3.3.5.2 Grade Separated Junctions

Of the 90 junctions, there are four existing grade separated junctions:

- A820/Doune Road grade separated junction west of Dunblane;
- Queen Victoria Slip Roads north of Dunblane which connects the B8033 to the A9;
- A822 Greenloaning; and
- Loaninghead Interchange (Gleneagles) which connects the A823 to the A9.

However, as the Greenloaning junction only has south facing slip roads it does not provide grade separation for all movements at that location. Traffic turning into the A822 from the A9 north is still required to undertake a conflicting at-grade right-turn manoeuvre at the north-eastern end of Greenloaning.

3.3.5.3 A & B Class Roads

Two 'A' Class and four 'B' Class road junctions currently connect to the A9 dual carriageway:

- A824 south of Auchterarder;
- A824 north of Aberuthven;
- B8081 south of Blackford;
- B8081 northbound merge only located just north of Blackford;
- B9141 located at Broom of Dalreoch, leading to Findo Gask and Dunning; and
- B934 priority junction which leads to the village of Forteviot.

Capabilities on project:
Transportation

-

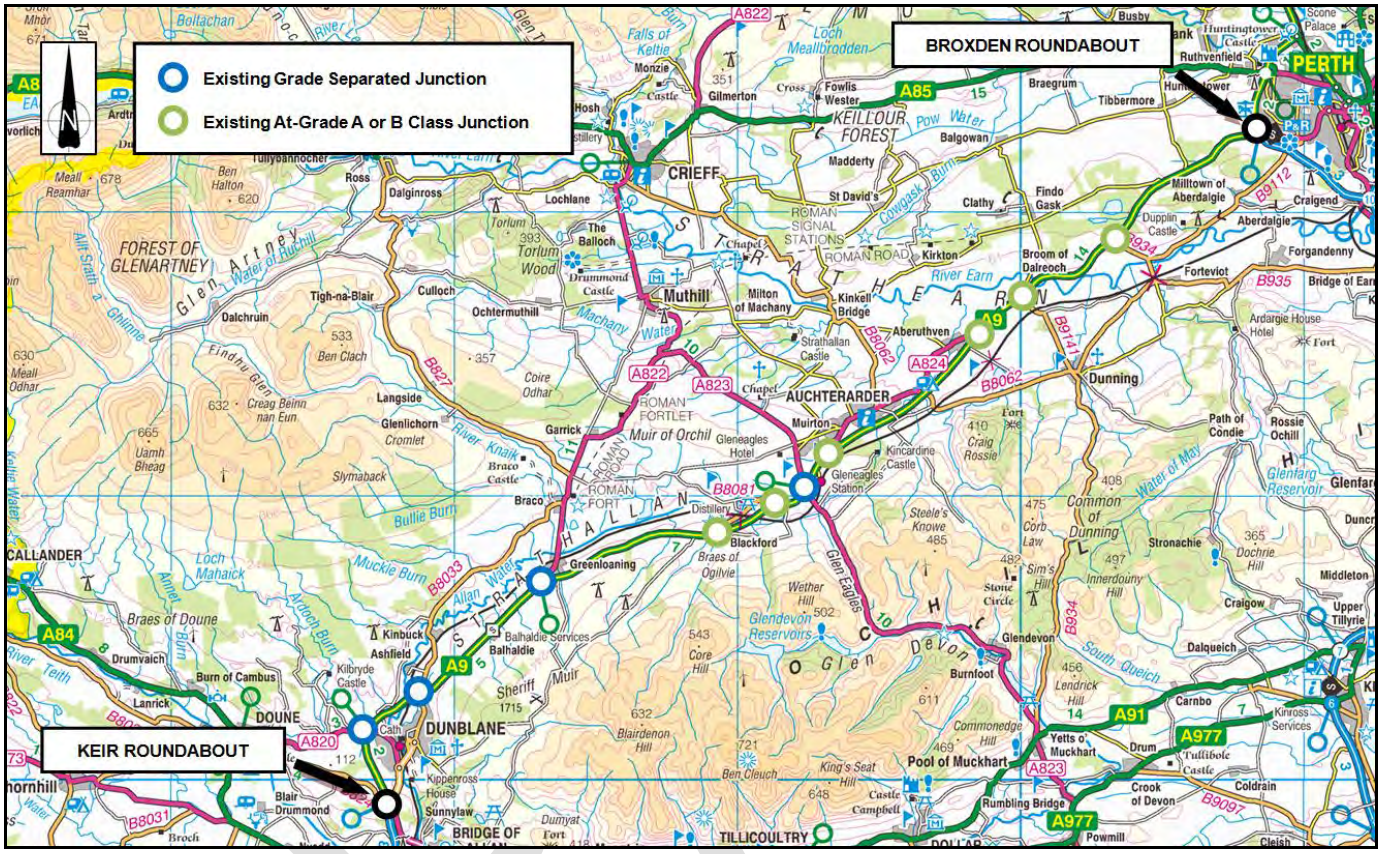

Figure 12 - Location of A Class and B Class road junctions with the A9

Each of the junctions connecting the 'A' and 'B' class roads accommodates right turning traffic in both directions through gaps in the central reserve.

3.3.5.4 'C' & Unclassified

There are 28 'C' Class or Unclassified ('U') side roads which connect to the A9 via simple priority junctions that cater for right turning vehicles entering or exiting the A9 through gaps in the central reserve.

Services, rest areas, private, agricultural and woodland access are not considered appropriate for grade separation and are not considered further under this strategy.

3.3.5.5 Traffic Flows

A review of available traffic data for the main carriageways and side roads was undertaken. As may be expected, due to the nature of the network no data was available for many of the side roads and for the purposes of reassignment under median closures, estimates have been made for these. In general, for the 'U' class roads which provide access to agricultural, residential and woodland premises/areas an annual average daily traffic (AADT) flow of 50 veh/day has been assumed. The service area/fuel stations on either carriageway are accessed via left in/left out junctions and estimates of up to 2000vpd have been made for movements in and out. A flow diagram indicating the traffic movements at each junction is provided in Appendix 7.

There are ten 'C' class roads which have junctions with the A9 and flow levels vary from less than 100 vpd at the Buttergask junction west of Blackford to around 1200 at the Windyedge/Tibbermore junction.

Inclusive of the Queen Victoria slips there are six 'B' road junctions with the A9 however the only movement allowed at the B8081 at the north end of Blackford, is a merge for northbound traffic. This leaves the B8081 at Blackford (south), B9141 Findo Gask (Broom of Dalreoch) and B934 Forteviot as junctions where right turn manoeuvres are currently facilitated. The B8081 at Blackford is well used with the Highland Springs and Tullibardine Distillery both being serviced from it and, together with local traffic, producing around 2,300 traffic movements per day to and from the A9. At the B9141 there are around 1100 movements to/from the A9 while the B934 has around 650 movements suggesting that both of these are not as busy as the Tibbermore/Windyedge junction.

There are a number of 'A' road junctions;

- A820 Doune;
- A822 Greenloaning;
- A823 Loaninghead Interchange (Gleneagles);
- A824 Auchterarder (south); and
- A824 Aberuthven (north)

However, of these, only the A824 junctions are at-grade. The others are already grade separated although the Greenloaning junction only has south facing slip roads.

The A824 junctions have complementary movements in that the northern junction caters for significant left out / right in (2080 and 1940 respectively) while the southern junction primarily caters for left in / right out (1400 and 850 respectively). There are other conflicting right turn manoeuvres at each location but the numbers are low compared to the major turns.

The assessment has focussed on those minor roads with greater than 500 right turn vehicles movements per day in an assumed design year of 2040. These are summarised in Table 21 below. The proximity of the A824 (S) at Auchterarder to the Loaninghead Interchange would rule out the construction of a new grade separated junction here due to conflict arising from inadequate junction spacing. Therefore the construction of a grade separated junction with connection to the A9 at Auchterarder is not considered in this assessment.

NORTHBOUND	TRAFFIC FLOWS AADT (ASSUMED DESIGN YEAR OF 2040)				
JUNCTION NAME	**LEFT IN**	**LEFT OUT**	**RIGHT IN**	**RIGHT OUT**	**SIDE ROAD TOTAL**
Dunblane / A820	1230	1496	-	-	2726
Dunblane North Grade Separated Junction	887	938	-	-	1825
Greenloaning	2409	-	-	-	2409
Blackford South (S)	824	557	976	583	2940
Blackford North (N)	-	761	-	-	761
Loaninghead Interchange A823	1408	-	-	-	1408
Loaninghead Interchange A9	-	964	-	-	964
A9 A824 (S)	1775	177	203	1077	3231
A9 A824 (N)	190	2637	2459	139	5425
Windyedge Cottage	393	646	418	291	1748

Table 21 – A9 Northbound side road traffic flows in excess of 500 AADT for an assumed design year of 2040

SOUTHBOUND	TRAFFIC FLOWS AADT (ASSUMED DESIGN YEAR OF 2040)				
JUNCTION NAME	**LEFT IN**	**LEFT OUT**	**RIGHT IN**	**RIGHT OUT**	**SIDE ROAD TOTAL**
Dunblane / A820	1560	1547	-	-	**3107**
Dunblane North Grade Separated Junction	1116	1230	-	-	**2346**
Greenloaning	-	2346	-	< 50	**2346**
Loaninghead Interchange	992	1902	-	-	**2894**
Findo Gask	355	342	279	406	**1382**
Forteviot	203	190	317	101	**812**

Table 22 – A9 Southbound side road traffic flows in excess of 500 AADT for an assumed design year of 2040

3.3.5.6 Collisions

Whilst collisions would typically be a useful indicator of those junctions that may merit grade separation, the provision of a central median barrier and closure of all median gaps would effectively remove all right turn manoeuvres onto and off the A9. The collisions resulting from these types manoeuvres would be eliminated and therefore collisions are not considered in this assessment.

The closure of median gaps will in some instances result in traffic diverting on to the side road network. It is recommended that further work be undertaken at subsequent stages of DMRB Assessment to assess the potential for collision migration.

3.3.5.7 Economic Impacts

In order to provide an economic estimate of the impact of the median closures combined with the provision of new grade separated junctions, a spreadsheet assessment was developed which considered;

- turning counts;
- diversion distances; and
- travel times.

All costs were obtained from WebTAG.

The diversion distances also considered alternative local routes that may be used by motorists, such as those near Auchterarder, rather than the full A9 diversion.

Having determined the worst-case scenario under Strategy 1 (no new GSJs), subsequent iterations were tested with a view to optimising:

- additional trip lengths;
- additional vehicles at existing junctions; and
- travel time and collision benefits.

The scenarios tested provided grade separation at one or a number of the following locations in combination.

- Greenloaning;
- Blackford;
- Aberuthven;
- Findo Gask;
- Forteviot; and
- Windyedge Cottages.

The following tables summarise the findings indicating the site(s) which produced the best return through the addition of 1, 2, 3, 4, 5, or 6 junctions. For the purposes of the Stage 1 Assessment, it has been assumed that the cost of grade separated junction provision will be largely similar at each location and therefore this assessment was based on benefits only. The best performing combinations are summarised in Table 23 below. The 'Total Benefits' figure in the table includes for the collision savings made as a result of the RIRO restrictions.

Capabilities on project:
Transportation

NO. OF JUNCTIONS	LOCATION(S)	ADDITIONAL VEHKM/DAY	ANNUALISED TRAVEL TIME COSTS (£M)	ANNUALISED ADDITIONAL COLLISION COSTS (£M)	ANNUALISED TOTAL BENEFITS (£M)	ADDITIONAL DAILY MOVEMENTS		
						VICTORIA SLIPS	LOANINGHEAD INTERCHANGE	BROXDEN ROUNDABOUT
1	A824 Aberuthven	64,570	-£3.37	-£0.73	-£2.06	1255	2061	1693
2	Blackford south A824 Aberuthven	35,130	-£1.92	-£0.40	-£0.27	279	1326	1693
3	Blackford south A824 Aberuthven B9141 Findo Gask	19,950	-£1.15	-£0.23	£0.67	279	1326	1156
4	Blackford south A824 Aberuthven B9141 Findo Gask Greenloaning	16,250	-£0.99	-£0.19	£0.87	92	1326	1156
5	Blackford south A824 Aberuthven B9141 Findo Gask Greenloaning Windyedge	11,850	-£0.70	-£1.35	£1.21	92	1326	101

NO. OF JUNCTIONS	LOCATION(S)	ADDITIONAL VEHKM/DAY	ANNUALISED TRAVEL TIME COSTS (£M)	ANNUALISED ADDITIONAL COLLISION COSTS (£M)	ANNUALISED TOTAL BENEFITS (£M)	ADDITIONAL DAILY MOVEMENTS		
						VICTORIA SLIPS	LOANINGHEAD INTERCHANGE	BROXDEN ROUNDABOUT
6	Blackford south A824 Aberuthven B9141 Findo Gask Greenloaning Windyedge Forteviot	8,409	-£0.51	-£0.96	£1.44	92	1326	101

Table 23 - Junction Location Assessment

When the collision benefits of restricting the right in/right out movements are included, the results indicate that a minimum of three additional junctions may result in positive economic benefits in the first year (£0.67m). However, with three junctions the additional traffic on the existing grade separated junctions is anticipated to be relatively high.

With the six junction improvements the economic benefits are seen to increase to £1.44m with minimal additional traffic at the Victoria slips and Broxden.

In each case it can be seen that the overall benefits increase when compared to the previous scenario. In addition, there are slight reductions in the diverted flow at the Victoria slips junction.

This assessment has demonstrated that positive benefits can be achieved by a number of potential iterations, however it does not take construction costs into consideration. It has not yet been demonstrated that any particular scenario can deliver value for money and therefore further assessment would be required in this respect.

3.4 Additional Options for Grade Separation

The assessment undertaken and described above focussed on those junctions with greater than 500 right turn manoeuvres daily. It may be appropriate at subsequent stages of Scheme Assessment to give consideration to some form of grade separation at another two locations – the A824 at Auchterarder and Shinafoot.

3.4.1 A824 Auchterarder/Loaninghead Interchange Link

The A824/A9 junction at Auctherarder was not included in the testing of scenarios described above due to its proximity to the Loaninghead junction. However, the various scenarios tested above all still result in over 1000 vehicles diverting through Gleneagles village. This additional traffic could be facilitated separately by providing an unconnected grade separated link from the A824 to the Loaninghead Interchange via the new Railway Link Road currently under construction. This would significantly reduce the volume of traffic diverting on the side road network whilst offering the added benefit of providing enhanced

connectivity from the village of Auchterader to the railway station. A new link here would allow bus services to pass by the railway station further enhancing integration of the transport network

3.4.2 Shinafoot

An existing underpass at Shinafoot offers further opportunity to provide a grade separated junction with the A9. The B8062 passes under the A9 midway between the towns of Auchterarder and Aberuthven via the Shinafoot Underpass.

As a sensitivity test, the Shinafoot junction was included in the assessment to allow comparison to be made between a possible junction there and at A824 Aberuthven. The analysis undertaken suggests that a grade separated junction (GSJ) at Shinafoot does not provide as much benefit compared to a grade separated junction at A824 Aberuthven, however the difference was marginal.

3.5 Other Minor Roads/Accesses

TD9 states that for Category 6 or 7A Dual Carriageways, minor side roads shall be stopped up, provided with a left in/left out connection or grade separated without connection. Isolated existing accesses would revert to left in left out movements only and major junctions would be fully grade separated. Opportunities may exist to connect minor roads and accesses into proposed grade separated junctions, thus reducing the number that remain on the A9. This would offer the added benefit of providing improved access arrangements and potentially reducing the online detour distances for certain landowners.

Elsewhere, it may be appropriate to rationalise several side roads and accesses into a single left in left out junction.

The identification of suitable interventions at minor roads and accesses would be dependent upon the confirmation of those junctions to be grade separated, which should be undertaken at a later stage of DMRB scheme reporting process.

3.6 Alternative Strategy Conclusions

The assessment of alternative strategies concluded the following:

- The closure of median gaps and the prohibiting of right turn manoeuvres onto or off the A9 is considered necessary to deliver the scheme objective of reducing the collision severity for this section of the A9.
- The existing congestion and collisions indicate that it is appropriate to consider Keir Roundabout for grade separation as part of any option to provide improvements to this section of the A9
- The closure of median gaps without the provision of new grade separated junctions is not likely to deliver positive economic benefits, and is therefore dismissed as an alternative strategy.
- The provision of online roundabouts as a means of access to the A9, and u-turn facility is likely to result in increased delay to the network and is therefore dismissed as an alternative strategy.
- Full median closure would require at least three additional grade separated junctions north of Keir Roundabout to deliver positive economic benefits, subject to construction costs.

Therefore, based on the assessment of the Alternative Strategies, it is considered appropriate to take Strategy 3 forward for further consideration.

4 Engineering Assessment

4.1 Introduction

The previous chapter proposed that further consideration be given to grade separation of Keir Roundabout, along with the grade separation of additional junctions on the A9 between Keir Roundabout and Broxden Roundabout. Locations where grade separation may be considered appropriate were identified and this chapter provides a broad assessment of the existing features at each which may influence any future improvements.

This chapter considers other engineering aspects of the A9 which may be relevant under any proposed route improvement strategy, particularly with respect to problems identified under Chapter 2. The chapter also provides a summary of existing utilities and services along the route corridor.

4.2 Locations considered for grade separation

At this stage of scheme assessment, the number, exact location and layout of any potential grade separated junctions to be provided under the strategy set out in Chapter 3 is yet to be established. However, based on the preliminary traffic analysis described in the previous chapter, consideration can be given to a number of locations where grade separation may be reasonable. The topographical, hydrological and geological features of the following locations are described below:

- Keir Roundabout
- Greenloaning
- Blackford
- Aberuthven
- Findo Gask
- Forteviot
- Windyedge Cottages

Capabilities on project:
Transportation

4.3 Keir Roundabout

4.3.1 Site Description

Keir Roundabout forms the node point where the A9, travelling north from Falkirk and Stirling, changes from a single lane carriageway to a two lane all purpose dual carriageway en route to Perth. It is a five armed roundabout that provides additional connections to the M9 motorway, which continues south towards the Central Belt, the B8033 to the north and the B824 to the west which lead to the towns of Dunblane and Doune, respectively. The Keir Roundabout study area is shown in below.

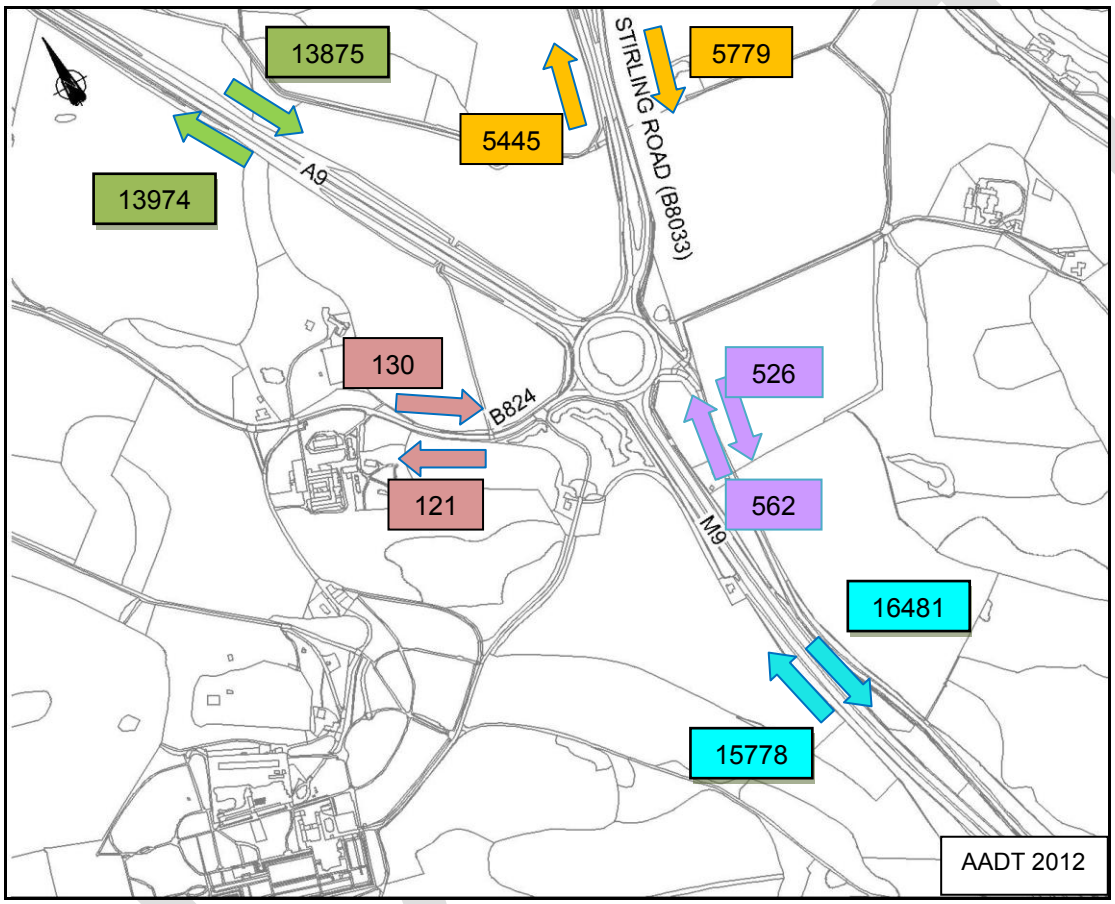

Figure 13 - Existing Road Layout at Keir Roundabout

There are no structures in the immediate vicinity of the roundabout with the exception of an agricultural underpass crossing the A9 dual carriageway approximately 250 metres to the north. An at-grade non-motorised user (NMU) crossing of the A9 dual carriageway at the roundabout connects the B8033 and B824 for pedestrians.

The area surrounding Keir Roundabout is predominately agricultural farmland interspersed with pockets of woodland and interconnecting laneways provide access to the adjacent land and properties. Generally, the land around Keir Roundabout slopes in a north to south direction. The A9 dual carriageway to the north ascends at a relatively steep incline away from the roundabout for just over a kilometre before reaching the top of the hill and subsequently falling back down to the west of Dunblane.

4.3.2 Topography and Land Use

The primary topographical and land use features within the Keir Roundabout study area are as follows:

- The junction consists of a roundabout with 5 entry/exit roads;
- The M9 is located to the south and the A9 to the north. Other roads off the roundabout are the A9 junction to/from Bridge of Allan (south-east of the M9), the B824 towards Doune to the north-west, and the B8033 towards Dunblane (Stirling Road) to the north east;
- The approach roads at the roundabout junction comprise the following construction features;
- The M9 consists of low cut on the east side and a low embankment on the west side;
- The A9 to the north consists of a low embankment on the east side and a medium height cut on the west side tapering down to the north;
- The A9 on the south side appears generally at grade/low embankment;
- The B824 on the west side of the roundabout consists of low embankment on the south side, and a medium height cut on the north side;
- The B8033 on the north east side of the roundabout is formed on low embankment;
- The local topography comprises low lying rolling ground with shallow gradients. To the south the ground descends to form the northern flank of the Forth Valley;
- The site is situated in a rural environment with the surrounding land appearing to be used for agricultural purposes. This appears to mainly consist of grazing; and
- Individual houses are also located locally to the roundabout.

4.3.3 Geomorphology

British Geological Survey (BGS) geological maps show the predominant superficial deposits at the junction to comprise Glacial Till. A localised band of alluvium aligned to the north-west is also shown as being located at the junction. This is indicated as comprising silt, sand and gravel.

A geological plan showing superficial deposits is included in Appendix 8.

4.3.4 Existing Ground Investigation

A review of the BGS geo-index shows several boreholes relating to the road schemes (and earlier investigations) to have been carried out. Information from selected records indicate ground conditions to be glacial till, described as firm to stiff, becoming very stiff, sandy CLAY with gravel and pockets of sand. Thicknesses of between 4m to 6m or more are indicated overlying SANDSTONE bedrock.

Groundwater level was encountered at around 1.2m below ground level.

4.3.5 Other Features

- The Allan Water is present around 700m to the east of the junction flowing to the south;
- Galloway Quarry (disused) is present around 300m to the south east of the junction; and
- A small watercourse is present within the Dunblane show-field north of the roundabout.

4.4 Greenloaning

4.4.1 Site Description

Greenloaning, located approximately 5 miles north of Dunblane, is a small village that sits between the A9 dual carriageway to the south and the Perth to Dunblane railway line to the north.

The A822 forms the main road in to the village from the A9 and continues north passing through the villages of Braco and Muthill, terminating at Crieff approximately 11 miles north of Greenloaning. The existing layout of the A822 junction to the south west of Greenloaning comprises of a northbound merge lane entering the village and a southbound merge lane via a one way overbridge for vehicles leaving Greenloaning. The Greenloaning study area is shown in below.

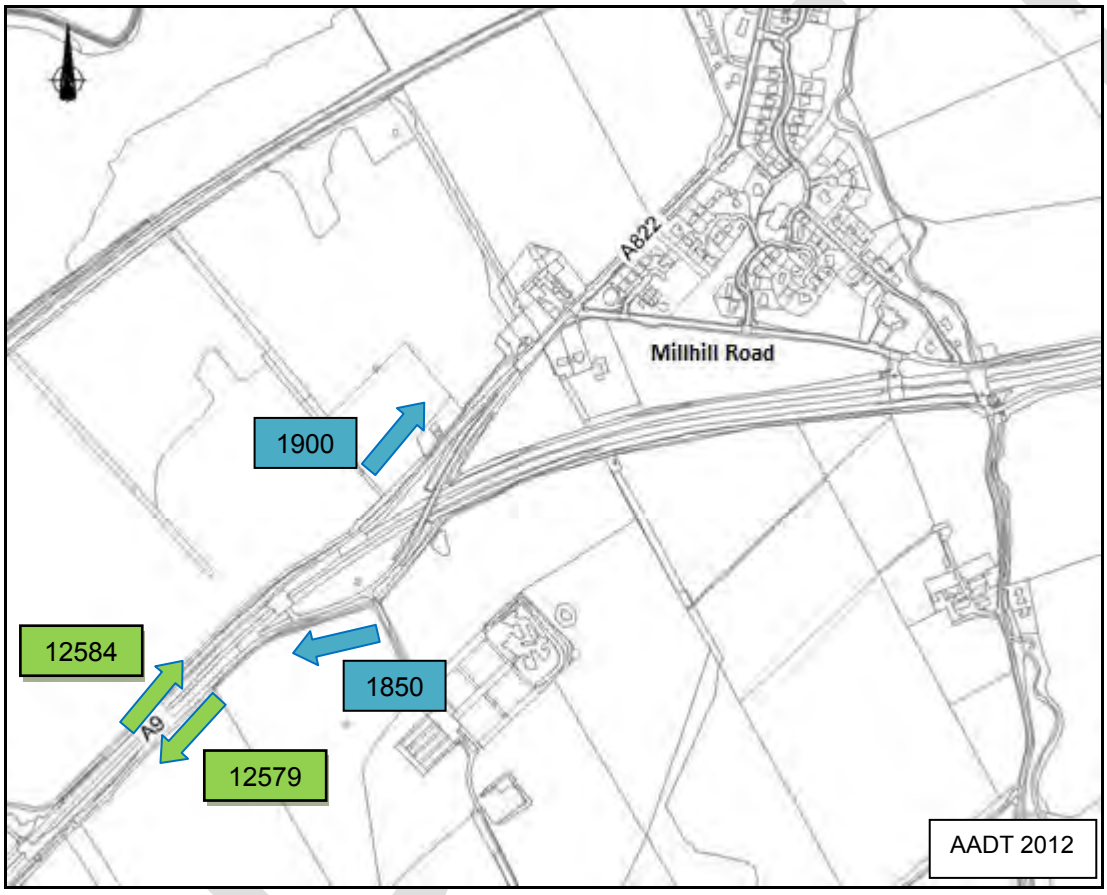

Figure 14 - Existing Road Layout at Greenloaning

The Millhill Road junction to the east provides additional access to and from the village which also links to the A822. Access to and from the south is provided through a short nearside diverge lane. A merge lane is not provided at this junction. A gap in the central median facilitates right turn manoeuvres and a right turning lane is provided within the central reserve. An at-grade NMU crossing is also provided.

The junction to the east of Greenloaning and on the southbound carriageway provides access to properties and agricultural land south of the A9. A short diverge and merge lane are included within the layout of the junction. Right turning vehicles gain access through an offside diverge lane within the central median and a gap in the central reserve.

The rural land that surrounds Greenloaning is largely pastures for grazing animals and to a lesser extent fields for arable farming. On the whole, the land tends to slope across the carriageway from the south east toward Allan Water in the north. Millstone Burn, the only significant watercourse that crosses the A9 near the village, is located to the east of Greenloaning and is culverted under the road.

4.4.2 Topography and Land Use

The primary topographical and land use features within the Greenloaning study area are as follows:

- The junction off the northbound A9 carriageway consists of a diverge slip road directly on to the A822. The slip road construction consists of low embankment and at grade sections;
- From the A822 the southbound slip road approach consists of a 2 span single lane overbridge carrying the A822 across the A9 and on to the merge to the A9. The overbridge approaches are constructed using embankments. The bridge has a heavy skew, and the central pier is located in the central reserve;
- The south bound slip road has been constructed within a cutting on the south side. A junction for a minor road leading to Townhead Farm (Quoiggs Beef Lot) is also present off the south bound slip road – access is only available on to the southbound A9 carriageway from here;
- To the west of the overbridge where both slip roads to the A9 are located, the A9 has been constructed on low embankment;
- East of the overbridge, the A9 itself enters an area of low cutting;
- The site is situated in a rural environment with much of the surrounding land appearing to mainly comprise agricultural grazing land and some rough pasture;
- Greenloaning village is situated around 500m north-east from the overbridge;
- Townhead Farm is located just to the south of the junction;
- The local topography typically comprises rolling ground with shallow gradients, which fall to the north-west. To the north the ground falls away towards a relatively level floodplain area containing the Allan Water;
- An overhead electricity line crosses the junction aligned south to north. A supporting pylon is located on the south bound verge on the north side of the overbridge slip road; and
- The A822 crosses the Glasgow/Perth railway and the Allan Water just north of the village which may constrain junction options.

4.4.3 Geomorphology

BGS geological maps show the predominant superficial deposits at the junction to comprise Glacial Fluvial Ice Contact Deposits; gravel, sand and silt. To the immediate south, glacial till deposits are present towards the higher ground beyond. To the north alluvial deposits are present as part of the Allan Water flood plain – these form a feature along the margin of Strathallan. A narrow band of alluvial deposits are indicated crossing the A9 to the east of the overbridge, linked to the presence of a watercourse culverted under the A9. The watercourse drains the higher land in the south to the Allan Water north of the A9.

A geological plan extract showing superficial deposits is included in Appendix 8.

4.4.4 Existing Ground Investigation

A review of the BGS geo-index shows several boreholes relating to the road schemes (and earlier investigations) to be available in the area. From selected records ground conditions are described as well graded sand, gravel and cobbles to around 4m overlying glacial till. Groundwater level was encountered at around 4m below ground level.

4.4.5 Other Features

- The Allan Water is present around 900m to the north of the overbridge;
- Watercourses cross the A9 on both sides of the overbridge; and
- 2 localised water features were noted to be present to the east of the A9.

4.5 Blackford

4.5.1 Site Description

Blackford is a small village located five miles south west of Auchterarder just north of the A9. It is home to Highland Spring's main site as well as the Tullibardine whisky distillery. It lies between the A9 dual carriageway in the south and the Perth to Dunblane rail line in the north.

The B8081, Moray Street, forms the main road running through the village of Blackford and connects to the A9 at the south west end of the village and again north of the village via a northbound merge taper. The Blackford study area is shown below.

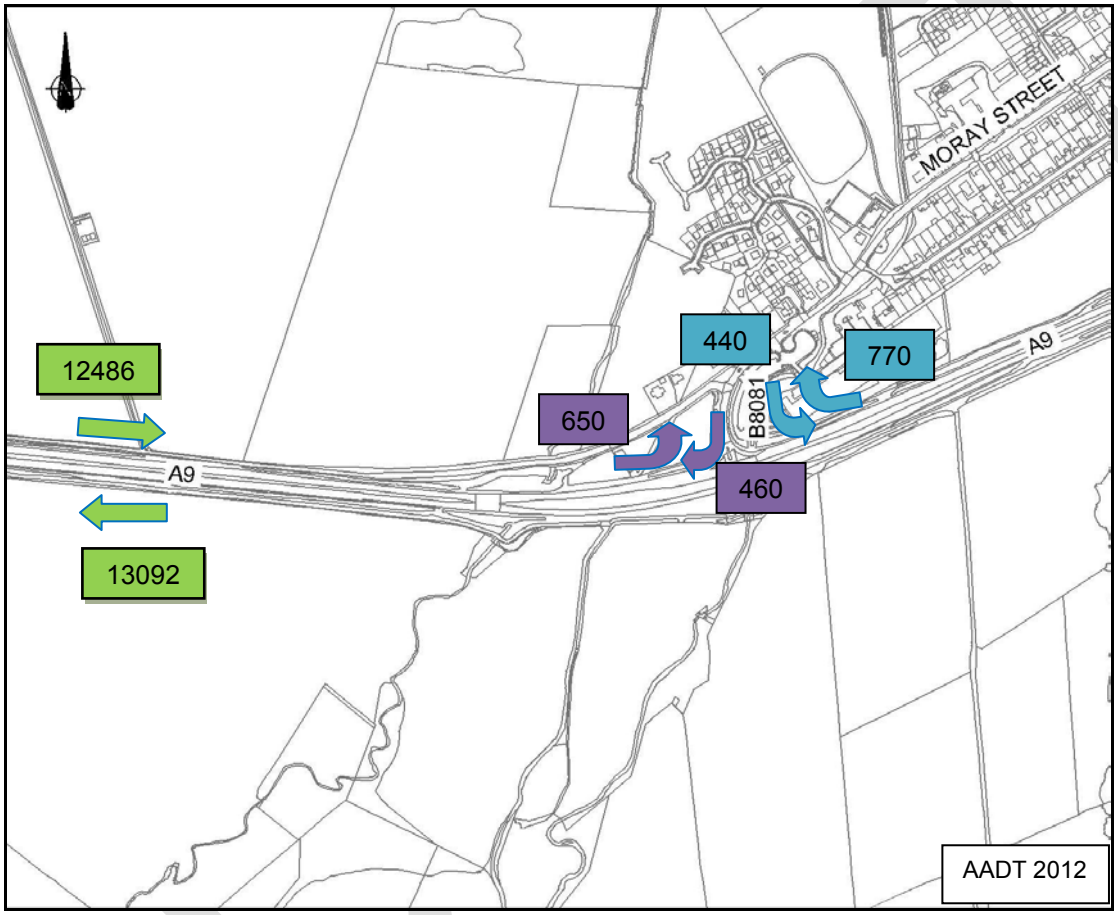

Figure 15 - Existing Road Layout at Blackford

Access from the south onto the B8081 at the south eastern end of Blackford is provided through a nearside diverge lane; while a gap in the central reserve and a right turn lane provides access for vehicles travelling from the north. The gap also allows right turning traffic from Blackford to turn out onto the A9 southbound carriageway. There is a merge lane on the nearside of the northbound carriageway to accommodate vehicles turning north onto the A9 from Blackford.

Directly opposite the B8081 junction, there is a priority junction which provides direct access to a small number of residential properties, farm holdings and agricultural land on the south side of the A9. Whilst there is no diverge or merge lane, it does provide for right turn manoeuvres through a gap in the central median and a right turn lane.

The Burn of Ogilvie crosses the A9 dual carriageway just to the west of Blackford through a culvert. A localised depression in the land surrounding the river results in the A9 being at an elevated position however this begins to flatten out on the approach to Blackford.

4.5.2 Topography and Land Use

The primary topographical and land use features within the Blackford study area are as follows:

- The junction on the north side of the A9 to Blackford consists of a slip road off, and a T-junction on to the A9. Construction of this side of the junction consists of low embankment;
- The minor access on the south side of the A9 consists of a T-junction on to the A9;
- The Danny Burn flows below the A9 at the junction in culvert;
- The site is situated in a rural environment with much of the surrounding land appearing to be used for agricultural purposes; this comprises mainly grazing;
- Blackford village is situated around 300m north-east from the junction; and
- The local topography typically comprises relatively flat rolling ground with shallow gradients, which falls from south to north. To the north the ground falls away towards a relatively level floodplain of the Allan Water.

4.5.3 Geomorphology

BGS geological maps show the predominant superficial deposits at the junction to comprise glacial sand and gravel deposits; gravel, sand and silt. To the north of the junction alluvial deposits are present as part of the Allan Water flood plain. Two bands of alluvial deposits are indicated crossing the A9 in the region of the junction. One of these may be linked with the presence of the Danny Burn below the junction. A localised area of Glacial Till is present on the south side of the A9 and to the west of the junction.

A geological plan extract showing superficial deposits is included in Appendix 8.

4.5.4 Existing Ground Investigation

A review of the BGS geo-index shows several boreholes relating to the road schemes (and earlier investigations) to have been carried out. From selected records glacial sand and gravel are described as clayey gravelly sand with some silt. Depths of around 4.5m were recorded.

Groundwater level was encountered at around 6m below ground level.

4.5.5 Other Features

- The Danny Burn flows below the A9 at the junction; and
- Smaller streams flow below the A9 around 280m to the west of the junction and around 500m to the east.

Capabilities on project:
Transportation

4.6 Aberuthven

4.6.1 Site Description

The village of Aberuthven, approximately 2.5 miles north east of Auchterarder, lies between the A9 dual carriageway and Ruthven Water. The A824, the main road passing through the village, forms a junction to the A9 at its north eastern edge. Access to Aberuthven from the south is provided for by a nearside diverge followed by a tight left hand bend. A gap in the central reserve and a right hand turning lane permits right turn manoeuvres and access to the village for vehicles travelling from the north. A northbound merge lane is also accommodated in to the layout of the junction. The Aberuthven study area is shown below.

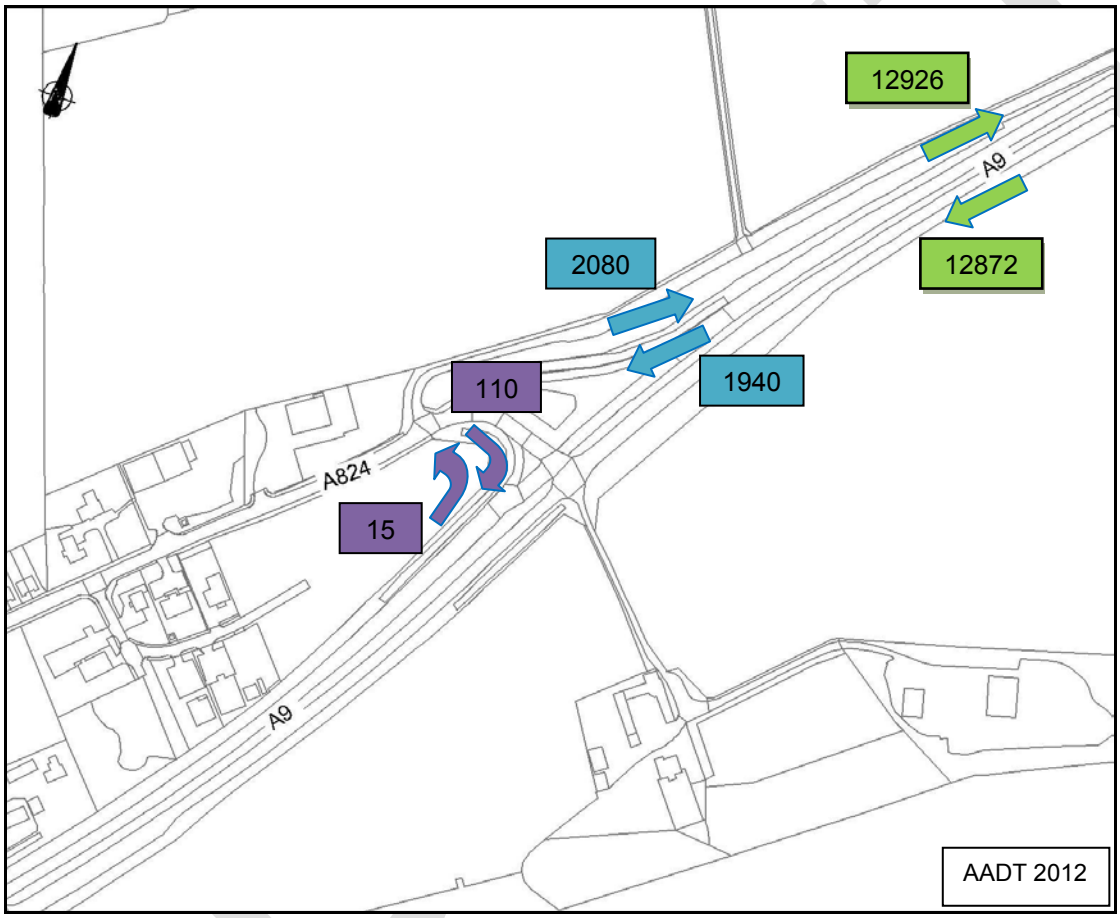

Figure 16 - Existing Road Layout at Aberuthven

Sitting opposite the A824 junction and on the southbound carriageway of the A9 is a priority junction that connects a private laneway to Maidenplain Farmhouse and Woodlands Farm. A right turning lane and a gap in the central reserve provide access to the property from the northbound carriageway.

The farmland neighbouring the A824 junction at Aberuthven is generally quite flat, sloping only slightly away from the road on either side.

4.6.2 Topography and Land Use

The primary topographical and land use features within the Aberuthven study area are as follows:

- The junction on the west side of the A9 consists of a slip road off, and a T-junction on to the northbound carriageway of the A9;
- On the south bound carriageway, a central slip road is positioned leading to an opening in the central reservation allowing turning from the southbound carriageway;
- Road construction of the A9 over the junction area consists of low cut. The site is situated in a rural environment with the surrounding land appearing to be used for agricultural purposes; this comprises crops and grazing;
- Aberuthven Village is situated around 200m to the south-west of the junction;
- Some local areas of scrub and woodland are also present along the west verge of the A9; and
- The topography typically comprises low lying level ground.

4.6.3 Geomorphology

BGS geological maps show the predominant superficial deposits at the junction to comprise fluvio-glacial sheet deposits; gravel, sand and silt. A band of alluvium aligned roughly north-south is also shown as being located just to the east of the junction. This is indicated as comprising silt, sand and gravel.

A geological plan extract showing superficial deposits is included in Appendix 8.

4.6.4 Existing Ground Investigation

A review of the BGS geo-index shows several boreholes relating to the road schemes (and earlier investigations) to have been carried out. Information from three historical boreholes was obtained for the site. A summary of these are as follows;

- Upper horizons of sandy clay/loose clayey sand with some boulders;
- Compact very clayey SAND with some gravel and boulders; and
- Glacial sand and gravel deposits to 4.5m or more.

No groundwater was encountered in the boreholes at depths up to 4m below ground level.

4.6.5 Other Features

- The Ruthven Water is located around 700m to the north west of the junction and flows to the north.

4.7 Findo Gask

4.7.1 Site Description

The Broom of Dalreoch is a small hamlet that lies just to the south east of the River Earn Bridge, approximately 2 miles north east of Aberuthven and a similar distance north of Dunning.

The B9141 and an unclassified road leading north to Findo Gask form a right left staggered crossroad junction to the A9 dual carriageway. Vehicles from the north gain access to the B9141 through a nearside diverge lane and a give way arrangement at the junction. A similar layout is used for vehicles from the south exiting the A9 and headed north toward Findo Gask. There are no merge lanes at either junction. Gaps in the central reserve allow right turn manoeuvres and right turning lanes provide access to either junction for vehicles on the opposing carriageway. The Findo Gask study area is shown below.

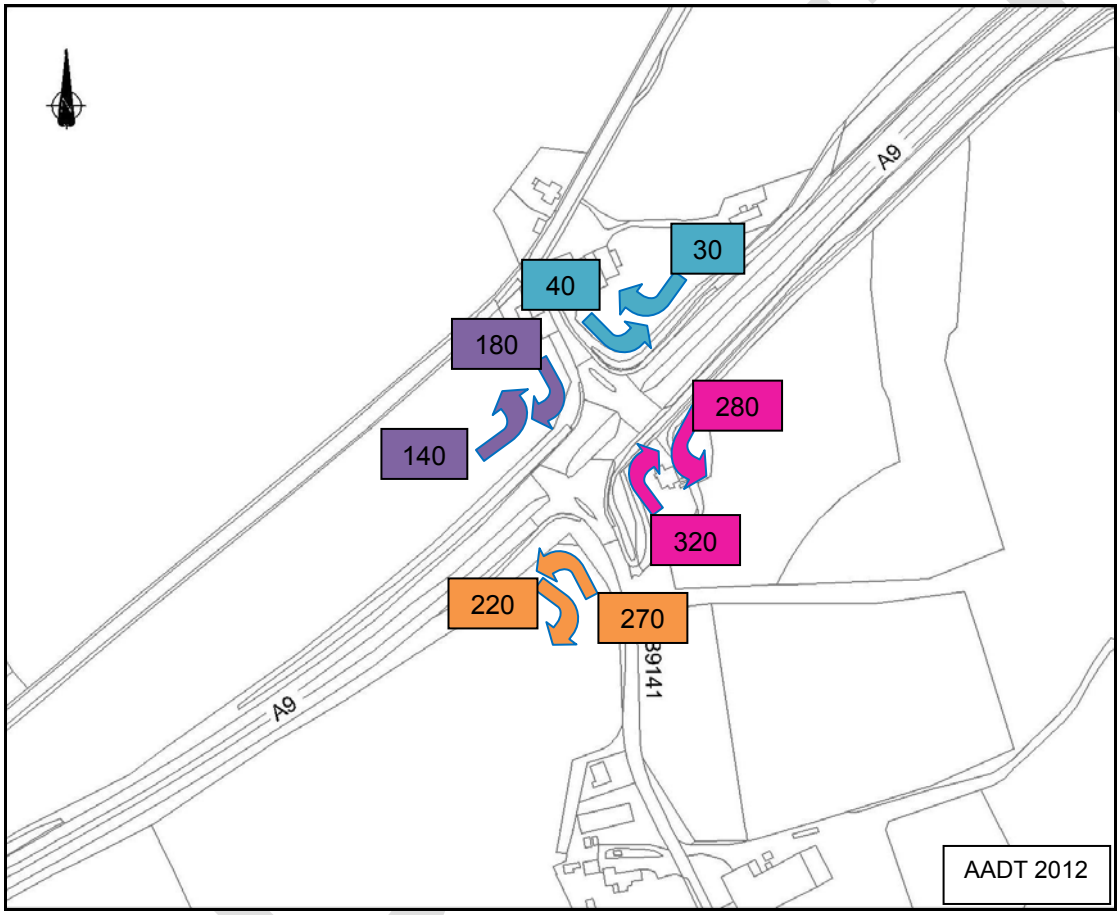

Figure 17 - Existing Road Layout at Findo Gask/Dunning Junction

Bus stops are present immediately after both junctions and a formal at-grade NMU crossing has been provided to allow pedestrians to cross the A9.

The Broom of Dalreoch has a low elevation at 16m above ordnance datum and slopes only slightly toward the nearby River Earn to the north east. The majority of the surrounding area is used as arable farmland to grow crops.

4.7.2 Topography and Land Use

The primary topographical and land use features within the Findo Gask study area are as follows:

- The junction on the north side of the A9 to Findo Gask consists of a slip road off, and a T-junction on to the A9;
- The junction on the south side of the A9 consists of a slip road off and a T-junction on to the A9;
- Construction of the A9 over the area of the junctions consists of low embankment;
- A flood relief culvert on a former channel of River Earn lies east of the junction;
- The site is situated in a rural environment with the surrounding land appearing to be used for agricultural purposes; this comprises mainly grazing;
- Several farms and houses are present locally particularly adjacent to the north junction;
- The local topography typically comprises low lying level ground with some shallow gradients; and
- The floodplain of the River Earn lies east of the junctions.

4.7.3 Geomorphology

BGS geological maps show the superficial deposits at the junction to comprise the following:

- River Terrace Deposits locally at the junction, containing gravel, sand and silt;
- A flood plain of alluvium running west-east associated with the River Earn;
- At the south edge of the A9, Glaciofluvial sheet deposits are present, containing gravel, sand and silt; and
- The junction lies just west of the terrace of the River Earn flood plain, which forms the buried valley, former river course and associated deep deposits of late glacial clays.

A geological plan extract showing superficial deposits is included in Appendix 8.

4.7.4 Existing Ground Investigation

A review of the BGS geo-index shows a series of boreholes associated with the existing road scheme. Information from the road scheme in this area shows its location within the buried valley of the River Earn. This has been infilled at depth with late glacial lake deposits, with sand and gravel deposits closer to the surface. Local alluvial sands are also present.

4.7.5 Other Features

- The River Earn is located around 450m north of the junction, and is aligned east west;
- Associated flood plain and former river channels are indicated between the junction and the river to the east; and
- The area overlies the buried valley of the River Earn, with relatively thin granular subsoils overlying deep deposits of laminated silty clays.

4.8 Forteviot

4.8.1 Site Description

The site is located on the A9 around 1.5km north of Forteviot. The B934 on the south side of the A9 is essentially a T junction and road construction of the A9 over the area of the junction's consists of low embankment. The main A9 route climbs the Cairnie Braes heading north-east out of the Earn valley on a sidelong embankment and the B934 runs steeply down the valley side between the A9 towards the River Earn below.

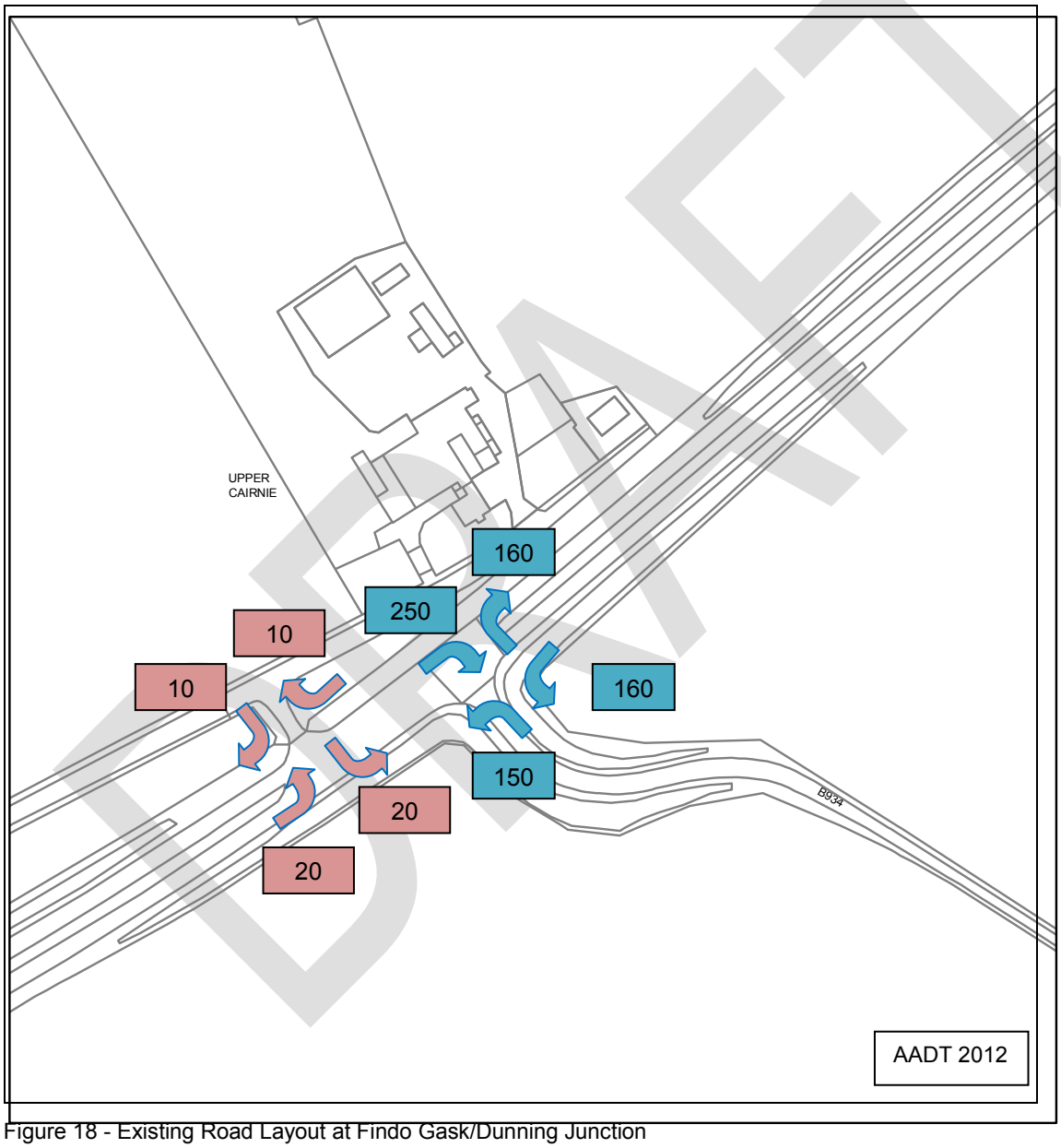

Figure 18 - Existing Road Layout at Findo Gask/Dunning Junction

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4.8.2 Topography and land use

- The site is situated in a rural environment with the surrounding land appearing to be used for agricultural purposes; this appears to mainly comprise grazing.
- Farms and some houses are present locally.
- The local topography forms part of the upper valley side and is relatively flat. To the north the surface comprises rolling ground forming the northern valley side of the Cairnie Braes.
- Westwards down the Carnie Braes, the A9 is formed in deep soil/rock cuttings comprising glacial till over sandstone (Old Red Sandstone Strata)

4.8.3 Geomorphology

BGS geological maps show the predominant superficial deposits at the junction to comprise Glacial Till.

A geological plan extract showing superficial deposits is included in Appendix 8.

4.8.4 Existing Ground Investigation

A review of the BGS Geo-Index shows a series of boreholes associated with the existing road scheme with indicate that soil/rock cuts occur to the west on the A9.

4.9 Windyedge Cottages

4.9.1 Site Description

Windyedge Cottages lie less than two miles south east of Broxden Roundabout. The private laneway to the south of the A9 leads to a single farm holding and agricultural land. The road leading north passes through the village of Tibbermore, 1.5 miles away, and subsequently meets up with the A85 Perth to Crieff road. The Windyedge Cottages study area is shown below

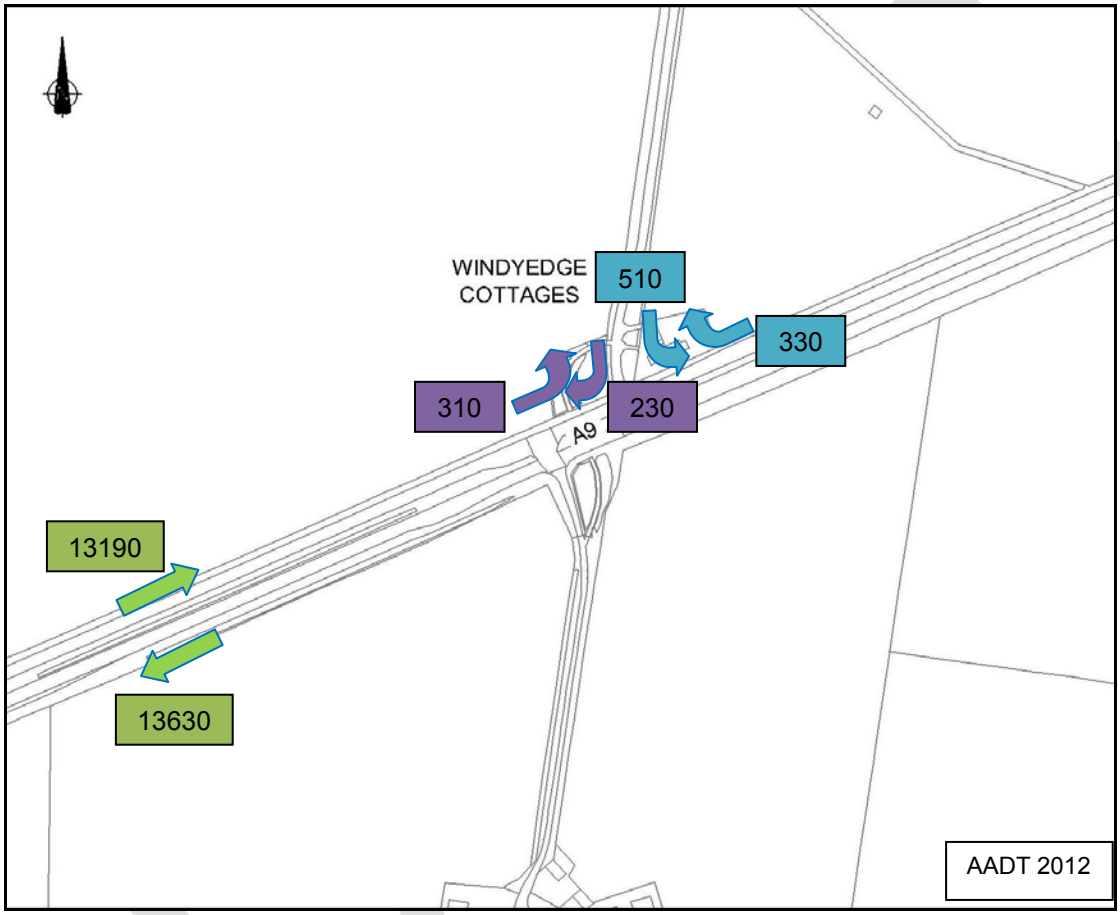

Figure 19 - Existing Road Layout at Windyedge Cottages

The two roads form a right left staggered crossroad junction to the A9 neither of which include a merge nor diverge lane. There is however gaps in the central median and right turning lanes accommodated within the central reserve to permit right turning manoeuvres.

A bus stop either side of the carriageway is located immediately after each junction and an at-grade NMU crossing permits the crossing of pedestrians. An agricultural underpass crosses the A9 at this location and allows agricultural vehicles access to the lands north of the dual carriageway.

The area surrounding Windyedge Cottages is relatively flat land with only a slight decline on the approach to the junction from the south west. In the locality of the junction the land is mainly used for farming crops however further to the north east, the arable farmland makes way for large areas of woodland on either side of the carriageway.

4.9.2 Topography and Land Use

The primary topographical and land use features within the Windyedge Cottages study area are as follows:

- The junction on the north side of the A9 to Tibbermore consists of a dual lane T-junction from a minor road – The Tibbermore Road on to the A9;
- The south side of the A9 has an access to Windyedge;
- A subway passes beneath the A9 under the footprint of the junction. This is presumed to be accommodation works for a farm underpass;
- Road construction of the A9 over the area of Windyedge junction consists of low embankment;
- The site is situated in a rural environment with the surrounding land appearing to be used for agricultural purposes; this appears to comprise mainly crop growing;
- Woodland and forestry are present to the north and south of the junction;
- A farm and some houses are present locally on the south and north sides respectively; and
- The local topography typically comprises level ground with any gradients being shallow.

4.9.3 Geomorphology

BGS geological maps show the predominant superficial deposits at the junction to comprise glacial till. Maps indicate instances of rock (sandstone) at or near surface in the area.

A geological plan extract showing superficial deposits is included in Appendix 8.

4.9.4 Existing Ground Investigation

A review of the BGS Geo-Index shows a series of boreholes associated with the existing road scheme.

4.9.5 Other Features

West of the junction, at Crossgates, the A9 traverses deep rock cuttings with relatively thin soil cover.

The sandstones are understood to be aquifers, as indicated by a number of wells in the area.

4.10 Minor Road and Access Treatment

Under the proposed strategy set out in Chapter 3, major junctions on the A9 would be fully grade separated, and all median gaps closed. This is in line with the recommendations in TD9 for a Category 7A Dual Carriageway.

For a 7A Dual Carriageway, TD9 also recommends that minor side roads shall be stopped up, provided with left in/left out connections, or grade separated without connection. Isolated existing accesses are permitted, again operating as left in/left out only.

There is currently a high level of direct access to the A9 with 76 C Class, Unclassified Roads, Agricultural and Private Accesses over the 40km section. Once any proposed locations for grade separation have been established, consideration can be given to reducing the number of junctions and accesses to the A9.

This can be achieved in a number of ways:

- tying minor roads and accesses into nearby junctions.
- rationalising side roads and accesses to reduce the overall number on the A9
- closing up minor roads and accesses where suitable alternative routes/accesses exist.

Parallel access lanes may be required to collect and connect minor accesses where they are situated in relatively close proximity to existing or proposed grade separated junctions.

There may be instances where it will not be feasible to gain access via the local road network, provide connection to a Grade Separated Junction, or collect with other minor accesses into a Left in Left out (LILO) junction. In these instances, it may be appropriate for the existing access to remain as a single isolated LILO access.

The proposed treatment of minor roads and accesses will be dependent upon identifying those junctions where it is appropriate to provide grade separation, and therefore specific treatments have not been considered at this stage of assessment.

4.11 Laybys

The standards for laybys are contained in TD69 of the DMRB which, for a dual carriageway recommends that Type A laybys be provided at 2.5km spacing. TD69 also recommends laybys be located a minimum of 1km before and beyond any grade separated junctions.

There are currently a total of 28 laybys on the A9, of which only two are Type A, the remainder being the lower standard Type B layby.

It is recommended that a review of laybys be undertaken following identification of junctions for grade separation, and consideration be given to upgrading existing Type B lay-bys to Type A, or constructing new Type A lay-bys along the route.

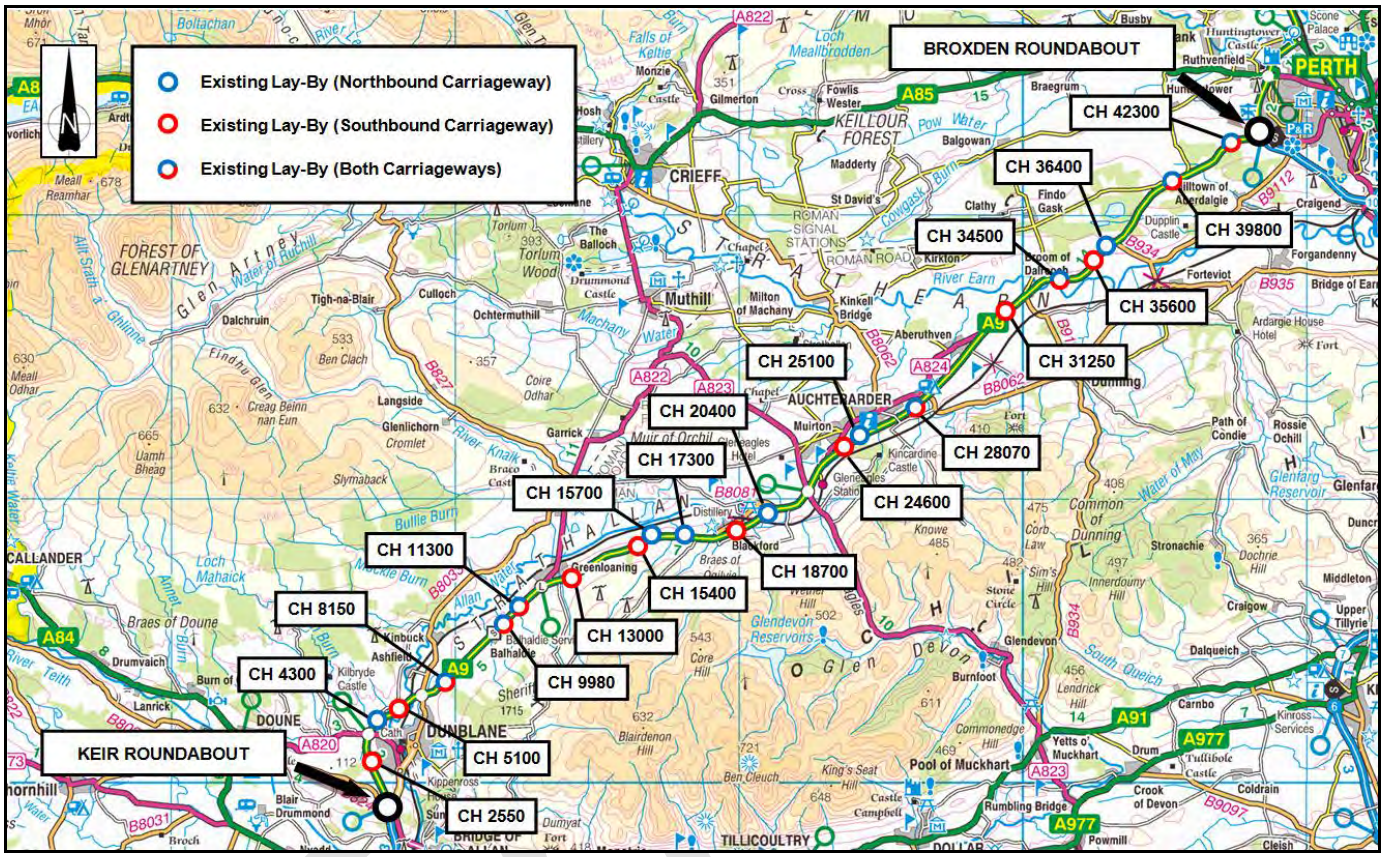

Figure 20 - Existing Layby Locations

4.12 Use Of Existing Grade Separated Junctions And Any Other Planned Improvements

4.12.1 Gleneagles Station Link Road

Gleneagles Railway Station is currently accessed via a priority junction on the southbound carriageway of the A9. The current junction arrangement facilitates left in and left out movements from the southbound carriageway; and a gap in the central median permits vehicles to turn right into the station access from the northbound carriageway. The median gap has been formed to restrict right turn movements from the access onto the northbound carriageway; instead vehicles are directed to turn left and access the northbound carriageway via the Loaninghead Interchange, just under a kilometre away.

Perth and Kinross Council (PKC) are currently promoting a scheme to close the existing access and median gap on the A9 and provide a direct link from the rail station to the Loaninghead Interchange via a new road running parallel with, and to the south of the A9. This scheme will also include the closure of a nearby farm access and median gap on the A9.

It is anticipated that this scheme will be delivered by the summer of 2014 and as such the access from the railway station onto the A9 has not been considered as part of this assessment. Nevertheless, based on the proximity of the junction to the Loaninghead Interchange, the nature of the access, and volume of traffic using it, the PKC scheme corresponds with the anticipated measures when assessed in relation to the A9 Junction Strategy.

4.12.2 Loaninghead Interchange and A824 Junction

The proximity of the A824/A9 junction to the Loaninghead Interchange would mean that the provision of a grade separated junction here would result in limited weaving length between junctions, which would not be within standard. A Grade separation junction between the A9 and the A824 at Auchterarder has not be considered as part of the assessment in Chapter 3.

However, any future assessment should give consideration to an additional link connecting the A824 at Auchterarder with the Loaninghead Interchange via an overbridge to the A9. This would tie into the new link from Gleneagles Railway Station to the Loaninghead Interchange. It would offer wider benefits particularly with respect to public transport improving integration by taking buses directly past the railway station.

4.12.3 Shinafoot Junction

The B8062 passes under the A9 midway between the towns of Auchterarder and Aberuthven via the Shinafoot Underpass. The Auchterarder Development Framework published by PKC in 2012 establishes a series of trunk road interventions to be provided based on the construction of new houses. Over 200 houses have been constructed to date, and the next intervention is required on the construction of the 500th house. This will consist of the provision of merge and diverge slips on the southbound carriageway only, allied with minor alignment improvements to the B8062.

The analysis undertaken to ascertain the need for grade separation (described in Chapter 3) included testing of a junction at Shinafoot and found that it offered similar, if slightly less benefits to a junction at Aberuthven. The spacing would not preclude the grade separation of both, however it is recommended that further analysis be undertaken to establish the most suitable location for grade separation which will deliver best value for money.

4.12.4 Proposals to the West of Broxden Roundabout

The scope of this DMRB Route Study covers the section of the A9 between Keir Roundabout and Broxden Roundabout. A Part 1 STAG Appraisal is being undertaken concurrently considering the road issues around Perth, and some of the options generated as part of this process have the potential to impact upon any proposals on the A9 to the west of Broxden Roundabout. Furthermore, it is understood that the development of the land to the north-west of Broxden Roundabout for housing may include the provision of a new Grade Separated Junction to the A9 at a location between Broxden Roundabout and Windyedge Cottages.

Therefore, whilst this DMRB Route Study considers the provision of a new Grade Separated Junction at the Windyedge junction, this should be kept under review taking account of any further developments in relation to the STAG 1 Appraisal, and the development of land to the north-west of Broxden Roundabout.

4.13 Other Potential Route Improvements

The more significant potential interventions for this section of the A9 between Keir Roundabout and west of Broxden Roundabout are outlined above. There are a number of other improvements which fall under the remit of this study and these are outlined below.

It should be noted that BEAR Scotland is currently acting as operator for this section of the route and is responsible for maintenance on this part of the A9. Furthermore, as operator, BEAR has and continue to monitor the safety record on the A9, identifying locations or sections with a significantly poor record by way of the Moving Cursor Programme, and implementing specific collision mitigation measures as appropriate. This report does not consider maintenance issues or minor improvement schemes.

4.13.1 Provision of Hard Strips

As noted before, the existing hard strip provision varies along the length of the route. A 1m wide hard strip to both the near and offside of each carriageway would be the minimum requirement for a Category 7A dual carriageway. However, there are significant lengths of the A9 where the existing hard strip is significantly narrower, in the order of around 200mm to 300mm.

The introduction of hard strips in line with current standards should have a significant positive impact on driver stress along the route and it is recommended that further consideration be given to this as part of any wider improvement scheme.

4.13.2 Improvements to Existing Merge/Diverge

Of the existing grade separated junctions, the merge and diverge tapers at Queen Victoria Slips would not satisfy the DMRB standards of new construction. To maintain consistency along the route it is proposed to upgrade the merge and diverge tapers at existing junctions to bring into line with the DMRB.

4.13.3 Opportunities to facilitate NMUs

Opportunities to provide enhanced facilities for non-motorised users should be considered as part of any wider route improvement scheme. NMU facilities should be incorporated into any new grade separated junction and improvements elsewhere on the network should be enhanced where there is a demonstrable need.

4.13.4 Improvements to Access/Egress at Services

The existing services northbound and southbound at Balhaldie, and at Loaninghead are all served by what would be considered substandard access and egress provision based on the likely existing or potential daily traffic movements into and out of each site.

None of the site provides any merge provision on egress, and the diverge provision at Balhaldie Northbound and Loaninghead is significantly less than the desirable length set out in TD42 of the DMRB. The diverge taper length at Balhaldie Southbound would satisfy the desirable length set out in the DMRB, but the proximity of a private access immediately preceding it is likely to result in conflicts between decelerating and accelerating vehicles.

A proliferation of accesses on both sides of the carriageway at Balhaldie adds further to driver confusion and increase the potential for collisions, and any improvements should seek to rationalise accesses into a single junction on each carriageway.

Similarly the exit from Loaninghead Services is directly before the off-slip at Loaninghead Interchange, which again leads to conflicts between vehicles turning onto and off the A9. The presence of a stone wall at this exit reduces visibility and the radii on exit would appear to be inadequate for the HGV movements, evidenced by the extensive kerb damage at this location.

The costs of the improvements to the access/egress to existing services would be comparatively low in nature compared to other interventions along the route, and again these improvements could be considered as part of any future scheme.

4.14 Public Utilities

Consultations show that there are several utility companies that may be affected by the proposed improvement works within the A9 study corridor. Up to date drawings showing the locations of any services and equipment were acquired from seven utility companies who were found to operate in the area.

The utility companies and statutory authorities include; British Telecom, Cable & Wireless, National Grid, Scotia Gas Networks, Scottish and Southern Energy, Scottish Water and Virgin Media.

4.14.1 British Telecom

Within the study corridor, underground British Telecom (BT) services generally run in the verge of the northbound carriageway between the Queen Victoria Slip Roads and Broxden Roundabout. There are however sections of the road where it crosses over and runs in the southbound carriageway verge. This occurs for about 2km just east of Blackford and again near Loaninghead Interchange. There is also a 4.5km section of road where the service runs in the southbound carriageway verge between Burnside Cottage and Broxden.

Underground services do not run along either verge of the mainline carriageway from Keir Roundabout to the B8033 overbridge north of Dunblane.

Underground service road crossings of the mainline carriageway occur frequently at minor road junctions and accesses, serving commercial and residential buildings.

There are approximately 52 locations where underground services cross the A9 mainline with additional crossings at existing and proposed grade separated junction locations. Overhead services are also present within the study corridor.

A more in depth assessment of the type and location of these BT services will be undertaken during the Stage 2 assessment phase. It will be necessary to establish the impact, if any, of the proposed improvement works on BT services in the area in order to establish and put in place protective and diversionary measures.

4.14.2 Cable & Wireless

After discussion with Cable & Wireless, it was found that they have no apparatus within the study corridor between Keir Roundabout and Broxden. However, records show that Cable & Wireless have leased network within the study area but do not have as built records of this information shown on any drawings..

4.14.3 National Grid

National Grid's gas utilities should not be affected by the proposed A9 improvement works from Keir Roundabout to just south of Broxden. At their closest point, the gas mains pass approximately 120 metres east of the proposed works boundary at the Doune Road overbridge near Dunblane. It also comes within 250 metres of the proposed boundary approximately 500 metres north of the Doune Road overbridge.

North of Dunblane, the mains generally follow a north easterly direction on route to Aberdeen passing a safe distance from the A9 study corridor. It crosses the A9 just North of Luncarty, however, this is out with the proposed works boundary.

4.14.4 Scotia Gas Networks

Scotia Gas Network services are encountered in the study area of the A9. There are four occasions where the gas main crosses the mainline carriageway.

A medium pressure gas main crosses the A9 over a central median gap near Dunning Road, Aberuthven. The gas main may potentially be affected due to the proposed closure of central median gaps and the provision of safety barriers at this location.

Another medium pressure gas main crosses the junction of the A9 dual carriageway at Keir Roundabout and goes on to cross the B824 and the B8033 roads on either side of the A9. Disruption is likely at this location due to the proposed grade separation of Keir Roundabout connecting the M9 motorway and the A9 dual carriageway.

It is envisaged that the remaining two crossings, a medium pressure gas main crossing south of Old Doune Road footbridge and a low pressure gas main crossing on the B8033 overbridge north of Dunblane, would not be affected by the proposed works.

4.14.5 Scottish and Southern Energy

An extensive network of Scottish and Southern Energy utilities exist in the study area consisting of low, high and extra high voltage cables/lines.

Plans indicate there are 37 buried low and high voltage cables which cross the A9 mainline. Within the road boundary, there are small sections of road where buried cables run in the verge parallel to the carriageway. Some of these utilities will likely be affected by the proposed improvement works on the A9 and plans should be put in place for protective and diversionary measures. However, the extent of disruption will depend on the final location and layout of the proposed compact grade separated junctions, the provision of alternative access lanes and any additional works to the existing carriageway.

Five extra high voltage (EHV) overhead lines cross the A9 carriageway at various locations along the scheme, however it is not thought at this stage that the lines will be affected by the proposed improvement works.

4.14.6 Scottish Water

Records from Scottish Water show that there is existing apparatus present in the A9 study corridor. Water mains were found to cross the A9 mainline at 22 locations along the route and further crossings of side roads connecting the A9 were also identified.

In addition to these crossings, water mains were found to run parallel and close to the mainline carriageway on several sections of the route, including areas where compact grade separated junctions are proposed.

A large diameter water main crosses the mainline at the junction to the A9 dual carriageway at Keir Roundabout. This water main may potentially be affected by the proposed flyover of Keir Roundabout and it is likely that plans to mitigate this disruption will need to be considered.

It is noted that a water works is located just east of Roman Road junction however it should not be affected by the improvement works.

Scottish Waters sewage network briefly runs alongside a layby adjacent to the mainline carriageway just south of Auchterarder. There are no road crossings for foul or storm sewage systems and it is thought minimal disruption will be encountered.

4.14.7 Virgin Media

After consultation with Virgin Media it was determined that none of their services cross or come close to the study corridor between Keir Roundabout and Broxden.

4.15 Existing Road Pavement and Structures

The condition of the existing road pavement on the trunk road network is measured every two years and entered onto the Scottish Executive Road Information System (SERIS). The skid resistance and structural strength of the pavement is measured and recorded on the SERIS database. Sections that do not exhibit satisfactory performance levels are identified for further site investigation to ascertain what improvements may be required.

BEAR Scotland, as operator of this section of the A9, are responsible for the management and ongoing maintenance of pavements and structures along the route. BEAR's duties include carriageway and bridge inspections; routine carriageway and bridge repairs; and carriageway reconstruction and resurfacing.

Due to the nature and objectives of this route study, and BEAR's responsibility for pavement and structure inspection and repair, this report does not consider these aspects unless it directly affects the specific route interventions discussed further in this chapter.

4.16 Flooding

Scottish Environment Protection Agency Flood Maps has been reviewed to identify areas that may be affected by flooding. SEPA advises that the scale of a flood can depend on a variety of things including:

- the amount of rain and how quickly it has fallen;
- the conditions in the area around the river, known as the catchment, such as how hilly or vegetated an area is and how dry or wet the ground is, can affect how much rain soaks into the ground and how much water runs directly into the river;
- if there is a particularly high tide; and
- if there is a tidal surge or waves caused by strong winds and currents.

The Flood Map provides an estimate of the areas of Scotland with a 1 in 200 or greater chance of being flooded in any given year.

Drawings indicating the potential flood mapping along the route are contained in Appendix 9.

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5 Environmental Assessment

5.1 Introduction

In accordance with the DMRB, AECOM have undertaken an initial assessment within the environmental impact assessment (EIA) process to decide which environmental topics are to be examined in statutory and non-statutory EIAs and to determine the data, survey needs and level of effort required. The findings of this scoping exercise are summarised in this chapter.

The scoping exercise has considered the route corridor as a whole, but where appropriate makes reference to the specific locations where grade separation may be considered.

5.2 Air Quality

The proposed junction improvements have the potential to cause temporary localised dust nuisance during construction. This deposition would hold particular significance for any residential properties located close to the proposed junction upgrade sites. Other than these residential areas, nuisance is unlikely to have significant impact due to the rural nature of the study area. Exhaust emissions from construction vehicles will also impact on local air quality during the construction phase. However, the total number of construction vehicles using the local network is anticipated to be small compared with normal traffic flows. Both potential impacts are likely to be mitigable through best practice.

During operation, the closure of a number of minor T-Junctions/median crossovers on A9 between Keir roundabout and Broxden roundabout could result in a slight increase in traffic flows if vehicles have to travel further. However, any increase is expected to be very small. The creation of six grade separated junctions is likely to result in less queuing at those junctions as the grade separation should result in free flowing traffic. This should be beneficial to local air quality due to the reduced congestion but the effect is expected to be very small. Widening of the existing grade separated junction at Greenloaning should provide greater capacity which would be beneficial to reducing congestion and local air quality. However, the effect is expected to be very small.

There is not expected to be any change in air quality in the Perth AQMA as a result of the scheme. However, traffic data is required to quantitatively assess the change in local air quality and greenhouse gas emissions. A DMRB simple level assessment will be carried out using the DMRB screening method for local and regional effects.

5.3 Cultural Heritage

Data was collected from The Perth and Heritage Trust Historic Environment Record (HER) and the Royal Commission on Ancient and Historic Monuments Scotland (RCAHMS) online sources in order to carry out a scoping study for proposed junction developments on the A9 between Dunblane and Perth.

The results of the study show that there are 198 recorded heritage assets within 500m of the eight junction locations. This includes 14 Scheduled Monuments and 22 listed buildings. There is the potential for unrecorded archaeological features to survive, particularly in the area surrounding the proposed junction to the south of Auchterarder.

It is recommended that a simple assessment following DMRB guidance should be undertaken.

5.4 Landscape Effects

The landscape of the study area is considered to be of a relatively high quality due to the intactness of its features and presence of designated landscapes and features such as Areas of Great Landscape Value (AGLV), Gardens and Designed Landscapes (GDL) and Ancient Woodland. The area, with its rolling hills and valleys, is scenically attractive, with few detractors.

Despite this, the proposals are not anticipated to introduce any significant effects on landscape character, due to the relatively localised nature of the proposals within an existing road corridor. Where the proposals occur within or in close proximity to designated landscape, care will need to be taken to ensure that important landscape features and views of the designated landscapes are preserved.

Visual effects are likely to occur where high sensitivity residential receptors are in close proximity to the proposals, where new structures become apparent in views or close off existing views. Potentially significant effects may occur, although in the long term mitigation measures may reduce these to non-significant levels.

Cumulative effects in specific locations and visual effects on individual or specific groups of receptors would be considered as part of the Stage 2 Assessment.

5.5 Ecology & Nature Conservation

The proposed A9 upgrade development has the potential to adversely affect a number of habitats that appear to be mainly of low conservation interest. Road improvements do however have the potential to adversely affect hedgerows and trees along the route of the A9 in addition to indirect impacts upon statutorily designated sites. A final objective assessment of the conservation value of the area will be made at Stage 2 once detailed surveys as outlined above have been undertaken. Measures need to be taken to prevent sediment run-off into watercourses, in particular the River Teith, and drainage ditches within the Study Area during road improvements.

A number of protected species are considered likely to be present within the Study Area, surveys will be required to establish their presence and any potential direct and indirect impacts from the proposed junction improvements.

At this stage, it is not possible to objectively discuss the likely effects of the proposed scheme. However, preliminary desk based information reviewed would indicate that the conservation and ecology of the habitats adjoining the existing road are of low to medium quality and providing that best practice is followed with regards to construction activities then the impact of the proposed scheme should be not significant.

5.6 Geology & Soils

This preliminary assessment of the baseline geo-environmental conditions has identified that potential adverse impacts may occur during the construction and operational phases of the proposed scheme. At this stage, it is considered that the risk of encountering contamination in the study area is low. However, once a preliminary design is provided, a further desk study and potentially intrusive ground investigation should be undertaken to more fully characterise ground conditions, determine the severity of potential adverse impacts and identify mitigation measures.

5.7 Materials

Due to the size of the Development and the expected works that will be required to be undertaken, there are potential impacts as a result of the materials to be used during the construction, where material use will be greatest, and the operational phases of the Development.

Materials that are of greatest concern are aggregates, concrete and the production and management of waste material produced from construction. A Simple Assessment is required to determine the significance of the impacts from these materials on the surrounding environment, with particular consideration of the various water bodies and ecological designated sites within the study area. The likelihood of these potential impacts is expected to be decreased significantly by the production and undertaking of several site-based management plans, therefore reducing the significance of these impacts.

From initial desk-based survey work carried out on the study area, there are a number of sensitive receptors with the potential to be affected as a result of the use and storage of materials on the Development construction site. Further to these potential impacts, the project exceeds the £300,000 threshold set within the DMRB Interim Advice Note 153/11 that requires the project to be subject to at least a Simple Assessment.

Additional information required in order to complete the Simple Assessment, as per DMRB Interim Advice Note 153/11, includes site preparation and construction works, quantities of materials required for the project, estimate quantities of waste material anticipated and the source or origin of the materials used.

5.8 Noise & Vibration

A qualitative assessment of the noise and vibration impact from the proposed improvements at seven locations along the A9 Keir Roundabout to Broxden Roundabout where grade separated junctions are proposed was undertaken. This assessment concluded that at the majority of the sites it is unlikely that noise levels will increase at noise sensitive receptors within the study area, which exceed the short term day time noise threshold levels or the long term day and night noise thresholds. This conclusion assumes that traffic flows using the proposed junctions will be a magnitude lower than traffic flows on the A9 (i.e. less than 10%) and so for the following proposed grade separated junctions a Simple Assessment need only to be carried out at this stage:

- Greenloaning
- Blackford
- Auchterarder
- Aberuthven
- Findo Gask
- Windyedge Cottage

At the Keir Roundabout, where the proposal includes moving the whole carriageway closer to noise sensitive receptors that are located on the northbound carriageway, noise threshold levels in the short and long term are likely to be exceeded and a Detailed Assessment needs to be carried out.

It is not expected that any of the noise sensitive receptors in the vicinity of any of the proposed road improvements will be affected by vibration effects from traffic, either ground borne or from low frequency noise, providing there are no road surface irregularities or the gradients of the overbridges are such as to cause HGV's to change down in gear.

At this stage only noise and vibration impacts relating to the operational use of the proposed development is considered. Noise and vibration impacts relating to the construction of the proposed road improvements will be dealt with at later stages of the assessment.

5.9 Effects on All Travellers

The A9 between Keir Roundabout and Broxden Roundabout is a long established corridor and does not sever any of the communities along the route in of themselves. Communities located to the north of the A9 do however experience a degree of severance with the rural countryside to the south. Recreational walkers, cyclists and equestrians also experience a degree of severance, although, it should be noted that rivers and the railway also contribute to severance.

The effects on all travellers are minimal because the A9 is long established and the proposals do not include any sections of new alignment.

The proposals to grade separate junctions will provide additional amenity for pedestrians, cyclists and equestrians by providing a safe manner in which to cross the A9 without interacting with it. However, journey lengths, depending on the location and design, may increase slightly.

The proposal to grade separate Keir Roundabout will increase amenity for pedestrians and cyclists, from Bridge of Allan especially, by removing the interaction with the A9.

Proposals to close central reservations will have an effect on low numbers of pedestrians, cyclists and equestrians but if no alternative provision is made for these users then severance with the countryside and journey length will both be increased.

The view from the road for the majority of the route will remain unaffected by the proposals. The exceptions to this will be the introduction of a grade separated junction at Findo Gask which will have an adverse effect on the view from the road over short sections.

The levels of driver stress, for both drivers on the A9 and drivers joining the A9, will be reduced at localised sections as a result of the introduction of grade separated junctions and the closing of central reservations.

5.10 Community & Private Assets

The proposed closure of central reserves and installation of grade separated junctions on the A9 between Keir and Broxden roundabouts are likely to require land take from the surrounding areas of the new junctions. This land is predominantly going to be taken from agricultural land of moderate productivity, with additional areas of forestry, open space and private land (both residential and industrial) also required.

Where work is required at urban areas, there is also the potential for areas of community land to be taken and an indirect impact on users of the community facilities within the villages through reduced or altered access during periods of construction. However, these impacts are predicted to be minor and many of them will also be limited to periods of construction.

5.11 Road Drainage and the Water Environment

Along the study area of the A9 between Keir and Broxden roundabouts, there are several watercourses that cross or run parallel to the A9 route and are therefore subject to potential adverse impacts as a result of the Development. According to the DMRB, Volume 11, Section 3, Part 10 guidance, due to the developments potential to “affect several existing watercourses” and alter the type of junctions along the course of the route, the Development is subject to further assessment to determine the likelihood and potential significance of these impacts.

There are several particular aspects of the water environment within the study area that are likely to be sensitive receptor sites for adverse impacts from the Development, including the two SSSI, RSPB and RAMSAR designated sites, and the fresh water fish populations that are supported within the surrounding surface water bodies. There is also the potential for further intrusion in to the water environment from new or increased road sections that cross the various watercourses at Greenloaning and Blackford villages and the B8062 junction.

Before mitigation or any detailed design, it is likely that there will be a significant impact on the water environment within the study area as a result of the Development, in regards to the sensitivity of the receptors (supporting fresh water fish populations, and being of national and international importance for the support of other wildlife), the likely invasive requirement of building over or in proximity to watercourses, and the scale and nature of the Development in changing the type of junctions on the A9 trunk road. Therefore at least a simple assessment will be required following further design detail to determine the significance of the aforementioned impacts. However, it is considered likely that with appropriate mitigation the impacts will not be significant.

5.12 Consideration of Cumulative Effects

A full assessment of cumulative impacts will be undertaken at design stage 2. This will include a consideration of planning applications in the study area, as well as impacts to other roads works in the area.

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6 Traffic & Economic Assessment

6.1 Introduction

This section describes an outline economic assessment of improvements to the A9 between Keir Roundabout and Broxden Roundabout. Existing traffic conditions are described in detail in Chapter 2, and an assessment of the traffic impact of various scenarios is dealt with in Chpater 3.

Whilst only very broad recommendations are put forward in this report with respect to proposed improvements to the A9, it was nevertheless deemed reasonable to undertake a preliminary economic assessment of a potential scenario comprising the interventions described in the previous chapters. The scenario tested was suitably conservative to ensure a robust assessment.

6.2 Economics

Guidance on the appraisal of road schemes in Scotland is set-out in DMRB Volume 5, "SH 1/97 - The Traffic and Economic Assessment of Road Schemes in Scotland". Economy is also one of Transport Scotland's five STAG (Scottish Transport Appraisal Guidance) criteria. The Economy criterion itself has three sub-criteria. Together, these provide a full assessment of the impacts of a scheme on the economy. The sub-criteria are:

- Transport Economic Efficiency (TEE) covers the benefits ordinarily captured by standard cost-benefit analysis – the transport impacts of an option;
- Wider Economic Benefits (WEBs) relate to the notion of potential transport impacts on agglomeration and the relationship between agglomeration and productivity. Further guidance can be found in the STAG Technical Database and practitioners should note that it is likely that appraisal of this sub-criterion should only be completed in Part 2 Appraisal; and
- Economic Activity and Location Impacts (EALIs) allow the impact of an option to be expressed in terms of the net effects of the option on the local and/or national economy.

This section focuses in particular on TEE, the economic assessment of a transport scheme based on a comparison of the total benefits generated by the scheme with its total associated costs. The following three elements have been considered in the assessment of the scheme:

- The impacts of the scheme on road collisions in the study area: estimated using NESA 10 methodology and changes in traffic levels forecast by the traffic assignment model. Travel demand data has been appropriated from the Transport Model for Scotland (TMfS07);
- The impacts of the scheme on travel times and costs for trips affected by the scheme together with the associated impacts on revenue and indirect tax levels have been estimated using the NESA program; and
- The capital costs associated with the scheme. An allowance has also been made for optimism bias and risk.

Forecast costs and calculated benefits have been combined to produce an overall estimate of the balance of the costs and benefits of the scheme over a 60-year appraisal period. 2025 has been selected as the opening year of the scheme as it is assumed that all proposed works in the corridor will be completed to coincide with completion of the A9 Dualling Project (Perth to Inverness).

6.2.1 Elements of the Assessment

The following sections outline the approaches used to estimate the value of schemes costs and benefits.

6.2.1.1 Assessment of Safety Impacts

The impact of the scheme on the number of collisions in the study area has been estimated using NESA 10 methodology for calculating combined link and junction collision numbers and costs.

The estimated value of impacts for the forecast years has in turn been converted into an estimated Net Present Value (NPV) of collision savings in 2002 prices and values over a 60-year appraisal period (2025 – 2084).

6.2.1.2 Assessment of Travel Times and Costs

Within the NESA program, the benefits experienced by road users are split broadly into two categories:

- Consumer User Benefits: Benefits for those road users who are not travelling on the road for primarily business purposes (typically commuting or non-work purposes); and
- Business User Benefits: Benefits for those road users who are travelling on the road primarily for business purposes (e.g. to meetings or road haulage).

Within NESA, each user is assigned a 'value of time' whereby, when a highway improvement is provided, the user enjoys a 'consumer surplus', i.e. in this case they travel along a section of road in a shorter amount of time, and therefore save money. This surplus or benefit is summed for all of the respective road users over the whole period of assessment and the total benefits calculated. Typically 'value of time' is much higher for business users in comparison to consumer users, and therefore business users benefit most from any such improvement.

6.2.1.3 Other Impacts Calculated

The other impacts calculated within the NESA program are detailed below:

- Private Sector Provider Impacts: Benefits for those in the private sector who operate on the road network (typically bus services);
- Collision Benefits: Benefits in terms of reduced number and severity of collisions in monetary terms (this will be one of the key sources of benefits with the anticipated savings from the reduction in the number and severity of collisions); and
- Change to Indirect Tax Revenues: Change in tax revenues to central government due to changes in fuel economy etc.

6.2.1.4 Assessment of Capital Costs

The various route interventions included in the test scenario, and the corresponding estimated cost are set out in Table 24 below:

	TOTAL CONSTRUCTION COST (£'000's)	COMMENTS
TEST SCENARIO	£69,730	Construction of 6no new GSJ (inc Keir Roundabout), 14km of parallel side roads, 9 new LILO, 24 new Type A laybys etc. Includes allowance for land costs.

Table 24 - Estimated Costs (Q4, 2012 Prices) [excluding Optimism Bias]

6.2.1.5 Allowance for Optimism Bias

Optimism Bias (OB) is defined as the systematic tendency for project appraisers to underestimate their scheme's cost (and therefore overestimate the strength of its economic case).

The NESA manual gives further guidance on the treatment of OB in a Scottish context. It states (Chapter 7: Part 6 Valuation of Costs and Benefits, Paragraph 7.18):

"For economic assessment of Scottish trunk road schemes, Scottish Executive advice with regard to Optimism Bias is that Total Scheme Costs (TSC) should generally have an Optimism Bias of +25% applied and Works Duration an Optimism Bias of +10% applied. These values accord with historic available to the Scottish Executive and are generally considered acceptable for trunk road schemes with TSCs of up to £50m. For trunk road schemes with estimated TSC greater than £50m further advice and agreement must be sought from Scottish Executive as to the appropriate levels of Optimism Bias which should be applied."

As the overall total scheme cost at this stage of the project is greater than £50m then the guidance above has been deemed and agreed to not be applicable. Therefore in line with the guidance on appraisal and evaluation given in HM Treasury's Green Book, an allowance was also applied to costs to account for optimism bias. In line with this guidance, the cost estimate for the test scenario has been uplifted by 44% to allow for optimism bias. However, it is noted that whole scheme will not in all likelihood be implemented in a single phase and as such the various packages of work will be advanced on priorities and available funding. As these packages are brought forward, they are likely to be below the £50m threshold and so may attract the lower rate of OB.

6.2.2 The NESA Analysis

The NESA (Network Evaluation from Survey and Assignment) program compares the costs of providing road schemes with the benefits derived by road users (in terms of time, vehicle operating costs and collisions), and expresses the results in terms of a monetary valuation.

NESA 10 was used for the assessment. The essence of NESA is that the travel cost for each component (link and junction) of the network is calculated separately according to the flows and turning movements assigned to it. The individual link and junction costs that are time, vehicle operating costs and collisions are summarised to yield the total costs over the network.

The benefits are calculated for the assessment period of 60 years, which is in accordance with DMRB Volume 5, "SH 1/97 - The Traffic and Economic Assessment of Road Schemes in Scotland", and are balanced against the construction and maintenance costs over the same period.

Carrying out a road scheme normally results in a stream of costs, followed by a stream of benefits associated with the improved flow of traffic and a reduction in collisions. This information must be compared to arrive at an understanding of the overall worth of the scheme. However they cannot simply be added as if they occurred simultaneously. Cost and benefits arising in different years are therefore expressed in terms of their 'present value' i.e. their value in a given year. This is called the present value year and in the NESA programme this is taken to be 2010.

The Net Present Value (NPV) of any scheme can be calculated by subtracting the Present Value of Costs (PVC) from the Present Value of Benefits (PVB). This figure is expressed as a 2002 price discounted from the current year to 2002. A positive NPV indicates that the benefits of the proposed scheme outweigh the costs indicating that a scheme is potentially economically viable. The assessment period is 2025 to 2084, with 2025 assumed to be the full opening year and 2084 assumed to be the final assessment year. These assumptions result in a 60-year assessment period, in accordance with current STAG guidance.

Environmental effects such as noise, changes in air quality, visual intrusion and severance are not evaluated in the NESA assessment but are covered in the accompanying environmental report.

6.2.3 NESA Inputs

The NESA assessment has utilised the following data and parameters:

- Typical 12 hour matrix of traffic movements between NESA model zones;
- Default collision data (with specific junction collision rates);
- Route based traffic composition; and
- Link and junction details for the Do-Minimum and Do-Something scenarios.

Construction and land costs have been input in multiples of £1,000 at 2012 Q4 prices. NESA calculates the equivalent costs in the present year value and allocates them to the correct year.

6.2.4 Transport Economic Efficiency Results

The Net Present Value (NPV) for the test scenario is provided in Table 25. In this instance the 'Core' traffic growth scenario has been assumed.

It should be noted that the cost estimates used within the NESA assessments include 44% Optimism Bias however this percentage should reduce as the proposed scheme moves through the appraisal process.

NESA ELEMENT	
Consumer User Benefits (£k)	55,160
Business User Benefits (£k)	48,920
Private Sector Provider Impacts (£k)	-230
Collision Benefits (£k)	62,940
Present Value of Benefits (PVB) (£k)	166,800
Present Value of Costs (PVC) (£k)	46,480
Net Present Value (NPV) (£k)	120,310
Benefit to Cost Ratio (BCR)	3.59

Table 25 - Detailed Transport Economic Efficiency (TEE) Results

6.2.5 Impacts on Public Accounts

The NESA analysis for the test scenario reveals that the proposed scheme should provide a positive impact on the public accounts. Whilst the Present Value of Costs (PVC) of providing the scheme is £46,980k, this is compensated for by a Present Value of Benefits (PVB) value of £166,800k. The benefits being derived from a combination of journey time savings from grade-separation of Keir Roundabout and collision savings from removal of all at-grade junctions.

6.2.6 Transport Economic Efficiency for Consumer Users

Consumer users are those who use a highway for reasons other than business, i.e. they could be commuters or those on leisure trips. Such users therefore typically have a lower value of time than business users and transport providers. The benefits identified for this scheme are £60,440k for the scenario tested.

6.2.7 Transport Economic Efficiency for Business Users and Transport Providers

Business users and transport providers are a key beneficiary of any highway improvement as a reduction in congestion or improvement in safety helps to bring about savings or an increase in productivity for their businesses. As such, their value of time is higher than for consumer users and this is reflected in this instance by a benefit of £48,920k for the scenario tested.

6.2.8 Reliability

This sub-objective summarises the proposal's impact on the objective to improve journey time reliability for transport users, including both passengers and freight.

For journeys by private road vehicles (including road goods vehicles), it is reasonable to expect travellers to be aware of the average journey time, including variations caused by factors such as different traffic conditions at different times of the day. Thus reliability should be measured in terms of the unpredictable variability in travel times about these averages, measured by the standard deviation of travel time.

At this early stage in the appraisal process, reliability is assessed on a qualitative rather than quantitative basis using measured and estimated journey times.

It is considered that for strategic traffic on the A9, journey time reliability will see an improvement as a result of the closure of the median crossovers which will eliminate queuing right turning traffic at junctions. The provision of a continuous central median barrier along the A9 between Keir and Broxden will reduce conflicts between emerging and strategic traffic which will improve driver confidence.

6.2.9 Wider Economic Impacts

Transport is a key driver of economic development, whereby transport investments can, in particular, affect the location and pattern of economic activity.

The proposed improvements to the A9 between Keir and Broxden will collectively enhance the attractiveness of the A9 corridor. The scheme will improve traffic conditions on the A9 by maintaining journey time reliability and improving safety. The A9 is already a key transport corridor and the proposed improvements will further enhance the attractiveness of the route.

A significant part of the benefits delivered by transport improvements is normally in the form of time savings to travellers. This time has a 'value' to travellers and therefore any saving in travel time induces a 'consumer surplus' or benefit for the user. These benefits to transport users are sometimes transferred to others. In theory, the time savings to firms will lead them to reduce prices and increase output – passing benefits on to those who buy their products. Time savings for commuters and others in an area might make this area more attractive to live in – so benefits are passed on to homeowners and landowners.

In summary, the wider economic impacts of a road scheme are determined by the improved local and strategic accessibility it may provide. In terms of strategic accessibility, the proposed scheme will enhance existing links between Dunblane/Perth and the principal settlements located to the north of the A9 carriageway. The scheme will also enhance the attractiveness of the area in general. In terms of local accessibility, the scheme will improve access for those using the A9 by making turning movements safer, which may have the effect of making the local area more attractive to live or locate a business in.

One of the disbenefits of the scheme will be the length of detours required which would appear to have an immediate impact on the cost of journeys. However it is considered that road users will determine suitable alternative detours once the scheme has opened, with these journeys being viewed as acceptable in order to benefit from the use of a high standard dual carriageway. A further analysis of detours, to include consideration of the impacts upon side roads and the potential for collision migration, may be undertaken at Stage 2.

6.3 Summary of Economy for Test Secnario

The Economic Appraisal of example scenario tested is summarised in Table 26.

NESA ELEMENT	TEST SCENARIO
Benefit to Cost Ratio (BCR)	3.59
Net Present Value (NPV) (£k)	120,310
Reliability	Slight Beneficial
Wider Economic Impact	Slight Beneficial
Present Value of Costs (PVC) (£k)	46,480

Table 26 - Economic Appraisal of Test Scenario

6.4 Summary of Economic Assessment

This chapter has examined the traffic and economic impacts of providing upgrades to the junctions and intermediate sections of the A9 between the Keir Roundabout and Broxden Roundabout. There is an evident need for the scheme arising from the observed collision rate on this section of the A9 as well as the delays for turning traffic that occur at the side road junctions. Even with the impact of the current economic downturn, it is forecast that volumes on the A9 will continue to increase year on year which potentially could further increase both collisions and delays leading to deterioration in the attractiveness of the route and increasingly unreliable journey times.

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For the purposes of the economic assessment, the impact of closing the central median crossovers has been assumed as an “A9 Only“ diversion scenario whereby traffic diverts using the A9 alone rather than via the minor road network. An economic assessment of the proposed scheme has been undertaken using the NESA software, within which the traffic forecast data has been utilised. It is considered that this has resulted in a robust assessment of the economic benefits of the scheme at Stage 1.

In this regard, the NESA assessment have shown that the example scheme (comprising the grade separation of 6 junctions including Keir Roundabout) generates a BCR of 3.59 and Net Present Value (NPV) of £120m (2002 prices) over the 60-year appraisal period.

7 Conclusions & Recommendations

7.1 Summary

The A9 forms the main road link between the Central Belt of Scotland and Inverness. The section of the A9 from Keir Roundabout at Dunblane to the west of Broxden Roundabout at Perth is dual carriageway for its full length and experiences problems arising from congestion during peak traffic hours at Keir Roundabout resulting in unreliable journey times. It also has a poor collision record resulting from the proliferation of median gaps which allow right turn manoeuvres onto and off the route. This contributies to a higher than average number of serious and fatal collisions.

STPR16 acknowledged these issues and proposed grade separation of all junctions along this section of the route, as part of the wider planned improvements to the A9 from Dunblane to Inverness.

This DMRB Stage 1 Preliminary Assessment considered a number of strategies to address these specific issues and to meet the study objectives:

- Make improvements to tackle congestion and support the promotion of journey times reductions on this section of the A9, particularly through Keir Roundabout;
- Reduce collision severity and the number of collisions on the A9 between Keir Roundabout and west of Broxden Roundabout.

A recent survey by route operators BEAR highlighted a significant queuing issue at Keir Roundabout resulting in delays of up to 15 minutes through the junction. The queuing that occurs at this junction during peak periods is thought to contribute to the significant number of shunt type accidents on the approaches. This assessment concludes that grade separation of Keir Roundabout should remain part of any strategy for dealing with the route going forward.

An assessment of strategies to deal with the remainder of the route concluded that closure of the median gaps without the provision of any new grade separated junctions would have resulted in:

- a significant increase in vehicle kilometres travelled;
- a significant increase in turning movements at the existing grade separated junctions and roundabouts; and
- would have resulted in unreasonable diversion lengths for some travellers.

This was not considered a reasonable approach and was discounted.

The provision of roundabouts in lieu of new grade separated junctions at existing major junctions along the route was also dismissed on the basis that they would have introduced delay into the road network. This would not have supported the objective of promoting journey time reductions.

The third strategy to deal with the section of the A9 beyond Keir Roundabout considered the provision of a number of grade separated junctions at various locations along the route. This assessment tested numerous scenarios to find a solution which would:

- Minimise the additional trip lengths;
- Reduce additional vehicles at existing junctions; and
- Provide travel time and accident benefits.

Numerous scenarios were tested comprising individual grade separated junctions for major side roads along the route as well as multiple combinations of these junctions from two to five. The tests provided an estimate of the total economic benefits that each scenario may accrue, as well as an estimate of the additional daily movements at existing grade separated junctions.

The assessment concluded that a minimum of at least three new grade separated junctions would be required to return a positive economic benefit, however in this scenario the additional traffic on existing grade separated junctions was estimated to be in excess of 1000 vpd at each. The inclusion of an additional grade separated junction into the scenarios tested elicited a

corresponding increase in the estimated overall total economic benefits. A greater number of new grade separated junction as a reduction in the additional vehicles at existing junctions.

The analysis undertaken confirmed that the closure of median gaps and the provision of new grade separated junctions along this section of the A9 could generate positive economic benefits. It is concluded that the third strategy considered in this report be taken forward for further consideration at subsequent stages of DMRB Scheme Assessment.

The work undertaken at this stage of the Scheme Assessment did not seek to confirm the specific number of locations of any new grade separated junctions. As a result, it has not been possible to determine the additional infrastructure (parallel side roads, minor road improvements etc.) that may be required for the scheme. Nevertheless, in the interest of assessing the economic viability of undertaking improvements to this section of the A9, a preliminary economic assessment was undertaken based on very broad and conservative assumptions regarding a potential scheme. The outcome of this assessment would suggest that an economically viable solution could be developed.

7.2 Recommendations

The assessment work undertaken at this stage has concluded that grade separation of Keir Roundabout, along with the grade separation of additional junctions between Keir Roundabout and Broxden Roundabout should be taken forward for further consideration as part of the Scheme Assessment process. A number of specific recommendations are made based on the outcomes of the work undertaken to date. These are as follows:

- Median closures would make a significant reduction on the severity of accidents by disallowing right turning traffic to and from this section of the A9. This should be taken forward as the basis of the scheme in a Stage 2 DMRB assessment;
- Construction of new grade separated junctions on the route will reduce the delays caused by banning right turns. Increasing the number of grade separated junctions on the route has an inverse exponential effect on the reduction of diversion kms. Further traffic and economic analysis is required to determine the number and location of these junctions;
- The only solution considered to address the STPRs aim of reducing journey times is to grade separate Keir Roundabout. This should be taken forward to the DMRB Stage 2 Assessment;
- Additional Topographical data should be obtained to allow a more detailed assessment of the existing road geometry, including the analysis of the vertical alignment and the visibility at junctions;

Once the optimum number and location of grade separated junctions has been determined, a strategy to rationalise the remaining existing junctions and accesses should be developed.

Appendices

Capabilities on project:
Transportation

Appendix 1 – Existing Road Features

Capabilities on project:
Transportation

Appendix 2 – Plan indicating sections of sub-standard geometry

Capabilities on project:
Transportation

Appendix 3 – Junction Geometry Review Schedule

Capabilities on project:
Transportation

Appendix 4 - List of Horse Crossing Points on the A9 between Keir Roundabout and Broxden Roundabout

List of Horse Crossing Points on the A9 between Keir Roundabout and Broxden Roundabout

1. Cotton to the Peel.
2. Windyedge to Tibbermore
3. Crossgates to the Gask Roman Road
4. B934 – Upper Cairnie
5. Dalreoch crossing
6. Strathy to Haugh of Aberuthven
7. Shinafoot Underpass
8. Milton Flyover
9. Auchterarder Underpass Nr Woodend
10. A823 Crossing
11. Blackford Entrance
12. Netherton underpass
13. Greenloaning and the Harperstone road
14. Kinbuck Flyover
15. Lower Auchinlay
16. Moon Cottage crossing
17. Doune and Dunblane showfield underpass.

No crossing point is provided however an need for a crossing point has been identified for horse riders at Woodside of Balhaldie..

Capabilities on project:
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Appendix 5 – Letter from CTC Scotland regarding cycling on A9 between Keir Roundabout and Broxden Roundabout

Capabilities on project:
Transportation

Appendix 6 –Plan indicating Edge of Pavement Details

Capabilities on project:
Transportation

Appendix 7 – Junction Flow Diagram

Capabilities on project:
Transportation

Appendix 8 - Geological Plans

Capabilities on project:
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Appendix 9 – Indicative Flood Maps