Remarkables Ski Area Expansion Project

Water Intake Concept Report

Prepared for:
NZSki Limited

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Code of Conduct

The author of this report is Cristian Hadad. I am a Principal Water Resources Engineer and my qualifications are BScE, Member of Engineering New Zealand, P.Eng(CL). I have 16 years' experience in Hydraulics and Engineering Hydrology. I have worked on Dams and Hydropower, Flood Risk and Mitigation, River Engineering, and Surface Water Management across Mining, Transport, Irrigation and Infrastructure sectors.

I have contributed to international projects from concept through to construction, with a focus on hydraulic design, modelling, and engineering hydrology. My early career in South America centred on large-scale Mining and Hydropower developments, and since relocating to Wellington, I have worked on projects in NZ, Australia, and internationally in Fiji, Samoa, Laos, and Saudi Arabia.

My key areas of expertise include Dam Safety, Hydraulic Design, Flood Hazard Assessment, and Surface Water Management, with extensive experience in flood hydrology in both humid and arid regions, PMP/PMF studies, and consequence assessments

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.

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1 Executive Summary

This report presents the concept design and effects for a new water intake to support the proposed expansion of the Remarkables Ski Area into the upper Doolans Creek Right Branch. The primary objective is to ensure a reliable water supply that meets operational needs for the expanded ski area.

Water flow in Doolans Creek was monitored by e3Scientific Scientific between May and September 2025 in winter. Two monitoring sites were established within Doolans Creek, known as DC2 and DC3 in the locations shown below:

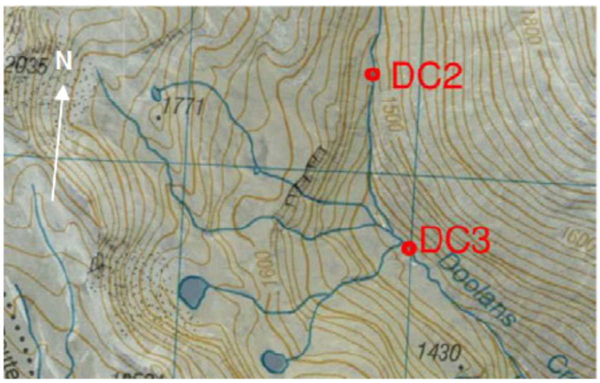


Figure 1: Flow monitoring sites DC2 and DC3 in Doolans Creek Right Branch

The flow monitoring indicated that the flow in the creek was unlikely to drop below 65 l/s at the monitoring location identified as DC3.

The approach recommended for the Doolans Creek Right Branch Water Intake is as follows.

- Develop a Site downstream of DC3 as this avoids damaging the dracophyllum vegetation which is located immediately adjacent to DC3. Dracophyllum is not of notable high value species within the area, but it is not widely distributed and NZSki wish to minimise disturbance of this vegetation.
- Construct a Tyrolean weir situated low within the river
- Install a piped connection to an (sediment exclusion) overflow /flushing chamber
  - Divided into two chambers
  - Chamber one is for flushing through unwanted sediment
  - An overflow weir allows clean water to pass into chamber two, also referred to as the pumping chamber
- Construct a piped flushing line connected to the flushing chamber, leading back to the river which includes an adjustable flushing control valve
- Install a submersible pump within the pumping chamber (second chamber) including a low head submersible pumps to the high-head pump station
- Construct a dedicated high-head pump station on elevated area to pump to the snow making reservoir and Gondola Return Station buildings. This is on the elevated terrace to protect from flood and located safely from avalanche risk.
- The following alternative approaches were considered and rejected:

  - DC2 was rejected due to poor access to the creek, low winter flow and avalanche risk at the site
  - DC3 has suitable winter water flow but was rejected due to adjacent dracophyllum vegetation. NZSki wishes to minimise disturbance to this vegetation.
  - Site 100m upstream of DC3, rejected as this site fails to capture the flow from the twin tarns in the catchment the flow is consequently not as reliable as the site selected.
- Alternative Weir Types
  - An assessment was conducted to evaluate various weir types for the water intake system. The alternatives considered included:
    - Frontal weirs
    - Lateral weirs
    - Tyrolean weirs
    - Coanda weirs

    The evaluation process ensured that the most suitable weir type was selected for reliable and efficient operation within the context of Doolans Creek Right Branch and its environmental conditions.

The key benefits of the recommended approach selected are:

- Reliable operation of the intake during low flow and high flow events in Doolans Creek.
- A sediment exclusion / flushing chamber allows the water system to operate in a high sediment environment, with minimal maintenance required.
- An elevated pump station located on the terrace above the river provides resilience from floods plus protection from snow avalanche due the width of the terrace.

The key risks identified are:

- Uncertainty on long term hydrological flow in Doolans Creek.
- Blockages caused by sediment and/or snow.
- Sediment flushing may not function as required.

2 Introduction

This report is one of a number of reports produced by Stantec on various Engineering related elements of the proposed development of the Remarkables Ski Area into the upper Doolans Creek Right Branch Basin. This report addresses the water intake proposed to abstract water from the upper Doolans Creek Right Branch. The water will be used for winter snowmaking, firefighting reserve at the Gondola Return Station facilities and some water will be treated for potable water at these facilities. The largest use of the water will be for winter snow making.

Currently NZSki operate the Remarkables Ski Area with maximum daily visitor numbers up to approximately 3,500 people. The proposed expansion into the upper Doolans Basin is intended to increase total visitor numbers to approximately 6,000 with up to approximately 2,500 visitors within the basin in the upper Doolans Creek Right Branch.

This report describes the options for abstracting water from the upper Doolans Creek Right Branch and pumping it to the snow making Reservoir and to the Doolans Gondola Return station facilities. This report describes the intake selected and the plant layout for pumping.

A 'Tyrolean weir' intake structure has been selected to take water from the stream bed. A small low-head pump station, utilising submersible pumps, will be located in a chamber adjacent to the weir will pump water to the main high-head pump station building. The main high-head pump station will pump water to both the snow making reservoir and to the Gondola Return Station buildings. The high-head pump station building will be located on a terrace adjacent to, and above, the riverbed. This location protects the main high-head pump station from floods within Doolans Creek. The main high-head pump station location is located at the edge of a terrace which is considered sufficiently wide to protect from foreseeable snow avalanches.

3 Existing Environment

3.1 Existing Intakes in the Rastus Burn

NZSki operate three consented water intake structures within the Rastus Burn catchment. These are:

- Seasonal snow making intake in Lake Alta, which is removed in spring and replaced in autumn,
- Potable water and Fire Fighting intake immediately upstream of the crossing over the Rastus Burn,
- snow making intake adjacent to the Alta Chair base station.

The Lake Alta intake involves a trolley mounted with submersible pumps and a demountable delivery pipeline. Prior to winter this trolley is pushed out into Lake Alta (using the delivery pipes). The delivery pipes are then bolted to existing, buried, pipes at a flanged connection in a box on the shoreline. The trolley is removed from the lake in spring by pulling it to the shore and then lifting it out by helicopter for maintenance. The trolley and pumps are replaced in autumn. The location of the intake is shown in the figure below.

Figure 2: Aerial view of existing Lake Alta Intake and its location

The location of the potable intake and snow making intake in the Rastus Burn are shown below:

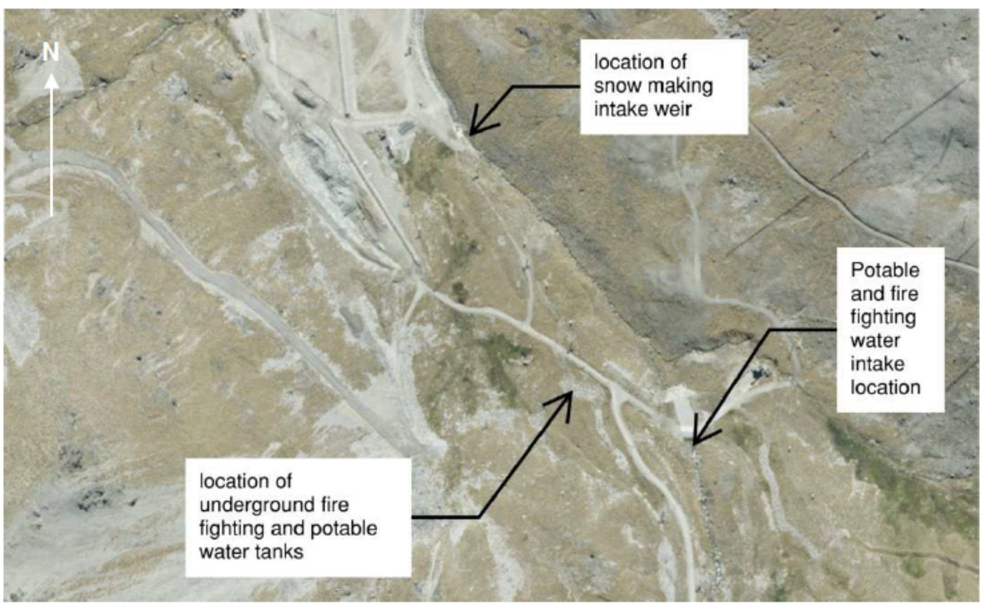


Figure 3: Location of existing water intakes in the Rastus Burn Creek

3.2 Doolans Creek Intake Location Description.

The proposed water intake for the Remarkables Ski Area Expansion Project is located on the upper Doolans Creek Right Branch, a steep alpine stream within the Southern Lakes region. The proposed intake site is at an approximate altitude of 1,370 metres. The catchment is steep mountainous terrain, and the upper part of the catchment is snow covered during winter months. Doolans Creek Right Branch has a boulder bed with step pool morphology typical of high energy alpine environments which is a crucial factor for the selection of an appropriate water intake type. Seasonal snow accumulation and freezing conditions occur between May and November.

Doolans Creek Right Branch drains a high-altitude catchment characterised by steep slopes, shallow soils, and schist bedrock, typical of the Otago high country. The geomorphology reflects a mix of glacial and fluvial processes, with visible moraine remnants, active scree zones, and confined channel forms. The creek exhibits a step-pool morphology, coarse bed material, and a flashy hydrological regime, indicating high sediment transport potential during storm events and snowmelt periods.

Vegetation in the area transitions from alpine tussock grasslands at higher elevations to subalpine shrublands further downslope. The catchment is undeveloped. The creek bed is gravel and tussock vegetation extends to the sides of the channel.

The site selected for the intake location is downstream of the DC3 monitoring site, and downstream of the confluence of Doolans Creek Right Branch and the side streams from the tarns to the west. This selection maximises the flow available within a practical distance of the snow making and Gondola Return Station facilities. There are other potential locations for an intake immediately upstream of this location, but the site selected provides the following benefits:

- It maximises the flow in Doolans Creek Right Branch by being downstream of the confluence with creek from the tarns to the west,
- It has a practical gradient for the access road minimises disturbance to the dracophyllum vegetation, which is a desire of NZSki,
- Has a suitably wide area of bed to allow the below ground low-head pump chamber (which pumps a short distance and height to the high-head pump building) plus the weir to be fitted into the site,
- It has an adjacent terrace platform which allows the high-head pump station building (which contains skid mounted multi-stage high-head pumps which pump to the snow making reservoir and Doolans Return Station infrastructure) to be located beyond potential flooding,
- It is not an impractical distance downstream.

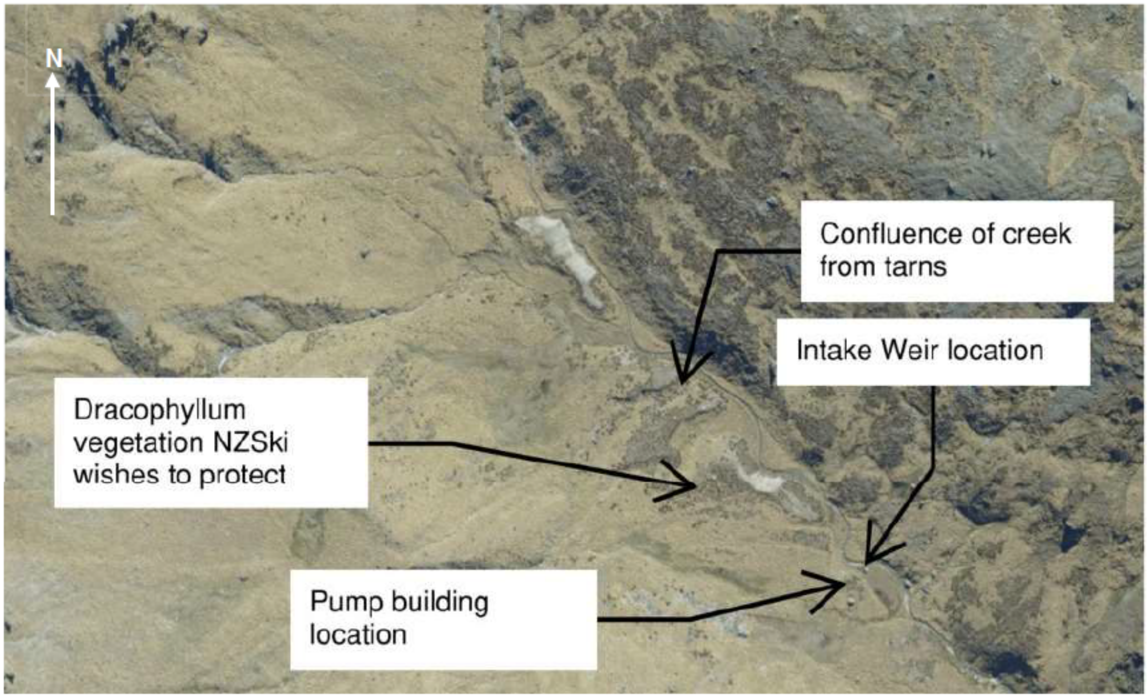


Figure 4: Location of proposed intake within Doolans Creek

4 Existing Catchment Monitoring Sites

e3Scientific undertook flow monitoring at two sites within Doolans Creek Right Branch between May and September 2025. The two monitoring sites were known as DC2 and DC3 and the locations of these two sites are shown in the figures below. The e3Scientific report on flow monitoring of the Doolans Creek Right Branch, 'Doolans Creek Water Take Assessment of Effects' March 2026, includes the following section regarding minimum flow at the DC3 monitoring location:

> Figure 11 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 5. Section from e3 report 'Doolans Creek Water Take Assessment of Effects' March 2026

The catchment of both DC2 and DC3 are shown in the figure below:

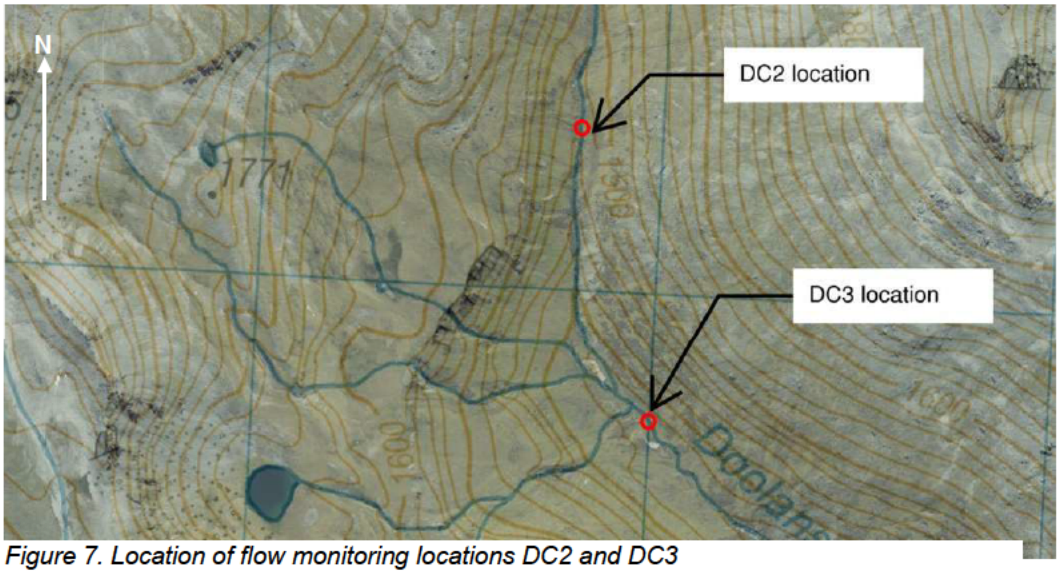


Figure 7. Location of flow monitoring locations DC2 and DC3

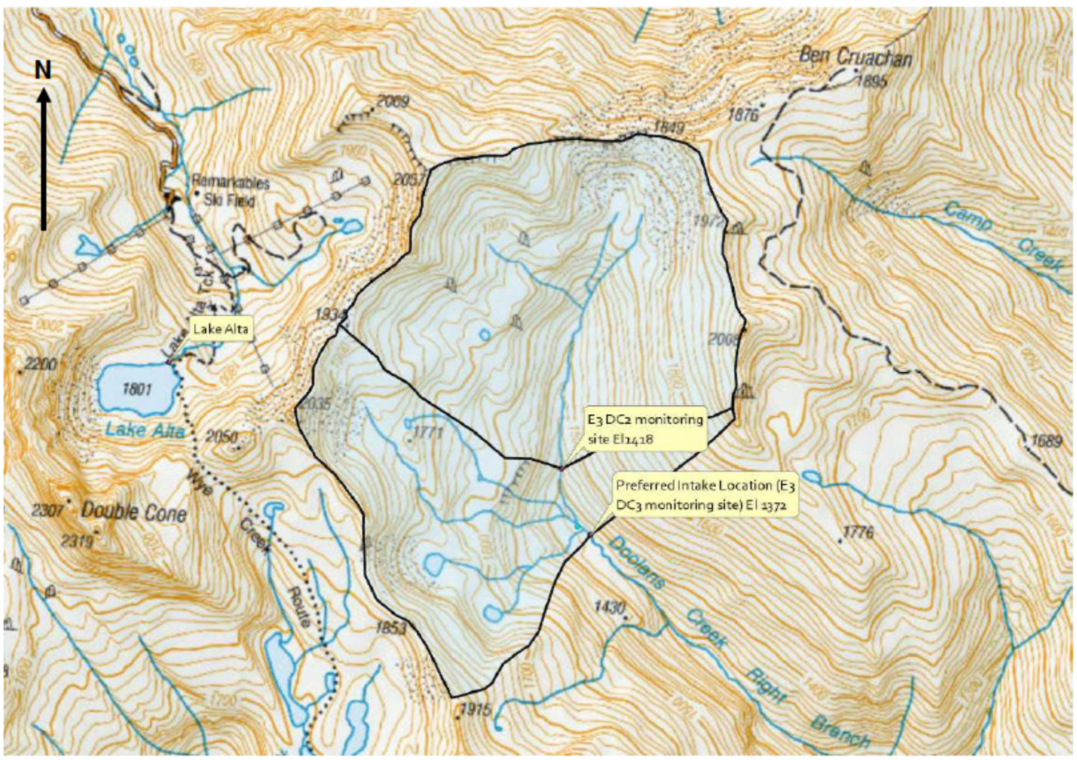


Figure 6. Monitoring Sites DC2 and DC3 and their respective catchments.

Photographs of the DC2 and DC3 are shown in the figures below:

Figure 8. Approximate location of DC3

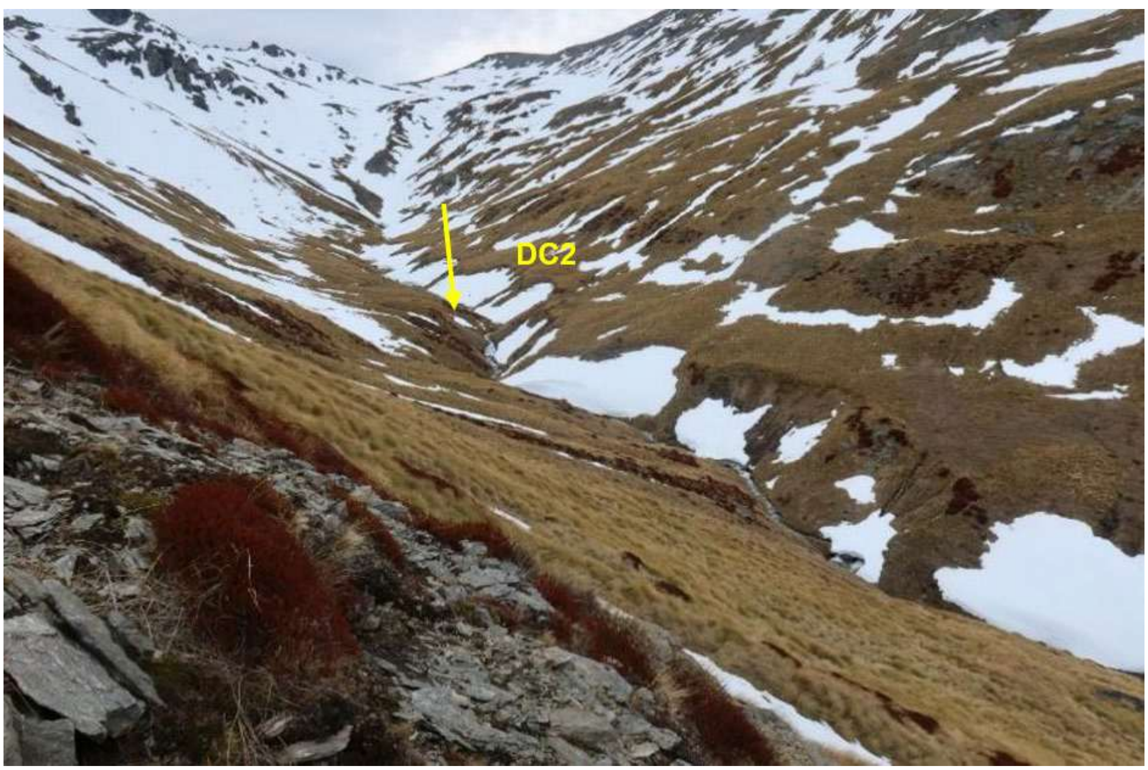


Figure 9. Approximate Location of DC2

Photographs of the two measuring sites are shown below. The confined nature of DC2, on the left, is apparent in these pictures.

Figure 10: Site DC2 (left) and Site DC3 (right)

Doolans Creek Right Branch was inspected by Stantec staff on 7 November 2025. This inspection was at the time of the highest rate of snow melt and followed several occurrences of heavy rain during the previous weeks. During the inspection the channel geometry and flow speed was measured, and the flow was estimated to be approximately 1 m^3/s at a site which was approximately 100m upstream of DC3. This location is shown in the figures below.

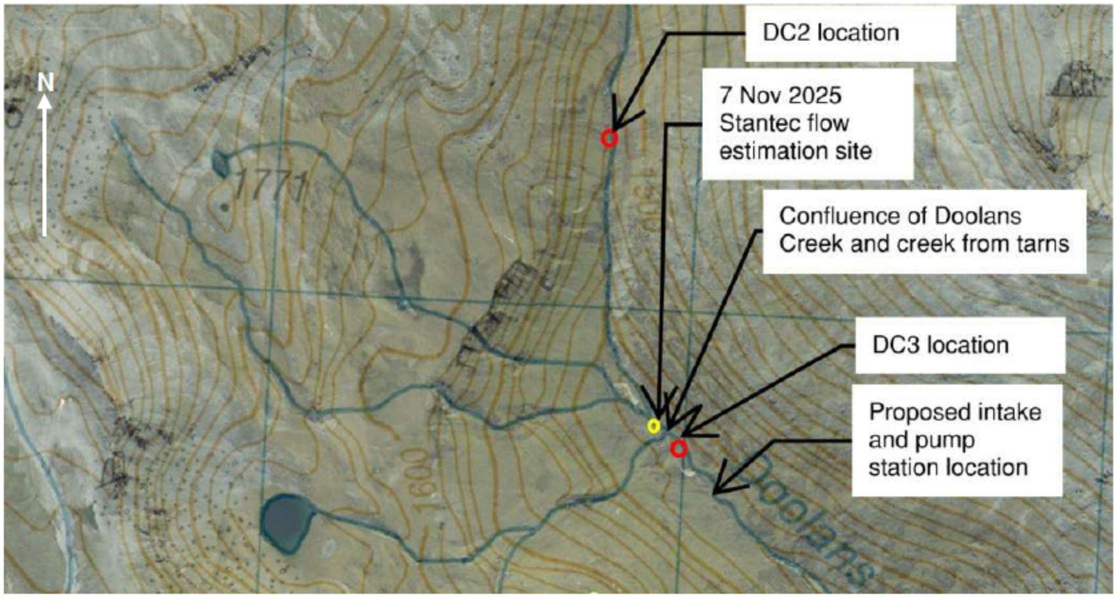


Figure 11: Location of Stantec November 2025 flow estimation and flow monitoring sites

Figure 12: Photograph of Stantec Nov 2025 flow estimation site

4.1 Intake Capacity

The intake pumps will be designed with capacity to abstract up to 30 l/s from Doolans creek Right Branch in accordance with the flow rate proposed in the e3 report 'Doolans Creek Water Take Assessment of Effects' March 2026 which includes the following section on abstraction and pumping rates:

> NZ Ski 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.

Figure 13. Proposed Abstraction Rates From e3 Report 'Doolans Creek Water Take Assessment of Effects' report

Flow monitoring undertaken by e3 Scientific at the DC3 site in Doolans Creek, over the period 26 2025 to 21 February 2026, is shown in the figure below. This shows the lowest flow rate recorded at C3 was 65.1 l/s.

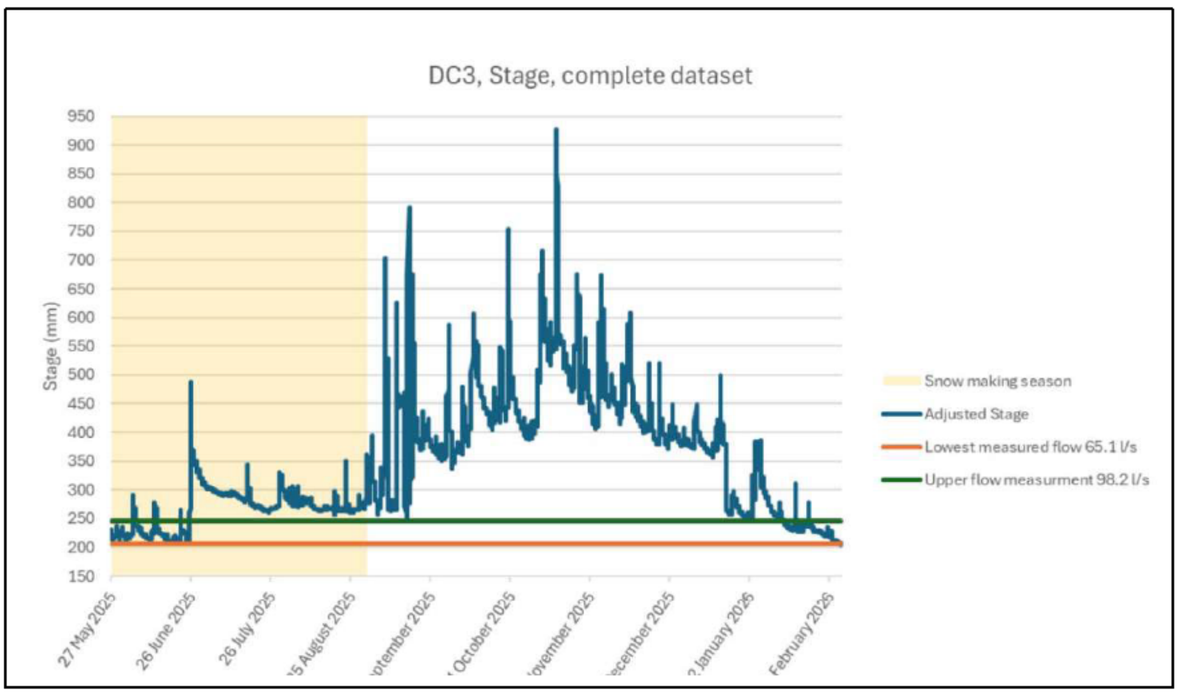


Figure 14. Flow records between 27 May 2025 & 21 February 2026 from e3 report 'Doolans Creek Water Take Assessment of Effects'

The e3 Scientific report proposes that a consent condition that a minimum residual flow of 20 l/s in the creek at the intake location to guarantee sustained flow downstream of the intake. The relevant section from the e3 Scientific report is reproduced below.

> 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.

Figure 15. e3 Scientific recommendation re 20 l/s residual flow within Doolans

The method of residual flow monitoring is a detailed design consideration. We anticipate that this will be achieved by a standpipe and pressure sensor at the flume outlet location calibrated to a rating curve for the creek location. This system will allow flow monitoring even in conditions where the stream and weir are snow covered.

5 Intake Site Selection

5.1 Site Selection Criteria

The requirements for a suitable site include the following elements,

- Flow greater than 20 l/s during winter,
- Suitable access for maintenance and inspection in both winter and summer,
- Sufficient space to install an intake weir and pumping,
- A location not prone to excessive snow buildup during winter,
- Not exposed to snow avalanche risk,
- Minimise disturbance to the dracophyllum, a desire of NZSki.

5.1.1 River Flood Design Event

The proposed intake structure, and associated training walls/flumes, will be designed to pass a 1:100-year flood event. It is anticipated that 'super-design events' (an event greater than a 1:100 flood) will overflow the channel onto the existing floodplain, and the intake structure will be submerged. Some deposition of sediment is possible, or even likely, in a super design event and removal of excess sediment may be required following such an event. The intake structure will feature riprap protection installed both upstream and downstream of the weir to mitigate erosion and to protect the structure during flood events.

Connections between the intake, pumping/flushing chamber, and flushing pipe will be routed underground, with additional protection for these elements to be evaluated in the preliminary design stage.

The low-head pump facility is in a below ground chamber adjacent to the intake weir. This low-head installation pumps water up to the high-head pump station. This consists of a chamber which houses the sediment by-pass chamber connected to a flow bypass pipeline which returns some flow plus sediment back to the creek channel. This installation includes a second separate, but hydraulically connected, chamber housing the low-head submersible pumps. Sediment that enters the weir structure and is conveyed to the chamber will be flushed back into the creek in most flow conditions. During a flood event some sediment accumulation in both the by-pass chamber and the pump chamber is likely and may require cleaning out. The low-head pumps will be configured to allow flushing of this sediment. As the chamber is below ground level and the pumps are submersible, no significant flood damage to either the chamber or submersible pumps is anticipated.

The main, high head, pump station building will be positioned on the adjacent elevated river terrace. These pumps are skid mounted and are not designed to be submerged, but the building and pumps are located on the terrace a safe height above conceivable flood level.

5.1.2 Avalanche Risk

The anticipated pump building location, downstream of DC3, has been assessed to be free from significant snow avalanche danger. This is due to the low altitude of the site and the near horizontal run out distance of approximately 200m along the terrace from any avalanche threatened slopes. This is shown in the figure below.

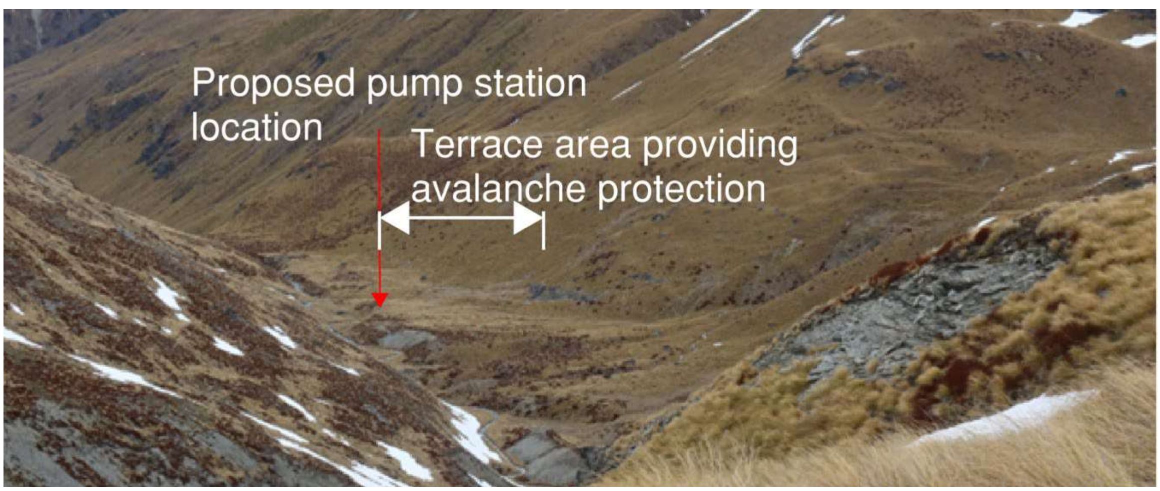


Figure 16: Photograph showing avalanche run out distance to proposed pump station location

Possible intake sites adjacent to DC2 have been rejected as an intake location for the following reasons:

- Significant snow build-up within the creek, potentially more than 5m depth, during winter,
- Deeply incised creek resulting in very difficult construction and maintenance access,
- Exposure to snow avalanches from both sides of the creek,

These issues associated with the potential DC2 are apparent in the figure below.

Figure 17: Sites adjacent to DC 2 either inaccessible or exposed to potential snow avalanche and snow accumulation

5.1.3 Creek Gradient

The topographical map indicates that in the intake area there is a stream bed drop of 20m over 455m, or approximately 4.4%. A specific survey check of the bed gradient will be required to confirm the intake type selection. To achieve flushing of the structure a minimum gradient of 2% is required.

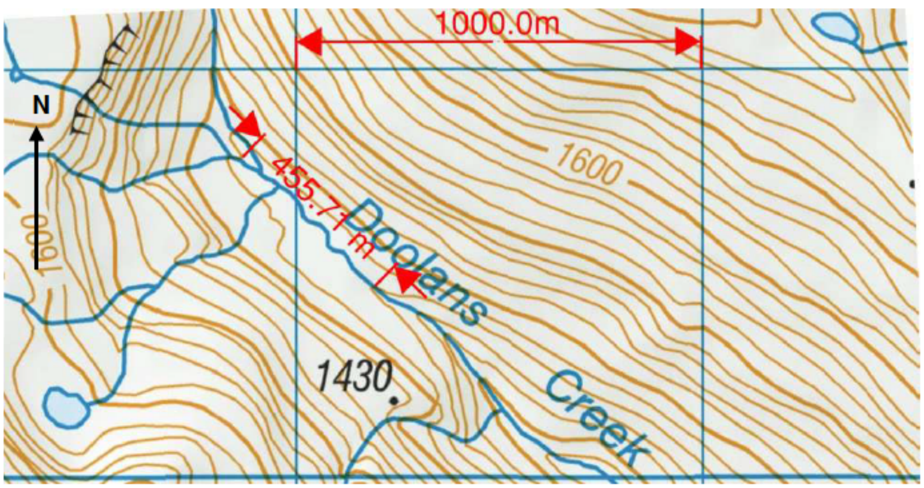


Figure 18: Measurement from 1:50,000 Map indicating river gradient of approximately 4.3%

5.1.4 Fish Passage

Stantec have been advised by the e3Scientific environmental team that fish passage is not required in this location as there are no fish species this high in the creek.

5.1.5 Sediment transport

There are two key sediment considerations when designing a weir intake structure: Suspended sediment and bedload.

Suspended sediment includes all particles carried (suspended) by the water, from fine silt and clay to sand and small gravel. Suspended sediment load is high during flood and snowmelt conditions, when fast-moving water keeps fine particles mixed throughout the flow.

Bedload refers specifically to the larger, heavier particles such as gravel and cobbles which are transported along the creek bed. Bedload is mobilized mainly during high-energy events (large floods). Bedload material rolls or slides along the bottom. Alpine streams with steep gradients and rapid flows can transport significant bedload, which can damage or block intake structures.

Intake systems for alpine creeks must be designed to manage both suspended sediment and bedload transport. Based on site observations, bedload presents the most critical challenge in this case. Suspended sediment is typically addressed by filtration systems and settling chambers. In contrast, effective management of bedload requires the implementation of robust screening mechanisms and reliable flushing systems to prevent blockages and reduce maintenance requirements.

To ensure the effectiveness of flushing operations, the intake design must incorporate a suitable natural river gradient. A minimum slope of 2% is generally required to facilitate the return of flushing flows downstream. Steeper localised grades may also be required.

6 Intake options considered

Given the location of the project, the intake must be designed with the following key performance aspects:

- Must be able to manage high sediment rates during snow melt or storm events,
- Must not require significant maintenance.

The main technical reference adopted to guide our analysis and design is the International Hydraulic Research publication “Mobile barrages and Intakes in Sediment Transporting rivers” (Bouvard,1992 IAHR Hydraulic design manuals).

Bouvard (1992) and subsequent references classify intakes by their hydraulic arrangement and sediment exclusion principles. In this location a Tyrolean weir is judged to be the most suitable selection. The various intake types available and considered are discussed below.

6.1.1 Frontal Weir

A frontal weir intake comprises of a simple weir built across a river or stream to divert water into an intake channel or pipeline using a raised weir to maintain a steady flow. For areas with high sediment loads during snowmelt, the design would require sediment management features such as flushing sluices to reduce buildup. Debris screens would also be featured and configured for self-cleaning where possible to minimize maintenance. This type of intake requires a broad weir and intake bay to ensure approach flow stability and is generally not economical for very small flows, making it less suitable for alpine conditions.

There are numerous examples of this type of weir in the area including the Teviot and Arrow Irrigation schemes and the Wye Creek Power Station intake. The Wye Creek and Teviot intakes are shown below:

Figure 19: Wye Creek frontal weir intake structure

Figure 20: Teviot Irrigation Company – Frontal Weir Intake

6.1.2 Lateral Intake

A lateral intake comprises of a simple screen (and no weir) positioned along the riverbank to divert water into an intake channel or pipeline. This design relies on natural river flow and is best suited for locations with stable water levels and low sediment loads. To manage sediment during snowmelt, the intake would incorporate features such as settling basins or sediment traps to reduce buildup. Debris screens would also be included and configured for self-cleaning where possible to minimize maintenance. Generally, this option requires a deep river to achieve the necessary elevation change, which may make it unsuitable for the DC2 and DC3 site due to its shallow conditions.

An example of this type of intake is shown below:

Figure 21: Waimakariri Irrigation - Lateral Intake without weir

6.1.3 Tyrolean Weir

Tyrolean weir comprises of a simple, typically low height, weir built across a stream or river to divert water through a screen built into the weir crest. This allows most of the sediment and bedload to pass over the screen and flow downstream. The intake features a slotted or screened section that captures water from the overtopping flow. The screen geometry is setup to minimise sediment entry and push large bed load over the screen into the downstream channel. This design is particularly well suited for steep, high-energy streams with significant sediment transport, such as alpine environments during snowmelt or high intensity rainfall events. It can operate at small discharges but is prone to blockage by sediment and bedload, which can be managed with proper screening, settlement and flushing design.

An example of this type of intake is shown below:

Figure 22: Tyrolean Weir intake - Big Wainihinihi Intake 2, Westland District

6.1.4 Coanda Weir

This intake is similar to a Tyrolean weir and consists of an overflow weir (and debris rack) directing water onto a curved fine-mesh screen that uses the Coanda effect to separate water from sediment and debris. Water passes through the screen into the intake, while the remaining flow (sediment, bedload, debris, fish) continue downstream. The screen is designed to be self-cleaning and can include flushing arrangements to prevent sediment and debris buildup. These systems are compact, require minimal maintenance, and are well suited for small hydro or water supply in mountainous environments. Due to the self-cleaning requirements (velocity) these systems often require a higher weir than the traditional Tyrolean intake.

An example of this type of screen is shown below:

Figure 23: Coanda Wier Intake – JX Filtration

7 Benefits, Risks and Cost of options

Each configuration differs in complexity, sediment/bedload handling capability, and operational reliability. For small alpine streams, passive systems such as Tyrolean or Coanda intakes are preferred due to their simplicity and low maintenance demand.

Our evaluation of intake options has considered hydraulic efficiency, sediment and debris control, resilience to snow and ice, constructability, and maintenance access.

The table below summarises our evaluation of each intake type considered:

Table 7-1 Option evaluation summary

Intake Type	Sediment Handling	Maintenance	Suitability for Alpine conditions	Remarks for a low to moderate flow abstraction rate and costs
Frontal Weir	Moderate	Low	Low	May require a flushing channel. Requires a broad weir and intake bay to ensure approach flow stability Requires complex sediment/bedload processing. Typically, not economical for small flows.
Lateral Intake	Moderate	Medium	Low	Requires stable bank alignment and guide walls. May suffer clogging and sediment deposition at low approach velocities. Requires an intake pond or deep channel. Typically, not suited to shallow channels.
Tyrolean Intake	High	Low	High	Can operate at small discharges. Prone to blockage by coarse material which can be handled by a proper screen design. Robust under alpine/freeze conditions. Low relative cost compared to other alternatives
Coanda Intake	High	Medium	High	Higher cost. Less effective in low flow conditions. Needs greater fall over the screen than a Tyrolean weir and this fall is not available at the site.

8 Ranking of the options

The following ranking matrix takes our assessment from Table 4-1 and provides a numeric scoring for each intake type:

Table 8-1 Trade off matrix

Intake Type	**Sediment Handling**	**Maintenance requirements**	**Suitability for Alpine conditions**	**Remarks for a low to moderate flow abstraction rate**
Scoring	**4 = High** **3 = Moderate** **2 = Medium** **1 = Low**	**1 = High** **2 = Moderate** **3 = Medium** **4 = Low**	**4 = High** **3 = Moderate** **2 = Medium** **1 = Low**	**Total Score**
Weighting	**33.3%**	**33.3%**	**33.3%**	
Intake Weir or Dam (Frontal barrage with or without gates)	3	4	1	8
Lateral Intake	2	3	1	6
Tyrolean Intake	4	4	4	12
Coanda Intake	4	3	4	11

8.1 Discussion and Recommendation for a Tyrolean Weir

The Tyrolean intake allows most bed load to continue downstream while screened water passes through the slots. They are generally cheaper and lower maintenance and repair costs than the Coanda. They can perform efficiently over a wide range of discharges and can operate under partial submergence conditions.

The Tyrolean intake is recommended as the preferred option due to its simplicity, hydraulic efficiency, and low maintenance requirements. It can be constructed with locally available materials and operates without mechanical cleaning devices.

The intake will consist of a slotted screen embedded in a weir within a flume. Water flows through the screen into a small collection chamber connected to the conveyance pipeline, while a high portion of sediment and debris continue downstream.

A small bypass or sluice gate will be included to flush sediment during high flow events. The screen width spacing will be designed following international guidelines (Bouvard, 1992) to limit entry of coarse bedload particles.

8.2 Risks

The following risks should be considered in adopting the proposed option:

- There is a risk associated with the limited flow data available. Only one season of flow data is available and variations in precipitation, and snow melt, over different winters may affect the flow.

- Sediments/bedload issues are difficult to predict and may require further attention or upgrades when in service.
- Proposed intake design will be site specific and may require additional modification post construction.

9 Layout of the Tyrolean Weir Concept Selected

9.1 Design Assumptions

The intake system for the Doolans Creek Right Branch expansion will be designed to support snowmaking and potable water demand at NZSki's alpine facilities. The intake must reliably abstract surface water, accommodate variable flows, and manage sediment loads typical of alpine catchments. The intake will require robust sediment management, adequate maintenance access, and redundancy in pumping systems to ensure continuous operation. Water quality is expected to be suitable for snowmaking with coarse filtration and settlement provided at the intake.

The design assumptions are described in the Principal's Requirements (PR) document, and summarised as follows.

Table 9-1 Principles Requirements (intake relevant elements only)

Element	Description
Abstraction rate from Doolans Creek Right Branch	Design intake grating and pumps for a max of 30L/s (Techno Alpin figure) with the flow rate measured by e3Scientific in Doolans Creek Right Branch in 2025 between the end of May and the end of August being greater of 66 l/s
Expected water quality	Adequate for snowmaking with sediment settlement within an inlet chamber and coarse inlet filters on the pump
Pumping head (static)	Approximately 300m to the reservoir and 150m to the firefighting tank farm
Volumetric flow rates to meet operational and firefighting demands	500 litres / hour
Construction access	4WD Ute access is required, otherwise helicopter or tracked Canam
Redundancy levels	Duty/standby pumps for water supply and snowmaking
Maintenance needs	Access for service vehicles and the ability to lift pumps in and out as required
Power and control systems	Hydraulic power for snow making = 89 kW actual operational power demand (@ 75% efficiency) 120 kW Hydraulic power demand for potable water = 45 kW assuming 75% efficiency operating demand = 60 kW Telemetry monitoring power demand = minimal

9.2 Service Level

The structural and hydraulic design will adopt a 1 in 100 AEP event as the design event for determining wall height and anchorage. This aligns with practices adopted in other alpine intake projects in New Zealand and overseas.

The intake will be designed to remain operational during moderate snow and debris movement events, with allowances for occasional blockage and manual clearing once per winter season. Operational limits may need to be reassessed depending on how the intake operates when in service in order to minimise maintenance requirements and blockage frequency.

9.3 Intake General Arrangement

The proposed intake design is based on a site downstream of the DC3 monitoring location. This location was selected for the reasons listed above namely.

- It maximises the flow in Doolans Creek Right Branch by being downstream of the confluence with creek from the tarns to the west,
- It has a practical gradient for the access road,
- minimises disturbance to the dracophyllum vegetation, which is a desire of NZSki,
- Has a suitably wide area of bed to allow the below ground low-head pump chamber (which pumps a short distance and height to the high-head pump building) plus the weir to be fitted into the site,
- It has an adjacent terrace platform which allows the high-head pump station building (which contains skid mounted multi-stage high-head pumps which pump to the snow making reservoir and Gondola Return Station infrastructure) to be located out of potential flooding,
- It is a practical distance from the Gondola Return Station and is not an impractical distance downstream.

The proposed intake arrangement considers important design aspects such as flood risk, avalanche risk, sediment transport and variability in offtake requirements. The proposed arrangement is as follows.

- Tyrolean Weir with Upstream and Downstream Flumes,
- Captures high-flow water from the river,
- Maintains flushing capability to prevent sediment buildup,
- Piped Offtake to Overflow/Flushing Chamber,
- Transfers water from the weir to the chamber,
- Submersible Pump in Chamber,
- Pumps abstracted water a short distance to a dedicated pump station building,
- Pump Station Building,
- Located above river level on an elevated area safe from avalanche risk.

This arrangement is shown in the Figure below:

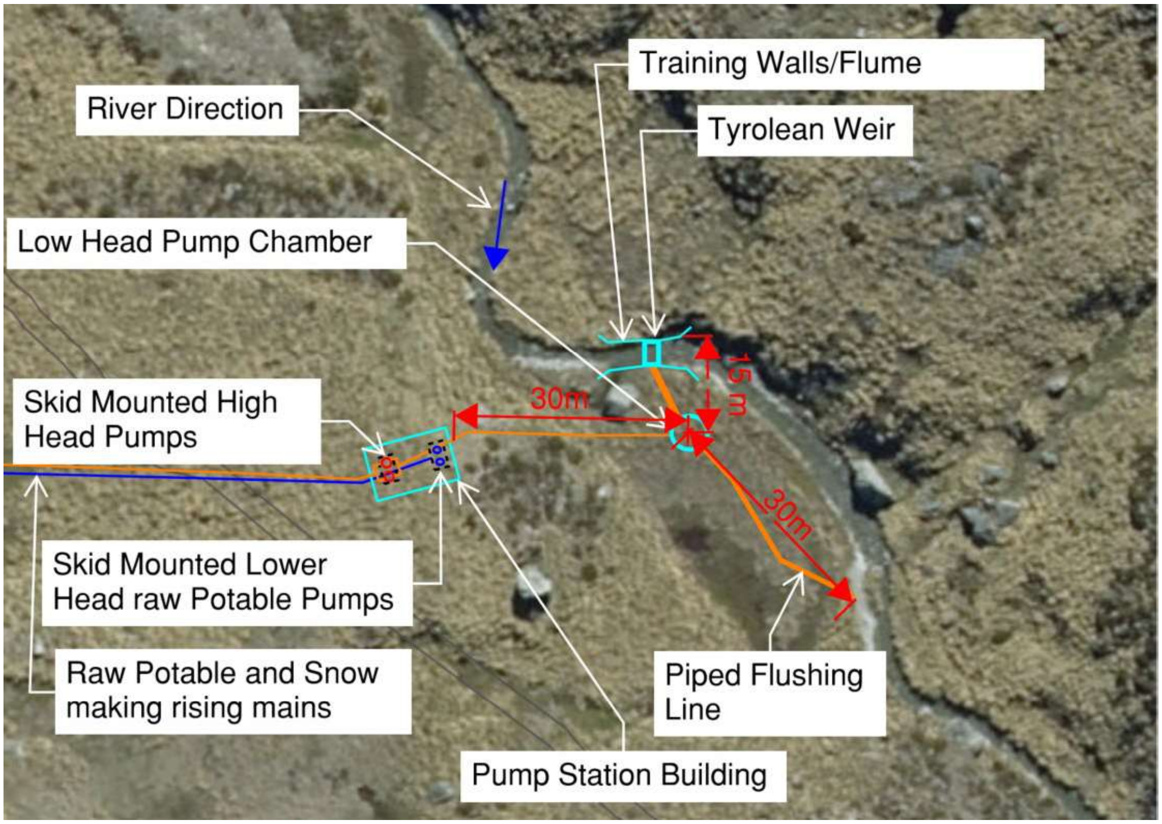


Figure 24: General Arrangement at preferred site downstream of DC3, distances are approximate only

This arrangement allows water to be abstracted from Doolans Creek Right Branch via a Tyrolean weir. A higher portion of flow than required at the reservoir will be abstracted, to allow flushing of sediment from the weir and submersible pump chamber.

Flow is intended to pass through an overflow weir chamber, before returning excess flow to the creek via the flushing line. Water will flow over the chamber weir, into a wet well. A low head submersible pump then moves water to the dedicated pumping station, elevated above the river. The pump station houses two skid mounted pumps that move water to the reservoir (approximately 300m head) and to the Gondola Return Station). A key aspect of this design is the flushing arrangement. The above diagram is only indicative only at this stage.

9.3.1 Intake Weir

A Tyrolean weir is preferred due to its ability to reliably exclude larger debris, bedload and sediment, reduce maintenance and ensure consistent water availability.

The weir structure is likely to be constructed from a combination of galvanised steel, precast concrete and/or in situ concrete. Offsite prefabrication of the weir components will allow it to be transported to site by either wheeled transport or helicopter and to be installed into the riverbed using a simple site plant (e.g. hydraulic excavator). This methodology will minimise the need to transport wet concrete to site and will limit the risk of having wet concrete potentially in contact with the stream. The details of the Tyrolean weir structure remain to be developed but we anticipate that it will be made up of a flume unit and a separable screen unit. Once the flume unit is placed in a prepared excavation in the creek bed, the bed material will be backfilled upstream and downstream of the flume. The screen unit can then be installed over the flume. Some minor in situ concrete may be required to form foundations and fill voids.

It is anticipated that the upstream and downstream approach training walls will be constructed in a similar prefabricated manner and placed along stream banks.

The figure below shows the nominal arrangement for the intake site.

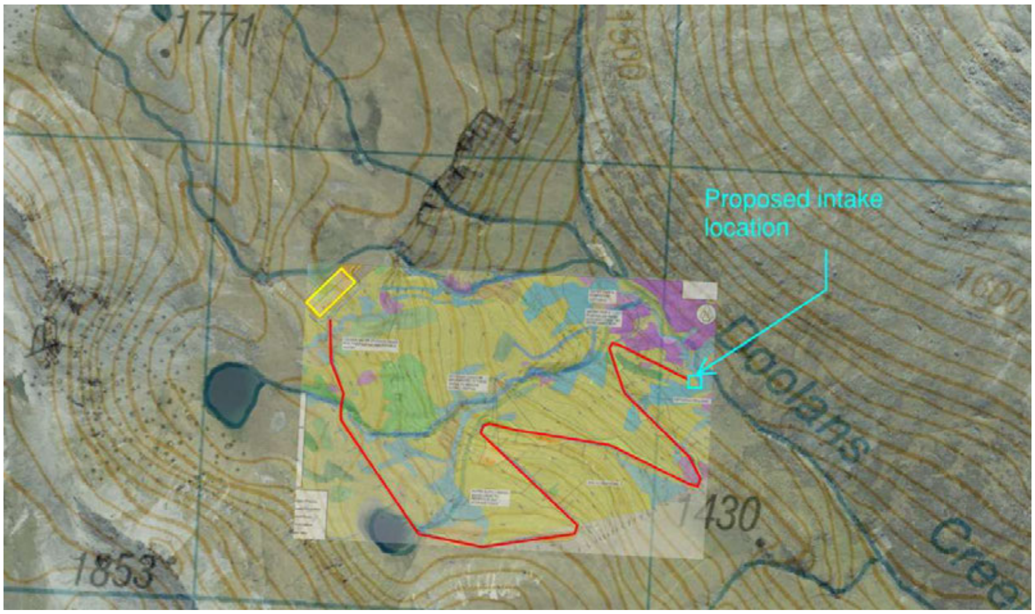


Figure 25: Approximate pump Station Location (Blue box) and access road

9.3.2 Overflow/Flushing (OF)Chamber

Flow from the intake weir will be piped to a below ground structure, the Overflow/flushing chamber, which contains two connected chambers. The upstream of the two chambers will be used to collect sediment and allow it to be flushed back into the creek via the flushing line. The flushing line will have continuous flow, as a proportion of the water entering the chamber will flow back to the creek to clear sediment from the chamber. The second chamber is hydraulically connected to the first chamber and contains the low-head submersible pumps which pump up the building containing the high-head pumps. The low-head pumps will be configured in such a way to allow pumped higher pressure to clear the sediment flushing line should this be required. Sediment exclusion is required to reduce maintenance at the intake and to meet the water quality requirements. We anticipate that the connection between the weir structure and the Overflow/Flushing-chamber will be made of polyethylene to allow a makeup length to be cut on site and then bonded to the chamber. A low head polyethylene rising main will be provided between the submersible pump(s) in the OF chamber and the skid mounted high-head and low-head pumps in the pump building. The rising main between the high-head multistage pumps and the gondola return station and the snow making reservoir will be ductile iron as these are subjected to particularly high pressure, and polyethylene or PVC would be unsuitable.

9.3.3 Submersible pump

One or two submersible pumps will be placed in the OF-chamber adjacent to the weir. A polyethylene manhole can be used for the chamber. The flow rate and operational details remain to be resolved as part of preliminary design. A typical submersible pump and manhole are shown below.

Figure 26: A Typical bespoke polyethylene manhole and a submersible pump

9.3.4 Flushing line

It is anticipated that the pipeline to flush the weir and OF-chamber will be a polyethylene line approximately 300mm in diameter and will have swept bends to reduce the risk of blockage. Downstream of the OF-chamber this pipe will discharge back into Doolans Creek Right Branch, downstream of the intake weir structure. There is also the option to back-feed additional flow from the pumps to allow higher pressure and improved clearing of the line from sediment build-up. The nominal location of the flushing line is shown in figure 23 above.

9.3.5 Pump Building

The pump station building is anticipated to be steel and timber framed, coloursteel clad and on a concrete slab. We expect that the building will have steel portal frames with timber infill and plywood lining. There is an existing similar pump building at the top of the Alta Chairlift in the Rastus Burn area of the Remarkables. This building will house the high-head skid mounted pumps and their control equipment. The building will require appropriate design for both wind and snow loads and is likely to require insulation and heating to prevent freezing.

An example of multistage snow making pumps is shown below (although these are larger than is anticipated to be required at the Doolans Creek Right Branch Site).

Figure 27: Large skid mounted multistage snow making pumps within a timber building.

Figure 28: Proposed Pump Station Building Approximate Location

10 Winter Maintenance Access

During winter access to the intake works will be via a dedicated access track from the gondola return station. As wheeled vehicles cannot access the Doolans Basin in winter, tracked vehicles such as NZSki's tracked Canam 'side by side' vehicle will be used for access. The access road to the intake structure may not always have sufficient snow to be suitable for access by snow groomers, which may require alternative transport options. The nominal route of the access track from the gondola return station to the intake location is shown below.

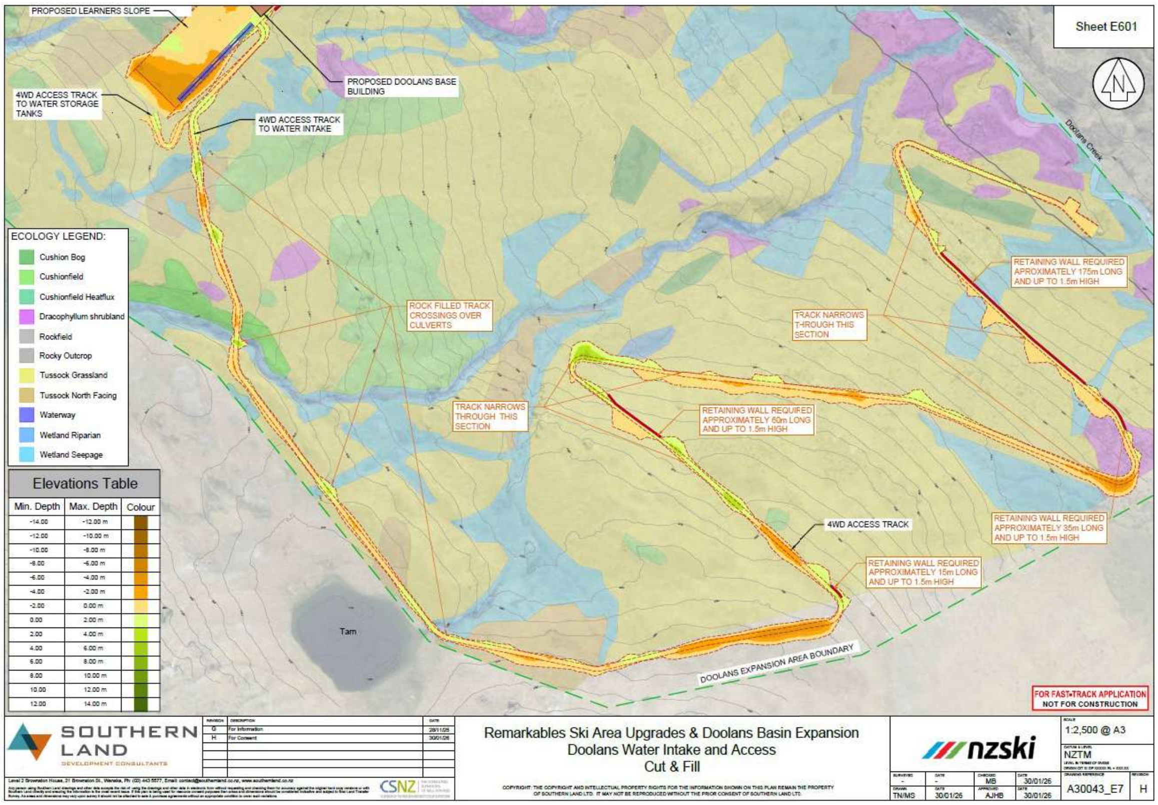


Figure 29: Preliminary route of access track between Gondola Return Station and intake location. The extent of dracophyllum vegetation is shown in purple

11 Standards and Statutory Requirements

There are no specific water intake design regulations for New Zealand. In terms of standards and statutory requirements, further concept design stages will follow international guidelines as the ones already mentioned in this report from the IAHR which is the most relevant international reference on hydraulic structures design.

The design of the pump station building will be to the requirements of the New Zealand Building Code and will require specific design as it is outside of the scope of NZS 3604 'Timber Framed Buildings'. The pump station building is unlikely to require a Building Consent as is it is an 'unoccupied detached building for hosing fixed plant and machinery and entered only on intermittent occasions'. This is covered by an exemption in the Building Act for such buildings. Nevertheless, compliance with the Building Act is required.

12 Development to Preliminary Design

This report describes the concept for the intake structure and associated civil works. To develop this concept into a preliminary design the following inputs will be required.

- Accurate topographical survey of the intake and pump station location in order that the distances and heights between the elements are well understood and the slope of the creek bed is accurately identified. A slope of greater than 2% is required for the flushing of the weir and the overflow/flushing chamber,
- Geotechnical assessment of the site to confirm that the foundation conditions for the pump building are suitable and that the bed and banks of Doolans Creek Right Branch is granular material and suitable for the installation of the intake weir.

The Preliminary design will include the following elements.

- Dimensions for the intake weir structure
- Nominal layout for wing walls and scour protection rip rap
- Layout for the overflow/flushing chamber and sediment flushing return pipe to the creek
- Low head pump selection and physical dimensions to confirm the dimensions of the OF-chamber
- Diameter, route and material for the rising main from the low head pump chamber to the main pump building
- Dimensions and layout of the main pump building
- Preliminary selection of pump control equipment and power demand

13 References

Bouvard, M. (1992). Mobile Barrages and Intakes on Sediment Transporting Rivers. IAHR Monographs

United States Bureau of Reclamation (1978). Design of Small Canal Structures.

United States Army Corps of Engineers (1991). Hydraulic Design of Flood Control Channels.

NZSKi Doolans Expansion Principal's Requirements Water Intake. Stantec (2025)

Appendices

Appendix A Hydrological Background

e3ScientificScientific investigated an initial assessment of water availability in the Doolans catchment to support potential ski field expansion. It's worth mentioning they did not assess any potential intakes on Lake Alta / Rastus Burn.

e3Scientific findings are based on a combination of desktop review and limited field investigations.

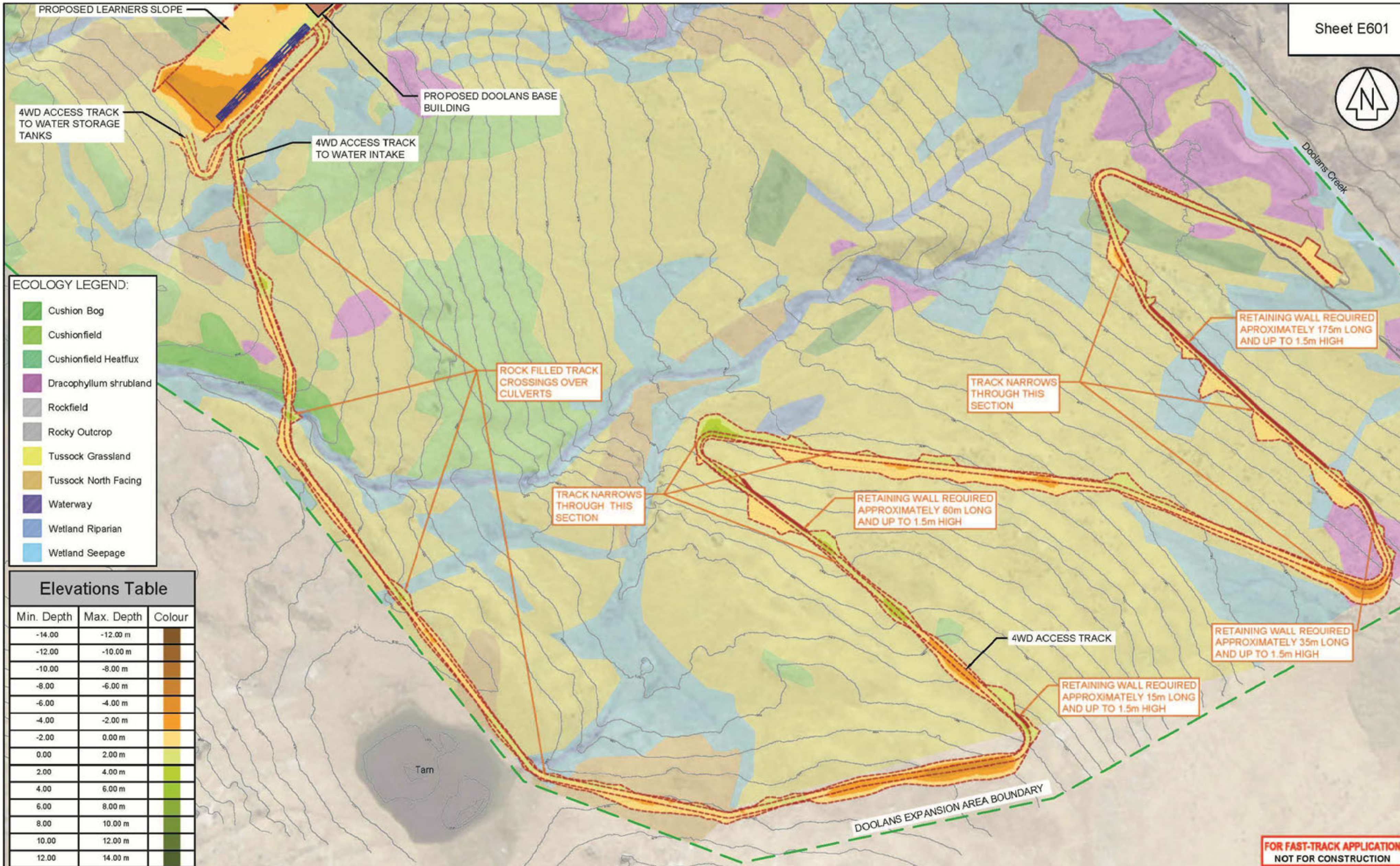
- Surface Water: Doolans Creek Right Branch is identified as the most viable source, with flow measurements taken at four locations. DC3 showed the highest measured flow (64 L/s) and has the largest catchment (568 ha). Flow statistics from NIWA and MFE suggest a MALF of 65 to 67 L/s at DC3. Up to 32 L/s may be available for primary allocation under Otago Regional Council guidelines.
- Rainfall Estimation: Rainfall was estimated using elevation-adjusted Queenstown Airport data, NIWA Virtual Climate Station Network (VCN) data and Mt Larkins records. Annual rainfall estimates ranged from 754 mm to 1634 mm. Flow estimates derived from rainfall and PET data using a runoff coefficient of 0.5 were discarded due to unrealistic results.
- Groundwater and Tarns: Groundwater was excluded due to expected low yields and access limitations. Tarns were assessed but ruled out for buffer storage due to ecological value.
- Monitoring: Capacitance probes were installed at DC2 and DC3 to record water levels. Flow measurements were conducted using a Flow Tracker 2 and manual methods. Further gauging is planned to support rating curve development.
- Water Quality: Water quality at DC3 was tested and found suitable for drinking water supply. No issues were identified that would affect intake or infrastructure design.

While the e3ScientificScientific memo provides a useful starting point, several limitations are evident:

- No proper hydrological modelling was undertaken to simulate seasonal or long-term variability; the application of techniques suitable for data-scarce alpine catchments such as rainfall-runoff modelling using synthetic gauges, transposition from nearby gauged sites, regional regression tools, or even satellite-derived rainfall datasets (e.g. CHIRPS, GPM) is not discussed and could provide greater certainty around the sustainability and reliability of water supply for the proposed development
- Flow estimates based on rainfall and PET were attempted but discarded, indicating uncertainty in runoff generation; the assumptions used for rainfall estimation appear high level, relying on simplified elevation corrections. Incorporating updated mean annual rainfall isohyet maps and applying hypsometric analysis of the catchment could provide a more spatially distributed and defensible basis for runoff estimation.
- No long-term flow gauging data is available for Doolans Creek Right Branch, and while spot flow measurements were taken during specific site visits, these isolated values cannot be considered representative without associating them with exceedance probabilities linked to monthly, annual or event-based rainfall and snow conditions. Establishing flow duration curves or seasonal flow statistics would require continuous monitoring or robust hydrological modelling
- Climate change impacts were not considered or discussed.
- Flow statistics were sourced from regional models and nearby gauged sites, then adjusted for Doolans Creek Right Branch using catchment characteristics, but were not validated against continuous local measurements, limiting confidence in their representativeness.
- There are no flood estimates that are required for the design of the water intake structure.

While the existing data provides a useful starting point for initial concept design, its limitations mean that confidence in flow availability, abstraction feasibility and long-term supply reliability remains low. In the next concept design stages, high-level checks and definitions will be included as part of the design process.

Appendix B Approximate Intake Layout Drawing with Dimensions Added



Elevations Table

Min. Depth	Max. Depth	Colour
-14.00	-12.00 m	
-12.00	-10.00 m	
-10.00	-8.00 m	
-8.00	-6.00 m	
-6.00	-4.00 m	
-4.00	-2.00 m	
-2.00	0.00 m	
0.00	2.00 m	
2.00	4.00 m	
4.00	6.00 m	
6.00	8.00 m	
8.00	10.00 m	
10.00	12.00 m	
12.00	14.00 m	

FOR FAST-TRACK APPLICATION
NOT FOR CONSTRUCTION

SOUTHERN LAND
DEVELOPMENT CONSULTANTS

REVISION	DESCRIPTION	DATE
G	For Information	28/11/25
H	For Consent	30/01/26

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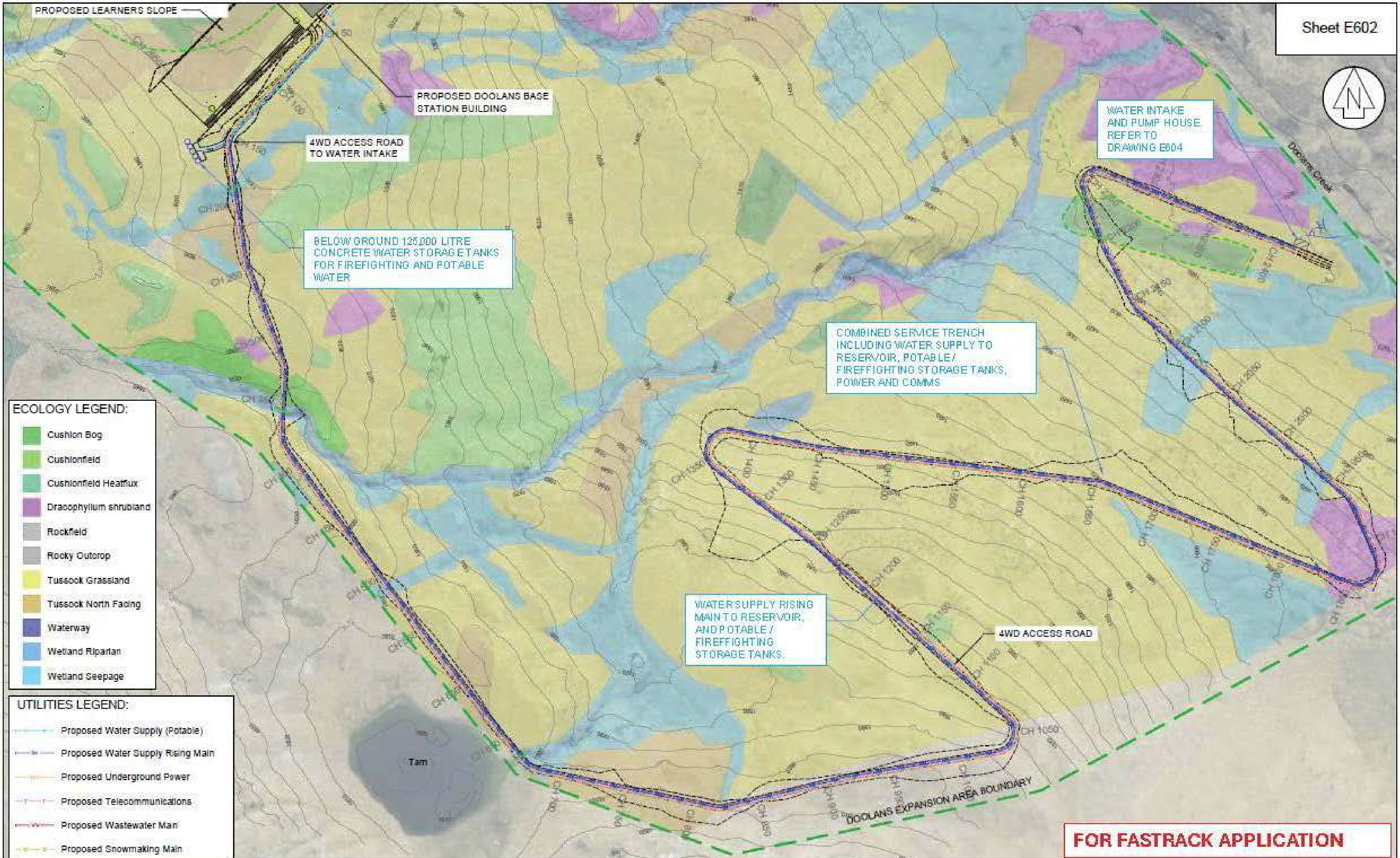
CSNZ

Remarkables Ski Area Upgrades & Doolans Basin Expansion
Doolans Water Intake and Access
Cut & Fill

nzski

SURVEYED -	DATE -	CHECKED MB	DATE 30/01/26
DRAWN TN/MS	DATE 30/01/26	APPROVED AJHB	DATE 30/01/26

SCALE 1:2,500 @ A3
DATUM & LEVEL NZTM
DRAWING REFERENCE A30043_E7
REVISION H



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Remarkables Ski Area Upgrades & Doolans Basin Expansion
Doolans Water Intake and Access
Proposed Utilities

nzski

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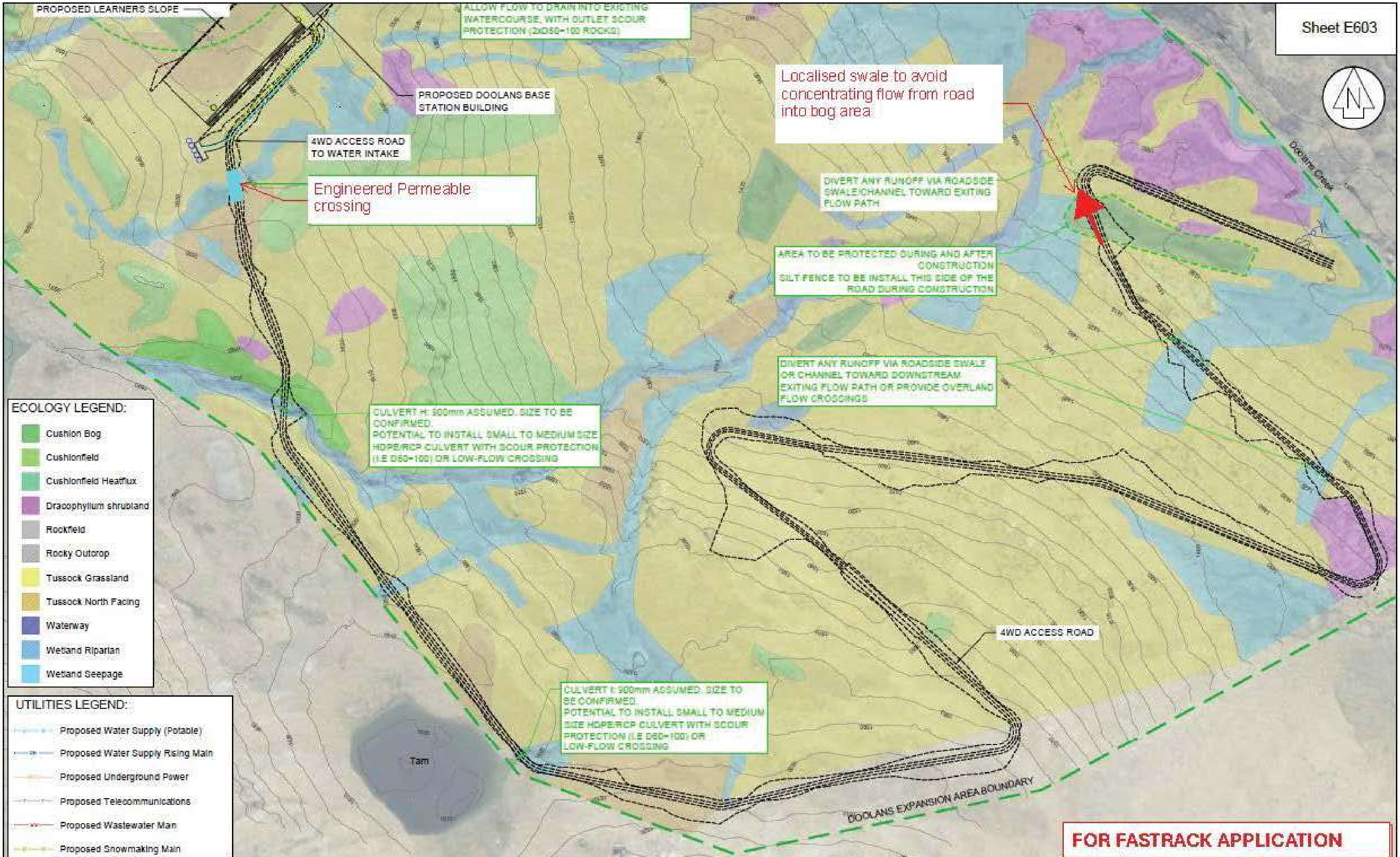
-	-	AJHB	28/11/25
DRAWN	DATE	APPROVED	DATE
TN/MS	28/11/25	AJHB	28/11/25

SCALE: 1:2,500 @ A3
DATUM & LEVEL: NZTM
DRAWING REFERENCE: A30043_E7
REVISION: H



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Doolans Water Intake and Access
Stormwater

nzski

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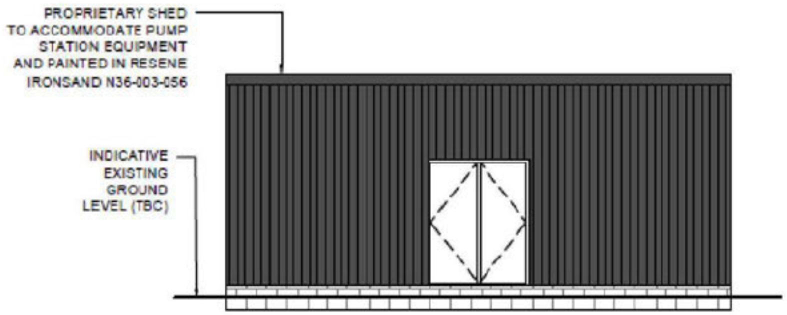
DRAWN: TN/MS	DATE: 30/01/26	APPROVED: AJHB	DATE: 30/01/26

SCALE: 1:2,500 @ A3
DATUM & LEVEL: NZTM
DRAWING REFERENCE: A30043_E7
REVISION: H

WATER SUPPLY PUMP STATION BUILDING



SOUTHERN ELEVATION
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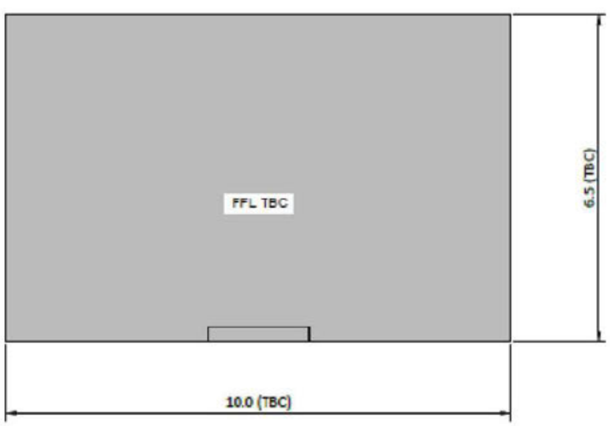

FOUNDATION PLAN
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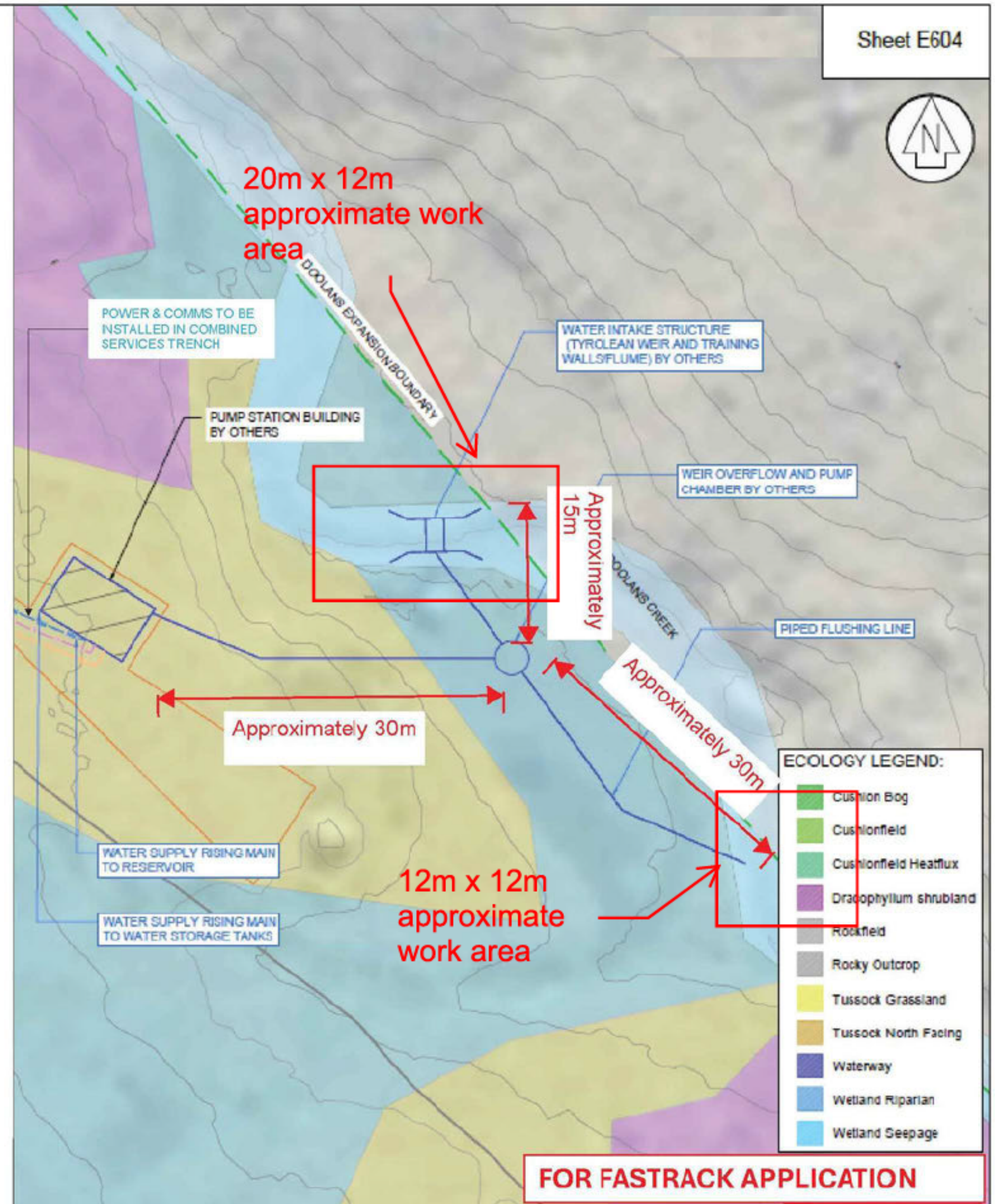
SERVICES REQUIRED TO BUILDING:
1. POWER SUPPLY – UNDERGROUND MAINS
2. DATA/WIFI SUPPLY

Sheet E604



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H	For Consent	30/01/26

Remarkables Ski Area Upgrades & Doolans Basin Expansion
Doolans Water Intake and Access
Water Intake & Pumphouse Details

nzski

Scale: 1:500 @ A3
Datum & Level: NZTM

Surveyed	Date	Checked	Date
-	-	AJHB	30/01/26
Drawn	Date	Approved	Date
TN/MS	30/01/26	AJHB	30/01/26

Drawing reference: A30043_E7
Revision: H

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