A27 Arundel Bypass Combined Modelling and Appraisal Report

30 August 2019

Notification made on 6th September: The Combined Modelling and Appraisal Report (ComMA) published on 30th August did not contain updates to the noise economic data. This version includes the updates. This affects: ComMA tables 3-11, 3-17, 3-22 to 3-27 and 14-17 to 14-23; and appendix E-7. No other consultation documents are affected. The ComMAs that were placed in deposit points on 30th August are also unaffected as they contained the updated noise economic data.

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1 Introduction

1.1 Purpose of report

1.1.1 The purpose of the Combined Modelling and Appraisal (ComMA) report is to inform decision makers and stakeholders on how the evidence underpinning the business case has been developed, from the initial identification of the underlying problem through the collection of data and the production of any supporting traffic models and the forecast impacts of the Scheme on traffic to the eventual economic appraisal. The ComMA report addresses how the analytical requirements, from the Analytical Requirements Report (ARR[1]), have been met through the approaches laid out in the Appraisal Specification Report (ASR[2]).

1.1.2 The ComMA is an 'end of stage' report, the intention of which is to comprehensively report all assessments, relating to traffic, economics and environment undertaken throughout the Project Control Framework (PCF) Stage. This ComMA presents information produced during PCF Stage 2 and PCF Stage 2 Further Consultation but supersedes the previous version of the report (May 2018). The ComMA compiles the contents of the following underlying PCF products:

- Transport data package
- Transport model package
- Transport forecasting package
- Economic appraisal package

1.1.3 The economic appraisal detailed within the ComMA assists decision-makers in:

- prioritising between schemes
- prioritising between options
- ensuring that value for public money is achieved

1.1.4 This report is based upon Highways England's PCF product description for the ComMA, dated 01 March 2019, version 5.

[1] A27 Arundel Bypass, Analytical Requirements Report (February 2019)

[2] A27 Arundel Bypass, PCF Stage 2 Appraisal Specification Report

1.2 Project background

1.2.1 The A27 is a strategically important corridor on the south coast, which is used by both long distance strategic traffic and local traffic alike. The Arundel section is one of a number of bottlenecks which causes delay and variable journey times due to the single carriageway alignments and the number and the layout of junctions.

1.2.2 The A27 Arundel Bypass is one of three Road Investment Strategy (RIS) schemes along the A27 which are being progressed by Highways England as part of a route strategy. The RIS announcement in December 2014 described the Scheme as 'a new dual carriageway Bypass, linking together the two existing dual carriageway sections of road'. The other schemes are the A27 Worthing and Lancing Improvements and the A27 East of Lewes.

1.2.3 Three scheme options for the A27 Arundel Bypass were developed during PCF Stage 2 and the public were consulted between August and October 2017. Further consideration was then given to how each scheme option could be improved, informed by feedback from the consultation. The preferred route for the A27 Arundel Bypass was announced as Option 5A (variant 3) in May 2018.

1.2.4 In October 2018, Highways England announced the decision to undertake a further consultation to give the public and stakeholders another opportunity to comment on the options proposed for the Scheme. Since the public consultation in 2017, there have been a number of further developments in the Scheme, including the redesign of the western tie-in for Option 5A.

1.2.5 The decision to consult again on options has resulted in the continuation of PCF Stage 2. During this stage, the Scheme is subject to review and further development. A range of options are considered during this stage, including but not limited to options 1, 3 and 5A (the options considered in the 2017 consultation).

1.2.6 Once the further scheme option development has been undertaken, transport appraisal is carried out, including forecast modelling, economic and environmental assessment. Further development and analysis of the Scheme may be carried out post-consultation to reflect any further design development.

1.3 Client scheme requirements

1.3.1 High-level objectives and more detailed objectives together with challenges, issues and constraints are included within the Client Scheme Requirements (CSR[3]) for the project described above. The high-level objectives are set out below.

High level objectives

1.3.2 Scheme objectives were developed whilst working with statutory consultees including the local authorities, South Downs National Park Authority, environmental bodies and the emergency services. The objectives of the Scheme are to:

- improve the safety of travellers along the A27 and consequently the wider local road network
- ensure that customers and communities are fully considered throughout the design and delivery stages
- improve capacity of the A27 whilst supporting local planning authorities to manage the impact of planned economic growth
- reduce congestion, reduce travel time and improve journey time reliability along the A27
- improve accessibility for all users to local services and facilities
- deliver a scheme that minimises environmental impact and seeks to protect and enhance the quality of the surrounding environment through its high-quality design
- respect the South Downs National Park and its special qualities in our decision-making

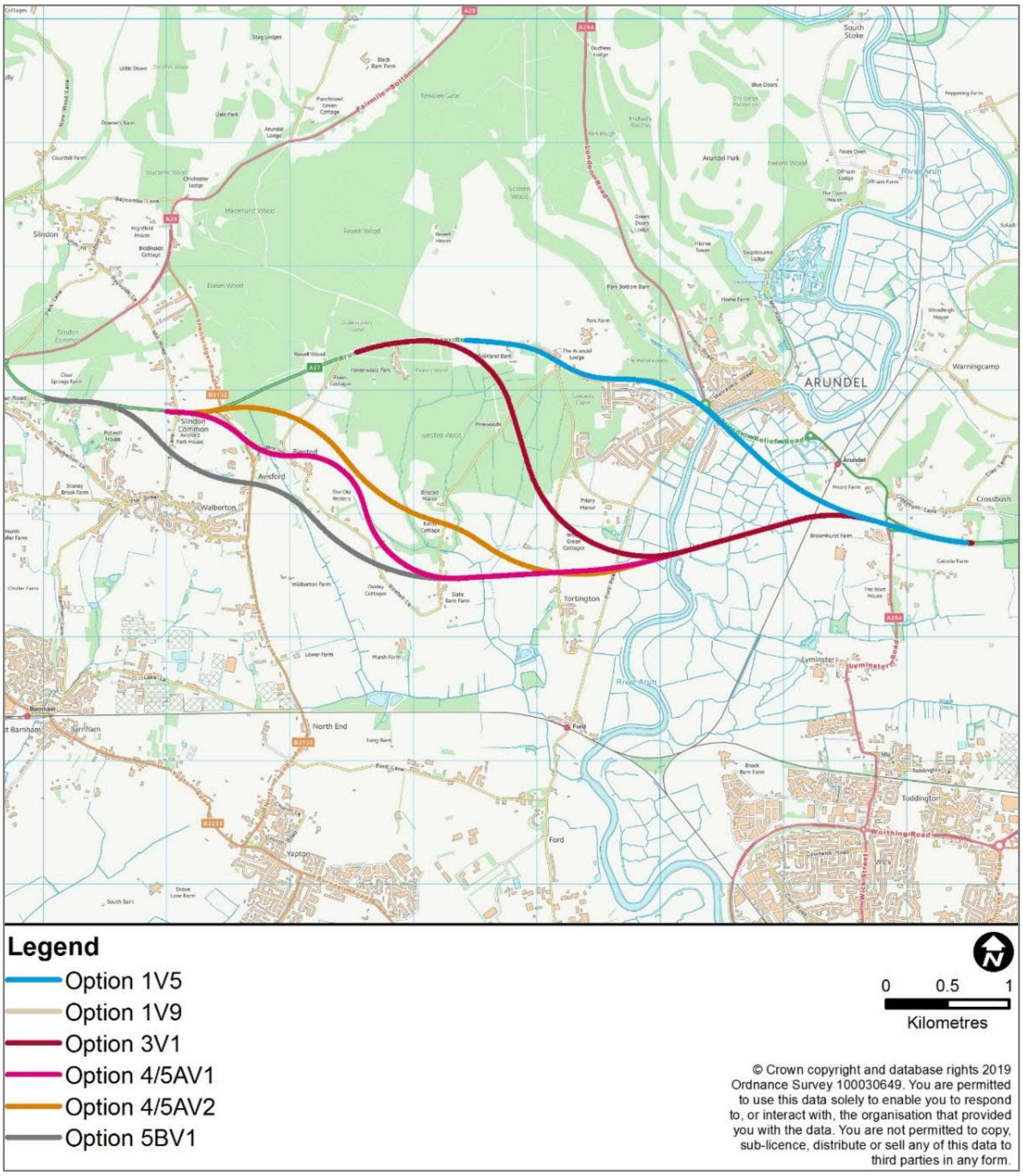
1.4 Scheme description

1.4.1 The Scheme comprises the replacement of the A27 single carriageway road sections within Arundel with a dual carriageway bypass, linking together the two existing dual carriageway sections of the road. This corresponds to the 6 kilometre section of the A27 from the A284 Crossbush junction (east of Arundel) to an area as far west of Arundel as Yapton Lane. The A27 currently goes through the South Downs National Park (SDNP) and the town of Arundel passing over the River Arun and crossing the Arun Valley railway line.

[3] A27 Arundel, Client Scheme Requirements – Stage 2

1.4.2 Figure 1-1 illustrates the options that have been assessed for the A27 Arundel Bypass Scheme during PCF Stage 2 Further Consultation. Option 1V9 follows the same alignment as Option 1V5.

Figure 1-1: Location of A27 Arundel Bypass options



1.4.3 For the purposes of the PCF Stage 2 Further Consultation, the options have been given the following colour references:

- Option 1V5 (Cyan)
- Option 1V9 (Beige)
- Option 3V1 (Crimson)
- Option 4/5AV1 (Magenta)
- Option 4/5AV2 (Amber)
- Option 5BV1 (Grey)

Option 1V5 and Option 1V9

1.4.4 Option 1 consists of online[4] dualling with a short offline section between Ford Road Roundabout and a fully grade separated Crossbush junction, bypassing Arundel station. Option 1 V5 includes a grade separated junction at the current Ford Road roundabout with no connection between the local and strategic road networks. Option 1 V9 proposes an expanded signalised through-about form of junction at Ford Road Roundabout, with speed restriction to the west.

Option 3V1

1.4.5 This option would be a new offline dual carriageway south of Arundel tying in to the existing A27 west of Arundel with a partial movements grade separated junction, and with a fully grade separated all movements Crossbush junction to the east.

Option 4/5AV1, Option 4/5AV2 and Option 5BV1

1.4.6 These options would provide a new offline dual carriageway passing to the south of Arundel. The alignments would provide a new connection between a fully grade separated all movements Crossbush junction to the east, and a new grade separated form of junction to tie in to the existing A27 to the west, to the north of Walberton

1.4.7 A more detailed description of the options is presented in chapter 8 of the Scheme Assessment Report (SAR)[5].

1.5 Previous analysis and economic assessments

PCF Stage 1 (option identification)

1.5.1 PCF Stage 1 of the A27 Arundel Bypass study considered a range of options, with a shortlist of five options subject to economic assessment.

- **Option 0A:** Junction improvements only encompassing improvements to Crossbush Junction, Causeway roundabout and Ford Road roundabout.

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[4] Online refers to improvements to the existing highway network where offline refers new highway infrastructure that is located away from the existing highway network

[5] A27 Arundel Bypass, PCF Stage 2 Further Consultation Scheme Assessment Report (August 2019)

- **Option 1:** D2AP[6] widening on current existing alignment, then offline D2AP to tie into Crossbush Junction to incorporate an online then offline improvement, from west to east.
- **Option 3:** An offline D2AP route bypassing the existing A27 alignment. This alignment continues in a south easterly direction through ancient woodland at Tortington Common to create four new under-bridges at Old Scotland Lane, Binsted Lane, Tortington Lane and Ford Road. The alignment then turns eastwards to create two new over-bridges at the River Arun and Arun Valley Railway. The alignment then ties into the existing A27 to form a new grade separated interchange at Crossbush Junction.
- **Option 5A:** An Offline D2AP route. A hybrid of Option 3 and Option 5 alignments, passing south of the Guest Houses on Priory Lane along Ford Road, joining with the existing A27 dual carriageway at Crossbush and a new grade separated junction near Yapton Lane.
- **Option 5B:** An offline D2AP route starting at Crossbush Junction to form a new grade separated interchange with the existing A27 dual carriageway, running west, south of Arundel town, and across the Arun floodplain between Tortington Priory and Tortington village. It bypasses the ancient woodland areas completely running between Binsted and Walberton, to join the existing A27 dual carriageway north of the Hilton Hotel and Avisford Park Golf Course, west of the existing junction with Mill Road/Tye Lane.

1.5.2 Table 1-1 shows the Analysis of Monetised Costs and Benefits (AMCB) for a 60-year appraisal period for the A27 Arundel Bypass options at the end of PCF Stage 1. These are included within the PCF Stage 1 Economic Assessment Report (April 2017)[7].

[6] Dual 2 lane all purpose (D2AP), terminology describing a road standard

[7] https://highwaysengland.citizenspace.com/he/a27-arundel-bypass/supporting_documents/A27%20Arundel%20%20Economic%20Assessment%20Report%20%20Website%20Version.pdf-1

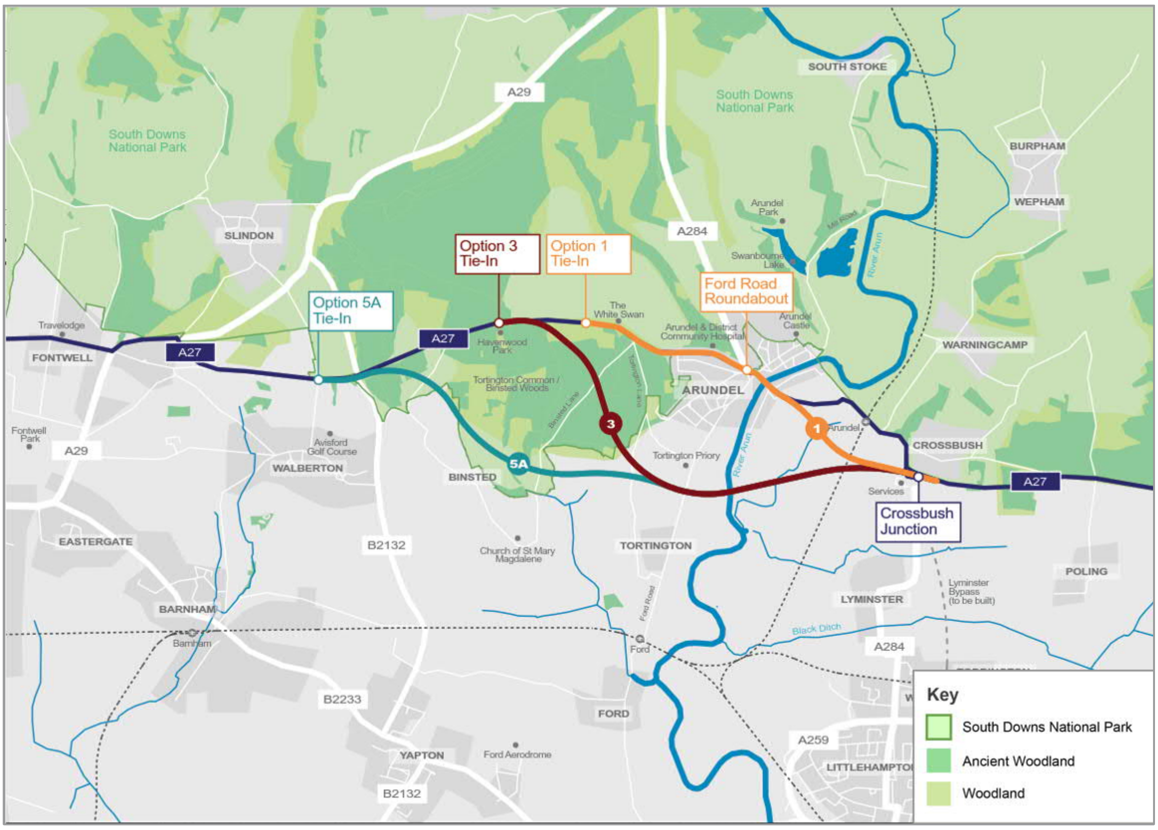
Table 1-1: PCF Stage 1 - Analysis of Monetised Costs and Benefits (£m)

Type	Option 0A	Option 1	Option 3	Option 5A	Option 5B
Economic Efficiency: Consumer Users (Commuting)	40.676	95.704	90.739	117.253	96.154
Economic Efficiency: Consumer Users (Other)	22.356	57.682	50.539	65.641	52.957
Economic Efficiency: Business Users and Providers	52.629	129.889	131.869	167.873	142.217
Wider Public Finances (Indirect Taxation Revenues)	-3.047	-8.129	-0.863	-5.317	-4.417
Accidents	0.053	38.504	63.715	76.412	63.833
Present Value of Benefits (PVB)	**112.667**	**313.650**	**335.999**	**421.862**	**350.744**
Broad Transport Budget	25.573	87.190	166.997	162.005	213.756
Present Value of Costs (PVC)	**25.573**	**87.190**	**166.997**	**162.005**	**213.756**
OVERALL IMPACTS					
Net Present Value (NPV)	**87.094**	**226.460**	**169.002**	**259.857**	**136.988**
Benefit to Cost Ratio (BCR)	**4.41**	**3.60**	**2.01**	**2.60**	**1.64**

PCF Stage 2 (option selection)

1.5.3 A27 Arundel Bypass Options 1, 3 and 5A were shortlisted during PCF Stage 1 and were taken forward to PCF Stage 2 for assessment and public consultation in Summer 2017. A plan showing the alignments of these options is presented in Figure 1-2.

Figure 1-2: Options taken forward to PCF Stage 2 public consultation



1.5.4 The previous PCF Stage 2 analysis and economic assessment is reported in the PCF Stage 2 ComMA[8]. A summary of the previous analysis and economic assessment for Options 1, 3 and 5A is presented below.

1.5.5 The results for A27 Arundel Bypass Option 1 are presented for completeness as the benefits are likely to be over- estimated. This is because the Simulation and Assignment of Traffic to Urban Road Networks (SATURN) model under-represented the delays which may potentially remain on the scheme section of the A27 - specifically at Ford Road Roundabout. A description of the further assessment of Option 1 is provided in section 16 of the PCF Stage 2 ComMA, and section 6.6 of the PCF Stage 2 SAR[9]. An explanation of how this limitation has been mitigated during the PCF Stage 2 Further Consultation modelling is described in section 12.6.

1.5.6 The PCF Stage 2 economic assessment results for the three options are presented in Table 1-2.

[8] A27 Arundel Bypass, PCF Stage 2 - Combined Modelling and Appraisal (ComMA), May 2018

[9] https://highwaysengland.citizenspace.com/he/a27-arundel-bypass/results/sarv1forpublishing.pdf

Table 1-2: Analysis of monetised (£m) costs and benefits – PCF Stage 2

Type	Option 1 £m	Option 3 £m	Option 5A £m
Greenhouse gases	-19.145	-25.181	-23.899
Economic Efficiency: Consumer Users (Commuting)	40.177	50.311	64.478
Economic Efficiency: Consumer Users (Other)	63.516	64.417	78.333
Economic Efficiency: Business Users and Providers	55.722	52.090	67.242
Wider Public Finances (Indirect Taxation Revenues)	17.056	23.821	21.461
Accident benefits	16.008	34.778	30.042
Construction Delay	-6.522	-1.445	-1.755
Air Quality	9.252	9.016	9.465
Noise	-9.967	-1.334	-1.519
Present Value of Benefits (PVB)	**166.097**	**206.473**	**243.848**
Broad Transport Budget	87.190	166.997	162.005
Present Value of Costs (PVC)	**87.190**	**166.997**	**162.005**
Net Present Value (NPV)	**78.907**	**39.476**	**81.843**
Benefit to Cost Ratio (BCR)	**1.91**	**1.24**	**1.51**

1.5.7 The above table shows that Option 1 had the highest BCR between 1.5 and 2, however, as cited above, the relief that the Scheme offers had been exaggerated within SATURN hence the PVB of £166m is likely to be an overestimate which results in a higher BCR. Option 3 returned a BCR that was between 1 and 1.5, and Option 5A a BCR that was just above 1.5.

1.5.8 Table 1-3 presents the adjusted BCR which includes wider economic impacts as reported in ComMA. The BCR of between 2 and 2.5 for Option 1 needs to be read in the context of the explanation provided above. The results for the adjusted BCR showed that Option 3 returned a BCR between 1 and 1.5, and Option 5A above 1.5.

Table 1-3: Adjusted BCR – PCF Stage 2

Type	Option 1	Option 3	Option 5A
BCR (adjusted)	2.45	1.36	1.62

1.6 Analytical assurance

1.6.1 Highways England has developed an Analytical Assurance Framework to provide a robust internal arrangement to assure the specification, production and use of analysis. Following consideration of the risks and likelihoods associated with the Scheme, the ARR sets out that the 3rd line of defence applies to this project. The three lines of assurance are:

1. Operational management - peer and management review within the project and programme
2. Executive overview – management review from the responsible officers for the task, project and programme
3. Internal assurance – independent technical specialists from within Highways England

1.6.2 As a response to the specification of analytical assurance, quality management activities are in place in order to provide the necessary level of assurance, and this is summarised below in terms of product production.

1.6.3 A product production process has been established for the purposes of this project which aligns with the first two lines of defence described above.

1.6.4 The first line requires the preparer / originator to develop the product in conformance with the project requirements, and applicable standards and specification. The deliverables are self-checked by the preparer / originator. A check / peer review is then undertaken by someone who is not involved in production of the deliverable wherever possible and has a detailed understanding of the subject.

1.6.5 For the second line of defence, the product is then verified by a Design Manager or Discipline Lead, prior to approval from the Project Manager or Project Director that the assurance process has been carried out and the product is suitable for release.

1.6.6 The third line of assurance comprises an internal review by independent technical specialists, the outcomes of which include a judgement on the level of assurance achieved and consideration of how this may affect the interpretation of the study outputs and the Scheme value for money.

2 Local transport situation

2.1 Local transport system

Highway network

2.1.1 The A27 is the only east-west trunk road south of the M25. It links many of the towns and cities along the south coast, including Portsmouth, Havant, Chichester, Arundel, Worthing, Adur, Brighton and Hove, Lewes, and Eastbourne, serving a combined population of around 1.2 million people as well as a large number of businesses. The A27 also provides access to the wider Strategic Road Network (SRN[10]) including the A3(M), M27 and A23 / M23, The A27 is therefore an important corridor for both longer distance travel and local traffic.

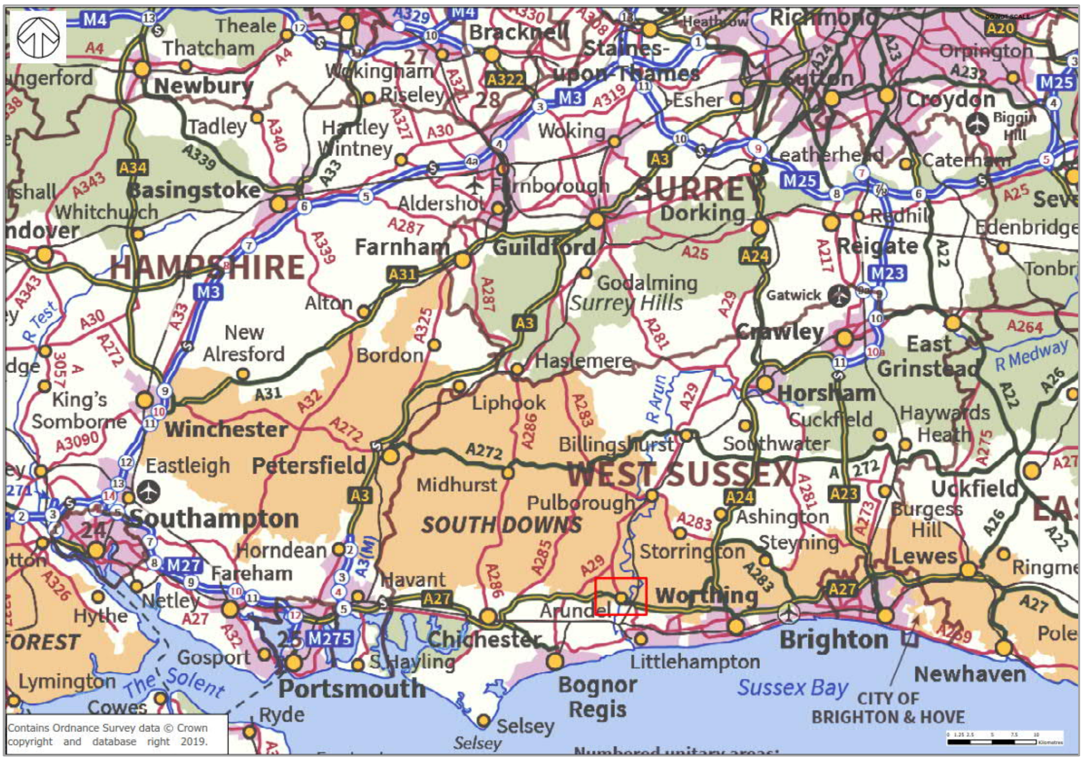
2.1.2 The A272 provides a predominantly single carriageway parallel route between Winchester and the Haywards Heath area along a similar east – west alignment, to the north of the A27. The route passes extensively through the SDNP. The A259 provides a predominantly urban route between Chichester and Brighton and Hove and continues to the east. Neither route is considered to offer a genuine alternative to the A27 as a strategic long-distance route. Figure 2-1 presents the location of the A27 Arundel Bypass (illustrated with a red box) in a wider geographical context.

2.1.3 Locally to Arundel, there are two east-west routes that are used as alternatives to particular sections of the A27. The first is located to the north, the A29 / B2139 / A283, which passes through the SDNP and the villages of Storrington and Steyning. To the south is the B2233 / A259 which runs through Eastergate, Barnham, Yapton and Climping, north of Littlehampton and then on to Goring-by-Sea and Worthing.

2.1.4 Other A roads within the area include the A29, which intersects with the A27 to the east of Fontwell, at an uncontrolled at-grade roundabout. The A284 connects with the A27 in two locations, at the Ford Road five-arm roundabout and at the Crossbush junction. It is the primary route used for those in Littlehampton, Wick and Lyminster to travel to and from locations to the north. Other local roads include the B2130 to the north of the town and the B2233 to the south.

[10] The Strategic Road Network is made up of motorways and trunk roads managed by Highways England

Figure 2-1: A27 Arundel Bypass - wider geographical context



2.1.5 The section of the A27 from Crossbush to Ford Road roundabout caters for both east-west movements on the A27 and north-south movements on the A284 which links Littlehampton with the A29 near Madehurst and provides a bypass to the historic town and former route of the A27. The town has since grown to the southwest in the corridor between the A27 Chichester Road and the Ford Road and this more modern residential area is severed from the town centre by the high traffic flows on this section of the A27 and by the lack of controlled pedestrian crossing facilities.

2.1.6 The section of the existing A27 that represents the scheme extent (as illustrated in Figure 1-1) is approximately 8.5 km in length, from the approach to the Crossbush junction to the east of Arundel, and Fontwell to the west. Currently, the A27 bisects the SDNP and the town of Arundel, and passes over the River Arun and the Arun Valley railway line.

2.1.7 The section of the A27 between Crossbush junction and Fontwell roundabout is described in greater detail in the following paragraphs.

Crossbush Junction

2.1.7.1 The existing Crossbush Junction was developed as a temporary end to the A27 Crossbush bypass[11], waiting for the completion of a bypass to Arundel. It comprises a partially signal controlled gyratory with the A284 Lyminster Road and is a major junction on the A27 providing access to Littlehampton.

2.1.7.2 On the westbound approach, the A27 is a dual carriageway with a national speed limit road (70mph), dropping to 50 mph closer to the Crossbush junction, and 40mph at the base of the ramp up to the junction. At the west bound approach, the A27 bound traffic is directed to one lane with the other lane for A284 bound traffic. The eastbound A27 approach and A284 approach are both single carriageway with a 40mph speed limits. Access to the Crossbush services area is provided to the south of the junction off the A284. Congestion at peak times is a regular feature at this junction, particularly on the A27 westbound in the morning peak.

Crossbush junction to Causeway Junction

2.1.7.3 The 1km section between the Crossbush Junction and the Causeway Junction is single carriageway with a 40mph speed limit and has street lighting throughout. There are four minor priority junctions including the access to The Premier Inn Hotel, Crossbush Lane, Angmering Park Estate and the access to Arundel Station. In addition, there are numerous direct accesses to private properties and field accesses. This section of the route has a winding alignment as it drops down the valley side of the River Arun. The alignment is further constrained at the Arundel Station Bridge which carries the A27 over the Arun Valley Railway. Heading west there are dramatic views of Arundel Castle (scheduled monument) and Cathedral (listed building).

2.1.7.4 There is a continuous footway between the Crossbush and Causeway junctions which switches between carriageways at 2 uncontrolled crossings with central islands. There is a signal controlled crossing approximately 110m from Arundel railway station, on the eastern arm of the Causeway junction. Pedestrian and cycle access to the Arundel station is provided by means of a shared use footway/cycleway adjacent to the A27 eastbound carriageway. The shared use path follows an off-road alignment on the approach to the railway overbridge before entering the station forecourt under the A27.

[11] A27 Corridor Feasibility Study – Report 3 of 3: Investment Cases, Highways Agency, (February 2015), section 5.2.5

2.1.7.5 The Causeway Junction is a three-armed roundabout between the Causeway, which provides access to Arundel, and the A27. A footway runs around the outside of the roundabout with uncontrolled crossings at each of the three arms of the roundabout.

Causeway Junction to Ford Road junction

2.1.7.6 This section of the existing A27 crosses the floodplain of the River Arun and on a low embankment. It was constructed in the 1970's as a bypass to the south of the historic town centre of Arundel. It is a single carriageway of about 0.85km long, is subject to 40mph speed limit, and has street lighting throughout. There is one minor junction with Fitzalan Road and a continuous footway adjacent to the west bound carriageway.

2.1.7.7 A bridge carries the existing A27 over the River Arun and Fitzalan Road. It has restricted headroom over Fitzalan Road (signed as 2.8m). A footway is provided under the bridge adjacent to Fitzalan Road and footpath FP 206 passes under the bridge with restricted headroom on the west bank of the river. Ramps provide access to the footway on the A27 on both sides of the bridge.

2.1.7.8 The Ford Road Junction is an existing five arm roundabout at the intersection of the existing A27, A284, Ford Road and Maltravers Street. The residential area of the Arundel south is located to the south of the junction and the historic town centre to the north. There are uncontrolled pedestrian crossings points across each of the five arms of the roundabout linking a footway located around the outside of the roundabout with links to FP 206. A bus stop is provided on both carriageways of the A27 east arm of the roundabout. The high traffic flows at the junction and on the existing A27 together with the poor facilities for pedestrians and cyclists lead to severance.

2.1.7.9 The A27 between Crossbush and Ford Road, as well as carrying through traffic also carries traffic traveling between sections of the A284, which links Littlehampton with the A29 near Madehurst and traffic local to Arundel. The reduction in road standard and poor alignment, coupled with presence of two at-grade roundabouts gives rise to excess congestion at peak times, above average safety problems and the occurrence of rat running to avoid delays.

Ford Road Junction to Long Lane

2.1.7.10 This section of the existing A27 is single carriageway for approximately 1.7km before transitioning to dual carriageway near Long Lane. The single carriageway section is subject to a 40mph speed limit for approximately 400m west of the Ford Road Junction, beyond which the national speed limit applies. There are four minor priority junctions along this section with accesses serving the Arundel District Hospital, Jarvis Road, Binsted lane and at the access to White Swan Hotel. In addition, the section also directly serves a number of private properties and farms.

2.1.7.11 There is a continuous footway which switch carriageways at uncontrolled at 2 grade crossings. The footway is in poor condition and in places both narrow and directly adjacent to the existing A27 carriageway. The public rights of way (PRoW) network intersect with the existing A27 at two locations. Access between the PRoW is provided via the existing footway and uncontrolled crossings.

Long Lane to Fontwell Junction (east)

2.1.7.12 This section of the existing A27 is dual carriageway with a de-restricted (70mph) speed limit and is signed as a clearway (no stopping). There are three minor junctions with gaps in the central reserve located at Havenwood Park access, the B2132 Yapton Lane junction and Copse Lane Junction. In addition, there are four minor junctions with access to one carriageway of the existing A27 only. Three are located on the westbound carriageway at Binsted Lane, Tye Lane and Arundel Road and one on the eastbound carriageway at Mill Road. There are also many private accesses and farm accesses directly off the A27 on both carriageways. The route leaves the SDNP at the B2132 Yapton Lane / Shellbridge Road Junction.

2.1.8 There is a continuous footway adjacent to the west bound carriageway up to Havenwood Caravan park where a gap in the central reserve provides pedestrian access to bus stops located on both carriageways. The PRoW network intersections with the existing A27 at 5 locations with four informal crossing points with gaps in the central reserve. In addition, there are informal pedestrian crossing points with gaps in the central reserve at the Mill Road/Tye Lane Junction and B2132 Yapton Lane / Shellbridge Road Junctions.

2.2 Key demands for travel

Sources of data

2.2.1 The data used to describe existing traffic conditions comprises the following sources:

- Census journey to work, sourced from Nomis[12], the official labour market statistics website
- Traffic count data from WebTRIS[13], WSCC and other sources
- Journey time data from TrafficMaster
- A27 transport model

2.2.2 The A27 transport model reflects an average weekday in March 2015, with March classified as a neutral month. The modelled time periods are:

- AM peak – 07:00 – 10:00
- Inter peak (IP) – 10:00 – 16:00
- PM peak – 16:00 -19:00

Journey patterns

2.2.3 The PCF Stage 2 A27 transport model indicates that two thirds (67%) of the traffic that currently uses the A27 along the extent of the proposed Scheme, is through traffic, whilst the remaining third (33%) is local traffic[14].

2.2.4 Roadside interviews on the A27 west of Arundel in 2015 indicated that there are higher traffic volumes eastbound (10,433 vehicles) than westbound (7,109 vehicles) between 07:00 and 19:00[15].

2.2.5 Based on Census Journey to Work (2011) data, the car is the most prevalent means of transport within Arun district as a whole, with 45% of Arun District residents (aged 16 to 74) travelling to work by car or van. Walking is the second highest mode of transport at 6%, followed by working from home at 4%, train at 3%, cycling at 2%, bus/minibus/coach at 2%, motorcycle at 1%, other at 0.4%, taxi at 0.2% and lastly underground/metro/light train/tram at 0.1%[16] . The remaining 36% of the residents are not in employment.

[12] https://www.nomisweb.co.uk/

[13] http://webtris.highwaysengland.co.uk/

[14] Based on traffic on the A27 between Crossbush roundabout and Causeway roundabout. Local traffic defined as having an origin or destination within Arundel. Through-traffic has an origin and a destination outside of Arundel.

[15] HE551523,4_WSP-PB_A27AWL_P012_TDCRv1.4.1

[16] Qs701EW Method of travel to work: 2011 Census NOMIS

2.2.6 The majority of travel to work movements are those which are travelling out of the district, at over 27,000 (75%)[17]. This is compared to nearly 9,000 (25%) who travel into the district to work[17]. The major inflows into the Arun district are from the east, with inflows from Worthing accounting for 35% of the total journey to work movements and Adur accounting for 6%. From the west, 25% of the inflows originate in Chichester and 7% are from Horsham[18]. The highest outflows are for destinations to the west, with 39% of outflows associated with Chichester at 39% and Horsham at 7%. To the east, 21% of outflows travel to Worthing whilst 3% travel to Adur. This illustrates a tidal movement of journey to work trips which is highest in a westbound direction in the morning peak, into and out of Arun, with the reverse pattern of movement in an eastbound direction during the evening peak.

2.3 Existing transport issues and underlying contributory factors

2.3.1 The A27 through Arundel experiences issues relating to:

- **Lack of capacity:** There are existing capacity constraints due to sections of single carriageway and the number and the layout of at-grade junctions. Uncontrolled at-grade roundabouts are present at Ford Road and the Causeway junctions, whilst the Crossbush junction is partially signal controlled. On either side of Arundel, the A27 is a dual-carriageway which has the capacity to carry existing traffic flows and is more able to cope with future traffic growth. However, the single carriageway section and junctions through Arundel do not cope with existing traffic. This often results in long queues of traffic approaching Arundel
- **Congestion, travel time and journey time reliability:** sections of single carriageway and at-grade junctions result in congestion and delays which impact on the efficient and safe movement of people and goods. Congestion is a problem at a number of locations in Arundel
- **Economic growth:** Future growth would result in the demand further exceeding capacity through Arundel, and this section of the A27 would act as a constraint to the planned growth in housing and employment in the corridor.

[17] https://www.nomisweb.co.uk/census/2011/qs701ew

[18] ONS, Census WU03UK – Location of usual residence and place of work by method of travel to work. https://www.nomisweb.co.uk/census/2011/WU03UK/chart/1132462325

- **Road safety:** Collisions are a significant challenge along certain links, with incidents leading to further impacts on journey-time reliability. Traffic is also currently diverted from the A27 to use alternative, less suitable routes (e.g. local roads such as the B2139 and B2233). These local roads are not suited to large volumes of traffic so their safety is compromised.

  Accessibility: The route runs through and close to settlements causing severance issues at Arundel. Local residents can find it difficult to access services and facilities.
- **Air quality:** Traffic and congestion affect air quality, in particular at locations in Arundel due to high volumes of traffic. Due to congestion, some longer distance traffic subsequently diverts away from the A27 to alternative routes which are less suited to high volumes of traffic. To the north, this includes the B2139 through the SDNP and local villages and towns (Houghton, Amberley and Storrington). The traffic disrupts the otherwise tranquil nature of the SDNP and affects the quality of life for those living alongside the route. An Air Quality Management Area (AQMA) has been in effect in Storrington since December 2010 in areas of the village that are likely to exceed the air quality objective for nitrogen dioxide[19].
- **Lack of alternative modes of travel:** Even if greater reliance on public transport, walking and cycling could reduce some of the future demand for car travel, this is unlikely to solve the problems of queueing and congestion on the A27 through Arundel. There are no significant plans for public transport improvements in the area.

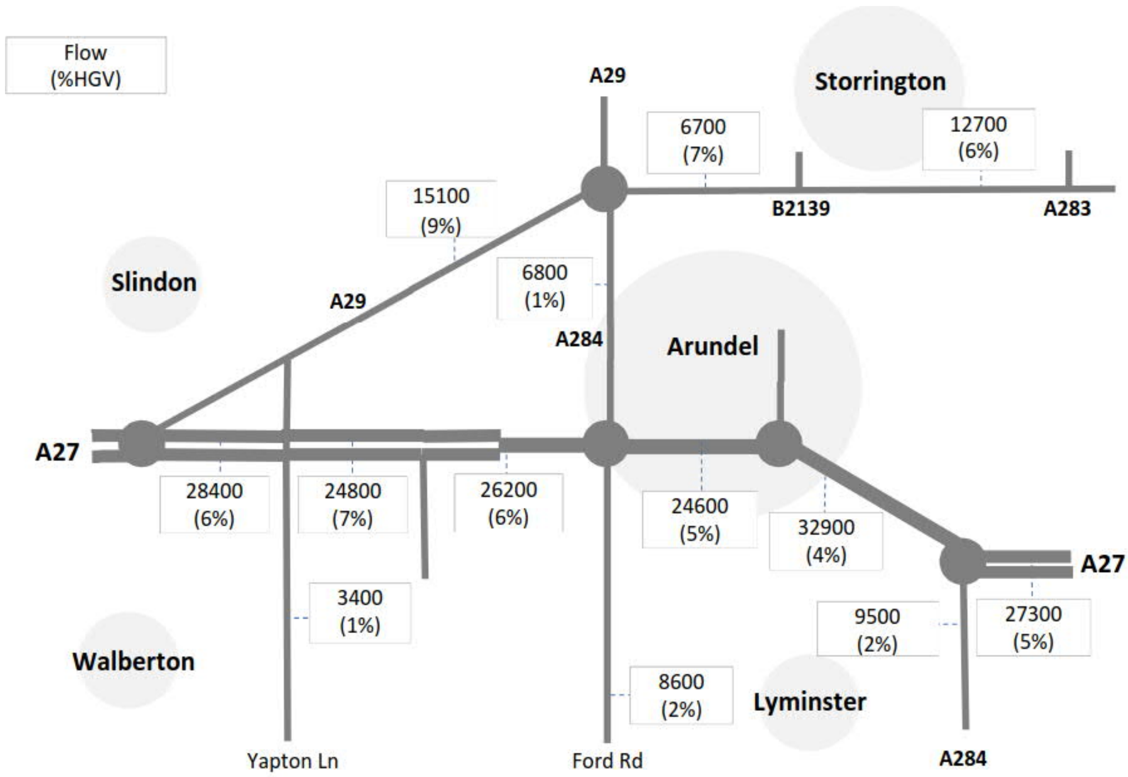
2.3.2 The transport issues identified above are explored in greater detail in the following sections, including the supporting quantitative and qualitative evidence where available and appropriate. The environmental impacts are summarised in the SAR.

[19] https://www.horsham.gov.uk/environmentalhealth/environmental-health/air-quality/storrington-air-quality

Traffic volumes and link capacity

2.3.3 Figure 2-2 presents the estimated Average Annual Daily Traffic (AADT) two-way flows within the study area for the year 2015 and an estimate of the % of Heavy Goods Vehicles (HGV). AADT is calculated by converting the average and inter-peak hourly flows, extracted from the PCF Stage 2 A27 transport model for the 2015 base year, into the respective 12 hour and 24 hour AADT flows using pre-determined conversion factors.

Figure 2-2: Base year (2015) two-way AADT



2.3.4 Within the study area, current traffic volumes are highest along the A27, particularly on the single carriageway section to the West of Crossbush where there is a volume of over 32,000 vehicles per day. The AADT has not changed notably since 2015[20].

[20] Based on DfT manual count point data which illustrates an increase of around 5% in AADT between the years 2015 and 2018 at Arundel Station. AADT has been estimated between 29.000 and 35,000 vehicles per day since the year 2000. https://roadtraffic.dft.gov.uk/manualcountpoints/6297

2.3.5 AADT remains high on the A27 as it bisects Arundel, with 24,000 to over 26,000 vehicles per day using these sections of road. The A29 experiences flows of over 15,000 vehicles per day. The lower order roads in the study area, such as Yapton Lane, Ford Road and the A284, have lower AADT flows.

2.3.6 Along the A27, the proportion of HGVs is highest to the west of Arundel, with a high of 7% of total vehicles on the dual carriageway section between Yapton Lane and Ford Road roundabout. To the east of this roundabout, HGV numbers decrease as a number have destinations within Arundel or along Ford Road. The percentage of HGVs along the A29 is high relative to other routes, at 9%.

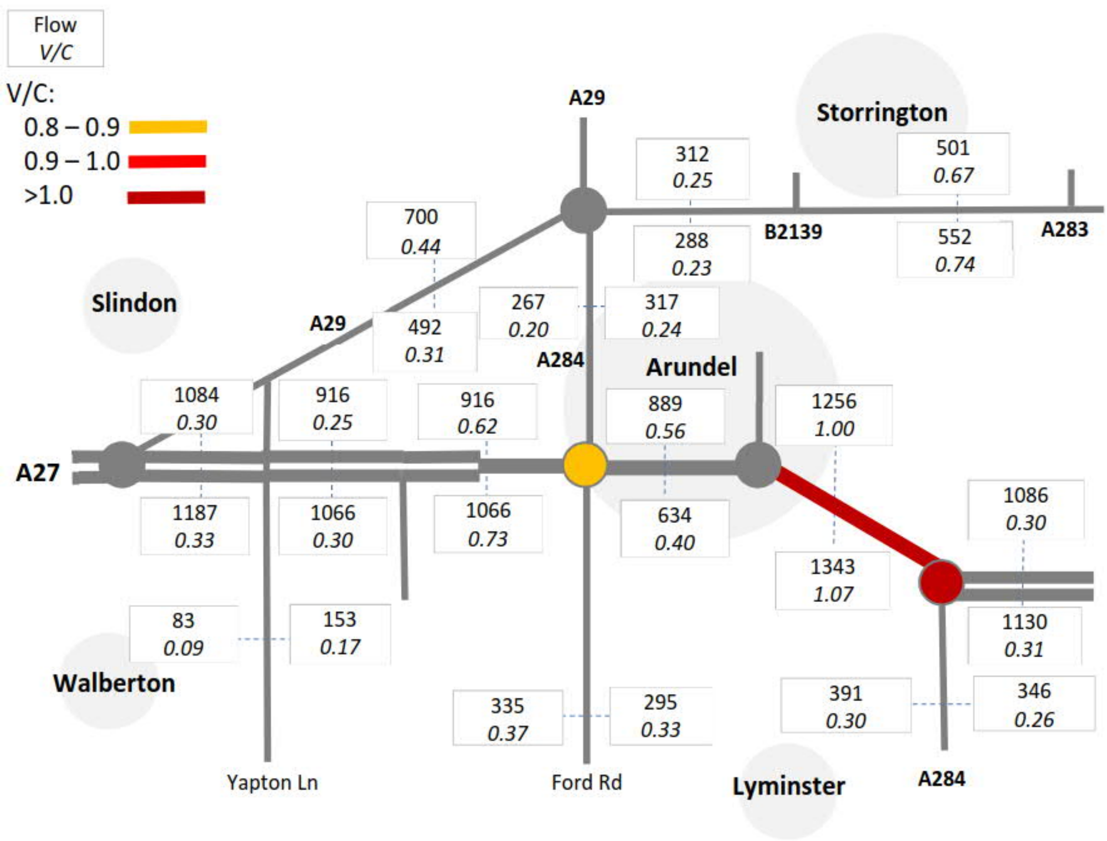
2.3.7 The dual carriageway on either side of Arundel has the capacity to carry existing traffic flows and accommodate future traffic growth. However, the single carriageway sections are not able to accommodate the demand during peak periods, resulting in congestion. The main congestion points are observed at the Ford Road roundabout, the section between the Causeway roundabout and Crossbush, and the approaches to Crossbush junction.

2.3.8 Figure 2-3 and Figure 2-4 summarise the AM and PM peak flows and capacity, measured in number of vehicles, from the PCF Stage 2 A27 transport model. Capacity is defined in TA 79/99[21] as the maximum sustainable flow of traffic passing in one hour, under favourable road and traffic conditions and is measured in one-way hourly flow in each direction.

[21] Design Manual for Roads and Bridges (DMRB), Volume 5, Section 1, Part 2, TA 79/99 Traffic Capacity of Urban Roads (February 1999)

2.3.9 A Volume / Capacity (V/C) figure is presented for each link. Peak V/C compares traffic volume with the capacity of the road. The higher the value, the closer the road is to capacity, and therefore the more prevalent congestion is likely to be. In addition, where maximum junction Ratio of Flow to Capacity (RFC[22]) or Degree of Saturation (DoS[23]) exceeds 0.8, 0.9 or 1.0, this is indicated on the figures with the corresponding colour for the A27 / A284 / Ford Road and A27 / A284 Crossbush junctions. These junctions have been identified during earlier PCF stages as having a significant impact on the performance of the A27. The junction modelling results are presented later in this section.

Figure 2-3: Base year peak period flow and V/C (AM)



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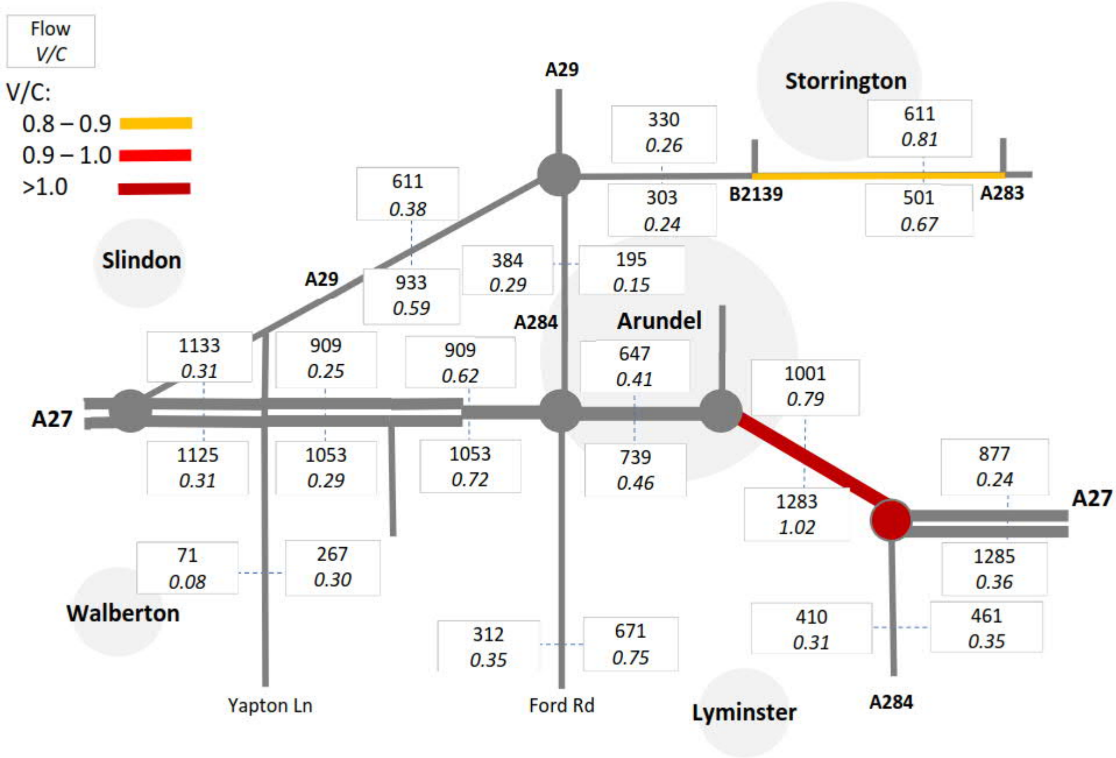
[22] The Ratio of Flow to Capacity (RFC) is a measure of how well roundabout and priority junction approaches perform under varying flow conditions. In the case of roundabouts, the capacity is determined by the entry flows, circulatory flows and the junction geometric parameters. Similarly, for priority junctions, the scale of magnitude of opposed and opposing movements influence capacity, besides geometry. Typically, an RFC of less than 0.85 is considered to indicate satisfactory performance.

[23] Degree of saturation (DoS) is a measure of how well an approach lane to a signalled junction is performing. It is the ratio of the number of vehicles known to be approaching a stopline over an hour (the demand flow), to the number of vehicles which can actually get over the stopline (the capacity). A stopline with a DoS level below 90% is said to have spare capacity, whilst a value above 90% indicates queues and congestion.

Figure 2-4: Base year peak period flow and V/C (PM)



2.3.10 The capacity of the A27 carriageway within the area varies according to the number of lanes, the width and other road characteristics[24].

2.3.11 The A27 carriageway capacity is lowest in the single carriageway section between Causeway roundabout and Crossbush junction past Arundel railway station where the carriageway narrows and gradient increases. This section also has a number of at-grade side road junctions along the route which are a factor in the capacity of the link. The signal controlled pedestrian crossing just east of Causeway roundabout interrupts the flow of traffic.

2.3.12 To the west of this section, the road capacity increases between Causeway and Ford Road roundabout as the standard of road improves. The capacity then significantly increases from 1,590 to over 3,000 vehicles per hour where the single carriageway becomes dual carriageway. Other local routes have lower capacities, commensurate with the standard of the road.

[24] http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol5/section1/ta7999.pdf

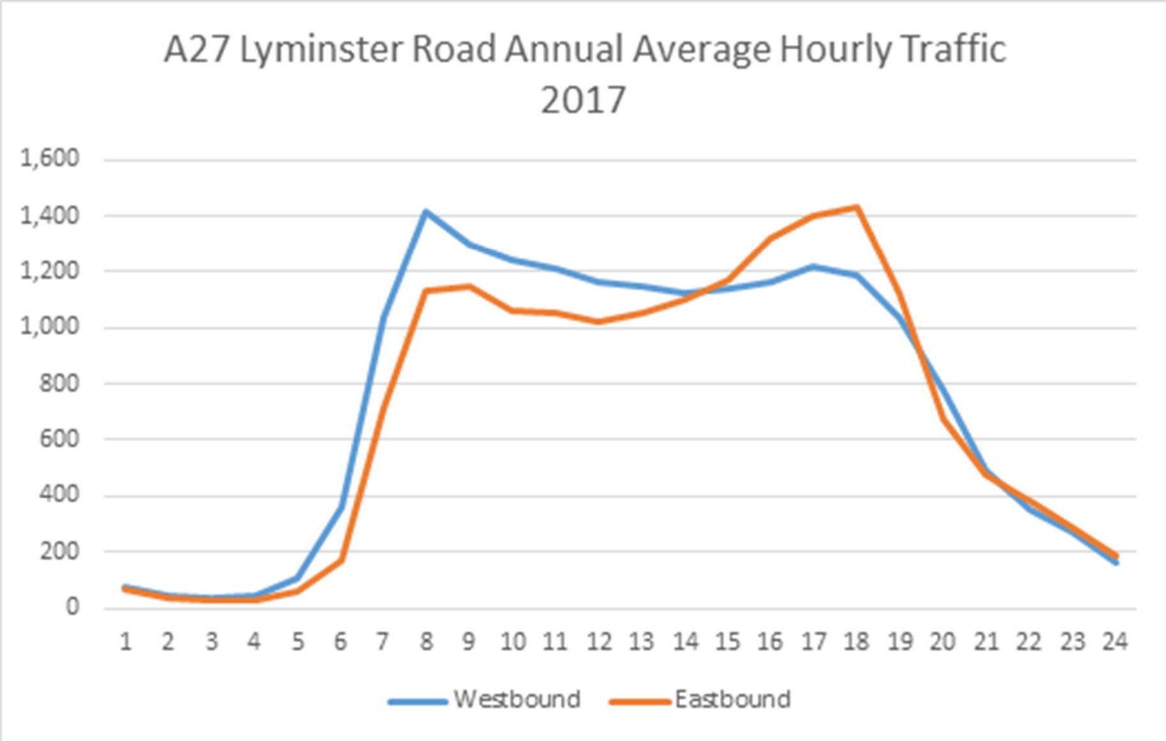
2.3.13 Peak flows are generally highest in the AM peak and travelling westbound, which reflects the dominant tidal commuting pattern to destinations to the west of Arundel including Chichester. The highest average hourly flows are between Causeway roundabout and Crossbush junction, past Arundel Station. As this is a single carriageway section, congestion here is a significant problem and V/Cs indicate the link is operating at capacity.

2.3.14 Elsewhere on the A27 within the study area, flows typically range from 900 to 1,200 vehicles per peak period in each direction. The only exception is on the link between Causeway roundabout and Ford Road roundabout, where flows are about 700 vehicles per hour. This is because traffic on the A27 with destinations within Arundel or to areas to the north or south exits at either one of these two roundabouts.

2.3.15 Away from the A27, the highest average flows are found on the A29. This indicates that this is the predominant route into the area from the north, with high AM southbound and PM northbound flows. Other routes within the locality see lower peak flows, although various lower order roads within the study area can be considered sensitive to traffic volumes due to their residential or rural nature and can be affected by 'rat-running' traffic which can utilise local roads in the event of congestion or incidents on the SRN. These roads include Ford Road and Yapton Lane.

2.3.16 The average 24 hour weekday traffic profile on the A27 Lyminster Road, the section of the A27 past Arundel railway station and on the approach to Crossbush junction, is illustrated on Figure 2-5. The average daily weekday flows (07:00 to 19:00) at this site totalled 18,114 vehicles westbound, and 17,147 eastbound.

Figure 2-5: Average 24-hour weekday traffic flow profile (A27 Lyminster Road)



Capacity assessment of Ford Road roundabout and Crossbush junction

2.3.17 Table 2-1 and Table 2-2 summarise the operational modelling results of Ford Road roundabout and Crossbush junction for 2015, in both the AM and PM peak periods. RFC's are presented in red where the value exceeds 0.85, and DoS presented in red where the value exceeds 90% (see section 2.3.9). The results are presented in vehicles for Ford Road roundabout and in Passenger Car Units (PCUs) for Crossbush junction.

2.3.18 The tables illustrate that the Ford Road roundabout is approaching capacity, and Crossbush junction is over capacity in the base year. Ensuing long queues and delays are, therefore, a regular occurrence of the section of the A27 through Arundel.

Table 2-1: Ford Road junction assessment (2015 AM and PM)

Junction Arm		AM Peak (2015)			PM Peak (2015)		
		RFC	Queue (Veh)	Delay (s/Veh)	RFC	Queue (Veh)	Delay (s/Veh)
A	A284	0.27	0.36	5.43	0.31	0.44	5.46
B	Maltravers Street	0.63	1.69	12.47	0.54	1.14	10
C	A27 East (existing)	0.59	1.41	7.35	0.71	2.39	10.77
D	Ford Road	0.53	1.12	11.13	0.47	0.88	9.34
E	A27 West (Chichester Road)	0.84	5.11	19.04	0.76	3.15	11.59

Table 2-2: Crossbush junction assessment (2015 AM and PM)

Junction Arm		AM Peak (2015)			PM Peak (2015)		
Arm / Movement	Lane(s)	DoS (%)	MMQ[25] (PCUs)	Delay (s/PCU)	DoS (%)	MMQ (PCUs)	Delay (s/PCU)
A27 Westbound Left Turn	1/1	5	1	7	29	4	10
A27 Westbound Ahead	1/2	101	61	87	94	37	40
A27 WB Circulatory	2/1	80	12	68	34	5	44
A284 Northbound	3/1+3/2	98	19	126	95	18	99
A284 N/B Circulatory Right Turn	4/1	79	2	6	74	2	5
N/B Circulatory Give-way Right	5/1	38	5	22	25	4	10
Total Delay (PCUhr)		50.51			27.36		
Practical Reserve Capacity (%)		-12.7			-5.5		

Journey times

2.3.19 The average peak period journey times on the A27 between the junctions of A27/A29 at Fontwell, and Blakehurst Lane/ Poling Street to the east of Crossbush, extending 8.5km, are presented in Table 2-3. This data illustrates the typical peak period traffic conditions along the A27 within the study area, and compares it to free flow conditions (based on the lowest inter-peak journey time in either direction).

[25] Mean Maximum Queue

Table 2-3: Base year (2015) A27 journey times

ROUTE		AM	IP	PM
A27 EB	**Journey time**	10:38	10:03	17:58
	Increase relative to free flow	+0:35	0.00	+7:45
A27 WB	**Journey time**	11:09	10:51	10:03
	Increase relative to free flow	+1:06	+0:48	00:00

2.3.20 The free flow time to travel this route is about 10 minutes. Travelling along the A27 eastbound during the PM peak period is the longest journey duration of all the time periods, taking up to 7 minutes longer than in the AM and inter-peak periods. Much of this delay is caused by the lack of capacity in the section of the A27 near Arundel Station which results in traffic queuing back through Causeway junction and to Ford Road roundabout. The longer journey times in an eastbound direction reflects the tidal nature of the traffic volumes which indicate higher traffic volumes westbound in the morning peak, and eastbound in the evening peak.

2.3.21 During the AM peak, the route is less affected by congestion, as the journey only takes an extra 35 seconds eastbound. In the westbound direction, it is the AM peak which takes the longest of journeys for this direction, with delays of over 1 minute.

2.3.22 Journey time reliability is one of the main issues associated with the Arundel section of the A27. The current congestion and delays impact upon the efficient and safe movement of people and goods within the area.

Collisions

2.3.23 Analysis has been undertaken of data available for all personal injury collisions (PICs) that have been reported on the section of the A27 between the A27 junctions with the A29, to the west, and with Crossbush Lane to the east over the latest 5-year period; 2013-2017. Rates and trends identified are compared with national statistics for rural A roads, as presented in 'Reported Road Casualties Great Britain: 2017 Annual Report' (RCGB)[26].

[26] Department for Transport, "Reported Road Casualties Great Britain: 2017 Annual Report," September 2018. Available [Online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/755698/rrcgb-2017.pdf. [Accessed 14/07/19]

2.3.24 There have been 81 personal injury collisions recorded in the latest 5-year period (2013-2017) on the existing A27; resulting in 121 casualties. A broadly similar number of PICs and resulting casualties have been recorded each year; on average 16 PICs and 24 casualties. Although there have been no fatalities in the latest 5-year period, 12% (15) of all casualties are recorded as serious, increasing to 19% of all casualties in 2017. Whilst the 5-year killed and seriously injured (KSI) casualty rate is comparable with national statistics for all rural A roads, the 2017 rate is significantly higher. National rates, as presented in RCGB (2017), report KSIs as accounting for 13% of all casualties in the same 5 year period and 14% of all casualties in 2017.

2.3.25 More than half (47) of the PICs were recorded on the existing single carriageway section of the A27. In turn, more than half (8) of all PICs resulting in serious injury were recorded on the single carriageway section.

2.3.26 The distribution of PICs recorded and factors contributing to their occurrence are common to a heavily trafficked, high speed, strategic rural A road; with key collision types identified as:

- Loss of control - 14 collisions: 6 on single carriageway, 5 on dual west, 3 on dual east
- Rear-end shunts in traffic - 13 collisions: all on single carriageway section
- Side roads/accesses - 10 collisions: 9 on single carriageway, 1 on dual west
- Rear-end shunts at roundabouts - 21 collisions: 10 at Crossbush Roundabout, 9 at Ford Road Roundabout

Lack of alternative modes of travel

2.3.27 Analysis of 2001 and 2011 Census Journey to Work data for East Sussex and West Sussex indicated that the proportion of non-car based modes has increased relative to travel by car in recent years. However, population growth has led to a continued increase in the volume of car-based travel demand. The level of increase in vehicle use is greater than the corresponding reduction in vehicle trips achieved through modal transfer.

2.3.28 The existing bus services operating around Arundel provide connections to a number of destinations including Chichester, Worthing and Littlehampton, and offer an alternative transport mode for local traffic. There are currently no regular long-distance services operating along the A27 to offer a suitable alternative transport mode for through traffic.

2.3.29 Southern Railway operates rail services through Arundel between London Victoria and Bognor Regis. There are currently no direct services operating through Arundel parallel to the A27 in an east-west direction. Passengers must change at Barnham or Ford for further services to Chichester, Portsmouth, Brighton and Littlehampton.

2.3.30 The PCF Stage 2 Multi-Modal Study[27] summarised the potential impact of public transport schemes and travel demand management, and concluded that whilst these options could move a small proportion of trips off the road network, the problems along the A27, and the objectives relating to the A27 Arundel Bypass, still had to be addressed.

2.3.31 The London and South Coast Rail Corridor Study[28] looked at infrastructure investment priorities for the London to South Coast Corridor. The Sussex Area Route Study[29] also examined opportunities for improvement and the practicality and costs of improvements to the Coastway rail service. Neither study recommended improvements in the Arundel area as a priority nor found them to offer good value for money.

2.3.32 The PCF Stage 2 Multi-Modal Study concluded that:

"Neither the South East Route: Sussex Area Route Study or the London and South Coast Rail Corridor Study recommended improvements in the Arundel area as a priority, nor found them to offer good value for money".

"Since no significant improvements are planned for the Coastway Services it is unlikely that the rail network alone will be able to support the regional growth aspirations along the corridor."

"People travelling on foot will remain similar to current levels of approximately 10%. Furthermore, the combination of through traffic (67%) and local traffic (33%) using the A27 means that walking (…and cycling…) will not always be a suitable alternative to car travel."

2.3.33 In summary, there is no evidence to suggest that there would be any material switch from road to rail along the A27 corridor between Chichester and Brighton that would reduce congestion at Arundel.

[27] A27 Arundel Bypass – PCF Stage 2 Multi-Modal Study, Highways England (August 2017)

[28] London & South Coast Rail Corridor Study, Department for Transport (April 2016)

[29] South East Route: Sussex Area Route Study, Network Rail (September 2015)

3 Summary

3.1 Overview of modelling and economic appraisal

2015 base year model

3.1.1 The transport model utilised in the A27 Arundel Bypass PCF Stage 2 Further Consultation assessment is the same model used in PCF Stage 2 as the model remains suitable for this stage of appraisal. This model has been derived from the South East Regional Traffic Model (SERTM) (Version DF3). A cordon of the SERTM (network and matrix) has been extracted to produce the PCF Stage 2 A27 transport model.

3.1.2 The PCF Stage 2 A27 transport model modelled time periods are:

- AM Peak (average hour: 07:00 - 10:00)
- Inter Peak (average hour: 10:00 - 16:00)
- PM Peak (average hour: 16:00 - 19:00)

3.1.3 There is a Variable Demand component to the model. The Department for Transport's (DfT's) DIADEM (Dynamic Integrated Assignment and Demand Modelling) software (version 6.3.3) has been used for setting up the transport demand model and finding equilibrium between demand and supply, using SATURN as the supply model.

3.1.4 The model calibration and validation process (see chapters 9 and 10) was undertaken successfully and shows the model provides a satisfactory representation of the existing traffic situation across all peaks.

3.1.5 The link flow calibration and validation results for all time periods are at a sufficient standard to provide confidence that the model is replicating existing traffic conditions. Screenlines and journey time data provide further confirmation that the PCF Stage 2 A27 base year transport model reasonably represents 2015 observed traffic conditions.

3.1.6 Table 3-1 sets out the flow calibration and validation and journey time validation results.

Table 3-1: Performance of base year model

Peak	Flow calibration			Flow validation			Journey time	
	No. of links	%Flow criteria	%GEH	No. of links	%Flow criteria	%GEH	No. of routes	Pass
AM	40	98%	93%	56	93%	88%	16	100%
PM		98%	98%		93%	86%		94%

3.1.7 The PCF Stage 2 A27 transport model calibration is above the 85% threshold (see section 9.1.10 and 9.1.11) for all peak hours for all vehicles. Similarly, in terms of model validation, all link flow and GEH[30] criteria are above the 85% threshold for AM, Inter and PM peak periods. This indicates the modelled data provides a good fit with the observed data and provides a suitable basis for transport forecasting and scheme appraisal.

Traffic forecasts

3.1.8 A description of the traffic forecasting methodology is presented in chapter 11 and the results in chapter 12. The forecast years are:

- 2026 opening year
- 2041 design year
- 2051 final forecast year

3.1.9 Data was provided by Local Authorities to determine the anticipated level of development surrounding the A27 and proposed Scheme:

- West Sussex County Council
- Adur and Worthing Councils
- Arun District Council

3.1.10 The Local Authorities provided information for potential residential and employment development sites and infrastructure schemes in their respective areas. This information was analysed and the development sites were entered into an Uncertainty Log.

[30] The GEH statistic is similar to a chi-squared test and is used in traffic modelling to compare two sets of traffic volumes. The GEH formula gets its name from Geoffrey E. Havers, who invented it

Economic appraisal

3.1.11 The appraisal of the economic elements associated with the Scheme has been undertaken in accordance with WebTAG Unit A1.1 Cost-Benefit Analysis and is described in detail in chapter 13.

3.1.12 Transport User Benefit Appraisal (TUBA) version 1.9.12 with TUBA Economics File (version 1.9.12) using TAG Data Book v1.11 (November 2018). TUBA was used to carry out the economic appraisal of the A27 Arundel Bypass Scheme.

3.1.13 COst and Benefit to Accidents – Light Touch (COBALT) version 2013.02 with COBALT parameter file (version 2018.1) has been used to undertake the assessment of accident impacts.

3.1.14 The cost of delays during construction were estimated by coding traffic management measures provided by the Morgan Sindall buildability report (April 2019) in the SATURN Do Minimum models for 2026 and comparing the 2026 construction models against the 2026 Do Minimum models. The TUBA v1.9.12 program has been used to calculate the dis-benefit occurring as a result of construction of the A27 Arundel Bypass options. No maintenance profiles were available to enable an estimate of maintenance impacts.

3.1.15 A Wider Impacts Transport Assessment captures the impacts of a transport intervention which are additional to those experienced directly by the transport user (transport user benefits being journey time reductions and fewer collisions etc.). Based on scoping of the likely impacts of the A27 Arundel Bypass, three types of wider impact have been assessed:

- Agglomeration improvement benefits
- Labour market supply impacts
- Output change in imperfectly competitive markets

Summary of benefits and costs (£m)

3.1.16 Table 3-2 sets out a PCF Stage 2 Further Consultation summary of benefits and costs comprising travel time benefits from TUBA, accident benefits from COBALT, construction delays, greenhouse gases, air quality and noise impacts and costs for the A27 Arundel Bypass options. These form the basis of the initial BCR. An adjusted BCR has also been estimated to account for the wider economic benefits. Further detail is presented in chapters 13 and 14.

Table 3-2: Summary of benefits and costs (£m)

	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Present Value of Benefits (initial)	226.40	220.91	264.31	280.84	304.74	294.07
Present Value of Benefits (adjusted)	**286.76**	**266.80**	**350.24**	**352.66**	**377.19**	**378.47**
Present Value of Costs	**132.99**	**129.65**	**161.61**	**174.82**	**183.06**	**193.97**
Initial BCR	**1.70**	**1.70**	**1.64**	**1.61**	**1.66**	**1.52**
Adjusted BCR	**2.16**	**2.06**	**2.17**	**2.02**	**2.06**	**1.95**

Sources of costs

3.1.17 The overall scheme costs for the A27 Arundel Bypass for all six options have been produced by Highway's England's Commercial Services Division. These prices have been inflated to outturn costs using Highways England's projected construction related inflation and then rebased to 2010 prices, using factors published in the TAG Databook, for economic calculations.

Sources of benefits

3.1.18 The majority of the benefits associated with the A27 Arundel Bypass options are associated with travel time benefits calculated using TUBA. The TUBA impacts also include impacts (dis-benefits) during construction.

3.1.19 Consistent across all options, most origin sectors/areas have strong benefits, with those sectors/areas away from the Scheme demonstrating higher benefits, and for sectors/areas closer to the Scheme showing lower benefits or, in the case of a few, disbenefits. This is indicative of long-distance trips benefitting more from the Scheme when compared to local trips. The destinations sectors/areas generally show lower benefits overall. Disbenefits to sectors/areas to the east of the modelled area occur mainly as a result of increased delays in the Worthing and Lancing area due to increased traffic on the existing A27.

3.1.20 There are benefits arising from accident savings for all options. The creation of new links leads to accidents where there were none before, such as on new bypass sections of the Scheme. However, junctions and links designed to modern highway standards are associated with lower accident rates than existing ones. The transfer of traffic from the local routes on to the proposed A27 Arundel Bypass results in less traffic on the existing A27 / relieved route and other alternative routes, and consequently fewer accidents, translating to accident savings.

3.1.21 There are wider impact benefits associated with the Scheme due to a) agglomeration impacts b) output change in imperfectly competitive markets c) labour supply impacts.

3.1.22 The environmental impacts associated with the Scheme include benefits associated with air quality, and dis-benefits associated with noise and greenhouse gases. Further information is presented in the SAR.

Demand growth along the route (Do Minimum)

3.1.23 Table 3-3 sets out the estimated AADT flows along the route of the A27 Arundel Bypass for the 2026 opening year and 2041 design year without the Scheme included i.e. Do Minimum. The lack of traffic growth between the opening year and design year reflects the capacity constraints on the existing A27 route in the Do Minimum scenario.

Table 3-3: Change in demand growth (Do Minimum)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	31,096	31,904	3%
A27 Mill Road to Shellbridge Road	31,630	32,361	2%
A27 Binsted Lane to Ford Roundabout	28,018	28,217	1%
A27 Ford Roundabout to Causeway Roundabout	32,771	31,443	-4%
A27 Causeway Roundabout to Crossbush Lane	39,686	40,331	2%
A27 Crossbush Lane to Crossbush Junction	39,364	39,998	2%
Distance-weighted Average	31,572	31,989	1%

Demand growth along the route (Do Something)

3.1.24 Table 3-4 to Table 3-9 sets out the estimated AADT flows along the route of the A27 Arundel Bypass for the 2026 opening year and 2041 design year with the Scheme included, for all the options.

Table 3-4: Change in demand growth (Option 1V5)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	42,421	45,440	7%
A27 Mill Road to Shellbridge Road	43,767	47,064	8%
A27 Binsted Lane to Ford Roundabout	43,297	46,664	8%
A27 Ford Roundabout to Causeway Roundabout	15,963	18,824	18%
A27 Causeway Roundabout to Crossbush Lane	20,059	23,015	15%
A27 Crossbush Lane to Crossbush Junction	20,957	24,037	15%
Distance-weighted Average	37,872	41,036	8%

Table 3-5: Change in demand growth (Option 1V9)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	43,000	46,281	8%
A27 Mill Road to Shellbridge Road	44,068	47,731	8%
A27 Binsted Lane to Ford Roundabout	43,215	46,886	8%
A27 Ford Roundabout to Causeway Roundabout	8,456	9,993	18%
A27 Causeway Roundabout to Crossbush Lane	11,482	13,344	16%
A27 Crossbush Lane to Crossbush Junction	11,872	13,810	16%
Distance-weighted Average	34,111	37,133	9%

Table 3-6: Change in demand growth (Option 3V1)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	43,968	46,814	6%
A27 Mill Road to Shellbridge Road	45,292	48,479	7%
A27 Binsted Lane to Ford Roundabout	3,952	4,272	8%
A27 Ford Roundabout to Causeway Roundabout	16,779	19,353	15%
A27 Causeway Roundabout to Crossbush Lane	18,451	21,253	15%
A27 Crossbush Lane to Crossbush Junction	19,062	22,012	15%
Distance-weighted Average	23,255	25,254	9%

Table 3-7: Change in demand growth (Option 4/5AV1)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	45,624	48,378	6%
A27 Mill Road to Shellbridge Road	45,624	48,378	6%
A27 Binsted Lane to Ford Roundabout	3,833	4,260	11%
A27 Ford Roundabout to Causeway Roundabout	16,258	18,548	14%
A27 Causeway Roundabout to Crossbush Lane	18,041	20,474	13%
A27 Crossbush Lane to Crossbush Junction	18,791	21,295	13%
Distance-weighted Average	25,279	27,284	8%

Table 3-8: Change in demand growth (Option 4/5AV2)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	46,087	49,047	6%
A27 Mill Road to Shellbridge Road	46,087	49,047	6%
A27 Binsted Lane to Ford Roundabout	3,834	4,384	14%
A27 Ford Roundabout to Causeway Roundabout	16,368	18,992	16%
A27 Causeway Roundabout to Crossbush Lane	18,151	20,966	16%
A27 Crossbush Lane to Crossbush Junction	18,888	21,790	15%
Distance-weighted Average	22,852	24,885	9%

Table 3-9: Change in demand growth (Option 5BV1)

Link	AADT (opening year)	AADT (design year)	AADT change (%)
A27 Fontwell roundabout to Mill Road	46,840	50,122	7%
A27 Mill Road to Shellbridge Road	4,499	4,833	7%
A27 Binsted Lane to Ford Roundabout	3,680	4,599	25%
A27 Ford Roundabout to Causeway Roundabout	16,549	18,888	14%
A27 Causeway Roundabout to Crossbush Lane	18,397	21,042	14%
A27 Crossbush Lane to Crossbush Junction	19,134	21,861	14%
Distance-weighted Average	19,346	21,332	10%

Key monetised benefits and costs

3.1.25 Table 3-10 to Table 3-15 shows the key monetised benefits and costs for the A27 Arundel Bypass for Option 1V5, Option 1V9, Option 3V1, Option 4/5AV1, Option 4/5AV2 and Option 5BV1 respectively.

Table 3-10: Key monetised costs and benefits (Option 1V5)

Category	Benefits and costs in £'000 (PV)
Business Users	
Journey Time Savings	70933
Vehicle Operating Costs	410
Non-Business users	
Journey Time Savings	164552
Vehicle Operating Costs	-14764
Reliability	
Business Reliability	N/A
Non-business Reliability	N/A
Safety	
Safety	23210
Environmental Impacts	
Noise	-5074
Local Air Quality	-6852
Greenhouse Gases	-10724
Landscape	N/A
Wider Economic Impacts	
Agglomeration	54159
Market Competition	4771
Dependent Development	N/A
Labour Supply	1430
Customer Impact	
Traffic delays due to Construction	-8959
Traffic impacts due to Maintenance	N/A
Journey Quality	N/A
Developer contributions	
Developer contributions	N/A
Other Impacts	
Indirect tax Revenues	-13670
[Other - please specify]	N/A
Costs	
Cost to Broad Transport Budget	132993
Cost savings(where relevant)*	N/A

Table 3-11: Key monetised costs and benefits (Option 1V9)

Category	Benefits and costs in £'000 (PV)
Business Users	
Journey Time Savings	66827
Vehicle Operating Costs	3195
Non-Business users	
Journey Time Savings	151547
Vehicle Operating Costs	-5936
Reliability	
Business Reliability	N/A
Non-business Reliability	N/A
Safety	
Safety	21815
Environmental Impacts	
Noise	-5423
Local Air Quality	-2656
Greenhouse Gases	-7718
Landscape	N/A
Wider Economic Impacts	
Agglomeration	40238
Market Competition	4536
Dependent Development	N/A
Labour Supply	1117
Customer Impact	
Traffic delays due to Construction	-8959
Traffic impacts due to Maintenance	N/A
Journey Quality	N/A
Developer contributions	
Developer contributions	N/A
Other Impacts	
Indirect tax Revenues	-7989
[Other - please specify]	N/A
Costs	
Cost to Broad Transport Budget	129647
Cost savings(where relevant)*	N/A

Table 3-12: Key monetised costs and benefits (Option 3V1)

Category	Benefits and costs in £'000 (PV)
Business Users	
Journey Time Savings	83286
Vehicle Operating Costs	-449
Non-Business users	
Journey Time Savings	192031
Vehicle Operating Costs	-18394
Reliability	
Business Reliability	N/A
Non-business Reliability	N/A
Safety	
Safety	21970
Environmental Impacts	
Noise	-1997
Local Air Quality	-7736
Greenhouse Gases	-13477
Landscape	N/A
Wider Economic Impacts	
Agglomeration	78109
Market Competition	6029
Dependent Development	N/A
Labour Supply	1789
Customer Impact	
Traffic delays due to Construction	-6634
Traffic impacts due to Maintenance	N/A
Journey Quality	N/A
Developer contributions	
Developer contributions	N/A
Other Impacts	
Indirect tax Revenues	-15713
[Other - please specify]	N/A
Costs	
Cost to Broad Transport Budget	161605
Cost savings(where relevant)*	N/A

Table 3-13: Key monetised costs and benefits (Option 4/5AV1)

Category	Benefits and costs in £'000 (PV)
Business Users	
Journey Time Savings	81457
Vehicle Operating Costs	4840
Non-Business users	
Journey Time Savings	190072
Vehicle Operating Costs	-10724
Reliability	
Business Reliability	N/A
Non-business Reliability	N/A
Safety	
Safety	29022
Environmental Impacts	
Noise	-880
Local Air Quality	-7462
Greenhouse Gases	-9644
Landscape	N/A
Wider Economic Impacts	
Agglomeration	64259
Market Competition	5888
Dependent Development	N/A
Labour Supply	1673
Customer Impact	
Traffic delays due to Construction	-7528
Traffic impacts due to Maintenance	N/A
Journey Quality	N/A
Developer contributions	
Developer contributions	N/A
Other Impacts	
Indirect tax Revenues	-11684
[Other - please specify]	N/A
Costs	
Cost to Broad Transport Budget	174819
Cost savings(where relevant)*	N/A

Table 3-14: Key monetised costs and benefits (Option 4/5AV2)

Category	Benefits and costs in £'000 (PV)
Business Users	
Journey Time Savings	86883
Vehicle Operating Costs	5011
Non-Business users	
Journey Time Savings	196730
Vehicle Operating Costs	-3924
Reliability	
Business Reliability	N/A
Non-business Reliability	N/A
Safety	
Safety	36904
Environmental Impacts	
Noise	-856
Local Air Quality	-6631
Greenhouse Gases	-8107
Landscape	N/A
Wider Economic Impacts	
Agglomeration	65286
Market Competition	5910
Dependent Development	N/A
Labour Supply	1644
Customer Impact	
Traffic delays due to Construction	-7528
Traffic impacts due to Maintenance	N/A
Journey Quality	N/A
Developer contributions	
Developer contributions	N/A
Other Impacts	
Indirect tax Revenues	-5870
[Other - please specify]	N/A
Costs	
Cost to Broad Transport Budget	183060
Cost savings(where relevant)*	N/A

Table 3-15: Key monetised costs and benefits (Option 5Bv1)

Category	Benefits and costs in £'000 (PV)
Business Users	
Journey Time Savings	81193
Vehicle Operating Costs	4377
Non-Business users	
Journey Time Savings	194499
Vehicle Operating Costs	-9832
Reliability	
Business Reliability	N/A
Non-business Reliability	N/A
Safety	
Safety	35026
Environmental Impacts	
Noise	-1669
Local Air Quality	-7128
Greenhouse Gases	-6547
Landscape	N/A
Wider Economic Impacts	
Agglomeration	76080
Market Competition	6458
Dependent Development	N/A
Labour Supply	1858
Customer Impact	
Traffic delays due to Construction	-6941
Traffic impacts due to Maintenance	N/A
Journey Quality	N/A
Developer contributions	
Developer contributions	N/A
Other Impacts	
Indirect tax Revenues	-11094
[Other - please specify]	N/A
Costs	
Cost to Broad Transport Budget	193966
Cost savings(where relevant)*	N/A

Key quantified benefits

3.1.26 Table 3-16 to Table 3-21 shows the key quantified benefits and costs for the A27 Arundel Bypass for Option 1V5, Option 1V9, Option 3V1, Option 4/5AV1, Option 4/5AV2 and Option 5BV1 respectively. Casualty savings are presented as the number of fatalities, seriously injured and slightly injured, and these relate specifically to the number of accidents saved.

Table 3-16: Key quantified benefits: Option 1V5

Category	Quantified impacts	Units
Journey times		
Journey Time Savings	6.4	*(average saving per journey on scheme sections in minutes)**
Accidents	411	*(total number saved)*
Fatalities	4	*(total number saved)*
Seriously injured	85	*(total number saved)*
Slightly injured	500	*(total number saved)*
Environmental Impacts		
Number of Noise important areas affected	4	*(number)*
Names of AQMAs	Storrington Chichester Worthing	*(names)*
Change in NOx emissions	304	*(tonnes)*
Change in PM10 emissions	94	*(tonnes)*
Change in greenhouse gas emissions	247,028	*(tonnes CO2e)*
Customer Impact: Totals		
Traffic delays due to Construction	2,279	*(total loss on scheme sections in hours)*
Traffic impacts due to Maintenance	N/A	*(total impact on scheme sections in hours)*
Customer Impact: Per journey		
Traffic delays due to Construction (cars)	2.98	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (LGVs)	-0.09	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (HGVs)	-0.003	*(average loss per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (cars)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (LGVs)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (HGVs)	N/A	*(average impact per journey on scheme sections in minutes) **

Table 3-17: Key quantified benefits: Option 1V9

Category	Quantified impacts	Units
Journey times		
Journey Time Savings	5.6	*(average saving per journey on scheme sections in minutes)**
Accidents	397	*(total number saved)*
Fatalities	4	*(total number saved)*
Seriously injured	78	*(total number saved)*
Slightly injured	473	*(total number saved)*
Environmental Impacts		
Number of Noise important areas affected	3	*(number)*
Names of AQMAs	Storrington Worthing	*(names)*
Change in NOx emissions	259	*(tonnes)*
Change in PM10 emissions	24	*(tonnes)*
Change in greenhouse gas emissions	177353	*(tonnes CO2e)*
Customer Impact: Totals		
Traffic delays due to Construction	2,279	*(total loss on scheme sections in hours)*
Traffic impacts due to Maintenance	N/A	*(total impact on scheme sections in hours)*
Customer Impact: Per journey		
Traffic delays due to Construction (cars)	2.98	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (LGVs)	-0.09	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (HGVs)	0.003	*(average loss per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (cars)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (LGVs)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (HGVs)	N/A	*(average impact per journey on scheme sections in minutes) **

Table 3-18: Key quantified benefits: Option 3V1

Category	Quantified impacts	Units
Journey times		
Journey Time Savings	6.9	*(average saving per journey on scheme sections in minutes)**
Accidents	379	*(total number saved)*
Fatalities	4	*(total number saved)*
Seriously injured	85	*(total number saved)*
Slightly injured	457	*(total number saved)*
Environmental Impacts		
Number of Noise important areas affected	5	*(number)*
Names of AQMAs	Storrington Worthing	*(names)*
Change in NOx emissions	385	*(tonnes)*
Change in PM10 emissions	103	*(tonnes)*
Change in greenhouse gas emissions	309819	*(tonnes CO2e)*
Customer Impact: Totals		
Traffic delays due to Construction	1,164	*(total loss on scheme sections in hours)*
Traffic impacts due to Maintenance	N/A	*(total impact on scheme sections in hours)*
Customer Impact: Per journey		
Traffic delays due to Construction (cars)	1.93	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (LGVs)	0.03	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (HGVs)	0.08	*(average loss per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (cars)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (LGVs)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (HGVs)	N/A	*(average impact per journey on scheme sections in minutes) **

Table 3-19: Key quantified benefits: Option 4/5AV1

Category	Quantified impacts	Units
Journey times		
Journey Time Savings	6.8	*(average saving per journey on scheme sections in minutes)**
Accidents	527	*(total number saved)*
Fatalities	8	*(total number saved)*
Seriously injured	105	*(total number saved)*
Slightly injured	639	*(total number saved)*
Environmental Impacts		
Number of Noise important areas affected	4	*(number)*
Names of AQMAs	Storrington Worthing	*(names)*
Change in NOx emissions	273	*(tonnes)*
Change in PM10 emissions	108	*(tonnes)*
Change in greenhouse gas emissions	222105	*(tonnes CO2e)*
Customer Impact: Totals		
Traffic delays due to Construction	1,350	*(total loss on scheme sections in hours)*
Traffic impacts due to Maintenance	N/A	*(total impact on scheme sections in hours)*
Customer Impact: Per journey		
Traffic delays due to Construction (cars)	2.14	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (LGVs)	0.05	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (HGVs)	0.07	*(average loss per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (cars)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (LGVs)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (HGVs)	N/A	*(average impact per journey on scheme sections in minutes) **

Table 3-20: Key quantified benefits: Option 4/5AV2

Category	Quantified impacts	Units
Journey times		
Journey Time Savings	6.9	*(average saving per journey on scheme sections in minutes)**
Accidents	727	*(total number saved)*
Fatalities	9	*(total number saved)*
Seriously injured	133	*(total number saved)*
Slightly injured	878	*(total number saved)*
Environmental Impacts		
Number of Noise important areas affected	4	*(number)*
Names of AQMAs	Storrington Worthing	*(names)*
Change in NOx emissions	233	*(tonnes)*
Change in PM10 emissions	97	*(tonnes)*
Change in greenhouse gas emissions	187208	*(tonnes CO2e)*
Customer Impact: Totals		
Traffic delays due to Construction	1,350	*(total loss on scheme sections in hours)*
Traffic impacts due to Maintenance	N/A	*(total impact on scheme sections in hours)*
Customer Impact: Per journey		
Traffic delays due to Construction (cars)	2.14	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (LGVs)	0.05	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (HGVs)	0.07	*(average loss per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (cars)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (LGVs)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (HGVs)	N/A	*(average impact per journey on scheme sections in minutes) **

Table 3-21: Key quantified benefits: Option 5BV1

Category	Quantified impacts	Units
Journey times		
Journey Time Savings	7.1	*(average saving per journey on scheme sections in minutes)**
Accidents	676	*(total number saved)*
Fatalities	9	*(total number saved)*
Seriously injured	126	*(total number saved)*
Slightly injured	817	*(total number saved)*
Environmental Impacts		
Number of Noise important areas affected	4	*(number)*
Names of AQMAs	Storrington-Beneficial Worthing-Imperceptible	*(names)*
Change in NOx emissions	209	*(tonnes)*
Change in PM10 emissions	108	*(tonnes)*
Change in greenhouse gas emissions	151808	*(tonnes CO2e)*
Customer Impact: Totals		
Traffic delays due to Construction	1,197	*(total loss on scheme sections in hours)*
Traffic impacts due to Maintenance	N/A	*(total impact on scheme sections in hours)*
Customer Impact: Per journey		
Traffic delays due to Construction (cars)	1.92	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (LGVs)	0.04	*(average loss per journey on scheme sections in minutes) **
Traffic delays due to Construction (HGVs)	0.07	*(average loss per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (cars)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (LGVs)	N/A	*(average impact per journey on scheme sections in minutes) **
Traffic impacts due to Maintenance (HGVs)	N/A	*(average impact per journey on scheme sections in minutes) **

Key performance indicators

3.1.27 Table 3-22 to Table 3-27 shows the key performance indicators for the A27 Arundel Bypass for Option 1V5, Option 1V9, Option 3V1, Option 4/5AV1, Option 4/5AV2 and Option 5BV1 respectively.

Table 3-22: Key performance indicators (Option 1V5)

Strategic Outcome	KPI	Scheme contribution – qualitative	Scheme contribution - quantitative
Making the network safer	The number of KSIs on the SRN.	A reduction in the total number of collisions and the number of KSIs on the SRN within the scheme extents (from Mill Road / Tye Lane to Crossbush junction)	See section 14.4
Delivery of better environmental outcomes	Noise: Number of Noise Important Areas (NIA) mitigated. Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	NIAs to the west of the Scheme, along the A27, at Ford Road roundabout, and to the east and south of Crossbush (6158, 5490, 12489, 5488, 12488, 5485, 5486, 5484, 6157, 12485, 5482 and 12486) generally experience a minor to moderate adverse impact in the short-term, and negligible impact in the long-term. Properties within NIA 5487 along the A27 would be demolished.* Biodiversity improvements an early stage of design and will be assessed at PCF Stage 3 for the Option selected as the Preferred Route.	N/A
Helping cyclists / walkers and other vulnerable users	The number of new and upgraded crossings	Scheme does not include any new or upgraded crossings.	0
***It should be noted that what is being reported here are the impacts for all the NIAs in the Study Area and not just those that are mitigated.**			

Table 3-23: Key performance indicators (Option 1V9)

Strategic Outcome	KPI	Scheme contribution – qualitative	Scheme contribution - quantitative
Making the network safer	The number of KSIs on the SRN.	A reduction in the total number of collisions and the number of KSIs on the SRN	See section 14.4
Delivery of better environmental outcomes	Noise: Number of Noise Important Areas mitigated. Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	NIAs to the west of the Scheme, along the existing A27, and to the east and south of Crossbush (12491, 5491, 12490, 6158, 5490, 12489, 5487, 5488, 12488, 5485, 5486, 5484, 6157) generally experience a negligible to minor adverse impact, and negligible impact in the long-term; although two areas continue to experience minor adverse impact in the long-term (6157 and 5486). Conversely, two properties within NIAs 6157 and 5487 experience a minor beneficial impact in the short-term and negligible in the long-term.* Biodiversity improvements an early stage of design and will be assessed at PCF Stage 3 for the Option selected as the Preferred Route.	N/A
Helping cyclists / walkers and other vulnerable users	The number of new and upgraded crossings	Scheme includes new signalised crossing infrastructure providing an at-grade route across Ford Road Roundabout	1 location – new signalised crossing facilities
***It should be noted that what is being reported here are the impacts for all the NIAs in the Study Area and not just those that are mitigated.**			

Table 3-24: Key performance indicators (Option 3V1)

Strategic Outcome	KPI	Scheme contribution – qualitative	Scheme contribution - quantitative
Making the network safer	The number of KSIs on the SRN.	A reduction in the total number of collisions and the number of KSIs on the SRN	See section 14.4
Delivery of better environmental outcomes	Noise: Number of Noise Important Areas mitigated. Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	NIAs to the west of the Scheme (6158 and 5490) generally experience a minor adverse impact in the short-term, and negligible impact in the long-term. NIAs to the east and south of Crossbush (12486, 12485 and 5482) experience a minor to moderate adverse impact in the short-term and long-term. NIAs along the existing A27 through Arundel (12489, 5487, 5488, 12488, 5485 and 5486) generally experience a minor to moderate beneficial impact in the short-term and negligible to minor beneficial impact in the long-term.* Biodiversity improvements an early stage of design and will be assessed at PCF Stage 3 for the Option selected as the Preferred Route.	N/A
Helping cyclists / walkers and other vulnerable users	The number of new and upgraded crossings	Scheme does not include any new or upgraded crossings.	0
***It should be noted that what is being reported here are the impacts for all the NIAs in the Study Area and not just those that are mitigated.**			

Table 3-25: Key performance indicators (Option 4/5AV1)

Strategic Outcome	KPI	Scheme contribution – qualitative	Scheme contribution - quantitative
Making the network safer	The number of KSIs on the SRN.	A reduction in the total number of collisions and the number of KSIs on the SRN	See section 14.4
Delivery of better environmental outcomes	Noise: Number of Noise Important Areas mitigated. Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	NIAs to the west of the Scheme (6158 and 5490) and to the east and south of Crossbush (12486, 12485 and 5482) generally experience a minor adverse impact in the short-term, and negligible impact in the long-term. NIAs along the existing A27 through Arundel (12489, 5487, 5488, 12488, 5485 and 5486) generally experience a moderate to major beneficial impact in the short-term and minor to moderate beneficial impact in the long-term.* Biodiversity improvements an early stage of design and will be assessed at PCF Stage 3 for the Option selected as the Preferred Route.	N/A
Helping cyclists / walkers and other vulnerable users	The number of new and upgraded crossings	Scheme does not include any new or upgraded crossings.	0
***It should be noted that what is being reported here are the impacts for all the NIAs in the Study Area and not just those that are mitigated.**			

Table 3-26: Key performance indicators (Option 4/5AV2)

Strategic Outcome	KPI	Scheme contribution – qualitative	Scheme contribution - quantitative
Making the network safer	The number of KSIs on the SRN.	A reduction in the total number of collisions and the number of KSIs on the SRN	See section 14.4
Delivery of better environmental outcomes	Noise: Number of Noise Important Areas mitigated. Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	NIAs to the west of the Scheme (6158 and 5490) and to the east and south of Crossbush (12486, 12485 and 5482) generally experience a minor adverse impact in the short-term, and negligible impact in the long-term. NIAs along the existing A27 through Arundel (12489, 5487, 5488, 12488, 5485 and 5486) generally experience a moderate to major beneficial impact in the short-term and minor to moderate beneficial impact in the long-term.* Biodiversity improvements an early stage of design and will be assessed at PCF Stage 3 for the Option selected as the Preferred Route.	N/A
Helping cyclists / walkers and other vulnerable users	The number of new and upgraded crossings	Scheme does not include any new or upgraded crossings.	0
***It should be noted that what is being reported here are the impacts for all the NIAs in the Study Area and not just those that are mitigated.**			

Table 3-27: Key performance indicators (Option 5BV1)

Strategic Outcome	KPI	Scheme contribution – qualitative	Scheme contribution - quantitative
Making the network safer	The number of KSIs on the SRN.	A reduction in the total number of collisions and the number of KSIs on the SRN	See section 14.4
Delivery of better environmental outcomes	Noise: Number of Noise Important Areas mitigated. Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	A NIA to the west of the Scheme (6158) and NIAs to the east and south of Crossbush (12486, 12487, 12485 and 5482) generally experience a minor adverse impact in the short-term, and negligible impact in the long-term. NIAs along the existing A27 through Arundel (12489, 5487, 5488, 12488, 5485 and 5486) generally experience a moderate to major beneficial impact in the short-term and minor to moderate beneficial impact in the long-term.* Biodiversity improvements an early stage of design and will be assessed at PCF Stage 3 for the Option selected as the Preferred Route.	N/A
Helping cyclists / walkers and other vulnerable users	The number of new and upgraded crossings	Scheme does not include any new or upgraded crossings.	0
***It should be noted that what is being reported here are the impacts for all the NIAs in the Study Area and not just those that are mitigated.**			

3.2 Summary of economic performance

3.2.1 The A27 Arundel Bypass options which performs most favourably in terms of initial BCR are Option 1V5 and Option 1V9 with a BCR of 1.70. This includes journey time and operating cost benefits, accident benefits, construction delay costs, greenhouse gases, air quality and noise. Options 3V1, 4/5Av1, 4/5AV2 and 5BV1 have BCRs of 1.64, 1.61, 1.66 and 1.52 respectively.

3.2.2 When the wider economic benefits are taken into account, Option 3V1 generates the highest BCR of 2.17, which is closely followed by Option 1V5 with 2.16. Option 1V9 and Option 4/5AV2 have a BCR of 2.06, with Option 4/5AV1 and Option 5BV1 having 2.02 and 1.95 respectively.

3.2.3 In summary, all options return a similar level of economic performance, with the range in initial and adjusted BCR's from highest to lowest of less than 0.25. All options return an initial BCR in the range of 1.5 – 2.0. All options return an adjusted BCR of just above 2.0, with the exception of 5BV1 which returns a BCR of just below 2.0.

3.3 Summary of major assumptions

3.3.1 The following key assumptions form part of the assessment of the A27 Arundel Bypass options:

Base model

- Use of SERTM (DF3) as the prior average peak hour model which informed the demand and supply components of the A27 transport model

Forecast models

- Variable demand modelling (see section 7.4) has been undertaken using the DfT DIADEM software (version 6.3.3) which has been used for setting up the transport demand model and finding equilibrium between demand and supply, using SATURN as the supply model

Economic appraisal

- There are 253 peaked weekdays (excludes weekdays falling on bank holidays) however specific AM peak and PM peak annualisation factors have been calculated using long term Automatic Traffic Counts (ATC's) which are:
  - AM peak (07:00-10:00): 759
  - PM peak (16:00-19:00): 759
  - Inter-peak (10:00-16:00): 1,518

3.3.2 The following are the key limitations associated with the PCF Stage 2 A27 transport model and forecast models. These limitations are typical of large strategic models and following review are not considered to detract from the model's suitability for the A27 scheme appraisals. These limitations apply equally to each option and are not considered to prejudice or benefit one option over another. The known limitations include the following:

- Although the model meets WebTAG standards in terms of calibration and validation, the model is not comprehensively validated against observed junction turning flows
- The variable demand model represents travel demands as Origin and Destination (O-D)[31] movements, not as Production and Attraction (P-A) movements, which does entail a small risk of not replicating any linkage and constraint on travel choices associated with outward and return home-based journeys during a typical day
- The model contains a proportionate and appropriate level of network and zone detail, in the areas of influence for the A27 scheme options but it does not include sufficient detail to replicate every intricate facet of how the scheme sections operate
- The model shows some coarseness in how travel demands are segmented into just five user classes
- A small number of locations within the model which are away from the vicinity of the A27 Arundel Bypass Scheme do not reflect the observed traffic flows within TAG GEH or flow criteria. These include:
  - A27 West of Chichester
  - A27 Chichester Bypass, north of A259
  - A27 Shoreham Bypass, near Shoreham-by-Sea
  - Some roads within urban areas such as Worthing, including Lyndhurst Road
- The coverage of calibration and validation count data does not cover all links within the broad model area, therefore the performance of the model on these links is not known. Where supplementary data is available, it has been identified that the modelled flows are not consistent with observed flows on Yapton Lane
- There are some differences between network coding within the base and forecast models. This includes the junction of Ford Road, where network coding detail was added in the forecast models for the purposes of air quality and noise assessment
- Some forecast scenarios converge only after a large number of iterations, or do not fully converge, in part due to the level of growth within the forecast matrices and associated model network capacity

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[31] An origin represents the start point for a trip and the destination the end point. Productions and attractions differ from origins and destinations. Based on the assumption that trips are produced by households and attracted to non-households, trips are produced by households even when they are returning home.

issues, in particular at the edges of the model including the Chichester area. Where 'model noise' results in spurious economic impacts, these impacts have been excluded from the final economic assessments

3.3.3 The outputs of the model, and their use, and considered carefully as part of the process of scheme appraisal to ensure the results are interpreted appropriately. Where there is significant deviation between observed and modelled flows in the A27 transport model, and where necessary for operational assessment, sensitivity tests have been undertaken based on different traffic flow forecasts.

3.3.4 There are differences between the specification and outputs of the A27 Arundel PCF Stage 2 and the A27 Arundel PCF Stage 2 Further Consultation forecast models. The latest forecasting has been updated to account for:

- a revised scheme opening year which has changed from 2023 to 2026
- the latest car forecast growth factors using the National Trip End Model (NTEM) version 7.2 datasets, published on 1 March 2017, which present a lower level of traffic growth than previous forecasts
- the updated LGV and HGV forecasts from the National Transport Model (NTM using the latest National Road Traffic Forecasts (NRTF) 2018 (Scenario 1, September 2018), which present a lower level of growth than previous forecasts
- up-to-date information on planning and infrastructure assumptions obtained from the local planning authorities in 2018
- a change in the level of certainty associated with key infrastructure schemes, with the A27 Worthing and Lancing scheme now forming part of the core scenario
- the latest generalised cost parameters for route assignment in pence per minute (PPM) and pence per kilometre (PPK) using the Highway England Transport Planning Group (TPG) Value of Time (VoT)/ Vehicle Operating Cost (VOC) spreadsheet (VoT_and_VOC_from_ webTAG_Databook (Nov 2018)

3.3.5 The A27 Arundel transport model would continue to be revised in further stages of work which may address, where possible, some of the limitations described above.

3.3.6 For the economic appraisal of the A27 Arundel Bypass scheme options, no quantification of journey time reliability has yet been undertaken. Furthermore, no benefits associated with weekends or bank holidays have been calculated. Where justified and quantified, journey time reliability and impacts on weekends and bank holidays would typically increase the level of economic benefit associated with a scheme.

4 Summary and review of existing data

4.1 Review of existing data

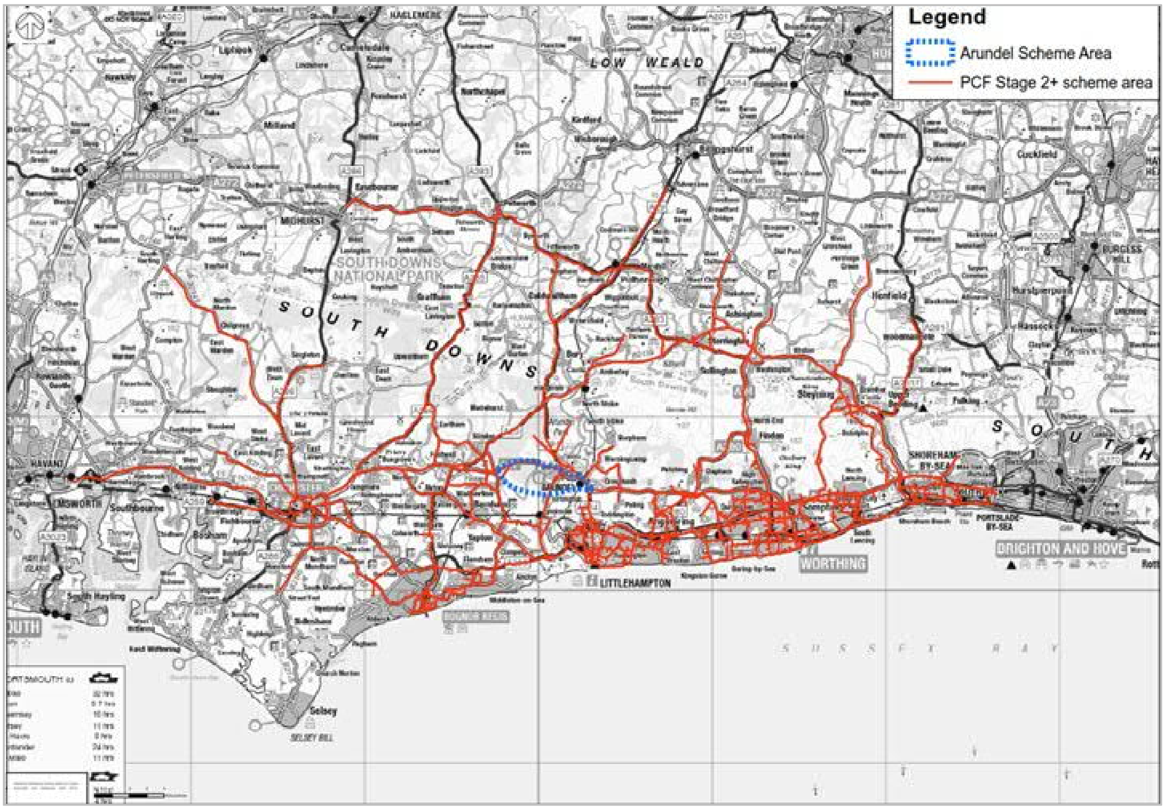
4.1.1 The PCF Stage 2 transport modelling process utilises SERTM (Version DF3) with the coverage shown in Figure 4-1. The SERTM was used to create a cordoned[34] model for PCF Stage 2 to assess the value for money of the A27 Arundel Bypass Scheme. The model developed during PCF Stage 2 prior to the 2018 preferred route announcement is used as a basis for the further analysis during the PCF Stage 2 Further Consultation.

Figure 4-1: Coverage of the South East Regional Traffic Model

4.1.2 The PCF Stage 2 A27 transport model study area is shown in Figure 4-2. The transport model study area for PCF Stage 2 was defined following a review of the outputs of the PCF Stage 1 modelling and was specified to capture the impacts of the Scheme. This resulted in an expanded model study area including to the west, in the Chichester area.

[34] TAG Unit M3-1, Highway Assignment Modelling (January 2014), Department for Transport, section 2.2.10 – 2.2.13

Figure 4-2: PCF Stage 2 A27 transport model study area/network extent



Demand Data

4.1.3 SERTM is one of five strategic transport models which simulate average peak period traffic conditions across a broad regional area from Norfolk in the north of the model area to the south coast including Hampshire, Sussex and Kent. The development of SERTM enabled Highways England to progress the schemes identified in the RIS within the first Road Period (2015-2020). The development of the SERTM required the use of a substantial dataset for network and matrix production, as well as traffic counts and journey time data for model calibration and validation.

4.1.4 The SERTM base year model has been defined as an average (Monday to Friday) weekday in March 2015 (March is classified as a 'neutral' month in WebTAG Unit M1.2, paragraph 3.3.6). This was specified for the following reasons:

- Mobile phone data, the primary source for use in developing base year demand matrices, was available for March 2015 from Highways England
- Availability of the Trip Information System Interim Dataset
- Additional traffic count and journey time data collected and converted to represent March 2015

4.1.5 The locations of the SERTM volumetric dataset are shown in Figure 4-3. Having reviewed the existing data, set out in more detail in Appendix A-4, it was deemed suitable and sufficient to be used in the continued PCF Stage 2 analysis, given the age, quality, geographic and temporal coverage of the data.

4.1.6 The modelled time periods represent the following:

- AM Peak, average hour from 07:00 – 10:00
- Inter Peak, average hour from 10:00 – 16:00
- PM Peak, average hour from 16:00 – 19:00

Summary of Traffic Data

4.1.7 Prior to PCF Stage 2, various forms of traffic data had been collected and were available for use as part of the A27 Arundel Bypass scheme development. These included:

- Roadside Interviews (RSI)
- Manual Classified Counts (MCC) and Junction Turning Counts (JTC) at or near all RSI sites
- ATCs at or near the RSI sites
- TrafficMaster data and Moving Car Observer (MCO) journey time surveys (MCO surveys used in conjunction with TrafficMaster data to validate journey times)
- Collision data (for economic appraisal of accident savings)

4.1.8 The PCF Stage 1 Traffic Data Collection Report provides an overview and initial analysis of the traffic data collected for the PCF Stage 1 A27 transport model.

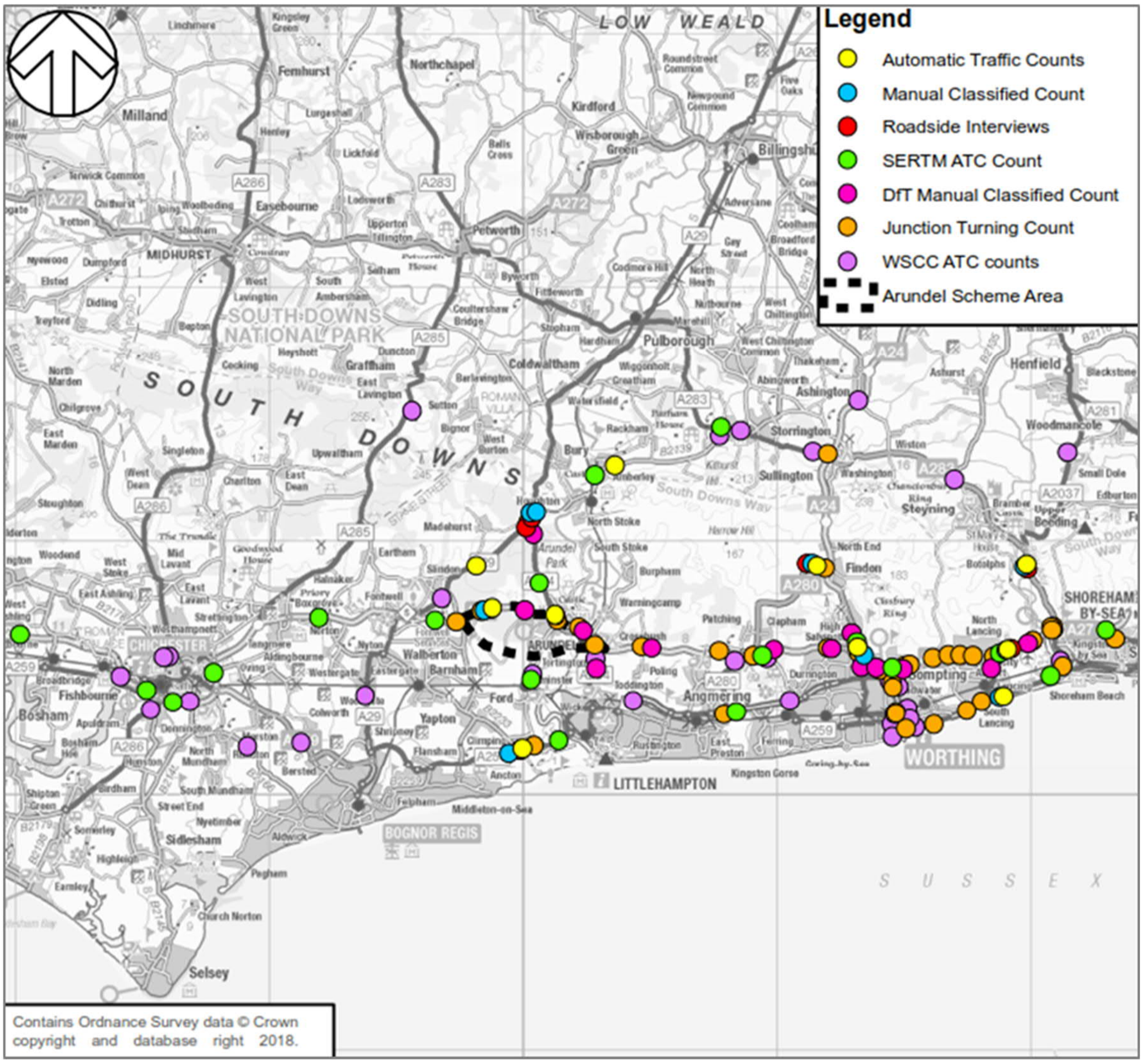
4.1.9 The current PCF Stage 2 Further Consultation uses the data collected in the previous PCF Stage 1 and the data from the study work undertaken in PCF Stage 2 to date, as the basis for analysis.

4.1.10 Other data that was available at the start of PCF Stage 2 included:

- Traffic flow data available from SERTM which represents an average weekday in March 2015
- ATC information from West Sussex County Council (WSCC) Traffic Monitoring Database

4.1.11 The locations of all available surveys listed above (excluding the Traffic Master data and MCO journey time surveys) are shown in Figure 4-3.

Figure 4-3: PCF Stage 2 traffic survey and data locations



Volumetric Data

4.1.12 Table 4-1 sets out the counts available from previous stages of analysis, including PCF Stage 1 and PCF Stage 2, to date. The data recorded for each count is summarised in Appendix A-4, and the locations of the counts are shown in Figure 4-3. The SERTM counts that cover the SRN are available on WebTRIS[35]. The adequacy of the dataset is considered in section 6.2.

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[35] http://webtris.highwaysengland.co.uk/

Table 4-1: Count Data Summary

Source	Counts	Summary	Purpose	Date
ATC collection prior to Stage 2 analysis	10	ATC data collection undertaken at 10 key sites within vicinity of scheduled RSI sites over a period of 2-3 weeks	Validation (ATC3-8) and Calibration (ATC1-2)	June 2015
JTC Collection prior to Stage 2 analysis	38	Data from JTCs available from 38 sites, at or near RSI sites	Validation	24th June 2015
WSCC Traffic Monitoring Database	27	Contains a consistent record of traffic flows at 160 permanent count sites. Counts from 27 sites were extracted for the report, with the flow data classified by type of vehicle and by flow period.	Validation (WSCC1-2, 4, 9-10, 12-27) and Calibration (WSCC3, 5-8, 11)	March 2015
South East Regional Traffic Model (SERTM)	18	18 counts were available from the SERTM in the Arundel area, with the flow data classified by type of vehicle and by flow period. Data represents an average weekday in March 2015	Validation (SERTM14-18) and Calibration (SERTM1-13)	March 2015

4.1.13 The count data summarised in Table 4-1 was reviewed and considered to be suitable and sufficient for continued use in PCF Stage 2 Further Consultation, considering the age, quality, geographic and temporal coverage of the data. However, the review highlighted a small number of locations where further data would provide additional value, and supplement the counts already available (see section 5.2).

4.1.14 In the final dataset for PCF Stage 2 Further Consultation, the data from SERTM counts 2 and 10 used previously have been excluded, as they are duplicated by counts available from the WSCC count data.

Journey Time Data

4.1.15 Two types of journey time data were collected during PCF Stage 1. These included:

- Traffic Master via the DfT
- Moving Car Observer Journey Time Surveys

4.1.16 A database of journey time data from May and June 2014 was obtained from TrafficMaster via the DfT, to provide a large sample size covering all the main routes within the study area. This provided the primary source of journey time data for model journey time validation for the periods described in 4.1.6.

4.1.17 MCO journey time surveys were carried out in June 2015. The journey time data was used in conjunction with the TrafficMaster data. Journey time data was collected for the AM peak (07:00-10:00), inter peak (12:00-14:00) and PM peak period (16:00-19:00).

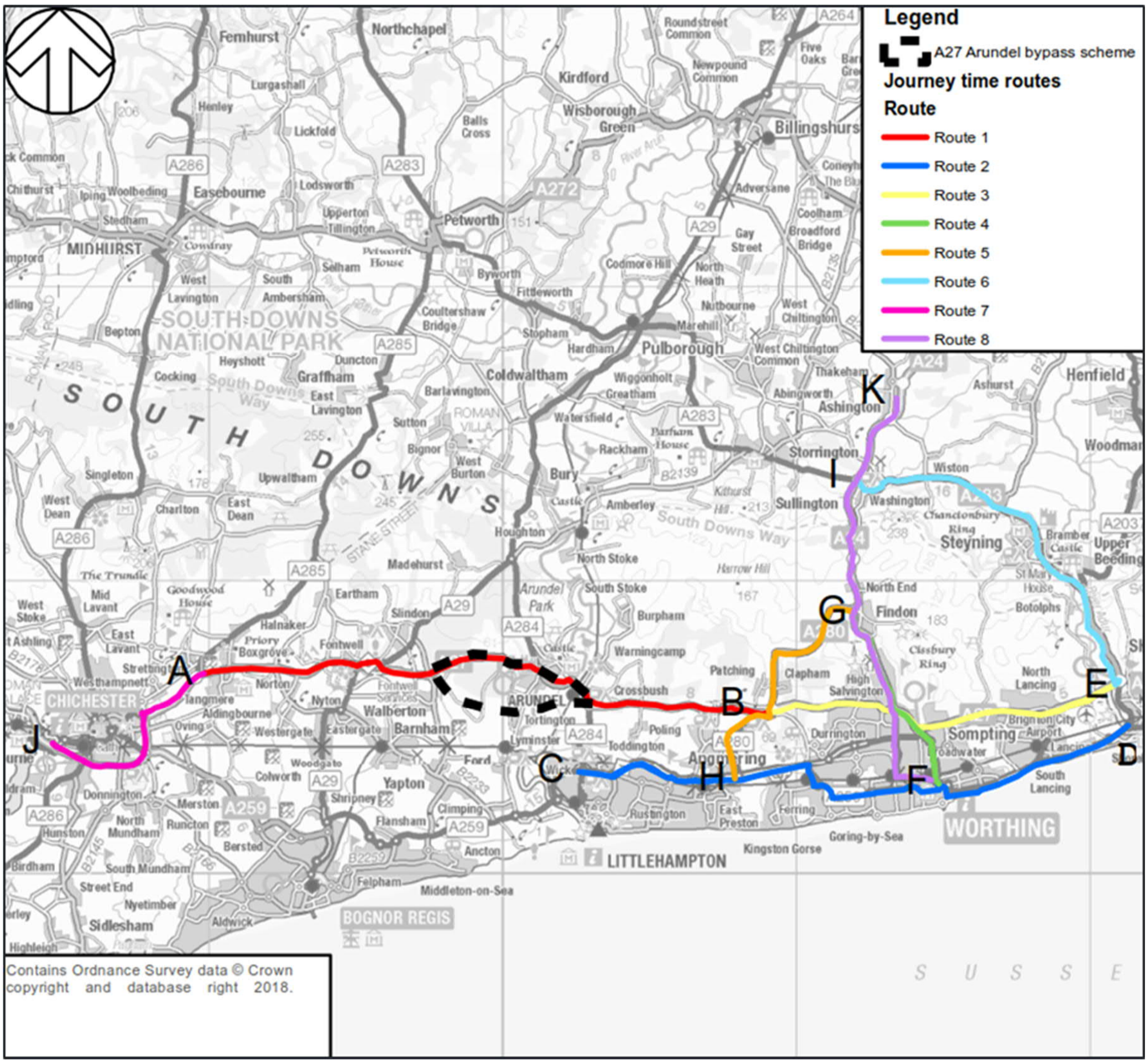
4.1.18 The journey time data was collected under typical traffic conditions i.e., no roadworks were in place at the time of the surveys, and no road collisions occurred on the day. The weather was fine and sunny.

4.1.19 Routes were chosen to ensure full coverage of the principal competing journey routes of the A27 and A259 through the study area. The routes used are illustrated in Figure 4-4 and a brief description of the routes is set out below:

- Route 1 (Eastbound (EB) & Westbound (WB)) – A27 between A285 and Long Furlong junction (A to B in Figure 4-4)
- Route 2 (EB & WB) – A259 between Wick Roundabout and Shoreham High Street roundabout (C to D in Figure 4-4)
- Route 3 (EB & WB) – A27 between Long Furlong and A27/A283 diverge (B to E in Figure 4-4)
- Route 4 (Northbound (NB) & Southbound (SB)) – A24 between Chapel Road/North Street roundabout and Long Furlong (F to G in Figure 4-4)
- Route 5 (NB & SB) – A280 between Roundstone and Long Furlong (H to G in Figure 4-4)
- Route 6 (EB & WB) – A283 between Shoreham bypass and A283/A24 junction (I to E in Figure 4-4)
- Route 7 (EB & WB) – A27 between Fishbourne Roundabout and A285 junction (J to A in Figure 4-4)
- Route 8 (NB & SB) – North street/Chapel road roundabout to A24/B2133 junction (F to K in Figure 4-4)

4.1.20 The journey time data obtained from the TrafficMaster database for the peak hours was deemed to be sufficient with which to validate the PCF Stage 2 A27 transport model.

Figure 4-4: Journey Time Routes



Collision Data

4.1.21 In PCF Stage 1, collision data was obtained from Sussex Safer Roads Data Partnership, covering the period between 1 June 2010 and 31 May 2015, for the extent of the two A27 schemes. The sections for which data was provided are:

- A27 Worthing and Lancing - from the western boundary of the Worthing urban area to the bridge over the River Adur
- A27 Arundel - from the junction with Shellbridge Road / Yapton Lane west of Arundel to east of Crossbush junction

4.1.22 In PCF Stage 2, prior to the 2017 consultation, collision data for the period 1 January 2012 to 31 December 2016 was obtained from the DfT, for the entire model coverage area.

Mapping Data

4.1.23 The network was verified using Geographic Information Software (GIS) program ArcGIS and aerial photography. In particular, checks were carried out to verify:

- Node co-ordinates
- Link length check against measured GIS distance
- Speed/flow relationship
- Link type
- Link capacity
- One way/two-way operation
- Number of (effective) lanes
- Length and position of flares
- Any observed turn delays/penalties
- Access points

Operational Data

4.1.24 Videos of larger junctions within the traffic survey area (as detailed in Appendix A-4) were recorded at the same time as the 2015 JTC surveys. These were used to assist with the modelling in terms of accurately reflecting existing conditions, including average queue lengths.

Summary of Additional Requirements

4.1.25 The A27 Arundel Bypass options for PCF Stage 2 Further Consultation are of a similar specification and geography to those appraised in previous stages. It was considered that the existing data, described in the previous section, is suitable in its coverage and detail, and was of a suitable age and quality to robustly support the appraisal of the Scheme through the current PCF Stage 2 Further Consultation.

4.1.26 It was identified that updated collision data for the period between January 2013 and December 2017 was required, and, as part of the review of data, it was identified that there would be value in obtaining data at a small number of additional locations.

5 Data collection

5.1 Introduction

5.1.1 The approach undertaken for data collection prior to the PCF Stage 2 Further Consultation is consistent with that undertaken in previous stages, which is detailed in the PCF Stage 1 Data Collection Report[33] and the PCF Stage 2 ComMA report.

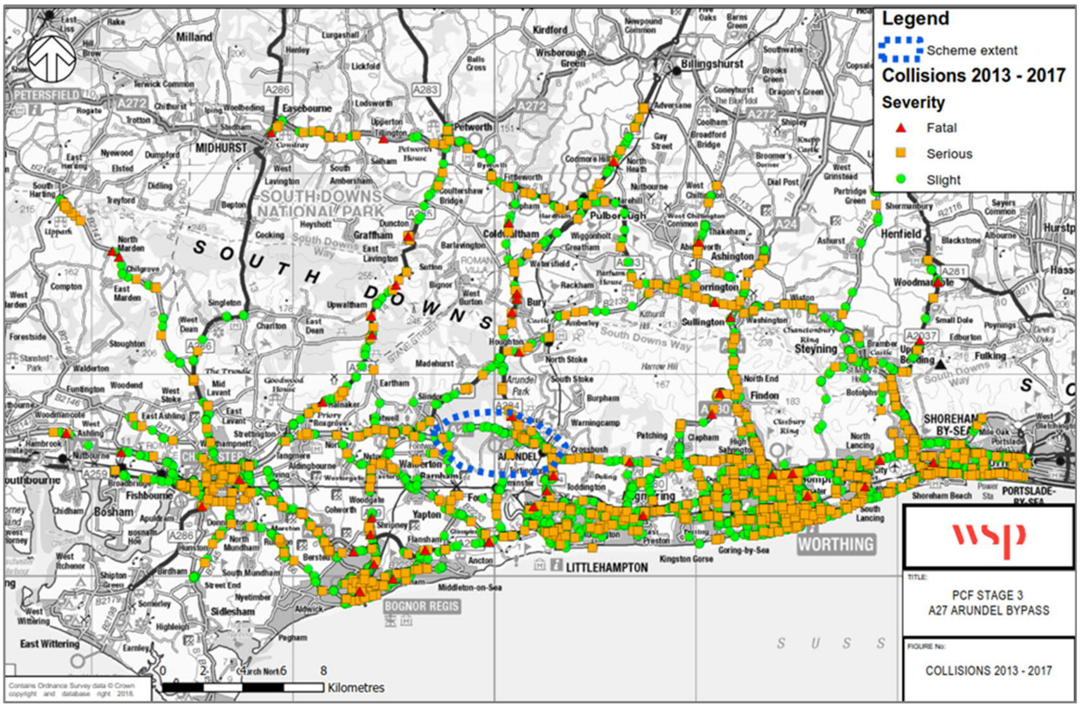
5.1.2 A description of the data used in the calibration/validation of the PCF Stage 2 A27 transport model is included in chapter 6.

5.2 Outcome of the surveys

5.2.1 When the data available was reviewed, the need to obtain additional data at a small number of locations was identified. An additional four counts were collected from the WSCC Traffic Monitoring Database, three in the Storrington area and one on the A29. In addition to these, an additional count at Yapton Lane level crossing was requested and supplied by Network Rail.

5.2.2 To inform the PCF Stage 2 Further Consultation study work, an updated collision dataset has been obtained from Sussex Safer Roads Data Partnership, for the period between January 2013 - December 2017. The collision coverage area remains the same as that collected earlier in PCF Stage 2. The recorded collisions by severity are illustrated in Figure 5-1.

Figure 5-1: Collision plot



5.2.3 Following continued engagement with local stakeholders, the need to collect further count data to inform analysis during PCF Stage 2 Further Consultation has been reviewed. A programme of supplementary data collection has been undertaken in early July 2019, focused in the area within and around Walberton. This data has been collected to inform the production of a Local Roads Study[36]. The study is supplementary to the ComMA and the data is additional to that specified for the PCF Stage 2 A27 transport model and the PCF Stage 2 Further Consultation forecasting and economic appraisal.

[36] A27 Arundel Bypass – PCF Stage 2 Further Consultation Local Roads Study, August 2019

6 Final datasets

6.1 Overview of the full datasets

6.1.1 This section sets out an overview of the datasets used within the transport modelling, forecasting and appraisal work for the PCF Stage 2 Further Consultation.

Volumetric Data

6.1.2 Appendix A-2 and Appendix A-3 illustrate the locations of the observed counts used in the validation and calibration, respectively, of the PCF Stage 2 A27 transport model. A brief description of the count locations is outlined in Table 6-1. The junction turning counts are set out in Table 6-2. SERTM counts 2 and 10 are excluded, as the counts are duplicates with WSCC counts 12 and 16 respectively.

Table 6-1: Description and source of observed traffic data

Count	Description	Date collected	Source
ATC1	A27 Arundel Road - Site 1 - F	15-28 June 2015	WSP
ATC3	A259 Crookthorn Lane - Site 3 – F	15-28 June 2015	WSP
ATC5	Arundel Bypass - Site 5 – F	15-28 June 2015	WSP
ATC6	A280 Long Furlong - Site 6 – F	15-28 June 2015	WSP
ATC8	A283 Steyning Road - Site 8 – F	15-28 June 2015	WSP
SERTM1	A259 Bridge Road	March 2015	SERTM
SERTM3	A284 London Road	March 2015	SERTM
SERTM4	B2139 Amberley, New Barn Rd	March 2015	SERTM
SERTM5	A283 Pulborough Rd	March 2015	SERTM
SERTM6	A259 Shoreham, E. OF New Salts Farm Rdbt	March 2015	SERTM
SERTM7	A27 Old Shoreham Road	March 2015	SERTM
SERTM8	A24 Findon Road	March 2015	SERTM
SERTM9	A27 Arundel Road	March 2015	SERTM
SERTM11	A259 Littlehampton Road	March 2015	SERTM
SERTM12	A27 west of Chichester	March 2015	SERTM

Count	Description	Date collected	Source
SERTM13	A27 A285 Chichester (E) to A29 Bognor Regis (W)	March 2015	SERTM
SERTM14	A27 Chichester (A259-A286)	March 2015	SERTM
SERTM15	A27 between A286 and B2145	March 2015	SERTM
SERTM16	A27, Portfield (E487804, N104821)	March 2015	SERTM
SERTM17	A27 Worthing (Grove Road - Lyons Way)	March 2015	SERTM
SERTM18	A27 between A270 near Brighton (west) and A293	March 2015	SERTM
WSCC1	A2037 Small Dole, Shoreham Rd. O/S The Wickets	March 2015	WSCC
WSCC2	A24 Ashington By-Pass, Just N. Of London Rd.	March 2015	WSCC
WSCC3	A259 Fishbourne, Just West of Roundabout	March 2015	WSCC
WSCC4	A24 Worthing, Broadwater St West O/S No.47/49	March 2015	WSCC
WSCC5	A259 Bognor Regis, Chichester Rd. (Elbridge Farm)	March 2015	WSCC
WSCC6	Runcton, Lagness Rd. / Pagham Rd. By Garden Cent.	March 2015	WSCC
WSCC7	A284 Lyminster, Lyminster Road North of Bends	March 2015	WSCC
WSCC8	A259 Rustington bypass	March 2015	WSCC
WSCC9	A259 Worthing, Brighton Rd O/S Aquarena	March 2015	WSCC
WSCC10	A285 Duncton, Outside Dogkennel Cottages	March 2015	WSCC
WSCC11	Steyning A283 Washington Road, West of B2135	March 2015	WSCC
WSCC12	C17 Ford Rd. Just S. Of Jct. With Tortington	March 2015	WSCC
WSCC13	B2223 Worthing, Sompting Ave O/S No.22	March 2015	WSCC
WSCC14	Worthing, Chesswood Rd O/S No.1 E. Of Station	March 2015	WSCC
WSCC15	Worthing, Lyndhurst Rd. O/S Hospital E. Of Park Rd	March 2015	WSCC
WSCC16	Worthing, Titnore Lane, S. Of A27/A280 Jct.	March 2015	WSCC
WSCC17	A283 Shoreham, Old Shoreham Rd N. Of Buckingham St	March 2015	WSCC
WSCC18	A2031 Worthing, Teville Rd W of Christchurch Rd	March 2015	WSCC
WSCC19	A259 Worthing, Richmond Rd. E. Of Salisbury Rd.	March 2015	WSCC
WSCC20	A280 Angmering, Water Lane	March 2015	WSCC
WSCC21	A29 Woodgate, Lidsey Rd. (S. Of Railway Crossing)	March 2015	WSCC
WSCC22	Worthing, Marine Parade W. Of Prospect Place & Lid	March 2015	WSCC
WSCC23	A2032 Worthing, Durrington O/S Northbrook College	March 2015	WSCC
WSCC24	A286 Chichester, Broyle Rd Just N. Of The Bell Inn	March 2015	WSCC
WSCC25	B2178 Chichester, St Paul's Rd. O/P No.55	March 2015	WSCC
WSCC26	A286 Chichester, Stockbridge, Birdham Rd O/S 53	March 2015	WSCC
WSCC27	Hunston, B2145 Hunston Rd. By Sub Station	March 2015	WSCC
WSCC28	A29 London Rd., North of Mill Rd.	March 2015	WSCC

Count	Description	Date collected	Source
WSCC29	A283 Storrington, West Street E. of Rectory Rd.	March 2015	WSCC
WSCC30	A283 Storrington Rd. W. of A24 Roundabout.	March 2015	WSCC
WSCC31	B2139 Amberly Road, Storrington	March 2015	WSCC
Yapton Lane	Yapton Ln, at Level Crossing South of Lake Ln.	August 2017	Network Rail

Table 6-2: Description and source of junction turning counts

Count	Description	Date Collected	Source
JTC 1	B2132/A27 Arundel Road	24 June 2015	WSP
JTC 2	A27 Arundel Road/Binstead Lane	24 June 2015	WSP
JTC 3	A27 / A284 / Maltravers Street	24 June 2015	WSP
JTC 4	A27 / The Causeway	24 June 2015	WSP
JTC 5	A27 / A284 Lyminster Rd (Crossbush Junction)	24 June 2015	WSP
JTC 6	A284 Ford Road / A259 Crookthorn Lane	24 June 2015	WSP
JTC 7	A29 / B2139 / A284 London Road	24 June 2015	WSP
JTC 8	Blakehurst Lane / A27 / Poling Street	24 June 2015	WSP
JTC 9	A27 Arundel Road off-slip / Arundel Road	24 June 2015	WSP
JTC 10	A24 / A283 The Pike / A283	24 June 2015	WSP
JTC 11	A24 Findon bypass / School Hill / A280	24 June 2015	WSP
JTC 12	A280 / A27	24 June 2015	WSP
JTC 13	A24 / A27 / A2031 / Goodwood Road	24 June 2015	WSP
JTC 14	Salvington Hill / A27 / Durrington Hill	24 June 2015	WSP
JTC 15	Hill Barn Lane / A27 / A24	24 June 2015	WSP
JTC 16	Sompting Road / A27	24 June 2015	WSP
JTC 17	Lyons Way / A27 / Upper Brighton Road	24 June 2015	WSP
JTC 18	Church Lane / A27	24 June 2015	WSP
JTC 19	Dankton Lane / A27 Upper Brighton Road	24 June 2015	WSP
JTC 20	Halewick Lane / A27 / Busticle Lane	24 June 2015	WSP
JTC 21	Manor Road / A27 / Upper Boundstone Lane	24 June 2015	WSP

Count	Description	Date Collected	Source
JTC 22	Manor Road / A27 / A2025 Grinstead Lane	24 June 2015	WSP
JTC 23	A27 Shoreham bypass / Old Shoreham Road	24 June 2015	WSP
JTC 24	Coombes Road / A27 Shoreham bypass	24 June 2015	WSP
JTC 25	A27 Shoreham bypass East and West Slips	24 June 2015	WSP
JTC 26	A283 Steyning Road	24 June 2015	WSP
JTC 27	A283 Steyning Road (n)	24 June 2015	WSP
JTC 28	A27 / A270 / Stoney Ln / Upper Shoreham Rd	24 June 2015	WSP
JTC 29	A283 / A259 High St / A259 Brighton Rd	24 June 2015	WSP
JTC 30	A2025 South Street / A259 Brighton Road	24 June 2015	WSP
JTC 31	Western Road / A259 Brighton Road	24 June 2015	WSP
JTC 32	B2223 / A259 Brighton Road	24 June 2015	WSP
JTC 33	A24 / Broadwater Street East	24 June 2015	WSP
JTC 34	A24 / B2223 Sompting Ave / Carnegie Rd	24 June 2015	WSP
JTC 35	A259 / The Steyne	24 June 2015	WSP
JTC 36	A24 / Newland Road	24 June 2015	WSP
JTC 37	A24 / A24 Chapel Road / A2031 Teville Road	24 June 2015	WSP
JTC 38	A280 / A259 / B2140	24 June 2015	WSP

6.1.3 Table 6-3 summarises the traffic data, in vehicles per hour (veh/hr) for the count locations set out in Table 6-1. This includes Average Daily Traffic (ADT[37]), Average Weekday Traffic (AWT[38]), and the AM and PM peak period average hourly flow. The peak period data is for the average weekday (Monday to Thursday) at each site by direction, during March 2015, unless otherwise stated.

[37] ADT is the average daily (Monday to Sunday) traffic volume over a 24-hour period
[38] AWT is the average weekday (Monday to Friday) traffic volume over a 24-hour period

Table 6-3: summary of observed traffic data from locations

Count	Direction	ADT (veh/hr)	AWT (veh/hr)	AM peak period average flow (veh/hr)	PM peak period average flow (veh/hr)
ATC1	EB	13062	13419	904	859
	WB	11879	11879	1027	1011
ATC3	EB	11488	12352	916	851
	WB	11813	12648	682	1066
ATC5	NB	3515	3566	329	221
	SB	3611	3666	210	342
ATC6	EB	8504	8879	725	537
	WB	8562	9153	539	909
ATC8	NB	11344	12280	901	1042
	SB	10960	11757	941	967
SERTM1	EB	13996	14883	1090	1161
	WB	14182	14917	1106	1108
SERTM3	SB	3652	3784	212	379
	NB	3287	3379	318	191
SERTM4	EB	4221	4439	374	359
	WB	4356	4615	384	389
SERTM5	EB	3721	3951	245	322
	WB	3660	3888	297	249
SERTM6	EB	12527	13234	1090	884
	WB	13066	13733	746	1245
SERTM7	EB	22674	24970	2363	1710
	WB	23769	26430	1781	2489
SERTM8	NB	12592[39]	13389[39]	947	872
	SB	13268[39]	14108[39]	891	1070
SERTM9	EB	14913	15773	1074	1242

[39] Only AM and PM peak data available, therefore ADT and AWT calculated using factor with AM and PM peak data

Count	Direction	ADT (veh/hr)	AWT (veh/hr)	AM peak period average flow (veh/hr)	PM peak period average flow (veh/hr)
	WB	15377	16297	1427	1002
SERTM11	EB	19247	20333	1562	1335
	WB	18297	19108	1034	1457
SERTM12[40]	EB	22680	24062	1919	1791
	WB	21056	22687	1704	1726
SERTM13	EB	21930	22519	1440	1993
	WB	18730	19868	1731	1307
SERTM14	EB	23092	24170	1530	1837
	WB	23390	24304	1954	1551
SERTM15	EB	23283	24212	1512	1841
	WB	23511	25022	2003	1586
SERTM16	EB	18033	18510	1181	1206
	WB	17696	18247	1333	1085
SERTM17	EB	17428	18170	1206	1254
	WB	16024	16474	1103	1048
SERTM18	EB	22686	24534	2279	1881
	WB	21719	24005	1846	2049
WSCC1	NB	3706	4091	390	280
	SB	3770	4171	272	387
WSCC2	NB	15116	15981	1533	918
	SB	15352	16371	1010	1687
WSCC3	EB	6594	6930	507	484
	WB	6515	6859	474	471
WSCC4	NB	11113	11739	704	895
	SB	10535	11069	824	738
WSCC5	SB	12011	12792	665	1145
	NB	12365	13164	1172	731

[40] 2015 data unavailable, therefore 2014 (EB) and 2013 (WB) data was used in its place

Count	Direction	ADT (veh/hr)	AWT (veh/hr)	AM peak period average flow (veh/hr)	PM peak period average flow (veh/hr)
WSCC6	EB	7299	7865	362	871
	WB	6784	7243	797	371
WSCC7	NB	5720	5986	431	396
	SB	6360	6732	438	549
WSCC8	EB	13458	14354	1096	1031
	WB	13705	14561	927	1169
WSCC9	EB	8795	9397	730	639
	WB	10219	10771	742	814
WSCC10	NB	2706	2766	238	182
	SB	2580	2664	174	245
WSCC11	EB	6814	7483	636	692
	WB	7399	8193	673	718
WSCC12[41]	NB	2914	2965	258	184
	SB	2493	2495	161	204
WSCC13	EB	6979	7463	605	527
	WB	9100	9657	636	760
WSCC14	EB	3791	4172	373	261
	WB	3513	3949	262	348
WSCC15	EB	7427	8214	610	581
	WB	5057	5564	387	471
WSCC16	NB	5334	5877	463	488
	SB	5585	6125	531	549
WSCC17	NB	6477	6813	524	422
	SB	6278	6570	391	582
WSCC18	EB	7359	7866	623	536
	WB	6755	7066	400	519
WSCC19	EB	6708	7222	609	472

[41] 2015 data unavailable, therefore 2016 data was used in its place

Count	Direction	ADT (veh/hr)	AWT (veh/hr)	AM peak period average flow (veh/hr)	PM peak period average flow (veh/hr)
	WB	6502	6985	400	626
WSCC20	NB	7782	8140	677	491
	SB	8710	9238	536	911
WSCC21	NB	5552	5909	467	381
	SB	5641	6004	378	543
WSCC22	EB	7491	8015	728	521
	WB	9306	9694	542	801
WSCC23	EB	13250	14367	1157	1007
	WB	12268	13202	874	1007
WSCC24	NB	5226	5576	336	435
	SB	5743	6178	451	432
WSCC25	NB	6160	6688	355	646
	SB	6079	6586	629	421
WSCC26	EB	5604	5649	375	398
	WB	5550	5703	352	407
WSCC27	NB	8094[39]	8639[39]	824	450
	SB	7771[39]	8294[39]	423	756
WSCC28	NB	6455	6849	588	504
	SB	6462	6938	519	630
WSCC29	EB	8773	9300	727	700
	WB	8721	9268	680	750
WSCC30	EB	9085	9672	762	766
	WB	9220	9842	737	787
WSCC31	EB	4195	4412	382	357
	WB	4343	4590	377	394
Yapton Lane (Network Rail)	NB	2862	3161	349	175
	SB	3077	3367	168	386

6.1.4 Figure 6-1 and Figure 6-2 show the traffic profile along the A27 between Fishbourne Roundabout in Chichester and Shoreham bypass, west of the A283. The hourly traffic data is taken from SERTM data, extracted from WebTRIS, at 7 sites with continuous data available, and the average flow in vehicles on the A27 based on these sites has been calculated.

Figure 6-1: A27 traffic profile, eastbound

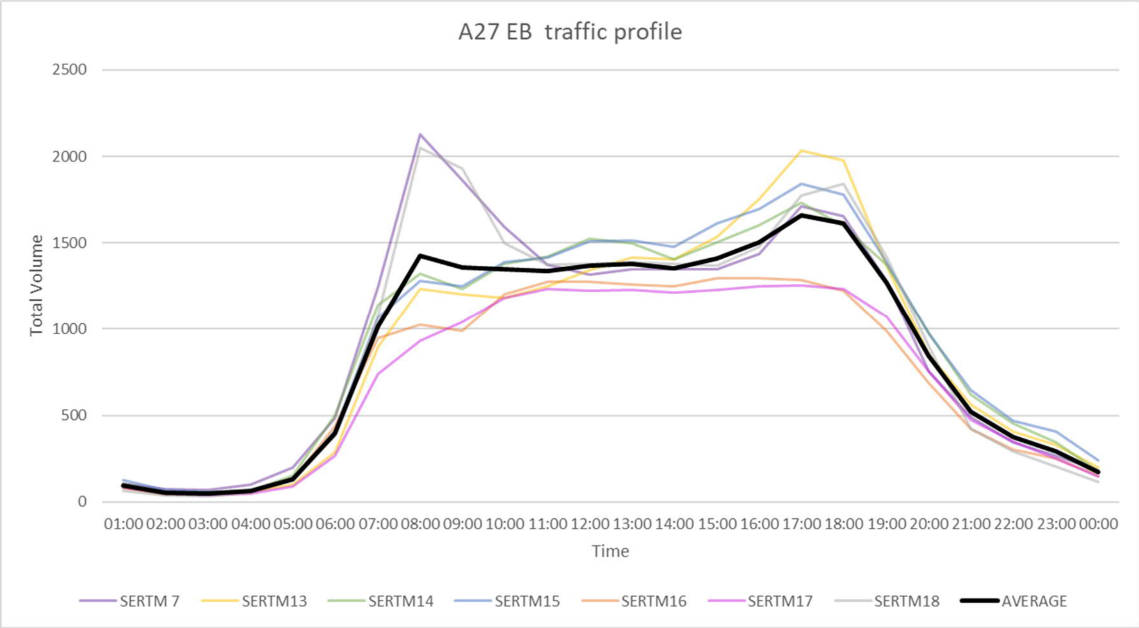
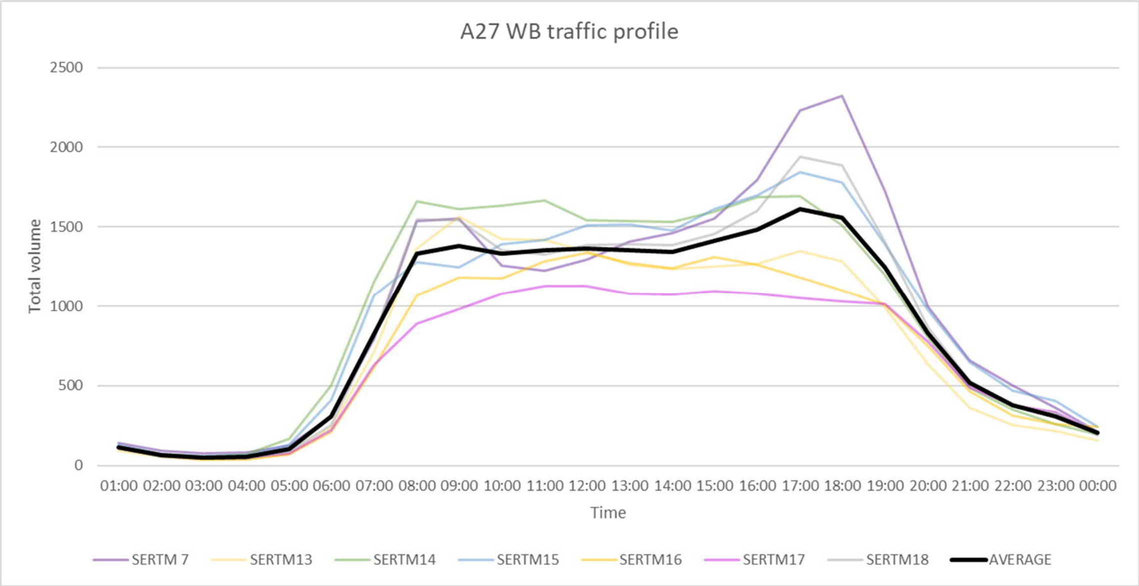


Figure 6-2: A27 traffic profile, westbound



6.1.5 The peak traffic volume data presented in the preceding Table 6-3 is the AM and PM peak period average hourly flow during weekdays. These periods are consistent with the periods represented by the SERTM demand data which were the basis for the development of the PCF Stage 2 A27 transport model (see chapter 7). Table 6-4 highlights the difference in peak traffic volumes between the peak period average hour and the highest peak hour during that period, for strategic and other roads respectively.

Table 6-4: Average peak period and peak hour traffic volume comparison

Type	AM Period	AM Peak	% Diff.	PM Period	PM Peak	% Diff.
Strategic roads	1632	1824	+11.7%	1589	1786	+11.3%
Other roads	578	675	+16.8%	604	683	+13.1%

Journey Times

6.1.6 Journey time data was obtained from the TrafficMaster database for the routes discussed in paragraph 4.1.19. The TrafficMaster data was collected using Global Positioning System (GPS) technology, with the data presented in 15-minute intervals, for the months of May and June 2014, for the modelled time periods.

6.1.7 Journey time against distance graphs for an average hour in the AM, PM and inter-peak periods for each journey are included in Appendix A-5.

6.1.8 Table 6-5 details the journey time routes with the observed time (in seconds) for the 2014 AM peak, Inter-peak and PM peak, for the journey time routes presented graphically in Figure 4-4.

Table 6-5: Journey Time (Seconds)

Route number	Description	AM peak	Inter peak	PM peak
1	A27 eastbound	949	951	1424
1	A27 westbound	1124	1044	1017
2	A259 eastbound	2034	1954	2049
2	A259 westbound	1920	2068	2261
3	A27 eastbound	1161	961	1067
3	A27 westbound	1115	1025	1121
4	A24 northbound	658	644	792
4	A24 southbound	905	784	806
5	A280 northbound	521	513	500
5	A280 southbound	512	519	533
6	A283 eastbound	751	734	737
6	A283 westbound	753	741	770
7	A27 Chichester eastbound	680	531	579
7	A27 Chichester westbound	550	586	846
8	A2031 / A24 northbound	1275	1180	1188
8	A24 / A2031 southbound	1272	1232	1303

Collisions

6.1.9 Observed collision data is required for use within COBALT version 2013.02, a computer program developed by the DfT to undertake analysis on the impact of accidents as part of economic appraisal of a road scheme[42].

6.1.10 Table 6-6 sets out a summary of the collisions that occurred on the links within the PCF Stage 2 modelled area, between January 2013 and December 2017 (at the locations illustrated in Figure 5-1).

Table 6-6: Annual collision summary

Years	Collisions (No.)			Total
	Fatal	Serious	Slight	
January 2013 to December 2013	9	161	644	814
January 2014 to December 2014	8	182	712	902
January 2015 to December 2015	7	163	702	872
January 2016 to December 2016	15	163	642	820
January 2017 to December 2017	8	174	619	801
Total	**47**	**843**	**3319**	**4209**

6.1.11 Of the 4,209 personal injury collisions recorded, between 1 January 2013 and 31 December 2017, within the study area, 47 (1.1%) were classified as 'fatal', 843 (20.0%) were recorded as 'serious' and 3,319 (78.9%) were categorised as 'slight' in terms of severity.

6.2 Adequacy of datasets

6.2.1 The development of the SERTM enabled Highways England to progress the schemes identified in the RIS within the first Road Period (2015-2020). The development of the SERTM required the use of a substantial dataset for network and matrix production, as well as traffic counts and journey time data for model calibration and validation. The standards associated with the processing of data for SERTM were specified and examined.

6.2.2 The base year for SERTM is 2015, with data which represents an average weekday in March. The SERTM was specified as a suitable starting point to allow a cordoned model to be created for the PCF Stage 2 A27 transport model to allow an assessment of the value for money of the A27 Arundel Bypass.

6.2.3 A large proportion of the volumetric dataset was collected in 2015. To ascertain the robustness and suitability of year 2015 data for use in PCF Stage 2 Further Consultation, an analysis has been undertaken of the observed AADT counts. The analysis is based on the full years data that was available at the time of analysis, which included the years 2015, 2016 and 2017 for various counts sites across the modelled network.

6.2.4 The analysis confirmed the 2015 flows as a reasonable representation of current flows on the basis that traffic volume changes were less than 5% on average, within typical levels of daily variation in traffic volume, and within the 95% confidence interval for the accuracy of ATC's. The results of the analysis is presented in Appendix A of the ASR[44].

6.2.5 The collision data to be used in the COBALT assessment of the A27 Arundel Bypass Scheme has been updated to include all collision records within the modelled area for 2017.

6.2.6 In summary, the datasets available in PCF Stage 2 for the calibration and validation of the PCF Stage 2 A27 transport model are considered adequate to provide a 2015 base year that is suitable for forecasting the impacts of the Scheme and for the economic appraisal.

[44] HE551523_WSP_GEN_A27A_PCF2_TP_P01.3, dated 2 November 2017

7 Model description/specification

7.1 Transport model build

7.1.1 The transport model utilised in the A27 Arundel Bypass PCF Stage 2 Further Consultation assessment was derived from SERTM. A cordon of the SERTM (network and matrix) has been extracted for this purpose.

7.1.2 There is a variable demand component to the model. The DfT's DIADEM software has been used for setting up the transport demand model and finding equilibrium between demand and supply, using the SATURN package as the supply model.

7.2 Model's geographical coverage

7.2.1 The PCF Stage 2 Further Consultation transport modelling process utilised the SERTM with the general coverage shown in chapter 4, Figure 4-1.

7.2.2 A cordon of the SERTM (network and matrix) was extracted for use in the A27 Arundel Bypass PCF Stage 2 A27 transport model. Figure 4-2 shows the coverage of the PCF Stage 2 A27 transport model study area/network extent. The model network is all coded in simulation (greater detail) and represents the Fully Modelled Area (FMA) with no buffer network (less detail) included. There are external zones which represent the wider regional network.

7.2.3 The zoning system provided sufficient detail for route choice to be modelled appropriately with the model network area shown in Appendix A-1, alongside the zoning system included in Appendix A-6.

7.3 Model's temporal coverage

7.3.1 The base year for the model is 2015 and represents an average weekday in a neutral month. The modelled time periods represent the following:

- AM Peak, average hour from 07:00 – 10:00
- Inter peak, average hour from 10:00 – 16:00
- PM Peak, average hour from 16:00 – 19:00

7.3.2 An off-peak (19:00-07:00) model has not been developed as off-peak benefits are anticipated to be limited due to lower traffic flows and lower delays.

7.3.3 There are increases in traffic during the summer months associated with the tourist season which do add to the congestion however this is not unusual for a coastal town in the UK. The temporal coverage of the models does not reflect these summer months. There are no known major employers with unusual shift patterns that would significantly alter traffic flows / patterns.

7.4 Overview of the model system

Demand component

7.4.1 The O-D trip matrices, representing highway demand in the SERTM were sourced from mobile phone data, provided by Telefonica (O2) UK. The data, referred to as “provisional data”, was made available in the autumn of 2015 and was produced using Telefonica’s existing processes.

7.4.2 Other data sources such as 2011 Census Journey to Work (JTW), National Travel Survey data (NTS), and demand estimates based on NTEM (v6.2) were used to augment the mobile phone data.

7.4.3 It should be noted that there is no established practice or indeed complete technical appreciation of the issues associated with using mobile phone data to develop trip matrices. The Matrix Technical Consistency Group (MTCG) was set up by Highways England to set out good practice on how to approach the matrix development task. The MTCG also aimed to ensure that all elements of the work were undertaken in a consistent manner by all matrix development teams across the Regional Traffic Models.

7.4.4 Further details are set out in the SERTM Model Validation Report, Version DF3 (March 2017).

7.4.5 The PCF Stage 2 A27 transport model has used a prior matrix estimated cordoned matrix extracted from the full SERTM for the area shown in Figure 4-2.

7.4.6 The use of Variable Demand seeks to quantify the impact of new infrastructure. The Variable Demand assessment of the A27 Arundel Bypass has included for the impact on trip patterns and the amount of traffic using the Scheme i.e. trip distribution. The PCF Stage 2 A27 transport model is a highway only model therefore only the impact of trip frequency and trip distribution has been undertaken.

7.4.7 For the purposes of the A27 Arundel Bypass scheme appraisal no assessment of mode choice (e.g. switch to public transport) has been undertaken as the PCF Stage 2 A27 transport model is a highway only model. Therefore, trips have not been suppressed or induced and only the change in trip patterns and the amount of traffic using the Scheme has been assessed.

Highway model component

7.4.8 SATURN has been identified as the most appropriate tool for building the PCF Stage 2 A27 transport model. SATURN operates as a static equilibrium highway assignment model which incorporates both simulation and assignment loops. SATURN is jointly developed by the Institute for Transport Studies, University of Leeds and Atkins. As a "conventional" traffic assignment model it can deal with local, large conurbation, regional or even national models thus making it appropriate for the modelling of traffic in the South East of England.

7.4.9 The highway model component is undertaken using the SATURN V11.3.12W software, which was released April 2016, which was the most recent version of the software available at the time.

Public transport component

7.4.10 There is no public transport component to the model system due to the nature of the scheme being appraised.

7.5 Software packages and versions

7.5.1 SATURN V11.3.12W has been used for the PCF Stage 2 A27 transport model.

7.5.2 DIADEM V6.3.3 (64bit) has been used for setting up the transport demand model and finding equilibrium between demand and supply, using the SATURN package as the supply model.

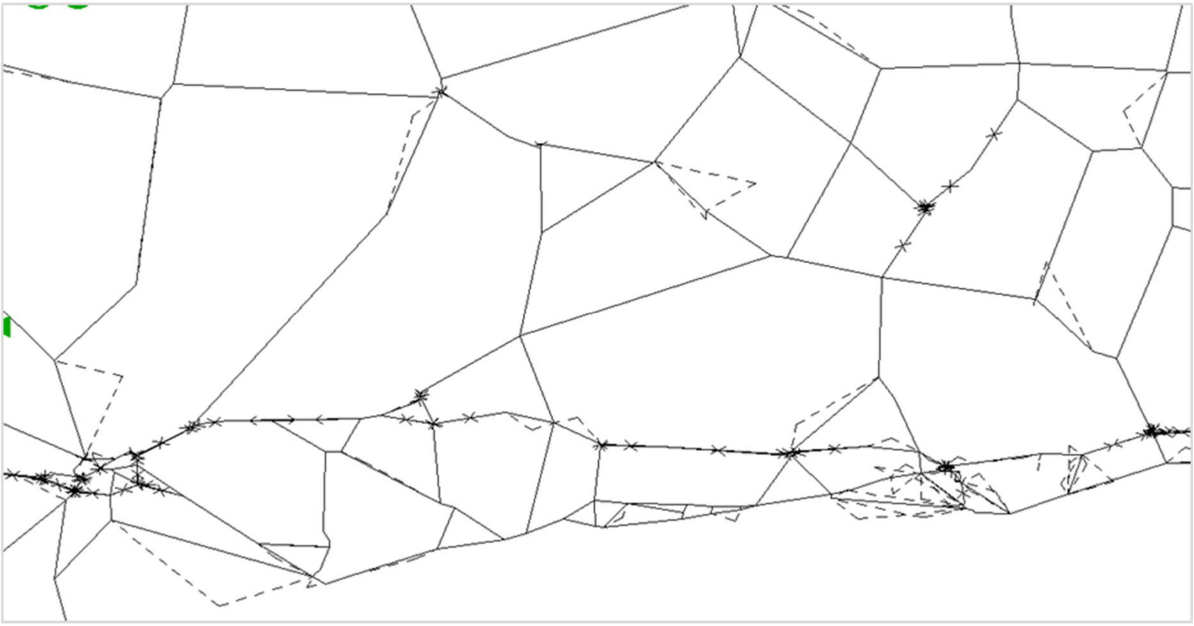
8 Model development

8.1 Demand model

8.1.1 The model network was based on the existing SERTM SATURN model network. This chapter describes the model development work that was undertaken in PCF Stage 2, prior to the preferred route announcement, and is being taken forward for use in PCF Stage 2 Further Consultation.

8.1.2 The SERTM model network has been cordoned to the area shown in Figure 8-1 (consistent with the area shown in Figure 4-2 and repeated in Figure 8-3) which shows the coverage of the PCF Stage 2 A27 transport model with external zones representing the External Area.

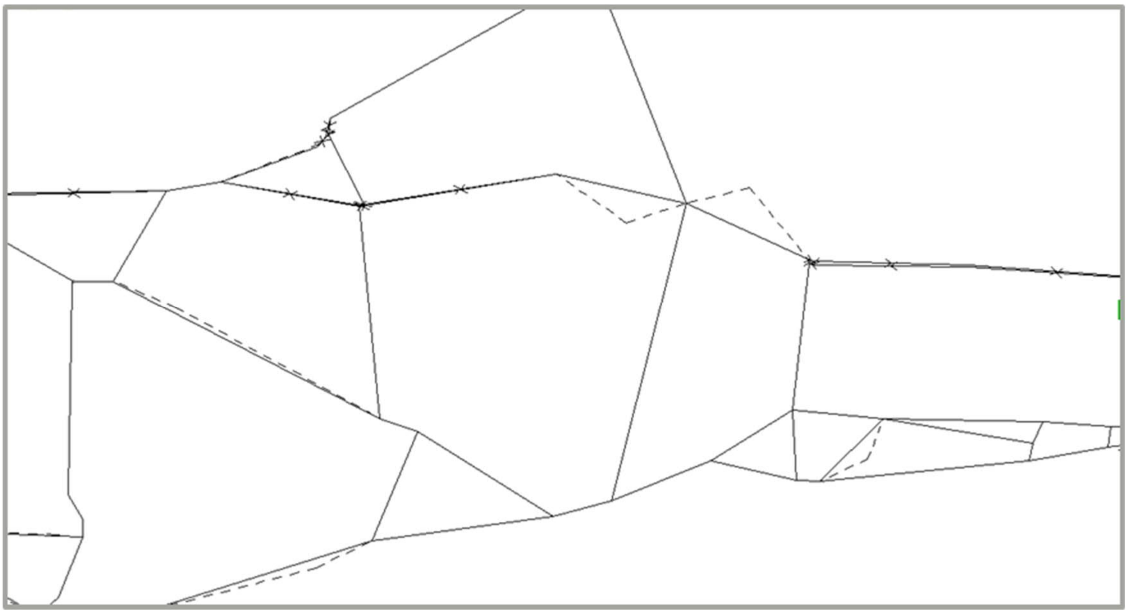
Figure 8-1: Cordoned SERTM network



8.1.3 The coverage of the cordoned model extends from Chichester in the west to Shoreham in the east and then up to the A283 at Petworth / Pulborough / Washington / Steyning.

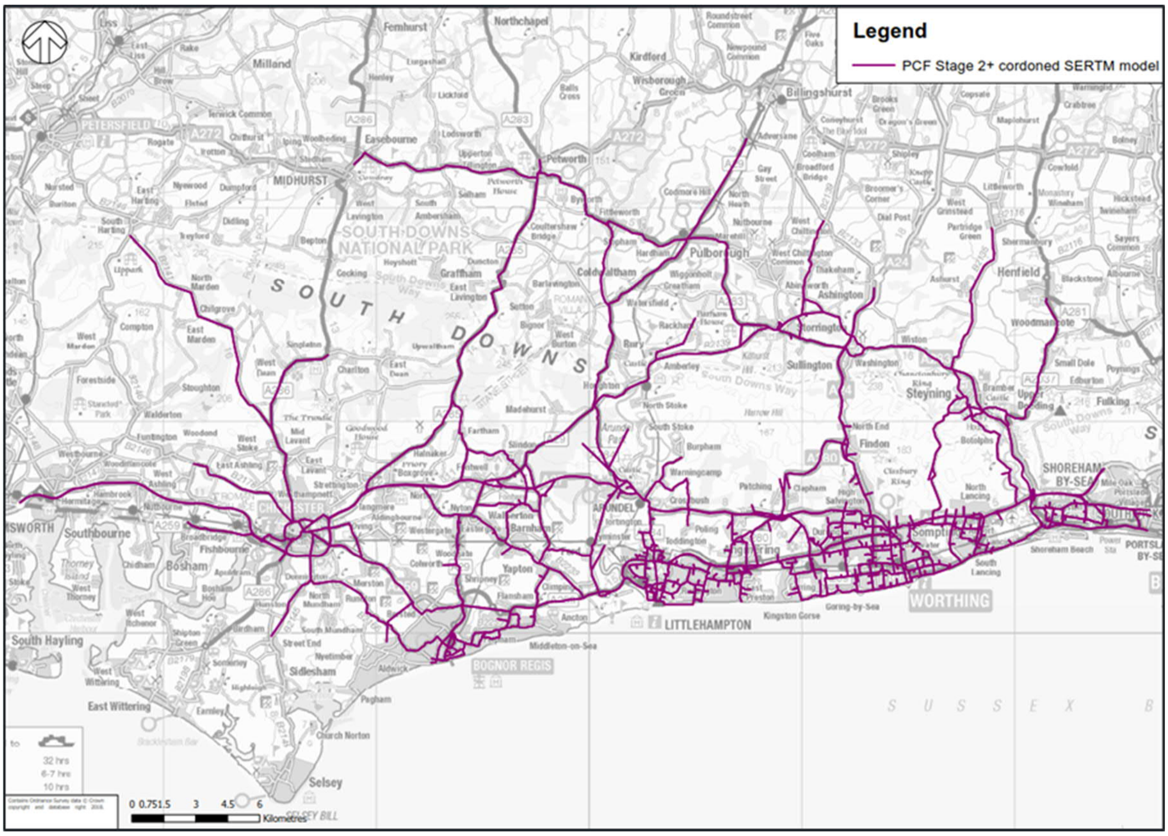
8.1.4 As can be seen from Figure 8-2 the extent of highway network in the study area is not as detailed as is necessary for the assessment of the proposed A27 Arundel Bypass Scheme.

Figure 8-2: SATURN network coverage of Arundel in SERTM



8.1.5 Further network was coded into the model to the specification described later in this chapter, and Figure 8-3 shows the final coverage of the PCF Stage 2 highway model.

Figure 8-3: Coverage of PCF Stage 2 cordoned model



Zones

8.1.6 The zoning system in Appendix A-6 provides sufficient detail for route choice to be modelled appropriately within the model area.

8.1.7 In total, 2306 zones have been produced for SERTM, which include 2173 internal zones, 87 external zones, 8 seaports, 8 airports and 30 spare zones reserved for model forecast years.

8.1.8 The sectors are included in Appendix B-1.

Demand segmentation

8.1.9 There are five user classes within the PCF Stage 2 A27 transport model which are:

- Car: Business
- Car: Commute
- Car: Other
- LGV
- HGV

Matrix building process

8.1.10 The following key steps were involved in order to process the Provisional Data into the final SERTM prior matrices:

- build separate aggregate matrices for each model time period (AM peak, Inter peak and PM peak)
- split the O-D matrix by vehicle type and trip purpose
- disaggregate the matrices from mobile data sectors into model zones
- convert matrices from O-D level to P-A level
- convert matrices from person trips to vehicle trips.

8.1.11 In terms of vehicle type and trip purpose, the following segmentations were required for SERTM assignment matrices:

- car commuting
- car employers' business
- car other
- LGV
- HGV

8.1.12 The variable demand model requires the following more disaggregated segmentation:

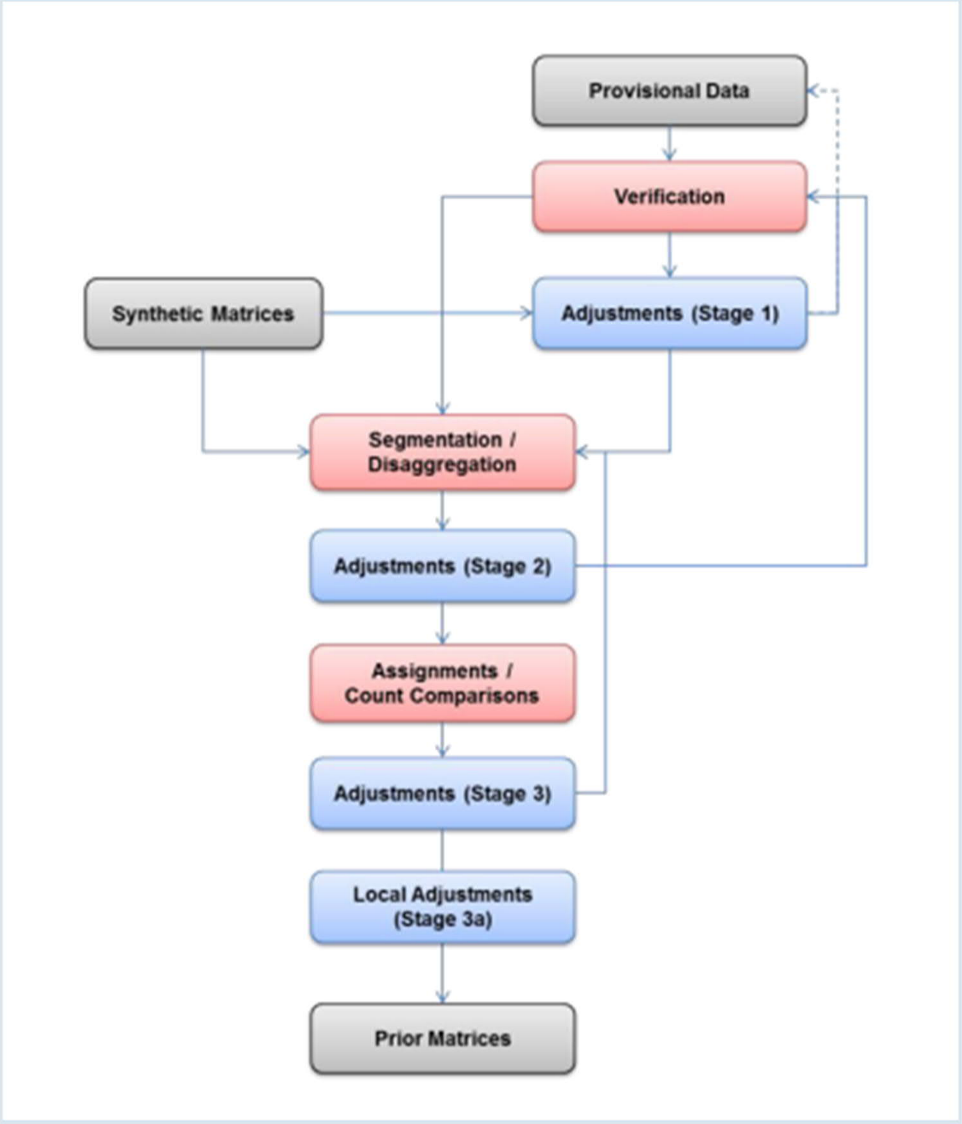
- employers' business and other trip purposes segmented by home-based and non-home-based
- home-based commuting, employers' business, and other trip purposes segmented by direction (i.e. from-home and to-home).

8.1.13 Morning, inter-peak and evening assignment time periods are required; matrices were produced for the periods described in section 3.1.2.

8.1.14 Further details are set out in the SERTM Model Validation Report, Version DF3 (March 2017).

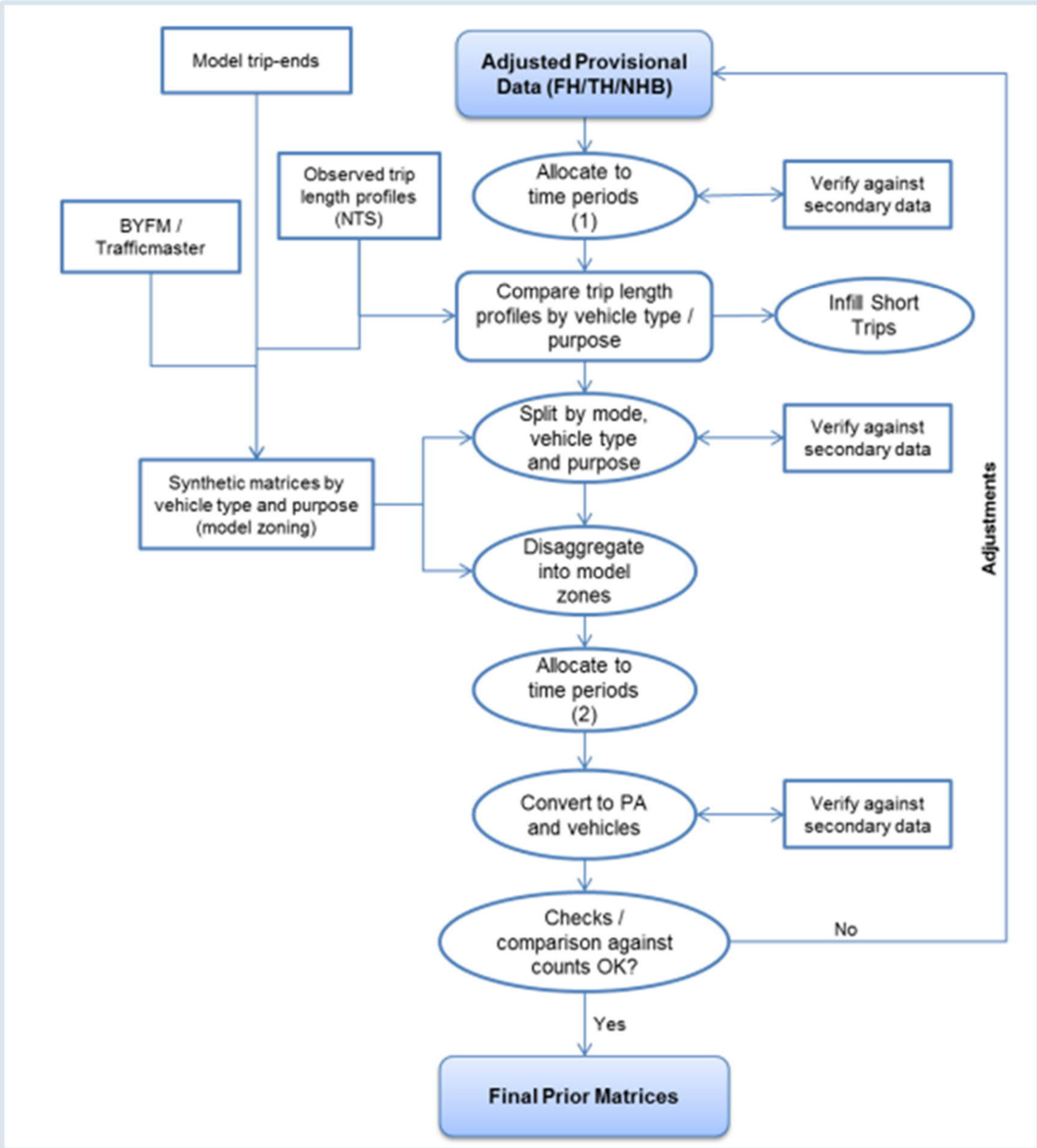
8.1.15 Figure 8-4 summarises the overall process of converting Provisional Data into final prior matrices.

Figure 8-4: Summary of SERTM matrix development process



8.1.16 Figure 8-5 summarises the matrix segmentation process which forms part of the component in developing prior matrices from Provisional Data. Synthetic matrices were required, separately by vehicle type and trip purpose, to support matrix build processing in various stages. In particular, these were used to infill short distance trips, as well as segmenting the Provisional Data matrices by vehicle type and journey purpose.

Figure 8-5: Summary of SERTM segmentation matrix development process



Freight matrices

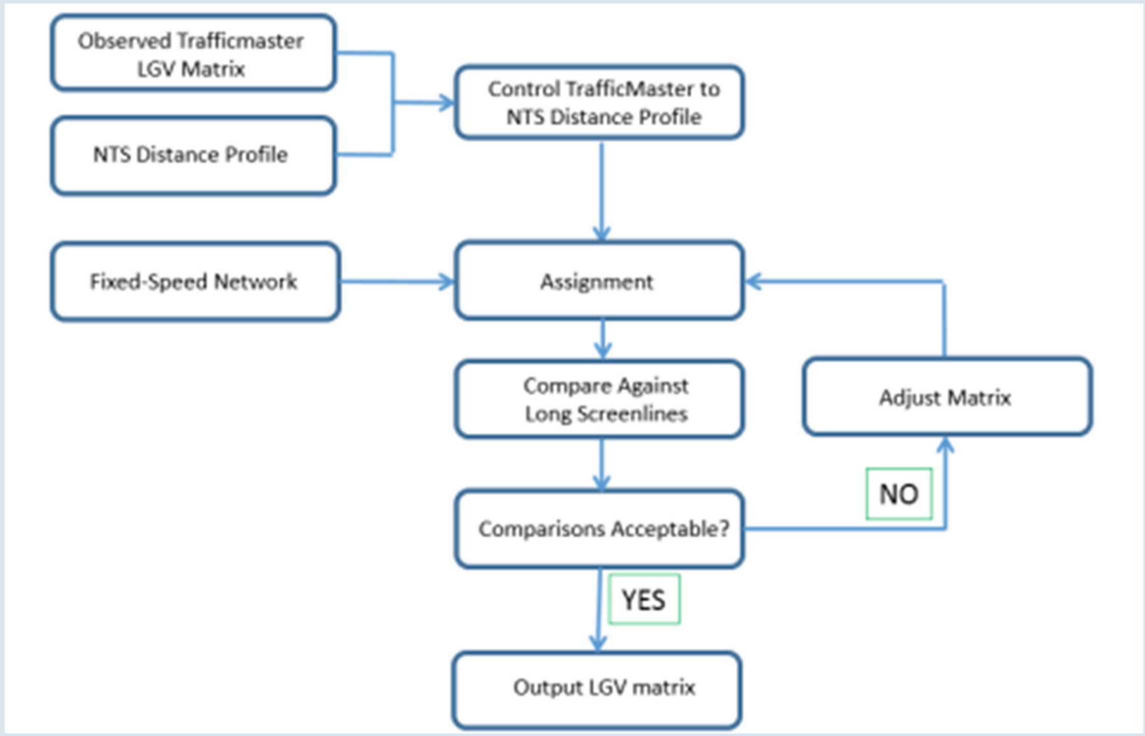
8.1.17 Separate freight matrices, for LGVs and HGVs, were required in order to separate the vehicles in the Provisional Data. The movement of freight is determined by complex logistic networks meaning that its trip patterns cannot be reliably estimated in the same way as car trips. The MTCG, viewed that, in order to derive freight matrices, a synthetic approach would not be suitable, and agreed the following approaches which were followed to develop SERTM freight matrices.

Light goods vehicles

8.1.18 LGV O-D information was made available for this project in the form of the DfT's Trafficmaster dataset. The information is based on a sample of around 75,000 LGV, which constitutes approximately 2% of the national fleet. The start and end locations are available at a high level of spatial granularity making it straightforward to convert the data into any zoning system. While potential sample bias of the dataset is acknowledged as a limitation, the MTCG were not aware of an alternative spatially detailed data source.

8.1.19 The process for converting the Trafficmaster data into assignment matrices is shown in Figure 8-6. This was undertaken separately for each time period. The first stage was to address the trip length bias by controlling the raw data to fit observed trip-length distributions from NTS, and to expand the matrix using traffic count data. It is noted that comparison of the trip length distribution with the NTS did not suggest any apparent bias; therefore, no adjustment to the trip length distribution was made for SERTM.

Figure 8-6: Summary of SERTM LGV matrix development process

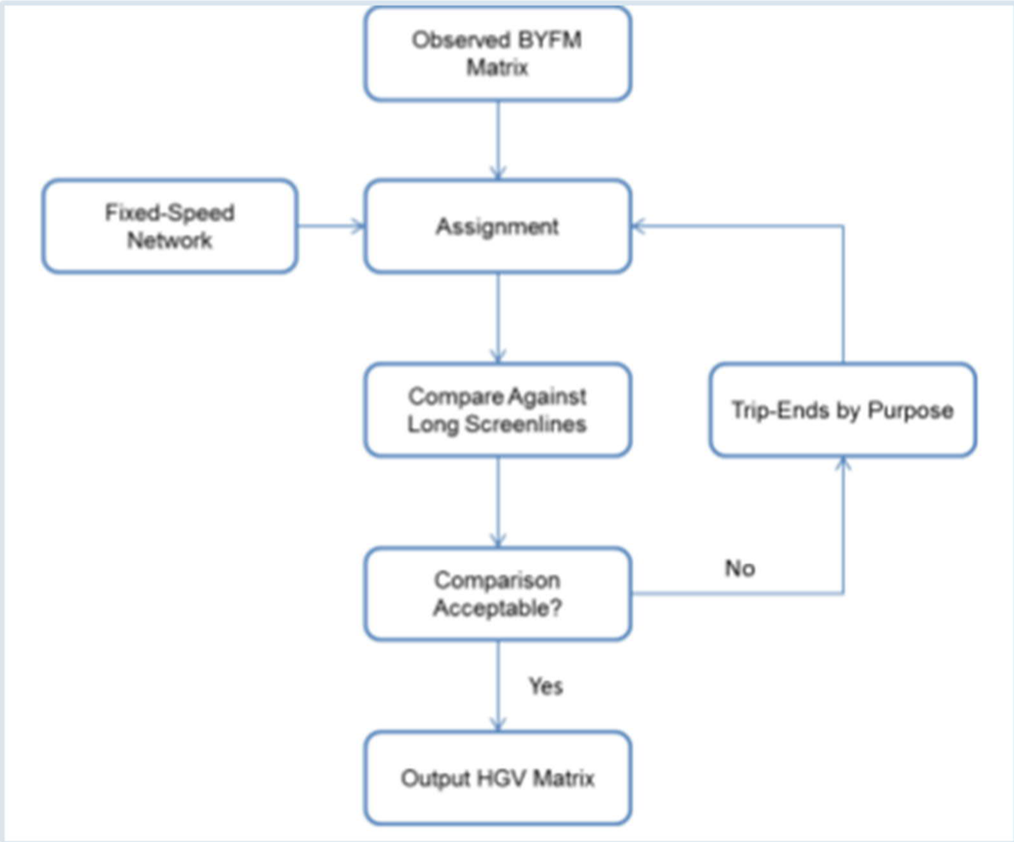


Heavy goods vehicles

8.1.20 Trafficmaster is installed on only 1,870 HGVs, representing about 0.3% of the HGV population, and this small sample is not likely to support reliable analysis. Therefore, for HGV matrices, the agreed data source is the DfT's Base Year Freight Matrices (BYFM), which provide road freight vehicle movements for a base year of 2006. Given the age of the matrices, they were factored to 2015 using observed factors from the DfT's NTM.

8.1.21 The processing of the HGV matrices, as shown in Figure 8-7, followed a similar approach undertaken for LGV.

Figure 8-7: Summary of SERTM HGV matrix development process



Final prior matrices

8.1.22 The SERTM AM peak, Inter peak and PM peak matrices have been cordoned to the PCF Stage 2 A27 transport model study area as shown in Figure 8-3.

8.1.23 This SERTM cordoned matrix has been used as the prior matrix for the PCF Stage 2 A27 transport model.

Matrix infilling process

8.1.24 Synthetic matrices were required mainly to segment mobile phone data matrices by vehicle type and trip purpose, to infill short distance trips missing from mobile phone data, and to disaggregate them geographically from mobile data sectors into model zones, if required.

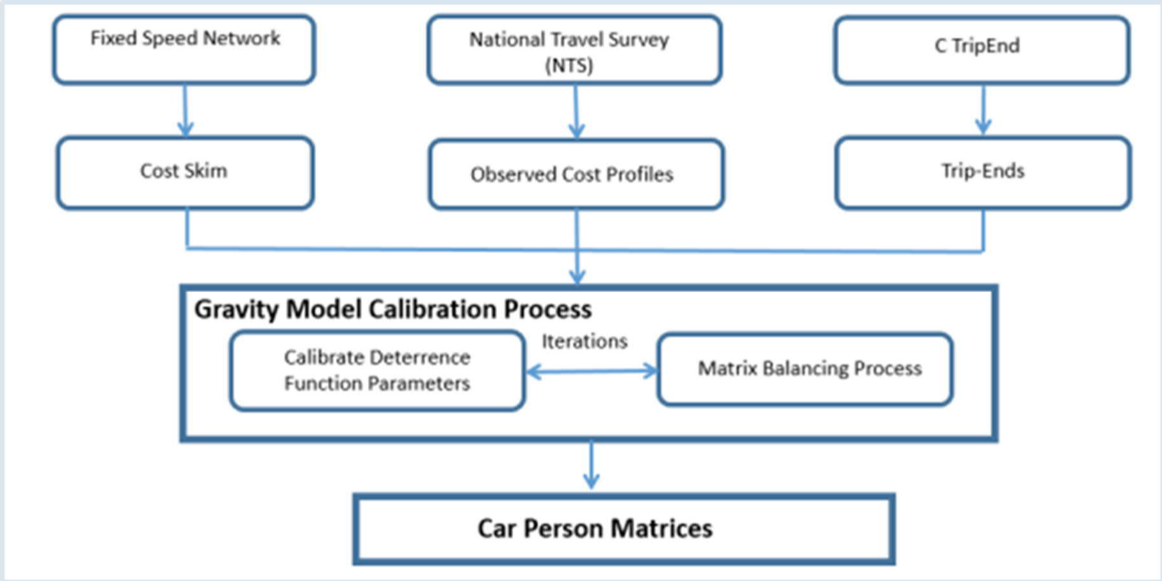
8.1.25 In accordance with the specification of the Regional Transport Models including SERTM, the car synthetic matrices need to be segmented by the following purposes:

- home-based work
- home-based employer's business

- home-based other
- non- home-based employer's business
- non- home-based other

8.1.26 The process requires the preparation of a set of inputs for a distribution model. These inputs take the form of an observed cost profile, a cost skim of the modelled area and a set of trip-ends for each zone. The distribution model calibration process is then undertaken, and its outputs converted into car assignment matrices. The process, outlined in Figure 8-8 was run separately for each trip purpose, time period and direction.

Figure 8-8: Overview of SERTM synthetic matrix development process



Variable demand model building processes

8.1.27 For PCF Stage 2 a Variable Demand Model (VDM) was built using DIADEM V6.3.3 software and this is used in the PCF Stage 2 Further Consultation.

8.1.28 In keeping with guidance in TAG Unit M2 (March 2017), the preferred demand model form is an incremental rather than an absolute model. An incremental model works by adjusting an input reference demand matrix according to changes between forecast travel costs and input reference travel costs. In other words, incremental models are used where the costs and demand for a reference case are known as we want to estimate how a change in cost would affect demand.

8.1.29 The main form of demand model available in DIADEM is the incremental hierarchical logit model, as recommended in TAG. This can be used to model trip distribution, mode choice and time period choice and can also be linked to an incremental trip frequency model.

8.1.30 For PCF Stage 2 VDM the input matrices are based on origin and destination, with the time periods modelled in DIADEM consistent with the AM, Inter-peak and PM periods defined in section 3.1.2.

8.1.31 Doubly constrained models are used for commuting which reflects the relative confidence in the measures of attraction (employment) for commuting trips, as well as the relatively fixed nature of these attraction values in the short term.

8.1.32 Other purposes such as Employer's Business and Other are production-end constrained i.e. origin. For these purposes, the trip end factors reflect the attraction of destinations, not the actual numbers of trips attracted and ideally the availability of intervening similar destinations between the origin zone and the zone in question.

8.2 Network coding processes

General model characteristics

Assignment methodology

8.2.1 The SERTM uses the Wardrop (User) Equilibrium procedure for traffic assignment in the SATURN model and has therefore been used in the PCF Stage 2 A27 transport model. This method arranges traffic on congested networks such that the cost of travel on all routes used between each O-D pair is equal to the minimum cost of travel and all unused routes have equal or greater cost.

8.2.2 The Frank-Wolfe solution algorithm is used in SATURN in an iterative process that minimises travel costs across the network. Link speed flow and junction modelling is used to build capacity restrained minimum cost routes, and then an all-or-nothing assignment is used to produce an updated set of volumes which are combined with flows from the previous assignment using calculated proportions that minimise total travel costs. It should be noted that an all-or-nothing assignment is only used in the first iteration to provide the initial flows; subsequent iterations allow multiple routes to be chosen. This process is then repeated until appropriate convergence levels are achieved.

Convergence criteria

8.2.3 Before the results of any traffic assignment are used to influence decisions, the stability (or degree of convergence) of the assignment must be confirmed. The importance of achieving convergence, at an appropriate level, is related to the need to provide stable, consistent and robust model results. When model outputs are being used to compare the with-scheme and without-scheme cases, and especially when estimating the Transport Economic Efficiency (TEE) impacts of a scheme, it is important to be able to distinguish differences due to the scheme from those associated with different degrees of convergence. Similar considerations apply when the costs (dis-benefits) and benefits of different interventions are being compared. Model convergence is therefore integral to a robust TEE appraisal. To monitor model convergence, the following measures are used:

- the percentage of links on which flows or costs change by less than 1% between successive iterations, known as “P” or “P2” respectively
- the difference between the costs along the chosen routes and those along the minimum costs routes, summed across the whole network, and expressed as a percentage of the minimum costs, usually known as the “Delta” or “%GAP”.

8.2.4 The “convergence” criteria or “stopping” criteria that has been used in the PCF Stage 2 A27 transport model is both the %GAP and RSTOP which have been set at 0.05 and 98% respectively.

PCU factor

8.2.5 In line with TAG Unit M3.1: Highway Assignment Modelling (January 2014):

“The capacities and breakpoints in the relationships set out in Sections D.2 to D.6 are specified in terms of vehicles per hour. It is common for all trip matrices to be converted to Passenger Car Unit (PCU) equivalents prior to assignment. The capacities and breakpoints in the speed/flow relationships therefore also need to be converted to passenger car unit equivalents.”

8.2.6 In line with the SERTM, a PCU value of 2.5 was used in converting HGV (vehicle units) to PCU whereas other vehicle classes remain constant (i.e. 1 vehicle unit = 1 PCU for Cars and LGV).

Generalised cost

8.2.7 Generalised cost parameters for route assignment in PPM and PPK have been calculated using the latest Highway England TPG VoT/VOC spreadsheet (VoT_and_VOC_from_ WebTAG_Databook (November 2018).

8.2.8 Table 8-1 shows the PPM and PPK values utilised for the 2015 base year assignment for the AM peak, Inter peak and PM peak.

Table 8-1: Values of Time & Distance (PPM/PPK) - 2015 values 2010 prices

User Class	AM		IP		PM	
	PPM	PPK	PPM	PPK	PPM	PPK
Car - Business	29.81	13.18	30.54	13.18	30.24	13.18
Car – Commute	19.99	6.46	20.31	6.46	20.06	6.46
Car – Other	13.79	6.46	14.69	6.46	14.44	6.46
LGV	21.07	13.80	21.07	13.80	21.07	13.80
HGV	42.78	47.14	42.78	47.14	42.78	47.14

8.2.9 For the purposes of assignment, and consistent with guidance, PPM values pertaining to HGVs have been doubled.

Time slices

8.2.10 Base year demand matrices were based on the SERTM which were built such that they are representative of average peak hour models for the morning peak, inter peak and evening peak, as described in section 3.1.2.

Links and nodes

8.2.11 The model network was based on the existing SERTM model network which was updated, including the dis-aggregation of zones and the inclusion of additional local roads to take account of local issues and to better reflect the local network. The network was verified using ArcGIS and aerial photography. Checks were carried out to verify:

- Node co-ordinates
- Link length check against measured GIS distance
- Speed/flow relationship
- Link type

- Link capacity
- One-way/two-way operation
- Number of (effective) lanes
- Length and position of flares
- Any observed turn delays/penalties
- Access points

8.2.12 Traffic loads onto the model network from zones in the form of centroid connectors. The centroid zone connectors in the PCF Stage 2 A27 transport model have been reviewed and refined to realistically represent the way in which traffic joins the road network. Specific access roads from residential and commercial areas have been used as a basis for connecting zones to the network via centroid connectors.

8.2.13 The external zones which have a large geographical coverage and significant demand associated with them, are generally connected to major routes to enter the network.

Speed

8.2.14 Within the urban area of the model, speed flow curves were not necessary due to capacity restraints from the junctions at either end of the link.

8.2.15 These links were given fixed speeds based on their individual speed limit as obtained from imagery and site visits.

8.2.16 These speeds reflect the free flow speed whilst the delay at junctions reflect the conditions in busier periods.

8.2.17 Highway capacity is restrained by junctions and by the speed-flow curves allocated to links in the study area. Speed-flow curves have generally only been used on rural or inter-urban links where the characteristics of the link itself, rather than junction capacity, have an impact on traffic speed. It has been necessary in some circumstances to use speed-flow curves in suburban areas to replicate the impacts of un-modelled minor junctions.

8.2.18 The speed flow curves used are shown in Appendix A-7 and are the same as used in the SERTM.

Junction types and characteristics

8.2.19 Each junction included in the network required several parameters as detailed below:

- Lane allocations
- Turn allocations
- Junction type

- Saturation flows at signal-controlled and priority-controlled junctions
- Signal times, stages and phases
- Circulation and saturation flows at roundabouts

Junction capacity saturations

8.2.20 The default saturation flows per lane for priority junctions are:

- Major straight-ahead movement (unopposed): 1,980 pcu/hr
- Major left turn movement (unopposed): 1,500 pcu/hr
- Major right turn movement (opposed): 687 pcu/hr
- Minor left turn movement (opposed): 721 pcu/hr
- Minor right turn movement (opposed): 621 pcu/hr
- Minor straight-ahead movement (opposed): 721 pcu/hr

8.2.21 Default saturation flows at signalised junctions are set to:

- Straight ahead movement: 1,980 pcu/hr
- Left or right turn movement: 1,740 pcu/hr

8.2.22 Where necessary, saturation flows per lane were defined as they appear via aerial imagery. The network was used in conjunction with the demand set described below to appropriately model traffic conditions within the study area.

8.2.23 The following junctions were modelled in the junction modelling software LinSig. The optimised signal timings derived from LinSig were then replicated within SATURN.

- A27 / Crossbush Junction
- A27 / Lyon's Farm West (Sompting Road)
- A27 / Lyon's Farm East (Upper Brighton Rd)
- Sussex Pad Junction
- A27 Grove Lodge Roundabout
- A27 / Busticle Lane / Halewick Lane

8.2.24 Signal controller specification information was used to incorporate the appropriate timings for other junctions, where available.

Public transport services

8.2.25 For the purposes of the PCF Stage 2 A27 transport model, public transport has not been modelled due to the scope of the A27 Arundel Bypass Scheme.

Freight transport

8.2.26 LGVs and HGVs have been modelled as individual user classes as taken from the SERTM.

Assumptions

8.2.27 Within the PCF Stage 2 A27 transport model there is no representation of tolls, High Occupancy Vehicle (HOV) lanes, Active Traffic Management (ATM) or variable speed limits as these are not present within the model study area.

Additional network

8.2.28 The zoning system used in the A27 transport model was consistent with that used with SERTM, but some minor disaggregation of zones was undertaken, consistent with areas of additional network coding, including within the Walberton area. This was undertaken to improve the representation of the location of trip origin and destination points within certain areas of the model.

9 Model calibration

9.1 Identification of data

9.1.1 Calibration of the PCF Stage 2 A27 transport model involves ensuring the model represents the on-site observed conditions by adjusting model inputs and parameters. The process involves examination of the network, checking for errors, and improving the performance of the model in terms of comparisons with observed data. Calibration statistics are presented using the DfT TAG criteria.

9.1.2 Calibration is undertaken for the four main components of the model:

- Network calibration
- Route choice calibration
- Trip matrix calibration
- Assignment calibration

9.1.3 Each of the tasks above is linked with each other and it is often a combination of all that are required to address each problem identified by the calibration process.

Data

9.1.4 Traffic data collected in 2015 in a variety of forms has been used to calibrate the PCF Stage 2 A27 transport model including:

- WSCC count data
- Highways England WebTRIS data
- ATC data from the SERTM

9.1.5 A set of counts were selected from the final traffic count dataset for the purposes of model calibration, with other counts reserved for model validation.

9.1.6 Table 9-1 gives a description of the calibration count locations with the sites shown graphically in Appendix A-3.

Table 9-1: 2015 calibration count sites

Count	Site	Description	Direction
1	ATC1	A27 Arundel Road - Site 1 - F	EB
2	ATC2	A27 Arundel Road - Site 1 - R	WB
32	SERTM1	A259 Bridge Road	EB
35	SERTM3	A284 London Road	EB
36	SERTM4	B2139 Amberley, New Barn Rd	EB
37	SERTM5	A283 Pulborough Rd	EB
38	SERTM1	A259 Bridge Road	WB
41	SERTM3	A284 London Road	WB
42	SERTM4	B2139 Amberley, New Barn Rd	WB
43	SERTM5	A283 Pulborough Rd	WB
44	SERTM6	A259 Shoreham, E. OF New Salts Farm Roundabout	WB
45	SERTM7	A27 Old Shoreham Road	WB
46	SERTM8	A24 Findon Road	SB
47	SERTM9	A27 Arundel Road	EB
49	SERTM11	A259 Littlehampton Road	EB
50	SERTM6	A259 Shoreham, E. OF New Salts Farm Roundabout	EB
51	SERTM7	A27 Old Shoreham Road	EB
52	SERTM8	A24 Findon Road	NB
53	SERTM9	A27 Arundel Road	WB
55	SERTM11	A259 Littlehampton Road	WB
56	SERTM12	A27 west of Chichester	WB

Count	Site	Description	Direction
57	SERTM12	A27 west of Chichester	EB
58	SERTM13	A27 between A285 and A29	EB
59	SERTM13	A27 between A29 and A285	WB
74	WSCC3	A259 Fishbourne, Just West of Roundabout	EB
75	WSCC3	A259 Fishbourne, Just West of Roundabout	WB
78	WSCC5	A259 Bognor Regis, Chichester Rd. (Elbridge Farm)	WB
79	WSCC5	A259 Bognor Regis, Chichester Rd. (Elbridge Farm)	EB
80	WSCC6	Runcton, Lagness Rd. / Pagham Rd. By Garden Cent.	EB
81	WSCC6	Runcton, Lagness Rd. / Pagham Rd. By Garden Cent.	WB
82	WSCC7	A284 Lyminster, Lyminster Road North of Bends	NB
83	WSCC7	A284 Lyminster, Lyminster Road North of Bends	SB
84	WSCC8	A259 Rustington bypass	EB
85	WSCC8	A259 Rustington bypass	WB
90	WSCC11	Steyning A283 Washington Road, West of B2135	EB
91	WSCC11	Steyning A283 Washington Road, West of B2135	WB
102	WSCC17	A283 Shoreham, Old Shoreham Rd N. of Buckingham St	NB
103	WSCC17	A283 Shoreham, Old Shoreham Rd N. of Buckingham St	SB
108	WSCC20	A280 Angmering, Water Lane	NB
109	WSCC20	A280 Angmering, Water Lane	SB

Network calibration

9.1.7 During the network building process, the following activities were undertaken:

- Review of the network coding warnings produced by the SATURN program SATNET
- Network distance and speed checks
- Review of junction approaches and saturation flows
- Detailed review of the coding of complex junctions
- Exclusion of neighbouring turning counts from the validation spreadsheet which would have caused failures when attempting to run the model calibration/validation procedure

Route Choice Calculation

9.1.8 At various stages of model development, the minimum cost routes for a range of selected O-D pairs were plotted and checked for plausibility. Modelled route choice depends on:

- Zone size
- Network structure
- Centroid connectors
- Trip matrix accuracy
- Representation of speeds and delays
- Junction coding accuracy

9.1.9 Where routes were found to be implausible one or more of the above aspects have been adjusted.

Trip matrix calibration

9.1.10 As part of the trip matrix calibration it is essential to validate the trip matrices by comparing assigned flows with traffic counts with the GEH[45] statistic used to compare observed and assigned flow. The statistic uses the following formula to calculate a value for the difference between observed (survey data) (ME) and modelled (M G) (SATURN flow) traffic flow:

[45] The GEH statistic is similar to a chi-squared test and is used in traffic modelling to compare two sets of traffic volumes. The GEH formula gets its name from Geoffrey E. Havers, who invented it

$$GEH\ Statistic = \sqrt{\frac{M_E - M_G{}^2}{0.5(M_E - M_G)}}$$

9.1.11 The GEH statistic takes account of the fact that when traffic flows are low, the percentage difference between observed and modelled flow may be high but the significance of this difference is small and conversely, a small percentage difference on a large base might be important. A GEH value greater than 10 indicates that closer attention is required, as the match between observed and modelled flows is poor, while a GEH less than 5 indicates a good fit. The aim is to achieve at least 85% links and turns with a GEH less than 5 as specified in TAG Unit M3.1.

9.1.12 The following sections set out the comparison of the modelled flows and observed flows.

Assignment Calibration

9.1.13 TAG Unit M3.1 also specifies the following flow validation criteria for links and turns:

- Individual flows within 100 vehicles per hour (veh/hr) for flows less than 700 veh/hr in more than 85% of cases;
- Individual flows within 15% for flows between 700 – 2,700 veh/hr in more than 85% of cases; and
- Individual flows within 400 veh/hr for flows greater than 2,700 veh/hr in more than 85% of cases.

9.1.14 The subsequent model outputs are assessed in compliance with the criteria outlined above.

Pre-matrix estimation (ME) calibration

9.1.15 Following the development of the prior trip matrices, significant work and investigations were undertaken to ensure the prior matrix performance within the PCF Stage 2 A27 transport model was as good as possible prior to using ME. This included adjustments to the prior matrices to achieve a better fit between the observed link flows and the modelled flows.

9.1.16 Table 9-2 to Table 9-4 show the results of the highway model matrix performance for the AM peak, Inter peak and PM peak respectively. Flow criteria is displayed in vehicles per hour (vph)

Table 9-2: AM peak – Prior to matrix estimation

Criteria and Measure		Acceptability Guideline	ALL						CAR					
Flow Criteria			Calibration			Validation			Calibration			Validation		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%	Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	22	16	73%	33	27	82%	25	19	76%	37	28	76%
700-2,700 vph	+/- 15%		22	16	73%	23	14	61%	19	14	74%	19	12	63%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%	0	0	0%	0	0	0%
GEH Criteria														
GEH Statistic for individual links <5		>85% of links	44	36	82%	56	40	71%	44	36	82%	56	40	71%

	ALL						CAR					
GEH Range	Calibration		Validation		Combined		Calibration		Validation		Combined	
GEH < 2	13	30%	0	0%	13	13%	14	32%	21	38%	35	35%
GEH < 4	26	59%	32	57%	58	58%	26	59%	34	61%	60	60%
GEH < 6	39	89%	46	82%	85	85%	41	93%	45	80%	86	86%
GEH < 8	42	95%	52	93%	94	94%	43	98%	53	95%	96	96%
GEH < 10	44	100%	54	96%	98	98%	44	100%	55	98%	99	99%
GEH < 5	36	82%	40	71%	76	76%	36	82%	40	71%	76	76%

Table 9-3: Inter peak – Prior to matrix estimation

Criteria and Measure		Acceptability Guideline	ALL						CAR					
Flow Criteria			Calibration			Validation			Calibration			Validation		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%	Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	22	20	91%	37	28	76%	28	28	100%	43	34	79%
700-2,700 vph	+/- 15%		22	18	82%	19	14	74%	16	14	88%	13	10	77%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%	0	0	0%	0	0	0%
GEH Criteria														
GEH Statistic for individual links <5		>85% of links	44	37	84%	56	45	80%	44	41	93%	56	47	84%

	ALL						CAR					
GEH Range	Calibration		Validation		Combined		Calibration		Validation		Combined	
GEH < 2	17	39%	0	0%	17	17%	18	41%	19	34%	37	37%
GEH < 4	32	73%	38	68%	70	70%	39	89%	38	68%	77	77%
GEH < 6	43	98%	48	86%	91	91%	43	98%	49	88%	92	92%
GEH < 8	43	98%	54	96%	97	97%	44	100%	54	96%	98	98%
GEH < 10	44	100%	56	100%	100	100%	44	100%	56	100%	100	100%
GEH < 5	37	84%	45	80%	82	82%	41	93%	47	84%	88	88%

Table 9-4: PM peak – Prior to matrix estimation

Criteria and Measure		Acceptability Guideline	ALL						CAR					
Flow Criteria			Calibration			Validation			Calibration			Validation		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%	Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	19	17	89%	31	22	71%	21	20	95%	35	28	80%
700-2,700 vph	+/- 15%		25	23	92%	25	22	88%	23	18	78%	21	20	95%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%	0	0	0%	0	0	0%
GEH Criteria														
GEH Statistic for individual links <5		>85% of links	44	41	93%	56	48	86%	44	39	89%	56	50	89%

	ALL						CAR					
GEH Range	Calibration		Validation		Combined		Calibration		Validation		Combined	
GEH < 2	24	55%	0	0%	24	24%	19	43%	25	45%	44	44%
GEH < 4	37	84%	38	68%	75	75%	36	82%	43	77%	79	79%
GEH < 6	42	95%	50	89%	92	92%	39	89%	51	91%	90	90%
GEH < 8	42	95%	55	98%	97	97%	42	95%	55	98%	97	97%
GEH < 10	44	100%	55	98%	99	99%	43	98%	55	98%	98	98%
GEH < 5	41	93%	48	86%	89	89%	39	89%	50	89%	89	89%

9.1.17 The information shown in Table 9-2 to Table 9-4 shows that even though there are 85% of links meeting the GEH criteria of less than 5 for all counts i.e. cars in the Inter peak and PM peak calibration and validation, there are some issues in flow criteria. The AM peak shows that neither the flow or GEH criteria is met for the car vehicle types.

9.1.18 Table 9-5 shows the calibration and validation summary for the individual vehicles types (Car, LGV and HGV) prior to ME.

Table 9-5: Summary of calibration/validation for Car, LGV and HGV (pre-ME)

		Car	LGV	HGV
AM peak	Calibration	82%	95%	91%
	Validation	71%	96%	93%
Inter peak	Calibration	93%	95%	91%
	Validation	84%	100%	96%
PM peak	Calibration	89%	93%	93%
	Validation	89%	96%	98%

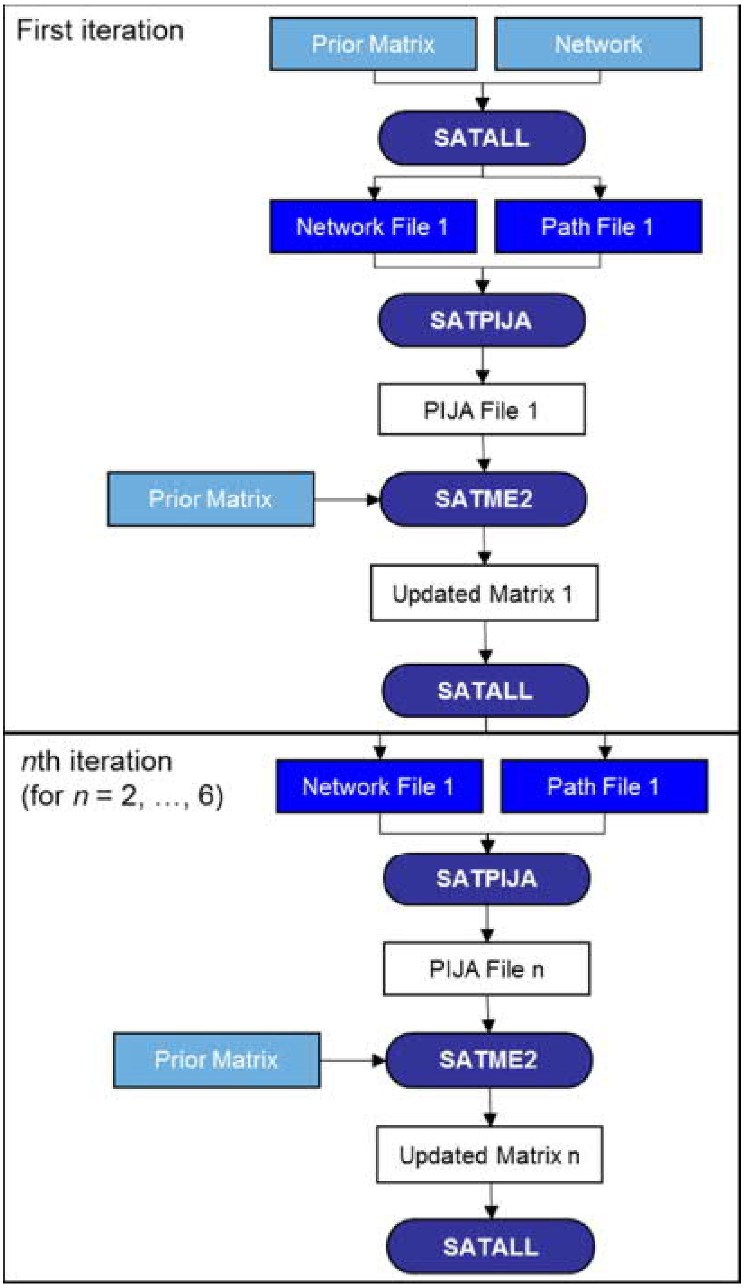
9.1.19 The information shown in Table 9-5 shows that calibration and validation results are strong, but do not meet GEH criteria, and therefore ME is required to be undertaken.

9.2 Matrix estimation process

9.2.1 Following the development of the prior trip matrices, ME techniques have been used. The model calibration process used ME procedures as contained in the SATME2 program. The basic operation of this uses the best estimation of trip movements, as contained in the prior matrix, and adjusts the pattern of trip distribution and volumes in order to match input traffic flows.

9.2.2 The ME process employed within SATURN is illustrated in Figure 9-1.

Figure 9-1: Matrix estimation process in SATURN



9.2.3 The Prior Matrix was assigned to a network representing the current highway network. SATME2 requires a PIJA file which represents the proportion (P) of trips between a particular O-D pair (IJ) which uses the counted link (A). The PIJA data is obtained through the program SATPIJA following a SATURN assignment using the SAVEIT option.

9.2.4 This produced PIJA output files for LGV and HGV which were used by SATME2 along with the Prior Matrix to produce updated 2015 Car, LGV and HGV matrices which were then combined into a 'stacked' estimated matrix for assignment. No cells were frozen and there were no zonal constraints applied.

9.2.5 Primary inputs to the calibration process were traffic flows used as target counts for the ME process. For the calibration of the PCF Stage 2 A27 transport model it was decided that six ME loops would be sufficient to produce an improved goodness of fit to the prior matrices. There are no specific convergence criteria for ME, but the aim of the procedure is to improve the goodness of fit between modelled flows and counts. The parameters that were adopted for the ME within SATURN are shown in Table 9-6.

Table 9-6: Parameters used for matrix estimation

parameter	description	value
XAMAX	The maximum balancing factor to be applied to avoid large changes to the prior matrix. (The minimum balancing factor is taken as the Inverse)	2.0
EPSILN	The convergence criteria for the difference between individual observed counts and their respective model flow	0.01
ITERMX	The maximum number of iterations that will be run to achieve convergence.	30

9.2.6 ME was undertaken using selected traffic counts in the calibration count set, aligned to areas in the model where there were greater differences between observed and modelled data in the pre-ME assignments. The change in the matrix totals by each user class is summarised in Table 9-7.

9.2.7 The table shows that the changes that ME are making to the overall matrix total are relatively small i.e. less than 4% in the AM peak and less than 2% in the Inter peak and PM peak.

9.2.8 Table 9-7 shows a 13.8% increase in the HGV trips in the PM peak. The higher proportional change reflects the relatively small number of HGV's within the prior matrices during this peak. In both pre- and post-estimation matrices, the PM peak HGV totals represent approximately 6% of the overall total post-ME matrix which is proportionately the same as the prior matrix. The impact of the changes in matrix totals is then explained in information presented later in this chapter.

Table 9-7: Changes in matrix totals due to matrix estimation

User class	AM peak		Inter peak		PM peak	
Car: Business	3,171	3,280	2,241	2,240	3,024	3,049
%Change		3.44%		-0.04%		0.83%
Car: Commute	11,902	12,237	6,303	6,442	13,406	13,549
%Change		2.81%		2.21%		1.07%
Car: Other	16,354	17,088	22,781	23,161	23,459	23,631
%Change		4.49%		1.67%		0.73%
LGV	5,669	5,863	5,041	5,156	5,424	5,498
%Change		3.42%		2.28%		1.36%
HGV	3,785	3,961	3,791	3,905	2,558	2,911
%Change		4.65%		3.01%		13.80%
Total	**40,881**	**42,428**	**40,156**	**40,904**	**47,870**	**48,638**
%Change		**3.78%**		**1.86%**		**1.60%**

Link flows against counts

9.2.9 Table 9-8 to Table 9-10 show the final model calibration of the PCF Stage 2 A27 transport model for the AM peak, Inter peak and PM peak respectively.

Table 9-8: AM peak – Post matrix estimation

Criteria and Measure		Acceptability Guideline	All Vehicles			Car		
Flow Criteria			Calibration			Calibration		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	18	18	100%	20	20	100%
700-2,700 vph	+/- 15%		22	21	95%	20	17	85%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%
GEH Criteria								
GEH for individual links <5		>85% of links	40	39	98%	40	37	93%

	All Vehicles		Car	
GEH Range	Calibration		Calibration	
GEH < 2	29	73%	26	65%
GEH < 4	35	88%	33	83%
GEH < 6	37	93%	36	90%
GEH < 8	40	100%	39	98%
GEH < 10	40	100%	39	98%
GEH < 5	37	93%	35	88%

Table 9-9: Inter peak – Post matrix estimation

Criteria and Measure		Acceptability Guideline	All Vehicles			Car		
Flow Criteria			Calibration			Calibration		
Observed	**Modelled**		**Total count**	**Meet criteria**	**%**	**Total count**	**Meet criteria**	**%**
<700 vph	+/- 100 vph	>85% of links	18	17	94%	22	22	100%
700-2,700 vph	+/- 15%		22	22	100%	18	18	100%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%
GEH Criteria								
GEH for individual links <5		>85% of links	40	39	98%	40	40	100%

	All Vehicles		Car	
GEH Range	Calibration		Calibration	
GEH < 2	29	73%	29	73%
GEH < 4	37	93%	37	93%
GEH < 6	39	98%	40	100%
GEH < 8	40	100%	40	100%
GEH < 10	40	100%	40	100%
GEH < 5	38	95%	40	100%

Table 9-10: PM peak – Post matrix estimation

Criteria and Measure		Acceptability Guidelines	All Vehicles			Car		
Flow Criteria			Calibration			Calibration		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	15	15	100%	17	17	100%
700-2,700 vph	+/- 15%		25	24	96%	23	22	96%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%
GEH Criteria								
GEH Statistic for individual links <5		>85% of links	40	39	98%	40	39	98%

	All Vehicles		Car	
GEH Range	Calibration		Calibration	
GEH < 2	30	75%	27	68%
GEH < 4	37	93%	37	93%
GEH < 6	39	98%	39	98%
GEH < 8	39	98%	39	98%
GEH < 10	39	98%	39	98%
GEH < 5	39	98%	39	98%

9.2.10 Table 9-11 shows the calibration and validation summary for Car, LGV and HGV after ME.

Table 9-11: Summary of calibration for Car, LGV and HGV (post-ME)

		Car	LGV	HGV
AM peak	Calibration	93%	95%	98%
Inter peak	Calibration	100%	100%	100%
PM peak	Calibration	98%	98%	100%

9.2.11 Full details of the comparison between the modelled and observed flows for the 2015 AM peak, Inter peak and PM peak is included in Appendix B-2.

9.2.12 Overall, the PCF Stage 2 transport model shows good individual link calibration, in terms of

- modelled flow ranges
- Car, LGV and HGV for each of the AM peak, Inter peak and PM peak

9.2.13 Appendix B-3 contains diagrams showing the calibration GEH values for All Vehicles and split by Car, LGV and HGV for the 2015 base year (AM peak, Inter peak and PM peak).

9.2.14 Appendix B-4 contains diagrams showing the comparison of the calibration counts for All Vehicles and split by Car, LGV and HGV for the 2015 base year (AM peak, Inter peak and PM peak).

9.2.15 To ensure that ME was a controlled process, due care and attention was given to the requirements set out in TAG Unit M3.1 (January 2014) to monitor the impacts of ME. Information has been therefore presented on:

- Matrix zonal cell values
- Matrix zonal trip ends
- Trip length distributions
- Sector to sector level matrices

Matrix zonal cell values

9.2.16 Table 9-12 shows the guidance for significance criteria regarding the matrix zonal cell value changes during the ME process which is defined in TAG Unit M3.1 Highway Assignment Modelling (January 2014).

9.2.17 the mean and the standard deviation between the prior matrix and post matrix has to be within 5%.

Table 9-12: Matrix estimation effects, TAG criteria – matrix zonal cell values

Measure	Significance criteria
Matrix zonal cell values	• Slope within 0.98 and 1.02
	• Intercept near zero
	• R^2 in excess of 0.95

9.2.18 Table 9-13 shows the outcome of regression analysis of the post-ME and prior matrices, at the zonal cell level for the AM peak, Inter peak and PM peak models.

Table 9-13: Regression statistics – matrix zonal cell values, AM, Inter-peak and PM

Measure	AM peak	Inter peak	PM peak
Slope	1.044	1.029	1.104
Intercept	-0.003	-0.006	-0.005
R2	0.951	0.960	0.938

9.2.19 Comparison of the regression output against the TAG criteria indicates that all criteria are met or almost met with the exception of the Slope value in the PM peak. This value may be associated with the large percentage change in HGV trip matrices between prior- and post-ME. However, paragraph 4.2.6 explains that in both prior and post matrices, HGV volumes are proportionally consistent as they account for around 6% of the total matrices. Furthermore Table 9-11 and the validation summary table indicate a good level of validation of HGV’s in prior and post matrices respectively.

Matrix zonal trip ends

9.2.20 Table 9-14 shows the guidance for significance criteria regarding the matrix zonal trip end changes during the ME process which is defined in TAG Unit M3.1.

Table 9-14: Matrix estimation effects, TAG criteria – matrix zonal trip end values

Measure	significance criteria
Matrix zonal trip ends	• Slope within 0.99 and 1.01
	• Intercept near zero
	• R2 in excess of 0.98

9.2.21 Table 9-15 shows the outcome of regression analysis of the post-ME and prior matrices, at the zonal trip end level for the AM peak, Inter peak and PM peak models.

Table 9-15: Regression statistics - matrix zonal trip end, AM, Inter peak and PM

	Measure	am peak	inter peak	pm peak
Origin	Slope	1.062	1.005	1.033
Origin	Intercept	-3.586	1.903	-2.958
Origin	R^2	0.984	0.983	0.986
Destination	Slope	1.059	1.023	1.044
Destination	Intercept	-3.168	-0.664	-4.845
Destination	R^2	0.982	0.987	0.983

9.2.22 Comparison of the regression output against the TAG criteria indicates that all criteria are met or almost met with the exception of the slope value in all peak hours.

9.2.23 Figure 9-2 and Figure 9-3 show the row and columns scatter plots for the 2015 AM peak.

Figure 9-2: AM peak – Matrix row totals scatter plot

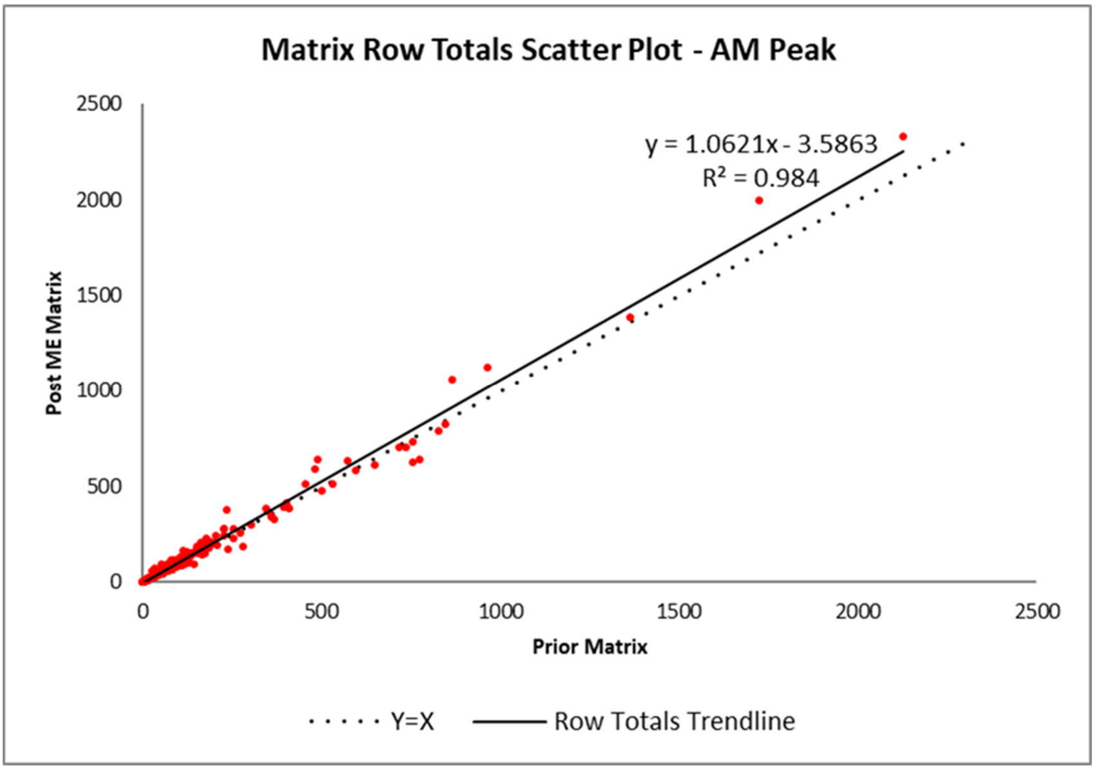
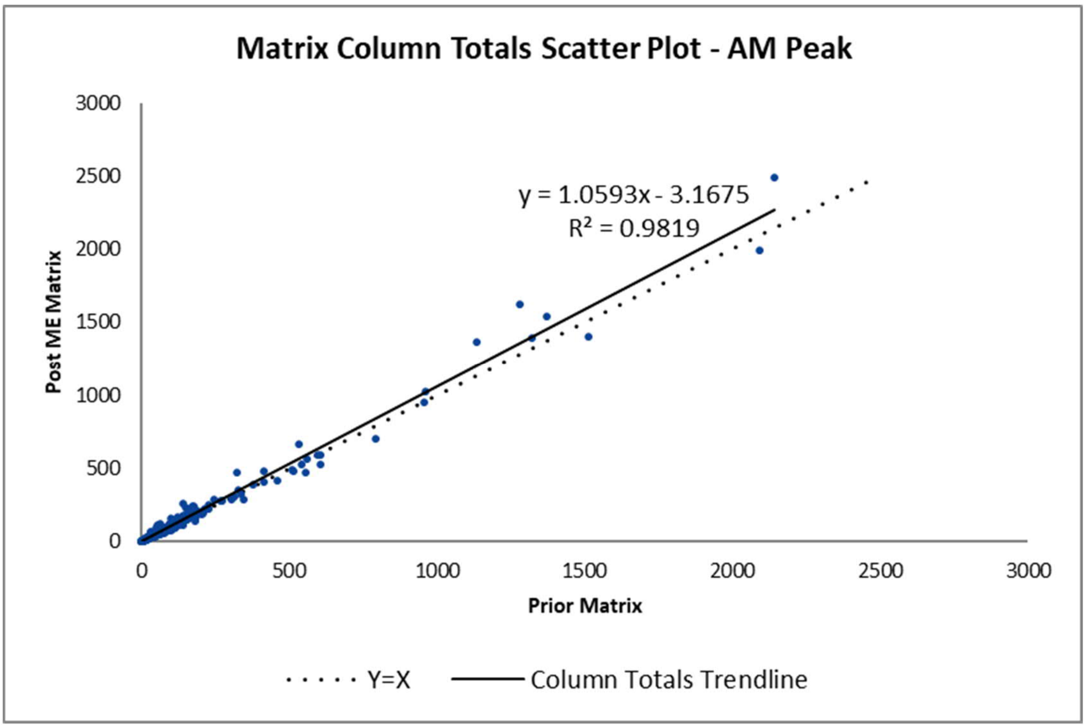


Figure 9-3: AM peak – Matrix columns totals scatter plot



9.2.24 Figure 9-4 and Figure 9-5 show the row and columns scatter plots for the 2015 Inter peak.

Figure 9-4: Inter peak – Matrix row totals scatter plot

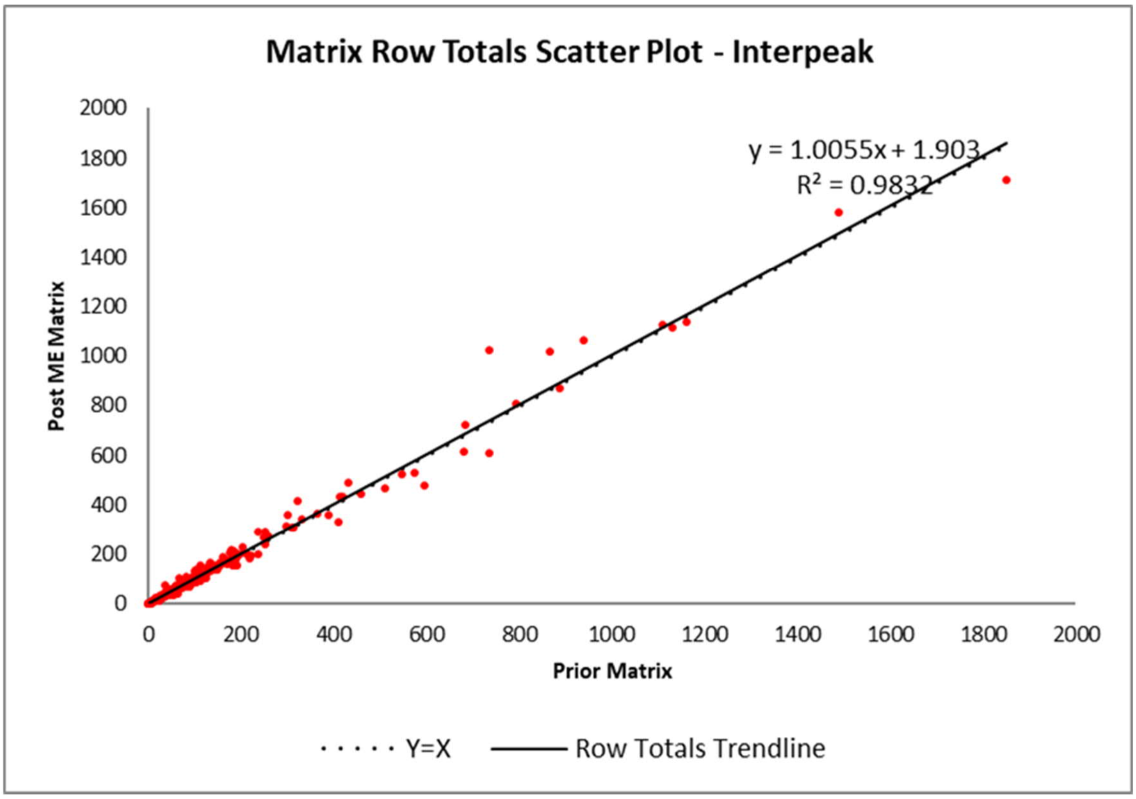
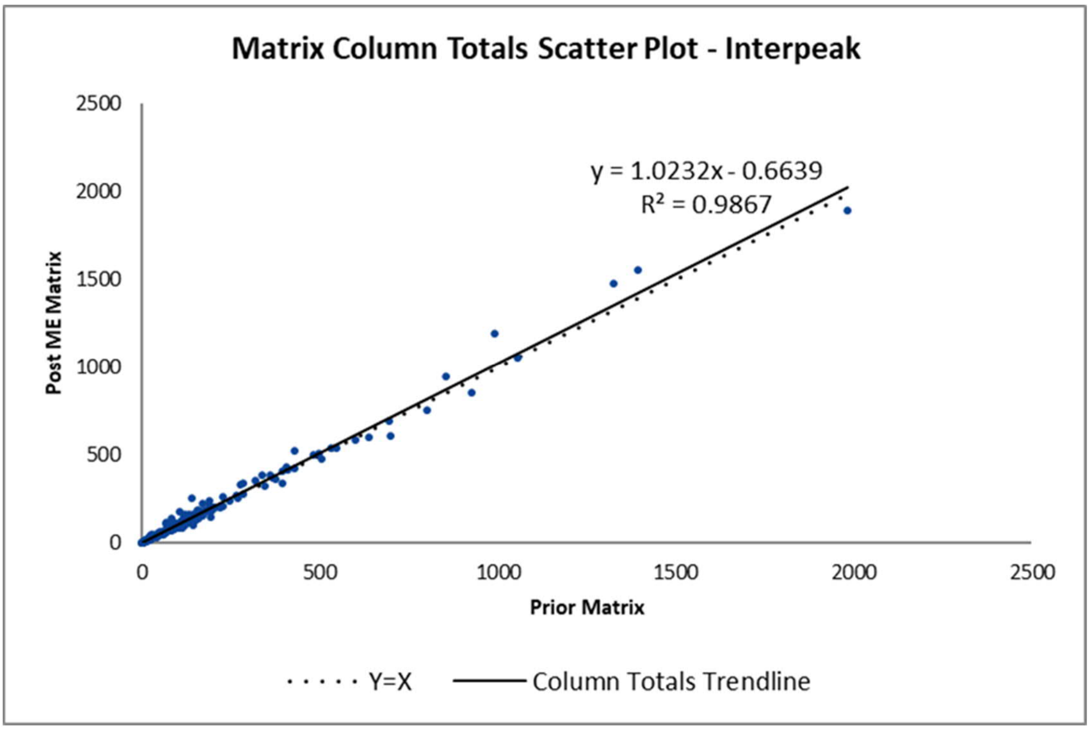


Figure 9-5: Inter peak – Matrix columns totals scatter plot



9.2.25 Figure 9-6 and Figure 9-7 show the row and columns scatter plots for the 2015 PM peak.

Figure 9-6: PM peak – Matrix row totals scatter plot

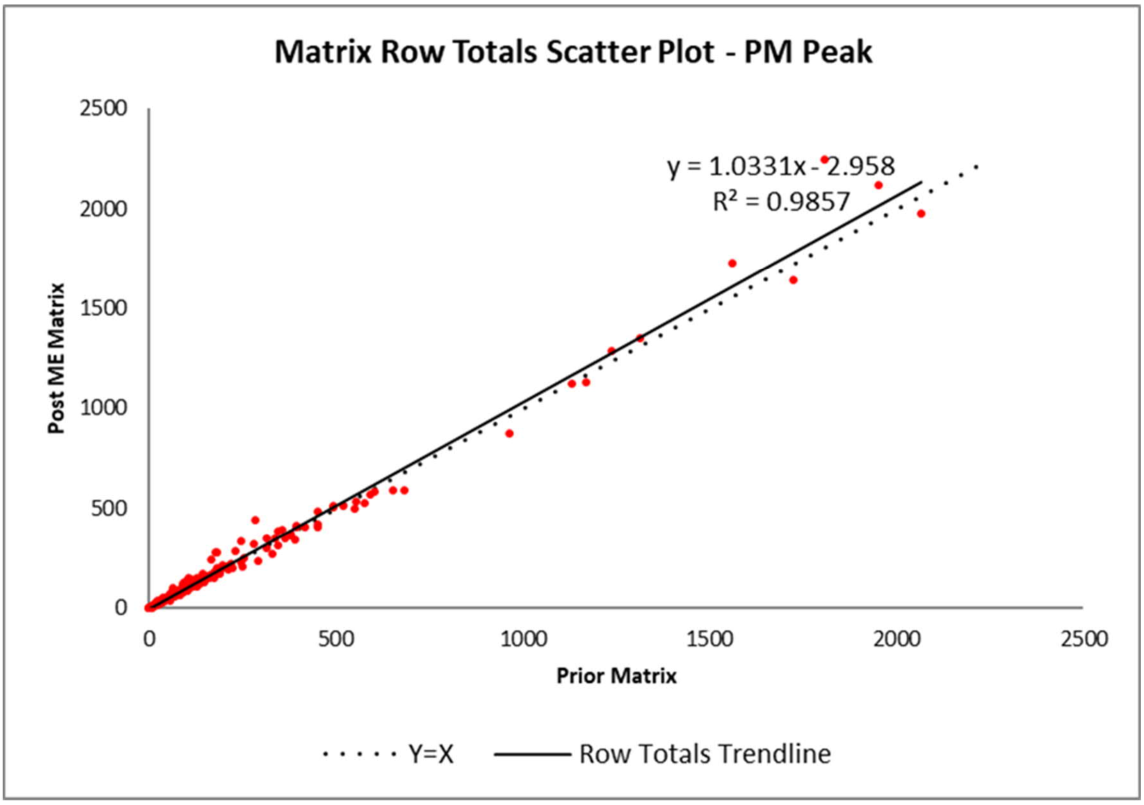
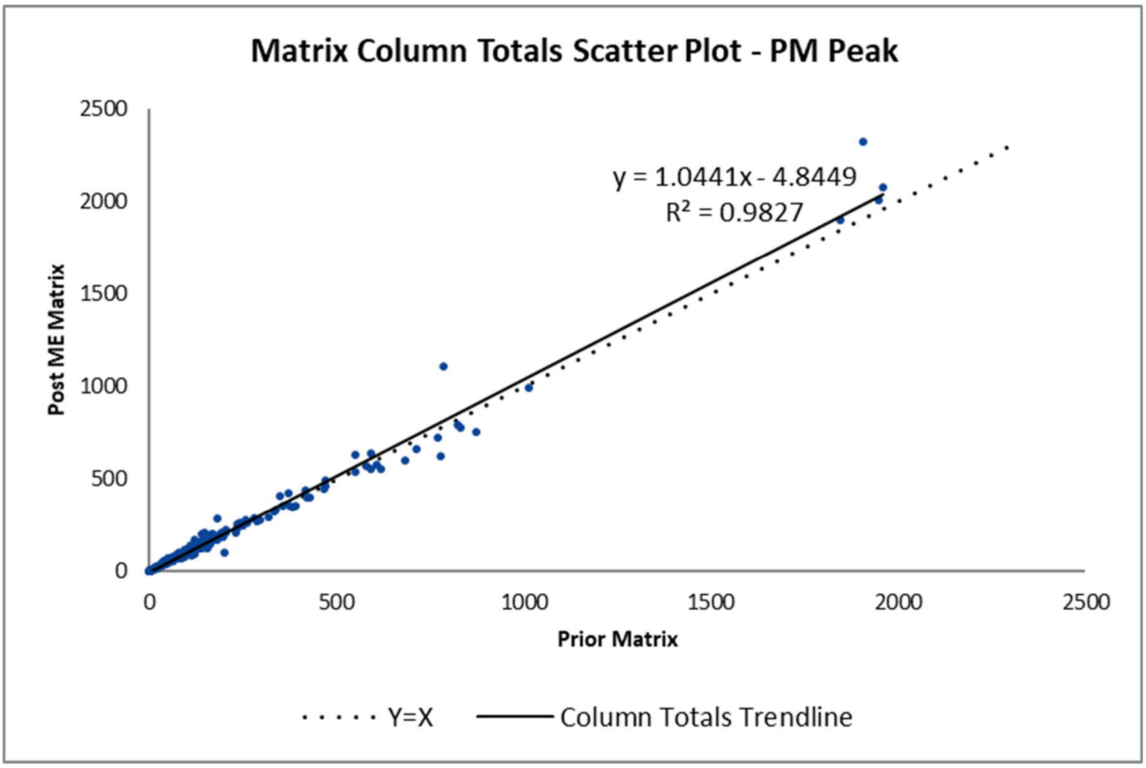


Figure 9-7: PM peak – Matrix columns totals scatter plot



Trip length distributions

9.2.26 The ME process has been used, alongside observed count data, to alter the prior matrices to improve the flow calibration and validation of the model. The trip length distribution comparison between the prior and post matrices are shown in Figure 9-8 to Figure 9-10.

Figure 9-8: AM peak – trip length distribution

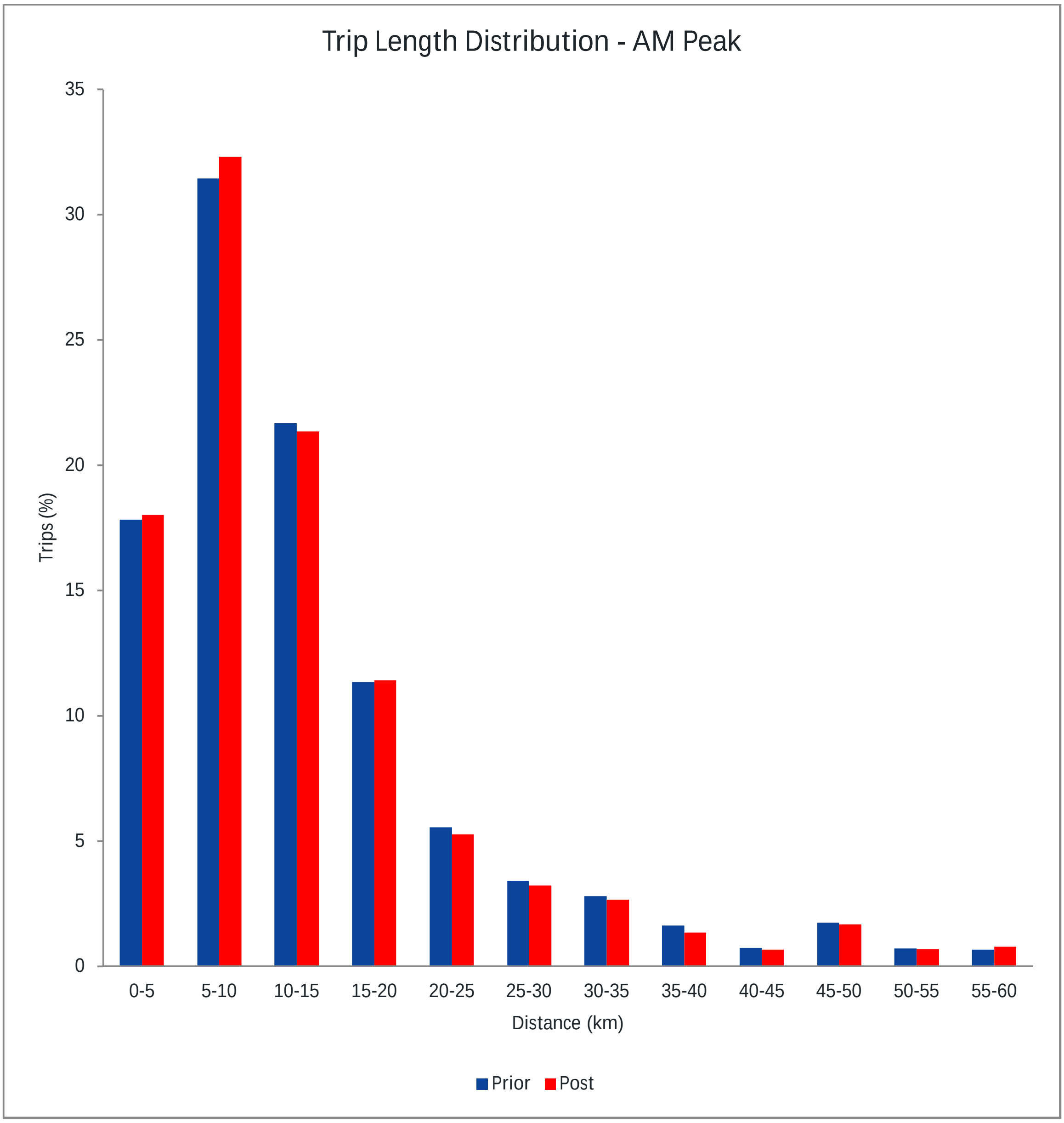


Figure 9-9: Inter peak – trip length distribution

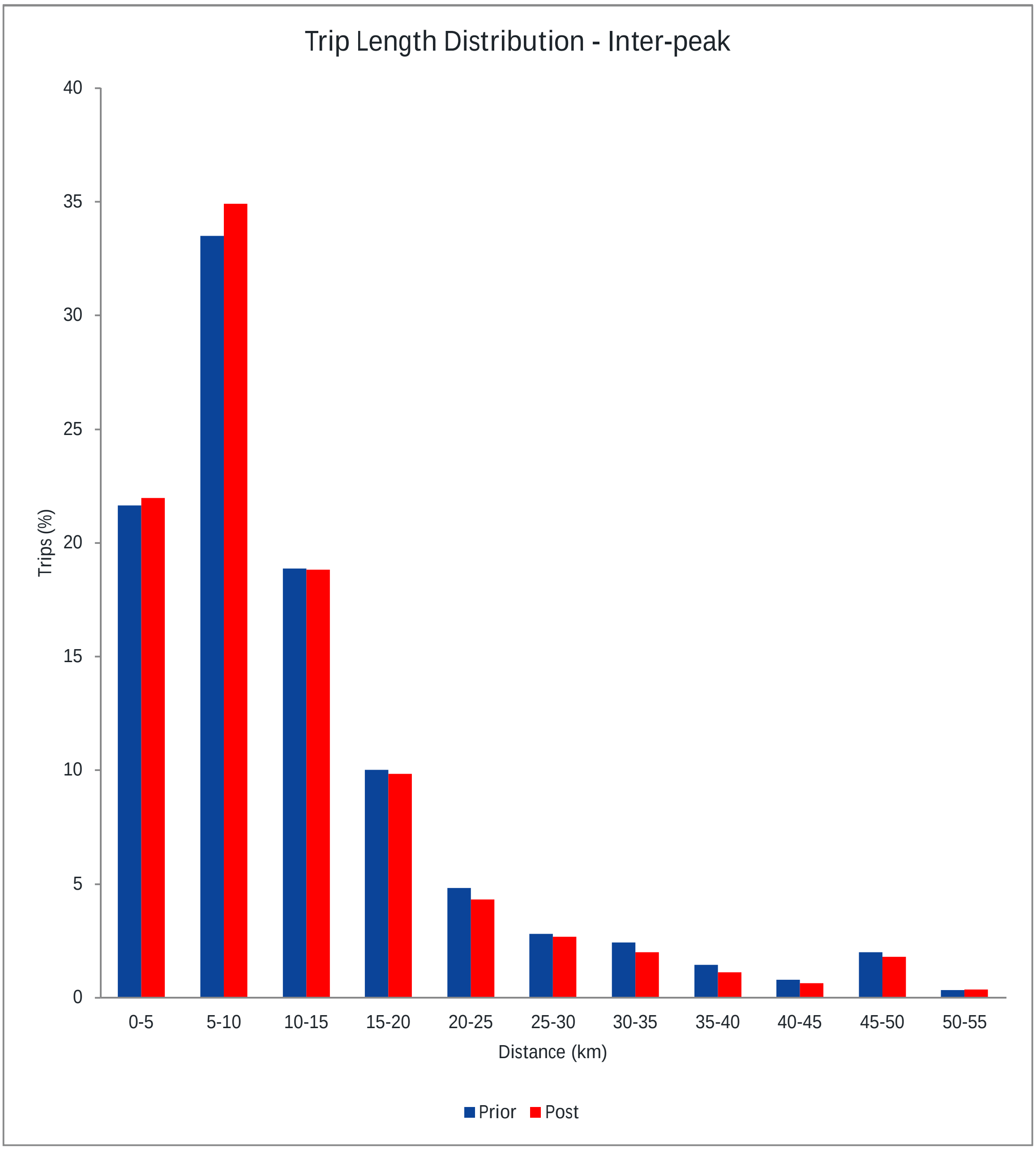
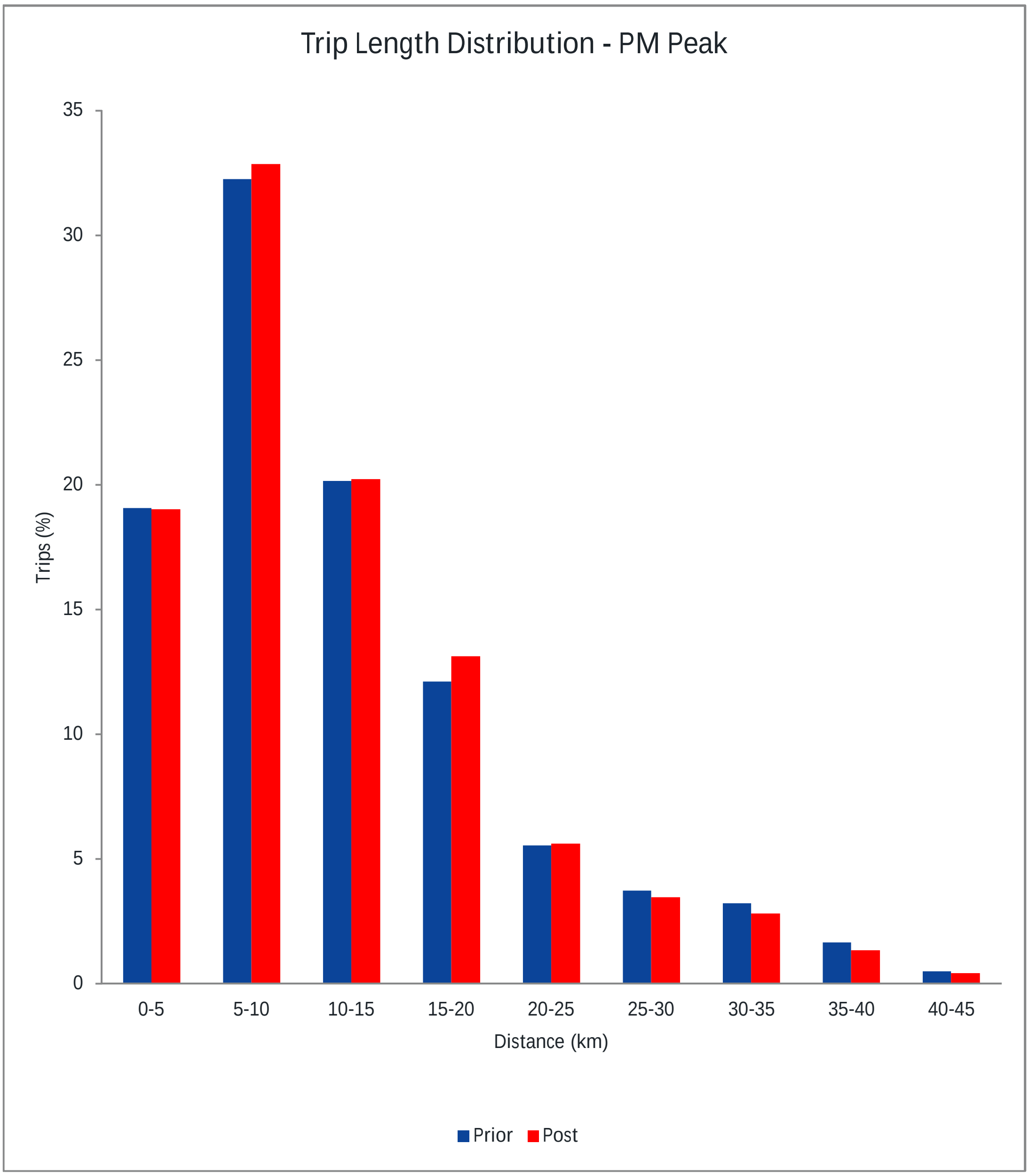


Figure 9-10: PM peak – trip length distribution



9.2.27 The increase from the Prior-ME matrix to the Post-ME matrix is:

- AM peak matrix shows an overall increase in the number of trips of 4% equating to an increase in the overall trip matrix from 40,881 trips to 42,428 trips
- Inter peak matrix shows an overall increase in the number of trips of 2% equating to an increase in the overall trip matrix from 40,156 trips to 40,904 trips
- PM peak matrix shows an overall increase in the number of trips of 2% equating to an increase in the overall trip matrix from 47,870 trips

to 48,638 trips. The point to note is a 14% increase in the HGV matrix from 2,558 trips to 2,911 trips.

9.2.28 As stated in TAG Unit M3.1 Highway Assignment Modelling, Table 5 (January 2014) the mean and the standard deviation between the prior matrix and post matrix has to be within 5%.

9.2.29 Table 9-16 to Table 9-18 show the mean and standard deviation calculations for the AM peak, Inter peak and PM peak respectively.

Table 9-16: AM peak – mean and standard deviation

Measurement		Requirement	Value	Pass?
Mean	Prior	Within 5%	13.225	Yes
	Post		13.047	
	Diff		1.3%	
Standard Dev	Prior	Within 5%	3.637	Yes
	Post		3.612	
	Diff		0.7%	

Table 9-17: Inter peak – mean and standard deviation

Measurement		Requirement	Value	Pass?
Mean	Prior	Within 5%	12.438	Yes
	Post		12.056	
	Diff		3.1%	
Standard Dev	Prior	Within 5%	3.527	Yes
	Post		3.472	
	Diff		1.5%	

Table 9-18: PM peak – mean and standard deviation

Measurement		Requirement	Value	Pass?
Mean	Prior	Within 5%	12.428	Yes
	Post		11.990	
	Diff		3.5%	
Standard Dev	Prior	Within 5%	3.525	Yes
	Post		3.463	
	Diff		1.8%	

9.2.30 As shown in Table 9-16 to Table 9-18 the AM peak has a mean of 1.3%, Inter peak has a mean of 3.1% and the PM peak has a mean of 3.5% which are all within the 5% criteria set by TAG.

9.2.31 The AM peak has a standard deviation of 0.7%, Inter peak has a standard deviation of 1.5% and the PM peak has a standard deviation of 1.8% which are all within the 5% criteria set by TAG.

Sector to sector level matrices

9.2.32 Table 9-19 shows the TAG significance criteria for the comparison of prior and post-ME sector-to-sector matrices.

Table 9-19: Matrix estimation effects, TAG criteria - sector-to-sector matrices

Measure	Significance Criteria
Sector to sector level matrices	Difference within 5%

9.2.33 The sector system shown in Table 9-20 has been used to undertake the analysis and is shown graphically in Appendix B-1.

Table 9-20: Sector description

Sector number	Area covered
1	Lancing (east)
2	Lancing (west)
3	Worthing (east)
4	Worthing (west)
5	Littlehampton
6	Arundel
7	North of Chichester
8	External zones
9	Pulborough
10	Midhurst
11	Findon

12	Steyning
13	Chichester / Bognor Regis
14	Barnham / Yapton
15	Burpham
16	Clapham
17	Storrington
18	Small Dole
19	Shoreham
20	Goring

9.2.34 Table 9-21 to Table 9-23 show the percentage change in sector to sector movements for the AM peak, Inter peak and PM peak respectively. Sector 8 represents the external zones coming into and out of the model area. It can be seen that the changes in sector to sector movements are greater than the criteria set out in TAG, partly because some of the individual sector to sector trip numbers are small which give rise to larger percentage increases.

9.2.35 To illustrate the degree of significance of these changes, sector to sector GEH tables of differences Pre-ME and Post-ME have been prepared for the AM peak, Inter peak and PM peak (Table 9-24 to Table 9-26 respectively. These tables show that most of the sector changes have a GEH of less than 5 and all sector changes have a GEH of less than 7. From this, it can be considered that ME has not had a significant impact at the sector level.

Table 9-21: % change in sector to sector movements (AM peak)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	3%	8%	-27%	6%	2%	51%	5%	10%	-10%	42%	16%	-2%	29%	41%	58%	19%	-25%	-27%	23%	10%
2	-4%	23%	-11%	-20%	-19%	23%	-17%	12%	1%	2%	-20%	36%	-4%	3%	25%	-19%	-39%	40%	18%	-5%
3	-26%	0%	0%	-19%	-16%	37%	-13%	-26%	17%	1%	-16%	-6%	7%	16%	38%	0%	-34%	-3%	-29%	1%
4	-15%	-19%	-21%	0%	0%	15%	-23%	-22%	-3%	1%	-22%	-3%	-2%	43%	37%	-38%	-46%	3%	-33%	18%
5	-12%	0%	-1%	-11%	7%	-2%	-30%	-18%	5%	-16%	-25%	4%	-5%	43%	49%	13%	-43%	12%	-34%	20%
6	49%	8%	4%	-13%	5%	0%	-36%	17%	44%	8%	8%	68%	36%	51%	11%	10%	-3%	69%	21%	11%
7	4%	-34%	-45%	-43%	-25%	-38%	0%	-20%	-33%	8%	-26%	3%	2%	-27%	-26%	-34%	-44%	3%	-37%	-34%
8	25%	-5%	-24%	-10%	-31%	7%	-17%	0%!	11%	30%	-3%	14%	-11%	-15%	16%	22%	27%	21%	19%	-11%
9	5%	11%	13%	1%	-5%	-18%	-48%	6%	0%	-5%	13%	14%	-3%	-4%	0%	15%	9%	14%	-18%	20%
10	41%	-7%	-24%	-49%	-11%	-5%	8%	19%	2%	4%	-2%	34%	10%	31%	10%	-8%	-27%	25%	-6%	-11%
11	28%	21%	8%	0%	4%	35%	-11%	7%	56%	22%	-9%	48%	12%	32%	45%	30%	-12%	62%	2%	10%
12	1%	18%	-1%	7%	0%	0%	-31%	4%	4%	9%	29%	0%	3%	41%	12%	13%	9%	-3%	-4%	25%
13	1%	-13%	-21%	-17%	10%	-9%	1%	-23%	2%	-5%	-23%	17%	-2%	19%	-13%	1%	-21%	26%	-40%	-10%
14	4%	1%	4%	-6%	28%	12%	4%	6%	-17%	-6%	-15%	9%	13%	22%	33%	14%	-54%	11%	-31%	20%
15	36%	-6%	-5%	-13%	10%	-37%	-37%	3%	10%	29%	-3%	36%	8%	21%	0%	-7%	-10%	40%	-22%	0%
16	53%	3%	-26%	-10%	1%	24%	-12%	23%	65%	21%	58%	68%	17%	30%	36%	0%	-5%	80%	16%	11%
17	41%	16%	15%	-6%	-12%	-24%	-55%	119%	24%	-5%	3%	74%	-1%	-21%	-14%	1%	0%	78%	59%	11%
18	-14%	-52%	-35%	0%	-6%	-20%	-49%	17%	5%	-5%	14%	-1%	-10%	20%	-4%	10%	10%	0%!	-15%	4%
19	40%	32%	-13%	-33%	-49%	-35%	-58%	12%	-2%	6%	-23%	-5%	-40%	-38%	-26%	-9%	-15%	-17%	-3%	-11%
20	-19%	0%	18%	-16%	-11%	8%	-29%	-18%	38%	-21%	-22%	-10%	-12%	19%	16%	-8%	-20%	-16%	-22%	5%

Table 9-22: % change in sector to sector movements (Inter peak)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1%	5%	0%	31%	14%	67%	-10%	15%	3%	53%	13%	0%	39%	55%	36%	23%	5%	-22%	4%	10%
2	12%	11%	-5%	-17%	-24%	3%	-40%	13%	-10%	-19%	-25%	36%	-19%	1%	-20%	-13%	-32%	47%	2%	-9%
3	-21%	-2%	0%	-14%	-13%	20%	-31%	-16%	17%	-15%	-7%	-3%	-12%	15%	-9%	-7%	-10%	1%	-33%	-9%
4	0%	-15%	1%	0%	-7%	29%	-27%	-14%	-7%	-10%	-13%	-2%	-2%	28%	-1%	-10%	-22%	6%	-31%	5%
5	-4%	3%	14%	-5%	4%	5%	-32%	-20%	-4%	-28%	-10%	-11%	13%	50%	16%	38%	-18%	12%	-31%	12%
6	6%	-2%	-37%	15%	16%	0%	-42%	-22%	-34%	11%	-12%	3%	36%	51%	-16%	-4%	-29%	-3%	-36%	-13%
7	-33%	-35%	-58%	-27%	-22%	-36%	0%	-42%	-54%	13%	-43%	-34%	1%	3%	-45%	-42%	-55%	-38%	-53%	-49%
8	22%	-12%	-24%	-6%	-23%	1%	-32%	0%	15%	22%	-10%	13%	-14%	-8%	-13%	17%	20%	20%	4%	-14%
9	-6%	9%	2%	1%	0%	-17%	-51%	10%	0%	-4%	10%	10%	12%	-19%	-17%	-10%	7%	11%	-8%	-5%
10	9%	2%	-35%	-37%	-26%	16%	-2%	7%	-5%	3%	-5%	18%	-2%	53%	12%	-9%	-19%	19%	-3%	-22%
11	30%	5%	-7%	9%	6%	6%	-38%	12%	28%	17%	-10%	27%	-6%	22%	-12%	7%	-3%	33%	-2%	-10%
12	1%	10%	3%	6%	-1%	19%	-22%	15%	6%	18%	15%	0%	16%	41%	-3%	-8%	4%	-2%	-9%	19%
13	-10%	-17%	-34%	-18%	-9%	-2%	0%	-28%	-32%	-2%	-25%	-10%	8%	29%	-22%	-10%	-30%	-6%	-38%	-27%
14	-4%	6%	13%	4%	24%	14%	-15%	-25%	-22%	4%	-15%	-14%	12%	25%	-6%	50%	-18%	0%	-34%	15%
15	39%	17%	-25%	35%	21%	46%	-22%	5%	7%	38%	19%	48%	24%	-5%	0%	19%	19%	58%	-19%	5%
16	14%	4%	-37%	24%	21%	29%	-27%	25%	11%	20%	18%	17%	11%	53%	-1%	0%	-14%	18%	-4%	-11%
17	3%	-7%	-11%	-17%	-18%	-27%	-61%	70%	11%	6%	-6%	34%	-1%	-50%	-38%	-28%	0%	36%	30%	-22%
18	-20%	-40%	-22%	-18%	-17%	-28%	-60%	25%	6%	-25%	-2%	0%	-4%	-9%	-33%	-28%	3%	0%	-8%	-23%
19	32%	29%	-4%	-25%	-38%	-29%	-49%	5%	12%	1%	-22%	0%	-31%	-26%	-33%	-3%	-2%	-4%	-4%	-12%
20	-10%	3%	11%	3%	-1%	20%	-31%	-13%	19%	-31%	-11%	-3%	-9%	30%	-3%	-2%	-10%	-7%	-29%	5%

Table 9-23: % change in sector to sector movements (PM peak)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0%	12%	-9%	24%	-1%	153%	21%	0%	-18%	0%	48%	-1%	59%	30%	26%	23%	6%	-42%	11%	3%
2	3%	6%	-5%	-15%	-22%	91%	-7%	-3%	-11%	-23%	-3%	30%	1%	3%	-3%	-3%	-14%	36%	10%	0%
3	0%	-2%	0%	-16%	-7%	94%	-6%	-18%	-11%	-18%	-2%	6%	-1%	19%	-3%	-13%	-14%	6%	-22%	-5%
4	5%	-10%	-4%	0%	-2%	98%	-2%	-22%	-8%	-19%	-11%	0%	8%	18%	0%	-13%	-11%	-10%	-34%	18%
5	8%	1%	9%	11%	0%	42%	-24%	-21%	0%	-22%	-4%	6%	8%	16%	-7%	42%	5%	10%	-34%	23%
6	-39%	-32%	-47%	136%	88%	0%	-49%	-25%	-47%	-53%	-37%	-35%	-12%	86%	-42%	-44%	-10%	-13%	-46%	-47%
7	-13%	-39%	-30%	-27%	-20%	2%	0%	-25%	-42%	30%	-23%	-13%	4%	-15%	-6%	7%	-40%	-34%	-50%	-27%
8	5%	4%	-18%	-2%	-15%	118%	-12%	0%	-1%	-28%	7%	-10%	17%	24%	21%	1%	38%	-1%	13%	-11%
9	-13%	7%	13%	-4%	-3%	23%	-33%	27%	0%	-13%	16%	16%	-7%	-49%	-7%	-18%	17%	10%	-4%	-16%
10	21%	-33%	-12%	-28%	-3%	32%	-2%	5%	-10%	1%	1%	14%	2%	-4%	14%	34%	-7%	-1%	-32%	-18%
11	46%	-10%	-2%	9%	0%	33%	-30%	4%	2%	-31%	5%	32%	13%	15%	-33%	2%	-4%	17%	-4%	-8%
12	-7%	27%	6%	8%	3%	124%	-3%	-2%	7%	-13%	44%	0%	32%	11%	15%	-14%	42%	-6%	-13%	14%
13	-2%	-25%	-13%	-20%	-17%	46%	1%	-21%	-25%	10%	-10%	-7%	-1%	16%	-4%	13%	-3%	-11%	-39%	-6%
14	17%	11%	23%	39%	14%	12%	-6%	-9%	2%	-25%	0%	22%	-5%	8%	-1%	57%	11%	30%	-21%	37%
15	6%	-1%	10%	41%	6%	91%	-2%	-15%	2%	-13%	3%	5%	46%	94%	0%	26%	8%	5%	-20%	16%
16	-14%	-23%	-5%	36%	31%	99%	-1%	-12%	12%	-18%	50%	1%	42%	58%	0%	0%	9%	3%	-13%	12%
17	-13%	-13%	-9%	-26%	-26%	30%	-40%	20%	2%	-40%	-13%	8%	-2%	-43%	-21%	-40%	0%	7%	-15%	-39%
18	-34%	-39%	-27%	3%	4%	85%	-14%	16%	9%	-26%	26%	0%	29%	-3%	-6%	-20%	43%	0%	-21%	-21%
19	13%	-6%	-24%	7%	-12%	89%	5%	6%	-10%	-33%	15%	11%	12%	-2%	23%	-3%	7%	-25%	-2%	-13%
20	6%	-3%	-2%	-1%	-5%	77%	-17%	-18%	-10%	-29%	-6%	8%	-3%	16%	-9%	-11%	-15%	10%	-26%	3%

Table 9-24: GEH in sector to sector movements (AM peak)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.3	1.8	3.9	0.3	0.1	0.3	0.1	2.6	1.1	2.1	1.0	0.1	1.2	0.7	0.6	0.3	0.5	3.0	3.9	1.1
2	0.8	5.6	2.7	2.1	2.7	0.4	0.7	3.0	0.2	0.2	3.5	2.5	0.4	0.1	0.7	0.8	0.9	3.0	3.1	1.4
3	3.3	0.1	0.0	2.3	2.5	0.6	0.5	4.3	2.8	0.1	1.6	0.3	0.6	0.6	1.0	0.0	0.7	0.2	2.1	0.2
4	0.8	2.3	2.6	0.0	0.1	0.2	0.7	1.5	0.3	0.1	1.1	0.1	0.1	1.4	0.8	0.5	0.4	0.1	0.9	2.0
5	1.0	0.1	0.2	1.7	2.3	0.1	2.2	2.4	1.0	2.4	2.6	0.2	0.9	4.3	4.0	0.4	0.8	0.8	1.5	3.8
6	0.5	0.2	0.1	0.3	0.3	0.0	0.7	0.3	1.2	0.2	0.2	0.4	1.8	1.1	0.2	0.1	0.0	0.5	0.1	0.3
7	0.1	1.2	1.4	1.0	1.7	0.5	0.0	0.5	1.3	1.2	0.6	0.0	0.3	1.6	0.6	0.4	0.1	0.0	0.3	1.3
8	4.9	1.1	2.7	0.5	3.4	0.1	0.7	0.0	1.2	4.3	0.2	1.6	1.1	0.6	0.4	0.4	1.2	4.0	3.6	1.2
9	0.5	1.4	1.5	0.1	0.9	0.6	2.4	0.8	0.1	1.3	1.1	1.6	0.6	0.2	0.0	0.5	0.5	3.0	1.4	2.2
10	2.5	0.7	2.0	2.7	1.8	0.2	1.6	2.9	0.5	0.6	0.1	1.1	4.3	2.3	0.5	0.2	0.3	1.1	0.2	1.1
11	1.9	3.6	0.9	0.0	0.4	0.6	0.2	0.6	6.8	1.1	0.5	1.6	0.6	0.9	1.1	0.5	0.2	2.9	0.1	1.1
12	0.1	1.6	0.0	0.2	0.0	0.0	0.4	0.5	0.6	0.3	0.9	0.0	0.1	0.4	0.1	0.1	0.2	0.2	0.2	1.0
13	0.0	1.2	1.5	1.0	1.9	0.3	0.3	2.1	0.4	2.0	1.3	0.5	1.1	3.0	0.7	0.0	0.3	1.1	1.2	0.9
14	0.1	0.1	0.2	0.2	3.5	0.2	0.3	0.3	1.7	0.6	0.4	0.1	2.8	1.8	1.1	0.2	0.4	0.3	0.5	1.0
15	0.5	0.2	0.2	0.5	1.0	0.5	1.3	0.1	0.4	1.3	0.1	0.4	0.5	0.6	0.0	0.1	0.0	0.6	0.2	0.0
16	0.8	0.1	0.9	0.2	0.0	0.1	0.1	0.4	2.4	0.4	0.9	0.6	0.3	0.2	0.3	0.0	0.0	1.0	0.1	0.3
17	0.7	0.4	0.2	0.1	0.2	0.0	0.3	3.8	1.5	0.1	0.0	1.1	0.0	0.1	0.0	0.0	0.0	2.2	1.1	0.2
18	1.0	4.3	1.8	0.0	0.4	0.1	0.9	2.6	1.3	0.3	0.7	0.1	0.4	0.3	0.0	0.2	0.4	0.0	1.3	0.2
19	5.5	6.0	0.8	0.7	2.0	0.2	0.8	2.8	0.2	0.3	0.7	0.2	1.3	0.6	0.3	0.1	0.3	1.4	0.2	0.6
20	2.0	0.1	2.5	1.9	2.0	0.1	1.3	2.2	5.9	1.8	2.4	0.5	1.0	0.8	0.5	0.3	0.4	1.0	1.2	0.7

Table 9-25: GEH in sector to sector movements (Inter peak)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.1	1.1	0.0	1.1	0.8	0.5	0.1	2.9	0.2	2.6	0.9	0.0	1.2	1.0	0.4	0.3	0.1	2.0	0.8	1.0
2	2.8	2.5	1.3	2.2	4.3	0.1	1.2	2.5	1.5	2.1	5.2	2.8	1.5	0.0	0.7	0.6	0.7	3.0	0.4	2.6
3	2.5	0.5	0.0	2.1	2.2	0.4	0.8	1.7	2.2	1.2	0.9	0.1	0.8	0.5	0.3	0.3	0.1	0.0	2.1	1.4
4	0.0	1.7	0.2	0.0	1.2	0.6	0.6	0.7	0.7	0.6	0.7	0.0	0.1	1.0	0.0	0.2	0.2	0.2	0.8	0.7
5	0.3	0.5	2.1	0.8	1.5	0.2	2.2	2.1	0.7	4.1	0.9	0.4	2.2	5.4	1.7	1.1	0.2	0.6	1.3	2.3
6	0.0	0.0	0.7	0.2	0.7	0.0	0.6	0.4	1.0	0.3	0.2	0.0	1.4	0.8	0.2	0.0	0.1	0.0	0.2	0.2
7	0.5	1.3	1.9	0.7	1.8	0.7	0.0	1.6	3.0	2.0	1.0	0.4	0.2	0.2	1.5	0.4	0.3	0.6	0.7	2.0
8	4.4	2.4	2.8	0.3	2.4	0.0	0.9	0.0	1.3	3.3	0.7	1.3	1.2	0.3	0.3	0.3	0.8	3.4	1.1	1.3
9	0.6	1.3	0.3	0.1	0.0	0.4	2.3	0.8	0.1	1.1	1.0	1.2	2.2	1.3	0.7	0.4	0.4	2.6	0.7	0.7
10	0.5	0.2	2.7	2.1	3.7	0.5	0.3	1.1	1.2	0.4	0.3	0.6	0.8	4.0	0.6	0.2	0.3	1.0	0.1	1.9
11	2.2	0.9	0.9	0.5	0.5	0.1	0.9	0.8	3.0	0.9	0.6	0.9	0.3	0.5	0.3	0.1	0.0	1.7	0.1	1.2
12	0.1	0.8	0.2	0.1	0.0	0.1	0.2	1.3	0.7	0.6	0.5	0.0	0.3	0.5	0.0	0.1	0.1	0.2	0.6	0.8
13	0.5	1.5	2.7	1.2	1.8	0.1	0.1	3.0	6.6	1.0	1.5	0.3	3.1	6.4	1.6	0.2	0.4	0.3	1.4	2.4
14	0.1	0.2	0.5	0.2	2.8	0.3	0.7	1.1	1.8	0.4	0.4	0.2	2.1	2.1	0.2	0.4	0.1	0.0	0.6	0.7
15	0.5	0.6	0.7	0.9	2.0	0.8	0.6	0.1	0.3	1.7	0.4	0.4	1.4	0.1	0.0	0.2	0.1	0.7	0.2	0.2
16	0.2	0.2	1.5	0.5	0.8	0.2	0.2	0.4	0.5	0.4	0.3	0.2	0.2	0.5	0.0	0.0	0.1	0.3	0.0	0.4
17	0.1	0.2	0.2	0.2	0.3	0.0	0.2	2.2	0.7	0.1	0.1	0.7	0.0	0.2	0.1	0.1	0.0	1.4	0.7	0.4
18	1.6	3.0	1.1	0.7	1.1	0.2	0.6	3.4	1.4	1.3	0.1	0.0	0.1	0.2	0.4	0.4	0.1	0.0	0.7	1.5
19	5.9	6.5	0.3	0.5	1.3	0.2	0.3	1.0	0.9	0.0	0.6	0.0	0.8	0.3	0.3	0.0	0.0	0.3	0.3	0.6
20	1.1	0.8	1.8	0.5	0.3	0.4	0.9	1.4	2.7	2.8	1.4	0.1	0.7	1.2	0.1	0.1	0.2	0.3	1.5	0.9

Table 9-26: GEH in sector to sector movements (PM peak)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.0	2.5	1.6	0.9	0.1	1.1	0.2	0.1	1.5	0.0	2.9	0.0	3.0	0.7	0.3	0.2	0.1	5.1	1.9	0.4
2	0.6	1.5	1.5	2.3	4.8	2.2	0.2	0.7	1.8	2.1	0.7	3.1	0.1	0.2	0.1	0.2	0.3	4.0	1.9	0.1
3	0.0	0.5	0.0	2.3	1.3	2.2	0.2	2.3	1.7	1.1	0.2	0.3	0.1	0.8	0.1	0.5	0.2	0.3	1.2	0.8
4	0.2	0.9	0.4	0.0	0.3	2.3	0.0	1.3	0.7	1.0	0.5	0.0	0.5	0.8	0.0	0.1	0.1	0.3	0.7	2.1
5	0.5	0.2	1.4	1.8	0.1	2.6	1.3	2.4	0.1	3.6	0.3	0.2	1.8	2.6	0.5	1.3	0.1	0.5	1.5	4.5
6	0.2	0.6	0.8	2.2	5.1	0.0	0.4	0.2	1.4	1.1	0.4	0.1	0.8	5.8	0.3	0.2	0.0	0.0	0.2	1.0
7	0.5	2.5	2.0	0.8	2.6	0.0	0.0	0.6	1.5	5.6	0.7	0.2	0.8	1.4	0.2	0.1	0.2	0.4	0.5	1.8
8	1.5	0.9	2.1	0.1	1.2	1.1	0.2	0.0	0.1	2.8	0.5	1.5	1.2	0.8	0.3	0.0	2.2	0.3	4.1	0.9
9	1.4	1.1	2.5	0.5	0.6	0.6	0.7	2.7	0.0	3.3	2.1	2.1	2.3	4.1	0.1	0.7	1.2	2.4	0.3	2.5
10	1.6	3.1	1.0	1.2	0.5	1.2	0.4	0.6	2.5	0.2	0.1	0.5	0.7	0.5	0.6	1.0	0.1	0.0	1.1	1.4
11	3.7	1.9	0.2	0.5	0.0	0.6	0.5	0.3	0.3	1.4	0.2	1.2	0.9	0.5	1.0	0.0	0.1	0.9	0.1	0.8
12	0.4	2.3	0.3	0.2	0.2	0.5	0.0	0.2	0.9	0.4	1.5	0.0	1.1	0.1	0.1	0.1	0.7	0.4	0.7	0.5
13	0.2	2.7	1.4	1.2	4.4	2.7	0.2	1.7	5.3	4.6	0.8	0.3	0.6	4.0	0.3	0.5	0.0	0.6	1.3	0.6
14	0.4	0.4	0.8	1.2	1.6	0.3	0.2	0.4	0.2	2.2	0.0	0.3	1.0	0.9	0.0	0.5	0.1	0.5	0.3	1.5
15	0.1	0.0	0.5	1.5	0.6	2.5	0.0	0.5	0.1	0.6	0.1	0.0	3.5	4.2	0.0	0.5	0.0	0.1	0.2	0.9
16	0.3	1.0	0.1	0.7	1.3	0.9	0.0	0.3	0.7	0.4	0.9	0.0	1.2	0.6	0.0	0.0	0.1	0.1	0.1	0.3
17	0.3	0.4	0.2	0.4	0.6	0.0	0.1	0.8	0.2	0.5	0.3	0.1	0.0	0.2	0.0	0.2	0.0	0.2	0.3	0.8
18	2.8	4.0	1.9	0.2	0.4	0.4	0.1	2.4	2.1	1.1	1.5	0.0	1.6	0.1	0.0	0.3	1.3	0.0	1.7	1.3
19	2.7	1.5	2.1	0.1	0.3	0.3	0.0	1.4	0.7	1.1	0.4	0.7	0.3	0.0	0.1	0.0	0.2	2.5	0.2	0.6
20	0.6	0.7	0.3	0.2	1.2	2.1	0.5	2.5	1.7	2.3	0.8	0.4	0.3	0.9	0.4	0.4	0.3	0.6	1.3	0.5

9.3 Network characteristics

Review of network structure

9.3.1 A comprehensive review of the network structure has been undertaken as described in section 8.2. The SATURN network has been compared to the existing PCF Stage 1 A27 transport model base year network.

Modelled link lengths

9.3.2 Checks of modelled link lengths against actual lengths have been undertaken i.e. same distance coded in both directions and against measured distance in GIS.

Directionality

9.3.3 Checks of two-way roads and one-way roads have been undertaken to ensure these are reflected within the PCF Stage 2 A27 transport model.

HGV and other access restrictions

9.3.4 Checks of Traffic Regulation Orders (TRO) of vehicle restrictions i.e. HGV bans have been undertaken to ensure where present these are reflected within the PCF Stage 2 A27 transport model.

Realistic link speeds and junction delay

9.3.5 As part of the validation of modelled time against observed Trafficmaster journey times speed/flow curves have been included as appropriate to better reflect link speeds and junction delays. This can be seen in the validation graphs of observed journey time against modelled journey times (presented in Appendix B-10).

9.4 Variable demand model calibration

9.4.1 The principles of demand modelling are set out in DfT TAG Unit M2 (March 2017). This chapter does not attempt to replicate the information contained in this TAG unit but aims to represent the approach to developing a PCF Stage 2 A27 demand model.

9.4.2 The DfT DIADEM V6.3.3 program has been used to undertake the variable demand modelling. DIADEM software is designed to enable practitioners to set up variable demand models. It provides a user-friendly method for setting up a multi-stage transport demand model and finding equilibrium between demand and supply, using the SATURN package as the supply model. The process iterates between demand calculations and highway assignments until a converged solution is reached.

9.4.3 DIADEM is used to represent the variable travel demand choices available to transport users as a response to changing travel costs. This VDM was included because:

- There is sufficient highway congestion, (whereby demand exceeds capacity) and travel time variability, in the areas of influence for the

A27 schemes, for road users to consider other journey options than their usual travel pattern
- There are several journey choices available for many travellers in the areas of influence, which could encourage them to change their journey patterns, when costs increase or decrease, specifically: change their route used between journey origin and destination; change their trip destination; change their frequency of journey; or change their travel mode used
- If users do make alternative travel choices, then traffic conditions around the proposed Scheme become unpredictable and may turn out differently to those expected if people are assumed to stick to their initial patterns; this could lead to misrepresentation of scheme impacts, if VDM choices are not modelled realistically.

9.4.4 The form used for the DIADEM VDM choice mechanism is 'hierarchical' and 'incremental' meaning:

- In a 'hierarchical' VDM situation, choices are made in a sequential order of increasing sensitivity to travel cost change
- Choices are made in a sequential order of dependency upon other journey decisions earlier in the hierarchy
- A particular type of journey choice is dependent upon the 'composite' travel cost impact of the combined decisions made earlier in the hierarchy
- In an 'incremental' VDM situation, travel choices are made only in response to a change in the generalised cost of a journey, occurring from one situation to another, (within a specific demand segment – i.e. combination of O-D, time period, purpose and mode); choices are not made in response to the absolute cost of a journey in a particular situation.

9.4.5 The highway assignment model sits at the bottom of the hierarchy, with skim matrices extracted from the assignment and used within the demand model to calculate the generalised costs of travel and derive the demand responses. As there is no public transport element associated with the PCF Stage 2 A27 transport model the demand model models trip frequency and trip distribution.

9.4.6 For PCF Stage 2 VDM the input matrices would be based on origin and destination with the time periods modelled in DIADEM consistent with those described in section 3.1.2.

9.4.7 Traffic demand is split into various demand segments in order to generate the correct responses in the demand model. These are not all required at assignment stage, so some segments are aggregated into assignment user classes. Demand is segmented into user class:

- Car: Business
- Car: Commute
- Car: Other
- LGV
- HGV

9.4.8 LGV and HGV are included in the demand model however these trips remain fixed, as growth in these vehicles is driven by factors other than those affecting the generalised cost of travel.

9.4.9 External to external trips in the Car user classes (Business, Commute and Other) have been fixed in the demand model.

The model area, network coverage and trip-end zone configuration for the DIADEM VDM is entirely consistent with that represented in the SATURN highway model.

9.5 Demand-supply convergence

9.5.1 It is critical that the entire model system converges to a satisfactory level to ensure that derived forecasts are free from model noise. The measure recommended by TAG for monitoring convergence is the demand/supply gap, defined as:

$$\%GAP = \frac{\sum_a C(X_a^n)\left|D\left(C(X_a^n)\right) - X_a^n\right|}{\sum_a C(X_a^n)X_a^n} * 100$$

Where:

- Xan is cell a in the previous assignment matrix for iteration n
- C(Xan) is cell a in the generalised costs resulting from assigning that matrix
- D(C(Xan)) is cell a in the matrix output by the demand model based on costs C(Xan). This is equal to Xan+1.
- a represents every combination of origin, destination, demand segment, time period and mode.

9.5.2 This directly measures how far the model is from equilibrium between demand and supply, and is zero in a perfectly converged model. TAG Unit M2 (March 2017) section 6 recommends that a %GAP value of 0.1% should be achievable for most models, but this may need to be relaxed to 0.2%. The iteration process for the PCF Stage 2 A27 demand model is set up so that when a demand/supply gap of 0.1% is achieved, the model stops iterating.

9.5.3 The VDM DIADEM model iterations were concluded and outcomes extracted only once the model had reached a steady state of equilibrium, in terms of there being minimal further change in travel demands and travel costs. The DIADEM routine was carefully controlled to achieve acceptable convergence in the travel choice mechanisms. All the variable demand models converge to a gap of 0.1% or less in a reasonable number of iterations as can be seen in Table 9-27 for the 2015 base year.

Table 9-27: DIADEM convergence – 2015

	2015
AM peak	0.082%
Inter peak	
PM peak	

Model Parameters

9.5.4 TAG Unit M2, Variable Demand Modelling (March 2017) includes some illustrative/published values for model parameters. Table 9-28 shows the parameters that have been used to calibrate the DIADEM variable demand model, compared to the parameters included in Table 10-1 of TAG Unit M2, Variable Demand Modelling (March 2017).

Table 9-28: DIADEM variable demand model

Trip Purpose	actual	minimum	median	maximum
Business	0.038	0.038	0.067	0.106
Commuting	0.113	0.054	0.065	0.113
Other	0.081	0.074	0.090	0.160

9.5.5 DIADEM has been satisfactorily configured and tested for ‘realism’ and integrated with the SATURN model, as a tool for predicting ‘variable demand’ or people’s changing travel decisions, in response to changing travel costs. This enables a realistic picture of how travellers may change trip frequency, travel mode, trip destination or highway route, as generalised travel costs (time and distance) rise and fall. The outputs of the realism tests are described in sections 10.9 and 10.10.

9.5.6 This VDM aspect of the PCF Stage 2 A27 transport model is important, as it could have a considerable influence on the outcomes and reliability of the forecast A27 scheme appraisals.

Cost Damping

9.5.7 No cost damping has been undertaken. However, External to External trips have been fixed.

10 Model validation

10.1 Independence of validation data

10.1.1 To demonstrate the extent to which the model is robust and representative of current conditions, appropriate independent data, external to the model development / ME process, is used as validation along key sections in the network. Journey time data is also used as an additional measure to assess the performance and validation of the base model.

10.1.2 Table 10-1 shows the counts that have been used in validation, with Appendix A-2 showing the locations graphically.

Table 10-1: 2015 Validation count sites

Count	Site	Description	Direction
5	ATC3	A259 Crookthorn Lane - Site 3 - F	EB
6	ATC3	A259 Crookthorn Lane - Site 3 - R	WB
9	ATC5	Arundel Bypass - Site 5 - F	SB
10	ATC5	Arundel Bypass - Site 5 - R	NB
11	ATC6	A280 Long Furlong - Site 6 - F	WB
12	ATC6	A280 Long Furlong - Site 6 - R	EB
15	ATC8	A283 Steyning Road - Site 8 - F	SB
16	ATC8	A283 Steyning Road - Site 8 - R	NB
60	SERTM14	A27 Chichester (A259-A286)	EB
61	SERTM14	A27 Chichester (A259-A286)	WB
62	SERTM15	A27 between A286 and B2145	EB
63	SERTM15	A27 between A286 and B2145	WB
64	SERTM16	A27, Portfield	EB
65	SERTM16	A27, Portfield	WB

Count	Site	Description	Direction
66	SERTM17	A27 Worthing (Grove Road - Lyons Way)	EB
67	SERTM17	A27 Worthing (Grove Road - Lyons Way)	WB
68	SERTM18	A27 between A270 near Brighton (west) and A293	EB
69	SERTM18	A27 between A270 near Brighton (west) and A293	WB
70	WSCC1	A2037 Small Dole, Shoreham Rd. O/S The Wickets	NB
71	WSCC1	A2037 Small Dole, Shoreham Rd. O/S The Wickets	SB
72	WSCC2	A24 Ashington By-Pass, Just N. Of London Rd.	NB
73	WSCC2	A24 Ashington By-Pass, Just N. Of London Rd.	SB
76	WSCC4	A24 Worthing, Broadwater St West O/S No.47/49	NB
77	WSCC4	A24 Worthing, Broadwater St West O/S No.47/49	SB
86	WSCC9	A259 Worthing, Brighton Rd O/S Aquarena E. Of Made	EB
87	WSCC9	A259 Worthing, Brighton Rd O/S Aquarena E. Of Made	WB
88	WSCC10	A285 Duncton, Outside Dogkennel Cottages	NB
89	WSCC10	A285 Duncton, Outside Dogkennel Cottages	SB
92	WSCC12	C17 Ford, Ford Rd. Just S. Of Jct. With Tortington	NB
93	WSCC12	C17 Ford, Ford Rd. Just S. Of Jct. With Tortington	SB
94	WSCC13	B2223 Worthing, Sompting Ave O/S No.22	EB
95	WSCC13	B2223 Worthing, Sompting Ave O/S No.22	WB
96	WSCC14	Worthing, Chesswood Rd O/S No.1 Just E. Of Station	EB
97	WSCC14	Worthing, Chesswood Rd O/S No.1 Just E. Of Station	WB
98	WSCC15	Worthing, Lyndhurst Rd. O/S Hospital E. Of Park Rd	EB

Count	Site	Description	Direction
99	WSCC15	Worthing, Lyndhurst Rd. O/S Hospital E. Of Park Rd	WB
100	WSCC16	Worthing, Titnor Lane, S. Of A27/A280 Jct.	NB
101	WSCC16	Worthing, Titnore Lane, S. Of A27/A280 Jct.	SB
104	WSCC18	A2031 Worthing, Teville Rd W Of Christchurch Rd	EB
105	WSCC18	A2031 Worthing, Teville Rd W Of Christchurch Rd	WB
106	WSCC19	A259 Worthing, Richmond Rd. E. Of Salisbury Rd.	EB
107	WSCC19	A259 Worthing, Richmond Rd. E. Of Salisbury Rd.	WB
110	WSCC21	A29 Woodgate, Lidsey Rd. (S. Of Railway Crossing)	NB
111	WSCC21	A29 Woodgate, Lidsey Rd. (S. Of Railway Crossing)	SB
112	WSCC22	Worthing, Marine Parade W. Of Prospect Place & Lid	EB
113	WSCC22	Worthing, Marine Parade W. Of Prospect Place & Lid	WB
114	WSCC23	A2032 Worthing, Durrington O/S Northbrook College	EB
115	WSCC23	A2032 Worthing, Durrington O/S Northbrook College	WB
116	WSCC24	A286 Chichester, Broyle Rd Just N. Of The Bell Inn	NB
117	WSCC24	A286 Chichester, Broyle Rd Just N. Of The Bell Inn	SB
118	WSCC25	B2178 Chichester, St Paul's Rd. O/P No.55	NB
119	WSCC25	B2178 Chichester, St Paul's Rd. O/P No.55	SB
120	WSCC26	A286 Chichester, Stockbridge, Birdham Rd O/S 53	EB
121	WSCC26	A286 Chichester, Stockbridge, Birdham Rd O/S 53	WB
122	WSCC27	Hunston, B2145 Hunston Rd. By Sub Station	NB
123	WSCC27	Hunston, B2145 Hunston Rd. By Sub Station	SB

10.1.3 Appendix B-5 shows the comparison of the observed counts against modelled flows for the validation sites.

10.1.4 Overall, the PCF Stage 2 A27 transport model shows good individual link validation, in terms of

- modelled flow ranges
- Car, LGV and HGV for each of the AM peak, Inter peak and PM peak

10.1.5 Appendix B-6 contains diagrams showing the Validation GEH values for All Vehicles and split by Car, LGV and HGV for the 2015 base year (AM peak, Inter peak and PM peak).

10.2 Analysis of routeing choices and paths

10.2.1 Information has been presented for a selected number of O-D pairs to demonstrate that the routing is logical for the AM peak, Inter peak and PM peak. These are included in Appendix B-8.

10.3 Comparison of modelled zonal demand for key movements against independent data

10.3.1 There are no suitable counts or zones to allow a comparison to be undertaken.

10.4 Comparison of modelled sector-to-sector demand

10.4.1 Due to the fact there are more detailed sector to sector movements, there is no truly independent screenline counts within the PCF Stage 2 A27 transport model study area.

10.5 Deviations from default assignment parameters

10.5.1 There are no deviations from default assignment parameters and a summary of the key parameters used relating to model convergence within SATURN are outlined in Table 10-2.

Table 10-2: Required values for model convergence

Saturn parameter	value
PCNEAR	1
STPGAP	0.05
NISTOP	4
ISTOP	98.5
RSTOP	98.0
MASL	400
KOMBI	0

10.6 Convergence stability and proximity

10.6.1 Before the results of any traffic assignment are used to influence decisions, the stability (or degree of convergence) of the assignment must be confirmed at the appropriate level. The importance of achieving convergence, at an appropriate level, is related to the need to provide stable, consistent and robust model results. A description of the convergence measures is presented in sections 8.2.3 and 8.2.4.

10.6.2 The convergence statistics are shown in Table 10-3 for the 2015 base year AM peak, Inter peak and PM peak models.

Table 10-3: PCF Stage 2 A27 transport model – convergence criteria

AM Peak				Inter peak				PM Peak			
Iteration	Delta	%Flow	%Gap	Iteration	Delta	%Flow	%Gap	Iteration	Delta	%Flow	%Gap
13	0.0087	96.5	0.024	10	0.0066	96.9	0.0063	16	0.0171	97.5	0.054
14	0.0145	97.3	0.012	11	0.0056	97.6	0.0059	17	0.0143	97.8	0.026
15	0.006	98.2	0.017	12	0.0045	98.2	0.0052	18	0.0139	98.4	0.05
16	0.0053	98.3	0.0087	13	0.0038	99	0.0039	19	0.0134	98.4	0.024
17	0.0046	98	0.013	14	0.0032	98.4	0.0036	20	0.0138	98.6	0.046
18	0.0037	98.8	0.0056	15	0.0033	99	0.0031	21	0.0281	98.8	0.014

SATURN Parameter	Required value	AM peak	Inter peak	PM peak
PCNEAR	1	1	1	1
RSTOP	98	98	98	98
STPGAP	0.1	0.1	0.1	0.1
NISTOP	4	4	4	4
KONSTP	5	5	5	5

MEASURE OF CONVERGENCE	ACCEPTABLE VALUE	AM peak	Inter peak	PM peak
"Delta" and % GAP	Less than 0.1% or at least stable	Pass	Pass	Pass
Percentage of links with flow change < 1%	Four consecutive iterations greater than 98%	Pass	Pass	Pass
Percentage of links with cost change < 1%	Four consecutive iterations greater than 98%	Not reported by SATURN	Not reported by SATURN	Not reported by SATURN
Percentage change in total user costs	Four consecutive iterations less than 0.1%	Pass	Pass	Pass

10.7 Modelled flows

10.7.1 Information has been presented for the post-ME matrices on the following:

- Counts and screenlines

Counts

10.7.2 Table 10-4 to Table 10-6 show the final model validation of the PCF Stage 2 A27 transport model for the AM peak, Inter peak and PM peak respectively.

Table 10-4: AM peak – Post matrix estimation

Criteria and Measure		Acceptability Guidance	ALL			Car		
Flow Criteria			Validation			Validation		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	32	29	91%	37	35	95%
700-2,700 vph	+/- 15%		24	23	96%	19	18	95%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%
GEH Criteria								
GEH Statistic for individual links <5		>85% of links	56	52	93%	56	53	95%

	ALL				Car			
GEH Range	Validation		Combined		Validation		Combined	
GEH < 2	41	73%	70	73%	35	63%	61	64%
GEH < 4	48	86%	83	86%	50	89%	83	86%
GEH < 6	51	91%	88	92%	52	93%	88	92%
GEH < 8	52	93%	92	96%	53	95%	92	96%
GEH < 10	52	93%	92	96%	53	95%	92	96%
GEH < 5	49	88%	86	90%	51	91%	86	90%

Table 10-5: Inter peak – Post matrix estimation

Criteria and Measure		Acceptability Guidance	All Vehicles			Car		
Flow Criteria			Validation			Validation		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	36	34	94%	42	40	95%
700-2,700 vph	+/- 15%		20	19	95%	14	13	93%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%
GEH Criteria								
GEH Statistic for individual links <5		>85% of links	56	53	95%	56	53	95%

	All Vehicles				Car			
GEH Range	Validation		Combined		Validation		Combined	
GEH < 2	42	75%	71	74%	40	71%	69	72%
GEH < 4	48	86%	85	89%	50	89%	87	91%
GEH < 6	51	91%	90	94%	52	93%	92	96%
GEH < 8	55	98%	95	99%	55	98%	95	99%
GEH < 10	55	98%	95	99%	55	98%	95	99%
GEH < 5	51	91%	89	93%	50	89%	90	94%

Table 10-6: PM peak – Post matrix estimation

Criteria and Measure		Acceptability Guidance	All Vehicles			Car		
Flow Criteria			Validation			Validation		
Observed	Modelled		Total count	Meet criteria	%	Total count	Meet criteria	%
<700 vph	+/- 100 vph	>85% of links	30	27	90%	34	30	88%
700-2,700 vph	+/- 15%		26	25	96%	22	21	95%
>2,700 vph	+/- 400 vph		0	0	0%	0	0	0%
GEH Criteria								
GEH Statistic for individual links <5		>85% of links	56	52	93%	56	51	91%

	All Vehicles				Car			
GEH Range	Validation		Combined		Validation		Combined	
GEH < 2	42	75%	72	75%	37	66%	66	69%
GEH < 4	47	84%	84	88%	48	86%	83	86%
GEH < 6	50	89%	89	93%	50	89%	90	94%
GEH < 8	52	93%	91	95%	51	91%	92	96%
GEH < 10	54	96%	93	97%	53	95%	93	97%
GEH < 5	48	86%	87	91%	48	86%	87	91%

10.7.3 The tables above show that, for PCF Stage 2 A27 transport model validation, all link flow and GEH criteria are above the 85% threshold for AM, Inter and PM peaks. Table 10-7 shows the calibration and validation summary for Car, LGV and HGV after ME.

Table 10-7: Summary of validation for Car, LGV and HGV (post-ME)

		Car	LGV	HGV
AM peak	Validation	95%	93%	100%
Inter peak	Validation	95%	100%	100%
PM peak	Validation	91%	98%	100%

10.7.4 Appendix B-7 contains diagrams showing the comparison of the validation counts for All Vehicles and split by Car, LGV and HGV for the 2015 base year (AM peak, Inter peak and PM peak).

Screenlines

10.7.5 In accordance with the requirements presented in section 3.2 of TAG Unit M3.1 (January 2014), screenline totals are presented for each vehicle type. Total modelled flows across screenlines for each vehicle type should be within 5% of observed flows. TAG recommends that this should apply to "all, or nearly all" screenlines. We have applied a threshold of 85% of screenline totals to meet this criterion.

10.7.6 The screenlines used for the PCF Stage 2 A27 transport model are detailed in Table 10-8, and the location is shown in Figure 10-1.

10.7.7 Table 10-9 to Table 10-11 show the results of the screenline assessment. More detailed information on the screenlines is included in Appendix B-9. The majority of screenlines meet the TAG criteria of being within 5% of observed flows (all vehicles). However, there is greater variance when the results are considered for each user class. In particular, larger % differences are indicated for LGV and HGV user classes, however this is a result of the low total volumes within each of these user classes, relative to the volumes in the car user class and for all vehicles. The GEH statistics indicates that most of the screenlines perform within GEH of 5 at user class level.

Table 10-8: PCF Stage 2 Screenlines

Screenline ID	Name	Type
1	Screenline 1 – A27 Arundel	Calibration
2	Screenline 2 – A27 Arundel	Calibration
3	Screenline 3 – A27 Worthing and Lancing	Calibration
4	Screenline 4 – A27 Worthing and Lancing	Calibration
5	Screenline 5 - Outbound	Validation
6	Screenline 6 - Inbound	Validation
7	Screenline 7 – A27	Calibration
8	Screenline 8 – A27	Calibration

Figure 10-1: PCF Stage 2 Screenlines

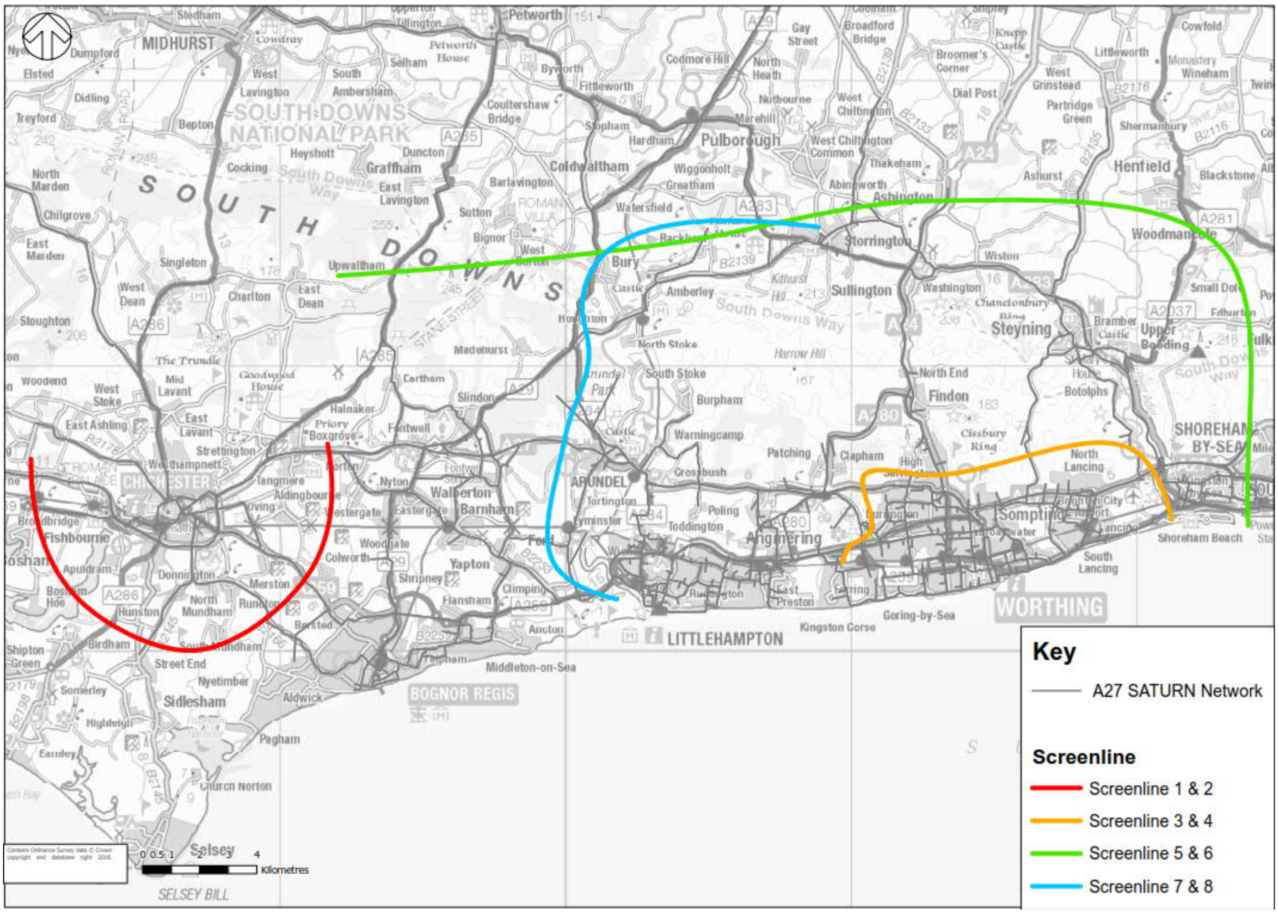


Table 10-9: PCF Stage 2 A27 transport model – AM peak screenline

	All				Car				LGV				HGV			
ID	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH
1	4679	4918	-5%	3	3602	3816	-6%	3	802	696	13%	3	266	406	-53%	6
2	6092	5855	4%	3	5138	4800	7%	4	711	743	-4%	1	227	313	-38%	4
3	6420	6202	3%	2	5472	4945	10%	6	729	800	-10%	2	194	457	-136%	11
4	6932	6629	4%	3	5781	5218	10%	6	903	968	-7%	2	240	443	-84%	9
5	4997	4904	2%	1	4054	3930	3%	2	700	707	-1%	0	225	268	-19%	2
6	3672	3628	1%	1	2943	2831	4%	2	505	528	-5%	1	215	269	-25%	3
7	3084	3110	-1%	0	2448	2520	-3%	1	479	445	7%	1	154	146	5%	1
8	3289	3112	5%	3	2700	2496	8%	3	451	469	-4%	1	135	147	-9%	1

Table 10-10: PCF Stage 2 A27 transport model – IP peak screenline

	All				Car				LGV				HGV			
ID	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH
1	4608	4697	-2%	1	3754	3792	-1%	1	621	577	7%	1	225	328	-45%	5
2	4351	4618	-6%	3	3537	3605	-2%	1	565	634	-12%	2	242	378	-57%	6
3	5813	5877	-1%	1	4883	4579	6%	4	692	806	-17%	3	221	492	-123%	11
4	5692	5891	-4%	2	4851	4653	4%	2	624	802	-29%	5	207	435	-110%	10
5	2950	2960	0%	0	2319	2289	1%	1	405	427	-6%	1	203	244	-20%	2
6	3150	3196	-1%	1	2494	2469	1%	0	425	456	-7%	1	206	271	-32%	3

7	2787	2777	0%	0	2246	2245	0%	0	391	387	1%	0	145	145	0%	0
8	2831	2789	2%	1	2258	2246	1%	0	417	404	3%	1	151	139	8%	1

Table 10-11: PCF Stage 2 A27 transport model – PM peak screenline

	All				Car				LGV				HGV			
ID	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH	Observed	Modelled	Diff.	GEH
1	6219	6349	-2%	1	5487	5441	1%	1	586	746	-27%	5	129	162	-26%	2
2	4670	4895	-5%	3	3943	4140	-5%	3	591	576	3%	1	126	180	-43%	3
3	7654	6459	16%	12	6614	5273	20%	14	823	871	-6%	1	189	416	-120%	10
4	6402	6534	-2%	1	5736	5421	5%	3	548	861	-57%	9	96	352	-265%	13
5	3745	3719	1%	0	3216	3096	4%	2	411	492	-20%	3	136	131	4%	0
6	5093	4927	3%	2	4278	4088	4%	2	658	696	-6%	1	218	143	35%	5
7	3266	3304	-1%	1	2835	2864	-1%	0	360	372	-3%	1	66	68	-3%	0
8	3159	3292	-4%	2	2729	2785	-2%	1	354	438	-24%	3	73	70	4%	0

10.8 Journey times

10.8.1 Journey time data was obtained from Trafficmaster via the DfT, to provide a large sample size covering all the main routes within the study area. This provided the primary source of journey time data for model journey time validation.

10.8.2 The Trafficmaster data is collected using GPS with the data provided in 15-minute intervals for the months of May and June 2014 (both considered neutral months) covering the study area for the following periods:

- AM peak: (07:00 – 10:00)
- Inter peak: (10:00 – 16:00)
- PM peak: (16:00 – 19:00)

10.8.3 The data has been used in the validation of modelled journey times in the base year transport model.

10.8.4 16 journey time routes have been used to validate the model which are shown graphically in Figure 10-2 with Table 10-13 summarising the journey time performance for all the routes across the AM peak, Inter peak and PM peak.

10.8.5 Table 10-12 provides a list of the route names. A comparison between the observed and modelled journey times in graphical format as included in Appendix B-10.

Figure 10-2: Observed journey time routes

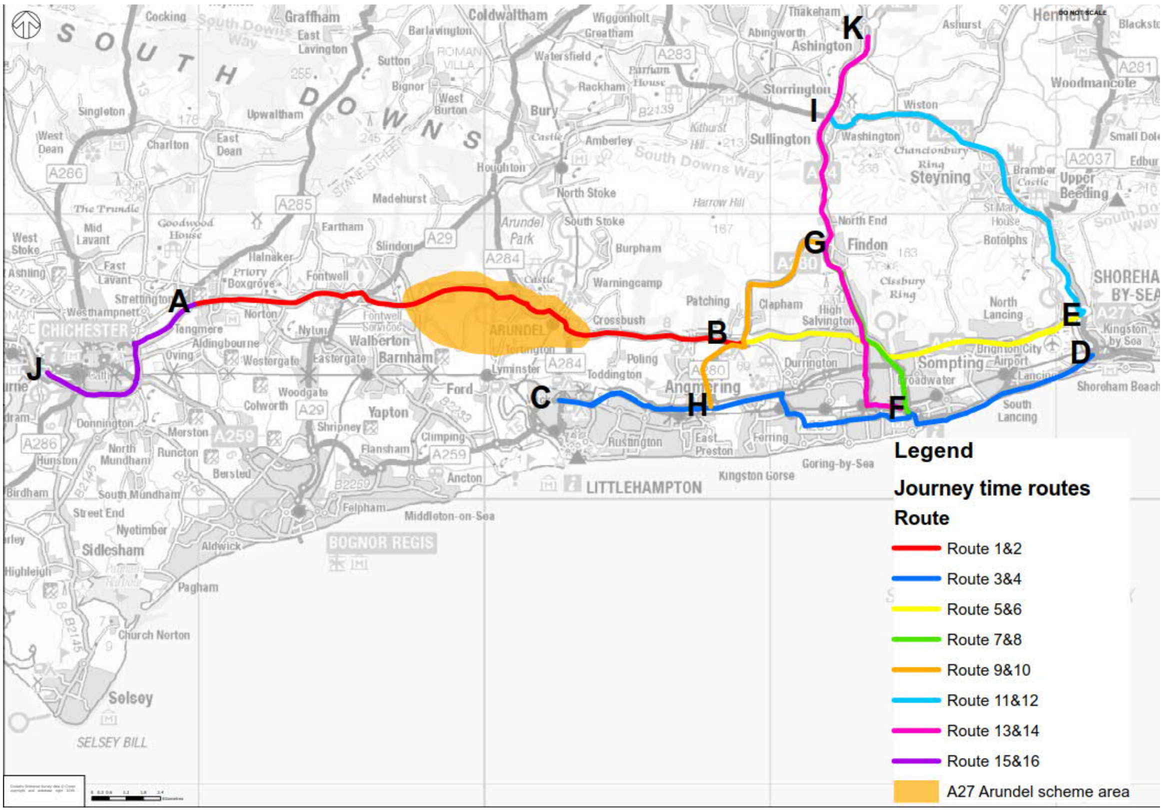


Table 10-12: Route names and description

Route ID	Journey time terminal points	Name
1	A – B	A27 eastbound
2	B – A	A27 westbound
3	C – D	A259 eastbound
4	D – C	A259 westbound
5	B – E	A27 eastbound
6	E – B	A27 westbound
7	F – G	A24 northbound
8	G – F	A24 southbound
9	H – G	A280 northbound
10	G – H	A280 southbound
11	I – E	A283 eastbound
12	E – I	A283 westbound
13	F – K	A2031 / A24
14	K – F	A24 / A2031
15	J – A	A27 Chichester eastbound
16	A – J	A27 Chichester westbound

Table 10-13: Journey time route comparison

	AM peak					Inter peak					PM peak				
Route ID	Observed (s)	Modelled (s)	Diff.	%	Pass	Observed (s)	Modelled (s)	Diff.	%	Pass	Observed (s)	Modelled (s)	Diff.	%	Pass
1	949	1041	92	10%	Yes	951	1024	73	8%	Yes	1423	1537	114	8%	Yes
2	1124	1133	9	1%	Yes	1044	1060	16	2%	Yes	1017	1020	3	0%	Yes
3	2035	1862	-173	-9%	Yes	1954	1905	-49	-3%	Yes	2049	1763	-286	-14%	Yes
4	1920	1899	-21	-1%	Yes	2068	2045	-23	-1%	Yes	2262	2025	-237	-10%	Yes
5	1161	1199	38	3%	Yes	960	997	37	4%	Yes	1066	1015	-51	-5%	Yes
6	1115	1098	-17	-2%	Yes	1025	970	-55	-5%	Yes	1120	1111	-9	-1%	Yes
7	658	710	52	8%	Yes	644	568	-76	-12%	Yes	792	750	-42	-5%	Yes
8	905	904	-1	0%	Yes	784	728	-56	-7%	Yes	806	798	-8	-1%	Yes
9	521	531	10	2%	Yes	513	513	0	0%	Yes	500	487	-13	-3%	Yes
10	512	455	-57	-11%	Yes	519	530	11	2%	Yes	533	488	-45	-8%	Yes
11	751	765	14	2%	Yes	734	758	24	3%	Yes	737	765	28	4%	Yes
12	753	767	14	2%	Yes	741	756	15	2%	Yes	770	773	3	0%	Yes
13	1275	1166	-109	-9%	Yes	1180	1110	-70	-6%	Yes	1188	1142	-46	-4%	Yes
14	1272	1268	-4	0%	Yes	1232	1201	-31	-2%	Yes	1303	1390	87	7%	Yes
15	680	580	-100	-15%	Yes	531	490	-41	-8%	Yes	579	690	111	19%	No
16	550	488	-62	-11%	Yes	586	601	15	3%	Yes	846	827	-19	-2%	Yes

10.8.6 Table 10-13 shows that 15 of all 16 routes meet the TAG criteria of being within 15% (or 1 minute) of the observed time. Route 15 only meets the criteria for the AM and Inter peak data, but as route 15 is located on the boundary of the PCF Stage 2 A27 transport model, and some distance from Arundel, near Chichester, this is unlikely to have a significant effect on the model accuracy around the scheme area.

10.8.7 The graphs of observed journey time compared to modelled journey time (Appendix B-10) show a good comparison, meaning that queues and delays are being accurately reflected within the 2015 base year models.

10.9 Realism test outputs from the variable demand model

10.9.1 Realism testing is a series of tests recommended in TAG Unit M2 (March 2017) to ensure that the model exhibits realistic behaviour in response to specific changes in generalised cost components. All realism tests calculate elasticity, which is a measure of the proportionate change in travel in response to a proportionate change in cost. The recommended elasticity definition is:

$$\varepsilon = \frac{\log T^1 - \log T^0}{\log C^1 - \log C^0}$$

Where:

- C_0 and C_1 are the costs before and after the change, respectively
- T_0 and T_1 are the travel demands before and after the change in costs, respectively. T_0 and T_1 are in terms of vehicle-kilometre seconds (veh-kms) for Test 1, and person trips for Test 2 and 3.

10.9.2 For all tests, a cost increase of 10% is generally preferred however a value of 20% has had to be used for plausible results to be obtained. This makes the denominator of the elasticity calculation equal to 1.2 which is applied to the fuel cost element of the generalised cost only. Table 10-14 summarises the elasticity ranges recommended by TAG for each of the realism tests carried out.

Table 10-14: TAG-recommended elasticity ranges

Elasticity Test	TAG Recommended Range	
	High	Low
Car Fuel Cost (veh-kms)	-0.35	-0.25
Car Journey Time (car trips)	No stronger than -2.0	

10.9.3 To account for congestion and crowding, the car fuel cost elasticities have been calculated from converged runs of the demand/supply. The car journey time test was not iterated because the TAG-recommended target values were derived from stated preference surveys.

10.9.4 The External to External relations are fixed in the demand model and not giving any response. The trips in these relations are excluded from the realism test calculations both on link and matrix level to get more accurate results.

10.10 Car fuel cost elasticity

10.10.1 The car fuel cost elasticity is the percentage change in car veh-kms with respect to the percentage change in fuel cost. This should be tested with a fully-converged run of the demand model. Elasticities should be calculated for all purposes and time periods, with both matrix-based and network-based methodologies. Where possible, external to external movements should be removed prior to calculation.

10.10.2 The combined annual average fuel cost elasticity should lie in the range -0.25 to -0.35, across all purposes. They should be closer to -0.1 for employers' business trips and -0.4 for discretionary trips. Peak period elasticities should also be generally lower than Inter peak elasticities.

Matrix-Based Method

10.10.3 In the matrix-based method, the change in car veh-kms is calculated from the skimmed distance matrices and the car trip matrices which relate to the before and after fuel cost change model runs.

10.10.4 The calculations have been carried out on an O-D basis, by time period and demand purpose. They have then been aggregated over time periods and demand strata to produce elasticities on an overall average level.

10.10.5 As external to external trips are treated as fixed in the PCF Stage 2 A27 demand model, TAG recommends matrix-based calculations only use movements with possible full response. It is important to note that elasticity figures have been calculated from a converged run of the demand/supply loop. The demand/supply convergence results are:

- Car Fuel Cost Realism Demand/Supply Convergence: 0.082 after 10 iterations

10.10.6 Table 10-15 presents the car fuel cost realism test results from an iterated run of the PCF Stage 2 A27 demand model. It shows the elasticity by trip purpose and time period and the overall elasticity based on the final O-D level matrices.

Table 10-15: Matrix-based car fuel cost realism results

Trip Purpose	AM	IP	PM	Annual
Business	-0.086	-0.076	-0.087	-0.083
Commuting	-0.265	-0.264	-0.268	-0.266
Other	-0.449	-0.393	-0.378	-0.400
Overall	**-0.324**	**-0.335**	**-0.308**	**-0.323**

10.10.7 The results show that for all purposes an acceptable level of elasticity is met with the overall annual elasticity meeting with TAG criteria of being between -0.25 and -0.35.

Network-Based Method

10.10.8 In the network-based method, the car veh-kms are accumulated over the highway network from the before and after cost change converged runs and compared. The highway network used for the calculations only covers the internal area over which it has been validated. Furthermore, an O-D pair filter has been applied on link volumes to filter out the movements of the fixed relations.

10.10.9 Table 10-16 shows the results by time period and trip purpose.

Table 10-16: Network-based car fuel cost realism results

Trip Purpose	AM	IP	PM	Annual
Commuting	-0.091	-0.064	-0.077	-0.077
Employer's Business	-0.251	-0.244	-0.253	-0.249
Other	-0.381	-0.339	-0.347	-0.350
Overall	**-0.290**	**-0.292**	**-0.284**	**-0.289**

10.10.10 The results of the network-based method are very similar to the matrix-based calculations with the network-based overall annual elasticity meeting the TAG criteria.

10.11 Model robustness and performance

10.11.1 The PCF Stage 2 A27 transport model is considered to be a robust overall representation of current traffic conditions. The model does display some limitations which are not considered to detract from the model's usefulness for the forecast A27 scheme appraisals. The known limitations which are considered to be typical of strategic models include the following:

- The model is not comprehensively validated against observed junction turning flows
- The variable demand model represents travel demands as Origin and Destination O-D movements, not as P-A movements, which does entail a small risk of not replicating any linkage and constraint on travel choices associated with outward and return home-based journeys during a typical day
- The model contains a proportionate and appropriate level of network and zone detail, in the areas of influence for the A27 schemes but it does not include sufficient detail to replicate every intricate facet of how the scheme sections operate
- The model shows some coarseness in how travel demands are segmented into just five user classes
- A small number of locations within the model which are away from the vicinity of the A27 Arundel Bypass Scheme do not reflect the observed traffic flows within TAG GEH or flow criteria. These include:
  - A27 West of Chichester
  - A27 Chichester Bypass, north of A259
  - A27 Shoreham Bypass, near Shoreham-by-Sea
  - Some roads within urban areas such as Worthing, including Lyndhurst Road
- The coverage of calibration and validation count data does not cover all links within the broad model area, therefore the performance of the model on these links is not known. Where supplementary data is available, it has been identified that the modelled flows are not consistent with observed flows on Yapton Lane.

10.11.2 Where there is significant deviation between observed and modelled flows, and where necessary for operational assessment, sensitivity tests have been undertaken based on different traffic flow forecasts.

11 Forecast methodology

11.1 Description of the forecast years

11.1.1 The forecast years were identified and described within the ASR and these are as follows:

- 2026 opening year
- 2041 design year
- 2051 final forecast year

11.1.2 The opening year has changed from the previous forecasting for PCF Stage 2, when the opening year was forecast to be 2023. The programme for scheme development and construction has since been reviewed, and a new opening year has been established. The design year is 15 years from date of opening. The final forecast year has been established for economic appraisal purposes only, and is the final forecast year available in the current version of the DfT NTEM.

11.1.3 The generalised costs are calculated for these three forecast years. This chapter presents the forecasting assumptions for 2026, 2041 and 2051. Full forecasting results are presented for 2026 and 2041 in chapter 12, with summary information presented for 2051 only as this scenario is used for economic assessment purposes only.

11.2 Uncertainty Log

Justification for the developments and improvements

11.2.1 The uncertainty log identifies land use and transport infrastructure development within the area of the proposed Scheme. The purpose of an uncertainty log is to highlight all the local and external uncertainties and factors which could affect traffic/patronage, revenues and delivery of scheme benefits. Typically, these factors include proposed developments and transport infrastructure improvements. The log identifies a number of uncertainties, including factors affecting the traffic and demand such as the location, timing, size and nature of developments.

11.2.2 Data was provided by the Local Authorities listed below based on current Local Plans and other planning information in Summer 2018 to determine the anticipated level of development surrounding the A27 and the proposed Scheme:

- West Sussex County Council
- Adur and Worthing Councils

- Arun District Council

11.2.3 The local authorities provided information for residential and employment development sites in their respective areas. This information was analysed and the development sites were entered into an uncertainty log. The certainty of each development (see Table 11-1) was established in consultation with the local authorities. This process was undertaken in accordance with the guidance in WebTAG Unit M4 'Forecasting and Uncertainty'. The uncertainty log was finalised in Autumn 2018 in order to commence the forecasting process.

11.2.4 The uncertainty log outlines the developments which are to be explicitly modelled as part of the core scenario and the evidence behind this inclusion. The uncertainty logs for development and infrastructure are presented in Appendix C-1 and Appendix C-3 respectively.

The likelihood category

11.2.5 The uncertainty log presents the developments included and excluded from the forecasting model and a justification which shows the likelihood category assigned to them. Based on this 'likelihood category' provided by the local authority this determined whether the development was to be included explicitly in the forecast modelling. Table 11-1 presents the definition of uncertainty with more details of the developments and transport network[46] .

[46] TAG Unit M4 – Forecasting and Uncertainty, Department for Transport, Table A2

Table 11-1: Definition of uncertainty

Uncertainty assumption	Definition of Development Type	Status
Near Certain	The outcome will happen, or there is a high probability that it will happen	• Intent announced by proponent to regulatory agencies • Approved development proposals • Projects under construction
More than Likely	The outcome is likely to happen, but there is some uncertainty	• Submission of planning or consent application imminent • Development application within the consent process
Reasonably Foreseeable	The outcome may happen, but there is significant uncertainty	• Identified within a development plan • Not directly associated with the transport strategy/scheme, but may occur if the transport strategy/scheme is implemented • Development conditional on the transport strategy/scheme proceeding • A committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty
Hypothetical	There is considerable uncertainty whether the outcome will ever happen	• Conjecture based on currently available information • Discussed on a conceptual basis • One of a number of possible inputs in an initial consultation process • A policy aspiration

11.2.6 The guidance set out in TAG Unit M4 (May 2018) recommends that, in addition to the core scenario, at least two sensitivity tests should be considered, therefore a low growth scenario and an optimistic growth scenario have been considered. Table 11-2 sets out the categories of supply and demand that are included within each scenario.

Table 11-2: Categories of uncertainty included in different scenarios

Scenario	Supply	Demand	TEMPRO Constraint
Core	Near Certain and More Than Likely schemes	Near Certain and More Than Likely Developments	Standard TEMPRO
Optimistic	Near Certain, More Than Likely and Reasonably Foreseeable schemes	Near Certain, More Than Likely and Reasonably Foreseeable Developments	High Growth TEMPRO
Low	Near Certain and More Than Likely schemes	Near Certain and More Than Likely Developments	Low Growth TEMPRO

11.3 Assumptions

11.3.1 A core forecast scenario has been created using the following information:

- NTEM version 7.2 datasets accessed through TEMPro[47] version 7.2 software to obtain factors for car growth
- NTM using NRTF 2018 (Scenario 1, September 2018) for LGV and HGV
- Dwellings within the PCF Stage 2 A27 transport model study area as provided by the local authorities
- Jobs within the PCF Stage 2 A27 transport model study area as provided by the local authorities

11.3.2 The NTEM version 7.2 datasets were published on 1 March 2017 and were the latest available data at the time the PCF Stage 2 Further Consultation forecasts were being produced. Year 2026, 2041 and 2051 planning projections included within TEMPro v7.2 for the Local Authorities in the vicinity of the PCF Stage 2 A27 transport model area are reproduced in Table 11-3 and Table 11-4.

[47] TEMPro (Trip End Model Presentation Programme) is software that provides access to the NTEM dataset and provides forecasts of trip ends for analysis across geographical areas, by transport mode, time of day, purpose of journey, type of trips and for years of interest (2011 to 2051)

Table 11-3: TEMPro district household planning projections

Locality	Households						
	2015	2026	**2015 - 2026**	2041	**2015 - 2041**	2051	**2015-2051**
Arun	70,051	78,874	**8,823**	87,587	**17,536**	92,897	**22,846**
Adur	27,962	30,759	**2,797**	32,249	**4,287**	33,277	**5,315**
Worthing	48,757	52,112	**3,355**	55,684	**6,927**	57,912	**9,155**

Table 11-4: TEMPro district jobs planning projections

Locality	Jobs						
	2015	2026	**2015-2026**	2041	**2015-2041**	2051	**2015-2051**
Arun	57,622	60,661	**3,039**	63,275	**5,653**	65,327	**7,705**
Adur	25,913	27,175	**1,262**	28,344	**2,431**	29,267	**3,354**
Worthing	57,782	60,748	**2,966**	63,366	**5,584**	65,424	**7,642**

11.3.3 Growth for LGV and HGV was obtained from the NTM using NRTF (2018 – Scenario 1, September 2018). Growth rates for each region were applied depending on the PCF Stage 2 A27 transport model zone locations which are shown for the South East in Table 11-5.

Table 11-5: National Road Traffic Forecast growth factors

Region	LGV growth	HGV growth
South East (2026)	17.42%	2.39%
South East (2041)	41.15%	10.21%

11.4 Generalised cost parameters

11.4.1 Generalised cost parameters for route assignment in PPM and PPK have been calculated using the latest Highway England TPG VoT/VOC spreadsheet (VoT_and_VOC_from_webTAG_Databook (Nov 2018). Table 11-6 shows the PPM and PPK values utilised for the 2026 and 2041 assignment for the AM peak, Inter Peak and PM peak. The year 2051 forecasts are based on year 2041 PPM and PPK values.

Table 11-6: Values of time and distance (PPM / PPK)

	User Class	AM		IP		PM	
		PPM	PPK	PPM	PPK	PPM	PPK
2026	Car - Business	33.65	11.63	34.48	11.7	34.14	11.78
	Car – Commute	22.57	5.46	22.93	5.49	22.64	5.51
	Car – Other	15.57	5.46	16.59	5.49	16.3	5.51
	LGV	23.79	13.55	23.79	13.56	23.79	13.57
	HGV	48.29	48.33	48.29	48.7	48.29	49.12
2041	Car - Business	44.57	10.72	45.67	10.79	45.21	10.87
	Car – Commute	29.89	5.26	30.37	5.28	29.99	5.31
	Car – Other	20.62	5.26	21.97	5.28	21.59	5.31
	LGV	31.5	13.12	31.5	13.12	31.5	13.14
	HGV	63.96	52.4	63.96	52.79	63.96	53.25

11.4.2 In line with WebTAG unit 3.1 section 2.8.8, for the purposes of assignment, PPM values pertaining to HGVs have been doubled to avoid routeing through urban areas as the VoTs do not take account of the influence of owners on the routeing of these vehicles.

11.5 Dependency

11.5.1 Dependent development refers to new development that is dependent on the provision of a transport scheme and for which, with the new development but in the absence of the transport scheme, the existing transport network would not provide a reasonable level of service to existing and/or new users. This has the implication that the development would not be delivered in the absence of the transport scheme.

11.5.2 Based on the information provided by Arun District Council, Adur & Worthing Councils and West Sussex County Council, no dependant supply or land use developments were identified. Accordingly, dependency testing is not required and has not been undertaken. The Scheme has been considered solely on transport grounds.

11.6 Modelled developments

11.6.1 Information regarding residential and employment sites within the PCF Stage 2 A27 transport model study area was obtained from Arun District Council and Adur and Worthing Councils, and compared to TEMPRO v7.2 planning projections. Employment sites were provided in terms of net floor space, so conversion factors from the Homes and Communities Agency Employment Density Guide 3rd Edition (November 2015) were used to calculate the number of jobs.

11.6.2 The near certain and more than likely developments that have been included in the 2026, 2041 and 2051 forecast year matrices have been summarised within Appendix C-1. Development locations are also presented in Appendix C-2.

11.6.3 The number of households and jobs from the developments shown in Appendix C-1 are summarised in Table 11-7. The table shows that all explicitly modelled developments are assumed to be built out and fully operational by the opening year 2026. All other land use development, including development after 2026, is therefore captured within background traffic growth.

Table 11-7: Forecasted households and jobs

Locality	Households		Jobs	
	2015 - 2026	2015 – 2041/2051	2015 - 2026	2015 – 2041/2051
Arun	7,091	7,091	5,098	5,098
Adur	1,620	1,620	2,148	2,148
Worthing	1,563	1,563	0	0

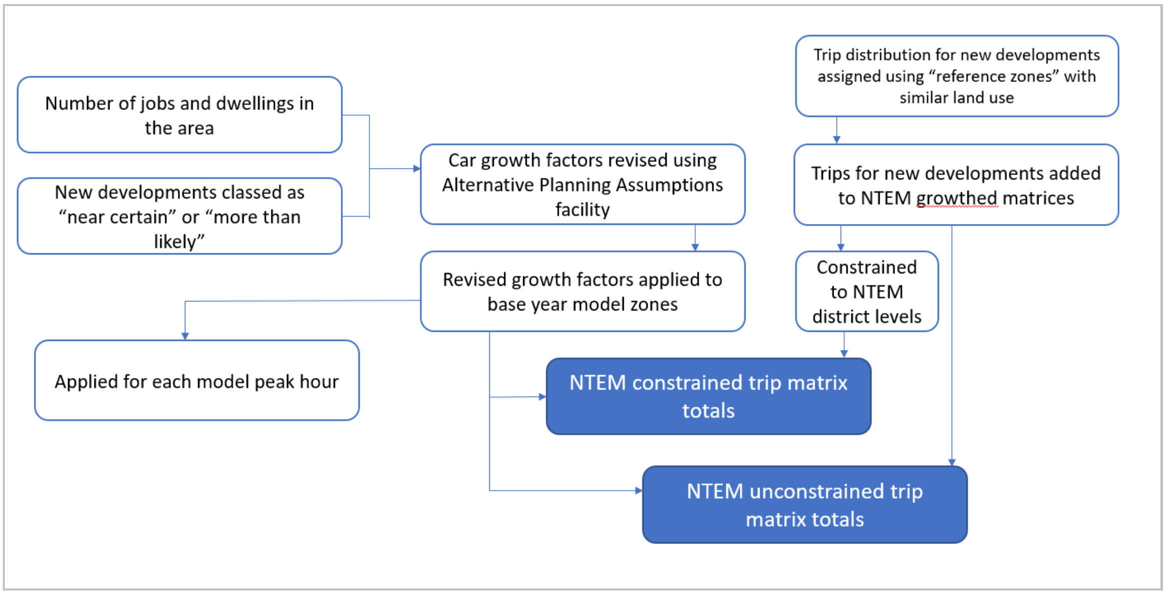
11.6.4 Each of the development sites shown in Appendix C-1 has been allocated to a PCF Stage 2 A27 transport model zone. Trip generation rates for the site-specific developments shown in Appendix C-1 were calculated using information obtained from the TRICS database.

11.7 Forecast growth matrices

11.7.1 The number of dwellings and jobs was adjusted to include those developments classed as near certain or more than likely using the alternative planning assumptions facility within the TEMPro version 7.2 program to produce revised car growth factors for the area. These revised growth factors were then assigned to each base model zone and the origin and destination totals for each base year zone increased appropriately, prior to the addition of the development matrices. This was carried out for each modelled peak hour.

11.7.2 Trips for the new developments were added to the NTEM growthed matrices, with trip distribution based on trip distribution in zones with similar land use. The growth generated from TEMPRO with the added new development trips was constrained to NTEM district levels. Figure 11-1 illustrates the process for producing trip matrices.

Figure 11-1: Production of constrained and unconstrained trip matrices



11.7.3 Table 11-8 shows a comparison of the unconstrained and NTEM constrained trip matrix totals for the AM peak, Inter peak and PM peak time periods in the forecast years of 2026, 2041 and 2051.

Table 11-8: Trip matrix totals

	Year	Unconstrained	Constrained
AM peak	2026	50,270	47,190
	2041	56,042	52,894
	2051	58,667	55,589
Inter peak	2026	51,199	45,762
	2041	57,083	51,483
	2051	59,558	54,027
PM peak	2026	58,510	53,071
	2041	64,606	58,908
	2051	67,862	62,233

11.7.4 Sections 11.7.1 and 11.7.2 set out how the growth factors for cars were developed. The growth factors for LGVs and HGVs were obtained using NRTF (2018, Scenario 1 – September 2018), as is described in 11.3.3. The combination of NTEM growth, NRTF growth and development traffic make up the 2026, 2041 and 2051 forecast year matrices for the AM peak, Inter peak and PM peak periods.

11.7.5 The trip matrix totals produced through the forecasting matrix procedure are summarised in Table 11-9 and Table 11-10 and Table 11-11, for the 2026, 2041 and 2051 Do Minimum for the AM peak, Inter peak and PM peak respectively. The base year matrix totals are provided for comparison.

Table 11-9: Comparison of AM peak trip matrices

Purpose	2015	2026	% change (2015 - 2026)	2041	% change (2015 - 2041)	2051	% change (2015 - 2051)
Car Business	3280	3563	8.62	3883	18.39	4122	20.42
Car Commute	12237	13046	6.61	14086	15.11	14655	16.50
Car Other	17088	19646	14.97	22293	30.46	23550	27.44
LGV	5863	6884	17.42	8275	41.14	8771	33.16
HGV	3961	4052	2.30	4357	9.99	4491	11.79
Total	**42429**	**47191**	**11.22**	**52894**	**24.66**	**55589**	**31.02**

Table 11-10: Comparison of Inter peak trip matrices

Purpose	2015	2026	% change (2015 - 2026)	2041	% change (2015 - 2041)	2051	% change (2015 - 2051)
Car Business	2240	2421	8.08	2627	17.30	2783	19.50
Car Commute	6442	6859	6.47	7416	15.12	7767	17.06
Car Other	23161	26435	14.13	29865	28.95	31317	26.04
LGV	5156	6053	17.40	7278	41.16	7732	33.31
HGV	3905	3995	2.29	4296	10.02	4429	11.84
Total	**40904**	**45762**	**11.88**	**51483**	**25.86**	**54027**	**32.08**

Table 11-11: Comparison of PM peak trip matrices

Purpose	2015	2026	% change (2015 - 2026)	2041	% change (2015 - 2041)	2051	% change (2015 - 2051)
Car Business	3005	3253	8.26	3523	17.23	3734	19.52
Car Commute	13453	14263	6.02	15310	13.81	16128	16.59
Car Other	23441	26157	11.59	29146	24.34	30857	24.03
LGV	5476	6430	17.42	7729	41.14	8201	33.23
HGV	2893	2967	2.57	3200	10.62	3313	12.68
Total	**48268**	**53071**	**9.95**	**58908**	**22.04**	**62233**	**28.93**

11.8 Do Minimum network

11.8.1 WSCC were contacted in Summer 2018 to ascertain the committed highways schemes that may have a bearing on the network performance in the future. Appendix C-3 contains an uncertainty log for highway infrastructure which was finalised in Autumn 2018 as part of the commencement of the forecasting process. The information is also presented geographically in Appendix C-4. Schemes that are considered to be near certain or more than likely are presented in Table 11-12 and are included within the 2026, 2041 and 2051 core scenario.

Table 11-12: Summary of uncertainty log for highway infrastructure

Scheme	Authority	Uncertainty
A284 Lyminster Bypass / Fitzalan Link Road (Opening Year 2021): The northern section of a new road from south of the A27 at Crossbush to East Street in Littlehampton town centre, with a new roundabout on the A259 Worthing Road. The southern section between Toddington Nurseries and the A259 and the Littlehampton Academy access extension will be delivered by private developers	WSCC	More than likely
A259 Corridor Improvements (Opening Year 2020): This scheme provides a continuous strategic corridor comprising approximately 5.1km of dual carriageway between the new A259/A284 roundabout in the west and the A259/A280 roundabout in the east.	WSCC	Near Certain

Scheme	Authority	Uncertainty
Bognor Regis Relief Road (Opened in March 2016): This scheme connects the A29 at Shripney to the A259 at Felpham, through a viaduct and forms part of the Bognor Regis Northern Relief Road	WSCC	Near Certain
A27 Worthing and Lancing: Highways England has determined that all schemes within a published RIS should be considered 'more than likely' whilst in development, or 'near certain' once in construction. A preferred route has not been announced, but the latest arrangement of the scheme has been included within the forecasts	Highways England	More than Likely
Yapton Level Crossing: Network Rail has programmed this work for spring 2019. The existing crossing has a fixed life and will require replacement prior to 2025 and will not be replaced like for like. Extended crossing closure times will be introduced on the local road	Network Rail	More than Likely
Arundel 20mph zone: The introduction of a permanent TRO to reduce speed limits within Arundel including a 20mph speed limit covering roads within Arundel, and a 30mph speed limit on Mill Road	WSCC	Near Certain
Fontwell: Access changes relating to new land use development, including the partial signalisation of the A27 A29 / Arundel Road roundabout	WSCC	Near Certain
New Monks Farm (Ikea) Infrastructure Improvements: The introduction of a new high capacity roundabout on the A27 and highway improvements at the Grinstead Lane / A27 roundabout. Associated highway alterations as per proposed scheme Masterplan	WSCC	Near Certain

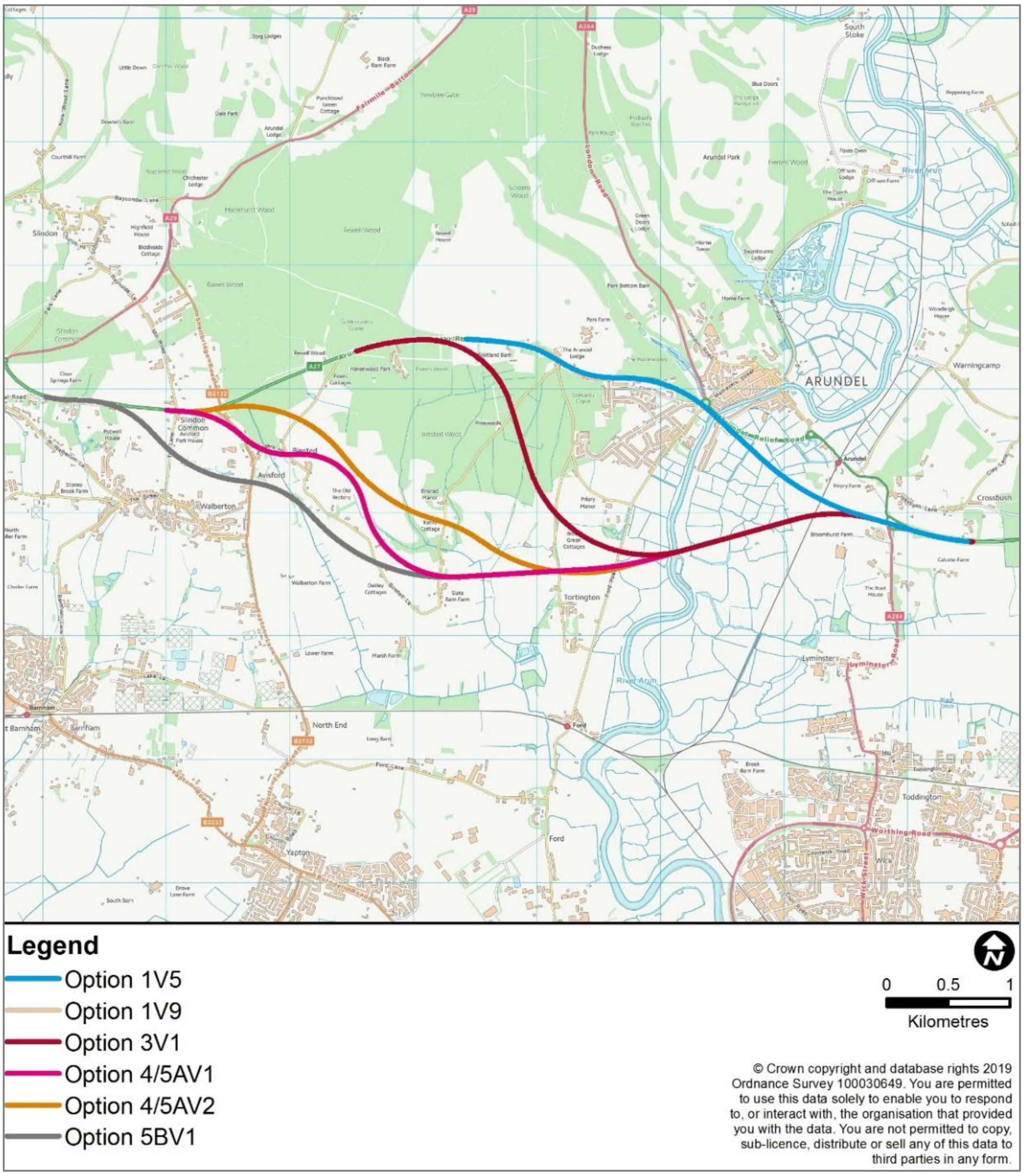
11.8.2 In line with the information contained in Table 11-2, those highway infrastructure schemes that are considered near certain or more than likely are included within the core and low growth scenarios. The optimistic scenario includes those highway infrastructure schemes that have the category of near certain, more than likely and also reasonably foreseeable.

11.8.3 Yapton Level Crossing, Arundel 20mph zone, Fontwell developments and New Monks Farm Infrastructure Improvements are all new additions to the highway infrastructure uncertainty log, compared to the preceding forecasts. The uncertainty of the A27 Worthing and Lancing improvements scheme has been changed from “Reasonably Foreseeable” in the previous forecasts to “More than likely”, and hence are included in the core, low and optimistic growth scenarios. Otherwise, there have been no changes since the previous PCF Stage 2 assumptions.

11.9 Do Something network

11.9.1 Figure 11-2 illustrates the options that have been assessed for the A27 Arundel Bypass Scheme. The options are described in section 1.4.

Figure 11-2: Location of A27 Arundel Bypass options



11.10 Matrices for alternative scenario

11.10.1 In line with TAG Unit M4, traffic growth from the 2015 base year has been accounted for in all the model forecasts. Traffic growth is a response to economic and demographic change with the rate of traffic growth and the amount of movement between zones being uncertain.

11.10.2 The guidance in TAG Unit M4 recommends that, in addition to the core scenario, at least two sensitivity tests must be considered, therefore low scenario and optimistic scenarios have been produced. The determinants of each growth scenario are as follows:

- land use plans i.e. NTEM local area planning and travel data and NTM planning and travel data
- site-specific development proposals

Low growth scenario

11.10.3 The low growth scenario has been assumed to include:

- low growth scenario estimate of vehicle trip growth, using NTEM growth reduced for uncertainty and NTM growth
- near certain and more than likely land use developments
- near certain and more than likely highway infrastructure

11.10.4 The low growth scenario was developed in a similar way, but the local uncertainty was unchanged from the core scenario. Total growth was constrained at district level to NTEM growth minus U (U=2.5% x √n, where n is the number of years after the base year). In circumstances where this resulted in the number of trips in the low growth scenario being less than in the base case, the base scenario was used as the low growth scenario i.e. zero growth).

Optimistic scenario

11.10.5 The optimistic scenario has been assumed to include:

- optimistic estimate of vehicle trip growth, using NTEM growth increased for uncertainty and NTM growth
- near certain, more than likely and reasonably foreseeable land use developments
- near certain, more than likely and reasonably foreseeable highway infrastructure

11.10.6 The optimistic scenario was calculated using the uncertainty log. Trips from near certain, more than likely and reasonably foreseeable developments were added as appropriate. Total growth was constrained at district level to NTEM growth plus U (as defined in 2.10.4). This is the same methodology used when calculating the core scenario, with the difference being the level of growth to which the matrices were constrained. However, the results of the optimistic scenario are not presented (see section 12.8.1).

11.11 Sensitivity tests - infrastructure

11.11.1 Further forecasting scenarios have been developed as an alternative to the core scenario. These sensitivity tests include variations to the core scenario infrastructure assumptions, and include:

- core scenario, excluding the A27 Worthing and Lancing
- core scenario, excluding the Lyminster Bypass

11.12 Annual Average Daily Traffic (AADT)

11.12.1 Estimates of forecast AADT as well as forecast Annual Average Weekday Traffic (AAWT), 18-hour flows and 12-hour off peak flows have been produced from the AM peak, Inter peak and PM peak modelled flows using factors derived from local observed traffic data. The observed data was taken from the WSCC traffic database and Highways England's WebTRIS traffic database.

11.12.2 The factors used to convert the average peak and inter peak hourly flows to the respective 18-hour, 24-hour AADT and AAWT and 12-hour off peak flows are set out in Table 11-13. These factors were applied to the sum of the AM, inter-peak and PM average flows. The E factor (AWT 12-hour to AWT 16-hour) is also shown in Table 11-13.

11.12.3 Strategic roads comprise those that are part of Highways England motorway and trunk road network.

Table 11-13: Peak hour conversion factors

	Conversion factor	
	Strategic roads	All other roads
12-hour to 24-hour AADT	1.164	1.099
12-hour to 24-hour AAWT	1.225	1.145
12-hour to 18-hour AAWT	1.187	1.123
Average modelled peak hours (AM+IP +PM) to 12-hour Off Peak (1900-0700)	0.073	0.060
E factor	1.167	1.100

12 Forecast results

12.1 Introduction

12.1.1 This chapter presents a summary of the model performance statistics of the fixed demand models (FDM) and the VDMs, in terms of the levels of convergence achieved, against the criteria set out within the relevant TAG documents. The chapter also presents a range of model outputs including traffic flows, journey times and network performance statistics in order to compare the performance of the scheme options and options against the 'Do Minimum' scenario, as well as providing a relative comparison between options. The performance of the base model is summarised in chapter 3, including the limitations of the model.

12.1.2 This section includes the 2026 and 2041 core scenario outputs. The year 2051 forecasts are produced to inform economic appraisal only, and are not presented in detail in this report. In addition, the results of a number of core scenario sensitivity tests are presented for different infrastructure and traffic growth assumptions.

12.2 Impact of variable demand modelling

12.2.1 The impact of future changes in travel costs, upon journey choices made by road users, is handled within the model forecasts for the A27 Arundel Bypass Scheme by a DIADEM variable demand mechanism. This mechanism can apply an 'incremental hierarchical' adjustment to trip frequency, modal share (between highway and public transport) and trip destination in the forecast trip matrix for a particular scenario, depending upon the scale of travel cost change calculated by a variable demand model 'pivot point' procedure.

12.2.2 Control of this VDM adjustment to the trip matrix is determined by the calibrated sensitivity parameters calculated for the PCF Stage 2 A27 transport model 2015 base VDM mechanism during a 'realism test'. The sensitivity parameters are applied in DIADEM by user-class, travel mode / vehicle type, journey purpose and car-availability segments of the trip matrix. These parameters determine the outturn 'elasticity of demand' or [proportionate change in demand] / [proportionate change in cost] predicted by DIADEM.

12.2.3 Realism tests, which were undertaken in the base VDM, entail re-calibrating the sensitivity parameters within DIADEM such that for an applied 20% increase in the fuel cost component journey purpose fall within acceptable limits as specified by WebTAG. The calibrated DIADEM parameters can then be applied in the PCF Stage 2 Further Consultation A27 transport model forecast scenarios.

12.2.4 In line with TAG unit M2 (variable demand modelling), the effects of ''variable demand' upon the performance of the scheme options have been taken into account. Variable demand entails there being a difference in the magnitude and pattern of trips between the forecast years Do Minimum and Do Something networks as a consequence of differences in travel costs.

12.2.5 It is generally accepted that there is an inverse change in vehicle kilometres travelled relative to a change in journey cost and likewise an inverse change in vehicle hours spent on the network relative to a change in journey cost. These responses reflect a negative 'elasticity of demand' with respect to travel cost.

12.2.6 Variable demand has been assessed using the DIADEM (version 6.3.3) program in conjunction with the PCF Stage 2 A27 transport model. The purpose of VDM is to allow for the effect of differences in trip movements, in the with-scheme and without-scheme situations, upon scheme economic benefits and upon scheme appraisal / development in general.

12.2.7 In accordance with advice in TAG an 'incremental' rather than 'absolute' model has been used to represent demand responses to changes in travel cost. This means that a change in O-D movement can only occur if there is a change in relative travel cost for that O-D movement compared with a 'pivot point' situation.

12.2.8 To establish the pattern of forecast VDM Do Minimum O-D demand DIADEM adjusts the forecast reference case O-D matrix by 'pivoting' the costs from an assignment of reference case demand on the Do Minimum network, off the base year 2015 costs.

12.2.9 To establish the pattern of forecast VDM Do Something O-D demand DIADEM adjusts the forecast Do Minimum O-D matrix by 'pivoting' the costs from an assignment of Do Minimum VDM demand on the Do Something network off the forecast Do Minimum.

DIADEM convergence

12.2.10 DIADEM calculates a %Gap measurement, which indicates the degree of mismatch between the level of demand in the trip matrix and the target level of demand at which equilibrium with supply (travel cost) will be achieved. The aim is to reduce the %Gap measurement to as small a value as possible, ideally within the range 0.1%-0.2%.

12.2.11 The following DIADEM convergence settings have been used:

- Select Algorithm: Fixed Step Length
- Initial step length: 0.5
- Maximum iterations: 300
- Maximum flow change: 0
- Absolute Gap: 0
- Full Model Area Relative Gap (%): 0.1

12.2.12 All 2026 and 2041 models converge within a reasonable number of iterations with the convergence achieved exceeded that required by TAG guidance. The final convergences achieved when the iterations were completed are given in Table 12-1.

Table 12-1: DIADEM convergence

Peak	Year	% GAP						
		DM	1v5	1v9	3v1	4/5Av1	4/5Av2	5Bv1
AM peak	2026	0.10	0.08	0.08	0.09	0.10	0.08	0.07
Inter peak		0.09	0.08	0.06	0.07	0.09	0.08	0.08
PM peak		0.09	0.09	0.09	0.09	0.10	0.09	0.09
AM peak	2041	0.10	0.08	0.09	0.09	0.10	0.10	0.09
Inter peak		0.08	0.10	0.09	0.08	0.10	0.09	0.10
PM peak		0.09	0.09	0.10	0.10	0.09	0.10	0.09
AM peak	2051	0.10	0.09	0.07	0.11	0.10	0.10	0.10
Inter peak		0.12	0.10	0.10	0.10	0.10	0.09	0.23
PM peak		0.07	0.10	0.10	0.20	0.29	0.24	1.05

12.2.13 Where the percentage relative gap of the final iteration exceeded a convergence level of 0.1% in the 2051 scenarios, the iteration with the lowest GAP level is used instead, in accordance with WebTAG guidance[48]. The process followed for models that did converge comprised examining all 300 iterations of the demand model and selecting the best iteration (with the least gap).

12.2.14 In order to establish whether the models would likely converge to a better standard with a greater number of iterations, the 2051 scenario was run for Option 5BV1. The %GAP value did not improve after 600 iterations.

12.2.15 Although a small number of scenarios indicate DIADEM non-convergence, the results have been reviewed and no unusual impacts were identified. Furthermore, the A27 transport models achieve good levels of convergence (reported later in this chapter).

12.3 Variable demand model outputs

12.3.1 The following section outlines the impacts of the VDM, comparing the pre-VDM (i.e. fixed demand) against the post-VDM demand matrix.

12.3.2 The trip matrix totals produced through the FDM and VDM processes, for all the scheme options, are summarised and compared in Table 12-2. A comparison of forecast year matrices by user class is presented in Appendix D-1.

[48] TAG Unit M2 – Variable Demand Modelling, Appendix H

Table 12-2: Comparison of forecast matrices: core scenario

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Fixed Demand Model								
All	47191	45762	53071	52894	51483	58908	55589	54027	62233
	Variable Demand Model								
DM	47246	45850	53132	52974	51587	58977	55643	54099	62249
1V5	47258	45862	53145	52988	51591	58989	55659	54102	62264
1V9	47258	45859	53144	52987	51588	58991	55660	54100	62268
3V1	47259	45863	53147	52989	51592	58989	55661	54103	62268
4/5AV1	47259	45863	53147	52989	51592	58992	55662	54103	62273
4/5AV2	47258	45862	53145	52988	51591	58989	55660	54102	62202
5BV1	47258	45862	53146	52989	51591	58991	55661	54102	62270
	Difference								
DM	56	88	61	80	104	68	55	71	17
1V5	67	100	74	94	108	81	71	74	31
1V9	67	97	73	93	105	83	71	73	35
3V1	68	101	76	95	109	81	72	76	36
4/5AV1	68	101	76	95	109	84	73	75	40
4/5AV2	67	100	74	94	108	81	71	74	-31
5BV1	67	100	75	95	108	83	72	75	38
	% Difference								
DM	0.12	0.19	0.12	0.15	0.20	0.12	0.10	0.13	0.03
1V5	0.14	0.22	0.14	0.18	0.21	0.14	0.13	0.14	0.05
1V9	0.14	0.21	0.14	0.18	0.20	0.14	0.13	0.13	0.06
3V1	0.15	0.22	0.14	0.18	0.21	0.14	0.13	0.14	0.06
4/5AV1	0.15	0.22	0.14	0.18	0.21	0.14	0.13	0.14	0.06
4/5AV2	0.14	0.22	0.14	0.18	0.21	0.14	0.13	0.14	-0.05
5BV1	0.14	0.22	0.14	0.18	0.21	0.14	0.13	0.14	0.06

12.3.3 The comparison of the 2026 VDM and FDM shows that the total increase in trips for the Do Minimum and all the options ranges between 0.12% - 0.15% in the AM Peak, 0.19% - 0.22% in the inter-peak and a 0.12% - 0.14% in the PM Peak. Similarly, in 2041, the difference varies between 0.15% - 0.18% in the AM peak, 0.20% - 0.21% in the inter peak and a 0.12% - 0.14% in the PM peak. In the 2051 forecasts the difference is between 0.10%-0.13% in the AM Peak,0.13%-0.14% in the inter peak and 0.03% - 0.06% in the PM Peak, with the exception of Option 4/5AV2 which illustrates a -0.05% reduction in matrix totals.

12.3.4 In summary, the changes to the matrix totals can be considered insignificant both in terms of absolute and percentage change. This reflects that the PCF Stage 2 A27 transport model is a highway only model therefore only the impact of trip frequency and trip distribution has been undertaken. No assessment of mode choice. Therefore, trips have not been suppressed or induced and only the change in trip patterns and the amount of traffic using the Scheme has been assessed.

12.4 SATURN model convergence statistics

12.4.1 Model convergence is needed to ensure traffic flows remain stable between successive iterations of the model. In accordance with criteria set out in the TAG Unit M3.1, the parameters %Flow and Delta (δ) have been monitored to determine the level of convergence. %Flow measures the proportion of links in the network with flows changing by less than 5% from the previous iteration and δ is the difference between costs on chosen routes and costs on minimum cost paths.

12.4.2 The %GAP value is a generalisation of the δ function to include the iteration effects within the simulation. The convergence criteria used to assess when a model is considered to have converged is shown in Table 12-3.

Table 12-3: Convergence criteria

Measure of convergence	Acceptable value
'Delta' and %GAP	Less than 0.1%, or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change < 1%	Four consecutive iterations greater than 98%
Percentage of links with cost change < 1%	Four consecutive iterations greater than 98%
Percentage change in total user costs	Four consecutive iterations less than 0.1%

12.4.3 A level of convergence which is sufficient to ensure that scheme benefits can be estimated robustly above model 'noise' is essential and a lower value of %GAP than the 0.1% guideline may need to be achieved. The Core (Do Minimum) 2026, 2041 and 2051 forecast year models have an ISTOP value of 98.5% (RSTOP value of 98.0%) with a %GAP of 0.05 set as the convergence criteria with both needing to be reached for four successive iterations before convergence is reached.

Fixed demand models

12.4.4 Achieving model convergence is important when using the model for scheme assessment. By ensuring that the forecast models are well converged it is assured that the differences between Do Minimum and Do Something model runs arise from the Scheme, and not from the noise in the modelling process.

12.4.5 A summary of the convergence statistics for the Do Minimum as well as the Do Something scheme options, for the core FDM and VDM scenarios, based on the final iteration, is set out in Table 12-4 and Table 12-5. Detailed convergence statistics based on the last four iterations for the Fixed Demand and the Variable Demand scheme options are included at Appendix D-2 and D-3 respectively. TAG Unit M2 suggests that delta (δ) values of less than 0.1% are reasonable targets.

12.4.6 Table 12-4 indicates that, based on the final iteration, all delta values are less than 0.2% and the core scenario FDMs (2026, 2041 and 2051) meet the required convergence standards. Tables set out in Appendix D-2 demonstrate that the convergence statistics for the last four iterations are fairly consistent, with delta (δ) and %Flow values in line with the TAG requirements.

Table 12-4: Core fixed demand scenario: convergence criteria

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Final iteration								
DM	227	42	53	62	55	78	89	48	117
1V5	41	36	90	41	44	75	58	74	115
1V9	63	40	92	48	44	93	60	52	86
3V1	61	38	85	34	34	68	60	46	109
4/5AV1	70	33	70	45	39	75	106	47	94
4/5AV2	43	36	73	66	44	78	58	50	106
5BV1	90	33	85	53	41	73	59	71	83
	Final Delta (δ)								
DM	0.0330	0.0133	0.0497	0.0189	0.0153	0.0421	0.0392	0.0391	0.0290
1V5	0.0586	0.0165	0.0205	0.0370	0.0266	0.0276	0.0387	0.0345	0.0274
1V9	0.0547	0.0126	0.0257	0.0204	0.0204	0.0223	0.0348	0.0224	0.0423
3V1	0.0535	0.0107	0.0606	0.0679	0.0330	0.0641	0.0275	0.0253	0.0242
4/5AV1	0.0585	0.0262	0.0206	0.0521	0.0326	0.0277	0.0342	0.0264	0.0305
4/5AV2	0.0281	0.0174	0.0206	0.0347	0.0286	0.0309	0.0512	0.0249	0.0342
5BV1	0.0495	0.0119	0.0198	0.0307	0.0338	0.0309	0.0272	0.0243	0.0356
	Final %Flow								
DM	98.9	98.6	99.2	98.7	99.5	98.7	99.0	98.9	99.6
1V5	98.8	98.6	99.2	99.4	99.2	99.2	99.5	98.7	99.5
1V9	98.6	99.1	99.1	99.2	98.7	99.2	99.3	98.5	99.5
3V1	98.9	98.8	99.0	98.9	99.2	98.9	99.1	98.8	99.6
4/5AV1	98.7	98.8	99.3	98.9	99.1	99.3	99.6	98.6	99.5
4/5AV2	98.4	98.6	98.7	99.1	98.9	99.3	99.0	98.7	99.6
5BV1	98.4	99.1	99.2	98.9	98.6	98.8	99.4	99.1	99.1
	Final %Gap								
DM	0.030	0.040	0.037	0.036	0.032	0.038	0.034	0.041	0.042

1V5	0.028	0.034	0.023	0.038	0.049	0.048	0.025	0.033	0.031
1V9	0.033	0.020	0.021	0.032	0.032	0.043	0.027	0.034	0.045
3V1	0.044	0.016	0.032	0.047	0.040	0.048	0.040	0.045	0.050
4/5AV1	0.025	0.035	0.029	0.036	0.033	0.043	0.031	0.04	0.041
4/5AV2	0.037	0.036	0.029	0.034	0.035	0.044	0.045	0.04	0.031
5BV1	0.027	0.020	0.047	0.049	0.044	0.050	0.025	0.03	0.043

12.4.7 Table 12-5 indicates that satisfactory convergence has been achieved for all the VDMs. As the results indicate, all delta values are less than 0.1% therefore the core variable demand scenario models (2026, 2041 and 2051) meet the required convergence standards. Similar to the FDM scenario, tables set out in Appendix D-3 demonstrate that the convergence statistics for the last four iterations of the VDMs are fairly consistent, with delta (δ) and %Flow values in line with the TAG requirements.

Table 12-5: Core variable demand scenario-convergence criteria

	2026			2041			2051		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
	Final iteration								
DM	53	33	30	49	45	193	80	55	107
1V5	55	29	45	50	57	78	77	132	86
1V9	56	32	49	56	37	99	94	113	80
3V1	44	25	26	56	42	79	111	101	85
4/5AV1	59	26	31	59	52	83	105	126	63
4/5AV2	33	29	28	51	50	83	110	96	112
5BV1	50	30	55	51	59	83	95	84	60
	Final Delta (δ)								
DM	0.0083	0.0195	0.0367	0.0289	0.0289	0.0316	0.0234	0.029	0.0392
1V5	0.0115	0.0187	0.0375	0.0250	0.0216	0.0235	0.0573	0.0226	0.0273
1V9	0.0129	0.0186	0.0199	0.0297	0.0347	0.0332	0.0291	0.0196	0.0416
3V1	0.0155	0.0255	0.0366	0.0257	0.0407	0.0232	0.0227	0.0415	0.0204
4/5AV1	0.0382	0.0183	0.0236	0.0252	0.0326	0.0411	0.0414	0.0242	0.0274
4/5AV2	0.0213	0.0177	0.0308	0.0432	0.0251	0.0460	0.0289	0.0284	0.0206

5BV1	0.0129	0.0150	0.0184	0.0450	0.0197	0.0222	0.0338	0.0471	0.0472
	Final %Flow								
DM	98.9	98.2	98.6	98.1	98.2	99.4	98.6	98.5	99.7
1V5	99.6	98.9	98.9	98.8	99.1	99.3	98.9	99.6	99.5
1V9	99.0	98.7	99.1	99.2	98.2	98.8	98.9	99.5	99.5
3V1	98.5	98.5	98.5	99.2	99.1	98.9	99.1	99.1	99.5
4/5AV1	99.3	98.9	98.8	99.1	99.0	99.0	98.9	99.5	99.6
4/5AV2	98.6	98.6	98.5	99.1	99.1	99.4	99.0	99.3	99.5
5BV1	99.1	98.8	99.2	99.1	99.0	99.6	98.5	98.8	99.3
	Final %Gap								
DM	0.017	0.017	0.034	0.029	0.029	0.028	0.037	0.027	0.047
1V5	0.034	0.017	0.037	0.040	0.038	0.038	0.040	0.039	0.042
1V9	0.023	0.041	0.038	0.044	0.034	0.026	0.043	0.048	0.048
3V1	0.049	0.023	0.036	0.034	0.048	0.022	0.043	0.028	0.048
4/5AV1	0.019	0.015	0.030	0.043	0.039	0.032	0.040	0.020	0.026
4/5AV2	0.026	0.019	0.036	0.034	0.037	0.045	0.045	0.027	0.044
5BV1	0.045	0.025	0.025	0.039	0.035	0.044	0.045	0.047	0.033

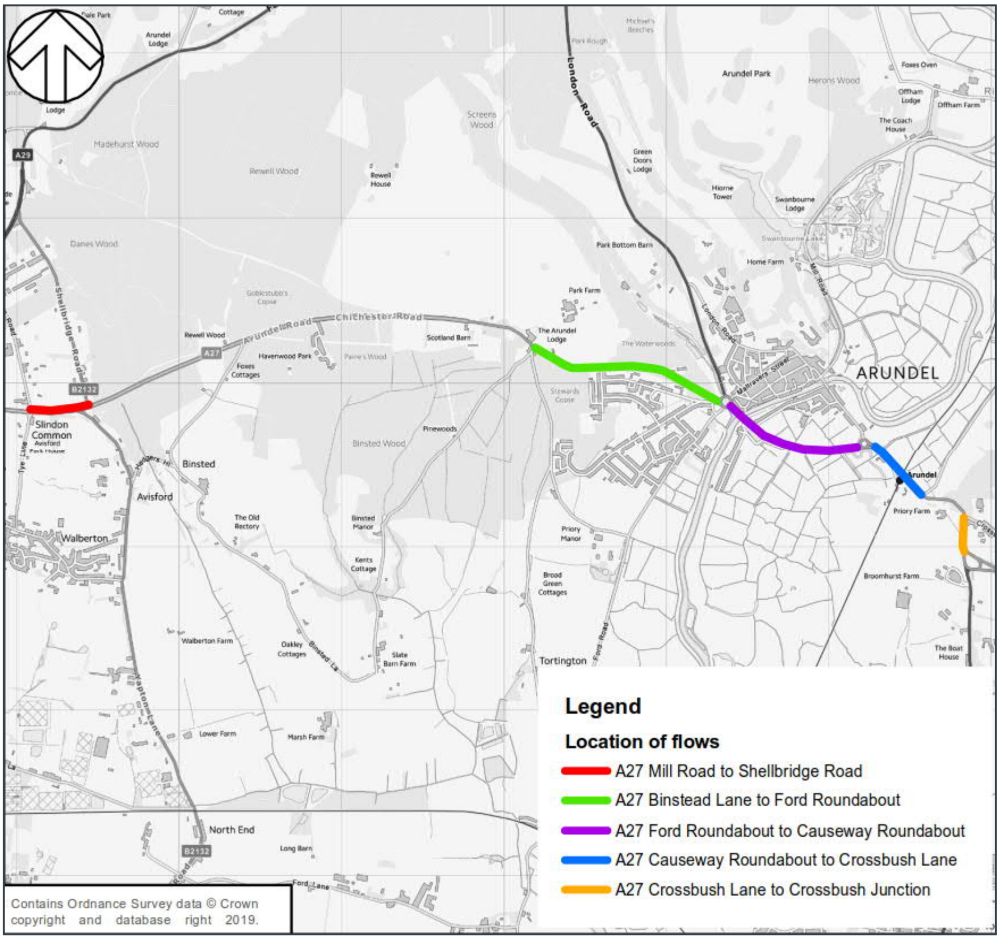
12.5 Core scenario forecast outputs

Traffic flows

12.5.1 Traffic flows on key links, along the A27, within the study area for the Do Minimum and the Do Something scheme options have been extracted and presented in the following sections for the 2026 and 2041 forecast scenarios. A plan showing the location of the links is illustrated in Figure 12-1.

12.5.2 Where figures are presented to illustrate changes in traffic flows, these are presented for the AM and PM peak periods.

Figure 12-1: Location of links



Traffic flow comparison - 2026 / 2041 Do Minimum with 2015 base flows

12.5.3 Figure 12-2 and Figure 12-3 demonstrates the change in flows on the modelled network between 2015 and 2026. The green bands indicate an increase in traffic whereas the blue bands indicate a decrease. The general effect of the traffic growth and Do Minimum infrastructure changes are:

- a general growth in traffic on road links across the network
- a reduced level of traffic growth on the A27 through Arundel when compared with adjacent sections of the A27 as a result of road capacity constraints
- a reduction in traffic volume on sections of road network that are bypassed by new road infrastructure (e.g. A284 Lyminster)
- the re-routing of traffic within the Worthing area as a result of the introduction of the A27 Worthing and Lancing improvements

Figure 12-2: 2026 Do Minimum – 2015 base (AM)

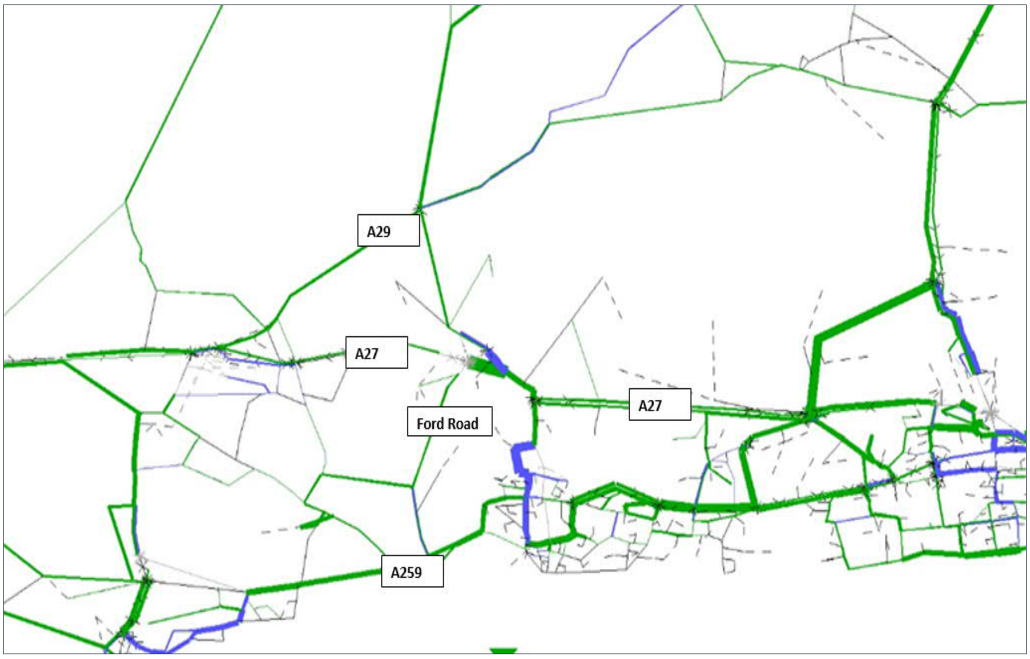
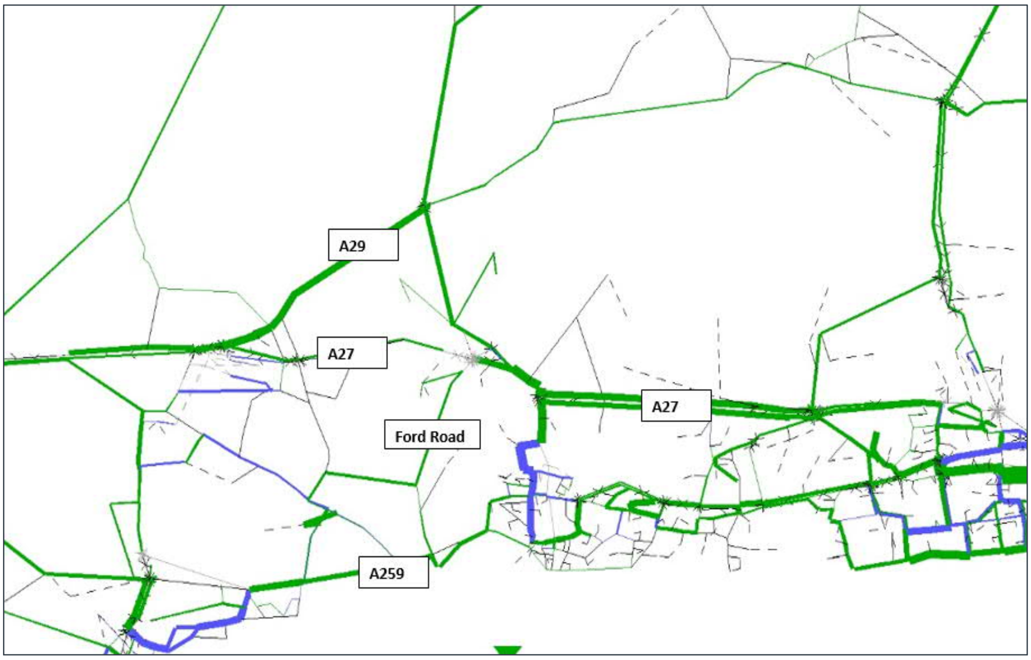


Figure 12-3: 2026 Do Minimum – 2015 base (PM)



12.5.4 Table 12-6 presents the traffic flow on various sections of the A27, as shown in Figure 12-1, during the Do Minimum AM, inter-peak and PM peak hours in 2026. The % change figures are coloured in green where an increase in traffic is greater than 10%, and in blue where a decrease in traffic is greater than -10%.

12.5.5 There is an increase in traffic flows during these periods on all routes, with the exception of the A27 between Mill Road and Shellbridge Road where a small decrease is indicated. This illustrates road and junction capacity limitations within the Arundel area which is influencing traffic route choice, in particular in a westbound direction.

12.5.6 On the A27, the highest percentage growth is between the Ford Road and the Causeway roundabouts in the AM peak, which is in part a result of the introduction of the Lyminster Bypass and the associated increase in traffic volume using the A284.

Table 12-6: A27 traffic flow difference between 2015 base and 2026 Do Minimum

		AM			IP			PM		
A27 Link	**Dir.**	**2015**	**2026**	**%**	**2015**	**2026**	**%**	**2015**	**2026**	**%**
Mill Road to Shellbridge Rd	EB	1086	1220	12.4	1072	1159	8.0	1177	1340	13.8
	WB	1166	1093	-6.3	998	972	-2.6	1125	1119	-0.5
Binsted Lane to Ford Rd Rdbt	EB	916	1047	14.3	880	935	6.2	909	1057	16.3
	WB	1066	1104	3.6	906	941	3.9	1053	1059	0.6
Ford Rdbt to Causeway Rdbt	EB	901	1361	51.1	1034	1278	23.6	611	934	52.7
	WB	650	1157	78.1	1056	1231	16.5	720	884	22.8
Causeway Rdbt to Crossbush Ln	EB	1258	1487	18.2	1128	1340	18.8	1062	1579	48.7
	WB	1340	1543	15.2	1142	1323	15.8	1302	1427	9.6
Crossbush Ln to Crossbush Jct	EB	1256	1462	16.5	1131	1328	17.4	1001	1519	51.7
	WB	1343	1552	15.6	1144	1330	16.3	1283	1417	10.5

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.5.7 An increase in flows between Ford Road Roundabout and Causeway Roundabout is also influenced by the introduction of speed reduction measures which discourages traffic within Arundel town. These measures are described in the infrastructure Uncertainty Log (Appendix C-3).

12.5.8 An increase in eastbound flows is seen between Causeway roundabout and Crossbush junction, especially during the PM peak, due to an increase in southbound flows on the A284, which have re-routed to join the A27 at Crossbush junction.

12.5.9 Figure 12-4 and Figure 12-5 demonstrate the change in flows on the modelled network between 2015 and Do Minimum 2041. Consistent with the traffic flow patterns in 2026, congestion on the A27 is drawing traffic away from the A27 on to other competing and lower order routes on the network.

Figure 12-4: 2041 Do Minimum – 2015 base (AM)

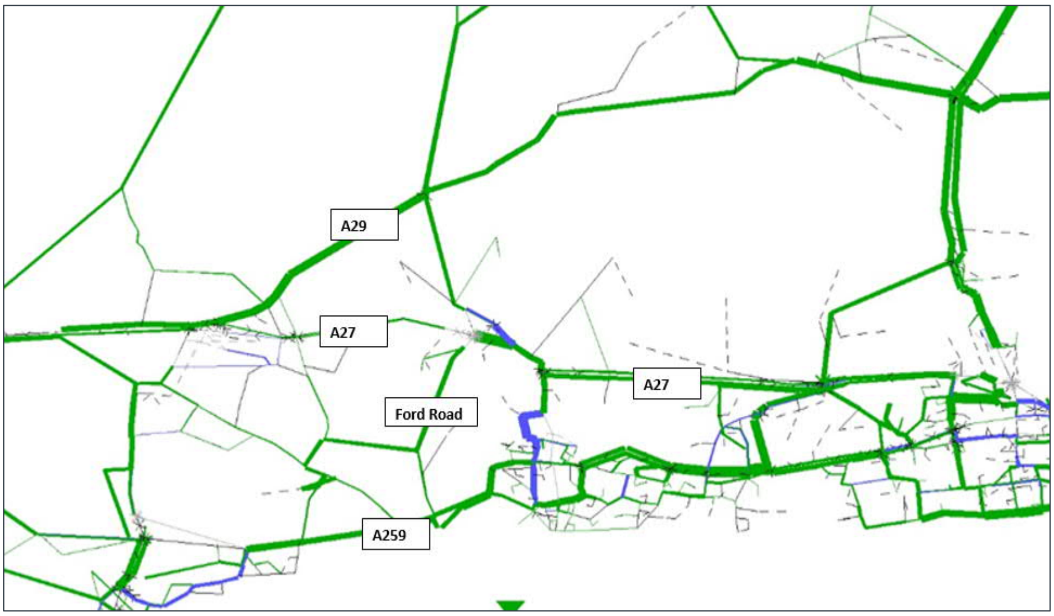
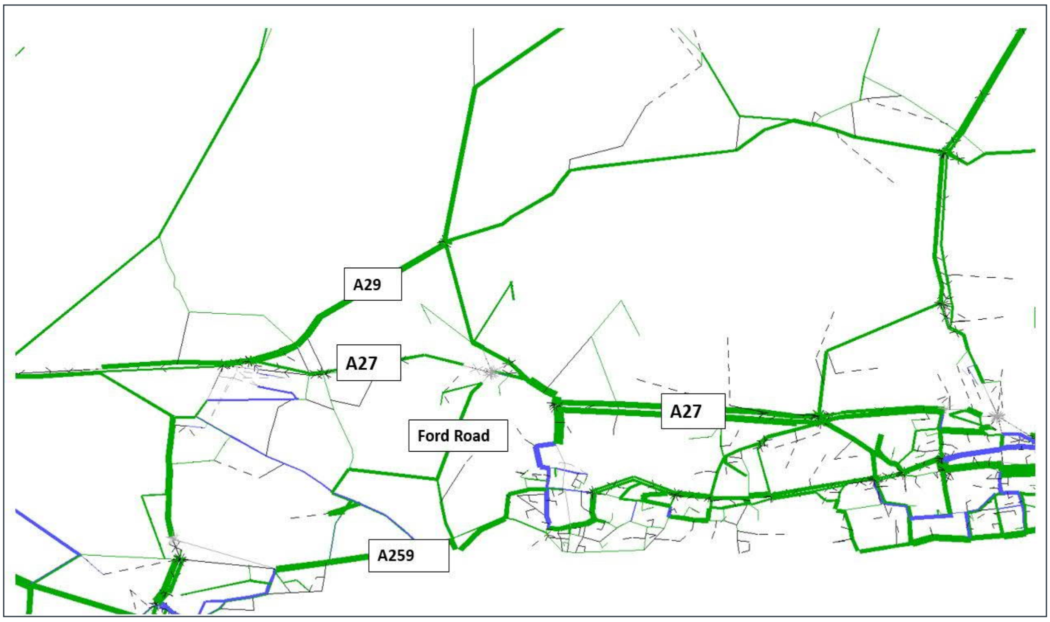


Figure 12-5: 2041 Do Minimum – 2015 base (PM)



12.5.10 Table 12-7 sets out the traffic flow on various sections of the A27, as shown in Figure 12-1, during the AM, inter-peak and PM peak hours in 2041. There is a general increase in traffic flows during these periods on all routes, with the exception of a small number of locations during these peak hours in a westbound direction where the increase in flows is constrained by road and junction capacities.

12.5.11 On the A27, the highest percentage growth is between the Ford Road and the Causeway roundabouts in the AM peak. The percentage difference in flow increase for the 2041 forecast year is lower than the 2026 forecast year along various sections of the route; this can be attributed to the general rerouting of traffic as a response to capacity constraints on the A27.

Table 12-7: A27 traffic flow difference between 2015 base and 2041 Do Minimum

		AM			IP			PM		
A27 Link	Dir.	2015	2041	%	2015	2041	%	2015	2041	%
Mill Road to Shellbridge Rd	EB	1086	1163	7.2	1072	1179	9.9	1177	1423	20.9
	WB	1166	1190	2.0	998	958	-4.0	1125	1215	8.0
Binsted Lane to Ford Rd Rdbt	EB	916	973	6.2	880	920	4.5	909	1150	26.6
	WB	1066	1169	9.7	906	920	1.6	1053	1105	5.0
Ford Rdbt to Causeway Rdbt	EB	901	1344	49.2	1034	1288	24.5	611	938	53.5
	WB	650	1048	61.3	1056	1182	11.9	720	690	-4.2
Causeway Rdbt to Crossbush Ln	EB	1258	1481	17.7	1128	1379	22.2	1062	1654	55.7
	WB	1340	1577	17.7	1142	1328	16.3	1302	1438	10.4
Crossbush Ln to Crossbush Jct	EB	1256	1452	15.6	1131	1365	20.7	1001	1592	59.0
	WB	1343	1587	18.1	1144	1338	16.9	1283	1430	11.5

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.5.12 A notable increase in flow is forecast between Ford Road Roundabout and Causeway Roundabout in the 2041 model, in part due to the speed reduction measures in Arundel described in the infrastructure uncertainty log (Appendix C-3). The increase in eastbound flows between Causeway roundabout and Crossbush junction is also seen in the 2041 model, due to increased southbound flows along the A284 joining the A27 at Crossbush junction.

Traffic flows on the A27 Arundel Bypass

12.5.13 Table 12-8 compares the volume of traffic on the A27 Arundel Bypass at a point located immediately west of Crossbush junction for all the Do Something scheme options with the equivalent flows on the existing A27 under a Do Minimum scenario. The table demonstrates that traffic flows typically increase for all options and across all peaks in 2026 and 2041, indicating that the scheme options have the effect of accommodating traffic growth and drawing traffic away from lower order roads and onto the A27.

Table 12-8: Traffic flows on the bypass between Ford Road and Crossbush

		AM				IP				PM			
	Dir.	2026	%	2041	%	2026	%	2041	%	2026	%	2041	%
DM	EB	1462		1452		1328		1365		1519		1592	
	WB	1552		1587		1330		1338		1417		1430	
1V5	EB	1676	14.6	1794	23.5	1499	12.9	1591	16.6	1690	11.3	1786	12.2
	WB	1639	5.6	1741	9.7	1397	5.0	1568	17.2	1600	12.9	1722	20.4
1V9	EB	1430	-2.2	1540	6.0	1348	1.5	1432	4.9	1580	4.0	1671	4.9
	WB	2063	32.9	2274	43.3	1775	33.4	1982	48.1	1899	34.0	2060	44.1
3V1	EB	1495	2.2	1603	10.4	1388	4.5	1475	8.0	1671	10.1	1735	9.0
	WB	1569	1.0	1720	8.4	1322	-0.6	1462	9.3	1493	5.4	1582	10.6
4/5A v1	EB	1579	7.9	1710	17.8	1521	14.5	1619	18.6	1881	23.9	1983	24.6
	WB	1578	1.6	1680	5.9	1367	2.8	1502	12.3	1531	8.0	1643	14.9
4/5A v2	EB	1554	6.2	1672	15.1	1471	10.7	1551	13.6	1785	17.6	1832	15.1
	WB	1548	-0.3	1644	3.6	1356	1.9	1487	11.2	1482	4.6	1576	10.2
5B v1	EB	1558	6.5	1692	16.5	1460	10.0	1562	14.4	1913	26.0	1987	24.8
	WB	1547	-0.4	1627	2.6	1324	-0.5	1456	8.8	1475	4.1	1559	9.0

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

Summary of traffic flows on the A27 in 2026 and 2041

12.5.14 Table 12-9 and Table 12-11 presents the change in flows on the existing alignment of the A27, for all the 2041 Do Something options, in comparison to the 2041 Do Minimum scenarios. Only 2041 data is included, but the trends in the 2026 data are similar to those presented below.

12.5.15 The analysis demonstrates that there is a significant reduction in traffic flows on the existing A27, with the exception of the section between Mill Road and Shellbridge Road in all options except option 5BV1, and A27 Binsted Lane to Ford Road roundabout with options 1V5 and 1V9, where flows increase. Reductions in flow are attributed to the location of the section relative to western tie-in. For example, in the case of option 5BV1, the western tie-in is further west of this section of the A27, and the Mill Road to Shellbridge Road section would therefore be part of the bypassed section and subject to significantly lower flows.

Table 12-9: Flows on the A27 – 2041 AM

		2041 AM actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1163	1822	1810	1807	1838	1841	148	57	56	55	58	58	-87
	WB	1190	1658	1633	1727	1653	1751	102	39	37	45	39	47	-91
A27 Binsted Ln to Ford Rdbt	EB	973	1794	1773	174	183	159	139	84	82	-82	-81	-84	-86
	WB	1169	1741	1693	108	102	120	128	49	45	-91	-91	-90	-89
A27 Ford Rdbt to Causeway Rdbt	EB	1344	762	771	858	773	798	764	-43	-43	-36	-43	-41	-43
	WB	1048	763	48	761	736	734	742	-27	-96	-27	-30	-30	-29
A27 Cause-way Rdbt to Crossbush Ln	EB	1481	933	913	910	823	855	847	-37	-38	-39	-44	-42	-43
	WB	1577	936	168	831	802	806	842	-41	-89	-47	-49	-49	-47
A27 Cross-bush Ln to Crossbush Jct	EB	1452	956	921	916	833	868	860	-34	-37	-37	-43	-40	-41
	WB	1587	969	188	847	821	829	864	-39	-88	-47	-48	-48	-46

Table 12-10: Flows on the A27 – 2041 IP

		2041 IP actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1179	1627	1633	1603	1648	1642	106	38	39	36	40	39	-91
	WB	958	1552	1502	1566	1567	1624	152	32	27	33	33	38	-87
A27 Binsted Ln to Ford Rdbt	EB	920	1591	1590	91	87	85	84	35	35	-92	-93	-93	-93
	WB	920	1568	1484	127	162	161	166	33	26	-89	-86	-86	-86
A27 Ford Rdbt to Causeway Rdbt	EB	1288	696	642	690	628	688	647	-41	-46	-41	-47	-42	-45
	WB	1182	697	41	694	686	687	689	-41	-97	-41	-42	-42	-42
A27 Cause-way Rdbt to Crossbush Ln	EB	1379	836	752	751	687	746	706	-29	-36	-36	-42	-37	-40
	WB	1328	827	143	746	735	735	737	-30	-88	-37	-38	-38	-38
A27 Cross-bush Ln to Crossbush Jct	EB	1365	863	773	775	712	771	730	-27	-34	-34	-40	-35	-38
	WB	1338	854	165	771	761	761	761	-28	-86	-35	-35	-35	-35

Table 12-11: Flows on the A27 – 2041 PM

		2041 IP actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1423	1925	2295	2263	2228	2245	469	35	61	59	58	57	-67
	WB	1215	1712	1640	1745	1702	1675	231	41	35	44	38	40	-81
A27 Binsted Ln to Ford Rdbt	EB	1150	1786	2169	403	331	343	284	55	89	-65	-70	-71	-75
	WB	1105	1722	1621	174	177	215	345	56	47	-84	-81	-84	-69
A27 Ford Rdbt to Causeway Rdbt	EB	938	767	819	731	723	722	716	-18	-13	-22	-23	-23	-24
	WB	690	654	29	752	764	758	835	-5	-96	9	10	11	21
A27 Cause-way Rdbt to Crossbush Ln	EB	1654	1035	1063	973	963	962	952	-37	-36	-41	-42	-42	-43
	WB	1438	750	110	740	780	774	856	-48	-92	-49	-46	-46	-41
A27 Cross-bush Ln to Crossbush Jct	EB	1592	1112	1085	1032	1024	1023	1013	-30	-32	-35	-36	-36	-36
	WB	1430	819	125	789	835	827	911	-43	-91	-45	-42	-42	-36

Traffic flow difference between Do Minimum and Do Something

12.5.16 Figure 12-6 to Figure 12-17 demonstrate the general pattern of change in traffic flows across the modelled network, for all the Do Something options, when compared against the 2041 Do Minimum scenario. The volume of change is proportional to the bandwidth of the line, with green indicating a flow increase, and blue a flow decrease.

12.5.17 The figures indicate that the scheme options are resulting in a broadly similar effect in terms of changes in traffic volume and can be summarised as:

- a reduction in traffic volume on the bypassed section of the current A27 route
- an increase in traffic volume on the A27 either side of the A27 Arundel Bypass Scheme as a result of the road capacity increases at Arundel
- an increase in the use of the A284 Lyminster Bypass, resulting from the improvements to the Crossbush junction
- a decrease in traffic on the A259 through Littlehampton in particular between Ford Road to the west and the Angmering Bypass to the east
- a decrease in traffic on other lower order roads, including the route to the north of Arundel through the SDNP, resulting from the re-routing of ‘rat running’ traffic onto the A27

Figure 12-6: Do Something (1V5) - Do Minimum – 2041 AM

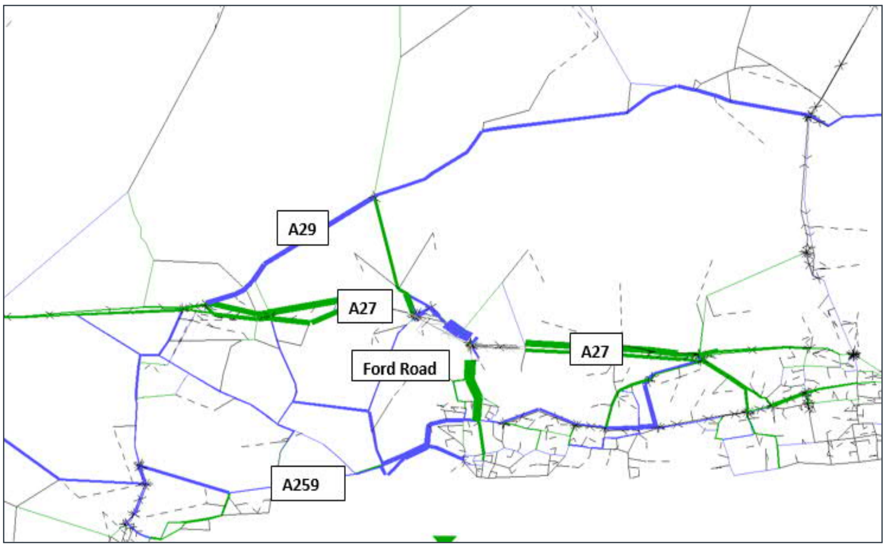


Figure 12-7: Do Something (1V5) - Do Minimum – 2041 PM

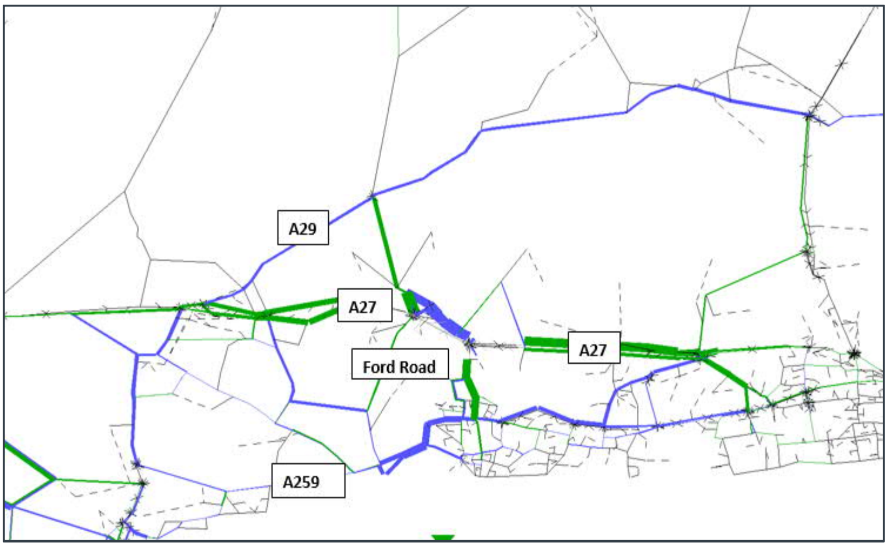


Figure 12-8: Do Something (1V9) - Do Minimum – 2041 AM

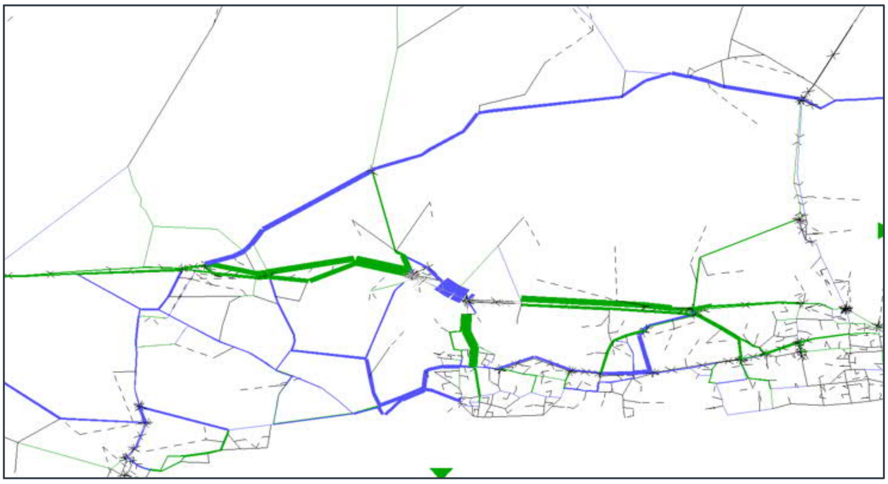


Figure 12-9: Do Something (1V9) - Do Minimum – 2041 PM

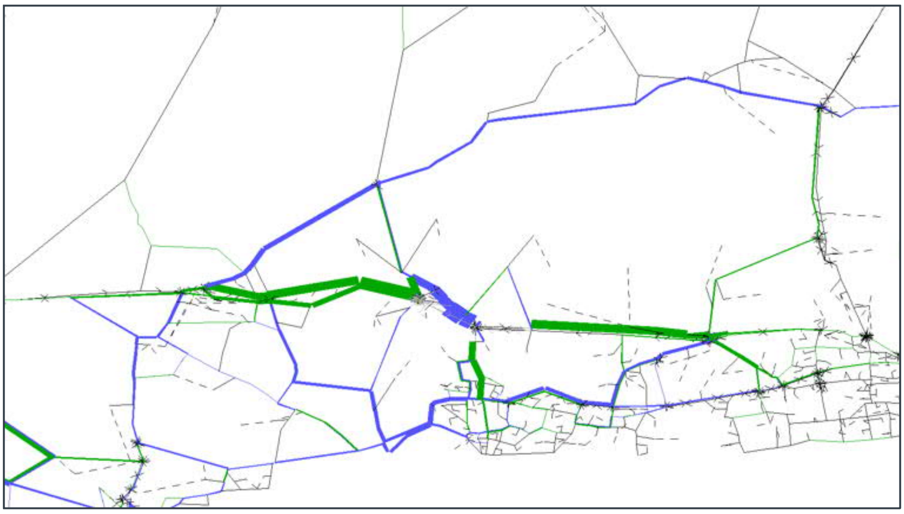


Figure 12-10: Do Something (3V1) - Do Minimum – 2041 AM

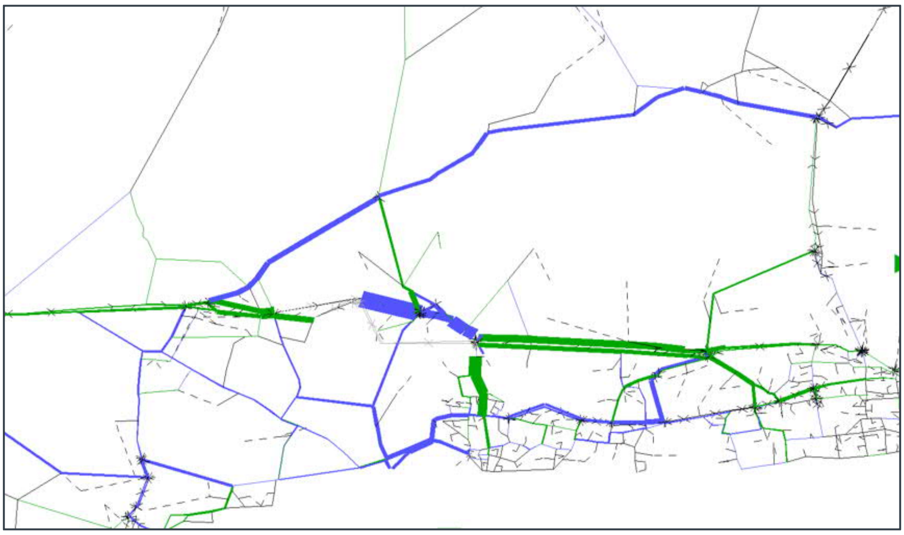


Figure 12-11: Do Something (3V1) - Do Minimum – 2041 PM

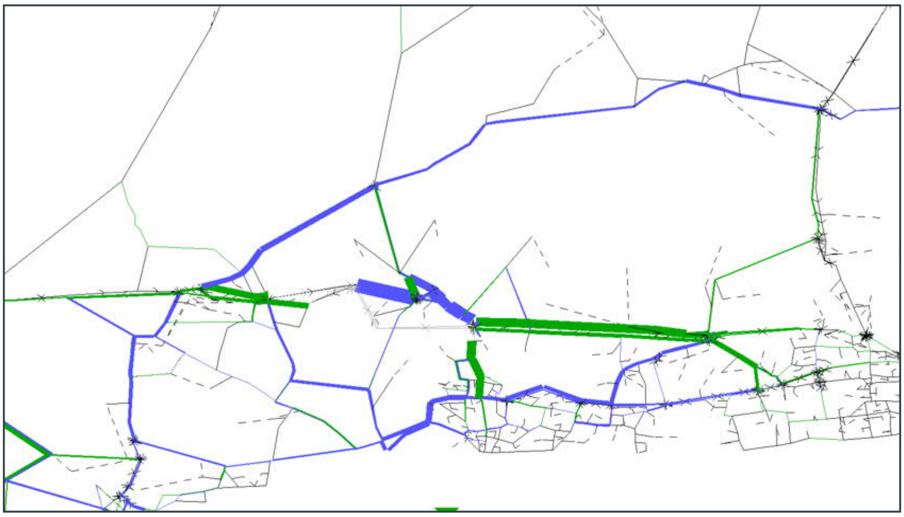


Figure 12-12: Do Something (4/5AV1) - Do Minimum – 2041 AM

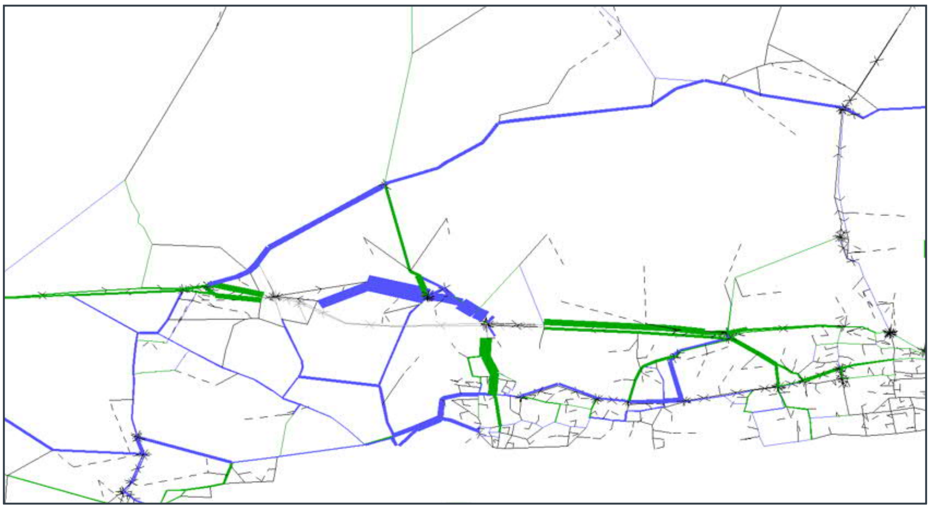


Figure 12-13: Do Something (4/5AV1) - Do Minimum – 2041 PM

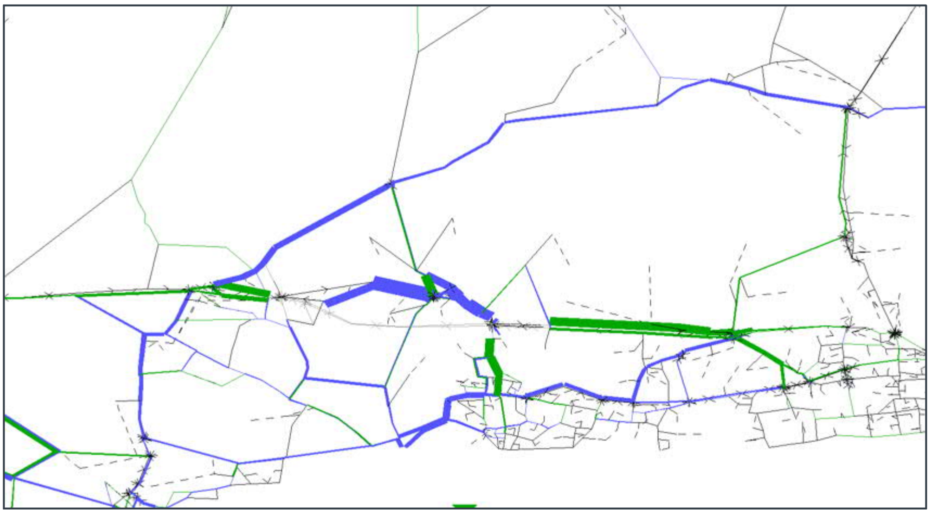


Figure 12-14: Do Something (4/5AV2) - Do Minimum – 2041 AM

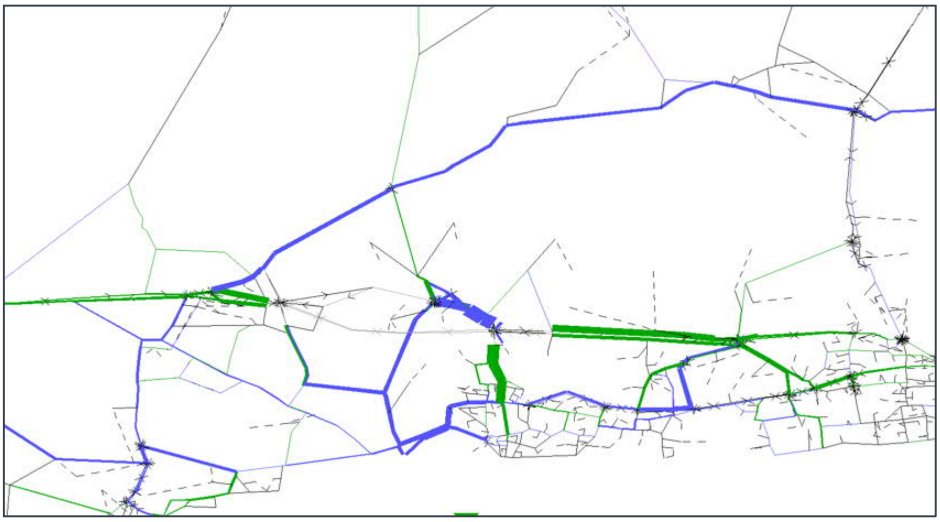


Figure 12-15: Do Something (4/5AV2) - Do Minimum – 2041 PM

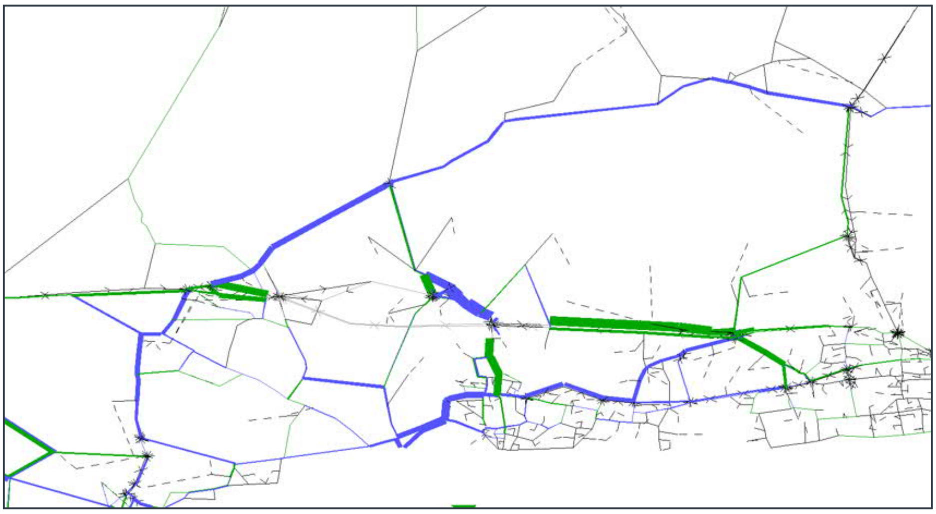


Figure 12-16: Do Something (5BV1) - Do Minimum – 2041 AM

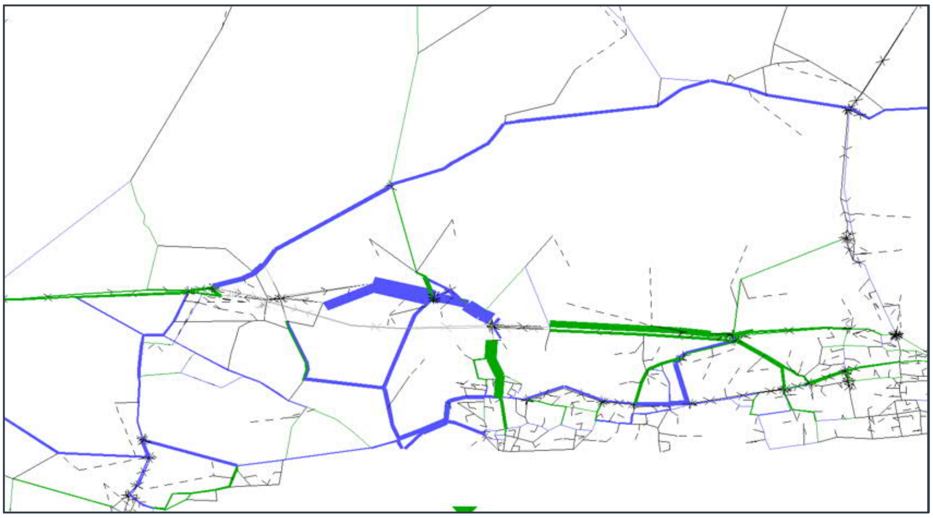
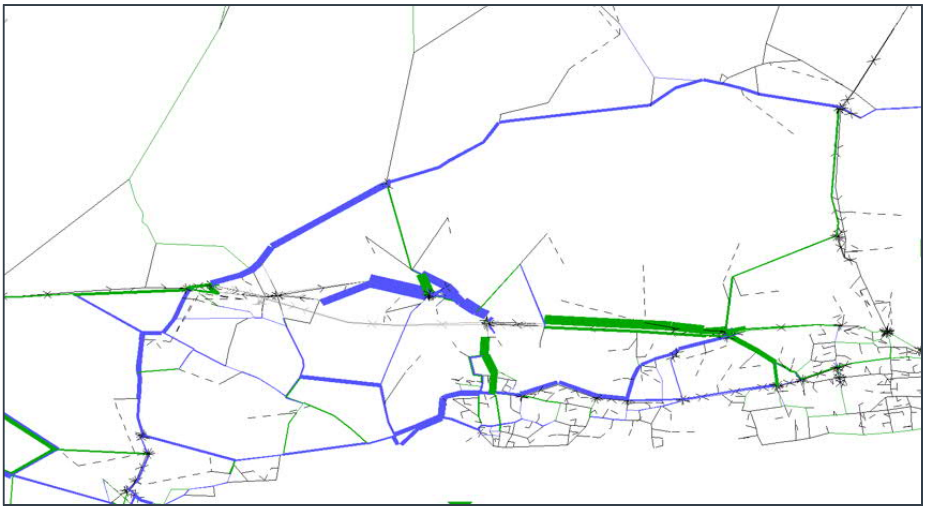


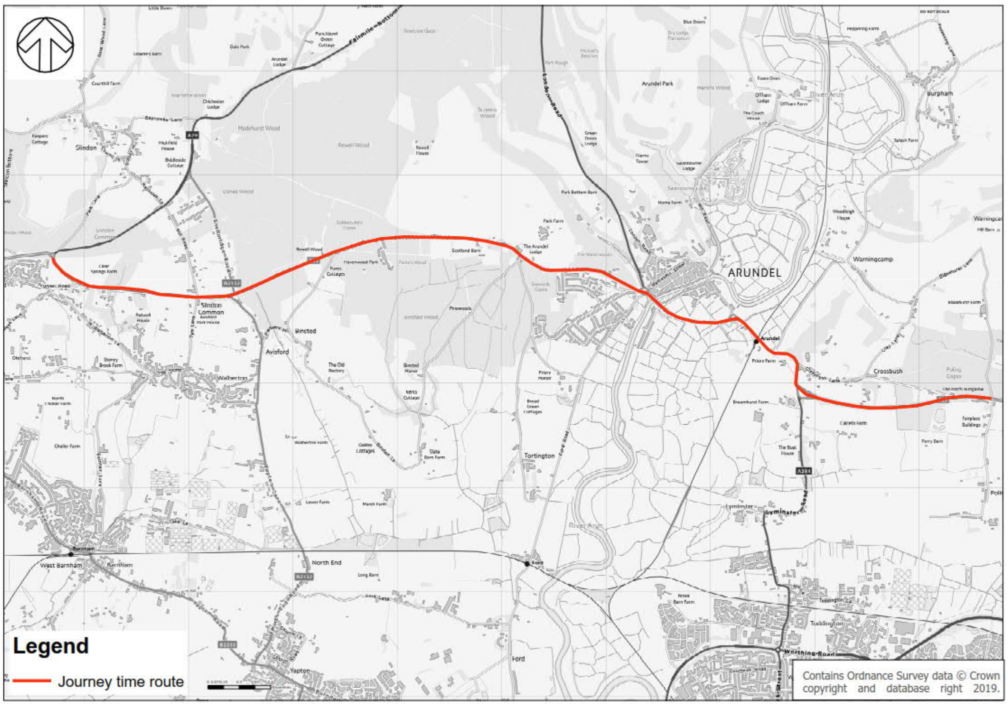
Figure 12-17: Do Something (5BV1) - Do Minimum – 2041 PM



Journey times

12.5.18 Journey time analysis has been undertaken on the A27 over the extent of the proposed junction improvements between the A27 / A29 junction and the A27 / Poling Street / Blakehurst Lane junction for the AM peak, Inter peak and PM peak modelled periods. Journey time information has been extracted from the forecast year PCF Stage 2 Further Consultation A27 transport model in the eastbound and westbound directions. The extent of the journey time route for comparison is illustrated for the Do Minimum scenario in Figure 12-18 and the results in Table 12-13.

Figure 12-18: Do Minimum journey time route



12.5.19 Table 12-12 shows the comparison of the 2015 modelled journey time and the 2026 / 2041 Do Minimum journey times in seconds for the A27 journey time route 1 presented on Figure 4-4. The journey times eastbound in the PM peak have not increased as the eastbound in the PM was already subject to significant congestion in the base year.

Table 12-12: Comparison of 2015, 2026 (DM) and 2041 (DM) journey times

	AM peak			Inter peak			PM peak		
A27 route	2015	2026	2041	2015	2026	2041	2015	2026	2041
Eastbound	1041	1141	1156	1024	1087	1178	1537	1486	1557
% change		10%	11%		6%	15%		-3%	1%
Westbound	1133	1238	1320	1060	1117	1142	1020	1102	1203
% change		9%	17%		5%	8%		8%	18%

12.5.20 Table 12-13 shows the journey time for the scheme extent for the 2026 and 2041 Do Minimum forecast years in seconds. The analysis demonstrates that there would be a decrease in journey time on the A27 between Crossbush and Fontwell, for all scheme options, between 29% and 67%.

Table 12-13: Journey time over scheme extent compared to Do Minimum

			Journey time							% change to DM					
Year	**Peak**	**Dir**	**DM**	**1 v5**	**1 v9**	**3 v1**	**5A v1**	**5A v2**	**5B v1**	**1 v5**	**1 v9**	**3 v1**	**5A v1**	**5A v2**	**5B v1**
2026	AM	EB	710	340	393	354	331	331	330	-52	-45	-50	-53	-53	-54
		WB	748	434	490	381	426	433	428	-42	-35	-49	-43	-42	-43
	IP	EB	701	338	390	353	329	329	327	-52	-44	-50	-53	-53	-53
		WB	702	393	465	366	386	390	386	-44	-34	-48	-45	-44	-45
	PM	EB	1007	553	528	477	438	439	337	-45	-48	-53	-56	-56	-67
		WB	677	403	479	369	396	400	396	-40	-29	-46	-42	-41	-42
2041	AM	EB	719	342	395	354	333	334	332	-52	-45	-51	-54	-54	-54
		WB	815	439	497	382	432	438	433	-46	-39	-53	-47	-46	-47
	IP	EB	786	339	392	354	331	331	329	-57	-50	-55	-58	-58	-58
		WB	708	399	474	366	392	396	393	-44	-33	-48	-45	-44	-45
	PM	EB	1,018	562	533	480	443	443	340	-45	-48	-53	-56	-56	-67
		WB	754	413	490	372	405	409	404	-45	-35	-51	-46	-46	-46

12.5.21 To illustrate the journey time and changes in journey time over the wider A27 corridor, Table 12-14 presents the forecast 2041 Am and PM peak journey times for the Do Minimum and Do Something options. The route is the A27 from the A27 / A285 (Portfield Roundabout) at Chichester to the west to the A27 / A283 Steyning Road junction on the Shoreham Bypass to the east.

Table 12-14: Journey time over wider A27 corridor – 2041 AM and PM

			Journey time							% change to DM					
Year	**Peak**	**Dir**	**DM**	**1 v5**	**1 v9**	**3 v1**	**5A v1**	**5A v2**	**5B v1**	**1 v5**	**1 v9**	**3 v1**	**5A v1**	**5A v2**	**5B v1**
2041	AM	EB	2346	2085	2253	2185	2173	2171	2173	-11	-4	-7	-7	-7	-7
		WB	2561	2386	2433	2467	2392	2399	2422	-7	-5	-4	-7	-6	-5
	PM	EB	2578	2276	2284	2201	2192	2172	2103	-12	-11	-15	-15	-16	-18
		WB	2591	2381	2481	2445	2406	2367	2408	-8	-4	-6	-7	-9	-7

12.5.22 Table 12-14 illustrates that for the wider corridor there would be a decrease in journey time on the A27 between Chichester and Shoreham by Sea, for all scheme options, of between 4% and 18%. The proportional change in journey time is not directly comparable to that shown in Table 12-13 due to the longer distance of the route.

12.5.23 Overall, the total saving in journey time is lower for the wider corridor than the section at Arundel. The journey time saving at Arundel for the route illustrated in Figure 12-18 is between 4 and 11 minutes in 2041 AM and PM peaks. For the wider route between Chichester and Shoreham Bypass, the saving is between 2 and 8 minutes. The lower level of journey time saving is due to the increase in traffic volumes on sections of the A27 which are located away from the A27 Arundel Bypass Scheme.

Network performance statistics

12.5.24 The network performance statistics for the Do Minimum and the Do Something scheme options are presented in Table 12-15. For all options, there is a combined overall reduction in total journey times over the AM, inter-peak and PM peak hours. Comparison of the average network speeds in 2041 indicates that there would be overall increase in average speeds between 0.2% and 5.1% across the scheme options in the AM, inter-peak and PM peak hours.

Table 12-15: Network performance statistics 2041

	Total travel time		Average speed					
	AM+IP+PM		AM	IP	PM	AM	IP	PM
Option	**2041**	**Change**	**2041**			**Change (%)**		
DM	42755		51.0	50.3	46.8	-	-	-
1V5	42470	-285	51.7	50.6	48.8	1.4	0.6	4.3
1V9	42436	-319	51.5	50.4	48.6	1.0	0.2	3.8
3V1	42308	-447	52.0	50.9	49.1	2.0	1.2	4.9
4/5AV1	42383	-372	51.7	50.5	49.0	1.4	0.4	4.7
4/5AV2	42318	-437	51.6	50.6	48.9	1.2	0.6	4.5
5BV1	42276	-479	51.7	50.6	49.2	1.4	0.6	5.1

12.6 Operational assessment

12.6.1 This section presents the results of the operational assessment of the Do Minimum and Do Something option scenarios. The assessment for the year 2041 scenario is presented for the key A27 junctions that are within the scope of the Scheme which comprise the A27 Ford Road roundabout and the A27 Crossbush junction.

12.6.2 Where the scope of the A27 Arundel Bypass Scheme includes new priority junctions at the western tie-in with the A27, operational assessment has been undertaken. The data presented is for Options 4/5AV1 and 4/5AV2.

12.6.3 Junction performance data is presented in Tables 12-16 to 12-31. The performance includes the RFC or DoS and MMQ from the operational modelling results.

12.6.4 For the Ford Road Roundabout, a previous limitation with the modelling results was reported in relation to how comparable the results of the strategic and operational modelling were (see section 1.5.5). This limitation related to the degree of detail within the forecast model coding at Ford Road Roundabout. The network coding has been updated within the forecast models for PCF Stage 2 Further Consultation modelling. The results of the strategic and operational modelling have been compared, confirming good consistency between the two scales of modelling in terms of maximum RFC's / V/C's.

A27 Ford Road Roundabout

Table 12-16: Ford Rd Roundabout performance – Do Minimum 2041

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
A	A284	0.74	2.7	0.51	1.0
B	Maltravers Street	0.41	0.7	0.73	2.6
C	A27 East (existing)	0.88	6.9	0.72	2.5
D	Ford Road	0.94	9.8	0.77	3.1
E	A27 West (Chichester Road)	0.99	20.0	1.04	41.0

Table 12-17: Ford Rd Roundabout performance – Option 1V5

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
A	A284	0.55	1.2	0.88	6.8
B	Maltravers Street	0.00	0.0	0.00	0.0
C	Existing A27 (East)	0.51	1.0	0.57	1.3
D	Ford Road	0.61	1.6	0.55	1.2

Table 12-18: Ford Rd through-about performance – Option 1V9

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		DoS (%)	MMQ	DoS (%)	MMQ
A284 SB	1/1+1/2	49	1	60	2
Maltravers Street	2/1	11	0	23	0
SB Circulatory A27 Crossing	3/1+3/2	59	3	84	9
A27 EB Internal Stopline	4/1+4/2+4/3	64	1	90	5
A27 WB External Left Turn	5/1+5/2	45	3	56	4
A27 WB External Ahead	5/3+5/4+5/5	63	5	73	6
Ford Road NB	7/1	62	2	62	2
NB Circulatory A27 Crossing	8/1+8/2+8/3	77	6	75	5
A27 WB Internal Stopline	9/1+9/2+9/3	63	2	50	1
A27 EB External Left Turn	10/1	72	6	76	7
A27 EB External Ahead	10/2+10/3+10/4	80	7	73	7
A27 EB Exit (Existing Bridge ped)	19/1+19/2	44	3	40	3

Table 12-19: Ford Rd Roundabout performance – Option 3V1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
A	A284	0.61	1.5	0.72	2.6
B	Maltravers Street	0.00	0.0	0.00	0.0
C	A27 East (Arundel Bypass)	0.52	1.1	0.62	1.6
D	Ford Road	0.61	1.6	0.58	1.4
E	A27 West (Chichester Road)	0.25	0.3	0.47	0.9

Table 12-20: Ford Rd Roundabout performance – Option 4/5AV1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
A	A284	0.58	1.4	0.71	2.4
B	Maltravers Street	0.00	0.0	0.00	0.0
C	A27 East (Arundel Bypass)	0.50	1.0	0.63	1.7
D	Ford Road	0.38	0.6	0.59	1.5
E	A27 West (Chichester Road)	0.24	0.3	0.39	0.6

Table 12-21: Ford Rd Roundabout performance – Option 4/5AV2

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
A	A284	0.60	1.5	0.74	2.8
B	Maltravers Street	0.00	0.0	0.00	0.0
C	A27 East (Arundel Bypass)	0.51	1.0	0.63	1.7
D	Ford Road	0.64	1.8	0.61	1.5
E	A27 West (Chichester Road)	0.23	0.3	0.40	0.7

Table 12-22: Ford Rd Roundabout performance – Option 5BV1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
A	A284	0.60	1.5	0.75	2.9
B	Maltravers Street	0.00	0.0	0.00	0.0
C	A27 East (Arundel Bypass)	0.51	1.1	0.66	1.9
D	Ford Road	0.43	0.7	0.65	1.8
E	A27 West (Chichester Road)	0.18	0.2	0.33	0.5

12.6.5 The junction performance data illustrates the significant operational issues at the Ford Road roundabout in the Do Minimum scenario, with multiple arms of the junction operating in excess of an RFC of 0.85 in both peak periods.

12.6.6 The performance data for options 3V1, 4/5AV1, 4/5AV2 and 5BV1 shows that all arms of the junction would operate within an RFC of 0.85, which reflects the significant reduction in traffic volume passing through this junction with these options.

12.6.7 Option 1V5 operates within capacity with the exception of the A284 in the PM peak, however it is considered that further minor design revisions to the junction would result in the junction operating within capacity.

12.6.8 Option 1V9, the signalised through-about arrangement, shows the junction operating close to or at capacity, with the A27 eastbound reaching capacity during the PM peak. Under average peak hour conditions, the junction operates with 12.1% and 0.4% PRC in the AM and PM peaks respectively.

12.6.9 Option 1V9 has been subject to an iterative process of design development to optimise junction capacity. It is considered that further design revisions that maintain this form of junction and footprint of junction would offer limited performance improvements only.

A27 Crossbush Junction

Table 12-23: Crossbush Junction performance – Do Minimum

Junction Arm		AM Peak (2041)		PM Peak (2041)	
Arm / Movement	Lane(s)	DoS (%)	MMQ (PCUs)	DoS (%)	MMQ (PCUs)
A27 Westbound Left Turn	1/1	25	4	91	31
A27 Westbound Ahead	1/2	121	171	106	75
A27 WB Circulatory	2/1	89	16	52	8
A284 Northbound	3/1+3/2	119	62	106	39
A284 N/B Circulatory Right Turn	4/1	79	2	78	2
N/B Circulatory Give-way Right	5/1	41	4	41	4

Table 12-24: Crossbush Junction performance – 1V5

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
North Rbt	The Causeway	0.60	2	0.68	2
	Overbridge northbound	0.57	1	0.59	1
	A27 eastbound off-slip	0.78	3	0.44	1
South Rbt	Overbridge southbound	0.47	1	0.35	1
	A27 westbound off-slip	0.23	0	0.50	1
	A284 Lyminster Road	0.65	2	0.69	2

Table 12-25: Crossbush Junction performance – 1V9

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
North Rbt	The Causeway	0.58	1	0.66	2
	Overbridge northbound	0.31	0	0.30	0
	A27 eastbound off-slip	0.30	0	0.21	0
South Rbt	Overbridge southbound	0.42	1	0.36	1
	A27 westbound off-slip	0.10	0	0.28	0
	A284 Lyminster Road	0.61	2	0.60	2

Table 12-26: Crossbush Junction performance – 3V1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
North Rbt	The Causeway	0.59	1	0.65	2
	Overbridge northbound	0.63	2	0.61	2
	A27 eastbound off-slip	0.54	1	0.43	1
South Rbt	Overbridge southbound	0.43	1	0.32	1
	A27 westbound off-slip	0.29	0	0.56	1
	A284 Lyminster Road	0.67	2	0.66	2

Table 12-27: Crossbush Junction performance – 4/5AV1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
North Rbt	The Causeway	0.52	1	0.62	2
	Overbridge northbound	0.58	1	0.56	1
	A27 eastbound off-slip	0.50	1	0.50	1
South Rbt	Overbridge southbound	0.43	1	0.34	1
	A27 westbound off-slip	0.22	0	0.50	1
	A284 Lyminster Road	0.63	2	0.65	2

Table 12-28: Crossbush Junction performance – 4/5AV2

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
North Rbt	The Causeway	0.54	1	0.64	2
	Overbridge northbound	0.58	1	0.60	2
	A27 eastbound off-slip	0.55	1	0.53	1
South Rbt	Overbridge southbound	0.43	1	0.35	1
	A27 westbound off-slip	0.22	0	0.50	1
	A284 Lyminster Road	0.63	2	0.68	2

Table 12-29: Crossbush Junction performance – 5BV1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
North Rbt	The Causeway	0.54	1	0.64	2
	Overbridge northbound	0.59	1	0.60	2
	A27 eastbound off-slip	0.57	1	0.68	2
South Rbt	Overbridge southbound	0.43	1	0.35	1
	A27 westbound off-slip	0.22	0	0.51	1
	A284 Lyminster Road	0.64	2	0.67	2

12.6.10 The junction performance data illustrates the significant operational issues at the Crossbush junction in the Do Minimum scenario, with multiple arms of the junction operating in excess of a DoS of 0.90 in both peak periods, and queues in excess of 150 vehicles on the A27 westbound.

12.6.11 The performance data for all scheme options shows that all arms of the junction would operate within an RFC of 0.85. This performance data reflects some minor geometry revisions to achieve these RFCs. The layout of the junction would be subject to further design development, depending upon which option is selected.

A27 Arundel Bypass - Western Tie-In Junction

Table 12-30: Western Tie-In Junction performance – Option 4/5AV1

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
1A-1C	Existing A27 (from Arundel) at Shellbridge Road	0.23	0.3	0.42	0.7
1B	Shellbridge Road Southbound at existing A27	0.20	0.2	0.65	1.8
2A-2C	Shellbridge Road Southbound at new overbridge	0.00	0.0	0.10	0.1
2B	A27 Arundel Bypass Overbridge at Shellbridge Road	0.46	0.8	0.33	0.5
3A-3C	A27 Arundel Bypass Overbridge at Yapton Lane	0.06	0.1	0.42	0.9
3B	Yapton Lane Northbound	0.44	0.8	0..25	0.3

Table 12-31: Western Tie-In Junction performance – Option 4/5AV2

Junction Arm		AM Peak (2041)		PM Peak (2041)	
		RFC	Queue (Veh)	RFC	Queue (Veh)
1B	A27 Arundel Bypass Eastbound Offslip	0.37	0.6	0.82	4.1
2A-2C	Binsted Lane junction with Westbound Onslip	0.00	0.0	0.00	0.0

12.6.12 The junction performance data for the scheme options shows that all movements would operate within an RFC of 0.85. Performance improvements would be possible to reduce the RFCs and the layout of the junction would be subject to further design development, depending upon which option is selected.

Operational sensitivity tests

12.6.13 Additional operational assessments were carried out as a sensitivity test to reflect the difference between average peak period and highest peak hour flows. An uplift factor of 11.5% was applied to the 2041 forecast traffic demand based on the data presented in Table 6-4. The results of the additional operational assessments are presented within Appendix D-4.

12.6.14 The results from the sensitivity tests indicate that the Ford Road Roundabout would operate slightly over capacity for Option 4/5Av2 and 5Bv1 with an RFC of 0.86. Capacity constraints are limited to individual arms and it is considered that this could be mitigated through design modifications in future stages of scheme development.

12.6.15 For Option 1v9, the Ford Road Roundabout junction would operate at -11.6% PRC in the PM Peak. It is considered that this would be challenging to mitigate through further design development without significant impact upon adjacent land use.

12.6.16 At the Crossbush Junction, the eastbound offslip would operate slightly over capacity with an RFC of 0.88 for Option 5Bv1, however it is considered this could be mitigated through design modifications in a future stage of scheme development.

12.6.17 At the western tie-in the increase in traffic has no notable effect on the overall performance of the junction.

12.7 Sensitivity tests – traffic growth – low traffic growth

12.7.1 A sensitivity test was carried out to consider the changes in forecast traffic volumes and journey times in a scenario with low growth. This section summarises the forecasting results and compares these to the results of the core scenario.

DIADEM convergence – low growth scenario

12.7.2 The DIADEM convergence data is presented in Table 12-32. The majority of model scenarios converge within a reasonable number of iterations with the convergence achieved exceeded that required by TAG guidance. The process described in section 12.2.13 was followed where scenarios did not converge within stated criteria. The final convergences achieved when the iterations were completed are presented below.

Table 12-32: DIADEM convergence

Peak	Year	% GAP						
		DM	1v5	1v9	3v1	4/5Av1	4/5Av2	5Bv1
AM peak	2026	0.08	0.09	0.06	0.09	0.08	0.08	0.09
Inter peak		0.07	0.08	0.07	0.08	0.09	0.09	0.10
PM peak		0.10	0.10	0.10	0.10	0.09	0.09	0.09
AM peak	2041	0.07	0.12	0.07	0.09	0.10	0.09	0.09
Inter peak		0.06	0.08	0.09	0.07	0.07	0.08	0.08
PM peak		0.09	0.06	0.09	0.09	0.09	0.08	0.09
AM peak	2051	0.10	0.08	0.08	0.10	0.09	0.10	0.10
Inter peak		0.08	0.09	0.09	0.08	0.09	0.09	0.10
PM peak		0.09	0.08	0.09	0.10	0.09	0.09	0.10

Forecast matrices – low growth scenario

12.7.3 The trip matrix totals produced through the FDM and VDM processes for the A27 Arundel Bypass scheme options in a low growth scenario are summarised in Table 12-33.

Table 12-33: Core fixed demand scenario – trip matrix totals

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Fixed Demand Model								
All	43673	42370	49068	47485	46269	52756	49225	47892	54993
	Variable Demand Model								
DM	43744	42472	49157	47600	46413	52888	49333	48027	55110
1v5	43754	42486	49127	47612	46424	52901	49345	48033	55123
1v9	43754	42484	49170	47612	46422	52900	49345	48032	55123
3v1	43756	42487	49175	47613	46425	52904	49347	48034	55126
4/5Av1	43755	42487	49174	47613	46425	52905	49346	48034	55084
4/5Av2	43755	42486	49173	47613	46424	52904	49345	48033	55088
5Bv1	43755	42486	49177	47613	46424	52907	49345	48033	55130
	Difference								
DM	72	102	88	115	144	132	108	135	118
1v5	82	116	59	126	155	146	120	141	131
1v9	82	113	101	127	153	145	120	140	131
3v1	83	116	107	128	156	149	122	143	133
4/5Av1	83	116	106	128	156	149	121	143	91
4/5Av2	82	116	105	127	155	148	120	142	95
5Bv1	82	116	108	128	155	152	121	142	137
	% Difference								
DM	0.16	0.24	0.18	0.24	0.31	0.25	0.22	0.28	0.21
1v5	0.19	0.27	0.12	0.27	0.34	0.28	0.24	0.30	0.24
1v9	0.19	0.27	0.21	0.27	0.33	0.27	0.24	0.29	0.24
3v1	0.19	0.27	0.22	0.27	0.34	0.28	0.25	0.30	0.24
4/5Av1	0.19	0.27	0.22	0.27	0.34	0.28	0.25	0.30	0.17
4/5Av2	0.19	0.27	0.21	0.27	0.34	0.28	0.24	0.30	0.17
5Bv1	0.19	0.27	0.22	0.27	0.34	0.29	0.25	0.30	0.25

12.7.4 A summary of the convergence statistics for the Do Minimum as well as the Do Something scheme options, for the core FDM and VDM scenarios, based on the final iteration, is set out in Table 12-34 and Table 12-35.

12.7.5 Table 12-34 indicates that, based on the final iteration, all delta values are less than 0.1%, confirming that the core scenario fixed demand meet the required convergence standards.

Table 12-34: Core fixed demand scenario – convergence criteria

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Final iteration								
DM	42	24	29	82	39	79	65	56	53
1v5	37	30	20	61	61	58	88	84	45
1v9	34	32	21	55	385	72	41	63	59
3v1	43	27	31	44	56	46	67	93	55
4/5Av	41	33	22	56	43	65	50	82	57
4/5Av	37	31	25	63	73	71	54	78	53
5Bv1	35	28	24	49	50	51	40	90	46
	Final Delta (δ)								
DM	0.007	0.014	0.021	0.011	0.023	0.012	0.023	0.020	0.032
1v5	0.010	0.012	0.031	0.012	0.010	0.021	0.012	0.010	0.040
1v9	0.022	0.008	0.029	0.013	0.009	0.020	0.040	0.018	0.057
3v1	0.012	0.012	0.016	0.018	0.006	0.034	0.018	0.006	0.060
4/5Av	0.009	0.006	0.043	0.013	0.018	0.041	0.036	0.007	0.027
4/5Av	0.008	0.006	0.019	0.017	0.011	0.017	0.036	0.01	0.069
5Bv1	0.011	0.007	0.017	0.018	0.014	0.019	0.036	0.008	0.052
	Final %Flow								
DM	98.1	98.8	99	99.5	98.4	99.5	98.4	99.1	99
1v5	99	99	99	99.3	99.6	99.3	99.6	99.7	99.2
1v9	99	98.8	98.5	99.4	99.7	99.5	99.1	98.3	99.4

3v1	99	98.4	99.3	99.7	99.7	99.1	99.4	99.8	99
4/5Av	98.5	98.4	98.7	99.7	98.5	99.3	99.4	99.8	99.3
4/5Av	98.3	98.6	99.1	99.7	99.8	99.5	99.2	99.7	99.4
5Bv1	98.4	99.1	99.3	99.6	99.3	99.2	98.9	99.9	99
	Final %Gap								
DM	0.039	0.012	0.023	0.023	0.024	0.015	0.023	0.048	0.037
1v5	0.015	0.012	0.029	0.045	0.031	0.021	0.049	0.049	0.05
1v9	0.026	0.012	0.028	0.046	0.006	0.048	0.031	0.026	0.02
3v1	0.037	0.014	0.018	0.024	0.028	0.021	0.045	0.032	0.023
4/5Av	0.01	0.009	0.026	0.043	0.049	0.015	0.031	0.037	0.019
4/5Av	0.039	0.009	0.018	0.036	0.047	0.019	0.031	0.045	0.028
5Bv1	0.009	0.014	0.021	0.019	0.045	0.016	0.046	0.047	0.04

12.7.6 Table 12-35 indicates the level of convergence achieved for all the VDMs. As the results indicate, all delta values are less than 0.1%.

Table 12-35: Core variable demand scenario – convergence criteria

	2026			**2041**			**2051**		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
	Final iteration								
DM	47	31	27	68	40	91	77	46	63
1v5	45	36	21	74	51	71	74	59	72
1v9	40	35	22	40	55	47	104	62	63
3v1	51	36	31	53	48	75	65	58	63
4/5Av1	36	25	25	52	46	73	48	35	77
4/5Av2	63	33	38	46	49	72	54	44	61
5Bv1	43	55	32	62	50	53	57	73	65
	Final Delta (δ)								
DM	0.009	0.007	0.018	0.017	0.015	0.041	0.029	0.016	0.043
1v5	0.008	0.003	0.028	0.014	0.010	0.031	0.018	0.017	0.066

1v9	0.018	0.004	0.025	0.024	0.011	0.070	0.062	0.015	0.025
3v1	0.007	0.003	0.026	0.021	0.013	0.022	0.018	0.014	0.046
4/5Av	0.024	0.007	0.019	0.029	0.012	0.027	0.043	0.023	0.020
4/5Av	0.046	0.005	0.016	0.019	0.011	0.027	0.046	0.016	0.046
5Bv1	0.018	0.003	0.014	0.024	0.010	0.048	0.019	0.014	0.033
	Final %Flow								
DM	98.9	99.4	99.2	98.7	98.4	99	98.8	99.4	98.8
1v5	98.8	99	99	99.6	98.9	99.1	99.3	99.2	98.8
1v9	98.6	99.1	98.9	99	98.7	99.1	98.8	98.1	99
3v1	99.1	98.4	99.2	99.2	99.2	99.2	99.1	99.5	99.2
4/5Av	99	98.6	99.6	98.9	98.6	98.7	99.3	98.7	98.8
4/5Av	99.2	99.4	99.4	99.2	99.3	99.1	99.1	98.3	98.4
5Bv1	99.2	98.4	99	99.3	98.6	98.2	99.3	99.4	98.4
	Final %Gap								
DM	0.008	0.01	0.03	0.02	0.031	0.021	0.028	0.019	0.027
1v5	0.044	0.006	0.022	0.015	0.016	0.033	0.02	0.045	0.037
1v9	0.045	0.016	0.031	0.032	0.042	0.035	0.012	0.025	0.047
3v1	0.041	0.006	0.042	0.042	0.037	0.03	0.02	0.028	0.032
4/5Av	0.019	0.009	0.025	0.024	0.019	0.046	0.047	0.031	0.018
4/5Av	0.032	0.011	0.036	0.031	0.035	0.042	0.019	0.033	0.031
5Bv1	0.042	0.008	0.049	0.043	0.008	0.05	0.028	0.03	0.036

12.7.7 Table 12-36 to Table 12-38 present a comparison of the change in flows on the existing alignment of the A27, for all the 2041 Do Something options, and 2041 Do Minimum low growth scenarios. Only 2041 data is included, as the trends in the 2026 data are similar to those presented below.

12.7.8 The analysis demonstrates a similar effect to that illustrated by the results for the core scenario.

Table 12-36: Flows on the A27 – 2041 AM (Low Growth)

		2041 IP actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1201	1837	1808	1830	1819	1849	158	53	51	52	51	54	-87
	WB	1148	1647	1592	1675	1652	1738	96	43	39	46	44	51	-92
A27 Binsted Ln to Ford Rdbt	EB	1020	1796	1764	167	177	156	131	76	73	-84	-83	-85	-87
	WB	1147	1721	1650	98	98	102	121	50	44	-91	-91	-91	-89
A27 Ford Rdbt to Causeway Rdbt	EB	1367	700	688	766	715	738	707	-49	-50	-44	-48	-46	-48
	WB	1116	692	42	684	660	659	667	-38	-96	-39	-41	-41	-40
A27 Cause-way Rdbt to Crossbush Ln	EB	1489	852	813	810	758	785	781	-43	-45	-46	-49	-47	-48
	WB	1555	848	148	744	716	720	753	-45	-90	-52	-54	-54	-52
A27 Cross-bush Ln to Crossbush Jct	EB	1462	873	821	817	767	796	792	-40	-44	-44	-48	-46	-46
	WB	1562	878	165	760	733	740	773	-44	-89	-51	-53	-53	-50

Table 12-37: Flows on the A27 – 2041 IP (Low Growth)

		2041 IP actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1203	1667	1667	1646	1655	1682	125	39	39	37	38	40	-90
	WB	1019	1575	1520	1568	1539	1652	145	31	26	30	28	37	-88
A27 Binsted Ln to Ford Rdbt	EB	958	1621	1615	87	82	81	80	35	34	-93	-93	-93	-93
	WB	980	1601	1503	102	138	152	158	33	25	-92	-89	-87	-87
A27 Ford Rdbt to Causeway Rdbt	EB	1302	599	537	573	569	575	565	-50	-55	-52	-53	-52	-53
	WB	1241	634	36	627	622	620	623	-47	-97	-48	-48	-48	-48
	EB	1369	724	634	625	619	625	616	-40	-47	-48	-49	-48	-49

		2041 IP actual flow							% change to DM					
A27 Cause-way Rdbt to Crossbush	WB	1367	750	126	672	663	660	664	-38	-90	-44	-45	-45	-45
A27 Cross-bush Ln to Crossbush Jct	EB	1356	748	652	648	644	648	638	-38	-46	-46	-46	-46	-47
	WB	1375	775	145	695	689	685	687	-36	-88	-42	-43	-43	-43

Table 12-38: Flows on the A27 – 2041 PM (Low Growth)

		2041 PM actual flow							% change to DM					
Link	**Dir**	**DM**	**1 v5**	**1 v9**	**3 v1**	**5A v1**	**5A v2**	**5B v1**	**1 v5**	**1 v9**	**3 v1**	**5A v1**	**5A v2**	**5B v1**
A27 Mill Rd to Shellbridge Rd	EB	1399	1905	2296	2345	2225	2368	470	36	64	68	59	69	-66
	WB	1214	1749	1659	1816	1743	1743	188	44	37	50	44	44	-85
A27 Binsted Ln to Ford Rdbt	EB	1133	1772	2169	405	351	359	292	56	91	-64	-69	-68	-74
	WB	1136	1763	1642	162	160	173	215	55	45	-86	-86	-85	-81
A27 Ford Rdbt to Causeway Rdbt	EB	946	713	754	694	663	665	659	-25	-20	-27	-30	-30	-30
	WB	706	606	26	708	703	705	777	-14	-96	0	0	0	10
A27 Cause-way Rdbt to Crossbush Ln	EB	1588	966	968	884	869	869	863	-39	-39	-44	-45	-45	-46
	WB	1439	703	98	694	717	718	796	-51	-93	-52	-50	-50	-45
A27 Cross-bush Ln to Crossbush Jct	EB	1528	1036	987	937	926	924	918	-32	-35	-39	-39	-40	-40
	WB	1432	763	105	743	770	768	852	-47	-93	-48	-46	-46	-40

Summary

12.7.9 In summary, the results of the sensitivity test which includes a low growth scenario has illustrated broadly similar forecasting results to the core scenario. When the results of the core and sensitivity scenarios are compared this shows:

- a similar effect on traffic volumes for each Do Something scheme option, with forecast A27 traffic volumes typically varying by less than 15%

12.8 Sensitivity tests – traffic growth – optimistic traffic growth

12.8.1 The results of the alternative scenarios for optimistic traffic growth are not presented. During the forecasting process, it has been established that the majority of the 2041 and 2051 scenarios are failing to reach convergence criteria. This is due to the increased level of traffic volume present within the matrices. For example, the AM, inter-peak and PM scenarios for the 2041 Do Minimum all fail to converge. Due to the broad level of non-convergence, and the associated lower level of confidence in the forecasting and any associated economic outputs, these scenarios are not included within this report.

12.9 Sensitivity tests – infrastructure – without A27 Worthing and Lancing

12.9.1 This section includes the results for the sensitivity test related to A27 Worthing and Lancing. The results for the infrastructure sensitivity test for Lyminster Bypass are presented in section 12.10.

12.9.2 A sensitivity test was carried out to consider the changes in forecast traffic volumes and journey times in an A27 Arundel Bypass scenario without the A27 Worthing and Lancing. This section summarises the forecasting results and compares these to the results of the scenario with the A27 Worthing and Lancing included.

DIADEM convergence – without A27 Worthing and Lancing

12.9.3 The DIADEM convergence data is presented in Table 12-39. The majority of model scenarios converge within a reasonable number of iterations with the convergence achieved exceeded that required by TAG guidance. The process described in section 12.2.13 was followed where scenarios did not converge within stated criteria. The final convergences achieved when the iterations were completed are presented below.

Table 12-39: DIADEM convergence (no A27 Worthing and Lancing (WL))

Peak	Year	% GAP						
		DM	1V5	1V9	3V1	4/5A V1	4/5A V2	5BV1
AM peak	2026	0.10	0.10	0.11	0.13	0.10	0.10	0.09
Inter peak		0.10	0.10	0.10	0.09	0.08	0.09	0.08
PM peak		0.10	0.09	0.09	0.08	0.09	0.10	0.08
AM peak	2041	0.20	0.09	0.07	0.08	0.09	0.09	0.08
Inter peak		0.07	0.09	0.09	0.08	0.10	0.09	0.10
PM peak		0.08	0.28	0.28	0.27	0.26	0.26	0.25
AM peak	2051	0.10	0.14	0.14	0.17	0.11	0.10	0.15
Inter peak		0.09	0.08	0.10	0.07	0.08	0.08	0.08
PM peak		0.08	0.08	0.09	0.10	0.09	0.09	0.09

Forecast matrices – without A27 Worthing and Lancing

12.9.4 The trip matrix totals produced through the FDM and VDM processes for the A27 Arundel Bypass scheme options without A27 Worthing and Lancing are summarised in Table 12-40.

Table 12-40: Core fixed demand scenario – trip matrix totals

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Fixed Demand Model								
All	47191	45762	53071	52894	51483	58908	55589	54027	62233
	Variable Demand Model								
DM	47246	45851	53129	52965	51588	58967	55635	54115	62257
1V5	47253	45862	53144	52980	51589	58983	55651	54120	62277
1V9	47254	45860	53143	52980	51586	58984	55653	54117	62278
3V1	47256	45886	53147	52981	51591	58987	55651	54120	62279
4/5AV1	47254	45863	53146	52982	51590	58990	55653	54121	62280
4/5AV2	47254	45862	53145	52980	51589	58988	55651	54120	62278
5BV1	47254	45862	53149	52982	51589	58991	55652	54119	62280
	Difference								
DM	55	89	59	71	105	67	46	88	25
1V5	63	100	73	86	106	82	62	92	44
1V9	63	98	72	86	103	84	64	89	45
3V1	65	124	76	87	107	87	63	93	46
4/5AV1	64	101	76	88	106	89	64	93	47
4/5AV2	63	100	75	86	105	88	62	92	45
5BV1	64	100	78	88	106	91	63	91	48
	% Difference								
DM	0.12%	0.19%	0.11%	0.13%	0.20%	0.11%	0.08%	0.16%	0.04%
1V5	0.13%	0.22%	0.14%	0.16%	0.21%	0.14%	0.11%	0.17%	0.07%
1V9	0.13%	0.21%	0.14%	0.16%	0.20%	0.14%	0.12%	0.17%	0.07%
3V1	0.14%	0.27%	0.14%	0.16%	0.21%	0.15%	0.11%	0.17%	0.07%
4/5AV1	0.14%	0.22%	0.14%	0.17%	0.21%	0.15%	0.11%	0.17%	0.08%
4/5AV2	0.13%	0.22%	0.14%	0.16%	0.20%	0.15%	0.11%	0.17%	0.07%
5BV1	0.13%	0.22%	0.15%	0.17%	0.21%	0.15%	0.11%	0.17%	0.08%

12.9.5 A summary of the convergence statistics for the Do Minimum as well as the Do Something scheme options, for the core FDM and VDM scenarios, based on the final iteration, is set out in Table 12-41 and Table 12-42.

12.9.6 Table 12-41 indicates that, based on the final iteration, all delta values are less than 0.1%, confirming that the core scenario fixed demand meet the required convergence standards.

Table 12-41: Core fixed demand scenario – convergence criteria

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Final iteration								
DM	227	42	53	62	55	78	89	48	117
1V5	41	36	90	41	44	75	58	74	115
1V9	63	40	92	48	44	93	60	52	86
3V1	61	38	85	34	34	68	60	46	109
4/5AV1	43	36	73	66	44	78	106	47	94
4/5AV2	70	33	70	45	39	75	58	50	106
5BV1	90	33	85	53	41	73	59	71	83
	Final Delta (δ)								
DM	0.0330	0.0133	0.0497	0.0189	0.0153	0.0421	0.0392	0.0391	0.0290
1V5	0.0586	0.0165	0.0205	0.0370	0.0266	0.0276	0.0387	0.0345	0.0274
1V9	0.0547	0.0126	0.0257	0.0204	0.0204	0.0223	0.0348	0.0224	0.0423
3V1	0.0535	0.0107	0.0606	0.0679	0.0330	0.0641	0.0275	0.0253	0.0242
4/5AV1	0.0281	0.0174	0.0206	0.0347	0.0286	0.0309	0.0342	0.0264	0.0305
4/5AV2	0.0585	0.0262	0.0206	0.0521	0.0326	0.0277	0.0512	0.0249	0.0342
5BV1	0.0495	0.0119	0.0198	0.0307	0.0338	0.0309	0.0272	0.0243	0.0356
	Final %Flow								
DM	98.9	98.6	99.2	98.7	99.5	98.7	99.0	98.9	99.6
1V5	98.8	98.6	99.2	99.4	99.2	99.2	99.5	98.7	99.5
1V9	98.6	99.1	99.1	99.2	98.7	99.2	99.3	98.5	99.5
3V1	98.9	98.8	99.0	98.9	99.2	98.9	99.1	98.8	99.6

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
4/5AV1	98.4	98.6	98.7	99.1	98.9	99.3	99.6	98.6	99.5
4/5AV2	98.7	98.8	99.3	98.9	99.1	99.3	99.0	98.7	99.6
5BV1	98.4	99.1	99.2	98.9	98.6	98.8	99.4	99.1	99.1
	Final %Gap								
DM	0.030	0.040	0.037	0.036	0.032	0.038	0.034	0.041	0.042
1V5	0.028	0.034	0.023	0.038	0.049	0.048	0.025	0.033	0.031
1V9	0.033	0.020	0.021	0.032	0.032	0.043	0.027	0.034	0.045
3V1	0.044	0.016	0.032	0.047	0.040	0.048	0.040	0.045	0.050
4/5AV1	0.037	0.036	0.029	0.034	0.035	0.044	0.031	0.04	0.041
4/5AV2	0.025	0.035	0.029	0.036	0.033	0.043	0.045	0.04	0.031
5BV1	0.027	0.020	0.047	0.049	0.044	0.050	0.025	0.03	0.043

12.9.7 Table 12-42 indicates the level of convergence achieved for all the VDMs. As the results indicate, all delta values with the exception of one value are less than 0.1%.

Table 12-42: Core variable demand scenario – convergence criteria

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Final iteration								
DM	63	56	41	51	92	48	45	174	74
1V5	56	70	36	400	106	43	400	190	46
1V9	60	77	39	400	125	38	400	126	51
3V1	41	64	45	400	109	43	400	247	45
4/5AV1	62	75	51	400	97	38	400	162	45
4/5AV2	30	101	47	327	93	37	400	151	48
5BV1	37	79	61	146	85	38	400	91	41
	Final Delta (δ)								
DM	0.0097	0.009	0.0193	0.0228	0.0378	0.0278	0.0275	0.015	0.03

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
1V5	0.0132	0.0102	0.0349	0.0411	0.143	0.0689	0.0424	0.0122	0.0336
1V9	0.0092	0.009	0.031	0.03	0.0156	0.0406	0.0391	0.0174	0.0285
3V1	0.0129	0.0074	0.0209	0.0456	0.0195	0.0553	0.085	0.0116	0.0478
4/5AV1	0.015	0.0098	0.0154	0.0516	0.0161	0.0511	0.0736	0.0136	0.0603
4/5AV2	0.0394	0.0067	0.021	0.0284	0.0194	0.0396	0.0742	0.0185	0.0605
5BV1	0.0266	0.0153	0.0354	0.034	0.0212	0.0451	0.0584	0.013	0.0298
	Final %Flow								
DM	98.2	98.1	98.6	98.7	99.1	98.3	99.0	99.3	99.7
1V5	99.0	98.5	98.0	98.1	99.1	98.9	98.8	99.1	98.8
1V9	99.0	98.6	98.5	98.4	99.3	98.7	98.1	98.8	98.8
3V1	99.2	99.1	99.1	95.2	98.4	99.1	94.6	99.4	98.9
4/5AV1	99.2	99.2	99.0	95.8	98.9	98.5	98.7	99.6	98.9
4/5AV2	99.1	98.9	99.0	99.0	98.7	98.4	94.8	99.1	99.0
5BV1	98.8	99.3	98.4	99.2	99.2	98.6	98.8	99.3	98.8
	Final %Gap								
DM	0.028	0.0093	0.026	0.021	0.04	0.047	0.038	0.049	0.032
1V5	0.045	0.048	0.025	0.036	0.048	0.024	0.104	0.021	0.036
1V9	0.048	0.05	0.034	0.3073	0.038	0.036	0.219	0.022	0.038
3V1	0.022	0.0072	0.048	0.116	0.032	0.033	0.152	0.039	0.035
4/5AV1	0.041	0.045	0.032	0.061	0.043	0.035	0.082	0.045	0.041
4/5AV2	0.028	0.046	0.021	0.046	0.02	0.049	0.166	0.04	0.031
5BV1	0.019	0.012	0.016	0.041	0.041	0.029	0.061	0.041	0.034

Traffic flows – without A27 Worthing and Lancing

12.9.8 Traffic flows on key links, along the A27, within the study area for the Do Minimum and the Do Something scheme without A27 Worthing and Lancing options have been extracted and presented in the following sections.

12.9.9 The year 2041 forecast scenario has generally been used to illustrate any differences in the forecast results.

12.9.10 Figure 12-19 and Figure 12-20 demonstrate the change in flows on the modelled network between 2015 and 2026. The green bands indicate an increase in traffic whereas the blue bands indicate a decrease. The general effect of the traffic growth and infrastructure changes without the A27 Worthing and Lancing is comparable to that summarised in section 12.5.17. The only notable difference in traffic routing and volumes is within the Worthing area on the A24 Findon Road and the A280, resulting from changes associated with the A27 Worthing and Lancing scheme.

Figure 12-19: 2026 Do Minimum – 2015 base (AM)

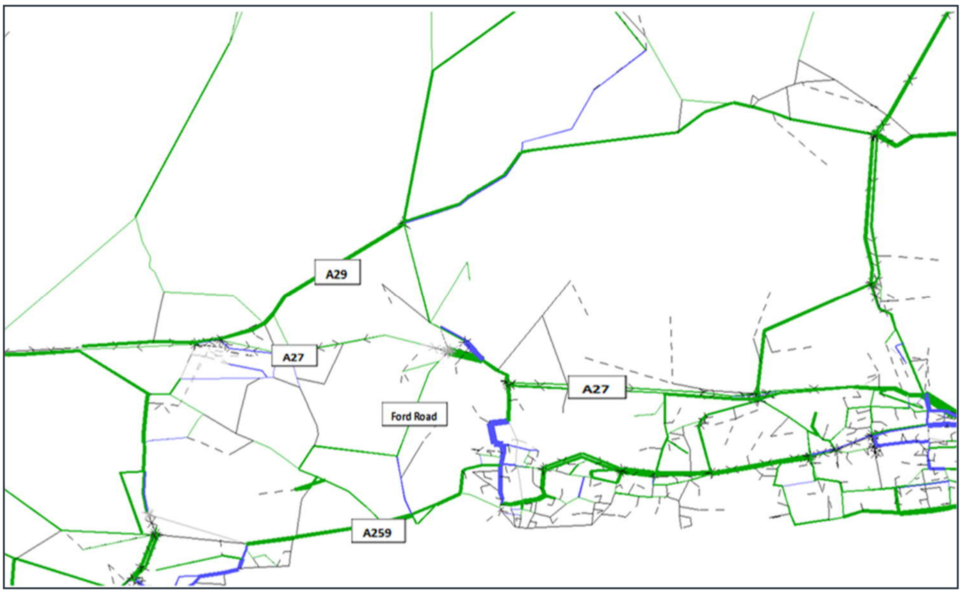
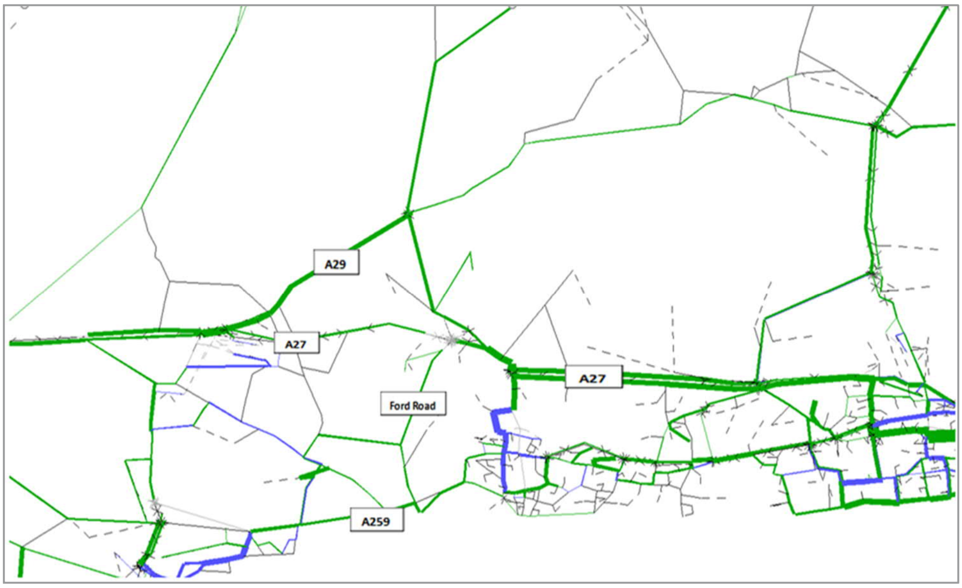


Figure 12-20: 2026 Do Minimum – 2015 base (PM)



12.9.11 Table 12-43 presents the traffic flow on various sections of the A27, during the Do Minimum AM, inter-peak and PM peak hours in 2026. There is an increase in traffic flows during these periods on all routes, with the exception of the A27 between Mill Road to Shellbridge Road where a small decrease is indicated. On the A27, the highest percentage growth is between the Ford Road and the Causeway roundabouts in the AM peak. Overall, the pattern of change in traffic volume is of a similar order to that shown in Table 12-6, which includes the A27 Worthing and Lancing scheme.

Table 12-43: A27 traffic flow difference 2015 base and 2026 Do Minimum (no A27 WL)

		AM			IP			PM		
A27 Link	Dir.	2015	2026	%	2015	2026	%	2015	2026	%
Mill Road to Shellbridge Rd	EB	1086	1114	2.7	1072	1158	7.9	1177	1324	12.5
	WB	1166	1126	-3.4	998	1045	4.7	1125	1199	6.6
Binsted Lane to Ford Rd Rdbt	EB	916	959	4.7	880	941	7.0	909	1066	17.3
	WB	1066	1122	5.2	906	1008	11.3	1053	1109	5.4
Ford Rdbt to Causeway Rdbt	EB	901	1311	45.6	1034	1277	23.5	611	901	47.5
	WB	650	1088	67.4	1056	1227	16.2	720	865	20.1
Causeway Rdbt to Crossbush Ln	EB	1258	1392	10.7	1128	1338	18.6	1062	1570	47.8
	WB	1340	1547	15.4	1142	1381	20.9	1302	1492	14.5
Crossbush Ln to Crossbush Jct	EB	1256	1365	8.7	1131	1325	17.1	1001	1509	50.8
	WB	1343	1555	15.8	1144	1389	21.4	1283	1486	15.8

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.9.12 Figure 12-21 and Figure 12-22 demonstrate the change in flows on the modelled network between 2015 and Do Minimum 2041. Consistent with the traffic flow patterns in 2026, congestion on the A27 is drawing traffic to away from the A27 on to other competing and lower order routes on the network.

Figure 12-21: 2041 Do Minimum – 2015 base (AM) (no A27 WL)

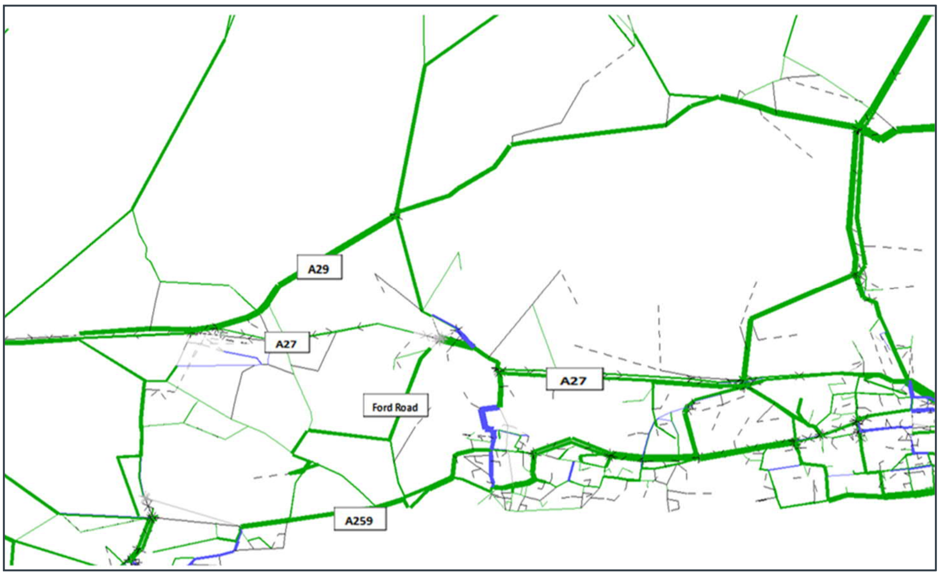
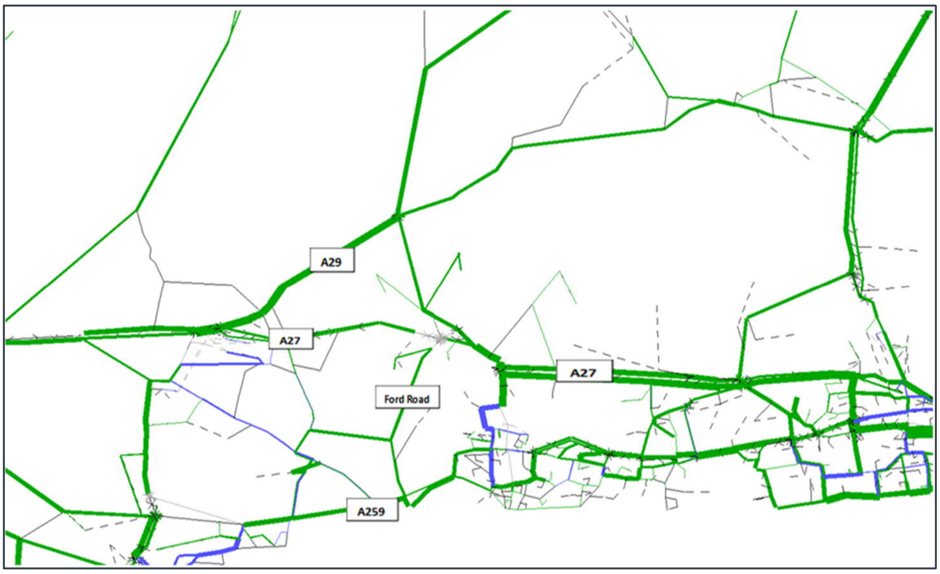


Figure 12-22: 2041 Do Minimum – 2015 base (PM) (no A27 WL)



12.9.13 Table 12-44 sets out the traffic flow on various sections of the A27 (see Figure 12-1), during the AM, inter-peak and PM peak hours in 2041. There is a general increase in traffic flows during these periods on all routes, with the exception of the A27 between Ford Road and Causeway roundabouts where a small decrease is indicated in the PM peak hour.

12.9.14 On the A27, the highest percentage growth is between the Ford Road and the Causeway roundabouts in the AM peak. The percentage difference in flow increase for the 2041 forecast year is lower than the 2026 forecast year along various sections of the route, this can be attributed to the general rerouting of traffic as a response to capacity constraints on the A27. Overall, the pattern of change in traffic volume is of a similar order to that shown in Table 12-7, including the A27 Worthing and Lancing scheme.

Table 12-44: A27 traffic flow difference 2015 base and 2041 Do Minimum (no A27 WL)

		AM			IP			PM		
A27 Link	Dir.	2015	2041	%	2015	2041	%	2015	2041	%
Mill Road to Shellbridge Rd	EB	1086	1149	5.9	1072	1187	10.7	1177	1414	20.1
	WB	1166	1195	2.4	998	1039	4.1	1125	1288	14.6
Binsted Lane to Ford Rd Rdbt	EB	916	960	4.9	880	924	5.0	909	1168	28.5
	WB	1066	1168	9.6	906	994	9.7	1053	1153	9.6
Ford Rdbt to Causeway Rdbt	EB	901	1318	46.3	1034	1244	20.3	611	930	52.1
	WB	650	1043	60.5	1056	1148	8.7	720	703	-2.4
Causeway Rdbt to Crossbush Ln	EB	1258	1448	15.1	1128	1329	17.9	1062	1640	54.4
	WB	1340	1577	17.6	1142	1386	21.3	1302	1469	12.8
Crossbush Ln to Crossbush Jct	EB	1256	1419	13.0	1131	1315	16.2	1001	1576	57.4
	WB	1343	1586	18.1	1144	1396	21.9	1283	1464	14.1

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.9.15 Table 12-45 compares the volume of traffic on the A27 Arundel Bypass between Crossbush and Ford Road junctions for all the Do Something scheme options with the equivalent flows on the existing A27 under a Do Minimum scenario. The table demonstrates that traffic flows typically increase for all options and across the peaks in 2026 and 2041, indicating that the scheme options have the effect of drawing traffic away from lower order roads and onto the A27.

Table 12-45: Traffic flows A27 Arundel Bypass Ford Road to Crossbush (no A27 WL)

		AM				IP				PM			
	Dir.	**2026**	**%**	**2041**	**%**	**2026**	**%**	**2041**	**%**	**2026**	**%**	**2041**	**%**
DM	EB	1365		1419		1325		1315		1509		1576	
	WB	1555		1586		1389		1396		1486		1464	
1V5	EB	1635	19.8	1676	18.2	1527	15.3	1620	23.2	1703	12.8	1735	10.1
	WB	1677	7.9	1817	14.5	1509	8.7	1660	18.9	1720	15.7	1828	24.9
1V9	EB	1341	-1.7	1347	-5.0	1372	3.5	1470	11.8	1597	5.8	1689	7.2
	WB	2105	35.4	2337	47.3	1845	32.8	2076	48.7	2033	36.8	2111	44.2
3V1	EB	1420	4.0	1439	1.5	1394	5.2	1510	14.9	1727	14.4	1816	15.3
	WB	1604	3.2	1783	12.4	1257	-9.5	1561	11.8	1622	9.1	1689	15.4
4/5A v1	EB	1521	11.5	1578	11.3	1493	12.7	1564	18.9	1874	24.1	1950	23.7
	WB	1602	3.0	1740	9.7	1454	4.7	1583	13.4	1627	9.4	1646	12.5
4/5A v2	EB	1543	13.1	1615	13.8	1543	16.4	1632	24.1	1962	30.0	2095	32.9
	WB	1615	3.9	1760	11.0	1468	5.7	1591	14.0	1656	11.4	1728	18.1
5B v1	EB	1534	12.4	1608	13.3	1483	11.9	1555	18.3	1542	2.2	2201	39.7
	WB	1564	0.6	1708	7.7	1420	2.2	1546	10.8	1438	-3.3	1745	19.2

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.9.16 Table 12-46 and Table 12-48 and presents a comparison of the change in flows on the existing alignment of the A27, for all the 2041 Do Something options, and 2041 Do Minimum scenarios without the A27 Worthing and Lancing scheme. Only 2041 data is included, as the trends in the 2026 data are similar to those presented below.

12.9.17 The analysis demonstrates a similar effect to that illustrated by the results for the core scenario that includes the A27 Worthing and Lancing scheme.

Table 12-46: Flows on the A27 – 2041 AM (no A27 WL)

		2041 AM actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1149	1715	1634	1659	1757	1728	165	49	42	44	53	50	-86
	WB	1195	1714	1679	1777	1829	1733	115	44	41	49	53	45	-90
A27 Binsted Ln to Ford Rdbt	EB	960	1676	1586	180	169	189	144	75	65	-81	-83	-80	-85
	WB	1168	1817	1736	104	107	106	125	56	49	-91	-91	-91	-89
A27 Ford Rdbt to Causeway Rdbt	EB	1318	770	767	852	821	770	768	-42	-42	-35	-38	-42	-42
	WB	1043	768	48	758	735	738	744	-26	-95	-27	-30	-29	-29
A27 Cause-way Rdbt to Crossbush Ln	EB	1448	941	908	901	876	818	850	-35	-37	-38	-40	-44	-41
	WB	1577	944	169	827	808	804	844	-40	-89	-48	-49	-49	-47
A27 Cross-bush Ln to Crossbush Jct	EB	1419	964	917	908	888	830	863	-32	-35	-36	-37	-42	-39
	WB	1586	977	189	843	830	827	867	-38	-88	-47	-48	-48	-45

Table 12-47: Flows on the A27 – 2041 IP (no A27 WL)

		2041 IP actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1187	1670	1702	1661	1645	1642	131	41	43	40	39	38	-89
	WB	1039	1642	1588	1697	1726	1653	154	38	34	43	45	39	-87
A27 Binsted Ln to Ford Rdbt	EB	924	1620	1633	94	87	90	86	36	38	-92	-93	-92	-93
	WB	994	1660	1562	159	167	164	169	40	32	-87	-86	-86	-86
A27 Ford Rdbt to Causeway Rdbt	EB	1244	691	647	693	684	623	643	-42	-46	-42	-42	-48	-46
	WB	1148	705	41	699	692	690	693	-41	-97	-41	-42	-42	-42
A27 Cause-way Rdbt to Crossbush Ln	EB	1329	831	757	753	742	681	701	-30	-36	-37	-38	-43	-41
	WB	1386	835	144	752	741	739	741	-30	-88	-37	-38	-38	-38
A27 Cross-bush Ln to Crossbush Jct	EB	1315	858	777	776	767	706	724	-28	-35	-35	-35	-41	-39
	WB	1396	863	166	776	767	765	766	-27	-86	-35	-35	-36	-35

Table 12-48: Flows on the A27 – 2041 PM (no A27 WL)

		2041 PM actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1414	1832	2269	2291	2263	2374	488	30	60	62	60	68	-66
	WB	1288	1767	1726	1824	1710	1743	276	37	34	42	33	35	-79
A27 Binsted Ln to Ford Rdbt	EB	1168	1735	2194	416	365	384	309	49	88	-64	-69	-67	-74
	WB	1153	1828	1752	212	182	184	404	59	52	-82	-84	-84	-65
A27 Ford Rdbt to Causeway Rdbt	EB	930	752	819	733	722	717	706	-19	-12	-21	-22	-23	-24
	WB	703	640	30	768	749	768	860	-9	-96	9	7	9	22
A27 Cause-way Rdbt to Crossbush Ln	EB	1640	1036	1063	972	957	951	938	-37	-35	-41	-42	-42	-43
	WB	1469	741	141	754	760	783	881	-50	-90	-49	-48	-47	-40
A27 Cross-bush Ln to Crossbush Jct	EB	1576	1107	1060	1032	1018	1012	1000	-30	-33	-34	-35	-36	-37
	WB	1464	800	132	808	818	841	942	-45	-91	-45	-44	-43	-36

Traffic flow difference between Do Minimum and Do Something – without A27 Worthing and Lancing

12.9.18 Figure 12-23 to Figure 12-34 demonstrate the general pattern of change in traffic flows across the modelled network without the A27 Worthing and Lancing scheme, for all the Do Something options, when compared against the 2041 Do Minimum scenario.

Figure 12-23: Do Something (1V5) - Do Minimum – 2041 AM (no A27 WL)

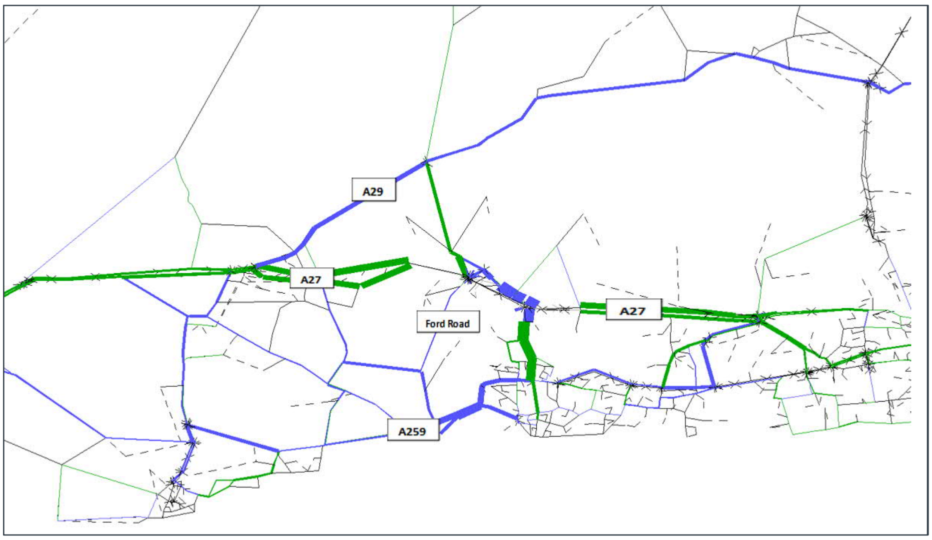


Figure 12-24: Do Something (1V5) - Do Minimum – 2041 PM (no A27 WL)

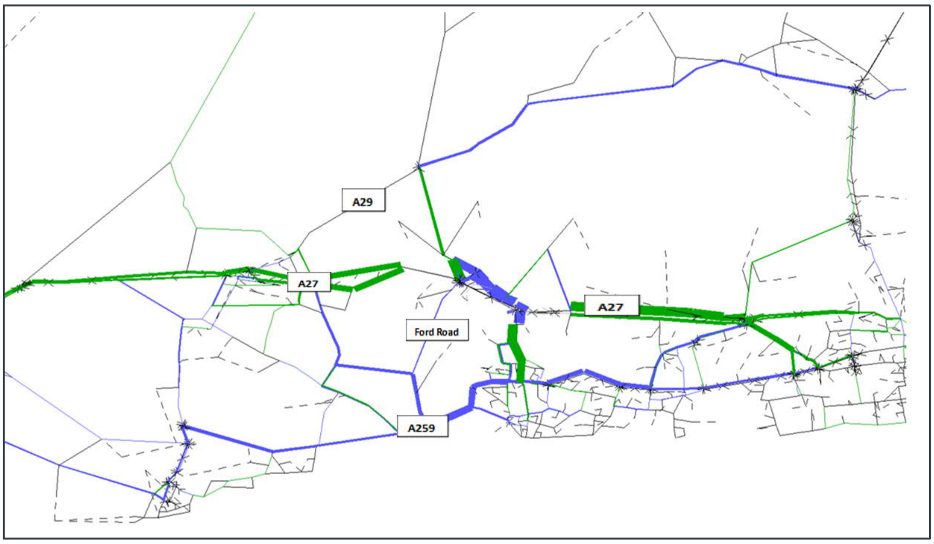


Figure 12-25: Do Something (1V9) - Do Minimum – 2041 AM (no A27 WL)

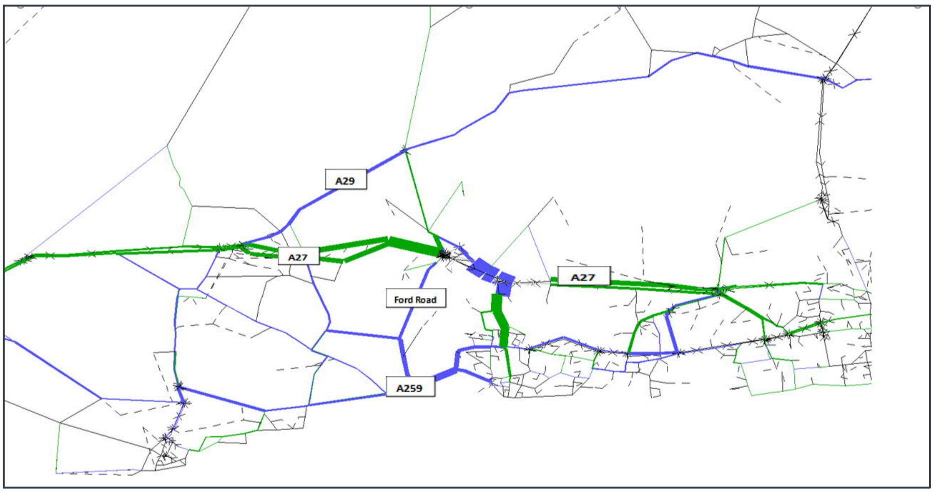


Figure 12-26: Do Something (1V9) - Do Minimum – 2041 PM (no A27 WL)

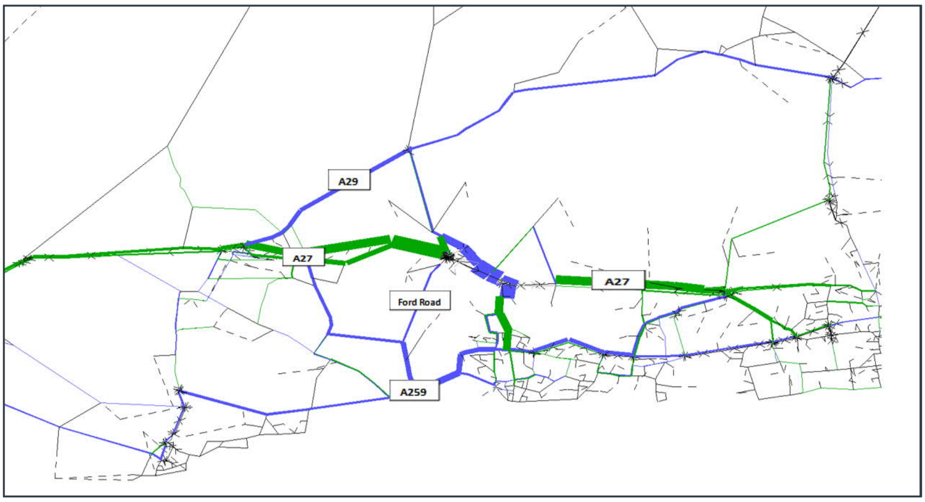


Figure 12-27: Do Something (3V1) - Do Minimum – 2041 AM (no A27 WL)

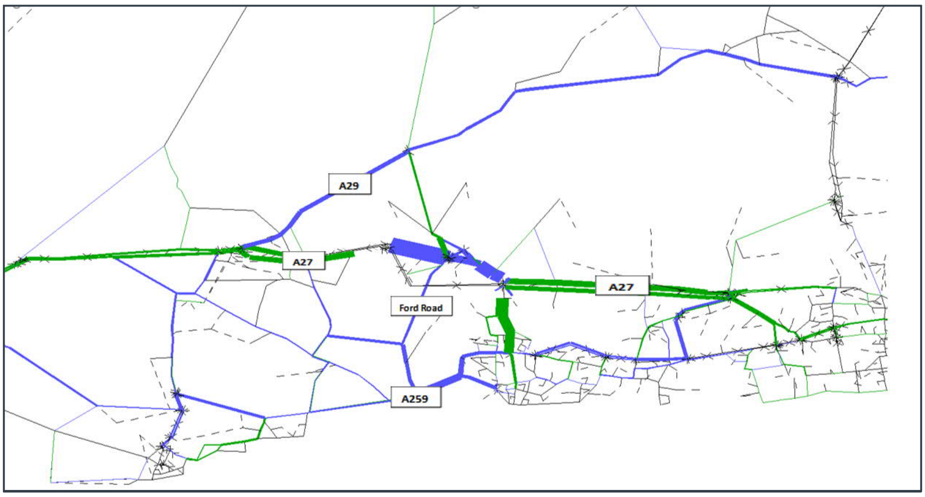


Figure 12-28: Do Something (3V1) - Do Minimum – 2041 PM (no A27 WL)

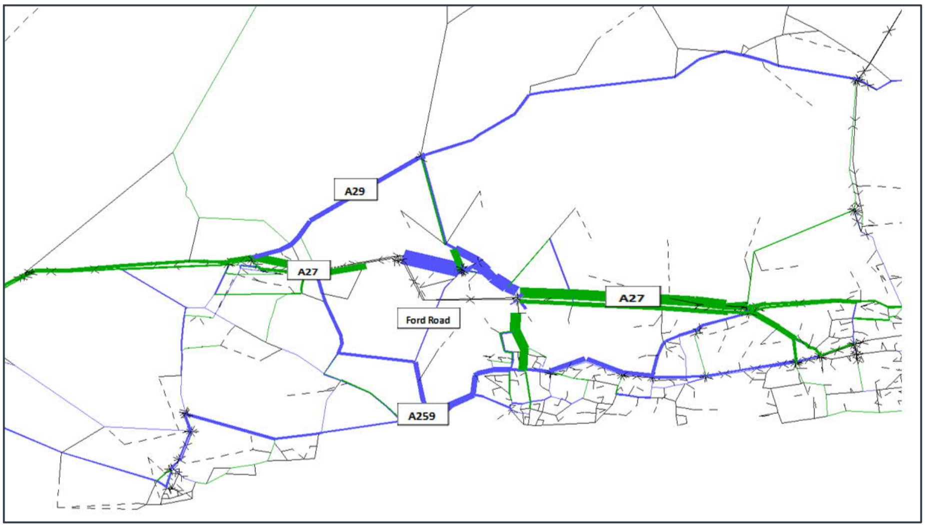


Figure 12-29: Do Something (4/5AV1) - Do Minimum – 2041 AM (no A27 WL)

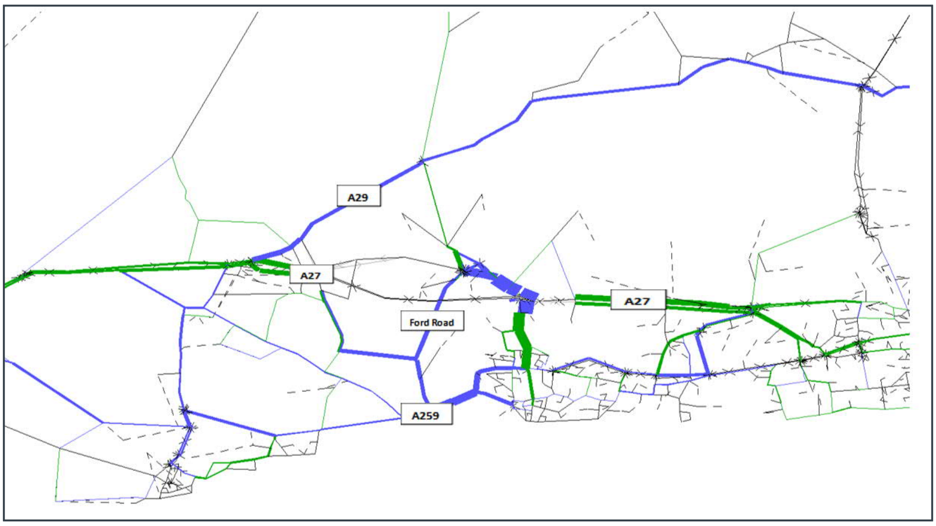


Figure 12-30: Do Something (4/5AV1) - Do Minimum – 2041 PM (no A27 WL)

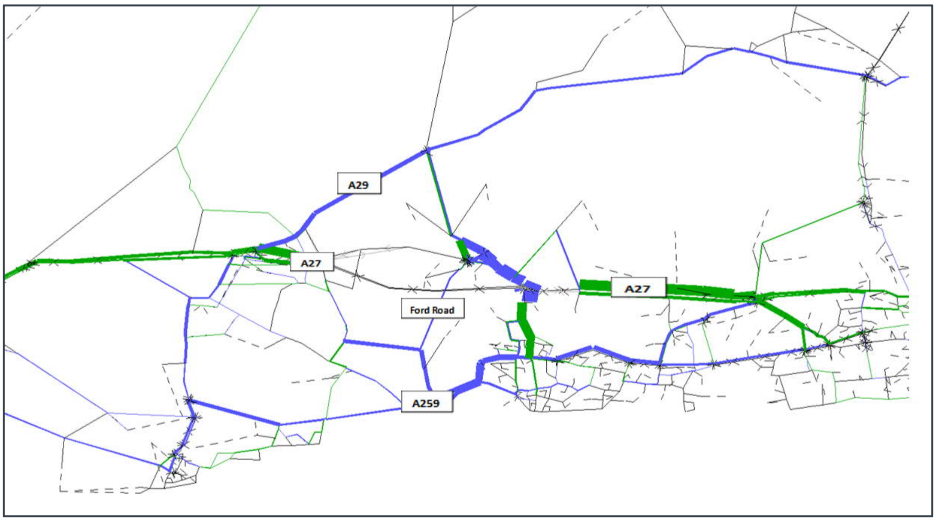


Figure 12-31: Do Something (4/5AV2) - Do Minimum – 2041 AM (no A27 WL)

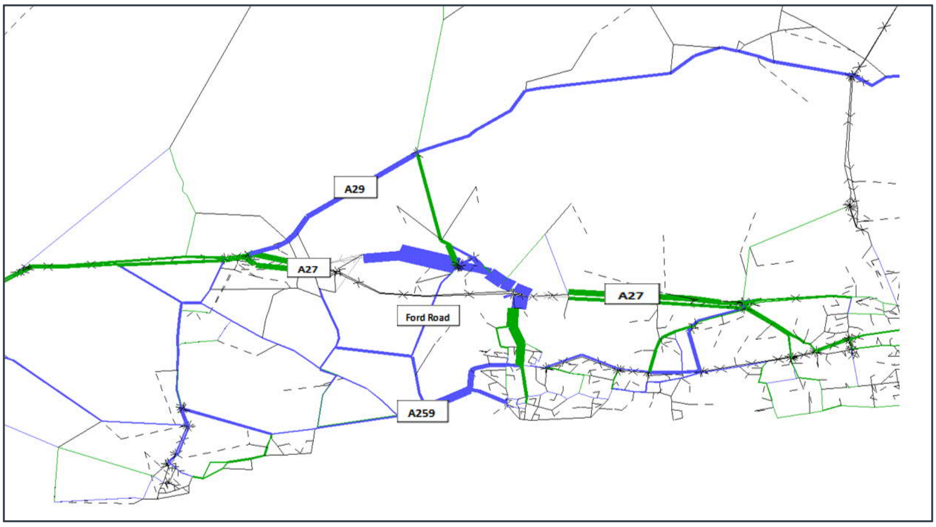


Figure 12-32: Do Something (4/5AV2) - Do Minimum – 2041 PM (no A27 WL)

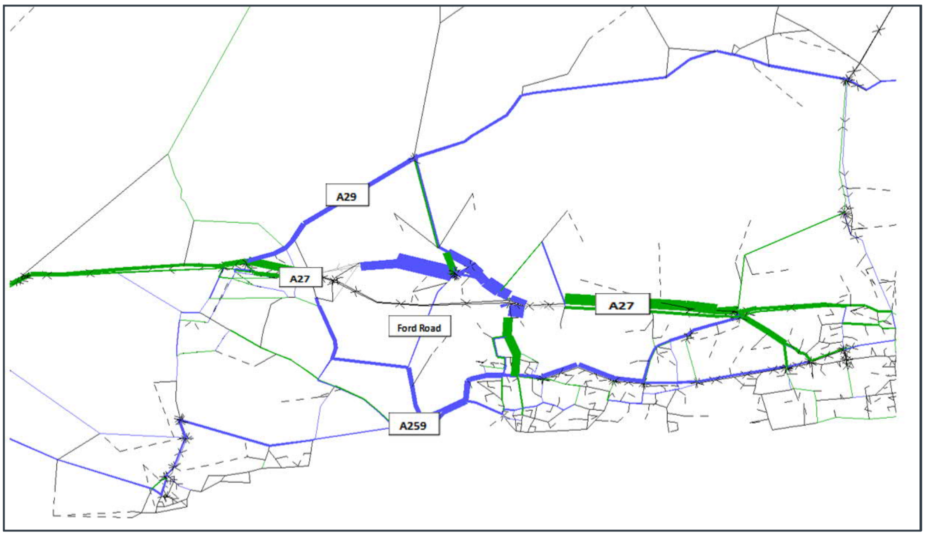


Figure 12-33: Do Something (5BV1) - Do Minimum – 2041 AM (no A27 WL)

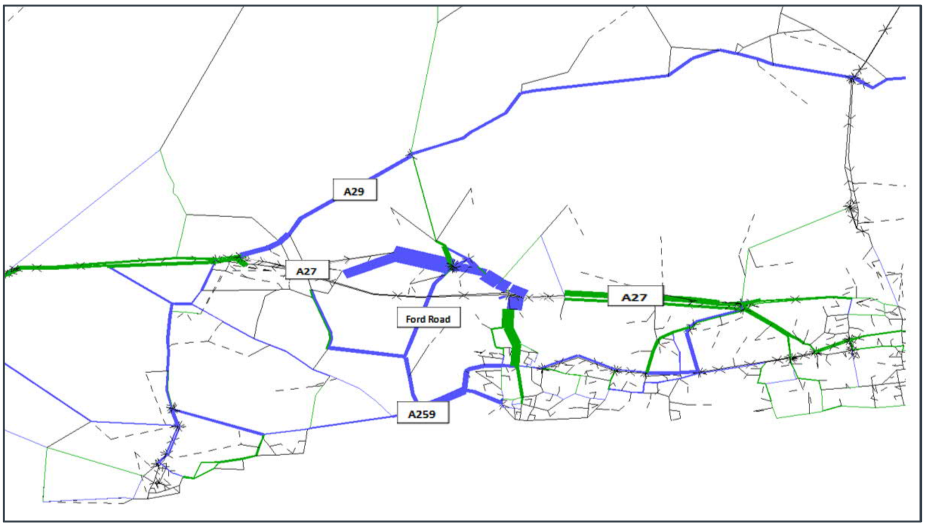
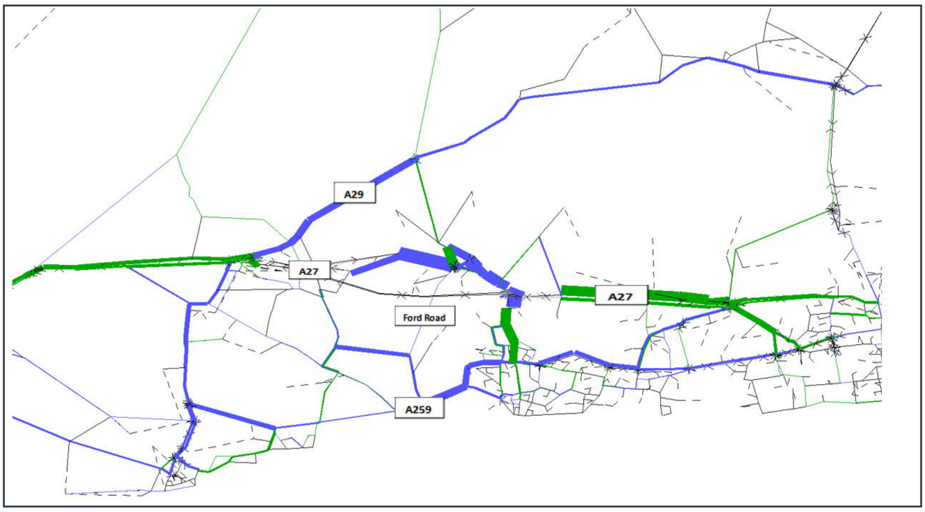


Figure 12-34: Do Something (5BV1) - Do Minimum – 2041 PM (no A27 WL)



Journey times

12.9.19 Journey time analysis has been undertaken on the A27 over the extent of the proposed junction improvements between the A27 / A29 junction and the A27 / Poling Street / Blakehurst Lane junction for the AM peak, Inter peak and PM peak modelled periods. Table 12-49 shows the journey time for the scheme extent without A27 Worthing and Lancing for the 2026 and 2041 Do Minimum forecast years. The analysis demonstrates that there would be a decrease in journey time on the A27 between Crossbush and Fontwell, for all scheme options, between 21% and 66%. The journey time impacts are similar to those presented in Table 12-13.

Table 12-49: Journey time over scheme extent compared to Do Minimum

			Journey time							% change to DM					
Year	Peak	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
2026	AM	EB	617	339	391	354	331	330	329	-45	-37	-43	-46	-46	-47
		WB	757	436	492	382	435	429	429	-42	-35	-50	-43	-43	-43
	IP	EB	688	338	391	353	330	330	328	-51	-43	-49	-52	-52	-52
		WB	725	395	468	366	393	388	388	-45	-35	-50	-46	-46	-47
	PM	EB	1004	562	542	483	447	449	345	-44	-46	-52	-55	-55	-66
		WB	774	467	526	430	512	461	400	-40	-32	-44	-34	-40	-48
2041	AM	EB	691	341	391	354	333	332	331	-51	-43	-49	-52	-52	-52
		WB	814	443	502	386	444	436	437	-46	-38	-53	-45	-46	-46
	IP	EB	731	340	394	354	332	332	330	-54	-46	-52	-55	-55	-55
		WB	739	402	477	367	400	395	395	-46	-35	-50	-46	-47	-46
	PM	EB	1,007	564	537	483	448	453	348	-44	-47	-52	-56	-55	-65
		WB	846	547	636	549	670	531	410	-35	-25	-35	-21	-37	-51

Summary

12.9.20 In summary, the results of the sensitivity test which excludes A27 Worthing and Lancing has illustrated broadly similar forecasting results to the core scenario. When the results of the core and sensitivity scenarios are compared this shows:

- Similar traffic volumes on the A27 under a Do Minimum scenario, with differences of less than 100 vehicles per hour
- A similar effect on traffic volumes for each Do Something scheme option, with forecast A27 traffic volumes typically varying by less than 10%
- A similar pattern of change in traffic volumes in the wider study area
- A similar order of journey time savings for the Do Something scheme options, of between 20% and 70% depending upon year and peak

12.10 Sensitivity tests – infrastructure – without Lyminster Bypass

12.10.1 This section presents the infrastructure sensitivity test related to the Lyminster Bypass. The results for a separate infrastructure sensitivity test for the A27 Worthing and Lancing are presented in section 12.9.

12.10.2 A sensitivity test was carried out to consider the changes in forecast traffic volumes and journey times in a scenario that includes the A27 Arundel Bypass but without the Lyminster Bypass. This section summarises the forecasting results and compares these to the results of the scenario with the Lyminster Bypass included.

DIADEM convergence – without Lyminster Bypass

12.10.3 The DIADEM convergence data is presented in Table 12-50. The majority of model scenarios converge within a reasonable number of iterations with the convergence achieved exceeded that required by TAG guidance. The process described in section 12.2.13 was followed where scenarios did not converge within stated criteria. The final convergences achieved when the iterations were completed are presented below.

Table 12-50: DIADEM convergence (no Lyminster Bypass (LB))

Peak	Year	% GAP						
		DM	1V5	1V9	3V1	4/5A v1	4/5A v2	5BV1
AM peak	2026	0.08	0.10	0.07	0.07	0.07	0.09	0.10
Inter peak		0.07	0.09	0.10	0.09	0.07	0.09	0.08
PM peak		0.09	0.09	0.09	0.09	0.10	0.08	0.10
AM peak	2041	0.11	0.08	0.06	0.10	0.08	0.09	0.06
Inter peak		0.09	0.09	0.07	0.09	0.09	0.09	0.09
PM peak		0.09	0.10	0.09	0.09	0.09	0.10	0.09
AM peak	2051	0.09	0.10	0.08	0.08	0.09	0.10	0.09
Inter peak		0.08	0.09	0.09	0.09	0.10	0.09	0.08
PM peak		0.10	0.15	0.15	0.23	1.02	1.05	2.11

Forecast matrices – without Lyminster Bypass

12.10.4 The trip matrix totals produced through the FDM and VDM processes for the A27 Arundel Bypass scheme options without Lyminster Bypass are summarised in Table 12-51.

Table 12-51: Core fixed demand scenario – trip matrix totals (no LB)

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Fixed Demand Model								
All	47191	45762	53071	52894	51483	58908	55589	53872	62233
	Variable Demand Model								
DM	47245	45847	53130	52973	51584	58977	55642	54096	62248
1V5	47254	45858	53143	52985	51588	58988	55657	54098	62262
1V9	47254	45855	53142	52985	51585	58989	55656	54096	62265
3V1	47256	45858	53147	52987	51588	58992	55657	54099	62268

4/5AV1	47256	45858	53146	52987	51588	58995	55658	54099	62269
4/5AV2	47255	45858	53145	52985	51587	58993	55657	54098	62268
5BV1	47256	45858	53148	52987	51588	58997	55657	54098	62271
	Difference								
DM	55	85	60	79	101	68	53	225	15
1V5	64	96	73	91	105	80	68	226	29
1V9	64	93	72	91	102	81	68	225	33
3V1	65	96	76	93	105	84	68	227	35
4/5AV1	65	96	75	93	105	86	69	227	37
4/5AV2	64	96	75	91	104	85	68	226	35
5BV1	65	96	78	93	105	89	68	226	38
	% Difference								
DM	0.12	0.19	0.11	0.15	0.20	0.12	0.10	0.42	0.02
1V5	0.14	0.21	0.14	0.17	0.20	0.14	0.12	0.42	0.05
1V9	0.13	0.20	0.14	0.17	0.20	0.14	0.12	0.42	0.05
3V1	0.14	0.21	0.14	0.18	0.20	0.14	0.12	0.42	0.06
4/5AV1	0.14	0.21	0.14	0.18	0.20	0.15	0.12	0.42	0.06
4/5AV2	0.14	0.21	0.14	0.17	0.20	0.14	0.12	0.42	0.06
5BV1	0.10	0.21	0.15	0.18	0.20	0.15	0.12	0.42	0.06

12.10.5 A summary of the convergence statistics for the Do Minimum as well as the Do Something scheme options, for the core FDM and VDM scenarios, based on the final iteration, is set out in Table 12-52 and 12-53.

12.10.6 Table 12-52 indicates that, based on the final iteration, all delta values are less than 0.1%, confirming that the core scenario FDMs (2026, 2041 and 2051) meet the required convergence standards.

Table 12-52: Core fixed demand scenario – convergence criteria (no LB)

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Final iteration								
DM	32	18	22	30	20	77	45	42	99
1V5	47	52	76	39	49	77	63	41	99
1V9	357	58	65	40	39	85	62	54	81
3V1	163	31	49	42	38	74	73	61	400
4/5AV1	187	45	87	39	39	79	60	51	98
4/5AV2	105	44	51	36	43	81	60	47	120
5BV1	44	40	48	42	43	83	60	59	114
	Final Delta (δ)								
DM	0.0096	0.0134	0.021	0.0293	0.0274	0.0447	0.021	0.0319	0.0301
1V5	0.0598	0.0154	0.0225	0.0323	0.0206	0.0359	0.0375	0.0425	0.0238
1V9	0.0324	0.0137	0.0182	0.0303	0.0303	0.029	0.0265	0.023	0.0312
3V1	0.0502	0.0128	0.0669	0.0509	0.0284	0.0392	0.0185	0.0346	0.0229
4/5AV1	0.0402	0.0148	0.0172	0.0483	0.0397	0.0463	0.0417	0.0226	0.0295
4/5AV2	0.0548	0.0165	0.0224	0.034	0.024	0.0253	0.0487	0.0317	0.0188
5BV1	0.049	0.0188	0.0254	0.0363	0.0295	0.057	0.0421	0.0251	0.0206
	Final %Flow								
DM	98.8	98.8	99.1	98.5	98.9	99.3	99.1	98.8	99.6
1V5	98.8	98.7	98.8	99.2	98.9	99.1	99.3	98.4	99.5
1V9	99.5	98.7	99	99.2	98.9	99.4	99.5	98.7	99.4
3V1	98.8	98.7	99.4	99.3	99.1	99.1	99.1	99.1	99.7
4/5AV1	99.2	98.1	99.2	98.6	98.8	99.1	99.2	99.1	99.3
4/5AV2	98.4	98.6	98.9	98.9	98.9	99.2	98.5	98.5	99.8
5BV1	98.9	98.2	99	99.3	98.5	99	99.5	98.8	98.8
	Final %Gap								
DM	0.024	0.022	0.038	0.042	0.029	0.04	0.036	0.017	0.044

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
1V5	0.031	0.028	0.041	0.036	0.038	0.044	0.029	0.035	0.046
1V9	0.049	0.038	0.026	0.037	0.037	0.038	0.039	0.035	0.04
3V1	0.019	0.045	0.026	0.034	0.049	0.044	0.041	0.041	0.051
4/5AV1	0.028	0.03	0.047	0.042	0.033	0.046	0.042	0.041	0.041
4/5AV2	0.028	0.03	0.031	0.031	0.041	0.036	0.035	0.032	0.033
5BV1	0.028	0.033	0.034	0.031	0.032	0.028	0.026	0.043	0.036

12.10.7 Table 12-53 indicates the level of convergence achieved for all the VDMs. As the results indicate, all delta values with the exception of one value are less than 0.1%.

Table 12-53: Core variable demand scenario – convergence criteria (no LB)

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
	Final iteration								
DM	56	48	50	45	35	91	66	52	113
1V5	51	45	30	50	44	71	78	48	82
1V9	58	45	31	62	40	91	80	41	95
3V1	56	35	33	61	45	64	79	45	76
4/5AV1	57	64	42	51	41	75	57	45	87
4/5AV2	49	67	31	45	38	73	70	45	400
5BV1	55	46	33	48	39	82	77	44	73
	Final Delta (δ)								
DM	0.0092	0.0123	0.0176	0.0559	0.0266	0.0499	0.0417	0.0203	0.0257
1V5	0.017	0.0142	0.0343	0.0327	0.0369	0.0499	0.0291	0.0214	0.0265
1V9	0.013	0.0155	0.0307	0.0515	0.0308	0.0333	0.0259	0.0235	0.04
3V1	0.037	0.0095	0.0316	0.0484	0.0412	0.0238	0.0378	0.0323	0.0281
4/5AV1	0.0144	0.0123	0.0435	0.0321	0.0222	0.0262	0.0443	0.0191	0.0198
4/5AV2	0.0335	0.0102	0.0504	0.032	0.0385	0.0262	0.0378	0.0171	0.535

	2026			2041			2051		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
5BV1	0.0157	0.0154	0.0616	0.0376	0.0403	0.022	0.0336	0.0185	0.0352
	Final %Flow								
DM	98.8	98.6	98.6	98.7	99.1	99.1	98.5	99	99.4
1V5	98.9	99.2	98.3	98.9	99.1	99.6	99.5	98.8	99.4
1V9	99.1	99	98.4	99.6	98.6	99.3	99.4	98.2	99.4
3V1	98.8	99	98.2	99.1	98.7	99.3	99.2	98.7	99.4
4/5AV1	99.1	98.5	99	99.1	99.1	99	99.1	98.1	99.6
4/5AV2	98.7	98.1	98.9	98.9	99.1	98.9	99.7	99.3	80.9
5BV1	99.4	98.1	98.6	99.2	99.1	99.4	99.5	99	99.3
	Final %Gap								
DM	0.031	0.022	0.024	0.049	0.027	0.030	0.029	0.027	0.047
1V5	0.023	0.039	0.025	0.042	0.027	0.049	0.037	0.025	0.049
1V9	0.030	0.030	0.049	0.026	0.043	0.047	0.043	0.031	0.038
3V1	0.024	0.024	0.024	0.042	0.036	0.046	0.04	0.042	0.044
4/5AV1	0.033	0.018	0.019	0.045	0.028	0.046	0.042	0.038	0.033
4/5AV2	0.025	0.025	0.034	0.046	0.029	0.039	0.036	0.026	0.929
5BV1	0.020	0.024	0.023	0.031	0.034	0.040	0.037	0.026	0.037

Traffic flows – without Lyminster Bypass

12.10.8 Traffic flows on key links, along the A27, within the study area for the Do Minimum and the Do Something scheme without Lyminster Bypass options have been extracted and presented in the following sections.

12.10.9 The year 2041 forecast scenario has generally been used to illustrate any differences in the forecast results.

12.10.10 Figure 12-35 and Figure 12-36 demonstrate the change in flows on the modelled network between 2015 and 2026. The green bands indicate an increase in traffic whereas the blue bands indicate a decrease. The general effect of the traffic growth and infrastructure changes without the Lyminster Bypass is comparable to that summarised in section 12.5.17. The only notable difference in traffic routing and volumes is within the Worthing area on the A24 Findon Road and the A280, resulting from changes associated with the A27 Worthing and Lancing scheme.

Figure 12-35: 2026 Do Minimum (no LB) – 2015 base (AM)

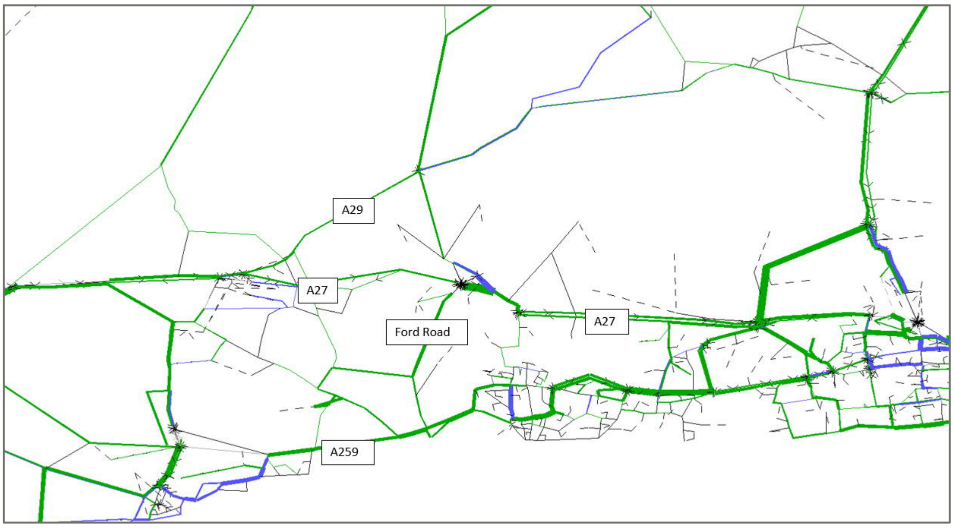
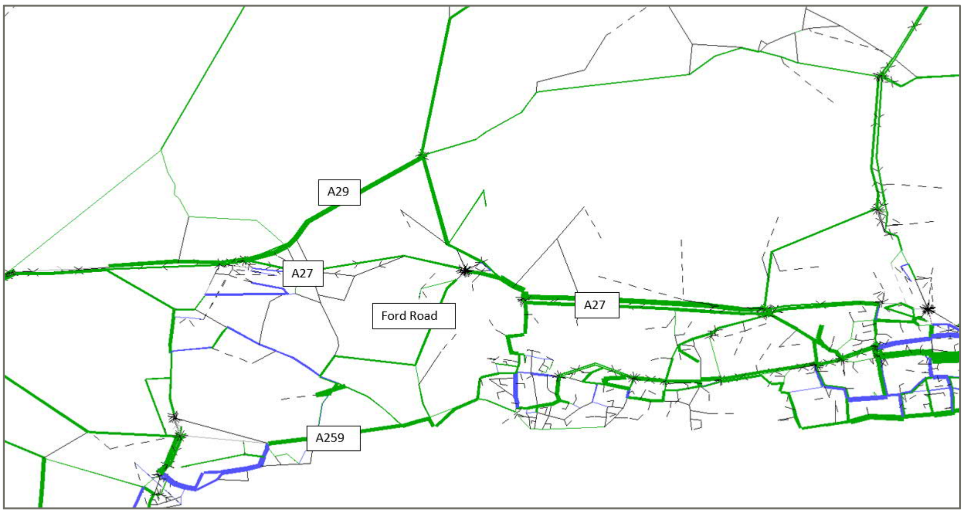


Figure 12-36: 2026 Do Minimum (no LB) – 2015 base (PM)



12.10.11 Table 12-54 presents the traffic flow on various sections of the A27, during the Do Minimum AM, inter-peak and PM peak hours in 2026. There is an increase in traffic flows during these periods on all routes, with the exception of the A27 between Mill Road to Shellbridge Road where a small decrease is indicated. On the A27, the highest percentage growth is between the Ford Road and the Causeway roundabouts in the AM peak. Overall, the pattern of change in traffic volume is of a similar order to that shown in Table 12-6, which includes the Lyminster Bypass scheme.

Table 12-54: A27 traffic flow difference 2015 base and 2026 Do Minimum (no LB)

		AM			IP			PM		
A27 Link	Dir.	2015	2026	%	2015	2026	%	2015	2026	%
Mill Road to Shellbridge Rd	EB	1086	1231	13.4	1072	1170	9.1	1177	1351	14.8
	WB	1166	1128	-3.3	998	1017	2.0	1125	1117	-0.7
Binsted Lane to Ford Rd Rdbt	EB	916	1048	14.4	880	939	6.6	909	1066	17.2
	WB	1066	1127	5.7	906	975	7.7	1053	1046	-0.6
Ford Rdbt to Causeway Rdbt	EB	901	1330	47.6	1034	1259	21.7	611	904	47.9
	WB	650	1100	69.3	1056	1215	15.0	720	862	19.7
Causeway Rdbt to Crossbush Ln	EB	1258	1453	15.5	1128	1314	16.5	1062	1542	45.2
	WB	1340	1495	11.5	1142	1298	13.6	1302	1413	8.5
Crossbush Ln to Crossbush Jct	EB	1256	1427	13.7	1131	1317	16.4	1001	1481	48.0
	WB	1343	1500	11.6	1144	1303	13.9	1283	1399	9.1

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.10.12 Figure 12-37 and Figure 12-38 demonstrate the change in flows on the modelled network between 2015 and Do Minimum 2041. Consistent with the traffic flow patterns in 2026, congestion on the A27 is drawing traffic to away from the A27 on to other competing and lower order routes on the network.

Figure 12-37: 2041 Do Minimum – 2015 base (AM) (no LB)

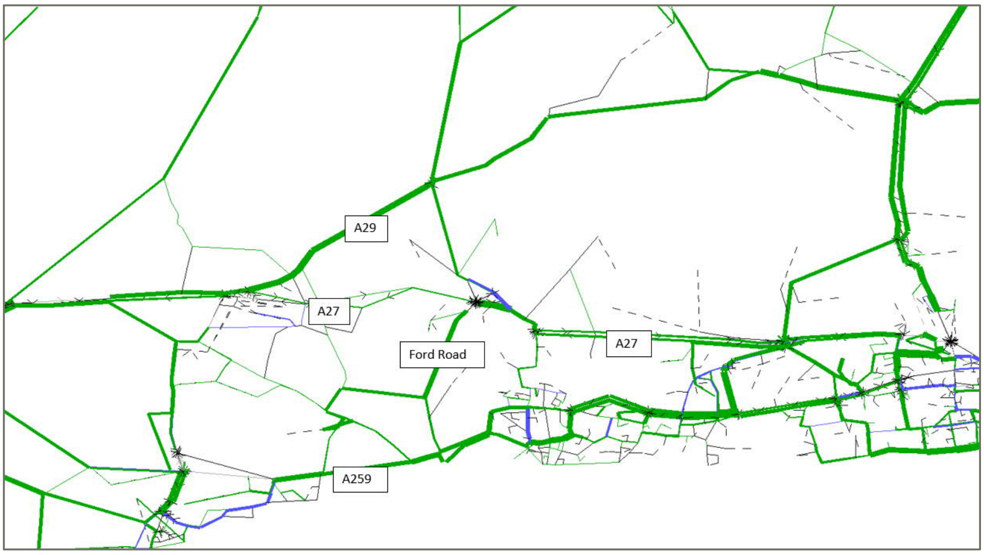
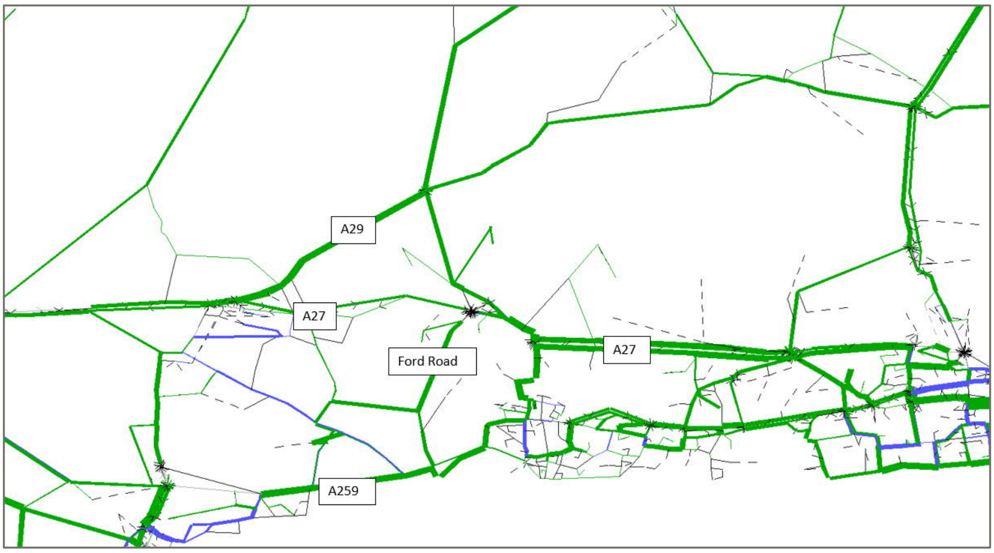


Figure 12-38: 2041 Do Minimum – 2015 base (PM) (no LB)



12.10.13 Table 12-55 sets out the traffic flow on various sections of the A27 (see Figure 12-1), during the AM, inter-peak and PM peak hours in 2041. There is a general increase in traffic flows during these periods on all routes, with the exception of the A27 between Ford Road and Causeway roundabouts where a small decrease is indicated in the PM peak hour.

12.10.14 On the A27, the highest percentage growth is between the Ford Road and the Causeway roundabouts in the AM peak. Overall, the pattern of change in traffic volume is of a similar order to that shown in Table 12-7, including the Lyminster Bypass scheme.

Table 12-55: A27 traffic flow difference 2015 base and 2041 Do Minimum (no LB)

		AM			IP			PM		
A27 Link	**Dir.**	**2015**	**2041**	**%**	**2015**	**2041**	**%**	**2015**	**2041**	**%**
Mill Road to Shellbridg	EB	1086	1164	7.2	1072	1176	9.6	1177	1416	20.3
	WB	1166	1214	4.1	998	999	0.2	1125	1237	10.0
Binsted Lane to Ford Rd	EB	916	974	6.4	880	924	5.0	909	1140	25.4
	WB	1066	1177	10.4	906	949	4.8	1053	1101	4.6
Ford Rdbt to Causeway	EB	901	1324	47.0	1034	1273	23.1	611	938	53.5
	WB	650	950	46.3	1056	1161	9.9	720	683	-5.2
Causeway Rdbt to Crossbush	EB	1258	1444	14.8	1128	1345	19.3	1062	1632	53.6
	WB	1340	1539	14.8	1142	1271	11.3	1302	1423	9.3
Crossbush Ln to Crossbush	EB	1256	1415	12.7	1131	1333	17.8	1001	1568	56.6
	WB	1343	1546	15.1	1144	1278	11.7	1283	1417	10.4

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.10.15 Table 12-56 compares the volume of traffic on the A27 Arundel Bypass between Crossbush and Ford Road junctions for all the Do Something scheme options with the equivalent flows on the existing A27 under a Do Minimum scenario. The table demonstrates that traffic flows typically increase for all options and across the peaks in 2026 and 2041, indicating that the scheme options have the effect of drawing traffic away from lower order roads and onto the A27.

Table 12-56: Traffic flows A27 Arundel Bypass Ford Road to Crossbush (no LB)

		AM				IP				PM			
	Dir.	2026	%	2041	%	2026	%	2041	%	2026	%	2041	%
DM	EB	1427		1415		1317		1333		1481		1568	
	WB	1500		1546		1303		1278		1399		1417	
1V5	EB	1607	12.6	1740	23.0	1427	8.4	1538	15.4	1698	14.6	1814	15.7
	WB	1597	11.9	1737	22.7	1403	6.6	1554	16.6	1616	9.1	1799	14.7
1V9	EB	1360	-4.7	1460	3.2	1270	-3.5	1364	2.3	1593	7.5	1700	8.4
	WB	2008	33.9	2201	42.4	1726	32.4	1950	52.5	1909	36.4	2086	47.2
3V1	EB	1418	-0.6	1740	23.0	1320	0.3	1424	6.9	1731	16.9	1864	18.9
	WB	1536	7.6	1737	22.7	1307	-0.7	1439	7.9	1519	2.5	1691	7.8
4/5A v1	EB	1503	5.3	1649	16.5	1445	9.8	1555	16.7	1935	30.6	2059	31.3
	WB	1535	7.6	1654	16.9	1370	4.0	1485	11.4	1543	4.2	1669	6.5
4/5A v2	EB	1499	5.0	1614	14.0	1394	5.8	1507	13.1	1881	27.0	1943	23.9
	WB	1515	6.1	1611	13.8	1359	3.2	1467	10.0	1533	3.5	1656	5.6
5B v1	EB	1493	4.6	1639	15.9	1387	5.4	1517	13.8	2048	38.3	2148	37.0
	WB	1507	0.5	1616	4.6	1327	1.9	1436	12.3	1545	10.4	1634	15.4

Note: Green indicates flow increase >10%. Blue indicates flow decrease >-10%

12.10.16 Table 12-57 to Table 12-59 present a comparison of the change in flows on the existing alignment of the A27, for all the 2041 Do Something options, and 2041 Do Minimum scenarios without the Lyminster Bypass scheme. Only 2041 data is included, as the trends in the 2026 data are similar to those presented below.

12.10.17 The analysis demonstrates a similar effect to that illustrated by the results for the core scenario that includes the Lyminster Bypass scheme.

Table 12-57: Flows on the A27 – 2041 AM (no LB)

		2041 AM actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1164	1776	1744	1761	1778	1787	159	53	50	51	53	54	-86
	WB	1214	1644	1592	1703	1640	1727	106	35	31	40	35	42	-91
A27 Binsted Ln to Ford Rdbt	EB	974	1740	1697	177	184	164	141	79	74	-82	-81	-83	-85
	WB	1177	1737	1650	111	105	125	133	48	40	-91	-91	-89	-89
A27 Ford Rdbt to Causeway Rdbt	EB	1324	719	711	823	692	743	693	-46	-46	-38	-48	-44	-48
	WB	950	718	46	717	685	690	700	-24	-95	-25	-28	-27	-26
A27 Cause-way Rdbt to Crossbush Ln	EB	1444	889	850	871	738	796	774	-38	-41	-40	-49	-45	-46
	WB	1539	889	161	780	744	755	794	-42	-90	-49	-52	-51	-48
A27 Cross-bush Ln to Crossbush Jct	EB	1415	911	858	876	752	807	785	-36	-39	-38	-47	-43	-45
	WB	1546	920	179	793	768	776	814	-40	-88	-49	-50	-50	-47

Table 12-58: Flows on the A27 – 2041 IP (no LB)

		2041 IP actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1176	1580	1582	1561	1607	1603	126	34	34	33	37	36	-89
	WB	999	1534	1467	1526	1533	1608	157	30	25	30	30	37	-87
A27 Binsted Ln to Ford Rdbt	EB	924	1538	1527	94	90	88	87	31	30	-	-92	-93	-93
	WB	949	1554	1449	110	149	165	173	32	23	-	-87	-86	-85
A27 Ford Rdbt to Causeway Rdbt	EB	1273	657	610	662	587	645	607	-	-	-	-50	-45	-48
	WB	1161	672	39	666	650	655	677	-	-	-	-45	-44	-42
A27 Cause-way Rdbt to Crossbush Ln	EB	1345	796	718	721	643	701	663	-	-	-	-45	-40	-44
	WB	1271	799	138	712	693	697	719	-	-	-	-41	-41	-39
A27 Cross-bush Ln to Crossbush Jct	EB	1333	822	738	743	667	727	686	-	-	-	-43	-38	-42
	WB	1417	809	125	760	800	795	899	-	-	-	-43	-44	-37

Table 12-59: Flows on the A27 – 2041 PM (no LB)

		2041 PM actual flow							% change to DM					
Link	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
A27 Mill Rd to Shellbridge Rd	EB	1416	1955	2342	2409	2357	2395	501	38	65	70	67	69	-65
	WB	1237	1794	1672	1864	1742	1756	241	45	35	51	41	42	-81
A27 Binsted Ln to Ford Rdbt	EB	1140	1814	2214	426	381	379	309	59	94	-63	-67	-67	-73
	WB	1101	1799	1678	180	185	209	365	63	52	-84	-83	-81	-67
A27 Ford Rdbt to Causeway Rdbt	EB	938	740	799	727	707	701	694	-21	-15	-23	-25	-25	-26
	WB	683	631	29	724	733	729	823	-8	-96	6	7	7	21
A27 Cause-way Rdbt to Crossbush Ln	EB	1632	1025	1041	964	938	931	924	-37	-36	-41	-43	-43	-43
	WB	1423	740	109	707	744	739	840	-48	-92	-50	-48	-48	-41
A27 Cross-bush Ln to Crossbush Jct	EB	1568	1100	1063	1024	998	990	983	-30	-32	-35	-36	-37	-37
	WB	1417	809	125	760	800	795	899	-43	-91	-46	-43	-44	-37

Traffic flow difference between Do Minimum and Do Something – without Lyminster Bypass

12.10.18 Figure 12-39 to Figure 12-50 demonstrate the general pattern of change in traffic flows across the modelled network without the Lyminster Bypass scheme, for all the Do Something options, when compared against the 2041 Do Minimum scenario.

Figure 12-39: Do Something (1V5) - Do Minimum – 2041 AM (no LB)

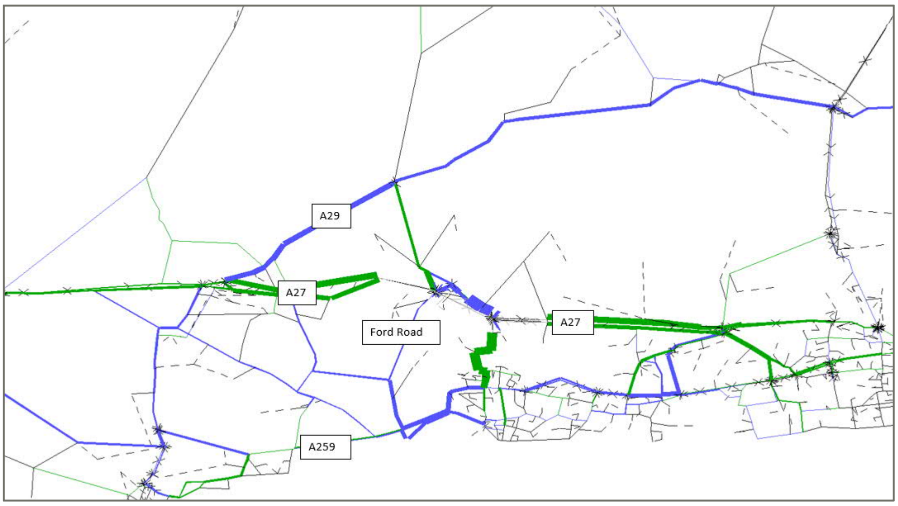


Figure 12-40: Do Something (1V5) - Do Minimum – 2041 PM (no LB)

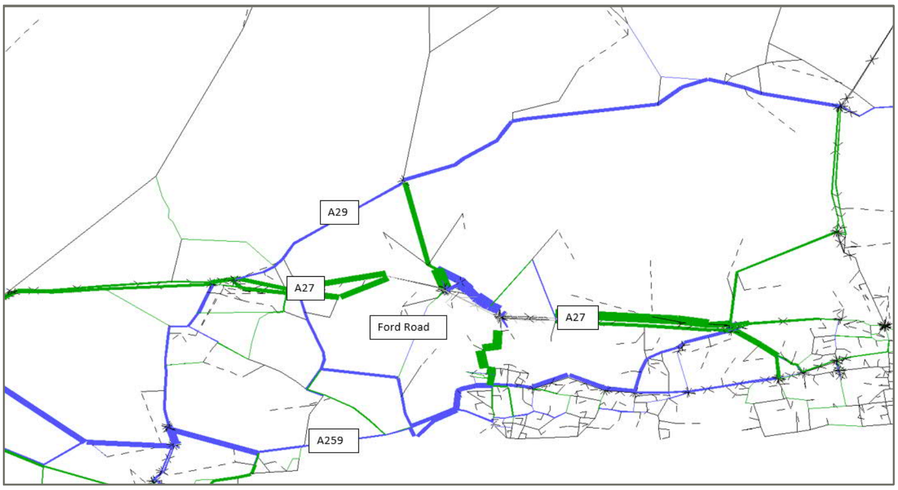


Figure 12-41: Do Something (1V9) - Do Minimum – 2041 AM (no LB)

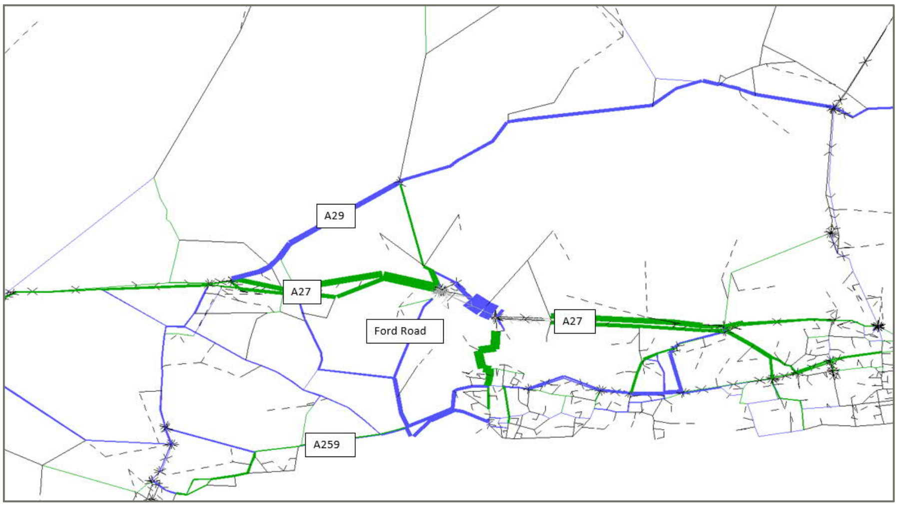


Figure 12-42: Do Something (1V9) - Do Minimum – 2041 PM (no LB)

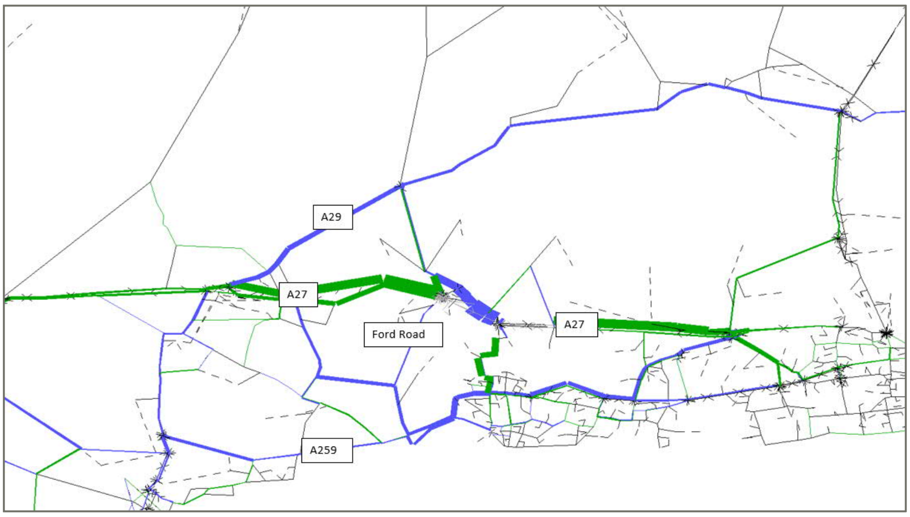


Figure 12-43: Do Something (3V1) - Do Minimum – 2041 AM (no LB)

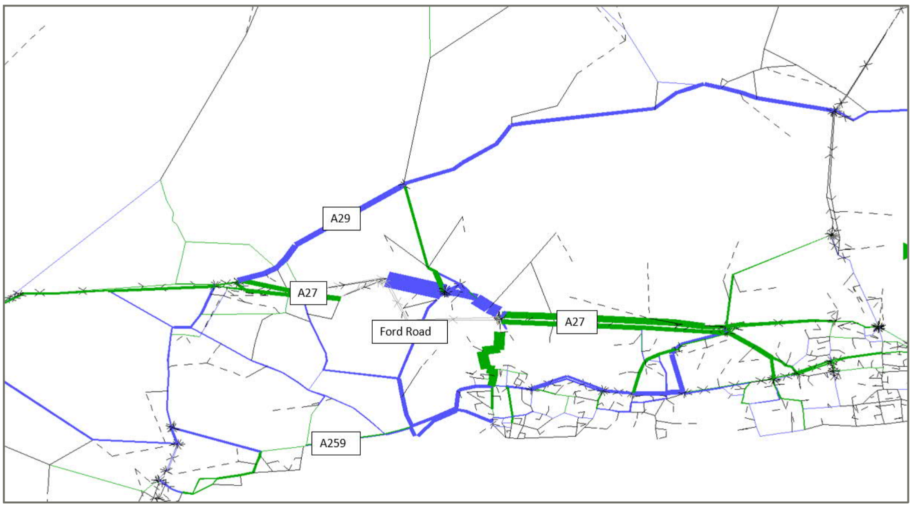


Figure 12-44: Do Something (3V1) - Do Minimum – 2041 PM (no LB)

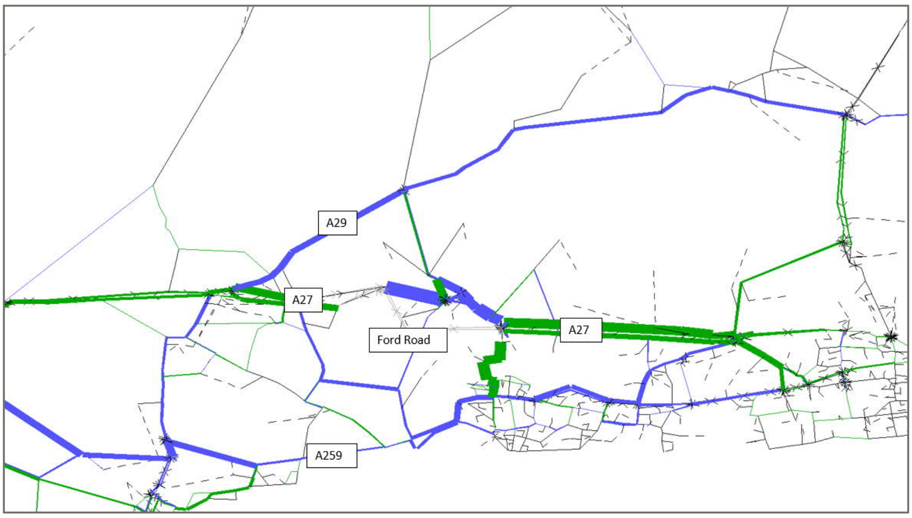


Figure 12-45: Do Something (4/5AV1) - Do Minimum – 2041 AM (no LB)

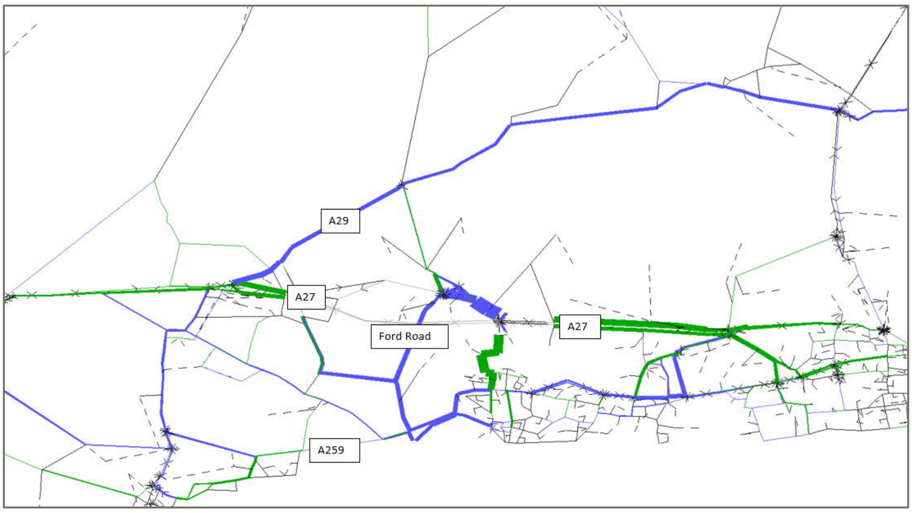


Figure 12-46: Do Something (4/5AV1) - Do Minimum – 2041 PM (no LB)

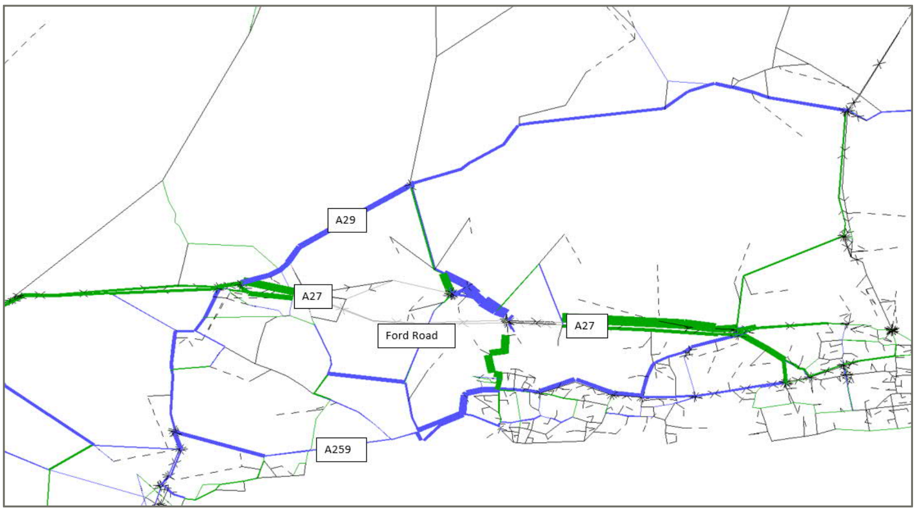


Figure 12-47: Do Something (4/5AV2) - Do Minimum – 2041 AM (no LB)

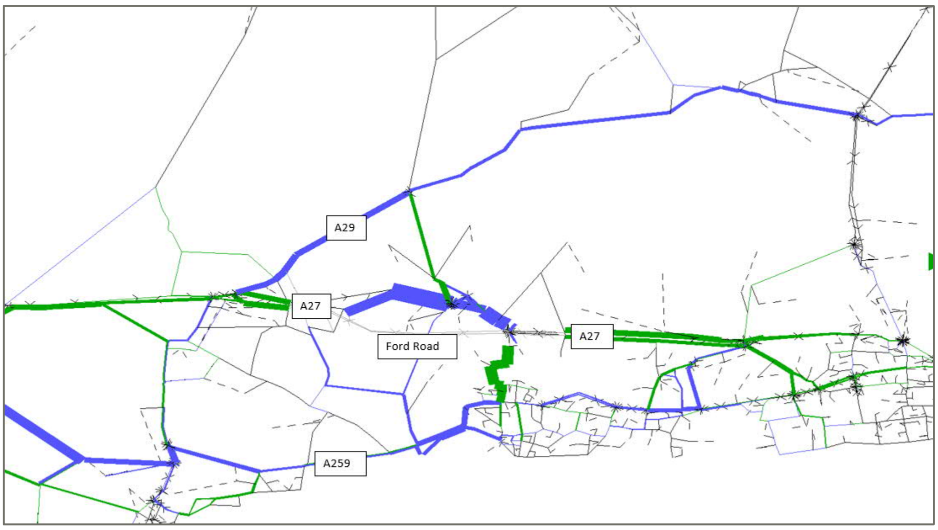


Figure 12-48: Do Something (4/5AV2) - Do Minimum – 2041 PM (no LB)

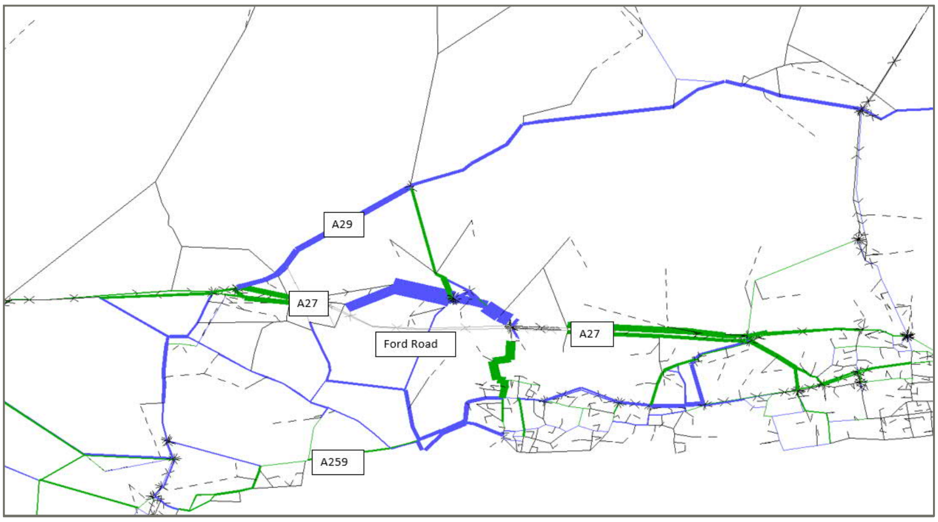


Figure 12-49: Do Something (5BV1) - Do Minimum – 2041 AM (no LB)

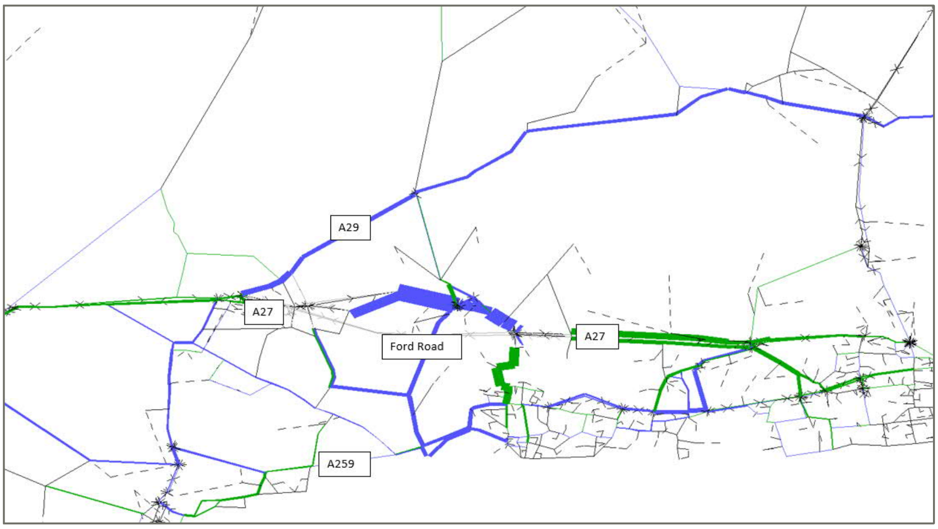
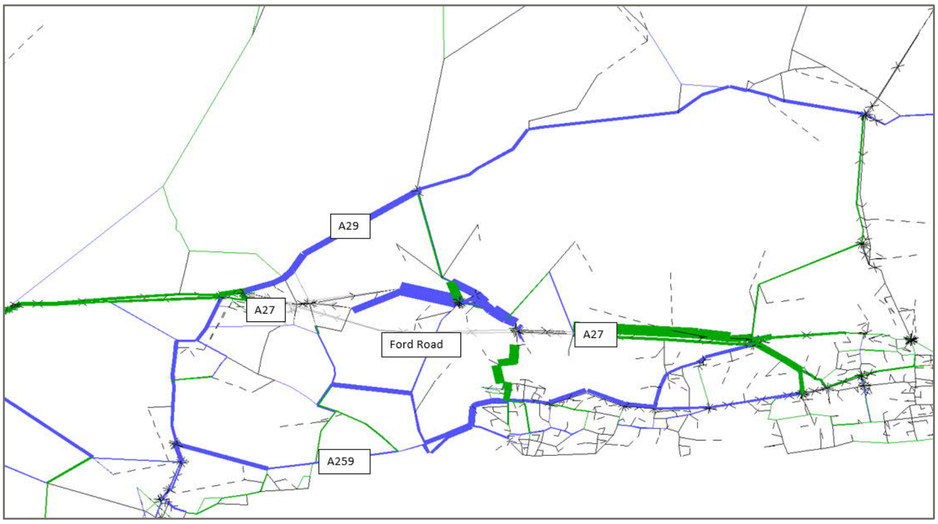


Figure 12-50: Do Something (5BV1) - Do Minimum – 2041 PM (no LB)



Journey times

12.10.19 Journey time analysis has been undertaken on the A27 over the extent of the proposed junction improvements between the A27 / A29 junction and the A27 / Poling Street / Blakehurst Lane junction for the AM peak, Inter peak and PM peak modelled periods. Table 12-60 shows the journey time for the scheme extent without Lyminster Bypass for the 2026 and 2041 Do Minimum forecast years. The analysis demonstrates that there would be a decrease in journey time on the A27 between Crossbush and Fontwell, for all scheme options, between 21% and 66%. The journey time impacts are similar to those presented in Table 12-13.

Table 12-60: Journey time over scheme extent compared to Do Minimum (no LB)

			Journey time							% change to DM					
Year	Peak	Dir	DM	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1	1 v5	1 v9	3 v1	5A v1	5A v2	5B v1
2026	AM	EB	706	339	391	354	330	331	329	-52	-45	-50	-53	-53	-53
		WB	726	433	489	380	426	433	428	-40	-33	-48	-41	-40	-41
	IP	EB	689	337	389	353	328	328	326	-51	-44	-49	-52	-52	-53
		WB	689	392	465	366	385	389	385	-43	-33	-47	-44	-44	-44
	PM	EB	996	554	530	480	442	444	341	-44	-47	-52	-56	-55	-66
		WB	678	404	479	369	397	402	398	-40	-29	-45	-41	-41	-41
2041	AM	EB	714	341	393	354	332	333	331	-52	-45	-50	-53	-53	-54
		WB	821	439	496	382	431	438	434	-47	-40	-53	-47	-47	-47
	IP	EB	782	339	391	354	330	330	329	-57	-50	-55	-58	-58	-58
		WB	699	398	472	366	391	395	391	-43	-32	-48	-44	-43	-44
	PM	EB	1004	565	536	485	448	450	345	-44	-47	-52	-55	-55	-66
		WB	779	415	491	374	407	413	408	-47	-37	-52	-48	-47	-48

Summary

12.10.20 In summary, the results of the sensitivity test which excludes the Lyminster Bypass has illustrated broadly similar forecasting results to the core scenario. When the results of the core and sensitivity scenarios are compared this shows:

- Similar traffic volumes on the A27 under a Do Minimum scenario, with differences of less than 100 vehicles per hour
- A similar effect on traffic volumes for each Do Something scheme option, with forecast A27 traffic volumes typically varying by less than 10%
- A similar pattern of change in traffic volumes in the wider study area
- A similar order of journey time savings for the Do Something scheme options, of between 20% and 70% depending upon year and peak

13 Economic appraisal approach

13.1 Introduction

13.1.1 The appraisal of the economic elements associated with the Scheme has been undertaken in accordance with WebTAG Unit A1-1 Cost-Benefit Analysis (May 2018). The scope of the economic appraisal comprises the assessment of:

- Transport economic efficiency of costs and benefits using TUBA software
- Accident analysis using COBALT software
- Delays during construction using TUBA
- Monetised environmental impacts for landscape, greenhouse gases, air quality and noise
- Wider economic impacts using the Wider Impacts in Transport Appraisal (WITA) software

13.2 Economic appraisal processes

Transport user benefit appraisal (TUBA)

13.2.1 TUBA version 1.9.12 with TUBA Economics File (version 1.9.12) using TAG Data Book v1.11 (November 2018). TUBA was used to carry out the economic appraisal of the A27 Arundel Bypass options. All costs and benefits reported by TUBA are based on willingness to pay and expressed in the market price unit of account.

13.2.2 The following economic elements have been considered for the PCF Stage 2 Further Consultation of the study include:

- Time savings
- Vehicle operating costs
- Scheme costs
- Indirect tax revenue

13.2.3 The economic appraisal was carried out for a 60-year appraisal period, from 2026 (opening year) to 2085.

13.2.4 Travel time savings are monetised as a perceived benefit, reflecting users' willingness to pay for a quicker journey. The value of those savings differs depending on the reason for the trip, of which three are defined in TAG; business users, commuters, and non-commuting consumers e.g. leisure trips.

Cost and benefit to accidents – light touch (COBALT)

13.2.5 COBALT is a computer program developed by the DfT to undertake the analysis of the impact on accidents as part of economic appraisal for a road scheme. It uses detailed inputs of separate road links and road junctions impacted by the Scheme.

13.2.6 The assessment is based on a comparison of accidents by severity and associated costs across an identified network in 'without-scheme' and 'with-scheme' forecasts, using details of link and junction characteristics, relevant accident rates and costs and forecast traffic volumes by link and junction.

13.2.7 COBALT version 2013.02 with COBALT parameter file (version 2018.1) has been used to undertake the assessment of accident impacts.

13.3 Economic parameters

13.3.1 The economic input file contains all of the economic data and parameters required by TUBA in the economic appraisal.

13.3.2 The scheme input file contains data regarding scheme costs, user classes, modelled years, annualisation factors and input matrices.

Modelled years

13.3.3 Traffic flows for the economic appraisal have been based on the 2026, 2041 and 2051 forecast year PCF Stage 2 Further Consultation A27 transport model (Variable Demand Model) results.

13.3.4 Annualisation factors have been applied to convert peak period flows into annual flows. Details are provided in the following sections.

Time scales / annualisation

13.3.5 TUBA makes a distinction between time slices (single hours) and time periods. Standard time periods are defined in the economics file as:

- AM Peak (Weekday 07:00 – 10:00)
- PM Peak (Weekday 16:00 – 19:00)
- Inter-peak (Weekday 10:00 – 16:00)
- Off-peak (Weekday 19:00 – 07:00)
- Weekend

13.3.6 The A27 transport model does not include weekend and off-peak periods as origin-destination data were not collected for these time periods. This is consistent with typical practice. The potential benefits for these periods have not been determined.

13.3.7 The SATURN model has been assigned as an average hour model for the AM peak, inter-peak and PM peak periods which enables the benefits for these peak periods to be used in TUBA.

13.3.8 In order to model the time slices in TUBA, an annualisation factor is required to convert to each time period. The annualisation factor is given by h x d where h is the number of this time slice in the time period and d is the number of days a year containing the time period. The annualisation factor is specified in the scheme input file.

13.3.9 From the information detailed above, the modelled time slices used to represent the weekday benefit are detailed below:

- Average AM peak period average hour time slice
- Average PM peak period average hour time slice
- Average Inter-peak period average hour time slice

13.3.10 There are 253 peaked weekdays (excludes weekdays falling on bank holidays) meaning that the annualisation factors are:

- AM peak (07:00-10:00): 759
- PM peak (16:00-19:00): 759
- Inter-peak (10:00-16:00): 1,518

13.3.11 The benefits produced in this assessment represent a conservative estimate of the total benefits produced from the Scheme. This is due to two main reasons:

- No benefits were calculated for weekday off-peak periods (19:00 – 07:00)
- No benefits have been calculated for weekends or bank holidays

Matrix input

13.3.12 Matrix inputs were required for the number of trips and journey time for each user class and also for trip distance for input to TUBA and COBALT. The trip distance and journey time matrices were taken from the A27 transport model model directly for the 2026, 2041 and 2051 periods.

Journey purpose / user class

13.3.13 The trip matrices were split into vehicle types and journey purposes as shown in Table 13-1. The correspondence between the SATURN matrix user classes and TUBA user classes is also shown.

13.3.14 In line with SERTM a PCU value of 2.5 was used in converting HGV (vehicle units) to PCU whereas other vehicle classes remain constant i.e. 1 veh unit = 1 PCU for Car and LGV. For use within TUBA the HGV user class needs to be converted to vehicles therefore a factor of 0.4 i.e. 1/2.5 has been used.

13.3.15 All HGVs were defined as Vehicle Type 4 (Other Goods Vehicle (OGV)1) in TUBA. As these have lower operating costs than OGV2, which is likely to have resulted in a conservative estimate of benefits attributable to HGVs.

Table 13-1: TUBA to SATURN matrix user class correspondence

SATURN User Class	Vehicle Type	Journey Purpose	Tuba User Class	Tuba Purpose	PCU to Vehicle Factor
1	Car	Business	1	Business	1
2		Commuting		Commuting	
3		Other		Other	
4	LGV	LGV	2	LGV Personnel	
5			3	LGV Freight	
6	HGV	HGV	4	OGV1	0.4

13.3.16 Public transport demand has not been explicitly modelled due to the nature of the A27 Arundel Bypass Scheme and the appraisal specification. No major public transport improvement schemes proposed on the network were included in the model. As such, benefits to public transport users such as reduced journey times have not been included in the overall economic assessment.

13.4 Non-standard procedures and economic parameters

13.4.1 Standard procedures and economic parameters have been used in the economic appraisal.

13.5 Construction, operation and maintenance costs and profile

13.5.1 The scheme costs and scheme profile over the scheme period is presented in Table 13-2. A breakdown of the scheme costs can be found in Appendix E-1.

Table 13-2: Scheme cost profile (%) and costs (£m)

	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
2019	4.55%	4.37%	2.20%	4.50%	3.48%	3.39%
2020	4.34%	4.35%	3.69%	4.56%	4.01%	3.87%
2021	2.62%	2.56%	2.07%	2.80%	2.39%	2.28%
2022	8.39%	9.25%	8.75%	9.05%	9.57%	8.09%
2023	33.77%	34.72%	35.59%	38.74%	41.09%	37.30%
2024	33.14%	34.74%	32.99%	32.80%	33.48%	31.78%
2025	11.60%	8.49%	12.76%	6.23%	5.46%	12.00%
2026	1.28%	1.24%	1.48%	1.06%	0.44%	1.16%
2027	0.30%	0.26%	0.43%	0.20%	0.08%	0.09%
2028		0.02%	0.02%	0.02%		0.01%
2029		0.01%	0.01%	0.01%		0.01%
2030		0.01%	0.01%	0.01%		0.01%
2031			0.01%	0.01%		0.01%
2032						0.01%
TOTA	**£175.54**	**£170.86**	**£214.52**	**£229.73m**	**£240.82m**	**£256.57m**

13.6 Risk and optimism bias assumptions

13.6.1 The cost estimates produced by Highways England's Commercial Services Division do not include optimism bias, instead risk is assessed and incorporated at the following levels; project-specific risk, uncertainty assessment, inflation risk and systemic risk (often called 'portfolio risk' in Highways England).

13.7 Grants, subsidies, tolls and charging

13.7.1 There are no grants or subsidies included, nor any tolls or user charges.

13.8 Travel time changes calculation

13.8.1 The trip length, trip volume and journey time information needed for the travel time changes calculation in TUBA have been taken from the relevant SATURN models.

13.8.2 Table 13-3 to Table 13-15 show the time matrices (in hours) for the 2026, 2041 and 2051 forecast years for the AM peak, Inter peak and PM peak respectively for all six A27 Arundel Bypass options. This represents the total travel time in hours for each user class.

Table 13-3: AM peak – matrix total travel time (hours) by user class

Year	Option	Business	Commute	Other	LGV	HGV	Total
2026	DM	22,689	22,642	22,698	22,779	23,097	113,905
	1V5	21,996	21,956	22,002	22,094	22,439	110,486
	1V9	22,042	22,003	22,047	22,142	22,478	110,712
	3V1	21,863	21,819	21,869	21,958	22,347	109,856
	4/5AV1	21,974	21,934	21,979	22,072	22,410	110,370
	4/5AV2	22,011	21,970	22,015	22,108	22,447	110,552
	5BV1	21,977	21,937	21,982	22,072	22,420	110,388
2041	DM	23,767	23,748	23,774	23,840	24,123	119,252
	1V5	23,189	23,173	23,195	23,254	23,565	116,376
	1V9	23,317	23,303	23,324	23,388	23,690	117,023
	3V1	23,116	23,095	23,123	23,183	23,551	116,069
	4/5AV1	23,137	23,125	23,144	23,200	23,508	116,114
	4/5AV2	23,197	23,182	23,203	23,263	23,565	116,410
	5BV1	23,199	23,182	23,206	23,264	23,575	116,426
2051	DM	24,487	24,462	24,494	24,567	24,860	122,870
	1V5	23,874	23,854	23,880	23,955	24,285	119,848
	1V9	23,816	23,805	23,822	23,880	24,213	119,537
	3V1	23,787	23,771	23,794	23,855	24,236	119,445
	4/5AV1	23,808	23,791	23,815	23,880	24,197	119,491
	4/5AV2	23,925	23,905	23,929	24,001	24,311	120,071
	5BV1	23,842	23,828	23,848	23,915	24,225	119,658

Table 13-4: Inter peak – matrix total travel time (hours) by user class

Year	Option	Business	Commute	Other	LGV	HGV	Total
2026	DM	22,247	22,198	22,239	22,315	22,707	111,706
	1V5	21,571	21,521	21,563	21,645	22,081	108,380
	1V9	21,718	21,672	21,709	21,788	22,190	109,077
	3V1	21,440	21,390	21,435	21,508	21,508	107,281
	4/5AV1	21,577	21,569	21,569	21,648	22,077	108,440
	4/5AV2	21,571	21,519	21,565	21,642	22,062	108,359
	5BV1	21,525	21,473	21,519	21,598	22,022	108,137
2041	DM	23,535	23,496	23,541	23,594	23,948	118,114
	1V5	23,242	23,204	23,246	23,283	23,698	116,673
	1V9	23,325	23,286	23,328	23,369	23,764	117,072
	3V1	23,093	23,061	23,095	23,139	23,597	115,985
	4/5AV1	23,218	23,180	23,221	23,259	23,665	116,545
	4/5AV2	23,145	23,100	23,148	23,189	23,594	116,176
	5BV1	23,139	23,097	23,144	23,184	23,593	116,158
2051	DM	24,341	24,299	24,351	24,407	24,769	122,166
	1V5	23,955	23,918	23,961	24,021	24,447	120,302
	1V9	24,098	24,063	24,105	24,158	24,561	120,984
	3V1	23,912	23,882	23,918	23,976	24,453	120,140
	4/5AV1	23,890	23,850	23,977	23,947	24,380	120,043
	4/5AV2	23,919	23,879	23,925	23,978	24,409	120,109
	5BV1	23,946	23,905	23,952	24,013	24,437	120,253

Table 13-5: PM peak – matrix total travel time (hours) by user class

Year	Option	Business	Commute	Other	LGV	HGV	Total
2026	DM	22,879	22,805	22,872	22,982	23,362	114,900
	1V5	22,260	22,209	22,257	22,338	22,776	111,839
	1V9	22,485	22,406	22,476	22,551	22,951	112,869
	3V1	22,092	22,044	22,086	22,178	22,664	111,065
	4/5AV1	22,193	22,144	22,189	22,270	22,710	111,507
	4/5AV2	22,180	22,132	22,176	22,256	22,698	111,441
	5BV1	22,068	22,012	22,063	22,147	22,592	110,882
2041	DM	24,281	24,241	24,297	24,350	24,766	121,935
	1V5	23,739	23,704	23,743	23,797	24,222	119,205
	1V9	23,851	23,822	23,859	23,913	24,294	119,737
	3V1	23,555	23,523	23,557	23,602	24,083	118,320
	4/5AV1	23,653	23,617	23,657	23,706	24,131	118,764
	4/5AV2	23,550	23,521	23,554	23,605	24,030	118,260
	5BV1	23,522	23,494	23,525	23,580	23,997	118,118
2051	DM	25,235	25,193	25,245	25,306	25,723	126,702
	1V5	24,898	24,873	24,903	24,954	25,371	124,999
	1V9	25,010	24,990	25,016	25,075	25,456	125,548
	3V1	24,765	24,742	24,768	24,814	25,306	124,395
	4/5AV1	24,822	24,798	24,829	24,894	25,307	124,650
	4/5AV2	24,267	24,245	24,274	24,319	24,778	121,883
	5BV1	24,785	24,761	24,793	24,858	25,278	124,475

13.8.3 As can be seen in Table 13-3 to Table 13-5, all travel time matrices reduce between the Do Minimum and Do Something in all forecast years and all peak periods. This shows that the six scheme options would result in all user classes spending less time on the network, during all three time periods. The scale of magnitude of the travel time reduction between Do Minimum and Do Something is in the range of 1% to 6% for all user classes, across all time periods and modelled years.

13.9 TUBA - warnings

13.9.1 TUBA displays warnings when the ratio of the without scheme (Do Minimum) scenario and with scheme (Do Something) scenario travel time is outside the limits recommended by TUBA. The criteria that determine the type of error are set out in Table 13-6 and the TUBA limit values are presented in Table 13-7.

Table 13-6: TUBA – data checks

Value of r	Action
r<A or r>D	Serious warning
A<r<B or C<r<D	Warning
B<r<C	OK, no warning

Table 13-7: TUBA - limit values

A	B	C	D
0.33	0.67	1.5	3.0

13.9.2 It is typical for TUBA to provide a series of warning messages to prompt and direct the checking of the outputs. A thorough checking process was in place to ensure that the input information including economics and model data have been input into TUBA correctly. A number of runs were carried out for each option prior to running the final TUBA. This process eliminated the likelihood of any input errors or anomalies that might otherwise have been present in the final TUBA run. The interrogation of the TUBA outputs specifically focused serious warnings. Further details of serious warnings for each option are provided in Table 13-8.

Table 13-8: Summary of serious errors in TUBA

Option	Criteria	DM to DS travel time	DM to DS distance
1V5	Lower than the limit	2311	21
	Higher than the limit	96	777
1V9	Lower than the limit	2293	22
	Higher than the limit	180	1277
3V1	Lower than the limit	2511	23
	Higher than the limit	111	1185
4/5AV1	Lower than the limit	2293	21
	Higher than the limit	111	985
4/5AV2	Lower than the limit	2365	21
	Higher than the limit	111	1036
5BV1	Lower than the limit	2293	33
	Higher than the limit	96	912

13.9.3 Contents relating to serious warnings, in terms of zone pair, number of trips affected, and magnitude of quantum were examined. An examination of the above serious warnings neither indicated errors in the input data nor revealed sufficient evidence to indicate that there might be spuriousness in the estimated benefits.

13.9.4 Appendix E-2 shows the analysis of the partitioned time benefits (*.tbn) file in TUBA for all A27 Arundel Bypass options. The partitioned time benefits files (*.tbn) cross-tabulates the percentage changes in travel time and trip numbers at origin-destination (OD) level. TUBA uses the rule of a half (ROH) to calculate user benefits. However, if the change in generalised cost between the Do Minimum and Do Something is too large then the ROH can become inaccurate.

13.9.5 As a general rule, the ROH is acceptable, i.e. the error is less than ±10%, provided that the change in the generalised cost and the change in the number of trips are both less than 33%.

13.9.6 Appendix E-2 shows that the majority of the total time benefits according to change in travel time and change in trip numbers are in the range 0% to 30% and 0% to -30% meaning that there is no need to include an intermediate year between 2026, 2041 and 2051.

13.10 Justification of any methods

13.10.1 The results of the TUBA assessments were reviewed in detail. The distribution and magnitude of positive and negative journey time impacts across the model network were reviewed. From this, the locations with the most significant impacts on journey time (and therefore economic impact) were reviewed for plausibility.

13.10.2 Where the significant impacts were considered to relate to 'model noise' (see section 3.3.2), and not the direct impacts of the Scheme, a small number of minor coding amendments were made consistently to each forecast model and then re-assigned to remove any spurious impacts within the economic outputs.

13.10.3 Further to this review and updated input, a review of the sector to sector benefits and disbenefits, for each of the scheme options, has been undertaken to identify any significantly high or low spurious benefits or disbenefits. The sector to sector analysis has not resulted in the removal of any values from the assessment.

13.11 Vehicle operating cost changes

13.11.1 Vehicle operating cost savings accrue in two categories; fuel costs, a function of the speed of the vehicle through the network and fuel efficiency, and non-fuel costs such as oil, tyres, vehicle maintenance depreciation and business vehicle capital costs, largely a function of the distance travelled by the vehicle.

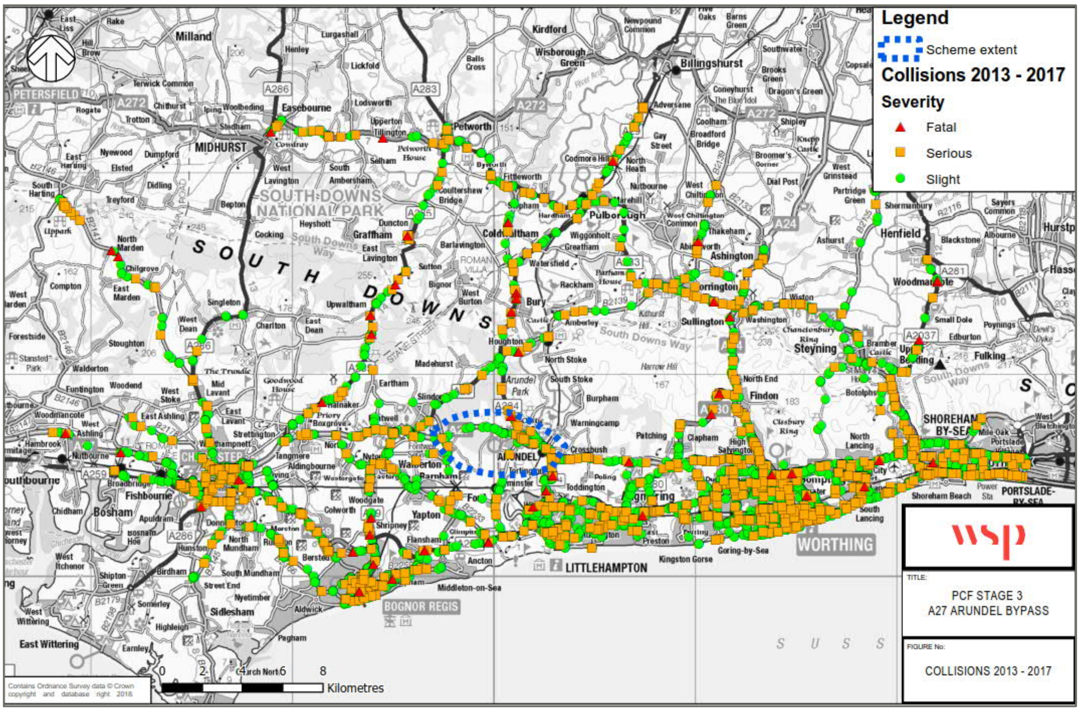
13.11.2 The costs and benefits for vehicle operating costs have been assessed using TUBA. The trip length, trip volume and journey time information needed for this has been skimmed from the relevant SATURN models.

13.12 Accident cost changes

13.12.1 For PCF Stage 2 Further Consultation, year 2017 collision data was requested from Sussex police. Collision data was updated in the COBALT to reflect the period between January 2013 - December 2017. Figure 13-1 shows the location of the fatal, serious and slight collisions for this period.

13.12.2 All observed collisions as shown in Figure 13-1 were attributed to the relevant SATURN link (A-node to B-node) within PCF Stage 2 Further Consultation A27 transport model for use within COBALT. Any SATURN model link that did not have an observed collision associated with it used the default rate within COBALT.

Figure 13-1: Collisions plot – January 2013 to December 2017



13.13 Incident delay and travel time variability

13.13.1 These have not been calculated and are not included, therefore any economic benefits that may arise from improved travel time variability (and journey time reliability) are excluded from the scheme economic benefit.

13.14 Wider economic impacts

13.14.1 Wider Impacts are designed to capture the impacts of a transport intervention which are additional to those experienced directly by the transport user (transport user benefits being journey time reductions and fewer collisions etc.).

13.14.2 In ‘perfect markets’, all economic benefits attributable to a scheme would be captured through direct transport user impacts. Given market imperfections, however, additional analysis is required to capture the full range of economic benefits as some of these benefits are not covered in conventional traffic modelling-based impacts.

13.14.3 On this basis, three types of wider impact have been assessed:

- Agglomeration improvement benefits
- Labour market supply impacts
- Output change in imperfectly competitive markets

13.14.4 It is important to note the status of these impacts under current appraisal guidance. Firstly, agglomeration-based impacts and the methodology to calculate these impacts are covered under DfT's Wider Impacts guidance (TAG unit 2.4, May 2018). Labour market impacts and output change in imperfectly competitive markets are accounted for in DfT's WebTAG units 2.3 (May 2018) and 2.2 (May 2018) respectively. All of these impact types are also covered in Highways England's Economic Growth Technical Annex of February 2018.

13.14.5 To assess the wider economic impacts for each of the proposed options for the Arundel Bypass Scheme, WSP's bespoke WITA tool has been used. The tool was created to correct existing issues with the DfT's current version[49] of the WITA software and has been used in the analysis of the Trans-Pennine scheme, which was approved and signed off by the DfT.

13.14.6 WITA implements the calculations of wider impacts as described in WebTAG Units A2.1, A2.2, A2.3 and A2.4. In all cases the WITA methodology seeks only to capture the part of the above impacts that is not already captured in conventional transport user benefit calculations.

13.14.7 The wider economic impacts are calculated over a standard 60-year appraisal period. For agglomeration impacts the total values given below cover four sectors of the economy (construction, consumer services, manufacturing and producer services). The total improvement in agglomeration depends on the bypass option being considered.

13.14.8 The estimation of positive labour supply impacts is based on the expected increase in employment from people entering work due to the Scheme being implemented. These people would otherwise be inactive due to high commuting costs.

13.14.9 The value of 'increased output in imperfectly competitive markets' resulting from each option has been estimated by applying a 10% uplift to business user benefits, in accordance with TAG unit A2.2.

13.14.10 All the results of the wider economic impacts analysis for the A27 Arundel Bypass scheme options are based on information from the A27 transport model.

[49] An updated version of DfT's WITA software, WITA 2, was expected in 2018 but to-date this has still not been released by DfT.

13.15 Delays during construction and future maintenance

13.15.1 Morgan Sindall has prepared a draft buildability report (April 2019) for the A27 Arundel Bypass scheme options. Traffic management (TM) measures for various scheme options have been provided within the buildability report. This information has been used to define a series of assumptions for traffic modelling and the estimation of delays during construction. Whilst TM assumptions for most options remain the same, some variations have been assumed for individual option. The main variations are road closures, reduced capacity at a roundabout and distance affected by speed and capacity reductions.

13.15.2 The main TM measures consist of:

- Reduction of speeds from 70mph to 50mph
- Dual carriageway from 2 lanes to 1 lane
- Single carriageway speed reduced from 60mph to 40mph
- Conversion of a priority junction to signalised junction
- 2 lane to 1 lane at junction approach and corresponding reduction in saturation flows

13.16 Monetised impacts of delays during construction

13.16.1 For modelling the impact of construction on the users, a TM model for each option has been developed using the SATURN 2026 Do Minimum forecast. The TM Do Something models have been developed for three time periods; AM peak, Inter-peak and PM peak models. The Do Minimum and the TM Do Something outputs have been used in TUBA (1.9.12) to assess the economic impacts of the TM measures on the users.

13.16.2 Given 2026 is the assumed opening year of the Scheme and the duration of construction is 2 years, monetised impacts of delays have been analysed using TUBA for the years 2024 and 2025.

13.17 Delays during maintenance

13.17.1 Maintenance data is not available to carry out user impacts during maintenance.

14 Economic appraisal results

14.1 TUBA results

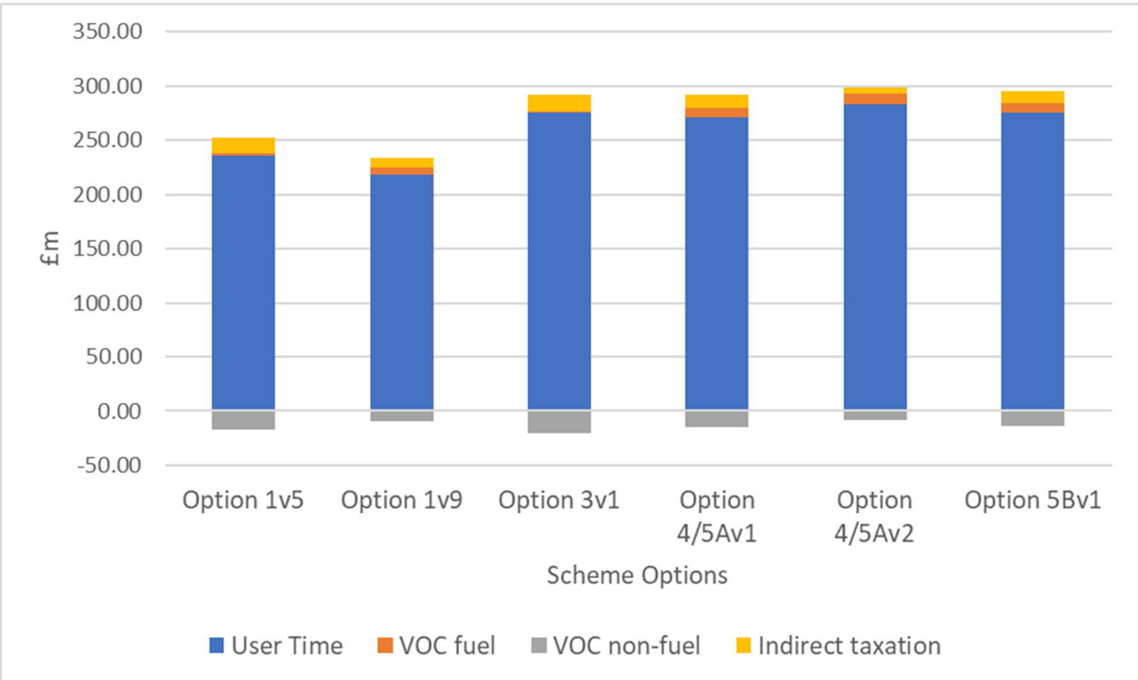
Benefits by time saving and distance travelled

14.1.1 The total benefit outputs by TUBA for each option are shown in Table 14-1 and Figure 14-1.

Table 14-1: Total impacts (TUBA) (£m)

Total impacts	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Time	235.48	218.37	275.32	271.53	283.61	275.69
VOC - Fuel	2.82	6.94	1.15	8.77	8.87	8.44
VOC - Non-fuel	-17.18	-9.69	-19.99	-14.66	-7.78	-13.89
Indirect	13.67	7.99	15.71	11.68	5.87	11.09
Total	**234.80**	**223.62**	**272.18**	**277.33**	**290.57**	**281.33**

Figure 14-1: Total impacts (TUBA) (£m)



14.1.2 The benefits as banded by size of travel time saving, as output by TUBA, are shown in Table 14-2 with the time bands being the defaults used in TUBA.

14.1.3 There are benefits delivered from journey time improvements of between 0 minutes and 2 minutes, but also dis-benefits in journey time saving of between 0 minutes to -2 minutes.

Table 14-2: Total benefits (VoT and VOC) by size of travel time saving (£m)

Option	Mode and purpose	<-5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	>5 min	Total
Option 1V5	Car (Business)	-1.58	-4.34	-8.24	10.25	20.14	17.10	**33.32**
	Car (Commuting)	-6.41	-9.75	-26.90	38.19	40.23	28.83	**64.18**
	Car (Other)	-11.69	-18.44	-48.64	51.14	58.95	52.53	**83.85**
	LGV (Personal)	-0.38	-0.79	-1.32	1.31	1.60	1.34	**1.76**
	LGV (Freight)	-5.95	-12.90	-21.55	22.01	28.05	23.15	**32.81**
	OGV1	-1.73	-7.56	-9.20	5.45	10.02	8.24	**5.21**
Total		**-27.74**	**-53.78**	**-115.84**	**128.33**	**158.99**	**131.17**	**221.13**
Option 1V9	Car (Business)	-1.12	-3.44	-9.18	10.95	20.07	13.49	**30.77**
	Car (Commuting)	-4.52	-9.10	-29.08	38.38	43.21	19.40	**58.29**
	Car (Other)	-8.08	-13.90	-52.74	51.98	61.55	46.68	**85.49**
	LGV (Personal)	-0.26	-0.62	-1.38	1.31	1.70	1.09	**1.84**
	LGV (Freight)	-4.03	-10.34	-22.79	21.81	29.37	18.47	**32.49**
	OGV1	-1.31	-5.98	-9.65	6.09	9.95	7.66	**6.76**
Total		**-19.31**	**-43.39**	**-124.83**	**130.52**	**165.85**	**106.78**	**215.63**
Option 3V1	Car (Business)	-1.34	-3.54	-8.24	10.62	21.27	18.62	**37.38**
	Car (Commuting)	-5.46	-8.43	-25.91	39.11	41.64	31.72	**72.67**
	Car (Other)	-10.30	-15.32	-47.71	53.08	61.40	57.80	**98.95**
	LGV (Personal)	-0.30	-0.66	-1.31	1.33	1.61	1.35	**2.02**
	LGV (Freight)	-4.78	-10.94	-21.52	22.34	29.33	24.17	**38.60**
	OGV1	-1.32	-6.18	-9.65	5.79	10.48	7.75	**6.86**
Total		**-23.51**	**-45.09**	**-114.34**	**132.28**	**165.72**	**141.41**	**256.47**
Option 4/5AV1	Car (Business)	-1.19	-3.92	-8.39	10.79	20.77	19.54	**37.59**

Option	Mode and purpose	<-5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	>5 min	Total
	Car (Commuting)	-4.66	-8.87	-26.82	40.48	41.96	32.54	**74.61**
	Car (Other)	-9.01	-15.73	-49.74	55.26	60.68	60.98	**102.44**
	LGV (Personal)	-0.27	-0.72	-1.32	1.39	1.71	1.51	**2.30**
	LGV (Freight)	-4.29	-11.87	-21.69	22.95	29.39	25.50	**39.99**
	OGV1	-1.29	-6.91	-9.40	5.96	11.30	9.06	**8.72**
Total		**-20.71**	**-48.03**	**-117.36**	**136.82**	**165.81**	**149.11**	**265.65**
Option 4/5AV2	Car (Business)	-1.13	-3.92	-8.37	11.30	20.17	21.16	**39.21**
	Car (Commuting)	-4.59	-9.27	-28.16	42.84	44.01	35.16	**80.00**
	Car (Other)	-8.32	-17.92	-50.21	58.68	61.29	66.76	**110.28**
	LGV (Personal)	-0.27	-0.63	-1.33	1.45	1.77	1.55	**2.53**
	LGV (Freight)	-4.22	-10.50	-21.82	23.94	30.16	26.10	**43.67**
	OGV1	-1.34	-6.66	-9.46	6.17	12.23	8.08	**9.02**
Total		**-19.87**	**-48.89**	**-119.33**	**144.37**	**169.63**	**158.79**	**284.70**
Option 5BV1	Car (Business)	-1.16	-4.23	-8.12	10.69	20.04	21.03	**38.26**
	Car (Commuting)	-4.44	-9.50	-26.82	40.10	40.91	36.06	**76.30**
	Car (Other)	-8.61	-17.03	-48.03	54.42	59.54	65.85	**106.14**
	LGV (Personal)	-0.26	-0.77	-1.34	1.36	1.68	1.56	**2.22**
	LGV (Freight)	-4.12	-12.79	-21.90	22.56	28.81	26.39	**38.96**
	OGV1	-1.29	-7.17	-9.26	5.79	10.98	9.29	**8.36**
Total		**-19.88**	**-51.49**	**-115.46**	**134.92**	**161.95**	**160.18**	**270.24**

Travel time and vehicle operating cost results

14.1.4 Table 14-3 to Table 14-5 show the travel time benefits, as output by TUBA, for each option broken down by time period for the variable demand assignment. The results are also presented using the standard TEE and Analysis of Monetised Costs and Benefits (AMCB) tables in Appendix E-5 and Appendix E-7. The results are presented for the years 2026, 2041 and 2051, and for the total 60-year appraisal period.

Table 14-3: Transport user impacts by time period: travel time (£m)

		AM Peak	Inter Peak	PM Peak	Total
Option 1V5	2026	1.04	2.08	1.11	**4.23**
	2041	1.05	1.51	2.89	**5.45**
	2051	0.98	1.64	1.28	**3.89**
	Total	**54.83**	**89.29**	**91.37**	**235.48**
Option 1V9	2026	1.02	1.68	0.85	**3.54**
	2041	1.00	1.38	3.22	**5.60**
	2051	1.06	1.40	1.03	**3.49**
	Total	**56.84**	**83.05**	**78.48**	**218.37**
Option 3V1	2026	1.26	2.30	1.53	**5.10**
	2041	1.19	1.87	3.65	**6.71**
	2051	1.09	1.66	1.64	**4.39**
	Total	**62.31**	**114.72**	**98.28**	**275.32**
Option 4/5AV1	2026	1.10	2.12	1.28	**4.50**
	2041	1.19	1.55	3.62	**6.35**
	2051	1.14	1.81	1.59	**4.54**
	Total	**62.80**	**110.73**	**98.00**	**271.53**
Option 4/5AV2	2026	1.06	2.02	1.28	**4.36**
	2041	1.04	1.66	3.66	**6.36**
	2051	1.04	1.72	2.16	**4.92**
	Total	**57.09**	**130.92**	**95.61**	**283.61**
Option 5BV1	2026	1.11	2.08	1.64	**4.83**
	2041	1.20	1.51	3.81	**6.52**
	2051	1.09	1.67	1.78	**4.53**
	Total	**61.06**	**122.30**	**92.34**	**275.69**

Table 14-4: Transport user impacts by time period: VOC fuel (£m)

		AM Peak	Inter Peak	PM Peak	Total
Option 1V5	2026	-0.01	-0.09	-0.01	**-0.11**
	2041	0.02	-0.01	0.12	**0.13**
	2051	0.03	0.01	0.03	**0.06**
	Total	**0.96**	**-0.53**	**2.40**	**2.82**
Option 1V9	2026	0.02	-0.03	0.05	**0.04**
	2041	0.05	0.03	0.16	**0.24**
	2051	0.05	0.03	0.05	**0.12**
	Total	**2.11**	**1.02**	**3.81**	**6.94**
Option 3V1	2026	-0.04	-0.16	0.00	**-0.19**
	2041	0.01	-0.04	0.14	**0.11**
	2051	0.02	-0.02	0.04	**0.04**
	Total	**0.39**	**-2.23**	**2.99**	**1.15**
Option 4/5AV1	2026	0.04	-0.01	0.06	**0.08**
	2041	0.06	0.03	0.17	**0.26**
	2051	0.06	0.04	0.07	**0.17**
	Total	**2.68**	**1.57**	**4.52**	**8.77**
Option 4/5AV2	2026	0.03	-0.02	0.05	**0.07**
	2041	0.05	0.05	0.17	**0.27**
	2051	0.05	0.04	0.07	**0.17**
	Total	**2.42**	**1.73**	**4.72**	**8.87**
Option 5BV1	2026	0.03	-0.02	0.05	**0.07**
	2041	0.06	0.04	0.17	**0.26**
	2051	0.05	0.04	0.06	**0.16**
	Total	**2.50**	**1.48**	**4.46**	**8.44**

Table 14-5: Transport user impacts by time period: VOC non-fuel (£m)

		AM Peak	Inter Peak	PM Peak	Total
Option 1V5	2026	-0.21	-0.42	-0.24	**-0.86**
	2041	-0.08	-0.17	-0.06	**-0.31**
	2051	-0.06	-0.12	-0.09	**-0.26**
	Total	**-4.00**	**-8.38**	**-4.79**	**-17.18**
Option 1V9	2026	-0.16	-0.27	-0.14	**-0.56**
	2041	-0.05	-0.08	0.00	**-0.13**
	2051	-0.04	-0.06	-0.05	**-0.15**
	Total	**-2.71**	**-4.58**	**-2.39**	**-9.69**
Option 3V1	2026	-0.25	-0.48	-0.24	**-0.97**
	2041	-0.10	-0.20	-0.04	**-0.34**
	2051	-0.07	-0.15	-0.10	**-0.32**
	Total	**-5.13**	**-10.10**	**-4.77**	**-19.99**
Option 4/5AV1	2026	-0.18	-0.39	-0.21	**-0.78**
	2041	-0.06	-0.15	-0.03	**-0.24**
	2051	-0.04	-0.10	-0.08	**-0.22**
	Total	**-3.16**	**-7.46**	**-4.04**	**-14.66**
Option 4/5AV2	2026	-0.17	-0.38	-0.18	**-0.73**
	2041	-0.05	-0.13	0.00	**-0.18**
	2051	-0.04	-0.10	0.12	**-0.02**
	Total	**-2.85**	**-6.91**	**1.98**	**-7.78**
Option 5BV1	2026	-0.18	-0.38	-0.19	**-0.74**
	2041	-0.06	-0.14	-0.02	**-0.21**
	2051	-0.04	-0.10	-0.08	**-0.22**
	Total	**-3.02**	**-7.11**	**-3.76**	**-13.89**

14.1.5 Table 14-6 to Table 14-8 show the benefits broken down by trip purpose for variable assignment. The benefits are presented for the years 2026, 2041 and 2051, and for the total 60-year appraisal period (2026 to 2085).

Table 14-6: Transport user impacts by user class: travel time (£m)

		Business	Commute	Other	Total
Option 1V5	2026	1.26	1.11	1.86	**4.23**
	2041	1.62	1.58	2.25	**5.45**
	2051	1.18	1.15	1.56	**3.89**
	Total	**70.93**	**68.06**	**96.49**	**235.49**
Option 1V9	2026	1.06	0.84	1.64	**3.54**
	2041	1.69	1.54	2.36	**5.60**
	2051	1.08	0.98	1.43	**3.49**
	Total	**66.83**	**59.78**	**91.76**	**218.37**
Option 3V1	2026	1.51	1.37	2.21	**5.10**
	2041	2.02	1.90	2.79	**6.71**
	2051	1.34	1.27	1.78	**4.39**
	Total	**83.29**	**78.47**	**113.57**	**275.32**
Option 4/5AV1	2026	1.31	1.19	2.00	**4.50**
	2041	1.92	1.84	2.60	**6.35**
	2051	1.37	1.32	1.86	**4.54**
	Total	**81.46**	**77.97**	**112.11**	**271.53**
Option 4/5AV2	2026	1.28	1.14	1.93	**4.36**
	2041	1.91	1.80	2.65	**6.36**
	2051	1.53	1.44	1.95	**4.92**
	Total	**86.88**	**81.20**	**115.53**	**283.61**
Option 5BV1	2026	1.40	1.27	2.16	**4.83**
	2041	1.93	1.86	2.74	**6.52**
	2051	1.34	1.33	1.86	**4.53**
	Total	**81.19**	**79.27**	**115.23**	**275.69**

Table 14-7: Transport user impacts by user class: VOC fuel (£m)

		Business	Commuting	Other	Total
Option 1V5	2026	-0.14	0.04	-0.01	**-0.11**
	2041	-0.04	0.08	0.09	**0.13**
	2051	-0.02	0.05	0.04	**0.06**
	Total	**-2.08**	**2.74**	**2.15**	**2.82**
Option 1V9	2026	-0.07	0.05	0.05	**0.03**
	2041	0.01	0.09	0.14	**0.24**
	2051	0.01	0.05	0.06	**0.12**
	Total	**-0.15**	**3.04**	**4.06**	**6.94**
Option 3V1	2026	-0.18	0.01	-0.03	**-0.19**
	2041	-0.05	0.06	0.09	**0.11**
	2051	-0.04	0.04	0.03	**0.04**
	Total	**-2.91**	**2.17**	**1.89**	**1.15**
Option 4/5AV1	2026	-0.05	0.06	0.07	**0.08**
	2041	0.02	0.09	0.15	**0.26**
	2051	0.02	0.06	0.08	**0.17**
	Total	**0.49**	**3.45**	**4.84**	**8.77**
Option 4/5AV2	2026	-0.06	0.06	0.07	**0.07**
	2041	0.02	0.09	0.16	**0.27**
	2051	0.02	0.06	0.09	**0.17**
	Total	**0.53**	**3.34**	**5.00**	**8.87**
Option 5BV1	2026	-0.07	0.06	0.07	**0.07**
	2041	0.02	0.09	0.16	**0.26**
	2051	0.01	0.06	0.08	**0.16**
	Total	**0.14**	**3.44**	**4.85**	**8.44**

Table 14-8: Transport user impacts by user class: VOC non-fuel (£m)

		Business	Commute	Other	Total
Option 1V5	2026	0.03	-0.31	-0.59	**-0.86**
	2041	0.08	-0.13	-0.25	**-0.31**
	2051	0.05	-0.10	-0.21	**-0.26**
	Total	**2.49**	**-6.62**	**-13.04**	**-17.18**
Option 1V9	2026	0.06	-0.22	-0.40	**-0.56**
	2041	0.11	-0.09	-0.15	**-0.13**
	2051	0.06	-0.07	-0.14	**-0.15**
	Total	**3.35**	**-4.53**	**-8.50**	**-9.69**
Option 3V1	2026	0.03	-0.37	-0.63	**-0.97**
	2041	0.09	-0.16	-0.27	**-0.34**
	2051	0.04	-0.12	-0.24	**-0.32**
	Total	**2.47**	**-7.97**	**-14.49**	**-19.99**
Option 4/5AV1	2026	0.09	-0.32	-0.55	**-0.78**
	2041	0.12	-0.13	-0.23	**-0.24**
	2051	0.08	-0.11	-0.19	**-0.22**
	Total	**4.35**	**-6.80**	**-12.21**	**-14.66**
Option 4/5AV2	2026	0.08	-0.29	-0.52	**-0.73**
	2041	0.12	-0.11	-0.19	**-0.18**
	2051	0.08	-0.04	-0.06	**-0.01**
	Total	**4.48**	**-4.55**	**-7.71**	**-7.78**
Option 5BV1	2026	0.09	-0.30	-0.53	**-0.74**
	2041	0.12	-0.12	-0.21	**-0.21**
	2051	0.07	-0.10	-0.19	**-0.22**
	Total	**4.23**	**-6.41**	**-11.72**	**-13.89**

14.1.6 Analysis of benefits has been carried on a geographical basis by running TUBA with a sector file. This has enabled user benefits between each model zone origin and destination pair to be aggregated into larger geographical areas. The sectors are shown in Appendix B-1.

14.1.7 Figure 14-2 to Figure 14-13 show the 60 year origin and destination benefits for individual sectors within the modelled area. Consistent across all options, most origin sectors have strong benefits, with those sectors away from the Scheme demonstrating higher benefits, and for sectors closer to the Scheme showing lower benefits or, in the case of a few, disbenefits. This is indicative of long-distance trips benefitting more from the Scheme when compared to local trips. The destinations sectors generally show lower benefits overall. Disbenefits to sectors to the east of the modelled area occur mainly as a result of increased delays in the Worthing and Lancing area due to increased traffic on the existing A27.

Figure 14-2: 60 year origin benefits by sector: Option 1V5

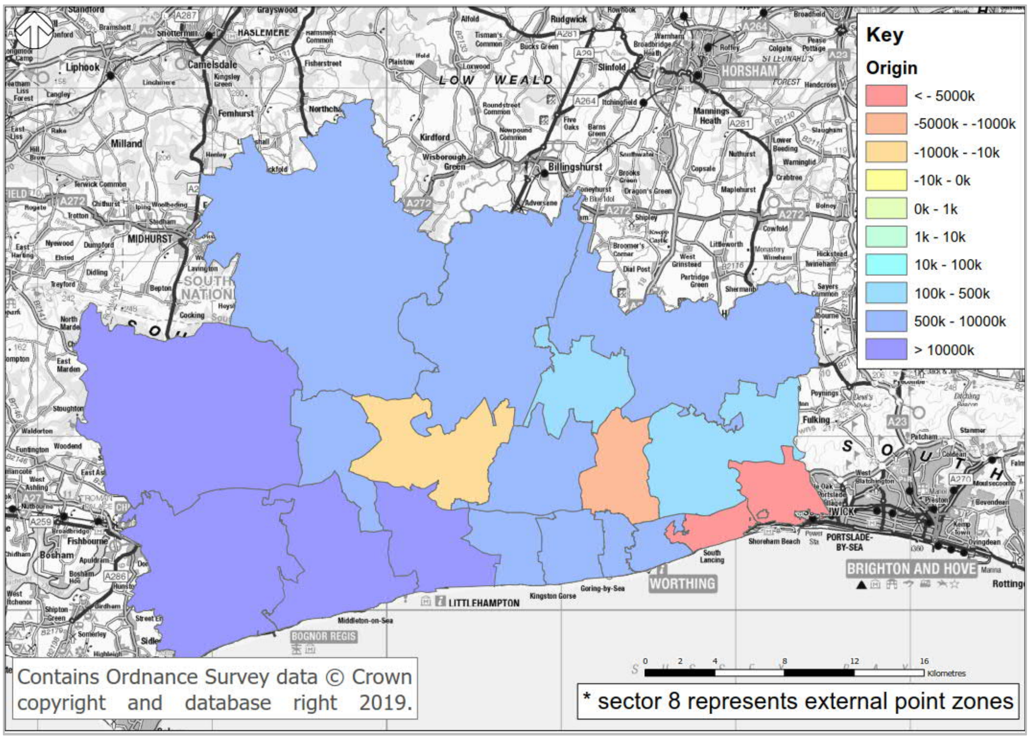


Figure 14-3: 60 year destination benefits by sector: Option 1V5

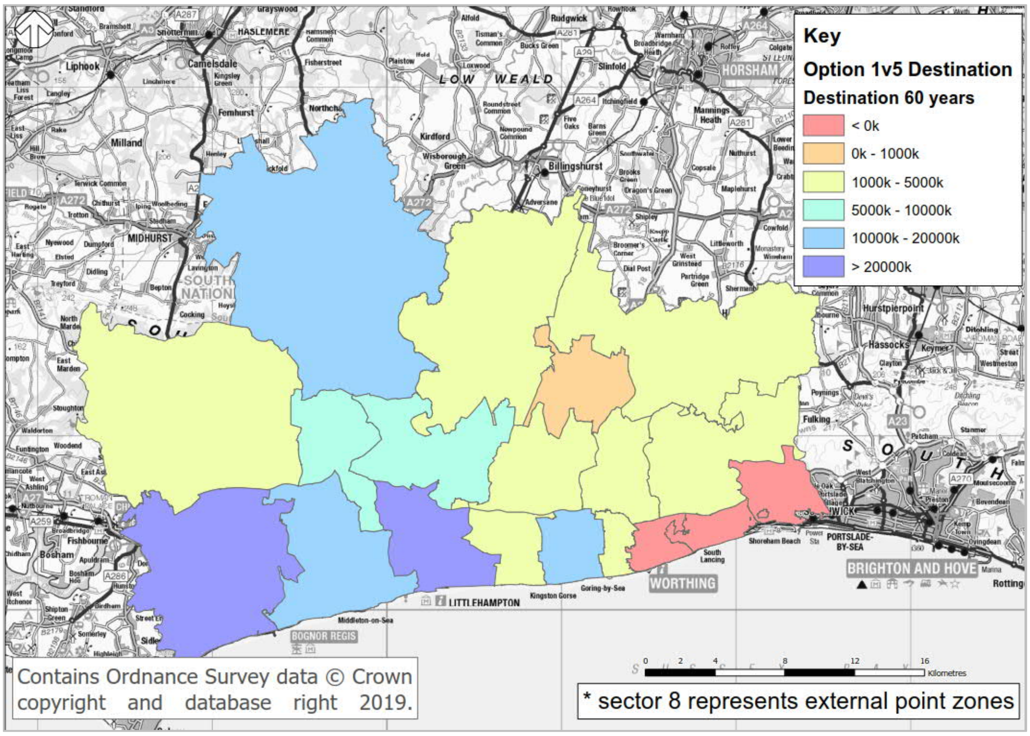


Figure 14-4: 60 year origin benefits by sector: Option 1V9

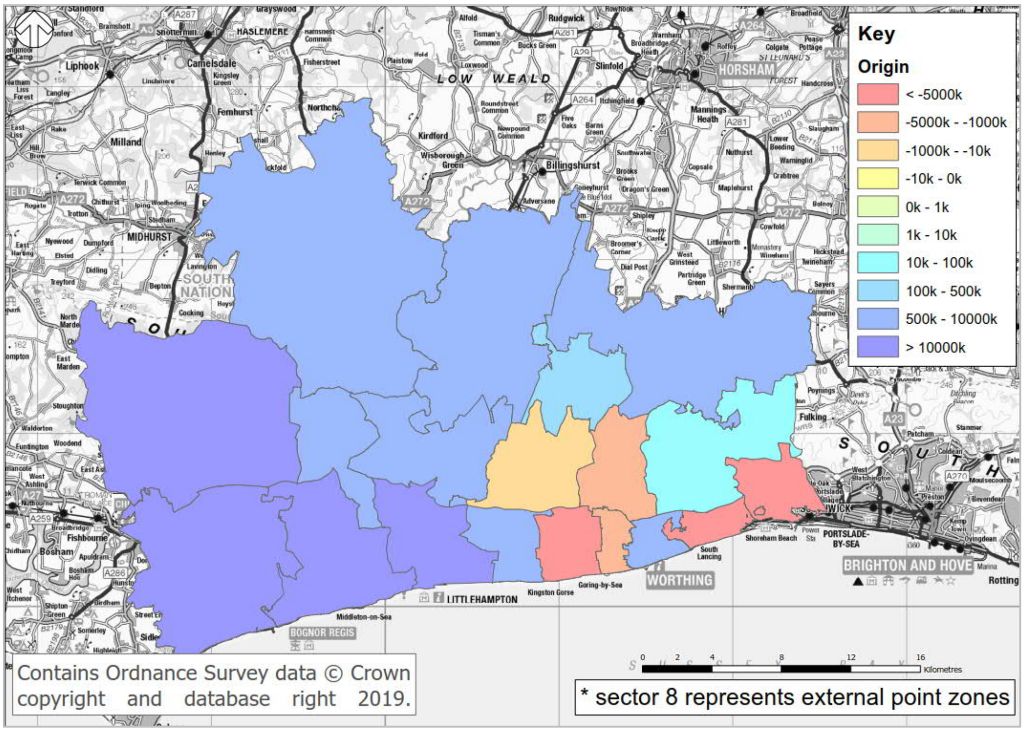


Figure 14-5: 60 year destination benefits by sector: Option 1V9

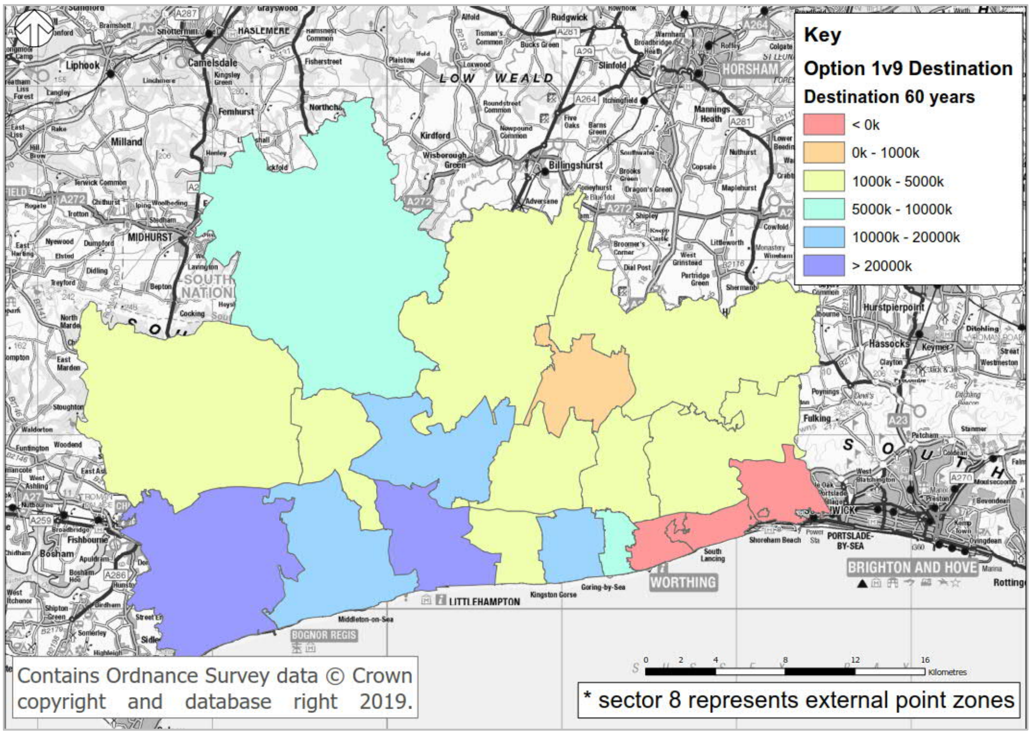


Figure 14-6: 60 year origin benefits by sector: Option 3V1

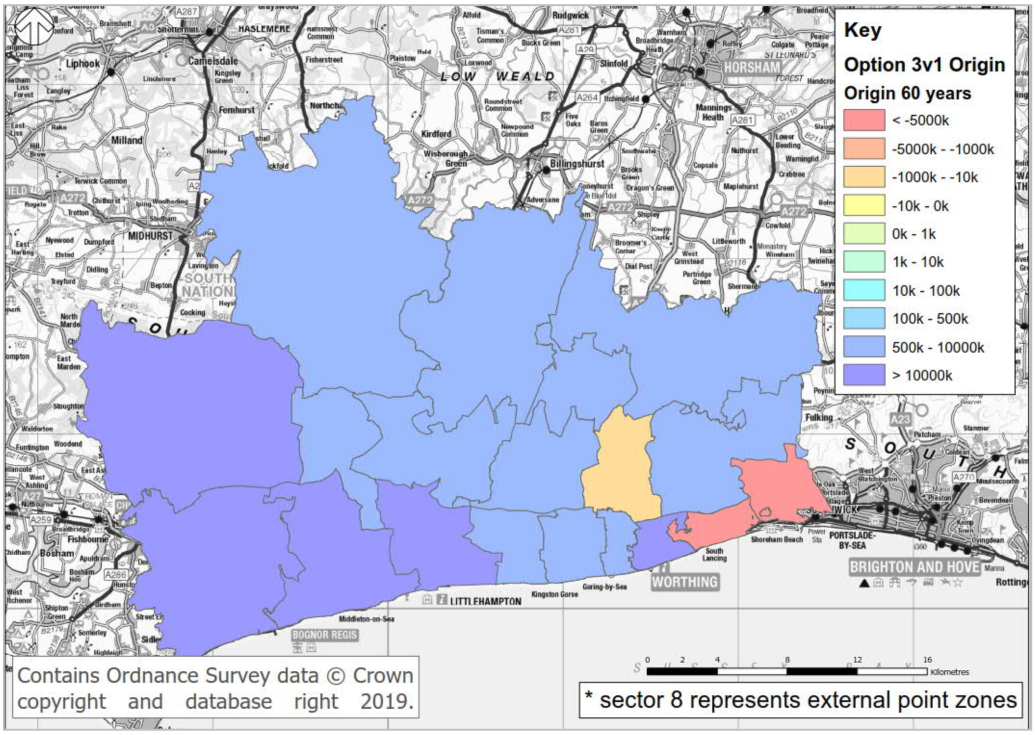


Figure 14-7: 60 year destination benefits by sector: Option 3V1

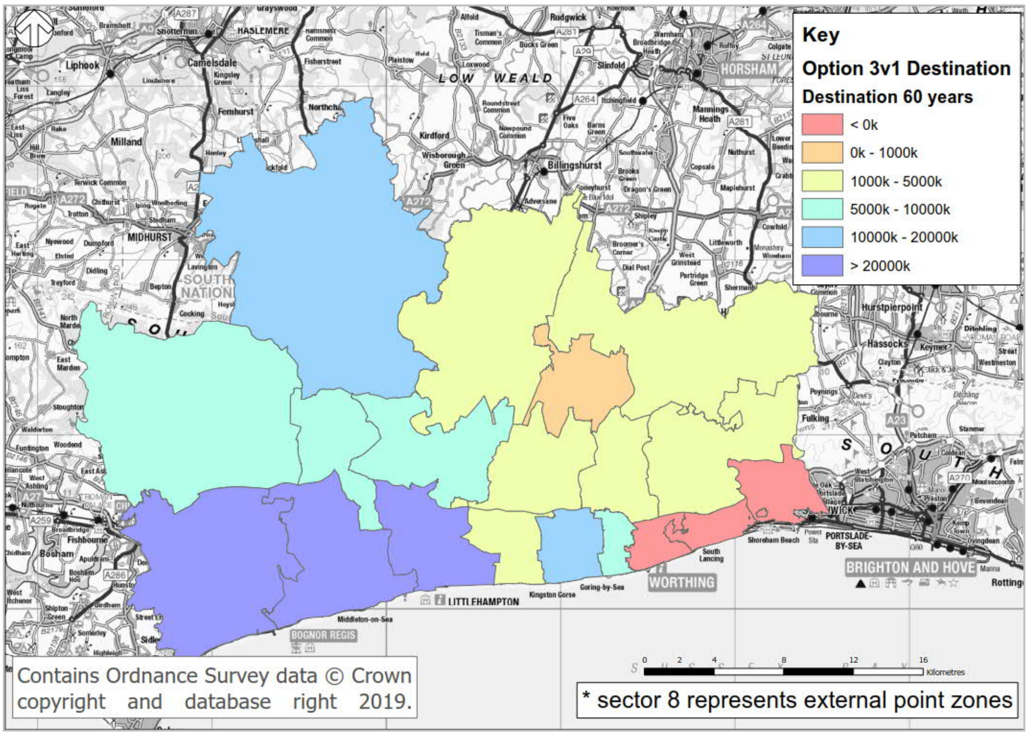


Figure 14-8: 60 year origin benefits by sector: Option 4/5AV1

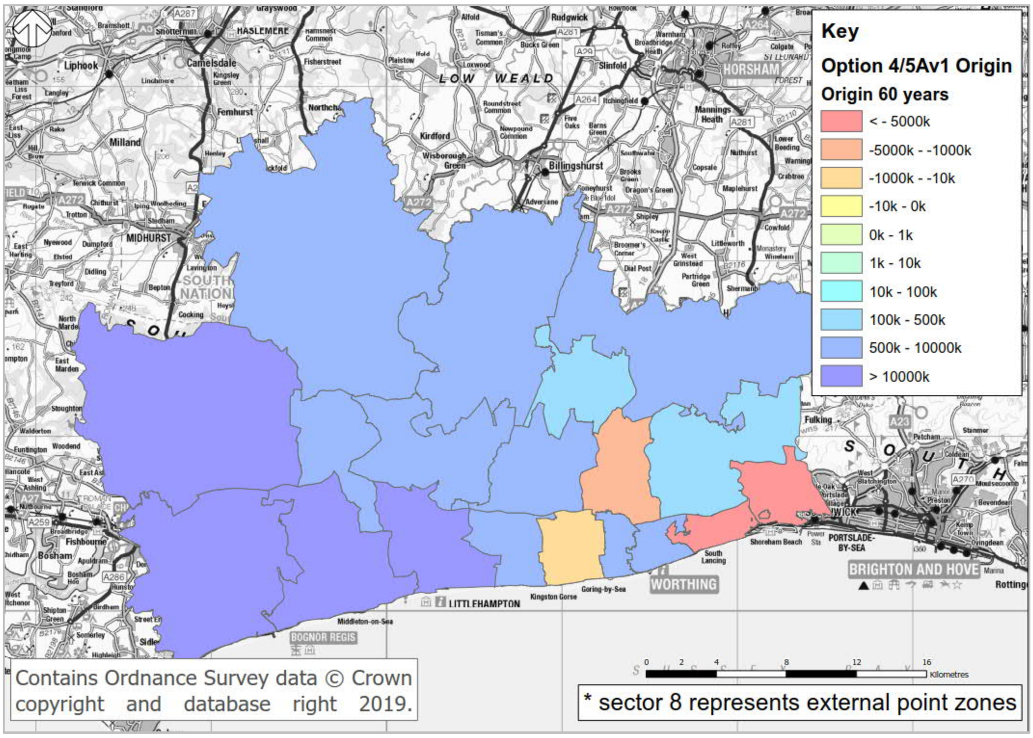


Figure 14-9: 60 year destination benefits by sector: Option 4/5AV1

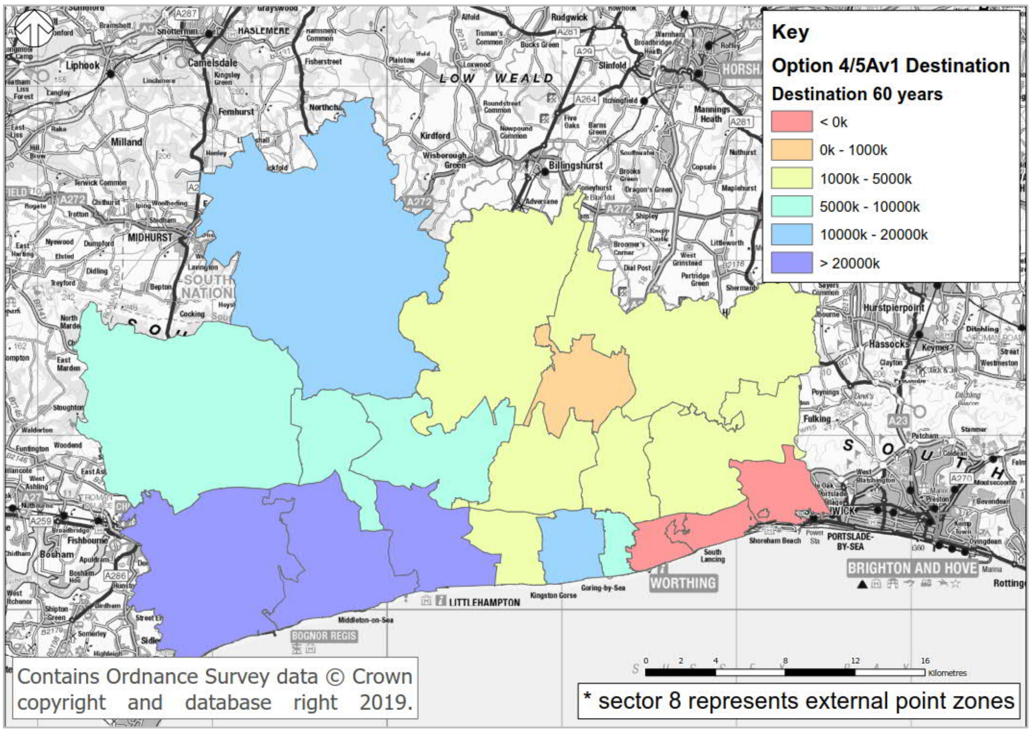


Figure 14-10: 60 year origin benefits by sector: Option 4/5AV2

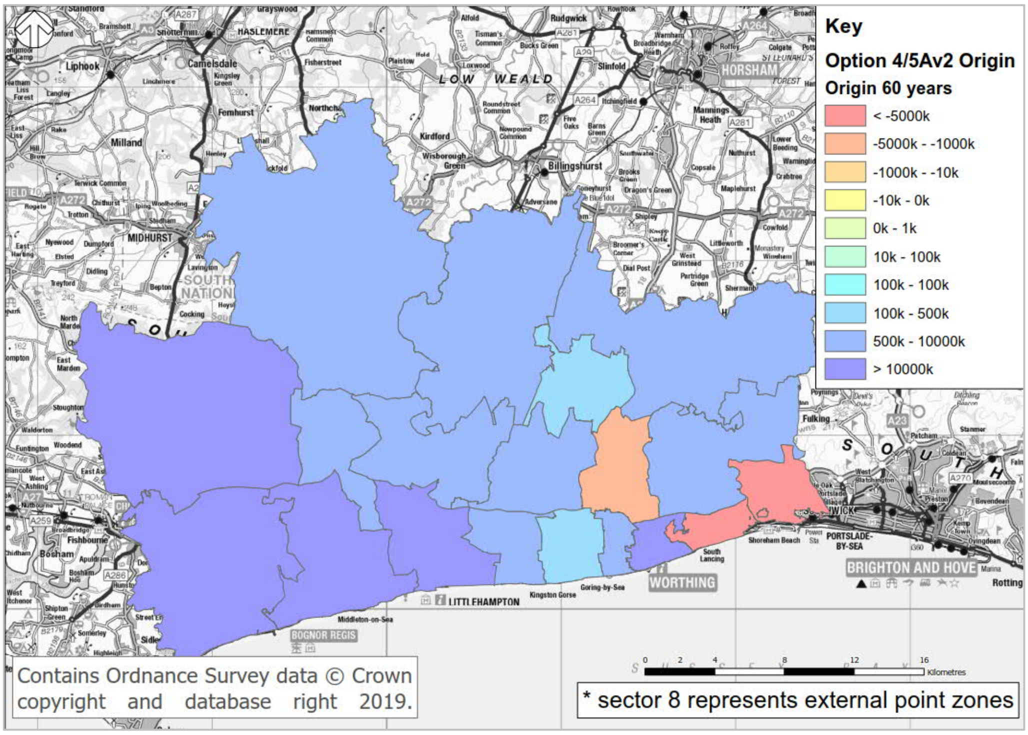


Figure 14-11: 60 year destination benefits by sector: Option 4/5AV2

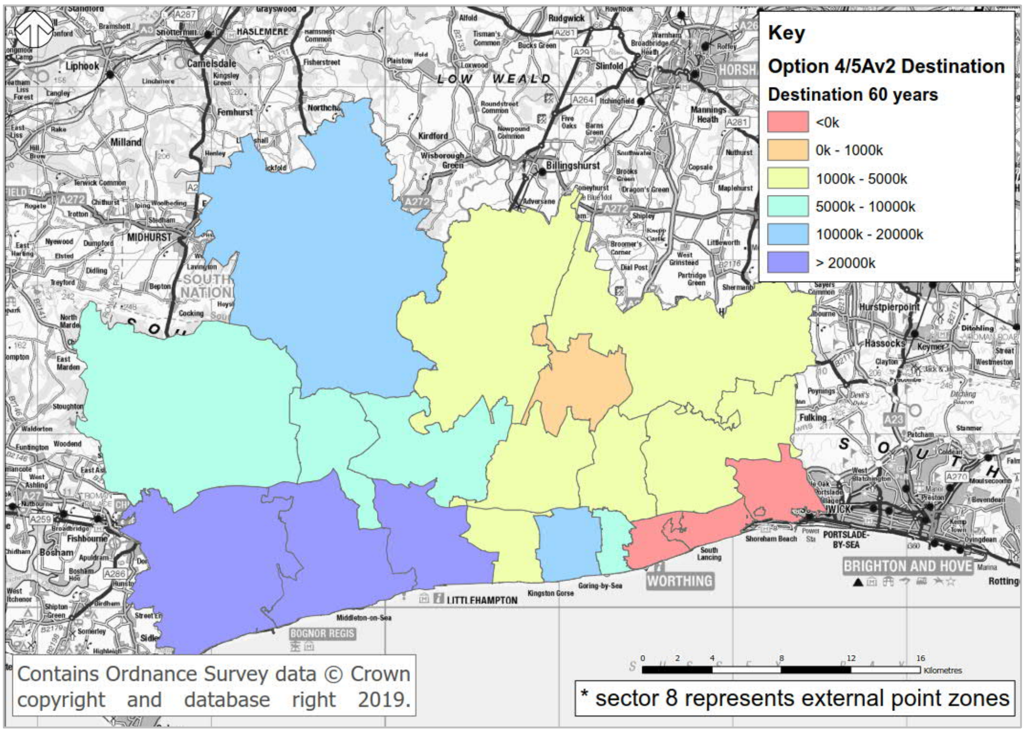


Figure 14-12: 60 year origin benefits by sector: Option 5BV1

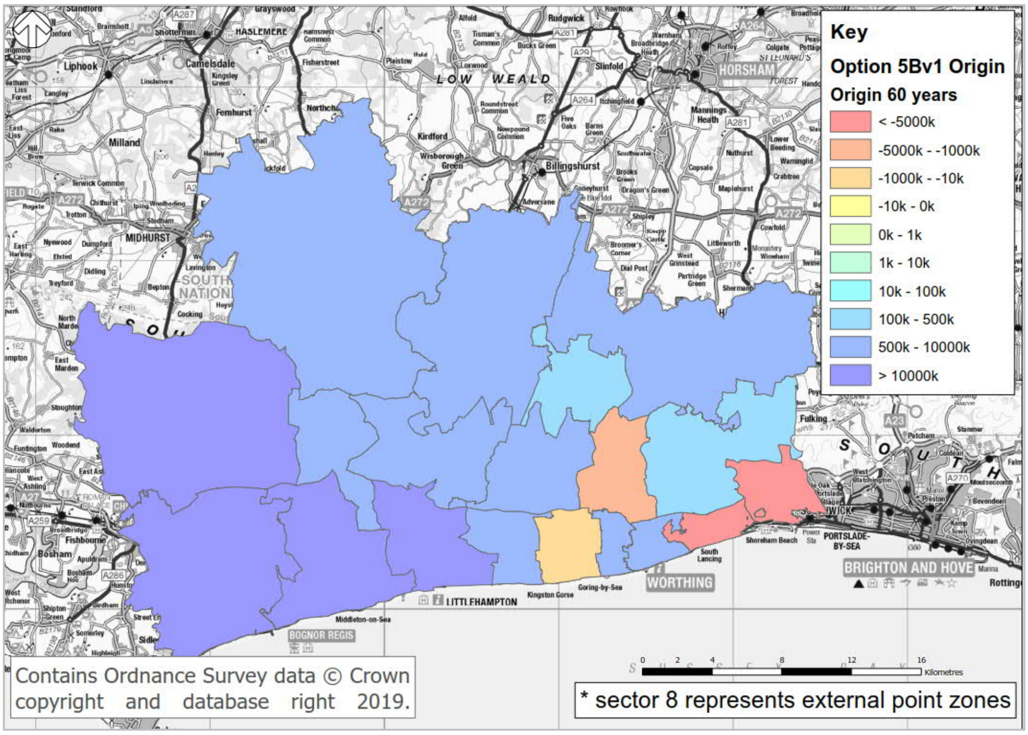
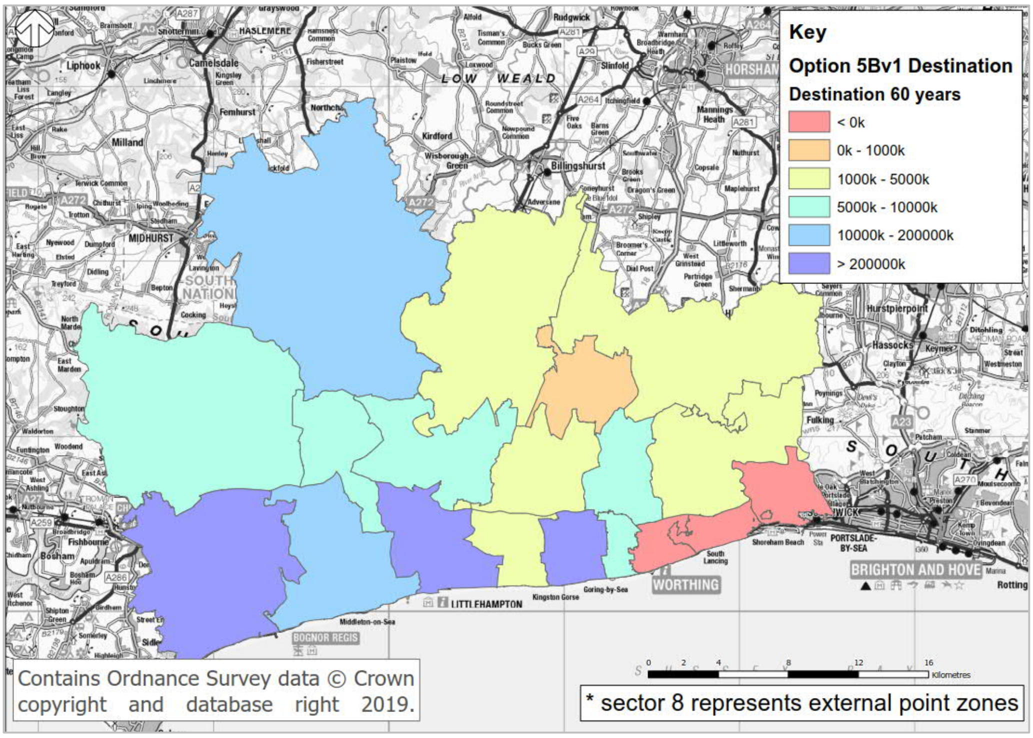


Figure 14-13: 60 year destination benefits by sector: Option 5BV1

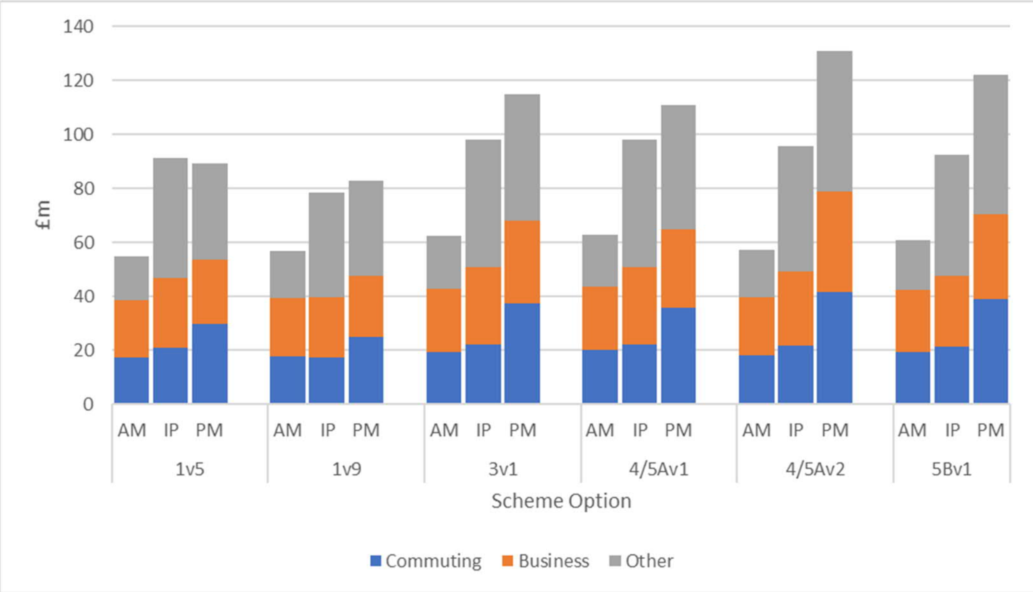


14.1.8 Tables showing the sector-to-sector benefit are included in Appendix E-4**.**

14.2 Profile of the benefits

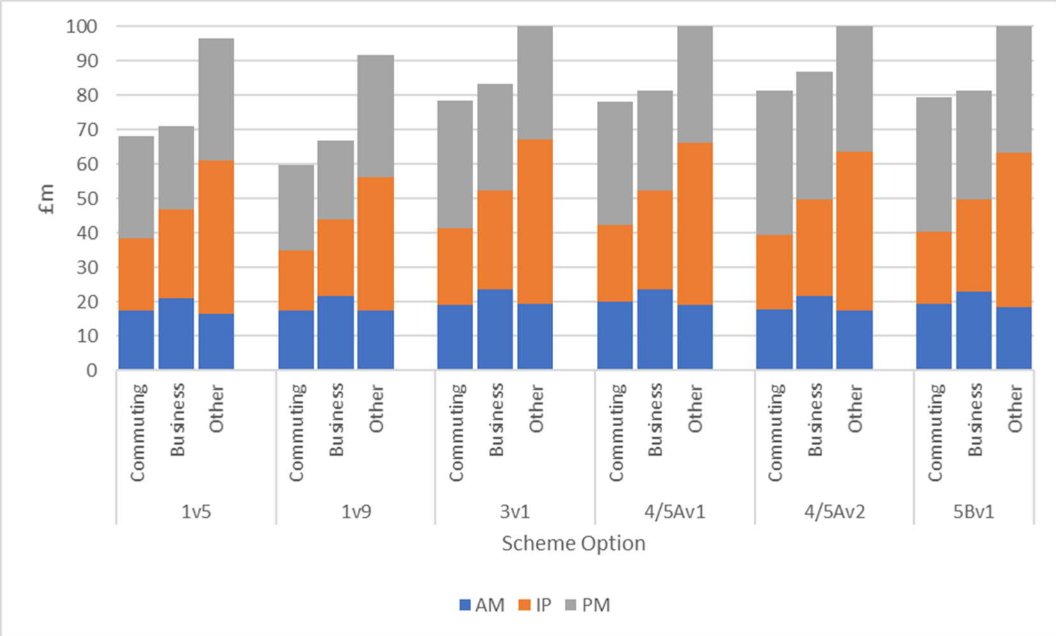
14.2.1 Figure 14-14 shows the profile of benefits, for all six A27 Arundel Bypass options, by time period. As can be seen, the benefits are mostly highest in the PM peak, with the exception of Option 1V5 where the benefits are slightly higher in the Inter-peak.

Figure 14-14: Profile of benefits core scenario, by time period



14.2.2 Figure 14-15 shows the profile of benefits, for all six A27 Arundel Bypass options, by purpose. As can be seen, the benefits are highest for Other users, and lowest for Commuters for all options.

Figure 14-15: Profile of benefits, core scenario, by purpose

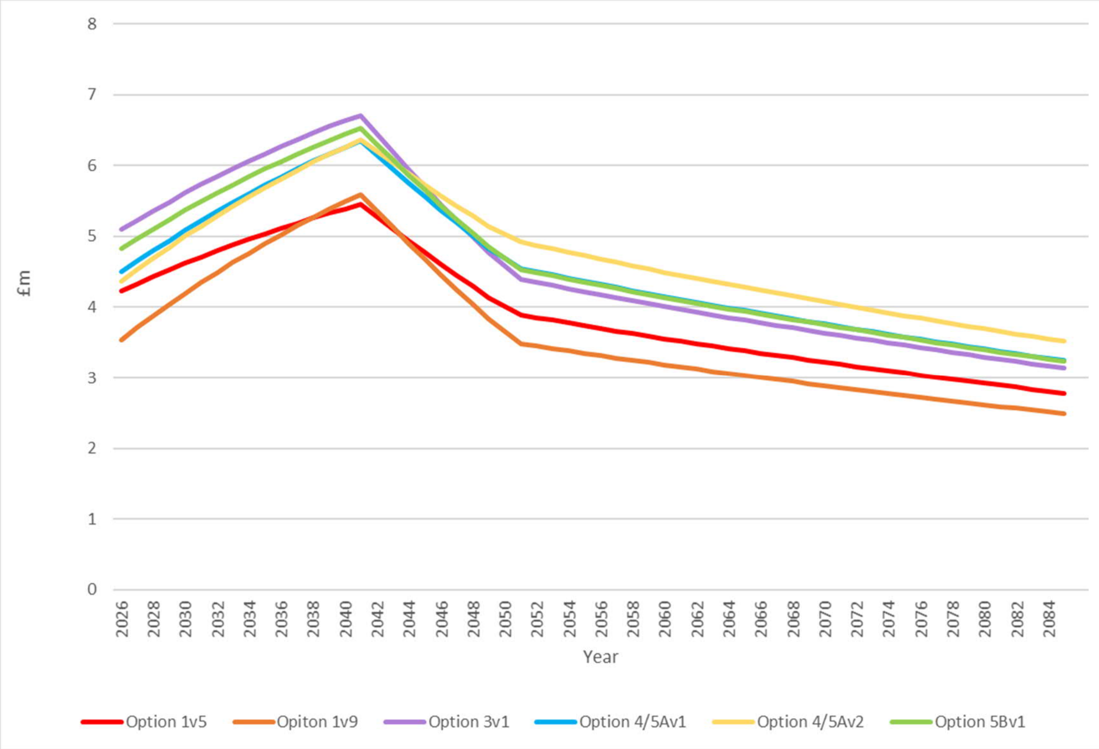


14.3 Profile of the benefits over 60 years

14.3.1 The scheme benefits are explicitly calculated only for the modelled years of 2026, 2041 and 2051. Benefits for each year between those years are interpolated from their outputs. The default assumption in TUBA is that there is no growth in the magnitude of impacts after the last modelled year, and this is assumed for the purposes of this Scheme.

14.3.2 The benefits accrued in each year over the life of the Scheme, given these assumptions, are shown in Figure 14-16. For all options scheme benefits peak in 2041 and reduce to year 2051. Thereafter scheme benefits are slowly reduced year-on-year due to the effects of congestion, inflation and the discounting of benefits further into the future.

Figure 14-16: TUBA benefits by year (60-year appraisal period)

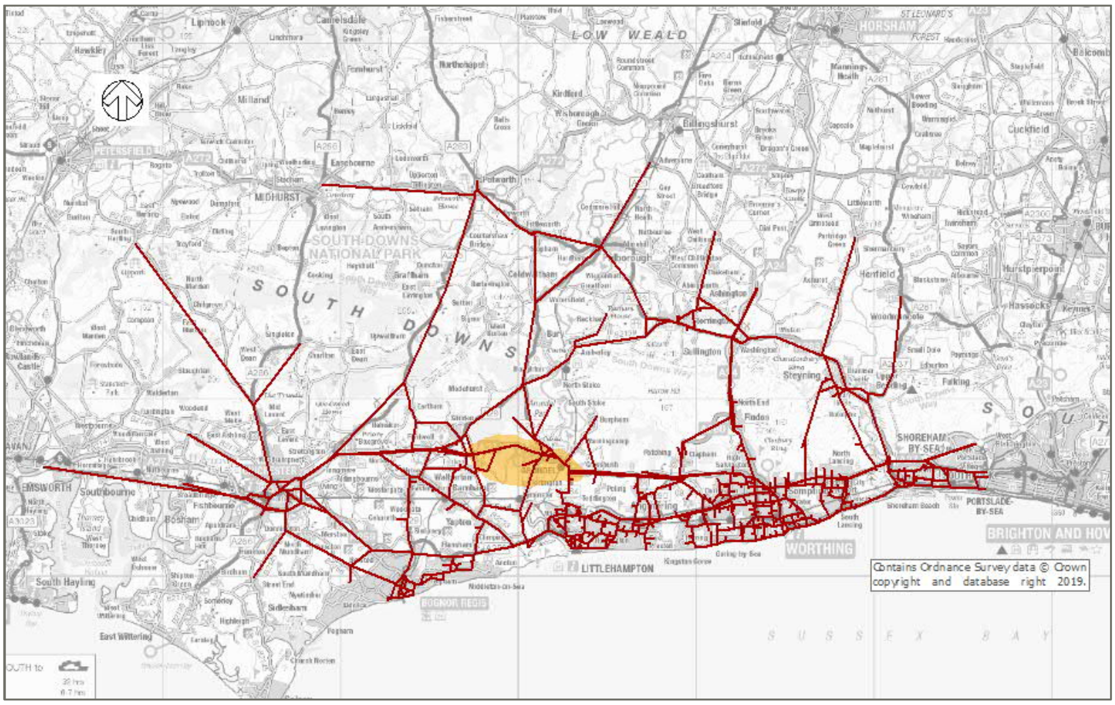


14.4 Accident analysis using COBALT

14.4.1 The accident analysis, in COBALT, for the A27 Arundel Bypass scheme options are based on traffic flows from the A27 transport model for PCF Stage 2 Further Consultation. The extent of the COBALT network used for this Scheme is shown in Figure 14-17, with the A27 Arundel Bypass site highlighted.

14.4.2 The results from COBALT were subject to review to confirm the plausibility of the results. Detailed analysis of the accident benefits has revealed that a link in Chichester, which can be considered as being outside the influence of the Scheme, was generating unrealistically high benefits. In keeping with COBALT good practice principles, this link has been removed from the assessment. The results presented below reflect the removal of this link.

Figure 14-17: Extent of COBALT network



14.4.3 The results of the COBALT analysis for the A27 Arundel Bypass Scheme options are presented in Table 14-9.

Table 14-9: A27 Arundel Bypass - Total accident benefits (£m)

Period	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Total Without-Scheme Accident Costs	2396.24					
Total With-Scheme Accident Costs	2373.03	2374.43	2374.27	2367.22	2359.34	2361.22
Total Accident Benefits Saved by Scheme	23.21	21.82	21.97	29.02	36.90	35.03

14.4.4 Table 14-10 shows the total number of accidents saved over the 60-year appraisal period across the COBALT network.

Table 14-10: Accident summary

Period	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Total Without-Scheme Accidents	55,484					
Total With-Scheme Accidents	55,073	55,087	55,105	54,957	54,757	54,808
Total Accidents Saved by Scheme	411	397	379	527	727	676

14.4.5 A breakdown of the casualties saved across the COBALT network as a result of the Scheme is shown in Table 14-11.

Table 14-11: Casualties saved by scheme

Period	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Fatal	4	4	4	8	9	9
Serious	85	78	85	105	133	126
Slight	500	473	457	639	878	817
Total	589	555	545	751	1,019	952

Accident results: A27 scheme section - monetised impacts

14.4.6 Figure 14-18 to Figure 14-23 show the accident benefits or disbenefits over the length of the A27 Arundel Bypass Scheme. The information shown is the 60 year appraisal period and show the monetised safety benefits by link for the A27 scheme section. The benefits shown are the difference between the Do Minimum (without scheme) and Do Something (with scheme), therefore the creation of new links leads to accidents where there were none before, such as on new bypass sections of the Scheme. This is countered by less traffic and consequently fewer accidents on the existing A27/relieved route and other alternative routes.

14.4.7 Appendix E-1 presents further information including the number of accidents on each section of road.

Figure 14-18: Accident impacts - Option 1V5

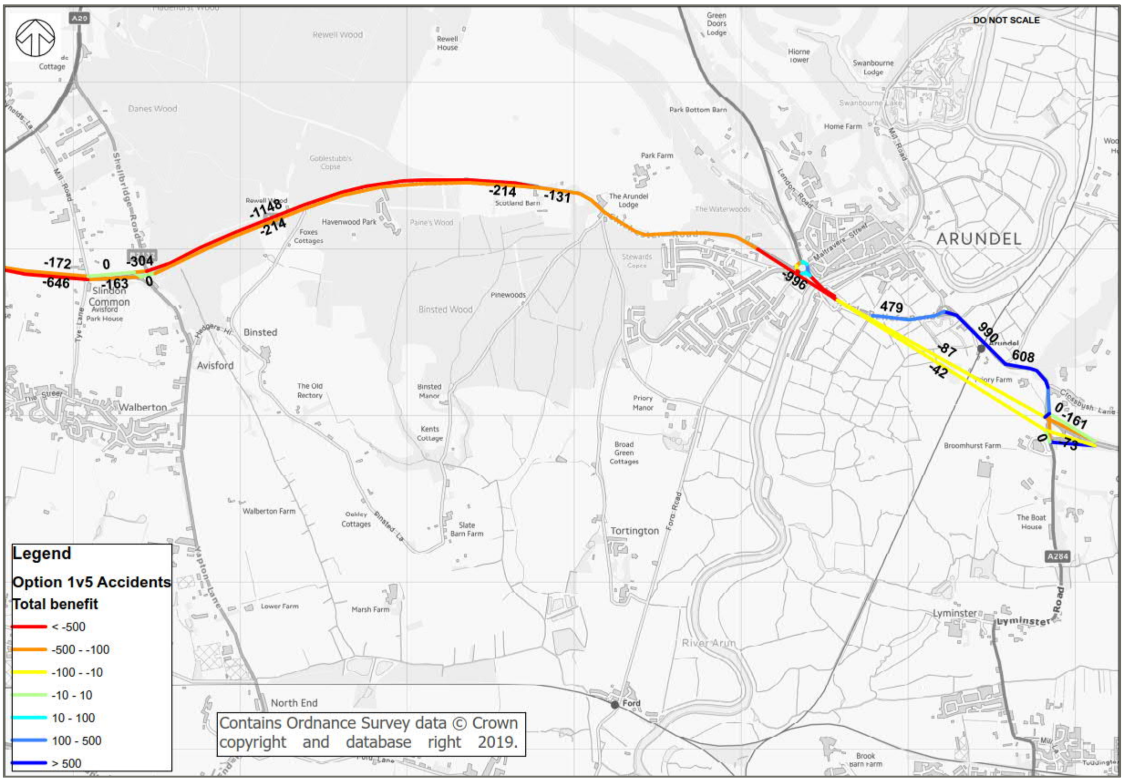


Figure 14-19: Accident impacts - Option 1V9

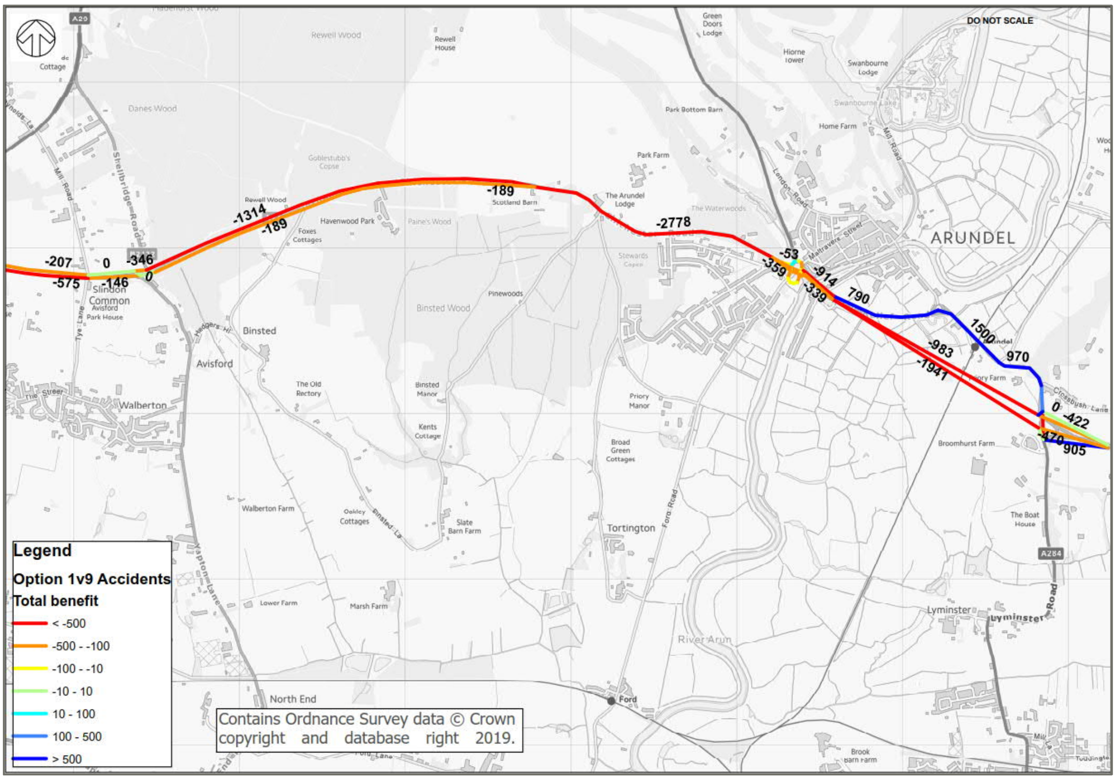


Figure 14-20: Accident impacts - Option 3V1

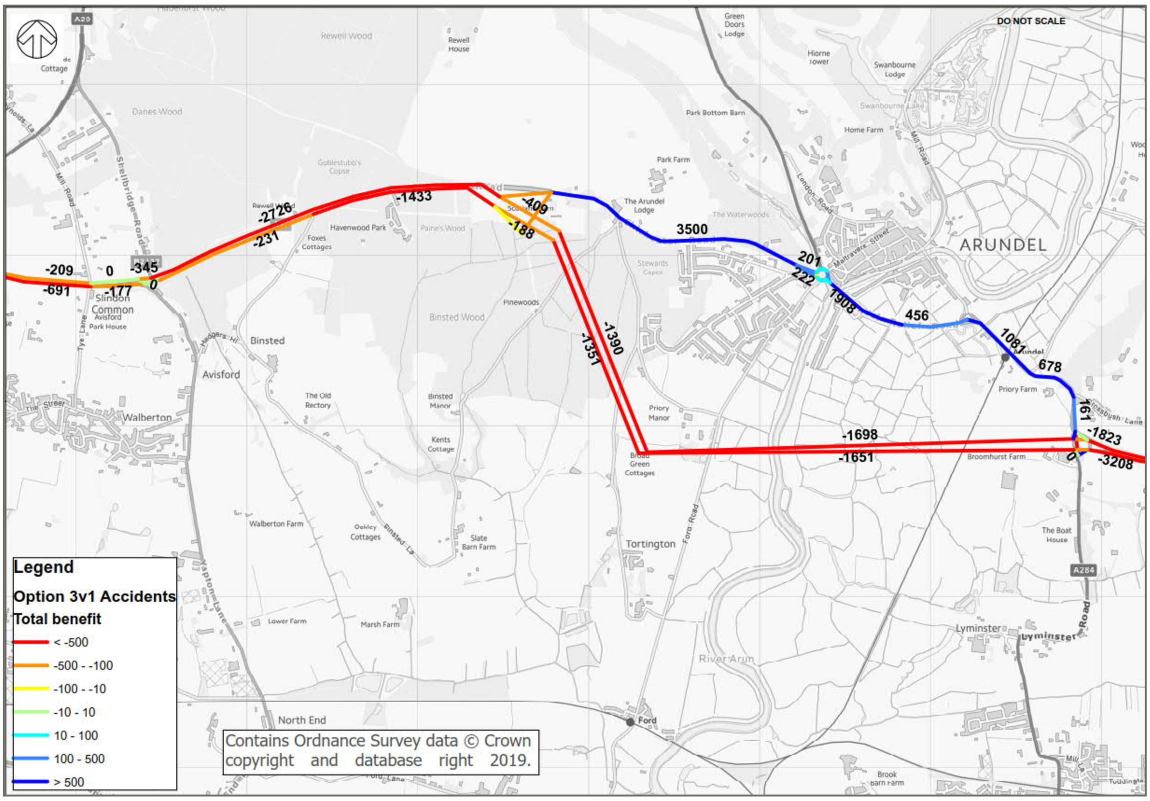


Figure 14-21: Accident impacts - Option 4/5AV1

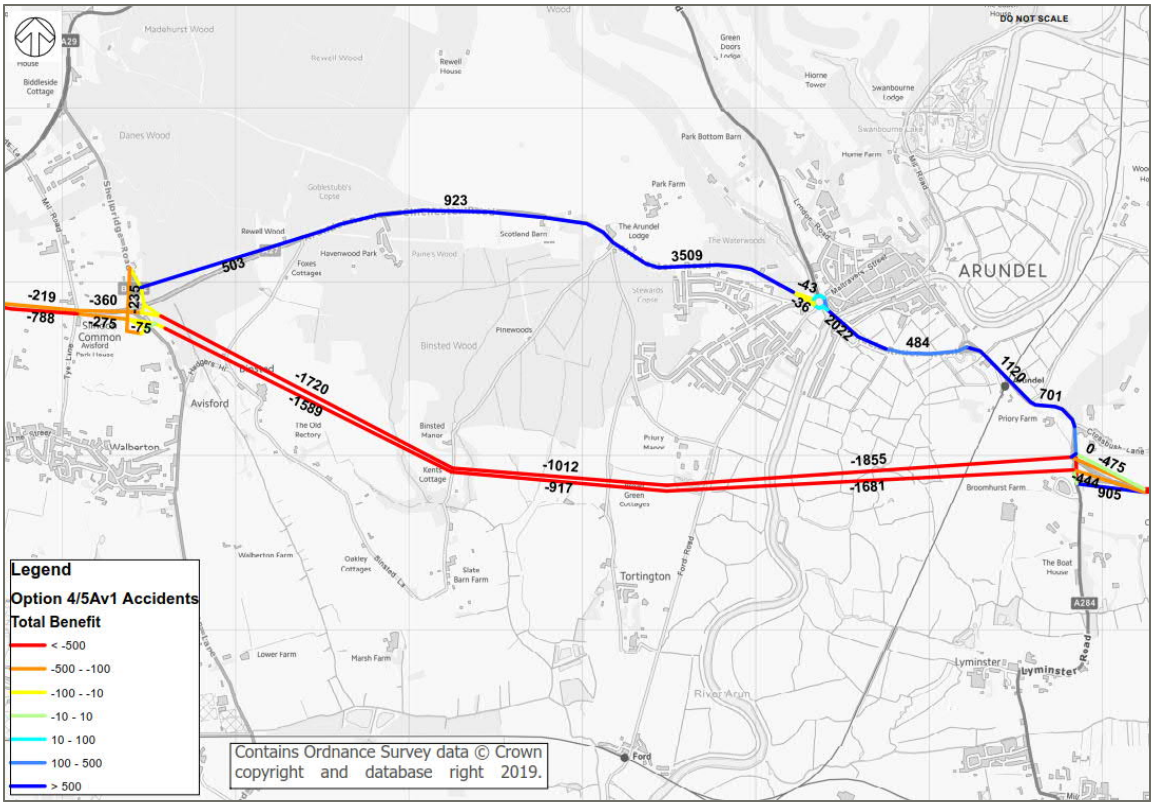


Figure 14-22: Accident impacts - Option 4/5AV2

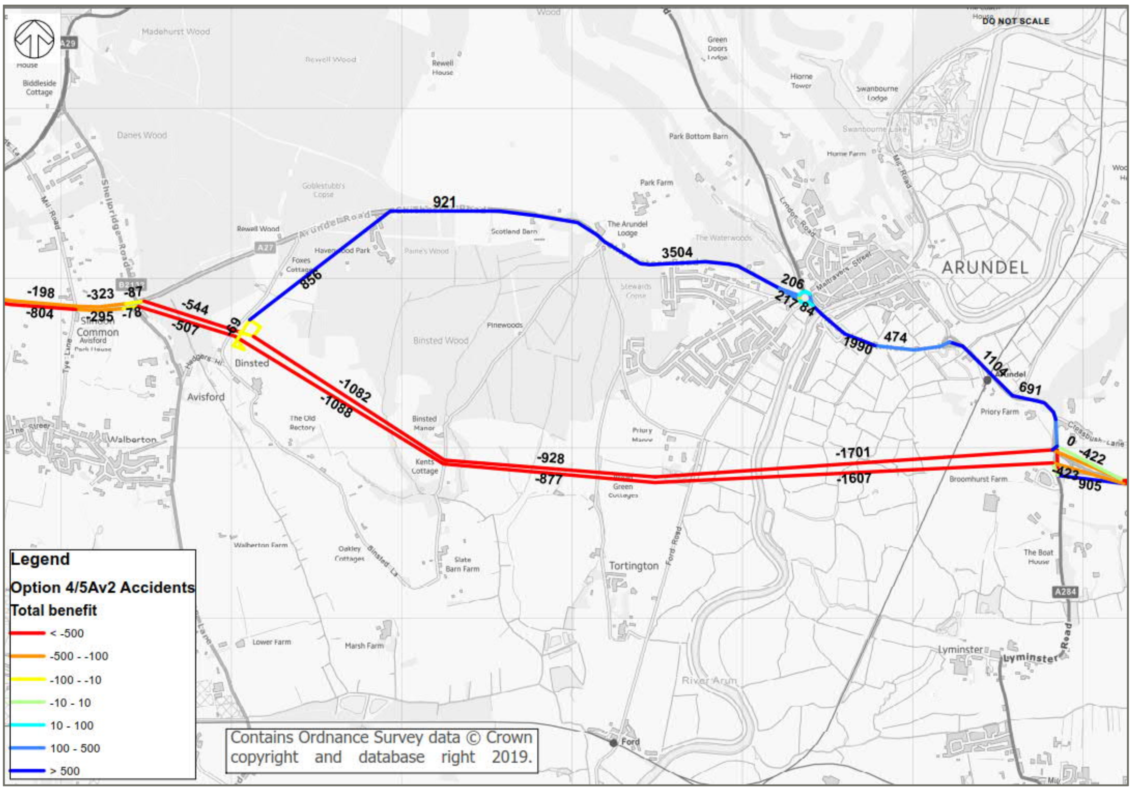
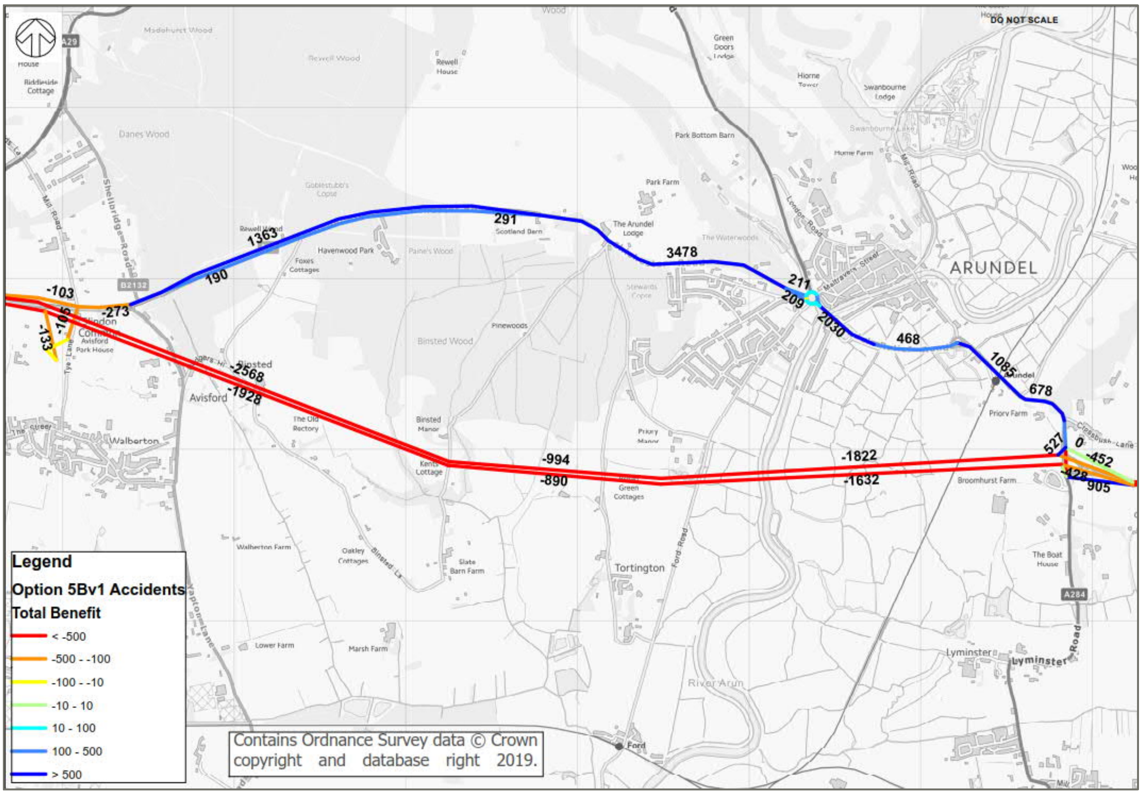


Figure 14-23: Accident impacts - Option 5BV1



Accident results: A27 scheme section – number of accidents

14.4.8 The total number of accidents on the existing A27 between Mill Road/Tye Lane and Crossbush junction and the scheme extents are shown in Table 14-12. The numbers that have been included within Table 14-12 have been taken from the model extent shown in Appendix A-1.

14.4.9 For the purposes of Table 14-12, the number of accidents on the A27 Arundel Bypass off-line options (Option 3V1, Option 4/5AV1, Option 4/5AV2, Option 5BV1) is assumed to be the total of the mainline i.e. not including the on-slips and off-slips at the western junction as these serve traffic wanting to access Arundel from the west.

Table 14-12: Comparison of accidents on the A27 (Number of accidents)

Period	DM	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Accidents on existing A27 route	436	290	352	316	216	228	195
Accidents on new A27 route	-	138	366	273	207	196	213
Accidents including new A27 route	-	315	465	464	409	388	414

14.4.10 As can be seen in Table 14-12**,** the COBALT program predicts that there would be a total of 436 accidents in the Do Minimum along the existing A27 between Mill Road/Tye Lane and Crossbush junction.

14.4.11 The total number of accidents on the existing A27 route and the new A27 route is predicted to decrease for all options except Option 1V9 and Option 3V1, which have total numbers of accidents of 465 and 464 respectively. Option 1V5 has the greatest decrease in accidents with a total of 315 accidents along the existing A27 route and the new A27 route.

14.4.12 It should be noted that the figures in Table 14-12 do not take into account differences in scheme length. The scheme length varies significantly between options due to the addition of the new bypass sections. Therefore, the number of accidents included in the comparison needs to be considered in the context of the varying lengths of the scheme extents.

14.4.13 The number of accidents per billion vehicle kilometres within the extent of road network described above is presented in Table 14-13.

Table 14-13: Comparison of accidents on the A27 (per billion veh kms)

Period	DM	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Accidents per billion veh kms	116	64	103	76	80	71	73

14.4.14 Table 14-13 shows that all options reduce the number of accidents per billion vehicle kilometres on the A27, with Option 1V9 indicated to provide the least benefit in terms of accident reduction.

14.5 Incident delay and travel time variability results

14.5.1 These have not been calculated and are not included.

14.6 Wider impacts assessment

14.6.1 Table 14-14 presents a summary of the WITA impacts for each of the A27 Arundel Bypass options in 2010 values, discounted to 2010.

Table 14-14: Summary of WITA impacts (£m)

		Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
WI1: Agglomeration impacts	Manufacturing	2.67	2.26	3.28	3.00	3.02	3.15
	Construction	2.87	2.57	3.53	3.28	3.27	3.43
	Consumer Services	8.55	7.64	10.91	10.19	10.08	11.20
	Producer Services	40.08	27.76	60.39	47.79	48.91	58.30
	Sub-Total	**54.16**	**40.24**	**78.11**	**64.26**	**65.29**	**76.08**
WI3: Output change in imperfectly competitive markets	Output change in imperfectly competitive markets	4.77	4.54	6.03	5.89	5.91	6.46
WI4: Tax revenues arising from labour market impacts	Labour supply impacts	1.43	1.12	1.79	1.67	1.64	1.86
Total Wider Impact Benefits		**60.36**	**45.89**	**85.93**	**71.82**	**72.84**	**84.40**

14.6.1.1 Table 14-15 demonstrates that the all options presented below fall either within or close to the 'rule of thumb' assumption that WITA benefits should typically fall between 10-30% of user benefits[50]. A second reference point for the level of wider impacts is the Highways England Economic Growth Technical Annex[51] which states WITA benefits '…typically represent between 20% and 107% of business user benefits'.

Table 14-15: WITA as a % of total user benefit

	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
TUBA[52]	212.17	206.67	249.84	258.12	277.17	263.30
WITA	60.36	45.89	85.93	71.82	72.84	84.40
%	**28.4%**	**22.2%**	**34.4%**	**27.8%**	**26.3%**	**32.1%**

14.7 Delay due to construction and maintenance results

14.7.1 The construction dis-benefits are presented in Table 14-16. The table shows that Option 1 variants incur the highest disbenefits at almost £9m. This is because the TM measures to be implemented at Ford Road roundabout are only applicable to the Option 1V5 and Option 1V9 and therefore incur the highest delay.

14.7.2 Option 4/5AV1 and Option 4/5AV2 disbenefits are higher than Option 5BV1. This is mainly due to the total length of links affected by speed reductions. For the options 4/5AV1 and 4/5AV2, about 11km of links are affected by speed reductions whereas for Option 5BV1, around 7km of links are affected by speed reductions. Compared to options 4/5AV1, 4/5AV2 and 5BV1, Option 3V1 incurs slightly less disbenefits, mainly because the Option 5BV1 has saturation flow reductions at a few more locations (A29 and A27 in between Mill Road and Shellbridge Road).

[50] Table 7, TAG Unit 2.4 Appraisal of Productivity Impacts

[51] Economic Growth Technical Annex, Highways England (February 2018)

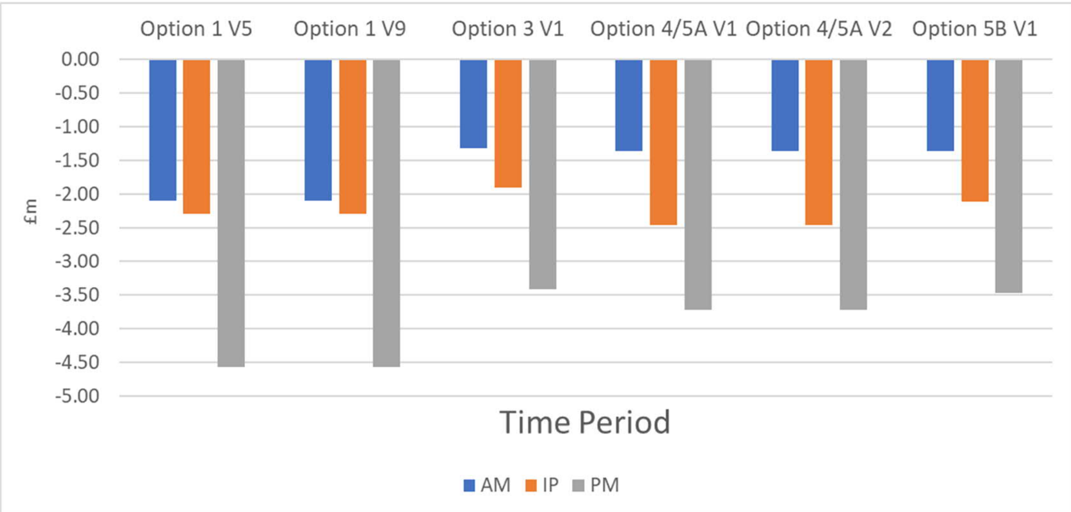
[52] TUBA values presented have been taken from the TEE table and therefore include construction delays presented in Table 14-16

Table 14-16: Delays during construction (£m)

	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
User Time	-7.53	-7.53	-5.53	-6.31	-6.31	-5.77
Vehicle Operating Costs Fuel	-1.12	-1.12	-0.84	-0.93	-0.93	-0.89
Vehicle Operating Costs Non-Fuel	-0.96	-0.96	-0.75	-0.83	-0.83	-0.80
Indirect Taxation Revenues	0.65	0.65	0.48	0.54	0.54	0.51
Total	**-8.96**	**-8.96**	**-6.63**	**-7.53**	**-7.53**	**-6.94**

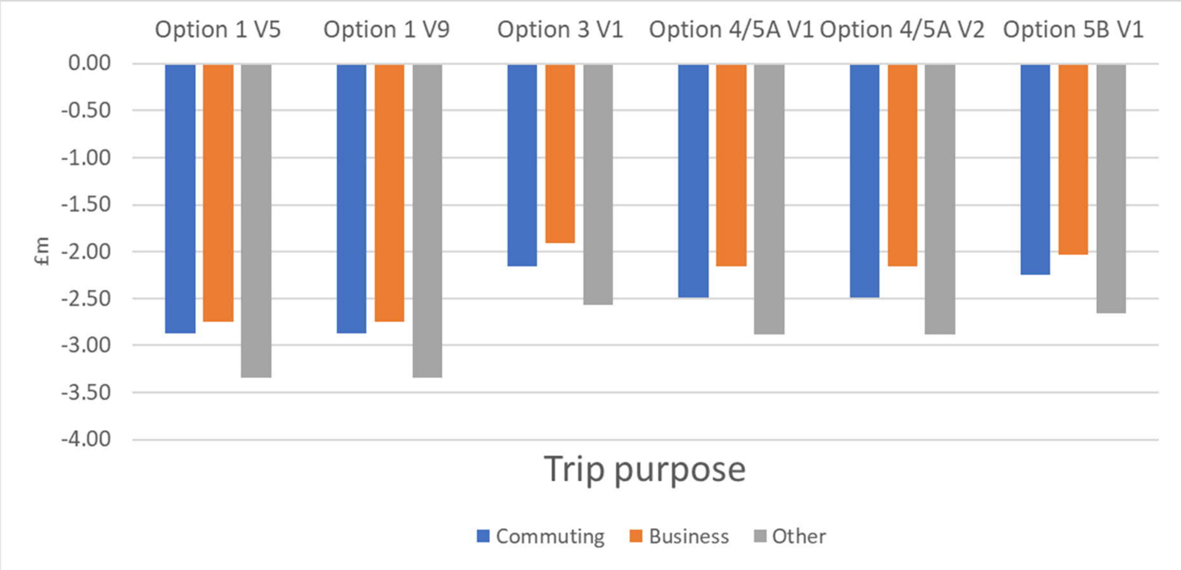
14.7.3 Figure 14-24 shows the profile of disbenefits, for the A27 all variants core scenario, by time period. As can be seen, the disbenefits mostly occur in the PM peak.

Figure 14-24: Profile of construction disbenefits core scenario, by time period (£m)



14.7.4 Figure 14-25 shows the profile of benefits, for the A27 Arundel all variants core scenario, by purpose. As can be seen, the disbenefits are realised for other users more than for commuting or business users.

Figure 14-25: Profile of construction disbenefits core scenario, by purpose (£m)



14.8 Transport economic efficiency

14.8.1 Appendix E-5, Appendix E-6 and Appendix E-7 contains the TEE table, Public Accounts (PA) table and an AMCB respectively for the A27 Arundel Bypass options. A summary of the AMCB for all six options is presented in Table 14-17.

Table 14-17: Analysis of Monetised Costs and Benefits (£m)

Type	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Greenhouse Gases	-10.72	-7.72	-13.48	-9.64	-8.11	-6.55
Economic Efficiency: Consumer Users (Commuting)	64.18	58.29	72.67	74.61	79.99	76.30
Economic Efficiency: Consumer Users (Other)	85.61	87.32	100.97	104.73	112.81	108.37
Economic Efficiency: Business Users	71.34	70.02	82.84	86.30	91.89	85.57
Wider Public Finances (Indirect taxation)	13.67	7.99	15.71	11.68	5.87	11.09
Construction delays	-8.96	-8.96	-6.63	-7.53	-7.53	-6.94
Accidents	23.21	21.82	21.97	29.02	36.90	35.03
Air quality	-6.85	-2.66	-7.74	-7.46	-6.63	-7.13
Noise	-5.07	-5.42	-2.00	-0.88	-0.86	-1.67
Present Value of Benefits (PVB)	**226.40**	**220.68**	**264.31**	**280.84**	**304.35**	**294.07**
Broad Transport Budget	132.99	129.65	161.61	174.82	183.06	193.97

Type	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Present Value of Costs	**132.99**	**129.65**	**161.61**	**174.82**	**183.06**	**193.97**
Net Present Value	93.41	91.03	102.71	106.02	121.29	100.11
Benefit to Cost Ratio (BCR)	**1.70**	**1.70**	**1.64**	**1.61**	**1.66**	**1.52**

14.9 Adjusted BCR (includes wider economic impacts)

14.9.1 An adjusted BCR has been calculated by including the wider economic impacts. The Scheme would serve two key economic purposes:

- It would provide the much-needed additional connectivity for residents in Arun District and specifically for certain wards in Littlehampton where there is clear evidence of relative deprivation and a lack of economic opportunities
- It would provide improved connectivity for longer distance travellers on the east – west A27 corridor who currently experience severe congestion and delays as they negotiate the A27 near Arundel

14.9.2 The adjusted BCR results for A27 Arundel Bypass all options are presented at Table 14-18.

Table 14-18: Adjusted BCR (included Wider Economic Impacts) (£m)

Type	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
Present Value of Benefits (excl. wider impacts)	226.40	220.68	264.31	280.84	304.35	294.07
Wider Economic Benefits	60.36	45.89	85.93	71.82	72.84	84.40
Present Value of Benefits (adjusted)	**286.76**	**266.57**	**350.24**	**352.66**	**377.19**	**378.47**
Present Value of Costs (PVC)	**132.99**	**129.65**	**161.61**	**174.82**	**183.06**	**193.97**
Net Present Value (NPV)	153.77	136.92	188.64	177.84	194.13	184.50
Adjusted BCR	**2.16**	**2.06**	**2.17**	**2.02**	**2.06**	**1.95**

14.9.3 The value for money assessment of this Scheme takes into account the adjusted BCR and other impacts as detailed in the Appraisal Summary Table for each of the A27 Arundel Bypass scheme options.

14.10 Sensitivity tests – scheme cost

14.10.1 The BCR's presented in Table 14-17 and 14-18 are based on the central estimate scheme costs for each option. The sensitivity of the BCR's to changes in scheme cost has been considered, and the results presented in Tables 14-19 and 14-20.

14.10.2 The Highways England range estimate output includes a minimum and maximum value as a part of the 3-point estimate; the calculated PVC and respective adjusted BCR is shown in Table 14-19.

Table 14-19: Adjusted BCR - alternative scheme costs – min and max (£m)

Type	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
PVB (adjusted)	286.76	266.57	350.24	352.66	377.19	378.47
PVC – Range Estimate Minimum Cost (P2.5)	88.56	88.04	111.23	128.19	128.30	141.56
PVC – Range Estimate Maximum Cost (P97.5)	427.99	410.66	528.4	572.25	585.40	618.53
Adjusted BCR – Minimum Cost	**3.24**	**3.03**	**3.15**	**2.75**	**2.94**	**2.67**
Adjusted BCR – Maximum Cost	**0.67**	**0.65**	**0.66**	**0.62**	**0.64**	**0.61**

14.10.3 The costs are early estimates based on work done to date. They do not represent our final costs for the project but to understand the results for a narrower cost range, sensitivity testing has been undertaken on these cost ranges in addition to the minimum and maximum cost sensitivity tests. The calculated PVC and respective adjusted BCR for the lower and upper values of this testing is shown in Table 14-20.

Table 14-20: Adjusted BCR - alternative scheme costs – lower and upper (£m)

Type	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
PVB (adjusted)	286.76	266.57	350.24	352.66	377.19	378.47
PVC – Narrower Range Lower Cost	115.04	113.72	144.20	161.09	164.53	179.01
PVC – narrower Range Upper Cost	167.32	163.84	208.84	227.66	235.67	251.75
Adjusted BCR – Lower Cost	**2.49**	**2.34**	**2.43**	**2.19**	**2.29**	**2.11**
Adjusted BCR – Upper Cost	**1.71**	**1.63**	**1.68**	**1.55**	**1.60**	**1.50**

14.11 Sensitivity tests – traffic growth

Low growth

14.11.1 The Low growth scenario has been assumed to include:

- Low growth scenario estimate of vehicle trip growth, using NTEM growth reduced for uncertainty and NTM growth
- Inclusion of Near Certain and More than Likely land use developments
- Inclusion of Near Certain and More than Likely highway infrastructure

14.11.2 The Low growth scenario was developed in a similar way to the Core scenario. The local uncertainty was unchanged from the core scenario but total growth was constrained at district level to NTEM growth minus U (U=2.5% x √years). In circumstances where this resulted in the number of trips in the low scenario being less than in the base case, the base scenario was used as the low scenario i.e. zero growth.

14.11.3 The TUBA benefits for the sensitivity test under a low growth scenario are presented in Table 14-20 and Figure 14-26.

14.11.4 Table 14-21 also presents an estimated value for 'other impacts'. These impacts are those that have not been quantified using the A27 transport model outputs. The non-TUBA benefits comprise accidents, impacts during construction, wider impacts, greenhouse gases, air and noise impacts.

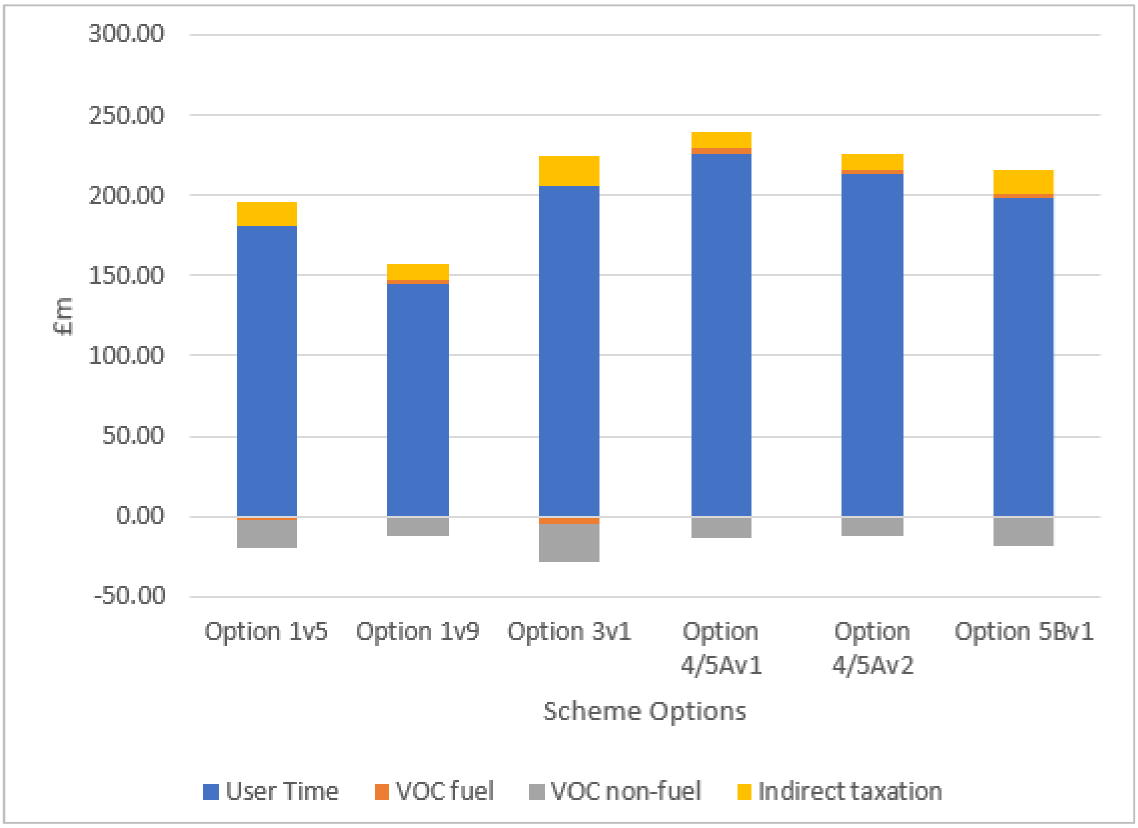
14.11.5 The estimated value of the non-TUBA benefits based on the ratio of non-TUBA benefits to total benefits from the core scenario. It is assumed that the proportion of non-TUBA impacts would be the same in the sensitivity test scenario when compared with the core scenario.

14.11.6 The BCRs presented in Table 14-21 have been produced in order to understand how the changes in modelling assumptions may affect the overall economic impact of the A27 Arundel Bypass scheme options. The sensitivity test BCR's are associated with a lower level of confidence than those presented for the core scenario.

Table 14-21: Economic impacts (£m) low growth

Total Benefit	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
User Time	181.39	145.19	205.33	225.93	213.05	198.56
VOC fuel	-2.27	1.91	-4.61	3.69	3.27	2.54
VOC non-fuel	-17.37	-12.72	-23.98	-13.35	-12.64	-19.05
Indirect taxation	14.36	10.54	19.21	10.59	10.12	15.23
TUBA Total	176.11	144.92	195.95	226.86	213.79	197.28
Other Impacts	38.97	27.83	56.19	61.62	63.73	68.12
Estimated PVB	**215.09**	**172.76**	**252.14**	**288.48**	**277.53**	**265.40**
PVC	**132.99**	**129.65**	**161.61**	**174.82**	**183.06**	**193.97**
BCR (adjusted)	**1.62**	**1.33**	**1.56**	**1.65**	**1.52**	**1.37**

Figure 14-26: TUBA impacts for low growth



14.12 Sensitivity tests – infrastructure

14.12.1 The results of the TUBA economic appraisal for the infrastructure sensitivity tests are presented in this section relating to the A27 Worthing and Lancing and the Lyminster Bypass schemes.

14.12.2 A version of the A27 transport model was run excluding the proposed improvements at A27 Worthing and Lancing. The scheme lies to the east of the A27 Arundel Bypass Scheme and includes the following junctions:

- Durrington Hill/Salvington Hill/A27
- Offington Corner Roundabout
- Grove Lodge Roundabout
- Sompting Road/A27
- Lyons Way/Upper Brighton Road
- Busticle Lane/Halewick Lane/A27
- Manor Road/Grinstead Lane roundabout

14.12.3 The TUBA benefits for the sensitivity test without A27 Worthing and Lancing are presented in Table 14-22 and Figure 14-27.

14.12.4 Table 14-22 also presents an estimated value for 'other impacts'. These impacts are those that have not been quantified using the A27 transport model outputs. The non-TUBA benefits comprise accidents, impacts during construction, wider impacts, greenhouse gases, air and noise impacts.

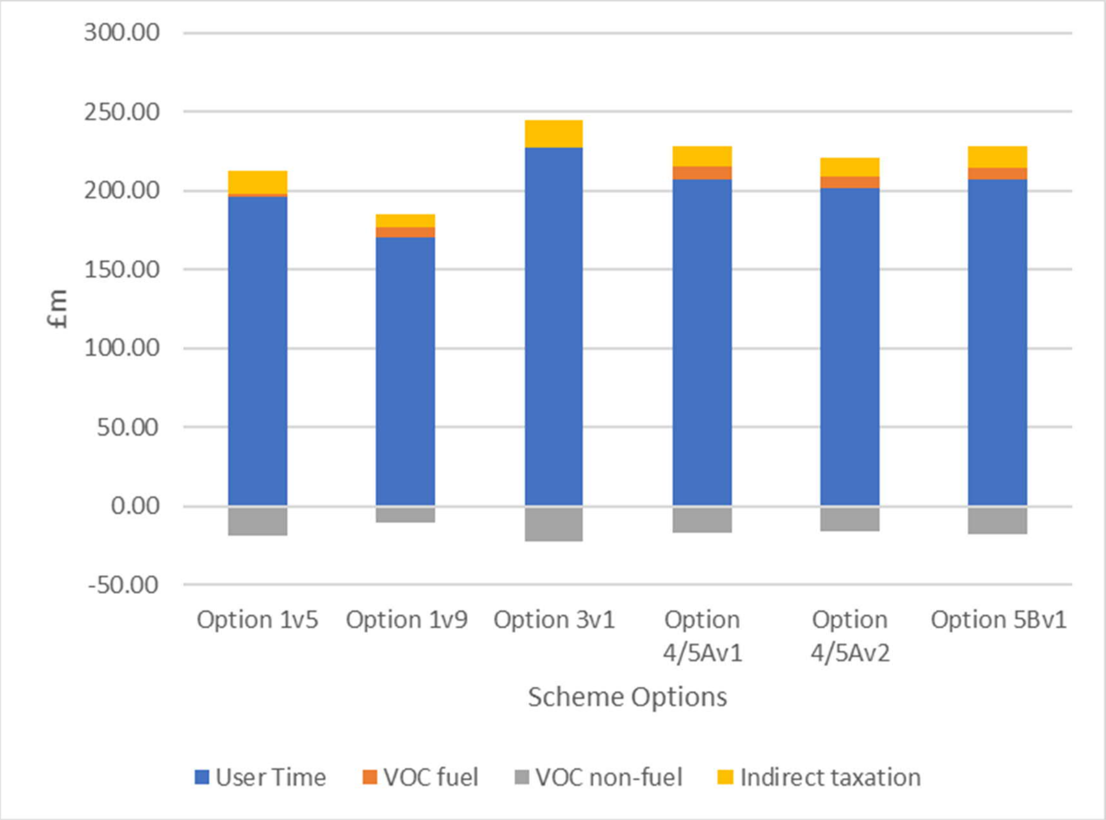
14.12.5 The estimated value of the non-TUBA benefits based on the ratio of non-TUBA benefits to total benefits from the core scenario (A27 Arundel Bypass with A27 Worthing and Lancing). It is assumed that the proportion of non-TUBA impacts would be the same in the sensitivity test scenario when compared with the core scenario.

14.12.6 The BCR's presented in Table 14-22 have been produced in order to understand how the changes in modelling assumptions may affect the overall economic impact of the A27 Arundel Bypass scheme options. The sensitivity test BCR's are associated with a lower level of confidence than those presented for the core scenario.

Table 14-22: Economic impacts (£m) without A27 Worthing and Lancing

Total Benefit	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
User Time	196.02	170.30	227.46	207.45	201.25	207.22
VOC fuel	2.03	6.22	0.38	7.68	7.41	7.02
VOC non-fuel	-19.03	-10.84	-22.36	-16.94	-15.61	-17.83
Indirect taxation	14.54	8.56	17.22	13.26	12.39	13.89
TUBA Total	193.57	174.24	222.70	211.44	205.44	210.30
Other Impacts	42.83	33.46	63.86	57.43	61.25	72.61
Estimated PVB	**236.40**	**207.70**	**286.56**	**268.87**	**266.69**	**282.91**
PVC	**132.99**	**129.65**	**161.61**	**174.82**	**183.06**	**193.97**
BCR (adjusted)	**1.78**	**1.60**	**1.77**	**1.54**	**1.46**	**1.46**

Figure 14-27: TUBA impacts for without A27 Worthing and Lancing



14.12.7 The results of the sensitivity test illustrate a reduction in TUBA benefits, and a total reduction in PVB of 15 – 30%.

14.12.8 The TUBA benefits for the sensitivity test without Lyminster Bypass are presented in Table 14-23 and Figure 14-28.

14.12.9 Table 14-23 also presents an estimated value for ‘other impacts’. These impacts are those that have not been quantified using the A27 transport model outputs. The non-TUBA benefits comprise accidents, impacts during construction, wider impacts, greenhouse gases, air and noise impacts.

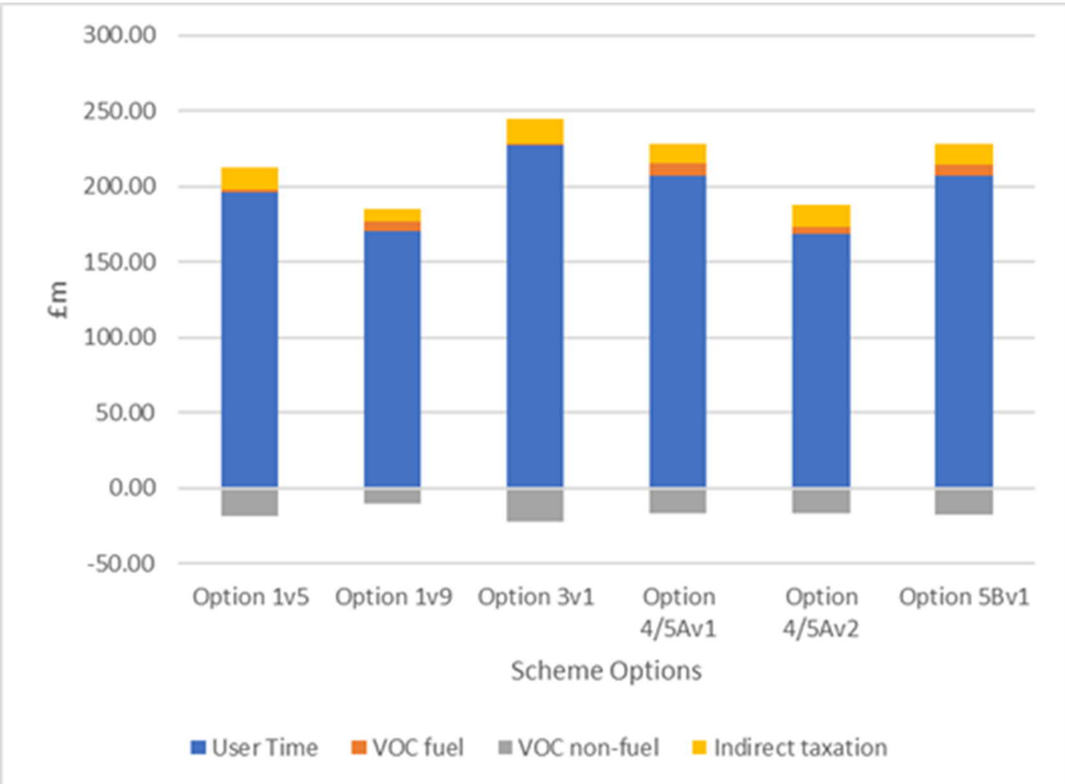
14.12.10 The estimated value of the non-TUBA benefits based on the ratio of non-TUBA benefits to total benefits from the core scenario (A27 Arundel Bypass with Lyminster Bypass). It is assumed that the proportion of non-TUBA impacts would be the same in the sensitivity test scenario when compared with the core scenario.

14.12.11 The BCR’s presented in Table 14-23 have been produced in order to understand how the changes in modelling assumptions may affect the overall economic impact of the A27 Arundel Bypass scheme options. The sensitivity test BCR’s are associated with a lower level of confidence than those presented for the core scenario.

Table 14-23: Economic impacts (£m) without Lyminster Bypass

Total Benefit	Option 1V5	Option 1V9	Option 3V1	Option 4/5AV1	Option 4/5AV2	Option 5BV1
User Time	164.45	160.33	192.96	194.19	168.91	195.18
VOC fuel	-0.36	4.41	-2.11	5.44	4.54	4.89
VOC non-fuel	-19.74	-11.59	-23.17	-17.53	-17.16	-18.29
Indirect taxation	16.21	9.93	18.67	14.50	14.25	14.97
TUBA Total	160.55	163.09	186.36	196.61	170.54	196.74
Other Impacts	35.53	31.32	53.44	53.40	50.84	67.93
Estimated PVB	196.08	194.41	239.80	250.01	221.38	264.67
PVC	132.99	129.65	161.61	174.82	183.06	193.97
BCR (adjusted)	1.47	1.50	1.48	1.43	1.21	1.36

Figure 14-28: TUBA impacts for without Lyminster Bypass



14.12.12 The results of the sensitivity test illustrate a reduction in TUBA benefits, and a total reduction in PVB of approximately 30 – 40%.