

# Wolgan Gap Road STATUS UPDATE

MARCH 2023

During 2022, protracted above average rainfall triggered mobilisation of numerous upslope and downslope landslides resulting in extensive material loss and damage to the road.

Wolgan Road traverses an area of historic and ongoing slope hazard. Between 2006 and 2016, the dominant slope hazard affecting road users was rockfall with an upslope source zone over a length of approximately 240 m north of Wolgan Gap lookout. Following a rockfall in that area in late 2008, Council scheduled a re-assessment of the risks posed by upslope hazards to road users and undertook targeted remediation works. The remediation works were completed in 2009 and included installation of permanent monitoring points for selected rock topple hazards, scaling and targeted rock bolting. On-going periodic monitoring and re-assessment of the area continued and from 2009 to the end of 2021 the dominant slope hazard affecting road users continued to be rockfall with an upslope source zone.

## WSP UPDATE

WSP Australia Pty Ltd (WSP) has been working with Council during 2022 and 2023 to update previous slope risk assessments for an increased length of Wolgan Gap Road due to the 2022 landslide events. During this time, WSP has produced the following reports:

- Review of Wolgan Gap Slope Hazards (2022). This report summarises the geotechnical slope hazards identified after a landslide which occurred on 5th November 2022
- Slope Risk Assessment Update (2022). This report presents a Slope Risk Assessment (SRA) and Quantitative Risk Analysis (QRA) for the hazards identified over the increased length of Wolgan Road.

### In this document you will find

- Definition of hazard and how hazards have been ranked
- Definition of risk to persons (loss of life) and property
- Description of some of the hazards identified on Wolgan Road
- Outline on what industry considers tolerable or acceptable
- What the cost of remediation may look like to achieve tolerable risk levels

- How the potential cost of remediation compares with value of the existing asset
- Comparison of cost of remediation to risk improvement

If financially feasible, re-opening Wolgan Road requires extensive remediation works to reduce the risk to road users.



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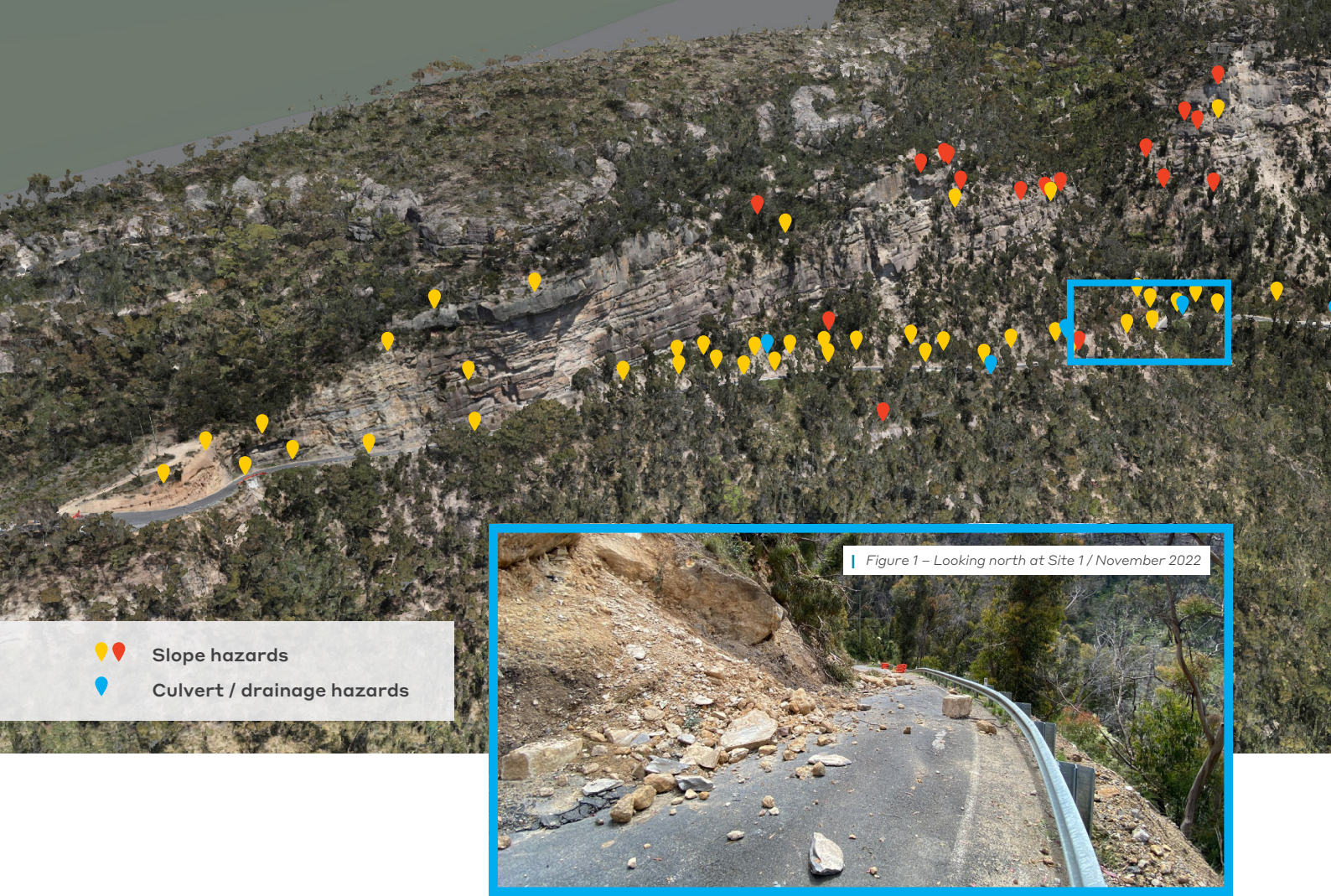


Figure 1 – Looking north at Site 1 / November 2022

- ● Slope hazards
- Culvert / drainage hazards

## HAZARD IDENTIFICATION

A Hazard is defined as a condition with the potential to cause an undesirable consequence. Hazards at the Wolgan Road include:

- small and large rockfall
- rock topple and slides
- upslope and downslope debris slides
- failure of retaining wall or and drainage element

A total of 128 specific slope hazards were identified by WSP during late 2022.

Of these hazards, 37 were actively moving and were mostly upslope and downslope debris slides and flows.

## SLOPE RISK

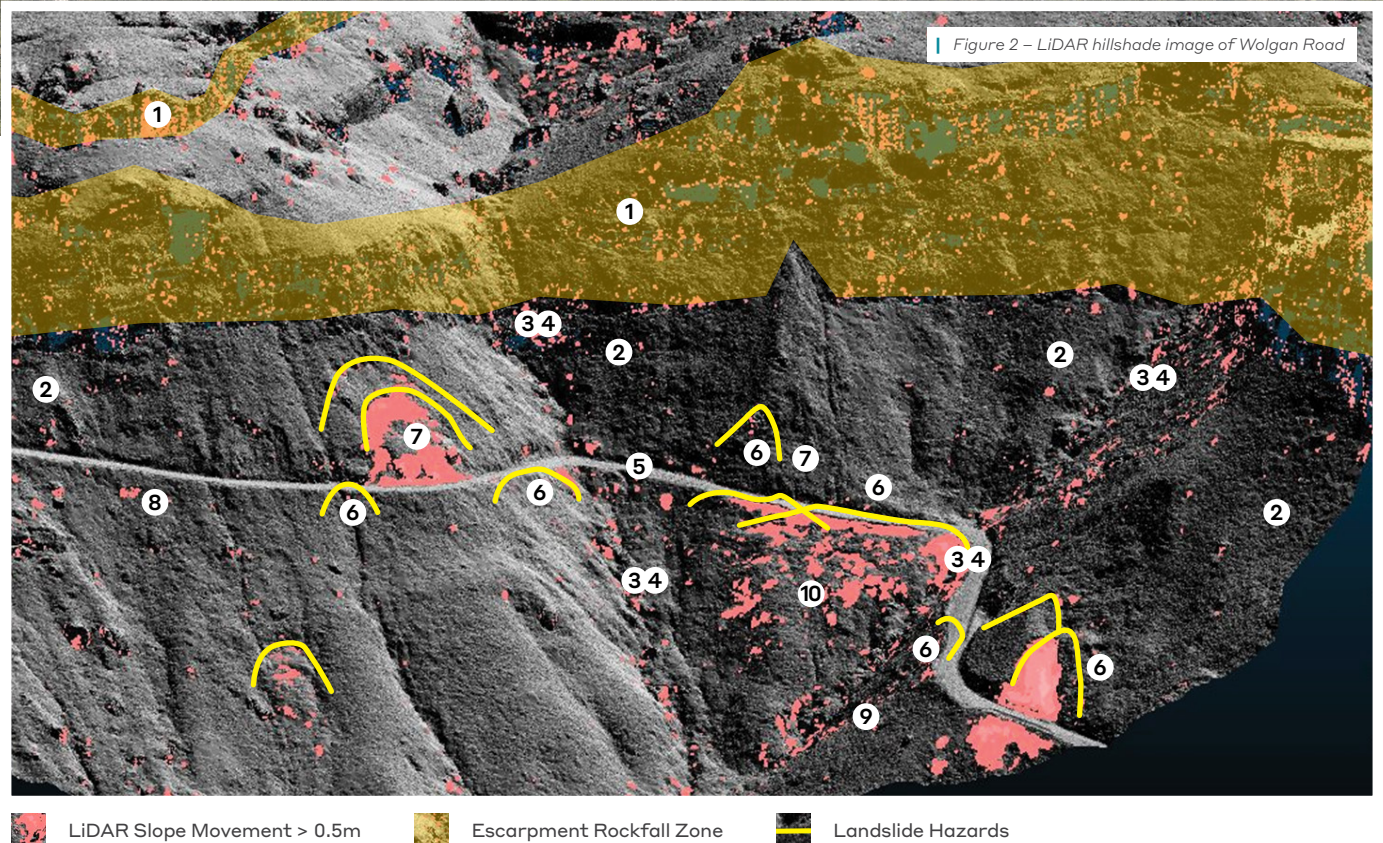
Risk is the probability and severity of an adverse effect due to a hazard. Slope risk calculations for Wolgan Road consider the number of vehicles using Wolgan Road, probability of a landslide event, vehicle speed and vulnerability of the road users.

Slope risk can be mitigated in a variety of ways, the most effective of which is to avoid or (where possible) eliminate the hazard such that there is no on-going (i.e. residual) risk. An example of elimination of a slope hazard would be removal of a boulder rockfall hazard entirely without disturbance of the surrounding slope.

Examples of other slope risk mitigation measures include reduction of the risk posed by a hazard at its source (e.g. rock bolting and netting of a rockfall source zone) or reduction of the risk posed by a hazard closer to where impact with a road user is possible (e.g. installation of a rockfall catch fence). Except for the cases of avoidance and elimination, some residual risk will remain following remediation.

Safe implementation of risk mitigation measures can be a complex and costly exercise, particularly where numerous slope hazards exist in proximity to one another. Staging of remediation works in this setting must be carefully planned to ensure adequate worker safety and avoid the implementation of remedial measures for one slope hazard causing de-stabilisation of other slope hazards. On Wolgan Road, active and enlarging landslides are present and safe staging and implementation of remediation measures is particularly challenging. Worker safety risks and a risk that remedial measures may be damaged during construction exists, due to on-going slope movement.

Figure 2 opposite shows areas of the slope at Wolgan Road in the vicinity of some of the highest risk hazards, where more than 0.5 m of ground movement has been recorded between August 2022 and January 2023. Key features of slope hazards in that area are labeled. These slope hazards have the potential to interact with one another as described below Figure 2 (right).



### KEY SLOPE HAZARD FEATURES

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|--|--|--|
| <p><b>1</b> Cliff-lines above the site contain rockfall, rockslide and rock topple hazards to which road users and workers would be exposed at road level.</p> <p><b>2</b> Rock ledges and colluvial slopes contain prior rockfall which has come to rest on the slopes but may re-mobilise and reach the road below.</p> <p><b>3</b> Surface flows within major drainage lines saturate and scour the flanks of previous landslides and colluvial masses causing de-stabilisation.</p> <p><b>4</b> Collection of rockfall within drainage lines, blocks and re-directs surface flow causing further de-stabilisation.</p> | <p><b>5</b> Blockage of drainage lines and culverts above the road level causes re-direction of surface flows and downslope scour, de-stabilising the road edge.</p> <p><b>6</b> Debris flows at the flanks of existing landslides or colluvial masses reduces stability of the central portion of those landslides/colluvial masses. Where culverts exist at flanks, their damage results in re-direction of sub-surface flows and causes further de-stabilisation.</p> | <p><b>7</b> (Re-)mobilisation of significant debris slides results in de-stabilisation of slopes above and potential for de-stabilisation of the road and slopes below due to surcharge from the displaced material.</p> <p><b>8</b> Small scale landslides de-stabilise and impact the road.</p> <p><b>9</b> (Re-)mobilisation of landslides within the lower portions of the colluvial slopes de-stabilise the slope above.</p> <p><b>10</b> Combinations of the key slope hazard features above have the potential to lead to complex landslides which have the potential to de-stabilise and impact significant lengths of the road.</p> |
|--|--|--|

## SLOPE RISK (CONTINUED)

In consideration of the complex nature of hazards, their proximity to one another, active and enlarging nature and potential for interaction, 13 hazards have been referred to as Category 1 hazards.

Category 1 hazards would require careful staged remediation due to the risk they pose to investigation and remediation workers before access and remediation of other slope hazards could commence.

An additional 66 Slope hazards have been referred to as Category 2 hazards, meaning those hazards require remediation to meet industry annual individual loss of life tolerability criteria. A further 49 slope hazards are referred to as Category 3 hazards meaning they would require remediation to meet industry annual societal loss of life tolerability criteria. A general rockfall hazard also exists across the entire length of road assessed. Mitigation of slope risk to tolerable levels during construction would be a challenging exercise and significant residual loss of life and property risk would remain following remediation of Category 1, Category 2 and selected Category 3 hazards.

## LOSS OF LIFE RISK ANALYSIS

### Current Risk of Loss of Life

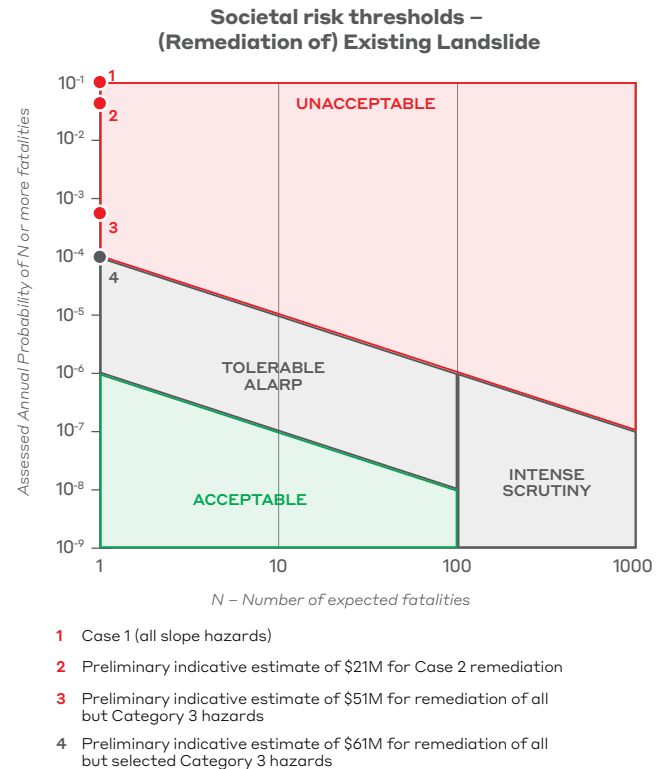
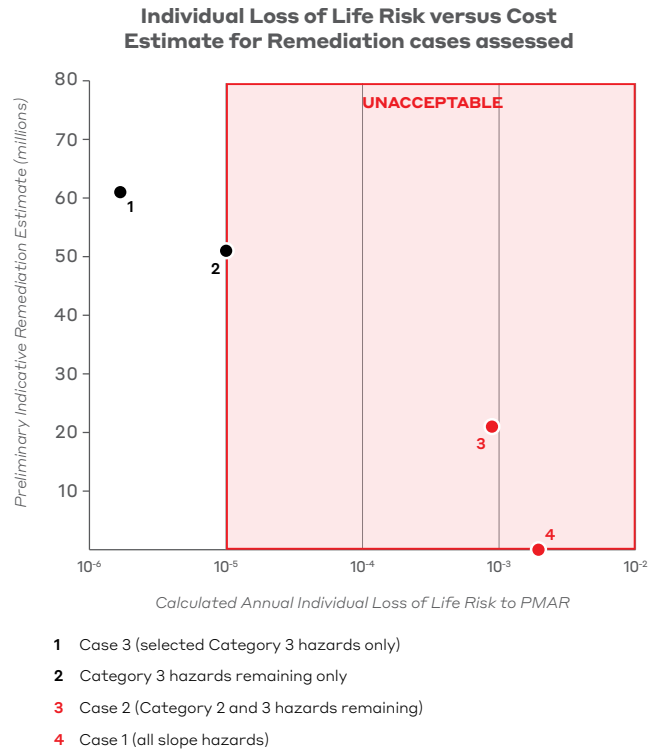
When considering loss of individual life and tolerable risk is 0.00001/annum, for existing landslides (industry accepted standards).

The current risk to individual loss of life, is 0.002/annum, which is 200 times greater than tolerable.

### Cost of Remediation and Residual Risk

- The potential remediation cost for the 13 Category 1 Hazards is estimated to be over \$20 million and does not reduce the risk to below tolerable levels
- The potential remediation costs for all Category 1 and 2 Hazards is estimated to be over \$50 million and achieves only marginally acceptable residual risk. Actual remediation costs to target industry risk tolerability criteria where careful staging is required and complex interacting hazards are present could be a multiple of that amount.
- For context, the asset is considered to have a value of \$20 million
- Because of the scale of and number of hazards, the cost of remediation is disproportionate to the risk improvements obtained.

This is shown in the following charts when considering individual loss of life and societal risk for multiple fatalities.



## MORE INFORMATION

**Landslide Risk Management – Guidelines**  
[landsliderisk.org/resources/guidelines/](http://landsliderisk.org/resources/guidelines/)

**Wolgan Road Disaster Response**  
[council.lithgow.com/wolgan-road-disaster-response/](http://council.lithgow.com/wolgan-road-disaster-response/)

