URS

Stromeferry Bypass, The Scottish Highlands

A890 Slope Inspection Report

September 2012

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Prepared for:
The Highland Council

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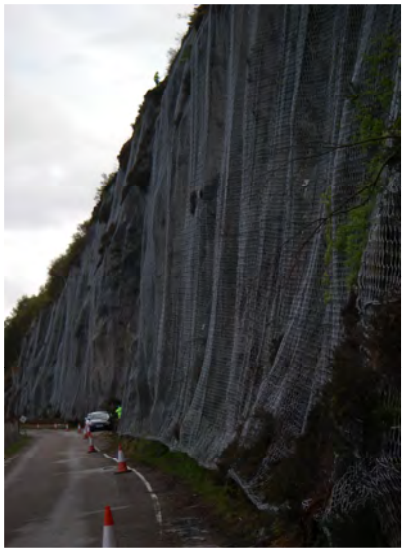

The Highland Council
Comhairle na Gàidhealtachd

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The methodology adopted and the sources of information used by URS in providing its services are outlined in this Report. The fieldwork described in this Report was undertaken between 13th - 21st May 2012 and 20th – 21st June 2012and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

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Forecast cost estimates do not include such costs associated with any negotiations, appeals or other non-technical actions associated with the agreement on measures to meet the requirements of the authorities, nor are potential business loss and interruption costs considered that may be incurred as part of any technical measures.

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TABLE OF CONTENTS

1. INTRODUCTION

1.1 General

URS Infrastructure & Environment UK Limited (URS) was appointed by The Highland Council in April 2012 to undertake a rope access inspection of the rock faces along the A890 between Attadale and Ardnarff locally known as the Stromeferry bypass, in the Scottish Highlands.

The work undertaken included a road level inspection of the site followed by a rope access inspection of specific areas of significance identified during the road level inspection. Inspections of the previously installed remedial works were also undertaken.

This report presents the findings of the inspection works undertaken at the site and the subsequent modelling and risk assessment of the rock faces. Recommendations for remedial works and management actions to reasonably reduce the risk posed by the rock slopes are also presented in the report.

1.2 Background

The A890 serves as the main link road down the west coast of Scotland and is also a significant transit for east-west traffic travelling between the Isle of Skye and Inverness. The A890 is mainly single carriageway but frequently reduces to single track with passing places along the stretch between Attadale and Ardnarff.

The road was opened in 1970 following the excavation of a number of rock slopes for the road alignment. There has been a long history of rockfall at the site since the road was opened.

1.3 Scope of Works

The following provides a summary of the assessment undertaken for the preparation of this report:

Review of published geological maps in order to understand the geological setting of the site;

- Review and summary of the monthly inspections undertaken by The Highland Council in 2010 and 2011;
- Review of previous Annual Inspection Reports carried out by Coffey in 2009 and 2010.
- Road level inspection of the road cutting and drainage channels along the A890 between Ardnarff and Attadale;
- Rope access inspections of features identified during the road-level inspection considered to represent a risk to the road;
- Inspection of existing remedial works along the rock slope; and
- Identification of areas of potential risk and recommendations for remedial works.

2. SITE DESCRIPTION

2.1 General

The rock slope under inspection is adjacent to the southeastern edge of the A890 road between Ardnarff (situated approximately 2.7km northeast of the village of Stromeferry) and Attadale (approximately 3.5km southwest of the hamlet of Strathcarron) in the Scottish Highlands. The A890 runs parallel (southwest to northeast) to the southeastern shore of Loch Carron.

The site runs approximately southwest to northeast for a distance of approximately 3.9km. The A890 is generally between 5m Above Ordnance Datum (AOD) and 12m AOD within the site, but starts to climb to the northeastern extent to approximately 32m AOD, giving a maximum height difference of 27m.

The majority of the site works comprised inspections of the rock slopes immediately adjacent to the road. However, the remit for the inspection was to also include any rock faces higher up the hill slope where a potential rock fall from the slope could pose a hazard to the road.

The majority of the rock slope is formed by side long cuttings, with a single box cutting towards the northeastern limit. The A890 forms the toe of the rock slope, with a railway line on the far side of the road running parallel to it along much of the section. An avalanche shelter which spans both the road and railway line is located towards the northeastern limit of the site. The crest of the exposed rock slope generally extends up the slope further southeast at a steep gradient towards the hills Cnoc nam Mult and Aonach Baile na Creige.

The slopes under inspection typically comprise two distinct landform types. The first consists of steep, near vertical rock slopes typically between 70° and 85°, which were excavated and reprofiled to allow the construction of the road and railway. These range in height from less than 5m to over 40m in places. The majority of these slopes are poorly vegetated, however the quantity of vegetation does vary and some slopes have recently been devegetated for inspection purposes. The type of vegetation varies, but was dominantly observed to consist of grass and moss, locally with ferns, heather, ivy, gorse and tree saplings. Some areas also had large trees and cut tree trunks. In some locations where the slope was off-set from the road, vegetated talus slopes were observed at an angle of approximately 30-45°.

The second landform (situated above the rock slopes adjacent to the road) consists of the natural hillside which rises steeply towards the hills Cnoc nam Mult and Aonach Baile na Creige at angles of approximately 35° to 45° to a level of approximately 350m AOD. Localised rock exposures are present on this upper slope between approximately 60 and 80m AOD. The dominant vegetation cover on the upper slopes consist of ferns, mature trees and grass. A number of fallen trees are also present on the upper slopes.

Towards the northeastern extent of the site (and inclusive of the avalanche shelter) has been designated as a Site of Special Scientific Interest (SSSI). The site designation name is Attadale. This SSSI is categorised as a feature of structural and metamorphic geology of the Moine and is documented as 6.58ha in area.

The site chainage has been set up along the A890. 0m is located at the far southwest, at the road closure gates near Ardnarff and extends northeast to a chainage of 3864m at the road closure gates before Attadale. For inspection and reporting purposes the site has been divided into 33 individual rock slopes which are individually numbered e.g. AA19. Where a second

upper tier of natural rock exposures exist, these are suffixed by the word 'Upper' e.g. AA19 Upper. Slope references match those previously used by Coffey ([Ref 1]).

2.2 Site Geology

Overview

Information regarding the geological conditions at the site was obtained from the BGS GeoIndex digital map database (1:50,000 scale) (Ref.[2]).

Superficial deposits are generally indicated as being thin / not present along the majority of the rock slope. However, alluvial fan deposits are recorded near to Ardnarff, comprising gravel, sand, silt and clay. Near to Attadale, marine beach deposits and raised beach deposits, both comprising gravel, sand and silt, as well as glacial till deposits consisting of clay, gravel, sand and silt are recorded. Additionally, localised peat deposits are recorded on the hillside to the southeast of the rock slope.

The solid geology beneath the site is generally recorded to comprise psammite rock belonging to the Morar Group (lowest group of the early Neoproterozoic Moine Supergroup). Psammite is a metamorphosed sedimentary rock with a dominantly sandstone protolith.

Towards the northeastern section of the rock slope, it crosses a relatively thin section of rock recorded as a gneissose pelite of the Basal Pelite Formation (also part of the Morar Group), before the rock type changes to orthogneiss (a coarse-grained foliated metamorphic rock formed under conditions of high-grade regional metamorphism of igneous origin) of the Loch Duich Gneisses. Locally, orthoamphibolite is recorded within the Loch Duich Gneisses.

No major faults are recorded to cross the site, but some small normal faults are indicated in the area.

The rocks are described in more detail below.

Morar Group

The Morar Group is the lowermost group of the early Neoproterozoic siliclastic Moine Supergroup and occurs in the hanging wall of the Moine Thrust. It consists of a sequence of metamorphosed sandstone (psammite) with minor meta-mudstone (pelite and semipelite) greater than 5km thick.

The Group comprises four formations. These are in ascending order: the Basal Pelite; Lower Morar Psammite; Morar Semi-Pelite; and Upper Morar Psammite formations. Locally the base of the Basal Pelite Formation is marked by a thin highly deformed basal meta-conglomerate, showing an unconformity with the Lewisianoid basement.

The majority of the exposed rock along the site generally comprised a very strong, thinly foliated, very closely to medium spaced, grey, locally pinkish grey, fine to medium grained schist (psammite). Locally this was observed to be micaceous. Weathering was generally observed as a surface discolouration to orange / red along discontinuities; however no reduction in strength was associated.

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[1] Coffey Geotechnics Ltd. (2012) Annual Rock Slope Inspection – A890 Stromeferry Bypass, July 2010

[2] Summary Table

Loch Duich Gneisses

The Loch Duich Gneisses form part of the Lewisian complex or Lewisian Gneiss, which is a suite of Precambrian metamorphic rocks of Archaean and Paleoproterozoic age. They form the basement on which the Torridonian and Moine Supergroup sediments were deposited. The Lewisian consists mainly of granitic gneisses with a minor amount of supracrustal rocks.

Where encountered, this rock generally comprised very strong to extremely strong, very thinly to thickly banded, closely to widely spaced, grey and white coarse grained gneiss with occasional white or pink quartz bands.

Structural Geology

Due to the complex and varied metamorphic nature of the rock and the length of the slope assessed, a detailed generalised description of the discontinuities along the entire length of the slope would not be practical. However, as outlined in Section 2.1, the site has been broken down into smaller sections and discontinuity measurements for each rock slope are recorded on the Geological Assessment Sheet included in Appendix B.

The following generalised observations can be made for the rock groups observed:

Morar Psammites

Typically two or three joint sets were observed within this rock type, with the number of joints per m3 of material typically varying between 12 and 30. The close spacing of the discontinuities (i.e. both the foliation and joint sets) gives rise potentially to both block fall and ravelling type failures. However, potential topple, wedge and planar failures were also observed.

Typically, the discontinuities apertures are very tight to moderately wide and contain no infill. Locally, aperture was observed to be up to very wide (measured up to 200mm in section AA3).

Gneiss

Generally three joint sets were observed, locally only two, with the number of joints per m3 of material ranging from 6 to 18. This material was generally observed to be more massive in structure than the psammites of the Morar Group, however, potential areas of block fall, wedge, planar and ravelling failure were observed on the slopes.

Typically, the discontinuities apertures are very tight to open and contain no infill.

3. SUMMARY OF PREVIOUS INSPECTIONS

3.1 Annual Rock Slope Inspection Report 2010

Annual rock slope inspections have been undertaken by Coffey Geotechnics. Table 3.1 below summarises the principal recommendations made following the last annual inspection undertaken in June 2010.

Table: 3.1 – Principal Recommendations from Annual Inspection Undertaken in June 2010.

Slope	Recommendations	Action	Timescale	Action completed at the time of July 2012 inspection	2012 URS Action
AA1	#0023 to #0178 Remove vegetation and light scale slope.	THC	Next Phase (VI) of works	Devegetation - Yes Scaling - No	Light scaling added to Summary Table in Appendix D
	Remove trees on edge of crest above the rock slope.	THC	**Outstanding** Next Phase (VI) of works	Yes	No Action
	Clear out ditch	THC	Annual maintenance	Yes	No Action
AA2	Clear out ditch	THC	Annual maintenance	Yes	No Action
AA3	Abandon the tell tale. The slope is performing satisfactorily, whilst the rock trap remains functioning.	None	None	No Action	No Action
AA4	#0705 to 0751 Remove vegetation and light scale slope.	THC	Next Phase (VI) of works	Devegetation - Yes Scaling - No	Light scaling added to Summary Table in Appendix D
	#0712 Install dentition to base of undercut column.	THC	Next Phase (VI) of works	No	Dowelling of individual overhanging blocks added to Summary Table in Appendix D
	Clear out ditch	THC	Annual maintenance	Yes	No Action
AA6	#1420 Large fallen pine tree at crest of slope requires removal.	THC	Next Phase (VI) of works	URS unable to determine if this tree has been removed	No Action
AA7	Clear culverts	THC	Annual maintenance	Not inspected by URS	See Section 6
AA9	#1906 Heavy scaled area – keep under observation.	THC & Coffey	All inspections	Area Inspected by URS	Keep under observation in future inspections
	Clear out ditch	THC	Annual maintenance	Yes	No Action

Slope	Recommendations	Action	Timescale	Action completed at the time of July 2012 inspection	2012 URS Action
AA10	#2053 Large partially undercut block on small ridge – keep under observation – annual inspections.	Coffey	All inspections	Area Inspected by URS	Within extent of proposed catch fence added to Summary Table in Appendix D.
AA13	#2404 to 2491 Remove vegetation from rock slope at crest area.	THC	Next Phase (VI) of works	Yes	No Action
AA14 West	#2500 to 2539 Remove vegetation from upper slope.	THC	Next Phase (VI) of works	Yes	No Action
	#2543 Rock fall (<0.125m³) material lying on top of buttress. Keep under particular observation during periodic inspections.	THC & Coffey	All inspections	Area Inspected by URS	Clearance of failed material from behind netting added to Appendix B.
	Rope access inspection of area above buttress.	Coffey	Next Phase (VI) of works	Yes	No Action
AA15	#2592 to 2760 Remove vegetation from rock slope and crest area.	THC	Next Phase (VI) of works	Yes	No Action
AA17	#2860 Column of fractured rock under existing netting by “Hughie MacKenzy” graffiti – keep under specific observation during periodic and annual inspections.	THC & Coffey	All inspections	Area Inspected by URS	Clearance of failed material from behind netting added to Appendix B.
AA18	Clear out ditch	THC	Annual maintenance	Yes	No Action
AA20	#3080 “I” beam post – the measurements do not enable monitoring of the whole wall. Hence, additional tell tales and inclinometer should be installed.	THC & Coffey	Next Phase (VI) of works	No	Removal of accumulated debris from behind rockfall barrier added to Summary table in Appendix D.
	The “I” beams require maintenance to treat existing corrosion and to protect steel work from further corrosion.	THC	**Outstanding** Next Phase (VI) of works		
	Clear culverts	THC	Annual maintenance	Not inspected by URS	See Section 6

Slope	Recommendations	Action	Timescale	Action completed at the time of July 2012 inspection	2012 URS Action
AA21	#3271 Removal block next to buttress	THC	Next Phase (VI) of works	No	Light scaling added to Summary Table in Appendix B.
AA22b	#3356, 3372 and 3382 Potential failures keep under particular observation during periodic inspections.	THC & Coffey	All inspections	Area Inspected by URS	Heavy scaling of nose, installation of additional reinforcing cables and repair to areas of damaged netting added to Summary Table in Appendix B.
	#3356, 3372 and 3382 Noses should be heavy scaled/removed under supervision of geotechnical engineer/engineering geologist.	THC & Coffey	Next Phase (VI) of works	No	
AA24	#3672 rope access inspection of area of rock fall.	Coffey	Next Phase (VI) of works	Area Inspected by URS	Repair vertical joins between netting panels where these were observed to have come apart during the inspection.
AA25, AA26N and AA26S	Slopes not considered a significant hazard. Hence, removed from slope inspection list. Recommend a visual inspection during the annual inspections, with reporting only if significant features observed.	Coffey	Annual inspections (ongoing)	Not Considered Significant. Removed from List	

3.2 Monthly Inspections

A review of the monthly inspections of the rock slopes along the A890 Stromeferry Bypass carried out by The Highland Council between 2nd February 2010 and 9th December 2011 was undertaken.

The following table provides details of the inspections carried out by the Highland Council between these periods, however slopes where no issues were reported have been omitted from the table:

Table: 3.2 – Summary of Monthly Inspections

Slope	Chainage	Highland Council Observations
AA1	0023m	**16/03/2010:-** Small scale fall from 1m below crest into ditch. 3 loose rocks visible but will also likely be contained by ditch. Slight scaling required.

Slope	Chainage	Highland Council Observations
AA2	0176m	**24/02/2011:-** Both shackles missing on first net.
AA2	0176m	**15/03/2011:-** Small rocks on existing pile near end of second net.
		09/12/2011:- Approximately 40T of superficial material was cleared from road. Culvert under road was blocked but cleared.
AA4	0705m	**02/02/2010:-** Small boulder in ditch from rock outcrop near toe of slope about midway along slope.
AA6	1390m	**15/04/2010:-** Very small fall – 3 stones into ditch from low level.
		10/12/10:- Small stones on road.
AA7	1720m	**10/12/10:-** Small stones on road.
		24/02/2011:- Possible loose block.
		09/12/11:- Culvert at end of pitched cascade (290199, 936993) blocked with gravel – water overflow and debris on road. Water diverted to adjacent culvert prior to reopening road.
AA8	1810m	**26/04/2010:-** Rock debris fall to west of gully at start of slope 8. Cleared by DLO. Needs to be investigated at annual inspection.
		10/12/10:- Small stones on road.
AA9	1873m	From 1906m, heavily scaled area – keep under observation (reported on all inspection sheets).
		09/12/2011:- Culvert at 290397, 937090 partially blocked with branches – water overflow and debris on road. Outlet clear but inlet to culvert under railway blocked. Branches removed prior to reopening road, location marked and Network Rail personnel on site advised of problem with culvert under railway.
Frenchman's Burn (Allt na Fhrangaich)	2200m	**02/02/2010 – 26/05/2010:-** Top basin approximately 1/3 full but lower basin still fairly clear.
		30/06/2010 – 10/12/2010:- Top basin fairly clear, lower basin clear.
		20/01/2011 – 20/05/2011:- Top basin nearly ½ full, lower basin less than 1/3 full.
		22/06/2011 – 02/12/2011:- Top basin clear, lower basin clear.
		09/12/2011:- Burn had overflown on to road but rock traps effective. Burn under bridge clear. Top basin full, lower basin full.
AA11	2285m	**09/12/11:-** Some small stones on road but no sign of problem.
AA14	2500m	At 2543m material on top of buttress – keep under observation.
AA15	2592m	**26/05/2010:-** Approx. 0.6 x 0.4 x 0.1m thick block of material from uplink side of nose, 3m up, 5m from start of slope. More loose to follow but all has been and will be contained by netting.

Slope	Chainage	Highland Council Observations
AA16	2770m	**16/03/2010:-** Large block in rock trap.
AA16	2770m	**10/12/10:-** Single slab (0.5 x 0.4 x 0.2m) contained by netting.
AA17	2838m	At 2860m column of fractured rock under netting by 'Hughie' graffiti – keep under observation.
AA18	2908m	**29/07/2010:-** Rock fall, contained by netting. Ch 2292m (adjacent to culvert). 1 large triangular slab 0.2m thick by approx. 1m long and 4 smaller irregular blocks ranging from cobble to 0.3 x 0.3 x 0.3m boulder. Appears to have come from crest of slope.
		01/11/11:- Shackle at start of toe rope replaced.
Natural Crag above AA18 & AA19	Not given	**26/05/2010:-** New stones in pit at head of pipe. Mostly small but 3 are approx. 0.25 x 0.2 x 0.15m. Probably brought down gully by 2 dead tree branches. No sign of anything related to crag.
		10/12/10:- Large stone (0.6 x 0.4 x 0.3m) with other smaller stones on road cleared by DLO. Source unknown but appears to be from upper slopes.
		20/05/2011:- Small block (0.3 x 0.3 x 0.3m) from 4m up – contained by netting at Ch 2880m. Further similar block above loose but will not lead to more extensive problem due to change in planes above.
AA19	2990m	**20/01/2011:-** Small pile of friable rock contained by netting at Ch 3006m.
		02/12/2011:- $1m^3$ of very friable rock at existing pile at Ch 3010m.
Stream Gully between AA19 & AA20	3072m	**03/10/2011:-** One large block 0.3 x 0.4 x 0.6 & several small cobble sized stones fell from crest 7m high downlink of gully – falling into passing place.
		09/12/11:- Significant quantity of rock washed down gully. Overflowed with mud and gravel washed on to road but large blocks contained by rock trap. Rock fall from end of concrete beam. Has slipped under three restraint wires and exposed part and exposed part of rock bolt securing end of netting used to stabilise face. This needs further investigation.
AA20	3072m	Additional tell tales required to wall and monitor erosion of superficial materials within gully.
		02/02/2010:- Top tell tale = -7.0, -2.0V. No change.
		16/03/2010 – 20/01/2011:- Top tell tale = -8.0, -2.0V.
		24/02/2011 – 19/04/2011:- Top tell tale = -9.0, -2.0V.
		20/05/2011:- Top tell tale = -9.5, -3.0V. Continued movement.
AA21	3188m	**16/03/2010:-** Cobbles contained by netting at Ch 3227m and 3255m.

Slope	Chainage	Highland Council Observations
		26/08/2011:- Single block – 0.5 x 0.5 x 0.3m contained by netting. Source is from edge / underside of an overhang block which is bolted. Located to left of block restrained by rope. Ch 3261m.
AA21	3188m	**02/12/2011:-** Very large cobbles and one small plate shaped boulder at Ch 3248m adjacent to previous.
		09/12/2011:- No new stones at location of recent minor falls. Small stones thrown directly on to road by force of water in stream which usually runs down rock face.
AA22B	3328m	3356m, 3372m & 3382m potential failures – keep under observation.
		02/02/2010:- Approximately 1m^3 rock fall contained within netting and barrier. Location is 6th post from west end of barrier.
		15/04/2010:- 3m^3 rock fall contained by netting and barrier adjacent to fall reported in February 2010. Fall centred 5m further along slope.
		10/12/10:- Active erosion of overburden from un-netted slopes between AA22 and AA23.
AA24	3627m	**02/02/2010:-** Accident damage to east end of netting. Netting pulled west along slope about 2m. Slight damage to netting. Main bottom restraint wire needs retightened. Original old wire broken and securing bolt pulled out.

The above table indicates that the majority of the slope sections under inspection have indicated some form of instability, the majority of which are small scale. Additionally, at some points problems with the netting have been identified.

3.3 Recent Significant Events

On the 22nd December 2011 a rock fall occurred on the A890 Stromeferry Bypass between Strathcarron and Stromeferry at Section AA19. As a result of the rockfall the road was closed.

The area of the rock fall was on a narrow section which had already been protected by mesh draped down the rock face. The rock fall split the mesh, although the restraint provided by the it may have prevented the rock reaching the railway line. The material was cleared and there were preparations underway to assess the area of the fall when a second rock fall occurred a few days later. Following this second rock fall the road was closed indefinitely until the area made stable.

URS reviewed the area and advised the Council that the rock slope exhibited significant potential for failure. With areas of highly fractured and dilated rock mass, the affected area was covered and anchored using TECCO mesh.

The first stage of the works involved implementing a safe system of work for controlled rock removal. Vegetation and soil was cleared from across the slope section and the old mesh cut away to fully expose the rock face. It was at this point that the full extent of the works was assessed and it was realised a rock plane failure of 20m width had occurred with potential for further failures. Rock scaling works were started to clear away loose rock including significant sized boulders (up to 9 tonne), which were able to be moved out by hand illustrating the highly unstable condition of the rock face.

It is estimated that, including the removal of the original rock fall, approximately 500 tonnes of material was removed from the affected area.

The slope requiring remediation was ultimately 150m long and up to 40m high representing a considerable meshed area. Following the removal of all the loose material several areas were identified to require rock bolts where it was considered blocks had to be retained on the face. Rock bolts up to 8m in length were drilled and grouted. Although there was potential for removal of these areas, often, due to the steep nature of the slope, it was assessed that they were acting as a buttress to the material above and removal may have initiated instability or failure at a greater height.

Once these areas were considered stable then the main drilling works for mesh anchors commenced. The crest of the slope was found to consist of debris flow materials over the bedrock, with some narrow deep buried channels present resulting in anchors installed up to 13m deep in localised areas.

The main rock face area was stabilised and the road reopened to traffic in late April 2012.

4. 2012 ANNUAL INSPECTION

4.1 Road Level Inspection

A road level inspection of the slopes was carried out between 13th May 2012 and 18th May 2012. This involved a general site walkover and allowed the identification of potential failures and also any other features of significance such as possible pathways for falling material. A geotechnical appraisal of the rock mass and discontinuities was also undertaken and is presented in Geotechnical Assessment Sheets which are included in Appendix B. The data obtained is similar to they previously recorded as part of the appraisal using TRL's Rock Hazard Index System, which should enable comparison from this assessment to previous work. In general more detail was obtained to allow a bespoke risk assessment to be completed.

Although an original chainage system had been set up at the site, URS identified errors in measurement of the original chainage with slope references, which increased towards Attadale. URS therefore established their own chainage system for their works along the loch-side edge of the existing A890 road. This started at Ch 0m at the road closure gates at Ardnarff (NGR NG 89056, 35700) to Ch 3864m at the road closure gates before Attadale (NGR NG 91806, 38187).

Although the chainages may have changed slightly due to the URS chainage system, due to devegetation works that had taken place earlier this year (2012), some of the sections have been extended to take into consideration the newly exposed rock faces.

Features have been referenced to the URS established chainage system set up at the site, along the road.

Photographs were taken of the rock faces during the ground level inspection and a selection of key photographs are attached in Appendix C. Photographs of the slopes are also provided within the Geotechnical Assessment Sheets in Appendix B.

4.2 Rope Access Inspection

Rope access inspections were carried out concurrently with the ground level inspection between the 14th and 18th May with an additional visit undertaken between the 20th and 21st of June to inspect the upper rock slopes. For the rope access inspections an Industrial Rope Access Trade Association (IRATA) Level Three Supervisor was employed to set up a safe system of work. Significant features identified during the ground level survey that appeared to present a potential hazard were investigated by rope access. Structural characteristics of the potential failures (including dimensions and discontinuity characteristics) were recorded.

In general the main potential mechanisms of failure identified were block fall and ravelling, with fewer potential toppling, wedge and planar mechanisms. Due to the more closely spaced discontinuities, the majority of potential failures were identified within the psammite. A selection of photographs from the inspection are included in Appendix C.

Loose talus was identified at the base of many of the rock faces which were offset from the road, and were often covered with vegetation (typically grass). This is considered to be a lesser risk than loose rocks on the rock faces as the talus is likely to have rested at a natural angle of repose and should be relatively stable. Movement from the talus is considered only likely to occur during periods of extremely heavy rainfall or if it is disturbed by animals, primarily deer, traversing the slopes. If movement of talus material does occur it is unlikely to pose a significant risk to the road, consequently it has not been considered further in this report.

4.3 Inspection of the Existing Installed Remedial Works

Where existing rockfall netting had been installed, inspections were carried out in order to obtain a description of its condition. This was carried out from both road level and by rope access to obtain information of the condition of the top cable and top anchor points. The condition of the installations varied considerably.

A rock fall catch fence which was present in one section (AA14E) was also inspected. No evidence of major rock fall strike to the fence was evident and the fence appeared to be in good working order.

Details of the condition of the existing remedial works are given on the Geotechnical Assessment Sheets in Appendix B.

4.4 Kinematic Analysis

Dips (Ref. [3]) is a stereonet program for the analysis and presentation of structural data. It is designed for the interactive analysis of orientation based geological data. Using the joint data recorded during the site inspections the potential for the presence of potential planar, wedge or toppling failures was assessed for each rock slope in turn. The results of this analysis is included on the Geotechnical Assessment Sheets in Appendix B.

The analysis was also used to identify plane failures similar to those associated with the large rock fall of December 2011. These potential failures have been identified in the risk assessment, which are shown on the Geotechnical Assessment Sheets.

[3] www.rocscience.com

5. RISK ASSESSMENT

5.1 Risk Assessment Approach

A bespoke risk assessment has been developed for the rock slopes at Stromeferry. The assessment considers the size of a potential rock fall (the hazard), the potential pathway for a fallen block to reach the carriageway and finally the available sighting distance on the carriageway (the receptor).

The ratings of the hazard, pathway and receptor are multiplied together to give the level of risk for each of the rock faces. The ratings are summarised in Table 5.1 below.

Table 5.1 – Description of Risk

Risk Value (hazard x pathway x receptor)	Risk level	Description
0 to 5	Low	Minor to medium sized failures with a low chance of causing minor injuries to road users.
5 to 10	Moderate	Medium sized failures with a low chance of causing major damage to road users.
10 to 15	High	Medium to large sized failures with a moderate chance of causing major injury or loss of life to road users.
Greater than 15	Very High	Large failures to very large failures which have a high chance of causing loss of life.

5.2 Hazard Rating

The hazards have been split into three categories which cover the main sizes of failures identified at the site. They are listed as follows:

Small ravelling type failures = Hazard Rating 1

Moderate failure size of football sized blocks (typically 0.02m3) = Hazard Rating 2

Large failures, typically 1m3 or greater = Hazard Rating 3

Very large failures, typically 10m3 or greater = Hazard Rating 4

5.3 Pathway Rating

Slopes without existing remedial works

The assignment of a pathway rating for rock faces without existing remedial works is based upon a qualitative inspection of the slope form (height, angle, shape and vegetation cover) between the position of a potential rock fall and the road (i.e. the receptor). The presence of other features such as ditches or berms that are likely to have an effect on the pathway of a block have also been included into the rating. Wherever possible test blocks were also dropped from the rock faces to determine the likely pathway of fallen blocks during an actual rock fall. They have been rated as follows:

Table 5.2 – Pathway Rating for rock faces without existing remedial works

Pathway Rating	Description
1	No failed blocks are expected to reach the road, e.g. The rock face is separated from the road by a large flat area / large bund.
2	Most failed blocks are not expected to reach the road, e.g. Effective rock trap ditch / presence of wide verge or bund. Lots of dense vegetation.
3	Approximately half of the failed blocks are expected to reach the road.
4	Most failed blocks are expected to reach the road, e.g. No ditch or shallow ditch / narrow verge. Little vegetation. Potential for blocks to bounce.
5	All failed blocks are expected to reach the road, e.g. Fallen blocks are likely to free fall or bounce directly onto the road. No or very narrow verge. No ditch or bund.

Slopes with existing remedial works

The assignment of a pathway rating for rock faces with existing remedial works is based upon a qualitative inspection of the existing remedial works. The rating considers the condition of the installation (e.g. corrosion or damage to the anchors, cables or netting) and also whether the design and the construction of the remedial works is suitable considering the size and type of rock fall expected from the rock face. They have been rated as follows:

Table 5.3 – Pathway Rating for rock faces with existing remedial works

Pathway Rating	Description
1	Remedial works are in excellent condition and are of a suitable design / construction that all blocks of the expected failure size/type will be retained by the remedial works.
2	Remedial works are in general good condition and are of a suitable design / construction that most of the blocks of the expected failure size/type will be retained by the remedial works. Most or all of the blocks that are not retained are expected to reach the road.
3	Remedial works are in general good condition but are sub-standard for the type of failure expected. It is expected that approximately half of blocks of the expected failure size/type will be retained by the remedial works. Most or all of the blocks that are not retained are expected to reach the road.
4	Remedial works are in poor condition and are sub-standard for the type of failure expected. It is expected that most of the blocks of the expected failure size/type will not be retained by the remedial works. Most or all of the blocks that are not retained are expected to reach the road.

Pathway Rating	Description
5	Remedial works are in extremely poor condition or are not suitable for the type of failure expected. The existing remedial works are likely to fail catastrophically should the expected type/size of failure occur. Most or all of the blocks that are not retained are expected to reach the road.

5.4 Receptor Rating

The approximate sighting distance that a driver would have when driving adjacent to each of the rock faces (in good weather during daylight hours) was estimated for each of the rock faces. The receptor rating for each sighting distance is then based on stopping distances from the Highway Code for a vehicle travelling at 40 and 60mph (36m and 73m respectively). The ratings are as follows:

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

5.5 Recommended Timescale for Remedial Works / Actions

For each rock face where it is considered that remedial works or actions are required, the recommended timescale within which the remedial works are implemented has been divided into three categories as follows:

- Within 1 year
- Within 3 years
- Within 3 – 5 years

The timescale for remedial works/ actions recommended is based on the risk rating calculated for the rock slope (i.e. a long term indication of the risk posed by the slope) combined with an estimate of how soon individual potential rock falls observed are estimated to occur. The timescales recommended are based on the assumption that the recommendation for annual inspections and 5-yearly detailed inspections by engineering geologists/geotechnical engineers will be carried out as detailed in section 6.2.

5.6 Risk Assessment

The risk assessment process has been undertaken on each of the 33 rock slopes, the results and build up of which are presented in full in Appendix D. The rock slopes which are ranked as high or very high risk are summarised in Table 5.4 below.

Table 5.4 – High and Very High Risk Rock Slopes

Slope	Developing Hazards Observed	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level
AA7	-Planar -Ravelling	3	3	1.2	10.8	High
AA8	-Toppling -Ravelling	4	3	1	12	High
AA12	-Planar -Blockfall -Ravelling	4	3	1	12	High
AA13	-Wedge -Planar	3	3	1.2	10.8	High
AA14 West	-Toppling -Blockfall -Planar	3	4	1.2	14.4	High
AA15 Upper	-Blockfall -Ravelling	3	5	1.2	18	Very High
AA16-17 Upper	-Blockfall -Toppling -Planar	3	3	1.2	10.8	High
AA17	-Planar	3	4	1.2	14.4	High
AA22B	-Blockfall	4	3	1	12	High

6. RECOMMENDATIONS

6.1 Proposed remedial works

Where remedial works / actions are recommended a preliminary estimate of the extent and timescale of the works is provided for outline budget purposes in Appendix D.

Of the 33 rock slopes inspected, it is recommended that remedial works be undertaken on five of the rock slopes as a priority within the next year. These are summarised in the table below.

Table 6.1 – Rock Slope Remedial Works / Actions Recommended Within 1 Year

Slope	Developing Hazards Observed	Recommended Remedial Works / Actions	Volume / area / length	Unit
AA14 West	-Toppling -Planar	- Install new top anchors and top cable	20	No.
		- Clear failed material from behind netting	25	m^3
AA15 Upper	-Blockfall -Toppling	-Controlled removal of block using pyrotechnic breaking capsules	4	m^3
AA16-17 Upper	-Blockfall -Toppling -Sliding	-Controlled removal of blocks	10	m^3
AA19 Upper	-Blockfall -Planar -Ravelling -Root jacking	-Light scale face	3650	m^2
		-Remove 2m^3 tree stump currently retained by cable straps	2	m^3
		-Remove fallen/ cut logs from ledge between AA19 and AA19 Upper	NA	Sum
AA22B	-Toppling	-Heavy scaling of nose at Ch 3425	12	m^3
		-Install additional cable reinforcement	2500	m^2
		-Repair damaged netting	NA	Sum

6.2 Management Actions & Other Considerations / Recommendations

In addition to the recommended remedial works outlined in Section 6 and Appendix D, the following ongoing management actions are recommended:

1) Continued monthly inspections (preferably by the same inspector) to identify and record the following:

- Any significant accumulations of failed debris within the netting requiring clearance;

- Any damage to existing installations caused by rockfall or damage caused by vehicles or theft of metal components;

- The size and location of any rock falls to allow targeted inspection of high risk areas during the annual inspections.

2) Ongoing annual inspections by a suitably qualified Engineering Geologist using a combination of road side inspection and targeted roped access inspection of the higher risk and also less accessible upper rock slopes.

3) 5-yearly detailed inspections by a suitably qualified Engineering Geologist using roped access to inspect all rock faces.

4) The following other considerations have been identified during the annual inspection. Although these are not directly related to hazards presented by the rock slopes themselves, it is recommended that action is taken to consider addressing these issues.

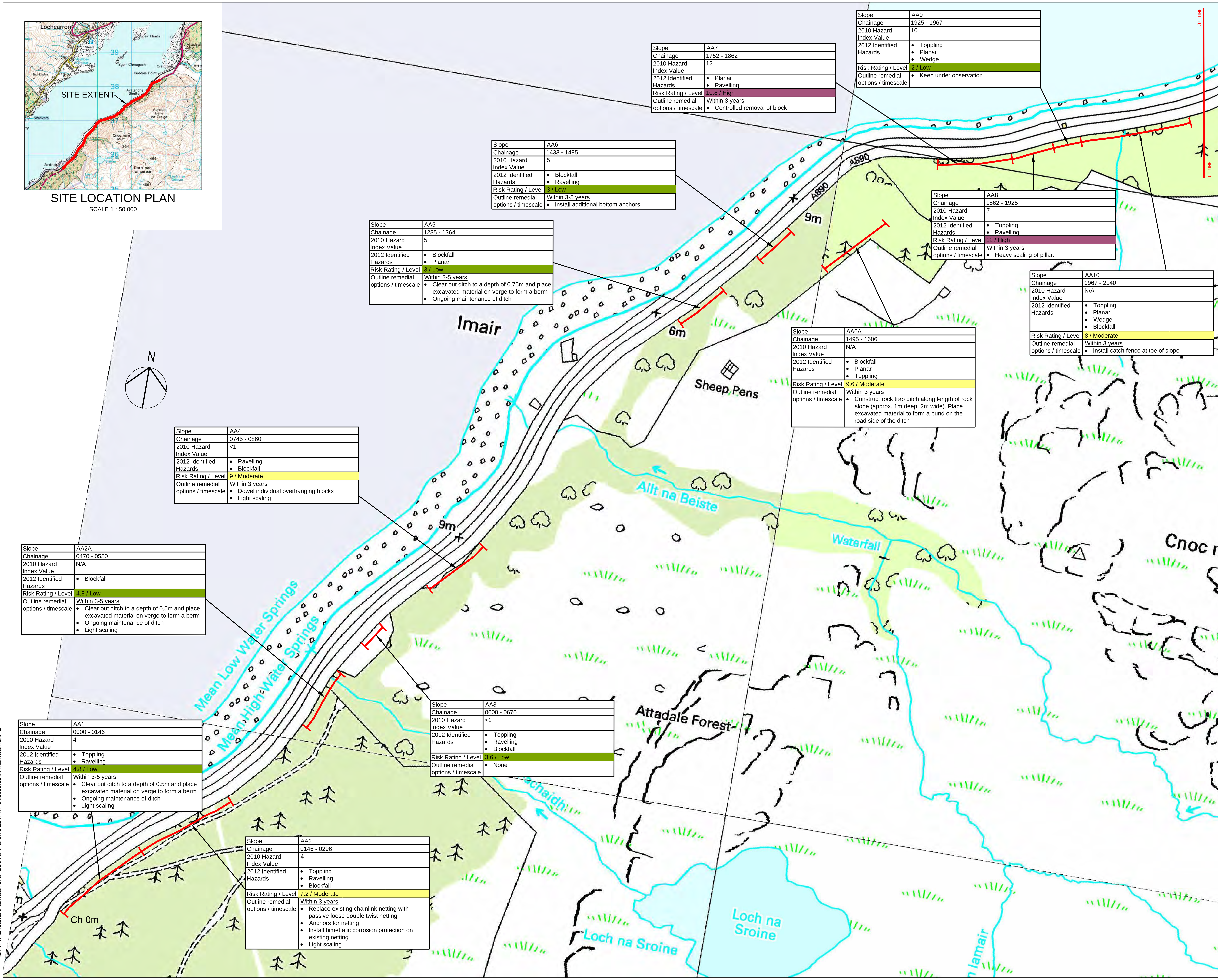
- Fallen trees on upper slopes - Several hundred fallen and uprooted pine trees were observed on the upper vegetated slopes between AA12 and AA22B. In several locations a number of logs appear to be unstable and are only retained on the slope as they have temporarily come to rest against the remaining live trees or dead stumps. It is recommended that all the fallen trees are removed from the hillside as they are considered to pose a hazard to road users. The uprooting of the trees has also caused a large number of rock blocks to be gouged out of the ground within the root balls and are now resting on the upper slopes (see photograph in Appendix C). As a longer-term solution, consideration should be given to felling some or all the remaining live (and now exposed) pine trees between AA12 and AA22B to remove the hazard posed by the trees and the rock blocks within the root balls.

- Gully between AA5 & AA6 – It is recommended that minor works are undertaken on the ditch immediately upstream of the catch pit at the top of the gully. There is evidence that an accumulation of sediment in the ditch is enabling water to skirt around the side of the catch pit and onto the slope face below. Periodic clearing of the ditch to maintain its depth is required to maintain the flow of water into the catch pit and pipe.

- Frenchman's Burn – Periodic inspection of the stilling basins and removal of accumulated debris to maintain the basin capacity.

- Culverts – It is understood that culvert crossings underneath the road and railway were inspected and cleared as part of the de-vegetation/ remedial works earlier this year consequently; URS did not inspect these as part of this work. Periodic inspection of the culverts is recommended along with clearance of accumulated debris when required to maintain the flow capacity of the culverts.

APPENDIX A DRAWINGS



Slope	AA9
Chainage	1925 - 1967
2010 Hazard Index Value	10
2012 Identified Hazards	• Toppling • Planar • Wedge
Risk Rating / Level	2 / Low
Outline remedial options / timescale	• Keep under observation

Slope	AA7
Chainage	1752 - 1862
2010 Hazard Index Value	12
2012 Identified Hazards	• Planar • Ravelling
Risk Rating / Level	10.8 / High
Outline remedial options / timescale	Within 3 years • Controlled removal of block

Slope	AA6
Chainage	1433 - 1495
2010 Hazard Index Value	5
2012 Identified Hazards	• Blockfall • Ravelling
Risk Rating / Level	3 / Low
Outline remedial options / timescale	Within 3-5 years • Install additional bottom anchors

Slope	AA8
Chainage	1862 - 1925
2010 Hazard Index Value	7
2012 Identified Hazards	• Toppling • Ravelling
Risk Rating / Level	12 / High
Outline remedial options / timescale	Within 3 years • Heavy scaling of pillar.

Slope	AA5
Chainage	1285 - 1364
2010 Hazard Index Value	5
2012 Identified Hazards	• Blockfall • Planar
Risk Rating / Level	3 / Low
Outline remedial options / timescale	Within 3-5 years • Clear out ditch to a depth of 0.75m and place excavated material on verge to form a berm • Ongoing maintenance of ditch

Slope	AA10
Chainage	1967 - 2140
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Toppling • Planar • Wedge • Blockfall
Risk Rating / Level	8 / Moderate
Outline remedial options / timescale	Within 3 years • Install catch fence at toe of slope

Slope	AA6A
Chainage	1495 - 1606
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Blockfall • Planar • Toppling
Risk Rating / Level	9.6 / Moderate
Outline remedial options / timescale	Within 3 years • Construct rock trap ditch along length of rock slope (approx. 1m deep, 2m wide). Place excavated material to form a bund on the road side of the ditch

Slope	AA4
Chainage	0745 - 0860
2010 Hazard Index Value	<1
2012 Identified Hazards	• Ravelling • Blockfall
Risk Rating / Level	9 / Moderate
Outline remedial options / timescale	Within 3-5 years • Dowel individual overhanging blocks • Light scaling

Slope	AA2A
Chainage	0470 - 0550
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Blockfall
Risk Rating / Level	4.8 / Low
Outline remedial options / timescale	Within 3-5 years • Clear out ditch to a depth of 0.5m and place excavated material on verge to form a berm • Ongoing maintenance of ditch • Light scaling

Slope	AA3
Chainage	0600 - 0670
2010 Hazard Index Value	<1
2012 Identified Hazards	• Toppling • Ravelling • Blockfall
Risk Rating / Level	3.6 / Low
Outline remedial options / timescale	• None

Slope	AA1
Chainage	0000 - 0146
2010 Hazard Index Value	4
2012 Identified Hazards	• Toppling • Ravelling
Risk Rating / Level	4.8 / Low
Outline remedial options / timescale	Within 3-5 years • Clear out ditch to a depth of 0.5m and place excavated material on verge to form a berm • Ongoing maintenance of ditch • Light scaling

Slope	AA2
Chainage	0146 - 0296
2010 Hazard Index Value	4
2012 Identified Hazards	• Toppling • Ravelling • Blockfall
Risk Rating / Level	7.2 / Moderate
Outline remedial options / timescale	Within 3 years • Replace existing chainlink netting with passive loose double twist netting • Anchors for netting • Install bimettalic corrosion protection on existing netting • Light scaling

NOTES

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Revision Details	By	Check	Date	Suffix

Purpose of issue

Client

THE HIGHLAND COUNCIL

Project Title

A890 STROMEFERRY BYPASS
ANNUAL ROCK SLOPE
INSPECTION JUNE 2012

Drawing Title

ROCK SLOPE
SUMMARY SHEET

SHEET 1 OF 2

Drawn	Checked	Approved	Date
SW	RGP	AK	07/12
URS Internal Project No. 4640007		Suitability	
Scale @ A1 1:2,500		Zone / Mileage	

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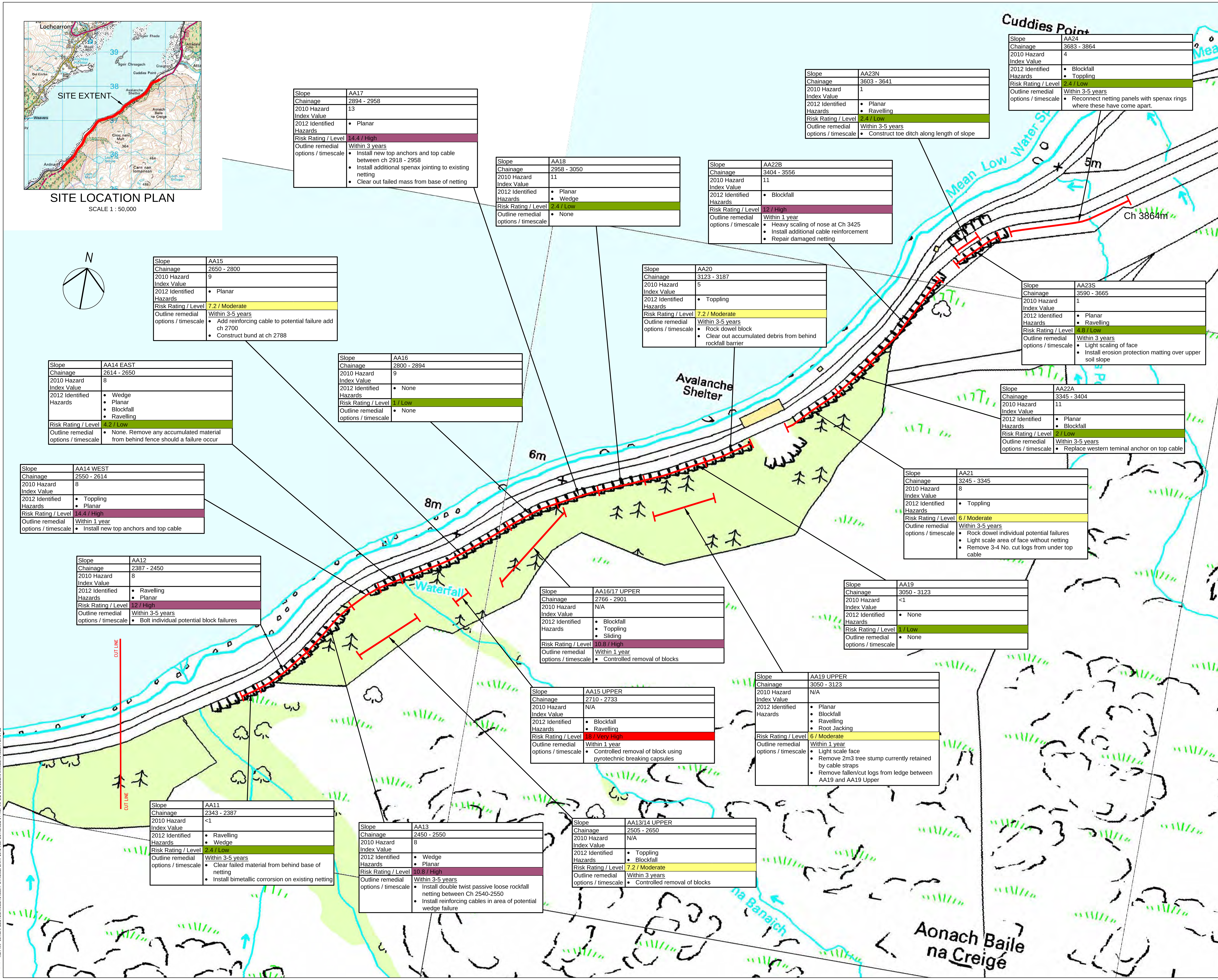
Drawing Number: 46400079 / SI / 01
Rev: -

Plot Date : 12/07/2012 0 :12:10
File Name : CH-WIP-001 CH GEOTECHNICS 4640007 STROMEFERRY 2012 INSPECTIONS 2-0 PRO INFO 2-3 DOCS DRAWINGS 4640007 SI 01-02



SITE LOCATION PLAN

SCALE 1 : 50,000

Slope	AA17
Chainage	2894 - 2958
2010 Hazard Index Value	13
2012 Identified Hazards	• Planar
Risk Rating / Level	14.4 / High
Outline remedial options / timescale	Within 3 years • Install new top anchors and top cable between ch 2918 - 2958 • Install additional spenax jointing to existing netting • Clear out failed mass from base of netting

Slope	AA18
Chainage	2958 - 3050
2010 Hazard Index Value	11
2012 Identified Hazards	• Planar • Wedge
Risk Rating / Level	2.4 / Low
Outline remedial options / timescale	• None

Slope	AA23N
Chainage	3603 - 3641
2010 Hazard Index Value	1
2012 Identified Hazards	• Planar • Ravelling
Risk Rating / Level	2.4 / Low
Outline remedial options / timescale	Within 3-5 years • Construct toe ditch along length of slope

Slope	AA24
Chainage	3683 - 3864
2010 Hazard Index Value	4
2012 Identified Hazards	• Blockfall • Toppling
Risk Rating / Level	2.4 / Low
Outline remedial options / timescale	Within 3-5 years • Reconnect netting panels with spenax rings where these have come apart.

Slope	AA22B
Chainage	3404 - 3556
2010 Hazard Index Value	11
2012 Identified Hazards	• Blockfall
Risk Rating / Level	12 / High
Outline remedial options / timescale	Within 1 year • Heavy scaling of nose at Ch 3425 • Install additional cable reinforcement • Repair damaged netting

Slope	AA15
Chainage	2650 - 2800
2010 Hazard Index Value	9
2012 Identified Hazards	• Planar
Risk Rating / Level	7.2 / Moderate
Outline remedial options / timescale	Within 3-5 years • Add reinforcing cable to potential failure add ch 2700 • Construct bund at ch 2788

Slope	AA20
Chainage	3123 - 3187
2010 Hazard Index Value	5
2012 Identified Hazards	• Toppling
Risk Rating / Level	7.2 / Moderate
Outline remedial options / timescale	Within 3-5 years • Rock dowel block • Clear out accumulated debris from behind rockfall barrier

Slope	AA23S
Chainage	3590 - 3665
2010 Hazard Index Value	1
2012 Identified Hazards	• Planar • Ravelling
Risk Rating / Level	4.8 / Low
Outline remedial options / timescale	Within 3 years • Light scaling of face • Install erosion protection matting over upper soil slope

Slope	AA14 EAST
Chainage	2614 - 2650
2010 Hazard Index Value	8
2012 Identified Hazards	• Wedge • Planar • Blockfall • Ravelling
Risk Rating / Level	4.2 / Low
Outline remedial options / timescale	• None. Remove any accumulated material from behind fence should a failure occur

Slope	AA16
Chainage	2800 - 2894
2010 Hazard Index Value	9
2012 Identified Hazards	• None
Risk Rating / Level	1 / Low
Outline remedial options / timescale	• None

Slope	AA22A
Chainage	3345 - 3404
2010 Hazard Index Value	11
2012 Identified Hazards	• Planar • Blockfall
Risk Rating / Level	2 / Low
Outline remedial options / timescale	Within 3-5 years • Replace western teminal anchor on top cable

Slope	AA14 WEST
Chainage	2550 - 2614
2010 Hazard Index Value	8
2012 Identified Hazards	• Toppling • Planar
Risk Rating / Level	14.4 / High
Outline remedial options / timescale	Within 1 year • Install new top anchors and top cable

Slope	AA21
Chainage	3245 - 3345
2010 Hazard Index Value	8
2012 Identified Hazards	• Toppling
Risk Rating / Level	6 / Moderate
Outline remedial options / timescale	Within 3-5 years • Rock dowel individual potential failures • Light scale area of face without netting • Remove 3-4 No. cut logs from under top cable

Slope	AA12
Chainage	2387 - 2450
2010 Hazard Index Value	8
2012 Identified Hazards	• Ravelling • Planar
Risk Rating / Level	12 / High
Outline remedial options / timescale	Within 3-5 years • Bolt individual potential block failures

Slope	AA16/17 UPPER
Chainage	2766 - 2901
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Blockfall • Toppling • Sliding
Risk Rating / Level	10.8 / High
Outline remedial options / timescale	Within 1 year • Controlled removal of blocks

Slope	AA19
Chainage	3050 - 3123
2010 Hazard Index Value	<1
2012 Identified Hazards	• None
Risk Rating / Level	1 / Low
Outline remedial options / timescale	• None

Slope	AA15 UPPER
Chainage	2710 - 2733
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Blockfall • Ravelling
Risk Rating / Level	18 / Very High
Outline remedial options / timescale	Within 1 year • Controlled removal of block using pyrotechnic breaking capsules

Slope	AA19 UPPER
Chainage	3050 - 3123
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Planar • Blockfall • Ravelling • Root Jacking
Risk Rating / Level	6 / Moderate
Outline remedial options / timescale	Within 1 year • Light scale face • Remove 2m3 tree stump currently retained by cable straps • Remove fallen/cut logs from ledge between AA19 and AA19 Upper

Slope	AA11
Chainage	2343 - 2387
2010 Hazard Index Value	<1
2012 Identified Hazards	• Ravelling • Wedge
Risk Rating / Level	2.4 / Low
Outline remedial options / timescale	Within 3-5 years • Clear failed material from behind base of netting • Install bimetallic corrorsion on existing netting

Slope	AA13
Chainage	2450 - 2550
2010 Hazard Index Value	8
2012 Identified Hazards	• Wedge • Planar
Risk Rating / Level	10.8 / High
Outline remedial options / timescale	Within 3-5 years • Install double twist passive loose rockfall netting between Ch 2540-2550 • Install reinforcing cables in area of potential wedge failure

Slope	AA13/14 UPPER
Chainage	2505 - 2650
2010 Hazard Index Value	N/A
2012 Identified Hazards	• Toppling • Blockfall
Risk Rating / Level	7.2 / Moderate
Outline remedial options / timescale	Within 3 years • Controlled removal of blocks

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Revision Details	By / Check	Date	Suffix

Purpose of issue

Client

THE HIGHLAND COUNCIL

Project Title

A8□0 STROMEFERRY BYPASS
ANNUAL ROCK SLOPE
INSPECTION □UNE 2012

Drawing Title

ROCK SLOPE
SUMMARY SHEET

SHEET 2 OF 2

Drawn	Checked	Approved	Date
SW	RGP	AK	07/12

URS Internal Project No.	Suitability
4640007□	
Scale @ A1	**Zone / Mileage**
1:2,500	

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Drawing Number	Rev
46400079 / SI / 02	-

Plot Date : 12/07/2012 08:51:07
File Name : □□CH-WIP-001□CH□ GEOTECHNICS□4640007□ STROMEFERRY 2012 INSPECTIONS□2-0 PRO□ INFO□2-3 DOCS□DRAWINGS□4640007□□ SI□ 01-02

APPENDIX B GEOTECHNICAL ASSESSMENT SHEETS

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA1	**Chainage:**	0 - 146	**Start Grid Ref:**	NG 89056, 35700	**End Grid Ref:**	NG 89152, 35817	**Elevation:**	17 mAOD

Rock Slope Characteristics:

Dip:	85	Azimuth:	302	Height (m):	7	Length (m):	146	Vegetation Cover:	50-60% cover comprising moss, grass and ferns. Occasional saplings and cut tree stumps.	Ditch Details:	0.4m deep, 1.0m wide
Roughness (Profile):	Rough	Verge Width:	1.5m								

Engineering Description of Rock:

Very strong thinly foliated dark bluish grey fine to medium grained micaceous SCHIST (PSAMMITE).

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Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	15	272	0.01 – 0.4m	>20m	Smooth, Planar, Rough	<0.1 – 0.25mm	None	None	
2	Joint	78	119	0.1m	>4.0m	Smooth, Planar, Rough	<0.1 – 30mm	None	None	
3	Joint	60	150	0.1 – 0.5m	3.0 – 8.0m	Smooth, Planar, Rough	<0.1mm	None	None	
4	Joint	70	003	0.1 – 2.0	1.0 -3.0m	Smooth, Undulating, Rough	<0.1 – 0.5	None	None	

Existing Netting Details or other remedial work details:									
Netting Type	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
None									

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 4 Recommended Remedial Works: Ch 23 – 178: remove vegetation and light scale slope. Remove trees on edge of crest above rock slope Clear out ditch	2.5 – 5.0

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Toppling	Set 2 & 3
2	Plane	Set 4
3		

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Toppling	5.0	1.4	Ch 50
2	Ravelling	3.0 – 5.0m	0.008	Ravelling rock mass present along the top 2m of the rock face.
3				

SUMMARY		**Comments**
Overall Hazard Rating =	2	
Pathway Rating =	2	1.5m verge, drainage ditch and a talus slope at toe. Most blocks not expected to reach the road. No test block reached the road during the inspection.
Receptor Rating =	1.2	
Risk Value =	**4.8**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Clear out existing ditch to a total depth of 0.5m. - Place excavated material on verge to form a berm. - Light scaling.	2.4	3 – 5yrs

Assessed in field by:	RA	**Date:**	14/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 Stromeferry Bypass	**Slope Ref:** AA2	**Chainage:** 0146 - 0296	**Start Grid Ref:** NG 89152, 35817	**End Grid Ref:** NG 89267, 35915	**Elevation:** 9 mAOD

Rock Slope Characteristics:

Dip: 74	Azimuth: 319	Height (m): 20	Length (m): 150	Vegetation Cover:	60 – 65% cover. Generally comprises moss and heather with occasional fern. Trees along crest.	Ditch Details:	0.5m wide, 0.4m deep	Roughness (Profile): Rough	Verge width: 0.8m

Engineering Description of Rock:

Very strong thinly foliated dark grey fine to medium grained SCHIST (PSAMMITE).

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	8	300	0.01 – 0.3m	>20m	Undulating, smooth	<0.1 – 0.5mm	None	None	
2	Joint	68	185	0.05 – 1.0	0.5 – 3.0m	Straight, Planar, Smooth	<0.1 – 2mm	None	None	
3	Joint	77	300	0.05 – 3m	2	Straight, Planar, Rough	<0.1 - 4mm	None	None	

Existing Netting Details or other remedial work details:									
Netting Type	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
PVC coated double twist	16mm galvanised	5m	25mm galvanized bars	Galvanised eye nuts	3	Spenax rings	No	None	Netting over part of slope only.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 4 Clear out ditch	0.9 – 1.7

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	-	
2		
3		

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Ravelling	18	0.16	Located in area where there is a $20m^2$ hole in the old chainlink netting.
2	Block fall	14	0.075	
3	Toppling	6	0.008	

SUMMARY		**Comments**
Overall Hazard Rating =	2	
Pathway Rating =	3	
Receptor Rating =	1.2	
Risk Value =	**7.2**	
Risk Level =	**Medium**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Replace existing damaged chainlink netting with double twist netting over (20m^2) - Install bimetallic corrosion protection on existing netting - Light scale	1.2	3 yrs

Assessed in field by: RA	**Date:** 14/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 Stromeferry Bypass	**Slope Ref:** AA2A	**Chainage:** 0470 - 0550	**Start Grid Ref:** NG 89364, 36025	**End Grid Ref:** NG 89394, 35115	**Elevation:** 15 mAOD

Rock Slope Characteristics:

Dip:	84	Azimuth:	300	Height (m):	12	Length (m):	80	Vegetation Cover:	70 – 80% cover. Generally comprises moss and grass. Many tree stumps, branches, wood chip and root systems.	Ditch Details:	1.0m wide, 0.2 m deep

Roughness (Profile):	Rough	Verge Details:	3.4m		

Engineering Description of Rock:

Strong thinly foliated dark grey fine to medium grained SCHIST (PSAMMITE).

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	11	313	0.02 – 0.3m	>20m	Straight, Planar, Rough	<0.1 – 0.25mm	None	None	
2	Joint	89	355	0.1 – 1.5m	0.1 – 0.5m	Straight, Planar, Rough	<0.1 – 0.25mm	None	None	
3	Joint	80	082	0.3m	0.5m	Straight, Planar, Smooth	<0.1 - 4mm	None	None	

Existing Netting Details or other remedial work details:	
None	
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
Not previously inspected.	0.9 – 1.3

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1		
2		
3		

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Blockfall	12	0.125	All test blocks caught by ditch
2				
3				

SUMMARY		Comments
Overall Hazard Rating =	2	
Pathway Rating =	2	
Receptor Rating =	1.2	
Risk Value =	**4.8**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Excavate ditch to 0.5m depth. Place excavated material on verge to form berm. - Maintain ditch - Light scale	2.4	3-5 yrs

Assessed in field by: RA	**Date:** 15/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA3	**Chainage:**	0600 - 0670	**Start Grid Ref:**	NG 89411, 36068	**End Grid Ref:**	NG 89436, 36201	**Elevation:**	14 mAOD

Rock Slope Characteristics:

Dip:	80	Azimuth:	317	Height (m):	16	Length (m):	70	Vegetation Cover:	5 - 10% cover. Moss and ground cover with occasional trees. Trees on ditch edge forming barrier. Some trees overhanging at crest.	Ditch Details:	2.2m wide, 1.2m deep	Roughness (Profile):	Smooth	Verge Details:	13.0m

Engineering Description of Rock:

Medium strong thinly to narrowly foliated light pinkish grey schist (PSAMMITE).

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	8	152	0.05 – 0.5m	>20m	Straight, Planar, Smooth	<0.1 – 2mm	None	None	
2	Joint	82	272	0.1 – 1.0m	10m	Straight, Planar, Smooth	<0.1 – 200mm	None	None	
3	Joint	84	171	0.3 – 2.0m	2m	Straight, Stepped, Smooth	<0.1 - 1mm	None	None	

Existing Netting Details or other remedial work details:	
None	
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = <1	2.8 – 4.3

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1		
2		
3		

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Toppling	10	2	
2	Blockfall	10	<0.1	
3	Ravelling	16	<0.1	

SUMMARY		**Comments**
Overall Hazard Rating =	3	
Pathway Rating =	1	
Receptor Rating =	1.2	
Risk Value =	**3.6**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
None	3.6	

Assessed in field by:	RA	**Date:**	16/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 Stromeferry Bypass	**Slope Ref:** AA4	**Chainage:** 0745 – 0860	**Start Grid Ref:** NG 89513, 36253	**End Grid Ref:** NG 89572, 36332	**Elevation:** 21 mAOD

Rock Slope Characteristics:

Dip:	80	Azimuth:	310	Height (m):	20	Length (m):	115	Vegetation Cover:	60 – 70% cover. Generally comprised ground cover.	Ditch Details:	1.0m wide, 0.6m deep
Roughness (Profile):	Rough	Verge Details:	1.0m								

Engineering Description of Rock:

Very strong thinly foliated grey fine grained schist (PSAMMITE).

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	10	105	0.1 – 0.5m	>20m	Straight, Planar, Smooth	<0.1 – 5mm	None	None	

2	Joint	88	100	0.1 – 0.5m	10m	Straight, Planar, Smooth	<0.1 – 10mm	None	None	
3	Joint	80	185	0.1 – 0.3m	2m	Straight, Planar, Smooth	<0.1 - 5mm	None	None	
4	Joint	18	020	1.0m	>8m	Straight, Planar, Smooth	<0.1mm	None	None	
5	Joint	50	285	0.1 – 1.0m	0.4m	Straight, Planar, Smooth	<0.1 - 5mm	None	None	

Existing Netting Details or other remedial work details:

None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = <1 Ch 705 – 751: Remove vegetation and light scale slope. Ch 712: Install dentition to base of undercut column. Clear out ditch.	2.0

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Plane	Joint set 5
2	Wedge	Joint sets 3 and 5
3		

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Blockfall	20	0.5	
2	Ravelling	20	0.001	Gravel sized

SUMMARY		**Comments**
Overall Hazard Rating =	3	
Pathway Rating =	3	
Receptor Rating =	1	
Risk Value =	**9**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
Dowel individual overhanging blocks 2 No. Light scale.	3	Within 3 yrs.

Assessed in field by: RA	**Date:** 16/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET									
Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA5	**Chainage:**	1285 – 1364	**Start Grid Ref:**	NG 89796, 36710	**End Grid Ref:**	NG 89852, 36764	**Elevation:**	19 mAOD

URS

Rock Slope Characteristics:									
Dip: 70	Azimuth: 320	Height (m): 70	Length (m): 79	Vegetation Cover:	90% cover lower lope, 60% cover upper slope. Moss and bracken. Moss is up to 0.15 to 2.0m thick.	Ditch Details:	0.3m wide, 0.5m deep	Roughness (Profile): Rough	Verge Details: 2.0m

Engineering Description of Rock:

Strong to very strong thinly foliated pinkish grey medium grained schist (PSAMMITE).

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	32	100	0.5m	1.2m	Straight, Planar, Smooth	1 – 5mm	None	None	
2	Joint	60	275	0.9m	>3.5	Straight, Planar, Smooth	30mm	None	None	
3	Joint	55	170	0.1 – 0.4m	0.6	Wavey, Stepped, Rough	0.5mm	None	None	
4	Joint	70	190	0.6 - 1.0m	0.3m	Straight, Planar, Smooth	10mm	None	None	

Existing Netting Details or other remedial work details:

None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 5	1.9 – 5.8

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Joint set 3
2	Plane	Joint set 3

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Blockfall	50 (above road level)	0.027 – 0.125	
2	Plane	50 (above road level)	0.027 – 0.125	Large existing failure. Most of the debris came to rest on the slope. 2 No. blocks in ditch.

SUMMARY		Comments
Overall Hazard Rating =	3	
Pathway Rating =	1	25m long lower slope at ~40°. Moss and bracken covered. Low pathway.
Receptor Rating =	1	
Risk Value =	**3**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Excavate ditch to a depth of 0.75m. Maintain ditch thereafter.	3	3 - 5 yrs.

Assessed in field by: RP/LN	**Date:** 16/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 Stromeferry Bypass	**Slope Ref:** AA6	**Chainage:** 1433 – 1495	**Start Grid Ref:** NG 89897, 36816	**End Grid Ref:** NG 89933, 36865	**Elevation:** 10 mAOD

Rock Slope Characteristics:

Dip:	71	Azimuth:	310	Height (m):	35	Length (m):	62	Vegetation Cover:	50% cover. Generally comprises ground cover.	Ditch Details:	Widest section 0.8m deep, 2.3m wide (no ditch where rock slope close to road).

Roughness (Profile):	Rough	Verge Details:	0.8 - 3.0m

Engineering Description of Rock:

Very strong thinly foliated dark grey fine to medium grained schist (PSAMMITE).

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	24	129	0.01 - 0.5m	>20	Wavey, Planar, Rough	<0.1mm	None	None	
2	Joint	68	274	0.02 - 1m	0.3 – 2	Planar, Smooth	<0.1 – 1mm	None	None	
3	Joint	80	011	0.02 – 2m	0.1	Stepped, Rough	<0.1 – 1mm	None	None	
4	Joint	35	059	0.5 - 3m	1 - 2m	Straight, Planar, Smooth	<0.1 – 1mm	None	None	

Existing Netting Details or other remedial work details:									
Netting Type	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
Double twist netting	16mm galvanised	5m	25mm galvanized bars	Galvanised eye nuts	3	Spenax rings	No	None	

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 5 Ch 1420: Large fallen pine tree at crest of slope requires removal.	0.4 – 1.3

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Wedge	Joint sets 2 and 3

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Blockfall	8	0.003	Tight joints
2	Ravelling	8	0.003	

SUMMARY		Comments
Overall Hazard Rating =	1	
Pathway Rating =	3	
Receptor Rating =	1	
Risk Value =	**3**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Additional bottom anchors (1 No.) to prevent blocks from escaping from base of netting.	2	3 - 5 yrs.

Assessed in field by:	RA	**Date:**	16/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA6A	**Chainage:**	1495 – 1606	**Start Grid Ref:**	NG 90003, 36809	**End Grid Ref:**	NG 90080, 36892	**Elevation:**	76 mAOD

Rock Slope Characteristics:

Dip:	70	Azimuth:	300	Height (m):	35	Length (m):	111	Vegetation Cover:	Ferns and trees.	Ditch Details:	CH 1495 - 1525: 0.7m wide, 0.3m deep CH 1525 - 1606: 0.5m wide, 0.3m deep

Roughness (Profile):	Rough	Verge Details:	CH 1495 - 1525: 1.0m CH 1525 - 1606: 8.0m								

Engineering Description of Rock:

Strong very narrowly banded dark grey crystalline medium grained schist (PSAMMITE/SCHIST). Well defined foliation with schistocity.

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Joint	48	300	0.3 - 0.5m	1 – 5m	Straight, Stepped, Smooth	150mm	None	None	
2	Foliation	30	100	0.005 – 0.3m	>8m	Straight, Planar, Rough	0 -2mm	None	None	
3	Joint	80	020	0.5m	1 – 5m	Straight, Planar, Rough	1mm	None	None	

Existing Netting Details or other remedial work details:	
None	
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
Not previously inspected.	4.4

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Planar	Joint set 1
2	Wedge	Joint set 3 and Joint set 1

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Planar	75m (above road level)	0.625	Approx. 30mm of movement.
2	Toppling	75m (above road level)	12 - 20	150mm dilated joints.
3	Blockfall	75m (above road level)	0.125	Greater than 3 No. on upper outcrop.

SUMMARY		Comments
Overall Hazard Rating =	4	
Pathway Rating =	2	
Receptor Rating =	1.2	
Risk Value =	**9.6**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Construct rock trap ditch along the length of the rock slope (approx. 1m deep, 2m wide). Place excavated material to form a bund on the road side of the ditch.	4.8	Within 3 yrs.

Assessed in field by:	RA	**Date:**	16/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA7	**Chainage:**	1752 - 1862	**Start Grid Ref:**	NG 90139, 36994	**End Grid Ref:**	NG 90245, 37017	**Elevation:**	13	mAOD

URS

Rock Slope Characteristics:												
Dip:	75 - 80	Azimuth:	336	Height (m):	30	Length (m):	110	Vegetation Cover:	50% cover. Generally comprises small trees.	Ditch Details:	None. Large ditch by slope AA8.	Roughness (Profile):	Rough	Verge Details:	1.0m

Engineering Description of Rock:

Very strong thinly foliated dark grey schist (PSAMMITE).

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	16	143	0.1 -1.0m	>20m	Curved, Planar, Smooth	<0.1	None.	None.	
2	Joint	75	041	0.3 – 2m	0.5 – 1m	Curved, Planar, Rough	Unable to measure	None.	None.	
3	Joint	79	293	0.5 – 3m	0.3 – 3m	Curved, Planar, Smooth	Unable to measure	None.	None.	

Existing Netting Details or other remedial work details:

None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 12 Clear culverts.	2.5 – 3.8

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Wedge	Joint sets 2 and 3

Developing Hazards Observed (Considered likely to fail with the next 5 years):

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Plane	20	4 - 5	1 block observed
2	Ravelling	All over slope	0.001	

SUMMARY		Comments
Overall Hazard Rating =	3	
Pathway Rating =	3	
Receptor Rating =	1.2	
Risk Value =	**10.8**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Controlled removal of block.	2.4	Within 3 yrs

Assessed in field by: RA	**Date:** 16/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA8	**Chainage:**	1862 - 1925	**Start Grid Ref:**	NG 90245, 37017	**End Grid Ref:**	NG 90299, 37050	**Elevation:**	20 mAOD

Rock Slope Characteristics:

Dip:	75 – 80	Azimuth:	326	Height (m):	25 – 30	Length (m):	63	Vegetation Cover:	50 – 60% cover. Generally comprises ground cover and trees.	Ditch Details:	None
Roughness (Profile):	Rough	Verge Details:	1 -5m								

Engineering Description of Rock:

Very strong thinly foliated dark grey schist. Contains occasional thin quartz foliations (PSAMMITE).

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	27	156	0.02 – 1m	>20m	Curved, Planar, Rough	<0.1 – 1mm	None.	None.	
2	Joint	88	021	0.02 – 0.5m	0.05 – 2m	Stepped, Rough	<0.1 – 1mm	None.	None.	
3	Joint	74	91	0.05 – 1.5m	0.05 – 4m	Curved, Stepped, Smooth	<0.1 – 0.25mm	None.	None.	

Existing Netting Details or other remedial work details:									
Netting Type	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
PVC coated double twist	16mm galvanised	7	25mm galvanized bars?	Galvanised eye nuts?	?	Spenax rings	No	None	

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 7	0.8 – 1.6

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Toppling	7.8	30	
2	Ravelling	4	0.02	

SUMMARY		**Comments**
Overall Hazard Rating =	4	
Pathway Rating =	3	
Receptor Rating =	1	
Risk Value =	**12**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
Heavy scaling of pillar.	3	Within 3 yrs.

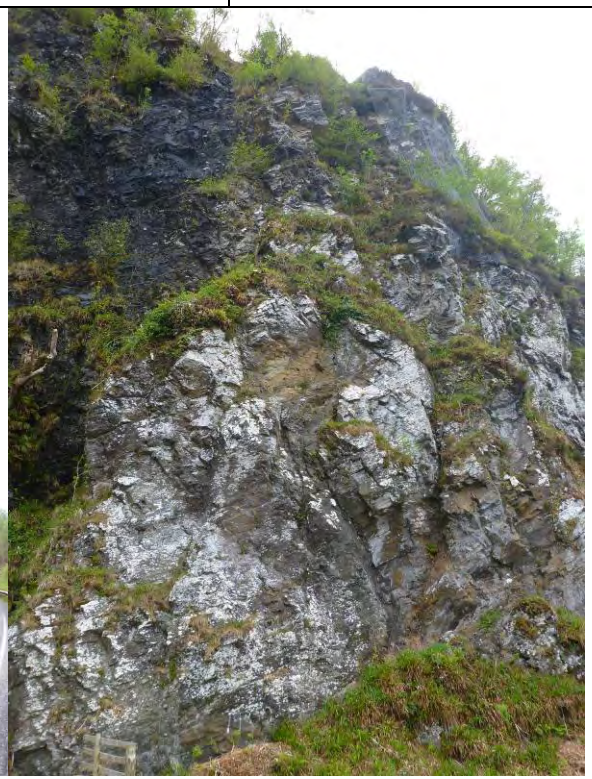
Assessed in field by: RA	**Date:** 16/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA9	**Chainage:**	1925 - 1967	**Start Grid Ref:**	NG 90299, 37050	**End Grid Ref:**	NG 90338, 37064	**Elevation:**	12 mAOD





Rock Slope Characteristics:

Dip:	82	Azimuth:	350	Height (m):	30	Length (m):	42	Vegetation Cover:	20% cover. Generally comprises grass and small to medium trees.	Ditch Details:	None
Roughness (Profile):	Rough	Verge Details:	1.4m								

Engineering Description of Rock:

Strong thinly foliated dark grey medium schist. Some foliations are mica rich. Small ‘z’ folds were noted. (PSAMMITE).

URS

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	29	120	0.015 – 0.7m	>20m	Straight, Undulating, Rough	<0.1 – 4mm	None	None	
2	Joint	76	027	0.05 – 0.3m	0.3 – 3m	Straight, Planar, Smooth	<0.1 – 5mm	None	None	
3	Joint	68	338	0.03 – 1m	0.2 – 4m	Straight, Planar, Smooth	<0.1 – 10mm	None	None	
4	Joint	74	185	0.5 – 1m	10m	Curved, Planar, Rough	<0.1mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	16mm galvanised	5?	25mm stainless steel bars	Stainless steel eye nuts	3?	Spenax rings	No	None	No netting on lower 15m of slope. 0.2 – 0.3m gap between bottom cable and rock face.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 10 Ch 1906: heavy scaled area - keep under observation. Clear out ditch.	0.4 – 1.3

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Joint set 4
2	Plane	Joint sets 2 and 3
3	Wedge	Joint sets 2 and 3

Developing Hazards Observed (Considered likely to fail with the next 5 years):

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Blockfall	25	0.05	
2	Ravelling	5 – 30	0.004	

SUMMARY		Comments
Overall Hazard Rating =	2	
Pathway Rating =	1	
Receptor Rating =	1	
Risk Value =	**2**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Keep under observation.	2	NA

Assessed in field by: RA	**Date:** 16/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA10	**Chainage:**	1967 – 2140	**Start Grid Ref:**	NG 90338, 37064	**End Grid Ref:**	NG 90486, 37126	**Elevation:**	15 mAOD

Rock Slope Characteristics:

Dip:	85	Azimuth:	332	Height (m):	40	Length (m):	173	Vegetation Cover:	40% cover. Generally comprises grass and small to medium sized trees, with occasional large trees.	Ditch Details:	Slight ditch at start of AA10 - Width 1.7, Depth 0.4	Roughness (Profile):	Rough	Verge Details:	Generally 10m, but 1m minimum.

URS

Engineering Description of Rock:
Very strong thinly foliated dark grey and white fine to medium schist. Contains thin laminations of quartz. (PSAMMITE)

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	30	105	0.01 – 0.5m	>20m	Straight, Planar, Smooth	<0.1 – 5mm	None	None	
2	Joint	62	275	0.1 – 1.2m	0.3 – 0.4m	Straight, Planar, Smooth	<0.1 – 5mm	None	None	
3	Joint	65	180	0.5m	>2.2m	Curved, Undulating, Smooth	<0.1 – 10mm	None	None	
4	Joint	80	350	0.3 – 0.5	0.5m	Straight, Planar, Smooth	<0.1mm	None	None	

Existing Netting Details or other remedial work details:
None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = NA Ch 2053: large partially undercut block on small ridge – keep under observation – annual inspections.	1.7 – 3.3

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Joint set 3
2	Plane	Joint sets 2 and 4
3	Wedge	Joint sets 4 and 2

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Wedge	10	4.5	CH 1991; CH2075
2	Plane	40	13.5	
3	Ravelling	20 – 40	0.004	Seen all over face
4	Blockfall	40	3	CH 1971 (1 observed)

SUMMARY		Comments
Overall Hazard Rating =	4	
Pathway Rating =	2	
Receptor Rating =	1	
Risk Value =	**8**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Installation of catch fence at toe of slope.	4	Within 3 yrs

Assessed in field by:	RA	Date:	16/5/12	Reviewed by:	LN	Date:	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA11	**Chainage:**	2343 - 2387	**Start Grid Ref:**	NG 90665, 37240	**End Grid Ref:**	NG 90691,37250	**Elevation:**	10 mAOD

Rock Slope Characteristics:

Dip:	80	Azimuth:	322	Height (m):	20	Length (m):	44	Vegetation Cover:	60% cover comprising heather, grass and some sapling trees.	Ditch Details:	0.4m deep, 0.6m wide	Roughness (Profile):	Rough	Verge Width:	0.3m min.

Engineering Description of Rock:

Extremely strong thinly foliated dark grey and white SCHIST. Foliations comprise quartz. Approximately the same quantity of dark grey and white foliations. (PSAMMITE)

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	30	146	0.05 – 0.5m	>20m	Straight, Planar, Smooth	<0.1 – 1mm	None	None	
2	Joint	64	169	0.2 – 0.7m	0.02 - 2m	Smooth, Planar, Smooth	<0.1 – 30mm	None	None	
3	Joint	78	282	0.05 – 1.5m	1.0 – 5.0m	Smooth, Planar, Smooth	<0.1 -5mm	None	None	
4										

Existing Netting Details or other remedial work details:									
Netting Type	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
None	16mm galvanised	5 – 6m	25mm stainless bars (2 No. platipus anchors)	Stainless eye nuts (M20 thread)	4 No.	2 staggered rows of spenax rings every aperture	No	None	No bimetallic corrosion protection between cable and eye nuts.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = <1 Recommended Remedial Works: None	1.7

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Wedge	Set 3 & 2
2	Plane	Set 2
3		

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Wedge	7.0	0.4	Under netting
2	Ravelling	5.0	0.004	
3				

SUMMARY		**Comments**
Overall Hazard Rating =	2	
Pathway Rating =	2	
Receptor Rating =	1.4	
Risk Value =	**2.4**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Clear failed material from behind base of netting. - Install bimetallic corrosion protect where this is missing.	2.4	3-5 years

Assessed in field by:	RA	**Date:**	17/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 Stromeferry Bypass	**Slope Ref:** AA12	**Chainage:** 2387 - 2450	**Start Grid Ref:** NG 90619, 37250	**End Grid Ref:** NG 90742, 37319	**Elevation:** 20 mAOD

Rock Slope Characteristics:

Dip:	80	Azimuth:	306	Height (m):	20	Length (m):	63	Vegetation Cover:	40% ground cover b (gorse, heather, ferns) and small to medium trees.	Ditch Details:	None in part, otherwise: 1.1m deep, 2.8m wide

Roughness (Profile):	Rough	Verge Width:	0m

Engineering Description of Rock:

Very strong dark to light grey very narrowly banded crystalline coarse to medium grained SCHIST.

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Joint	82	288	0.15 – 0.5m	>15m	Straight, stepped, rough	<3 – 4mm	None	None	
2	Joint	37	270	0.05 – 1.0m	0.5 – 1.5m	Straight, stepped, smooth	<0 – 1mm	None	None	
3	Joint	62	340	1.0 – 2.0m	0.1 – 0.5m	Straight, stepped, rough	Not seen	None	None	
4	Foliation	27	102	0.1 – 1.0m	0.5m	Wavy, undulating, smooth	0 – 20mm	None	None	

Existing Netting Details or other remedial work details:	
None	
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 8 Recommended Remedial Works: None	2.4 – 3.7

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Wedge	Set 1 & 3, 2 & 3.
2	Plane	Set 2 & 3
3		

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Planar	7.0	30	Not joint to fail in the near future. Joints are tight.
2	Blockfall	10.0	0.008	
3	Ravelling	6.0	0.125	Total volume

SUMMARY		Comments
Overall Hazard Rating =	4	
Pathway Rating =	3	
Receptor Rating =	1	
Risk Value =	**12**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Bolt individual potential block failures	2	3-5 years

Assessed in field by:	RA	**Date:**	17/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 Stromeferry Bypass	**Slope Ref:** AA13	**Chainage:** 2450 - 2550	**Start Grid Ref:** NG 90742, 37319	**End Grid Ref:** NG 90795, 37399	**Elevation:** 12 mAOD

Rock Slope Characteristics:

Dip:	70 to 80	Azimuth:	301	Height (m):	25 to 30	Length (m):	100	Vegetation Cover:	50-60% cover. Generally comprises ground cover and trees.	Ditch Details:	0.5m deep, 1.0m wide. Bund half way along

Roughness (Profile):	Rough	Verge Width:	1-4m

URS

Engineering Description of Rock:
Very strong thickly foliated GNEISS with quartz rich bands.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	20	068	0.2 – 1.0m	>20m	Curved, planar, rough	<0.1mm	None	None	
2	Joint	85	282	0.3 – 2.0m	2.0 – 6.0m	Curved, planar, rough	<0.1 – 2.5mm	None	None	
3	Joint	50	312	1.0 – 4.0m	3.0m	Straight, planar, rough	0.1-0.25mm	None	None	
4	Joint	80	194	1.0 – 4.0m	2-8m	Curved, undulating, rough	0.1-0.25mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	12mm galvanised	5.5	25mm stainless steel bars	Stainless steel eye nuts	3	3 rows of spenax rings every third aperture.	No	8mm cable at 1m centres	Not all of the face netted

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 8 Recommended Remedial Works: Ch 2404 – 2491: Remove vegetation from rock slope in crest area.	3.7 – 7.4

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Wedge	Set 3 & 4.
2	Plane	Set 3
3		

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Wedge	20	3	Wedge at Ch 1532
2	Planar	10 - 20	0.5 – 1.0	Within area without netting
3		6		

SUMMARY		Comments
Overall Hazard Rating =	3	
Pathway Rating =	3	
Receptor Rating =	1.2	
Risk Value =	**10.8**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Add reinforcing cables across wedge failure (Ch 1532) - Install netting Ch 2540 - 2550	3.6	3-5 years

Assessed in field by:	RA	**Date:**	17/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA13/14 Upper	**Chainage:**	2505 – 2650	**Start Grid Ref:**	NG 90830, 37319	**End Grid Ref:**	NG 90904, 37388	**Elevation:**	90 mAOD

Rock Slope Characteristics:

Dip:	50 – 80	Azimuth:	320	Height (m):	7 – 8	Length (m):	145	Vegetation Cover:	Ferns, grass/ground cover and fir trees.	Ditch Details:	None
Roughness (Profile):	Rough	Verge Details:	1-4m								

Engineering Description of Rock:

Strong to very strong narrowly banded crystalline coarse grained GNEISS.

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	28	120	0.06 – 1.5m	5m	Wavy, Undulating, Rough	1 – 10mm	None	None	
2	Joint	88	205	0.2 – 1.7m	2m	Straight, Undulating, Rough	2 – 10mm	None	None	
3	Joint	70	300	0.5 – 1m	3m	Straight, Planar, Rough	15 – 50mm	None	None	

Existing Netting Details or other remedial work details:	
None	
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
Not previously inspected.	4.1 – 8.2

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Toppling	90m above road	6.6	
2	Blockfall	90m above road	0.5	Gouging of blocks in root balls of fallen trees.

SUMMARY		Comments
Overall Hazard Rating =	3	
Pathway Rating =	2	
Receptor Rating =	1.2	
Risk Value =	**7.2**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
-Controlled removal of blocks -Include in future inspections	2.4	Within 3 yrs

Assessed in field by:	RP	**Date:**	17/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA14E	**Chainage:**	2614 – 2650	**Start Grid Ref:**	NG 90883, 37435	**End Grid Ref:**	NG 90868, 37444	**Elevation:**	11 mAOD

Rock Slope Characteristics:

Dip:	86	Azimuth:	347	Height (m):	30	Length (m):	36	Vegetation Cover:	5 – 10% cover. Some grass with occasional sapling and gorse at crest of rock slope.	Ditch Details:	Width 1.2 Depth 0.8	Roughness (Profile):	Rough	Verge Details:	25m

Engineering Description of Rock:

Strong thinly foliated dark grey fine to medium grained SCHIST. Contains occasional thin foliations of quartz. Some laminations were noted to be mica rich. (PSAMMITE)

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	18	120	0.01 – 0.7m	>20m	Curved, Planar, Rough	<0.1 – 0.5mm	None	None	
2	Joint	72	024	0.03 – 0.5m	0.3 – 1m	Straight, Planar, Smooth	<0.1 – 0.1mm	None	None	
3	Joint	68	287	0.1 – 0.5m	0.2 – 1.2m	Straight, Planar, Smooth	<0.1 – 0.2mm	None	None	
4	Joint	47	326	0.3 – 5m	0.3 – 0.5m	Straight, Undulating, Smooth	Can't measure	None	None	

Existing Netting Details or other remedial work details:	
Catch fence at toe. 2 m high, posts at 6m centres (140mm diameter, 8mm thick steel tubes. Fence constructed from double twist netting with 16mm horizontal stainless steel reinforcing cables at 0.4m vertical spacing. No damage/defects observed.	
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 8	0.7 – 1.4

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Planar	Joint sets 2, 3 and 4
2	Wedge	Joint sets 2 and 4, 2 and 3, 3 and 4

Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Wedge	15	0.25	
2	Planar	17	3	
3	Blockfall	25	0.015	
4	Ravelling	20	0.002	

SUMMARY		**Comments**
Overall Hazard Rating =	3	
Pathway Rating =	1	
Receptor Rating =	1.4	
Risk Value =	**4.2**	
Risk Level =	**Low**	

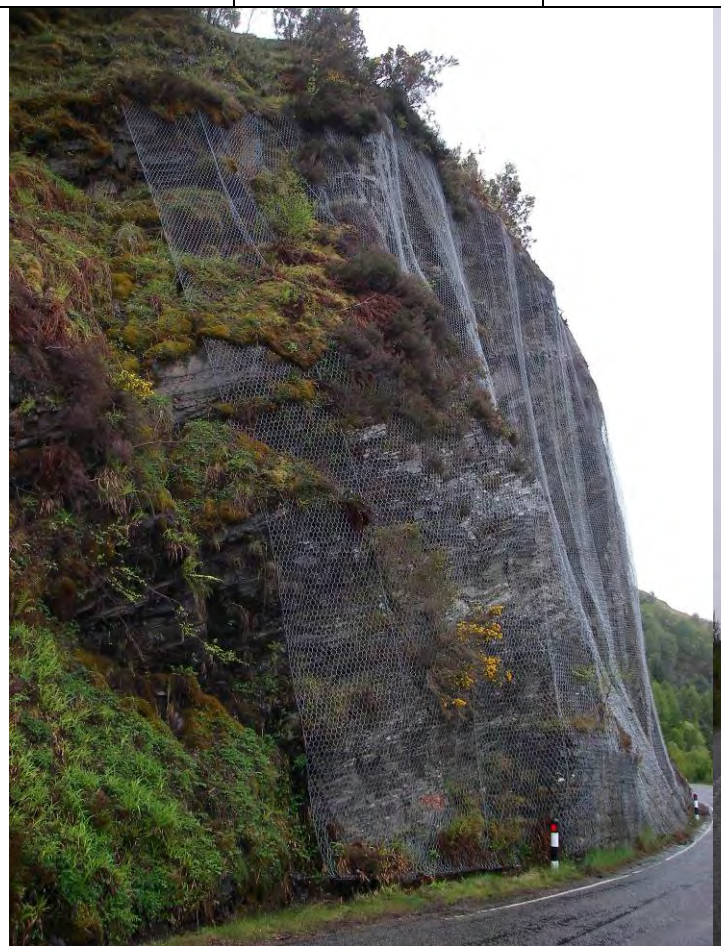
Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
Observation, remove any failed material if failure occurs	4.2	NA

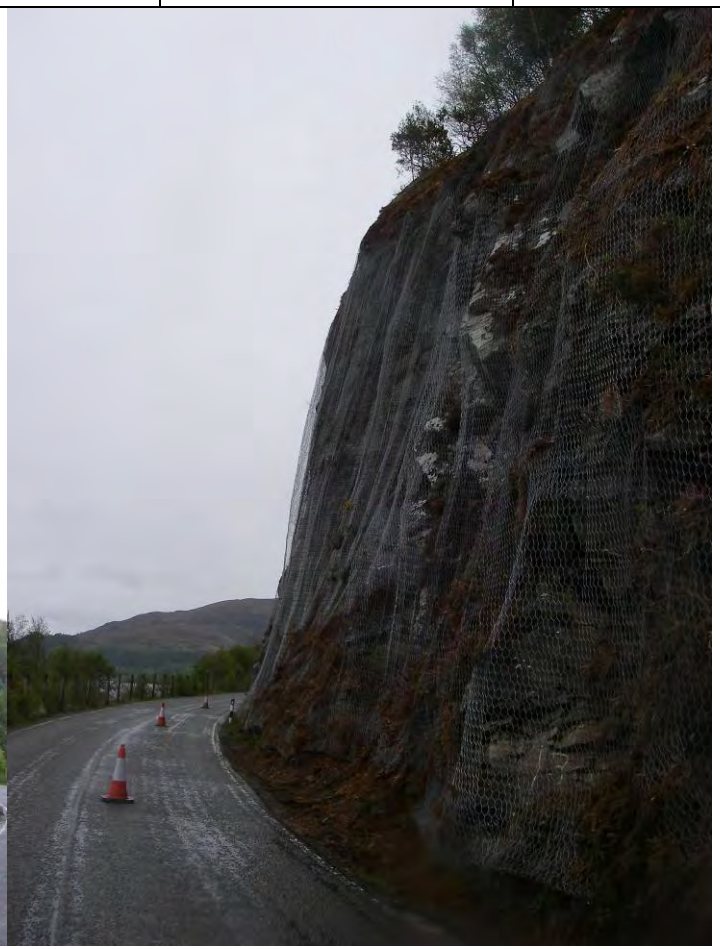
Assessed in field by:	RA	**Date:**	17/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA14W	**Chainage:**	2250 – 2614	**Start Grid Ref:**	NG 90795, 37399	**End Grid Ref:**	NG 90833, 37435	**Elevation:**	12 mAOD





Rock Slope Characteristics:

Dip:	75	Azimuth:	324	Height (m):	15	Length (m):	364	Vegetation Cover:	20% gorse	Ditch Details:	Width 1.0 Depth 0.3	Roughness (Profile):	Rough	Verge Details:	0.4m

URS

Engineering Description of Rock:

Extremely strong to very strong grey and pink medium banded crystalline coarse grained GNEISS.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	25	66	0.01 – 2m	15m+	Wavy, Undulating, Rough	0 – 15mm	None	None	
2	Joint	81	122	0.2 – 0.5m	1 – 5m	Straight, Undulating, Rough	0mm	None	None	
3	Joint	50	184	0.3 – 1m	15m+	Straight, Planar, Smooth	0-1mm	None	None	
4	Joint	45	35	0.5 – 1m	2 – 4m	Straight, Stepped, Rough	1 – 5mm	Occasional vegetation	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	12mm galvanised	Up to 15m	Terminal anchors are 15mm bar with machine thread. Intermediate anchors are droppers (12mm) from rotting tree stumps	D shackle (connected with locking nuts on one side only)	3	2 rows of cable twist connections every fourth aperture	No	None	- Corroded terminal anchors and very poor intermediate anchors. - Incorrect use of D shakle on terminal anchors (different diameter threads). - Corroded cable clamps.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 8 Ch 2500 – 2539: Remove vegetation from rock slope at crest area. Ch 2543: Rock fall (<0.125m³) material lying on top of buttress. Keep under particular observation during periodic inspections. Rope access inspection of area above buttress.	1.5 – 4.4

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Joint set 2
2	Planar	Joint set 4

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Wedge	10	3	
2	Planar	5	2	
3	Blockfall	10	1	

SUMMARY		**Comments**
Overall Hazard Rating =	3	
Pathway Rating =	4	Only 2 No. top anchors (both rotting tree stumps) over 40m length of cable. Terminal anchors in poor condition

Receptor Rating =	1.2	
Risk Value =	**14.4**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
- Install top anchors and top cable	3.6	Within 1yr

Assessed in field by: RA	**Date:** 17/6/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA15 Upper	**Chainage:**	2710 – 2733	**Start Grid Ref:**	NG 90955, 37420	**End Grid Ref:**	NG 90971, 37437	**Elevation:**	100 mAOD

Rock Slope Characteristics:

Dip:	60 – 90	Azimuth:	335	Height (m):	6	Length (m):	23	Vegetation Cover:	Ferns and trees	Ditch Details:	None	Roughness (Profile):	Rough	Verge Details:	0.5 – 2.0m

URS

Engineering Description of Rock:
Strong grey and black narrowly banded crystalline and medium grained GNEISS.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	42	012	0.02 – 1m	>10m	Straight, Undulating, Rough	2 – 50mm	None	None	
2	Joint	48	268	0.35m	1.5m	Curved, Planar, Rough	0.2mm	None	None	
3	Joint	82	288	0.7m	>5m	Straight, Planar, Rough	Face	None	None	
4	Joint	43	280	0.012 – 0.7m	1.3m	Straight, Planar, Rough	0 – 1mm	None	None	
5	Joint	70	000	0.4m	>4m	Straight, Planar, Rough	3mm	None	None	

Existing Netting Details or other remedial work details:
None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = NA	3.3 – 6.6

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Foliation, Joint set 2 and joint set 5
2	Wedge	Joint set 1 and 3, 1 and 2, 2 and 4, 4 and 3.

Developing Hazards Observed (Considered likely to fail with the next 5 years):

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Blockfall	100 (above road level)	4	Block is undercut and wedged in behind a flake that shows signs of dilation
2	Ravelling	100 (above road level)	0.025	
3				

SUMMARY		Comments
Overall Hazard Rating =	3	
Pathway Rating =	5	
Receptor Rating =	1.2	
Risk Value =	**18**	
Risk Level =	**Very high**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Controlled removal of block using pyrotechnic breaking capsules	4.8	Within 1 yr

Assessed in field by: RP	**Date:** 17/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA15	**Chainage:**	2650 – 2800	**Start Grid Ref:**	NG 90868, 37444	**End Grid Ref:**	NG 91005, 37551	**Elevation:**	18 mAOD

Rock Slope Characteristics:

Dip:	75	Azimuth:	335	Height (m):	25 - 30	Length (m):	150	Vegetation Cover:	50% cover. Generally comprised ground cover.	Ditch Details:	None	Roughness (Profile):	Rough	Verge Details:	0.5 – 2.0m

Engineering Description of Rock:

Very strong thickly foliated dark GNEISS with pinkish quartz bands.

URS

Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	18	110	0.1 – 1m	>20m	Curved, Planar, Rough	<0.1 – 0.5mm	None	None	
2	Joint	86	286	0.3 – 3m	0.5 – 2m	Straight, Undulating, Rough	<0.1 – 0.2mm	None	None	
3	Joint	56	031	>6m	3 – 10m	Straight, Planar, Rough	Not seen	None	None	
4	Joint	82	174	3 – 6m	0.5 – 2m	Wavy, Undulating, Rough	Not seen	Occasional vegetation	None	

Existing Netting Details or other remedial work details:									
Netting Type	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
PVC coated double twist	12mm galvanised	4 – 7m	25mm? stainless bars and occasional platypus anchors (6mm stainless cable)	Stainless eye nuts (bar machined to M20 thread) and 150mm stainless faceplates	3	2 rows of spenax rings	No	8mm cable at 1m spacing (3 cable clamps)	

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 9 Ch 2592 – 2760: Remove vegetation from rock slope and crest area	2.6 – 5.2

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Planar	Joint set 3
2	Toppling	Joint set 4
3	Wedge	Joint set 2 and 3

Developing Hazards Observed (Considered likely to fail with the next 5 years):				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Planar	10 - 20	6	Ch 2700
2				
3				

SUMMARY		**Comments**
Overall Hazard Rating =	3	
Pathway Rating =	2	
Receptor Rating =	1.2	
Risk Value =	**7.2**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
- Add reinforcing cable across at potential failure Ch 2700 - Ch 2788 create bund	3.6	3 -5yrs

Assessed in field by: RA	**Date:** 17/6/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA16	**Chainage:**	2800 - 2894	**Start Grid Ref:**	NG 91005, 37551	**End Grid Ref:**	NG 91069, 37600	**Elevation:**	18 mAOD

Rock Slope Characteristics:

Dip:	60 – 75	Azimuth:	322	Height (m):	15 - 20m	Length (m):	94	Vegetation Cover:	25% cover. Generally comprised ground cover	Ditch Details:	None	Roughness (Profile):	Rough	Verge Details:	1m

URS

Engineering Description of Rock:
Very strong thinly foliated dark grey schist. (PSAMMITE)

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	25	138	0.1 – 1m	>20m	Curved, Stepped, Rough	<0.1mm	None	None	
2	Joint	60	287	0.5 – 2m	2m	Wavy, Undulating, Rough	0.5 – 2mm	None	None	
3	Joint	50	318	0.5 – 1m	4m	Straight, Undulating, Rough	Not seen	None	None	
4	Joint	80	005	1 – 3m	1 – 2m	Straight, Planar, Rough	1mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	16mm galvanised	4 - 5	25mm galvanized bars	Galvanised eye nuts	3	3 rows of galvanised spenax rings	No	None?	At each top anchor on the top cable an additional dowel is located approximately 2m above and connected to the main cable with a 16mm dropper cable.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 9	3.7 – 7.4

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Joint set 2 and 3
2	Wedge	Joint sets 2 and 3, 3 and 4, 2 and 4

Hazards Observed:
None observed

SUMMARY		Comments
Overall Hazard Rating =	1	
Pathway Rating =	1	
Receptor Rating =	1	
Risk Value =	**1**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Maintain netting	1	NA

Assessed in field by: RA	**Date:** 17/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA16-AA17 Upper	**Chainage:**	2766 – 2901	**Start Grid Ref:**	NG 91016, 37460	**End Grid Ref:**	NG 91089, 37577	**Elevation:**	50 mAOD



Rock Slope Characteristics:

Dip:	70 - 80	Azimuth:	322	Height (m):	60 (3 cliffs separated by 40 - 50 ° slope	Length (m):	135	Vegetation Cover:	Ferns, brambles and trees	Ditch Details:	None	Roughness (Profile):	Rough	Verge Details:	1m

URS

Engineering Description of Rock:
Strong very narrowly banded grey crystalline coarse grey GNEISS.

Principal Discontinuities:

Slope section	Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
AA16 – AA17 Upper West	1	Joint	80	300	0.2 – 0.6m	>10m	Straight, Planar, Rough	<200mm	None	None	
	2	Joint	85	192	2.5m	6m	Straight, Planar, Rough	Forms faces	None	None	
	3	Foliation	40	134	0.015 – 4m	1m	Wavy, Undulating, Rough	0 – 1mm	None	None	
AA16 – AA17 Upper East	1	Joint	78	100	0.1 – 0.6m	3 – 4m	Straight, Stepped, Rough	1 – 30mm	None	None	
	2	Joint	75	193	0.7m	1 – 2m	Wavy, Stepped, Rough	Forms faces	None	None	
	3	Foliation	18	130	0.2 – 1m	3m	Straight, Planar, Rough	0 – 5mm	None	None	

Existing Netting Details or other remedial work details:
None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
Not previously inspected	3.3 – 6.6

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Foliation
2	Wedge	Joint set 3 and 4

Developing Hazards Observed (Considered likely to fail with the next 5 years):

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Blockfall	100m above road	0.5	
2	Toppling	85m above road	0.6	5 No. at one location (NG 91054, 37487)
3	Planar	60m above road	1.875	

SUMMARY		Comments
Overall Hazard Rating =	3	Only ~1/4 of rock inspected due to vegetation cover
Pathway Rating =	3	
Receptor Rating =	1.2	
Risk Value =	**10.8**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Controlled removal of large blocks Light scaling	3.6	1 yr

Assessed in field by: RP	**Date:** 17/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA17	**Chainage:**	2894 - 2958	**Start Grid Ref:**	NG 91069, 37600	**End Grid Ref:**	NG 91127, 37628	**Elevation:**	11 mAOD

Rock Slope Characteristics:

Dip:	80	Azimuth:	322	Height (m):	20	Length (m):	135	Vegetation Cover:	10% ground cover (moss, ferns, heather, gorse)	Ditch Details:	Width 1.0m Depth 0.3m	Roughness (Profile):	Rough	Verge Details:	1 – 3m

URS

Engineering Description of Rock:

Extremely strong to very strong dark grey narrowly banded crystalline medium grained GNEISS.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Joint	88	285	0.5 – 2m	15m	Straight, Planar, Smooth	0 – 50mm	None	None	
2	Foliation	30	135	0.1 – 0.7m	20m+	Wavy, Undulating, Rough	0 – 5 mm	Occasional quartz	None	
3	Joint	70	088	0.4 – 5m	1 – 10m	Wavy, Stepped, Rough	0 – 10 mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	20mm galvanised	2.5m	25mm galvanized bar driven using sledge hammer?	None	2	Netting joined with cable twists and lacing wire	No	None	It would appear that the bars have been driven in using a sledge hammer as there are burr marks on the top of each bar and various lengths are sticking out of the ground (up to 0.5m). There are several breaks in the top cable where large turnbuckles have been included in the construction.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 13 Ch 2860: column of fractured rock under the netting by "Hughie MacKenzy" graffiti – keep under observation during periodic and annual inspections.	2.5 – 7.5

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Planar	2.5	3	Failed and resting on netting

SUMMARY		Comments
Overall Hazard Rating =	3	
Pathway Rating =	4	
Receptor Rating =	1.2	
Risk Value =	**14.4**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Ch 2918 – 2958: new top anchors and cable. Addition of spenax jointing to old netting. Also remove failed mass from behind netting.	3.6	3 yrs

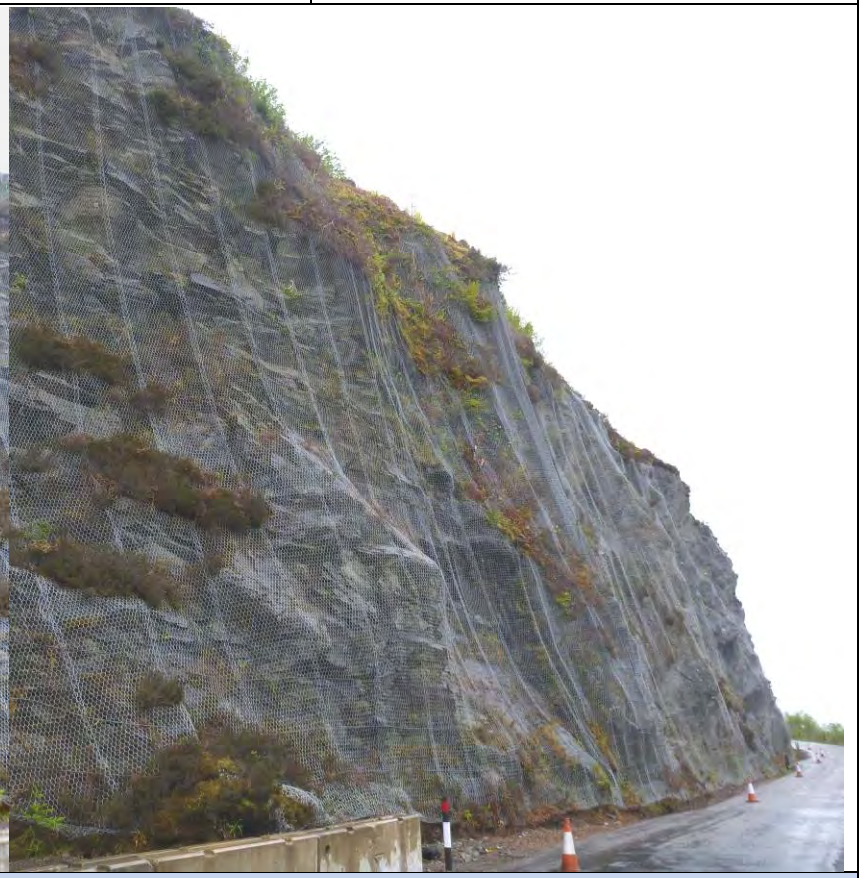
Assessed in field by: RA	**Date:** 17/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA18	**Chainage:**	2958 – 3050	**Start Grid Ref:**	NG 91127, 37628	**End Grid Ref:**	NG 91198, 37638	**Elevation:**	10 mAOD





Rock Slope Characteristics:

Dip:	76	Azimuth:	346	Height (m):	15	Length (m):	92	Vegetation Cover:	20% cover. Generally comprised grass, moss and heather	Ditch Details:	Width 1.0m Depth 0.4m (ditch clear and contains running water)	Roughness (Profile):	Rough	Verge Details:	1.2m

URS

Engineering Description of Rock:
Extremely strong thinly foliated dark grey SCHIST. Contains occasional thin foliations of quartz.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	42	149	0.001 – 1.5m	>20m	Straight, Undulating, Smooth	<0.1 – 3mm	None	None	
2	Joint	57	011	0.4 – 1.1m	0.1 – 3m	Straight, Planar, Smooth	<0.1mm	None	None	
3	Joint	82	301	0.3 – 2m	1 – 4m	Straight, Planar, Smooth	<0.1 - 1mm	None	None	
4	Joint	85	201	0.2 – 5m	1 – 3m	Straight, Undulating, Smooth	<0.1 - 3mm	None	None	
5	Joint	55	345	3m	0.5 – 5m	Straight, Undulating, Smooth	<0.1mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	8mm galvanised, later reinforced with a 12mm galvanised cable connected with cable clamps every 1 – 2m	5m (12m top cable) & 15m (8mm top cable)	Platipus anchors (6mm stainless cable) on 12mm top cable. Dead tree stumps on 8mm top cable.	Crimped connection on platipus anchor cable. Top cable threaded through loop.	2?	2 rows of wire twists every 0.3m	No	8mm cable at 1m spacing (3 cable clamps)	Some netting panels are not lapped around the top cable directly, but begin approximately 3-5m below and are connected to loops of 8mm cable running down from the top cable.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 11 Clear out ditch	1.7 – 3.3

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Foliation
2	Planar	Joint set 5 and 2
3	Wedge	Joint sets 4 and 5, 5 and 3, 5 and 2, 2 and 3

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Planar	10	0.3	
2	Wedge	10	0.4	

SUMMARY		Comments
Overall Hazard Rating =	2	
Pathway Rating =	1	
Receptor Rating =	1.2	
Risk Value =	**2.4**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
None	N/A	N/A

Assessed in field by: RA	**Date:** 17/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA19 Upper	**Chainage:**	3050 - 3123	**Start Grid Ref:**	NG 91198, 37638	**End Grid Ref:**	NG 91278, 37685	**Elevation:**	60 mAOD

Rock Slope Characteristics:

Dip:	70	Azimuth:	285	Height (m):	50	Length (m):	73	Vegetation Cover:	60% cover. Grass, ferns and trees	Ditch Details:	Width 0.9m Depth 0.4m (ditch clear with some standing water)	Roughness (Profile):	Rough	Verge Details:	0m

URS

Engineering Description of Rock:

Strong very narrowly banded grey crystalline coarse grained GNEISS.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	40	215	0.2 – 2m	2 – 3m	Wavy, Undulating, Rough	0 – 1mm	None	None	
2	Joint	80	270	0.1 – 0.4m	>3m	Straight, Undulating, Smooth	2 – 10mm	None	None	
3	Joint	40	315	2 – 5m	0.5m	Straight, Planar, Smooth	Forms face	None	None	
4	Joint	75	000	1m	0.3m	Wavy, Undulating, Rough	Forms face	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
4 No. rock dowels with 2 No. horizontal cables holding tree stump on the face. 1 No. spot rock dowel, placed to secure single block not grouted to surface and face plate not attached									

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
NA	2.2 – 6.6

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Foliation, Joint set 3
2	Wedge	Joint set 3 and 4

Developing Hazards Observed (Considered likely to fail with the next 5 years):

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Blockfall	60	0.5 – 1.0	
2	Planar	60	0.5 – 1.0	
3	Ravelling	60	0.125	
4	Root jacking	60	0.125	

SUMMARY		Comments
Overall Hazard Rating =	2	
Pathway Rating =	3	
Receptor Rating =	1	
Risk Value =	**6**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
-Scale face -Remove 2m^3 tree stump currently retained by cable straps and add nut to existing rock dowel to secure face plate -Remove fallen/cut logs from above AA19	3	1 yr

Assessed in field by: RP	**Date:** 17/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA19	**Chainage:**	3050 – 3123	**Start Grid Ref:**	NG 91198, 37638	**End Grid Ref:**	NG 91278, 37685	**Elevation:**	10 mAOD

Rock Slope Characteristics:

Dip:	74	Azimuth:	341	Height (m):	25	Length (m):	73	Vegetation Cover:	5% cover. Grass and ferns	Ditch Details:	Width 0.9m Depth 0.4m (clear with some standing water)	Roughness (Profile):	Rough	Verge Details:	0m

URS

Engineering Description of Rock:
Very strong thinly foliated dark grey fine to medium grained SCHIST. Contains occasional thin foliations of quartz. (PSAMMITE).

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	24	166	0.1 – 0.5m	>20m	Wavy, Planar, Smooth	<0.1 – 1mm	None	None	
2	Joint	86	011	0.4 – 2m	0.3 – 4m	Straight, Planar, Rough	<0.1mm	None	None	
3	Joint	86	280	0.1 – 4m	0.7 – 6m	Curved, Undulating, Smooth	<0.1 - 1mm	None	None	
4	Joint	32	316	1 – 5m	3 – 8m	Straight, Undulating, Smooth	<0.1mm	None	None	

Existing Netting Details or other remedial work details:

Tecco netting with 12mm galvanised top cable and typical anchor spacing of 2.5 to 3.5m. Top anchors are 25mm, 28mm solid galvanised bar and 32mm hollow galvanised bar with galvanised eye nuts & 4 No. cable clamps. Netting lap connection is Tecco T3 clips. Vertical/Diagonal Reinforcing cables (12mm galvanised) strategically placed to profile netting (Tecco T1 clips to secure to netting). 37 No. rock bolts (28mm) installed within block and left buttress.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = <1	2.1 – 4.2

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Joint set 4
2	Wedge	Joint set 2 and 4

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments

SUMMARY		Comments
Overall Hazard Rating =	1	
Pathway Rating =	1	
Receptor Rating =	1	
Risk Value =	**1**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
None	N/A	N/A

Assessed in field by:	RA	Date:	17/5/12	Reviewed by:	LN	Date:	5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA20	**Chainage:**	3123 – 3187	**Start Grid Ref:**	NG 91278, 37685	**End Grid Ref:**	NG 91330, 37738	**Elevation:**	13 mAOD

Rock Slope Characteristics:

Dip:	80 (rock slope)	Azimuth:	326	Height (m):	40m (10m immediately next to road)	Length (m):	64	Vegetation Cover:	80% ground cover, trees above 20m up the slope	Ditch Details:	None
Roughness (Profile):	Rough	Verge Details:	None								

Engineering Description of Rock:

Lower slope adjacent to the road - very strong to strong dark grey mottled pink narrowly banded crystalline coarse grained GNEISS.
Upper slope - very strong to strong dark grey mottled pink very narrowly banded crystalline medium grained SCHIST.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Joint	5	125	2 – 0.15m	5 -10m	Straight, Planar, Rough	1 – 20mm	None	None	
2	Joint	82	180	0.23 – 2.1m	1 – 3m	Straight, Stepped, Rough	1 – 3mm	None	None	

3	Joint	62	015	2.4m	4m	Straight, Stepped, Rough	5 – 20mm	Some vegetation	None	
4	Joint	85	278	0.07 – 0.35m	0.5 – 1m	Straight, Stepped, Rough	1 – 3mm	None	None	
5	Joint	68	299	0.05 – 2m	5m	Straight, Stepped, Rough	1 – 3mm	Some vegetation	None	
6	Joint	20	337	1 – 3m	0.1 – 1.5m	Wavy, Rough, Undulating	0 – 10mm	None	None	

Existing Netting Details or other remedial work details:

- 4 No. rock dowels / bolts adjacent to the avalanche shelter bar approx 20mm diameter, 150mm*150mm face plate. Bar length etc unknown
- Concrete and steel retaining wall/debris trap between ch3123 & ch3156, 3.4m high 33m long
- Concrete block with 10No, ground anchors on upper slope, details unknown. Below this is temporary works that have been left in place and consist of a catch fence of Maccaferri double twist netting between 2 tall tree stumps supported by cable to nearby rock out crop and a catch fence of railway sleepers between 2 tree stumps.

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 5 Ch 3080: 'I' beam post – the measurements do not enable monitoring of the whole wall. Hence, additional telltales and an inclinometer should be installed. The 'I' beams require maintenance to treat existing corrosion and to protect the steel work from further corrosion. Clear culverts.	3.3 – 6.7

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Joint sets 5 and 3
2	Wedge	Joint sets 5 and 2, 3 and 5, 5 and 4, 3 and 4

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Toppling	2	0.75	Tight (2 – 3mm) joints not going to fail imminently
2				
3				
4				

SUMMARY		**Comments**
Overall Hazard Rating =	2	
Pathway Rating =	3	
Receptor Rating =	1.2	
Risk Value =	**7.2**	
Risk Level =	**Moderate**	

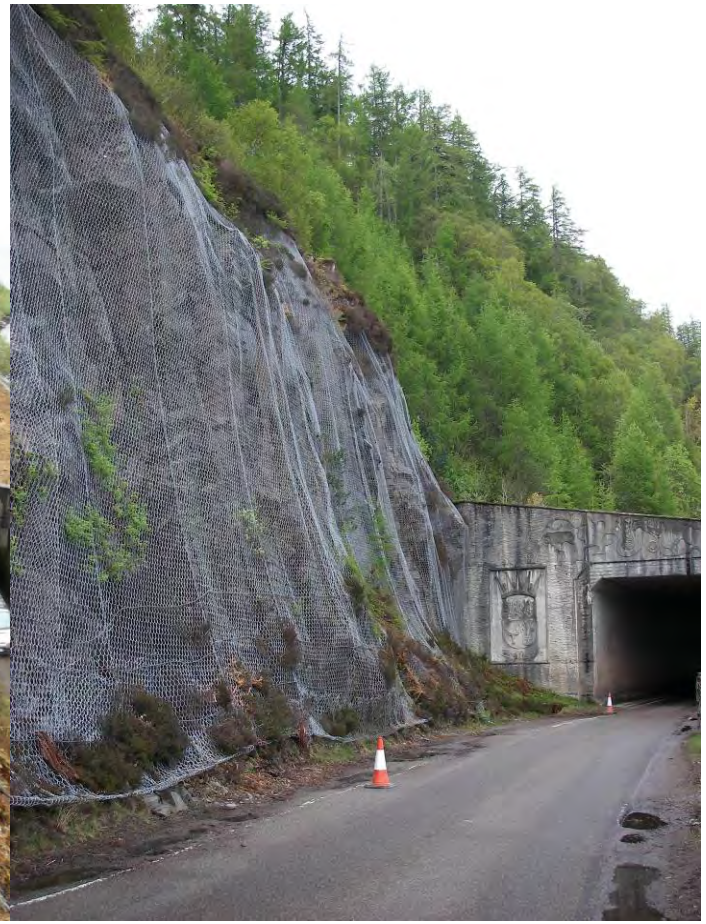
Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
1 No. rock dowel Clear out base of gully behind fence	1.2	3 – 5 yrs

Assessed in field by: RA	**Date:** 18/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA21	**Chainage:**	3245 – 3345	**Start Grid Ref:**	NG 91377, 37769	**End Grid Ref:**	NG 91446, 37824	**Elevation:**	18 mAOD



Rock Slope Characteristics:

Dip:	75	Azimuth:	320	Height (m):	15	Length (m):	100	Vegetation Cover:	10% cover. Generally comprises ground cover and shrubs.	Ditch Details:	None	Roughness (Profile):	Rough	Verge Details:	0.5m

URS

Engineering Description of Rock:

Very strong thinly foliated dark grey GNEISS with white quartz banding.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	45	140	0.5 – 2m	>20m	Straight, Undulating, Rough	<0.1 – 2mm	None	None	
2	Joint	90	317	Not observed	>20m	Straight, Planar	Not observed	None	None	
3	Joint	30	043	2m	3m	Straight, Planar	Not observed	None	None	
4	Joint	60	320	0.5 – 2m	6m	Straight, Planar	Not observed	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	16mm galvanised	5 – 5.5m	25mm? galvanized bars	Stainless steel eye nuts (bar machined to M20 thread)	4	2 rows of staggered spenax rings	Yes, every fourth anchor. 2 cable clamps on each side	8mm cable at 1m spacing (2 cable clamps)	Logs resting on top cable to be removed. Unused resin capsules noted at slope crest

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 8 Ch 3271: removal block next to buttress	2.0 – 6.0

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Foliation
2	Planar	Joint set 4

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Toppling	5	5	Failure at end of netting where water flows over face

SUMMARY		**Comments**
Overall Hazard Rating =	3	
Pathway Rating =	2	
Receptor Rating =	1	
Risk Value =	**6**	
Risk Level =	**Moderate**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
3 – 4 No. logs trapped under top cable to be removed Bolt and light scale unnetted area	2	3 – 5 yrs

Assessed in field by: RA	**Date:** 18/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA22A	**Chainage:**	3345 – 3404	**Start Grid Ref:**	NG 91446, 37824	**End Grid Ref:**	NG 91477, 37880	**Elevation:**	17 mAOD

Rock Slope Characteristics:

Dip:	75 - 80	Azimuth:	310	Height (m):	30	Length (m):	49	Vegetation Cover:	40% cover. Generally comprises ground cover	Ditch Details:	Width 1.0m Depth 0.3m	Roughness (Profile):	Rough	Verge Details:	2 – 5m

URS

Engineering Description of Rock:
Very strong thinly to thickly foliated dark grey GNEISS with thin pink and white quartz bands.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	50	069	0.2 -2m	>20m	Wavy, Undulating, Rough	<0.1 – 2mm	None	None	
2	Joint	88	008	0.5 – 2m	4m	Straight, Undulating, Rough	Not observed	None	None	
3	Joint	66	319	0.5 – 1m	1 – 2m	Straight, Planar, Rough	0.5 – 1mm	None	None	
4	Joint	65	355	1m	3m	Curved, Undulating, Rough	0.5 – 2 mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	12mm galvanised	5.5 – 7.0	25mm? stainless bars and occasional old 18mm machine threaded bars	Stainless steel eye nuts (bar machined to M20 thread)	3	2 rows of cable twists every fourth aperture	No	8mm cable at 1m spacing (3 cable clamps) in some areas	Western terminal anchor is loose and can be moved with hand pressure

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 11	3.8 – 7.6

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Planar	Joint sets 3 and 4
2	Wedge	Joint sets 2 and 3, 3 and 4

Developing Hazards Observed (Considered likely to fail with the next 5 years):

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Planar	5	0.5	
2	Blockfall	8 – 20	0.25 – 0.5	

SUMMARY		Comments
Overall Hazard Rating =	2	
Pathway Rating =	1	
Receptor Rating =	1	
Risk Value =	**2**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Western terminal anchor needs replacing	2	3 – 5 yrs

Assessed in field by: RA	**Date:** 18/5/12	**Reviewed by:** LN	**Date:** 5/7/12

URS

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA22B	**Chainage:**	3404 – 3556	**Start Grid Ref:**	NG 91477, 37880	**End Grid Ref:**	NG 91558, 38013	**Elevation:**	11 mAOD

Rock Slope Characteristics:

Dip:	85	Azimuth:	296	Height (m):	20	Length (m):	152	Vegetation Cover:	10% cover. Generally comprises ferns, heather and gorse	Ditch Details:	None
Roughness (Profile):	Rough	Verge Details:	1.5m								

Engineering Description of Rock:

Extremely strong dark grey and white irregular narrow banding crystalline coarse grained GNEISS. Particularly massive along this section of road.

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Principal Discontinuities:										
Set	**Type**	**Dip**	**Azi.**	**Spacing**	**Persistence**	**Roughness**	**Aperture**	**Infill**	**Seepage**	**Comments**
1	Foliation	36	108	0.2 – 3m	10m	Wavy, Undulating, Rough	<0.1 – 3mm	None	None	
2	Joint	86	307	0.2 – 0.8m	3 – 10m	Straight, Undulating, Smooth	<0.1 – 1mm	None	None	
3	Joint	80	148	1 – 2m	0.5 – 1m	Wavy, Stepped, Rough	Not seen	None	None	

Existing Netting Details or other remedial work details:										
Chainage	**Netting Type**	**Top cable**	**Typical anchor spacing (m)**	**Anchor Type**	**Cable-Anchor connection**	**No. of cable clamps**	**Netting lap connections**	**Laps on anchors**	**Vertical Reinforcing**	**Notes**
3404 – 3531	PVC coated double twist	8 mm galvanised, later reinforced with a 12mm galvanised cable connected with cable clamps every 1 – 2m	5.5	25mm? stainless bars and occasional old 18mm machine threaded bars	Stainless eye nuts(bar machines to M20 thread)	3	2 rows of cable twists ever fourth aperture	No	8 mm cable at 1m spacing (3 cable clamps) in some areas	
3532 – 3556	PVC coated double twist	12mm galvanised	8	18mm machine threaded bars	D shackle (connected with locking nuts on one side only)	2	2 rows of cable twists every fourth aperture	No	None	

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 11	5.5 – 8.2

Potential Failure Types (From Stereographic Analysis):		
Ref	**Type**	**Comments**
1	Toppling	Foliation

Developing Hazards Observed (Considered likely to fail with the next 5 years):				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Blockfall	8	12	Has potential to split netting, possibly along the seam

SUMMARY		**Comments**
Overall Hazard Rating =	4	
Pathway Rating =	3	
Receptor Rating =	1	
Risk Value =	**12**	
Risk Level =	**High**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Remove column from beneath netting and install additional reinforcement Repair damaged netting Maintain netting	2	Within 1 yr

Assessed in field by: RA	**Date:** 18/5/12	**Reviewed by:** LN	**Date:** 5/7/12

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GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA23N	**Chainage:**	3603 – 3641	**Start Grid Ref:**	NG 91586, 38053	**End Grid Ref:**	NG 91612, 38080	**Elevation:**	26 mAOD

Rock Slope Characteristics:

Dip:	60	Azimuth:	144	Height (m):	6	Length (m):	38	Vegetation Cover:	10% cover. Generally comprised gorse	Ditch Details:	None
Roughness (Profile):	Rough	Verge Details:	1.0m								

Engineering Description of Rock:

Very strong very thinly banded grey and white GNEISS.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	30	061	1 – 3m	>20m	Straight, Undulating, Rough	<5mm	None	None	
2	Joint	75	110	0.1 – 0.8m	0.5 – 3m	Curved, Planar, Rough	1 – 10mm	None	None	
3	Joint	47	172	0.5 – 2m	3 – 5m	Curved, Undulating, Rough	5mm	None	None	
4	Joint	70	190	0.5 – 2m	1 – 2m	Curved, Undulating, Rough	3 – 5mm	None	None	

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Existing Netting Details or other remedial work details:				
None				
Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):			**Current NGI 'Q' Value**	
RSHV = 1			3.0 – 6.0	
Potential Failure Types (From Stereographic Analysis):				
Ref	**Type**		**Comments**	
1	Planar		Joint set 3	
2	Wedge		Joint sets 2 and3	
Hazards Observed:				
Ref	**Type**	**Height above toe (m)**	**Size of individual failure(s) (m^3)**	**Comments**
1	Planar	3	0.008 – 0.015	
2	Ravelling	3 – 4	0.002	

SUMMARY		**Comments**
Overall Hazard Rating =	1	
Pathway Rating =	2	
Receptor Rating =	1.2	
Risk Value =	**2.4**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
Create toe ditch/bund	1.2	3 – 5 yrs

Assessed in field by: RA	**Date:** 14/5/12	**Reviewed by:** LN	**Date:** 5/7/12

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GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA23S	**Chainage:**	3590 – 3665	**Start Grid Ref:**	NG 91575, 38045	**End Grid Ref:**	NG 91634, 38098	**Elevation:**	23 mAOD

Rock Slope Characteristics:

Dip:	70	Azimuth:	324	Height (m):	8	Length (m):	75	Vegetation Cover:	5% cover. Grass, ferns and gorse	Ditch Details:	Width 1.0m Depth 0.5m
Roughness (Profile):	Rough	Verge Details:	2m								

Engineering Description of Rock:

Extremely strong very thinly banded grey and white GNEISS.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	40	110	0.02 – 1m	15m	Straight, Undulating, Rough	<0.1 – 5mm	None	None	

2	Joint	70	017	0.5 – 2m	>3m	Straight, Undulating, Smooth	<0.1mm	None	None	
3	Joint	64	292	0.3 – 0.5m	1 -5m	Straight, Planar, Smooth	<0.1 – 1mm	None	None	
4	Joint	65	253	0.1 – 2.5m	1 – 2m	Straight, Undulating, Rough	<0.1 – 3mm	None	None	

Existing Netting Details or other remedial work details:

None

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	**Current NGI 'Q' Value**
RSHV = 1	1.9 – 5.8

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Plane	Joint set 3
2	Wedge	Joint sets 2 and3, 2 and 4

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Plane	7	0.25	
2	Ravelling	7	0.008	From soil cover at slope crest

SUMMARY		**Comments**
Overall Hazard Rating =	2	
Pathway Rating =	2	
Receptor Rating =	1.2	
Risk Value =	**4.8**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	**Residual Risk Value After Remedial Works / Actions**	**Timescales for Remedial works / Management Actions**
Light scale and placement of erosion protection	2.4	Within 3 yrs

Assessed in field by:	RA	**Date:**	14/5/12	**Reviewed by:**	LN	**Date:**	5/7/12

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GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Stromeferry Bypass	**Slope Ref:**	AA24	**Chainage:**	3683 – 3864	**Start Grid Ref:**	NG 91649, 38111	**End Grid Ref:**	NG 91806, 38187	**Elevation:**	32 mAOD

Rock Slope Characteristics:

Dip:	80	Azimuth:	340	Height (m):	12	Length (m):	81	Vegetation Cover:	30% cover. Generally comprised grass, ferns and gorse.	Ditch Details:	Width 0.5m Depth 0.3m
Roughness (Profile):	Rough	Verge Details:	0.5m								

Engineering Description of Rock:

Very strong very thinly banded grey and white GNEISS with occasional quartz foliation.

Principal Discontinuities:

Set	Type	Dip	Azi.	Spacing	Persistence	Roughness	Aperture	Infill	Seepage	Comments
1	Foliation	24	070	0.01 – 0.06m	>20m	Straight, Planar, Rough	<0.1mm	None	None	

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2	Joint	64	208	1 – 2m	1 – 3m	Curved, Planar, Rough	<0.1mm	None	None	
3	Joint	52	140	0.1m	>20m	Wavy, Undulating, Rough	<0.1mm	None	None	

Existing Netting Details or other remedial work details:

Netting Type	Top cable	Typical anchor spacing (m)	Anchor Type	Cable-Anchor connection	No. of cable clamps	Netting lap connections	Laps on anchors	Vertical Reinforcing	Notes
PVC coated double twist	12mm galvanised	5m	18mm machine threaded bars	D shackle (connected on one side only)	3	Cable twists	No	None	

Previous Rock Slope Hazard Index Value and Recommended Remedial Works (2010):	Current NGI 'Q' Value
RSHV = 4 Ch 3672: rope access inspection of area of rock fall	3.8 – 7.5

Potential Failure Types (From Stereographic Analysis):

Ref	Type	Comments
1	Toppling	Joint set 3
2		

Hazards Observed:

Ref	Type	Height above toe (m)	Size of individual failure(s) (m^3)	Comments
1	Toppling	8	0.027	
2	Blockfall	10	0.027	

SUMMARY		Comments
Overall Hazard Rating =	2	
Pathway Rating =	1	
Receptor Rating =	1.2	
Risk Value =	**2.4**	
Risk Level =	**Low**	

Recommended Remedial Works / Actions	Residual Risk Value After Remedial Works / Actions	Timescales for Remedial works / Management Actions
Reconnect netting panels with spenax rings where the existing joins have come apart.	2.4	3 – 5yrs

Assessed in field by:	RA	Date:	13/5/12	Reviewed by:	LN	Date:	5/7/12

APPENDIX C PHOTOGRAPHS

Photo 1: AA7 - 5m^3 detached block with a 150mm dialated release joint.

Photo 2: AA8 - 30m^3 pinnacle previously subjected to root jacking.

Photo 3: Gully between AA5 and AA6 - End of ditch at catch pit requiring removal of sediment build up to prevent overflowing of water onto slope surface.

Photo 4: AA14W - Top cable anchor consisting of a rotting tree stump.

Photo 5: AA13-14 Upper - Detached blocks resting on slope

Photo 6: AA15 Upper - 4m^3 block wedged behind flake showing signs of dilation.

Photo 7: AA16-17 Upper - Unstable detached blocks retained only by fallen trees.

Photo 8: AA16-17 Upper 5 No. block (0.6m^3 each) prone to toppling.

Photo 9: AA19 Upper - Unstable fallen block restrained by vegetation only.

Photo 10: AA19 Upper - 2m^3 dead tree stump and rock blocks with cable straps.

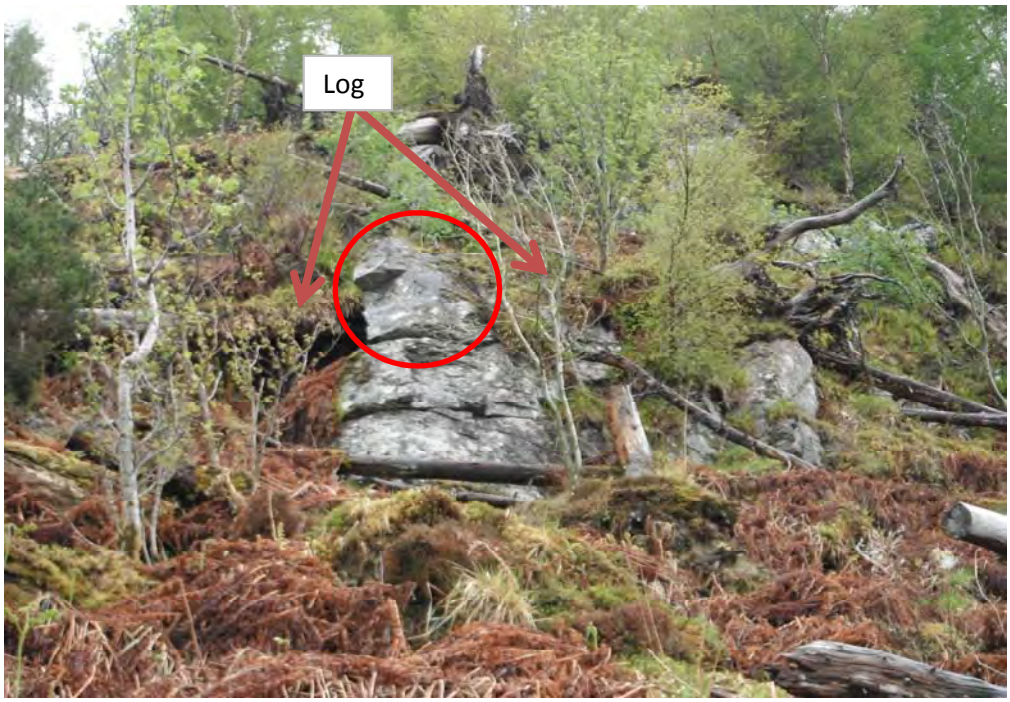

Photo 11: AA16-17 Upper - 1.9m^3 block detached block with a fallen tree jammed behind it.

Photo 12: AA17 - Top anchors driven into ground, no evidence of grout.

Photo 13: AA22B - 12m^3 'nose' resting on ravelling blocks centred on a poor join in the netting (wire twist joins at 0.5 - 0.7m centres)

APPENDIX D SUMMARY TABLE

Slope No.	Developing Hazards Observed	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level Low = <5 Med = 5 - 10 High = 10 - 15 Very High = >15	Risk Rating Following Remedial Works / Actions	Risk Level Following Remedial Works / Actions Low = <5 Med = 5 - 10 High = 10 - 15 Very High = >15	Recommended Remedial Works / Actions	Volume / area / length to be treated	Unit	Recommended timescale for Remedial Works / Actions
AA1	-Toppling -Ravelling	2	2	1.2	4.8	Low	1.2	Low	-Clear out ditch to a depth of 0.5m and place excavated material on verge to form a berm. -Ongoing maintenance of ditch.	146	m	3-5 years
									-Light Scaling	876	m^2	
AA2	-Toppling -Ravelling -Blockfall	2	3	1.2	7.2	Moderate	2.4	Low	-Replace existing chainlink netting with passive loose double twist netting.	20	m^2	Within 3 years
									-Anchors for netting	11	No.	
									-Install bimetallic corrosion protection on existing netting.	NA	Sum	
									-Light Scaling	150	m^2	
AA2A	-Blockfall	2	2	1.2	4.8	Low	2.4	Low	-Clear out ditch to a depth of 0.5m and place excavated material on verge to form a berm. -Ongoing maintenance of ditch.	80	m	3 -5 years
									- Light scaling	480	m^2	
AA3	-Toppling -Blockfall -Ravelling	3	1	1.2	3.6	Low	3.6	Low	-None	-	-	-
AA4	-Blockfall -Ravelling	3	3	1	9	Moderate	3	Low	-Dowel individual overhanging blocks	2	No.	Within 3 years
									-Light Scaling	1725	m^2	
AA5	-Blockfall -Planar	3	1	1	3	Low	3	Low	-Clear out ditch to a depth of 0.5m and place excavated material on verge to form a berm. -Ongoing maintenance of ditch.	79	m	3 -5 years
AA6	-Blockfall -Ravelling	1	3	1	3	Low	2	Low	-Install additional bottom anchors	1	No.	3 -5 years
AA6A	-Blockfall -Planar -Toppling	4	2	1.2	9.6	Moderate	4.8	Low	-Construct rock trap ditch along length of rock slope (approx 1m deep, 2m wide). Place excavated material to form a bund on the road side of the ditch.	111	m	Within 3 years
AA7	-Planar -Ravelling	3	3	1.2	10.8	High	2.4	Low	-Controlled removal of block.	5	m^3	Within 3 years
AA8	-Toppling -Ravelling	4	3	1	12	High	3	Low	-Heavy scaling of pillar.	8	m^3	Within 3 years

Slope No.	Developing Hazards Observed	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level Low = <5 Med = 5 - 10 High = 10 - 15 Very High = >15	Risk Rating Following Remedial Works / Actions	Risk Level Following Remedial Works / Actions Low = <5 Med = 5 - 10 High = 10 - 15 Very High = >15	Recommended Remedial Works / Actions	Volume / area / length to be treated	Unit	Recommended timescale for Remedial Works / Actions
AA9	-Toppling -Planar -Wedge	2	1	1	2	Low	2	Low	- Keep under observation	-	-	-
AA10	-Toppling -Planar -Wedge	4	2	1	8	Moderate	4	Low	-Install catch fence at toe of slope.	390	m^2	Within 3 years
AA11	-Wedge -Ravelling	2	1	1.2	2.4	Low	2.4	Low	-Clear failed material from behind base of netting.	44	m^2	3 -5 years
									-Install bimetallic corrosion protection on existing netting.	NA	Sum	
AA12	-Planar -Ravelling -Blockfall	4	3	1	12	High	2	Low	-Bolt individual potential failures.	7	No.	3 -5 years
AA13	-Wedge -Planar	3	3	1.2	10.8	High	3.6	Low	-Install double twist passive loose rockfall netting between ch 2540 - 2550.	300	m^2	3 -5 years
									- Anchors for rock fall netting.	82	No.	
									-Install reinforcing cables in area of potential wedge failure.	300	m^2	
AA13-14 Upper	-Toppling -Blockfall	3	2	1.2	7.2	Moderate	2.4	Low	-Controlled removal of blocks.	10	m^3	Within 3 years
AA14 West	-Toppling -Planar -Blockfall	3	4	1.2	14.4	High	3.6	Low	- Install new top anchors and top cable	20	No.	Within 1 year
									- Clear failed material from behind netting	25	m^2	
AA14 East	-Wedge -Planar -Blockfall -Ravelling	3	1	1.4	4.2	Low	4.2	Low	-None. Remove any accumulated material from behind fence should a failure occur.	-	-	-
AA15	-Planar	3	2	1.2	7.2	Moderate	3.6	Low	-Add reinforcing cable to potential failure add ch 2700.	300	m^2	3 - 5 years
									- Construct bund at ch 2788	30	m	
AA15 Upper	-Blockfall -Ravelling	3	5	1.2	18	Very High	4.8	Low	-Controlled removal of block using pyrotechnic breaking capsules.	4	m^3	Within 1 year
AA16	-None observed	1	1	1	1	Low	1	Low	-None	-	-	-

Slope No.	Developing Hazards Observed	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level Low = <5 Med = 5 - 10 High = 10 - 15 Very High = >15	Risk Rating Following Remedial Works / Actions	Risk Level Following Remedial Works / Actions Low = <5 Med = 5 - 10 High = 10 - 15 Very High = >15	Recommended Remedial Works / Actions	Volume / area / length to be treated	Unit	Recommended timescale for Remedial Works / Actions
AA16-17 Upper	-Blockfall -Toppling -Planar	3	3	1.2	10.8	High	3.6	Low	-Controlled removal of blocks.	10	m^3	Within 1 year
AA17	-Planar	3	4	1.2	14.4	High	3.6	Low	- Install new top anchors and top cable between ch 2918 - 2958.	20	No.	3 years
									-Install additional spenax jointing to existing netting.	NA	Sum	
									-Clear out failed mass from base of netting.	2.5	m^3	
AA18	-Planar -Wedge	2	1	1.2	2.4	Low	2.4	Low	-None	-	-	-
AA19	-None observed	1	1	1	1	Low	1	Low	-None	-	-	-
AA19 Upper	-Blockfall -Planar -Ravelling -Root jacking	2	4	1	8	Moderate	3	Low	-Light scale face.	3650	m^2	Within 1 year
									-Remove 2m^3 tree stump currently retained by cable straps and replace nut on rock dowel to secure face plate.	2	m^3	
									-Remove fallen/cut logs from ledge between AA19 and AA19 Upper.	NA	Sum	
AA20	-Toppling	2	3	1.2	7.2	Moderate	1.2	Low	- Rock dowel block.	1	No.	3 - 5 years
									- Clear out accumulated debris from behind rockfall barrier.	NA	Sum	
AA21	-Toppling	3	2	1	6	Moderate	2	Low	-Rock dowel individual potential failures.	1	No.	3 - 5 years
									-Light scale area of face without netting.	150	m^2	
									- Remove 3-4 No. cut logs trapped under top netting cable.	NA	Sum	
AA22A	-Planar -Blockfall	2	1	1	2	Low	2	Low	-Replace western terminal anchor on top cable.	1	No.	3 - 5 years
AA22B	-Blockfall	4	3	1	12	High	2	Low	-Heavy scaling of nose at Ch 3425	12	m^3	Within 1 year
									-Install additional cable reinforcement	2500	m^2	
									-Repair damaged netting	NA	Sum	
AA23N	-Planar -Ravelling	1	2	1.2	2.4	Low	1.2	Low	-Construct toe ditch along length of slope.	38	m	3 - 5 years
AA23S	-Planar -Ravelling	2	2	1.2	4.8	Low	2.4	Low	-Light scaling of face.	450	m^2	Within 3 years
									-Install erosion protection matting over upper soil slope.	200	m^2	
AA24	-Toppling -Blockfall	2	1	1.2	2.4	Low	2.4	Low	-Reconnect netting panels with spenax rings where these have come apart.	NA	Sum	3 - 5 years