A890 Maman Hill

Annual Slope Inspection Report 2023

The Highland Council

Project number: 60658712
AECOM Report Ref: GLRP0004

15 June 2023

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
Jennifer Greenhill Engineering Geologist	Martha Taylor Associate Director	Peter Morgan Associate Director	Peter Morgan Associate Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position

Distribution List

# Hard Copies	PDF Required	Association / Company Name
0	Y	The Highland Council

Prepared for:

The Highland Council

Prepared by:

AECOM Limited
2nd Floor
177 Bothwell Street
Glasgow G2 7ER
United Kingdom

T: +44 141 202 0500
aecom.com

Table of Contents

1. Introduction

1.1 General

AECOM Limited (AECOM) was appointed by The Highland Council (THC) on 29th April 2022 (THC letter ref. YEHAS6098) to undertake annual inspections of rock faces along part of the A890 in Wester Ross in the Scottish Highlands. The main site extends between the properties of Attadale and Ardnarff, known locally as the Stromeferry Bypass, but also includes rock slopes to the north of Attadale at Maman Hill that form the subject of this report. The works were commissioned under the Scotland Excel Framework for Engineering and Technical Consultancy Services: Ref. 0820 – A890 Stromeferry Bypass Rockworks, Job No: YEHAS6098 which runs until 2026.

AECOM (formerly URS) first undertook a detailed inspection of the slopes between Ardnarff and Attadale in May 2012. AECOM first undertook additional inspections of the slopes located alongside the A890 to the immediate north of Attadale (on Maman Hill) in April 2019 following discussions with THC on the potential risk associated with other rock slopes beyond the extents of the Attadale to Ardnarff section of the A890. It is not known if these rock slopes were subject to earlier inspections and/or risk assessments, although the localised presence of rock fall netting suggests a potential risk had been identified at this location in the past.

Applying the same risk assessment methodology as used on the Stromeferry Bypass between Attadale and Ardnarff, one very high risk slope and one high risk slope were identified within the Maman Hill site in 2019. It was therefore recommended that a similar risk management approach to that currently in place for the slopes between Attadale and Ardnarff be adopted, including monthly inspections by THC and annual inspections by suitably qualified and experienced engineering geologists. The last annual inspection was carried out in June 2022 and reported in AECOM report 60658712, 'A890 Maman Hill, Annual Slope Inspection Report, 30 August 2022'.

This report summarises the findings of the 2023 inspection. The report objectives are to:

- Provide a summary of any significant events that have occurred at the site since the 2022 annual inspection;
- Present the findings of the 2023 inspection, including comment on the condition of the rock slopes and any existing remedial measures;
- Comment on the level of risk associated with the rock faces; and
- Provide recommendations for ongoing management and risk reduction, where appropriate.

1.2 Background

The site is located along the A890 between approximately 130m and 600m north of Attadale Station (between National Grid References (NGRs) 192443 839288 and 192616 839683. A site location plan is included in Appendix A.

Within the site extents the A890 is single carriageway and rises steeply from approximately 5m above ordnance datum (AOD) in the south to approximately 55m AOD in the north. The road is located on sidelong ground with a series of predominantly man-made rock slopes ranging in height from 2m to 20m on the upslope (eastern) side of the road.

At the southern extent of the site the road runs adjacent to the railway, which continues around the coastline of Loch Carron as the road rises up the slopes of Maman Hill. The land between the road and the railway is undeveloped heath and woodland, whilst the land immediately upslope of the road comprises a commercial forestry plantation. No surface water flows or groundwater flows were observed within the site, however it should be noted that groundwater levels may vary owing to seasonal or other effects.

The construction of the A890 in the 1960s involved the widening of an existing track / road at Maman Hill and the creation / widening of several rock slopes along the eastern (upslope) side of the road. It is considered that over-blasting during construction resulted in the rock cutting slopes being left in a

fractured state prone to rock falls. These conditions have also left the exposed rock mass susceptible to weathering, frost and root action.

Further details on the site history and geology are included in the 2019 inspection report[1]. The site has no environmental or historical designations, and AECOM is not aware of any ecological constraints affecting the site. This should, however, be confirmed during the planning of any physical works.

1.3 Works Since the 2022 Inspection

1.3.1 THC Inspections

The ongoing management of the slopes alongside the A890, including at Maman Hill, involves the completion of daily 'drive through' inspections and more detailed monthly 'walk through' inspections by local THC personnel familiar with the site. Any new slope movements or hazards are reported directly to AECOM. The THC inspections have not recorded changes to the slopes at Maman Hill between June 2022 and April 2023.

1.3.2 Maintenance / Remedial Works

AECOM is not aware of any work having been carried out on the slopes at Maman Hill since the June 2022 inspection.

[1] AECOM report 60598147, 'A890 Maman Hill, Rock Slope Inspection Report, 26 July 2019'.

2. 2023 Inspection and Risk Assessment Methodology

A team of three AECOM geologists inspected the rock slopes at Maman Hill on the 17th April 2023. The weather during the inspection was mild, dry and sunny.

During the 2019 inspection, a local chainage system was established and the rock slope was divided into six zones of similar rock slope geometry, slope bearing and rock mass structure (referenced Slopes M1 to M6). Chainage 0 was positioned opposite the northern end of the layby at the top of the hill (NGR 192616 839683). The chainage system and the approximate location and extent of each rock slope zone are shown on Figure 2 in Appendix B.

Each zone of the rock slope was inspected from road level with the aim of identifying potential instability issues and changes since the 2022 inspection that may require further investigation (e.g. using rope access techniques). Traffic management was provided by Alba Traffic Management Ltd. (a sub-contractor of Geo-rope Ltd.) for the duration of the inspection.

The risk assessment approach adopted to rank the relative rock fall risk presented by each slope to the road and its users is detailed below. This is the same methodology used to assess the slopes along the nearby Ardnarff to Attadale section of the Stromeferry Bypass. The relative risk level for each slope at Maman Hill is therefore directly comparable to those for the slopes between Ardnarff and Attadale.

The risk assessment considers the size of a potential rock fall (the hazard), the potential likelihood of debris from the rock fall reaching the carriageway (the pathway) and the available sighting distance on the carriageway (the receptor). The ratings assigned to each of these criteria are multiplied together to give a risk rating. Further details are provided in Sections 2.1 to 2.4.

The potential consequence of a rock fall will clearly vary depending on the presence/absence of road users beneath or approaching the slope at the specific time. It must be appreciated that due to the number or variables involved this is impossible to predict. It should be recognised that the assigned level of risk takes a conservative approach and assumes the potential presence of road users beneath or approaching the slope at the time of rock fall. A more likely scenario is that a rock fall occurs when no road users are directly beneath and fallen blocks which have come to rest on the road present a hazard to road users after the event. To differentiate and risk rank the slopes, (e.g. to prioritise remedial works) sightlines and stopping distances are also factored in to the assessment to recognise the higher potential for road users to interact with rock fall debris on the road at locations with poorer sightlines as opposed to straight sections of road (see section 2.3).

Following the initial risk assessment the inspecting geologists reviewed the relative risk rankings and, where necessary, adjusted the scoring to reflect the overall setting and their professional judgement.

2.1 Hazard Rating

Four categories of hazard rating have been selected based on the main sizes of rock falls (and potential rock falls) identified at the site, as detailed in Table 2-1. During the risk assessment the hazard rating representative of the scale of observed or potential rock falls at each slope was selected.

Table 2-1: Hazard Rating

Hazard Rating	Description
1	Small ravelling type rock falls (typically up to 0.02m^3).
2	Moderate rock falls (typically between 0.02m^3 and 1m^3).
3	Large rock falls (typically between 1m^3 and 10m^3).
4	Very large rock falls (typically greater than 10m^3)

2.2 Pathway Rating

Each slope has been assigned a pathway rating (Table 2-2) based upon a qualitative inspection of the slope form (height, angle, profile/roughness, vegetation cover, and presence or absence and suitability of existing remedial measures) between the position of a potential rock fall and the road. The rating also

takes into account an estimated termination location of fallen material. If debris from previous rock fall events was evident, the location of this was considered during this assessment.

Table 2-2: Pathway Rating

Pathway Rating	Description
1	No falling blocks are expected to reach the road (e.g. effective remedial measures and/or a wide verge or rock trap ditch).
2	Most falling blocks are not expected to reach the road (e.g. largely effective remedial measures/verge/rock trap ditch).
3	Approximately half of the falling blocks are expected to reach the road (e.g. partially effective remedial measures/verge/rock trap ditch).
4	Most falling blocks are expected to reach the road (e.g. no or ineffective remedial measures and/or narrow verge/shallow rock trap ditch).
5	All falling blocks are expected to reach the road (e.g. no or ineffective remedial measures and no verge or rock trap ditch - fallen blocks are likely to free fall or bounce directly onto the road).

2.3 Receptor Rating

For slopes with pathway ratings of ≥2 (i.e. at least some blocks are expected to reach the road), a receptor rating is included in the assessment to reflect the potential of a vehicle coming into contact with, or having to take action to avoid, rock fall debris. The minimum sighting distance that a driver would have when driving adjacent to each of the slopes (in good weather conditions and during daylight hours) was estimated based on stopping distances from the Highway Code for cars travelling at 40mph and 60mph (36m and 73m respectively).

Table 2-3: Receptor Rating

Receptor Rating	Description
1	Sighting distance > 73m
1.2	Sighting distance 36 to 73m
1.4	Sighting distance < 36m

2.4 Risk Rating

The ratings assigned to the hazard, pathway and receptor were multiplied to give a risk rating for each of the slopes. The relative risk levels are described in Table 2-4, along with the colour coding used to depict these.

Table 2-4: Risk Rating

Risk Rating	Relative Risk Level	Description
<5	Low	Small to moderate sized rock falls with a low probability of causing damage to or closure of the road and/or injuries to road users. Risk normally acceptable.
5 to <10	Moderate	Moderate sized rock falls with potential to cause moderate damage to road and short term road closures (a few hours) but a low probability of causing injuries to road users. Risk likely to be tolerable but client needs to be made aware of hazards and monitor these.
10 to <15	High	Moderate to large sized rock falls with a higher probability of causing major damage to the road and/or road closures of a few days to a few weeks and potential of causing major injury or loss of life should road users be present beneath (or approaching) slope at time of rock fall. Risk likely to require remedial measures / risk management actions.
>=15	Very High	Large to very large rock falls which have a high probability of causing significant damage to road and/or long term road closures (weeks to months) and the potential of resulting in major injury or loss of life should road users be present beneath (or approaching) slope at time of rock fall. Risk likely to require remedial measures.

3. Inspection and Risk Assessment Findings

3.1 Summary of Findings: Geotechnical Assessment Sheets

A Geotechnical Assessment Sheet for each slope reference is provided within the following sections of this report. They include the inspection findings and a summary of the slope risk rating. Within the Geotechnical Assessment Sheets, photo references are provided for key observations identified during the inspection. Each photo has a unique reference number which relates to the slope reference; for example, photos of features from slope reference M1 are referenced as ‘M1-1, M1-2, M1-3’ etc. The photographs are provided in Appendix C.

3.1.1 Slope Ref. M1

GEOTECHNICAL ASSESSMENT SHEET											
Site:	A890 Maman Hill	**Slope Ref:**	M1	**Chainage:**	015 - 075	**Start Grid Ref:**	NG 92612 39681	**End Grid Ref:**	NG 92572 39636	**Elevation:**	ca. 50 - 55m AOD

Photo at Start Chainage (looking west)	**Photo at End Chainage (looking east)**
	

Rock Slope Characteristics:							
Dip (°): 70	Azimuth (°): 310	Height (m): 7	Length (m): 60	Vegetation Cover: 30% of slope covered in heather and grass. Trees along crest.	Ditch Details: No ditch	Roughness: Rough	Verge Width (m): 0.9

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	**Location**	**Purpose**
N/A		

THC Monthly Inspection Observations:		
Date	**Location**	**Comments**
N/A		

Existing netting or other remedial work details:				
Year of Works	**Description of Works**	**Comments**	**2023 Inspection Observations**	**Photo Reference**
Unknown. Pre-dates AECOM's first involvement in the A890 Stromeferry Bypass in 2012.	Localised chain-link drape netting between Ch 030 to 070.	Netting covers c.65% of slope (anchorages have not been inspected). The netting is highly corroded and locally damaged and should be considered ineffective.	No change noted during the 2023 Inspection	M1-1

Hazards Observed:			
Location	**Description of Hazard (s) from Previous Inspections**	**2023 Inspection Observations**	**Photo Reference**
Throughout M1	**2019 Inspection:** Small scale (<0.01m^3) ravelling type rock falls likely as rock mass continues to weather.	There are a few dilated blocks behind the netting (between Ch. 030 to 070) which look keyed in – could benefit from scaling.	N/A
Throughout M1	**2019 Inspection:** Semi-mature coniferous trees growing at crest have potential to cause root jacking (e.g. Ch. 018)	No change noted during the 2023 Inspection	N/A
Ch. 018	**2022 Inspection:** Trees at crest of slope presenting risk of root-jacking. Approx. 6 blocks c.2m x 0.1m x 0.1m are in the verge.	No change noted during the 2023 Inspection	N/A

Ch. 020	**2022 Inspection:** Block (c.2m x 1m x 1.5m) with dilated back fracture (low risk due to presence of verge)	No change noted during the 2023 Inspection	M1-2

Other Comments:
No surface or groundwater flows. Rock mass generally in good condition, although dilated fractures noted locally. Potential for kinematic failure is low. Based on the current condition of the rock slope and the presence of a 0.9m verge at the toe of the slope the likelihood of debris from a rock fall landing on the road is considered to be relatively low.

RISK RATING		**Comments**
Hazard Rating =	2	Generally limited to small scale ravelling although locally potential for larger block fall(s) associated with root jacking. Block size not expected to exceed 1m^3.
Pathway Rating =	2	Most rock fall debris likely to land in verge.
Receptor Rating =	1.2	Minimum sightline 45m.
Risk Value =	**4.8**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions		
Large Scale Rock Fall Protection Works (Category 3)	**Localised Targeted Rock Fall Protection Works (Category 2)**	**Ongoing Maintenance (Category 1)**
N/A	N/A	- Re-inspection by end of April 2024 - Felling of trees along crest - Scaling of loose rock behind netting (between Ch. 030 to 070)

Assessed in field by:	MT/JG/PLM	**Date:**	17/04/2023	**Reviewed by:**	PLM	**Date:**	15/06/2023

3.1.2 Slope Ref. M2

GEOTECHNICAL ASSESSMENT SHEET													
Site:	A890 Maman Hill	**Slope Ref:**	M2	**Chainage:**	200 - 280	**Start Grid Ref:**	NG 92536 39506	**End Grid Ref:**	NG 92513 39431	**Elevation:**	ca. 30 - 35m AOD		

Photo at Start Chainage (looking east)	**Photo at End Chainage (looking west)**
	

Rock Slope Characteristics:									
Dip (°):	60	Azimuth (°):	305	Height (m):	2	Length (m):	80	Vegetation Cover:	95% of slope covered in heather and grass and semi-mature trees.
Ditch Details:	0.5m deep, 1m wide ditch.	Roughness:	Rough	Verge Width (m):	1				

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	**Location**	**Purpose**
N/A		

THC Monthly Inspection Observations:		
Date	**Location**	**Comments**
N/A		

Existing netting or other remedial work details:				
Year of Works	**Description of Works**	**Comments**	**2023 Inspection Observations**	**Photo Reference**
N/A				

Hazards Observed:			
Location	**Description of Hazard (s) from Previous Inspections**	**2023 Inspection Observations**	**Photo Reference**
Throughout M2	**2019 Inspection:** Small scale (<0.02m^3) ravelling / root jacking rock falls likely as rock mass continues to weather. However, ditch and verge at toe are considered effective and the associated likelihood of debris reaching the road is therefore low.	No change noted during the 2023 Inspection	
Ch. 226 to 235	N/A	Ditch has been locally damaged by vehicle going off road. Maintenance works not required as ditch is not below an area of significant rock fall hazard.	M2-1

Other Comments:
No surface or groundwater flows. Isolated low height (2m max) rock exposures. Rock mass generally in good condition, although dilated fractures noted locally. Potential for kinematic failure is low. No debris at toe or other evidence of previous rock falls at this location. Presence of effective ditch and verge.

RISK RATING		Comments
Hazard Rating =	1	Generally limited to small scale ravelling.
Pathway Rating =	1	Ditch considered effective.
Receptor Rating =	N/A	Receptor rating only applicable when pathway rating is ≥2.
Risk Value =	**1**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions		
Large Scale Rock Fall Protection Works (Category 3)	**Localised Targeted Rock Fall Protection Works (Category 2)**	**Ongoing Maintenance (Category 1)**
N/A	N/A	- Re-inspection by end of April 2024

Assessed in field by:	MT/JG/PLM	**Date:**	17/04/2023	**Reviewed by:**	PLM	**Date:**	15/06/2023

3.1.3 Slope Ref. M3

GEOTECHNICAL ASSESSMENT SHEET													
Site:	A890 Maman Hill	**Slope Ref:**	M3	**Chainage:**	280 - 330	**Start Grid Ref:**	NG 92513 39431	**End Grid Ref:**	NG 92469 39371	**Elevation:**	ca. 25 - 30m AOD		

Photo at Start Chainage (looking east)	**Photo at End Chainage (looking west)**
	

Rock Slope Characteristics:									
Dip (°):	65	Azimuth (°):	300	Height (m):	4 to 8	Length (m):	50	Vegetation Cover:	25% of slope covered in heather, grass and occasional small trees. Trees along crest.
Ditch Details:	0.4 to 0.75m deep, 1.2m wide.	Roughness:	Rough	Verge Width (m):	1				

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	**Location**	**Purpose**
N/A		

THC Monthly Inspection Observations:		
Date	**Location**	**Comments**
N/A		

Existing netting or other remedial work details:				
Year of Works	**Description of Works**	**Comments**	**2023 Inspection Observations**	**Photo Reference**
December 2020	Tree felled by THC at Ch. 304	There was a large fir tree growing from crest of rock face. Risk of root-jacking and potential rock fall volume up to 0.5m³.	No change.	N/A

Hazards Observed:			
Location	**Description of Hazard (s) from Previous Inspections**	**2023 Inspection Observations**	**Photo Reference**
Throughout M3	**2019 Inspection:** Numerous small scale (<0.02m^3) ravelling type rock falls observed, some of which were deemed to be imminent (i.e. readily dislodged by hand).	No change noted during the 2023 Inspection	
Throughout M3	**2019 Inspection:** Localised overhangs with potential for rock fall of unsupported blocks. Individual block size typically <0.1m^3 (e.g. at Ch. 311)	No change noted during the 2023 Inspection	M3-1
Ch. 304	N/A	Rock mass beneath tree exhibiting root-jacking potential	M3-2

Other Comments:
No surface or groundwater flows.

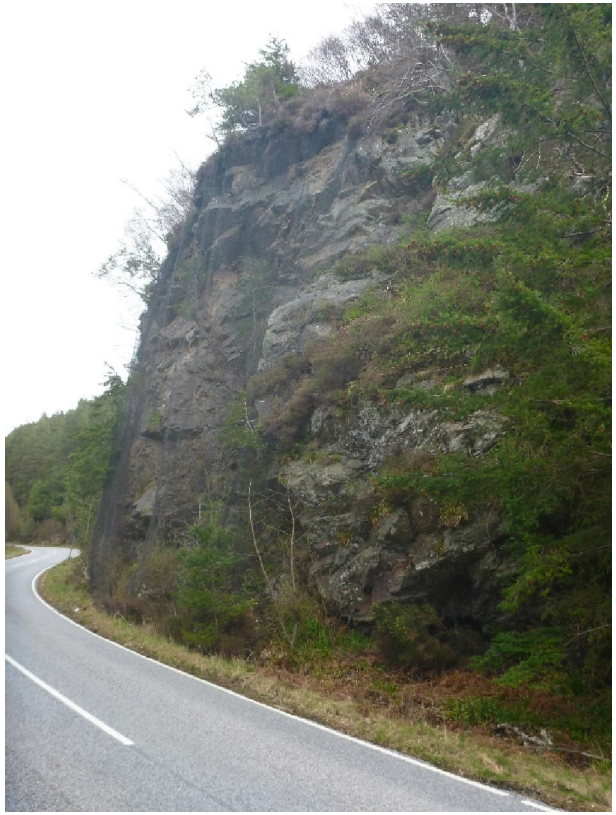
Rock mass generally in good condition, although dilated fractures associated with blast damage and root jacking noted locally. Potential for kinematic failure is low but ravelling, root jacking and block falls from above overhangs possible. Maximum rock fall size 0.5m^3. Ditch and verge likely to retain debris from most small scale rock falls. Occasional blocks observed at toe – typical dimensions 0.1 x 0.1 x 0.1m.

RISK RATING		**Comments**
Hazard Rating =	2	Generally limited to small scale ravelling although locally potential for larger block fall(s) associated with root jacking. Rock fall volume not expected to exceed 0.5m^3.
Pathway Rating =	2	Most rock fall debris likely to land in ditch verge.
Receptor Rating =	1.2	Minimum sightline 60m.
Risk Value =	**4.8**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions							
Large Scale Rock Fall Protection Works (Category 3)		**Localised Targeted Rock Fall Protection Works (Category 2)**		**Ongoing Maintenance (Category 1)**			
N/A		N/A		- Re-inspection by end of April 2023 - Fell trees along crest			
Assessed in field by:	MT/JG/PLM	**Date:**	17/04/2023	**Reviewed by:**	PLM	**Date:**	151/06/2023

3.1.4 Slope Ref. M4

GEOTECHNICAL ASSESSMENT SHEET											
Site:	A890 Maman Hill	**Slope Ref:**	M4	**Chainage:**	335 - 395	**Start Grid Ref:**	NG 92469 39371	**End Grid Ref:**	NG 92452 39339	**Elevation:**	ca. 15 - 20m AOD

Photo at Start Chainage (looking east)	**Photo at End Chainage (looking west)**
	

Rock Slope Characteristics:									
Dip (°):	80	Azimuth (°):	300	Height (m):	4 to 15	Length (m):	60	Vegetation Cover:	15% of slope covered in heather, grass and occasional small trees.
Ditch Details:	0 to 0.4m deep, 0 to 1m wide.	Roughness:	Rough	Verge Width (m):	0.5 to 1				

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:

Year of Rope Access Inspection	Location	Purpose
2019	Ch. 370 to 380	Rope access inspection carried out to assess potential hazards identified from road level behind netting. Findings – A number of hazards were identified including: a significant overhang (1.6m) c.3-5m below crest, a dilated sliding plane with 1.5m high x 2.5m wide x 1.5m deep block c.10m above road level, a block with dilated back fracture c.8m above road level at Ch. 378 and areas of blast damaged rock mass. Additionally, the netting was confirmed to be plastic 'geogrid' and adjacent panels are not attached.
2021	Ch. 370	Rope access inspection carried out to re-assess previously identified hazards. Condition remains unchanged.
2021	Ch. 374	Rope access inspection carried out to assess overhang at crest. Findings - Overhang observed to be 1.0-1.3m with a dilated fracture along the left hand side. "Supporting block" on 58° sliding plane with dilated fracture. Root jacking potential from trees at crest. Two loose blocks were removed by hand during the rope access inspections to make safe. Total volume ca. 0.25m^3.

THC Monthly Inspection Observations:

Date	Location	Comments
N/A		

Existing Netting Details or other remedial work details:				
Year of Works	**Description of Works**	**Comments**	**2023 Inspection Observations**	**Photo Reference**
Unknown. Pre-dates AECOM's first involvement in the A890 Stromeferry Bypass in 2012.	Chain-link netting installed between Ch. 360 to 375.	Netting is corroded and damaged and should be considered ineffective for the retention of anything but the smallest blocks (anchorages have not been inspected).	No change.	N/A
Unknown. Pre-dates AECOM's first involvement in the A890 Stromeferry Bypass in 2012.	Plastic 'geo-grid' style netting between Ch. 375 to 385.	Individual panels un-joined and anchor points have not been inspected. This type of netting is not suitable for the retention of rock falls and should be considered ineffective.	No change.	N/A

Hazards Observed:			
Location	**Description of Hazard (s) from Previous Inspections**	**2023 Inspection Observations**	**Photo Reference**
Throughout M4	**2019 Inspection:** Numerous small scale (<0.02m^3) ravelling type failures observed, some of which were deemed to be imminent (i.e. readily dislodged by hand).	No change noted during the 2023 Inspection	N/A
Ch. 370	**2019 Inspection:** A dilated sliding plane at 50° and with a 1.5m high x 2.5m wide x 1.5m deep block above was observed ca. 10m above road level. Loose rock noted along sliding plane. Risk of ca. 5m^3 plane failure. No ditch and narrow verge so rock fall debris likely to reach road. (Repeat rope access inspection completed in 2021 – no change)	No change noted during the 2023 Inspection	N/A
Ch. 370 to 380	**2019 Inspection:** A large overhang was observed ca. 3-5m below the crest of the rock face, however, joints were observed to be tight and no significant risk of rock fall identified.	No change noted during the 2023 Inspection	M4-1
Ch. 370 to 380	**2019 Inspection:** Several areas of blast damage noted with dilated joints and loose rock observed. No ditch and only a narrow verge present beneath highest section of the rock slope. Debris noted along toe of slope in this area and potential for additional rock falls to occur.	No change noted during the 2023 Inspection	N/A
Ch. 374	**2019 Inspection:** Overhang at crest (1.0-1.3m) with dilated fracture along left hand side. "Supporting block" on 58° sliding plane. Root jacking potential. (Rope access completed in 2021)	No change noted during the 2023 Inspection	N/A

Ch. 378	**2019 Inspection:** Dilated plane observed 8m above road level. Slightly keyed in at left hand side but fractured rock mass ca. 3.5m wide x 0.5m deep x 1m high. Potential for rock fall exists and narrow verge below means this poses a risk to the road.	No change noted during the 2023 Inspection	N/A
Ch. 388	**-**	3 new blocks in ditch up to 0.3m side length.	M4-2

Oher Comments:
No surface or groundwater flows. Rock mass in poor condition with frequent dilated fractures associated with blast damage, weathering and root jacking. Potential for planar failures as well as ravelling, root jacking and block falls from above overhangs. Some small scale ravelling type failures were noted to be imminent with blocks readily dislodge by hand. Ditch and verge likely to retain debris from some small scale rock falls but locally absent / narrow. Occasional blocks observed at toe – typical dimensions 0.1 x 0.1 x 0.1m.

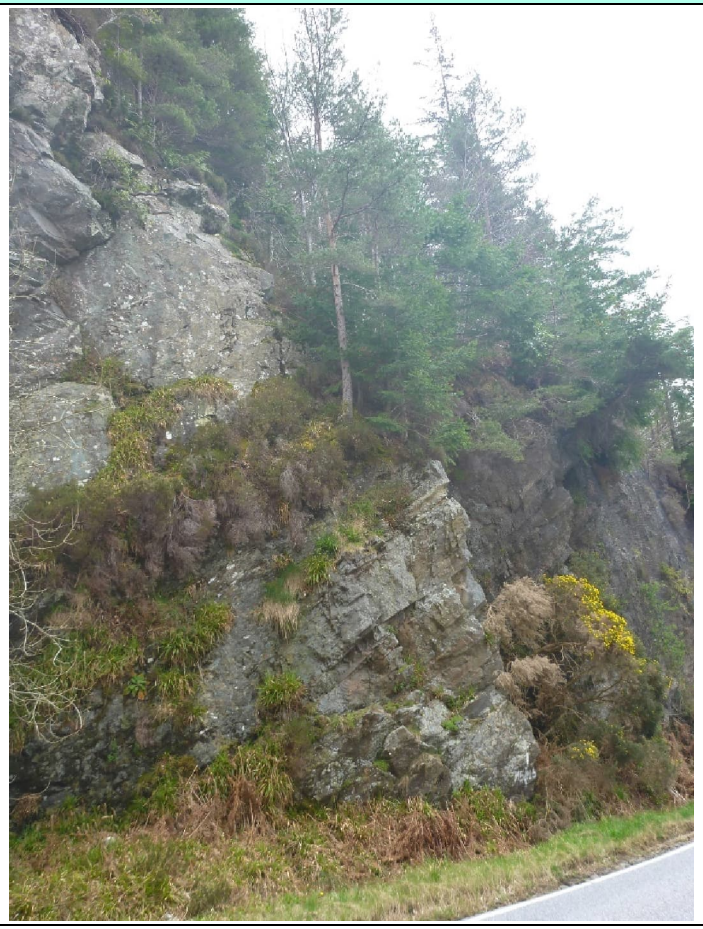
RISK RATING		**Comments**
Hazard Rating =	3	Potential failure volumes up to $5m^3$ identified.
Pathway Rating =	5	Existing remedial measures considered ineffective and there is no ditch and only a narrow verge beneath the largest potential failures. Due to potential rock fall trajectories, all rock fall debris is considered likely to reach road.
Receptor Rating =	1.2	Minimum sightline 60m.
Risk Value =	**18.0**	
Risk Level =	**Very High**	

Recommended Remedial Works / Actions		
Large Scale Rock Fall Protection Works (Category 3)	**Localised Targeted Rock Fall Protection Works (Category 2)**	**Ongoing Maintenance (Category 1)**
- Targeted active netting system over highest section of slope where potential rock falls identified. A potential design solution could be: Install active TECCO netting between Ch. 362 to 395 (starting from end of ditch), which will need to wrap around the gully (so additional 5m of netting); and between Ch. 347 to Ch 362, install drape netting.	N/A	- Full de-vegetation (including felling of trees along crest) and light scaling (will be required as enabling / preparatory works for Category 3 works).

Assessed in field by:	MT/JG/PLM	**Date:**	17/04/2023	**Reviewed by:**	PLM	**Date:**	15/06/2023

3.1.5 Slope Ref. M5

GEOTECHNICAL ASSESSMENT SHEET									
Site:	A890 Maman Hill	**Slope Ref:**	M5	**Chainage:**	395 - 415	**Start Grid Ref:**	NG 92452 39339	**End Grid Ref:**	NG 92445 39309	**Elevation:**	ca. 10 - 15m AOD

Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
	

Rock Slope Characteristics:									
Dip (°):	80 to 90	Azimuth (°):	315	Height (m):	15 to 20	Length (m):	20	Vegetation Cover:	<10% of slope is vegetated. Localised heather and grass. Trees also present at crest.
Ditch Details:	No ditch	Roughness:	Rough	Verge Width (m):	5				

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	**Location**	**Purpose**
2019	Ch. 398	Rope access inspection carried out to assess potential hazards identified from road level. Findings: a detached block 2m x 2 m x 0.7m is open on left hand side and a dilated back release joint. Keyed in on right hand side but difficult to see how well keyed in.
2019	Ch. 405	Rope access inspection carried out to assess potential hazards identified from road level. Findings: c.8-10m above road level there is a dilated crack to rear of green lichen covered block. Keyed in below.
2021	Ch. 400	Rope access inspection of block at crest carried out. Findings: 10-50cm wide release joint around overhanging block.
2021	Ch. 402	Rope access inspection of dilated block ca. 10m above toe of slope. Findings: Basal fracture dips into slope (“keyed in”).

THC Monthly Inspection Observations:		
Date	**Location**	**Comments**
N/A		

Existing netting or other remedial work details:				
Year of Works	**Description of Works**	**Comments**	**2023 Inspection Observations**	**Photo Reference**
N/A				

Hazards Observed:			
Location	**Description of Hazard (s) from Previous Inspections**	**2023 Inspection Observations**	**Photo Reference**
Throughout M5	**2019 Inspection:** Ongoing ravelling. Precarious blocks noted along crest.	No change noted during the 2023 Inspection	N/A
Ch. 398	**2019 Inspection:** Detached block ca. 2m x 2m x 0.7m. Open on left hand side and with a dilated back release joint. Keyed in on right hand side but difficult to see how well. Upper part of right hand side has 70mm dilated joint. Trajectory of block fall hard to predict so doweling may be required to protect road.	No change noted during the 2023 Inspection	N/A
Ch. 400	**2019 Inspection:** Overhanging block at crest with 10-50cm wide dilated release joint.	No change noted during the 2023 Inspection	N/A
Ch. 405	**2019 Inspection:** Column of rock ca. 4-8m above road level. 1.5m wide, 0.5m deep. Potential for rock fall as unsupported but wide verge below likely to prevent debris reaching road.	No change noted during the 2023 Inspection	M5-1
Ch. 407	**2019 Inspection:** Dilated crack to rear of lichen covered block 8-10m above road level. Keyed in below.	No change noted during the 2023 Inspection	N/A

Other Comments:
No surface or groundwater flows. Rock slope set slightly back from road and appears to comprise natural crags rather than a man-made (blasted) rock slope. The slope is locally overhanging and a cave feature is present at the northern end of the slope, possibly a former sea cave. Rock mass generally in good condition with tight fractures but occasionally noted to be very dilated suggesting historical movement. Ongoing ravelling of small blocks is evident, with several precarious blocks observed along the crest of the slope. Localised potential for larger scale rock falls up to around $3m^3$ observed. Wide verge (5m) likely to retain debris from all but the largest of rock falls.

RISK RATING		Comments
Hazard Rating =	3	Potential rock fall volumes up to $3m^3$ identified.
Pathway Rating =	3	Majority of rock fall debris likely to land on roadside verge. Potential for some debris from larger scale rock falls to reach road. Trajectories of rock falls hard to predict due to slope profile so conservative value chosen for pathway rating.
Receptor Rating =	1.2	Minimum sightline 60m.

Risk Value =	**10.8**	
Risk Level =	**High**	

Recommended Remedial Works / Actions							
Large Scale Rock Fall Protection Works (Category 3)		**Localised Targeted Rock Fall Protection Works (Category 2)**		**Ongoing Maintenance (Category 1)**			
N/A		- Installation of spot dowels in individual blocks / area of rock mass at risk of rock falls. Provisionally allow for 20 No. 4m long dowels.		- Re-inspection by end of April 2023			
Assessed in field by:	MT/JG/PLM	**Date:**	17/04/2023	**Reviewed by:**	PLM	**Date:**	15/06/2023

3.1.6 Slope Ref. M6

GEOTECHNICAL ASSESSMENT SHEET									
Site:	A890 Maman Hill	**Slope Ref:**	M6	**Chainage:**	415 - 460	**Start Grid Ref:**	NG 92445 39309	**End Grid Ref:**	NG 92450 39264	**Elevation:**	ca. 5 - 10m AOD

Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
	

Rock Slope Characteristics:							
Dip (°): 80	Azimuth (°): 285	Height (m): 3 to 10	Length (m): 45	Vegetation Cover: 15% vegetation cover – gorse, heather and grass. Trees at crest.	Ditch Details: No ditch	Roughness: Smooth	Verge Width (m): 0.5 to 1

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	**Location**	**Purpose**
N/A		

THC Monthly Inspection Observations:		
Date	**Location**	**Comments**
N/A		

Existing netting or other remedial work details:				
Year of Works	**Description of Works**	**Comments**	**2023 Inspection Observations**	**Photo Reference**
Unknown. Pre-dates AECOM's first involvement in the A890 Stromeferry Bypass in 2012.	Chain-link drape netting installed between Ch 415 to 435.	Corroded and locally damaged. Only effective for small scale ravelling type rock falls.	No change.	N/A

Hazards Observed:			
Location	**Description of Hazard (s) from Previous Inspections**	**2023 Inspection Observations**	**Photo Reference**
Throughout M6	**2019 Inspection:** Ongoing ravelling and root jacking, particularly along crest.	No change noted during the 2023 Inspection	N/A
Ch. 420	**2019 Inspection:** Potential toppling failure identified ca. 6m above road level. Dilated fractures. 0.5-1.0m^3.	No change noted during the 2023 Inspection	M6-1

Ch. 455	**2022 Inspection:** Fallen tree c.3m back from crest of slope. Tree has been cut (unsure when this was completed). Not posing risk to road.	No change noted during the 2023 Inspection	N/A
Ch. 455	**2022 Inspection:** Fresh surfaces at crest of slope indicating recent rockfall. Block not currently in ditch/verge so has been moved. Block anticipated to have been 0.3m x 0.2m based upon fresh surface.	No change noted during the 2023 Inspection	M6-2

Other Comment:
No surface or groundwater flows. Rock mass generally favourable with tight fractures but occasionally noted to be dilated where affected by blasting, weathering and/or root jacking. Potential for kinematic failures is generally low, although localised toppling potential observed (up to $1m^3$). Ongoing ravelling and root jacking of small blocks from crest should also be anticipated. No ditch and only a narrow verge so there is potential for some small blocks to reach road.

RISK RATING		**Comments**
Hazard Rating =	2	Potential rock fall volumes up to $1m^3$ identified.
Pathway Rating =	3	Increased from 2 in 2023 as now expected that half of falling blocks will reach road. Debris from larger potential toppling failure at Ch. 420 may reach road.
Receptor Rating =	1.2	Minimum sightline 60m.
Risk Value =	**7.2**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions							
Large Scale Rock Fall Protection Works (Category 3)		**Localised Targeted Rock Fall Protection Works (Category 2)**		**Ongoing Maintenance (Category 1)**			
N/A		N/A		- Re-inspection by end of April 2024. - Fell trees at crest of rock face and scaling of loose rock			
Assessed in field by:	MT/JG/PLM	**Date:**	17/04/2023	**Reviewed by:**	PLM	**Date:**	15/06/2023

4. Discussion and Recommendations

The inspection of the rock slopes at Maman Hill in April 2023 did not identify any hazards or features posing an immediate risk of rock fall affecting the operation of the road. However, one 'very high' risk slope (M4) and one 'high' risk slope (M5) were identified and, at these slopes in particular, frequent small scale ravelling type rock falls should be anticipated along with the occurrence of occasional larger scale block falls as the rock mass continues to degrade through weathering, root action, etc. The potential for rock fall debris to reach the road, and therefore the relative risk level, is higher at M4 due to the narrow roadside verge.

The assessed risk levels associated with the rock slopes at Maman Hill are ranked from highest to lowest in Table 4-1. It important to note that the risk ratings are relative and that a risk of 'low' does not mean that a rock fall will not occur, but that it is considered that the likelihood and/or consequences of a rock fall is lower than at other locations.

Table 4-1: Relative Risk Level of Slopes

Risk Ranking	Slope Ref.	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level
1	M4	3	5	1.2	18.0	Very High
2	M5	3	3	1.2	10.8	High
3	M6	2	3	1.2	7.2	Moderate
4	M1	2	2	1.2	4.8	Low
	M3	2	2	1.2	4.8	Low
5	M2	1	1	1.0	1.0	Low

Although a form of drape netting is in place over some of the slopes at Maman Hill it is either highly corroded and damaged chain-link netting or plastic 'geo-grid' netting hung over the face (often with no connection between individual panels) i.e. not a product designed for rock fall control. It is not known when the netting was installed but based on the materials used it is likely to have been in place for at least 30 years. Although the netting may control the trajectory of very small blocks (up to cobble size) neither the chain-link netting nor the plastic geo-grid offers sufficient risk reduction to the road from larger blocks.

Given the identified level of risk associated with the slopes at Maman Hill it is recommended that the risk management approach similar to that in place for the slopes between Ardnarff and Attadale be continued. This comprises:

Regular inspections by THC:

THC staff familiar with the site should undertake regular inspections of the rock slopes with the aim of identifying any rock falls / increased risk to the road. Elsewhere along the Stromeferry Bypass (between Ardnarff and Attadale) these inspections involve driving through the site each weekday morning and walking through the site on a monthly basis. Identified issues should be reported internally within THC and advice sought from a suitably qualified and experienced Engineering Geologist / Geotechnical Engineer where appropriate.

Annual inspection by suitably qualified and experienced Engineering Geologists / Geotechnical Engineers:

This should involve the roadside inspection of all slopes and targeted rope access inspections of selected higher risk slopes, particularly where potential hazards have been identified during previous inspections. The next inspection should be carried out in the Spring of 2023, when vegetation cover is at a minimum and rope access inspections are feasible. It is recommended that inspections at height by rope access are carried out at slopes M4 and M5.

Targeted remedial works at the highest risk slopes:

It is recognised that THC has a limited budget for remedial works and to achieve the maximum level of risk reduction it is recommended that works are prioritised to address the highest risk rock faces and hazards in the first instance. AECOM is in regular discussions with THC in relation to the budget and timing of planned remedial works along the A890 such that an appropriate scope of remedial work can be selected.

Appendix A Site Location Plan

Project Management Initials: PLM Designer: MT Checked: MT Approved: PLM

SITE LOCATION

N

AECOM

PROJECT

A890 MAMAN HILL
ROCK SLOPE INSPECTIONS

CLIENT

THE HIGHLAND COUNCIL

KEY:

Approximate Site Boundary

PROJECT NUMBER

60685712

SHEET TITLE

Site Location Plan

SHEET NUMBER

1 of 1

Appendix B Slope Location Plan

Client:	The Highland Council	Project:	A890 Maman Hill Rock Slope Inspections			Title:	Rock Slope Extents
AECOM	AECOM Ltd. 2nd Floor, 177 Bothwell Street Glasgow G2 7ER	Drawn:	MT	Revision:	0	Figure No.:	2
		Designed:	MT				
		Checked:	PLM	Job Number:	60685712	Scale:	NOT TO SCALE
		Approved:	PLM				

Appendix C 2023 Inspection Photographs

Photograph M1-1	Between Ch. 030 to 070 – Chain-link netting is highly corroded.	Year observation first noted: 2019

Photographs taken on 17 April 2023

Photograph M1-2	At Ch. 020 – Block (c.2m x 1m x 1.5m) with dilated back fracture (low risk due to presence of ditch)	Year observation first noted: 2019

Photograph M2-1	Between Ch. 226 to 235 – Ditch has been locally damaged by vehicle off road.	Year observation first noted: 2023

Photographs taken on 17 April 2023

Photograph M3-1	At Ch. 311 – Localised overhangs with potential for rock fall of unsupported blocks.	Year observation first noted: 2019

Photographs taken on 17 April 2023

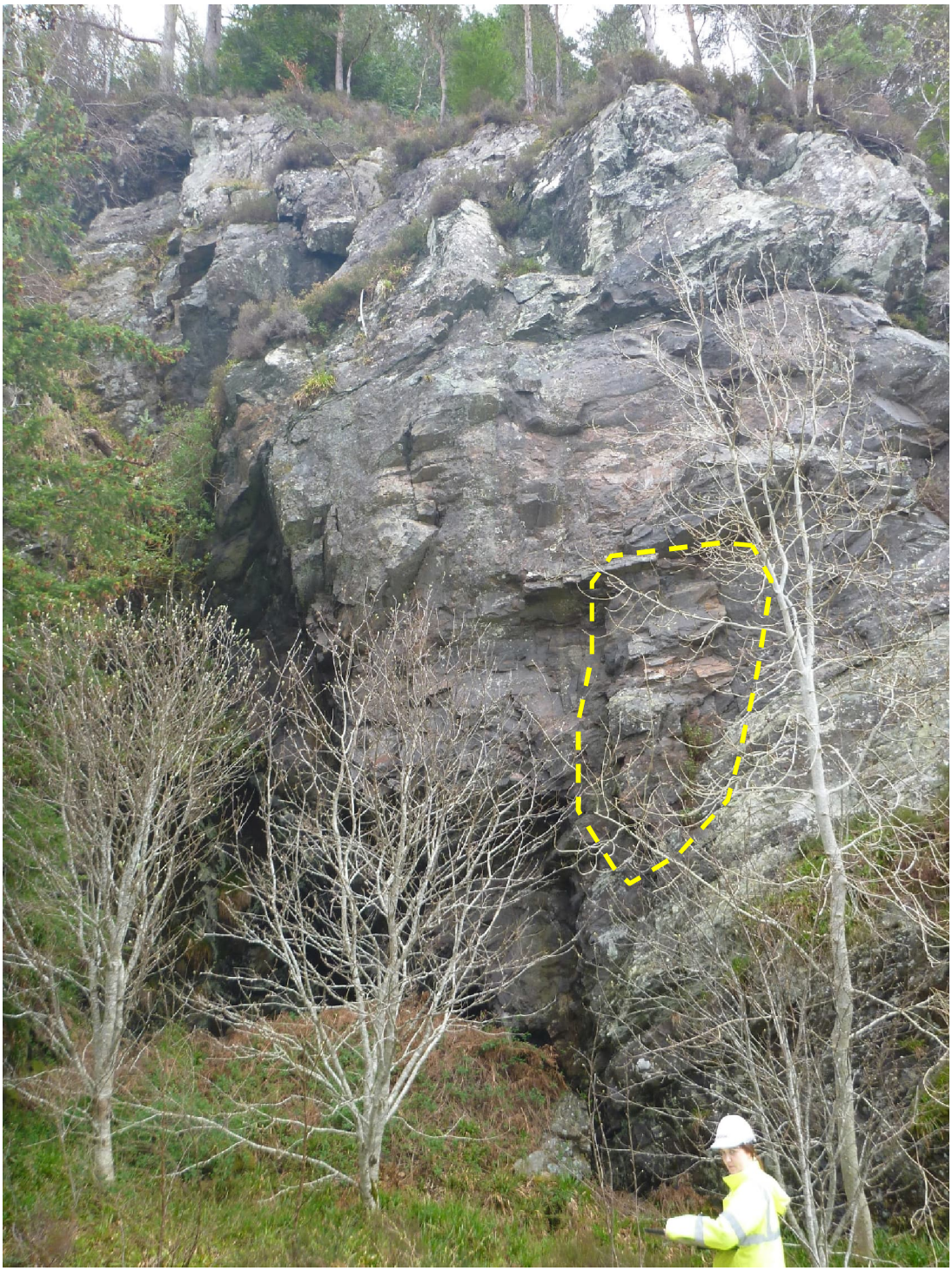
Photograph M3-2	At Ch. 304 – Material beneath tree creating root-jacking potential	Year observation first noted: 2023

Photograph M4-1	General photo of hazardous area at rock slope including the large overhang c.3 to 5m below crest of slope.	Year observation first noted: 2019

Photographs taken on 17 April 2023

Photograph M4-1	At Ch. 388 - 3 new blocks in ditch up to 0.3m.	Year observation first noted: 2023

Photographs taken on 17 April 2023



Photograph M5-1	At Ch. 405 – Column of rock ca. 4-8m above road level. 1.5m wide, 0.5m deep. Potential for rock fall as unsupported but wide verge below likely to prevent debris reaching road.	Year observation first noted: 2019

Photograph M6-1	At Ch. 420 – Potential toppling failure identified ca. 6m above road level. Dilated fractures. 0.5-1.0m^3.	Year observation first noted: 2019

Photograph M6-2	At Ch. 455 - Fallen tree 3m back from slope posing no risk to the road. Fresh surfaces indicating a relatively recent rock fall.	Year observation first noted: 2022

Photographs taken on 17 April 2023

aecom.com