Access to Argyll & Bute [A83]

DMRB Stage 2 Scheme Assessment Report

Volume 1 – Part 3 Environmental Assessment

Transport Scotland

May 2023

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Client	Transport Scotland
Project	Access to Argyll & Bute [A83]

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Contents

1. Summary of Previous Environmental Assessment

1.1. Introduction

This chapter provides a summary of the previous studies and assessments that have been undertaken to inform the A83 Access to Argyll and Bute scheme (hereafter referred to as 'the Proposed Scheme'). Route wide assessment work on the Proposed Scheme has culminated in the production of a Design Manual for Roads and Bridges (DMRB) Stage 1 Report[1] and associated Strategic Environmental Assessment (SEA)[2].

1.2. Background and Context

The A83 Rest and Be Thankful is part of the Trunk Road Network (TRN) which is located within Argyll and Bute and runs from west of Ardgarten, along Glen Croe to the Rest and Be Thankful Viewpoint before passing Loch Restil and dropping down Glen Kinglas. The A83 through Glen Croe is the highest point on the A83 (approximately 265m AOD) and lies in a known risk area for landslides and debris flow which has increased in frequency and severity over recent years. The road has experienced an increased frequency of closure during bad weather with landslides and a flow of debris caused by hillside movement.

Full details of the Scheme background and context can be found in Part 1.

1.3. Previous A83 Studies and Assessments

Several previous studies have been undertaken in order to reach the decision to improve the resilience of the A83(T) in this location. Key studies are summarised below.

- Scottish Road Network Landslide Study[3];
- A83 Trunk Road Route Study[4];
- A83 Glen Kinglas Options Report – 2019 Update[5];
- STPR2: Initial Appraisal: Case for Change – Argyll and Bute Region Report, Feb 2021;
- STPR2: Update and Phase 1 recommendations Report, Feb 2021; and

[1] A83 Access to Argyll and Bute (A83), Strategic Environmental Assessment & Preliminary Engineering Services; DMRB Stage 1 Assessment Report. Transport Scotland, 2021.
[2] A83 Access to Argyll and Bute (A83), Strategic Environmental Assessment; Draft Environmental Report for Consultation. Transport Scotland, 2021.
[3] Scottish Road Network Landslide Study: Implementation. Transport Scotland, 2008
[4] A83 Trunk Road Route Study; Part A – A83 Rest and be Thankful, Final Report. Transport Scotland, 2013.
[5] A83 Glen Kinglas Options Report – 2019 Update, Jacobs, 2019

- Access to Argyll and Bute (A83) – DMRB Stage 1 Assessment Report, Apr 2021.

The preliminary Assessment undertaken at DMRB Stage 1 considered 11 route corridor options, as shown on Plate 1.1, which were identified as part of STPR2. In addition to these 11 route corridor options a further four route corridor options were proposed by the public during consultation held in September and October 2020.

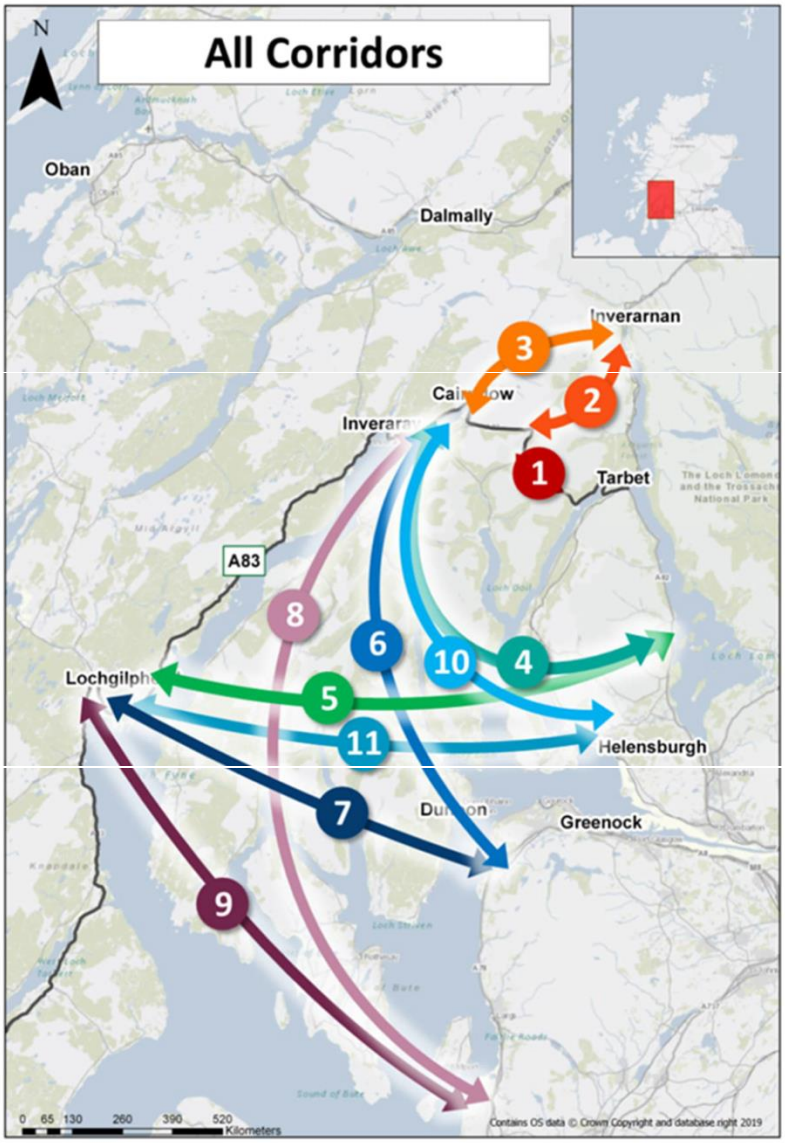

Plate 1.1 Access to Argyll and Bute (A83(T)) Route Corridor Options

1.3.1. Strategic Environmental Assessment

In Scotland, SEA is legislated through the Environmental Assessment (Scotland) Act 2005, which requires SEA for all public sector plans, programmes and strategies with the potential to present significant effects on the environment.

The assessment for the SEA has been carried out in two stages:

- Preliminary Assessment – an initial assessment considering 11 route corridors and four additional corridors suggested as part of public consultation in Autumn 2020, with the objective of identifying if corridors can be removed from further consideration at that stage and any further assessment necessary to allow a recommendation on the preferred corridor to be made.
- Detailed Assessment – detailed assessment of the residual corridor options remaining following the Preliminary Assessment (in this case only Corridor 1 – Glen Croe – remaining) undertaken in line with the SEA Directive and appropriate guidance documents, considering environmental aspects.

The emerging recommendation as a result of the environmental assessment undertaken was to retain route Corridor 1 as the preferred route corridor, for the following reasons:

- The environmental impacts within Corridor 1 would be significantly less.
- Scheme objectives show some benefit, although other route corridors may perform better except in relation to environmental benefits.
- Traffic and safety benefits are not significant overall, but improved resilience is noted.
- It is likely that a solution can be delivered most quickly and cost effectively.
- There are some engineering complexities, particularly geotechnical and structural but potentially less and different than other route corridors which have major challenges with bridges at the upper limits of technology and longer tunnels.

The SEA Post Adoption Statement (PAS) 2021[6] was the last formal output of the Stage 1 process. It outlines how the assessment findings and the comments received through consultation have been taken into account, as well as the mitigation and monitoring strategy to be considered at Stages 2 and 3 of the DMRB of the development of the Proposed Scheme.

1.3.2. DMRB Stage 1 Recommendations

A recommended preferred route corridor for the Proposed Scheme was announced on 18th March 2021. The outcome of the DMRB Stage 1 assessment (including the SEA) was the recommendation of Corridor 1, Glen Croe as the preferred corridor.

The recommended corridor generally follows the existing A83(T), starting south-east of the junction between the A83(T) and the Old Military Road (OMR). It typically follows the route of

[6] A83 Access to Argyll and Bute (A83), Strategic Environmental Assessment; Post Adoption Statement. Transport Scotland, 2021.

the existing A83(T) as it rises through Glen Croe and then past Loch Restil. The corridor ends where the A83(T) passes the west end of Glen Kinglas and is approximately 6km long.

2. Overview of the Environmental Assessment

2.1. Introduction

This chapter outlines the approach undertaken for the DMRB Stage 2 Environmental Assessment of the Scheme Options and includes the following:

- a description of the approach to, and scope of the DMRB Stage 2 Environmental Assessment; and
- an outline of the structure of the environmental report.

The DMRB Stage 2 Assessment identifies the factors to be taken into account in choosing alternative route options and to identify the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with those routes or schemes.

The Scheme Options being subject to assessment have been developed to an appropriate level of detail to enable rigorous evaluation, however, it is important to note that these are indicative designs. The Preferred Option at the conclusion of Stage 2 will be developed further during DMRB Stage 3 as part of an iterative design process taking into account emerging findings from Stage 3 environmental survey work and assessments.

2.2. Proposed Scheme Development

Details of the Scheme Options that are subject to assessment are set out in Part 1, Chapter 3, Description of Scheme Options in Volume 1 of the DMRB Stage 2 Scheme Assessment Report.

The assumed land take for the Scheme Options includes the road, structures, side roads, drainage ponds, earthworks and maintenance access. Land-take for the siting of site compounds has not been included. The land boundary width of the road would vary according to topography and the lateral extent of cuttings, embankments and the location of attenuation ponds where required. Specific assessment study areas have been used for each technical assessment these are described in the relevant chapter.

2.2.1. Environmental Design and Embedded Mitigation

The development of the Scheme Options has included consideration of the environmental constraints present within Glen Croe and has sought to mitigate, where possible, the potential for adverse environmental impact. Such mitigation has been embedded into the

design of the Scheme Options and has focussed on the avoidance of features of environmental interest/importance and on achieving best fit within the existing environment.

2.3. Environmental Assessment Process

DMRB sets out guidance on the development of trunk road schemes and is therefore applicable to the Proposed Scheme. Volume 11 of the DMRB specifically provides guidance on the environmental assessment of trunk road schemes, including the level of assessment required at key stages of development.

The purpose of the DMRB Stage 2 assessment is to identify the factors to be taken into account in choosing alternative routes and to identify the advantages, disadvantages and constraints (environmental, engineering, economic and traffic) associated with those routes. The DMRB Stage 2 Environmental Assessment helps to ensure that the importance of predicted environmental impacts, and the opportunity for reducing them, is properly understood, and fully incorporated into the engineering and economics of the scheme development.

The requirement for Environmental Impact Assessment (EIA) stems from the European Commission Directive 85/337/EEC, as amended by Directive 97/11/EC, regarding the assessment of the environmental effects of certain public and private projects (hereafter referred to as the EIA Directive) and Directive 2003/35/EC regarding public participation. The EIA Directive was updated and a new EU Directive (2014/52/EU) was adopted on 15 May 2014, which was transposed into UK legislation on 16 May 2017. In Scotland the EIA regulations that implement the requirements of the EIA Directive in relation to the construction of trunk roads are The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017 (hereafter referred to as the EIA Regulations).

The assessments presented within this DMRB Stage 2 Environmental Assessment are not undertaken in the same level of detail as an EIA but the principles of impact assessment from EIA provide a robust basis for examination of the Scheme Options. EIA will be undertaken on the Preferred Option at DMRB Stage 3.

The DMRB Stage 2 environmental assessment approach is based on current methodologies from relevant Standards in the DMRB as well as on relevant current best practice in environmental assessment. It reflects the guidance provided in DMRB in relation to focusing assessment on significant effects and on proportionate reporting. The guidance followed for each assessment is set out in Chapters 3 to 15.

2.4. Scope of the Stage 2 Environmental Assessment

A scoping exercise was undertaken to determine those topics and associated sub-topics to be included within the DMRB Stage 2 Assessment. This exercise consisted of a review of existing information and reports in order to identify those environmental constraints relevant to both the construction or operation of the Proposed Scheme which could be considered to be subject to materially different environmental impacts to inform the identification of a Preferred Option.

The Scheme Options have been assessed in relation to the topics listed below (reported in Chapters 3 to 15 respectively):

- Chapter 3 – Air Quality
- Chapter 4 – Cultural Heritage
- Chapter 5 – Landscape
- Chapter 6 – Visual Effects
- Chapter 7 – Biodiversity
- Chapter 8 – Geology and Soils
- Chapter 9 – Material Assets and Waste
- Chapter 10 – Noise and Vibration
- Chapter 11 – Population and Human Health
- Chapter 12 – Effects on Climate
- Chapter 13 – Climate Vulnerability
- Chapter 14 – Major Accidents and Disasters
- Chapter 15 – Road Drainage and the Water Environment

All Appendices to the technical chapters are located within Volume 1, Part 6

2.4.1. Cumulative Impacts

The term ‘cumulative’ is not defined within the EIA Directive; however, the European Commission (EC) guidelines (European Commission 1999[7]) define ‘cumulative impacts’ as those that result ‘*from incremental changes caused by other past, present or reasonably foreseeable actions together with the project*’. DMRB LA 104[8] provides a glossary of terms and further defines cumulative effects as ‘*impacts that result from incremental changes caused by other present or reasonably foreseeable actions together with the project*’.

[7] Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions. European Commission, 1999.
[8] Design Manual for Roads and Bridges: LA 104 Environmental Assessment and Monitoring. Highways England et al., 2020.

Cumulative impacts can be identified as either the combined effect of different environmental impacts on a single receptor/resource, or the combined effect of impacts from a number of different proposed developments.

During consideration of Scheme Options at DMRB Stage 2 there is limited opportunity to identify cumulative impacts, due to factors such as the early development of the design; absence of details on construction programming and methods; and the need to consider multiple options. At this stage of assessment, it is noted that any potential cumulative impacts would be broadly comparable between the Scheme Options and would therefore be unlikely to influence the selection of the Preferred Option.

The EIA Regulations require cumulative impacts to be considered as part of a statutory EIA, and as such this will form part of the scope for EIA at DMRB Stage 3. This will include identification of other major projects that could contribute to a cumulative impact.

2.5. Environmental Reporting

The environmental chapters as listed in Section 2.4 provide the following:

- an introduction to the subject area, an outline of the focus of the assessment;
- a description of the study area within which each environmental assessment is undertaken;
- the approach and methods used, consultation undertaken, and a summary of any aspects that have been scoped out of the assessment;
- a description of the baseline conditions;
- potential impacts (during construction and operation) of the Scheme Options under consideration;
- an outline of potential mitigation proposed to address adverse impacts;
- summary of the Scheme Option's residual impacts; and
- the scope of the DMRB Stage 3 Assessment.

2.5.1. Baseline Conditions

The impact assessment for each environmental topic has been undertaken in comparison with the 'baseline' situation within a defined study area. The 'baseline' refers to the existing site conditions and how these are predicted to change if the Proposed Scheme did not proceed.

Baseline information has been gathered through site visits, the review of maps and previous environmental studies, data collection, consultation with statutory and non-statutory organisations and field surveys.

2.5.2. Potential Impacts

The assessment focuses on the impacts from both the construction and operation of the Scheme Options including the change in use of the land (e.g. habitat loss), and from the operational effect of traffic using the road. The significance of impact varies according to the environmental discipline and the context in which the assessment is made. However, in general, the level of significance of impacts has been determined through a combination of the sensitivity of the environmental aspect and the magnitude of impact. The significance of impacts has been defined where applicable for each environmental topic in the appropriate sections.

Sensitivity has generally been defined according to the relative value or importance of the feature, and the magnitude of impact has been determined by reference to any legislative or policy standards or guidelines, and the following factors:

- the degree to which the environment is affected, e.g. whether the quality is enhanced or impaired;
- the scale of the change, e.g. the size of land area or number of people affected and degree of change from the existing situation;
- the scale of change resulting from impacts; and
- whether the impact is temporary or permanent.

The nature of impacts may vary and may be direct or indirect, secondary, cumulative, short, medium, or long-term, permanent, or temporary and positive or adverse. These types of impacts have all been considered.

2.5.3. Potential Mitigation

The design at DMRB Stage 2 has not been sufficiently developed to allow detailed mitigation measures to be developed. The assessments presented for each environmental discipline therefore identify potential mitigation taking into account best practice, legislation, and appropriate guidance.

The mitigation measures identified are those measures that are known to be effective, which follow good environmental practice and legislative standards, and can reasonably be assumed to be implemented and committed in scheme delivery.

Once the Preferred Option has been identified to take forward for assessment at DMRB Stage 3 the mitigation measures required for the Proposed Scheme would be further developed and refined. The DMRB Stage 3 assessment will also consider any identified enhancement measures that will result in net benefits to the environment being achieved.

2.5.4. Summary of Scheme Option Impacts

This section of each environmental assessment undertaken sets out a summary of the assessment of each Scheme Option, and where possible, takes into account potential mitigation to provide an indication of the likely residual impacts. A comparative appraisal is also provided to enable differentiators between the options to be identified.

2.5.5. Scope of DMRB Stage 3 Assessment

A summary of the proposed scope of the DMRB Stage 3 assessment (subject to consultation), which will be reported within the Environmental Impact Assessment Report (EIA Report).

2.6. Consultation

Consultations have been undertaken to inform the environmental assessment work, this consultation has:

- sought feedback and comments on environmental aspects of the Proposed Scheme;
- requested relevant information and baseline data to inform the assessment work; and
- obtained feedback on the Scheme Options which have been developed.

Throughout the DMRB Stage 2 process a range of statutory and non-statutory consultees have been consulted on specific issues (refer to Chapters 3 to 15 for topic-specific consultation summaries). In addition to this consultation an Environmental Steering Group (ESG) has been set-up by Transport Scotland to facilitate consultation between A83 consultants and stakeholders; to provide an opportunity to discuss requirements relating to statutory responsibilities and other issues; and to provide regular updates on and an opportunity for ESG members to review emerging design work. The ESG comprises the following statutory stakeholders:

- Argyll and Bute Council;
- Historic Environment Scotland;
- Loch Lomond and The Trossachs National Park Authority
- NatureScot;
- Scottish Environment Protection Agency;
- Scottish Forestry.

2.6.1. Landowner Consultation

Landowner consultation to inform the DMRB Stage 2 assessment process commenced in 2022 and involved meetings with landowners to discuss the development of the Scheme Options subject to assessment, as well as gathering further information, including:

- the extent of ownership information relating to any other land which was occupied either under lease, or through another informal agreement; and
- information relating to the type of land use.

Information was recorded in meeting notes, and the information gathered during the landowner consultation process has been used to inform the project development.

3. Air Quality

3.1. Introduction

This chapter presents the DMRB Stage 2 air quality assessment for the Proposed Scheme. The assessment has been carried out in accordance with DMRB LA 105 Air Quality[9], as used by all Overseeing Transport Organisations including Transport Scotland.

The assessment includes the determination of the air quality study area; the existing baseline conditions and constraints; the approach used for the assessment; and the impacts on local air quality and emissions during the construction and operational phases.

The local air quality assessment has focused on the impacts of the air pollutants nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) as the air quality criteria for these pollutants are likely to be most difficult to achieve in the vicinity of roads. A qualitative assessment is presented as sufficiently detailed traffic data are not available for the Scheme Options at this time. A simple assessment such as this is the recommended approach in DMRB at the optioneering stage for a low risk potential project (i.e. one which is likely to result in traffic changes that are localised to the project rather than over a wider area) in a low risk receiving environment.

3.2. Approach and Methods

3.2.1. Introduction

This assessment was carried out in accordance with DMRB Stage 2 requirements. The aim is to examine the significant effects on air quality that are likely to result in differentiation between the Scheme Options and therefore contribute to the identification of a Preferred Option. Information on Legislation and Framework can be found in Appendix 3.1.

3.2.2. Sources of Information

Information has been collated from the following data sources:

- Air Quality Management Area (AQMA) mapping[10];

[9] DMRB: LA 105 Air Quality. Highways England et al., 2019
[10] Scottish air quality. (2023). Air Quality Management Areas. (online). Available at: https://www.scottishairquality.scot/laqm/aqma

- DEFRA Pollution Climate Mapping (PCM) model data (based on a 2018 reference year)[11];
- Local Authority Local Air Quality Management (LAQM) reports, including local monitoring data for the local authorities included in the study area;
- Mapped background pollutant concentrations for the UK available from Defra UK-Air website[12];
- Ordnance Survey base mapping to identify locations of sensitive human health receptors (e.g. residential properties, schools and hospitals) on likely affected road network;
- Multi-Agency Geographic Information for the Countryside (MAGIC) website[13], to identify boundaries of national and internationally designated ecological sites;
- Woodland Trust Ancient Tree Inventory to identify veteran trees[14]; and
- Critical loads and habitat types from the Air Pollution Information System (APIS)[15] website.

3.2.3. Legislation and Policy

Legislation

There are two types of air quality legislation that apply in Scotland:

- The EU (Withdrawal Agreement) Act 2020 and UK Withdrawal from the European Union (Continuity) (Scotland) Act 202116 which implement the legally binding, mandatory limit values originally set by the EU Directive 2008/50/EC17 on ambient air quality and cleaner air for Europe; and
- Regulations implementing national air quality objectives as set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS)18: Air Quality (Scotland) Regulations 2000 (SI 2000/97 and Air Quality (Amendment) (Scotland) Regulations 2002 (SI 2002/297)19,20.

[11] Department of Environment, Food and Rural Affairs. (2021). UK AIR. (online). Available at: http://uk-air.DEFRA.gov.uk/data/gis-mapping
[12] Department for Environment, Food and Rural Affairs (Defra), Air Quality Background Concentration Maps, 2018 base year. Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018
[13] Magic, Defra. (2018). Interactive mapping at your fingertips. (online). Available at: http://magic.DEFRA.gov.uk/
[14] Woodland Trust. (2022). Ancient Tree Inventory's. (online). Available at: https://ati.woodlandtrust.org.uk/tree-search.
[15] Air Pollution Information System. Available at: https://www.apis.ac.uk/
[16] UK Withdrawal from the European Union (Continuity) (Scotland) Act 2021 (legislation.gov.uk)
[17] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0050
[18] Defra (2011). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Available at; https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1
[19] The Air Quality (Scotland) Regulations 2000: https://www.legislation.gov.uk/ssi/2000/97/contents/made
[20] The Air Quality (Scotland) (Amendment) Regulations 2002: https://www.legislation.gov.uk/ssi/2002/297/contents/made

The air quality criteria in the context of this assessment for the protection of human health for NO_2 and fine particulate matter are presented in are presented in Table 3.1.

Table 3.1 Air Quality Criteria in Scotland

Pollutant	Objective
NO_2	Hourly mean concentration should not exceed 200 µg/m^3 more than 18 times a year Annual mean concentration should not exceed 40 µg/m^3
PM_{10}	24-hour mean concentration should not exceed 50 µg/m^3 more than 7 times a year Annual mean concentration should not exceed 18 µg/m^3
$PM_{2.5}$	Annual mean concentration should not exceed 10 µg/m^3 Exposure reduction^ (UK urban areas): target of 15% reduction in concentrations at urban background between 2010 and 2020

^ EU limit value exposure reduction target of 20% reduction between 2010 and 2020.

Responsibility for achieving the national air quality criteria lies with the Government, although local authorities should contribute to this through local action plans designed to reduce pollution levels in AQMAs, and through the targeted feasibility studies, including clean air zones where appropriate, to supplement the government's air quality plan for nitrogen dioxide in the UK[21].

3.2.3.1. Limit Values

The EU (Withdrawal Agreement) Act 2020 implements the air quality limit values that are included in the EU Directive on ambient air quality and cleaner air for Europe (2008/50/EC) and were previously included in Air Quality Scotland Regulations 2010(SI 2010 No.1001)[22] and as amended (SI 2016 No.1184)[23]. The relevant limit values in the context of this assessment for the protection of human health for NO_2 and fine particulate matter are presented in Table 3.1.

3.2.3.2. National Air Quality Strategy

The 2007 Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS)[18] sets out the national air quality standards and objectives for a number of local air pollutants. The standards are set by expert organisations with regard to scientific and medical evidence on the effects of the particular pollutant on health and define the level of pollution below which health effects are expected to be minimum or low risk even for the most sensitive members of the population. The objectives are targets for air pollution levels to be achieved by a specified timescale, which take account of the costs and benefits of achieving the

[21] DEFRA, UK plan for tackling roadside nitrogen dioxide concentrations, July 2017, Available at: https://uk-air.defra.gov.uk/library/no2ten/index
[22] The Air Quality Standards Regulations 2010 (legislation.gov.uk)
[23] The Air Quality Standards (Amendment) Regulations 2016 (legislation.gov.uk)

standard, either without exception or, for certain short-term averaging period standards, with a permitted number of exceedances.

Local authorities have a responsibility (under Part IV of the Environment Act 1995, as amended by Schedule 11 of the Environment Act 2021)[24] to review and assess local pollution levels against these objectives.

It should be noted that the AQS objectives only apply in locations likely to have 'relevant exposure' i.e., where members of the public are exposed for periods equal to or exceeding the averaging periods set for the standards. For this assessment, locations of relevant exposure including building façades of residential premises, schools, public buildings and medical facilities; places of work (other than certain community facilities) are excluded.

In January 2019, the UK Government published its new Clean Air Strategy[25], which set out actions to improve air quality by reducing pollution from a wide range of sources. Although international commitments are agreed at UK level, air quality is a substantially devolved policy area. The Cleaner Air for Scotland 2 (CAFS2) Strategy[26] sets out how the Scottish Government proposes to reduce air pollution to protect human health and fulfil Scotland's legal responsibilities over the period 2021 – 2026.

3.2.3.3. Dust

There are no national standards or guidelines for dust deposition currently set in the UK, or by any international organisation. This is mainly due to the difficulty that any standard set would need to relate to dust being a perceptual problem, rather than being specifically related to health effects. A threshold of 200 mg/m^2/day is recommended as a level for action by best practice guidance[27].

3.2.3.4. Ecological Criteria

Critical loads for nitrogen deposition have been set by the United Nations Economic Commission for Europe (UNECE)[28]. A critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive

[24] Environment Act 2021 (legislation.gov.uk)
[25] DEFRA, 2019. Clean Air Strategy 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf. [Accessed April 2023]
[26] Scottish Government. 2021.Cleaner Air for Scotland 2 available at: Cleaner Air for Scotland 2 - Towards a Better Place for Everyone - gov.scot (www.gov.scot)
[27] IAQM Guidance on Air Quality Monitoring in the Vicinity of Demolition and Construction Sites, http://www.iaqm.co.uk/wp-content/uploads/guidance/monitoring_construction_sites_2012.pdf
[28] UNECE, "Convention on Long-range Transboundary Air Pollution," Retrieved 2020 from https://www.unece.org/env/lrtap/welcome.html.html

elements of the environment do not occur, according to present knowledge. Critical loads vary by type of habitat and species and are available from the Air Pollution Information System (APIS) website[29]. The critical load for deposition (eutrophication) is given as a range and is quoted in units of kilograms per hectare per year (kg/ha/year), however the lower limit of the range is typically used in assessment as a precautionary principle.

3.2.3.5. Policy

National Planning Framework 4 (NPF4)[30], sets out policies for the development and use of land across Scotland up to 2045. It provides guidance for local authorities on incorporating air quality considerations into planning decisions and aims to protect the environment and to promote sustainable growth. Policy 27: Health and Safety states that *"Development proposals that are likely to have significant adverse effects on air quality will not be supported. Development proposals will consider opportunities to improve air quality and reduce exposure to poor air quality. An air quality assessment may be required where the nature of the proposal or the air quality in the location suggest significant effects are likely".*

There are no actions specific to the improvement of air quality although associated improvements are noted for the following national developments of need which will support the delivery of the spatial strategy: Urban Mass/Rapid Transit Network and National Walking, Cycling and Wheeling Network.

The Argyll and Bute Council Development Local Plan (LDP)[31] was adopted in March 2015 and sets out a strategic planning framework to guide change and development in Argyle and Bute of which key objective E is *'To ensure that outstanding quality of the natural, historical and cultural environment is protected, conserved and embraced'.*

The Argyll and Bute Council Development Local Plan 2 (LDP2)[32] is currently being prepared, however there are no specific policies related to air quality. The Strategic Environmental Assessment (SEA) for the LDP2 notes for air quality:

"Argyll and Bute is a predominantly rural area, with a relatively low population density and low level of emissions from transport and industry. It is unlikely that Argyll and Bute will have any Air Quality Management Areas declared. Good air quality is indicated by the prevalence of lichen communities and native woodlands of international importance."

[29] Centre for Ecology and Hydrology and the UK pollution and conservation agencies (2015), Air Pollution Information System: APIS [online] http://www.apis.ac.uk/
[30] National Planning Framework 4 - gov.scot (www.gov.scot)
[31] The Argyll and Bute Local Development Plan 2015 https://www.argyll-bute.gov.uk/ldp
[32] Proposed Argyll and Bute Local Development Plan 2 written Statement written Statement (argyll-bute.gov.uk)

The Local Development Plan for Loch Lomond & The Trossachs National Park Overarching Policy 2 requires that development proposals must address the following requirements in relation to air quality:

- *Amenity and Environmental Effects: avoid any significant adverse impacts of ... air emissions/odour/fumes/dust;*
- *Natural Environment: protect and/or enhance the biodiversity, sites and species designated at any level.*

3.2.4. Consultation

The Stage 2 assessment for air quality has used numerous online data sources and reports that are publicly available for air quality. Further consultation has not been undertaken at this time specifically for air quality as no issues have been identified, but it has been undertaken as part of the Stage 2 assessment of designated sites, as reported in Chapter 7 Biodiversity.

3.2.5. Scope of Stage 2 Assessment

A scoping review was carried out in line with DMRB guidelines to assess the work required for the assessment of air quality at DMRB Stage 2. The main objectives of the scoping review were to:

- review existing air quality information and reports relating to the Scheme Options;
- identify which aspects of air quality should be assessed in more detail as part of the DMRB Stage 2 Scheme Assessment Report due to their potential to inform the identification of a Preferred Option; and
- identify the scope of the DMRB Stage 2 air quality assessment.

DMRB LA 105 states that where construction is expected to last for more than two years, the traffic management measures and the effect of the additional construction vehicles should be assessed as an additional scenario.

The conclusion of the scoping assessment was that a simple qualitative assessment would be undertaken for construction dust and traffic, and for operational traffic, focusing on sensitive receptors within 200m of the Scheme Option Boundaries.

3.2.6. Assessment Methodology

The air quality assessment for the Proposed Scheme has been undertaken in line with DMRB LA 105 and consists of the following:

- description of existing baseline conditions;

- identification of sensitive receptors and AQMA;
- qualitative assessment of the likely effect on air quality during construction phase, see Appendix 3.2;
- qualitative assessment of the likely changes in air pollutant concentrations during operation of the Proposed Scheme at selected human health and ecological receptors;
- assessment of significance of the air quality effects in the Proposed Scheme opening year, using professional judgement; and
- identification of the need for mitigation measures where appropriate.

3.2.6.1. Limitations and Assumptions

Information on the extent and locations of construction compounds, laydown areas and other ancillary works are not defined at this stage. These will be assessed at DMRB Stage 3.

Insufficiently detailed traffic data (including flows, speeds and composition) for the construction and operational phases are available at this stage, therefore a qualitative assessment was undertaken based on experience of similar schemes where appropriate. Traffic impacts will be assessed quantitively at DMRB Stage 3.

3.3. Baseline Conditions

3.3.1. Study Area

The air quality study area for assessment of both the construction phase and the operational phase was defined accordance with DMRB LA 105 Air Quality[9].

- For the potential effects of construction dust, the study area was defined as the area within 200m of the temporary Scheme Option Boundaries (DMRB LA 105 paragraph 2.57). There is not sufficient information available at this stage to determine the affected road network (ARN) for construction traffic and any traffic management measures therefore this was defined as the A83(T) within 2km north or south of the Scheme Option Boundaries.
- For the potential effects of traffic emissions during the operational phase, in absence of sufficiently detailed traffic data at the time of writing, the study area was defined as where there are human health and ecological receptors identified within 200m of the combined extents of the Scheme Options and A83(T) mainline in the immediate vicinity (DMRB LA 105 paragraph 2.18 and 2.25).

The study area for air quality during construction and operation is provided in Volume 3, Figure 3.1. There are six sensitive human health receptors (residential properties,

represented by R1 to R6) and two designated ecological sites within 200m of the Scheme Options or potentially affected sections of the A83(T).

3.3.2. Study Area Context

The Proposed Scheme is located within the administrative area of Argyll and Bute Council and lies within the Loch Lomond and The Trossachs National Park.

3.3.2.1. Local Air Quality Management

There are no AQMAs within the administrative area of Argyll and Bute Council. The nearest AQMA is almost 50km away in East Dunbartonshire. The latest annual Air Quality Progress Report (2020[33]) states that air quality in Argyll and Bute is considered to be generally very good and complies with all relevant air quality objectives. Argyll and Bute Council has not identified any areas where air quality objectives may be under threat and where specific action is required to improve air quality. In the absence of industry hotspots the major potential source of pollution that may impact on human health is the motor vehicle. Traffic flows tend to reflect the low dispersed population in an area 73% of which is classified as remote[16]. However, tourism makes a significant and important contribution to the Argyll and Bute economy and is responsible for higher summer-time traffic flows in some areas.

3.3.2.2. Air Quality Monitoring

Measurements of pollutant concentrations can be made by establishing analytical instruments that can measure across a continuous time frame and record average, minimum and maximum concentrations over specified periods.

Sampling equipment, such as passive diffusion tubes, absorb pollutants over a longer time period and are subsequently analysed at an accredited laboratory to give an average concertation over the course of the monitoring term. Survey results from continuous monitoring are made available on UK-AIR[34] and the Air Quality in Scotland website[35] whereas results from local passive monitoring are available in the Annual Status Report published by Argyll and Bute Council[36].

[33] 2020 Air Quality Annual Progress Report (APR) for Argyll And Bute Council (June 2020), (online) Available at APR_2020_Argyll_and_Bute_Final.pdf (scottishairquality.scot)
[34] Department for Environment, Food and Rural Affairs (Defra), Interactive Monitoring Networks Map, Available at https://uk-air.defra.gov.uk/interactive-map
[35] Air Quality in Scotland (2015), Monitoring Data; (online). Available at: http://www.scottishairquality.co.uk/latest/summary
[36] Air Quality in Scotland (2021). Argyll and Bute Council. (online). Available at: https://www.scottishairquality.scot/laqm-reports/argyll-bute-council.

No continuous or passive air quality monitoring is undertaken in the vicinity of the Proposed Scheme. The closest diffusion tube monitoring sites is N10 located approximately 23km south of the Proposed Scheme. The measured NO_2 concentrations are shown in Table 3.2. The relevant criterion is the Scottish AQ objective 40µg/m^3 as an annual mean.

Table 3.2 Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) at Diffusion Tube Sites in Argyll and Bute, 2017-2021.

Site ID	Site Name	X coordinate	Y coordinate	Site type	In AQMA?	2017	2018	2019	2020	2021
N10	Sinclair Street, Helensburgh	229675	682442	Roadside	No	17.1	15.0	15.5	10.9	14.1
N8	East Princes Street. Helensburgh	229919	682287	Roadside	No	10.8	9.9	11.8	10.3	10.0
N9	Main Road, Cardross	234338	677717	Roadside	No	10.7	11.1	13.0	9.3	11.7
N4	Argyll Street, Dunoon	217324	676894	Roadside	No	12.1	12.1	13.5	8.2	9.6
N6	Colchester Square. Lochgiphead	186280	687920	Roadside	No	17.8	13.5	14.8	10.3	10.8

Given the urban roadside location of these monitoring sites, the reported concentrations are not representative of the conditions within the Proposed Scheme study area, which is predominantly rural. However, as the NO_2 concentrations are below the annual mean AQS objective at the urban sites, it is reasonable to assume that pollutant concentrations within the Proposed Scheme study area would be well below the respective objectives.

3.3.2.3. Defra Mapped Concentrations

Estimates of current and future year background pollutant concentrations in the UK are available on the UK-AIR website[12]. The Defra background estimates, which are a combination of measured and modelled data, are available for each 1 x 1km grid square throughout the UK for a reference year of 2018 which is the basis for the future year estimates up to 2030. These background estimates include contributions from all source sectors, e.g. road transport, industry and domestic and commercial heating systems.

Table 3. presents the pollutants NO_2, PM_{10} and $PM_{2.5}$ for the year 2022. The concentrations of these pollutants indicate that background concentrations in the air quality study area are well below relevant AQS objectives.

Table 3.3 Defra Mapped Background Concentrations (µg/m^3)

X coordinate	Y coordinate	Total NO_2 µg/m^3	Total PM_{10} µg/m^3	Total $PM_{2.5}$ µg/m^3
222500	704500	1.9	6.1	3.8
222500	705500	1.9	6.0	3.8
222500	706500	1.9	5.9	3.8
222500	707500	1.4	5.9	3.8
223500	704500	1.9	5.9	3.8
223500	705500	1.9	5.9	3.8
223500	706500	2.0	5.9	3.8
223500	707500	2.0	6.0	3.9
224500	704500	2.0	6.0	3.9
224500	705500	2.0	6.0	3.9
224500	706500	2.0	5.6	3.8
224500	707500	1.9	5.9	3.8
	Objective	*40*	*18*	*10*

3.3.2.4. Pollution Climate Mapping

Pollution Climate Mapping (PCM) model link data were obtained from Defra's UK Ambient Air Quality Interactive Map[11] for the Proposed Scheme air quality study area[11]. There are no PCM model links within 2km of the combined extents of the Scheme Options.

3.3.2.5. Ecological Designations

The potential impact of air quality on ecological receptors is related to the sensitivity of vegetation to nitrogen deposition, which is derived from vehicle emissions of oxides of nitrogen (NO_x). The nearest designated ecological site to the existing route is Beinn an Lochain Site of Special Scientific Interest (SSSI), located immediately to the west of the northern extent of the Scheme Options. The SSSI contains various habitats that are sensitive to nitrogen deposition including blanket bog, neutral grassland and wetland within 200m of the road edge. Critical load ranges and existing nitrogen deposition rates for the sensitive habitats within the SSSI are shown in Table 3.4. The background nitrogen deposition rate within the SSSI (2018 to 2020) exceeds the upper level of the relevant critical load range for blanket bog and the lower level of the range for neutral grassland habitats.

The Glen Etive and Glen Fyne Special Protection Area (SPA) also lies within 2km of the Scheme Options. The qualifying interest of the SPA is its importance to support a population of golden eagle; however, the supporting habitats, moss, lichen and wet heath, are not identified on APIS as being sensitive to nitrogen therefore the SPA does not require further assessment within this chapter. A Habitats Regulations Appraisal (HRA) screening

assessment was undertaken to inform the DMRB Stage 1 assessment[37]. As all Proposed Scheme Options remain under consideration and no further construction details are available, there is no merit in undertaking an additional HRA at DMRB Stage 2. Further detail is provided within Chapter 7 Biodiversity.

No other national or international designated sites have been identified within 2km of the Proposed Scheme. There are no non-statutory designated sites, or local wildlife sites, present in the Ecological Zone of Influence (EZoI) of the Proposed Scheme. There is no woodland listed in the Ancient Woodland Inventory within 1km of the Biodiversity Study Area (see Chapter 7 Biodiversity).

Table 3.4 Ecological designations sensitive to air quality within the study area

Site Name	Designation	Habitat	Critical Load Range (kg N/ha/yr)	APIS 2018-20 background (max) (kg N/ha/yr)
Beinn an Lochain	SSSI	Blanket bog	5-10	14.9-16.4
		Neutral grassland, Upland heathland	10-20	
		Wetland	20-30	

3.3.2.6. Summary of Baseline Conditions

A review of baseline air quality information for the air quality study area for the Proposed Scheme indicated:

- there are few receptors (human health / ecological) close to roads with the potential to trigger DMRB traffic change criteria;
- the Proposed Scheme is not within an AQMA;
- Defra mapped background concentrations are below 36µg/m^3 as an annual mean for NO_2 and PM_{10} and well below all Scottish AQS criteria and EU limit values;
- monitoring undertaken at the nearest diffusion tube monitoring sites to the Proposed Scheme recorded annual mean NO_2 concentrations below the relevant AQS objectives, indicating that there are unlikely to be exceedances in the immediate vicinity of the rural study area for the Proposed Scheme; and
- none of the Scheme Options is likely to affect compliance with Air Quality Limit Values.

[37] Jacobs AECOM (2022) Access to Argyll and Bute (A83) DRMB Stage 1 Habitats Regulations Appraisal, Transport Scotland, February 2022. Doc ref: A83AAB-JAC-EGN-XX_XX-RP-LE-0026 | P02

The receiving environment is classed to be of low sensitivity with reference to Table 2.11b of DMRB LA 105.

3.4. Potential Impacts

3.4.1. Construction

3.4.1.1. Construction Dust

Sensitive receptors, both human health and ecological, may potentially be adversely affected by dust generated by the construction of a road scheme if appropriate mitigation and monitoring is not implemented. This may occur within the Scheme Option temporary boundaries or along wider construction traffic or haul routes.

All Scheme Options

All of the Scheme Options have long duration construction periods, ranging from three to seven years, and are expected to comprise the handling and transport of large volumes of construction material, over 100,000m^3 of cut/fill and with onsite concrete batching. Therefore, in accordance with DMRB LA 105 guidance all Scheme Options are classified as a “large” potential dust source.

There are sensitive receptors, both residential and ecological, within 100m of the combined extents of the Scheme Option temporary boundaries and potential construction traffic and haul routes along the A83(T). These include residential properties and the Beinn an Lochain SSSI. In accordance with DMRB LA 105 all Scheme Options are therefore considered to have a “high” construction dust risk potential at this stage.

Any adverse air quality effects due to construction dust would be temporary and will be minimised by the application of appropriate mitigation measures. On this basis, there is unlikely to be a significant effect on air quality due construction dust emissions from any of the Scheme Options. Particular attention should be paid to areas of the SSSI within 50m of construction works and traffic.

3.4.1.2. Traffic emissions

All of the Scheme Options are likely to have construction periods lasting over two years. At this stage, traffic data for the construction phase are not available therefore a qualitative assessment has been undertaken considering likely traffic routes and receptor locations.

Green, Yellow, Pink and Purple Options

During construction of the Green, Yellow and Purple Scheme Options, traffic will continue to use the existing A83(T). For the Pink Option a temporary diversion would be required to facilitate the southern portal construction and mining works; this would include approximately 950m of realignment starting 450m north of the existing junction that currently allows access from the A83(T) to the OMR and ending on the bridge that carries the A83(T) over the Croe Water.

Construction haul routes are not confirmed but it has been assumed that light and heavy duty vehicles (LDVs and HDVs) would need to travel several kilometres on the A83(T) to the north and/or south beyond the Proposed Scheme extents. In addition to the two properties within 200m of the combined extents of the Proposed Scheme Options or the A83(T) in the immediate vicinity, there are properties within 200m of the A83(T) approximately 2km to the south that could also be affected by construction vehicle emissions. However, given the background pollutant concentrations within the study area, and existing traffic flows, it is unlikely that the impact of construction traffic would lead to a significant effect at properties within 200m such that air quality criteria for human health are exceeded.

Given the proximity of the SSSI to the road edge, the potential number of vehicle movements required to transport large volumes of material and the existing exceedance of the critical load at sensitive habitats means there is the potential for adverse impacts from construction traffic on designated habitats. It is recommended that detailed modelling is completed at Stage 3 when traffic data is available to quantify the potential impacts and identify appropriate management and mitigation.

Brown Option

For the Brown Option, the OMR will be used as a traffic management route while works are undertaken to construct the debris flow shelter on the existing A83(T). This temporary route would increase the distance to receptor R1 by 45 m but would reduce the distance to R6 by 10m, as seen in the figure. As an alternative, one lane of the existing A83(T) may be upgraded at a time. This will double the duration of the construction programme but would not change the distance to R6. Depending on where contraflows are set up, there could be queuing traffic near receptors R1 and R6 which would increase emissions. Construction haul routes are not yet known but it is assumed that vehicles would travel several kilometres on the A83(T) beyond the Proposed Scheme extents.

Given the existing good air quality within the air quality study area, and the distance of the current route to human health receptors, it is considered unlikely that the impact of traffic management and construction vehicles would have a significant effect on local air quality.

Given the proximity of the SSSI to the road edge and the large volumes of material required to be transported there is potential for adverse impacts from construction traffic on designated habitats. As critical loads for nitrogen deposition are exceeded within the SSSI, effects of construction traffic may be of minor significance for all Scheme Options. It is recommended that detailed modelling is completed at Stage 3 when traffic data is available to quantify the potential impact and identify appropriate management and mitigation.

3.4.2. Operation

3.4.2.1. Human Health Impacts

There are two Human Health receptors (R1 and R6) within the study area i.e. 200m of the combined extents across all Scheme Options or the A83(T) in the immediate vicinity. Table 3.2 shows the shortest distance to the A83(T) for the existing alignment and each of the Scheme Options to the Human Health receptors. All of the Scheme Options with the exception of the Brown Option result in a change in road alignment of more than 5m, and so have the potential for a significant change in air quality at receptors. The traffic flow on the existing A83(T) is 5,000 AADT which is considered a relatively low volume of traffic, there is insufficient detail available to inform a quantitative assessment of whether there are likely to be any pollutant exceedances near the human health receptors within the study area; however, given the nature of the Proposed Scheme, an increase in traffic flow or change in speed band that exceeds the DMRB LA 105 criteria is not expected.

Baseline pollutant mapping data can be used to indicate whether pollutant concentrations are at risk of exceeding Scottish air quality criteria with the Proposed Scheme due to the change in alignment. Table 3.3 shows the mapped background concentrations for 2022, at the location of the two human health receptors in the Proposed Scheme study area. The concentrations at R1 and R6 are significantly lower than the Scottish air quality targets for the Defra background mapped data for 2022.

Table 3.2 Distance of Human Health receptors to A83(T) for Existing and Proposed Scheme Options

Scheme Option	Distance from A83(T) to R1, m	Distance from nearest tunnel portal to R1, m	Distance from A83(T) to R6, m	Distance from nearest tunnel portal to R6, m
Existing	43	n/a	265	n/a
Green	513	n/a	302	n/a
Yellow	43	n/a	104	n/a
Brown	43	n/a	271	n/a
Pink	n/a (property lost with scheme)	n/a (property lost with scheme)	n/a (road in tunnel)	>1000

Scheme Option	Distance from A83(T) to R1, m	Distance from nearest tunnel portal to R1, m	Distance from A83(T) to R6, m	Distance from nearest tunnel portal to R6, m
Purple	43	>1000	82	320

Green Option

The Green Option results in the distance to the A83(T) centreline increasing to over 200m from both receptors R1 and R6. As existing air quality is good, effects of the increased distance to the Proposed Scheme when operational will be of negligible significance.

Yellow Option

The Yellow Option introduces a viaduct which will not significantly change the horizontal alignment of the A83(T) at its closest point to receptor R1 but for receptor R6 the distance to the A83(T) centreline reduces to 104m. Even if there were to be a doubling of the pollutant concentrations with the Proposed Scheme, AQS objectives would continue to be met given the low baseline data as set out in Section 3.4. On this basis, and given the low traffic flow of around 5,000 AADT this change is likely to be of negligible significance.

Brown Option

There will be no change in centreline alignment for the A83(T) therefore the effect on operational air quality for both receptors R1 and R6 is considered to be of negligible significance.

Pink Option

The Pink Option introduces a tunnel which would result in vehicle emissions being released from the portals only. Receptor R1 would be lost due to the alignment of the Pink Option. The distance between the A83(T) and receptor R6 would increase substantially as the northern tunnel portal will be located over 1km away. The effects of portal emissions on local air quality can therefore be considered to be of negligible significance.

Purple Option

The Purple Option includes a viaduct followed by a tunnel which would result in vehicle emissions being released from the portals. For R1, the A83(T) alignment is unchanged at the nearest point which is 43m away. There is no tunnel portal near R1 as the Purple Option is a viaduct at that point. R6 is 82m from the Purple Option, 189m nearer than the existing A83(T), and 320m from a tunnel portal. Even if there were to be a doubling of the pollutant concentration at R6 with the Purple Option, AQS objectives would continue to be met. On

this basis, and given the low traffic flow of around 5,000 AADT on the A83(T), this change is likely to be of negligible significance.

Table 3.3 Background pollutant concentrations 2022, µg/m^3

Receptor ID	X	Y	NO_2	PM_{10}	$PM_{2.5}$
R1	224425	705557	2.0	6.0	3.9
R6	223500	706500	2.0	5.9	3.8
AQ Criterion			40.0	18.0	10.0

3.4.2.2. Designated Habitat Impacts

There is one designated habitat, Beinn an Lochain SSSI, within 200m of all Scheme Options which may be affected by the Proposed Scheme when operational. The existing nitrogen deposition rate for the 5km grid square comprising the site in proximity to the A83(T) is 21.6kg N/ha/yr for forest and 16.5kg N/ha/yr for moorland habitat. This latter value exceeds the critical load for several types of relevant habitat that are sensitive to nitrogen within 200m of the road edge; bog, scree and neutral grassland lower bound critical loads are 5, 5 and 10kg/ha/yr respectively.

The APIS website indicates that the main contributing sources to the total nitrogen deposition rate at the SSSI are livestock farming and transboundary emissions, rather than road traffic emissions. The traffic flow on the existing A83(T) is 5,000 AADT which is considered a relatively low volume of traffic. Nevertheless, as the critical loads are already likely to be exceeded (Table 3.4), changes in the location and nature of vehicle emissions once operational could have a potential effect of minor (adverse) significance on air quality at the relevant habitat.

Yellow and Brown Options

The Yellow and Brown Options do not introduce a change in A83(T) centreline alignment in proximity to the identified sensitive habitats within the SSSI. As there is not expected to be a change in speed band, composition or volume of traffic once operational, a change in the rate of nitrogen deposition at the SSSI with these Scheme Options is likely to be of negligible significance.

Green Option

The Green Option includes a short section with a change in alignment of the A83(T) where the A83(T) centreline moves closer to the SSSI within 200m of its boundary at the northern Scheme extent. As there is not expected to be a change in speed band, composition or

volume of traffic once operational, a change in the rate of nitrogen deposition at the SSSI with this Scheme Option is likely to be of negligible significance.

Pink and Purple Options

Both the Pink and Purple Options involve a more substantial change in alignment of the A83(T) and introduce a tunnel, which would change the location and dispersion of emissions relative to the SSSI at its closest point. While the volume of traffic is expected to remain unchanged, the presence of a tunnel portal within 200m of relevant habitat (including bog) could cause a change in the nitrogen deposition rate as vehicle emissions are released from a single point rather than dispersed over a wider area. However, for both the Pink and Purple Options the alignment and portal will be further away than the existing A83(T) and SSSI. Detailed modelling is required to quantify this potential change when traffic data is available at Stage 3; the significance of the change will be interpreted in the Biodiversity assessment but in terms of air quality it may be considered of minor significance.

Overall significance of the Potential Scheme Options is discussed in Table 3.4 which outlines the supporting information used to arrive at the evaluation of significance of effects on air quality for the Scheme Options for the operational phase in line with DMRB LA 105.

Table 3.4 Overall evaluation of Air Quality Significance of Scheme Options.

Key Criteria Questions	Yes/No
Is there a risk that environmental standards will be breached?	Not for human health, as existing concentrations are well below AQS objectives (less than 36 µg/m^3 as an annual mean). Baseline critical loads for nitrogen deposition are exceeded at sensitive habitats within a SSSI and this may worsen with the Pink & Purple Options..
Will there be a large change in environmental conditions?	None of the Scheme Options is expected to significantly change flow, speed or composition. Existing traffic flow is relatively low and no measurable change is expected at human health receptors. The Pink and Purple Options introduce tunnel portals which may cause a change in nitrogen deposition at the Beinn an Lochain SSSI. Detailed modelling will be required to determine the magnitude of change for ecological sites.
Will the effect continue for a long time?	There are not expected to be significant adverse effects for human health receptors from operation of the Scheme. Detailed modelling will be required to determine the duration of impact for ecological sites noting the critical load is exceeded in the baseline.
Will many people be affected?	No. There are few human health receptors and there are not expected to be significant adverse effects from operation of the Scheme.
Is there a risk that designated sites, areas, or features will be affected?	Nationally designated site (SSSI) containing sensitive habitat; potential for worsening of the rate of nitrogen deposition which already exceeds the critical load within 200m of the A83(T). Further investigation at Stage 3 to determine potential for significant impacts.
Will it be difficult to avoid or reduce or repair or compensate for the effect?	The rate of nitrogen deposition already exceeds the critical load for some habitats. Further consideration of the magnitude of change and

Key Criteria Questions	Yes/No
	effects of nitrogen deposition on designated sites during operation of the Preferred Scheme is required at Stage 3.
On balance is the overall effect significant?	Overall, there is not expected to be a significant adverse effect on human health due to operation of any of the Scheme Options. There are no anticipated exceedances of AQS objectives and there is not a risk of non-compliance with the Air Quality Directive. The effect on ecological receptors within the SSSI will require further assessment at Stage 3, particularly for the Pink and Purple Options which introduce tunnel portals and where nitrogen deposition critical loads are currently exceeded; the overall significance on designated sites will be assessed by the competent biodiversity expert but for the purposes of air quality is assigned minor adverse significance for Pink and Purple Options only. It is not predicted that any of the Scheme Options would conflict with planning policy.

3.5. Potential Mitigation

3.5.1. Construction

Construction activities for all of the Scheme Options are assessed as a ‘high’ construction dust risk potential. Mitigation measures to control dust during construction will be specified within contract documentation and will be incorporated into the Construction Environmental Management Plan (CEMP) or equivalent for the Proposed Scheme. The precise measures, suitable for a ‘high’ construction dust risk will depend on the intended construction methods and the degree of dust generation for each Scheme Option.

Such measures may include but not necessarily be limited to:

- regular water-spraying and sweeping of unpaved and paved roads to minimise dust and remove mud and debris;
- using wheel washes, shaker bars or rotating bristles for vehicles leaving the site where appropriate to minimise the amount of mud and debris deposited on the roads;
- sheeting vehicles carrying dusty materials to prevent materials being blown from the vehicles whilst travelling;
- enforcing speed limits for vehicles on unmade surfaces to minimise dust entrainment and dispersion;
- ensuring any temporary site roads are no wider than necessary to minimise their surface area;
- damping down of surfaces prior to their being worked;
- storing dusty materials away from the Scheme Option Boundary and in appropriate containment (e.g. sheeting, sacks, barrels etc.); and

- securing an adequate water supply (ideally rainwater) on site for the effective suppression of dust.

Other best practice for minimising construction emissions includes:

- selecting electric or hybrid/battery powered equipment rather than diesel;
- ensuring plant and equipment is maintained in good working order;
- ensuring construction plant is not left running when not in use; and
- locating plant away from sensitive receptors (including residential and ecological).

The need for any mitigation measures in relation to potential operational impacts on designated ecological sites due to construction traffic emissions will be investigated as part of the assessment at DMRB Stage 3.

DMRB LA 105 states that the use of good practice mitigation and monitoring measures set out within a dust management plan, including daily on and offsite visual inspection at sensitive receptors and records of complaints/exceptional events, would be effective to mitigate the risk of construction dust impacts in the majority of cases i.e. such that residual impacts are not of significance.

DMRB LA 105 states that monitoring would not be required for the majority of road construction projects.

3.5.2. Operation

There are not expected to be any significant adverse effects with the any of the Scheme Options for the Human Health receptors, or risk of non-compliance with the Air Quality Directive. As such mitigation of the operational impacts for these receptors is not required.

The need for any mitigation measures in relation to potential operational impacts on designated ecological sites will be investigated as part of the assessment at DMRB Stage 3.

3.6. Conclusions

The impact significance of residual impacts in the table below is based on professional judgement in the absence of a defined method for qualitative simple assessment in DMRB LA 105, pending detailed, quantitative assessment at Stage 3.

The potential changes in air quality at human health receptors due to road realignment are not considered to be significant as total concentrations will remain well below objectives. Therefore, none of the Options are necessarily favoured from an air quality perspective and the differentiators are the potential impacts on ecological sites. Overall, the Green, Brown and Yellow Options are considered to have minor or negligible impacts while the Pink and Purple Options are considered to be least favourable due to the potential operational impacts on the SSSI due to the introduction of a tunnel portal. This is because there are sensitive habitats close to the road edge which currently exceed critical loads for nitrogen deposition.

Table 3.7 Air Quality Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Human Health	R1 to R6*	Emissions from construction dust/traffic	Negligible	Negligible	Negligible	Negligible	Negligible	No preference due to no significant impacts
Human Health	R1	Change in air quality during operation	Negligible	Negligible	N/A	Negligible	Negligible	No preference due to no significant impacts
Human Health	R6	Change in air quality during operation	Negligible	Negligible	Negligible	Negligible	Negligible	No preference due to no significant impacts
Ecological Sites	Beinn an Lochain SSSI	Emissions from construction dust	Negligible	Negligible	Negligible	Negligible	Negligible	No preference due to no significant impacts
Ecological Sites	Beinn an Lochain SSSI	Change in nitrogen deposition rate during construction	Minor	Minor	Minor	Minor	Minor	Cannot differentiate until traffic data available but likely to be similar in all cases

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Ecological Sites	Beinn an Lochain SSSI	Change in nitrogen deposition rate during operation.	Negligible	Negligible	Minor	Minor	Negligible	Pink and Purple Options are least favourable due to potential impact from portal emissions

*The location of these receptors is shown in Volume 3, Figure 3.1

3.7. Scope of DMRB Stage 3 Assessment

For Stage 3, potential effects on local air quality resulting from both the construction and operation of the Preferred Option will be assessed in accordance with relevant guidance outlined in DMRB LA 105.

Construction dust effects will be assessed qualitatively, taking into account the nature of any Proposed Scheme construction activities that have the potential to generate dust and the location of any of sensitive receptors situated within 200m of the Preferred Option construction works. Suitable mitigation measures to control/minimise construction dust emissions will be recommended. If traffic data for the construction phase are available, given the duration of construction is expected to exceed two years, quantitative assessment of construction vehicle emissions will be undertaken to examine the potential impact on human health and ecology.

For the assessment of operational effects, DMRB LA 105 provides methodologies for undertaking simple and/or detailed levels of assessment. Given the changes expected with some of the Scheme Options, both in terms of alignment and road type (viaduct, tunnel) and the proximity to a designated habitat that is sensitive to nitrogen deposition, it is anticipated that a detailed assessment will be required for operational effects if DMRB traffic change criteria are exceeded.

4. Cultural Heritage

4.1. Introduction

This chapter sets out the predicted effects on cultural heritage arising from the Scheme Options for the A83 Access Argyll and Bute project.

This chapter is supported by the following:

- Volume 3, Figure 4.1: Cultural Heritage Assets
- Appendix 4.1: Historic Background and Cultural Heritage Gazetteer.

4.2. Approach and Methods

4.2.1. Introduction

The assessment follows the guidance outlined in the DMRB for assessment of cultural heritage. The relevant sections of the guidance are LA 104 Environmental assessment and monitoring and DMRB LA 106 Cultural heritage Assessment[38].

4.2.2. Sources of Information

The following additional sources of information have been used for this assessment:

- Historic Environment Scotland (HES) datasets, updated in February 2023[39] Listed Buildings;
- West of Scotland Archaeology Service (WoSAS) online Historic Environment Record (HER), accessed February 2023[40];
- the Scottish National Record of the Historic Environment (SNRHE), accessed February 2023[41]; and
- notes and observation from an initial site meeting with the project team undertaken in December 2022.

4.2.3. Policy, Legislation and Guidance

The following national and local legislation and guidance forms the background against which the assessment has been made:

[38] DMRB LA 106 Cultural Heritage Assessment. Highways England et al. 2020
[39] Historic Environment Scotland Portal. Available at: https://portal.historicenvironment.scot/downloads
[40] West of Scotland Archaeology Service (WoSAS) online HER. Available at: http://wosas.net/search.php
[41] Historic Environment Scotland Portal. Available at: https://portal.historicenvironment.scot/downloads

- Scotland National Planning Framework 4 (2023)[42];
- The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017[43];
- Planning Advice Note (PAN) 2/2011: Planning and Archaeology (2011)[44];
- Town and Country Planning (Scotland) Act 1997[45];
- The Historic Environment Scotland Act 2014[46];
- Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997[47];
- Historic Environment Scotland Policy Statement (2016)[48];
- Our Place in Time: The Historic Environment Strategy for Scotland (2014)[49]; and
- Managing Change in the Historic Environment – Historic Environment Scotland's guidance note series[50];
- Argyll and Bute Council Local Development Plan[51]; and
- Loch Lomond and The Trossachs National Park Authority (LLTNPA) Development Plan, 2017-2021 (extended to 2024)[52].

The assessment follows the guidance outlined in the DMRB for assessment of cultural heritage:

- DMRB LA 104 guides the assessment from the magnitude of effect to determining the significance of effect for the cultural heritage resource; and
- DMRB LA 106 outlines the assessment process for the cultural heritage resource and refers to the process of determining significance criteria presented in DMRB LA 104.

The assessment is compliant with the planning policy and legislation listed above.

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[42] Scottish Government (2023). Fourth National Planning Framework 2023. Available at: https://www.gov.scot/publications/scotlands-fourth-national-planning-framework-position-statement/documents/
[43] The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017 https://www.legislation.gov.uk/sdsi/2017/9780111034941
[44] Scottish Government (2011). Planning Advice Note (PAN) 2/2011: Planning and Archaeology
[45] Town and Country Planning (Scotland) Act 1997 https://www.legislation.gov.uk/ukpga/1997/8/pdfs/ukpga_19970008_en.pdf
[46] Scottish Government (2014). The Historic Environment Scotland Act 2014
[47] UK Government (1997). Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997
[48] Historic Environment Scotland (2019). Historic Environment Policy for Scotland.
[49] Historic Environment Scotland (2014) Our Place in Time: The Historic Environment Strategy for Scotland. Available at https://www.gov.scot/publications/place-time-historic-environment-strategy-scotland/
[50] Historic Environment Scotland (2020), Managing Change in the Historic Environment: Setting. Available at: https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationid=80b7c0a0-584b-4625-b1fd-a60b009c254
[51] Argyll and Bute Council, (2020). Local Development Plan: Written Statement. Available at: https://www.argyll-bute.gov.uk/sites/default/files/written_statement_0_1_ac_0.pdf [Accessed April 2023].
[52] Loch Lomond and the Trossachs National Park Authority, (2017-2021). Local Development Plan. [Online] Available at: Our Local Development Plan - #LetsDoNetZero -Loch Lomond & The Trossachs National Park. Available at: lochlomond-trossachs.org. [Accessed April 2023].

4.2.4. Consultation

Consultation has been undertaken with HES, in their role on the A83 Environmental Steering Group (ESG), and with WoSAS. Comments were sought at DMRB Stage 2 from the above consultees to ensure a holistic view on potential impacts on cultural heritage assets arising from the Scheme Options.

HES provides advice on all heritage assets which are protected by statutory legislation within the scope of this assessment, including Scheduled Monuments, Category A Listed Buildings, Garden & Designed Landscapes and Inventory Battlefields. WoSAS provides advice on behalf of Argyll and Bute Council and Loch Lomond and The Trossachs National Park (LLTNP) as archaeological advisors, and cover Category B and C Listed Buildings and non-designated archaeology. The Proposed Scheme is located within the local authority area of the Argyll and Bute Council who are advised on archaeological matters by West of Scotland Archaeology Service (WoSAS).

Table 4.1 Consultation undertaken

Consultee	Response	Action
Historic Environment Scotland ESG Meeting 25/05/2021	It should be highlighted that the OMR is a heritage asset, albeit non-designated and is an important component of the cultural connections in the area.	Comments noted. The OMR has been identified as a heritage asset though review of data on Canmore. Additional non-designated assets along the OMR and the Rest and be Thankful viewpoint have also been identified.
West of Scotland Archaeology Service Pre-application consultation 16/03/2023	No real detail at this stage on the design of the scheme. An Initial review of the study area which covers the valley floor and lower slopes, highlights a number of general points. The area remains under-surveyed, but shows no show stoppers such as scheduled sites of prehistoric sites. Glencroe has a rich history that is evident on the ground in the form of ruins, field systems, sheilings and Roy's Map has named farmsteads in the valley too. A detailed ground survey of the preferred option would be required as a first stage in establishing the baseline for the area and subsequent avoidance or further mitigation as necessary for sites to be directly impacted.	Comments noted. Further detailed site survey will be undertaken as the scheme progresses into Stage 3 and detailed design. Further information will be gathered from WoSAS at this next stage with HER data purchases to ensure coverage of cultural heritage baseline.

4.2.5. Scope of Stage 2 Assessment

The assessment was undertaken with respect to the guidance provided by the DMRB LA 104 Environmental assessment and monitoring, and DMRB LA 106, which refers to the Chartered Institute for Archaeologists (CIfA) Standards and Guidance for Historic Environment Desk-Based Assessments[53].

This section provides an overview of the scope of the assessment and re-iterates the evidence base for scoping out elements of the topic following iterative assessment.

The elements shown in Table 4.2 are not considered to give rise to likely significant effects as a result of the Proposed Scheme and have therefore not been considered within the report.

Table 4.2 Elements Scoped out of the assessment

Element scoped out	Justification
World Heritage Sites	There are no World Heritage Sites within any of the Scheme Option boundaries or within the Study Area.
Scheduled Monuments	There are no Scheduled Monuments within any of the Scheme Option boundaries or within the Study Area.
Inventory Garden & Designed Landscapes	There are no Inventory Garden & Designed Landscapes within any of the Scheme Option boundaries or within the Study Area.
Inventory Battlefields	There are no Inventory Battlefields within any of the Scheme Option boundaries or within the Study Area.
Listed Buildings (Category A)	There are no Category A Listed Buildings within any of the Scheme Option boundaries or within the Study Area.
Conservation Areas	There are no Conservation Areas within any of the Scheme Option boundaries or within the Study Area.

4.2.6. Assessment Methodology

The assessment of the value of cultural heritage assets has involved consideration of how far the asset(s) contribute to an understanding of the past, through their individual or group qualities, either directly or potentially. These are professional judgements, but they are also guided by legislation, national policies, acknowledged standards, designation, criteria and priorities.

The assessment has followed the guidance tables for assessing value/sensitivity from the DMRB LA 104, which recommends the adoption of five ratings for value in relation to the

[53] Chartered Institute for Archaeologists (2020). Standard and Guidance for Historic Environment Desk-Based Assessments.

cultural heritage resource: very high, high, medium, low, and negligible (see Table 4.3). Example categories have been added. These have been taken from HES Designation Policy and Selection Guidance[54] and the Historic Environment Policy for Scotland (HEPS)[55].

Table 4.3 Factors for assessing the value of heritage assets

Value (sensitivity) of receptor / resource	Typical description and examples
Very High	Very high importance and rarity, international scale and very limited potential for substitution. • World Heritage Sites (including nominated sites); and • Assets of acknowledged international importance.
High	High importance and rarity, national scale, and limited potential for substitution. • Scheduled Monuments (including proposed sites); • Listed Buildings (Category A and B); • Battlefields included within the Inventory; • Marine Protected Areas; • Gardens and Designed Landscapes • Conservation areas containing nationally important buildings; • Non-designated assets of scheduled quality and importance; and • Assets of national importance.
Medium	Medium or high importance and rarity, regional scale, limited potential for substitution. • Listed Buildings (Category C); • Conservation areas containing buildings that contribute significantly to its historic character; and • Assets of regional importance.
Low	Low or medium importance and rarity, local scale. • Assets of local importance; • Assets compromised by poor preservation and/or poor survival of contextual associations; and • Buildings of modest quality in their fabric or historical association.
Negligible	Very low importance and rarity, local scale. • Assets with very little or no surviving archaeological interest; • Artefact find spots (where the artefacts are no longer in situ and where their provenance is uncertain); and • Poorly preserved examples of particular types of minor historic landscape features (e.g. quarries and gravel pits, dilapidated sheepfolds, etc).

[54] Historic Environment Scotland (2019b). Designation Policy and Selection Guidance.
[55] Historic Environment Scotland (2019a). Historic Environment Policy for Scotland.

Magnitude of Impact

The magnitude of impact is assessed using the guidance contained in DMRB LA 104 and is presented in Table 4.4.

Table 4.4 Factors for assessing the magnitude of impact on heritage assets

Magnitude of impact (change)		
Major	Adverse	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.
	Beneficial	Large scale or major improvement of resource quality; extensive restoration; major improvement of attribute of quality.
Moderate	Adverse	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements.
	Beneficial	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Minor	Adverse	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
	Beneficial	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	Adverse	Very minor loss or detrimental alteration to one or more characteristics, features or elements.
	Beneficial	Very minor benefit to or positive addition of one or more characteristics, features or elements.
No Change		No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Effect Significance

The significance of effect has been assessed using the following matrix from the DMRB LA 104 (Table 4.5).

Table 4.5 Significance of Effect Matrix

	Magnitude of impact (degree of change)					
Environmental value (sensitivity)		No change	Negligible	Minor	Moderate	Major
	Very High	Neutral	Slight	Moderate or large	Large or very large	Very large
	High	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
	Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
	Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate

	Magnitude of impact (degree of change)					
	Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

Significant effects comprise those effects that are within the moderate, large or very large categories, in accordance with LA 104.

Guidance

The following guidance has been applied to the appraisal process:

- Designation Policy and Selection Guidance[56];
- Managing Change in the Historic Environment Setting[57]; and
- Procedural Guidance for Archaeology and Development[58]

All elements of the appraisal have been undertaken in accordance with the following policies and guidelines of the Chartered Institute for Archaeologists (CIfA):

- Standards and Guidance for Historic Environment Desk-Based Assessment[59]; and
- Standards and Guidance for commissioning work on, or providing consultancy advice on, archaeology and the historic environment[60].

Limitations and Assumptions

This assessment has been prepared based on the results of desk-based research and initial walkover surveys only. No intrusive archaeological investigations have been undertaken. This is in line with the approach to DMRB Stage 2 assessment which was established in consultation with HES and WoSAS.

The Preferred Option will be assessed in DMRB Stage 3. A more detailed assessment will give further consideration to potential impacts on the cultural heritage resource of the Preferred Option. Cultural heritage design objectives shall be developed for the project and mitigation measures shall be identified.

[56] Historic Environment Scotland (2019). Designation Policy and Selection Guidance.
[57] Historic Environment Scotland (2020). Managing Change in the Historic Environment Setting – Historic Environment Scotland's guidance note series.
[58] West of Scotland Archaeology Service (2009). Procedural Guidance for Archaeology and Development
[59] Chartered Institute for Archaeologists (2021). Standards and Guidance for Historic Environment Desk Based Assessment.
[60] Chartered Institute for Archaeologists (2021). Standards and Guidance for commissioning work on, or providing consultancy advice on, archaeology and the historic environment.

Final details of the exact nature, location and scale of construction activities have not yet been established, nor have the structure design, associated landscape design, and final land take and therefore it has been assumed that assets within the Scheme Option boundaries would be affected. A worst-case scenario has been assumed at this stage of the assessment. Key design information set out in Part 1, Chapter 3, Description of Scheme Options in Volume 1 of the DMRB Stage 2 Scheme Assessment Report has informed the assessment.

4.3. Baseline Conditions

4.3.1. Study Area

The focus of this assessment is on the direct impacts caused by physical impacts to heritage assets and impacts to the significance of heritage assets caused by changes to their setting from the Proposed Scheme. The study of the heritage assets in the surrounding landscape establishes the local archaeological and historical context, providing a broader understanding of the historic development of the area and the potential for as-yet unidentified archaeological remains within the Scheme Options.

The nature and extent of any known or potential archaeological and historical resources has been examined to determine the potential impact of the Proposed Scheme within a study area encompassing the Scheme Options and a 250m buffer around their boundaries. A 1km buffer was also examined around the Scheme Options for statutory designated heritage assets and incorporates any additional important assets to inform a greater understanding of the archaeological landscape. The 250m study area adopted is shown on Volume 3, Figure 4.1. As there is only one asset within the 1km buffer, which is also shown on Volume 3, Figure 4.1, the 1km study area is not shown.

4.3.2. Study Area Context

The Proposed Scheme crosses an undulating landscape which consists of low intensity agriculture, grazing, moorland and dispersed settlement. The nature of the topography in the area means that the current A83(T) follows an elevated route on the hillside above the valley floor.

A total of 69 cultural heritage assets have been identified within the Study Areas. The location of the assets is shown on Volume 3, Figure 4.1 and are presented in Appendix 4.1: Historic Background and Cultural Heritage Gazetteer, alongside a detailed archaeological and historical background. This information has been gathered from review of the WoSAS

Online HER viewer[61], data from HES, an initial walkover survey conducted in December 2022.

There are no World Heritage Sites, Scheduled Monuments, Inventory Battlefields, Inventory Gardens and Designed Landscapes or Conservation Areas within the study area. There are two Listed Buildings (Category B and C) within the Study area. These assets are presented in Table 4.6 and on Volume 3, Figure 4.1.

Table 4.6 Summary of Designated Heritage Assets

Asset Number	HES Reference	Site Name	Designation
1	LB50538	Kinglas Water, Butter Bridge	Category B Listed Building
4	LB11816	Glen Croe, 'Rest and be Thankful' Stone	Category C Listed Building

Further to the designated assets, a summary of the non-designated heritage assets within the study area is provided in Table 4.7 below. Those assets without a reference number were identified from an archaeological desk-based assessment and field survey undertaken by CFA Archaeology in 2012[62]. All assets are shown on Volume 3, Figure 4.1.

Table 4.7 Summary of Non-designated Heritage Assets

Asset No.	Reference Number	Site Name		Asset No.	Reference Number	Site Name
2	WoSAS ID 21653 WoSAS ID 21692	Dumbarton - Tarbet - Inveraray - Tyndrum Military Road		39	-	Culvert - stone
3	-	Culvert - Stone		40	-	Culvert - Ceramic Pipe
5	-	Bridge		41	WoSAS ID 68819	Glen Croe - Structure
6	-	Concrete Plinth		42	-	Culvert - structure unclear
7	-	Bridge		43	-	Bridge
8	-	Wall		44	WoSAS ID 68820	Glen Croe - Shielings
9	-	Concrete Structure		45	Canmore ID 150772 WoSAS 44649	Mid Glen Croe - Building

[61] West of Scotland Archaeology Service, Online Historic Environment Record Viewer, available online: http://www.wosas.net/mapsearch.html

[62] Tweedie, H., & Karsgaard, P. (2012) Old Military Road, Rest and Be Thankful Diversion Route: Cultural Heritage Assessment. Report No. 2115

Asset No.	Reference Number	Site Name		Asset No.	Reference Number	Site Name
10	-	Concrete Plinth		46	-	Culvert - Ceramic Pipe
11	-	Brick Structure		47	-	Culvert - Ceramic Pipe
12	Canmore ID 293674	Rest and Be Thankful, Home Guards Stop Defence		48	-	Agricultrual/Industrial Installation
13	-	Culvert - Ceramic Pipe		49	Canmore ID 126140 WoSAS ID 21589	Laigh Glencroe, farmstead, sheepfold
14	-	Culvert - stone and concrete		50	Canmore ID 126139 WoSAS ID 21588	Laigh Glencroe, farmstead
15	-	Culvert - ceramic pipe		51	Canmore ID 126139 WoSAS ID 21588	Laigh Glen Croe
16	-	Culvert - stone		52	-	Culvert - Ceramic Pipe
17	-	Wall		53	-	Wall
18	Canmore ID 150778 WoSAS ID 44648	High Glen Croe		54	-	Quarry
19	-	Culvert - plastic pipe		55	-	Culvert - Ceramic Pipe
20	-	Culvert - stone, ceramic pipe		56	-	Culvert - concrete Pipe
21	-	Culvert - stone		57	-	Culvert - structure unclear
22	-	Culvert structure unclear		58	-	Culvert - Ceramic Pipe
23	-	Wall		59	Canmore ID 124257 WoSAS ID 21282	Croe Water - Farmstead
24	-	Wall		60	-	Culvert - Ceramic Pipe
25	Canmore ID 150772 WoSAS ID 44649	Mid Glen Croe, Hut circle or Cairn		61	-	Culvert - stone (N) and ceramic pipe (S)

Asset No.	Reference Number	Site Name		Asset No.	Reference Number	Site Name
26	-	Culvert - Ceramic Pipe		62	Canmore ID 176601 WoSAS ID 46003	Remains of a house and associated features
27	-	Brick Structure		63	Canmore ID 124262 WoSAS ID 28275	Structural remains
28	-	Culvert - Ceramic Pipe		64	Canmore ID 363452 WoSAS ID 94493	Glen Croe archaeological landscape
29	Canmore ID 150772 WoSAS ID 44649	Mid Glen Croe, Rig - Bank and Track		65	WoSAS ID 68815	Platform
30	Canmore ID 150772 WoSAS ID 44649	Mid Glen Croe, Enclosures		66	WoSAS ID 43329	Shielings
31	Canmore ID 150772 WoSAS ID 44649	Mid Glen Croe, Buildings (possible longhouses)		67	WoSAS ID 68817	Possible shieling mound
33	-	Wall		68	WoSAS ID 69922	Possible shieling platform
34	-	Culvert - stone		69	WoSAS 43329	Shieling
35	-	Culvert - stone				
36	-	Culvert -stone				
37	-	Wall				
38	WoSAS ID 68818	Glen Croe - Wall				
32	WoSAS ID 66823	Glen Croe - Quarry				

4.4. Potential Impacts

This section provides an introduction to the impact assessment of the Scheme Options. The potential impacts detailed below are reported in line with the following:

- Potential impacts represent those which could result from the generic construction or operation of the Scheme Options.
- Potential impacts are described without mitigation, and therefore represent a worse-case scenario. Mitigation to reduce these impacts will be developed for the Preferred Option during DMRB Stage 3 Assessment.

- The assessment of impacts identifies those that are common to all Scheme Options and those that vary between them.

Construction

Potential impacts for all Scheme Options are set out below. The majority of impacts upon cultural heritage remains will occur during the construction phase. Development activities such as groundworks, topsoil stripping, landscaping, ground compaction, access, service installation, stockpiling and storage will all have a negative effect on cultural heritage assets. These construction related impacts could lead to the following effects upon the historic environment:

- permanent complete or partial loss of an archaeological feature, structure or deposit as a result of ground excavation;
- permanent or temporary loss of the physical and/or visual integrity of a feature, monument, building or group of monuments;
- damage to resources as a result of ground excavation;
- damage to resources due to compaction, desiccation or waterlogging; and
- damage to resources as a result of ground vibration caused by construction.

Operation

As stated above, the majority of the impacts to the historic environment would occur during the construction phase. Operational impacts would relate to indirect setting impacts due to:

- potential increased width of the roads and or changes in infrastructure;
- the introduction of new infrastructure and lighting; and
- the introduction of light, visual and noise intrusion from traffic.

4.4.1. Construction

Impacts Common to all Scheme Options

Based on the presence of known assets associated with known and potential settlement activity extending from prehistory through to the post-medieval period, the potential for archaeological remains within the study area has been assessed to be medium. All of the Scheme Options could result in the removal of previously unrecorded archaeological remains during construction. The significance of this impact in unknown at this stage of assessment. This will be considered in more detail at Stage 3.

Although assets may have changes in their setting, where the setting of an individual asset does not contribute to its significance (i.e. why it is important), it is considered that there would be no impact.

Green Option

The Green Option has the potential for physical impacts on two assets. Construction activity also has the potential to impact these assets caused by changes in their setting, and of on an additional eight non-designated assets.

There is the potential for physical impacts during construction on a single designated asset, the Glen Croe 'Rest and be Thankful' Stone *(Asset 4)* from the Green Option. Construction activity also has the potential to impact the asset caused by changes to its setting. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is considered to be Slight Adverse.

There is the potential for physical impacts during construction on the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road *(Asset 2).* The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. Construction activity also has the potential to impact the asset caused by changes to its setting. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect has been assigned Slight Adverse.

Construction activity has the potential to impact the structures at High Glen Croe *(Asset 18),* caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance, and key views face away from the Green Option. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is Slight Adverse. This is a temporary, construction phase impact.

Construction activity also has the potential to impact seven additional assets. These include a former farmstead of medium value (Asset 59), the base of a former buildings related to World War II defences, including pillboxes and a Nissen hut (*Assets 6, 9, 10, 11 & 12*) of low value, a wall of negligible value (*Asset 8)*. However, the setting of these assets is not a key contributor to their value, and the farmstead is screened by existing woodland. Therefore the magnitude of impact is no more than minor, resulting in a significance of effect of Slight Adverse.

Yellow Option

In addition to the common impacts outlined above, during construction, the Yellow Option has the potential for physical impacts on an additional five non-designated assets**.** The introduction of new elements of infrastructure also has the potential to impact these assets and cause changes to their setting.

The introduction of new elements of infrastructure also has the potential to impact a single designated asset, the Glen Croe 'Rest and be Thankful' Stone (Asset 4) caused by changes to its setting. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is considered to be Slight Adverse.

There is the potential for physical impacts during Construction on the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2). The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. Construction activity also has the potential to impact the asset caused by changes to its setting. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect has been assigned Slight Adverse. Construction activity also has the potential to impact on three culverts (Assets 3, 39 & 40) located along the road but these impacts are considered to be Neutral.

Construction activity has the potential to impact the structures at High Glen Croe (Asset 18), caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect has been assigned Slight Adverse. This is a temporary, construction phase impact.

The site of archaeological features including two possible hut circles, areas of field systems and clearance and two substantial features which may be the remains of longhouses or, possibly though less likely, the robbed remains of a prehistoric long cairn (Asset 4), is located on the alignment of the Yellow Option. These assets relate to prehistoric, post-medieval agricultural activity and clearance settlement adjacent to the military road and are of medium value. As not all of this site will be impacted by construction, the magnitude of impact is moderate, resulting in a Moderate Adverse significance of effect without mitigation.

Brown Option

The Brown Option has the potential for impacts on one designated asset and on two non-designated assets.

There is the potential to impact a single designated asset, the Glen Croe 'Rest and be Thankful' Stone (Asset 4), caused by changes in its setting. As a Grade C listed building it is considered to be of medium value. The magnitude of impact on this medium value asset has been assessed as minor, and therefore the significance of effect is considered to be Slight Adverse.

Construction activity has the potential to impact the structures at High Glen Croe *(Asset 18),* caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance, and the Brown Option is online. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is considered to be Slight Adverse. This is a temporary, construction phase impact.

Construction activity has the potential to impact the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2)caused by changes to its setting. The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect is therefore Slight Adverse.

A structure of unknown date and function (Asset 41) is located within the footprint of the Brown Option. It is likely that this is related to agricultural activity and is therefore of no more than low value. This asset would be removed by the construction of the Brown Option, resulting in a major magnitude of impact. On this low value asset this is considered to be no more than a Slight Adverse significance of effect.

Pink Option

During construction, the Pink Option has the potential to physically impact on one non-designated assets. This is a rectangular structure of unknown date (Asset 41). It is considered to be of no more than low value. The magnitude of impact has been assessed as moderate and the significance of effect is therefore Slight Adverse.

Purple Option

There is the potential for physical impacts during construction on the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2). The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. Construction activity also has the potential to impact the asset caused by changes to its setting. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect is considered to be Slight Adverse.

Construction activity has the potential to impact the structures at High Glen Croe (Asset 18), caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance. The

magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is considered to be Slight Adverse. This is a temporary, construction phase impact.

The site of archaeological features including two possible hut circles, areas of field systems and clearance and two substantial features which may be the remains of longhouses or, possibly though less likely, the robbed remains of a prehistoric long cairn (Asset 29), is located on the alignment of the Purple Option. These assets relate to prehistoric, post-medieval agricultural activity and clearance settlement adjacent to the military road and are of medium value. As not all of this site would be impacted by Construction, the magnitude of impact is moderate, resulting in a Moderate Adverse significance of effect without mitigation.

Construction Impacts Summary

Table 4.8 presents a summary of impacts for the Scheme Options during the construction period, prior to the adoption of any mitigation.

Table 4.8 Summary of Impacts for the Scheme Options during construction

Asset No.	Asset Name	Description of Impact	Value	Magnitude of Impact	Overall Significance of Effect	Impacted by
2	Dumbarton – Tarbet – Inveraray – Tyndrum Military Road	Construction of new infrastructure and upgrades of existing infrastructure may introduce physical impacts on elements of this asset. Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting.	High Value	Minor	Slight Adverse	Green Option Yellow Option Brown Option Purple Option
3	Culvert – Stone	Construction of the Scheme Option has the potential for physical impacts on this asset.	Negligible Value	Negligible	Neutral	Yellow Option
4	Glen Croe 'Rest and be Thankful' Stone	Construction of new infrastructure and upgrades of existing infrastructure may result in physical impacts on elements of this asset. Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting.	Medium Value	Minor	Slight Adverse	Green Option Brown Option Yellow Option
6	Concrete Plinth	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Low Value	Minor	Slight Adverse	Green Option
8	Wall	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Negligible Value	Minor	Slight Adverse	Green Option
9	Concrete Structure	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Low Value	Minor	Slight Adverse	Green Option
10	Concrete Plinth	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Low Value	Minor	Slight Adverse	Green Option

Asset No.	Asset Name	Description of Impact	Value	Magnitude of Impact	Overall Significance of Effect	Impacted by
11	Brick Structure	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Low Value	Minor	Slight Adverse	Green Option
12	Rest and be Thankful, Home Guards Stop Defence	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Low Value	Minor	Slight Adverse	Green Option
18	High Glen Croe	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Medium Value	Minor	Slight Adverse	Green Option Brown Option Purple Option Yellow Option
29	Mid Glen Croe, Rig – Bank and Track	Potential for physical impacts on this asset.	Medium Value	Moderate	Moderate Adverse	Purple Option Yellow Option
39	Culvert – stone	Potential for physical impacts on this asset.	Negligible Value	Negligible	Neutral	Yellow Option
40	Culvert – Ceramic Pipe	Potential for physical impacts on this asset.	Negligible Value	Negligible	Neutral	Yellow Option
41	Glen Croe – Structure	Widening of the existing A83(T) and earthworks in this area will result in physical impacts on this asset.	Low Value	Major	Slight Adverse	Brown Option
				Moderate	Slight Adverse	Pink Option
59	Croe Water - farmstead	Temporary noise and visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Medium Value	Minor	Slight Adverse	Green Option

4.4.2. Operation

Green Option

There is the potential for impacts caused by changes to setting during Operation on a single designated asset, the Glen Croe 'Rest and be Thankful' Stone (Asset 4). The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of impact has been assigned Slight Adverse.

There is the potential to impact the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2) caused by changes to its setting. The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect has been assigned Slight Adverse.

The operation of the Green Option has the potential to impact the structures at High Glen Croe (Asset 18), caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance, and key views face away from the Scheme Option. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is Slight Adverse.

Seven additional assets could also be impacted by changes to their setting, caused by the presence of the Green Option on the landscape. These include a former farmstead of medium value (Asset 59), the base of a former buildings related to World War II defences, including pillboxes and a Nissen hut (Assets 6, 9, 10, 11 & 12) of low value, a wall of negligible value (Asset 8). However, the setting of these assets is not a key contributor to their value, and the farmstead is screened by existing woodland. Therefore, the magnitude of impact is no more than minor, resulting in a significance of effect of Slight Adverse.

Yellow Option

There is the potential for impacts caused by changes to setting during the operation of the Yellow Option on a single designated asset, the Glen Croe 'Rest and be Thankful' Stone (Asset 4). The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is considered to be Slight Adverse.

There is the potential to impact the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2) caused by changes to its setting. The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and

consequently is considered to be of high value. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect is therefore Slight Adverse.

The operation of the Yellow Option has the potential to impact the structures at High Glen Croe (Asset 18), caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is Slight Adverse.

Brown Option

There is the potential for impacts caused by changes to setting during the operation of the Brown Option on a single designated asset, the Glen Croe 'Rest and be Thankful' Stone (Asset 4). The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of impact has been assigned Slight Adverse.

There is the potential to impact the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2) caused by changes to its setting. The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. While the setting of the Military Road in this area does contribute to its significance, it is only in relation to its cross-country route through the valley and related to its use for motorsport racing. This is specifically related to the hill climb, narrow bridges, steep corners, and the final hairpin bend at its northern end. Although the Brown Option will add a rock shelter to the existing A83, increasing its visual presence on the landscape, the key parts of the setting of the Military Road are not affected. The magnitude of impact on this high value asset has therefore been assessed as minor, and the significance of effect is therefore Slight Adverse.

The operation of the Brown Option has the potential to impact the structures at High Glen Croe (Asset 18), caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance, and although the Brown Option adds a rock shelter to the existing A83, it is an online option. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is Slight Adverse.

Pink Option

During operation, no impacts are predicted on any assets from the Pink Option

Purple Option

There is the potential to impact the Dumbarton – Tarbet – Inveraray – Tyndrum Military Road (Asset 2) caused by changes to its setting during the operation of the scheme. The asset represents a key transient route through Glen Croe and provides evidence of the militarisation of Scotland, and consequently is considered to be of high value. The magnitude of impact on this high value asset has been assessed to be minor, and the significance of effect is therefore Slight Adverse.

The operation of the Purple Option has the potential to impact the structures at High Glen Croe (Asset 18), caused by changes to its setting. It is considered to be of medium value as an example of post-medieval agricultural activity and clearance settlement adjacent to the military road. However, its setting is not considered to be a key factor in the asset's importance. The magnitude of impact on this medium value asset has been assessed to be minor, and the significance of effect is Slight Adverse.

Operation Impacts Summary

Table 4.9 presents a summary of impacts for the Scheme Options during the operational period, prior to the adoption of any mitigation.

Table 4.9 Summary of Impacts for the Scheme Option during operation

Asset No.	Asset Name	Description of Impact	Value	Magnitude of Impact	Significance of Effect	Impacted by
2	Dumbarton – Tarbet – Inveraray – Tyndrum Military Road	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	High Value	Minor	Slight Adverse	Green Option Purple Option Yellow Option Brown Option
4	Glen Croe 'Rest and be Thankful' Stone	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Medium Value	Minor	Slight Adverse	Green Option Brown Option Yellow Option
6	Concrete Plinth	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Low Value	Minor	Slight Adverse	Green Option
8	Wall	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Negligible Value	Minor	Slight Adverse	Green Option
9	Concrete Structure	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Low Value	Minor	Slight Adverse	Green Option
10	Concrete Plinth	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Low Value	Minor	Slight Adverse	Green Option
11	Brick Structure	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Low Value	Minor	Slight Adverse	Green Option

Asset No.	Asset Name	Description of Impact	Value	Magnitude of Impact	Significance of Effect	Impacted by
12	Rest and be Thankful, Home Guards Stop Defence	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Low Value	Minor	Slight Adverse	Green Option
18	High Glen Croe	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Medium Value	Minor	Slight Adverse	Green Option Brown Option Purple Option Yellow Option
59	Croe Water	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting.	Medium Value	Minor	Slight Adverse	Green Option

4.5. Potential Mitigation

The design of the Scheme Options has not been sufficiently developed to allow mitigation measures to be defined in detail at this stage. The objective of this section is to identify potential mitigation taking into account best practice, legislation and guidance. This would be developed and refined during the next stage of assessment. Potential mitigation could include:

- Development of the horizontal and/or vertical alignments and location of the SuDS to avoid or reduce impacts on the cultural heritage resource. Design development should seek to avoid impacts and where this is not feasible should seek to minimise impacts.
- Where it is not possible to avoid or reduce impacts on the cultural heritage resource, it may be possible to reduce the magnitude of impact through mitigation works in advance of or during construction, for example archaeological excavation, watching brief, landscape survey, historic building recording, and the dissemination of the results of these works, including readily accessible archives to provide a permanent record of the any assets. In this way recording can reduce the magnitude of impact that would otherwise occur if a heritage asset were to be damaged or destroyed unrecorded.
- The potential to enhance the archaeological record through the introduction of interpretation boards and/or recording and archiving of interviews encompassing intangible elements and motorsport links with the hill-climb events should also be explored.

Measures to reduce impacts on the setting of the cultural heritage resource potentially include:

- Design of earthworks to avoid an overly engineering appearance and enable as much land as possible to be returned to agriculture.
- Avoidance of loss or damage to landscape features such as mature trees, walls, water features or field systems as far as possible.
- Retention of existing trees and vegetation where possible and incorporation with new planting proposals.
- Mitigation planting to aid the integration of the Proposed Scheme into the landscape. Planting will initially provide relatively limited screening but will mature and become more effective over time. It should be noted that unless designed sympathetically, mitigation planting can itself increase the impact on the setting of heritage assets.

The scope of any future mitigation will be agreed with WoSAS and Transport Scotland's Historic Environment Advisor and will be carried out in order to address the adverse effect on the cultural heritage resource.

4.6. Conclusions

This section provides a summary of the assessment of potential impacts for the Scheme Options. Two aspects are considered: whether any potential effects would be considered significant (i.e. a residual impact of Moderate or greater), and whether any of the potential impacts identified differ sufficiently between the Scheme Options.

Assessment of the Scheme Options indicates that during construction, all Scheme Options have the potential to impact on both known and previously unrecorded elements of the Historic Environment. The Green Option would have a Slight Adverse significance of effect on ten assets. There would be three Slight Adverse effects caused by the Brown Option. The Pink Option would have a Slight Adverse effect on one asset and the Purple Option would have one Moderate Adverse (significant) effect and two Slight Adverse impacts. The Yellow Option has one Moderate Adverse (significant) effect, three Slight Adverse and three neutral effects.

The operation of the Proposed scheme would result in nine slight adverse effects by the Green Option, three Slight Adverse effects from the Brown Option, no effects from the Pink Option, two Slight Adverse effects from the Purple Option and three slight adverse effects from the Yellow Option.

In conclusion, the greatest residual significance of effect on the historic environment is caused by the Purple and Yellow Options. While the Green Option and Brown Option would impact on a number of assets, this is lesser than by the Purple and Yellow Options. The Pink Option would be the most favourable in terms of the Historic Environment. Table 4.10 shows the assets where there is a difference in the significance of effect between the options.

Table 4.10 Cultural Heritage Comparative Appraisal

Receptor	Potential Impact	Significance of Effects (Residual Impacts)					Comparative Appraisal
		Green	Brown	Pink	Purple	Yellow	
Asset 2 Dumbarton – Tarbet – Inveraray – Tyndrum Military Road	Increase noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting. Impact during construction and operation	Slight Adverse	Slight Adverse	Neutral	Slight Adverse	Slight Adverse	For the Green, Brown, Purple and Yellow Options, there is the potential for physical impacts and impacts caused by changes to the setting of the asset due to the introduction of infrastructure.
Asset 4 Glen Croe 'Rest and be Thankful' Stone	Construction of new infrastructure and upgrades of existing infrastructure may result in physical impacts on elements of this asset. Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting.	Slight Adverse	Slight Adverse	Neutral	Neutral	Slight Adverse	There is potential to physically impact this asset during construction from the Green Option, and impacts caused by changes to setting during construction and operation by the Green, Brown and Yellow Options.
Asset 6 Concrete Plinth	Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.
Asset 8 Wall	Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.
Asset 9 Concrete Structure	Noise, visual intrusion and construction activity has the	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.

Receptor	Potential Impact	Significance of Effects (Residual Impacts)					Comparative Appraisal
		Green	Brown	Pink	Purple	Yellow	
	potential to impact the asset caused by changes to its setting						
Asset 10 Concrete Plinth	Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.
Asset 11 Brick Structure	Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.
Asset 12 Rest and be Thankful, Home Guards Stop Defence	Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.
Asset 18 High Glen Croe	Increased noise and visual intrusion and the introduction of new elements of infrastructure has the potential to impact the asset caused by changes to its setting. Impact during construction and operation.	Slight Adverse	Slight Adverse	Neutral	Slight Adverse	Slight Adverse	For the Green, Brown, Purple and Yellow Options, there is the potential for impacts caused by changes to the setting of the asset due to the introduction of infrastructure.
Asset 29 Mid Glen Croe, Rig – Bank and Track	Potential for physical impacts on this asset during construction.	Neutral	Neutral	Neutral	Moderate Adverse	Moderate Adverse	For the Purple and Yellow Options there is the potential for physical impacts on this asset.

Receptor	Potential Impact	Significance of Effects (Residual Impacts)					Comparative Appraisal
		Green	Brown	Pink	Purple	Yellow	
Asset 39 Culvert – stone	Potential for physical impacts on this asset.	Neutral	Neutral	Neutral	Neutral	Slight Adverse	For the Yellow Options there is the potential for physical impacts on this asset.
Asset 40 Culvert – Ceramic Pipe	Potential for physical impacts on this asset.	Neutral	Neutral	Neutral	Neutral	Slight Adverse	For the Yellow Options there is the potential for physical impacts on this asset.
Asset 41 Glen Croe – Structure	Widening of the existing A83(T) and earthworks in this area will result in physical impacts on this asset.	Neutral	Slight Adverse	Slight Adverse	Neutral	Neutral	For the Brown and Pink Options there is the potential for physical impacts on this asset.
Asset 59 Croe Water - farmstead	Noise, visual intrusion and construction activity has the potential to impact the asset caused by changes to its setting	Slight Adverse	Neutral	Neutral	Neutral	Neutral	There is potential for impact caused by changes to the setting of this asset during construction and operation by the Green Option.

4.7. Scope of DMRB Stage 3 Assessment

As part of the DMRB Stage 3, the design of the Preferred Option would be reviewed and, where possible, be further developed to minimise impacts on the cultural heritage resource.

A detailed archaeological walkover survey of the site will be undertaken to identify any heritage assets which are not currently listed on the HER, as well as to assess the condition of recorded assets. WoSAS will also be approached for detailed HER data to supplement and enhance current datasets and to identify any additional heritage assets. Further review of historic mapping will also be undertaken where considered necessary.

Impacts on the setting of heritage assets should be assessed based on the guidance provided by Managing Change Guidance[63]. The assessment will otherwise follow DMRB.

[63] Historic Environment Scotland (2020), Managing Change in the Historic Environment: Setting. Available at: https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationid=80b7c0a0-584b-4625-b1fd-a60b009c254

5. Landscape

5.1. Introduction

Landscape character assessment is the systematic description and analysis of the elements and features, such as landform, vegetation cover, settlement, land use and transport pattern present in the landscape which together make up the landscape pattern or sense of place.

The assessment of landscape receptors concerns direct anticipated changes to the landscape including impacts to designated landscapes, to the landscape character, and considers the Special Landscape Qualities (SLQ) of the landscape as defined by The Loch Lomond and The Trossachs National Park Authority (LLTNPA).

This chapter identifies and assesses the existing landscape receptors within the identified study area likely to be affected by the Scheme Options.

5.2. Approach and Methods

5.2.1. Introduction

The assessment approach was informed by the Methodology which was informed by the DMRB LA 107 Landscape and Visual Effects[64] and DMRB LA 104 standards, which were based on the Guidelines for Landscape and Visual Impact Assessment (GLVIA3)[65] . Fitting Landscapes66 also informed the process of route appraisal for landscape in terms of understanding the context of the landscape (e.g. through the perceptual qualities as well as the physical pattern of the landscape which, though not a differentiator at Stage 2, highlighted where potential impacts might occur at this early stage which will be further considered at Stage 3.

Given the iconic nature of the route and the sensitivity of the landscape, the methodology includes consideration of the SLQs of the LLTNP.

The assessment was undertaken by a Chartered Landscape Architect and comprised of desk and field study. A site visit was undertaken in March 2023 and helped to gain an

[64] DMRB LA 107 Landscape and Visual Effects. Highways England et al. 2020
[65] The Landscape Institute and Institute of Environmental Management and Assessment (2013). Guidelines Landscape and Visual Impact Assessment (Third Edition). Routledge.
[66] Transport Scotland, 2014, *Fitting Landscapes: Securing more sustainable landscapes.*

understanding of the landscape context and to supplement information gathered during the desk study.

At DMRB Stage 2 the focus is on comparative assessment that will facilitate differentiation between the Scheme Options.

The assessment has considered the impact of the Scheme Options in the winter of year 1 (WY1) and the summer of year 15 (SY15) in line with DMRB requirements, as well as potential temporary effects during construction. The impacts of the Scheme Options have been assessed with essential mitigation (as described in Section 5.4) as embedded mitigation as part of the design has not yet been defined.

5.2.2. Sources of Information

The first stage of the assessment is to determine the baseline against which the magnitude of impact can be assessed. A desk study was carried out to review existing maps and information. The following sources of information were integral to the baseline:

- Aerial Photography;
- Geographical Information Systems (GIS) datasets;
- Infraworks 3D models; and
- Ordinance Survey (OS) maps.

5.2.3. Policy, Legislation and Guidance

Landscape and landscape-related policy is set out in section 5.3.3. The policies are not considered to be differentiators between options but will be assessed at DMRB Stage 3. The relevant policy and legislation is as follows:

- National Planning Framework 4 (NPF4), 2023[67];
- The LLTNP Development Plan, 2017-2021 (extended to 2024)[68];
- Argyll and Bute Local Development Plan, 2015[69];
- Argyll and Bute Supplementary Guidance, adopted 2016[70];

[67] Scottish Government. (2023) National Planning Framework 4. [Online]. Available at: National Planning Framework 4 - gov.scot (www.gov.scot)
[68] The Loch Lomond and the Trossachs National Park Authority (2017-2021). Local Development Plan. [Online] Available at: Our Local Development Plan - #LetsDoNetZero -Loch Lomond & The Trossachs National Park (lochlomond-trossachs.org)
[69] Argyll and Bute Council (2015). Local Development Plan. [Online] Available at: Local Development Plan (argyll-bute.gov.uk)
[70] Argyll and Bute Council (March 2016). Local Development Plan Supplementary Guidance. [Online]. Available at: Supplementary guidance (argyll-bute.gov.uk)

- The Special Landscape Qualities of the Loch Lomond and The Trossachs National Park, 2010[71]; and
- Argyll and Bute Proposed Local Development Plan 2, 2019[72];

5.2.4. Consultation

No specific consultation relating to landscape has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA, NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

5.2.5. Scope of Stage 2 Assessment

Landscape and visual receptors within a study area of 3km have been considered in the assessment.

There are no National Scenic Areas (NSAs) within the study area. The Loch Lomond NSA lies to the east of the study area (the nearest part of the NSA to the study areas is Tarbet). However, there is no ZTV coverage and it has not been considered further.

There are no Gardens or Designed Landscape within the study area.

Ancient Woodland is land that has maintained continuous woodland habitat since at least 1750. Ancient Woodland Inventory is limited to small pockets in the south of the study area (see Volume 3, Figure 5.2A). None of the Scheme Options would have any impact on these and they have not been considered further.

The Landscape Character Types (LCTs) within the study area which contain no part of the option footprint and/or which have no ZTV coverage have not been considered further though they are shown on Volume 3, Figure 5.3B for context. This includes The Settled Coastal Fringe LCT No.265 which lies within the study area for the Green Option.

5.2.6. Assessment Methodology

In accordance with DMRB and GLVIA3, the assessment has considered the sensitivity of the landscape receptor, the magnitude of impact of the Proposed Scheme upon it and resulted

[71] NatureScot Commissioned Report No.376 (2010). The Special Landscape Qualities of the Loch Lomond and The Trossachs National Park. [Online] Available at: NatureScot Commissioned Report 376: The Special Landscape Qualities of the Loch Lomond and The Trossachs National Park | NatureScot
[72] Argyll and Bute Council (November 2019). Proposed Local Development Plan 2

in determination of the significance of effect of the Proposed Scheme on the landscape resource.

The landscape assessment considered designated landscapes, landscape character and the SLQs of the LLTNP.

5.2.6.1. Sensitivity

Sensitivity was assessed by considering landscape value and susceptibility and has been assigned levels as set out in DMRB LA 107 and shown in Table 5.1 below.

Table 5.1 Landscape Sensitivity (susceptibility and value) and typical descriptions

Sensitivity (susceptibility and value) of receptor/resource	Typical Descriptions
Very high	Landscapes of very high international/national importance and rarity or value with no or very limited ability to accommodate change without substantial loss/gain (i.e. national parks, internationally acclaimed landscapes – UNESCO World Heritage Sites).
High	Landscapes of high national importance containing distinctive features/elements with limited ability to accommodate change without incurring substantial loss/gain (i.e. designated areas, areas of strong sense of place – registered parks and gardens, country parks).
Medium	Landscape of moderately valued characteristics considered reasonably tolerant of change. Landscapes which by nature of their character and value would be able to partly accommodate change of the type proposed.
Low	Landscape of generally low valued characteristics considered potentially tolerant of substantial change. Landscapes which by nature of their character and value would be able to accommodate change of the type proposed.
Negligible	Landscapes of very low importance and rarity able to accommodate change.

5.2.6.2. Magnitude of Impact

The magnitude of landscape impact was derived from the size or scale, geographical extent, duration and reversibility of the change on the landscape resource and is set out in Table 5.2 below.

Table 5.2 Magnitude and nature of effect on the landscape and typical descriptions

Magnitude of effect (change)		Typical descriptions
Major	Adverse	Total loss or large scale damage to existing landscape character or distinctive features or elements; and/or addition of new uncharacteristic, conspicuous features or elements (i.e. road infrastructure).
	Beneficial	Large scale improvement of landscape character to features and elements; and/or addition of new distinctive features or elements, or removal of conspicuous road infrastructure elements.

High	Adverse	Partial loss or noticeable damage to exiting landscape character or distinctive features or elements; and/or addition of new uncharacteristic, noticeable features or elements (i.e. road infrastructure).
	Beneficial	Partial or noticeable improvement of landscape character by restoration of existing features or elements; or addition of new characteristic features or elements or removal of noticeable features or elements.
Medium	Adverse	Slight loss or dames to existing landscape character of one (maybe more) key features and elements; and/or addition of new uncharacteristic features and elements.
	Beneficial	Slight improvement of landscape character by the restoration of one (maybe more) key existing features and elements; and/or the addition of new characteristic features.
Low	Adverse	Very minor loss, damage or alteration of existing landscape character of one or more features and elements.
	Beneficial	Very minor noticeable improvement of character bey the restoration of one or more existing features and elements.
Negligible/None		No noticeable alteration or improvement, temporary or permanent, of landscape character of existing features and elements.

5.2.6.3. Significance of Effect

The significance of effect has been determined using professional judgement by considering the sensitivity of the landscape resource and the magnitude of impact upon it in relation to the Scheme Options. The matrix used is taken from DMRB LA 104 as shown in Table 5.3.

Table 5.3 Significance Matrix

	Magnitude of Impact (degree of change)					
		No change	Negligible	Minor	Moderate	Major
Landscape Sensitivity	Very high	Neutral	Slight	Moderate or large	Large or very large	Very large
	High	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
	Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
	Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
	Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

5.2.6.4. Limitations and Assumptions

Information on the construction compounds, drainage features, laybys, and signage are not yet defined. The determination of the public perception of landscape value, and summer surveys was not undertaken at DMRB Stage 2. These will be assessed at DMRB Stage 3. A

night-time assessment will be undertaken at DMRB Stage 3 as lighting is anticipated to be a requirement albeit limited to the tunnels and debris flow shelters.

5.3. Baseline Conditions

5.3.1. Study Area

The study area for landscape extends to 3km (Volume 3, Figure 5.1A). Beyond that distance there is some limited Zone of Theoretical Visibility (ZTV) coverage and these areas have been included in the assessment (Volume 3, Figure 6.1 and 5.1B). This also gives a wider landscape context which reflects the scale of the landscape in the context of the LLTNP, the Argyll and Bute Area of Panoramic Quality (ABAPQ), Areas of Wild Land and the regional landscape assessments.

Based on the nature of the Scheme Options, topography and forestry cover, potential landscape effects are likely to occur within 3km. The extent of this study area was determined by desk studies and field survey.

5.3.2. Study Area Context

5.3.2.1. Topography

The study area is centred around the Glen Croe Valley which lies within the ‘Arrochar Alps’ to the west of Loch Long and Loch Lomond. The distinctive peaks of The Cobbler (Ben Arthur) and Ben Dorich, The Brack, Beinn Luibheann and Ben Lochain range between 847 and 901m and are distinguished by rocky outcrops, boulders and screes.

5.3.2.2. Drainage

The Croe Water drains into Loch Long to the south of the study area. Kinglas Water lies within the north of the study area. Loch Restil is a notable waterbody. There are numerous tributaries draining into these waterbodies.

5.3.2.3. Landcover

The Argyll Forest Park covers approximately half of the study area and comprises conifer forest plantation along the lower glen sides and Loch Long where it forms the Ardgartan Forest. The valley is very sparsely populated today with few residences, a caravan park and some pastoral farming but there is evidence of historic settlement pattern. Modern day infrastructure is limited to a few car parks, some masts near the Rest and Be Thankful pass and at Butterbridge, and a small hamlet community at Ardgarten.

5.3.2.4. Infrastructure

The A83(T) is the main transport route through the study area, with the OMR acting as a regular diversion route in periods of high landslide risk and used by NMUs and as a farm access track. The B828 is the only other road in the study area.

5.3.3. Landscape Policy

5.3.3.1. National Planning Framework 4, February 2023

Natural Places Policy 4 states:

"*c) Development proposals that will affect a National Park, National Scenic Area, Site of Special Scientific Interest or a National Nature Reserve will only be supported where:*

i. The objectives of designation and the overall integrity of the areas will not be compromised; or

ii. Any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by social, environmental or economic benefits of national importance."

Natural Places Policy 6 states:

"*Development proposals that enhance, expand and improve woodland and tree cover will be supported. b) Development proposals will not be supported where they will result in:*

i. Any loss of ancient woodlands, ancient and veteran trees, or adverse impact on their ecological condition;

ii. Adverse impacts on native woodlands, hedgerows and individual trees of high biodiversity value, or identified for protection in the Forestry and Woodland Strategy;

iii. Fragmenting or severing woodland habitats, unless appropriate mitigation measures are identified and implemented in line with the mitigation hierarchy;

iv. Conflict with Restocking Direction, Remedial Notice or Registered Notice to Comply issued by Scottish Forestry"

5.3.3.2. LLTNP Statutory Development Plan

The Statutory Development Plan for the National Park Planning Authority Area comprises the adopted National Planning Framework 4 (February 2023) (NPF4), and the Local

Development Plan (2017-2021) (LDP) and its supplementary guidance. The plan is dated 2017-2021 but will remain in place until 2024 to align with the new planning legislation.

Overarching Policy 2 states:

"*Development proposals should not conflict with nearby land uses and where relevant, must address the following requirements:*

- *Landscape & Visual Amenity: safeguard visual amenity and important views, protect and/or enhance rich landscape character, and features and areas specifically designated for their landscape values at any level;*
- *Amenity and Environmental Effects: avoid any significant adverse impacts of; flooding, noise/vibration, air emissions/ odour/fumes/dust, light pollution, loss of privacy/sunlight/daylight;*
- *Historic Environment: protect and/or enhance the character, appearance and setting of the historic environment;*
- *Natural Environment: protect and/or enhance the biodiversity, geodiversity, water environment, sites and species designated at any level (international, national or local) including ancient and semi-natural woodland, green infrastructure and habitat networks"*

Natural Environment Policy 1 states:

"*National Park Landscapes, seascape and Visual Impact Development will protect the special landscape qualities of the National Park in accordance with The Special Landscape Qualities of Loch Lomond & The Trossachs National Park (SNH 2010). Development proposals will be required to be sympathetic to their setting and minimise visual impact, including areas of wild land character (1) and wild land areas. Note: The special landscapes of the National Park include a range of character types and are covered by various designations.*"

Natural Environment Policy 8 states:

"*Development Impacts on Trees and Woodlands Development proposals will not be supported when it would result in the loss or deterioration of an ancient or long-established plantation or semi-natural woodland unless there are overriding public benefits from the development that outweigh the loss of the woodland habitat. Development proposals will not be supported where it is likely to lead to the loss of, or damage to, important individual trees, hedgerows or groups of trees or woodlands that contribute to local amenity, the character of the area and/or are of nature conservation value or historic significance. Where development is accommodated, compensatory planting is to be undertaken to contribute to the National*

Park's Biodiversity Action Plan. Where trees, hedgerows or woodlands may be potentially affected by development or landuse change, the following measures may be required on a case by case basis:

(a) Provision for the protection, management and planting of new trees, hedgerows and woodlands in keeping with distinctive landscape character of the area and where possible enhancing existing or creating new wildlife habitat;

(b) Tree Preservation Orders to protect important trees or groups of trees or woodlands perceived to be under threat of damage or removal if it appears expedient in the interests of amenity, and/or the trees and woodlands are of cultural or historical significance;

(c) Control of Woodland Removal Policy (Scottish Government) to assess acceptability of woodland removal and need for associated compensatory planting

(d) Management agreements and/or legal agreements to encourage positive management of trees, hedgerows and woodlands on or adjacent to development sites."

5.3.3.3. Argyll and Bute Local Development Plan, 2015

The Argyll and Bute Local Development Plan is a planning document that sets out a strategy and framework for how the Council wants to see Argyll and Bute develop to 2024 and beyond, excluding the area of Argyll and Bute covered by the LLTNP that has its own plan.

Policy LDP 3 – Supporting the Protection, Conservation and Enhancement of our Environment states:

"*A development proposal will not be supported when it: (A) does not protect, conserve or where possible enhance biodiversity, geodiversity, soils and peat, woodland, green networks, wild land, water environment and the marine environment. (B) does not protect, conserve or where possible enhance; (i) the established character and local distinctiveness of the landscape and seascape in terms of its location, scale, form and design.*"

The Supplementary Guidance SG LDP ENV9: Development Impact on Areas of Wild Land, Adopted March 2016 states:

"*Argyll and Bute Council will resist development proposals where it is determined that the proposal would significantly diminish the wild character of a Wild Land Area, as identified on the 2014 SNH map of wild land areas, unless it is clearly demonstrated that these adverse effects can be substantially overcome by siting, design or other mitigation."*

The Supplementary Guidance SG LDP ENV13: Development Impact on Areas of Panoramic Quality, Adopted March 2016 states:

"Argyll and Bute Council will resist development in, or affecting, an Area of Panoramic Quality where its scale, location or design will have a significant adverse impact on the character of the landscape unless it is adequately demonstrated that: (A) Any significant adverse effects on the landscape quality for which the area has been designated are clearly outweighed by social, economic or environmental benefits of community wide importance."

The Supplementary Guidance SG LDP ENV14: Landscape states:

"*Outwith National Scenic Areas and Areas of Panoramic Quality, Argyll and Bute Council will consider landscape impact when assessing development proposals, and will resist development when its scale, location or design will have a significant adverse impact on the character of the landscape unless it is demonstrated that: (A) Any such effects on the landscape quality are clearly outweighed by social, economic or environmental benefits of community wide importance; AND (B) The Council is satisfied that all possible mitigation measures have been incorporated into the development proposal to minimise adverse effects.*"

5.3.3.4. Argyll and Bute Proposed Local Development Plan 2

The consultation period has closed and the Proposed Local Development Plan is yet to be adopted.

Policy 72 states:

'*Development Impact on Areas of Wild Land Argyll and Bute Council will resist development proposals, located either within or outwith the defined Wild Land Areas, where it is determined that the proposal would significantly diminish the wild character of an Area of Wild Land, unless these adverse effects are clearly outweighed by social, economic or environmental benefits of national importance*'.

It refers to Assessing impacts on Wild Land Areas[73] – technical guidance which states:

'This guidance should only be applied to proposals whose nature, siting, scale or design are likely to result in a significant effect on the qualities of a WLA. Given this, assessments are more likely for proposals within a WLA, and are less-likely for proposals outwith the WLA.'.

[73] NatureScot (2020). *Assessing impacts on Wild Land Areas – technical guidance*

In relation to forestry, woodland and trees Proposal G states:

'*The Council commits to undertake a review and update of the Argyll and Bute Woodland and Forestry Strategy, working in partnership with Scottish Forestry and engaging with other key stakeholders to bring forward Supplementary Guidance to LDP2. This will take into account monitoring information and new or changing issues, including the Scottish Forestry Strategy 2019 – 2029 and heat mapping to identify the potential for co-locating developments with a high heat demand with sources of heat supply*'.

5.3.3.5. Fitting Landscapes

Fitting Landscapes aims to:

'ensure high quality of design and place; enhance and protect natural heritage; use resources wisely; and build in adaptability to change'.

5.3.4. Landscape/landscape-related designations

5.3.4.1. National Parks

The LLTNP was designated, among other reasons, to "*conserve and enhance the natural and cultural heritage*".

Approximately two thirds of the study area lies within the LLTNP. The Loch Lomond and The Trossachs National Park Authority (LLTNPA) have identified the SLQ of the Park.

The Special Landscape Qualities of the Loch Lomond and The Trossachs National Park Report, 2010 states that "The identification of the special qualities provides a sound baseline for future work on the celebration, promotion and safeguarding of the Loch Lomond and The Trossachs National Park". The SLQs that are considered to be most relevant to the Argyll Forest Park within the study area are:

- a remote area of high hills and deep glens;
- a land of forests and trees;
- Arrochar's mountains and distinctive peaks;
- the variety of glens; and
- the dramatic pass of Rest and be Thankful.

The SLQs are considered as they relate to each specific Landscape Character Type (LCT) in the assessment section of this report.

The LLTNP is very high sensitivity due to the national importance and value associated with the designation.

5.3.4.2. Areas of Panoramic Quality

Areas of Panoramic Quality (APQ) were designated in the Argyll and Bute adopted Local Development Plan. These are areas of regional importance in terms of landscape quality which were previously identified as 'Regional Scenic Areas' in the former Strathclyde Structure Plan.

The Argyll and Bute APQ of relevance to the study areas is part of the North Argyll Area of Panoramic Quality (NAAPQ) which lies within the north of the study area though is extensive beyond it. None of the Scheme Options lie within the designation so that there is no direct effect upon it. It is a high sensitivity designation based on the regional importance.

5.3.4.3. Forest Parks

The Argyll Forest Park (AFP) is extensive across the study area and beyond over the Cowal Peninsula and to the east of Loch Lomond to Strathearn and Callander as shown on Volume 3, Figure 5.1B. The Forest Parks within LLNTP were designated for recreation and early plantings and are one of the SLQs of the LLTNP. Part of each Scheme Option lies within the North Area of the AFP (NAAFP). It is high sensitivity due to the national importance and containing distinctive forestry elements which contribute to the landscape character.

5.3.4.4. Wild Land Areas

Wild Land Areas are high sensitivity due to their importance and rarity. There are no Wild Land Areas within the study area (see Volume 3, Figure 5.1A) Wild Land is indicated in Volume 3, Figure 5.1B. There is very limited ZTV coverage for some Scheme Options distant from the study area and where this occurs the Wild Land Area has been included in the assessment.

5.3.4.5. Landscape Setting of Cultural Heritage

Glen Croe is the setting for one of William Wordsworth's sonnets '*Rest and Be Thankful – At the Head of Glencroe'* and is also associated with the poet John Keats, and the writers Samuel Johnson and James Boswell. Further detail is provided in Appendix 4-1: Historical Background and Cultural Heritage Gazetteer.

The OMR has been used as a testing hill climb route for the racing of sports cars and the activity contributes to the cultural heritage of the OMR and its role in the landscape.

5.3.5. Landscape Character

Review of the published regional landscape assessment documents including the LLTNP Landscape Assessment identified the key characteristics of the landscape resource.

Landscape Assessment is available from NatureScot online with mapping and descriptions including key characteristics of each numbered LCT; these supersede the 1990s reports and earlier datasets.

The LCTs in which the Scheme Options lie have been assessed and are:

- Upland Glens LCT No.252, Loch Lomond and the Trossachs; and
- Highland Summits LCT No.251.

LCTs through which the Scheme Options do not run, but which are within the study area and have ZTV coverage have also been assessed; these are:

- Steep Ridges and Mountains LCT No.34;
- Steep Ridges and Hills LCT No.250;
- Rugged Mountains LCT No.35; and
- Steep Ridges and Hills LCT No.250.

5.3.5.1. Upland Glens (Loch Lomond and the Trossachs) LCT No.252

This is a very high sensitivity LCT due to being within the LLTNP and having iconic rare features such as the Rest and Be Thankful Pass, and associated value of the culture and heritage of the drover's route and OMRs. Key characteristics of the LCT most relevant to the study area are:

- adjacent Steep Ridges and Hills and Highland Summits;
- Steep glen sides often patterned with rocky outcrops, boulders and screes but also extensively forested, particularly on lower slopes;
- Tributary burns and rivers cut deep gullies into slopes and many feature waterfalls and cascades, pools and rocky outcrops;
- Walled pastures sometimes occasionally occurring on lower (usually south-facing) slopes. Heather covers better drained areas and bright green flushes appear at spring lines on hill slopes;
- Some glens covered with extensive coniferous forestry;
- Scattered trees and native woodland trace the edges of burns;
- Sparsely settled but with some isolated farms in lower reaches of glens, these often south-facing;

- Significant cultural features in more open glens, including shielings and abandoned field systems.
- Areas of crofting evident on some lower slopes;
- Some important historic strategic routes for communications and accommodate key road and rail links today for example; and
- Classic views channelled up and down the Glens, with steep side slopes framing landscapes that lie beyond them.

Special Qualities of the LLTNP most relevant to the LCT are:

- a remote area of high hills and deep glens;
- a land of forests and trees;
- Arrochar's mountains and distinctive peaks;
- the variety of glens; and
- the dramatic pass of Rest and be Thankful.

Plate 5.1 View from the B828 looking southeast with The Cobbler and The Brack on the horizon, the A83(T) and OMR

5.3.5.2. Highland Summits LCT No.251

This is a very high sensitivity LCT due to being within the LLTNP and having iconic peaks such as The Cobbler. Key characteristics of the LCT most relevant to the study area are:

- High mountains generally lying above 800 metres, but lower and intensely craggy in the core of the Trossachs where geology is particularly complex;
- Steep slopes often covered in scree;
- Narrow rocky ridges, deeply scooped corries and rocky gullies on many of these mountains;
- Narrow glens deeply cut into the mountains, often contain fast-flowing burns and waterfalls;
- Strongly patterned landscape with exposed rock, crags, small lochs and myriad water courses significantly increasing complexity;
- Simple vegetation cover is, largely comprising semi-natural grassland with patchy heather and ground-hugging alpine species on upper slopes and summits. Bracken and bog occurs on lower slopes and within glen floors. Coniferous forestry present on some lower slopes, extending up into glens;
- Very sparsely populated with roads and dispersed settlement occurring only on its fringes;
- Highly visible massive peaks and ridges of the mountains forming a scenic rugged backdrop to the lower settled loch shores, glens and straths;
- Instantly recognisable mountain forms such as the Cobbler and Ben Lomond. Ben Ledi, Ben Vorlich and Ben Lomond are important landmark features, marking the Highland edge seen widely from the Central Lowlands of Scotland;
- Popular mountains with walkers because of their highly natural and rugged character, and the presence of ‘Munro’ and ‘Corbett’ peaks. The higher summits offer extensive views; and
- Distinct sense of wild character of the summits due to their rugged and natural qualities, especially away from hydro-electric infrastructure and poorly integrated forestry.

Special Qualities of the LLTNP most relevant to the LCT are:

- Arrochar’s mountains and distinctive peaks; and
- the dramatic pass of Rest and be Thankful.

5.3.5.3. Steep Ridges and Mountains LCT No.34

This is a high sensitivity LCT due to part of it being in the landscape setting area just outside the LLTNP and part of it being within the NAAPQ. Key characteristics of the LCT most relevant to the study area are:

- Dramatic mountain ridges with steep, plummeting slopes and numerous rocky outcrops;

- Ribbon lochs and meandering rivers on narrow floodplains form dramatic contrast to surrounding slopes; and
- Extensive conifer forests on lower slopes and open moorland, with bare rock faces on upper slopes and summits.

5.3.5.4. Rugged Mountains LCT No.35

This is a high sensitivity LCT due to part of it being in the landscape setting area just outside the LLTNP and part of it being within the NAAPQ. Key characteristics of the LCT most relevant to the study area are:

- Rugged, steep sided mountain ranges with a massive scale;
- Diverse landform with gullies, scarp slopes and rocky screes;
- Striking exposed rock faces, with scrubby birch-oak woodland in gullies;
- Relatively wide glens between mountain ranges;
- Fast-flowing burns, waterfalls and small upland lochs are distinctive features;
- Extensive conifer forests on some lower slopes;
- Inaccessible and relatively uninhabited, with strong wildness qualities; and
- Dramatic mountain scenery.

5.3.5.5. Steep Ridges and Hills LCT No.250

This is a very high sensitivity LCT due to being within the LLTNP and having iconic peaks such as The Cobbler. Key characteristics of the LCT most relevant to the study area are:

- Steep-sided hills, with pronounced summits, which rise dramatically from narrow sea lochs and deep glens;
- Long and narrow sea lochs of Loch Long, and the more sinuous Loch Goil;
- Generally smoother Luss Hills forming conical peaks and long narrow ridges and spurs. These hills are more open with only small areas of coniferous forestry on lower slopes;
- Hills often seen in conjunction with the higher Highland Summits;
- Some hills form key landmark features in views along the sea lochs; and
- Settlement largely absent even from the narrow rocky coastal edges along the sea lochs and some parts feel relatively remote.

Special Qualities of the LLTNP most relevant to the LCT within the study area are:

- a remote area of high hills and deep glens;
- a land of forests and trees;
- Arrochar's mountains and distinctive peaks; and

- the variety of glens.

5.4. Potential Impacts

The assessment of landscape receptors concerns anticipated changes to the landscape such as impacts to designated landscapes and to landscape character. The SLQs of the landscape as defined by the LLTNPA have also been considered.

ZTVs (Volume 3, 6.1) were used to help determine landscape receptors. Where no visibility or relatively limited visibility exists for landscape receptors the receptors have not been assessed further.

The LLTNP is extensive beyond the study area and is a very high sensitivity designation.

All Scheme Options lie within the LLTNP. Due to the extent of the LLTNP designation, none of the Scheme Options will have a likely significant adverse effect on the designation overall at construction or operation. Therefore, the LLTNP is not a differentiator in this regard. In terms of a more detailed assessment of the designation, consideration of the LCTs within LLTNP and the impact on the SLQs of the LLTNP, has been undertaken as part of this assessment.

5.4.1. Construction

The Scheme Options would have construction impacts which could include all or some of the following (those with an * will be included in Stage 3 as there is not enough information at this stage (see Limitations Section 5.2.5.4):

- vegetation clearance to facilitate construction is anticipated to occur during the initial mobilisation phase, requiring the removal of landscape features that contribute to the vegetation cover, the result will be newly exposed views of the wider landscape and the construction activity therein;
- areas of additional tree clearance as a result of potential safety concerns relating to the windthrow effect of vegetation removal on the fringes of woodland, particularly associated with plantation woodland;
- loss of embankments and/or rock outcrops;
- disturbance caused by blasting related to rock cuts being reformed and drill and blast techniques to excavate tunnels;
- temporary spoil heaps, material storage, and site compounds will occur throughout the construction phase;*
- lighting associated with working in winter hours of darkness;
- plant, machinery and traffic management will be conspicuous in views*;

- temporary realignments and diversions and traffic management will result in a broader footprint;
- piling activity to facilitate the viaduct piers with associated temporary working platforms during construction;
- temporary stabilisation measures for protection of workforce; and
- formation of drainage features*.

The duration of construction is within 3.25 to 4.25 years for all Scheme Options with the exception of the Green Option which is seven years.

Essential mitigation will include general best practice during construction.

5.4.1.1. Green Option

The duration of construction for the Green Option is seven years.

Landscape designations

Argyll Forest Park (Northern Area)

The AFP is high sensitivity. The Green Option lies almost entirely within the NNAFP. During construction rock debris fall fences and mesh would be required. Temporary working platforms associated with the viaduct piers and temporary stabilisation measures will be required to protect the workforce from any unstable ground. Felling of forest trees would be required to facilitate new built elements of the viaducts and flow shelter plus access tracks to maintain the rock fall catchment area. While the magnitude of impact to the AFP(NA) designation as a whole would be minor adverse due to the scale of the designation, within the study area this option would have the greatest impact on the designation due to the reduction in tree cover and the construction of road infrastructure elements to the west side of the Croe Valley. The significance of effect is slight adverse.

Wild Land Areas

The Ben Lui Wild Land Area has limited ZTV coverage of Beinn Damhain, Maol Breac, Meall nan Caora and Meall an Fhudair summits. As these are distant (see Volume 3, Figure 6.1) and due to the elevation, direction and focus of the view there is not likely to be a significant effect on them. During construction it may be possible to distinguish some activity (for example, flashing lights from construction vehicles).

The magnitude of impact is no change - negligible. The significance of effect is neutral – slight adverse.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There will be views of very limited parts of the Green Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri and part of Beinn an t-Seilich (see Volume 3, Figure 5.1).

The magnitude of impact is minor adverse as construction activity would be perceptible but not alter the balance of the view. Significance of effect is temporary slight adverse.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. The Option would run mostly within the forested parts of this LCT, lying in the open upland glen only for its most northerly extent. It would result in the loss of more of the forested landscape element than any of the other Scheme Options.

During construction rock debris fall fences and mesh would be required. Temporary working platforms associated with the viaduct piers and temporary stabilisation measures will be required to protect the workforce from any unstable ground. Felling of forest trees would be required to facilitate new built elements of the viaducts and flow shelter plus access tracks to maintain the rock fall catchment area.

Special Landscape Qualities: the SLQ *'a land of forests and trees*' would be adversely affected by this option.

The magnitude of impact to the LCT would be major adverse due to felling and construction activity for the introduction of new road infrastructure elements and features to the west side of the Croe Valley.

The significance of effect is temporary very large adverse.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Green Option lies within this LCT. However, despite the existing A83(T), the perceptual landscape qualities of remoteness and tranquillity would be affected by the felling of forest trees and the construction of major road infrastructure in the form of two viaducts and a flow shelter with associated rock and debris fences to a part of the Croe Valley which currently has no road infrastructure.

Special Landscape Qualities: The SLQs "*Arrochar's mountains and distinctive peaks"* and "*dramatic pass of the Rest and Be Thankful'"* would be affected by the felling and construction works.

The magnitude of impact to the LCT would be moderate adverse due to construction activity.

The significance of effect is temporary large adverse.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Green Option lies within this LCT. The LCT lies outside the LLTNP.

The magnitude of impact to the LCT would be moderate adverse due to felling and construction activity for new road infrastructure elements and features to the west side of the Croe Valley which doesn't have existing construction activity.

The significance of effect is temporary large adverse.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Green Option lies within this LCT. The LCT lies outside the LLTNP.

The magnitude of impact to the LCT would be minor adverse due to the distance between the Green Option and this LCT.

The significance of effect is judged to be temporary slight adverse.

Steep Ridges and Hills LCT No.250 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Green Option lies within this LCT. The LCT lies within the LLTNP. However, despite the existing A83(T), the perceptual landscape qualities of remoteness and tranquillity would be affected by felling works and the construction works for the introduction of road infrastructure at the northern extent of the Green Option in the form of the viaducts, flow shelter and works to the junction at the Rest and Be Thankful.

Special Landscape Qualities: The SLQ "*a remote area of high peaks and deep glens'"* perceptual quality elements, particularly of remoteness, would be affected during construction.

The magnitude of impact (change) to the LCT would be moderate adverse due to the construction of new road infrastructure elements and the effect on the SLQ.

The significance of effect is temporary large adverse.

5.4.1.2. Yellow Option

Landscape designations

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area is high sensitivity. Only the southern extent lies within the AFP(NA) where the Yellow Option would be on embankment. During construction there would be changes due to felling of trees within the designation. Forest management practices would likely include felling of tree coupes as standard without the Yellow Option. General best practice construction mitigation will apply.

The magnitude of impact to the AFP(NA) would be minor adverse due to a slight loss of the woodland element and introduction of new elements and features not likely to have a significant impact due to the overall extent of the designation. The significance of effect is temporary slight adverse.

Wild Land Area

The Ben Lui Wild Land Area has some limited ZTV coverage of Beinn Damhain, Maol Breac, Meall nan Caora and Meall an Fhudair summits. As these are distant (see Volume 3, Figure 6.1) there is not likely to be a significant effect on them. During construction it may be possible to distinguish some activity (for example, flashing lights from construction vehicles). The magnitude of impact is no change - negligible. The significance of effect is temporary neutral – slight adverse.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There will be views of very limited parts of the Yellow Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri and part of Beinn an t-Seilich (see Volume 3, Figure 5.1). Embedded mitigation would include adherence to best construction practices.

The magnitude of impact is minor adverse as construction activity would be perceptible but not alter the balance of the view. Significance of effect is temporary slight adverse.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. Only the southern extent of the Yellow Option lies within the forested area of the LCT with the majority routing through the farmed glen areas. During construction there would be changes due to felling of trees within the LCT and the introduction of the viaduct structure and associated retaining walls to protect the viaduct piers as well as tie in embankments at each end of the viaduct.

Special Landscape Qualities: The SLQ 'a *land of forests and trees'* would be somewhat impacted by this Option with a small area of trees requiring to be felled. The SLQ '*dramatic Pass of the Rest and Be Thankful*' would be impacted by the Yellow Option.

The magnitude of impact to the LCT would be moderate adverse due to the construction of new elements and features within the pastoral landscape of the valley floor. The significance of effect is temporary large adverse.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Yellow Option lies within this LCT. During construction there would be changes in the perceptive qualities of the landscape due to the construction of the viaduct structure and associated retaining walls to protect the viaduct piers from debris fall as well as tie in embankments at each end of the viaduct.

Special Landscape Qualities: The SLQ '*the dramatic pass of the Rest and Be Thankful'* would be impacted by this Option due to the verge widening works at the junction of the B828.

The magnitude of impact to the LCT would be moderate adverse due mainly to the widening of the verge at the Pass, and general construction works. The significance of effect is temporary large adverse.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Yellow Option lies within this LCT. The LCT lies outside the LLTNP.

The magnitude of impact to the LCT is minor adverse as there is existing road infrastructure and construction works in close proximity to this landscape receptor and the significance of effect is temporary moderate adverse.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Yellow Option lies within this LCT. The LCT lies outside the LLTNP.

The magnitude of impact to the LCT is minor adverse due to the relative distance of the works for the Yellow Option from the LCT and the significance of effect is temporary slight adverse.

Steep Ridges and Hills LCT No.250 (LLTNP)

This is a very high sensitivity LCT. No part of the Yellow Option lies within this LCT. The LCT lies within the LLNTP. Construction activity associated with the viaduct and tie in embankments, and retaining walls at the piers for debris fall and temporary working platforms will affect the perceptual qualities of the LCT, most notably the sense of remoteness.

Special Landscape Qualities: The SLQ '*a remote area of high hills and deep glens*' may be affected during construction.

The magnitude of impact to the LCT is moderate adverse due to the relative distance from the Yellow Option. The significance of effect is temporary moderate adverse**.**

5.4.1.3. Brown Option

Landscape designations

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area and is high sensitivity. Only the southern extent lies within the AFP(NA). This would be the location of the start of the southern end of the debris flow shelter and associated maintenance access. During construction there would be changes due to a slight reduction in the tree cover within the designation and construction activity due to the introduction of the structures. The magnitude of effect to the AFP(NA) would be minor adverse due to the overall extent of the designation. The significance of effect is temporary slight adverse.

Wild Land Area

The Ben Lui Wild Land Area has some limited ZTV coverage of Beinn Damhain, Maol Breac, Meall nan Caora and Meall an Fhudair summits. As these are over 4km distant there is not likely to be a significant effect on them. During construction it may be possible to distinguish

some activity (for example, flashing lights from construction vehicles). The magnitude of impact is no change - negligible. The significance of effect is temporary neutral – slight adverse.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There may be views of very limited parts of the Brown Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri where part of a retaining wall may be perceptible and part of Beinn an t-Seilich where part of the flow shelter may be perceptible (see Volume 3, Figure 5.1 and Volume 3, Figure 6.1).

The magnitude of impact is minor adverse as construction activity would be perceptible but not alter the balance of the view. Significance of effect is temporary slight adverse.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. The LCT lies within the LLTNP. The Brown Option would run mostly within the open upland glen parts of this LCT, lying in the forested area only for its southerly extent. Construction would result in activity to build the debris flow shelter and catch pit and a new junction with the B828. The latter would include notable verge widening to the inside bend opposite the B828 and have a direct impact on the Rest and Be Thankful Pass.

Special Landscape Qualities: The SLQs *'the dramatic pass of the Rest and Be Thankful'* would be compromised by the notable verge widening of the bend. There would be no notable impact on the SLQ '*a land of forests and trees'.*

The magnitude of impact to the LCT would be moderate adverse during construction due to the structural elements and the rock cuts to facilitate these. The significance of effect is temporary large adverse.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Brown Option lies within this LCT. The LCT lies within the LLTNP. The Brown Option would involve construction activity for the debris flow shelter and catch pit and a new junction with the B828. The latter would include notable verge widening to the inside bend opposite the B828. This would affect the perceptual landscape characteristic of 'wild character' for this landscape receptor.

Special Landscape Qualities: The SLQs '*the dramatic pass of the Rest and Be Thankful*' would be compromised by the notable verge widening of the bend. There would also be very small, localised impact on the SLQ *'a land of forests and trees'.*

The magnitude of impact to the LCT would be moderate adverse during construction due to the works affecting the key characteristic of 'wild character' of the landscape receptor and the SLQs. The significance of effect is temporary large adverse.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Brown Option lies within this LCT. The LCT lies outside the LLTNP.

The magnitude of impact to the LCT would be minor adverse as there is existing construction work along the A83(T) in close proximity to the landscape receptor. The significance of effect is temporary moderate adverse.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Brown Option lies within this LCT. The LCT lies outside the LLTNP. The perceptual quality of 'strong wildness' is a key characteristic of the LCT.

The magnitude of impact to the LCT would be moderate adverse during construction due to the impact on remoteness and the 'strong wildness' qualities key characteristic of the LCT. The significance of effect is moderate adverse.

Steep Ridges and Hills LCT No.250 within the study area

This is a very high sensitivity LCT. No part of the Brown Option lies within this LCT. The LCT lies within the LLTNP. The Brown Option would involve construction activity for the debris flow shelter and catch pit and a new junction with the B828. The latter would include notable verge widening to the inside bend opposite the B828.

Special Landscape Qualities: The SLQs '*a remote area of high hills and deep glens*' would be compromised in terms of its sense of remoteness during the construction phase.

The magnitude of impact to the LCT would be moderate adverse during construction due to the impact on remoteness and the 'strong wildness qualities' which is a key characteristic of this LCT. The significance of effect is temporary large adverse.

5.4.1.4. Pink Option

Landscape designations

Construction would involve drill and blast techniques to facilitate excavation of the tunnel with portals at either end and the introduction of new junctions. Construction of a new control building in proximity to the northern portal would be perceptible.

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area is high sensitivity. Only the northern and southern extents lie within the AFP(NA).The tunnel section lies mostly outwith the designation but the approach to the tunnel portals and associated rock cuts, stabilisation measures and rock debris fences would be additional elements within this designation. The magnitude of impact to the AFP(NA) would be minor adverse due to felling and construction of new elements and features not likely to have a significant impact due to the overall extent of the designation. The significance of effect is temporary slight adverse.

Wild Land Area

The Ben Lui Wild Land Area will not be affected by the Pink Option.

The magnitude of impact is no change. The significance of effect is neutral.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There may be views of very limited parts of the Pink Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri (see Volume 3, Figure 5.1 and Volume 3, Figure 6.1).

The magnitude of impact is minor adverse as construction activity would be perceptible but not alter the balance of the view. Significance of effect is temporary slight adverse.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Pink Option lies within this LCT. The LCT lies within the LLTNP.

This Option will run a tunnel mostly within the open glen part of the LCT with only the northern and southern extents within the forested glen. There would be construction of a new control building in proximity to the northern and southern portals.

Special Landscape Qualities: The SLQ 'a *land of forests and trees'* would be slightly impacted by this Pink Option.

The magnitude of impact to the LCT would be moderate adverse for the LCT due to felling and construction and drill and blast techniques to excavate the tunnel. The significance of effect is temporary large adverse.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. A small section of the tunnel lies within this LCT. There would be construction of a new control building in proximity to the northern and southern portals. The construction activity would affect the perception of wild character.

Special Landscape Qualities: There would be no significant localised impact on the SLQ '*a land of forests and trees'.*

The magnitude of impact to the LCT would be moderate adverse due to the works affecting the key characteristic of 'wild character' of the landscape receptor. The significance of effect is judged to be temporary large adverse.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Pink Option lies within this LCT. The LCT lies outside the LLTNP. There would be construction of a new control building in proximity to the northern and southern portals. The magnitude of impact to the LCT would be moderate adverse due to the construction of the utility building, the portals in close proximity to the LCT. The significance of effect is temporary large adverse.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Option lies within this LCT. The LCT lies outside the LLTNP. Construction of a new control building in proximity to the northern portal would be perceptible. The construction activity would affect the perception of strong wildness which is a key characteristic of this LCT.

The magnitude of impact to the LCT would be moderate adverse. The significance of effect is large adverse.

Steep Ridges and Hills LCT No.250 within the study area

This is a very high sensitivity LCT. No part of the Pink Option lies within this LCT. Construction would involve associated rock cuts additional elements and activity affecting this LCT. There would be construction of a new control building in proximity to the northern and southern portals.

Special Landscape Qualities: The SLQs 'a remote area of high hills and deep glens' would be compromised in terms of its sense of remoteness during the construction phase.

The magnitude of impact to the LCT would be moderate adverse due to the works affecting the key sense of remoteness of the landscape receptor. The significance of effect is large adverse.

5.4.1.5. Purple Option

Landscape designations

Argyll Forest Park (Northern Area)

The AFP is extensive beyond the study area and is high sensitivity.

Only northern and southern extents of the Purple Option lie within the AFP(NA). The extents of the Purple Option would be on embankment/open road within the designation. The magnitude of impact to the AFP(NA) would be minor adverse due to felling and construction activity for the introduction of new elements and features not likely to have a significant impact due to the overall extent of the designation. The significance of effect is slight adverse.

Wild Land Area

The Ben Lui Wild Land Area would not be affected by the Purple Option.

The magnitude of impact is no change. The significance of effect is neutral.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There may be views of very limited parts of the Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri and part of Beinn an t-Seilich where the northern portal and utility building may be perceptible (see Volume 3, Figure 5.1 and Volume 3, Figure 6.1).

The magnitude of impact is minor adverse as construction activity would be perceptible but not alter the balance of the view. Significance of effect is temporary slight adverse.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. The Purple Option lies entirely within this LCT. Only northern and southern extents lie within the forested areas of the LCT with the majority routing through the farmed and open glen areas. The extents of the Purple Option would be on embankment/open road. The viaduct and tunnel with associated portals, retaining walls to each viaduct pier, and temporary working platforms which would impact the farmed character of the valley floor during construction. There would also be a new junction at the B828. There would be construction of a new control building in proximity to the northern and southern portals.

Special Landscape Qualities: The SLQ 'a *land of forests and trees'* would be slightly impacted by the Purple Option.

The magnitude of impact to the LCT would be moderate adverse due felling and the construction of new elements and features. The significance of effect is large adverse.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Purple Option lies within this LCT. The construction activity for the viaduct and tunnel with associated portals, temporary working platforms and the retaining walls to each viaduct pier would affect the perceptual qualities of the LCT as the Purple Option is in relatively close proximity to the LCT. There would also be a new junction at the B828.

Special Landscape Qualities: The SLQs '*Arrochar's mountains and distinctive peaks'* would be affected in terms of the key characteristic of wild character of this LCT.

The magnitude of impact to the LCT would be moderate adverse due to construction activity for new elements and features which would compromise the key characteristic of '*wild character of the summits*'. The significance of effect is temporary large adverse.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Purple Option lies within this LCT. The LCT lies outside the LLTNP. Construction would involve drill and blast techniques to facilitate excavation of the tunnel, portals and viaduct, construction compounds, and the introduction

of new junctions. There would be construction of a new control building in proximity to the northern portal. The magnitude of impact to the LCT would be moderate adverse. The significance of effect is temporary large adverse.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Purple Option lies within this LCT. The LCT lies outside the LLTNP. Construction would involve drill and blast techniques to facilitate excavation of the tunnel, portals and viaduct, construction compounds, and the introduction of new junctions. There would be construction of a new control building in proximity to the northern portal. The construction activity would affect the perception of strong wildness which is a key characteristic of this LCT. The magnitude of impact to the LCT would be moderate adverse. The significance of effect is temporary large adverse.

Steep Ridges and Hills LCT No.250 within the study area

This is a very high sensitivity LCT. No part of the Purple Option lies within this LCT. Construction would involve drill and blast techniques to facilitate excavation of the tunnel and construction compound and the formation of a new junction closest to this LCT.

Special Landscape Qualities: The SLQs '*a remote area of high hills and deep glens*' would be compromised in terms of its sense of remoteness during the construction phase.

The magnitude of impact to the LCT would be minor adverse as while the works would affect the perceptual qualities of the sense of remoteness of the landscape receptor there is a relative greater distance from the works for this LCT. The significance of effect is temporary moderate adverse.

5.4.2. Operation

Potential effects for each of the Scheme Options are described during operation in the winter of year 1 and the summer of year 15. The landscape effects associated with the Scheme Options include (but are not limited to):

- alteration of the local landscape character affecting the perception of landscape designations due to loss of existing landscape elements such as established woodland, changes to rock faces due to rock cuts and changes to existing views;
- changed appearance of landform due to new earthworks such as embankments and cuttings;
- changed appearance of rock faces due to new rock cuts;

- the addition of new viaducts, flow shelters, and bridge structures across rivers and small watercourses;
- introduction of new infrastructure elements such as new retaining walls, signage and attenuation ponds and access tracks that could affect the overall pattern of the landscape;
- the introduction of lighting to previously unlit areas at tunnel portals and potentially associated with debris flow shelters; and
- the 'opening up' of the views due to vegetation removal.

5.4.2.1. Green Option

Landscape designations

Embedded mitigation is undefined at this time. Opportunity for mitigation planting within the forested areas would be possible but would have to be determined in relation to the forestry planning and agreements. Planting would not be sympathetic to the open farmed glen in the non-forested areas.

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area and is high sensitivity. The Green Option lies almost entirely within the AFP(NA). During operation the viaducts and flow shelter would be new features in the designation.

While the magnitude of effect to the AFP(NA) designation as a whole would be minor adverse due to the scale of the designation, within the study area the Green Option would have the greatest impact on the designation due to the reduction in the tree cover and the introduction of road infrastructure elements to the west side of the Croe Valley where none exists. In the WY1 the significance of effect is slight adverse for the AFP(NA) as a whole and this would remain by SY15.

Wild Land Area

The Ben Lui Wild Land Area has some limited ZTV coverage of Beinn Damhain, Maol Breac, Meall nan Caora and Meall an Fhudair summits. As these are distant there is not likely to be a significant effect on them. During operation perception would be barely discernible.

WY1: The magnitude of impact is no change - negligible. The significance of effect is neutral – slight adverse.

SY15: The magnitude of impact is no change. The significance of effect is neutral.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There will be views of very limited parts of the Green Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri and part of Beinn an t-Seilich (see Volume 3, Figure 5.1).

WY1: The magnitude of impact is minor adverse as elements may be perceptible but not alter the balance of the view. Significance of effect is slight adverse.

SY15: The magnitude of impact would reduce to negligible due to essential mitigation planting and the significance of effect would be slight adverse at most.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. The Green Option will run mostly within the forested parts of this LCT, lying in the open upland glen only for its most northerly extent. It would result in the loss of more of the forested landscape element than any of the other Scheme Options due to felling to accommodate the flow shelter and viaducts and the maintenance access tracks. Road infrastructure would be a new element to the west side of the Croe Valley. During operation the rock debris fall fences and mesh installed during construction would be retained.

Special Landscape Qualities: the SLQ *'a land of forests and trees*' would be adversely affected by the Green Option.

WY1: The magnitude of impact to the LCT would be major adverse due to removal of trees and introduction of new road infrastructure elements and features to the west side of the Croe Valley. The significance of effect is very large adverse.

SY15: The magnitude of impact to the LCT would be moderate adverse due to essential mitigation planting within the limits of the reinforcement solutions. The significance of effect is large adverse as the road infrastructure would alter the character of the west side of the valley.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Green Option lies within this LCT. However, the perceptual landscape qualities of remoteness and tranquillity would be affected by the introduction of major road infrastructure in the form of two viaducts and a flow shelter

with associated rock and debris fences and maintenance tracks to a part of the Croe Valley which currently has no road infrastructure.

Special Landscape Qualities: The SLQ '*Arrochar's mountains and distinctive peaks*' perceptual quality would be affected by the new elements.

WY1: The magnitude of impact to the LCT would be moderate adverse due to removal of trees and introduction of new road infrastructure elements and features to the west side of the Croe Valley. The significance of effect is large adverse.

SY15: The magnitude of impact to the LCT would be negligible-minor adverse due to essential mitigation planting. The significance of effect is slight adverse.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Green Option lies within this LCT. The LCT lies outside the LLNTP.

WY1: The magnitude of impact to the LCT would be moderate adverse due to removal of trees and introduction of new road infrastructure elements and features to the west side of the Croe Valley. The significance of effect is large adverse.

SY15: The magnitude of impact to the LCT would be negligible-minor adverse due to essential mitigation planting and the significance of effect is slight adverse.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Green Option lies within this LCT. The LCT lies outside the LLNTP.

WY1: The magnitude of impact to the LCT would be negligible adverse due to the new road infrastructure elements not being in close proximity to this LCT. The significance of effect is slight adverse.

SY15: The magnitude of impact to the LCT would be no change-negligible due to essential mitigation planting and the significance of effect would be neutral-slight adverse.

Steep Ridges and Hills LCT No.250 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Green Option lies within this LCT. Due to the existing A83(T) and the distance, elevation and remaining tree cover on the southwest side of the Croe valley, the perceptual landscape qualities of remoteness and tranquillity

would not likely be significantly adversely affected by the Green Option for this LCT during operation.

Special Landscape Qualities: The SLQ '*a remote area of high peaks and deep glens*' perceptual quality elements, particularly of remoteness, would be unlikely to be adversely affected during operation.

WY1: The magnitude of impact to the LCT would be minor adverse due to the new road infrastructure elements. The significance of effect is moderate adverse.

SY15: The magnitude of impact would be negligible adverse due to essential mitigation planting. The significance of effect is slight adverse.

5.4.2.2. Yellow Option

Landscape designations

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area and is high sensitivity. Only the southern extent of the Yellow Option lies within the Forest Park.

At WY1 the magnitude of effect to the AFP(NA) designation as a whole would be minor adverse due to the scale of the designation. Within the study area the Yellow Option would have a negligible impact on the designation due to localised reduction of trees and the introduction of new (viaduct) road infrastructure elements to the Croe Valley. The significance of effect is slight adverse for the AFP(NA) as a whole. Essential mitigation planting would be possible but is likely to be limited by topography, and the open character of the pastoral valley floor so that the magnitude of impact at SY15 is likely to remain minor adverse and the significance of effect slight adverse.

Wild Land Area

The Ben Lui Wild Land Area has some limited ZTV coverage of Beinn Damhain, Maol Breac, Meall nan Caora and Meall an Fhudair summits. As these are over 4km distant there is not likely to be a significant effect on them. During operation perception will be barely discernible.

The magnitude of impact is no change - negligible. The significance of effect is neutral – slight adverse at both WY1 and SY15.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There will be views of very limited parts of the Yellow Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri and part of Beinn an t-Seilich (see Volume 3, Figure 5.1).

The magnitude of impact is negligible adverse as the Yellow Option would be barely discernible. Significance of effect is slight adverse. This would be the same for WY1 and SY15 as the viaduct would likely remain perceptible with essential mitigation having established.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. The Yellow Option lies within this LCT. Only the southern extent lies within the forested area of the LCT with the majority routing through the farmed glen areas. During operation there would be changes due to felling of trees within the LCT and the introduction of the viaduct structure and associated retaining walls to protect the viaduct piers as well as tie in embankments at each end of the viaduct.

Special Landscape Qualities: The SLQ 'a *land of forests and trees'* would be slightly impacted by the Yellow Option.

WY1: The magnitude of impact to the LCT would be moderate adverse due to a slight loss of the woodland element and introduction of new elements and features particularly the retaining walls associated with the piers and verge widening at the Pass. The significance of effect is large adverse.

SY15: The magnitude of impact to the LCT would remain the same as for WY1 due to the limited appropriateness of mitigation planting and the scale of the new elements. This could be reduced by embedded mitigation when that has been developed further.

Highland Summits LCT No.251 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Yellow Option lies within this LCT. During operation there would be changes in the perceptive qualities of the landscape where the

introduction of the viaduct structure and associated retaining walls to protect the viaduct piers from debris fall as well as tie in embankments at each end of the viaduct.

Special Landscape Qualities: The SLQ '*the dramatic pass of the Rest and Be Thankful*' would be impacted by the Yellow Option due to the verge widening at the junction of the B828.

WY1: The magnitude of impact to the LCT would be minor-moderate adverse due mainly to the widening at the Pass, the introduction of new elements and features, and to a slight loss of the woodland element. With mitigation opportunities focused on embedded mitigation of the viaduct and retaining structures through appropriate aesthetic design, the simplicity of the viaduct option could potentially be less adverse, neutral or beneficial feature of the valley. Currently, the significance of effect is moderate adverse but could be less if it were possible to avoid notable verge widening at the Pass.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Mountains LCT No.34 within the study area

This is a high sensitivity LCT. No part of the Yellow Option lies within this LCT. The LCT lies outside the LLTNP.

Essential mitigation in the form of planting is likely to be limited due to space available at the rocky Pass and within the open glen areas where it would not by sympathetic with the existing landscape character though there may be some limited scope for planting in the existing forested areas of the LCT in which the yellow option lies.

WY1: The magnitude of impact to the LCT would be moderate adverse due to removal of trees and introduction of new road infrastructure elements and features including associated verge widening at the Pass. The significance of effect is moderate adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Rugged Mountains LCT No.35 within the study area

This is a high sensitivity LCT. No part of the Yellow Option lies within this LCT. The LCT lies outside the LLTNP.

WY1: The magnitude of impact to the LCT would be minor adverse due to the new road infrastructure elements not being in close proximity to this LCT. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Hills LCT No.250 (LLTNP) within the study area

This is a very high sensitivity LCT. No part of the Yellow Option lies within this LCT. Due to the exiting A83(T) and the distance, elevation the perceptual landscape qualities of remoteness and tranquillity would not likely be significantly adversely affected by the Yellow Option for this LCT during operation.

Special Landscape Qualities: The SLQ '*a remote area of high peaks and deep glens*' perceptual quality elements, particularly of remoteness, would be unlikely to be adversely affected.

Essential mitigation in the form of planting along the Yellow Option is likely to be limited due to space available at the rocky Pass and within the open glen areas where it would not by sympathetic with the existing landscape character though there may be some limited scope for planting in the existing forested areas of the LCT in which the Yellow Option lies.

WY1: The magnitude of impact to the LCT would be moderate adverse during operation due to the impact on the Pass from verge widening. The significance of effect is moderate adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

5.4.2.3. Brown Option

Landscape designations

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area and is high sensitivity. Only the southern extent of the Brown Option lies within the AFP(NA). This would be the location of the start of the southern end of the debris flow shelter and associated maintenance access. During operation there would be changes due to a slight reduction in the tree cover within the designation and the introduction of new elements.

There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

The magnitude of effect at WY1 and SY15 to the AFP(NA) would be negligible adverse due to the overall extent of the designation. The significance of effect is slight adverse at both WY1 and SY15.

Wild Land Area

The Ben Lui Wild Land Area has some limited ZTV coverage of Beinn Damhain, Maol Breac, Meall nan Caora and Meall an Fhudair summits. As these are distant there is not likely to be a significant effect on them. During operation perception would be barely discernible.

The magnitude of impact at WY1 and SY15 is no change - negligible. The significance of effect is neutral – slight adverse at both WY1 and SY15.

Areas of Panoramic Quality

Part of the NAAPQ, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There may be views of very limited parts of the Brown Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri where part of a retaining wall may be perceptible and part of Beinn an t-Seilich where part of the flow shelter may be perceptible (see Volume 3, Figure 5.1).

The magnitude of impact is negligible adverse as the flow shelter may be perceptible but not alter the balance of the view. Significance of effect is slight adverse at both WY1 and SY15 as essential mitigation would not play a transformative role here.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP) within the study area

This is a very high sensitivity LCT. The Brown Option will run mostly within the open upland glen parts of this LCT, lying in the forested area only for its southerly extent. The debris flow shelter and catch pit and junction with the B828 would be new elements. The latter would include notable verge widening to the inside bend opposite the B828 and have a direct impact on the Rest and Be Thankful Pass.

Special Landscape Qualities: The SLQs '*the dramatic pass of the Rest and Be Thankful'* would be compromised by the notable verge widening of the bend. There would also be localised impact on the SLQ *'a land of forests and trees'.*

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

WY1: The magnitude of impact to the LCT would be moderate adverse due to the structural elements and the rock cuts to facilitate these – particularly at the Pass. The significance of effect is large adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Highland Summits LCT No.251 (LLTNP)

This is a very high sensitivity LCT. No part of the Brown Option lies within this LCT. The Brown Option would introduce new features including the debris flow shelter and catch pit and a new junction element with the B828. The latter would include notable verge widening to the inside bend opposite the B828.

Special Landscape Qualities: The SLQs '*the dramatic pass of the Rest and Be Thankful*' would be compromised by the notable verge widening of the bend. There would also be localised impact on the SLQ *'a land of forests and trees'.*

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

WY1: The magnitude of impact to the LCT would be moderate adverse during operation due to the widening of the verge at the Pass and the new structure. The significance of effect is large adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Mountains LCT No.34

This is a high sensitivity LCT. No part of the Brown Option lies within this LCT. The LCT lies outside the LLTNP.

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

WY1: The magnitude of impact to the LCT would be moderate adverse due to the widening of the verge at the Pass and the introduction of the flow shelter and the proximity of this LCT to the Pass. The significance of effect is large adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Rugged Mountains LCT No.35

This is a high sensitivity LCT. No part of the Brown Option lies within this LCT. The LCT lies outside the LLTNP. The perceptual quality of ‘strong wildness’ is a key characteristic of the LCT.

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

WY1: The magnitude of impact to the LCT would be negligible adverse during operation due to the distance of the LCT from the new elements which would not impact upon the key characteristics of the LCT. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Hills LCT No.250 (LLTNP)

This is a very high sensitivity LCT. No part of the Brown Option lies within this LCT. The Brown Option would involve the addition of the debris flow shelter and catch pit and a new junction with the B828. The latter would include notable verge widening to the inside bend opposite the B828.

Special Landscape Qualities: The SLQs *‘a remote area of high hills and deep glens*’ would not be compromised in terms of its sense of remoteness during the operation phase.

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open farmed glen in the non-forested areas and at the rocky Pass where it would not by sympathetic with the existing landscape character.

WY1: magnitude of impact to the LCT would be minor adverse during operation due to the impact on the Pass from verge widening. The significance of effect is moderate adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

5.4.2.4. Pink Option

Landscape designations

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open glen in the non-forested areas where it would not align with the landscape character.

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area and is high sensitivity. Only the northern and southern extents lie within the AFP(NA). The southern tunnel portal and tie ins would be new elements for this designation within the study area. The tunnel section lies mostly outwith the designation, but the associated stabilisation measures and rock debris fences would be additional elements within this designation – however these would be in the context of similar existing elements.

The magnitude of impact at WY1 and SY15 to the AFP(NA) would be negligible adverse due to a slight loss of the woodland element and introduction of the portal not is not likely to have a significant impact on the experience of the NAAPF due to the overall extent of the designation. The significance of effect is slight adverse at both WY1 and SY15.

Wild Land Area

The Ben Lui Wild Land Area will not be affected by the Pink Option.

The magnitude of impact at WY1 and SY15 is no change. The significance of effect is neutral at both WY1 and SY15.

Areas of Panoramic Quality

Part of the North Argyll Area of Panoramic Quality, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There may be views of very limited parts of the Pink Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri (see Volume 3, Figure 6.1).

The magnitude of impact is minor adverse as the portal and control building may be perceptible but not alter the balance of the view. Significance of effect is slight adverse.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP)

This is a very high sensitivity LCT. The Pink Option mostly lies within this LCT. The Pink Option will run a tunnel mostly within the open glen with only the northern and southern extents within the forested glen. The tunnel with portals would be new elements and the tie-ins, junctions and stablisation measures would be additional elements in the context of similar existing elements. There would also be the addition of two new control buildings.

Special Landscape Qualities: The SLQ 'a *land of forests and trees'* would be slightly impacted by the Pink Option.

WY1: The magnitude of impact to the LCT would be negligible adverse due to felling and new portal elements. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Highland Summits LCT No.251 (LLTNP)

This is a very high sensitivity LCT with a key characteristic being its wild character. A small section of the tunnel lies within this LCT. The tunnel portals would be new element and the tie-ins, junctions and stabilisation measures would be additional elements in the context of similar existing elements within this LCT. There would be two new control buildings near each portal.

Special Landscape Qualities: There would be localised impact on the SLQ '*a land of forests and trees*'.

WY1: The magnitude of impact to the LCT would be minor adverse due to planting to replace felled trees and new the new portal elements not having an adverse effect on the SLQ. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Mountains LCT No.34

This is a high sensitivity LCT. No part of the Pink Option lies within this LCT. The LCT lies outside the LLTNP.

WY1: The magnitude of impact to the LCT would be negligible adverse as no new elements will affect the LCT though may be visible from it. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Rugged Mountains LCT No.35

This is a high sensitivity LCT. No part of the Pink Option lies within this LCT. The LCT lies outside the LLTNP.

WY1: The magnitude of impact to the LCT would be negligible adverse as there would be very minor change affecting the LCT. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Hills LCT No.250 (LLTNP)

This is a very high sensitivity LCT. No part of the Pink Option lies within this LCT. The tunnel portal at the southern extent and tie-ins with some localised tree reduction would affect this LCT in terms of the indirect effect on the experience of perceptual qualities from this LCT.

Special Landscape Qualities: The SLQs *'a remote area of high hills and deep glens*' would not be compromised in terms of its sense of remoteness during operation.

WY1: The magnitude of impact to the LCT would be negligible adverse. The significance of effect is judged to be slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

5.4.2.5. Purple Option

Landscape designations

Embedded mitigation is undefined at this time. There is likely to be some limited opportunity for essential mitigation planting at the southern extent. Planting would not be sympathetic to the open glen in the non-forested areas where it would not by sympathetic with the existing landscape character.

Argyll Forest Park (Northern Area)

The AFP(NA) is extensive beyond the study area and is high sensitivity. Only the northern and southern extents lie within the AFP(NA). The extents of the Purple Option would be on embankment/open road within the designation.

The magnitude of impact at WY1 and SY15 to the AFP(NA) would be negligible adverse due to a slight loss of the woodland element and the introduction of new elements and features not likely to have a significant impact due to the overall extent of the designation. The significance of effect is slight adverse at both WY1 and SY15.

Wild Land Area

The Ben Lui Wild Land Area would not be affected by this Option.

The magnitude of impact at WY1 and SY15 is no change. The significance of effect is neutral at both WY1 and SY15.

Areas of Panoramic Quality

Part of the North Argyll Area of Panoramic Quality, which is high sensitivity, lies within the north of the study area and is extensive beyond it. There may be views of very limited parts of the Purple Option from the NAAPQ within the study area specifically from very limited areas of Binnein an Fhidhleri and part of Beinn an t-Seilich where the northern portal and utility building may be perceptible (see Volume 3, Figure 5.1).

The magnitude of impact is minor adverse as the new elements would be perceptible but not alter the balance of the view. Significance of effect is slight adverse at both WY1 and SY15.

Landscape character and Special Landscape Qualities of LLTNP

Upland Glens LCT No.252 (LLTNP)

This is a very high sensitivity LCT. The Purple Option lies entirely within this LCT. Only northern and southern extents lie within the forested areas of the LCT with the majority routing through the farmed and open glen areas. The extents of the Purple Option would be on embankment/open road. The viaduct and tunnel with associated portals, retaining walls to each viaduct pier, and temporary working platforms which would impact the farmed character of the valley floor. There would also be a new junction at the B828 and the addition of a new utility building.

Special Landscape Qualities: The SLQ 'a *land of forests and trees'* would be slightly impacted by the Purple Option.

WY1: The magnitude of impact to the LCT would be moderate adverse due to a slight loss of the woodland element and introduction of new elements and features altering the character of the farmed valley floor. The significance of effect is large adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Highland Summits LCT No.251 (LLTNP)

This is a very high sensitivity LCT. No part of the Purple Option lies within this LCT. The tunnel with associated portals and the retaining walls to each viaduct pier would affect the perceptual qualities of the LCT as the Purple Option is within relatively close proximity to the LCT. There would also be a new junction at the B828.

Special Landscape Qualities: The SLQs '*Arrochar's mountains and distinctive peaks*' would not be affected in terms of the key LCT characteristic of wild character of this LCT during operation.

WY1: The magnitude of impact to the LCT would be minor adverse due to the new elements of viaduct and associated retaining walls at the piers. The significance of effect is moderate adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Steep Ridges and Mountains LCT No.34

This is a high sensitivity LCT. No part of the Purple Option lies within this LCT. The LCT lies outside the LLTNP.

WY1: The magnitude of impact to the LCT would be negligible adverse as no new elements would affect the LCT. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

Rugged Mountains LCT No.35

This is a high sensitivity LCT. No part of the Purple Option lies within this LCT. The LCT lies outside the LLTNP.

WY1: The magnitude of impact to the LCT would be negligible adverse as there will be no/ very minor change affecting the LCT. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements

Steep Ridges and Hills LCT No.250 (LLTNP)

This is a very high sensitivity LCT. No part of the Purple Option lies within this LCT. However, the tunnel portal at the southern extent, new viaduct feature, and tie-ins with some localised tree reduction would affect this LCT in terms of indirect perceptual landscape qualities experienced from it.

Special Landscape Qualities: The SLQs '*a remote area of high hills and deep glens*' would not be compromised in terms of its sense of remoteness during operation.

WY1: The magnitude of impact to the LCT would be minor adverse. The significance of effect is slight adverse.

SY15: The magnitude and significance remain the same as WY1 due to the limited appropriateness for essential mitigation planting and the scale of the new elements.

5.5. Potential Mitigation

5.5.1. Embedded Mitigation

In accordance with DMRB, embedded mitigation must be shown to be effective, deliverable and committed. Mitigation can only be taken into account in relation to the significance if the success of the features/measures delivering the desired outcome is supported by evidence and the project has an identified legal mechanism to implement the features/measures. As embedded mitigation relating to the features/measures associated with each of the Scheme Options has not yet been defined it has not been factored into the assessment of significance. However, where there are opportunities to define embedded mitigation further at Stage 3 and this has been recognised in this assessment (refer to Table 5.4 where an * identifies the potential embedded mitigation).

Potential embedded mitigation which may reduce significance levels might include:

- appropriate aesthetic design of structures including viaducts, flow shelters, retaining walls and bridges to achieve best fit with the localised landscape character;
- appropriate aesthetic design of utility buildings to achieve best fit with the localised landscape vernacular character;
- rock cut design which is sympathetic to the Special Landscape Qualities of the LLTNP particularly at the Pass near the Rest and Be Thankful;
- design solutions which avoid and/or minimise impacts on the cultural character associated with the OMR;
- the DMRB Stage 2 optioneering process is of itself part of the embedded mitigation process/measures in that it helps identify the Scheme Options that would likely result in greater effects on landscape.

5.5.2. Construction

During construction mitigation measures could potentially include (but not be limited to):

- adherence to best construction practices to minimise landscape impact; and
- careful selection of construction site compound locations to avoid adverse impact on the landscape resource.

5.5.3. Operation

During operation landscape mitigation measures could potentially include (but not be limited to):

- establishment of essential mitigation planting to mitigate trees lost – including appropriate use of native species to promote biodiversity;
- careful consideration of design and materials used for structures;
- incorporation of sensitive slope profiling to achieve best landscape fit; and
- incorporation of naturalistic edges to road drainage features and establishment of planting to improve their appearance.

5.6. Conclusions

There are no differentiators for landscape designations as there are no significant effects resulting from any of the Scheme Options upon them. The differentiators are set out in the Summary section below for construction, winter of year 1 and summer of year 15. There is a higher impact on the Green Option in terms of the landscape character of the Upland Glens LCT.

The levels of impact, where significant, could reduce with exploring opportunities for embedded mitigation. Where this is the case they are marked with an *. Policy is not considered to be a differentiator between Options.

Table 5.4 Landscape Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Effect Significance (Residual Effect)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Landscape Designation (not a differentiator)	Loch Lomond and The Trossachs National Park (LLTNP)	Construction and Operation: All Scheme Options lie within the LLTNP. Due to the extent of the LLTNP designation, none of the Scheme Options will have a likely significant adverse effect on the physical designation overall. Negligible adverse magnitude of impact.	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	While all Scheme Options are slight adverse for the LLTNP as a whole, the Green Option has a greater impact on the LLTNP Special Landscape Quality (SLQ) *'a land of forest and trees'*
Landscape Designation (not a differentiator)	Argyll Forest Park – northern area (AFPNA)	Construction: minor adverse magnitude of impact for all Scheme Options.	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	While all Scheme Options are slight adverse for the designation as a whole during construction and WY1 the Green Option would have the greatest impact on the designation due to the reduction in the tree cover and the introduction of road infrastructure elements to the west side of the Croe Valley.
		Operation: All Scheme Options have some extent within the AFP(NA) which is extensive across the study area and beyond. Negligible	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
			Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	

Sub-topic	Receptor	Potential Impact	Effect Significance (Residual Effect)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
		to minor adverse magnitude of impact at WY1 and SY15.						
Landscape Designation (not a differentiator)	Ben Lui Wild Land Area	<u>Construction and Operation:</u> The ZTV coverage is approx. between 5-10km beyond the study area. The magnitude of impact is no change-negligible adverse.	Neutral-slight adverse	Neutral-slight adverse	Neutral	Neutral	Neutral-slight adverse	There is no ZTV coverage for the Pink and Purple Options and limited likely actual visibility due to the distance for the remaining Scheme Options. No likely significant effects.
			Neutral-slight adverse	Neutral-slight adverse	Neutral	Neutral	Neutral-slight adverse	
			Neutral	Neutral-slight adverse	Neutral	Neutral	Neutral-slight adverse	
Landscape Designation (Not a differentiator)	North Argyll Area of Panoramic Quality	<u>Construction and Operation:</u> Limited ZTV coverage. Negligible to minor adverse magnitude of impact.	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Limited ZTV and distant from the Scheme Options.
Landscape Character	Upland Glens LCT (within the study area)	<u>Construction:</u> Four of the Scheme Options lie entirely within this LCT; with the Pink Option lying almost entirely within it. Reduction of forestry trees, introduction of road infrastructure elements to the west of the valley, notable verge widening at the Rest and Be Thankful Pass, altered character to the farmed glen area. Magnitude ranges from moderate to major adverse.	Very large adverse	Large adverse	Large adverse	Large adverse	Large adverse	The Green Option is very large adverse during construction due to increased felling area and the introduction of construction activity to the west side of the valley.

Sub-topic	Receptor	Potential Impact	Effect Significance (Residual Effect)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
		Operation: Four Scheme Options lie entirely within this LCT; with the Pink Option lying almost entirely within it. Reduction of forestry trees, introduction of road infrastructure elements to the west of the valley, notable verge widening at the Rest and Be Thankful Pass, altered character to the farmed glen area for some Scheme Options. Magnitude ranges from negligible to major adverse.	Very large adverse	Large adverse	Slight adverse	Large adverse	Large adverse	The Green Option results in the greatest impact on forestry cover and the Brown and Yellow Options would have an adverse impact on the Rest and Be Thankful Pass – both are SLQs of the LLTNP. The Pink Option is slightly less adverse than the rest due to the tunnel portals being the main new element during operation coupled with less tree loss. While all Scheme Options introduce new features and elements, the purple and yellow introduce these to the farmed valley floor altering the character. *Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.
			Large adverse	Large adverse	Slight adverse	Large adverse	Large adverse	Essential mitigation is possible to screen/soften the green option which reduces the impact. Essential mitigation is largely inappropriate for the other Scheme Options. * Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.

Sub-topic	Receptor	Potential Impact	Effect Significance (Residual Effect)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Landscape Character	Highland Summits LCT (within the study area)	Construction: Moderate adverse magnitude of impact.	Large adverse	Large adverse	Slight adverse	Large adverse	Large adverse	The Pink Option is less adverse due to its tunnel configuration.
		Operation: Only a small part of the tunnelled section of the Pink Option lies within this LCT. Magnitude of impact is negligible to moderate adverse.	Large adverse	Large adverse	Slight adverse	Moderate adverse	Moderate adverse	The Pink Option is less adverse due to the new portal elements not having an adverse effect on the SLQ. * Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.
			Slight adverse	Large adverse	Slight adverse	Moderate adverse	Moderate adverse	The Green Option has reduced to slight adverse effect by SY15 due to greater opportunity for essential mitigation in the form of tree planting.
Landscape Character	Steep Ridges and Mountains LCT (within the study area)	Construction: Magnitude of impact is minor to moderate adverse.	Large adverse	Moderate adverse	Large adverse	Large adverse	Moderate adverse	These are all significant adverse. * Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.
		Operation: No Scheme Options lie within this LCT. Magnitude of impact ranges from negligible to moderate adverse.	Large adverse	Large adverse	Slight adverse	Slight adverse	Moderate adverse	The Green, Brown and Yellow Options are more adverse due to the Green Option introducing road infrastructure to the opposite side of the valley and both affecting the widening at the Pass. The Pink and Purple Options both present their main changes closest to the LCT as a tunnel portal and tie-

Sub-topic	Receptor	Potential Impact	Effect Significance (Residual Effect)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
								ins and neither affect the rocky Pass (which the Yellow Option does). * Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.
			Slight adverse	Large adverse	Slight adverse	Slight adverse	Moderate adverse	The Green Option has reduced impact by a greater margin due to the opportunity for essential mitigation planting. *Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.
Landscape Character	Rugged Mountains LCT (within the study area)	Construction: Minor to moderate adverse magnitude of impact.	Slight adverse	Moderate adverse	Large adverse	Large adverse	Slight adverse	This LCT lies further removed from the changes for any of the Scheme Options at operation. The Green Option has greater opportunities for mitigation planting.
		Operation: No Scheme Options lie within this LCT. No change to negligible magnitude of impact.	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
			Neutral-Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
Landscape Character	Steep Ridges and Hills LCT	Construction: Moderate adverse magnitude of impact.	Large adverse	Large adverse	Large adverse	Moderate adverse	Moderate adverse	.
		Operation: No Scheme Options lie within this LCT.	Moderate adverse	Moderate adverse	Slight adverse	Slight adverse	Moderate adverse	

Sub-topic	Receptor	Potential Impact	Effect Significance (Residual Effect)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
	(within the study area)	Negligible to minor adverse magnitude of impact.	Slight adverse	Moderate adverse	Slight adverse	Slight adverse	Moderate adverse	The Brown and Yellow Options are more adverse due to the widening of the verge at the Pass. * Embedded design for the viaducts, flow shelters, utility buildings and widening of the Pass could reduce the significance levels.

5.6.1. Summary

For landscape, the Pink Option is the most favourable with the Green and Brown Options being the least favourable. The Purple and Yellow Options lie between these two thresholds.

In accordance with DMRB, a combined conclusion for landscape and visual (though they must be assessed separately) is Pink and Purple are considered most favourable.

5.7. Scope of DMRB Stage 3 Assessment

The DMRB Stage 3 assessment process will be based on GLVIA3 and DMRB LA 107 Landscape and Visual Effects. It will consist of a more detailed review of the Preferred Option and its effects on landscape receptors within the study area during construction and at both Winter Year 1 and Summer Year 15 during operation. The key aspects of the DMRB Stage 3 process are as follows:

- based on the Preferred Option, a revised specific landscape study area will be defined informed by a new digital ZTV and site analysis;
- where it serves to illustrate effects and mitigation measures, wirelines and/or photomontages will be produced;
- additional site surveys of both public and private land will be undertaken to add to the existing baseline information;
- the Preferred Option will be reviewed against the developed strategic landscape objectives;
- sensitive landscape receptors will be reviewed to ascertain if additional mitigation measures are possible;
- ongoing consultation with NatureScot, LLTNPA, Argyll & Bute Council and the landscape advisor at Transport Scotland will take place to discuss the method and scope of the LVIA, landscape sensitivities, further development of the landscape design objectives and potential landscape effects and mitigation measures; and
- public consultation to determine what the public consider to be valuable in the landscape.

6. Visual Effects

6.1. Introduction

Visual assessment is a tool used to identify and assess the significance of and the effect of change resulting from a project on people's views and visual amenity.

This chapter identifies, describes and assesses the existing visual receptors likely to be affected by the Scheme Options.

6.2. Approach and Methods

6.2.1. Introduction

The assessment methodology is derived from the DMRB LA 107 and DMRB LA 104 standards, which was informed by the Guidelines for Landscape and Visual Impact Assessment[74] (GLVIA3).

The assessment was undertaken by a Chartered Landscape Architect and comprised of desk study, field surveys and consultation. A site visit was undertaken in March 2023 and helped to gain an understanding of the visual context and to supplement information gathered during the desk study.

At DMRB Stage 2 the focus is on a comparative assessment that will allow for differentiation between the Scheme Options and on providing information to inform the selection of a preferred route.

The assessment has considered the effect of the Scheme Options at construction, in the winter of year 1 (WY1) and the summer of year 15 (SY15) in line with DMRB guidance, as well as potentially significant temporary effects during construction. The effects of the Scheme Options have been assessed with potential mitigation i.e. both embedded mitigation during construction and essential mitigation in year 15.

6.2.2. Sources of Information

The first stage of the assessment is to determine the baseline against which the magnitude of impact can be assessed. A desk study was carried out to review existing maps and data. The following were integral to the approach to the methodology:

[74] Landscape Institute and Institute of Environmental Management and Assessment (2013). Guidelines for Landscape and Visual Impact Assessment (Third edition). Routledge

- Zone of Theoretic Visibility (ZTV) mapping;
- Geographical Information Systems (GIS) datasets;
- Infraworks 3D design models of the Scheme Options; and
- Ordnance Survey (OS) maps.

6.2.3. Policy, Legislation and Guidance

Policy related to visual effect has been set out in section 6.3.3 and is not considered to be a differentiator between Options but will be assessed at Stage 3. he relevant policy and legislation is as follows:

- National Planning Framework 4, 2023[75];
- LLTNP Development Plan 2017-202176 (extended to 2024);
- Argyll and Bute Local Development Plan, 2015[77];
- Argyll and Bute Supplementary Guidance, adopted 2016[78];
- Argyll and Bute Council Proposed Local Development Plan 2, 2019[79]

6.2.4. Consultation

No specific consultation relating to the visual effects assessment has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA, NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

6.2.5. Scope of Stage 2 Assessment

Visual receptors were scoped in within a 3km study area. However, this did provide a worse-case scenario i.e. trees not in leaf. Night time assessment has not been undertaken at Stage 2. The ZTV indicates very limited theoretical visibility from the Cowal Way and the Three Lochs Way and these have been scoped out of the assessment.

[75] Scottish Government. (2023) National Planning Framework 4. [Online]. Available at: National Planning Framework 4 - gov.scot (www.gov.scot)
[76] The Loch Lomond and The Trossachs National Park Authority (2017-2021). Local Development Plan . [Online] Available at: Our Local Development Plan - #LetsDoNetZero -Loch Lomond & The Trossachs National Park (lochlomond-trossachs.org)
[77] Argyll and Bute Council (2015). Local Development Plan. [Online] Available at: Local Development Plan (argyll-bute.gov.uk)
[78] Argyll and Bute Council (March 2016). Local Development Plan Supplementary Guidance. [Online]. Available at: Supplementary guidance (argyll-bute.gov.uk)
[79] Argyll and Bute Council (November 2019). Proposed Local Development Plan 2

6.2.6. Assessment Methodology

In accordance with DMRB LA 107 and DMRB LA 104 and GLVIA3, the assessment has considered the sensitivity of the visual receptor, the magnitude of impact of the Scheme Option(s) upon it and resulted in a determination of the significance of effect of the Scheme Options on the visual receptor.

The visual assessment considered a range of visual receptors including representative views from residential and recreational receptors, specific view locations such as the Rest and Be Thankful car park, and illustrative viewpoints to demonstrate a particular issue.

In accordance with the methodology the assessment of sensitivity is based on consideration of value and susceptibility of the visual receptor.

6.2.6.1. Sensitivity

Sensitivity was assessed by considering visual value and susceptibility and has been assigned levels of very high, high, moderate , low and negligible as set out in DMRB LA 107 and shown in Table 6.1 below.

Table 6.1 Visual Sensitivity (susceptibility and value) and typical descriptions

Sensitivity (susceptibility and value)	Typical Descriptions
Very high	• Static views from and of major tourist attractions; • View from and of very important national/international landscape, cultural/historical sites (e.g. National Parks, UNESCO World Heritage sites); • Receptors engaged in specific activities for enjoyment of dark skies.
High	• Views by users of nationally important PRoW/recreational trails (e.g. national trials, long distance footpaths); • Views by users of public open spaces for enjoyment of the countryside (e.g. country parks); • Static views from dense residential areas, longer transient views from designated public open space, recreational areas; • Views from and of rare designated landscape of national importance.
Moderate	• Static views from less populated residential areas, schools and other institutional buildings and their outdoor areas; • Views by outdoor workers; • Transient views from local/regional areas such as public open space, scenic roads, railways or waterways, users of local/regional designated tourist routes of moderate importance; • Views from and of landscapes of regional importance.
Low	• Views by users of main roads or passengers in public transport on main arterial routes;

Sensitivity (susceptibility and value)	Typical Descriptions
	• Views by indoor workers; • Views by users of recreational/formal sports facilities where the landscape is secondary to t enjoyment of the sport; • Views by users of local public open spaces of limited importance with limited variety or distinctiveness.
Negligible	• Quick transient views such as from fast moving vehicles; • Views from industrial area, land awaiting re-development; • Views from landscape of no importance with no variety or distinctiveness.

6.2.6.2. Magnitude of Impact

The magnitude of visual effect was derived from the size or scale, geographical extent, duration and reversibility of the change on the visual receptor and is set out in Table 6.2 below.

Table 6.2 Magnitude (change) of visual effect and typical descriptions

Magnitude (change) of visual effect	Typical descriptions
Major	The project, or a part of it, would become the dominant feature or focal point of the view.
Moderate	The project, or a part of it, would form a noticeable feature or element of the view which is readily apparent to the receptor.
Minor	The project, or a part of it, would be perceptible but not alter the overall balance of features and elements that comprise the existing view.
Negligible	Only a very small part of the project work or activity would be discernible, or being at such a distance it would form a barely noticeable feature or element oof the view.
No change	No part of the project work or activity would be discernible.

6.2.6.3. Significance of Effect

The significance of effect has been determined using professional judgement by considering the sensitivity of the visual receptor and the magnitude of impact upon it in relation to the Scheme Options. Significant effect is considered to be moderate or greater.

Table 6.3 Significance Matrix

		Magnitude of Impact (degree of change)				
		No change	Negligible	Minor	Moderate	Major
Landscape Sensitivity	Very high	Neutral	Slight	Moderate or large	Large or very large	Very large

	Magnitude of Impact (degree of change)				
	No change	Negligible	Minor	Moderate	Major
High	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

6.2.6.4. Zone of Theoretical Visibility (ZTV)

Zones of Theoretical Visibility (ZTV) (Volume 3, Figure 6.1) were used to help determine visual receptors. Where no visibility or relatively limited visibility exists for visual receptors the receptors have not been assessed further.

The ZTVs have been run with a viewer's eye height of 1.5m, using OS Terrain 50 as the digital terrain model. The Scheme Option infrastructure height was calculated by using points present where infrastructure is proposed, or is existing and these points contain the topmost height of infrastructure for maximum visibility e.g. top of wall, pier height at surface level of carriageway. The existing A83(T) height was taken from the OS Terrain 50 digital terrain model.

6.2.6.5. Limitations and Assumptions

Due to seasonality for surveys and the DMRB Stage 2 programme, a high level visual amenity appraisal was carried out to help determine the likely significant effects resulting from the Scheme Options. This was undertaken in winter season only. A night time assessment was not undertaken as lighting is expected to be limited to tunnel portal areas and potentially within flow shelters and will be assessed at DMRB Stage 3. The viewpoints may change at DMRB Stage 3 following more consultation and more detailed surveys.

6.3. Baseline Conditions

6.3.1. Study Area

Following an appraisal of the theoretical visibility shown in the ZTV and observation made during site visits, the visual assessment has focused on potential visual impacts up to 3km from each Scheme Option though receptors beyond this extent are included where it is

judged they may be significantly affected. Based on professional judgement it was assessed that while there may be potential effects on visual receptors beyond 3km, these are not likely to have a significant effect upon them due to distance and/or intervening localised topography, built form and/or vegetation cover.

6.3.2. Study Area Context

The landscape and visual impacts are separate but linked procedures. The visual context of the baseline within the study area is therefore described in Chapter 5 Landscape and is not repeated here.

Visual receptors comprise of mostly walkers on the network of paths and drivers on the road network (A83(T), and the B828 Glen Mhor local road). The A83(T) is also the Argyll Coastal Route and the Rest and Be Thankful car park is a popular stopping point and is an OS map marked viewpoint.

The study area has very few residential properties. Not all of these may be occupied but for the purposes of this assessment those with a roof have been included in this assessment. There is also a caravan park at Ardgarten which lies within the study area for the Green Option.

Many of the walking routes are forest walks (one on a Core Path and the rest on local paths) and open views toward the Scheme Options are likely to be limited to paths to summits, the most notable of which is The Cobbler, and to open areas along the A83(T) within Glen Croe and along Loch Restil.

6.3.3. Visual Policy

6.3.3.1. National Planning Framework 4 (NPF4), February 2023

While visual impact is not mentioned specifically for the type of development proposed, NPF4 does refer to visual impact in relation to historic assets and places. There is more information in Chapter 4 Cultural Heritage but in relation to the visual impact of the setting of culturally significant elements the following is relevant. NFP4 Policy 7 states:

"*Development proposals with a potentially significant impact on historic assets or places will be accompanied by an assessment which is based on an understanding of the cultural significance of the historic asset and/or place. The assessment should identify the likely visual or physical impact of any proposals for change, including cumulative effects and provide a sound basis for managing the impacts of change.*"

NPF4 also states:

"*Cultural significance means aesthetic, historic, scientific or social value for past, present or future generations. Cultural significance can be embodied in a place itself, its fabric, setting, use, associations, meanings, records, related places and related objects.*"

6.3.3.2. LLTNP Statutory Development Plan

The Statutory Development Plan for the National Park Planning Authority Area comprises the adopted National Planning Framework 4 (February 2023) (NPF4), and the Local Development Plan (2017-2021) (LDP) and its supplementary guidance. The plan is dated 2017-2021 but will remain in place until 2024 to align with the new planning legislation.

Overarching Policy 2 states:

"*Development proposals should not conflict with nearby land uses and where relevant, must address the following requirements:*

Landscape & Visual Amenity: safeguard visual amenity and important views, protect and/or enhance rich landscape character, and features and areas specifically designated for their landscape values at any level;

Amenity and Environmental Effects: avoid any significant adverse impacts of; flooding, noise/vibration, air emissions/ odour/fumes/dust, light pollution, loss of privacy/sunlight/daylight;"

Natural Environment Policy 1 states:

"*National Park Landscapes, seascape and Visual Impact Development will protect the special landscape qualities of the National Park in accordance with The Special Landscape Qualities of Loch Lomond & The Trossachs National Park (SNH 2010). Development proposals will be required to be sympathetic to their setting and minimise visual impact, including areas of wild land character (1) and wild land areas. Note: The special landscapes of the National Park include a range of character types and are covered by various designations.*"

6.3.4. Visual Receptors

6.3.4.1. Views from the Road (A83(T))

The A83(T) is part of the Argyll Coastal Route and lies partly within the LLTNP. It is considered to be moderate sensitivity due to the value of the designation and its role as a noted tourist route.

6.3.4.2. Residential

Residential property is very limited within the study area. All residential receptors are considered to be high sensitivity. There are five locations with a residential property/small cluster of residential properties which have ZTV coverage for one or more of the Scheme Options (see Volume 3, Figure 6.1g). These are Larachpark (Larach Park and Guthas Cottage), Creagdhu, Laigh Glencroe (Roadmans Cottage) High Glencroe, and Butterbridge Cottage.

6.3.4.3. Recreational

Recreational receptors are more numerous as the study area lies partly within the LLTNP and also partly within the Argyll Forest Park which was designated partly for recreational purposes.

The Rest and Be Thankful Car Park is a very popular stopping off point on the Argyll Coastal Route. It contains the Rest and Be Thankful stone (which has Listed status) and is also an OS map marked viewpoint within the LLTNP. Visual receptors from this location are high sensitivity.

Forest walks and cycle paths lie mostly within the Argyll Forest Park and the LLTNP and visual receptors using them are considered to be high sensitivity. During construction, Non-Motorised Users (NMUs) would be diverted temporarily onto some of these routes.

Walkers on The Cobbler are high sensitivity receptors as the route is a recreational trail used for enjoyment of the countryside.

Users of the OMR are moderate sensitivity receptors experiencing transient views from a local scenic route with links to cultural regional importance.

6.4. Potential Impacts

This section provides a summary of the potential impacts during construction and operation for each of the Scheme Options.

6.4.1. Construction

The Scheme Options will have construction impacts which would include all or some of the following (those with an * have been scoped out of Stage 2 as there is not enough information on their location and scale at this stage (see Limitations section of this report):

- Vegetation clearance to facilitate construction is anticipated to occur during the initial mobilisation phase, requiring the removal of landscape features that contribute to the vegetation cover, the result will be newly exposed views of the wider landscape and the construction activity therein;
- Areas of additional tree clearance as a result of potential safety concerns relating to the windthrow effect of vegetation removal on the fringes of woodland, particularly associated with plantation woodland;
- Loss of embankments and/or rock outcrops;
- Disturbance caused by blasting related to rock cuts being reformed and mining activity;
- Temporary spoil heaps, material storage, and site compounds will occur throughout the construction phase*;
- Lighting associated with working in winter hours of darkness;
- Plant, machinery and traffic management will be conspicuous in views*;
- Temporary realignments and diversions and traffic management will result in a broader footprint;
- Piling activity to facilitate the viaduct piers with associated temporary working platforms during construction;
- Temporary stabilisation measures for protection of workforce;
- Formation of temporary drainage features*;

The duration of construction is within 3.25 to 4.25 years for all Scheme Options with the exception of the green option which is 7 years.

Mitigation during construction is the same for all Scheme Options and is not a differentiator.

6.4.1.1. Green Option

During construction rock debris fall fences and mesh would be required. Temporary working platforms associated with the viaduct piers and temporary stabilisation measures will be required to protect the workforce from any unstable ground. Felling of forest trees would be required to facilitate new built elements of the viaducts and flow shelter plus access tracks to maintain the rock fall catchment area. The duration of construction is longer for the Green Option than for any of the other Scheme Options.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors as the A83(T) is part of the Argyll Coastal Route and within the LLTNP. There would be visibility of the felling and construction works to the west side of Glen Croe for users of most of the A83(T) within the study area with the exception of the area around Ardgartan and from Butterbridge Car Park to the

western extent of the study area. The works would be seen in the context of the existing engineering measures within the Croe Valley but would introduce activity to an area with no road infrastructure works.

The magnitude of impact is moderate adverse as construction would be a noticeable feature/element, and the significance of effect is temporary moderate adverse.

Residential

All residents are high sensitivity. Views from residential properties would include construction works except for the residents at Butterbridge property which has no ZTV coverage. The works would be seen in the context of the existing engineering measures within the Croe Valley though would introduce activity to an area with no road infrastructure works.

The magnitude of impact is major adverse for Laigh Glencroe (Roadmans Cottage) and High Glencroe as, although there is existing construction works in the valley, the construction would be a noticeable feature/element on the west side of the valley, and the significance of effect is temporary large adverse. Magnitude of impact is minor for residents at Larchpark (Larach Park and Guthas Cottage) due to intervening trees with a significance of effect of temporary slight adverse. Magnitude of impact is moderate for residents at Craigdhu with a temporary moderate adverse significance of effect.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There would be extensive visibility of construction works which would be in immediate proximity to the car park.

The magnitude of impact is moderate adverse as construction would be a noticeable feature of the view. The significance of effect is temporary large adverse.

Users of the Forest Parks, including cycle paths, are high sensitivity receptors and would experience direct changes to one of the forest trails as the Green Option footprint would lie along part of this trail. Users on the parallel forest trail at slightly higher elevation would experience the works during construction and may be diverted to the OMR (if the latter is in temporary use for users of the A83(T), then the NMUs would potentially commute via shuttlebus). There is no ZTV coverage for the trails in the southern part of the study area.

The magnitude of impact is moderate adverse as construction would be a noticeable feature of the view whether on the elevated forest path or the OMR. The significance of effect is temporary large adverse.

From The Cobbler there would be no visibility of the Green Option from the path to the summit. From the summit and the west faces of The Cobbler there would be visibility of construction of both the north viaduct and the flow shelter. This would be experienced in the context of the wider views in all other directions.

The magnitude of impact is minor adverse as construction would be perceptible but not likely to alter the overall balance of the view. The significance of effect is temporary moderate adverse.

Users of the OMR are considered to be of moderate sensitivity. There would be visibility of construction works for those using the OMR which would be most perceptible in the open areas and in proximity to the Rest and Be Thankful car park.

The magnitude of impact is moderate adverse and the significance of effect is temporary moderate adverse.

6.4.1.2. Yellow Option

During construction there would be changes due to felling of trees and the introduction of the viaduct structure and associated retaining walls to protect the viaduct piers as well as tie in embankments at each end of the viaduct.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. There is likely to be visibility of the felling and construction works to the floor of the Croe Valley for most of the A83(T) within the study area with the exception of the area around Ardgartan and from Butterbridge Car Park to the western extent of the study area. The works would be seen in the context of the existing engineering measures within the Croe Valley.

The magnitude of impact is moderate adverse as construction would be a noticeable feature/element, and the significance of effect is temporary moderate adverse.

Residential

The ZTV indicates that there will be no visibility of the Proposed Scheme for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge although there is likely to be an awareness of increased construction traffic movement in the area. Residents of Laigh Glencroe (Roadmans Cottage) and High Glencroe would have a clear view of construction works.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

The magnitude of impact for residents at Laigh Glencroe and High Glencroe is major adverse, and the significance of effect is temporary large adverse.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There would be extensive visibility of construction works which would be in immediate proximity to the car park.

The magnitude of impact is major adverse as construction would be a noticeable feature of the view. The significance of effect is temporary large adverse.

There is no ZTV coverage for the trails in the southern part of the study area. Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience less actual visibility than the ZTV indicates due to intervening forestry tree cover. The magnitude of impact is minor-moderate adverse as construction would be a noticeable feature of the view but likely only intermittently for some parts of the forest trails. The significance of effect is temporary slight - moderate adverse.

From The Cobbler there would be no visibility of the Yellow Option from the path to the summit. From the summit and the west faces of The Cobbler there would be visibility of construction of the viaduct. This would be experienced in the context of the wider views in all other directions, and the elevation.

The magnitude of impact is minor adverse as construction would be perceptible but not likely to alter the overall balance of the view. The significance of effect is temporary moderate adverse.

Users of the OMR are considered to be of moderate sensitivity. There would be close proximity visibility of construction works for those using the OMR and in proximity to the Rest and Be Thankful car park. During periods when the OMR is being used for traffic diverted from the A83(T), the NMUs would be redirected to the forestry tracks on the west side of the valley. The magnitude of impact is major adverse and the significance of effect is temporary large adverse.

6.4.1.3. Brown Option

Construction would result in activity to build the debris flow shelter and the retaining wall, the catch pit and a new junction with the B828. The latter would include notable verge widening to the inside bend opposite the B828 and have a direct impact on the Rest and Be Thankful Pass.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. As the Brown Option follows the footprint of the existing A83(T), there would be no users of the A83(T) during construction as they would be diverted to the OMR. From the OMR they would experience views of the construction works from just north of the Croe Water crossing to the Rest and Be Thankful car park.

The magnitude of impact is moderate adverse as the works would be a noticeable feature but in the context of the existing works to the A83(T) as experienced from the OMR. The significance of effect is temporary moderate adverse.

Residential

The ZTV indicates that there will be no visibility of the Brown Option for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. Residents of Laigh Glencroe (Roadmans Cottage) may be afforded some restricted views of construction activity which would be experienced in the context of the existing engineering works and High Glencroe would have a clear view of construction works.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

The magnitude of impact for residents at Laigh Glencroe and High Glencroe is moderate adverse, and the significance of effect is temporary moderate adverse.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There would be extensive visibility of construction works which would be in immediate proximity to the car park.

The magnitude of impact is moderate adverse as construction would be a noticeable feature of the view though experienced in the context of existing construction works on the A83(T). The significance of effect is temporary moderate-large adverse.

There is no ZTV coverage for the trails in the southern part of the study area. Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience less actual visibility than the ZTV indicates due to intervening forestry tree cover.

The magnitude of impact is minor-moderate adverse as construction would be a noticeable feature of the view but likely only intermittently for some parts of the forest trails and in the context of existing works on the A83(T). The significance of effect is temporary slight - moderate adverse.

From The Cobbler there would be no visibility of the Brown Option from the path to the summit. From the summit and the northwest faces of The Cobbler there would be visibility of construction. This would be experienced in the context of the wider views in all other directions and existing construction associated with the A83(T) and OMR.

The magnitude of impact is minor adverse as construction would be perceptible but not likely to alter the overall balance of the view. The significance of effect is temporary moderate adverse.

Users of the OMR are considered to be of moderate sensitivity. There would be close proximity visibility of construction works for those using the OMR and in proximity to the Rest and Be Thankful car park.

The magnitude of impact is moderate adverse and the significance of effect is temporary moderate adverse.

6.4.1.4. Pink Option

Construction would involve mining works to facilitate the tunnel with portals at either end where construction compounds would likely be situated and the introduction of new junctions. Two new control buildings – one at each end of the tunnel - would be constructed. The approach to the tunnel portals and associated rock cuts, stabilisation measures and rock debris fences would be additional visual elements. There would be a diversion in place for users of the A83(T) at the southern end of the Pink Option. One residential property would be demolished (Roadmans Cottage) to facilitate the Pink Option.

Views from the Road

Users of the A83(T), moderate sensitivity receptors, would be diverted to the OMR during construction. Therefore, the views would be of the construction of the southern tunnel portal and the demolition of the residential property at Laigh Glencroe and a new control building

near the southern portal. Further north the construction of the northern portal and a new control building would be evident between Loch Restil and Butterbridge.

The magnitude of change is minor adverse, and the significance of effect is temporary slight-moderate adverse.

Residential

There would be no visibility of the Pink Option for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. Residents of High Glencroe would have a clear view of construction works. Laigh Glencroe residence (Roadmans Cottage) would be demolished for the Pink Option.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

The magnitude of impact for residents at High Glencroe is moderate adverse and the significance of effect is temporary moderate adverse.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There would be some visibility of construction works but not in close proximity to the car park.

The magnitude of impact is minor adverse as construction would be perceptible but not alter the balance of the view. The significance of effect is temporary slight adverse.

Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience visibility associated with construction of the portal areas. This visibility would be intermittent due to intervening forestry. Construction would be seen in the context of existing works on the A83(T) at the southern end of the Pink Option. Users of the trails in the southern part of the study area would not have visibility.

The magnitude of impact is minor adverse as construction would be a noticeable feature of the view but likely only intermittently for some parts of the forest trails and in the context of existing works on the A83(T). The significance of effect is temporary slight adverse.

From The Cobbler there would be no visibility of the Pink Option from the path to the summit. From the summit and the northwest faces of The Cobbler there would be limited views of construction. This would be experienced in the context of the wider views in all other directions.

The magnitude of impact is negligible adverse as construction would be perceptible but not likely to alter the overall balance of the view. The significance of effect is temporary slight adverse.

Users of the OMR are considered to be of moderate sensitivity. There would be close proximity visibility of construction works for those using the OMR which would be experienced in the context of existing engineering works. NMUs would be diverted to the OMR with rest stops for cyclists at the northern end of the glen. The magnitude of impact is moderate adverse, and the significance of effect is temporary moderate adverse.

6.4.1.5. Purple Option

Only northern and southern extents lie within the forested areas with the majority routing through the farmed and open glen areas. The extents of the Purple Option would be on embankment/open road. The viaduct and tunnel with associated portals, retaining walls to each viaduct pier, and temporary working platforms would impact the visual receptors during construction. There would be a new control building near the northern portal location. There would also be a new junction at the B828.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. Construction of the viaduct, retaining walls, tunnel portals and new control building would be evident. The magnitude of impact would be moderate adverse and the significance of effect is temporary moderate adverse.

Residential

There would be no visibility of the Purple Option for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. Residents of Laigh Glencroe (Roadmans Cottage) and High Glencroe would have a clear view of construction works.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

The magnitude of impact for residents at High Glencroe is minor adverse as the works would be seen at a distance and in the context of the existing engineering works on the A83(T). The significance of effect is temporary slight adverse. The magnitude of impact for residents at Laigh Glencroe is moderate adverse as the southern tunnel portal is in closer proximity; the significance of effect is temporary moderate adverse.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There would be some visibility of construction works but not in close proximity to the car park. The magnitude of impact is minor adverse as construction would be a noticeable feature of the view. The significance of effect is temporary slight adverse.

Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience visibility associated with construction of the portal areas. This visibility would be intermittent due to intervening forestry. Construction would be seen in the context of existing works on the A83(T). Users of the trails in the southern part of the study area would not have visibility. The magnitude of impact is minor adverse as construction would be a noticeable feature of the view but likely only intermittently for some parts of the forest trails and in the context of existing works on the A83(T). The significance of effect is temporary slight adverse.

From The Cobbler there would be no visibility of the Purple Option from the path to the summit. From the summit and the northwest faces of The Cobbler there would views of construction. This would be experienced in the context of the wider views in all other directions. The magnitude of impact is minor adverse as construction would be perceptible but not likely to alter the overall balance of the view. The significance of effect is temporary slight adverse.

Users of the OMR are considered to be of moderate sensitivity. There would be close proximity visibility of construction works for those using the OMR. As the OMR may be used as a haul route NMUs would likely be temporarily diverted to the forestry track on the west side of the valley. The magnitude of impact is moderate adverse, and the significance of effect is temporary moderate adverse.

6.4.2. Operation

Potential effects for each of the Scheme Options are described during operation in the winter of year 1 and the summer of year 15. The effects associated with the Scheme Options on the visual receptor include (but are not limited to):

- alteration of the local landscape character affecting the perception of landscape designations due to loss of existing landscape elements such as established woodland, changes to rock faces due to rock cuts and changes to existing views;
- changed appearance of the landform;
- changed appearance of rock faces due to new rock cuts particularly where these may involve the iconic Pass at the Rest and Be Thankful;

- the addition of new viaducts, flow shelters, bridge structures across rivers and small watercourses;
- introduction of new infrastructure elements such as new including retaining walls, signage and attenuation ponds and access tracks that could affect the overall perception of the valley including the cultural associations with the OMR;
- the introduction of lighting to previously unlit areas at tunnel portals; and
- the 'opening up' of the views due to vegetation removal.

6.4.2.1. Green Option

The Green Option will run mostly within the forested area, lying in the open upland glen only for its most northerly extent. It would result in the loss of more of the forested landscape element than any of the other Scheme Options due to felling to accommodate the flow shelter and viaducts and the maintenance access tracks and open up views of the Croe Valley. Road infrastructure would be a new element to the west side of the Croe Valley. During operation the rock debris fall fences and mesh installed during construction may be retained. This would be considered further at DMRB Stage 3

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. During operation the Green Option would become the A83(T) and the views from the road would be open and elevated from the southern viaduct and northern viaduct. There would be limited views from the flow shelter towards the east which would be likely be filtered by trees.

WY1: The magnitude of impact is moderate adverse as the experience will be very different to that experienced on the existing A83(T) as the viaducts cross the open valley floor where views would be more extensive and in different view envelope. In addition, and by contrast, there would be restricted views from the section within the flow shelter. The significance of effect is moderate adverse.

SY15: The magnitude and significance would remain the same as essential mitigation planting to the upper side of the Green Option would not affect visibility within the flow shelter, and planting to the east of the flow shelter would further restrict views from it. Essential mitigation planting elsewhere is likely to be limited and would not change views from the open viaduct areas.

Residential

All residents are high sensitivity. There would be views of the flow shelter and viaducts for receptors of all residential properties except the residence at Butterbridge. The new

structural elements and traffic movement would be experienced in an area of the Croe Valley which previously had no road infrastructure.

WY1: The magnitude of impact is minor adverse from properties at Larachpark (Larach Park and Guthas Cottage) as new elements would generally be screened by intervening trees, and the significance of effect is slight adverse for most residential receptors though views from High Glencroe, Craigdhu and Laigh Glencroe (Roadmans Cottage) would likely include the viaducts and potentially the flow shelter and have a moderate magnitude of change and moderate adverse significance of effect.

SY15: The magnitude of impact is likely to remain the same for all residents except for High Glencroe, Craigdhu and Laigh Glencroe (Roadmans Cottage) where essential mitigation planting would likely reduce the magnitude to minor adverse and the significance to slight adverse.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. The northernmost viaduct would be visible in immediate proximity to the car park with the southernmost viaduct perceptible in the distance. The flow shelter would be partially visible through the intervening trees.

WY1: The magnitude of impact is moderate adverse. The significance of effect is moderate adverse.

SY15: The magnitude of impact and the significance of effect would likely remain the same as essential mitigation planting would not screen the flow shelter without also restricting views from within it and planting would not screen the viaducts.

Users of the Forest Parks, including cycle paths, are high sensitivity receptors and would experience direct changes to one of the forest trails as the Proposed Scheme footprint would lie along part of this trail. Users on the parallel forest trail at slightly higher elevation would experience both the viaducts and flow shelter. There is no ZTV coverage for the trails in the southern part of the study area.

WY1: The magnitude of impact is moderate adverse. The significance of effect is large adverse.

SY15: The magnitude of impact would likely reduce to minor as essential mitigation planting would provide some screening of the flow shelter as experienced from elevated views with

views of the northern viaduct in particular being afforded. The significance of effect is judged to be slight –moderate adverse along the trail.

From The Cobbler there would be no visibility of the Green Option from the path to the summit. From the summit and the west faces of The Cobbler there would be visibility of both the north viaduct and the flow shelter. This would be experienced in the context of the wider views in all other directions.

WY1: The magnitude of impact is minor adverse as new elements would be perceptible but not likely to alter the overall balance of the view. The significance of effect is moderate adverse.

SY15: The magnitude and effect would remain much the same as mitigation planting would not affect views toward the flow shelter from the east.

Users of the OMR are considered to be of moderate sensitivity. There would be visibility of both viaducts though the flow shelter would be partially screened by intervening trees for those using the OMR. Built elements and features would be most perceptible in the open areas and in proximity to the Rest and Be Thankful car park.

WY1 and SY15: The magnitude of impact is minor - moderate adverse and the significance of effect is moderate adverse for both years due to mitigation planting not being transformative in views from the east. Though mitigation planting may soften some of the viaduct piers from the lower levels of the OMR, they would not alter the significance levels.

6.4.2.2. Yellow Option

Only the southern extent of the Yellow Option lies within the forested area with the majority routing through the farmed glen areas. The viaduct structure (including associated parapets for safety from wind, accidents and misuse resulting in public safety concerns) and associated retaining walls to protect the viaduct piers as well as tie in embankments at each end of the viaduct would be new features in the view.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. The new A83(T) will be on a viaduct above the valley floor. The view would change, being more open, and include an improved perspective for road users of The Cobbler and Beinn Luibheann.

WY1 and SY15: The magnitude of impact is minor beneficial and the significance of effect slight beneficial for both years as mitigation planting would not affect views from the viaduct.

Residential

The ZTV indicates that there would be no visibility of the Yellow Option for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. Residents of Laigh Glencroe (Roadmans Cottage) and High Glencroe would have a clear view of the viaduct and traffic upon it.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

WY1 and SY15: The magnitude of impact for residents at Laigh Glencroe and High Glencroe is major adverse, and the significance of effect is large adverse for both years as mitigation planting would not affect views for these visual receptors given that the main feature is a viaduct.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. The viaduct would be a new feature in the view extending from the proximity of the car park to the middle distance of the view.

WY1 and SY15: The magnitude of impact is minor-moderate adverse as, while it would be an important element in the view, it would not alter the focus of the view which are the summits which comprise the horizon. The significance of effect is slight-moderate adverse.

There is no ZTV coverage for the forest trails in the southern part of the study area. Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience less actual visibility than the ZTV indicates due to intervening forestry tree cover. The magnitude of impact is minor adverse as the viaduct would be a noticeable feature of the view but likely only intermittently for some parts of the forest trails and in the open areas at the north end of Glen Croe where existing road infrastructure is an existing element of the view. The significance of effect is slight adverse. This would be the same for WY1 and SY15 as the viaduct would likely remain perceptible with essential mitigation having established.

From The Cobbler there would be no visibility of the Yellow Option from the path to the summit. From the summit and the west faces of The Cobbler there would be visibility of the viaduct. This would be experienced in the context of the wider views in all other directions, and the elevation. The magnitude of impact is minor adverse as the viaduct would be perceptible but not likely to alter the overall balance of the view which is elevated and extensive. The significance of effect is slight adverse. This would be the same for WY1 and

SY15 as the viaduct would likely remain perceptible even with essential mitigation having established.

Users of the OMR are considered to be of moderate sensitivity. There would be close proximity visibility of the viaduct for those using the OMR. The magnitude of impact is moderate adverse, and the significance of effect is moderate adverse. This would be the same for WY1 and SY15 as the viaduct would remain readily apparent with essential mitigation having established.

6.4.2.3. Brown Option

The Brown Option would introduce a debris flow shelter and the retaining wall, the catch pit and a new junction with the B828. The latter would include notable verge widening to the inside bend opposite the B828 and have a direct impact on the Rest and Be Thankful Pass.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. The brown option follows the footprint of the existing A83(T), but views would be restricted in comparison to the existing open views due to the pillars and roof of the flow shelter. The magnitude of impact is moderate adverse the flow shelter would alter the extent of view along this part of the A83(T). The significance of effect is moderate adverse and would remain the same at both WY1 and SY15.

Residential

The ZTV indicates that there would be no visibility of the Proposed Scheme for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. The ZTV indicated residents of Laigh Glencroe (Roadmans Cottage) and High Glencroe would have potential visibility of the Brown Option. However, for Laigh Glencroe visibility would be restricted by existing conifer trees so that only High Glencroe would have views of the flow shelter.

The magnitude of impact for the residents at Larachpark, Butterbridge and Laigh Glencroe is no change, and the significance of effect is neutral at both WY1 and SY15.

The magnitude of impact for residents at High Glencroe is minor adverse as the flow shelter will be perceptible but in the context of existing engineering works and would not alter the overall focus of the view and the significance of effect is slight adverse at both WY1 and SY15 as essential mitigation would not play a significant role here.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. The flow shelter would be perceptible but not alter the balance of the view or the focus of the view which is to the summits which form the horizon. The magnitude of impact is minor adverse experienced in the context of existing works on the A83(T). The significance of effect is slight adverse at both WY1 and SY15 as essential mitigation would not play a transformative role here.

There is no ZTV coverage for the trails in the southern part of the study area. Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience less actual visibility than the ZTV indicates due to intervening forestry tree cover. The magnitude of impact is minor adverse as the flow shelter would be perceptible but likely only intermittently for some parts of the forest trails and in the context of existing works on the A83(T). The significance of effect is slight adverse at both WY1 and SY15 as essential mitigation would not play a transformative role here.

From The Cobbler there would be no visibility of the Brown Option from the path to the summit. From the summit and the northwest faces of The Cobbler there may be visibility of part of the flow shelter. This would be experienced in the context of the wider views in all other directions and existing construction associated with the A83(T) and OMR. The magnitude of impact is negligible adverse as the flow shelter may be perceptible but not likely to alter the overall balance of the view. The significance of effect is slight adverse at both WY1 and SY15 as essential mitigation would not play a transformative role here.

Users of the OMR are considered to be of moderate sensitivity. The flow shelter would be in close proximity visibility for those using the OMR. The magnitude of impact is slight-moderate adverse depending on the sequential views from areas of existing intervening trees and more open areas and the significance of effect is slight-moderate adverse at both WY1 and SY15 as essential mitigation would not play a transformative role here.

6.4.2.4. Pink Option

The Pink Option would introduce tunnel portals at either end and new junctions. Two new control buildings – one at each end of the tunnel - would be new elements. The approach to the tunnel portals and associated rock cuts, stabilisation measures and rock debris fences would be additional visual elements.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. The southern and northern tunnel portals and associated wing/retaining walls and new control buildings would be new

elements in the view on approach to the tunnel. The main change would be that drivers would not be able to appreciate the views of the Croe Valley and part of Gleann Mor due to being within the tunnel which is approximately 3.9km long.

The magnitude of change is major adverse, and the significance of effect is very large adverse at both WY1 and SY15 as essential mitigation would not play a role here.

Residential

There would be no visibility of the Proposed Scheme for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. Residents of High Glencroe would have a clear view of the changes. Laigh Glencroe (Roadmans Cottage) residence would be demolished for the Pink Option.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

The magnitude of impact for residents at High Glencroe is minor adverse and the significance of effect is slight adverse at both WY1 and SY15 as though there may be essential mitigation planting opportunities to soften the new control building near the southern portal this will still be a new element.

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There may be some visibility of the control building near the north portal at Loch Restil from parts of the car park works.

WY1: The magnitude of impact is negligible adverse as the addition would be perceptible but not alter the balance of the view and the focus of the summits. The significance of effect is slight adverse.

SY15: The control building near Loch Restil could be softened by mitigation planting which could reduce magnitude of change somewhat but not to the level of ‘no change’ so that the significance remains slight adverse at SY15.

Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and may experience intermittent sequential visibility (due to forestry) of the portal areas and wing/retaining walls for the southern portal. These new elements would be seen in the context of existing works on the A83(T) at the southern end of the Pink Option. Users of the trails in the southern part of the study area would not have visibility. The magnitude of impact is negligible adverse as the retaining walls and the utility

buildings would be new elements in the view but likely only intermittently for some parts of the forest trails and in the context of existing works on the A83(T). The significance of effect is slight adverse at both the SY15 and WY1.

From The Cobbler there would be no visibility of the Pink Option from the path to the summit. From the summit and the northwest faces of the Cobbler there would be limited views which are not likely to include the portals but may include the control buildings. This would be experienced in the context of the wider views in all other directions. The magnitude of impact is negligible adverse as though these might be perceptible it is not likely to alter the overall balance of the view. The significance of effect is slight adverse at both WY1 and SY15.

Users of the OMR are considered to be of moderate sensitivity. There would be visibility of the portals and associated wing/retaining walls and new control buildings for those using the OMR which would be experienced in the context of existing engineering works. The magnitude of impact is minor adverse, and the significance of effect is slight adverse at both WY1 and SY15.

6.4.2.5. Purple Option

Only northern and southern extents lie within the forested areas with the majority routing through the farmed and open glen areas. The extents of the Purple Option would be on embankment/open road. The viaduct (including associated parapets for safety from wind, accidents and misuse resulting in public safety concerns) and tunnel with associated portals, retaining walls to each viaduct pier, and temporary working platforms would impact the visual receptors. There would be a new control building near the northern portal location. There would also be a new junction at the B828.

Views from the Road

Users of the A83(T) are moderate sensitivity receptors. The introduction of the viaduct would open views up in both directions to a greater extent than those on the existing A83(T) alignment. This would be a beneficial effect. The retaining walls, tunnel portals and new control building would be evident on the approaches to the tunnel from either end where they would be new elements in the view but in the context of existing engineering works on the A83(T). The tunnel section would change the views for drivers as there would be no views of the landscape for approximately 1.1km which would have an adverse effect.

The magnitude of impact would therefore range from moderate beneficial (for the viaduct section) to moderate adverse (for the tunnel section) and the significance of effect would range from moderate beneficial to moderate adverse. This would remain the same at WY1 or SY15.

Residential

There would be no visibility of the Proposed Scheme for residents at Larachpark (Larach Park and Guthas Cottage), Creagdhu and Butterbridge. Residents of Laigh Glencroe (Roadmans Cottage) and High Glencroe would have a view of the viaduct.

The magnitude of impact for the residents at Larachpark and Butterbridge is no change, and the significance of effect is neutral.

The magnitude of impact for residents at High Glencroe and Laigh Glencroe during operation is moderate adverse as the new elements would be visible but not alter the context of the view. The significance of effect is moderate adverse at WY1 and SY15**.**

Recreational

Users of the Rest and Be Thankful car park are high sensitivity visual receptors. There would be visibility of the viaduct. The magnitude of impact is minor adverse as although a noticeable feature of the view, it would not alter the overall balance of the view which focuses on the hills comprising the horizon. The significance of effect is slight adverse at both WY1 and SY15.

Users of the Forest Parks, including cycle paths, in the central and northern part of the study area are high sensitivity receptors and would experience visibility of the viaduct and portal area. This visibility would be intermittent due to intervening forestry. Users of the trails in the southern part of the study area would not have visibility. The magnitude of impact is minor adverse as the viaduct and southern portal area would be a noticeable feature of the view but likely only intermittently for some parts of the forest trails and in the context of existing works on the A83(T). The significance of effect is slight adverse at both WY1 and SY15.

From The Cobbler there would be no visibility of the Purple Option from the path to the summit. From the summit and the northwest faces of the Cobbler there would views of the viaduct. This would be experienced in the context of the wider views in all other directions. The magnitude of impact is minor adverse as the viaduct would be perceptible but not likely to alter the overall balance of the view. The significance of effect is slight adverse at both WY1 and SY15.

Users of the OMR are considered to be of moderate sensitivity. There would be visibility of the viaduct and the portals, and control building for those using the OMR. The magnitude of impact is moderate adverse, and the significance of effect is moderate adverse at both WY1 and SY15.

6.5. Potential Mitigation

Mitigation can either be embedded into the scheme design or essential mitigation i.e. mitigation proposed to reduce the impact of the Proposed Scheme - for example, through planting.

6.5.1. Embedded mitigation during design

In accordance with DMRB embedded mitigation must be shown to be effective, deliverable and committed. Mitigation can only be taken into account in relation to the significance if the success of the features/measures delivering the desired outcome is supported by evidence and the project has an identified legal mechanism to implement the features/measures. As embedded mitigation relating to the aesthetics of features/measures has not yet been defined it has not been factored into the assessment of significance. However, where there are opportunities to define embedded mitigation further at Stage 3 and what that might mean for the significance levels this has been included in this assessment (refer to Table 6.4 where an * identifies the potential embedded mitigation).

Potential embedded mitigation which may reduce significance levels might include but not be limited to:

- embedded mitigation would include adherence to best construction practices;
- appropriate aesthetic design of structures including viaducts (including associated parapets for safety from wind, accidents and misuse resulting in public safety risks), flow shelters, retaining walls and bridges to minimise visual impact and enhance the experience for visual receptors;
- appropriate aesthetic design of control buildings to minimise visual impact and enhance the experience for visual receptors;
- design solutions which avoid and/or minimise impacts on the cultural character associated with the OMR; and
- the DMRB Stage 2 optioneering process is of itself part of the embedded mitigation process/measures in that it helps identify the Scheme Options that would likely result in greater effects on visual receptors.

6.5.2. Construction

During construction mitigation measures could potentially include (but not be limited to):

- adherence to best construction practices to minimise visual impact;
- careful selection of construction site compound locations to avoid adverse impact on visual receptors; and

- appropriate rock cut design to ensure the drama and special landscape qualities are not compromised for visual receptors;

6.5.3. Operation

During operation mitigation measures could potentially include (but not be limited to):

- establishment of essential mitigation planting to mitigate trees lost and provide screening and/or softening of new elements for visual receptors;
- careful consideration of design and materials used for structures to minimise visual impact; and
- incorporation of sensitive slope profiling and incorporation of naturalistic edges to road drainage features and establishment of planting to improve the appearance of these elements or visual receptors.

6.6. Conclusions

The levels of effect, where significant, could reduce with exploring opportunities for embedded mitigation in the form of design aesthetics. Where this is the case they are marked with an *. For each receptor there are three residual impacts – construction, operation at winter year 1 and operation at summer year 15. Policy is not considered to be a differentiator between Options.

Table 6.4 Visual Effects Comparative Appraisal

Sub-topic	Receptor	Magnitude of Impact	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Views from the Road	A83(T)	Construction: Magnitude of impact ranges from minor to moderate adverse	Moderate adverse	Moderate adverse	Slight-moderate adverse	Moderate adverse	Moderate adverse	The Pink Option is less adverse during construction as A83(T) users are diverted but during operation has the largest impact as there will be no view from the tunnel. The Purple Option varies from beneficial to adverse during operation as the viaduct views will be an improvement to the existing, but the tunnel section will not afford any view. * Embedded design for the viaducts, flow shelters, control buildings and widening of the Pass could reduce the significance levels.
		Operation: Magnitude of impact ranges from minor beneficial to major adverse	Moderate adverse	Moderate adverse	Very large adverse	Moderate beneficial to moderate adverse	Slight beneficial	
			Moderate adverse	Moderate adverse	Very large adverse	Moderate beneficial to moderate adverse	Slight beneficial	
Residential	Lararchpark (Larach Park and Guthas Cottage)	Construction: Magnitude of impact ranges from no change to major.	Slight adverse	Neutral	Neutral	Neutral	Neutral	Green Option is the only one with theoretical visibility from Larachpark
			Slight adverse	Neutral	Neutral	Neutral	Neutral	

Sub-topic	Receptor	Magnitude of Impact	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
		Operation: Magnitude of impact ranges from no change to moderate adverse	Slight adverse	Neutral	Neutral	Neutral	Neutral	
Residential	Creagdhu		Moderate adverse	Neutral	Neutral	Neutral	Neutral	Green is the only option with theoretical visibility from Creagdhu
			Moderate adverse	Neutral	Neutral	Neutral	Neutral	
			Moderate adverse	Neutral	Neutral	Neutral	Neutral	
Residential	Laigh Glencroe (Roadmans Cottage)		Large adverse	Moderate adverse	N/A (demolished)	Moderate	Large adverse	The Pink Option demolishes this property, so it hasn't been assessed. The Yellow Option is most adverse as essential mitigation is unlikely to contribute to reduction in impact. * Embedded design for the viaducts, flow shelters, control buildings and widening of the Pass could reduce the significance levels.
			Moderate adverse	Neutral		Moderate adverse	Moderate adverse	
			Slight adverse	Neutral		Moderate adverse	Large adverse	
Residential	High Glencroe		Large adverse	Moderate adverse	Moderate adverse	Slight adverse	Large adverse	The Yellow Option has most residual impact due to the open nature of the view towards it from the property, the scale of the viaduct and its greater proximity to the receptor * Embedded design for the viaducts, flow shelters, control buildings and widening of the Pass could reduce the significance levels.
			Moderate adverse	Slight adverse	Slight adverse	Moderate adverse	Moderate adverse	
			Sight adverse	Slight adverse	Slight adverse	Moderate adverse	Large adverse	
Residential	Butterbridge Cottage		Neutral	Neutral	Neutral	Neutral	Neutral	There is no ZTV or actual visibility from the residence at Butterbridge

Sub-topic	Receptor	Magnitude of Impact	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Recreational	Rest and Be Thankful	Construction: Ranges from minor to moderate adverse magnitude of impact Operation: Ranges from negligible to moderate adverse for magnitude of impact	Large adverse	Moderate—large adverse	Slight adverse	Slight adverse	Large adverse	The Green Option is most adverse due to sensitivity RBT being very high (a marked OS viewpoint in the LLTNP) and introducing new elements to the view to the south side of the valley. * Embedded design for the viaducts, flow shelters, control buildings and widening of the Pass could reduce the significance levels.
			Moderate adverse	Slight adverse	Slight adverse	Slight adverse	Slight-moderate adverse	
			Moderate adverse	Slight adverse	Slight adverse	Slight adverse	Slight-moderate adverse	
Recreational	Forest Paths/Cycle Paths	Construction: Minor to moderate adverse magnitude of impact Operation: Negligible to moderate magnitude of impact	Large adverse	Slight-moderate adverse	Slight adverse	Slight adverse	Slight-moderate adverse	The Green Option has greater potential adverse impact due to the option being on the route of one of the forest paths and close to the other parallel forest park – all other Scheme Options are more distant.
			Large adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
			Slight-moderate adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
Recreational	The Cobbler (Ben Arthur)	Construction: Minor adverse magnitude of impact for all Scheme Options Operation: negligible to minor adverse magnitude of impact.	Moderate adverse	Moderate adverse	Slight adverse	Slight adverse	Moderate adverse	The Green Option is likely to have most impact as it introduces road infrastructure to the west side of the valley which has none. * Embedded design for the viaducts, flow shelters, control buildings and widening of the Pass could reduce the significance levels.
			Moderate adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
			Moderate adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	
Recreational	OMR	Construction: Moderate to major adverse magnitude of impact. Operation: Slight to moderate adverse magnitude of impact.	Moderate adverse	Moderate adverse	Moderate adverse	Moderate adverse	Large adverse	The Brown Option would have less of an impact as it is further removed and on the existing A83(T) so that road infrastructure is not a new addition.
			Moderate adverse	Slight-moderate adverse	Moderate adverse	Moderate adverse	Moderate adverse	

Sub-topic	Receptor	Magnitude of Impact	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
			Moderate adverse	Slight-moderate adverse	Moderate adverse	Moderate adverse	Moderate adverse	* Embedded design for the viaducts, flow shelters, control buildings and widening of the Pass could reduce the significance levels.

The Purple and Brown Scheme Options result in being the most favourable with the Green Option resulting in the most overall significant effects and therefore considered least favourable from a visual perspective.

In accordance with DMRB, a combined conclusion for landscape and visual (though they must be assessed separately) is that the Pink and Purple Options are considered most favourable.

6.7. Scope of DMRB Stage 3 Assessment

The DMRB Stage 3 assessment process will be based on GLVIA3 and DMRB LA 107 Landscape and Visual Effects. It will consist of a more detailed review of the Preferred Option and its effects on visual receptors within the study area during construction and at both Winter Year 1 and Summer Year 15 during operation. The key aspects of the DMRB Stage 3 process are as follows:

- based on the Preferred Option, a revised specific visual study area will be defined informed by a new digital ZTV and site analysis;
- where it serves to illustrate effects and mitigation measures, wirelines and/or photomontages will be produced;
- additional site surveys of both public and private land will be undertaken to add to the existing baseline information;
- sensitive visual receptors will be reviewed to ascertain if additional mitigation measures are possible;
- ongoing consultation with NatureScot, LLTNPA, Argyll & Bute Council and the landscape advisor at Transport Scotland will take place to discuss the method and scope of the LVIA, visual sensitivities, further development of the landscape design objectives and potential visual effects and mitigation measures; and
- public consultation to determine what the public consider to be valuable in the landscape;

7. Biodiversity

7.1. Introduction

This chapter presents the results of the Biodiversity assessment undertaken to inform the DMRB Stage 2 Assessment. It discusses baseline conditions and potential impacts of each Scheme Option on scoped in terrestrial and aquatic ecological receptors and considers designated sites, terrestrial and freshwater habitats, plants and fauna.

This DMRB Stage 2 Assessment has been informed by desk study and preliminary field survey data. The field surveys for this assessment have focused on identifying priority and ecologically important habitats and the presence of, and potentially suitable habitat for, legally protected and notable species of conservation concern. The information collected through the desk study and field surveys has been used to identify likely ecological impacts associated with the Scheme Options, thereby allowing a Preferred Option to be identified from an ecological perspective which will inform the overall Preferred Option selection process. It has also been used to identify the requirement for specific surveys during the DMRB Stage 3 Assessment of the final selected Scheme Options.

7.2. Approach and Methods

7.2.1. Study Area

The Study Areas for the data gathering and field surveys have been determined in accordance with standard best practice[80] and DMRB LA 103. The ecological Study Areas are detailed in Table 7.1.

7.2.2. Policy, Legislation and Guidance

The assessment has been undertaken in accordance with DMRB guidance:

- DMRB LA 104: Environmental Assessment and Monitoring; and
- DMRB LA 108: Biodiversity[81].

In addition to DMRB guidance, other policy documents and guidance have been considered during the preparation of this chapter, including:

[80] CIEEM, (2021). Good Practice Guidance for Habitats and Species. Version 3. Available at: https://cieem.net/wp-content/uploads/2021/05/Good-Practice-Guide-April-2021-v6.pdf [Accessed 13 March 2023].
[81] DMRB LA 108 Biodiversity. Highways England et al. 2020

- Scottish Transport Appraisal Guidance (STAG)[82];
- The Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in the United Kingdom[83];
- NatureScot and Historic Environment Scotland's handbook on Environmental Impact Assessment[84]; and
- Relevant legislation and policy considered as part of this assessment relating to protected species and designated sites in Appendix 7.1. Relevant national and local planning policy includes:

    - National Planning Framework 4 (NPF4)[85];
    - Argyll and Bute Council Local Development Plan[86]; and
    - Loch Lomond and The Trossachs National Park Authority (LLTNPA) Development Plan, 2017-2021 (extended to 2024)[87].

Policy related to Biodiversity is set out in Appendix 7.1 and is not considered to be a differentiator between Options at this time but will be taken into account in designing the selected option including mitigation, compensation and additional enhancement.

7.2.3. Desk Study and Consultation

The geographical area for obtaining ecological data through desk studies has been determined using professional judgement. Baseline data has been gathered from a range of sources through data requests, consultation, and using online resources as outlined below. This included data gathering in relation to statutory and non-statutory designated sites and protected and priority species as listed on the Scottish Biodiversity List (SBL) and UK Biodiversity Action Plan (UK BAP).

The following online resources were accessed:

[82] Transport Scotland, (2022). Scottish Transport Appraisal Guidance - Managers Guide. [Online] Available at: https://www.transport.gov.scot/publication/scottish-transport-appraisal-guidance-managers-guide/ [Accessed 14 March 2023].
[83] CIEEM, (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.2. Chartered Institute of Ecology and Environmental Management, Winchester.
[84] NatureScot and Historic Environment Scotland, (2018). Environmental Impact Assessment Handbook, Version 5. [Online] Available at: https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=6ed33b65-9df1-4a2f-acbb-a8e800a592c0 [Accessed 14 March 2023].
[85] Scottish Government, (2023). National Planning Framework 4. [online] Available at: https://www.gov.scot/publications/national-planning-framework-4/documents/ [Accessed April 2023].
[86] Argyll and Bute Council, (2020). Local Development Plan: Written Statement. Available at: https://www.argyll-bute.gov.uk/sites/default/files/written_statement_0_1_ac_0.pdf [Accessed April 2023].
[87] Loch Lomond and the Trossachs National Park Authority, (2017-2021). Local Development Plan. [Online] Available at: Our Local Development Plan - #LetsDoNetZero -Loch Lomond & The Trossachs National Park. Available at: lochlomond-trossachs.org. [Accessed April 2023].

- National Biodiversity Network (NBN) biological records which were publicly available and excluded 'CC-BY-NC' data which are not permitted for commercial use;
- Water Framework Directive (WFD) water bodies and Scotland's River Basin Management Plan (RBMP)[88];
- Scottish Environment Protection Agency (SEPA) River Classifications[89];
- SEPA Obstacles to Fish Migration[90];
- Records for Native Woodland Survey of Scotland (NWSS) were accessed from Scottish Forestry's data explorer; and
- Saving Scotland's Red Squirrels interactive map[91].

The following organisations were contacted to request relevant desk study data, including details of non-statutory designated sites:

- Argyll Raptor Study Group (ARSG);
- Argyll Biological Records Centre (ABRC)92;
- Argyll Fisheries Trust (AFT);
- Botanical Society of Britain and Ireland (BSBI);
- Forestry and Land Scotland (FLS);
- Loch Lomond and The Trossachs National Park Authority (LLTNPA);
- NatureScot;
- Royal Society for the Protection of Birds (RSPB); and
- Scottish Badgers.

In addition, a review of the available survey data on the Scheme Options collected on behalf of Transport Scotland has been undertaken below.

Broad principles in terms of what was scoped in and out of the assessment topics at Stage 2 (see Section 7.2.5) have been discussed with the following statutory consultees:

- NatureScot;
- Argyll and Bute Council;

[88] SEPA, (2021). Water Environment Hub. [Online] Available at: https://informatics.sepa.org.uk/RBMP3/ [Accessed: 16 March 2023].
[89] SEPA, (2020). Water Classification Hub. [Online] Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed: 16 March 2023].
[90] Scotland's Environment, (2023). Obstacles to Fish Migration Map. [Online] Available at: https://map.environment.gov.scot/sewebmap/?layers=obstaclesToFishMigration [Accessed: 16/03/2023].
[91] Saving Scotland's Red Squirrels, (2023). Squirrel Sightings Interactive Map. [online] Available at: https://scottishsquirrels.org.uk/squirrel-sightings/ [Accessed: 14 March 2023].
[92] Argyll Biological Records Centre (ABRC), (2023). Data search. Available at: http://www.abrec.org.uk/data-searches.htm [Accessed: date 14 March 2023].

- SEPA; and
- Loch Lomond and The Trossachs National Park Authority.

7.2.4. Methodology

This DMRB Stage 2 Assessment has been informed by a series of technical field surveys and protected and notable species surveys. During all site surveys, incidental records were also recorded where any protected species were sighted. Surveys are summarised in Table 7.1.

Volume 3, Figure 7.1 shows the designated sites within 2km of the Proposed Options.

Table 7.1 Extent of data gathering and ecological field surveys

Receptor	Desk Study search area	Type of Survey	Survey dates	Study area – distance from the Proposed Scheme boundary
International designated sites (Special Protection Area [SPA]; Special Area of Conservation [SAC]; Ramsar site)	2km[93]	n/a	n/a	n/a
Other statutory designated sites (Site of Special Scientific Interest [SSSI], National Nature Reserve [NNR], Local Nature Reserves [LNR])	2km	n/a	n/a	n/a
Non-statutory designated sites and habitat status (Local Wildlife Sites, Ancient Woodland and NWSS)	1km	n/a	n/a	n/a
Habitats / botany	200m	Phase 1 / UK Habitat Classification (UKHab) / INNS	June 2021 July - September 2022	200m
Aquatic habitats and species	2km	Fish, macroinvertebrate and macrophyte surveys	Autumn 2021 and spring 2022 (macroinvertebrates), August 2022	150m (extended to 2km where there is

[93] Potential impact pathways were also considered to identify international designated sites that could be receptors at greater distance following the guidance on pathways in Highways England, (2020). Design Manual for Roads and Bridges: DMRB LA 115 Habitats Regulations assessment. Available at: e2fdab58-d293-4af7-b737-b55e08e045ae (standardsforhighways.co.uk) [Accessed: 20 April 2023].

Receptor	Desk Study search area	Type of Survey	Survey dates	Study area – distance from the Proposed Scheme boundary
			(macrophyte and fish)	hydrological connectivity[94])
Badger (*Meles meles*)	2km	Badger survey	June 2021 October 2021 July 2022	100m
		Targeted monitoring was conducted at two badger setts using infra-red cameras	Sett 1: July - September 2022 Sett 2: July - October 2022	n/a
Bats	2km	Preliminary Roost Assessments (PRA)	October 2021	50m
		Winter hibernation inspections	January - March 2022	
		Static bat detector monitoring	May to October 2022	
		Emergence / re-entry surveys	May – September 2022	
		Bat activity transect surveys	May - October 2022	
Barn owl (*Tyto alba*)	2km	Barn owl surveys	May 2022	200m
Black grouse (*Lyrurus tetrix*)	1.5km	Black grouse habitat suitability walkover	May 2021	1.5km
		Lekking black grouse surveys	April - May 2022	
Breeding birds	2km	Breeding bird survey	April – July 2022	500m
Golden eagle (*Aquila chrysaetos*)	6km	Raptor habitat assessment	Desk study only	
Great crested newt (*Triturus cristatus*)	2km	Great crested newt desk study of aerial habitat imagery only	n/a	500m
Herpetofauna (Amphibians and Reptiles)	1km	ABRC data request only	n/a	n/a
Invertebrates	1km	ABRC data request only	n/a	n/a

[94] The study area for aquatic habitats and species is 2km for those aquatic features within or hydrologically connected to aquatic features identified within a screening area of 150m from the Scheme Options (i.e. the location where impacts may arise).

Receptor	Desk Study search area	Type of Survey	Survey dates	Study area – distance from the Proposed Scheme boundary
Otter (*Lutra lutra*)	1km	Otter survey	June 2021 October 2021	200m
Pine marten (*Martes martes*)	1km	Pine marten survey	October 2021	200m
Red squirrel (*Sciurus vulgaris*)	1km	Red squirrel survey ABRC data request only	n/a	
Water vole (*Arvicola amphibius*)	1km	Water vole survey – determined to be absent	June 2021 October 2021	200m
Scottish wildcat (*Felis sylvestris*)	5km	Wildcat survey	October 2021	200m

7.2.5. Scope of Stage 2 Assessment

In accordance with DMRB LA 103 'Scoping projects for environmental assessment' and a scoping exercise undertaken, this chapter has considered the following biodiversity factors as scoped in for assessment:

7.2.5.1. Designated Sites

- Glen Etive and Glen Fyne SPA;
- Loch Lomond Wood SAC; and
- Beinn an Lochain SSSI.

7.2.5.2. Habitats

- Semi-natural woodland and related habitats;
- Mires (including wet heath, flush and bog vegetation);
- Dry heaths;
- Grasslands and related vegetation;
- Watercourses;
- Standing waterbodies; and
- Other habitats including fern communities, unvegetated inland cliff, largely unvegetated scree and coniferous plantation woodland (primarily comprising Sitka spruce *Picea sitchensis*).

7.2.5.3. Species of Conservation Interest

- Badger;
- Bats;
- Barn owl;
- Black grouse;
- Breeding birds (including barn owl and general assemblage);
- Golden eagle;
- Reptiles;
- Otter;
- Pine marten;
- Great crested newt;
- Invertebrates (terrestrial and aquatic, including Freshwater Pearl Mussel (FWPM));
- Fish; and
- Aquatic plants (macrophytes and bryophytes).

In accordance with LA 103 guidance previously discussed, based on the lack of desk study records and field evidence and the species' known distribution, the likely presence of Scottish wildcat has been scoped out of the assessment. Due to the absence of any desk study records or field evidence, beaver has been scoped out of the Stage 2 Assessment.

7.2.6. Assessment Methodology

The assessment was undertaken in accordance with the DMRB guidance LA 108 Biodiversity and CIEEM Ecological Impact Assessment (EcIA) Guidelines. DMRB LA 108 requires the identification of biodiversity resources including habitats, species and sites (designated and non-designated) for the assessment of biodiversity impacts. The potential receptors to be assessed are based on the project boundary, construction footprint and project's zone of influence on biodiversity resources. Further details of the assessment methodology are shown in Appendix 7.2.

As per the LA 103, the scope of Stage 2 Assessment does not need to include any features if they are not present or if there is unlikely to be potential for a significant effect in EIA terms.

CIEEM EcIA guidelines state that the assessment process does not require consideration of effects on ecological features deemed to be below a predefined nature conservation importance threshold. Therefore, an assessment of the effects upon features of less than local value, and/or those which are not known to occur within the Proposed Scheme

Ecological Zone of Influence (EZoI)[95], have been excluded from further assessment. The assessment has also focused on receptors where there is potential for them to be differentiators between the Scheme Options.

7.2.7. Limitations and Assumptions

Information on the extent and locations of construction compounds, drainage features, laybys, laydown areas and other ancillary works or operational service areas are not defined at this stage. These will be assessed at DMRB Stage 3.

In the area of permanent land take, there will be areas of new habitat creation, but as no design information is available calculations are based on an assumption that all habitat in these areas would be permanently lost for the purposes of this comparative assessment. Information on the reinstatement of the habitats lost through temporary works areas is currently unknown and for the purpose of this assessment it is assumed that any temporary habitat loss will be reinstated on a like-for-like (or better) basis.

During the pre-Stage 2 baseline collection surveys undertaken by Jacobs/AECOM for the A83 Access to Argyll and Bute commission, on behalf of Transport Scotland, no survey access was taken to the active landslide area controlled by BEAR / Georope, east of the A83(T) on Beinn Luibhean. The forestry plantation west of the OMR is densely planted in some sections and also located on steep terrain; therefore, some areas of the plantation were deemed inaccessible due to health and safety concerns. There were varied landowner-imposed access restrictions throughout the 2021-2022 ecology surveys, limiting the extent and / or validity of the ecology surveys.

The May and September 2022 bat emergence and re-entry surveys did not have full land access, therefore sites with high bat roost suitability were only surveyed twice. No data was collected for the April 2022 bat Static Detector Deployment.

During the breeding bird surveys and lekking black grouse surveys undertaken in 2021/2022, there were access restrictions in the floor of Glen Croe; surveyors were unable to enter any enclosed fields in the glen or to walk along the edge of the fields by the Croe Water, due to the presence of livestock. Therefore, all breeding bird surveys and black grouse surveys within Glen Croe were carried out entirely by walking along the OMR. Both the 500m

[95] This is defined in the CIEEM EcIA guidelines as the area over which ecological features may be subject to significant effects as a result of the Proposed Scheme. This could extend to transboundary effects. The EZoI will vary for each ecological feature due to the mobility range of the ecological features being assessed. For example, the EzoI for birds and otters (which are more mobile) will be greater than the EZoI for habitats (which are sedentary). Other factors such as supporting habitat, connectivity, sensitivity to disturbance, are considered when determining if a feature falls within the Proposed Scheme's EZoI.

breeding bird survey buffer and the 1.5km black grouse survey buffer extend to the east and north east of the A83(T), and these areas were not accessed during the survey. This was in part to avoid the existing landslide remediation works, and also due to the presence of cattle. Steep terrain in several areas also prevented access on foot.

The terrestrial habitats and species desk study data was incomplete at the time of writing due to supplier turnaround timescales. A precautionary approach has been adopted and any new emerging information will be supplemented into the Stage 3 Assessment. Surveys are to be undertaken in 2023 to complete the datasets.

The aquatic habitats and species baseline assessment is principally based on desk study data and supported by limited fish and macroinvertebrate surveys. In particular, there are no species survey data for the unnamed headwater streams within the Study Area. As such, a professional judgement has been applied to provide an importance valuation of these features at this stage. These importance valuations will be reviewed in subsequent assessments for the Proposed Scheme, supported by further field data collection.

Aquatic species have been considered when determining aquatic receptor importance (as described in **Section 7.3.3**). However, potential impacts on aquatic receptors that act as differentiators between the Scheme Options (i.e. watercourse crossings) are associated with habitats at this stage (noting that changes in habitat could have subsequent effects on species). All notable aquatic species identified are sensitive to potential impacts that do not differentiate between Scheme Options at this stage, for example habitat deterioration (through construction and operational changes in hydrology, water quality and physical habitat structure) and visual/noise and vibration disturbance. These impacts to species are considered to be the same for all Scheme Options at this stage. Protected and notable aquatic species can therefore not be used as a differentiator and are scoped out. Impacts on aquatic species will be assessed within the Stage 3 Assessment of the Preferred Option.

There is currently limited information on the design of the Scheme Options, as such, assumptions have been made with regards to the proposed watercourse crossings. Whilst watercourse structure types at each location have been broadly defined (namely, culverts, bridges, viaducts, and tunnels) professional judgement has been applied to inform the comparative impact of different crossing types and therefore Scheme Options.

In determining the length of watercourse lost, it is assumed that culvert and bridge crossings are the only crossing types to result in channel loss. Watercourse channels are assumed to be retained for viaduct and tunnel crossings, although it is recognised that there may be associated habitat degradation and riparian loss, for the viaduct crossings in particular, which will require further consideration and during DMRB Stage 3.

Where survey results were restricted or limited and data is deficient for a particular biodiversity receptor, a precautionary approach has been taken in this Stage 2 Assessment. This approach takes into account of the limitations of the project programme at the Stage 2 Assessment, the seasonality and potential extent of the Study Area. It is expected that more detailed survey will be undertaken to inform Stage 3.

7.3. Baseline Conditions

7.3.1. Designated Sites

The Desk Study Area falls within or adjacent to statutory designated sites of international and national importance for their conservation value as follows:

- Glen Etive and Glen Fyne SPA – designated for golden eagle;
- Loch Lomond Woods SAC – designated for otter[96] and western acidic oak woodland (Old sessile oak woods with Ilex and Blechnum in the British Isles); and
- Beinn an Lochain SSSI – notified for its siliceous scree (including boulder fields), tall herb ledge, and upland habitat assemblage.

Most of the Study Area falls within the LLTNP which is a managed area of outstanding landscape where some forms of development are restricted to preserve the landscape and natural environment. The LLTNP is discussed in Chapter 5 Landscape.

There are no non-statutory designated sites, or local wildlife sites, present in the EZoI of the Proposed Scheme.

7.3.2. Terrestrial Habitats

There is no woodland listed in the Ancient Woodland Inventory within 1km of the Study Area.

There are areas of native upland birchwood, wet woodland and bog woodland identified within the NWSS within the Study Area. The NWSS identified the location, type, extent, composition and condition of native and nearly-native woods and is considered by the Scottish Government to be a key woodland information resource.

Broad habitat types recorded during the field surveys comprised the following:

- semi-natural woodland and related habitats;
- mires (including wet heath, flush and bog vegetation);

[96] This international designated site is at a greater distance than 2km, but a potential impact pathway has been identified as otters from the Loch Lomond Woods SAC may also use watercourses relevant to all Scheme Options.

- dry heaths;
- grasslands and related vegetation;
- habitats supporting aquatic vegetation;
- rivers and streams; and
- other habitats including fern communities, unvegetated inland cliff, largely unvegetated scree and coniferous plantation woodland (primarily comprising Sitka spruce (Picea sitchensis)).

The Croe Water is the main watercourse within the vicinity of the Proposed Scheme (discussed further under Section 7.3.3), with a catchment draining the surrounding steep mountainous area, including the facing slopes of Beinn Ime, Beinn Luibhean, Ben Arthur (The Cobbler), Ben Donich and The Brack.

Within the broad habitats listed above, the following priority features were identified:

- Several Annex I[97] habitats including blanket bog, transition mire, alkaline fens, species-rich *Nardus* grassland on siliceous substrates in mountain areas, northern Atlantic wet heaths with *Erica tetralix* and European dry heaths and oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and / or of the *Isoëto-Nanojuncetea*.
- Several SBL priority habitats, including upland birch wood, wet woodland, blanket bog, upland flushes, fens and swamps, purple moor-grass and rush pasture, upland calcareous grassland, basic (calcareous) grassland, lowland meadow, upland heathland, inland rock and scree and oligotrophic lake and rivers.
- Headwaters which are listed as a priority habitat under the UKBAP and SBL (discussed further in Section 7.3.3). A headwater is broadly defined[98] as a watercourse within 2.5km of its furthest source as marked with a blue line on a 1:50k Ordnance Survey (OS) Landranger map. Further condition criteria apply in order to qualify under this definition, as discussed in Section 7.3.3.

[97] NatureScot, (2019). Habitats (listed on Annex I) and species (listed on Annex II) of the Habitats Directive which occur in Scotland and for which Special Areas of Conservation are selected. [online] Available at: https://www.nature.scot/doc/habitats-and-species-habitats-directive-which-occur-scotland-and-which-special-areas-conservation [Accessed: 14 April 2023].

[98] UK Biodiversity Action Plan Priority Habitat Descriptions: Rivers, (Updated from December 2011). Available at https://data.jncc.gov.uk/data/01d6ab5b-6805-4c4c-8d84-16bfebe95d31/UKBAP-BAPHabitats-45-Rivers-2011.pdf [Accessed: 16 March 2023].

7.3.3. Aquatic Habitats and Species

Desk study identified 55 watercourses on a 1:25k OS Landranger map within the combined aquatic habitats and species Study Area. These include 44 watercourses that are crossed by the Scheme Options (see Volume 3, Figure 15.1 Hydrology Detail and WFD). Loch Restil is the only standing waterbody within 150m of the Scheme Options. The current identified temporary boundary of the Yellow Option results in very marginal encroachment of Loch Restil. However, this marginal encroachment will be corrected to avoid this impact if selected as the preferred option. Therefore, for the purpose of this Stage 2 Assessment, Loch Restil is not considered to fall within the footprint of any Scheme Options.

Table 7.2 details the number of watercourses and standing waterbodies crossed by and within the Study Area for each of the Scheme Options.

Table 7.2 Aquatic receptors crossed by and within 150m of each Scheme Option

Scheme Options	Number of watercourses crossed on a 1:25k map	Number of watercourses within 150m that are not crossed (1:25k)	Number of waterbodies within 150m
Green Option	9	6	1
Yellow Option	16	5	1
Brown Option	17	5	1
Pink Option	28	3	1
Purple Option	22	5	1

Two watercourses within the Study Area are classified under the Water Framework Directive (WFD): the Croe Water (WFD ID: 10215) and the Kinglas Water (WFD ID: 10217)[99]. These watercourses are classed as having moderate overall ecological condition and bad ecological potential respectively under WFD classification methods. The quality elements failing to achieve good status in Croe Water are macroinvertebrates and water quality. The quality elements preventing the Kinglas Water achieving good ecological potential are fish and hydromorphology.

The Croe Water flows north to south down Glen Croe and falls within 150m of all Scheme Options and is crossed by the Green Option. The Kinglas Water is situated downstream of Loch Restil and the Proposed Scheme, at the northern extent of the Study Area for each of the Scheme Options.

[99] SEPA, (2020). Water Classification Hub. [Online] Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed: 16/03/2023].

The Croe Water and Kinglas Water have both been assigned a value of regional importance given they are WFD delineated watercourses, and therefore subject to management under the RBMP which takes a catchment and regional approach to river management. It is considered that these watercourses are likely to provide habitat for and support an aquatic species assemblage that may be important at the regional scale.

All other watercourses within the Study Area are small headwater streams. Given the lack of background records available for non WFD watercourses (as identified on the OS 1:25k Landranger map), a precautionary approach has been taken when assigning an importance valuation to these. All non WFD delineated watercourses identified within the Study Area are considered to be headwaters[100], which is priority habitat listed under the UKBAP and SBL. The definition is based on watercourses which are visible on the 1:50k OS map. Headwaters that have been significantly altered from their natural state are excluded from the definition. On a precautionary basis, all headwaters within the Study Area (including those only visible on the OS 1:25k map) are assumed to fulfil this criterion. As this assumption applies to all Scheme Options, with the character of the identified watercourses being broadly similar throughout the Study Area, this is not considered to be a significant limitation to the assessment but will be refined through further field surveys as part of the Stage 3 Assessment for the Preferred Option. The DMRB LA 108 guidance lists priority habitat as an example of sites which should be assigned an importance value of UK or National. However, it is recognised that whilst important habitats integral to the functioning of wider watercourse systems, headwaters are thought to represent >70% of the total length of flowing waters in the UK. Moreover, within the context of the Study Area and wider local area, headwater systems are very well represented and are likely to comprise an even greater proportion of the watercourse habitat resource. As such, this habitat is considered to be common within the Study Area and wider local area. Subsequently, a valuation of local importance has been assigned to these features.

Data from the Argyll Fisheries Trust indicates that both watercourses support populations of brown trout (*'Salmo trutta').* Atlantic salmon (*'Salmo salar')* are also present in the lower reaches of the Croe Water within the Study Area. The presence of a natural impassable barrier within the downstream extent of the Croe Water is likely to limit the presence of migratory species throughout the majority of the Study Area. Proposed Scheme surveys undertaken to date (see

[100] A watercourse within 2.5km of its furthest source. As defined in: JNCC, (2011). UK Biodiversity Action Plan Priority Habitat Descriptions: Rivers, [online] Available at https://data.jncc.gov.uk/data/01d6ab5b-6805-4c4c-8d84-16bfebe95d31/UKBAP-BAPHabitats-45-Rivers-2011.pdf [Accessed: 16/03/2023].

Table 7.3) also confirmed the presence of what are likely to be non-migratory resident populations of brown trout within the Croe Water. Fish are therefore also likely to be present within other suitable tributary watercourses of the Croe Water in the Study Area, noting that many of the high-gradient headwater systems are likely to be unsuitable for fish.

Brown trout and Atlantic salmon are listed under the SBL and the UKBAP. Additionally, Atlantic salmon is designated as an Annex 2 and Annex 5 species[101]. Under the UKBAP priority river definition, both brown trout and Atlantic salmon are identified as a criterion level B priority species (widespread BAP priority species which are less dependent on river habitat quality alone). Consequently, their presence alone does not qualify a given watercourse as a UK BAP priority habitat (noting that many of the watercourses are considered likely to qualify as priority habitats in their own right through their classification as headwaters).

Freshwater pearl mussel is considered unlikely to be present with the Study Area based on the desk study undertaken to date. The majority of watercourses (i.e. headwater systems) are unsuitable for this species. The larger watercourses (such as the Croe Water) within the Study Area may potentially be suitable and further screening and habitat suitability survey for FWPM will be undertaken as part of the Stage 3 Assessment.

One standing waterbody is located within the Study Area (Loch Restil). Loch Restil is not a WFD classified water body. Brown trout are present at the outflow of Loch Restil and macroinvertebrate surveys indicate a typical upland waterbody species assemblage with the addition of *Paraleptophlebia cincta* and *Paraleptophlebia werneri* which are two notable mayfly species (see

Table 7.3). A precautionary approach has been taken to value Loch Restil as of national importance given the presence of nationally rare mayfly species**.**

7.3.4. Protected and Notable Species

The table below details the desk study records and available site information for each species or species group. A full dataset is not available for badger, bat roosts, barn owl, black grouse, breeding birds, golden eagle, herpetofauna, botany, otter, pine marten and red squirrel. A such we have assumed presence in areas of potentially suitable habitat as part of a precautionary approach. The relative importance for each species / species group is summarised below:

[101] Annex 2 - Animal and plant species of Community interest (i.e. endangered, vulnerable, rare or endemic in the European Community) whose conservation requires the designation of special areas of conservation. Annex 5 - Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measure

- Badger are considered to be a receptor of less than local importance, due to the widespread nature of this species and the available information indicating that activity from this species in the area is likely low.
- Bats are considered to be of regional importance due to the high activity levels and the presence of at least eight bat roosts; however, no rare species have been flagged to date.
- Barn owl have been precautionarily assessed as regional importance due to the conservation status of the species and possibly reduced likelihood of the species occurring frequently within the wider area due to habitat suitability; further surveys are planned to establish whether breeding sites are present.
- Black grouse is precautionarily assessed as being of regional importance due to conservation status and the species' relatively wide distribution across Scotland but restricted distribution at a lower spatial scale due to requirement for typically upland habitats.
- Common breeding bird species are considered to be of local importance as the species noted are generally widely occurring within the habitat types present.
- Golden eagle are considered to be of international importance given the potential presence of individuals/pairs forming part the Glen Etive and Glen Fyne SPA population their conservation status and their limited distribution/relatively small population in Scotland in relation to suitable breeding habitat.
- Herpetofauna are considered to be of local importance as species present are likely to be common and widespread. This may change with future survey data.
- Otter and pine marten are considered to be of regional importance due to their widespread presence in this area of Scotland.
- Red squirrel are considered to be of regional importance due to their status and distribution.

Table 7.3 Protected and Notable Species within EZoI

Species or species group	Desk study records including incidentals recordings 2021 and 2022 field surveys	Summary of 2021 / 2022 field survey records / habitat assessment	Assessment of Importance
Badger	Forestry and Land Scotland provided records of unknown age for four badger setts. No further information in relation to the type of sett or current activity levels at these locations is known at this stage Nine records of badger, all fatalities on the A83, were received from Scottish Badgers	Two setts, an active potential breeding sett, and a disused sett were recorded in the Study Area. The available evidence suggests that badgers travel through and forage in the lower altitude parts of Glen Croe, including the glen floor, banks of the Croe Water, and	Considered to be of less than local importance but considered due to legal protection and vulnerability.

Species or species group	Desk study records including incidentals recordings 2021 and 2022 field surveys	Summary of 2021 / 2022 field survey records / habitat assessment	Assessment of Importance
	during the desk study; most of these records were recorded within the previous 10 years.	areas beside the existing OMR. It is considered unlikely that badger makes any frequent use of the main Sitka spruce plantation, which provides sub-optimal foraging opportunities for this species.	
Bats	Two records of soprano pipistrelle (*Pipistrellus pygmaeus*) were identified from the desk study; however, these records were dated from 2006 and 2008.	Within the Study Area, eight structures / buildings / trees were confirmed to contain non-breeding roosting bats during the nocturnal emergence / re-entry bat surveys. The habitat surrounding the Proposed Scheme was assessed as suitable for commuting and foraging bat species as well as roosting bats. The activity surveys carried out for bats were predominantly in the coniferous plantation to the west of the OMR and demonstrated that activity levels for bats were moderate to high based on statistical analysis undertaken using ECOBAT[102]. Species recorded included common pipistrelle (*P. pipistellus*), soprano pipistrelle, brown long-eared bat (*Plecotus auritus*), and Myotis species. At least four bat species were recorded by the static detectors: common pipistrelle, soprano pipistrelle, brown long-eared bat and unidentified *Myotis* species of bats. A total of 13 structures, buildings and trees were identified as having bat roost suitability.	Considered to be of regional importance due to high levels of activity and eight bat roosts.

[102] Mammal Society, (2023). Ecobat Tool. [online] Available at: http://www.ecobat.org.uk/ [Accessed 15 March 2023].

Species or species group	Desk study records including incidentals recordings 2021 and 2022 field surveys	Summary of 2021 / 2022 field survey records / habitat assessment	Assessment of Importance
Barn owl	The desk study returned no records of barn owl.	Two buildings and a tree in the Study Area were flagged with suitability for roosting barn owl during the baseline ecology surveys. Breeding use was not confirmed, though dedicated surveys were not conducted. Barn owl have been sighted incidentally during other surveys such as bat surveys, in proximity to the OMR in the Study Area.	Assessed to be of regional importance on a precautionary basis (based on current survey data) and likelihood of the species occurring frequently in the wider area (habitat suitability limited to glen floors and lower slopes without dense forest).
Black grouse	An incidental record of a single black grouse feather was recorded within the black grouse Study Area in 2021. Publicly available records from NBN show records of black grouse within areas such as woodland within the Study Area/wider area. These records are a part of an RSPB lekking survey project between 2002 and 2011 which indicate breeding has historically occurred.	Previous surveys concluded that breeding black grouse is not considered to occur within the Study Area as no evidence was recorded during the black grouse surveys. However, parts of the Study Area were not able to be accessed and some surveys, or parts of surveys, were undertaken in changing/ challenging weather conditions resulting in potentially reduced lekking behaviour/detectability of leks. The feather that was recorded incidentally indicates that the species is present within at least the wider vicinity of the Study Area.	Assessed to be of regional importance on a precautionary basis (based on current survey data).
Breeding birds	Forestry and Land Scotland have provided historical data in relation to nesting peregrine, in addition to nesting sites for raven *Corvus corax*, common buzzard *Buteo buteo* and sparrowhawk *Accipiter nisus* within the Study Area. ARSG also returned records of single raven and sparrowhawk nest sites. The RSPB desk study returned no records of Schedule 1 listed species (other than golden eagle, see below) within the Study Area.	A total of 42 bird species were recorded during the breeding bird survey (BBS). Of those, 16 are considered to be notable and of conservation concern.	Assessed to be of local importance.

Species or species group	Desk study records including incidentals recordings 2021 and 2022 field surveys	Summary of 2021 / 2022 field survey records / habitat assessment	Assessment of Importance
	The NBN search returned no commercially available records of Schedule 1 listed birds.		
Golden eagle	RSPB provided restricted information relating to golden eagle records from 2015 which was provided by 'The Scottish Raptor Group'. Nest records for golden eagle within the study area for 2020-2022 (inclusive) were also returned by ARSG. NatureScot Provided a confidential Golden Eagle Range Report for the Glen Etive and Glen Fyne SPA area. This report details suitable habitat for this species by the prey habitat communities present and details golden eagle use of SPA.	Golden eagle were noted to be active and breeding within the Desk Study and therefore the Study Area	Assessed to be of international importance.
Herpeto-fauna (amphibians and reptiles)	The desk study returned no commercially available data for amphibians. However, there are two water bodies within the Study Area which may offer suitability for great crested newts. The known populations in Scotland are limited to other geographical areas, so presence is very unlikely. The desk study only returned historical data for common lizard *Zootoca vivipara* within the Study Area.	One incidental sighting of a common lizard was recorded in the south-east of the Study Area.	Assessed to be of local importance for common species of reptile. No valuation assigned for great crested newts as they are unlikely to be present.
Invertebrates	At the time of writing, no information relating to terrestrial invertebrates is available; however, it is possible that the Study Area contains suitable habitat for a range of invertebrate species.	No field survey data	None assigned
Aquatic invertebrates (including freshwater pearl mussel)	No desk study records of notable or protected aquatic invertebrates received to date. At the time of writing, no information relating to FWPM is available; however, it is possible	3-minute macroinvertebrate kick samples were taken within the Croe Water (OS NGRs NN 23840 06443, NN 24000 06003, NN 24263 05627,	Included (where available) to support aquatic habitat valuation

Species or species group	Desk study records including incidentals recordings 2021 and 2022 field surveys	Summary of 2021 / 2022 field survey records / habitat assessment	Assessment of Importance
	that the Study Area contains habitat capable of supporting FWPM.	NN 24554 04943, NN 238 060336) and Loch Restil (OS NGRs NN 23227 08664, NN 23057 08195, NN 22898 07561) in autumn 2021 and spring 2022. The nationally rare mayfly species *Paraleptophlebia cincta and Paraleptophlebia werneri* were found within Loch Restil.	
Fish	Single pass electrofishing surveys conducted in 2008 by The Argyll Fisheries Trust confirmed the presence of juvenile Atlantic salmon and brown trout. Sample sites were within the Kinglas Water (OS National Grid Reference (NGR) NN 23410 09435) and Croe Water (OS NGRs NN 25873 04179, NN 25350 04300, NN 24548 04774, NN 23852 06109).	Single pass electrofishing surveys conducted in August 2022 within the Croe Water (OS NGRs NN 24352 05208, NN 23125 08615) identified brown trout.	Included (where available) to support aquatic habitat valuation
Aquatic plants (macrophytes and bryophytes)	No desk study records of notable or protected aquatic plants received to date.	No records of notable or protected aquatic plants were recorded during the August 2022 survey.	Included (where available) to support aquatic habitat valuation
Plants	The BSBI returned five records of plants within the Study Area for botany including three records of common bluebell, mossy saxifrage and Wilson's filmy-fern *Hymenophyllum wilsonii*.	No other notable plant species were recorded during the phase 1 and UKHab surveys.	Assessed to be of local importance.
Otter	No commercially available records of otter were returned from the desk study.	Four confirmed non-breeding holts and three features with the potential to be used as holts were identified in the Study Area. The Croe Water and tributaries are frequented by otter with spraint recorded throughout the Study Area.	Assessed to be of regional importance.

Species or species group	Desk study records including incidentals recordings 2021 and 2022 field surveys	Summary of 2021 / 2022 field survey records / habitat assessment	Assessment of Importance
Pine Marten	One commercially available record of pine marten from 2014 was identified during the desk study. This record described a dead pine marten (road casualty) in a 1km OS grid square that coincides with the northern boundary of the Study Area.	A non-breeding pine marten den was identified within the Study Area. Three further features with the potential to be used by pine marten were recorded in the south of the Study Area. Evidence of pine marten found during the surveys comprised scats, mainly along the forestry track but also beside the Croe Water and latterly also on the OMR. One sighting of pine marten was noted in the north of the plantation forestry in the west of the Study Area.	Assessed to be of regional importance
Red Squirrel	A total of 242 commercially available records of red squirrel were identified from the desk study. Many of the records are located within the Study Area. Saving Scotland's Red Squirrels interactive map[91] showed many red squirrel sightings in the vicinity of the Study Area and further afield.	No field survey data. However, the Study Area was assessed as offering low habitat suitability associated with sitka spruce woodland plantation. It is expected that the red squirrel population within the Study Area will be low due to the less favourable woodland type.	Assessed to be of regional importance

7.4. Potential Impacts

This section details the potential impacts and effects of the Scheme Options on the ecological features identified in the baseline data above. The impacts identified below are relevant to all Scheme Options, and where there are differences between options commentary is provided on the differences. Receptors outside the EZoI would not be affected by any activities or processes involved in the Proposed Scheme and are therefore not considered in this impact assessment. For all ecological receptors scoped in, potential construction impacts and operational impacts that have been identified are detailed below.

7.4.1. Designated Sites

None of the Scheme Options are situated within any international designated sites (e.g. SPA, SAC or Ramsar sites).

One international designated site is within 2km of all five Scheme Options: Glen Etive and Glen Fyne SPA. A second international designated site is at a greater distance, but an impact pathway has been identified as otters from the Loch Lomond Woods SAC may also use watercourses relevant to the Scheme Options. The distances of these sites from each of the Scheme Options are detailed in

Table 7.4.

Table 7.4 Potential Construction and Operational Impacts on International Designated Sites within the EZoI

Designated Site	Distance to Scheme Option				
	Green	Yellow	Brown	Pink	Purple
Glen Etive and Glen Fyne SPA	1.9km	1.8km	1.9km	0.7km	0.7km
Loch Lomond Woods SAC	4.9km	5.7km	5.7km	5.5km	5.6km

No habitat loss would be anticipated to the Glen Etive and Glen Fyne SPA owing to the Scheme Options being at least 700m distant from the site boundary. The SPA is designated for its golden eagle populations and the areas surrounding the SPA (which includes the Study Area) may be part of the eagles' feeding range or within line of sight of display, nesting, roosting or feeding sites. The extent to which noise from the construction of the Proposed Scheme may affect golden eagle, specifically breeding sites (breeding being the time when most sensitive to disturbance) would depend on the type and timing of activity being carried out and noise modelling would be undertaken at DMRB Stage 3 to determine likely significant effects on golden eagle. The construction methods, footprint and duration of the proposed works for the Brown Option would be anticipated to result in a potentially lower impact on golden eagle compared with the other Scheme Options, whereas the Pink and Purple Options are located within the closest proximity (0.7km) to the SPA and are therefore more likely to have a risk of causing disturbance impacts. The operational impacts of the Proposed Scheme are likely to be negligible, since golden eagle are already habituated to road traffic and maintenance operations along the existing A83(T). It is not anticipated that non-vehicular recreational use (pedestrians, cycle users etc) of the land surrounding the Proposed Scheme is likely to increase significantly above the baseline during the operational phase, based on current proposals; a number of public footpaths and hill access paths to the summits of surrounding mountains are present already and it is therefore considered that eagles are already habituated to a level of human / pedestrian presence. If any additional non-vehicular access were to be provided as part of the Proposed Scheme, impacts would be further assessed at DMRB stage 3 and within the Habitat Regulations Appraisal (HRA).

The SPA is a receptor of international value. The Brown Option is considered to result in No Change, with neutral significance of effect. The Yellow and Green Options could affect golden eagle activity temporarily, but this is considered to be at a Negligible level so has slight significance of effect. On a precautionary basis, due to their closer proximity to the SPA, the Pink and Purple Options may have potential to result in a temporary minor impact during the construction of the cut-and-cover portals (acknowledging that the drill and blast tunnelling operations would be underground resulting in lower disturbance potential), which is then considered to have a Moderate significance of effect.

No habitat loss would be anticipated to the Loch Lomond Woods SAC and all the Scheme Options would be approx. 5km away from the Annex I habitats that are a primary reason for selection of this site (old sessile oak woods with *Ilex* and *Blechnum*). Even taking into account potential effects of airborne pollution it is not feasible for the Proposed Scheme to result in direct or indirect effects on the woodland habitats such that these would be scoped out of further assessment at Stage 3. Otter is one of the qualifying species of the SAC and this species is mobile and can hold territory sizes of many square kilometres (over 20km of watercourse or seashore) and, as such, individuals or populations of otter using Loch Restil and the River Croe and its tributaries may also use the shores of Loch Long and the Loin Water which falls within the Loch Lomond Woods SAC. All of the Scheme Options would involve watercourse crossings and the construction and operational impacts on otter would be assessed as being similar despite the Green Option being closer to the SAC; detailed survey and assessment would be required at Stage 3 to determine likely significant effects and mitigation would be required. Operational impacts of the Proposed Scheme are likely to be negligible, provided otter can still use watercourses for foraging and commuting. Mitigation is described below for otters, but the SAC is not considered further in this study as it is not considered a potential differentiator.

A Habitats Regulations Appraisal (HRA) screening assessment was undertaken to inform the DMRB Stage 1 assessment[103]. As all Proposed Scheme Options remain under consideration and no further construction details are available, there is no merit in undertaking an additional HRA at DMRB Stage 2. In accordance with the assessment set out above, the DMRB Stage 1 HRA identified that there is potential for disturbance of golden eagle whilst breeding, but also that there is scope to avoid / mitigate for potential disturbance impacts and therefore the construction of the selected option will not be prevented. A detailed HRA will be undertaken at DMRB Stage 3 to assess the likely significant effects and potential for impacts on integrity of the Preferred Option on international designated sites and their

[103] Jacobs AECOM (2022) Access to Argyll and Bute (A83) DRMB Stage 1 Habitats Regulations Appraisal, Transport Scotland, February 2022. Doc ref: A83AAB-JAC-EGN-XX_XX-RP-LE-0026 | P02

qualifying interest features and identify appropriate avoidance and mitigation measures. While there are differentiators between the Proposed Scheme Options in terms of the level of risk and potential requirement for mitigation, there is confidence that 'no adverse effects on site integrity' could be concluded at HRA Stage 2 Appropriate Assessment.

One national designated site - Beinn an Lochain SSSI - falls partially within the Scheme Options and would be directly impacted during construction. The level of impact in terms of land take varies for each option, and this is detailed in Table 7.5.

Table 7.5 Area of Beinn an Lochain SSSI Falling Within the Five Scheme Options

Scheme Options	Estimated permanent habitat loss from overlap with SSSI and % of designated site affected (habitat loss calculations allow for direct loss under the scheme footprint)		Estimated temporary habitat loss from overlap with SSSI and % of designated site affected (habitat loss calculations allow for direct loss under the scheme footprint)	
	Ha	% of SSSI	Ha	% of SSSI
Green Option	0.37	0.02%	0.32	0.02%
Yellow Option	0.12	0.00%*	0.20	0.01%
Brown Option	0.05	0.00%*	0.09	0.00%*
Pink Option	0.28	0.02%	0.38	0.02%
Purple Option	0.35	0.02%	0.36	0.02%

* Indicates where habitat loss would be anticipated to occur but the area of loss would be less than 0.01 hectares (equivalent to a square of 10m x 10m).

Table 7.6 Potential Permanent Habitat Loss within Beinn an Lochain SSSI

UK Habitat Type	Permanent habitat loss from overlap with SSSI (habitat loss calculations allow for direct loss under the scheme footprint)				
	Ha				
	Green	Yellow	Brown	Pink	Purple
Upland heathland	0.05	-	-	0.00*	0.00*
Other neutral grassland	0.10	0.07	0.04	0.05	0.06
Fens (upland and lowland)	0.17	0.00*	-	0.03	0.05
Purple moor grass and rush pastures	0.03	0.04	0.00*	0.16	0.22
Upland acid grassland	0.00*	-	-	-	-

* Indicates where habitat loss would be anticipated to occur but the area of loss would be less than 0.01 hectares (equivalent to a square of 10m x 10m)

Table 7.7 Temporary Habitat Loss from Overlap with Beinn an Lochain SSSI

UK Habitat Type	Temporary habitat loss from overlap with SSSI designated site affected (habitat loss calculations allow for direct loss under the scheme footprint)				
	Ha				
	Green	Yellow	Brown	Pink	Purple
Upland heathland	0.01	-	0.00*	0.04	0.03
Other neutral grassland	0.03	0.08	0.05	0.04	0.04
Fens (upland and lowland)	0.19	0.04	0.01	0.04	0.04
Purple moor grass and rush pastures	0.05	0.03	0.01	0.24	0.22
Upland acid grassland	0.01	0.01	0.00*	-	-

* Indicates where habitat loss occurs but the area of loss would be less than 0.01 hectares (equivalent to a square of 10m x 10m).

Table 7.6 indicates that the Brown Option would result in the smallest area of permanent habitat loss (0.05ha), followed by the Yellow Option (0.12ha), then the Pink Option (0.28ha) and then the Purple Option (0.35ha). The Green Option would result in the largest area of permanent habitat loss (0.37ha). As a proportion of the overall area of the Beinn an Lochain SSSI the area of land which would be permanently lost as a result of any of the Scheme Options would be equivalent to less than 0.1%.

Temporary habitat loss refers to habitat which would be lost to enable or facilitate construction of the Proposed Scheme but which would be reinstated and replaced at the end of the construction phase. The Purple Option would result in the smallest area of temporary habitat loss (0.03ha) followed by the Brown Option (0.09ha) then the Yellow Option (0.20ha) then Green Option (0.32ha) and the Pink Option would result in the greatest temporary loss of habitat (0.38ha). As a proportion of the overall area of the Beinn an Lochain SSSI the area of land which would be permanently lost as a result of any of the Scheme Options would be equivalent to less than 0.1%.

When assessing both the permanent and temporary habitat loss in combination and considering permanent loss as the greater impact, the Brown and Yellow Options are comparably the most favourable of the Scheme Options and the Purple, Pink, and Green Options would be the least favourable of the Scheme Options in respect of the Beinn an Lochain SSSI, although there is a small difference in the proportion of land within the Beinn an Lochain SSSI boundary that would be lost.

It is important to note that in considering the potential impacts from construction or operation on Beinn an Lochain SSSI, physical area of land-take *per se* is less important than the habitats themselves and/or their functional or ecological linkage with the habitats for which the SSSI is designated. The SSSI is notified for three features:

- Boulder fields amongst which bryophytes and ferns grow: this feature is largely on the north of Beinn an Lochain summit and would not be directly or indirectly affected by any of the Scheme Options.
- Tall herb and fern communities on rocky ledges and cliff edges and carpets of acidophilous plant species in the sub-montane zone – again this habitat type would not be anticipated to be directly or indirectly affected by any of the Scheme Options.
- Upland assemblage which includes a wide range of grassland, heath, fen, flush and bog communities, reflecting varied topography and soil status. This feature is much more broadly defined and a review of the available data indicates that there are five UKhab broad habitats which may overlap with the habitats for which the SSSI is notified, and which would be lost either permanently (see Table 7.6) or temporarily (see

- Table 7.7) due to the construction and operation of the Proposed Scheme. In terms of permanent habitat loss, the Green Option has the greatest adverse impact, by directly affecting all five habitat types, one of which (upland acid grassland) would not be affected by any of the other Scheme Options; and also by resulting in the largest area of habitat loss in four out of the five habitat types. The Purple Option would result in the largest loss (in area terms) of purple moor grass and rush pastures although there is little to differentiate between the Purple and Pink Options in terms of habitat loss. The Yellow Option appears to be the second most favourable, with smaller losses to three habitat types (purple moor grass and rush pasture and neutral grassland, and a negligible loss of fen habitat). The Brown Option would directly and permanently affect only two sensitive habitat types and may be the most favourable option with reference to habitat loss; the Brown Option would also result in the smallest permanent physical loss of habitat from the SSSI. The picture is less clear from temporary habitat loss (see

- Table 7.7) figures and would not be a reliable differentiator between Scheme Options.

Air quality modelling has not been undertaken at this stage. However, it is recognised that there is potential for impacts to the SSSI and habitats due to changes in air quality during both construction and operation. Impacts on the SSSI are possible with the Purple and Pink Options, where proposed tunnel entrances are located close to habitats such as blanket bog, grassland and wetland within the SSSI that may be vulnerable to nitrogen deposition associated with vehicle emissions. Construction haul routes are not confirmed but it has been assumed that light and heavy-duty vehicles (LDVs and HDVs) would need to travel several kilometres on the A83(T) to the north and/or south beyond the Proposed Scheme extents; all the Scheme Options have relatively long construction periods, during which construction-related emissions could be expected to have potential impact on surrounding habitats. Although specific detail is not yet available, it is anticipated that Scheme Options with longer construction periods or more intensive use of construction vehicles would be expected to have the greatest impact on air quality via vehicle emissions. The Green Option has the longest anticipated construction period of around seven years, with the remaining Options all anticipated to have construction periods of around 3.25 to 4.25 years. Further detail on the effects of air quality / dust deposition is provided in Chapter 3 Air Quality and further assessment will be undertaken as part of DMRB Stage 3.

In accordance with DMRB LA 105 guidance all route options are classified as a ‘large’ potential dust source (refer to Chapter 3 Air Quality). There are sensitive ecological receptors within 100m of the Scheme Option temporary boundaries and construction traffic routes. In accordance with DMRB LA 105 all Scheme Options are considered to have a high construction dust risk potential.

Detailed habitat surveys, including an assessment of habitat quality and consideration of hydrological and other environmental changes would be required at Stage 3 for the Preferred Option, given the direct impacts anticipated on a SSSI.

In summary, adverse impacts of a minor magnitude are predicted on the SSSI as a result of construction and operation. The SSSI is valued as being of National Importance. Given the relatively small extent of the predicted habitat loss, the potential adverse impacts are considered to be minor for all Scheme Options, resulting in a Moderate Significance of Effect.

7.4.2. Terrestrial habitats

There are areas of native upland birchwood, wet woodland and bog woodland identified within the NWSS located in the Study Area. The NWSS identified is considered in the notable habitat section below.

During construction terrestrial habitats could be affected by the following:

- direct loss of terrestrial habitat as a result of the construction footprint;
- indirect loss of habitats through sedimentation and pollution, for example areas of marshy grassland and flushes are likely to be affected by changes in water quality;
- fragmentation and severance of habitats; and
- changes to local hydrology and flow pathways (which could affect overall availability, distribution and quality of habitat).

Whilst these impacts will be common to all the Scheme Options, the degree of habitat affected varies across these. Due to the extent of the habitats present, this assessment focuses on the degree of overall habitat loss and the loss of potential priority and Annex I habitats based on the UKHab habitat survey data, these extents are detailed in Table 7.8.

A number of habitat types, while likely to be affected by Scheme Options, would be unlikely to be differentiators in EIA terms, either because all the Scheme Options would result in negligible or no discernible loss of habitat (0.1ha or less).

Some habitat types are not present in all Scheme Options; and some would only be directly affected if certain Scheme Options were taken forward, for example: Other inland rock and scree; Other Scots Pine woodland; Other woodland; broadleaved; wet woodland.

Details of the overall potential impacts on Annex I habitats, UK BAP priority habitats and 'other habitats'[104] are shown in Table 7.8 and Table 7.9 below. Permanent losses are described in Table 7.8, and temporary losses in Table 7.9.

For the Pink and Purple Options (i.e. those that would involve tunnelling) it has been assumed for the purpose of calculating permanent habitat loss that habitats and hydrology directly above the tunnelled sections would not be affected.

Table 7.8 Area of Permanent Habitat Loss from the Scheme Options

[104] 'Other habitat' refers to habitats that are not Annex 1 Habitats or UK BAP Habitats e.g. species-poor grassland.

Notable Habitat	Mainline Alignment Option – Area of loss (ha)				
	Green	Yellow	Brown	Pink	Purple
Overall loss of potential Annex I Habitats	1.54	4.47	5.2	2.69^	3.34^
Overall loss of UK BAP priority Habitats	2.3	2.93	2.15	3.87^	3.49^
Other habitat loss (all habitats excluding Annex I)	10.56	1.28	2.37	3.74	1.19
Breakdown of potential Annex I habitats and priority habitat loss					
Blanket bog	-	-	-	0.00*	-
Fens (upland and lowland)	0.26	1.3	0.14	1.01	0.48
Lowland dry acid grassland	-	0.01	-	-	0.01
Lowland mixed deciduous woodland	-	-	-	0.00*	0.01
Oligotrophic and dystrophic lakes	-	0.00*	-	-	-
Other inland rock and scree	-	-	0.78	-	-
Other neutral grassland	0.26	0.61	0.11	0.10	0.57
Other Scots Pine woodland	-	-	0.09	-	-
Other woodland; broadleaved	0.66	-	-	0.39	-
Other woodland; mixed	0.49	-	-	1.62	1.45
Purple moor grass and rush pastures	0.10	0.57	0.60	0.41	0.74
Rivers and streams	0.01	0.01	-	0.00*	0.02
Upland acid grassland	0.44	1.55	3.31	0.9	1.31
Upland birchwoods	0.05	-	0.26	0.07	-
Upland Heathland	0.43	0.43	0.17	0.27	0.21
Wet woodland	0.04	-	-	-	-

* Indicates where habitat loss would be anticipated to occur but the area of loss would be less than 0.01 hectares (equivalent to a square of 10m x 10m).

^ Indicates habitats which are beneath the Proposed Scheme footprint but for which a portion may be retained if tunnelling options were to avoid changes in habitat or hydrology. As such the retained area is not included in the overall area of loss.

For Annex I habitats, the area of permanent loss is highest in the Brown (5.2ha) and Yellow (4.47ha) Options. The smallest area of Annex I permanent habitat loss would be in the Green Option (1.54ha) since this option primarily bisects other habitat types.

For UK BAP habitats the Pink (3.87ha) and Purple (3.49ha) Options would be anticipated to result in the largest area of permanent habitat loss assuming that the habitats and groundwater would not be affected by tunnelling activity. The smallest area of UK BAP permanent habitat loss would be the Brown Option (2.15ha).

In terms of overall permanent habitat loss (excluding Annex I habitats), the Green Option would clearly result in the largest area lost (10.56ha); the other options would result in less than 4ha of habitat loss, with the Purple Option having the smallest area loss (1.19ha).

Table 7.9 Area of Temporary Habitat Loss from the Scheme Options

Notable Habitat	Mainline Alignment Option – Area of loss (ha)				
	Green	Yellow	Brown	Pink	Purple
Overall loss of potential Annex I habitats	1.34	8.04	7.88	2.69	9.81
Overall loss of UK BAP Priority habitats	2.36	4.65	2.09	2.54	6.87
Other habitat loss (all habitats excluding Annex I)	16.44	3.94	3.81	1.61	3.88
Breakdown of potential Annex I and priority habitats loss					
Blanket bog	-	-	-	0.00*	-
Fens (upland and lowland)	0.26	1.47	0.43	0.41	1.59
Lowland dry acid grassland	-	0.14	0.01	-	0.13
Lowland mixed deciduous woodland	-	-	-	0.02	0.02
Oligotrophic and dystrophic lakes	-	0.01	-	-	-
Other inland rock and scree	-	-	0.19	0.00*	-
Other neutral grassland	0.23	1.06	0.12	0.28	1.07
Other Scots Pine woodland	-	-	0.57	0.00*	-
Other woodland; broadleaved	0.57	0.00*	0.00*	0.09	0.00*
Other woodland; mixed	0.72	-	-	1.08	1.23
Purple moor grass and rush pastures	0.15	1.75	0.45	0.39	2.57
Rivers and streams	0.03	0.06	0.00*	0.01	0.05
Upland acid grassland	0.40	3.57	5.92	1.43	4.34
Upland birchwoods	0.13	0.04	0.12	0.11	0.04
Upland Heathland	0.17	0.11	0.19	0.15	0.16
Wet woodland	0.10	0.01	0.01	-	0.01

* Indicates where habitat loss would be anticipated to occur but the area of loss would be less than 0.01 hectares (equivalent to a square of 10m x 10m).

For Annex I habitats, the area of temporary loss is predicted to be highest in the Purple (9.81ha) and Yellow (8.04ha) Options. Regarding the Purple Option, with exception of the ingress and egress ‘cut and cover’ sections, this option involves tunnelling through rock so the habitat above the tunnel is understood to be retained, albeit with potential for indirect effects if local hydrology is altered. Regarding the Yellow Option temporary habitat loss would relate to the construction of an elevated viaduct and associated piers and the habitats beneath the operational viaduct would be retained. The smallest area of Annex I habitat loss would be in the Green Option (1.34ha) since this option primarily bisects other habitat types.

For UK BAP habitats, the Purple and Yellow Options would be anticipated to result in the largest area of temporary habitat loss although the tunnelling options would be anticipated to reduce this area provided groundwater levels or flows were not affected (see below). The smallest area of UK BAP temporary habitat loss would be the Brown Option (2.09ha).

In terms of overall temporary habitat loss (excluding Annex I habitats), the Green Option would result in the largest area lost (16.44ha) owing to the majority of the Proposed Scheme being offline and also requiring felling of a buffer of woodland; the other Scheme Options would result in less than 4ha of habitat lost, with the Pink Option having the smallest area temporary habitat loss (1.61ha).

It is expected that for both the areas of permanent and temporary habitat loss that some of the groundwater would flow into the tunnel drainage area, to reduce the water pressure on the structure. This is likely to lead to a drop in the groundwater level in the surrounding area. This could therefore lead to dewatering of any groundwater-dependent receptors within this area. All communities found on minerotrophic mires likely found in the area are highly groundwater dependent. Ground Water Dependent Terrestrial Ecosystems (GWDTE) habitats are fully assessed in Chapter 8 Geology and Soils and not considered further within this chapter.

Factoring in retention of habitat above the tunnels, areas of permanent Annex I habitat loss shown in Table 7.8 show that the Brown Option and the Yellow Option would result in the largest area of loss and the Green Option is the most favourable.

For UK BAP habitats, the Pink and Purple Options would be anticipated to result in the largest area of permanent habitat loss. The smallest area of UK BAP permanent habitat loss would be the Brown Option.

Air quality modelling has not been undertaken at this stage. However, it is recognised that there is potential for impacts to habitats due to changes in air quality during both construction and operation. In particular, in the Purple and Pink Options proposed tunnel entrances are located close to habitats such as blanket bog, grassland and wetland that may be vulnerable to nitrogen deposition associated with vehicle emissions. Construction haul routes are not confirmed but it has been assumed that light and heavy-duty vehicles (LDVs and HDVs) would need to travel several kilometres on the A83(T) to the north and/or south beyond the Proposed Scheme extents; all Scheme Options have relatively long construction periods, during which construction-related emissions could be expected to have potential impact on surrounding habitats. Although specific detail is not yet available, it is anticipated that Scheme Options with longer construction periods or more intensive use of construction vehicles would be expected to have the greatest impact on air quality via vehicle emissions.

The Green Option has the longest anticipated construction period of around seven years, with the remaining Scheme Options all anticipated to have construction periods of around 3.25 to 4.25 years. Further detail on the effects of air quality/dust deposition is provided in Chapter 3 Air Quality and further assessment will be undertaken as part of DMRB Stage 3.

In summary, minor adverse impacts are predicted on Annex I and UK BAP priority habitats as a result of the construction and operational phase. The Annex I habitats are valued as being a biodiversity receptor of National Importance and the UK BAP habitats are of National Importance. Given the extent of the predicted habitat loss, the potential significance of effect for all Scheme Options is considered to be Slight Adverse.

7.4.3. Aquatic Habitats and Species

During construction aquatic habitats could be affected by the following:

- direct loss of open channel habitat as a result of construction footprint;
- fragmentation and severance principally as a result of watercourse crossings and subsequent realignments. The level of impact is likely to be different depending on number of watercourses crossed and type of crossing. Culverts may affect the value of the watercourse and its riparian zone as wildlife corridors;
- changes to local hydrology and flow pathways which could affect overall availability, distribution and quality of aquatic habitat;
- loss of watercourse riparian habitat as a result of the construction of culverts;
- changes to local hydro-morphology which could affect overall availability, distribution and quality of aquatic habitat; and
- deterioration in habitat quality as a result of altered flow character and water quality (due to sediment and drainage run-off during construction).

Some of the identified potential impacts (for example severance) occur initially during construction but continue during operation. Others (for example construction drainage and disturbance) occur during construction only. In addition, permanent road drainage and outfalls have the potential to change the hydrology and water quality of receiving watercourses during operation. The majority of identified potential impacts on aquatic habitats are common to all Scheme Options and are therefore not considered to be key differentiators as part of this Stage 2 Assessment.

The number and type of permanent watercourse crossings is an exception and is a key differentiator for aquatic habitats between Scheme Options at this stage. Table 7.10 therefore outlines the number of watercourses crossed by each option, the type of crossing and total extent of watercourse loss associated with the permanent construction boundary.

The extent of watercourse loss refers to the estimated length of watercourse lost to each of the Scheme Options.

Total extent of watercourse loss within Table 7.10 is an estimate of the length of watercourses crossed by each of the Scheme Options (culverts and bridges only). Watercourse length crossed by viaduct and tunnel are assumed to be retained at this stage, whilst noting that with both crossing types there remains potential for impacts on riparian character and a reduction in watercourse condition. The type of crossing has been used to determine the impact magnitude on the watercourse for assessment purposes (aligned to DMRB LA 108):

- Culverts would result in direct and permanent impacts on riverbed habitat, planform and potentially flow characteristics that may affect the integrity or key characteristics of the habitat resource. Culverts are therefore assumed to have potential for Major Adverse impacts on watercourses.
- Bridges can cause extensive shading depending on their elevation, which can adversely impact species assemblages. Depending on construction type; footings, foundations, bank reinforcements and channel/bank protection could result in permanent channel and bankface habitat loss and alter flow character, potentially affecting the integrity or key characteristics of the habitat resource. Whilst there is greater potential for sensitive design of bridges than for culverts, on a precautionary basis, bridges are assumed to have potential for Major Adverse impacts on watercourses.
- Viaducts are typically constructed at higher elevations (or rather, at similar elevations but over lower ground) than bridges and culverts and therefore are more likely to avoid shading impacts on watercourses and, by virtue of their elevation, are likely to leave watercourses and their floodplains more open and less constrained by permanent ground infrastructure than equivalent at-grade alignment and bridge/culvert crossing options. Whilst there are likely to be some permanent effects of viaduct options on watercourses, these are far less likely to affect the integrity of watercourse habitat resources. Viaducts are therefore assumed to have potential for Minor Adverse impacts on watercourses.
- The Scheme Options that include tunnelling would use drill and blast methods with cut and cover at the portals. Watercourses that intersect the tunnelled options therefore do so over ground and are assumed to be retained, with negligible impacts on watercourses.

Table 7.10 Watercourses crossed by each Scheme Option

Scheme Option	No. watercourses crossed (as shown on the OS 1:25k map)	No. of crossings by type				Extent of watercourse loss (km)
		Culvert	Bridge	Viaduct	Tunnel	
Green Option	9	7	0	2	0	0.24
Yellow Option	16	1	0	15	0	0.02
Brown Option	17*	16	2	0	0	0.42
Pink Option	28^	10	2	0	19	0.49
Purple Option	22	5	0	15	2	0.16

*Note that there are 17 watercourses crossed with one watercourse crossed twice.

^Note that there are 28 watercourses crossed with three watercourses crossed twice.

The Yellow Option is associated with the lowest watercourse loss of all the Scheme Options. Like the Brown and Green Options, it is an overland (as opposed to tunnelled) option. However, it relies extensively on viaduct crossings (as opposed culverts) to span the watercourses with which it interacts.

The Purple Option is associated with the second lowest watercourse loss (behind the Yellow Option) of all the Scheme Options. Like the Pink Option, it is a (partly) tunnelled (as opposed to overland) option. However, it requires fewer and shorter culverts than required by the Pink Option, with the majority of overland crossings spanned by viaduct.

The Green Option is associated with lower watercourse loss than the Brown Option and the Pink Option. Like the Brown Option, it is an overland (as opposed to tunnelled) option which relies on numerous culverts (as opposed to viaducts) to span the watercourses with which it interacts (except for the Croe Water viaduct).

The Pink Option is associated with the highest watercourse loss of all the Scheme Options. Like the Purple Option, it is a tunnelled (as opposed to overland) option. However, the small number of overland crossings that are required by the Pink Option are spanned by comparatively long culverts, relative to the other Scheme Options.

The Brown Option is also associated with high watercourse loss (relative to most other Scheme Options (other than the Pink Option) as it is an overland (as opposed to tunnelled) option which relies on numerous culverts (as opposed viaducts) to span the watercourses with which it interacts.

Overall, based on the number of watercourses crossed and crossing type, the Brown Option would have the highest impact on aquatic receptors and the Yellow Option the least. However, based on the receptor importance assigned to identified watercourses and the

impact magnitude associated with the various watercourse crossing types, all options are considered to result in impacts with Slight Adverse significance of effects.

7.4.4. Protected and Notable Terrestrial Species

During construction species could be affected by the following:

- noise disturbance (from site personnel, generators, vehicles and machinery, blasting, piling and construction traffic);
- vibration disturbance (from piling, blasting and machinery);
- visual disturbance (from site personnel, lighting, vehicles and machinery);
- habitat loss and a reduction in habitat quality, which may result in the loss of areas suitable for resting sites and habitats used for foraging;
- severance of habitat (from creation of the road, watercourse realignment, haul roads and site access tracks); and
- mortality and injury from collision impacts from construction traffic, diverted non-construction traffic and machinery (such as excavators).

During operational phase species could be affected by the following:

- fragmentation (primarily as a result of habitat loss at junction locations) and severance (primarily in relation to water courses);
- injury and mortality of protected and priority species from vehicle collisions;
- disturbance including noise and vibration to protected and priority species;
- pollution events; and
- changes to hydrological conditions.

Table 7.11 below, outlines the potential impacts on terrestrial protected and notable species across all Scheme Options.

For all the Scheme Options, loss of habitat, disturbance, severance and increased risks of mortality/injury could affect mobile animal species. However, these are likely to be possible to mitigate with the inclusion of embedded mitigation such as mammal permeability.

While there are some potential benefits from putting part of the road into tunnel on the Pink and Purple Options, all Scheme Options would result in impacts requiring mitigation and none are anticipated to result in significant impacts that could not be reduced by mitigation.

Much of the land in the Green Option is in woodland. Despite this being commercial forestry, the baseline level of disturbance from increased traffic movement across this habitat is likely to result in disturbance to other species such as pine martin. The Green Option also has the

longest construction period. Given the construction timescale for the Green Option is seven years, this will result in a prolonged sustained level of ongoing disturbance to mammals and birds in the local area.

The Green Option intersects a large section of forest and would result in felling of trees and loss of suitable habitat for pine marten, red squirrel, breeding birds and bats. The southern part of the Green Option could have impacts on two potential otter holts within less than 30m of the Option. The presence of new traffic flow through this habitat is also likely to cause bird and mammal mortality (particularly bats and birds crossing overhead). The Green Option would likely cause a greater impact operationally due to collision risk from bats and birds with vehicles and the loss of wooded habitat would potentially have a larger impact on foraging and commuting bats than the other Scheme Options.

The Brown Option follows the same alignment as the existing A83(T), so land take is anticipated to be smaller in comparison to the other Scheme Options. However, one known bat roost would potentially be impacted.

The Pink and Purple Options are discussed together as both involve proposed tunnels. The Pink Option would result in the loss of one bat roost and will also include demolishing a building with high bat roost suitability. Vibration from the Pink Option would also likely to impact a potential badger sett. The Purple Option would affect three structures with roosting bats.

Due to the proposed works associated with the creation of tunnels for the Pink and Purple Option, there would be temporary increases in disturbance from construction methods such as blasting. However, there may be longer term beneficial impacts to consider from the Pink and Purple Options, as tunnels may reduce disturbance associated with road traffic compared to the baseline. Severance may be reduced for the Pink Option and Purple Option due to the parts of the route that would be tunnelled.

The Yellow Option would affect three structures with roosting bats. Additionally, the vibration from piling to install piers for the viaducts would also cause disturbance to commuting and foraging otter on the Water Croe and its tributaries.

With regards to herpetofauna (great crested newts and reptiles), all of the Scheme Options are likely to have similar impacts on these, as all Options will impact on habitat which is potentially suitable for these species groups. Although the level of severance caused may vary to a degree, suitable mitigation can be adopted.

The baseline dataset is incomplete, so a precautionary assessment approach has been taken. To avoid repetition, a cumulative assessment of protected and notable species as groups has been completed instead of a series of individual species assessment.

In summary, minor adverse impacts are predicted on bats, pine marten, otter, barn owl, black grouse and red squirrel as a result of construction and operation. These species are valued as being of Regional Importance. Given the precautionary approach taken (assuming presence in suitable habitat), the predicted loss of suitable habitat and resting sites and increased risk of mortality the likely significance of effect for these species are considered to be Slight Adverse for all the Scheme Options. The summary conclusions in

Table 7.7 report on all species considered collectively, so that sets out the most severe significance of effect, which is Slight Adverse for all Scheme Options, but due to intersecting a large section of forest, habitat severance and prolonged level of disturbance the Green Option is predicted to have the greatest likely impacts on protected species.

Table 7.11 provides a comparative summary of potential impacts to mammals, birds and herpetofauna for the Scheme Options.

Table 7.11 Potential impacts on Terrestrial Protected and Notable Species across all Scheme Options[105]

Receptor	Potential Impacts from Construction (C) and Operation (O)																								
	Loss of resting sites (e.g. roost, den, holt, nest)					Disturbance					Severance (e.g. of commuting routes, connections to suitable habitat)					Loss of suitable habitat (e.g. for foraging) – includes direct loss and indirect loss					Increased mortality risk compared to existing road				
	G	Y	B	Pi	Pu	G	Y	B	Pi	Pu	G	Y	B	Pi	Pu	G	Y	B	Pi	Pu	G	Y	B	Pi	Pu
Bats		C	C	C	C	C	C	C	C	C	C	C		C	C	C			C		O			C	
Badger				C		C/O	C/O		C	C/O	C		C	C			C			C	O	O	O	C	O
Birds	C	C	C	C	C	C/O	C/O	C/O	C/O	C/O	C	C	C	C	C	C	C	C	C	C	C/O	C	C	C	C
Great crested newt														C	C				C	C				C	C
Red squirrel	C	C	C	C	C	C/O	C	C	C	C	C			C		C	C	C	C	C	C/O	C	C	C/O	C
Reptiles	C	C	C	C	C						C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Otter						C	C		C	C	C	C	C/O	C	C	C		C	C	C	O		C/O	C	C
Pine marten						C/O			C	C	C		C	C	C	C			C	C	C/O		C	C/O	C/O

[105] In the table, G = Green; Y = Yellow; B = Brown; Pi = Pink; and Pu = Purple

7.5. Potential Mitigation

7.5.1. Overview

For the Preferred Option, once surveys and EIA are completed, an Ecological Management and Mitigation Plan (EcMMP) will be created which will detail the ecological mitigation. This would be applied in conjunction with the Construction Environment Management Plan (CEMP), which will include general environmental measures such as pollution control.

The mitigation hierarchy will be followed during design. This means design will aim to avoid impacts where possible, and if they cannot be avoided they will be reduced. Any remaining significant impacts would then be subject to onsite restoration / compensation and finally offsite offsetting as a last resort. Efforts to reduce impacts would focus on reducing losses and indirect impacts on the most sensitive areas, i.e. designated sites, important habitats or areas of importance to protected species.

General mitigation measures are described below, followed by additional mitigation details where appropriate in relation to specific sites, habitats and species. These measures include embedded measures that will be incorporated into design and additional measures.

7.5.2. General Mitigation Measures

General mitigation methods will include:

- Design measures for the Proposed Scheme will minimise land take where possible;
- Design measures will aim to minimise severance and improve connectivity for protected and notable species. Consideration of mammal permeability requirements, including otter and pine marten and badger where appropriate, will be included in culvert/underpass design;
- Temporary works areas will be reinstated on a like-for-like or better basis;
- Material storage areas and site compounds will be sited sensitivity;
- Scheduling construction activities outwith sensitive periods (e.g. seasonal restrictions or avoidance of works during the hours of darkness). For example, where possible, vegetation clearance will be minimised and undertaken outside the core bird nesting season. If this cannot be achieved, pre-work checks and measures such as exclusion zones will be used;
- Duration and timing of noisy activities, such as piling, will be minimised. Use methods that reduce noise disturbance such as choice of equipment or ‘Soft-start’ techniques, where work increases gradually at the start of a work period;

- Any temporary lighting will be directed towards areas of construction to minimise light spill;
- Excavations will be filled or covered overnight, or ramps provided to allow animals to escape, and exposed pipes will be capped if left unattended in locations where there is a risk of animals becoming trapped;
- Temporary fencing will be used where appropriate to protect sensitive habitats and to deter and redirect animals during construction;
- The risk of pollution will be controlled by strict adherence to best practice procedures (including Pollution Prevention Guidelines (PPGs106) and Construction Industry Research and Information Association (CIRIA) guidance). Mitigation outlined in the Chapter 8 Geology and Soils will supplement the general mitigation.
- Pre-construction protected species surveys and any required monitoring will take place;
- Any licensing required would be defined upon completion of the surveys and would be in place prior to works affecting the relevant species. Measures to protect individuals of such species would be set out in licenced method statements or other documents detailing precautionary methods of working; and
- Post-construction monitoring will be undertaken if required for habitats and species.

7.5.3. Designated Sites

Following the Mitigation Hierarchy, loss of habitat within the Beinn an Lochain SSSI should be avoided if possible. If this cannot be practicably avoided, it should be minimised as far as possible.

The EcMMP and CEMP will include, but not limited to, the following:

- to provide compensatory replacement of lost habitat, planted in cognisance with the ecological sensitivities of the SSSI qualifying features;
- pollution prevention measures; and
- a surface water management system following relevant best practice guidelines should be followed to ensure there are no impacts on hydrologically sensitive habitat via drainage ditches and adjoining watercourses.

Additional mitigation is outlined in the Chapter 8 Geology and Soils.

[106] Netregs, (2023). Guidance for Pollution Prevention (GPP) documents. Available at: https://www.netregs.org.uk/environmental-topics/guidance-for-pollution-prevention-gpp-documents/ [Accessed on 17 March 2023].

Potential mitigation for the qualifying feature (golden eagle) of the Glen Etive and Glen Fyne SPA is detailed in Section 7.5.5.

7.5.4. Terrestrial habitats

The general mitigation measures and mitigation for designated sites discussed above will ensure best practice guidance are adhered to. These measures will follow the Mitigation Hierarchy.

7.5.5. Birds

One designated site within the EZoI, Glen Etive and Glen Fyne SPA (designated for golden eagle) for which specific mitigation measures are likely to be required. These measures will be determined during the DMRB Stage 3 Assessment.

7.5.6. Bats

The final scheme design will aim to incorporate the retention of trees and suitable commuting corridors (e.g. woodland edges) where possible.

Should bats be roosting within the trees or structures affected by the Proposed Scheme, then a Species Protection Plan, and a European Protected Species (EPS) licence will be required from NatureScot to destroy or disturb any roosts present. This will set out compensation and working methods. Compensation may also be required for reduction in roosting opportunities. Where culverts or bridges are to be replaced, modified or extended, consideration should be given to installing bat bricks and boxes within the structures.

Where important bat commuting corridors and foraging habitats are located in proximity to the Proposed Scheme, consideration will need to be given to lighting, specifically in proximity to watercourses, and planting.

7.5.7. Aquatic Habitats and Species

In addition to the general measures discussed in Section 7.5.2, measures identified within Chapter 15 Road Drainage and the Water Environment and design mitigation (which will be developed in detail during the Stage 3 Assessment of the Preferred Option), the following general mitigation measures will be required:

- Appropriate / sensitive ecological watercourse realignment and crossing design, prioritising clear-span structures over culverts and minimising watercourse crossing lengths and riparian habitat loss as far as practically possible. New or extended

watercourse crossings (including culvert inlets and outlets), should be sensitively designed and constructed with reference to SEPA's Good Practice Guides, namely:

- Engineering in the Water Environment Good Practice Guide: Bank Protection Rivers and Lochs[107];
- Engineering in the Water Environment: Good Practice Guide - River Crossings[108]; and
- Position Statement WAT-PS-06-02 - Culverting of Watercourses – Position Statement and Supporting Guidance[109].

- Timing restrictions for all in channel works (temporary watercourse realignments) based on the species assemblages within the watercourse. Given the presence of salmonids, works restrictions on watercourses with confirmed potential to support fish are likely to be placed around the autumn spawning run up to and including fry emergence in spring. This is likely to be an identified working restriction within required SEPA licences for works affecting watercourses under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR);
- Fish management plans for de-watering activities, including fish rescue where habitat potential for fish is identified;
- Sediment and pollution management plans for in-channel working;
- Noise and vibration management where works (e.g. piling) are within or adjacent to watercourses with fish;
- Reinstatement of riparian vegetation following construction as well as enhancements to watercourses and other aquatic habitats within the study area where feasible, particularly where realignments are required as part of the scheme design; and
- The treatment of road drainage runoff and associated pollutants with appropriate drainage such as SuDS.

7.5.8. Badgers

Should an active badger sett be found within 100m of the Proposed Scheme during pre-construction badger surveys, a licence may be required from NatureScot to disturb the sett,

[107] SEPA, (2008). Bank Protection Rivers and Lochs. Engineering in the Water Environment Good Practice Guide. Available at: https://www.sepa.org.uk/media/150971/wat_sg_23.pdf [Accessed March 2023].
[108] SEPA, (2010). River Crossings. Engineering in the Water Environment: good practice guide. fdocuments.net_sg-25-gpg-river-crossings-2nd-ed-final.pdf [Accessed March 2023].
[109] SEPA, (2015). WAT-PS-06-02: Culverting of Watercourses – Position Statement and Supporting Guidance. Available at: https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf [Accessed March 2023].

depending on nearby works. This will set out working methods and, if needed, compensation to protect

Where badger activity or suitability for badgers is recorded, crossing points (culverts and underpasses) should be integrated into the Proposed Scheme to allow mammal; permeability including safe passage for badgers. Consideration should also be given to permanent badger-spec fencing to direct badgers away from areas with mortality risk, designed according to DMRB specifications.

7.5.9. Otters

To reduce disturbance to commuting and foraging otters, no night working will be undertaken within 50m of any watercourse or waterbody during the construction phase of the Proposed Scheme.

Should any otter resting sites be found within 50m of the Proposed Scheme (200m for breeding holts) then an EPS licence will be required from NS if disturbing or destroying the site cannot be avoided. This will set out working methods and, if needed, alternative artificial resting sites as compensation.

During operation there will be no lighting in proximity to watercourses to avoid disturbance to potential commuting and foraging corridors, except for health and safety requirements. In such scenarios, lighting will be designed to minimise light spill on waterways and riparian corridors.

7.5.10. Red Squirrel and Pine Marten

Should any dreys or dens be found within 50-100m of the Proposed Scheme, a disturbance licence (red squirrel and pine marten) may be required from NatureScot. If disturbing or destroying the site cannot be avoided, the licence will set out working methods and, if needed, compensation.

7.6. Conclusions

A summary of the significant impacts, assuming the application of the mitigation measures identified in Section 7.5 is provided in Table 7.12.

For legally protected species, it is considered that the mitigation measures identified above will remove significant impacts from the construction and operation phases. The need for these mitigation measures and the detail of these measures will be reviewed at DMRB Stage 3 once detailed survey data has been collected and specific design details are known.

Species which are qualifying features for designated sites are considered within the impacts affecting the designated sites, as summarised in Table 7.12 and detailed in the sections above. Based on the information available, most predicted impacts are of neutral or slight significance of effect, but on a precautionary basis moderate significance of effect is identified for designated site receptors. Commentary is provided in the table to provide a comparison of the options.

Policy related to Biodiversity is set out in Appendix 7.1 and is not considered to be a differentiator between Options at this time, but will be taken into account in designing the selected option including mitigation, compensation and additional enhancement.

Table 7.12 Biodiversity Comparative Appraisal

	Receptor	Potential Impact	Significance of effect (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
Designated Site	Glen Etive and Glen Fyne SPA	Disturbance of golden eagle	Slight adverse	Slight adverse	Neutral	Moderate adverse	Moderate adverse	The Brown Option is most favourable as it does not have as intensive construction methods as the other Scheme Options. It also has a smaller works footprint, and one of the shorter works durations. This is a precautionary report and further detail will be provided in the HRA to be undertaken at DMRB Stage 3. The potential effects on the designated site are temporary and can be mitigated.
Designated Site	Beinn an Lochain SSSI	Habitat loss	Moderate adverse	Moderate adverse	Moderate adverse	Moderate adverse	Moderate adverse	For all the Scheme Options, the proportion of the overall area of the Beinn an Lochain SSSI that would be permanently lost as a result of any of the Scheme Options would be less than 0.1%. The Brown Option would result in the smallest area of permanent habitat loss, followed by the Yellow, then Pink and then Purple, and the Green Option being the worst in terms of habitat loss.
Notable Habitats	Potential Annex I Habitats	Habitat loss	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	For Annex I habitats the area of permanent habitat loss is highest in the Brown and Yellow Options. The smallest area of Annex I habitat loss would be in the Green Option since this option primarily bisects other habitat types. The Green Option would result in the least temporary loss of Annex I habitat, followed by the

	Receptor	Potential Impact	Significance of effect (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
								Pink, and the least favourable would be the Purple Option. For all the Scheme Options there is potential for a range of impacts for which mitigation and compensation would be required.
Notable Terrestrial Habitats	Habitats (other than Annex I)	Habitat loss	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	For UK BAP habitats the Pink and Purple Options would be anticipated to result in the largest area of permanent habitat loss. The smallest area of UK BAP permanent habitat loss would be the Brown Option. The UK BAP habitats indicated that the Purple Option would be anticipated to result in the largest area of temporary habitat loss. The smallest area of UK BAP habitat temporary loss would be the Brown Option. For all the Scheme Options there is potential for a range of impacts for which mitigation and compensation would be required.
Aquatic Habitats	Head-waters (Priority Habitat)	Habitat loss and degradation	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Overall, based on the number of watercourses crossed and crossing type, the Brown Option would have the highest impact on aquatic receptors and the Yellow Option the least. The Yellow Option is associated with the lowest watercourse loss of all the route options. Like the Brown and Green Option, it is an overland (as opposed to tunnelled) option. However, it relies extensively on viaduct crossings (as opposed

	Receptor	Potential Impact	Significance of effect (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
								culverts) to span the watercourses with which it interacts. The Brown Option is associated with high watercourse loss (relative to most other options other than the Pink Option) as it is an overland (as opposed to tunnelled) option which relies on numerous culverts (as opposed viaducts) to span the watercourses with which it interacts.
Aquatic Habitats	Other watercourses (Croe Water)	Habitat loss and degradation	Slight adverse	Neutral	Neutral	Neutral	Neutral	The Croe Water is only crossed by the Green Option (viaduct crossing).
Protected and Notable Species	Differentiators were identified for mammals and birds	Loss of rest sites, disturbance to rest sites and individuals, mortality, injury, habitat loss and habitat severance.	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	While all the Scheme Options have Slight adverse significance of effect, the predicted impacts are greater for the Green Option because of the larger additional land take, which could affect a number of protected species.

7.7. Scope of DMRB Stage 3 Assessment

The DMRB Stage 3 Assessment for Biodiversity will be undertaken in accordance with DMRB LA 108 and 118 and relevant guidance and standards.

Detailed field surveys will be undertaken to identify the presence or likely absence of protected and notable species and to provide further information on habitats, to inform the assessment. The surveys will include the following:

- Aquatic surveys: Modular River Physical Surveys (MoRPh); aquatic macroinvertebrate surveys, fish surveys (depending on the outcome of watercourse screening for fish suitability); and macrophyte surveys (depending on initial walkover survey observations to determine requirement);
- Botanical surveys: Bryological and National Vegetation Classification (NVC) surveys;
- Badger surveys including sett monitoring and / or territorial analysis surveys;
- Bats: Preliminary Roost Assessment surveys; emergence / re-entry surveys;
- Barn owl surveys of suitable buildings;
- Black grouse surveys;
- Breeding bird surveys;
- Habitat Suitability Index Assessment (HSI) surveys for great crested newt;
- Reptile habitat appraisal;
- Initial invertebrate assessment;
- Otter surveys including resting site monitoring;
- Pine marten surveys including den monitoring; and
- Red squirrel surveys.

7.7.1. Designated sites

Given the anticipated direct impacts on Beinn an Lochain SSSI, a detailed habitat survey including an assessment of habitat quality and consideration of hydrological and other environmental changes would be required at Stage 3, whichever of the Scheme Options is selected. After initial surveys and consideration of potential impact pathways, golden eagle survey may be undertaken, but this will be determined after further studies.

A HRA screening assessment (HRA Stage 1) and, if required, appropriate assessment (HRA Stage 2) will be undertaken at DRMB Stage 3 to assess the likely significant effects of the Preferred Option on the Glen Etive and Glen Fyne SPA and Loch Lomond Woods SAC.

8. Geology and Soils

8.1. Introduction

This chapter presents the DMRB Stage 2 assessment of Scheme Options in relation to the impacts on geology, soils and groundwater. Specifically, it aims to differentiate between Scheme Options to establish those that have a greater or lesser effect on local receptors.

A Stage 2 scoping assessment was carried out in line with DMRB LA 103. The details of this scoping exercise are provided within Section 8.2.5 of this report. As part of this work geology and contaminated land were scoped out of this assessment. Therefore, the potential significant impacts considered within this report are limited to:

- Change to or loss of Agricultural lands under the permeant or temporary footprint of the road. Agricultural lands are defined by the Land Capability for Agriculture in Scotland (LCA) data from the James Hutton Institute[110].
- Change to or loss of peat or carbon rich soils under the temporary or permanent footprint of the road. Peat and carbon rich soils have been defined by the Carbon and Peatland 2016 data by Scottish Natural Heritage (now NatureScot) and the James Hutton Institute[111].
- Direct loss or changes to groundwater aquifers and groundwater supported public and private water supplies, either below the footprint of the Scheme Options, or as a result of changes to groundwater flows and levels associated with the dewatering of deep cuttings and foundation excavations;
- Indirect loss or change to surface water receptors, as a result of dewatering of groundwater aquifers;
- Loss or changes to Groundwater Dependent Terrestrial Ecosystems (GWDTEs), including peatland habitats, either below the footprint of the Scheme Options, as a result of severance of habitat or as a result of changes to groundwater flows and levels associated with dewatering activities.

It should be noted that consequential impacts on sites designated for their conservation value, groundwater dependent habitats and associated fauna are discussed in Chapter 7

[110] The James Hutton Institute, 2010. Land Capability for Agriculture in Scotland. [Online] Available at: https://map.environment.gov.scot/Soil_maps/?layer=1# [Accessed: 17/03/2023]
[111] Scottish Natural Heritage, 2016. Carbon and Peatland 2016. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed: 14/03/2023]

Biodiversity. Pollution impacts on surface waters and flooding, including groundwater flooding are discussed in Chapter 15 Road Drainage and the Water Environment.

8.2. Approach and Methods

8.2.1. Introduction

The assessment has been carried out in accordance with the guidance contained in the DMRB LA 109 Geology and Soils[112] and LA 113[113] Road Drainage and the Water Environment. An explanation of the methods used is provided in Section 8.2.6 below.

8.2.2. Sources of Information

The following sources of information have been used as part of this assessment:

- British Geological Survey (BGS) 1:50,000 and 1:10,000 superficial and bedrock geology mapping[114];
- Scotland's environment web map – Aquifer Classifications[115];
- National Soil Map of Scotland[116];
- Carbon and peatland Map 2016[117];
- Land Capability for Agricultural in Scotland[118];
- British Geological Survey (BGS) Groundwater Vulnerability Map of Scotland 1:100 000 scale[119];
- Coal Authority online interactive map data[120];
- BGS 'Directory of Mines and Quarries'[121];
- Ordnance Survey (OS) raster mapping on 1:25k scale[122];

[112] DMRB LA 109 Geology and Soils. Highways England et al. 2019
[113] DMRB LA 113 Road Drainage and The Water Environment. Highways England et al. 2020
[114] British Geological Survey, 2020. GeoIndex Onshore. [online] Available at: GeoIndex - British Geological Survey (bgs.ac.uk) [Accessed:14/03/2023]
[115] Scottish Environment Protection Agency, 2023. Groundwater Classification. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed: 14/03/2023]
[116] Soil Survey of Scotland Staff, 1981. Soil Map of Scotland at a Scale of 1:250,000. Macaulay Institute for Soil Research, Aberdeen. [Online] Available At: Scotland's Soils - soil maps (environment.gov.scot) [Accessed: 17/03/2023]
[117] Scottish Natural Heritage, 2016. Carbon and Peatland 2016. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed: 14/03/2023]
[118]The James Hutton Institute, 2010. Land Capability for Agriculture in Scotland. [Online] Available at: https://map.environment.gov.scot/Soil_maps/?layer=1# [Accessed: 17/03/2023]
[119] British Geological Survey, 2023. Hydrogeological Maps of Scotland. [Online] Available at: Hydrogeological maps of Scotland - British Geological Survey (bgs.ac.uk) [Accessed: 14/03/2023]
[120] Coal Authority, 2020. Interactive Map. [Online] Available at: Interactive Map Viewer | Coal Authority (bgs.ac.uk) [Accessed: 14/03/2023]
[121] British Geological Survey (2020), Directory of Mines and Quarries. Eleventh Edition. Nottingham: BGS
[122] Ordnance Survey (2023), 1:25k Raster Mapping

- Ordnance Survey Terrain 50 Mapping[123].

In relation to GWDTE, UKHab mapping has been carried out by the Ecology team as detailed within Chapter 7 Biodiversity).

8.2.3. Policy, Legislation and Guidance

Legislation

The following national and local legislation forms the background against which the assessment has been made:

- The Contaminated Land (Scotland) Regulations 2005 (SSI 2005/658)[124]
- Control of Substances Hazardous to Human Health Regulations, 2002 (as amended)[125];
- The Dangerous Substances and Preparations (Safety) Regulations 2006[126];
- Water Environment and Water Services (Scotland) Act 2003[127];
- Habitats Directive (92/43/EEC)[128];
- National Planning Policy Framework (NPPF) 2021[129];
- Anti-pollution Works Regulations (1999)[130];
- Environment Act (1995)[131];
- Environmental Damage (Prevention and Remediation) Regulations (2015)[132];
- Highways Act 1980 (HA 1980)[133];

[123] Ordnance Survey, 2023. Survey Terrain 50 mapping. [Online] Available at: OS Terrain 50 DTM - data.gov.uk [Accessed:14/03/2023]
[124] The Contaminated Land (Scotland) Regulations 2005 (SSI 2005/658). Available at: https://www.legislation.gov.uk/ssi/2005/658/contents/made
[125] Control of Substances Hazardous to Human Health Regulations, 2002. Available at: https://www.hse.gov.uk/nanotechnology/coshh.htm#:~:text=COSHH%20is%20the%20law%20that,to%20health%20(risk%20assessment)%3B
[126] The Dangerous Substances and Preparations (Safety) Regulations 2006. Available at: https://www.legislation.gov.uk/uksi/2006/2916/note/made#:~:text=Directive%202005%2F90%2FEC%20of%20the%20European%20Parliament%20and%20of,or%20toxic%20to%20reproduction%29%20%28O.J.%20L33%2C%204.2.2006%2C%20p.28%29.
[127] Water Environment and Water Services (Scotland) Act 2003. Available at: https://www.legislation.gov.uk/asp/2003/3/contents
[128] Habitats Directive (92/433/EEC). Available at: https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive_en#:~:text=The%20Habitats%20Directive%20%28Council%20Directive%2092%2F43%2FEEC%29%20was%20adopted,IV%2C%20both%20inside%20and%20outside%20Natura%202000%20sites.
[129] National Planning Policy Framework (NPPF) 2021. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2
[130] Anti-pollution Works Regulations (1999). Available at: https://www.legislation.gov.uk/uksi/1999/1006/contents/made
[131] Environment Act (1995). Available at: https://www.legislation.gov.uk/ukpga/1995/25/contents
[132] Environmental Damage (Prevention and Remediation) Regulations (2015). Available at: https://www.legislation.gov.uk/uksi/2015/810/contents
[133] Highways Act 1980. https://www.legislation.gov.uk/ukpga/1980/66/contents

- Water Act 2003 and Water Act 2014;
- Water Resources Act 1991;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)[134];
- Scottish Government - National Planning Framework 4 (NPF4)[135];
- DMRB LA 113, Road Drainage and the Water Environment[136];
- DMRB LA 109, Geology and Soils[137]
- Scottish Government, Scottish Soils Framework[138]
- Scottish Government, Planning Advice Notice 33: Development of Contaminated Land[139]

More details on the relevant flood risk legislation and standards that this assessment has been carried out in adherence with, is provided in Appendix 15.1.

Policy

This Chapter has been prepared in accordance with the Government's National Planning Practice Guidance (National Planning Policy Framework, 2012).

Guidance

The key national and local planning guidance relevant to Geology and Soils are summarised below:

- Framework for the definition, identification and remediation of contaminated land, within Environmental Protection Act 1990 - Part IIA Contaminated Land: statutory guidance edition 2[140];
- SEPA Regulatory Position Statement - Developments on Peat (SEPA, 2010)[141];
- Developments on Peatland - Guidance on the assessment of peat volumes, re-use of excavated peat and the minimisation of waste (Scottish Renewables & SEPA, 2012)[142];

[134] Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended). Available at::https://www.legislation.gov.uk/ssi/2011/209/contents/made
[135] Scottish Government, National Planning Framework 4 (2023). Available at: https://www.gov.scot/publications/national-planning-framework-4/ [Accessed 03 April 2023].
[136] DMRB LA 113 Road Drainage and The Water Environment. Highways England et al. 2020
[137] DMRB LA 109 Geology and Soils. Highways England et al. 2019
[138] Scottish Soils Framework, Scottish Government. 2009
[139] Planning Advice Notice 33: Development of Contaminated Land. Scottish Government. 2017
[140] Environmental Protection Act 1990 - Part IIA Contaminated Land: statutory guidance edition 2. Available at: https://www.gov.scot/publications/environmental-protection-act-1990-part-iia-contaminated-land-statutory-guidance/
[141] SEPA Regulatory Position Statement - Developments on Peat (SEPA, 2010. Available at: https://www.sepa.org.uk/media/143822/peat_position_statement.pdf
[142] Developments on Peatland – Guidance. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2014/07/assessment-of-peat-volumes-reuse-of-excavated-peat-and-minimisation-of-waste-guidance/documents/guidance-on-the-assessment-of-peat-volumes-reuse-of-excavated-peat-and-the-minimisation-of-waste/guidance-on-the-assessment-of-peat-volumes-reuse-of-

- EA Principles and Practice for the Protection of Groundwater (GP3)[143];
- CIRIA Control of Water Pollution from Linear Construction Sites, Technical Guidance[144];
- SEPA Land Use Planning System (LUPS) Guidance Note 31[145]
- NatureScot Environmental Impact Assessment Handbook[146]
- SEPA Guidance for Transport Infrastructure Projects - WAT-SG-93[147];
- SNIFFER WFD95: A Functional Wetland Typology for Scotland[148]
- CIRIA Contaminated Land Risk Assessment: A guide to good practice (C552)[149]
- Land Contamination Risk Management (LCRM)[150]

8.2.4. Consultation

As part of this assessment written consultation has been undertaken with Argyll and Bute Council to access data on private and public water supplies in the area. A response was received on the 21st of March 2023.

Written consultation has also been undertaken with the SEPA in regard to the GWDTE assessment. Responses to date have been taken into consideration within this assessment.

8.2.5. Scope of Stage 2 Assessment

The following assessment has been recommended as part of the stage 2 DMRB environmental assessment based on this scoping exercise:

8.2.5.1. Geology

The aim of the assessment was to identify potential risks associated with geology that would result in differentiators between the Scheme Options. None of the Scheme Options were found to lie within geological conservation areas and are therefore impacts are likely to be low. The nearest geological conservation review site (GCR) is associated with the peak of Ben Arthur (The Cobbler) and is located between 0.9km and 1km east of all the Scheme

excavated-peat-and-the-minimisation-of-waste/govscot%3Adocument/Guidance%2Bon%2Bthe%2Bassessment%2Bof%2Bpeat%2Bvolumes%252C%2Breuse%2Bof%2Bexcavated%2Bpeat%252C%2Band%2Bthe%2Bminimisation%2Bof%2Bwaste.pdf

[143] EA Principles and Practice for the Protection of Groundwater . Available at: https://www.gov.uk/government/publications/groundwater-protection-principles-and-practice-gp3

[144] CIRIA Control of Pollution from Construction Sites, Technical Guidance – C648 (2006).

[145] SEPA, Available at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions.pdf [Accessed March 2023]

[146] NatureScot, Environmental Impact Assessment Handbook

[147] SEPA, Transport Scotland, Available at: Guidance for Transport Infrastructure Projects (WAT-SG-93) (sepa.org.uk) [Accessed 15 March 2023].

[148] SNIFFER, WFD 95: A Functional Typology for Scotland, 2009

[149] CIRIA, Contaminated land risk assessment. A Guide to good practice (C552). 2001

[150] Environment Agency, Land Contamination Risk Management (LCRM), 2021

Options (Volume 3, Figure 8.4) which is deemed too far from the Scheme Options for potential impact. Geology has therefore been scoped out of Stage 2 assessment.

8.2.5.2. Soils

Based on the results of the scoping assessment further assessment was required for differentiators between the Scheme Options associated with soils. This assessment included the following steps:

- review of available desktop and ground investigation data from the Jacobs 2022 ground investigation associated with peaty and carbon rich soils;
- review available desktop data associated with land classified for agriculture;
- assessment of the potential impact of each Scheme Option on carbon rich and peaty soils based on the available data through quantification of areas lost under the footprint of each Scheme Option;
- assessment of the potential impacts of each Scheme Option to agricultural soils;
- provide potential mitigation measure for the impact on carbon rich and agricultural soils; and
- provide information on further investigation that may be required as part of the stage three assessment.

8.2.5.3. Contaminated Land

The aim of this assessment was to identify potential risk associated with contaminated land that that would result in differentiators between Scheme Options. One disused quarry and two potential gravel pits were located within 250m of the Scheme Options. No other potentially contaminative land uses were identified. The potential for contamination associated with Made Ground from road construction and localised spillages was identified for all Scheme Options. Based on the identified potential sources of contamination identified at the site the risk for contaminated land is likely to be low for all Scheme Options and is therefore not considered to be a differentiator and therefore contaminated land has been scoped out of Stage 2 assessment.

8.2.5.4. Groundwater

Based on the results of the Scoping assessment further work was required to assess differentiators between Scheme Options associated with groundwater. This assessment will include the following steps:

- Desk based assessment of available groundwater data and preliminary ground investigation data.
- Review of existing GWDTE survey data.
- Review of available information on the location of any potential private or public water supplies.
- Assessment of area of GWDTE lost under the footprint of each Scheme Option or within 250m of each Scheme Option.
- Assessment of the impact on Private/ public water supplies from earthworks associated with each Scheme Option.
- Provide mitigation measures for any impacts to private/ public water supplies or GWDTE identified.
- Provide information on further survey/ investigation that may be required as part of the Stage 3 assessment.

8.2.5.5. Groundwater Pollution from routine runoff

A broad range of potential pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving water bodies.

No groundwater discharge through infiltration basins was found to be expected at any of the Scheme Options. Therefore the risk posed by pollution from routine run off is likely to be the same at all Scheme Options. Groundwater pollution from routine runoff has therefore been scoped out of stage 2 assessment.

8.2.5.6. Groundwater Pollution during Construction

Potential impacts on groundwater quality during construction relate to the removal of surface cover, including soils and superficial deposits, during the creation of cuttings and potential excavation close to or below the groundwater table. Spillages in these areas could introduce pollutants directly into the groundwater aquifers.

As discussed in Section 8.3.5.2, groundwater was found to be present within both the superficial and bedrock aquifers across the majority of the Scheme Options at depths between 0.2 and 11.1m bgl.

It was estimated that the depth of the tunnels will generally be up to 50m, and road cuttings would be up to 10m in depth. This would suggest that it is likely that groundwater will be

intercepted in all of cuttings which are excavated into both superficial and bedrock deposits, with a subsequent potential for introduction of pollutants.

All of the Scheme Options will involve cutting into superficial and bedrock aquifers with vulnerability classifications of either Class 4 or Class 5.

Based on the criteria in Section 8.2.6, the groundwater vulnerability designations of Class 4 and 5 are considered to be of High Sensitivity. It is considered that the potential impact from construction pollution for all Scheme Options would be of Minor magnitude as only minor temporary changes in water quality would be expected from construction. The associated impact significance is Slight.

Groundwater pollution during construction is therefore not considered to be a differentiator has been scoped out of Stage 2 assessment.

8.2.5.7. Groundwater Pollution during Road Operation

On all roads there is a risk that road traffic accidents or vehicle fires may result in accidental spillage of potential pollutants on the road surface. These may then enter the road drainage network and subsequently be discharged to the water environment, causing an acute pollution event.

No groundwater discharge through infiltration basins is expected at any of the Scheme Options. Therefore, the risk posed by accidental spillage is likely to be the same at all Scheme Options. Groundwater pollution during road operation has therefore been scoped out of stage 2 assessment.

8.2.6. Assessment Methodology

The assessment of significance of impacts in relation to soils has been based on the guidance provided in the DMRB LA 109. For the sensitivity of groundwater receptors the criteria within DMRB LA 113 Road drainage and the water environment has been used.

The impact of groundwater changes related to the Scheme Options on GWDTE has been assessed in line with SEPA LUPS Guidance Note 31[151]. SEPA guidance recommends that buffers of 100m from excavations less than 1m deep, and 250m from excavations greater than 1m deep are applied to identify GWDTE which may be at risk from associated groundwater changes. At the time of writing this report, excavation depths along the Scheme

[151] Scottish Environment Protection Agency, 2017. Land Use Planning System SEPA Guidance Note 31. [Online] Available at: lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions.pdf (sepa.org.uk) [Accessed:25/04/2023]

Options are likely to be greater than 1m in depth and therefore GWDTE located within 250m of all Scheme Options have been identified.

8.2.6.1. Value/ Sensitivity

Application of the DMRB guidance has involved consideration of the importance/ sensitivity of relevant attributes of the geology, soils and groundwater receptors and evaluation of the magnitude of the impact. Importance/ sensitivity has been evaluated taking into account quality, rarity, scale and substitutability in keeping with the DMRB guidance and using the criteria shown in Table 8.1 below.

Table 8.1 Environmental value (Sensitivity) and description

Receptor value (sensitivity)	Description
Very High	Soils & Peat: 1) soils directly supporting an EU designated site (e.g. SAC, SPA, Ramsar); 2) ALC grade 1 & 2 or LCA grade 1 & 2; and/or 3) areas of peatland designated as part of SSSIs, with national importance Groundwater: 1) Public Water Supply or large private water supply serving >10 properties; and/or 2) GWDTE located within designated areas
High	Soils: 1) soils directly supporting a UK designated site (e.g SSSI); 2) ALC grade 3a, or LCA grade 3.1; and/or 3) class 1 priority peatland, carbon rich and peaty soils. Groundwater: 1) Water Framework Directive (WFD) Good overall status groundwater body; 2) British Geological Survey (BGS) High productivity aquifer; 3) groundwater vulnerability classes 4a and 4b; 4) private water supply serving 2-10 properties; and/or 5) GWDTE with potential highly groundwater dependency, not located within designated areas.
Medium	Soils: 1) soils supporting non-statutory designated sites (e.g. Local Nature Reserves (LNR), LGS's; Sites of Nature Conservation Importance (SNCIs)); 2) ALC grade 3b or LCA grade 3.2; and / or 3) Class 2 and 3 priority peatland areas, carbon rich and peaty soils. Groundwater: 1) BGS Moderate and Low productivity aquifers; 2) Groundwater vulnerability classes 2 and 3; 3) Private water supply serving a single property; and/or 4) GWDTE with potential moderately groundwater dependency, not located within designated areas.

Receptor value (sensitivity)	Description
Low	Soils: 1) ALC grade 4 & 5 or LCA grade 4.1 to 7; 2) soils supporting non-designated notable or priority habitats; and/or 3) class 4 and 5 peatland areas and unclassified areas (class 0, -1 and -2) Groundwater: 1) WFD Poor overall status groundwater body; 2) BGS very low productivity aquifers; 3) groundwater vulnerability classes 1 and 0; and/or 4) habitats confirmed not to be GWDTE.
Negligible	Groundwater: 1) unproductive strata.

DMRB LA 109 table 3.11

8.2.6.2. Magnitude of Impact

Magnitude has been determined by taking into account the extent of loss and effects on integrity of an attribute in keeping with the DMRB guidance and using the criteria shown in Table 8.2.

Table 8.2 Magnitude of impact and typical descriptions

Magnitude of Impact (change)	Typical Description
Major	Groundwater: 1) loss of, or extensive change to, an aquifer; 2) loss of regionally important water supply; 3) potential high risk of pollution to groundwater from routine runoff – risk score >250 (groundwater quality and runoff assessment); 4) calculated risk of spillages to groundwater >2% annually (spillage assessment); 5) major loss of, or extensive change to GWDTE; 6) reduction in waterbody WFD classification; and/or 7) loss or significant damage to major structures through subsidence or similar effects.
Moderate	Soils: permanent loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g through degradation, compaction, erosion of soil resource.) Groundwater: 1) partial loss or change to aquifer; 2) degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies; 3) potential medium risk of pollution to groundwater from routine runoff – risk score 150 – 250; 4) calculated risk of pollution from spillages to groundwater >1% annually and <2% annually;

Magnitude of Impact (change)	Typical Description
	5) partial change or loss of integrity of GWDTE; 6) contribution to reduction in water body WFD classification; and/or 7) damage to major structure through subsidence or similar effects or loss of minor structures.
Minor	Soils: temporary loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g through degradation, compaction, erosion of soil resource.) Groundwater: 1) potential low risk of pollution to groundwater from routine runoff – risk score <150; 2) calculated risk of pollution from spillages to groundwater >0.5% annually and <1% annually; 3) minor effects on an aquifer; 4) minor direct or indirect effects of GWDTE; 5) minor effects on abstractions; and/or 6) minor effects on structures.
Negligible	Soils: no discernible loss / reduction of soil function(s) that restrict current or approved future use. Groundwater (see Chapter 15 Road Drainage and the Water Environment): 1) no measurable impact upon an aquifer and/or groundwater receptors; and/or 2) risk of pollution from spillages <0.5%

8.2.6.3. Impact Significance

The evaluation of significance has been derived by combining the sensitivity of the affected attributes and the magnitude of the impacts using the matrix recommended in DMRB LA 104 Guidance. The impact threshold of ‘significant’ is defined as a significance level of moderate and above.

Table 8.3 Significance Matrix

	Magnitude of impact					
Environmental Value (Sensitivity)		No change	Negligible	Minor	Moderate	Major
	Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or slight	Slight	Slight or Moderate	Moderate or Large
	Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

8.2.6.4. Limitations and Assumptions

This assessment has relied upon the accuracy and level of detail of the documented data sources listed within Section 8.2.2.

The scale of various mapping datasets, such as groundwater vulnerability and soils mapping, is such that only broad characterisation of these attributes and high-level assessment of potential impacts has been possible at this stage. Both the aquifer productivity and groundwater vulnerability data only provide a guide to aquifer conditions at a 1:100,000 scale. Further detailed site investigations and consultation will inform the DMRB Stage 3 Assessment of the Preferred Option.

A ground investigation was carried out by Raeburn and Jacobs in 2022. At the time of writing the final version of the factual report from this ground investigation was not available and therefore a draft version of this report has been used[152]. It is possible that the data provided within this draft report is updated when the final version is published. This update will not be represented within this reporting.

National Vegetation Classification (NVC) data was not available to determine the extent of GWDTE within the study area. Potential GWDTE were identified using targeted UKHab surveys combined with aerial imagery analysis. Therefore, this is likely to provide conservative figures for effects on GWDTE.

[152] Jacobs UK Limited (2022), Access to Argyll &Bute (A83) Report on preliminary Ground Investigation. Draft Edition. Glasgow.

8.3. Baseline Conditions

8.3.1. Topography

The Scheme Options are situated within Glen Croe, an upland glaciated U-shaped valley featuring steep valley sides and a relatively flat base (Volume 3, Figure 8.1). Phases of glacier advance and retreat have resulted in erosion forming the steep valley sides with subsequent deposition of material on the valley floor and sides.

The valley is orientated northwest - southeast with Croe Water flowing southeast towards where it discharges into Loch Long at Ardgartan. The elevation of the valley bottom ranges from ~85m above ordnance datum (AOD) at the southeast extent of the Scheme Options, to ~240 mAOD at the northern extent.

On the eastern side of the valley are steep slopes leading up to the summits of Beinn Luibhean and The Cobbler, which have elevations of 858 mAOD, and 884 mAOD, respectively. The western side of the valley features slopes leading to Ben Donich and Beinn an Lochain, which have summit elevations of 847 mAOD, and 901 mAOD, respectively

The Preliminary Sources Study Report (PSSR)[153] have used current OS mapping to show that the hillside terrain is characterised by steep, uneven slopes with numerous channels of varying size and incision level, which provide drainage pathways towards to the valley floor. The most noteworthy channel is situated between Beinn Luibhean and The Cobbler and accommodates Croe Water. The Croe Water flows southwest from Coire Croe through a hanging valley, before reaching the valley floor of Glen Croe where it proceeds to flow southeast towards Loch Long.

At the northern extent of the Scheme Options is Loch Restil, located at the toe of the eastern slopes of Beinn an Lochain, immediately west of the A83(T) to the north of the Rest and Be Thankful car park. The loch drains to the north, initially across relatively flat land and then more steeply, particularly at Easan Dubh Fall.

The upper slopes and summits of the mountains are rugged, with rocky crags and scarps, loose boulders and debris. The PSSR[11] carried out an assessment of the slope angles within the area, and found that:

- valley floors are typically less than 10-20 degrees;
- lower north-eastern facing slopes of Ben Donich have angles up to 40 degrees;

[153] Jacobs Aecom,(2022), access to Argyll and Bute (A83) Preliminary Sources Study Report.

- south-western facing slopes of Beinn Luibhean and The Cobbler have angles from 20 – 50 degrees;
- north-western facing slopes of Beinn Luibhean have angles from 10 - 30 degrees;
- middle and upper slopes of Beinn an Lochain have the steepest slopes in the area, with slope angles of 40 – 70 degrees.

8.3.2. Geology

The information below is summarised from the Geotechnical PSSR[20], where further baseline information on geology is discussed. Although Geology has been scoped out of this assessment (as detailed in Sections 8.1 and 8.2.5), baseline geological information has been provided to help provide context to the groundwater assessment.

8.3.2.1. Bedrock Geology

As determined from available BGS mapping (shown in Volume 3, Figure 8.2), the majority of Scheme Options are underlain by Neoproterozoic metamorphic bedrock. An extensive igneous intrusion and numerous igneous dykes are also present within the study area. Bedrock is noted to be at or near the ground surface at numerous locations in close proximity to the Scheme Options, typically across areas of steep hillside. The distribution of bedrock geology is shown in Volume 3, Figure 8.2.

Bedrock comprises the Beinn Bheula Schist Formation of Neoproterozoic age, which is part of the Southern Highland Group. Pelite, semipelite and psammite lithologies are dominant across the Scheme Options and wider area, with metawackes recorded underlying the nearby hillsides of Beinn an Lochain and Ben Donich.

An extensive igneous intrusion of the Siluro-Devonian South of Scotland Granitic Suite situated between Beinn Luibhean and The Cobbler. The exposure stretches from the A83(T) in the south-west, north-easterly up to Coire Croe and into Glean Leacann Sheileach.

The intrusion is recorded to comprise Pyroxene-Mica Diorite. Localised smaller intrusions of Intrusion-Breccia and Tuffisite, Tonalite and Meladiorite associated with the same granitic suite, are recorded both within and at the extents of the main intrusion, and under the superficial deposits from the A83(T).

Numerous igneous dyke suites are recorded in the west of the study area comprising the following:

- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite, various orientations and predominantly on the east facing slopes of Beinn an Lochain and Ben Donich, and also at High Glencroe where the B828 meets the A83(T).
- Central Scotland Late Carboniferous Tholeiitic Dyke Swarm, predominantly orientated east-west and exposed from Loch Fyne to Beinn an Lochain, approximately 500m north-west of the Scheme Options.
- Mull Dyke Swarm of the North Britain Paleogene Dyke Suite. Variable orientation and predominantly on the east facing slopes of Beinn an Lochain and Ben Donich.
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite, which includes a felsic intrusion along the south-eastern facing slopes of Beinn an Lochain, approximately 380m southwest of the study area boundary.

8.3.2.2. Structural Geology

As well as information on the distribution of and material that constitutes the Bedrock geology, available BGS maps also include information relevant to the Scheme Options on the structural geology. The features discussed in the following Sections are shown on Volume 3, Figure 8.2. The Beinn Bheula Schist Formation (Southern Highland Group) has experienced significant deformation and metamorphism as a result of the Grampian Event of the Caledonian Orogeny (Tanner et al., 2013). BGS mapping (Sheet 37E) indicates the typical dip of the bedrock is between 15 and 40 degrees, however locally in the study area, dips are shown to range from 7 to 80 degrees. Folding within the Southern Highland Group is suggested to form part of the Aberfoyle Anticline (BGS mapping Sheet 37E).

The mapping (Sheet 37E) indicates the western section of the study area is heavily faulted, with normal faults predominantly trending northeast-southwest. Three faults are shown to cross through the northern end of the Scheme Options, all trending northeast-southwest, which comprise:

- inferred fault with unknown displacement crosses the Scheme Options at NGR 224103 706947 (Green Option), NGR 223102 707365 (Yellow and Brown Scheme Options), 223147707509 (Purple Option), and 223215 707768 (Pink Option);
- inferred fault with unknown displacement crosses the Green Option at NGR 223115 706767;
- inferred fault with unknown displacement crosses the Scheme Options at NGR 223220 706618 (Green Option), NGR 223282 707196 (Yellow and Purple Options), NGR 223295 707363 (Brown Option) and NGR 223297 707570 (Pink Option).

Few faults are mapped within the eastern part of the study area (Sheet 38W), however there is potential for unnamed faults to be present.

8.3.2.3. Superficial Geology

BGS mapping (shown in Volume 3, Figure 8.3) indicates the majority of the Scheme Options are underlain by Glacial Till deposits, which line the base of most river valleys within the region. Alluvium, Hummocky/Glacial deposits and River Terrace Deposits are also present within the area of the Proposed Scheme. The upper slopes and summits of the surrounding mountains of Ben Donich, Beinn Luibhean and The Cobbler, have no mapped deposits, indicating that superficial deposits are thin or completely absent.

Made Ground is not recorded with the area of the Scheme Options, However, engineered fill would be present locally in association the A83(T) and potentially present associated with local forest tracks and car parks. Surface peat is not recorded by BGS mapping.

Alluvium deposits are recorded to underly the central Sections of both the Yellow and Purple Options and the northern extents of the Purple and Pink Options. They comprise soft to firm, consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A limited area of River Terrace Deposits underlies the Yellow and Green Options to the south-east of the Alluvium. River Terrace Deposits typically comprise sand and gravel, locally with lenses of silt, clay or peat.

The Glacial Till, which underlies all of the Scheme Options within Glen Croe and extends up into Coire Croe to the east, typically comprises unsorted and unstratified drift with generally over-consolidated, heterogenous mixtures of clay, sand, gravel, and boulders varying widely in size and shape. The Till is also likely to underly the Alluvium and River Terrace Deposits.

Hummocky/Glacial deposits underly the northern extents of Scheme Options and are likely to underlie the Alluvium and overly the Glacial Till deposits in the centre of the Scheme Options. They predominantly comprise rock debris, clayey till and poorly- to well-stratified sand and gravel.

8.3.3. Soils

The soil units present on site are summarised from the 1:250,000 Soil Map of Scotland by the James Hutton Institute[154] (accessed through Scotland's Soils) and shown on Volume 3, Figure 8.5. The distribution of soils within the study area is dependent on the geology, topography and drainage regime of the area.

[154] Scottish Government, 2016. Soil Map of Scotland James Hutton. [Online] Maps | Scotland's soils (environment.gov.scot) [Accessed: 15/12/2014]

The Proposed Scheme is entirely underlain by peaty podzol soils, which are described as peaty gleyed podzols with peaty gleys with dystrophic semi-confined peat. Podzols are typically free-draining acid soils developed under aerobic conditions. They are generally nutrient-deficient and heavily leached in the upper horizons, with an accumulation of iron/aluminium oxides ('ironpan') or organic material at lower levels within the soil profile. Peaty podzols, such as the soils underlying the Proposed Scheme, have a peat-rich surface horizon.

The peaty podzols soils underly the majority of the valley bottoms in the local area and also extend up the steep sided hills to the northeast and southwest of the Proposed Scheme. In addition, peaty ranker soils are also found on the slopes at higher elevations, which comprise an organic or organo-mineral surface horizon but lack subsoil.

The summits of the hills near the Scheme Options comprise subalpine podzols, which comprise a mixture of podzols, rankers and peaty soils.

The 1:250,000 Land Capability for Agriculture (LCA) map, also provided by the James Hutton Institute[155] (shown in Volume 3, Figure 8.6), shows there are four classifications within the local area, which are described in Table 8.4.

The entirety of the Scheme Options and local area is underlain by poor quality soils (land capability classes 6 and 7) where the soils are of low quality and therefore are considered to be of low sensitivity.

Table 8.4 Land Capability for Agriculture (LCA) descriptions

Extent relative to Scheme Options	LCA class code	LCA description	LCA division description	Soil description
2.7km^2 area within the Croe valley, extending from Croe Water up to the southeast facing slopes of Beinn Luibhean and The Cobbler. Underlies parts of the Brown and Pink Scheme Options. Also underlies the Gail valley to the west.	6.1	Land capable of use as rough grazings. The land has very severe site, soil or wetness limitations which generally prevent the use of tractor-operated machinery for improvement. Reclamation of small areas to encourage stock to range is often possible. Climate is often a very significant limiting factor. A range of widely different qualities of grazing is included from very steep land with significant grazing value in the lowland situation to moorland	Land in this division has high proportions of palatable herbage in the sward, principally the better grasses	Peaty podzols with peaty gleys with blanket peat
Underlies majority of the Scheme Options and local area	6.2		Moderate quality herbage such as white and flying bent grasslands, rush	Peaty podzols, peaty gleys, peaty ranker,

[155] Land capability for agriculture map

Extent relative to Scheme Options	LCA class code	LCA description	LCA division description	Soil description
		with a low but sustained production in the uplands. Grazing is usually insignificant in the full arctic zones of the mountains but below this level grazings which can be utilised for five months or longer in any year are included in the class. Land affected by industrial pollution or dereliction may be included if the effects of the pollution are non-toxic.	pastures and herb-rich moorlands or mosaics of high and low grazing values characterise land in this division.	subalpine soils
Underlies the summits of Stob an Eas and Beinn an t-Seilich, ~3km west of the Scheme Options	6.3		This vegetation is dominated by plant communities with low grazing values. Particularly heather moor, bog heather moor and blanket bog.	Peaty podzols, peaty gleys, peaty ranker, subalpine soils
Underlies the summits of Beinn an Lochain, Beinn Ime, The Cobbler and Beinn Narnain	7.0	Land of very limited agricultural value. This land has extremely severe limitations that cannot be rectified. The limitations may result from one or more of the following: extremely severe wetness, extremely stony rocky land, unvegetated soils, scree or beach gravels, toxic waste tips and dereliction, very steep gradients, severe erosion including intensively hagged peatland and extremely severe climates (exposed situations, protracted snow cover and short growing season). Agricultural use id restricted to a very poor rough grazing.	Not divided	Peaty podzols, peaty gleys, peaty ranker, subalpine soils

8.3.4. Peat

The BGS mapping indicates that peat is not present within the area of the Scheme Options (Volume 3, Figure 8.3). However, the Carbon and Peat 2016 map[156] (Volume 3, Figure 8.7) shows that all Scheme Options are underlain by Class 3 and 4 Peat. Description of the peat classifications are shown in Table 8.5.

In addition, the recent PSSR found thin layers of peat present in three of the exploratory holes, pockets of peat within four boreholes, and the presence of peaty silty sand at seven locations. Of the three locations where distinct peat layers were observed, one location recorded its presence from ground level to 0.5m bgl, whereas the other two observed it from

[156] Scottish Government, 2016. Carbon and Peat 2016 map. [Online] Scotland's Soils - soil maps (environment.gov.scot). [Accessed: 27/04/2023].

1.2m to 1.45m bgl. Pockets of peat and peaty material was observed at various depths down to 7.2m bgl.

The 2022 ground investigation identified Peat or peaty soils at 37 locations between 0.15 and 1.5m in thickness. The ground investigation data suggest that the majority of peat/ peaty soil recorded during the 2022 ground investigation was found at the bottom of the valley in close proximity to the footprint of the Purple and Yellow Options. Peat/ peaty soil was also recorded between 0.3m and 1.05m in close proximity to the Green Option, between 0.2m and 0.7m at the northern tunnel portal of the Pink and Purple Options and between 0.8 and 0.4m thick near the Brown Option.

Given that peat typically has a low bearing resistance and is compressible with poor engineering properties, consideration of special measures would be required for stability and settlement. Since it is likely that peat is only present locally, it will be a possibility to replace the peat with a suitable engineered fill. However, ground improvement or piling may be required for areas of thicker peat deposits (>2 m).

Geochemical testing will be required on any peat encountered to assess its potential corrosivity to steel and / or concrete. In addition, it should be noted that the removal of substantial areas of peat would likely require a peat management plan and represents an environmental constraint to the Scheme Options.

Table 8.5 Peat deposits extent and description[14]

Class	Description from Scotland's Soils	Study Area Presence
Class -2	Non-soil (e.g. loch, built up area, rock and scree)	Loch Restil, located west of the A83(T) in the northern part of the study area.
Class -1	Unknown soil type – information to be updated when new data are released	Not present
Class 0	Mineral soil - Peatland habitats are not typically found on such soils	Upper slopes and summits of Beinn Luibhean and The Cobbler, in addition to Beinn an Lochain and Ben Donich.
Class 1	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value.	On northeast facing slopes of Ben Donich, ~800m south-west of the Scheme Options.
Class 2	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential	Not present
Class 3	Dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic type. Occasional peatland habitats can be found. Most soils are carbon-rich soils, with some areas of deep peat	Predominantly underlies the eastern side of the Croe valley and majority of the Scheme Options (excluding the Green Option).

Class	Description from Scotland's Soils	Study Area Presence
Class 4	Area unlikely to be associated with peatland habitats or wet and acidic type. Area unlikely to include carbon-rich soils	Mid-upper slopes of Beinn Luibhean, The Cobbler, Beinn an Lochain and Ben Donich.
Class 5	Soil information takes precedence over vegetation data. No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat.	Predominantly underlies the western side of the Croe valley and most of the Green Option. Also underlies Sections of all the other Scheme Options.

8.3.5. Groundwater

8.3.5.1. Hydrogeology

The BGS Aquifer Productivity Report[157] indicates the superficial Alluvium and River Terrace Deposits would form low productivity aquifers if they predominantly comprise silts and clays. However, if dominated by granular sands and gravels, the deposits have the potential to represent high productivity aquifers due top intergranular groundwater flow, with expected yields of 1 - >10 l/s.) Although Hummocky/Glacial deposits in some areas can be highly productive, in Scotland Hummocky/Glacial deposits and till are mapped interchangeably, hence they are both mapped as non-significant aquifers[158]. However, locally these deposits may be highly permeable and have the potential to form local aquifers. A summary of the hydrogeological classifications is shown in Table 8.6.

The BGS Hydrogeology map for Scotland[159] shows that the Beinn Bheula Schist bedrock and the unnamed igneous intrusion are categorised as a 2C low productivity aquifer, where flow is fracture dominated and there are small amounts of groundwater in the near surface weathered zone and secondary fractures. In addition, the BGS Aquifer Productivity Report[160] suggests the bedrock is expected to have low aquifer productivity yields (0.1 – 1.0l/s).

Table 8.6 Hydrogeology Summary

Strata	Deposit/lithology	SEPA aquifer classification
Superficial deposits	Alluvium	Low to high productivity
	River terrace deposits	Low to high productivity
	Hummocky glacial deposits	Non-significant
	Glacial till	Non-significant
Bedrock	Unnamed igneous intrusion	2C low productivity
	Beinn Bheula Schist	2C low productivity

[157] BGS aquifer productivity report
[158] Dochartaigh et al., (2015)
[159] British Geological Survey 2011, User Guide: Aquifer Productivity (Scotland) GIS datasets, Version 2 (Open Report: OR/11/065). [Online]. Available: http://nora.nerc.ac.uk/id/eprint/16222/1/OR11065.pdf. [Accessed 2 June 2021].
[160] British Geological Survey, "User Guide: Aquifer Productivity (Scotland) GIS datasets, Version 2 (Open Report: OR/11/065)," 2011. [Online]. Available: http://nora.nerc.ac.uk/id/eprint/16222/1/OR11065.pdf. [Accessed 2 June 2021].

8.3.5.2. Groundwater Observations

Groundwater levels were monitored within 31 exploratory holes during recent ground investigation throughout the area of the Scheme Options, carried out by Raeburn and Jacobs in 2022, locations of which are shown in Volume 3, Figure 8.8. Table 8.7 shows a summary of the groundwater monitoring data. Groundwater levels are generally shallow and range from 0.2 to 11.1m bgl across the area of the Scheme Options.

Observations indicate the presence of shallow groundwater within both the superficial and bedrock aquifers and in 26 of the 31 boreholes.

In five of the 31 exploratory holes where Glacial Till deposits overly the bedrock, groundwater was only observed within the bedrock aquifer.

Table 8.7 Summary of groundwater level monitoring data

Groundwater presence	Superficial Geology	Bedrock Geology	Superficial deposit thickness			Groundwater levels		
			Average (m)	Minimum (m)	Maximum (m)	Average (m bgl)	Minimum (m bgl)	Maximum (m bgl)
Within both superficial and bedrock aquifers	Alluvium underlain by Glacial Till	Beinn Bhleu Schist	10.5	3.7	15.9	2.6	5.8	0.2
	Hummocky glacial underlain by glacial till		15.9	15.9	15.9	2.6	3	2.4
	Made Ground underlain by glacial till**		3.3	2	4.5	1.8	2.8	0.8
	Peat underlain by glacial till**		2.1	1.1	3.1	0.6	2.1	0.2
	River terrace deposits underlain by till		12.1	12.1	12.1	1.6	1.8	1.4
	Glacial till		6.8	2.1	14.7	2.5	7.5	0.2
	Made Ground underlain		2.1	2.1	2.1	3.2	3.9	2.5

Groundwater presence	Superficial Geology	Bedrock Geology	Superficial deposit thickness			Groundwater levels		
			Average (m)	Minimum (m)	Maximum (m)	Average (m bgl)	Minimum (m bgl)	Maximum (m bgl)
Within bedrock aquifer only	by glacial till**							
	Glacial till		1.2	0.2	1.9	5.7	11.1	1.2

**Superficial deposits are not mapped by BGS, but GI descriptions note there are deposits overlying the bedrock

8.3.5.3. Groundwater Vulnerability

The BGS Groundwater Vulnerability report[161] indicates that the groundwater within the bedrock underlying the Scheme Options exhibits vulnerability Classes 4 and 5. Class 4 indicates that groundwater is vulnerable to pollutants which are not readily absorbed or transformed, whereas Class 5 is where groundwater is vulnerable to most pollutants, with rapid impact in many scenarios.

8.3.5.4. Water Framework Directive Status

South of the Rest and be Thankful car park, the Scheme Options are underlain by the Cowal and Lomond groundwater body, as defined by SEPA[162] whereas north of the car park it is underlain by the Oban and Kintyre groundwater body. Both groundwater bodies are defined as having an ‘good’ condition and ‘good’ water quality.

8.3.5.5. Public Water Supplies

There are no known public water supplies in the area.

8.3.5.6. Private Water Supplies

Argyll and Bute Council have provided the locations of all private water supplies within the council area. Two of these Private water supplies have been identified within 250m of the Scheme Options (Roadmans Cottage NN 24437 05555 and High Glencroe at NN 23337 06965). Both of these private water supplies are detailed as being fed by a burn and therefore impacts to these receptors have been assessed within Chapter 15 Road Drainage and the Water Environment. No groundwater fed private water supplies were identified within 250m of the scheme.

[161] British Geological Survey, 2020. Groundwater Vulnerability Map.
[162] Scottish Environment Protection Agency, 2020. Groundwater Classifications. [Online] Map | Scotland's environment web. [Accessed: 27/04/2023].

8.3.5.7. GWDTE

GWDTE are types of wetland which are specifically protected under the WFD and can include: fens, springs, flushes, seepages, quaking bog, wet woodland, marshy grassland and some types of wet heath, reedbed and swamp.

There is one designated site at the northern extent, Beinn an Lochain Site of Special Scientific Interest (SSSI) (site code 163), which is designated for the presence of siliceous cree, tall herb ledge and upland assemblage. The location of the SSSI is shown on Volume 3, Figure 8.4.

A UKHab survey has been undertaken for the study area, within 250m of the Scheme Options, which identified potential GWDTE in the study area. For further details on habitats, please refer to Chapter 7 Biodiversity.

Within the study area, local characteristics indicate that communities with groundwater dependency are likely to be very limited, with the wet soil conditions on the steep slopes and valley floor of the study area considered to be primarily due to direct precipitation and surface water runoff contribution.

However, there is insufficient resolution of data to differentiate between the GWDTE areas with high and moderate dependency on groundwater, therefore a reasonably precautionary approach has been taken and it is currently assumed that all areas are highly groundwater dependent and of high sensitivity (see Table 8.1).

A number of GWDTE at the northern extent fall within the Beinn an Lochain SSSI, potential GWDTE areas within designated sites are considered of very high sensitivity.

GWDTE within the study area may be impacted through direct loss of habitat under the footprint of the Scheme Options, through severance of habitat and through changes to the groundwater regime supporting the habitat. This could result in altered vegetation in corridors close to infrastructure.

Details of the area of GWDTE lost under the footprint and within 250m of the proposed works have been assessed individually for each of the Scheme Options in Section 8.4.2.

Direct losses under the Scheme Option footprints are typically relatively small. Indirect losses within the 250m buffer of the Scheme Options are more extensive. However, as the groundwater drawdown effect will reduce with distance from the Scheme Options it is anticipated that the overall changes to GWDTE within the 250m buffer will be small. The location of GWDTEs in relation to the scheme have been shown in Volume 3, Figure 8.9.

It is highly likely that the area of GWDTE within the 250m buffer will significantly reduce at DMRB Stage 3 with more detailed habitats data. In addition, it is likely that some of the potential GWDTE will be found to have limited groundwater dependency and can be scoped out from the DMRB Stage 3 assessment.

8.3.6. Study Area

The assessment study area for soils includes the footprint of the Scheme Options and the temporary works footprint. The footprint of the Scheme Options and the temporary works footprint can be seen in Volume 3, Figures 8.1 - 8.8 and within the relevant figures included in Volume 2 of the DMRB Stage 2 Scheme Assessment Report.

The assessment study areas for groundwater includes the footprint and temporary footprint of the Scheme Options and a buffer of 250m from all Scheme Options. It is recognised that the impacts of the Scheme Options on groundwater receptors may extend some distance away from the Proposed Scheme footprint. 250m is considered a conservative estimate of the extent of the impacts. This assessment will therefore cover both the direct and indirect impacts of groundwater receptors.

The assessment study area for GWDTE includes the footprint of the Scheme Options and a buffer of 250m, this is in recognition that the potential impacts on these receptors may extend some distance from the Scheme Options. For the purposes of calculating GWDTE direct and indirect loss, the study area has been defined based on the combination of all the Scheme Options 250m buffers.

8.4. Potential Impacts

The potential impacts for the Scheme Options are discussed in Section 8.4.2 below, they have been subdivided into construction and operational impacts. For the purposes of this assessment, construction impacts are generally considered to be short-term impacts which occur during the construction phase only. Operational impacts are considered to be long-term or permanent impacts affecting receptors after the construction phase is complete. It is recognised that many operational impacts are initiated by construction activities e.g. excavation of cuttings, however the full effect of the impact may only manifest itself in the long-term.

All impacts that are discussed within this assessment are negative impacts unless it is clearly stated otherwise.

Each impact is assessed using the methods outlined in Section 8.2.5. The potential impacts are assessed before mitigation, with potential mitigation detailed following this assessment and a summary including residual impact.

Potential receptors that do not have differentiators have been scoped out of this assessment as detailed in Section 8.2.5 and therefore no impacts common to all Scheme Options have been discussed in this Section. The impact differentiators have been discussed in more detail in Section 8.4.1 below.

8.4.1. Impacts Specific to Scheme Options

8.4.1.1. Construction

Green Option

Agricultural Land

Construction of the Green Option would result in the disturbance of soils and impact on soil quality. As discussed in Section 8.3.3 the Green Option is underlain by class 6.1 and 6.2 soils, which are classified as Low sensitivity. The total construction phase land take of soils is 32.6 ha of which 15.25 ha would be permanently lost. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance is Slight.

Peat

As discussed in Section 8.3.4, shallow peat present under the footprint of the Green Option is likely to be excavated out and replaced with suitable engineering fill. Construction activities would likely result in an impact on 2.5 ha of Class 3 peat (Medium sensitivity) of which 1.25ha would be permanently lost. It would also lead to an impact on 30.1 ha of Class 5 peat (Low sensitivity) of which 14ha would be permanently lost. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance is Slight.

Loss or Change of Groundwater Aquifers

Without any tunnel Sections, the Green Option is likely to have a limited impact on the groundwater levels within the superficial and bedrock aquifers. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Negligible as minimal or no change in water level is expected and therefore the impact significance is Slight.

The magnitude of impact on the Low productivity aquifers (Medium sensitivity) is also anticipated to be Negligible, with a subsequent significance of Slight.

GWDTE

The debris flow shelter proposed for the Green Option would require diversion of surface channels and installation of these structures may also interrupt near-surface flows on the mid-slopes of respective valley sides. This could alter flowpaths and groundwater input to plant communities downslope.

For the Green Option, the area of GWDTE lost under the footprint and within 250m of the proposed works has been quantified in Table 8.8.

Table 8.8 Impact on GWDTE from Green Option

Potential groundwater dependency	Area of Potential GWDTE directly lost under the Green Option footprint (ha)	% of Potential GWDTE within the study area that are directly lost under the Green Option footprint	Area of GWDTE within 250m of the Green Option (ha)	% of GWDTE within the study area that are within 250m of the Green Option
Highly	0.85	0.6%	26.8	20.0%
Moderately	<0.1	<0.1%	4.6	3.4%
Total	0.85	0.6%	31.4	23.4%

The Green Option would result in 0.6% of potential GWDTE within the study area being directly lost under the footprint. Approximately 23.4% of potential GWDTE within the study area could be potentially altered by changes to the groundwater regime supporting the habitat.

Based on the currently available information, and due to the combined effects of direct loss under the footprint and alteration of GWDTE within the 250m buffer, the potential magnitude of the impact on potential GWDTE (high sensitivity) during construction for the Green Option is considered to be Minor, with a resulting significance of Slight.

At the northern extent of the Green Option, a number of GWDTE are located within the Beinn an Lochain SSSI, therefore have been assessed as very high sensitivity. The Green Option would result in 0.2% of potential GWDTE within the SSSI being directly lost under the footprint. Approximately 38.6% of potential GWDTE within the SSSI could be potentially altered by changes to the groundwater regime supporting the habitat.

The potential magnitude of the impact on potential GWDTE in Beinn an Lochain SSSI (very high sensitivity) during construction for the Green Option is considered to be Minor, with a resulting significance of Moderate.

Yellow Option

Agricultural Soils

Construction of the Proposed Option would result in the disturbance of soils and impact on soil quality. As discussed in Section 8.3.3, the Yellow Option is underlain by class 6.1 and 6.2 soils, which are classified as Low sensitivity. The total construction phase land take of soils is 18.1ha of which 6.9ha would be lost permanently. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance for the Yellow Option is Slight.

Peat

As discussed in Section 8.3.4, shallow peat present under the footprint of the Yellow Option is likely to be excavated out and replaced with suitable engineering fill. Construction activities would likely result an impact on 12ha of Class 3 peat (Medium sensitivity), of which 4ha would be lost permanently.

Construction activities would also impact 6.1ha of Class 5 peat (Low sensitivity) of which 2.9ha would be lost permanently. The majority of the lost/ impacted peat would be Medium sensitivity. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact significance for the Yellow Option is Moderate.

Loss or Change of Groundwater Aquifers

Without any tunnel Sections, the Yellow Option is likely to have a limited impact on the groundwater levels within the superficial and bedrock aquifers. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Negligible as minimal or no change in water level is expected and therefore the significance of Slight. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Negligible, with a subsequent significance of Slight.

GWDTE

Individual pier supports proposed for the Yellow Option will be less liable to alter near-surface flow paths on the crossed slope and valley floor, with more limited potential for

localised alteration adjacent to the pier support foundations, which would be unlikely to alter the regional baseline conditions.

For the Yellow Option, the area of GWDTE lost under the footprint and within 250m of the proposed works has been quantified in Table 8.9.

Table 8.9 Impact on GWDTE from Yellow Option

Potential groundwater dependency	Area of Potential GWDTE directly lost under the Yellow Option footprint (ha)	% of Potential GWDTE within the study area that are directly lost under the Yellow Option footprint	Area of GWDTE within 250m of the Yellow Option (ha)	% of GWDTE within the study area that are within 250m of the Yellow Option
Highly	5.5	4.1%	56.4	42.1%
Moderately	1.2	0.9%	5.5	4.1%
Total	6.7	5.0%	61.9	46.2%

The Yellow Option would result in 5.0% of potential GWDTE within the study area being directly lost under the footprint. Approximately 46.2% of potential GWDTE within the study area could be potentially altered by changes to the groundwater regime supporting the habitat.

Based on the currently available information, and due to the combined effects of direct loss under the footprint and alteration of GWDTE within the 250m buffer, the potential magnitude of the impact on potential GWDTE (high sensitivity) during construction for the Yellow Option is considered to be Moderate, with a resulting significance of Moderate.

At the northern extent of the Yellow Option, a number of GWDTE are located within the Beinn an Lochain SSSI therefore have been assessed as very high sensitivity. The Yellow Option would result on 0.7% of potential GWDTE within the SSSI being directly lost under the footprint. Approximately 32.9% of potential GWDTE within the SSSI could be potentially altered by changes to the groundwater regime supporting the habitat.

The potential magnitude of the impact on potential GWDTE in Beinn an Lochain SSSI (very high sensitivity) during construction for the Yellow Option is considered to be Minor, with a resulting significance of Moderate.

Brown Option

Agricultural Land

Construction of the Brown Option would result in the disturbance of soils and impact on soil quality. As discussed in Section 8.3.3, the Brown Option is underlain by class 6.1 and 6.2 soils, which are classified as low sensitivity. The total construction phase land take of soils is 19.8ha of which 9.1ha would be lost permanently. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance for the Brown Option is Slight. The presence of the existing A83(T) has not been considered when carrying out the agricultural land assessment for the Brown Option. This is because it was not possible to accurately estimate the impact of its presence. The assessment for the Brown Option for agricultural land is therefore conservative.

Peat

As discussed in Section 8.3.4, shallow peat present under the footprint of the Brown Option is likely to be excavated out and replaced with suitable engineering fill. Construction activities would likely result an impact on 15.6ha of Class 3 peat (Medium sensitivity) if which 6.2ha would be lost permanently. Construction activities would lead to an impact on 4.2ha of Class 5 peat (low sensitivity) of which 2.9ha would be lost permanently. The majority of the lost peat is Medium sensitivity and therefore the overall sensitivity is considered to be Medium. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. The impact Significance is Slight. The presence of the existing A83(T) has not been considered when carrying out the peat assessment for the Brown Option. This is because it was not possible to accurately estimate the impact of its presence. The assessment for the Brown Option for agricultural land is therefore conservative.

Loss or Change of Groundwater Aquifers

Without any tunnel Sections, the Brown Option is likely to have a limited impact on the groundwater levels within the superficial and bedrock aquifers. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Negligible as minimal or no change to groundwater levels is expected. Therefore, the subsequent significance is Slight. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Negligible, with a subsequent significance of Slight.

GWDTE

The debris flow shelter proposed for the Brown Option would require diversion of surface channels and installation of these structures may also interrupt near-surface flows on the mid-slopes of respective valley sides. This could alter flow-paths and groundwater input to plant communities downslope.

The Brown Option follows the existing A83(T) , with a number of proposed excavations along the entire length, therefore adverse effects on groundwater and habitats are deemed to be minimal in comparison to the other Scheme Options.

For the Brown Option, the area of GWDTE lost under the footprint and within 250m of the proposed works has been quantified in Table 8.10.

Table 8.10 Impact on GWDTE from Brown Option

Potential groundwater dependency	Area of Potential GWDTE directly lost under the Brown Option footprint (ha)	% of Potential GWDTE within the study area that are directly lost under the Brown Option footprint	Area of GWDTE within 250m of the Brown Option (ha)	% of GWDTE within the study area that are within 250m of the Brown Option
Highly	8.7	6.5%	75.0	56.0%
Moderately	0.01	0.007%	2.1	1.6%
Total	8.7	6.5%	77.1	57.6%

The Brown Option would result in 6.5% of potential GWDTE within the study area being directly lost under the footprint. Approximately 57.6% of potential GWDTE within the study area could be potentially altered by changes to the groundwater regime supporting the habitat.

Based on the currently available information, and due to the combined effects of direct loss under the footprint and alteration of GWDTE within the 250m buffer, the potential magnitude of the impact on potential GWDTE (high sensitivity) during construction for the Brown Option is considered to be Moderate, with a resulting significance of Moderate.

At the northern extent of the Brown Option, a number of GWDTE are located within the Beinn an Lochain SSSI therefore have been assessed as very high sensitivity. The Brown Option would result on 0.4% of potential GWDTE within the SSSI being directly lost under the footprint. Approximately 27.9% of potential GWDTE within the SSSI could be potentially altered by changes to the groundwater regime supporting the habitat.

The potential magnitude of the impact on potential GWDTE in Beinn an Lochain SSSI (very high sensitivity) during construction for the Brown Option is considered to be Minor, with a resulting significance of Moderate.

Pink Option

Agricultural Land

Construction of the Proposed Scheme would result in the disturbance of soils and impact on soil quality. As discussed in Section 8.3.3 the Pink Option is underlain by class 6.1 and 6.2 soils, which are classified as low sensitivity. The total construction phase land take of soils is 13.9ha of which 8.3ha would be lost permanently. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance is Slight.

Peat

As discussed in Section 8.3.4, shallow peat present under the footprint of the non-tunnel parts of the Pink Option is likely to be excavated out and replaced with suitable engineering fill. Construction activities would likely result in an impact on of 8.6ha of Class 3 peat (Medium sensitivity) of which 5.4ha would be lost permanently. Construction activities would result in an impact on 9.5ha of Class 5 peat (Low sensitivity) of which 5.9ha would be permanently lost. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance is Slight.

Loss or Change of Groundwater Aquifers

Dewatering, which is required as part of the tunnel section of the Pink Option, would likely reduce the groundwater level in the vicinity of the tunnels. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Moderate as a partial change or loss to the bedrock and/ or superficial aquifer is expected. The subsequent significance is therefore Moderate. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Moderate, with a subsequent significance of Slight.

Note that that without sufficient knowledge about the continuity of perched groundwater levels within the potentially high productivity alluvium and river terrace deposits aquifers, it can be assumed that tunnel dewatering would lower the overall groundwater level of the area affected.

GWDTE

The tunnel proposed for Pink Option is understood to be designed to be bored at approximately 50m bgl when beyond the transitional tunnel portal zones. At 50m depth, these are unlikely to interrupt near-surface flows that would be supplying groundwater to plant communities in the study area.

For the Pink Option, the area of GWDTE lost under the footprint and within 250m of the proposed works has been quantified in Table 8.11. Based on the fact that a large proportion of the Pink Option is at a depth of 50m bgl, which is unlikely to interact with the groundwater levels feeding potential GWDTE, the calculations have been split into two.

Table 8.11 Impact on GWDTE from Pink Option

Potential groundwater dependency	Footprint loss due to excavations	Area of Potential GWDTE directly lost under the Pink Option footprint (ha)	% of Potential GWDTE within the study area that are directly lost under the Pink Option footprint	Area of GWDTE within 250m of the Pink Option (ha)	% of GWDTE within the study area that are within 250m of the Pink Option
Highly	Entire Pink Option	5.9	4.4%	94.3	70.4%
	Pink Option excluding tunnel section	2.5	1.9%	38.3	28.6%
Moderately	Entire Pink Option	0.9	0.7%	7.0	5.2%
	Pink Option excluding tunnel section	0.9	0.7%	6.8	5.1%
Total	Entire Pink Option	6.8	5.1%	101.3	75.6%
	Pink Option excluding tunnel section	3.4	2.5%	45.1	33.6%

The Pink Option would result in 5.1% of potential GWDTE within the study area being directly lost under the footprint. Approximately 75.6% of potential GWDTE within the study area could be potentially altered by changes to the groundwater regime supporting the habitat.

Based on the currently available information, and due to the combined effects of direct loss under the footprint and alteration of GWDTE within the 250m buffer, the potential magnitude of the impact on potential GWDTE (high sensitivity) during construction for the Pink Option is considered to be Major, with a resulting significance of Large.

At the northern extent of the Pink Option, a number of GWDTE are located within the Beinn an Lochain SSSI therefore have been assessed as very high sensitivity. The Pink Option would result on 2.6% of potential GWDTE within the SSSI being directly lost under the footprint. Approximately 69.1% of potential GWDTE within the SSSI could be potentially altered by changes to the groundwater regime supporting the habitat.

The potential magnitude of the impact on potential GWDTE in Beinn an Lochain SSSI (very high sensitivity) during construction for the Pink Option is considered to be Major, with a resulting significance of Very Large.

Purple Option

Agricultural Land

Construction of the Proposed Scheme would result in the disturbance of soils and impact on soil quality. As discussed in Section 8.3.3, the Purple Option is underlain by class 6.1 and 6.2 soils, which are classified as low sensitivity. The total construction phase land take of soils is 21.1ha of which 3.75ha would be lost permanently. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance is Slight.

Peat

As discussed in Section 8.3.4, shallow peat present under the footprint of the non-tunnel parts of the Purple Option is likely to be excavated out and replaced with suitable engineering fill. Construction activities would likely result an impact on 12.4ha of Class 3 peat (Medium sensitivity) of which 0.62ha would be lost permanently.

Construction activities would have an impact on 10.32ha of Class 5 (Low sensitivity) peat of which 3.13ha would be lost permanently. As detailed in Table 8.2, permanent loss or reduction of a soil function is considered to have Moderate magnitude of impact. Therefore, the impact Significance is Moderate.

Loss or Change of Groundwater Aquifers

Dewatering, which is required as part of the tunnel section of the Purple Option, would likely reduce the groundwater level in the vicinity of the tunnels. With the tunnel section being

relatively short, slight or no change to groundwater levels are expected and therefore the magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Minor, with a subsequent significance of Slight. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Minor, with a subsequent significance of Slight.

Note that that without sufficient knowledge about the continuity of perched groundwater levels within the potentially high productivity alluvium and river terrace deposits aquifers, it can be assumed that tunnel dewatering would lower the overall groundwater level of the area affected.

GWDTE

The tunnel proposed for the Purple Option is understood to be designed to be bored at approximately 50m bgl when beyond the transitional tunnel portal zones. At 50m depth, these are unlikely to interrupt near-surface flows that would be supplying groundwater to plant communities in the study area.

For the Purple Option, the area of GWDTE lost under the footprint and within 250m of the proposed works has been quantified in Table 8.12. Based on the fact that a section of the Purple Option is at a depth of 50m bgl, which is unlikely to interact with the groundwater levels feeding potential GWDTE, the calculations have been split into two. The areas on the top row have considered the entire Purple Option would involve excavations and the second (in bold) showing the loss excluding the tunnel section.

Table 8.12 Impact on GWDTE from Purple Option

Potential groundwater dependency	Footprint loss due to excavations	Area of Potential GWDTE directly lost under the Purple Option footprint (ha)	% of Potential GWDTE within the study area that are directly lost under the Purple Option footprint	Area of GWDTE within 250m of the Purple Option (ha)	% of GWDTE within the study area that are within 250m of the Purple Option
Highly	Entire Pink Option	6.9	5.1%	87.8	65.5%
	Pink Option excluding tunnel section	6.4	4.8%	82.3	61.4%
Moderately	Entire Pink Option	1.6	1.2%	12.9	9.6%
	Pink Option excluding	1.6	1.2%	12.6	9.4%

Potential groundwater dependency	Footprint loss due to excavations	Area of Potential GWDTE directly lost under the Purple Option footprint (ha)	% of Potential GWDTE within the study area that are directly lost under the Purple Option footprint	Area of GWDTE within 250m of the Purple Option (ha)	% of GWDTE within the study area that are within 250m of the Purple Option
	tunnel section				
Total	Entire Pink Option	8.5	6.3%	100.7	75.1%
	Pink Option excluding tunnel section	8.0	6.0%	94.9%	70.8%

The Purple Option would result in 6.3% of potential GWDTE within the study area being directly lost under the footprint. Approximately 75.1% of potential GWDTE within the study area could be potentially altered by changes to the groundwater regime supporting the habitat.

Based on the currently available information, and due to the combined effects of direct loss under the footprint and alteration of GWDTE within the 250m buffer, the potential magnitude of the impact on potential GWDTE (high sensitivity) during construction for the Purple Option is considered to be Major, with a resulting significance of Large.

At the northern extent of the Purple Option, a number of GWDTE are located within the Beinn an Lochain SSSI therefore have been assessed as very high sensitivity. The Purple Option would result on 2.6% of potential GWDTE within the SSSI being directly lost under the footprint. Approximately 69.1% of potential GWDTE within the SSSI could be potentially altered by changes to the groundwater regime supporting the habitat.

The potential magnitude of the impact on potential GWDTE in Beinn an Lochain SSSI (very high sensitivity) during construction for the Purple Option is considered to be Major, with a resulting significance of Very Large.

8.4.1.2. Operation

Green Option

Loss or change to Groundwater Aquifers

Without any tunnel Sections, the Green Option is likely to have a limited impact on the groundwater levels within the superficial and bedrock aquifers during operation. The

magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is therefore anticipated to be Negligible, with a subsequent significance of Slight. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Negligible, with a subsequent significance of Slight.

Yellow Option

Loss or Change to Groundwater Aquifers

Without any tunnel Sections, the Yellow Option is likely to have a limited impact on the groundwater levels within the superficial and bedrock aquifers during operation. The proposed viaduct is likely to have limited impact on groundwater regime. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is therefore anticipated to be Negligible, with a subsequent significance of Neutral/Slight. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Negligible, with a subsequent significance of Slight.

Brown Option

Loss or Change to Groundwater Aquifers

Without any tunnel Sections, the Brown Option is likely to have a limited impact on the groundwater levels within the superficial and bedrock aquifers during operation. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is therefore anticipated to be Negligible, with a subsequent significance of Slight. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is also anticipated to be Negligible, with a subsequent significance of Slight.

Pink Option

Loss or Change to groundwater Aquifers

Dewatering, which is required as part of the tunnel section of the Pink Option, would likely reduce the groundwater level in the vicinity of the tunnels during operation. The magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Moderate, with a subsequent significance of Moderate. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is anticipated to be Moderate, with a subsequent significance of Slight.

Note that that without sufficient knowledge about the continuity of perched groundwater levels within the potentially high productivity Alluvium and River Terrace Deposits aquifers, it

can be assumed that tunnel dewatering would lower the overall groundwater level of the area affected.

Purple Option

Loss or Change to Groundwater Aquifer

Dewatering, which is required as part of the tunnel section of the Purple Option, would likely reduce the groundwater level in the vicinity of the tunnels during operation. With the tunnel section being relatively short, the magnitude of impact on the low-high productivity aquifers (Medium - High sensitivity) is anticipated to be Minor, with a subsequent significance of Moderate. The magnitude of impact on the low productivity aquifers (Medium sensitivity) is anticipated to be Minor, with a subsequent significance of Slight.

Note that that without sufficient knowledge about the continuity of perched groundwater levels within the potentially high productivity Alluvium and River Terrace Deposits aquifers, it can be assumed that tunnel dewatering would lower the overall groundwater level of the area affected.

8.5. Potential Mitigation

At DMRB Stage 2 the design of the Proposed Scheme has not been sufficiently developed to allow detailed mitigation to be specified for each of the Scheme Options. However potential generic mitigation, based on current legislation, guidance and good practice, has been outlined below.

As part of DMRB Stage 3 the design of the Preferred Option and the potential mitigation measures will be developed and refined to minimise the impacts on geology, soils and groundwater wherever possible.

8.5.1. Construction

8.5.1.1. Soils and Peat

In relation to soils and peat, development of the DMRB Stage 3 design will seek to minimise impacts on soils and peat where practicable, including localised realignment to avoid areas of deep peat (if discovered) and optimising the cut and fill balance. Reuse of soils and peat within the Preferred Option will be considered wherever possible e.g. for dressing earthworks slopes. Good practice methods of excavation and storage of soils and peat will be used, including: minimising the time they are stored for, removing vegetated turves and storing them so that they remain in good condition (this may include watering when dry weather could lead to desiccation) and storing top soil and sub soil separately. Soils and peat out with

the footprint of the Preferred Option will be protected from compaction by restricting vehicle movements to clearly demarcated construction areas and access tracks. If there is a significant excess of excavated soils and peat, consideration will be given to use off-site, e.g. excavated peat could be used in the restoration of nearby degraded peatland habitats, in consultation with SEPA and affected landowners.

8.5.1.2. Groundwater

The impacts on groundwater aquifers due to the dewatering of cuttings and deep excavations during construction could be minimised through sensitive design of the dewatering operations or permanent drainage.

An assessment of the groundwater quality will need to be undertaken alongside robust calculations of the anticipated groundwater discharge rate along cuttings and within the tunnel section. This will enable the creation of a discharge and drainage plan and application of a discharge permit, if required, to minimise impacts from dewatering and groundwater discharge.

8.5.1.3. GWDTE

In relation to GWDTE, following the detailed DMRB Stage 3 assessments those GWDTE considered to be at risk of impact may be monitored prior, during and after construction to determine the level of impact. Monitoring may involve both groundwater readings and repeated NVC surveys.

Where road embankments may result in severance of a GWDTE consideration will be given to the use of permeable fill in the embankment construction to maintain groundwater flows. Groundwater entering cuttings will be directed to the down gradient side and allowed to infiltrate. Where possible the location and frequency of these discharges will be designed to replicate the natural groundwater flow as closely as possible.

8.5.2. Operation

8.5.2.1. Groundwater

There may be long term changes to groundwater levels within both the superficial and bedrock aquifers (especially in relation to the tunnelling options), which may require continued monitoring post construction to determine any impacts on GWDTE and groundwater levels after construction has ended.

8.6. Conclusions

The conclusions of the above assessment have been summarised in Table 8.13 below.

Table 8.13 Geology and Soils Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Soils and peat	Soils	Loss of soils	Slight	Slight	Slight	Slight	Slight	All Scheme Options are located on low sensitivity agricultural land and therefore the residual impact of all Scheme Options is considered to be slight. The Brown Option is located on the existing A83(T) and is therefore the assessment carried out is likely to be conservative.
	Peat	Loss of peat	Slight	Slight	Slight	Moderate	Moderate	A large portion of the Green Option goes through forestry land where peat/ carbon rich soils are not expected and therefore the residual impact is slight. The Pink Option is mainly a tunnel and would therefore have a lesser impact on peat/ carbon rich soils at surface and therefore the impact is slight. The Brown Option follows the existing A83(T) and is expected to have a lesser impact on the underlying peat/ carbon rich soils therefore the impact is slight. Both the Purple and Yellow Options are located on large areas of class three peat/ carbon rich soils and therefore the residual impact is moderate.

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Groundwater	GWDTE	Loss or change to GWDTE	Slight	Moderate	Large	Large	Moderate	A large proportion of the Green Option goes through forestry and therefore the direct and indirect impacts to GWDTEs are considered to be Slight. The rest of the Scheme Options have similar direct and indirect losses of potential GWDTEs, hence impact significance varies from Moderate to Large.
	Beinn an Lochain SSSI GWDTE	Loss or change to GWDTE	Moderate	Moderate	Very Large	Very Large	Moderate	All the Scheme Options potentially impact GWDTEs within the SSSI, resulting in direct and indirect losses.
	Groundwater (construction)	Construction pollution - change to groundwater quality	Slight	Slight	Slight	Slight	Slight	Groundwater vulnerability across all Scheme Options is class 4 and class 5 which are considered to be high sensitivity. Therefore, construction pollution is considered to be the same across all Scheme Options.
		Loss or change to groundwater aquifers (low-high productivity)	Slight	Slight	Moderate	Slight	Slight	The Pink Option is the longest tunnelling Option. Dewatering associated with the tunnel may cause a reduction in groundwater level during construction.
		Loss or change to groundwater aquifers (low productivity)	Slight	Slight	Moderate	Slight	Slight	The Pink Option is the longest tunnelling Option. Dewatering associated with the tunnel may cause a reduction in groundwater level during construction.

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
	Groundwater (Operation)	Pollution from Routine Runoff	Slight	Slight	Slight	Slight	Slight	Groundwater vulnerability across all Scheme Options is class 4 and class 5 which are considered to be high sensitivity. No groundwater discharges through infiltration basins have been planned for any of the Scheme Options. Therefore, pollution from routine runoff is considered to be the same across all Scheme Options.
		Pollution from Accidental Spillage	Slight	Slight	Slight	Slight	Slight	Groundwater vulnerability across all Scheme Options is class 4 and class 5 which are considered to be high sensitivity. Therefore, pollution from accidental spillage is considered to be the same across all Scheme Options.
		Loss or change to groundwater aquifers (low-high productivity)	Slight	Slight	Moderate	Slight	Slight	The Pink and Purple Options are tunnel Options. Dewatering associated with the tunnels may cause a reduction in groundwater level during operation. The Pink Option has the longest tunnel and therefore the impact of groundwater aquifers is expected to be larger.
		Loss or change to groundwater aquifers (low productivity)	Slight	Slight	Slight	Slight	Slight	The Pink and Purple Options are the tunnel Options. Dewatering associated with the tunnel may cause a localised reduction in groundwater level during operation.

Based on this above assessment the Green Option is the most favourable. Due to the potential for direct and indirect losses to potential GWDTEs within the SSSI a moderate impact significance was identified. However, all other impacts to the geology soils and groundwater receptors that were assessed for the Green Option have been identified to be of slight significance.

The assessment for the Brown Option identified a slight impact significance to all receptors with the exception of GWDTEs both within the study area and the SSSI where the potential impacts were identified as Moderate. The presence of the existing A83(T) was not considered when carrying out the assessment on the Brown Option, it is therefore possible a conservative assessment has been carried out on this Scheme Option. This suggests the Brown Option is also favourable.

The Yellow Option was found to have a potential moderate impact on peat and GWDTEs in both the study area and the SSSI. All other impacts on the geology, soils and groundwater receptors that were assessed were found to be of slight significance. Due to the potential impacts on both GWDTEs and peat, the Yellow Option is considered to be slightly less favourable than the Green and Brown Options.

The Assessment identified the Pink and Purple Options as the least favourable. The Purple Option has a moderate impact on peat due to direct losses of class 3 and class 5 peat under both the temporary and permanent footprint. Both the Pink and Purple Options have the largest direct and indirect losses to GWDTEs both across the study area and specifically within the SSSI resulting in Large and Very Large impact significances respectively. The Pink Option has the largest tunnelled section which suggests there could be a larger loss or change to groundwater aquifers under the footprint of the scheme and has resulted in a potential moderate impact significance during both construction and operational phases.

8.7. Scope of DMRB Stage 3 Assessment

Soils

Further survey work will be carried out to refine the characterisation of the soils within the study area. As the design of the Preferred Option is developed a more refined analysis of the area of soils lost to hardstanding will be undertaken. More detailed GI will be carried out to help determine the volumes of soils to be excavated. Measures to minimise soil losses will be investigated and estimates made of the volumes of excavated soil that can be reused on site.

Peat

Detailed peat surveys will be carried out for the Preferred Option, including probing, coring and testing in line with the Scottish Government guidance on peat surveys. This data will be used to refine the design of the Preferred Option to, wherever possible, avoid peatland areas. The data will also be used to estimate the volume of peat (both acrotelmic and catotelmic) that will require excavation and assess peat stability within the study area.

An assessment of the indirect impact on the peat due to changes in the hydrological and hydrogeological regime will be carried out, taking into consideration the effect of drainage, and cut and fill proposals.

Peat management and restoration plans will be developed in consultation with SEPA and NatureScot, which will include estimates of the volumes of peat which can be re-used on site.

A peat stability risk assessment will be carried out in line with Scottish Government Peat Landslide and Risk Assessment guidance, to identify if there is likely to be a risk of peat slides along the Proposed Scheme.

Groundwater

Future ground investigation works data and subsequent groundwater monitoring will be used to determine groundwater levels and aquifer properties in the vicinity of proposed cuttings and deep excavations. Using this information, the drawdown and zone of influence of dewatering will be estimated, and an assessment of the magnitude of impact on the aquifers themselves carried out.

Private Water Supplies

Once data on the presence of any groundwater dependant private water supplies is received a detailed assessment of private water supplies identified as potentially at risk of impact will be carried out.

GWDTE

Further survey work is required to positively identify all GWDTE within the study area. NVC surveys will be undertaken within at least a 250m buffer of the Preferred Option. An assessment of the likely impacts on GWDTE will be carried out in accordance with the SEPA guidance provided in LUPS-GU31.

The area of GWDTE lost under the footprint of the Preferred Option will be quantified. Additionally, GWDTE within 100m of shallow excavations (<1 m) and those within 250m of

deep excavations (>1 m) will be identified. In these instances, detailed study/assessment will determine the indirect impact that changes to the hydrological regime caused by the Proposed Scheme will have. Where necessary monitoring and GWDTE management plans will be agreed with SEPA and NatureScot.

Contaminated Land

Although contaminated land was scoped out as part of the DMRB Stage 2 Assessment, further contaminated land assessment will be required as part of the DMRB Stage 3 reporting. This will enable a further assessment of the contamination status of the site and to inform the earthworks design. Intrusive sampling, chemical testing and interpretative reporting will include:

- sampling and chemical testing of soils and groundwater along the Preferred Option for general coverage as well as focusing on any areas of potential contamination;
- sampling from watercourses upstream and downstream of where they intersect the A83(T);
- assessment of the chemical analysis against the relevant guidelines / standards in order to assess the risk to human health, property, site infrastructure and the water environment; and
- reporting of findings from the chemical assessment along with recommendations for any remedial works where necessary.

9. Material Assets and Waste

9.1. Introduction

This Chapter has been prepared to assess the potential environmental impacts and effects associated with material resource use, and waste generation and disposal, arising from the Scheme Options. This assessment will contribute to the selection of the Preferred Option which will be further developed and assessed at DMRB Stage 3.

This Chapter has been completed in accordance with guidance set out in DMRB Standard LA 110 Material Assets and Waste[163], herein 'DMRB LA 110'.

The topics considered in this chapter are:

- Consumption of natural and non-renewable resources; and
- Generation and disposal of waste.

The remainder of this Chapter describes the assessment methodology and the baseline conditions relevant to the assessment (both of which have been used to reach the conclusions made) as well as a summary of the likely significant effects. It outlines the essential mitigation measures required to avoid, prevent, reduce or, if possible, offset any likely significant adverse effects, and reports on the likely residual effects after these measures have been employed.

This Chapter is intended to be read as part of the wider Environmental Assessment, with particular reference to Chapter 5 Landscape, Chapter 8 Geology and Soils, Chapter 10 Noise and Vibration, Chapter 11 Population and Human Health and Chapter 12 Effects on Climate.

9.2. Approach and Methods

9.2.1. Introduction

This section details the data sources which have helped to build an accurate account of the baseline conditions, before describing the scope of assessment, assessment methodology, and any consultation undertaken to date. Detailed discussion of the baseline conditions related to materials and waste follows in Section 9.3.

[163] DMRB LA 110 Material Assets and Waste. Highways England et al. 2019

9.2.2. Sources of Information

The baseline data collected and presented in this chapter was obtained through desk study.

The data acquired during the desk study describes the regional and national availability of materials that would typically be required for the Proposed Scheme, and the capacity of regional facilities to recover and dispose of waste generated.

Data relating to the volumes of materials, their source and recycled content, as well as volumes of waste and their disposal method have been obtained from design estimates.

Baseline data has been sourced from publicly available data sources comprising:

- Argyll and Bute Council (2018) Draft Waste Strategy[164];
- Department for Business, Energy & Industrial Strategy (2023) Monthly Bulletin of Building Materials and Components[165];
- Mineral Products Association, Profile of the UK Mineral Products Industry, 2020 Edition[166];
- Ministry of Housing, Communities and Local Government (2009) National and regional guidelines for aggregates provision in Scotland 2005-2020 (Online)[167];
- Scottish Environment Protection Agency (SEPA), Waste Data for Scotland, Waste from all sources – Summary data 2017[168];
- SEPA, Data analysis - Landfill site and capacity summary (2021)[169];
- United Kingdom Steel Production I 1969-2020 Data I Historical[170].

[164] Argyll and Bute Council (2018) Draft Waste Strategy. [Online]. Available at: draft_waste_strategy_document.pdf (argyll-bute.gov.uk) [Accessed 8 March 2023].
[165] Department for Business, Energy & Industrial Strategy (2023) Monthly Bulletin of Building Materials and Components Available at: https://data.gov.uk/dataset/75ee36ed-21f7-4d7b-9e7c-f5bf4546145d/monthly-statistics-of-building-materials-and-components.
[166] Mineral Products Association, Profile of the UK Mineral Products Industry, 2020 Edition. Available at: https://www.mineralproducts.org/MPA/media/root/Publications/2021/Profile_of_the_UK_Mineral_Products_Industry_2021.pdf and https://www.mineralproducts.org/MPA/media/root/Publications/2021/Profile_of_the_UK_Mineral_Products_Industry_2020_Statistical_Background.xlsx
[167] Ministry of Housing, Communities & Local Government, (2009). National and regional guidelines for aggregates provision in England 2005-2020 [online]. Available at https://www.gov.uk/government/publications/national-and-regional-guidelines-for-aggregates-provision-in-england-2005-to-2020 [Accessed 08 March 2023].
168 Scottish Environment Protection Agency. (2017). Waste Data for Scotland, Waste from all sources – Summary data 2017 Waste (from all sources) (sepa.org.uk)
[169] Scottish Environment Protection Agency (2021) Data analysis - Landfill site and capacity summary. Available at: https://www.sepa.org.uk/data-visualisation/waste-sites-and-capacity-tool/ [Accessed 6 March 2023]
[170] United Kingdom Steel Production I 1969-2020 Data I Historical. Available at: https://tradingeconomics.com/united-kingdom/steel-production

9.2.3. Policy, Legislation and Guidance

The following national and local legislation and policy forms the background against which the assessment has been made:

- Waste Framework Directive 2008/98/EC;
- The Environmental Protection (Duty of Care) (Scotland) Regulations 2014;
- The Waste (Scotland) Regulations 2012;
- The Waste Management Licensing (Scotland) Regulations 2011;
- The Landfill (Scotland) Regulations 2003 (and Amendment Regulations 2003 & 2013);
- Waste and Emissions Trading Act 2003;
- The Special Waste Amendment (Scotland) Regulations 2004;
- The Special Waste Regulations 1996;
- The Controlled Waste Regulations 1992;
- Environment Act 1995;
- Environmental Protection Act 1990;
- Scotland National Planning Framework 4 (2023);
- Argyll and Bute Council Local Development Plan (adopted 2015) and interactive online policy map[171]; and
- Loch Lomond and The Trossachs National Park Local Development Plan 2017-2021 (2016) and interactive policy map[172].

The policies are not considered to be differentiators between options but will be assessed at DMRB Stage 3.

The assessment follows the guidance outlined in the DMRB standard for assessment of materials and waste:

- DMRB LA 110 Material Assets and Waste.

9.2.4. Consultation

No specific consultation relating to materials and waste has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA,

[171] Argyll and Bute Council Local Development Plan adopted 2015. Available at: https://www.argyll-bute.gov.uk/sites/default/files/written_statement_0_1_ac_0.pdf Online interactive plan available at: https://www.argyll-bute.gov.uk/online-local-development-plan

[172] Loch Lomond & The Trossachs National Park Local Development Plan 2017-2021 (2016) Available at: https://www.lochlomond-trossachs.org/planning/planning-guidance/local-development-plan/ Online interactive map available at: https://nationalparkscot.maps.arcgis.com/apps/webappviewer/index.html?id=4ccdad00fbd74e54bd74516b6cfa5b77

NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

9.2.5. Scope of Stage 2 Assessment

This section details the elements of material assets and waste topic that have been scoped in for this Stage 2 assessment. These elements have been chosen for assessment based on their potential to cause significant adverse environmental effects, and also to inform the selection of a Preferred Option.

9.2.5.1. Scoped In

Use and consumption of material assets

There is potential for 'material assets' to act as a Scheme Option differentiator. At this stage, the consumption of material assets can be directly correlated to the types and quantities of construction materials required for each Scheme Option. This has been used to inform the Preferred Option selection process.

Production and disposal of construction and demolition of waste

There is potential for 'waste' to act as a Scheme Option differentiator. At this stage the production and disposal of waste can be directly correlated to disposal to landfill, as well as the associated costs. This information has been used to inform the preferred Scheme Option selection process.

9.2.5.2. Scoped Out

Sterilisation of mineral safeguarding sites and peat resources

No differentiators identified as there are no mineral safeguarding sites or peat resources intersecting with, or with the potential to be sterilised by (e.g. through adjacency), any of the Scheme Options[171] [172]. Localised pockets of peat/peaty soils are present beneath some of the Scheme Options, however, these are not classified as a peat resource. Further details on the classifications are described in Chapter 8 Geology and Soils.

Operation phase

An assessment of impacts following the first year of operation (the first year is considered as part of the construction phase as described in DMRB LA 110) has been scoped out. The consumption of materials and generation of waste during the operation and maintenance phase of the Proposed Scheme is considered negligible i.e. likely to be the result of ongoing minor and routine maintenance, removal of vegetation and litter.

9.2.6. Assessment Methodology

The primary guidance used to inform the assessment process is set out in DMRB LA 110.

9.2.6.1. Baseline Data Collection

Through desktop research, the baseline scenario describes the current and likely future state (in the absence of the Proposed Scheme) of:

- The types and quantity of material required associated with the operation of the existing land use within the primary study area defined in Section 9.1.6;
- the types and quantities of waste produced associated with the operation of the existing land use within the primary study area;
- the availability of key construction materials required for the Scheme Options within the secondary study area defined in Section 9.1.6; and
- waste infrastructure and remaining landfill capacity within the secondary study area.

9.2.6.2. Assessment Data Collection

In accordance with LA 110, the assessment of material assets and waste is a quantitative exercise that aims to identify the following.

For material assets:

- types and quantities of materials required to construct the Scheme Options;
- information on materials that contain secondary / recycled content;
- information on any known sustainability credentials of materials to be consumed;
- the type and volume of materials that will be recovered from off-site sources for use on the Proposed Scheme; and
- the cut and fill balance.

An assessment of the effects of consuming materials required during the construction phase and first year of operation has been undertaken by considering the origins and sources of materials, including their general availability (production, stock, sales) and the proportion of recovered (reused or recycled) materials they contain (as well as other sustainability features).

The reuse of excavated and other arisings (that meet waste exemption and other recognised reuse criteria) has been evaluated as part of the assessment of materials, to determine whether the adverse impacts associated with the consumption of primary resources can be reduced.

For waste:

- the amount of waste (by weight) that will be recovered and diverted from landfill either on site or off site (i.e. for use on other projects);
- types and quantities of waste arising from the Proposed Scheme (demolition, excavation arisings and remediation) requiring disposal to landfill; and
- an assessment of the remaining landfill capacity in the secondary study area is used to determine the impacts and effects of waste generated during the construction phase and first year of operation of the Proposed Scheme, in accordance with the DMRB LA 110.

The assessment considers the type and volume of waste to be generated by the Proposed Scheme and determines the potential impact on remaining landfill capacity in the secondary study area; this is completed for inert and non-inert (non-hazardous and hazardous) waste types, where data are available. Wherever waste is recovered (diverted from landfill) the influence of this action is taken into account in the assessment of significance.

The quantitative exercise of assessment conducted for this chapter has used early design data provided by the design team.

9.2.6.3. Significance Criteria

The assessment in this chapter has adopted the significance criteria set out in DMRB LA 110, as replicated in Table 9.1. The criteria set out by DMRB LA 110 do not require a separate assessment of sensitivity and magnitude of change. Instead, assessment criteria are applied individually to material assets (using Column 2 of Table 9.1) and waste (using Column 3).

Table 9.1 Material assets and waste significance criteria

Significance category	Material Assets	Waste
Very Large	(No criteria for 'Very Large': use criteria for 'Large').	>1% reduction or alteration in national capacity of landfill, as a result of accommodating waste from a project; or Construction of new (permanent) waste infrastructure is required to accommodate waste from a project.
Large	Project achieves <70% overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition Waste (CDW) to substitute use of primary materials; and Aggregates required to be imported to site comprise <1% re-used / recycled content.	>1% reduction in the regional capacity of landfill as a result of accommodating waste from a project; and 50% of project waste for disposal outside of the region.

Significance category	Material Assets	Waste
Moderate	Project achieves <70% overall material recovery / recycling (by weight) of non-hazardous CDW to substitute use of primary materials; and Aggregates required to be imported to site comprise re-used/recycled content below the relevant regional percentage target*.	>1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from a project; and 1-50% of project waste for disposal outside of the region.
Slight	Project achieves 70-99% overall material recovery / recycling (by weight) of non-hazardous CDW to substitute use of primary materials; and Aggregates required to be imported to site comprise re-used/recycled content in line with the relevant regional percentage target*.	≤1% reduction or alteration in the regional capacity of landfill; and Waste infrastructure has sufficient capacity to accommodate waste from a project, without compromising integrity of the receiving infrastructure (design life or capacity) within the region.
Neutral	Project achieves >99% overall material recovery / recycling (by weight) of non-hazardous Construction Demolition Waste (CDW) to substitute use of primary materials; and Aggregates required to be imported to site comprise >99% re-used / recycled content.	No reduction or alteration in the capacity of waste infrastructure within the region.
Notes	*Recycled aggregate target. The Recycled Aggregate Targets[167] included in DMRB LA 110 are applicable to England and its regions. For Scotland (as detailed in Scotland National Application Annex to DMRB LA 110 Material Assets and Waste Rev 0 2019[163]), Government projects have a target to include a minimum of 10% by value of recycled content on construction projects. This 10% value is used as the Recycled Aggregate Target for the Proposed Scheme.	

Effects that are classified as slight, moderate, large and very large are adverse. Effects that are classified as moderate, large or very large are considered significant, for both materials and waste. Effects classified as slight or neutral are considered to be not significant in either case.

9.2.6.4. Limitations and Assumptions

As defined in DMRB LA 110, the temporal scope of the assessment comprises the construction phase and first year of operation. Professional judgement has been used to support the assertion to scope out impacts beyond the first year of operation, as – based on schemes of a similar size and nature – the Proposed Scheme is not expected to result in significant adverse effects from material consumption during this phase. This is understood to be a proportionate approach that has good provenance in other environmental assessments for major road schemes.

The materials and construction waste data used for this assessment were provided by the design team, based on preliminary designs for the Scheme Options. The data includes only key materials required for construction based upon the level of design suitable for a DMRB Stage 2 assessment for each of the Scheme Options.

Material Assets

The assessment of material assets is dependent on the validity and availability of collated information, regarding the resources that are expected to be consumed during the 'in scope' lifecycle phases of the Proposed Scheme.

Baseline data and information for the assessment uses the most recent available published data; typically, this varies between 2017 and 2022.

A lifecycle assessment (LCA) - including embodied carbon and water - of materials has not been included in the scope as the effort and resources required are deemed disproportionate to the benefit they would offer the assessment of significance of effect. LCAs cover a wider range of environmental topics (e.g. water, eutrophication, radiation etc.) as well as carbon. Consideration of these elements are not directly relevant or proportionate to the goals of this chapter. Embodied carbon is assessed in Chapter 12 Effects on Climate.

The recycled content target for aggregates is 10% as detailed in Scotland National Application Annex to DMRB LA 110 Material Assets and Waste Rev 0 2019[163]). The recycled content target is used to help assess the potential for significant adverse environmental effects.

Waste

Published data in relation to transfer, recovery and recycling infrastructure in Scotland is limited and generally only available until 2018, as published by SEPA.

The assessment of impacts and effects on landfill void capacity is based upon the validity of the collated information, regarding the waste generated and disposed by the Proposed Scheme.

Hazardous wastes may be generated during the construction phase, however at the current design stage, the associated types and volumes cannot be quantified.

9.3. Baseline Conditions

9.3.1. Study Area

The study areas for Materials Assets and Waste that are applicable to the Proposed Scheme (as defined in LA 110[163]) are as follows:

- The primary study area is defined by the extent of works within the site boundary for each of the Scheme Options. Each of the Scheme Options comprises the likely footprint and any areas required for temporary access, working platforms and other enabling activities as far as appropriate for a DMRB Stage 2 assessment.
- The secondary study area comprises the extent to which infrastructure is suitable and available for the management of arisings and waste generated by the Scheme Options. Accordingly, the second study area for waste is determined to be the local authorities of Argyll and Bute, The Highlands, Inverclyde, North Ayrshire, Perth and Kinross, Stirling, and West Dunbartonshire (as used in data by SEPA), and – where necessary or especially where regional data are unavailable – Scotland and then the UK. The secondary study area has been set using professional judgement of the balance between the proximity principle and value for money (with regard to materials and waste logistics), and considering the extent of available data to compile a baseline assessment.
- In accordance with good practice, a study area for the availability of typical materials required for the Proposed Scheme has been included. The study area for materials has the same geographical extent as that for waste management infrastructure.

The materials baseline has considered regional and national availability of key construction materials through stock, production and / or sales required for the Proposed Scheme; where data on critical raw materials are available, this will be included.

The waste baseline has assessed the availability and capacity of regional landfill and material recovery/recycling facilities and incorporates an assessment of future trends in landfill capacity. Where available, the current material consumption and waste generated by the existing site has been be incorporated to inform the baseline.

9.3.2. Study Area Context

This section provides an overview of the baseline material consumption and waste disposal for the current land use within which the Scheme Options are located and provides regional information and data in the context of which the assessment has been undertaken.

The current land uses relating to the Scheme Options consist of the existing single-carriageway A83(T) and the OMR, which sit within a valley of rural, mountainous terrain with

many watercourses and areas of woodland, some of which is managed by Forestry and Land Scotland.

The most up to date sources of information have been used to collate data for material resource availability, landfill capacity and waste recovery. An indication of the most recent year from which data has been acquired, has been provided throughout.

9.3.2.1. Material Resources

Materials Currently Required

The operation and maintenance of assets (including the existing A83(T) and OMR) within the boundary encompassing all of the Scheme Options requires a small number of specialist components (for example, signage and wire fencing) as well as some bulk products (for example, asphalt for minor re-surfacing) for routine maintenance of the existing road infrastructure.

Overall, the current consumption of construction and other material resources within each of the Scheme Option boundaries is deemed minimal, because resources required for day-to-day maintenance and operation of the current assets would be very limited in scale, while some areas (greenfield) currently consume no resources.

UK and Regional Perspective: Availability of Construction Materials

Table 9.2 provides a summary of the availability of the main construction materials in Scotland and the UK, as required to deliver typical road schemes. The overview provides a context in which the assessment of impacts and significant effects from material consumption from the Proposed Scheme can be undertaken.

Table 9.2 Construction Materials Availability in Scotland and the UK

Material Type	Scotland	UK
Sand and gravel *	5.5 million tonnes (Mt)	60.2 Mt (2021)
Permitted crushed rock *	23.8 Mt	116.5 Mt (GB)
Concrete blocks #[165]	0.9 million square meters (Mm2) (Scotland and Wales, 2022)	5.2 Mm2 (2022)
Primary aggregate *	29.4Mt	198.8 Mt
Recycled and secondary aggregate *	(no data)	74 Mt (2017)
Ready-mix concrete *	1.2 Mm3	24.7 Mm3
Steel +[170]	(no data)	7.2 Mt (2020)
Asphalt *	2.3 Mt	27.4 Mt

stocks + production * sales

Data availability: 2019 unless otherwise stated
GB: Great Britain (England, Wales and Scotland) figures used where UK figures (including Northern Ireland) are unavailable
Data source[166] unless otherwise stated

Currently, data for Scotland regarding materials typically required for road construction is incomplete. Accordingly, a full picture of resource availability in the secondary study area cannot be obtained. For example, information on recycled and secondary aggregate sales and steel production are not currently available for the region (Table 9.2).

Where data are available, the availability of construction materials typically required for construction of road schemes in Scotland and across the UK, indicates that sales remain buoyant.

Regional Perspective: Transfer, Recovery and Recycling

SEPA data[168] (Table 9.3) show that within Scotland, the recovery rate for non-hazardous construction and demolition wastes have remained above 90% since 2011. 2018 is the year of latest publicly published data.

Table 9.3 Non-hazardous construction and demolition waste recovery in Scotland

Year	Generation (Mt)	Recovery rate (%)
2011	5	92.9
2012	3.6	91.1
2013	4.7	91.8
2014	4.1	92.7
2015	5	94.5
2016	5	95
2017	5.5	95
2018	5.7	97.3

Table 9.4 presents data on operational waste facilities within the region.

Table 9.4 Permitted operational waste recovery management sites in Argyll and Bute, Highland, Inverclyde, North Ayrshire, Perth and Kinross, Stirling, and West Dunbartonshire (2021)

Local Authority	Waste recovery facility type(s)	Total number of operational sites
Argyll and Bute	Transfer station, composting, metal recycling and other treatment	18
Highland	Transfer station, composting, metal recycling and other treatment	46
Inverclyde	Metal recycling and transfer station	6
North Ayrshire	Transfer station, composting, metal recycling, and other treatment	18
Perth and Kinross	Transfer station, composting, metal recycling and other treatment	22
Stirling	Transfer station, composting, metal recycling and other treatment	7
West Dunbartonshire	Transfer station, composting, metal recycling and other treatment	8
Total		125

Data indicates that there is likely to be regional infrastructure and capacity for the transfer and recovery for Construction, Demolition and Excavation (CDE) wastes from the Proposed Scheme to facilitate diversion of waste from landfill. Construction and demolition recovery trends across Scotland (Table 9.3) and data in

Table 9.4 confirm this assertion. This is further supported by Argyll and Bute's Waste Strategy[164] which states a commitment to convert some landfill sites into facilities that can recover materials and hence divert a greater proportion of waste from landfill.

The availability of material recovery infrastructure in the locality of the Proposed Scheme suggests that there is strong potential to divert from landfill site arisings generated by the Proposed Scheme. The importance (positive value) of this infrastructure indicates there is potential to maximise the re-use / recycling value of site arisings. This has the potential to materially influence the assessment of materials and waste.

9.3.2.2. Waste Generation and Disposal

Waste Currently generated and disposed of

The operation and maintenance of assets (the existing A83(T) and OMR) within the boundaries of the Scheme Options generates small volumes of waste from routine maintenance of the existing road infrastructure, such as replacement of signage and reflective road studs (cats' eyes), some of which is anticipated to be sent to landfill. The anticipated magnitude of impact associated with disposing of this waste is deemed negligible in the context of available regional capacity. This excludes the construction activities associated with current resilience improvement works being undertaken.

The areas of greenfield land marked for development in the Scheme Options currently generates no waste or site arisings.

Overall, the current waste generation is deemed minimal within each of the Scheme Option boundaries.

Regional Perspective: Remaining Landfill Capacity

At the end of 2021, the landfill sites in Argyll and Bute, and the immediate surrounding local authorities comprising The Highlands, Inverclyde, North Ayrshire, Perth and Kinross, Stirling, and West Dunbartonshire were recorded as having remaining capacity, as presented in Table 9.5[169].

Table 9.5 Materials availability in Argyll and Bute, The Highlands, Inverclyde, North Ayrshire, Perth and Kinross, Stirling and West Dunbartonshire

Local Authority	Landfill Site Type	Remaining Capacity 2021 (tonnes)
Argyll and Bute	Inert	0
	Non Hazardous	267,939
Highland	Inert	46,433

	Non Hazardous	503,610
Inverclyde	Inert	0
North Ayrshire	Inert	5,500,000
	Non Hazardous	120,000
	Hazardous	0
Perth and Kinross	Inert	0
	Non Hazardous	0
Stirling	Inert	0
	Non Hazardous	0
West Dunbartonshire	Inert	250,000
	Non Hazardous	2,051,813
Total Capacity		8,739,795

SEPA data[169] confirms that at the end of 2021, 92 landfill sites in the local authorities of Argyll and Bute, The Highlands, Inverclyde, North Ayrshire, Perth and Kinross, Stirling and West Dunbartonshire were recorded as having 8.7 Mt of remaining capacity. This is split into the capacities by waste type which confirms that there is no hazardous waste landfill capacity in the region (Table 9.5). The change in capacity from 2020 to 2021 is also shown in Table 9.6.

Table 9.6 Remaining landfill capacity in Argyll and Bute, The Highlands, Inverclyde, North Ayrshire, Perth and Kinross, Stirling and West Dunbartonshire

Landfill type	Capacity in 2020 (tonnes)	Remaining capacity in 2021 (tonnes)	2020 to 2021 capacity comparison (tonnes)
Hazardous (merchant and restricted)	0	0	No change
Inert	373,406	5,796,433	5,423,027 increase
Non-hazardous	3,040,732	2,943,362	97,370 decrease
Total	3,414,138	8,739,795	5,325,657 increase

Argyll and Bute Council's Waste Strategy[164] does not specify any proposal for the development of additional landfill sites; instead, it states a commitment to convert some landfill sites to other waste management facilities that will help facilitate a greater diversion of resources from landfill. The Strategy sets out how it aims to meet the impending Scottish Government ban on biodegradable municipal waste to landfill, but it does not include a ban or target on CDE waste to landfill.

Baseline regional capacity is detailed in Plate 9.1. Simple statistical forecasting (using the Microsoft Excel forecasting function) has been used to demonstrate long term void capacity to the year of planned Proposed Scheme completion (2030) in the absence of future provision for non-hazardous capacity. However, it was not possible to accurately and usefully apply the Microsoft Excel forecasting function to forecast inert and total capacity due to the additional landfill capacity engineered between 2020 and 2021 in North Ayrshire (the additional landfill capacity disproportionately skews trendlines applied). Instead, the forecasting beyond 2021 for inert and total landfill capacity has been predicated on a calculation of the average annual decrease in capacity between 2015 and 2020.

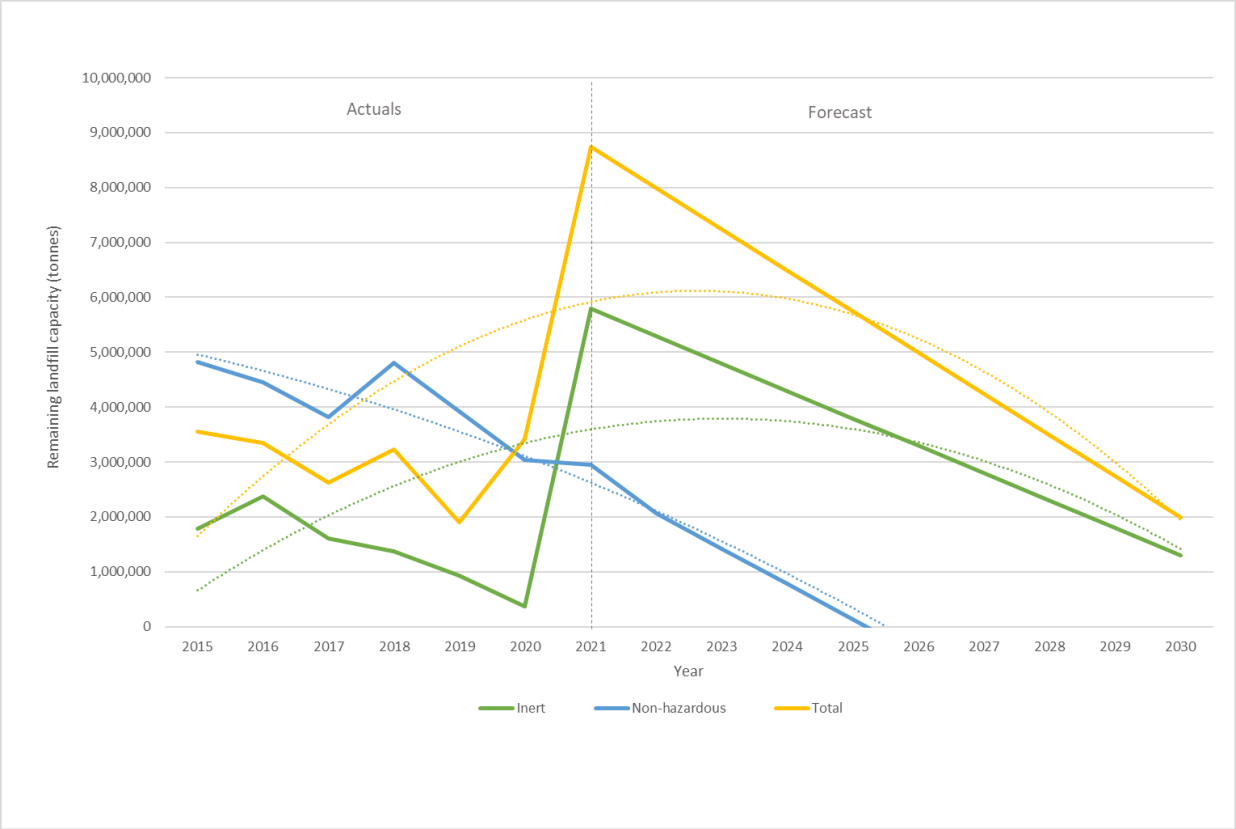


Plate 9.1 Remaining landfill capacity in Argyll and Bute, The Highlands, Inverclyde, North Ayrshire, Perth and Kinross, Stirling, and West Dunbartonshire

In summary: although trendlines can be plotted to forecast remaining landfill capacity in 2030, the results cannot be relied on due to the spike in the data where additional capacity was engineered in 2021. Therefore, the current remaining landfill capacity data has been used as the baseline for the purposes of this assessment.

These forecasts are based on the assumption that no new landfill capacity will be added up to 2030. This assumption is supported by Argyll and Bute Council's Waste Strategy[164] which states commitments to divert waste from landfill, convert landfill sites to other waste site

types, and facilitate compliance with the Scottish Government's ban on biodegradable municipal waste to landfill by 2025. The strategy does not make any commitment to increase landfill capacity.

9.3.3. Future Baseline

9.3.3.1. Material resources

In the future baseline it is anticipated that there will be no change to the scale and nature of materials resource consumption in comparison to the current baseline scenario for each of the Scheme Options. The consumption of materials in the future baseline is expected to remain minimal and is likely to be required for ongoing routine maintenance of the existing road.

9.3.3.2. Waste generation and disposal

In the future baseline, it is anticipated that there will be no change to the scale and nature of the waste generation and disposal in comparison to the current baseline scenario for each of the Scheme Options. In the future baseline, the volume of waste generated is expected to remain minimal in the context of available regional capacity. Waste is likely to be generated from ongoing routine maintenance, removal of land slipped debris, vegetation, and litter.

9.4. Potential Impacts

9.4.1. Construction

Each Scheme Option can be differentiated by the extent of development on greenfield land. All Scheme Options involve development on greenfield land, with the Brown Option requiring the least intrusion in this context. The Brown Option is a predominantly online route, which means it is located on or very close to the route of the existing A83(T) and OMR. This Scheme Option largely consists of widening the existing A83(T) to accommodate a debris flow shelter. The Pink, Green, Yellow and Purple Options are predominantly located off-line from the existing road, and involve development of new road, tunnels, and viaducts on greenfield sites, prior to their re-connection to the existing road infrastructure in the local area. The Green Option would make use of an existing forestry access track on land managed by Forestry and Land Scotland.

At this stage, the most robust information available regarding materials, site arisings, and waste, as associated with each of the Scheme Options, comprises the bulk cut and fill volumes of earthwork material and the volume of imported key materials required for construction (fill, concrete, steel and road pavement). These data are described in

Table 9.7 and Table 9.8.

9.4.1.1. Materials

The consumption of primary and secondary materials would be required for the construction of new road sections on viaducts and within tunnels, debris flow shelters, the widening of the existing A83(T) asset (where applicable), and tie-in of structures and local roads. Primary materials required for the Proposed Scheme are a finite resource and whilst some will be available through local and regional supply, national or wider sourcing is also likely to be required.

Preliminary design estimates presented in Table 9.7, considered appropriate for the level of detail expected at DMRB Stage 2, of the volume of imported materials that are likely to be required for the construction of the Scheme Options.

During construction there will be a requirement for bulk construction materials which would result in the depletion of natural resources, particularly of virgin materials and local or regional stocks and degradation of the natural environment. A proportion of rock and fill is likely to be sourced from the arisings generated on site during excavation for the Proposed Scheme, thereby maximising overall material recovery / recycling (by weight) of non-hazardous construction and demolition waste to substitute use of primary materials. In order to determine the significance of effect for materials, DMRB LA 110 requires an assessment of overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition Waste to substitute use of primary materials. Therefore, the data in Table 9.8 has been used to demonstrate the reuse of site-won arisings for each Scheme Option.

Based on the information available at the time of publication, an estimate of the percentage of reused, recycled and secondary materials cannot currently be calculated; it is, however, expected that the regional average for recycled aggregates would as a minimum, be achieved (based on knowledge of other recent similar schemes achieving 10% in this context).

Table 9.7 Imported Materials required for each Scheme Option

Scheme Option	Sub-option (Viaduct)	Imported Materials (tonnes)				
		Earthworks (Fill)	Concrete	Steel	Pavement	TOTAL
Green Option	N/A	99,110	315,653	64,313	15,300	494,376
Yellow Option	Concrete Balance	86,134	257,059	37,896	9,010	390,099

Scheme Option	Sub-option (Viaduct)	Imported Materials (tonnes)				
		Earthworks (Fill)	Concrete	Steel	Pavement	TOTAL
	Cantilever (RC)					
	Steel and Concrete Composite Deck	86,134	75,910	38,268	9,010	209,322
Brown Option	N/A	843	203,647	22,862	10,200	237,552
Pink Option	N/A	215,490	276,627	12,541	13,787	518,445
Purple Option	Concrete Balance Cantilever (RC)	142,416	278,126	26,549	13,906	460,997
	Steel and Concrete Composite Deck	142,416	177,046	34,288	13,906	367,656

Whilst it is anticipated that all efforts will be made to maximise the specification and use of materials with known sustainability credentials, impacts from consuming primary resources would still arise. These would be considered adverse, direct and permanent.

Table 9.8 describes the following:

A) Cut: the volume of earthworks that need to be excavated from the Proposed Scheme, to facilitate construction.

B) Fill: the volume of earth fill required for the Proposed Scheme. This is the volume of earth fill that would be reused on site.

A-B) Net: the volume of surplus earthworks that needs to be removed from site, should a use for this material not be found. Some of this is classed as acceptable material and therefore can potentially be reused off site on other schemes (C). However, a proportion of this has been identified as potentially unsuitable and a worst-case scenario (export to landfill) has been adopted (D).

E) Recovery of primary materials for reuse: the total volume of recovered arisings suitable for reuse both on-and (potentially) off-site (calculated as B+C). This volume is expressed as a percentage to use with the assessment methodology by calculating the volume of excavated material reused on- and off-site.

Table 9.8 Waste generated, recovery for reuse and disposal

Scheme Option	Cut (A)	Fill (B)	Net Surplus Earthworks Volume (A-B)		Recovery of primary materials for reuse (B+C)	
	Excavate	Reuse on site	Reuse off-site (C)	Dispose to Landfill (D)	Total Recovered Arisings (E)	Overall Material Recovery (E/A)
Green Option	1,529,918	41,978	1,264,966	222,974	1,306,944	85%
Yellow Option	681,724	97,978	380,372	203,374	478,350	71%
Brown Option	1,058,910	5,556	934,206	119,148	939,762	89%
Pink Option	1,911,164	248,704	1,500,788	161,672	1,749,492	92%
Purple Option	1,106,134	80,928	700,720	324,486	781,648	71%

Notes: all quantities are in tonnes

Green Option

Large scale consumption of primary and secondary materials would be anticipated to deliver the Green Option, as it requires the construction of a new single carriageway road, approximately 4,300m in length on the opposite side of the valley to the existing A83(T), following the route of an existing access track through an area of land managed by Forestry and Land Scotland. Construction materials would also be required for the debris flow shelters, the two viaducts to span the glen at the southern and northern ends and realignment works to the A83(T) and B828 junction.

The Green Option requires the second greatest volume of construction materials (at just under 495,000 tonnes), with the highest requirement for both concrete and steel of all of the Scheme Options.

Preliminary design data provided in Table 9.8 indicates that the Green Option will achieve 85% overall material recovery, therefore it falls within the 70-99% criteria which equates to a slight adverse effect significance of effect (as per Table 9.1).

Yellow Option

A large volume of primary and secondary materials is expected to be consumed to deliver the Yellow Option, as it requires the construction of a new single carriageway road, approximately 2,650m in length, part of which would be constructed on a viaduct up to 70m in height and 1,870m in length. There are two types of viaduct construction which could be implemented, the Concrete Balance Cantilever using reinforced concrete and the Steel and Concrete Composite Deck construction method, which comprises pre-cast concrete slabs.

By comparison with the Steel and Concrete Composite Deck construction option, the Concrete Balance Cantilever option requires a greater volume of construction materials (181,000 tonnes more than the Steel and Concrete Composite Deck), comprising predominantly concrete. It is noteworthy that the Steel and Concrete Composite Deck method requires the least volume of construction materials of all of the Scheme Options.

Preliminary design data for earthworks provided in Table 9.8 indicates that the Yellow Option will achieve 71% overall material recovery, therefore it falls within the 70-99% criteria which equates to a slight adverse effect significance of effect (as per Table 9.1), regardless of which construction method is selected.

Brown Option

The lowest volume of primary and secondary materials is expected to be consumed to deliver the Brown Option which comprises widening of the existing A83(T) to accommodate a debris flow shelter to protect the road and construction of a viaduct approximately 300m in length (where the debris flow shelter ends to improve the road alignment).

The Brown Option requires one of the lowest volumes of construction materials (just under 240,000 tonnes), with the lowest requirement for imported fill of all of the Scheme Options (lower by approximately 85,000 tonnes).

Preliminary design data provided in Table 9.8 indicates that the Brown Option will achieve 89% overall material recovery, therefore it falls within the 70-99% criteria which equates to a slight adverse effect significance of effect (as per Table 9.1).

Pink Option

A large volume of primary and secondary materials is expected to be consumed to deliver the Pink Option, as it requires the construction of a new single carriageway road, of which approximately 3km would be within a tunnel. The southern section of the route would be an open road generally at existing ground level or on embankments on the approach to the southern tunnel entrance. The northern end of the route would require modifications to the local roads to tie in with the proposed tunnel.

This option requires the highest volume of construction materials (at just under 519,000 tonnes), with the greatest requirement for imported fill and one of the highest requirements for concrete. However, of all of the options, the Pink Option will require the least amount of steel.

Preliminary design data provided in Table 9.8 indicates that this Option will achieve 92% overall material recovery, therefore it falls within the 70-99% criteria which equates to a slight adverse effect significance of effect (as per Table 9.1).

Purple Option

Large scale consumption of primary and secondary materials would be anticipated to deliver the Purple Option, as it requires the construction of a new single carriageway road, partially on a new viaduct then passing into a tunnel approximately 1,200m in length. Construction materials would also be required for realignment works to the local roads at the northern end of the tunnel. There are two types of viaduct construction which could be implemented, the Concrete Balance Cantilever (using reinforced concrete) and the Steel and Concrete Composite Deck construction method (which comprises pre-cast concrete slabs).

The Concrete Balance Cantilever option requires a greater volume of construction materials (at just over 461,000 tonnes), with a higher requirement for concrete (almost 100,000 tonnes more than the Steel and Concrete Composite Deck option).

Preliminary design data for earthworks provided in Table 9.8 indicates that the Purple Option will achieve 71% overall material recovery, therefore it falls within the 70-99% criteria which equates to a slight adverse effect significance of effect (as per Table 9.1), regardless of which construction method is selected.

9.4.1.2. Waste

Site preparation and remediation, incorporating ground works, excavation and site clearance, will generate site arisings (topsoil, planings, other earthworks).

The current working assumption is that surplus arisings that cannot be used off-site on other schemes will be sent to landfill, as the suitability of arisings for engineering uses and other purposes has not yet been determined. The exact proportion of site arisings that can be recovered would be assessed as part of DMRB Stage 3.

Where diverting site arisings from landfill is not possible, the impacts associated with disposing of waste would be adverse, permanent and direct.

Any wastes which cannot be diverted from landfill are likely to have an adverse impact on the regional environment. Currently, measures to reduce impacts on the Scheme Options are anticipated to include reuse of material resources from excavation in the construction, and the recycling of any surplus site arisings (including vegetation).

As the design progresses, and the results of ground investigations are obtained, the volumes in Table 9.8 will be refined for the Preferred Option at DMRB Stage 3.

The subsequent sections of this report describe the effects of each Scheme Option on remaining landfill void capacity, based on the information in Table 9.8. As stated in the baseline section, current landfill capacity has been used as the baseline figure to provide robust calculations for the assessment.

Green Option

The Green Option is forecast to be one of the largest net exporters of site arisings. A proportion of the surplus arisings have been identified as potentially suitable for reuse off-site on other schemes, however approximately 222,974 tonnes has been estimated as unsuitable for reuse and, under a worst-case scenario, will be sent for disposal to landfill. It is considered, using the criteria in Table 9.1, that the disposal of waste generated by the Green Option would reduce regional landfill void by more than 1% of the current remaining capacity, resulting in a moderate adverse effect.

Yellow Option

The Yellow Option is forecast to be the lowest net exporter of site arisings. A proportion of the surplus arisings have been identified as potentially suitable for reuse off-site on other schemes, however, 203,374 tonnes has been estimated as unsuitable for reuse and, under a worst-case scenario, sent for disposal to landfill, which would increase potential impacts on landfill capacity. It is considered, using the criteria in Table 9.1, that the disposal of waste generated by the Yellow Option would reduce regional landfill void capacity by more than 1%, resulting in a moderate adverse effect.

Brown Option

The Brown Option is forecast to be a moderate net exporter of site arisings. A proportion of the surplus arisings have been identified as potentially suitable for reuse off-site on other schemes, however, 119,148 tonnes has been estimated as unsuitable for reuse and, under a worst-case scenario, sent for disposal to landfill. It is considered, using the criteria in Table 9.1, that the disposal of waste generated by the Brown Option would reduce regional landfill void capacity by more than 1%, resulting in a moderate adverse effect.

Pink Option

This Pink Option is forecast to be the largest net exporter of site arisings, due to the proposed tunnel. A proportion of the surplus arisings have been identified as potentially suitable for reuse off-site on other schemes, however, 161,672 tonnes has been estimated as unsuitable for reuse and, under a worst-case scenario, sent for disposal to landfill, which

would increase potential impacts on landfill capacity. It is considered, using the criteria in Table 9.1, that the disposal of waste generated by the Pink Option would reduce regional landfill void capacity by more than 1%, resulting in a moderate adverse effect.

Purple Option

Comparatively, the Purple Option is forecast to be the second lowest net exporter of site arisings. A proportion of the surplus arisings has been identified as potentially suitable for reuse off-site on other schemes, however, approximately 324,486 tonnes has been estimated as unsuitable for reuse and, under a worst-case scenario, will be sent for disposal to landfill. It is considered, using the criteria in Table 9.1, that the disposal of waste generated by the Purple Option would reduce regional landfill void capacity by more than 1%, resulting in a moderate adverse effect.

9.5. Potential Mitigation

9.5.1. Construction

Where significant effects are identified, mitigation measures will be required, including but not limited to the examples outlined below.

The costs of undertaking mitigation will be most impactful for those options with higher impacts.

Recycled or reused resources will be sourced where design specifications permit. Even where this is not possible, significant adverse effects would not be expected.

Provided the following mitigation measures are adopted during the works, effects during construction are anticipated to be not significant:

- A Construction Environment Management Plan (CEMP) incorporating a Site Waste Management Plan (SWMP) and a Materials Management Plan (MMP), or similar document, should be put in place and adhered to by the contractor.
- Reduce overall demand from external sources through the reuse of materials, where feasible.
- All waste should be dealt with following the Waste Hierarchy.
- The contractor shall identify the waste category, quantities, opportunities for recycling and reuse, disposal routes and licensing requirements for all spoil and waste.
- Procurement of products and materials with high levels of recycled content where possible.
- Use of renewable materials from legal and sustainable sources and minimise use of virgin material where possible.

9.6. Conclusions

Table 9.9 Materials and Waste Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Likely Significance of Effects (Pre-mitigation)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
Materials	Availability of construction materials	The consumption of large quantities of materials could have a potentially significant adverse effect on the environment through the depletion of natural resources.	Slight adverse Not significant	Slight adverse Not significant	Slight adverse Not significant	Slight adverse Not significant	Slight adverse Not significant	Overall material recovery (on- and off-site): >70% reuse (Pink Option 92%) (Brown option 89%) (Green Option 85%) (Purple option 71%) (Yellow option 71%)
Waste	Availability of landfill void capacity (construction phase)	The generation and disposal of waste from the Proposed Scheme is commensurate with a reduction in regional landfill void capacity and the loss of resources.	Moderate adverse Significant	Moderate adverse Significant	Moderate adverse Significant	Moderate adverse Significant	Moderate adverse Significant	Site arisings for disposal to landfill (t) and percentage of disposal on remaining capacity (current available capacity) Brown option - 119,148t waste to landfill (landfill capacity reduction is 1.4%) Pink option - 161,672t waste to landfill (landfill capacity reduction is 1.8%) Yellow option - 203,374t waste to landfill (landfill capacity reduction is 2.3%) Green option - 222,974t waste to landfill (landfill capacity reduction is 2.6%) Purple option - 324,486t waste to landfill (landfill capacity reduction is 3.7%)

Based on the findings in Table 9.9, there are no differentiators in terms of significance of effects for the Scheme Options for both materials and waste. However, for materials it is evident that the Pink Option is the favourable option as it has the highest percentage of quantity of overall material recovery, whereas the Purple and Yellow Options are the least favourable options due to these options achieving the lowest percentage of overall material recovery.

At this stage of the project the waste quantities would all lead to a significant reduction in available landfill capacity, based on the current data. Therefore, based on this worst-case scenario the favourable option is the Brown Option as this generates the lowest volume of waste to be potentially disposed to landfill with a resulting lowest impact on available landfill capacity. The Purple Option is the least favourable option as this generates the highest quantity of waste to be potentially disposed to landfill, with a corresponding greater impact on available capacity in the region.

9.7. Scope of DMRB Stage 3 Assessment

The DMRB Stage 3 Assessment for Materials Assets and Waste will assess the significance of effect of the Preferred Option and will include a review of relevant legislation, policy and guidance documents, to determine and confirm the waste and mineral strategy for the region.

A review of the baseline information in the DMRB Stage 2 report will be carried out and updated accordingly. This will set out the baseline for material resources, site arisings and waste to provide regional and national information on material consumption and waste disposal data in the context of which the assessment of environmental effects can be undertaken.

The assessment will identify and set out any primary and tertiary mitigation measures already committed to by the client, and how these will influence the potential impacts and effects of the scheme.

The assessment will seek to identify the anticipated types and quantities of material (primary, secondary, recycled, arisings for reuse) required and likely types and quantities of waste generated for the project. These data will be provided from (for example) a Bill of Quantities or Schedule of Rates. The overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition Waste (CDW) to substitute use of primary materials and the recycled content of aggregates required to be imported to site will be used to assess the associated significance of effects. The anticipated waste types and quantities to be disposed

to landfill will be reviewed against future (forecast) landfill capacity to assess the associated significance of effects.

Any opportunities for site arisings to be re-used on or off site, or recovered and therefore diverted from landfill to align with the highest tiers of the Waste Hierarchy / Proximity Principle, will be identified in the assessment. Furthermore, recommendations will be made for incentivising circular economy practice alongside improved materials sustainability performance, especially where reduced impacts can be quantified or described.

10. Noise and Vibration

10.1. Introduction

This chapter sets out a qualitative comparison of the predicted noise and vibration effects arising from the five Scheme Options. Specifically, it aims to differentiate between Scheme Options to establish those that have a greater or lesser effect on sensitive receptors.

10.2. Approach and Methods

10.2.1. Introduction

The assessment is based on the DMRB. The relevant section of the DMRB is LA 111 Noise and vibration[173].

10.2.2. Sources of Information

The following additional sources of information have been considered in this assessment:

- Infraworks 3D models showing the spatial alignments of the Scheme Options;
- Geographical Information Systems (GIS) datasets;
- Ordnance Survey (OS) maps; and
- Aerial Photography.

10.2.3. Policy, Legislation and Guidance

The following policy, legislation and guidance have been considered in this assessment:

- DMRB LA 111 Noise and Vibration, 2020;
- National Planning Framework 4 (NPF4), 2023[174];
- Assessment of Noise: Technical Advice Note (TAN), 2011[175];
- Planning Advice Note 1/2011: planning and noise, 2011[176];

[173] DMRB LA 111 revision 2. Noise and Vibration. Highways England et al. 2020. [Online]. Available at: LA 111 - Noise and vibration (standardsforhighways.co.uk)
[174] Scottish Government. (2023) National Planning Framework 4. [Online]. Available at: https://www.gov.scot/publications/national-planning-framework-4/
[175] Scottish Government. (2011) Assessment of noise: technical advice note. [Online]. Available at: https://www.gov.scot/publications/technical-advice-note-assessment-noise/
[176] Scottish Government. (2011) Planning Advice Note 1/2011: planning and noise. [Online]. Available at: https://www.gov.scot/publications/planning-advice-note-1-2011-planning-noise/

- Planning Advice Note 50: controlling the environmental effects of surface mineral workings, 1996[177];
- The Noise Insulation (Scotland) Regulations (NI(S)R), 1975[178],
- Argyll and Bute Local Development Plan, 2015[179];
- Argyll and Bute Supplementary Guidance, adopted 2016[180];
- Loch Lomond and The Trossachs National Park (LLTNP) Local Development Plan[181];

10.2.4. Consultation

No specific consultation relating to noise and vibration has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA, NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

Consultation with stakeholders will be undertaken at Stage 3 to determine the requirement for further assessment of construction noise, construction vibration and operational noise of the Preferred Option.

10.2.5. Scope of Stage 2 Assessment

The assessment is based the DMRB LA 111. The potential impacts considered within this chapter are:

- Construction noise;
- Construction vibration; and
- Operational noise.

Operational vibration is scoped out of the DMRB LA 111 assessment methodology as a maintained road surface will be free of irregularities, so operational vibration would not have the potential to lead to significant adverse effects.

[177] Scottish Government. (1996) Planning Advice Note 50: controlling the environmental effects of surface mineral workings. [Online]. Available at: https://www.gov.scot/publications/planning-advice-note-pan-50-controlling-environmental-effects-surface-mineral/
[178] UK Statutory Instruments. (1975). No. 460 (S. 60). The Noise Insulation (Scotland) Regulations 1975. [Online]. Available at: The Noise Insulation (Scotland) Regulations 1975 (legislation.gov.uk)
[179] Argyll and Bute Council. (2015) Local Development Plan. [Online]. Available at: Local Development Plan (argyll-bute.gov.uk)
[180] Argyll and Bute Council. (2016) Local Development Plan Supplementary Guidance. [Online]. Available at: Supplementary guidance (argyll-bute.gov.uk)
[181] Loch Lomond and the Trossachs National Park (2017-2021) Local Development Plan. [Online]. Available at: Our Local Development Plan (lochlomond-trossachs.org)

10.2.6. Assessment Methodology

In line with DMRB LA 111, during options identification, the level of detail of a noise and vibration assessment shall be proportionate to the quality of the data available and the risk of likely significant effects occurring.

For the construction phase, a qualitative assessment of noise and vibration has been completed based on the available information. Differentiation between options is based on the proximity of works to sensitive receptors and the available construction information. Construction information considered includes the anticipated total duration of the works, the amount of cut/fill required and other material requirements, including concrete, steel and pavement. The most favourable and least favourable options have been identified based on the above and using professional judgement.

For the operational phase, a qualitative assessment of noise has been complete based on the available information. Differentiation between options is based on the proximity of the carriageway alignment to sensitive receptors and the proportion of carriageway that is in tunnel. Where the carriageway is in a tunnel, road traffic noise will be screened, resulting in a reduction in operational road traffic levels in the glen. The impact significance, and the most and least favourable options have been identified based on the above and using professional judgement and knowledge from the assessment of other road schemes.

The completed qualitative assessments are considered to be compliant with the policy, legislation and guidance listed in section 10.2.3 above.

10.2.6.1. Limitations and Assumptions

This chapter has been prepared based on the results of a desk-based assessment.

The ‘with scheme’ traffic data - total vehicle flow, composition of vehicle types and vehicle speeds - is assumed to be equivalent for all options.

In terms of the operational noise assessment, the ‘with scheme’ traffic data is assumed to be equivalent to the ‘without scheme’ traffic data.

10.3. Baseline Conditions

10.3.1. Study Area

The study areas are based on the normal DMRB LA 111 study areas distances. The noise and vibration study areas are shown on Volume 3, Figure 10.1 and are described below:

- Construction noise: 300m around the combined Scheme Option extents;

- Construction vibration: 100m around the combined Scheme Option extents;
- Operational noise: 600m around the combined Scheme Option extents.

Within the study areas there are two residential receptors and a small number of non-residential receptors, including a Site of Special Scientific Interest (SSSI), footpaths and other non-motorised user (NMU) routes.

The residential receptors are shown on Volume 3, Figure 10.1 and are described below:

- Laigh Glencroe (grid reference 224422, 705554) is 35m west of the A83(T) and 100m east of the OMR. The A83(T) runs at a higher elevation than the property and the OMR runs at a lower elevation.
- High Glencroe (grid reference 223328, 706978) is 250m west of the A83(T) and 140m west of the OMR. Both roads run at a higher elevation than the property.

The non-residential receptors are:

1. Beinn an Lochain SSSI

- The Beinn an Lochain SSSI is located near the head of Loch Fyne, the site is notified for its siliceous scree (including boulder fields), tall herb ledge and upland habitat assemblage.
- The designated features of this SSSI are not considered sensitive in terms of noise and vibration and given the spatial extent of the SSSI, the noise and vibration impacts from construction and operation are considered to be similar for all options, and have therefore be scoped out of further assessment at this stage.

2. Footpaths and other Non-Motorised Users

- Beinn Luibhean is accessed from a small parking area approximately 460m north of Laigh Glencroe (grid reference 224270, 705994). The footpath climbs directly up and down the hill from the A83(T). There is also a footpath which travels eastwards from the same parking area but remains on the south bank of Croe Water.
- Beinn an Lochain is accessed from the A83(T) layby 650m north east of Loch Restil (grid reference 223371, 708790). The footpath takes a line up to the ridge close to the forest then swings southwards on the ridge line to the summit.
- The OMR is also used as a non-motorised user route.

Off road cycling route (forest recreation):

The Ardgarten Peninsula Circuit uses a section of forest track on the lower slopes of Ben Donich. This same section of trail is also used as a footpath (Loch Lomond and The

Trossachs National Park Core Path) which can be accessed from the B828 to south-west of the Rest and Be Thankful car park.

10.3.2. Study Area Context

Road traffic noise is expected to be the dominant noise source for the baseline conditions, with noise levels higher at Laigh Glencroe than High Glencroe due to its proximity to the A83(T). Daily traffic on the A83(T) is understood to be around 4,500 vehicles per day, of which about 10% are heavy vehicles. Traffic flow on the OMR is negligible unless it is in operation as the A83(T) diversion route, this occurs approximately 40 days each year.

For construction noise, a study area of 300m from the closest construction activity is normally sufficient to encompass noise sensitive receptors. As detailed information on construction activities is not currently known, a study area of 300m around the combined Scheme Option carriageway extents has been adopted.

For construction vibration, a study area of 100m from the closest construction activity with the potential to generate vibration is normally sufficient to encompass vibration sensitive receptors. As detailed information of vibration generating construction activities is not currently known, a study area of 100m around the combined Scheme Option carriageway extents has been adopted.

For operational noise, a study area of 600m around the combined Scheme Option carriageway extents has been adopted.

In addition to the normal DMRB LA 111 study area distances, consideration is given to construction traffic impacts on sensitive receptor properties outside Glen Croe, that are located in the vicinity of the existing A83(T). All Scheme Options have cut and fill requirements which will necessitate large amounts of material to be transported to and from the glen. Construction traffic arriving/departing from the east will pass nearby sensitive receptor properties, including those in Ardgartan, Arrochar and Tarbet. Traffic arriving/departing from the west will pass near to sensitive receptor properties, including those in Cairndow, Inveraray and Lochgilphead. These construction traffic movements are expected to increase the number of heavy vehicles on the A83(T) for the duration of the construction works, and they have the potential to adversely impact sensitive receptor properties.

The adopted study areas are considered sufficient to encompass sensitive receptors potential affected by the Scheme Options.

Due to the small number of permanent noise sensitive receptors, the transient use of footpaths and other NMU routes, and because the extent of impact is small relative to the length of routes, noise and vibration impacts are not considered to be a key factor in the decision-making process for the Proposed Scheme.

10.4. Potential Impacts

10.4.1. Construction

The Scheme Options would have construction noise and vibration impacts which will include all or some of the following (those with an * have been scoped out of Stage 2 as there is not enough information on their location and scale at this stage):

- construction of bridges, viaducts, flow shelters and other structures;
- vehicle activity due to excavation, earth moving and construction;
- mining activity, rock cuts;
- piling activity;
- temporary working platforms for construction of piers;
- temporary stabilisation measures for protection of workforce;
- removal of vegetation to facilitate works;
- changes in landform due to earthworks;
- site compound areas and storage of materials*; and
- traffic management systems*.

Mitigation during construction is the same for all Scheme Options – adherence to best working practices - and is not a differentiator.

10.4.1.1. Green Option

The Green Option is located on the lower slopes of Ben Donich on the western side of Glen Croe, the option includes two viaducts and a debris flow shelter.

The shortest distance between the Green Option carriageway alignment and the residential receptor Laigh Glecroe is c. 500m. The shortest distance between the Green Option carriageway alignment and the residential receptor High Glencroe is c. 315m.

At these distances, both residential receptors sit outside the construction study area boundaries, as such significant noise and vibration construction impacts are not expected.

The Ardgarten Peninsula Circuit runs adjacent to the Green Option. Construction noise impacts on transient users would occur.

The Green Option has the longest construction duration in conjunction with a large cut/fill requirement which would result in construction traffic impacts outside the glen. This option is the least favourable in terms of construction traffic impacts at sensitive receptor properties adjacent to the A83(T) outside of Glen Croe. The construction noise and vibration impact significance is determined to be minor adverse.

10.4.1.2. Yellow Option

The Yellow Option is located on the lower slopes of Beinn Luibhean, the alignment is on viaduct for majority of its length through the glen.

The shortest distance between the Yellow Option carriageway alignment and the residential receptor Laigh Glecroe is c. 35m. The shortest distance between the Yellow Option carriageway alignment and the residential receptor High Glencroe is c. 235m.

At these distances, both residential receptors sit inside the construction noise study area boundaries, and Laigh Glencroe is also within the construction vibration study area. Construction noise and vibration impacts have the potential to impact on Laigh Glencroe. Construction noise has the potential to impact High Glencroe.

The Yellow Option has the joint shortest construction duration in conjunction with the smallest cut/fill requirement, therefore, the construction traffic impacts at sensitive receptor properties adjacent to the A83(T) outside of Glen Croe would be lowest. This option would have greater construction impacts than the Pink Option, but lower impacts than the other options. The construction noise and vibration impact significance is determined to be minor adverse.

10.4.1.3. Brown Option

The Brown Option is predominantly online with a debris flow shelter and a short viaduct. The OMR would be used as the A83(T) diversion route during the construction phase, which is estimated to be four years duration.

The shortest distance between the Brown Option carriageway alignment and the residential receptor Laigh Glecroe is c. 260m. The shortest distance between the Brown Option carriageway alignment and the residential receptor High Glencroe is c. 270m.

At these distances, both residential receptors sit inside the construction noise study area boundaries and outside the construction vibration area.

Construction impacts associated with the Brown Option would include road traffic noise impacts from the use of the OMR as the diversion route. The construction noise and vibration impact significance is determined to be minor adverse.

10.4.1.4. Pink Option

The majority of the Pink Option is in a tunnel beneath the western slope of Beinn Luibhean. This option would result in the demolition of the residential receptor Laigh Glencroe.

The shortest distance between the Pink Option carriageway alignment and the residential receptor High Glencroe is more than 700m.

At this distance and because the works will be underground, construction noise and vibration impacts at the receptor are not expected.

For construction, the Pink Option is the most favourable as most of the works would be underground, and the glen would be largely screened from noise and vibration impacts. A negative impact of the Pink Option is the large amount of cut and fill, so there would be impacts at receptors outside the glen from construction vehicles transporting this material. The construction noise and vibration impact significance is determined to be minor adverse.

10.4.1.5. Purple Option

The Purple Option is located on the lower slopes of Beinn Luibhean and includes a viaduct through the centre of the glen and a tunnel ending north of Loch Restil.

The shortest distance between the Purple Option carriageway alignment and the residential receptor Laigh Glecroe is c. 95m. The shortest distance between the Purple Option carriageway alignment and the residential receptor High Glencroe is c. 95m

At these distances, both residential receptors sit inside the construction noise and vibration study area boundaries.

The Purple Option is the least favourable due to the proximity to High Glencroe and the potential for noise and vibration impacts from the viaduct and tunnel formation. The construction noise and vibration impact significance is determined to be minor adverse.

10.4.2. Operation

Changes in noise at the two residential receptors will depend on the relative proximity of the Scheme Options to the properties, taking both plan distance and vertical elevation changes into account.

Where the option alignment moves closer to receptors it is likely that noise levels would increase, and where the option alignment moves further away it is likely that noise levels would decrease. There may be some variation in this due to changes in elevation and localised screening.

The traffic flow on the A83(T) indicates that it is unlikely that any option would result in impacts triggering the Noise Insulation (Scotland) Regulations 1975.

10.4.2.1. Green Option

The shortest distance between the Green Option carriageway alignment and the residential receptor Laigh Glecroe is c. 500m. The shortest distance between the Green Option carriageway alignment and the residential receptor High Glencroe is c. 315m.

For operational noise, higher impacts would be generated by the Green Option when compared to the Pink Option. The Green Option would have lower impacts than other options because the alignment is further away from the residential receptors. Although, there would be noise impacts on transient uses of the nearby NMU (footpath and mountain bike tracks). The operational noise impact significance is determined to be minor adverse.

10.4.2.2. Yellow Option

The shortest distance between the Yellow Option carriageway alignment and the residential receptor Laigh Glecroe is c. 35m. The shortest distance between the Yellow Option carriageway alignment and the residential receptor High Glencroe is c. 235m.

For operational noise, higher impacts would be generated by the Yellow Option when compared to the Pink Option. The operational impacts are similar to the Brown Option, as the Yellow Option carriageway alignment is closer to High Glencroe, more adverse operational road traffic noise impacts would be expected. The operational noise impact significance is determined to be minor adverse.

10.4.2.3. Brown Option

The shortest distance between the Brown Option carriageway alignment and the residential receptor Laigh Glecroe is c. 35m. The shortest distance between the Brown Option carriageway alignment and the residential receptor High Glencroe is c. 270m.

For operational noise, higher impact would be generated by the Brown Option when compared to the Pink Option. The debris flow shelter roof will screen traffic noise up slope. The operational noise impact significance is determined to be minor adverse.

10.4.2.4. Pink Option

The shortest distance between the Pink Option carriageway alignment and the residential receptor High Glencroe is more than 700m.

For operational noise, the Pink Option is most favourable, this is because the tunnel would result in a reduction in traffic noise throughout the glen. The operational noise impact significance is determined to be moderate beneficial.

10.4.2.5. Purple Option

The shortest distance between the Purple Option carriageway alignment and the residential receptor Laigh Glecroe is c. 95m. The shortest distance between the Purple Option carriageway alignment and the residential receptor High Glencroe is c. 95m

For operational noise, the Purple Option is the least favourable because the alignment is closest to the High Glencroe residential property. The operational noise impact significance is determined to be minor adverse.

10.5. Potential Mitigation

10.5.1. Construction

Best practicable means shall be adopted to control and minimise construction noise and vibration impacts.

There are a very limited number of fixed, permanent sensitive receptors in Glen Croe. As such, it may be the case that methods to mitigate any construction noise impacts through localised measures at the receptors themselves would be more practical and effective.

10.5.2. Operation

Given the limited number of fixed, permanent sensitive receptors, and the proximity to the Scheme Options, there is unlikely to be a requirement for operational noise mitigation.

It may be more practicable for any required mitigation to be applied locally to the receptor through the provision of noise insulation or very localised noise barriers and/or earth bunding at the receptor boundary rather than applying mitigation in the vicinity of the A83(T) carriageway. This will be further explored at DMRB Stage 3.

10.6. Conclusions

Table 10.1 Noise and Vibration Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Construction noise	Residential properties in Glen Croe.	Noise impact from construction activities.	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Pink Option is most favourable. Green Option is least favourable.
Construction vibration	Residential properties in Glen Croe.	Vibration impact from construction activities.	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Pink Option is most favourable. Green Option is least favourable.
Construction traffic	Residential properties outside Glen Croe.	Noise impacts from construction traffic movements along the existing A83(T).	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Yellow Option is most favourable. Green Option is least favourable.
Operational noise	Residential properties in Glen Croe.	Noise impacts from operational traffic movements along the scheme extent.	Minor Adverse	Minor Adverse	Moderate Beneficial	Minor Adverse	Minor Adverse	Pink Option is most favourable. Purple Option is least favourable.

The qualitative assessment of the Scheme Options has determined that the Pink Option is most favourable for both construction and operational phase impacts, this is primarily because the tunnel would screen and protect the Glen from most of the noise and vibration impacts.

The Purple Option is considered the least favourable option because the road alignment is closest to the sensitive receptor High Glencroe. It is likely that temporary construction and permanent operational impacts would be greater at this property, including vibration

impacts resulting from the formation of the tunnel. The Green Option is considered the least favourable option, this is because this option has the longest construction duration in conjunction with a large cut/fill requirement which would result in construction traffic impacts outside the glen.

10.7. Scope of DMRB Stage 3 Assessment

The Stage 3 noise and vibration assessment will undertake the following:

- Scoping assessment will determine the requirement for further assessment of construction noise, construction vibration and operational noise.
- Subject to the outcome of the Scoping assessment, the following quantified assessments will be completed for the Preferred Option: construction noise, construction vibration and operational noise.
- The noise and vibration assessment will describe the likely significant effects of the Preferred Option on the environment.
- If required, specific noise mitigation measures will be determined and reported.

11. Population and Human Health

11.1. Introduction

This chapter presents the assessment of the potential impacts from the construction and operation of the Scheme Options, with the aim of identifying a favourable Scheme Option in terms of population and human health. It is based on the requirements and methodology set out in the DMRB 'LA 112 Population and Human Health' (LA 112)[182], and DMRB 'LA 104 Environmental Assessment and monitoring', using professional judgement, best practice and knowledge from the assessment of other road schemes.

11.2. Approach and Methods

11.2.1. Introduction

This Stage 2 assessment has been carried out in line with the DMRB Stage 2 scoping projects for environmental assessment guidance (LA 103)[183] and also considered to a proportionate level of detail, those aspects set out in LA 112.

Consideration has been given to the following land use and accessibility elements:

- Private property and housing;
- Community land and assets;
- Development land and businesses;
- Agricultural land holdings; and
- Walkers, Cyclists and Horse Riders (WCH).

In terms of human health, consideration has been made of:

- Health profile of affected communities; and
- Health determinants – note this has considered those findings made by relevant specialist topics reported in other chapters within this report and appropriate cross referencing provided. The Population and Human Health assessment has not sought to reassess these technical elements, rather they have informed this topic's findings.

[182] Design Manual for Roads and Bridges: LA 112 Population and Human health. Highways England et al. 2020
[183] Design Manual for Roads and Bridges: LA 103 Scoping projects for environmental assessment. Highways England et al. 2020.

Early consideration has been made of the likely health outcomes, with the potential for both positive health outcomes, as well as negative identified as per LA 112. Consideration has been made of population groups, not individuals.

11.2.2. Sources of Information

No detailed site surveys have been undertaken. Desk based data from a range of open access sources has been sufficient at this Stage. This includes from:

- Open Data Scotland[184]
- Historic Environment Scotland[185]
- NatureScot data services[186]

11.2.3. Policy, Legislation and Guidance

National, regional and local policy as well as guidance, relating to the assessment of Population and Human health has been reviewed and an overview of implications and key aspects of relevance to the A83 are set out as follows. It is to be noted that for the most part there are limited aspects of Policy which would result in differentiators between Scheme Options, though these are noted where applicable.

Note that the consideration of population and human health is cross cutting across a number of environmental topics such as air quality, noise etc. Reference should be made of those technical chapters in respect of policy, legislation and guidance relevant to that topic.

There are a wide range of documents relating to health in Scotland e.g. 'A Scotland where everybody thrives: Public Health Scotland's strategic plan 2022-2025[187]. While brevity does not allow full exploration of all these documents, general themes can be determined which recognise that Scotland has significant public health challenges and set out (amongst a range of aims and objectives) to improve life expectancy, reduce health inequalities, improve health outcomes and promote health and wellbeing.

National Transport Strategy – Protecting our Climate and Improving Lives (2020)[188]: This Strategy advocates a Vision for Scotland's transport system, that will help create great places - a sustainable, inclusive, safe and accessible transport system, helping deliver a healthier, fairer and more prosperous Scotland for communities, businesses and visitors. This Strategy has four priorities, including reducing inequalities and improve health and

[184] Opendata Scotland. (2023). Opendata. [Online]. Opendata. Available at: https://opendata.scot/ [Accessed 25 April 2023].
[185] Historic Environment Scotland. (2023). Downloads. [Online]. Historic Environment Scot. Available at: https://portal.historicenvironment.scot/downloads [Accessed 25 April 2023].
[186] NatureScot. (2023). Data services. [Online]. NatureScot. Available at: https://www.nature.scot/information-hub/naturescot-data-services [Accessed 25 April 2023].
[187] A Scotland where everybody thrives: Public Health Scotland's strategic plan 2022 to 2025 - Our organisation - Public Health Scotland (Accessed 22 May 2023)
[188] Transport Scotland. (Feb 2020). National Transport Strategy. [Online]. TransportScot. Available at: https://www.transport.gov.scot/media/47052/national-transport-strategy.pdf [Accessed 23 May 2023].

wellbeing. A strong emphasis is placed on a number of elements relevant to the A83 project, including active travel (of relevance to the walking routes in Glen Croe), safety and minimising connectivity disadvantages (relevant to the need to provide a robust and safe route through this rural area to allow people to access the key services, community and healthcare facilities, as well as the employment opportunities they require).

National Planning Framework 4 (2023)[189]: In respect of Population and Human health, NPF4 clearly recognises there are significant health inequalities in Scotland, with a clear need for community resilience and sets out as a spatial principle, support for local living, that will improve community health and wellbeing by ensuring people can easily access services, greenspace, learning, work and leisure locally. The A83 provides that function to access services for the population within the immediate area to the route such as at Succoth and Arrochar, as well as those in key centres across the wider Argyll and Bute area. Similarly, the A83 will help support rural revitalisation, another key aim of NPF4, by helping provide access to wider markets, as well as support tourist movement to and through the area. The A83 will also ensure safe and effective social connectivity to allow people to visit friends and family – with a positive benefit on health and wellbeing, reflecting a key element of successful places.

NPF4 recognises that economic development has an effect on overall health and wellbeing and it is to be recognised that the A83 would have an important role in the economy by providing route to markets, supporting local supply chains and commercial businesses and so on. NPF4 also recognises the importance of protecting people from harm and mitigating risks arising from safety hazards – key elements of the A83 project.

NPF4 also places an important emphasis on a national walking, cycling and wheeling network, with an ambition to strengthen and extend a national active travel network. While this is closely linked to reducing emissions from transport, there are also linkages to health and wellbeing. Within the area of Glen Croe, there are numerous active travel routes, some of which could be impacted by Scheme Options.

Argyll and Bute Indicative Regional Spatial Strategy[190]: While this document does not apply to the area of A83 (which falls within the Loch Lomond and The Trossachs National Park), it does provide an indication of population, health and wellbeing issues considered of note in the wider area. A key element in this document is the wish for Argyll and Bute to have well connected places where people are able to meet their full potential without prejudicing the quality of life of future generations. Improved access to key global markets and lifeline services is critically important to the region as without this, businesses and population may relocate out of the area if they feel that their access routes are not fit for purpose or resilient

[189] Local Government and Housing Directorate. (2023). National Planning Framework 4. [Online]. Scottish Government. Available at: https://www.gov.scot/publications/national-planning-framework-4/pages/3/ [Accessed 23 May 2023].
[190] Argyll and Bute Council. (2021). Indicative Regional Spatial Strategy. [Online]. Argyll and Bute Council. Available at: https://www.argyll-bute.gov.uk/moderngov/documents/s166821/Draft%20FULL%20Indicative%20RSS%20v7.pdf [Accessed 23 May 2023].

enough. The A83 project is clearly aligned with these aspirations and note is also made that the A83 (along with A82 and A85) provides lifeline access to the rest of Argyll and the Inner and Outer Hebridean Islands, as well as the North West Highlands and the general western seaboard. The A83 is recognised as being a particularly fragile, though significant link, with significant safety issues. Network resilience is recognised as critical to community wellbeing.

Argyll and Bute Local Development Plan 2015[191]: Key population and health challenges recognised in the LDP and associated documents are the decline in population numbers, alongside a change in the population make up to a more elderly profile. There is also a recognition of the need to improve health and wellbeing and reduce health inequalities, as well as improve infrastructure to help economic growth. It is noted that many of the communities within Argyll and Bute are isolated and risk collapse as population changes take affect. The LDP contains a series of Key Policy Themes which interact with population and health, with an aim to result in healthier and more attractive environments and more active and healthier people. An example of particular note to the A83 Project is Policy LDP11 which relates to improving connectivity and infrastructure, and which deals with rights of way and public access and recognises in the supporting text that good connectivity and infrastructure are of fundamental importance to the way of life, economy and health of the people of Argyll and Bute. Planning guidance within the Plan also provides additional detail to Policy on a range of issues including on issues such as access to Core Paths, which clearly has linkages to the Glen Croe area, given the number of paths located here and a focus on protecting these needs to be made.

Argyll and Bute Local Development Plan 2 (In development)[192]: LDP2 will replace the 2015 LDP. LDP2 also contains a wide range of aspects with implications for population and human health. As with LDP 2015, there is a focus on tackling deprivation and health inequalities and promoting healthier and more active lifestyles e.g. through protecting long distance routes – this could have implications for some of the Scheme Options, given the need to protect such long distance routes.

Loch Lomond and The Trossachs National Park Local Development Plan (2017-2021)[193]: It is noted within this Plan that the area around Succoth and Arrochar will likely have a growing population, with a number of housing sites identified. There are also noted plans for additional community facilities and it is noted that the area offers great opportunities for a range of new homes, employment, community and visitor infrastructure. It is also noted that the population profile within the park area is trending toward older cohorts, reflecting Argyll and Bute and Scotland as a whole.

[191] Argyll and Bute Council. (2015). Local Development Plan. [Online]. Argyll and Bute Council. Available at: https://www.argyll-bute.gov.uk/ldp [Accessed 23 May 2023].
[192] Argyll and Bute Council. (2019). Proposed Local Development Plan Part 2. [Online]. Argyll and Bute Council. Available at: https://www.argyll-bute.gov.uk/sites/default/files/finalpldp2writtenstatementdepositv2_ac1.pdf [Accessed 23 May 2023].
[193] Loch Lomond and The Trossachs National Park. (2021). Local Development Plan. [Online]. Loch Lomond. Available at: https://www.lochlomond-trossachs.org/planning/planning-guidance/local-development-plan/ [Accessed 23 May 2023].

The National Park Plan also references the Community Action Plan (2014-2019) for Arrochar which notes among the top 10 priorities for the local community as being 'Safe and well maintained trunk road corridors through our villages, along with better transport links for residents and visitors' and 'improving transport links between villages and major settlements'.

DMRB LA 112 Population and Human Health (2020): This document provides a framework for assessing, mitigating and reporting the effects of motorway and all-purpose trunk road projects on population and health. It introduces significance criteria that aid consistent and proportionate assessment to support the reporting of significant effects of population and human health. Environmental assessment of population and human health effects shall report on the following elements:

1) land-use and accessibility including private property and housing; community land and assets; development land and businesses; agricultural land holdings; and walkers, cyclists and horse-riders (WCH).

2) human health including; health profiles of affected communities; health determinants (e.g noise or air pollution); and likely health outcomes.

DMRB LA 104 'Environmental Assessment and monitoring' (2020): This document provides additional information to be considered in respect of LA 112 and sets out how environmental assessment is the process by which information about environmental effects is collected, assessed and used to inform decision-making. This includes Environmental Impact Assessment (EIA) and non-statutory environmental assessment.

Institute of Environmental Management and Assessment (IEMA) Guidance on 'Determining Significance for Human Health in Environmental Impact Assessment' (2022): This guidance covers the consideration of health as a topic in environmental impact assessment (EIA). It presents a framework that supports a proportionate approach that can apply to all scales of EIA. Of relevance to this project is that it allows differentiation to be made of effects on human health, to a greater degree than DMRB allows, by allowing significance of effect on health to be attributed. It is also the case that the Scheme Option will be subject to EIA at Stage 3 and use of this guidance at Stage 2 will allow a consistent approach to these health related issues.

11.2.4. Consultation

No specific consultation relating to population and human health has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA, NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

11.2.5. Assessment Methodology

This section introduces the assessment methodology adopted for the Population and Human Health assessment. Technical detail, including determination of value and sensitivity in deriving significance of effect for both the Population (Land use and accessibility) and the Human health components are detailed in Appendix 11.1.

11.2.5.1. Population / Land Use and Accessibility / Socio-Economic

LA 112 sets out the requirements for assessing and reporting the environmental effects on population from construction and operation of roads projects. However, professional judgement is also used to guide the assessment.

11.2.5.2. Human health

LA 112 sets out the requirements for assessing and reporting the environmental effects on human health for construction and operation of roads projects. While regard is made of these requirements, it must be borne in mind that LA 112 provides a means to derive a human health outcome category and provides no mechanism to derive significance of effect. Deriving significance of effect is a requirement of The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations) 2017 (SSI 2017 No.137) (hereafter referred to as the EIA Regulations) and can also allow differentiation to be identified between Scheme Options.

The Institute of Environmental Management and Assessment (IEMA) Guide To 'Determining Significance for Human Health in Environmental Impact Assessment'[194] sets out the requirements for assessing the direct and indirect effects, in an appropriate manner, of a proposed development on human health.

Health is influenced by a range of factors, termed the 'wider determinants of health'. Determinants of health span the bio-physical, social, behavioural, economic and institutional factors. The IEMA guidance document provides a framework for concluding on the significance of population health effects that can be applied across the wider determinants of health.

The IEMA guidance document recognises that significance at the level of individuals is not proportionate, and as such establishes a method for assessing significance at a population

[194] Institute of Environmental Management and Assessment. (2022). Determining Significance for Human health in Environmental Impact Assessment. UK: IEMA.

level, or disproportionate effects to relevant sub-populations, i.e. groups of more sensitive individuals.

It is considered that the requirements set out in LA 112 can be integrated with the IEMA guidance in order to provide an assessment that is both compliant with LA 112 and the EIA Regulations whilst also allowing differentiation between Scheme Options to be identified.

In an effort to integrate the separate but overlapping requirements set out in the respective DMRB and the IEMA guidance, this assessment links the 'Wider determinants of health' and 'Community aspect' headings. For the purpose of reporting potential impacts, the DMRB Community Aspect heading is adopted and taken to reflect the linked IEMA wider determinants of health. This linkage is set out in Table 11.1.

Table 11.1 Linking the IEMA wider determinants of health with the requirements of DMRB LA 112

IEMA Categories	Wider determinants of health (IEMA – Human health)	Community Aspect (DMRB LA 112 – Land use and accessibility)
Health related behaviours	Physical activity	Walkers, cyclists and horse-riders
Social Environment	Housing	Private property and housing
	Open space, leisure and play	Community land and assets
Bio-physical environment	Climate change mitigation and adaptation*	
	Air quality*	
	Water quality or availability*	
	Land quality*	
	Noise and vibration*	
Institutional and Built Environment	Wider societal infrastructure and resources**	Agricultural Land Holdings

*These topics have been considered in detail in the relevant specialist chapters which should be consulted for further information. **It is considered that, at this stage of assessment typical considerations under this heading are appropriately identified and considered through the other scoped in wider determinants of health.

For the purpose of this Stage 2 assessment of the Scheme Options, consideration has been made of those categories in Table 11.1. It is considered that at this optioneering stage and from a review of the baseline environment and the Scheme Options, those categories are broadly aligned with DMRB and most likely to inform the consideration of Scheme Options. Those categories listed in Table 11.2 have been scoped out at this stage. For example, 'Development land and business' which falls under an Economic Environment Category has been scoped out from further consideration as there are no development land or businesses

within the immediate area of any Scheme Options. It is also considered that the respective community aspects and wider determinants of health reported in Table 11.2 are not considered to be a differentiator between Scheme Options at this stage. Nevertheless, it is to be noted that opportunity remains to scope in those categories in any future assessment of the Preferred Option.

Table 11.2 Categories scoped out from further assessment at this stage

IEMA Categories	Wider determinants of health (IEMA – Human health)	Community Aspect (DMRB LA 112 – Land use and accessibility)
Health related behaviours	Risk taking behaviour	
	Diet and nutrition	
Social Environment	Relocation	
	Transport modes, access and connections	
	Community safety	
	Community identity, culture, resilience, and influence	
	Social participation, interaction and support	
Economic environment	Education and training	
	Employment and income	Development land and business
Bio-physical environment	Radiation	
Institutional and built environment	Health and social care services	
	Built environment	

Note that the IEMA guidance has been followed in relation to deriving significance of effect in respect of health (with note also made of anticipated health outcome as per LA 112).

11.3. Baseline Conditions

This section introduces and sets the context for the baseline review which has been used to support identification of vulnerable groups as reported in Table 11.3. Please see Appendix 11.2 for the review of baseline.

11.3.1. Study Area

Within LA 112, in terms of Land Use and Accessibility, there is a requirement for the study area to be based on the construction footprint / project boundary (including compounds and temporary land take) plus a 500m area surrounding the Scheme Option Boundary. However, at this stage, the location of compounds is not fully understood / known and as such a

precautionary study area was identified using a Geographical Information System (GIS) and applicable mapping of the Scheme Option boundary.

In relation to human health, LA 112 notes that the study area shall be defined based on the extent and characteristics of the project and the communities / wards directly and indirectly affected by the project. Therefore, in respect of human health, consideration was made of the population of a wider study area used to define the characteristics of population and human health and health inequalities, including the area within which the local and regional National Health Service (NHS) organisations operate. Consideration was also made of the Scottish Government statistics[195], Public Health Scotland[196], Scottish Public Health Observatory datasets[197] and Argyll and Bute Local Authority area as a whole (including for example Local Authority Profiles and data sourced from Joint Strategic Needs Assessments[198] and Joint Strategic Plans[199]), as well as through consideration of applicable Ward level data, in addition to information at Data Zone level.

As such, by using these LA 112 study area requirements, along with professional judgement, industry best practice and knowledge from other transportation schemes, it is considered that these study areas will capture any significant population and human health effects resulting from the Scheme Options, including those on physical and mental health and social wellbeing.

11.3.2. Study Area Context

The Proposed Scheme is located within the administrative boundaries of Loch Lomond and The Trossachs National Park Authority and falls under the Argyll and Bute Council area, an area which covers almost 9% of the total Scottish land area and which is, for the most part, sparsely populated. Argyll and Bute has the fourth sparsest population of the 32 Scottish local authorities, with an average population density of 0.12 persons per hectare. This compares to a Scottish average of 0.70 persons per hectare[200].

[195] Scottish Government (2023) (https://statistics.gov.scot/atlas/resource?uri=http%3A%2F%2Fstatistics.gov.scot%2Fid%2Fstatistical-geography%2FS12000035)
[196] Public Health Scotland (2022) (https://www.scotpho.org.uk/)
[197] Public Health Scotland (2022) ScotPHO Profiles (https://scotland.shinyapps.io/ScotPHO_profiles_tool/)
[198] Living Well in Argyll and Bute (2020) Joint Strategic Needs Assessment (JSNA) (http://healthyargyllandbute.co.uk/joint-strategic-needs-assessment-jsna/)
[199] Argyll and Bute Health and Social Care Partnership (2022) Joint Strategic Plan 2022-2025 (https://www.nhshighland.scot.nhs.uk/media/phxd2bgi/argyll-and-bute-joint-strategic-plan-15-06-2022.pdf)
[200] Argyll and Bute Council, Information about Argyll and Bute (argyll-bute.gov.uk) (Last accessed 04/05/23)

11.3.3. Identification of vulnerable groups

From a review of the population and human health baseline for Argyll and Bute Local Authority as a whole, as well as data from within this area (e.g. Ward level data), it has been possible to identify a number of groups within the population and communities of Lomond North ward, who, along with the population as a whole (wider groups) could be considered vulnerable in terms of their health and wellbeing. These groups and the rationale for their identification is outlined as follows:

Table 11.3 Identification of Vulnerable Groups

Groups	Relevant receptor / medium	Explanation	Are these groups identified in the study area?
Wider Groups – adults / working people	Residents living in houses, operators and users of community land and facilities, business owners and users, users of open space, recreation and leisure activities, WCH, public transport users and vehicle travellers	The key challenge to the physical health, mental and social wellbeing of the local resident population arises from inactivity and unhealthy lifestyle choices and are also linked to the local transportation and road network. Residents of properties in the wider study area, employees and customers at the businesses interspersed throughout the area, walkers and cyclists using recreation routes and the local footpath and cycleway network, visitors to nearby visitor attractions, and public transport users are likely to be most exposed to health impacts.	Yes – while there are a very small number (two) of residential properties within 500m of the scheme options, there are residents within the wider area, particularly at Succoth and Arrochar, but also within scattered residential properties. There are also a number of businesses in the wider area, particularly at Arrochar, but also near to the scheme options such as Ardgartan. These businesses provide services for both locals and visitors to the area and access would be via the A83(T) for many.
Sensitive Group - Families with children and adolescents, (pregnant women, babies, children and adolescents)	Residential houses, community services and facilities, open space, greenspace and recreational facilities, local footpaths and cycleways, Schools nurseries, day care centres, residential houses	Children and adolescents constitute a sensitive population group due partly to their need to be able to move around freely to and from school, open space, greenspace and recreational activities, whilst they lack the experience and judgement displayed by adults when moving around in traffic and public spaces[201] and when using public transport and related infrastructure. Hence, children and adolescents as pedestrians[202] and cyclists are at elevated risk from danger distributed by motorised transport.	Yes - while there are a very small number (two) of residential properties within 500m of the scheme options, and the wider population of Argyll and Bute is increasingly in the older age cohort, there are residents within the wider area particularly at Succoth and Arrochar, but also within scattered residential properties and it is expected that there will be families with small children, pregnant women, babies, children and adolescents. There are a number of schools in the

[201] World Health Organisation (2018, December) Adolescents: health risks and solutions (https://www.who.int/news-room/fact-sheets/detail/adolescents-health-risks-and-solutions)
[202] Child Accident Prevention Trust (2013) Child death from road traffic accidents (http://makingthelink.net/child-deaths-road-traffic-accidents)

Groups	Relevant receptor / medium	Explanation	Are these groups identified in the study area?
		Furthermore, children are more sensitive than adults to air pollution[203], noise[204], odour[205] and other environmental factors and their bodies and minds are less able to deal with them. Particularly susceptible children are those from low-income[206] and/or black and minority ethnic (BME) backgrounds[207] and/or living in deprived areas.	wider area including at primary and secondary level with catchment areas resulting in the potential need for access along the A83(T).
Sensitive Group – People who are physically or mentally disadvantaged (elderly people, people with physical disabilities, people with other health	Residential houses, retirement / Care homes, community services and facilities (including health centres / clinics and hospitals), open space, trails and local footpaths	Elderly people constitute a sensitive group as they are more sensitive than young and middle-aged adults. Generally, the older people are, the slower their movement and reactions and the poorer their hearing[208]. They can be more at risk from injury and may fear falls, steps or lack of suitable footpaths, lack of safe crossing points and short crossing times at safe crossing points and other aspects of the surrounding built environment[209]. This can deter them from outdoor activity, especially walking, whereas walking is critical for muscle strength and reduces the risk of falls amongst other benefits. Elderly people can also feel more sensitive when using public transport[210,211]. They also often need to seek health services. Their	Yes – while the general population in Argyll and Bute performs better in many health outcomes than Scotland as a whole, it has nevertheless been shown that there are areas within Argyll and Bute which have a prevalence of unhealthy behaviours (>20% drink hazardous/harmful levels of alcohol, STDs increasing, 1 in 3 not physically active enough, 20% smoking, etc.) and higher rates of smoking during pregnancies.

[203] World Health Organisation (2018) Air pollution and child health: prescribing clean air (https://www.who.int/ceh/publications/air-pollution-child-health/en/)
[204] World Health Organisation Data and statistics (http://www.euro.who.int/en/health-topics/environment-and-health/noise/data-and-statistics)
[205] Agency for Toxic Substances and Disease Registry (2015, October) (https://www.atsdr.cdc.gov/odors/faqs.html)
[206] British Medical Journals, Wickham. S, Anwar. E, Barr.B, Law. C, Taylor-Robinson.D (2016, July) Poverty and child health in the UK: using evidence for action (https://adc.bmj.com/content/101/8/759)
[207] Parliamentary Office of Science and Technology (2007, January) (https://www.parliament.uk/documents/post/postpn276.pdf)
[208] Transport for London (2013, April) Older Pedestrians and Road Safety, Research Debrief (http://content.tfl.gov.uk/older-pedestrians-research-report.pdf)
[209] Asher. L, Aresu. M, Falaschetti. E, Minell. J (2012) Most older pedestrians are unable to cross the road in time: a cross-sectional study (http://ageing.oxfordjournals.org/content/41/5/690.full.pdf+html?sid=4b5142fa-92a1-4cd5-80b1-4eb35701432e)
[210] Shrestha.B.P, Millonig.A, Hounsell.N.B, McDonald.M (2017) Review of Public Transport Needs of Older People in European Context (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5656732/)
[211] https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/reports-and-briefings/active-communities/rb_june15_the_future_of_transport_in_an_ageing_society.pdf (page 10)

Groups	Relevant receptor / medium	Explanation	Are these groups identified in the study area?
problems or impairments)		continuing independence at home is often dependent on having available a range of transport mode and route options. People who are disabled and/or with physical and/or mental illnesses or impairments constitute a sensitive group as they may not be able to access many forms of transport or need special arrangements and/or support to access these[212]. They are more likely to find it difficult to walk or travel independently and can also be disadvantaged by the cost of transport. Any changes in access, such as greater travel distances, diversions or replacement services during construction would have particular impacts on this group. Chronically ill persons, for example, people with impaired lung function, can be more adversely affected by air pollution[213]. The same is true of hypersensitive individuals such as asthmatics[214]. Noise can cause hypertension and cardio-vascular problems[215]. Those who already have these conditions can be more troubled by noise than others. People with existing physical and mental illnesses, including sleep disturbance, anxiety and depression, are likely to be more sensitive to changes to their local environment.	It is noted that 1 in 3 adults in Argyll and Bute have a limiting long-term condition. It is also the case that the Argyll and Bute area has an increasingly older population profile and 1 in 4 of Argyll and Bute's population are of pensionable age (joint highest of all Scottish Local Authorities) along with an increase in 75-84 and 85+ year olds. NHS Highland has higher levels of people 65+ with high levels of care needs who are cared for at home but fewer adults claiming incapacity benefit/severe disability allowance compared to the rest of Scotland.
Sensitive Group - People who are materially disadvantaged	Residential houses, community services and facilities, local businesses, open space, greenspace and recreational facilities, PRoW, local footpaths	People on low incomes (living in deprived areas is a proxy measure for low income) and people without access to a car constitute a sensitive group as they are likely to walk further because they cannot afford public transport or to own a car, and their lack of transport options may limit life and work opportunities. Those on low	Yes – it has been shown that areas within Argyll and Bute are among the most deprived 20% in Scotland. Deprivation within rural areas is also likely to be hidden by the mixed socioeconomic status of small rural

[212] House of Commons Briefing Paper (2018, October) Access to transport for disabled people, Number CBP 601 (https://researchbriefings.files.parliament.uk/documents/SN00601/SN00601.pdf)
[213] DEFRA UK AIR, Air Information Resource, Effects of air pollution (https://uk-air.defra.gov.uk/air-pollution/effects)
[214] Asthma UK (https://www.asthma.org.uk/advice/triggers/pollution/)
[215] Munzel T, Schmidt FP, Steven S, Herzog J, Daiber A, Sorensen M. Environmental Noise and the Cardiovascular System. J Am Coll Cardiol. 2018;71(6):688-97 (Extract from Journal of the American College of Cardiology 2018; http://www.intuition-physician.com/wp-content/uploads/2018/05/Evironmental-Noise-and-Cardiovascular-Health.pdf)

Groups	Relevant receptor / medium	Explanation	Are these groups identified in the study area?
	and cycleways, public transport, bus stops	incomes may be less able to adapt to changes in access, such as greater travel distance or alternative transport provision. People living in deprived areas are generally more likely to already have reduced access to health and social care as well as reduced access to other services and amenities. This group may have increased stress levels due to the factors above. In addition, this group is more sensitive to food insecurity, which has an access dimension.	areas. It is also the case that the population of Argyll and Bute is relatively older in general and as such will be living with fixed and potentially restricted (pension) incomes. The economy of the local area is also recognised as being more fragile than Scotland's as a whole, with a large seasonality aspect to it. 17% of those aged under 16 (2,215 children) are estimated to be living in relative poverty (2019/20) in Argyll and Bute. Child poverty has long-term implications and the proportion living in relative poverty has increased since 2013/14 in Argyll and Bute alongside the rest of the UK.

11.4. Potential Impacts

11.4.1. Construction

The following sets out the anticipated construction impacts in relation to each of the Scheme Options and utilises the Categories and linkages as set out in Table 11.1 to meet the reporting requirements for Population and Human health. This section then informs the Assessment of Effects which have been summarised here and further explored in corresponding Assessment Tables, provided in Appendix 11.3. Note that while reporting of potential impacts is facilitated under the collective headings established in Table 11.1, reporting of potential effects has been separated under the respective 'Population / Land use and accessibility' and 'Human health' heading for clarity and in order to maintain consistency with the assessment tables. In line with DMRB LA 112 reporting requirements, it is to be noted that beneficial effects are associated with a positive health outcome, while adverse effects on human health are associated with negative health outcomes. At this stage it is considered that wider determinants of health including air quality, noise and vibration, water, land quality and climate have been appropriately identified and assessed in the respective technical chapters which should be consulted for further information.

There are a number of impacts on land use and accessibility and on human health that would be typical during construction of a road scheme. For example, it is anticipated that there would be some level of disruption or changes to access of community land and assets. Potential impacts such as disruption to access to public open space, recreation and leisure time activities as well as on walking cycling and horse-riding routes within the study and wider area would have consequent health and wellbeing outcomes by reducing opportunities for physical activity. Similarly, changes in access to public transport, or disruption to public transport could also have an impact on health outcomes. These aspects are explored further in the assessment tables (Appendix 11.3).

It is anticipated that the construction phase would require a workforce that would be considered relatively high in the local context. It is anticipated that while many of the operatives required would be from the local area, some specialist operatives may be required to travel from further afield and this could put pressure on the local housing / rental market. Impacts from increased demand on health and recreational facilities and other essential services in the wider area from the workforce required to build any of the Scheme Options.

The assessment of effects resulting from these and other typical impacts are reported as follows. Note these summaries are further developed in Assessment Tables provided in Appendix 11.3:

Health Related Behaviours

Walkers, cyclists and horse-riders (Population / Land use and accessibility)

Disruption of public transport routes in the wider area is associated with Slight adverse effects for each of the Scheme Options. These effects would be temporary to the construction phase, direct and reversible.

Physical Activity (Human health)

Disruption of public transport routes in the wider area is associated with Slight adverse effects on health and well-being for each of the Scheme Options. These effects would be temporary to the construction phase, direct and reversible.

Social Environment

Private property and housing (Population / Land use and accessibility)

Slight adverse impacts are anticipated on the housing market and housing availability due to the potential need to accommodate a construction workforce in the local area, particularly during phases of specialist work such as bridge work as the workforce is less likely to be from local area. These effects would be temporary to the construction phase, direct and reversible.

Housing (Human health)

There may be moderate adverse effects on health and well-being as a result of disruption to access and amenity impacts in the wider study area.

Minor adverse effects are also anticipated on health and well-being as a result of reduced availability of housing in the wider area. These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Population / Land use and accessibility)

Slight adverse impacts are anticipated due to disruption and reduced access to Community Assets within the wider area. These impacts would be temporary, direct and reversible.

Increased demand on health and recreational facilities and other essential services during construction is associated with Slight adverse effects for each of the Scheme Options noting a large workforce (relative to overall local population) would put increased pressure on such facilities. These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Human health)

Common effects have not been identified at this stage.

Institutional and built environment

Agricultural Land Holdings (Population / Land use and accessibility)

Loss, disruption, and / or changes to access and viability of forestry holdings within the study area is associated with Slight adverse effects across each of the Scheme Options. While there would be a need to fell a large number of trees within a commercial plantation along the Green Scheme Option, it is not anticipated that this would affect the viability of the plantation, particularly if these trees are felled for commercial purposes prior to the Proposed Scheme being developed, should that Option be progressed. Note that where forestry is lost an equivalent area will need to be provided elsewhere to ensure no net loss of woodland.

11.4.1.1. Green Option

Health related behaviours

Walkers, cyclists and horse-riders

The middle section of the Green Option follows a current local path for around 2.1km and it is assumed that it would effectively be lost for walkers, cyclists and horseriders if this option was chosen. This path is mostly used by recreational walkers and mountain bikers and links the current A83(T) and OMR with the WCH paths on the south side of Glen Croe and alternative options to do this with current paths would require either a detour either via the Rest and Be Thankful car park or crossing the Croe Water near the Honeymoon Bridge Car Park or at the Ardgartan Hotel.

It is assumed that the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path, the south-eastern end of the OMR and the local path along the Croe Water to the northeast of the current road.

The Green Option is additionally directly adjacent to the Ardgartan Peninsula Circuit cycle route and a Loch Lomond and The Trossachs National Park core path on the southwestern side of Glen Croe for around 350m. While the footprint of the Green Option would not impact this path, it would likely need to be closed during parts of the construction period to allow for downslope excavation. During such closures, users would be diverted to the OMR, and in the case of the OMR being required as a temporary diversion for the current A83(T) a shuttle service would be provided to allow users to cross the construction site. Additionally, the Green Option also intersects a short (100m) section of the Loch Lomond and The Trossachs

National Park core path as well as a hillwalking path for Ben Donich would be used as a construction route with the Green Option.

Social Environment

Private property and housing

There are two residential properties located c.300m and 510m from the Green Option and there is a potential for disruption to access and amenity. It is assumed that the current A83(T) would remain in place as an access road to the property at Laigh Glencroe from the south.

The Green Option would cross the OMR's link to the current A83(T), although there is another link between the two 180m further northwest that would not be affected. There is a potential impact on human health and wellbeing as a result of access disruption at houses immediately adjacent the Green Option, with effects also possible on residents of houses further afield (e.g. residents within Succoth and Arrochar). Amenity impacts may also arise as a result of construction activities.

Community Land and Assets

The Green Option would result in the loss of 0.14ha of the Rest and Be Thankful car park / viewpoint, although during construction this Option would effectively result in a complete loss of the car park.

Honeymoon Bridge car park and picnic area is located approximately 600m from the southern end of the Green Option and there is a potential for disruption to access and amenity. This is a popular stop for drivers as well as a possible starting point for climbing Ben Arthur (The Cobbler) and local bouldering.

The Green Option would require realignment of the junction to the B828 and as a consequence the bus turning area and stop. It is noted that due to the alignment less space will be available, but a turning area of equivalent dimensions is considered practicable.

Institutional and built environment

Agricultural Land Holdings

The Green Option is for the most part through an existing area of forestry which was planted for commercial purposes. It is anticipated that the Green Option would result in the requirement to fell trees along its length (though this is reduced by following the alignment of existing forestry tracks).

There are also small areas of the Green Option which would be suitable for rough grazing and which may be lost during construction.

The assessment of effects resulting from these potential impacts are reported as follows. Note these summaries are further developed in Assessment Tables provided in Appendix 11.3:

Health related behaviours

Walkers, cyclists and horse – riders (Population / Land use and accessibility)

The loss of, or significant and prolonged disruption to important and popular WCH routes within Ardgartan / Argyll Forest Park are anticipated to have moderate adverse effects.

Physical activity (Human health)

Significant adverse effects are anticipated in respect of human health due to the loss / significant disruption to WCH routes, particularly those within Ardgartan / Argyll Forest.

Social Environment

Private property and housing (Population / Land use and accessibility)

Slight adverse effects are anticipated on the houses within the study area due to temporary disruption to access. These effects would be temporary to the construction phase, direct and reversible.

Housing (Human health)

Slight Adverse effects due to construction of the project having impact on amenity / access to housing within the study area. These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Population / Land use and accessibility)

Within the study area, Large adverse effects are anticipated at the Rest and Be Thankful Viewpoint due to disruption, changes to access and or amenity effects. The effects would be temporary, direct and reversible.

Community Land and Assets (Human health)

Moderate adverse effects on human health are anticipated in respect of loss / reduction in access to open space at the Rest and Be Thankful Viewpoint, as well as disruption to wider community assets. These effects would be temporary, direct and reversible.

Institutional and built environment

Agricultural Land Holdings (Population / Land use and accessibility)

Slight adverse effects are anticipated on those agricultural activities linked to grazing in rough upland areas or on those areas at valley floor which are of improved / semi-improved pasture. This is due to potential disruption to access and potential loss of small areas utilised for grazing.

11.4.1.2. Yellow Option

Health related behaviours

Walkers, cyclists and horse-riders

The Yellow Option crosses the OMR at two points, with the OMR likely to be used as the principal access and haul road to the site during construction. Therefore access disruption and associated health and well-being impacts are associated with construction works at this location.

It is assumed that the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path (part of the Loch Lomond and The Trossachs National Park route network) and the local path along the Croe Water to the northeast of the A83(T).

There is a potential impact on human health and wellbeing from amenity / access impacts at houses immediately adjacent the Yellow Option, with effects also possible on residents of houses further afield such as those in Succoth and Arrochar.

Social Environment

Private property and housing

There are two residential properties located c.100m and c.170m from the Yellow Option and there is a potential for disruption to access and amenity.

The Yellow option crosses the access from the OMR to the closer property at High Glencroe, resulting in the potential need to plan for an alternative access during construction of the viaduct.

Community Land and Assets

The Yellow Option would result in the loss of 0.1ha of the Rest and Be Thankful car park, although during construction the Yellow Option would effectively result in a complete loss of the car park.

As part of the Yellow Option, improvements are proposed to the B828 junction to the A83(T). These improvements may result in modifications being required to the bus stop and turning area local to the Rest and Be Thankful.

Institutional and built environment

Agricultural Land Holdings

There is potential direct impact on / loss of land which is used for grazing and which can be considered improved or semi-improved pasture. Some very small areas of commercial forestry could be lost.

There are a number of agricultural buildings and livestock pens along the OMR, particularly in proximity to the southern part of the Yellow Option where it crosses the OMR. While direct loss is not anticipated, there could be impacts on access or the potential for severance between these and the areas of agriculture which they serve.

The assessment of effects resulting from these potential impacts are reported as follows. Note these summaries are further developed in Assessment Tables provided in Appendix 11.3:

Health related behaviours

Walkers, cyclists and horse – riders (Population / Land use and accessibility)

The loss of, or significant and prolonged disruption to important and popular WCH routes along OMR are anticipated to have significant (very large) adverse effects. Impact on bus routes and other walking routes are anticipated to be slight adverse.

Physical activity (Human health)

Moderate negative health outcomes are anticipated in respect of human health due to the loss / significant disruption to WCH routes, particularly those along the OMR. These health effects are anticipated to be significant for all groups.

Social Environment

Private property and housing (Population / Land use and accessibility)

Moderate adverse effects are anticipated on property immediately adjacent the Yellow Option and within the study area due to disruption to access. These effects would be temporary to the construction phase, direct and reversible.

Housing (Human health)

Slight Adverse effects due to construction of the project having impact on amenity / access to the property immediately adjacent the Yellow Option or in vicinity of compounds within the study area and construction activities having an influential effect on the ability to deliver current health policy and/or the ability to narrow health inequalities. These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Population / Land use and accessibility)

Large adverse impacts are anticipated on the Community Asset / Public Open Space, Recreation and Leisure within the study area of the Rest and Be Thankful Viewpoint due to disruption, changes to access and or amenity impacts. The effects would be temporary, direct and reversible.

Community Land and Assets (Human health)

Moderate adverse effects on human health are anticipated in respect of loss / reduction in access to open space at the Rest and Be Thankful Viewpoint, as well as disruption to wider community assets. These effects would be temporary, direct and reversible.

Institutional and built environment

Agricultural Land Holdings (Population / Land use and accessibility)

Moderate adverse effects are anticipated on those agricultural activities linked to grazing in areas at valley floor which are of improved / semi-improved pasture. This is due to potential disruption to access, potential loss of small areas utilised for grazing and potential impacts to agricultural outbuildings. There is also a potential for severance of farming activities.

11.4.1.3. Brown Option

Health related behaviours

Walkers, cyclists and horse-riders

During construction, it is planned to divert traffic (including WCH) to the OMR. North of High Glencroe the OMR's gradient increases above 14.7% for a distance of 140m, resulting in a more challenging route for cyclists and potential safety concerns, particularly if vehicles cannot overtake due to the horizontal geometry. While the OMR is already currently used as a temporary diversion due to landslides, this is currently only for isolated periods, using this as a diversion would result in the temporary loss of it as a route for NMUs aside from cyclists.

Disruption to the start points at both the Loch Lomond and The Trossachs National Park Core Path (running immediately adjacent south the Croe Water) and a Hill Walking Route (immediately adjacent north of the Croe Water) where they meet the A83(T).

The Brown Option includes verge widening that overlaps with the start of the path for Beinn Luibhean and a local path, although this would not strongly impact either path as a whole.

There is a potential impact on human health and wellbeing from amenity / access impacts at house immediately adjacent the Brown Option alignment, with effects also possible on residents of houses further afield such as those in Succoth and Arrochar.

Social Environment

Private property and housing

There are two residential properties both located approximately c.270m from the Brown Option and there is a potential for disruption to access and amenity. As this is an online Proposed Scheme the distance between the road and the properties is equivalent to the current situation.

Community Land and Assets

This option will result in the loss of 0.12ha of the Rest and Be Thankful car park, although during construction this Option would effectively result in a complete loss of the car park.

As part of the brown option, improvements are proposed to the B828 junction to the A83(T). These improvements may result in modifications being required to the bus stop and turning

area local to the Rest and Be Thankful. Therefore potential disruption, closure and / or loss of part of the Rest and Be Thankful car park is anticipated.

Institutional and built environment

Agricultural Land Holdings

For the most part, the Brown Option is along the existing A83(T), though there would be some very small areas currently utilised for commercial forestry plantation potentially lost.

There are also small areas of the Brown Option which would be suitable for rough grazing and which may be lost during construction.

The assessment of effects resulting from these potential impacts are reported as follows. Note these summaries are further developed in Assessment Tables provided in Appendix 11.3:

Health related behaviours

Walkers, cyclists and horse – riders (Population / Land use and accessibility)

The loss of elements, or significant and prolonged disruption to important and popular WCH routes accessed via A83(T) are anticipated to have significant Moderate adverse effects. Note that it is accepted that access can be maintained during construction, though disruption would be likely. Impact on bus routes and other walking routes are anticipated to be slight adverse.

Physical activity (Human health)

Slight adverse effects are anticipated in respect of human health due to the loss / disruption to WCH routes, particularly those accessed via A83(T).

Social Environment

Private property and housing (Population / Land use and accessibility)

Slight adverse effects are anticipated on the houses immediately adjacent the Brown Option and within the wider area as access would be lost to A83(T) and due to temporary disruptions to access along OMR. These effects would be temporary to the construction phase, direct and reversible.

Housing (Human health)

Moderate Adverse effects due to construction of the project having impact on amenity / access to housing within the study area. Construction activities may have an influential effect on the ability to deliver current health policy and/or the ability to narrow health inequalities. These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Population / Land use and accessibility)

Large adverse effects are anticipated on the Rest and Be Thankful Viewpoint due to disruption, changes to access and or amenity impacts. The effects would be temporary, direct and reversible.

Community Land and Assets (Human health)

Moderate adverse effects on human health are anticipated in respect of loss / reduction in access to open space at the Rest and Be Thankful Viewpoint, as well as disruption to wider community assets. These effects would be temporary, direct and reversible.

Institutional and built environment

Agricultural Land Holdings (Population / Land use and accessibility)

Slight adverse effects are anticipated on those agricultural activities linked to grazing in areas which are of improved / semi-improved pasture. This is due to potential disruption to access, potential loss of small areas utilised for grazing and potential access impacts to agricultural outbuildings.

11.4.1.4. Pink Option

Health related behaviours

Walkers, cyclists and horse riders

It is assumed that part of the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path and the local path along the Croe Water to the northeast of the A83(T).

The widening of the road at the northern end of the Pink Option would result in the loss of the current parking spaces for the path to Beinn an Lochain.

The Pink Option crosses underneath the Beinn Luibhean path and the local path along the Croe Water to the northeast of the A83(T), with construction activities leading to a requirement to temporarily close or divert access to these routes.

There is a potential impact on human health and wellbeing from amenity / access impacts at house immediately adjacent the Pink Option alignment, with effects also possible on residents of houses further afield such as those in Succoth and Arrochar.

Social Environment

Private property and housing

There is one residential property located within the construction footprint of the Pink Option and one located c.350m from the Pink Option. There is therefore a potential for disruption to access and amenity. There would be a requirement for demolition of one property.

Community Land and Assets

The Pink Option requires a new junction between the B828 and the A83(T) to be formed several hundred metres north meaning a section of the existing A83(T) will be de-trunked to become the extended B828. The A83(T) south of the existing junction to the B828 would be closed to public traffic and the priority changed to continue along the B828. As a result, minor realignment is required in the proximity of the bus stop and turning area to allow of the change in priority.

Institutional and built environment

Agricultural Land Holdings

While the Pink Option is largely within a tunnel, there would be some relatively small areas currently utilised for commercial forestry plantation potentially lost. There are also some areas currently utilised for rough pasture that could potentially be directly lost.

The assessment of effects resulting from these potential impacts are reported as follows. Note these summaries are further developed in Assessment Tables provided in Appendix 11.3:

Health related behaviours

Walkers, cyclists and horse – riders (Population / Land use and accessibility)

The loss of elements, or significant and prolonged disruption to important and popular WCH routes accessed via A83(T) are anticipated to have significant Moderate adverse effects. Note that it is accepted that access can be maintained during construction, though disruption would be likely.

Physical activity (Human health)

Moderate negative health outcomes are anticipated in respect of human health due to the loss / significant disruption to WCH routes, particularly those accessed via A83.

Social Environment

Private property and housing (Population / Land use and accessibility)

This option results in the loss of one property, with anticipated large adverse impacts.

Housing (Human health)

Moderate adverse effects are made in respect of the loss of one property, due to the potential for impacts on residents / property owner due to stress etc. There is a potential such impacts could be permanent.

Moderate Adverse effects due to construction of the project having impact on amenity / access to housing in vicinity of compounds within the study area and construction activities having an influential effect on the ability to deliver current health policy and/or the ability to narrow health inequalities.

These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Population / Land use and accessibility)

Neutral impacts are anticipated on the Community Asset / Public Open Space, Recreation and Leisure within the study area as there would be no impact on the Rest and Be Thankful Viewpoint due to disruption, changes to access and or amenity impacts.

Community Land and Assets (Human health)

Minor adverse effects on human health are anticipated in respect of loss / reduction in access to open space due to disruption to wider community assets. These effects would be temporary, direct and reversible.

Institutional and built environment

Agricultural Land Holdings (Population / Land use and accessibility)

Slight adverse effects are anticipated on those agricultural activities linked to grazing in areas which are of improved / semi-improved pasture. This is due to potential disruption to access along the OMR (including from temporary diversions from the A83), potential loss of small areas utilised for rough grazing and potential access impacts to agricultural outbuildings.

11.4.1.5. Purple Option

Health related behaviours

Walkers, cyclists and horse riders

It is assumed that the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path and the local path along the Croe Water to the northeast of the current road.

The Purple Option crosses the OMR at two points. While the finished route footprint would not further impact this path, sections would likely be used as the principal access and haul road to the site during construction and for maintenance.

Due to the level of access required to construct the viaduct element consideration will be given to the provision of a parallel haul road adjacent to the OMR from a point in the vicinity of the Croe Water to a point south of where the tunnel begins in order to limit disruption to users including the current landowners and WCH's. It is noted however during certain construction activities, access along the OMR would need to be restricted for safety reasons. In this case, users would be diverted to a local path or the core path which run parallel to the OMR on the southwestern side of the valley. It is predicated that the majority of the tunnelling operation would be undertaken from the north extending south, due to the impact of accessing the southern portal along the OMR. This will reduce the time of the conflict existing.

The widening of the road at the northwestern end of the Purple Option would result in the loss of the current parking spaces for the path to Beinn an Lochain.

There is a potential impact on human health and wellbeing from amenity / access impacts at house immediately adjacent the route alignment, with effects also possible on residents of houses further afield such as those in Succoth and Arrochar.

Social Environment

Private property and housing

There are two residential properties located 70m and 100m from the Purple Option and there is a potential for disruption to access and amenity.

The Purple Option crosses the access from the OMR to the closer property at High Glencroe, resulting in the need to plan for an alternative access during construction of the viaduct.

Community Land and Assets

The Purple Option requires a new junction between the B828 and the A83(T) to be formed several hundred metres north meaning a section of the existing A83(T) will be de-trunked to become the extended B828. The A83(T) south of the existing junction to the B828 would be closed to public traffic and the priority changed to continue along the B828. As a result, minor realignment is required in the proximity of the bus stop and turning area to allow for the change in priority. This is not anticipated to adversely impact the bus stop which would remain accessible from the A83(T). The works are not considered to adversely impact the current provision.

Institutional and built environment

Agricultural Land Holdings

There is potential direct impact on / loss of land which is used for grazing and which can be considered improved or semi-improved pasture. Some very small areas of commercial forestry could be lost.

There are a number of agricultural buildings and livestock pens along the OMR, particularly in proximity to the southern point where the Purple Option crosses the OMR. While direct loss is not anticipated, there could be impacts on access or the potential for severance between these and the areas of agriculture which they serve.

The assessment of effects resulting from these potential impacts are reported as follows. Note these summaries are further developed in Assessment Tables provided in Appendix 11.3:

Health related behaviours

Walkers, cyclists and horse – riders (Population / Land use and accessibility)

The loss of, or significant and prolonged disruption to important and popular WCH routes along OMR are anticipated to have significant (very large) adverse effects. Note that it is accepted that access can be maintained during construction to other routes, though disruption would be likely. Effects on bus routes and other walking routes are anticipated to be slight adverse.

Physical activity (Human health)

Moderate negative health outcomes are anticipated in respect of human health due to the loss / significant disruption to WCH routes, particularly those along the OMR. These health effects are anticipated to be significant for all groups.

Social Environment

Private property and housing (Population / Land use and accessibility)

Moderate adverse effects are anticipated on the houses immediately adjacent the Purple Option and within the study area due to disruption to access.

These effects would be temporary to the construction phase, direct and reversible.

Housing (Human health)

Slight Adverse effects due to construction of the project having impact on amenity / access to housing immediately adjacent the Purple Option or in vicinity of compounds within the study area and construction activities having an influential effect on the ability to deliver current health policy and/or the ability to narrow health inequalities.

These effects would be temporary to the construction phase, direct and reversible.

Community Land and Assets (Population / Land use and accessibility)

Neutral effects are anticipated on the Community Asset / Public Open Space, Recreation and Leisure within the study area as there would be no impact on the Rest and Be Thankful Viewpoint due to disruption, changes to access and or amenity impacts.

Community Land and Assets (Human health)

Minor adverse effects on human health are anticipated in respect of loss / reduction in access to open space due to disruption to wider community assets.

These effects would be temporary, direct and reversible.

Institutional and built environment

Agricultural Land Holdings (Population / Land use and accessibility)

Moderate adverse effects are anticipated on those agricultural activities linked to grazing in areas which are of improved / semi-improved pasture. This is due to potential disruption to

access, potential loss of small areas utilised for grazing and potential access impacts to agricultural outbuildings.

11.4.2. Operation

The following sets out the anticipated operation impacts in relation to each of the Scheme Options in terms of population and human health. It is useful to note that, as would be typical of any new road scheme, robust and safe connections through the region would be anticipated, reducing severance and allowing people to access the health, educational, economic and leisure facilities and opportunities that they require. It is not anticipated that access to property would be worsened and any community facility / bus stop provisions would be reinstated to an equivalent standard. In light of the similar nature of potential impacts identified during operation, considerations of potential effects has been provided in narrative only, under Section 11.4.3.

11.4.2.1. Green Option

Health related behaviours

Walkers, cyclists and horse riders

The middle section of the Green Option follows a current local path for around 2.14km and it is assumed that it would effectively be lost for WCHs. This path is mostly used by recreational walkers and mountain bikers and links the current A83(T) and OMR with the WCH paths on the south side of Glen Croe and alternative options to do this with current paths would require either a detour either via the Rest and Be Thankful car park or crossing the Croe Water near the Honeymoon Bridge Car Park or at the Ardgartan Hotel. Diverting users to the core path to the southwest which is similar in nature is considered the most appropriate mitigation. It is noted that the cross section of the structure could be amended to include for a footpath, however further consultation is required to confirm if this is desirable by users should this option be taken forward.

It is assumed that road cyclists who currently use the A83(T) would move to the new route which has a similar vertical profile to the current road, although 1km longer, the current A83(T) would be de-trunked and removed as a through road. It is assumed that part of the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path, the south-eastern end of the OMR and the local path along the Croe Water to the northeast of the current road.

The Green Option is additionally directly adjacent to the Ardgartan Peninsula Circuit cycle route and a Loch Lomond and The Trossachs NP core path on the southwestern side of

Glen Croe for around 350m, although the footprint of the finished route would not impact this path.

As the core path is also a forestry extraction route, the temporary diversion or widening measures put in place during construction for the northernmost 100m of the path could be made permanent.

The Green Option would cross the OMR's link to the current A83(T), although there is another link between the two 180m further northwest that would not be affected.

Social Environment

Private property and housing

There are two residential properties located c.300m and c.510m from the Green Option. It is assumed that the current A83(T) would remain in place as an access road to the property at Laigh Glencroe from the south.

Community Land and Assets

The Green Option would result in the loss of 0.14ha of the current Rest and Be Thankful car park. While the viewpoint may be smaller than that at present, it is anticipated that the viewpoint would be renewed and upgraded.

The option would require realignment of the junction to the B828 and the current bus turning area and bus stop, but a new turning area of equivalent dimensions would be provided.

Institutional and built environment

Agricultural Land Holdings

It is anticipated that this option would have no ongoing issues with the area of improved and semi-improved pasture used for grazing, with no implications for ongoing farming viability.

This option would result in less area available for commercial forestry plantation, though it is anticipated trees could be replanted in relatively close proximity to the new route (at a distance while still maintaining road safety) and ongoing viability of the commercial forestry would not be threatened.

11.4.2.2. Yellow Option

Health related behaviours

Walkers, cyclists and horse riders

The Yellow Option crosses the OMR at two points. While the permanent footprint would not further impact this route, sections would likely be used as the principal access for maintenance of the new route. During operation, access to the viaduct for maintenance actives should be of low frequency with any vehicles accessing in a controlled environment. Therefore, there should be little disturbance to the users of the OMR during operation.

It is assumed that road cyclists who currently use the A83(T) would move to the new route, which has a similar vertical profile to the current road. The current A83(T) would be de-trunked and removed as a through road.

It is assumed that part of the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path and the local path along the Croe Water to the northeast of the current road.

Social Environment

Private property and housing

There are two residential properties located c.100m and c.170m from the Yellow Option. The Yellow Option crosses the access from the OMR to the closer property at High Glencroe, although due to being a viaduct at this point the access to the property will not be affected during operation aside from occasional maintenance access from the OMR.

Community Land and Assets

The Yellow Option will have resulted in the loss of 0.1ha of the Rest and Be Thankful car park. While the viewpoint may be smaller than that at present, it is anticipated that the viewpoint will be renewed and upgraded.

The Yellow Option would include improvements to the junction to the B828 which may require modifications to the bus stop and turning area local to the Rest and Be Thankful viewpoint. Should the Yellow Option encroach onto the bus turning area, the bus turning area and stop will be restored to the same or better standard in consultation with the local authority and other relevant parties.

Institutional and built environment

Agricultural Land Holdings

There are a number of agricultural buildings and livestock pens along the OMR, particularly in proximity to the southern point where the Yellow Option crosses the OMR. This option would result in less area available for grazing but is not anticipated to lead to issues regarding viability or severance.

11.4.2.3. Brown Option

Health related behaviours

Walkers, cyclists and horse riders

As the Brown Option is online of the current A83(T) and gradients are remaining the same, it is assumed that road cyclists will continue to use this road. The Brown Option includes verge widening that overlaps with the start of the path for Beinn Luibhean and a local path, although this would not strongly impact either path as a whole.

Social Environment

Private property and housing

There are two residential properties both located approximately c.270m from the Brown Option. As this is an online option the distance between the road and the properties will remain equivalent to the current situation. It is anticipated access to the new route will be maintained and will be designed to the latest standards.

Community Land and Assets

The Brown Option will have resulted in the loss of 0.12ha of the Rest and Be Thankful car park. While the viewpoint will be smaller than that at present, it is anticipated that the viewpoint will be renewed and upgraded.

The Brown Option would include improvements to the junction to the B828 which may require modifications to the bus stop and turning area local to the Rest and Be Thankful. Should the Brown Option encroach onto the bus turning area, the bus turning area and stop will be restored to the same or better standard in consultation with the local authority and other relevant parties.

Institutional and built environment

Agricultural Land Holdings

As the Brown Option is for the most part aligned with the existing A83(T), it is considered there will be no ongoing issues for agricultural operations in the area. The new route will potentially provide opportunities to improve aspects such as local access to agricultural holdings through a general route upgrade and improved access points to current design standards.

11.4.2.4. Pink Option

Health related behaviours

Walkers, cyclists and horse riders

It is assumed that part of the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path and the local path along the Croe Water to the northeast of the current road, although it would no longer be a through road.

As the Pink Option includes a tunnel, road cyclists that currently use the A83(T) would be prohibited from using the new road. Cyclists who wish to continue to use the A83(T) will be directed to bypass the tunnel and will be directed to the OMR via a new cycle track. Once on the OMR the cyclists can join the B828 and then the de-trunked section of the A83(T) which will now act as an extension of the B828 to the new junction to the A83(T) north of the tunnel. The gradients on the new cycle track/OMR would be above 14.7% for a distance of 140m to the north of High Glencroe. This may represent a challenge to some cyclists. To mitigate this rest areas will be considered along the steeper sections of the OMR in consultation with user group.

The Pink Option crosses underneath the Beinn Luibhean path and the local path along the Croe Water to the northeast of the current road, although due to being a tunnel the finished route would not impact either path.

Social Environment

Private property and housing

This Pink Option will have led to the removal (demolition) of one property at Construction phase, so there will be only one property located c.350m from the Pink Option.

It is anticipated that during operation there would be generally only a requirement for ad hoc maintenance squads (though a small maintenance facility would be required) and the workforce required to build this route would have left the area. As such there will be no ongoing impact on housing availability, cost and availability of rental properties.

Community Land and Assets

The Pink Option will not result in any loss to the Rest and Be Thankful car park, although it would result in the car park being a detour from the main road.

The Pink Option requires minor realignment in the proximity of the bus stop and turning area to allow of the change in priority. The works are not considered to adversely impact the current provision however this will be reviewed and should the Pink Option be taken forward the bus stop and turning area will be provided to a standard equivalent or better than the existing in consultation with the local authority and other relevant parties.

Institutional and built environment

Agricultural Land Holdings

It is anticipated that the Pink Option would have no ongoing issues with the area of improved and semi-improved pasture used for grazing. While some area of forestry land would have been lost it is anticipated there would be no ongoing impacts on forestry operations.

11.4.2.5. Purple Option

Health related behaviours

Walkers, cyclists and horse riders

It is assumed that part of the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path and the local path along the Croe Water to the northeast of the current road, although it would no longer be a through road.

As the Purple Option includes a tunnel, road cyclists that currently use the A83(T) would be prohibited from using the new road. Cyclists who wish to continue to use the A83(T) will be directed to bypass the tunnel and will be directed to the OMR via a new cycle track. Once on the OMR the cyclists can join the B828 and then the de-trunked section of the A83(T) which will not act as an extension of the B828 to the new junction to the A83(T) north of the tunnel. The gradients on the new cycle track/OMR would be above 14.7% for a distance of 140m to the north of High Glencroe. This may represent a challenge to some cyclists. To mitigate this

rest areas will be considered along the steeper sections of Local Path 2(OMR) in consultation with user group.

The Purple Option crosses the OMR at two points. While the finished route footprint would not further impact this path, sections would likely be used as the principal access for maintenance. During operation, access to via the OMR will be limited to maintenance actives which should be of low frequency with any vehicles accessing in a controlled environment. Therefore, there should be little disturbance to the users of the OMR during operation.

The widening of the road at the northern end of the Purple Option would have resulted in the loss of the current parking spaces for the path to Beinn an Lochain.

Social Environment

Private property and housing

There are two residential properties located c.80m and c.110m from the Purple Option.

The Purple Option crosses the access from the OMR to the closer property at High Glencroe, although due to being a viaduct at this point the access path will not be affected during operation aside from occasional maintenance access from the OMR.

Community Land and Assets

This Option would not result in any loss to the Rest and Be Thankful car park. It is anticipated that the viewpoint will be renewed and upgraded.

This option requires minor realignment in the proximity of the bus stop and turning area to allow for the change in priority. This is not anticipated to adversely impact the bus stop which will remain accessible from the A83(T). The works are not considered to adversely impact the current provision, however this will be reviewed and should this be taken forward the bus stop and turning area will be provided to a standard equivalent or better than the existing in consultation with the local authority and other relevant parties.

Institutional and built environment

Agricultural Land Holdings

There are a number of agricultural buildings and livestock pens along the OMR, particularly in proximity to the southern point where the Purple Option crosses the OMR. This option would result in less area available for grazing but is not anticipated to lead to issues regarding viability or severance.

11.4.3. Operational Phase – Summary of Assessment

The following sets out consideration of effects during operation of the proposed scheme. As per LA 112, in terms of land use and accessibility, consideration has been made up to year 1 of operation after which it is considered that land use and accessibility effects associated with routine maintenance operations are unlikely to be significant. In terms of human health, consideration has been made up to year 15 of operation after which it is considered that human health effects associated with routine maintenance operations are unlikely to be significant.

It is to be recognised that completion of any of the Options would be in line with general Policy objectives (set out in Section 11.2.3) to reduce health inequalities, improve connectivity to health services, improve safety etc and have beneficial effects across the wider area in terms of land use and accessibility and health during operation and at this stage no clear differentials between the Scheme Options has been identified. This is reflected below with operational effects reported as narrative only, with no effects tables for this phase derived. It is to be considered that operational effects are applicable with each of the options unless otherwise noted.

It is anticipated that all Scheme Options will provide robust and safe connections through the region, reducing severance and allowing people to access the health, educational, economic and leisure facilities and opportunities that they require.

11.4.3.1. Social Environment

Private property and Housing

During operation it is not anticipated there would be any significant impacts to private property and housing from development of any of the Scheme Options beyond that which is identified in other discipline chapters. Note that the loss of one residential property (due to maintaining traffic on the A83(T) during construction of the Pink Option) has been addressed at construction stage and is not considered further here.

It is anticipated that for all Scheme Options, any temporary land take from private property and housing during construction would be returned to its original condition on completion of the works and as such neutral impacts and a neutral health outcome are predicted.

It is anticipated that for all Scheme Options, access to properties (residential and agricultural) will be upgraded where required. Accesses would be designed to the latest standards and as such can be anticipated to be safe. Depending upon the scheme option chosen, some property may experience an increase in journey time to access the main route

than at present, though this is not considered to be significant (slight adverse) and a neutral health outcome. Such changes to access would be considered permanent.

In respect of all Scheme Options, there may be some beneficial indirect effects on the wider housing market and housing availability due to improved connectivity, reduced congestion (improved traffic flow), more reliable journey times, and overall improvements to access, however any impacts are not predicted to be significant (slight beneficial) and are anticipated to likely result in a positive health outcome.

Community Land and Assets

Operational activities are not anticipated to impact on community land and assets beyond that which is identified in other discipline chapters for any of the Scheme Options. Disruptions and changes to access as a result of construction activities would all be alleviated on completion of the scheme.

Similarly, it is anticipated that any increased demand on Community Assets such as health, recreational and educational facilities from a large construction related workforce required for any of the Scheme Options in the area will be dissipated as the construction period ends. As such effects are considered neutral and a neutral health outcome is reported.

Provision of improved pedestrian and cyclist crossing facilities and new underpasses to maintain farm access (if required) and provide a safe route for walkers, cyclists and horse riders ensures access to existing community land and assets would be maintained and improved during operation. Slight beneficial effects and a positive health outcome are then anticipated. Any impacts that the Scheme Options had on the Rest and Be Thankful Viewpoint will also be removed via either replacement of the viewpoint with a new area (in the case of the Green, Yellow and Brown Options), or potentially an upgrade to the existing viewpoint in respect of the Pink and Purple Options. In short, it is anticipated that all of the Scheme Options will result in enhanced facilities at a new or existing viewpoint at Rest and Be Thankful. Slight beneficial effects and a positive health outcome are then anticipated. Similarly, it is anticipated that amenity value at the Honeymoon Bridge car park / picnic area will be restored and enhanced for all options.

In terms of health, operational activities related to the Scheme Options are not anticipated to impact on community land and assets beyond that which is identified in other topic areas within this assessment. Amenity impacts as a result of construction activities would all be alleviated on completion of the scheme. While the different scheme options have different route lengths and as such, relatively longer or shorter journey times, it is anticipated that this would still have positive health outcomes i.e. a beneficial health impact is identified for all

Scheme Options due to all routes providing robust and safe connections through the region, reducing severance and allowing people to access the health, educational, economic and leisure facilities and opportunities that they require. Note that health benefits are anticipated in the wider area (some of which could be potentially significant), with no differential seen between Scheme Options.

11.4.3.2. Institutional and Built Environment

Agricultural Land Holdings

There would be no operational impacts on land use as road and landscape maintenance will take place within the road boundary for all of the Scheme Options. It is anticipated that all of the Scheme Options will have adequate fencing etc., to ensure no encroachment of livestock onto the route. Matters of compensation or ongoing landowner engagement are outside the scope of this option assessment.

In respect of the Yellow and Purple Options, permanent land acquisition of areas currently utilised for agriculture (improved and semi-improved grazing) will be required, though it is anticipated that neither Option would result in loss of viability of farm holdings. Both Options also offer the potential for increased / improved access to agricultural outbuildings. The use of a viaduct in these areas should mean that farm severance is not an issue.

In relation to the Green Option, there would be the permanent loss of land that is currently utilised for forestry plantation, though it is anticipated that this loss of land would not affect the viability of future forestry plantation in this area. Of note, any net loss of woodland cover shall be replaced at an equivalent rate at another location in consultation with the landowner.

In short, it is anticipated that while there would be permanent land loss for all of the options, none of the Scheme Options would result in the loss of viability of any land holding and effects are considered neutral.

No health impacts have been identified in relation to any of the Scheme Options in terms of the operational phase on any agricultural land holdings.

11.4.3.3. Health related behaviours

Walkers, Cyclists and Horse riders

During the operational phase of the scheme, it is anticipated that whichever Scheme Option is utilised, improvements will be made to the WCH network, both along the new route and in the wider area. Different patterns of use will likely emerge, but it is not anticipated that there would be any significant adverse effects. For example, in relation to the Green Option, it is

assumed that road cyclists who currently use the A83(T) would move to the new route which has a similar vertical profile to the current road, although 1km longer, the current A83(T) would be de-trunked and removed as a through road. It is assumed that part of the current A83(T) would remain open as an access road from the south to allow continued access to the Beinn Luibhean path, the south-eastern end of the OMR and the local path along the Croe Water to the northeast of the current road. It is also anticipated that walkers and cyclists who currently use the existing forestry track which would be lost through the development of the Green Scheme Option would utilise alternative routes within the wider WCH network.

In respect of the Purple Scheme Option, as this route includes a tunnel, road cyclists that currently use the A83(T) would be prohibited from using the new road. Cyclists travelling north who wish to continue to use the A83(T) will be directed to bypass the tunnel from the southern portal and having travelled along the new viaduct will be directed to the OMR via a new cycle track. Once on the OMR the cyclists can join the B828 and then the de-trunked section of the A83(T) which will not act as an extension of the B828 to the new junction to the A83(T) north of the tunnel. The gradients on the new cycle track/OMR would be above 14.7% for a distance of 140m to the north of High Glencroe. This may represent a challenge to some cyclists. To mitigate this rest areas will be considered along the steeper sections of Local Path 2(OMR) in consultation with user groups.

In short, it is anticipated that none of the Scheme Options would have adverse effects during operation on WCH, rather the Scheme Options all present opportunities for improvements.

On a wider note, which applies to all Scheme Options, in the early period of operation, changes in traffic levels and an unawareness of altered traffic movements or new road layouts, can result in concern or stress in road users particularly from sensitive road users (e.g. motorcyclists, elderly drivers, children, pedestrians, new drivers and cyclists). This could lead to the increased risk of injury and death / decline in safety. While a negative health outcome is anticipated, these are not considered to be significant and effects are considered temporary, direct, and reversible as people become familiar with the new road layout and changes in traffic.

11.5. Potential Mitigation

As part of the assessment, it is assumed that an Environmental Management Plan will be enacted during the Construction phase, with clear maintenance management protocols enacted during the Operation Phase and this will set out clear and concise information that states how the mitigation and management of environmental effects will be delivered and maintained. It is also anticipated that in relation to Land Use and Accessibility and Human

health that the mitigation hierarchy outlined in LA 112 would be followed during the design process and also at Stage 3.

It should be noted that mitigation of relevance to land use and accessibility, as well as human health, is also set out in relevant technical chapters.

11.5.1. Construction

While the Proposed Scheme design has not commenced, it is anticipated that during construction of the Proposed Scheme, a number of mitigation measures would be put in place to reduce potential impacts on population and human health and would likely include the following.

A Traffic Management Plan (TMP) would be implemented by the appointed Principal Contractor to reduce the impacts from construction traffic, including measures to reduce worker vehicle movements and HGV movements, particularly at peak periods. It is anticipated this would include measures to control / reduce vehicle movement outside typical working hours e.g. weekends, Bank Holidays etc.

It is expected that some works may need to be carried out at night, (for example, road crossings and final surfacing tie ins). Night working would be agreed in advance with the relevant local authority. Similarly, particular attention will be paid to holiday periods.

It is anticipated dedicated haul routes will follow the new main line alignment where possible. Access for construction vehicles to the site would be from the trunk road network on designated routes which would be clearly signposted.

The main areas where the construction sites would interface with the travelling public would be at locations where connections to the existing network would be created. In these locations, extensive traffic management would be required to segregate the construction sites from road vehicles.

Planning of the Scheme construction works would be undertaken in order to minimise the need to close and divert footways, PRoW and cycle facilities, and minimise closures and diversion durations. Where the closure of WCH routes would be required (or diversion onto other routes) and safe and appropriate alternative means of access would be provided to ensure access would be maintained at all times in order to minimise temporary severance. This could include a shuttle service to take relevant users through the construction works.

Temporary road closures and diversions would be arranged following discussions with Argyll and Bute Council, police and the Trunk Road maintaining authority.

Land temporarily acquired for construction will be restored to a condition equivalent to its original state. This will be achieved by means of a Soil Resource Plan (SRP) following best practice such as that set out in DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[216].

There is no mitigation for permanent loss of agricultural land, apart from financial compensation which is outside the scope of an environmental assessment.

If required, it is anticipated underpasses and other means of access will be built into the Proposed Scheme where possible and so no agricultural land will be permanently severed. The only mitigation for extra journey times and other inconvenience caused by division of the agricultural holdings is financial compensation which, again, is outside the scope of an environmental assessment.

During the Proposed Scheme construction phase, appropriate mechanisms to communicate with local residents and businesses, as well as the wider community, would be set up to highlight potential periods of disruption (e.g. web-based, newsletters, newspapers, radio announcements, etc.). This would include the appointment of a Community Relation Manager (CRM) responsible for leading engagement with affected communities. The Community Engagement Plan would be prepared prior to construction and annexed to the EMP to outline the methods in which the local and surrounding community will be engaged during construction of the Proposed Scheme including contact details for key site management, including agricultural liaison officer.

The Proposed Scheme web-page would also provide up-to-date construction and community liaison information. The web-page would continue to provide updates regarding progress, details of areas affected by construction, and mitigation in place to reduce adverse effects. The communication approaches would help drivers and local residents to plan their journeys and take account of potential disruption due to the Proposed Scheme construction, as well as provide local residents with details of construction phase activities.

The EMP will include mitigation measures to minimise impacts on agricultural holdings during construction, these are anticipated to include:

- Arrangements through land agreements with the landowner for the maintenance of farm and field accesses affected by construction

[216] Department for Environment, Food and Rural Affairs. (`). Construction code of practice for the sustainable use of soils on construction sites. [Online]. Gov.uk. Last Updated: 2011. Available at: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-cons [Accessed 2 May 2023].

- The protection and maintenance of livestock water supply systems, where reasonably practicable, in agreement with the landowner through the Agricultural Liaison Officer and the Community Engagement Plan that would be prepared at prior to construction and annexed to the EMP
- The protection of agricultural land adjacent to the construction site, including the provision and maintenance of appropriate stock-proof fencing. This would be in agreement with the landowner through the Agricultural Liaison Officer and the Community Engagement Plan that would be prepared at prior to construction and annexed to the EMP
- The adoption of measures to control the deposition of dust on nearby receptors. Best Practice guidance will be followed to determine appropriate limits for the implementation of dust control measures to inform the development of the Nuisance Management Plan, annexed to the EMP
- The control of invasive and non-native species and the prevention of the spread of weeds generally from the construction site to adjacent agricultural land through an Invasive Non-Native Species Management Plan, that would be prepared at prior to construction and annexed to the EMP
- The adoption of standard industry best practice measures to prevent, insofar as reasonably practicable, the spread of soil-borne, tree-crop and animal diseases from the construction area
- Liaison and advisory arrangement with affected landowners, occupiers and agents, as appropriate, through the Agricultural Liaison Officer and the Community Engagement Plan that would be prepared at prior to construction and annexed to the EMP
- Replacement tree planting to ensure no net loss of area of forestry.

Where unrestricted agricultural uses are to be resumed on land disturbed during the construction of the Proposed Scheme, the design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land, through the adoption of good practice techniques in handling, storing and reinstating soils and field drains.

11.5.2. Operation

With respect to paths, these will be realigned as close to their original alignment as practical to avoid extending WCH routes, where possible. Where the Scheme would affect existing paths, replacement network provision would be made to ensure routes remain open by providing suitable crossing points or diversions. Where new paths are required, they would be designed to be as fully accessible as possible.

All other measures are covered in respective Technical Chapters.

11.6. Conclusions

A comparative summary table which outlines effects during construction is provided as Table 11.4. Note that in this assessment, effects which are considered Moderate, Large, or Very Large are considered to be Significant, while those which are considered to be Slight or Neutral are considered non-significant.

Please note that the following table does not consider issues such as Noise or Air Quality as these are addressed under individual specialist sections.

Table 11.4 Comparative Appraisal Population and Human Health (Construction)

Sub-topic	Receptor	Potential Impact	Significance of Effect (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Private Property and Housing – **Land Use and Accessibility**	Residential Properties within 500m of the Scheme Option	Disruption to Access and / or loss of property during construction	Slight Adverse	Slight Adverse	Large Adverse	Moderate Adverse	Moderate Adverse	The overall numbers of houses are very low in the immediate (500m) of all Options. The Pink Option results in the loss of 1 property. The Yellow and Purple Options result in substantial changes to access to 1 property during the construction phase. The Brown Option is along A83(T) and would avoid houses, though there could be disruption. The Green Option has the least adverse effects on residential properties.
	Housing market in wider area	Potential Impact on Housing Market	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	There is a potential that increased construction workers in the wider area (relative to overall local population) may put a pressure on the availability of local housing / rental accommodation. This is considered most likely during specialist periods such as bridge or tunnel work, as workers are less likely to be from the local area. As such, this may be greatest for the Yellow, Purple and Pink Options, though it is not considered significant for any Option.
Private Property and Housing – **Health**	Residential Properties within 500m of the Scheme Option	Disruption to Access and Amenity and / or loss of property	Slight Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Slight Adverse Negative health outcome	Slight Adverse Negative health outcome	The two residential properties are set well back from the Green Option (with only 1 being within 500m), though these are closer in proximity for all other options. However, for all options other than Brown, the majority of works would be offline from the A83(T) and as such disruption can be more easily managed

Sub-topic	Receptor	Potential Impact	Significance of Effect (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
								in terms of access along the A83, though it is accepted that OMR will be in use in respect of Brown Option. The Pink Option would result in the loss of one property and this could have adverse effects on residents in terms of health and wellbeing e.g. through stress.
	Houses within the wider area	Disruption to Access and Amenity	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Greater numbers of people would be frequently disrupted in the wider area, with all outcomes being considered of Moderate Adverse effect. Access can still be maintained along the A83(T) for all options other than Brown, while the Brown scheme option can avail of alternative routes.
	Housing market in wider area	Availability of housing	Minor Adverse Neutral health outcome – no discernible health impact is identified	Minor Adverse Neutral health outcome – no discernible health impact is identified	Minor Adverse Neutral health outcome – no discernible health impact is identified	Minor Adverse Neutral health outcome – no discernible health impact is identified	Minor Adverse Neutral health outcome – no discernible health impact is identified	Reduced availability of housing, or higher rental costs can be stressful and reduce wellbeing, leading to a negative health outcome. This is considered most likely during specialist periods such as bridge or tunnel work, as workers are less likely to be from the local area. As such, this may be greatest for the Yellow, Purple and Pink Options, but is not considered a significant impact for any Option.
Community Land and Assets – Land Use and Accessibility	Community Assets in the wider area	Disruption to Access and Amenity	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	It is considered that while there would be disruption to access to Community Assets in the wider area, there will be adequate accessibility provision made i.e. most works will be offline from A83, or OMR will be available for use.

Sub-topic	Receptor	Potential Impact	Significance of Effect (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
	Community Assets in the wider area	Increased demand on health and recreational facilities and other essential services from workforce	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	A large workforce in the area (relative to overall local population) may lead to increased demand on Community Assets such as health, recreational and educational facilities. This is considered most likely during specialist periods such as bridge or tunnel work, as workers are less likely to be from the local area. As such, this may be greatest for the Yellow, Purple and Pink Options, but is not considered a significant impact for any Option.
	Community Assets in the study area	Disruption to Access and Amenity	Large Adverse	Large Adverse	Neutral	Neutral	Large Adverse	The Green, Yellow and Brown Options would lead to the loss of the Rest and Be Thankful Viewpoint. Amenity value could be lost at Honeymoon Bridge car park / picnic area. There would be no impact on these areas of Open space and recreation from the Pink and Purple Options.
Community Land and Assets – Health	Community facilities within the study and wider area	Health and wellbeing outcome from disruptions, amenity impacts and changes in access to public open space and other community facilities within the wider area	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Slight Adverse Neutral health outcome – no discernible health impact is identified	Slight Adverse Neutral health outcome – no discernible health impact is identified	Moderate Adverse Negative health outcome	Moderate adverse effects on human health are anticipated in respect of loss / reduction in access to open space at the Rest and Be Thankful Viewpoint, as well as disruption to wider community assets. These effects would be temporary, direct and reversible and amount to a Negative Health Outcome in line with LA 112.

Sub-topic	Receptor	Potential Impact	Significance of Effect (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Agricultural Land Holdings – Land Use and Accessibility	Agricultural Land holdings within study area	Loss, disruption, changes to access and viability of holding - pasture	Slight Adverse	Slight Adverse	Slight Adverse	Moderate Adverse	Moderate Adverse	The Green and Brown Options result in minimal loss of areas of pasture, though Green results in loss of forestry. The Yellow and Purple Options are along the valley floor in an area of improved / semi-improved pasture. The Yellow and Purple Options also pass in close proximity to agricultural out buildings and could lead to severance of agricultural activities, during construction of the viaduct. The Pink Option results in the loss of some forestry and potential rough grazing areas.
		Loss, disruption, changes to access and viability of holding - Forestry	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	While there would be a need to fell a large number of trees along the Green Option, it is not anticipated that this would adversely effect the viability of this commercial forestry, particularly if a commercial yield can be taken prior to construction. Smaller areas of tree loss are also associated with the Pink and Brown Options.
Walker, Cyclists and Horseriders (WCH) – Land Use and Accessibility	WCH Routes	Disruption, changes to access and viability of WCH routes in the study area	Moderate Adverse	Moderate Adverse	Moderate Adverse	Slight Adverse	Slight Adverse	There would likely be disruption to access to walking routes in the study area. Of particular note, the Green and Brown Options would lead to disruption / diversion of the start of routes, while the Pink Option would lead to disruption at the start of two routes from A83(T) to higher ground and also bisect these routes at a higher elevation. Note that it is accepted that access can be

Sub-topic	Receptor	Potential Impact	Significance of Effect (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
								maintained during construction, though disruption would be likely.
		Direct loss of WCH route – loss of core paths, forest recreation routes	Very large	Moderate Adverse	Moderate Adverse	Very large	Very large	The Green, Purple and Yellow Options are likely to lead to the loss of, or significant and prolonged disruption to important and popular WCH routes in Ardgartan Forest or along OMR.
	Public transport	Disruption of public transport routes in wider area	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	It is considered that while there would be disruption to public transport in the wider area, there will be adequate accessibility provision made i.e. most works will be offline from A83, or OMR will be available for use.
Walker, Cyclists and Horseriders (WCH) – Health	WCH Routes	Health and wellbeing outcome from disruption, changes to access and viability of WCH routes in the study area	Moderate Adverse Negative health outcome	Slight Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	The Brown Option is mainly along the existing A83(T) and as such for the most part avoids walking trails.
		Health and wellbeing outcome from direct loss of WCH route – loss of Core Paths, Forest recreation routes	Moderate Adverse Negative health outcome	Slight Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	Moderate Adverse Negative health outcome	The Brown Option is mainly along the existing A83(T) and as such avoids walking trails. Greatest disruption and loss to walking trails is along the Green Scheme Option, though for all Options there are likely opportunities to mitigate impacts. There are also extensive walking routes in the wider area which would remain undisturbed.
	Public transport	Health and wellbeing outcome from disruption of public transport routes in wider area	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	It is considered that while there would be disruption to public transport in the wider area, there will be adequate accessibility provision made i.e. most

Sub-topic	Receptor	Potential Impact	Significance of Effect (Residual Effects)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
			Negative health outcome	Negative health outcome	Negative health outcome	Negative health outcome	Negative health outcome	works will be offline from A83, or OMR will be available for use.

It is clear from the assessment of options and comparative analysis presented in Section 11.6 that the construction and operation of the Scheme Options would result in effects on population and human health. For the most part effects are confined to the construction phase and in some instances, it is anticipated that effects could be significant due to the nature of construction activities, including the requirement to close or divert walking routes and disruption to access. However, it is anticipated that such effects can be mitigated and would be temporary to the construction phase.

During the construction stage, it is possible to identify the Brown Scheme Option as the most favourable out of the Options from consideration of Population and Human Health issues. Of particular note, the Brown Scheme Option is along an existing route and has little direct impact on Agricultural Land Use or WCH routes. Both the Purple and Pink Scheme Options are anticipated to have the least impact on the Rest and Be Thankful viewpoints, but this is offset by impacts on WCH routes.

The Pink Scheme Option would result in the loss of a residential property, and as such is considered the least favourable along with Green and Yellow Scheme Options which both have potentially significant impacts on the Rest and be Thankful viewpoint and loss of (or significant and prolonged disruption to) important and popular WCH routes.

From a health perspective, during operation no significant differentiators between any of the Scheme Options have been identified at this stage. It is anticipated that the Proposed Scheme (whichever Scheme Option is chosen) will provide robust and safe connections through the region, reducing severance and allowing people to access the health, educational, economic and leisure facilities and opportunities that they require.

Detailed population and human health Assessment Tables for the construction phase are set out in Appendix 11.3 for each Scheme Option.

11.7. Scope of DMRB Stage 3 Assessment

DMRB Stage 3 would be undertaken for the Preferred Option, examining at a greater level of detail those issues set out in LA 112 as follows:

Land-use and accessibility including;

- private property and housing;
- community land and assets;

- development land and businesses[217];
- agricultural land holdings; and
- walkers, cyclists and horse-riders (WCH).

Human health including;

- health profiles of affected communities;
- health determinants (e.g noise or air pollution); and
- likely health outcomes.

The methodology followed would be as per LA 112 and would build upon that set out in this Stage 2 assessment. For example, more detailed consideration would be given on agricultural activities within the study area, with consideration made of the specific ownership of land holdings and how farms operate.

Note that The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017 (SSI 2017 No.137) require an Environmental Impact Assessment Report to include, among other topics, assessment of potential effects upon human health, and it is taken that this will include potential impacts/effects on physical, mental, and social wellbeing. A key element to the EIA Regulations is that they require identification and a description of 'the likely significant effects of the project'.

While LA 112 sets out the requirements for assessing and reporting the environmental effects on human health for construction and operation of roads projects, it must be borne in mind that LA 112 provides a means to derive a human health outcome category and provides no mechanism to derive significance of effect, which as noted, is a requirement of the EIA Regulations.

The Institute of Environmental Management and Assessment (IEMA) Guide To 'Determining Significance for Human health in Environmental Impact Assessment' sets out the requirements for assessing the direct and indirect effects, in an appropriate manner, of a proposed development on human health.

The Stage 3 assessment will use the World Health Organization (WHO) definition of health, as set out in the IEMA Guidance document which means 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'.

[217] Note this element has been scoped out of this route selection appraisal due to the lack of development land and business in the route corridor, but this decision would be reviewed as part of Stage 3 and would be scoped back into the assessment if required.

Health is influenced by a range of factors, termed the ‘wider determinants of health’. Determinants of health span the bio-physical, social, behavioural, economic and institutional factors The IEMA guidance document provides a framework for concluding on the significance of population health effects that can be applied across the wider determinants of health.

The IEMA guidance document recognises that significance at the level of individuals is not proportionate, and as such establishes a method for assessing significance at a populations, or disproportionate effects to relevant sub-populations, i.e. groups of more sensitive individuals.

It is considered that the requirements set out in LA 112 can be integrated with the IEMA guidance in order to provide an assessment and report that is both compliant with LA 112 and that of the EIA Regulations. This is the approach that has been taken in this DMRB Stage 2 assessment and it is considered that this approach would be built upon at DMRB Stage 3.

12. Effects on Climate

12.1. Introduction

This chapter of the DMRB Stage 2 Report presents the assessment of the potential impacts on the climate from the Greenhouse Gas (GHG) emissions emitted from Scheme Options, identifying baseline conditions, the anticipated impacts, and the mitigation and enhancement measures that may be required to avoid or reduce effects during both the construction and operational phases.

The climate assessment is split into two parts with climate vulnerability and resilience being assessed within Chapter 13 Climate Vulnerability.

12.2. Approach and Methods

12.2.1. Introduction

The scope of the Effects on Climate assesses the effects of the Scheme Options on climate during construction and operation. It identifies the study area, describes the methodology, presents baseline conditions, identified potential impacts on climate and presents suggested mitigation measures during construction and operation. The approach taken aligns with the guidance set out in DMRB LA 114 Climate.

The Scheme Options have the potential to affect the Earth's climate by emitting GHGs into the atmosphere, which will occur during construction and throughout its operational life. The earth absorbs energy from the sun and re-emits it as thermal infrared radiation. GHGs in the atmosphere absorb this radiation, preventing it from escaping into space. The higher the concentration of GHGs, the more heat energy is retained, and the higher global temperatures become. Due to human activities the concentration of GHGs in the atmosphere has increased dramatically, leading to global warming. This leads to a myriad of indirect impacts as the climate responds to the increased atmospheric temperature.

The UK has made commitments to tackle the root cause of climate change by reducing GHG emissions, as well as to increase the resilience of development and infrastructure to the changing climate. The Climate Change Act 2008 (amended in 2019) sets a target to reduce net GHG emissions by at least 100% from 1990 levels by the year 2050 (i.e. reach Net Zero).

Scotland also has its own GHG emissions targets. The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 sets a target to reduce GHG emissions by at least

100% from 1990 levels by the year 2045[218], 5 years ahead of the UK target. Scotland also has interim targets for each year in place. The interim target for 2030 is a 75% reduction in GHG emissions from 1990 levels[219].

The effective assessment and management of impacts on climate offers the opportunity to reduce the impact of projects on climate by minimising the magnitude of GHG emissions as far as possible.

This chapter presents the assessment of the Scheme Options and their effect on climate. To differentiate between the Scheme Options, a 'most favourable' and 'least favourable' option has been identified for Effects on Climate.

12.2.2. Sources of Information

The primary source of information for the Stage 2 Assessment has been provided by the design team.

Materials emissions factors are sourced from the Bath Inventory of Carbon and Energy (ICE) database v2 and v3[220]. All energy and waste factors are taken from Government Carbon Factors 2021. Where an input unit is not required as a mass, such as numbers or metres of a product, a conversion factor is applied. This is based upon the mass of a product calculated using suppliers' specifications and technical drawings.

12.2.3. Policy, Legislation and Guidance

Table 12-1 - Summary of Legislation and Policy relevant to Effects on Climate

Policy / Legislation	Summary
Paris Agreement (2015)	Strengthened negotiations at COP21 led to the 2015 Paris Agreement, the aim of which is to maintain the increase in global average temperature at 'well below' 2°C and 'pursue efforts' to limit the temperature increase even further to 1.5°C. In 2018, the IPCC published a special report in response to the Paris Agreement, to present the impacts of the targeted 1.5°C temperature rise. The report highlighted that to achieve this, global emissions must decrease by 45% by 2030 (against a 1990 baseline), and that net zero global emissions (where emissions and removals from the atmosphere are balanced) must be achieved by 2050. This is noted to require rapid and far-reaching transitions of every sector on an unprecedented scale.

[218] Climate Change (Emissions Reduction Targets) (Scotland) Act, 2019, Acts of Scottish Parliament, Available from: https://www.legislation.gov.uk/asp/2019/15/enacted
[219] Climate Change (Scotland) Act 2009 interim target amendment regulations 2023, 2023, Scottish Government, Available from: https://www.gov.scot/publications/climate-change-scotland-act-2009-interim-target-amendments/
[220] Embodied Carbon – The ICE Database, 2019, Circular Ecology, Available from: https://circularecology.com/embodied-carbon-footprint-database.html

	The Glasgow Climate Pact, resulting from COP26 held in 2021, strengthened focus on limiting the temperature rise to 1.5°C, recognising the severity of climate impacts above this limit.
Climate Change Act (2008) as amended in 2019	To support international efforts, the UK Climate Change Act (2008) set a legal reduction target of 80% for the UK against 1990 levels by 2050. It also introduced a series of carbon 'budgets' for five-year periods, to act as stepping-stones to the overall reduction. There are budgets currently set up to 2037. In response to the ambitions of the Paris Agreement, in 2019 the Climate Change Act was amended to set the overall reduction target by 2050 to at least 100% in net emissions against 1990 levels. The UK has so far outperformed its budgets, but progress is slowing, and the country is not on track to meet its future budgets or the overall reduction target, according to the most recent Progress Report to Parliament by the CCC.
Climate Change (Scotland) Act (2009)	This Act was a direct parallel of the UK's Climate Change Act (2008) requiring a reduction target of 80% against 1990 levels by 2050 for Scotland only. It also sets annual GHG emission targets. The Act requires the preparation of strategic programmes for climate change adaptation, as soon as reasonably practicable after each round of UK Climate Change Risk Assessment.
The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019	This Act changed the legal reduction target set in the 2009 Climate Change Act to 100% reduction against 1990 levels by 2045. This moved the target data for 'net zero' for Scotland forward by five years and set the statutory interim and annual targets.
National Policy Framework 4 (NPF4) – Scotland 2022	NPF4 sets out the long term plan for Scotland for 2045. It was published in 2021 and public consultation closed on March 2022. It includes how to tackle and adapt to climate change, and how to make progress towards the target of net zero emissions, including the importance of offshore renewables in transitioning to net zero.
Transport Scotland's Carbon Management Plan 4th Edition (2022-2027)	The 4th edition of the Carbon Management Plan sets out Transport Scotland's commitment to achieving Net Zero across their corporate functions. They have set the following targets, that align with the Scottish Government's net zero targets: • By 2025, Transport Scotland's Scope 1 emissions will be zero, • By 2025, Transport Scotland's Scope 2 emissions will be Net Zero, • By 2025, Transport Scotland's Scope 3 emissions will be Net Zero primed, • By 2027, Transport Scotland will reduce indirect emissions by 15% (combination of Scope 2 & 3) • By 2045, Transport Scotland's Scope 'I' emissions will be Net Zero. Scope 'I' emissions are those outside of Transport Scotland's direct operational control.
Argyll & Bute Council Decarbonisation Plan 2022-2025 (2021)	The Council's Decarbonisation Plan sets out a 3 year framework to aid the Council in their following targets: • Achieve a 75% carbon reduction by 2030 • Achieve net zero before 2045

12.2.4. Consultation

No specific consultation relating to effects on climate has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA, NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

12.2.5. Scope of Stage 2 Assessment

The life cycle stages and GHG emissions sources included or not included within the assessment are presented in Table 12.1, in accordance with DMRB LA 114 Section 3.11.1.

Table 12.2 Sources and lifecycle stages for Stage 2 route carbon emissions

Main stage of project lifecycle	Sub-stage of life cycle	Potential sources of GHG emissions (not exhaustive)	Scoped in or scoped out?
Construction Stage	Product stage; including raw material supply, transport and infrastructure	Embodied GHG emissions associated with the required raw materials	Scoped In – For major bulk materials only
	Construction processes stage; including transport to and from works site and construction processes	Activities for organisations conducting construction work.	Scoped In – Qualitative assessment undertaken
	Land Use Change	GHG emissions mobilised from vegetation or soil loss during construction	Scoped Out – land use change not a Stage 2 differentiator
Operational Stage	Use of infrastructure by the end-user (road user)	Vehicles using roads infrastructure	Scoped Out – operational aspects not a Stage 2 differentiator
	Operation and maintenance	Energy consumption for infrastructure operation and activities of organisations conducting routine maintenance.	Scoped Out – operational aspects not a Stage 2 differentiator
	Land use and forestry	Ongoing land use GHG emissions/sequestration each year	Scoped Out – land use change not a Stage 2 differentiator
Opportunities for reduction	GHG emissions potential of recovery including reuse and recycling GHG emissions potential of benefits and loads of additional functions associated with the study system	Avoided GHG emissions through substitution of virgin raw materials with those from recovered sources	Scoped In - waste arisings and material quantities recycling / reuse fate.

12.2.6. Assessment Methodology

The approach taken aligns with the DMRB LA 114 Climate, DMRB LA 105 Air quality and TAG Unit A3 Environmental Impact Appraisal, Chapter 4 Greenhouse Gases[221]

It is key to note that whilst Effects on Climate is a wide-ranging topic in terms of potential sources, it is simple in terms of its receptors and impacts because:

- there is only one receptor, the atmosphere; and
- there is only one direct impact, global warming.

All units of Carbon Dioxide equivalent (CO_2e) (the standard unit that compared emissions of GHGs based on their Global Warming Potential) can be considered to have the same impact no matter where they are emitted.

The assessment of the effects of the Scheme Options (referred to as the Do-Something scenario) on climate is limited to quantification of the magnitude of emissions, from individual sources and in total, and comparison of these to the baseline (referred to as the Do-Minimum Scenario). Different GHGs have different global warming potentials, and to account for this they will be reported throughout this assessment as their CO_2e.

The goal of the assessment is to calculate the emissions anticipated to be generated by the Proposed Scheme to:

- determine the magnitude of the Scheme Options' effect on climate, in comparison with the Do Minimum scenario;
- assess the significance of the effect on climate by considering it in context with UK carbon reduction targets and carbon budgets; and
- enable identification of emissions hot spots within the design to inform identification of appropriate mitigation measures.

Emissions calculations are carried out by multiplying activity data by an emission factor associated with the activity being measured. Activity data is a quantitative measure of an activity that results in emissions during a given period of time (e.g. kilometres driven, kWh electricity consumed, tonnes waste sent to landfill). An emission factor is a measure of the mass of emissions relative to a unit of activity.

[221] TAG Unit A3 – Environmental Impact Appraisal, 2022, Department for Transport. Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1102784/tag-unit-a3-environmental-impact-appraisal.pdf

12.2.6.1. Calculating construction emissions

A quantification of construction phase emissions for each Scheme Option has been calculated using the Atkins' Carbon Knowledgebase tool (hereafter referred to as the 'Carbon Tool'). The Carbon Tool contains a detailed library of calculation formulae and over 1,000 emissions factors from authoritative sources such as the Inventory of Carbon and Energy (ICE, versions 1.6(a), 2.0 and 3.0) (Circular Ecology, 2022), the Department for Environment, Food and Rural Affairs (Defra) Greenhouse Gas Reporting Conversion Factors (Defra, 2022), and the EMEP/CORINAIR Emission Inventory Guidebook (EMEP/EEA, 2019).

The Carbon Tool uses a range of pre-programmed materials data (e.g. mass) and carbon factors to calculate an itemised and overall emissions total. Materials emissions factors are sourced from the Bath Inventory of Carbon and Energy (ICE) database v2 and v3[222]. These factors are given as tonnes of CO_2e per tonne of material (written as tCO_2e/t). All energy and waste factors are taken from Government Carbon Factors 2021. Where an input unit is not required as a mass, such as numbers or metres of a product, a conversion factor is applied. This is based upon the mass of a product calculated using suppliers' specifications and technical drawings.

When a product contains multiple materials a weighted average carbon factor has been calculated using multiple factors from the ICE. ICE carbon factors used within the Carbon Tool include the embodied carbon within the raw materials but do not account for the carbon associated with the manufacture or processing of the raw materials into a product prior to their purchase by the reporting contractor[223].

The design and construction information for each of the Scheme Options was obtained from the design team.

Data for as many categories as possible has been collected for this stage. However, data is not available for several categories of materials due to the current stage of design for each of the Scheme Options and therefore several components have not been modelled at this stage of the assessment.

There is no data available on the expected construction plant usage and activities for the Scheme Options therefore the anticipated emissions from construction activities have been qualified using specialist judgement and construction activity emissions produced from

[222] Embodied Carbon – The ICE Database, 2019, Circular Ecology, Available from: https://circularecology.com/embodied-carbon-footprint-database.html
[223] Emissions Factors tab of the Carbon Tool

similar schemes. Each of the Scheme Options has been given a rating based on this judgement. The ratings are:

- High – Construction activity emissions anticipated to be >20% of total construction phase emissions.
- Medium – Construction activity emissions anticipated to be between 10-20% of total construction phase emissions.
- Low – Construction activity emissions anticipated to be <10% of total construction phase emissions.

12.2.6.2. Transportation of materials

Information relating to where materials will be sourced is not yet available, as this will be determined at a later date by the appointed Principal Designer and Principal Contractor. It has been assumed that all materials would be transported an approximate worst-case distance of 50km by HGV, based on previous experience by specialists of materials transportation for infrastructure schemes, including road schemes and guidance provided by the Royal Institution of Chartered Surveyors[224]. Locally sourced materials are often preferentially used to reduce transportation cost and to minimise transport emissions, and many materials will be sourced from a distance of less than 50km.

12.2.6.3. Calculating operational emissions

As the Scheme Options are all designed to improve the safety and viability of the road, rather than to increase the capacity of the A83(T) it is assumed that the level of road-users will not change between the existing baseline and the Proposed Scheme. Therefore it is assumed that road user emissions are equal for each of the Scheme Options and compared to the baseline.

There is no project-specific data available for direct emissions associated with operating the Proposed Scheme, such as for lighting, or for maintenance and refurbishment during the Proposed Scheme's operational life.

[224] Whole Life Carbon Assessment for the Built Environment, 2017, Royal Institution of Chartered Surveyors. Available from: https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/whole-life-carbon-assessment-for-the-built-environment#:~:text=This%20guidance%20mandates%20a%20whole%20life%20approach%20to,the%20interpretation%20and%20implementation%20of%20EN%2015978%20methodology.

Overall, no operational emissions will be calculated for the Stage 2 assessment due to a lack of data available at this stage of design development, although it is noted that this is not considered a differentiator between Scheme Options.

12.2.6.4. IPCC's 2006 National Greenhouse Gas Inventories Comparison to UK carbon budgets

The UK has in place carbon budgets for five-year periods up to 2037. The proposed construction starting year for the Proposed Scheme is 2026 which falls within the fourth budget period (2022 to 2027). Each of the Scheme Options has a different construction phase length, they are:

- Yellow Option – 3.5 years;
- Brown Option – 4 years;
- Pink Option – 4.25 years;
- Purple Option – 3.75 years; and
- Green Option – 7 years.

For this assessment, each construction length is rounded to the nearest whole year. Given the different lengths in time for construction, the first year of the operational phase will vary for each of the Scheme Options and therefore will begin operating in different carbon budgets.

The results of emissions calculations will be presented in terms of their percentage contribution to the fourth, fifth and sixth carbon budget periods. It is assumed that these emissions are evenly distributed across the years.

12.2.6.5. Significance assessment

The emissions calculated for the Do Something scenario of the Scheme Options have been compared against the Do Minimum scenario baseline for the assessment years. The difference between the individual Scheme Options Do Minimum and Do Something scenario emissions can be considered to be the emissions impact for each of the Scheme Options.

DMRB LA 114, section 3.20 states that: 'The assessment of projects on climate shall only report significant effects where increases in GHG emissions will have a material impact on the ability of Government to meet its carbon reduction targets'. The table of reporting significance in section 3.18 of DMRB LA 114 has been used to compare the Proposed Scheme's carbon emissions with respective carbon budget periods. DMRB LA 114 also states 'it is considered unlikely that projects will in isolation conclude significant effects on climate'.

For this assessment, the Interim emission reduction targets for Scotland have been used. These are summarised in Table 12.3.

Table 12.3 Annual Emissions Targets for Scotland

Year	Emissions reduction target (compared to 1990 baseline) (%)	Annual Target (tCO_2e)
1990 (baseline year)	n/a	81,600,000 (actual emissions)
2023	61.7	31,252,800
2024	63.6	29,702,400
2025	65.5	28,152,000
2026	67.4	26,601,600
2027	69.3	25,051,200
2028	71.2	23,500,800
2029	73.1	21,950,400
2030	75	20,400,000
2031	76.5	19,176,000
2032	78.0	17,952,000

Source: Climate Change (Emissions Reduction Targets) (Scotland) Act 2019. Note that targets exist until 2045 but are not included to shorten the table.

12.2.6.6. Limitations and Assumptions

The data for the assessment has been provided by the design team and is as up to date for this stage of the design as can be reasonably expected. Where assumptions have been made, they have been selected to present the worst-case scenario for that item/factor.

Due to the Proposed Scheme being at Stage 2, there are a number of limitations due to insufficient knowledge and accuracy at this stage for the construction phase and where no general or specific assumption could be applied. The list of exclusions is provided below:

- drainage;
- fencing. barrier and road restraint systems;
- street furniture;
- electrical equipment;
- business and employee transport;
- land use and land use change;
- operational road user emissions;
- operational energy consumption; and
- operational maintenance and repair requirements.

A limitation of the assessment is the availability and accuracy of design and construction information to enable calculations. This may require assumptions to be made, and some industry standard data to be used as a proxy. The data and associated assumptions considered for the carbon emissions assessment are:

- road user emissions are assumed to be exactly the same for all Scheme Options.

12.3. Baseline Conditions

12.3.1. Study Area

The study area has been defined according to the DMRB LA 114. For the construction and operational maintenance, the study area comprises of the GHG emissions associated with project construction related activities/materials and their associated transport. For operational road user GHG emissions, the study area is consistent with the affected road network defined in the project's traffic model. The study area is not limited to the geographic extent of the Scheme Options themselves, as many emissions will result from upstream and off-site activities such as raw material extraction and processing.

The activities for which emissions have been quantified in the assessment include the direct and supply chain activities for the Do-Something scenario of the Scheme Options' lifecycle, for both the construction and operation stages. The specific elements of the Scheme Options' lifecycle included in the assessment boundary are listed in Table 12.2. The 'assessment boundary' defines the source of emissions considered, including direct or supply chain emissions.

12.3.2. Study Area Context

Baseline conditions are defined by the:

- total background emissions from all sources, i.e., all UK emissions, at all scales; and
- predicted total emissions assuming the Proposed Scheme is not constructed, i.e., the 'Do Minimum' scenario.

12.3.2.1. National emissions baseline

The UK's emissions for 2020 (the last reported year) were 406 million tonnes of CO_2e[225]. The transport sector was the largest emitting sector of UK GHG emissions in 2020,

[225] 2020 UK Greenhouse Gas Emissions, 2021, Department for Business, Energy and Industrial Strategy, Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1051407/2020-final-emissions-statistics-one-page-summary.pdf

contributing 24% of emissions. Transport delivered the largest reduction in emissions in the UK from 2019 to 2020 (9%), as Covid-19 restrictions limited public travel.

Provisional figures have been released for 2021 and total UK emissions were 424.5 million tonnes of CO_2e[226]. This is 4.7% higher than 2020, yet 5.2% lower than 2019, reflecting the impacts of Covid-19 restrictions on emissions. Transport emissions rose 10% from 2020 to 2021, but remained the largest emitting sector, responsible for 31.5% of emissions.

The UK is currently in the fourth carbon budgetary period (2023-27), the budget for which is 1,950 $MtCO_2e$. The UK cannot legally emit more GHG than this within the budgetary period. The fifth carbon budget is 1,725 $MtCO_2e$ (2028-32), and the sixth carbon budget is 965 $MtCO_2e$ (2033-37). Whilst budgets are not set beyond this, there is a legal requirement for the UK to reach 'net zero' emissions (0 $MtCO_2e$) by 2050. The construction of the Scheme Options begins within the fourth carbon budget.

Scotland's emissions for 2020 (the last reported year) were 40.0 million tonnes of CO_2e[227]. This is a 12% reduction from 2019's emissions and a 58.7% reduction from 1990's emissions (the baseline year for Scottish carbon targets). The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 specifies a target reduction of 56.0% of emissions from 1990 by 2020. Therefore, this interim target has been met.

In Scotland, domestic transport emitted 9.5 million tonnes of CO_2e in 2020 and was the largest source of emissions in the country. Domestic transport emissions have reduced by 29.9% from the 1990 baseline (4.1 million tonnes CO_2e[228]).

12.3.2.2. Proposed Scheme baseline

There are a series of existing and future construction works taking place at the Proposed Scheme. This includes creating catch pits and erecting debris flow fencing. However, at this stage of assessment, there is no information on the materials and construction plant involved in these works. Therefore, as a worst-case scenario, it is assumed that there are no emissions associated with construction in the Do-Minimum scenario.

As no traffic modelling has been undertaken for this stage of the assessment, the existing road user emissions for the Do Minimum scenario are unknown. However, it is assumed that

[226] 2021 UK Greenhouse Gas Emissions, 2022, Department for Business, Energy and Industrial Strategy, Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1064921/2021-uk-ghg-provisional-figures-statistical-summary.pdf
[227] Scottish Greenhouse Has Statistics 2020, 2022, Scottish Government, Available from: https://www.gov.scot/publications/scottish-greenhouse-gas-statistics-2020/pages/1/
[228] Scottish Greenhouse Has Statistics 2020, 2022, Scottish Government, Available from: https://www.gov.scot/publications/scottish-greenhouse-gas-statistics-2020/pages/3/

there will be no difference in road user emissions between the existing road and the Scheme Options. Therefore, the difference in emissions between the Do Minimum and Scheme Options is assumed to be 0 tCO_2e/year.

12.4. Potential Impacts

12.4.1.1. Potential Impacts During Construction

The construction stage of the Proposed Scheme would have an adverse effect on climate, as it would give rise to emissions. These emissions would arise from the production of materials to be used in construction, their transportation to site, and onsite through construction activities (e.g. emissions from diesel-fueled construction plant).

12.4.1.2. Potential Impacts During Operation

The operational stage of the Proposed Scheme would give rise to emissions from road users and operational energy use (for example, street lighting). Impacts may be positive or negative depending on whether this presents an increase or decrease against the baseline scenario.

12.4.2. Construction

The calculated construction phase emissions for the Scheme Options, compared with the Do Minimum, are shown in Table 12.4.

The construction phase would generate between 129,439 tCO2e and 266,102 tCO2e, depending on the option selected.

All of the Scheme Options are rated as High for construction activity emissions, meaning that it is anticipated that they would generate at least an additional 20% carbon emissions from the construction activities that take place during the construction phase.

Table 12.4 Construction phase emissions

Scheme Option	Emissions (tCO_2e)			Construction Activities emissions rating	Total emissions (tCO_2e)
	Materials	Waste	Transportation		
Yellow Option	169,421	342	5,595	High	175,358
Brown Option	122,268	1,433	5,738	High	129,439
Pink Option	134,851	1,899	9,286	High	146,036
Purple Option	178,296	828	7,698	High	186,821
Green Option	255,447	1,419	9,236	High	266,102

12.4.3. Comparison to UK Carbon Budgets

12.4.3.1. Green Option

The construction phase of the Green Option will take seven years and contribute 266,102 tCO_2e to the Scottish emissions reduction targets across the 2026-2032 period. Therefore, the Green Option would contribute 38,015 tCO_2e for each year to the Scottish emissions reduction targets. These contributions are detailed in Table 12.5.

The Green Option will contribute between 0.14 - 0.21% to a single year's emissions reduction target.

Given the level of contribution of the Green Option to the Scottish emissions reduction targets for all years of construction, it is not considered that the magnitude of emissions from the Green Option would materially impact the Scottish Government's ability to meet its emissions reduction target for each year, and therefore this option would not have a significant effect on climate.

This is in line with Note 2 of DMRB LA 114, which states "*it is considered unlikely that projects will in isolation conclude significant effects on climate*".

Therefore, the Green Option would cause a non-significant impact on climate.

Table 12.5 Comparison of Green Option to UK Government Carbon Budgets

Project Stage	Estimated total carbon over carbon budget (tCO2e) ('Do Something' scenario)	Net CO2 project GHG emissions (tCO2e) (Do Something – Do Minimum)	Relevant Scottish emission reduction target						
			2026 – 26,601,600 tCO_2e	2027 – 25,051,200 tCO_2e	2028 – 23,500,800 tCO_2e	2029 – 21,950,400 tCO_2e	2030 – 20,400,000 tCO_2e	2031 – 19,176,000 tCO_2e	2032 – 17,952,000 tCO_2e
Construction	266,102	266,102	38,015	38,015	38,015	38,015	38,015	38,015	38,015
Percentage of emission reduction target	-	-	0.14%	0.15%	0.16%	0.17%	0.19%	0.20%	0.21%

12.4.3.2. Yellow Option

The construction phase of the Yellow Option will take four years and contribute 175,358 tCO_2e to the Scottish emissions reduction targets across the 2026-2029 period. Therefore, the Yellow Option would contribute 43,840 tCO_2e for each year to the Scottish emissions reduction targets. These contributions are detailed in Table 12.6.

The Yellow Option will contribute between 0.16 - 0.20% to a single year's emissions reduction target.

Given the level of contribution of the Yellow Option to the Scottish emissions reduction targets for all years of construction, it is not considered that the magnitude of emissions from the Yellow Option would materially impact the Scottish Government's ability to meet its emissions reduction target for each year, and therefore this option would not have a significant effect on climate.

This is in line with Note 2 of DMRB LA 114, which states "*it is considered unlikely that projects will in isolation conclude significant effects on climate*".

The Yellow Option would cause a non-significant impact on climate.

Table 12.6 Comparison of Yellow Option to UK Government Carbon Budgets

Project Stage	Estimated total carbon over carbon budget (tCO2e) ('Do Something' scenario)	Net CO2 project GHG emissions (tCO2e) (Do Something – Do Minimum)	Relevant Scottish emission reduction target			
			2026 – 26,601,600 tCO_2e	2027 – 25,051,200 tCO_2e	2028 – 23,500,800 tCO_2e	2029 – 21,950,400 tCO_2e
Construction	175,358	175,358	43,840	43,840	43,840	43,840
Percentage of emission reduction target	-	-	0.16%	0.17%	0.19%	0.20%

12.4.3.3. Brown Option

The construction phase of the Brown Option will take four years and contribute 129,439 tCO_2e to the Scottish emissions reduction targets across the 2026-2029 period. Therefore, the Brown Option would contribute 32,360 tCO_2e for each year to the Scottish emissions reduction targets. These contributions are detailed in Table 12.7.

The Brown Option will contribute between 0.12 - 0.15% to a single year's emissions reduction target.

Given the level of contribution of the Brown Option to the Scottish emissions reduction targets for all years of construction, it is not considered that the magnitude of emissions from the Brown Option would materially impact the Scottish Government's ability to meet its emissions reduction target for each year, and therefore this option would not have a significant effect on climate.

This is in line with Note 2 of DMRB LA 114, which states "*it is considered unlikely that projects will in isolation conclude significant effects on climate*".

The Brown Option would cause a non-significant impact on climate.

Table 12.7 Comparison of Brown Option to UK Government Carbon Budgets

Project Stage	Estimated total carbon over carbon budget (tCO2e) ('Do Something' scenario)	Net CO2 project GHG emissions (tCO2e) (Do Something – Do Minimum)	Relevant Scottish emission reduction target			
			2026 – 26,601,600 tCO_2e	2027 – 25,051,200 tCO_2e	2028 – 23,500,800 tCO_2e	2029 – 21,950,400 tCO_2e
Construction	129,439	129,439	32,360	32,360	32,360	32,360
Percentage of emission reduction target	-	-	0.12%	0.13%	0.14%	0.15%

12.4.3.4. Pink Option

The construction phase of the Pink Option will take four years and contribute 146,036 tCO_2e to the Scottish emissions reduction targets across the 2026-2029 period. Therefore the Pink Option would contribute 32,360 tCO_2e for each year to the Scottish emissions reduction targets. These contributions are detailed in Table 12.8.

The Pink Option will contribute between 0.14 - 0.17% to a single year's emissions reduction target.

Given the level of contribution of the Pink Option to the Scottish emissions reduction targets for all years of construction, it is not considered that the magnitude of emissions from the Pink Option would materially impact the Scottish Government's ability to meet its emissions reduction target for each year, and therefore this option would not have a significant effect on climate.

This is in line with Note 2 of DMRB LA 114, which states "*it is considered unlikely that projects will in isolation conclude significant effects on climate*".

The Pink Option would cause a non-significant impact on climate.

Table 12.8 Comparison of Pink Option to UK Government Carbon Budgets

Project Stage	Estimated total carbon over carbon budget (tCO2e) ('Do Something' scenario)	Net CO2 project GHG emissions (tCO2e) (Do Something – Do Minimum)	Relevant Scottish emission reduction target			
			2026 – 26,601,600 tCO_2e	2027 – 25,051,200 tCO_2e	2028 – 23,500,800 tCO_2e	2029 – 21,950,400 tCO_2e
Construction	146,036	146,036	36,509	36,509	36,509	36,509
Percentage of emission reduction target	-	-	0.14%	0.15%	0.16%	0.17%

12.4.3.5. Purple Option

The construction phase of the Purple Option will take four years and contribute 186,821 tCO_2e to the Scottish emissions reduction targets across the 2026-2029 period. Therefore the Purple Option would contribute 46,705 tCO_2e for each year to the Scottish emissions reduction targets. These contributions are detailed in Table 12.9.

The Purple Option will contribute between 0.18 - 0.21% to a single year's emissions reduction target.

Given the level of contribution of the Purple Option to the Scottish emissions reduction targets for all years of construction, it is not considered that the magnitude of emissions from the Purple Option would materially impact the Scottish Government's ability to meet its emissions reduction target for each year, and therefore this option would not have a significant effect on climate.

This is in line with Note 2 of DMRB LA 114, which states "*it is considered unlikely that projects will in isolation conclude significant effects on climate*".

The Purple Option would cause a non-significant impact on climate.

Table 12.9 Comparison of Purple Option to UK Government Carbon Budgets

Project Stage	Estimated total carbon over carbon budget (tCO2e) ('Do Something' scenario)	Net CO2 project GHG emissions (tCO2e) (Do Something – Do Minimum)	Relevant Scottish emission reduction target			
			2026 – 26,601,600 tCO_2e	2027 – 25,051,200 tCO_2e	2028 – 23,500,800 tCO_2e	2029 – 21,950,400 tCO_2e
Construction	186,821	186,821	46,705	46,705	46,705	46,705
Percentage of emission reduction target	-	-	0.18%	0.19%	0.20%	0.21%

12.5. Potential Mitigation

DMRB LA 114 states that: '*Projects shall seek to minimise carbon emissions in all cases to contribute to the UK's target for net reduction in carbon emissions*'. This requirement applies whether or not the Proposed Scheme is anticipated to generate a significant effect on climate.

Emissions are mitigated by applying the carbon reduction hierarchy set out in DMRB LA 114: Avoid / Prevent, reduce, Remediate. Items at the top of the hierarchy have a greater potential to reduce emissions and are prioritised.

- Avoid / prevent:
  - Maximise potential for re-using and / or refurbishing existing assets to reduce the extent of new construction required.
  - Explore alternative lower carbon options to deliver the project objectives (i.e. shorter route options with smaller construction footprints).
- Reduce:
  - Apply low carbon solutions (including technologies, materials, and products) to minimise resource consumption during the construction, operation, user's use of the project, and at end-of-life.
  - It is recommended that as far as possible, materials are locally procured to minimised transportation emissions.
  - Construct efficiently, using techniques (e.g. during construction and operation) that reduce resource consumption over the life cycle of the project.
- Remediate:

- After addressing steps 1 and 2 projects will identify, assess and integrate measures to further reduce carbon through on or off-site offsetting or sequestration.

To fully embed this hierarchy in the project team's ways of working, the Principal Contractor should commit to adhering to the principles of the PAS 2080 – Carbon Management in Infrastructure verification[229]. PAS 2080 is a global standard for managing infrastructure carbon and looks at reducing carbon across the whole value chain through more intelligent design, construction and use. It also ensures that carbon consistently and more transparently quantified at key points during the process, to inform decision-making.

12.6. Conclusions

In terms of construction phase emissions, the Green Option would generate the highest amount of emissions (266,102 tCO2e) whereas the Brown Option would generate the lowest amount of emissions (129,439 tCO2e). All of the Scheme Options were rated High for construction activity emissions, meaning that this lifecycle module is expected to contribute at least an additional 20% more emissions to the construction phase once quantified.

The Green Option is considered the least favourable option to take forward when considering impacts on climate from carbon emissions.

The Brown Option is considered the most favourable option to take forward when considering impacts on climate from carbon emissions.

As detailed in Table 12.4, each of the Scheme Options would emit a minimum of 129,439 tCO2e compared to the Do-Minimum scenario.

In line with the conclusions drawn in DMRB LA 114, it is not deemed that any of the Scheme Options would have a significant impact on climate. Therefore, none of the Scheme Options would significantly compromise the Scottish Government's ability to meet their carbon reduction targets as part of their net zero policy (as required by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019).

[229] https://www.bsigroup.com/en-GB/our-services/product-certification/product-certification-schemes/pas-2080-carbon-management-in-infrastructure-verification/

Table 12.9 Effects on Climate Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)					Comparative Appraisal
			Green	Brown	Pink	Purple	Yellow	
Climate effects	Atmosphere	Release of carbon emissions, contributing to climate change	Minor adverse	Minor adverse	Minor adverse	Minor adverse	Minor adverse	All of the Scheme Options would have a minor adverse, non-significant impact on climate. However, the Green Option is considered the least favourable and the Brown Option the most favourable

12.7. Scope of DMRB Stage 3 Assessment

The scope of the Stage 3 assessment would follow the methodology set out in DMRB LA 114, similar to the methodology set out in Section 0. However, unlike the assessment completed at Stage 2, the Stage 3 assessment should aim to include all lifecycle stages mentioned in Table 12.2, particularly road-user emissions for the operational stage, construction plant and activity emissions and emissions from land use and land use change.

The scope should also look to include benchmarking of the Proposed Scheme against other, similar road projects, in line with Section 3.21 of LA 114.

13. Climate Vulnerability

13.1. Introduction

The climate assessment is split into two parts. Chapter 12 Effects on Climate contains the Climate Emissions assessment, which considers the potential effects of the Scheme Options on climate. This chapter contains the Climate Vulnerability Assessment, which considers the resilience of the Scheme Options to climate change impacts.

The main objective of the climate vulnerability assessment is to ensure that climate change and impacts associated with extreme weather are considered during the planning of the Scheme Options so that they can be avoided and, if that is not possible, mitigated during its construction and operation. To achieve this objective this chapter presents:

- an examination of the current climate baseline using the Met Offices latest regional dataset of 30-year averages and data from nearby long running meteorological stations;
- a consideration of the projected future climate for the study area;
- an assessment of how the Proposed Scheme may be vulnerable to the impacts of climate change during its construction and operation;
- identification of specific mitigation to adapt the design and operational processes to reduce the Proposed Scheme's potential adverse climate vulnerabilities; and
- an assessment of the residual climate change vulnerability of the Proposed Scheme that considers both adverse and beneficial vulnerability impacts by quantifying their likelihood and consequence of each potential vulnerability.

The adopted assessment approach reviews how climate change could affect the Proposed Scheme's assets, as well as how it could affect the potential environmental impacts identified in the other chapters of this assessment, i.e. how it could impact environmental receptors. The methodology follows guidance set out in DMRB LA 114[230] and is informed by best practice climate assessment approaches and literature, as well as professional judgement.

This chapter should be read in conjunction with the description of the development presented in Part 1, Chapter 3, Description of Scheme Options in Volume 1 of the DMRB Stage 2 Scheme Assessment Report. It is noted that the scope of the climate vulnerability assessment has overlaps with aspects of other chapters in this report, in particular Chapter 15 Road Drainage and the Water Environment - which includes consideration of the impact

[230] DMRB LA 114 Climate. Highways England et al. 2021

of future climate change on the water environment through and, for example, how this could affect flood risk.

13.2. Approach and Methods

13.2.1. Introduction

Where the climate change impact on project receptors is potentially significant, a risk assessment has been undertaken. The method for this assessment is set out in this section. It follows the guidance set out in DMRB LA 114 and is informed by best practice climate assessment approaches and literature, as well as professional judgement.

To enable differentiation between the Scheme Options the method is enhanced to allow consideration of a wider range of input categories for likelihood and consequence, such that the significance output is not binary, i.e. significant or not significant, and therefore allowing differentiation within the not significant category to support optioneering. This has been indicated through assigning a 'most preferred' and 'least preferred' for each impact.

13.2.2. Sources of Information

The climate vulnerability assessment relies on information from the Meteorological Office. Specifically, climate projections from United Kingdom Climate Projections 2018 (UKCP18[231]). These projections have been developed by the Met Office Hadley Centre Climate Programme which is supported by the Department of Business, Energy and Industrial Strategy (BEIS) and the DEFRA. This chapter also presents data from the Meteorological Office to summarise the Argyll River Basin current climate.

Information regarding mitigations and risks rely largely on other topic chapters, such as design details and Chapter 15 Road Drainage and the Water Environment.

13.2.3. Policy, Legislation and Guidance

National, regional and local policy as well as guidance, relating to climate vulnerability has been reviewed and an overview of implications and key aspects of relevance to the A83 are set out in the following table. It is noted that there are no aspects of Policy, Legislation or Guidance which would result in noteworthy differentiators between the Scheme Options for climate vulnerability. For climate vulnerability all routes are considered to be compliant; this will be assessed further at Stage 3 for the preferred option.

[231] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp

Table 13.1 13.2.3. Policy, Legislation and Guidance

Policy / Legislation	Summary
Paris Agreement (2015)	The Paris Agreement establishes a global goal on adaptation – of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change in the context of the temperature goal of the Agreement. It aims to significantly strengthen national adaptation efforts, including through support and international cooperation. It recognises that adaptation is a global challenge faced by all. All Parties should engage in adaptation, including by formulating and implementing National Adaptation Plans, and should submit and periodically update an adaptation communication describing their priorities, needs, plans and actions. The adaptation efforts of developing countries should be recognized The Glasgow Climate Pact, resulting from COP26 held in 2021, added record amounts of pledged adaptation finance, including commitments to doubling 2019 levels of adaptation finance by 2025. This was the first time an adaptation specific financing goal has ever been agreed globally.
Climate Change Act (2008) as amended in 2019	The Climate Change Act requires the UK Government to produce a UK Climate Change Risk Assessment (CCRA) every five years. The CCRA assesses current and future risks to and opportunities for the UK from climate change. In response to the CCRA, the Climate Change Act also requires the UK government to produce a National Adaptation Programme (NAP). The NAP covers England, while the devolved administrations produce their own programmes and policies. The Act also gives powers to the UK Government to require certain organisations to report on how they are adapting to climate change.
Climate Change (Scotland) Act (2009)	This Act was a direct parallel of the UK's Climate Change Act (2008). The Act requires the preparation of strategic programmes for climate change adaptation, as soon as reasonably practicable after each round of UK Climate Change Risk Assessment.
National Policy Framework 4 (NPF4) – Scotland 2022	NPF4 sets out the long term plan for Scotland for 2045. It was published in 2021 and public consultation closed on March 2022. It includes how to tackle and adapt to climate change.
Argyll & Bute Council Decarbonisation Plan 2022-2025 (2021)	The Plan acknowledges that the Council needs to plan and invest in infrastructure and resilience that will be ready for additional flooding, storm events, sea level rises and service disruption. The Plan outlines the Council's varied capital investment plan that includes a number of resilience and climate change related projects preparing for sea level rises, increased flood events and protection of essential infrastructure such as roads, bridges, ferry routes and buildings. The Councils action plan includes commitments to review Council Flooding & Coastal Protection Policy.

13.2.4. Consultation

For climate vulnerability consultation has been undertaken regarding how climate change could affect flood risk. This has been carried out with the key stakeholders through the A83 Environmental Steering Group (ESG), with data requests issued to SEPA and Argyll & Bute Council in March 2023 for historic flood records.

A detailed Flood Risk Assessment (FRA) will be undertaken once a Preferred Option is selected. Consultation will be undertaken with stakeholders, including SEPA, on the FRA to agree it's scope and specific approaches regarding:

- climate change allowances;
- assessment of the baseline flood risk; and
- assessment of the with-scheme conditions to evaluate the impacts and determine any additional mitigation.

Further details about the projects FRA can be found in Chapter 15 Road Drainage and the Water Environment.

13.2.5. Scope of Stage 2 Assessment

13.2.5.1. Potential Impacts During Construction

The climate of the study area has already changed from its natural state, as a result of climate change. However, the Proposed Scheme's construction is not expected to be so far in the future that the climate will notably change further from the current baseline prior to construction. Climate vulnerability impacts linked to slow onset changes in the climate, e.g. changes in average temperature, are therefore not expected to impact construction. They are therefore scoped out of further assessment for all options.

If construction coincides with extreme weather event(s) such as drought or storms, the frequency of which can be linked to climate change, there may potentially be construction impacts. These are scoped in for further assessment since they could generate differentiators between the Scheme Options. In some instances, they are addressed by the other relevant topics, for example, appropriate construction controls are identified in Chapter 15 Road Drainage and the Water Environment to manage construction related flood risk impacts. This climate vulnerability chapter considers the impact of landslide risk during construction which can be significantly affected by metrological conditions, and in particular by extreme weather.

13.2.5.2. Potential Impacts During Operation

Potential operational impacts on asset receptors (including their operation, maintenance and refurbishment) and end users (e.g., members of the public, commercial operators etc.) that have been scoped out of further assessment, for all Scheme Options (at this stage), since they would not generate differentiators (these will be assessed in detail for the Preferred Option at a later stage):

- Warmer winters could reduce winter maintenance and associated traffic disruption (benefit from reduced road salting requirements and less freeze thaw damage).
- Hotter summers could damage materials (rutting, shrinkage and expansion) increasing maintenance requirements and associated traffic disruption.
- Hotter temperatures can dry out soils and so increase erosion. This may cause sedimentation within the Scheme's drainage infrastructure and reduce its drainage capacity, therefore increasing the risk of flooding causing traffic disruption. Additional maintenance work to prevent flooding may also cause traffic disruption.
- Heavier rain and wetter winters may increase the risk of flooding affecting culverts/flow diversions/flood compensation areas etc. Flooding and additional maintenance requirements could both cause traffic disruption.
- Milder winters could reduce freeze thaw erosion, which can damage underground assets, and so may reduce maintenance requirements and associated traffic disruption.
- Drier summers could damage the Proposed Scheme's landscaping. More regular maintenance may cause traffic disruption.
- Warmer winters will improve winter driver safety and so could reduce traffic disruption caused by accidents
- Hotter summers increase vehicle breakdowns and so could increase the traffic disruption they cause, and associated accidents.
- Hotter summers increase accident rates and so could increase traffic disruption.
- More heavy rain and wetter winters reduce driver safety and so could increase traffic disruption associated with accidents.
- Heavier rain and wetter winters can cause pot holes (by weakening the soil beneath the carriageway) that could increase maintenance requirements and associated traffic disruption. It can also impact driver experience, reducing visibility, stopping distances increase and standing water creates an aquaplaning risk.

The following potential climate vulnerability impacts have been scoped in for assessment at this stage, as they may provide differentiators between the Scheme Options:

- Hotter summers could reduce the asset lives of structures (over expansion and buckling) and increase maintenance requirements and associated traffic disruption.
- Drier summers and wetter winters could cause soil instability (intensify and extend soil moisture deficits and impact groundwater levels and earth pressures) affecting structures and embankments and potentially increasing maintenance requirements and associated traffic disruption.

- Storms and high winds reduce driver safety, in particular - potentially affecting high sided vehicles on an exposed viaduct, and so could increase traffic disruption associated with accidents.
- Although winters are forecast to be warmer, extreme weather is still expected; snow and ice could create a hazard at the tunnel portals (entrance /exit), at the tunnel escape shafts and also at ventilation points.
- The Proposed Scheme itself will reduce consequences of landslide impacts on assets and users – the degree to which they achieve this, and the maintenance it requires, varies from one option to another. Potential impacts of landslides across the Brown, Green and Yellow Options include destruction of/damage to the road and potential loss of life including the safety of maintenance workers, e.g., when clearing debris pits. Impacts on assets will also be considered, including:

    - Landslide impacts on debris flow shelters, i.e., ensuring they are adequately protected against boulder rock falls, gravel, slurry and water movements; and
    - Landslide impacts on viaduct piers.

Potential operational impacts on environmental receptors that are related to, or could be intensified by, climate change will be assessed as cumulative impacts. Where these are not covered by the other environmental topic chapters they are scoped out of further assessment since they would be unlikely to cause significant differentiators. Cumulative climate vulnerability impacts will be assessed at a later stage of the environmental assessment.

13.2.6. Assessment Methodology

There are four stages to the climate vulnerability assessment method:

- Stage 1 - Identify the hazards and receptors.
- Stage 2 - Assess the likelihood of impacts on each receptor.
- Stage 3 - Assess the consequence of impacts for each receptor.
- Stage 4 - Determine the significance of each impact based on a combination of the likelihood of an impact occurring and the consequences of that impact.

13.2.6.1. Stage 1 - Identification of hazards and receptors

Receptors which may be affected by climate change hazards have been identified with consideration of the characteristics of potential future extreme weather events as well as gradual changes to the climate that could occur in the study area over the Proposed Scheme's design life. Identification of these is based on an assessment of climate

projections from United Kingdom Climate Projections 2018 (UKCP18[232]). These projections have been developed by the Met Office Hadley Centre Climate Programme which is supported by the Department of Business, Energy and Industrial Strategy (BEIS) and the DEFRA. They provide the most up-to-date assessment of how the climate of the UK may change over the 21st Century.

In accordance with Section 3.34 of the DMRB LA 114 the assessment has considered the impacts of climate change on the following receptors:

- construction process (including workforce, plant, machinery etc.);
- the assets and their operation, maintenance, and refurbishment (including pavements, structures, earthworks and drainage and technology assets such as signals and signs); and
- end-users (members of the public, commercial operators, nearby residential properties, road user safety and experience).

13.2.6.2. Stage 2 - Assess the likelihood of impacts

In accordance with DMRB LA 114, the likelihood of potential climate changes and events occurring are determined using available data (such as the known recurrence interval of extreme weather events) and professional judgement, based on knowledge and experience of other similar schemes. The likelihood categories and associated frequencies are provided in Table 13.2.

Table 13.2 Likelihood categories

Likelihood category	Description (probability and frequency of occurrence)
Very high	The event occurs multiple times during the lifetime of the project (60 years) e.g., approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the project (60 years) e.g., approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g., approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the project (60 years) e.g., once in 60 years.
Very low	The event can occur once during the lifetime of the project (60 years).

Table Notes: Project lifetime is considered to include construction and operational phases; project lifetime is take to be 60 years in line with LA 114

Table Source: DMRB Climate: LA 114 Table 3.39a (June, 2021).

[232] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp

13.2.6.3. Stage 3 - Assess the consequence of impacts

The consequence of climate change impacts on the Proposed Scheme receptors are categorised using the criteria in

Table 13.3.

Table 13.3 Measure of consequence

Consequence of impact	Example description
Very large adverse	Operation – national level (or greater) disruption to strategic route(s) lasting more than 1 week.
Large adverse	Operation – national level disruption to strategic route(s) lasting more than 1 day but less than 1 week or regional level disruption to strategic route(s) lasting more than 1 week.
Moderate adverse	Operation – regional level disruption to strategic route(s) lasting more than 1 day but less than 1 week.
Minor adverse	Operation – regional level disruption to strategic route(s) lasting less than 1 day.
Negligible	Operation – disruption to an isolated section of a strategic route lasting less than 1 day.

Table Source: DMRB Climate: LA 114 Table 3.39b (June, 2021).

13.2.6.4. Table Note: Consequences can be adverse or beneficial. Beneficial consequences would result in a beneficial outcome in stage 4.Stage 4 – Determine significance of impacts

The results of the likelihood and consequence assessments are combined to derive a significance classification as outlined in Table 13.4.

Table 13.4 Significance matrix

Impact consequence	Impact likelihood				
	Very low	Low	Medium	High	Very high
Very large	NS	S	S	S	S
Large	NS	NS	S	S	S
Moderate	NS	NS	S	S	S
Minor	NS	NS	NS	NS	NS
Negligible	NS	NS	NS	NS	NS

Table notes: NS = Not Significant, S = Significant. Impacts can be adverse or beneficial (where consequence is beneficial).

Table Source: DMRB LA 114 Table 3.41 (June, 2021).

The assessment is undertaken with consideration of the Scheme Options design and mitigation.

To maximise the value of the climate vulnerability assessment to the optioneering process, as well as completing a LA 114 compliant assessment, an assignment of 'most favourable' and 'least favourable' of the Scheme Options is also completed to enable differentiation, based on professional judgement. This is helpful since it enables an option preference to be established, with regard to climate vulnerability, where multiple, or all, options have the same outcome for the LA 114 significance assessment. This means that, for example, if all impacts are found to be not significant the knowledge collected by the assessment can still be used to identify a Preferred Option from a climate vulnerability perspective.

13.2.6.5. Limitations and Assumptions

The climate vulnerability assessment provides a broad, high-level indication of the potential impacts of climate change on the Scheme Options based on professional judgement.

The climate projections used are from UKCP18. The UKCP18 projections do not provide a single precise prediction of how weather and climate will change years into the future. Instead UKCP18 provides ranges that aim to capture a spread of possible climate responses. This better represents the uncertainty of climate prediction science. It should also be noted that the level of uncertainty of the projections is dependent on the climate variable, for example, there is greater confidence around changes in temperature than there is in wind. In the climate vulnerability assessment this is considered when assessing the likelihood of impacts.

The climate vulnerability assessment is based on data from RCP 8.5. This is a Greenhouse Gas (GHG) concentration trajectory under which it is assumed that emissions continue to rise throughout the 21st Century. There is considerable uncertainty regarding if, how far and how quickly emissions will be reduced in the future. Using RCP 8.5 represents a conservative position.

Other key caveats and limitations of UKCP18 data are presented on the Met Office website[233].

[233] www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---caveats-and-limitations.pdf

13.3. Baseline Conditions

13.3.1. Study Area

In accordance with Section 3.25 of DMRB LA 114, the study area for the climate vulnerability assessment incorporates the construction footprint of the Proposed Scheme (the Scheme Option Boundary including temporary land take) and all potential environmental receptors that could be impacted by the Proposed Scheme.

The temporal scope of the study has, in accordance with Section 3.31 of DMRB LA 114, taken the lifespan of the project to be 60 years.

13.3.2. Study Area Context

The baseline for climate change vulnerability is presented in two parts:

the first section describes the current climatic conditions in the study area; and
the second presents a range of possible future climate projections in the study area.

It should be noted that climate change is not only a challenge for the future. The UK is already observing changes in its climate.

13.3.2.1. Current climate baseline

The Proposed Scheme is situated within the Argyll River Basin. To inform adaptation decisions this section presents data from the Meteorological Office to summarise the Argyll River Basin current climate. The Met Office's standard average data tables are used, they show the latest set of 30-year averages covering the period 1981-2010. Context to this is provided by including comparison to the equivalent national dataset (UK minimum, average and maximum temperatures).

To support the above average regional data a local dataset has also been collected from the closest long running climate station to the Proposed Scheme. The closest climate station is located at Dunstaffnage (188100E 734000N – approximately 25 miles northwest of the Proposed Scheme) and has been recording observations since 1972[234].

13.3.2.2. Current temperature

The climate in the Argyll River Basin is one of relatively mild winters and warm summers. As shown in Plate 13.1 and Plate 13.2, monthly average and mean maximum temperatures are between the UK average and minimum. Across the timeseries, 1981-2010, peak summer (July) average maximum temperatures of 13.1 °C in the Argyll River Basin are below the

[234] https://www.metoffice.gov.uk/pub/data/weather/uk/climate/stationdata/dunstaffnagedata.txt

average, but slightly above the minimum (12.7 °C) across the UK. Note that mean maximum temperatures are calculated as the monthly average of daily maximums – as such some individual days are likely to have recorded hotter temperatures than those stated.

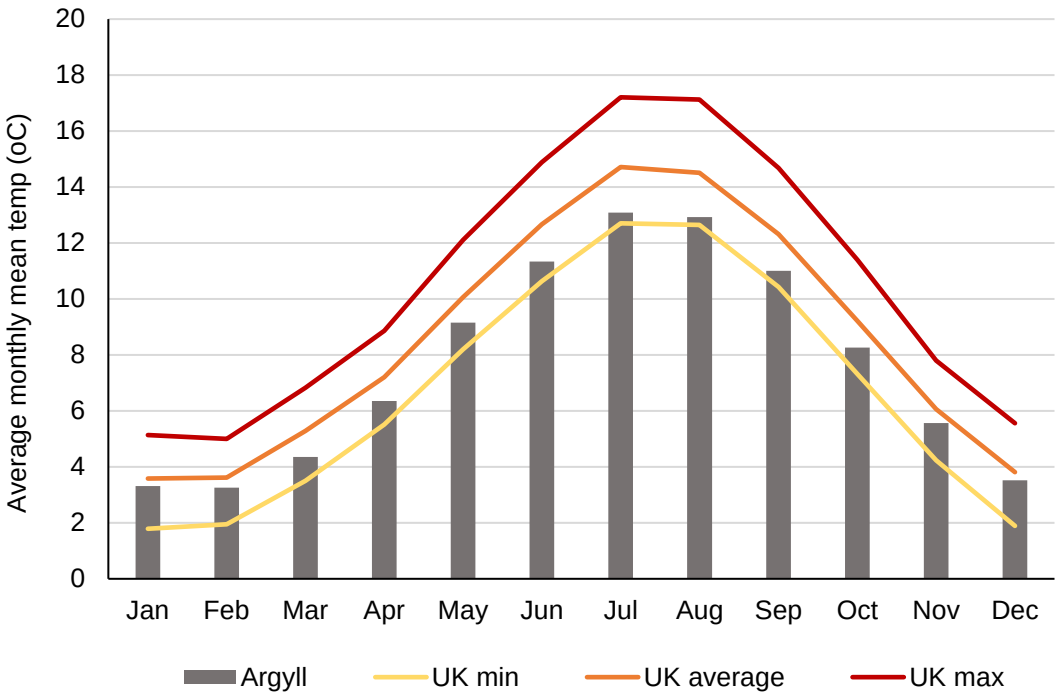


Plate 13.1 Long-term average monthly mean temperature (°C) (1981-2010)

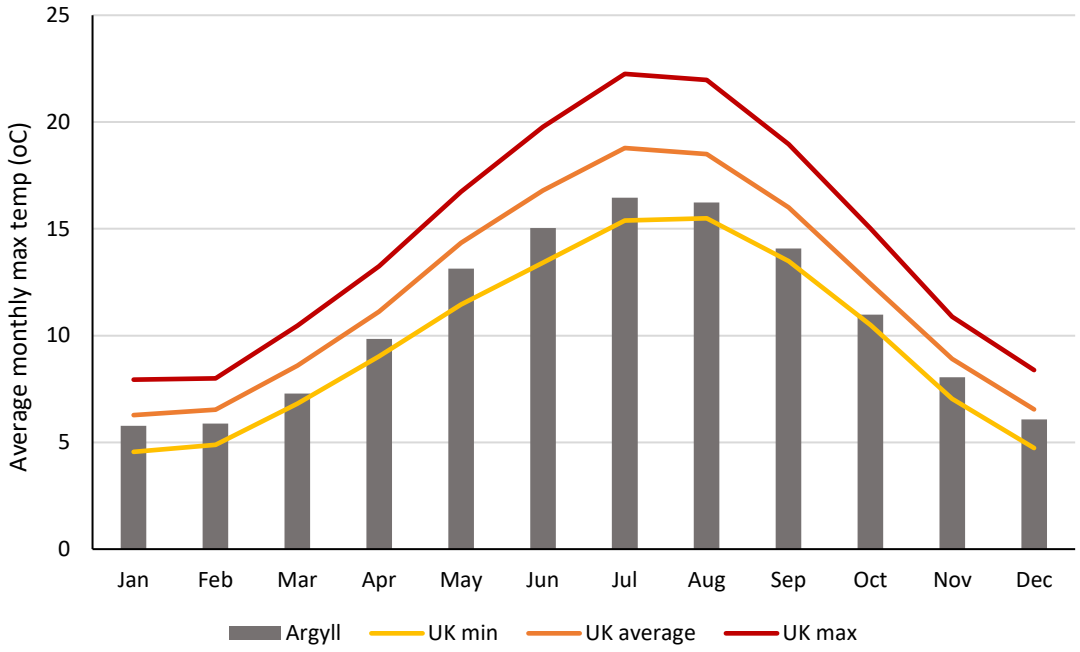


Plate 13.2 Long-term average monthly maximum temperature (°C) (1981-2010)

Note: the maximum data presented is a monthly average of daily maximums.

Observations for the UK show that the decade leading up to the publication of UKCP18 (2008-2017) was on average 0.3°C warmer than the 1981-2010 average and 0.8 °C warmer than 1961-1990. All of the top ten warmest years have occurred since 2002[235].

The summer of 1976 was one of the hottest recorded in the UK and this is reflected in the temperature record at the Durham climate station (Plate 13.3). It was one of the driest, sunniest and warmest summers (June/July/August) in the 20th century[236]. Provisional data available for 2022 shows it to be the joint (with 2018) hottest summer on record[237]. While a 2022 peak doesn't stand out for the Dunstaffnage climate station, 2018 is reflected in the temperature record showing an average summer maximum daily temperature of 19.3 °C. The highest peak is recorded in 2021 where an average summer maximum daily temperature was 19.7 °C – the final peak shown on Plate 13.3.

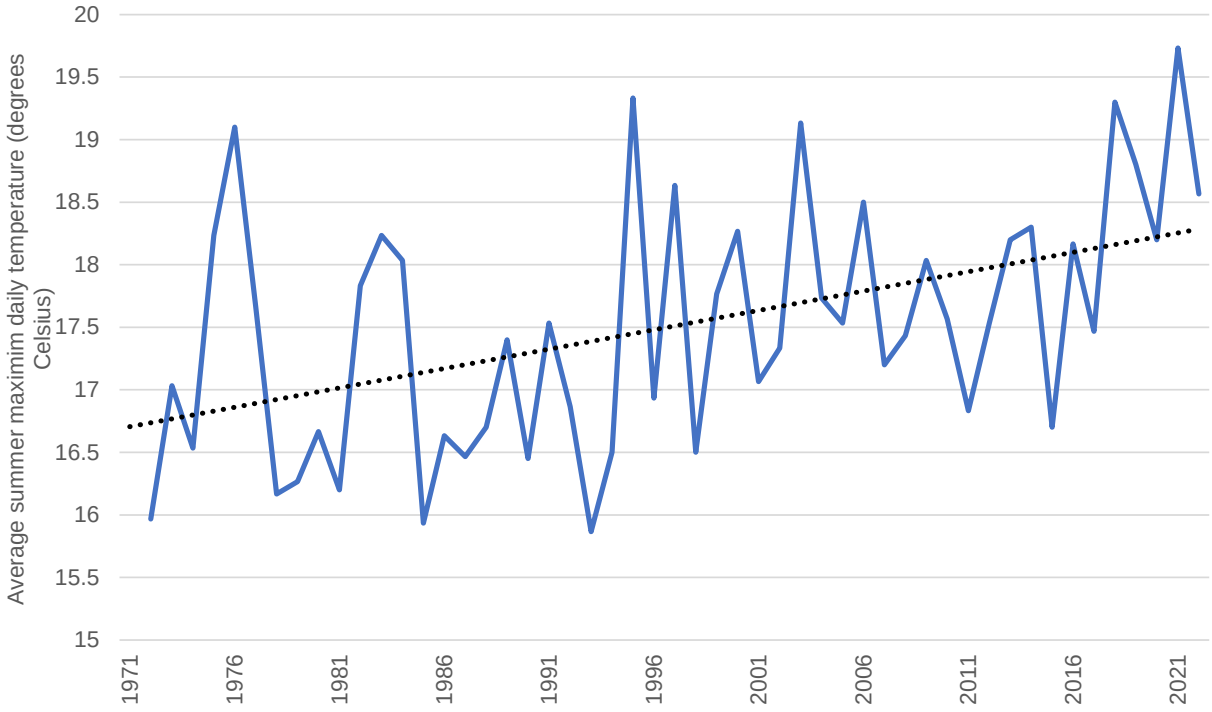


Plate 13.3 Average summer maximum daily temperature (°C) (1900-2022) (Dunstaffnage). Note 2022 data is provisional.

Observation from the Dunstaffnage climate station reveal that seven of the 10 highest monthly mean daily maximum temperatures (t-max) it has recorded have been since 2006.

[235] https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2019/state-of-the-uk-climate-2018
[236] https://www.bbc.co.uk/news/newsbeat-40358961
[237] https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/joint-hottest-summer-on-record-for-england

The data from the met station also shows that over the period 1930 to 2022 both the average daily summer maximum temperatures and average daily winter maximum temperatures have been increasing (conclusion based on linear trendlines on Plate 13.3 and Plate 13.4).

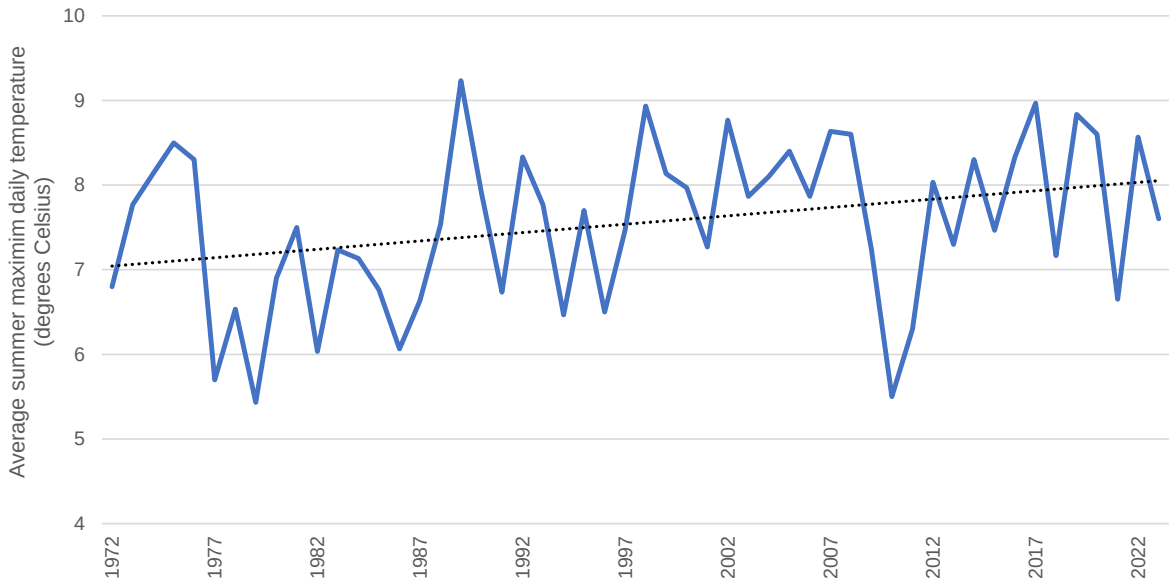


Plate 13.4 Average winter maximum daily temperature (°C) (1900-2022) (Dunstaffnage). Note 2022 and 2023 data is provisional.

As shown in Plate 13.5 the long-term average days with ground frost (1981-2010) in the Argyll River Basin are similar to the UK average.

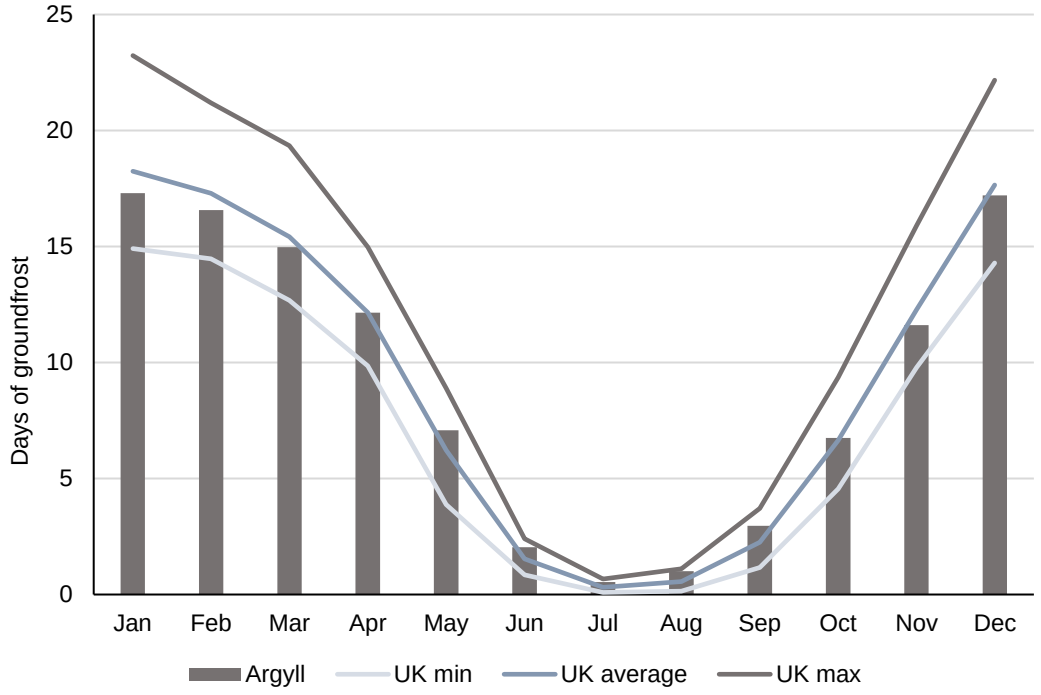


Plate 13.5 Long-term average days with ground frost (1981-2010)

In accordance with the observed increasing winter temperatures (see Plate 13.4), the linear trendline on Plate 13.6 shows that at the nearest long running climate station, the number of days with air frost each winter has been reducing since 1972.

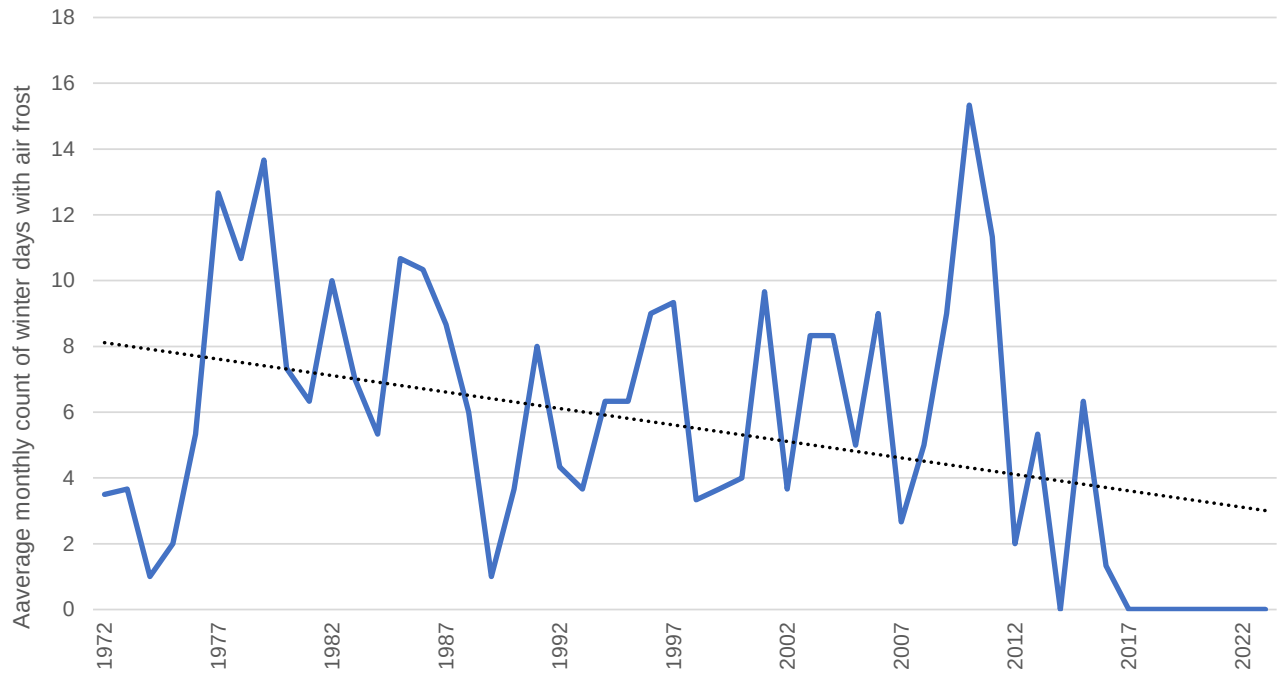


Plate 13.6 Average monthly count of winter days with air frost (1900-2022) (Dunstaffnage). Note 2022 data is provisional.

13.3.2.3. Current precipitation

Observations across the UK show a high level of variability in precipitation from year to year, with a slight overall increase in UK winter precipitation in recent decades.

As shown in Plate 13.7, long-term average daily rainfall for each month (1981-2010) in the Argyll River Basin is in line with the maximum for the UK.

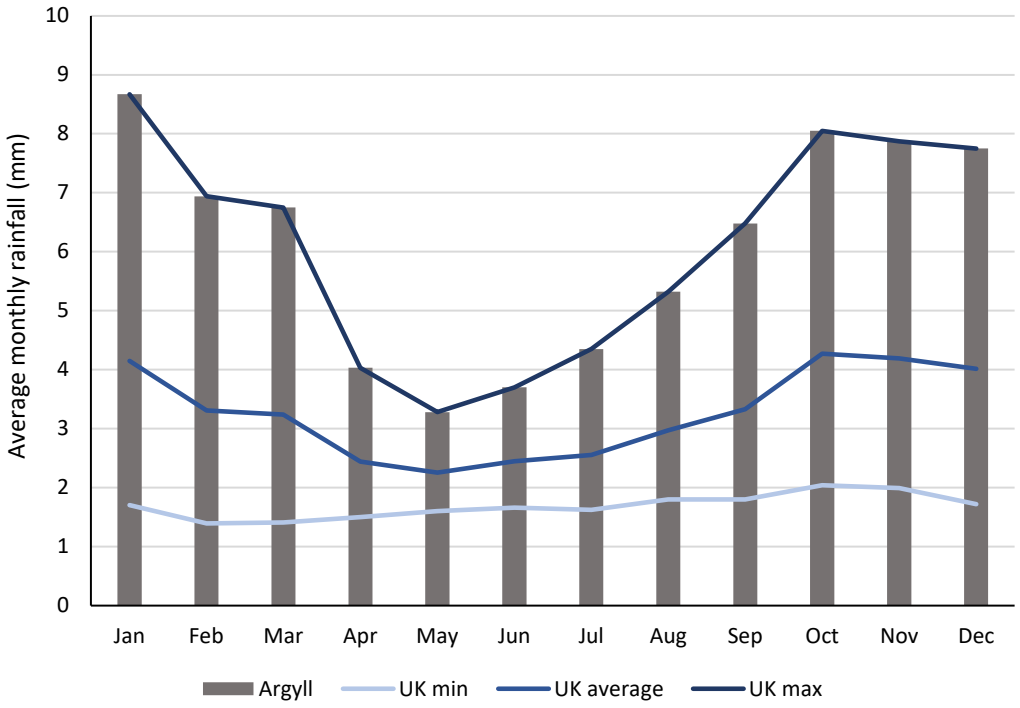


Plate 13.7 Long-term average daily rainfall for each month (1981-2010)

Plate 13.8 shows the long-term average number of days that had rainfall over 10mm. It shows that the Argyll River Basin experiences the maximum heavy rainfall days for the UK.

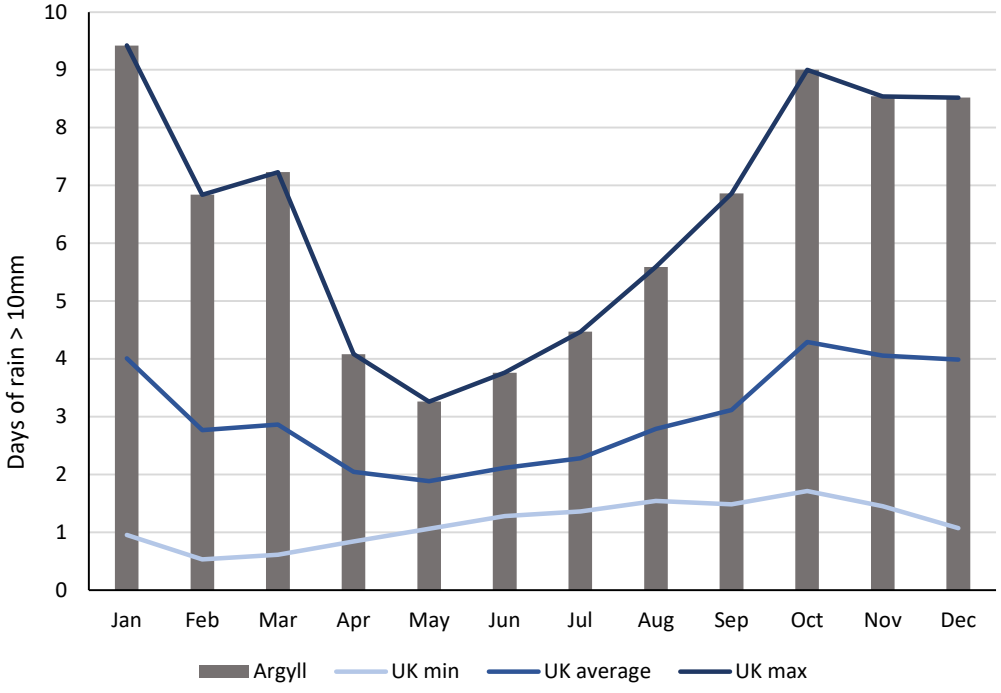


Plate 13.8 Long-term average days with rainfall above 10mm (1981-2010)

Data from the Dunstaffnage climate station shows winter to have variable precipitation and that rainfall has been increasing since 1900 (conclusion based on fit of linear trendline on Plate 13.9).

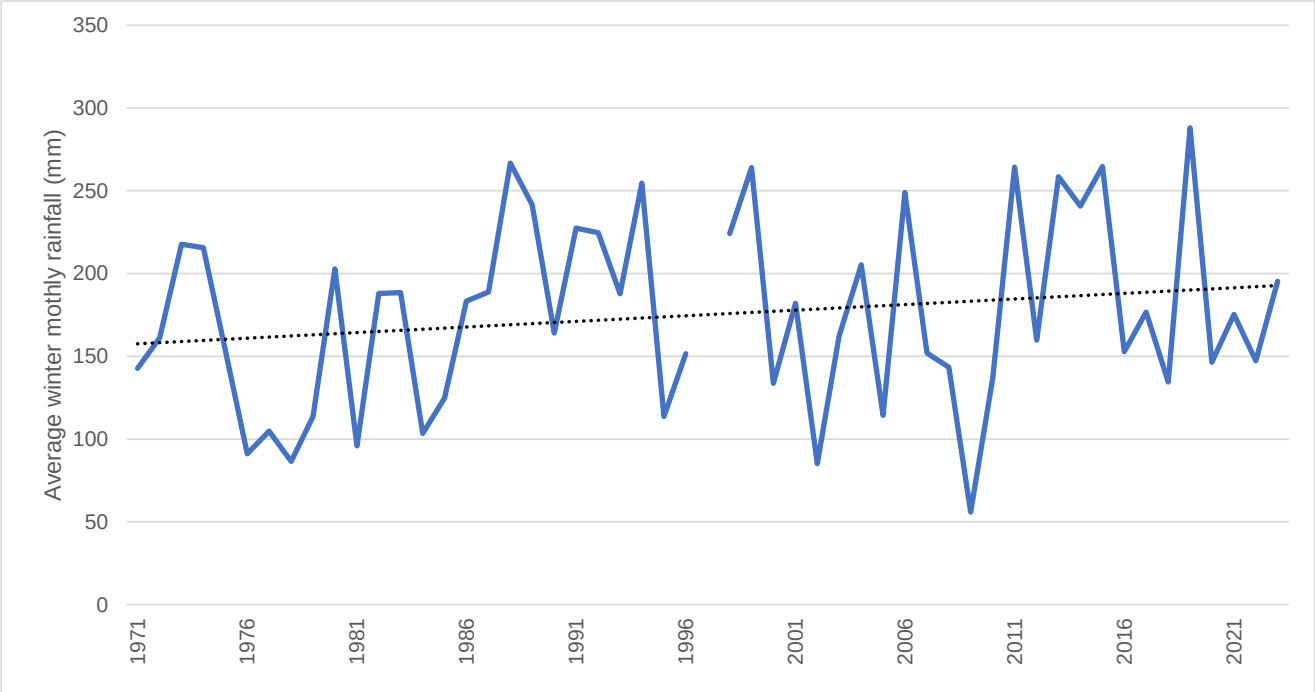


Plate 13.9 Winter (Dec/Jan/Feb) average monthly rainfall (mm) (1900-2022) (Durham). Note 2022 and 2023 data is provisional.

Across the UK, the amount of rain from extremely wet days has increased by 17% when comparing the period 2008-2017 to 1961-1990 period (Met Office, 2018[238]). These changes are largest for Scotland and not significant for most of southern and eastern areas of England. Other extreme rainfall indices exhibit large inter-annual variability but are broadly consistent with increased rainfall over the UK[239].

In the study area impacts from extreme weather have been recorded. Winter *et al.,* (2019)[240] discusses the economic impacts of landslides and floods on a road network using the A83(T) as a case study. It highlights the regular occurrence of landslide events associated with monthly average rainfall substantially in excess of the average in Scotland. The A83(T) Rest and be Thankful site is identified as being extremely active in recent years with multiple debris flow events and road associated closures. Between 2007 and 2019, nine of those years had at least one event that had an adverse effect on the travelling public.

[238] https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-and-global-extreme-events-heavy-rainfall-and-floods
[239] http://research.ncl.ac.uk/convex/ [Accessed 21st February 2018]
[240] Winter, M. G., Peeling, D., Palmer, D., Peeling, J. (2019): Economic impacts of landslides and floods on a road network. AUC Geographica 54(2), 207–220 https://doi.org/10.14712/23361980.2019.18

Other extreme weather examples include:

- In November 2020, the A83(T) had barely been open for three weeks since August 4, when a landslip brought about by rain blocked the road[241]. It left motorists with a 60 mile diversion as the single track alternative route was also closed that evening due to heavy rain forecasted.
- In January 2023, a Met Office yellow weather warning prompted five flood alerts across Scotland, including Argyll and Bute[242].
- In December 2022, the Scottish Environment Protection Agency (SEPA) issued yellow flood warnings for several regions, including Argyll and Bute[243].
- In July 2022, two children and four adults were rescued from flooding at their campsite at Loch Lomond, approximately 10 miles from the Proposed Scheme[244].

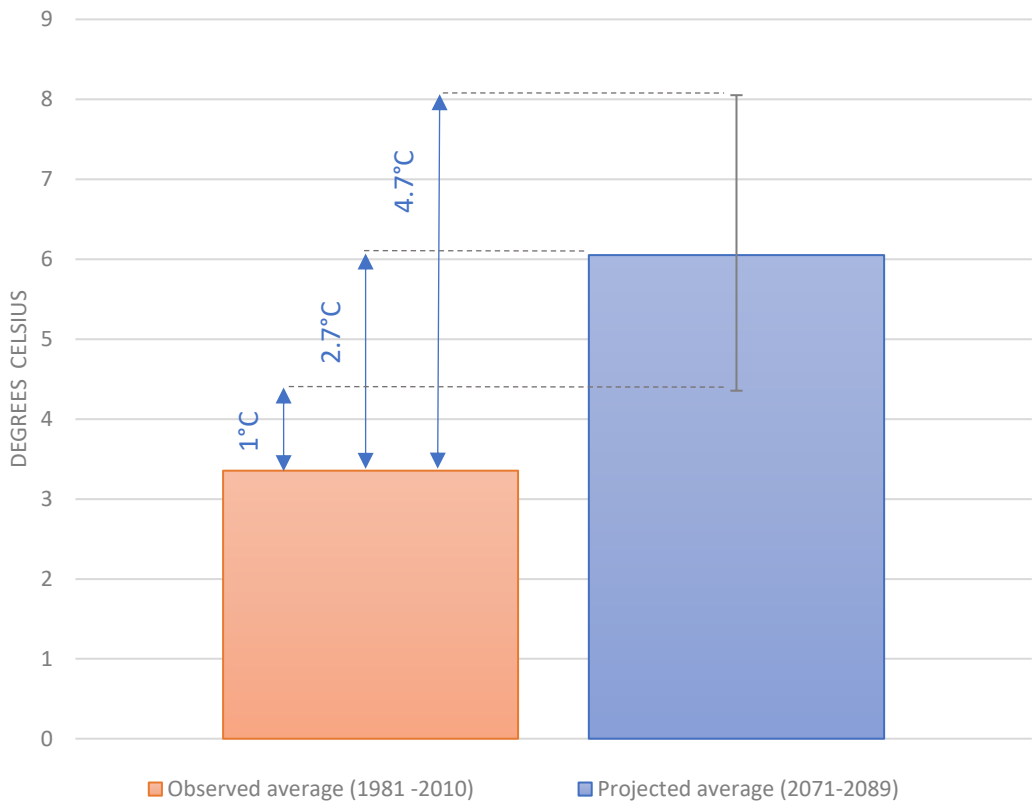
With regard to storminess, across the UK historical data provides no compelling trends as determined by maximum gust speeds from the UK wind network over the last four decades (UKCP18).

13.3.2.4. Future climate projections

13.3.2.5. Temperature projections - warmer winters

Plate 13.10 shows that under RCP8.5 average winter temperatures in the Argyll River Basin are expected to increase from 3.4ºC (observed average 1981-2010) to 6.1ºC (projected average 2071-2089), an increase of 2.7ºC (based on the central estimate, i.e. 50th percentile). The uncertainty around this estimate of change ranges from 1.0ºC to 4.7ºC (represented by the 10th and 90th percentiles respectively).

241 https://www.heraldscotland.com/news/18839563.a83-rest-thankful-shut-third-successive-day-two-landslides/
242 https://www.thenational.scot/news/23240642.flooding-yellow-warning-issued-parts-scotland/
243 https://www.heraldscotland.com/news/23218415.met-office-issues-amber-weather-warning-parts-scotland/
244 https://news.stv.tv/west-central/six-rescued-from-loch-lomond-campsites-after-yellow-weather-warning-issued-for-heavy-rain



NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles.

Plate 13.10 Projected average mean winter temperatures (2071-2089)

In the UK, the heaviest snowfalls tend to occur when the air temperature is between zero and 2°C[245]. The projected increase in winter temperatures is therefore expected to reduce mean snowfall, number of snow days and heavy snow events[246]. While there is less certainty in the magnitude of these changes, there is confidence in the negative direction of the change[247]. This is supported by the fact that the decade leading up to the publication of UKCP18 (2008-2017) had 5% fewer days of air frost and 9% fewer days of ground frost compared to the 1981-2010 average, and 15% and 14% respectively compared to 1961-1990[248]. Plate 13.11 shows a plume plot containing regional results (12km resolution) of

[245] Met Office. (2013). Met Office. [online] Available at: http://www.metoffice.gov.uk/learning/learn-about-the-weather/weather-phenomena
[246] Brown, S., Boorman, P. and Murphy, J. (2010). Interpretation and use of future snow projections from the 11member Met Office Regional Climate Model ensemble. UKCP09 Technical note, Met Office Hadley Centre, Exeter, UK
[247] McColl, L., Palin, E. J., Thornton, H. E., Sexton,·D. M. H., Betts, R. and Mylne, K. (2012). Assessing the potential impact of climate change on the UK's electricity network. Climatic Change, 115: 821-835. OR McColl, L., Angelini, T. and Betts, R. (2012) UK Climate Change Risk Assessment for the Energy Sector. Department for Environment Food and Rural Affairs, London, UK
[248] Met Office, (2019) UKCP18 Science Overview Report, online: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

RCP 8.5 projections for surface snow amount anomaly (mm), the middle model projections are highlighted. Only one of the twelve model outputs presented show positive values; and it is only within one year of the twenty-year time period presented. For the period 2060-2079, under a high emissions scenario (RCP8.5), the Regional (12km) and Local (2.2km) projections show a decrease in both falling and lying snow across the UK relative to the 1981-2000 baseline[249].

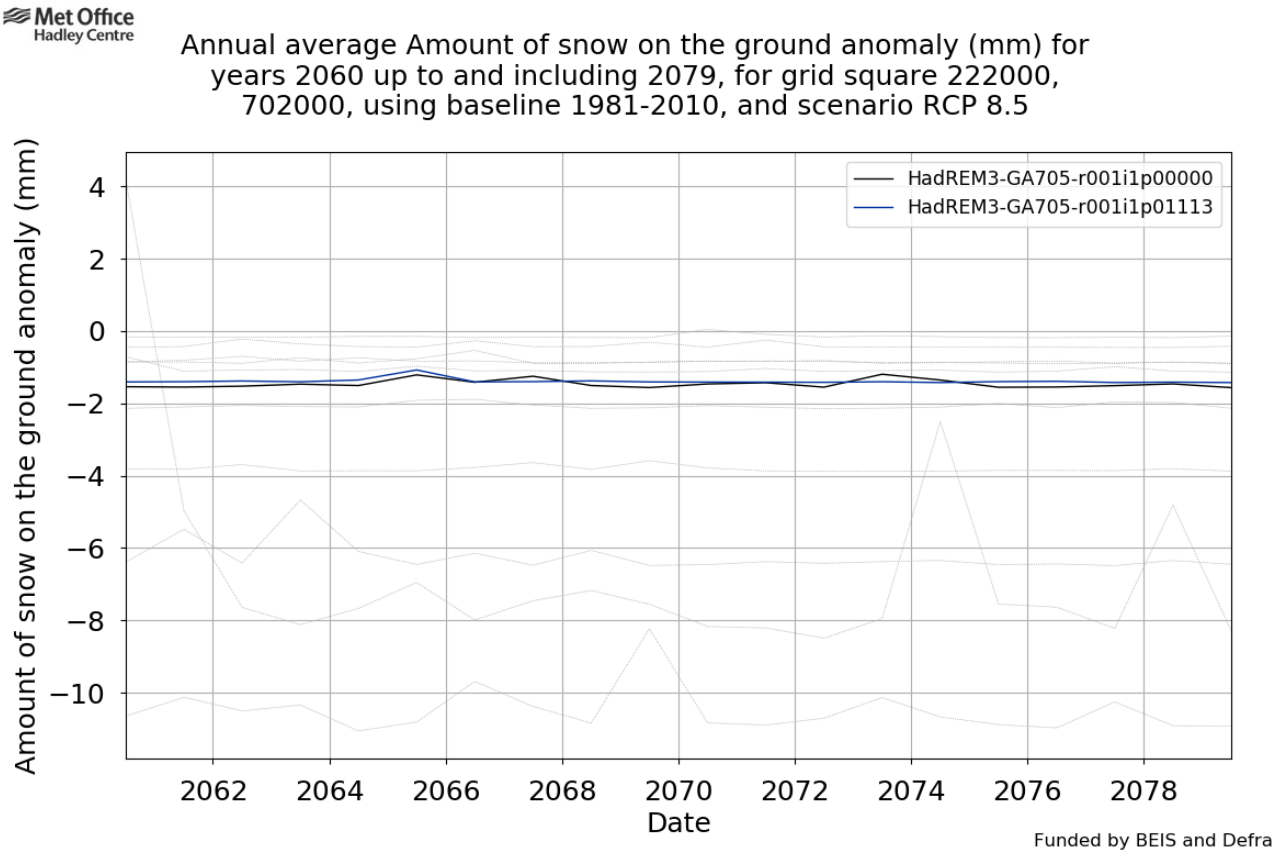


Plate 13.11 Annual average amount of snow on the ground anomaly (mm) for years 2060 up to and including 2079 for the 12km grid square containing the Project (222000, 702000)

Temperature projections - hotter summers

In the recent past (1981-2000) the probability of seeing a summer as hot as 2018 in the UK was low (<10%). This probability has already increased due to climate change and is now estimated to be between 10-25%. With future warming, hot summers by the mid-century could become even more common (with probabilities of the order of 50% depending on the

[249] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-factsheet-snow.pdf

emissions scenario followed)[39]. The summer of 2022 was the joint, with 2018, hottest summer on record for England[250].

In the Argyll River Basin, within which the Proposed Scheme is located, projected mean daily maximum summer temperatures have been obtained from the UKCP18 probabilistic projections for 2071-89. Since these are an average of summer daily maximum temperatures it should be noted that some days in this period are likely to be hotter than the values indicated below. Plate 13.12 shows that an increase in summer temperatures is expected by the 2080s under RCP8.5. The central estimate (i.e., 50th percentile) projects an increase of 3.0ºC in summer mean daily maximum temperatures by 2071-89.

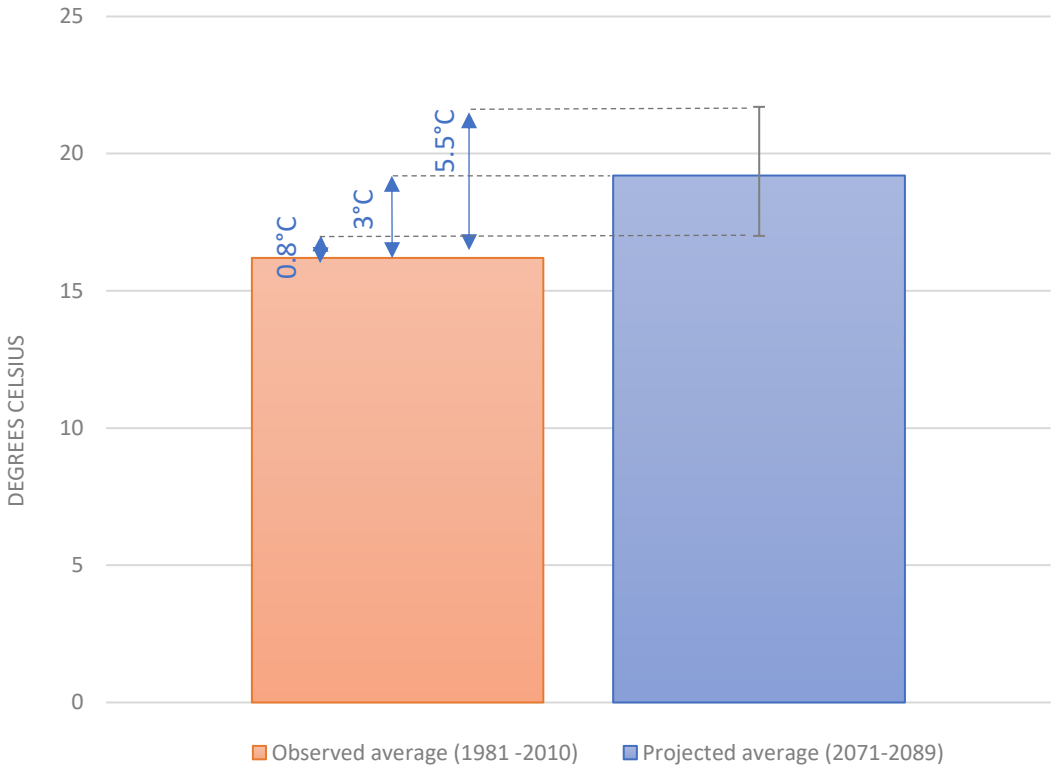
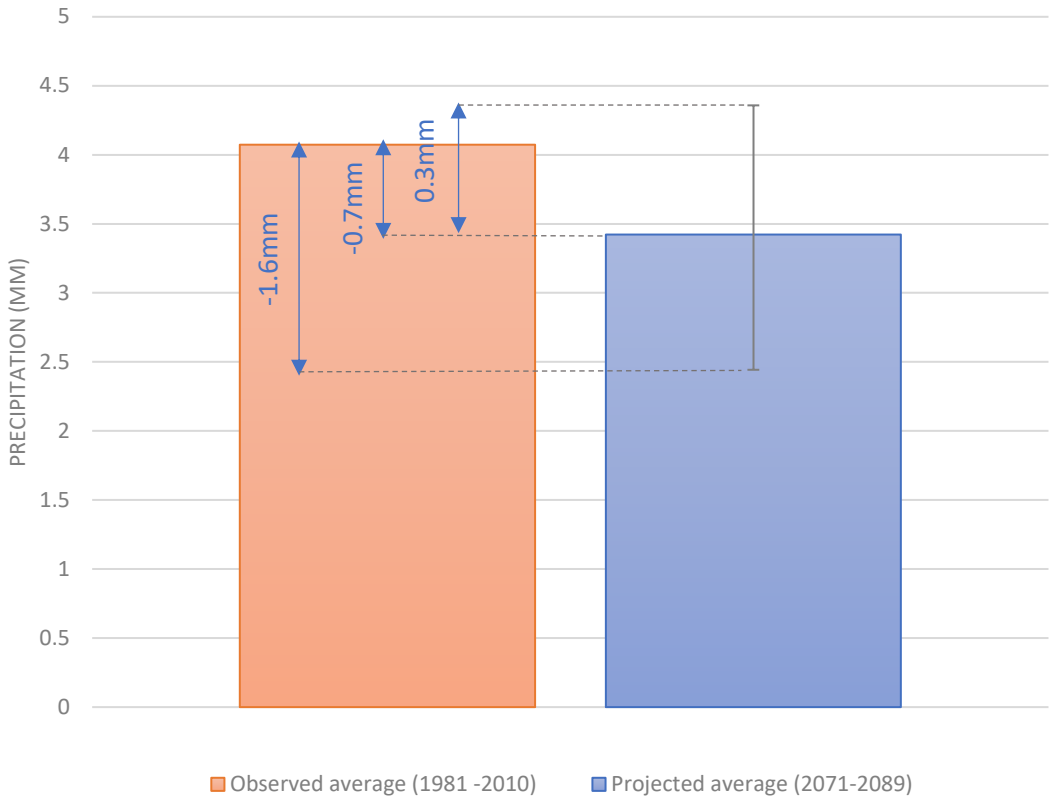


Plate 13.12 Projected average maximum summer temperature (2071-2089)

[250] https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/joint-hottest-summer-on-record-for-england

13.3.2.6. Precipitation projections - drier summers

Projected precipitation levels for RCP 8.5 have been averaged across the Argyll River basin, within which the Proposed Scheme is located, to give a range of projected average rainfall change between the 10% and 90% probability levels. As shown in Plate 13.13 by 2071-89 this range falls between a +0.3mm to -1.6mm change to rainfall. The central estimate of change (i.e., 50th percentile) in mean summer precipitation for the same period is a 0.7mm reduction. These projections suggest that future average rainfall trends are uncertain, but it is more likely than not that summer rainfall will decrease. This supports the finding that future average rainfall trends are uncertain.

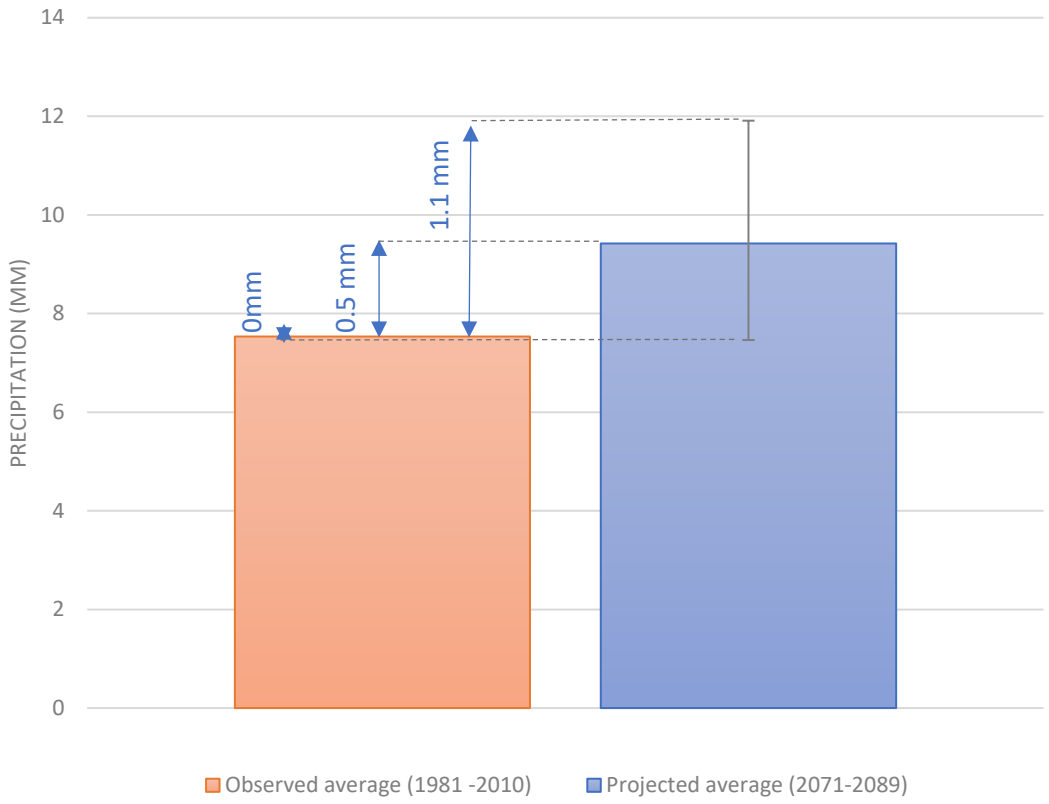


NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles

Plate 13.13 Projected average summer precipitation (2071-2089)

13.3.2.7. Precipitation projections - heavier rainfall and wetter winters

Plate 13.14 shows that UKCP18 climate projections forecast that by 2071-89, under RCP 8.5 central estimate (i.e. 50th percentile), winter mean precipitation will increase by 0.5 mm. However, it should be noted that year to year, levels are expected to continue to vary widely.



NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles

Plate 13.14 Projected average winter precipitation (2071-2089)

13.3.2.8. Extreme weather projections

Future projections of storms and high winds are uncertain. They depict a wide spread of future changes in mean surface wind speed, see Plate 13.15 which shows UKCP18 data specific to the 12km grid square within which the Proposed Scheme is located. This uncertainty is partly due to large uncertainty in projected changes in circulation over the UK, and also because of wide ranging natural climate variability[251]. It is therefore difficult to represent extreme winds and gusts within regional climate models[41]. Global projections show

[251] Brown, S., Boorman, P., McDonald, R., and Murphy. J. (2012) Interpretation for use of surface wind speed projections from the 11-member Met Office Regional Climate Model ensemble. Post-launch technical documentation for UKCP09. Met Office Hadley Centre, Exeter, UK. Crown copyright

an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season[252]. These studies suggest that climate-driven storm changes are less distinct in the Northern than Southern hemisphere[253]. There is some agreement of a projected poleward shift in storm tracks across the Atlantic Ocean. However, for mid-Atlantic storms, such as those that affected the UK in early 2014, projections are less certain[254]. Potentially, those mid-Atlantic storms may become more intense, particularly with the long-term warming of the sub-tropical Atlantic that could increase the amount of moisture that those storms carry[255]. However, such is the wide range of inter-model variation, robust projections of changes in storm tracks over the UK are not yet possible, and there is low confidence in the direction of future changes in the frequency, duration or intensity of storms affecting the UK.

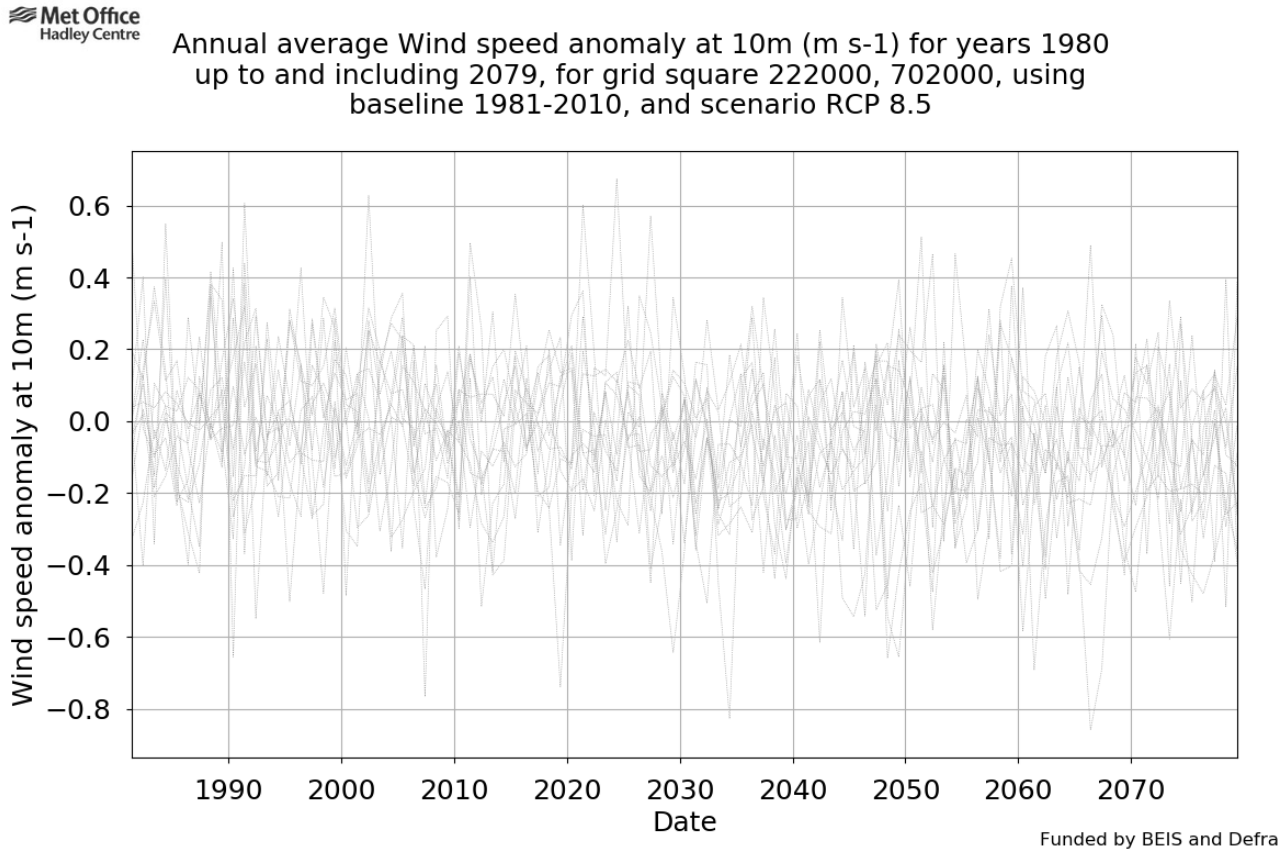


Plate 13.15 Projected seasonal average wind speed anomaly (1980-2079)

[252] Met Office, UKCP18 Factsheet: Wind, www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind.pdf
[253] Bengtsson, L., Hodges, K. I. (2005). Storm Tracks and Climate Change. Journal of Climate, 19: 3518-3543. http://dx.doi.org/10.1175/JCLI3815.1
[254] Slingo, J., Belcher, S., Scaife, A., McCarthy, M., Saulter, A., McBeath, K., Jenkins, A., Huntingford, C., Marsh, T., Hannaford, J. and Parry, S. (2014). The recent storms and floods in the UK, Met Office, Exeter, 29pp
[255] Ibid

13.4. Potential Impacts

Each of the potential impacts assessed are not significant for all Scheme Options. To enable differentiation between the scheme options each has been assigned ‘most favourable’ and ‘least favourable’ in relation to each potential impact. Where the Scheme Options are not most or least favourable and can still be differentiated, these are also indicated in the rating column.

Table 13.5 Potential construction impacts

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
Extreme weather triggering landslides that endanger construction workers or increasing landslide risk to an unacceptable level that requires construction work to be suspended. Extreme weather such as heavy rainfall increases the risk of landslides and other geohazards occurring. Construction will be occurring within landslide prone areas. Some options will be more exposed to this risk than others. **Generic mitigation common to all options** Health and Safety protocols as part of the CEMP are assumed, where weather forecasts, severe weather plans and stability observations and protocols are in place to protect the safety of the construction workers (see **Chapter 14 Major Accidents and Disasters**).	Likelihood: Low Following Transport Scotland guidance and in line with the UKCP18 projections and the precautionary principle it is considered that there is very low certainty that prevailing rainfall will get heavier and more frequent over the Scheme's construction period. While emissions scenario RCP8.5 suggests that a central estimate of mean winter precipitation change is an increase of 0.5 mm by 2071-89 changes on a shorter timescale, when construction will occur, will be significantly less. Although the prevailing climate is not expected to change during construction extreme weather is still possible and so the likelihood of this is assessed as low. Green Option specific mitigation To facilitate excavation into the hillside to construct the flow shelter protective measures in the form of rock/debris fall fences and mesh would be required upslope of the excavation. It is envisaged that the excavation would be undertaken in a phased manner, opening approx. 50m sections at a time with the fencing moved to the subsequent section as works progress. Moving the fencing would be the highest risk part of the construction with regard to landslide impact exposure – although it is noted that this exposure would be less than for the Brown Option which would require construction of a longer flow shelter and therefore is considered higher risk with regard to potential landslide construction risks. Although construction of the viaduct piers and end abutments would be away from the steeper areas of the valley used for the construction of some of the other Scheme Options they would still be vulnerable to landslide impacts and so these working areas will need protection and stabilisation measures. Consequence: Large Without mitigation a landslide event during construction working hours has the potential to cause loss of life of the construction workers. With mitigation the risk to life will be reduced to an acceptable level but a landslide could still have impacts on the construction schedule and so cause a large amount of traffic disruption. Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Yellow Option specific mitigation Whilst the alignment has sought to utilise the flatter and less landslide vulnerable ground below the OMR, protection and stabilisation measures would still be required upstream of working areas to mitigate landslide risks. Consequence: Moderate Without mitigation a landslide event during construction working hours has the potential to cause loss of life of the construction workers. With mitigation the risk to life will be reduced to an acceptable level. A landslide could still have significant impacts on the construction schedule and therefore cause traffic delays by delaying the reopening but the consequences can more easily be mitigated than for the construction of a flow shelter and so they are considered to be moderate. Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Brown Option specific mitigation To facilitate excavation into the hillside, protective measures in the form of rock/debris fall fences and mesh would be required upslope of the excavation. The excavation would likely be undertaken in a phased manner, opening approx. 50m sections at a time with the fencing moved to the subsequent section as works progress. Moving the fencing would be the highest risk part of the construction with regard to landslide impact exposure. Consequence: Large Shares the same consequences as the Green Option. Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Pink Option specific mitigation It is assumed the tunnel would be excavated by means of drill and blast from both sides meaning temporary construction areas would be required at both portals. These are small, compared to the other Scheme Options, and fixed areas that would require protection from landslide impacts that would be similar, to that required around the viaduct piers presented for the Yellow and Green options. Consequence: Minor The portals would be fixed locations and landslide impacts upon them can be mitigated more easily than the vulnerable construction locations associated with the other options because the tunnel portals will be at either end of the valley in areas of lower landslide risk. Significance: Not significant .	Likelihood: Low Shares the same likelihood as the Green Option. Purple Option specific mitigation The mitigation presented for both the Pink and Yellow Options would apply. Consequence: Moderate Taking a precautionary approach the option consequence is considered to be the same as for the Yellow option. Significance: Not significant	The Pink Option is the favourable as most of the construction work would be underground and not vulnerable to landslide impacts. The Brown Option is the least favourable due to construction being in the area of high instability.

Table 13.6 Potential operational impacts

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
Hotter summers affecting structures Hotter summers could reduce the asset lives of structures, for example causing: • Over expansion and buckling (e.g., of culverts or kerbs); or • Failure of expansion joints. Generic mitigation common to all options The design is expected to ensure structures can adapt to expected future variations in temperature. The Eurocodes[256] stipulate design to a temperature range which is adjusted to take account of altitude, material type and depth of surfacing thickness, for example. No further option specific mitigation is presented for this impact at this stage, it will be developed as the design progresses.	Likelihood: High - Following LA 114 and in line with the UKCP18 projections and the precautionary principle it is considered that there is high certainty that summer mean temperatures will increase over the Scheme's lifetime (by 2071-89 summer mean daily maximum temperatures could be up to +5.5ºC warmer [central estimate under emissions scenario RCP8.5]). Consequence: Minor - Emergency repairs and more regular maintenance interventions may be required, in response to changes in deterioration rates. These would create associated traffic delays (minor adverse). Under very extreme temperatures, certain maintenance activities may be required to be undertaken at night, to keep work to schedule, thus incurring higher programme costs (e.g. labour and illumination) but causing less traffic disruption (negligible). Significance: Not significant Green Option rating commentary Incorporation of an exposed viaduct makes the Green Option higher risk compared to those Scheme Options without a viaduct or significant bridge structures. It is rated above the Purple Option due to the lesser distance of the viaduct (~0.4km versus 1.5km). The flow shelter will also be exposed, though to a lesser extent, with the flow shelter itself shading some vulnerable assets e.g. long kerbs, on the road beneath it.	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option. Significance: Not significant Yellow Option rating commentary This option contains a very large exposed structure compared to the other Scheme Options.	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option. Significance: Not significant Brown Option rating commentary The Brown Option is less dependent on expansion joints and/or bridge bearings than those containing a viaduct. The Brown Option's assets would be partially exposed to temperature impacts, for many of the assets these will be mitigated by the shade the flow shelter will provide.	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Negligible With a large proportion of the Pink Option's assets underground exposure to increased temperatures is much reduced and so consequences are likely to be predominantly negligible. Some assets will be located outside of the tunnel and there could be minor impacts on these. Significance: Not significant Pink Option rating commentary The Pink Option does not include large bridge/viaduct features. The predominance of the tunnel reduces the exposure of the Pink Option to temperature related impacts.	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option. Significance: Not significant Purple Option rating commentary The Purple Option contains a large exposed structure compared to the other Scheme Options. However, the tunnel would reduce the exposure of a large part of the Purple Option to temperature related impacts.	As the risks for this potential impact are largely related to bridge/viaduct structures, the predominance of the tunnel in the Pink Option rates it as the most favourable. The Yellow Option contains a very large exposed structure compared to the other Scheme Options, making it the least favourable.

[256] The Eurocodes are European standards specifying how structural design should be conducted within the European Union. These were developed by the European Committee for Standardisation upon the request of the European Commission.

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
Drier summers and wetter winters impacting soil instability and affecting structures Climate change could adversely affect soil stability impacting structures. This could affect physical assets (e.g. foundations) as well as semi natural features (e.g. embankments) and natural structures (e.g. trees). Impact pathways include: • The expected reduction in summer average rainfall is likely to intensify and extend soil moisture deficits and impact groundwater levels. This could impact soil stability, for example causing subsidence or increasing earth pressures. • Wetter winters could cause soil instability as heave causes the upward movement of the ground; usually associated with the expansion of clay soils which swell when wet. • Wetter winters and heavier rain could cause weakening or washout of structural soils. • Wetter winters may increase regularity of soil saturation and increase risk of embankment collapse, i.e., landslip. Generic mitigation common to all options Risk will be managed by best practice design and construction. The geotechnical design will be in accordance with BS EN 1997-1:2004 Eurocode 7 Geotechnical Design Part 1 General rules. So, for example, cuttings and embankment works will be designed based on slope-stability analysis using site specific soil parameters. Additionally, to avoid waterlogging around embankments appropriate drainage will be included, for example so that runoff is collected and stored before being released gradually to infiltrate after a storm has passed, see DMRB, CG501 - Design of highway drainage systems. The geotechnical construction will be in line with DMRB Standards (DMRB CD 622 Managing Geotechnical Risk) so risks will be controlled, for example, by: • Providing appropriate soil compaction. • Completing stability assessments as part of design. Including analysis and modelling to predict maximum and permittable magnitude of movement. • Undertaking appropriate ground investigations. • Collecting appropriate groundwater flow data.	Likelihood: High - Following LA 114 and in line with the UKCP18 projections and the precautionary principle it is considered that there is high certainty that summer mean temperatures will increase over the Proposed Scheme's lifetime (by 2071-89 summer mean daily maximum temperatures could be up to +5.5ºC warmer [central estimate under emissions scenario RCP8.5]). There is less certainty winters will become wetter but, following a precautionary approach, the likelihood for these changes is taken to be high. Consequence: Minor Emergency repairs and more regular maintenance interventions may be required, in response to changes in deterioration rates. These would create associated traffic delays (minor adverse). Under very extreme temperatures, certain maintenance activities may be required to be undertaken at night, to keep work to schedule, thus incurring higher programme costs (e.g., labour and illumination) but causing less traffic disruption (negligible). Significance: Not significant	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option. Significance: Not significant	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option. Significance: Not significant	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option Significance: Not significant	Likelihood: High Shares the same likelihood as the Green Option. Consequence: Minor Shares the same consequence as the Green Option. Significance: Not significant	As the Pink Option is predominantly a tunnel, the risk of soil instability is much less in comparison to the other Scheme Options. The Pink Option is therefore favourable. The Green, Yellow and Brown Option are all least favourable as while impacts from settlement are magnified on larger structures, there is higher exposure to these processes higher up in the glen.

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
• Where foundations extend below the existing groundwater table or could extend below the future groundwater level, they are designed in accordance with industry standards. • Monitoring during the construction works to measure movements, with agreed trigger level and action plan. In addition to the above, vulnerable assets in the study area will be regularly inspected to assess movements. Option specific mitigation will be developed as the design progresses.						
Extreme weather (wind) affecting driver experience Storms and high winds reduce driver safety, in particular - potentially affecting high sided vehicles and so could increase traffic disruption associated with accidents / overturned vehicles. Generic mitigation common to all Scheme Options It is noted that risks associated with driving cannot be fully removed by changes to the Proposed Scheme design. This reflects the fact that the cause of most traffic accidents is composite and often includes driver error.	Likelihood: Low Climate projections show there is low certainty of how climate change will alter extreme weather in the future, particularly wind. Consequence: Moderate Accident rates could increase creating more traffic disruption (minor adverse). Significance: Not Significant Green Option specific mitigation Operational procedures will be developed to manage the risks, for example closing the viaduct or speed restrictions during high wind periods.	Likelihood: Low Shares the same likelihood as the Green Option. Yellow Option specific mitigation Operational procedures will be developed to manage the risks, for example closing the viaduct or speed restrictions during high wind periods. Consequence: Moderate Accident rates could increase creating more traffic disruption (minor adverse). Significance: Not Significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Negligible Option does not expose traffic to increased wind impacts. Significance: Not Significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Negligible Option does not expose traffic to increased wind impacts. Significance: Not Significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Moderate Accident rates could increase creating more traffic disruption (minor adverse). Significance: Not Significant	The majority of the Pink Option is a tunnel and does not include significant exposed areas such as viaducts. Risks from high winds are therefore negligible making it the favourable option. The majority of the Yellow Option is a viaduct and as such risk from high winds is higher compared to other options, making it the least favourable.

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
Extreme weather (snow and ice) affecting driver experience Although winters are forecast to be warmer, extreme weather is still expected; snow and ice could create a hazard for drivers. Generic mitigation common to all options Roads will be salted and ploughed as needed, based on forecasts and road conditions, in line with the Transport Scotland winter service procedures. Detailed option specific mitigation will be prepared during the development of the designs. It is noted that risks associated with driving cannot be fully removed by changes to the Proposed Scheme design. This reflects the fact that the cause of most traffic accidents is composite and often includes driver error.	Likelihood: Low Climate projections show there is low certainty of how climate change will alter extreme weather in the future. Consequence: Minor Accident rates could increase during extreme cold weather creating more traffic disruption (minor adverse). Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Minor Accident rates could increase during extreme cold weather creating more traffic disruption (minor adverse). Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Minor Accident rates could increase during extreme cold weather creating more traffic disruption (minor adverse). Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Moderate Accident rates could increase during extreme cold weather creating more traffic disruption (minor adverse). Tunnel portals present a particular risk as snow and ice can build up here potentially then falling en masse onto vehicle or blocking the road. Significance: Not significant	Likelihood: Low Shares the same likelihood as the Green Option. Consequence: Moderate Accident rates could increase during extreme cold weather creating more traffic disruption (minor adverse). Tunnel portals present a particular risk as snow and ice can build up here potentially then falling en masse onto vehicle or blocking the road. Significance: Not significant	The flow shelter entrance and exit could be affected where snow builds up and then falls onto the road in a similar but less severe way as the tunnel option. The Yellow Option is therefore identified as favourable for this impact. The tunnel portals may create hazard points. The sudden change in the external environment, especially at the entrance of the tunnel, requires drivers to adjust and adapt quickly, resulting in a higher chance of an accident occurring[257]. Therefore, the Pink and Purple Options are least favourable.
Heavier rain and wetter winters could impact driver experience In the future heavier rain resulting from climate change will create dangerous driving conditions more often as spray reduces visibility, stopping distances increase and standing water creates an aquaplaning risk. Generic mitigation common to all options To inform the design of the Scheme an FRA will be completed along with a detailed Drainage Strategy and the Chapter 15 Road Drainage and the Water Environment. These will describe how the Proposed Scheme will ensure drainage will be sufficient for future rainfall. It is noted that risks associated with driving cannot be fully removed by changes to the Proposed Scheme design. This reflects the fact that the cause of most traffic accidents is composite and often includes driver error. Detailed option specific embedded mitigation will be developed as the design progresses.	Likelihood: Medium Following Transport Scotland guidance and in line with the UKCP18 projections and the precautionary principle it is considered that there is medium certainty that rainfall will get heavier over the Scheme's lifetime. Emissions scenario RCP8.5 suggests that a central estimate of mean winter precipitation change is an increase of 0.5 mm by 2071-89. Changes to extreme rainfall are less clear. Consequence: Minor Accident rates could increase, particularly during wet weather, creating more traffic disruption (minor adverse). Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Minor Shares the same consequence as the Green option. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Minor Shares the same consequence as the Green option. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Minor Shares the same consequence as the Green option. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Minor Shares the same consequence as the Green option. Significance: Not significant	The Pink Option is favourable as very little of the Scheme Option is exposed to the elements. The Yellow Option is least favourable as the Scheme Option is exposed to the elements.

[257] http://ojs.bbwpublisher.com/index.php/JARD/article/view/4560

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
Wetter winters and extreme weather could increase landslide risk in the future impacting maintenance work Increased rainfall intensity resulting from climate change could create dangerous environments for maintenance workers, e.g. when clearing debris pits, by increasing landslide risk. Generic mitigation common to all Scheme Options It is expected that health and safety measures would be implemented that would monitor forecasts and stability in the area of work. Detailed option specific mitigation will be prepared as the design progresses.	Likelihood: Medium Following Transport Scotland guidance and in line with the UKCP18 projections and the precautionary principle it is considered that there is medium certainty that rainfall will get heavier over the Green Option's lifetime. Emissions scenario RCP8.5 suggests that a central estimate of mean winter precipitation change is an increase of 0.5 mm by 2071-89. Changes to extreme rainfall are less clear. Consequence Minor Delays on maintenance may occur to avoid bad weather forecasts. This might extend maintenance work periods. If maintenance is unable to be completed the road may need to be temporarily closed until the assets can be inspected and debris removed after a landslide. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green Option. Consequence: Negligible Maintenance workers would not be regularly exposed to landslide risks. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green Option. Consequence: Minor Shares the same likelihood as the Green option. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green Option. Consequence: Negligible Maintenance workers would not be regularly exposed to landslide risks. Significance: Not significant	Likelihood: Medium Shares the same likelihood as the Green Option. Consequence: Negligible Maintenance workers would not be regularly exposed to landslide risks. Significance: Not significant	Pink is the favourable option as maintenance of the tunnel route is unlikely to put maintenance workers at risk in relation to a landslide occurrence. The Brown Option is least favourable as clearing of debris pits included which is likely the highest risk for the safety of maintenance workers in relation to landslide occurrence. This is rated worse than the Green Option due to the longer length of the flow shelter structure in this option.
Wetter winters and extreme weather could increase the risk of landslides in the future which may damage scheme assets The Proposed Scheme itself will reduce consequences of landslide impacts on assets – the degree to which they achieve this, and the maintenance it requires, varies from one option to another. Heavier rainfall and increased intensity of rainfall increases the risk of landslides and other geohazards occurring. Impacts on assets include: • Landslide impacts on debris flow shelters, i.e., ensuring they are adequately protected against boulder rock falls, gravel, slurry and water movements; and • Landslide impacts on viaduct piers. Generic mitigation common to all Scheme Options Mitigation measures are described under each Option as they are specific for each	Likelihood: Medium Following Transport Scotland guidance and in line with the UKCP18 projections and the precautionary principle it is considered that there is medium certainty that rainfall will get heavier over the Green Option's lifetime. Emissions scenario RCP8.5 suggests that a central estimate of mean winter precipitation change is an increase of 0.5 mm by 2071-89. Changes to extreme rainfall are less clear. Green Option specific mitigation To protect the piers in vulnerable areas debris defence structures, in the form of reinforced concrete retaining type structures, would be required to divert material around the piers in the event of a slip. A debris flow shelter in combination with a catch pit would also be installed. Consequence: Minor Emergency repairs and more regular maintenance interventions may be required, in response to increased landslide occurrence. These would create associated traffic delays (minor adverse). Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green Option. Yellow Option specific mitigation To protect the piers in vulnerable areas debris defence structures, in the form of reinforced concrete retaining type structures, would be required to divert material around the piers in the event of a slip. Consequence: Minor Emergency repairs and more regular maintenance interventions may be required, in response to increased landslide occurrence. These would create associated traffic delays (minor adverse). Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green Option. Brown Option specific mitigation A debris flow shelter in combination with a catch pit would be installed. The catchpit would be up to 6m wide with a protection wall between the road and catchpit of up to around 7.5m in height. Consequence: Minor Emergency repairs and more regular maintenance interventions may be required, in response to increased landslide occurrence. These would create associated traffic delays (minor adverse). Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green Option. Pink Option specific mitigation Above ground assets and tunnel portals may need to be protected from landslide impacts. Consequence: Negligible The majority of the road will be completely protected from landslides. Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green Option. Purple Option specific mitigation To protect the piers in vulnerable areas debris defence structures, in the form of reinforced concrete retaining type structures, would be required to divert material around the piers in the event of a slip. Consequence: Minor Emergency repairs and more regular maintenance interventions may be required, in response to increased landslide occurrence. These would create associated traffic delays (minor adverse). Significance: Not Significant	The Pink Option is favourable as landslide risk to structures is eliminated. The Brown Option is least favourable as flow shelters will be in area of high instability, so likely to be increased maintenance and check requirements compared to for example the Green, Pink and Purple options.

Potential impact and mitigation relevant to all Scheme Options	Green Option (viaduct and flow shelter) impact significance	Yellow Option (viaduct) impact significance	Brown Option (Flow shelter and catch pit) impact significance	Pink Option (Tunnel) impact significance	Purple Option (viaduct and tunnel) impact significance	Comparative Appraisal
Wetter winters and extreme weather could increase the risk of landslides in the future which could affect end users (drivers) Heavier rainfall and increased intensity of rainfall increases the risk of landslides and other geohazards occurring. The Proposed Scheme itself will reduce consequences of landslide impacts on end users – the degree to which they achieve this, and the maintenance it requires, varies from one option to another. Generic mitigation common to all options Maintenance of landslide defence structures, previously described for the protection of assets from landslide risks.	Likelihood: Medium Following Transport Scotland guidance and in line with the UKCP18 projections and the precautionary principle it is considered that there is medium certainty that rainfall will get heavier over the Scheme's lifetime. Emissions scenario RCP8.5 suggests that a central estimate of mean winter precipitation change is an increase of 0.5 mm by 2071-89. Changes to extreme rainfall are less clear. Consequence: Negligible Closure of the road will be reduced due to the reduced consequence of landslide impacts. The net impact is therefore beneficial. Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Negligible Shares the same consequence as the Green Option. Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Negligible Shares the same consequence as the Green Option. Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Negligible Shares the same consequence as the Green Option. Significance: Not Significant	Likelihood: Medium Shares the same likelihood as the Green option. Consequence: Negligible Shares the same consequence as the Green Option. Significance: Not Significant	All Scheme Options would significantly reduce the risk of landslides impacting traffic. With the exception of the tunnel all options have some exposure to be overwhelmed by a significant landslide as the protective structures are exposed. The Pink Option is therefore favourable. Green, Yellow and Brown Options are equally least favourable.

13.5. Conclusions

Table 13.7 Climate Vulnerability Comparative Appraisal

Sub-topic	Receptor	Potential Impact	Impact Significance (Residual Impacts)[1]					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
Construction	Construction process	Extreme weather triggering landslides that endanger construction workers or increasing landslide risk to an unacceptable level that requires construction work to be suspended.	NS	NS	NS	NS	NS	Pink Option most favourable Brown Option least favourable
Operation	Assets	Hotter summers affecting structures	NS	NS	NS	NS	NS	Pink Option most favourable Yellow Option least favourable
Operation	Assets	Drier summers and wetter winters impacting soil stability and affecting structures	NS	NS	NS	NS	NS	Pink Option most favourable All other Options least favourable
Operation	End users	Extreme weather (wind) affecting driver experience	NS	NS	NS	NS	NS	Pink Option most favourable Yellow Option least favourable
Operation	End users	Extreme weather (snow and ice) affecting driver experience	NS	NS	NS	NS	NS	Yellow Option most favourable Pink and Purple Options least favourable
Operation	End users	Heavier rain and wetter winters could impact driver experience	NS	NS	NS	NS	NS	Pink Option most favourable Yellow Option least favourable
Operation	End users	Wetter winters and extreme weather could increase landslide risk in the future impacting maintenance work	NS	NS	NS	NS	NS	Pink Option most favourable Brown Option least favourable
Operation	End users	Wetter winters and extreme weather could increase the risk of landslides in the future which may damage scheme assets	NS	NS	NS	NS	NS	Pink Option most favourable Brown Option least favourable
Operation	End users	Wetter winters and extreme weather could increase the risk of landslides in the future which could affect end users (drivers)	NS	NS	NS	NS	NS	Pink Option most favourable Brown, Yellow, and Green Options least favourable

[1]NS=Not Significant

The climate change risk assessment finds that the Scheme Options could be vulnerable to impacts linked to these changes in the climate. Mitigation measures that either avoids these impacts, minimises them or reduces their consequences to acceptable levels are presented. After consideration of this mitigation none of the potential climate vulnerability impacts are found to be significant adverse. It has however been possible to identify differentiators between the Scheme Options and this has allowed a ‘most favourable’ and ‘least favourable’ assignment with regard to their resilience to climate vulnerability impacts. The outcome is summarised in the table above. With regard to minimising climate vulnerability impacts the Preferred Option is found to be the Pink Option).

This climate vulnerability assessment has only assessed potential impacts that could generate differentiators between the Scheme Options. A full assessment will be completed once the Preferred Option is further progressed to DMRB Stage 3.

13.6. Scope of DMRB Stage 3 Assessment

For DMRB Stage 3 (following selection of a Preferred Option), all potential operational impacts that were scoped out at this stage will be assessed. Cumulative impacts will also be considered at DMRB Stage 3, as further data is collated for the Preferred Option.

Additional baseline information shall be collated to supplement the data available at DMRB Stage 2, such as landslide occurrence and local rainfall data.

Mitigation measures specific to each potential impact will be set out in further detail at Stage 3.

14. Major Accidents and Disasters

14.1. Introduction

This chapter presents the DMRB Stage 2 assessment of Scheme Options in relation to their vulnerability to risks of either major accidents and/or disasters (hereafter referred to as major events). Specifically it aims to differentiate between Scheme Options to establish those that have a greater or lesser effect on sensitive receptors.

Major events are events or situations that have the potential to affect the Proposed Scheme causing immediate or delayed serious damage to one or more of the following human health, welfare and the environment. Major events are events which rarely occur due to the mitigation, management or regulatory controls implemented to prevent them. The assessment considers the risks of major events during construction and operation caused by natural hazards or manmade hazards (including operational failure).

This chapter should be read in conjunction with Chapters 3 to 15 to provide a broader environmental context on the risks associated with these major event types.

14.2. Approach and Methods

14.2.1. Introduction

This chapter has been prepared in accordance with the DMRB LA 104. The following sections describe the methodology used in the assessment of the vulnerability of the Proposed Scheme to major events, including any assumptions and limitations of the approach.

14.2.2. Guidance

14.2.3. Policy, Legislation and Guidance

14.2.3.1. Policy

The key national and local policies relevant to the assessment of major events are as follows:

- The Scottish Government National Planning Framework 4[258]; and

[258] Local Government and Housing Directorate, (2023). National Planning Framework 4. [online] Available at https://www.gov.scot/publications/national-planning-framework-4/documents/. [Accessed 23 May 2023].

- The Argyll and Bute Local Development Plan[259].

14.2.3.2. Legislation

The key pieces of legislation relevant to the assessment of major events are as follows:

- The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017[260];
- Health and Safety at Work etc. Act 1974 (c. 37)[261];
- Construction (Design and Management) (CDM) Regulations 2015[262]; and
- Occupier's Liability Act 1984 (c.3)[263].

14.2.3.3. Guidance

To date, there is no specific regulatory guidance on how to consider major events within the context of EIA. However, the assessment takes account of the following guidance and emerging EIA good practice:

- IEMA Major Accidents and Disasters in EIA Guide[264];
- DEFRA Guidelines for Environmental Risk Assessment and Management Green Leaves III[265];
- Chemical and Downstream Oil Industries Forum: Guideline – Environmental Risk Tolerability for COMAH Establishments[266];
- The International Standards Organization's ISO 31000: 2018 Risk Management – Guidelines[267];

[259] Argyll and Bute Council, (2015). The Argyll and Bute Local Development Plan. [online] Available at https://www.argyll-bute.gov.uk/ldp. [Accessed 23 May 2023].
[260] HM Government, (2017). The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017. [online] Available at: https://www.legislation.gov.uk/sdsi/2017/9780111035160/contents. [Accessed: 21 February 2023].
[261] HM Government, (1974). Health and Safety at Work etc. Act 1974. [online] Available at https://www.legislation.gov.uk/ukpga/1974/37/contents. [Accessed: 21 February 2023].
[262] HM Government, (2015). The Construction (Design and Management) Regulations 2015. [online] Available at: https://www.legislation.gov.uk/uksi/2015/51/contents/made. [Accessed:21 February 2023].
[263] HM Government, (1984). Occupiers Liability Act 1984. [online] Available at: https://www.legislation.gov.uk/ukpga/1984/3/contents. [Accessed: 21 February 2023].
[264] Institute of Environmental Management and Assessment, (2020). Major Accidents and Disasters in EIA: A Primer. [online] Available at: https://www.iema.net/resources/blog/2020/09/23/iema-major-accidents-and-disasters-in-eia-primer. [Accessed: 21 February 2023].
[265] Department for Environment, Food & Rural Affairs, (2011). Guidelines for Environmental Risk Assessment and Management Green Leaves III. [online] Available at: https://www.gov.uk/government/publications/guidelines-for-environmental-risk-assessment-and-management-green-leaves-iii. [Accessed: 21 February 2023].
[266] Chemical and Downstream Oil Industries Forum, (2013). Guideline - Environmental Risk Tolerability for COMAH Establishments. [online] Available at: https://www.sepa.org.uk/media/219154/cdoif_guideline__environmental_risk_assessment_v2.pdf. [Accessed: 21 February 2023].
[267] International Standards Organisation, (2018). ISO 31000:2018 Risk management – Guidelines. [online] Available at: https://www.iso.org/standard/65694.html. [Accessed: 21 February 2023].

- EIA Quality Mark Article: What is this MADness?[268];
- EIA Quality Mark Article: Major Accidents and Disasters in EIA[269]; and
- Disasters in EIA[270].

14.2.4. Sources of Information

A desk-based assessment has been undertaken to collate baseline data within the Study Area. This information has been collated from the following sources which have also been used to support the identification of potential major events:

- The Cabinet Office's National Risk Register (2020 Edition)[271];
- The International Federation of Red Cross & Red Crescent Societies Early Warning, Early Action[272];
- The International Disaster Database[273];
- Health and Safety Executive COMAH 2015 Public Information[274];
- Health and Safety Executive's Planning Advice Web App[275];
- The British Geological Survey GeoIndex Onshore[276]; and
- Technical Topic Chapters: Chapter 13 Climate Vulnerability and Chapter 15 Road Drainage and the Water Environment.

14.2.5. Consultation

No specific consultation relating to major events has been undertaken to inform the DMRB Stage 2 Assessment. Consultation was undertaken throughout the DMRB Stage 2 process through the A83 Environmental Steering Group (ESG) which comprised of LLTNPA,

[268] AMEC, (2017). EIA Quality Mark Article: What is this MADness? [online] Available at: https://s3.eu-west-2.amazonaws.com/iema.net/archive/assets/uploads/EIA%20Articles/AMEC%20What%20is%20this%20MADness.pdf. [Accessed: 21 February 2023].
[269] Temple Group, (2018). EIA Quality Mark Article: Major Accidents and Disasters in EIA. [online] Available at: https://s3.eu-west-2.amazonaws.com/iema.net/archive/assets/uploads/EIA%20Articles/Temple%20Article%201.pdf. [Accessed: 21 February 2023].
[270] TUV SUD, (2018). Disasters in EIA. [online] Available at: https://www.iema.net/articles/disasters-in-eia. [Accessed: 21 February 2023].
[271] HM Government, (2020). Guidance: National Risk Register 2020. [online] Available at: https://www.gov.uk/government/publications/national-risk-register-2020. [Accessed: 21 February 2023].
[272] The International Federation of Red Cross and Red Crescent Societies, (2021). Early Warning, Early Action. [online] Available at: https://www.ifrc.org/early-warning-early-action [Accessed: 15 March 2023].
[273] Centre for Research on the Epidemiology of Disasters, (2021). The International Disaster Database. [online] Available at: https://www.emdat.be/. [Accessed: 15 March 2023].
[274] Health and Safety Executive, (2023). COMAH 2015 Public Information Search. [online] Available at: https://notifications.hse.gov.uk/COMAH2015/Search.aspx. [Accessed: 24 January 2023].
[275] Health and Safety Executive, (2023). Planning Advice Web App. [online] Available at: https://pa.hsl.gov.uk/. [Accessed 24 January 2023].
[276] British Geological Survey, (2020). Geo Index Onshore. [online] Available at: http://mapapps2.bgs.ac.uk/geoindex/home.html. [Accessed 24 January 2023].

NatureScot, Scottish Environment Protection Agency (SEPA), Historic Environment Scotland, Scottish Forestry and Argyll and Bute Council.

14.2.6. Scope of Stage 2 Assessment

A scoping assessment has been undertaken which considered the potential vulnerability of the Proposed Scheme to the following major event categories and types:

- Natural hazards:
  - Geophysical;
  - Hydrological;
  - Climatological and meteorological; and
  - Biological.
- Technological or manmade hazards:
  - Societal;
  - Industrial and urban accidents;
  - Transport accidents;
  - Pollution accidents;
  - Utility failures;
  - Malicious attacks; and
  - Engineering accidents and failures.

This scoping assessment concluded that the potential major events to which the Proposed Scheme may be at risk of vulnerability during the construction and operation phases and therefore require further assessment are as follows:

- Natural hazards:
  - Landslides; and
  - Flooding.
- Technological or manmade hazards:
  - Bridge failure;
  - Flow shelter failure;
  - Tunnel failure / fire; and
  - Construction methodology causing ground movement.

14.2.6.1. Sensitive Receptors

In accordance with The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017[277], the following sensitive receptors will be considered with respect to major events:

- Population and human health;
- Biodiversity;
- Land, soil, water, air and climate;
- Material assets, cultural heritage and the landscape; and
- the interaction between the factors above.

The specific potential receptors of effects resulting from major events are reported in the relevant technical chapters.

Receptors that have been excluded from the assessment, are set out in Table 14.1 below.

Table 14.1 Excluded Receptors

Receptor	Justification for Exclusion
Employees of Transport Scotland and/or its suppliers, whether during construction, operation, or maintenance of the Proposed Scheme.	Employer's commitment and obligations to manage risks to employees are addressed in the Health and Safety at Work etc Act 1974[278].
Members of the public who are wilfully trespassing, for example, a breach of the Proposed Scheme security fencing during construction.	Transport Scotland's commitment and obligations under the CDM Regulations 2015 to manage risks during the construction stage are addressed through the requirement to produce a suitable risk assessment that informs the identification and subsequent implementation of appropriate mitigation measures. In addition, those wilfully trespassing are outside the occupier's legal requirements under the Occupiers' Liability Act 1984[279].

14.2.7. Assessment Methodology

There are three steps to the assessment of the vulnerability of each of the Scheme Options to the risk of major events:

[277] HM Government, (2017). The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017. [online] Available at: https://www.legislation.gov.uk/sdsi/2017/9780111035160/contents. [Accessed: 21 February 2023].
[278] : HM Government, (1974). Health and Safety at Work etc. Act 1974. [online] Available at: https://www.legislation.gov.uk/ukpga/1974/37/contents. [Accessed: 15 March 2023].
[279] HM Government, (1984). 'Occupiers Liability Act 1984. [online] Available at: https://www.legislation.gov.uk/ukpga/1984/3/contents. [Accessed: 15 March 2023].

14.2.7.1. Step 1 – Identification of Potential Hazard Sources and Receptors

Potential hazard sources which may increase the vulnerability of the Scheme Options to a major event within each of the major event categories and types which were scoped in at DMRB stage 2 scoping have been identified.

Potential receptors of effects resulting from major events have been identified through a review of the desk study sources outlined in Section 14.3.2 of this chapter.

14.2.7.2. Step 2 – Identification of Potential Hazards Applicable to each of the Scheme Options

For each of the Scheme Options, the potential hazard sources identified during Step 1 were reviewed with regards to their applicability to the location of each individual Scheme Option. Consideration was then given to which phases (construction and/or operation) of the Proposed Scheme would potentially increase the vulnerability of the Scheme Options to the risk of a major event. This information was collated from a desk study review of technical topic chapters: Chapter 13 Climate Vulnerability, Chapter 15 Road Drainage and the Water Environment and Part 2, Chapter 5.7, Geotechnics and Earthworks in Volume 1 of the DMRB Stage 2 Scheme Assessment Report.

14.2.7.3. Step 3 – Identification of the Preferred Option for Major Events

A review of each of the Scheme Options was undertaken, for both the construction and operation phases, to identify the route vulnerable to the fewest identified potential hazards.

14.2.7.4. Significance Criteria

In the context of this chapter, major events are events which rarely occur due to the mitigation, management or regulatory controls implemented to prevent them. By definition, if a major event were to occur the likely worst case would always be a major adverse effect.

14.2.7.5. Limitations and Assumptions

The assumptions and limitations for this assessment are detailed below:

- The design of the Proposed Scheme and its implementation is guided by industry standards and codes, many of which are mandatory. These require infrastructure and systems to be designed so that risks to people and the environment are either eliminated or reduced to levels that are As Low As Reasonably Practicable (ALARP).
- The construction phase(s) of the Proposed Scheme will be managed through the implementation of the Construction Phase Plan (required under the CDM Regulations

2015[280]). A CEMP will be prepared by the Principal Contractor which will contain the mitigation relied upon to manage the environmental impacts of the Proposed Scheme.

- Environmental effects associated with unplanned events that do not meet the definition of a major accident and/or disaster e.g. minor leaks and spills that may be contained within the construction sites are addressed in other relevant Technical Chapters.
- It is recognised that the management framework for the Proposed Scheme is not fully defined at this stage; however, a presumption of standard practice and regulatory compliance within the adopted management framework has been assumed and will be developed following the appointment of the Principal Contractor.
- The design, installation, commissioning, operation and maintenance of drainage systems and equipment, including associated systems, will consider Good Engineering Practice.
- In accordance with good environmental and safety management principles, it has been assumed that all risks that have the potential to be major accidents or disasters, and could impact a local environmental receptor, will be managed using the ALARP principle.
- The assessment is based on information available at the time of writing.

14.3. Baseline Conditions

14.3.1. Study Area

The Study Area for major events has been developed based on professional judgement as there is no specific regulatory guidance nor significant precedent or standardised methodology. The following factors and associated distances were adopted for setting the Study Area in order to capture internal and external influencing factors which may have high adverse consequences on the Proposed Scheme:

- Manmade features:
  - Control of major accident hazard facilities within 3km;
  - Major accident hazard pipelines within 1km;
  - Fuel retail sites (including Liquified Natural Gas, Liquified Petroleum Gas) within 1km;
  - Rail infrastructure within 1km; and
  - Transmission (gas, electrical, oil/fuels) crossing the development limits.
- Natural features with the potential to create risks within:
  - 3km (chiefly hydrological and geological, for example dam failure and seismic activity respectively); and

[280] HM Government, (2015). The Construction (Design and Management) Regulations 2015. [online] Available at: https://www.legislation.gov.uk/uksi/2015/51/contents/made. [Accessed: 15 March 2023].

- 1km (chiefly hydrological and geological, for example flood risk and unstable ground conditions respectively).

14.3.2. Study Area Context

The baseline conditions described for major events are derived from the following desk study sources:

- National Risk Register of Civil Emergencies;
- British Geological Survey 'Onshore GeoIndex';
- Tsunamis Hazard Map[281];
- The International Disaster Database;
- Health and Safety Executive's Planning Advice Web App;
- Health and Safety Executive's COMAH 2015 Public Information Search;
- Google aerial and street view maps covering study area; and
- Chapter 8 Geology and Soils, Chapter 13 Climate Vulnerability, Chapter 15 Road Drainage and the Water Environment and Part 2, Chapter 5.7, Geotechnics and Earthworks in Volume 1 of the DMRB Stage 2 Scheme Assessment Report.

14.3.2.1. Summary of Baseline Conditions for the Proposed Scheme

This section provides an overview of the baseline conditions for the Proposed Scheme. The baseline features have been identified using professional judgement, those which are most significant to this Proposed Scheme are shown in Table 14.2.

Table 14.2 Major Events Baseline

Baseline Features	Hazard Source / Receptor	Activities	Approximate Distance and Direction from Proposed Scheme
Beinn Luibhean	Source	Landslide risk	Adjacent to east of A83(T)
The Cobbler	Source	Landslide risk	Adjacent to east of A83(T)
Ben Donich	Source	Landslide risk	Adjacent to west of A83(T)
Beinn an Lochain	Source	Landslide risk	Adjacent to west of A83(T)
Croe Water	Source and receptor	River and floodplain	Within 200m of centreline for all options

[281] Prevention Web Europe, (2005). Tsunamis Hazard Map. [online]. Available at: https://www.preventionweb.net/english/professional/maps/v.php?id=3831. [Accessed 15 March 2023].

Baseline Features	Hazard Source / Receptor	Activities	Approximate Distance and Direction from Proposed Scheme
Loch Restil	Source and receptor	Freshwater water body and floodplain	Adjacent to A83(T)
OMR	Receptor	Roadway	Within 200m of centreline for all Scheme Options
Lower Forestry Track	Receptor	Forest recreation route	Within 525m of centreline for all Scheme Options
Upper Forestry Track	Receptor	Forest recreation route	Within 620m of centreline for all Scheme Options
Residential properties (x2)	Receptor	-	Within 515m of centreline for all Scheme Options

14.4. Assessment of Vulnerability to the Risk of Major Events

14.4.1. Construction

The vulnerability of each Scheme Option to the risk of a major event is presented in Table 14.3 below.

Table 14.3 Vulnerability to the Risk of Major Events during Construction

Major Event Category	Major Event Type	Vulnerability of each Scheme Option to the Risk of a Major Event				
		Green	Yellow	Brown	Pink	Purple
Natural Hazards	Landslides	Construction of the debris flow shelter is within an area at risk of debris flow and boulderfall. The risk to members of the public is no different to the current situation on the A83(T).	Construction of the viaduct is within an area at risk of debris flow and boulderfall. The risk to members of the public is no different to the current situation on the A83(T).	Construction of the debris flow shelter is within an area at risk of debris flow and boulderfall. The risk to members of the public is lower than the current situation on the A83(T) as road users will be diverted onto the OMR.	Construction of the portals and cut and cover sections are within an area at risk of debris flow and boulderfall. The risk to members of the public is no different to the current situation on the A83(T).	Construction of the portals and cut and cover sections are within an area at risk of debris flow and boulderfall. The risk to members of the public is no different to the current situation on the A83(T).
	Flooding	Construction of the 450m long southern viaduct would take place on the 200-year + climate change floodplain for approximately two years with flat temporary working platforms required to grant access from the	The viaduct pier and SuDS feature construction zone would be near the footprint of Croe Water, and within the functional floodplain. This may increase flood risk to the OMR and culverts.	Construction work for the Brown Scheme Option would primarily take place away from the floodplain, however, watercourse diversions across the length of the route and interacting with the floodplain at Croe Water would have	The potential impacts on flood risk would be limited to those watercourses within the sections of the A83(T) outside of the tunnel sections and construction activities beyond the footprint of the Proposed Option.	Construction work would take place on the functional floodplain while the viaduct structure is being built. Construction zones for the pier and SuDS would be within the 200-year + climate change floodplain.

Major Event Category	Major Event Type	Vulnerability of each Scheme Option to the Risk of a Major Event				
		Green	Yellow	Brown	Pink	Purple
		OMR and adjacent forestry tracks. Construction of the southern tie in road would also take place on the floodplain at the A83(T) The SuDS basin construction zones would take place on and immediately adjacent to the 200-year + climate change floodplain. Watercourse diversions at the lower forestry track have potential for impacts. Viaduct construction on floodplain may impact the lower forestry track.		minor impacts on the A83(T) and the OMR.	Construction of the temporary road would take place on the floodplain at the east of Croe Water which may have minor impacts on the A83(T) and the OMR.	Watercourse diversions at the southern tie in road have potential to interact with the A83(T) and OMR, and construction works on the floodplain also have potential to impact the OMR and the southern extent of the A83(T) within the study area which interacts with the floodplain. Additionally, the construction in the floodplain may have a minor impact on the southern extent of the lower forestry track which interacts with the floodplain.
Technological or manmade hazards	Construction methodology causing ground movement	Low potential for ground vibration induced slope movement during piling. Risk of instability through catch pit excavation.	Low potential for ground vibration induced slope movement during piling. Risk of instability through piling platform excavation.	Risk of instability through catch pit excavation.	Drill and blast techniques have the potential to generate ground vibration levels that could lead to ground movement, if not properly designed or managed during construction.	Drill and blast techniques have the potential to generate ground vibration levels that could lead to ground movement, if not properly designed or managed during construction.

Major Event Category	Major Event Type	Vulnerability of each Scheme Option to the Risk of a Major Event				
		Green	Yellow	Brown	Pink	Purple
					Risk of instability through tunnel portal and cut and cover excavation.	Low potential for ground vibration induced slope movement during piling. Risk of instability through tunnel portal, cut and cover, and piling platform excavation.

14.4.2. Operation

The vulnerability of each Scheme Option to the risk of a major event is presented in Table 14.4 below.

Table 14.4 Vulnerability to the Risk of Major Events during Operation

Major Event Category	Major Event Type	Vulnerability of each Scheme Option to the Risk of a Major Event				
		Green	Yellow	Brown	Pink	Purple
Natural Hazards	Landslides	Piers of the viaduct vulnerable to scour (flooding).	Piers of the viaduct vulnerable to scour (debris flow).	Damage to the debris flow shelter.	N/A	Piers of the viaduct vulnerable to scour.
	Flooding	The southern viaduct structure would cross the active 200-year + climate change floodplain and the Croe Water. The southern tie in road crosses the floodplain for approximately 80m and comes in close vicinity to the floodplain for the remainder of the tie in road. Increased flood risk due to structure location and proposed SuDS features within/in the immediate vicinity of the 200-year +	Viaduct piers located in the functional floodplain leading to flood plain displacement. Potential for impacts downstream where the A83(T) and OMR interacts with the floodplain. The tie in roads would not interact with the floodplain. SuDS ponds introduced across the viaduct of the Scheme Option would be in close vicinity to the 200-year + climate change floodplain, and immediately adjacent at points,	Southern extent operational in the functional floodplain. SuDS features are not expected to encroach the floodplain.	The Pink Scheme Option would only interact with the functional floodplain across the tunnel section. SuDS measures would be introduced at the tie in roads, which would be in close vicinity to the floodplain, and immediately adjacent at points at the northern extent.	Viaduct piers located in the functional floodplain leading to flood plain displacement. Potential for impacts downstream where the A83(T) and OMR interacts with the flood plain.

		climate change flood extents.	which could increase the risk of inundation.			
Technological or manmade hazards	Bridge failure	Scheme Option includes the construction of a viaduct.	Scheme Option includes the construction of a viaduct.	N/A	N/A	Scheme Option includes the construction of a viaduct.
	Flow shelter failure	Scheme Option includes construction of a debris flow shelter.	N/A	Scheme Option includes construction of a debris flow shelter over the existing A83(T).	N/A	N/A
	Tunnel failure / fire	N/A	N/A	N/A	Scheme Option includes construction of a tunnel.	Scheme Option includes construction of a tunnel.

14.5. Potential Mitigation

Transport Scotland will require the construction and management of the Proposed Scheme in accordance with the following non-exhaustive list of standards and systems:

- Environmental, Health & Safety Management systems;
- manage all construction risks in accordance with the CDM Construction Phase Plan;
- supplier management environmental, health & safety standards (for example, Construction Skills Certification Scheme);
- risk management systems; and
- Construction and Environmental Management systems (including the CEMP).

14.6. Conclusions

Table 14.5 below summarises the vulnerability of each of the Scheme Options to the identified major event types.

Table 14.5 Major Accidents and Disasters Comparative Appraisal

Scheme Option	Construction / Operation Phase	Vulnerability to the Risk of a Major Event					
		Landslides	Flooding	Construction methodology causing ground movement	Bridge failure	Flow shelter failure	Tunnel failure / fire
Green	Construction		X	X			
	Operation	X	X		X	X	
Yellow	Construction		X	X			
	Operation	X	X		X		
Brown	Construction		X	X			
	Operation	X	X			X	
Pink	Construction		X	X			
	Operation		X				X
Purple	Construction		X	X			
	Operation	X	X		X		X

Table 14.5 above illustrates that the favourable Scheme Option from the perspective of the vulnerability of the Proposed Scheme to major events is the Pink Option followed by the Yellow and Brown Options, as these Scheme Options are vulnerable to the fewest major event types.

14.7. Scope of DMRB Stage 3 Assessment

14.7.1. Identify Risks

The major events which will be considered in the assessment are rare events.

All low consequence events, whatever their likelihood, do not meet the definition of a major event as defined in IEMA's Primer. For example, minor spills which may occur during construction, but would be limited in area and volume and temporary in nature, do not meet the definition of a major event. Such minor events would be dealt with under the Principal Contractor's Environmental Management System (EMS) and will not fall within the scope of this assessment. Similar events during operation would adopt the same approach.

The assessment will focus on low likelihood, but potentially high consequence events as illustrated in Plate 14.1 which is based on Figure 2 in IEMA's Primer.

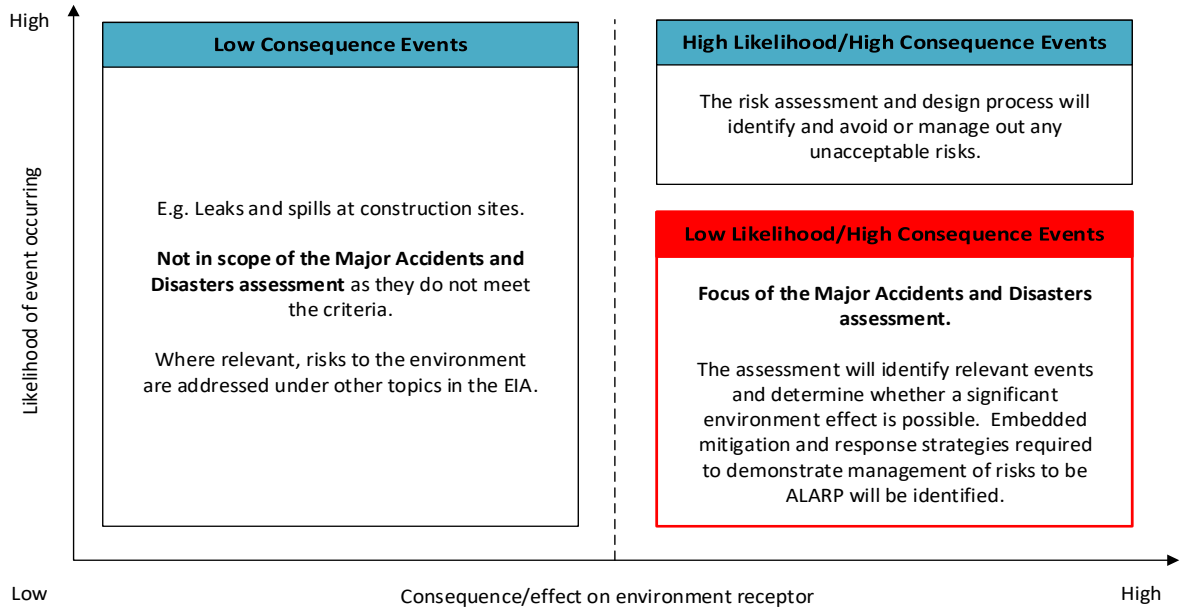


Plate 14.1 Graphical Representation of Major Accidents and Disasters Consequence Significance

Low likelihood is defined for the purposes of the assessment, as: May occur during the lifetime of the Proposed Scheme, so no more than once in 10 years for the construction phase, and no more than once in 100 years for the operational phase.

This is an upper boundary for low likelihood. Very low likelihood events will also be included in the assessment, which may only occur at most once in every 1,000 years. Mitigation

measures will reflect what is reasonable for such rare events, considering their potential consequence, within the guiding principle of risks being ALARP.

High consequence events are considered to lead to a significant adverse effect.

The risk identification process will use existing sources of information wherever possible, such as risk assessments undertaken for the Proposed Scheme as part of other processes (many of which are required by law) or Risk Events identified within the UK's current National Risk Register. No additional risk assessments will be undertaken and the risk identification activity will focus on collating and reviewing existing sources.

In order to identify whether a Risk Event has the potential to be a major event, which also has the potential to have a significant adverse effect on an environmental receptor, three components need to be present: a source, a pathway (between source and receptor) and a receptor. As such, and as recommended by DEFRA, the assessment will use the following conceptual model:

- The source is the original cause of the hazard, which has the potential to cause harm;
- The pathway is the route by which the source can reach the receptor; and
- The receptor, which is the specific component of the environment that could be adversely affected, if the source reaches it.
- Risk Events which do not have all three components will be screened out from the assessment.

14.7.2. Screen Risks

The following major events screening process will be used to identify those Risk Events which would require further consideration within the assessment as illustrated in Plate 14.2 below:

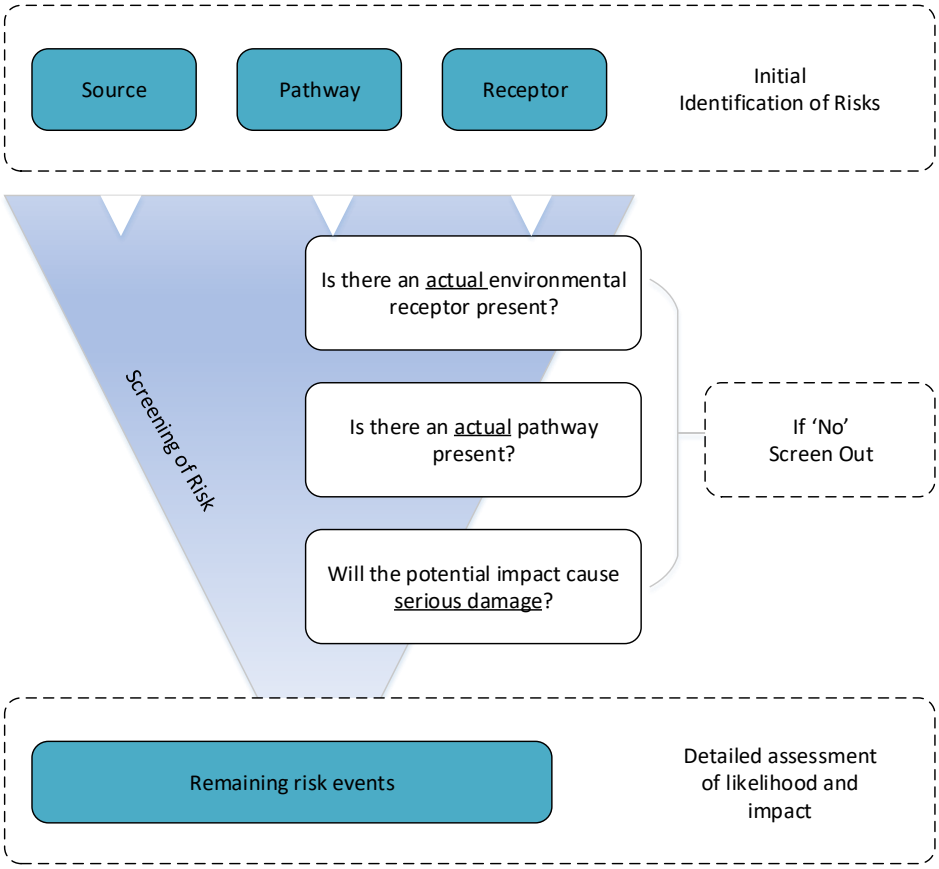


Plate 14.2 Screening Process Flow Diagram

For those Risk Events which are not screened out during the three-step process, the following assessment methodology will be used. The assessment forms the basis for recommending additional mitigation measures, as appropriate.

14.7.3. Define Impact

Several mechanisms are in place to reduce the vulnerability of the Proposed Scheme to major events or mitigate significant effects on the environment should they occur. All measures to manage and reduce the risk of significant adverse effects occurring as a result of the vulnerability of the Proposed Scheme to major events will be considered to be primary mitigation measures for the purposes of the assessment.

It will be assumed that:

- The design, installation, commissioning, operation and maintenance of plant, drainage systems, equipment and machinery, including associated systems, will take into account Good Engineering Practice to ensure compliance with applicable regulatory regimes.

- The construction stage(s) of the Proposed Scheme will be managed through the implementation of the Construction Phase Plan (required under the CDM Regulations 2015) and mitigation measures relating to major events would be set out by the Principal Contractor for approval prior to construction as part of the CEMP.

A reasonable worst-case environmental impact(s) will be identified for each scoped-in Risk Event. Impacts will be identified in consultation with relevant disciplines for each environmental factor assessed within the DMRB Stage 3 assessment. The environmental impacts will be identified through a qualitative process which seeks to answer the question 'could this event constitute a major event in terms of the definitions provided'. Where relevant, specific sensitive receptors around the Proposed Scheme will be considered. The outcome of this process will be recorded in a Risk Record.

14.7.4. Assess Risk

The likelihood of the reasonable worst-case environmental effect(s) occurring will be evaluated taking into account the following:

- The likelihood of the Risk Event occurring considering the measures already embedded into the design and execution of the Proposed Scheme; and
- The likelihood that an environmental receptor is affected by the Risk Event.

Likelihood assessments evaluate whether the effect (for example, loss of life) is a possible outcome of the Risk Event.

This evaluation will refer to existing risk assessments as well as consultation with relevant discipline specialists.

The assessment of the risk will be carried out in line with the IEMA Primer on Major Accidents and Disasters in EIA. Where likely significant adverse effects are identified, mitigation measures must be in place, commensurate with the likelihood of the event occurring. The assessment will consider, in consultation with relevant environmental topics, whether the risk to the environmental receptor is managed to be ALARP with the existing measures. If gaps are identified, where the existing measures do not represent management of risks to an environmental receptor to be ALARP, then additional measures would be required. The outcome of the assessment will be recorded in a Risk Record.

14.7.5. Appraise Risk Management Options

Risk management options fall into the following categories:

- Eliminate (or ‘avoid’) the risk, by adopting alternative processes in order to eliminate the source of the hazard, or remove the receptor;
- Reduce the risk by adapting proposed processes such that either the likelihood or the impact of the Risk Event can be reduced;
- Isolate the risk, by using physical measures to ensure that should the Risk Event occur, it can be effectively isolated such that there is no pathway;
- Control the risk, by ensuring that appropriate control measures are in place (for example emergency response) so that should a Risk Event occur, it can be controlled and managed appropriately. The mitigation hierarchy of repair and compensate any significant damage to environmental receptors may then apply following a control measure; and
- Exploit the risk if it presents potential benefits or new opportunities.

15. Road Drainage and the Water Environment

15.1. Introduction

This chapter presents the DMRB Stage 2 Assessment of the predicted effects of the Scheme Options on the Road Drainage and the Water Environment (RDWE). Purposefully, it seeks differentiating factors between the various options (including recognition of baseline conditions) in order to establish those that may have a greater or lesser effect on local receptors.

Although interlinked, three main sub-topics are addressed, with appropriate specialists directly involved in the assessment and reporting inputs:

- Surface water quality;
- Hydromorphology (fluvial geomorphology); and
- Flood risk.

This chapter is supported by the following:

- Volume 3, Figure 15.1: Hydrology Detail and WFD Catchments
- Volume 3, Figure 15.2 (a) to (e): Hydrology Detail (all options)
- Volume 3, Figure 15.3: Slope Gradient
- Volume 3, Figure 15.4: Baseline Flood Risk
- Appendix 15.1: Flood Risk Policies and Guidance
- Appendix 15.2: Surface Water Calculations
- Appendix 15.3: Watercourse and Crossings Naming Reference System
- Appendix 15.4: Hydromorphology Receptors

15.2. Approach and Methods

15.2.1. Introduction

The following section describes the methodology used in the assessment of potential effects of the Proposed Scheme on the RDWE, including any assumptions and limitations of the approach.

15.2.2. Sources of Information

The sources of information used for the purpose of this assessment consist of a combination of online sources and findings from visiting the site in December 2022 and February 2023. The assessment has been undertaken in accordance with Revision 1 of the LA 113 guidance, using the following data:

- Flood Estimation Handbook (FEH)[282];
- The River Basin Management Plan for Scotland 2021 – 2027;
- SEPA Water Classification Hub[283];
- Historic flood data;
- Ordnance Survey (OS) 1:25,000 and 1:50,000 scale mapping;
- Topographical data, such as surveys;
- Stage 2 modelled flows, depths, velocity, and flood plain extents;
- Rainfall data (as provided by SEPA);
- Site walkover findings, observations and photos;
- 20cm LiDAR digital elevation model provided by Transport Scotland;
- Aerial photographs; and
- Scheme Options.

15.2.3. Policy, Legislation and Guidance

Policy

This assessment has taken account of the Scottish Government's National Planning Framework 4 (NPF4)[284].

Legislation

The following national and local legislation forms the background against which the assessment has been made:

- The European Union's (EU) Water Framework Directive (WFD) becoming law in Scotland as the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act); and

[282] Flood Estimation Handbook (FEH) Web Service, Available at: https://fehweb.ceh.ac.uk [Accessed 27 February 2023].
[283] SEPA Water Classification Hub, Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed 27 February 2023].
[284] Scottish Government, National Planning Framework 4 (2023). Available at: https://www.gov.scot/publications/national-planning-framework-4/ [Accessed 03 April 2023].

- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (2017 amendments)[285].

More details on the relevant flood risk legislation and standards that this assessment has been carried out in adherence with, is provided in Appendix 15.1.

Guidance

The key national and local planning guidance relevant to Road Drainage and the Water Environment are summarised below:

- A Practical Guide to Controlled Activities Regulations (also known as CAR)[286];
- DMRB LA 113, Road Drainage and the Water Environment[287];
- CIRIA SuDS Manual[288];
- CIRIA Control of Water Pollution from Linear Construction Sites, Technical Guidance[289];
- Technical Flood Risk Guidance for Stakeholders – SEPA requirements for undertaking a Flood Risk Assessment[290];
- Argyll and Bute Council Flood Risk Management Policy[291];
- SEPA Guidance for Transport Infrastructure Projects - WAT-SG-93[292];
- SEPA Regulation of Engineering Activities – WAT-RM-02[293];
- SEPA Culverting of Watercourses - WAT-PS-06-02[294]; and
- SEPA Sediment Management Authorisation - WAT-SG-78[295].

15.2.4. Consultation

General consultation on the water environment has been carried out with the key stakeholders through the A83 Environmental Steering Group (ESG), with data requests

[285] SEPA, Controlled Activities Regulations, Available at: The Water Environment (Miscellaneous) (Scotland) Regulations 2017 (legislation.gov.uk) [Accessed 15 March 2023].
[286] SEPA, Available at: car_a_practical_guide.pdf (sepa.org.uk) version 9.2, (2022). [Accessed 15 March 2023].
[287] DMRB LA 113 Road Drainage and The Water Environment. Highways England et al. 2020
[288] CIRIA SuDS Manual – C753 (2015).
[289] CIRIA Control of Pollution from Construction Sites, Technical Guidance – C648 (2006).
[290] SEPA, Technical Flood Risk Guidance for Stakeholders – SEPA requirements for undertaking a Flood Risk Assessment, Version 13, (2022). [Accessed 27 February 2023].
[291] Argyll and Bute Council, Development and Infrastructure Services, Version 1 (2015). [Accessed 13 March 2023].
[292] SEPA, Transport Scotland, Available at: Guidance for Transport Infrastructure Projects (WAT-SG-93) (sepa.org.uk) [Accessed 15 March 2023].
[293] SEPA Regulatory Method for Engineering Activities (2022). Available at: https://www.sepa.org.uk/media/594105/wat-rm-02-v80.pdf [Accessed 03 April 2023].
[294] SEPA Culverting of Watercourses – Position Statement and Supporting Guidance – WAT-PS-06-02 (2015). Available at: https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf [Accessed 03 April 2023].
[295] SEPA Sediment Management Authorisation – WAT-SG-78. Available at: https://www.sepa.org.uk/media/151062/wat-sg-78.pdf [Accessed 03 April 2023].

issued to SEPA and Argyll and Bute Council in March 2023 for data on abstractions/discharges, private water supplies and historic flood records.

15.2.5. Scope of Stage 2 Assessment

The assessment has been carried out in accordance with the guidance contained in the DMRB. The approach has focused upon the characteristics and subsequent Proposed Scheme impacts upon surface water hydrological catchments with reference to water bodies characterised by SEPA under the WFD.

This hydrological catchment-based approach enables due consideration to be given to both individual locations and the wider cumulative impacts within larger surface water body areas.

15.2.6. Assessment Methodology

The RDWE assessment has been undertaken in accordance with the principles of DMRB LA 113, and industry standard guidance, including CIRIA and SEPA guidance. DMRB LA 113 describes a series of methods for assessing impacts of road schemes on the water environment.

The sensitivity/importance of the surface waters has been evaluated, as has the magnitude of impact of the Scheme Options on each, as further detailed below.

15.2.6.1. Construction Pollution

Evaluation of the potential for pollution of surface waters as a result of spillage and of the release of sediments into watercourses or water bodies has involved a review of areas where construction would be required within or in close proximity (i.e. within 50m) of watercourses and water bodies. The approximate land take of construction activities (including temporary and permanent areas) which lies within 50m of surface water features identified on Ordnance Survey 1:25,000 mapping, the number of these watercourses crossed, and the number of proposed permanent road drainage discharge structures has been quantified for each Scheme Option.

Information on private water supplies has been provided by Argyll and Bute Council. SEPA have provided abstraction locations registered within the Controlled Activities Regulations process.

Data from both sources have been reviewed and entered into mapping software to establish receptor locations within the Study Area and potential connectivity from the various Scheme Options.

15.2.6.2. Pollution from Routine Runoff

DMRB LA 113 specifies procedures for the assessment of pollution impacts from routine runoff on surface waters, known as 'Method A'. The Method A assessment comprises two separate elements:

- HEWRAT Assessment: The Highways England Water Risk Assessment Tool (HEWRAT) is a Microsoft Excel application designed to assess the short-term risks related to the intermittent nature of road runoff. It assesses the acute and chronic pollution impacts on aquatic ecology associated with soluble and sediment bound pollutants, respectively; and
- EQS Assessment: Environmental Quality Standards (EQS) are the maximum permissible annual average concentrations of potentially hazardous chemicals, as defined under the WFD. The long-term risks over the period of one year are assessed through comparison of the annual average concentration of pollutants discharged with the published EQS for those pollutants.

To fully carry out these assessments a variety of baseline and drainage design information is required, including:

- Traffic volumes;
- Areas of impermeable and permeable road surfaces to be drained;
- Receiving watercourse dimensions and flow data;
- Water hardness;
- Presence of sensitive sites (considered as international/national designated conservation sites);
- In-stream structures or features which may influence the flow; and
- Proposed treatment train.

Stage 1 HEWRAT and EQS assessments have been carried out for each road drainage outfall within each Scheme Option (Appendix 15.2), noting the number of outfalls passing/failing the HEWRAT and EQS assessments, without treatment (i.e. without the proposed treatment train data) – indicating whether existing low flow conditions provide sufficient dilution of drainage contaminants. The proposed treatment will be designed at Stage 3 to achieve pass status for all networks, this assumption is considered as embedded mitigation and assessed accordingly within Section 15.4.

At DMRB Stage 2 there is limited information available on the proposed treatment or drainage design for side roads and accommodation tracks, with this information becoming available to enable assessment and design of appropriate treatment measures at Stage 3.

15.2.6.3. Hydromorphological Risk Assessment

The hydromorphological assessment is desk-based, making use of available digital data, GIS analysis and limited walkover data and photographs, to make an informed judgement as to the potential impacts of each Scheme Option on the hydromorphological function of the affected watercourses.

DMRB LA 113 does not specify a prescriptive method for undertaking a hydromorphological assessment. Rather, it states that the approach should be tailored to the project and the affected watercourses but should consider the effects of the Proposed Scheme to the form and function of the watercourses and the connectivity with the wider landscape. The aim of the assessment is to identify the hydromorphological risk associated with each Scheme Option that would result in differentiation.

The assessment considers the number and type of watercourse crossings associated with each Scheme Option. Each type of crossing (culvert, bridge, viaduct or tunnel) has the potential for a different magnitude of impact to watercourses. Section 0 outlines the approach to the classification criteria and the methodology by which this has been applied to the watercourse assessment. The watercourse receptors have been identified as those crossed using the OS 1:25,000 mapping.

15.2.6.4. Flood Risk

The baseline conditions have been informed primarily by desk-based assessments and supported by site walkovers and photographs. The approach has been to compare the potential impacts of the alternative Scheme Options on flood risk using metrics. The metrics include, the number of watercourses crossed and the proximity to the 200-year plus climate change (CC) flood plain. The assessment is based on flood receptors as defined by SEPA with particular focus on properties and infrastructure.

In accordance with DMRB LA 113, The Proposed Scheme would be designed to:

- remain operational and safe for all users in times of flood;
- result in no net loss of flood plain storage;
- not impede water flows; and
- not increase flood risk elsewhere.

15.2.7. Assessment Criteria

15.2.7.1. Importance/Sensitivity

The importance/sensitivity of water bodies have been evaluated taking into account their quality, rarity, scale and substitutability. The typical criteria provided in DMRB LA 113 are given in Table 15.1, with additional criteria detailed in

Table 15.2, in accordance with the guidance and examples provided in DMRB LA 113. The criteria used to estimate impact magnitude on receptors is detailed in Table 15.3.

Table 15.1 Typical Importance Criteria for Road Drainage and the Water Environment Receptors (DMRB LA 113, Table 3.70)

Importance	Typical Criteria	Typical Examples	
Very high	Nationally significant attribute of high importance	Surface Water	Watercourse classified under Water Framework Directive, with Q_{95} flow value of 1m^3/s or greater Site protected/designated under EC or UK legislation (SAC, SPA, SSSI, Ramsar site, salmonid water)/Species protected by EC legislation
		Flood Risk	Essential infrastructure or highly vulnerable development
High	Locally significant attribute of high importance	Surface Water	Watercourse classified under Water Framework Directive, with Q_{95} flow value of less than 1m^3/s Species protected by EC legislation
		Flood Risk	More vulnerable development
Medium	Of moderate quality and rarity	Surface Water	Watercourse not classified under Water Framework Directive, with Q_{95} flow value of less than 1m^3/s but greater than 0.001m^3/s
		Flood Risk	Less vulnerable development
Low	Lower quality	Surface Water	Watercourse not classified under Water Framework Directive, with Q_{95} flow value of less than 0.001m^3/s
		Flood Risk	Water compatible development

Table 15.2 Specific Criteria Used to Estimate the Importance/Sensitivity of Receptors

Importance/ Sensitivity	Criteria
Very High	Surface Water Quality and Biodiversity Watercourse classified under Water Framework Directive, with low flow (Q95) value of 1m3/s or greater Sites protected under EU wildlife legislation (Special Area of conservation (SAC), Special Protection Areas (SPA) and Ramsar) Watercourses supporting a wide range of significant species and habitats sensitive to changes in suspended sediment concentrations and turbidity such as salmon or freshwater pearl mussels Water dependent ecosystems of international/national biodiversity value Water Supplies Watercourse supporting major/critical public water supplies Public water supply or large private water supply serving >10 properties Hydromorphology A watercourse exhibiting a range of natural morphological features such as pools and riffles, active gravel bars and varied river bank types, such morphological variability is a primary determinant of ecological diversity. Minimal modification. Hydrology & Flood Risk Watercourses or floodplains, with direct or indirect flood risk to adjacent populated areas and/or presence of essential infrastructure such as schools, hospitals and isolated dwellings in sparsely populated areas, which are highly sensitive to increased flood risk by the possible increase in water levels
High	Surface Water Quality and Biodiversity Watercourse classified under Water Framework Directive, with low flow (Q95) value of 0.001m3/s to 1m3/s Sites protected under UK wildlife legislation (Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR)) Water dependent ecosystems of regional/county biodiversity value Watercourses supporting some species and habitats sensitive to changes in suspended sediment concentrations and turbidity Water Supplies Watercourses supporting minor/non-critical public drinking water supplies Private water supply serving 2-10 properties Hydromorphology A watercourse exhibiting a range of morphological features with very little modification. Hydrology & Flood Risk Watercourses or floodplains, with a possibility of direct or indirect flood risk to less populated areas without essential infrastructure, which are sensitive to increased flood risk by the possible increase in water levels
Medium	Surface Water Quality and Biodiversity No Water Framework Directive classification, low flow (Q95) value of 0.001m3/s or greater Water dependent ecosystems of county/district biodiversity value Watercourses supporting limited species and habitats sensitive to changes in suspended sediment concentrations and turbidity

Importance/ Sensitivity	Criteria
	Water Supplies Watercourses supporting private drinking water supplies or for agricultural/industrial use Private water supply serving a single property Hydromorphology A watercourse exhibiting some signs of modifications and recovering to a natural equilibrium. Limited morphological features and a limited range of fluvial processes. Hydrology & Flood Risk Watercourses or floodplains, with direct or indirect flood risk to agricultural or recreational land and/or affecting <10 industrial premises and high value agriculture (e.g. arable pastures, complex cultivation patterns and agro- forestry), which are sensitive to increased flood risk by the possible increase in water levels
Low	Surface Water Quality and Biodiversity No Water Framework Directive classification, with low flow (Q95) value of less than 0.001m3/s Water dependent ecosystems of local/less than local biodiversity value Watercourses which do not support any significant species and habitats sensitive to changes in suspended sediment concentrations and turbidity Low flow (Q95) value of less than 0.001m3/s Water Supplies Watercourses not supporting water abstractions Hydromorphology A watercourse exhibiting no morphological diversity; flow is uniform, gravel bars absent and bank type's uniform and stable, with no evidence of active fluvial processes. Such watercourses may have been subject to past modification such as straightening, bank protection and culverting, or other anthropogenic pressures. Hydrology & Flood Risk Watercourses or floodplains with a possibility of direct or indirect flood risk to low value agricultural areas, such as rough grazing, which are less sensitive to increased flood risk by the possible increase in water levels

15.2.7.2. Magnitude of Impact

The magnitude of the various impacts is evaluated taking into account the extent of loss and effects on integrity of the relevant water body attributes. The Stage 2 criteria used in determining the magnitude of impact are detailed in Table 15.3, in accordance with the principles and examples provided in DMRB LA 113.

Table 15.3 Criteria Used to Estimate the Magnitude of Impact on Receptors

Magnitude	Criteria
Major Adverse	Surface Water Quality and Biodiversity High risk of pollution to surface water during construction, significant temporary or long-term change in water quality, resulting in a permanent change in WFD status

Magnitude	Criteria
	Failure of both soluble and sediment bound pollutants in HEWRAT and EQS routine runoff compliance failure Water Supplies Permanent loss of surface water supply Hydromorphology Results in loss of feature(s) and failure of hydromorphological elements (morphology, quantity and dynamics of flow) resulting from the works, e.g., significant physical modification relating to debris flow shelter. Loss or damage to existing habitats. Significant/extensive alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. Flood Risk Results in loss of or significant alteration to the 0.5% AEP plus climate change event flood plain. Significant increase in downstream peak flows due to upsizing of watercourse crossings to the 0.5% plus climate change AEP. Significant changes in surface water flow paths leading to increased peak flows.
Moderate Adverse	Surface Water Quality and Biodiversity Moderate risk of pollution to surface water during construction, moderate temporary change in water quality, resulting in a temporary change of WFD status or preventing attainment of target overall status of 'Good' Failure of both soluble and sediment bound pollutants in HEWRAT routine runoff but compliance with EQS limits Water Supplies Temporary loss of water supply Hydromorphology Results in adverse impact on integrity of feature(s) or loss of part of feature/moderate shift away from baseline conditions. Failure of one or more hydromorphological elements (morphology, quantity and dynamics of flow) resulting from the works e.g., potential impacts on sediment transport and morphology from the installation of culverts. Some damage or loss to habitat due to the modifications. Some alteration to channel planform and/or cross section, including modification to bank profiles or the replacement of a natural bed. Flood Risk Results in loss of or significant alteration to the 0.5% AEP plus climate change event flood plain. Increase in downstream peak flows due to upsizing of watercourse crossings to the 0.5% plus climate change AEP. Changes in surface water flow paths leading to increased peak flows.
Minor Adverse	Surface Water Quality and Biodiversity Minor risk of pollution during construction to surface water, relatively minor temporary changes in water quality such that ecology is temporarily affected. Equivalent to a temporary minor, but measurable, change within WFD status class Failure of either soluble or sediment bound pollutants in HEWRAT routine runoff but compliance with EQS limits Water Supplies Temporarily reduced quality of water supply Hydromorphology Potential failure in one of hydromorphological elements (morphology, quantity and dynamics of flow) resulting from the works. Results in Minor Adverse impact on feature/minimal shift away from baseline conditions or partial loss or damage to habitat due to modifications e.g., viaducts and bridges with no in channel works.

Magnitude	Criteria
	Flood Risk Changes to existing culvert hydraulic capacity leading to the potential for minor changes in downstream peak flow. Floodplain impacts which result in small increases in peak flood level (of the order of >10mm) for the 0.5% plus climate change AEP.
Negligible	Surface Water Quality and Biodiversity Negligible risk of pollution to surface water during construction, very slight temporary change in water quality with no discernible effect on watercourse ecology or water supply All elements of HEWRAT and EQS routine runoff assessments passed Water Supplies No anticipated effect on water supply Hydromorphology No alteration to hydromorphological elements. Some impact on feature(s), but of insufficient magnitude to affect the use/integrity, approximating to a 'no change' situation Flood Risk No alteration to downstream peak flows at existing culvert crossings for the 0.5% plus climate change AEP. No detectable potential effects on floodplain (0.5% plus climate change AEP) <10mm
Minor Beneficial	Surface Water Quality and Biodiversity Minor permanent improvement over baseline conditions or larger temporary improvement, with the potential to facilitate a slight increase in the capacity to dilute pollutants or waste products Water Supplies Temporarily improved quality of water supply Hydromorphology Partial improvement to sediment processes at the reach scale, including reduction in siltation and localised recovery of sediment transport processes Partial improvements include enhancements to in-channel habitat, riparian zone and morphological diversity of the bed and/or banks Slight improvement on baseline conditions with potential to improve flow processes at the reach scale Slight beneficial impacts at the reach scale, which may cause partial habitat enhancement. Impacts have limited potential to improve hydromorphological-related parameters in WFD classification Flood Risk: Moderate improvement over baseline conditions involving a reduction in 0.5% AEP peak flood level >10mm
Moderate Beneficial	Surface Water Quality A moderate permanent improvement over baseline conditions with the potential to facilitate an upgrade in individual WFD quality elements and/or moderate increase in the capacity to dilute pollutants or waste products Removal or reduction of an polluting discharge which has limited baseline effect, or removing the likelihood of polluting discharges occurring to a watercourse Water Supplies Permanent moderate improvement of water supply, in terms of quality or yield to an existing resource

Magnitude	Criteria
	Hydromorphology Reduction in siltation and recovery of sediment transport processes at the reach or multiple reach scale Partial creation of both in-channel and vegetated riparian habitat. Improvement in morphological diversity of the bed and/or banks at the reach or multiple reach scale. Includes partial or complete removal of structures and/or artificial materials Notable improvements on baseline conditions and recovery of fluvial processes at the reach or multiple reach scale, with potential to improve one hydromorphological-related parameter in WFD classification Flood Risk Moderate improvement over baseline conditions involving a reduction in 0.5% AEP peak flood level >50mm
Major Beneficial	Surface Water Quality Major permanent improvement over baseline conditions with the potential to facilitate an upgrade in WFD overall status and/or a substantial increase in the capacity to dilute pollutants or waste products Removal of a polluting discharge with baseline effect, or removing the likelihood of polluting discharges occurring to a watercourse Water Supplies Permanent major improvement of water supply, in terms of quality or yield or enabling access to new resource Hydromorphology Improvement to sediment processes at the catchment scale, including recovery of sediment supply and transport processes Extensive creation of both in-channel habitat and riparian zone. Morphological diversity of the bed and/or banks restoration, such as natural planform, varied natural cross-sectional profiles, recovery of fluvial features (e.g. cascades, pools, riffles, bars) expected for river type. Removal of modifications, structures, and artificial materials anticipated to lead to improved status of at least one hydromorphological-related parameter in WFD classification Flood Risk: Large improvement over baseline conditions involving a reduction in 0.5% AEP peak flood level >100mm

15.2.7.3. Effect Significance

The estimation of the significance of potential effects has been arrived at by combining the estimated sensitivity of the affected water bodies and the magnitude of the impacts as indicated in Table 15.4, prior to consideration of any potential mitigation, following guidance provided in DMRB LA 104.

Where the significance of potential effects (i.e. the consequence of impacts) is shown as being one of two alternatives; a single description may be provided based upon reasoned judgement if sufficient information available to do so.

Table 15.4 Criteria Used to Estimate the Significance of Potential Effects (DMRB LA 104, Table 3.8.1)

Environmental Value (Sensitivity)	Magnitude of Impact (Degree of Change)				
	Major	Moderate	Minor	Negligible	No Change
Very High	Very Large	Large/Very Large	Moderate/Large	Slight	Neutral
High	Large/Very Large	Moderate/Large	Slight/Moderate	Slight	Neutral
Medium	Moderate/Large	Moderate	Slight	Neutral/Slight	Neutral
Low	Slight/Moderate	Slight	Neutral/Slight	Neutral/Slight	Neutral
Negligible	Slight	Neutral/Slight	Neutral/Slight	Neutral	Neutral

15.2.7.4. Limitations and Assumptions

This assessment has relied upon the accuracy and level of detail of the documented data sources. For instance, the identification of water bodies and current characteristics has involved reference to Scotland's Environment and SEPA websites for RBMPs and associated WFD water body information sheets. The datasets have been updated annually up to the latest available year: 2020, which has been included, to be revised as updated information becomes available during DMRB Stage 3.

Information on abstractions and private water supplies has been provided by SEPA and Argyll and Bute Council, respectively. It is recognised that data may not have been accurately registered for all local properties, with limited associated information relating to current use, source type and source locations. Where supply locations are unknown, supplies are assumed to be located within the most likely hydrological catchment associated with the Study Area. A comprehensive survey/consultation of abstractions and private water supplies within 1km of the Proposed Scheme (and up to 5km downstream) is planned as part of the Stage 3 assessment.

The assessments are partially reliant on desk-based data sources. The watercourse crossing information has been confirmed through site visits and watercourse delineation.

With regards to the routine runoff assessment, use of HEWRAT presents several limitations. Firstly, a rainfall site must be selected from an embedded list of 21 sites across the UK, with only three located in Scotland. The closest and most geographically similar rainfall site is Ardtalnaig (near Aberfeldy). The annual average rainfall at Ardtalnaig is reported as being 1344mm, compared to the higher annual average rainfall within the Study Area of approximately 2847mm (based on the Falloch at Glen Falloch NRFA catchment). Therefore, there is potential for underestimation of flows (and associated dilution potential) within the

receiving watercourses and from the road drainage networks in the Study Area. The process assumes flowing water, therefore flows of small input tributaries to Loch Restil have been used as indicators of loch throughput for any outfalls directly into this standing waterbody. Additionally, HEWRAT uses two-way Annual Average Daily Traffic (AADT) volumes in the estimation of pollutant build-up on the road, where AADT data is entered in broad bands of 10,000 to 50,000, 50,000 to 100,000, and >100,000. Given that the volumes of traffic estimated for the Proposed Scheme are substantially below 10,000 (understood to be approximately 5,000), it is likely that there is overestimation of the pollutant concentrations in the road runoff. Combining the reduced traffic flow with greater dilution potential, this is considered to present a precautionary HEWRAT outcome. This conservative outcome from local rainfall conditions applies to all assessed options and does not introduce a false differential in the Stage 2 process.

In addition to the limitations associated with HEWRAT as outlined above, it should be noted that there is no direct linkage between the results and current or targeted WFD objectives. In order to be certain of the direction of impact (adverse/beneficial) it would be necessary to carry out a baseline HEWRAT assessment of the existing drainage system and compare the existing and proposed scenarios; however, there is no formal collection system or outfalls identified for the existing A83(T) drainage. Notwithstanding this, the fact that the existing drainage system provides no treatment, while the Proposed Scheme has committed to treatment for each network provides an adequate level of certainty that there will be beneficial impacts associated with the proposed drainage discharges.

HEWRAT is designed for predicting the potential effect of runoff on receiving rivers and streams for soluble pollutants (acute impacts) and sediment related pollutants (chronic impacts) and requires input of specific watercourse dimensions in order to assess the impact of the sediment related pollutants. However, a number of outfalls discharge to Loch Restil, therefore, the parameters of representative tributaries have been used to establish a reasonable Loch Restil throughput flow rate.

Detailed topographic survey data is not currently available for the watercourses where outfalls are proposed at DMRB Stage 2, therefore the routine runoff assessments have been undertaken using reasonable assumptions for a number of the input parameters. Additional data to update the assessments will be obtained during DMRB Stage 3.

Information from walkovers along the OMR was used together with observations made upstream and downstream of the OMR watercourse crossings and aerial imagery. The results of the hydromorphology assessment are predominantly based on a desk-based approach using all available data, which includes notes and photos taken during site

walkovers by other disciplines. It has not been possible to walk the alignment of the Scheme Options primarily due to accessibility issues.

The Scheme Options are currently subject to ongoing design development and the precise nature of the impacts on the watercourses are uncertain. These have been assessed applying a precautionary approach at DMRB Stage 2.

The SEPA Flood Maps are indicative and provide a strategic national overview of areas estimated to be at risk of flooding from river and/or sea. It is noted that the maps have limitations, as these are based on broad scale hydrological and hydraulic modelling techniques along with digital terrain models. They also do not take account of hydraulic structures or flood prevention schemes.

The Stage 2 hydraulic model used to assess the potential effect on flood risk of the Scheme Options and junctions on the 0.5% AEP 20% climate change floodplain of the Croe Water is indicative at this time as all Scheme Options would affect floodplain topography and replace existing culvert crossings. Precautionary assumptions have been made which are sufficient to assess the significance of potential effects and the need for more detailed assessment of mitigation at Stage 3.

The limitations discussed above are typical of a DMRB Stage 2 Assessment, and the assessment detailed herein is considered to be robust and of an appropriate level of detail to inform the selection of a Preferred Option. As noted above further detailed investigations and assessments will be undertaken at DMRB Stage 3 to inform the design of the Preferred Option.

15.3. Baseline Conditions

15.3.1. Definition of Study Area

The Study Area generally refers to a broad 5km buffer surrounding the extent of all the Scheme Options, where hydrological connectivity is considered to exist. This is based on the catchment of the Croe Water and Kinglas Water, including standing waterbodies and downstream watercourse reaches due to hydrological connectivity and potential impacts on sensitive receptors at extended distances downstream.

Specific baseline datasets are more limited in extent, to focus attention closer to the Proposed Scheme, for example water supplies have been identified within 1km of the Proposed Scheme, extending to 5km downstream.

The hydromorphology assessment Study Area includes all main watercourses hydrologically linked within 1km of the Scheme Option footprints. Main watercourses are defined in the SEPA Controlled Activities Regulations (CAR) licensing guidance[296] as those shown on the OS 1:50,000 maps. For the purposes of this Stage 2 assessment, all those watercourses visible on the OS 1:25,000 map have been assessed.

The Baseline Study Area assessed for the Stage 2 Flood Risk Assessment (FRA) consists of the Ardgartan region beginning on the banks of Loch Long and the Croe Water and Loch Restil hydrological catchments, as shown in Volume 3, Figure 15.1.

15.3.2. Land Use

Contained within these hydrological catchment areas are three roads for primary consideration: the A83(T), the OMR and the B828. The A83(T) and OMR run through the Glen Croe valley with the OMR, traversing the valley floor at lower elevation to the A83(T).

To the south-east of the Study Area, the A83(T) passes through the Ardgartan Forest. Much of this woodland is managed under the Ardgartan Land Management Plan, approved by Scottish Forestry in February 2021[297]. The sides of the Glen Croe valley on the east of the A83(T) are primarily used for woodland planting. A site walkover on the 17th of February 2023 confirmed this. The Glen Croe valley is used for agriculture (livestock). This is within the immediate 200-year + CC floodplain of the Croe Water and lies further up the unnamed tributary of Croe Water.

15.3.3. Topography

The Ardgartan Forest surrounds the A83(T) at the south-eastern-most extent of the study area. The A83(T) then travels northwest around the base of The Cobbler and Beinn Luibhean through the Glen Croe valley. The elevation of the A83(T) from the south-eastern-most extent in Ardgartan Forest up to the northern-most extent of the catchment as the road heads through the Rest and Be Thankful car park varies between 51mAOD and 276mAOD.

East of the A83(T) as it progresses through the valley are the The Cobbler, Beinn Luibhean and Beinn Ime which reach peaks of approximately 884mAOD, 858mAOD and 1,011mAOD respectively. The B828 junction is also overlooked by Beinn an Lochain to the west of the

[296] SEPA Water Environment (Controlled Activities) (Scotland) Regulations 2011, Guidance for Transport Infrastructure Projects (WAT-SG-93), (2018). Available at: https://www.sepa.org.uk/media/399167/wat-sg-93.pdf [Accessed 13 March 2023].
[297] Ardgartan land management plan – Forestry and Land Scotland, (2021). Available at: https://forestryandland.gov.scot/what-we-do/planning/active/ardgartan-land-management-plan [Accessed 27 February 2023].

northern-most section of the A83(T) as it goes through Bealach an Easain Duibh, which peaks at approximately 901mAOD. The gradients of both sides of the valley are very steep and generally consist of varied vegetation and multiple watercourses flowing down the valley sides towards the flood plain in the valley basin.

The OMR shares a junction with the A83(T) in the southern region of the site before splitting off and traversing the valley floor at a lower elevation to the A83(T). The road is closer to the valley floor, crossing the Croe Water at approximately 127mAOD. The road bends along the valley floor in a north-westerly direction before rising up and reaching meeting back up with the A83(T) at the A83/B828 junction.

Volume 3, Figure 15.3 identifies gradients for the Study Area.

15.3.4. Geology

The Study Area comprises of multiple soil types, as detailed in Scotland's Soils online mapping resources[298].

The soil type of the majority of the Study Area is the strichen association with the generalised soil type being classed as peaty podzols. More specifically, the component soils are peaty gleyed podzols with peaty gleys with dystrophic semi-confined peat. The landform where this soil type is located in the Study Area is mostly hummocky valley and slope moraines in the vicinity of the A83(T) / OMR themselves and also on the woodland on the other side of the valley. Towards the top of The Cobbler and Beinn Luibhean the soil type remains the same but the landform changes to hill sides with strong to very steep slopes, moderately to very rocky.

There are also regions of soil of strichen association but with the generalised soil type being classed as montane soils the landform at these locations is also different; it is classed as mountains with gentle to very steep slopes, non- to very rocky. The regions with this soil type are located at the southern extent of the hydrological catchment area at The Brack and Cruach Fhiarach, to the east of the Glen Croe valley at Ben Donich, further up the valley slopes towards the peaks of The Cobbler and Beinn Luibhean and each of Loch Restil at Beinn an Lochain.

[298] Scotland's Soils Online Mapping, Available at: https://map.environment.gov.scot/Soil_maps/?layer=1 [Accessed: 21 February 2023].

15.3.5. Surface Water

Volume 3, Figures 15.1 and 15.2 (a)-(e) display surface water features in the Study Area and adjacent downstream catchments.

Watercourse ID's have been given to all watercourses crossed. (Volume 3, Figure 15.2 (a)-(e)). Additionally, where the OS 1:25k mapping does not show a watercourse, but a crossing (culvert or bridge) has been identified at that location, an assumption has been made that a watercourse exists, and a watercourse I.D. has been generated.

A full table of the watercourse IDs as well as the corresponding structure ID, its location and size, is shown in Appendix 15.3. The locations of such features are shown on Volume 3, Figure 15.4.

15.3.5.1. Croe Water

To the south of the Rest and Be Thankful car park, the OS 1:25,000 mapping identifies a larger number of channels on the eastern slope of Glen Croe (runoff from western and southern slopes of Beinn Luibhean and The Cobber/Ben Arthur) than on the western slope (runoff from eastern slopes of Ben Donich and northern slopes of The Brack). All channels merge on the Glen Croe valley floor, with the Croe Water passing under the A83(T) and reaching the valley floor near Laigh Glencroe. The Croe Water flows east to meet Loch Long (sea loch) at Ardgartan.

Croe Water is one of the main tributaries of Loch Long within the A83(T) corridor and has a catchment of approximately 18km^{2} [282] (CEH, 2022) and is approximately 7.7km in length (SEPA, 2022). The catchment is rural and includes a number of minor watercourses.

The Croe Water is classified by SEPA under the Water Framework Directive (WFD) (ID: 10215) as 'Moderate' overall status (latest dataset from 2020), with limiting parameters of water quality, invertebrate and macroinvertebrates preventing attainment of target 'Good' status. This catchment drains the area south of the Rest and Be Thankful car park.

The A83(T) Croe Water crossing, referred to as the 'Cobbler' structure, lies within the fluvial 0.5% AEP (200-year) flood extents of the Croe Water according to indicative flood maps published by SEPA (SEPA, 2022), at NGR NN 24245 06024. Additionally, the A83(T) lies within the fluvial 0.5% AEP (200-year) flood extents between NGR NN 25010 04430 and NN 26345 04139. The Croe Water, pictured from the lower forestry track, is shown in Plate 15.1.

Plate 15.1 A83(T) and OMR crossings of Croe Water, photographed from western slope of Glen Croe at NGR NN 23570 06096 (Dated: 17 February 2023)

15.3.5.2. Loch Long

Loch Long is a coastal water body, covering an area of approximately 10km^2 (CEH, 2022). The water body was classified by SEPA in 2020 as having 'Good' overall status (SEPA, 2020). The A83(T) lies within the 0.5% Annual Exceedance Probability (AEP) (200-year) coastal flood extents for Loch Long, generally at Succoth and east of Ardgartan where the carriageway is adjacent to the loch (SEPA, 2022), however, this is beyond the parameters of the study extents highlighted in Volume 3, Figure 15.1.

15.3.5.3. Kinglas Water

From the Rest and Be Thankful car park to the north, runoff channels from eastern slopes of Beinn an Lochain mainly flow directly into Loch Restil, with the outflow channel, Easan Dubh, from Loch Restil flowing north east via the Bealach an Easain Dubh pass, west of the A83, to converge with the Kinglas Water. To the east of the A83(T), runoff from the western slopes of Beinn Luibhean also flow to Loch Restil, with more northerly channels converging with the Easan Dubh. The Kinglas Water flows west to enter Loch Fyne (sea loch) at Cairndow.

The Kinglas Water (WFD ID: 10217) is defined by SEPA as a heavily modified water body on account of physical alterations relating to hydroelectrical infrastructure. It has been classified as 'Bad Ecological Potential' overall status (2020), limited by hydromorphology, hydrology, overall ecology and biological parameters from reaching target 'Good Ecological Potential' status. The Easan Dubh is the outflow channel from Loch Restil, a tributary of the Kinglas Water and is not separately classified, this channel has no hydroelectrical infrastructure on this channel and drains an area with similar features to the Croe Water, thus it is considered to hold similar status and limitations.

Kinglas Water is one of the main tributaries of Loch Fyne and has a catchment of approximately 30km^2 (CEH, 2022). It is not located within the hydrological study extent, however, one identified crossing of the A83(T) sits within the floodplain at the bridge crossing (A83_60).

15.3.5.4. Loch Restil

Loch Restil (Plate 15.2) is a freshwater water body covering an area of approximately 0.1km^2 (CEH, 2022). The water body is unclassified by SEPA and lies within the Kinglas Water catchment. The A83(T) lies adjacent to the loch, however, does not lie within the 0.5% Annual Exceedance Probability (AEP) (200-year) surface water flood extent for the loch (SEPA, 2020).

Plate 15.2 Loch Restil as photographed from NGR NN 22964 07328 (Dated: 17 February 2023)

15.3.5.5. Water Supplies and Abstractions

The Study Area does not lie within the catchment of Scottish Water reservoir catchments, there may be distribution networks located in wayleaves of the existing A83(T) corridor, such assets shall be verified during Stage 3 with Scottish Water and BEAR Scotland.

Information received from Argyll and Bute Council in March 2023 has identified a number of registered private water supplies (PWS) in the Study Area, with data provided of the served property. SEPA provided data in March 2023 on abstractions within the Study Area, as registered under the Controlled Activities Regulations (CAR).

In accordance with the Private Water Supply (Scotland) Regulations 2006, PWS Type A supplies are those supplying a larger population and/or for commercial purposes, with Type A1 supplies the lowest Type A abstraction category; abstracting less than 100m^3 per day for human consumption. PWS Type B supplies represent small domestic supplies, typically for a single property.

Table 15.5 provides the combined PWS and the abstraction details. These locations are shown on Volume 3, Figures 15.1 and 15.2 (a)-(e).

Two Class B supplies are located within 100m of the various Scheme Options (High Glencroe and Roadmans Cottage). The remaining PWS (including Type A1 supplies) and single abstraction location registered with SEPA are located at distances in excess of 1.5km downstream or not hydrologically connected to the Study Area.

Sources without potential connectivity are not discussed further in this assessment.

Table 15.5 Private Water Supplies and CAR Abstractions

Information Source	Location	Type of Supply	Source	NGR	Connectivity to Options
Argyll and Bute Council Private Water Supply Register	Morelaggan House (Auld)	PWS B	Burn	227490, 701460	No Burn/stream supply without connectivity to Croe Water
	March Cottage	PWS B	Burn	226866, 702097	No Burn/stream supply without connectivity to Croe Water
	Ardgartan Campsite/Caravans	PWS A1 Regulated	Borehole	227455, 702923	No Borehole source
	Creagmhor	PWS B	Burn	227697, 703361	No Burn/stream supply without connectivity to Croe Water
	Goldberry Cottage	PWS A1 Regulated	Burn	227669, 703399	No Burn/stream supply without connectivity to Croe Water
	Guithas Cottage	PWS B	Burn	226977, 703797	Possible Potential downstream hydrological connectivity via Croe Water 1.7km downstream of nearest option
	Larach Park, Glen Croe	PWS B	Unknown	226790, 703964	Possible Potential downstream hydrological connectivity via Croe Water 1.5km downstream of nearest option
	Range Cottages, Arrochar	PWS B	Burn	228751, 704111	No Burn/stream supply without connectivity to Croe Water

Information Source	Location	Type of Supply	Source	NGR	Connectivity to Options
	Hazelwood Cottage	PWS B	Burn	229631, 704521	No Burn/stream supply without connectivity to Croe Water
	Roadmans Cottage	PWS B	Burn	224437, 705555	Yes Within 100m of various options in Croe Water catchment
	High Glencroe	PWS B	Burn	223337, 706965	Yes Within 100m of various options in Croe Water catchment
	Croft Kennels	PWS B	Burn	217212, 709358	No Burn/stream supply without connectivity to Kinglas Water
	Upper Croitachonie	PWS A1 Regulated	Burn	217584, 709534	No Burn/stream supply without connectivity to Kinglas Water
	Ardkinglas Estate	PWS A1 Regulated	Burn	217470, 710160	No Burn/stream supply without connectivity to Kinglas Water
	Drishaig Cottage, Cairndow	PWS B	Burn	215877, 710680	No Burn/stream supply without connectivity to Kinglas Water
	Cairndow Scottish Salmon Company	PWS A1 Regulated	Spring	217791, 710959	No Spring source
SEPA Registered CAR Abstraction	Ardgartan Hotel	Drinking Water Abstraction		227494, 703081	Yes Potential downstream hydrological connectivity via Croe Water 6.9km downstream of nearest option

15.3.5.6. Road Drainage

The current A83(T) and occasional diversion via the OMR have no installed measures designed to attenuate peak flow, contain accidental spillages nor treat routine runoff water quality.

There are a series of slope management works and channel modifications undertaken by BEAR Scotland with pre-approval by SEPA via CAR registrations and simple licences adjacent to the A83(T) in the Study Area. These include channel diversions, straightening, reprofiling, scour protection and catchpits. The catchpit features have been installed upslope of the A83, with a total length of approximately 200m, to intercept and collect incoming

surface flows and landslide material, diverting runoff through chambers to pipes below the carriageway. These may provide limited flow attenuation and require ongoing removal of collected sediment. Plates 15.3 to 15.5 show these existing modifications.

As part of the Medium-Term Solution (MTS), there are plans to introduce limited improvements to the drainage of the OMR (including better peak flow attenuation, runoff treatment and containment for accidental spillages) and these are considered to present a future baseline context for the Long-Term Solution (LTS).

Plate 15.3 Construction of A83(T) catchpit, adjacent to A83(T). Taken at approximately NGR 223790, 706850 (Dated: 31 January 2021)

Plate 15.4 Engineered rock slope, adjacent to A83(T) catchpit. Upslope catch fencing across slope and channel. Taken at approximately NGR 223790, 706850 (Dated: November 2022)

Plate 15.5 Incised channel (A83_ML_024_000) entering catchpit, enclosed inlet to A83(T) culvert on right of image. Taken at approximately NGR 223800, 706830 (Dated: November 2022)

15.3.5.7. Hydromorphology

As identified above, the Scheme Options are located within the catchments of two WFD water bodies, the Croe Water and the Kinglas Water. The WFD catchment boundaries are shown on Volume 3, Figure 15.1.

The Croe Water exhibits a range of morphological features with very little modification as can be seen in Plate 15.6. The Croe Water flows from north to south through Glen Croe and is an active meandering channel with exposed cobbles and gravel bars. The dominant riparian land use/cover is rough grassland. The in-channel slopes for the Croe Water are much shallower (~0.01m/m) than they are for the watercourses draining the valley sides (~0.1 to 0.3 m/m where the watercourses cross the OMR).

The most substantial lateral inflow to the WFD designated Croe Water drains an area of approximately 3.4km^2 (watercourse ID: A83_ML_015_000). The watercourse is steep (0.085m/m) and high energy, the bed and banks are dominated by large cobbles and boulders characterised as a cascading system (Plate 15.7 below). The watercourse has two bridge crossings associated with the existing A83(T) and the OMR.

The watercourses that drain the eastern slopes of Glen Croe are very steep and are characterised as high energy cascades, mostly with bed material consisting of cobbles and boulders, though some are over bedrock. The riparian land use/cover is predominantly rough grassland that is grazed in some locations, especially downstream of the existing A83(T).

Generally, the slopes are much steeper upslope of the existing A83(T) (~0.6 to 0.7m/m) and the gradients reduce as the watercourses approach the valley base (~0.1 to 0.3m/m where the watercourses cross the OMR) and join the Croe Water (Volume 3, Figure 15.3). These watercourses are currently crossed by the A83(T), and modifications are evident such as catchpits, culverts, drop chambers and cascades with baffles, disrupting flows and sediment transfer processes – as discussed, including photographs, in the Road Drainage section. Where the gradients are shallower, there is a greater amount of finer sand and gravel substrate within the channel bed. There are numerous existing crossings of most of these watercourses associated with the existing A83(T) and OMR as shown in Plate 15.8. Slope gradients for the Study Area are provided on Volume 3, Figure 15.3.

Plate 15.6 Image of the Croe Water, taken from Google Earth (Imagery Date: 21 April 2021)

Plate 15.7 Croe Water (A83_ML_015_000), looking upstream from the existing OMR bridge (Dated: 09 December 2022)

Plate 15.8 Typical channels along the OMR route (Dated: 09 December 2022)

There are a large number of watercourses draining the western slopes of Glen Croe, below the summit of Ben Donich. The watercourses are very steep and are characterised as high energy cascades, mostly with bed material consisting of cobbles and boulders, though some are over bedrock. The riparian land use/cover is currently forestry plantation so sediment supply is lower than on the eastern side but may increase if the trees are felled. Currently there is a forestry track that traverses this hillside, and the watercourses predominantly flow through pipe culverts at this location, see Plate 15.9.

Plate 15.9 Typical cascade characteristics of the watercourses draining the steep afforested western slopes of Glen Croe (Dated: January 2023)

Four watercourses identifiable on the OS 1:25,000 mapping are located within the catchment of the Kinglas Water WFD water body. All four watercourses drain the steep (~0.4 to 0.5m/m), north-western slopes of Beinn Luibhean. The channels are incised and can be

characterised as steep cascades with a dominant bed material of cobbles and boulders (see Plate 15.10). Three of the watercourses discharge directly into Loch Restil, with A83_ML_051_000 discharging downstream of Loch Restil to the north flowing outflow channel, Easan Dubh.

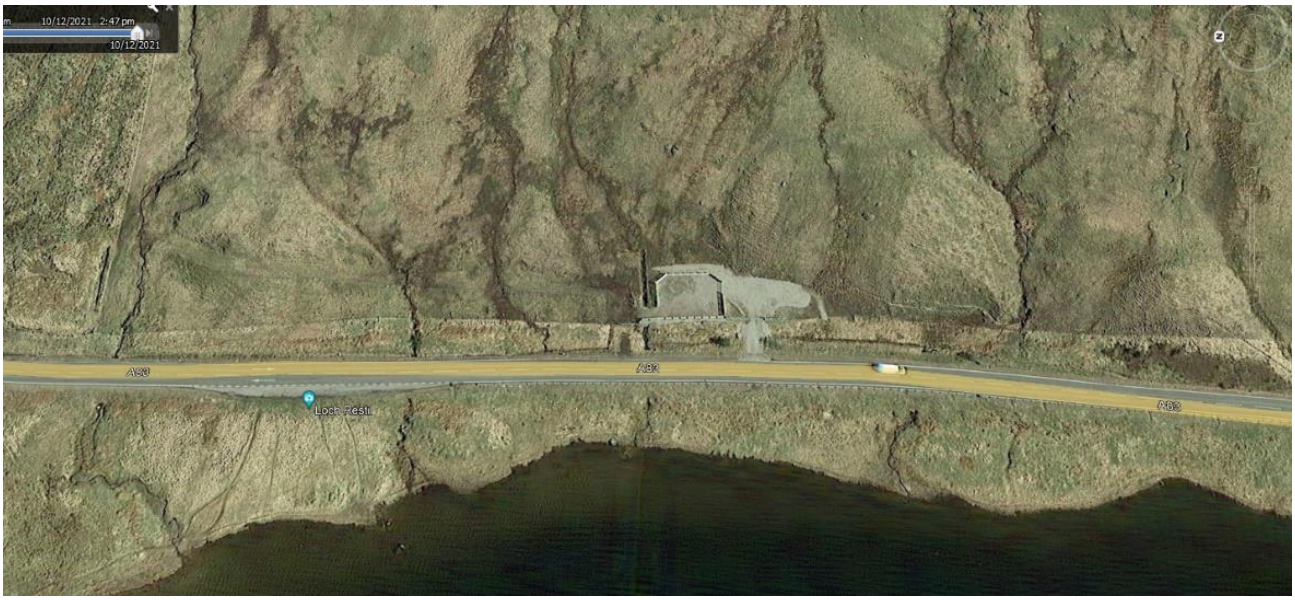


Plate 15.10 Image of the watercourses that drain the north-western slopes of Beinn Luibhean to Loch Restil, taken from Google Earth (Imagery Date: 21 April 2021)

15.3.5.8. Watercourse Crossings

There are four bridge structures present along the Study Area of the A83(T). 'The Cobbler' bridge (A83_15 Bridge) carries the A83(T) over Croe Water (Plate 15.11), this is a three-span structure with four piers supporting the central span. The road elevation is at 165mAOD at the northern abutment falling to 163mAOD at the southern abutment. The A83(T) is considered to have a very low risk of flooding from fluvial sources at this location based on results found in the baseline flood study. At the southern extent of the Study Area, there are two further bridges carrying the A83(T) over the Croe Water (A83_03 and A83_04 Bridges). The Kinglas Water is crossed by the Kinglas bridge (A83_60 Bridge). The maximum flood levels and velocities at this crossing are unknown.

In addition, there are 56 culvert crossings of the A83(T), 18 of which have been confirmed by site visits carried out during DMRB Stage 1 and 2. Of the 18 culverts assessed, seven have the capacity to pass the estimated 0.5% AEP (200-year) plus CC event. Nine of the 18 culverts assessed, have capacities less than the estimated 2% AEP (50-year) event.

Thirty-six crossings of the OMR have been confirmed by site visits carried out during DMRB Stage 1 and 2, and by Transport Scotland, all in the Croe Water catchment.

There are three bridge structures present along the OMR, with the OMR crossing of the Croe Water (OMR_13 Bridge) approximately 170m downstream of the A83(T) crossing (A83_15 Bridge) and consisting of three openings; a main box culvert with two side flood relief culverts (Plate 15.12). The main box culvert (approximately 5.5m wide x 0.7m high) has a soffit level of 126.55mAOD and the two flood relief culverts (each approximately 0.5m wide x 0.6m high) have a soffit level of 126.7mAOD.

Flood risk associated with the structure will be sensitive to blockage and associated reductions in cross-sectional area, reducing the hydraulic performance of the structure. The Croe Water is a steep, high-energy watercourse with competence to mobilise and transport large cobbles and boulders, evident from the bed materials observed in the channel. Therefore, the structure requires regular monitoring, particularly after storm events and any blockage of the openings should be managed to minimise flood risk at this location.

Plate 15.11 A83_15 Bridge ('The Cobbler') across the Croe Water (A83_ML_015_000), looking upstream (Dated: 28 April 2022)

The other two bridge crossings on the OMR consist of a stone masonry arch (OMR_30 Bridge) and a pipe culvert bridge (OMR_31 Bridge). There are 33 culvert crossings of the

OMR which have been confirmed by site visits and informed by Transport Scotland. These are typically single barrel or twin barrel pipe culverts with diameters ranging between 150mm to 1000mm, however most commonly between 450mm to 900mm.

Along the forestry tracks which traverse the western slopes of Glen Croe, 33 crossings of the upper forestry track and 50 crossings of the lower forestry track have been confirmed by a walkover survey undertaken during DMRB Stage 1, as well as on the walkover survey carried out by AWJV in February 2023. Crossings are single barrel or twin barrel pipe culverts with diameters ranging between 300mm to 600mm. The culverts at the forestry track have not been assessed, however from walkover observations it is assumed they have limited capacities.

In summary, including bridges and culverts, there are 179 bridge and culvert crossings that have been identified within the Study Area. These are shown in Volume 3, Figure 15.4 and comprise of crossings of the A83(T), the OMR and the upper and lower forestry tracks.

Plate 15.12 OMR crossing of the Croe Water (A83_ML_015_000), looking downstream at the inlet of the structure (Dated: 07 December 2022)

15.3.5.9. Flood Risk

SEPA Flood Mapping

The SEPA Indicative River and Coastal Flood Maps have been reviewed as part of the baseline assessment for the Proposed Scheme. The published flood map return periods categorise flood risk in the following way:

- High likelihood: A flood event is likely to occur in the defined area on average once in every ten years (1:10). Or a 10% chance of happening in any one year.
- Medium likelihood: A flood event is likely to occur in the defined-on average once in every two hundred years (1:200). Or a 0.5% chance of happening in any one year.
- Medium likelihood (plus climate change): A flood extent is likely to occur in the defined-on average once in every two hundred years plus climate change (1:200 + CC).
- Low likelihood: A flood event is likely to occur in the defined area on average once in every thousand years (1:1000). Or a 0.1% chance of happening in any one year.

The SEPA river flood maps for the baseline Study Area for the 10, 200 and 1000-year return periods are found in Volume 3, Figure 15.4. Sections of the A83(T) carriageway and the OMR lie within the functional floodplain, defined as the 0.5% AEP + CC fluvial flood extents.

SEPA have also published flood mapping showing the likelihood of flooding from surface water, these were reviewed using SEPA Surface Water Flood Maps geodatabase. The surface water flood maps show that there are some relatively small, localised pockets of flooding on the valley of Glen Croe, with medium likelihood of surface flooding.

The SEPA Flood Map for groundwater shows that there is no likelihood of flooding from groundwater, within the Proposed Scheme. However, groundwater is often a contributing factor to flooding rather than a primary source, including groundwater contribution to river baseflows.

Baseline Modelling

Baseline modelling for The Proposed Scheme has been undertaken, detailing the baseline hydrology, as well as the results of Glen Croe and Loch Restil baseline modelling.

The Glen Croe hydraulic modelling provides details of the modelling approach used to assess the fluvial flood risk posed by the Croe Water and its primary tributary (‘High Glen Croe tributary’). The modelled area covers a 4.2km stretch of the Croe Water in addition to a 1.7km stretch of this tributary. The upstream extent of the Croe Water is approximately 220m upstream of the A83(T) crossing (NGR 224374, 706143) and the upstream extent of the

tributary is 1.7km upstream of its confluence with the Croe Water (NGR 223273, 706927). The downstream extent of the model is around 415m downstream from the section A83(T) crossing of the Croe Water (Little Rest bridge) near Creagdhu (NGR 225981, 704192).

The Loch Restil hydraulic modelling was undertaken to give details on the process of building a model to represent fluvial flooding from the Easan Dubh and associated tributaries. The Study Area is a 1.2km-long stretch of the Easan Dubh, with the upstream extent being approximately 270m downstream from Loch Restil NGR (223092 708607) and the downstream extent being 250m upstream of Easan Dubh's confluence with the Kinglas Water watercourse NGR (223452 709417).

The modelling approach utilises data obtained from site surveys carried out between 2019 and 2021, as well as desk-based data obtained from Transport Scotland, SEPA and Fugro.

The models were built as a combination of 1D/2D techniques using Flood Modeller Pro Version 5.1 and TUFLOW 2020, allowing for the transfer of water between the watercourses and the floodplains. Predictions were made regarding the peak water levels for the floodplain/modelled river reach for the following annual exceedance probability (AEP) events:

- 50% AEP (2-year);
- 10% AEP (10-year);
- 3.33% AEP (30-year);
- 2% AEP (50-year);
- 1.33% AEP (75-year);
- 1% AEP (100-year);
- 0.5% AEP (200-year); and
- 0.5% AEP (200-year) plus Climate Change allowance.

The outputs give visualisations of the flow directions, depths and flood extents for all of the above AEP rainfall events and the extents of the anticipated flooding produced.

The results of the hydraulic modelling have been used as the baseline modelling for this assessment.

Hydrometrics

There are two automated rain gauges in the Study Area operated by SEPA. One located at the Rest and be Thankful (Station Number 485490, NGR NN 22835 06967) with the other at

Loch Restil (Station Number 485489, NGR NN 23249 08496), details are provided on Table 15.6.

Table 15.6 Gauging Stations near the Study Area

Gauging Station Number	Name	Watercourse	Grid Reference	Record Length
485490	Rest and be Thankful	Unnamed Watercourse	NN 22835 06967	2013 - present
485489	Loch Restil	Loch Restil	NN 23249 08496	2013 - present

There are no other gauging stations present near the Study Area, with the nearest stations outside of the Study Area at Inveruglas (Station Number 115588) and Glen Falloch (Station Number 133089) approximately 6km and 13km from the Study Area extent, respectively.

Flood Defences

No formal flood defences, suggested flood mitigation measures from DMRB LA 113 (Section 3.68.1), nor other noticeable flood prevention measures were observed during the site walkover on 17 February 2023. It has therefore been assumed that there are no formal flood defence assets or schemes as defined in the Flood Risk Management (Scotland) Act 2009 in the Proposed Scheme Study Area. In addition to this, no informal flood defences are located along the A83(T) or OMR.

There is a gabion wall in the vicinity of OMR culverts 19 and 20 but this is considered to have been installed as a slope support measure to mitigate the landslide hazard in this locality, rather than flood defence.

Historical Flooding Information

Historical flood information has been assessed within a 6km buffer of the current A83(T) between Ardgartan and Kinglas Water.

The information below summarises correspondence from SEPA with regard to flood risk received on the 20th of April 2023:

SEPA hold 10 records of pluvial flooding in the Rest and Be Thankful area since 2006, all referring to the A83 Trunk Road being closed due to landslips following heavy rain. SEPA are not aware of any flood risk assessments which have been undertaken in the study area, and they do not hold any level or flow information within a 6km buffer of the site of interest.

The most likely source of flood risk would be from culvert blockage under the A83, resulting in the back-up of water which may then overtop onto the road. In addition, the land in the vicinity of grid reference NN 24028 05871 lies within an area at flood risk from the Croe Water.

The information below summarises correspondence from Argyll and Bute Council with regard to flood risk, received on the 23rd of March 2023:

Argyll and Bute Council do not hold any records of flood incidents at the location specified and have not undertaken any flood risk assessments for this area. Argyll and Bute Council have no gauges in the specified area and do not hold any data on rainfall, flows and depths. The area is not a priority for any study or investigation by Argyll and Bute Council at present as it has not been identified as a PVA/Target area by SEPA.

If further information is required on past flood events in this location, please see Appendix 15.1 for the full correspondence.

15.3.6. Future Baseline

The associated MTS development will introduce upgrades to the OMR with increased impermeable surfaces to the current baseline conditions, including upgraded drainage networks to attenuate peak flow, treat runoff and contain accidental spillage.

The commercial forestry on the western slopes of Glen Croe is understood to be due for harvesting in the same timeframe as LTS delivery, with some felling underway during March 2023. This forestry shall be assumed to be felled before the completion of the construction phase of the LTS (with this issue most relevant to the future baseline for the Green Option).

15.3.7. Site Walkovers

Site walkovers with the aim of observing the watercourse crossings and the Glen Croe valley floodplain were carried out on the 7th of December 2022 and 17th of February 2023. All 36 crossings on the OMR were examined and photographed, as well as photographs of the A83(T) from the walkover, and of the slope of Beinn Luibhean. Photographs of the Beinn Luibhean slope at the eastern side of the A83(T) were taken on the 17th of February walkover, as well as the valley floodplain as viewed from the lower forestry track.

15.3.8. Receptor Importance/Sensitivity

This evaluation has been undertaken using the criteria and information provided in Section 15.2.

15.3.8.1. Review of Surface Water Receptors

The Croe Water is the only High Importance/Sensitive watercourse that is crossed by the Scheme Options. All remaining watercourses that are crossed are tributaries of the Croe Water or Kinglas Water, draining the steep valley sides and are assessed as Medium Importance/Sensitivity.

Loch Restil is also considered a High Importance/Sensitivity receptor, as located within the Beinn an Lochain SSSI designated site.

Further details on the watercourses, Loch Restil, PWS and abstractions are provided in Table 15.9.

15.3.8.2. Review of Hydromorphology Receptors

A total of 44 watercourse receptors have been identified, from the OS 1:25,000 mapping, as being crossed by the Scheme Options. Not all of the Scheme Options affect all 44 watercourses, only a subset of these are impacted by each of the Scheme Options. All receptors are listed in Appendix 15.4.

As aforementioned, the Croe Water, Loch Restil and outflow channel (Easan Dubh) are the only High Importance/Sensitivity watercourse receptors in the Study Area.

15.3.8.3. Review of Flood Risk Receptors

A receptor in the context of this Stage 2 assessment includes anything that can be put at risk from flooding sources, primarily with regards to infrastructure and dwellings. To determine the receptors within the Proposed Scheme Study Area two guidance sources have been used: Table 1 and Table 2 of SEPA's Flood Risk and Land Use Vulnerability Guidance[299] which classify land use vulnerability and a matrix of flood risk respectively, and Table 3.70 in DMRB LA 113.

SEPA's Flood Risk and Land Use Vulnerability Guidance classification system is split in to five categories, as shown in Table 15.7.

Combining both of these classification methods, the flood receptors for the study area are summarised in Table 15.8 and a map of their location is shown in Volume 3, Figure 15.4.

[299] SEPA Flood Risk and Land Use Vulnerability Guidance, (2018). Available at: https://www.sepa.org.uk/media/143416/land-use-vulnerability-guidance.pdf [Accessed 14 March 2023].

Table 15.7 SEPA Flood Risk and Land Use Vulnerability Guidance Classification System

Most Vulnerable Uses	Highly Vulnerable Uses	Least Vulnerable Uses	Essential Infrastructure	Water Compatible Uses
Examples include Police Stations, Hospitals, Holiday caravan, chalet, and camping sites; and isolated dwelling(s) in sparsely populated areas.	Examples include buildings used for dwelling houses, hostels and hotels; and landfill and sites used for waste management facilities for hazardous waste.	Examples include shops, storage and distribution and waste treatment.	Examples include essential transport infrastructure that has to cross the area at risk and essential utility infrastructure that has to be located in a flood risk area for operational reasons.	Examples include flood control infrastructure, environmental monitoring stations, water transmission infrastructure and pumping stations, sewage transmission infrastructure and pumping stations, sand and gravel workings.

Table 15.8 Summary of Flood Receptors within the 0.5% AEP + 20% Climate Change Allowance, in Accordance with DMRB and SEPA Guidance

Receptor*	Description	DMRB Importance Estimation	Land Use Vulnerability Classification	Flood Risk (in accordance with SEPA Matrix of Flood Risk[299])
NN 27547 03013	Caravan Holiday Park – Forest Holidays Ardgartan	High	Highly Vulnerable Uses	Low to medium risk (0.1% - 0.5% AEP)
NN 27314 02812	Ardgartan Hotel	High	Highly Vulnerable Uses	Medium to high risk within built up area (>0.5% AEP)
NN 26959 03714	Dwelling (cabin/visitor centre)	High	Highly Vulnerable Uses	Medium to high risk within built up area (>0.5% AEP)
NN 26972 03816	Residential dwelling	High	Highly Vulnerable Uses	Low to medium risk (0.1% - 0.5% AEP)
NN 26777 03966	Residential dwelling	Medium	Least Vulnerable Uses (appears to be uninhabited from DTS)	Little or no risk (<0.1% AEP)
NN 26286 04062	Residential dwelling	High	Highly Vulnerable Uses	Little or no risk (<0.1% AEP)

Receptor*	Description	DMRB Importance Estimation	Land Use Vulnerability Classification	Flood Risk (in accordance with SEPA Matrix of Flood Risk[299])
NN 24423 05554	Residential dwelling	High	Highly Vulnerable Uses	Little or no risk (<0.1% AEP)
NN 24282 05565	Structure used for agricultural purposes	Medium	Least Vulnerable Use	Little or no risk (<0.1% AEP)
NN 24207 05681	Structure used for agricultural purposes	Medium	Least Vulnerable Use	Little or no risk (<0.1% AEP)
NN 24013 06056	Structure used for agricultural purposes	High	Least Vulnerable Use	Low to medium risk (0.1% - 0.5% AEP)
NN 23328 06978	Residential dwelling	High	Highly Vulnerable Uses	Little or no risk (<0.1% AEP)
A83(T)	Road	High	Highly Vulnerable Uses	Little or no risk (<0.1% AEP)
OMR	Road	Medium	Least Vulnerable Use	Low to medium risk (0.1% - 0.5% AEP)
Lower forestry track	Road	Medium	Least Vulnerable Use	Little or no risk (<0.1% AEP)
Upper forestry track	Road	Medium	Least Vulnerable Use	Little or no risk (<0.1% AEP)
B828	Road	Medium	Least Vulnerable Use	Little or no risk (<0.1% AEP)
BT Underground Lines	Underground Lines following OMR & A83(T)	Very High	Essential Infrastructure	Low to medium risk (0.1%-0.5% AEP)

* Further investigation required to determine which of the receptor structures are subject to planning control.

15.3.8.4. Summary of Receptor Importance/Sensitivity

Receptor importance has been evaluated using baseline information in accordance with DMRB LA 113 guidelines, using criteria identified in Table 15.4, with outcomes provided in Table 15.9.

Table 15.9 Importance/Sensitivity Evaluation for Road Drainage and the Water Environment Receptors

WFD Catchment	Receptor	Attribute	Comment	Importance / Sensitivity
Croe Water	Croe Water	Surface Water Quality & Biodiversity	Croe Water defined by WFD, with overall status of 'Moderate', with water quality and biological parameters preventing attainment of target 'Good' status. Croe Water flow values in Study Area between 0.001m^3/s - 1m^3/s Tributary channels are assumed to hold equivalent importance, primarily due to flow values between 0.001m^3/s - 1m^3/s	High
			Croe Water tributary channels, not identified on WFD mapping, with flow values between 0.001m^3/s - 1m^3/s	Medium
		Water Supplies & Abstractions	High Glencroe PWS (Type B) There are a small number of PWS downstream, plus a drinking water abstraction for Ardgartan Hotel, with further details to be collected at Stage 3	Medium
			Roadmans Cottage PWS (Type B)	Medium
			There are three PWS (including Type A1 categorisation) at distances over 1.5km downstream of all options, plus a drinking water abstraction for Ardgartan Hotel (3km downstream)	High
		Hydromorphology	Croe Water	High
			Tributaries of Croe Water	Medium
		Hydrology & Flood Risk	Croe Water has a floodplain which provides attenuation and storage for the 200-year + CC flood event.	n/a
Kinglas Water	Kinglas Water	Surface Water Quality & Biodiversity	WFD overall status is 'Bad Ecological Potential', however, this has been determined by features of the downstream reach, outwith the Study Area. Not identified on WFD mapping, flow values between 0.001m^3/s - 1m^3/s	Medium
		Water Supplies & Abstractions	There are two PWS Type A categorisation at distances over 6km downstream of all options	High
		Hydromorphology	Kinglas Water	Medium

WFD Catchment	Receptor	Attribute	Comment	Importance / Sensitivity
			Tributaries of Kinglas Water	Medium
		Hydrology & Flood Risk	Kinglas Water has a floodplain downstream of Loch Restil	n/a
	Loch Restil	Surface Water Quality & Biodiversity	Loch Restil (and outflow channel – Easan Dubh) lie within Beinn an Lochain SSSI	High
		Water Supplies & Abstractions	None	n/a
		Hydromorphology	Tributaries of Kinglas Water	Medium
		Hydrology & Flood Risk	Not located within a floodplain	n/a

15.4. Potential Effects

This section presents a summary of the proposed construction of infrastructure affecting watercourses for each of the Scheme Options, followed by a description of the potential operational effects of the options on the water environment.

All options pass through the Glen Croe valley, within the Croe Water catchment and all interact with the southern boundary of the Kinglas Water catchment, adjacent to the Rest and Be Thankful car park (south of Loch Restil). The tunnel options (Pink Option and Purple Option) each have northern tunnel portals to the north of Loch Restil, further within the Kinglas Water catchment.

Table 15.10 presents a summary of the number of watercourses affected and the anticipated crossing structures required for each of the Scheme Options. Each option is described in more detail in the following sections.

Table 15.10 Watercourse Interactions of the Scheme Options

Option	Total No. of watercourse interactions (all map scales)	No. of watercourse receptors assessed (OS 1:25,000)	No. of watercourse crossings of OS 1:25,000 receptors	Structure Type				
				DFS	C	B	V	T
Green	50	9	9	5	2	0	2	0
Yellow	21	16	16	0	1	0	15	0
Brown	24	17	18	12	4	2	0	0
Pink	44	28	31 (11 excluding T)	0	10	1	0	20
Purple	37	22	22 (20 excluding T)	0	5	0	15	2

Crossing Type:- DFS – Debris Flow Shelter (Culvert), C – Culvert, B – Bridge, V – Viaduct, T – Tunnel (‘Drill and Blast’ Section)

Potential effect significance levels are reported on the basis of good practice being adopted for design and construction procedures, with any additional mitigation measures detailed in Section 15.5.

15.4.1. Construction

Construction impacts and associated effects common to all Scheme Options and option-specific factors are identified in the sections below, summarised in Table 15.11. For the

purposes of this assessment construction effects are generally considered to be short term which occur during the construction phase only.

The criteria for assessment are provided in Section 15.2, with receptor sensitivity provided in Table 15.9.

15.4.1.1. Effects Common to all Scheme Options

Construction Pollution

Silt and sediment-laden site runoff generated during construction activities, such as soil stripping and earthworks can have a detrimental effect if allowed to enter watercourses untreated. Fine sediments can increase water turbidity and smother stream beds, affecting water quality and causing harm to fish, aquatic invertebrates and plants by interfering with feeding, respiration and spawning. The effects of sediment release can extend considerable distances downstream.

In addition, spillages of potential pollutants such as oils, fuels, concrete, cement and sewage from construction staff welfare facilities can potentially occur during construction. Oils form a film on the water surface and can coat organisms, blocking respiration, photosynthesis and feeding. Biodegradation of oils in aquatic systems can lead to oxygen depletion and many hydrocarbons are toxic, persistent and bio-accumulate in the environment i.e. they build-up in the body tissue both directly and from feeding on other contaminated organisms. Concrete and cement are highly alkaline and can harm aquatic organisms if the pH of the receiving waters are affected.

The highest risk of sedimentation or spillage affecting water bodies, and dependent private water supplies and abstractions would be at locations where construction would be required within 50m of a watercourse and also at locations where direct interaction with the water environment occurs, such as bridge and culvert crossing structures, where watercourse diversions are required and at drainage discharge outfalls.

Each of the options include a number of watercourse crossings, these have been noted in the option-specific sections below using both the OS 1:25,000 mapping and additional watercourse channel information, including existing culverts, as reference, noting crossing types and identifying channels where cut and cover tunnel sections would pass below.

All of the Scheme Options have hydrological connection to Beinn an Lochain SSSI, which includes Loch Restil and the associated outflow channel (Easan Dubh) from Loch Restil which flows north to the Kinglas Water. These features, within the SSSI, are considered High Sensitivity/Importance receptors.

There are a number of supplies over 1km downstream in the Croe Water catchment of all Scheme Options. These include a single registered CAR abstraction for drinking water supply downstream for Ardgartan Hotel and PWS for Larach Park and Guithas Cottage. Such distant sources are less likely to be impacted as the proportion of the contributing catchment disrupted by the scheme would be relatively small. These potential effects are considered to be equivalent for all Scheme Options (and non-significant, based on sensitivity and magnitude criteria) and do not present any differential, therefore these have not been considered further.

Hydromorphology

All Scheme Options would be complex to construct and would directly interact with numerous watercourses. There would be a requirement for temporary watercourse diversions or/and over pumping during the construction phase. The steep topography promotes a flashy response to rainfall events and an abundant sediment supply resulting in dynamic channel behaviour which would not always be predictable. Controlling the overland surface water flows together with potential pollution risks would be important and would require careful management and monitoring throughout the construction phase. Construction works nearer the valley floor would be extensive for the viaduct options and works would be prone to flooding and possible debris/sediment splays. Disturbance of groundwater flow paths where subsurface structures/foundations and dewatering are proposed could also intercept or alter groundwater flows/levels and in turn, watercourse baseflow.

All Scheme Options would have an impact on the Croe Water (High sensitivity), directly or indirectly via the incoming tributaries, therefore the significance of potential effects across all options is Moderate/Large Adverse for construction prior to implementation of any specific mitigation.

Flood Risk

All Scheme Options have the potential to impact the floodplain due to construction works on/near the floodplain and diversion of a number of watercourses.

It is likely that the construction phase for all Scheme Options would require ongoing management in adherence with a Construction Environmental Management Plan and/or Flood Risk Management Plan to ensure all potential risks and the need for mitigation are fully assessed.

An assessment of the significance of potential effects has been carried out for each of the Scheme Options and is discussed in the sections below.

15.4.1.2. Green Option

Construction Pollution

The creation of the debris flow shelter and associated catchpit, culverts and channel diversions on the steep cross-slopes of western Glen Croe is likely to lead to silt/sediment transfer into nearby watercourses, decreasing the local water quality of the Croe Water tributary channels and the downstream Croe Water.

The earthworks and installation associated with the debris flow shelter is likely to present challenges for sediment management, with the steep adjacent cross-slope limiting the potential for large-scale settlement lagoons in the adjacent area and a likely requirement to over-pump channels via flexible hoses to avoid washout during the construction programme. The lengthy construction programme for the debris flow shelter may introduce a longer period of potential pollution effect on surface waters.

The relatively few OS 1:25,000 channel interaction results in 8.2ha of works (permanent plus temporary land take) within 50m of these channels, which is the lowest of all the Scheme Options. However, this value would be substantially different if the metric included the smaller channels, which dominate the current drainage regime on the western slopes of Glen Croe. Slight-Moderate Adverse potential effects are predicted to surface watercourses.

At the northern end, there would be construction works adjacent to the southern banks of Loch Restil, including tie-ins of the A83(T)and B828 and creation of two drainage discharge outfalls on the banks of Loch Restil, with Slight Adverse potential effects identified to this receptor within the Beinn an Lochain SSSI.

Neither PWS High Glencroe nor PWS Roadmans Cottage are within the Green Option hydrological catchments, with no anticipated effect.

Hydromorphology

The Green Option has a particularly long construction phase at more than seven years, which has the potential to disrupt watercourses with changes in flow dynamics and sediment supply/transport. The Green Option would traverse steep ground on the western valley side (albeit currently a forest track and the surrounding land wooded) and affect nine watercourses that are identifiable on the OS 1:25,000 mapping but over 50 watercourses in total. Watercourse diversions/convergence are likely to be required to accommodate the debris flow shelters and culvert installations with disruption on the floodplain to construct the viaduct elements at the southern end over Croe Water.

Flood Risk

Construction of the 450m long southern viaduct would take place on the 200-year + CC floodplain for approximately two years, with flat temporary working platforms required to grant access from the OMR and adjacent forestry tracks. Construction of the southern tie in road would also take place on the floodplain at the A83(T), which would have a minor impact on both the A83(T) and OMR. The impacts on agricultural and residential receptors in the Glen Croe valley are considered negligible due to the Green Option being located on the western slopes. Two receptors (Ardgartan Hotel and a visitor centre) located downstream of the Green Option have the potential for Slight/Moderate Adverse effects as they lie on the functional floodplain and may be impacted by construction works on floodplain. There may be temporary impacts to watercourses during construction, with access roads and temporary watercourses diversions in place, having a Slight Adverse potential effect on the lower forestry track. The SuDS basin construction zones would take place on and immediately adjacent to the 200-year + CC floodplain.

Overall, the significance of effect for the Green Option is considered to be Slight/Moderate Adverse due to the construction works on the floodplain.

15.4.1.3. Yellow Option

Construction Pollution

The avoidance of in-channel supports would reduce potential for construction pollution from in-channel works, however, the viaduct construction would require the installation and raising of support piers on the lower slopes of Glen Croe above and adjacent to channels shown on OS 1:25,000 mapping and on a floodplain subject to potential inundation. Piers would be placed with a maximum spacing of 100m, with some variation to avoid localised constraints.

Each pier would require earthworks to create level working zones, generally within 50m of local watercourses, with a combined 12.4ha of works (permanent plus temporary land take) within 50m of the OS 1:25,000 channels, including the Croe Water. Significance of potential effects is predicted to be Slight-Moderate Adverse to surface watercourses.

At the northern end, there would be construction works adjacent to the southern banks of Loch Restil, including tie-ins of the A83(T) and B828 and creation of a drainage discharge outfall on the banks of Loch Restil, with a Slight Adverse effect identified to this receptor within the Beinn an Lochain SSSI.

PWS High Glencroe is approximately 100m downstream of the viaduct section of the Yellow Option, with a Moderate Adverse effect to supply quality or yield during construction.

Hydromorphology

The construction duration is to be over three years, with potential disruption to watercourses, as the bulk of the works constructing the viaduct between the OMR and the valley bottom. The pier pads for viaduct construction are likely to have a significant footprint which may temporarily affect the 16 watercourses along the Yellow Option. Some diversions may be required whilst the structure is positioned but the shallower gradient and more defined channels would make appropriate mitigation measures easier to implement compared to those for other options on the steeper ground, although more vulnerable to flooding. No in-channel working is assumed, and only one culvert crossing is proposed.

Flood Risk

The viaduct pier and SuDS feature construction zone would be within the functional floodplain for a period of approximately 3.5 years due to temporary working platforms being required on flat ground on the valley floor to construct the piers. This would need to be accessible from the OMR/temporary access roads. This may increase flood risk to the OMR and culverts while works are ongoing. Construction in an area where landslides are likely may increase construction time and thus increase the time spent on the floodplain. Construction works are considered to have minor impacts on an agricultural receptor and residential dwelling due to watercourse diversions on the eastern slope, and floodplain construction works have potential for minor impacts on the A83(T), OMR and lower forestry track which all sit in the floodplain at their southern extents within the Study Area. In addition, Ardgartan Hotel and a visitor centre have potential for minor impacts as they lie on the functional floodplain further southeast and may be impacted by construction works on floodplain.

The significance of effect for the Yellow Option is considered to be Slight/Moderate Adverse due to the viaduct construction works and watercourse diversions.

15.4.1.4. Brown Option

Construction Pollution

The debris flow shelter issues identified for the Green Option also apply for the Brown Option.

There are 13.2ha of works (permanent plus temporary land take) within 50m of the OS 1:25,000 channels, with these larger channels dominating the drainage of the eastern slopes of Glen Croe, with relatively few smaller channels along the orientation of the existing

A83(T). A Slight Adverse potential effect is predicted to surface watercourses, taking account of existing channel modifications and catchpits in this location.

At the northern end, there would be construction works adjacent to the southern banks of Loch Restil, including tie-ins of the A83(T) and B828 and creation of a drainage discharge outfall on the banks of Loch Restil, with a Slight Adverse potential effect identified to this receptor within the Beinn an Lochain SSSI.

PWS High Glencroe is approximately 300m downstream of the viaduct section of the Brown Option, with a Moderate Adverse potential effect to supply quality or yield during construction.

Hydromorphology

The Brown Option crosses 17 watercourses of which 12 are within the debris flow shelter section, four are culvert crossings and one watercourse is crossed by two bridges. There would be severe disruption to the watercourse flows and sediment supply and transfer downstream. Diversions/convergence of watercourses and overland flow would be required. Careful consideration of how to mitigate and monitor throughout the construction phase would be essential.

Flood Risk

Construction works have the potential to impact watercourses at all sections of the Brown Option, and temporary diversions would be carried out at temporary access roads which would be installed for use during construction. Construction work for the Brown Option would primarily take place away from the floodplain, however, watercourse diversions across the length of the Brown Option and interaction with the floodplain at Croe Water would have minor impacts on the A83(T), OMR and two receptors (agricultural and residential), giving a significance of potential effects of Slight/Moderate Adverse. The upper and lower forestry tracks would not be impacted by construction works for the Brown Option.

15.4.1.5. Pink Option

Construction Pollution

The ‘cut and cover’ section of tunnel portals would involve extensive alteration to the ground profile, with watercourses requiring alteration and channel reinstatement. Sediment from earthworks is likely to be transferred into nearby channels, with this potential increased during prolonged wet weather or intensive rainfall events.

There are 9.1ha of works (permanent plus temporary land take) within 50m of the OS 1:25,000 channels, with these larger channels dominating the drainage of the eastern slopes of Glen Croe and adjacent to Loch Restil, with relatively few smaller channels. This excludes the 'drill and blast' section of tunnel, but does include the 'cut and cover' zones at each portal, which would involve extensive earthworks, over-pumping and subsequent channel realignment into culverts.

The diversion of the A83(T), adjacent to the southern tunnel portal would require a number of additional watercourse crossings and associated embankments, plus an additional bridge over the Croe Water, downstream of the existing A83(T) bridge (A83_15).

The tunnel is anticipated to be excavated by 'drill and blast' from both ends, this would require material to be removed from the tunnel and stored adjacent to portal zones. Such stockpiles have potential for sediment-laden runoff to reach local surface water receptors, which would include Loch Restil at the northern portal. A Slight-Moderate Adverse significance of potential effects is predicted to surface watercourses.

At the northern end, there are no discharge outfalls being constructed on the banks of Loch Restil, However, this option requires the creation of the northern tunnel portal and additional construction works adjacent to the northern banks of Loch Restil, including tie-in of the A83(T) and creation of two drainage discharge outfalls into Loch Restil's outflow channel, the Easan Dubh. A Moderate Adverse potential effect applies to this receptor within the Beinn an Lochain SSSI.

The PWS High Glencroe may be subject to Slight Adverse significance of effect with tunnel construction 350m upslope. The Roadmans Cottage property (and associated PWS Roadmans Cottage) is under the footprint of the Pink Option, this property would be removed if this option is constructed and therefore the demand for this PWS would be removed, with an associated reduction in sensitivity of the PWS to N/A and no significant effect. Further PWS details to be collated at Stage 3.

Hydromorphology

The Pink Option crosses over 28 watercourses displayed on the OS 1:25,000 map of which 20 are tunnelled (including one crossing under the Croe Water) approximately 50m below the surface. There would be 10 culvert installations within the cut and cover sections at either end of the tunnel (two culvert crossings on two watercourses to accommodate the temporary access) and there would be one bridge over the Croe Water. These 'cut and cover' zone watercourses would require flow diversion during portal excavation, followed by consideration of reinstatement options following tunnel cover installation. The construction

duration is likely to be >4 years but the disruption to watercourses would be focused on the south and north ends. Mitigation measures will be applied to minimise disturbance and potential pollution to these watercourses. It is assumed the tunnelling works would have negligible impact to the watercourses flowing at the surface.

Flood Risk

The potential effects on flood risk would be limited to those watercourses within the sections of the A83(T) outside of the tunnel sections and construction activities beyond the footprint of the Pink Option. Construction of the temporary road would take place on the floodplain at the east of Croe Water which may have minor impacts on two receptors, as well as the A83(T) and OMR. The number of watercourses to be considered for Pink Option is also lower than the Green/Brown Options; any measures to prevent watercourse impacts during construction will be covered under an appropriate Flood Risk Management Plan. Watercourse diversions located uphill of two receptors (agricultural and residential) have potential for interaction at the southern tie in road and temporary road, as well as having a minor impact on the A83(T) and OMR at this southern tie in section.

The assessed significance of potential effects for the Pink Option is Slight/Moderate Adverse. However, the number of watercourses requiring diversions for the Pink Option are much lower than those required for the Brown Option. Similar to the Brown Option, the upper and lower forestry tracks would not be impacted by construction works.

15.4.1.6. Purple Option

Construction Pollution

The Pink Option description relating to potential sedimentation from tunnel portal construction also applies to the Purple Option, albeit the shorter tunnel would have reduced levels of material generated and stockpiled during construction.

The Yellow Option description of viaduct pier construction will also apply, with extensive works likely within the floodplain on lower slopes Glen Croe. The piers are not as high as proposed in the Yellow Option so the construction footings may be smaller in area, but would be at same frequency, at a maximum spacing of 100m, with some minor variation to avoid localised constraints.

There are 16.0ha of works (permanent plus temporary land take) within 50m of the OS 1:25,000 channels, with these larger channels dominating the drainage of the eastern slopes of Glen Croe and adjacent to Loch Restil, with relatively few smaller channels. This excludes the ‘drill and blast’ section of tunnel but does include the ‘cut and cover’ zones at each

Purple Option portal, which will involve extensive earthworks, over-pumping and subsequent channel realignment into culverts. Moderate Adverse potential effects are predicted to surface watercourses.

At the northern end, there are no discharge outfalls being constructed on the banks of Loch Restil. However, similarly to the Pink Option, there requires construction of a tunnel portal and works adjacent to the northern banks of Loch Restil, including tie-in of the A83(T) and creation of two drainage discharge outfalls into Loch Restil's outflow channel, the Easan Dubh. A Moderate Adverse potential effect applies to this receptor within the Beinn an Lochain SSSI.

PWS High Glencroe is approximately 70m downstream of the viaduct section of the Purple Option, with Moderate Adverse potential effects to supply quality or yield during construction.

Hydromorphology

As for the Pink Option, 'cut and cover' tunnel portal zones would require watercourse diversion, followed by possible reinstatement but only five culvert crossings are proposed. Tunnelling would be under two watercourses along the Purple Option. Construction of the piers within the floodplain would result in the need for watercourse mitigation in the form of temporary diversions and pollution control as there are 15 watercourses crossed by the viaduct element of the works.

Flood Risk

Construction work would take place on the functional floodplain while the viaduct structure is being built over a period of approximately 3.5 years, with temporary flat working platforms being established at each pier during this time for construction access. As a result of this, construction zones for the pier and SuDS would be within the 200-year + CC floodplain; temporary impacts from working in the floodplain would be expected, such as floodplain displacement requiring temporary mitigation. This potential significant effect will be managed as part of a Flood Risk Management Plan in managing the location of access tracks, mobile plants, equipment, and the wider construction site.

Watercourse diversions at the southern tie in road have potential to interact with two receptors (agricultural and residential), as well as the A83(T) and OMR, and construction works on the floodplain also have potential for minor impacts on the OMR and the southern extent of the A83(T) within the study area which interacts with the floodplain. Additionally, the construction in the floodplain may have a minor impact on the southern extent of the lower forestry track which interacts with the floodplain.

The significance of potential effects for the Purple Option is Slight/Moderate Adverse, however, no impact would be expected at the tunnel section.

Table 15.11 Potential Construction Significance of Effects

Construction Effects	Green	Yellow	Brown	Pink	Purple
Construction Pollution to Surface Watercourses	Combined permanent and temporary works footprint of 8.2ha within 50m of OS 1:25,000 watercourses Construction zones at 9 watercourses on OS 1:25,000 mapping, as detailed in Hydromorphology entry Construction of lengthy debris flow shelter and new catchpits and extensive associated earthworks Croe Water: Magnitude - Minor Adverse Sensitivity – High Effect – Moderate Adverse Croe Water Tributaries: Magnitude - Moderate Adverse Sensitivity – Medium Effect – Moderate Adverse	Combined permanent and temporary works footprint of 12.4ha within 50m of OS 1:25,000 watercourses Construction zones at 16 watercourses on OS 1:25,000 mapping Construction of pier supports and extensive associated earthworks Croe Water: Magnitude - Moderate Adverse Sensitivity – High Effect – Moderate Adverse Croe Water Tributaries: Magnitude - Moderate Adverse Sensitivity – Medium Effect – Moderate Adverse Kinglas Water Tributaries:	Combined permanent and temporary works footprint of 13.2ha within 50m of OS 1:25,000 watercourses Construction zones at 17 watercourses on OS 1:25,000 mapping Construction of debris flow shelter and extended catchpits and associated earthworks Croe Water: Magnitude - Minor Adverse Sensitivity – High Effect – Slight Adverse Croe Water Tributaries and Kinglas Water Tributaries: Magnitude - Minor Adverse Sensitivity – Medium Effect – Slight Adverse	Combined permanent and temporary works footprint of 9.1ha (excluding 'drill and blast' tunnel section) within 50m of OS 1:25,000 watercourses Construction zones at 11 watercourses on OS 1:25,000 mapping (excluding 'drill and blast' tunnel section) Construction of A83(T) diversion and tunnel portals, with extensive associated earthworks Croe Water: Magnitude - Minor Adverse Sensitivity – High Effect – Slight Adverse Croe Water Tributaries and Kinglas Water Tributaries: Magnitude - Moderate Adverse Sensitivity – Medium	Combined permanent and temporary works footprint of 16.0ha (excluding 'drill and blast' tunnel section) within 50m of OS 1:25,000 watercourses Construction zones at 20 watercourse crossings pm 1:25,000 mapping (excluding 'drill and blast' tunnel section) Construction of pier supports and tunnel portals, with extensive associated earthworks Croe Water: Magnitude - Moderate Adverse Sensitivity – High Effect – Moderate Adverse Croe Water Tributaries and Kinglas Water Tributaries:

Construction Effects	Green	Yellow	Brown	Pink	Purple
	Kinglas Water Tributaries: Magnitude - Minor Adverse Sensitivity – Medium Effect – Slight Adverse	Magnitude - Minor Adverse Sensitivity – Medium Effect – Slight Adverse		Effect – Moderate Adverse	Magnitude - Moderate Adverse Sensitivity – Medium Effect – Moderate Adverse
Construction Pollution to Loch Restil, within Beinn an Lochain SSSI	Northern tie-in with A83(T) and B828 at southern boundary of Beinn an Lochain SSSI/Loch Restil Construction phase runoff likely to flow to Loch Restil, adjacent to Rest and Be Thankful Car Park Two permanent road drainage outfalls constructed on banks of Loch Restil Magnitude - Minor Adverse Sensitivity – High Effect – Slight Adverse	Northern tie-in with A83(T) and B828 at southern boundary of Beinn an Lochain SSSI/Loch Restil Construction phase runoff likely to flow to Loch Restil, adjacent to Rest and Be Thankful Car Park One permanent road drainage outfall constructed on banks of Loch Restil Magnitude - Minor Adverse Sensitivity – High Effect – Slight Adverse	Northern tie-in with A83(T) and B828 at southern boundary of Beinn an Lochain SSSI/Loch Restil Construction phase runoff likely to flow to Loch Restil, adjacent to Rest and Be Thankful Car Park One permanent road drainage outfall constructed on banks of Loch Restil Magnitude - Minor Adverse Sensitivity – High Effect – Slight Adverse	Northern tie-in with A83(T) and B828 to north of Loch Restil Although no drainage outfall into Loch Restil, requires substantial excavation of northern tunnel portal, with associated runoff likely to flow to Loch Restil and Easan Dubh outflow channel Magnitude - Moderate Adverse Sensitivity – High Effect – Moderate Adverse	Northern tie-in with A83(T) and B828 to north of Loch Restil Although no drainage outfall into Loch Restil, requires substantial excavation of northern tunnel portal, with associated runoff likely to flow to Loch Restil and Easan Dubh outflow channel Magnitude - Moderate Adverse Sensitivity – High Effect – Moderate Adverse
Construction Pollution (or Interruption) to PWS High Glencroe	PWS High Glencroe (Type B) is not in same catchment Magnitude – No Change Sensitivity – Medium Effect – Neutral	PWS High Glencroe (Type B) is located downslope and within 100m of viaduct construction area Magnitude - Moderate Adverse	PWS High Glencroe (Type B) is located downslope and within 300m of debris flow shelter construction area	PWS High Glen Croe (Type B) unlikely to be adversely influenced by tunnel 350m upslope (assumed as surface water supply)	PWS High Glencroe (Type B) is located downslope and within 100m of viaduct construction area

Construction Effects	Green	Yellow	Brown	Pink	Purple
		Sensitivity – Medium Effect – Moderate Adverse	Magnitude - Moderate Adverse Sensitivity – Medium Effect – Moderate Adverse	Magnitude – Negligible Sensitivity – Medium Effect – Slight Adverse	Magnitude - Moderate Adverse Sensitivity – Medium Effect – Moderate Adverse
Construction Pollution (or Interruption) to PWS Roadmans Cottage	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral	PWS Roadmans Cottage (Type B) is under the Pink option, situated at A83(T) temporary diversion at southern portal. This property (and associated PWS demand) will be removed during construction Magnitude – No Change Sensitivity – N/A Effect – N/A	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral
Hydromorphology	Nine watercourses (1:25,000) crossed: 5 Debris Flow Shelters 2 Culverts 2 Viaducts Complex diversion or/and converging of watercourses Croe Water Sensitivity - High	16 watercourses (1:25,000) crossed: 1 Culvert 15 Viaducts Construction of piers in floodplain, potential diversions of watercourses Croe Water	17 watercourses (1:25,000) crossed: 12 Debris Flow Shelters 4 Culverts 2 Bridges (over 1 watercourse) Complex diversion or/and converging of watercourses Croe Water	28 watercourses (1:25,000) crossed (11 directly affected): 10 Culverts (2 watercourses with 2 culverts) 1 Bridge 20 Tunnels Potential diversions of watercourses	22 watercourses (1:25,000) crossed (20 directly affected): 5 Culverts 15 Viaducts 2 Tunnels Construction of piers in floodplain, potential diversions of watercourses

Construction Effects	Green	Yellow	Brown	Pink	Purple
	Magnitude - Moderate Effect – Moderate/Large All other watercourses Sensitivity – Medium Magnitude: 5 Major 3 Moderate Effect: 5 Moderate/Large Adverse 3 Moderate Adverse	Sensitivity - High Magnitude - Moderate Effect – Moderate/Large All other watercourses Sensitivity – Medium Magnitude: 15 Moderate Effect: 15 Moderate Adverse	Sensitivity - High Magnitude - Moderate Effect – Moderate/Large All other watercourses Sensitivity – Medium Magnitude: 12 Major 4 Moderate Effect: 12 Moderate/Large Adverse 4 Moderate Adverse	Croe Water Sensitivity - High Magnitude - Moderate Effect – Moderate/Large All other watercourses Sensitivity – Medium Magnitude: 7 Moderate Effect: 7 Moderate Adverse	Croe Water Sensitivity - High Magnitude - Moderate Effect – Moderate/Large All other watercourses Sensitivity – Medium Magnitude: 19 Moderate Effect: 19 Moderate Adverse
Flood Risk: Residential Dwellings, Hotel, Caravan Park & Agriculture Uses	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on receptors out of floodplain (agricultural & residential) considered negligible. Two minor impacts on receptors in floodplain. Sensitivity – High Magnitude: 2 Minor (Ardgartan Hotel and cabin/visitor centre)	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on agricultural building, residential dwelling, visitor centre and hotel considered minor due to watercourses managed in the construction zone near the receptors and floodplain construction. Sensitivity – High Magnitude:	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on agricultural building and residential dwelling considered minor due to watercourses managed in the construction zone near the receptors. No potential impacts on receptors in floodplain downstream of construction. Sensitivity – High Magnitude:	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on agricultural building, residential dwelling, visitor centre and hotel considered minor due to watercourses managed in the construction zone near the receptors. No potential impacts on receptors in floodplain downstream of construction. Sensitivity – High	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on agricultural building, residential dwelling, visitor centre & hotel considered minor due to watercourses managed in the construction zone near the receptors and floodplain construction. Sensitivity – High Magnitude:

Construction Effects	Green	Yellow	Brown	Pink	Purple
	1 Negligible (Residential dwelling) Effect: 2 Slight/Moderate Adverse (Ardgartan Hotel and cabin/visitor centre) 1 Slight Adverse (Residential dwelling) Sensitivity – Medium Magnitude: 1 Negligible (Structure used for agricultural purposes) Effect: 1 Neutral/Slight Adverse (Structure used for agricultural purposes)	3 Minor (Ardgartan Hotel, cabin/visitor centre and Residential dwelling) Effect: 3 Slight/Moderate Adverse (Ardgartan Hotel, cabin/visitor centre and Residential dwelling) Sensitivity – Medium Magnitude: 1 Minor (Structure used for agricultural purposes) Effect: 1 Slight Adverse (Structure used for agricultural purposes)	1 Minor (Residential dwelling) 2 Negligible (Ardgartan Hotel and cabin/visitor centre) Effect: 1 Slight/Moderate Adverse (*Residential dwelling*) 2 Slight Adverse (Ardgartan Hotel and cabin/visitor centre) Sensitivity – Medium Magnitude: 1 Minor (Structure used for agricultural purposes) Effect: 1 Slight Adverse (Structure used for agricultural purposes)	Magnitude: 3 Negligible (Ardgartan Hotel, cabin/visitor centre and Residential dwelling) Effect: 3 Slight Adverse (Ardgartan Hotel, cabin/visitor centre and Residential dwelling) Sensitivity – Medium Magnitude: 1 Minor (Structure used for agricultural purposes) Effect: 1 Slight Adverse (Structure used for agricultural purposes)	3 Negligible (Ardgartan Hotel, cabin/visitor centre and Residential dwelling) Effect: 3 Slight Adverse (Ardgartan Hotel, cabin/visitor centre and Residential dwelling) Sensitivity – Medium Magnitude: 1 Negligible (Structure used for agricultural purposes) Effect: 1 Neutral/Slight Adverse (Structure used for agricultural purposes)
Flood Risk: A83(T) & OMR	Southern tie in road construction takes place on floodplain at A83(T). Construction works would take place on OMR access track floodplain. Sensitivity – High Magnitude: Minor (A83(T)) Effect:	Construction expected to take place on the 200-year + CC floodplain over the course of 3.5 years, leading to temporary floodplain displacement. Construction works would take place on the OMR & viaduct construction would take place on floodplain. Construction traffic would	Construction works would not take place on or near the floodplain. Watercourse diversions across the Brown Option have potential to impact OMR and A83(T). Sensitivity – High Magnitude: Minor (A83(T))	Watercourses at tunnel section not expected to impact OMR or A83(T). Watercourse diversions at southern tie in have potential to impact OMR and A83(T). Sensitivity – High Magnitude: Minor (A83(T))	Potential for **minor impacts** to A83(T) and OMR where watercourses may be diverted at tie in roads. **No impacts** expected at tunnel section. Viaduct construction on floodplain may lead to temporary floodplain displacement and

Construction Effects	Green	Yellow	Brown	Pink	Purple
	Slight/Moderate Adverse (*A83(T)*) Sensitivity – Medium Magnitude: Minor (*OMR*) Effect: Slight Adverse (*OMR*)	use OMR for access, which may increase flood risk. Sensitivity – High Magnitude: Minor (A83(T)) Effect: Slight/Moderate Adverse (A83(T)) Sensitivity – Medium Magnitude: Minor (OMR) Effect: Slight Adverse (OMR)	Effect: Slight/Moderate Adverse (A83(T)) Sensitivity – Medium Magnitude: Minor (OMR) Effect: Slight Adverse (OMR)	Effect: Slight/Moderate Adverse (A83(T)) Sensitivity – Medium Magnitude: Minor (OMR) Effect: Slight Adverse (OMR)	construction works would take place on floodplain for the viaduct structure. Sensitivity – High Magnitude: Minor (A83(T)) Effect: Slight/Moderate Adverse (A83(T)) Sensitivity – Medium Magnitude: Minor (OMR) Effect: Slight Adverse (OMR)
Flood Risk: Lower & Upper forestry track, B828	Watercourse diversions at lower forestry track have potential for impacts. Viaduct construction on floodplain may impact lower forestry track. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track) Effect: 1 Slight Adverse (Lower forestry track)	Construction expected to take place in the 200-year + CC flood plain over the course of 3.5 years, leading to temporary flood plain displacement. Potential for impacts to the lower forestry track downstream. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track) Effect:	Potential for **minor impacts** resulting from temporary watercourse diversions during construction. Temporary access routes installed for construction would likely to bear a degree of flood risk and would need to be assessed on their own merit. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track)	Potential for construction to take place on the flatter ground on the valley floor, potentially encroaching on the flood plain. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track) Effect: 1 Slight Adverse (Lower forestry track)	Construction expected to take place in the 200-year + CC flood plain over the course of 3.5 years, leading to temporary flood plain displacement. Potential for impacts to small section of the lower forestry track that encroaches on flood plain. Sensitivity – Medium Magnitude:

Construction Effects	Green	Yellow	Brown	Pink	Purple
		1 Slight Adverse (Lower forestry track)	Effect: 1 Slight Adverse (Lower forestry track)		1 Minor (Lower forestry track) Effect: 1 Slight Adverse (Lower forestry track)
Flood Risk: Underground Utility Cables	Scoped out as no differentiator	Scoped out as no differentiator	Scoped out as no differentiator	Scoped out as no differentiator	Scoped out as no differentiator

15.4.2. Operation

Operational impacts are considered to be long term or permanent impacts affecting receptors after the construction phase is complete. It is recognised that many operational impacts are initiated by construction activities, however the full effect of the impact may only manifest itself in the long term.

As for construction impacts, these have been assessed on the basis that good practice measures shall be adopted within the design and construction phases of the Scheme Option, to achieve regulatory approval.

Operational impacts common to all Scheme Options and option-specific impacts are identified in the sections below, summarised in Table 15.17.

The criteria for impact assessment are provided in Section 15.2, with receptor sensitivity provided in Table 15.9.

15.4.2.1. Issues Common to All Options

The Scheme Options shall employ SuDS to regulate flow and meet DMRB water quality objectives, in comparison with the lack of such measures on the A83(T), this is considered an upgrade. The drainage upgrades would meet a higher standard than those temporarily installed as part of the future baseline for the MTS.

Routine Runoff Pollution

Surface water concerns relating to the operational phase are primarily concerned with the discharge of routine runoff into the water environment.

During operation, a broad range of potential pollutants, such as hydrocarbons i.e. fuel and lubricants, fuel additives, metal from corrosion of vehicles, de-icer and gritting material, can accumulate on road surfaces. These can subsequently be washed off the road during rainfall events, polluting the receiving water bodies. Routine runoff from road drainage networks can result in both acute and chronic impacts on water quality and subsequently on the biodiversity of the receiving watercourses, due to both soluble (in particular, dissolved copper and dissolved zinc) and sediment bound pollutants. All discharges are anticipated to be into surface receiving waters, to the Croe Water and Kinglas Water WFD catchments. See Volume 3, Figures 15.2 (a)-(e) for provisional (Stage 2) drainage discharge outfall locations for each option.

However, the option progressed will incorporate appropriate treatment of road runoff via SuDS (designed at Stage 3) to meet DMRB LA 113 standards, with no treatment present

currently, this will represent an improvement in runoff quality into the Croe Water and Kinglas Water catchments. Cumulative outfall assessments will also be undertaken as part of the Stage 3 process, noted in Section 15.6.

As for the construction phase, all Scheme Options have hydrological connection to Beinn an Lochain SSSI, which includes Loch Restil and its outflow channel (Easan Dubh), flowing north.

Hydromorphology

Typical hydromorphological impacts upon receptors for large infrastructure works such as this include potential failure of hydromorphological elements (morphology, quantity and quality and dynamics of flow), loss of watercourse features or damage to existing habitats, replacement of natural bed or/and banks with artificial materials and changes to planform. This is generally as a result of permanent in-channel structures, watercourse realignments (lateral or vertical), additional drainage flows and groundwater disturbance.

The number of watercourses impacted and the type of crossing structure largely dictates the significance of potential effects for hydromorphology at the Operational phase. Consideration of likely Water Framework Directive compliance (via SEPA permits under the Controlled Activities Regulations) has been undertaken at a high level.

Each impact is discussed in the option-specific sections below.

Flood Risk

The drainage design for each mainline and junction network includes at least two levels of treatment, in the form of sustainable drainage systems (SuDS), as standard. The treatment stages typically consist of filter drains and wet/retention or dry/detention ponds. The SuDS have been positioned outwith the mapping extents of SEPA's medium flood risk zones where practicable, the extents of these zones will be subject to further verification in DMRB Stage 3, and contributions to compensatory floodplain storage will be considered where required.

15.4.2.2. Green Option

Routine Runoff Pollution

See Volume 3, Figure 15.2 (b) for outfall locations for the Green Option.

As displayed in Table 15.12, all individual outfalls proposed for the Green Option pass all elements of the routine runoff assessment. HEWRAT datasheet screenshots provided in

Appendix 15.2. Consequently, taking account that this represents an improvement on treatment for an existing road, this is a Slight-Moderate Beneficial effect for receiving waters.

Table 15.12 Routine Runoff Assessment for the Green Option

Drainage Network	Surface Water Receptor (WFD Catchment)	Routine Runoff Result (HEWRAT Stage 2)*	Commentary and Fail Results** (if applicable)
LA0-Outfall 1	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
LA0-Outfall 2	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
LA0-Outfall 3	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
LA0-Outfall 4	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
LA0-Outfall 5	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
LA0-Outfall 6	High Glen Croe tributary (Croe Water WFD Catchment)	Pass	
LA0-Outfall 7	Loch Restil (Kinglas Water WFD Catchment)	Pass	Discharge to standing water
LA0-Outfall 8	Loch Restil (Kinglas Water WFD Catchment)	Pass	Discharge to standing water

*HEWRAT Stage 2 Test Suite - Soluble Copper and Zinc, Sediment and EQS Assessment, excludes SuDS application

**SuDS to be developed at Stage 3 for all networks, all networks anticipated to meet pass standard with SuDS applied

The Green Option includes two outfalls direct to Loch Restil, within Beinn an Lochain SSSI. Discharges of road runoff to standing waterbodies are less desired, given uncertainties relating to flow rate and potential for sediment build-up within the loch. These discharges have been identified as passes in table above, however, the application of SuDS would still be designed at Stage 3. This represents Slight Beneficial potential effects, over current untreated drainage conditions, to this receptor.

The Green Option does not impact on any private water supply receptors.

Hydromorphology

The installed 2.3km length of debris flow shelter and culverts, with interception of upslope channels into catchpits, introduces new physical modifications to the Croe Water WFD catchment. Combining the flow of watercourses (those on the OS 1:50,000 and 1:25,000

map as well as the many other smaller watercourses) at discrete locations to drain under the Green Option has implications on natural processes and morphological features. The watercourses along the Green Option would require, permanent, localised realignment and bed and bank protection at the crossing locations. Flows and sediment supply and transport processes would be adversely affected. There are Moderate/Large Adverse potential effects with this option which would be challenging to fully mitigate. The watercourse receptors, their sensitivity and crossing type are listed in Appendix 15.4.

Flood Risk

The Green Option would not have any potential interaction with any of the building receptors identified and shown in Volume 3, Figure 15.4 due to it being primarily located on the western slope of the valley. The southern viaduct structure would sit on the active 200-year + CC floodplain which has the potential to increase flood risk at the A83(T) and OMR at the southern extent. In addition, watercourse diversions across the Green Option have potential for minor impacts to the lower forestry track, and the viaduct piers in the floodplain have potential for minor impacts to the southern extent of the lower forestry track, as well as Ardgartan Hotel and a visitor centre located near Loch Long. SuDS basins introduced across the valley would be in close vicinity to the floodplain, and immediately adjacent at points. It is likely that along the section of the 2.3km long flow shelter, the 6m wide catchpit would provide additional flow attenuation relative to the baseline conditions. The number of culverted watercourses, designed in adherence to DMRB CD 529, is expected to decrease as watercourses would be realigned at the debris shelter.

The significance of potential effects for the Green Option is considered to be Slight/Moderate Adverse due to the location in the floodplain having an impact on five receptors. However, there is potential for a minor beneficial impact resulting from the flow shelter as the 6m wide catchpit would provide additional flow attenuation and it is expected that impacts will be managed through an on-site Flood Risk Management Plan.

15.4.2.3. Yellow Option

Routine Runoff Pollution

See Volume 3, Figure 15.2 (e) for outfall locations for the Yellow Option.

As displayed in Table 15.13, 10 of the 11 individual outfalls proposed for the Yellow Option pass all elements of the routine runoff assessment with the exception of Outfall 1 (to Loch Restil). However, this outcome does not include Step 3 – Mitigation. HEWRAT datasheet screenshots provided in Appendix 15.2.

The Stage 3 process will seek to achieve pass (with mitigation via SuDS) for all road drainage discharges. Consequently, taking account that this represents an improvement on treatment for an existing road, this is a Slight-Moderate Beneficial potential effect for receiving waters.

The Yellow Option includes one outfall direct to Loch Restil, within Beinn an Lochain SSSI, which is a fail in the table above. The Stage 3 process will seek to achieve pass for this discharge, via application of SuDS. As for the Green Option, discharges of road runoff to standing waterbodies are less desired but would represent Slight Beneficial potential effects, over current untreated conditions.

The improvement to water quality from treatment of road drainage is considered to be Slight Beneficial potential effects to PWS High Glencroe.

Table 15.13 Routine Runoff Assessment for the Yellow Option

Drainage Network	Surface Water Receptor (WFD Catchment)	Routine Runoff Result (HEWRAT Stage 2*)	Commentary and Fail Results** (if applicable)
Yellow 1	Loch Restil (Kinglas Water WFD Catchment)	Fail	Discharge to standing water Fail: Soluble Zinc – Acute Impact Sediment – Chronic Impact
Yellow 2	High Glen Croe tributary (Croe Water WFD Catchment)	Pass	
Yellow 3	High Glen Croe tributary (Croe Water WFD Catchment)	Pass	
Yellow 4	High Glen Croe tributary (Croe Water WFD Catchment)	Pass	
Yellow 5	A83_ML_025_000 (Croe Water WFD Catchment)	Pass	
Yellow 6	A83_ML_023_000 (Croe Water WFD Catchment)	Pass	
Yellow 7	A83_ML_021_000 (Croe Water WFD Catchment)	Pass	
Yellow 8	A83_ML_018_000 (Croe Water WFD Catchment)	Pass	
Yellow 9	A83_ML_017_B01 (Croe Water WFD Catchment)	Pass	
Yellow 10	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	

Drainage Network	Surface Water Receptor (WFD Catchment)	Routine Runoff Result (HEWRAT Stage 2*)	Commentary and Fail Results** (if applicable)
Yellow 11	A83_ML_011_000 (Croe Water WFD Catchment)	Pass	

*HEWRAT Stage 2 Test Suite - Soluble Copper and Zinc, Sediment and EQS Assessment, excludes SuDS application

**SuDS to be developed at Stage 3 for all networks, all networks anticipated to meet pass standard with SuDS applied

Hydromorphology

Operationally, the Yellow Option would have little interaction with the surrounding watercourses during normal flow conditions. During high magnitude rainfall events, the floodplain within which the viaduct stands may become inundated, but the structure would be designed to accommodate this. There would be no in-channel piers. Some minor watercourse diversions or/and bank protection may be required to minimise lateral migration near to the structure, but this would be sensitively designed to ensure sustainable river behaviour and processes are supported. The Yellow Option for hydromorphology operational significance of effects has been assessed as having one watercourse receptor at Moderate Adverse and 14 watercourses having Slight Adverse effects and many of the impacts would be able to be mitigated for. The watercourse receptors, their sensitivity and crossing type are listed in Appendix 15.4.

Flood Risk

Watercourse diversions uphill of two receptors (agricultural and residential) have potential for minor impacts. Additionally, viaduct piers across the Yellow Option may encroach the floodplain when operational, leading to floodplain displacement and consideration would be given to the provision of mitigation in the form of compensatory flood storage. There is potential for impacts where the A83(T) and OMR interact with the floodplain at the southern extent of the Study Area, as well as at the southern extent of the lower forestry track which lies in the floodplain. Additionally, similar to the Green Option, Ardgartan Hotel and a visitor centre both interact with the functional floodplain further southeast, and minor impacts may be expected where the viaduct piers sit in the floodplain. SuDS ponds introduced across the viaduct of the Yellow Option would be in close vicinity to the 200-year + CC floodplain, and immediately adjacent at points. The length of viaduct in the floodplain for the Yellow Option is less than the Green Option however, and the number of new culverts required would be significantly less in comparison with other options.

The Yellow Option would have a Slight/Moderate Adverse significance of effect due to viaducts in the floodplain and diverted watercourses.

15.4.2.4. Brown Option

Routine Runoff Pollution

See Volume 3, Figure 15.2 (a) for outfall locations for the Brown Option.

As displayed in Table 15.14, of the six individual outfalls proposed for the Brown Option, three pass all elements of the routine runoff assessment and three fail the sediment assessment, including Outfall 6 discharging to Loch Restil. However, this outcome does not include Step 3 – Mitigation. HEWRAT datasheet screenshots provided in Appendix 15.2.

The Stage 3 process will seek to achieve pass (with mitigation via SuDS) for all road drainage discharges. Consequently, taking account that this represents an improvement on treatment for an existing road, this is a Slight-Moderate Beneficial potential effect for receiving waters.

Table 15.14 Routine Runoff Assessment for the Brown Option

Drainage Network	Surface Water Receptor (WFD Catchment)	Routine Runoff Result (HEWRAT Stage 2*)	Commentary and Fail Results** (if applicable)
Brown 1	A83_ML_012_000 (Croe Water WFD Catchment)	Fail	Fail: Sediment – Chronic Impact
Brown 2	Croe Water – A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
Brown 3	A83_ML_017_B01 (Croe Water WFD Catchment)	Pass	
Brown 4	A83_ML_026_B01 (Croe Water WFD Catchment)	Fail	Fail: Sediment – Chronic Impact
Brown 5	A83_ML_032_000 (Croe Water WFD Catchment)	Pass	
Brown 6	Loch Restil (Kinglas Water WFD Catchment)	Fail	Discharge to standing water Fail: Sediment – Chronic Impact

*HEWRAT Stage 2 Test Suite – Soluble Copper and Zinc, Sediment and EQS Assessment, excludes SuDS application

**SuDS to be developed at Stage 3 for all networks, all networks anticipated to meet pass standard with SuDS applied

The Brown Option includes one outfall direct to Loch Restil, within Beinn an Lochain SSSI, which is a fail in the table above. The Stage 3 process will seek to achieve pass for this discharge, via application of SuDS. As for the Green and Yellow Options, discharges of road

runoff to standing waterbodies are less desired but would represent a Slight Beneficial potential effect, over current untreated conditions.

The improvement to water quality from treatment of road drainage is a Slight Beneficial potential effect to PWS High Glencroe.

Hydromorphology

Similarly for the Green Option, the installed length of debris flow shelter, with interception of upslope channels into catchpit, introduces new modifications to the Croe Water WFD catchment. The watercourses along the Brown Option would require substantial modification in the form of catchpits, culverts and flow baffles, and would require ongoing maintenance although some of these modifications already exist to some degree at a number of crossings, as discussed in Section 15.3. Flows and sediment supply and transport processes would be altered. There are 12 Moderate/Large Adverse potential effects with the Brown Option which would be challenging to fully mitigate. The watercourse receptors, their sensitivity and crossing type are listed in Appendix 15.4.

Flood Risk

The Brown Option would briefly interact with the functional floodplain, being routed primarily over the existing A83(T) and over the Croe Water floodplain. In total, the Brown Option would cross 24 watercourses: 17 at the debris flow shelter and seven at the tie in roads north and south of the flow shelter. Realignment of watercourses at the debris flow shelter section could lower the number of culvert crossings, and there would be no detrimental effects on the downstream flows, however, two receptors (agricultural and residential) may experience Minor impacts from watercourse diversions. Similar to the Green Option, there is potential for a Minor Beneficial impact resulting from the 1.4km flow shelter as, like the Green Option, the 6m wide catchpit would provide additional flow attenuation.

The significance of potential effects for the Brown Option is considered to be Slight/Moderate Adverse, due to the potential minor impacts on the receptors. This impact is lower than the Green Option though as in this case, the Brown Option would only interact with the functional floodplain at the Croe Water crossing. SuDS features are not expected to encroach the floodplain.

15.4.2.5. Pink Option

Routine Runoff Pollution

See Volume 3, Figure 15.2 (c) for outfall locations for the Pink Option.

As displayed in Table 15.15, of the four individual outfalls proposed for the Pink Option, three pass all elements of the routine runoff assessment and Outfall 3 fails the soluble zinc and sediment assessment. However, this outcome does not include Step 3 – Mitigation. HEWRAT datasheet screenshots provided in Appendix 15.2.

Table 15.15 Routine Runoff Assessment for the Pink Option

Drainage Network	Surface Water Receptor (WFD Catchment)	Routine Runoff Result (HEWRAT Stage 2*)	Commentary and Fail Results** (if applicable)
Pink 1	Easan Dubh, Loch Restil outflow channel (Kinglas Water WFD Catchment)	Pass	
Pink 2	Easan Dubh, Loch Restil outflow channel (Kinglas Water WFD Catchment)	Pass	
Pink 3	A83_ML_008_000 (Croe Water WFD Catchment)	Fail	Fail: Sediment – Chronic Impact Soluble Zinc – Acute Impact
Pink 4	A83_ML_011_000 (Croe Water WFD Catchment)	Pass	

*HEWRAT Stage 2 Test Suite - Soluble Copper and Zinc, Sediment and EQS Assessment, excludes SuDS application

**SuDS to be developed at Stage 3 for all networks, all networks anticipated to meet pass standard with SuDS applied

The Stage 3 process will seek to achieve pass (with mitigation via SuDS) for all road drainage discharges. Consequently, taking account that this represents an improvement on treatment for an existing road, this is a Slight-Moderate Beneficial potential effect for receiving waters.

The Pink Option has no outfalls discharging directly to Loch Restil, within Beinn an Lochain SSSI, but does discharge to the Easan Dubh outflow channel. This is a Moderate Beneficial potential effect to current untreated discharge conditions.

The improvement to water quality from treatment of road drainage is a Slight Beneficial potential effect to PWS High Glencroe. The removal of the Roadmans Cottage and the associated PWS demand at the construction phase removes this as a potential operational receptor.

Hydromorphology

The majority of the Pink Option would be tunnelled and would only directly interact with eight watercourses at the surface, the Croe Water, where a bridge is proposed at the southern end (the parallel (permanent A83(T)) road is tunnelled under the Croe Water, and seven other medium sensitivity watercourse that would have culvert crossings. Some modification would be required to accommodate the catchpits upstream of the culvert crossings (10 in total) and bank and bed protection downstream. Any permanent watercourse realignments required would be relatively short and focused at the southern and northern ends of the Pink Option. Seven watercourse receptors are assessed as having Moderate Adverse potential effects , some of which could be mitigated. The watercourse receptors, their sensitivity and crossing type are listed in Appendix 15.4.

Flood Risk

The Pink Option would only interact with the functional floodplain across the tunnel section, so impacts are expected to be negligible at this point relative to other Scheme Options. The tie in roads and temporary diversion road would cross, in total, 19 watercourses, and newly designed culverts would not be expected to impact downstream flows or the floodplain extent. The total number of culverts impacted by the Pink Option is expected to be lower than that for the Green and Brown Options as the presence of the tunnel would reduce the number of culvert crossings. Impacts on two receptors (agricultural and residential) are considered to be minor due to watercourse diversions at the southern tie in road section, and the Ardgartan Hotel and the visitor centre would not be impacted by operation of the Pink Option. The Pink Option would have negligible impacts on the A83(T), OMR and forestry tracks. Drainage would be brought out of the approximately 3km long tunnel and managed through SuDS measures. SuDS measures would also be introduced at the tie in roads, which would be in close vicinity to the floodplain, and immediately adjacent at points at the northern extent.

The significance of potential effects for the Pink Option is considered to be Slight/Moderate Adverse, only due to the potential for watercourse diversions having minor impacts on the receptors. The impacts associated with the Pink Option are lower than for those with structures interacting with the floodplain, such as the Green, Yellow and Purple Options.

15.4.2.6. Purple Option

Routine Runoff Pollution

See Volume 3, Figure 15.2 (d) for outfall locations for the Purple Option.

As displayed in Table 15.16 of the 10 individual outfalls proposed for the Purple Option, nine pass all elements of the routine runoff assessment with the exception of Outfall 9. However, this outcome does not include Step 3 – Mitigation. HEWRAT datasheet screenshots provided in Appendix 15.2.

Table 15.16 Routine Runoff Assessment for the Purple Option

Drainage Network	Surface Water Receptor (WFD Catchment)	Routine Runoff Result (HEWRAT Stage 2*)	Commentary and Fail Results** (if applicable)
Purple 1	A83_ML_011_000 (Croe Water WFD Catchment)	Pass	
Purple 2	Croe Water - A83_ML_015_000 (Croe Water WFD Catchment)	Pass	
Purple 3	A83_ML_017_B01 (Croe Water WFD Catchment)	Pass	
Purple 4	A83_ML_018_000 (Croe Water WFD Catchment)	Pass	
Purple 5	A83_ML_021_B01 (Croe Water WFD Catchment)	Pass	
Purple 6	A83_ML_024_000 (Croe Water WFD Catchment)	Pass	
Purple 7	A83_ML_026_B01 (Croe Water WFD Catchment)	Pass	
Purple 8	A83_ML_027_000 (Croe Water WFD Catchment)	Pass	
Purple 9	A83_ML_028_000 (Croe Water WFD Catchment)	Fail	Fail: Sediment – Chronic Impact
Purple 10	Easan Dubh, Loch Restil outflow channel (Kinglas Water WFD Catchment)	Pass	2 network outfall locations on same channel, tested on basis of combined discharge to downstream outfall

*HEWRAT Stage 2 Test Suite - Soluble Copper and Zinc, Sediment and EQS Assessment, excludes SuDS application

**SuDS to be developed at Stage 3 for all networks, all networks anticipated to meet pass standard with SuDS applied

The Stage 3 process will seek to achieve pass (with mitigation via SuDS) for all road drainage discharges. Consequently, taking account that this represents an improvement on treatment for an existing road, the significance of effects for receiving waters of discharges have been assessed as Slight-Moderate Beneficial.

The Purple Option has no outfalls discharging directly to Loch Restil, within Beinn an Lochain SSSI but does discharge to Easan Dubh, the outflow channel. This is a Moderate Beneficial potential effect to current untreated discharge conditions.

The improvement to water quality from treatment of road drainage is a Slight Beneficial potential effects to PWS High Glencroe.

Hydromorphology

There are five culvert crossings which would require short diversions, catchpits and channel protection resulting in a Moderate Adverse impact. The Purple Option would have little interaction with the watercourses under the viaduct during normal flow conditions. During high magnitude rainfall events, the floodplain may become inundated, but the structure would be designed to accommodate this. There would be no in-channel piers. Some minor watercourse diversions or/and bank protection may be required to minimise lateral migration near to the structure, but this would be sensitively designed to ensure sustainable river behaviour and processes are supported. Minor Adverse impacts have been assigned for the receptors that are crossed by the viaduct. The watercourse receptors, their sensitivity and crossing type are listed in Appendix 15.4.

Flood Risk

Similar to the other Options, The Purple Option, consisting of a tunnel and viaduct, would have minor impacts on two receptors due to watercourse diversions at the southern tie in road, excluding those which the tunnel would cross. The viaduct section would interact with the functional floodplain for approximately 240m, which could have minor impacts on parts of the A83(T), OMR and lower forestry track which also lie in the floodplain, as well as Ardgartan Hotel and the visitor centre southeast of the Purple Option. Like the Pink Option, drainage would be brought out of the approximately 1.2km long tunnel structure and managed through SuDS measures. New culverts designed along the Purple Option would not impact downstream flows.

The significance of potential effects for the Purple Option is Slight/Moderate Adverse, primarily due to the viaduct section being operational on the functional floodplain.

Table 15.17 Potential Operational Significance of Effects

Operational Effects	Green	Yellow	Brown	Pink	Purple
Routine Runoff Pollution to Surface Watercourses	Pre-SuDS HEWRAT & EQS outcomes for drainage outfalls: 8 Pass, 0 Fail SuDS designed and installed to achieve pass, improving treatment levels of road runoff Croe Water: Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial Croe Water Tributaries: Magnitude - Minor Beneficial Sensitivity – Medium Effect – Slight Beneficial	Pre-SuDS HEWRAT & EQS outcomes for drainage outfalls: 10 Pass, 1 Fail SuDS designed and installed to achieve pass, improving treatment levels of road runoff Croe Water: Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial Croe Water Tributaries: Magnitude - Moderate Beneficial Sensitivity – Medium Effect – Moderate Beneficial Kinglas Water Tributaries: Magnitude - Minor Beneficial	Pre-SuDS HEWRAT & EQS outcomes for drainage outfalls: 3 Pass, 3 Fail SuDS designed and installed to achieve pass, improving treatment levels of road runoff Croe Water: Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial Croe Water Tributaries: Magnitude - Moderate Beneficial Sensitivity – Medium Effect – Moderate Beneficial Kinglas Water Tributaries: Magnitude - Minor Beneficial	Pre-SuDS HEWRAT & EQS outcomes for drainage outfalls: 3 Pass, 1 Fail SuDS designed and installed to achieve pass, improving treatment levels of road runoff Croe Water: Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial Croe Water Tributaries: Magnitude - Major Beneficial Sensitivity – Medium Effect – Moderate Beneficial Kinglas Water Tributaries: Magnitude - Minor Beneficial Sensitivity – Medium Effect – Slight Beneficial	Pre-SuDS HEWRAT & EQS outcomes for drainage outfalls: 9 Pass, 1 Fail SuDS designed and installed to achieve pass, improving treatment levels of road runoff Croe Water: Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial Croe Water Tributaries: Magnitude - Moderate Beneficial Sensitivity – Medium Effect – Moderate Beneficial Kinglas Water Tributaries: Magnitude - Minor Beneficial Sensitivity – Medium Effect – Slight Beneficial

Operational Effects	Green	Yellow	Brown	Pink	Purple
	Kinglas Water Tributaries: Magnitude - Minor Beneficial Sensitivity – Medium Effect – Slight Beneficial	Sensitivity – Medium Effect – Slight Beneficial	Sensitivity – Medium Effect – Slight Beneficial		
Routine Runoff Pollution to Loch Restil, within Beinn an Lochain SSSI	Improvement to treatment levels of road runoff treatment discharging via SuDS to Loch Restil Two permanent road drainage outfalls constructed on banks of Loch Restil Magnitude – Minor Beneficial Sensitivity – High Effect – Slight Beneficial	Improvement to treatment levels of road runoff treatment discharging via SuDS to Loch Restil One permanent road drainage outfall constructed on banks of Loch Restil Magnitude – Minor Beneficial Sensitivity – High Effect – Slight Beneficial	Improvement to treatment levels of road runoff treatment discharging via SuDS to Loch Restil One permanent road drainage outfall constructed on banks of Loch Restil Magnitude – Minor Beneficial Sensitivity – High Effect – Slight Beneficial	Reduced traffic and associated contaminant load on routes with untreated road runoff discharging to Loch Restil No discharge to Loch Restil, with SuDS treatment to new discharges into northern outflow channel (Easan Dubh) Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial	Reduced traffic and associated contaminant load on routes with untreated road runoff discharging to Loch Restil, within Beinn an Lochain SSSI Reduced traffic and associated contaminant load on routes with untreated road runoff discharging to Loch Restil No discharge to Loch Restil, with SuDS treatment to new discharges into northern outflow channel (Easan Dubh) Magnitude – Moderate Beneficial Sensitivity – High Effect – Moderate Beneficial
Routine Runoff Pollution to PWS High Glencroe	PWS High Glencroe (Type B) is not in same catchment Magnitude – No Change	PWS High Glencroe (Type B) is located downslope and within 100m of viaduct construction area	PWS High Glencroe (Type B) is located downslope and within 300m of debris flow shelter construction area	PWS High Glencroe (Type B) unlikely to be adversely influenced by tunnel upslope (if surface supply) Magnitude – Negligible	PWS High Glencroe (Type B) is located downslope and within 100m of viaduct construction area Magnitude – Minor Beneficial

Operational Effects	Green	Yellow	Brown	Pink	Purple
	Sensitivity – Medium Effect – Neutral	Magnitude – Minor Beneficial Sensitivity – Medium Effect – Slight Beneficial	Magnitude – Minor Beneficial Sensitivity – Medium Effect – Slight Beneficial	Sensitivity – Medium Effect – Neutral	Sensitivity – Medium Effect – Slight Beneficial
Routine Runoff Pollution to PWS Roadmans Cottage	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral	Roadmans Cottage and associated PWS shall be removed during construction, thus no potential impact during operation N/A	PWS Roadmans Cottage (Type B) is not in same catchment as option Magnitude – No Change Sensitivity – Medium Effect – Neutral
Hydromorphology	Debris flow shelter sections and associated culverts will require substantial watercourse modification. Croe Water Sensitivity –High Magnitude – Minor Effect – Slight/Moderate Adverse All other watercourses Sensitivity – Medium	No in-channel viaduct piers and only one culvert crossing required. Croe Water Sensitivity –High Magnitude – Minor Effect – Slight/Moderate Adverse All other watercourses Sensitivity – Medium Magnitude: 1 Moderate 14 Minor	Debris flow shelter sections and associated culverts will require substantial watercourse modification. Croe Water Sensitivity –High Magnitude – Minor Effect – Slight/Moderate Adverse All other watercourses Sensitivity – Medium Magnitude:	Over two-thirds (20/28) of watercourses crossed below ground through tunnel so no direct impact at surface. Ten culvert crossings which would require catchpits and bed/bank protection, potential realignment(s). Croe Water Sensitivity –High Magnitude – Minor Effect – Slight/Moderate Adverse All other watercourses	No in-channel viaduct piers required and five culvert crossings which would require catchpits and bed/bank protection, potential realignment(s). Croe Water Sensitivity –High Magnitude – Minor Effect – Slight/Moderate Adverse All other watercourses Sensitivity – Medium Magnitude:

Operational Effects	Green	Yellow	Brown	Pink	Purple
	Magnitude: 5 Major 2 Moderate 1 Minor Effect: 5 Moderate/Large Adverse 2 Moderate Adverse - 1 Slight Adverse	Effect: 1 Moderate Adverse 14 Slight Adverse	12 Major 4 Moderate Effect: 12 Moderate/Large Adverse 4 Moderate Adverse	Sensitivity – Medium Magnitude: 7 Moderate 20 Negligible Effect: 7 Moderate Adverse 20 Neutral/Slight Adverse	5 Moderate 14 Minor Effect: 5 Moderate Adverse 14 Slight Adverse
Flood Risk: Residential Dwellings, Hotels, Caravan Park & Agriculture Uses	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Two receptors in Glen Croe valley not considered to be impacted by Green Option. Two receptors downstream lie in floodplain and may be impacted by viaduct operation in floodplain. Sensitivity – High Magnitude: 2 Minor (Ardgartan Hotel & cabin/visitor centre) Effect:	Seven identified flood risk receptors (Volume 3, 15.4) scoped out as no differential between options. Impacts on remaining receptors considered to be minor due to watercourse diversions and floodplain interaction. Sensitivity – High Magnitude: 2 Minor (Ardgartan Hotel & cabin/visitor centre) Effect: 2 Slight/Moderate Adverse (Ardgartan Hotel & cabin/visitor centre) Sensitivity – Medium	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on receptors in Glen Croe valley considered to be minor due to watercourse diversions. Impacts on downstream receptors considered negligible. Sensitivity – High Magnitude: 2 Negligible (Ardgartan Hotel & cabin/visitor centre) Effect: 2 Slight Adverse (Ardgartan Hotel & cabin/visitor centre)	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on receptors in Glen Croe valley considered to be minor due to watercourse diversions. Impacts on downstream receptors considered negligible. Sensitivity – High Magnitude: 2 Negligible (Ardgartan Hotel & cabin/visitor centre) Effect: 2 Slight Adverse (Ardgartan Hotel & cabin/visitor centre) Sensitivity – Medium None	Seven identified flood risk receptors (Volume 3, Figure 15.4) scoped out as no differential between options. Impacts on remaining receptors considered to be minor due to watercourse diversions and floodplain interaction. Sensitivity – High Magnitude: 2 Minor (Ardgartan Hotel & cabin/visitor centre) Effect: 2 Slight/Moderate Adverse (Ardgartan Hotel & cabin/visitor centre) Sensitivity – Medium None

Operational Effects	Green	Yellow	Brown	Pink	Purple
	2 Slight/Moderate Adverse (Ardgartan Hotel & cabin/visitor centre) Sensitivity – Medium None	None	Sensitivity – Medium None		
Flood Risk: A83(T) & OMR	Potential for the southern viaduct structure to encroach on the floodplain, therefore increasing flood risk upstream to the A83(T) and OMR. Sensitivity – High Magnitude: 1 Minor (*A83(T)*) Effect: 1 Slight/Moderate Adverse (*A83(T)*) Sensitivity – Medium Magnitude: 1 Minor (*OMR*) Effect: 1 Slight Adverse (*OMR*)	Viaduct piers located in the functional floodplain leading to flood plain displacement. Potential for impacts downstream where the A83(T) and OMR interacts with the floodplain. Sensitivity – High Magnitude: 1 Minor (*A83(T)*) Effect: 1 Slight/Moderate Adverse (*A83(T)*) Sensitivity – Medium Magnitude: 1 Minor (*OMR*) Effect: 1 Slight Adverse (*OMR*)	Southern extent operational on functional floodplain. Catchpits at the debris flow shelters offer opportunity for improved attenuation and reduction in number of culverted watercourses. Sensitivity – High Magnitude: 1 Negligible (*A83(T)*) Effect: 1 Slight Adverse (*A83(T)*) Sensitivity – Medium Magnitude: 1 Negligible (*OMR*) Effect: 1 Neutral/Slight Adverse (*OMR*)	Only tunnel interaction with the functional floodplain and watercourse crossings/anticipated flow volumes to be managed by culverts designed in accordance with DMRB LA 113. Sensitivity – High Magnitude: 1 Negligible (*A83(T)*) Effect: 1 Slight Adverse (*A83(T)*) Sensitivity – Medium Magnitude: 1 Negligible (*OMR*) Effect: 1 Neutral/Slight Adverse (*OMR*)	Viaduct piers located in the functional floodplain leading to flood plain displacement. Potential for impacts downstream where the A83(T) and OMR interacts with the flood plain. Sensitivity – High Magnitude: 1 Minor (*A83(T)*) Effect: 1 Slight/Moderate Adverse (*A83(T)*) Sensitivity – Medium Magnitude: 1 Minor (*OMR*) Effect: 1 Slight Adverse (*OMR)*

Operational Effects	Green	Yellow	Brown	Pink	Purple
Flood Risk: Lower & Upper forestry track, B828	Watercourse diversions at upper & lower forestry track and B828 (northern tie in road) may have potential impacts. Viaduct piers in floodplain may impact southern extent of lower forestry track. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track) Effect: 1 Slight Adverse (Lower forestry track)	Viaduct piers in floodplain may impact southern extent of lower forestry track. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track) Effect: 1 Slight Adverse (Lower forestry track)	Southern road in floodplain may impact southern extent of lower forestry track. Sensitivity – Medium Magnitude: 1 Negligible (Lower forestry track) Effect: 1 Neutral/Slight Adverse (*Lower forestry track*)	Impacts to listed receptor considered **negligible**. Sensitivity – Medium Magnitude: 1 Negligible (Lower forestry track) Effect: 1 Neutral/Slight Adverse (*Lower forestry track*)	Viaduct piers in floodplain may impact southern extent of lower forestry track. Sensitivity – Medium Magnitude: 1 Minor (Lower forestry track) Effect: 1 Slight Adverse (Lower forestry track)
Flood Risk: Underground Utility Cables	Scoped out as no differentiator	Scoped out as no differentiator	Scoped out as no differentiator	Scoped out as no differentiator	Scoped out as no differentiator

15.5. Potential Mitigation

Section 15.4 includes the expectation that the design, construction and operation of the Scheme Options shall follow good practice in terms of environmental management, including DMRB LA 113, SEPA Guidance and CIRIA Guidance – which would be required to gain regulatory approval in order to commence the works.

This section considers further measures that can aid reduction in the likelihood or severity of these potential impacts being realised, beyond standard practice.

15.5.1. Construction

15.5.1.1. Construction Pollution

During construction in areas draining to Loch Restil, additional measures shall be employed to collect and treat sediment-laden runoff to reduce sediment loading to this high importance/sensitivity feature of the Beinn an Lochain SSSI.

Specific measures for this location would be established at Stage 3 and subsequent design stages, with these likely to include:

- pre-construction establishment of surface and sub-surface drainage channels and surface flowpaths where construction is planned in the Loch Restil catchment area (including the Rest and Be Thankful Car Park);
- installation of temporary barriers to reduce direct flow to Loch Restil from construction zone runoff during or following prolonged or intense rainfall events;
- installing sufficiently-sized runoff containment and sediment treatment measures, such as settlement lagoons in combination with filter strips, including consideration of contingency measures during peak flow events;
- capability to prevent discharge into Loch Restil, if required; and
- monitoring performance of measures at discharge location(s), to optimise sediment removal.

Although the above would be primarily designed to contain and manage sediment before entry to Loch Restil, it would also provide containment to less likely hydrocarbon or chemical spillages, enabling removal from the temporary drainage network.

These measures will provide additional protection during construction of all options, including the northern tunnel portals and associated ‘cut and cover’ sections of the Pink and Purple Options and the works at the southern end of Loch Restil for the Green, Yellow and Brown Options. These measures will reduce the magnitude for construction pollution impact to the Kinglas Water tributaries and to Beinn an Lochain SSSI (Loch Restil) to

Minor Adverse, with an associated reduction to the residual significance of effect to Slight Adverse.

The southern portal zones for both Pink and Purple Options are located on longer cross-slopes, with less space for settlement ponds (without extensive earthworks) and, accordingly, likely reduced efficacy of the above measures to provide demonstrable benefit. Alternative proprietary sediment removal solutions could be employed, within portable units and potentially operated in series to optimise sediment removal. The adoption of these measures will be of benefit during construction of these options, but insufficient to reduce the residual impact outcomes for the Croe Water tributaries during construction at each of the southern portal zones. Similarly, although the above measures will also be of benefit for construction of the debris flow shelters for the Green and Brown Options in relation to Croe Water and Croe Water tributaries, the associated residual impacts are not considered to be reduced.

The construction of the viaduct for the Yellow and Purple Options could also benefit from the above measures, plus access to relatively level ground on the Glen Croe floodplain. However, such areas may be sensitive to flood inundation and wash-out, therefore the residual impact outcomes are also unchanged for the Croe Water and Croe Water tributaries.

15.5.1.2. Private Water Supplies and Abstractions

The properties of High Glencroe and Roadmans Cottage are likely to be adversely affected by construction in the vicinity and upslope of their private water supply sources, dependent upon the option selected for progression at Stage 3.

These supplies will be further investigated at Stage 3, with potential for temporary or permanent replacement supplies, subject to owner-occupier discussions, should the Stage 2 outcome (Preferred Option selection) and ongoing design and investigation tasks determine this is necessary.

These mitigation measures will reduce the residual magnitude and significance of impact for private water supplies.

15.5.1.3. Hydromorphology

The design process would seek to minimise works to watercourses and specific mitigation will be identified in more detail during Stage 3 but may include:

- Sensitive design and sequencing of temporary watercourse diversions; and

- Consideration of sediment supply/transfer and erosion via a maintenance and adaptive management plan during construction.

15.5.1.4. Flood Risk

Potential mitigation measured are discussed in this section in accordance with guidance outlined in DMRB LA 113.

A sequential approach to the development of the Scheme Options was followed, with the aim of avoiding potential impacts on the water environment where possible. It is not possible to avoid all potential impacts given the nature of the development and the Study Area. In these cases, the design aims to reduce the impact, for example, through minimising encroachment on the floodplain. Mitigation is proposed where predicted effects remain. The sequential approach will continue to be applied through design development at DMRB Stage 3.

The guiding principle with regards to flood risk mitigation is that the need for it should be avoided in the first instance. Section 3.67 to 3.68.2 of DMRB LA 113 states that the flood impacts in the relevant catchment area should be assessed and that effective mitigation should be incorporated into the design. Listed mitigation measures include, but are not limited to, the following:

- Flood relief culverts;
- Replacement flood storage areas; and
- Flood protection embankments, levees or berms.

Across all Scheme Options, the first endeavour will be to avoid the floodplain through construction of the Proposed Scheme. It is, however, acknowledged that the need for mitigation measures could be required in instances where SuDS features are designed too close to the 200-year + CC floodplain as they would need to be moved away to a safer location. If any of these SuDS features do require mitigation measures to be taken, further assessment will be carried out at Stage 3.

15.5.2. Operation

15.5.2.1. Hydromorphology

The design for bridges, culverts, watercourse diversions and drainage outfalls will be developed in light of both generic good practice embedded in the design and location-specific measures to be identified during DMRB Stage 3. Information derived from the hydromorphology assessment will input into the design and maintenance requirements of

structures interacting with the water environment (e.g., sediment management), with guidance from SEPA.

15.6. Conclusions

Table 15.18 provides residual impact values for each Scheme Option, taking into account any identified mitigation measures from Section 15.5, beyond those considered good design and construction procedures incorporated into the Section 15.4 (Potential Impacts) outcomes (Table 15.11 and Table 15.17).

As the Road Drainage and Water Environment team includes a number of specialist disciplines, each specialism has independently evaluated residual risk values for the various options.

The Pink Option has least adverse construction effect in terms of water quality, with the lengthy ‘drill and blast’ tunnel section requiring less interaction and disruption to watercourse channels and adjacent working zones. The Green and Brown Options both involve the construction of debris flow shelters, with associated challenges anticipated in preventing sediment transport into adjacent channels from extensive cross-slopes during installation. However, the Brown Option has a baseline of catchpits and altered channel morphology for existing A83(T) slope management and watercourse crossings and, with less further modification necessary than for construction of the Green Option. For the operational phase, all options offer beneficial effects to receptors from the introduction of road runoff treatment within a SuDS treatment train. The Pink and Purple Options are considered more favourable, as both avoid any routine runoff discharging into Loch Restil within the Beinn an Lochain SSSI, which would represent a significant (moderate beneficial) residual impact to Loch Restil water quality, in comparison to the untreated drainage from the existing road network.

The construction is complex for all Scheme Options in terms of hydromorphology and significance of effect on the watercourses to a similar degree (Slight / Moderate Adverse). The Pink Option displays the least direct interaction with watercourses so would be most favoured, followed by the Yellow Option. For Operation, the Yellow Option is most favourable (with the assumption of no in-channel piers), with the Pink Option second and Purple Option third (all Slight Adverse) The Green and Brown options would require substantial physical modification to watercourses and result in a Moderate Adverse residual effect, these are not recommended from a hydromorphology perspective.

The Brown and Pink Options have the least construction activities planned on floodplain, with the Brown Option considered to be of lower residual effect. A key differential in relation to flood risk impacts are that the Yellow and Purple Options (and to a lesser

extent, the Green Option) require the installation of pier supports into the Glen Croe (Croe Water) floodplain, with an associated impact during construction phase but principally causing impact during the operational phase and which may require compensatory storage to avoid reducing the capacity of the floodplain. Therefore, the most favourable in terms of flood risk is the Brown Option, as it is expected that the debris flow shelter may allow for flows to be attenuated in addition to having the lowest residual effects.

Table 15.18 Road Drainage and the Water Environment Comparative Appraisal

Sub-topic	Receptor	Potential Effect	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
Construction Phase								
Construction Pollution	Surface Water	Water quality: Croe Water	Moderate Adverse	Moderate Adverse	Slight Adverse	Slight Adverse	Moderate Adverse	Pink Option has least interaction with surface water channels and adjacent zones The Brown Option has pre-existing catchpit structures
		Water quality: Croe Water tributaries	Moderate Adverse	Moderate Adverse	Slight Adverse	Moderate Adverse	Moderate Adverse	
		Water quality: Kinglas Water tribuaries	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	
Construction Pollution	Beinn an Lochain SSSI	Water quality: Loch Restil	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Less construction runoff to Loch Restil from Green, Yellow and Brown Options
	PWS and Abstractions	Water quality (or interruption) to PWS High Glencroe (Type B)	Neutral	Slight Adverse	Slight Adverse	Negligible	Slight Adverse	Green Option has no impact, with Pink Option negligible
		Water quality (or interruption) to PWS Roadmans Cottage (Type B)	Neutral	Neutral	Neutral	N/A	Neutral	Roadmans Cottage and associated PWS demand removed for Pink Option

Sub-topic	Receptor	Potential Effect	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
Hydromorph-ology	Croe & Kinglas Water and their tributaries	Adverse effects to sediment transport and channel morphology	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	All Scheme Options will be complex to construct. The Pink Option has the least interaction with the surface water environment
Flood risk	Residential Dwellings, Hotels, Caravan Park & Agriculture Uses	Increased flood risk due to floodplain loss resulting from construction works taking place on the floodplain and diversion of watercourses	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	No differential between seven identified receptors, lowest potential effect on remaining receptors for Brown and Pink Options as minimal construction works on floodplain
Flood risk	A83(T) & OMR	Increased flood risk due to floodplain loss resulting from construction works taking place on the floodplain and diversion of watercourses	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight / Moderate Adverse	Construction works on floodplain for Purple and Yellow have the greatest significance of effect for flood risk on the OMR and may require temporary compensatory flood storage
Flood risk	Lower & Upper forestry tracks and B828	Increased flood risk due to floodplain loss resulting from construction	Slight Adverse	Slight Adverse	Neutral / Slight Adverse	Neutral / Slight Adverse	Slight Adverse	Green viaduct construction works and watercourse diversions to have largest potential effect on forestry tracks

Sub-topic	Receptor	Potential Effect	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
		works taking place on the floodplain and diversion of watercourses						
Flood risk	BT Underground Lines	Increased flood risk due to floodplain loss resulting from construction works taking place on the floodplain	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	No differential
Operational Phase								
Routine Runoff Pollution	Surface Water	Water quality: Croe Water	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	No differential
		Water quality: Croe Water tributaries	Neutral	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Green Option has less benefit to tributary channels, as no prior untreated outfalls
		Water quality: Kinglas Water tributaries	Slight Beneficial	Slight Beneficial	Slight Beneficial	Slight Beneficial	Slight Beneficial	Pink and Purple Options avoid discharge to Loch Restil
Routine Runoff Pollution	Beinn an Lochain SSSI	Water quality: Loch Restil	Slight Beneficial	Slight Beneficial	Slight Beneficial	Moderate Beneficial	Moderate Beneficial	Pink and Purple Options avoid discharge to Loch Restil
	PWS & Abstractions	Water quality (or interruption) to Private Water	Neutral	Slight Beneficial	Slight Beneficial	Negligible	Slight Beneficial	Yellow, Brown and Purple Options have greater beneficial impact

Sub-topic	Receptor	Potential Effect	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
		Supply serving High Glencroe						
		Water quality (or interruption) to Private Water Supply serving Roadmans Cottage	Neutral	Neutral	Neutral	N/A	Neutral	No differential, with Pink Option removing this receptor
Hydromorph-ology	Croe Water, Kinglas Water and their tributaries	Adverse effects to sediment transport and channel morphology	Moderate Adverse	Slight Adverse	Moderate Adverse	Slight Adverse	Slight Adverse	The Yellow Option is most favourable having only one receptor of residual Slight Adverse and the others Neutral/Slight Adverse. The Green and Brown Options will require greater watercourse modification
Flood risk	Residential Dwellings, Hotels, Caravan Park & Agriculture Uses	Increased flood risk due to structure location and proposed SuDS features within/in the immediate vicinity of the 200-year + CC flood extents	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight Adverse	Slight Adverse	Slight / Moderate Adverse	Viaduct operation on floodplains for Green, Yellow and Purple Options would have largest impact on receptors
Flood risk	A83(T) & OMR	Increased flood risk due to structure location and	Slight / Moderate Adverse	Slight / Moderate Adverse	Slight Adverse	Slight Adverse	Slight / Moderate Adverse	Brown and Pink Options do not encroach on the 200-year + CC

Sub-topic	Receptor	Potential Effect	Effect Significance (Residual Effects)					Comparative Appraisal
			Green	Yellow	Brown	Pink	Purple	
		proposed SuDS features within/in the immediate vicinity of the 200-year + CC flood extents						floodplain and no adverse impacts are expected from SuDS features
Flood risk	Lower & Upper forestry tracks and B828	Increased flood risk due to structure location and proposed SuDS features within/in the immediate vicinity of the 200-year + CC flood extents	Slight Adverse	Slight Adverse	Neutral / Slight Adverse	Neutral / Slight Adverse	Slight Adverse	Viaduct piers for Green Option may impact on floodplain adjacent to lower forestry track. Purple and Yellow viaduct piers would potentially impact the same area of the lower forestry track
Flood risk	BT Underground Lines	Increased flood risk due to placement of viaduct piers and proposed SuDS features within/in the immediate vicinity of the 200-year + CC flood extents	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	No differential.

15.7. Scope of DMRB Stage 3 Assessment

For DMRB Stage 3 (following selection of a Preferred Option), a review of the hydrology and flood risk management strategy will be undertaken in liaison with project design teams, SEPA, Argyll and Bute Council, Transport Scotland and other stakeholders to ensure that the most appropriate approaches are followed, including consideration of site-specific features and local constraints.

Additional baseline information shall be collated to supplement the data available at DMRB Stage 2.

Cumulative and indirect impacts will be considered at DMRB Stage 3, as further data is collated for the Preferred Option.

Specific mitigation measures applicable to the potential impacts shall be identified and established as technically feasible following final design of the Preferred Option and reported in the DMRB Stage 3 Assessment. These measures would reduce potential impacts upon water quality, hydromorphology, flood risk and water supply receptors. DMRB Stage 3 technical items specific for identified impacts are outlined in the sections below.

15.7.1. Construction Pollution

Abstractions and discharges registered within the SEPA CAR and waste management licencing system shall be investigated to identify source-pathway-receptor linkages.

Water quality monitoring plans shall be prepared in Stage 3 for local watercourses and standing waters, including control locations upstream of the Proposed Scheme and on separate catchments, with monitoring to commence pre-construction to gain an understanding of natural seasonal variations. Water quality monitoring locations shall be co-located with aquatic monitoring locations, where feasible. Locations, frequency of sampling and parameters tested shall be agreed in advance with stakeholders, including SEPA and the Argyll District Salmon Fishery Board.

15.7.2. Loss or Change to Water Supplies

There are a small number of properties with registered private water supply status within the Study Area, plus a drinking water abstraction for Ardgartan Hotel. Surveys shall be conducted at DMRB Stage 3 to confirm supply details, usage pattern and linkages with the Proposed Scheme. Water supplies will also be assessed for potential impact upon water quality, yield and flow rates from construction or operation of the Preferred Option at DMRB Stage 3.

Appropriate mitigation measures, including a potential water quality monitoring programme for specific private water supplies, abstractions and surface watercourses considered at risk of adverse effect from the Proposed Scheme, shall be developed during Stage 3, to commence pre-construction.

Scottish Water assets shall be confirmed for the Preferred Option at Stage 3, including dialogue with Scottish Water and BEAR Scotland to establish potential assets along the existing A83(T) corridor.

15.7.3. Pollution from Routine Runoff

Site-specific data for routine runoff for the Preferred Option will enable refined surface water quality calculations to be undertaken, following DMRB methodologies. As more data is gathered for the Preferred Option in DMRB Stage 3 the calculations will be updated, and suitable mitigation measures or alternative discharge locations will be identified to meet the treatment requirement for all drainage networks. It is assumed that at least one level of treatment will be applied for all drainage networks.

Cumulative assessments, in addition to individual outfall assessments, shall be undertaken as part of the Stage 3 process.

Side roads shall be individually assessed following the Simple Index Approach detailed in the CIRIA SuDS Manual[300] and SEPA Regulatory Method (WAT-RM-08) Sustainable Urban Drainage Systems[301], to ensure discharges meet good practice requirements.

Should particularly sensitive habitats or species, such as freshwater pearl mussels, be identified within 1km downstream of planned discharge outfalls, as per DMRB LA 113 Method A assessment guidance, water quality discharge modelling may be necessary in order to confirm potential downstream effect. This may lead to a revised outfall location or additional design measures to reduce effect prior to discharge.

Ongoing inputs for water quality and flood risk requirements shall be provided as part of the iterative drainage design process during DMRB Stage 3.

[300] CIRIA SuDS Manual C753 (2015).
[301] SEPA Regulatory Method (WAT-RM-08) Sustainable Urban Drainage Systems, Version 6.4, (2019). Available at: https://www.sepa.org.uk/media/219048/wat-rm-08-regulation-of-sustainable-urban-drainage-systems-suds.pdf [Accessed 23 March 2023].

15.7.4. Pollution from Accidental Spillage

At DMRB Stage 3, the development of the drainage network data and traffic data will enable the risk of accidental spillage to be prepared for surface water drainage networks.

15.7.5. Alteration to Hydromorphological Regime

A more detailed assessment of the hydromorphological impacts shall be undertaken at DMRB Stage 3 once the Preferred Option has been selected and the precise nature of the engineering works ascertained. This shall improve the understanding of sensitivities and magnitude of the proposed works. Potential mitigation can then be included in the Preferred Option design for each potential crossing and realignment. Following this, the residual impacts would be identified.

Direct and indirect impacts will also be considered with regards to the cumulative impacts relating to the wider WFD objectives in the vicinity of the Proposed Scheme, with a preliminary WFD compliance evaluation undertaken in conjunction with SEPA.

Opportunities to improve local hydromorphology (and the wider water environment) shall also be considered at DMRB Stage 3 where feasible and, with clear benefit, i.e. removal of existing channel impediments or poorly performing structures, hillside planting, wetland creation for example.

15.7.6. Flood Risk

The Stage 2 assessment has confirmed that the Proposed Scheme would potentially impact floodplains across the route; and mitigation measures would be required to mitigate the flood risk in accordance with NPF4.

The DMRB Stage 3 assessment will develop mitigation measures and strategies in line with DMRB LA 113. It compares the pre and post development scenarios, based on a Preferred Option. The following key tasks and considerations will be undertaken as part of the Stage 3 assessment:

- Baseline hydraulic capacity determined for all structures, including bridges and culverts;
- The baseline models will be refined to include additional topographical survey information and culvert surveys;
- Verification of the flood model extents compared with local flood history based on information from Argyll and Bute Council and SEPA;
- Detailed consideration will be given to the possible mitigation measures and consultation will be undertaken with the roads and structures design teams;

- Flood Compensatory Storage will be sought for all locations where there is floodplain loss;
- Suitable locations for storage will be identified, as close to the source of loss as possible, providing and maintaining connectivity of the floodplains and will seek to achieve level for level storage, where possible;
- Additional topographical survey may be obtained to improve the accuracy of modelling assessments of flood storage loss and mitigation;
- It may be that a combination of storage options and other flood defence measures are considered to mitigate any impacts to third party receptors;
- Sensitivity testing will be undertaken to assess the impact of the scheme on downstream receptors;
- The flood risk impacts related to blockage of the proposed new or replacement watercourse crossing structures will be assessed;
- All culvert crossings will be designed in accordance with DMRB CD 529 by either incorporating them into the hydraulic models or developing standalone models;
- Estimation of peak design flows for a range of return periods using standard FEH methodologies. Local gauged data will be used where applicable. An analysis will be undertaken to determine whether ReFH2 is suitable for use within the Study Area and consultation carried out with SEPA to agree on the proposed approach to high flows estimation;
- The design flow estimates will be used to inform the design of bridges, culverts and channel realignments and to aid the assessment of impacts on hydrology and flood risk; and
- A qualitative assessment will also be made of potential impacts on catchment hydrology which could lead to effects on flood risk.

The flood risk assessment will include the following:

- Hydraulic modelling of sensitive watercourses to provide a quantitative assessment of existing flood extents and levels, and the predicted change in flood risk to sensitive receptors for the Preferred Option;
- Mitigation design to achieve no increase in flood risk at sensitive receptors where possible, including the use of flood relief culverts and compensatory storage; and
- Assessment of flood risk from all sources including fluvial, surface water, groundwater and infrastructure failure.

The works would not affect sensitive downstream flood receptors (especially if structure sizes are increased thus inadvertently increasing peak flows passing downstream). The

design will be integrated with the ecological, geomorphological, and drainage requirements. It will also consider the long-term maintenance and access requirements.

Consultation will be undertaken with the key stakeholders to ensure their concerns are taken into consideration and incorporated into the design approach.