4 Iterative Design Development

4.1 Introduction

4.1.1 The DMRB Stage 3 design of the proposed scheme as assessed and reported in this ES is the result of approximately 12 months of design development to the preferred route option that was identified at DMRB Stage 2 (refer to Chapter 3: Consideration of Alternatives).

4.1.2 Environmental considerations have influenced the design, with knowledge of these gained through the EIA process, and from the environmental and engineering teams, consultees, and Transport Scotland. Through this process, the design has been iteratively updated and improved to reach the final DMRB Stage 3 design.

4.1.3 The DMRB Stage 3 is a vital part of the EIA process for major roads infrastructure, as it presents an opportunity to avoid or mitigate potential effects through changes to aspects such as road alignment, land requirements, or the type and form of major structures. Changes incorporated into the DMRB Stage 3 design during the design process that have 'already' avoided or reduced potential environmental impacts are often referred to as embedded mitigation.

4.1.4 The potential impacts and proposed mitigation as reported in this ES are those identified following assessment of the final DMRB Stage 3 design of the proposed scheme. As such, the potential effects of earlier scheme design iterations are not described in the EIA chapters. This chapter (Chapter 4) therefore provides an overview of the iterative design process, and sets out the key environmental constraints and considerations that informed the final DMRB Stage 3 design.

4.2 Iterative Design Process

Constraints Review

4.2.1 One of the key project tools used to consider environmental constraints was the Jacobs GIS-based ProjectMapper®. All relevant environmental datasets, including those provided by statutory consultees and other environmental bodies (refer to Chapter 7: Consultation and Scoping) and those gathered through desk-based research and field surveys, were loaded onto an interactive database as 'layers'. Each environmental GIS dataset layer can be switched on or off to show its extents in relation to the emerging proposed scheme design.

4.2.2 The ProjectMapper® tool was accessible to all those working on the project, enabling engineers to undertake preliminary sifting prior to review and input by the environmental team (e.g. locating Sustainable Drainage Systems (SuDS) outside of designated sites). The datasets were used extensively through the design process to enable quick identification of potential issues to inform design development. Photograph 4.1 provides an example of how the proposed scheme interacts with environmental constraints at specific locations using the datasets. Figure 5.1 provides an overview of the proposed scheme in context with the environmental constraints.

Design Assessment

4.2.3 As part of the design process, the engineering design is subject to constant development and refinement. Examples of design refinement include revisions made to reflect landowner consultation, modelling or survey results (e.g. traffic movements, flood levels, geotechnical surveys), or adding further technical design detail.

4.2.4 To enable informed and timely input to the design, a programme of 'interim design fixes' was therefore established. These snapshots of the draft design enabled all environmental specialists to review the same proposals, and provide feedback to the engineers to inform the ongoing scheme development.

4.2.5 A total of three interim design fixes were issued, each having been informed by environmental, engineering/technical and consultation input.

4.2.6 Design fixes typically included refinements to:

- vertical alignment (i.e. altering the road height relative to existing ground).
- horizontal alignment (i.e. altering the precise route of the road);
- structures design (e.g. bridge design including pier locations, and culvert positioning);
- routeing of access tracks, side roads and NMU provision;
- positioning of drainage features and associated outfalls; and
- gradients of earthworks slopes (embankments and cuttings).

Mitigation Workshops

4.2.7 Following assessment of each of the interim design fixes, a schedule of proposed design changes was prepared by the environmental teams. The schedules typically included changes such as modifications to road alignment, suggestions regarding siting of drainage features, proposals for grading out of side slopes, or identification of environmentally sensitive areas to be avoided if possible.

4.2.8 Mitigation workshops were then held by the project team to enable the environmental specialists, EIA Coordinators and engineering design teams to discuss proposals and influence the ongoing design development. These workshops were key to ensuring mitigation to avoid and minimise impacts were incorporated into the proposed scheme design as further described in Section 4.3 (Embedded Mitigation) of this chapter.

4.2.9 A specific example of the effectiveness of mitigation workshops combined with the use of the ProjectMapper® tool is the lack of significant impacts in the cultural heritage assessment as reported in Chapter 15 of this ES. For example, the design of the alignment and drainage north of the River Tummel minimises impacts on a Scheduled Monument (Asset 271). Similarly, the access track to Littleton of Fonab and the junction at Foss Road at Balmore Cottages were designed to minimise impacts on Asset 775 and Asset 296, respectively. The design of the Faskally Crossing with widening to the east of the existing structure minimises impacts on Asset 303, the existing aluminium footbridge over Loch Faskally.

Stakeholder Input

4.2.10 As explained in Chapter 7 (Consultation and Scoping), the A9 Dualling Environmental Steering Group (ESG) meets on a monthly basis through DMRB Stages 2 and 3, covering all A9 dualling projects. In addition to input to environmental mitigation as described in the respective chapters of this ES, statutory consultees were able to advise and influence various aspects of the draft DMRB Stage 3 design. The ESG is a valuable consultation forum but it is not a decision making or approval mechanism. Statutory consultee input to draft designs for this project include, for example:

- selection of a design for the new Tummel Crossing;
- location of SuDS;
- gradient of side slopes and earthworks along the route; and
- landscape and ecology mitigation.

4.2.11 The Stage 3 design has also been informed by discussions with landowners and the owners of affected properties. These discussions have influenced the:

- refinement of access arrangements to the properties at Littleton of Fonab, Middleton of Fonab, Overton of Fonab, Balmore Cottages, Kennels Cottage;
- design of the Rob Roy Way Underpass;
- design of the proposed landscape and ecology planting; and
- location of SuDS in the vicinity of River Tummel and Loch Faskally.

4.3 Embedded Mitigation

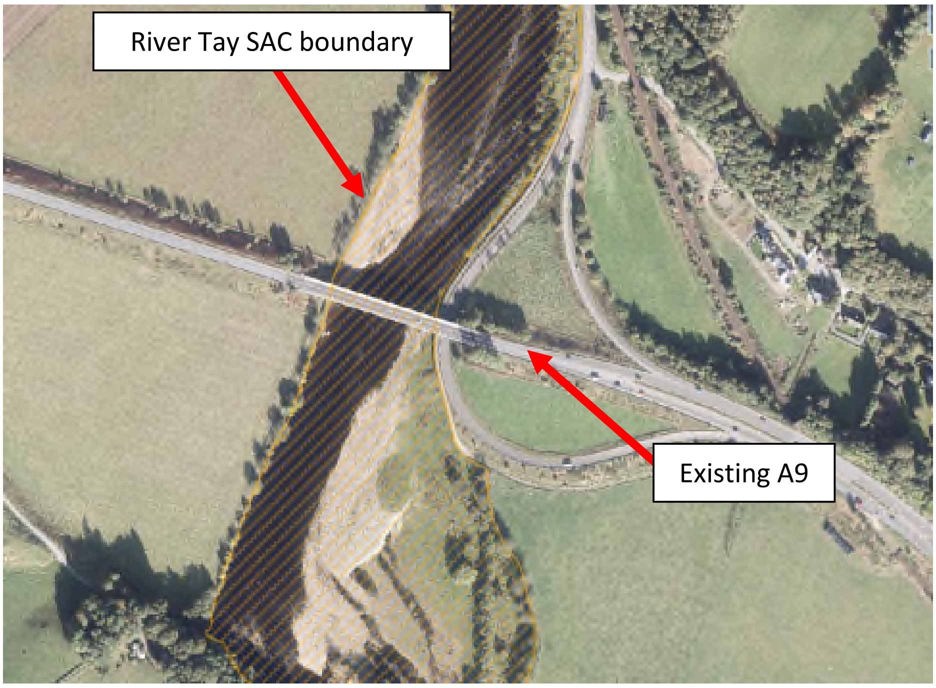
4.3.1 Some of the key design considerations during DMRB Stage 3 design development that avoided or reduced potential impacts are described further below.

Avoiding Loss of Designated Areas (River Tay SAC)

4.3.2 The River Tay SAC is designated as a Special Area of Conservation (SAC) under the EU Habitats Directive, providing protection in relation to otter, Atlantic salmon and lamprey (sea, brook and river).

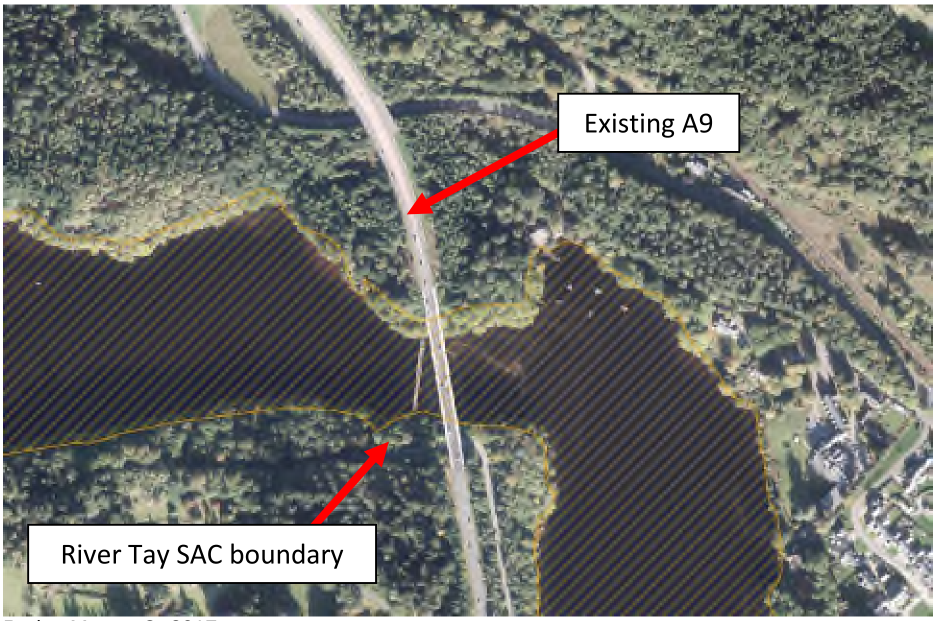
4.3.3 The existing A9 between Pitlochry and Killiecrankie crosses the River Tay SAC at two locations (River Tummel at ch900 to ch1050 and Loch Faskally at ch4200 to ch4350) as shown in Photographs 4.1 and 4.2.

Photograph 4.1: Aerial imagery and the River Tay SAC boundary at Pitlochry South Junction and Tummel Crossing



ProjectMapper®, 2017

Photograph 4.2: Aerial imagery and the River Tay SAC boundary at Pitlochry North Junction



ProjectMapper®, 2017

4.3.4 The River Tay SAC was identified as a key constraint during design development, with the aim of avoiding or minimising the potential impacts of construction and operation such as habitat loss, changes to the watercourse, and water quality.

4.3.5 Examples of specific design changes that removed elements of the proposed scheme from the River Tay SAC habitat were:

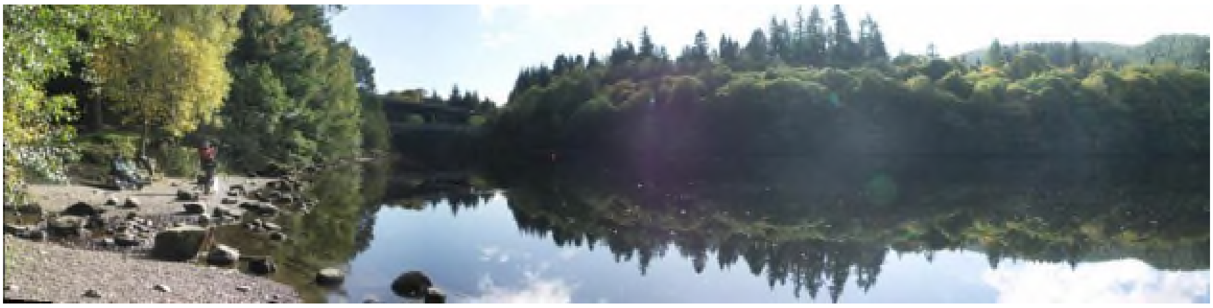
- realignment of the access track at ch900 to minimise loss of River Tay SAC aquatic habitat; and
- position of the outfalls at Pitlochry South Junction and around Loch Faskally.

Reducing Loss of Native and Ancient Woodland

4.3.6 The existing A9 passes through extensive areas of woodland, some of which are identified in SNH's Ancient Woodland Inventory (AWI) and/or identified as native woodland through the Native Woodland Survey for Scotland. Woodland designated in the AWI is widespread across the study area, typically being found along watercourses (such as the River Tummel and Loch Faskally, as shown in Photograph 4.3) as well as on hillsides such as Craigower. From Port-na-Craig Dam at the south-eastern end of Loch Faskally to Faskally Caravan Park, the existing A9 passes through ancient woodland designated as long-established of plantation origin.

4.3.7 In addition to AWI, woodland identified in the Forestry Commission's Native Woodland Survey of Scotland (NWSS) is also widespread within the study area and along parts of the existing A9 corridor, overlapping in a number of areas with AWI woodland close to the A9, including around Littleton of Fonab, Pitlochry Estate and Craiglunie.

Photograph 4.3: Ancient Woodland at the north-east shore of Loch Faskally.



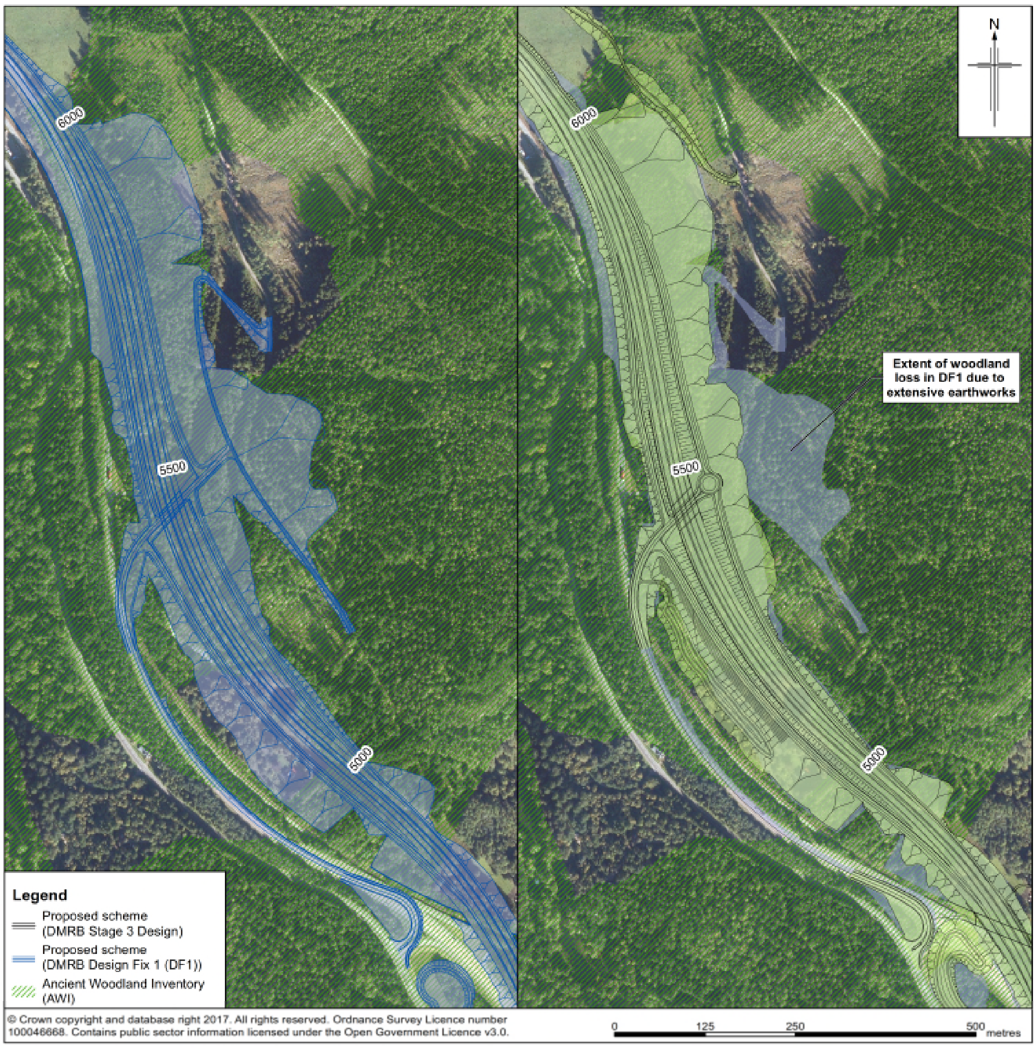
4.3.8 The iterative design process has developed so that the final DMRB Stage 3 design avoids or minimises the loss of AWI and native woodland at the following locations:

- ch2400, the footprint of the access track has been reduced by removing embankment to reduce loss of habitats listed on the AWI and NWSS woodland.
- The alignment of the proposed A9 was altered to minimise the loss of AWI between ch3100 and ch3400.
- A retaining wall has been incorporated into the design at ch4000 to avoid the loss of AWI.
- The SuDS feature originally proposed at ch4150, was removed avoiding loss of AWI.
- The access track to Littleton of Fonab was positioned to reduce loss of AWI.
- The design of Pitlochry North Junction, and in particular access to Forestry Commission land, was refined to reduce loss of AWI.

4.3.9 To illustrate the reduction of the loss of woodland (including AWI) at the Pitlochry North Junction Diagram 4.1 shows a comparison of an early design of the junction with the junction design incorporated into the proposed scheme.

4.3.10 The woodland loss as a result of the proposed scheme is considered to represent a practicable minimum, taking into account other constraints, particularly the River Tay SAC and technical/safety considerations such as road gradient and visibility.

Diagram 4.1: Pitlochry North Junction Comparative Design Iterations



Bridge Design to Reduce Ecological and Landscape Effects (Tummel Crossing)

4.3.11 The A9 currently crosses the River Tummel (part of the River Tay SAC) via the existing bridge at ch900 to ch1050, where the river is approximately 80m wide bank to bank. Carriageway widening, required to provide the dual carriageway, necessitates construction of a new bridge for northbound traffic which will be located adjacent to the existing structure.

4.3.12 The key environmental issues associated with the new bridge are potential implications on the River Tay SAC, loss of flood plain and the landscape/visual impacts of the new structure. Other issues relate generally to the footprint of the bridge options, with potential consequent implications on aspects such as land-take and flood risk.

4.3.13 The A9 Dualling Strategic Environmental Assessment (SEA) (Transport Scotland, 2013) established a principle of avoiding construction within watercourses where possible and as such, a number of design options were considered for the Tummel Crossing. If a clear span bridge is provided (i.e. no piers in the watercourse), matching the existing Tummel Underbridge in form the bridge structure would be longer and vertical alignment higher than the existing with a deeper deck structure. Conversely, a new bridge option with piers in the watercourse could be designed to closely resemble the existing bridge, which would result in a better landscape fit and lower visual impacts.

4.3.14 Given the above challenges in terms of engineering, economic and conflicting environmental factors, two additional options were considered. The first option provided a new clear span bowstring arch structure that is aligned at the same elevation and length as the existing structure, and a further option which would require demolishing the existing structure and providing two new clear span structures that would mirror each other. Table 4.1 below provides a summary of the four options considered, also shown in Illustrations 4.2 to 4.5.

4.3.15 A sifting assessment was undertaken to consider the potential impacts of each option. This was presented to the ESG who were asked to consider the assessment and associated illustrations of these four options. Following the assessment and consultation, it was considered that the bowstring arch option achieves a balance between the engineering, environmental and economic constraints and is included in the proposed scheme design. Further details are provided in Appendix A7.2 (Summary of Consultation Responses).

Table 4.1: Summary of Tummel Structure Options

Option	Existing Bridge	New Bridge	Piers
Piers in the watercourse	Retained	Steel girder composite with reinforced concrete slab deck. New three span structure to carry the new northbound carriageway, mirroring the existing structural form and span configuration.	Two piers located within the River Tay SAC, with the southern pier located on a gravel bank during normal flow conditions, and the northern pier located within the watercourse (as per existing). Loss of flood plain approximately 7,500m^2.
Bowstring arch (assessed as the proposed scheme)	Retained	Braced pair of steel bowstring arches supporting a reinforced concrete deck slab. Span length of approx. 150m to match the length of the existing three span structure.	No piers required, with the bridge abutments located outwith the River Tay SAC. There may be need for a temporary pier to be located within the SAC to aid construction of the structure. This pier would be located outwith the main channel on a gravel bank which is dry during normal flow conditions. Loss of flood plain approximately 7,500m^2.
Deep deck	Retained	New northbound carriageway approx. 2.5m higher than existing. Twin steel box girders of uniform depth, with a reinforced concrete deck. Overall length of 285m.	The new piers would be located outwith the boundaries of the River Tay SAC. Loss of flood plain approximately 9,500m^2
Demolish existing bridge deck (existing piers partially demolished)	Removed	New three span structure to carry both northbound and southbound carriageways. Twin steel box girders of uniform depth, with a reinforced concrete deck. Overall length of 294m.	The new piers would be located outwith the boundaries of the River Tay SAC. Loss of flood plain approximately 18,500m^2

Illustration 4.2: Pier in the watercourse option (existing bridge retained) for Tummel Crossing (sifted out)

Illustration 4.3: Bowstring arch option (existing bridge retained) for Tummel Crossing (assessed as the proposed scheme)

Illustration 4.4: Northbound deep deck option (existing bridge retained) for Tummel Crossing (sifted out)

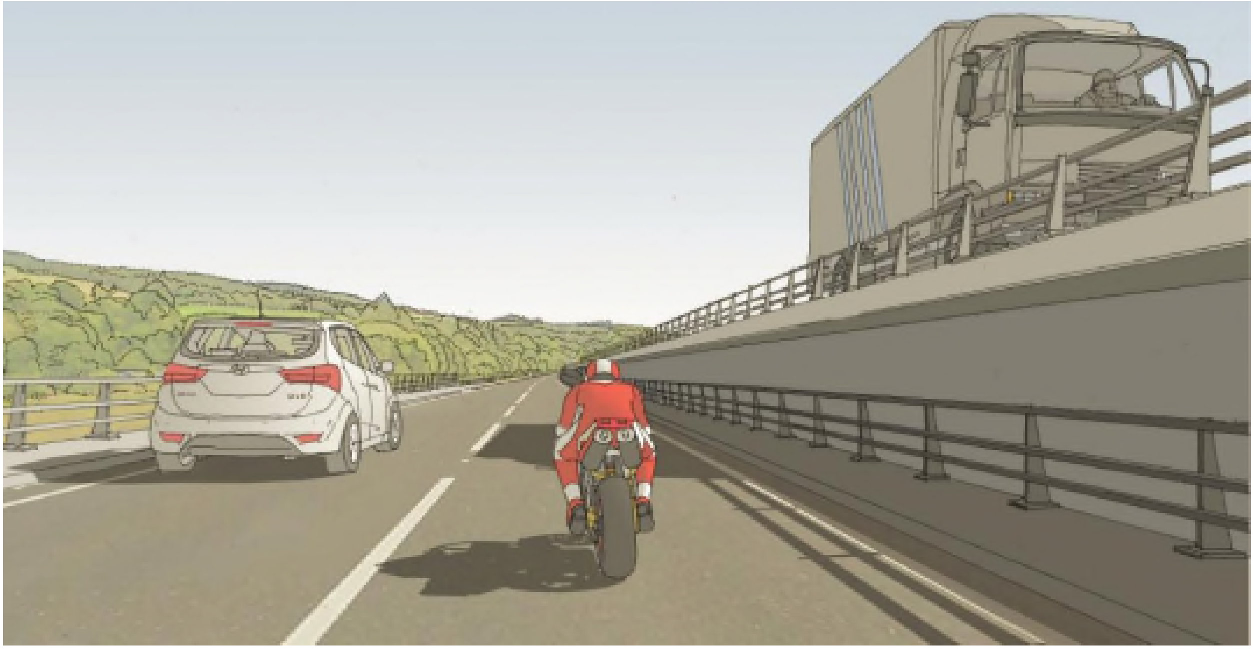


Illustration 4.5: Northbound and southbound deep deck option (existing bridge demolished) for Tummel Crossing (sifted out)

Avoiding Building Demolition

4.3.16 As part of the development of the proposed scheme during the DMRB Stage 2 design, a number of options were developed for connecting C452 Clunie-Foss Road to the proposed A9, one of which required the demolition of the Gate House (ch3900). The preferred option, which avoided this demolition, has been carried through to the final DMRB Stage 3 design.

Drainage Design – Constrained Sites

4.3.17 During the design development from the drainage design proposed at DMRB Stage 2 to DMRB Stage 3, various issues were identified which effect the type and location of proposed SuDS components, resulting in a departure from the preferred provision of conventional SuDS at some locations. Constraints have included existing transport infrastructure, steep topography, loss of Ancient Woodland, and increased flood risk. Four constrained drainage catchments were identified during the iterative drainage design process:

- Drainage Catchment A - conventional SuDS were not possible due to the extended Dalshian Rail Underbridge, Highland Main Line railway and both the 3.33% AEP (30-year) and 0.5% AEP (200-year) flood extents of the River Tummel.
- Drainage Catchment D - to move the SuDS retention pond further from the River Tummel (to minimise impact on the River Tummel, see below section), the drainage catchment had to be sub-divided in two (D1 and D2) and a 350m length of carriageway (Drainage Catchment D1) could not be drained via conventional SuDS.
- Drainage Catchments E and F - providing a SuDS detention basin or SuDS retention pond at ch4200 and ch4450 would require the loss of a substantial area of woodland on the AWI due to the steep topography and subsequent earthworks required.

4.3.18 To provide water quality treatment for these drainage catchments, filter drains are proposed in combination with a hydrodynamic vortex separator (HVS) (a proprietary system). The use of proprietary systems in these constrained circumstances has been discussed with SEPA.

Drainage Design - Minimising Impacts on Watercourses

4.3.19 Various iterations have been made to the DMRB Stage 3 drainage to avoid or reduce potential water quality and geomorphology impacts on watercourses. These include moving SuDS features away from watercourses to reduce the risk of sediment and pollutants entering watercourses during construction, moving outfall locations to areas of faster flowing water to maximise the rate of dispersal of treated water, and separating outfalls into the same watercourse to minimise the concentration of treated water entering watercourses. Specific examples include:

- A SuDS feature originally proposed at ch50 was removed to avoid loss of floodplain capacity.
- Outfall at ch900 moved downstream of Tummel Crossing from its previous location 65m upstream to avoid impacts on a site where erosion is currently occurring at the bank and where existing bank reinforcement has become undermined. The outfall of the SuDS basin has also been set back from the bank to avoid direct modification to the bank and therefore reduce potential geomorphological impacts.
- SuDS pond (as discussed in paragraph 4.3.17) at ch1100 was originally located within the 10-year floodplain and therefore was susceptible to flooding which would have resulted in mobilisation of pollutants and discharge into River Tummel. This SuDS pond has been moved approximately 200m back from previous location and the outfall from this pond moved to a minor watercourse which outfalls to the River Tummel.
- Outfall from SuDS feature at ch4600 moved from discharging upstream of Clunie Footbridge to downstream of Clunie Underbridge avoiding additional disturbance to habitats and visual impacts in an area otherwise directly unaffected by the works.

Drainage Design - SuDS: Detention Basin Vs Retention Pond

4.3.20 The proposed scheme includes five SuDS retention ponds to attenuate runoff from the dual carriageway, via filter drains. The SuDS is designed to treat road runoff pollutants to acceptable levels before it enters watercourses. The construction and footprint of the SuDS features are included as part of the DMRB Stage 3 design of the proposed scheme as an embedded measure to mitigate potential water quality impacts.

4.3.21 During design development, engineering and environmental factors were considered to confirm the design of each SuDS feature, including whether attenuation should be achieved by a dry detention basin or by a wet retention pond. The decision was based on guidance in the Construction Industry Research and Information Association (CIRIA) SuDS Manual (2015), which sets out the four pillars of SuDS design which are water quantity, water quality, amenity and biodiversity. As such, the following were considered:

- Highways Agency Water Risk Assessment Tool (HAWRAT) assessment which shows the attenuation levels of a retention pond are typically higher than a detention basin;
- size and topography of the catchment area;
- potential issues with seepage into the structural embankment;
- integrating the SuDS feature within the surrounding landscape character and topography;
- potential to contribute to visual amenity; and
- potential to contribute to biodiversity including areas of potential habitat for northern damselfly.

4.3.22 Table 11.19 (Chapter 11: Road Drainage and the Water Environment) provides the outcomes of the process, while further details of the SuDS design principles to be adopted as part of the detailed design and construction of the proposed scheme are set out in Appendix A13.7 (SuDS Design Principles).

Provisions for Non-Motorised Users

4.3.23 During the design development, the engineering and environmental team worked to fully consider, maintain and where possible enhance NMU routes affected by the proposed scheme. Embedded mitigation that emerged from this process includes:

- new underpass providing a safe crossing point of the A9 for users of the Rob Roy Way;
- NMU route realignments (refer to Table 4.2 and Figure 9.2); and
- enhanced NMU connections to Tay Forest Park (Craigower) (shown on Figure 9.2f).

Table 4.2: NMU Route Realignments, as shown on Figure 9.2

Location (Path ref.)	Description of Realignment Proposed
Path 69	Local path realigned along new access track with a type 1 compacted surface.
Path 72 (Rob Roy Way)	NMUs rerouted via new underpass with appropriate signage provided and a paved surface
Path 76	Path realigned along new footway with a paved surface.
Path 76a	Path realigned along new footway in road verge with a paved surface.
Path 95	NMUs accessing Tay Forest Park (Craigower) to be rerouted from A924 across new bridge, via stairs, with a paved surface, connecting into Path 96 which is unsurfaced.

4.4 Conclusions

4.4.1 The DMRB Stage 3 design of the proposed scheme is the result of an iterative design development process that avoids or reduces the potential for impacts on the surrounding environment. It has developed and improved the preferred route option that was identified at DMRB Stage 2 (refer to Chapter 3: Alternatives Considered) to reach a design that is described in Chapter 5 (The Proposed Scheme) and assessed as part of the DMRB Stage 3 EIA.

4.5 References

Construction Industry Research and Information Association (2015). The SuDS Manual, CIRIA C753.

Transport Scotland (2013) A9 Dualling Programme Strategic Environmental Assessment (SEA) – Environmental Report