

## Before the Fast-track Panel

**Under:** Fast-track Approvals Act 2024

**In the matter of:** FTAA-2605-1236 – Remarkables Ski Area Upgrade and Doolans  
Expansion

**Statement of advice:** David John Arnold BARRELL

Geomorphology

Independent consultant

12 October 2026



Department of  
Conservation  
*Te Papa Atawhai*

**Te Kāwanatanga  
o Aotearoa**  
New Zealand Government

## **Introduction**

1. My full name is David John Arnold BARRELL

## **Instruction**

2. I have been requested to provide expert advice to the Director-General of Conservation (DOC/the Department) for the purposes of his comments on the Remarkables Ski Area Upgrade and Doolans Expansion Project Fast-track application.
3. My advice will be used to inform DOC's s51 reporting and s53 comments on the application.

## **Qualification and Experience**

4. I hold two degrees from University of Canterbury; a Bachelor of Science in Geology awarded 1984, and a Master of Science in Engineering Geology, awarded 1989.
5. I have 38 years of experience in geoscience research and consultancy, with the past 32 years under my current employer, Earth Sciences New Zealand, and its predecessors.
6. My specialist expertise includes geological science, mapping, and professional practice; engineering geology and geomorphology; paleoclimatology; and landforms and landscape-changing processes. Most of my professional work has been undertaken in the central to southern South Island.
7. As a result of my research work, I have authored or co-authored 60 journal articles and 8 books or book chapters. About half of those publications focus on, or include, the mapping and/or dating of glacier landforms as a means of assessing past climatic conditions. In addition, my applied science outputs include 171 consultancy and technical reports that I have authored or co-authored.
8. I have been a member of the New Zealand Geotechnical Society since 1994, and the Geoscience Society of New Zealand since 1996. I have received two of the major awards of the Geoscience Society of New Zealand; the McKay Hammer in 2012, and the Hochstetter Lecturer in 2023.

## **Code of conduct**

9. Whilst it is acknowledged this is not an Environment Court Proceeding, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. I have complied with the Code of Conduct in the preparation of this advice. Unless I state otherwise, this advice 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 I express.

## **Scope of advice and expert opinion**

10. My expert advice relates to the following:
- i. The geomorphological values of the Doolans Creek Right Branch Basin, The Remarkables, in relation to the proposed fast-track expansion of the Remarkables Ski Area into the Doolans Basin.
  - ii. The paleoclimatic relevance of The Remarkables area, including its position close to the transition between the humid Western South Island and drier Eastern South Island climate regions.
  - iii. The scientific significance of a late-glacial moraine sequence preserved in the Doolans Creek Right Branch Basin, including the sequence's comparison with dated moraine sequences elsewhere in the Southern Alps, and the occurrence of similarly preserved moraine features in other basins of The Remarkables and the ranges of the wider central and western Otago areas.
  - iv. Identification and assessment of the geomorphological values, features, landforms and scientific information likely to be lost or adversely affected by the works described in Document B-14 (access tracking, utility trenching, stream crossings, stormwater swales and associated earthworks, including works adjacent to an existing moraine wall) and the cut and fill, track, trail, reservoir and utilities layouts shown in Document C-08, including the sensitivity of surface-exposure dating to earthmoving activity.
  - v. Identification of any mitigatory measures that could be undertaken should the project proceed, and assessment of any benefits and limitations.

## Material Considered

11. In preparing this advice I have reviewed the following documents that form part of the substantive application:

- i. B-14 Tracks, Crossings, Stormwater Freshwater Ecological and Hydrological Impact Assessment Updated 27 Aug 26
- ii. C-08 Remarkables Ski Area Upgrade and Doolans Expansion – Doolans Access, Trails and Utilities

12. I have not undertaken a site visit due to the timing of my engagement on this project. My knowledge of the site is based on desktop examination and interpretation of:

- i. Published topographic maps (NZ Topo 50 series; Land Information NZ – 1:50,000 scale)
- ii. Digital elevation model (DEM), identified as supplied by Otago Regional Council, and dated 2018
- iii. 1-m interval topographic contours for the basin and surrounds, that I generated from the DEM via GIS processing tools
- iv. Google Earth
- v. Review of evidence statements by Jeremy Head and Susan Walker.

13. I have reviewed and will refer to the following published scientific articles, listed in date order:

- i. Chinn TJH. (1995). Glacier fluctuations in the Southern Alps of New Zealand determined from snowline elevations. *Arctic and Alpine Research*. 27(2): 187-198.
- ii. Lamont GN, Chinn TJ, Fitzharris BB. (1999). Slopes of glacier ELAs in the Southern Alps of New Zealand in relation to atmospheric circulation patterns. *Global and Planetary Change*, 22(1-4): 209-219.
- iii. Alloway BV, Lowe DJ, Barrell DJA, Newnham RM, Almond PC, et al. (2007). Towards a climate event stratigraphy for New Zealand over the past 30,000 years (NZ-INTIMATE project). *Journal of Quaternary Science*. 22: 9-35
- iv. Lorrey A, Fowler AM, Salinger J. (2007). Regional climate regime classification as a qualitative tool for interpreting multi-proxy palaeoclimate data spatial patterns: A New Zealand case study. *Palaeogeography, Palaeoclimatology, Palaeoecology*. 253: 407–433.
- v. Schaefer JM, Denton GH, Kaplan M, Putnam A, Finkel RC, Barrell DJA, et al. (2009). High-frequency Holocene glacier fluctuations in New Zealand differ from the northern signature. *Science*. 324(5927): 622-625.
- vi. Cheng H, Edwards RL, Broecker WS, Denton GH, Kong X, et al. (2009). Ice Age Terminations. *Science*. 326: 248-252.
- vii. Putnam AE, Schaefer JM, Barrell DJA, Vandergoes MJ, Denton GH, et al. (2010a). In situ cosmogenic <sup>10</sup>Be production-rate calibration from the Southern Alps, New Zealand. *Quaternary Geochronology*. 5: 392-409.
- viii. Kaplan MR, Schaefer JM, Denton GH, Barrell DJA, Chinn TJH, et al. (2010). Glacier retreat in New Zealand during the Younger Dryas stadial. *Nature*. 467(7312): 194-197.
- ix. Putnam AE, Denton GH, Schaefer JM, Barrell DJA, Andersen BG, et al. (2010b). Glacier advance in southern middle-latitudes during the Antarctic Cold Reversal. *Nature Geoscience*. 3: 700-704.

- x. Barrell DJA, Andersen BG, Denton GH. (2011). Glacial geomorphology of the central South Island, New Zealand. GNS Science Monograph 27. 81 p. + map (5 sheets) + legend (1 sheet). [At the time of writing, an interactive webmap of the dataset is accessible at <https://www.gns.cri.nz/data-and-resources/central-south-island-glacial-geomorphology/> ]
- xi. Barrell DJA. (2011). Quaternary glaciers of New Zealand. p. 1047-1064 (chapter 75); In: Ehlers J, Gibbard PL, Hughes PD (eds). Quaternary glaciations, extent and chronology: a closer look. Amsterdam: Elsevier. Developments in Quaternary Science. 15.
- xii. Putnam AE, Schaefer JM, Denton GH, Barrell DJA, Finkel RC, et al. (2012). Regional climate control of glaciers in New Zealand and Europe during the pre-industrial Holocene. *Nature Geoscience*. 5: 627-630.
- xiii. Barrell DJA, Almond PC, Vandergoes MJ, Lowe DJ, Newnham RM. (2013). A composite pollen-based stratotype for inter-regional evaluation of climatic events in New Zealand over the past 30,000 years (NZ-INTIMATE project). *Quaternary Science Reviews*. 74: 4-20.
- xiv. Doughty AM, Anderson BM, Mackintosh AN, Kaplan MR, Vandergoes MJ, Barrell DJA, et al. (2013). Evaluation of Lateglacial temperatures in the Southern Alps of New Zealand based on glacier modelling at Irishman Stream, Ben Ohau Range. *Quaternary Science Reviews*. 74: 160-169.
- xv. Kaplan MR, Schaefer JM, Denton GH, Doughty AM, Barrell DJA, et al. (2013). The anatomy of long-term warming since 15 ka in New Zealand based on net glacier snowline rise. *Geology*. 41(8): 887-890.
- xvi. Eaves SR, Anderson BM, Mackintosh AN. (2017). Glacier-based climate reconstructions for the last glacial–interglacial transition: Arthur’s Pass, New Zealand (43°S). *Journal of Quaternary Science*. 32: 877-887.
- xvii. Koffman TNB, Schaefer JM, Putnam AE, Denton GH, Barrell DJA, et al. (2017). A beryllium-10 chronology of late-glacial moraines in the upper Rakaia valley, Southern Alps, New Zealand supports Southern-Hemisphere warming during the Younger Dryas. *Quaternary Science Reviews*. 170: 14-25.
- xviii. Denton GH, Putnam AE, Russell JL, Barrell DJA, Schaefer JM, et al. (2021). The Zealandia Switch: ice age climate shifts viewed from Southern Hemisphere moraines. *Quaternary Science Reviews*. 257: article 106771.
- xix. Denton GH, Toucanne S, Putnam AE, Barrell DJA, Russell JL. (2022). Heinrich summers. *Quaternary Science Reviews*, 295: article 107750.
- xx. Tielidze LG, Eaves SR, Norton KP, Mackintosh AN, Pedro JB, Hidy AJ. (2023). Early glacier advance in New Zealand during the Antarctic Cold Reversal. *Journal of Quaternary Science*. 38: 544-562.
- xxi. Eaves SR, Mackintosh AN, Pedro JB, Bostock HC, Ryan MT, et al. (2024). Coupled atmosphere-ocean response of the southwest Pacific to deglacial changes in Atlantic meridional overturning circulation. *Earth and Planetary Science Letters*. 641: article 118802.
- xxii. Strand PD, Putnam AE, Schaefer JM, Denton GH, Barrell DJA. (2024). Tracking rapid ice recession in a major Southern Alps valley during the last glacial termination. *Quaternary Science Reviews*. 335: article 108737.
- xxiii. Winkler S. (2025). Improved chronological constraints for Holocene rock glacier activity in the Ben Ohau Range, Southern Alps/New Zealand. *The Holocene*. 35: 352-372.

## **Geomorphological values of the Doolans Creek Right Branch Basin**

14. Doolans Creek Right Branch Basin is a typical example of the glacially shaped basins of The Remarkables and the adjoining northern to central part of Tapuae-o-Uenuku / Hector Mountains. The general landscape form provides a basis for

interpreting its evolution. The landscape evolution of these basins links to globally recognised cycles of glacial and interglacial climate. The character of the basins indicates to me that they formed over at least several successive glacial episodes.

15. Glaciers formed in these basins during glacial climate episodes. They would have eroded, and carried away down-valley, soil and debris accumulated during the preceding interglacial and further shaped the basins' bedrock floors and sides.
16. During episodes of full interglacial climate, such as today, the basins would have become ice-free, heralding (re)colonisation by biota, formation and evolution of hydrologic features such as tarns, stream channels, gullies and alluvial fans, and in places progressive evolution of gravitational landforms such as landslides, scree and periglacial solifluction features. Examples of the latter include creeping debris lobes and rock glaciers. The basin landscapes in places include relict glacial-episode landforms such as ice-smoothed bedrock surfaces, moraine benches, U-shaped valley sides, and overdeepened bedrock basins within cirques commonly occupied by water bodies at scale ranging from tarns to small lakes.
17. A prominent feature of the northwestern head of the Doolans Creek Right Branch Basin is an exceptionally well-preserved moraine sequence (Figure 1), which based on altitude and setting I interpret to be of late-glacial age (approximately 16,000 through to 12,000 years old. Henceforth in this statement I will use a chronological terminology of thousands of years before present ("ka"); thus the late-glacial age range is approximately 16 ka to 12 ka.
18. Late-glacial moraines are a distinctive, but not extensively preserved, feature of parts of the Southern Alps. Over the past decade or so, in interludes between funded work tasks, I have been compiling an inventory, via Google Earth placemarks, of sites with sufficiently well-preserved moraines for use in glacier and ELA reconstruction. Moraines of assessed late-glacial age are generally found only in the Southern Alps moderate to high precipitation zones in generally stable landscape settings, commonly relatively close to the Main Divide. All of the good examples of which I am aware are shown in Figure 2. Most have already been investigated and documented in detail by mapping, geological dating methods, and paleoclimatic modelling or interpretation. In total, the well-preserved late-glacial moraine sequences amount to little more than a handful of locations. .

19. Apart from the late-glacial moraines, I consider that the Doolans Creek Right Branch Basin does not contain any rare or unusual geomorphological features, in the context of The Remarkables and adjoining mountainous areas.

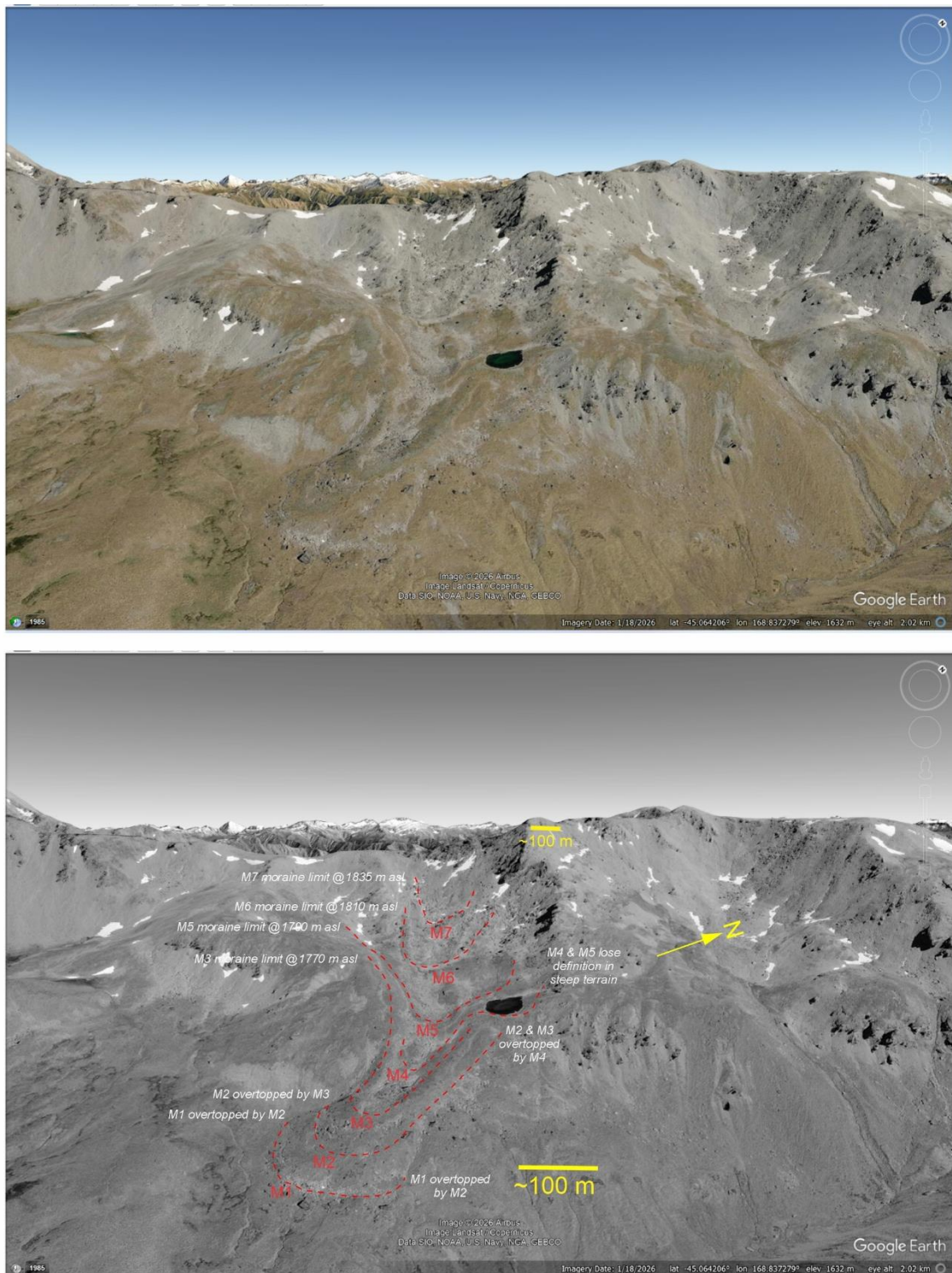


**Figure 1.** Google Earth oblique perspective view of the Doolans Creek Right Branch Basin moraine sequence. My interpretation identifies moraine ridges (red dashed lines, M1 (lowest=oldest) to M7 (highest=youngest)). Yellow bars indicate scale, assessed from Google Earth. Elevation of uphill limit of moraine ridges is estimated from the digital elevation model delivered via Google Earth.

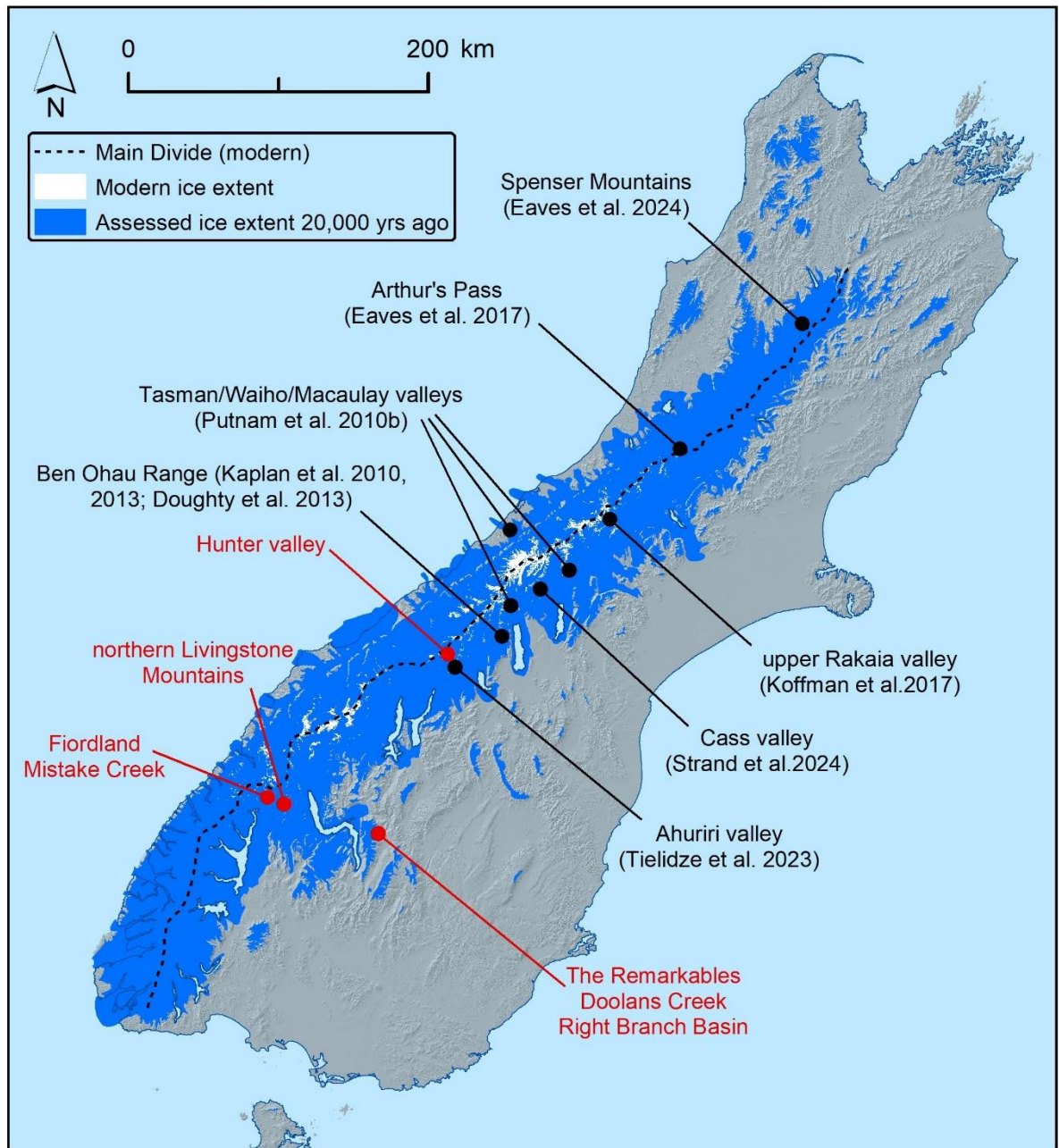


**Figure 2.** Identified late-glacial moraine locations in the South Island. Published studies denoted in black text, locations in red text have been identified by me but, to my knowledge, not yet scientifically investigated. The base map is amended from Barrell (2011; ref 13 xi). The assessed extent of ice at 20 ka is my most recent (2023) iteration of an evolving dataset. Position of the modern Main Divide is my 2011 interpretation, and the modern ice extent is from the digital Topo 250 topographic map dataset.

### **Paleoclimatic relevance of The Remarkables area**

20. A key parameter for glaciers is the Equilibrium Line Altitude (ELA). It represents the boundary between the accumulation area (up-valley), where there is annual net gain of snow, and thus ice, and the adjoining ablation area (down-valley), where there is annual net loss of ice. This boundary is observable on glaciers in late

summer/early autumn, where the previous winter's snow still lies on the accumulation area, and glacier ice is exposed on the ablation area. The 'end of summer snowline' may vary from year to year, depending on weather patterns. It has been surveyed annually for 50 index glaciers across the Southern Alps since 1977. The data enable definition of the ELA, and changes to the ELA since 1977 (refs 13 i - Chinn 1995; 13 ii - Lamont et al. 1999). Contemporary ELAs are as low as about 1600 m above sea level in the south and west where conditions were more humid, with greater precipitation and cooler temperature, and rise eastward to more than 2200 m in the less humid rainshadow ('sloping-roof ELA; ref 13 ii - Lamont et al. 1999).

21. The assessed extent of ice on the South Island at about 20 ka (Figure 2) is based on a combination of the presence or inference of glacier-generated landforms (ref 13 xi; Barrell 2011). The depicted ice extent approximates the time of the last glacial maximum (LGM) globally. The extent is compatible with a prevailing westerly windflow across the South Island broadly similar to that of today, but with ELAs some 700-800 m lower.
22. The Remarkables mountain range lies close to the transition between the humid Western South Island and drier Eastern South Island climate regions (ref 13 iv; Lorrey et al. 2007). There has been much debate about climatic conditions associated with the late-glacial climate episode, which was associated with relatively expanded glaciers in higher parts of the South Island (refs 13 iii - Alloway et al. 2007; 13 xiii – Barrell et al. 2013). Debated issues include whether the climatic regime at that time was due to weaker westerlies, stronger westerlies, cooler air temperatures or enhanced precipitation. The Doolans Right Branch Basin late-glacial moraine sequence is at an ideal location to help test those competing ideas, if it were to be mapped in detail and dated.

### **Scientific significance of a late-glacial moraine sequence preserved in the Doolans Creek Right Branch Basin**

23. The transitions from glacial to interglacial climate states are of international scientific interest, because the elements and timings of the transitions may yield insights to the operation of the global climate system (ref 13 vi; Cheng et al. 2009).

24. A striking characteristic of the Southern Alps glacial geomorphology record is the individuality and serendipity of preservation of landforms within any one glacier catchment. One catchment may contain moraines that most other catchments do not (ref 13 x; Barrell et al. 2011). For example, the last glaciation moraine belt of Lake Ohau has preserved moraines, youngest to oldest, formed at 18 ka, 22.5 ka and 32 ka. In contrast, only the 18 ka moraine is present in the adjacent Lake Pukaki moraine belt, which is dominated by moraines of 20 ka age that are not preserved at Ohau (ref 13 xviii – Denton et al. 2021). Well-preserved late-glacial moraines, suitable for dating and the derivation of associated climatic parameters, are rare (Figure 2). In the larger valleys, the moraines comprise localised remnants of end moraines at glacier terminal zones (Waiho Loop, Macaulay valley and Arthur’s Pass; refs 13 ix - Putnam et al. 2010b; 13 xvi Eaves et al. 2017) or lateral moraine ridges formed at glacier margins (Tasman valley (Birch Hill), ref 13 ix Putnam et al. 2010b; upper Rakaia valley, ref 13 xvii Koffman et al. 2017; Cass valley, ref 13 xxii Strand et al. 2024). In headwater basins and cirques, full terminal and lateral late-glacial moraine limits are preserved in some places, and these can be used with good confidence to reconstruct the glacier’s former extent and geometry and obtain estimates of climatic conditions at the time of moraine formation. Representative examples of such moraines occur in the Ben Ohau Range (Irishman Stream, ref 13 viii – Kaplan et al. 2010; Whale Stream, ref 13 xv – Kaplan et al. 2013), Ahuriri valley, ref 13 xx – Tielidze et al. 2023; and the Spenser Mountains, ref 13 xxi – Eaves et al. 2024 – see Figure 3).
25. A break-through in the ability to obtain high-precision numerical ages for moraines has occurred in the past two decades, via development and refinement of terrestrial in-situ-produced cosmogenic nuclide analysis of exposed rock surfaces (hereafter, ‘surface exposure dating’). Incoming cosmic radiation from deep space causes, over time, measurable change in the isotopic components in some minerals. In quartz-bearing rocks, which are abundant in the Southern Alps, the incoming radiation occasionally impacts oxygen atoms within the silica molecule, converting the oxygen into beryllium-10 ( $^{10}\text{Be}$ ). The longer the rock surface lies exposed to the sky, the more  $^{10}\text{Be}$  accumulates. It is ideally suited to dating the exposed surfaces of undisturbed boulders on glacial moraines, among many other uses. Sampling for dating necessitates that moraine boulders need to be

carefully selected, based on their composition, assessed long-term stability, and minimal indications of surface erosion (e.g. exfoliation). Not just any boulder will do, and this limits how many dates can be obtained for a moraine. Ideally a population of at least 5 boulders should be sampled on each moraine ridge to obtain a well-constrained statistical age.

26. In the early 2000s, there was debate globally about the rate at which  $^{10}\text{Be}$  is produced, which is critical for the calculation of accurate surface exposure dates. This was overcome by the documentation of an independently-dated production rate site in the Southern Alps (ref 13 vii – Putnam et al. 2010a). That production rate enabled the calculation of the first high-precision moraine chronology dataset for the Southern Alps (ref 13 v – Schaefer et al. 2009) and is now routinely used for most Southern Alps moraine surface exposure dating projects.



**Figure 3.** View of the late-glacial moraine sequence (five ridges, A-E) and surface exposure dating results from the Spenser Mountains site (see Figure 2). Ages and uncertainties are in thousands of years. Reproduced from Figure 3 of ref 13 xxi (Eaves et al. 2024).

27. In most cases, glaciological modelling is needed to derive climatic parameters from mapped and dated moraines (e.g. refs 13 xiv – Doughty et al. 2013; 13 xvi – Eaves et al. 2017). Where preservation allows, a simple and robust method to estimate the ELA associated with a moraine is the maximum elevation of the lateral moraine (MELM). Lateral moraines only form at, and down-valley of, the ELA, and so the MELM provides a direct estimate of the ELA. This was used to good effect in the Cass valley (ref 13 xxii – Strand et al. 2024) and would be ideally suited for use on the late-glacial moraine sequence of the Doolans Creek Right Branch Basin (Figure 1).
28. A question that could be raised is whether the late-glacial moraine sequence of the Doolans Creek Right Branch Basin represent true glacier moraines, or rock

glacier deposits. The formation and movements of rock glaciers are usually associated with localised permafrost conditions, and they do not necessarily reflect true atmospheric climatic conditions in the way that ice-dominated glaciers do. Rock glaciers (of which there are examples elsewhere in The Remarkables) characteristically have wrinkled surfaces (e.g. ref 13 xxiii – Winkler 2025), and the ridges on them tend to be somewhat irregular and converge upslope to a single location.

29. The Doolans Creek Right Branch Basin moraine sequence is quite unlike that, with a succession of well-defined ridges ending at progressively higher elevations. I am confident that they are true glacier moraines formed by a conventional ice glacier. The amount of material in the moraines suggests to me that it was a debris-laden glacier, consistent with an abundant source of rock from the steep bluff forming part of the cirque head (Figure 1). A rock-covered glacier is somewhat insulated from ablation and its trunk may descend to a lower-elevation terminus than that of a similar clean ice glacier, but the MELM will nevertheless be a good indicator of the ELA position.
30. A final comment on the scientific significance of moraines. Dating allows moraine sequences to be compared across the globe, to establish the synchronicity or otherwise of major climatic events or shifts (e.g. ref 13 xii – Putnam et al. 2012). The Southern Alps high-precision moraine dating has yielded a major breakthrough, by showing that the late-glacial climatic shifts were globally extensive, rather than involving a warm-cold seesaw between the northern and southern hemispheres, as previously thought. That has led to new hypotheses about the drivers and functioning of the global climate system (ref 13 xviii – Denton et al. 2021; xix – Denton et al. 2022).
31. An ability to obtaining age and climatic data from the Doolans Creek Right Branch Basin late-glacial moraine sequence will fill a considerable geographic gap in the Southern Alps late-glacial moraine chronology and paleoclimatic dataset and will feed into internationally relevant climatic assessments.
32. There are no other locations within a 60 – 110 km radius where similar information could be obtained, and nowhere else in the Southern Alps that far east of the Main Divide with such well-preserved late-glacial moraines. As such, I consider that the

Doolans Creek Right Branch Basin moraine sequence can be regarded as an outstanding natural feature of national scientific relevance. As the surface exposure dating method is critically dependent on having undisturbed boulders, any human activity or modifications may adversely affect their scientific value.

**Assessment of the geomorphological values, features, landforms and scientific information likely to be lost or adversely affected by the proposed development**

33. My assessment of the application documents (see clause 11 above) is that the proposed gondola line, towers and base buildings are not in locations that compromise any landforms of notable significance.
34. The proposed northern 4WD access track and nearby accompanying groomed ski trail traverse the axis and/or margins of the lower 5 ridges of the moraine sequence (M1-M5; Figure 1) and would appear to involve considerable ground modification and earthworks.
35. The proposed reservoir, occupying a large footprint centred on the existing tarn that is ponded between moraine ridges M4 and M5 is likely to considerably disrupt the natural integrity of that part of those moraines.
36. The development as proposed will at a minimum compromise the character of the outstanding landform feature and adversely impact the ability to obtain key scientific information from this landform feature of assessed national scientific relevance. Any human disturbance of the boulders will be problematic in that regard. If boulders suitable for dating are few on any of the moraine ridges, and all suitable boulders are disturbed or removed, the proposed development will prevent, in perpetuity, the obtaining of relevant scientific information.

**Identification of any mitigatory measures could be undertaken should the project proceed, and assessment of any benefits and limitations**

37. One mitigation to protect this moraine sequence of assessed outstanding natural character and national scientific relevance would be to develop an alternative water reservoir location and refocus all earthworks and ski activity into the southern part of the basin and avoid the moraine sequence. Noting that my statement of advice relates solely to geomorphology and so I do not make comment on whether that may have other undesirable adverse effects.

38. Another mitigation would be to enable the collection and dating of samples from the moraine sequence to secure the scientific knowledge, before proceeding with the proposed development. A disadvantage is the development may preclude or compromise the use of any yet-to-be-developed methods of scientific enquiry that may be applicable to the moraine sequence. For example, 25 years ago, I would not have thought that boulders on moraines would have value for scientific enquiry.

## **Conclusions**

39. The Doolans Creek Right Branch Basin moraine sequence is an exceedingly well-preserved landform feature, assessed as having formed during late-glacial time (in the period between about 16 ka and 12 ka), and at a climatically important juncture in New Zealand's recent geological history. Few such examples of these landforms are preserved in the Southern Alps.
40. The Doolans Creek Right Branch Basin moraine sequence can be regarded as an outstanding natural feature of national scientific relevance. Age-dating and mapping of the sequence, and paleoclimatic interpretation is expected to yield scientific information not available from any other source in the wider region.
41. Moraine age determination by surface exposure dating of boulders on the moraine ridges is critically dependent on having undisturbed boulders and any human activity or modifications may adversely affect their scientific value.
42. Suggested mitigations include reconfiguring the proposed development to avoid this landform feature, or the collection of scientific information prior to development.