be affected by loss of seepage due to lining this tarn. The nearest downgradient wetlands are ~260 m from the tarn (see

Section 3.4.1), and are therefore outside of the 100 m buffer required for assessment under the NES-FM.

There are wetlands 39 m upgradient of the tarn (see Figure 5) which feed the small inflow to the tarn. The NES-FM Rule 54 (c) states that "the taking, use, damming, or diversion of water within, or within a 100 m setback from, a natural inland wetland" would be non-complying "if

(i) there is a hydrological connection between the taking, use, damming, or diversion and the wetland; and

(ii) the taking, use, damming, or diversion will change, or is likely to change, the water level range or hydrological function of the wetland:

As the catchment of these wetlands is upgradient of the wetlands, lining of the tarn will not affect the water level range or hydrological function of these wetlands. There will be no earthworks within 10 m of these wetlands.

5.7 Alternative Water Sources

Groundwater conditions beneath the site have not been investigated, however it is expected that any resource would be low yielding within the schist bedrock, and important for maintaining baseflows to the seepage wetlands. Given the difficulty of access to drill investigation wells, the low likelihood of success, and high likelihood of significant adverse effects on wetlands and tarns due to groundwater drawdown, groundwater supply was not considered further.

A water take from the largest nearby Tarn 1 was considered, however due to the high ecological values of the tarn (e3Scientific, Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment. March 2026., 2026b), and the tributaries and wetlands sustained by the tarn, it was not considered further.

Taking of additional flow from Lake Alta or the Rastas Burn was not considered viable due to the current water take in that catchment. Also, this would not be culturally sensitive due to water being sourced from one catchment and transferred to another.

Alternative sites were investigated for the proposed water take within Doolans Creek, however there was insufficient flow higher in the catchment to provide an adequate sustainable take.

5.8 Climate Change

The effects of climate change have been considered as a part of this assessment. As discussed, the site may be impacted by future climate changes and part of the purpose of snow-making is to cater for variation in climate conditions i.e. to make snow when there is not enough coverage of the trails. Further site-specific assessment may be required for operational matters as the current assessment is off Queenstown Airport. Regardless of any change in flows resulting from climate change, we consider that these will be managed to appropriately mitigate effects by maintaining a residual flow within the creek downstream of the take.

5.9 Summary of Effects

The proposed water take of 30 L/s will have less than minor effects on the allocation or flows within the Nevis River, as the catchment above the intake site is 568 ha and is only 0.8 % of the overall Nevis River catchment. The take is 1% of the allocation available within the Nevis River catchment and representative of approximately 0.6% of the Nevis River MALF. Water level and flow monitoring indicates that flow in Doolans Creek at the intake is unlikely to decrease below 65 L/s for extended periods during the snow-making season and therefore the proposed maximum take of 30 L/s would result in 54% of the flow at this location remaining in the creek under low flow conditions.

The proposed rates of take are considered to be reasonable and efficient for the uses of potable water supply and snow-making, with the demand buffered by appropriate water storage. Given the take will be operational during the winter months when downstream irrigation takes are dormant, there will be no adverse effects on downstream water users or flows. A proposed condition of consent is to retain a residual flow of 20 L/s in the creek at the intake location at all times to guarantee sustained flow within the creek downstream of the take. The wetlands present within the catchment are mostly elevated above the creek within the steep sided valley. Minor lowering of the water level within the creek will not alter the hydraulic gradient to the creek and therefore will not impact on water levels within these wetlands. Given that the proposed take is equivalent to only 16 days of take at the maximum rate, and will be mostly taken during the winter months, reduced water levels will be of short duration and will not affect any riparian wetlands that may be present downstream of the take.

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To summarise, the effects of the water take on Doolans Creek will be mitigated by only taking the water quantities required for outlined activities, storing water to buffer the water demand and maintaining flow during low flow periods. To understand the ecological effects of this take, this assessment should be read in conjunction with the following ecological impact assessments:

- e3Scientific, (2026b). Doolans Basin Tarns, Weir, Water Take and Reservoir Freshwater Ecological Impact Assessment. March 2026.
- e3Scientific, (2026c). Remarkables Skifield Expansion Project Ecological Impact Assessment. March 2026

6 Proposed Consent Conditions

The Client is seeking a consenting period of 35 years.

1. The take and use of surface water as primary allocation from Doolans Creek at the map references specified above and the land legally described above for operating a ski resort must be carried out in accordance with the plans and all information submitted with the application and any amendments to the application lodged, detailed below, and all referenced by the Consent Authority as application number [TBC] :

a) Application form, and assessment of environmental effects dated March 2026.

If there are any inconsistencies between the above information and the conditions of this consent, the conditions of this consent will prevail.

2. The rate and quantity of abstraction as primary allocation from Doolans Creek must not exceed:
    a. 30 litres per second;
    b. 38,872 cubic metres per month (m^3/month)
    c. 41,240 m^3/year in each 12 month period, starting 1 January and ending 31st December of the following year

   The total annual take under this consent shall not exceed 41,240 m^3
3. A residual flow of no less than 20 litres per second shall be maintained in the Doolans Creek immediately downstream of the point of intake identified on this permit for Doolans Creek when the stream flow at the point of take is at or above 20 litres per second
4. No abstraction shall occur from Doolans Creek when the stream flow at the point of take is less than 20 L/s.
5. The Consent Holder must maintain:

i. water meters at the point of take that will measure the rate and the volume of water taken to within an accuracy of +/- 5% over the meter's nominal flow range at the locations specified. The water meter must be capable of output to a datalogger. No mechanical or clamp on water meters must be installed.

ii. a datalogger for each location of take that time stamps a pulse from the flow meter at least once every 15 minutes and have the capacity to hold at least twelve months data of water taken.

iii. a data logger which enables all of the data to be sent to the Consent Authority.

6. The Consent Holder must provide data once yearly to the Consent Authority. The Consent Holder must ensure data compatibility with the Consent Authority's time-series database and conform with Consent Authority's data standards.
7. Within 20 working days of the installation of the water meter / datalogger/ telemetry unit, any subsequent replacement of the water meter / datalogger/ telemetry unit and at five yearly intervals thereafter, and at any time when requested by the Council, the Consent Holder must provide written certification to the Consent Authority signed by a suitably qualified person certifying, and demonstrating by means of a clear diagram, that:

    i. each device is installed in accordance with the manufacturer's specifications;

    ii. data from the recording device can be readily accessed and/or retrieved in accordance with the conditions above; and

    iii. that the water meter has been verified as accurate. d) The water meter / datalogger / telemetry unit must be installed and maintained throughout the duration of the consent in accordance with the manufacturer's specifications.
8. All practicable measures must be taken to ensure that the water meter and recording device(s) are fully functional at all times.
9. The Consent Holder must report any malfunction of the water meter / datalogger/ telemetry unit to the Consent Authority within 5 working days of observation of the malfunction. The malfunction must be repaired within 10 working days of observation of the malfunction or within a timeframe agreed with the Consent Authority in writing and the Consent Holder must provide proof of the repair, including photographic evidence, to the Consent Authority within 5 working days of the completion of repairs.

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Appendices

Appendix A: Water Quality Sample Results

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

0508 HILL LAB (44 555 22)
+64 7 858 2000
mail@hill-labs.co.nz
www.hill-labs.co.nz

Certificate of Analysis

Client:	E3 Scientific Limited	**Lab No:**	3901315 DWAPv1
Contact:	[redacted]	**Date Received:**	28-May-2025
		Date Reported:	03-Jun-2025
		Quote No:	137750
		Order No:	
		Client Reference:	25047
		Submitted By:	[redacted]

Sample Type: Drinking Water for DWSNZ Compliance

			Aesthetic Values	Maximum Acceptable Values (MAV)
Sample Name:		Dc3 27-May-2025 11:30 am		
Lab Number:		3901315.1		
Routine Water + E.coli profile Kit				
Escherichia coli	MPN / 100mL	< 1	-	< 1
Routine Water Profile				
Turbidity	NTU	0.08	≤ 5	-
pH	pH Units	7.4	7.0 - 8.5	-
Total Alkalinity	g/m³ as $CaCO_3$	24	-	-
Free Carbon Dioxide	g/m³ at 25°C	2.0	-	-
Total Hardness	g/m³ as $CaCO_3$	24	≤ 200	-
Electrical Conductivity (EC)	mS/m	5.6	-	-
Electrical Conductivity (EC)	µS/cm	56	-	-
Approx Total Dissolved Salts	g/m³	37	≤ 1000	-
Total Arsenic	g/m³	< 0.0011	-	0.01
Total Boron	g/m³	< 0.0053	-	2.4
Total Calcium	g/m³	8.6	-	-
Total Copper	g/m³	< 0.00053	≤ 1	2
Total Iron	g/m³	< 0.021	≤ 0.3	-
Total Lead	g/m³	< 0.00011	-	0.01
Total Magnesium	g/m³	0.50	-	-
Total Manganese	g/m³	< 0.00053	≤ 0.04 (Staining) ≤ 0.10 (Taste)	0.4
Total Potassium	g/m³	0.24	-	-
Total Sodium	g/m³	0.75	≤ 200	-
Total Zinc	g/m³	< 0.0011	≤ 1.5	-
Chloride	g/m³	< 0.5	≤ 250	-
Nitrate-N	g/m³	< 0.05	-	11.3
Sulphate	g/m³	4.0	≤ 250	-

Note: The Maximum Acceptable Values (MAV) are taken from the 'Water Services (Drinking Water Standards for New Zealand) Regulations 2022', published under the authority of the New Zealand Government-2022. Copies of this publication are available from: https://www.legislation.govt.nz/regulation/public/2022/0168/latest/whole.html

The standards set limits for the concentration of determinands in drinking water. The Maximum Acceptable Values (MAVs) for any determinand must not be exceeded at any time.

The Aesthetic Values are taken the publication, 'Aesthetic Values for Drinking Water Notice 2022' issued by the Water Services Regulator ("Taumata Arowai"). Aesthetic values specify or provide minimum or maximum values for substances and other characteristics that relate to the acceptability of drinking water to consumers (such as appearance, taste or odour).

Note that the units: g/m³ are the same as mg/L and ppm.

Routine Water Assessment for Sample No 3901315.1 - Dc3 27-May-2025 11:30 am

pH/Alkalinity and Corrosiveness Assessment
The pH of a water sample is a measure of its acidity or basicity. Waters with a low pH can be corrosive and those with a high pH can promote scale formation in pipes and hot water cylinders.
The guideline level for pH in drinking water is 7.0-8.5. Below this range the water will be corrosive and may cause problems with disinfection if such treatment is used.

The alkalinity of a water is a measure of its acid neutralising capacity and is usually related to the concentration of carbonate, bicarbonate and hydroxide. Low alkalinities (25 g/m^3) promote corrosion and high alkalinities can cause problems with scale formation in metal pipes and tanks.

The pH of this water is within the NZ Drinking Water Guidelines, the ideal range being 7.0 to 8.0.

Hardness/Total Dissolved Salts Assessment
The water contains a very low amount of dissolved solids and would be regarded as being very soft.

Nitrate Assessment
Nitrate-nitrogen at elevated levels is considered undesirable in natural waters as this element can cause a health disorder called methaemaglobinaemia. Very young infants (less than six months old) are especially vulnerable. The 'Water Services (Drinking Water Standards for New Zealand) Regulations 2022' sets a maximum permissible level of 11.3 g/m^3 as Nitrate-nitrogen (50 g/m^3 as Nitrate).

Nitrate-nitrogen was not found in this water.

Boron Assessment
Boron may be present in natural waters and if present at high concentrations can be toxic to plants.
Boron was not detected in this water.

Metals Assessment
Iron and manganese are two problem elements that commonly occur in natural waters. These elements may cause unsightly stains and produce a brown/black precipitate. Iron is not toxic but manganese, at concentrations above 0.5 g/m^3, may adversely affect health. At concentrations below this it may cause stains on clothing and sanitary ware.

Neither element was detected in this water, which is a pleasing feature.
Treatment to remove iron and/or manganese should not be necessary.

Bacteriological Tests
The Drinking Water Standards for NZ state that there should be no Escherichia coli (E coli) in water used for human consumption. The presence of these organisms would indicate that other pathogens of faecal origin may be present.
Results obtained for Total Coliforms are only significant if the sample has not also been tested for E coli.

Escherichia coli was not detected in this sample.

Final Assessment
All parameters tested for meet the guidelines laid down in the 'Water Services (Drinking Water Standards for New Zealand) Regulations 2022' and the 'Aesthetic Values for Drinking Water Notice 2022' issued by the Water Services Regulator ("Taumata Arowai") for water which is suitable for drinking purposes.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Drinking Water for DWSNZ Compliance

Test	Method Description	Default Detection Limit	Sample No
Routine Water Profile		-	1
Filtration, Unpreserved	Sample filtration through 0.45 µm membrane filter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Turbidity	Analysis by Turbidity meter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1
pH	pH meter. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2320 B (modified for Alkalinity <20) : Online Edition.	1.0 g/m^3 as $CaCO_3$	1
Free Carbon Dioxide	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D : Online Edition.	1.0 g/m^3 at 25°C	1
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B : Online Edition.	1.0 g/m^3 as $CaCO_3$	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. Analysed at Hill Laboratories - Chemistry; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 2510 B : Online Edition.	0.1 mS/m	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	1 µS/cm	1
Approx Total Dissolved Salts	Calculation: from Electrical Conductivity.	2 g/m^3	1
Total Arsenic	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0011 g/m^3	1
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0053 g/m^3	1
Total Calcium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.053 g/m^3	1
Total Copper	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.00053 g/m^3	1
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m^3	1
Total Lead	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.00011 g/m^3	1
Total Magnesium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m^3	1
Total Manganese	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.00053 g/m^3	1
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.053 g/m^3	1
Total Sodium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m^3	1
Total Zinc	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0011 g/m^3	1
Chloride	Filtered sample from Christchurch. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1
Nitrate-N	Filtered (if required) sample from Christchurch. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.05 g/m^3	1
Sulphate	Filtered sample from Christchurch. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1
Escherichia coli	MPN count using Colilert (Incubated at 35°C for 24 hours) and 97 wells. Analysed at Hill Laboratories - Microbiology; Unit 1, 17 Print Place, Middleton, Christchurch. APHA 9223 B : Online Edition.	1 MPN / 100mL	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 28-May-2025 and 03-Jun-2025. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

[redacted]

Appendix B: Snow Making Water Demand Calculations

		Trail A	Trail B	Trail D	Trail C	Total	Total	
Date:	5/03/2026							
The Doolans - Snowmaking calculations		Doolans Stage 1	Rastasburn Stage 1	Rastasburn Stage 1	Doolans Stage 1	Rastasburn Stage 1	Doolans Stage 1	
		Main trail in Doolans	Trail out to sugar	Trail out to Curvey	Learners slope			
Area								
Stage								
Width		30	7	15	40			Width
Trail length		2550	1100	480	160	1580	2710	Trail length
Area		76500	7700	7200	6400	14900	82900	Area
Height of snow base - [m] *	0,5	0,5	0,5	0,5	0,5			
Addition (wind transport / evaporation, etc.) [%] **	15%	15%	15%	15%	15%			
Snow density [kg/m³]	400	400	400	400	400			
Ratio m³ water / m³ snow	2,5	2,5	2,5	2,5	2,5			
Amount of snow for base [m³]		43988	4428	4140	3680	8568	47668	
Amount of water for base [m³]		17595	1771	1656	1472	3427	19067	Amount of water for base [m³]
Height of snow - Conditioning [m]	0,5	0,5	0,5	0,5	0,5			
Addition (wind transport / evaporation, etc.) [%] **	15%	15%	15%	15%	15%			
Amount of snow for conditioning [m³]		43987,5	4427,5	4140	3680	8568	47668	
Amount of water for conditioning [m³]		17595	1771	1656	1472	3427	19067	Amount of water for conditioning [m³]
Total amount of water base and conditioning. [m³]		35190	3542	3312	2944	6854	38134	Total amount of water base and conditioning. [m³]
Design time for snowmaking - Base [h]	50	50	50	50	50			
Water flow [m³/h]		351,9	35,4	33,1	29,4			Water flow [m³/h]
Water flow [l/sec]	3,6	97,8	9,8	9,2	8,2	19	106	Required water flow [l/sec]
Proposed snow producers								
TT10		24	2	2	2	4	26	TT10
TT9			8	8		16	0	TT9
Flow rates of the proposed snow producers								
Water flow [l/sec] at	-2° C	70,8	23,1	23,1	5,9	46	77	Water flow [l/sec]
Time to produce base [h]	-2° C	69	21	20	69	60	60	Average Time
Water flow [l/sec] at	-4° C	96	34,8	34,8	8	69,6	104	Water flow [l/sec]
Time to produce base [h]	-4° C	51	14	13	51	50	50	Average Time
Water flow [l/sec] at	-6° C	128,4	46,7	46,7	10,7	93,4	139	Water flow [l/sec]
Time to produce base [h]	-6° C	38	11	10	38	38	38	Average Time
Water flow [l/sec] at	-8° C	152,4	58,3	58,3	12,7	117	165	Water flow [l/sec] at
Time to produce base [h]	-8° C	32	8	8	32			Average Time