A83 Rest and Be Thankful

DMRB STAGE 3 SCHEME ASSESSMENT REPORT - VOLUME 1 PART 1 - ENGINEERING

Transport Scotland

09/12/24

A83AAB-AWJ-GEN-LTS_GEN-RP-ZZ-000006

Notice

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1. Project Background

1.1. Introduction

1.1.1. The A83 Trunk Road is one of two east-west strategic trunk roads that connects Argyll and Bute to the central belt of Scotland, making it a vital link in the region's transportation infrastructure. The A83 is a 98 mile (158km) predominantly single carriageway road originating in Tarbet, where the A82 and A83 meets at the junction on the western side of Loch Lomond. It then terminates in Campbeltown, near the southern tip of the Kintyre Peninsula.

1.1.2. The section of the A83 through Glen Croe, between Ardgartan and the Rest and Be Thankful viewpoint at the junction between the A83 and B828 Glenmore local road includes the highest point along the A83 at approximately 265m above ordnance datum. This section passes along the west facing slopes of Beinn Luibhean which have been increasingly affected by debris flow and landslide events impacting the existing A83 route, leading to frequent road closures and diversions.

1.1.1. During landslide events, or when there is a risk of landslide events, which close the A83 through Glen Croe, the Old Military Road (OMR) is used as a diversion route featuring convoy controlled single lane traffic for much of its length. When a landslide, or risk of landslide, results in the closure of both the A83 and the OMR, traffic is diverted via a much longer diversion to the north using the A82, A85 and A819. Travelling from Tarbet to Inveraray, this adds around 26 miles onto a 23-mile journey and can take approximately 60 to 70 minutes, which is approximately 25 to 35 minutes longer than when the A83 is fully open to traffic. For journeys between Cairndow and Tarbet it adds 46 miles onto a 13-mile journey and can take approximately 80 minutes, which is approximately 60 minutes longer than when the A83 is fully open to traffic.

1.1.3. The A83 Rest and Be Thankful scheme (Proposed Scheme) location as it passes through Glen Croe is shown in **Figure 1-1**, below.

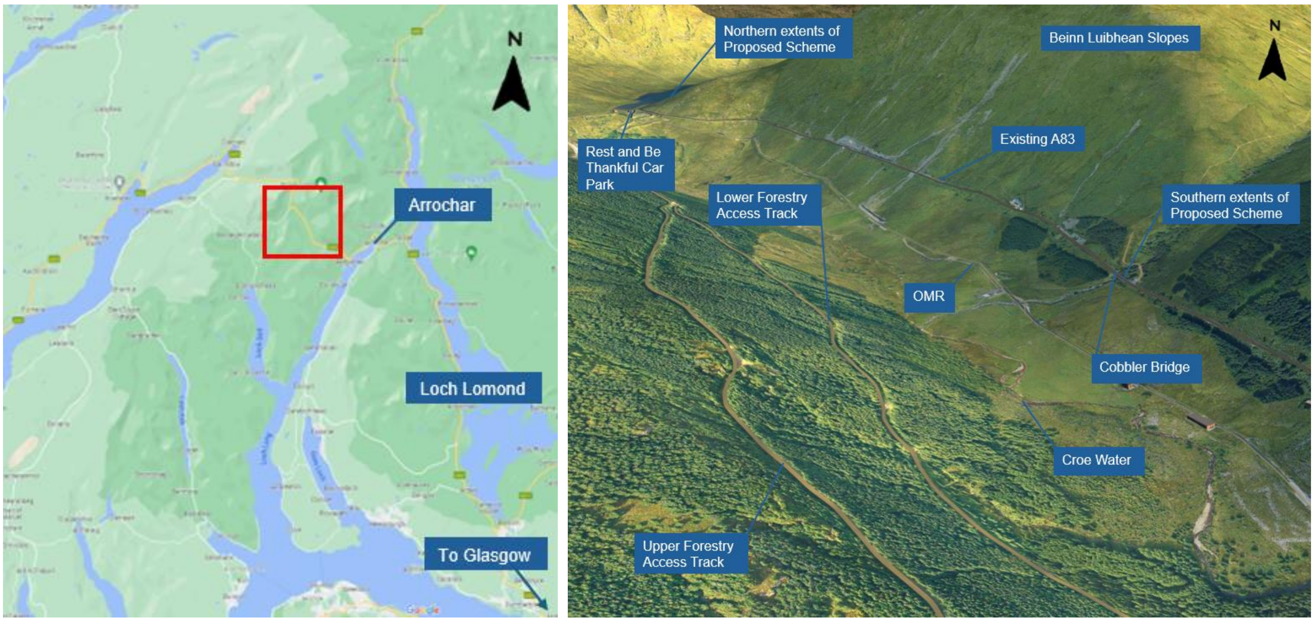

Figure 1-1 – Map of Argyll and Bute showing the A83 Rest and Be Thankful (Proposed Scheme) Extents and an aerial view of Glen Croe detailing key existing elements adjacent to the Proposed Scheme

1.1.4. On 18 March 2021, the then Cabinet Secretary for Transport, Infrastructure and Connectivity announced that the preferred route corridor for the permanent, Long-Term Solution (LTS) was through Glen Croe. The Design Manual for Roads and Bridges (DMRB) Stage 1 Assessment and Strategic Environmental Assessment (SEA) were published on 29 April 2021.

1.1.5. The AtkinsRéalis WSP Joint Venture (AWJV) was appointed in September 2022 to undertake the DMRB Stage 2 and Stage 3 Assessments, followed by statutory process, procurement and site supervision.

1.1.6. The DMRB Stage 2 Assessment considered five route options within the Glen Croe corridor (Green, Yellow, Brown, Purple and Pink) which consisted of viaducts, tunnels and debris flow shelters.

1.2. Preferred Route

1.2.1. On 2 June 2023 the preferred route option for the permanent LTS was announced as the 'Brown Option' which consists predominantly of a Debris Flow Shelter (DFS). This announcement marked the end of the DMRB Stage 2 Assessment.

1.2.2. The Proposed Scheme, shown in **Figure 1-2** below, is predominantly online and is therefore on or very close to the line and level of the existing A83. Its overall length is 2.25km, starting broadly at the Croe Water (Cobbler Bridge) and extending to a point north of the junction to the B828 Glenmore local road, adjacent to Loch Restil.

1.2.3. Landslide, debris flow and boulder protection are achieved through the inclusion of a DFS combined with a catchpit over a length of 1.4km, with an additional 146m of catchpit and Debris Flow Protection Wall (DFW) to the north. It is proposed that maintenance of the catchpit, which sits on the uphill side of the DFS and DFW, will be achieved via the roof the DFS with access taken directly from the A83 via a new direct access, as shown in **Figure 1-3**. The Proposed Scheme also includes improvements to the B828 Glenmore local road junction and Rest and Be Thankful Viewpoint car park and bus stop / turning area. Extending from the Rest and Be Thankful Viewpoint car park and bus stop / turning area, to the Core Path on the lower slopes of Ben Donich, the Proposed Scheme includes an Active Travel Link which closely follows the B828 Glenmore local road in the southern verge.

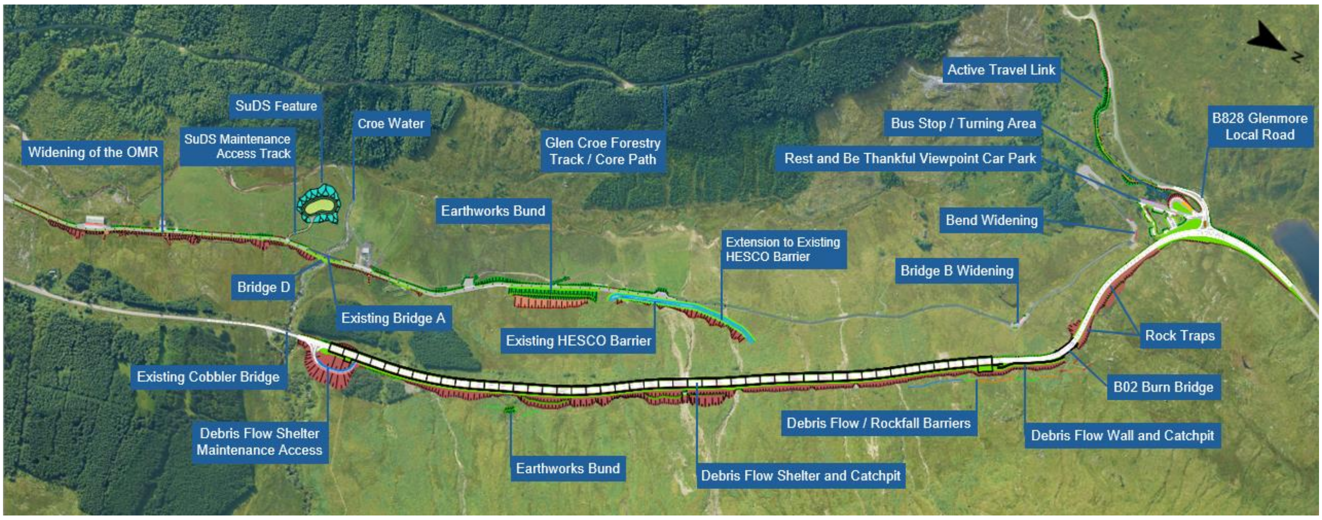

Figure 1-2 – Aerial view of Glen Croe including an overview of the Proposed Scheme layout

1.2.4. There are several other key structures as part of the Proposed Scheme including 16 No. culverts (12 within the extents of the DFS and a further four to the north of the DFS) and a 30m bridge structure, referenced B02 Burn Bridge at the northern extents of the project.

Figure 1-3 – Debris Flow Shelter and associated maintenance access (Visualisation)

1.2.5. To support the construction of the Proposed Scheme and provide a suitable, and more resilient diversion route for A83 Trunk Road traffic, a series of Improvements to the OMR are proposed as follows:

- widening of the OMR over a length of approximately 1.4km to accommodate two-way traffic including a new proprietary bridge structure that will carry southbound traffic with northbound traffic continuing on the existing bridge over the Croe Water (refer to Section 2.9.5, below);
- localised widening at three existing sharp bends at the northern end of Glen Croe to assist HGVs in navigating the narrow carriageway when using the OMR as the diversion route;
- an approximately 150m long debris flow protection earthwork bund to protect the OMR during debris flow and rock fall events;
- extension of the existing HESCO barrier by approximately 150m to protect the OMR during debris flow and rock fall events; and,

- installation of debris flow and rock fall fences above the A83 Trunk Road to increase resilience of the OMR. New fences are proposed where there are currently no geotechnical interventions.

1.3. Scheme Objectives

1.3.1. The Proposed Scheme objectives were defined in the Access to Argyll and Bute (A83) DMRB Stage 1 Assessment Report (Strategic Environmental Assessment (SEA) and Preliminary Engineering Services (PES)). The objectives were developed based on the problems and opportunities relating to the strategic road network through an extensive review of existing studies. Additional cognisance was taken of public and stakeholder feedback obtained through consultation in September and October 2020.

1.3.2. The A83 Rest and Be Thankful scheme objectives are:

- **Resilience** – Reduce the impact of disruption for travel to, from and between key towns within Argyll and Bute, and for communities accessed via the strategic road network.
- **Safety** – Positively contribute towards the Scottish Government's Vision Zero road safety target by reducing accidents on the road network and their severity.
- **Economy** – Reduce geographic and economic inequalities within Argyll and Bute through improved connectivity and resilience.
- **Sustainable travel** – Encourage sustainable travel to, from and within Argyll and Bute through facilitating bus, active travel and sustainable travel choices.
- **Environment** – Protect the environment, including the benefits local communities and visitors obtain from the natural environment, by enhancing natural capital assets and ecosystem service provision through delivery of sustainable transport infrastructure.

1.4. Previous Studies

1.4.1. Previous studies undertaken by various parties have been significant in shaping the project to date. Key studies are summarised below:

- Scottish Road Network Landslide Study: Implementation, Transport Scotland, 2008.
- A83 Trunk Road Route Study, Jacobs, 2013.
- A83 Glen Kinglas Options Report – 2019 Update, Jacobs, 2019. This report was prepared for BEAR Scotland by Jacobs to assess the risk due to debris flow landslide hazards along the A83 Trunk Road in Glen Kinglas and identify areas where future work could be focussed. This was an update to a report prepared in 2014 to assess the impact associated with changes to the hillside during the intervening period including remedial measures implemented and deforestation.
- STPR2: Initial Appraisal: Case for Change – Argyll and Bute Region Report, Feb 2021.
- STPR2: Update and Phase 1 recommendations Report, Feb 2021.
- Access to Argyll and Bute (A83) – DMRB Stage 1 Assessment Report, Apr 2021.

1.4.2. In conducting these studies, Transport Scotland and its consultants engaged in significant early consultation with key stakeholders and the wider public. A preliminary assessment was undertaken on the eleven route corridor options identified as part of STPR2, as well as four additional route corridor options proposed by members of the public during the consultation held in September and October 2020.

1.5. Selection of the Preferred Route Option

1.5.1. The principal objective of the Access to Argyll and Bute (A83) DMRB Stage 2 Scheme Assessment Report was to impartially assess several possible route alignment options such that a preferred route could be established.

1.5.2. Following on from the findings of the Preliminary Engineering Services (PES) (DMRB Stage 1) report, the assessment considered the following options:

- **Yellow Option**: An offline option on the east side of Glen Croe below the existing A83 and the OMR consisting predominantly of a viaduct;
- **Brown Option**: An online alternative to the existing A83, consisting predominantly of a debris flow shelter to protect the road;
- **Green Option**: An offline option on the west side of Glen Croe consisting of two viaducts and a debris flow shelter to protect the road;
- **Purple Option**: An offline option on the east side of Glen Croe consisting of a viaduct below the A83 and OMR and then into a tunnel; and,
- **Pink Option**: An offline option on the east side of Glen Croe consisting predominantly of a tunnel under the Beinn Luibhean hillside.

1.5.3. The mainline and junction options were sufficiently developed in three-dimensional models to indicate the approximate dimensions of the embankments, cuttings and the locations of structures. This enabled an assessment of their comparative impact and performance and the appraisal of Engineering, Economic and Environmental impacts.

Outcome of DMRB Stage 2 Assessment

1.5.4. The outcome of the DMRB Stage 2 Scheme Assessment was the recommendation that the Brown Option was taken forward as the preferred route option, with the key reasons to support this as follows:

- improved resilience and operational safety of the trunk road network by reducing the impact of disruption for travel to, from and between Argyll and Bute and the Central Belt of Scotland;
- most favourable performance across a broad range of environmental criteria;
- the greatest potential to be delivered quickly; and,
- the greatest opportunity to encourage sustainable travel.

1.6. DMRB Stage 3 Scheme Development History

1.6.1. The Proposed Scheme has been progressed to a 'Stage 3' level of design in accordance with the DMRB. The purpose of the DMRB Stage 3 report is to identify clearly the advantages and disadvantages, in environmental, engineering and economic and traffic terms, of the Proposed Scheme. DMRB Stage 3 represents the conceptual basis for the detailed design to be developed and constructed by the appointed Contractor, subject to the agreement of Transport Scotland.

1.6.2. This section of the report outlines the development of the Proposed Scheme since the publication of the DMRB Stage 2 Assessment Report dated May 2023, published on the Transport Scotland website and DMRB Stage 2 preferred route announcement in June 2023.

1.6.3. The design development undertaken at this stage is sufficient to determine the land required to construct the Proposed Scheme, including any areas of environmental mitigation. A series of on-site environmental surveys have also been undertaken to inform the Environmental Impact Assessment (EIA). This is reported in detail in the EIA Report.

1.6.4. During DMRB Stage 3, the design of the Proposed Scheme has been developed in an iterative manner which has involved successive refinement to mitigate issues arising through the collation of new information on constraints or engineering problems as the Proposed Scheme has progressed. Each design iteration has resulted in incremental changes that provide solutions until an optimum DMRB Stage 3 design is reached, taking cognisance of the overall scheme objectives throughout.

1.6.5. For the Proposed Scheme, the iterative design process has included the following:

- Multi-disciplinary design coordination meetings;
- development and use of an environmental constraints mapping tool, capturing information held by stakeholders and supplemented by recent survey data;
- a series of design refreshes; and,
- stakeholder engagement.

1.6.6. Design coordination meetings were held at regular intervals to provide environmental (and other) disciplines a forum to provide feedback on any constraints and an opportunity to mitigate potential impacts associated with design proposals and refinements. This informed and influenced the development of the Proposed Scheme design.

1.6.7. In order to collate and share environmental and design information across the project team a web-based GIS tool, known as WebGIS, was developed. WebGIS is accessible to all project team members, providing easy access to a wide range of information including:

- environmental constraints (protected species, habitats, cultural heritage features etc);
- geotechnical and topographical mapping; and,
- aerial imagery and design information.

1.6.8. Information was regularly updated to capture site surveys, desk studies, stakeholder information and design refreshes. WebGIS allowed the developing design to be overlain with known constraint information to understand any impacts associated with the Proposed Scheme.

1.6.9. The iterative design process has also included stakeholder engagement, primarily via regular meetings with Forestry and Land Scotland (FLS) and Argyll and Bute Council, bi-monthly meetings of the A83 Environmental Steering Group (ESG) and triannual meetings of the A83 Task Force. Engagement with the emergency services, road haulage groups and bus operators has also been undertaken.

1.6.10. Engagement was also undertaken with potentially affected landowners and occupiers, as well as the wider public through engagement events held in March 2024. The public engagement events provided an update on progress and the emerging Proposed Scheme design including the OMR Improvements and sought feedback. The public events were held in Campbeltown, Lochgoilhead, Lochgilphead and Arrochar and were supplemented by a virtual exhibition room accessed via the Transport Scotland website and the A83 Rest and Be Thankful Story Map.

1.6.11. The key developments to the Proposed Scheme during DMRB Stage 3 include:

- OMR Interventions now included as part of the Proposed Scheme works;
- Maintenance access to the roof of the DFS moved north of the Croe Water to avoid impact on the watercourse;
- Alignment and cross-section amended to provide a reduced cross-section (more akin to existing), and therefore reduced earthworks, north of the DFS;
- Earthworks slopes further developed to include berms (where appropriate) at estimated rock / soil interface;
- B828 Glenmore local road junction refined to provide a compliant ghost-island and a reduced junction bellmouth footprint, reducing impact on the adjacent Benn an Lochain Site of Special Scientific Interest (SSSI) site;
- RaBT Viewpoint car park proposals developed with environmentally led design in consultation with key stakeholders (public, A83 Task Force, A83 ESG, Argyll and Bute Council, FLS, Loch Lomond and the Trossachs National Park Authority (LLTNPA), Transport Scotland directorates etc);
- Active Travel Link included between the RaBT Viewpoint car park and the Glen Croe Forestry Track / Core Path on opposite side of Glen adjacent to and south of the B828 Glenmore local road;
- Drainage design refined – now only one SuDS feature at southern end of Proposed Scheme, reducing impact on adjacent constraints. Northern SuDS feature within Beinn an Lochain SSSI removed with agreement from NatureScot and the Scottish Environment Protection Agency (SEPA);
- DFS design refined to accommodate fire and smoke modelling. DFS now 5.3m headroom with a 4-degree incline on the soffit with an external emergency walkway, accessed via gaps in a concrete vehicle restraint system (VRS).;
- DFW design north of the DFS refined to accommodate future maintenance access;

- ITS / Systems rooms included at either end of the DFS to manage and maintain critical systems infrastructure within the DFS. At the southern end of the DFS this is included, as a buried structure, under the DFS maintenance access and at the northern end it is below the DFS turning area.
- A new bridge structure (B02 Burn Bridge) included at northern end of the Proposed Scheme to allow debris flow, landslide and boulder fall material to pass below the A83;
- Watercourse design developed to include suitable mitigation measures (aprons, cascades etc) on the downstream side of the A83; and,
- Natural Capital and Biodiversity Net Gain mitigation sites developed and included.

1.6.12. Further details on the Proposed Scheme development are provided in **Section 3.2** to **Section 3.8**.

1.7. DMRB Stage 3 Scheme Assessment Report Methodology

Purpose of Report

1.7.1. This DMRB Stage 3 Scheme Assessment Report for the Proposed Scheme has been prepared in accordance with the guidance contained in DMRB, TD 37/93 'Scheme Assessment Reporting'. It is noted that DMRB TD 37 / 93 has been withdrawn from the wider DMRB. However, this remains applicable to trunk road projects in Scotland.

1.7.2. Through the DMRB Stage 3 process, the A83 mainline and B828 Glenmore local road junction have been developed in sufficient detail to enable assessment of their impact and performance and to enable the appraisal of costs, engineering, traffic and environmental impacts of each.

1.7.3. The Proposed Scheme alignments have been modelled in three-dimensions, and layout drawings have been prepared to illustrate the developed designs. The drawings are presented in **Volume 2** of this DMRB Stage 3 Scheme Assessment Report.

Format of Report

1.7.4. The report is structured in line with the DMRB, Volume 5, Section 1, Part 2, TD 37/93 'Scheme Assessment Reporting' and follows the principles set out in the guidance on the preparation of the DMRB Stage 3 Scheme Assessment Report.

1.7.5. To accommodate the extent of information presented, the report is divided into two volumes, as follows:

- **Volume 1** – Report
- **Volume 2** – Drawings

1.7.6. Volume 1 (Main Report) is sub-divided into eight chapters as outlined below:

- **Chapter 1** – Scheme Background
- **Chapter 2** – Existing Conditions
- **Chapter 3** – Description of the Proposed Scheme
- **Chapter 4** – Engineering Assessment
- **Chapter 5** – Traffic Modelling and Forecasting
- **Chapter 6** – Operational Assessment of the Proposed Scheme
- **Chapter 7** – Economic Performance of the Proposed Scheme
- **Chapter 8** – Summary

1.7.7. This DMRB Stage 3 Scheme Assessment Report should be read in conjunction with the EIA Report, which can be found on the Transport Scotland website.

Assessment Reporting

1.7.8. This Volume 1: Engineering, Traffic and Economic Assessment describes the existing conditions along the A83 and OMR corridors within the Proposed Scheme extents. It then presents the findings of the engineering, traffic and economic assessment.

1.7.9. The alignments of the mainline, junctions, tracks and water features mentioned above were all modelled in three-dimensions, and the corresponding layout drawings are presented within Volume 2 of this DMRB Stage 3 Scheme Assessment Report.

1.7.10. This report also summarises the main environmental impacts identified within the EIA Report and briefly explains how these would be reduced or avoided where possible.

1.7.11. In summary, this DMRB Stage 3 Report provides:

- a brief summary of the history of the scheme proposals, and in particular, developments since the publication of the DMRB Stage 2 Assessment Report dated May 2023, published on the Transport Scotland website and DMRB Stage 2 preferred route announcement in June 2023;
- a description of the existing traffic, engineering and environmental conditions;
- details of the design of the Proposed Scheme;
- an estimate of the cost of the Proposed Scheme;
- a summary of key engineering issues;
- an overview of the traffic modelling and economic assessment; and
- an outline of how the Proposed Scheme meets the A83 scheme objectives.

1.7.12. The detail provided within this report is based on the preliminary design proposals for the Proposed Scheme using the knowledge acquired and survey information available at the time of writing. The design remains open to change following consultation and at detailed design stage subject to compliance with the EIA Report and as a result of further value engineering.

2. Existing Conditions

2.1. Introduction

2.1.1. This section of the report describes the engineering conditions of, and adjacent to, the existing A83 Trunk Road and OMR within the extents of the Proposed Scheme through Glen Croe.

2.1.2. Drawing series A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 in **Volume 2** illustrates the existing conditions and includes chainages which have been used in this chapter for reference.

2.1.3. The existing conditions relating to the Proposed Scheme location, including climate, topography, watercourses and land use are described in **Section 2.2**.

2.1.4. The engineering factors relating to the existing A83, B828 and OMR have been considered and are described in **Section 2.3** to **2.15** including the following existing features:

- Existing Roads;
- Existing Lay-bys;
- Existing Drainage;
- Existing Ground Conditions;
- Existing Road Pavement;
- Existing Roadside Features;
- Existing Structures (including culverts and retaining walls);
- Existing Utilities;
- Existing Traffic Flows;
- Road Traffic Collisions;
- Existing Active Travel Facilities;
- Existing Bus Services;

- Diversion Routes; and,
- Existing Environmental Aspects.

2.2. Scheme Location and Environment

Location

2.2.1. The Proposed Scheme is located in Glen Croe in Argyll and Bute and extends for approximately 2.25km. It begins immediately north of the existing bridge over the Croe Water extending to a point north of the existing junction between the A83 and B828 Glenmore local road, adjacent to Loch Restil.

Climate

2.2.2. The location of the Proposed Scheme, and its surrounding area, is known for its cold and wet climate. Met Office (2021) reported an annual average maximum temperature of 11.65 degrees centigrade in the West of Scotland for the period between 1991 and 2020. The Centre for Ecology and Hydrology (2021) reported an annual average rainfall of approximately 3,145mm in Glen Falloch (located around 11km northeast of the Proposed Scheme). Met Office 2021 data for the period between 1991 and 2020 indicates that Scotland receives an average annual rainfall of 1,573mm.

2.2.3. The current road network may be impacted by climate change in a number of ways. SEPA guidance (SEPA, 2019) includes allowances for peak rainfall, peak river flows and sea levels. Between now (2024) and 2100, it is expected that peak river flow allowances will rise by 56% in the Argyll River Basin Region and by 44% in the Clyde River Basin Region, both of which the A83 traverses.

Topography

2.2.4. Within the extents of the Proposed Scheme, the A83 traverses through Glen Croe, which is flanked on both sides by various mountains, namely The Cobbler, Cruach Fhiarach, The Brack, Ben Donich, Beinn Luibhean, and Beinn an Lochain. The existing ground levels along the Proposed Scheme rise from circa 152m above ordnance datum (AOD) at the south-eastern extents to a height of circa 261m AOD at a point adjacent to the Rest and Be Thankful Viewpoint car park, before falling to circa 255m at the northern extents.

2.2.5. Ground levels on the eastern side of Glen Croe rise steeply to the summits of The Cobbler, at approximately 884m AOD and Beinn Luibhean, at approximately 858m AOD. On the western side of Glen Croe ground levels again rise steeply to the summit of Ben Donich, at approximately 847m above ordnance datum.

2.2.6. The existing conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2** exhibit existing ground contours at 5 metre intervals.

Watercourses

2.2.7. The main watercourses and waterbodies running through, or lying adjacent to, the Proposed Scheme are Croe Water and Loch Restil.

2.2.8. Croe Water is one of the main tributaries of Loch Long within the A83 corridor and has a rural catchment of approximately 18km^2 including several minor watercourses. It is approximately 7.7km in length.

2.2.9. Loch Restil is a freshwater water body covering an area of approximately 0.1km^2. The water body is unclassified by SEPA and lies within the Kinglas Water catchment.

2.2.10. The existing conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2** include the main watercourses and waterbodies within the Proposed Scheme and indicate the extents of the flood plains associated with these bodies of water.

2.2.11. In addition to the water bodies noted above there are a further 22 watercourses within the Proposed Scheme footprint, with 15 watercourses within the footprint of the proposed DFS and DFW. A summary of the watercourses are included in **Table 2-2** and **Table 2-4** in **Section 2.9**.

Land Use

2.2.12. There are six properties within the extents of the Proposed Scheme, including two residential properties. One located to the south of the Proposed Scheme adjacent to the A83, south of the existing bridge over the Croe Water and one at the northern end of the Proposed Scheme extents on the valley floor below the Rest and Be Thankful Viewpoint car park. Along the valley floor, adjacent to the OMR, there are four outbuildings / livestock sheds.

2.2.13. The land use within the locality of the Proposed Scheme is mostly agricultural and commercial forestry. This is in the form of coniferous plantation woodland on the adjacent slopes, including portions of The Brack and Ben Donich on the south-western side, and The Cobbler on the north-eastern side.

2.2.14. Ardgartan forest can be found to the west of the existing A83 within the extents of the Proposed Scheme.

2.2.15. A desk study indicates that, at the time of writing, there are no relevant planning applications within the extents of the Proposed Scheme.

2.3. Existing Roads

Trunk Road (A83 (Tarbet to Campbeltown))

2.3.1. This section of the A83 Trunk Road is currently managed and maintained by Network Operator BEAR Scotland on behalf of Transport Scotland.

2.3.2. As a rural trunk road, the national speed limit for single carriageway roads applies to the length of the A83 throughout the extents of the Proposed Scheme.

2.3.3. The cross-section of the existing A83 through Glen Croe is mostly that of rural, un-kerbed single carriageway with no hard strips and constantly varying verge widths with no or minimal verge at some locations. The only kerbing within the extents of the Proposed Scheme is found at junction bellmouths.

2.3.4. The average cross-sectional width of the existing A83 single carriageway within the extents of the Proposed Scheme is 6.5m. This value is above the minimum specified cross-sectional width of a single carriageway, as per Table 2.3 of DMRB CD 109 'Highway Link Design'.

2.3.5. Due to the historic nature of the A83 and the variance from standard, the overall cross-section is generally non-compliant with current design standards for a rural single all-purpose carriageway.

Old Military Road

2.3.6. The OMR is located within the base of Glen Croe and was originally constructed in the 18th century linking Dumbarton with Inveraray and was in operation until the late 1930s when it was replaced with a new road to the east, upslope of existing. This subsequently became the present day A83 Trunk Road.

2.3.7. The OMR is approximately 4km long in total, all within the Proposed Scheme extents, of which approximately 2.6km is situated within privately owned land and the remaining 1.4km within land owned by Scottish Ministers and managed by FLS.

2.3.8. The section within private ownership stays true to the original geometry where it is single-track with a varying carriageway width between 3m to 3.5m. Given its age, the OMR does not comply with modern design standards. Localised widening has been undertaken as part of improvements by Transport Scotland over the years since it became a diversion route for the A83 Trunk Road in 2013. The road is un-kerbed with no road markings.

2.3.9. The section in Scottish Minister ownership is two-way single carriageway with an average width of 6.5m. The widening was introduced through an improvement scheme to reduce journey times. It is un-kerbed with the edges delineated by continuous longitudinal road markings. No hard strips are provided. To help manage speed, seven sets of speed cushions are placed along the length at varying intervals. While completed in more recent years, the alignment generally follows the route of the original OMR and is therefore not compliant with current design standards.

2.3.10. Although owned by Scottish Ministers, this section does not operate as a public road with only private local traffic or FLS vehicles using it for access. When operating as an emergency diversion for the A83 Trunk Road, a 15mph speed limit is applied and 10mph convoy working used on the single-track section.

Existing Junctions and Accesses

2.3.11. There are a total of five junctions and accesses connecting directly to the A83 within the Proposed Scheme extents. These are shown on the Existing Conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2** and are summarised below:

- B-road junction: 1
- OMR access: 1
- Residential access: 1
- Access Tracks / Field Access: 2

2.3.12. The junction between the A83 and B828 is an at-grade simple priority junction, located immediately north of the Rest and Be Thankful Viewpoint car park. It connects the A83 and the B828 Glenmore local road on the northbound side of the A83. The existing layout is loosely based on an at-grade simple priority junction in accordance with DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions' but incorporates a lay-by within the merge radius. An aerial plan of the junction can be seen in **Figure 2-1**.

Figure 2-1 – Plan view showing the existing A83 / B828 Glenmore local road junction including the Rest and Be Thankful Viewpoint Car Park and Bus Stop / Turning Area

2.3.13. The existing junction between the A83 and B828 serves multiple purposes, including:

- providing access to the Rest and Be Thankful Viewpoint car park and bus stop / turning area;
- providing access to the non-primary B828 Glenmore local road linking to Lochgoilhead; and,
- providing a temporary through road, from the OMR to the A83, when the OMR is in operation during A83 closures caused by potential debris flow and landslide events.

2.3.14. There is a single informal access, within the extents of the Proposed Scheme, located approximately 500m north of the Cobbler Bridge on the southbound side of the A83. The access provides direct entry into an existing quarry which is also used as a site compound for maintenance and resilience works relating to the A83.

2.3.15. There is also an existing informal access beyond the southern extent of the Proposed Scheme, at the tie-in to the existing A83, immediately south of the Cobbler Bridge. At the south abutment of the Cobbler Bridge, the existing informal access is situated on the southbound side of the A83 on the inside of a curve. The informal access is unmarked with no signage or broken edge of carriageway road markings to signify to road users that there is an access. The access is used by FLS and Scottish and Southern Energy (SSE) to take access to their assets on the slopes above the A83. Additionally, it is understood the access is used by hill walkers to gain access to Beinn Luibhean, The Cobbler and the hills beyond.

2.3.16. Beyond the Proposed Scheme extents, to the south, there is a further direct access between the A83 and OMR on the northbound side of the A83 which provides access to the OMR for FLS and a private landowner. This access is secured by a locked gate.

2.3.17. Approximately 280m north of this access there is a ‘link’ which gives vehicles access to the OMR and operates under free flow conditions when the temporary diversion comes into operation. The ‘link’ is closed off through the use of bollards when the diversion is not in operation and is also secured with a locked gate. This was realigned in early 2024 to move the ‘link’ north, outwith an area prone to flooding.

Existing Local Roads

2.3.18. The B828 Glenmore local road is a single lane local road with passing places that connects into the B839 which continues to Lochgoilhead. The road does not meet current design standards.

2.3.19. The road is operated and maintained by Argyll and Bute Council.

2.4. Existing Lay-bys

2.4.1. There are two existing lay-bys within the extents of the Proposed Scheme, one northbound in the vicinity of the B828 Glenmore local road junction and one southbound approximately 250m north of the Cobbler Bridge, see **Figure 2-2**.

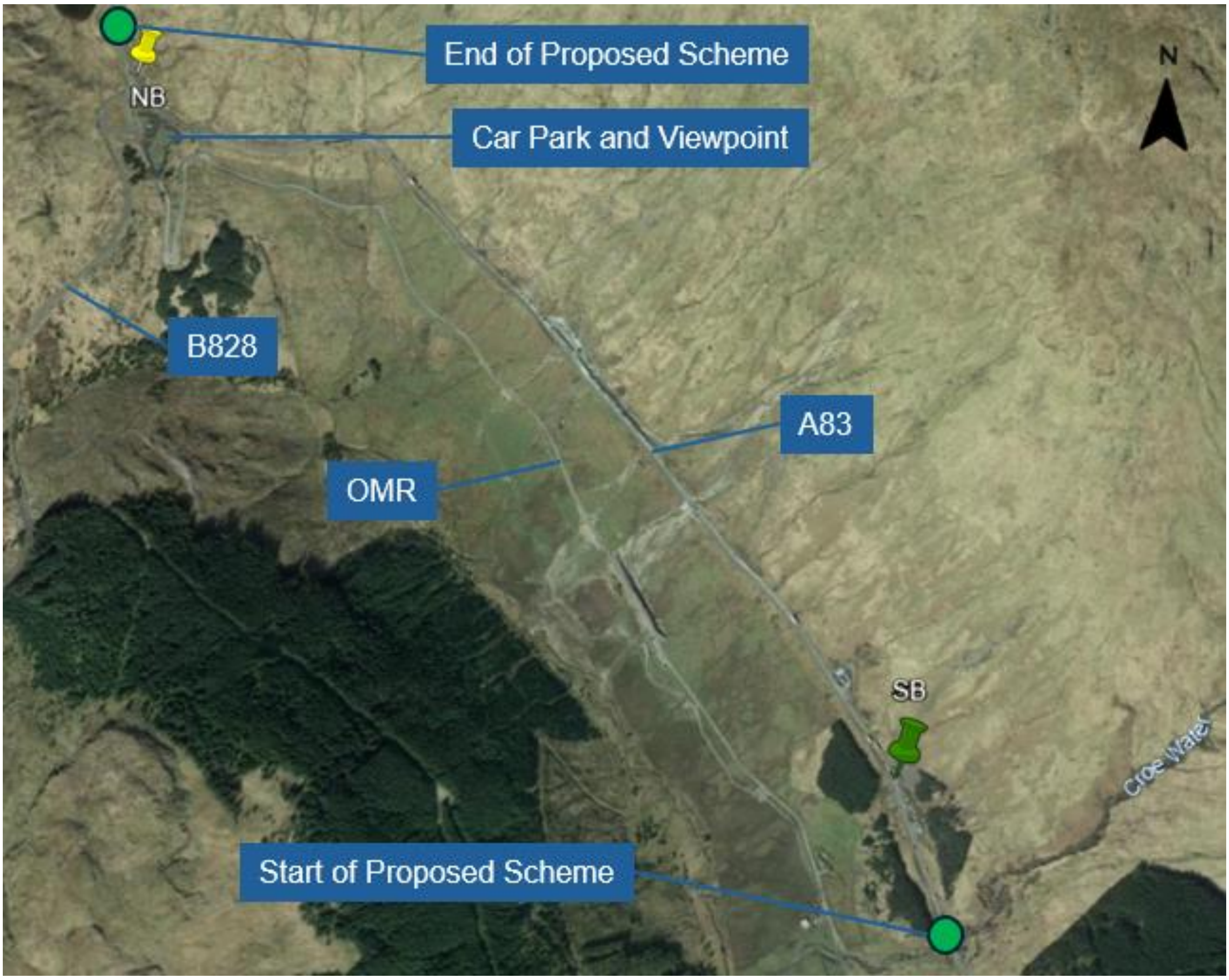

Figure 2-2 – Aerial imagery of Glen Croe with two existing lay-bys highlighted within the Proposed Scheme extents

2.4.2. The layout of the existing northbound lay-by, as well as the B828 priority junction, does not conform to the standards set out in both DMRB CD 123 'Geometric

Design of At-Grade Priority and Signal-Controlled Junctions' and DMRB CD 169 'The Design of Lay-Bys, Maintenance Hardstandings, Rest Areas, Service Areas and Observation Platforms'.

2.4.3. This existing northbound lay-by is a sub-standard Type A lay-by with road markings that are an extension of the B828 junction merge with the A83. The lay-by is capable of providing space for the use of approximately five cars or two Heavy Goods Vehicles (HGVs).

2.4.4. The layout of the existing southbound lay-by does not meet the requirements of Figure 4.30N of DMRB CD 169 'The Design of Lay-Bys, Maintenance Hardstandings, Rest Areas, Service Areas and Observation Platforms'.

2.4.5. This existing southbound lay-by is a sub-standard Type B lay-by which is capable of providing space for approximately eight cars or two to three HGVs.

2.4.6. The two lay-bys are shown on the Existing Conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2**.

2.5. Existing Drainage

Trunk Road (A83 (Tarbet to Campbeltown))

2.5.1. Existing drainage along the A83 consists of ditches and short lengths of filter stone trenches that discharge into a number of minor watercourses, channels and ephemeral streams which are tributaries of the Croe Water and Loch Restil.

2.5.2. Generally, the ditches and stone trenches collect runoff from both the existing carriageway and the natural catchment which drains from upslope of the A83. Where ditches or stone trenches are not present, or where the crossfall of the road does not drain towards such features, it is assumed that runoff drains over the edge and generally disperses into the natural channels directly or infiltrates into the ground.

2.5.3. There are no existing highway drainage pipe networks on the A83 within the Proposed Scheme extents.

2.5.4. Within the extents of the Proposed Scheme, there are a total of 23 watercourse crossings of the A83 that have been identified. These are discussed further in **Section 2.9.8**, below.

Old Military Road

2.5.5. Existing drainage along the OMR consists of ditches and filter drains adjacent to the road that discharge into a number of minor watercourses and channels which are tributaries of the Croe Water.

2.5.6. Generally, the ditches and filter drains collect runoff from both the existing carriageway and the natural catchment which drains from the upslope between the OMR and A83.

2.5.7. Where ditches or filter drains are not present, it is assumed that runoff currently drains over the edge and generally disperses into the natural channels directly or infiltrates into the ground.

2.5.8. A total of 33 culverts and three bridges cross the OMR which convey watercourses and channels from the upslope on the eastern side of the valley to the western side, where they typically feed into Croe Water. These are discussed further in **Section 2.9.8**, below

2.5.9. There is no formal drainage system across the existing bridges, with the understanding that the runoff from the carriageway drains against existing parapets and disperses into downstream drainage features or into surrounding land.

B828 Glenmore Local Road

2.5.10. Existing drainage along the B828 consists of ditches and short lengths of filter stone trenches that discharge into a number of minor watercourses, channels and ephemeral streams which are tributaries of the Croe Water and Loch Restil.

2.5.11. Generally, the ditches and stone trenches collect runoff from both the existing carriageway and the natural catchment which drains from the upslope of the B828.

2.5.12. Where ditches or stone trenches are not present, or where the crossfall of the road does not drain towards such features, it is assumed that runoff currently drains over the edge and generally disperses into the natural channels directly or it infiltrates into the ground.

2.5.13. Four culverts cross the B828 and convey watercourses and channels from the upslope within the Proposed Scheme extents. There are no existing road drainage pipe networks on the B828 within the Proposed Scheme extents.

2.6. Existing Ground Conditions

2.6.1. An overview of the anticipated ground conditions and geotechnical hazards is provided in **Section 4**.

Existing Geotechnical Assets

2.6.2. There are various geotechnical assets related to the construction of the A83 and OMR, ground stabilisation measures and geo-hazard mitigation measures. Existing retaining walls within the Proposed Scheme extents are discussed in **Section 2.9**, below.

Ground Stabilisation Measures

2.6.3. Ground stabilisation measures have been identified adjacent to the A83, as follows:

- A piled concrete ground beam is located along the downslope verge of the A83 between Ch. 1,340 and Ch. 1,360. This beam is approximately 20m in length and was installed to support the vehicle restraint system following settlement of the road in this location. There is a section of soil nailing and coarse rock fill downslope of the ground beam between Ch. 1,330 to Ch. 1,360. Records indicate that the soil nails were drilled through the superficial deposits into bedrock. The maximum length of soil nails is 17m.

- There are various areas of coarse granular rock blankets that appear to have been installed as repairs to localised areas of washout / instability. There do not appear to be any formal records of these works. The location of the rock blankets are as follows:
  - Immediately downslope Ch. 220: The rock blanket appears to have been installed to treat an area of washout, which occurred in 2015. The depth of treatment is expected to be relatively shallow.
  - Upslope of Ch. 240 to Ch. 270: Available records suggest that the rock blanket was installed to reinstate a shallow landslide failure.
  - Upslope of Ch. 1,430: Available records suggest that the rock blanket was installed to reinstate a shallow landslide failure. Recent landslide activity affected this location in October 2023.

- Below Ch. 1,130, downslope of the existing culvert A83_26, a Reno Mattress was installed in 2010 and soil nails were installed with a sprayed concrete facing in 2015. The works were undertaken to remediate an area prone to scour. In addition, an in-channel boulder fence was installed to retain rock fill. The soil nails were drilled to 3m depth at an inclination of 10 degrees to the horizontal and the anchors for the boulder fence were drilled up to 6m depth.
- At culvert A83_30, approximate Ch. 1,395, there is a stepped concrete cascade upslope of the A83 and a 15m length of U-shaped concrete channel at the culvert outfall. Details of these watercourse diversion works are unknown. However, it is understood that these measures were installed in response to ground movements at this location.

2.6.4. There are also two areas of ground stabilisation measures related to the OMR. These relate to an area of soil nailing and an area of coarse granular rock fill:

- At OMR Ch. 3,200, soil nails with a flexible mesh facing were installed to facilitate the widening of the bend on the approach / exit to an existing masonry arch bridge on the OMR, see **Figure 2-3** below. The works were undertaken as part of improvement work to the OMR when it was upgraded to become the temporary diversion route.

- Coarse granular rockfill has been installed above OMR Retaining Wall 2, see **Section 2.9.17** below.

Figure 2-3 – Existing soil nailed slope above the OMR, looking east with The Cobbler in the background

Debris Flow and Boulder Fall Mitigation Measures

2.6.5. There are a number of existing landslide mitigation measures including debris flow and boulder fall catch fences and catchpits, which were installed in various phases from 2010 until 2021. These are displayed on the geotechnical plan and profile drawings A83AAB-AWJ-HGT-LTS_POC_M01-DR-GE-000007 and A83AAB-AWJ-HGT-LTS_POC_M01-DR-GE-000008 included in **Volume 2**.

2.6.6. A total of 27 fences have been installed across the Beinn Luibhean slopes that are a mix of shallow landslide barriers (see **Figure 2-4**), rockfall barriers and in-channel barriers (see **Figure 2-5**). The shallow landslide and rockfall barriers range in length from approximately 25m to over 90m and vary in height between 2m and

5m. The in-channel barriers protect localised watercourses and are up to 25m in length with heights varying between 1.3m and 6.7m. The foundations for the barriers are anchored into bedrock with drilled anchor lengths varying between 3m and 18m.

Figure 2-4 – Typical example of a shallow landslide barrier on the Beinn Luibhean hillside

Figure 2-5 – Typical example of an in-channel barrier on the Beinn Luibhean hillside

2.6.7. Three of the fences have been replaced since installation. However, some of the foundations and anchorages for the fences are still apparent.

2.6.8. In late 2024 / early 2025, an additional shallow landslide barrier is due to be constructed above the existing retaining wall between approximate Ch. 830 and Ch. 890.

2.6.9. The first catchpit to be constructed at the site is located adjacent to the southbound carriageway between approximate Ch. 910 and Ch. 930. This pit was extended approximately 145m northward in 2018 and a further extension to approximate Ch.

1,200 was completed in 2021. A photograph of the extended catchpit is included in **Figure 2-6**, below.

Figure 2-6 – Photograph of the extended catchpit adjacent to the A83, below the Beinn Luibhean hillside

2.6.10. The back wall of the pit varies in height from between 10m and 15m, with slope angles between 60 degrees and 70 degrees. Areas where superficial deposits are present have been soil nailed and covered with netting or sprayed concrete facings. The catchpit was excavated up to approximately 2.7m below the level of the existing road and has a slope of about 35 degrees between the base of the pit and the carriageway. To ensure stability of this slope, a combination of soil nails, anchors and dowels have been drilled into bedrock and a 200mm thick sprayed concrete facing applied, including two layers of reinforcement mesh. Weepholes were drilled approximately 500mm above the base of the catchpit and installed with a perforated PVC pipe. Two culverts were also modified during these works.

2.6.11. At approximate Ch. 1,340, a bund and small catch pit have been formed adjacent to the A83 southbound carriageway. The bund is approximately 24m in length and up to 2m in height, with culvert pipes below the southern extent. No formal records of the bund construction are available. It appears to be constructed from granular fill (possible landslide debris) and is covered in a black geotextile.

2.6.12. The large catchpit at Ch. 810 was completed in 2022. On the uphill side of the pit there is a reinforced concrete crest beam. Three sides of the catchpit have a 350mm thick reinforced concrete skin wall formed of sprayed concrete at an angle of 65 degrees retaining superficial deposits. The sprayed concrete wall is approximately 10m in height and supported by passive ground anchors drilled at 1.5m horizontal spacing and 1.0m vertical spacing. There are 50mm diameter weep holes at 3.0m horizontal spacing and 1.0m vertical spacing.

2.6.13. The base of the catchpit is approximately 2.5m below carriageway level and a 3m high gravity retaining wall supports the A83 southbound carriageway. The wall is 700mm thick with a 45 degree sloping face and is founded 300mm below the base of the pit, dowelled into the underlying bedrock.

2.6.14. During construction of the existing catchpit at Ch. 810, a 200m long temporary barrier was installed on the centreline of the A83 to protect road users and provide mitigation for potential debris flow events. The barrier was removed following completion of the catchpit and it is understood that the barrier foundation anchors were cut off below road level.

2.7. Existing Road Pavement

A83 Road Pavement

2.7.1. As far as could be assessed, the A83 appears to be of flexible construction with a bituminous / asphaltic surface course. Recent improvement schemes will have applied TS 2010 surface course in line with other Scottish trunk roads.

2.7.2. Horizontal curves towards the northern end of the corridor have worn high friction surfacing.

2.7.3. No further assessment of the pavement condition has been carried out during the DMRB Stage 3 assessment.

2.7.4. Coring of the existing road pavement will be undertaken as part of future Ground Investigation survey works to determine the existing road pavement and to inform an assessment on the structural condition of the road.

2.7.5. The DMRB Stage 3 design presently assumes that there will be no re-use of the existing pavement and foundation, and the pavement will be replaced in its entirety. Further consideration of the potential to retain sections of the existing pavement, particularly outwith the DFS, will be given following receipt of road pavement core information.

OMR Road Pavement

2.7.6. The original OMR carriageway was constructed prior to the development of modern pavement materials and is assumed to have been replaced in a piecemeal approach, as and when required, in the years prior to its use as an emergency diversion route for the A83 Trunk Road.

2.7.7. In more recent years, the Trunk Road Operating Company have improved notable lengths as part of maintenance and upgrade schemes. Road core information is not currently available to determine the foundation, but as-built records show that the upper layers consist of flexible asphalt.

2.8. Existing Roadside Features

Road Restraint Systems

2.8.1. Road Restraint Systems, often known as safety barriers, are widely deployed along the A83 within the extents of the Proposed Scheme. These barriers consist of tension corrugated beam (TCB).

2.8.2. Certain stretches of barrier employ ramp-style terminals, which are typically of performance class P2. There are currently a total of 12 ramp-style terminals within the Proposed Scheme extents, with a further three to the south of the Proposed Scheme between the junction with the OMR and the Cobbler Bridge, and one location with no terminal included. These do not conform to the required specifications for a two-way single carriageway road, which state that the road must have a performance class of P4 terminals and be energy absorbing (that is, not ramped). There are three P4 terminals deployed on the A83 within the extents of the Proposed Scheme.

2.8.3. The parapets of the bridges are generally constructed out of masonry.

2.8.4. These are identified on the existing conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2**.

Signage

2.8.5. Signing on the A83 within the extents of the Proposed Scheme includes warning, advance directional, directional, route confirmation, tourist and information signs. Signs are positioned in expected peripheral locations and do not obstruct footpaths. Generally, signs are mounted at appropriate heights with observations as below:

- Directional signage includes Gaelic and English;
- No regulatory signs are present; and,
- No traffic or road lighting are present.

Winter Maintenance and Snow Poles

2.8.6. Snow pole provision is included in Scotland's Winter Service Plan for the Northwest Unit, as is a precautionary salting and plough route between Campbeltown and the Rest and Be Thankful. This indicates that there is snow build-up or surface frost and ice in this area, which may influence route resilience during snowstorms.

2.8.7. Due to the increased elevation of the A83 through Glen Croe and Glen Kinglas snow poles are situated adjacent to the A83 carriageway for approximately 7.8km. Snow pole provision commences approximately 500m south of the Proposed Scheme next to the informal lay-by with access to Roadmans Cottage and terminates approximately 1.6km east of the A815 junction with the A83.

Emergency Roadside Telephones

2.8.8. There is a single Emergency Roadside Telephone (ERT) in the northbound verge of the A83 adjacent to the lay-by immediately north of the B828 Glenmore local road junction.

2.9. Existing Structures

Bridges

2.9.1. The following information relating to existing structures has been provided by Transport Scotland from the Integrated Road Information System (IRIS).

A83 Bridge Structures

2.9.2. The Cobbler Bridge, shown in **Figure 2-7**, is located immediately outwith the southern extents of the Proposed Scheme. The structure is a three-span reinforced concrete bridge with a reinforced concrete slab and masonry clad parapets. It is supported on masonry clad columns and a reinforced concrete foundation.

Figure 2-7 – Western elevation of The Cobbler Bridge, looking east up Croe Water

2.9.3. The structure (A83 60) carries the A83 over the Croe Water with a span of 14.6m and a deck width of 7.5m.

Old Military Road Bridge Structures

2.9.4. There are a total of three existing bridges, Bridge A, Bridge B and Bridge C, located along the length of the OMR. This includes a bridge over the Croe Water in the lower lying southern area of Glen Croe and two crossings of unnamed watercourses in the northern, steeper extents of Glen Croe. Summary information for the three bridges is contained in **Table 2-1**.

Table 2-1 – Summary Information for existing OMR bridge structures

Reference	Chainage (m)	Watercourse Crossed	Structure No.	Deck Width (m)	Bridge Span (m)	Structure Type
Bridge A	1,740	Croe Water	N/A	5.7	5.5	Reinforced Concrete
Bridge B	3,215	Unnamed	N/A	7.0	4.2	Masonry Arch
Bridge C	3,305	Unnamed	N/A	7.0	4.2	Masonry Arch

2.9.5. Bridge A shown in **Figure 2-8** carries the OMR over the Croe Water and has a single main span with two flood spans on either side of the structure. The main span and flood spans consist of precast reinforced concrete culvert units for the full length and width of the deck. There is a reinforced concrete “spreader slab” on top of the culvert units. There is a stone masonry parapet over the bridge, and stone masonry training walls either side of the bridge.

Figure 2-8 – OMR Bridge A, looking east up Croe Water towards the A83, with the A83, Cobbler Bridge and The Cobbler in the background

2.9.6. Bridge B, shown in **Figure 2-9**, carries the OMR over an unnamed watercourse and is a single span masonry arch structure. The bridge has stone masonry parapets and spandrels, and part of the parapet to the southwest of the structure has been struck and subsequently removed.

Figure 2-9 – OMR Bridge B, South-Western Elevation, looking north towards the Rest and Be Thankful Viewpoint car park

2.9.7. Bridge C, shown in **Figure 2-10**, carries the OMR over an unnamed watercourse and is a single-span masonry arch structure, with a solid spandrel. The eastern elevation of the bridge consists of a masonry headwall and drainage pipe. This pipe is approximately 1.5m in length and transitions into the structure near the bridge edge.

Figure 2-10 – OMR Bridge C, Western Elevation

Other Structures

A83 Culverts

2.9.8. Within the extents of the Proposed Scheme there are a total of 22 watercourse crossings (21 culverts and one bridge) of the A83 that have been identified. Of the culvert crossings, 18 have been confirmed by topographic survey undertaken by Jacobs (2020) and the additional three have been confirmed by AWJV. There are 16 pipe culverts with diameters ranging from 375mm to 900mm and five box culverts.

2.9.9. It is noted that CCTV surveys of all existing A83 culverts are proposed as part of future Ground Investigation survey works. Results from the survey works will be used to inform ongoing design development.

2.9.10. **Table 2-2** contains details of the existing A83 culverts.

Table 2-2 – Summary Information for existing A83 culverts including watercourse ID, chainage, catchment and structure type

Proposed Scheme Watercourse ID	Chainage (m)*	WFD Catchment	Structure Type / Geometry	Culvert Capacity (m^3/s) +	Capacity Return Period (years) +	Does it Coincide with the DFS / DFW?
A83_ML_14	-105	Croe Water	Pipe culvert, unknown dimension	-	-	No
A83_ML_16	185	Croe Water	Pipe culvert, 0.6m diameter	0.42	<20-yr	Yes
A83_ML_17	270	Croe Water	Box culvert 0.9m (W) x 1.0m (H)	1.36	>200-yr + CC	Yes
A83_ ML_18	430	Croe Water	Pipe culvert, 0.6m diameter	0.25	<2-yr	Yes
A83_ ML_19	570	Croe Water	Pipe culvert, 0.45m diameter	0.2	<20-yr	Yes
A83_ ML_20	625	Croe Water	Pipe culvert, 0.375 m diameter	0.13	~5-yr	Yes

Proposed Scheme Watercourse ID	Chainage (m)*	WFD Catchment	Structure Type / Geometry	Culvert Capacity (m^3/s) +	Capacity Return Period (years) +	Does it Coincide with the DFS / DFW?
A83_ ML_21	640	Croe Water	Pipe culvert, 0.6m diameter	0.34	<5-yr	Yes
A83_ ML_22	765	Croe Water	Pipe culvert, 0.375 m diameter	0.13	>200-yr + CC	Yes
A83_ ML_23	810	Croe Water	Pipe culvert, 0.45m diameter	0.2	>200-yr + CC	Yes
A83_ ML_24	920	Croe Water	Box culvert 1.2m (W) x 1.4m (H)	3	>200-yr + CC	Yes
A83_ ML_25	1,065	Croe Water	Pipe culvert, 0.9m diameter	0.96	~100-yr	Yes
A83_ ML_26	1,135	Croe Water	Box culvert 1.4m (W) x 1.5m (H)	4.2	>200-yr + CC	Yes

Proposed Scheme Watercourse ID	Chainage (m)*	WFD Catchment	Structure Type / Geometry	Culvert Capacity (m^3/s) +	Capacity Return Period (years) +	Does it Coincide with the DFS / DFW?
A83_ ML_27	1,265	Croe Water	Pipe culvert, 0.6m diameter	0.36	<2-yr	Yes
A83_ ML_28	1,315	Croe Water	Pipe culvert, 0.46 m diameter	0.21	<20-yr	Yes
A83_ ML_29	1,400	Croe Water	Box culvert 1.7m (W) x 1.3m (H)	3.1	>200-yr + CC	Yes
A83_ ML_30	1,500	Croe Water	Pipe culvert, 0.5m diameter	0.2	<5-yr	Yes (DFW)
A83_ ML_31	1,600	Croe Water	Box culvert 1.2m (W) x 1.5m (H)	3.95	>200-yr + CC	No
A83_ ML_32	1,690	Croe Water	Pipe culvert, 0.9m diameter	1.01	<50-yr	No

Proposed Scheme Watercourse ID	Chainage (m)*	WFD Catchment	Structure Type / Geometry	Culvert Capacity (m^3/s) +	Capacity Return Period (years) +	Does it Coincide with the DFS / DFW?
A83_ ML_33	1,860	Croe Water	Pipe culvert, 0.4 m diameter	0.15	>200-yr	No
A83_ ML_34	2,045	Kinglas Water	Pipe culvert, unknown dimension	-	-	No
A83_ ML_35	2,230	Kinglas Water	Pipe culvert, unknown dimension	-	-	-

* The chainage provided relates to the Proposed Scheme chainage

+ Jacobs Baseline Culvert Hydraulic Assessment (Pre-DMRB Stage 2)

A83 Cascades

2.9.11. Several existing cascade and scour mitigation structures are located throughout the Proposed Scheme extents. The existing structures have not been surveyed and therefore the existing dimensions are unknown. A summary of the existing structures is provided in **Table 2-3**, below.

Table 2-3 – Summary of existing cascade and scour mitigation features adjacent to the existing A83

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_017	270	Stone pitch lined channel immediately downstream of outlet.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_021	640	Variable gradient masonry cascade with masonry side walls.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_025	1,065	Stone pitch lined channel immediately downstream of outlet. Evidence of surrounding slope failures above culvert and bank failures in channel downstream. Stone pitching is being undermined due to scour at transition.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_026	1,135	Originally constructed as a reno mattress cascade structure with reno mattress lined banks. The cascade mesh has now failed resulting in material loss. The banks are still intact.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_027	1,265	Stone pitch channel immediately downstream of culvert outlet. Narrow channel with masonry retaining walls. Exposed bedrock in channel downstream of stone pitching. Currently in good condition.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_028	1,315	Stone pitch lined channel and drop structure downstream of A83. Currently in good condition.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_029 (Upstream Cascade)	1,400	Large cast in-situ concrete cascade structure located on upstream side of A83. Upstream cascade comprises low flow notch and end sills.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_029 (Downstream Cascade)	1,400	Large cast in-situ concrete cascade structure located on downstream side of A83. Downstream cascade comprises of a meandered structure with high side walls transitioning to stone pitch apron. Downstream extent of stone-pitching is becoming undermined by scour processes.	

Proposed Scheme Watercourse ID	Scheme Chainage	Description	Photo
A83_ML_030	1,500	Fibreglass lined cascade. Original channel appears to be of a masonry construction and subsequently lined at a later date. Channel width of approximately 500mm.	

Old Military Road Culverts

2.9.12. Over the length of the OMR there are a total of 33 culverts present which all convey watercourses or channels from the upslope on the southbound side of the OMR to the centre of Glen Croe. The existing culverts are summarised in **Table 2-4**.

Table 2-4 – Summary Information for existing OMR culverts including culvert reference, chainage and span / diameter

Culvert Reference	Chainage (m) *	Span / Diameter (m)
OMR_01 (New Phase 1)	320	0.6
OMR_02	510	0.6
OMR_03	705	0.6
OMR_04	785	0.6
OMR_05	805	0.6
OMR_06	915	0.45
OMR_07	985	0.6
OMR_08	1,195	0.375
OMR_09	1,315	0.9
OMR_10	1,410	0.9
OMR_11	1,455	0.45
OMR_12	1,610	0.375
OMR_14	1,840	0.9
OMR_15	1,985	0.6
OMR_16	2,065	0.75
OMR_17	2,165	0.45
OMR_18	2,255	0.75

Culvert Reference	Chainage (m) *	Span / Diameter (m)
OMR_19	2,375	0.9
OMR_20	2,485	0.375
OMR_21	2,580	1.05
OMR_22	2,640	0.375
OMR_23	2,720	1.05
OMR_24	2,755	0.375
OMR_25	2,830	0.6
OMR_26	2,890	0.375
OMR_27	2,940	0.6
OMR_28	2,995	0.6
OMR_29	3,115	0.45
OMR_32	3,335	0.6
OMR_33	3,480	0.6
OMR_34	3,500	0.375
OMR_35	3,520	0.3
OMR_36**	3,580	0.15

* The chainage provided relates to the Proposed Scheme chainage

** OMR_36 was not assessed as it is 0.15m diameter and therefore not considered a culvert

A83 Retaining Walls

2.9.13. There are two existing retaining wall structures adjacent to the A83 trunk road, as detailed in Transport Scotland's Integrated Road Information System (IRIS):

- A 10m section approximately 2.5m in height adjacent to the northbound carriageway (approximate Ch. 810), which was constructed following a debris flow event in August 2020. This wall is piled and anchored into bedrock, with anchors extending below the A83 at relatively shallow depth. There is a VRS support beam on the north side of the wall, which is also anchored but not piled. The VRS support beam on the south side of the wall is not anchored or piled.

- An 82m long masonry retaining wall adjacent to the southbound carriageway between approximately Ch. 820 and Ch. 910, which was built in 1938 during the construction of the existing A83. The height of the structure varies from 0.6m to a maximum height of 6.0m around Ch. 880. The northern end of the structure was amended during construction of the catchpit (refer to Section 2.6.9, above). The wall was extended over a 20m section, extending the length by 5m and height by up to 2.6m. Ground anchors up to 16m in length were installed to support the structure.

2.9.14. There are other low height retaining structures adjacent to the southbound carriageway associated with existing culvert intake structures between approximate Ch. 520 to Ch. 570 and Ch. 1,545 to Ch. 1,580.

Old Military Road Retaining Walls

2.9.15. There are four existing retaining walls related to the construction of the OMR.

2.9.16. Retaining Wall 1 as shown in **Figure 2-11** is approximately 50m in length and 2m in height, constructed from stone. It is obscured by dense vegetation along the western verge of the OMR. The exact length of the wall is not clear due to the presence of vegetation, lack of historical data and weathered boulders which may have been the top of the retaining wall, or debris from the hillside.

Figure 2-11 – OMR Retaining Wall 1, looking south with The Cobbler (left) and The Brack (right) in the background

2.9.17. Retaining Wall 2 is located at the northern end of the OMR in the northbound verge. The wall is located behind a post and wire fence and has a drainage culvert through the wall, approximately halfway along its length, see **Figure 2-12**.

Figure 2-12 – OMR Retaining Wall 2, looking east with the lower slope of Beinn Luibhean above

2.9.18. Retaining Wall 3, as shown in **Figure 2-13**, is located at the northern extents of the OMR near the and Rest and be Thankful Viewpoint Car Park. The structure is located in the southbound verge of the road, retaining the OMR. There are areas of vegetation growth along the wall and a rectangular opening at the base of the wall, approximately halfway along its length.

Figure 2-13 – OMR Retaining Wall 3, looking north towards the Rest and Be Thankful Viewpoint Car Park with vegetation in the foreground and trees in the background

2.9.19. Retaining Wall 4, as shown in **Figure 2-14**, is located upslope of approximate Ch. 2,760m and appears to be related to the original construction of the A83. The wall is approximately 2m in height and stands on a concrete footing.

Figure 2-14 – OMR Retaining Wall 4, looking north towards the Rest and Be Thankful Viewpoint Car Park with vegetation in the foreground and grassed slopes in the background

Old Military Road HESCO Barrier

2.9.20. There is a HESCO barrier adjacent to the OMR at approximate Ch. 2,350 to 2,525m. The barrier takes the form of a gravity retaining wall formed of welded mesh concertina baskets lined with a heavy-duty geotextile on the vertical sides. The baskets are filled with free draining granular fill. It is approximately 6.6m in height and 175m in length, offset approximately 2m from the edge of the OMR, see **Figure 2-15**.

Figure 2-15 – HESCO Barrier, looking north towards the Rest and Be Thankful Viewpoint Car Park with Beinn an Lochain (left) and Beinn Luibhean (right) in the background

2.9.21. To provide appropriate tie-ins to the hillside, the barrier has been constructed to form a return to the uphill slope at its southern and northern ends. The shape of the barrier has been developed to generate capacity (volume) for the retention of landslide and debris flow material and to reduce the ability for material to spill around its ends onto the OMR beyond.

2.9.22. The HESCO barrier was constructed between December 2020 and January 2021 as part of emergency mitigation works following the debris flow events in August and September 2020.

2.10. Existing Utilities and Associated Infrastructure

2.10.1. Existing utilities within the study area have been identified through review of information provided by the utility providers. These are identified on the Existing Conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2**.

2.10.2. C2 notifications were issued to Statutory Undertakers in line with the New Roads and Street Works Act (NRSWA) 1991. Responses were received from all Statutory Undertakers contacted, with only two confirming they had apparatus within the preferred corridor. Within the extents of the Proposed Scheme, BT Openreach currently have existing apparatus in the form of:

- underground cables and chambers running parallel to both the A83 and the OMR, along the respective lower slope verges; and,
- an overhead line running parallel to the B828 between Lochgoilhead and the Rest and Be Thankful viewpoint car park, where the overhead is then routed underground.

2.10.3. Mobile Broadband Network Limited (MBNL) also have apparatus within the extents of the Proposed Scheme in the form of a mast which is located adjacent to the southbound verge of the B828, approximately 200m south-west of the Rest and Be Thankful viewpoint car park.

2.10.4. C3 notifications were issued to BT Openreach and MBNL. BT Openreach submitted estimated costs and drawings showing proposed alterations to their apparatus whilst MBNL confirmed their apparatus was unaffected by the Proposed Scheme.

2.11. Existing Traffic Flows

Current Situation

2.11.1. Since the 2020 landslides, the A83 has mostly been operating under signal control, and by convoy. Even with the engineering works to improve safety along the A83, closures are still not uncommon. Monitoring of the Beinn Luibhean hillside is currently undertaken by BEAR Scotland and when the risk of landslide increases, the A83 road is pre-emptively closed, and traffic is diverted onto the OMR which represents the local diversion. The longer diversion route to the north using the A82, A85 and A819 is rarely used.

Traffic Surveys

2.11.2. Three sets of traffic count surveys were commissioned, at different locations within Glen Croe, for a two-week period. The surveys were undertaken on the following dates:

- 30 October 2023 to 12 November 2023
- 27 February 2024 to 11 March 2024
- 1 April 2024 to 8 April 2024

2.11.3. The data collected in the most recent survey of April 2024 has not been used as the A83 was closed for a large portion of the surveyed period. The October / November 2023 and February / March 2024 surveys have been used to calculate an Annual Average Daily Traffic (AADT) value for the surveyed periods. A seasonality factor, derived from a National Traffic Data System (NTDS) count site, was then applied to these values to get a yearly AADT value, with an average value calculated.

2.11.4. An AADT of 4,200 was determined from the above with the percentage of HGVs approximately 12%.

Transport Model for Scotland

2.11.5. The Transport Model for Scotland (TMfS) was used in Stage 3 to forecast the future flows along the A83. Forecast percentage change in AADT across the Proposed Scheme was extracted from the TMfS for both the ‘With Policy Ambition’ and ‘Without Policy Ambition’ forecast traffic scenarios.

2.11.6. The ‘With Policy Ambition’ traffic flow forecast is a low traffic scenario, called ‘Low Motorised Traffic / Emissions Scenario’ at DMRB Stage 1 and makes the following assumptions:

- Phase out the need for new petrol and diesel cars and vans by 2030.
- Car ownership numbers in all cities constrained to numbers at 2020.
- Decline in trip rates: -25% commute, -66% business, all others – extrapolate decline.
- No connected and autonomous vehicles (CAV’s) by 2050.
- Car generalised cost increase to achieve 20% reduction in car vehicle kms by 2030.

2.11.7. The ‘Without Policy Ambition’ traffic flow forecast is a high traffic scenario, called ‘High Motorised Traffic / Emissions Scenario’ at DMRB Stage 1 and makes the following assumptions:

- Existing electric vehicle growth with no further interventions promoting uptake.
- Car ownership will only be constrained in city centres where there are existing parking constraints.
- Decline in trip rates: -15% commute, -33% business, all others – stable.
- A 40% update of connected and autonomous vehicles (CAV’s) by 2050 with the first CAV’s appearing in the mid 2020’s.
- No change in fuel cost.

National Traffic Data System Traffic Counts

2.11.8. Access to the NTDS database has been provided to AWJV to aid in the traffic appraisal. There is only one active traffic counter located on the A83 in proximity to the Proposed Scheme, which is to the south-east of Glen Croe. The counter has been used to verify average monthly vehicle counts during the 2019-2024 period, shown in **Figure 2-16**.

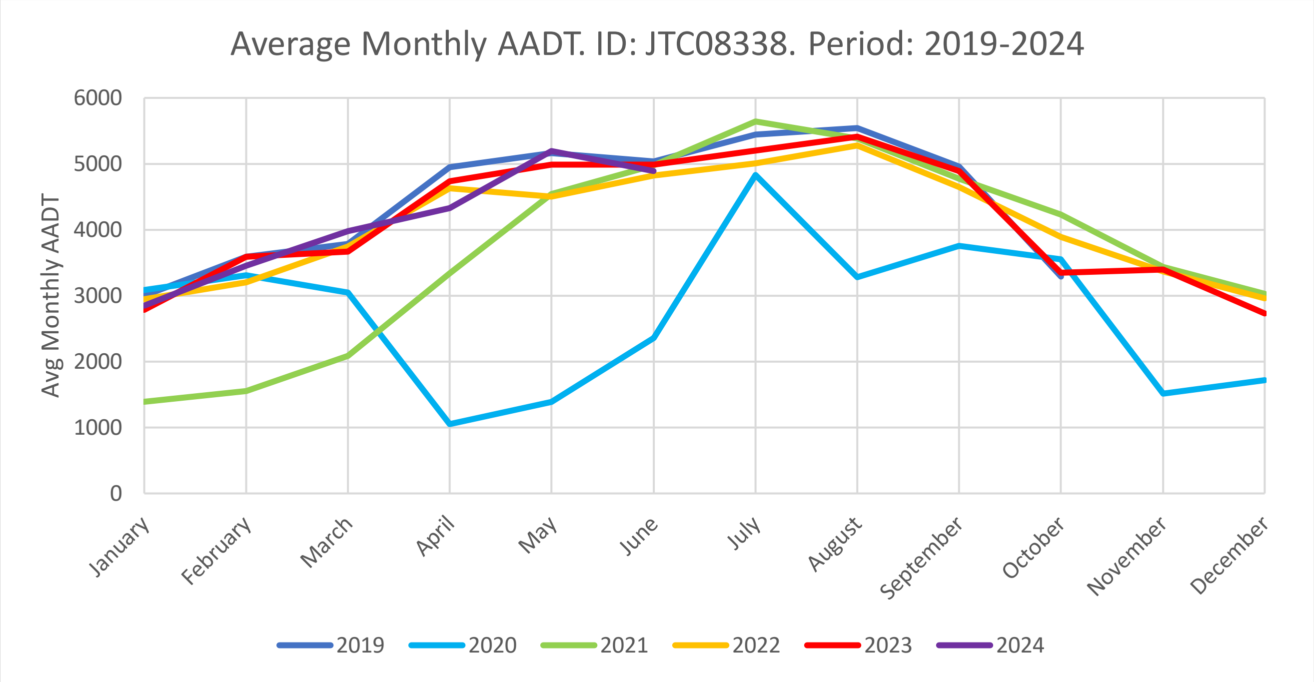

Figure 2-16 – National Traffic Data System average vehicle counts for the period 2019-2024 for the traffic counter located south-east of the Proposed Scheme extents

2.12. Road Traffic Collisions

2.12.1. An analysis of road traffic collision data has been undertaken. This has enabled an assessment of current road safety conditions by establishing the number and severity of collisions and the collision rate in relation to traffic flow, allowing comparison with national trends. Road traffic collisions are classified as fatal, serious or slight dependent on the most severely injured casualty while the collision rate is expressed as the number of road traffic collisions per million vehicle kilometres travelled.

2.12.2. Road traffic collision data from 1 January 2014 to 31 December 2023 for the A83 is outlined in **Figure 2-17**. In total, two collisions were recorded within the Proposed Scheme extents within the ten-year period (one serious and one slight). There were a further three collisions recorded immediately outwith the Proposed Scheme extents, one to the south and two to the north (all serious).

2.12.3. The study within the extents of the Proposed Scheme reveals that the collision severity ranges from slight to serious.

Figure 2-17 – Aerial Image of Glen Croe, covering the Proposed Scheme extents, highlighting Road Traffic Collision locations and severities

2.13. Existing Walking, Cycling and Horse-Riding Facilities

2.13.1. A review of the existing Walking, Cycling and Horse-Riding Facilities in proximity to the Proposed Scheme has been undertaken in accordance with DMRB GG 142.

2.13.2. Within the extents and adjacent to the Proposed Scheme, existing active travel provision is limited, consisting principally of one Core Path and three Local Paths. These existing facilities appear to be predominantly used for recreation and leisure purposes rather than commuting or active travel. This assumption is based on their location, i.e. proximity to trip generators etc, and type, i.e. gradient, alignment and amenity.

2.13.3. The four principal paths are shown in **Figure 2-18** and on the Existing Conditions drawings A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000001 to A83AAB-AWJ-GEN-LTS_GEN_M01-DR-CX-000002 contained in **Volume 2**. The information on the existing core path and three local paths identified within, and adjacent to, the Proposed Scheme are outlined below.

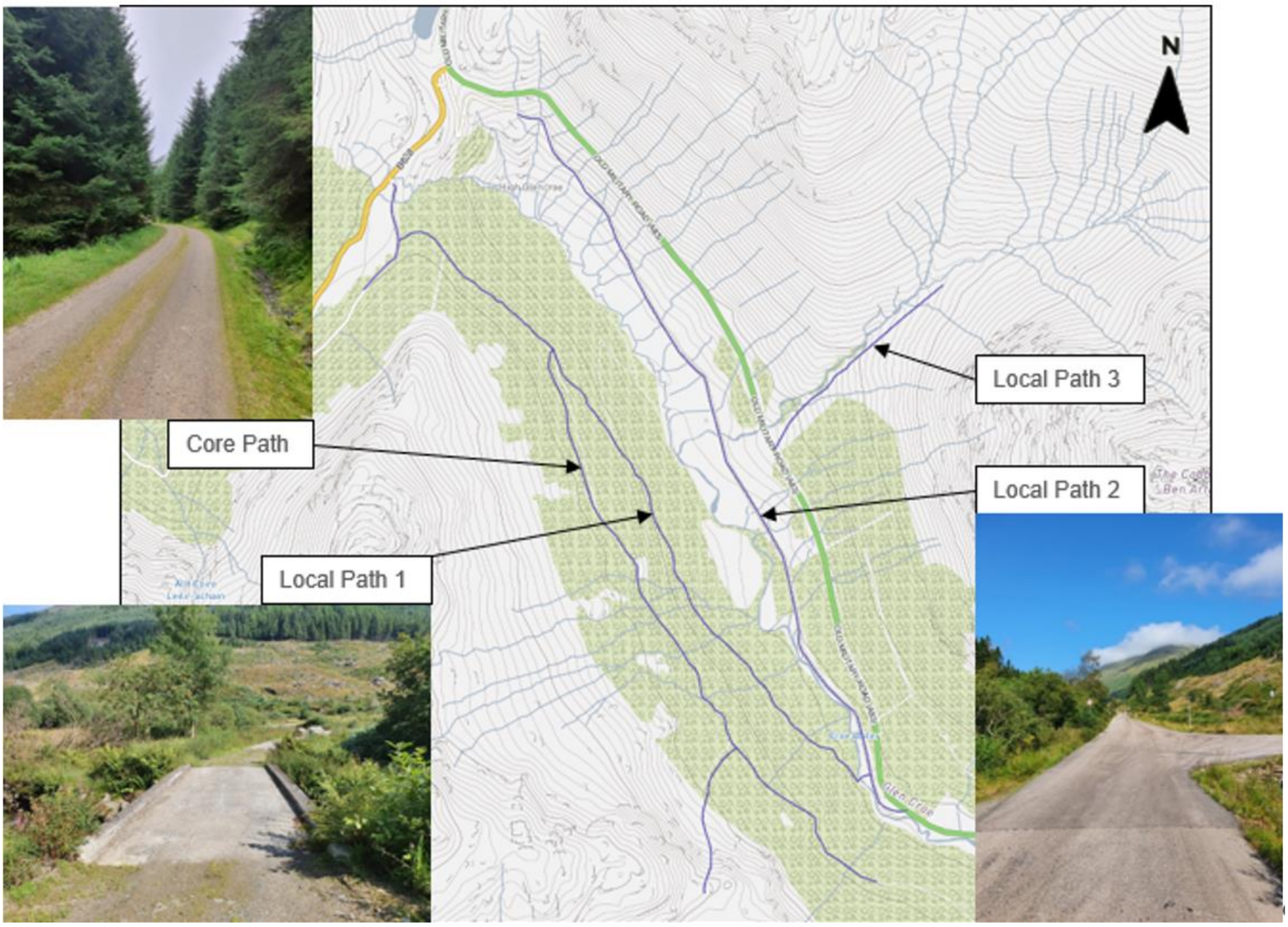

Figure 2-18 – Existing Walking, Wheeling and Cycling provision within Glen Croe with photographs showing typical examples of the Core Path and Local Path One and Two

2.13.4. The existing A83 generally consists of a 6m wide carriageway with grassed verges varying between 0.5m and 2m within the Proposed Scheme extents. Beyond the Proposed Scheme extents, there are isolated lengths of the existing A83 which do contain footways with the nearest identified being east of the Ardgartan Holiday Park connecting to Arrochar and two short, isolated sections at Cairndow and the top of Loch Shira which are approximately 3km, 6.8km and 19km from the extents of the Proposed Scheme, respectively.

2.13.5. From AWJV's ongoing site inspection and consultation, there is evidence of the A83 being used by road cyclists, mostly for recreation and leisure activities. This is supported by Strava and other equivalent open data sources.

2.13.6. Due to the cross-section of the existing A83, there is no evidence to suggest this is used by pedestrians.

Core Paths

2.13.7. Core Paths facilitate, promote, and manage access rights under the Land Reform (Scotland) Act 2003, providing the public access throughout the local area. The Core Path network is a key part of outdoor access provision and is intended to cater for a range of public users, including walkers, cyclists, horse riders and disabled people. Therefore, every local authority and National Park are responsible for preparing a Core Path Plan. This Core Path is included in the Core Paths Plan for the Loch Lomond and The Trossachs National Park by the National Park Authority which was adopted on 14 June 2021.

2.13.8. Located on the western side of Glen Croe, the Core Path runs north from Ardgartan along a forestry track to a point adjacent to the Glen Mohr car park and approximately 430m south-west of the Rest and Be Thankful Viewpoint car park, where it then turns south-west towards Gleann Mòr and Lochgoilhead.

2.13.9. The Core Path uses an FLS access track known as the Upper Forestry Access Track. It has an unbound granular surface with gradients varying significantly along its length within the Proposed Scheme extents. The average gradient is approximately 5.0 to 5.5% but increases in points to over 8%. The width also varies with an average of 3.1m and a minimum of 2.5m in points. The route is used as a forestry maintenance access and a forestry extraction route where access to walking, wheeling and cycling is temporarily restricted.

2.13.10. A typical image of the Core Path is shown in **Figure 2-18**.

2.13.11. Additionally, the Ardgartan Peninsula Loop, a 33km forest recreation mountain bike route, utilises the Core Path/Upper Forestry Access Track.

Local Paths

2.13.12. Local paths are routes which have been identified through consultation or where there is anecdotal evidence of use but do not have a formal status.

Local Path 1

2.13.13. Local Path 1 is an undesignated path located on the western slopes of Glen Croe, positioned generally downslope of the Core Path described above. It loops between the A83 and OMR junction via a bridge to the Core Path towards High Glen Croe.

2.13.14. Like the Core Path, it runs along an FLS access track known as the Lower Forestry Access Track. As such, it also has an unbound granular surface. Average gradients are around 6% but increase in points to over 10%. The width varies with an average of 3.1m and a minimum of 2.5m in points.

2.13.15. To cross the Croe Water, users must pass over a concrete bridge which has a width of around 3m. However, no edge protection in the form of a parapet or guardrail is provided and only minor upstands are present, see **Figure 2-18**. The route is used as a forestry maintenance access and a forestry extraction route where access to walkers, wheelers and equestrians is temporarily restricted.

Local Path 2

2.13.16. Local Path 2 is an undesignated path which follows the OMR. It runs from the A83 / OMR junction along the floor of Glen Croe to High Glencroe at which point it climbs sharply with hairpin bends where it connects into the Rest and Be Thankful Viewpoint car park, see **Figure 2-18**.

2.13.17. Despite a notable length of the OMR being privately owned, it can be used by walkers, wheelers and cyclists due to the Land Reform (Scotland) Act 2003, although there are gates that need to be negotiated which act as a barrier to some. However, Transport Scotland has agreement with the current landowners and when the A83 is closed as a result of landslides or risk of landslides, the OMR is used as a temporary diversion route for the displaced traffic. During its operation as a diversion route, the OMR effectively becomes unusable for walkers, wheelers, cyclists and equestrians. Alternative arrangements are made to accommodate the movement of these users along the OMR whilst the diversion route is in place – for instance, walkers, wheelers and cyclists are transported along the route by the convoy vehicles.

2.13.18. The OMR has a bound paved surface and a typical width of 4.3m. It is wider at the southern end which can facilitate two-way traffic and narrows further north where it is still suitably wide to accommodate motorised traffic. Along the valley floor, the route undulates significantly with localised steep sections but has an average gradient of 1.8% over 2km. However, north of High Glencroe gradients increase to over 14.7% for a length of 140m.

Local Path 3

2.13.19. Local Path 3 is an undesignated path located to the east of the A83. It is accessed from an existing informal access immediately south of the Cobbler Bridge, which carries the A83 over the Croe Water, generally running parallel to the watercourse as it heads uphill providing access to the adjacent hills, particularly Beinn Luibhean and The Cobbler, see **Figure 2-18**. Furthermore, it is known through consultation that SSE and FLS use this path as a means of foot access to their infrastructure within the area.

2.13.20. It is understood that the path is informal and has formed over time through continual use. As a result, it is a mixture of natural surface and sub-surface ground material and is uneven underfoot.

Additional Informal Paths

2.13.21. In addition to the four paths noted above, two informal mountain biking trails and a hill walking route are present on the western slopes of Glen Croe. These were identified through local knowledge of the area and are shown on **Figure 2-19**, below.

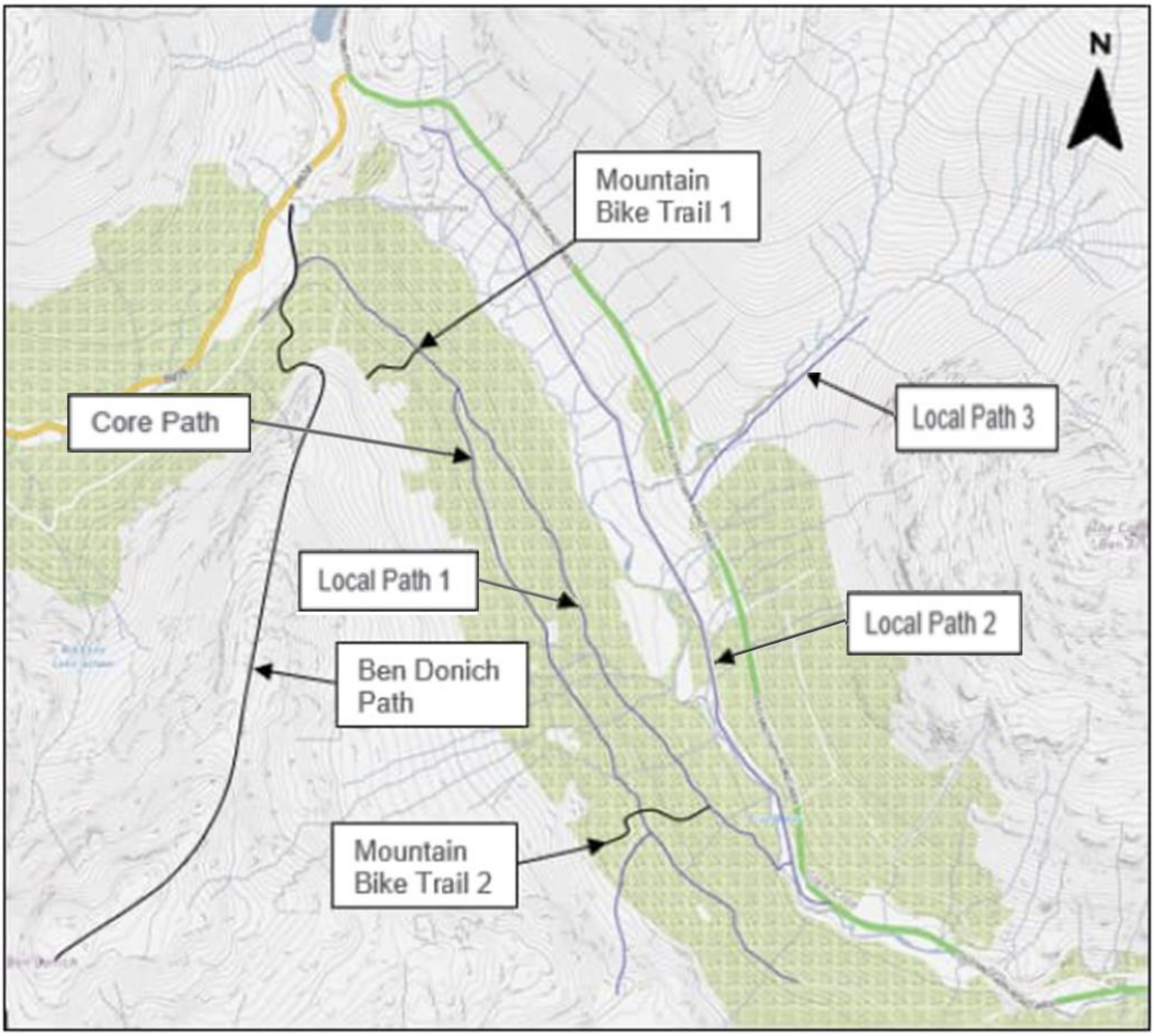

Figure 2-19 – Additional Informal Paths adjacent to the Proposed Scheme within Glen Croe on the lower slopes of Ben Donich

2.13.22. Mountain Bike Trail 1 is towards the northern end of Glen Croe. It is accessed from, and also ends at, the Core Path where users traverse through the trees on the lower slopes of Ben Donich.

2.13.23. Mountain Bike Trail 2 is at the southern end of Glen Croe. Again, it is accessed from the Core Path and traverses through the trees on the lower slopes of Ben Donich passing over the Upper Forestry Access Track and ends on the Lower Forestry Access Track / Local Path 1.

2.13.24. A hillwalking route to Ben Donich starts at the Glen Mohr FLS car park, crossing the Core Path and continuing up the ridge of the hill. The route up and down follows the same path.

National Cycle Network (NCN) Routes

2.13.25. There are no Sustrans National Cycle Network (NCN) routes within the Proposed Scheme extents or in the surrounding area. However, there are several off-road cycle routes, see **Figure 2-20**, below.

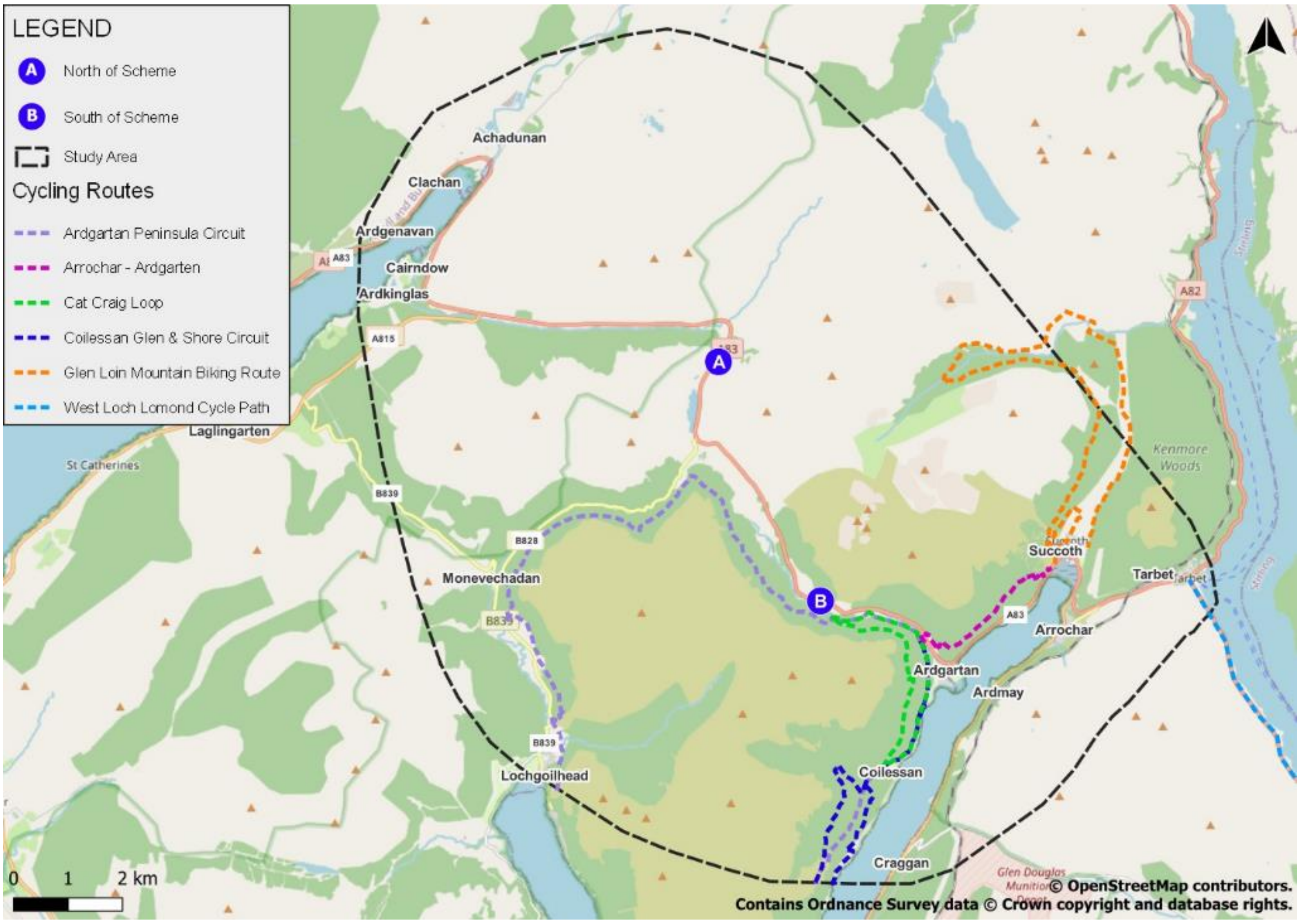

Figure 2-20 – Cycling routes within close proximity to the Proposed Scheme

2.14. Existing Bus Services

2.14.1. Within the extents of the Proposed Scheme, the A83 forms part of the route of three bus services. This includes two services providing links to strategic and regional destinations and one regional service.

2.14.2. There is a single bus stop, shown in **Figure 2-21**, currently located immediately west of the Rest and Be Thankful Viewpoint car park within a bus turning area off the B828 Glenmore local road.

Figure 2-21 – Bus Stop Adjacent to the Rest and Be Thankful Viewpoint car park with Beinn an Lochain and Loch Restil in the background

2.14.3. Bus companies operating within the extents of the Proposed Scheme are West Coast Motors (on behalf of Scottish Citylink), operating the 926 and 076 services, and Garelochhead Coaches, operating the 302 service.

2.14.4. The 302 service operates between Helensburgh and Carrick Castle with a typical frequency of four times per day in each direction from Monday to Friday, and three times per day in each direction on Saturdays and Sundays.

2.14.5. The 926 service operates between Glasgow and Campbeltown with a typical service of five times per day in each direction from Monday to Friday and six times per day in each direction on Saturdays and Sundays.

2.14.6. The 976 service operates between Glasgow and Oban with a typical service of two times per day, seven days a week.

2.15. Existing Environmental Constraints

2.15.1. The development of the Proposed Scheme has included consideration of the environmental constraints present within the Proposed Scheme extents and has sought to mitigate, where possible, the potential for adverse environmental impact. Such mitigation has been embedded into the design of the Proposed Scheme and this has focussed on the avoidance of features of environmental interest / importance and on achieving best fit within the existing environment. Further details on the design development and the consideration of the existing environmental aspects are provided in the EIA Report.

3. Description of the Proposed Scheme

3.1. Introduction

3.1.1. This chapter sets out the description of the Proposed Scheme assessed within this DMRB Stage 3 Scheme Assessment report, which comprises:

- A83 Mainline
- B828 Glenmore local road junction
- DFS maintenance access
- Rest and Be Thankful Viewpoint car park and bus stop / turning area
- Active Travel Link
- Old Military Road Improvements
- Structures, including the DFS and DFW

3.1.2. Where this chapter provides details such as types of structures, drainage, road pavement, road restraint systems, traffic signs, ITS, fencing and utility diversions, these are considered indicative of what the finished design may be, and are subject to further detailed design.

3.2. A83 Mainline

3.2.1. The proposed design speed for the A83 mainline, based on design speed calculations undertaken in line with DMRB CD 109 'Highway Link Design' and supported by speed surveys undertaken on site in October / November 2023 and January / February 2024, is 100kph (band 100B). This has been reviewed and endorsed by Transport Scotland Standards Branch to allow development of the design and associated departures based on the promoted design speed.

3.2.2. The proposed mainline alignment consists of a 7.3m wide carriageway with 1m wide hard strips and 2.5m wide verges within the extents of the DFS, in line with the requirements for Rural Single Carriageways as set out in DMRB CD 127 'Cross-Sections and Headrooms'. Outwith the DFS, lane widths have been reduced from the required 3.65m to 3.35m and hard strips have been reduced from the required 1m to 0.3m due to horizontal geometry constraints including steep sidelong ground on both sides of the trunk road and the presence of the Rest and Be Thankful Viewpoint car park and Loch Restil. The reduction in cross-sectional width requires a Departure from Standard, refer to **Section 4.4** for further details. Verges have been widened locally where practicable for improved visibility.

3.2.3. Cuttings and earthworks are required along the length of the proposed A83 trunk road with the height and extent of these varying depending on local topography and any stability requirements. The design has been developed to minimise the need for earthworks on the lower slopes of Beinn Luibhean, between the A83 and OMR. However, there are significant cuttings required above the A83 in order to accommodate the works proposed for the DFS / DFW and adjacent catchpit.

3.2.4. The proposed mainline includes localised widening in the vicinity of the B828 Glenmore local road junction to accommodate sufficient space for a ghost island, in accordance with DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions'. The provision offers a compliant length right-turn lane of increased width (4.0m) to cater for the increased width of an articulated vehicle.

3.2.5. Engineering plan and profile drawings A83AAB-AWJ-HML-LTS_POC_M01-DR-CH-100002 to A83AAB-AWJ-HML-LTS_POC_M01-DR-CH-100003 for the A83 mainline, detailing the horizontal alignment and vertical profile, can be found in **Volume 2**.

3.3. Junctions and Accesses

B828 Glenmore Local Road Junction

3.3.1. At the existing simple priority junction connecting the A83 and B828 Glenmore local road, it is proposed that the junction design be upgraded to a ghost island junction, see **Figure 3-1** below.

3.3.2. Traffic data collected in October / November 2023 and February / March 2024, indicates an Annual Average Daily Traffic (AADT) count of 4,400 vehicles for the A83 and 300 vehicles for the B828 Glenmore local road within the Proposed

Scheme extents. This data used in accordance with Figure 2.3.1 of DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions' determines a suitable junction form based on traffic volumes, in this case a ghost island junction.

3.3.3. In addition to the provision of a ghost island on the mainline, a traffic island is proposed in the B828 Glenmore local road junction bellmouth to channelise right turning traffic. The island also provides a useful location for flag-type direction signs that would otherwise be located in the opposite verge where they could cause an obstruction to Stopping Sight Distance (SSD) for southbound traffic on the A83.

Figure 3-1 – Plan view of the proposed junction between the A83 and B828 Glenmore local road including the ghost island on the A83 and the channelising island on the B828

3.3.4. An engineering plan and profile drawing A83AAB-AWJ-HSR-LTS_POC_M01-DR-CH-100104 for the B828 Glenmore local road junction, detailing the horizontal alignment and vertical profile, can be found in **Volume 2**.

Debris Flow Shelter Maintenance Access

3.3.5. Located midway between the existing Cobbler Bridge and the start of the DFS, a direct access is proposed to connect the roof of the DFS to the A83 via a maintenance access track. This is to allow maintenance vehicles to access the roof directly to conduct inspections and clear the proposed catchpit of any debris after debris flow or landslide events on the Beinn Luibhean hillside. A plan view of the direct access and maintenance track is presented in **Figure 3-2**, below.

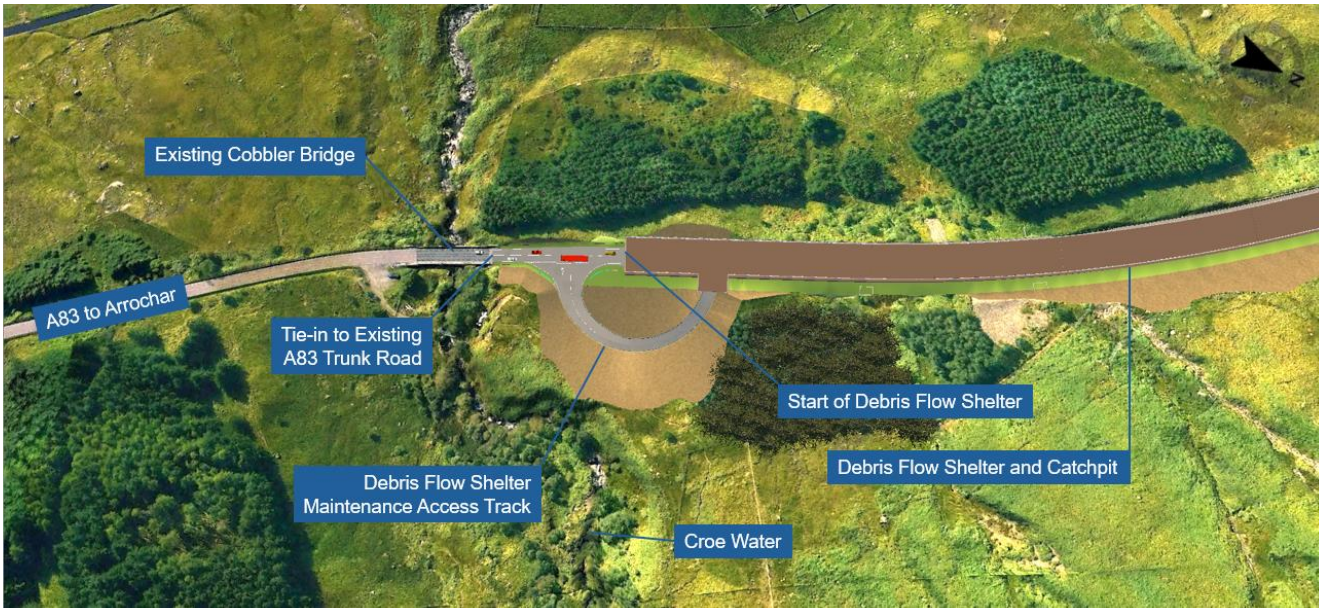

Figure 3-2 – Plan view of the proposed direct access and maintenance track located immediately north of the Croe Water (Cobbler Bridge) providing maintenance access directly to the roof of the DFS

3.3.6. An engineering plan and profile drawing A83AAB-AWJ-HSR-LTS_POC_M01-DR-CH-100105 for the DFS Maintenance Access, detailing the horizontal alignment and vertical profile, can be found in **Volume 2**.

3.4. Proposed Rest and Be Thankful Viewpoint Car Park and Bus Stop / Turning Area

3.4.1. The Proposed Scheme includes improvements to the Rest and Be Thankful Viewpoint car park and bus stop / turning area, see **Figure 3-3**. The Proposed

Scheme layout has been developed to rationalise the current junctions and accesses to the Rest and Be Thankful Viewpoint car park and bus stop / turning area and reduce the number of conflict points on the B828 Glenmore local road.

3.4.2. As such, the Proposed Scheme layout incorporates a single junction between the Rest and Be Thankful Viewpoint car park / OMR and the B828 Glenmore local road. The existing layout has three junctions, all situated within 100m of the junction between the A83 and B828 Glenmore local road.

3.4.3. With the removal of the bus turning area junctions the singular proposed junction can be relocated, further away from the junction between the A83 and B828 Glenmore local road. This relocation increases the distance between the B828 Glenmore local road junction with the A83 and the junction to the Rest and Be Thankful Viewpoint car park from 17m (existing) to 36m (proposed), measured from the centre of the car park junctions to the centreline of the A83 carriageway. This reduces the risk of rear end shunts and queuing back onto the A83 caused by vehicles leaving the A83 and turning directly into the Rest and Be Thankful Viewpoint car park.

3.4.4. Additionally, the proposed Rest and Be Thankful Viewpoint car park junction meets the B828 Glenmore local road at 85 degrees, whist the existing arrangement produces an 80-degree angle. The proposed angle presents an improvement over existing conditions and affords road users better visibility to the left along the B828 Glenmore local road, when exiting the car park junction. The proposed junction will have corner radii of 8m on both sides, which is an improvement over the existing provision, further facilitating easier and safer manoeuvres for vehicles using the junction to enter or exit the car park and bus turning provisions.

Figure 3-3 – Concept design of the proposed Rest and Be Thankful Viewpoint car park improvements with a single junction providing access to the car park and an integrated bus stop / turning area

3.4.5. The proposed car park layout largely replicates the existing arrangement, whereby the public parking facility consists of a large loop that is bisected by a road that creates a second smaller loop. In the proposed layout it is envisaged that the larger loop will be used by smaller passenger vehicles owing to the steeper gradients encountered and the smaller loop will be utilised by larger commercial vehicles (coaches, HGV's etc).

3.4.6. Engineering plan and profile drawings A83AAB-AWJ-HSR-LTS_PRP_V01-DR-CH-100101 to A83AAB-AWJ-HSR-LTS_PRP_V01-DR-CH-100102 for the Rest and Be

Thankful Viewpoint car park, detailing the horizontal alignment and vertical profile, can be found in **Volume 2**.

3.4.7. The proposed layout also provides a similar number of parking bays situated within the car park, albeit in a slightly different arrangement to existing, owing to other car park enhancements. To reduce congestion and driver confusion when navigating the car park, a one-way clockwise system is proposed. This system will be indicated to road users via road markings and traffic signs as appropriate.

3.4.8. Contrary to the existing layout, the proposed layout incorporates the bus stop / turning area within the car park extents. This provision will be situated in a similar footprint to the exiting bus stop / turning area. However, in order to increase the spacing between the car park access and the B828 junction with the A83, the turning area will share a single access with the Rest and Be Thankful Viewpoint car park onto the B828 Glenmore local road.

3.4.9. The proposed arrangement of the bus turning area connects it to the through road of the Rest and Be Thankful Viewpoint car park, which is an extension of the OMR, at two points. The proposed amendments to the bus turning area will incorporate a one-way system and will only be for the use of local and regional buses with appropriate road markings and signage used to indicate this.

3.5. Active Travel Provision

3.5.1. An Active Travel Link, designed in accordance with ‘Cycling by Design’ (2021), has been included as part of the Proposed Scheme providing a link between the Rest and Be Thankful Viewpoint car park and the forestry tracks on the lower slopes of Ben Donich, on the opposite side of Glen Croe.

3.5.2. The Active Travel Link, as shown in **Figure 3-4**, is approximately 560m long, consisting of a 2.75m wide paved surface and 0.5m (min.) wide verges. The Active Travel Link runs immediately adjacent to the B828 Glenmore local road for approximately 315m, with separation provided by a kerb. The Active Travel Link then meanders away from the edge of the B828 for approximately 315m to avoid clashing with existing utility and cultural heritage assets.

3.5.3. Engineering plan and profile drawings A83AAB-AWJ-HKF-LTS_GEN_V01-DR-CH-001102 to A83AAB-AWJ-HKF-LTS_GEN_V01-DR-CH-001103 for the Active Travel Link, detailing the horizontal alignment and vertical profile, can be found in **Volume 2**.

Figure 3-4 – Plan view of the proposed Active Travel Link adjacent to the B828 Glenmore local road connecting the Rest and Be Thankful Viewpoint car park to the Glen Croe Forestry Track / Core Path

3.5.4. The design of the active travel link has evolved to avoid impact on the important cultural heritage assets that form the remains of a Home Guard Stop Defence from World War Two (WWII). The ruins are composed of a group of WWII assets, including a spigot mortar emplacement and a Nissen hut, located in and around a natural depression adjacent to, and south of, the B828 Glenmore local road. A picture of the spigot mortar emplacement is included in **Figure 3-5**, below.

Figure 3-5 – Photograph of a spigot mortar emplacement adjacent to the B828 Glenmore Local Road with the A83, OMR, Beinn Luibhean and The Cobbler in the background

3.5.5. In addition, the paths to the east of the A83 which access the Arrochar Alps from the existing informal access to the south of the Croe Water (Cobbler Bridge) will be retained and the Proposed Scheme will ensure access is retained to existing routes.

3.6. Old Military Road Improvements

3.6.1. To support the construction of the Proposed Scheme and provide a suitable, more resilient diversion route for A83 Trunk Road traffic, a series of Improvements to the OMR are proposed as follows:

- widening of the OMR over a length of approximately 1.4km to accommodate two-way traffic including a new proprietary bridge structure that will carry southbound traffic with northbound traffic continuing on the existing bridge over the Croe Water (refer to Section 2.9.5, above);
- localised widening at three existing sharp bends at the northern end of Glen Croe to assist HGVs in navigating the narrow carriageway when using the OMR as the diversion route;
- an approximately 150m long debris flow protection earthwork bund to protect the OMR during debris flow and rock fall events;
- extension of the existing HESCO barrier by approximately 150m to protect the OMR during debris flow and rock fall events; and,
- installation of debris flow and rock fall fences above the A83 Trunk Road to increase resilience of the OMR. New fences are proposed where there are currently no geotechnical interventions.

3.6.2. **Figure 3-6** shows the OMR Improvements in context to the A83 Trunk Road.

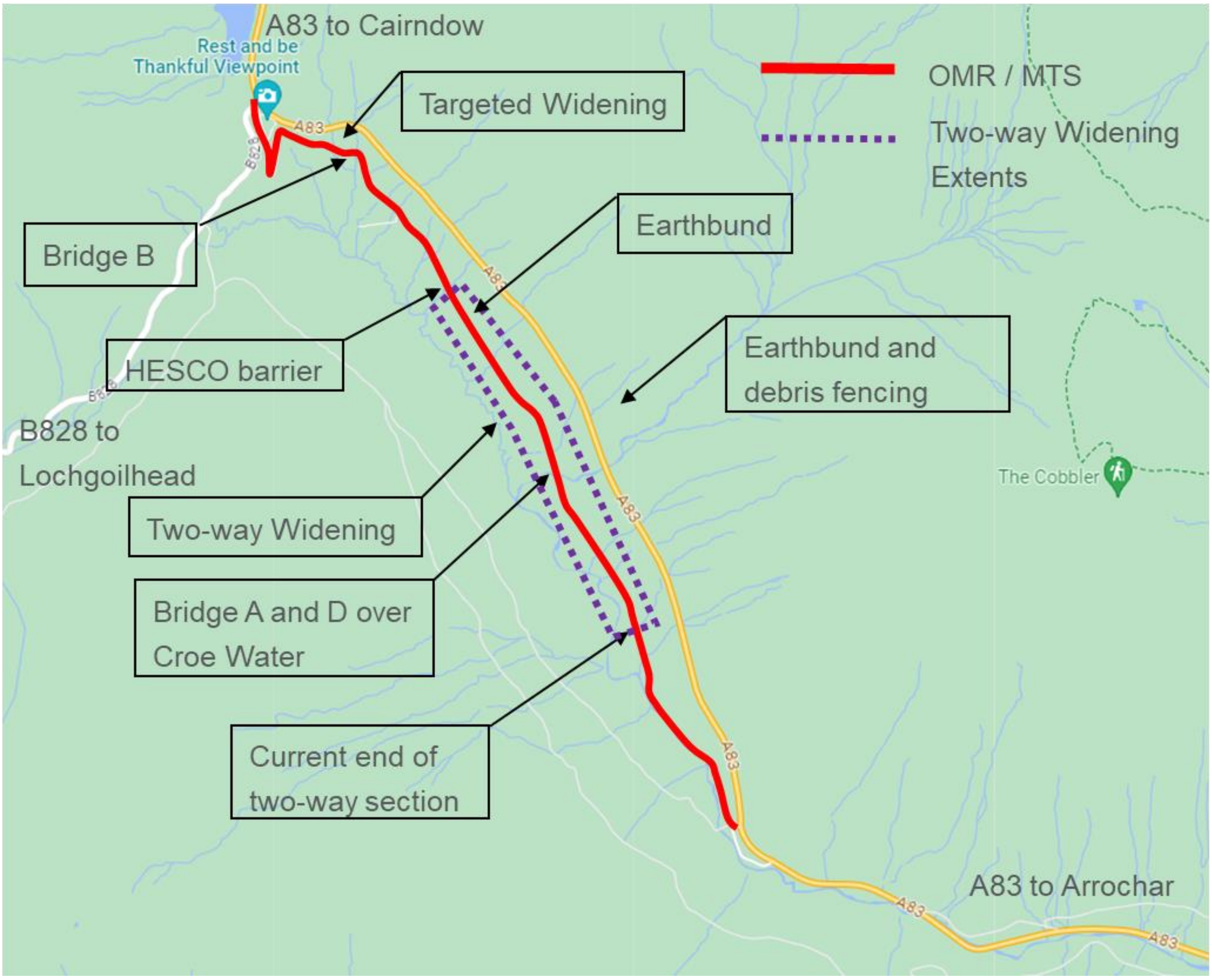

Figure 3-6 – Improvements to the OMR in context to the A83 Trunk Road

3.6.3. Engineering plan and profile drawings A83AAB-AWJ-HGN-MTS_MB0-DR-CH-000050 to A83AAB-AWJ-HGN-MTS_MB0-DR-CH-000056 for the OMR Improvements, detailing the horizontal alignment and vertical profile, can be found in **Volume 2**.

3.7. Drainage

A83 Mainline, B828 Glenmore Local Road and Active Travel Link Drainage

3.7.1. The drainage proposals for the Proposed Scheme have been developed in accordance with the DMRB.

3.7.2. Generally, the proposed road drainage philosophy looks to formalise the road drainage with proposed networks to drain the carriageway, verges and earthworks. This provides formalisation of treatment proposals, ensuring Highways England Water Risk Assessment Tool (HEWRAT) compliance, as well as ensuring road flooding compliance with the DMRB.

3.7.3. Where required to intercept natural catchment runoff prior to the road, cut-off drainage is proposed which diverts runoff to culverts and watercourses / channels.

3.7.4. Where new drainage is proposed, the design includes the following features:

- Filter Drains (acting as combined surface and sub-surface drains)
- Carrier Drains
- Filter-Carrier ‘Piggy-Back’ Drains
- Gullies
- Cut-Off Ditches and Filter Drains
- Precast Concrete Headwalls
- Type 8 Inspection Chambers
- Type 7 Catchpits
- Manholes (Type 2A and 4A)
- Combined Kerb Drainage Units
- Linear Drainage Channel Units
- A bespoke pipe bridge design to cross the Croe Water (Network 1 specific)
- Penstock Emergency Shut-Off Valves
- Flow Controls (Orifice Plates and Vortex Flow Controls)

3.7.5. The drainage layouts for the Proposed Scheme are included on drawings A83AAB-AWJ-HDG-LTS_POC-DR-CD-000001 to A83AAB-AWJ-HDG-LTS_POC-DR-CD-000010 contained in **Volume 2**.

3.7.6. In relation to water quality treatment, Network 1 specifies filter drains and a detention basin, with all other A83 networks proposing filter drains for treatment. Network 4A to 4G, which drains the Active Travel Link adjacent to the B828 Glenmore local road, doesn't provide treatment as the runoff from the proposed footpath is considered 'clean'. AWJV have presented the proposals to SEPA at meetings held on 27 September 2023 and 15 May 2024, gaining approval in principle.

3.7.7. In relation to flood risk, the road networks along the A83 have been designed to ensure no flooding of the pipe networks during the 1 in 5 year plus 46% climate change event. For Network 1, attenuation is provided within the detention basin, with the basin itself designed to contain the 1 in 200 year plus 46% climate change event. For the other networks along the A83, attenuation is provided within oversized pipes due to the constrained locations restricting alternative storage options. For the networks along the Active Travel Link adjacent to the B828 Glenmore local road, the additional catchment area due to the link is proposed to be captured and attenuated within oversized pipes, with no flooding during the 1 in 30 year plus 46% climate change event, in line with local authority guidance. The networks all discharge during the relevant return periods at a rate of Q-Bar greenfield rate estimation.

Old Military Road Drainage

3.7.8. It is not deemed proportionate to fully achieve DMRB compliance for the OMR drainage works due to the nature of the road and Proposed Scheme interventions. The drainage strategy has been developed with consideration of DMRB and Local Authority (Argyll and Bute Council) standards, where possible.

3.7.9. Generally, the proposed road drainage philosophy followed is to maintain the existing drainage scenario or feasibly formalise drainage elements along the OMR.

Assessments have been conducted on the existing drainage to determine the suitability for retention. In locations where road works are proposed and existing drainage is impacted, such as the 2-way widening and locations of sharp bend widening, feasible drainage amendments have been proposed.

3.7.10. Where new drainage is proposed, the design includes the following features:

- Filter Drains (acting as combined surface and sub-surface drains)
- Carrier Drains
- Gullies
- Cut-Off Ditches and Filter Drains
- Stone Mesh Headwalls
- Type 8 Inspection Chambers
- Type 7 Catchpits
- Flow Controls (Orifice Plates and Vortex Flow Controls)

3.7.11. The drainage layouts for the Proposed Scheme are included on drawings A83AAB-AWJ-HDG-MTS_MB0-DR-CD-050151 to A83AAB-AWJ-HDG-MTS_MB0-DR-CD-050154 and A83AAB-AWJ-HDG-MTS_MB0-DR-CD-050170 to A83AAB-AWJ-HDG-MTS_MB0-DR-CD-050171 contained in **Volume 2**.

3.7.12. Surface water runoff from the OMR drainage system derives from the road cross-section, including the carriageway and verges, together with the associated earthworks. Additional surface flow from runoff draining towards the Proposed Scheme from natural catchment outside the road corridor will be kept separate from the road drainage system where practicable by cut-off drainage (ditches and filter drains where space constraints require).

3.7.13. This cut-off drainage will be used to control surface water run-off from embankments, cuttings, existing hillside etc. and where existing ground profiles require them to act as cut-off drains to contribute to controlling run-off. These will replace existing cut-off drainage where required and divert runoff to local watercourses / channels.

3.7.14. In relation to water quality treatment, the drainage strategy aims to provide betterment and formalisation of drainage in comparison to the current arrangement. AWJV have presented the proposals to SEPA within the ESG January 2024 consultation meeting, gaining approval in principle.

3.7.15. In relation to flood risk, a zero-detriment approach in comparison to the existing scenario has been followed for the new alignment proposals. Where drainage networks are controlled to allowable discharge rates (based on a zero-detriment approach pre and post development assessment), the restriction of flow is achieved through the installation of flow controls (vortex flow controls and orifice plates). With regards to Flood Management, Argyll and Bute Council are in a local plan district with Highland Council, with Highland Council being the Lead Local Authority. In line with section 6.13 of 'The Highland Council's Flood Risk and Drainage Impact – Supplementary Guidance', allowable discharge rates and volumes draining to a receiving watercourse/waterbody shall not exceed the existing runoff rates for Brownfield sites, or the Greenfield runoff rate for previously undeveloped sites. This is why a zero-detriment approach pre and post development assessment is conducted.

3.7.16. Where required, attenuation of runoff is achieved in the use of oversized pipes. This avoids the need for attenuation features such as ponds and basins to be specified.

3.8. Structures

Debris Flow Shelter

3.8.1. The DFS is the primary structure within the Proposed Scheme, see **Figure 3-7** below. The DFS acts as a rigid barrier to protect the A83 from debris flow, landslide and rockfall events. An approximately 6m wide catchpit, with minor width variations along its length due to the existing ground profile, is located at the rear of the hillside wall. The catchpit provides capacity for debris and rockfall collection, and to convey watercourses from the slopes of Beinn Luibhean above, into culverts beneath the A83.

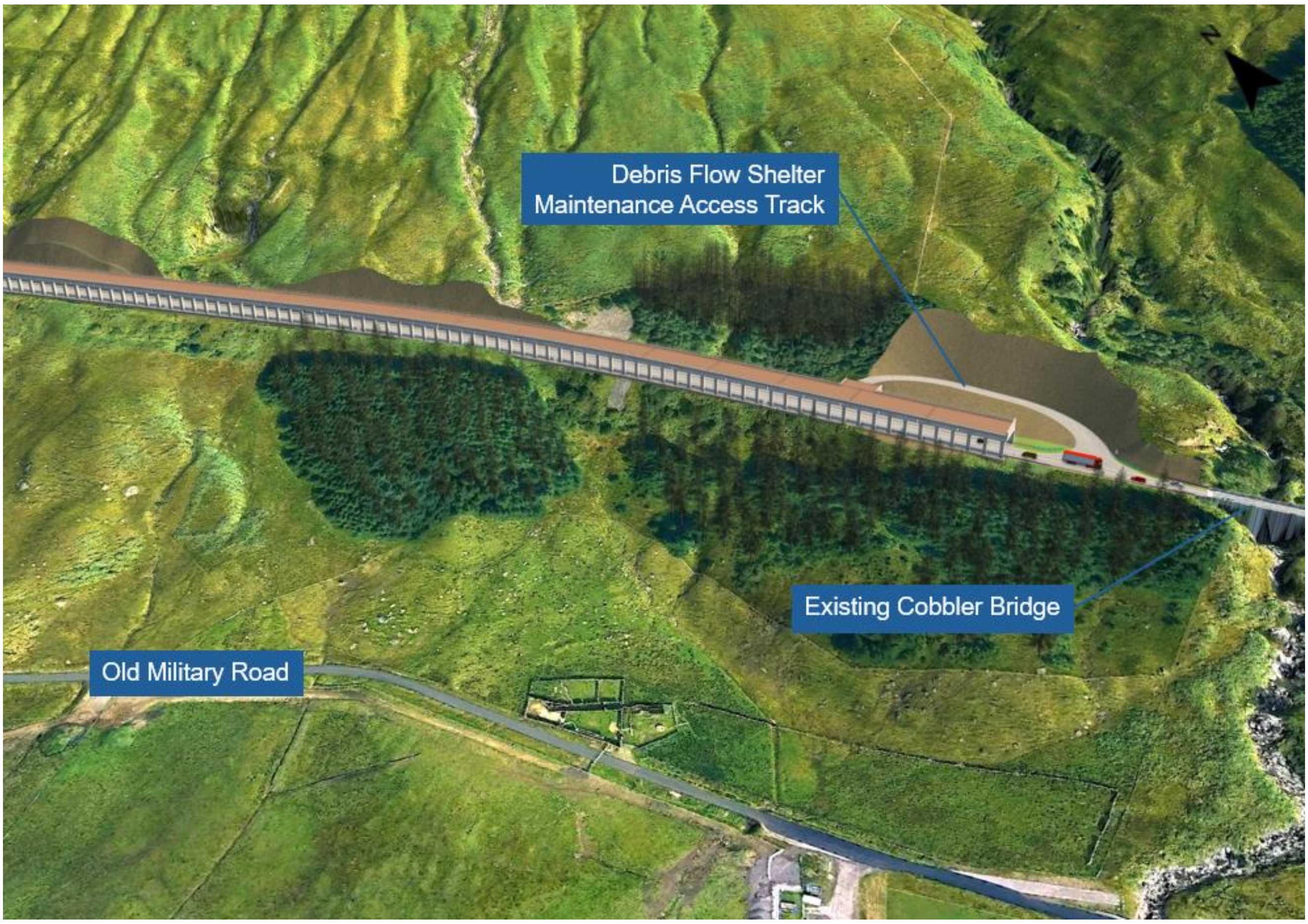

Figure 3-7 – Computer generated image of the DFS at the southern end of the Proposed Scheme

Debris Flow Protection Wall

3.8.2. Two DFWs are proposed in a staggered arrangement to the north of the DFS in the southbound verge to allow access behind the DFW, see **Figure 3-8** below. The DFWs will provide a similar function to the DFS, acting as barriers to protect the A83 from debris flow and rockfall events. Similar to the DFS, a catchpit to the rear of the DFWs will provide additional debris collection capacity. Access will be provided to the catchpit behind the DFW at its southern end for maintenance and operation activities. However, there is also the potential for equipment and plant to locally lifted into the catchpit from the roof of the DFS where necessary.

Figure 3-8 – Computer generated image of the DFW at the northern end of the Proposed Scheme

B02 Burn Bridge

3.8.3. A new crossing carrying the A83 over an unnamed watercourse is proposed to the north of the DFW, see **Figure 3-9** below. The A83 is curved on plan with a variable radius at this location. Debris flow and landslide material will be allowed to pass under the A83 at this location and into the base of Glen Croe below.

Figure 3-9 – Computer generated image of B02 Burn Bridge at the northern end of the Proposed Scheme

A83 Culverts and Watercourse Realignments

3.8.4. It is proposed that the 15 existing watercourse crossings within the footprint of the DFS and DFW shall be replaced with 13 new crossing structures. Watercourses A83_ML_020, A83_ML_021 and A83_ML_022 are proposed as a single combined crossing, as these watercourses currently share a confluence downstream of the A83. Further information regarding the appraisal process and siting of the proposed structures can be found in **Volume 2**. The culverts are required to facilitate the conveyance of existing watercourse channels and sediment underneath the DFS and DFW structures.

3.8.5. Sizing requirements have been dictated by the need to convey fluvial flows and sediment whilst also providing suitable access for maintenance and inspection. As the culverts are confined spaces the proposed sizing and hydraulic performance has been optimised to reduce the requirement for man-entry into the structure.

3.8.6. The culvert inlets shall comprise of grated drop inlet structures located in the base of the catchpit. The location of the culvert inlets is such that in the event of blockage of one culvert, flows will be conveyed south via the catchpit to the next available culvert. The grated inlet is suitably sized to limit the size of sediment which can enter the culvert structures. Sediment conveyance through the structure shall be further improved by inclusion of a low flow notch running longitudinally in the invert of the structure.

3.8.7. Downstream of the culvert crossings, culvert aprons shall be implemented to facilitate maintenance access to the box culverts. A secondary function of the apron shall be to provide energy dissipation of flows exiting the culvert, prior to discharging to the downstream channel. Transverse baffles shall therefore be incorporated into the channel invert.

3.8.8. The proposed culvert alignments have been defined by identifying the existing culvert inlet and outlet locations in cognisance of the condition of the hillside downslope of the existing A83. The proposed culverts have been aligned perpendicular to the road to minimise the crossing length and to fit the structures in between the piles which form the foundation for the DFS.

3.8.9. Where practicable the proposed crossing alignment (vertical and planform) has been defined to ensure the proposed culvert ties in with the existing watercourse channel downstream of the DFS and DFW. However, due to the depth of some of the existing culverts below the existing A83, several proposed culverts will require additional engineering measures on the downslope side to achieve the tie-in with the existing watercourse. Vertical and planform watercourse realignments will be required in these cases to provide a tie-in channel between the proposed culverts and the existing watercourse channels.

3.8.10. Of the 13 proposed watercourse crossings under the DFS and DFW, 11 shall require channels to be implemented between the culvert apron and the existing downstream channel. Of these 11 channels, two are required to replace existing cascade structures, and nine are required to implement a transition channel where one does not currently exist. Due to the steep nature of these channels and the ground conditions underlying the site, scour risk is very high and presents a high likelihood of material loss on the downslope side of the road unless appropriately mitigated. In addition, saturation of the superficial deposits is thought to contribute to the propagation of debris flows. Existing scour processes are prevalent throughout the Proposed Scheme extents, and future scour could result in material loss around the piled foundation of the culverts and DFS if not appropriately mitigated. Preference has been given to realignment solutions which are scour resistant and reduce the risk of ground saturation adjacent to the A83. It is proposed that the 11 diversions shall utilise engineered cascades for these reasons.

3.8.11. The engineered cascades are required to convey the flow and sediment from the channel upstream of the A83 to the existing downstream channel. Introducing a stepped profile will aid in the management of energy through the transition between these two points. Introducing a stepped profile in the channel will encourage aeration of the flow and thus the flow will operate in accordance with two-phase flow hydraulics. The proposed design will be required to operate in either the nappe flow or skimming flow regime at the design discharge. Transitional flow regimes should be avoided at high flows due to induced pressure fluctuations and unpredictable flow velocities and depths. Further information on the form of the cascades is provided in **Section 4.9**.

3.8.12. Flexible scour mitigation is proposed at all transition points between hard inverts and erodible material within the water environment. Flexible solutions are required where scour is likely to occur to adapt to material loss and changes in bed profile over time, as evidenced by the undermining of the existing energy dissipation structures on the A83.

Bridge B

3.8.13. Bridge B is an existing single span masonry arch bridge located on the OMR and crossing a tributary of Croe Water. Alterations to this bridge will be required. To minimise disruption, sections of the OMR will be widened, which includes the widening of Bridge B, where the downstream parapet will be demolished and rebuilt to extend the structure's width by 1.5 meters.

Bridge D

3.8.14. A temporary bridge structure will span a tributary of Croe water. The structure will be located adjacent to the existing OMR parallel to, and approximately 3m upstream of the existing Bridge A. Due to limited width at the existing Bridge A site, the temporary bridge structure will carry the southbound traffic, and the existing bridge will carry the northbound traffic.

Bridge E

3.8.15. A new pipe bridge will span approximately 13 meters across the Croe water. The bridge will be located adjacent to Bridge A. The bridge will channel water directly into the proposed attenuation basin. The carrier pipe will have sufficient diameter to accommodate expected water flow into the attenuation basin.

3.9. Land Required for the Proposed Scheme

General Summary

3.9.1. The overall Proposed Scheme requires the purchase of land to allow its construction, future operation and maintenance. Land required for the Proposed Scheme, in excess of that already owned by Scottish Ministers, will be acquired through the Compulsory Purchase Order (CPO) process.

3.9.2. It may be desirable for the successful Contractor to acquire additional areas of land for locating the construction site compound and any storage areas. Such additional areas will not be included within the Land Made Available (LMA) by the Employer for the Works and will be required to be obtained by the Contractor through negotiation with adjacent Landowners, and subject to a separate planning process as appropriate.

Land Take Required for the A83 Improvements

3.9.3. The total land take for the Proposed Scheme is approximately **31.15ha.** This includes **10.85ha (34.85%)** of land currently owned by The Scottish Ministers as

FLS and Transport Scotland. This land does not include the existing A83 Trunk Road carriageway but includes land adjacent to the carriageway on the slopes of Beinn Luibhean. The areas of land included in the compulsory purchase orders (CPO) is approximately **20.29ha**, (**65.15%**).

3.9.4. The majority of the CPO land is acquired from private landowners (**12.01ha**).

3.9.5. Land to be acquired from Argyll and Bute Council accounts for **0.38ha**.

3.9.6. A large portion of land, including the existing A83 carriageway and sections of the B828 Glenmore local road carriageway does not have a registered title or otherwise does not have confirmed land ownership ("unknown" plots). These areas account for **7.9ha**.

Land Take Required for the OMR Improvements

3.9.7. The total land take necessary for the OMR Improvements is approximately **10.47ha.** This includes **2.4ha (22.96%)** of land currently owned by The Scottish Ministers. The areas of land included in the compulsory purchase orders (CPO) is approximately **8.06ha**, (**77.04%**).

3.9.8. The majority of the CPO land is acquired from a private landowners (**7.29ha**).

3.9.9. Land to be acquired from Argyll and Bute Council accounts for **0.03ha**.

3.9.10. A portion of land does not have a registered title or otherwise does not have confirmed land ownership ("unknown" plots). These areas account **0.7ha**.

3.10. Cost Estimate

3.10.1. Throughout the development of the Proposed Scheme, the cost estimate has been reviewed and refined. The out-turn cost estimate is provided in **Table 3-1**.

Table 3-1 – Range Estimate at Outturn

Range Description	Range Estimate at Outturn (£ @ Q2, 2024) (including project risk and opportunity, Optimism Bias (OB) and Value Added Tax (VAT))
Minimum Estimate	£408,741,429
Central Estimate	£458,659,020
Maximum Estimate	£508,504,937

Cost Overview

3.10.2. The total capital cost estimate at Q2 2024 price base is £286m; while the direct construction cost including preliminaries is £237.5m; with supervision, statutory undertaker and non-recoverable VAT totalling £48.5m as shown below in **Table 3-2**.

Table 3-2 – Summary Scheme Cost Estimate Breakdown ("Q2 2024" capital costs)

Element	**Latest Indicative Forecasts (£ @ Q2, 2024)**
Construction Phase Costs	
Preliminaries	£58.9m
Sub Total A83 Core Construction (Series 200 to Series 3000)	£110.8m
Total Cost of Structures	£67.8m
Total Direct Construction Costs	**£237.5m**
Other Costs in Construction (Supervision, Statutory Undertakers, NR-VAT)	**£48.5**
Capital Cost (Total Base Estimate)	**£286m**

3.10.3. A summary of project risk, opportunity and optimism bias is included in **Table 3-3**, below.

Table 3-3 – Summary of Risk, Opportunity and Optimism Bias

Element	Minimum Estimate	Central Estimate	Maximum Estimate
Total Project Risk – Opportunity	£27.0m	£66.5m	£105.9m
Optimism Bias Adjustment – Roads (23%), Fixed Links (32%)	£88.3m	£98.7m	£109.1m

Scheme Preparation Costs

3.10.4. The Employer's costs contained within the above cost estimate are made up of the following:

- Professional fees – including all consultants and other advisors appointed in respect of the Proposed Scheme during both preparation and site supervision stages
- Survey costs – including ground investigations
- Land purchase and compensation payments
- District valuer and legal fees
- Statutory diversions

Works Costs

3.10.5. The Works Costs are priced on the basis of quantities and rates. Quantities were generated from the DMRB Stage 3 design and rates were obtained through comparison with similar contracts and from standard industry pricing information. Prices are for Q2 2024.

Project Risk and Opportunity

3.10.6. A comprehensive list of project risks and opportunities have been considered in the cost estimates. These risks and opportunities were evaluated using the Scottish Governments guidance ‘Risk Management – The Scottish Government Guide (October 2023)’ with potential impact and potential likelihood assessed to establish an overall risk profile. The analysis was undertaken to generate appropriate risk allowances to apply to cost estimates in line with HM Treasury Guidance.

3.10.7. The range of costs presented i.e. “minimum” and “maximum” and the mid-range “central” estimates within **Table 3-3** were developed from these risk range values.

Optimism Bias

3.10.8. HM Treasury Guidance also requires that an assessment of optimism bias is undertaken for the Proposed Scheme which takes account of the risk assessment process and the relevant assessment stage.

3.10.9. The optimism bias values adopted in the DMRB Stage 3 cost estimation are in line with the guidance set out in the Department for Transport ‘Transport Analysis Guidance (May 2024)’ which indicates values of 23% and 32% for roads and fixed links, respectively.

Do Minimum Definition

3.10.10. For the Proposed Scheme economic assessment (see Chapters 5 and 6), it is necessary to compare the Proposed Scheme with a Do-Minimum scheme. The Do-Minimum scheme incorporates any improvements which are foreseeable if the Proposed Scheme was not to be built. The Do-Minimum scheme therefore comprises the existing “asset” plus any future programmed maintenance interventions as described below.

Programmed Maintenance Interventions

3.10.11. For the economic assessment, the Do-Minimum scheme is assumed to include the retention of the existing asset, with the addition of the programmed maintenance interventions assumed in the costing model. These maintenance interventions ensure the level of service of the road is maintained at an operational level throughout the assessment period of 60 years.

3.10.12. The likely maintenance intervention works all assume medium to major works which aim to improve the condition and functionality of the asset e.g. carriageway resurfacing and replacement of bridge components. These assumptions have been incorporated into a costing model over the 60-year assessment period.

Typical Routine Maintenance Works

3.10.13. Routine service operations include cyclic, reactive and planned activities that enable the trunk road network to remain safe and serviceable. These activities include reactive repairs and winter maintenance, as well as flood and emergency responses. The three main types of activity are:

- Cyclic maintenance – examples of cyclic activities include cutting of vegetation, cleaning of drainage systems, replacement of lighting lamps, and litter picking
- Reactive and planned routine maintenance – reactive maintenance covers a range of unplanned activities that may arise on the trunk road network, including essential maintenance to fix defects
- Winter maintenance – the implementation of Winter Service Plans.

Whole Life Cost Models for both ‘Do-Minimum’ and ‘Do-Something’

3.10.14. The inclusion of programmed maintenance interventions and routine works costs help determine the whole life costing of both scenarios during the 60-year assessment period and hence allow the overall costs of both scenarios to be determined.

3.10.15. In order to develop a cost model for both the Do-Minimum and Do-Something scenarios it was necessary to review typical costs for single carriageway assets and incorporate these allowances into the costing models for each of the costing scenarios. The typical assumptions included are outlined in **Table 3-4**, below.

Table 3-4 – General 'Do Minimum' Cost / Maintenance Assumptions

Item No.	Variations Considered
1	Full reconstruction, assume 2035
2	10 years – Surface course treatment, 2045
3	10 years – Surface course treatment, 2055
4	30 years after item 2 – Replace Binder and Thin Surface Course, 2065
5	10 years – Surface course treatment, 2075
6	10 years – Surface course treatment, 2085
7	Risk of landslide and implementation of the local diversion
8	Landslide, clearance of debris flow / landslide material and implementation of the local diversion

4. Engineering Assessment

4.1. Introduction

4.1.1. The Proposed Scheme, as described in Chapter 3, has been developed from the preferred route outlined and recommended in the DMRB Stage 2 Assessment Report.

4.1.2. This chapter provides a review of key design elements, such as, the alignment of the Proposed Scheme, a summary of the geotechnical survey information, drainage and hydrology issues, an assessment of the proposed structures, a review of the engineering problems and significant layout issues including proposed departures from standards. The chapter also discusses constructability and potential traffic management arrangements, as well as operational considerations.

4.1.3. Where this chapter provides details on the various elements of the design, these are merely indicative of what the finished design may be and are subject to further detailed design and consultation.

4.2. Engineering Standards

4.2.1. The Proposed Scheme has been designed in accordance with the guidance set out in DMRB Volume 6 'Road Geometry' and other design standards as noted below:

- DMRB CD 109 – Highway Link Design;
- DMRB CD 123 – Geometric Design of At-grade Priority and Signal-controlled Junctions;
- DMRB CD 127 – Cross-Sections and Headrooms;
- DMRB CD 169 – The Design of Lay-bys, Maintenance Hardstandings, Rest Areas, Services Areas and Observation Platforms;
- DMRB CD 352 – Design of Road Tunnels;
- DMRB CD 377 – Requirements for Road Restraint Systems; and TD19/06 - Requirement for Road Restraint Systems;

- DMRB CG 501 – Design of Highway Drainage Systems;
- DMRB GD 300 – Requirements for new and upgraded all-purpose trunk roads (expressways); and
- DMRB CG 300, Technical approval of highway structures
- DMRB CD 350, The design of highway structures
- DMRB CD 355, Application of whole-life costs for design and maintenance of highway structures
- DMRB CD 358, Waterproofing and surfacing of concrete bridge decks
- DMRB CD 369, Surface protection for concrete highway structures
- DMRB CD 373, Impregnation of reinforced and prestressed concrete highway structures using hydrophobic pore-lining impregnants
- DMRB CD 374, The use of recycled aggregates in structural concrete
- DMRB GD 304, Designing health and safety into maintenance
- National Road Development Guide (SCOTS)
- Manual for Streets 2.
- BS EN 1990:2023, Eurocode – Basis of structural and geotechnical design
- National Annex to BS EN 1990:2002+A1:2005
- BS EN 1997-1:2004, Eurocode 7: Geotechnical design
- National Annex to BS EN 1997-1:2004
- BS EN 1990:2023, Eurocode – Basis of structural and geotechnical design
- National Annex to BS EN 1990:2002+A1:2005
- BS EN 1991-1-1:2002, Actions on structures. General Actions. Densities, self-weight, imposed load for buildings
- NA to BS EN 1991-1-1:2002, UK National Annex to Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings
- BS EN 1991-1-5:2003, Actions on structures. General Actions. Thermal actions
- NA to BS EN 1991-1-5:2003, Actions on structures. General Actions. Thermal actions

- BS EN 1991-1-6:2005, Actions on structures. General Actions. Actions during execution
- NA to BS EN 1991-1-6:2005, Actions on structures. General Actions. Actions during execution
- BS EN 1991-1-7:2006 +A1:2014, Actions on structures. General Actions. Accidental actions
- NA+A1 to BS EN 1991-1-7:2006+A1:2014, UK National Annex to Eurocode 1: Actions on structures. Part 1-7: Accidental actions
- BS EN 1991-2:2003, Actions on structures. Traffic loads on bridges
- NA +A1:2020 to BS EN 1991-2:2003, Actions on structures. Traffic loads on bridges
- BS EN 1992-1-1:2004 + A1:2014, Eurocode 2: Design of concrete structures - General rules and rules for buildings
- NA + A2:2014 to BS EN 1992-1-1:2004 + A1:2014, UK National Annex to Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings
- BS EN 1992-2:2005, Eurocode 2: Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules
- NA to BS EN 1992-2:2005, UK National Annex to Eurocode 2: Design of concrete structure – Part 2: Concrete bridges – Design and detailing rules
- BS EN 1992-4:2018, Design of concrete structures – Part 4: Design of fastenings for use in concrete
- NA to BS EN 1992-4:2018, Design of concrete structures – Part 4: Design of fastenings for use in concrete
- BS EN 1994-1-1:2004, Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings
- NA to BS EN 1994-1-1:2004, Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings
- BS EN 1994-2:2005, Design of composite steel and concrete structures – Part 2 General rules and rules for bridges

- NA to BS EN 1994-2:2005, Design of composite steel and concrete structures – Part 2 General rules and rules for bridges
- PD 6694-1:2011 + A1:2020, Recommendations for the design of structures subject to traffic loading to BS EN 1997-1
- BS EN 13670:2009, Execution of concrete structures
- BS 8500-1:2023, Concrete – Complementary British Standard to BS EN 206: Method of specifying and guidance for the specifier.
- BS 8500-2:2023, Concrete – Complementary British Standard to BS EN 206: Specification for constituent materials and concrete.
- BS 8666:2020, Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete
- BS 6031:2009, Code of practice for earthworks
- BS 8002:2015, Code of practice for earth retaining structures
- BS 8004:2015, Code of practice for foundations
- BS 8006-2:2011 + A1:2017, Code of practice for strengthened/reinforced soils. Soil nail design
- BS 8081:2015, Code of practice for grouted anchors
- BS EN 14490:2010, Execution of special geotechnical works - Soil nailing
- BS EN ISO 22477-5:2018, Geotechnical investigation and testing. Testing of geotechnical structures - Testing of grouted anchors
- CIRIA C543, Bridge Detailing Guide
- CIRIA C686, Safe Access for Maintenance and Repair
- CIRIA C760, Guidance on embedded retaining wall design
- CIRIA C766, Control of cracking caused by restrained deformation in concrete

- Austrian Standards
  - ASI (2009) ONR 24800: Protection works for torrent control – Terms and their definitions as well as classification. Austrian Standards Institute, Vienna, Austria

  - ASI (2013) ONR 24801: Protection works for torrent control – Static and dynamic actions on structures. Austrian Standards Institute, Vienna, Austria
  - ASI (2011) ONR 24802: Protection works for torrent control – Design of structures. Austrian Standards Institute, Vienna, Austria
  - ASI (2009) ONR 24803: Protection works for torrent control – operation, monitoring, maintenance. Austrian Standards Institute, Vienna, Austria

- Chinese Standard (MLR, 2006)
  - Specification of Geological Investigation for Debris Flow Stabilisation by the ministry of Land and Resources, China

- Japan Technical Standard (NILIM, 2007)
  - Manual of Technical Standard for Designing Sabo Facilities against Debris Flow and Driftwood by the National Institute for Land and Infrastructure Management, Japan

- Taiwanese Technical Manual (SWCB, 2005)
  - Manual of Soil and Water Conservation by the Soil and Water Conservation Bureau, Taiwan

- Hong Kong GEO Reports
  - Lo, D.O.K. (2000) Review of natural terrain landslide debris-resisting barrier design. Geo Report No.104. Civil Engineering and Development Department, Hong Kong.
  - Kwan, J.S.H. (2012) Supplementary technical guidance on design of rigid debris-resisting barriers. GEO Report No. 270. Civil Engineering and development Department, Hong Kong

4.2.2. The list is not exhaustive, and elements of good industry practice have been applied throughout the design as necessary.

4.3. Proposed Scheme (Geometry)

4.3.1. A design speed analysis has been undertaken on the proposed A83 in accordance with DMRB CD 109 'Highway Link Design' with the results of a speed survey used to verify the desk-based assessment. This concluded a proposed design speed of 100kph (band 100B). This is one band above the existing design speed 85A, which was expected given the proposed modifications as follows:

- Bendiness (B) – Unchanged, as the proposed highway geometry is largely coincident with the existing layout.
- Harmonic Mean Visibility (VISI) – A minor improvement is demonstrated in the proposed layout as the slight reductions through the DFS are more than offset by the increased forward visibility associated with the bends near the Rest and Be Thankful Viewpoint and Car Park.
- Layout Constraint (Lc) – Represents the most significant change, by increasing the carriageway cross-section from 6.0m to 7.3m and the verges from 1.5m to 2.5m. This results in a seven-point change in Lc from 28 to 21, which has the effect of raising the design speed by one band (85A to 100B in this case).

4.3.2. It is considered that the existing speed survey data correlates well with the theoretical analysis undertaken for the existing layout, with the surveyed 85th percentile average speed of 87.4kph and the calculated design speed of 85kph (band 85A). It is therefore considered that the proposed increase in cross-section will produce the anticipated increase in speed and the 100kph (band 100B) design speed calculated in the desk-based assessment will likely be realised when the proposed layout opens to traffic. Whilst it is thought that the confines of the DFS could result in additional "driver shyness" which the Layout Constraint does not take into account, it is considered that this speed reduction will not be sufficient to reduce the design speed given that the proposed layout represents a 100kph (band 100B) design speed at the upper end of the band.

A83 Mainline

4.3.3. In general, the line of the existing horizontal alignment on the A83 has been used to create the route alignment. **Table 4-1**, below, provides a summary of the horizontal elements associated with the proposed alignment.

Table 4-1 – A83 Mainline Horizontal Design Summary

Start Ch. (m)	End Ch. (m)	Element	Radius(m)	Length (m)
0+000.00	0+012.35	Straight	-	12.352
0+012.35	0+074.87	Left Arc	2040.000	62.519
0+074.87	0+158.55	Straight	-	83.676
0+158.55	0+206.55	Transition	-	48.000
0+206.55	0+357.74	Left Arc	750.000	151.193
0+357.74	0+405.74	Transition	-	48.000
0+405.74	0+501.46	Straight	-	95.724
0+501.46	0+554.46	Transition	-	53.000
0+554.46	0+627.78	Left Arc	680.000	73.316
0+627.78	0+680.78	Transition	-	53.000
0+680.78	0+734.78	Transition	-	54.000
0+734.78	0+746.26	Right Arc	670.000	11.477
0+746.26	0+800.26	Transition	-	54.000
0+800.26	0+840.30	Straight	-	40.043
0+840.30	0+875.30	Transition	-	35.000
0+875.30	0+895.00	Left Arc	1020.000	19.696
0+895.00	0+930.00	Transition	-	35.000
0+930.00	0+958.04	Straight	-	28.044

Start Ch. (m)	End Ch. (m)	Element	Radius(m)	Length (m)
0+958.04	1+042.49	Left Arc	2040.000	84.453
1+042.49	1+109.33	Straight	-	66.837
1+109.33	1+144.33	Transition	-	35.000
1+144.33	1+228.74	Left Arc	1050.000	84.407
1+228.74	1+263.74	Transition	-	35.000
1+263.74	1+282.63	Transition	-	18.894
1+282.63	1+512.73	Right Arc	2040.000	230.097
1+512.73	1+522.73	Transition	-	10.000
1+522.73	1+569.23	Transition	-	46.500
1+569.23	1+620.56	Left Arc	90.000	51.330
1+620.56	1+667.06	Transition	-	46.500
1+667.06	1+691.92	Transition	-	24.865
1+691.92	1+751.92	Transition	-	60.000
1+751.92	1+761.98	Right Arc	150.000	10.054
1+761.98	1+821.98	Transition	-	60.000
1+821.98	1+844.40	Straight	-	22.420
1+844.40	1+906.40	Transition	-	62.000
1+906.40	2+026.58	Right Arc	160.000	120.180
2+026.58	2+058.58	Transition	-	32.000
2+058.58	2+172.62	Right Arc	360.000	114.044
2+172.62	2+265.62	Transition	-	93.000
2+265.62	2+315.96	Straight	-	50.339

4.3.4. The vertical geometry provided in the design are in accordance with the requirements of DMRB CD 109 'Highway Link Design' for a 100B kph Design Speed. Vertical alignment details are show in **Table 4-2**, below.

Table 4-2 – A83 Mainline Vertical Design Summary

Start Ch. (m)	End Ch. (m)	Element	K Value	Grade (%)	Length (m)
0+000.00	0+126.20	-	-	5.25	126.203
0+126.20	1+454.96	Crest	200	-	1328.760
1+454.96	1+553.08	Sag	150	5.37	98.120
1+553.08	1+637.37	Crest	100	4.59	84.290
1+637.37	1+672.03	Sag	26	5.23	34.660
1+672.03	1+707.88	Crest	100	4.70	35.850
1+707.88	1+804.07	Sag	40	5.17	96.190
1+804.07	1+840.34	Crest	100	4.82	36.270
1+840.34	1+955.95	Sag	26	5.13	115.610
1+955.95	2+075.25	Crest	12	6.61	34.275
2+075.25	2+187.75	Sag	13	4.82	15.171
2+187.75	2+220.41	Sag	26	1.02	7.936
2+220.41	2+263.14	Crest	52	1.12	41.197
2+263.14	2+316.27	Sag	70	0.25	140.871

4.3.5. Where practicable verge widening for forward visibility has been applied.

4.3.6. The geometric design of the mainline alignment and vertical profile are illustrated in plan and profile drawings A83AAB-AWJ-HML-LTS_POC_M01-DR-CH-000002 to A83AAB-AWJ-HML-LTS_POC_M01-DR-CH-000003 in **Volume 2**. These drawings display the horizontal and vertical geometry including radii, and proposed levels.

B828 Glenmore Local Road Junction

4.3.7. The proposed B828 Glenmore local road junction is comprised of a ghost island junction layout in accordance with DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions'.

4.3.8. The layout of the ghost island junction incorporates the following:

- A maximum gradient on the minor road approach of 3 percent;
- Angle of minor road approach (measured over 15m from the edge of the major road carriageway) of 90 degrees;
- Merge layout comprising a 15m radius and 30m taper;
- Diverge layout comprising a 15m radius;
- A 15m long kerbed traffic island in the bellmouth of the B828; and,
- A 4m wide ghost island in the A83 with a 5% crossfall, and an overall length of 80m.

4.3.9. An overview of the B828 Glenmore local road junction is included in **Figure 4-1**, below.

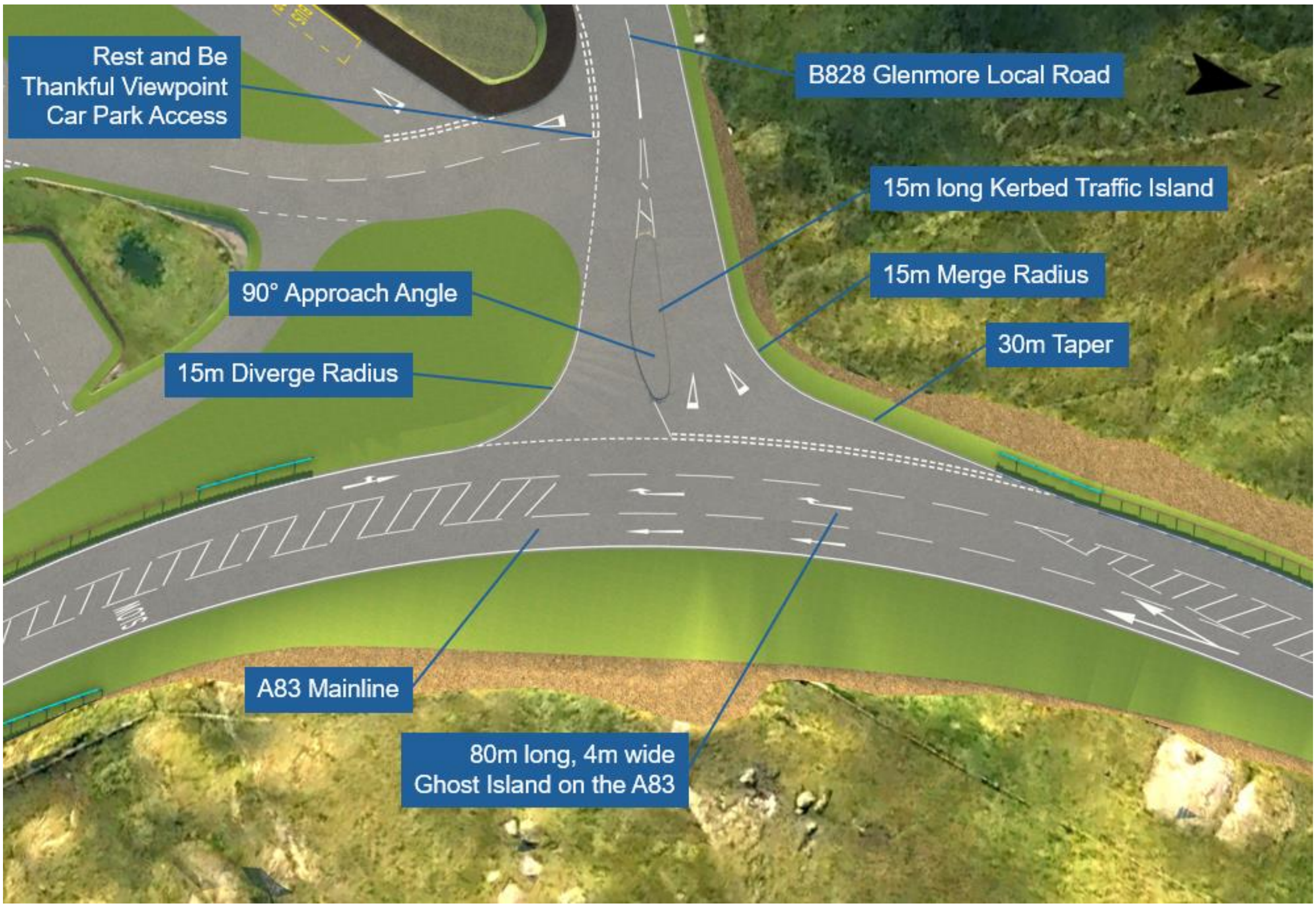

Figure 4-1 – Plan view of the B828 Glenmore local road junction with pertinent features labelled

4.3.10. The proposed junction visibility splays, to the left and right, for vehicles joining the A83 mainline from the B828 Glenmore local road are presented in **Table 4-3**, below.

Table 4-3 – B828 Glenmore local road junction visibility splays

Set Back 'X'	Available 'Y' Distance Left – (1.05m to 0.26m)	Available 'Y' Distance Left – (1.05m to 1.05m)	Available 'Y' Distance Right – (1.05m to 0.26m)	Available 'Y' Distance Right – (1.05m to 1.05m)
9.0m	215m	215m	125m	130m

Set Back 'X'	Available 'Y' Distance Left – (1.05m to 0.26m)	Available 'Y' Distance Left – (1.05m to 1.05m)	Available 'Y' Distance Right – (1.05m to 0.26m)	Available 'Y' Distance Right – (1.05m to 1.05m)
4.5m	215m	215m	90m	95m

4.3.11. The visibility to the right, represents a departure from the standards set out in DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions' which requires a 'Y' distance of 215m for a 100kph design speed. Visibility to the right represents a 3-step reduction which is caused by the vertical crest of the A83 mainline south of the B828 Glenmore local road junction. For further details on the Departure from Standard refer to **Section 4.4.3**.

DFS Maintenance Track Direct Access

4.3.12. At the southern extent of the Proposed Scheme, midway between the Cobbler Bridge and the southern portal of the DFS, a direct access is proposed to provide access to the roof of DFS via a maintenance track, from the A83 mainline.

4.3.13. The layout of the direct access is in accordance with DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions'.

4.3.14. The arrangement of the direct access, including the merge and diverge tapers, is as follows:

- A maximum gradient on the minor road approach of 3.3%;
- Angle of minor road approach (measured over 15m from the edge of the major road carriageway) of 90 degrees;
- Merge layout comprising a 15m radius and 13.5m taper (reduced to avoid impact on the existing Cobbler Bridge but has been developed based on vehicle tracking); and,
- Diverge layout comprising a 15m radius;

4.3.15. An overview of the DFS maintenance track direct access is included in **Figure 4-2**, below.

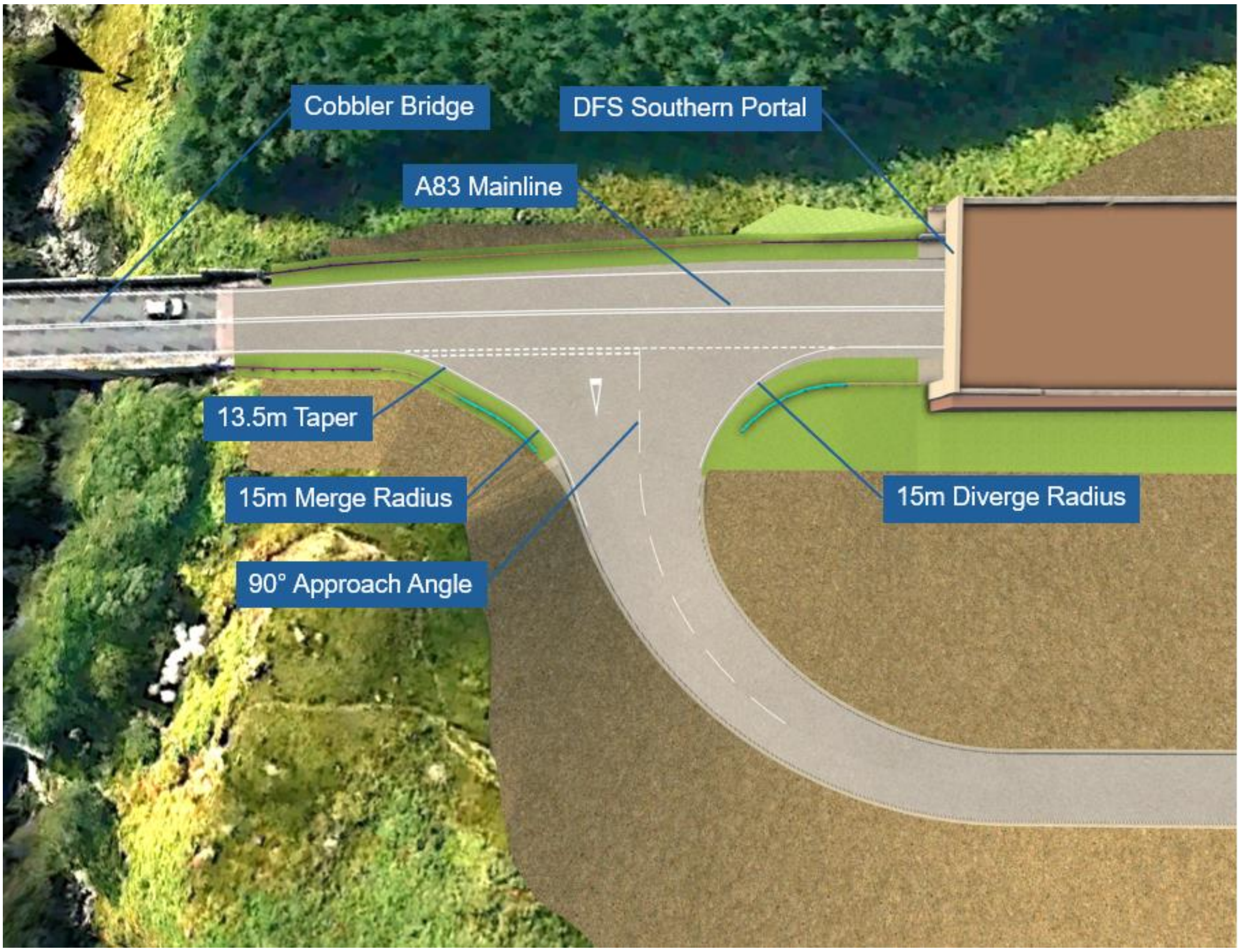

Figure 4-2 – Plan view of the DFS maintenance access with pertinent features labelled

4.3.16. **Table 4-4** details the visibility provision from the mouth of the DFS maintenance track junction at specified set back distances. Further detail outlining the geometric features that limit the visibility are provided below:

- The visibility to the left (south) at a 9m setback from the junction give way line is obstructed by the proposed earthworks cut slope within the southbound verge of the A83 mainline limiting visibility to 31m across the whole carriageway.

- The visibility to the right (north) at a 9m setback from the junction give way line is obstructed by the DFS wall and Vehicle Restraint System (VRS) limiting visibility to 28m across the whole carriageway.
- At a setback of 2m there is unrestricted visibility up to 215m in the right (north) direction across the whole carriageway.
- At a setback of 2m, visibility to the left (south) is limited to 67m. This is due to the existing VRS / parapet associated with the Cobbler Bridge immediately south of the proposed DFS maintenance access. The limited visibility to the left represents a departure from the standards set out in DMRB CD 123 'Geometric Design of At-Grade Priority and Signal-Controlled Junctions' which requires a 'Y' distance of 215m for a 100kph design speed. For further details on the Departure from Standard refer to **Section 4.4**.

Table 4-4 – DFS Maintenance Access Track Junction Visibility Splays

Set Back 'X'	Available 'Y' Distance Left – (1.05m to 0.26m)	Available 'Y' Distance Left – (1.05m to 1.05m)	Available 'Y' Distance Right – (1.05m to 0.26m)	Available 'Y' Distance Right – (1.05m to 1.05m)
9.0m	31m	37m	28m	28m
2.0m	67m	162m	215m	215m

Rest and Be Thankful Viewpoint Car Park and Bus Stop / Turning Area

4.3.17. Access to the Rest and Be Thankful Viewpoint car park and bus stop / turning area is afforded by a single junction onto the B828 Glenmore local road. The layout of the associated junction is as follows:

- Merge layout comprising an 8m radius
- Diverge layout comprising an 8m radius

- Junction spacing to the A83 mainline (measured from the Rest and Be Thankful Viewpoint car park junction to the edge of the A83 mainline) of 30m

4.3.18. An overview of the Rest and Be Thankful Viewpoint car park junction is included in Figure 4-3, below.

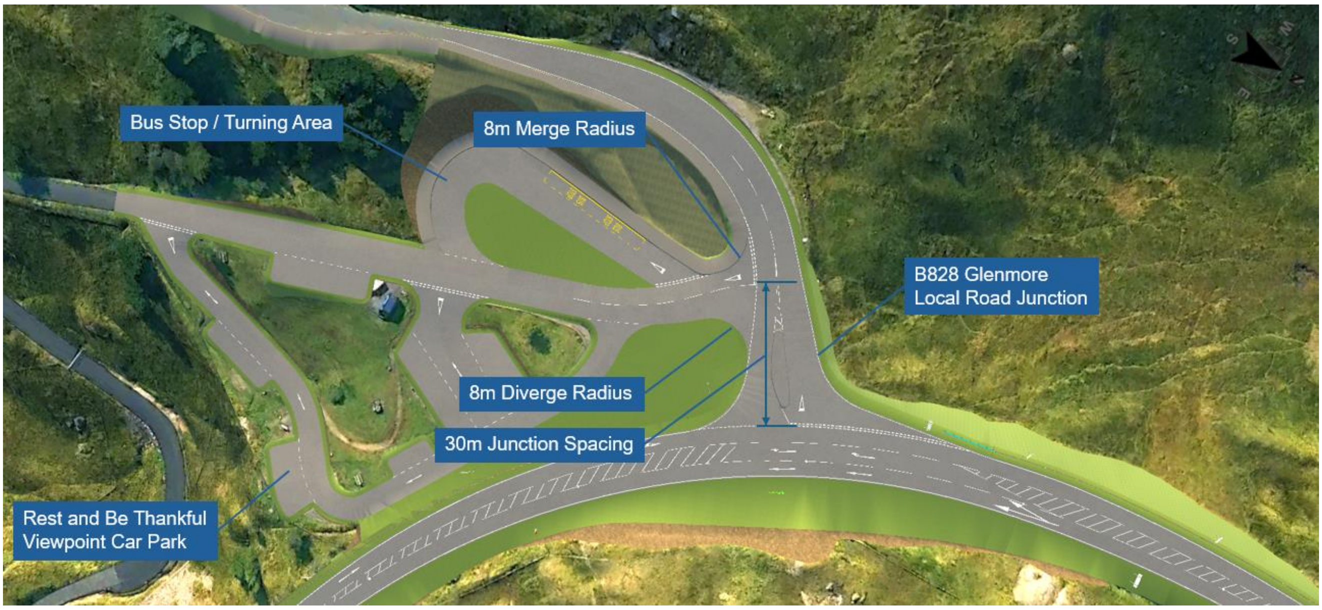

Figure 4-3 – Rest and Be Thankful Viewpoint car park junction with pertinent features labelled

4.3.19. The proposed junction visibility splays for vehicles joining the B828 Glenmore local road from the Rest and Be Thankful Viewpoint car park to the left (west) and right (east) are presented in **Table 4-5**, below.

Table 4-5 – Rest and Be Thankful Viewpoint Junction Visibility Splays

Set Back 'X'	Available 'Y' Distance Left – (1.05m to 0.26m)	Available 'Y' Distance Left – (1.05m to 1.05m)	Available 'Y' Distance Right – (1.05m to 0.26m)	Available 'Y' Distance Right – (1.05m to 1.05m)
9.0m	33m	33m	22m	22m

Set Back ‘X’	Available ‘Y’ Distance Left – (1.05m to 0.26m)	Available ‘Y’ Distance Left – (1.05m to 1.05m)	Available ‘Y’ Distance Right – (1.05m to 0.26m)	Available ‘Y’ Distance Right – (1.05m to 1.05m)
4.5m	28m	28m	14m	14m

4.3.20. As the Rest and Be Thankful Viewpoint car park junction is located on the inside of a bend it is conservatively assumed that drivers exiting the junction onto the B828 Glenmore local road will only have visibility of 90 degrees from the ahead position. The visibility splay values in both directions are dictated by the horizontal geometry of the B828 Glenmore local road and the close proximity of the junction to the A83 mainline.

4.3.21. The limited visibility to the left and right present a departure from the standards set out in set out in DMRB CD 123 ‘Geometric Design of At-Grade Priority and Signal-Controlled Junctions’ which requires a ‘Y’ distance of 70m. For further details on the Departure from Standard refer to **Section 4.4.4**.

4.3.22. In addition to improvements to the Rest and Be Thankful Viewpoint car park junction with the B828 Glenmore local road, the bus stop / turning area junction arrangement has also been improved. The bus stop / turning area is now accessed via the Rest and Be Thankful Viewpoint car park which has the following benefits:

- Reduces the number of junctions on the B828 Glenmore local road on a section that is constrained in terms of horizontal and vertical geometry, therefore reducing conflict points; and,
- Allows improved vertical geometry within the bus turning area from approximately 12% (worst case) in the existing scenario to less than 5% in the Proposed Scheme design.

Active Travel Provision

4.3.23. **Table 4-6** provides a summary of the horizontal geometry associated with the proposed alignment of the Active Travel Link between the Rest and Be Thankful Viewpoint car park, and the core path / forestry tracks on the lower slopes of Ben Donich.

Table 4-6 – Active Travel Link Horizontal Design Summary

Start Ch. (m)	End Ch. (m)	Element	Radius(m)	Length (m)
0+000.00	0+021.96	Curve	40.000	21.956
0+021.96	0+043.33	Curve	71.000	21.370
0+043.33	0+059.82	Line	-	16.495
0+059.82	0+071.04	Line	-	11.215
0+071.04	0+76.36	Curve	34.000	5.328
0+076.36	0+080.58	Line	-	4.212
0+080.57	0+085.71	Curve	25.000	5.132
0+085.71	0+093.35	Line	-	7.646
0+093.35	0+101.03	Curve	25.000	7.680
0+101.03	0+107.76	Line	-	6.730
0+107.76	0+109.95	Curve	27.000	2.189
0+109.95	0+132.50	Line	-	22.548
0+132.50	0+137.69	Curve	14.000	5.190
0+137.69	0+159.77	Line	-	22.082
0+159.77	0+171.13	Curve	14.000	11.361
0+171.13	0+242.06	Line	-	70.932
0+242.06	0+253.61	Curve	30.000	11.546
0+253.61	0+276.38	Line	-	22.766

Start Ch. (m)	End Ch. (m)	Element	Radius(m)	Length (m)
0+276.38	0+285.28	Curve	30.000	8.899
0+285.28	0+314.39	Line	-	29.112
0+314.39	0+320.82	Curve	14.000	6.435
0+320.82	0+324.64	Line	-	3.812
0+324.64	0+335.26	Curve	14.000	10.622
0+335.26	0+339.24	Line	-	3.985
0+339.24	0+352.21	Curve	14.000	12.968
0+352.21	0+360.63	Line	-	8.424
0+360.63	0+363.47	Curve	30.000	2.834
0+363.47	0+372.45	Line	-	8.986
0+372.45	0+378.26	Curve	30.000	5.810
0+378.26	0+385.24	Line	-	6.976
0+385.24	0+387.73	Curve	14.000	2.488
0+387.73	0+390.03	Line	-	2.298
0+390.03	0+401.38	Curve	50.000	11.355
0+401.38	0+413.16	Line	-	11.779
0+413.16	0+431.50	Curve	50.000	18.343
0+431.50	0+451.35	Line	-	19.844
0+451.35	0+458.15	Curve	18.000	6.804
0+458.15	0+470.19	Line	-	12.040
0+470.19	0+516.64	Curve	269.000	46.446
0+516.64	0+522.53	Line	-	5.897
0+522.53	0+530.82	Curve	18.000	8.284

Start Ch. (m)	End Ch. (m)	Element	Radius(m)	Length (m)
0+530.82	0+533.29	Line	-	2.471
0+533.29	0+550.19	Curve	14.000	16.902
0+550.19	0+561.41	Line	-	11.223

4.3.24. The vertical geometry of the Active Travel Link is detailed in **Table 4-7**, below.

Table 4-7 – Active Travel Link Vertical Design Summary

Start Ch. (m)	End Ch. (m)	Element	K Value	Grade (%)	Length (m)
0+000.0	0+032.47			9.62%	32.467
0+032.47	0+040.13	Crest	6	9.28%	7.666
0+040.13	0+051.98	Crest	6	9.00%	11.846
0+051.98	0+061.48	Sag	5	9.74%	9.502
0+061.48	0+073.36	Crest	6	7.37%	11.879
0+073.36	0+085.17	Sag	5	7.66%	11.813
0+085.17	0+099.42	Crest	6	5.58%	14.247
0+099.42	0+125.19	Sag	5	7.42%	25.77
0+125.19	0+167.05	Crest	6	1.48%	41.858
0+167.05	0+261.08	Sag	5	11.10%	94.031
0+261.08	0+328.06	Crest	10	0.77%	66.984
0+328.06	0+387.31	Sag	5	6.90%	59.243
0+387.31	0+431.69	Crest	6	3.65%	44.387
0+431.69	0+456.94	Crest	6	-1.55%	25.246
0+456.94	0+503.97	Crest	1	-14.56%	47.034
0+503.97	0+561.41	Sag	5	0.52%	57.441

4.3.25. The geometric design of the Active Travel Link alignment and vertical profile are illustrated in plan and profile drawings A83AAB-AWJ-HKF-LTS_GEN_V01-DR-CH-101102 to A83AAB-AWJ-HKF-LTS_GEN_V01-DR-CH-101103 in **Volume 2**. These drawings display the horizontal and vertical geometry including radii, and proposed levels.

4.3.26. An Active Travel Design Review, in accordance with ‘Cycling by Design’ (2021), was carried out on the Active Travel Link. This review assessed the suitability of the Active Travel Link against the core principles (safety, coherence, directness, comfort, attractiveness and adaptability) of ‘Cycling by Design’ (2021).

4.3.27. The design review found that the proposed design may deter ‘novice’ or ‘intermediate’ users, or those with mobility issues from using the Active Travel Link. However, there is no mitigation proposed for this as the Active Travel Link provides access to advanced hill-walking and cycling routes which may not be suitable for ‘novice’ or ‘intermediate’ users or those with mobility issues.

4.3.28. The existing rural terrain and steep sidelong topography constrain the geometry of the Active Travel Link. Therefore, it is impracticable to meet the link geometry standards set out in ‘Cycling by Design’ (2021) without significant engineering interventions. This meant alternative design options were largely unviable.

4.3.29. The desirable minimum dynamic sight distance (DSD) and SSD for a local access link specified in ‘Cycling by Design’ (2021) standards is 44m and 17m, respectively. **Table 4-8** and **Table 4-9** show the minimum DSD and SSD afforded in both directions of travel along the proposed Active Travel Link.

Table 4-8 – Active Travel Link Dynamic Sight Distance

	Northbound (0.8m to 0.8m)	Northbound (2.2m to 0.8m)	Southbound (0.8m to 0.8m)	Southbound (2.2m to 0.8m)
Minimum Available Visibility (m)	37	44	36	43

Table 4-9 – Active Travel Link Stopping Site Distance

	N'bound (2.2m to 2.2m)	N'bound (0.8m to 2.2m)	N'bound (0.8m to 0m)	S'bound (2.2m to 2.2m)	S'bound (0.8m to 2.2m)	S'bound (0.8m to 0m)
Minimum Available Visibility (m)	17	17	10	36	43	10

4.4. Departures from Standard

4.4.1. In order to avoid incurring high construction, social or environmental costs it can be efficient to adopt geometric elements of the design that are below the desirable minimum standard recommended by the DMRB. These geometric elements include gradient, visibility as well as horizontal and vertical curvature. A procedure exists whereby such departures from DMRB Standards are applied for by the designer to the roads authority and the application is independently scrutinised and due diligence is applied in approving or rejecting the application.

4.4.2. A total of 11 departures have been identified, 9 of which are associated with the A83 Trunk Road and 2 of which are associated with the B828 Glenmore local road.

A83 Trunk Road Departures

4.4.3. The nine departures associated with the A83 Trunk Road are summarised in **Table 4-10**, below.

Table 4-10 – A83 Trunk Road departures summary

Reference	Location	Description of Departure
DP-CH-ML-002	A83 Ch. 1,360 to Ch. 1,750 (NB & SB)	A 6-step reduction in horizontal radius and a maximum 5-step reduction in southbound SSD is proposed. This departure presents engineering, environmental and economic benefits as it would be impractical to straighten the alignment sufficiently to meet design standards at this location. Meeting of the respective design standards would require substantial excavation into the Beinn Luibhean slopes or building out onto the lower slopes of Beinn Luibhean, introducing significant earthworks fill in Glen Croe. Whilst this departure is required for the Proposed Scheme, it does represent a minor improvement over the existing A83 in terms of SSD.
DP-CH-ML-003	A83 Ch. 1,620 to Ch. 1,900 (NB & SB)	A 5-step reduction in horizontal radius, a maximum 5-step reduction in southbound SSD and 3-step reduction in northbound SSD, and 5% superelevation is proposed. This departure presents engineering, environmental and economic benefits as it would be impractical to straighten the alignment sufficiently to meet design standards at this location. Meeting of the respective design standards would require substantial excavation into the Beinn Luibhean slopes or building out into the Glen Croe valley. Whilst this departure is required for the Proposed Scheme, it does represent a minor improvement over the existing A83 in terms of SSD.

Reference	Location	Description of Departure
DP-CH-ML-004	A83 Ch. 1,760 to Ch. 2,250 (NB & SB)	A 5-step reduction in horizontal radius, a maximum 5-step reduction in southbound SSD and 3-step reduction in northbound SSD, 5% superelevation, as well as a 4-step and 2-step reduction in vertical curvature is proposed. This departure presents engineering, environmental and economic benefits as it would be impractical to straighten the alignment sufficiently to meet design standards at this location. Meeting of the respective design standards would require substantial excavation into the Beinn Luibhean slopes or building out into the Glen Croe valley. Whilst this departure is required for the Proposed Scheme, it does represent a minor improvement over the existing A83 in terms of vertical curvature and SSD.
DP-CH-ML-005	A83 Ch. 40	DFS Maintenance Access Y-distance visibility of the A83 carriageway is substandard to the left. Visibility is impaired by the existing VRS / parapet associated with the Cobbler Bridge immediately south of the proposed DFS maintenance access. Maintaining, instead of removal and replacement, of the bridge presents engineering, environmental and economic benefits.
DP-CH-ML-006	A83 Ch. 1,995	B828 junction Y-distance visibility of the A83 carriageway is substandard to the right. Increasing of the available visibility right would require the introduction of significant earthworks and substantial slope stabilising works. Therefore, the departure presents engineering, environmental and economic benefits. Whilst this departure is required for the Proposed Scheme, it does represent a minor improvement over the existing B828 Glenmore local road junction visibilities.

Reference	Location	Description of Departure
DP-CH-ML-007	A83 Ch. 1,480 to Ch. 2,200	A reduction in lane width over a defined length of the proposed mainline north of the DFS. Throughout this area, the A83 carriageway has substandard geometry, and this departure is intended to provide a cross-section that is more closely related to that of the existing carriageway rather than a compliant cross-section that has the potential to result in increased vehicle speed. Given this section of the carriageway has a relatively good collision record the proposed lane widths offer a slight and consistent improvement over that of the existing which has operated well historically.
DP-CH-ML-008	A83 Ch. 1,480 to Ch. 2,200	A reduction in hard strip width with over a defined length of the proposed mainline north of the DFS. Throughout this area, the A83 carriageway has substandard geometry, and this departure is intended to provide a cross-section that is more closely related to that of the existing carriageway rather than a compliant cross-section that has the potential to result in increased vehicle speed. Given this section of the carriageway has a relatively good collision record the proposed lane widths offer a slight and consistent improvement over that of the existing which has operated well historically.
DP-CH-ML-009	A83 Ch. 0 to Ch. 2,205	The Proposed Scheme layout is constrained by the existing topography where the road alignment is such that overtaking cannot be provided due to the substandard alignment. It would be impracticable to provide a compliant solution as it would require straightening the alignment within this section and excavating further into the slopes of Beinn Luibhean or a possible tunnel. Departure of standard therefore presents engineering, environmental and economic benefits.

Reference	Location	Description of Departure
DP-CH-ML-014	A83 Ch. 67. to Ch. 1,430	Regularly spaced 1.5m gaps are proposed in the concrete safety barrier within the DFS to provide an acceptable means of emergency egress from the structure. Design standards dictate that there should be no breaks in the VRS through the DFS extents. However, provision of the gaps in the VRS aids in the evacuation of road users . In addition, this arrangement also provides improvements to SSD and forward visibility throughout the DFS extents as a result of the increased set-back from the edge of carriageway.

B828 Glenmore Local Road Departures

4.4.4. The two departures associated with B828 Glenmore local road are summarised in **Table 4-11**, below.

Table 4-11 – B828 Glenmore local road departures summary

Reference	Location	Description of Departure
DP-CH-SR-001	B828 Ch. 0 to Ch. 130	A 4-step reduction in horizontal Radius, 8.5% longitudinal gradient, Vertical 5K crest and sag and 2.5% Superelevation along the B828 Glenmore local road in advance of the junction with the A83. This departure represents a minor improvement over the existing arrangement. Any further improvement would compromise the integrity of the Rest and Be Thankful Viewpoint car park or require more extensive realignment to the north towards Loch Restil, impacting the Beinn An Lochain SSSI.
DP-CH-SR-002	B828 Ch. 40	Y-Distance visibility from the Rest and Be Thankful Viewpoint Car Park junction to the B828 Glenmore local road is substandard to the left and right. Y-distance visibility is compromised by the existing car park being on the inside of the curve and the nearside channels of the B828 extending

Reference	Location	Description of Departure
		behind a driver waiting at the give way line. No road traffic collisions have been recorded at this junction in the last 10 years and whilst the proposed layout remains substandard in many respects, the proposed alterations are an improvement over the existing layout.

4.5. Road Infrastructure

Operations Infrastructure

4.5.1. The key facilities considered to support safe operation of the Proposed Scheme, particularly the DFS are outlined in **Table 4-12**, below.

Table 4-12 – Summary of key facilities to support the safe operation of the DFS

Operational Facilities	Function
Maintenance operations facilities	Facilities to support the management of the DFS structure, landslide incidents and severe weather will be undertaken from existing Transport Scotland depot facilities. Should additional area be required, this would be subject to a separate planning condition.
Control room facilities	At this stage it is not envisaged that the DFS will require any dedicated control room facility to operate. Dependant on the nature of the DFS design / operation, there may be a need to provide access from an existing control room to any systems that are within the structure for monitoring and control purposes.

Snow Poles

4.5.2. There is currently snow pole provision along the existing A83 carriageway within the Proposed Scheme extents, refer to **Section 2.8**. It is proposed that these poles are replaced like-for-like within the Proposed Scheme extents outwith the DFS.

4.5.3. There are no design standards that cover the provision of snow poles. Therefore, these will be provided in consultation with the regional Operating Company. Snow Pole provision will be further developed at Specimen Design.

4.6. Ground Conditions, Geology and Geomorphology

Summary of Ground Conditions

4.6.1. The ground conditions for the Proposed Scheme have been determined from detailed review of geological mapping and historical ground investigation data in conjunction with the findings of the Preliminary Ground Investigation for the wider scheme, undertaken by Raeburn Drilling and Geotechnical Ltd. Further ground investigations are being undertaken and this information will be available to support the next stage of design development, i.e. specimen design.

4.6.2. Plan and profile drawings A83AAB-AWJ-HGT-LTS_POC_M01-DR-GE-000007 to A83AAB-AWJ-HGT-LTS_POC_M01-DR-GE-000008 showing exploratory hole locations and corresponding ground conditions, from the historical and prelim ground investigations, are included in **Volume 2**.

Superficial Deposits

4.6.3. Made ground is present locally across the scheme area associated with the existing road network (A83, B828 Glenmore local road and OMR), the Rest and Be Thankful Viewpoint car park, a disused quarry and compound area, farm tracks and buildings. There is also made ground associated with existing ground stabilisation and landslide mitigation measures. Made ground encountered during ground investigations includes tarmac layers, engineered and non-engineered fill. Given the age of the original construction of the A83, the tarmac layers may be contaminated with tar or tar-bitumen binders.

4.6.4. The natural superficial deposits underlying the site are reported to comprise:

- Peat: Surface deposits and buried peat have been identified across the Proposed Scheme area with recorded thicknesses ranging from 0.2m to 1.5m. The peat is generally described as soft to firm dark brown slightly sandy slightly silty fibrous peat. Plastic pseudo-fibrous peat and plastic amorphous peat have also been recorded.
- Alluvium and River Terrace Deposits: Based on the published geology, alluvium, alluvial fan deposits and river terrace deposits are anticipated to be present within the Glen Croe floor and locally underlying the OMR. Descriptions of the deposits vary from loose orangish brown slightly gravelly silty fine to coarse sand to very loose to medium dense greyish brown very sandy silty fine to coarse subangular and subrounded gravel. Laminations of sandy clay and silt and lenses of peat are expected to occur locally within these deposits.
- Colluvium: Colluvial deposits are expected throughout the Proposed Scheme area with thicknesses and extents highly dependent on the locations, types, and volumes of historical failure events. Available data indicates that colluvial deposits may be encountered overlying or interbedded with topsoil, peat, alluvial and glacial deposits. Typical descriptions of these deposits include loose to medium dense silty or clayey sands and gravels with varying proportions of subrounded to angular cobbles and boulders of schist. For the purposes of this assessment, the deposits which result from the debris flow events have been considered within the overall category of colluvium. Very loose and loose sands and gravels, interpreted to be debris flow deposits have been recorded at various exploratory holes, to a maximum depth of 11.7m bgl.
- Glacial deposits: Published geological maps indicate both hummocky (moundy) glacial deposits and glacial till within the Proposed Scheme area. Typical descriptions of the glacial deposits identify granular material comprising medium dense to very dense light brown to brown slightly silty or clayey fine to coarse sand and angular to subangular fine to coarse gravel with occasional angular to subangular cobbles and boulders of schist. Drillers records show the presence of large boulders within the glacial deposits.

- Weathered bedrock: A layer of weathered bedrock overlying the competent bedrock has been interpreted in various exploratory holes. Descriptions of the material interpreted as weathered bedrock typically comprise extremely weak to moderately weak brown psammite and drillers' descriptions of broken schist and fractured schist.

4.6.5. Available data and site reconnaissance indicates that bedrock is at or near the surface across the higher ground and at the northern extent of Glen Croe. Within the lower parts of Glen Croe the depth to bedrock increases, with recorded thickness of superficial deposits up to approximately 18m.

Bedrock

4.6.6. The predominant bedrock geology beneath the site is reported to comprise metamorphic strata of the Beinn Bheula Schist Formation. Geological mapping has identified subdivisions within this formation comprising psammites and semipelites. The subdivided rock units are lithologically very similar and the boundaries between them are generally gradational. The sub-divisions are based on the nature of their foliation and mineralogy. Each unit has a schistose fabric. Field strength descriptions range from ‘medium strong to strong’ and ‘strong to very strong’.

4.6.7. Borehole records indicate metamorphic strata as consisting of:

- Psammite: generally described as "strong and very strong very narrowly and narrowly banded schistose grey psammite with very closely spaced very narrow and narrow white quartzite, dark grey semi-pelite and dark grey pelite bands".
- Pelites and semi-pelite: generally described as "strong and very strong very narrowly and narrowly banded schistose dark greenish grey pelite with extremely closely and very closely spaced very narrow to thin dark grey semi-pelite bands".

4.6.8. British Geological Survey (BGS) mapping indicates an intrusion of the South of Scotland Granitic Suite present between Ch. 150 and Ch. 750. This appears to have been exploited at the disused quarry upslope of Ch. 700, where exposures of dolerite/diorite have been mapped. Various intrusive dykes and sills have also been encountered during mapping of the Beinn Luibhean slopes, including an andesitic dyke exposed in the existing catchpit at Ch. 900 to Ch. 1,130. Igneous features predominantly behaved as very strong to extremely strong materials regardless of compositional differences.

4.6.9. Igneous strata encountered during the intrusive investigations have generally been identified as dolerite. The dolerite is typically described as "very strong dark grey dolerite with very narrow (0.5mm-2mm thick) closely spaced grey quartz veins; Slightly weathered evident as slight loss of strength and green staining on fracture surfaces".

4.6.10. Two major faults are shown on BGS maps within the northwest of the Proposed Scheme area, intersecting at Ch. 1,540 and Ch. 1,860. The type and displacement of these faults are not recorded. However, there is a visible discontinuity within the bedrock outcrops at these locations aligned with the proposed fault location. As these discontinuities follow generally straight lines across the topography, they are likely close to vertical and steeply dipping.

4.6.11. A third fault has been identified from site mapping in the existing catchpit at Ch. 1,130 and the watercourse above the pit. This north-east to south-west trending feature dips at approximately 60 degrees toward the southeast.

4.6.12. Fault breccia has been recorded in four boreholes undertaken for the Preliminary Ground Investigation. The boreholes (AAB-BH1002, AAB-BH1027A, AAB3-BH1032 and AABBH1037i) are all located close to the valley floor. At borehole AAB-BH1032, artesian groundwater conditions have been recorded associated with the fault zone.

Groundwater

4.6.13. The SEPA Water Environment Hub interactive map indicates that the Proposed Scheme area is underlain by the Cowal and Lomond groundwater body, which is defined as having a 'good' overall condition and 'good' water quality.

4.6.14. The published BGS Hydrogeology map and BGS GeoIndex indicate that the Southern Highland Group (i.e. the parent unit of the Beinn Bheula Schist Formation which underlies the majority of the Proposed Scheme area) and the unnamed igneous intrusions are both Class 2C low productivity aquifers. Small amounts of groundwater are expected to be present in the near surface weathered zones and in secondary fractures, with rare springs.

4.6.15. Available information indicates that groundwater levels vary across the Proposed Scheme area. Monitoring readings record levels between 0.15m bgl and 7.48m bgl, with levels typically <4m bgl. Groundwater strikes were encountered at depths between 0.2m bgl and 7.7m bgl. Most of the groundwater strikes were recorded in the interpreted colluvium.

Geotechnical Engineering Risks and Mitigation

Natural Geo-Hazards

4.6.16. The Proposed Scheme is located partially along slopes which are subject to geohazards, particularly debris flow and boulder fall events. The nature and degree of hazard varies depending on the location within the glen. A natural terrain hazards study has been undertaken, which covers the western slopes of Beinn Luibhean above the A83 and OMR. The study assesses the principle geohazards of debris flows and boulder fall events and the likely consequences of these events on the proposed DFS, DFW and other mitigation measures.

4.6.17. The results of the natural terrain hazards study have been used to inform the development of the design of appropriate structural and earthwork protective elements for the Proposed Scheme. In addition, the effects of the passage of debris over the slopes and through the catchpits and culverts has been considered to determine whether this may result in undermining of the Proposed Scheme and / or damage to other infrastructure.

4.6.18. Consideration has also been given to the long-term maintenance requirements of the DFS and DFW, including provision of access for inspection and to enable debris to be removed following an event. The DFS and DFW have been designed to withstand large loads imposed by debris flow, landslide and boulder fall events.

However, in the rare event that the DFS and / or DFW were to be damaged during a debris flow, landslide or other geohazard event, access may be required to undertake repairs of the structure. Consequently, the protection afforded to the A83 may be temporarily reduced and temporary closures may be required.

4.6.19. Other natural hazard considerations include:

- The potential for fresh rockfall originating from the crags above the northern end of the DFS / DFW between Ch. 1,300 and Ch. 1,600. In these areas additional retention measures to stabilise block in-situ may be required.
- A historical rock slope failure has been identified above Ch. 1,450 at approximately 300m AOD, comprising large scale blocks that may be completely detached from the bedrock. This material is thought to be stable under its own self-weight and embedment but may be susceptible to failure if disturbed by the excavation methodology. This is also a risk for rockfall debris at rest on the slope from other historic failures. The excavation methodology will need to consider this specific hazard in order to minimise the risk of remobilising metastable debris.

Adverse Ground Conditions

Made Ground

4.6.20. Made Ground deposits comprising engineered and non-engineered fill are anticipated across the Proposed Scheme in association with existing infrastructure. Available data shows the existing OMR and A83 are underlain by fill, most likely derived from locally sourced material. Made Ground deposits are typically heterogeneous and can have low bearing resistance and potentially high differential and total settlement characteristics. Further ground investigation is required to confirm the extent and properties (geotechnical and contamination) of the made ground to determine the suitability for re-use (ref. **Section 4.6.67**).

Peat

4.6.21. Layers of peat have been encountered in some exploratory holes located in the lower areas of Glen Croe, where it is typically interbedded with colluvium, with a maximum recorded thickness of 1.5m. Peat has low bearing resistance, is highly compressible and has poor engineering properties. Therefore, it requires consideration of special measures for stability and settlement issues. If encountered within the footprint of the earthworks for the proposed OMR Interventions or for the extension of the HESCO barrier, ground improvement by excavation and replacement is likely to be required (ref. **Section 4.6.56**).

Alluvium and River Terrace Deposits

4.6.22. Alluvium and River Terrace Deposits are anticipated to be present locally within the Glen Croe floor and in the vicinity of watercourses. Therefore, these deposits may be encountered at the proposed location of the SuDS attenuation basin (ref. **Section 4.7.11**). adjacent to the Croe Water.

4.6.23. Investigations undertaken to date have not identified any deposits of cohesive alluvium. However, there remains the potential for localised pockets of soft, highly compressible materials. Due to the potential for alluvial deposits to have varying, potentially poor, engineering properties, ground investigation should be undertaken to assess the thickness and engineering properties of the alluvial soils at the attenuation basin location.

Colluvium

4.6.24. Colluvium is comprised of unsorted material washed down slopes during failure events. Large boulders are often observed within debris flow channels and it is likely that these are present within the colluvium. In lower parts of the glen, colluvium may overlie lower strength, compressible soils such as alluvium or peat.

4.6.25. Further ground investigation is required to assess the engineering properties and spatial variability of the colluvium. The material can be loose and therefore a hazard to excavations, and sensitive to vibrations from construction. Colluvium encountered in the cut slopes for the proposed catchpit will require additional support for long term stability. Soil nailing with flexible facings have been proposed depending on the depth of the deposits.

4.6.26. In addition, the colluvium will not provide a suitable founding stratum for the DFS, DFW and Burn Bridge structures. Piled solutions will be required where there is a significant thickness of colluvium. Where the deposits are relatively thin, it may be possible to remove the colluvium locally to found on underlying bedrock. For other mitigation measures, such as the HESCO barrier and earthwork bunds, geotechnical solutions are dependent on the proposed works and thickness / nature of the colluvium deposits but could include basal reinforcement or ground improvement.

Glacial Deposits

4.6.27. The difference between the colluvium and undisturbed glacial deposits has been inferred from changes in relative density and cobble and boulder content. The distinction is approximate and there may be some overlap. Generally, the glacial deposits are expected at depth in areas of thick superficial deposits, locally overlain by reworked material nearer to and at the ground surface. Available test data suggests similarities in the engineering properties of the glacial deposits and the colluvium. As such, it is reasonable to anticipate similar issues with stability and foundations as identified above.

Bedrock

4.6.28. The depth of bedrock will affect the volumes of soil and rock to be removed for excavations and consequently affect slope stabilisation requirements and excavation rates. The anticipated stepped rockhead profile may result in excavations where bedrock is only exposed in the middle of the slope. Localised lateral variations in bedrock depth may result in excavations with vertical boundaries between soil and rock. These variations will affect excavation methods, cutting geometries and support measures.

4.6.29. The stepped bedrock profile also presents significant risk to the foundations of the main structures. Variable pile lengths are expected depending on the location of steps in the bedrock profile. Steep rockhead levels will also present difficulties to piling operations.

4.6.30. Strong, intact bedrock and limitations on blasting/vibrations in areas of landslide risk will present challenges for excavation for the Proposed Scheme. Available data indicates generally good quality rock mass, which are anticipated to be stable at high slope angles in excavations. However, bedrock may split readily along foliation planes, and intersecting subvertical joint sets are known to produce detached blocks liable to wedge or toppling failure.

4.6.31. Structural deformation, particularly faulting, is also likely to pose a significant challenge to excavations. Faults form zones of highly fractured bedrock which can either form a fault breccia, providing a zone of weakness preferential pathway for groundwater, or form a welded fault rock which may significantly impact excavations. Aerial photography and geophysical surveys indicate that unmapped faults are likely to be present within the Proposed Scheme area.

Groundwater and Flood Risk

4.6.32. In general, it is anticipated that shallow groundwater levels will be encountered local to existing watercourses and in lower areas of Glen Croe. Similarly, several watercourses located within the Glen Croe floor and local areas of minor watercourses on the lower slopes are located within areas susceptible to river and surface water flooding.

4.6.33. Elements of the Proposed Scheme most at risk from the destabilising effects of high groundwater tables, flooding and surface water run-off are the proposed proprietary bridge (Bridge D) across the Croe Water on the OMR and the SuDS attenuation basin for A83 Network 1. Appropriate control measures need to be adopted in the design and construction of these structures.

Geo-environmental and Geochemical Risks

4.6.34. Qualitative geo-environmental assessment has identified the risk to receptors of potentially coming across harmful elements / contamination as low to moderate with specific risks as follows:

- Given the intended use as a trunk road, there will be limited potential exposure pathways to site end users post construction. The presence of hardstanding on the carriageway will limit the direct exposure of future site users to underlying soils and effectively break any potential pollutant linkage. Site end user interaction is likely to be limited. The risks posed to end users will be considered during the detailed design and construction stages of the Proposed Scheme as more information becomes available and construction methods are finalised.

- On the existing road alignments, construction workers will be exposed to the existing road construction, made ground / engineering fill and underlying natural soils during excavation works. The made ground materials are anticipated to be of limited thickness associated with road construction. Locally more extensive deposits of re-worked natural deposits / colluvium from previous mass movement events are likely to be present. The existing road construction materials and colluvium have the potential to represent a potential source of contamination.
- Construction works completed outwith the footprint of existing road infrastructure will be primarily in natural or locally reworked natural soils. Whilst of relatively low likelihood, it is also possible that locally contaminated soils could be encountered by construction workers associated with localised spills of fuels or agricultural chemicals arising from the agricultural and forestry land uses, specifically in the vicinity of existing buildings.

4.6.35. Soil and groundwater geo-environmental analysis will be taken where future geotechnical site investigative works are scheduled. In addition to geo-environmental analysis requirements, laboratory testing within groundwater and soil will be required to determine the presence of chemicals such as sulphate likely to cause deterioration of buried structural concrete and / or corrosion of steel reinforcement. Limited testing undertaken in soil to date suggest the Design Sulphate Class DS-1 is applicable within the tested areas.

4.6.36. Depending on the composition of the existing road make up, the asphalt may be contaminated with tar or tar-bitumen binders rendering the material unsuitable for re-use. It is therefore recommended that the composition of any asphalt encountered is confirmed as part of future ground investigations.

Earthwork Design Overview

4.6.37. The Proposed Scheme will require extensive earthworks to achieve the required road alignment and construct the DFS, DFW and associated catchpit. The following notable sections are identified:

Southern Tie-In (Ch. 0 to Ch. 67)

4.6.38. The southern tie-in provides for widening of the existing road to current standards, primarily through excavation into the slopes adjacent to the southbound carriageway. The preliminary design identifies 1v:1.5h slopes to approximate Ch. 20 with slope heights up to 5.5m. From Ch. 20 to Ch. 67, the excavation adjacent to the southbound carriageway widens and steepens for the DFS maintenance access track. Where embankment slopes are identified adjacent to the northbound carriageway (Ch. 50 to Ch. 67), retaining wall or reinforced earth solutions are likely to be preferred.

Catchpit (Ch. 67 to Ch. 1,590)

4.6.39. The alignment of the Proposed Scheme has been designed such that it removes the need for earthworks or retaining structures on the downhill side of the road. This is to minimise construction on potentially unstable existing debris flow deposits that are a prominent feature on the lower slopes of Beinn Luibhean.

4.6.40. Due to the widening for the road cross-section, in addition to accounting for the walls of the DFS and the catchpit, it is not possible to avoid excavation into the hillside. As such, along the full extents of the DFS and DFW the cross section predominantly features cuttings in soil and rock on the uphill side of the A83.

4.6.41. The preliminary design for the catchpit comprises a 6m base and a nominal 60-degree cut slope with a general dip direction of approximately 220 degrees. The proposed cut slope angle is broadly consistent with the rock slopes at the existing catchpits on the A83. Where deep superficial deposits are expected to be encountered, the proposed slope profile has been amended to allow for 45-degree slopes in the superficial deposits and a berm at rockhead.

Burn Bridge (Ch. 1,590 to Ch. 1,620)

4.6.42. At the northern end of the catchpit, a bridge (B02 Burn Bridge) is proposed that will allow channelised debris flows to pass below the A83 (ref. Section 4.9). The existing A83 is on embankment at this location and the embankment materials and existing culvert will be removed during construction of the structure. Additional excavation into the underlying bedrock will be required on the upstream side of the structure to ensure that large boulders can pass below the bridge deck.

Northern Tie-in (Ch. 1,620 to Ch. 2,220)

4.6.43. Beyond Burn Bridge, significant excavation for verge widening has been included in the southbound verge of the proposed alignment at the northern tie-in, opposite the junction with the B828 Glenmore local road. The widening is to allow suitable forward visibility of the road ahead for drivers.

4.6.44. From review of aerial imagery and site observations, superficial deposits are expected to be very thin or absent at the location of the excavations. As such, the majority of cutting is expected to be in rock. The preliminary design includes 60-degree cut slopes adjacent to the southbound carriageway, with maximum slope heights of approximately 28m at Ch. 1,740. There is an allowance for rock traps where the verge is of insufficient width to retain typical rock falls and a berm is included at mid height where the cut slopes exceed approximately 12m.

Cuttings

4.6.45. The main areas of cuttings for the Proposed Scheme are the catchpit and rock cut slopes, which are detailed above. Cut slopes will also be required for the improvement to the B828 Glenmore local road and the bus turning area at the Rest and Be Thankful Viewpoint car park, where the proposed slopes are up to approximately 7m in height with a gradient of 1v:1.5h. Site observations suggest that rockhead is relatively shallow and the majority of the cut will be in rock. Where soil slopes are identified it is anticipated that reinforcement such as soil nailing will be required to maintain stability of the steepened soil slopes.

4.6.46. At the location of the proposed catchpit slackening of slope angles to attain stable slopes in the superficial deposits is not feasible due to the steep topography of the site. The location also precludes the use of earth retaining structures. Therefore, stabilisation measures such as soil nails with either flexible or sprayed concrete facing will be required.

4.6.47. Where channels carrying surface water flows or surface water run-off interface with the cut slope of the catchpit additional detailing will be required to ensure long term stability. It is expected that, local to the crest of the cutting, the channel will be excavated to rockhead to minimise potential erosion and the side slopes will be stabilised, as required.

4.6.48. The design of rock cuttings throughout the Proposed Scheme has been progressed to achieve the strategic aim of providing rock slopes that are safe and sustainable. The design aims to minimise instability in the resultant faces and the need for geotechnical measures to be adopted to reduce the risk from this.

4.6.49. Where cuttings are in rock, the slopes should follow existing discontinuities, as far as possible, and incorporate natural features and / or benches to maintain the stability of the rock. This is intended to minimise the environmental / visual impact and maintain the look of a natural slope.

4.6.50. Initial rock slope stability assessments confirm the preliminary rock slope design to be acceptable. However, all rock cut excavation works shall be subject to inspections and assessment during excavation to allow the identification of potential failure planes or blocks and the need to for any additional stabilisation works.

4.6.51. Excavations for the channel reprofiling works both above and below the A83 should be undertaken from the top down to minimise the risk of instability during construction. At locations where soil stabilisation measures are not required, the excavated channel slopes should be seeded / planted, to promote vegetation growth as soon as practicable. The use of biodegradable liners should be considered to minimise the potential for erosion and scour.

Embankments

4.6.52. There are no significant embankments required for construction of the A83 mainline. Minor upfill is required for widening to provide additional verge width at the northern tie-in. At this location the embankment shoulders are up to approximately 4.5m height with slopes of 1v:1.5h. The proposed Active Travel Link from the Rest and Be Thankful Viewpoint car park to the forestry tracks on the lower slopes of Ben Donich also requires widening of existing on embankments with slopes of 1v:1.5h shown in the preliminary design.

4.6.53. A reinforced earth solution or high friction fill would be required to ensure stability of the steepened slopes. Alternatively, slackening of the slopes may be considered during future design development. Placement of the fill will require benching into the existing slopes where the existing ground is steeper than 1v:5h.

4.6.54. Other areas of upfill include the proposed detention basin for drainage Network 1, which requires construction of a perimeter bund to form the SuDS attenuation basin. In addition, the existing catchpits will be infilled to the level of the proposed road. The infill will be completed with a layer of concrete to provide the base of the proposed catchpit.

4.6.55. Where existing embankments require widening, for example at tie-ins or crossings, benching into the existing slope faces will be required. If the existing fill is proven to be of inadequate strength to withstand increased loads, it may be necessary to partially remove it by increasing the extent of benching into the existing slope and replacing the material with appropriate general fill as stated in the Specification for Highway Works (SHW), Volume 1, Series 600).

4.6.56. It is anticipated that some form of ground improvement will be required in areas of widening on embankment where soft and / or organic materials are encountered at the foundation level of the embankment. The required depth of ground improvement is expected to be relatively shallow. Given the anticipated shallow depth of improvement, excavation and replacement is likely be the preferred method of ground improvement for the sections of OMR widening on embankment.

High groundwater levels mean that temporary dewatering measures will be required during excavation below the earthworks footprint.

4.6.57. For the debris flow protection bund adjacent to the OMR Ch. 2,150 to Ch. 2,300, localised soft and / or organic materials may also be excavated and replaced within the footprint of the earthwork embankment. The embankment foundation may include reinforcement using geogrids and separator layers to prevent migration of fines, similar to the foundation of the existing HESCO barrier, refer to drawings A83AAB-AWJ-HGN-MTS_MB0-DR-CH-000047 and A83AAB-AWJ-HGN-MTS_MB0-DR-CH-000048 contained in **Volume 2**.

4.6.58. The debris flow protection bund at the old quarry above the A83 is expected to be founded on bedrock. Loose debris and accumulation of materials within the footprint of the proposed bund should be removed prior to the placement of fill materials.

4.6.59. It is assumed that imported granular fill will be used for the sections of widening on embankment. Imported fill for embankments is expected to comply with Class 1 General Fill requirements. Embankment slopes of 1v:2h have been proposed to help minimise the volume of imported fill required for the Proposed Scheme.

Earthwork drainage

4.6.60. The catchpit will be designed to facilitate the drainage of water and suspended debris from normal rainfall and run-off. Where appropriate, surface water channels that flow into the proposed catchpit will be excavated to bedrock level to minimise the risk of significant erosion at the immediate crest of the catchpit during intense rainfall or potential debris flow events. The banks of these channels will need to be re-profiled locally to accommodate the additional excavation depth and may require slope retention measures depending on the slope angles that can be achieved. Surface water funnelled through the channels will cascade from rockhead level into the catchpit.

4.6.61. The catchpit floor will need to be relatively impermeable and a concrete slab will be provided where superficial deposits are encountered within the base of the pit. Grouting of bedrock may be required if significant open fractures are encountered.

4.6.62. The drainage design will aim to limit the passage of material deposited in debris flow events to prevent blockages within the culverts and reduce maintenance. At present, it is expected that the floor of the catchpit will be pitched approximately 5° downslope to promote drainage into drop chambers leading to culverts below the A83. The preliminary design considers drop chambers covered by 4m x 6m grates with 100mm openings to allow water and sediment to pass through. The dimensions of these features are preliminary and may be subject to change as the design progresses.

4.6.63. As part of the general earthwork construction, temporary and permanent earthwork drainage will be required. Typical examples of drainage measures include:

- Cut-off drains;
- Surface water interceptor drains;
- Counterfort and slope drains; and,
- Herringbone drains.

4.6.64. The exact drainage requirements to assist with the long-term performance of the earthworks will be considered as part of the detailed design. In particular, the design of the catchpit and rock cut slopes will make allowance for raking drains, weepholes and berm drainage, as required. The drainage design will consider the discharge of collected water.

4.6.65. In support of earthwork construction, temporary (and permanent) drainage measures will be required. This will require the construction of "pre-earthwork" drainage which will serve the purpose of collecting water which would daylight or impact on the slope face. As previously, the drainage design will consider the discharge of collected water with adequate gradient allowed.

Earthworks acceptability

4.6.66. Excavations for the Proposed Scheme are expected to encounter made ground, topsoil, natural superficial deposits and bedrock.

4.6.67. A significant quantity of made ground will be excavated, generally related to the existing road construction and Rest and Be Thankful Viewpoint car park. It is expected that the majority of the existing A83 road construction will be removed over the full length of the Proposed Scheme and that existing road materials could be re-used, subject to appropriate classification and assessment. An exception to this would be the presence of coal tars within the asphalt. In this instance the potential for the materials to be reused under Clause 947 or 948 of the Specification for Highway Works as a cold recycled bound material would require further consideration or the material be treated as hazardous waste and be disposed of off-site appropriately.

4.6.68. At this stage of assessment, no contaminated materials (Class U2) have been identified for disposal. A review of historical mapping has not identified any significant potentially contaminative developments / land uses within the Proposed Scheme area or identified any specific point sources of land contamination. However, there is the possibility of localised or diffuse contamination / spills associated with agriculture or commercial forestry activity or anthropogenic materials within the existing road infrastructure construction materials, including the potential for asphalt to contain coal tar binders. In addition, there may be contaminated ground associated with the disused quarry.

4.6.69. Available ground investigation data indicates that the topsoil encountered on site is generally very thin. In addition, the presence of boulders and irregular topography will cause significant difficulties in separating the topsoil from the underlying superficial deposits. Therefore, only a limited quantity of topsoil is expected to be available for re-use from areas of proposed excavation.

4.6.70. Existing information also suggests that natural superficial deposits that will be excavated in areas of proposed cut can be relatively wet and contain relict soil layers. As indicated above, separating the topsoil layer will also be difficult due to the undulating, irregular topography and this may lead to further entrainment of organic materials. As such, as-dug superficial materials may not comply with the requirements of Class 1 or 2 General Fill for re-use in the works.

4.6.71. The re-use of excavated material relating to the OMR widening may be limited to Class 4 fill for landscaping areas with shallower slopes.

4.6.72. As more ground investigation data becomes available, there will be greater certainty over the quality of the natural superficial deposits, and it may be possible to permit processing for re-use. In particular, granular superficial deposits could be screened and graded to provide fill suitable for use as cushioning material on the roof of the DFS.

4.6.73. Bedrock at the site generally comprises interbedded sequences of metamorphic rock identified as psammites, pelites and semi-pelites with occasional phyllites. Igneous intrusions, recorded as dolerites and occasional diorite have been identified toward the southern extent of the Proposed Scheme including the disused quarry.

4.6.74. It is anticipated that the majority of the excavated metamorphic rock can be processed for re-use as SHW Class 1 engineered fill. Argillaceous rock types including pelites and phyllites are permitted constituents of Class 1 fills. However, they are precluded from re-use as Class 6 fills. As the psammites are interbedded with argillaceous units it is unlikely that these strata could be processed separately.

4.6.75. While the available testing indicates that the metamorphic rock should be durable in the long term, it is noted that recent experience of re-using excavated rock from the A83 catchpits to construct bunds in Glen Kinglas suggests that this material can be prone to disintegration during processing and handling, or over-compaction.

4.6.76. Class 6 fill materials such as capping, backfill to structures and gabion fill for the DFS may be derived from the igneous bedrock, subject to rock composition and grading requirements being met. Further ground investigation will determine the extent of the igneous intrusions and whether it is viable to process this material separately during the excavation works.

Excavatability and bulking

4.6.77. Published BGS data for excavatability is based on typical strength and density classifications for material in the 0-2m depth range. As such, the excavatability shown within the Proposed Scheme area is largely related to the mapped distribution of superficial deposits and where bedrock is encountered at surface.

4.6.78. Where superficial deposits are present the excavatability is identified as requiring hand tools. Based on the available material descriptions and particle size distribution test data it is assumed that the excavatability of the superficial deposits will most likely be easy digging with a high rate of excavatability. Large boulders are expected to be present within the colluvium and glacial deposits, which are likely to require breaking to smaller fragments for haulage.

4.6.79. Where bedrock is at surface the BGS data identifies excavatability as requiring ripping, which is consistent with medium strong to strong rock. Rock excavatability assessments have been carried out using "Graphical Methods for assessing the Excavatability of Rock" from Pettifer and Fookes. The assessments are based on rock quality measurements of cores recovered from boreholes along the Proposed Scheme and relevant strength test results from the available ground investigations. The results of the assessment are summarised by rock type as follows:

- Igneous (Diorite/Dolerite): Generally hard ripping with some very hard ripping.
- Metamorphic (Psammite/Pelite/Semi-pelite): Generally hard and very hard ripping with possible blasting.

4.6.80. The available ground investigation data does not indicate any significant trend in strength or rock quality with depth, which suggests that there is unlikely to be any notable change in excavatability with depth.

4.6.81. The excavation of rocks or soils is usually accompanied by an increase in volume. This change in volume is referred to as 'bulking' and the measure of the change is the 'bulking factor'. Bulking factors can be influenced by a number of different characteristics including lithological properties (specifically mineralogy, particle-size distribution, particle shape, porosity, density, and strength), alteration (weathering, hydrothermal alteration, and metamorphism) and the excavation method (digging, ripping or blasting).

4.6.82. The BGS Civils data set identifies six bulking classes based on typical lithology characteristics. For superficial deposits across the study area the bulking class is 1 or 2, which have bulking factors ranging from 5 to 20 percent and 20 to 40 percent, respectively. For the bedrock the bulking class is 5, typical of strong rocks that form blocky material when excavated, which have bulking factors greater than 65 percent. Taking into consideration the BGS Civils data and bulking factors identified in literature for metamorphic and igneous rocks, the following factors have been used to assess the volume of surplus materials to be taken off-site:

- Superficial deposits – 20%
- Bedrock – 65%

Earthworks Volumes

4.6.83. Approximate bulk earthworks volumes for the permanent works associated with the Proposed Scheme (A83, B828, DFS Maintenance Access, Rest and Be Thankful Viewpoint Car Park, Active Travel Link and SuDS Basin plus access) are included in **Table 4-13**, below.

Table 4-13 - Earthworks Summary for the Proposed Scheme

Quantity / details	A83 Mainline	B828 Junction and RaBT Car Park	Side Roads / Access Tracks / SuDS	Total
1. Cut (Acceptable)	99,161 m^3	913 m^3	24,695 m^3	124,769 m^3
2. Cut (Unacceptable)	104,747 m^3	2,991 m^3	6,464 m^3	114,202 m^3
3. Cut (Bulked Rock)	162,624 m^3	1,497 m^3	40,500 m^3	204,621 m^3
4. Cut (Bulked Soil)	125,696 m^3	3,589 m^3	7,757 m^3	137,042 m^3
5. Engineering Fill	2,382 m^3	778 m^3	1,368 m^3	4,528 m^3

Quantity / details	A83 Mainline	B828 Junction and RaBT Car Park	Side Roads / Access Tracks / SuDS	Total
Approx. Surplus / Deficit Volume (3+4-5)	285,938 m^3 Surplus	4,309 m^3 Surplus	46,889 m^3 Surplus	337,136 m^3 Surplus

Notes:

1. Bulked rock figures are based on a rock bulking factor of 1.64.

2. Bulked soil figures are based on a soil bulking factor of 1.20.

4.7. Drainage, Hydrology and Hydrogeology

Road Drainage Hydrology

4.7.1. Surface water runoff derives from the road cross-section, including the carriageway and verges, together with the associated earthworks. Additional surface flow from runoff draining towards the Proposed Scheme from natural catchment outside the road corridor will be kept separate from the road drainage system where practicable by cut-off drainage (ditches and filter drains where space constraints require).

4.7.2. The runoff estimation method used for the engineered (road based) catchment is based on the Wallingford Procedure. The runoff contributing to each drainage network has been obtained by applying the following Percentage Runoff factors to the contributing areas:

- Carriageway – 100% impermeable
- Grassed Verges, Cut Slopes, Embankments, Natural Catchment – 53% impermeable

4.7.3. A Percentage Impervious value of 53 percent has been assumed for verges, cut slopes, embankments, and natural catchments according to the Standard

Percentage Runoff value associated with the soil using the Flood Studies Report method.

4.7.4. Design storms are based on rainfall intensities appropriate to the area where the road is situated (Flood Studies Report data) with an additional 46 percent allowance for climate change. Climate change allowance value based on synthetic design storms have been generated for storms of varying duration and return periods (RP) obtained from computer simulated rainfall profile data.

4.7.5. Due to site specific topography, it was determined that peak flow estimates for the overland flow intercepted by the cut off drains should be calculated based on time of area concentration calculations.

4.7.6. Groundwater has been assumed to be at a low enough level to not interact with the road drainage at the OMR, A83 and B828 Glenmore local road extents. Near the A83 Network 1 Basin feature, it has been considered that groundwater is at ground level and the design has been adapted to propose the basin in fill above ground level. Assumptions are to be reviewed following completion of the Ground Investigation works.

Road Drainage Allowable Discharge

4.7.7. In the proposed scenario for the OMR Improvements, a zero-detriment approach in comparison to the existing scenario has been followed for the new alignment proposals. Where drainage networks are controlled to allowable discharge rates (based on a zero-detriment approach pre and post development assessment), the restriction of flow is achieved through the installation of flow controls (vortex flow controls and orifice plates). With regards to Flood Management, Argyll and Bute Council are in a local plan district with Highland Council, with Highland Council being the Lead Local Authority. In line with section 6.13 of 'The Highland Council's Flood Risk and Drainage Impact – Supplementary Guidance', allowable discharge rates and volumes draining to a receiving watercourse / waterbody shall not exceed the existing runoff rates for Brownfield sites, or the Greenfield runoff rate for previously undeveloped sites. This is why a zero-detriment approach pre and post development assessment is conducted.

4.7.8. In the proposed scenario for the A83, the networks all discharge during the relevant return periods at a rate of Q-Bar greenfield rate estimation. The restriction of flow is achieved through the installation of flow controls (vortex flow controls and orifice plates).

Road Drainage Design Storms

4.7.9. The following design storms have been applied to the design of the OMR Improvements drainage proposals:

- Pipe networks:
  - 1-year plus 46% climate change in-bore
  - 5-year plus 46% climate change no surcharge of water levels in filter drains into the pavement formation (considered to be 600mm deep)
  - 30-year plus 46% climate change no flooding
- Oversized pipes for attenuation:
  - 30-year plus 46% climate change no flooding
- Cut-off drainage:
  - 50-year plus 46% climate change no flooding (on basis that the OMR culverts are designed for the 50-year event).
- The spacing of gullies has been designed in accordance with HA 102/17 ‘Spacing of Road Gullies’. The following maximum channel flow widths have been adopted:
  - 0.75m (considered to be suitable on basis that carriageway does not have a hardstrip. However, also does not have a pedestrian footpath adjacent to road).

4.7.10. The following design storms have been applied to the design of the A83 drainage proposals:

- Pipe networks:
  - 1-year plus 46% climate change in-bore

  - 5-year plus 46% climate change no surcharge of water levels in filter drains into the pavement formation (considered to be 600mm deep)
  - 5-year plus 46% climate change no flooding of pipe network

- Oversized pipes for attenuation:
  - 5-year plus 46% climate change no flooding

- Network 1 Detention Basin for attenuation:
  - 200-year plus 46% climate change no flooding

- Cut-off drainage:
  - 100-year plus 46% climate change no flooding

- The spacing of gullies has been designed in accordance with HA102/17 Spacing of Road Gullies. The following maximum channel flow widths have been adopted:
  - 0.5m (as they are adjacent to a pedestrian footpath adjacent to road).

A83 Road Drainage Proposals

4.7.11. Network 1 consists of gullies discharging to carrier drains underneath the DFS extents. Filter drains are proposed outside the DFS at the southern portal to drain the road extents with a combined drainage kerb system provided to drain the DFS maintenance access track. The network extends down the slope between the A83 and the OMR via a ‘stepped’ drainage arrangement, crossing the OMR with a bespoke shallow triple pipe arrangement, and crossing the Croe Water via a pipe bridge. The network outfalls to a detention basin feature for attenuation and treatment prior to outfall to the Croe Water.

4.7.12. Networks 2A and 2B drain the road extents between the DFS northern portal to the A83 alignment high point at ~ Ch. 1,945. The networks are split due to the proposal of the bridge structure (B02 Burn Bridge) at Ch. 1,600. These networks utilise filter drains and filter-carrier ‘piggy-back’ drains to capture and treat runoff. Attenuation is provided in oversized pipes prior to discharge to existing watercourses / channels on the downslope between the A83 and OMR.

4.7.13. Networks 3A, 3B and 3C drain the road extents between the A83 alignment high-point at ~ Ch. 1,945 to the A83 northern tie-in. These networks are split to maintain existing catchment areas draining to each culvert (as much as feasibly possible). These networks utilise filter drains and filter-carrier ‘piggy-back’ drains to capture and treat runoff. Attenuation is provided in oversized pipes prior to discharge to existing watercourses / channels which are tributaries to Loch Restil.

4.7.14. Networks 4A to 4G are proposed along the Active Travel Link which sits adjacent and parallel to the B828 Glenmore local road. These networks are split to maintain existing catchment areas draining to each culvert or watercourse / channel (as much as feasibly possible). These networks utilise gullies and linear drainage channels to capture runoff from the Active Travel Link (and where applicable the runoff from the existing B828 Glenmore local road) and convey the runoff to a carrier drain network. As the Active Travel Link is not trafficked, it’s considered that this additional runoff is ‘clean’ and therefore no treatment proposals are specified. Attenuation is provided in oversized pipes prior to discharge to existing watercourses / channels which are tributaries to Loch Restil and / or Croe Water.

4.7.15. The Rest and Be Thankful Viewpoint car park alignment proposals generally match the existing with the main difference being the bus turning area which is now incorporated into the car park layout using the same access to the B828 Glenmore local road. The design proposals reduce the impermeable area of the car park extents. On the basis that the proposed design does not change the expected treatment scenario, it is proposed to retain the existing drainage philosophy as far as practicable. From a visual drainage survey, it appears that the Rest and Be Thankful Viewpoint car park generally drains runoff to the surrounding soft landscape to dissipate, with some ditches and a potential infiltration trench visible. It is proposed that existing ditches will be realigned to drain runoff to existing outfall locations and maintain the existing drainage strategy.

4.7.16. For the DFS roof, the roof material is proposed to be a granular fill to act as a ‘cushioning material’ during debris flow and landslide events. The drainage strategy is for filter drains (minimum 650mm cover) to be located along the east side of the roof at the downstream of crossfall. It is proposed that rodding eyes should be specified at upstream and downstream of filter drains. The 225mm dia. filter drains will regularly outfall into the DFS 'catchpit' every 100m (max). It is expected that the outlet pipes will be kept at a high level exiting the roof so that during a landslide event, outfalls would not become blocked (if one is blocked, then the water would build up, bypass and exit out one of the many outlets downstream). A penstock valve could be introduced on the outlet pipe to allow outfalls to be closed off to allow local maintenance of the DFS 'catchpit' below.

4.7.17. For the cut-off drainage, ditches and filter drains are proposed where required to intercept natural catchment runoff prior to entering the highway drainage network. Between Ch. 125 to Ch. 1,890, the natural catchment will be intercepted by the DFS 'catchpit' and specified rock traps which will act as the cut-off drainage. Along the B828 Glenmore local road, the existing cut-off drainage ditches not impacted by the works will be retained.

OMR Improvement Drainage Proposals

4.7.18. In order to best summarise the Proposed Highway Drainage, the OMR (excluding Phase 1) has been split into 3 sections for clarity on proposals:

- Existing 2-Way Extents [Ch. 160 to Ch. 1,090]
- 2-Way Widening Extents [Ch. 1,090 to Ch. 2,480]
- Existing 1-Way Extents including Sharp Bend Widening [Ch. 2,480 to Ch. 3,836]

4.7.19. Between Existing 2-Way Extents Ch. 160 to Ch. 1,090, it is proposed to retain the existing ditches. There is no significant road widening works proposed along these extents and there is therefore no significant increase to flood risk. It is expected that any existing ditches will be remediated if required. However, general parameters will be the same to remain 'like-for-like'.

4.7.20. Between 2-Way Widening Extents Ch. 1,090 to Ch. 2,480, formalised drainage networks are proposed. There are 19 no. networks throughout these extents.

These contain filter drains, carrier drains, gullies and chambers (Type 8 inspection chambers and Type 7 catchpits). These have been designed with oversized pipes for attenuation and flow controls to restrict the flow. These will outfall via proposed stone mesh headwalls to the downstream end of culverts

4.7.21. Between Existing 1-Way Extents including Sharp Bend Widening Ch. 2,480 to Ch. 3,836, it is proposed to retain the existing ditches and filter drains along this extent where they are not impacted by the sharp bend widening proposals. It is expected that any existing ditches will be remediated if required. However, general parameters will be the same to remain 'like-for-like'. At the sharp bend locations, localised drainage proposals have been specified where retaining the existing drainage is not feasible and is impacted by the road widening.

4.7.22. Cut-Off Drainage has been proposed where required (due to existing cut-off drainage being impacted) to seek design compliance with DMRB CG 522 'Drainage of Runoff from Natural Catchments' which stipulates that natural catchment drainage systems should be separated from road drainage systems. Generally, where new road drainage is proposed, natural catchment has been separated out with independent cut-off drainage features. However, there is one location between Ch. 2,080 to Ch. 2,130 where cut-off drainage was found to be unfeasible (with no existing feature in place) and therefore the natural catchment was considered within the modelling of the road drainage of Network 14 and 15. Cut-Off Drainage design consists of ditches, filter drains, carrier drains, chambers (Type 8 inspection chambers and Type 7 catchpits) and stone mesh headwalls for outfall.

A83 Watercourse Hydrology

4.7.23. Hydrological assessments have been completed for the 22 watercourses within the LTS scheme footprint. For details on the hydrological assessment method reference should be made to the LTS EIAR Volume 4, Appendix 19.6 – Flood Risk Assessment (A83AAB-AWJ-EAC-LTS_GEN-RP-LE-000297).

Watercourses and Culverts Design Load Cases

4.7.24. The adopted hydraulic load cases for the culvert and watercourse realignment designs in the DFS and DFW footprint are presented in **Table 4-14**. The load cases are defined as:

- Standard Scenario Load Case – the standard scenario comprises of the contributing hydrological inflows for a single delineated contributing catchment, as defined within the Stage 3 Flood Risk Assessment.
- Blockage Scenario Load Case – the blockage scenario comprises the hydrological inflows for the delineated contributing catchment for a given watercourse plus the hydrological inflows for the adjacent watercourse to the north.

4.7.25. The adopted design discharge for the culvert and watercourse realignment designs is the 0.5% Annual Exceedance Probability (AEP) event with a 46% uplift as an allowance for future climate change impacts. This value has been adopted in line with DRMB LA113 and National Planning Framework 4.

Table 4-14 – Adopted hydraulic load cases for the culvert and watercourse realignment designs in the DFS and DFW footprint

Proposed Scheme Watercourse ID	Chainage	Standard Load Case Design Discharge 0.5% AEP + CC (m^3/s)	Blockage Load Case Design Discharge 0.5% AEP + CC (m^3/s)
A83_ML_016	185	1.13	2.77
A83_ML_017	270	1.64	2.92
A83_ML_018	430	1.28	1.96
A83_ML_019	570	0.68	3.02
A83_ML_020*	640	1.38*	2.59*
A83_ML_023	810	0.24	3.87
A83_ML_024	920	3.62	5.75

Proposed Scheme Watercourse ID	Chainage	Standard Load Case Design Discharge 0.5% AEP + CC (m^3/s)	Blockage Load Case Design Discharge 0.5% AEP + CC (m^3/s)
A83_ML_025	1,065	2.13	3.15
A83_ML_026	1,135	1.02	3.28
A83_ML_027	1,265	2.26	3.24
A83_ML_028	1,315	0.99	1.71
A83_ML_029	1,400	0.72	1.60
A83_ML_030	1,500	0.88	N/A – No connected uphill catchment

* Accounts for the combined hydrological loading of catchments A83_ML_020, A83_ML_021 and A83_ML_022

A83 Watercourse Realignments

4.7.26. Eleven watercourse realignments are required as part of the Proposed Scheme, all of which are proposed as engineered cascade structures. Reference should be made to **Section 4.9** for further information.

LTS Scour Mitigation

4.7.27. Flexible scour mitigation shall be utilised at all transitions within the LTS watercourses between concrete inverts and existing bed material to mitigate the risk of local scour. The proposed scour mitigation comprises locally sourced rock encased in a high tensile strength steel mesh. The proposed scour mitigation will line the channel invert and the lower portion of the banks up to the 0.5% AEP + CC flow level plus and allowance for freeboard to provide resilience to flow bulking due to sediment entrainment and aeration. Suitability of using site won rock shall be assessed upon receipt of the Ground Investigation (GI) data.

4.7.28. There is a high likelihood that the proposed scour mitigation mattresses shall require anchoring into the hillslope to stabilise them due to the steep topography within the watercourses. The suitability of anchors shall be assessed upon receipt of GI.

4.7.29. A summary of the proposed scour mitigation associated with the A83 culverts is shown in **Table 4-15**, below.

Table 4-15 – Summary of proposed scour mitigation for the A83 culverts

Proposed Scheme Watercourse ID	Chainage	Scour Protection Length (m)	Scour Protection Width (m)	Material Depth (m)
A83_ML_016	185	7	8.51	0.5
A83_ML_017	270	10	12.09	0.5
A83_ML_018	430	5	7.37	0.5
A83_ML_019	570	10	8.96	0.5
A83_ML_020	640	7.6	8.31	0.5
A83_ML_023	810	10	9.85	0.5
A83_ML_024	920	7.5	8.06	0.5
A83_ML_025	1,065	7.5	8.96	0.5
A83_ML_026	1,135	9.5	8.76	0.5
A83_ML_027	1,265	13.4	2.25	0.5
A83_ML_028	1,315	5	7.17	0.5
A83_ML_029	1,400	7	15.67	0.5
A83_ML_030	1,500	40	6.72	0.5

4.8. Public Utilities

Introduction

4.8.1. At DMRB Stage 2, a C2 notification was issued to Statutory Undertakers in line with the New Roads and Street Works Act (NRSWA) 1991. As part of the Proposed

Scheme development, at DMRB Stage 3, C3 Budget Estimate notices have been issued to the following Statutory Undertakers whose existing plant, at the C2 stage, was identified to be affected by the Proposed Scheme.

BT Openreach

4.8.2. BT Openreach have returned their proposals following the C3 NRSWA notice and have indicated that the underground cable and chambers running parallel to the A83, in the northbound verge, require temporary diversion away from the A83 corridor to allow construction of the DFS. Post construction the cables and chambers will be permanently diverted back into the A83 northbound verge. Exact locations will be confirmed at NRSWA C4 stage, to be carried out during Specimen Design.

4.8.3. The budget estimate for diversion of the Openreach apparatus, including production of NRSWA C4 specification and detailed estimate, is £978,500.75 including VAT.

Mobile Broadband Network Limited (MBNL)

4.8.4. Awaiting response to C3 request submission.

4.9. Structures

Introduction

4.9.1. The Proposed Scheme includes three principal structures on, or adjacent to, the A83 mainline, namely the DFS, DFW and B02 Burn Bridge. The A83 mainline works also includes 13 new culvert structures within the footprint of the DFS and DFW.

4.9.2. As part of the OMR Improvements, to support the construction of the Proposed Scheme, three structures are required namely Bridge B, Bridge D and Bridge E.

4.9.3. General arrangement drawings of all structures are included in Volume 2.

Summary Details of Principal Structures

Debris Flow Shelter

4.9.4. The proposed superstructure comprises a monolithic portal frame with a solid reinforced concrete wall on the hillside, discrete reinforced concrete columns on the valley side, and a solid reinforced concrete roof slab. A minimum internal width of 14.3m and minimum internal height of 5.3m will be provided.

4.9.5. Due to the variable rockhead profile along the length of the A83, the substructure of the DFS is expected to vary. On the hillside, the substructure will consist of either a shear key with spread footing (shown in **Figure 4-4**, below) or a pile cap with twin piles, while on the valley side it will consist of a single row of piles. The hillside pile cap and spread footing are proposed to be the same dimension and depth below finished ground level to reduce variability along the length of the DFS. A 4-degree slope on the soffit of the roof slab will allow rising smoke to exit the DFS through the open valley side in the event of a fire.

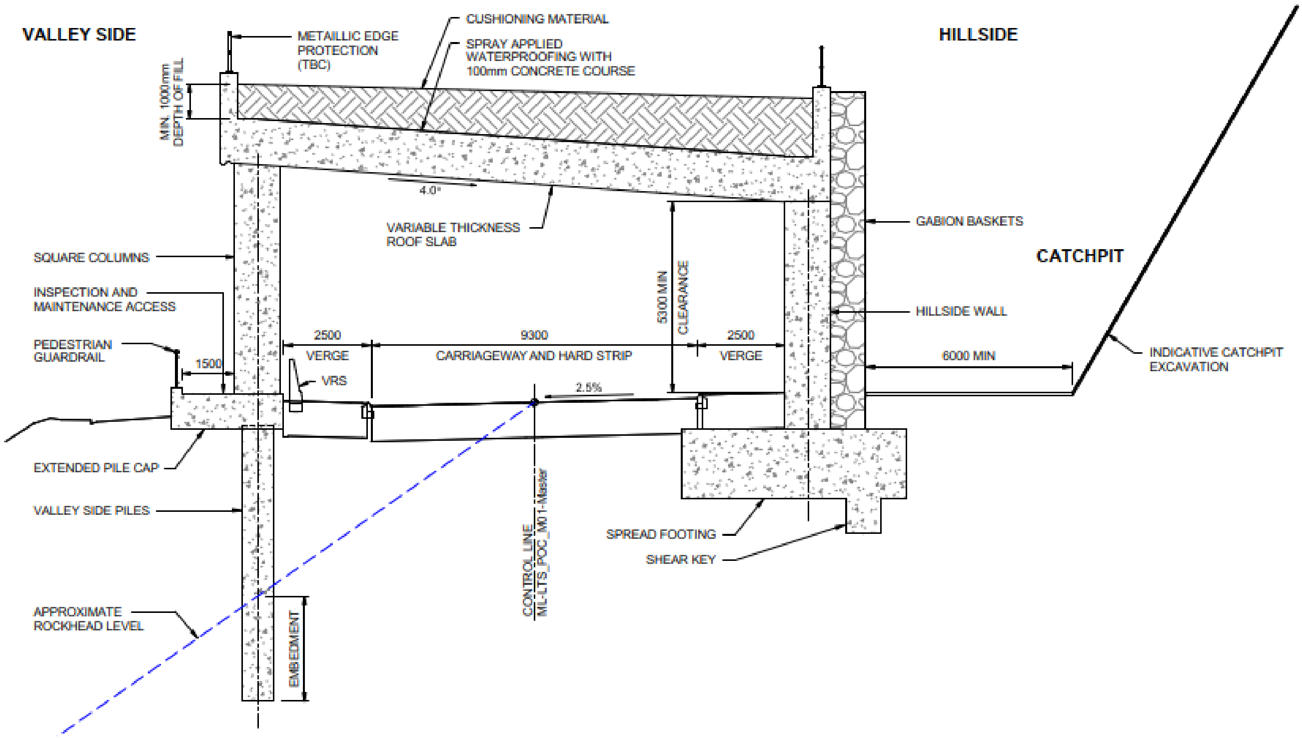

Figure 4-4 – Typical DFS cross section with spread footing

4.9.6. The DFS will accommodate a 3.65m single lane in each direction with a 1m hard strip and 2.5m verge on either side. An emergency evacuation and maintenance walkway with a minimum clear width of 1.5m is proposed on the valley side of the structure and will be formed as part of the pile cap. A 1m high pedestrian parapet will be provided along the length of this walkway. A concrete barrier forming the VRS will be provided in the northbound verge with discrete breaks to facilitate emergency exit of the DFS.

4.9.7. The DFS will include a maintenance access track on the roof to facilitate the clearance of debris from both the catchpit and the roof itself. Access to the roof will be provided at the southern end via a direct access and maintenance track from the A83. This access will be restricted and via secure gates with no public access permitted. A turning area will be provided at the northern end of the structure. A minimum 1m depth of fill will be provided on the roof to dissipate energy from boulder impacts. It is proposed that the fill material is planted with suitable low-lying, wildflower and grass mix to create a green roof. A 1m thick layer of gabions will also be provided at the rear of the hillside wall to dissipate energy from lateral boulder and debris loads impacting the wall. A 1m high pedestrian fence is proposed along the perimeter of the roof of the DFS with the exception of the ends of the structure where a solid reinforced concrete upstand is proposed.

4.9.8. DFS general arrangement, plan & elevation and cross section drawings A83AAB-AWJ-SSP-LTS_DFS_V01-DR-CB-001001 to A83AAB-AWJ-SSP-LTS_DFS_V01-DR-CB-001011 are included in **Volume 2**.

4.9.9. At either end of the DFS there is a requirement for plant / equipment rooms which will be arranged into service buildings. At the southern end it is proposed to include the service building to the rear of the DFS embedded below the DFS maintenance access track to minimise visual impact and avoid the need for greater land take. At the northern end it is proposed to include the service building below the turning area on the roof of the DFS, utilising a combined maintenance access to the catchpit for access.

4.9.10. Welfare facilities are proposed to be included in both service buildings with foul drainage contained in a septic tank.

Debris Flow Protection Wall

4.9.11. The proposed superstructure comprises a reinforced concrete wall embedded into rockhead along its length. The first DFW extends from the end of the DFS at Ch. 1,445m for a length of approximately 21m at a constant offset of 2.5m from the edge of the proposed A83 Trunk Road. The second DFW commences at Ch. 1,456m behind the first DFW with a 10m overlap and extends north for a length of approximately 135m terminating adjacent to B02 Burn Bridge, as shown in **Figure 4-5**.

Figure 4-5 – Computer generated image of the DFW at the northern end of the Proposed Scheme

4.9.12. DFW general arrangement and cross section drawings A83AAB-AWJ-SSP-LTS_DFW_V01-DR-CB-001001 to A83AAB-AWJ-SSP-LTS_DFW_V01-DR-CB-001002 are included in **Volume 2**.

B02 Burn Bridge

4.9.13. The structure comprises a 30m single span, precast, prestressed beam bridge with a skew of 12-degrees to the A83 alignment.

4.9.14. The structure carries a 3.35m wide lane in each direction with 0.3m hard strips and 2.5m (minimum) verges on either side. Normal containment parapets of 1m height will be provided at either edge of the bridge. The parapet on the southbound side of the bridge at the east abutment will transition into a removal barrier section adjacent to the gap between the first and second DFW to allow maintenance access to the catchpit behind the DFW.

4.9.15. A general arrangement drawing of B02 Burn Bridge, A83AAB-AWJ-SBR-LTS_B02_M01-DR-CB-101001, is included in **Volume 2**.

Bridge B

4.9.16. A proprietary unreinforced concrete arch with a clear span of 4.4m will be installed. The arch will be supported off newly constructed reinforced concrete abutments and spread foundations. A bond breaker will be installed between the existing bridge and the widened section, allowing for the widened section’s removal upon completion of the OMR Improvement works.

4.9.17. A general arrangement drawing of Bridge B, A83AAB-AWJ-SBR-MTS_BRB-DR-CB-000004, is included in **Volume 2**.

Bridge D

4.9.18. The temporary bridge structure will be a proprietary design supplied by a specialist manufacturer, with a 12m span. The bridge will be constructed from structural steel and will feature a carriageway width of 4.2m, measured from kerb to kerb. The superstructure will rest on reinforced concrete abutments set on spread foundations over granular material. Fixed bearings will support one abutment, while free bearings will be used on the other.

4.9.19. The proprietary bridge structure will be required during the full duration of the long-term construction works to the A83.

4.9.20. A general arrangement drawing of Bridge D, A83AAB-AWJ-SBR-MTS_BRD-DR-CB-000002, is included in **Volume 2**.

Bridge E

4.9.21. The new pipe bridge, located adjacent to Bridge A, will span approximately 13m across the Croe water. It will consist of a fully lined steel carrier pipe. The structure will be supported by reinforced concrete supports, anchored securely on reinforced concrete foundations at each end.

4.9.22. Bridge E will serve as a permanent installation, intended to support continuous water flow to the SuDS basin as part of the site's long-term water management system.

4.9.23. A general arrangement drawing of Bridge E, A83AAB-AWJ-SBR-MTS_BRE-DR-CB-000002, is included in **Volume 2**.

Summary Details of A83 Culverts

4.9.24. The Proposed Scheme culvert designs have been undertaken in line with CIRIA C786 'Culvert, Screen and Outfall Manual' as per the requirements of DRMB CD 529 'Design of Outfall and Culvert Details'. The culvert inlets shall comprise of a 6m long x 4m wide pre-cast reinforced concrete drop structure of variable depth. The inlet grate shall comprise of steel I-beams with 100mm transverse spacing.

4.9.25. The proposed culverts are proposed as 1.9m high x 1.9m wide pre-cast concrete box structures implemented perpendicular to the A83, with a standard length of 19.4m applied across the Proposed Scheme. A standard bed slope of 5% has been applied but will be subject to further review at specimen design to optimise sediment conveyance. Where shallow bedrock is encountered the culverts shall be founded on rock, with piling utilised where superficial deposits are deeper.

4.9.26. The culvert barrel shall incorporate a low flow notch cast into the culvert invert. Dimensions for the low flow notch shall be confirmed at specimen design.

4.9.27. **Table 4-16** provides a summary of the proposed culvert locations and internal dimensions for the Proposed Scheme design.

Table 4-16 – Summary of Proposed Scheme culverts associated with the A83 including locations and internal dimensions

Proposed Scheme Watercourse ID	Chainage	Easting (Outlet)	Northing (Outlet)	Outlet Invert Level (mAOD)	Length (m)	Width (m)	Height (m)	Bed Slope (%)
A83_ML_016	185	224177	706225	171.35	19.4	1.9	1.9	5.0
A83_ML_017	270	224153	706298	175.52	19.4	1.9	1.9	5.0
A83_ML_018	430	224075	706441	183.65	19.4	1.9	1.9	5.0
A83_ML_019	570	224005	706558	190.53	19.4	1.9	1.9	5.0
A83_ML_020	640	223970	706601	192.71	19.4	1.9	1.9	5.0
A83_ML_023	810	223853	706746	202.59	19.4	1.9	1.9	5.0
A83_ML_024	920	223786	706835	208.19	19.4	1.9	1.9	5.0
A83_ML_025	1,065	223699	706946	215.18	19.4	1.9	1.9	5.0
A83_ML_026	1,135	223657	707003	218.71	19.4	1.9	1.9	5.0
A83_ML_027	1,265	223573	707102	225.38	19.4	1.9	1.9	5.0
A83_ML_028	1,315	223538	707139	227.89	19.4	1.9	1.9	5.0

A83_ML_029	1,400	223483	707201	231.97	19.4	1.9	1.9	5.0
A83_ML_030	1,500	223423	707278	236.86	19.4	1.9	1.9	5.0

4.9.28. The hydraulic design of the culvert apron and energy dissipators has been undertaken in accordance with Hydraulic Engineering Circular 14 – Hydraulic Design of Energy Dissipators for Culverts and Channels (FHWA, 2006), as recommended by Chapter 12.5.4 of CIRIA C786 'Culvert, Screen and Outfall Manual'.

4.9.29. The aprons shall consist of pre-cast reinforced concrete rectangular channels and wingwalls. An upstream width of 1.9m shall apply, transitioning to 2.5m at the downstream end of the structure. Baffles shall be pre-cast into the channel invert to provide an energy dissipation function. The baffles shall be a standard 575mm wide x 300mm high with a minimum transverse spacing of 130mm and longitudinal spacing of 2.15m.

4.9.30. **Table 4-17** provides a summary of the proposed culvert apron extents and internal dimensions for the Proposed Scheme design.

Table 4-17 – Summary of Proposed Scheme culvert apron extents and internal dimensions

Proposed Scheme Watercourse ID	Chainage	Easting (Downstream extent)	Northing (Downstream extent)	Invert Level (mAOD)	Length (m)	Max Width (m)	Minimum Depth (m)	Bed Slope (%)
A83_ML_016	185	224174	706219	171.20	6.08	2.5	1.10	2.5
A83_ML_017	270	224145	706295	175.31	8.36	2.5	0.85	2.5
A83_ML_018	430	224070	706438	183.50	6.08	2.5	1.15	2.5
A83_ML_019	570	224001	706555	190.40	5.18	2.5	1.00	2.5
A83_ML_020	640	223965	706597	192.55	6.35	2.5	1.10	2.5
A83_ML_023	810	223850	7067442	202.50	3.50	2.5	1.40	2.5
A83_ML_024	920	223783	706832	208.10	3.70	2.5	1.40	2.5
A83_ML_025	1,065	223697	706944	215.10	3.35	2.5	1.15	2.5
A83_ML_026	1,135	223654	700701	218.60	4.35	2.5	1.20	2.5
A83_ML_027	1,265	223568	707098	225.20	7.05	2.5	1.20	2.5

Proposed Scheme Watercourse ID	Chainage	Easting (Downstream extent)	Northing (Downstream extent)	Invert Level (mAOD)	Length (m)	Max Width (m)	Minimum Depth (m)	Bed Slope (%)
A83_ML_028	1,315	223533	707135	227.73	6.50	2.5	0.85	2.5
A83_ML_029	1,400	223480	707198	231.80	6.61	2.5	0.75	2.5
A83_ML_030	1,500	223419	707275	236.70	6.40	2.5	0.50	2.5

A83 Cascades

4.9.31. The hydraulic design of cascades has been undertaken in accordance with the Spillway Design Guide (Environment Agency, 2022) and Hydraulic Engineering of Dams (Hager et al. 2019). The cascades have been sized to operate in either the nappe or skimming flow regimes at the design discharge for both standard and blockage load cases.

4.9.32. The cascades are proposed as cast in-situ reinforced concrete stepped structures with vertical reinforced concrete side walls. Scour mitigation shall be used to line the banks above the cascade side walls to provide additional resilience to flow bulking resulting from aeration and sediment entrainment.

4.9.33. Due to the variable loading experienced by each cascade and site-specific topographic constraints bespoke sizing has been applied to the length, height, step length and step height of each structure. The Proposed Scheme design information is provided in **Table 4-18**. A standard width and minimum channel depth have been proposed at 2.5m wide x 0.8m high, with the exception of A83_ML_024 which is likely to require a wider channel due to comparatively higher design discharges in the standard and blockage load cases.

4.9.34. The cascade foundation is proposed as a series of 200mm diameter mini piles at 1.0m centres with lengths of approximately 10.0m. The proposed cascade foundation should be interpreted as indicative until further GI is available.

Table 4-18 – Proposed Scheme cascade design summary information

Proposed Scheme Watercourse ID	Chainage	Length (m)	Height (m)	Slope (%)	Slope (1:X)	Width (m)	Minimum Depth (m)	Step Height (m)	Step Length (m)
A83_ML_016	185	11.30	7.20	63.72	1.57	2.5	0.8	0.8	1.26
A83_ML_018	430	10.56	6.13	58.05	1.72	2.5	0.8	0.7	1.21
A83_ML_019	570	7.13	4.17	58.49	1.71	2.5	0.8	0.7	1.20
A83_ML_020	640	8.77	5.79	66.02	1.51	2.5	0.8	0.9	1.36
A83_ML_023	810	19.60	13.14	67.04	1.49	2.5	0.8	1.1	1.64
A83_ML_024	920	16.28	12.20	74.94	1.33	3.0	0.8	1.2	1.6
A83_ML_025	1,065	20.50	13.60	66.34	1.51	2.5	0.8	0.9	1.36
A83_ML_026	1,135	25.46	17.50	68.74	1.45	2.5	0.8	0.9	1.31
A83_ML_028	1,315	9.10	5.04	55.38	1.81	2.5	0.8	0.6	1.08
A83_ML_029	1,400	13.13	4.37	33.28	3.00	2.5	0.8	0.5	1.50

Proposed Scheme Watercourse ID	Chainage	Length (m)	Height (m)	Slope (%)	Slope (1:X)	Width (m)	Minimum Depth (m)	Step Height (m)	Step Length (m)
A83_ML_030	1,500	22.08	13.15	59.56	1.68	2.5	0.8	0.5	0.84

4.10. Fencing and Environmental Barriers

Fencing

4.10.1. Permanent post and wire fencing that is being impacted by the Proposed Scheme will be replaced on a like-for-like basis, in accordance with Manual for Contract Documents for Highway Works (MCHW). Ecological fencing (e.g. otter / badger fencing) will also be introduced, where necessary, to guide mammals to safe crossings under the road.

4.10.2. On this basis, ecological fencing will be included at the southern end of the Proposed Scheme adjacent to, and north of, the Croe Water to compliment the existing fencing and ensure mammals are guided under the Cobbler Bridge. Similarly, at the northern end of the Proposed Scheme mammal fencing will be included on both sides of the A83 Trunk Road either side of Burn Bridge.

4.10.3. Existing deer fencing will be replaced where affected by the Proposed Scheme, and some additional deer fencing will be introduced at the Natural Capital / Biodiversity Net Gain sites to protect planting until it is sufficiently developed.

Debris Catch Fencing

4.10.4. The excavation and stabilisation of overburden material on the Beinn Luibhean slopes to form the proposed DFS and catchpit requires lengths of existing debris catch fences affected by the Proposed Scheme to be removed and replaced with new fences above the earthworks cuttings required for the Proposed Scheme.

4.10.5. The catch fences act as the first line of defence to the construction site of the Proposed Scheme and will require to be completed prior to commencement of excavation and stabilisation work. The total length of catch fencing is estimated to be approximately 700m if a single fence is adequate and longer if dual lines are required to cater for potential “boulder bounce”. The catch fence proposals will be developed further during specimen design.

4.11. Traffic Signs and Road Markings

Traffic Signs

4.11.1. The Proposed Scheme will require traffic signs in accordance with the Traffic Signs Manual (TSM), The Traffic Signs Regulations & General Directions (2016) (TSRGD) and Local Transport Note 1/94 “The Design and Use of Directional Informatory Signs”. The provision will include; regulatory signs, warning signs, and directional signs. Plan drawings of the traffic sign locations for the Proposed Scheme, A83AAB-AWJ-HSN-LTS_POC_M01-DR-CH-120001 and A83AAB-AWJ-HSN-LTS_POC_M01-DR-CH-120002 are provided in **Volume 2**.

4.11.2. The preliminary signing proposals have also considered:

- Transport Scotland’s ‘Trunk Road and Motorway Tourist Signposting Policy and Guidance’
- Scottish Governments ‘Gaelic Language Plan’. Gaelic language included on preliminary ADS, direction signs and route confirmatory signs
- Transport Scotland’s guidance on ‘Road Furniture in the Countryside’. Signs are required to have high visibility for road users, however, the siting of signage has been considered to minimise ‘skylining’ and visual clutter.

4.11.3. A Traffic Sign and Road Marking strategy has been developed for the Proposed Scheme. As part of detailed design, this will be further developed by the Appointed Contractor, taking cognisance of the environmental impact of signage, particularly in terms of landscape and visual intrusion.

“X” height adopted for Traffic Signs

4.11.4. The x-height of the proposed traffic signs has been developed taking cognisance of the existing provision within the Proposed Scheme extents as it is the intention to retain much of the existing traffic sign faces (subject to their condition). This results in x-heights which are less than prescribed by the TSM, and sign faces generally smaller than required. This decision was taken based on the safety record of the existing route within the Proposed Scheme extents over the last 10 years, and the necessity to manage the congestion of assets in the limited verge space throughout much of the Proposed Scheme extents, as a result of the steep topography either side of the A83.

4.11.5. The x-heights for proposed signs on the A83 mainline within the Proposed Scheme extents is 100mm for all sign types (e.g. advanced directional, directional, route confirmatory etc.). The x-heights for proposed signs on the B828 and within the Rest and Be Thankful Viewpoint car park is 75mm for directional signs, 62.5mm for regulatory signs and 50mm for regulatory supplementary plates.

4.11.6. As noted above, the Proposed Scheme proposes to retain much of the existing traffic signs. However, these will be relocated to allow siting in accordance with the TSM, ensuring drivers have sufficient time to react to hazards and changes in road layout. It is also proposed that any additional traffic signs required, over and above the existing, be designed in accordance with the existing x-heights used to ensure continuity within the Proposed Scheme extents.

Road Markings

4.11.7. The Proposed Scheme will require road markings in accordance with Chapter 5 ‘Road Markings’ of the TSM and TSRGD (2016).

4.11.8. The existing road marking provision on the A83 within the extents of the Proposed Scheme are generally in compliance with Chapter 5 ‘Road Markings’ of the TSM and as such much of the existing road markings are to be maintained in the Proposed Scheme design. However, within the Proposed Scheme extents it is proposed to make two amendments to the road markings on the A83.

4.11.9. The first of the amendments is the inclusion of double white lines along the centre of the A83 within, and on the approach to, the DFS extents to prohibit drivers from encroaching on the opposite lane used by opposing flows of traffic.

4.11.10. The second amendment, to improve safety for road users and aid the free flow of traffic on the A83, is the targeted improvements of the B828 Glenmore local road junction as part of the Proposed Scheme which will include updated markings in relation to the inclusion of the ghost island.

4.11.11. Road marking plan drawings for the Proposed Scheme, A83AAB-AWJ-HMK-LTS_POC_M01-DR-CH-000001 and A83AAB-AWJ-HMK-LTS_POC_M01-DR-CH-000002, are provided in **Volume 2**.

OMR Improvements – Traffic signs and road markings

4.11.12. To support the use of the OMR as the local diversion route during construction of the A83 (including the improvements to the B828 Glenmore local road junction and DFS maintenance access) additional signage, speed cushions, marker posts and gates will be required.

4.11.13. Similar to the main works, the detailed design of all signage and road furniture for the OMR Improvements will be part of the Appointed Contractor's responsibilities and will be undertaken in accordance with relevant design standards and the Proposed Scheme contract documentation. Consultation on the design proposals will be required with Transport Scotland and Argyll and Bute Council.

4.12. Lighting

4.12.1. The proposed lighting design, relating to the DFS, includes a combination of daylighting luminaires (located over the southbound lane), structure mounted night-time luminaires, along with some combination of emergency provisions as shown in **Figure 4-6**, below.

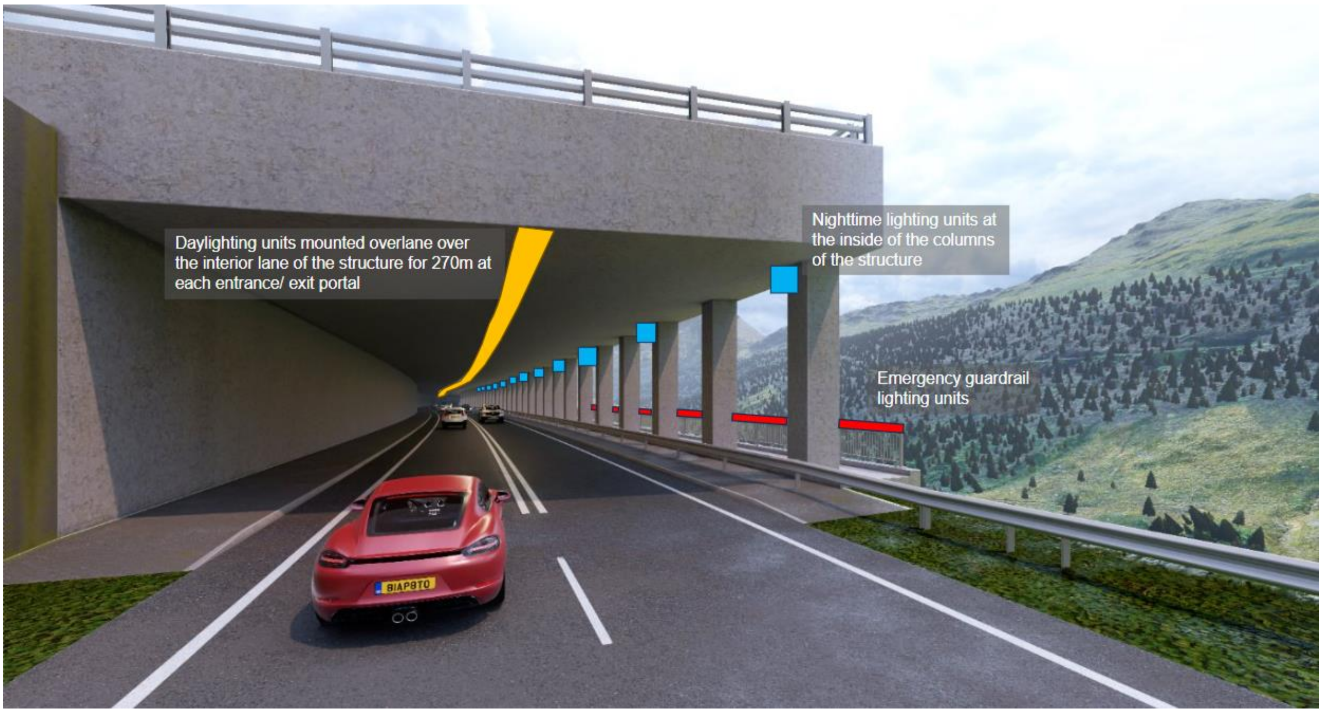

Figure 4-6 – Computer generated image of the DFS northern portal with the various lighting proposals illustrated

4.12.2. Where possible, reflective surfaces, including road markings, reflective strips, and brighter surface materials will be used throughout the DFS to enhance visibility and spatial orientation. Reflective road markings have been included as part of the Proposed Scheme design. However, the use of brighter surface colours for both the road surfacing and concrete materials within the DFS will continue to be considered and developed as part of specimen design with final commitments included in contract documents.

Daytime Lighting

4.12.3. The proposed daytime lighting is based on:

- artificial lighting provided for a length of 540m through the DFS (in 2 x 270m sections beginning at each portal);
- the potential to integrate control mechanisms such as photometers which will add efficiencies; and,

- the potential to include measures for surface finishes to aid the lighting, including the use of lighter materials in the interior walls and carriageway, and darker in the areas covering the approach to the structure.

Night-Time Lighting

1.1.2. The proposed night-time lighting provision is based on the following which takes account of the safety systems that are used for the DFS as well as environmental and visual impacts given the rural and remote location of the Proposed Scheme:

- lighting to be provided to the carriageway for the full length of the DFS in accordance with BS EN 13201 class M6. This would typically be achieved by cornice mounted or overhead tunnel lighting units;
- lighting to be provided for any potential pedestrian routes, derived from road lighting standards or from evacuation lighting standards, supporting safe egress in an emergency;
- all artificial lighting will use warm colour temperature sources (amber lighting) to mitigate environmental impact;
- highly reflective road markings to be used; and,
- surface finishes to be as light and reflective as possible, as for daytime considerations.

Emergency Lighting

1.1.3. The proposed approach for emergency lighting is subject to change, depending upon the safety systems that are implemented within the DFS. This will be considered further during development of the specimen design. The proposed provisions include:

- use of handrail mounted luminaires for the length of the walkway located on the open, valley side of the DFS, in combination with any illuminated signage proposed by the safety strategy;
- use of daytime and / or night-time luminaires as standby lighting in the event of an interruption to the power supply; and,

- reflective surfaces to be placed along pertinent walls and other structural elements to enhance wayfinding and orientation.

4.13. Vehicle Restraint Systems (VRS)

4.13.1. VRS will be provided at all locations identified during the process of assessment as required in DMRB CD 377 'Requirements for Road Restraint Systems'.

4.13.2. An initial assessment of the locations requiring VRS has been carried out using the Road Restraints Risk Assessment Process (RRRAP). The RRRAP software assesses hazards, calculating the likelihood and severity of a collision and identifies any lengths of VRS required. Preliminary proposals for the location and containment of VRS required for the Proposed Scheme are shown on drawings A83AAB-AWJ-HRR-LTS_POC_M01-DR-CH-000401 to A83AAB-AWJ-HRR-LTS_POC_M01-DR-CH-000402 contained in **Volume 2**.

4.13.3. The majority of the Proposed Scheme VRS provision is proposed as Tension Corrugated Beam (TCB) steel sections. However, concrete barrier has been proposed in the northbound verge within the DFS extents to better facilitate safe egress from the DFS in the event of an emergency (e.g. vehicle fire).

4.13.4. To provide breaks in a steel TCB VRS, it would be necessary to provide a section of overlapping barrier such that full containment could be maintained. This overlapping section would result in road users having to navigate an additional length of the DFS during evacuation, leading to further time required to safely exit the structure. In order to provide an arrangement which facilitates a faster and less convoluted lateral egress to the external walkway, an alternative VRS proposal using a concrete barrier has been included as part of the Proposed Scheme design.

4.13.5. The concrete barrier is required end-to-end in the northbound verge of the DFS, set-back to provide minimum vehicle intrusion width (0.8m) between the barrier and the adjacent DFS columns. It is proposed that the gaps in the concrete barrier are 1.5m, with a chamfered profile on the approach in both directions in line with the guidance set out in paragraph 4.34 of DMRB BD 78/99 'Design of Road Tunnels' (withdrawn). Similar guidance is provided in the updated DMRB CD 352 'Design of Road Tunnels'. However, the revised guidance does not include the detail around the horizontal depth of chamfer or the taper ratio.

4.14. Road Pavement

4.14.1. Pavement areas and initial construction depths were calculated to inform the Proposed Scheme cost estimate, on the basis that full pavement re-construction would be required. The mainline pavement estimates were based on standard pavement construction depths of sub-base, lower base, upper base, binder and surface courses. A variance of this is implemented through the DFS extents where a concrete foundation layer is required below the sub-base layer.

4.14.2. As noted in Section 2.7.5, it is currently assumed that there will be no re-use of the existing pavement and foundation. The current design for the Proposed Scheme assumes replacement in its entirety. However, coring of the existing pavement will be undertaken as part of future GI survey works to determine the existing road pavement and to inform an assessment on the structural condition of the road.

4.14.3. As such, full road pavement design will be completed during specimen design in line with the following relevant DMRB design standards:

- DMRB HD24/06 Traffic Assessment;
- DMRB HD26/06 Pavement Design;
- TS2010 Surface Course Specification and Guidance; and,
- IAN 73/06 Design Guidance for Road Pavement Foundations.

4.15. Bus Services

4.15.1. As detailed in **Chapter 2**, there are two public bus service operators that presently use the bus stop / turning area adjacent to the Rest and Be Thankful Viewpoint car park at the head of Glen Croe as part of their serviced routes. Garelochhead Coaches provide the 302 service between Helensburgh and Carrick Castle and

West Coast Motors provide the 926 and 976 services between Glasgow and Campbeltown and Glasgow and Oban, respectively.

4.15.2. Consultation with the bus service operators and Argyll and Bute Council has been undertaken throughout DMRB Stage 3 to understand their views on the existing A83, B828 Glenmore local road junction and the bus stop / turning area provision adjacent to the Rest and Be Thankful Viewpoint car park. The feedback provided has been used to further develop the design proposals, covered in **Section 4.3.22**.

4.16. Intelligent Transport Systems (ITS)

Introduction

4.16.1. ITS technology equipment and systems are proposed both inside the DFS, and on the approaches, to support the safe operations of the DFS.

Variable Message Signs

4.16.2. Electronic matrix Variable Message Signs (VMS) are proposed on the immediate approaches to the DFS to provide a variety of fixed text messages to the road user. Messages shall be related to the availability of the DFS (lane closures), weather conditions (safety messages) and strategic messages regarding the wider Transport Scotland network. Operators at the National Control Centre (NCC) will be able to set specific messages from an approved list.

4.16.3. VMSs will be connected to the local optical fibre network that supports other systems at the DFS, before connecting into a local fixed communications line back to the NCC.

Ducts

4.16.4. A variety of buried ducts will be installed inside and outside of the DFS structure to protect cabling feeding Mechanical and Electrical (M&E) and technology equipment. Longitudinal ducting is proposed in the northbound (valley) side of the DFS, accompanied by local ducting to provide Low Voltage (LV) power and communications to M&E and technology equipment.

Close-Circuit Television (CCTV)

4.16.5. Pan-Tilt-Zoom (PTZ) CCTV cameras are proposed to provide the NCC with full continuous coverage inside the DFS and on the approaches to the DFS. Cameras will also be installed on the roof of the DFS to provide the NCC with visibility of any debris that has fallen onto the roof of the DFS structure.

4.16.6. Cameras will be connected to the local optical fibre network that supports other systems at the DFS, before connecting into a local fixed communications line back to the NCC. Operators shall be able to switch camera views and change the positions of each individual camera (including the zoom function) to gain alternative views required. Camera footage can be saved on the local server, located at the NCC.

Weather Stations

4.16.7. Weather stations are proposed outside of the DFS to provide the NCC with weather data, which can be used to warn road users (via VMSs) of inclement weather in and around the DFS.

Traffic Counters

4.16.8. Traffic counters proposed be provided to verify AADT (traffic counts) and allow a determination of quiet times for lane closures for annual maintenance.

4.17. Scheme Procurement

4.17.1. Whilst the type of contract is not yet determined we have progressed on the basis that the Proposed Scheme will be procured by means of a Design and Build type Contract. The Proposed Scheme has been designed to sufficient detail on behalf of Transport Scotland to complete the necessary statutory procedures. Thereafter, detailed design shall be the responsibility of the successful Design and Build Contractor. It is intended to allow the Contractor as much scope as possible within the Contract to design and construct the works by the most efficient and safest means available, within the constraints of the site and commitments made in the EIA Report.

4.17.2. The Contract will describe the Employer's Requirements for the works and the standards required for both construction and maintenance. The contract will include the Statutory Road Orders and the Land Made Available by the Employer for the works. The Contractor will take responsibility for the Design, Construction and Maintenance of the Works with the Contractor's obligations under the contract including a maintenance period after the completion of the works.

4.18. Maintenance Proposals

4.18.1. The maintenance proposals set out below defines the high-level principles for maintenance of the Proposed Scheme that are assumed will be undertaken by the respective regional Operating Company upon handover. This proposal provides a basis of consideration to be carried forward into the detailed design stage that will ultimately support the operational and maintenance handover of the Proposed Scheme.

4.18.2. Assets to be maintained within the Proposed Scheme extents are detailed in **Table 4-19**. **Table 4-19** presents a non-exhaustive list of assets that will require maintenance, further assets will likely be identified in the subsequent detailed design stage.

Table 4-19 – Proposed Scheme associated assets that will require maintenance

Asset Type	Description	New / Existing
Structures and Traffic Signs	Debris Flow Structures and foundations	New
	Retaining walls	New
	Existing structures	Existing
	Traffic signs	New & Existing
Technology	Closed circuit television (CCTV)	New
	Lighting	New
	Emergency telephones	New
	Ducts	New

Asset Type	Description	New / Existing
	Transmission network	New
Fences, VRS and Associated Infrastructure	Vehicle restraint systems	New & Existing
	Boundary fences	New & Existing
	Maintenance access gates	New
	Pedestrian handrails	New
Drainage	Drainage systems associated with DFS	New
	Piped drainage network	New
	Drainage Basin	New
	Culverts	New
Other	Earthworks and gabions	New & Existing
	Pavement	New & Existing

Road Maintenance

4.18.3. As the Proposed Scheme forms part of the Trunk Road Network, upon completion it shall be returned to the appointed regional Operating Company to be maintained. The maintenance of the proposed carriageway and associated road assets will therefore naturally integrate into the Operating Company's cyclic inspection and maintenance programmes.

Catchpit Clearance

4.18.4. A safe process of works will require to be developed by the Operating Company to clear debris following debris flow events that result in the catchpit behind the DFS and DFW having a build-up of detritus. To negate the need for work in a confined space the maintenance track provides access to the DFS roof for operatives and machinery to clear debris from the adjacent catchpit.

4.18.5. It is assumed that long-reach excavators will be brought onto the DFS roof to reach into the catchpit and remove the debris, they will then load the debris into the back of waiting multi-axle lorries. The lorries will be able to drive the entire length of the DFS roof, to prevent the need for them to complete a potentially dangerous reversing manoeuvre to exit the roof. To facilitate the turning of lorries on the roof there is a turning area incorporated at the northern extent of the roof.

Structural Inspections

4.18.6. A programme of routine inspections of structural elements will be required on existing and proposed structures within the Proposed Scheme extents. These will likely be integrated into the Operating Company's existing cyclic inspection programme. Safe access provision to inspect and perform maintenance on structures will be devised during the detailed design stage.

4.19. Constructability

Introduction

4.19.1. The following sections provide an overview of the main construction activities associated with the Proposed Scheme, with particular attention to their potential issues:

- contractor mobilisation and detailed design;
- OMR Improvements construction (advanced/enabling works);
- traffic management – diversion of traffic from the A83 to the OMR;
- site preparation (incl. excavation / slope stabilisation / installation of catch fences etc);
- culverts construction including outfall cascades;
- foundations / piling for DFS, DFW and B02 Burn Bridge substructure;
- construction of the DFS, DFW and B02 Burn Bridge superstructure;
- mechanical & electrical works; and,
- roadworks (including B828 Glenmore local road junction, Rest and Be Thankful Viewpoint car park and Active Travel Link) and finishes.

Contractor Mobilisation and Detailed Design

4.19.2. Following the successful tendering of the construction contract, procurement of the project offices and key equipment will be commenced by the contractor. It is estimated the facilities will have to be adequate for a team of circa 75 (Contractor staff, design representatives and client representatives), and provide access at least to potable water and data communications, but preferably also electricity and sewage. Such an area would usually require a planning application to be submitted and approved.

4.19.3. Further planning permission will likely have to be acquired for the local construction of a temporary concrete batching plant due to the lack of readymix plants local to the site with adequate capacity. This will need a suitable area to accommodate the batching plant, aggregate storage, truck mixer maintenance and washout.

4.19.4. The Proposed Scheme design will be developed by the successful Contractor to reflect their preferred method of construction. It is assumed that the design will be developed and approved on a progressive basis to facilitate the earliest start to construction.

4.19.5. Estimated detailed design periods are assumed and set out in **Table 4-20**.

Table 4-20 – Estimated detailed design durations for key design elements

Design Element	Estimated Design Duration
Hillside excavation and stabilisation	4 months (Assumed sufficient GI available at contract award)
DFS and DFW substructure	<9 months
DFS and DFW superstructure	<9 months

OMR Improvements

4.19.6. As noted in **Section 3.6** above, the OMR Improvements aim to provide a proportionate level of improvement to the OMR in order to facilitate a more resilient local diversion during construction of the A83 works. It is also unfeasible to upgrade the OMR such that it mirrors the existing efficiency of the A83 Trunk Road through Glen Croe. More substantial improvements to the OMR, over what is currently proposed, would increase construction cost and duration, to something more akin to that of a long-term solution.

4.19.7. As such, the targeted interventions to the OMR including widening to accommodate two-way traffic over a length of approximately 1.4km, localised widening at three existing sharp bends at the northern end of Glen Croe and the provision of new, and upgrades to existing, bridge structures all aim to improve the suitability of the temporary diversion. The OMR Improvement will result in journey time savings, which will be dictated by the interaction with the temporary traffic lights and convoy operation. In the best-case scenario, when a vehicle reaches the traffic lights as the convoy is about to leave, there will be journey time savings of approximately four minutes with the total journey along the OMR reducing from 13 minutes to 9 minutes. In the worst-case scenario where a vehicle reaches the traffic lights immediately after the convoy vehicle has left, there will be journey time savings of approximately 16 minutes with the total journey along the OMR reducing from 34 minutes to 18 minutes.

4.19.8. To provide improved resilience of the OMR, the OMR Improvements include a series of geotechnical interventions including an approximately 150m long debris flow protection earthwork bund, an extension to the existing HESCO barrier by approximately 150m and installation of debris flow and rock fall fences above the A83 Trunk Road. The new earthworks bund and extension to the existing HESCO barrier will intercept and retain debris flow events upstream of the OMR. The new earthworks bund requires relatively significant earthworks due to the steep sidelong ground between the OMR and the A83.

4.19.9. To provide improved resilience during the construction of the OMR Improvements, the proposed earthwork bund and extension to the existing HESCO barrier are anticipated to be completed first as these are intended to prevent debris flow and landslide material reaching the OMR, further assisted by the installation of other protective measures (i.e. debris catch fences) during site preparation works.

Traffic Management

4.19.10. Given the linear nature of the Proposed Scheme and the size and scale of the interventions it is likely that trunk road traffic will need to be diverted from the A83 to the OMR for the majority of the three-to-four-year construction period.

4.19.11. In order to facilitate the construction of the DFS and DFW, including excavation and rock cutting to form the base of the catchpit, the existing A83 Trunk Road will be required to allow for construction works including vehicle movements (diggers, dumpers, piling rigs etc.) and movement of excavated and construction materials around site. As a result, it will not be possible to maintain traffic on the A83 Trunk Road for the majority of the construction period to ensure safety of the construction workforce and the travelling public.

Site Preparation

4.19.12. The Beinn Luibhean hillside above the existing A83 will continue to present a geotechnical hazard during construction. Therefore, additional catch fences along the full extents of the proposed DFS will need to be constructed prior to construction commencement.

4.19.13. Catch fence foundation and anchorage detail requirements will be confirmed during specimen design, upon receipt of further detailed ground investigation. Based on discussions with those involved in erection of the current fences, durations are estimated to be between 6 and 12 months due to current geotechnical uncertainty. The contractor would benefit from further consultation with the regional Operating Company to identify a safe and effective method of construction for the fences.

Culvert Construction Including Outfall Cascades

4.19.14. Within the extents of the Proposed Scheme the A83 is crossed by 20 existing watercourses, of which 14 are located within the footprint of the DFS and one within the footprint of the DFW. The remaining 5 culverts are located to the north of the Proposed Scheme, beyond the DFS and DFW. The current design envisages that 12 of the culverts below the DFS and the culvert below the DFW will be replaced with new box culverts. A further existing culvert will be replaced with a new bridge structure (B02 Burn Bridge) to allow debris flow and landslide material to pass below the A83 into the base of Glen Croe. Culverts north of the DFS and DFW structures will also be replaced with box culverts.

4.19.15. The methodology is proposed with the geotechnical information available and reflects current assumptions on where rock head will be encountered. It is considered that construction of the majority of the new culverts is unlikely to be a project critical activity and construction is undertaken within available spatial and time windows.

4.19.16. Culverts are to be constructed in a phased manner consisting of the following elements:

- Outfall apron;
- Valley side units;
- Hillside units;
- Outfall cascade; and,
- Inlet works

4.19.17. The methodology for the construction of the outfall cascade will be dependant on the outcome of GI surveys and may require mini-piling / soil nailing / sprayed concrete. A long reach excavator is positioned on the apron slab to grade the cascade area to profile. The excavator could act as an anchor for soil nail rigs working on the graded area or a contractor may choose to include anchor blocks within the slab construction. The slope is stabilised and blinded with sprayed concrete. The large number of cascades offers the opportunity for standardisation and repetition of construction techniques and is likely to make both in-situ construction with bespoke formwork, or modular precast, viable.

Foundations / Piling for the Debris Flow Shelter Substructure

4.19.18. Piling will commence at each location once hillside excavation and stabilisation works on the hillside above are complete. The creation of the catchpit results in a widening of the site enabling a work zone for the piling rigs to be created on the valley side.

4.19.19. Piling rigs will sit across the carriageway on a prepared platform. The 5% longitudinal slope on the site will require that piling platforms are constructed to provide a level area for piling operations. Platforms may be restricted in length to 20m to limit the down chainage height to 1m with platforms formed by up chainage cut and down chainage fill to limit the amount of empty bore constructed. The material required for piling platforms is expected to be produced by reprocessing.

4.19.20. Pile construction is proposed using a casing sunk through the colluvium to the rock head. The sizing of piling rigs and detailed installation methodology will be developed when GI data becomes available.

4.19.21. Rebar cages are delivered to the piling location prefabricated to length. Where additional cage length is required, this will be achieved using normal splicing techniques. Concrete placement to be completed using concrete pumps with the concrete supplied from the previously proposed on-site batching plant.

4.19.22. It is assumed that pile testing is limited to Case Pile Wave Analysis Program (CAPWAP) integrity testing and load testing is not required.

Construction of the Debris Flow Shelter Superstructure

4.19.23. The DFS superstructure offers the greatest scope for the adoption of precast construction and the appointed contractor will select their preferred method based on cost, programme and mitigation of site-specific weather and geohazard risk.

4.19.24. It is assumed that the DFS superstructure construction methodology will follow a cascade of progressive work front activities. It is estimated this will achieve an output of 30 linear metres of constructed DFS per week.

4.19.25. The progressive work methodology is proposed to be undertaken in the following stages:

- Valley side columns;
- Rear wall;
- Roof;
- Roof upstands;

- Waterproofing; and,
- Rear wall external protection.

Mechanical and Electrical Works

4.19.26. The construction phases of the systems and equipment required to support tunnel operations will fall into three phases of works; and feature towards the end of the main DFS construction programme.

4.19.27. The first phase will require the construction of all equipment and services buried underground. This will include, but not limited to, service ducts for communications and power cabling (required to service the technology equipment), supporting chamber pits and the proposed water tanks to support the water system used by the fire service.

4.19.28. Once all the underground provisions are in place, the fit out and installation of the plantrooms can commence in phase two, which will include the installation of the power supply equipment, supporting systems equipment, heating equipment and the workers welfare facilities.

4.19.29. Phase three will see the installation of the technology systems inside the DFS and on the approaches, which will connect back into the services constructed as part of phases one and two.

Road Works and Finishes

4.19.30. Roadworks encompass all activities associated with the delivery of the trafficked pavement and walkways. This includes excavation of the existing carriageway to pavement formation, construction of the new pavement lower layers, pavement drainage, ducting and chambers.

4.19.31. Generally, it is envisaged that roadworks will be constructed in phased sections going up chainage to permit drainage of water down slope through the permanent drainage network to temporary discharge points into local water courses.

4.19.32. Roadworks will commence with the laying of all subsurface drainage and ductwork together with construction of associated manholes and chambers. Foundations associated with VRS, external emergency walkway and directional signage will also be constructed.

4.19.33. Pavement construction will commence after structural completion of the DFS with the excavation of the road box and is envisaged as being undertaken in two phases, from southern tie in to the north portal of the DFS and from the north portal of the DFS to the northern tie-in point.

4.19.34. Finishes will comprise of:

- Laying of surface course;
- VRS installation;
- White lining;
- Erection of signage;
- Completion of tie in works, and
- Completion of B828 junction works including the Rest and Be Thankful Viewpoint car park and bus stop / turning area and the Active Travel Link.

4.19.35. Surface course laying will proceed on an end-to-end basis to ensure the minimum number of joints in the completed surface course.

4.19.36. Surface course laying will generally proceed towards the direction of supply in order that delivery wagons do not need to traffic the completed layer. Current discussions with the supply chain indicate that the asphalt plant at Furnace, which is approximately 40km from the Proposed Scheme, has the capacity to meet the required daily tonnages.

4.20. Indicative Construction Sequence

Introduction

4.20.1. This section summarises a perceived construction sequence for the Proposed Scheme. Subject to the arrangement of the construction contract, the contractor is able to adopt a construction sequence of their choosing. Therefore, the construction sequencing described within this report is illustrative only and not prescriptive.

Indicative Construction Programme and Phasing

4.20.2. The programme of construction activities will be subject to development during both the detailed design and the construction phases.

4.20.3. The OMR Improvements will be constructed in advance of the Proposed Scheme to provide a suitable, more resilient diversion route for the A83 Trunk Road traffic. The estimated programme for completion of the OMR Improvements, from site preparation to issue of the substantial completion certificate, is likely to take approximately 12 months.

4.20.4. Construction of the Proposed Scheme in the vicinity of the proposed DFS, DFW and B02 Burn Bridge has been split into four distinct construction zones:

- A1 (Ch. 67 – Ch. 570)
- A2 (Ch. 570 – Ch. 920)
- A3 (Ch. 920 – Ch. 1,606)
- B02 (Burn Bridge)

4.20.5. The division of the Proposed Scheme into these distinct construction zones allows works to be completed across multiple fronts, compressing the total construction programme. The estimated programme for completion, from site preparation to issue of the substantial completion certificate, is likely to take between 36 and 48 months. This is considered appropriate until such time as more detailed planning is available through early Contractor engagement.

4.20.6. Some construction activities are intrinsically linked to timely progress on design certification, the approval of licenses and advantageous timing for advance and site preparatory works. Other considerations, such as: environmental restrictions, reduced production during the winter months, longer winter shutdowns, and the potential delays posed by both the forecasted risk, and actual occurrence, of debris flow events could also influence the actual construction period.

Main Construction Activities

4.20.7. The potential construction activities required to construct the DFS section of the Proposed Scheme will likely include:

- Preliminary works;
- Hillside stabilisation (catch fences and soiling nailing);
- Catchpit excavation;
- Culvert excavation;
- Culvert construction;
- Cascade construction;
- Pilling (Valley side and hillside);
- Pile capping;
- Embedded wall excavation;
- Precast superstructure installation;
- Gabion installation;
- Structural finishes;
- Road sublayer formation;
- Road pavement laying;
- Road work finishes (Street furniture, road markings, etc); and,
- Site restoration.

Earthworks

4.20.8. The Proposed Scheme will require extensive earthworks to achieve the required road alignment and construct the major elements of the DFS, DFW and associated catchpit. The alignment of the Proposed Scheme has been designed such that it removes the need for earthworks or retaining structures on the downhill side of the A83. This is to minimise construction on potentially unstable existing debris flow deposits that are a prominent feature on the lower slopes of Beinn Luibhean.

4.20.9. The following notable sections are identified in **Table 4-21**, below.

Table 4-21 – Earthworks summary for works on the A83

Proposed Earthwork Sections	Description
Southern Tie-in (Ch. 0 to Ch. 67)	The southern tie-in allows for widening of the existing road to current standards, primarily through excavation into the slopes adjacent to the southbound carriageway. The preliminary design identifies 1v:1.5h slopes to approximate Ch. 20 with slope heights up to 5.5m. From Ch. 20 to Ch. 67, the excavation adjacent to the southbound carriageway widens and steepens for the DFS maintenance access track. Where embankment slopes are identified adjacent to the northbound carriageway (Ch. 50 to Ch. 67), retaining wall or reinforced earth solutions are likely to be preferred.
DFS / DFW Catchpit (Ch. 67 to Ch. 1,590)	Due to the widening for the road cross-section, in addition to accounting for the walls of the debris flow shelter and the catchpit, it is not possible to avoid excavation into the hillside. As such, along the full extents of the DFS and DFW the cross section predominantly features cuttings in soil and rock on the uphill side of the A83. The preliminary design for the catchpit comprises a 6m base and a nominal 60° cut slope with a general dip direction of approximately 220°. The proposed cut slope angle is broadly consistent with the rock

Proposed Earthwork Sections	Description
	slopes at the existing catchpits on the A83 within Glen Croe. Where deep superficial deposits are expected to be encountered, the proposed slope profile has been amended to allow for 45° slopes in the superficial deposits and a berm at rockhead.
B02 Burn Bridge (Ch. 1,590 to Ch. 1,620)	At the northern end of the DFW, a bridge is proposed that will allow channelised debris flows to pass below the A83. The existing A83 is on embankment at this location and the embankment materials and existing culvert will be removed during construction of the structure. Additional excavation into the underlying bedrock will be required on the upstream side of the structure to ensure that large boulders can pass below the bridge deck.
Northern Tie-in (Ch. 1,620 to Ch. 2,220)	Beyond Burn Bridge, significant excavation for verge widening has been included in the southbound verge of the proposed alignment at the northern tie-in, opposite the junction with the B828 Glenmore local road. The widening is to allow suitable forward visibility of the road ahead for drivers. From review of aerial imagery and site observations, superficial deposits are expected to be very thin or absent at the location of the excavations. As such, the majority of cutting is expected to be in rock. The preliminary design includes 60° cut slopes adjacent to the southbound carriageway, with maximum slope heights of approximately 28m at Ch.1,740. There is an allowance for rock traps where the verge is of insufficient width to retain typical rock falls and a berm is included at mid height where the cut slopes exceed approximately 12m.

Erosion and sediment control during construction

4.20.10. Erosion and sediment control methods will be detailed within the Construction Environmental Management Plan (CEMP) as part of the Contractor's temporary works to suit their proposed construction phasing and works programme. Notwithstanding the foregoing, indicative estimates of sediment basin sizes have been calculated to help identify areas of land that may be of use to the Contractor for the purposes of erosion and sediment control. The Contractor will be required to consult with SEPA and obtain the Construction Site Licence.

4.20.11. The permanent Network 1 SuDS Basin has not been sized to include a Sediment Storage Volume. The expectation is for the Contractor to design and manage temporary SuDS during construction through a comprehensive erosion and sediment control plan.

Culverts and Watercourse Crossings

4.20.12. It is envisaged that before construction of the culverts, the associated watercourse will be diverted upstream. The culverts will then be backfilled and compacted in stages and the trench boxes removed. It is assumed that the hillside wall of the DFS and inlet structure will be constructed separately from the culverts and will be tied in with the precast section of the culvert.

4.20.13. It is proposed that the culvert cascades are constructed from the top of the hillslope and progressively constructed down the hillslope with appropriate cut and fill to achieve a stable slope.

4.20.14. It is assumed that once the construction of each culvert is complete, and the construction works for the other elements in the corresponding 100m section is complete, the watercourse diversion will be removed and put back on its original path with appropriate temporary bunding, if required.