URS

Stromeferry Appraisal

DMRB Stage 2 Report

Volume 1- Engineering Assessment

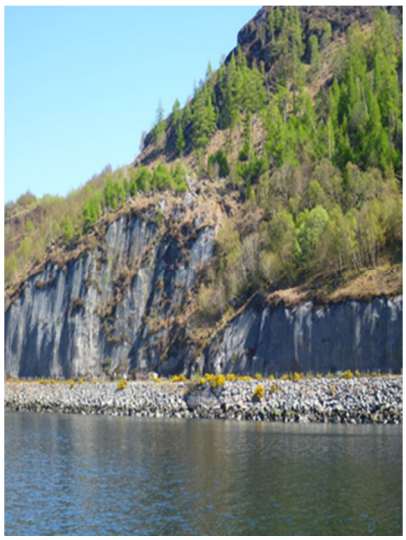
October 2014

47065084/Doc/B/001

Final Draft

Prepared for:
The Highland Council

UNITED KINGDOM & IRELAND



The Highland Council
Comhairle na Gàidhealtachd

REVISION SCHEDULE					
Rev	*Date*	*Details*	*Prepared by*	*Reviewed by*	*Approved by*
	June 2014	Draft Report	Anke Menzinger Project Engineer		David Taylor Commission Project Manager
01	July 2014	2nd Draft Report	Jill Irving Senior Engineer		David Taylor Commission Project Manager
02	July 2014	Final Draft	Jill Irving Senior Engineer	David Taylor Commission Project Manager	David Taylor Commission Project Manager
03	Oct 2014	Final Draft	Jill Irving Senior Engineer	David Taylor Commission Project Manager	David Taylor Commission Project Manager

URS
6 Ardross Street
Inverness
IV3 5NN
United Kingdom

Telephone: +44(0)141 354 6050
Fax: +44(0)141 354 6059

Limitations

URS Infrastructure & Environment UK Limited ("URS") has prepared this Report for the sole use of **The Highland Council** ("Client") in accordance with the Agreement under which our services were performed (refer to Client brief and Contract dated 10th October 2012). No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by URS. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of URS.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by URS has not been independently verified by URS, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by URS in providing its services are outlined in this Report. The work described in this Report was undertaken between November 2012 and September 2014 and 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.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

URS disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to URS' attention after the date of the Report.

Certain statements made in the Report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the Report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. URS specifically does not guarantee or warrant any estimate or projections contained in this Report.

Copyright

REPORT SUMMARY

S.1. INTRODUCTION

In reaction to a rock fall event in December in December 2011, which closed the A890 over a period of several months, The Highland Council approved the proposal to carry out a further options appraisal in connection with Stromeferry Bypass.

URS were appointed by The Highland Council to undertake an appraisal of route options for Stromeferry Bypass to satisfy the requirements of the Design Manual for Roads and Bridges (DMRB) Stage 2 Scheme Assessment. This is the non-technical executive summary of the report findings outlined in the 'Stromeferry Appraisal, DMRB Stage 2 Report, Volume 1 – Engineering Assessment'. Reference drawings abstracted from Appendix A to the report are included at the end of this summary.

S.2. STUDY AREA

Stromeferry Bypass is an approximately 12km long section of public road along side the southern shore of Lochcarron, located in Wester Ross in Western Highlands in Scotland. The road forms part of the A890 between the Strathcarron Junction and the tie in with the A87, Invergarry to Kyle of Lochalsh Trunk Road. The road is mainly a single carriageway but reduces frequently to single track with passing places along this section of road.

The existing Stromeferry bypass shares a narrow corridor with the single track Dingwall to Kyle of Lochalsh railway line along the southern shores of Loch Carron. This is particularly restricted over an approximately 4.5km long section from Ardnarff to Attadale, where the road / rail corridor is restricted by the Lochcarron shore to the west and the existing steep rock face to the east. The topography in the study area varies between sea level at Loch Carron up to levels of 490m above Ordinance Survey Datum along the range of hill south of Loch Carron. The existing A890 from the Kyle of Lochalsh to Loch Carron passes through undeveloped hill land and areas of forestry, experiencing steep road gradients of up to 14%. The land use within the area is agricultural, comprising mainline rough grazing in large of undeveloped heath and moorland, as well as areas of forestry and crofting. Other than the existing road network which includes the A890 Stromeferry Bypass, A896 and other local roads, other engineering constraints within the immediate study include:

- Dingwall to Kyle of Lochalsh railway line, and the existing level crossing at Strathcarron;
- Watercourses including Loch Carron and Strome Narrows, river Attadale, river Carron;
- Settlements of Stromeferry, Slumbay, Lochcarron, Strathcarron, Achintee, Kirkton and other properties; and
- Local steep topography, including the unstable rock face.

Since the existing road was opened, the approximately 4.5km long section of mainly single track road from Ardnarff to Attadale has been subject to landslides and rock fall events, causing the Highland Council to temporarily close the road on several occasions, in order to enable remedial works to the rock slopes to take place. The closure of the A890 alongside Loch Carron results in diversions via the wider public road network of 130 miles length, through Achnasheen, Muir of Ord, Loch Ness side and Kintail.

S.3. STAGE 1 SCHEME OBJECTIVES & CONSULTATIONS

Stakeholder Workshops were held during the DMRB Stage 1 and 2 Scheme Assessment in accordance with the requirements of Scottish Transport Appraisal Guidelines (STAG). Stakeholders were initially divided into 'Regulatory Stakeholders' and 'Economic Stakeholders' for the initial workshops, with joint workshops held in the later stages. The STAG Pre-Appraisal,

Part 1 & Part 2 process carried out for Stromeferry Bypass successfully delivered a set of Transport Planning Objectives to aid the appraisal of route options. A total of eleven scheme objectives were developed and are detailed below.

- Deliver a safe and reliable, 2 lane carriageway by applying appropriate / proportionate design standards.
- Minimise all risk during design, construction, operation and maintenance (with reference to risk register).
- Ensure deliverability of scheme within programme and to agreed capital cost and maintenance budgets, thus providing 'Value for Money'.
- Solution reduces, or does not increase, the risk to and liability of the railway and maintains suitable access over the life of the scheme.
- Deliver a scheme that assists both the local businesses to maximize opportunities for sustainable development and economic growth over the life of the scheme.
- Safeguard and, where possible and appropriate, enhance and provide access to the natural and built environment and areas of national, regional and local importance and heritage, during construction, maintenance and operation of the scheme (with reference to environmental appraisal).
- Scheme to take account of relevant local, regional and national planning policies (during the design stage).
- Keep the A890 and peripheral road network open during construction.
- Maintain and improve choice of transport mode and integration of public transport links over the lifetime of the scheme.
- Maintain and improve local social cohesion by improving accessibility for emergency services responding to call-outs, as well as for the local and regional leisure, health and educational facilities.
- Maximise / improve network efficiency, sustainable connectivity and social cohesion in terms of journey times and journey reliability in the Wester Ross area.

In addition to Stakeholder workshops, Public Exhibitions were held during Stage 2 of the appraisal in order to provide information on the process and considerations in relation to the Stromeferry appraisal to the wider public. Stage 2 public exhibitions were held on 27th March 2014 in Lochcarron Village Hall, and on 28th March 2014 in Achmore Village Hall. Feedback from the public exhibitions on the proposed options will assist in shaping the final preferred solution.

S.4. SCHEME OPTIONS

The DMRB Stage 1 Scheme Assessment recommended that a total of nine route options be taken forward for further assessment and development. The route options fall within three corridors: the North Shore Corridor includes three route options (N6, N6b and N9), the Online Corridor includes four route options (O2, O3, O5 and O7 and also the Do-Minimum case O4), and the South Corridor includes one route option (S4). The nine route options are summarised below.

- **Option N6** North Shore online, leaves the existing A890 at Achmore, passing west of Craeg Mhaol then crosses the Strome Narrows by a low level bridge, then follows the existing road through Stromemore, Slumbay, Lochcarron, Kirkton until Strathcarron Junction.

- **Option N6b** North Shore Tidal energy, emerging from the Stage 1 appraisal, proposed a north shore route with an integrated renewable energy solution. Various options were considered for generating electricity from the tidal flow, however renewable technology will not be included as part of the Stage 2 recommendations.
- **Option N9** North Shore offline, leaves the existing A890 at Achmore, passing west of Craeg Mhaol then crosses the Strome Narrows by a low level bridge, then continues offline north west of Slumbay and Lochcarron, before returning on-line at Kirkton until Strathcarron Junction.
- **Option O2** Online Viaduct, follows the existing A890 alignment with online improvements from Stromeferry to Frenchman's Burn, with a viaduct structure from Frenchman's Burns to Cuddies Point to bypass the rock fall area. From Cuddies Point to Strathcarron Junction, follows the existing alignment with local improvements at Maman Hill and Achintee.
- **Option O3** Online Tunnel, follows the existing A890 alignment with online improvements from Stromeferry to Frenchmans Burn, with a tunnel bypassing the rock fall area. From Cuddies Point to Strathcarron Junction, again follows the existing alignment with local improvements at Maman Hill and Achintee.
- **Option O4** Online Do-minimum baseline case option, adopting existing route as is including ongoing maintenance of the rock face and route corridor, but with no major works.
- **Option O5** Online Shared Use, follows the existing A890 alignment with online improvements from Stromeferry to Frenchmans Burn, with a shared road / rail section west of Cuddies point to bypass the rock fall area. From Cuddies Point to Strathcarron Junction, again follows the existing alignment with local improvements at Maman Hill and Achintee.
- **Option O7** Online, Avalanche Shelter, follows the existing A890 alignment with online improvements from Stromeferry to Frenchmans Burn, with worst of rock fall area protected by means of a developed avalanche shelter. From Cuddies Point to Strathcarron Junction, again follows the existing alignment with local improvements at Maman Hill and Achintee.
- **Option S4** South Glen Udalain, from the A890 follows the existing forestry track east through Gleann Udalain towards Loch nam Breac Mora and then northwards towards the Attadale valley. S4 follows the river Attadale north west and ties back into the existing A890 at Attadale. S4 then follows the existing alignment until Strathcarron Junction, with local improvements at Maman Hill and Achintee.

The route options were developed during Stage 2 to provide the optimum alignments, issues considered included:

- Create a safe bypass of the 4km of rock fall and unstable rock face area west of Cuddies Point;
- Achieving modern design standards (corridor widths and alignments);
- Buildability / minimising disruption during construction;
- Affecting properties and land; and
- Proposing a deliverable scheme.

Cost Estimates were developed for each route option. Total Scheme Cost Estimates for North Corridor options range from £105.75M for Option N6 to £108.62M for Option N9. Total Scheme Cost Estimates for Online Corridor Options range from £62.54M for Option O5 to £180.65M for Option O3. The Total Scheme Cost estimate for Southern Corridor Option S4 was found to be £81.41M.

As part of the brief for Stromeferry Bypass Appraisal, consideration was to be given to affordability of the proposed scheme. Therefore, phasing of route options was considered, and outline costs developed making assumptions on the delivery dates of the phases to investigate the advantages of a phased delivery of the scheme and whether this process would affect the ranking of options and therefore the route selection. The first phase of any option would involve scheme development to bypass the rockfall area as a minimum. Construction Costs were estimated for all options for all phases, Phase 1 only for Northern Corridor route options varied from £70.22M for Option N6 to £73.70M for Option N9. Phase 1 Construction Costs for Online Corridor Options varied from £8.87M for Option O5 to £89.50M for Option O3. Phase 1 Construction cost for Southern Corridor Option S4 was found to be £40.45M.

S.5. ENGINEERING ASSESSMENT

The engineering assessment carried out in relation to the Stromeferry Appraisal has been carried out in accordance with guidance provided in DMRB. This included an assessment of topography, geotechnical, existing structures and public utilities installations in the study area. The designs for each route option have been developed to a suitable level for DMRB Stage 2 Scheme Assessment.

The North Shore Options would include a crossing of the Strome Narrows. Both tunnel and bridge crossings have been considered for the Strome Narrows crossing, and the bridge included in Options N6 and N9 is considered to be the optimum bridge location. The bridge is a major structure with a span length of approximately 830m, which provides navigation clearance of approximately 20m. A tunnel structure under the Strome Narrows was also considered and the optimum tunnel crossing was found to be an 2.7km long structure. However, a tunnel crossing of the Narrows was rejected on cost and reduced amenity grounds.

The Online Options have been established as engineering solutions for distinct parts of the route. Due to the geometry of the existing road and rail corridors, the topography and in particular the variable risk of rock fall along the route, different solutions have been developed for the online section from east of Ardnarff to Cuddies Point. These include a sidelong viaduct structure which would carry the realigned railway, an inland tunnel, and a developed avalanche shelter structure, and a road rail shared solution. Otherwise, from Stromeferry to Ardnarff, and Cuddies Point to Strathcarron Junction, all Online options are the same aiming to follow the existing A890 alignment, with some local offline improvements at Maman Hill, to limit the gradient to 10%, and at Achintee to remove the existing railway level crossing. As a result of following the existing alignment, there are numerous geometry Departures from Standard, particularly from Stromeferry to Cuddies Point.

The Southern Corridor Option S4 follows the historical Glen Udalain route. Option S4 encounters some challenging topography through the upper Attadale valley, and long steep gradients are required to minimise the impact on land. A tight horizontal radii curve has also been provided to tie the alignment back online in advance of the existing river Attadale bridge whilst reducing the impact on the River Attadale valley. From Attadle to Strathcarron, Option S4 would follow the same alignment as the online options.

As part of the DMRB Stage 2 Assessment, a detailed geotechnical desk survey has been undertaken, which includes an assessment of underlying geology, hydrology and hydrogeology for each route corridor and provides details of potential constraints for development and recommendations for further investigation work. A Peat Management Report which considers options for treatment of peat in the study area has also been carried out as part of this assessment.

Public Utility companies have been contacted as part of the DMRB Stage 2 Assessment, and several companies have apparatus present within the study area. The diversion and re-routing of existing utilities are not expected to pose any problems to the development of the scheme.

As part of the DMRB Stage 2 Assessment, more detailed proposals regarding structures have been considered, regarding buildability, aesthetics, operation, maintenance and inspection risks and impact during construction. All junctions are proposed to be at-grade so no grade separated junctions are anticipated. Therefore, the majority of structures will involve the crossing of watercourses and water bodies – streams, rivers and Strome Narrows. Options being considered also include a bridge crossing of the railway and special structures for the online corridor options include a sidelong viaduct, an avalanche shelter and a tunnel. Retaining structures may also be required where online options are constrained by existing development or topography.

S.6. ENVIRONMENTAL ASSESSMENT

An Environmental Assessment was undertaken in accordance with the requirements of DMRB Chapter 11. Environmental advantages, disadvantages and constraints associated with each route option were considered and assessed against the environmental criteria.

The North Shore options were found to have a minor adverse effect on the environment, with Option N6 having noise and air quality impacts, and Option N9 having green field construction and impacting on a Site of Special Scientific Interest (SSSI).

The Online Options were found to have negligible or significantly beneficial benefits on the environment. Option O2 has a negligible effect on environment due to visual impact and effect on the marine conservation area. Options O3 and O5 were found to have minor impacts, Option O4 had was found to have no change, and Option O7 was found to be significantly beneficial with limited intrusion and enhanced views.

The Southern Option S4 was found to have negligible effect on the environment with green field construction and landscape impacts at Attadale. The Environmental Assessment is presented as Volume 2 of the report.

S.7. TRAFFIC & ECONOMIC ASSESSMENT

Traffic surveys were undertaken in March 2013 from which the DMRB Stage 2 Appraisal values for mean traffic flows, vehicle speeds and vehicle composition were derived. Additional data on trip purpose and destination were obtained from roadside interview surveys carried out in August 2013. Traffic flows from the survey data gave 7-day average 24 hour 2-way volumes of 695 vehicles at Attadale and 124 vehicles at Lochcarron. These traffic volumes do not present road capacity problems on the A890 in March, however it is noted that Government data sources show traffic volumes on the A890 increase significantly in the peak summer months.

As part of the DMRB Stage 2 Assessment, an economic appraisal was carried out using the standard Scottish Government economic modelling software, NESA. The NESA appraisal was based on Stage 2 option cost estimates and NTRF central traffic growth projections. The Benefit to Cost Ratio (BCR) calculated for the North Shore route options vary from 0.38 for Option N6 to 0.42 for Option N9. The BCR calculated for the Online options vary from 0.04 for Option O3 to 0.10 for Option O5. The BCR calculated for the Southern Route Option S4 was found to be -0.02.

These results were then adjusted for the particular circumstances of the route options, namely the effects of diversion, rock fall journey response, construction delays and remedial rock face maintenance. The NESA results were calculated to give adjusted BCRs. The adjusted BCRs calculated for the North Shore Options vary from 0.50 for Option N6 to 0.54 for Option N9. The adjusted BCRs calculated for the Online options vary from 0.06 for Options O3 and O7 to 0.29 for Option O5. The adjusted BCR calculated for Southern Corridor Option S4 was found to be 0.10.

A Wider Economic Appraisal (WEBs) was carried out as part of the Stage 2 economic appraisal. In terms of the WEBs benefits, the Northern Corridor routes, N6 and N9, have adjusted BCRs web of 0.58 and 0.62 respectively. However, the WEBs benefits for the other options are either negligible, or as in the case of Option S4, are negative.

An Economic Activity and Location Impacts (EALIs) appraisal was carried out as part of the Stage 2 economic appraisal. A business survey was undertaken in October and November 2013 to gather the data required for the EALI, and had a 41% response. Results of the business survey are summarised in The Business Survey Report.

S.8. APPRAISAL SUMMARY

Appraisal Summary Tables (ASTs) outlining the findings of this Stage 2 Assessment have been completed and describe and summarise the findings in further detail. Route options were considered against the Transport Planning Objectives. In addition, route options were considered against the overall DMRB criteria, which includes overall performance against Transport Planning Objectives, and performance against Government Criteria, namely Environment, Safety, Economy, Integration, Accessibility & Social Inclusion, Cost to Government and Risk & Uncertainty.

S.9. CONCLUSIONS & RECOMMENDATIONS

The DMRB Stage 2 Assessment has considered a full range of assessment criteria. Considering individual disciplines, it can be seen in general terms that new greenfield options score poorly on environmental grounds; online options (apart from Option O5) are expensive, have buildability and rail interface issues, and are expensive compared with the Southern Route when considering Phase 1 work.

The North Shore routes best satisfy all selection criteria, and received most positive responses from the public, but would require an expensive crossing of the Strome Narrows, with the longest and most expensive Phase 1 construction.

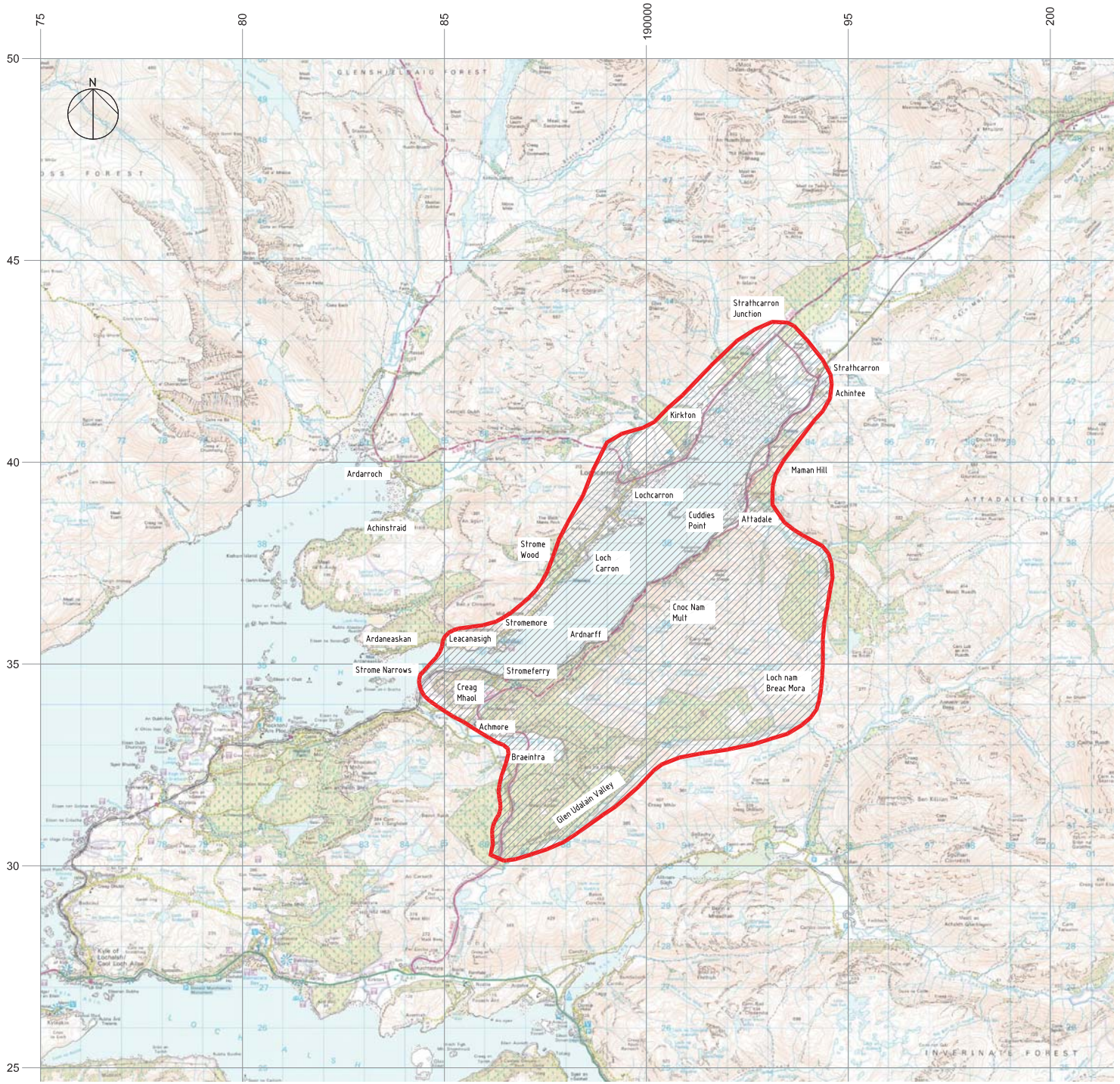
The Southern Route option satisfies less criteria and received less positive responses than the northern routes, but emerges as the most affordable solution in the short term. The route compares with an online option for Phase 1 works but would have significantly more difficulties in scheme promotion due to landowner difficulties.

This draft DMRB Stage 2 Scheme Assessment Report has identified the ‘best’ options from each route corridor. The ‘Do Minimum ‘ Option O4 has also been assessed as the baseline condition. Option N9 was found to be the best North Shore Option. Bypassing Slumbay and Lochcarron allows for a better standard of road and also minimises impact on land and especially property.

Option O2 was found to be the best Online Option, emerging as the most cost-effective online proposal, and has many advantages in comparison to other online solutions considered in relation to buildability and road closure issues.

Option S4 has been derived from historical work and offers the most favourable route through the Glen Udalain valley. As a greenfield route it does have environmental issues to overcome. The route is one of the least expensive options but performs poorly economically due to its length and associated journey times, and does not satisfy some of the connectivity Transport Planning Objectives. Community links have been considered but do not perform well economically.

It is recommended that URS work with a user group consisting of The Highland Council members, officers and key Stakeholders to allow recommendations to be made.



URS

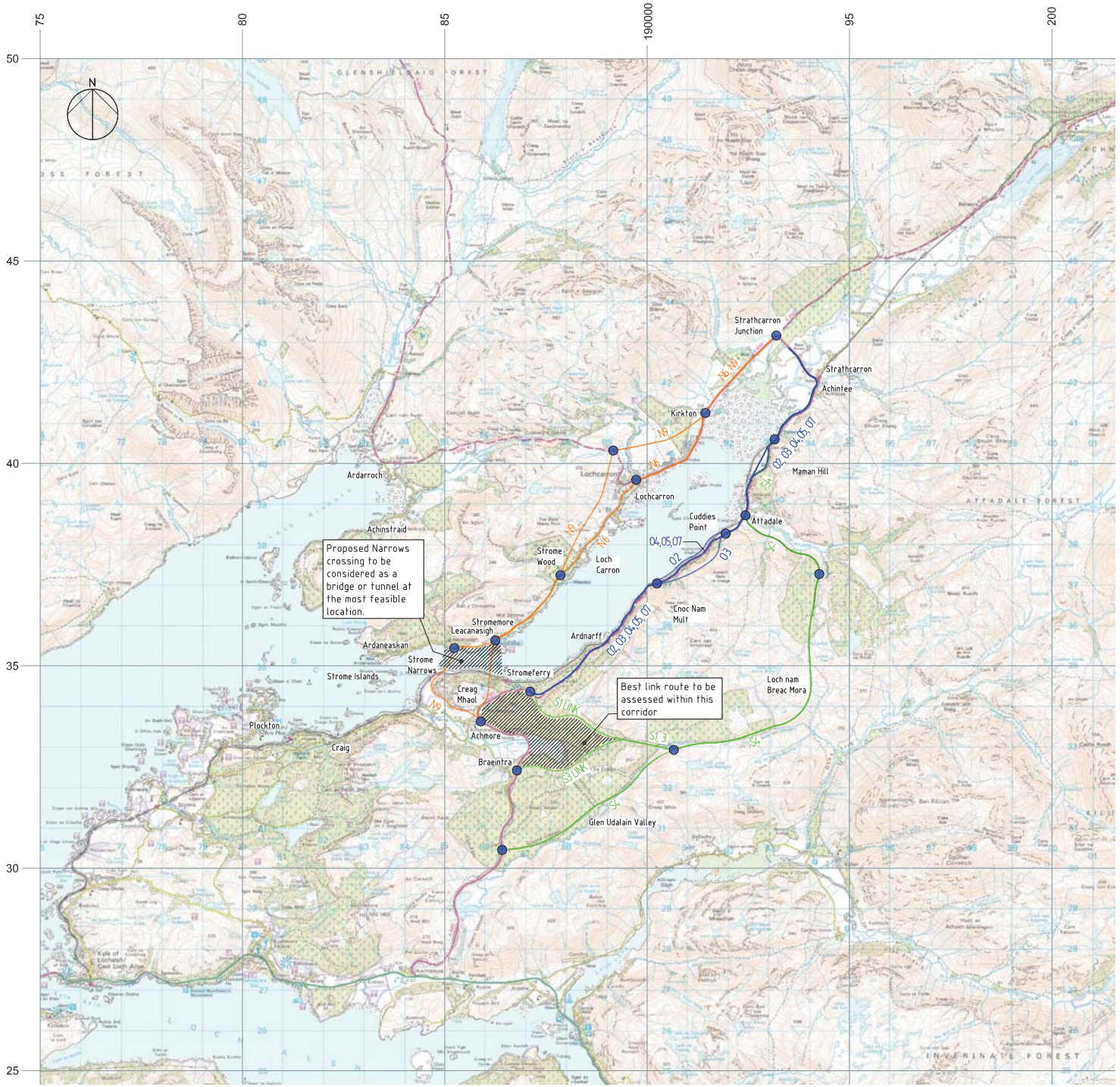
Key:

General study area

FINAL ISSUE

Title	General Study Area - Stage 2 Assessment
Drawing Number.	47065084 - 2-1000

Stromeferry Appraisal



URS

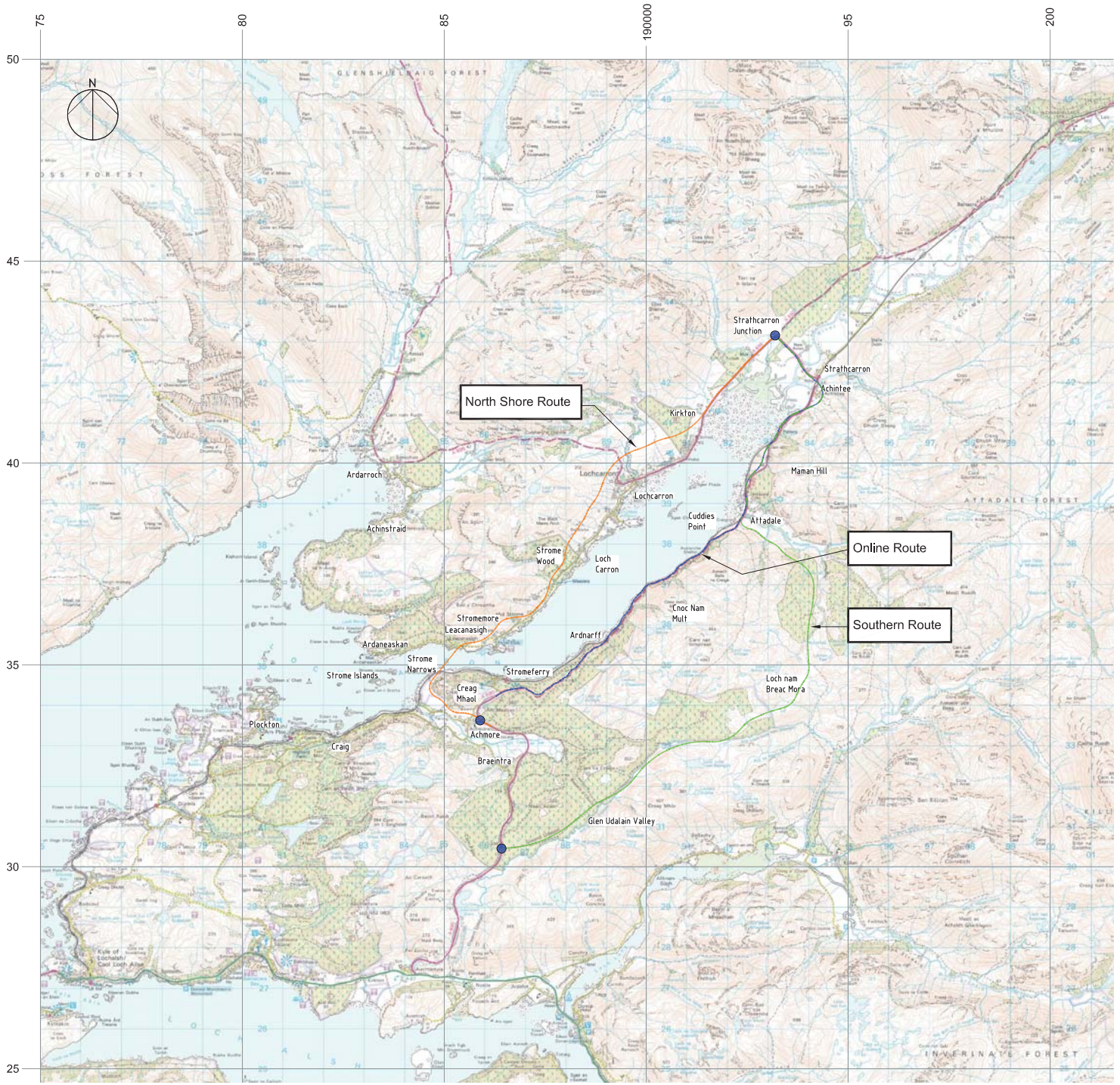
Key:

- Outer North Corridor Route Option Prefix ON
- North Shore Corridor Route Option Prefix N
- Online Corridor Route Option Prefix O
- Southern Corridor Route Option Prefix S
- Discounted Routes
- Route Junction Points

FINAL ISSUE

Title	Emerging Route Options - Stage 1 Assessment
Drawing Number.	47065084 - 2-1002

Stromeferry Appraisal



URS

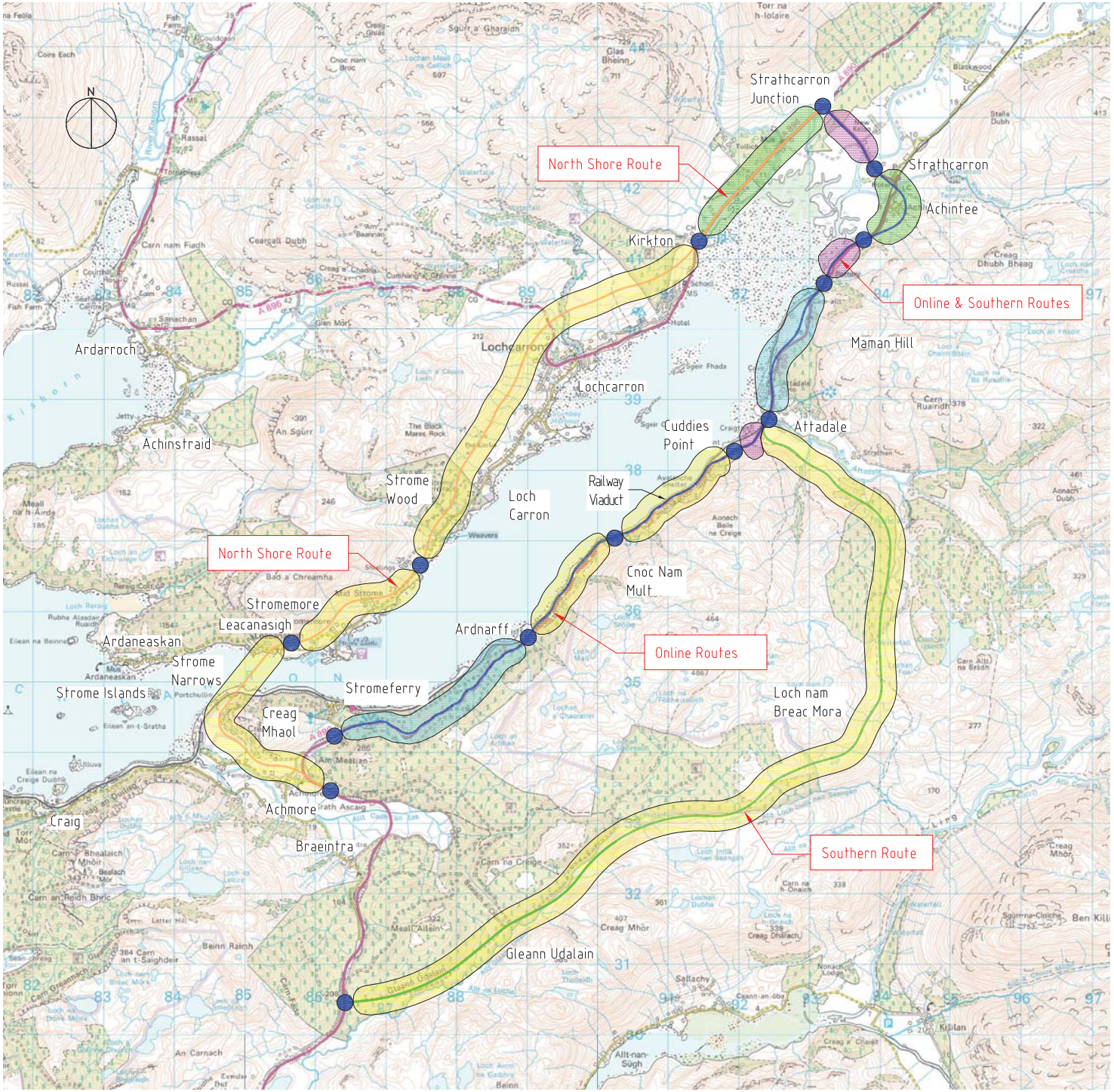
Key:

- North Shore Corridor Route Option
- Online Corridor Route Option
- Southern Corridor Route Option
- Route Junction Points with existing road network.

FINAL ISSUE

Title	3 Best Routes - Stage 2 Assessment
Drawing Number.	47065084 - 2-1003

Stromeferry Appraisal
Stage 2



Key:

- North shore bypass of Lochcarron route option
- Online railway viaduct route option
- Gleann Udalain.
- Phasing / Section Points
- First Phase
- Second Phase
- Third Phase
- Forth Phase

FINAL ISSUE

Title	Phased Route Delivery - Stage 2 Assessment Best Routes
Drawing Number.	47065084 - 2-1004

Stromeferry Appraisal Stage 2

TABLE OF CONTENTS

VOLUME 1

1 INTRODUCTION

1.1 Study Background

1.1.1 General

The Stromeferry Bypass is an approximately 12km long section of public road alongside the southern shore of Loch Carron, located in Wester Ross in the western Highlands of Scotland. The road forms part of the A 890 between the Strathcarron Junction and the tie in with the A87, Invergarry to Kyle of Lochalsh Trunk Road, at Auchtertyre. The road also forms part of the wider road network between Dingwall west to the Isle of Skye via Achnasheen, and provides a popular alternative route from Inverness to Kyle of Lochalsh and Skye.

The public road and a single track railway line are sharing a tight corridor along the southern shores of Loch Carron, which is particularly restricted over an approximately 4.5 km long section from Ardnarff to Attadale. The A 890 is mainly a single carriageway but reduces frequently to single track with passing places along this section of road.

Up until 1970, when the bypass was opened to the Public, the transport link from Kyle of Lochalsh north towards Ullapool was provided by a ferry service crossing the Strome Narrows in between South and North Strome, with minor roads linking the crossing to the local road network at either end.

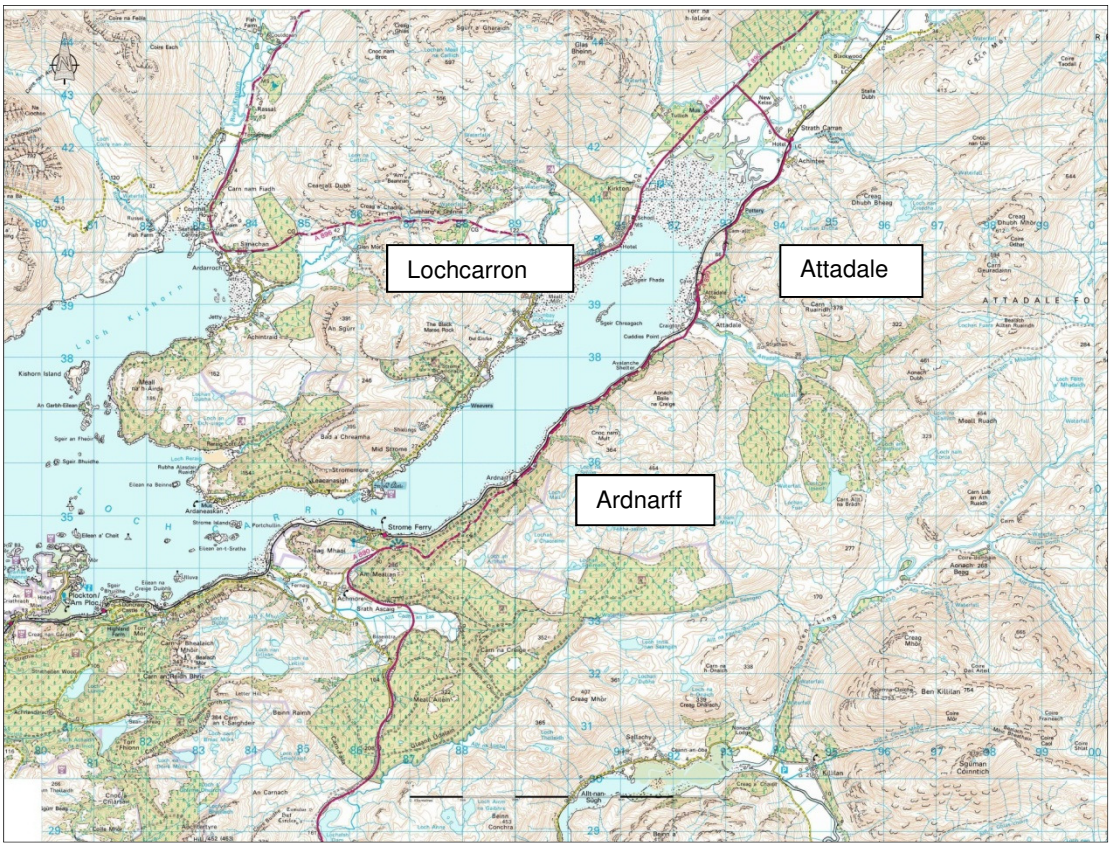


Figure 1.2 – Area Plan

1.1.2 Geographical & Economical Context

The issues with regards to ongoing rock fall events on the A 890 between Ardnarff and Cuddies' Point affect both the local Loch Carron area from Plockton, Starthcarron and Lochcarron Village up to Applecross, but also significant transport links from East to West, from Skye to Ullapool and Inverness and wider geographical linkages South to North between Fort William and the North West Coast of Scotland.

The Local Transport Strategy plan identifies the A890 as a 'H2a Regional' road in the context of the Highland roads hierarchy. The route does not feature in the Strategic Transport Projects Review, as it is not a Trunk Road. Although nationally not recognised as a 'strategic' route, locally it provides vital links to health, educational and leisure facilities, as well as places of work, and is a popular tourist route. The West Coast of Scotland is also home to a variety of businesses, from renewable energy developments and fish farming, to forestry enterprises, local shops and tourism related businesses, all of which rely on the availability of the (local) road network.

Transport reliability and dependency is seen as an important business consideration, with businesses vulnerable to delivery delays, uncertainty regarding connectivity and accessibility. This affects most local businesses in the retail, tourism, haulage and transportation and other sectors.

Closure of the A890 alongside Loch Carron results in diversions via the wider public road network of 130 miles length, through Achnasheen, Muir of Ord, Loch Ness side and Kintail as shown below.

Figure 1.3 – Diversion Route

1.1.3 Social Context

The Highland Council Local Transport Strategy outlines the 'uniqueness' of the Highland area, suggesting '*the Highlands are distinctive within the UK with their unique culture, extreme weather patterns and rugged topography.*.' as well as highlighting that 'outwith the Moray Firth

area there are many scattered rural communities with low population densities and a high car dependency. Many of these communities, including Wester Ross and Lochaber, are economically fragile and geographically remote'.

The study area is covered under the context of the 'Single-Outcome-Agreement' between the Scottish Government and the Highland Community Planning Partnership as part of the Highland area. This agreement document identifies the area under consideration as a 2 to 3 on a scale of 7 indicators for fragile areas, 7 being most fragile. On the Scottish index of Multiple Deprivation, the Loch Carron area is shown as 40 to 60% for level of deprivation in the Highlands, with 0% being most deprived and 100% least deprived.

The area under consideration forms part of Highland Ward 06. Current Ward statistics for Ward 06, Wester Ross, Strathpeffer and Lochalsh show that this Ward is the largest in Highland, with the second lowest population density. The overall age profile is older than the Highland average with a below average proportion in the under 45 age group. It also states that '*the rural nature of the Ward is reflected in highest proportion of self-employed workers in Highland /.. It has a large number of jobs in the health, retail and education sectors /.., with the highest percentage of people employed of 24.3% in 'accommodation and food services*'.

1.1.4 Project Brief

Since the Stromeferry Bypass was opened, the approximately 4.5km long section of mainly single track road from Ardnarff to Cuddies' Point, which is located just west of Attadale, has been subject to landslides and rock fall events, causing the Local Authority to temporarily close the road at several occasions in order to enable remedial works to the rock slopes to take place.

These events also affected the railway line and forced road and rail users to accept up to 130mile temporary road diversions during the closures. Contingency measures, including temporary dual running of road and rail and a ferry service from South to North Strome, were put in place by The Highland Council to alleviate some of the traffic problems through periods of road closures following more recent rock fall events.

Due to the ongoing problems with this section of public road, the Local Authority commissioned several feasibility studies in the 1990s, looking at various possible route options and schemes to bypass the problem areas. However, no final decision was reached on which option to take forward at that stage and The Highland Council continued to maintain the route and carry out emergency works, as and when required.

Following a rock fall event in December 2011, when the A890, Stromeferry Bypass, had to be closed over a period of several months, The Highland Council Committee for Transport, Environmental and Community Services, approved the proposal for a further options appraisal in connection with the Stromeferry Bypass to be carried out in August 2012.

URS Infrastructure and Environment UK Ltd were appointed by The Highland Council in October 2012.

The Client's brief included the following stipulations.

1. The study is to review and consider relevant historical information from The Highland Council archives;
2. The study is also to carry out proportionate appraisal work following current Scottish Government Appraisal Guidelines and the DMRB;
3. In accordance with STAG, during the Pre-Appraisal process the Consultant is to establish Stakeholder Groups, to carry out Stakeholder workshops and to develop the defined objectives for the scheme in consultation with the Stakeholders and the Client, considering identified problems and opportunities;

4. The commission is also to undertake a Stage 1, Option Generation, Sifting and Development process in accordance with the Scottish Transport Appraisal Guidelines (STAG) and the Design Manual for Roads and Bridges (DMRB) and to prepare material to allow presentations of the findings of the first appraisal stage to the public in March 2013;
5. In addition, the brief also includes the second stage appraisal in accordance with STAG Part 2 and DMRB Stage 2. A report to complete the appraisal process is to be issued to summarise the findings of both Part 1 and Part 2 assessments of the options in Spring 2014.

The outline design of a 'preferred route option', which should emerge after Stage 2 of this appraisal, is to consider aspects of highway, structures and geotechnical design issues, as well as economic impact and cost benefit analysis, in addition to suitable mitigation measures, including landscaping, to reduce the environmental impact and damage during construction and operation of the preferred route alignment.

Appreciating budget constraints, this brief also included considerations into the affordability of the proposed, preferred, solution to be presented at the outcome of the appraisal.

This Commission was to re-open the previous discussions and considerations on feasible route corridors and options in relation to the 'Stromeferry Bypass', applying the processes of current Government Guidelines, with the aim to generate a robust solution. The report and presentation material was to detail the outcome and findings of the whole appraisal process, and should allow consideration by The Highland Council Full Committee in their determination of the preferred (route) option in late Summer/Autumn 2014.

Following completion of the Stage 1 work in May 2013, The Highland Council agreed to take the preferred option into their list of proposed projects to be considered in the next 10 year Capital program, with an initial allocation to the project of £10M. The 10 year program will run between 2013 and 2023, and to deliver the full scheme, The Highland Council would seek Central Government funding to realise the project.

1.2 Scheme Objectives

The Stakeholder workshops held during the Pre-Appraisal stage of the project were conducted in accordance with the requirements of STAG, and as part of the whole appraisal process, which incorporates Pre-Appraisal, Part 1 & Part 2 Appraisal and Post Appraisal work.

The Pre-Appraisal process carried out in relation to the Stromeferry Bypass successfully resulted in delivering a set of 'local' Project Objectives, which were proposed to be taken forward as 'Transport Planning Objectives' to aid the appraisal of route options during the Part 1 and 2 appraisals. Developed Transport Planning Objectives in relation to this project were re-visited during Part 2 appraisal work, and are outlined in table 3.1 below.

'Strategic' Objectives, which consider the Government's Purpose, National Outcomes and Government Agencies' policy statements in relation to this study, were considered in detail during the first stage of the appraisal. These are considered to be well reflected in the set of agreed Transport Planning Objectives shown below.

The proposed Transport Planning Objectives are not weighted. Relevance in relation to the STAG criteria of environment, safety, economy, integration and accessibility has been considered and is shown in the table 1.1.1 below.

Table 1.1.1 – Scheme Objectives

TRANSPORT PLANNING OBJECTIVES TRANSLATED INTO SMART OBJECTIVES NOVEMBER 2013		
Ref.	**Scheme Objectives**	
1	Deliver a safe and reliable, 2 lane carriageway, by applying appropriate / proportionate design standards	Safety
2	Minimise **all risk** during design, construction, operation and maintenance (with reference to Risk Register)	Economy
3	Ensure deliverability of scheme within programme and to agreed capital cost and maintenance budgets, thus providing 'Value for Money'	
4	Solution reduces, or does not increase, the risk to and liability of the railway and maintains suitable access over the life of the scheme	
5	Deliver a scheme that assists both the local businesses to maximise opportunities for sustainable development and economic growth over the life of the scheme	
6	Safeguard and, where possible and appropriate, enhance and provide access to the natural and built environment and areas of national, regional and local importance and heritage, during construction, maintenance and operation of the scheme (with reference to environmental appraisal)	Environment
7	Scheme to take account of relevant local, regional and national planning policies (during the design stage)	
8	Keep the A 890 and peripheral road network open during construction	Integration
9	Maintain and improve choice of transport mode and integration of public transport links over the lifetime of the scheme	
10	Maintain and improve local social cohesion by improving accessibility for emergency services responding to call-outs, as well as for the local population making use of local and regional leisure, health and educational facilities	Accessibility
11	Maximise / improve network efficiency, sustainable connectivity and social cohesion in terms of journey times and journey reliability in the Wester Ross area	

1.3 Method of Assessment

The methodology agreed with the Client in relation to this study overall is as outlined in the project brief and appraisal process included in section 1.1 of this report. The methodology combines as appropriate the processes of the Scottish Transport Appraisal Guidance (STAG) and Design Manual for Roads and Bridges (DMRB). This methodology adopts a phased approach to scheme delivery as follows:

1. Pre-Appraisal stage; active involvement of local 'economic' and 'regulatory' stakeholders through workshop sessions to develop project (Transport Planning) Objectives, considering identified problems, constraints and opportunities, as well as develop route options and a first step sifting;

2. STAG Part 1 / DMRB Stage 1; high level appraisal of route options and corridors to fulfill the requirements for the preparation of a Stage 1 Scheme Assessment report in

accordance with the DMRB, in combination with an assessment of the route options and corridors against Transport Planning Objectives, STAG Criteria, established policy directives and public acceptability. This is to provide a rationale for the selection or rejection of a route or corridor option.

3. STAG Part 2 / DMRB Stage 2; further in-depth appraisal of emerging route options and corridors in accordance with the requirements of the DMRB Stage 2 Scheme Assessment process, in combination with an appraisal of options against the Transport Planning Objectives and other STAG criteria.

This report summarises the findings of the DMRB Stage 2 assessment. This report has been prepared in accordance with the DMRB Volume 5, Section 1, Part 2, TD 37 'Scheme Assessment Reporting'. A separate report has been compiled to summarise the findings of STAG Part 2.

In addition, drawings have been prepared which illustrate the extent of the proposals at this DMRB Stage 2. The options considered have been assessed to gauge their comparative impact and performance and to enable the appraisal of costs, engineering, traffic and environmental impacts for each option. The aim of the assessment process is to allow a preferred option to be identified which will be taken forward to the next stage of scheme development.

1.4 Consultation

1.4.1 Stakeholder Workshops

The Stakeholder consultation process in relation to the Stromeferry Appraisal involved consultations with various Stakeholder groups from an early stage, aiming to be an informed process from the onset of the project.

The Highland Council had proposed two Stakeholder groups prior to commencement of this appraisal. Details of these groups are shown in 1.4.1 below. Stakeholders were divided into 'Regulatory Stakeholders' and 'Economic Stakeholders' for the initial workshops, due to their differing requirements and in order to keep the numbers manageable. Later on during the appraisal process, joint workshops were held, as detailed below.

The Appraisal process involved the following workshops during the period November 2012 to November 2013: A final workshop was held after submission of the draft Stage 2 Report in June 2014.

Table 1.4.1 – Stakeholder Workshops

NO	DATE	STAKEHOLDER GROUP	VENUE	ATTENDANCE
1	21st November 2012	1st Regulatory	Columba Hotel, Inverness	13
2	4th December 2012	1st Economic	Strathcarron Hotel, Strathcarron	15
3	12th December 2012	2nd Regulatory	Columba Hotel, Inverness	10
4	10th January 2013	2nd Economic	Strathcarron Hotel, Strathcarron	17
5	31st January 2013	3rd Joint Regulatory & Economic	Strathcarron Hotel, Strathcarron	24
6	11th November 2013	4th Joint Regulatory & Economic	Strathcarron Hotel, Strathcarron	19

1.4.2 Public Exhibitions

In addition to Stakeholder workshops, Public Exhibitions were held during Stages 1 and 2 of the appraisal in order to provide information on the process and considerations in relation to the Stromeferry appraisal to the wider public. This also allowed to gain feedback from the public on proposed options, which assisted in shaping the final preferred solution as presented in the concluding part of this report.

Public Exhibitions during the two appraisal stages were held as follows:

Table 1.4.2 – Public Exhibitions

NO	DATE	VENUE	ATTENDANCE
1	Stage 1: 27th April 2013	Lochcarron Village hall	150
2	Stage 2: 27th March 2014	Lochcarron Village Hall	120
3	28th March 2014	Achmore Village Hall	50

Feedback from the public received in reaction to the Stage 2 exhibitions can be found in Appendix B of this report.

1.4.3 Stakeholders

The following Stakeholders were invited and represented during the various Stakeholder Workshops held during as outlined above:

Table 1.4.3– Stakeholders

STAKEHOLDER LIST		
Ref.	**Group**	**Stakeholder**
1	Statutory Stakeholders	Marine Scotland
2		Network Rail
3		First Scotrail
4		Transport Scotland
5		Highlands &Islands Enterprise
6		The Highland Council – Ward Manager
7		The Highland Council – Planning
8		Scottish Environment Protection Agency
9		Scottish Natural Heritage
10		Historic Scotland
11		National Trust for Scotland
12	Economic Stakeholders	The Highland Council – Ward Manager
13		The Highland Council – Transport
14		The Highland Council – Planning (local)
15		The Highland Council – TEC Services
16		Highland Councillors
17		Highlands & Islands Enterprise
18		Forestry Commission Scotland
19		Plockton Community Council
20		Stromeferry & Achmore Community Council
21		Lochcarron Community Council
22		Applecross Community Council
23		Lochcarron and District Business Association
24		Kirkton Woodland & Heritage Group

1.4.4 Other Consultations

In addition to the Stakeholder consultations as outlined above, further consultations have taken place during the appraisal process. These included:

- Further consultations with Statutory Bodies as part of the environmental assessment;
- Consultations with The Highland Council and Network Rail regarding engineering solutions, particularly for on-line proposals, tunnel design and bridge clearances;
- Consultations with The Highland Council and Highlands and Islands Enterprise to ensure economic considerations in relation to this appraisal sit well within the economic aspirations of the area;
- Consultations with major landowners;
- Consultations with Kishorn Port Ltd.
- Consultations with several bodies regarding bridge clearances, including: Marine & Coastguard Agency; Northern Lighthouse Board; UK Hydrographic Office; Crown Estate; Scottish Salmon Company; Royal Yachting Association; Lochcarron Sailing Club; and Harbour Master Kyle.

1.5 DMRB Stage 1 Assessment

A Stage 1 assessment report was delivered to The Highland Council in accordance with the requirements of DMRB Stage 1 and STAG Part 1 in May 2013, summarizing the first stage of the appraisal process.

The report concluded that 9 No. route options should be taken forward to Stage 2 for further analysis.

1.6 DMRB Stage 2 Report Structure

This report is structured around the DMRB TD 37 'Scheme Assessment Reporting' and follows the principles set out in the guidance for the preparation of the Stage 2 Report. The reporting has been split into 2 parts:

This document provides part1 of the Stage 2 DMRB Options Assessment, containing the engineering assessments of the options, made up of the report text, figures and appendices including the engineering drawings.

In addition, the traffic and economic assessment, as well as supporting engineering considerations regarding tunnel design and renewable energy solutions are provided in separate reports, contained in Appendices D and E.

Volume 2 of the DMRB report provides the Stage 2 Environmental Assessment and is under separate cover. This includes the following contents:

- Stage 2 Environmental Assessment Report;
- Appendix 1: Drawings;
- Appendix 2: Site Visit Report;
- Appendix 3: Ecology Field Notes; and,
- Appendix 4: Consultation Information

The chapter headings in this part of the report generally follow the guidance given in Annex B of TD 37:

- Chapter 2 outlines the existing conditions within the study area;
- Chapter 3 describes the scheme options being taken forward for consideration;
- Chapter 4 provides an engineering assessment of the options;
- Chapter 5 provides a summary of the environmental assessment report;
- Chapter 6 provides a traffic and economic assessment of the options;
- Chapter 7 draws the assessment considerations together in a summary table; and
- Chapter 8 makes conclusions and recommendations.

2 EXISTING CONDITIONS

2.1 Introduction

This section of the report describes the existing conditions of the A890, Stromeferry Bypass Appraisal study area, as outlined below, in terms of the existing natural and 'man-made' environment encountered and assessed as part of this appraisal.

2.2 Scheme Location and Environment

2.2.1 Location

The scheme is located in the north-west Highlands of Scotland, between the Isle of Skye and Ullapool.

The Stromeferry Bypass is an approximately 12km long section of public road alongside the southern shore of Loch Carron. The road forms part of the A 890, between the Strathcarron Junction and the tie in with the A87, Invergarry to Kyle of Lochalsh Trunk Road, at Auchtertyre. The road also forms part of the wider road network between Dingwall west to the Isle of Skye via Achnasheen, and provides a popular alternative route from Inverness to Kyle of Lochalsh and Skye.

2.2.2 Study Area

Suitable study areas have been agreed in order to set the geographical boundaries for this appraisal. Figure 2.1 below shows a wider area considered in relation to economical and strategic transport links to and from the area. Figure 2.2 shows the boundaries of the local area considered in relation to existing road network and infrastructure, and proposed route options, problems, opportunities and constraints relevant to the Stromeferry Options Appraisal.

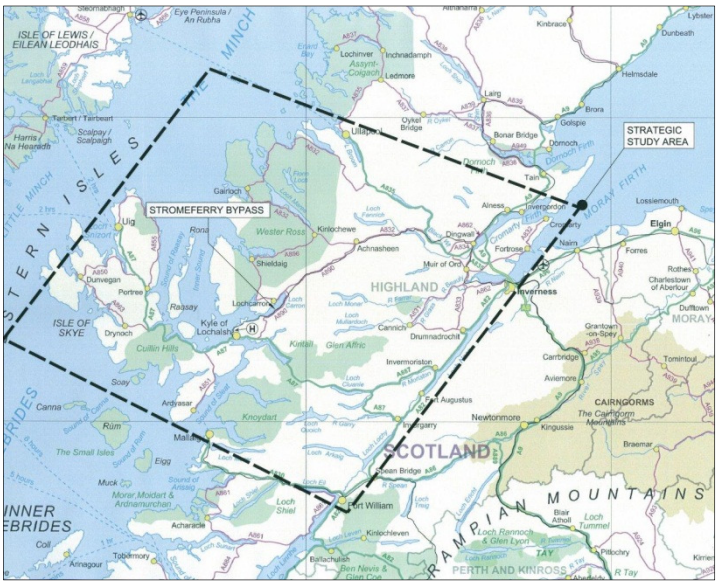


Figure 2.1 – Wider Study Area

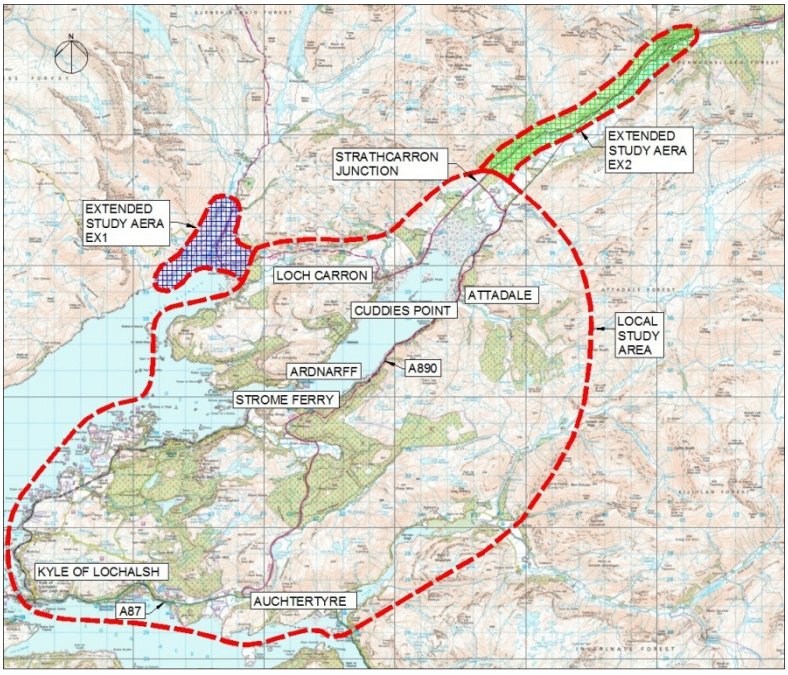


Figure 2.2 – Local Study Area

The above figure also includes further areas shown hatched, which were highlighted during Stakeholder workshop discussions as part of the local road network in need of upgrade, and therefore directly affecting or affected by the proposed works in relation to the Stromeferry bypass.

The western area is the local public and access road leading to the Kishorn yard, branching off from the A896 towards Ullapool and including a section of the minor public road to Applecross.

The eastern area is an 9.5km stretch along the A890 from the Strathcarron junction to the Lair railway bridge. This section of the public road is a recognised 'bottleneck', highlighted in The Highland Council's Local Strategy Plan as part of the Highland Council's strategic road network, where '*the road is of single track with passing place standard or structures on the route may be subject to height or weight restrictions*', and therefore potentially benefiting from improvements. The Highland Council is currently carrying out some minor road improvements on a 2km long section of the A890 just east of the Strathcarron Junction, with a second phase planned from Coulags bridge to Balnacra soon thereafter. There is also a budget allocated in the 10-year plan to carry out a further scheme between Balnacra and the Lair railway bridge in the future. Construction dates are yet to be confirmed.

2.2.3 Topography

The topography within the study area is typical for the west coast of Scotland. The area is bordered by Loch Alsh to the south, Loch Kishorn to the north-west and Loch Carron at the center. All these lochs are sea-lochs, with direct connection into the 'Minch' and Atlantic Ocean.

The land mass in between the lochs varies from sea level along the coast lines, to levels of up to 490m above Ordnance Datum along the range of hills including Cnoc nam Mult at the south side of Loch Carron and 390m above Ordnance Datum at An Sgurr between Loch Carron and Kishorn.

Travelling the main route (A890) from Kyle of Lochalsh north towards Loch Carron, the road passes through undeveloped hill land and areas of forestry, experiencing steep road gradients of up to 14%.

2.2.4 Climate

The Climate at Loch Carron can be described as a changeable, temperate climate, typical for the west coast of Scotland.

The average minimum temperature of the area is 6ºC and the average maximum temperature recorded is 12ºC. The total average annual rainfall recorded is 2037mm, with over 200 days of rainfall greater than 1mm. Monthly mean wind speed at 10m above ground is in average 8.2 knots. In addition, the area experiences approximately 36 days of air frost in a year.[1]

The effect of the climate on the engineering design will be addressed in further detail during Stage 3, detailed design. At this stage allowance has been made to set route option alignments below the 300m AOD contour to reduce risk of freezing during winter months. In addition, outline drainage design has taken account of existing and future climate conditions.

2.2.5 Land Use

The land-use within the study area is agricultural, comprising mainly rough grazing in large areas of undeveloped heath and moorland, as well as areas of forestry and crofting.

2.2.6 Man-made Features

Man-made features that have been identified in the study area are as follows:

Carriageways

The main carriageways within the study area are the A890 between Auchtertyre and the Strathcarron junction, and the A896 between the Strathcarron Junction and Kishorn. Both routes are mainly single carriageways of varying road and verge width, including sections of single track, with associated road structures. These comprise bridges, culverts and retaining walls, as well as a reinforced concrete avalanche shelter.

There are also several local road networks, comprising single track and single carriageway sections, between Achmore and Plockton, and to Stromeferry on the south side of Loch Carron, as well as in and around Lochcarron village, and towards Slumbay and Stromemore on the north side of the loch.

The main road network is shown on drawing numbers 5071 and 5072 in Appendix A.

Railway Line

A section of the railway line from Dingwall to Kyle of Lochalsh is located within the study area, as shown on drawing number 5071 and 5072 in Appendix A.

This comprises the trackbed, signals and associated infrastructure between Plockton, Stromeferry and Strathcarron, as well as station platforms at Duncraig, Stromeferry, Attadale and Strathcarron.

[1] Figures above were taken from the following source:
http://www.metoffice.gov.uk/public/weather/climate/loch-carron-highland#?tab=climateTables

There are also uncontrolled level crossings at Ardnarff and north of Maman Hill, as well as a signal controlled level crossing at Strathcarron.

Various minor under-bridges and culverts are located along this section of railway line, with the most significant bridge structures located at Duncraig, Craig, Fernaig, Attadale and Achintee. The rail track also shares the existing avalanche shelter with the A890 just west of Cuddies' Point.

Residential Properties

A large number of residential properties are located within the study area. These are mainly concentrated along the existing road network, forming part of the main settlements in the area. However, single dwellings remote from the existing public roads are also present and have been identified as far as possible where effected by proposed route options.

Existing properties identified are discussed further in section 9 of Volume 2 Environmental Assessment, and are shown on drawings 9.1.1 and 9.1.2 of the Volume 2 Environmental Assessment.

Commercial Properties

Commercial properties and businesses were identified within the study area. A business directory was established as part of the Business Survey conducted during the STAG appraisal process, as detailed in section 3.8.2 of the STAG Part 2 Report. Some larger commercial properties include:

- Attadale Gardens
- Lochcarron Pottery
- Lochcarron Craft center
- Lochcarron Golf Club
- Lochcarron Weavers
- Various Cafes, Restaurants, Hotels & B&B
- Forestry Commission

In addition, landownership and boundaries have been identified as far as possible and can be found on drawing number 5501 in Appendix A of this report.

Marine Use

A small harbour now mainly used for pleasure craft is located at Plockton. There are existing slipways formerly used by a ferry service at Stromeferry and North Strome, and a further small quay and jetty east of the slipway at Stromeferry.

On the northern shore of Loch Carron, there are various small slipways used for pleasure craft near Lochcarron village and Slumbay. A fish farm and jetty are located further west, near Strome Wood.

Other Properties

Other significant properties identified within the study area are as follows:

- Kirkton Church and graveyard
- Strome Castle

2.3 Engineering Conditions

The following paragraphs describe the existing conditions encountered in engineering terms for the existing principal road network in the study area. The A890 is described from south of Braeintra to the Strathcarron Junction, and the A896 from Kishorn hill above Lochcarron village, again up to the Strathcarron Junction.

The minor route from Ardaneaskan to Lochcarron Village is also described briefly.

2.3.1 Condition of Existing Carriageways

The existing public road under consideration in this appraisal forms part of the A890 from Auchtertyre on the West Coast of Scotland to Achnasheen, and in particular the section between Stromeferry and the Strathcarron Junction.

The Stromeferry Bypass is an approximately 12km long section of the A890 alongside the southern shore of Loch Carron. The road forms part of the local road network between the Lochcarron area and Skye, as well as the wider road network from the Isle of Skye east towards Dingwall, and north along the west coast. It also provides a popular alternative tourist and route from Kyle of Lochalsh and Skye to Inverness.

The public road and a single track railway line are sharing a tight corridor along the southern shores of Loch Carron, which is particularly restricted over an approximately 4.5 km long section from Ardnarff to Attadale. The A 890 is mainly a single carriageway but reduces frequently to single track with passing places along the section between Ardnarff and Cuddies' Point.

Currently national speed limits would apply on the existing route between Auchtertyre and the Strathcarron Junction. However, steep sections of the A890 with gradients of up to 12% between Stromeferry and Ardnarff, and up to 14% between Attadale and Strathcarron, as well as sections of single track road reduce the average speed of traveling considerably.

The minor road from Ardaneaskan to Lochcarron Village on the north side of Loch Carron is a single track carriageway with passing places. The route has very steep sections west of Stromemore, and experiences a tight route corridor with a lot of frontage activity throughout, with residential properties extending into the road verges. There are also various long sections of the route supported by high masonry retaining walls on the southern side, and numerous small burn crossings. In addition, the existing route also includes an approximately 50m long section of elevated single track road embankment retained by high masonry retaining walls and a masonry arch bridge just east of the Lochcarron Weavers.

The existing carriageways mainly provide single track widths which vary between 3.6m and 5.0m, with passing places, and only have short sections of two-way carriage way width of approximately 6.0m. Verge width provided varies greatly, with no or very restricted verges in large sections of the A890 between Ardnarff and Cuddies' Point, and the minor road through Slumbay. Road geometry and sight lines are generally below standard, in particular along the southern side of Loch Carron.

2.3.2 Rock Fall Issues

Since the Stromeferry Bypass was opened, the approximately 4.5km long section of mainly single track road from Ardnarff to Cuddies' Point, which is located just west of Attadale, has been subject to landslides and rock fall events, causing the Local Authority to temporarily close the road at several occasions, in order to enable remedial works to the rock slopes to take place.

The last major event, which caused closure of the road to through traffic over several months occurred in December 2011.

Detailed considerations regarding geotechnical issues in relation to the site are given in a separate report by URS with title 'Stromeferry Options Appraisal, Geotechnical Desk Study Report, February 2013'.

The Highland Council has currently a rigorous inspection regime in place, including daily drive pass inspections, as well as contingency measures in the event of further major rock slope works and associated road closures being required.

2.3.3 Public Road Junctions

Existing at-grade priority junctions of unclassified side roads onto the main A890 and A896 carriageways are located at:

- Braeintra;
- Achmore;
- Stromeferry;
- Achintee;
- Strathcarron;
- Lochcarron and
- Ardarroch.

There are various private access roads located along both carriageways. Ordnance Survey maps identify some of these at Attadale, New Kelso, Tullich, Kirkton and in Lochcarron Village.

Where junctions are affected by the proposed scheme, this will be identified and discussed further in chapter 4 of this report.

Where effected by new route proposals, these will be further described in detail in section 4.2 of this report.

2.3.4 Direct Accesses

There are numerous minor vehicular accesses onto the public road network within the study area. These are mainly for access to forestry, agricultural and railway premises, as well as private dwellings. Where effected by new route proposals, these will be further described in detail in section 4.2 of this report.

2.3.5 Existing Structures

There are various existing structures associated with the carriageway infrastructure along both the A890 between Glen Udalain and the Strathcarron Junction, as well as the route corridors of the minor road C1096 from Ardaneaskan to Lochcarron Village, and the A896 from the Kishorn Hill to the Strathcarron Junction.

Structures encountered are mainly small culverts and associated concrete or masonry head walls, retaining structures and small to large bridge structures of varying construction. Structures recorded in The Highland Council archives, or encountered and recorded on site, generally greater in size than 2.0m span, are shown in the table 2.3.1 below and also identified on drawing numbers 5401 to 5404 in Appendix A of this report.

Where feasible, it is proposed that existing structures will be retained as part of new route proposals.

Table 2.3.1 – Existing Structures

ROAD	STRUCTURE	APPROXIMATE LOCATION
A890		
	Bridge	Allt an Fhrangaich
	Avalanche Shelter	West of Cuddies' Point
	Bridge	Attadale River
	Culvert	Cam Allt
	Bridge	Carron Pottery
	Retaining Wall	Achintee
	Bridge	Achintee, River Taodail
	Level Crossing	Strathcarron
	Bridge	River Carron
C1096		
	Masonry Retaining Walls (various)	North Strome, Stromemore and Mid Strome, Shielings
	Masonry Arch Culvert	Mid Strome, Shielings
	Masonry Arch Bridge	Lochcarron Weavers
	Elevated Road, Masonry Retaining Walls	Lochcarron Weavers
	Masonry Arch Culvert	Strome Wood
	Cattle Grid	Strome Wood
	Masonry Retaining Walls (various)	Slumbay (west)
	Masonry Arch Culvert	Slumbay (west)
	Corrugated Steel Culvert	Slumbay
	Masonry Retaining Walls (various)	Lochcarron (west)
	Minor Culvert (2 No)	Lochcarron
	Bridge/ Culvert	Lochcarron

ROAD	STRUCTURE	APPROXIMATE LOCATION
A896		
	Corrugatd Steel Arch Bridge	Allt nan Carnan River, Lochcarron
	Masonry Arch Bridge	Kirkton
	Masonry Arch Bridge	Kirkton Church
	Bridge	Tullich Smiddy
	Masonry Arch Bridge	Balagnash West

2.3.6 Safety Fencing

Short sections of safety fencing are encountered along the public highways within the study area. Where effected by new route proposals, these will be included in the detailed route descriptions found in chapter 4.2 of this report.

2.3.7 Bridleways, Cyclepaths and Footpaths

No designated bridleways or cycleways have been identified in the study area.

There are no dedicated footways or paths alongside the A890, A896 or minor roads within the study area in general, unless the route passes through an area of housing.

Core paths have been identified west of Creag Mhaol and through woodland west of Stromeferry, from Attadale through Glen Attadale towards Loch an Lasaich, from Tulloch Woods to New Kelso and in Lochcarron Village. There are also local footpath networks at Tullich Woods and Kirkton Wood.

In addition, the Lochcarron Golf Club fairways are located on either side of the A896 at Kirkton.

The above has been considered in relation to proposed route options and is discussed further in section 8 of Volume 2 Environmental Assessment.

2.3.8 Lighting

None of the carriageways are continuously lit throughout the study area. However, streetlighting is provided along the A896 through Lochcarron Village.

2.3.9 Communications

There is no known carriageway communications apparatus provided along public road ways within the study area.

2.3.10 Existing Drainage and Watercourses

A limited amount of information was made available by The Highland Council in connection to existing drainage structures along the pubic road network within the study area.

Structures larger than 2.0m span have been identified in section 2.3.5 of this report.

Existing watercourses have been identified on drawing numbers 5401 to 5404 in Appendix A of this report.

In general, drainage structures comprise road side ditches and filterdrains, with associated culvert crossings of the carriageways outwith residential areas. Where the existing routes are located through developed or built up areas, road drainage also includes road gullies and associated pipework.

2.3.11 Public Utilities

Preliminary inquiries were made, in accordance with Appendix C2 of the Code of Practice to the New Roads and Streetworks Act 1991, to the undernoted major utility operators to establish the presence of their apparatus and assess the impact on each of the route option corridors. The following list summarises the information received:

- Openreach: ducting for local telecommunication services present
- National Grid: no electricity or gas transmission apparatus present
- Scotland Gas Networks: no gas apparatus affected
- Scottish and Southern Energy: low and high voltage electricity apparatus present
- Scottish Water: water and sewerage apparatus present
- Virgin Media: no Virgin Media or Viatel apparatus affected

Details of the utilities information received are reproduced in drawing numbers 5301 to 5306, and can be found in Appendix A of this report.

Openreach

The response received from Openreach indicates the presence of telecommunications apparatus, mainly in the form of general ducting for local services and joint boxes, along the main road network within the study areas, as indicated on drawings numbers 5301 to 5306 included in Appendix A of this report.

A review of the information received would suggest that BT Openreach apparatus will be encountered on various sections along proposed route options, but that none of the proposals are considered to require major re-locatiion of existing services. This would require confirmation from the Utility company once a detailed design stage is reached.

Scottish and Southern Energy

Electricity apparatus is present throughout the study area in the form of medium-voltage 11kV and 33kV overhead distribution lines, generally in the vicinity of existing roads: A890 south from Achmore and Stromeferry, A890 from Attadale and Achintee to Strathcarron Junction, A896 through Lochcarron and towards Kishorn and the C1096 from Lochcarron to North Strome. There are sub-stations between the two different voltage networks at Kishorn hill, adjacent to the A896, and Achintee adjacent to the A890.

Diversion of distribution lines should not add significantly to the cost of schemes.

The locations of conflicts between the 33kV medium voltage lines and the route option corridors are noted in Table 2.3.2. There are crossings of existing roads which could affect on-line sections of several options on the A890 at Achintee and on the A896 between Kirkton and Strathcarron junction.

An 11kV route runs parallel and crosses routes within the north of the study area and would particularly affect route northern routes N6 and N9 and the landing point of for any Strome Narrows bridge.

Table 2.3.2 – SSE apparatus within study area

OPTION	APPARATUS	APPROXIMATE LOCATION
North Shore		
N6, N6b, N9	33kV 33kV	A896 Lochcarron Industrial Estate A896 Ribhuachan
On-line		
O2, O3, O4, O5, O7	33kV	A890 Achintee
South		
S1, S3, S4	33kV	A890 Achintee

Scottish Water

There are localised water main networks ranging from 3" to 150mm diameter at the following settlements:

- Achmore and Stromeferry, affecting options N6, N9;
- Achinstraid;
- Slumbay, Lochcarron and Kirkton, affecting options N6, N9
- Achintee and Strathcarron, affecting On-line and Southern options.

The Lochcarron water treatment works are located above the village adjacent the A896 towards Kishorn hill. A summary of the Scottish Water apparatus conflicts is included in table 2.2.3 below.

Table 2.2.3 – Scottish Water apparatus within study area

OPTION	APPARATUS	APPROXIMATE LOCATION
North Shore		
N6, N6b, N9	3" 90mm 150mm 90mm	Achmore, Stromeferry C1096 Slumbay, A896 Lochcarron A896 Lochcarron A896 Kirkton to Strathcarron Jn
On-line		
O2, O3, O4, O5, O7	90mm	A890 Achintee to Strathcarron Jn
South		
S1, S3, S4	90mm	A890 Achintee to Strathcarron Jn

Sewer networks are present at Achmore, Achinstraid, Slumbay and Lochcarron, however the first two will not affect the route options. North Shore options involving widening of the existing carriageway could however be affected by the sewer network at Slumbay and Lochcarron which is adjacent the road and the foreshore.

2.4 Traffic Conditions

The existing road network in the study area is used for a variety of purposes. These include haulage serving the forestry, agriculture and fisheries industries, commuting and seasonally variable tourism trips. At present the route is lightly used for most of the year, but higher demand for the route occurs during the peak tourist summer months.

The DMRB Stage 1 appraisal was reliant on historic data from Transport Scotland for mean traffic flows and vehicle composition and for standard government values for traffic growth and vehicle speeds.

Figure 2.1 shows the monthly mean 24 hour two way traffic flows for Attadale for the year 2010. There is a strong seasonal variation in monthly traffic flows, peaking in August. Most of this seasonal variation is the result of additional tourist traffic in the summer months.

Figure 2.1: Monthly Mean 24hour Average Two Way Traffic Flows, A890 at Attadale, 2010

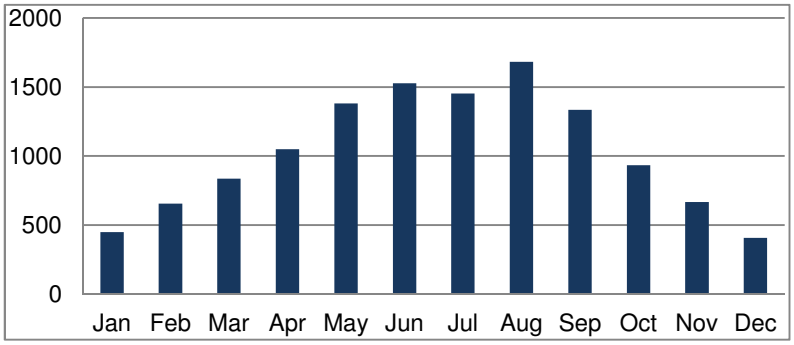


Figure 2.2: Monthly Mean 24hour Average Two Way Traffic Flows, A890, A82 and A9, 2010

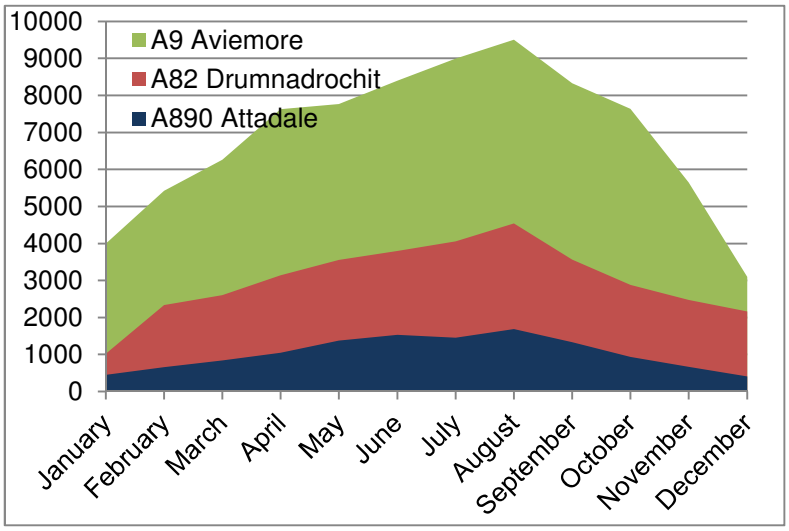


Figure 2.2 clearly demonstrates that in comparison with traffic flows on the trunk roads in the Highland region such as the A82 and A9, traffic volumes on the A890 are relatively very low, even in the peak summer months.

The DMRB Stage 2 appraisal has for the most part relied more heavily on survey data to augment both historic data and, where appropriate, standard government values used in the DMRB Stage 1 appraisal.

The DMRB Stage 2 appraisal values for mean traffic flows, vehicle speeds and vehicle composition were derived from a set of traffic surveys undertaken from the 12th to the 18th of March 2013. These consisted of:

- Manual Classified Turning Counts (MCC);
- Automatic Traffic Counts (ATC); and
- Journey Time Surveys (JTS).

Additional data on trip user purpose, trip origins and destinations and trip behaviour following a rock fall event were obtained from:

- Roadside Interview Surveys (RSI)

The RSIs were undertaken over two weekdays on the 27th and 28th August 2013.

Full details of the traffic survey results are presented in Chapter 6.

3 DESCRIPTION OF SCHEME OPTIONS

3.1 Option Development

The development and sifting of possible route corridors and options formed the central part of this appraisal. The process of considering and, where appropriate, eliminating proposed route options, was carried out in a logical, transparent and auditable manner.

The Stromeferry Bypass project has a long history of feasibility considerations for both on-line and off-line route options, reflecting the ongoing problems associated with the existing route. This historical work was given due consideration, but without prejudice for any particular option, alongside any new route options generated during the early appraisal stages.

3.1.1 Initial Options at Pre-Appraisal

During the Pre-Appraisal stage, 31 route options were identified. These were located in 6 No. route corridors, labeled (north to south) Outer North (ON), North Shore (NS), Mid Loch (M), On-Line (ON), Southern (S) and Outer South (OS). The route options were discussed and agreed in detail during Stakeholder workshops, and some (14 No.) dismissed during a first and second sift.

Reasons for dismissing routes early were mainly similarities with other route options, assumed buildability or deliverability issues due to estimated excessive costs, winter maintenance and routes taking traffic too far off the existing alignment.

This left 17 No. routes to be assessed during the Stage 1 appraisal.

3.1.2 Options Sifting (Stage 1)

During the Stage 1 assessment of the routes, a further 6 No. route options were dismissed due to their poor scoring against appraisal criteria, as well as on engineering, environmental and economic grounds.

In addition some of the north shore routes requiring a Strome Narrow crossing were rationalised. The on-line route option with potentially the highest risk during construction and long-term was also dismissed. Furthermore, southern routes were developed into a principal route with associated local link routes.

Therefore 9 No. route options were presented as the ‘emerging route options’ at the Stage 1 Public Exhibition in April 2013, with the Stage 1 report concluding that these routes should be taken for further assessment and development during Stage 2.

These included 2 No. northern route options (N6 & N9), 5 No. on-line proposals (O2, O3, O4, O5 & O7), 1 No. southern route, presented as one principal route (S4) with two local link routes (former S1/3). Renewable energy by means of tidal generation (N6b) was also to be considered at Stage 2.

3.1.3 Option Development during Stage 2

The 9 No. ‘emerging route options’ are detailed on drawing no 1002 in Appendix A.

Initially, the route options were re-examined and then split up into route sections, to aid appraisal where on- and off-line solutions were considered for a particular length / section of the route.

The 9 No. whole route options for assessment at Stage 2 were as follows:

1. **North Shore N6**, starting at the A890 near Achmore, crossing the Strome Narrows by means of either a bridge or tunnel, following the general alignment of the existing minor road along the north shore of Loch Carron from Stromemore to Stromewood, continuing online through Slumbay, Lochcarron Village and Kirkton to the Strathcarron Junction;

2. **North Shore N6b,** emerging from the Stage 1 appraisal proposed a north shore route, with an integrated renewable energy solution. The route crossed Strome Narrows on a barrage and the alignment would have followed either N6 above, or N9 as described below.

   Various engineering options to generate electricity from the strong tidal flows found in the Strome Narrows were evaluated during Stage 2, including a tidal barrage, tidal bridge or tidal stream devices. A detailed report, 'Stromeferry Tidal Generation Report, 47065084/001' on tidal generation was compiled and can be found in Appendix D.

   The study concluded that a tidal bridge would be the most feasible option considered to generate renewable energy at the Narrows; however, as this technology has not been well enough advanced at this stage, renewable technology will not be included as part of the recommendations at the stage of the process. Nevertheless, it is recommended that this should be re-visited at some later stage of the scheme, when technologies, revenue generation, incentives and funding models may be more mature.

3. **North Shore N9**; starting at the A890 near Achmore, crossing the Strome Narrows by means of either a bridge or a tunnel, following the general alignment of the existing minor road from Stromemore to Strome Wood, but proposing a full bypass of Slumbay and Lochcarron Village to the north up to Kirkton, and online improvements from Kirkton to the Strathcarron Junction;

4. **On-Line O2**, starting on the A890 west of Stromeferry, following the existing road alignment with online improvements up to the Frenchman's Burn (east of Ardnarff), proposing a viaduct structure to bypass the worst of the rockfall area up to Cuddies' Point. The route then follows the existing A890 up to the Strathcarron Junction, including local improvements to gradients and alignment and a bypass of the existing level crossing at Strathcarron.

5. **On-Line O3**, route description as above, but with a tunnel bypassing the rock fall area west of Cuddies' Point;

6. **On-Line O4** is the 'Do-Minimum' option providing a baseline case option. This would adopt the existing route as is, including ongoing maintenance of the rock face and route corridor, but no major works;

7. **On-Line O5**, online route description as for O2 above, considering a shared road / rail section west of Cudddies' point to bypass the rock fall area;

8. **On-Line O7**, online route description as for O2 above, with the worst of the rock fall area protected by means of an avalanche shelter;

9. **Southern S4,** southern route alignment, from the A890 following an existing forestry track east through Gleann Udalain towards Loch nam Breac Mora and then northwards towards Attadale valley. The route follows the river Attadale north west and ties back into the existing A890 at the Attadale river bridge. The alignment then follows the existing A890 to the Strathcarron Junction, including local improvements to gradients and alignments.

Numerous issues were taken into account during Stage 2 of the option development and assessment of the above detailed routes, including the scheme objectives identified during the

early stages of the appraisal, as well as government appraisal criteria. Issues considered most significant for this improvement scheme were:

- Creating a safe bypass of the 4km of rock fall and unstable rock face area west of Cuddies' Point;
- Achieving modern road standards (corridor width and alignments);
- Buildability / minimising disruption during construction;
- Affected properties and land;
- Proposing a deliverable scheme.

Each of these factors, and a full assessment of the route options, will be discussed in more detail in chapter 4, Engineering Assessment.

In addition, the Stage 2 options development also included considerations of a phased delivery of the preferred route options as outlined above to provide a more affordable solution. Route delivery was proposed in one to four phases, with the first phase starting in 2017 the earliest, involving a scheme to bypass the rockfall area as a minimum. Drawing number 1004 in Appendix A provides an indication of the phasing proposals developed.

The Public Exhibitions held on the 27th and 28th March 2014 at Lochcarron and Achmore provided an opportunity for the public to consider and discuss the route proposals and air any issues they may have regarding the proposals with representatives of The Highland Council and URS. The main issues of concern included an urgency to provide a safe and reliable route past the rock fall area, likely disruptions during construction of the scheme, and deliverability.

3.2 Cost Estimates

3.2.1 Introduction

A Stage 2 Appraisal offers preliminary proposals and therefore only broad-based estimates of cost can be made. Nevertheless, these should allow a meaningful comparison of options. The cost estimates developed are based on typical unit costs for new rural 7.3m wide single carriageway roads, with additions for major earthworks, major structures, service diversions, junctions and any other abnormal elements identified. Costs were derived from a combination of recognised reference material, including the SPONS Civil Engineering and Highway Works Price Book which was used as a comparator reference for consistency throughout the estimating process. Historical information from previous road projects has also been considered. Discussion also took place with a major civil engineering contractor in the Highlands. All costs are presented to the second quarter of 2013.

A further consideration has been phased construction for Stromeferry Bypass. That is initially providing improvements which would bypass the rockfall area as a minimum, with subsequent improvements phased over a further 3 stages ultimately providing improvements from Braeintra/ Achmore / Stromeferry to Strathcarron Junction. This phased approach would assist with affordability and deliverability whilst still satisfying the project objectives. Phasing cost estimates are discussed in section 3.2.13.

3.2.2 Earthworks Costs

Earthworks quantities were derived from the three dimensional MX model used to create the Route Options. It should be noted that these profiles are based on the preliminary ground contour information, supplemented with a local topography survey online from Ardnarff to Cuddies Point. It has been assumed across all routes that an average 50% of all excavated

material is reusable as fill, and that 100% of excavated rock is reusable as fill. At this stage, embankment slopes are assumed to be 1 in 2 slopes. Cutting slopes through normal material are assumed to be 1 in 2. Cutting slopes through rock are assumed to be steeper which are stepped bermed slopes as detailed in the Geotechnical Desk Study Report contained in Appendix F. Rock is assumed to be present throughout the majority of the study area. Rock is located at ground surface for online options from Stromeferry to Attadale; rock is present at 1m below ground surface for North Shore options; rock is present 1m below ground surface for Southern routes from Glen Udalain to Maman Hill; no rock is assumed to be present from Maman Hill to Strathcarron junction.

A higher excavation rate has been assumed for cutting into the rock face from Ardnarff to Cnoc Nam Mult. Estimating the costs associated with remodelling the existing rock face from Cnoc Nam Mult to Cuddie's Point, and throughout the study area offers a challenge as there are many variables, whether the existing slope would be repaired or excavated, whether the rock face would be excavated by drilling and blasting to expose the new face, the height of the slopes, and the geology etc. For this stage in the study, a standard rock cut rate has been assumed throughout which is an average of estimated rates for blasting and breaking out rock, and also includes an allowance for pre-splitting. The area of rock netting which would be replaced or renewed has been estimated and is included in the cost estimates. The lengths of new catch fences which would be installed has been estimated and included in the cost estimates. The requirement for any soil removal at rock slopes for the online options, which is expected to be minimal, has not been included at this stage. Costs associated with tree removal on the upper hillside of the online rock slopes have not been included at this stage.

Rates for rock stabilisation works are based on the costs incurred with the existing ongoing programme of rock slope maintenance works currently being undertaken by URS at Stromeferry on behalf of The Highland Council.

Allowances have also been made for areas of peat which are present in the study area, as detailed in the Peat Management Report contained in Appendix G as depths of peat would not be confirmed until ground investigation is carried out, for the purposes of the cost estimates, peat depths of 3m have been assumed throughout. Costs have been included for removal of peat beneath embankments.

The cost base for the earthworks required by the alignments being considered is detailed in tables 3.2.1 below and 3.2.2 overleaf.

Table 3.2.1: Cost Base for Earthworks

Estimate Rates for Earthworks	
Excavate, deposit & compact normal material	£4.18 / m^3
Excavate, deposit & compact rock	£13.95 / m^3
Import fill & compact	£22.46 / m^3
Excavate & dispose normal material / rock	£38.41 / m^3
Excavate & dispose peat	£115.81 / m^3
Rock netting	£1,000.00 / m
Rock fall catch fence	£5,000.00 / m
Rock fall debris flow barrier	£5,000.00 / m

Table 3.2.2: Cost Base for Earthworks

Option	Total Cut (m^3)	Total Fill (m^3)	Excavate, deposit + compact (m^3)	Import fill + compact (m^3)	Excavate + dispose (m^3)	Rock remodelling fences/barriers (m)	Earthworks Total (£M)
North Shore							
N6 - North bridge online	169,498	214,025	161,105	133,473	177,890	92	9.99
N9 - North bridge Lochcarron bypass	269,751	387,995	433,603	171,193	105,899	841	12.45
Online							
O2 – Online Viaduct	308,732	417,459	364,050	235,434	253,413	1,785	17.10
O3 – Online Tunnel	376,341	439,594	499,268	189,960	253,413	2,366	19.92
O5 – Online Shared Used Road/Rail	294,832	396,062	336,251	227,937	253,413	1,785	16.74
O7 – Online Avalanche Shelter	302,291	579,527	351,168	403,943	253,413	1,771	20.72
Southern							
S4 – South Glen Udalain	570,100	739,847	1,300,262	89,716	296,585	912	20.37

3.2.3 Roadworks Costs

Pavement

The lengths of carriageway required were derived from the three dimensional MX model. It has been assumed for the purposes of the cost estimating exercise that new pavement will be provided throughout, therefore allowing for full new road pavement construction along on-line sections. Details of pavement rates adopted are shown in table 3.2.3.

Table 3.2.3: Estimated Rates for Pavement

Estimate Rates for Pavement		
Dense bitumen	30mm surface course	£5.81 / m^2
Dense bitumen	50mm binder course	£7.95 / m^2
Dense bitumen	200mm road base	£22.96 / m^2
Granular sub-base	200mm sub base	£6.91 / m^2
Full pavement construction Total width of new pavement 7.3m		£43.63 / m^2
Cost per linear metre of new carriageway		£318.48 / m

3.2.4 Ancillary Costs

The cost of ancillary works required within a road construction project at this stage are most easily expressed as a price per linear metre as shown in table 3.2.4 below. Site clearance and soiling and seeding are expressed as a rate per metre area.

Table 3.2.4: Estimated Rates for Ancillary items

Estimate Rates for Ancillary items	
Fencing and safety barriers	£69.86 / m
Signs and road markings	£8.21 / m
Kerbs and drainage	£102.68 / m
Cost per linear metre of road	£180.75 / m
Site clearance	£0.13 / m^2
Soiling and seeding	£4.80 / m^2

Junctions and Side Roads

At -grade priority junctions are envisaged for the junctions on the proposed new alignment. Further sections of new carriageway may also be required for junctions to tie into the existing road network. At this stage, the costs of these junctions and sideroads have been estimated to be 1% of the pavement and ancillaries cost. The Roadworks cost estimate is detailed in table 3.2.5.

Table 3.2.5: Roadworks Costs

Option	Pavement (£M)	Ancillaries (£M)	Junctions & Side Roads (£M)	Roadworks Total (£M)
North Shore				
N6 - North bridge online	4.60	3.13	0.08	7.81
N9 - North bridge Lochcarron bypass	4.62	2.86	0.07	7.55
Online				
O2 – Online Viaduct	4.27	3.45	0.08	7.80
O3 – Online Tunnel	4.28	3.44	0.08	7.80
O5 – Online Shared Used Road/Rail	4.27	3.43	0.08	7.78
O7 – Online Avalanche Shelter	4.27	3.43	0.08	7.78
Southern				
S4 – South Glen Udalain	6.15	4.04	0.10	10.30

3.2.5 Structures Costs

Cost estimates for structures have been generated using standard rates applied to the structure cross section together with an estimate of the required length to derive the cost of individual structures. For the major structures, these costs have undergone a further level of interrogation to give the necessary levels of confidence. Details of structures rates adopted are shown in table 3.2.6.

Table 3.2.6: Estimated Rates for Structures

Estimate Rates for Structures		
Underbridge, rates vary		£1301.10 / m^2 to £2000.00 / m^2
Culverts,	minor (<1m diameter)	£636.70 / m
	small (>1m diameter)	£2690.82 / m
Retaining walls,	1m height	£518.36 / m
	2m height	£1308.00 / m
	3m height	£3266.27 / m
Strome Narrows bridge		£2600.00 / m^2
Rail viaduct		£2646.95 / m^2
Tunnel		£37,978.69 / m
Developed avalanche shelter		£13,430.12 / m

General bridge structure locations have been identified for crossings of large streams and rivers and railway crossings and span sizes estimated to suit. Culvert locations have been identified for small watercourse crossings and an average length assumed.

Allowance has been made for the potential need for retaining walls for online sections North Shore onoine option (N6) within the existing built-up development constraints of Slumbay and Lochcarron. Lengths of retaining walls have also been provided for online routes between Ardnarff and Cuddies Point, provided between the road and railway. A short length of retaining wall has also been provided at Maman Hill for the Online and Southern Route options. Precise requirements will be determined on the development of the Preferred Route Option design during Stage 3 and detailed design. Nominal overall lengths of walls of nominal heights have been allowed for at this stage.

The cost of the major structures as included under the north options (N6 and N9) and online options for the railway viaduct and developed avalanche shelter (O2 and O7), could vary from that assumed as conditions along each route are irregular or not know in detail. A preliminary design based on the parameters of each site/route would be necessary to carry out an accurate costing exercise. At this stage of the study, the cost estimate for the Strome Narrows crossings, North options N6 and N9, has been based on providing a composite steel/concrete box girder deck on reinforced concrete substructure. The cost estimate for the rail viaduct included under Online option O2 has been based on providing a continuous plate girder half-through structure with a reinforced concrete trough supporting the track bed. The cost estimate for the developed avalanche shelter, online option O7, has been based on providing a contiguous precast beam deck slab supported on a retaining wall to the south and reinforced concrete columns with a longitudinal crosshead to the north. These are preliminary estimates as very limited information is available on ground conditions, detailed bathymetric survey or the exact form of construction. The estimated cost for these structures has been based on experience of similar structures, expressed as an indicative rate per square metre of deck area.

The cost estimates included for the tunnel option (O3) are as detailed in the Tunnel Report contained in Appendix E. The preliminary generic costs are based on a DMRB BD 78/99 tunnel option, with elements of Norwegian practice being adopted, i.e. use of targeted rock support rather than providing a fully lined tunnel. Further assessment will be required, but adopting

some Norwegian practices would offer some cost savings. At this stage a 20% reduction of the BD 78/99 cost has been assumed.

The estimated structures costs are detailed in table 3.2.7 below.

Table 3.2.7: Estimated Structures Costs

Option	Major structures (£M)	Bridges (£M)	Culverts (£M)	Retaining Walls (£M)	Total Structure Cost (£M)
North Shore					
N6 - North bridge online	28.60	0.55	0.11	-	29.83
N9 - North bridge Lochcarron bypass	28.60	0.55	0.11	-	29.26
Online					
O2 – Online Viaduct	29.65	4.36	0.10	2.93	37.03
O3 – Online Tunnel	5.81	4.36	0.10	2.98	65.55
O5 – Online Shared Used Road/Rail	-	4.36	0.10	2.93	7.39
O7 – Online Avalanche Shelter	2.28	4.36	0.10	2.77	30.06
Southern					
S4 – South Glen Udalain	-	5.23	0.10	0.65	5.98

3.2.6 Other Cost Considerations

On-line/Off-line bias

Costs need to be recognised in the comparative evaluation for construction works at the critical 2km section of rock face and associated ongoing maintenance works which will still be necessary should an off-line option be selected. In this context, all online are deemed to be 'off-line' as these solutions all effectively bypass the critical road section.

It is suggested that a figure of £5.0 million is allocated, comprising £1.5 million for road works and £3.5 million for rock face treatment at time of the construction period. The £5.0 million has accordingly been applied to the North Shore and Southern options. Future maintenance costs, such as reactive maintenance costs associated with rock fall events, and ongoing routine maintenance costs, will be included separately in the economic appraisal; Chapter 6 of this report.

Do-Minimum

There are no capital costs associated with Option O4 Do-Minimum, all costs are future maintenance costs. Therefore, Option O4 has not been included in the cost summary tables below, instead Option O4 costs are considered separately in the economic appraisal. However it should be recognised a maintenance cost of some £30M is expected to be spent over 60 years, thus being the economic return period.

Road / Rail Share

Cost associated with works to the existing railway line have been included for realigning the railway for online option O2 rail viaduct. Costs have also been included for online option O7 developed avalanche shelter for works to the railway line during construction.

3.2.7 Landscaping, Accommodation Works, Statutory Undertakers and Land Costs

Land costs, the cost of Accommodation Works and the cost of alterations to Statutory Undertakers equipment are difficult to assess accurately at this stage, and the cost estimates shown in table 3.2.8 will be updated as more information becomes available during the detailed assessment.

At this stage the land cost has been based on the footprint area of each scheme. All land is assumed to be agricultural, with the land through the built up developed area through Slumbay associated with North Shore online option (N6) assumed to be residential land. Land costs are based on rates taken from the District Valuer Property Management Report 2011.

At this stage, the cost of Accommodation Works has been assumed as a percentage of the civils sub-total, (earthworks, roadworks, structures and other costs) estimated to be 3%. Further allowances have been included for the North Shore Lochcarron bypass (N9) option for three accommodation works bridges to provide access to crofting land.

Landscaping and environmental costs have been estimated as 1.5% of the total civils sub-total, and costs for statutory undertakers works have been derived at 2% of the civils sub-total.

Table 3.2.8: Landscape, Accommodation Works, Statutory Undertakers and Land Costs

Option	Landscaping + Environment (£M)	Accommodation Works (£M)	Statutory Undertakers (£M)	Land (£M)
North Shore				
N6 - North bridge online	0.79	1.58	1.05	0.52
N9 - North bridge Lochcarron bypass	0.81	2.23	1.09	0.35
Online				
O2 – Online Viaduct	0.94	1.87	1.25	0.49
O3 – Online Tunnel	1.40	2.80	1.87	0.39
O5 – Online Shared Used Road/Rail	0.49	0.97	0.65	0.38
O7 – Online Avalanche Shelter	0.89	1.77	1.18	0.38
Southern				
S4 – South Glen Udalain	0.62	1.25	0.83	0.53

3.2.8 Civil Engineering (Civils) Costs

It is not the intention that this document be used as the definitive cost estimate for the schemes under consideration, but rather as a guide to allow meaningful alignment comparisons to be made. These costs are for comparative purposes and do not include allowance for inter-alia, traffic management or aggregate tax. A summary of the cost estimates developed for each option is shown in table 3.2.9.

Table 3.2.9: Civil Engineering Costs

Option	Earthworks	Roadworks	Structures	Other costs	Landscaping Environ	Accommodation Works	Statutory Undertakers	Civils Cost
North Shore								
N6 - North bridge online	£9.99M	£7.81M	£29.83M	£5.00M	£0.79M	£1.58M	£1.05M	£56.04M
N9 - North bridge Lochcarron bypass	£12.45M	£7.55M	£29.26M	£5.00M	£0.81M	£2.23M	£1.09M	£58.39M
Online								
O2 – Online Viaduct	£17.10M	£7.80M	£37.03M	£0.44M	£0.94M	£1.87M	£1.25M	£66.42M
O3 – Online Tunnel	£19.92M	£7.80M	£65.55M	£0.04M	£1.40M	£2.80M	£1.87M	£99.38M
O5 – Online Shared Used Road/Rail	£16.74M	£7.78M	£7.39M	£0.45M	£0.49M	£0.97M	£0.65M	£34.46M
O7 – Online Avalanche Shelter	£20.72M	£7.78M	£30.06M	£0.44M	£0.89M	£1.77M	£1.18M	£62.84M
Southern								
S4 – South Glen Udalain	£20.37M	£10.30M	£5.98M	£5.00M	£0.62M	£1.25M	£0.83M	£44.35M

3.2.9 Construction, Risk & Land Costs

Allowances for preliminaries have been estimated using a cost multiplier applied to the total estimated build cost for each route option. Preliminaries of 30% of the Civils Cost, based on recent tenders and contractor discussions, have been added for these initial estimates to take allowance of interface issues, delays, restrictions, traffic management and general remoteness, particularly when considering on-line options.

An allowance has been included for risk following a review of the risk register and estimated costs. A risk analysis as described in the STAG Manual Database Section 13 was undertaken. Costs associated with individual items were assigned to each option under consideration. Full details of the risk analysis process is included in the STAG Part 2 Report.

Adding the estimated costs for Preliminaries, Land and Risk Allowance to the Civils Cost, gives the 'Construction Cost', as shown in table 3.2.10.

Table 3.2.10: Construction Cost

Option	Preliminaries	Civils Cost	Construction Sub-total (incl prelims)	Risk Allowance	Construction Cost (incl. Prelims & Risk)
North Shore					
N6 - North bridge online	16.81	56.04	72.85	6.10	78.95
N9 - North bridge Lochcarron bypass	17.52	58.39	75.91	5.30	81.21
Online					
O2 – Online Viaduct	19.93	66.42	86.35	5.80	92.15
O3 – Online Tunnel	29.81	99.38	129.19	4.80	133.99
O5 – Online Shared Used Road/Rail	10.34	34.46	44.80	2.90	47.80
O7 – Online Avalanche Shelter	18.85	62.84	81.70	7.10	88.80
Southern					
S4 – South Glen Udalain	13.30	44.35	57.65	4.50	62.15

3.2.10 Construction & Land Costs

Optimism Bias

HM Treasury guidance 'The Green Book – Appraisal and Evaluation in Central Government' recognises that there is a tendency for projects to be overly optimistic. To mitigate optimism in project estimates, the Green Book recommends that uplifts should be applied. Optimism bias of 15% uplift is recommended for Stage 2 road schemes, and 23% for fixed links (major structures and tunnels) to take account of unquantified risks associated with standard civil engineering projects. Applying the Optimism Bias therefore gives the Total Construction and Land Cost, as shown in table 3.2.11.

Table 3.2.11: Total Scheme Cost

Option	Construction Total (£M)	Optimism Bias (construction) (£M)	Land (£M)	Optimism Bias (Land) (£M)	Construction & Land Cost (incl. Prelims, Risk & OB) (£M)
North Shore					
N6 - North bridge online	78.95	13.22	0.52	0.08	92.76
N9 - North bridge Lochcarron bypass	81.21	13.67	0.35	0.05	95.28
Online					
O2 – Online Viaduct	92.15	15.32	0.49	0.07	108.04
O3 – Online Tunnel	133.99	24.03	0.39	0.06	158.47
O5 – Online Shared Used Road/Rail	47.70	6.72	0.38	0.06	54.86
O7 – Online Avalanche Shelter	88.80	14.08	0.38	0.06	103.32
Southern					
S4 – South Glen Udalain	62.15	8.65	0.53	0.08	71.42

3.2.11 Total Scheme Costs

Professional Fees

An estimate of fees likely to be incurred throughout the whole duration of the project has been included. Industry standard fees of 9% for preparation and design costs and 5% for construction supervision have been added to the Construction & Land Cost to give the total Scheme Cost, as shown in table 3.2.12.

Table 3.2.12: Professional Fees

Option	Construction & Land Cost (£M)	Preparation (£M)	Supervision (£M)	Total Scheme Cost (£M)	Scheme Length (km)
North Shore					
N6 - North bridge online	92.76	8.35	4.64	105.75	14.45
N9 - North bridge offline	95.28	8.58	4.76	108.62	14.50
Online					
O2 – Online Viaduct	108.04	9.72	5.40	123.16	13.41
O3 – Online Tunnel	158.47	14.26	7.92	180.65	13.45
O5 – Online Shared Used Road/Rail	54.86	4.94	2.74	62.54	11.13
O7 – Online Avalanche Shelter	103.32	9.30	5.17	117.78	13.41
Southern					
S4 – South Glen Udalain	71.42	6.43	3.57	81.41	19.32

3.2.12 Cost Estimate Summary

A summary of the full cost estimate is detailed in table 3.2.13.

Table 3.2.13: Cost Estimate Summary

Item	N6 - North bridge online	N9 - North bridge Lochcarron bypass	O2 - Online Viaduct	O3 –Online Tunnel	O5 –Online Road/rail share	O7 – Online avalanche shelter	S4 – South Glen Udalain
Prelims (30%)	£16.81M	£17.52M	£19.93M	£29.81M	£10.34M	£18.85M	£13.30M
Earthworks	£9.99M	£12.45M	£17.10M	£19.92M	£16.74M	£20.72M	£20.37M
Roadworks & Acc Wks	£9.38M	£9.78M	£9.67M	£10.60M	£8.75M	£9.55M	£11.55M
Structures	£29.83M	£29.26M	£37.03M	£65.55M	£7.39M	£30.06M	£5.98M
Statutory Undertakers	£1.05M	£1.09M	£1.25M	£1.87M	£0.65M	£1.18M	£0.83M
Landscaping & Environment	£0.79M	£0.81M	£0.94M	£1.40M	£0.49M	£0.89M	£0.62M
Other	£5.00M	£5.00M	£0.44M	£0.04M	£0.45M	£0.44M	£5.00M
Risk Allowance (construction)	£6.10M	£5.30M	£5.80M	£4.80M	£2.90M	£7.10M	£4.50M
OB Construction	£13.22M	£13.67M	£15.32M	£24.03	£6.72M	£14.08	£8.65M
Construction Total (incl Prelims, Risk & OB)	**£92.17M**	**94.88M**	**£107.48M**	**£158.02M**	**£54.42M**	**£102.88M**	**£70.80M**
Land	£0.52M	0.35M	£0.49M	£0.39M	£0.38M	£0.38M	£0.53M
OB land (15%)	£0.08M	0.05M	£0.07M	£0.06M	£0.06M	£0.06M	£0.08M
Construction & Land Total (incl Prelims, Risk & OB)	**£92.76M**	**95.28M**	**£108.04M**	**£158.47M**	**£54.86M**	**£103.32M**	**£71.42M**
Preparation (9%)	£8.35M	8.58M	£9.72M	£14.26M	£4.94M	£9.30M	£6.43M
Supervision (5%)	£4.64M	£4.76M	£5.40M	£7.92M	£2.74M	£5.17M	£3.57M
Total Scheme Cost	**£105.75M**	**£108.62M**	**£123.16M**	**£180.65M**	**£62.54M**	**£117.78M**	**£81.41M**

3.2.13 Phasing of Options

Limited funding for the development of the Stromeferry Bypass Project is within the 10-year Strategy. Capital construction funding is yet to be secured. Whilst the aim of the project is to deliver a full scheme between the A890 south of Achmore and Strathcarron Junction as set out in chapter 1, as part of the brief for this appraisal, considerations were to be given to affordability of the proposed scheme.

Therefore, phasing of route options was considered, and outline costs developed making assumptions on the delivery dates of the phases, to investigate the advantages of a phased delivery of the scheme and whether this process would affect the ranking of options and therefore route selection.

The first phase of any option would involve scheme development to bypass the rockfall area as a minimum. Phasing of the route options is also demonstrated on drawing number 1004 in Appendix A of this report.

Therefore, for the North Shore Options, this would involve construction of the section from Achmore to Kirkton in phase 1, followed by construction of the section from Kirkton to Strathcarron Junction in phase 2.

For any Online Option, phase 1 would include construction of the section from Ardnarff to Cuddies Point; phase 2 would be construction of the section from Achintee south to Strathcarron north; phase 3 would be construction of two sections, from Stromeferry to Ardnarff, and from Attadale to north of Maman Hill; and phase 4 would be construction of three sections, from Cuddies Point to Attadale, Maman Hill north to Achintee South, and Strathcarron north to Strathcarron Junction.

For the Southern Option, phase 1 would include construction of the section from Glen Udalain to Attadale; phase 2 would be construction of the section from Achintee south to Strathcarron north; phase 3 would be construction of the section from Attadale to Maman Hill north, and phase 4 would include two sections, from Maman Hill north to Achintee south, and from Strathcarron north to Strathcarron Junction.

A summary of the estimated phasing costs is included in table 3.2.14 detailing construction costs only. Table 3.2.15 offers a comparison of the estimated Total Scheme Costs for Phased and Single Delivery.

Table 3.2.14: Phasing Cost Estimate, Construction Cost Sub-Total

	N6 North Bridge Online	N9 North Bridge Lochcarron Bypass	O2 Online Rail Viaduct	O3 Online Tunnel	O5 Online Shared Use	O7 Online Avalanche Shelter	S4 South Glen Udalain
Phase 1 (2017)	£70.22M	£73.70M	£47.87M	£89.50M	£8.87M	£43.85M	£40.45M
Phase 2 (2022)	£3.09M	£3.08M	£10.79M	£10.79M	£10.79M	£10.79M	£10.80M
Phase 3 (2027)	-	-	£30.10M	£30.10M	£30.10M	£30.10M	£7.71M
Phase 4 (2032)	-	-	£3.77M	£3.77M	£3.77M	£3.77M	£1.77M
Construction Cost Phased Delivery	**£73.31M**	**£76.78M**	**£92.53M**	**£134.16M**	**£53.52M**	**£88.51M**	**£60.72M**

Table 3.2.15: Phasing Cost Estimate, Total Scheme Cost

	N6 North Bridge Online	N9 North Bridge Lochcarron Bypass	O2 Online Rail Viaduct	O3 Online Tunnel	O5 Online Shared Use	O7 Online Avalanche Shelter	S4 South Glen Udalain
Phase 1 (2017)	£101.98M	£104.95M	£69.55M	£126.71M	£12.43M	£64.21M	£57.16M
Phase 2 (2022)	£4.41M	£4.35M	£15.08M	£14.69M	£15.03M	£15.33M	£15.21M
Phase 3 (2027)	-	-	£42.17M	£41.10M	£42.04M	£42.86M	£10.93M
Phase 4 (2032)	-	-	£5.32M	£5.18M	£5.30M	£5.40M	£2.53M
Total Phased Delivery	**£106.39M**	**£109.30M**	**£132.13M**	**£187.68M**	**£74.80M**	**£127.80M**	**£85.83M**
Total Single Delivery	*£105.75M*	*£108.62M*	*£123.16M*	*£180.65M*	*£62.54M*	*£117.78M*	*£81.41M*

4 ENGINEERING ASSESSMENT

4.1 Introduction

The engineering assessment conducted in relation to the Stromeferry Bypass as outlined in this chapter has been carried out in accordance with the requirements of TD 37/93, Preparation of the Stage 2 Report.

Preliminary assessments regarding alignments include considerations for both motorised and non-motorised users.

4.2 Engineering Standards

Roads in Scotland are designed to the requirements set out in the Design Manual for Roads and Bridges (DMRB). These requirements include desirable minimum requirements and absolute requirements. Designs can be below the desirable minimum requirements at the discretion of the Designer, this is known as a Relaxation. If a design does not meet the absolute requirements, a Departure from Standard is required and this must be approved by the Overseeing Organisation, in this case, The Highland Council.

Road geometry is designed in accordance with DMRB Volume 6, Section 1, Part 1, TD 9/93 'Highway Link Design', which details the standards for horizontal and vertical geometry dependent on the design speed of a road. The existing design speed for Stromeferry Bypass was calculated to be 100 B kph for the section of road between Ardnarff and Cuddie's Point. The national speed limit of 60mph is equivalent to a design speed of 100kph. Therefore, the preliminary route options aim to have geometry appropriate for a design speed of 100kph. However due to the constrained nature of the study area and the local topography, relaxations in both the horizontal and vertical geometry are included to minimise the impact on the local environment. At this preliminary stage, verge widening for forward visibility has not been included for the route option alignments.

DMRB TD 9/93 Highway Link Design states that the desirable maximum gradient for a single carriageway road is 6%, and that gradients steeper than 8% shall be considered a Departure from Standard. TD 9/93 recognises that in hilly terrain steeper gradients will frequently be required, particularly where traffic volumes are low, which is the case for Stromeferry. Therefore, for offline options steep gradients have been fixed at maximum of10% (which would be a Departure from Standard), in an effort to minimise the height of cutting and embankment slopes, and thus reduce the scheme footprint and minimise the impact on the local environment. For on-line options, the existing steep gradients up to a maximum of 10% have been adopted. A further consideration when developing alignments has been the altitude of route options with regards to weather and especially snow, ice and ongoing winter maintenance. The level of route options has been kept below the level of 300m.

During Stage 3 the Preferred Route Option will undergo detailed design, and applications for any Departures from Standard will be sought from the Overseeing Organisation. However, an initial assessment on the mainline geometry standards achieved has been undertaken at Stage 2 and is reported in section 4.10 below.

4.2.1 Design Parameters

The following design parameters have been considered for new carriageway sections and on-line improvements as part of the proposed scheme

Cross Section

DMRB Volume 6, Section 1, Part 2 TD 27/05 Cross Sections and Headrooms states that the cross section for an all purpose single carriageway is a 7.3m wide carriageway (2 x 3.65m lanes) with 1.0m hard strips and 2.5m verges. A 6.0m carriageway is permitted in Scotland where the design year flow is 5,000 AADT or less, which is the case for the A890 at Stromeferry. In comparison Highland Council has adopted a cross section consisting of 5.5m carriageway with 0.65m hardstrips for a similar lightly trafficked road in Sutherland. Therefore, the proposed road cross section for Stromeferry Options Appraisal is a single carriageway consisting of two 3.0m lanes, two 0.65m hard strips and 2.5m verges. The typical cross section is detailed on drawing number 5203 in Appendix A.

For on-line route proposals, a cross section with reduced verges as shown on drawing number 5202 in Appendix A has been discussed and agreed with The Highland Council, in order to minimise significant rock cuts and railway re-alignment for the section between Ardnarff and Cuddies' Point.

Road Alignment

DMRB TD 37/93 requires the Stage 2 Assessment of road improvements to identify the factors to be taken into account in choosing alternative routes or improvements schemes and to identify the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with those routes or improvement strategies.

DMRB TD 37/93 Stage 1 Scheme Assessment identifies a wide range of scheme options for improving the road. The Stage 1 Report recommended the options which are most likely to meet the objectives and limitations of the scheme brief, as detailed in section 1.1.4. The scheme options selected are assessed in detail and are the subject of the assessment report.

At Stage 2, data has been collected on geotechnical aspects, topography, existing structures and public utilities installations. The engineering assessment of each option against these data should be reported.

4.2.2 Minor Junctions

Junction locations and sideroads will be considered in more detail at Stage 3, but it is envisaged that at-grade priority junctions would be provided at interfaces with existing roads. Impacts would be low and no engineering difficulties are envisaged.

4.3 Engineering Description of Each Option

The following route options are the emerging route options from the Stage 1 appraisal and have been assessed as part of this Stage 2 assessment in accordance with the requirements outlined in the DMRB.

Some of the options detailed below have been dismissed during the early stage of this appraisal, as indicated.

The following sections provide an engineering description of the proposed options and should be read in conjunction with and the Plan and Profile and other relevant drawings contained in Appendix A Drawings. It should be noted that the designs for each of the route options described below have been developed to a suitable level for Stage 2. Following selection of the Preferred Route Option, the design of the mainline, junction and sideroads would be subject to further development.

Whilst some consideration has been given to where sideroad junctions and access roads may be required, sideroads and accommodation works design has not been undertaken at this stage. This would be addressed at Stage 3 Assessment design development of the Preferred Route Option.

4.3.1 North Shore Route Options

The following engineering descriptions are in relation to 2 No of the alternative options considered for a North Shore route as part of this Stage 2 assessment. The renewable energy solutions have been considered and assessed in a separate report, as detailed in Appendix D.

Option N6 – Description (refer to drawing numbers 5251 to 5253)

Option N6 has a total length of approximately 14.5km and would leave the existing A896 at Achmore heading westwards passing north of Achmore. Option N6 would mostly be on embankment with slopes no greater than approximately 5.0 metres in height. An at grade priority junction would be provided with the existing A896 providing local access to Stromeferry and to Achmore. Continuing north of Achmore, Option N6 would skirt round the foot of Creag Mhaol, with some embankments of an average height of approximately 5 metres, and maximum embankment heights of approximately 12.5 metres. Option N6 would continue north westwards through a slight cutting approximately 1.0 metre deep before turning eastwards on a 255 metre radius curve. Option N6 would continue through a cutting up to approximately 9.5m deep on approach to the Strome Narrows Crossing. A major structure approximately 830m long would carry Option N9 across the Strome Narrows. The structure would also span the existing railway on the south bank.

At Leacanasigh, Option N6 would pass over the existing road and turn south eastwards on a 360metre radius curve. Option N6 would have a major cutting slope up to approximately 36.0 metres high on the north bound verge. Option N6 continues north eastwards mostly on embankments up to approximately 8.0m in height, and would return online at Stromemore. Lengths of retaining wall would be required adjacent to properties which front on to the existing road, to reduce the impact of the earthworks on adjacent land. This would be considered in more detail at during Stage 3, but the lengths of retaining wall has been estimated and is included in the cost estimate. Option N6 continues online from Mid Strome to the Weavers on embankments with slopes up to approximately 5.0 metres in height.

From the Weavers through to the southern end of Slumbay, Option N6 would continue online with relaxations in both horizontal and vertical geometry to more closely follow the existing road alignment. Horizontal curves of radius 360 metres are required which is a two step relaxation below desirable minimum standards. To allow Option N6 to follow the existing alignment, transitions have not been provided. Vertical sag curves and gradients provided are of at least desirable minimum standards, however crest curves of 30K are required to more closely follow the existing alignment. Option N6 would largely be on embankment, with slopes approximately 3.0 to 4.0 m in height, with some local embankments up to approximately 9.0 metres in height.

From Slumbay to the junction with the existing A896 in Lochcarron, Option N6 would continue to follow the existing road alignment. Therefore, the geometry provided would have relaxations in both horizontal and vertical geometry. Horizontal curves of radius 360metres, 255metres and one of 180metres are required to follow the existing road alignment. To allow Option N6 to follow the existing alignment, transitions have not been provided. At least desirable minimum vertical sag curves and gradients are provided through Slumbay, but relaxations in vertical crest curves are required to minimise the impact of earthworks on adjacent land and property, with some crest curves of 30K provided. Option N6 is largely on embankments through Slumbay, with slopes typically no greater than approximately 3.0 metres in height, with some local

embankments up to approximately 5.0 metres high. Option N6 includes lengths of retaining wall adjacent to properties which front on to the existing road, provided to minimise the impact of earthworks.

Through Lochcarron, Option N6 would continue online along the existing A896, with the existing A896 forming a priority junction with the new A890. Relaxations in horizontal and vertical geometry are required to follow the existing A896 alignment. Horizontal curves of radius 360metres are required, with two curves of radius 180metres also required. To allow Option N6 to follow the existing alignment, transitions have not been provided. Vertical sag curves and gradients of at least desirable minimum are provided, some vertical crest curves of 55K and 30K are required which are relaxations in standard. Minimal earthworks are envisaged through Lochcarron, and lengths of retaining wall would be provided where necessary to minimise the impact on adjacent land and property. From Lochcarron to Kirkton, Option N6 would have a similar standard of geometry, and would have embankment slopes approximately 3.0 metres in height in the southbound verge, and some minor cutting slopes up to approximately 2.0 metres in height in the northbound verge, with some local cutting slopes up to 4.0 metres high. The southbound verge would have embankment slopes up to approximately 3.0 metres high.

From Kirkton to the Strathcarron Junction, Option N6 would return online and follow the alignment of the existing A896 which includes some relaxations in vertical geometry to more closely follow the existing alignment. Option N6 would incur minimal earthworks, with embankment slopes up to approximately 1.0 metre in height.

Strome Narrows Tunnel

In addition to a major bridge structure across the Strome Narrows, structural proposals considered as part of this appraisal also include a tunnel under the Narrows.

A tunnel structure would be of considerable length greater than 500m, closer to 2.7km at the Strome Narrows with cuts in excess of approximately 15m at the southern portal.

Stage 1 proposals considered a tunnel cross section in accordance with the DMRB, BD 78/99-Design of Road Tunnels, which provides full carriageway width for two-way traffic flows, as well as verges and a narrow pedestrian strip alongside the carriageway in emergency or breakdown situations. In addition, the proposals included a fully segregated area, providing a safe route for Non Motorised Users of the route, as well as a safe exit route for emergency evacuation of the tunnel. This resulted in an overall cross sectional area of approximately 130m^2.

It was recognised during the Stage 1 assessment that cross sectional area of the tunnel is the main influence on construction costs. As a result, reduction of the area required for rock excavations would potentially reduce tunnel costs dramatically.

Norwegian, low cost tunnel construction reduces the cross sectional area, to about 60m^2, providing one or two way carriageways, depending on length of tunnel, and minimal tunnel linings in areas of worst rock conditions, and at carriageway and crown levels, for water and frost protection. Norwegian low cost tunnels do not provide separate areas for pedestrians.

The above outlined potential to reduce tunnel construction costs by up to 20% by means of providing a lesser cross sectional area and less facilities within the tunnel. Whilst offering savings, this reduced cross section option has been rejected as a means of crossing Strome Narrows on the grounds of safety and reduced amenity.

As a result, the cross section considered during the Stage 1 work was taken forward into further Stage 2 assessment. This too has been rejected i.e. to BD 78/99 on cost and technical risk grounds with a bridge offering a better value solution.

A full report into tunnel options considered as part of this appraisal, including technical details and outline cost estimates has been compiled and can be found in Appendix E of this report.

Refinement of Option N6

The location of the Strome Narrows bridge crossing has been revised during Stage 2. Several bridge locations were considered for the Strome Narrows crossing, which included bridge structures of different lengths and heights (refer the Strome Narrows Bridge Technical Note contained in Appendix H). The crossing location as shown at Stage 2 is approximately one kilometre west of the Stage 1 bridge location, and is considered to be the optimal crossing point.

Option N6 on the south of the Strome Narrows was realigned for the new bridge location, skirting round the west of Craeg Mhaol.

From Stromemore to Strathcarron junction, Option N6 remains unchanged from the alignment proposed at Stage 1.

Option N9 – Description (refer to drawing numbers 5001 to 5003)

Option N9 has an approximate length of 14.5km and would leave the existing A896 at Achmore heading westwards passing north of Achmore. Option N9 would mostly be on embankment with slopes no greater than approximately 5.0 metres high. An at grade priority junction would be provided with the existing A896 providing local access to Stromeferry to Achmore. Continuing north of Achmore, Option N9 would skirt round the foot of Creag Mhaol, with some large embankments, with an average height of approximately 5.0 metres with a maximum embankment height of approximately 12.5m. Option N9 would continue north westwards through a slight cutting approximately 1.0 metre deep before turning eastwards through a 255metre radius curve. Option N6 would continue through a cutting up to approximately 9.5m deep on approach to the Strome Narrows Crossing. A major structure approximately 830m long would carry Option N9 across the Strome Narrows. The structure would also span the existing railway on the south bank.

At Leacanasigh, Option N9 would pass over the existing road and turn south eastwards on a 360metre radius curve. Option N9 would have a major cutting slope up to approximately 36.0 metres in height on the north bound verge. Option N9 continues offline eastwards passing to the north of the Stromemore and would be largely on embankments approximately 8m to 15m in height. Option N9 would then continue on a right hand 400metre radius curve north of Stromemore. Option N9 has gradients of 8% on the approaches to a hill a Stromemore. Option N9 would then return online at Mid Strome with some embankments up to approximately 30m in height on the southbound verge, continuing online from Mid Strome to the Weavers, Option N9 would be on embankments approximately 5 0 metres high.

From the Weavers, Option N9 would then continue offline passing north of Slumbay with at least desirable minimum horizontal geometry. The vertical geometry would include some steep gradients up to 6.7%, and would largely be on embankments up to approximately 5.0 metres high. North of Slumbay, the geometry provided is largely to standard for a 100kph design speed, with some relaxations in vertical crest curves provided, including crest curves of 30K. Option N9 would run along the hillside with cut slopes on the northbound verge, and embankment slopes on the southbound verge. Cut slopes would be approximately 6.0 metres in height, embankment slopes would be approximately 4.0 metres high. Option N9 would then continue north eastwards and cross the existing A890 and the Allt Nan Carnan valley north of Lochcarron. An at-grade priority junction would be provided at the existing A890 to provide local access.

From the Allt Nan Carnan valley, Option N9 would continue north eastwards towards Kirkton. The horizontal geometry adopted is to standard, however relaxations in vertical crest curves are required, including crest curves of 30K. A 68m length of 10% gradient is required on the approach to Kirkton to minimise the impact of earthworks on adjacent land. This limits the height of cuttings through this section to a maximum of approximately 13.5 metres, and embankment slopes no greater than approximately 8.5 metres high.

From Kirkton to the Strathcarron Junction, Option N9 would return online and follow the alignment of the existing A896 which includes some relaxations in vertical geometry to more closely follow the existing road alignment. Option N9 would have minimal earthworks, with embankment slopes up to approximately 1.0m in height.

Refinement of Option N9

Option N9 has been realigned along the majority of the route during Stage 2. From Braeintra to the Strome Narrows, Option N9 has been moved southwards to reduce the impact on properties at Achmore, and to minimise the impact of earthworks. The alignment of the Strome Narrows bridge crossing has been realigned at Stage 2 such that the optimal crossing location is now proposed, as described for Option N6 above.

From Leacanasigh to Mid Strome, Option N9 has been realigned moved offline north of Stromemore to avoid impacting on properties which front on to the existing road.

From the Weavers to north of Slumbay, Option N9 has been moved further north to minimise the impact and severance of crofting land, and to minimise the impact of earthworks. During Stage 2, Option N9 has been realigned closer to Lochcarron to reduce the severance of crofting land. Option N9 also ties in to the existing A896 sooner to avoid impacting on Lochcarron Old Parish Church.

4.3.2 Online Options

The online options developed as part of this appraisal have been established as engineering solutions for distinct sections of the route. Due to the geometry of the existing road and rail corridors, the topography and in particular the variable risk of rock fall along the route, different solutions had to be developed during this Stage 2 assessment specifically for the various on-line sections as described below.

The most feasible whole route solution will be used for the final, full comparison of route options overall. All online options have a length of between 13.1km and 13.5km.

Online Options – Description (refer to drawing numbers 5041 to 5072 & 5255 to 5257)

All Online Options – Stromeferry to Frenchmans Burn

From Stromeferry to Ardnarff, the online options aim to follow the existing A890, therefore relaxations in the geometry provided are required to more closely follow the existing alignment. The horizontal geometry provided is largely below desirable minimum standards, typically with curves of radius 255 metres to 180metres, (a curve of radius 180metre is four steps below desirable minimum). In following the existing road alignment, transitions are not provided for horizontal curves. Relaxations in vertical geometry are also required, though all sag curves are at least of desirable minimum standard. Crest curves are typically 30K which is two steps below desirable minimum. Two steep gradients are provided, a 195m length of 6.5% gradient, and also a 560m length of 10% gradient on the southern approach to Ardnarff required to follow the existing gradient. Typically the online options are on embankment on the northbound verge, and in cutting on the southbound verge. Cutting slopes have a maximum heights varying

between approximately 4.0 metres and 8.0 metres, with some cutting slopes up to approximately 10.0 metres in height. Embankment slopes are typically no higher than approximately 5.0 metres in height, with local sections of embankment slopes approximately 24.0 metres and also 18.0 metres high.

From Ardnarff to the Frenchmans Burn, the existing A890 corridor becomes narrow constrained by the railway on the northbound verge, and by the existing steep rockface on the southbound verge. Therefore three lengths of retaining wall are required from Ardnarff to Frenchmans Burn, provided between the railway and the proposed road. Relaxations in horizontal geometry are required, with no transitions provided for horizontal curves. The horizontal geometry through this section is largely below desirable minimum standards, typically curves of radius 200 to 650 metre are provided which is up to four steps below desirable minimum standards. The vertical geometry provided has fewer relaxations, with relaxations in crest curves only up to two steps below desirable minimum. Cuts of varying heights are required on the southbound verge into the existing rock face, with sections of cutting slope typically up to approximately 7.0 metres high, with local sections of cut slopes approximately 18.0 metres, 21.0 metres and 35.0 metres high.

Option O2 Rail Viaduct- Frenchmans Burn to Cuddies Burn

From Frenchmans Burn to Cuddies Burn, Option O2 would realign the railway on to a viaduct structure along the side of the loch. The structure would be approximately 1.6km in length. This would allow a wider corridor to accommodate the two lane road including a wide verge which incorporates a rock trap adjacent to rock face.

Option O3 Tunnel - Frenchmans Burn to Cuddies Burn

From Frenchmans Burn to Cuddies Burn, Option O3 would provide an inland tunnel. The tunnel would be approximately 1.5km in length. Some rock cut would be required on the south tunnel portal at Frenchmans Burn.

Option O5 Road / Rail Share - Frenchmans Burn to Cuddies Burn

From Frenchmans Burn to Cuddies Burn, Option O5 would provide a section of shared road / railway such that road traffic would running on the same corridor as the railway. The road would share the railway line for a length of approximately 1.8km.

Option O7 Developed Avalanche Shelter - Frenchmans Burn to Cuddies Burn

From Frenchmans Burn to Cuddies Burn, Option O7 would provide a road viaduct which would carry the realigned A890 above the railway. The structure would be approximately 1.7km in length.

Refinement to Online Options

From Stromeferry to Frenchmans Burn, the online options remain largely unchanged from the Stage 1 alignment.

From Cuddies Burn to Strathcarron, the online options vary from the alignments proposed through Maman Hill at Stage 1, with the alignment moved offline to the west of the existing road to provide shallower gradients. A bypass of Achintee has been proposed during Stage 2, therefore the online options pass east of Achintee and two bridge structures carry the road over River Taodail, the existing A890 and the railway.

From Frenchmans Burn to Cuddies Burn, Option O2 (rail viaduct) has been developed during Stage 2 such that the railway would be carried along the viaduct structure. The alignment of the Stage 2 structure is shorter than that proposed during Stage 1.

From Frenchmans Burn to Cuddies Burn, Option O3 (tunnel) has been realigned slightly with changes made to the west portal location, moved slightly further west to a more suitable location at Frenchman's Burn.

From Frenchmans Burn to Cuddies Burn, Option O7 (developed avalanche shelter) has a structure approximately 300m shorter than that proposed at Stage 1.

Option O4 – 'Do-Minimum'

Option O4 is described as the 'do-minimum' scenario, with no improvements made to the existing road other than ongoing maintenance. The road would remain as per existing, therefore retaining sections of single track with passing places and existing route alignment and gradients all as described in Section 2.3 of this report.

The ongoing maintenance of this section of the road however is extensive. The Highland Council have a planned programme of reactive maintenance including daily and weekly inspections. In addition, there are planned bi-annual improvement measures in parallel with any necessary reactive maintenance.

All Online Options - Cuddie's Burn to Strathcarron Junction

From Cuddies Burn to Attadale, the online options would follow the existing A890, therefore relaxations in horizontal and vertical geometry are required to more closely follow the existing alignment. The horizontal geometry provided includes horizontal curves of radius 255metres which is three steps below the desirable minimum. The vertical geometry provided is below desirable minimum standards, including crest curves of 30K, and a gradient 6.5%. The sag curves provided are all at least to desirable minimum standards. The online options would include both cut and embankment slopes, with cuts up to approximately 21.0 metres in height in the southbound verge towards Cuddies Burn, and embankment slopes up to approximately 7.0 metres and 15.0 metres high on the northbound verge. The earthworks would reduce on the approach to the River Attadale.

The online options between Attadale and the Strathcarron Junction would follow the same alignment east of Attadale as the South Option as described under section 4.3. Therefore, from Attadale the online options follow the existing A890 corridor until Achintee, and would require relaxations in the horizontal and vertical geometry to follow the existing road alignment. The corridor is constrained by the railway and existing steep slopes. A length of retaining wall is required on the southern approach to Maman Hill between the road and the existing railway, and a cutting slope up to approximately 30.0 metres high is required on the southbound verge. Online options then move offline for a short section through Maman Hill, realigned to the west of the existing road to limit the steep gradients on both approaches to 10%, which is a departure in standard. (The existing A890 gradients through Maman Hill are 14%.) From Maman Hill to Achintee, online options pass through both cutting and embankments, with cuttings slopes up to a maximum of approximately 9.5 metres high, with some cuttings 17.0 metres high on the southbound verge through Maman Hill. Embankment slopes are between approximately 3.0 to 7.0 meters high, with some embankments slopes up to approximately 11.0 metres high.

Online options then continue offline passing to the east of Achintee. A horizontal curve of radius 310 metres is required to pass east of Achintee whilst remaining south of Strathcarron and then return online north west of Strathcarron. A bridge would carry the online options over the River Taodail and its tributary, and a further bridge structure would span the existing A890

and the existing railway line. The existing level crossing at Strathcarron would be removed. Relaxations in vertical crest curves are required, and a short length of 8% grade is required just south of Achintee, to more closely follow the existing topography and minimise the earthworks. Cutting slopes through this section are generally no greater than approximately 4.0 metres in height, with some cutting slopes up to approximately 8.0 metres high south of Achintee on the southbound verge, and up to approximately 18.5 metres high on the southbound verge east of Achintee. Embankment slopes through this section are generally no greater than approximately 3.5 metres in height.

From Strathcarron to Strathcarron Junction, the online options would return online to follow the alignment of the existing A890. Online options would have minimal earthworks with some local embankments up to approximately 3.0 metres in height. The vertical geometry provided would be to standard with one relaxation in horizontal geometry on the approach to Strathcarron junction.

4.3.3 Southern Route Option

The southern route options emerging from the Stage 1 appraisal include a principal route S4 as described below, plus considerations for a local link route S1/S3, should a local link be viable.

Option S4 – Description (refer to drawing numbers 5121 to 5124)

Option S4 has an approximate length of 19.3km and would leave the existing A890 south of Braeintra and follow the existing forest track through the Glen Udalain valley, remaining largely to the north of Allt Gleann Udalain. Option S4 would have some earthworks, with cutting and embankment slopes typically no greater than approximately 4.0 metres in height, but with some local embankments approximately 10.0 metres in height. The mainline geometry would largely be at least desirable minimum standards, with no steep gradients required. Option S4 would then cross to the Allt Gleann Udalain via a new bridge and continue to the east side of the river. The horizontal geometry provided would be at least of desirable minimum standards. Relaxations in vertical geometry would be required, including two sections of steep gradient, approximately 220m of 10% grade and a shorter length of 8% grade. Option S4 would be in cutting and on embankment through this section, with cutting slopes approximately 5.0 metres in height, with local cutting slopes up to a maximum of approximately 10.0 metres high. Embankment slopes through this section would be approximately 5.0 to 12.0 metres in height with some slopes up to a maximum of approximately 14.0 metres in height.

Option S4 would then continue northwards heading towards Loch nam Breac Mora. Relaxations in horizontal and vertical geometry are required to more closely follow the existing topography and reduce the impact of earthworks. Two horizontal curves of radius 450metres are required which is below desirable minimum standards. Vertical crest curves through this section are less than the desirable minimum standards, and two short sections of steep gradient are required, both 8% grades of less than 50m in length. Option S4 is both in cutting and on embankments approaching Loch nam Breach Mora, with embankments approximately 8.0 metres high and slopes up to approximately 23.0 metres in high at gulley crossings.

From Loch nam Breach Mora, Option S4 would continue northwards heading towards the River Attadale valley. Option S4 would have horizontal geometry largely to standard, but the vertical geometry provided requires relaxations in crest curves and gradient to allow an alignment which more closely follows the existing topography and therefore minimises earthworks. A steep grade of 10% is required on the approach to the River Attadale valley which is approximately 800m in length. Option S4 passes through sections of both cutting and embankment, each with slopes up to approximately 20.0 metres in height. Option S4 would then continue along the southern side of the River Attadale valley, with some relaxations in horizontal and vertical

geometry required to more closely follow the exiting topography. Horizontal curves with a radius of 500 metres are provided which is less than the desirable minimum. Vertical crest curves less than desirable minimum are provided, and two lengths of steep gradient are also required, a 630m length of 8% grade and a 150m length of 10%. Option S4 has sections of both cuttings and embankments through the River Attadale with greater earthworks in the upper valley. Cuttings vary with slopes up to approximately 12.5 metres high in the upper Attadale valley, reducing to approximately 6.5 metres high towards the lower Attadale valley. Embankment slopes are between approximately 6.0 to 9.5 metres high, with a section of high embankment slopes up to approximately 33.0 metres high in the upper valley. The earthworks reduce in height on the approach to returning online at Attadale. A horizontal curve of radius 180 metres is required to allow Option S4 to tie back online in advance of the existing River Attadale bridge, whilst also minimising intrusion into the River Attadale valley. This is four step relaxation below the desirable minimum standards.

The proposed route section between Attadale and the Strathcarron Junction will follow the same alignment as the online routes east of Attadale, as described above. Therefore, from Attadale, Option S4 continues online along the existing A890 corridor until Achintee. Option S4 requires relaxations in the horizontal and vertical geometry to follow the existing road alignment. The corridor is constrained by the railway and existing steep slopes. A length of retaining wall is required on the southern approach to Maman Hill between the road and the existing railway, and a cutting slope up to approximately 30.0 metre high is required on the southbound verge. Option S4 then moves offline for a short section through Maman Hill, realigned to the west of the existing road to limit the steep gradients on both approaches to 10% grades, which is a departure in standard. (The existing A890 gradients through Maman Hill are 14%.) From Maman Hill to Achintee, Option S4 continues through both cutting and embankment, with cuttings slopes up to a maximum of approximately 9.5 metres high, with some cuttings 17.0 metres high on the southbound verge through Maman Hill. Embankment slopes are between approximately 3.0 to 7.0 meters high, with some embankments slopes up to approximately 11.0 metres high.

Option S4 then continues offline passing to the east of Achintee. A horizontal curve of radius 310 metres is required to pass east of Achintee whilst remaining south of Strathcarron and then return online north west of Strathcarron. A bridge would carry the Option S4 over the River Taodail and its tributary, and a further bridge structure would span the existing A890 and the existing railway line. Relaxations in vertical crest curves are required, and a short length of 8% grade is required just south of Achintee, to more closely follow the existing topography and minimise earthworks. Cutting slopes through this section are generally no greater than approximately 4.0m in height, with some cutting slopes up to approximately 8.0 metres high south of Achintee on the southbound verge, and up to approximately 18.5 metres high on the southbound verge east of Achintee. Embankment slopes through this section are generally no greater than approximately 3.5 metres in height. *

From Strathcarron to Strathcarron Junction, Option S4 would return online to follow the alignment of the existing A890. Option S4 would have minimal earthworks with some local embankments up to approximately 3.0 metres in height. The vertical geometry provided would be to standard with a relaxation in horizontal geometry on the approach to Strathcarron junction.

Refinement of Option S4

Through the southern section of the Glen Udalain valley, Option S4 follows a similar alignment to that proposed at Stage 1. However, during Stage 2 Option S4 was realigned further west through the Allt Loch Innis Nan Seangan valley to reduce the earthworks and minimise steep gradients. Similarly, Option S4 was also realigned through the River Attadale valley to reduce the steep gradients and minimise the impact of earthworks.

The Stage 2 alignment ties in to the existing A890 in advance of the River Attadale bridge adopting a tighter horizontal curve on approach to minimise intrusion into the valley.

From Attadale to the Strathcarron junction, Option S4 would follow the same alignment as the online options. Therefore, the alignment through Maman Hill has been moved offline to the west of the existing road to provide shallower gradients. A bypass of Achintee has been proposed during Stage 2, therefore Option S4 passes east of Achintee and two bridge structures carry the road over River Taodail, the existing A890 and the railway.

Southern Option / S1 Link Options

Numerous alignments were considered for link based on the Stage 1 S1 and S3 routes. Alignments included routes which formed priority junctions with the existing A890 at Stromeferry, and also options between Achmore and Braeintra. The topography through this area is challenging such that all routes required either lengths of steep gradient, at least 8% with most routes requiring gradients of 10%, and still required substantial earthworks. The most plausible link route was based on the S1 link proposed at Stage 1, however the topography is also challenging through this section especially towards Stromeferry, with gradients of 10% required and major earthworks. Furthermore, providing an at-grade junction for local access northwards on the existing A890 northwards would be very challenging due to the topography. Therefore, it was concluded that if based on engineering criteria the Stromeferry link should not be included in the Southern Route Option.

4.4 Climate, Topography and Land Use

The effect of the climate on the engineering design will be addressed in detail during Stage 3 work. At this stage allowance has been made to set options below the 300m AOD contour and an assessment of drainage outflows to accommodate increased flows due to climate change issues is discussed in chapter 6.

Considerations regarding the existing topography and land-use within the study area are included in the Environmental Assessment, Volume 2 of this report.

4.5 Geology and Soils

A detailed geotechnical desk study has been undertaken to advise this Stage 2 appraisal. The URS, Stromeferry Options Appraisal, Geotechnical Desk Study Report 47065084 GLRP0001, March 2013' is contained in Appendix F. The desk study includes an assessment of underlying geology, hydrology and hydrogeology for each proposed route corridor and provides details of potential constraints for development and recommendations for further detailed intrusive investigation work.

Furthermore, a Peat Management Report which considers options for treatment of peat in the study area has been carried out and is included in Appendix G

A summary of the information presented in this report is provided in the following sections.

4.5.1 Geology

Information regarding the geological conditions at each of the proposed route corridors was obtained from available published geological sheets [2,3] and is summarised in Table 4.5.1 below.

Table 4.5.1 – Geological Conditions

Route Name	Geology Description
Northern Route Corridor	Where mapped, the superficial deposits along the majority of the northern route corridor are recorded to comprise moraine and undifferentiated drift, with the exception of the area between Kirkton and Strathcarron Junction, which is recorded to be underlain by freshwater alluvia. No indication of the depth of the superficial deposits is given; however superficial deposits were not consistently mapped across the site indicating that they are thin or absent. Around Stromeferry and Ardnarff the solid strata is changeable with massive and foliated pyroxenic hornblendic and micaceous gneiss affected by post-Cambrian movement; epidiorite and hornblende-schist affected by post-Cambrian movement; and flaggy quartz-feldspar granulite being recorded. Around Stromemore the routes were recorded to be underlain by massive and foliated pyroxenic hornblendic and micaceous gneiss affected by post-Cambrian movement and epidiorite and hornblende-schist affected by post-Cambrian movement. Beyond that, myolonite was recorded up to, and around, Slumbay Island, with the remainder of the routes being underlain by undifferentiated granulitic schists of the Moine Series. The solid strata were generally recorded to dip east towards Loch Carron at an unspecified angle.
Online Route Corridor	Where superficial deposits are mapped they are generally recorded to comprise moraine and undifferentiated drift of unspecified thickness. No indication of the depth of the superficial deposits is given; however superficial deposits were not consistently mapped across the site indicating that they are thin or absent. The solid strata are noted to vary across the proposed route corridor. Around Stromeferry and Ardnarff the strata is particularly changeable with massive and foliated pyroxenic hornblendic and micaceous gneiss affected by post-Cambrian movement; epidiorite and hornblende-schist affected by post-Cambrian movement; and flaggy quartz-feldspar granulite being noted. Along the remainder of the route, granulitic schists of the Moine series are noted to underlie the route. However, the strata immediately to the south of the routes along Loch Carron are recorded to comprise acid and hornblendic gneiss, amphibolite; and pelitic gneiss. The recorded dip varied from south east, to east, to north east.
Southern Route Corridor	Where mapped, the superficial deposits along the routes were recorded to comprise morainic deposits with some undifferentiated drift and peat. No indication of the depth of the superficial deposits is given; however superficial deposits were not consistently mapped across the site indicating that they are thin or absent. The solid strata were recorded to comprise undifferentiated granulitic schists of the Moine Series, and were noted to dip to the south east.

[2] British Geological Survey, 1:50,000 Geological Sheets, 82: Lochcarron and 81E: Loch Torridon.
[3] British Geological Survey, 1:10,560 Geological Sheets.

4.5.2 Seismic Activity

The BGS has recorded several historical earthquake events in the vicinity (approx. 20km radius) of the proposed route corridors. Their location and associated magnitude are listed in Table 4.5.2 below:

Table 4.5.2 – Historical Earthquake Events

Date	Location	Magnitude
03/12/1878	Kintail	3.3
06/08/1974	Kintail	4
10/08/1974	Kintail	4.4
27/11/1975	Kintail	4.1
12/02/1975	Loch an Lasaich	2.2
06/04/1978	Lochan Dubha	1.9
28/05/1978	Lochan Dubha	1.9
11/06/1978	Creag Mhor	2.3
11/08/1979	Carn Mor	1.5
30/08/1979	Loch Carron (near avalanche shelter)	2.3
07/02/1988	Criag Mhaol	2.4
08/02/1988	Criag Mhaol	1.9

4.5.3 Mining and Quarrying

Due to the nature of the underlying metamorphic bedrock, it is considered that the risk to the development with respect to mineral stability is very low.

In addition, from a review of historical maps of the area, no quarries have been recorded on, or within 250m, of the proposed route corridors.

4.5.4 Soil Quality

A map showing the soils present within the Stromeferry Bypass study area is shown in drawing number 6.10. The soil types indicated to be present within each route corridor are presented in Table 4.5.3.

Table 4.5.3 – Soil Types

Route Name	Soil Types
Northern Route Corridor	The majority of the northern route corridor is underlain by Arkaig soils (peaty soils, although they also contain some mineral and mountain soil) in the area around Lochcarron and Kirkton. Lochinver soils (described as brown forest soils and humous-iron podzols), are located in the southern part of the corridor and in the area of the Strome Narrows crossing.
Online Route Corridor	The on-line route corridor is underlain by alluvial, organic, corby/boyndie/dinnet and Arkaig soils between Strathcarron Junction and Attadale. From Attadale to Stromeferry, the on-line corridor is underlain by Lochinver soils.
Southern Route Corridor	The southern route corridor is underlain by alluvial, organic, corby/boyndie/dinnet and Arkaig soils between Strathcarron and Attadale. As the route traverses to the south it crosses Lochinver and Arkaig soils and then Lochinver soils only as the route corridor traverses to the west towards Achmore.

Consultation with SEPA has resulted in concerns being raised in relation to the presence of peat within the proposed route corridors. In response to SEPA's concerns, a technical note Constructing Roads over Peat and Peat Management was prepared. This document provides a summary of the geotechnical constraints peat can have on road construction, current guidance / best practice for the construction of roads in areas of peat land to assist in the appraisal of the re-route options, guidance on the management of peat and information on ground investigation works that may be required to investigate peat conditions within the selected road alignment corridors.

4.5.5 Man Made Features

The following existing man-made features (which potentially have associated made ground materials) have been recorded within the study area and include:

- Kyle of Lochalsh to Inverness Railway and its associated infrastructure including bridges and footbridges;
- Bridges;
- Existing road pavement with associated structures and earthworks;
- Side roads, farm tracks and footpaths; and
- Developments within the local area.

4.5.6 Contaminated Land

There is at present no information with regard to the presence of any potentially contaminated land sites within the study area. Given the rural nature of the study area, it is not anticipated that there will be any areas of potential contamination with the exception of the presence of made ground that may be associated with the man-made features referred to in Section 4.5.5. No areas of land have been highlighted during the consultation process.

4.5.7 Peat

A detailed assessment of peak areas likely to be encountered particularly on the Southern Options has been undertaken and is included in the Peat Management Report in Appendix G.

4.6 Hydrology, Hydrogeology and Drainage

Further details on assessments of the proposed scheme options in relation to hydrology and hydrogeology issues can be found in Volume 2, environmental assessment report.

4.6.1 Hydrology

The main water bodies in the study area are Loch Carron, Abhainn Cumhang a Ghlinne, River Carron, River Attadale, Allt Cadh an Eas, Allt Gleann Udalain, and Allt Loch Innis nan Seangan. These water bodies are discussed in more detailed in the environmental assessment report contained in Volume 2 of this report.

All of the above identified watercourses are potential outfalls for the road drainage system. Proposals for road drainage will be considered in more detail in Stage 3.

Due to the vulnerability of existing groundwater systems in the development area, road design is to include a high level of water treatment prior to discharge of road drainage into the existing systems. Where possible, discharge should be to open water rather than groundwater.

SEPA flood maps of Scotland gave no indication for risk of flooding for any of the proposed schemes.

4.6.2 Hydrogeology

The BGS aquifer maps [4] and accompanying report [5] indicate that:

- Alluvial and drift deposits recorded to underlie the majority of the site are regarded as a non-aquifer due to their low permeability.
- Groundwater flow within bedrock underlying the site is recorded to be through fractures (bedding planes, joints and faults.) These rocks are classified as aquifers with a low to very low productivity.

Groundwater flow directions within aquifer units in the drift deposits will be influenced by the local topography and also by nearby surface waters. A hydraulic connection between groundwater below the site and surface water is unknown.

The Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) groundwater vulnerability map [6] and accompanying report [7] have been consulted and the site has been given a vulnerability classification of 4, based on the assumption of there being approximately 1-3m of superficial deposits overlying bedrock. A vulnerability classification of 4 indicates that groundwater within bedrock beneath the site will be vulnerable to those pollutants not readily absorbed or transformed.

Where bedrock is exposed, or only a thin layer of topsoil is present, a vulnerability classification of 5 would be more appropriate. A vulnerability classification of 5 indicates that groundwater within the bedrock will be vulnerable to most water pollutants with rapid impact in many scenarios.

[4] BGS/SEPA, 2004. *Bedrock Aquifer Map and Superficial Aquifer Map*, Scale 1:100,000.
[5] BGS, 2004. *A GIS of aquifer productivity in Scotland: explanatory notes.* Commissioned Report CR/04/047N.
[6] Scotland and Northern Ireland Forum for Environmental Research (SNIFFER), 2004. *Vulnerability of Groundwater in the Uppermost Aquifer*, Scale 1:100,000.
[7] SNIFFER, 2004. *Development of a groundwater vulnerability screening methodology for the Water Framework Directive.*

Groundwater bodies are classified by SEPA, from which the water quality ratings range from Good to Poor. A search of SEPA's River Basin Management Plan (RBMP) database was conducted regarding the groundwater quality beneath the site, and was found to be classified as "good".

4.6.3 Drainage

Consideration has been given to four main elements of drainage design, namely:

- Flooding;
- Sustainable Drainage Systems (SuDS);
- Carriageway drainage; and
- Cross carriageway culverts.

Consultation with SEPA was carried out during the stages of this study and they set out their initial concern. The main issues were related to flood risk, the protection of the natural and water environment and management of waste. Further information relating to the consultation with SEPA is set out in Chapter 13, Road Drainage and the Water Environment, of the DMRB Stage 2 Report, Volume 2 Environmental Assessment.

Carriageway Drainage , SUDS & Flooding

Some preliminary design considerations have been undertaken to identify mainline drainage systems for costing purposes only at this stage. Detailed drainage design work would be considered in detailed during Stage 3.

Assumptions based on previous consultation with SEPA, assume two forms of treatment will be required prior to discharge into a water course. It is proposed that treatment will be a combination of carriageway filter drains and detention basins, where appropriate. All carriageway drainage design shall be in accordance with HD 33 – Surface and Sub-surface Drainage Systems for Highways. As detailed in section 3.2.4, the cost estimates include for carriageway filter drains and gullies only, based on the length of the proposed mainlines.

The approximate sizing and costing of SUDs detention basins has not been undertaken at this stage. Further design on the outfalls and detention basis (if required) will be carried out as part of the Stage 3 Assessment. The location of the outfalls and basins will have to carefully consider impacts on the environmental receptors, and approximate areas of land for the basins will need to be identified shaping of the ponds to best fit in with the surrounding topography. Further consultation will be required with SEPA.

As part of the environmental assessment, the flood risk has been assessed based on the SEPA Flood Risk Management Maps (2014), as reported in section 13.4.6 of the Stromeferry Appraisal, DMRB Stage 2 Report, Volume 2 Environmental Assessment. This highlights that flood risk from the coast appears to be greater for the North Shore Corridor than for the Online or Southern Corridors. Flood risk from the major watercourses affects all routes, particularly in the Strathcarron Junction area. Should a route option be progressed to a Stage 3 assessment, a flood risk assessment will be required to inform the design of the Scheme. It is not currently known if flood defences will be required or included in any of the proposed options.

Culverts

A preliminary assessment of the required cross carriageway culverts has been undertaken, using 1:50,000 scale OS mapping. This has identified drainage structures requirements, as

outlined in table 4.8.1 of this report, including both existing and new structures. This is further indicated on drawing numbers 5401 to 5404 in Appendix A of this report.

New drainage structures are proposed to be small bridges or bottomless culverts, where the required span is between 2m and 5m, and single pipe culverts up to approximately 1.0m diameter. The design requirements of the culverts will be confirmed at Stage 3, and are assumed to be required to pass a 1 in 200 year storm plus climate change flow. It will also take into account flood mitigation requirements, minimise geo-morphological impacts and shall consider the need to provide for the passage of migratory fish if required.

4.7 Public Utilities

BT Openreach, Scottish and Southern Energy and Scottish Water are all present within the study area as outlined in chapter 2 of this report, and are affected by the proposals at some degree.

Preliminary information was sourced from utility companies under Appendix C2 of the New Roads and Street Works Act 1991. The information returned indicated apparatus within the study area as discussed in Chapter 2 Existing Conditions. This information has been collated and is shown on drawing numbers 5301 to 5306.

BT Openreach and Scottish Water have underground apparatus located mainly within carriageway and verges in residential areas, with BT apparatus extending along the A890 from Achintee to Ardnarff, from Cuddies' Point to Maman Hill and Achinte to the Strathcarron Junction, as well as the full length of public road from Ardaneaskan to the Strathcarron Junction along the north shore of Loch Carron.

In addition, there is various low voltage overhead SSE apparatus within the study area, generally following the existing road networks. There is also a high voltage overhead SSE line running alongside the railway line from the north-east, to Strathcarron, Achintee and Attadale, turning south-east through Attadale valley towards Glen Ling and Loch Long.

The diversion or re-routing of the existing utilities are not expected to pose any particular problems to the development of the scheme, considering all route proposals, other than the usual implications affecting cost and programme.

Further consultation and C3 budget estimates for the anticipated diversionary work for the preferred scheme will be required at Stage 3. At the current stage of the assessment assumptions have been made to provide a cost estimate for public utilities for each of the scheme options considered.

4.8 Major Structures

The following chapter describes the preliminary engineering considerations made in relation to the scheme options further developed during the Stage 2 assessment. This includes more detailed structural proposals and considerations regarding buildability, aesthetics, operation, maintenance and inspection, risks and impact during construction. For costs associated with the proposed engineering solutions refer to chapter 3.2.

These will be further refined during Stage 3, when the preferred route will be further developed and a detailed design is carried out.

4.8.1 Structures (General)

Considering the traffic volumes in the study area, it is expected that new junctions and private accesses will be at-grade and there will be no requirement for grade-separated crossings of other roads. Therefore the majority of structures will involve the crossing of watercourses and water bodies - streams, rivers, and the Strome Narrows.

The options being considered also include bridge crossings of the railway and special structures on the On-line corridor comprising a sidelong viaduct, an avalanche shelter and a tunnel.

Several of the options include on-line sections of the existing A896, C1096 and A890 roads where existing structures would be upgraded or replaced. There will also be a need for retaining structures where improvement of on-line sections is constrained by existing development or topography.

Generally, the types of structure comprise;

- Culverts for small streams and large drains;
- Bridges for large streams and rivers, railways;
- Major bridges for crossings of the Strome Narrows;
- Multi-span viaduct - option O2 - Frenchman's Burn to Cuddies Point;
- Avalanche shelter - option O7 - Frenchman's Burn to Cuddies Point;
- Retaining structures for on-line improvement of existing roads.

Significant structures encountered for each of the proposed route options are summarised in Table 4.8.1 below. Where bridges cross watercourses and rivers, only those named on Ordnance Survey 1:50,000 mapping have been noted. Other smaller watercourses shown on the 1:50,000 mapping have been considered for minor bridges or culverts, and allowances made in the cost estimates for these. Refer to 4.8.2.

With reference to structures for online options O2, O3 and O7, a buildability study has been undertaken giving due consideration to programme and road closures, and is included in Appendix K.

Table 4.8.1 – Structures

OPTION	STRUCTURE	CROSSING	LOCATION
North Shore Options			
N6	830m major bridge or 2.7km tunnel	Strome Narrows	Portchullin – Leacanasigh
	Small culvert or bridge, single span 2m to 5m	Various watercourses (8 No.)	New route from Achmore to Midstrome
	Large bridge > 5m	Allt Torr nan Daoine river bridge	Lochcarron Weavers
	Existing small culvert or bridge, single span 2m to 5m, upgraded	Various watercourses (10 No.)	Lochcarron Weavers to A896
	Existing large culvert	Allt nan Carnan	A896 Lochcarron
	Existing small culvert	Various watercourses (8 No.)	A896 Lochcarron
	Large bridge > 5m	Watercourse	Kirkton
	Small culvert or bridge, single span 2m to 5m	Various watercourses (5 No.)	Kirkton to Strathcarron Junction
	Existing Tullich Smiddy bridge, retained	Watercourse	Tullich
N9	830m major bridge	Strome Narrows	Portchullin – Leacanasigh
	Small culvert or bridge, single span 2m to 5m	Various watercourses (9 No.)	New route from Achmore to Midstrome
	Large bridge > 5m	Allt Torr nan Daoine river bridge	Lochcarron Weavers
	Small culvert or bridge, single span 2m to 5m	Various watercourses (13 No.)	Lochcarron Weavers to A896 along new bypass
	Large bridge > 5m	Allt nan Carnan	New Lochcarron bypass
	Small culvert or bridge, single span 2m to 5m	Watercourse (1 No.)	New Lochcarron bypass
	Large bridge > 5m	Watercourse	Kirkton
	Small culvert or bridge, single span 2m to 5m	Various watercourses (5 No.)	Kirkton to Strathcarron Junction
	Existing Tullich Smiddy bridge, retained	Watercourse	Tullich

OPTION	STRUCTURE	CROSSING	LOCATION
On-line Options			
O2, O3, O5, O7, and also S4	Small culvert or bridge, single span 2m to 5m	Various watercourses (18 + 6 No.)	Stromeferry to Attadale, and Attadale to Strathcarron Junction
	Existing River Attadale bridge, retained	River Attadale	Attadale
	Existing Carron Pottery bridge, retained	Allt a Ghoirtein Mhoir	Carron Pottery
	River Taodil bridge, multi span, overall 30m length	River Toadil, tributary and railway	Strathcarron
	River Carron bridge, multi span, overall approximately 60m length	River Carron	New Kelso
O2	1.6km Railway Viaduct	Sidelong viaduct along Loch Carron	Frenchman's Burn to Cuddies' Point
O3	1.5km Tunnel	Inland tunnel to bypass rock fall area	Frenchman's Burn to Cuddies' Point
O7	1.7km Avalanche Shelter	On-line avalanche shelter	Frenchman's Burn to Cuddies' Point
Southern Option			
S1, S3 (link only)	Allt Gleann Udalain bridge	Allt Gleann Udalain	Gleann Udalain
S4	Allt Gleann Udalain bridge, approximately 15m single span	Allt Gleann Udalain	Gleann Udalain
	River bridge, approximately 10m single span	Watercourse	Allt an Lochain Fhuair, waterfalls
	River bridge or large culvert	Allt nan Darach Moire	Attadale Valley
	Small culvert or bridge, single span 2m to 5m	Various watercourses (16 No.)	Gleann Udalain to Attadale
S4 - Attadale to Strathcarron Junction	Refer on-line structures above	Refer on-line structures above	various

4.8.2 Culverts

Culverts for field drains and small streams would mostly be constructed using precast concrete pipes which are typically available up to 2.4m diameter. Rectangular precast concrete culverts require less depth of excavation to achieve the same discharge rate as circular culverts and can

offer cost savings from reduced time and labour on site but are generally more expensive than pipes. At this stage, it is assumed that 1.2m to 1.5m diameter precast concrete pipes would be sufficient to carry the flow from the small streams that cross the routes. Although it may become apparent that other construction types would be more applicable at some specific sites, this type of construction is fast and economic and is therefore deemed the preferred method.

Large streams could be accommodated with corrugated steel culverts, arches or pipe-arches which are plate structures consisting of various width, curved steel sheets of varying profiles, lengths and thicknesses that are bolted together to form durable structures. These are typically used for diameters of over 3.6m and are available in spans/diameters up to 12m. Bolted plate structures have a high loadbearing capacity and offer some advantages over concrete structures including strength to weight ratio, ease of installation and adaptability to changing conditions.

At present, the Stage 2 cost estimates include for structures as detailed in table 4.8 above, and also include an allowance for minor road drainage and culverts, up to a size of 1.0m diameter approximately.

4.8.3 Bridges

Simple short span bridge crossings would be constructed with decks of in-situ reinforced concrete slab or precast pre-stressed concrete beams on reinforced concrete abutments with appropriate footings. In-situ concrete box structures could be used as underpasses to carry minor access roads or accommodation tracks under the new routes where necessary.

Longer span bridge crossings will be necessary in places to cross a river with a wide floodplain or difficult topography, and to allow structures with an open aspect for aesthetic reasons. This type of crossing could be a multi-span structure consisting of composite pre-stressed precast concrete or structural steel beams and in-situ reinforced concrete slab deck. The potential main span range is quite large and could be in excess of 50m, if required.

The existing bridges on the A896, C1096 and A890 are of a variety of types, including pre-stressed precast concrete beam, reinforced concrete slab and reinforced concrete beam and slab bridges, as well as masonry structures. It is likely to be necessary to refurbish, upgrade or replace some of these structures within the on-line sections of the route improvement options, depending on their condition, load capacity and available road cross section.

Major bridge structures associated with the route options are discussed separately in following subsections of this chapter.

4.8.4 Retaining Structures

Retaining structures will be required within sections of the route options with existing development constraints or difficult topography such as North Shore option N6 through Slumbay and Lochcarron, as well as on-line options on the south side of Loch Carron, where the available room for construction of new embankments required for some of the options considered is very restricted due to the existing topography and adjacent railway line.

Retaining walls can be formed in reinforced concrete and special geotechnical measures such as reinforced soil treatments or soil nails can be used to enable steepened cutting and embankment slopes where there are space constraints.

4.8.5 Strome Narrows Bridge

The North Shore corridor options incorporate a major bridge or tunnel crossing of the Strome Narrows which would allow future traffic to be re-routed to avoid the problem area on the south side of Loch Carron. Furthermore these options can be constructed without being affected by the constraints of the problem area and without significantly affecting the existing A890 road traffic and rail traffic.

Several Strome Narrows crossing were considered as part of the Stage 2 Assessment, and are summarised in the Strome Narrows Crossing Technical Note included in Appendix H. The location considered to cross the Strome Narrows has been narrowed down to one principal location during the Stage 2 assessment, with the choices being determined by the need for southern approaches to a bridge to traverse around the steep sided Creag Mhaol hill. The proposed North Shore route alignments are to the west of Creag Mhaol and cross from near Portchulliin on the south shore to Leacanasigh on the north of the Narrows.

The following principles have informed this outline design of proposed bridge structures across the Strome Narrows:

- Set finished road level across the bridge and approach roads, to reduce earthworks requirements and to maintain reasonable cut and fill balance;
- Difficult / unknown foundation conditions on the sea bed;
- High tidal range of approximately 6.0m based on admiralty and tidal records for the Strome Narrows;
- Requirements for navigational clearances below the bridge;
- The design, detailing and finishes of the bridge should be of high quality, appropriate to the location of the site;
- Bridge structure to be straight on plan to simplify and facilitate construction techniques, such as launching;
- Aesthetics of the bridge structures, and views of the landscape from the bridge should be maximised;
- A ‘simple’ structure that frames the landscape and provides a good landscape contrast is preferable to a ‘complex’ option;
- Retain existing vegetation, minimizing the footprint and hard surfaces where possible to set the new structure within the existing landscape;
- Minimise excavation of hard material and associated environmental issues with disturbance and noise pollution;
- Overall estimated bridge construction costs.

Navigational Clearance Requirements

This appraisal included extensive consultations to establish requirements with regards to bridge clearances, both in height and width, for navigational purposes below a proposed bridge structure across the Narrows. Although Loch Carron does not experience a great amount of shipping, there are various user groups (mostly in relation to fishing and leisure), that would be affected by a structure crossing the western end of the loch.

Both historical as well as current requirements received during the consultations were considered. In agreement with The Highland Council Chief Structures Engineer it was

concluded, that the consultations to date provide a good indication on a variety of requirements, and that this appraisal should, as a result of this, consider a feasible range of clearances above MHWS, putting forward suitable outline bridge design proposals to suit.

In addition, if a northern route scheme including a bridge structure across the Strome Narrows was emerging as the preferred option after this Stage 2 assessment, an application to Marine Scotland under the Marine (Scotland) Act 2010 will be required. This process, similar to a Planning application process, will involve consultations by Marine Scotland with various user groups and public bodies to confirm that proposed navigational clearance is adequate.

Bridge clearance is considered in relation to a level slightly above recorded MHWS at Plockton, using a tidal range of 6.0m at the bridge location, established using admiralty charts and tidal information. Chart Datum at Plockton is 3.15m below Ordnance Datum, with the reference high water level at the bridge of 2.85m AoD used for the outline bridge design.

Based on the above, proposed bridge design proposals developed during Stage 2 include a cable stay structure, providing a centre span of approximately 700m length, and a height clearance above high water reference level of approximately 35m, and 4 No options for a low level structure, with multiple 40 to 65m spans, providing navigational clearances between approximately 20 and 23.5m above reference level. The bridge options with a clearance of 20m have been incorporated into the design for costing purposes.

Structural form

Examples of bridge solutions developed for the Strome Narrows crossing in the form of a concrete box girder bridge and a cable-stayed bridge are illustrated on drawing numbers 47065084/001 to 004 in Appendix H.

The nautical chart shows the sea bed at the Portchulliin - Leacanasigh location gradually deepening in the southern half to around 10m then markedly steepening to over 29.5m from Chart Datum closer to the north shore. This would lead towards a large main span in the northern half with shorter approach spans in the southern half.

4 no. options for a low level bridge have been developed as part of the appraisal, varying mainly in both horizontal and vertical alignments. End spans of 40m, with 15 to 16 no 50m long spans in the centre of the crossing have been considered, with a final preferred solution developed, providing spans of 40m, 9x48m, 53m, a navigational span of 65m, 53m, 3x48m and 40m, at an overall length of structure of 830m. The finished road level of this bridge has been set at 26mAoD, thus reducing required rock cuts on the north side of the Narrows in comparison to some of the other bridge options considered.

The structural form of a low level bridge would be a precast, pre-stressed concrete, or alternatively composite steel/concrete, box girder bridge deck, supported on reinforced concrete substructures, founded on piles or caissons into bedrock on the sea bed.

In addition, a high level bridge has been considered in the form of a cable stay structure. The advantage of this structure would be a large centre span of 700m length, allowing the main substructure to be located out with the deeper channel of the Narrows. It is anticipated that 3 no. side spans would be required at either side of the centre span of 105m, 85m and 75m length, resulting in an overall structure of 1.23km length. Road levels would be at 37.85mAoD, providing a bridge clearance of approximately 35m above reference high water level.

The structural form of a high level bridge would be cable stay bridge, comprising of a steel box girder deck structure, and reinforced concrete substructures, which are assumed to be founded on bedrock.

With this bridge and road alignment at a much higher level, the requirements for rock cuts in both the southern and northern approaches is reduced considerably.

Buildability

Given the nature of the glacially formed loch, it is expected that suitable foundation conditions for a bridge are available at relatively shallow depth however geotechnical investigations are required to confirm this. It is to be expected that bridge foundations and supports will require to be constructed within the loch. Depending on the structural form selected, the superstructure could be erected from floating working platforms or incrementally from the superstructure itself. Launching of the bridge deck from the southern shore has also been considered for the low level options, with the horizontal alignment been kept to a straight line to enable this method of construction.

The nearby former fabrication yard at Kishorn would be a suitable holding place for the delivery and assembly of components combined with local landfall areas created on both shores.

Construction of one of the southern spans over the existing Dingwall to Kyle railway line will also need to be considered, but is not assumed to present a problem.

The close vicinity of existing residential properties on both shores would need further consideration during detailed design of any of the considered bridge options.

An advantage of the north shore crossing would be that the existing route corridor of the A890 along the south side of Loch Carron would remain operational throughout the construction period.

Aesthetics

The bridge crossing main structures and associated approach spans would have a major visual impact in the landscape and the seascape and require careful consideration to ensure an elegant design that is fitting for this location.

The high level bridge could provide an ‘iconic’ statement, whereas a low level bridge is assumed to better blend into the surrounding landscape.

Operation/Maintenance/Inspection

The operation, maintenance and inspection requirements of these major bridge structures are not considered to be any different to other structure over water of a similar size and type. It would be important in the design phase to incorporate as many maintenance features as possible.

Routine maintenance and inspection could be carried out from the carriageway above, using underbridge units and roped access inspection. However given the large scale of these bridges, facilities for access for inspection and maintenance should be incorporated into the structure. It is likely that if box structures are adopted, the interior void will be a confined space, requiring special access measures.

Risks

There are risks to the construction relating to operations in tidal flow and working from water which would have to be addressed to satisfy the Construction Design and Management (CDM) Regulations’ 2007.

There is a residual risk that a high level bridge could be subject to traffic restrictions or closure in high winds which might be expected to occur at the Narrows.

Impact during Construction

The nearby settlements of Achmore and Slumbay would experience disruption from construction traffic accessing the site, although bringing materials and components in by sea would help to reduce this as well as ease the impact on the regional road network. There would be more significant disruption to the property holding immediately adjacent to the crossing locations.

The duration of the bridge works is likely to be over two years.

The proximity of existing residential properties on the north shore has also been recognised and will require further consideration during Stage 3, should a north shore route option be chosen as the preferred route.

Selection of Structural Form

URS have undertaken an in depth assessment of bridge options to cross the Strome Narrows. Whilst the high level structure could be designed as an iconic statement structure; giving due consideration to all factors i.e. fitting landscape, community impacts, buildability, operation and maintenance, and cost; the low level bridge has been taken forward to the Assessment Summary Tables. It should be noted however due to the number of intermediate piers, this structure form will impact on the loch bed. Best practice, legislation and guidance would inform mitigation measures. Mitigation would include a combination of minimising direct impacts on the marine environment (e.g. flameshells and various marine mammals) through detailed design as well as habitat creation/restoration where possible. Survey requirements and site specific mitigation measures would be developed at Stage 3 in consultation with statutory consultees where required.

4.8.6 Online Option O2 – Railway Viaduct

Stage 1 considered relocating the road onto a viaduct along the loch side of the railway which was to remove traffic from the hazard area immediately below the hillside and would have allowed construction to take place offline with less disruption to existing road traffic and rail services. The corridor of the existing road would then have provided a safety margin for future rockfalls impinging on the railway.

However, more detailed consideration of this option, and discussions with Network Rail, have resulted in an amended proposal, where the railway line is moved onto a new viaduct alongside the loch over a length of 1.6km past the rock fall area to west of the Cuddies' Point. This is further detailed on drawing number 5205. The road would be re-aligned on the existing railway corridor, leaving a wide enough separation to the unstable rock faces, which would be further made safe by additional rock fall measures and rock trap ditches. This amendment also omits the requirement for two cross-overs of railway and road, and is therefore considered the more feasible and less expensive alternative.

The construction of the railway tie-ins at each end of the viaduct would require the construction of a spur formed from filling behind a contiguous piled retaining wall.

The railway viaduct would be founded on the sidelong bed of Loch Carron. Some examples of sidelong viaduct construction are the A84 Cruachan viaduct at Loch Awe and the A82 Pulpit Rock viaduct at Loch Lomond, which is to be built in 2014, as well as the A9 Killiecrankie viaduct which is on hillside.

Structural form

A rock causeway has been considered as an alternative option to providing a viaduct. The nautical chart for Loch Carron indicates that the loch is 80m - 100m deep which has been confirmed by The Highland Council by sonar and bathymetrical survey. The detail indicates a 1 in 1.5 to 1 in 1.8 scree slope to a depth of 30m - 40m, then a shallower slope out towards the middle of the loch. Widening the shoreline by placing a 2km rock causeway at a 1 in 1.5 slope would take of the order of 2,000,000 m^3 of material plus an additional 800,000 m^3 as the toe would ravel down the slope. There would be an attendant risk of slip failure of this material and/or the underlying slope, and therefore this alternative has been dismissed at this stage of the appraisal.

The multi-span railway viaduct structure would take the form of a contiguous plate girder half-through structure, with a reinforced concrete trough supporting the track bed. The substructure would comprise reinforced concrete columns supported on rock socket mono piled columns.

Buildability

It is envisaged that a railway viaduct would be constructed from floating working platforms with barge-mounted piling rigs and cranes and that materials and components would be brought in by sea. The nearby former fabrication yard at Kishorn would be a suitable holding place for the delivery and assembly of components. A local landfall area could be created at Cuddies Point and a temporary bridge constructed over the railway for early access during the construction period until a permanent structure is built.

Deep piled concrete foundations would be required, constructed through the superficial deposits on the sloping loch bed and socketed into the underlying bedrock. Concrete piers would then be constructed from the piles using in-situ construction with a climbing formwork system. Depending on the superstructure adopted, the piers could take the form of individual columns only or columns combined with crossheads.

The superstructure could be formed from a number of material options (reinforced concrete, prestressed concrete or structural steel) however it is envisaged that steel beams would be used rather than concrete for ease of placement by barge-mounted cranes. Deck slab could either be in-situ reinforced concrete on permanent formwork or could make use of a precast deck slab system. As the deck construction progresses, access would also be made along the superstructure for the delivery and placement of materials.

Aesthetics

A viaduct would be a visible feature from across the loch. However it should be relatively discreet against the shoreline and the scale of the hillside above. The tidal range would expose varying appearances of the viaduct and care would be required to ensure an elegant structure particularly at low tide with appropriate attention to structure proportions, materials and finishes.

Railway passengers views of the scenic loch setting would arguably be enhanced from the viaduct while driver views should not be adversely affected.

Operation/Maintenance/Inspection

The operation, maintenance and inspection requirements of the viaduct are not considered to be any different to other structures over water of this size and type. It would be important in the design phase to incorporate as many maintenance features as possible e.g. minimising the number of expansion joints and making provision for bearing replacement and access for inspection. Routine maintenance and inspection could be carried out from the cess walkways,

using roped access or specialist access plant running on the rails. Choosing suitable steel specifications could help to limit future maintenance requirements.

Risks

The main risk associated with the viaduct option is the need for geophysical survey information on the underlying rockhead profile and the definition of the internal structure of the rock to determine the presence any fault zones which would affect the design.

Construction risks such as working from water would be addressed to satisfy the Construction Design and Management (CDM) Regulations' 2007. The residual risk of further rockfalls affecting the road would remain and is allowed for elsewhere in this report.

Impacts during Construction

Given that the new railway viaduct is offline from the existing A890, it can be constructed by taking access from the loch and bringing materials by sea, disruption to road and rail traffic should be limited. Railway services would likely be affected by piling operations depending on the method of working. Although the viaduct works would be undertaken from working platforms in the loch there will still be times when short term closures are required, particularly when plant or equipment is being repositioned.

Tie-in of road and railway at each end of the bypass would require careful consideration to minimise disruptions to both road and rail traffic. Works in the proximity to the existing road and railway track would require a certain amount of one-way traffic management. Some full-road and railway closures would have to be considered for short durations and these would be limited to night-time closures where possible.

Bringing materials and components in by sea has the benefit of reducing delivery by road transport and associated impact on the regional road network.

The duration of the railway viaduct works is likely to be over two years. Alterations to the road could not proceed until the rail is realigned to the new viaduct at which stage the new road could then be constructed on the existing track bed.

4.8.7 Online Option O3 – Inland Tunnel

In addition to the other online options, structural proposals considered as part of this appraisal also include an inland tunnel to bypass the rock fall areas locally. A tunnel structure would be of the order of 1.6km in length.

Stage 1 proposals considered a tunnel cross section in accordance with the DMRB, BD 78/99-Design of Road Tunnels, which provides full carriageway width for two-way traffic flows, as well as verges and a narrow pedestrian strip alongside the carriageway in emergency or breakdown situations. In addition, the proposals included a fully segregated area, providing a safe route for Non Motorised Users of the route, as well as a safe exit route for emergency evacuation of the tunnel. This resulted in an overall cross sectional area of approximately 130m^2.

It was recognised during the Stage 1 assessment that cross sectional area of the tunnel is the main influence on construction costs. As a result, reduction of the area required for rock excavations would potentially reduce tunnel costs dramatically.

Norwegian, low cost tunnel construction reduces the cross sectional area, to about 60m^2, providing one or two way carriageways, depending on length of tunnel, and minimal tunnel

linings in areas of worst rock conditions, and at carriage way and crown levels, for water and frost protection.

The typical Norwegian tunneling cross-section, as considered offers significant cost benefits but will not totally satisfy the UK design standards and safety regulations. Robust risk analysis and management techniques would have to be applied before it would satisfy the code of practice for risk management of tunnel works in the UK and taken further. Areas to consider include:

- Geology/Hydrogeology
- Drainage/Groundwater
- Pedestrians & Cyclists
- Operation & Maintenance
- Ventilation
- Escape & Refuge

However, from work to date and following a risk analysis it is likely the Norwegian cross section can be developed such that risks are As Low As Reasonably Practicable.

With regard to compliance with the UK standard BD78/99, we would recommend ongoing dialogue and meetings are held with the client; The Highland Council and Transport Scotland as the technical approval authority to set a series of 'Approval Gateways' where the subject is fully explored with the aspiration of final acceptance should the tunnel emerge as a preferred route option.

If an on-line tunnel is to be considered further it is recommended a hybrid solution is developed, taking aspects from the Norwegian design and incorporating them within a design to BD78/99. This solution would offer economies in price whilst conforming to standards. It should also be noted the current standard is some 15 years old. The overseeing authorities are aware of changing technologies for low trafficked roads which may be reflected in expected updates. A 20% reduction has been assumed in the costs for an on-line tunnel to reflect a hybrid solution.

A full report into tunnel options considered as part of this appraisal, including technical details and outline cost estimates has been compiled and can be found in Appendix E of this report.

4.8.8 Online Option O7 - Avalanche Shelter

Debris flow shelters, stone shelters or 'avalanche' shelters are engineered structures that form canopies over a section of road prone to rock fall or debris flows. These structures are usually formed from reinforced concrete and energy is dissipated by placing a depth of granular material on the roof on which the debris flow lands. Where the energy is anticipated to be very high, modifications can be made by shaping the roof so that the material passes over the structure without dissipating much energy.

The existing avalanche shelter built at time of the original road construction covers both the road and the railway for approximately 60m and is formed in reinforced concrete with 'window' openings in the wall between the road and railway and in the external lochside wall. The road is single track with hard strips through the shelter.

The general form of an extended shelter to provide protection for road users would be a prestressed concrete beam deck supported on reinforced concrete columns and a reinforced

concrete wall over the full length of the area of concern (approximately 1.7km). It may be possible to provide less coverage by only locating shelters at the high risk locations subject to appropriate slope treatment measures at the intervening sections. This could be considered at the detailed assessment stage of the study.

The shelter would be an 'open' structure towards the lochside to provide light and ventilation, thus avoiding the requirements that apply to a tunnel and reducing the impact on the views experienced by road and rail users.

Several configurations of shelter have been considered:

- Single track carriageway
- Two-way carriageway
- Single width covering road only
- Double width covering road and railway
- Rail above road
- Road above railway.

Extended Avalanche Shelter

A double-width structure covering both the road and railway was considered. The roof slab would need to be designed for rockfall loads depending on level of treatment to the existing rock slopes, as well as dead load from backfill materials and man-access.

In accordance with the DMRB, the minimum advisable carriageway width through an extended shelter would be 6.0m to allow traffic to pass broken down or stopped vehicles. DMRB Standard TD 42/95 for 'Design of Major/Minor Priority Junctions' requires minimum 6.0m wide carriageway at single lane sections greater than 50m. In comparison, Standard TD 27/05 'Cross Sections and Headrooms' requires at least 7.0m on all-purpose slip roads. This therefore rules out a minimal lane width single track option unless passing places can be accommodated. It would also rule against a road-over-road solution.

A carriageway width of 6.0m is however sufficient for two-way single carriageway operation. A footway would be necessary for pedestrian passage, particularly to enable safe egress from broken down vehicles. A suitable overall cross section would comprise a 6.0m wide carriageway with kerbed 2.0m wide footway on one side and a 0.6m raised verge on the other. Assuming a wall section of 0.8m and a 3.0m clearance to the railway, this would require a construction width at least 13m from the nearside rail which in turn would necessitate excavation in the rock face and associated slope stabilisation measures albeit that the excavation width would be less than that required to accommodate an open carriageway and adjacent rock catch ditch.

Structural Form

An extended avalanche shelter would be of similar construction to the existing shelter, i.e. be of reinforced concrete construction for the roof slab, supported on discrete reinforced concrete columns founded on mono piles on the lochside. Adjacent to the hill, the construction of a concrete abutment / retaining wall would be required in order to support both the extended rock excavations into the existing rock face to widen the road corridor, as well as the roof slab.

Buildability

Construction activities for this structure arrangement would be extremely constrained in the available working area between the rock face, the existing road and the railway. Construction would be carried out in a number of short sections to reduce the length of single lane traffic management where possible however it is inevitable that prolonged full closures will be necessary. Unknown stability of the existing rock face may require extensive over-excavations of rock in order to prevent instability during construction of the abutment/retaining wall and early (over)loading of the structure. There would be a significant risk associated with this during construction.

Aesthetics

The lochside aspect of the structure could be fairly open to minimise the visual impact from across the north side of the loch. However the over-excavation of rock likely required to enable construction will result in a very visible scaring of the hillside.

Driver experience within an extended avalanche shelter would be impacted by a reduction in the open and picturesque panoramic views currently enjoyed by travellers along this section of the A890. Railway passenger views would also be affected.

Operation/Maintenance/Inspection

There are no specific operational requirements for the shelter structure. Routine maintenance and inspection would be required as for any structure, with specific requirements relating to drainage, lighting and road surface issues. Maintenance would be required to remove any debris from the roof of the shelter requiring a means of access for small plant. A means for maintenance vehicles to access the railway would also need to be incorporated.

Risk

Significant risks include the risk to construction personnel from falling debris throughout a lengthy construction period, the stability of the slopes being affected by the shelter works and the risk of working in close proximity to railway operations.

Impact during Construction

Given the constraints of the narrow corridor it is inevitable that full road closures would be necessary for significant durations to allow rockface excavation and construction of a reinforced concrete structure. Even when construction activities allow traffic to be diverted onto the railway under one-way working, there would be long term traffic management delay and disruption. There would also be disruption and closure of rail services.

The duration of the works could be over two years.

Developed Avalanche Shelter

An alternative arrangement was considered during Stage 1, and further developed during this Stage 2 assessment, to avoid excavation of the rock face which would be required for the 'extended shelter' described above. This alternative would re-locate the road on a viaduct above the railway, leaving sufficient width for a rock catch ditch on the line of the existing road. The benefits of this type of solution over an extended avalanche shelter are considered to be:

- less encroachment into the rockface;
- less remediation measures essential to stabilise rockface;

- open aspect;
- less disruption during construction.

An outline of a viaduct-over-rail structure is shown in drawing number 5257.

Buildability

Construction activities in relation to this structure arrangement would be extremely constrained in the available working area between the rock face, the existing road and the railway. Construction is likely to require single lane traffic management and full closures of road and railway will also be necessary. In addition, access for construction traffic would be via the existing road corridor, causing further disruptions. The use of precast or pre-fabricated components such as columns, beams and deck slabs would allow some activities to take place offsite and help reduce work activity durations in the constrained site. As the deck construction progresses, access could also be made along the superstructure for the delivery and placement of materials.

In addition, the construction works would also be affected by the close proximity of the railway. All work activities would require to be fail-safe to prevent plant and materials falling or encroaching on the railway. It is envisaged that the structure arrangements would be founded on mono piled footings. It is likely excavation/drilling into rock will be necessary that will impinge on the railway track support zone. This proposal would also require demolition of the existing avalanche shelter. Tie in structures at each end would require special consideration to minimise any delays during construction.

Aesthetics

A viaduct above the railway would be visually intrusive within the setting of Loch Carron, although views from the opposite side of the loch would be distant and the structures themselves would be relatively insignificant against the scale of the hillside above.

Driver experience from the elevated road on the developed avalanche shelter would be greatly enhanced by views from the elevated position alongside the loch.

Operation/Maintenance/Inspection

There are no specific operational requirements for the extended shelter. Routine maintenance and inspection would be required as for any structure, with specific requirements relating to drainage, lighting and road surface issues. Maintenance would need to include the removal of any debris from the rock fall ditch proposed alongside the new structure, requiring a means of access for small plant. A means for maintenance vehicles to access the railway would also be need to be incorporated. The viaduct option would need a safe method of access to maintain bridge bearings in proximity to the railway.

In addition, provisions for non-motorised users would have to be carefully considered along a 1.6km elevated road way.

Risks

Significant risks include the risk to construction personnel from falling debris throughout a lengthy construction period, the stability of the slopes being affected by the shelter works and the risk of both options working in close proximity to railway operations.

Impact during Construction

Given the constraints of the narrow corridor it is inevitable that full road closures would be necessary for lengthy durations to allow construction of the piled foundations and columns. Even when construction activities allow traffic to be diverted onto the railway under one-way working, there would be long term traffic management delay and disruption. There would also be disruption and closure of rail services. Although it has its own disruption difficulties, it is assumed that the viaduct option should cause less impact overall than the construction of an extended shelter.

The duration of the works could be over two years.

Based on the above, the developed avalanche shelter, providing an elevated roadway above the existing railway track, has been considered the preferred alternative for option O7 and will be taken to the assessment summary tables discussed further on in this report.

4.9 Consenting and Statutory Processes

4.9.1 Introduction

Part of the appraisal brief for this Stage 2 assessment of scheme options was to determine statutory processes that are likely to be involved with each of the proposed scheme options in order to assist with determination of likely timescales required during the further stages of this development.

A full report has been compiled detailing all statutory processes determined at this stage of the scheme development, a copy of which can be found in Appendix C of this report.

4.9.2 Summary

A number of statutory processes must be followed at Stage 3 for a preferred scheme. This will include obtaining a number of consents and licences which depending on the route chosen may include the following:

Table 4.9.1 – Consenting and Statutory Processes

Consent / License or Statutory Process	Applicable to
Planning consent	All options
Marine Licence	N6, N9, O2
Compulsory Purchase	All options
De-crofting of land	All options
Environmental Impact Assessment	All options
Protected species disturbance licence	All options
Habitats Regulations Assessment	All options
Scheduled Monument consent	N6, N9
Listed Building consent	All options

Consent / License or Statutory Process	Applicable to
Tree felling licence	N6, N9, S4
Controlled Activities Regulations Licence	All options
Waste Management Licence	All options
Transport and Works (Scotland) Order	Option O2

It should be noted that a Public Local Inquiry may be required under some of the above processes depending on circumstances/objections and that statutory requirements will be determined at DMRB Stage 3 following further discussions with a number of statutory bodies.

4.10 Potential Departures from Standard

As described in section 4.2 above, roads in Scotland are designed to the requirements set out in the Design Manual for Roads and Bridges (DMRB). These design requirements include desirable minimum and absolute requirements. Designs can be below the desirable minimum requirements at the discretion of the Designer, this is known as a Relaxation. If the design does not meet the absolute requirements, a Departure from Standard is required and this must be approved by the Overseeing Organisation, in this case The Highland Council.

The route options aim to have geometry appropriate for a design speed of 100B kph. However, due to the constrained nature of the study area and the local topography, relaxations in both the horizontal and vertical geometry are included to minimise the impact on the local environment.

An initial review of the proposed mainline geometry has been carried out for the route options. At this preliminary stage, the designs do not include verge widening for stopping sight distance. Therefore the departures and relaxations listed below refer to the horizontal curves and transitions, and vertical curves and gradients only, and do not consider stopping sight distance. Similarly, although the potential location of sideroads junctions has been estimated and considered when assessing potential departures, junctions for private accesses have not been considered as part of this exercise.

A summary of the potential relaxations and departures is detailed in tables 4.10.1 to 4.10.7 below. It should be noted that values recorded in the tables below are as the route options currently stand. Further design development will be required on the Preferred Option and therefore the design and geometry will be subject to change.

North Shore Options

Option N6 (Online Lochcarron)

Option N6 includes a section of online alignment through Slumbay and Lochcarron which is currently subject to a 30mph speed limit (equivalent to 60B kph). Therefore, geometry through this section, from Chainage 6,490 to 11,800 has been assessed against a design speed of 60B kph.

Option N6 has undergone a preliminary mainline geometry assessment and has found to have 71 mainline departures as summarised in table 4.10.1. The majority of departures are associated with the non-provision of horizontal transition curves. Departures are also required where vertical crest curves and gradients have been relaxed near junctions, to more closely follow existing topography and therefore minimise the impact on adjacent land and property. The remaining departures are required at locations where relaxations in horizontal geometry are

coincident with relaxations in vertical geometry, therefore these combinations are considered to be Departures from Standard.

Option N9 (Lochcarron Bypass)

Option N9 has undergone a preliminary mainline geometry assessment and has found to have 16 mainline departures, as summarised in table 4.10.2. The majority of departures are related to the vertical geometry, with relaxations in crest curve and gradient required to more closely follow the existing topography and therefore minimise the impact on adjacent land and property. The remainder are required at locations where relaxations in horizontal geometry geometry are coincident with relaxations in vertical geometry, therefore these combinations are considered to be Departures from Standard.

Online Options

All online options follow the same alignment from Stromeferry to Frenchman's Burn, and then from Cuddies Point to Strathcarron Junction. Other than the section from Frenchmans Burn to Cuddies Point, where special structures are provided to bypass the rockfall area, and short sections of local offline improvements at Maman Hill and Achintee, all online options follow the existing A890. Therefore the online options have a higher number of departures as the alignments aim to follow the existing road alignment which has horizontal and vertical geometry of a lower standard.

Option O2 (Railway Viaduct)

Option O2 has undergone a preliminary mainline geometry assessment and has found to have 157 mainline departures. Table 4.10.3 summarises the departures, but due to the high numbers, the number of departures of similar types have been totalled for sections along the route. 137 of the departures occur between Stromeferry and Cuddies Point. The majority of departures are for the non-provision of horizontal transition curves. The remainder are mostly required at locations where relaxations in horizontal geometry are coincident with relaxations in vertical geometry.

Option O3 (Online Tunnel)

Option O3 has undergone a preliminary mainline geometry assessment and has found to have 129 mainline departures. Table 4.10.4 summarises the departures, but due to the high number of departures, similar types have been totalled for sections along the route. 109 of the departures occur between Stromeferry and Cuddies Point. The majority of the departures are for the non-provision of horizontal transition curves. The remainder are mostly required at locations where relaxations in horizontal geometry are coincident with relaxations in vertical geometry.

Option O5 (online Road / Rail share)

Option O5 has undergone a preliminary mainline geometry assessment and has found to have 156 mainline departures. Table 4.10.5 summarises the departures, but due to the high number of departures, similar types have been totaled for sections along the route. 136 of the departures occur between Stromeferry and Cuddies Point. The majority of the departures are for the non-provision of horizontal transition curves. The remainder are mostly required at locations where relaxations in horizontal geometry are coincident with relaxations in vertical geometry.

Option O7 (Developed Avalanche Shelter)

Option O7 has undergone a preliminary mainline geometry assessment and has found to have 156 mainline departures. Table 4.10.6 summarises the departures, but due to the high number of departures, similar types have been totaled for sections along the route. 136 of the departures occur between Stromeferry and Cuddies Point. The majority of the departures are for the non-provision of horizontal transition curves. The remainder are mostly required at locations where relaxations in horizontal geometry are coincident with relaxations in vertical geometry.

Southern Corridor

Option S4 (Glen Udalain)

Option S4 has undergone a preliminary mainline geometry assessment and has found to have 27 departures, as summarised in table 4.10.7. Option S4 has 10 departures from Glen Udalain to Cuddies Point, and then follows the same alignment as the online options from Attadale to Strathcarron junction. From Glen Udalain to Cuddies Point, three departures are required for steep gradients, provided to more closely follow the existing topography and therefore minimise the impact on adjacent land. The remainder of Departures are mostly required for locations where relaxations in horizontal geometry are coincident with relaxations in vertical geometry.

Table 4.10.1 Potential Departures from Standard – Option N6

OPTION N6	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
N6/D001	121 - 310	vertical curve	vertical crest - 1 step below des min, at junction	100K	55K	Achmore to Leacanasigh
N6/D002	348 - 468	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Achmore to Leacanasigh
N6/D003	637 - 937	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Achmore to Leacanasigh
N6/D004	1256 - 1702	vertical gradient	gradient greater than desirable maximum	6%	8%	Achmore to Leacanasigh
N6/D005	3334 - 3709	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Achmore to Leacanasigh
N6/D006-D008	various, 4274 - 4514	horizontal	length of transition curve	q=0.6	no provision	Leacanasigh to Strome Wood
N6/D009-D014	various, 4614 -5209	horizontal	length of transition curve	q=0.6	no provision	Leacanasigh to Strome Wood
N6/D015-D017	various, 5726-6126	horizontal	length of transition curve	q=0.6	no provision	Strome Wood to Kirkton
N6/D018	6236 - 6273	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Strome Wood to Kirkton
N6/D019-D020	various, 6270 - 6305	horizontal	length of transition curve	q=0.6	no provision	Strome Wood to Kirkton
N6/D021	6348 - 6417	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Strome Wood to Kirkton
N6/D022-D039	various, 6388 - 9417	horizontal	length of transition curve	q=0.6	no provision	Strome Wood to Kirkton
N6/D040	9417 - 9453	horizontal	horizontal - 5 steps below des min	720mR	50mR	Strome Wood to Kirkton
N6/D041-D064	various, 9463 - 12141	horizontal	length of transition curve	q=0.6	no provision	Strome Wood to Kirkton
N6/D065	901 - 937	combination	combination - horizontal & vertical relaxation			Achmore to Leacanasigh
N6/D066	1853 - 1989	combination	combination - horizontal & vertical relaxation			Achmore to Leacanasigh
N6/D067	3954 - 4024	combination	combination - horizontal & vertical relaxation			Leacanasigh to Strome Wood
N6/D068	4417 - 4514	combination	combination - horizontal & vertical relaxation			Leacanasigh to Strome Wood
N6/D069	4782 - 4851	combination	combination - horizontal & vertical relaxation			Leacanasigh to Strome Wood
N6/D070	6236 - 6270	combination	combination - horizontal & vertical relaxation			Strome Wood to Kirkton
N6/D071	6348 - 6388	combination	combination - horizontal & vertical relaxation			Strome Wood to Kirkton

Table 4.10.2 Potential Departures from Standard – Option N9

OPTION N9	ROAD GEOMETRY REQUIRING DEPARTURES/RELAXATIONS FROM STANDARD				
Ref No.	**Mainline location**	**Type**	**Description**	**Standard Required**	**Standard Achieved**
DEPARTURES					
N9/D001	121 - 310	vertical curve	vertical crest - 1 step below des min, at junction	55K	Achmore to Leacanasigh
N9/D002	348 - 468	vertical curve	vertical crest - 2 steps below des min, at junction	30K	Achmore to Leacanasigh
N9/D003	637 - 937	vertical curve	vertical crest - 2 steps below des min, at junction	30K	Achmore to Leacanasigh
N9/D004	1256 - 1702	vertical gradient	gradient greater than desirable maximum	8%	Achmore to Leacanasigh
N9/D005	3334 - 3675	vertical curve	vertical crest - 2 steps below des min, at junction	30K	Achmore to Leacanasigh
N9/D006	5378 - 5427	vertical curve	vertical crest - 1 step below des min, at junction	55K	Leacanasigh to Strome Wood
N9/D007	5748 - 6084	vertical curve	vertical crest - 2 steps below des min, at junction	35K	Strome Wood to Kirkton
N9/D008	6954	vertical gradient	gradient greater than desirable maximum	9.82%	Strome Wood to Kirkton
N9/D009	7920	vertical gradient	gradient greater than desirable maximum	9.08%	Strome Wood to Kirkton
N9/D010	9292 - 9449	vertical curve	vertical crest - 2 steps below des min, at junction	35K	Strome Wood to Kirkton
N9/D011	11082 - 11761	vertical gradient	gradient greater than desirable maximum	10%	Strome Wood to Kirkton
N9/D012	901 - 937	combination	combination - horizontal & vertical relaxation		Achmore to Leacanasigh
N9/D013	1853 - 1989	combination	combination - horizontal & vertical relaxation		Achmore to Leacanasigh
N9/D014	4374 - 4558	combination	combination - horizontal & vertical relaxation		Leacanasigh to Strome Wood
N9/D015	6641 - 6660	combination	combination - horizontal & vertical relaxation		Strome Wood to Kirkton
N9/D016	7015 - 7227	combination	combination - horizontal & vertical relaxation		Strome Wood to Kirkton

Table 4.10.3 Potential Departures from Standard – Option O2

OPTION O2	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O2/D001	404	horizontal	Length of Transition Curve - 720mR	q=0.6; 50m	No Provision	Stromeferry to Ardnarff
O2/D002	449 - 573	vertical curve	vertical crest - 4 steps below des min, at junction	100K	10K	Stromeferry to Ardnarff
O2/D003 - D039	various, 672 - 2814	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O2/D040	2866 - 3435	vertical grad	gradient greater than des max	6%	10%	Stromeferry to Ardnarff
O2/D041 - D046	various, 2908 - 3189	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O2/D047 - D081	various, 3291 - 5008	horizontal	length of transition curve	q=0.6	No Provision	Ardnarff to Cnoc Nam Mult
O2/D082 - D111	various, 5174 - 6935	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O2/D112	7009 - 7194	vertical curve	vertical crest - 2 steps below des min, at junction	100K	40K	Cnoc Nam Mult to Cuddies Point
O2/D113 - D114	7147	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O2/D115	7283 - 7638	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Cnoc Nam Mult to Cuddies Point
O2/D116 - D124	various, 7321 - 8502	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O2/D125	8789 - 9090	vertical grad	gradient greater than des max	6%	10%	Attadale to Maman
O2/D126	9690 - 9983	vertical grad	gradient greater than des max	6%	10%	Attadale to Maman
O2/D127	10309	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Attadale to Maman
O2/D128 - D129	various, 10472 - 10667	horizontal	length of transition curve	q=0.6	No Provision	Maman to Achintee
O2/D130	10762 - 10879	vertical curve	vertical crest - 2 steps below des min, at junction	100K	40K	Maman to Achintee
O2/D131	10846	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Maman to Achintee
O2/D132	11101 - 11219	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Maman to Achintee
O2/D133	884 - 938	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D134	938 - 998	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D135	998 - 1187	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff

OPTION O2	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O2/D136	1420 - 1467	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D137	1467 - 1551	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D138	1551 - 1666	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D139	1666 - 1777	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D140	1777 - 1801	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D141	2334 - 2398	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D142	2398 - 2452	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D143	2671 - 2709	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D144	2709 - 2814	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D145	2814 - 2866	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O2/D146	4480 - 4555	combination	combination - horizontal & vertical relaxation			Ardnarff to Cnoc Nam Mult
O2/D147	5477 - 5527	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O2/D148	6098 - 6179	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O2/D149	6212 - 6271	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O2/D150	7147 - 7194	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O2/D151	7283 - 7321	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O2/D152	7321 - 7481	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O2/D153	9090 - 9138	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O2/D154	9399 - 9532	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O2/D155	10472 - 10647	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O2/D156	10846 - 10879	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O2/D157	11713 - 11939	combination	combination - horizontal & vertical relaxation			Achintee to Strathcarron

Table 4.10.4: Potential Departures from Standard – Option O3

OPTION O3	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O3/D001 - D002	various, 404 - 672	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O3/D003	449 - 573	vertical curve	vertical crest - 4 steps below des min, at junction	100K	10K	Stromeferry to Ardnarff
O3/D004 - D039	various, 823 - 2814	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O3/D040	2866 - 3435	vertical grad	gradient greater than des max	6%	10%	Stromeferry to Ardnarff
O3/D041 - D046	various, 2866 - 3189	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O3/D047 - D081	various, 3291 - 5008	horizontal	length of transition curve	q=0.6	No Provision	Ardnarff to Cnoc Nam Mult
O3/D082 - D093	various, 5174 - 5615	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O3/D094 - D095	various, 8027 - 8049	horizontal	length of transition curve	q=0.6	No Provision	Cuddies Point to Attadale
O3/D096 - D100	various, 8099 - 8502	horizontal	length of transition curve	q=0.6	No Provision	Attadale to Maman
O3/D101	8789 - 9090	vertical grad	gradient greater than des max	6%	10%	Attadale to Maman
O3/D102	9690 - 9983	vertical grad	gradient greater than des max	6%	10%	Attadale to Maman
O3/D103	10309	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Attadale to Maman
O3/D104 - D105	various, 10472 - 10667	horizontal	length of transition curve	q=0.6	No Provision	Maman to Achintee
O3/D106	10762 - 10879	vertical curve	vertical crest - 2 steps below des min, at junction	100K	40K	Maman to Achintee
O3/D107	10846	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Maman to Achintee
O3/D108	11101 - 11219	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Maman to Achintee
O3/D109	884 - 938	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D110	938 - 998	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D111	998 - 1187	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D112	1420 - 1467	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D113	1467 - 1551	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D114	1551 - 1666	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff

OPTION O3	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O3/D115	1666 - 1777	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D116	1777 - 1801	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D117	2334 - 2398	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D118	2398 - 2452	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D119	2671 - 2709	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D120	2709 - 2814	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D121	2814 - 2866	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O3/D122	4480 - 4555	combination	combination - horizontal & vertical relaxation			Ardnarff to Cnoc Nam Mult
O3/D123	5523 - 5546	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O3/D124	7367 - 7520	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O3/D125	9090 - 9138	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O3/D126	9399 - 9532	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O3/D127	10472 - 10647	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O3/D128	10846 - 10879	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O3/D129	11713 - 11939	combination	combination - horizontal & vertical relaxation			Achintee to Strathcarron

Table 4.10.5: Potential Departures from Standard – Option O5

OPTION O5	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O5/D001	404	horizontal	Length of Transition Curve - 720mR	q=0.6; 50m	No Provision	Stromeferry to Ardnarff
O5/D002	449 - 573	vertical curve	vertical crest - 4 steps below des min, at junction	100K	10K	Stromeferry to Ardnarff
O5/D003 - D039	various, 672 - 2814	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O5/D040	2866 - 3435	vertical grad	gradient greater than des max	6%	10%	Stromeferry to Ardnarff
O5/D041 - D046	various, 2908 - 3189	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O5/D047 - D082	various, 3291 - 5107	horizontal	length of transition curve	q=0.6	No Provision	Ardnarff to Cnoc Nam Mult
O5/D083 - D108	various, 5181 - 6825	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O5/D109	7024 - 7148	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Cnoc Nam Mult to Cuddies Point
O5/D110 - D113	various, 6831 - 7148	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O5/D114	7283 - 7638	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Cnoc Nam Mult to Cuddies Point
O5/D115 - D116	7321	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O5/D117 - D118	various, 8027 - 8049	horizontal	length of transition curve	q=0.6	No Provision	Cuddies Point to Attadale
O5/D119 - D123	various, 8099 - 8502	horizontal	length of transition curve	q=0.6	No Provision	Attadale to Maman
O5/D124	8789 - 9090	vertical grad	gradient greater than des max	6%	10%	Attadale to Maman
O5/D125	9690 - 9983	vertical grad	gradient greater than des max	6%	10%	Attadale to Maman
O5/D126	10309	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Attadale to Maman
O5/D127 - D128	various, 10472 - 10667	horizontal	length of transition curve	q=0.6	No Provision	Maman to Achintee
O5/D129	10762 - 10879	vertical curve	vertical crest - 2 steps below des min, at junction	100K	40K	Maman to Achintee
O5/D130	10846	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Maman to Achintee
O5/D131	11101 - 11219	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Maman to Achintee
O5/D132	884 - 938	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D133	938 - 998	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D134	998 - 1187	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff

OPTION O5	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O5/D135	1420 - 1467	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D136	1467 - 1551	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D137	1551 - 1666	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D138	1666 - 1777	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D139	1777 - 1801	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D140	2334 - 2398	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D141	2398 - 2452	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D142	2671 - 2709	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D143	2709 - 2814	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D144	2814 - 2866	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O5/D145	4480 - 4555	combination	combination - horizontal & vertical relaxation			Ardnarff to Cnoc Nam Mult
O5/D146	5477 - 5527	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O5/D147	6098 - 6179	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O5/D148	6212 - 6271	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O5/D149	7147 - 7194	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O5/D150	7283 - 7321	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O5/D151	7321 - 7481	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O5/D152	9090 - 9138	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O5/D153	9399 - 9532	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O5/D154	10472 - 10647	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O5/D155	10846 - 10879	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O5/D156	11713 - 11939	combination	combination - horizontal & vertical relaxation			Achintee to Strathcarron

Table 4.10.6 Potential Departures from Standard – Option O7

OPTION O7	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O7/D001	404	horizontal	Length of Transition Curve - 720mR	q=0.6; 50m	No Provision	Stromeferry to Ardnarff
O7/D002	449 - 573	vertical curve	vertical crest - 4 steps below des min, at junction	100K	10K	Stromeferry to Ardnarff
O7/D003 - D039	various, 672 - 2814	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O7/D040	2866 - 3435	vertical gradient	gradient greater than des max	6%	10%	Stromeferry to Ardnarff
O7/D041 - D046	various, 2908 - 3189	horizontal	length of transition curve	q=0.6	No Provision	Stromeferry to Ardnarff
O7/D047 - D081	various, 3291 - 5008	horizontal	length of transition curve	q=0.6	No Provision	Ardnarff to Cnoc Nam Mult
O7/D082 - D113	various, 5180 - 7323	horizontal	length of transition curve	q=0.6	No Provision	Cnoc Nam Mult to Cuddies Point
O7/D114 - D115	various, 8029 - 8051	horizontal	length of transition curve	q=0.6	No Provision	Cuddies Point to Attadale
O7/D116 - D121	various, 8101 - 10309	horizontal	length of transition curve	q=0.6	No Provision	Attadale to Maman
O7/D122	8791 - 9092	vertical gradient	gradient greater than des max	6%	10%	Attadale to Maman
O7/D123	9692 - 9985	vertical gradient	gradient greater than des max	6%	10%	Attadale to Maman
O7/D124 - D125	various, 10474 - 10669	horizontal	length of transition curve	q=0.6	No Provision	Maman to Achintee
O7/D126	10764 - 10881	vertical curve	vertical crest - 2 steps below des min, at junction	100K	40K	Maman to Achintee
O7/D127	10848	horizontal	Length of Transition Curve - 380mR	q=0.6; 94m	No Provision	Maman to Achintee
O7/D128	11103 - 11221	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Maman to Achintee
O7/D129	884 - 938	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D130	938 - 998	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D131	998 - 1187	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D132	1420 - 1467	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D133	1467 - 1551	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D134	1551 - 1666	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff

OPTION O7	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
O7/D135	1666 - 1777	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D136	1777 - 1801	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D137	2334 - 2398	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D138	2398 - 2452	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D139	2671 - 2709	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D140	2709 - 2814	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D141	2814 - 2866	combination	combination - horizontal & vertical relaxation			Stromeferry to Ardnarff
O7/D142	4480 - 4555	combination	combination - horizontal & vertical relaxation			Ardnarff to Cnoc Nam Mult
O7/D143	5227 - 5340	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D144	5526 - 5619	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D145	5748 - 5762	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D146	6078 - 6197	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D147	6197 - 6274	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D148	6589 - 6671	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D149	7117 - 7147	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D150	7147 - 7196	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D151	7285 - 7323	combination	combination - horizontal & vertical relaxation			Cnoc Nam Mult to Cuddies Point
O7/D152	9401 - 9534	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O7/D153	9787 - 9983	combination	combination - horizontal & vertical relaxation			Attadale to Maman
O7/D154	10474 - 10649	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O7/D155	10849 - 10881	combination	combination - horizontal & vertical relaxation			Maman to Achintee
O7/D156	11715 - 11941	combination	combination - horizontal & vertical relaxation			Achintee to Strathcarron

Table 4.10.7 Potential Departures from Standard – Option S4

OPTION S4	ROAD GEOMETRY REQUIRING DEPARTURES FROM STANDARD					
Ref No.	**Chainage**	**Type**	**Description**	**Standard Required**	**Standard Achieved**	**Route Location**
DEPARTURES						
S4/D001	4140 - 4361	vertical gradient	gradient greater than des max	6%	10%	Glen Udalain Valley
S4/D002	10910 - 11722	vertical gradient	gradient greater than des max	6%	10%	Glen Udalain Valley
S4/D003	12942 - 13101	vertical gradient	gradient greater than des max	6%	10%	Glen Udalain Valley
S4/D004	13416 - 13665	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Glen Udalain Valley
S4/D005	13940	horizontal	Length of Transition Curve - 180mR	q=0.6; 198m	No Provision	Glen Udalain Valley
S4/D006 - D010	various, 13990 - 16201	horizontal	length of transition curve	q=0.6	No Provision	Attadale to Maman
S4/D011 - D013	various, 16363 - 16738	horizontal	length of transition curve	q=0.6	No Provision	Maman to Achintee
S4/D014	14982 - 14681	vertical gradient	gradient greater than des max	6%	10%	Attadale to Maman
S4/D015	15582 - 15874	vertical gradient	gradient greater than des max	6%	10%	Attadale to Maman
S4/D016	16654 - 16770	vertical curve	vertical crest - 2 steps below des min, at junction	100K	40K	Maman to Achintee
S4/D017	16992 - 17110	vertical curve	vertical crest - 2 steps below des min, at junction	100K	30K	Maman to Achintee
S4/D018	6987 - 7193	combination	combination - horizontal & vertical relaxation			Glen Udalain Valley
S4/D019	8320 - 8383	combination	combination - horizontal & vertical relaxation			Glen Udalain Valley
S4/D020	9076 - 9209	combination	combination - horizontal & vertical relaxation			Glen Udalain Valley
S4/D021	12705 - 12796	combination	combination - horizontal & vertical relaxation			Glen Udalain Valley
S4/D022	13416 - 13444	combination	combination - horizontal & vertical relaxation			Glen Udalain Valley
S4/D023	16363 - 16539	combination	combination - horizontal & vertical relaxation			Maman to Achintee
S4/D024	14982 - 15029	combination	combination - horizontal & vertical relaxation			Attadale to Maman
S4/D025	15291 - 15423	combination	combination - horizontal & vertical relaxation			Attadale to Maman
S4/D026	16738 - 16770	combination	combination - horizontal & vertical relaxation			Maman to Achintee
S4/D027	17604 - 17830	combination	combination - horizontal & vertical relaxation			Achintee to Strathcarron

5 ENVIRONMENTAL ASSESSMENT

5.1 Introduction

A report on the full environmental assessment carried out for this scheme appraisal can be found in Volume 2 of this report.

Table 5.1.1 summarises the findings of the environmental appraisal carried out. The appraisal was undertaken in accordance with the requirements of the DMRB Chapter 11, which sets out the various subject disciplines to be considered and assessed.

Environmental advantages, disadvantages and constraints associated with each route development, judged against the respective subject disciplines, are shown.

It should be noted, that the impacts identified and assessed as shown here are **prior** to mitigation. It has, at this stage, not been possible to identify specific mitigation measures, due to the level of information available at present. It may be that the impacts can be minimised once mitigation measures have been developed and proposed at the next stage of the assessment.

Table 5.1.2 offers a further development of the assessment the output from which has been carried forward to Chapter 8 of this report.

Table 5.1.1 – DMRB Stage 2 Environmental Assessment Summary Table

	Landscape	Nature Conservation	Road Drainage and Water Environment	Noise	Air	Geology and Soils	Cultural Heritage	Effects on all Travellers	Community and Private Assets
Option									
N6 – North Online through Lochcarron	×× Moderate negative landscape and visual impact due to increased traffic through Lochcarron and introduction of a bridge at Strome Narrows.	×× Moderate negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species. Degradation of benthic/intertidal habitats.	× Minor negative impact as may be slight change in water quality, geomorphology and hydrology	××× Major negative impact number of properties within 300m of route increases from 19 to 327 when compared within baseline scenario.	×Minor negative impact due to increase vehicle emissions in Lochcarron	×Minor negative impact – Although primarily utilises existing road, the route includes construction of a bridge across Strome Narrows, which will impact upon underlying geology.	× Possible setting impacts on Strome Castle from bridge and upon Lochcarron Old Parish Church	✓ Minor positive impact / 0 Neutral impact as this option may decrease through journey times but will also sever paths and may increase local journey times	×× Moderate negative impact due to slight land-take of agricultural/crofting and woodland areas and disruption to private and community assets within Lochcarron.
N9 – North Lochcarron Bypass	×× Moderate negative landscape and visual impact due to the introduction of a bridge at Strome Narrows.	×× Moderate negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species. Degradation of benthic/intertidal habitats.	×× Moderate Negative Impact as may be change in water quality, geomorphology, hydrology and groundwater movement	×× - Moderate negative impact number of properties within 300m of route increases from 19 to 86 when compared within baseline scenario.	- Negligible/No benefit or impact when compared to baseline	×× Moderate negative impact – Route utilises existing road and construction of new stretches of road, which pass through Allt nan Carnan SSSI and potential areas of peat land. The route also includes construction of a bridge across Strome Narrows, which will impact upon underlying geology.	××× Major physical impacts on non-designated assets on offline section south and north of Lochcarron	✓ Minor positive impact / 0 Neutral impact as this option may decrease through journey times but will also sever paths and may increase local journey times	×× Moderate negative impact due to land-take of agricultural/crofting, private assets and woodland areas, and disruption to private and community assets within Lochcarron.

	Landscape	Nature Conservation	Road Drainage and Water Environment	Noise	Air	Geology and Soils	Cultural Heritage	Effects on all Travellers	Community and Private Assets
O2 – Online with Rail Viaduct	× Minor negative landscape impact ××Minor to moderate negative visual impact due to widening of the road/ rail corridor and introduction of new structure along loch edge.	×× Moderate negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species. Degradation of benthic/intertidal habitats.	×× Moderate Negative Impact as may be moderate change in water quality, geomorphology and hydrology	o – No benefit or impact, no significant change in the number of properties within 300 metres of the alignment	o - Negligible/No benefit or impact when compared to baseline	o - Negligible impact - Utilises existing road, minimising impact to geology and soils but will include construction of rail viaduct and will require remedial works to be undertaken on unstable rock slope.	× Possible impacts upon loch bed deposits, palaeo-environmental remains, lithic scatters	✓✓ Moderate positive impact as may decrease journey times, reducing driver stress	× Minor negative / 0 Neutral impact due to minimal land-take of agricultural/crofting and woodland areas.
O3 – Online with Tunnel	o - Neutral landscape impacts × Minor negative visual impact due to localised significant impacts on a small number of receptors and limited change on the majority.	×× Moderate negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species. Degradation of aquatic habitats.	× Minor negative impact as may be slight change in water quality, geomorphology, hydrology and groundwater movement	o - No benefit or impact, no significant change in the number of properties within 300 metres of the alignment	o - Negligible/No benefit or impact when compared to baseline	×× Moderate negative impact – Utilises existing road, although includes construction of a tunnel which will have greater impact on geology and soils. Will require remedial works to be undertaken on unstable rock slope.	× Possible impacts upon, lithic scatters, setting impacts	✓✓ Moderate positive impact as may decrease journey times, reducing driver stress	× Minor negative / 0 Neutral impact due to minimal land-take of agricultural/crofting and woodland areas.

	Landscape	Nature Conservation	Road Drainage and Water Environment	Noise	Air	Geology and Soils	Cultural Heritage	Effects on all Travellers	Community and Private Assets
O4 – Do Minimum	**o** - No landscape or visual impacts.	× Minor negative impact during road repairs due to localised disturbance.	**o** - Negligible/No benefit or impact	Baseline case not assessed, other routes assessed against this scenario.	- Negligible/No benefit or impact when compared to baseline	✓ Minor positive impact - utilises existing road, which will minimise impact to geology and soils but will require remedial works to be undertaken on unstable rock slopes.	**o** - No change to existing baseline	**o** - No Effects on All Travellers.	**o** - No Community and Private Asset impacts.
O5 – Online with Road/Rail Share	× Minor negative landscape and visual impacts due to localised significant impacts on a small number of receptors and limited change on the majority.	×× Moderate negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species. Degradation of benthic/intertidal habitats.	**o** - Negligible/No benefit or impact	**o** - No benefit or impact, no significant change in the number of properties within 300 metres of the alignment	- Negligible/No benefit or impact when compared to baseline	✓ Minor positive impact - Utilises existing road/rail line, which will minimise impact to geology and soils but will require remedial works to be undertaken on unstable rock slopes.	× Possible impacts upon, lithic scatters, setting impacts	✓ Minor positive impact as this option may decrease journey times but may also disrupt rail services more than other options.	× Minor negative / 0 Neutral impact due to minimal land-take of agricultural/crofting and woodland areas.
O7 – Online with Developed Avalanche Shelter	×× Minor or moderate negative landscape impacts and moderate visual impact due to introduction of new large structure.	× Minor negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species.	**o** - Negligible/No benefit or impact	**o** - No benefit or impact, no significant change in the number of properties within 300 metres of the alignment	**o** - Negligible/No benefit or impact when compared to baseline	**o** - Negligible impact - Utilises existing road, minimising impact to geology and soils but will include extension of avalanche shelter and will require remedial works to be undertaken on unstable rock slopes.	× Possible impacts upon, lithic scatters, setting impacts	✓✓ Moderate positive impact as may decrease journey times, reducing driver stress.	× Minor negative / 0 Neutral impact due to minimal land-take of agricultural/crofting and woodland areas.

	Landscape	Nature Conservation	Road Drainage and Water Environment	Noise	Air	Geology and Soils	Cultural Heritage	Effects on all Travellers	Community and Private Assets
S4 – South Glen Udalain	×× Moderate negative landscape impact due to introduction of road and traffic into otherwise undeveloped landscape. ×Minor negative visual impacts due to limited visibility from most receptors.	××× Major negative impact due to habitat loss/ fragmentation and disturbance/mortality of protected species.	×× Moderate Negative Impact as may be moderate change in water quality, geomorphology, hydrology and groundwater movement	o - No benefit or impact, no significant change in the number of properties within 300 metres of the alignment	- Negligible/No benefit or impact when compared to baseline	✓✓ Moderate positive impact – Route comprises construction of a new road over peat land, which can be managed. Avoids unstable rock slopes along the A890, negating the requirement for remedial works and does not involve construction of tunnels/bridges.	× Possible impacts upon unknown archaeological assets	× Minor negative impact as this option may decrease through journey times but will also sever many RoWs and may increase local journey times considerably	× Minor negative impact due to minimal land-take of agricultural/crofting areas and sizable land-take required within woodland areas.

Table 5.1.2 - Environmental Scoring of Options (from Environment Report, May 2014)

Environmental Discipline		N6 – North Online through Lochcarron	N9 – North Lochcarron Bypass	O2 – Online with Rail Viaduct	O3 – Online with Tunnel	O4 – Do Minimum	O5 – Online with Road/Rail Share	O7 – Online with Developed Avalanche Shelter	S4 – South Glen Udalain
Landscape	L	✓	✓	✓	✓	✓	✓	✓	✓
	V	✓	✓	✓	✓	✓	✓	✓	✓
Nature Conservation		✓	✓	✓	✓	✓	✓	✓	✓
Cultural Heritage		✓	✓	✓	✓	✓	✓	✓	✓
Effects on All Travellers		✓	✓	✓	✓	✓	✓	✓	✓
Community & Private Assets		✓	✓	✓	✓	✓	✓	✓	✓
Geology & Soils		✓	✓	✓	✓	✓	✓	✓	✓
Air Quality		✓	✓	✓	✓	✓	✓	✓	✓
Noise & Vibration		✓	✓	✓	✓	✓	✓	✓	✓
Road Drainage & Water Environment		✓	✓	✓	✓	✓	✓	✓	✓
Materials (Not applicable as part of a 'Simple Assessment')		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Overall Score		Pink	Pink	Orange	Green	Green	Green	Green	Orange

✓ Least preferred ✓Intermediate ✓Preferred

6 TRAFFIC AND ECONOMIC ASSESSMENT

6.1 Introduction

The DMRB Stage 1 Scheme Assessment recommended that several route options are taken forward to the DMRB Stage 2 Scheme Assessment. During the early stages of the DMRB Stage 2 Assessment, further sifting of route options was conducted, with the number of route options being reduced to seven. The remaining seven route options have undergone a more refined economic assessment as part of this DMRB Stage 2 Scheme Assessment and this is summarised in this chapter.

For the purpose of the economic assessment it is necessary to define a 'Do-Minimum' scenario. This is the scenario that is most likely to occur without the intervention and which is used to test the sifted options against.

The Do-Minimum scenario is the existing condition of the A890 Stromeferry Bypass, with a diversion route undertaken by vehicles during future road closures due to rock falls. The effect of this is to increase journey times and vehicle operating costs which would be expected to have negative economic impacts compared with the DMRB Stage 2 route options.

Recorded rock fall events are detailed in Table 6.1.1.

Table 6.1.1: Rock Fall Events

CLOSURE EVENTS SINCE 1990 DUE TO SIGNIFICANT ROCK FACE FAILURE ON THE A890 STROMEFERRY BYPASS			
Date of Event	**Rock Displacement on Road (tonnes / m^3)**	**Length of Closure**	**Comments**
March 1990	200t	8 Weeks	Blocked both road and railway
October 2001	500m^3	Not stated	Blocked both road and railway
October 2004	5 m^3	Not stated	
January 2007	20 m^3	Not stated	Road and railway unaffected
May 2007	0.5 – 1.0m^3	Not stated	Affected both road and railway
August 2008	Not stated	Not stated	Required traffic closure
September 2009	Not stated	Not stated	Affected Road
November 2011	Not stated	Not stated	No road closure
December 2011	Not stated	Approximately 4 months	Road closed late December 2011 to late April 2012
December 2012	Not stated	2 days	

The seven Do-Something route options being assessed at DMRB Stage 2 are summarised below:

Northern Corridor -

- N6 route Off-line from A890, but On-line through Lochcarron Village; and
- N9 route Off-line from A890, bypass of Lochcarron Village.

On-line Corridor -

- 02 viaduct option;
- 03 tunnel option;
- 05 shared use option; and
- 07 avalanche shelter option.

Southern Corridor -

- S4 Glen Udalain option.

6.2 Traffic Assessment

6.2.1 Traffic Surveys

The DMRB Stage 2 appraisal values for mean traffic flows, vehicle speeds and vehicle composition were derived from a set of traffic surveys undertaken from the 12th to the 18th of March 2013. These consisted of:

- Manual Classified Turning Counts (MCC);
- Automatic Traffic Counts (ATC); and
- Journey Time Surveys (JTS).

Full details of the traffic surveys are contained in the Traffic Survey and Data Report which is contained in Appendix I.

Additional data on trip user purpose, trip origins and destinations and trip behaviour following a rock fall event were obtained from:

- Roadside Interview Surveys (RSI)

The RSIs were undertaken over two weekdays on the 27th and 28th August 2013. Full details of the roadside interviews are contained in the Roadside Interview and Traffic Survey and Data Report which is contained in Appendix J.

6.2.2 Mean Vehicle Flows

The ATC data from the March 2013 surveys was used to determine 24 hour and peak hour traffic flows.

Table 6.2.1 gives the 7-day 24 hour average one-way vehicle traffic flows for two sites, one at Attadale Gardens on the A890 close to the section of road vulnerable to rock fall and the other on the C1096 west of Lochcarron.

Table 6.2.1: 7-day Average 24 Hour One-way Vehicle Flows

7-DAY AVERAGE 24 HOUR ONE-WAY VEHICLE TRAFFIC FLOWS, A890 ATTADALE GARDENS & C1096 LOCHCARRON, MARCH 2013			
Year	**Direction**	**A890 Attadale Gardens**	**C1096 Lochcarron**
2013	Eastbound	338	63
	Westbound	357	61
	Two – way	695	124

Note: Friday data was taken as an average of the weekday values as this had not been recorded in the ATC data

The traffic flows from the survey data gave 7-day average 24 hour 2-way volumes of 695 vehicles at Attadale and 124 vehicles at Lochcarron. These traffic volumes do not present road capacity problems on the A890 in March. However it is noted that Government data sources show traffic volumes on the A890 increase significantly in the peak summer months, reflecting an appreciably higher level of demand for the route at that time of year.

Using ATC 7-day data from the March 2013 surveys, Table 6.2.2 indicates the AM and PM Peak Hour weekday traffic flows. The AM Peak is an average hourly flow for the peak period 0800hrs – 1000hrs and the PM peak is an average hourly flow for the peak period 16:00hrs – 18:00hrs. This gives a better representation of the flows during the peak period.

Table 6.2.2: Average Peak Hour Weekday Traffic Flows

AVERAGE PEAK HOUR WEEKDAY TRAFFIC FLOWS, A890 ATTADALE GARDENS & C1096 LOCHCARRON, MARCH 2013				
Year	**Direction**		**Attadale Gardens**	**C1096 Lochcarron**
2013	Eastbound	AM	25	4
		PM	34	5
	Westbound	AM	32	4
		PM	36	5

At between 25 and 36 vehicles on the A890 and between 4 and 5 vehicles on the C1096, peak hour traffic flows are easily accommodated within the current road capacity. The surveys indicated that there was no significant daily tidal flow direction and traffic volumes remained fairly consistent throughout the day.

6.2.3 Vehicle Composition

The values for vehicle composition used for the DMRB Stage 2 analysis have been derived from the actual values reported from the ATC data. Table 6.2.3 shows this recorded 7-day average vehicle composition.

Table 6.2.3: 7-day Average Vehicle Composition

7-DAY AVERAGE VEHICLE COMPOSITION, A890 ATTADALE, AUGUST 2013			
Direction	**Eastbound**	**Westbound**	**Two-way**
Cars	79.2%	83.7%	81.5%
LGVs	16.9%	13.8%	15.3%
OGV-1s	1.8%	0.8%	1.3%
OGV-2s	1.8%	1.4%	1.6%
PSVs	0.3%	0.3%	0.3%

Table 6.2.3 indicates that cars contributed nearly 82% to the overall vehicle mix depending on traffic direction. Cars, which together with light goods vehicles (LGVs) are classified as "lights", account for nearly 97% of all vehicles on the A890. However, heavy goods vehicles (HGVs) and public service vehicles (PSVs) contributed to less than 4% of the traffic mix on this route.

The percentage of cars recorded by the surveys is comparable to Government values for the equivalent road classification, which the NESA manual defines as 84.1% for a Rural Tourist Route (Table 5/2/7). However, as the surveys were conducted during the non-tourist season, the proportion of cars is likely to increase during summer months. Table 6.2.4 summarises the vehicle composition between recorded values and NESA values.

Table 6.2.4: Comparison of Vehicle Composition

COMPARISON OF VEHICLE COMPOSITION ON A RURAL TOURIST ROUTE, SURVEY DATA VERSES NESA DATA		
Vehicle Type	**Survey**	**NESA**
Cars	81.5%	84.1%
LGVs	15.3%	7.6%
OGV-1s	1.3%	4.5%
OGV-2s	1.6%	2.8%
PSVs	0.3%	1.0%

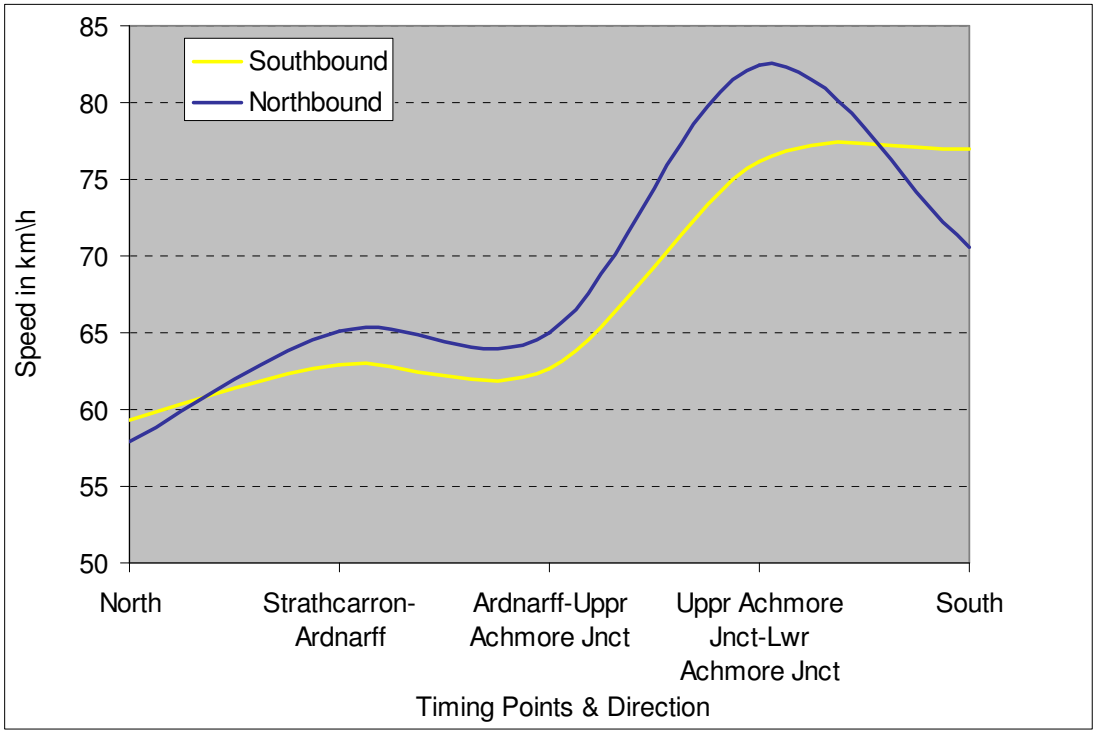
The percentage of LGVs recorded in the surveys is higher than the equivalent Government values, and the percentage of HGVs recorded in the surveys is considerably lower than defined in NESA.

6.2.4 Vehicle Speeds

For the DMRB Stage 1 assessment, there was no reliable data available within the study area for traffic speeds across the local road network. Therefore, for the purposes of the DMRB Stage 2 assessment, Government values were adopted based on road classification and default link speeds.

Journey time surveys were undertaken in August 2013 to establish actual link speeds on the A890 between the A890 Strathcarron junction at the northern end of the route and the A87/A890 junction at the southern end. The average speed between timing points are shown in Figure 6.2.1.

Figure 6.2.1 – Average Speeds, August 2013



The speeds recorded from the journey time surveys vary according to road quality. In general, recorded journey time speeds are higher than the Government default speeds for the equivalent road classification.

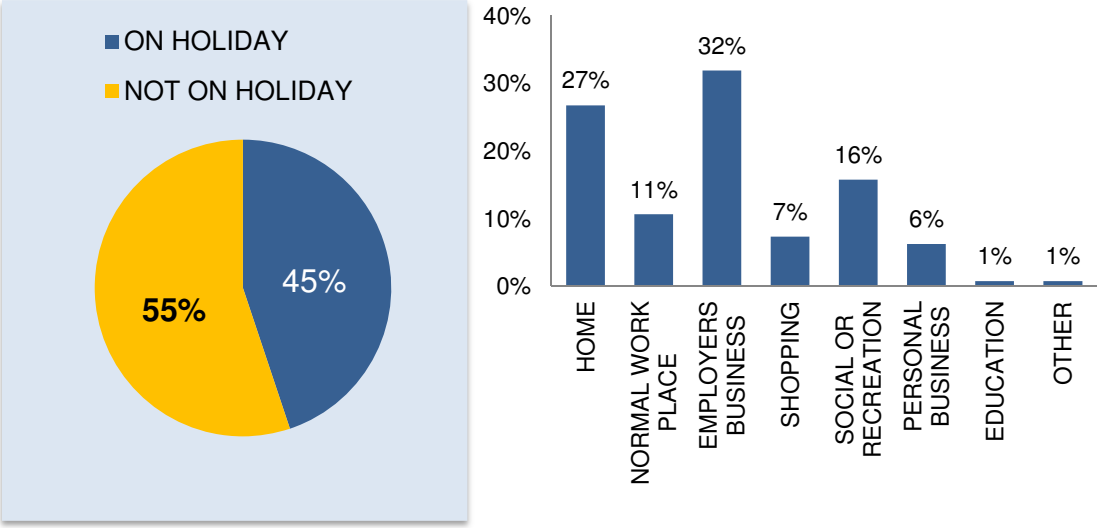
It should be noted that the surveys were undertaken in August when the A890 experiences the greatest demand from peak tourist traffic. Journey speeds would therefore be expected to be higher for other times of the year with reduced traffic volumes on the road.

6.2.5 Trip User Purpose

As detailed in the DMRB Stage 1 report, there was no information available to define trip user purpose. This was important with regards to the significant contribution to overall traffic volumes made by tourists, especially in the summer months.

The RSI survey results shown in Figure 6.2.2 indicated that the percentage of tourist traffic on the A890 was approximately 45% of all traffic. As the survey was undertaken in August, the peak tourist season, this percentage would be expected to reduce at other times of the year.

Figure 6.2.2 – Trip Purpose, Holiday Traffic verses non-holiday Traffic and Trip Purpose at Destination for Non-holiday Traffic, August 2013



Stripping out holiday traffic, the remaining most dominant trip purposes for traffic interviewed on the A890 were:

- Travelling on employers business;
- Travelling home, and
- Social or recreational trips.

6.2.6 Origin and Destination Data

There was no information available that indicated trip origin and destination data for the DMRB Stage 1 Scheme Assessment. Actual origin and destination data was therefore gathered from the RSI surveys undertaken during the DMRB Stage 2 assessment.

The survey results indicate that a significant proportion of trips have a regional origin defined as the rest of the Scottish Parliamentary Constituency of Skye, Lochaber and Badenoch. The survey results also indicated that a substantial proportion of trips had a local destination defined as a destination on the north or south shore of Loch Carron.

This pattern would be expected where a significant proportion of vehicles were tourists visiting the area as part of a holiday trip chain involving the wider region.

A summary of key findings are:

- 56% of respondents stated they were travelling to local destinations, 41% of which were travelling to destinations on the north shore of Loch Carron and 15% of which were travelling to destinations on the south shore of Loch Carron;
- 52% of respondents surveyed were regional in origin; and
- 24% of respondents were going to either Inverness or Moray.

6.2.7 Road Capacity

The vehicle capacity for the A890 was estimated using the DMRB (Volume 15). This sets out highway capacities for various road types, based on numbers of lanes and speed limits.

Road capacity of the A890 Stromeferry Bypass is determined by its width and condition. For part of the route between the Attadale Estate and the Stromeferry junction the route is classified as 4.0 metre width and is in poor condition. It is this section of the road that is most vulnerable to rock fall.

For a Rural Poor 4.0 metre single lane road, road capacity is 140 vehicles per hour per direction. For other sectors of the A890, which comprise a mix of 5.5 metre and 6 metre links, road capacity is 800 to 900 vehicles per hour per direction.

All route options are designed to a 6.0 metre wide carriageway and so would have a road capacity of 900 vehicles per hour per direction.

By comparing the Design Flows with the network capacities on each link, the level of congestion was estimated. This is based on the ratio of flow to capacity (RFC). The RFC is the standard network indicator used to show the level of utilisation of capacity. An RFC of greater than 85% represents conditions of significant congestion, when safety and delay issues can be expected. An RFC of greater than 100% represents complete saturation.

Peak hour flows from Table 6.2.2 indicates that the RFCs at Attadale are significantly less than 85% for all sections of the route. This suggests that in March, when the surveys were conducted, the 4 metre links on the A890 do not present a vehicle capacity constraint. The same is true of the C1096 west of Lochcarron. None of the new alignment options would be expected to experience capacity problems.

6.3 NESA Economic Appraisal

As more information became available during the DMRB Stage 2 assessment, and to meet the requirements for this level of assessment, the economic appraisal was developed and refined using the standard Scottish Government economic modelling software, NESA.

NESA is consistent with STAG and provides an accurate comparison of the performance of the Do-Something options against the Do-Minimum scenario.

Based on the scheme costs defined previously, and the application of the NRTF (1997) central traffic growth projections, the economic appraisal of the Scheme options defined in the NESA model are summarised in Table 6.3.1.

Table 6.3.1: NESA Appraisal Summary

NESA APPRAISAL SUMMARY in £m, 2002 prices				
Economic Indicator/ Option	**Present Value of Benefits (PVBs)**	**Present Value of Costs (PVCs)**	**Net Present Value (NPV)**	**Benefit to Cost Ratio (BCR)**
N6 route On-line	20.59	53.88	-33.30	0.38
N9 route Off-line	23.59	56.18	-32.59	0.42
02 viaduct	3.63	61.95	-58.32	0.06
03 tunnel	3.63	90.86	-87.23	0.04
05 shared use	3.03	31.45	-28.42	0.10
07 avalanche shelter	3.63	59.24	-55.61	0.06
S4 Glen Udalain	-0.78	42.80	-43.58	-0.02

It should be noted that the economic assessment above is based on the application of default accident rates defined in NESA for the local road types.

The results presented above require adjustment for the particular circumstances of the scheme options which will have an impact on the relevant Do Something option performance. These circumstances are as follows:

- Effects of Diversion;
- Rock fall Journey Response;
- Construction Delays; and
- Remedial Rock Face Maintenance.

6.3.1 Effects of Diversion

The primary objective of the proposed improvement was to eliminate the threat from and disruption caused by rock fall events on the A890.

Although relatively rare occurrences, rock falls can result in the closure of the road, and less frequently the railway line, for up to several weeks at a time. Details of the significant rock fall events since March 1990 are shown in Table 6.1.1 of this report.

Between March 1990 and December 2012, there have been 10 significant rock fall events, of which at least two required road closure for two months or more. Although the lengths of road closures are not stated, inspections required after each of the other events would also require road closure for short periods of time.

There have been road closures for both extended and shorter periods of time. The latter allows opportunities for the authorities to carry out both emergency and planned inspections. For appraisal purposes, as noted in the DMRB Stage 1 report, the combined effect of these has

been considered as an annualised closure period of approximately 9 days. This has necessitated the use of a diversion route for the duration of road closure.

In order to accommodate displaced traffic from the A890 Stromeferry Bypass onto the wider road network, there is only one feasible diversion route available. This would involve the use of all or part of the following road sections:

- Between the A890/A896 Strathcarron junction and the A832/A835 junction (53.9 km);
- Between the A832/A835 junction and the A835/A834 junction at Contin (13.6 km);
- Between the A835/A834 junction and the A82/A831 junction at Drumnadrochit (33.2km);
- Between the A82/A831 junction and the A87/A887 junction (44.6 km); and
- Between the A87/A887 junction and the A87/A890 junction near Dornie (49.4 km).

Use of the diversion route identified above would be required, for example, for trips between Kyle of Lochalsh / Skye and Lochcarron and would involve an additional distance of approximately 170 kilometers. However for trips between Plockton, Achmore or Stromeferry and Lochcarron the additional trip distance would be close to 200 kilometers and involve an extra 3 hours travel time.

With prior notice given to motorists of a rock fall event, it would be expected that only a proportion of these motorists planning to use the A890 would continue to complete the planned journey, so incurring the cost of the diversion.

6.3.2 Rock Fall Journey Responsiveness

To estimate the proportion of vehicles that would make the journey using the diversion route in the event of a rock fall, the RSIs included the question:

If you had planned to use the A890 and it was closed due to a landslip would you:

1. Take an alternative route;
2. Choose an alternative destination, or
3. Cancel the trip?

The proportion of respondents selecting option 1 to the question above would be needed in order to estimate the percentage of vehicles that would use the diversion route. Drivers who responded that they would either have chosen an alternative destination or would have cancelled the trip altogether would not have used the diversion route.

The results, shown in Table 6.3.2, indicate that approximately 30% of vehicles would either have chosen an alternative destination or would have cancelled the trip, and so would not have used the diversion route.

Table 6.3.2: Rock Fall Responsiveness

ESTIMATED ROCK FALL JOURNEY RESPONSIVENESS			
Rock fall journey diversion responsiveness on the A890	Cars and LGVs	33%	Don't make the original trip
	HGVs & PSVs	31%	Don't make the original trip

The corollary of Table 6.3.2 suggests that approximately 70% of vehicles would undertake the diversion trip. This proportion of vehicles was used in the economic analysis to compare traffic volumes between the Do-Minimum and Do-Something scenarios.

The impact of the diversion on the present value of discounted PVBs for each of the Do Something options is detailed in Table 6.3.3 with both the scenario of 100% of vehicles undertaking the diversion and the more robust scenario estimate of 70% of vehicles undertaking the diversion.

Table 6.3.3: Impact of Diversions

DIVERSION IMPACT ON PRESENT VALUE OF BENEFITS in £m, 2002 PRICES		
OPTION	**Present Value of Benefits**	
	100% of Vehicles using diversion route	70% of Vehicles using diversion route
N6 route On-line	6.98	4.88
N9 route Off-line	6.98	4.88
02 viaduct	6.98	4.88
03 tunnel	6.98	4.88
05 shared use	6.98	4.88
07 avalanche shelter	6.98	4.88
S4 Glen Udalain	6.98	4.88

Reducing the number of vehicles undertaking the diversion will reduce the benefits of the scheme options from £6.98m to £4.88m. Fewer vehicles are making the diversion, therefore fewer vehicles are incurring time and vehicle operating cost penalties.

6.3.3 Construction Diversion Delays

As detailed in the Engineering Assessment, the On-line options would incur significant delays associated with vehicle diversions during the construction period. Therefore, the DMRB Stage 2 economic appraisal accounts for these construction period diversion delays in more detail.

The duration of road closures and the impact this has on PVBs are shown in Table 6.3.4. The Table indicates the adjustments made to the PVBs resulting from these additional costs. It should be noted that diversion delays during construction represent a cost to users and therefore a reduction in PVBs. This is shown in Table 6.3.4.

Table 6.3.4: Impact of Construction Delays and Diversions

IMPACT OF CONSTRUCTION DELAYS AND DIVERSIONS ON PRESENT VALUE OF COSTS IN £m, 2002 PRICES		
OPTION	**Road Closure**	**Impact on PVB**
N6 route On-line	0 months	0.00
N9 route Off-line	0 months	0.00
02 viaduct	3 months	-1.83
03 tunnel	6 months	-3.66
05 shared use	0 months	0.00
07 avalanche shelter	15 months	-9.15
S4 Glen Udalain	0 months	0.00

6.3.4 Remedial Rock Face Maintenance

There will be significant savings associated with the reduction in on-going rock fall remedial maintenance work with the implementation of the Do-Something options identified above.

However, advice taken from The Highland Council suggests this cost will not be eliminated entirely. There will be a permanent requirement to maintain the rock face for the railway line and for residual users of the existing road. A lower cost saving will reduce the overall benefit associated with rock face remedial maintenance that had been assumed in the DMRB Stage 1 appraisal.

The base cost savings of remedial rock face maintenance associated with the Do-Minimum scenario and the design costs associated with on-going remedial maintenance costs required for each of the Do Something scenarios are shown in Table 6.3.5.

Table 6.3.5: Impact of Remedial Rock Face Maintenance

IMPACT OF REMEDIAL ROCK FACE MAINTENANCE ON PRESENT VALUE OF BENEFITS in £m, 2002 PRICES		
OPTION	**Base Cost Savings**	**Design Costs**
N6 route On-line	-5.25	1.83
N9 route Off-line	-5.25	1.83
02 viaduct	-5.25	0.75
03 tunnel	-5.25	0.75
05 shared use	-5.25	0.75
07 avalanche shelter	-5.25	0.75
S4 Glen Udalain	-5.25	1.83

6.4 NESA Economic Appraisal Adjusted

Based on the scheme costs defined previously, the application of the NRTF (1997) central traffic growth projects and the adjustments noted above, the economic appraisal of the route options defined in the NESA model are summarised in Table 6.4.1.

Table 6.4.1: NESA Appraisal Summary Adjusted

NESA APPRAISAL SUMMARY ADJUSTED				
Economic Indicator/ Option	**Adjusted PVB**	**Adjusted PVC**	**Adjusted NPV**	**Adjusted BCR**
N6 route On-line	25.47	50.46	-24.99	0.50
N9 route Off-line	28.47	52.76	-24.29	0.54
02 viaduct	6.68	57.45	-50.77	0.12
03 tunnel	4.85	86.36	-81.51	0.06
05 shared use	7.91	26.95	-19.04	0.29
07 avalanche shelter	-0.64	54.74	-55.38	-0.01
S4 Glen Udalain	4.10	39.38	-35.28	0.10

6.5 Safety Appraisal

The Safety objective identified within STAG is concerned with reducing the loss of life, injuries and damage to property resulting from transport accidents and crime.

6.5.1 Local Accident Data

The Highland Council provided Transport Scotland accident data in the Strathcarron area during the DMRB Stage 1 assessment. No additional information has been made available during the DMRB Stage 2 assessment period.

Accidents were classified into one of four categories namely, fatal, serious injury, slight injury or damage only. This is summarised in Table 6.5.1 for the A890 and for both the A890 and A896 combined. The values and percentages shown in the table indicate accidents by severity for the 5 years, commencing 1st August 2007 to 31st July 2012.

Table 6.5.1: Recorded Accidents by Severity

RECORDED ACCIDENTS BY SEVERITY, AUGUST 2007 TO JULY 2012		
Severity	**A890**	**A890 & A896**
Fatal	1 (5%)	1 (3%)
Serious injury	1 (5%)	2 (6%)
Slight injury	4 (18%)	7 (22%)
Damage only	16 (73%)	22 (69%)

6.5.2 Local Accident Risks

Table 6.7.2 shows the recorded accident rate in accidents per 100m vehicle-kilometres for the A890 for the 5 years, 1st August 2007 to 31st July 2012.

Table 6.7.2: Recorded Accident Rates by Severity

RECORDED ACCIDENT RATES FOR THE A890 BY SEVERITY, AUGUST 2007 TO JULY 2012	
Severity	**A890**
Fatal	2.3 accidents per 100m vehicle - kilometres
Serious injury	2.3 accidents per 100m vehicle - kilometres
Slight injury	9.1 accidents per 100m vehicle - kilometres
Personal Injury Accident	13.6 accidents per 100m vehicle - kilometres
Damage only	36.3 accidents per 100m vehicle - kilometres

Table 6.7.2 shows the average fatal accident rate was 2.3 accidents per 100m vehicle – kilometres for the A890 for the period 2007 to 2012.

In contrast, the latest data available for the Northern Region defined by police force area shows that the average fatal accident rates for local authority A roads fell from 2.4 to 0.7 accidents per 100m vehicle kilometres between the periods 2004 – 2008 and 2008 – 2012 respectively.

Therefore the fatal accident rate on the A890 between 2007 and 2012 is comparable to the 2004 - 2008 5-year value for the Northern Region as a whole, but is considerably higher than the 2008 – 2012 5-year value for this region, although it is acknowledged that this rate is based on 1 fatal accident.

The results for serious injury accident rates for local authority A roads for the years 2008 - 2012 in the Northern Region are 3.4 serious injury accidents per 100 million vehicle kilometres. The equivalent value for the A890 is substantially lower at 2.3 accidents per 100 million vehicle kilometres.

In terms of Personal Injury Accidents (PIA) the rate for the A890 is approximately 13.6 accidents per 100 million vehicle-kilometres. The comparable default accident rates defined in NESA varies from 22.6 for a rural typical single 6.0 metre road to 29.7 for a rural poor single 4.0 metre road. This suggests that local accident rates are substantially lower than national rates.

It is reasonable to assume that upgrading the current alignment or establishing a new alternative road alignment would help reduce the fatal accident rate to a rate closer to the most recent recorded Northern Region average rate and further reduce the number of serious injury accidents on the local road network.

Another key issue is the impact the route options may have on the ability to minimise response times to emergencies and access times to key local and regional facilities such as hospitals and clinics in Dingwall and Inverness.

There is little doubt that all the options under consideration, would, by removing the problem with rock fall, potentially improve both emergency response time and access to key facilities.

6.5.3 Removal of Other Accident Risks

In addition to the reduction of the accident rates described above, there are also safety benefits associated with road network improvements. This includes the removal of the threat from falling rock material onto the road and adjacent railway providing a safer transport environment.

There will be a residual threat element of falling rock, but this should be mitigated by continuing remedial maintenance work carried out on vulnerable sections of the rock face.

6.6 Public Transport

6.6.1 Rail

There is some separation between road and railway, which for minor rock failure provides a measure of safety for the railway. However on at least three occasions over the last twenty two years both the road and railway have been blocked by rock fall in the Attadale – Ardnarff area. It is only because the rail line is further from the rock face than the road that the rail line has been spared more frequent obstruction.

Nevertheless, rail services are subject to a 30mph speed limit to counter the risk of rock fall debris on the track giving time for the train to stop if necessary. Network Rail's policy is to minimise operational risk and manage the residual risk.

The rail line between Inverness and Kyle of Lochalsh is a passenger only line operated by 2 car class 155 trains. It operates Mondays to Saturdays with four services a day in each direction spaced out every two to three hours. Total journey time between Inverness and Kyle of Lochalsh is approximately two and half hours. Table 6.6.1 shows passenger patronage between Inverness and Kyle of Lochalsh in terms of total station entries and exits. The data was sourced from the Office of Rail Regulator (ORR).

Table 6.6.1: Passenger Patronage

PASSENGER PATRONAGE, INVERNESS – KYLE OF LOCHALSH BY STATION, '000							
	2006/07	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**	**2012/13**
Beauly	35.9	41.9	52.4	51.1	49.9	54.5	55.2
Muir of Ord	32.6	39.2	51.1	57.4	62.4	74.5	74.1
Dingwall	55.0	64.4	72.1	80.3	84.9	101.7	104.7
Garve	9.7	9.8	8.5	6.9	5.8	5.0	5.4
Lochluichart	0.3	0.4	0.2	0.4	0.3	0.4	0.4
Achanalt	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Achnasheen	2.7	3.0	3.2	3.6	3.7	4.0	3.6
Achnashellach	0.5	0.7	0.6	0.8	0.7	1.1	1.1
Strathcarron	7.9	8.6	8.3	8.2	8.1	11.0	9.3
Attadale	0.4	0.5	0.5	0.5	0.5	1.0	0.7
Stromeferry	1.1	1.0	1.0	1.1	1.4	2.2	2.1
Duncraig	0.3	0.5	0.4	0.4	0.6	0.7	0.8
Plockton	8.3	8.6	9.2	10.7	11.2	13.0	12.9
Duirinish	0.8	0.8	0.7	0.6	0.8	0.7	0.8
Kyle of Lochalsh	46.7	48.3	52.7	60.2	60.5	66.3	66.8

The stops within the study area are:

- Strathcarron;
- Attadale; and
- Stromeferry.

For most of the year passenger traffic using the rail service is relatively light. At each end of the day the service is used by commuters to Inverness. However, in the peak summer period rail patronage on this line can become heavy coinciding with the tourist season.

It can be seen from the table that incidents of rock fall would have a serious impact on rail passengers travelling between Kyle of Lochalsh and stations east of Strathcarron, by virtue of the numbers involved. In such an event Scot Rail would put on a substitute bus service, usually between Strathcarron and Kyle of Lochalsh.

The DMRB Stage 1 Scheme Assessment report outlined is some detail the appraisal of the impacts from rock fall events on the Inverness – Kyle of Lochalsh rail service. However, the measures put in place by Scot Rail noted above and information that has been made available since the submission of that report, would effectively remove these impacts on the service.

6.6.2 Bus Services

From October 2012, Lochcarron Garage began operating the 702 bus service between Lochcarron and Inverness twice a week. This is a flexible service calling in and dropping off passengers at their place of residence. DMK Motors also provides a bus service, service 704, which operates a minibus connection between Lochcarron and Strathcarron Station for the early morning Kyle train. However, this service is only provided on request.

Both the council and private operators run daily school bus services which use the A890 route. School bus services are poorly publicised. Many tourists and local residents are not aware that the services are also available for use by the general public. This is always subject to space permitting, but seating is usually available, especially for school bus runs using larger coaches. There is normally also space available when empty school buses return to their point of origin after dropping off children at their schools.

There is an acute concern amongst the local community of the direct danger rock falls present to school bus services and there is also unease over the potential amount of time schoolchildren would have to spend on the bus to and from school in the event of a substantial rock fall and subsequent closure of the A890 Stromeferry Bypass. By eliminating the threat from rock fall and potentially speeding up bus services, these concerns are addressed by all the route options being considered to address the rock fall issue.

7 APPRAISAL SUMMARY

7.1 Introduction

Appraisal Summary tables, outlining the findings of this Stage 2 assessment, are included in the following sections of this report. The tables describe and summarise the findings in further detail and lead to chapter 8, which concludes on the Stage 2 appraisal.

In keeping with the requirements of TD 37/93 for scheme Assessment Reporting, this appraisal of route options has been carried out using mainly qualitative descriptions supplemented and supported with quantative data where available.

The aim of this stage of the appraisal is to recommend one preferred route option, which will be taken forward for detailed scheme development during DMRB Stage 3 at completion of this assessment.

In addition to an appraisal in accordance with the DMRB, developed options were considered with regards to performance against STAG Criteria and Transport Planning Objectives, identified during the Pre-Appraisal Stage of this process. This part of the assessment can be found in Volume 3 of this Report.

7.2 Summary of Assessment

Route Options developed during the Pre-Appraisal and Stage 1 process, and further assessed during Stage 2, as described in chapter 4 of this document, have been appraised in accordance with the DMRB and Scottish Transport Appraisal Guidance against the following criteria:

- Implementability;
- Developed Transport Planning Objectives;
- Performance in relation to 'strategic' Objectives;
- STAG Criteria (Environment, Safety, Economy, Integration and Accessibility & Social Inclusion, refer to separate report for further details).

As part of the assessment into the 'implementability' of a developed option, an engineering, environmental and economic appraisal has been carried as required by TD 37/93 Stage 2 Scheme Assessment Reporting. This was to establish the feasibility of an option considering the technical and environmental issues, as well as outline costs.

Developed route options were appraised against the above criteria, using the standard seven point scale as shown below:

Major benefit	✓✓✓
Moderate benefit	✓✓
Minor Benefit	✓
No benefit or impact	0
Minor negative impact	×
Moderate Negative Impact	××
Major negative impact	×××

7.3 Scheme Objectives

Transport Planning Objectives developed for this project during the Pre-Appraisal stage are provided in table 1.1.1 in chapter 1 of this report.

The design of this scheme is in accordance with the Government guidelines and appraisal criteria for the assessment of road schemes, which take account of issues in relation to the environment, safety, economy, integration, accessibility and social inclusion. In addition, cost to the Government and risk and uncertainties should also be assessed against.

A summary of the Options Appraisal carried out against the Transport Planning Objectives, together with a brief rationale for the selection or rejection of each route option, summarising the discussions contained in this report, is shown on the summary tables 7.3.1.

Table 7.3.2 offers a further development of the Transport Planning Objectives for routes that "best" satisfy the requisite criteria.

Output from these appraisal tables should be read in conjunction with the STAG appraisal report and summary provided therein, and has fed into the overall Appraisal Summary Table 7.4.1.

Table 7.3.1 – Summary of Appraisal of Assessed Route Options against Transport Planning Objectives

SUMMARY OF ROUTE OPTIONS APPRAISED AGAINST TRANSPORT PLANNING OBJECTIVES									
Scheme Objectives		**Route Options**							
		N6	**N9**	**O2**	**O3**	**O4**	**O5**	**O7**	**S4**
Deliver a safe and reliable, 2 lane carriageway, by applying appropriate / proportionate design standards	Safety	✓✓✓	✓✓✓	✓✓✓	✓✓✓	×××	××	✓✓✓	✓✓✓
Minimise **all risk** during design, construction, operation and maintenance (with reference to Risk Register)	Economy	✓	✓✓	×	×	0	××	×	✓✓✓
Ensure deliverability of scheme within programme and to agreed capital cost and maintenance budgets, thus providing 'Value for Money'		✓	✓	××	×××	✓✓✓	✓✓✓	××	✓✓✓
Solution reduces, or does not increase, the risk to and liability of the railway and maintains suitable access over the life of the scheme		✓✓✓	✓✓✓	××	×	0	×××	××	✓✓✓
Deliver a scheme that assists both the local businesses to maximise opportunities for sustainable development and economic growth over the life of the scheme		✓✓	✓✓✓	0	0	×	×	0	×××
Safeguard and, where possible and appropriate, enhance and provide access to the natural and built environment and areas of national, regional and local importance and heritage, during construction, maintenance and operation of the scheme (with reference to environmental appraisal)	Environment	×	××	×	×	0	×	✓	××
Scheme to take account of relevant local, regional and national planning policies (during the design stage)		✓✓	✓✓✓	✓✓✓	✓✓✓	×	✓	✓✓✓	✓
Keep the A 890 and peripheral road network open during construction	Integration	✓✓✓	✓✓✓	×	××	✓✓	××	×××	✓✓✓
Maintain and improve choice of transport mode and integration of public transport links over the lifetime of the scheme		✓	✓	0	0	0	0	0	×
Maintain and improve local social cohesion by improving accessibility for emergency services responding to call-outs, as well as for the local population making use of local and regional leisure, health and educational facilities	Accessibility	✓	✓	0	0	0	0	0	××
Maximise / improve network efficiency, sustainable connectivity and social cohesion in terms of journey times and journey reliability in the Wester Ross area		✓	✓✓	0	0	0	0	0	✓

Table 7.3.2 – Best Options against Scheme Objectives

Scheme Objectives	North Shore N9 Lochcarron Bypass	Online O2 Railway Viaduct	Southern S4 Glen Udalain	Baseline O4 Do-minimum
Safeguard and enhance access to the natural and built environment during construction, maintenance and operation of the scheme				
Minimise all risks during design, construction, operation and maintenance				
Ensure deliverability of scheme and 'Value for Money'				
Deliver safe and reliable, two lane carriageway				
Ensure no increase in risk to and liability of the railway, maintaining access over the life of the scheme				
Keep the A890 and peripheral road network open during construction				
Maintain and improve social cohesion for the local population, making use of leisure, health and educational facilities and by improving accessibility for emergency services				
Maintain and improve choice of transport mode and integration of public transport links				
Take account of relevant local, regional and national planning policies during the design stage				
Maximise / improve network efficiency, sustainable connectivity and social cohesion in terms of journey times and journey reliability in the Wester Ross area				
Deliver a scheme that assists local businesses to maximise opportunities for sustainable development and economic growth				

Successfully meets objective Partially meets objective Does not meet Objective

7.4 Stage 2 DMRB Assessment Summary Tables

Table 7.4.1 summarises the assessment of each scheme option carried out in accordance with the DMRB and some aspects of the STAG, against each of the scheme objectives, which include criteria of:

- Environment
- Safety
- Economy
- Integration
- Accessibility & Social Inclusion
- Scheme Objectives
- Scheme Costs
- Risks.

Scale of assessment used:

Major benefit	✓✓✓
Moderate benefit	✓✓
Minor Benefit	✓
No benefit or impact	0
Minor negative impact	×
Moderate Negative Impact	××
Major negative impact	×××

Table 7.4.1 Overall DMRB Summary Table

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
North Shore 6	✓✓	×××	✓	××	✓✓	✓✓✓	×××	××	**General:** Route option provides good north south linkage and opens north, south corridor that will benefit future development of Kishorn. The option proposes on-line improvements through Lochcarron Village, rather than a bypass, with difficult route development due to existing frontage activity. **Ecology:** Generally moderate impact, but major impact on Loch Carron Marine Consultation Area. **Cultural Heritage**: Major impact on setting of Strome Castle and potential moderate/minor impact on setting on Lochcarron Old Parish Church **Landscape**: Major impact due to bridge crossing. **Noise:** Major impact – significant increase at properties along route corridor. **Air:** Increase in pollutant concentrations likely at receptors in Lochcarron and Slumbay **Community and Private Assets:** Moderate impact as increases traffic through Lochcarron and impacts numerous community assets. **Effects on all Travellers:** No benefit or impact as reduces journey times but may sever some paths **Engineering:** Some green field construction of new road alignment bypassing Stromemore. Involves major bridge crossing of the Narrows. Restricted corridor availability due to existing dwellings on roadside through village. **Economics:** Compared to the other routes, performs reasonably well in economic appraisal due to directness of route but is influenced by high bridge construction costs. **Costs:** Most economical northern option due to an on-line route alignment through Lochcarron. Limited opportunity for phased development. **Overall Assessment:** Route option performs well against Objectives and Assessment Criteria but with a lower score on Objectives due to on-line proposal through Lochcarron.

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
North Shore 9	✓✓✓	××	✓✓	××	✓	✓✓	×××	××	**General**: Route option provides good north south linkage and opens north, south corridor that will benefit future development of Kishorn. Route option provides a full bypass of Lochcarron village. **Ecology:** Major impact on Allt nan Carnan SSSI and ancient woodland **Landscape**: Generally moderate impact, but major impact on Loch Carron Marine Consultation Area. Major impact due to bridge crossing. **Noise:** Moderate impact – slight increase in properties along route corridor **Community and Private Assets:** Minor benefit as it diverts traffic away from Lochcarron and impacts very few community/private assets **Effects on all Travellers:** Minor negative impact as may increase journey times and may sever paths. **Engineering:** Green field construction of new road alignment, with gradients up to 10% in various sections. Involves major bridge crossing of the Narrows. **Economics:** Best performing option in economic appraisal. **Costs:** Cost is favorable northern route option and is comparable to cheapest Northern option, N6. Limited opportunity for phased development. **Overall Assessment:** Route option is best performing against Objectives and against Assessment Criteria with a higher acceptability score on due to proposal for a full bypass of Lochcarron.

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
On-line 2 (Railway Viaduct)	✓✓	×	✓✓	××	✓✓	✓✓	×××	×××	**General:** This route option bypasses the rockfall area by means of placing railway on a build-out viaduct, but there are potential railway interface and buildability issues. Option could potentially benefit Kishorn if option constructed using precast elements. **Ecology:** Major impact on Loch Carron Marine Consultation Area. **Landscape:** Minor impact due to introduction of new structure. **Road Drainage and Water Environment:** Minor impact on water environment due to viaduct. **Community and Private Assets:** No benefit or impact as it affects few residential, community and development areas. **Effects on all Travellers:** Minor benefit as proposal creates long term reduction in driver stress, but short term disruptions of traffic during construction. **Engineering:** 2km viaduct founded in potentially deep water, resulting in difficult construction and access and buildability issues. Alignment follows existing road and therefore incorporates substandard geometry at Ardnarff and some improvements at Maman Hill. Road closures during construction will be required, but solution does offer some off-line working. **Economics:** Cost of works and closures of existing road and railway during construction required affect scheme economics. **Costs:** With Option O3, this is the most cost viable online option. **Overall Assessment:** Route option performs well against Objectives. Due to some off-line construction this option provides least disruption during construction.

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
On-line 3 (Tunnel)	✓✓	✓	✓	×××	✓✓	✓✓	×××	×××	**General:** Route option incorporates tunnel section to bypass the rockfall area. Challenging construction method, but off-line tunnel route offers distinct advantages. **Ecology:** Minor impacts **Landscape:** Minor impacts **Road Drainage and Water Environment:** Potential minor impact on groundwater **Community and Private Assets:** No benefit or impact as it affects few residential, community and development areas. **Effects on all Travellers:** Minor benefit as solution creates long term reduction in driver stress; but short term disruptions during construction to be expected. **Engineering:** Includes 1.6km long 2lane tunnel section and associated portal structures, all with inherent engineering and construction difficulty. Adequate working space will have to be generated. Alignment follows existing road and therefore incorporates substandard geometry at Ardnarff with some improvements at Maman Hill. Delays to road and railway traffic during the construction period are to be expected. 1.0km long rock trap measures to be constructed along existing /abandoned road corridor. **Economics:** Cost of works and anticipated lengthy closures of existing road and railway during construction affect scheme economics. **Costs:** The most expensive considered on-line option. **Overall Assessment:** Route option performs poorly against Objectives, due to estimated scheme costs but satisfies STAG criteria generally and offers advantages due to off-line construction.

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
On-line 4 'Do-Minimum'	×××	0	××	0	×	0	0	×	**General:** Do-minimum option considered, low cost option, no improvements to carriageway or alignments. Ongoing rock slope maintenance to existing programme and reactive measures, as and when required. Option not satisfying local requirements. Minor negative impact to travellers as remains status quo. **Costs:** Least expensive, base-line option. **Overall Assessment:** Route does not satisfy Objectives or STAG criteria, and results in an overall neutral score, but required as the base-line case for comparison.
Online 5 (Road / Rail)	××	✓	××	××	×	✓✓	××	××× `	**General:** Proposes dual running of road and railway traffic. Some construction and operational risk and disruption, but cost effective solution. Possibly not satisfying local requirements. **Ecology:** Minor impacts. **Community and Private Assets:** No benefit or impact as it impacts few residential, community and development areas. **Effects on all Travellers**: Minor benefit as creates long term reduction in driver stress but short term increases. Dis-benefit to rail travellers. **Engineering:** Will require re-engineering of railway track which will be disruptive in short term. Alignment follows existing road and therefore incorporates substandard geometry at Ardnarff and some improvements at Maman Hill. **Economics:** Performance affected by delays to road traffic as trains pass through site. Costs. **Costs:** Cheapest on-line solution after Do-minimum **Overall Assessment:** Route does not satisfy the Objectives and has safety issues to overcome but has potential as a medium term, low cost solution.

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
On-line 7 (Developed Avalanche Shelter)	✓	✓	✓✓	×××	✓✓	✓✓	×××	××	**General:** Developed avalanche shelter provides protection to road and rail long term, but significant disruption during construction with railway interface issues. Road/railway likely to be closed for in excess of 9 months. Option could utilise Kishorn yard for production or shipping of precast elements. **Ecology:** Major impact on Loch Carron – especially if bridges/viaducts are part of proposals. **Landscape:** Minor impact due to introduction of additional structures, but enhanced views. **Geology and Soils**: Minor impact on Attadale SSSI **Community and Private Assets:** No benefit or impact as it impacts few residential, community and development areas. **Effects on all Travellers:** Minor benefit as creates long term reduction in driver stress but short term increases. **Engineering**: Complex engineering structures and rock treatment. Adopts significant existing road alignment with inherent sub-standard sections. **Economics:** Does not perform well in economic appraisal due to high structures costs and road closures. **Costs:** This is the second cheapest on-line option. **Overall Assessment:** Route option provides good long-term protection to the most difficult rock-fall area, but will involve complex engineering to minimise disruptions during construction.

STAG PART 2 SUMMARY TABLE									
Assessed Options	**Objectives**	**Government Criteria**							**Pros and Cons of Route Option**
	Transport Planning Objectives	Environment	Safety	Economy	Integration	Accessibility Social Inclusion	Cost to Government	Risk and Uncertainty	
South 4	✓	×	✓	××	✓	✓	××	×	**General:** Potential environmental impacts from new green field route and extended journey time. Promotes remote route alignment, with no direct link to communities. Low cost and least risk option. **Ecology:** Major impacts due to offline nature of route – loss of ancient woodland and montane habitat and impacts likely to protected species. **Landscape:** Minor impact due to visibility from properties in Attadale and local influence on rocky moorland. **Road Drainage and Water Environment:** Moderate impact due to high numbers of new watercourse crossings required. **Community and Private Assets:** Moderate negative impact due to the impacts on community and woodland areas. **Effects on all Travellers:** Minor negative impact as may increases journey times and may sever paths **Engineering:** Longer route with easy alignments and earthworks with some peat treatment, small to medium structures crossing water courses. Steeper gradients at Attadale and improvements to existing gradients on Maman Hill. **Economics:** Poor performing route due to length and extended journey times. **Costs:** Longest but least expensive southern route. **Overall Assessment:** Route performs reasonably well against Objectives and STAG criteria, apart from integration and environment. Route promotes a remote alignment, potentially bypassing existing communities. Community linkages proved uneconomical.

Table 7.4.2 Overall Stage 2 Assessment

STAG Criteria	North Shore		On-Line					Southern
	N6 – bridge & through Lochcarron	N9 – bridge & Lochcarron Bypass	O2 - Railway Viaduct	O3 - Tunnel	O4 - 'Do-Minimum'	O5 - Shared Road and Rail	O7 - Developed Avalanche Shelter	S4 - Gleann Udalain
Scheme Objectives	Good linkage but on-line through Loch Carron	Delivers on Objectives	Some buildability & environmental issues, limited road closures	Some buildability issues, road/ rail closures required	Does not satisfy Objectives	Issues with safety and delivering required road standard	Significant buildability issues for road and railway, closures inevitable	Environmental intrusion and lengthened journey times but safe and deliverable
Environment	Noise and air quality impacts	Green field construction and impact on SSSI	Visual impact and will effect marine conservation area	Minor impacts	No change	Minor impacts	Limited intrusion and enhanced views	Green field construction and landscape impacts at Attadale
Safety	Conflicts due to frontage activity	Best performing route for safety and security	Existing route made safe	Existing route made safe but tunnel less safe than road/bridge	Potential for further rock falls	Road/rail conflicts	Existing route made safe	Safe route but more remote
Economy	Benefit to cost ratio: 0.5	Benefit to cost ratio: 0.54	Benefit to cost ratio: 0.12	Benefit to cost ratio: 0.06	Benefit to cost ratio: n/a	Benefit to cost ratio: 0.29	Benefit to cost ratio: 0.06	Benefit to cost ratio: 0.1
Integration	Opens up north/south corridor	Opens up north/south corridor	Safeguards existing connections	Safeguards existing connections	Safeguards existing connections	No change	Safeguards existing connections	Extended journey times
Accessibility / Social Inclusion	Traffic through LochCarron but disbenefits Strathcarron area	Benefits LochCarron but disbenefits Strathcarron area	No change	No change	Reluctance to use route	No change	No change	Route lengthened
Cost to Government (Total Scheme Cost)	£106 Million	£109 Million	£123 Million	£181 Million	£30 Million *(maintenance cost, over 60 years)*	£63 Million	£118 Million	£81 Million
Risk and Uncertainty	Ground conditions for bridge and marine environment	Ground conditions for bridge and marine environment and Loch Carron Bypass	Ground conditions for structure, marine environment and working from barges	Rock quality for tunnel and portals, buildabilty- portals, adits, compound, spoil	Potential further rockfall events	Road/rail conflicts, not acceptable to Network Rail	Significant buildability issues and potential closures	Peat identified but otherwise little engineering/ construction risk
Best Route Option		Best north shore route option	Best online route option					Best southern route option

Significant Benefit *Minor Benefit* *Negligible Effect* *Minor Adverse* *Significant Adverse*

Table 7.4.3 Summary of Best Options Appraisal

Scottish Transport Appraisal Guidance Criteria	North Shore N9 Lochcarron Bypass	Online O2 Railway Viaduct	Southern S4 Glen Udalain	Baseline O4 Do-minimum
Scheme Objectives				
Environment				
Safety				
Economy				
Integration				
Accessibility / Social Inclusion				
Cost to Government				
Risk and Uncertainty				

Significant Benefit *Minor Benefit* *Negligible Effect* *Minor Adverse* *Significant Adverse*

8 CONCLUSIONS

8.1 Introduction

URS have undertaken a DMRB Stage 1 & 2 and STAG Part 1 & 2 Options Appraisal in accordance with the requirements of their appointment by The Highland Council, AR1185 dated October 2012. The various assessments undertaken have been presented in this report.

During the development of the report, the URS team considered relevant historical information abstracted from THC archives. In accordance with the requirements of STAG, extensive Stakeholder consultation was undertaken to advise the project, in particular to identify problems, opportunities and constraints and develop Transport Planning Objectives, during the Pre-Appraisal stage of the process.

Route corridors were identified, and an option generation and sifting process then took place during Stage 1 to identify alignments adequate to progress to further detailed assessment work. Stage 1 was concluded in April 2013, with conclusions taken into this Stage 2 assessment of route options.

The conclusions of this Stage 2 appraisal are presented below. URS will continue to work with The Highland Council and Stakeholders to develop recommendations on which 'preferred route' can be selected and put to The Highland Council Full Committee, and thereafter taken forward to a DMRB Stage 3 scheme design.

8.2 General Conclusions

It is essential at this stage of the process, that the full range of assessment criteria, i.e. Transport Planning Objectives, Environment, Safety, Economy, Integration, Accessibility & Social Inclusion, Deliverability, Public Acceptability & Affordability, are all considered to result in a balanced view.

Considering individual disciplines it can be seen in general terms:

- New (greenfield) options score poorly on environmental grounds;
- On-line options, apart from the shared road and rail option, are expensive, have buildability and rail interface issues and will require some element of road and railway closures. Online options are compared with the Southern Route when considering Phase 1 work.
- The North Shore route best satisfies most selection criteria and received most positive responses from the public, but requires an expensive crossing of the Strome Narrows and longer and more expensive first phase construction works.
- The Southern route option satisfies less criteria and received less positive responses than the northern route, but emerges as the most affordable solution in the short term. The route compares with an online option for Phase 1 works but would have significantly more difficulties in scheme promotion due to landowner difficulties.

Considering all the appraisal criteria, the differences between the North Shore route and the Southern route is marginal. However, the northern route remains approximately 14% more expensive, due to the requirement of a major bridge crossing across the Strome Narrows.

In addition, considerations in relation to phasing of options to assist in scheme affordability have been undertaken and an assessment made on the influence this may have on route selection.

8.3 Conclusions drawn from Summary Tables

The summary tables of the route options, appraised during this Stage 2 work, provide a tool to identify a preferred route option. Cognisance has also been taken of consultations with stakeholders and the public during workshops and the Public Exhibitions in March 2014.

8.3.1 Northern Routes.

The most advantageous northern route has been chosen. There are pros and cons for routes N6 and N9 and their variations regarding the Strome Narrows crossings, and a good balance was achieved considering all aspects of environmental, technical and socio-economic issues as well as compliance with the Transport Planning Objectives.

Option N9 Lochcarron Bypass crossing Strome Narrows with a low level bridge was found to be the best North Shore Option. Bypassing Slumbay and Lochcarron with the proposed road passing to the east allows for a better standard of geometry and also minimises the impact on land and especially property which fronts on to the existing road through Slumbay and Lochcarron. At-grade priority junctions are proposed where Option N9 crosses the existing A896 and where Option N9 moves offline south of Slumbay and at Kirkton. The existing road between Kirkton and Strathcarron Junction would be upgraded.

8.3.2 On-line Route

The majority of the on-line routes were taken forward to Stage 2. Recognising how cost-driven a possible route solution would be, considerations did not just focus on construction cost, but focused on buildability issues, construction periods, road and railway closures and railway interface issues, all of which potentially impact on cost. It was also recognised that The Highland Council have liability obligations with regard to long term maintenance of the route.

A recognised benefit of the on-line routes is that they lend themselves to phased construction, which would aid deliverability of a scheme and therefore satisfy the Project Objective. Phase 1 would cover the construction works required for the section near the avalanche shelter, to alleviate the on-going rock fall issues on that section of road first, and including the section between Stromeferry and Ardnarff. Further phases would cover the sections between Cuddies' Point east to Strathcarron and Starthcarron Junction.

The best on-line solution emerging from this appraisal is the proposal for a railway viaduct, which emerged as the most cost-effective on-line proposal, and had many advantages in comparison to other solutions considered in relation to buildability and road closure issues. (Option O2).

8.3.3 Southern Routes

Route S4 takes an alignment through Glen Udalain, east of Loch Nam Breac Mora through Attadale valley and continues online from Attadale to Strathcarron junction.

This option is the main 'Glen Udalain' route. It has been derived from historical work and offers the most favourable route alignment through the valley to satisfy the design parameters set in particular setting a route below the 300m contour. As a greenfield route there are environmental issues to overcome. The route is the least expensive of all options considered however due to length and associated journey times and performs poorly when compared to others with regard to scheme economics.

In addition, due to the relative remoteness of this route some of the developed Transport Planning Objectives regarding connectivity are not satisfied as well as some of the other routes.

Community links have been assessed but do not perform well when considering value for money and reduced journey times.

The best Southern route to be considered is that taking an alignment through Glen Udalain to Attadale and continuing with the online improvements to Strathcarron Junction.

8.3.4 Do-Minimum Scenario

Do-Minimum Scenario. A 'Do Minimum' scenario has been considered. This is the base case to measure the performance of alternative route options against and is representing the existing condition of the A890 Stromeferry Bypass, with known issues of a long diversion route and rail/ferry contingency measures during road closures due to rock falls. It should be noted whilst not having an assigned capital cost, the do-minimum scenario has been assessed to require some £30M of maintenance expenditure over 60 years.