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Remarkable Ski Area Upgrade and Doolans Expansion Freshwater Ecological Impact Assessment

Prepared for NZ Ski Limited

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Arrow Lane Arrowtown 9302

Remarkable Ski Area Upgrade and Doolans Expansion
Freshwater Ecological Impact Assessment

Prepared by e3Scientific for NZSki Limited

Document Status

Version 1

Executive Summary

NZSki proposes to extend the Remarkables Ski Area into the Doolans Basin, east of the existing ski field. The development requires additional infrastructure, including a water take weir on the Right Branch of Doolans Creek and the construction of a water storage reservoir through the reclamation of an existing tarn (Tarn 3). Earthworks and activities associated with the weir installation, water abstraction, and tarn reclamation have been assessed within this Freshwater Ecological Impact Assessment (FEcIA). Field assessments were undertaken on 12–13 April 2025 and 20 January 2026.

The characterisation of Doolans Creek and Tarn 3 determined that both habitats hold High ecological value under the Environmental Institute of Australia and New Zealand (EIANZ) (2018) framework, primarily due to their high representativeness and ecological context. A total of three tarns within the Doolans Basin were surveyed as part of this assessment and Tarn 3 was found to have the lowest ecological values of the surveyed tarns.

The earthworks required for the installation of the Tyrolean weir in Doolans Creek is proposed to be managed using best practice erosion and sediment controls, timing earthworks for dry, low flow periods, and preventing cement related contamination through strict dewatering and isolation procedures. Replanting disturbed streambanks with dense native vegetation to support rapid habitat recovery and incorporating backflushing controls and detailed operational procedures within the Environmental Management Plan (EMP) will further reduce downstream sedimentation risks. Collectively, these measures minimise construction related effects and promote the protection and restoration of stream health, resulting in a Low residual level of effect.

The proposed winter water abstraction (≤30 L/s, May–October) will reduce flows for a total of 16 days within the fishless upper reach of the Doolans Creek Right Branch. This abstraction is proposed to only occur during winter and spring and flows will be reduced for approximately 600 m before the next inflows increases flow by 13 L/s or an additional 20% (e3Scientific, 2026a). The abstracted water will largely remain within the same catchment and return to the stream during spring snow melt. Fish are identified as being present 7.4 km downstream, at which point the proposed water abstraction rate would represent 20% of mean annual low

flow (MALF), for the 16 days abstraction would be occurring. At the abstraction point no fish are present and this is attributed to the high altitude and naturally occurring fish passage restrictions downstream. Based on the above, the water abstraction activity is assessed as having a Low level of effect, and no mitigation is required.

Construction of the reservoir within Tarn 3 will permanently remove approximately 4,450 m² of tarn habitat. Tarn 3 was characterised as a largely fluctuating waterbody with schist cobble margins and sandy benthic substrate in the centre. No littoral wetland or aquatic plant communities were evident within this tarn. The macroinvertebrate community had less EPT present and zooplankton communities showed lower diversity at Tarn 3 than the other tarns. Based on these attributes, Tarn 3 was found to have the lowest ecological value of the three tarns assessed; however, due to its uncommon ecosystem type, significance within the Otago Region and high representativeness and ecological context it remains of overall high ecological value. The magnitude of habitat loss of 13.5% of Doolans Basin tarn habitat is moderate, resulting in an overall High level of effect.

Given the high naturalness of aquatic habitat within the Doolans Basin and the engineering design element requiring the tarn to be fully lined no avoidance, mitigation, remediation nor offset is available to manage the effects of this activity. NZSki is proposing the establishment of a biodiversity project which will provide a compensatory package for the Project. Currently, the overall loss of the tarn habitat associated with the reclamation for the reservoir establishment remains high, prior to the details of the compensatory measures being confirmed and implemented.

Management actions are required to reduce the potential effects of the installation of the weir, water abstraction, and reservoir establishment. These management actions are summarised below:

Doolans Creek Weir

1. An Environmental Management Plan (EMP) will be produced that outlines the Erosion and Sediment Control best practice approaches to be followed.
   a. The EMP will incorporate the in-water works guidelines (MfE, 2021) to be followed such as working from the banks where possible, limiting the works area to the extent practical and preventing cement from entering flowing water.

2. Undertake earthworks during a dry period where stream flow is stable and low e.g. below median flow at the Nevis at Wentworth Station recorder (11.7 m^3/s).
3. Follow Erosion and Sediment Control best practice such as geotextile and silt fence use e.g. Auckland Council (2016) as outlined in the EMP.
4. Any disturbed streambanks are to be replanted with dense plantings of suitable native Carex/tussock grasses.
5. The works area should be dewatered and ensure cement use is isolated and any high alkalinity water pumped to a tanker and trucked offsite for disposal into a tradewaste system.
6. Ensure water take duration only occurs between May to October (inclusive).
7. Include the back flushing process within the EMP to ensure no sedimentation effects.

We suggest it would be possible to compensate for the loss of Tarn 3 through the development of a Restoration Plan that for example would include restoration of Nevis galaxias habitat in a nearby catchment.

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1 Introduction

1.1 Overview

NZSki are proposing to extend the Remarkables Ski field into the Doolans Basin located east of the existing ski field (Figure 1). The development of this proposed ski field requires earthworks associated with lift towers for a new lift line, a new base building and roading. Some instream earthworks and a water take associated with the development of a water reservoir for snow production is planned also. A characterisation of the freshwater ecological values present for the Doolans Creek Right Branch (hereafter called Doolans Creek) where the weir installations and water abstraction is to occur and tarn habitat where a tarn is to be reclaimed for water storage is therefore required to outline the habitat and freshwater values present within this area.

The proposal involves establishing a new water abstraction from the Right Branch of Doolans Creek via construction of a Tyrolean weir. The water take will operate at a maximum rate of 30 L/s over a total of 16 days across May and October each year, and will supply the Doolans Operation with potable water, firefighting capacity, and snowmaking resources. The abstraction point is located within the Right Branch of Doolans Creek at an elevation of approximately 1380 m above sea level (a.s.l).

To access the intake site, a new 4WD access track will be constructed extending downslope from the Doolans Base building. A rising main, along with power and telecommunications services, will be installed within a trench beneath the access road. Construction of the Tyrolean weir will require temporary diversion of flow within Doolans Creek, excavation of approximately 20 m³ of streambed material, installation of prefabricated weir components to minimise the need for instream concrete works, and reinstatement of streambed material upstream and downstream once construction is complete.

The water will be pumped from Doolans Creek to a reservoir location situated at 1700 m a.s.l, approximately 1.5 km from the weir. This reservoir will be created by lining an existing tarn at this site. Abstracted water will be stored here and utilised from this location throughout the snow making season.

e3Scientific Limited (e3s) was commissioned by NZSki to complete the freshwater ecological impact assessment (FEcIA). This report provides the methodology, results and findings of the assessments undertaken. Fieldwork associated with this characterisation was completed on the 12th and 13th April 2025 and 20 January 2026.

The characterisation comprised of field sampling to characterise the freshwater ecological values of Doolans Creek, relevant tributaries, and tarns within Doolans Basin. The effects of the instream earthworks to install a water take weir, the abstraction of water, and the establishment of a water storage reservoir within an existing tarn are assessed within this report. The level of effect of the various activities is outlined and where required management actions are recommended.

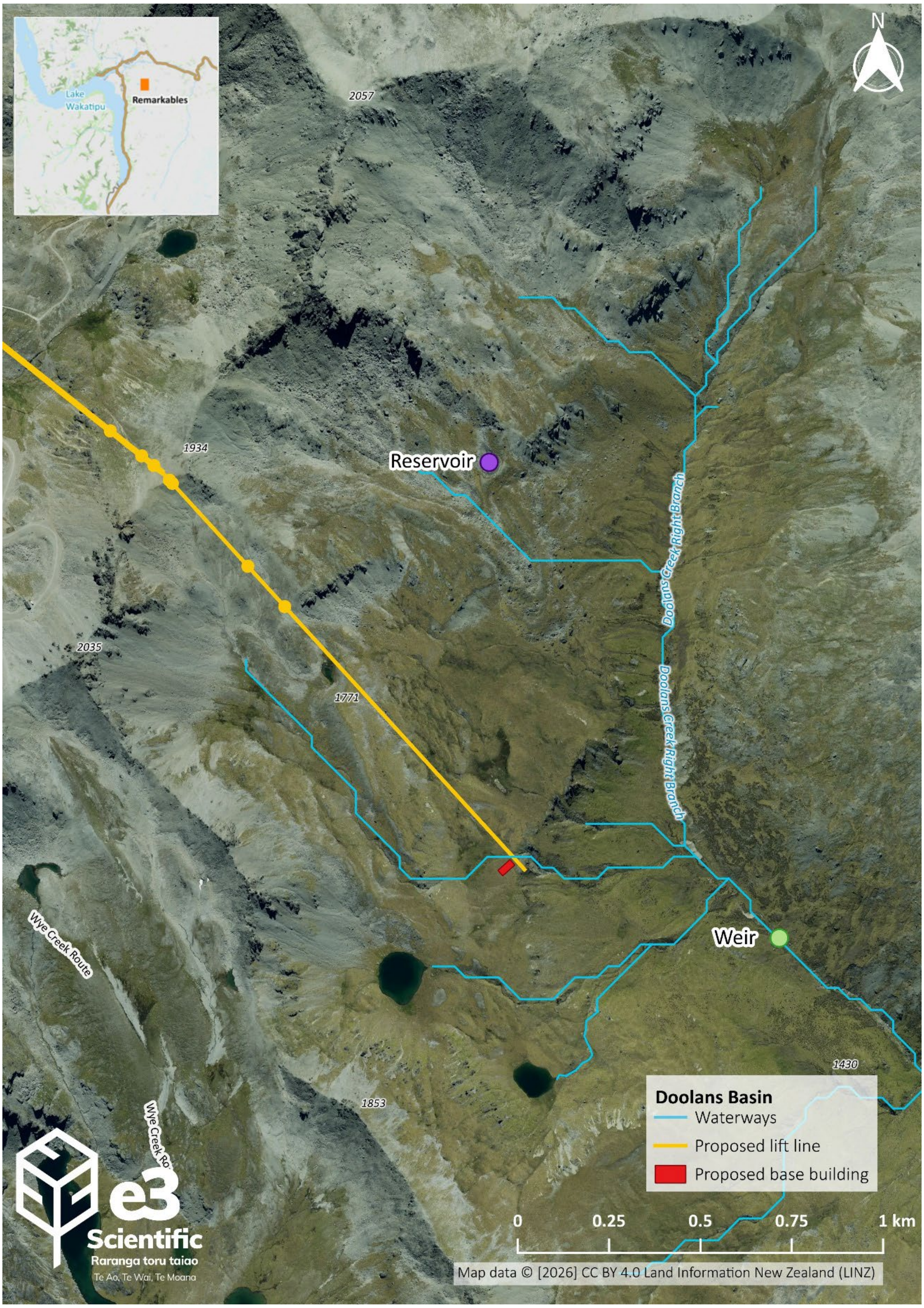


Figure 1: Study area overview, with location in inset.

1.2 Freshwater Ecological Report Structure

The FEcIA is structured as follows:
Section 2: Description of the proposed activity and environmental context.
Section 3: The methodology employed during the ecological assessment.
Section 4: Results.
Section 5: Ecological values assessment and summary.
Section 6: Ecological Impact Assessment.

1.3 Limitations

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, and limited data due to the large site and difficult access. A full range of biota that are present at this site may not have been seen or recorded; however, desktop research was utilised to aid the assessment.

The results of this assessment are based upon site inspections conducted by e3s personnel, and information provided in scientific literature. 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.

1.4 Code of Conduct

The authors of this report are Mark Hamer and reviewer Bryony Miller. Bryony Miller is the Technical Director of Marine and Freshwater Ecology at e3s and is a professional ecologist with over 15 years' experience. She regularly completes freshwater and marine ecological impact assessments on behalf of regional and district councils, private companies, national governmental organisations, not-for-profit and research groups. She has been an expert witness at Environment Court and hearings and has been involved in mediation and expert caucusing. She currently is a member of the NZ Freshwater Science Society, NZ Marine Science

Society, NZ Science Diving Committee and is an executive committee board member of the NZ Coastal Society.

Mark Hamer is a professional freshwater ecologist with over 17 years' experience working in the freshwater ecology and monitoring industry. Freshwater biomonitoring proficiency and experience includes wetland delineation, water and sediment quality assessments, eDNA, river periphyton, aquatic plant identification, riparian habitat assessment, macroinvertebrate collection and analysis. Freshwater fish monitoring using electric fishing, netting or spotlighting methods along with associated fish handling, analysis and fish passage assessments. At e3s for the past 3 years Mark's focus has been on ecological value assessments and reviewing and producing ecological impact assessments in the consenting process. He has been an expert witness at consent hearings and is a current member of the New Zealand Freshwater Sciences Society.

We confirm that we both 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, this report is within our area of expertise, and we have not omitted to consider material facts known to either of us that might alter or detract from the opinions expressed in this report.

2 Description of the Activity and Existing Environment

2.1 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). There are a number of alpine tarns and creeks with ephemeral headwaters 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. The waterways are largely fed by snow meltwater. The Otago Regional Plan outlines that the nearby Doolans Creek Left Branch is weed free and having rare invertebrates upstream of 1260 m a.s.l (Otago Regional Council, 2025).

2.1.1 Doolans Creek Right Branch (hereafter called Doolans Creek)

The area has a cold wet climate and hard sedimentary geology (Snelder, *et al*., 2010). The Doolans Creek has a medium elevation source of flow, tussock landcover, high gradient valley landform with an elevation of 1380-1750 m above sea level (a.s.l.) across the site and 240 km distance to the sea (Snelder, *et al*., 2010). 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 and the Clyde Dam. No regional council nor Land and Water Aotearoa (LAWA) water quality sites are nearby (within 20 km), but the water is clear and cool.

Doolans Creek typically has a low flow period from January to August and high flow period September to November during the spring snow melt (Figure 2) (ORC Website Accessed February, 2026).

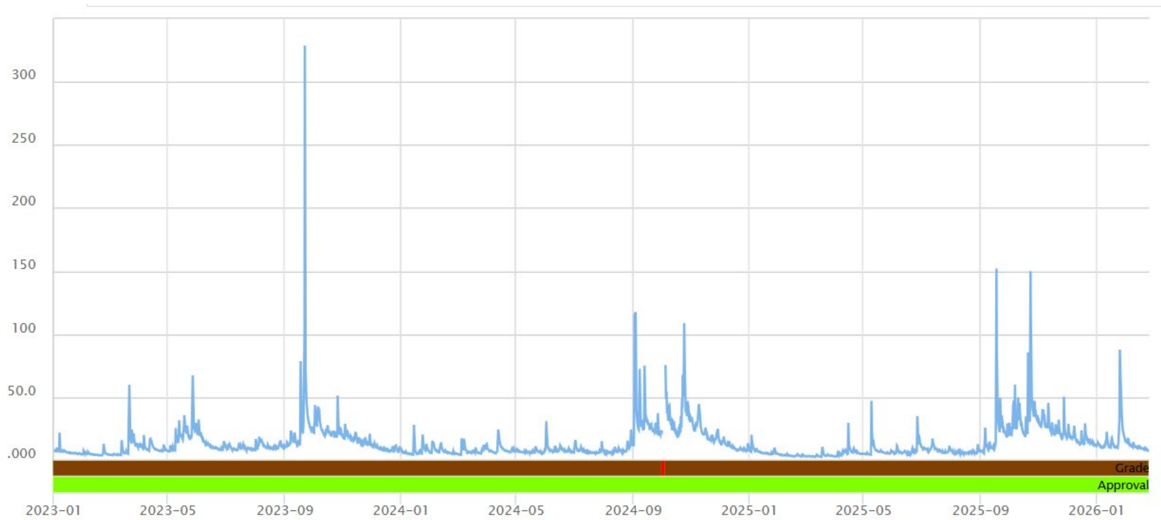


Figure 2: Hydrograph for the Nevis River at Wentworth Station for the last 3 years (Source ORC Website accessed February 2026).

2.1.2 Doolans Basin Tarns

Tarns are small alpine lakes and are present in mountains and inland basins of the South Island (Landcare Research, 2025). Low turf plants frequently form at tarn margins and extend from low water level to vegetation of the surrounding tussock grassland. The number of aquatic species typically decreases with increasing altitude (Landcare Research, 2025). As a wetland ecosystem type, tarns are considered uncommon but not threatened (Holdaway, *et al.*, 2012). Threats to tarns in the Doolans Basin are limited to ungulate browse, weed infestation, potentially water abstraction for snow making (Landcare Research, 2025), fires and climate change (Rance & Boddy, 2020). Common South Island zooplankton taxa are known to be present in the Doolan's tarns (Ryder, 2012). The tarns within the Doolans Basin range from small and shallow to large and deep with riparian margins varying from exposed bare rock to tussock and herbfields. Tarn 1 is large (13,750 m^2) and deep and surrounded by tussockland and feeds a small outflow stream. Tarn 2 is small (910 m^2) and shallow and surrounded by herbfield and alpine wetland and feeds a small outlow stream. Tarn 3 is of moderate size (4,450 m^2), shallow and surrounded by bare rock when water levels are low and tussocks when the tarn is full. Tarn 3 has a small seasonal inflow and no surface outflow and no marginal wetland fringe.

2.2 Description of Activity

The development of the ski field extension in the Doolans Basin requires earthworks associated with lift towers for a new lift line, earthworks associated with roading, a new base building and a water take associated with the development of a water reservoir for snow production, potable water and firefighting.

The ski field area may cover up to 320 hectares and will be used annually each winter and spring for skiing and snowboarding. The Doolans Basin is undeveloped currently and is part of DOC estate. A concession is required to utilise the land.

A weir is proposed to be installed in the Doolans Creek to support the water take associated with snow production and firefighting purposes. The water take is proposed to draw up to 30 L/S or 2,592 m^3/day of water for a total of 16 days (annual water take of 41,240 m^3/year) between May and October each year from this location. 30 L/S represents 50% of the estimated mean annual low flow (MALF) which is typically present in the drier summer months, as opposed to winter and spring when the flow is expected to be above low flow. Little to no water will be drawn from this location the remainder of the year (except in a firefighting emergency). The installation of the weir will involve in-stream earthworks over ~ 20 m^2 to install a Tyrolean type weir.

The abstracted water will then be pumped to the northernmost tarn for storage (Tarn 3) (see Figure 1). This tarn will be modified to be lined with geosynthetic liner to allow for effective water storage over the snowmaking season (e3Scientific 2026a).

Any further activities such as potential road stream crossings and culverting are not considered within this report. This is covered in a separate stormwater, roading and freshwater ecology report specific to that activity (see e3Scientific, 2026b).

2.2.1 Weir Location

The site lies approximately 12 km southeast of the Remarkables Ski Area in the Doolans Creek. The headwaters are very steep while the weir location is situated within a moderately sloped section. The right branch Doolans Creek merges with the left branch 12.5 km downstream to form Doolans Creek that then flows into the Nevis River shortly before it joins the Kawarau River.

The proposed weir and water take site is located on the Doolans Creek at an approximate altitude of 1,370 m a.s.l (NZTM E1273099; N5000556). The high-altitude catchment is defined by its steep, mountainous terrain snow cover in the winter months reducing instream flows.

The creek exhibits a step-pool morphology, coarse bed material and a flashy hydrological regime with this indicating a high sediment transport potential during storm events and snowmelt periods (e3Scientific, 2026a).

The weir location has been selected to be downstream from the outflows of two tarns at the southern end of Doolans Basin to maximise water source capture. The site was also chosen to avoid moderate value Dracophyllum vegetation identified upstream (Stantec, 2025).

2.2.2 Water Take

Doolans Creek is in the Nevis River catchment which Otago Regional Council (ORC) identifies as having 2,554 L/S of available water allocation (Otago Regional Council, 2025). 50% of the mean annual low flow (MALF) at the point of take would equate to 32 L/s and it is proposed the take would require residual flows to be maintained (e3Scientific, 2026a).

The proposal is for water to be abstracted May to October (inclusive) to supply the Doolans Ski Area with potable water, firefighting capacity and snowmaking resources. The activity proposes to take at a rate not exceeding 30 L/s (2592 m^3/day) from May to October where the winter base flow (MALF) is predicted to be approximately 67 L/S. The proposed annual take is 41,240 m^3/year which equates to a total water take of 16 days each year based on a rate of 30 L/s (e3Scientific, 2026a). A residual flow of at least 20 L/S will be maintained at all times.

The Tyrolean intake design (Figure 3) allows most bed load to continue downstream while screened water passes through the slots (Stantec, 2025). The water will then be pumped to a nearby low head pump chamber. The system will have facilities to use the pumps at the pump station to back flush sediment and gravel from the sediment trap and pump chamber, back to Doolans Creek. It is anticipated this would be undertaken once per year prior to the water take operation for the winter season to remove any gravel and sediment that has accrued in the previous season. Any extra water utilised to flush the system will be returned to the Doolans Creek approximately 45 m downstream (Figure 4). The downstream flushing pipeline may lay across some wetland habitat described (and assessed) in the terrestrial ecology impact assessment (e3Scientific, 2026c). The weir will be constructed of steel, precast concrete and some *in situ* concreting to fill voids and ensure a strong foundation. Excavation of the stream will be required to install the precast flume unit. No coffer dam or stream diversion is planned, rather the excavator will undertake work within the stream during a dry period and associated low flow, best practice erosion and sediment controls will be in place and the weir will be assembled and installed onsite.

Figure 3: Example of a Tyrolean weir (Source: Stantec, 2025).

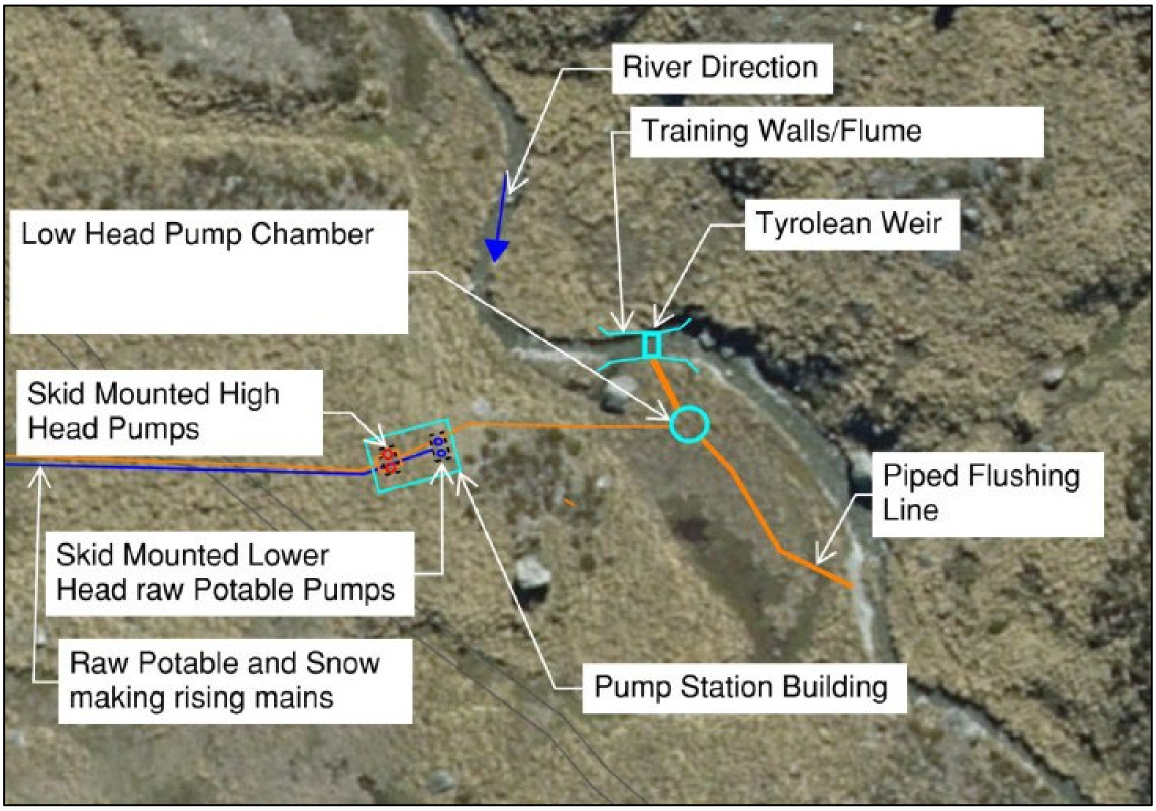


Figure 4: Weir location and design (Source: Stantec, 2025).

2.2.3 Reservoir

A water storage reservoir with a surface area of 4,450 m^2 is proposed to be established at the site of an existing alpine tarn (Figure 1). The reservoir will be ~3 m deep and enable the storage of 19,000 m^3 of water. Earthworks will be required to establish the reservoir foundation and fill embankments and create swales to divert water around the site (Stantec, 2026). A pump station will be used to pump water from the Doolans Creek to the reservoir, and a further pump station will be located near the reservoir to pump water for snowmaking, potable water and firefighting purposes. The reservoir will be lined with impervious geosynthetic liner to ensure water is not lost from the system.

Stormwater inflows to the proposed reservoir will be diverted around the structure via rock lined drainage swales. An inlet structure will be constructed on the northern side of the reservoir to capture runoff from the upstream catchment, and this will also function as a sediment control feature. Two stormwater discharge outlets will be established on the southern side of the reservoir. Both the inlet and outlet structures will be rock lined and fitted with scour protection to ensure stable conveyance of flows (See Figure 2.2 within Stantec, 2026).

A depression ~200 m north of the proposed location selected was considered as an alternative reservoir location but was discounted due to greater pumping distances and terrestrial ecological values present.

3 Methodology

3.1 Desktop Research

The desktop study included a review of existing ecological information and reports to determine ecological habitats and species likely present within the Doolans Creek and Doolans Basin Tarns. This was undertaken by utilising ORC Schedule 1A and 15 classifications, the Land and Water Aotearoa (LAWA) website to access water quality and macroinvertebrate records, the New Zealand Freshwater Fish Database (NZFFDB) and Wilderlab eDNA database to outlining historic fish records. The threat status of fish recorded from the catchment downstream determined by using the New Zealand Fish Threat Classifications as outlined in (Dunn, *et al.*, 2025). Flow regimes and hydrology assessments are covered in e3Scientific (2026a).

3.2 Site Visit

On 12 and 13 April 2025 and 20 January 2026, e3s freshwater ecologists visited the Doolan Basin to survey representative sections of streams including the proposed weir location in the Doolans Creek and three alpine tarns including Tarn 3 which is to be reclaimed. The site survey involved a visual assessment of habitat, aquatic plants and substrate. eDNA sample collection and macroinvertebrate sampling was completed within the streams of the area and local tarns to compare the ecological context of the area with the proposed stream site to be disturbed by the activity. The stream reach that will have reduced water flows at certain times of year due to the proposed water abstraction was assessed to record the species and communities present. Zooplankton samples were collected from three tarns on January 20, 2026, to further evaluate the ecological values of the tarns onsite and confirm which of the tarns was of lower ecological value. Representative photographs of the proposed area were taken and are provided within Appendix A of this report.

3.3 Sampling Strategy

The stream survey locations were located across the Doolan Creek Right Branch Mainstem, within the upper, middle, and lower sections and the proposed weir location (Figure 5; Table 1). The main tributary inputs to the Doolan Creek Right Branch were also assessed to allow for a robust characterisation of the freshwater habitats and ecological context present.

The Doolans Creek sites changed from small steep and bouldery in at DC1 upstream to less steep cobbly and greater flow downstream at DC3 and the DC Weir sites. The tributaries that flow into the Doolans Creek mainstem varied in size generally in relation to their catchment size. They were found to have both steep and flatter sections and all had riparian zones comprising of tussockland (Appendix A). Sites DC1, DC2 and DC3 were sampled in April 2025 while the Weir site (DC Weir) was sampled in January 2026 once the weir location was selected based on appropriate water volumes (Stantec, 2025; e3Scientific, 2026a).

Three of the four tarns present in the valley were also surveyed to assess the ecological values present. The fourth, most southern tarn, was considered far enough from activities to likely remain unaffected (Figure 5). Tarn 1 was large and deep and surrounded by tussockland. Tarns 2 and 3 were much smaller and shallower with tarn 2 surrounded by a herbfield and tarn 3 surrounded by bare rocks at low water levels and tussocks at higher water levels (Appendix A). Riparian plant communities have been assessed in a separate terrestrial ecology report (e3Scientific, 2026c). A return visit was made to sample zooplankton from the tarns in January 2026 to further assess the ecological values present. It was noted that the water level at Tarn 3 was considerably lower on the April 2025 visit than on the January 2026 survey date (Appendix A). Zooplankton are assessed in alpine tarns as they help indicate if there is nutrient enrichment, warming or algal blooms and respond rapidly to changes in conditions. With less water in a tarn the shallower water may become warmer and may result in a community shift to smaller taxa.

The physico-chemical properties of the waterways (Doolans Creek, tributaries and tarns) were assessed along with the stream macroinvertebrate community and habitat quality at each sampling site. eDNA samples were also collected at a number of sites to evaluate the presence of fish or rare taxa (Figure 5; Table 1). Methods utilised for these assessments are detailed in the following sections.

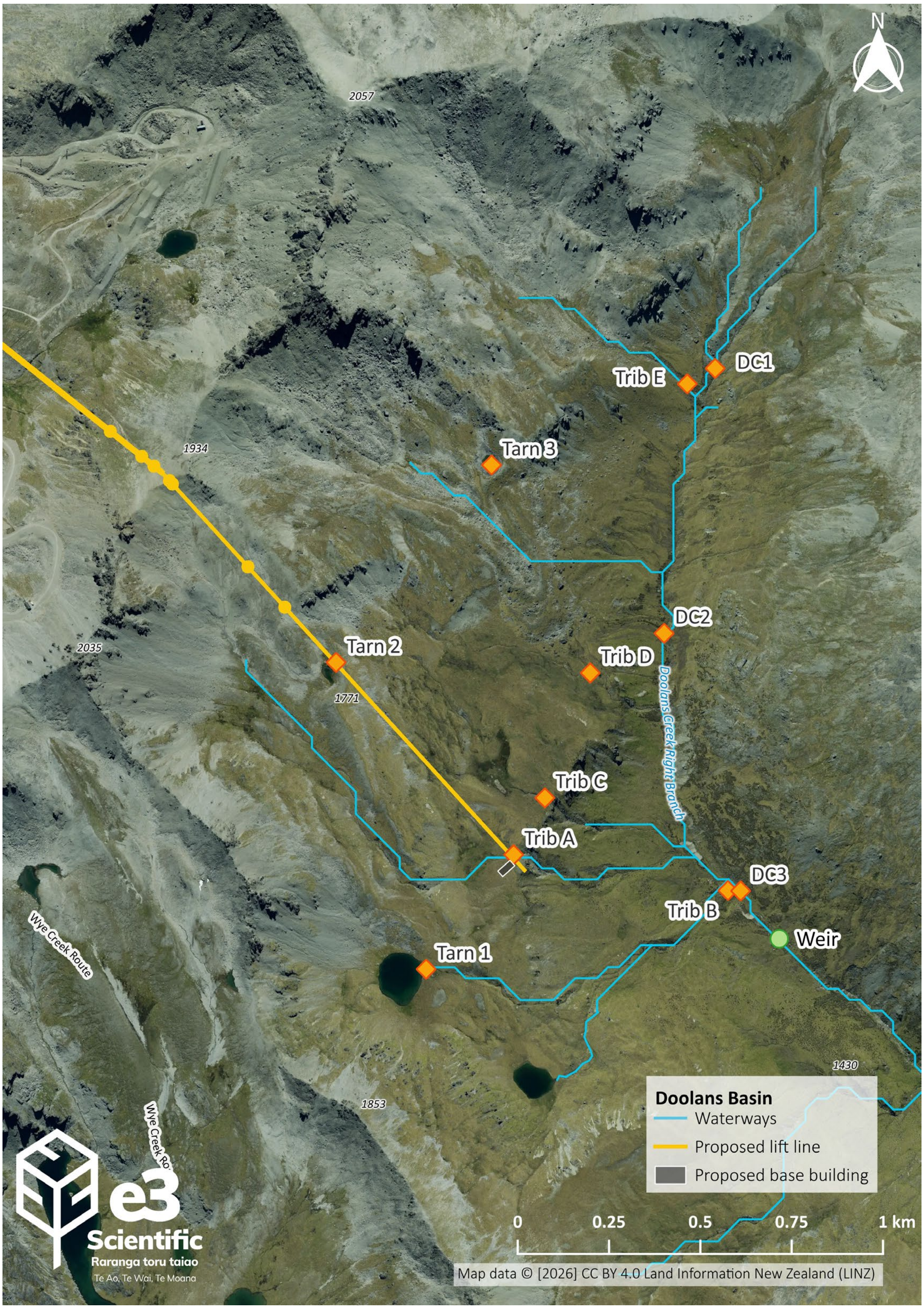


Figure 5: Tarn, Doolans Creek and tributary sampling locations (green diamonds).

Table 1: Freshwater ecological sampling locations (and rationale).

Site name	Description	Assessed
DC1	Steep upper section of Doolans Creek immediately below the confluence of two tributaries	Flow, habitat, Macroinvertebrates & eDNA
DC2	Mid-section of Doolans Creek approximately central of the two proposed lift lines.	Flow, habitat, Macroinvertebrates & eDNA
DC3	Lower section of Doolans Creek approximately at the downstream extent of any potential effects.	Flow, habitat, Macroinvertebrates & eDNA
DC Weir	Lower section of Doolans Creek at the proposed weir location.	Habitat, Macroinvertebrates & eDNA
Trib A	Tributary stream draining a reasonably large area, site near the down slope end of the proposed southern lift line.	Habitat, Macroinvertebrates & eDNA
Trib B	Tributary stream draining the two southern tarns (Tarn 1 and the unsampled tarn), just upstream of DC3.	eDNA
Trib C	Tributary stream draining a wetland area, site is 10 m north of the proposed base building.	Habitat, Macroinvertebrates & eDNA
Trib D	Assessed on-site to have ephemeral qualities upstream and very low flow downstream. Was not sampled.	Not assessed
Trib E	Tributary stream near the head of the Doolans Basin, reasonable flow present but flow measurement only undertaken.	Flow only
Tarn 1	Large, deep tarn to south of proposed lift lines at 1645 m a.s.l. Surrounded by tussockland.	Habitat, Macroinvertebrates, zooplankton & eDNA
Tarn 2	Central tarn below the proposed southern lift line. Surrounded by a herbfield.	Habitat, Macroinvertebrates, zooplankton & eDNA
Tarn 3	Northern tarn with no obvious outflow, 140 m southwest of proposed northern lift line. Surrounded by bare rocks at low water levels and tussocks at higher water levels.	Habitat, Macroinvertebrates, zooplankton & eDNA

3.4 Water Quality

3.4.1 Phyisco-Chemical Parameters

The properties of the water at each site were assessed by 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.

3.5 Habitat Assessment

The overall habitat was assessed by utilising a Rapid Habitat Assessment form (RHA) following Clapcott (2015). This habitat assessment includes assessment of streambed and riparian conditions along with instream macroinvertebrate and fish habitat.

Algal cover was assessed at each site by visually assessing 5 transects across the width of the waterbody and averaging the total estimated cover (Biggs & Kilroy, 2000; Collier *et al.,* 2014). Macrophyte cover assessments within the tarns were completed utilising grid visual cover estimates of littoral edge shallow enough to wade.

3.6 Aquatic Fauna Sampling

3.6.1 Macroinvertebrate Sampling

The stream sampling methods utilised followed Stark *et al*. (2001) and NEMS (2022). At each stream site three Surber samples were collected. Each sample was gathered by disturbing riffle riverbed in within the 0.1 m^2 Surber sampler with a 500 micron mesh net. Each sample was labelled and then preserved in ethanol following Stark, *et al*. (2001) methods. The samples were then transported to the e3s laboratory for identification, enumeration and metric calculation.

Tarn sampling utilised a slightly modified method whereby five kicknet (0.4 m wide net with 500 micron mesh) samples were collected and combined into a single composite sample. The habitat was sampled in proportion to presence with cobbles and gravels sampled, when present, and aquatic plants and algae sampled, when present. This method aligns with the soft bottomed stream method by creating some flow with the net and re-sweeping through that area a second time to collect and invertebrates that may have been dislodged and in the water column.

Zooplankton sampling within the tarns consisted of casting a zooplankton net from the water edge into deep water, letting the net sink for a few seconds and retrieving the net at ~1 m/S. This was repeated 3 times at Tarn 3 with the same sampling effort applied at Tarns 1 and 2. The zooplankton samples were then transferred to a small watertight labelled container and ethanol was added immediately to a 70% concentration to preserve the samples. The samples were then sent to the University of Otago for identification and enumeration.

Macroinvertebrate Metrics

The macroinvertebrate metrics were calculated following the methods outlined in Stark & Maxted, (2007) and Clapcott, *et al.*, (2017) for the Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI), while the Average Score Per Metric (ASPM) was normalised using the method outlined in the NPS-FM 2020. The macroinvertebrate results from the field survey were then compared against the NPS-FM attribute bands (Ministry for the Environment, 2020) which are based on the MCI and QMCI bands of (Stark & Maxted, 2007) and ASPM method developed by (Collier, 2008; Clapcott, *et al.*, 2017) (Table 2). The proportion of mayflies, stoneflies and caddisflies (EPT) was used to outline the pollution sensitive taxa present and help differentiate tarn quality. Additionally, the Shannon-Weiner Diversity Index and Shannon Evenness Index are used to help explain community diversity.

Table 2: Macroinvertebrate metric attribute bands (NPS-FM, 2020).

MCI and QMCI band and description	MCI	QMCI	ASPM Band description	ASPM
A - Macroinvertebrate community, indicative of pristine conditions with almost no organic pollution or nutrient enrichment.	>130	≥ 6.5	**A** - Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions.	≥ 0.6
B - Macroinvertebrate community indicative of mild organic pollution or nutrient enrichment. Largely composed of taxa sensitive to organic pollution/nutrient enrichment.	≥ 110 and <130	≥ 5.5 and < 6.5	**B** - Macroinvertebrate communities have mild to moderate loss of ecological integrity.	< 0.6 and ≥ 0.4

C - Macroinvertebrate community indicative of moderate organic pollution or nutrient enrichment. There is a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment.	≥ 90 and < 110	≥ 4.5 and < 5.5	**C** - Macroinvertebrate communities have moderate to severe loss of ecological integrity.	< 0.4 and ≥ 0.3
D - Macroinvertebrate community indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to inorganic pollution/nutrient enrichment.	< 90	< 4.5	**D** - Macroinvertebrate communities have severe loss of ecological integrity.	< 0.3

The zooplankton results were compared to a previous assessment of zooplankton undertaken within tarns of the Doolans Basin. Where low diversity of a few taxa was reported (Shallenberg, 2002; Ryder, 2012).

3.6.2 Fish and TICI Sampling

eDNA samples were collected to ascertain if fish are likely to be present within the focal reach. At each stream site two replicate samples were collected except the Weir Site where one replicate was collected (due to it being the most downstream location). At the tarns 6 eDNA samples were collected at each of Tarns 1 and 2, and 4 at Tarn 3 for a total of 16 tarn and 7 stream samples. For each of the replicates 1 L of water was filtered, the filter then had preservative added to it, was labelled and then sent to Wilderlab Ltd for analysis. Wilderlab then supply back a taxa list of the eDNA found to be present.

For the tarn samples, eDNA results were also used to create a Taxon-Independent Community Index (TICI) to utilise the whole community found to be present (e.g. bacteria, fungi, plants, algae, birds, invertebrates and fish) in the samples to produce a measure of ecological health (Wilkinson, *et al*., 2023).

Factors which influence eDNA sequence counts including the distance of organisms from the sampling point, the presence of dead and decaying organisms, environmental factors which can speed up or slow down eDNA breakdown (e.g. temperature and light), and assay biases, can lead to preferential detection of certain groups of organisms (Wilderlab, 2024). Therefore, sequence counts do not directly relate to fish abundance (Wilderlab, 2024). In addition, a low sequence count is considered a “tentative detection” (Wilderlab, 2024). Run-off and animal faeces are two ways in which external DNA could be introduced to a site (Wilderlab, 2024). Therefore, the presence of eDNA cannot be converted to a relative abundance of fish numbers present. It also means that eDNA of organisms not present at the site could be introduced to the site and detected in the samples. Therefore, false positives are possible.

The Wilderlab eDNA database was also interrogated for any relevant nearby data points.

4 Results

4.1 Water Quality

The LAWA website presents the 5-yearly median values for a range of freshwater quality parameters at the Nevis River at Wentworth Station, based on monitoring undertaken by the Otago Regional Council (ORC) (LAWA, Accessed 2026), located approximately 19 km downstream of the site. The results show the Nevis River has very low *E. coli* levels with A Band attribute. This indicates mammal gut bacteria and associated pathogens are very rarely present in the water (Ministry for the Environment, 2020). The water clarity as measured by black disk shows over 3 m through the water column horizontally. Nitrogen indicators are also in a good state and some aspects are improving while others are degrading. Phosphorus indicators are in the top 25% of sites across the country and likely improving (Table 3). Given the upstream and headwater location of the site within Doolans Creek it is likely that water quality is better still at the study site.

Table 3: ORC Water Quality and Ecology Results for the Nevis River at Wentworth Station (Source: LAWA website Accessed 26/2/2026).

Water Quality Parameter	5-Year median	NPS-FM 2020 Attribute Band	Trend Direction
***E. coli* (n/100ml)**	10.5	A	Degrading
Clarity (m)	3.12	A	No trend
Total Nitrogen (mg/L)	0.0555	N/A	No trend
Total Oxidised Nitrogen (mg/L)	0.0025	N/A	Degrading
Dissolved Inorganic Nitrogen (mg/L)	0.01	N/A	Degrading
Ammoniacal Nitrogen (mg/L)	0.005	A	Improving
Nitrate Nitrogen (mg/L)	0.0021	A	Degrading
Dissolved Reactive Phosphorous (mg/L)	0.003	A	Improving
Total Phosphorus (mg/L)	0.006	N/A	Improving
Macroinvertebrate Community Index (MCI) 0 - 200	101-106[1]	C	N/A
Quantitative Macroinvertebrate Community Index (QMCI) 0- 8	5.7-6.5[1]	A/B	N/A
Average Score per Metric (ASPM) 0-1	0.44-0.6[1]	A/B	N/A

[1] 2022-2024 result only

The results of the site-specific water physico-chemical surveys completed in April 2025 and January 2026 show that all the locations across the study area have cool, clear, well oxygenated water (Table 5). The tarns were assessed on two occasions the first occasion was in April 2025 and the second in January 2026. The January 2026 samples demonstrated warmer water temperatures and lower turbidity across all three tarns and slightly lower but still good, dissolved oxygen levels (Table 4). No consistent pattern was evident between April and January sampling events, other than conductivity being highest at Tarn 3 on both sampling occasions.

Table 4: Physico-chemical results.

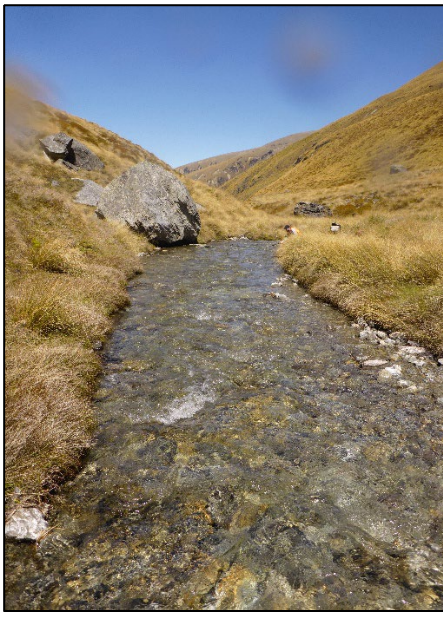
	Water Temperature (°C)	DO (%)	DO (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Visual clarity
DC 1	2.5	103.7	11.95	60.7	7.55	0	clear
DC 2	6.3	104.3	10.99	66.8	7.41	0.1	clear
DC 3	8.1	104.6	10.65	35	7.15	0.03	clear
DC Weir	12.2	99.7	9.13	47.3	7.42	0.35	clear
Trib A	6.6	100.2	10.38	12.9	7.3	0.03	clear
Trib B[1]	N/A						
Trib C	8.3	106.1	10.43	12.6	7.09	6.1	clear
Trib D[1]	N/A						
Trib E[1]	N/A						
Tarn 1 – Apr 25	5.8	104	10.96	12.3	7.77	0.67	clear
Tarn 1 – Jan 26	11.4	100.7	9.1	9.6	6.65	0.22	clear
Tarn 2 – Apr 25	6.4	108.6	11	20.1	7.59	1.2	clear
Tarn 2 – Jan 26	12.7	105.2	9.12	17.3	7.09	0.48	clear
Tarn 3 – Apr 25	4.2	104.2	11.25	26.3	7.5	0.86	clear
Tarn 3 – Jan 26	12	111.6	9.86	55.1	7.74	0.04	clear

[1] Trib B, D and E did not have physico-chemical parameters assessed.

4.2 Habitat

The streambed characteristics were consistent with an undeveloped alpine catchment with predominantly large substrates present and exposed bedrock in steeper sections (Figure 6; Appendix A). Although the environment was open with no tree cover to shade the watercourses, algal cover was limited, most likely due to the cold, low nutrient water present. Submerged bryophytes (moss) were present at a number of locations; however, submerged moss habitat was only included within the area sampled at DC3, Trib A and Trib C (Figure 6; Appendix A). Didymo was observed to be present at the DC Weir site in January 2026 which may be new arrival in the catchment as none was observed or identified within eDNA samples at DC1, DC2 or DC3 in April 2025; however, these sites were upstream, so this was not confirmed. The proposed weir site had a higher proportion of gravels and algal cover than the upstream sites assessed (Table 5). The RHA habitat scores were good across the sites; however, the natural lack of shade and some areas of erosion led to lower scores at all sites and the weir site had a low score for hydraulic heterogeneity as it was one long riffle habitat (Table 5).

Steep headwaters



Weir site

Weir site bed substrate

Submerged moss and didymo

Figure 6: Representative images of habitat.

Within the Doolans Basin the total mapped wetland area is 58.8 hectares (ha) and the total tarn area of the four tarns in the basin cover 3.3 ha. The tarn habitat varied between the three tarns assessed. Tarn 1 has an elevation of 1650 m a.s.l., was large and deep with gravels around the littoral edge and outlet. Sandy silt covered deeper areas and small tufts of brown algae were present on some boulders. Tarn 2 has an elevation of 1750 m a.s.l., had a turf bed of short macrophytes (potentially *Lilaeopsis ruthiana*) with areas of filamentous algae cover and a sandy/silty bed in deeper areas. Tarn 3 has an elevation of 1700 m a.s.l., had low water levels at the time of the April 2025 assessment and the bed comprised mainly of sand with some areas of stunted macrophyte present and areas of brown algae. In January 2026 Tarn 3 had much more water present, this appears to have caused the inundation of early succession terrestrial plants leading to them dying off and algae growing on top of them presumably utilising nutrients being released from the decaying plants (Figure 7).

Of the three Tarns, Tarn 3 was considered to have the lowest habitat diversity due to a lack of macrophytes and deep water.

Figure 7: Images of Tarn 3 in April 2025 (left) and January 2026 (right).

Table 5: Physical Habitat Results.

	DC1	DC2	DC3	DC Weir	Trib A	Trib C	Trib E	Tarn 1	Tarn 2	Tarn 3
	Substrate %									
Bedrock		10			10	20				
Boulder	20	10	5	10	10	5	60	5		
Cobble	40	65	80	35	65	60	30	20	10	10
Gravel	30	10	10	50	10	13	10	70	20	10
Sand	10	5	5	5	5	2		5	20	80
Silt									50	
	Habitat sampled %									
Stones	100	100	100	100	100	100	100	100	70	70
Wood										
Macrophytes									30	30
Edge plants										
	Algae & Macrophyte cover %									
Submerged moss cover	5	5	< 5	3	10	< 5		4		0
Total algal cover	0	< 5	< 5	6	< 5	< 5		< 5		5
Total macrophyte cover	0	0	0	0	0	0	0	0		2
	Habitat									
Invertebrate habitat diversity (n/10)	7	7	9	7	9	9	-	N/A	N/A	N/A
Invertebrate habitat abundance (n/10)	10	10	10	10	10	10	-	N/A	N/A	N/A
Hydraulic heterogeneity (n/10)	9	8	7	1	10	8	-	N/A	N/A	N/A
Habitat Score (RHA) (n/100)	73	83	82	65	85	83	72	N/A	N/A	N/A

4.3 Macroinvertebrates

The ORC Nevis River at Wentworth Station monitoring site added macroinvertebrate assessments in 2022, therefore long-term trends are not available. However, a review of the state of freshwater ecology attributes demonstrates the state at the Nevis River has a macroinvertebrate community

(MCI) in Band C indicative of moderate organic pollution or nutrient enrichment (101-106) based on the three samples collected to date. The similar metric QMCI has the Ecological State in Band A and B and indicative of pristine conditions with almost no organic pollution or nutrient enrichment to mild enrichment ranging from 5.7 to 6.5. The ASPM metric also ranges from Band A and B with values of 0.44 to 0.6, indicative of a macroinvertebrate community that has high ecological integrity to one with mild to moderate loss of ecological integrity.

The zooplankton community in three tarns in the Doolans Basin were assessed in February 2002 by Dr Marc Schallenberg and reported in Ryder (2012). The results of that study suggest the zooplankton community diversity in the tarns is low compared to South Island lakes but comparable to most alpine and subalpine lakes with *Ceriodaphnia dubia* and *Bosmina dilitata* dominating and cyclopoid copepods absent (Ryder, 2012). It is assumed the three larger southern tarns in the Doolans Basin were sampled in the 2002 survey rather than the smallest tarn in the basin which is Tarn 3 in the present study. The Zooplankton results for the samples collected in this study align with the previous assessment with a low diversity dominated by calonoid copepods and lacking predatory cyclopoid copepods. The larger Tarn 1 had a more diverse community with four taxa represented; Tarn 2 had two taxa present with Tarn 3 having one to two zooplankton taxa (Table 6). The calonoid copepods typically indicate stable low nutrient conditions while cyclopoids indicate greater predation and community shifts.

Table 6: Tarn zooplankton results.

			Zooplankton			
Location	**Identifier**	**sample date**	*Calanoid copepod*	*Ceriodaphnia*	*Cladoceran aloninae*	*Ostracod*
Tarn 1	Sample A	20/01/2026	Abundant	Common	Rare	None
Tarn 1	Sample B	20/01/2026	Occasional	Rare	None	None
Tarn 1	Sample C	20/01/2026	Occasional	Occasional	Rare	Occasiona
Tarn 2	Sample A	20/01/2026	Abundant	None	Occasional	None
Tarn 2	Sample B	20/01/2026	Common	None	Occasional	None
Tarn 2	Sample C	20/01/2026	Common	None	Occasional	None
Tarn 3	Sample A	20/01/2026	Abundant	Rare	None	None
Tarn 3	Sample B	20/01/2026	Abundant	None	None	None
Tarn 3	Sample C	20/01/2026	Abundant	None	None	None

Results from the macroinvertebrate samples collected in this study are provided in Table 7. Generally, there was low diversity and taxa richness across the samples. This led to lower MCI and ASPM scores than otherwise expected in cool clean water sites. This finding is characteristic of alpine environments with low organic matter with fauna limited to collector/browsers (Suren, 1991) and reduced dispersal (Barquin & Death, 2006). The Doolans Creek mainstem sites had mean MCI values within attribute Band B and C indicative of mild to moderate pollution with a mix of sensitive and tolerant taxa (Ministry for the Environment, 2020) and were comparable to the Nevis River downstream. The QMCI scores were within attribute Band A and indicative of pristine conditions. The ASPM were all within attribute Band B indicative of a community with mild to moderate loss of ecological integrity (Collier, 2008; Ministry for the Environment, 2020). The lower than expected MCI and ASPM scores suggest some ecological impairment; however, the proportions of EPT taxa present are high indicating there is a high proportion of cool water adapted, pollution sensitive taxa present and a good quality macroinvertebrate fauna for this alpine environment. The MCI, QMCI and ASPM (in part) were designed to assess organic pollution rather than to assess high quality alpine communities specifically, therefore the EPT metrics are more representative and better indicators of the alpine macroinvertebrate community.

The tarn benthic macroinvertebrate community comprised primarily of chironomid midges, oligochaete worms, Sphaeriidae and a few cased caddisflies (full macroinvertebrate results provided in Appendix B). The tarns generally had higher evenness scores with higher numbers of multiple taxa. The high Shannon Evenness was largely driven by the low taxa richness and dominance of 3 species in a sample. While low macroinvertebrate taxa richness was found in this study, Barclay (2020) suggests alpine tarns are diversity hotspots that are often home to endemic, threatened stenothermal species particularly in tarns with greater habitat structure, although the loss of predatory species shortens the food chains present. Of the three tarns assessed Tarn 3 had the least variety in habitat structure. During the January 2026 survey cranefly's were observed undertaking a mass oviposition event at Tarn 3. Of the three tarns assessed, Tarn 3 had the lowest EPT proportions and slightly higher diversity metrics. The presence of the data deficient stonefly *Zelandobius macburneyi* at Tarn 2 and the lower proportion of EPT taxa within Tarn 3 equates to the lowest quality tarn in terms of the macroinvertebrate community.

eDNA analysis demonstrated the presence of the stonefly *Zelandobius macburneyi* in Tarn 2, Trib C and the Doolans Creek weir site. This species is considered data deficient in the New Zealand freshwater invertebrate threat classification (Grainger, *et al*., 2018). Data deficient species are suspected to be rare but due to a lack of information are not assigned a threat category (Grainger, *et al*., 2018).

Table 7: Macroinvertebrate survey results (average of three samples per site).

Taxa	DC1	DC 2	DC 3	DC Weir	Trib A	Trib C	Tarn 1	Tarn 2	Tarn 3
Abundance	204	60	90	206	59	45	109	211	253
Taxa Richness	9	10	10	12	11	7	6	5	7
MCI	108	112	123	124	114	107	98	72	69
QMCI	6.9	6.8	6.7	7.7	6.5	6.5	2.2	2.4	2.9
ASPM	0.54	0.53	0.50	0.59	0.49	0.41	0.24	0.16	0.11
EPT % Abundance	99	84	71	93	70	59	16	7	0
EPT %Richness	57	58	53	57	57	46	33	16	0
EPT Richness	5	5.7	5	6	6	3	1.7	1	0
Shannon Diversity Index	1.04	1.35	1.34	1.12	1.69	1.20	0.76	1.15	1.41
Evenness	0.48	0.59	0.58	0.48	0.71	0.64	0.45	0.70	0.75

4.4 Fish

No fish records are present in the New Zealand Freshwater Fish Database (NZFFD) or Wilderlab database for the Doolans Creek in the vicinity of the proposed weir site. The site is considered naturally fishless due to natural waterfall and gorge barriers 2.5 to 6 km downstream (Figure 8).

A review of the wider area outlined that brown trout are known from the catchment approximately 7.5 km downstream on the Doolans Creek (Figure 8; NZFFDB, 2025). Fish records from the Doolans Creek Left Branch show no fish present there. Fish records from the Nevis River show rainbow trout are present along with brown trout and brook char further up the catchment. The native non-migratory Nevis galaxiid was also recorded in the Nevis River (NZFFDB records list this as *Gollum galaxias* but recent genetic analysis has reassigned this as a different species, *Galaxias 'nevis'* (Campbell, *et al.*, 2022)).

The Wilderlab eDNA database was also investigated to ascertain if any relevant fish records from the area were known. There were no records from nearby within the Doolans Basin. Records from the ORC monitoring site on the Nevis River at Wentworth Station were present and showed the presence of brown trout, brook char, rainbow trout, kōaro and Nevis galaxias. The threat classifications for the fish known from the wider catchment are outlined in Table 8 below.

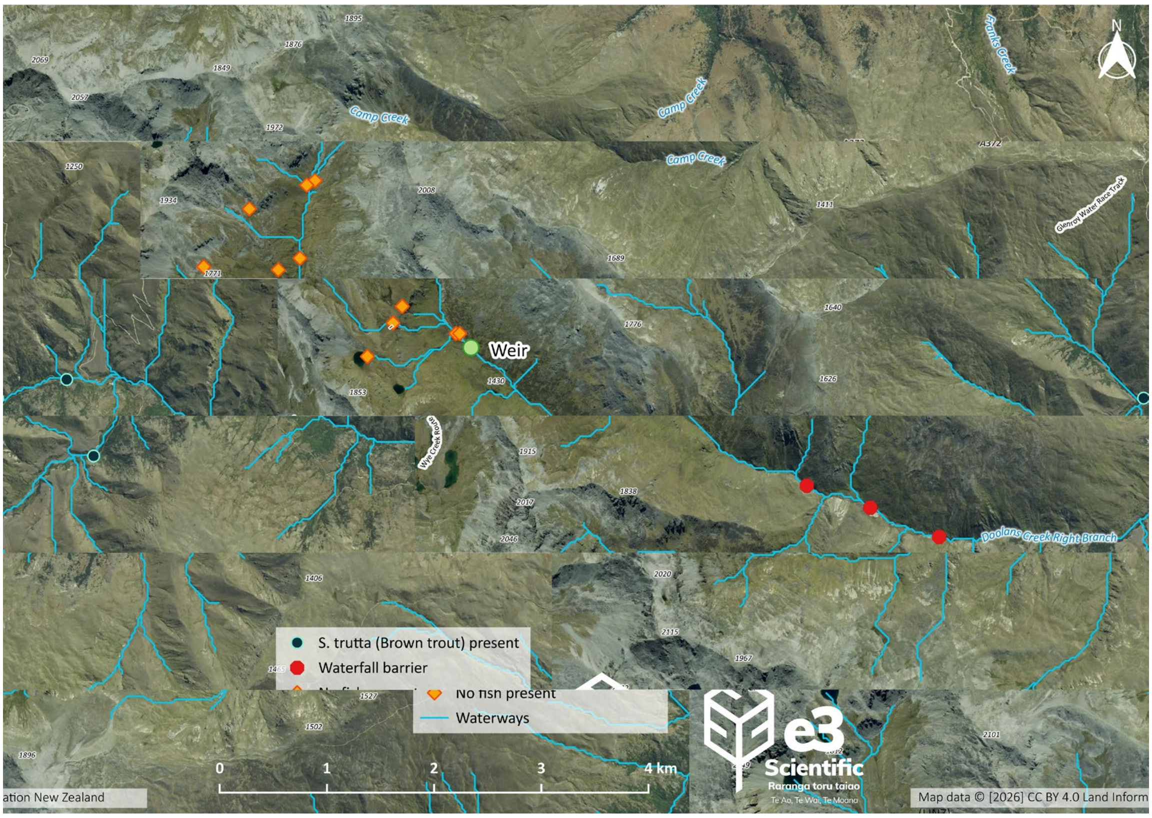


Figure 8: Fish presence/absence in relation to proposed weir location and natural barriers.

Table 8: Fish known from the wider catchment based on NZFFDB records and present in eDNA results and Wilderlab database with associated threat status.

Common Name^	Scientific Name	Threat Status*
Brown trout	*Salmo trutta*	Introduced and Naturalised
Rainbow trout	*Oncorhynchus mykiss*	Introduced and Naturalised
Brook char	*Salvelinus fontinalis*	Introduced and Naturalised
Nevis galaxias	*Galaxias 'nevis'*	Threatened - Nationally Endangered
Kōaro	*Galaxias brevipinnis*	At-Risk - Declining

***All fish threat classifications are from Dunn, *et al.*, (2025)**
^ No fish were identified as present near this section of Doolans Creek
 # None of these fish are considered taonga fish species in Schedule 98 of the Ngai Tahu Claims Settlement Act 1998.

eDNA samples were collected from 7 stream sites and three tarns. No fish eDNA was found in the samples of the streams or tarns. The lack of fish eDNA is unsurprising as this site is a great distance from the sea and upstream of Clyde Dam so migratory fish cannot access the area unaided (although kōaro are known to be within the Nevis River downstream and there is an eel trap and transfer regime at the Roxburgh and Clyde dams). The high altitude and steep catchment with multiple bedrock shoots, waterfalls and steep gorges limits access of fish to this section of Doolans Creek and the tarns. The cold winter conditions limit the ability of many fish species to survive at this altitude with few records above 1000 m in the freshwater fish database. The eDNA of the nationally endangered Nevis galaxias which is known only from the upper reaches of the Nevis River catchment approximately 20 km southeast of this study area were not present in the assessment.

Although we recognise this site is naturally fishless, the fish species richness was assessed against what is typical for this altitude. Using the method of Richardson & Jowett, (1996) the fish species richness is considered low for this site within a national context.

4.5 TICI Metric

Birds were not observed during the survey; however, eDNA analysis did identify the presence paradise shelduck (*Tadorna variegata*) in Tarns 2 and 3 which is considered a taonga species in Schedule 97 of the Ngai Tahu Claims Settlement Act 1998. No other taonga bird or fish species were identified within the eDNA nor sampling results.

The eDNA data from the tarns was used to produce the Taxon Independent Community Index (TICI). This holistic approach is a whole ecosystem measure of ecological health utilising all the eDNA found including, bacteria, algae, plants, invertebrate, fish, and mammals (Wilkinson, *et al*., 2024). The TICI scores were "Excellent" for all three tarns where eDNA samples were gathered.

Didymo was not observed nor identified via eDNA in any of the waterways sampled in the Doolan's Basin in April 2025. Didymo was observed and identified in the eDNA results from the DC Weir site in the January 2026 sampling round but not at the tarns. Didymo is now widespread throughout much of the South Island where human activities such as fly fishing are more prevalent. Care should be taken with any future sampling, installation activities and inwater equipment use in or near the waterways within the Doolans Basin to ensure Didymo does not spread across this environment.

5 Ecological Values

The Environment Institute of Australia and New Zealand (EIANZ) Guidelines set out evaluation criteria that can be used to determine the ecological values of a species or habitat. The assigned ecological value is then used along with the magnitude of the proposal to determine the ecological impact. The following sections use the EIANZ Guidelines to characterise the ecological value of the stream and tarn habitats and faunal species that may utilise the area.

5.1 Assessment of Ecological Value following the EIANZ Guidelines

Under the EIANZ guidelines (Roper-Lindsay, *et al.*, 2018) ecological value is assigned based on the following assessment matters:

- Representativeness
- Rarity and Distinctiveness
- Diversity and Pattern
- Ecological Context

The representative criteria is more difficult to utilise within the freshwater environment as it relies on a range of information to support the assessment. More easily incorporated into the EIANZ criteria are rarity, diversity and ecological context in the freshwater environment which is utilised to support an assessment of ecological value. These matters are each assessed on a five point scale from Negligible to Very High.

Representativeness

The representativeness value for the freshwater environment includes the extent to which the site is typical of the natural characteristics, catchment size, stream order, standing water characteristics and taxa present. Therefore, it is considered appropriate that sites classified as unmodified or representative are recognised with a higher value under the Representative criteria. An unmodified or more natural site or area is likely to be a better representative example than a more modified one; some people consider that representativeness is broadly equivalent to "naturalness".

Rarity / Distinctiveness

The New Zealand Threat Classification System (NZTCS) is used to assess the threat status of fish (Dunn, *et al*., 2025), freshwater macroinvertebrates (Grainger, *et al*., 2018), terrestrial and aquatic plants (de Lange, *et al.,* 2023) and birds (Robertson, *et al*., 2021). This impact assessment has utilised these NZTCS reports to inform an assessment of rarity. However, rare habitats, communities or ecosystem types should also be considered.

Diversity and Pattern

The desktop research undertaken within this report of the NZFFD, and Shannon Diversity Index provided within this report are the basis for an assessment of diversity at the proposed site. Diversity and pattern can include physical and biological diversity. Underlying physical patterns such as lower fish diversity at greater altitude or temporal gradients. Long-term trends and taxa density can also be considered.

Ecological Context

Ecological context describes an ecosystem's role in ecosystem functioning. Examples may include:

- freshwater and terrestrial habitat may provide an important food source for fish and/or birds.
- freshwater and terrestrial habitat may play an important part in the lifecycle of a species e.g. breeding or spawning locations for macroinvertebrate, bird or fish species.
- Macroinvertebrate metrics or TICI scores.

For the purpose of this assessment habitats that support Threatened and At - Risk species, are biologically diverse, provide an important food source or play a critical role in the lifecycle for a species are considered to have a high ecological value.

The ecological value findings based on the above approach are outlined in the following two tables. Table 9 for the Doolans Creek and Table 10 for the ecological value of Tarn 3.

Table 9: Assessment of the Doolans Creek Weir and water take location using the ecological criteria in the EIANZ Guidelines.

Matter	Criteria	Score
Representativeness	The Doolans catchment is unimpacted by human activity currently other than a small amount of cross-country skiing, hunting and hiking and as such is representative of the ecological communities present in 1840. Doolans Creek is naturally fishless at the weir site and downstream due to the distance inland, elevation and barriers downstream. Indigenous species dominate. The Doolans Creek Weir site is demonstrated to have cool clear water with macroinvertebrate community's indicative of high ecological integrity, representative of pristine reference conditions. Although didymo has been observed at the weir location.	High
Rarity/ distinctiveness	No rare native fish or macroinvertebrates were recorded at the Doolans Creek weir site. Although a data deficient stonefly was present at the weir site.	Moderate
Diversity and pattern	Doolans Creek has naturally low diversity due to the altitude and extreme conditions limiting the source pool of taxa. Very cool winter water temperatures. The alpine catchment is covered by snow in winter and is dry in summer. The stream site has low productivity and low overall densities of macroinvertebrates.	Moderate
Ecological context	The QMCI and high EPT proportions demonstrated the weir site is in excellent condition and indicative of pristine conditions. The Doolans Basin is part of a wider protected Kawarau / Remarkables conservation area which is intact, large and resilient to pest invasion.	Moderate

Table 10: Assessment of the Doolan Basin tarns using the ecological criteria in the EIANZ Guidelines.

Matter	Criteria	Score
Representativeness	The catchment is unimpacted by human activity currently other than a small amount of cross-country skiing, hunting and hiking, and as such is representative of the ecological communities present in 1840. The tarns differ physically from each other but represent a range of natural alpine tarn types. Wetlands above 800 m a.s.l. are considered regionally significant wetlands by ORC and tarns classified as an uncommon wetland type (Holdaway, *et al.*, 2012; ORC, 2016). Indigenous species dominate with a lack of pest species such as didymo in the tarns.	All tarns High
Rarity/ distinctiveness	No rare native fish or macroinvertebrates were recorded in the tarns. As a wetland ecosystem type tarns are considered uncommon but not threatened. A data deficient stonefly was present in the Tarn 2 eDNA samples.	Tarn 2 High Tarn 1 and 3 Moderate
Diversity and pattern	The tarns have naturally low diversity due to the altitude and conditions limiting the source pool of taxa. Tarn 1 was large and deep while Tarns 2 and 3 were much smaller and shallower. Tarn 1 and 3 are largely devoid of aquatic plants. In Tarn 3 EPT taxa were absent. The alpine catchment is covered by snow in winter and is dry in summer. Alpine tarns are considered diversity hotspots but have small food webs. Low diversity (but typical alpine) zooplankton community is present with lowest diversity at Tarn 3.	Tarn 1, 2 Moderate Tarn 3 Low

Matter	Criteria	Score
Ecological context	The TICI index suggests the tarns are indicative of excellent ecological condition. The Doolans Basin is part of a wider protected Kawarau / Remarkables conservation area which is intact, large and resilient to pest invasion.	All tarns High

5.2 Summary

The ecological survey was completed in April 2025 and January 2026, prior to the first snowfall for each year. Samples taken provide a robust representation of the waterbodies present within the Doolans Basin, including flowing and standing water, main stem Doolan Creek and smaller tributaries.

Combining these four matters using the method outlined in Table 6 of the EIANZ Guidelines (Roper-Lindsay, *et al.*, 2018) the overall ecological value is considered "**High**" for the Doolans Creek Weir Site and "**High**" for Tarn 1, 2 and 3. Tarn 3 is proposed to be reclaimed as a reservoir.

6 Ecological Impact Assessment

6.1 Ecological Impact Assessment Methodology

This ecological impact assessment (FEcIA) follows the EIANZ Ecological Impact Assessment Guidelines for New Zealand. The guidelines are based on the assessment of the ecological values present within the disturbance area of the proposed weir and reservoir footprint and the effects of reduced stream flow downstream of the water abstraction (see Section 2). The magnitude of the effect within the zone of influence and the wider context of species populations and extent of remaining freshwater habitat is then considered to establish the level of ecological effect.

The FEcIA guidelines provide a series of tables that assist with the assignment of value to the ecological features that will be disturbed and the magnitude of the activity. These tables are provided in Table 11 & 12 and referred to in the discussion below. A summary of the ecological effects and the measures employed to avoid and mitigate the ecological effects of the proposed works are presented in Table 13.

6.1.1 Assigning Magnitude of Effect

The EIANZ guidelines provide criteria for assigning the extent of the effects on the ecological values within the area that may be disturbed by the activity. This assessment adopts the criteria for describing magnitude of effect and is provided in Table 11 below.

Table 11: Criteria for describing magnitude of effect (Roper-Lindsay, *et al.*, 2018).

Magnitude	Description
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature

Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR having negligible effect on the known population or range of the element/feature

6.1.2 Assigning Level of Effect

The level of ecological effect is based on combining the ecological value of an environment that may be impacted by the proposed activities and the magnitude of the effect.

Table 12 is adapted from the EIANZ guidelines to provide a level of effect matrix. For the purpose of this assessment, where the level of effect is moderate or above, a management response is required to ensure potential environmental effects are managed appropriately. An effect level of Low or Very Low indicate the effect is ecologically less than minor.

Table 12: Criteria for describing level of effect (Roper-Lindsay, *et al.*, 2018).

		Ecological Value			
		Very High	**High**	**Moderate**	**Low**
Magnitude	**Very High**	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	High	High	Moderate	Low
	Low	Moderate	Low	Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low
	Positive	Net Gain	Net Gain	Net Gain	Net Gain

6.1.3 Residual Impact

The residual impact is the final impact level assigned to the proposed activity and potential effects once proposed mitigation/remediation options have been applied and is presented in Table 13.

6.2 Weir, Water Take and Reservoir Establishment Aquatic Effects

6.2.1 Weir Earthworks

Physical instream earthworks will lead to a permanent loss of ~20 m^2 of instream habitat and the disturbance of aquatic life due to the placement of the concrete and metal weir structure. The Doolans Creek has a low number of naturally occurring macroinvertebrate taxa present dominated by pollution intolerant mayflies and is naturally fishless at this location. The Doolans Creek Right Branch is 14.1 km long and the proposed instream works area covers approximately 0.05% of the streambed. Given the above the magnitude of the effect of the installation of the weir is considered Low and the resultant overall level of effect is Low.

A secondary effect of the earthworks associated with the Tyrolean weir establishment is the potential to contribute sediment to the high value Doolans Creek and on to downstream aquatic habitats. Sediment inputs can smother macroinvertebrates and clog aquatic macroinvertebrate gills and can have greater effects in alpine streams where sediment occurs at naturally low levels. Sediment arising from the earthworks will predominantly be generated from the banks as the creek as the creek bed has minimal fine sediment deposits. Erosion and sediment control best practice will be followed as per Enviroscope (2026) to ensure bankside earthworks sediment contributions to the stream are minimised. Providing effective ESC measures are implemented minor loss of sediment should occur and the magnitude of effect on the creek is therefore considered Low. Based on the High ecological value of Doolans Creek and a Low magnitude of effect, the overall level of effect is considered to be Low.

The use of small amounts of cement to fix the structure in place has potential for the release of alkaline leachates from fresh uncured concrete, concrete slurry, cement and washings. The leachate is toxic to aquatic life and can result in localised mortality of aquatic macroinvertebrates. The loss of leachate can be managed through diverting a short stretch of the creek while the weir is fixed in place. This approach will allow the recovery of alkaline leachates which can then be pumped to a tank and removed offsite. The diversion will minimise the loss of alkaline leachates and therefore effects on macroinvertebrates down gradient of the weir. The magnitude of effect of the use of the concrete products is therefore considered Low resulting in an overall Low level of effect.

In summary, the following measures are recommended to manage the effects of the weir installation:

- Earthworks should be undertaken during a dry period where stream flow is stable and low e.g. below median flow at the Nevis at Wentworth Station recorder (11.7 m^3/s).
- An Environmental Management Plan (EMP) should be prepared that outlines the Erosion and Sediment Control best practice approaches to be followed.
- The EMP will incorporate the in-water works guidelines (MfE, 2021) such as working from the banks where possible, limiting the works area to the extent practical and preventing cement from entering flowing water.
- The works area should be dewatered with a short diversion in place to ensure cement use is isolated and any high alkalinity water pumped to a tanker and trucked offsite for disposal into a tradewaste system[i].
- Any disturbed streambanks are to be replanted with dense plantings of eco-sourced native Carex/tussock grasses. This rehabilitation work will reduce the likelihood of bank erosion.

Providing the above measures are implemented effectively, e3scientific considers the proposed weir installation can be achieved with a Low level of effect on Doolans Creek (Table 13).

6.2.2 Water Take Flow Reduction Effect

A potential effect of the water abstraction from the weir is the reduced winter/spring base flow to Doolans Creek. The proposal is for water to be pumped from the surface water take to the reservoir for storage and use during the snowmaking season. The flow removal effects on the hydrological regime of the catchment are considered low with respect to base flow (e3Scientific 2026a). James (2008) found that water abstraction reduced depth, velocity, wetted width and increased fine sediment deposition but did not alter temperatures or lower dissolved oxygen levels. There are naturally low levels of sediment within this reach, and the macroinvertebrate community is not expected to be adversely affected as water temperature and dissolved oxygen levels are the main drivers of the alpine macroinvertebrate community. A reduction in flow downstream of

[i] As no fish are present at this location, fish migration and spawning timings do not need to be avoided, and fish salvage will not be required.

the weir is considered to have minimal impact on the instream ecology as it has been found that water takes generally exert minimal impact on macroinvertebrate communities (James, 2008).

Further evidence indicating a minor effect on macroinvertebrates associated with the proposed flow reduction and depth is provided in research by Stoffels *et al.*, (2026). This work examined the effects of flow rate and water depth on the density of macroinvertebrates in the Upper Selwyn River. The study found a minor change in mayfly (Deleatidium) densities where flow rates and depth changes were analogous to the proposed changes associated with the Doolans Creek water take (see Figure 9). Furthermore, macroinvertebrate abundance in Doolans Creek is naturally significantly lower than the Selwyn River. It therefore follows that a reduction in flow rate and water level in this location is likely to have a minor effect on macroinvertebrate density within the foodscape.

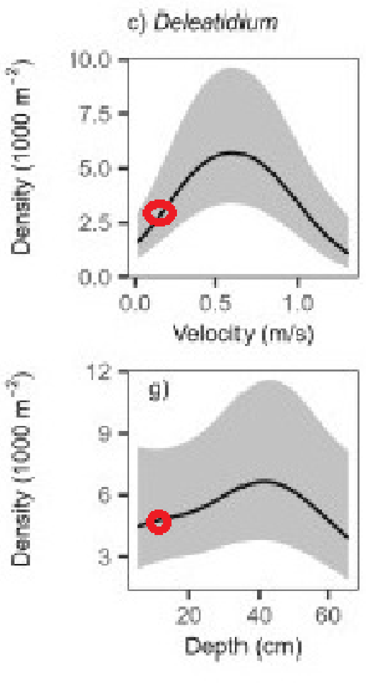


Figure 9: Predicted macroinvertebrate foodscape (Modified from Stoffels *et al.* 2026).

The next tributary input is 600 m downstream from the water take so the minor effects regarding reduced water levels are likely to be limited to a maximum of 600 m. The proposal is for at least 20 L/S to be maintained below the take at all times. e3Scientific (2026a) outlines that 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. As such the maximum water take associated ecological impacts are restricted to the 600 m downstream of the abstraction point and where no fish are present.

Additionally, the proposed water take design has a return pipe to aid with annually flushing sediment accumulated within the pumping chamber and pipes back to the Doolans Creek downstream of the water take (Figure 4). Sediment is naturally transported downstream periodically in Doolans Creek. The take may remove sediments through the weir take to the pumping chamber. When pre-season pipe backflushing occurs, this sediment will be returned to the stream to enable normal channel reworking to occur with sediment deposited at the pipe outlet.

Based on the above, considering the short duration of take during winter and spring, the lack of fish in this section of Doolans Creek, and limited effect on macroinvertebrates, e3scientific considers the magnitude of effect of the water take to be Low, resulting in an overall Low level of effect (Table 13). No management actions are therefore required.

6.2.3 Tarn Habitat Removal Effect

The reservoir creation will lead to the permanent loss of Tarn 3 which equates to the removal of 4450 m^2 of tarn habitat. This area of tarn equates to 13.5 % of the tarn area in the Doolans Basin and 0.75% of the overall wetland area within the Doolans Basin. The results of the assessment suggest Tarn 3 is the lowest quality of the three present, and water levels in this tarn can fluctuate significantly. There is a small intermittent inflow and no outflow and no wetland fringing vegetation. As demonstrated in the macroinvertebrate, zooplankton and eDNA analysis the tarn provides habitat for a low diversity of not-threatened aquatic invertebrates and lacked EPT taxa. Tarn 3 also has a limited aquatic plant and algae community in comparison to Tarn 2. Although Tarn 3 has lower ecological value compared to the other assessed tarns, it is still highly representative of the alpine environment, listed by ORC as a regionally significant wetland and considered an uncommon wetland type. It therefore has attributes that make the tarn ecologically significant (See Table 10, Section 5.1). In light of the high ecological value of Tarn 3 and the moderate magnitude of the loss of 13.5% of Doolans Basin tarn habitat, the overall level of effect is considered High.

As discussed, Tarn 3 was found to have the lowest ecological values of the three assessed tarns, and the modification of this tarn has been considered only after alternative reservoir locations and options were considered and discounted. The lack of further options was largely due to the terrestrial habitat having been assessed to have very high ecological values. Reservoir rehabilitation options such as adding cobbles and boulders onto the geosynthetic liner to mitigate effects of the loss were considered but were discounted due to the risk of liner wear and pump blockage. Options for offsetting the effects on the loss of the Tarn were not clear given the pristine nature of other tarns in the Doolans area. As such, compensation measures are the only available tool to manage the effects of the loss of Tarn 3.

Currently, the overall loss of the tarn habitat associated with the reclamation for the reservoir establishment remains high, prior to the details of the compensatory measures being confirmed and implemented.

Table 13: Ecological Impact Assessment Summary for proposed reservoir and associated earthworks.

Activity and Rationale		Ecological Value	Magnitude of Effect	Level of Effect	Recommended Impact Management Avoid/Mitigate/Remediate/Compensate	Residual Impact
Weir Installation	<u>Weir Earthworks</u> Permanent loss of 20 m^2 of streambed habitat by placement of the concrete and metal weir structure. Benthic macroinvertebrate communities at this site excellent. Represents a very small proportion of streambed within the Doolans Creek Right Branch. No fish present.	High	Low	Low	• Environmental Management Plan (EMP) will be produced that outlines the Erosion and Sediment Control best practice approaches to be followed. • The EMP will incorporate the in-water works guidelines (MfE, 2021) to be followed such as working from the banks where possible, limiting the works area to the extent practical and preventing cement from entering flowing water. • Undertake earthworks during a dry period and associated low flow e.g.. below median flow at the Nevis River at Wentworth Station recorder (11.7 m^3/s).	Low
	<u>Sediment mobilisation and deposition</u> There is potential for sediment associated with earthworks being mobilised and depositing in high value streambed downstream and smothering bed substrate and aquatic life.	High	Low	Low	• Follow Erosion and Sediment Control best practice such as geotextile and silt fence use e.g. Auckland Council (2016) as outlined in the EMP. • Any disturbed streambanks are to be replanted with at dense plantings of suitable native Carex/tussock grasses.	Low
	<u>Cement</u> Use of cement within the streambed can raise the alkalinity of the water to levels toxic to aquatic life.	High	Low	Low	• The works area should be dewatered and ensure cement use is isolated and any high alkalinity water pumped to a tanker and trucked offsite for disposal into a tradewaste system. This method should be included in the EMP.	Low

	Activity and Rationale	Ecological Value	Magnitude of Effect	Level of Effect	Recommended Impact Management Avoid/Mitigate/Remediate/Compensate	Residual Impact
Water abstraction	Removal of up to 30 L/S (2592 m^3/day, 41,240 m^3/year) Up to a 50% reduction in flow over 600m of Doolans Creek, for a total of 16 days per year. Reduced area for macroinvertebrates. Water abstraction only to occur May to October. Water reused in catchment during spring snowmelt. At least 20 L/S flow maintained below the weir at all times.	High	Low	Low	• No further actions required.	Low
	Pipe back flushing Has potential to return and deposit sediment and gravels to the stream	High	Low	Low	• Include the back flushing process within the EMP to ensure no sedimentation effects.	Low
Tarn Reclamation	Loss of 4450 m^2 tarn habitat Lowest quality tarn in the Doolans Basin but naturally uncommon waterway. Tarn 3 is to be replaced with lined water storage reservoir. Represents 13.5% of Doolan Basin tarn habitat or <1% of wetland habitat loss.	High	Moderate	High	• Currently, the overall loss of the tarn habitat associated with the reclamation for the reservoir establishment remains high, prior to the details of the compensatory measures being confirmed and implemented.	High

7 Conclusions and Recommendations

In summary the majority of effects associated with the installation of the weir and the taking of water from Doolans Creek can be adequately managed such that the effects on Doolans Creek are Low. Management actions proposed regarding the installation of the weir are set out below:

1. An Environmental Management Plan (EMP) will be produced that outlines the Erosion and Sediment Control best practice approaches to be followed.
    a. The EMP will incorporate the in-water works guidelines (MfE, 2021) to be followed such as working from the banks where possible, limiting the works area to the extent practical and preventing cement from entering flowing water.
2. Earthworks should be undertaken during a dry period where stream flow is stable and low e.g. below median flow at the Nevis at Wentworth Station recorder (11.7 m^3/s).
3. Follow Erosion and Sediment Control best practice such as geotextile and silt fence use e.g. Auckland Council (2016) as outlined in the EMP.
4. Any disturbed streambanks are to be replanted with dense plantings of suitable native Carex/tussock grasses.
5. The works area should be dewatered and ensure cement use is isolated and any high alkalinity water pumped to a tanker and trucked offsite for disposal into a tradewaste system.
6. Ensure water take duration is from May to October (inclusive).
7. Include the back flushing process within the EMP to ensure no sedimentation effects.

Converting Tarn 3 to a water storage pond is considered to be a High level of effect. Currently, the overall loss of the tarn habitat associated with the reclamation for the reservoir establishment remains high, prior to the details of the compensatory measures being confirmed and implemented.

Based on the above management actions, e3s finds the effects of the proposed weir installation and water take to be Low.

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Appendices

Appendix A: Survey Site Location Photos

DC1 - Doolans Creek Right Branch 1

DC2 - Doolans Creek Right Branch 2

DC3 - Doolans Creek Right Branch 3

Trib A – Tributary A

Trib B – Tributary B

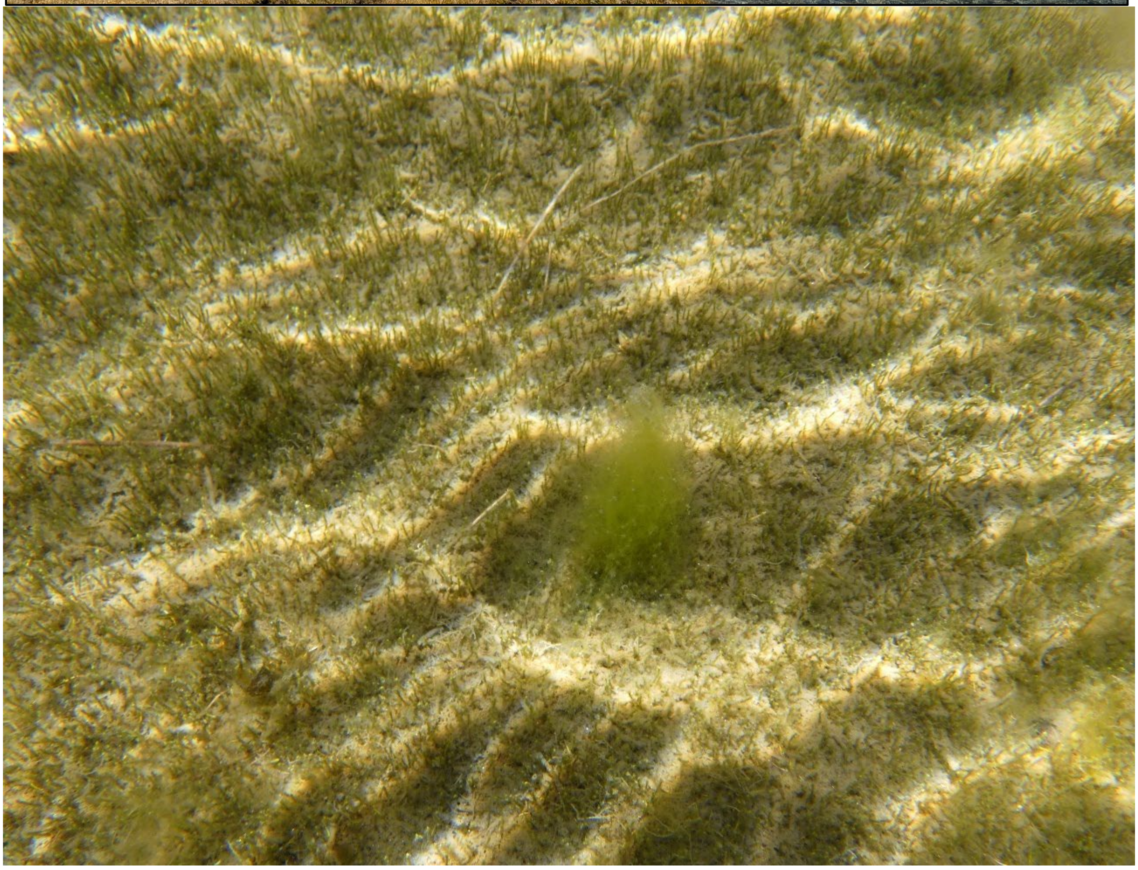
Trib C – Tributary C

No photo very small

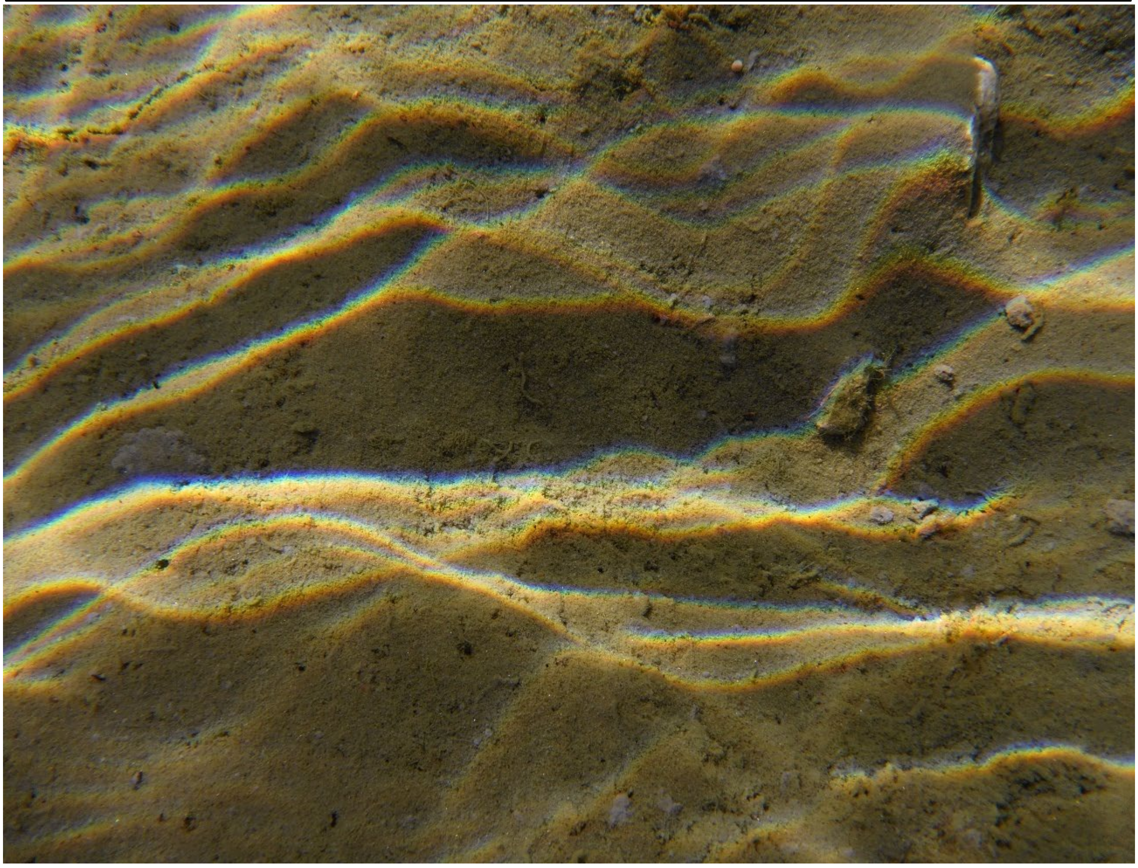
Trib D – Tributary D

Trib E – Tributary E

Tarn 1



Tarn 2



Tarn 3 - April 2025

Tarn 3 – January 2026

Appendix B: Macroinvertebrate raw data

Name	DC 1 (1)	DC 1 (2)	DC 1 (3)	DC1 mean	DC 2 (1)	DC 12(2)	DC 2 (3)	DC 2 mean	DC 3 (1)	DC 3 (2)	DC 3 (3)	DC 3 mean	DC Weir (1)	DC Weir (2)	DC Weir (3)	DC Weir mean
Ephemeroptera																
Deleatidium	219	159	59		41	38	33		79	95	5		103	270	61	
Nesameletus													13	22	18	
Plecoptera																
Zelandobius	36	27	12			4	12		1	18			26	18		
Austroperla									2	1			1	1		
Acroperla	8	1			6	2	1			5	5		1	3		
Zelandoperla					1	2	4						13	16	3	
Spaniocerca														2		
Trichoptera																
Tiphobiosis	1				1		1				2					
Hydrobiosis														1		
Hydrobiosella	2	15	1			1	1									
Psilochorema										1	1					
Hudsonema					1											
Confluens																
Oeconesus										1						
Periwinkla	6	9	4			1										
Philorheithrus									1				1		1	
Zelolessica											2					
Diptera																
Paralimnophila									1							
Tanypodinae	1	9				2								7		
Stictocladius	1					4	2			1						
Lobodiamesa																

Name	DC 1 (1)	DC 1 (2)	DC 1 (3)	DC1 mean	DC 2 (1)	DC 12(2)	DC 2 (3)	DC 2 mean	DC 3 (1)	DC 3 (2)	DC 3 (3)	DC 3 mean	DC Weir (1)	DC Weir (2)	DC Weir (3)	DC Weir mean
Maoridiamesa							1				1					
Chironomus		1											2			
Orthocladiinae											1			1		
Ephydridae							1				8					
Tabanidae						1										
Austrosimulium	4	9	3		1	1	2		2					1		
Aphrophila											2					
Eriopterini											1			1		
Limonia											8			1		
Neocurupira														6		
Muscidae															1	
Coleoptera																
Hydrophilidae																
Scirtidae											2					
Dytiscidae																
Antiporus																
Elmidae		1				5				1				3	1	
Tricladida																
Cura						4			3							
Neppia	14	9	1		5				13	7			13	2	1	
Hemiptera																
Anisops																
Mecoptera																
Nannochorista																
Sphaeriidae																

Name	DC 1 (1)	DC 1 (2)	DC 1 (3)	DC1 mean	DC 2 (1)	DC 12(2)	DC 2 (3)	DC 2 mean	DC 3 (1)	DC 3 (2)	DC 3 (3)	DC 3 mean	DC Weir (1)	DC Weir (2)	DC Weir (3)	DC Weir mean
Nematomorpha													3			
Nematoda														1		
Collembola	1															
Oligochaeta					1									1		
Abundance	293	240	80	204	57	65	58	60	102	130	38	90	176	357	86	206
Taxa Richness	11	10	6	9	8	12	10	10	8	9	12	10	10	18	7	12
MCI Taxa Richness	9	9	5	8	8	10	9	9	8	8	12	9	10	18	7	12
MCI	111	100	112	108	105	114	118	112	113	133	123	123	122	115.56	134.29	124
QMCI	7.03	6.89	6.91	6.94	7	6.48	6.84	6.77	7.09	7.14	5.92	6.72	7.23	7.78	8.14	7.7
ASPM	0.56	0.52	0.55	0.54	0.52	0.51	0.56	0.53	0.5	0.6	0.39	0.50	0.58	0.6	0.59	0.59
EPT % Abundance	93	88	95	92	88	74	90	84	81	93	39	71	89.77	93.28	96.51	93
EPT % Richness	55	50	67	57	63	50	60	58	50	67	42	53	70	44.44	57.14	57
EPT Richness	6	5	4	5	5	6	6	6	4	6	5	5	7	8	4	6
Shannon Diversity Index	0.97	1.25	0.89	1.04	1.04	1.6	1.41	1.35	0.85	0.97	2.19	1.34	1.38	1.09	0.9	1.12
Evenness	0.4	0.54	0.5	0.48	0.5	0.65	0.61	0.59	0.41	0.44	0.88	0.58	0.6	0.38	0.46	0.48
MCI Attribute Band	B	C	B	B	C	B	B	B	B	A	B	B	B	B	A	B
QMCI Attribute Band	A	A	A	A	A	B	A	A	A	A	B	A	A	A	A	A
ASPM Attribute Band	B	B	B	B	B	B	B	B	B	A	C	B	B	B	B	B

Name	Trib A (1)	Trib A (2)	Trib A (3)	Trib A Mean	Trib C (1)	Trib 2 (2)	Trib C (3)	Trib C Mean
Ephemeroptera								
Deleatidium	5	36	45		45		11	
Plecoptera								
Zelandobius		3	7		2			
Austroperla								
Acroperla	5	4	14					
Zelandoperla		3						
Trichoptera								
Tiphobiosis	2		1			4		
Hydrobiosis		1	1		2		21	
Hydrobiosella					1			
Psilochorema	1		1					
Hudsonema			2		1			
Confluens			1				1	
Oeconesus								
Periwinkla								
Philorheithrus								
Zelolessica	2							
Diptera								
Paralimnophila								
Tanypodinae								
Stictocladius							1	
Lobodiamesa			1					
Maoridiamesa	1		3					
Chironomus						1		
Orthocladiinae	1							
Ephydridae	8							
Tabanidae								
Austrosimulium		5	1		2		3	
Aphrophila	2							
Eriopterini	1							
Limonia	8					14	5	
Coleoptera								
Hydrophilidae						3		
Scirtidae	2					11	1	
Dytiscidae								
Antiporus								
Elmidae		4	4					
Tricladida								
Cura								
Neppia			1				4	
Hemiptera								
Anisops								
Mecoptera								
Nannochorista								
Sphaeriidae								

Name	Trib A (1)	Trib A (2)	Trib A (3)	Trib A Mean	Trib C (1)	Trib 2 (2)	Trib C (3)	Trib C Mean
Collembola								
Oligochaeta			1				1	
Abundance	38	56	83	59	53	33	48	45
Taxa Richness	12	7	14	11	6	5	9	7
MCI Taxa Richness	12	7	14	11	6	5	8	6
MCI	123	120	99	114	120	104	98	107
QMCI	5.92	7.09	6.58	6.53	7.57	6.42	5.38	6.46
ASPM	0.39	0.54	0.55	0.49	0.58	0.23	0.43	0.41
EPT % Abundance	39	84	87	70	96	12	69	59
EPT % Richness	42	71	57	57	83	20	33	46
EPT Richness	5	5	8	6	5	1	3	3
Shannon Diversity Index	2.19	1.26	1.62	1.69	0.66	1.31	1.64	1.20
Evenness	0.88	0.65	0.61	0.71	0.37	0.81	0.75	0.64
MCI Attribute Band	B	B	C	B	B	C	C	C
QMCI Attribute Band	B	A	A	A	A	B	C	B
ASPM Attribute Band	C	B	B	B	B	D	B	B

Name	Tarn 1 (1)	Tarn 1 (2)	Tarn 1 (3)	Tarn 1 Mean	Tarn 2 (1)	Tarn 2 (2)	Tarn 2 (3)	Tarn 2 Mean	Tarn 3 (1)	Tarn 3 (2)	Tarn 3 (3)	Tarn 3 Mean
Ephemeroptera												
Deleatidium	5		1									
Plecoptera												
Zelandobius												
Austroperla												
Acroperla												
Zelandoperla												
Trichoptera												
Tiphobiosis							2					
Hydrobiosis												
Hydrobiosella												
Psilochorema												
Hudsonema	7	17	13			2	40					
Confluens												
Oeconesus												
Periwinkla												
Philorheithrus												
Zelolessica												
Diptera												
Paralimnophila									1			

Name	Tarn 1 (1)	Tarn 1 (2)	Tarn 1 (3)	Tarn 1 Mean	Tarn 2 (1)	Tarn 2 (2)	Tarn 2 (3)	Tarn 2 Mean	Tarn 3 (1)	Tarn 3 (2)	Tarn 3 (3)	Tarn 3 Mean
Tanypodinae					85	44	16		57	95	68	
Stictocladius												
Lobodiamesa												
Maoridiamesa												
Chironomus	1				66	29	77		48	146	37	
Orthocladiinae												
Ephydridae		1			12	2				1	1	
Tabanidae												
Austrosimulium												
Aphrophila												
Eriopterini												
Limonia		1					1					
Coleoptera												
Hydrophilidae												
Scirtidae							2					
Dytiscidae		1							15	1	2	
Antiporus										1	3	
Elmidae												
Tricladida												
Cura												
Neppia												
Hemiptera												
Anisops	1											
Mecoptera												
Nannochorista	2	6	5									
Sphaeriidae		1							64	53	69	
Collembola												
Oligochaeta	34	152	79		25	167	63		30	55	11	
Abundance	50	179	98	109	188	244	201	211	215	352	191	253
Taxa Richness	6	7	4	6	4	5	7	5	6	7	7	7
MCI Taxa Richness	6	7	4	6	4	5	7	5	6	7	7	7
MCI	93	91	110	98	55	68	94	72	70	69	69	69
QMCI	2.72	1.75	2.04	2.17	3	1.79	2.46	2.42	2.96	2.41	3.27	2.88
ASPM	0.26	0.2	0.25	0.24	0.09	0.13	0.25	0.16	0.12	0.11	0.11	0.11
EPT % Abundance	24	10	14	16	0	1	21	7	0	0	0	0
EPT % Richness	33	14	50	33	0	20	29	16	0	0	0	0
EPT Richness	2	1	2	2	0	1	2	1	0	0	0	0
Shannon Diversity Index	1.05	0.59	0.64	0.76	1.17	0.9	1.37	1.15	1.53	1.34	1.36	1.41
Evenness	0.59	0.3	0.46	0.45	0.84	0.56	0.71	0.70	0.86	0.69	0.7	0.75
MCI Attribute Band	C	C	B	C	D	D	C	D	D	D	D	D
QMCI Attribute Band	D	D	D	D	D	D	D	D	D	D	D	D
ASPM Attribute Band	D	D	D	D	D	D	D	D	D	D	D	D

Appendix C: Doolans Creek (DC3) velocity table.

Date	Flow (ls)	Slope S (m/m)	Hydraulic Radius Rh (m)	Mannings n (coefficient)	Velocity v (m/s)
11/02/2026	98.2	0.0349	0.112	0.13	0.325
25/02/2026	65	0.0349	0.098	0.15	0.26
Half flow	32.5	0.0349	0.056	0.14	0.195

Formula used: v=1/n x Rh^(2/3) x S^(1/2)