



West Winch Housing Access Road

Transport Assessment

TA Appendix 5 - Paramics Modelling Technical Note

Author: WSP

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Foreword

WSP has been appointed to produce a Transport Assessment (TA) on behalf of Norfolk County Council (NCC) to support the planning application for the proposed West Winch Housing Access Road (WWHAR) scheme. This document sets out the Paramics Discovery Modelling methodology and results which have informed the TA.

Glossary of Abbreviations and Defined Terms

DfT – Department for Transport

GEH – Goodness of fit statistical test

KLTM – King’s Lynn Transport Model

MCC – Manually Classified Count

OBC – Outline Business Case

NCC – Norfolk County Council

LOS – Level of Service

TA – Transport Assessment

TAG – Transport Analysis Guidance

Vph – vehicles per hour

WWGA – West Winch Growth Area

WWHAR – West Winch Housing Access Road



1 Introduction

- 1.1.1 WSP has been appointed to produce a Transport Assessment (TA) on behalf of Norfolk County Council (NCC) to support the planning application for the proposed West Winch Housing Access Road (WWHAR) scheme. The proposed highway scheme is intended to support strategic housing growth within the West Winch Growth Area (WWGA).
- 1.1.2 This Technical Note outlines the microsimulation traffic modelling undertaken to assess the highway impact of the proposed scheme on the surrounding network to support the TA.
- 1.1.3 The model used for this assessment is the West Winch Paramics Discovery Model. This model has been derived from outputs of the strategic SATURN King's Lynn Transport Model (KLTM) used for the WWHAR Outline Business Case (OBC).
- 1.1.4 The TA assesses the potential impact of the Proposed Scheme in a future year of 2027 (anticipated WWHAR highway opening year) and a design year of 2037 (ten years post WWHAR scheme opening). However, the strategic model covers the future years of 2027 and 2042. Therefore, results for 2027, 2037 and 2042 will be presented in this report, where 2037 results will be estimated from a direct interpolation between 2027 and 2042 results.
- 1.1.5 The WWGA is a proposed 4,000 dwelling housing development. This development is comprised of a non-dependent development quantum of 300 dwellings (i.e. non-dependent on the construction of the WWHAR), while the remainder 3,700 dwellings are part of the dependent development.
- 1.1.6 Across the three forecast years, three scenarios and two time periods for assessment have been considered:
- 2027/2037/2042 AM period (07:00-10:00)/PM period (16:00-19:00) - Future Baseline without the WWHAR Scheme and with 300 dwellings



at the WWGA (Scenario P) – Referred to in the TA as Do Minimum or DM

- 2027/2037/2042 AM period (07:00-10:00)/PM period (16:00-19:00) - Future Situation with WWHAR and 300 dwellings at the WWGA (Scenario S) – Referred to in the TA as Do Something 1 or DS1
- 2037/2042 AM period (07:00-10:00)/PM period (16:00-19:00) - Future Situation with WWHAR and 4,000 dwellings at the WWGA (Scenario R) Referred to in the TA as Do Something 2 or DS2

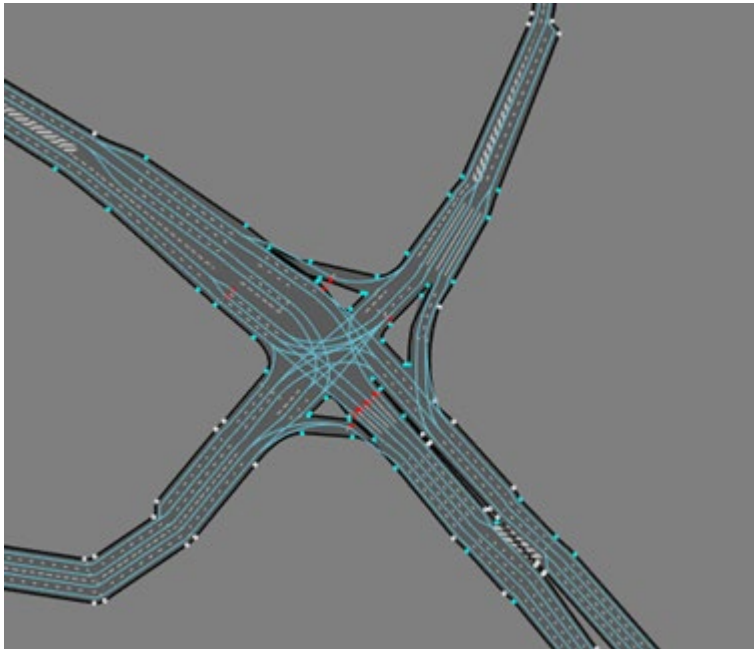
2 2018 base model update

2.1 Network update

- 2.1.1 The existing Paramics model has a base year of 2018 and was developed during 2019 in Paramics v20.0.1. A series of updates to the base year model have been undertaken for the purpose of the TA assessment, as mentioned below.
- 2.1.2 The model has been updated to the latest Paramics Discovery version 26.0.3 available in order to include the latest software improvements in the model.
- 2.1.3 The existing Paramics model was updated to include A149 / Scania Way junction to the North-West of Hardwick Roundabout so the interaction between this junction and Hardwick Interchange can be assessed. Figure 3-1 shows the screenshot new junction added. The additional network has been coded based upon Ordnance survey 1:1250 scale mapping and Google maps aerial view.



Figure 3-1 A149 / Scania Way Junction



2.1.4 A LinSig model previously developed covering the Hardwick interchange and the A149 / Scania Way junction was used as a basis to code the signals for the Paramics model. Traffic signals were set up at the approaches to the junction in the same way as that of the LinSig model in terms of phases, stages, intergreens and cycle time. Stage green times were slightly tweaked to account for the differences in demand between LinSig and Paramics models.

2.1.5 Other minor updates in the base model include changes in visibility and gap acceptance parameters at Beveridge Way approach to match the observed queues.

2.2 Matrix adjustment

2.2.1 2018 has been kept as the model base year, but the existing 2018 base matrix was expanded to include the A149 / Scania Way junction. The base year matrices were derived from the existing demand matrices using the splits from the MCC count data available at A149 / Scania Way junction.



2.3 Model calibration and validation

Introduction

2.3.1 The Paramics model has been calibrated and validated against the criteria set out in TAG Unit M3.1. While these criteria are primarily designed for Highway Assignment Modelling, they are still relevant and are typically applied to microsimulation models as well.

2.3.2 The model version control details are set out in Table 3-1 below.

Table 3-1 Model Version Control

Version	Details
Paramics File	WW_2018_Base_v1.4_26.0.3
Number of Runs	10
Validation Spreadsheet	WW_MVT_Base_v1.4_26.0.3
Paramics Discovery Version	26.0.3

Traffic Flow Calibration

2.3.3 Section 3.2 of DfT TAG Unit M3.1 (Department for Transport - Transport Analysis Guidance) sets out the traffic flow criteria for models, with the following measures being applied:

- Absolute / percentage differences between modelled and observed flows;
- The GEH statistic

2.3.4 TAG states that these measures are “broadly consistent” and that flows that meet either criterion are acceptable.

2.3.5 GEH is a form of Chi-squared statistic which is defined by the formula below where M is the modelled flow and C is the observed flow:

$$GEH = \sqrt{\frac{(M - C)^2}{0.5 \times (M + C)}}$$



2.3.6 Values of GEH that are less than five represent a good level of fit between modelled and observed flows, while values greater than five show increasingly worse fits between the data.

2.3.7 The two traffic flow criterion for models is summarised in Table 3-2 and Table 3-3.

Table 3-2 Traffic Flow Validation Criteria 1

Description	% of Cases
Count < 700vph, model within 100vph	>85%
Count 700 to 2700vph, model within 15%	>85%
Count > 2700vph, model within 400vph	>85%

Table 3-3 Traffic Flow Validation Criteria 2

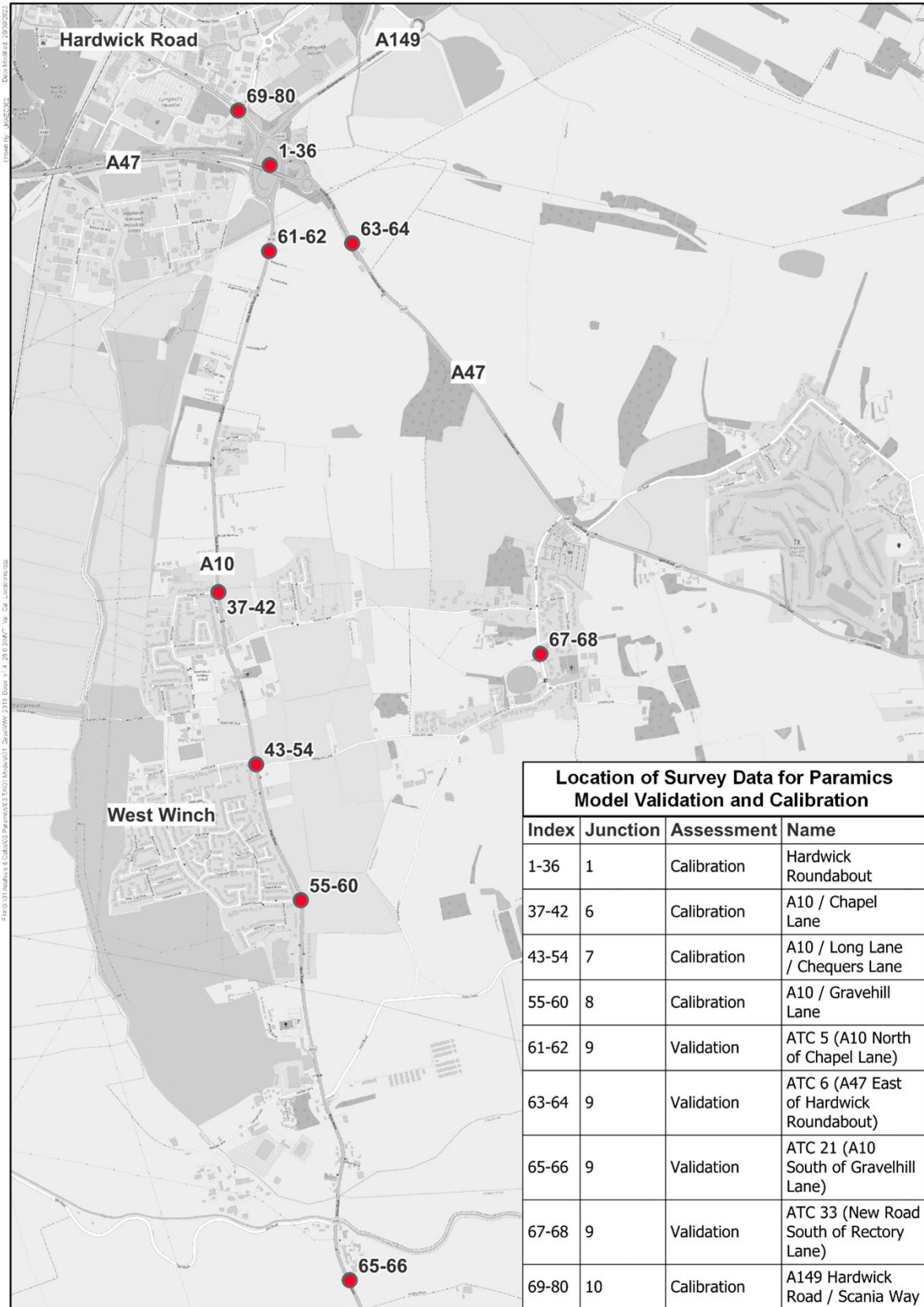
Description	% of Cases
GEH < 5 for individual flows	>85%

Source: DfT TAG Unit M3.1 Table 2 (vph = vehicles per hour)

2.3.8 All link and turn flows are included for calibration of the model and are shown in Figure 3.2.



Figure 3-2 Traffic Count Survey Locations



Location of Survey Data for Paramics Model Validation and Calibration			
Index	Junction	Assessment	Name
1-36	1	Calibration	Hardwick Roundabout
37-42	6	Calibration	A10 / Chapel Lane
43-54	7	Calibration	A10 / Long Lane / Chequers Lane
55-60	8	Calibration	A10 / Gravehill Lane
61-62	9	Validation	ATC 5 (A10 North of Chapel Lane)
63-64	9	Validation	ATC 6 (A47 East of Hardwick Roundabout)
65-66	9	Validation	ATC 21 (A10 South of Gravelhill Lane)
67-68	9	Validation	ATC 33 (New Road South of Rectory Lane)
69-80	10	Calibration	A149 Hardwick Road / Scania Way

Source: Map data from OpenStreetMap and Google Maps. © 2015. All rights reserved.



2.3.9 Table 3-4 and Table 3-5 summarise the performance of the West Winch model against the traffic flow validation criteria. Traffic flow data is shown in Appendix 6 of the TA (Document Reference **NCC/4.01.06/WWHAR**).

Table 3-4 Traffic Count Calibration in the AM Peak

Criteria	Count	No. Pass	%
< 700 vph	68	66	97.10%
700 – 2700 vph	4	4	100.00%
>2700 vph	0	0	0%
Overall	72	70	97.20%
GEH < 5	72	68	94.40%

Table 3-5 Traffic Count Calibration in the PM Peak

Criteria	Count	No. Pass	%
< 700 vph	66	65	98.50%
700 – 2700 vph	6	6	100.00%
>2700 vph	0	0	0%
Overall	72	71	98.60%
GEH < 5	72	69	95.80%

2.3.10 Table 3-4 and Table 3-5 show that both the AM and PM peak hours pass the specified traffic flow WebTAG criteria. The overall pass rate is significantly better than that required, being 96.7% in the AM and 98.3% in PM peak hour, compared to the 85% required. This pass rate provides confidence in both the network and the matrix for the model. In the AM peak, 97% of turns having flow within 700 vph has less than 15% difference between modelled flow and observed flow, and all the turns with flow within 2700 vph has less than 15% difference between modelled flow and observed flow. In the PM peak, all the turns with flow less than 2700vph meets the validation criteria and 98% turns with flow less than 700 vph meet the validation criteria.



2.3.11 WebTAG specifies that 85% of modelled movements should obtain a GEH score of less than 5 when compared to observed values. A GEH value of 0 represents a perfect fit, a value up to and including 5 reflects a good fit, a value between 5 and 10 represents an acceptable fit, and values over 10 represent a poor fit.

2.3.12 Table 3-6 and Table 3-7 provide a summary of the turning count assessments for the AM and PM peaks respectively.

Table 3-6 G.E.H Summary (AM Peak Hour)

GEH	No. Pass	%
GEH <5	68	94%
GEH <6	69	96%
GEH <8	70	97%
GEH <10	72	100%

2.3.13 Table 3-6 shows that the AM peak hour has a good turning count fit, with 93% of counts having a GEH of 5 or less, and 100% of turning counts having GEH of less than 10. This satisfies the TAG requirements whereby 85% of modelled movements should obtain a GEH score of less than 5. The average GEH across all turning movements in the AM peak hour is 2.1.

Table 3-7 G.E.H Summary (PM Peak Hour)

GEH	No. Pass	%
GEH <5	69	96%
GEH <6	69	96%
GEH <8	71	99%
GEH <10	72	100%

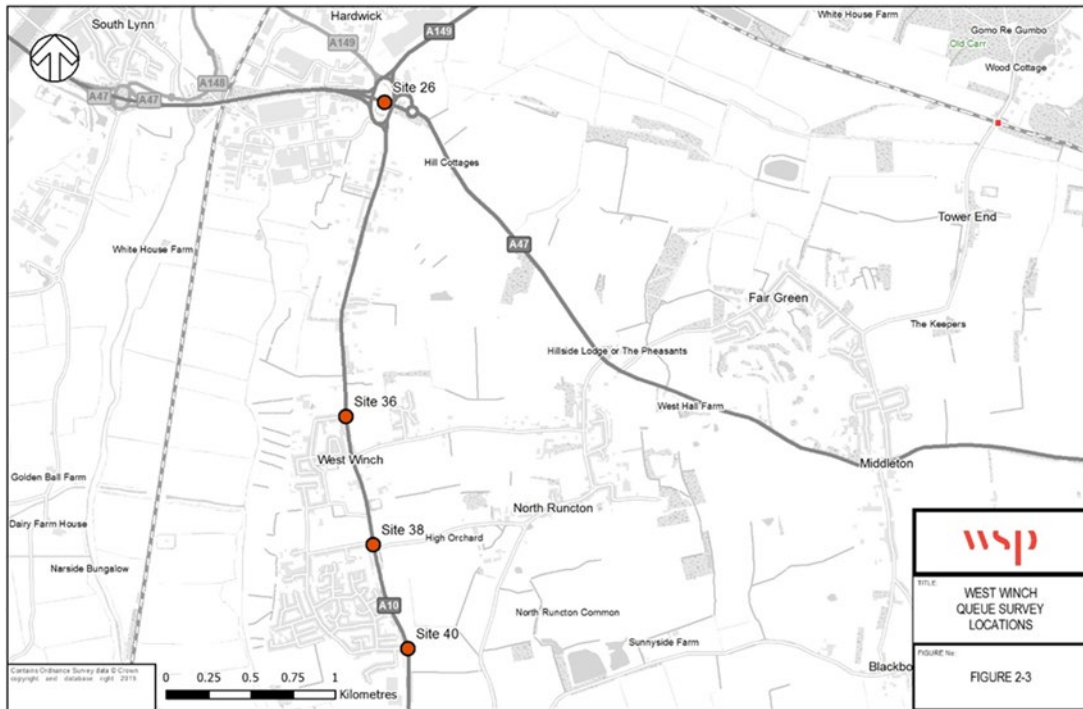
2.3.14 Table 3-7 shows that the PM peak hour has a good turning count fit, with 95% of counts having a GEH of 5 or less, and 100% of turning counts having a GEH of less than 10. This satisfies the TAG requirements whereby 85% of modelled movements should obtain a GEH score of less than 5. The average GEH across all turning movements in the AM peak hour is 1.6.



Queue Length Calibration

2.3.15 Queue length surveys were undertaken in five-minute intervals between 07:00 and 19:00 at the junctions shown in Figure 3-3..

Figure 3-3 Queue Survey Locations



2.3.16 The second calibration measure that has been used for the West Winch model is queue lengths. There are no formal criteria for queue length calibration, however it is generally seen as good practice for modelled queues to be of a similar magnitude and profile to the observed queue lengths.

2.3.17 It should be noted that observed queue length data is particularly susceptible to human error. A Paramics model is able to accurately monitor the maximum length of a queue based on a pre-defined definition of what constitutes a queue. In the case of Paramics, the default definition of a queue is a string of vehicles no more than 10m apart who are travelling less than 4.47mph and not subsequently above 6.71mph or 15m.

2.3.18 The observed data cannot possibly be recorded to this level of precision because it is not possible for a human observer to achieve. Also, for a human



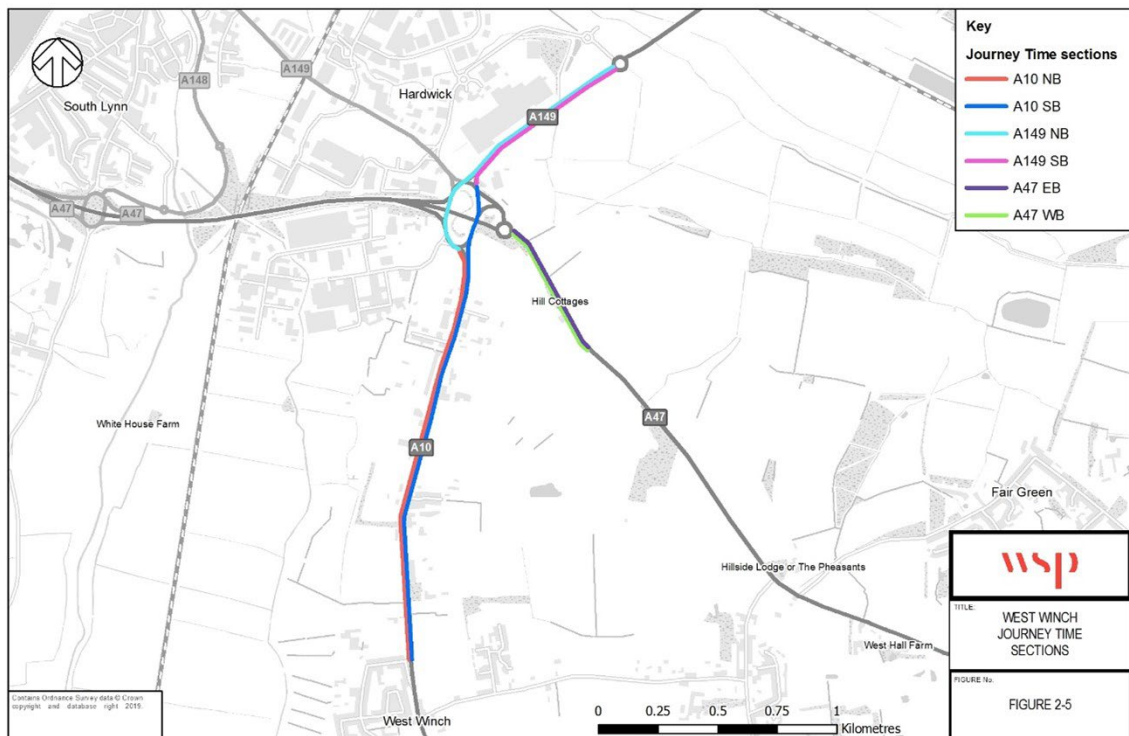
observer, the definition of a queue is extremely subjective so is likely to vary between observers.

2.3.19 The queue analysis shows that the modelled queues generally have a similar magnitude and profile to the observed queue data, and it is therefore considered that the model shows a good level of queue length calibration.

Journey time validation

2.3.20 The journey time data used for validation of the model is extracted from an INRIX dataset. The INRIX data has been provided for specified routes within the model study area which are shown in Figure 3-4.

Figure 3-4 Journey Time Routes



2.3.21 Table 3 of TAG Unit M3.1 summarises the journey time validation and acceptability criteria, and states that more than 85% of journey time routes should have a modelled journey time within 15% of the surveyed journey time (or one minute if higher than 15%).

2.3.22 The Paramics model contains 6 journey time routes, covering most of the study area. Table 3-8 summarises the journey time validation.



Table 3-8 Journey Time Validation

Measure	AM Peak	PM Peak
% Within 15%	67%	100%
% Within 60 seconds	100%	100%
% Passing WebTAG Criteria	100%	100%

2.3.23 Table 3-8 shows that most of the routes in both the AM and PM peaks meet the TAG criteria with the exception of two routes not within 15% of observed journey time in the AM peak. Both these routes are marginally failing the 15% criteria and are well within 60 seconds of observed journey time. Overall, since both the peaks are satisfying the TAG criteria, it can be considered that the model is replicating the observed traffic conditions well.

Summary

2.3.24 Overall, the modelled flows, queues and journey times compare well to the observed and therefore it can be concluded that the 2018 base model is able to replicate the observations and is a good fit for forecast option tests.

3 Forecast network development

3.1.1 The model forecast networks were produced using the Paramics base model. Three forecast networks were developed to model a combination of future scenarios with and without the dependent development at the WWGA and with and without the proposed WWHAR scheme. The three forecast networks are:

- Scenario P: network without the proposed transport scheme and with 300 dwellings at the WWGA (Referred to in the TA as Do Minimum)
- Scenario S: network with the proposed transport scheme and with 300 dwellings at the WWGA (Referred to in the TA as Do Something 1)



- Scenario R: network with the proposed transport scheme and with 4,000 dwellings at the WWGA (Referred to in the TA as Do Something 2).

3.1.2 Each of the scenarios were modelled for the forecast years of 2027 and 2042. However, the same network was used for Scenario S and Scenario R for the forecast year 2027, as in 2027 the dependent development will not yet be started.

3.1.3 The development of each forecast network is outlined below.

3.2 Scenario P – Do Minimum

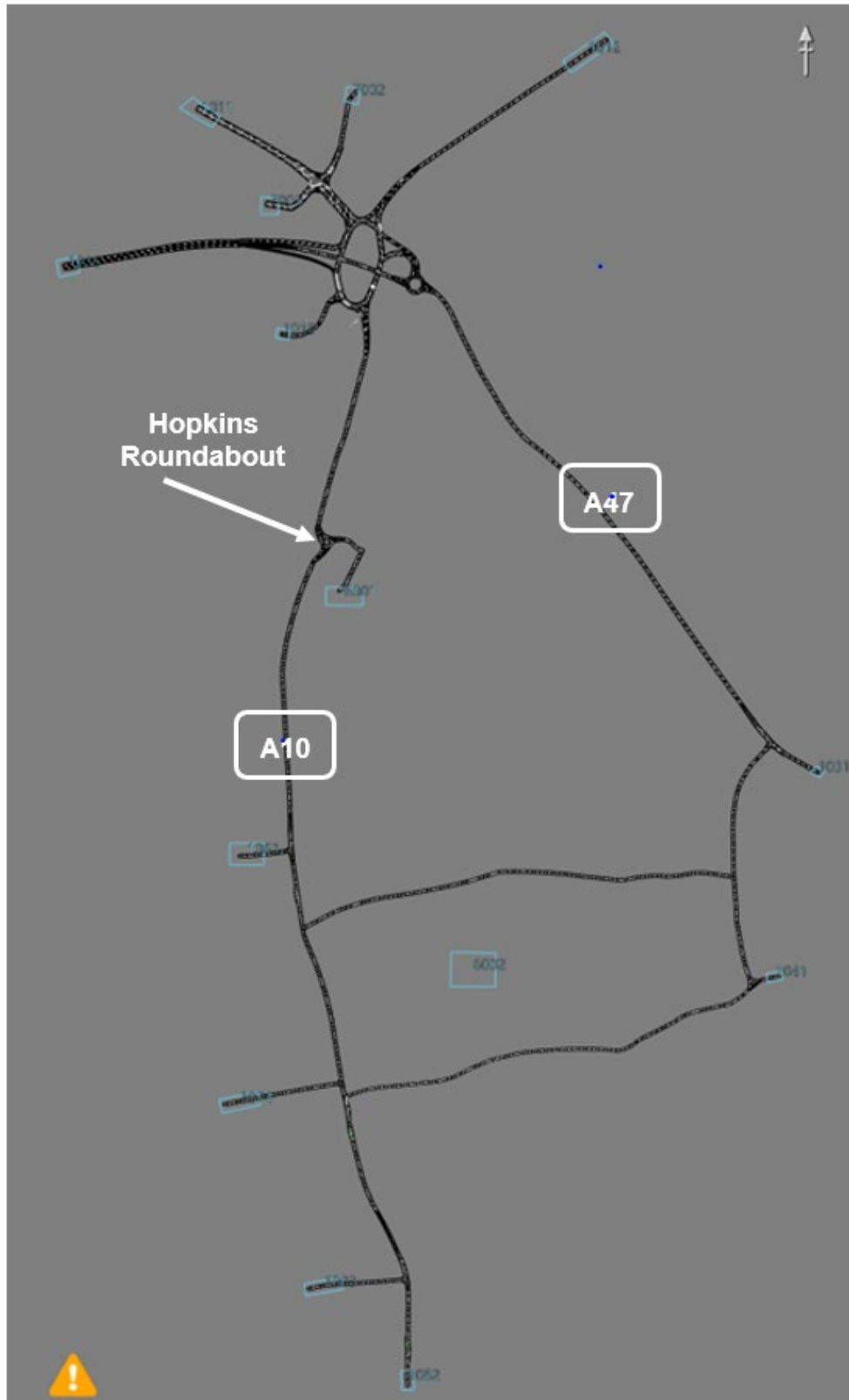
3.2.1 The Scenario P network does not include the dependant development or the transport scheme. The Scenario P network was based on the base model, with the following changes:

- A) Addition of Hopkins Roundabout on the A10: a three-arm priority roundabout with an access road (Hopkins Road) to the 300 dwelling WWGA development.

3.2.2 The Scenario P network is shown in Figure 4-1 with labels corresponding to the network changes.



Figure 4-1 Scenario P Paramics ~Do Minimum Network





3.3 Scenario R – Do Something 2

3.3.1 The Scenario R network includes the dependent development and the transport scheme. The following changes have been made to the base model to produce Scenario R:

- A) Addition of the WWHAR: a 40mph urban road which connect with the A47 to the north and the A10 to the south. The WWHAR connects with the A47 via a three-arm roundabout. The A47 approaches are signalised in both forecast years, while the WWHAR approach is unsignalised. There is a segregated left turn lane from the WWHAR to the A47. The WWHAR connects with the A10 via a three-arm priority roundabout. There are three development access roads off the WWHAR and each of these junctions are modelled as three-arm priority roundabouts. The northern section between the Hopkins access roundabout and the A47/WWHAR roundabout is a dual carriageway section, while the rest of the WWHAR is single carriageway.
- B) The main internal roads within the WWGA have been included in the model, including three access roads off the A10 and three access roads off Rectory Lane (all modelled as priority junctions). These roads were modelled with a 20mph speed limit.
- C) At the Hardwick Interchange, the signals at the A10 approach have been removed due to concerns about the signal operation in conjunction with the A47 off-slip node. The Beveridge Way approach has instead been signalised since previous Paramics tests showed significant congestion when the approach is operated as a priority junction. Signal timings in the AM and PM have been optimised to minimise delay on each approach.
- D) Constitution Hill Roundabout has been removed and replaced with a westbound off slip from the A47 to Hardwick Roundabout, and an eastbound on slip from Hardwick Roundabout to the A47. The dualled



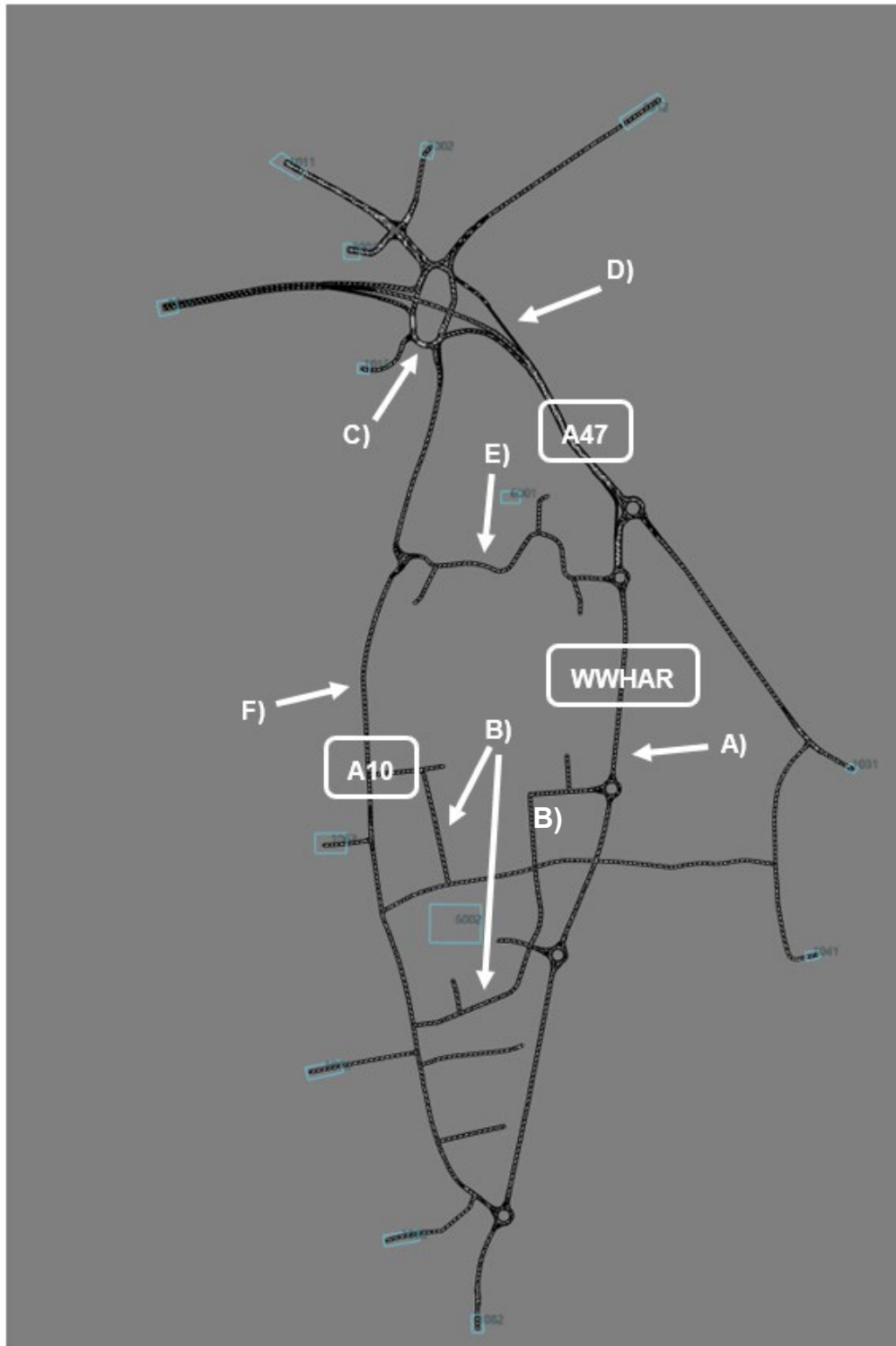
section of the A47 – between Hardwick Roundabout and the WWHAR – is modelled with a speed limit of 40mph.

- E) Addition of Hopkins Road through the Hopkins development, which connects with the A10 to the west via a three-arm priority roundabout, and with the WWHAR to the east via a three-arm priority roundabout.
- F) Sustainable transport measures on the A10. Along the A10, the speed limit has been reduced to 30mph, with a section of 20mph through the centre of West Winch. The bus stops have been moved inside the carriageway, and six signalised pedestrian crossings have been introduced along the corridor.

3.3.2 The Scenario R network is shown in Figure 4-2 with labels corresponding to the network changes.



Figure 4-2 Scenario R – Do Something 2 Paramics Network





3.4 Scenario S – Do Something 1

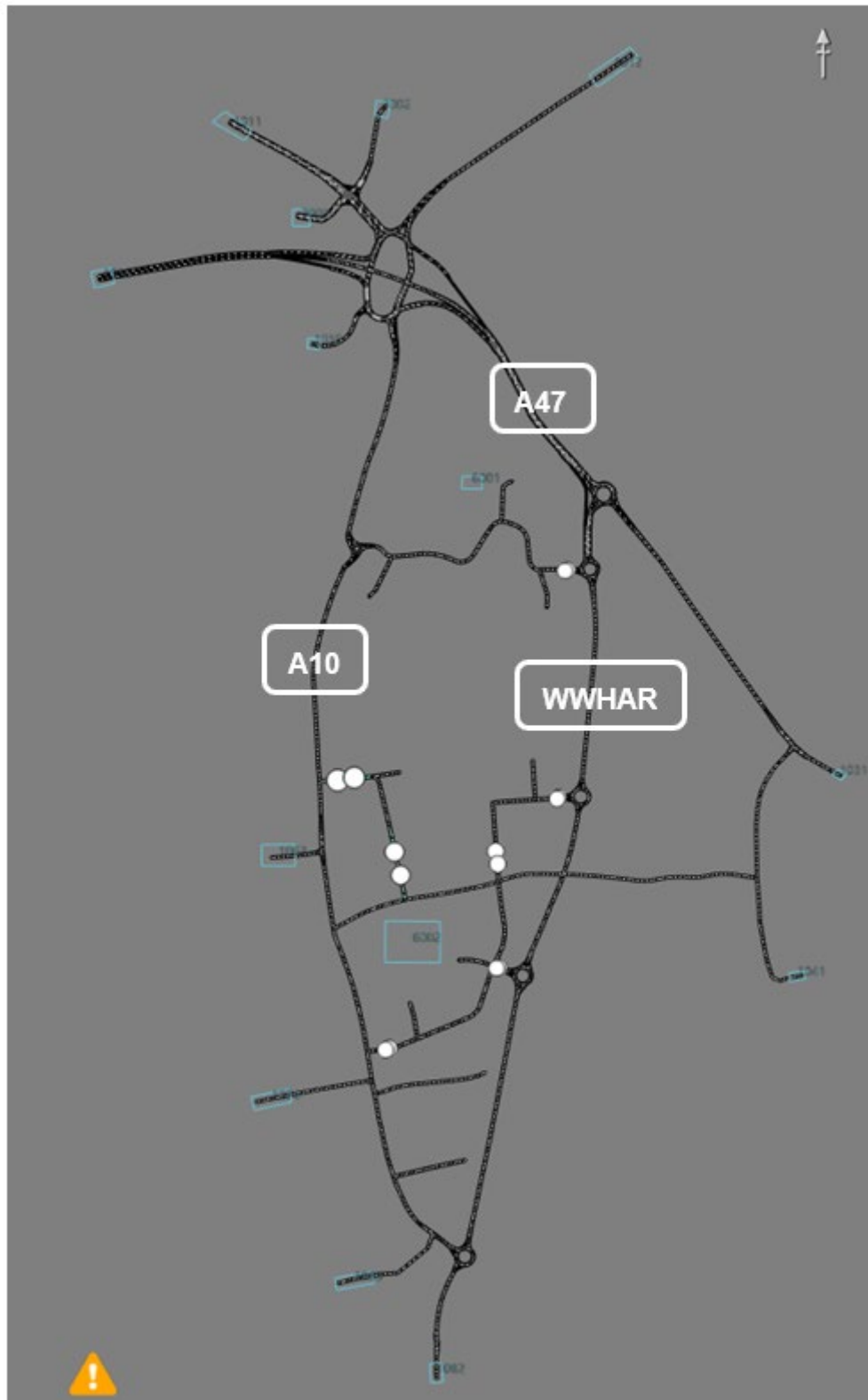
3.4.1 The Scenario S network does not include the dependent development but does include the transport scheme. The Scenario S model was produced from the Scenario R model, with the following changes:

- The links which provided access to the proposed dependent development via the A10 and WWHAR were closed.

3.4.2 The Scenario S network is shown in Figure 4-3. The white circles indicate the links which have a restricted movement (closure).



Figure 4-3 Scenario S – Do Something 1 Paramics Network





4 Forecast matrix development

4.1.1 Origin-Destination matrices have been developed for 2027 and 2042 forecast years for Scenario P, Scenario S and Scenario R. The forecast matrices for each modelled scenario includes:

- Scenario P 2027 – non-dependent development dwellings at WWGA (300) and without the proposed WWHAR transport scheme
- Scenario SR 2027 – non-dependent development dwellings at WWGA (300) and with the proposed WWHAR transport scheme
- Scenario P 2042 – non-dependent development dwellings at WWGA (300) and without the proposed WWHAR transport scheme
- Scenario S 2042 – non-dependent development dwellings at WWGA (300) and with the proposed WWHAR transport scheme
- Scenario R 2042 – full development (4,000 dwellings) at WWGA and with the proposed WWHAR transport scheme

4.1.2 The forecast matrices were developed using the matrices from the SATURN King's Lynn Transport Model (KLTM). The SATURN matrices used in the KLTM were COVID-19 adjusted to acknowledge the impact that COVID-19 has had on travel patterns and volumes which have remained after the ease of lockdown measures. The COVID-19 adjusted factor was calculated using traffic data collected in the King's Lynn area in 2019 and 2022 and was applied to all time periods and user classes in the 2019 base year matrices.

4.1.3 To develop the Paramics matrices, the traffic growth between the SATURN 2019 and 2027 scenarios, and the SATURN 2019 and 2042 scenarios was applied to the validated 2018 Paramics matrices to develop the 2027 and 2042 matrices, respectively. The following steps have been undertaken in the matrix transfer from the SATURN model to the Paramics model:

- Cordon the SATURN model to the Paramics model area;



- Import the SATURN 2019, 2027 and 2042 AM and PM matrices aggregated by vehicles class (Car, LGV and HGV);
- Convert the SATURN matrices from PCUs to vehicles;
- Convert the SATURN zones into Paramics zones;
- Calculate the difference between the 2019 and 2027, and 2019 and 2042 SATURN matrices by vehicle class;
- Convert the one-hour matrix to a three-hour matrix using the Paramics model base year profiles and profile assignments; and
- Add the growth matrices for each scenario and year to the validated 2018 Paramics base year matrix to produce the forecast matrices.

4.1.4 The final Paramics matrices input to the forecast model for Scenario P, Scenario S and Scenario R years 2027 and 2042 cover an AM period of 07:00 to 10:00, and a PM period of 16:00 to 19:00, and the matrices are measured in vehicles.

4.1.5 The matrix totals for each modelled scenario are listed in Table 5-1 to Table 5-5. To understand the change in car usage for each scenario, the matrix totals have been compared to the Base Scenario and the vehicle growth between 2018 and the scenario year has been calculated and is included in the tables below.

Table 5-1 Scenario P 2027 Paramics Matrix Totals

Vehicle Class	AM	PM	AM Growth	PM Growth
Car	12,261	15,218	7%	2%
LGV	3,982	2,898	13%	15%
HGV	962	464	6%	5%



Vehicle Class	AM	PM	AM Growth	PM Growth
Total	17,205	18,580	8%	4%

Table 5-2 Scenario SR 2027 Paramics Matrix Totals

Vehicle Class	AM	PM	AM Growth	PM Growth
Car	12,230	15,141	6%	1%
LGV	4,009	2,886	14%	14%
HGV	967	458	6%	3%
Total	17,206	18,485	8%	3%

Table 5-3 Scenario P 2042 Paramics Matrix Totals

Vehicle Class	AM	PM	AM Growth	PM Growth
Car	13,123	16,074	14%	8%
LGV	4,258	3,099	21%	22%
HGV	963	458	6%	3%
Total	18,344	19,631	15%	10%



Table 5-4 Scenario S 2042 Paramics Matrix Totals

Vehicle Class	AM	PM	AM Growth	PM Growth
Car	13,197	15,986	15%	7%
LGV	4,294	3,065	22%	21%
HGV	1,003	473	10%	7%
Total	18,494	19,524	16%	9%

Table 5-5 Scenario R 2042 Paramics Matrix Totals

Vehicle Class	AM	PM	AM Growth	PM Growth
Car	17,068	19,640	48%	32%
LGV	4,243	3,062	20%	21%
HGV	1,013	471	11%	6%
Total	22,324	23,173	40%	30%

5 Forecast model results

5.1 Modelled flows

5.1.1 Hourly modelled turning flows have been extracted from all forecast scenarios and presented as flow diagrams in Appendix 9 of the Transport Assessment (Document Reference **NCC/4.01.09/WWHAR**).

5.2 WWHAR select link analysis

5.2.1 Select link analysis is carried out at two locations as shown in Figure 6-2 to identify the origins and destinations of the trips using the WWHAR. The first



location is at the start of the housing access road and the second location is at the end of network at A10 Lynn Road.

Figure 6-1 Select Link Analysis Locations



5.2.2 Select link analysis has been done for 2042 Scenario R for both AM and PM peaks.



Figure 6-2 WWHAR SB Select Link Analysis for Scenario R AM Peak

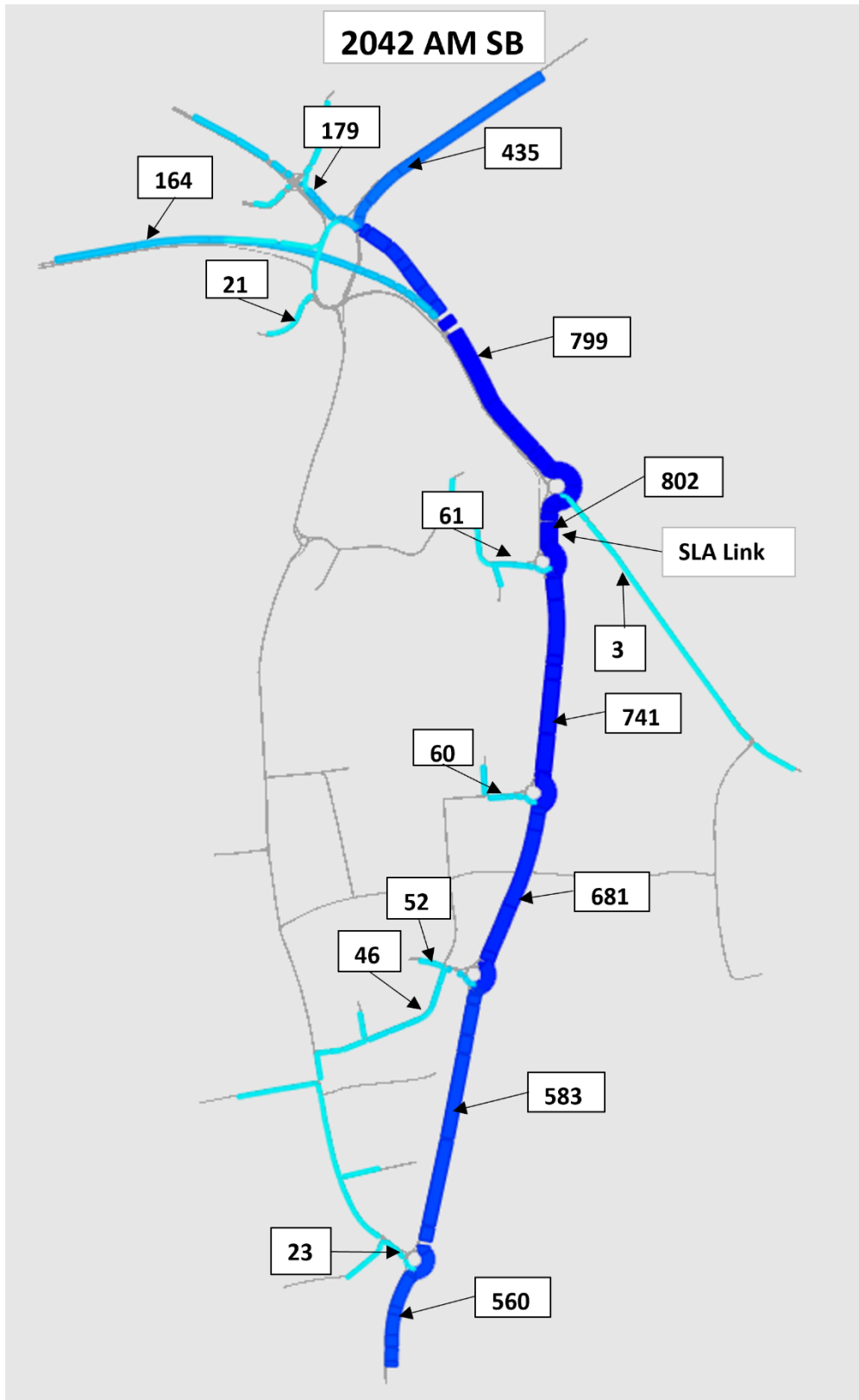
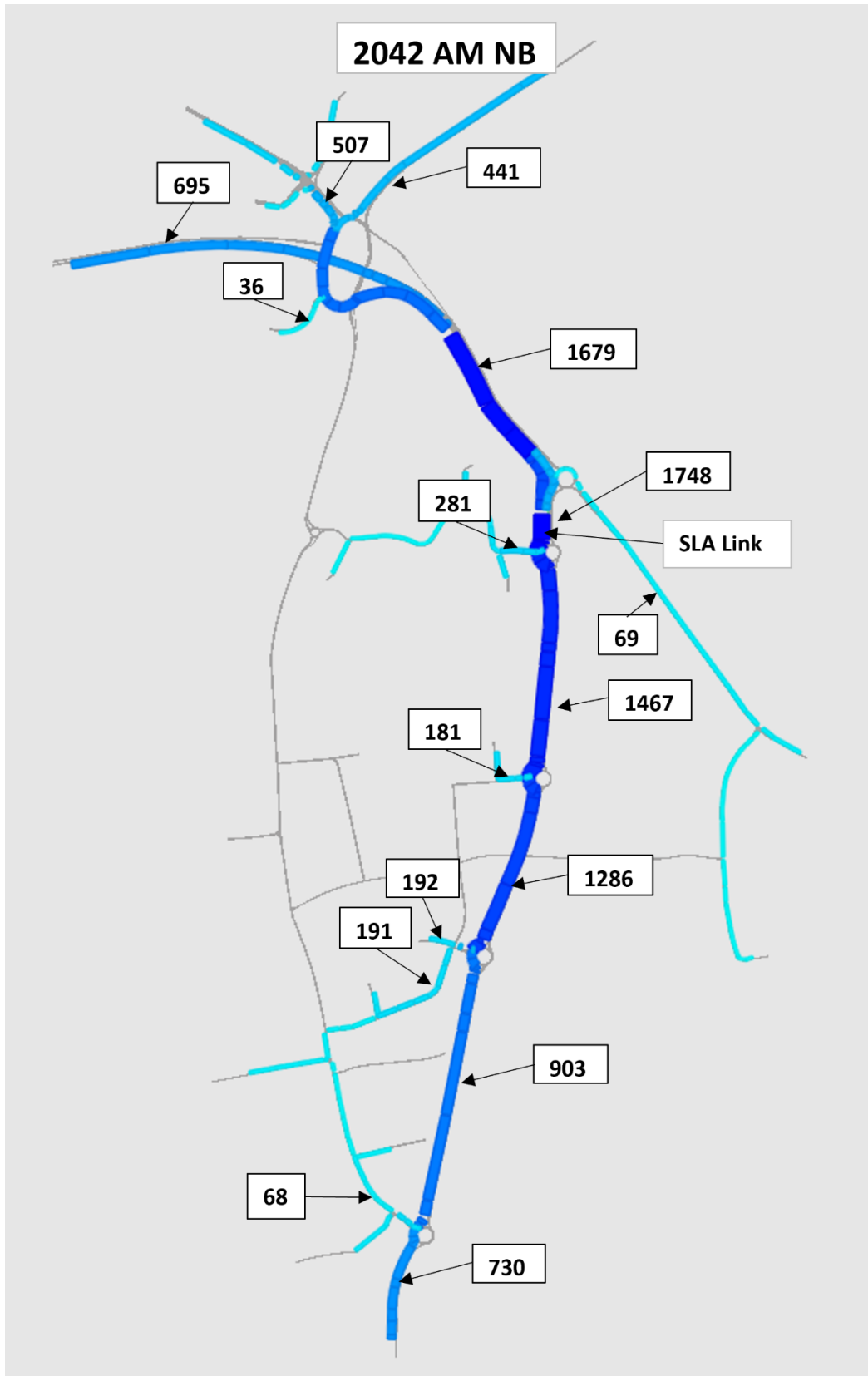




Figure 6-3 WWHAR NB Select Link Analysis for Scenario R AM Peak





5.2.3 Figure 6-3 shows the select link analysis for WWHAR SB link during AM peak hour for scenario R. It can be observed that the majority of trips are originating from A149, Hardwick Road and A47. Most of the trips are going to A10 South.

5.2.4 Figure 6-4 shows the select link analysis for WWHAR NB link during AM peak hour for scenario R. The majority of the vehicle trips going north are originating from A10 South. The main destinations for the trips through WWHAR are A47, Hardwick Road and A149.



Figure 6-4 WWHAR SB Select Link Analysis for Scenario R PM Peak

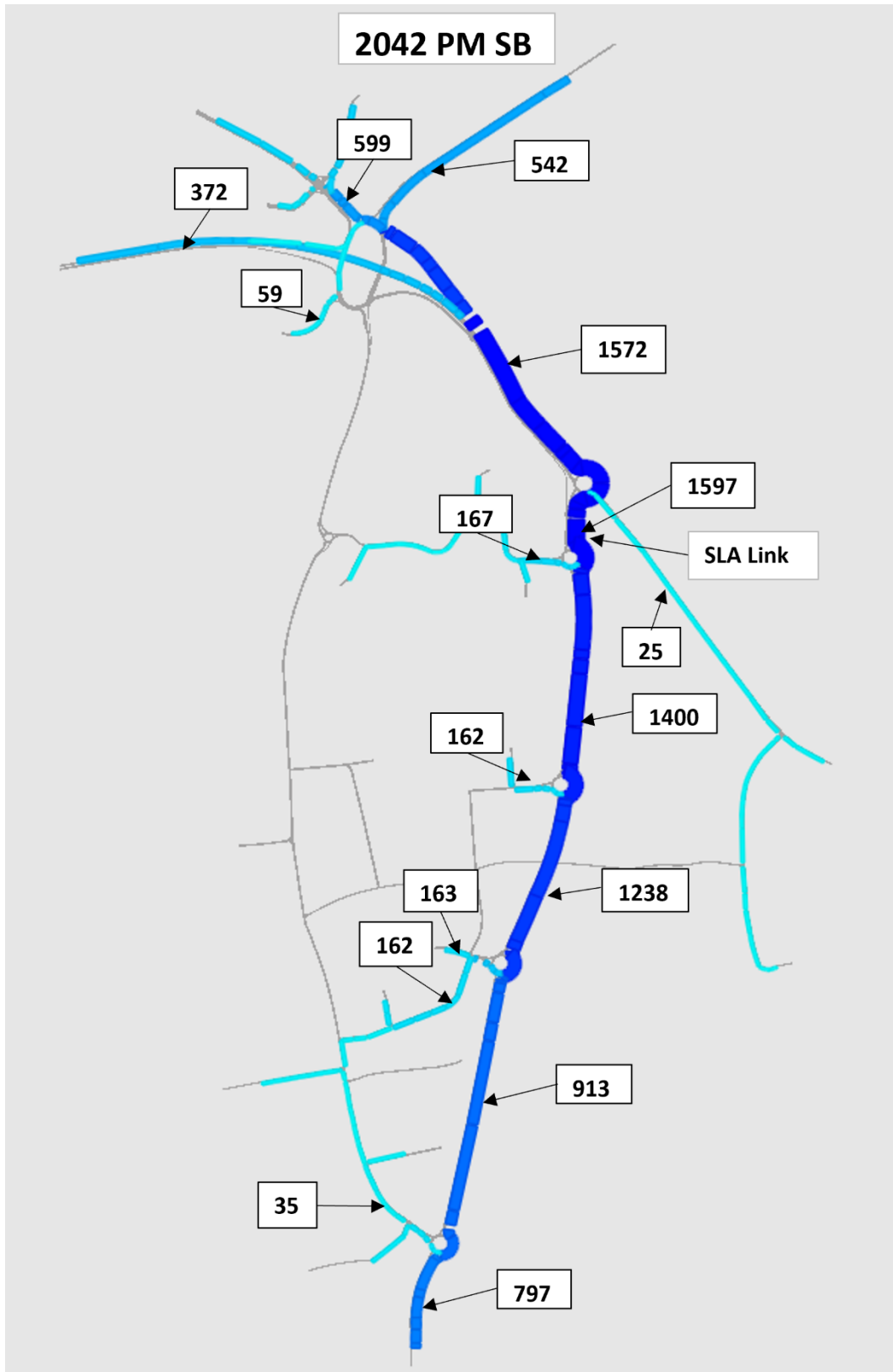
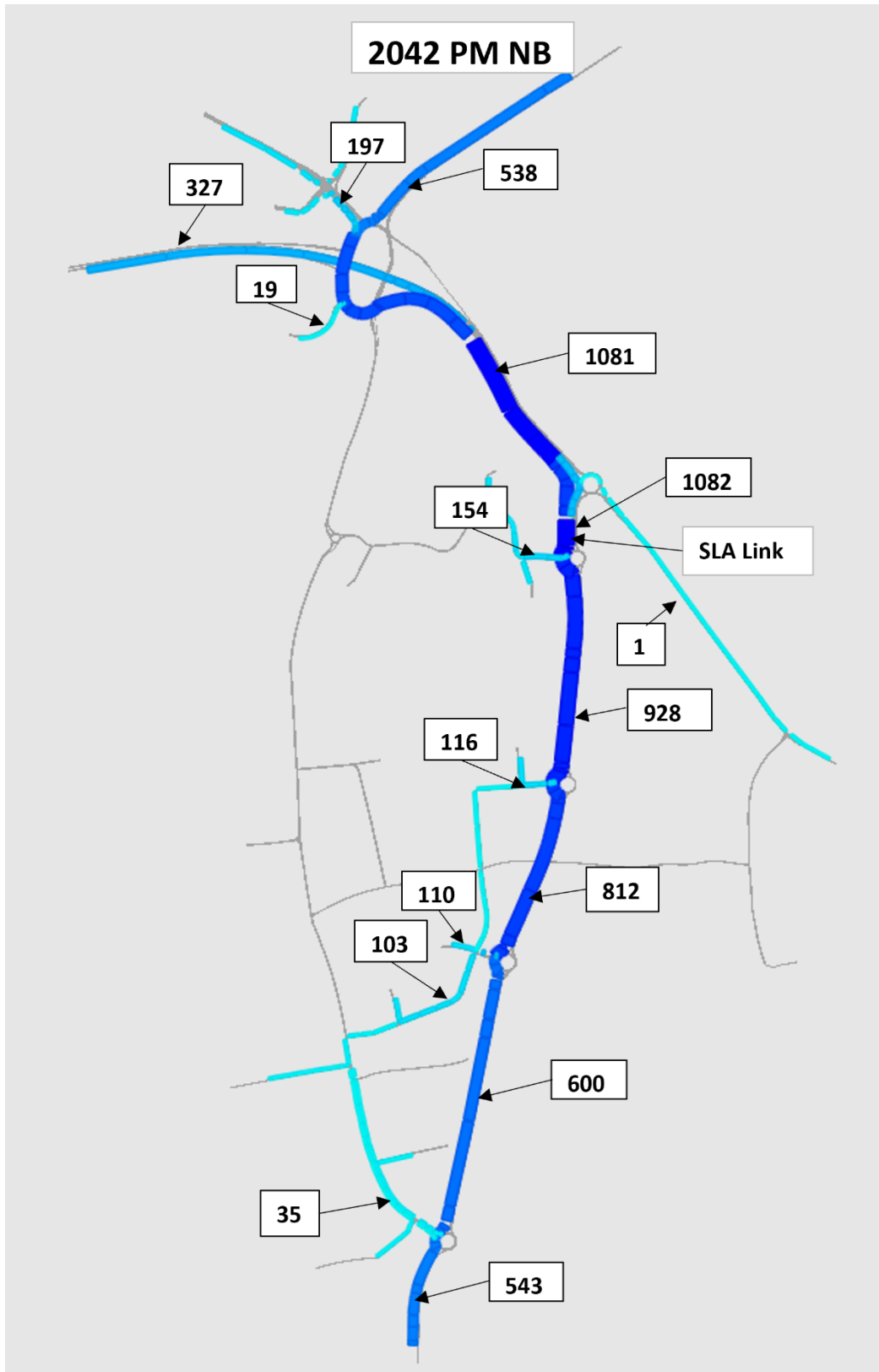




Figure 6-5 WWHAR NB Select Link Analysis for Scenario R PM Peak





- 5.2.5 Figure 6-5 shows the select link analysis for WWHAR SB link during PM peak hour for scenario R. Similar to AM peak, majority of the trips through WWHAR SB are originating from Hardwick Road, A149 and A47 with highest number of trips from Hardwick Road.
- 5.2.6 Figure 6-6 shows the select link analysis for WWHAR NB link during AM peak hour for scenario R. Most of the trips through WWHAR NB link are originating from A10 South. The main destinations for the trips include A149, A47 and Hardwick Road with highest number of trips going to A149.



Figure 6-6 Select Link Analysis for A10 NB AM Peak

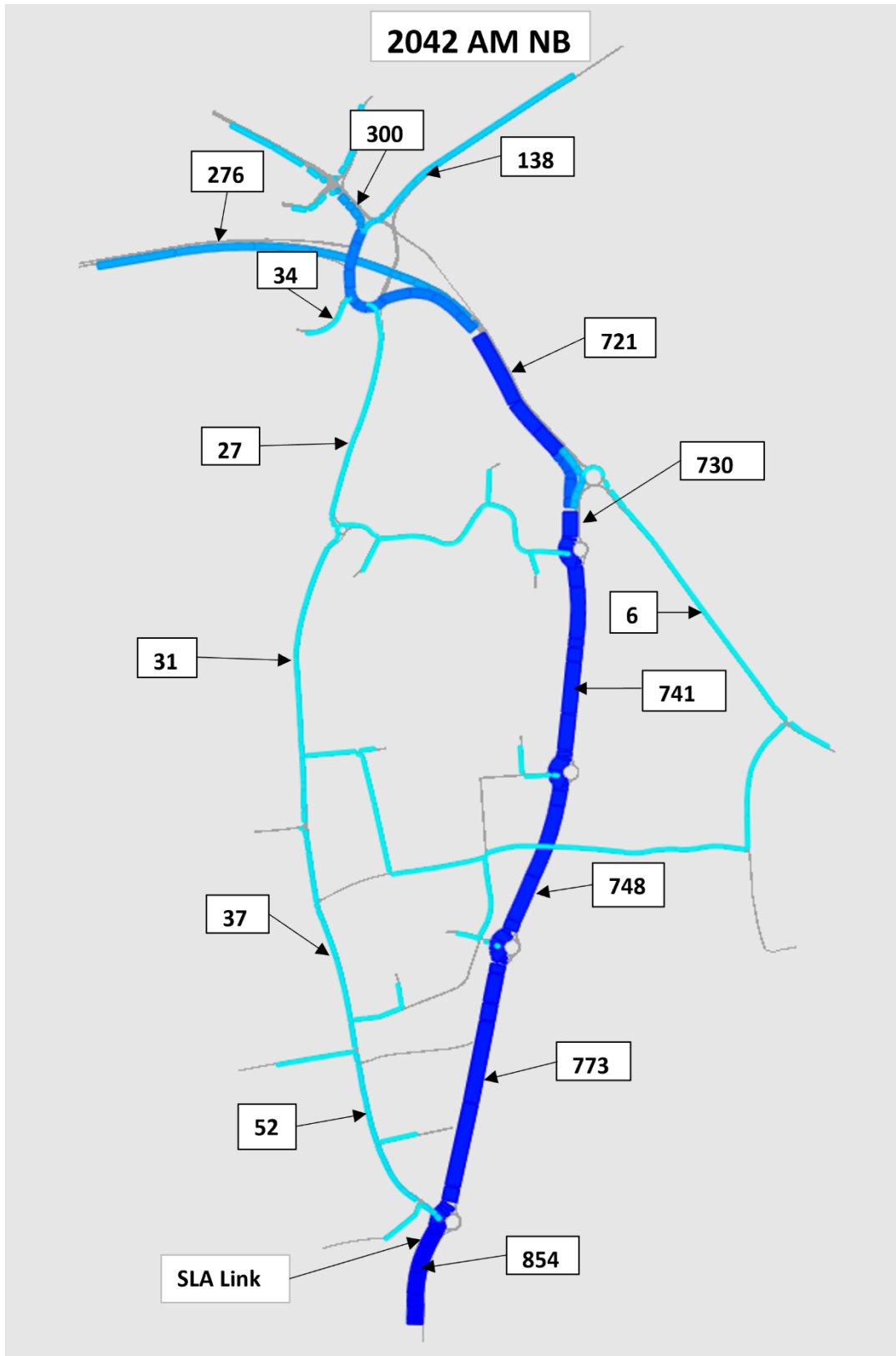
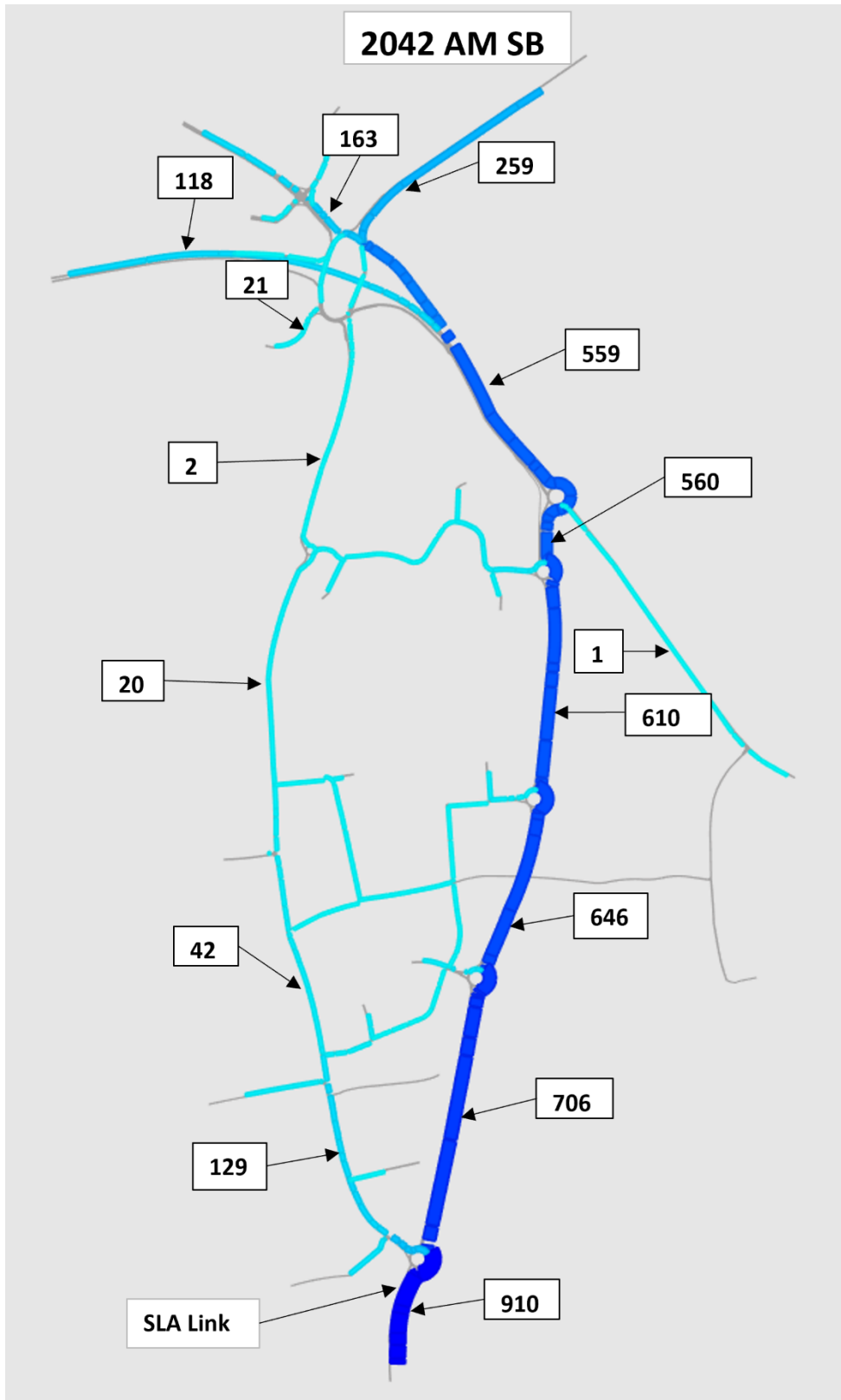




Figure 6-7 Select Link Analysis for A10 SB AM Peak





5.2.7 Figure 6-7 shows the select link analysis for A10 NB link during AM peak hour for scenario R. It can be observed that majority of trips are using WWHAR to go north to A149, Hardwick Road and A47.

5.2.8 Figure 6-8 shows the select link analysis for A10 SB link during AM peak hour for scenario R. Vehicles travelling to south are using WWHAR and are originating from A149, Hardwick Road and A47.



Figure 6-8 Select Link Analysis for A10 NB PM Peak

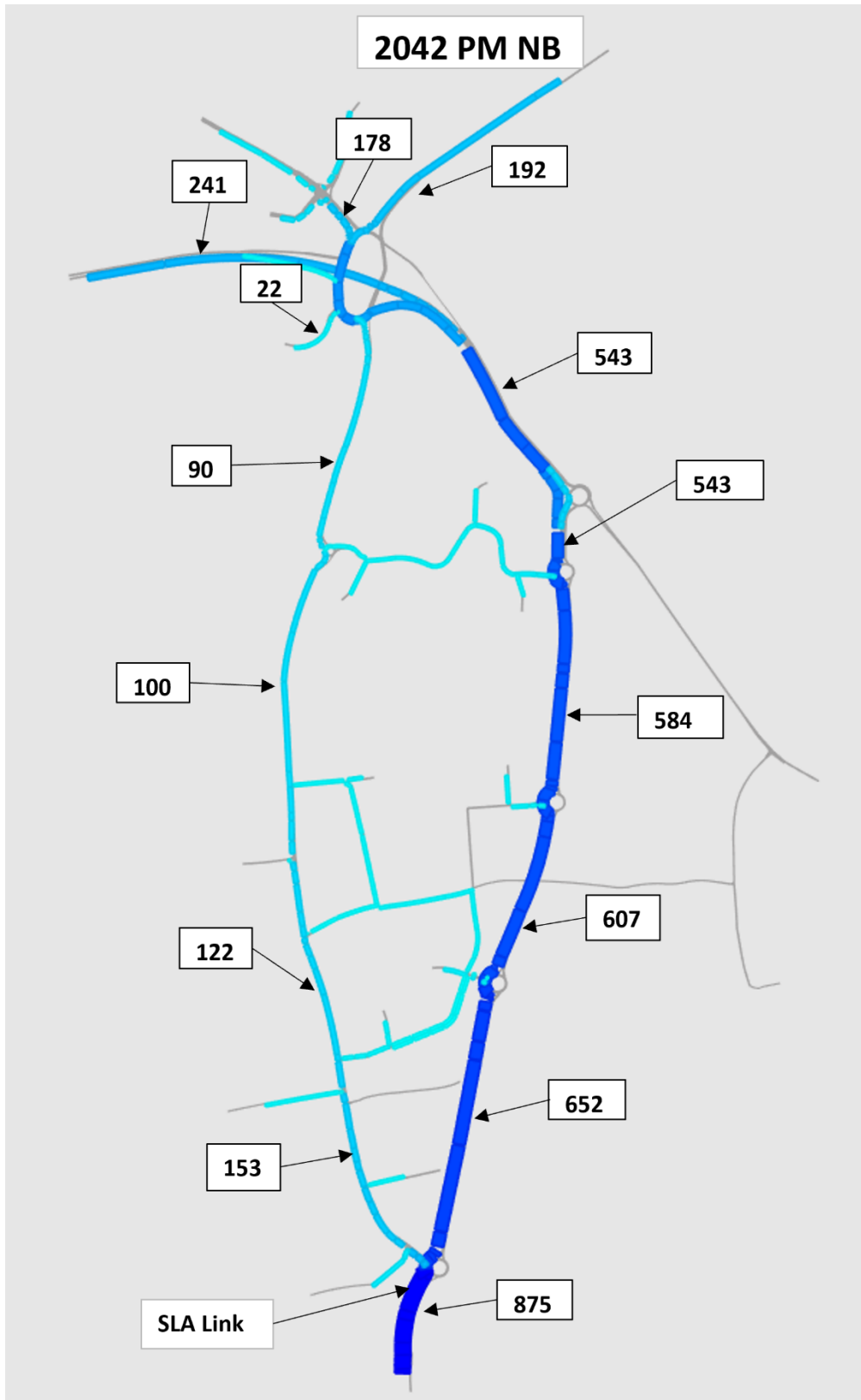
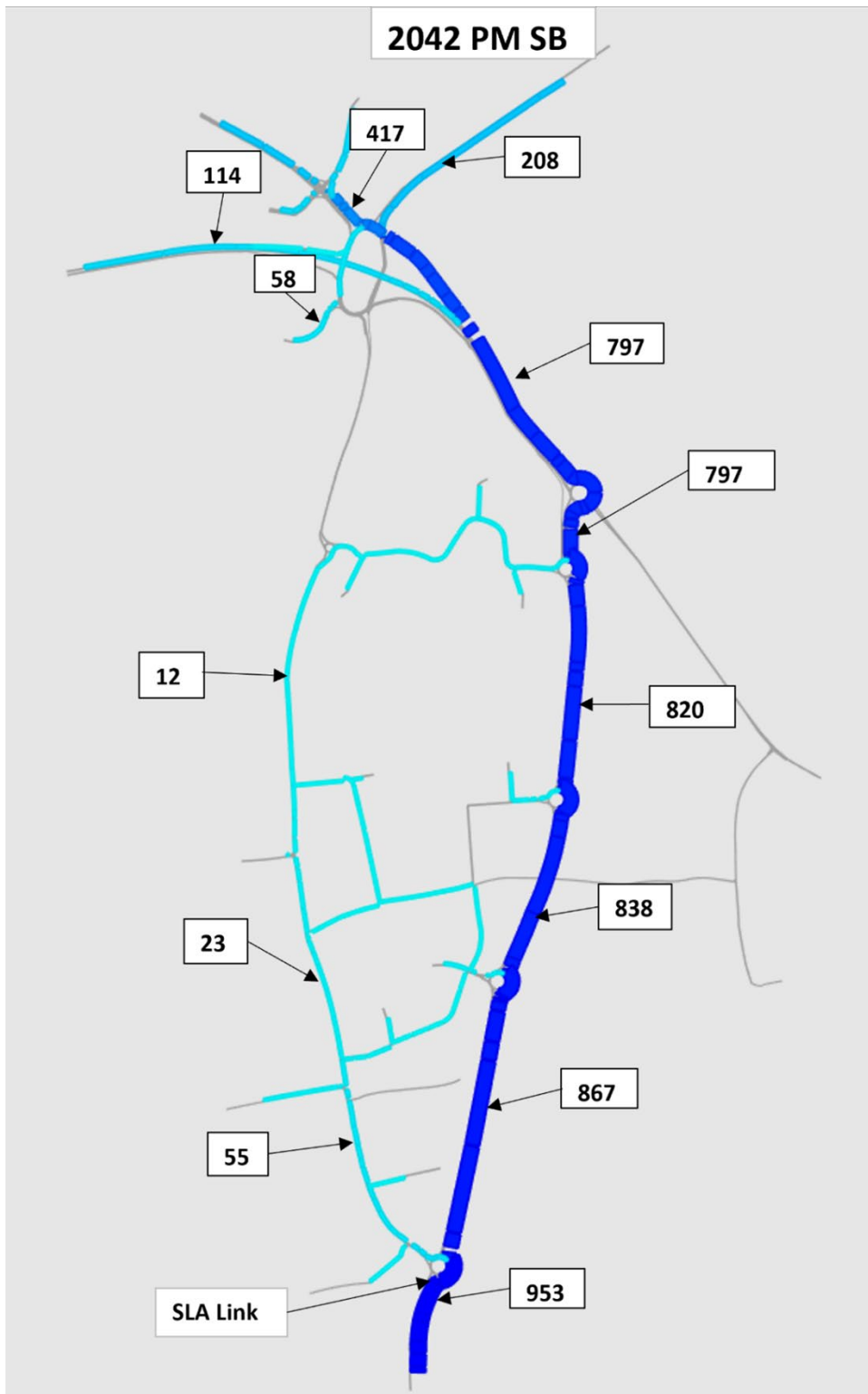




Figure 6-9 Select Link Analysis for A10 SB PM Peak





5.2.9 Figure 6-9 shows the select link analysis for A10 NB link during PM peak hour for scenario R. Most of the trips are using the WWHAR to go north to A47, A149 and Hardwick Road.

5.2.10 Figure 6-10 shows the select link analysis for A10 SB link during PM peak hour for scenario R. Most of the vehicle trips towards south are using WWHAR and are originating from Hardwick Road, A149 and A47.

5.2.11 Select link analysis has been done at two key locations for both directions and for AM and PM peaks (Figure 6-2) to understand the travel pattern of trips along WWHAR. It was observed that majority of trips are through WWHAR link instead of A10 for going Northbound and Southbound.

5.3 Junction capacity impact assessment

5.3.1 To assess junction capacity, model outputs for each scenario and year are assessed on the approach arms to each key junction in the network. The outputs assessed include maximum queue and average queue lengths in metres, average delay in seconds, and Level of Service (LOS).

5.3.2 The LOS is a quantitative measure defined in the Highway Capacity Manual used in the United States of America. Although this LOS definition is not included in UK guidance, it has been included in this assessment for reference as it provides the non-technical audience with a more intuitive way to assess junction performance. The LOS represents a value between A and F which corresponds with the amount of delay experienced by a driver, as shown in Table 6-3. LOS A represents free-flow conditions, while LOS F represents over capacity.

Table 6-1 Level of Service

Level of Service	Signalised Junction	Unsignalised Junction
A	≤ 10 seconds	≤ 10 seconds
B	11 - 20 seconds	11 – 15 seconds
C	21 - 35 seconds	16 - 25 seconds
D	36 - 55 seconds	26 - 35 seconds



Level of Service	Signalised Junction	Unsignalised Junction
E	56 - 80 seconds	36 - 50 seconds
F	≥ 81 seconds	≥ 51 seconds

5.3.3 The results presented in this section represent an average of 10 simulation runs. The results have been collected for AM and PM peak hours only (07:30-08:30 and 16:45-17:45 respectively) rather than the whole modelled period, as this represents the busiest time within the model.

5.3.4 The delay at the junction approaches was calculated by subtracting the journey times along each arm when there is no congestion (free flow conditions) from the journey times along each arm in the full demand conditions of each scenario. To replicate free flow conditions, the model was run for four simulations with only 10% of the full vehicle demand and the average of the resulting journey times on each arm were used.

5.3.5 The results for 2037 are the linear interpolation between the 2027 and 2042 model output results.

5.3.6 Table 6-4 to Table 6-15 sets out the performance results for the 2018 Base Scenario network junctions.

Table 6-2 Base Scenario: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	66	58	16	B
A149 Queen Elizabeth Way	101	91	21	C
A47 Constitution Hill	60	52	15	B
A10 West Winch Road	273	173	59	E
Beveridge Way	45	31	12	B
A47 (West)	127	115	35	C



Table 6-3 Base Scenario: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	155	114	33	C
A149 Queen Elizabeth Way	102	94	15	B
A47 Constitution Hill	53	42	19	B
A10 Westwinch Road	73	54	14	B
Beveridge Way	78	51	17	C
A47 (West)	96	88	23	C

Table 6-4 Base Scenario: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	80	75	45	D
Campbells Meadow	61	55	46	D
Scania Way SB	60	50	49	D
Scania Way EB	60	39	14	B
A149 SE	78	74	22	C

Table 6-5 Base Scenario: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	119	110	36	D
Campbells Meadow	96	90	43	D
Scania Way SB	181	108	76	E
Scania Way EB	160	110	43	D
A149 SE	68	63	33	C

Table 6-6 Base Scenario: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	58	36	34	D
Chequers Lane	0	0	10	A
A10 S	0	0	1	A



Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 N	0	0	17	C

Table 6-7 Base Scenario: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	16	8	23	C
Chequers Lane	6	1	10	A
A10 S	0	0	0	A
A10 N	0	0	22	C

Table 6-8 Base Scenario: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	25	13	7	A
A47 (W)	3	0	0	A

Table 6-9 Base Scenario: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	6	1	5	A
A47 (W)	8	2	0	A

Table 6-10 Base Scenario: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	10	3	No results	No results
Gravelhill Lane	35	26	No results	No results



Table 6-11 Base Scenario: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	17	8	No results	No results
Gravelhill Lane	18	14	No results	No results

Table 6-12 Base Scenario: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	No results	No results
A10 Main Road (S)	39	23	No results	No results

Table 6-13 Base Scenario: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	No results	No results
A10 Main Road (S)	10	3	No results	No results

5.3.7 Table 6-16 to Table 6-29 sets out the performance results for the 2027 Scenario P network junctions.

Table 6-14 Scenario P 2027: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	66	58	14	B
A149 Queen Elizabeth Way	123	104	25	C
A47 Constitution Hill	55	47	15	B
A10 Westwinch Road	386	258	103	F
Beveridge Way	44	34	15	B
A47 (West)	140	115	27	C

Table 6-15 Scenario P 2027: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	130	108	31	C
A149 Queen Elizabeth Way	119	108	18	B
A47 Constitution Hill	50	42	19	B



A10 Westwinch Road	66	58	13	B
Beveridge Way	96	58	26	D
A47 (West)	100	92	25	C

Table 6-16 Scenario P 2027: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	95	80	48	D
Campbells Meadow	69	64	54	D
Scania Way SB	68	52	56	E
Scania Way EB	61	47	18	B
A149 SE	87	73	25	C

Table 6-17 Scenario P 2027: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	125	115	38	D
Campbells Meadow	99	94	52	D
Scania Way SB	157	96	80	E
Scania Way EB	137	95	42	D
A149 SE	75	64	41	D



Table 6-18 Scenario P 2027: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	45	32	30	D
Chequers Lane	0	0	9	A
A10 S	55	18	1	A
A10 N	65	49	13	B

Table 6-19 Scenario P 2027: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	13	7	22	C
Chequers Lane	0	0	11	B
A10 S	0	0	0	A
A10 N	162	137	20	C

Table 6-20 Scenario P 2027: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	10	4	2	A
A10 South	27	19	1	A
Hopkins Road	22	15	7	A

Table 6-21 Scenario P 2027: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	30	14	4	A
A10 South	23	12	2	A
Hopkins Road	29	16	20	C



Table 6-22 Scenario P 2027: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	87	34	14	B
A47 (W)	5	1	0	A

Table 6-23 Scenario P 2027: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	5	1	5	A
A47 (W)	3	0	0	A

Table 6-24 Scenario P 2027: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	7	2	No results	No results
Gravelhill Lane	37	28	No results	No results

Table 6-25 Scenario P 2027: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	17	8	No results	No results
Gravelhill Lane	17	10	No results	No results

Table 6-26 Scenario P 2027: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	7	A
A10 Main Road (S)	128	59	8	A

Table 6-27 Scenario P 2027: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	7	C
A10 Main Road (S)	3	0	1	A



5.3.8 Table 6-32 to Table 6-47 sets out the performance results for the 2037 Scenario P network junctions.

Table 6-28 Scenario P 2037: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	71	63	15	B
A149 Queen Elizabeth Way	124	110	27	C
A47 Constitution Hill	59	51	15	B
A10 Westwinch Road	380	291	115	F
Beveridge Way	53	38	21	C
A47 (West)	164	128	36	D

Table 6-29 Scenario P 2037: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	132	116	45	D
A149 Queen Elizabeth Way	117	107	18	B
A47 Constitution Hill	50	44	19	B
A10 Westwinch Road	71	62	14	B
Beveridge Way	111	64	31	D
A47 (West)	105	96	27	C

Table 6-30 Scenario P 2037: Harwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	96	83	48	D
Campbells Meadow	74	66	55	E
Scania Way SB	62	51	55	D
Scania Way EB	67	48	17	B
A149 SE	88	76	25	C



Table 6-31 Scenario P 2037: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	129	118	39	D
Campbells Meadow	107	98	59	E
Scania Way SB	198	119	91	F
Scania Way EB	193	126	56	E
A149 SE	77	68	41	D

Table 6-32 Scenario P 2037: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	58	35	31	D
Chequers Lane	0	0	8	A
A10 S	76	34	3	A
A10 N	68	55	15	B

Table 6-33 Scenario P 2037: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	14	8	23	C
Chequers Lane	6	1	12	B
A10 S	7	1	0	A
A10 N	163	136	21	C

Table 6-34 Scenario P 2037: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	12	5	2	A
A10 South	30	22	2	A
Hopkins Road	24	18	8	A



Table 6-35 Scenario P 2037: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	36	19	4	A
A10 South	19	12	2	A
Hopkins Road	29	17	22	C

Table 6-36 Scenario P 2037: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	99	54	33	D
A47 (W)	7	1	0	A

Table 6-37 Scenario P 2037: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	5	1	6	A
A47 (W)	8	1	0	A

Table 6-38 Scenario P 2037: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	6	2	No results	No results
Gravelhill Lane	44	31	No results	No results

Table 6-39 Scenario P 2037: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	17	8	No results	No results
Gravelhill Lane	24	11	No results	No results

Table 6-40 Scenario P 2037: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	10	A
A10 Main Road (S)	150	87	15	C



Table 6-41 Scenario P 2037: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	21	C
A10 Main Road (S)	12	3	1	A

5.3.9 Table 6-48 to Table 6-63 sets out the results for the 2042 Scenario P.

Table 6-42 Scenario P 2042: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	73	65	15	B
A149 Queen Elizabeth Way	125	113	28	C
A47 Constitution Hill	61	52	15	B
A10 Westwinch Road	377	307	121	F
Beveridge Way	58	40	24	C
A47 (West)	176	135	40	D

Table 6-43 Scenario P 2042: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	133	120	52	E
A149 Queen Elizabeth Way	116	107	18	B
A47 Constitution Hill	50	45	19	B
A10 Westwinch Road	74	64	15	B
Beveridge Way	119	68	33	D
A47 (West)	108	98	28	C

Table 6-44 Scenario P 2042: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	97	84	48	D
Campbells Meadow	77	67	56	E
Scania Way SB	59	50	54	D
Scania Way EB	70	49	17	B
A149 SE	88	78	25	C



Table 6-45 Scenario P 2042: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	132	120	39	D
Campbells Meadow	111	101	63	E
Scania Way SB	218	130	97	F
Scania Way EB	221	142	63	E
A149 SE	78	70	41	D

Table 6-46 Scenario P 2042: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	64	37	31	D
Chequers Lane	0	0	8	A
A10 S	87	42	4	A
A10 N	69	57	16	C

Table 6-47 Scenario P 2042: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	14	9	23	C
Chequers Lane	9	1	13	B
A10 S	10	1	0	A
A10 N	163	135	21	C

Table 6-48 Scenario P 2042: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	12	6	2	A
A10 South	32	24	2	A
Hopkins Road	25	19	9	A



Table 6-49 Scenario P 2042: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	39	21	4	A
A10 South	17	13	2	A
Hopkins Road	29	18	23	C

Table 6-50 Scenario P 2042: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	105	64	42	E
A47 (W)	8	2	0	A

Table 6-51 Scenario P 2042: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	5	1	7	A
A47 (W)	10	1	0	A

Table 6-52 Scenario P 2042: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	5	2	No results	No results
Gravelhill Lane	48	32	No results	No results

Table 6-53 Scenario P 2042: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	17	8	No results	No results
Gravelhill Lane	27	12	No results	No results

Table 6-54 Scenario P 2042: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	11	B
A10 Main Road (S)	161	101	19	C



Table 6-55 Scenario P 2042: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	28	D
A10 Main Road (S)	17	5	1	A

5.3.10 The results show that in Scenario P, maximum and average queues and delay generally increase between 2027 and 2042, but not significantly. The Scenario P 2042 results, the worst-case scenario, show that the junctions are generally performing similarly to in the 2018 Base Scenario.

5.3.11 For Scenario P, the largest maximum queue length modelled was 386 metres at Hardwick Roundabout on the A10 approach in the 2027 AM peak, which is equal to approximately 64 vehicles (an average vehicle is usually assumed to be 6 metres in length, so a 60-metre queue represents in the region of 10 vehicles). The largest average queue length, 307 metres, was also modelled on this approach in the 2042 AM peak, which is approximately 51 vehicles. This suggests that significant queues can be expected on the A10 approach of Hardwick Roundabout in all modelled years in Scenario P. This is reflected in the LOS of F expected on this approach for all modelled years, which is awarded for delay longer than 80 seconds at signalised junctions. The longest modelled delay of 121 seconds in the 2042 AM peak significantly exceeds this and is approximately double the delay which is modelled on this approach in the AM peak of the Base Scenario.

5.3.12 In the PM peak, significant queues and delays are expected at the Hardwick Road/Scania Way junction. In 2042 a maximum queue of 221 metres is modelled on Scania Way EB, which is equal to approximately 37 vehicles, while an average queue of 142 metres is modelled, which is equal to approximately 24 vehicles. The delay on this approach in the 2042 PM peak is equivalent to an LOS of E, but the largest delay of 97 seconds is expected on Scania Way SB, which is equivalent to an LOS of F. In the 2018 Base Scenario, the LOS in the PM peak on these approaches were D and E



respectively, so the junction has not become significantly worse between these years.

5.3.13 Other changes to the queues and delays between Scenario P and the Base Scenario are modelled at the A47/New Road junction, where delay increases in the AM peak from an LOS of A in the AM Base Scenario to an LOS of E on the New Road approach. This could be attributed to vehicles travelling northbound along the A10 rerouting via Rectory Lane and Chequers Lane to avoid the significant delay on the A10 approach of Hardwick Roundabout during the AM peak. This is supported by the expected increase in delay on the A10 approaches of the A10/Rectory Lane and A10/Chequers Lane junctions in the AM peak between 2027 and 2042.

5.3.14 Table 6-64 to Table 6-87 sets out the performance results for the 2027 Scenario SR network junctions.

Table 6-56 Scenario SR 2027: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	81	77	27	C
A149 Queen Elizabeth Way	108	99	20	B
A47 Constitution Hill	74	69	12	B
A10 Westwinch Road	55	47	9	A
Beveridge Way	58	51	25	C
A47 (West)	129	119	34	C

Table 6-57 Scenario SR 2027: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	87	72	12	B
A149 Queen Elizabeth Way	117	111	19	B
A47 Constitution Hill	63	59	12	B
A10 Westwinch Road	42	36	17	C
Beveridge Way	89	71	30	C
A47 (West)	97	88	25	C



Table 6-58 Scenario SR 2027: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	97	87	49	D
Campbells Meadow	74	65	55	D
Scania Way SB	62	50	53	D
Scania Way EB	66	45	17	B
A149 SE	86	76	27	C

Table 6-59 Scenario SR 2027: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	126	113	37	D
Campbells Meadow	99	93	52	D
Scania Way SB	138	88	63	E
Scania Way EB	143	98	38	D
A149 SE	77	68	47	D

Table 6-60 Scenario SR 2027: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	4	1	0	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	0	0	0	A



Table 6-61 Scenario SR 2027: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	3	1	1	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	5	3	0	A

Table 6-62 Scenario SR 2027: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	0	0	0	A
A10 South	12	2	0	A
Hopkins Road	2	1	0	A

Table 6-63 Scenario SR 2027: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	5	1	0	A
A10 South	2	0	0	A
Hopkins Road	4	1	1	A

Table 6-64 Scenario SR 2027: A47/WWHAR, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	125	107	16	B
A47 South	69	61	14	B
WWHAR	15	9	4	A

Table 6-65 Scenario SR 2027: A47/WWHAR, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	90	79	9	A
A47 South	67	61	15	B
WWHAR	12	6	3	A



Table 6-66 Scenario SR 2027: WWHAR Roundabout 1, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	0	0	2	A
WWHAR South	0	0	2	A
Hopkins Road	No Access in 2027	No Access in 2027	No Access in 2027	No Access in 2027

Table 6-67 Scenario SR 2027: WWHAR Roundabout 1, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	0	0	1	A
WWHAR South	0	0	1	A
Hopkins Road	No Access in 2027	No Access in 2027	No Access in 2027	No Access in 2027

Table 6-68 Scenario SR 2027: WWHAR Roundabout 2, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	No Access in 2027	No Access in 2027	No Access in 2027	No Access in 2027
WWHAR SB	0	0	4	A
WWHAR NB	3	0	1	A

Table 6-69 Scenario SR 2027: WWHAR Roundabout 2, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	No Access in 2027	No Access in 2027	No Access in 2027	No Access in 2027
WWHAR SB	0	0	4	A
WWHAR NB	0	0	1	A



Table 6-70 Scenario SR 2027: WWHAR Roundabout 3, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	No Access in 2027	No Access in 2027	No Access in 2027	No Access in 2027
WWHAR SB	0	0	1	A
WWHAR NB	0	0	0	A

Table 6-71 Scenario SR 2027: WWHAR Roundabout 3, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	No Access in 2027	No Access in 2027	No Access in 2027	No Access in 2027
WWHAR SB	0	0	1	A
WWHAR NB	0	0	0	A

Table 6-72 Scenario SR 2027: WWHAR Roundabout 4, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	43	30	3	A
A10 North	28	16	3	A
WWHAR	33	20	7	A

Table 6-73 Scenario SR 2027: WWHAR Roundabout 4, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	49	42	4	A
A10 North	11	3	3	A
WWHAR	54	21	3	A

Table 6-74 Scenario SR 2027: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	5	1	1	A
A47 (W)	3	0	0	A



Table 6-75 Scenario SR 2027: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	2	0	1	A
A47 (W)	0	0	0	A

Table 6-76 Scenario SR 2027: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	0	0	1	A

Table 6-77 Scenario SR 2027: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	0	0	0	A

Table 6-78 Scenario SR 2027: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	1	A
A10 Main Road (S)	0	0	1	A

Table 6-79 Scenario SR 2027: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	0	A
A10 Main Road (S)	0	0	1	A



5.3.15 Table 6-88 to Table 6-111 sets out the performance results for the 2037 Scenario S network junctions.

Table 6-80 Scenario S 2037: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	88	81	30	C
A149 Queen Elizabeth Way	111	101	21	C
A47 Constitution Hill	78	72	12	B
A10 Westwinch Road	56	49	14	B
Beveridge Way	60	52	26	C
A47 (West)	132	122	37	D

Table 6-81 Scenario S 2037: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	94	78	15	B
A149 Queen Elizabeth Way	118	109	18	B
A47 Constitution Hill	68	62	13	B
A10 Westwinch Road	46	36	18	C
Beveridge Way	94	72	31	C
A47 (West)	102	93	28	C

Table 6-82 Scenario S 2037: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	101	89	48	D
Campbells Meadow	75	67	56	E
Scania Way SB	62	49	55	D
Scania Way EB	68	49	17	B
A149 SE	84	77	26	C



Table 6-83 Scenario S 2037: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	118	107	37	D
Campbells Meadow	102	94	53	D
Scania Way SB	225	129	82	F
Scania Way EB	227	137	51	D
A149 SE	80	71	48	D

Table 6-84 Scenario S 2037: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	6	2	0	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	0	0	0	A

Table 6-85 Scenario S 2037: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	6	1	1	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	6	3	0	A

Table 6-86 Scenario S 2037: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	0	0	0	A
A10 South	12	3	1	A
Hopkins Road	4	1	0	A



Table 6-87 Scenario S 2037: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	4	1	0	A
A10 South	2	0	0	A
Hopkins Road	3	1	0	A

Table 6-88 Scenario S 2037: A47/WWHAR, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	129	116	17	B
A47 South	74	66	15	B
WWHAR	19	12	5	A

Table 6-89 Scenario S 2037: A47/WWHAR, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	106	85	10	B
A47 South	72	63	15	B
WWHAR	16	6	3	A

Table 6-90 Scenario S 2037: WWHAR Roundabout 1, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	0	0	2	A
WWHAR South	0	0	2	A
Hopkins Road	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S

Table 6-91 Scenario S 2037: WWHAR Roundabout 1, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	0	0	2	A
WWHAR South	0	0	1	A
Hopkins Road	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S



Table 6-92 Scenario S 2037: WWHAR Roundabout 2, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	4	A
WWHAR NB	5	1	1	A

Table 6-93 Scenario S 2037: WWHAR Roundabout 2, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	4	A
WWHAR NB	2	0	1	A

Table 6-94 Scenario S 2037: WWHAR Roundabout 3, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	1	A
WWHAR NB	0	0	0	A

Table 6-95 Scenario S 2037: WWHAR Roundabout 3, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	1	A
WWHAR NB	0	0	0	A



Table 6-96 Scenario S 2037: WWHAR Roundabout 4, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	45	30	4	A
A10 North	32	20	3	A
WWHAR	33	22	8	A

Table 6-97 Scenario S 2037: WWHAR Roundabout 4, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	51	43	5	A
A10 North	10	4	4	A
WWHAR	46	22	4	A

Table 6-98 Scenario S 2037: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	5	1	1	A
A47 (W)	3	1	0	A

Table 6-99 Scenario S 2037: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	3	1	1	A
A47 (W)	0	0	0	A

Table 6-100 Scenario S 2037: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	0	0	1	A



Table 6-101 Scenario S 2037: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	0	0	1	A

Table 6-102 Scenario S 2037: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	1	A
A10 Main Road (S)	1	0	0	A

Table 6-103 Scenario S 2037: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	1	A
A10 Main Road (S)	0	0	0	A

5.3.16 Table 6-112 to Table 6-135 sets out the performance results for the 2042 Scenario S network junctions.

Table 6-104 Scenario S 2042: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	91	83	31	C
A149 Queen Elizabeth Way	112	103	21	C
A47 Constitution Hill	80	73	12	B
A10 Westwinch Road	56	50	16	C
Beveridge Way	61	53	26	C
A47 (West)	134	124	38	D



Table 6-105 Scenario S 2042: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	98	81	16	B
A149 Queen Elizabeth Way	119	108	18	B
A47 Constitution Hill	71	63	13	B
A10 Westwinch Road	48	36	18	C
Beveridge Way	97	73	32	C
A47 (West)	104	95	30	C

Table 6-106 Scenario S 2042: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	103	90	47	D
Campbells Meadow	75	68	57	E
Scania Way SB	62	49	56	E
Scania Way EB	69	51	17	B
A149 SE	83	78	26	C

Table 6-107 Scenario S 2042: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	115	104	37	D
Campbells Meadow	104	95	54	D
Scania Way SB	269	149	92	F
Scania Way EB	269	156	58	E
A149 SE	81	72	48	D



Table 6-108 Scenario S 2042: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	7	3	0	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	0	0	0	A

Table 6-109 Scenario S 2042: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	7	1	1	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	6	3	0	A

Table 6-110 Scenario S 2042: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	0	0	0	A
A10 South	11	4	1	A
Hopkins Road	5	1	0	A

Table 6-111 Scenario S 2042: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	3	1	0	A
A10 South	2	0	0	A
Hopkins Road	3	1	0	A



Table 6-112 Scenario S 2042: A47/WWHAR, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	131	120	18	B
A47 South	76	68	15	B
WWHAR	21	13	5	A

Table 6-113 Scenario S 2042: A47/WWHAR, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	114	87	11	B
A47 South	75	65	15	B
WWHAR	18	6	3	A

Table 6-114 Scenario S 2042: WWHAR Roundabout 1, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	0	0	2	A
WWHAR South	0	0	2	A
Hopkins Road	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S

Table 6-115 Scenario S 2042: WWHAR Roundabout 1, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	0	0	2	A
WWHAR South	0	0	1	A
Hopkins Road	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S



Table 6-116 Scenario S 2042: WWHAR Roundabout 2, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	4	A
WWHAR NB	6	1	1	A

Table 6-117 Scenario S 2042: WWHAR Roundabout 2, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	4	A
WWHAR NB	3	0	1	A

Table 6-118 Scenario S 2042: WWHAR Roundabout 3, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	1	A
WWHAR NB	0	0	0	A

Table 6-119 Scenario S 2042: WWHAR Roundabout 3, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	No Access in Sc S	No Access in Sc S	No Access in Sc S	No Access in Sc S
WWHAR SB	0	0	1	A
WWHAR NB	0	0	0	A



Table 6-120 Scenario S 2042: WWHAR Roundabout 4, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	46	31	4	A
A10 North	35	22	3	A
WWHAR	34	22	8	A

Table 6-121 Scenario S 2042: WWHAR Roundabout 4, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	53	44	5	A
A10 North	10	5	4	A
WWHAR	42	22	4	A

Table 6-122 Scenario S 2042: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	5	2	1	A
A47 (W)	3	1	0	A

Table 6-123 Scenario S 2042: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	3	1	1	A
A47 (W)	0	0	0	A

Table 6-124 Scenario S 2042: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	0	0	1	A



Table 6-125 Scenario S 2042: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	0	0	1	A

Table 6-126 Scenario S 2042: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	1	A
A10 Main Road (S)	1	0	0	A

Table 6-127 Scenario S 2042: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	1	A
A10 Main Road (S)	0	0	0	A

5.3.17 The results show that the maximum queues, average queues, and delay at the network junctions increase between 2027 and 2042.

5.3.18 In Scenario S, Hardwick Roundabout performs similarly or better than in Scenario P. The approaches at this junction generally achieve an LOS value between B and D in all the modelled years. The worst performing approaches from Scenario P have improved in Scenario S: from an LOS of F on the A10 approach in Scenario P 2042 AM peak, to an LOS of C in Scenario S; and from an LOS of E on the A149 Hardwick Road in the Scenario P 2042 PM peak to an LOS of B in Scenario S. This is caused by the optimisation of the signals at Hardwick Roundabout, and the reduction in demand on the A10 West Winch Road due vehicles rerouting via the WWHAR.

5.3.19 The longest maximum queue of 134 metres is expected on the A47 W approach in the 2042 AM peak, which is equal to approximately 22 vehicles. The longest average queue of 124 metres is also expected on this approach in the 2042 AM peak, which is equal to approximately 21 vehicles. The maximum and average queues modelled on this approach are not considered



to be significant on a signalised arm of a major junction such as Hardwick Roundabout.

5.3.20 The Hardwick Road / Scania Way junction is the worst performing junction in Scenario S, particularly in the PM peak. Scania Way SB and Scania Way EB are the worst performing approaches, with the maximum queue of 269 metres modelled on both Scania Way SB and Scania Way EB in the 2042 PM peak (equivalent to approximately 45 vehicles), and the longest average queue of 156 metres modelled on Scania Way EB in the 2042 PM peak (equivalent to approximately 26 vehicles). These approaches have an LOS of F and E respectively in the 2042 PM peak, which is the same LOS achieved on each approach in the Scenario P 2042 PM peak.

5.3.21 The junctions on the WWHAR perform well in all Scenario S modelled years, scoring an LOS of A or B in the AM and PM peaks, with minimal queuing expected. A minimal amount of queueing and delay is expected elsewhere on the network, with all other junctions achieving an LOS of A in all the modelled years, an improvement on Scenario P caused by the extra network capacity introduced by the WWHAR.

5.3.22 Table 6-136 to Table 6-159 sets out the performance results for the 2037 Scenario R network junctions.

Table 6-128 Scenario R 2037: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	87	83	31	C
A149 Queen Elizabeth Way	120	111	25	C
A47 Constitution Hill	81	73	12	B
A10 Westwinch Road	69	59	23	C
Beveridge Way	61	52	25	C
A47 (West)	122	113	32	C



Table 6-129 Scenario R 2037: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	111	87	19	B
A149 Queen Elizabeth Way	135	123	25	C
A47 Constitution Hill	80	73	14	B
A10 Westwinch Road	72	55	43	E
Beveridge Way	91	73	31	C
A47 (West)	94	88	26	C

Table 6-130 Scenario R 2037: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	100	90	48	D
Campbells Meadow	75	67	55	D
Scania Way SB	55	47	54	D
Scania Way EB	67	48	16	B
A149 SE	87	80	26	C

Table 6-131 Scenario R 2037: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	134	118	38	D
Campbells Meadow	122	110	71	E
Scania Way SB	225	126	80	E
Scania Way EB	234	139	50	D
A149 SE	83	73	50	D



Table 6-132 Scenario R 2037: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	13	7	1	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	5	2	1	A

Table 6-133 Scenario R 2037: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	10	4	3	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	19	8	2	A

Table 6-134 Scenario R 2037: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	2	0	0	A
A10 South	18	7	1	A
Hopkins Road	7	4	1	A

Table 6-135 Scenario R 2037: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	9	4	1	A
A10 South	5	2	0	A
Hopkins Road	6	3	3	A



Table 6-136 Scenario R 2037: A47/WWHAR, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	155	129	19	B
A47 South	71	63	14	B
WWHAR	34	25	5	A

Table 6-137 Scenario R 2037: A47/WWHAR, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	105	92	12	B
A47 South	74	64	15	B
WWHAR	15	9	3	A

Table 6-138 Scenario R 2037: WWHAR Roundabout 1, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	24	13	2	A
WWHAR South	36	28	4	A
Hopkins Road	30	26	13	B

Table 6-139 Scenario R 2037: WWHAR Roundabout 1, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	25	16	2	A
WWHAR South	47	41	6	A
Hopkins Road	15	12	4	A

Table 6-140 Scenario R 2037: WWHAR Roundabout 2, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	32	24	12	B
WWHAR SB	17	8	5	A
WWHAR NB	42	32	4	A



Table 6-141 Scenario R 2037: WWHAR Roundabout 2, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	17	10	4	A
WWHAR SB	19	9	5	A
WWHAR NB	86	52	12	B

Table 6-142 Scenario R 2037: WWHAR Roundabout 3, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	32	26	5	A
WWHAR SB	14	10	1	A
WWHAR NB	34	30	3	A

Table 6-143 Scenario R 2037: WWHAR Roundabout 3, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	18	12	3	A
WWHAR SB	11	7	1	A
WWHAR NB	80	46	15	B

Table 6-144 Scenario R 2037: WWHAR Roundabout 4, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	44	29	3	A
A10 North	36	27	3	A
WWHAR	41	31	7	A

Table 6-145 Scenario R 2037: WWHAR Roundabout 4, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	53	46	5	A
A10 North	16	8	2	A
WWHAR	40	22	4	A



Table 6-146 Scenario R 2037: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	9	4	2	A
A47 (W)	4	1	0	A

Table 6-147 Scenario R 2037: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	2	0	1	A
A47 (W)	0	0	0	A

Table 6-148 Scenario R 2037: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	1	0	1	A

Table 6-149 Scenario R 2037: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	1	0	1	A
Gravelhill Lane	0	0	1	A

Table 6-150 Scenario R 2037: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	1	0	2	A
A10 Main Road (S)	2	0	1	A

Table 6-151 Scenario R 2037: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	1	A
A10 Main Road (S)	0	0	1	A



5.3.23 Table 6-160 to Table 6-183 sets out the performance results for the 2042 Scenario R network junctions.

Table 6-152 Scenario R 2042: Hardwick Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	90	86	33	C
A149 Queen Elizabeth Way	126	117	27	C
A47 Constitution Hill	85	76	12	B
A10 Westwinch Road	77	65	30	D
Beveridge Way	62	52	25	C
A47 (West)	119	111	31	C

Table 6-153 Scenario R 2042: Hardwick Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 Hardwick Road	124	95	22	C
A149 Queen Elizabeth Way	144	129	28	C
A47 Constitution Hill	88	81	15	B
A10 Westwinch Road	87	64	56	F
Beveridge Way	93	74	31	C
A47 (West)	93	89	27	C

Table 6-154 Scenario R 2042: Hardwick Road/Scania Way, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	102	92	48	D
Campbells Meadow	76	68	55	D
Scania Way SB	52	46	54	D
Scania Way EB	67	49	16	B
A149 SE	88	82	26	C



Table 6-155 Scenario R 2042: Hardwick Road/Scania Way, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A149 NW	138	121	38	D
Campbells Meadow	134	119	80	E
Scania Way SB	268	144	88	F
Scania Way EB	279	159	56	E
A149 SE	86	75	51	D

Table 6-156 Scenario R 2042: A10/Chequers Lane/Long Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	18	10	2	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	7	3	1	A

Table 6-157 Scenario R 2042: A10/Chequers Lane/Long Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Long Lane (W)	13	6	4	A
Chequers Lane	0	0	0	A
A10 S	0	0	0	A
A10 N	26	11	3	A

Table 6-158 Scenario R 2042: Hopkins Roundabout, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	3	0	0	A
A10 South	21	10	1	A
Hopkins Road	10	6	2	A



Table 6-159 Scenario R 2042: Hopkins Roundabout, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 North	10	5	1	A
A10 South	7	3	0	A
Hopkins Road	8	4	4	A

Table 6-160 Scenario R 2042: A47/WWHAR, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	170	140	21	C
A47 South	71	64	14	B
WWHAR	43	33	5	A

Table 6-161 Scenario R 2042: A47/WWHAR, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A47 North	113	98	14	B
A47 South	78	66	15	B
WWHAR	16	10	3	A

Table 6-162 Scenario R 2042: WWHAR Roundabout 1, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	36	19	2	A
WWHAR South	54	43	5	A
Hopkins Road	46	39	19	C

Table 6-163 Scenario R 2042: WWHAR Roundabout 1, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
WWHAR North	38	25	3	A
WWHAR South	71	61	9	A
Hopkins Road	23	18	6	A



Table 6-164 Scenario R 2042: WWHAR Roundabout 2, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	47	36	18	C
WWHAR SB	25	12	5	A
WWHAR NB	61	48	6	A

Table 6-165 Scenario R 2042: WWHAR Roundabout 2, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access North	25	15	6	A
WWHAR SB	29	13	6	A
WWHAR NB	128	77	17	C

Table 6-166 Scenario R 2042: WWHAR Roundabout 3, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	48	39	7	A
WWHAR SB	22	16	1	A
WWHAR NB	51	46	5	A

Table 6-167 Scenario R 2042: WWHAR Roundabout 3, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Dev Access South	27	18	4	A
WWHAR SB	16	10	1	A
WWHAR NB	120	69	22	C

Table 6-168 Scenario R 2042: WWHAR Roundabout 4, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	45	29	3	A
A10 North	40	33	3	A
WWHAR	45	36	7	A



Table 6-169 Scenario R 2042: WWHAR Roundabout 4, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 South	55	48	6	A
A10 North	18	11	2	A
WWHAR	33	22	4	A

Table 6-170 Scenario R 2042: A47/New Road, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	12	6	2	A
A47 (W)	5	1	0	A

Table 6-171 Scenario R 2042: A47/New Road, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
New Road	2	0	1	A
A47 (W)	0	0	0	A

Table 6-172 Scenario R 2042: A10/Gravelhill Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	0	0	0	A
Gravelhill Lane	2	0	1	A

Table 6-173 Scenario R 2042: A10/Gravelhill Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
A10 Main Road (N)	2	0	1	A
Gravelhill Lane	0	0	2	A



Table 6-174 Scenario R 2042: A10/Rectory Lane, AM Peak (07:30-08:30)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	2	0	3	A
A10 Main Road (S)	2	1	1	A

Table 6-175 Scenario R 2042: A10/Rectory Lane, PM Peak (16:45-17:45)

Approach	Max Queue (m)	Average Queue (m)	Average Delay (s)	LOS
Rectory Lane	0	0	2	A
A10 Main Road (S)	0	0	1	A

5.3.24 The results show that for Scenario R, the maximum queues, average queues, and delay at the junctions increase between 2027 and 2042.

5.3.25 At Hardwick Roundabout in 2042, the junctions perform similarly to Scenario S 2042. The largest increase in queuing and delay are expected at the A10 approach, which achieves a LOS of D in the AM peak and F in the PM peak. The maximum queue expected at this approach is 77 metres in the AM peak and 87 metres in the PM peak, equal to approximately 13 vehicles and 15 vehicles respectively, which is not considered to be significant on an unsignalised arm of a major junction such as Hardwick Roundabout.

5.3.26 The results show that in Scenario R, the junction with the largest delay is Hardwick Road/Scania Road, particularly in the PM peak. Maximum queue lengths of 268 metres and 279 metres are expected on Scania Way SB and Scania Way EB respectively in the PM peak, which is equal to approximately 45 and 46 vehicles. The average queue lengths at this approach are 144 metres on Scania Way SB and 159 metres on Scania Way EB, which is equal to approximately 24 and 27 vehicles respectively.

5.3.27 The junctions on the WWHAR generally perform well in all Scenario R modelled years, generally scoring an LOS of A or B in the AM and PM peaks, with minimal queuing expected. In the AM peak, more delay is expected on the development access arms of the junctions, while in the PM peak more delay is expected on the northbound approach arms of the junctions.



6 Summary and conclusions

6.1.1 Paramics modelling of the West Winch Growth Area was undertaken to assess the network performance under three future scenarios: Scenario P with 300 dwellings at the WWGA and without the WWHAR; Scenario S with 300 dwellings at the WWGA and with the WWHAR; and Scenario R with 4,000 dwellings at the WWGA and with the WWHAR. Two future years were modelled for the AM and PM period, 2027 and 2042. An additional forecast year, 2037, has been included in the assessment but has not been modelled. Results for this forecast year have been obtained from a linear interpolation between the 2027 and 2042 modelled results.

6.1.2 The outputs from the Paramics models were analysed to assess: the expected hourly traffic flows around the West Winch highway network; the movement of traffic across the network, through select link analysis; and the performance of individual junctions. The following high-level conclusions can be drawn from the Paramics model results:

- The rerouting of strategic traffic from the A10 to the WWHAR in Scenario S and Scenario R is further demonstrated by the select link analysis, which showed that the majority of trips on the WWHAR originate from the A149, Hardwick Road, the A47, or the A10 (S), and have the same destinations.
- The junction with the highest level of delay is the Hardwick Road / Scania Way signalised junction, where the Scania Way southbound approach is over capacity in the PM. However, this approach is already reaching capacity in the base year without the Proposed Scheme.
- The junctions which are part of the proposed development at the WWGA (including WWHAR junctions and A10 access junctions) operate within capacity and are not expected to cause significant levels of queueing or delay in any of the forecast scenarios and either of the peak periods.