4 Design Development

4.1 Introduction

4.1.1 This chapter outlines the iterative DMRB Stage 3 design and environmental review processes that have informed the development of the Proposed Scheme since DMRB Stage 2 selection of the preferred mainline and junction options. The principal aim of the iterative approach was to ensure that a range of potential environmental impacts could, in the first instance, be addressed or avoided by embedding mitigation through revisions to the design.

4.2 Design Iterations

4.2.1 **Table 4-1** summarises the iterative design development / review processes undertaken during DMRB Stage 3, with further explanation provided below.

Table 4-1: DMRB Stage 3 Iterative Design and Environmental Review Processes

DMRB Stage 3 design iteration	Engineering design elements considered	Environmental inputs/ reviews
First iteration (2015)	• Horizontal and vertical alignment of mainline and junction • Initial earthworks (cuttings and embankments, engineered slopes) • Initial SuDS and culvert locations, cut-off drains and watercourse diversions	• Watercourse crossings workshop – mammal permeability – geomorphology and flood risk • Local landform review of earthworks (landscaped slopes)
Second iteration (May 2016)	Changes to above following First design review, plus: • Rock exposure designs • Location and arrangement of principal structures and lay-bys • Access to SuDS features	• Cross-topic review workshops – identifying conflicts with designated sites, peat, notable habitats and 1:200 flood plain extent constraints
Third iteration (July 2016)	Changes to above following Second design review, plus: • Revised landscape slopes • Revised access to Cuaich, Drumochter Estate, Non-Motorised User (NMU) routes and SuDS feature locations • Dalwhinnie Junction link road and River Truim crossing • Initial compensatory storage locations	• Cross-topic review of: – initial compensatory storage locations – junction link road and Truim crossing • Landscape review of SuDS feature layouts
Fourth iteration (September 2016)	Changes to above following Third design review, plus: • Details of the SSE Aqueduct diversion • Localised adjustments of landscape earthworks slopes • Bus stops at Dalwhinnie Junction • Revisions to principal structures to include mammal ledges and geomorphological clearance, where feasible Resulted in a design 'freeze' for preliminary EIA mitigation assessment and review	• Each EIA technical specialist conducted review to identify further opportunity for embedded mitigation, and to outline preliminary requirements for additional land for impact mitigation/ restoration/ compensation purposes • Design review record compiled on further mitigation requirements
Fifth iteration	• Changes made to design following preliminary EIA review • Further design mitigation incorporated where possible • Preliminary identification of additional land required for impact mitigation purposes	• EIA chapter production assessing the fifth iteration • Development of required mitigation proposals

DMRB Stage 3 design iteration	Engineering design elements considered	Environmental inputs/ reviews
Sixth iteration – Proposed Scheme for Environmental Impact Assessment	• Inclusion of new compact form layout design for proposed Dalwhinnie Junction, with auxiliary lane on north/ southbound merges increased to 130m • Changes to mainline alignment including - relocation of lay-bys - rock cut revision based on geotechnical information - amendment to left-in / left-out junction at ch. 29,120 - removal of bund/ cutting between mainline and SSE Aqueduct diversion (ch. 23,400 to 23,650), replaced with general grading out of this area • Amendments to access tracks including alignment at SuDS 277 and SuDS 306	• EIA chapter revision assessing the sixth iteration • Development of required mitigation proposals • Draft Environmental Statement produced
Seventh Design iteration – Final Scheme for Environmental Impact Assessment (October 2017)	• Addition of erosion protection measures following EIA hydromorphological risk assessment • Removal of sheep creep and associated track at approximately ch. 21,350 • Introduction of fencing in association with the proposed Land Made Available (LMA) land requirements and amendments to the LMA extents • Adjustment of sheep pen area south of Allt Coire Bhathaich • Adjustment to bus turning circle at the Dalwhinnie Junction • Footway on north side of the A889 link road extended through the junction underbridge • Vertical alignment adjustment to Dalwhinnie Junction southbound connector loop and the adjacent access track • Refinement of watercourse diversions • Vertical alignment and southbound embankment adjustment at Cuaich access in response to Flood Risk Assessment • Addition of access track to link lay-by at ch. 24,400 to existing hill walking track • Adjustments (additions/ removals) to Compensatory Storage Areas in response to Flood Risk Assessment • Relocation of access track to SuDS basin 277, including addition of a spur to access existing railway level crossing • Extension of LMA to accommodate geotechnical requirements for construction stage slope stability risk assessment	• EIA chapter finalisation assessing Final Proposed Scheme • Environmental Mitigation Plans and Schedules finalised • Environmental Statement finalised

First Iteration of DMRB Stage 3 Design

4.2.2 Following the initial selection of Mainline 1 and Junction Option 27, the horizontal alignment (i.e. the route of the road) including earthworks (engineered embankment and cutting slopes) was developed. At this stage, the various structural features (i.e. bridges and culverts), which could alter the vertical alignment (i.e. height) of the road were also further developed. The main issues driving the vertical alignment were associated road drainage and culvert levels.

4.2.3 A Watercourse Crossings Workshop was held in November 2015 to consider potential constraints and opportunities associated with existing watercourse crossings, including culverts and potential requirements for watercourse cascades and regrading. The workshop considered ecological, geomorphological and hydrological issues which could potentially affect the vertical alignment.

4.2.4 A landscape and visual review was then conducted to consider the aesthetic appearance of Mainline and Dalwhinnie Junction earthworks. As the Proposed Scheme extent is wholly situated

within the Cairngorms National Park (CNP), the CNP special landscape qualities were paramount in developing landscaped earthworks (i.e. slopes) for the Proposed Scheme. Landscape specialists reviewed design cross sections for slopes to develop a more naturalistic landform which aimed to better integrate into the surrounding landscape context. **Figure 4-1** below provides an example cross-section where initial engineered slopes (e.g. 1:2 gradient slopes) were amended following the landscape/ visual review (varying slopes up to 1:10 gradient where considered suitable).

Figure 4-1: Illustrative cross section showing typical landscape revisions to earthworks slopes

Second Iteration of DMRB Stage 3 Design

4.2.5 The second design iteration incorporated several design changes, from variations in landform slopes to vertical alignment modifications. Landform changes adopted softened landscape slopes at specific areas. This second iteration also included mammal ledges at specific culverts and wider bankside provision at certain watercourse crossing structures (as informed by the Watercourse Crossings Workshop).

4.2.6 The second iteration was then reviewed against a wide range of environmental baseline constraints, including known areas of peat, wet/ dry heath habitats and 1:200 year floodplain extents to determine where softened landscape slopes resulted in conflicts that could be avoided by tightening up the slopes to a more suitable gradient.

4.2.7 In general, engineering slopes were considered as the minimum required for slope stability (typically a 1:2, 1:2.5 or 1:3 gradient depending on local ground conditions) and, where conflicted, landscape slopes were brought back to no less than the engineering minimum, to develop a suitable balance between hydrology, geomorphology, geotechnical, ecology and landscape inputs. The principal aim at this point was achieving aesthetically favourable earthwork slopes whilst avoiding further encroachment into ecologically and hydrologically sensitive areas.

4.2.8 It should be noted that in relation to SAC and SPA designations, the Drumochter Hills SPA and SAC boundaries were considered as defined by the SNH Geographical Information Systems (GIS) source file for each designation. Because the site boundary varies slightly between SPA and SAC shape files, each site boundary was considered accordingly.

4.2.9 With respect to the River Spey SAC (River Truim), it was noted that A9 Dualling topographic survey and aerial imagery showed that the river had migrated in parts and did not match the SNH sourced SAC GIS shapefiles. In some cases, the river had migrated closer to, or further away from the existing A9. CH2M Hill Fairhurst Joint Venture (CFJV) highlighted and discussed the river migration issue with SNH.

4.2.10 SNH agreed that as it is the watercourse qualifying species, and supporting habitats, that are protected, and not the fixed area in a static shapefile, CFJV should take account of river migration in design and any related assessments. As such, minimum design offsets were applied from either the latest topographic survey information on the river bank position, or the GIS shape file boundary, whichever was closest to the A9. Offsets varied from 10m to 5m to 2m, depending on proximity to the watercourse through the scheme extent.

Third Iteration of DMRB Stage 3 Design

4.2.11 The third design development iteration focused on the location and design of SuDS features, the general arrangement detail of structure crossings, the extents of watercourse diversions required to tie in with culvert locations, associated slope designs and flood model analyses to develop preliminary options for compensatory flood storage requirements.

4.2.12 This stage also considered the location of SuDS feature maintenance access tracks, the link road from Dalwhinnie Junction to the A889 and the associated crossing of the River Truim. Each additional feature was informed by environmental constraints reviews in order to adjust locations to minimise conflicts as described previously.

4.2.13 This stage included detailed landscaping input to inform the shape of SuDS features and access route slopes, as well as input from Geotechnical specialists to avoid and minimise the likely requirements for peat excavations where possible.

4.2.14 In addition to maintenance access tracks, this stage included provision for NMU routes, and local property and estate accesses. This resulted in revisions to affected areas of National Cycle Route 7 (NCN7) together with adjustments to the access layout at Cuaich.

4.2.15 It should be noted that access provisions were informed by earlier work, including the A9 Dualling Programme Non-Motorised User (NMU) Access Strategy and a Project 8 specific access study, which considered a range of potential local access options, and was subject to consultation with local landowners and the A9 Dualling NMU Forum.

Local Design Development Variations Considered

4.2.16 During Iteration 3 there were three specific issues that required more detailed consideration. In order to select the most appropriate solution, local alternatives were developed and compared. The selection process was supported by assessment papers which considered the relative advantages/ disadvantages in terms of engineering, environmental and economic issues of each option.

4.2.17 These 'mini-assessments' ensured that an informed decision could be made before incorporation into the developing design. **Table 4-2** below summarises the three different studies undertaken.

Table 4-2: Detailed comparison studies undertaken during Iteration 3

Title	Variations considered	Outcome
Dalwhinnie Junction link road to A889 and River Truim crossing location	• Local alternative locations for the River Truim crossing, with associated variations to the junction link road and tie-in to the A889 • A889 tie-in variations included a roundabout, a T-junction and a through-route giving priority to A9 traffic	• T-junction between A9/ A889 preferred • River Truim crossing location reconfirmed as that proposed at DMRB Stage 2 • Link road SuDS basin relocated to avoid large area of deeper peat deposits • Truim crossing form amended to incorporate dry mammal passage above the 1:50 flood level

Title	Variations considered	Outcome
SuDS basins 241/ 254	• Retain separate SuDS basins or combine to create a larger basin at the SuDS 254 location • SuDS 241 required significant length of new parallel access track and was located on an area of deeper peat deposits	• SuDS 241 removed from the scheme • Larger basin provided at SuDS 254 location • Minimised requirement for additional habitat/ peat disturbance due to SuDS 241 location and parallel access track requirements • Resulted in larger SuDS 254 basin in Lechden Woods area
Drumochter Estate access provision (east side of A9)	• Direct accesses to A9 are being closed, alternative provisions required for estate access • Considered re-use of the former BDL temporary access track, against introduction of a new access track through tree belt to the east and closer to the A9 • New access track would be in former SSE wayleave which is within SSSI	• Principle of re-use of BDL established in favour of a new permanent track through relatively undisturbed SSSI habitats • BDL track between Project 8 extent and Drumochter Lodge to be made permanent and included within A9 Dualling proposals (to be delivered across Project 8 and adjacent Project 7 scheme proposals) • BDL track proposals to include upgraded drainage and associated works to replace temporary provisions and make permanent

Fourth Iteration – DMRB Stage 3 'Design Freeze'

4.2.18 The fourth design iteration incorporated the outcomes of the 'mini-assessment' options comparison studies. It considered potential compensatory flood storage locations and design changes to crossing structures, culverts, SuDS features, the SSE Aqueduct diversion, bus stops on the Dalwhinnie Junction slip roads and all related accesses. This effectively resulted in a dualling infrastructure 'Design Freeze' to enable consideration of land requirements for the construction of the Proposed Scheme.

4.2.19 This included a 'Buildability Review' with consideration of factors such as:

- space required and potential sequencing for the SSE Aqueduct and watercourse diversions, culverts and dualling parallel to existing carriageways with live traffic
- temporary haul routes and crossings for earthworks (cut/ fill) material transport to minimise construction traffic on live carriageways
- space required for temporary laydown/ stockpiling of construction materials, structural plant (i.e. cranes for structures), temporary storage of topsoil/ peat and temporary SuDS
- clearance (headroom) provided under structures and potential construction sequencing to enable material transfer between northbound/ southbound sides of the route
- winter resilience, i.e. potential losses to existing snow belt trees and effective replacement
- access for landowners and future maintenance of A9 infrastructure once completed

4.2.20 As a result, a working space buffer (typically 2-5m) was applied around all permanent infrastructure works, either from the outer extent of earthworks slopes or associated cut-off drains. This was considered sufficient to enable some minor flexibility on site, and the EIA therefore assumes that all land within this buffer zone is potentially subject to change.

4.2.21 Additional parcels of land that were considered necessary to enable construction activity (as listed above), were provided outwith the buffer zone. The EIA generally considers that these areas may be temporarily trafficked or otherwise used during construction, but will be available for suitable reinstatement following completion of construction activity in each area.

4.2.22 Following the buildability review, two assessment boundaries were developed; the permanent works boundary (including the 2-5m offset) and the temporary works boundary. The principal aims of the temporary works boundary are to provide sufficient land to enable the construction of the scheme and to limit risks to construction staff and the travelling public. For example, during the DMRB Stage 3 design development process, SEPA raised concerns about securing sufficient land for temporary watercourse diversions and to mitigate construction works runoff risks (i.e. to enable the inclusion of temporary SuDS).

4.2.23 The Iteration 4 Design Freeze, incorporating permanent and temporary works boundaries, was then subject to preliminary environmental assessment. EIA topic specialists considered the extents of permanent and temporary works boundaries to identify whether any further mitigation could be embedded into design, once the full extent of land required for works was understood. This included flood model re-runs to consider a full 'with scheme' scenario.

4.2.24 This preliminary assessment also enabled consideration of additional land that may be required for further environmental mitigation; for example, in terms of land potentially required for permanent peat placement and ecological habitat restoration, species fencing to mammal crossing provisions, fluvial morphology issues associated with watercourse crossings and diversions, landscape/ visual/ cultural heritage/ noise screening treatments and any resultant constraint conflicts between topics. Preliminary assessment results were fed back to the design team to enable a 'Design Fix'.

4.2.25 It should be noted that although the approach adopted identifies '*permanent*' and '*temporary*' works areas and additional land areas for mitigation, for the purposes of clarity, all land identified as '*necessary for the safe construction and operation of the scheme'* would be considered for permanent land take and purchase under the Roads (Scotland) Act 1984.

Fifth Iteration of DMRB Stage 3 Design

4.2.26 A further set of refinements to the infrastructure design included, for example, addition of a dry culvert for mammal passage, structures detailing to minimise scour potential and geomorphological risks in flood events, relocation of Cuaich underpass to remove an identified flooding risk, adjustment to SuDS feature outfalls to minimise scour potential and ensure discharges pass water quality assessments, refinement to accesses and landscape slopes to reduce floodplain encroachment and revision of compensatory storage requirements.

Sixth Iteration of DMRB Stage 3 Design – Proposed Scheme for EIA

4.2.27 During DMRB Stage 3 it was identified that other schemes within the A9 Dualling Programme were adopting compact form grade separated junctions to DMRB TD40/94 and DMRB TD42/95 standards. It was therefore considered important that a comparison assessment (considering Engineering, Environment and Economic considerations) should be made for the Dalwhinnie Junction, comparing between the previously selected DMRB Stage 2 junction option 27 (as shown in **Figure 3-3**) and an alternative compact form grade separated junction.

4.2.28 **Figure 4.2** below shows the layout of the compact form grade separated junction developed for Dalwhinnie, and the comparative assessment concluded that a compact grade separated design would offer a range of benefits.

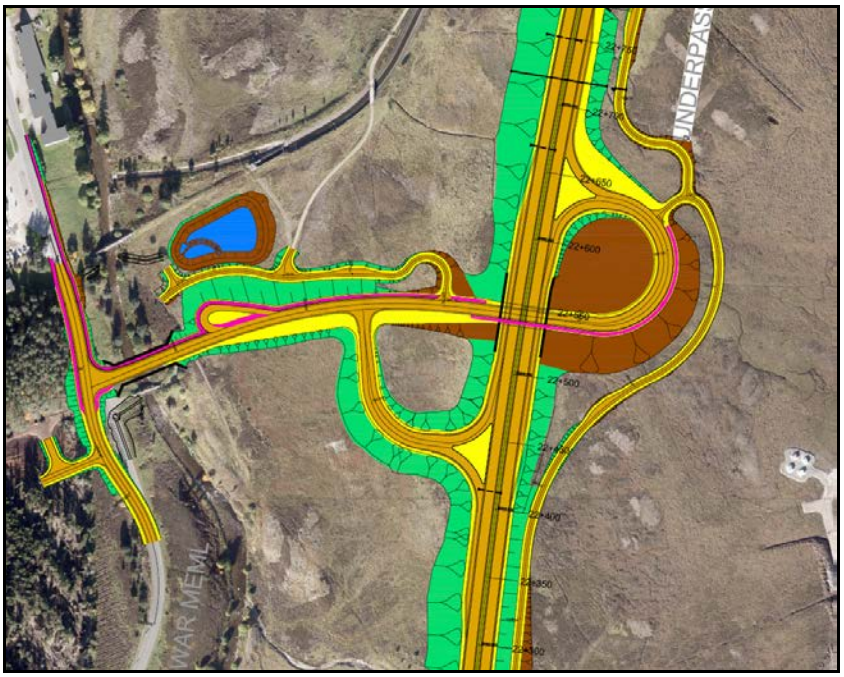

Figure 4-2: Dalwhinnie Junction – Compact Form Grade Separated Junction Layout

4.2.29 The compact design was preferred from the environmental perspective. The assessment concluded that it would reduce the amount of shallow and deep peat excavated (by approximately 5,000m^3) and reduce excavation in blanket bog habitat on the eastern side. The comparative assessment also concluded that there would be the following additional environmental benefits:

- reduced landscape and visual impacts (with improvement in views from the road)
- bus stop moved closer to Dalwhinnie and removed from slip roads
- reduced consumption of materials and production of waste
- reduction in road surface runoff volume, thereby less treatment volume
- reduction in watercourse crossings, bankside works and culvert lengths required
- slight reduction in floodplain encroachment
- SuDS access tracks closer to the mainline, reducing habitat fragmentation
- potential to replace existing sheep creep at ch. 22,770 (within Phoines Estate).

4.2.30 Following a community drop in event and consultation with CNPA and the ESG in May 2017, the Proposed Scheme was amended to include a compact grade separated junction at Dalwhinnie to replace the previous staggered diamond layout design.

4.2.31 Following this decision, some further refinements were made, including the relocation of north and southbound lay-bys to the north of the junction location, revisions to SuDS access tracks and the removal of a bund between the mainline and SSE Aqueduct diversion (ch. 23,400 to 23,650), replaced by general grading out of this area.

4.2.32 The sixth iteration was subject to EIA, undertaken in full cognisance of the various embedded mitigation measures into the Proposed Scheme:

- mammal ledges in a number of culverts and additional bankside space provided in watercourse crossing structures, where achievable, to provide for mammal permeability

- River Truim crossing at Dalwhinnie link road includes dry ledge above 1:50 flood level
- buried box culverts with natural bed material included to support fish permeability on certain watercourses
- SuDS features with a minimum of two levels of treatment provided where practicable, with enhanced treatment provided where water quality assessments identified a need
- SuDS outfalls to the River Truim designed as low velocity outfalls to reduce scour potential
- Dalwhinnie Junction layout reduced in scale, with bus stop moved closer to Dalwhinnie and removed from slip roads
- dry culvert (sheep creep) provided in the area between Dalwhinnie Junction and the SSE aqueduct diversion
- earthwork slopes (mainline, junction, SuDS and access tracks) developed to blend into surrounding landform, and to avoid sensitive habitats, deeper peat deposits and the 1:200 year flood zone where achievable
- access tracks designed to provide one level of drainage treatment (as agreed with SEPA via the Environmental Steering Group)
- reuse of the former BDL track, with local drainage upgrades, rather than create a new track through Drumochter Hills SSSI area
- lay-bys linked to local NMU routes where possible, and NMU routes realigned where necessary
- flood compensatory storage areas included in land required for the scheme.

Seventh Iteration – Final Scheme for EIA – October 2017

4.2.33 The final design iteration contained some design amendments to the Proposed Scheme, including for example the removal of a sheep creep, adjustments of the vertical profile of an access road at Cuaich and steepening of some embankments.

4.2.34 Updates were also made to the Proposed Scheme in terms of the inclusion of erosion protection measures, which were identified as mitigation through the EIA process undertaken on the sixth iteration design including rock armour and toe protection.

4.2.35 At the northern end of the Proposed Scheme (between ch. 29,950 and ch. 30,250), an additional parcel of land was included. This was included because if the Contractor was to carry out any works adjacent to existing slopes, they may have to carry out remedial works to ensure long term stability. This could mean re-grading of the slope, which will require more land.

4.2.36 Finally, the final design also included the removal of two Compensatory Storage Areas and the inclusion of one area, adjacent to SuDS Basin 306 (at approximately ch. 30,500).

4.2.37 Following this, the LMA and CPO boundary was fixed, encompassing all of the above changes to the Proposed Scheme.

4.3 References

4.3.1 Relevant references for introductory Chapters 1 to 7 of this ES are compiled and listed at the end of Chapter 7.