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Assessment of effects of proposed road formation.

Infracon Limited, Rocky Point, Bendigo

1. Introduction

This report provides an assessment of effects of the transport aspects of the proposed development. It also describes the transport environment in the vicinity of the site and identifies compliance issue with the transport provisions in the District Plan.

The report has been prepared by Matthew Suddaby, Registered Professional Surveyor. It has not been prepared by a specialist traffic engineer and is not a formal Integrated Traffic Assessment (ITA). We envisage that this would be submitted to Council as part of the engineering acceptance process, along with a comprehensive Road Safey Audit.

2. CODC Standards

Roading standards in Central Otago District are specified by a 2008 addendum to NZS 4404. Table 3.2(a) specified standards dependant on the type of road, the topography and the expected traffic. The proposed road is a Local Sealed Road located in mountainous topography, and therefore a 6.0m carriageway with 0.25m gravel shoulder is expected. A design speed of 50km/h and a maximum longitudinal grade of 10% is also specified.

3. Transport environment

The proposed road is accessed from Bendigo Loop Road, approximately 300m east of the Tarras-Cromwell Road (State Highway 8) / Bendigo Loop Road intersection. Bendigo Loop Road is currently unsealed. There is no speed restriction, however the unsealed, often corrugated formation restricts typical speeds to 80km maximum. The proposed intersection has been positioned to ensure excellent visibility in each direction.

4. Road Design

4.1. Road alignment design

The proposed road traverses across flat land and through a historic dry watercourse for about 100m before an S bend leads to a switchback at the base of the hill. These curves have a 15m radius. The grade has been reduced to 8% at the centreline, which ensures it is not excessively graded on the inside of these curves. The is section will be constructed with 30mm asphalt to minimise any damage to the surface in hot conditions. The road then climbs up the terrace face for 500m at a gradient of 15%. Significant cut is required on the uphill side of the road, while fill

is necessary to build the road up while crossing through the three existing dry gullies. A right of way branches to the east at the top of this crest.

The road then drops through a significant gully where up to 8m fill will be necessary. The climb out of this is at 15% for 250m, before the road levels off and terminates in a 10m radius cul-de-sac head.

4.2. Road surface design

The proposed road formation is compliant with Council's standard for Rural Roads. The road consists of a 6.0m carriageway with 0.25m metal shoulder on each side. A water table will be constructed on the hill side of the road. These water tables will be rock armoured where the grade exceeds 10%.

A 1.2m shoulder extension will be constructed on the outside of the road. This may be used in some locations for the location of a road safety barrier. (refer section below)

All sections with gradients in excess of 1:10 (10%) will be asphalted, as will all tight radii curves (less than 25m.

5. Compliance with standards

The proposed road meets CODC standards for carriageway width, shoulder width, design speed and surface type. It breaches the maximum grade of 10% (1 in 10) with a maximum grade of 15% (1 in 6.7).

6. Assessment of Road safety hazards

6.1. Steep Grade

Hazard	Steep grade.
Description	A steep grade can be more difficult for vehicles to climb, surface damage can occur, safety hazard of run-away vehicles
Mitigation	Sections with steep grades are surfaced in asphalt or concrete Steep grade signs W14-9 and W14-10 to be installed at top and bottom of section. Road safety barriers to be considered
Alternative	Physical constraints exist on this mountainous site. To design a road with flatter grades would necessitate lengthening the horizontal distance of the road. This would require significantly greater earthworks, and construction of another switchback on the slope. This would ave a negative visual and environmental impact.

6.2. Tight Radii Bends

Hazard	Tight radii bends
Description	Tight radii bends can be more difficult for large vehicles to negotiate. Bends need advance warning to ensure motorists travel at the correct speed. Some motorists will cross the centreline when travelling around corners.

Mitigation	Sections with tight radii bends have the vertical grades lessened. This ensures that the grade on the inside of the bends is not excessive. Localised road widening is constructed on the inside of the tight bends Tight radii bends are surfaced in asphalt or concrete Appropriate W12 curve signs and supplementary advisory speed signs are installed Curve cheveron signs are installed Retro-reflector edgeposts are used on the outside of curves Road safety barriers to be considered
Alternative	Physical constraints exist on a mountainous site. To design a road with larger radius bends would require extensive earthworks or tunnels. A wider road may reduce the possibility of cars crossing the centreline however this would have a negative visual and environmental impact. A centreline median could be installed, but this is not considered necessary due to the low traffic numbers

6.3. Embankment Slopes

Hazard	Embankment slopes
Description	The severity of impacts on embankments increases as their height increases and/or as their slope steepens. In an extreme situation, vehicles may become airborne as they cross the hinge point of steeper embankments.
Mitigation	Primary mitigation is to ensure a generous lane width and shoulder area. Lane width is 3.0m. Shoulder is 0.25m. Minimum distance from edge of shoulder to top of batter (hinge point) is 1.5m. White fog lines assist in keeping motorists on road. If there is a drop greater than 1.0m within 2.0m of the edge of the live lane then a safety barrier may be necessary. Appropriate road safety barriers would be flexible W-beam barriers at 915mm high at 2.0m spacing. Use of safety barriers requires a road design that ensures there is a minimum of 1m of reasonable flat ground behind the posts in a safety barrier so that the posts can resist the lateral impact loads.
Alternative	Physical constraints exist on a mountainous site. To design a road with lesser risk from embankment slopes requires more extensive earthworks and /or safety barriers.

	The use of safety barriers needs to be carefully considered and balanced against the expected number of users, the level of risk, the cost and the environmental effects.

6.4. Culverts

Hazard	Culverts
Description	There is potential risk to motorists leaving the road and crashing into culverts that do not match the embankment slope. . severity of impacts on embankments increases as their height increases and/or as their slope steepens. In an extreme situation, vehicles may become airborne as they cross the hinge point of steeper embankments.
Mitigation	Specific to culverts, it is recommended that the culvert is extended or shortened to match the embankment slope. Culverts with diameters greater than 900m should be made traversable by utilising cross-grated end treatments at 750mm centres. Safety barrier protection should be used where the formation height is greater than 2.0m As with embankment slopes, the primary mitigation method is to ensure a generous lane width and shoulder area.
Alternative	Culverts are essential part of road construction to allow water to pass from one side of the road to the other. Alternative options to mitigate risk are discussed above.

6.5. Winter road conditions

Hazard	Winter road conditions
Description	Winter road conditions can include snow, ice and frost. Conditions may contribute to drivers losing control.
Mitigation	The road should be constructed with the specified cross fall to ensure water drains from the road. The surface of the road should be sealed. Frost is more likely on sections of road shaded by high embankments or tall trees. The road is north facing and is not prone to frosting as the frost drains from the hillside.

	Heavy snowfall on the road could cause delays for motorists, however this occurs throughout the district. Heavy vehicles are more susceptible to being delayed by road conditions.
Alternative	Winter road conditions are an unavoidable aspect of living in the Central Otago District. Road users must take personal responsibility to drive in accordance with the weather conditions at the time. The proposed road is a no exist road, that will predominantly be used by local residents who will develop familiarity with the road. All motorists coming down the road will have first driven up the road.

7. Operational Effectiveness

The underlying purpose for this road is to provide safe and efficient access to the residents and guests of the development.

7.1. Usage

Typical long term use will be by domestic passenger vehicles. Some owners may also have boats, caravans and trailers.

During the establishment of the community, we envisage most road use will be by tradespersons' light commercial vehicles as well as heavy construction vehicles such as concrete mixers and supply trucks.

In the future, occasional usage may include service vehicles and emergency vehicles such as fire appliances.

The above usage patterns have been considered and we believe these are well met by construction of the proposed two lane 6.0m wide sealed road. This road allows two-way traffic at all times, and is trafficable in all weathers. Asphalt will be used in areas of high wear, and appropriate drainage constructed to ensure the road has low maintenance requirements.

As noted above, the vast majority of road users will be familiar with the road and will drive in accordance with the conditions. Prominent safety signage will be erected for less familiar drivers.

7.2. Gradient

Although the road has a maximum gradient of 15% (1:6.67), this is a grade which is commonly found in mountainous roads and highways throughout the South Island.

NZTA advise that grades steeper than 10% often cause speed variance problems. The main problem cited is the very slow uphill speeds of heavy vehicles but there is also the potential for high downhill speeds on steep grades and the safety problems associated with these. Speed variance wouldn't be a concern for this local road due to the infrequency of use by heavy vehicles, and the fact that this is a local road rather than an expressway. High, out of control, downhill speeds would be a concern, however the risk of this is managed by the horizontal road alignment, signage and possible safety barrier usage.

NZTA further report that most cars can climb at a grade of 30% on a sealed surface, but truck and trailer units are generally limited to approximately 15%. As noted above the typical usage will be passenger vehicles. The local, no-exit nature of the road means that there would be very, very few occasions that it would be used by a truck and trailer unit. Perhaps for delivery of furniture, building materials or an excavator. These deliveries would be made by a local driver, who would be familiar with the road conditions and the capabilities of their vehicle.

8. Summary

In summary, the construction standards meet the CODC standards for a Rural mountainous local sealed road with the exception of the maximum gradient. As has been demonstrated above, the increase in gradient is appropriate because the road traverses difficult terrain where achieving the maximum grade is not practical. The increased grade will have a negligible effect on the vast majority of vehicles using the road on a day to day basis. Safety hazards have been identified, and can be effectively managed.

Matthew Suddaby

B Surv, RP Surv. 9 August 2023