TECHNICAL NOTE

SUBJECT	**Traffic Modelling Technical Note – A647 Local Junction Models**		
DATE	20 July 2018	**AUTHOR**	**Amber Parkes**
CHECKER	Tom Crowther	**APPROVER**	Nathan Huntley
VERSION	**01 - LPTIP1-WSP-A647-XXX-TN-TP-000001**	**DESIGN STAGE**	Feasibility Design

1. INTRODUCTION

The A647 Corridor includes several packages to improve bus prioritisation along the A647 Armley Road and Stanningley Road to reduce bus journey times and improve the reliability of bus journey times along the corridor.

To understand the impact of the improvements to the junctions, as well as the impact to the corridor in terms of bus priorities and the interaction of traffic, there is a requirement to undertake preliminary junction/network modelling to assess and determine suitable junction arrangements (at concept level) with an associated signal strategy at key locations on Quality Bus Corridors (QBCs).

It is intended that this local junction modelling will form the first instance of the design process. As such, the purpose of this Technical Note is to summarise the initial findings and results of the modelling analysis.

2. STUDY AREA AND MODELLING OVERVIEW

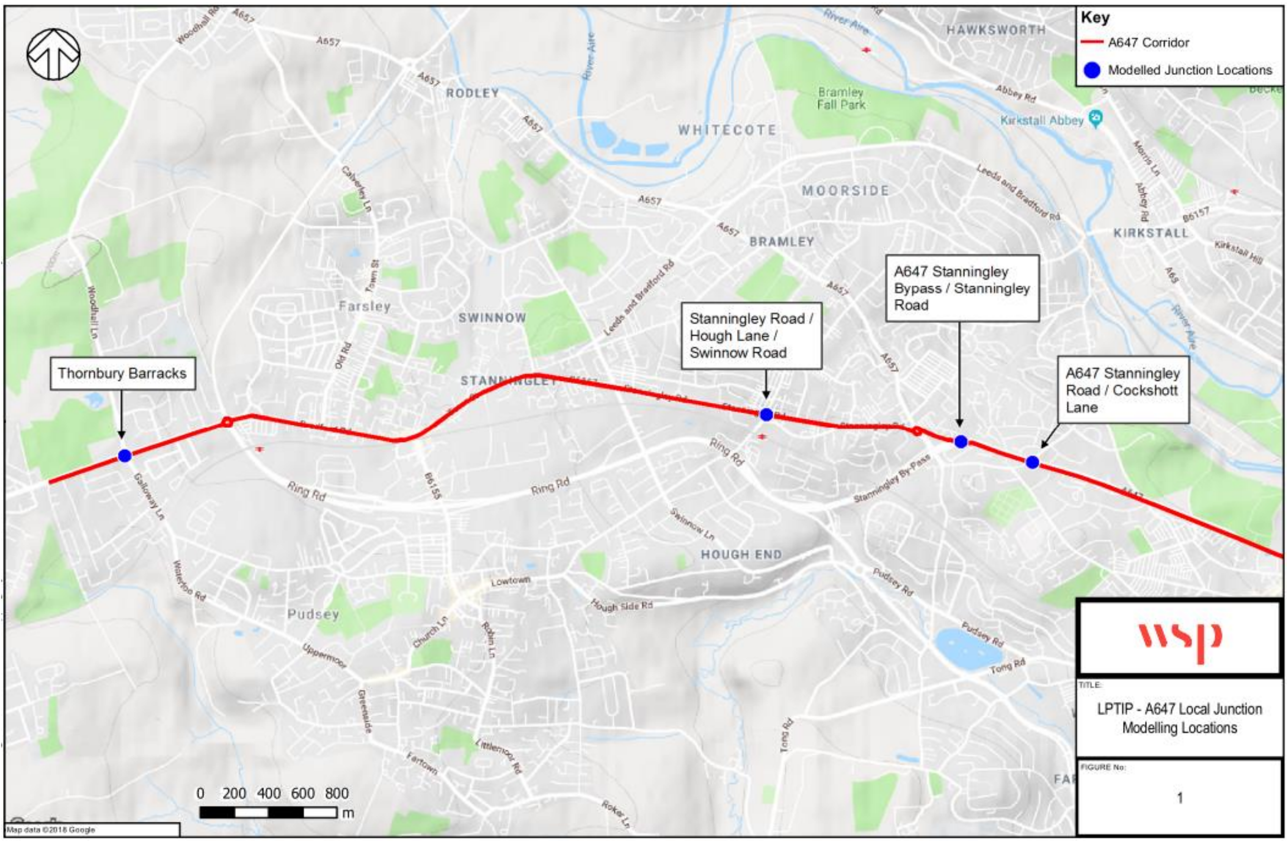
The study area defined for this technical note is defined by the following junctions:

- A647 Stanningley Road / Cockshott Lane
- A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road
- Stanningley Road / Hough Lane / Swinnow Road
- A647 Bradford Road / Woodhall Lane / Galloway Lane (Thornbury Barracks)

The location of each junction can be seen in figure 1 below.

It should be noted the length of the A647 corridor between Armley Ridge Road and Gloucester Terrace is being assessed via the use of bespoke Vissim model. This will be reported on separately to the local junction modelling.

Figure 1: A647 Local Junction Model Locations



Source: Google Maps

3. TRAFFIC FLOW DATA

Traffic surveys were carried out between the 17th and 19th of April 2018 at the following locations:

- A647 Stanningley Road / Cockshott Lane
- A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road
- Stanningley Road / Hough Lane / Swinnow Road
- A647 Bradford Road / Woodhall Lane / Galloway Lane (Thornbury Barracks)

Following the surveys, WSP received three days' worth of turning count data (Tues – Thurs) for the above junctions. Using this, base peak hour matrices were created.

For each day, the total number of PCUs per hour (07:00 – 19:00) were plotted and compared to see if there were any major differences with each days' data. After this assessment, a decision was taken to average the peak hour flows across all three days for robustness at most junctions. The only exception to this is Thornbury Barracks, which uses an average across all three days for the AM peak, but an average across only Tuesday and Thursday in the PM peak due to significantly lower PM peak flows on the Wednesday.

For each junction, the peak hours were determined to be:

Table 1: Network Peak Hours

	AM PEAK	PM PEAK
A647 Stanningley Rd / Cockshott Ln	07:00 – 08:00	16:30 – 17:30
A647 Stanningley Bypass / A647 Stanningley Rd / Stanningley Rd	07:00 – 08:00	N/A
Stanningley Rd / Hough Ln / Swinnow Rd	07:30 – 08:30	16:45 – 17:45
Thornbury Barracks	07:30 – 08:30	16:30 – 17:30

It should be noted that no PM peak hour has been modelled for the Stanningley Bypass junction, as this is a slip road onto the A647 eastbound towards Leeds city centre. Issues in the PM peak here occur on the westbound carriageway, which is not included as part of the model area.

The peak hour matrices for each junction are presented below.

A647 Stanningley Road / Cockshott Lane

Table 2: A647 Stanningley Road / Cockshott Lane - Peak Hour Flow Matrices (PCU/hr)

AM PEAK

	A	B	C	Tot
A	0	22	255	278
B	41	2	887	929
C	186	1251	0	1436
Tot	226	1274	1143	2643

PM PEAK

	A	B	C	Tot
A	0	35	263	298
B	59	4	1193	1256
C	244	911	0	1155
Tot	302	951	1456	2709

Where each zone is defined as:

- **Zone A:** Cockshott Lane
- **Zone B:** Stanningley Road (East)
- **Zone C:** Stanningley Road (West)

A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road

Table 3: A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road - Peak Hour Flow Matrices (PCU/hr)

AM PEAK

	A	B	C	Tot
A	0	461	0	461
B	0	0	0	0
C	0	986	0	986
Tot	0	1447	0	1447

Where each zone is defined as:

- **Zone A:** Stanningley Road
- **Zone B:** A647 Stanningley Road
- **Zone C:** A647 Stanningley Bypass

Stanningley Road / Hough Lane / Swinnow Road

Table 4: Stanningley Road / Hough Lane / Swinnow Road - Peak Hour Flow Matrices (PCU/hr)

AM PEAK

	A	B	C	D	Tot
A	0	12	284	18	314
B	7	0	78	222	307
C	141	35	0	77	252
D	22	336	155	0	512
Tot	170	383	516	317	1386

PM PEAK

	A	B	C	D	Tot
A	0	18	208	21	246
B	14	0	100	361	476
C	168	31	0	118	317
D	28	247	139	0	414
Tot	210	296	448	500	1454

Where each zone is defined as:

- **Zone A:** Hough Lane
- **Zone B:** Stanningley Road (East)
- **Zone C:** Swinnow Road
- **Zone D:** Stanningley Road (West)

Thornbury Barracks

Table 5: Thornbury Barracks - Peak Hour Flow Matrices (PCU/hr)

AM PEAK

	A	B	C	D	Tot
A	1	292	1665	232	2190
B	272	0	114	260	646
C	1957	67	6	81	2112
D	508	324	90	0	922
Tot	2738	684	1875	572	5870

PM PEAK

	A	B	C	D	Tot
A	2	280	1658	401	2342
B	156	0	72	151	378
C	1748	69	0	160	1978
D	307	269	64	0	639
Tot	2212	618	1793	713	5337

Where each zone is defined as:

- **Zone A:** A647 Bradford Road (West)
- **Zone B:** Woodhall Lane
- **Zone C:** A647 Bradford Road (East)
- **Zone D:** B6154 Galloway Lane

4. JUNCTION MODELLING METHODOLOGY

WSP has carried out an assessment of the proposed junction improvement works using LinSig (Version 3) and TRANSYT 15. Both programmes are industry standard software tools which allows traffic engineers to model junctions and their effect on capacities and queuing. They are used to model signalised junctions, and allow for the optimisation of traffic signals to increase capacity and/or reduce delays at junctions.

For base models, all traffic signals information, including phasing, staging and intergreens, have been based on the controller specifications provided by LCC. Signal timings for VA operated junctions (have been calculated from the phase maximums stated in the controller specification. Where UTC plans have been provided these have been used to calculate signal timings.

As built information provided by LCC included the following for each junction:

- **A647 Stanningley Road / Cockshott Lane**
  - 218L v1 03-09-15 (Traffic signal controller specification)

- UTC_218L_02 (Drawing)

- **A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road**
  - 360L v1 S 18_3_98 (Traffic signal controller specification)
  - 360L AM plan 1and PM plan 2 (UTC plans)
  - UTC-360L-13_08_01 (Drawing)
- **Stanningley Road / Hough Lane / Swinnow Road**
  - 358L v1 21-04-15 ISSUE (Traffic signal controller specification)
  - UTC_358L_02 (Drawing)
- **A647 Bradford Road / Woodhall Lane / Galloway Lane (Thornbury Barracks)**
  - 818L T v3 30_08_16 (Traffic signal controller specification)
  - UTC-818La (with Dynamic Signs) (Drawing)

For the Cockshott Lane and Hough Lane junctions, saturation flows have been estimated using the TRL RR67 formulae. For the Stanningley Bypass junction, a standard saturation flow of 1800 PCU/hr has been assumed. For Thornbury Barracks, a base model was provided by LCC which contained saturation flows for each lane.

Given the above assumptions and concept level design stage, results should be used for guidance only to inform the selection process for the preferred option improvement scheme going forward for more detailed design. Once this has been derived, a more detailed assessment will be required to assess the suitability of the final scheme.

5. RESULTS AND ANALYSIS

The results for each model have been summarised in the tables below, with summary of results focusing on capacity and / or operational issues on links which are over-saturated or predict excessive queuing which may result in blocking back through adjacent junctions.

5.1 A647 STANNINGLEY ROAD / COCKSHOTT LANE

Base Model

This model is based on the existing layout at A647 Stanningley Road / Cockshott Lane, shown in figure 2, and has validated been using both queue survey data and supporting video survey data.

Figure 2: A647 Stanningley Road / Cockshott Lane - Existing Layout

Source: Google Maps

Table 6 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 6: A647 Stanningley Road / Cockshott Lane - Summary Results - Base

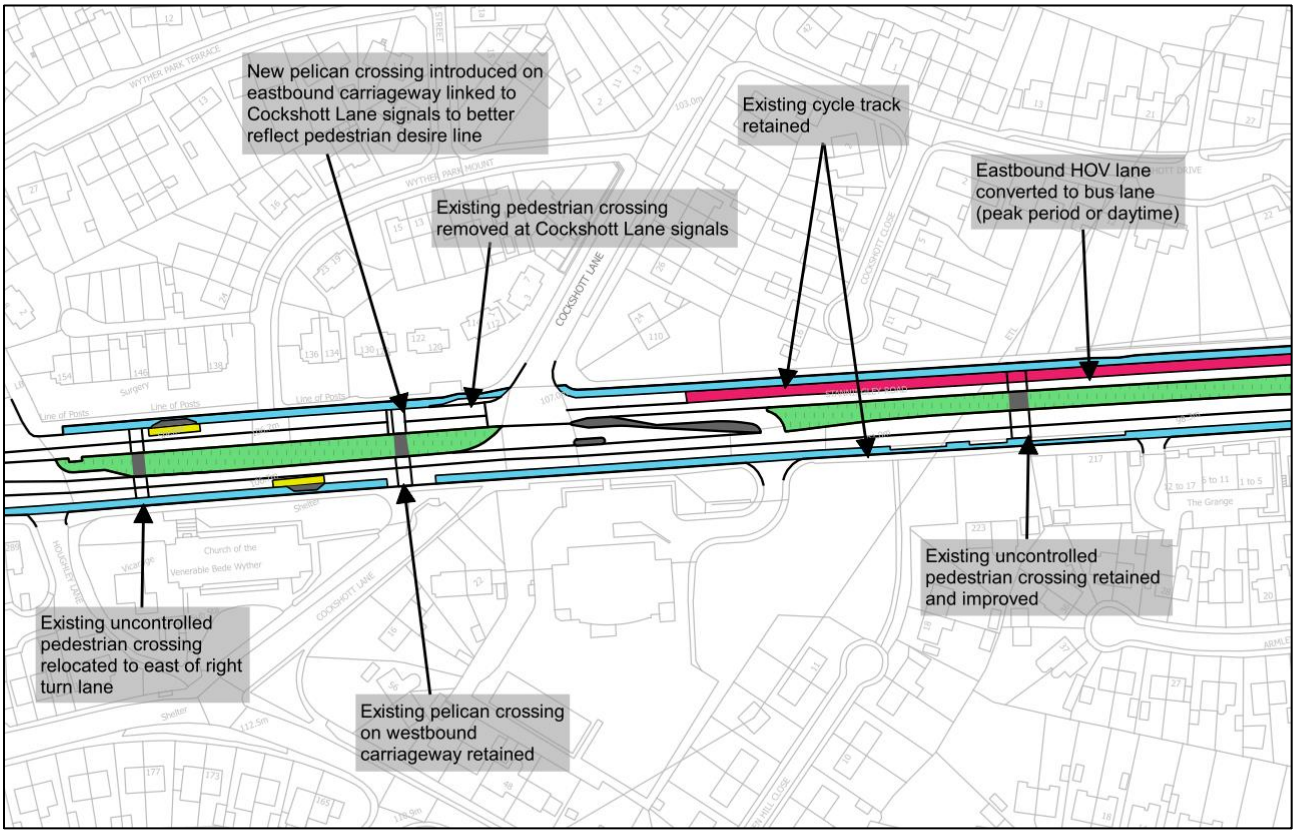
	Cockshott Lane: Base	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	74.8	68.8
PRC	-72.2%	-59.3%
Max DoS / RFC (Stream)	155.0% (Arm 1)	143.4% (Arm 1)
MMQ / Q (PCUs) (Stream)	64.4 (Arm 1)	58.5 (Arm 1)
Cycle Time	113s	97s

There are significant queues on Cockshott Lane and some queues on the A647 eastbound in both peak periods. In both peaks queues at the stopline for the exit pedestrian crossing (westbound) are long enough to block back into junction area. This pedestrian crossing runs alongside the Cockshott Lane approach, so it is possible that right turning traffic out of Cockshott Lane is unable to enter the junction due to blocking.

Proposed Scheme Model

The proposes changes for this junction includes the relocation of the crossing over the eastbound carriageway to better fit pedestrian desire lines, as proposed in the A647 WRIP (see figure 3). It also introduces an eastbound bus lane, which with a setback to accommodate turning traffic at the existing bus stop, approximately 65m from the junction.

Figure 3: A647 Stanningley Road / Cockshott Lane - Proposed Scheme



For the relocation of the crossing, a new stream (C1 Stream 3 in figure 4) has been added to the model, and the pedestrian phase at the main junction removed. For the new bus lane, bus zones and routes have been included in the scheme model. Signal timings have been optimised in both scenarios.

Figure 4: Model Screengrab Showing Additional Stream 3

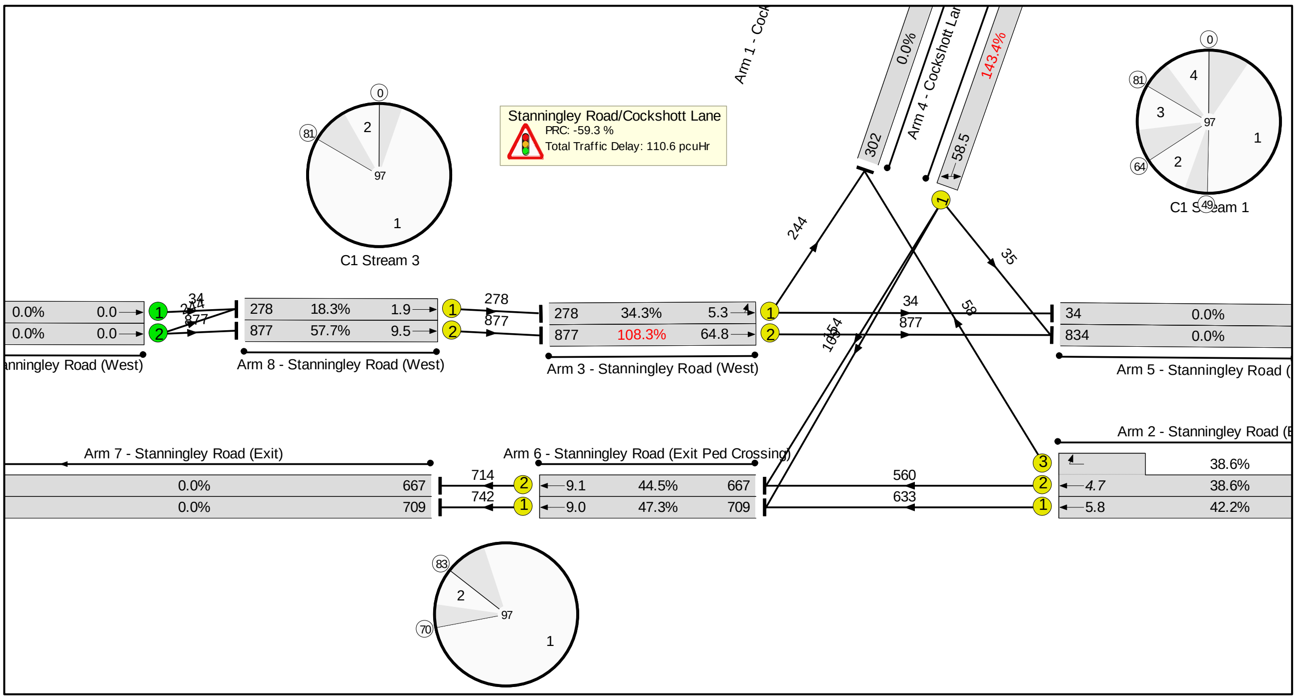


Table 7 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 7: A647 Stanningley Road / Cockshott Lane - Summary Results - Proposed Scheme

	Cockshott Lane: Proposed Scheme	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	202.0	110.6
PRC	-72.2%	-59.3%
Max DoS / RFC (Stream)	155.0% (Arm 1)	143.4% (Arm 1)
MMQ / Q (PCUs) (Stream)	159.5 (Arm 3)	64.8 (Arm 3)
Cycle Time	113s	97s

In the westbound direction, general traffic going ahead at this junction is restricted to a single lane. There are almost 1200 PCUs making this movement in the AM peak hour, which results in queues of 159.5 PCUs at the junction. Assuming one PCU is 6m in length, this queue is approximately 950m long, and ends after the next upstream junction, as seen in figure 5.

Figure 5: Predicted Queuing at Cockshott Lane

Source: Google Maps

Although not as extreme as in the AM peak, there are also significant issues with queuing on this approach in the PM peak. If general traffic is to run in a single lane through this stretch of the network as proposed here, it should be considered how the upstream traffic can be managed to control arrivals at this junction.

5.2 A647 STANNINGLEY BYPASS / A647 STANNINGLEY ROAD / STANNINGLEY ROAD

Base Model

This model is based on the existing layout at Stanningley Bypass / Stanningley Road (eastbound), and includes the High Occupancy Vehicle (HOV) lane on Stanningley Bypass, as shown in figure 6.

Figure 6: A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road - Existing Layout

Source: Google Maps

The base model has validated been using both queue survey data and supporting video survey data.

It should be noted that, for this junction, as it only serves an inbound route towards Leeds city centre, only the AM peak hour (07:00-08:00) has been modelled and analysed.

Table 8 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 8: A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road - Summary Results - Base

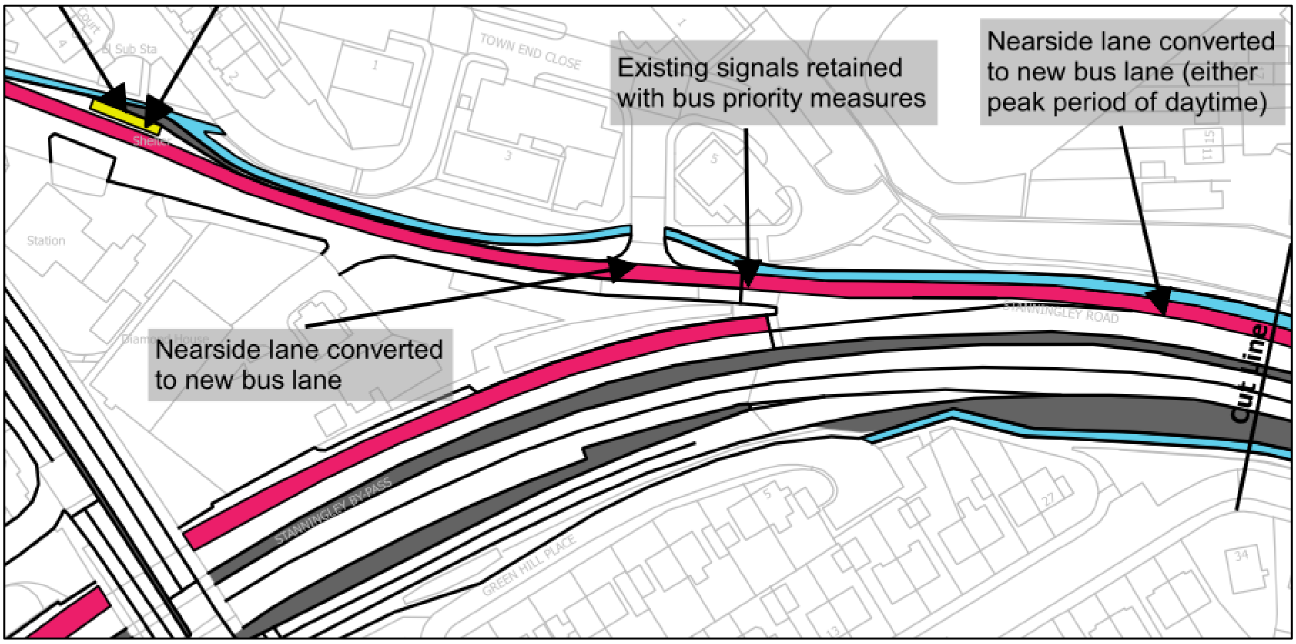
	Stanningley Bypass: Base
Peak Period	AM
Total Traffic Delay (pcuHr)	11.3
PRC	7.6%
Max DoS / RFC (Stream)	83.6% (1/2)
MMQ / Q (PCUs) (Stream)	16.0 (1/2)
Cycle Time	90s

The model results show that there are no significant problems at this junction currently, although it is operating close to capacity.

Proposed Scheme Model

The proposes changes for this junction see the existing HOV lane on Stanningley Bypass and the existing nearside traffic lane on Stanningley Road converted to a bus lane, as proposed in the A647 WRIP (see figure 7).

Figure 7: A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road - Proposed Scheme



The signal timings have been altered to help balance degree of saturation for general traffic on both approaches, giving more green time to Stanningley Road. It was also ensured that queue lengths did not reach back to the start of the bus lanes. Taking 1PCU as 6m of queue length, queues on neither approach reach the start of the bus lane.

Table 9 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 9: A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road - Summary Results - Proposed Scheme

	Stanningley Bypass: Proposed Scheme
Peak Period	AM
Total Traffic Delay (pcuHr)	13.1
PRC	4.9%
Max DoS / RFC (Stream)	85.8% (2/2)
MMQ / Q (PCUs) (Stream)	21.4 (1/2)
Cycle Time	90s

The results show that the proposed changes would work within capacity with moderate queuing on both approaches.

Whilst this is shown to work in as an isolated junction, there are c.1400 PCUs leaving the model area in an unrestricted single lane. This could potentially cause problems further along the corridor, particularly at junctions or pedestrian crossings, where it's likely that not all traffic will get through in one hour. It is possible that this could result in queuing and blocking back to this junction.

5.3 STANNINGLEY ROAD / HOUGH LANE / SWINNOW ROAD

Base Model

This model is based on the existing layout at Stanningley Road / Hough Lane / Swinnow Road, shown in figure 8, and has validated been using both queue survey data and supporting video survey data.

Figure 8: Stanningley Road / Hough Lane / Swinnow Road - Existing Layout

Source: Google Maps

Table 10 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 10: Stanningley Road / Hough Lane / Swinnow Road - Summary Results - Base

	Hough Lane: Base	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	17.2	20.2
PRC	13.1%	1.8%
Max DoS / RFC (Stream)	79.6% (Arm 4)	88.4% (Arm 3)
MMQ / Q (PCUs) (Stream)	14.6 (Arm 4)	13.7 (Arm 4)
Cycle Time	99s	99s

The model results show that there are no significant problems at this junction currently, although it is operating close to capacity in the PM peak.

Proposed Scheme Model

The proposed improvements at this junction include the removal of the parking bay at the stopline on the east approach, shown in figure 9, to allow for a short right turn lane. This aims to give right turning traffic its own space to prevent waiting vehicles from blocking the ahead traffic

Figure 9: Parking Bay to be Removed as Part of Proposed Scheme

Source: Google Maps

To reflect this in the LinSig model, a short lane (approximately 6 PCUs long) has been added Arm 4, as shown in figure 10. There is also an additional 2 PCUs non-blocking storage in front of the stopline. The signal timings have remained the same as in the base.

Figure 10: Model Screengrab Showing Proposed Right Turn Lane

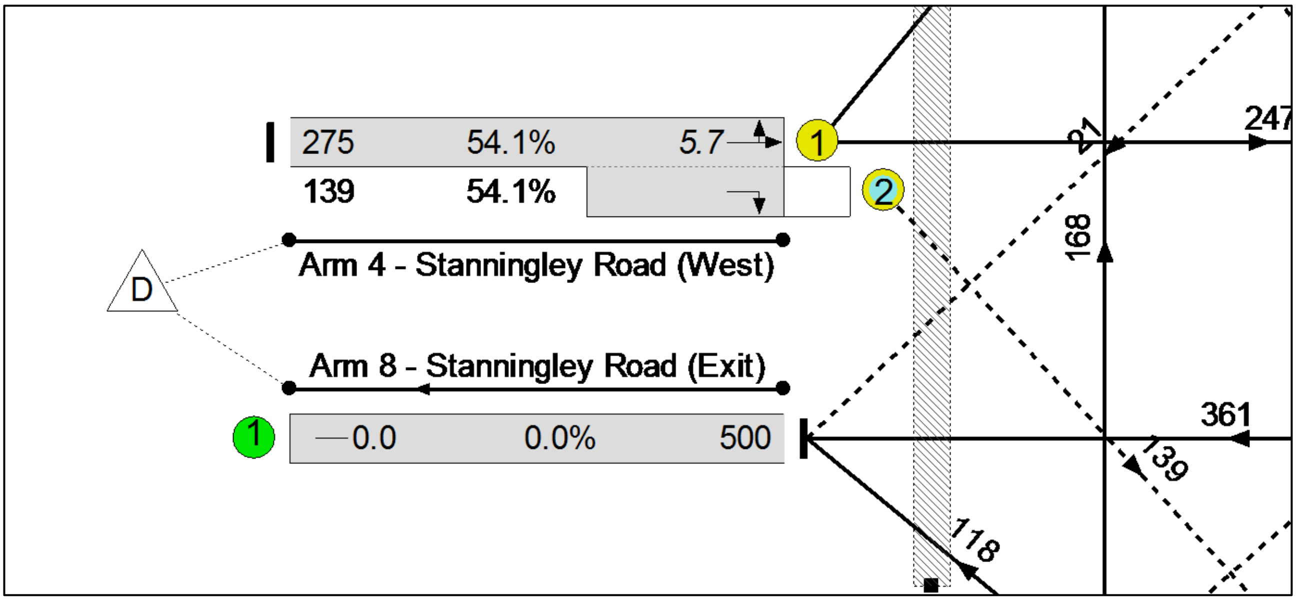


Table 11 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 11: Stanningley Road / Hough Lane / Swinnow Road - Summary Results - Proposed Scheme

	Hough Lane: Proposed Scheme	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	15.2	17.1
PRC	14.4%	1.8%
Max DoS / RFC (Stream)	78.6% (Arm 1)	88.4% (Arm 3)
MMQ / Q (PCUs) (Stream)	9.9 (Arm 1)	11.6 (Arm 3)
Cycle Time	99s	99s

In comparison to the base, the proposed scheme reduces queuing on the eastern approach in both scenarios, which consequently results in a decrease in total delay at the junction.

5.4 THORNBURY BARRACKS (A647 BRADFORD ROAD / WOODHALL LANE / GALLOWAY LANE)

Base Model

A base model for this junction was originally supplied by LCC. This was then amended by WSP to include pedestrian crossings, and to ensure signals information matched that of the most recent controller specification. The existing junction layout is shown in figure 11.

Figure 11: Thornbury Barracks - Exisitng Layout

Source: Google Maps

All traffic signals information for the base model, including phasing, staging and intergreens, have been based on the traffic signals controller specification provided by LCC.

As built information provided by LCC included:

- 818L T v3 30_08_16.pdf (traffic signals controller specification)
- UTC-818La (with Dynamic Signs).pdf (drawing).

The base model has validated been using both queue survey data and supporting video survey data. The supporting video data was also used to assess lane usage through the junction, in both AM and PM peak hours, to gain percentage splits traffic using each lane through the cut through which were then used in the model.

Table 12 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 12: Thornbury Barracks - Summary Results - Base

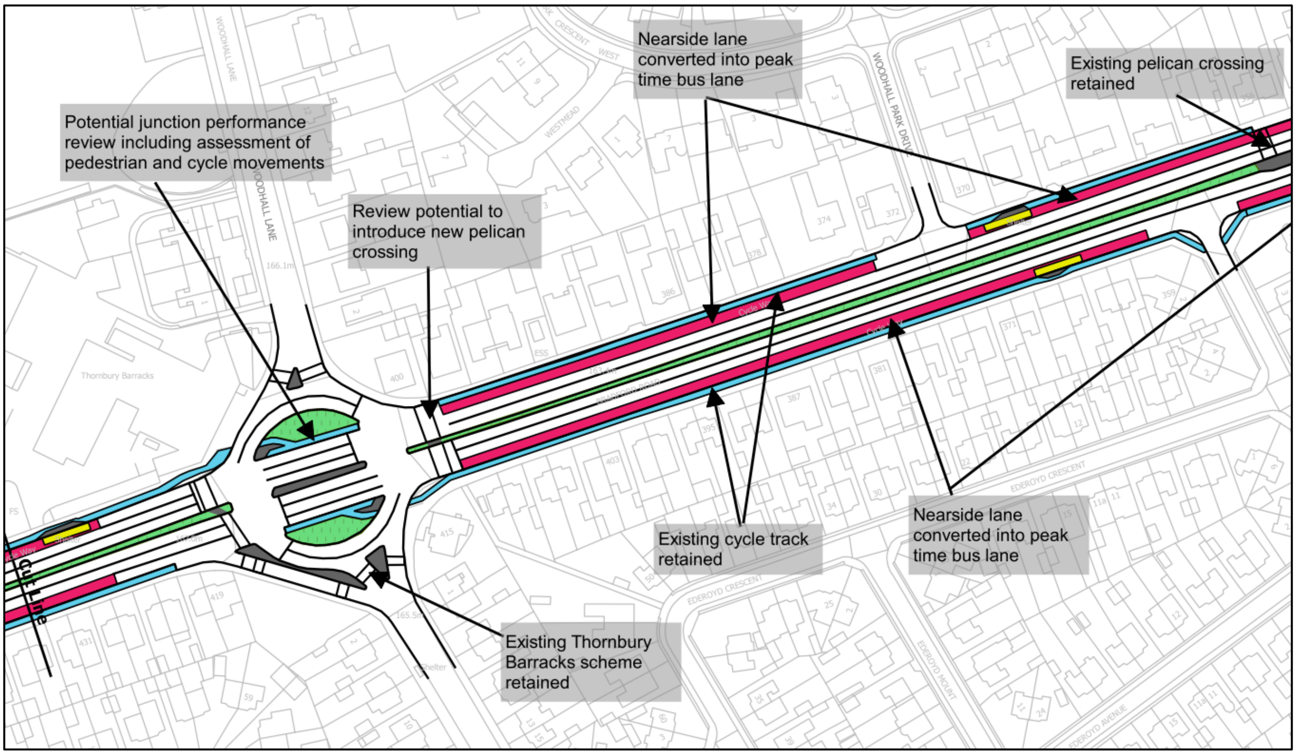
	Thornbury Barracks: Base	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	145.67	83.89
Max DoS / RFC (Stream)	113% (Ne2/1)	100% (WBe/2)
MMQ / Q (PCUs) (Stream)	44.34 (Ne2/1)	32.50 (EBe/1)
Cycle Time	72s	80s

Currently, there is queuing on the A647 in both directions in both peak hours. There are also excessive queues on Woodhall Lane during the AM peak hour.

Proposed Scheme Model

The A647 WRIP (see figure 12) proposed a number of changes to the Thornbury Barracks junction, including bus lanes on approach to and exit from the junction, and additional pedestrian facilities on the eastern arm of the junction.

Figure 12: Thornbury Barracks - Proposed Scheme



There are several different modelling scenarios for this junction testing facilities for pedestrians and buses separately, to access the viability of each proposed improvement and test any alternative options. The tested scenarios are outlined in the list below.

- **Option P1:**
  Introduces a pedestrian crossing at the junction, as shown in the WRIP drawing.
- **Option P2:**
  Introduces a pedestrian crossing approximately 60m to the east of the junction.
- **Option B1:**
  Introduces bus lanes on approach to and through the junction on both the east and west arms, with setbacks to accommodate turning traffic.
- **Option B2:**
  Introduces a bus lane on only the west approach to the junction. This includes setbacks to accommodate turning traffic, and continues through the junction following this.
- **Option B3:**
  As with option B2, but introduces a bus gate at the end of the bus lane on approach to the junction.

Option P1:

Option P1 provides for pedestrians at the junction itself, with similar facilities to those illustrated in the WRIP.

To accommodate the crossings, some changes have been made to the traffic signals. Where extra phases have been included, intergreens have been estimated from the near identical crossing over the eastbound entry, and assume that the traffic stop line is directly before the crossing.

An extra phase (phase M in figure 13) has been added to the existing arrangement for the crossing over the westbound carriageway, which runs in the same stage the eastbound cut-through and cycle crossing.

For the crossing over the eastbound carriageway, an extra controller stream has been added (controller stream 4 in figure 13). This crossing will have its own stop line, with a few PCUs storage between this and the main junction, and uses general phases and staging for a pedestrian crossing. This crossing has been modelled to operate when the traffic from Woodhall Lane is released, as there are few left turners from this approach, who should fit in the storage space without blocking.

Figure 13: Model Screengrab Showing Additional Controller Stream 4

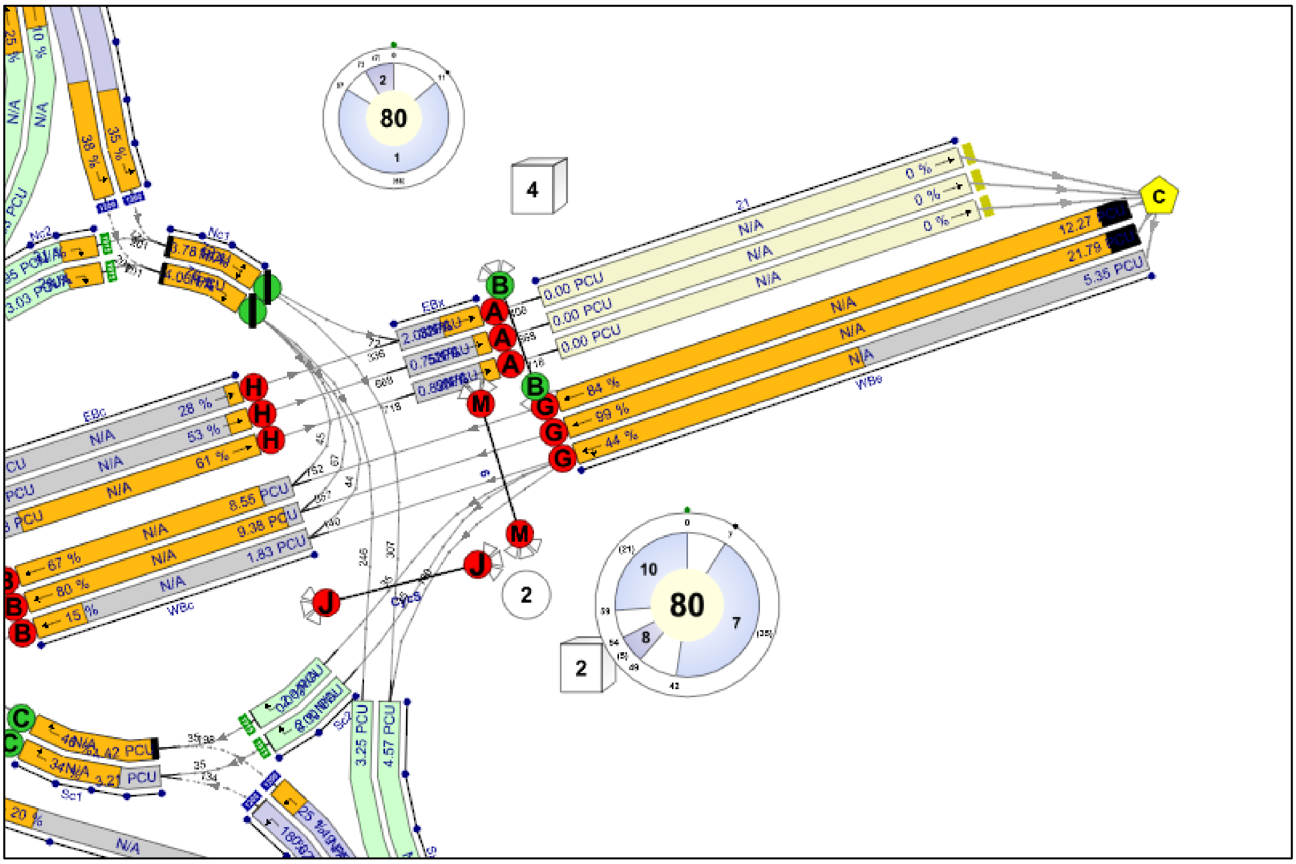


Table 13 shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 13: Thornbury Barracks - Summary Results - Option P1

	Thornbury Barracks: Option P1	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	145.86	77.60
Max DoS / RFC (Stream)	113% (Ne2/1)	100% (EBe/1)
MMQ / Q (PCUs) (Stream)	44.34 (Ne2/1)	30.60 (EBe/1)
Cycle Time	72s	80s

The results for this option show similar total traffic delay, maximum degree of saturation and mean max queues to the base model. Therefore this crossing could be implemented with minimal effect on current junction operation.

Option P2:

Option P2 introduces a pedestrian crossing approximately 60m east of the junction.

An extra controller stream has been added for each crossing (controller streams 4 and 5 in figure 14). Both crossings use general phases and staging for a pedestrian crossing. Intergreens have been estimated from the near identical crossing over the eastbound entry, and assume that the traffic stop line is directly before the crossing.

Figure 14: Model Screengrab Showing Additonal Controller Streams 4 & 5

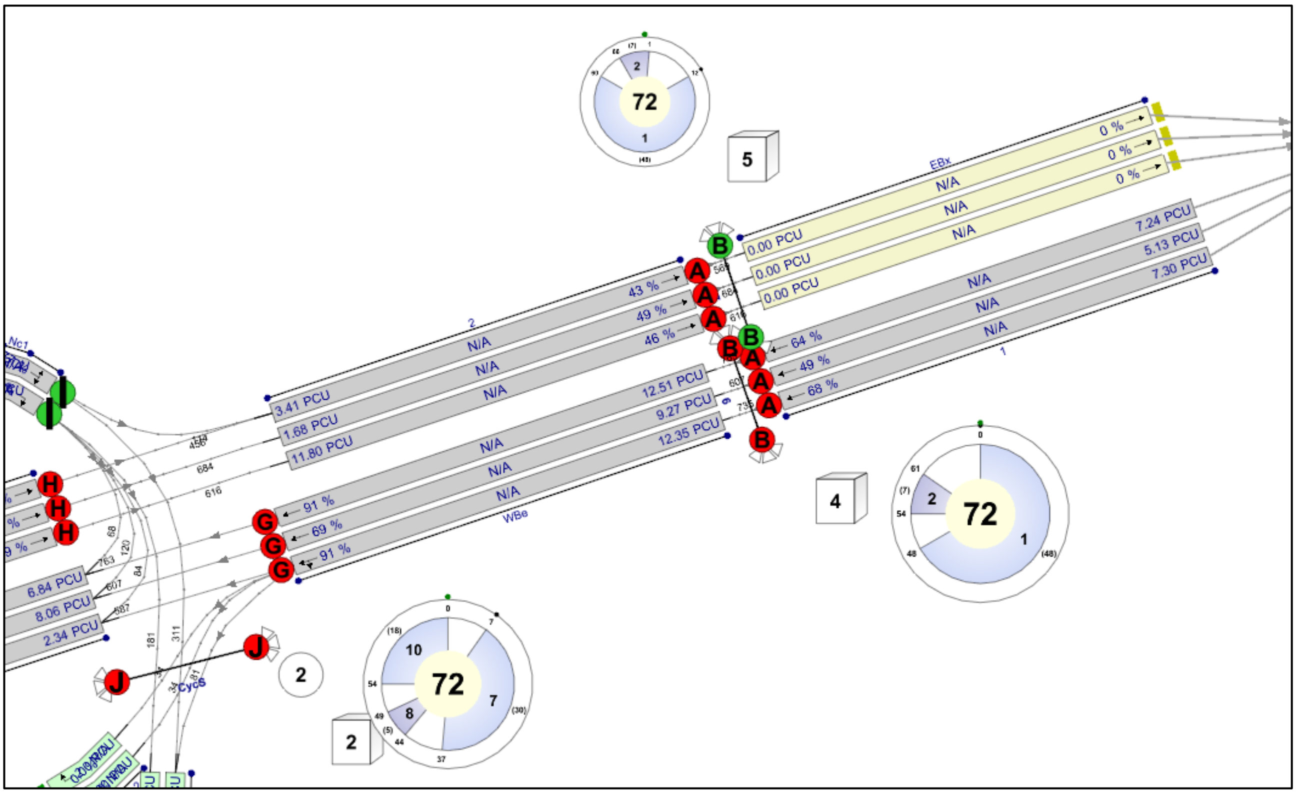


Table 14 shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 14: Thornbury Barracks - Summary Results - Option P2

	Thornbury Barracks: Option P2	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	148.19	88.11
Max DoS / RFC (Stream)	113% (Ne2/1)	100% (WBe/2)
MMQ / Q (PCUs) (Stream)	44.34 (Ne2/1)	32.50 (EBe/1)
Cycle Time	72s	80s

Again, these results show similar total traffic delay, maximum degree of saturation and mean max queues to the base model, meaning a crossing here would also have little effect on current operation.

Option B1:

Option B1 introduces bus lanes on approach to and through the junction on both the east and west arms, with setbacks to accommodate turning traffic.

Buses have been added into this model as a separate traffic type, with bus only traffic streams representing bus lanes, and certain bus paths set through the junction. The setback on the east approach is approximately 55m from the stopline, and the setback on the west approach is approximately 85m from the stopline.

Table 15 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 15: Thornbury Barracks - Summary Results - Option B1

	Thornbury Barracks: Option B1	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	357.84	131.25
Max DoS / RFC (Stream)	120% (WBe/2)	105% (WBe/2)
MMQ / Q (PCUs) (Stream)	107.81 (WBe/2)	49.73 (WBe/2)
Cycle Time	72s	80s

The addition of a westbound bus lane has caused queuing that is predicted to go beyond the next upstream junction, Dawsons corner (a major junction between the Ring Road and the A647 corridor), during the AM peak period. In addition to that there are significantly increase delays in both peak hours, with the total traffic delay in the AM peak being over 200pcuHr than in the base model.

The eastbound bus lane has not had as much of a significant impact, with queues and saturation on the west approach to the junction is similar to that in the base.

Option B2:

Option B2 introduces a bus lane on only the west approach to the junction. This includes setbacks to accommodate turning traffic, and continues through the junction following this.

As with option B1, buses have been added into this model as a separate traffic type, with bus only traffic streams representing bus lanes, and certain bus paths set through the junction. The bus setback is approximately 85m from the stopline.

Table 16 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 16: Thornbury Barracks - Summary Results - Option B2

	Thornbury Barracks: Option B2	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	159.48	131.25
Max DoS / RFC (Stream)	114% (Ne2/1)	105% (2/2)
MMQ / Q (PCUs) (Stream)	46.45 (Ne2/1)	34.76 (2/2)
Cycle Time	72s	80s

Introducing a bus lane with setback on just the west approach would not affect junction operation much in comparison to the base.

Option B3:

Option B3 introduces a bus lane on only the west approach to the junction. This is similar to option B2, but includes a bus gate at the end of the bus lane, rather than a setback.

As with other bus priority options, buses have been added into this model as a separate traffic type, with bus only traffic streams representing bus lanes, and certain bus paths set through the junction. For the bus gate, an extra controller stream (controller stream 4 in figure 15) has been added, with signals approximately 85m from the stopline.

This controller stream cycles between general traffic and buses, and green times are set and offset from the main junction to give priority to buses. Around 15s before traffic is given green at the main junction, general traffic is given green at the bus gate to allow it to fill the reservoir between two sets of signals. Traffic at the bus gate is then stopped approximately 4 seconds before traffic at the main junction, to ensure that the area between the bus gate and the main junction is kept clear for buses to progress through.

In this model, it is assumed that 10% of traffic travelling ahead at the junction from the west will move from lane 3 to lane 2 after turning traffic has moved into lane 1.

Figure 15: Model Screengrab Showing Additional Controller Stream 4

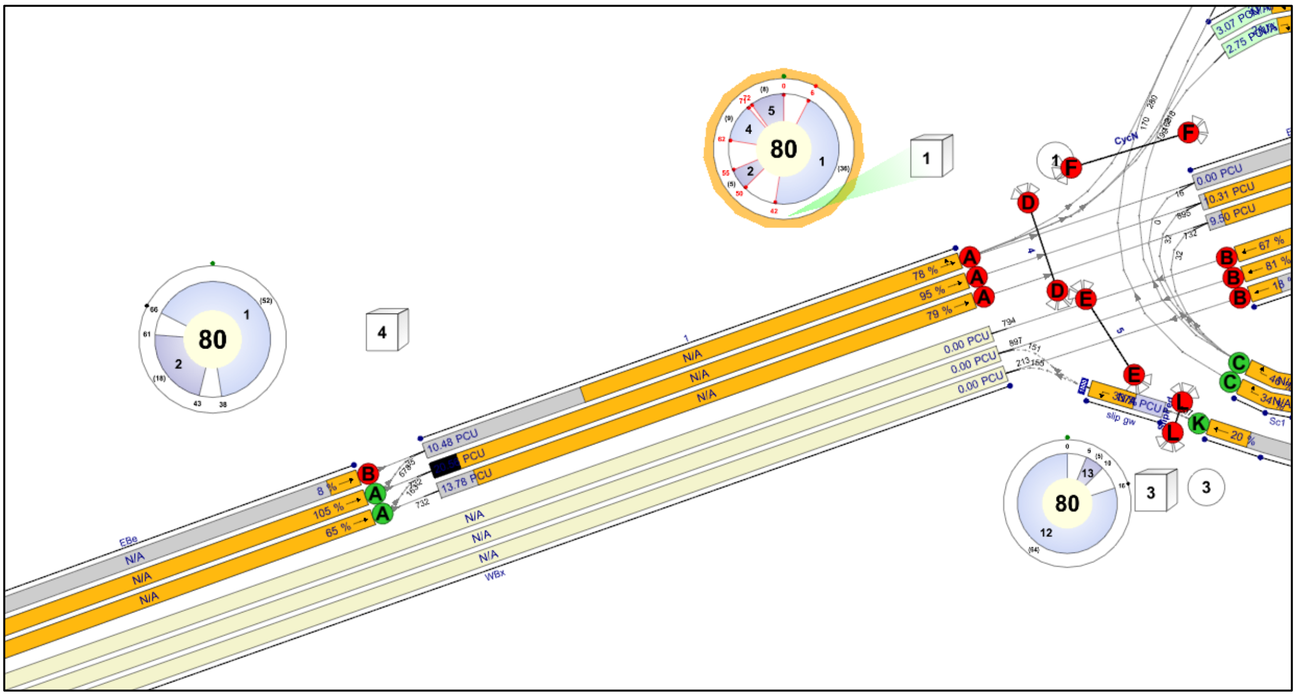


Table 17 below shows the worst performing traffic stream at the junction in the peak scenarios assessed. Please note that where the DoS is over 90% excessive queuing may be observed.

Table 17: Thornbury Barracks - Summary Results - Option B3

	Thornbury Barracks: Option B3	
Peak Period	AM	PM
Total Traffic Delay (pcuHr)	181.36	120.80
Max DoS / RFC (Stream)	114% (Ne2/1)	105% (EBe/2)
MMQ / Q (PCUs) (Stream)	46.45 (Ne2/1)	55.63 (EBe/2)
Cycle Time	72s	80s

Although this option shows longer eastbound queues than the base model or option B2, it is likely that these are moving queues. Furthermore, with the introduction of bus lanes and bus gates it is likely that general traffic at this junction will decrease, so queuing would be less of an issue. It's also important to note that this model is a fixed time model that is unable to represent an effective detection system at this bus gate.

If taken forward, this option should be looked at in more detail focussing on bus gate operation and linking to the main junction.

6. TESTING OF ALTERNATIVE FUTURE SCENARIOS

The best way to improve journey times is to avoid having demand exceed capacity. It will never be possible to build enough capacity to cater for the resulting increase in demand if all traffic is given faster journey times at peak periods. There should be a focus on efficient modes and managing demand for peak period vehicle trips, alongside best use of technology to optimise use of road-space.

Demand for travel may or may not grow – there are conflicting sources of evidence and opinion. Trends in Leeds suggest very limited growth in peak hour traffic over many years. To some extent this is a direct result of network constraints.

The scheme layouts are forecast to accommodate existing average peak hour flows, with only limited capacity for traffic growth. There will inevitably be some queues. Where provided, the bus lanes allow bus journeys to avoid significant delay under reasonable traffic growth scenarios.

Rather than focussing on model iterations which simply demonstrate that increasing demand will result in increased congestion, WSP has instead focussed on solutions.

WSP proposes that traffic is actively managed, taking account of queues on all approaches and downstream of each junction. It is also intended to provide traffic signal priority to buses based on a bus tracking system that provides "virtual detection" of individual buses on approaches. When a bus is detected approaching the junction (potentially tracking the bus at intervals from around five minutes travel time away), the area of carriageway between the bus gate and the junction will be emptied of traffic (if practical), so the bus can progress as quickly as possible through the junction. This allows dynamic adjustment of the traffic signal timings to minimise delay to each bus whilst also minimising the impact on other traffic.

Currently, there is strong evidence (inferring from multiple datasets) of traffic shifting between routes and time periods to take advantage of faster journey times where available, and avoid congestion.

There is also significant disruption to both public transport and private traffic on a reasonably frequent basis because of relatively minor incidents on the network. This has a greater impact on public transport users because of fixed routes, and as services end up delayed or cancelled, others overcrowded and users end up waiting at stops.

The network is passively managed at several locations to limit the amount of traffic entering key links so that these key links cope adequately under normal circumstances. There is limited scope for manual intervention to manage conditions when there is an incident.

Managing growth in (peak period) demand will be beneficial to all travellers due to the impacts of congestion. To cater for increasing travel demand, it is important to encourage as much new demand as possible to use modes other than the car, or to travel outside peak periods. This time shifting is an easier response for many users, due to the number of journeys made which are not on a direct bus route. Promoting flexible working would be beneficial alongside the infrastructure investment – including publishing time profiles of journey time to emphasise the savings that can be achieved by setting off at a more appropriate time. This information is needed prior to a trip commencing. When incidents occur, expected time for traffic conditions to improve is important, as this allows users to decide to delay departure (or not).

Under the traffic conditions that occur for most of time, bus lanes will not result in noticeable extra delay for general traffic. It is only when traffic demand exceeds capacity that extra delay will result. Even then, dis-benefits to general traffic are marginal in comparison with time saved by buses.

It is only in rare cases that queues prior to entry to bus lanes will result in an increase in overall delay, as there is usually a key capacity constraint and total traffic throughput at that point will lead to delays on the whole route. The exception is where "rat runs" allow traffic to bypass delay on a main route, and join the main road closer to the constraint. These situations need careful review, and measures on minor roads (eg lower speed limits, traffic calming measures, filtered permeability) to make the use of inappropriate routes less attractive. In many cases, overall capacity is reduced where traffic uses a minor route (eg where traffic has multiple lanes on the main road, but joining traffic from a single lane side road dramatically reduces capacity on the main road – perhaps by as much as 3 vehicles capacity lost for a single joining vehicle).

Optimising capacity at individual traffic signal installations is important. Currently this will be using MOVA, as the best available technology. Soon, taking account of technology and communications improvements, better systems might become available and there needs to be willingness and funding to invest both in the technology and the expertise required to optimise the system. There is also the need to optimise across the network, within local linked networks and system wide, both passively (through parameters set for all conditions, eg to always prioritise the main road over a side road) and actively (eg in response to congestion, side roads are further limited until a bus joins the side road queue). There is a lot of work to develop those strategies – perhaps 5-10 people full time for around 2 years to reflect the 5 corridors in LPTIP, and the complexity of prioritising buses whilst also maximising overall throughput.

7. CONCLUSIONS AND RECOMMENDATIONS

WSP have undertaken local junction modelling to assess the impact of proposed improvements at four junctions along the A647 corridor, focussing on providing bus priority and improving bus journey times and realiability.

A647 Stanningley Road / Cockshott Lane

Although the model showed the proposed scheme to cause significant queuing problems, these issues could be addressed by gating traffic further upstream. It is recommended that this scheme is taken forward to be considered alongside the proposals at A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road, with a focus on how these junctions can be used to manage traffic and how these schemes fit in with other proposals across the corridor and the overall corridor strategy.

A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road

The modelling results for this junction show that this junction would work within capacity with the proposed bus lanes. However, leaving this junction there are c.1400 PCUs travelling in a single lane, which is likely to cause issues at downstream which could cause blocking. As before, it is recommended that this scheme is taken forward to be considered alongside the proposals at A647 Stanningley Road / Cockshott Lane, with a particular focus on how this junction can be used to manage traffic entering the corridor at this point, and how that could form part of the overall corridor strategy.

Stanningley Road / Hough Lane / Swinnow Road

The proposed scheme has been shown to reduce total delay and queues on the west approach to the junction. The short right turn lane should also reduce blocking cause by right turners at this junction, although this cannot be shown in LinSig. It is therefore recommended that this option is taken forward to be considered in more detail.

Thornbury Barracks

Both pedestrian options were shown to have minimal effect on junction operation. Therefore, it is recommended that both options are assessed to see whether either can physically fit within the land constraints. If both options are viable, it is preferred that option P1 is taken forward.

In terms of bus provision, the modelling has shown that a westbound bus lane would cause unacceptable queues on approach to the junction, but an eastbound bus lane would not have an adverse effect on current junction operation. Option B3, which includes a bus gate, would be the preferred option, however it is recommended that the impact of a bus gate is further investigated. If option B3 is not viable, then it is recommended that option B2 is taken forward.

Once there is a decision regarding which pedestrian option, P1 or P2, is to be taken forward, then it is recommended that further modelling be done to test this with option B3.

To conclude, there are options for each junction that should be taken forward, however it must considered how the operation of these junctions will fit into the overall corridor and network strategy.

The junction assessment show that is spare capacity at A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road, such that the junction should be used as a storage point in which traffic can be metered to mitigate congestion further downstream on the corridor. From this modelling exercise, the critical point on the corridor is A647 Stanningley Road / Cockshott Lane, where eastbound traffic demand reaches 1200 PCUs in the AM peak hour, on a link which has capacity for around 850 PCUs with the proposed design. To ensure the corridor is operates as intended, this excess traffic should be stored at the A647 Stanningley Bypass / A647 Stanningley Road / Stanningley Road junction, where there is spare capacity to hold it. This process will be executed through traffic signal operation, which is to be covered in the Network Strategy document.

To ensure that network efficiency is maximised, the network will need to operate under a linked method of signal control (either linked MOVA or UTC/SCOOT) with associated improvements to technology and detection. This will ensure that appropriate bus priority is given whilst not impacting too much on the network as a whole.