

Bendigo/Ophir Gold Project Ardour Rise Alternative Alignment

Road design safety assessment review technical note

Prepared for	Central Otago District Council
Project number	CODC-J026
Revision	B
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1. Introduction

Abley Limited (Abley) was engaged by Central Otago District Council (Council) to provide independent transport planning advice in respect of a Fast-track Approvals Act (FTAA) application for the Bendigo-Ophir Gold Project (BOGP), which has recently been lodged by Matakanui Gold Limited (MGL).

As part of the application, part of Thomson Gorge Road is intended to be stopped and a new public road (referred to in the application documents as Ardour Rise) is proposed to be constructed to replace the stopped public road. The relevant section of Thomson Gorge Road is understood to be Four Wheel Drive (4WD) only, is primarily used for recreational purposes and attracts approximately 35 vehicles per day.

On Abley's review of this aspect of the application we made the following comments:

Ardour Rise is proposed as mitigation for the closure of Thompsons Gorge Road, which requires upgrades to an existing farm track including the construction and vesting of a new road. Condition 48 refers to this upgrade to provide "satisfactory alternative public access" and "suitable public access standards" which is very subjective and condition 49 states a "like-for-like replacement" which similarly is open to interpretation. More specific details of the required design standard are expected including to confirm that an agreed design standard is feasible, constructable and fit-for-purpose. Council's role in this is important as the road is intended to be vested in Council.

On 21st January 2026 Abley provided advice in relation to unsealed road design standards and concluded as follows: *It is recommended that the Table 3.10 design standards for 'road type 4C mountainous' corridors from the ARBB report be generally adopted as minimum design standards for Ardour Rise, however these should be considered in the local context including specialist civil engineering input to ensure the road is suitably engineered to be fit-for-purpose. It is recommended that the minimum design standards should also address pavement condition, drainage requirements and maintenance requirements which fall outside of the scope of this technical note.*

Subsequently additional design iterations have been prepared by MGL's experts. On 31st July 2026 an updated V5.0 alternative alignment design set was received including a Safety Review report 'Ardour

Rise Road Safety Review – Alternate Alignment Safety Review, 30 July 2026 prepared by Mr Mike Smith of Stantec. This technical note presents our findings and recommendations following a review of the Safety Review report.

Noting that the scope of our Abley review relates to road safety and functionality of the corridor, the design documents and reports have been shared with Mr Mark Cruden of Meyer Cruden to review civil engineering and geotechnical matters. Mr Cruden's review is appended to this technical note (refer Appendix A) and should be considered in full alongside our Abley recommendations.

2. Unsealed road design standards

The recommendation from our January technical note was that class 4C unsealed road for mountainous terrain was a suitable minimum design standard. The corresponding design parameters are presented in Table 3.10 (pages 71-72) of the ARBB guidance¹ which have been copied from the ARBB guidance into Table 2.1. It is noted that for some portions of the corridor a higher 'rolling' terrain design standard may be more appropriate. These have also been included for completeness. Please refer to the source document for a complete set of design parameters and footnotes which provide important additional detail.

Table 2.1 Guidelines for class 4C geometric design standards for unsealed roads (excerpt from ARBB Table 3.10)

Design parameter	4C Access road – rolling terrain	4C Access road – mountainous terrain
Operating speed	40 km/h	20 km/h
Minimum crossfall	5%	5%
Maximum superelevation	8%	10%
Minimum carriageway width	5m (3m lane + 1m shoulders)	4m (3m lane + 0.5m shoulders)
Minimum formed width (including verges)	7m	6m
Minimum curve radius	60m	15m
Minimum sight stopping sight distance	50m	30m
Minimum meeting sight distance	100m	60m
Maximum vertical grade	8%	12% although higher grades of up to 20% can be allowed for short sections (about 150m)
Minimum crest vertical curve	K value = 8	K value = 2
Minimum sag vertical curve	K value = 3	K value = 2

It is further noted that CODC's engineering standard (based on NZS4404:2004 Addendum) refers to maximum grades of 12.5%. For the purposes of this review grades of 12% and 12.5% and considered to be analogous.

¹ https://3003125.fs1.hubspotusercontent-ap1.net/hubfs/3003125/ARRB%20Unsealed%20Roads%20Best%20Practice%20Guide_Edition%202.pdf

3. Stantec Safety Review

The Stantec report presents an alternative alignment. Key features of this alignment and differences from the previous V4 alignment are as follows:

- The V5 alignment proposed has focused on eliminating grades over 12.5%. The length and steepness of grades have been reduced such that grades over 12.5% are now relatively short, isolated sections. Areas that exceed 12.5% are:
 - (chainage) 5180-5260 is (an approx) 80m (section) at 12.6%
 - 12300-12620 is 320m at 15.5%
 - 12840-12920 is 80m at 16%
 - 12980-13100 is 120m at 16.5%
 - 13320-13360 is 40m at 15.6%
 - 13600-13700 is 100m at 15.6%
 - 13880-13920 is 40m at 16.3%
 - 14180-14260 is 80m at 5.5-16.2%
- The above deviations from the ARRB standard are generally considered to be acceptable other than the extended length from chainage 12300-12620 where additional design work is recommended. It is noted that this section of the corridor has some gentle curves, requires cut-and-fill to achieve a consistent gradient, and sits above what appear to be small bluffs (based on aerial imagery). This may limit what can be practically achieved with the alignment therefore widening to avoid vehicles having to stop and/or reverse along this section is recommended.
- Recommendations in relation to sections with steep gradient including for vehicles to use lower gears and additional maintenance to avoid corrugation are noted. This does raise a question of Council receiving an asset with potentially higher ongoing maintenance requirements than the existing corridor. A direct comparison of likely maintenance costs between the existing and proposed V5 corridor is not provided and is recommended.
- The overall alignment length has increased by approximately 700m – this is to be expected as a result of longer sections of lower gradient replacing shorter steep sections.
- A comparison of grades included in figure 13 of the Stantec report shows similar proportions of the mountainous section of the existing Thomson Gorge Road route and the V5 alignment being of 5% or less grade. The V5 has a higher proportion of the route between 10-12.5% (37% of the route versus 14%) but less exceeding 12.5% (7.5% of the route versus 17%).
- Forward visibility and the addition of local widening are considered important road safety considerations although these are not addressed in the V5 design. The Stantec report states that in reference to incorporating layby areas for safe passing “*Initial reviews of the proposed alignment indicate that these can be formed at appropriate locations as part of the final design*”.
- The Stantec report addresses road surface material, design and maintenance considerations as well as drainage. These are outside of our field of expertise and are not discussed further in this report.
- Edge protection is recommended to be installed where it is feasible to do so in the form of a windrow of rocks or other materials. There is no discussion of the potential to use barriers (eg concrete or W-beam installations) at locations with steep drop offs. It is recommended this be considered further.

A range of mitigation measures are identified to be addressed through detailed design, specifically:

- Installation of advance road signage advising drivers of road conditions and hazards.
- Including edge protection within the design accompanied by hazard signage where suitable edge protection cannot be engineered. It is noted that there is no reference to the application of barrier technology.

- Localised widening is proposed, and in the view of the Stantec author “*can be achieved in the final design to ensure appropriate opportunity for safe passing and layby locations can be achieved.*” This is supported.

4. Recommendation

It is recommended that:

- The Meyer Cruden report dated 21 August 2026 addresses civil engineering and geotechnical matters and sets out a number of recommendations in Table 1 and Table 2. These should be considered in full alongside our recommendations below.
- The findings and recommendations of the Stantec report be included within a design statement to be conditioned as part of the wider application, including:
 - continuing to refer to the ARRB unsealed road guide as the appropriate design standard with any departures to be approved by Council.
 - The outcome of additional design investigations to mitigate the 320m continuous length of >12.5% gradient.
 - consideration of barrier technology to improve safety for areas with steep drop-offs.
 - requiring a detailed design safety audit to be undertaken in addition to Council engineering approval processes.
 - noting the challenging terrain, length of the corridor and potentially adverse safety outcomes it is recommended that mid-construction safety reviews be considered in addition to a post-construction safety audit.
- The V5 alignment be shared with the wider pool of experts, including landscape and ecology experts to understand any adverse effects beyond transportation which may require further assessment.

Appendix A.
Meyer Cruden Review Letter

21 August 2026

Quinton Penniall c/- Central Otago District Council

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Reference: L2025074.2

REVIEW OF TRAFFIC SAFETY & GEOTECHNICAL REPORTS – PROPOSED REALIGNMENT OF THOMSON GORGE ROAD.

Quinton,

Meyer Cruden Engineering Ltd. (MCE) was engaged by Central Otago District Council (CODC) to provide independent civil and geotechnical engineering advice on Santana Minerals Ltd's proposed realignment of part of the existing Thomson Gorge Road, commonly referred to as Thomsons Track.

MCE has previously reviewed several iterations of the proposed realignment, most recently the drawing set titled "BOGP Ardgour Rise Rev 4 260703". Our findings were provided to CODC in a letter dated 16 July 2026. In that review, we recommended that the applicant engage suitably qualified traffic safety and geotechnical professionals to assess the proposed alignment in further detail.

Those assessments have now been completed, and their recommendations have been incorporated into the revised Version 5 design alignment. In preparing this memo, we reviewed the following documents:

- Ardgour Rise Road Safety Review, Stantec, 30 July 2026
- Preliminary Geotechnical Assessment: Ardgour Rise Road Alignment, GeoOtago, 6 August 2026
- Rev 5 drawings of the proposed realignment, informed by the recommendations from the safety and geotechnical reports

Our comments and recommendations are set out in Tables 1 and 2 below. Please contact the undersigned if you require any further information.

Regards,



Mark Cruden, BEng (Hons) Civil, CMENGNZ, CPEng

Table 1 – Road Safety review comments and recommendations

Comments	Recommendations
<u>General</u> The main change in the Rev 5 drawings is the reduced road gradient. The revised grades generally align with the 12.5% maximum recommended in the ARRB unsealed roads guide, and we support this as a safety improvement. However, the lower grades increase the realigned route to more than 14 km, compared with about 9 km on the existing Thomsons Track over the same mountainous section. In our view, an optimised alignment should balance safety, maintenance requirements and travel time. The proposed 12.5% grade limit places greater emphasis on safety and maintenance. Local ski-field roads such as Treble Cone and Ohau show examples of more balanced approaches. We generally agree with the Stantec report recommendations, subject to the additional comments below.	No additional recommendation.
<u>Downslope edge treatments</u> The windrow edge protection proposed by Stantec is a simple and reasonable form of side protection. Similar treatments are used on local ski-field roads such as Treble Cone and Cardrona, often together with proprietary barrier systems. Higher-risk locations are usually protected with barriers. For windrows to be effective, they should be at least about 0.5 m high. With 1:1 side batters, this would require a base width of about 1 m. The design may therefore need a wider road cross-section, or a reduced carriageway width.	Consider proprietary barrier systems during detailed design, alongside the proposed windrow treatments. Stantec/Santana should show how the windrows will be built into the earthworks and road profile, and update the design to suit.
<u>Unsealed road metal (discussed in Section 3.4.2 of the Stantec report)</u> The Stantec report refers to the NZTA M-series Specifications as the “maintenance” series. However, “M” stands for “Materials”, not	Laboratory testing should be completed on the AP65 material that Santana intends to use, so its suitability as unsealed road aggregate can be assessed. Testing should include particle size distribution, plasticity and proportion of

maintenance. The NZTA M04 basecourse and M03 subbase specifications are mainly intended for aggregate used in sealed road pavements.

These specifications limit silt and clay to improve drainage when moisture enters a pavement. This is suitable for sealed pavements, but less suitable for unsealed wearing courses. Unsealed surfaces need enough clay content to help bind the surface and reduce ravelling.

CODC typically uses clay-bound, pit-won aggregate for unsealed road maintenance such as resheeting. This material tends to stay bound for longer during summer. Low-fines material is likely to increase corrugation, which can create safety issues, especially where vehicles brake on steeper grades. In hot, dry weather, grading corrugations is less effective because moisture is needed to rebind the surface.

crushed faces. Testing should be carried out at one test per 500 m³ of stockpiled material, with a minimum of three tests.

Crushing resistance and weathering resistance testing should also be completed at one test per 10,000 m³ of stockpiled material.

The material should also be classified for unsealed road use using the Paige-Green system.

Table 2 - Geotechnical review comments and recommendations

Comments	Recommendations
<u>General</u> The GeoOtago report is a high-level preliminary assessment. No invasive testing was completed, and only part of the alignment was walked over during the assessment. As a result, the report is not a detailed assessment of whether the proposed earthworks design is suitable. It provides general comments, including likely cut and fill batter slopes, based on engineering judgement. We generally agree with the preliminary assessment findings and recommendations, subject to the comments below.	The report indicates that the proposed earthworks are feasible. However, a more detailed assessment is required to support detailed design.
<u>Rock cuttings</u> Cut batter slopes in rock will depend strongly on the rock structure, including joints, foliation and faults. These conditions are likely to vary along the alignment. For example, where the road crosses a gully, foliation may allow steeper cuts on one side but require flatter cuts on the other. The assessment identifies possible mitigation measures, such as laying back batters and rock bolting, but it does not estimate how often or where these measures may be needed. This is especially important where high cut batters are proposed.	Site-specific investigations should be completed during detailed design to inform cut and fill batter design in both rock and soil. These investigations should include a more detailed visual assessment than has been completed to date, supported by invasive investigations where the geotechnical professional considers them necessary. Given the scale of the project, we would expect some invasive testing to be undertaken. Given the scale of the project, the detailed design should include typical details for mitigation measures such as fill reinforcement, rock bolting and shear keys. This would support an observational approach during construction, where pre-designed mitigation options can be used at specific locations if required.
<u>Fill batters and embankments (Section 5.7)</u> Section 5.7 suggests that fills could be placed in lifts up to 600 mm thick. For site-won rock, 600 mm lifts are not practical unless very large compaction equipment is used, such as a 20 T or larger single smooth steel drum vibratory roller. Using smaller equipment is likely to result in	Fill lift thickness should be selected based on the maximum stone size in the material and the compaction capability of the equipment being used.

lower density and higher voids at the base of each fill layer. High-void layers should be avoided because they can retain moisture and lead to settlement or instability in large fills. This type of settlement can continue over time and is difficult to repair after construction, as seen on sections of the Crown Range Road alignment. The single-drum vibratory rollers typically used on roading projects are usually in the 10 to 13 T range. These can generally compact a 300 mm loose layer effectively. NZTA F/1 provides guidance on suitable lift thicknesses based on maximum stone size.	
<u>Subgrade characterisation</u> The report does not describe the likely subgrade properties. These properties should be assessed because they will influence the unsealed pavement design.	Assess the subgrade properties during detailed design to inform the unsealed pavement design.
<u>Construction Specifications</u> The preliminary report includes some information on construction requirements, such as density testing and benching. However, it is not comprehensive. In addition to the construction drawings, a detailed construction specification is required. This should include inspection and testing requirements and cover earthworks, drainage and pavement construction. The specification should be provided to CODC for review and approval at the detailed design or engineering approval stage.	Provide a construction specification at the engineering approval stage for CODC review. The specification should include detailed inspection and testing requirements and form part of the wider detailed design submission. The detailed design submission should include, as a minimum, a detailed geotechnical assessment report, a construction specification with inspection and testing requirements, and detailed plans for earthworks, drainage and pavement works.

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