A9 Dualling Programme: Pass of Birnam to Tay Crossing

DMRB Stage 2 Scheme Assessment Report

Volume 1: Main Report and Appendices

Part 4 - Traffic and Economic Assessment

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List of Abbreviations

A9DTM	-	A9 Dualling Traffic Model
AADT	-	Annual Average Daily Traffic
ANPR	-	Automatic Number Plate Recognition
ATC	-	Automatic Traffic Counter
BCR	-	Benefit Cost Ratio
BLTM	-	Birnam Local Traffic Model
CfI	-	Case for Investment
CPI	-	Consumer Price Index
DfT	-	Department for Transport
DMRB	-	Design Manual for Roads and Bridges
D2AP	-	Dual 2-lane All-purpose
GDP	-	Gross Domestic Product
GI	-	Ground Investigation
HGV	-	Heavy Goods Vehicle
LGV	-	Light Goods Vehicle
LTEA	-	Lead Traffic and Economic Advisor
mph	-	Miles per hour
NESA	-	Network Evaluation from Surveys and Assignments
NPV	-	Net Present Value
OGV	-	Other Goods Vehicle
PVB	-	Present Value of Benefits
PVC	-	Present Value of Costs
TAG	-	Transport Appraisal Guidance
TEE	-	Transport Economic Efficiency
TMfS	-	Transport Model for Scotland
TUBA	-	Transport Users Benefit Appraisal
WCH	-	Walkers, Cyclists and Horse-riders
WS2+1	-	Wide Single 2 + 1 Carriageway

22. Transport Modelling Approach

22.1 Introduction

22.1.1 In accordance with the Design Manual for Roads and Bridges (DMRB) (TD 37/93: Scheme Assessment Reporting) this chapter presents the traffic and economic assessment of the route options.

22.1.2 The traffic and economic assessments have been undertaken using the Paramics A9 Dualling Traffic Model (A9DTM). The model years used in the assessment are 2026 and 2041, representing the first year of full programme operation and 15 years thereafter. The forecasting of traffic was undertaken by the Lead Traffic and Economic Advisor (LTEA) (AECOM) and details of the modelling assumptions etc. can be found in 'Technical Note 10: DMRB Stage 3 Approach to Transport Modelling and Appraisal - Revision 4 (AECOM, July 2017)', with results reported in line with 'Technical Note 7: DMRB Stage 2 Approach to Transport Modelling and Appraisal (AECOM, January 2016)'.

22.1.3 The Paramics model has been used to compare the route options in terms of performance indicators, such as changes in travel behaviour and route choice due to the introduction of each scheme option to the future year models. The outputs from these models have been used as the basis for an economic assessment using Transport Users Benefit Appraisal (TUBA, v1.9.9) software to determine the economic benefits of each option described in Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options), compared to the Do-Minimum scenario.

22.1.4 This chapter of the report (Transport Modelling Approach) describes the operation of the traffic model. Chapter 23 (Effects of Route Options) summarises the primary traffic effects of the options considered. The economic performance of the various route options is presented in Chapter 24 (Economic Performance of Route Options).

22.2 Transport Model for Scotland

22.2.1 The Transport Model for Scotland (TMfS) is Transport Scotland's national transport model. It is a multimodal, strategic transport model that covers the entire Scottish mainland and the connections to significant islands. The latest version of the model is TMfS:14 which represents a 2014 base year with a single, core forecast scenario available for the years 2017, 2022, 2027, 2032 and 2037. The network coverage in TMfS:14 is relatively detailed and covers all significant road and rail links throughout the country. As the focus of TMfS:14 is as a national model, the zoning system and representation of travel demand is aggregate in nature with a greater focus on inter-urban rather than local movements.

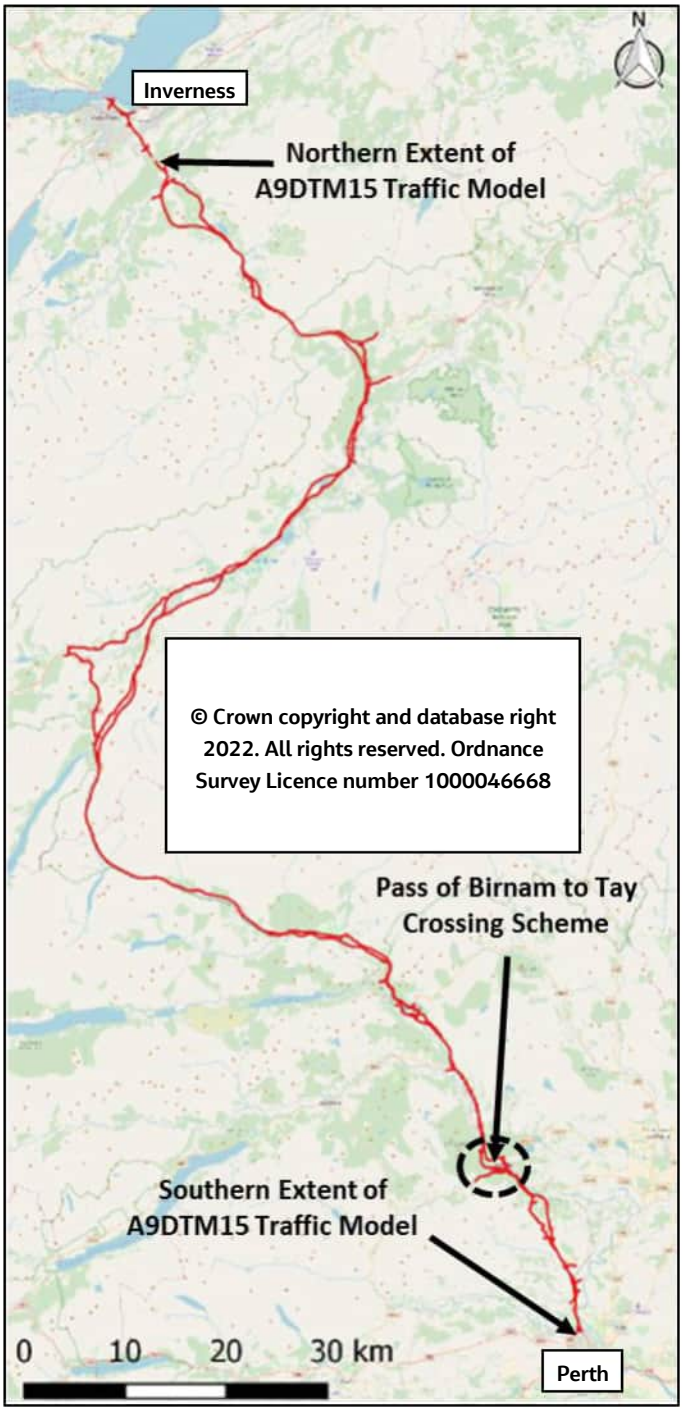
22.2.2 The main purpose of TMfS:14 in the context of the A9 Dualling Programme assessment is to provide traffic forecasts that can be fed down to lower tier models for both programme and project level assessment work such as the A9DTM. As such, TMfS:14 has not been used for detailed assessment of the options presented in this report.

22.3 A9 Dualling Traffic Model

Model Extents

22.3.1 The A9DTM is a corridor long S-Paramics microsimulation traffic model covering the A9 from Inveralmond Roundabout to north of Daviot, which is located to the south of Inverness. As shown in Figure 22.1:, the A9 and all major junctions with A and B class roads are modelled along with important local roads.

Figure 22.1: A9DTM-15 Model Extents



22.3.2 The A9DTM Paramics model was developed for Transport Scotland by SIAS Limited (now part of SYSTRA) for use as a planning and forecasting tool for projects on the A9 corridor. The model is maintained by AECOM, engineering consultants appointed under a separate commission by Transport Scotland. The most recent version of the model is A9DTM:15. Development of the model is documented in the 'A9 Dualling Traffic Model 15 Model Development Report (AECOM, April 2016)'.

Vehicle Types / Classifications

22.3.3 The following vehicle classifications are included in the model:

- Car;
- Car and Trailer;
- Car and Caravan;
- Motorhome;
- Light Goods Vehicles (LGVs);
- Other Goods Vehicles (OGV) 1 - Medium weight goods vehicle (2 axles, up to 7.5 tonnes);
- OGV1 - Medium weight goods vehicle (2 axles, between 7.5 and 12 tonnes);
- OGV1 - Medium weight goods vehicle (2 axles, over 12 tonnes);
- OGV1 - Medium weight goods vehicle (3 axles);
- OGV1 - Medium weight goods vehicle (rigid 4 axles);
- OGV2 - Heavy goods vehicle (HGV) (articulated 4 axles);
- OGV2 - HGV (articulated 5 axles);
- OGV2 - HGV (articulated 6 axles);
- Coach;
- Minibus (sprinter type); and
- Bus.

22.3.4 Scheduled bus and coach services are coded based on predefined routes and operator timetables. The trips undertaken by cars are further classified based on the purpose of the journey, which are:

- In-work;
- Non-work commute; and
- Non-work other.

Time Periods

22.3.5 The different time periods in the model are as follows:

- Period 1 - 07:00 to 10:00 (AM);
- Period 2 - 10:00 to 16:00;
- Period 3 - 16:00 to 19:00 (PM); and
- Period 4 - 19:00 to 07:00.

22.3.6 Period 4 (19:00 to 07:00) is only included as a warm-up and cool-down period to ensure that there is traffic in the model network at the start of Period 1 and to collect data for vehicles that do not complete their journey by the end of Period 3. It is not an accurate representation of traffic on the network during the night. The outputs from the modelled hours between 07:00 and 19:00 were used to derive estimates of flows and speeds in the non-modelled hours using factored inter-peak flows. These factors were derived from analysis of the classified Automatic Traffic Counter (ATC) data on the A9 mainline between Perth and Inverness that was used in the development of the A9DTM:15 base model. Further details are set out in 'Technical Note 10: DMRB Stage 3 Approach to Transport Modelling and Appraisal - Revision 4 (AECOM, July 2017)'.

22.3.7 The base model represents typical conditions for a 2015 weekday in March and June between 07:00 and 19:00 hours. The A9 and all major junctions (e.g., with other A and B-class roads) are represented, as are sections of the A889, A86 and A95 as well as the parallel routes through towns along the corridor such as Dunkeld, Pitlochry and Blair Atholl.

22.3.8 The model represents individual cars (split by in-work, non-work commute and non-work other) with proportions representing standard cars, those towing trailers or caravans and motorhomes. LGVs, HGVs and buses/coaches are also represented. The varying single, dual and Wide Single 2 + 1 Carriageway (WS2+1) standard along the length of the A9 are represented in the base model and both vertical and horizontal alignments are reflected. The differing vehicle and driver characteristics represented enable detailed operational effects, such as platooning (e.g., travelling behind slower moving HGVs), overtaking in the face of oncoming traffic (on single carriageways) and passing (on dual and WS2+1 sections) to be reflected.

22.3.9 Forecasting into the future with the A9DTM:15 is undertaken via a direct interface with TMfS:14 whereby absolute incremental forecasts of growth for the A9 corridor are applied directly to the A9DTM:15 base or future year Do-Minimum and Do-Something matrices accordingly. As well as the 2015 base model, the standard future years for the Transport Model for Scotland are 2027 and 2037 and these have been replicated in A9DTM:15. However, for the A9 DMRB assessments, future year models for 2026 and 2041 have been created.

22.3.10 For the purposes of the A9 Dualling Programme DMRB Stage 2 assessment, it is acknowledged that build out of the Local Development Plan alongside further capacity improvements will change travel patterns in and around Perth and specifically at Inveralmond Roundabout. It is also known that the interventions will, regardless of final form, improve the operational effectiveness of the A9 trunk road around Perth.

22.3.11 Based on the above, the A9DTM:15 forecast traffic models have been updated to reflect the commitment to improve operational effectiveness along the A9. Specifically, Inveralmond Roundabout has been modified in both the Do-Minimum and Do-Something scenarios in the years 2026 and 2041. This update will ensure that all traffic forecast to use the A9 in the first year of full programme operation is able to enter and leave the corridor within the modelled time-period, providing a traffic assessment that is reflective of the most likely future scenario.

22.4 Birnam Local Traffic Model

22.4.1 In addition to the A9DTM:15 Paramics corridor model, which is the principal assessment tool for this project, the Birnam Local Traffic Model (BLTM), which represents a typical summer weekend, was developed in Paramics Discovery to consider the operational aspects of the network under peak travel demand rather than the typical traffic flow represented in A9DTM:15. The base year traffic demand in the BLTM was developed from traffic surveys undertaken on a typical summer weekend in August 2017, with two separate models created representing a typical summer Saturday and a typical summer Sunday. Although not used for formal appraisal of the options in this DMRB Stage 2 assessment, this model was used to provide confidence that at-grade junction options would be expected to operate adequately during the peak tourist season.

22.4.2 Additionally, the smaller and more detailed BLTM is more sensitive than A9DTM to potential rerouting between the A9 and Perth Road due to changes in journey times, which allowed for further analysis that could not be undertaken using A9DTM:15. This included representing the potential effect of on-street parking on Perth Road through Birnam, which was observed to reduce the carriageway width to less than that required for two vehicles to pass. This would therefore act as a constraint on the volume of traffic that may divert along Perth Road at peak times. Automatic Number Plate Recognition (ANPR) surveys undertaken in August 2017 recorded traffic on Perth Road travelling between the A9 to the south and the A923 through Dunkeld, that did not stop in Birnam. The level of through traffic on Perth Road is not adequately represented in A9DTM but these through trips have been replicated in the

BLTM. At least some of these through trips on Perth Road are assumed to take this route due to the existing signing strategy, which directs northbound traffic for Dunkeld to exit the A9 at the existing left/right staggered priority junction at Birnam.

22.4.3 The BLTM was therefore also used to indicate the potential impact of changing the signing strategy on the A9 within the extents of the Pass of Birnam to Tay Crossing project. This was predominantly focused around the signing of traffic on the A9 from the south destined for Dunkeld to use the Dunkeld Junction rather than the Birnam Junction as is currently signposted.

Vehicle Types / Classifications

22.4.4 The same vehicle classifications were used in the BLTM as in the A9DTM:15 corridor model (see Paragraphs 22.3.3 and 22.3.4).

Time Periods

22.4.5 The time periods in the BLTM are as follows:

- Period 1 - 07:00 to 10:00 (AM);
- Period 2 - 10:00 to 16:00;
- Period 3 - 16:00 to 19:00 (PM);
- Period 4 - 06:00 to 07:00; and
- Period 5 - 19:00 to 20:00.

22.4.6 Note that these differ from A9DTM:15. As the BLTM is significantly smaller in terms of its geographical extents, the maximum route distance is significantly less than the A9DTM. Consequently, it was not necessary to allow a long warm-up and cool-down period and therefore these periods were reduced to one hour either side of the 12-hour modelled period. This model has a 2017 base year and the same forecast years as A9DTM:15. The local forecasts were derived using proportionate growth from the A9DTM.

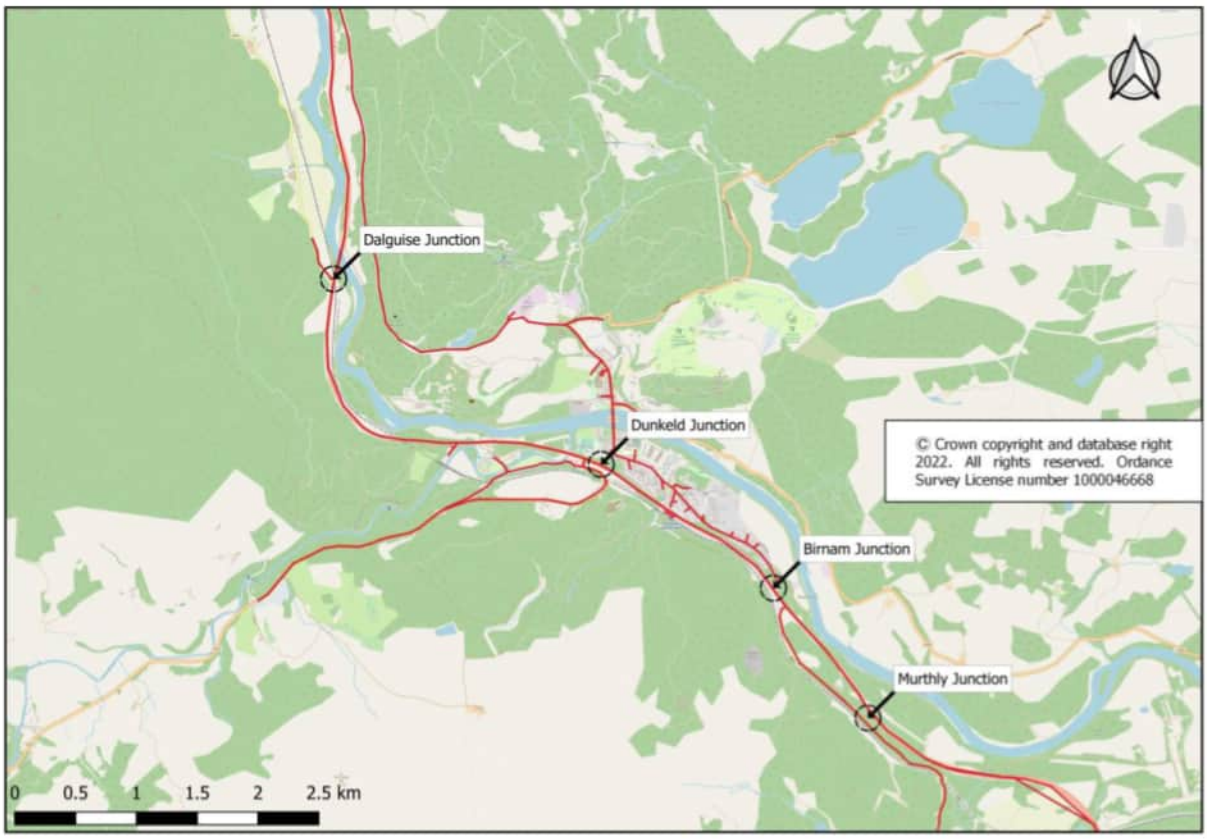
22.5 Future Year Networks

Do-Minimum Model

22.5.1 For the purposes of the economic, environmental and operations/design assessment, the Do-Minimum network relates to the conditions as they were in 2015 (i.e., after the introduction of the Average Speed Safety Cameras) and the infrastructure projects listed in Appendix 22.1: TMfS14 Do Minimum Definition, included in Volume 1, Part 6 - Appendices. These infrastructure projects are not coded in A9DTM:15 as they are outside of the model extents but are included within TMfS:14 from which future traffic growth is determined.

22.5.2 Figure 22.2 shows the existing road network represented in the Do-Minimum model, between the Pass of Birnam and Tay Crossing, which is the full extent of the project.

Figure 22.2: Do-Minimum Model Extents



Do-Something Model

22.5.3 For the purposes of the economic assessment the Do-Something network incorporates only the A9 Pass of Birnam to Tay Crossing project added to the Do-Minimum network. The traffic demand in each assessment year is the same as that applied to the Do-Minimum network (i.e., a fixed demand assessment). By adopting this approach, the DMRB Stage 2 assessment focuses only on the impacts of the A9 Pass of Birnam to Tay Crossing project and avoids the risk of overestimating the potential economic benefits.

22.5.4 In defining the Do-Something network for the environmental and operational/design assessment it is important to recognise that the approach outlined in Paragraph 22.5.3 cannot be adopted, as it would potentially result in an underestimation of the environmental impact associated should the full A9 Dualling Programme be complete. Therefore, in the case of the Do-Something scenario the demand associated with the full dualling was applied, thereby ensuring that the maximum impact of the upgrade was considered. This higher level of demand was determined by representation of the full A9 Dualling Programme in TMfS:14 to capture the change in travel patterns and mode choice that would arise from consistent dual carriageway standards from Perth to Inverness.

22.5.5 In the Do-Something model, the A9 has been coded as a dual carriageway along its entire length from Perth to Inverness with various junction improvements at different locations. The locations and form of junction improvements at each location reflected an option under consideration in November 2015. As such, any changes to junction layouts implemented after November 2015 will not have been considered. Within the context of this project, the different junction options described in Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options) have been modelled. In general, the only sections of the network that are subject to change (in traffic terms) between the various Do-Something options are at the Murthly/Birnam and Dunkeld Junctions.

22.6 Assessment Years

22.6.1 The Pass of Birnam to Tay Crossing scheme is one of the 11 projects forming the A9 Dualling Programme as outlined in Volume 1, Part 1 - The Scheme, Chapter 1 (Scheme Background). Each individual project within the A9 Dualling Programme will have a project specific opening year in the period up until 2025. However, a significant proportion of the journey time benefits arising from the A9 projects with the earliest opening years will likely be offset by delays incurred during the construction of other projects on the A9 that are later in the programme. As such, there is unlikely to be a significant volume of induced traffic and strategic rerouting during the period to 2025, when the A9 Dualling Programme is intended to be complete. Induced traffic is the term used to describe the phenomenon where an increase in the capacity of a road releases a latent demand for travel and results in an increase in traffic on the road following the upgrade. This is unlikely to be significant when works are ongoing elsewhere on the A9 between Perth and Inverness and therefore the Do-Minimum and Do-Something flows on the A9 are likely to be similar up to 2025. Following completion of the final project in the programme, the full benefits of upgrading the route to dual carriageway standard will begin to be realised.

22.6.2 Hence, for consistency, the assessment years adopted for operational assessment are 2026 and 2041 for all projects. Year 2026 is the first year of operation assumed for each individual project, irrespective of whether the project is identified as a possibility for early implementation. Year 2041 is the Design Year, as it is 15 years after the assumed first year of full programme operation in accordance with DMRB guidelines.

22.7 Demand Matrices

22.7.1 The demand matrices for the Do-Minimum and Do-Something models for the years 2026 and 2041 were produced by the LTEA for the A9 Dualling Programme (AECOM). These demand matrices were obtained directly through an interface with TMfS:14. The version used for this assessment was issued on 9th December 2016.

22.7.2 Table 22.1 shows the total traffic demand in the traffic models for the years 2015, 2026 and 2041 on a typical 12-hour weekday between 07:00 and 19:00. This traffic demand represents the demand of all types of vehicles through the entire A9DTM corridor, which includes the side road network. These figures should not be mistaken for observed or modelled traffic flows on any particular road within the project extents. The average traffic growth rate is approximately 1% per annum. It also shows that comparing the Do-Something and Do-Minimum models, there is a 7% increase in traffic demand within the model extents in both the years 2026 and 2041 following the completion of the A9 Dualling Programme.

Table 22.1: Traffic Demand (Vehicles)

Traffic Demand		Do-Minimum		Do-Something	
	Year 2015	Year 2026	Year 2041	Year 2026	Year 2041
Traffic demand for 12-hour weekday (07:00 to 19:00)	68,900	78,400	84,000	84,100	89,900
Growth (with respect to year 2015)	-	14%	22%	22%	30%
Growth (with respect to Do-Minimum)	-	-	-	7%	7%
Growth rate per annum (with respect to year 2015)	-	1.2%	0.8%	1.8%	1.0%

Table Notes:
1) Number of trips rounded to the nearest 100
2) Growth rates derived before rounding of trip demand
3) Do-Something travel demand relates to the Do-Something (Environmental) scenario

22.7.3 Table 22.2 shows the forecast traffic flows on the A9 at various locations between the Pass of Birnam and Tay Crossing for the model years 2015, 2026 and 2041. Further forecast traffic flows at key points within the project extents are shown on Drawings A9P02-JAC-VTR-X_ZZZZZ_ZZ-FG-TR-0003 and A9P02-JAC-VTR-X_ZZZZZ_ZZ-FG-TR-0004, included in Volume 2: Engineering Drawings.

22.7.4 Table 22.2 shows an increase in traffic on the Pass of Birnam to Tay Crossing section of the A9 Dualling Programme of between 30% and 40%, compared to the Do-Minimum, after completion of the A9 Dualling Programme.

Table 22.2: Annual Average Daily Traffic (AADT) Traffic Flows - Pass of Birnam to Tay Crossing

Traffic Demand		Do-Minimum		Do-Something	
	Year 2015	Year 2026	Year 2041	Year 2026	Year 2041
Southern Extent of Project 2	15,600	18,500	19,800	24,000 – 24,900	25,800 – 26,800
A9 Between Birnam/Murthly and Dunkeld Junction	15,300 – 15,400	17,900 – 18,000	19,000 – 19,100	23,700 – 24,600	25,400 – 26,400
A9 Between Dunkeld Junction and The Hermitage	14,900	17,600	18,500	24,400	25,900
A9 between The Hermitage and Dalguise Junction	15,000	17,600	18,600	24,300	25,800 – 25,900
Northern Extent of Project 2	14,600	17,100	18,000	23,600	25,000
Overall Growth (with respect to year 2015)	-	17% - 19%	22% - 27%	54% - 63%	65% - 73%
Overall Increase (with respect to Do-Minimum)	-	-	-	30% - 39%	31% - 40%
Growth Rate per annum (with respect to Do-Minimum	-	1.4% - 1.6%	0.8% - 0.9%	4.0% - 4.5%	1.9% - 2.1%

Table Notes:
1) Flows rounded to the nearest 100 AADT.
2) Growth rates derived before rounding traffic flows.
3) Do-Something traffic flows relate to all the Do-Something scenarios modelled.
4) Traffic flows on the A9 under the Do-Something varies depending on the option considered.

22.7.5 The overall growth rate from 2015 under the Do-Something scenario in 2026 outlined in Table 22.2 is significantly greater than the growth indicated in Table 22.1 because the latter is focussed on the growth of traffic on the A9, rather than all traffic within the model extents, which includes local traffic.

22.7.6 All traffic flows are presented from the traffic models used for environmental and operational/design assessment as indicated in Paragraph 22.5.4.

22.8 Pass of Birnam to Tay Crossing

22.8.1 The Pass of Birnam to Tay Crossing project is approximately 8.4 kilometres long, as described in Volume 1, Part 1 - The Scheme, Chapter 2 (Existing Conditions).

Future Junction Design Options

22.8.2 A full description of each proposed route option and junction option is included within Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options) and a further engineering description of each proposed route option and junction option is included within Volume 1, Part 2 - Engineering Assessment, Chapter 5 (Engineering Assessment).

Modelling

22.8.3 From a traffic modelling perspective, the proposed route options are similar, aside from the variations in layout at Murthly/Birnam Junction and Dunkeld Junction, and the differences in proposed speed limit on the A9 dual carriageway. All options assume the same junction layout at Dalguise Junction and The Hermitage. All options also provide access to Dunkeld & Birnam Station via Station Road in Birnam. The differences in mainline geometry, including changes to the vertical alignment to accommodate a cut and cover tunnel or an underpass (Options ST2A and ST2B) is not anticipated to have an impact on traffic flows or journey times on the A9.

22.8.4 The route options are all assessed with reference to two separate models for each junction option (A9DTM:15 and the BLTM). Journey times and traffic flow information is taken from the A9DTM:15 traffic model.

Option ST2A

22.8.5 Option ST2A is shown on drawings A9P02-JAC-HML-A_MLZZZ_ML-FG-RD-0001, A9P02-JAC-HML-A_MLZZZ-ML-FG-RD-0002, A9P02-JAC-HML-A_MLZZZ-ML-FG-RD-0003, A9P02-JAC-HML-A_MLZZZ-ML-FG-RD-0004, A9P02-JAC-HML-A_MLZZZ-ML-FG-RD-0005 and A9P02-JAC-HML-A_MLZZZ-ML-FG-RD-0006, included in Volume 2: Engineering Drawings. Option ST2A was developed during the A9 Co-Creative Process and was voted as the Community's Preferred Route Option by the local community at the final stage of the A9 Co-Creative Process.

22.8.6 Option ST2A includes a grade-separated junction, facilitating all vehicle movements in the locality of the existing private access to Murthly Castle. The option also incorporates a 1.5 kilometre cut and cover tunnel, beginning at its southern extent in the locality of the existing left/right staggered priority junction with the B867 and Perth Road at Birnam and terminating approximately 300 metres from the existing right/left staggered priority junction with the A923 and A822 (Old Military Road) at Little Dunkeld. Due to alignment constraints within the cut and cover tunnel, a 50 miles per hour (mph) speed limit is required through the tunnel. To avoid sudden changes in speed limit on approach to the tunnel, it is proposed that the 50mph speed limit is applied between the southern extent of the scheme and the proposed Dunkeld Junction. The remainder of the scheme will have a 70mph speed limit. An at-grade roundabout is proposed at Dunkeld Junction, in the locality of the existing right/left staggered priority junction with the A923 and A822 (Old Military Road) at Little Dunkeld. The roundabout provides connections to the A9 (north and south), A923, A822 (Old Military Road) and the road to Inver and includes a segregated left lane between the A923 and A9 (south).

Option ST2B

22.8.7 Option ST2B is shown on drawings A9P02-JAC-HML-B_MLZZZ_ML-FG-RD-0001, A9P02-JAC-HML-B_MLZZZ-ML-FG-RD-0002, A9P02-JAC-HML-B_MLZZZ-ML-FG-RD-0003, A9P02-JAC-HML-B_MLZZZ-ML-FG-RD-0004, A9P02-JAC-HML-B_MLZZZ-ML-FG-RD-0005 and A9P02-JAC-HML-B_MLZZZ-ML-FG-RD-0006, included in Volume 2: Engineering Drawings.

22.8.8 Option ST2B, includes a grade separated junction in the locality of the existing left/right staggered priority junction with the B867 and Perth Road at Birnam. The junction incorporates merge/diverge loops in the northbound direction and a merge slip road in the southbound direction, with no southbound diverge slip road. The B867 and Perth Road are connected, crossing the A9 via an underbridge. The A9 dual carriageway is generally on-line and is lowered into a 150-metre-long underpass structure in the locality of Dunkeld & Birnam Station. Dunkeld & Birnam Station is retained in its current position with Station Road re-connected to the station. Parking is provided on top of the underpass. As with Option ST2A, Option ST2B includes an at-grade roundabout at Dunkeld Junction, in the locality of the existing right/left staggered priority junction with the A923 and A822 (Old Military Road) at Little Dunkeld. The roundabout provides connections to the A9 (north and south), A923,

A822 (Old Military Road) and the road to Inver and includes a segregated left lane between the A923 and A9 (south).

22.8.9 Option ST2B has a speed limit of 70mph throughout.

Option ST2C

22.8.10 Option ST2C is shown on drawings A9P02-JAC-HML-C_MLZZZ_ML-FG-RD-0001, A9P02-JAC-HML-C_MLZZZ-ML-FG-RD-0002, A9P02-JAC-HML-C_MLZZZ-ML-FG-RD-0003, A9P02-JAC-HML-C_MLZZZ-ML-FG-RD-0004, A9P02-JAC-HML-C_MLZZZ-ML-FG-RD-0005 and A9P02-JAC-HML-C_MLZZZ-ML-FG-RD-0006, included in Volume 2: Engineering Drawings.

22.8.11 Option ST2C includes a grade separated junction in the locality of the existing left/right staggered priority junction with the B867 and Perth Road at Birnam, the same as that detailed for Option ST2B. The A9 dual carriageway is on-line, largely following the horizontal and vertical alignment of the existing A9 single carriageway, with Dunkeld & Birnam Station retained in its current position. Birnam Industrial Estate would be acquired, and the land used to construct a car parking facility accessed from Station Road. A new pedestrian underpass structure, incorporating lifts, constructed below the proposed A9 dual carriageway, would link the station car park to the station. A grade separated junction, facilitating all movements, is proposed at Dunkeld Junction, with merge and diverge slip roads in the northbound and southbound directions. The A822 (Old Military Road) and A923 are connected, crossing the A9 via an underbridge.

22.8.12 Option ST2C has a speed limit of 70mph throughout.

Option ST2D

22.8.13 Option ST2D is shown on drawings A9P02-JAC-HML-D_MLZZZ_ML-FG-RD-0001, A9P02-JAC-HML-D_MLZZZ-ML-FG-RD-0002, A9P02-JAC-HML-D_MLZZZ-ML-FG-RD-0003, A9P02-JAC-HML-D_MLZZZ-ML-FG-RD-0004, A9P02-JAC-HML-D_MLZZZ-ML-FG-RD-0005 and A9P02-JAC-HML-D_MLZZZ-ML-FG-RD-0006, included in Volume 2: Engineering Drawings.

22.8.14 Option ST2D and Option ST2C are similar. The only difference is the proposed junction at Dunkeld. Option ST2D includes an at-grade roundabout in the locality of the existing right/left staggered priority junction with the A923 and A822 (Old Military Road) at Little Dunkeld. The roundabout provides connections to the A9 (north and south), A923, A822 (Old Military Road) and the road to Inver and includes a segregated left lane between the A923 and A9 (south).

22.8.15 Option ST2D has a speed limit of 70mph throughout.

22.8.16 It should be noted that for traffic assessment purposes, Options ST2B and ST2D are considered to be the same. As such, forecast traffic flows and speeds will be identical.

Common Features of All Route Options

22.8.17 Options ST2A, ST2B, ST2C and ST2D include the same junction layouts at The Hermitage and Dalguise Junction, as shown in drawings A9P02-JAC-HML-A_MLZZZ_ML-FG-RD-0004 to A9P02-JAC-HML-A_MLZZZ_ML-FG-RD-0006, A9P02-JAC-HML-B_MLZZZ_ML-FG-RD-0004 to A9P02-JAC-HML-B_MLZZZ_ML-FG-RD-0006, A9P02-JAC-HML-C_MLZZZ_ML-FG-RD-0004 to A9P02-JAC-HML-C_MLZZZ_ML-FG-RD-0006 and A9P02-JAC-HML-D_MLZZZ_ML-FG-RD-0004 to A9P02-JAC-HML-D_MLZZZ_ML-FG-RD-0006, included in Volume 2: Engineering Drawings.

22.8.18 The proposed access at The Hermitage, which is a National Trust for Scotland site, is a left-in left-out at-grade junction on the northbound carriageway. As a result, Dunkeld Junction to the south and Dalguise Junction to the north are required to accommodate turning traffic utilising the left-in left-out junction.

22.8.19 At Dalguise, a grade separated junction, facilitating all movements is proposed in the locality of the existing junction with the B898. The junction incorporates merge/diverge loops in the northbound direction and slip roads in the southbound direction. The realigned B898 crosses the A9 on an underbridge, connecting to a roundabout on the east of the A9, which also connects to the southbound slip roads.

23. Effects of Route Options

23.1 Introduction

23.1.1 Differences in the design of the proposed route options would influence journey times for strategic and local traffic, as well as traffic flows on the local transport network on Perth Road through Birnam. Table 23.1 presents modelled journey times for the A9 between the project extents in the base year, 2015, and forecast values for 2026 and 2041 under the Do-Minimum and Do-Something options. Table 23.2 shows the forecast AADT flows at four locations along Perth Road that have been taken from the A9DTM:15 in the base year, 2015, and in 2026 and 2041. These are the traffic flows that have been extracted from the models used for environmental assessment as noted in Paragraphs 22.5.4 and 22.5.5.

23.1.2 However, reference has also been made in Section 22.4 to the existence of the BLTM, which is the summer weekend traffic model that was used to quantify the potential impact on Perth Road of changing the existing signing strategy.

23.1.3 Table 23.3 presents forecast 12-hour traffic flows at the same locations as defined in Table 23.2 on both a summer Saturday and summer Sunday under each scenario in 2041. As these are 12 hour forecast flows, they are not directly comparable with the AADT flows presented in Table 21.2 but give an indication of the magnitude of change in the volume of traffic that could be achieved. The specific impact of each proposed route option is discussed in the subsequent sections of this chapter.

Table 23.1: A9 Journey Times between Project Extents (minutes:seconds)

Scenario	Existing	Do-Minimum		Do-Something Option ST2A		Do-Something Options ST2B & ST2D		Do-Something Option ST2C	
Year	2015	2026	2041	2026	2041	2026	2041	2026	2041
Northbound Journey Time	05:57	06:03	06:07	05:48	05:51	05:11	05:16	04:56	04:59
Southbound Journey Time	06:15	06:21	06:24	05:47	05:50	05:11	05:15	04:54	04:59

Table 23.2: Forecast Traffic Flow on Perth Road from A9DTM:15 Paramics model

	Existing Traffic Flows 2015				Do-Minimum 2026 (2041)				Option ST2A Do-Something 2026 (2041)				Options ST2B & ST2D Do-Something 2026 (2041)				Option ST2C Do-Something 2026 (2041)			
	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]
Perth Road Traffic Flows (2-way AADT)	1,800	1,300	1,800	2,600	2,200 (2,400)	1,600 (1,700)	1,900 (1,800)	2,800 (2,800)	1,400 (1,600)	1,500 (1,600)	2,800 (2,900)	3,800 (4,000)	2,000 (2,200)	2,000 (2,100)	3,000 (3,100)	4,000 (4,100)	2,400 (2,700)	2,400 (2,600)	2,600 (2,600)	3,600 (3,600)

Table Notes:
1) Section 1 refers to Perth Road between A9 Murthly/Birnam Junction and Woodville
2) Section 2 refers to Perth Road between Woodville and Station Road
3) Section 3 refers to Perth Road between Station Road and Stell Park Road
4) Section 4 refers to Perth Road between Stell Park Road and the A923

Table 23.3: Forecast Traffic Flow on Perth Road from BLTM Discovery Model

	Existing Traffic Flows 2017				Do-Minimum 2041				Option ST2A Do-Something 2041				Options ST2B & ST2D Do-Something 2041				Option ST2C Do-Something 2041			
	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]	Section 1[1]	Section 2[2]	Section 3[3]	Section 4[4]
Summer Saturday (12-hour)	1,400	1,500	1,900	2,100	2,000	2,100	2,400	2,600	2,400	2,500	2,900	3,000	2,000	2,100	2,500	2,600	1,800	1,900	2,300	2,500
Summer Saturday with revised signage strategy (12-hour)	-	-	-	-	-	-	-	-	2,100	2,200	2,600	2,700	1,700	1,800	2,200	2,500	1,600	1,700	2,200	2,400
Potential impact of revising signing strategy Summer Saturday (12-hour)	-	-	-	-	-	-	-	-	-300	-300	-300	-300	-300	-300	-300	-100	-200	-200	-100	-100
Summer Sunday (12-hour)	1,400	1,400	1,700	1,800	1,900	2,000	2,200	2,200	2,100	2,200	2,500	2,500	1,700	1,800	2,100	2,200	1,500	1,600	1,900	2,100
Summer Sunday with revised signage strategy (12-hour)	-	-	-	-	-	-	-	-	1,900	1,900	2,200	2,300	1,500	1,600	1,800	2,000	1,400	1,500	1,800	2,000
Potential impact of revising signing strategy Summer Sunday (12-hour)	-	-	-	-	-	-	-	-	-200	-300	-300	-200	-200	-200	-300	-200	-100	-100	-100	-100

Table Notes:
1) Section 1 refers to Perth Road between A9 Murthly/Birnam Junction and Woodville
2) Section 2 refers to Perth Road between Woodville and Station Road
3) Section 3 refers to Perth Road between Station Road and Stell Park Road
4) Section 4 refers to Perth Road between Stell Park Road and the A923

23.2 Option ST2A

23.2.1 Table 23.1 shows that the estimated journey times for A9 traffic between the project extents for Option ST2A in 2041 are likely to be approximately 15 seconds quicker than the Do-Minimum scenario in the northbound direction, and approximately 35 seconds quicker in the southbound direction. Some of the journey time savings that may have been expected due to the A9 Dualling Programme are negated by the 50mph speed limit imposed from the southern extent of the scheme to the proposed Dunkeld Junction. Option ST2A would introduce some delay to vehicles on the A9 due to the roundabout at Dunkeld Junction, with the geometry of the approach and circulatory carriageway reducing vehicle speeds. Vehicles would also be required to give way to traffic on the roundabout.

23.2.2 The current signing strategy from the south directs traffic for Dunkeld through Birnam along Perth Road, but it is assumed that this will be changed as part of the upgrade to encourage traffic for Dunkeld to remain on the A9 until the Dunkeld Junction. In addition, the increased opportunities for vehicles to overtake slower moving vehicles is likely to encourage traffic to remain on the A9 for longer. Table 23.2 shows that A9DTM:15 indicates that compared to the Do-Minimum network, the two-way traffic flow on the southern section of Perth Road would reduce to the south of Woodville but that traffic levels on Perth Road would increase north of Station Road. This change may be partly attributed to the location of the proposed Murthly/Birnam Junction, which is approximately 1.5 kilometres south of the current A9 junction with Perth Road and therefore further from the centre of Birnam. This means that traffic travelling towards Birnam and Little Dunkeld from the south would perhaps be more likely to remain on the A9 as far as the proposed Dunkeld Junction.

23.2.3 However, as A9DTM does not adequately represent the existing level of through traffic on Perth Road, it is not particularly sensitive to the potential impact of the proposed 50mph speed restriction on the A9 under Option ST2A. The A9DTM:15 base model does not represent any through traffic on Perth Road with all traffic using Perth Road originating, destined for, or stopping in Birnam or Little Dunkeld. However, an ANPR survey undertaken in August 2017 indicated that approximately one third of traffic travelling between the A9 to the south and the A923 to Dunkeld routed via Perth Road. The consequence of this is that A9DTM:15 cannot properly replicate the likelihood of a greater proportion of through traffic switching to Perth Road because of the proposed 50mph speed limit on the A9 under Option ST2A. Also, A9DTM:15 does not use 'dynamic feedback', a function which allows vehicles to anticipate delay and alter their intended route towards their destination. Therefore, it is likely the forecast change in traffic flow on Perth Road in A9DTM:15 is not fully representative of the true effects of this route option on Perth Road. As such, the BLTM, which is calibrated to observed traffic flows along Perth Road, replicates the through vehicle movement on a summer weekend and uses dynamic feedback, has also been used as an indicator of the potential change in route choice due to the proposed 50mph speed limit on the A9 under this route option.

23.2.4 Table 23.3 shows that the BLTM suggests the two-way traffic flow on Perth Road, if the existing signing strategy is maintained, may increase by between 10% and 20% depending on the location and day (the BLTM represents both a typical summer Saturday and typical summer Sunday) compared to the Do-Minimum scenario. This could result in a potential increase of around 500 vehicles through Birnam on a typical summer weekend day between 07:00 and 19:00. This increase suggests that with a 50mph speed limit on the A9, more vehicles are likely to consider the B867 and Perth Road, as a viable alternative to the A9, between the Murthly/Birnam Junction and Birnam and Dunkeld. This is because the national speed limit for a single carriageway road (60mph) would apply to the minor road, whereas traffic on the new A9 would be restricted to 50mph, which explains the forecast increase in traffic flow on Perth Road under this route option.

23.2.5 The BLTM also suggests that a change in the signing strategy to direct all vehicles destined for Little Dunkeld and Dunkeld, as well as subsequent tourist destinations, to remain on the A9 until Dunkeld Junction, instead of using the junction at Murthly, has the potential to reduce the traffic flow on Perth Road by around 10% to 15% (about 200 to 300 vehicles per day). This reduction in traffic would result

in traffic flows on Perth Road being broadly comparable to the Do-Minimum scenario, albeit during peak periods, traffic may still be up to 10% higher under this option.

23.2.6 Analysis of the BLTM has indicated that any increase in traffic flow on Perth Road through Birnam in the summer months, is not anticipated to be significant enough to create operational issues on Perth Road. This assessment has considered the on-street parking that occurs on Perth Road, primarily in the locality of the junction with Station Road.

23.2.7 There may be delay at Dunkeld Junction, as a result of the roundabout, on the A923 and A822 (Old Military Road) approaches under peak traffic conditions in the summer, which will vary by approach, time and day. Delay on the A923 approach to the Dunkeld Junction may lead to some southbound traffic diverting onto Perth Road, but this is not likely to be significant.

23.3 Options ST2B and ST2D

23.3.1 Table 23.1 shows that journey times for A9 traffic between the project extents for Options ST2B and ST2D are anticipated to be approximately 50 to 70 seconds quicker than the Do-Minimum scenario (depending on direction of travel) and approximately 35 seconds quicker than Option ST2A in 2041. This is largely due to the increased speed limit (70mph) imposed for Options ST2B and ST2D in comparison to the Do-Minimum (60mph) and Option ST2A (50mph for the southern section). Some delays to through traffic on the A9 are anticipated at the proposed roundabout at Dunkeld Junction, which would be an average of approximately 15 seconds across the day in both northbound and southbound directions. This is of a similar magnitude to Option ST2A.

23.3.2 The proposed restricted movement junction at Birnam, which omits a southbound diverge slip road, generally increases traffic on Perth Road, compared to the Do-Minimum scenario. This increase in traffic flows, is largely traffic destined for the southern extent of Birnam, Bankfoot and the surrounding area, which currently use the existing Birnam Junction and the B867. As noted in Table 23.2, traffic within Sections 2, 3 and 4 increases, compared to the Do-Minimum scenario. This is largely as traffic destined for the north of Birnam, Little Dunkeld and Dunkeld is assumed to remain on the A9 for longer, given the increased speed limit and increased overtaking opportunities. Within Section 1, traffic is expected to decrease, compared to the Do-Minimum scenario. Traffic utilising this section of Perth Road is traffic destined for Bankfoot and the surrounding area, utilising Dunkeld Junction and Perth Road to access the B867. However, as indicated with Option ST2A, the A9DTM:15 potentially overstates this switching due to a combination of the zone definition in Birnam and lack of non-stopping through traffic on Perth Road in the base model. As such the BLTM has also been used to help identify potential route option effects.

23.3.3 Table 23.3 shows that the BLTM indicates that traffic flows on Perth Road for Options ST2B and ST2D are expected to be comparable, and up to approximately 4% higher than the Do-Minimum on a typical summer Saturday. On a typical summer Sunday, traffic flows are expected to be comparable, and up to 10% less than the Do-Minimum. This equates to a reduction of approximately 300 to 400 vehicles per day on Perth Road, compared to Option ST2A.

23.3.4 However, it is expected that the increase in traffic on Perth Road due to the omission of a southbound diverge slip road at Birnam Junction, would be offset by the reduction of traffic destined for the north of Birnam, Little Dunkeld and Dunkeld on Perth Road, which is assumed to remain on the A9 for longer, given the increased speed limit and increased overtaking opportunities. Provision of a segregated left lane between the A923 and A9 (south), which reduces vehicle delays at the junction, would also contribute towards reduced traffic on Perth Road. As a result, traffic flows on Perth Road are expected to be less for Options ST2B and ST2D, compared to Option ST2A.

23.3.5 As noted for Option ST2A, the BLTM suggests that a change in the signing strategy, directing vehicles from the south destined for Little Dunkeld and Dunkeld, and associated tourist destinations, to remain on the A9 until Dunkeld Junction, rather than utilise Birnam Junction, may reduce traffic flows on Perth

Road for Options ST2B and ST2D by approximately 10% to 15% (approximately 200 to 300 vehicles per day). This reduction is dependent on the location and day.

23.3.6 Analysis of the BLTM has also indicated that any increase in traffic flow on Perth Road through Birnam in the summer months, taking due cognisance of existing on-street parking on the route, is not anticipated to create operational issues.

23.3.7 There may be delay at Dunkeld Junction on the A923 and A822 (Old Military Road) roundabout approaches under peak traffic conditions in the summer. Delay on the A923 approach to the Dunkeld Junction may lead to some southbound traffic diverting onto Perth Road, but this is not likely to be significant.

23.4 Option ST2C

23.4.1 Table 23.1 shows that journey times for A9 traffic between the project extents for Option ST2C are approximately 65 to 85 seconds quicker than the Do-Minimum scenario (depending on direction of travel), approximately 50 seconds quicker than Option ST2A and approximately 15 seconds quicker than Options ST2B and ST2D in 2041. This is largely as all junctions are grade separated and the option has a 70mph speed limit throughout. Table 22.2 shows that A9DTM:15 suggests that the traffic flow on Perth Road in 2041 under Option ST2C would be higher than the Do-Minimum network for all sections of Perth Road. A9DTM:15 suggests there would potentially be more traffic at the southern end of Perth Road (Sections 1 and 2) than for the other route options, but less traffic at the northern end (Sections 3 and 4) than for Options ST2A, ST2B and ST2D.

23.4.2 The BLTM suggests that for Option ST2C the traffic flow on Perth Road is expected to be lower than the Do-Minimum scenario, depending on location and day. The BLTM also suggests that the traffic flow on Perth Road would likely be lower than the other Do-Something route options. The reduced traffic flows are expected as fewer vehicles would utilise Perth Road as a through route to travel between Dunkeld and the south, largely as a result of the increased speed and capacity of the A9 and the lack of delay at the proposed grade-separated junctions.

23.4.3 As noted for Options ST2A, ST2B and ST2D, the BLTM suggests a change in the signing strategy to direct all vehicles destined for Little Dunkeld and Dunkeld, and associated tourist destinations, to remain on the A9 until Dunkeld Junction, rather than utilise Birnam Junction, may reduce the traffic flows on Perth Road for Option ST2C by approximately 10% (approximately 100 to 200 vehicles per day). This reduction is dependent on the location and day.

23.4.4 Analysis of the BLTM has indicated that under Option ST2C no operational issues along Perth Road are anticipated, taking due cognisance of the on-street parking on the route and its impact on available road width.

23.4.5 Minimal delay is anticipated at the proposed grade separated junctions, even under peak traffic conditions on a typical summer weekend in 2041.

23.5 Access to and from The Hermitage

23.5.1 The current access to The Hermitage forms a priority junction with the A9 single carriageway between Dunkeld and Dalguise Junctions. The junction includes a diverge auxiliary lane approximately 75 metres long for northbound traffic to exit the A9 and a ghost island is provided to accommodate right-turning vehicles from the north. The proposed scheme includes a left-in left-out junction on the northbound carriageway at The Hermitage, with diverge auxiliary lane and merge taper. As such, traffic travelling from the south to The Hermitage and traffic from The Hermitage to the north, is largely unaffected by the proposed scheme. Traffic travelling from the north to The Hermitage, would utilise Dunkeld Junction to facilitate access to the northbound carriageway. This diversion is approximately 2.3 kilometres for Options ST2A, ST2B and ST2D, which incorporate a roundabout at Dunkeld Junction.

For Option ST2C, which includes a grade separated junction at Dunkeld, with slip roads and priority junctions, the diversion is approximately 150 metres longer, which will add an extra 15 seconds to the journey, compared to Options ST2A, ST2B and ST2D.

23.5.2 Traffic travelling from The Hermitage to the south would utilise the proposed Dalguise Junction, which is grade separated, as a turning facility. This diversion is approximately 4 kilometres in length and is anticipated to add around three minutes to the journey time for vehicles making this movement. The impact would be the same for all options.

23.5.3 A temporary two-way ATC situated at The Hermitage access over two weeks in October 2015 indicates that approximately 200 vehicles enter and exit The Hermitage on an average day. A junction turning count from April 2010 indicated that of traffic exiting The Hermitage, 64% turned right to the south. Therefore, between 100 and 150 trips would be expected to utilise Dalguise Junction to access the southbound A9 dual carriageway each day. Approximately 20% of trips to The Hermitage were recorded as right-turns from the A9 southbound. This suggests the volume of traffic that would utilise Dunkeld Junction to accommodate turning traffic would be in the region of 30 to 40 vehicles per day.

23.6 Impact of Adjacent Sections

23.6.1 The Do-Something models used for environmental and operational/design assessment purposes incorporate proposed improvements on other sections of the A9 with a reference date of November 2015. Assessment of Project 3: Tay Crossing to Ballinluig, immediately north of this project, has identified a requirement for a left-in left-out junction on the southbound carriageway in the locality of the existing junction with the Dunkeld to Rotmell (C502) Road. As such, Dalguise Junction to the south and the left-in left-out junctions on the northbound and southbound carriageways in the locality of Guay, linked by an overbridge, would be used as turning points for traffic utilising the left-in left-out junction at Rotmell, resulting in a diversion of up to 7 kilometres. However, it is anticipated that in practice, most traffic would not follow this diversion and would instead travel via the A923 and utilise the proposed Dunkeld Junction. This is likely to result in an increase in traffic on the northbound carriageway of the A9 between Dunkeld and Dowally by approximately 300 vehicles per day. It is noted that the impacts of the left-in left-out junction with the Dunkeld to Rotmell (C502) Road do not significantly impact Project 2: Pass of Birnam to Tay Crossing and, as it is consistent to all options, it is not a differentiating factor.

23.6.2 For information, the assessment undertaken for Project 3: Tay Crossing to Ballinluig suggests that an additional 300 vehicles will utilise the A923 per day as a result of the left-in left-out arrangement at the Dunkeld to Rotmell (C502) Road Junction. For reference, anticipated traffic on the A923 is approximately 6,000 AADT (2-way) in the year of opening (2026).

24. Economic Performance of Route Options

24.1 Introduction

24.1.1 The proposed upgrade of the section of the A9 between the Pass of Birnam and Tay Crossing forms part of the Scottish Government's commitment to upgrade the A9 to dual carriageway standards along the full length of the route between Perth and Inverness. The Investment Case for the upgrading of the entire route and a discussion on the Wider Economic Benefits of upgrading the A9, are set out in the 'Case for Investment (CfI) (Transport Scotland, 2016)'. The purpose of the economics section of this DMRB Stage 2 assessment is to identify the differences between the options in terms of economic performance and in doing so identify the option(s) that are anticipated to present the best value for money. It is noted that the level of benefits from individual sections of the route will be less than for the entire A9 Dualling Programme: Perth to Inverness. The accrued benefits, for the entire A9 Dualling Programme, are not presented.

24.1.2 To assist with identification of the option(s) likely to produce the greatest value for money, the costs and benefits have been indexed such that the lowest cost option has an index value of 100 and the option with the greatest benefits has an index value of 100. The costs and benefits of the other options are presented relative to this index value. This means that the cost index for all options is greater than or equal to 100 and the benefits for all options is less than or equal to 100.

24.1.3 The economic evaluation of the route options has been undertaken using software developed by the Department for Transport (DfT), named TUBA, version 1.9.9. The impact each of the options has on the likely number and severity of accidents in the area has been assessed using a spreadsheet tool developed by SYSTRA, which uses accident rates and values taken from the DMRB (Volume 15: Economic Assessment of Road Schemes in Scotland, Section 1 (The Network Evaluation from Surveys and Assignments (NESA) Manual)) and traffic flows output from the A9DTM.

24.2 Method of Appraisal

24.2.1 Inputs to TUBA are zone-to-zone trips, time and distance for the Do-Minimum and Do-Something options using data obtained from the A9DTM. The project benefits are calculated by comparing, for each pair of zones, the total costs of travel (including travel time, fares and vehicle operating costs) for the Do-Minimum and Do-Something scenarios.

24.2.2 The various components of the impacts have been assessed as follows:

- **Transport Economic Efficiency (TEE)** – The assessment of TEE benefits has been undertaken with a Fixed Trip Matrix using the A9DTM:15 linked to TUBA; and
- **Accidents** – Analysis of accidents on a project-by-project basis is spreadsheet based.

24.2.3 In accordance with DMRB guidance, the benefit stream is calculated for a 60-year appraisal period. TUBA calculates the benefits for the period 2026 to 2085 (inclusive).

24.3 Construction and Maintenance Costs

24.3.1 The derivation of the construction costs for each option are set out in Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options), and these assume that construction of the section of the A9 between Pass of Birnam and Tay Crossing is likely to commence in 2023. The construction duration varies between the route options and therefore the likely completion date varies by route option.

24.3.2 The duration for construction for each route option is given below.

- Option ST2A: 4 ½ to 5 years;
- Option ST2B: 4 to 4 ½ years;
- Option ST2C: 2 ½ to 3 years; and
- Option ST2D: 2 ½ to 3 years.

24.3.3 The range quoted has been considered taking into account expected construction durations and risk and opportunities. For the purposes of the economic assessment the completion of the scheme has been assumed to be that stated below, which is considered the most likely duration for construction based on the assessment undertaken at this stage.

- Option ST2A would be open to traffic at the end of Quarter 4 2027 (4 ½ years construction period);
- Option ST2B would be open to traffic at the end of Quarter 2 2027 (4 years construction period);
- Option ST2C would be open to traffic at the end of Quarter 2 2026 (3 years construction period); and
- Option ST2D would be open to traffic at the end of Quarter 4 2025 (2 ½ years construction period).
- The Do Minimum would be open to traffic at the end of Quarter 4 2025.

24.3.4 The total outturn cost estimate includes:

- Pre-construction phase costs;
- Construction phase costs;
- Risk, opportunity and uncertainty;
- Optimism Bias; and
- Inflation through to the end of the construction phase, which is taken as up to and including the quarter specified for each option, as noted in Paragraph 24.3.3.

24.3.5 For the purposes of scheme appraisal, all A9 projects have been appraised on the basis that 2026 will be the first year of full programme operation and the design year for all projects will therefore be 2041; 15 years thereafter. As such, the benefits arising from all A9 projects have been assessed over a 60-year period from 2026 to 2085 inclusive. The end date in this regard is consistent with the CfI for the whole A9 Dualling Programme.

24.3.6 To ensure that there is no discontinuity between the capital expenditure and the realisation of benefits, for economic appraisal purposes, the spend profile for this project has been redefined such that 2025 is considered the last year of construction (capital) expenditure for all options and therefore the expenditure profile for appraisal purposes has been adjusted from those presented in Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options). As such, all costs likely to be incurred in 2026 or 2027, are assumed to be expended in 2025. Less discounting is therefore applied to these costs in the derivation of the Present Value. All preparation costs incurred prior to 1st July 2019 have been removed from the appraisal as non-recoverable costs.

24.3.7 In line with guidance on the economic assessment of transport schemes, the adjusted costs inclusive of risk, Optimism Bias and additional construction price inflation have been deflated to 2010 prices using the Consumer Price Index (CPI) based Gross Domestic Product (GDP) Deflator Index, set out in the Transport Appraisal Guidance (TAG) Databook published by the Department for Transport (May 2019). As with the benefits stream, these costs are then discounted at a rate of 3.5% per annum for the first 30 years, from the assessment year (2019) and 3.0% per annum thereafter until 2085.

24.3.8 The Present Value of Costs is the difference between the construction and maintenance cost for the Do-Something and Do-Minimum scenarios and this difference has been indexed.

24.3.9 For operation and maintenance costs, these costs have been added to the capital costs included in Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options) and an Optimism Bias figure of 44% has been applied as per the 'Supplementary Green Book Guidance on Optimism Bias (HM Treasury, 2003)' and 'TAG Unit A1.2 Scheme Costs (Department for Transport, January 2014)'.

24.4 Accidents

24.4.1 The impact on accidents has been assessed for the various options using default rates/costs from the DMRB (Volume 15: Economic Assessment of Road Schemes in Scotland, Section 1 (The NESA Manual)) in both the Do-Something and the Do-Minimum scenarios. NESA recommends that, where possible, accident rates derived from local data should be used, however, this data must be taken from periods when conditions on the road have been broadly unchanged. Average Speed Cameras were introduced on the A9 in October 2014 to improve safety. Construction work on the A9 Dualling: Kincraig to Dalraddy project commenced in the Autumn of 2015 and this section opened to traffic in Summer 2017. Construction work on the A9 Dualling: Luncarty to Pass of Birnam project commenced in the Autumn of 2018 and this section opened to traffic in Summer 2021. In addition, various on-line Ground Investigation (GI) contracts for other A9 dualling projects have also resulted in constantly changing travel conditions along the A9. As such, conditions have not been broadly unchanged in recent years. Guidance states that for the derivation of local accident rates, data should cover the five years prior to the NESA assessment, and for local severity splits, data within a minimum of five years must be supplied. Since the A9 has been evolving over the last five years, the assessment has used national default rates.

24.4.2 For this DMRB Stage 2 assessment, the likely accident reductions for each proposed route option has been compared to the Do-Minimum scenario in the Design Year (2041).

24.4.3 Table 24.1 indicates that the average number of accidents forecast per year would be expected to reduce under all options, compared to the Do-Minimum scenario. All options are expected to result in a reduction in the number of personal injury accidents. This is expected due to the upgrade of 8.4 kilometres of single carriageway to dual carriageway standards, which prevents right-turn manoeuvres across the carriageway, along with the provision of improved junctions. It is noted that within Table 24.1, slight accidents for Option ST2A will nominally increase. This is a result of the Murthly Junction, which is further south than the existing junction and results in an increased volume of traffic utilising the B867, which is to a lesser standard than the A9.

Table 24.1: Average number of accidents saved per year (2041)

Accident Severity	Accidents Saved per year, Option ST2A	Accidents Saved per year, Option ST2B	Accidents Saved per year, Option ST2C	Accidents Saved per year, Option ST2D
Fatal	0.2	0.2	0.2	0.2
Serious	0.9	0.9	1.0	0.9
Slight	-0.1	0.0	1.0	0.0

24.4.4 Option ST2C includes grade separated junctions at Birnam, Dunkeld and Dalguise to access/egress the A9 and connect to the existing road network, which is in accordance with the recommendations in the DMRB (CD109: Highway link design) for a Dual 2-lane All-purpose (D2AP) road (sub-category c) (formerly Category 7A). This would provide a safety benefit over the existing layout, which incorporates at-grade junctions and right-turn manoeuvres across the carriageway. Options ST2A, ST2B and ST2D incorporate an at-grade roundabout at Little Dunkeld, which is a Deviation from recommendations for a D2AP (sub-category c) dual carriageway, and this presents a greater risk of an accident occurring at

this location, primarily as traffic decelerates and accelerates to navigate the roundabout. As detailed in Table 23.2, traffic on Perth Road is likely to increase, potentially increasing the local interaction between vehicular traffic and Walkers, Cyclists and Horse-riders (WCHs), albeit at relatively low speeds. As a result, relatively low savings in slight accidents are forecast. A higher saving in serious and fatal accidents is forecast, particularly for Option ST2C, which provides full grade separated junctions throughout.

24.4.5 Accidents at the proposed Dunkeld Junction for Options ST2A, ST2B and ST2D are most likely to be either rear-end shunts on the A9 approaches, or sideswipe type incidents as traffic enters the circulatory carriageway. Many of these accidents are anticipated to result in only vehicle damage, and therefore are not included in the above personal injury accident reductions.

24.4.6 For Options ST2A, ST2B and ST2D, which incorporate a roundabout at Dunkeld, accidents are more likely to occur at the entry to or on the circulatory carriageway. Should an accident limit the number of operational traffic lanes, there is potential for northbound traffic to queue on approach, which may extend to the Murthly/Birnam Junction, depending on the timing, location and severity of the accident. For Option ST2A this would result in traffic queueing within the cut and cover tunnel, introducing a potential safety issue. It is noted that the emergency services have noted the potential hazard and the impact that may have on response times. If Option ST2A was progressed, measures to prevent queuing within the cut and cover tunnel would be required. This may involve preventing northbound traffic entering the tunnel, which could extend queuing further south, beyond the scheme extents.

24.5 Assessing Maintenance and Delay

24.5.1 The potential delays associated with the construction and maintenance of each of the proposed options have not been assessed at this stage. It is envisaged that all options can be constructed whilst retaining two-way traffic on the A9 without the need to implement either shuttle working or diverting traffic onto local roads, such as Perth Road. As such, most delays would arise from an assumed 40mph speed restriction on the A9 through the roadworks. On any typical day, the level of delay experienced by traffic on the A9 would likely be similar for all route options. However, the construction of Option ST2A would take longer than the other options due to the complexity of the proposed cut and cover tunnel. It should be noted however, that this is not included within the economic assessment presented in this DMRB Stage 2 Scheme Assessment Report. Option ST2D is likely to have the shortest construction timescale and would therefore have the lowest total construction delay.

24.5.2 Most future maintenance operations would be common to all routes, however the cut and cover tunnel, included in Option ST2A would require more frequent, and extensive, maintenance. This would involve carriageway closures to undertake maintenance of equipment, such as air quality apparatus and fire suppression equipment. However, this work would be undertaken at night-time, where possible, under contra-flow conditions. As such, traffic delays due to maintenance activities for Option ST2A are expected to be minimal and have not been considered for the purposes of this assessment. The additional costs of this maintenance have however been included in the assessment.

24.6 Results

24.6.1 A comparison of the Economic Performance for each option is shown in Table 24.2. The cost of each route option is included in Table 4.1 within Volume 1, Part 1 - The Scheme, Chapter 4 (Description of Route Options).

Table 24.2: Indexed Economic Performance

Option	Option ST2A	Option ST2B	Option ST2C	Option ST2D
Indexed Total Present Value of Benefits (PVB)	32	78	100	78
Indexed Present Value of Costs (PVC)	374	135	133	100
Indexed Net Present Value (NPV)	21	68	74	100
Indexed Benefit to Cost Ratio (BCR)	11	74	96	100

24.6.2 indicates that Option ST2C would provide the greatest benefits for road users, as it includes grade separation throughout. The economic benefits of Options ST2B and ST2D would be broadly similar, but less than for Option ST2C, largely due to the reduction in vehicle speeds that would be necessary to negotiate the proposed at-grade roundabout at Dunkeld Junction. However, the travel time benefits of Option ST2A would be appreciably less than the other options, due to the 50mph speed limit on the A9 between the southern tie-in and the proposed Dunkeld Junction. This speed restriction, which is less than the existing posted speed limit on the A9, would result in increased journey times on this section of the A9, compared to other options.

24.6.3 As Option ST2A would provide the lowest level of economic benefits at the highest cost, this is clearly the worst performing option in economic terms. Options ST2B and ST2D would provide comparable benefits, but Option ST2D would produce these benefits at significantly lower cost and would therefore perform better than Option ST2B in economic terms. While Option ST2C would likely generate greater travel time benefits and accident savings than Option ST2D, the significantly higher capital cost of Option ST2C means that the NPV and BCR of Option ST2D is likely to be greater.

24.6.4 Consequently, in economic terms, Option ST2D is likely to be the best option.