AtkinsRéalis

B8035 - Mull Rockfall
Interim Assessment

10 October 2025

B8035 - Mull Rockfall Interim Assessment

B8035 - MULL ROCKFALL

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Project	B8035 - MULL ROCKFALL
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Client signature/date	

Contents

Figures

Executive Summary

Recent assessment of the B8035 at Gribun, Isle of Mull, has identified significant rockfall hazards. These arise from steep basaltic cliffs with both unweathered and weathered units, where erosion and structural weaknesses have led to recent failures impacting the carriageway. Further potential failures of a similar size have been identified.

The resultant risk to road users is calculated as unacceptable according to Health and Safety Executive (HSE) standards, with estimated fatality rates exceeding the tolerable threshold. This means intervention is required before the road can be safely reopened.

Potential remedial options include management measures such as continued closure and limited access, as well as engineering interventions like rock bolting, barriers and mesh installation. However, these present logistical and financial challenges due to the site's scale.

The final report will deliver a detailed risk assessment, incorporate results from ongoing rockfall runout modelling, and present a detailed appraisal and cost-benefit analysis of mitigation strategies.

1. Introduction

This interim appraisal report presents the findings of a preliminary geohazard risk assessment conducted along a section of the B8035 at Gribun, Isle of Mull.

The assessment was initiated in response to recent rockfall activity affecting the carriageway, posing a risk to road users.

The site is characterised by steep exposure of the Mull Lava Group, comprised of basalt, which exhibit varying degrees of weathering and structural complexity.

The purpose of this report is to document initial observations, characterise the geological and geotechnical conditions contributing to slope instability, present an initial assessment of the risk to road users, and initial discussion of potential remedial options.

The findings of this report will inform the final options report which will present the final assessment of the risk to road users across the site, and a more detailed appraisal of mitigation options.

2. Site Reconnaissance & Data Acquisition

A site visit was conducted by two AtkinsRéalis engineering geologists on 30/09/2025 between 9.00 and 15:00. The weather during the site visit consisted of low cloud, with light wind and rain throughout the day.

The site area and regional location is shown in Appendix A

Due to the rain, the planned drone survey was unable to be fully completed. A short drone flight was conducted during a brief weather window, allowing for a model of the central 1000m rock face, including the recently failed area, which can be seen in Appendix B.

A site walkover was conducted to collect data throughout the 1.8 km site area. Observations and photographs of the recent rockfall event were collected. Observations of the rest of the site area were then made to gather information including observations, rock strength measurements, discontinuity orientations, and photographs in order to inform the assessment of risk to road users on the B8035 from rockfall events.

Upon arrival to site, it was noted that the safety barrier denoting the road closure had been pushed aside to allow for access Figure 2-1. This had occurred at both ends of the closure. During the site walkover, three vehicles belonging to members of the public passed through the closure area, with one vehicle passing in both directions.

It has been reported that the debris on the road from recent failures has been removed by members of the public, indicating that the road is still in use, despite the closure notice. (Wild, 2025)

Figure 2-1 - Removal of road closure barriers

3. Preliminary Hazard Assessment

3.1 Site Geology

The geology of the cliffs at Gribun primarily consist of basaltic lava flows of the Mull Lava Group, with intrusions of the North Britain Palaogene Dyke suite and the Loch Scridain Sill Complex being mapped in the area, visible within the cliff face. (British Geological Survey, 2025)

The rock slopes can primarily be split into two units based upon their expected engineering properties. These units are a stronger, relatively unweathered unit of basalts, and a weaker, more weathered basalt unit.

Figure 3-1 – The upper section of rock face consist of the jointed, unweathered basaltic rock unit with the more weathered, less well jointed unit visible in the lower section.

3.1.1 Unweathered Basalt

The first unit primarily consists of unweathered basaltic lava.

This unit had a strength of approximately 40 - 50 MPa, as measured by Schmidt hammer on site, indicating a medium strong rock. (British Standards Institute, 2020).

It showed well-developed discontinuity sets in multiple orientations including columnar jointing. Evidence of kinematically controlled failures, predominantly toppling, due to unfavourable intersection of joint sets with the rock face was observed across the site. Many of these joints showed a wide aperture of up to 20 mm.

Intrusions of the Loch Scridain Sill Complex and North Britain Palaogene Dyke Suite are mapped within the site area, expected to be composed of basalt, gabbro, andesite. These intrusions can be seen within the main cliff face at Gribun due to their lighter colour and difference in strength and are generally between 1 and 5 m thick. They are expected to consist of competent rock, as they have been observed to protrude where the weaker weathered rock units surrounding them have been eroded.

3.1.2 Weathered Basalt

The second engineering unit consisted of weathered basaltic rock.

This unit showed a loss of strength (10-20 MPa) when compared to the unweathered rock, and the surface of blocks of this unit was able to be peeled and crushed by hand. This indicates a weak to moderately weak rock (British Standards Institute, 2020). Reddish discolouration of this unit was observed. Joint sets were not as well developed within this unit. With relatively few kinematically controlled failures due to the intersection of discontinuities being observed.

Figure 3-2 - Weathered basalt block (in impact crater) which the surface layer was able to be broken by hand, indicating a loss in strength

3.2 Slope failure mechanisms

Several contributing factors to rock slope instability were identified during the site walkover. More competent rock units have been undermined due to the erosion of the weaker, more weathered rock underlying it. This process has resulted in formerly stable blocks of competent rock becoming unsupported, leading to failure along intersecting discontinuity sets. Multiple kinematic failure mechanisms were observed in the field, including planar sliding, wedge failure, and toppling, as illustrated in Figure 3-3.

Figure 3-3 - (Top left) Potential toppling failure, (Top right) Planar sliding failure, (Bottom) Planar and wedge failures due to intersecting discontinuities

3.3 Block size & shape

A variety of block sizes were observed on site ranging from small blocks a few cm across to several large blocks around 3-5 m in length. Many of these larger blocks were located downslope of the road and tended to have a cubic shape. Blocks deposited adjacent to the road generally were of the scale of 0.2 - 0.5 m across, including those deposited during the recent rockfalls (Figure 3-4).

Figure 3-4 - (Left) Large approx. ~4m tall block located immediately adjacent to the road, person is approx. 2 m tall. (Right) Range of block sizes deposited next to the road including those from the most recent failures.

A variety of block shapes were observed across the site area including cubic, spherical, and columnar, as shown in Figure 3-5. Block shape impacts the expected runout of the block, with more equant shaped blocks (e.g. spherical or cubic blocks) expected to travel further than those with a flatter shape and therefore present a greater risk due to the increased likelihood of these rocks rolling and bouncing.

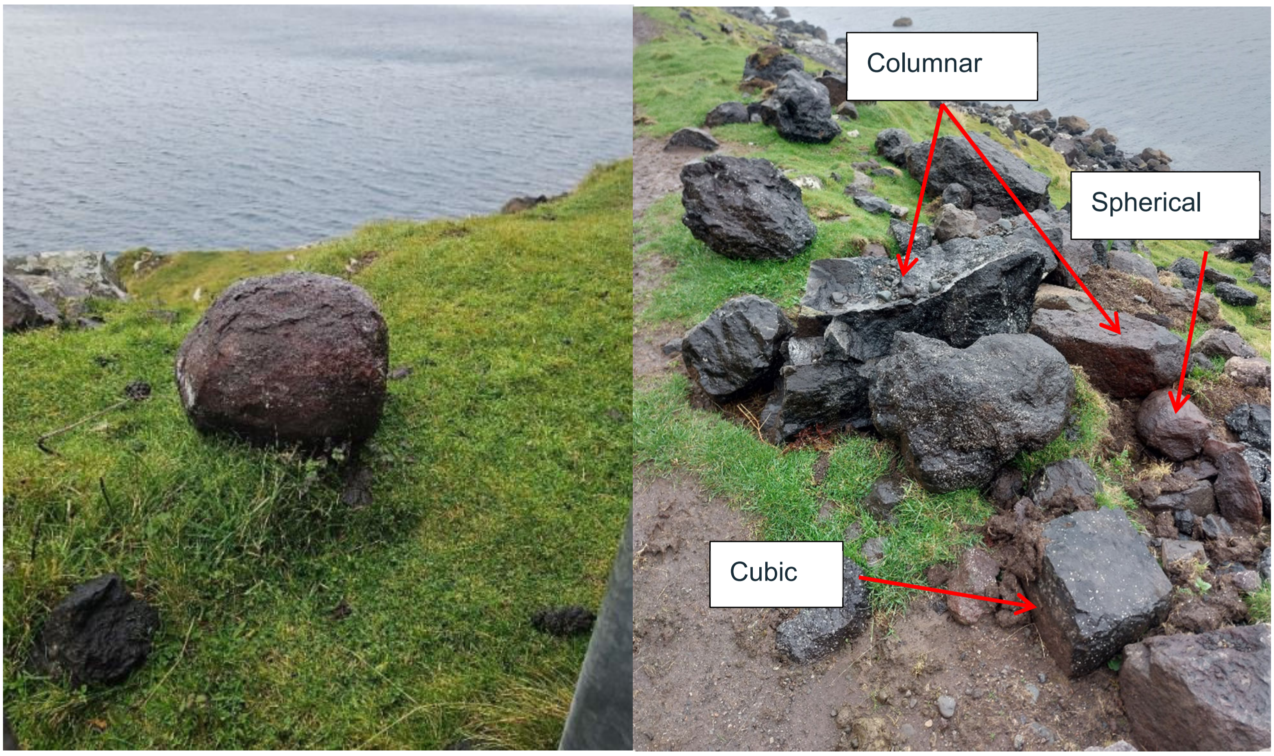

Figure 3-5 - (Left) Rounded block (0.3 m across), (Right) Variety of block shapes cleared from the recent event.

3.4 Rockfall Frequency

3.4.1 Known Events

Limited information is available regarding the frequency and magnitude of rockfalls in the site area, with all confirmed events having occurred recently (2025) and very limited long-term data being available.

A large rockfall event is known to have occurred on the 2nd of July 2025, with blocks up to approximately 0.5m being deposited on the B8035 road surface and damaging the roadside barrier. It is believed larger blocks came down, damaging the barrier, before landing in the sea.

Further rockfall at this location, assumed to have originated from the same source, associated with Storm Floris, was recorded on the 6th of August 2025. This failure caused further damage to the road and roadside barrier, depositing more blocks onto the road.

There was further washout of fine material onto the road which has been estimated to have occurred in early September, as evidenced by a photograph posted to the “Mull Charters” Facebook page on the 9th of September showing muddy water flowing below the failure area within the deposited material (Figure 3-6). The exact timing of movement is unknown but is assumed to be close to the time that the image was posted.

Figure 3-6 - Photograph posted on the "Mull Charters" Facebook page showing muddy water transporting failure material down to the road

Local history indicates that there may have been two fatalities in the 1700's due to rockfall approximately 1km outside of the site boundary at a location known as "tragedy rock" (NGR 145449, 735210), where a large boulder impacted a house, killing the two people inside (Isle of Mull Business & Leisure Directory, 2025). The boulder, which is several meters across is visible adjacent to the road, with the walls of the house still being visible beneath it.

Local road users indicate that rockfalls regularly occur within the site area and are typically cleared by the road users. These failures are likely smaller in magnitude than those known to have occurred in July and August 2025.

The inspection undertaken AtkinsRéails identified further potential failures of a similar size to the west of the previous failure.

3.4.2 Inferred Frequency

Throughout the site area there were many blocks located immediately above and below the road, indicating that rockfalls have frequently reached the road level in the past. While many of these blocks were covered in lichen indicating that they had been at their current location for a significant amount of time, many blocks showed fresh surfaces, indicating that they had been mobilised fairly recently[1]. The positioning of some of these smaller blocks within the verge right next to the road indicates that they may have been deposited on the road and have been moved by road users, seen in Figure 3-7

Figure 3-7 - (Left) Fresh rock blocks located immediately adjacent to the road, their positioning indicates that they may have been removed from the road by road users following failure. (Right) fresh surfaces visible on an otherwise weathered rock block indicating that the block may have been mobilised from the rock face, or impacted by another falling rock fairly recently

Fresh rock surfaces are also visible within the rock faces across the site. This is also indicated by the presence or absence of lichen and other vegetation, and lack of surface discolouration indicative of weathering processes affecting the rock face, as seen in Figure 3-8.

[1] It is understood that lichen is likely to take between 3-5 years to develop into patches and 10-30 years for well-developed cover.

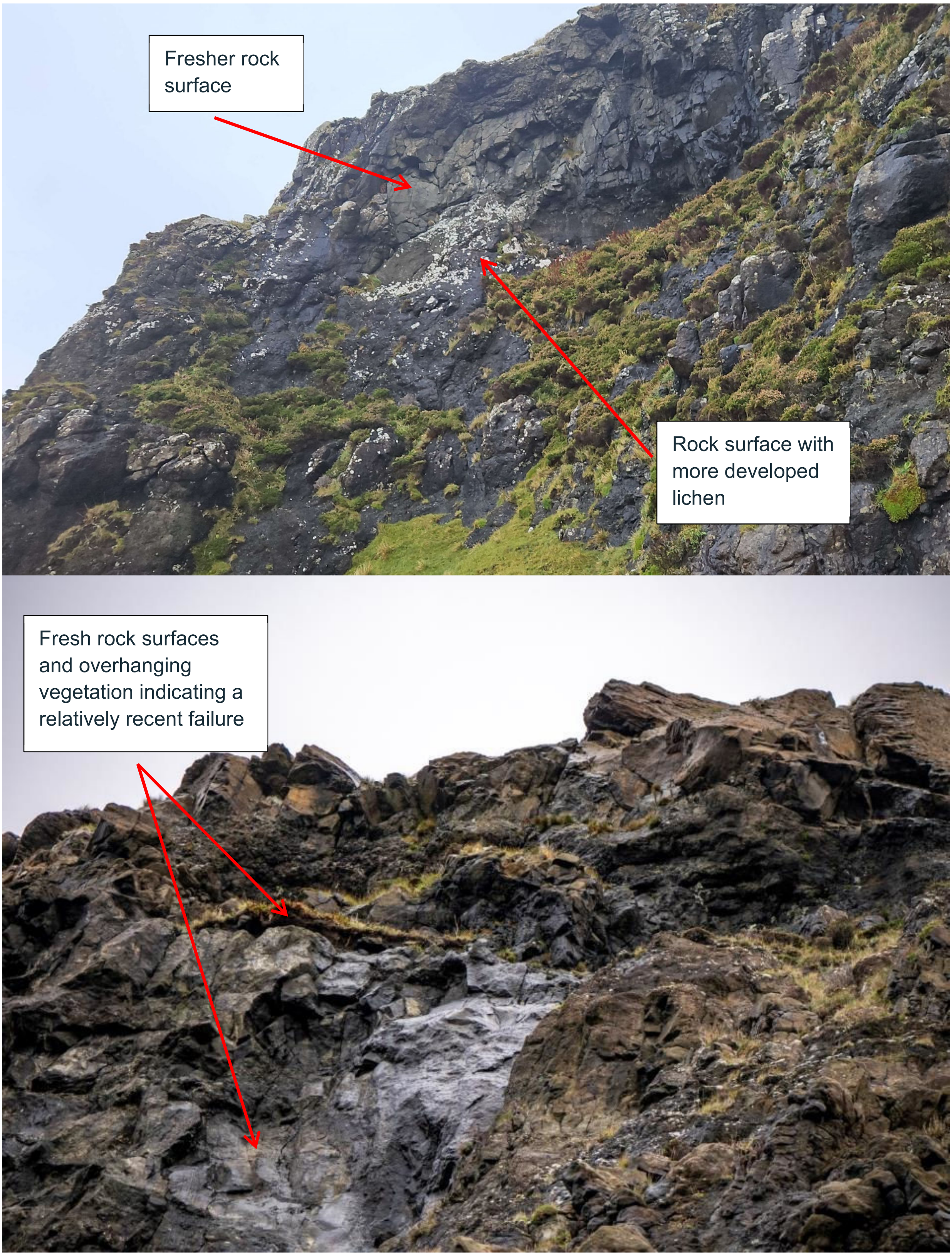

Figure 3-8 - (Top) Rock face showing areas with differing amounts of lichen development. (Bottom) Rock face showing fresh, non-discoloured rock faces and overhanging vegetation.

Blocks observed during the site visit (Figure 3-9) had displaced the fine material previously deposited on the road surface, indicating that their mobilisation occurred after the deposition of this material, which is estimated to have taken place in early September 2025.

Figure 3-9 - Block that has displaced fine debris material, indicating that it mobilised after the debris was washed onto the road. Block is approximately 0.2 m across

3.5 Rockfall runout

Due to the topography of the site, it is assumed that the likelihood of detached blocks reaching the B8035 is extremely high. Several rock faces are located immediately adjacent to the road, and any material detaching here will impact the road as seen in Figure 3-10.

Figure 3-10 - Rock slope immediately adjacent to the road

Within the central area of the site, there is a steep slope consisting of talus and debris from previous slope failures between the main rock slope and the road.

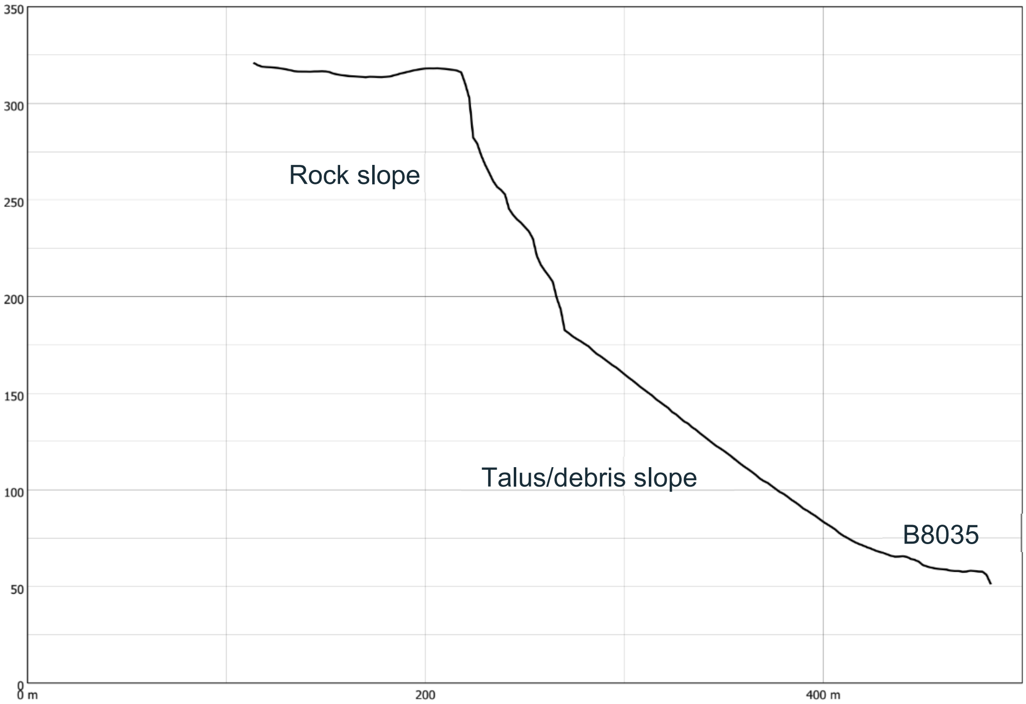

Figure 3-11 - Sample slope profile generated from the digital terrain model collected during the drone survey

Relatively few blocks can be observed having been deposited in the upper sections of this slope, with the majority of visible blocks being immediately above and below the road. This indicates that a high percentage of mobilised bocks are likely to reach the road level.

Figure 3-12 - Drone model showing blocks deposited immediately adjacent to the road

Rockfall runout modelling using the digital surface model generated from the drone survey is currently being undertaking to increase understanding on how the different observed block shapes, and sizes, will behave during a rockfall. This modelling will be used to inform the more risk assessment which will be presented in the final options report.

4. Preliminary Quantitative Risk Assessment

As recommended in CIRIA C810 (Koe, et al., 2023), the following relationship has been used to evaluate the risk posed by rockfall at the site.

$$Rs = P(Hi) \times \Sigma(E \times V \times Ex)$$

Where:

Rs = specific risk due to a particular magnitude of landslide Hi occurring within a specified area over a given period of time.
$P(Hi)$= probability of a particular magnitude of hazard Hi within a specific area and time frame
E = Elements at risk
V = Vulnerability of elements at risk
Ex = Exposure

4.1 Preliminary Assessment Rockfall Scenario

This scenario considers the impact of an approximately 20 cm^3 block across a 1km stretch of rock cliff.

A 1km section has been selected as a nominal region to allow the risk to be compared between scenarios and to other sites. The block size has been selected as a generally representative value based upon the blocks seen adjacent to the road as many were approximately this size, indicating that this is a frequent event volume. This includes assessment of collision with a recently fallen block of rock.

4.1.1 P(H) – Likelihood of hazard

P(H) considers the probability of a hazard reaching the area being considered (e.g. how likely is it that a block will detach from the cliff face and reach the road). This can be calculated using the following equation:

P(H) = pD x pT

Where:
pD = Probability of detachment
pT = Probability of travel

While there is limited data on confirmed rockfall events, due to fresh blocks being present throughout the site area, and anecdotal data from local road users indicating that material is regularly cleared from the road, values of between 1 and 10 blocks per annum of the specified size has been selected for this scenario.

Due to the large number of blocks located immediately above and below the road level, it is assumed that a high number of mobilised blocks will reach the road level. For the current scenario a value of 1.0 (the majority of mobilised blocks reaching the road level) has been selected.

These values give a P(H) value ranging between 1 and 10.

Further analysis of block runout in specific areas of the site is currently being undertaken through RAMMS::Rockfall modelling and will be considered for the final risk assessment.

4.1.2 E – Elements at risk

This variable considers the number of elements at risk (i.e. how many people are exposed to the risk). For the considered rockfall scenario, a single person in a car, and 4 people in a car (e.g. a family on holiday) have been considered.

4.1.3 V – Vulnerability of elements at risk

This variable considers the likelihood of fatality should an element at risk be impacted by a rockfall in the considered scenario. As it is assumed that road users will be in a car there is likely a low chance of a fatality occurring, therefore a value of 0.01 has been selected.

Vulnerability is likely to be variable due to a number of factors such as the age and health of road users, the vehicle they are travelling in, and the speed that they are travelling at with elderly people, those in more exposed vehicles such as motorcycles, and those travelling at a greater speed having a higher vulnerability.

4.1.4 Ex - Exposure

This variable considers the exposure of an element at risk to the considered rockfall hazard.

This section of the B8035 is designated national speed limit, however due to the width of the road it is likely that vehicles will be moving slower than this. Local road users familiar with the road are likely to be driving significantly faster than tourists unfamiliar with the area.

A speed of 30 mph has been chosen for this scenario. At this speed a standard car will have a stopping distance of 23 m (The AA, 2024) and will cross the 100m of road being considered in 75 seconds. This results in a spatial probability of 0.023, and a temporal probability of 2.36×10^{-6} per year.

Argyle and Bute Council traffic monitoring recorded 330 vehicles using the road daily on average during June 2022. While this likely represents a peak in road usage, at similar vehicle volumes this results in 120450 traffic movements per year.

4.1.5 Preliminary calculation of risk

The health and safety executive considers risk of fatalities below $1\text{x}10^{-6}$ per annum to be broadly acceptable to the public and workers. Risk above this is considered to be tolerable only if interventions to decrease the risk level is impractical or the cost to implement interventions is extremely disproportionate to the risk reduction. As shown in Figure 4-1, this level of risk is also referred to as the ALARP zone or as low as reasonably practicable. Risk levels above $1\text{x}10^{-4}$ is considered unacceptable and intervention to reduce the risk is required.

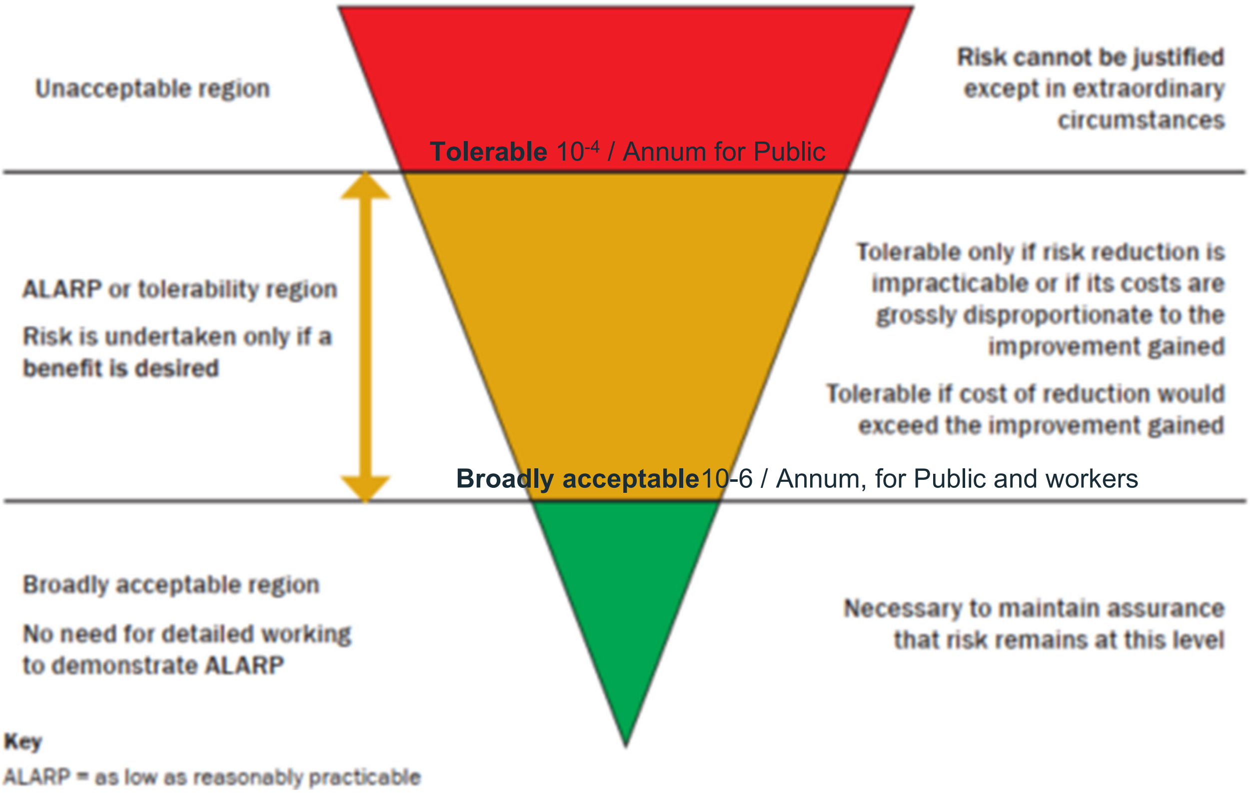

Figure 4-1 - Risk tolerability and the ALARP concept (modified from HSE, 1992)

For the considered scenario, the risk to road users has been calculated to be between 6.55×10^{-5} and 2.62×10^{-3}. This places the risk between the ALARP region and the unacceptable region and means that intervention to reduce the risk to road users to a more tolerable level is required.

Figure 4-2 shows the relationship between blockfall numbers and occupancy numbers on the risk tolerability rating.

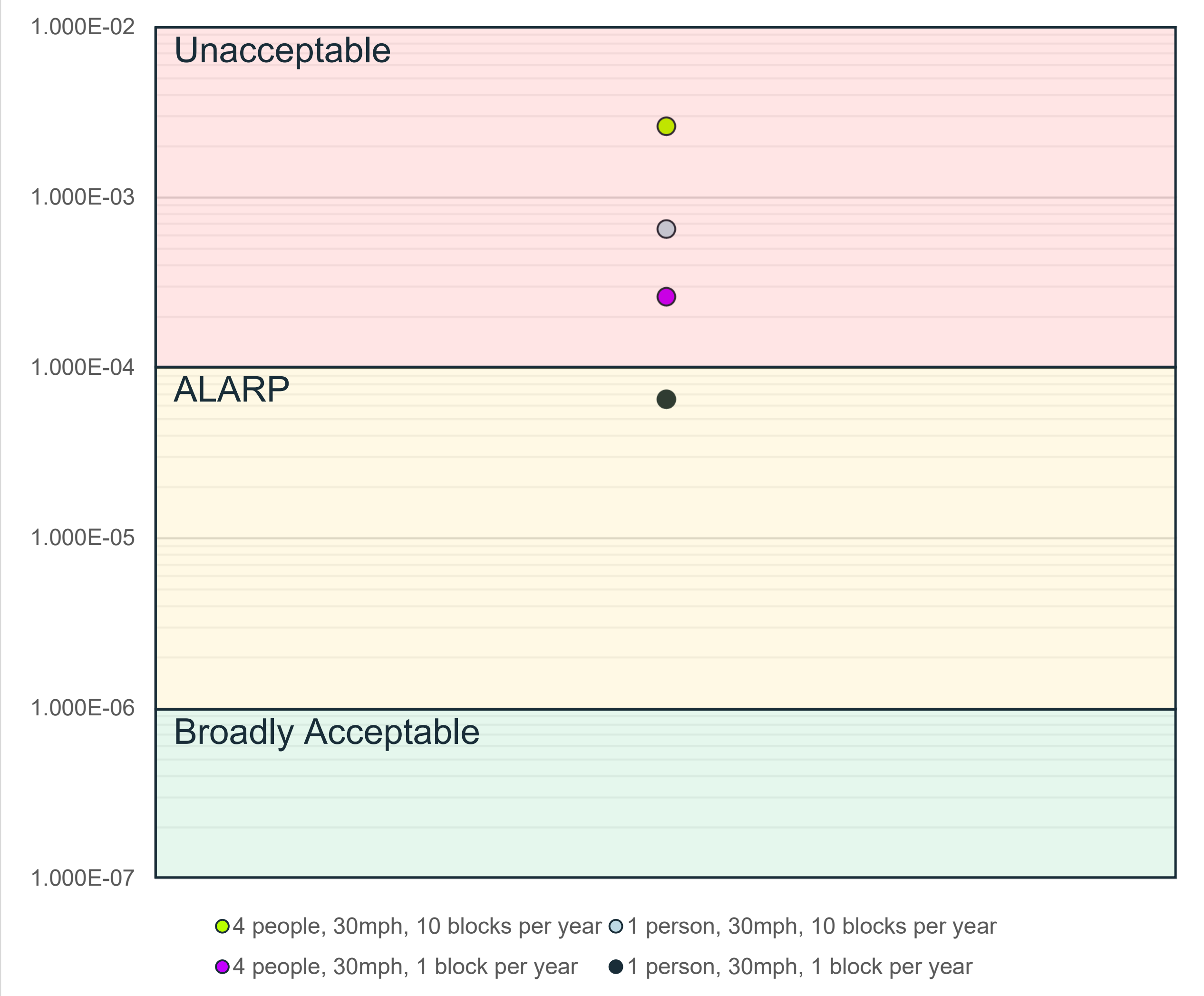

Figure 4-2 - Sensitivity analysis of risk zones at various occupancies and blockfall numbers

5. Interim conclusions and recommendations

Our interim assessment, prior to modelling concludes that the current level of risk posed to users of the B8035 within the considered site area is classified as unacceptable. Therefore, before the road can be re-opened to the public mitigation measures must be put in place to reduce the level of risk to an tolerable level.

As stated in CIRIA C810 (Koe, et al., 2023), mitigation strategies fall into two broad categories: management measures and engineering works. Avoidance measures such as closure of the road to the public, except for access to local properties, would allow for the overall risk to be lowered due to the significant reduction in traffic reducing the total exposure to rockfall risk. Inspection of the rock face and scaling of loose and overhanging blocks would reduce risk by reducing the number of rockfall events impacting the road. However, due to the scale of the site this option would be challenging.

Engineering interventions such as rock bolting of loose blocks, barriers, or the use of mesh to control material falling from the face would reduce the risk by reducing the frequency of rockfall reaching the road. However, due to the large scale of the rock faces on site, these solutions are likely to take a significant amount of time to implement at significant expense. Further assessment of potential remedial options and a cost-benefit analysis will be presented within the final options report.

The next report will deliver a final risk assessment, incorporate results from ongoing rockfall runout modelling concentrated in the area where a large rockfall occurred recently and further potential failures have be identified, and present an appraisal and cost-benefit analysis of mitigation strategies.

6. References

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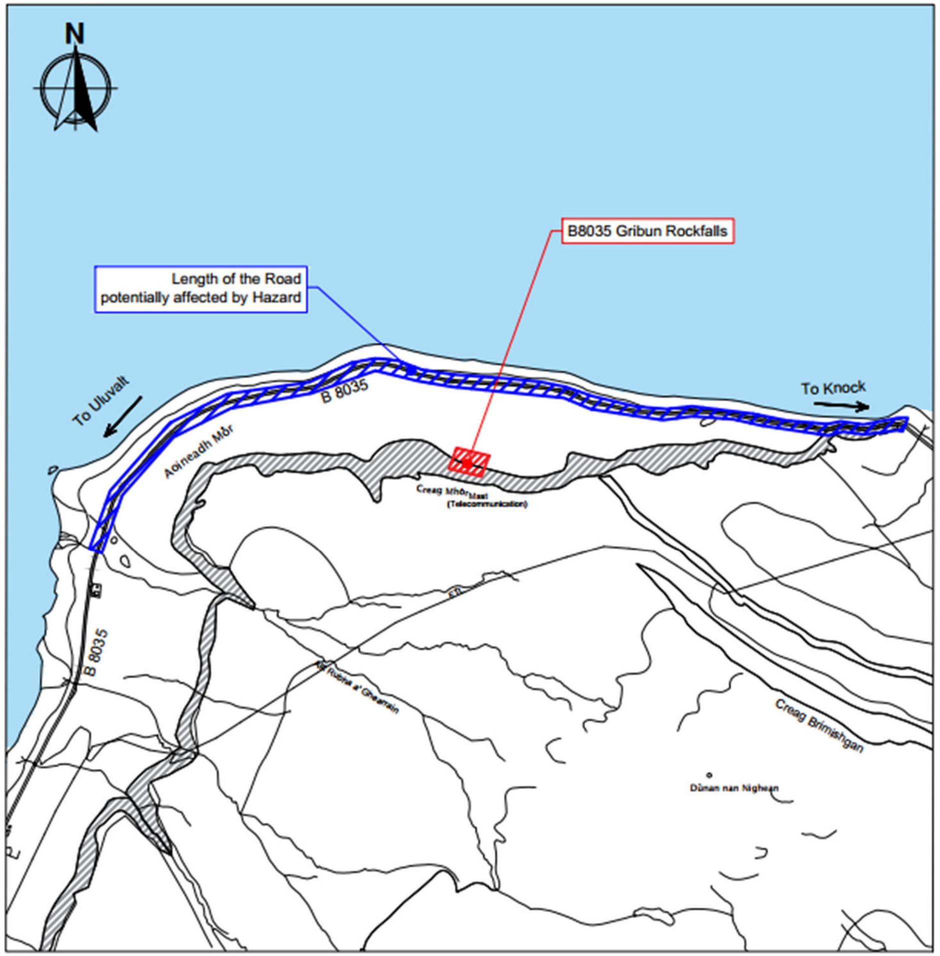
APPENDICES

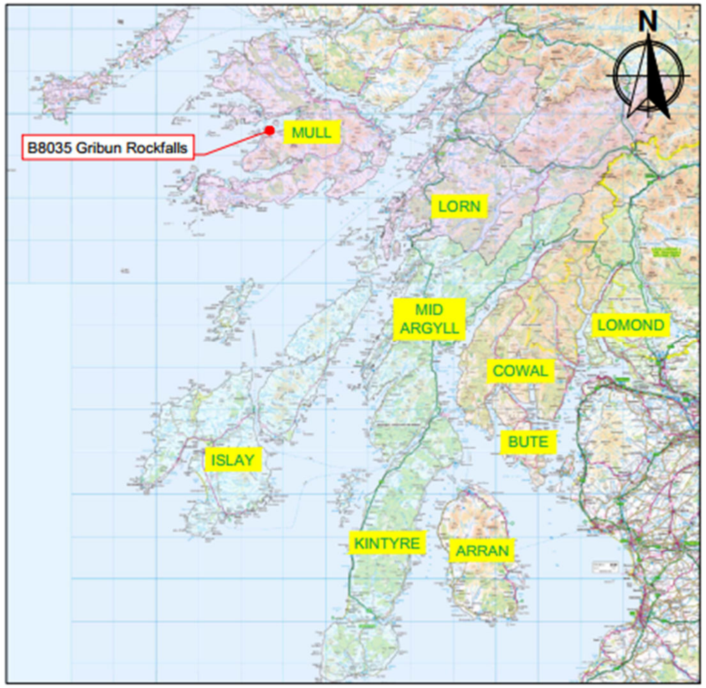
Appendix A. Site Location

ARGYLL & BUTE COUNCIL --- DEVELOPMENT AND INFRASTRUCTURE SERVICES



Location Plan

Scale 1: 1000



Supplementary Location Plan

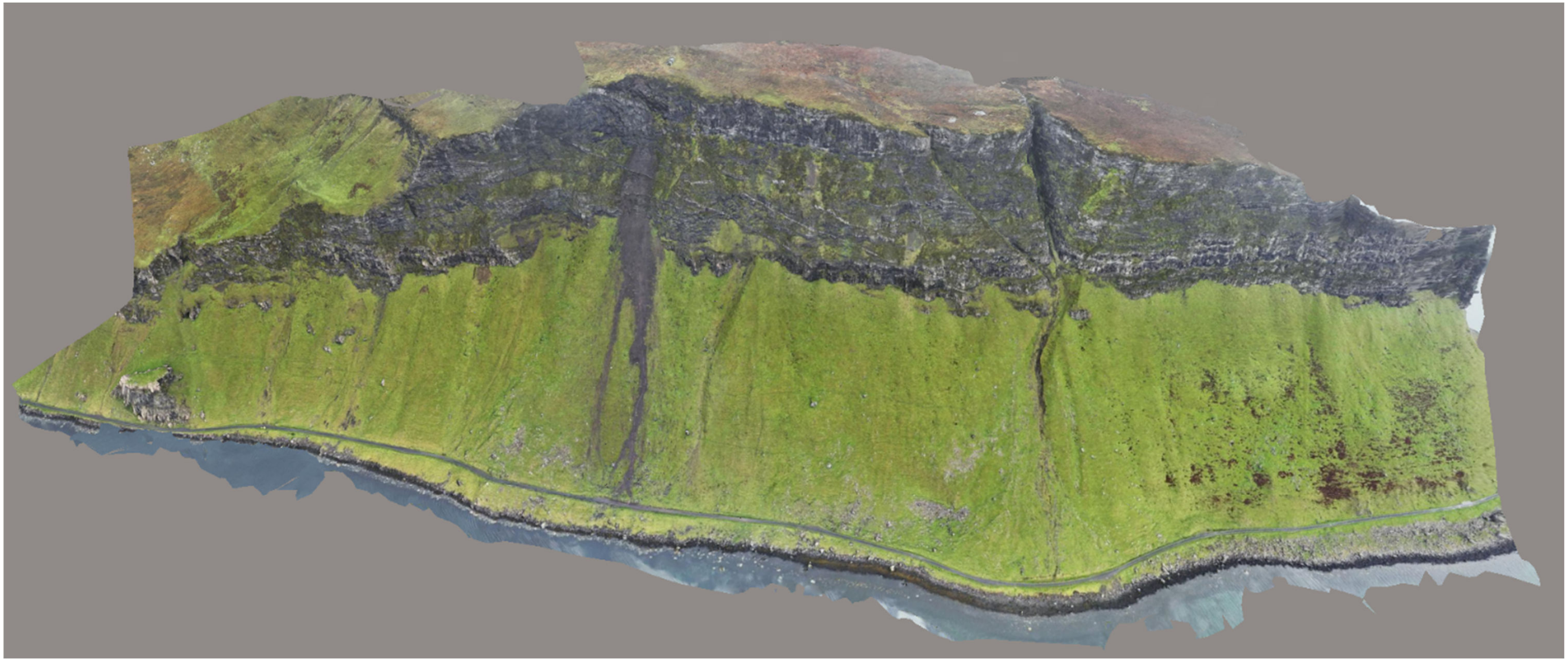
Not to Scale

Location	
Easting	146567
Northing	736174

TITLE	B8035 Gribun Rockfalls Location Plan
	INFRASTRUCTURE DESIGN, MANSE BRAE, LOCHGILPHEAD, ARGYLL,PA31 8RD
Head of Roads and Infrastructure Services	Andrew Summers
DESIGNED BY	JS
DRAWN BY	RR
CHECKED BY	JS
APPROVED BY	JS
DATE	01/09/2025
DRAWING NUMBER:	00011-028-001
SCALE:	As Shown @ A3

Argyll & Bute COUNCIL

Appendix B. Drone Model



AtkinsRéalis

Craig Parry
AtkinsRéalis UK Limited
2 Atlantic Square
York Street
Glasgow
G2 8NJ

craig.parry@atkinsrealis.com