POPE of LNMS

M18 J1 Signals

Highways Agency

December 2014

HIGHWAYS AGENCY

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An executive agency of the Department for Transport

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Glossary

Term	a.k.a.	Definition
Accessibility	**-**	Accessibility can be defined as ‘ease of reaching’. The accessibility objective is concerned with increasing the ability with which people in different locations, and with differing availability of transport, can reach different types of facility.
Annual Average Daily Traffic	**AADT**	The 24 hour total traffic flow for the average day of the year
Appraisal Summary Table	**AST**	This records the impacts of the scheme according to the Government’s five key objects for transport, as defined in **DfT** guidance contained on its **Transport Analysis Guidance** web pages, **WebTAG**
Automatic Traffic Count	**ATC**	An automated method of recording the volume (and sometimes classification) of vehicles passing a particular point on a road.
Average Daily Traffic	**ADT**	The 24 hour total traffic flow on an average day over a certain time period (Monday – Sunday)
Average Weekday Traffic	**AWT**	The 24 hour total traffic flow on an average weekday over a certain time period (Monday – Friday)
Benefit Cost Ratio	**BCR**	Benefit Cost Ratio is a ratio identifying the relationship between cost and benefits of a proposed project
Capitalisation	**-**	The process by which benefits for a scheme are factored to give an estimate for the appropriate appraisal period
Department for Transport	**DfT**	A Government department whose objective is to oversee the delivery of a reliable, safe and secure transport system that responds efficiently to the needs of individuals and business whilst safeguarding our environment. The **HA** is an executive of the **DfT**
Discounting	**-**	A technique used to compare costs and benefits that occur in different time periods and is the process of adjusting future cash flows to their present values to reflect the time value of money, e.g. £1 worth of benefits now is worth more than £1 in the future. A standard base year needs to be used which is 2002 for the appraisal used in this report
Dis-benefit	**-**	A negative benefit or something that detracts from the performance.
Evaluation Summary Table	**EST**	In **POPE** studies, this is a summary of the evaluations of the **TAG** objectives using a similar format to the forecasts in the **AST**

First Year Rate of Return	**FYRR**	First Year Rate of Return is the ratio of money gained on an investment relative to the amount of money invested.
Highways Agency	**HA**	An Executive Agency of the **DfT,** responsible for operating, maintaining and improving the strategic road network in England
Killed or Seriously Injured	**KSI**	A term used to describe the number of people killed or seriously injured as a result of **PICs.**
Local Network Management Scheme	**LNMS**	LNMS are improvement schemes where total overall estimated cost (including design, land, works, supervision, risk and VAT) is less than £10 million. They are categorised by the Government under Safety, Economy, Accessibility, Integration and Environment
Managing Agent Contractor	**MAC**	Responsible for the operation, maintenance, and improvement of the motorway and trunk road network of a HA area
New Approach to Appraisal	**NATA**	Used for transport scheme appraisal since 1998
Optimism Bias	**-**	Is a demonstrated systematic, tendency for project appraisers to be overly optimistic, and in effect, results in an underestimation of scheme costs. The base cost estimate is adjusted to account for optimism bias in order to obtain more accurate cost estimates.
Project Appraisal Report	**PAR**	A key document summarising the need for a project, plus its costs and benefits (including those that cannot be quantified in monetary terms)
Personal Injury Collison	**PIC**	A term commonly used to refer to road accidents
Post-Opening Project Evaluation	**POPE**	Before and after monitoring of all highway schemes in England
Present Value of Costs	**PVC**	Present Value of Costs is a term used in cost-benefit analysis and project appraisal that refers to the discounted sum, or Present Value, of a stream of costs associated with a project or proposal
Risk Allowance	**-**	**Risk** refers to identifiable future situations that could result in an over spend or under spend occurring. The base cost estimate is adjusted to account for risk in order to obtain more accurate cost estimates
Severance	**-**	Community severance is the separation of adjacent areas by road or heavy traffic, causing negative impact on non-motorised users, particularly pedestrians
-	**STATS 19**	A database of injury accident statistics recorded by police officers attending accidents
Traffic Database System	**TRADS**	Traffic count database developed by the HA, to hold data from traffic monitoring sites on the strategic network

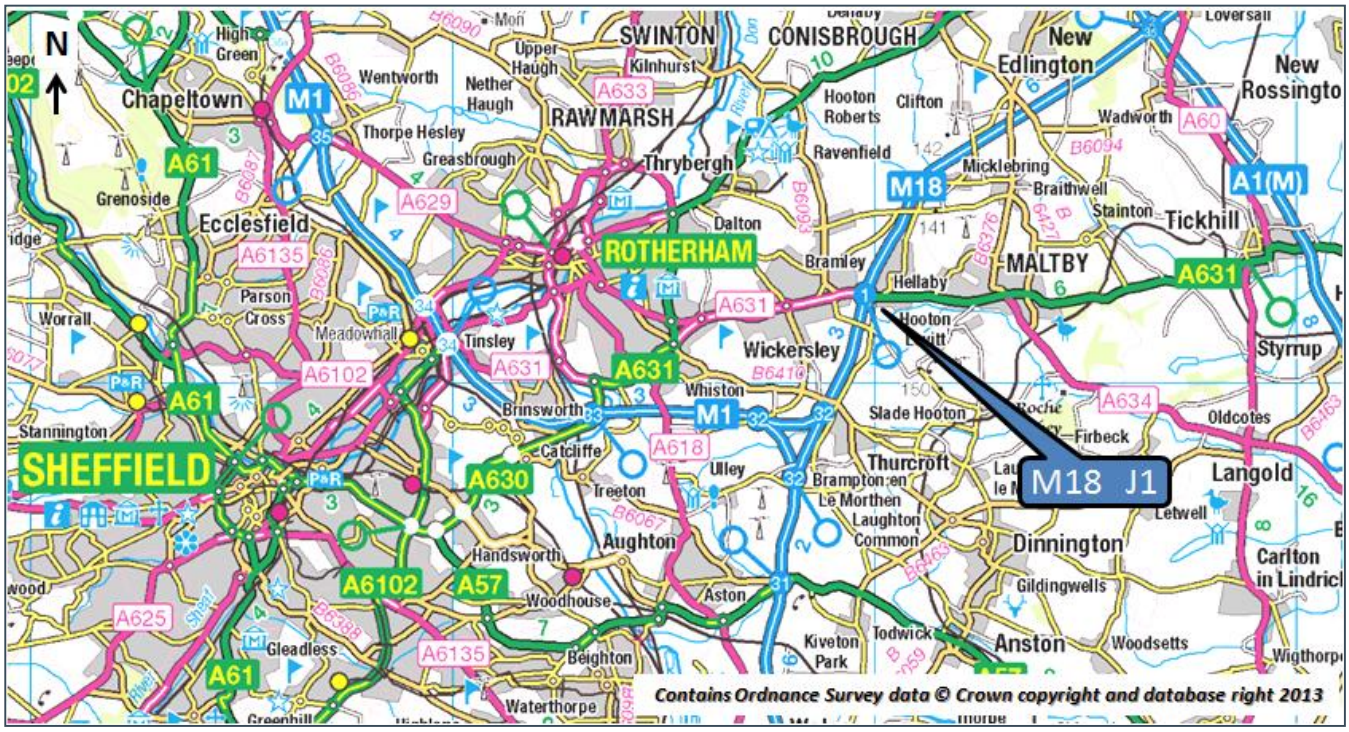
1. Introduction

Background

1.1. This report is the Post-Opening Project Evaluation (POPE) of the **M18 J1 Signals** Local Network Management Scheme (LNMS).

1.2. M18 Junction 1 is situated midway between Rotherham to the west and Maltby to the east. The junction is formed by the motorway slip roads and the A631. The A631 is a busy local road of significant importance which connects Junction 1 with Rotherham and Maltby/Bawtry to the west and east respectively. The location of the junction is indicated in **Figure 1.1**.

Figure 1.1 Location Plan



1.3. The interchange was a four-arm, partially signalised roundabout with the northbound motorway approach controlled by full time traffic signals. The other three (southbound exit-slip and both A631 approaches) were priority controlled.

1.4. The scheme was developed to address issues with delays and congestion on the M18 southbound exit slip road which affected the AM and PM peak hours. The A631 approaches also suffered from extensive queuing and delays. Furthermore, there was a safety issue associated with the junction with 42 Personal Injury Collisions (PICs) occurring during a five year period prior to the scheme.

1.5. The scheme introduced new traffic signals on the M18 southbound exit and A631 approach arms to mean all arms of the junction became fully signalised. The circulatory carriageway was also widened to provide three lanes throughout. The junction was linked to MOVA and new lane and destination markings were also

introduced on the slip road approaches. High friction surfacing was also installed on all approaches and around the circulatory carriageway.

1.6. Scheme construction began on 9th January 2012 and the scheme opened on the 17th March 2012.

Purpose of this report

1.7. As part of an ongoing programme, whereby the Highways Agency (HA) evaluates the impacts of trunk road schemes, Atkins is commissioned to undertake post-opening evaluations of LNMS with an implementation cost of between £25k and £10m.

1.8. This report sets out the results of the POPE of the M18 J1 LNMS. More specifically, this report examines the economic and safety impacts resulting from the improvements, with consideration also given to wider impacts on the environment and society.

1.9. It is intended that the findings from this report will feed into a wider summary of the outcomes of POPE. This is a document (namely the LNMS Annual Evaluation Report) produced in the 4th quarter of each year outlining the key messages from the entire POPE of LNMS process.

2. Scheme Detail

Introduction

2.1. This section of the report outlines the pre-scheme and post-scheme layout of the roundabout, using photos, diagrams and site observations to illustrate the changes made to the highway network. In addition, this section contains the views and feedback on the scheme from key stakeholders.

Background

2.2. The M18 J1 Signals LNMS introduced signals onto three approach arms of this four-arm roundabout. The remaining arm had already been signalised previously. The circulatory carriageway was also widened and MOVA integrated with the signals equipment. **Table 2.1** summarises the scheme details.

Table 2.1 – Summary of M18 J1 Signals LNMS

Scheme name	M18 J1 Signals
Area	12
Opening date	17th March 2012
Category	Economy
Reason for scheme	The scheme was developed to address issues with delays and congestion on the M18 southbound exit slip road, which affected the AM and PM peak hours. The A631 approaches also suffered from extensive queuing and delays. Furthermore, there was a safety issue associated with the junction with 42 Personal Injury Collisions (PICs) recorded in the PAR during a five year prior to the scheme.
Objectives	To reduce AM and PM peak congestion and delay on the M18 southbound exit slip road and both A631 approaches To reduce the annual accident rate
Alternative options	An economic study was undertaken which considered five alternative options in addition to the delivered scheme. These included a part signalisation solution which would have negated the need for widening on the southbound exit slip road.

Location

2.3. The scheme is located at M18 Junction 1; known as Bramley Interchange. The M18 at this point is of dual three lane motorway standard and passes below Bramley interchange in a north/south orientation. The A631 is a busy local road of significant importance which connects Junction 1 with Rotherham and Maltby/Bawtry to the west and east respectively.

2.4. Hellaby Industrial Estate is located to the immediate north-east of the junction which covers an area of around 0.95 km^2. The industrial estate meets the A631 around 300m east of the motorway junction at Denby Way. The outskirts of Maltby lie around 1.5 km east of the junction along the A631.

2.5. Towards Rotherham, there is a retail park (which includes a gym, Morrisons store, hotel and McDonalds) to the immediate south-west of the junction. The outskirts of Bramley then begin within a few hundred metres of the motorway junction. The centre of Rotherham is around 7 km west of the motorway junction.

2.6. **Figure 2.1** indicates the local context of the junction.

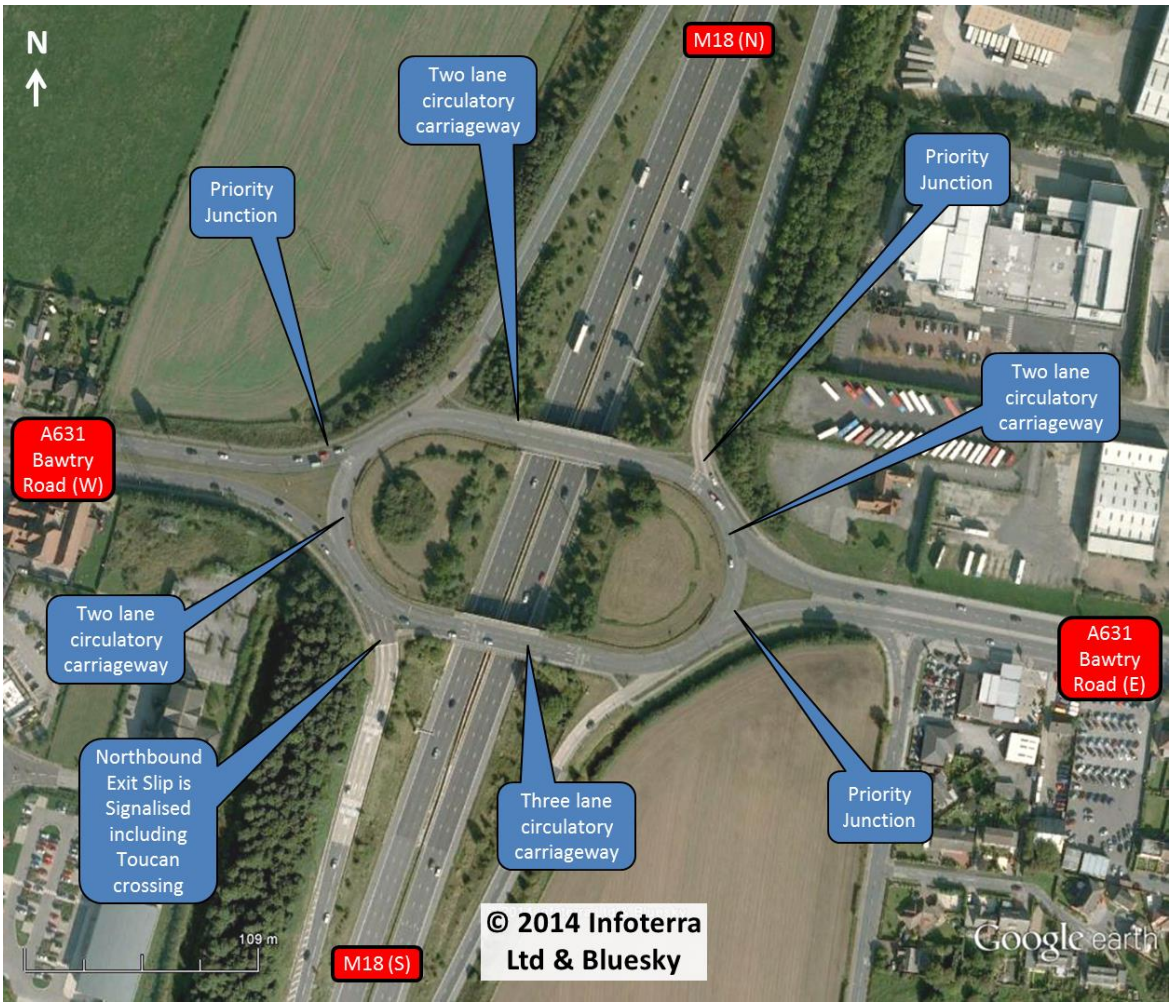
Figure 2.1 Junction Location Context Plan

Pre Scheme Junction Layout

2.7. Prior to the scheme, the interchange was a four-arm partial signalised roundabout as shown in **Figure 2.2**.

2.8. The northbound motorway approach was controlled by full time traffic signals with the other three (southbound exit-slip and both A631 approaches) all priority controlled.

Figure 2.2 Pre-Scheme Junction Layout



2.9. The circulatory carriageway was three lanes along the southern section, but two lanes for the majority of the junction. The approaches to the signalised section were designated with lane and destination markings but no other approach arms had destination markings.

2.10. There were only limited sections of high friction surfacing at various locations around the junction. Controlled pedestrian facilities were provided with the signalised M18 northbound approach but no other facilities were provided. In some areas footways ran up to the arms but without any formal provision to make crossing safe.

2.11. With this layout, the PAR states there were regular issues with delays and congestion on the M18 southbound exit slip road. This was common in both the AM and PM peak hours with queuing traffic also affecting traffic flow along the M18 southbound mainline. The A631 approaches also suffered from extensive queuing and delays.

2.12. In developing the PAR, the MAC prepared an improvements study which assessed traffic volume and delay at the junction. A 12-hour turning count was recorded at the junction on 18th March 2008 which identified all movements at the junction. Details for the 12 hour period (0700-1900) are presented in **Table 2.2**.

Table 2.2 – Pre-Scheme Junction Turning Flows

12 hour (0700-1900)	M18 North	A631 West	M18 South	A631 East	Total Flow From
M18 North	31 *0.1%*	2,439 *5.4%*	15 *0.0%*	2,000 *4.5%*	**4,485** ***10.0%***
A631 West	2,640 *5.9%*	0 *0.0%*	3,429 *7.6%*	7,373 *16.4%*	**13,442** ***30.0%***
M18 South	0 *0.0%*	3,878 *8.6%*	0 *0.0%*	6,324 *14.1%*	**10,202** ***22.7%***
A631 East	1,925 *4.3%*	8,079 *18.0%*	6,298 *14.0%*	415 *0.9%*	**16,717** ***37.3%***
Total Flow To	**4,596** ***10.2%***	**14,396** ***32.1%***	**9,742** ***21.7%***	**16,112** ***35.9%***	**44,846**

2.13. This data demonstrates that before the scheme, the largest traffic movements were between the east and west arms with 18.0% of trips made eastbound and 14.0% of trips made westbound across the junction over the 12 hour period.

2.14. The A631 East approach is the busiest, accounting for 37.3% of all vehicles approaching and 35.9% of all vehicles leaving the junction over the 12 hour period. 35.9% of all vehicles using the junction exited onto the A631 East, with 32.1% exiting onto the A631 West.

2.15. The data also shows there were very similar levels of vehicles entering and exiting each of the four arms of the roundabout across the day. This suggests that vehicles use the same routes when travelling to and from their destinations and there is a general equilibrium in trip making across the whole of the interchange.

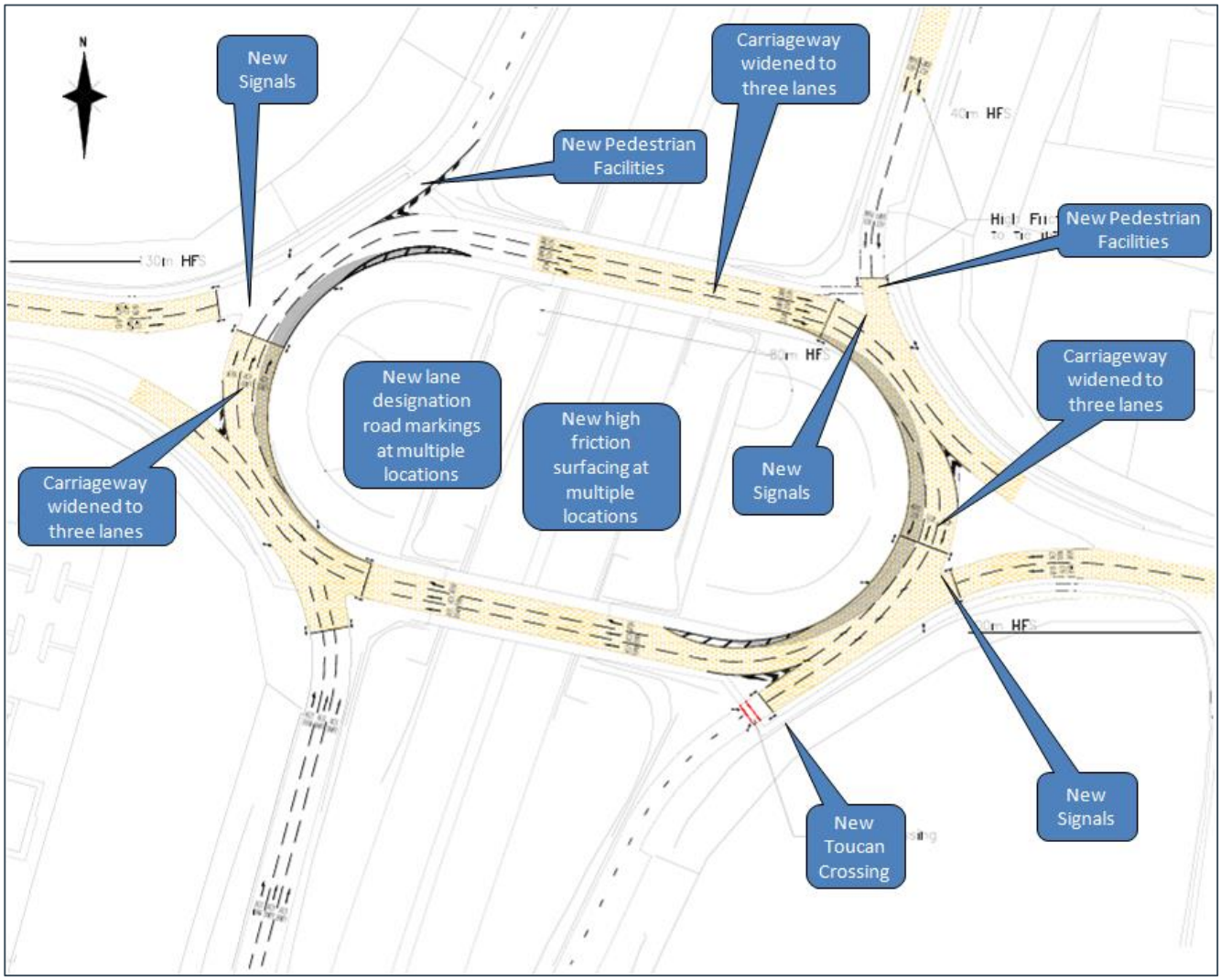
2.16. In preparing the report, the MAC also undertook queue length and delay surveys on all approaches at 10-minute intervals across the AM and PM peaks. The most significant queues were observed on the A631 East approach with a maximum queue of 132 vehicles per lane (450 seconds delay) in the AM peak and 183 vehicles per lane in the PM peak (526 seconds delay). Queues of more than 60 vehicles were also observed on the A631 West approach in both the AM and PM peaks. The maximum queue observed on the M18 Southbound exit slip was 38 vehicles per lane in both the AM and PM peaks with delays of 420 seconds and 411 seconds respectively.

2.17. As well as congestion issues, there was a safety issue associated with the junction, the PAR recording 42 Personal Injury Collisions (PICs) during a five year period prior to the scheme.

Post Scheme Junction Layout

2.18. Details of the scheme are shown in **Figure 2.3**. The scheme introduced new traffic signals on the M18 southbound exit and A631 approach arms to mean all arms of the junction became fully signalised. The traffic signals are all linked up to MOVA meaning the signals can run dynamically based on flow to provide a high level of efficiency.

Figure 2.3 Post-Scheme Junction Layout



2.19. The circulatory carriageway was also widened on the north, east and western sides to now provide three lanes throughout. This has significantly increased the capacity of the junction. Appropriate signing on the slip roads was introduced to give advanced warning of the signals.

2.20. New lane and destination markings have been introduced on all of the slip road approaches. This was with the specific intention of making navigation clearer for drivers and hoping to reduce the number of 'lane change' accidents occurring at the junction. The likelihood of an accident being caused by a vehicle failing to give way should also be eradicated by the removal of the priority arrangement and the introduction of the signal controls.

2.21. High friction surfacing was also improved in some areas and added to other areas to provide the measure on all approaches and around the circulatory carriageway.

2.22. Pedestrian accessibility around the junction was also improved with new pedestrian and cyclist facilities integrated into the junction as part of the traffic signals.

Post Scheme Site Observations

2.23. A site visit was undertaken during the AM peak (0730 – 0845) on Wednesday 23rd July 2014. The weather was dry and cloudy on the day. There were no known incidents or roadworks close by on the network which would mean that traffic activity was atypical, although the overall traffic flow could be slightly lower than at other times of the year as a result of the start of the summer holiday period.

2.24. All of the scheme elements were seen to be in place and operational. Some of the road markings were beginning to fade; a result of the scheme having been in situ for over two years and the high level of traffic which uses the area.

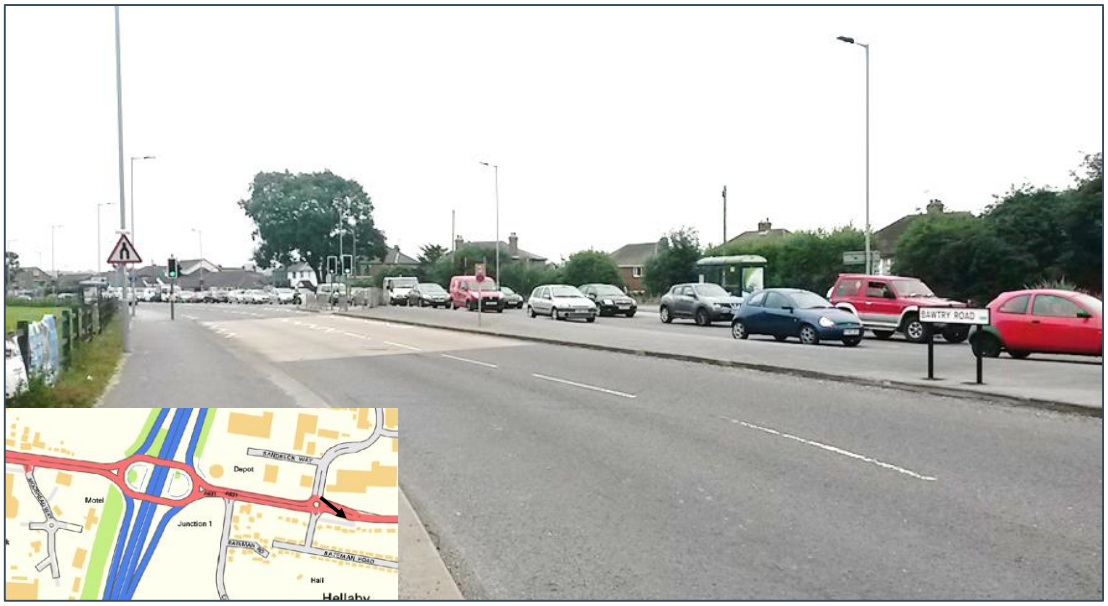
2.25. Generally, traffic operations at the junction appeared to function well with only sporadic instances of queuing and delay on certain arms of the junction. Across the whole junction it was observed that short green times were in place, meaning traffic was quickly moving around and through the junction.

2.26. The most notable delays on the approach arms were observed on the A631 East. Traffic queues were observed at around 0740 between the junction and Denby Way. This peaked at around 0810, when queues extended to around 500 metres and ran back from the junction stop line, through the roundabout which the A631 forms with Denby Way and beyond the signalised pedestrian crossing on the A631. This queuing is shown in **Figure 2.4** and **Figure 2.5**.

2.27. It was clear that traffic on the A631 favoured the left hand traffic lane, suggesting that most traffic is turning left to the M18 southbound or straight ahead towards Rotherham. The right hand lane can also be used by traffic travelling across towards Rotherham although it was noticeably less well used. Given the traffic turning count information, it was clear that a large proportion of the arrivals on this arm are travelling straight across the junction and so it was unclear why the right hand lane was not more heavily used. It could be due to the markings not being clear for drivers, or people may be being deterred from using the right hand lane as there is an increased chance of being blocked on the circulatory carriageway when they arrive at the desired exit.

Figure 2.4 AM Peak A631 East Queuing (facing west from Denby Way) at 0810

Figure 2.5 AM Peak A631 East Queuing (facing east from Denby Way) at 0810



2.28. In observing the operation of the link, it appeared that the delay in getting to M18 J1 was notably impacted by traffic movements to/from Denby Way. Denby Way is the main access for Hellaby Industrial Estate which contains a large number of industrial and warehouse spaces.

2.29. During a 10 minute period at around 0810, there was a constant demand of vehicles leaving the Industrial Estate, including a high proportion of HGVs. Almost all of these vehicles turned right to travel towards the motorway junction.

2.30. Figure 2.6 shows vehicles queuing on Denby Way, waiting to join the A631 westbound towards the motorway. The left traffic lane is noticeably less well used with little demand for travel towards Maltby.

Figure 2.6 AM Peak Traffic on Denby Way at 0810

2.31. This traffic turning out onto the A631, and predominantly attempting to merge into the left hand lane, exacerbates other congestion leading to additional delay impacts for the A631 East approach arm.

2.32. As with the other traffic signals at the motorway junction, the operation of the A631 East approach was observed to operate with a quick interchange between green time for the approach arm and the circulatory carriageway (both signals had around seven seconds of green time). On occasion, this meant that the A631 East approach was stopped despite the build-up of queues, when the circulatory carriageway was only lightly trafficked.

2.33. The build-up of queues were observed to dissipate quickly at around 0820. As well as a possible reduction in the traffic approaching from the Maltby area, this coincided with a notable decline in the traffic demand turning out of Denby Way.

2.34. **Figure 2.7** shows the approach to the motorway at 0820 without any significant queues or delay.

Figure 2.7 Traffic on A631 East Approach Arm at 8.20am

2.35. On the other approach arms there were no notable issues observed with traffic flow generally able to clear on each cycle of the traffic signals. The MAC's pre-scheme improvements study identified that there were significant delays on the A631 West approach arm although this was not observed on site, with all traffic able to enter the junction. The improvements study did identify that delays were worse in the PM peak, and so it may be that queues do occur in the PM peak. No site observations were made during the afternoon period.

2.36. On the circulatory carriageway, the junction appeared to operate reasonably well with only the occasional blocking. Blocking was most noticeable on the western side of the junction, when traffic waiting at the signals on the circulatory carriageway would infrequently extend back so as to block one lane of the traffic leaving the junction onto the A631 West towards Rotherham. All of the traffic was able to clear on each cycle of the traffic signals and the timing of the lights meant that any blocking did not occur for more than a few seconds. This is shown in **Figure 2.8**.

Figure 2.8 AM Peak Circulatory Carriageway Queuing

2.37. It is therefore concluded that overall, the operation of the junction appears to operate reasonably well, however the A631 East approach arm is impacted by traffic movements out of Denby Way. The queuing which was observed was significant but dissipated quickly after peak conditions. Observations of the signal timings would suggest that often a slightly longer green time could be afforded to the approach arms without any significant congestion impacts on the circulatory movements. This would help to reduce the length of queues on the approaches.

2.38. As well as providing the signal controls for vehicles, pedestrian and cyclist facilities were significantly improved as a result of the scheme with crossings now providing continuous routes through and around the junction. The pedestrian and cycle routes were all well signed, and were well maintained on site. In terms of actual use however, there was only infrequent pedestrian and cyclist activity observed throughout the period of the site visit.

Stakeholder Feedback

2.39. While the analysis in this report can consider the quantifiable impact of this scheme based on empirical data, it is also worth considering the opinions of major stakeholders of the scheme. For example, a scheme may save journey times in practice, but if this saving isn't perceived, the scheme may not be as successful as first thought.

2.40. The major stakeholders contacted for feedback on the M18 J1 Signals scheme are:

- Rotherham Metropolitan Borough Council; and
- Highways Agency.

2.41. The remainder of this section outlines the responses received from these stakeholders.

Rotherham Metropolitan Borough Council

2.42. A response was received on behalf of the Council comprising comments from Ian Ashmore (transportation and traffic manager) and Mick Powell (Senior Engineer). In summary:

"There appears to be an **on-going issue with signal operation**. Experience of it taking 3 cycles of the signals to clear to stop line on a Saturday afternoon where traffic flow was light. It's not an overly congested junction, therefore I suggest there is an ongoing operational issue."

"I recently travelled through the junction in the AM Peak and observed a significant queue on Bawtry Road (westbound from Maltby). The signals were running with very short greens on that approach and reverting to the circulatory with no traffic at all on this approach."

"We are aware that the signal timings are a regular issue which has also been reported by colleagues working at the Hellaby Depot who can observe the junction from their site."

Highways Agency

2.43. Tim Calvert (Service Delivery Manager (South Yorkshire)) provided some brief comments.

"I am aware that there have been issues with excessive queuing on the westbound approach (local road network) from Hellaby/Maltby particularly during the morning peak."

"The signals were officially handed over to the NE TechMAC (Amey) on 12 Feb 2013."

2.44. Overall, it appears that there are perceived to be some on-going issues with the junction signals, and that the timings could be reviewed with a view to improving the efficiency of the junction.

3. Traffic Volumes

Introduction

3.1. This section of the report considers the impact that the M18 J1 Signals Large LNMS has had on traffic volumes.

Data Source

3.2. As scheme planning and construction is a process that takes a number of years, it is important to understand how traffic volumes have changed over time and whether this will impact the way the scheme performs. To understand this, traffic data from three sources has been assessed:

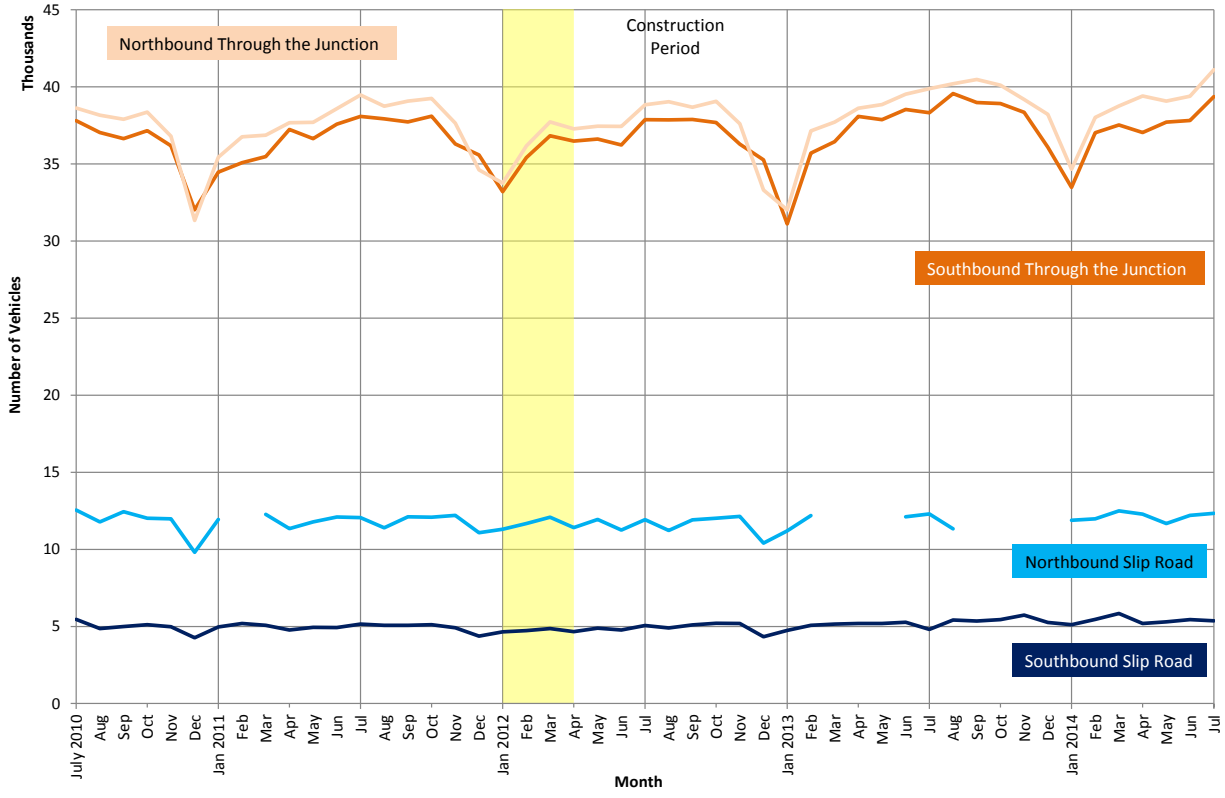
- Continuous ATC data collected on the M18 J1 Mainline and Exit Slip Roads, as collected by the Highways Agency (TRADS);
- ATC data collected in both directions on the A631 Bawtry Road during a two week period of June 2014 to support this scheme evaluation; and
- A turning count collected by the MAC for the junction in March 2008 is used to understand turning movements and turning proportions.

Traffic Volume

M18 Mainline and M18 Slip Road Approach Arms

3.3. TRADS count sites on both the motorway exit slip roads, and the M18 mainline through the junction have been evaluated. The Average Weekday Traffic (AWT) on a monthly basis is shown in **Figure 3.1**.

Figure 3.1 Monthly AWT on the M18 (Mainline and Slip Road Exits)



3.4. The data shows that traffic flow patterns have remained relatively consistent before and after the implementation of the scheme. There is also little difference in 2014 than in 2013 suggesting there has been no traffic growth in the periods since the scheme opened.

3.5. The chart demonstrates that the northbound exit slip road carries around twice as much traffic as the southbound exit slip road and that the volume of traffic on the slip roads is relatively constant throughout the year.

3.6. Vehicle flow on the mainline through the junction is shown to experience seasonal variation with traffic relatively constant through spring to autumn, but with a reduction each winter. Lower traffic levels through winter are considered typical across the highway network as wintery bad weather tends to reduce the traffic on the network. However, this effect is hardly evident in the traffic volume on the junction slip roads.

3.7. The chart also suggests that there has been a small overall increase in the M18 mainline vehicle flow since 2010. To understand how this trend compares to the national traffic growth, **Table 3.1** presents DfT statistics on Great British road traffic on motorways between 2010 Q3 and 2014 Q1, adjusted for seasonality.

Table 3.1 – Changes in Average Annual Traffic on Motorways since 2010 Q3

Period		Variation from 2010 Q2 (Billion vehicle miles)	% Change from 2010 Q2
2010	Q3	0.0	0.0%
	Q4	-0.3	-1.9%
2011	Q1	0.1	0.6%
	Q2	0.0	0.0%
	Q3	0.0	0.0%
	Q4	0.1	0.6%
2012	Q1	0.2	1.3%
	Q2	-0.1	-0.6%
	Q3	0.3	1.9%
	Q4	0.4	2.6%
2013	Q1	0.4	2.6%
	Q2	0.7	4.5%
	Q3	0.8	5.2%
	Q4	0.9	5.8%
2014	Q1	1.0	6.5%

3.8. **Figure 3.1** shows that there has been a minimal change in traffic flows on the M18 near to the scheme with **Table 3.2** demonstrating that traffic on both motorway slip road approach arms has slightly decreased (-1.4%) over the period that the scheme has been developed and opened.

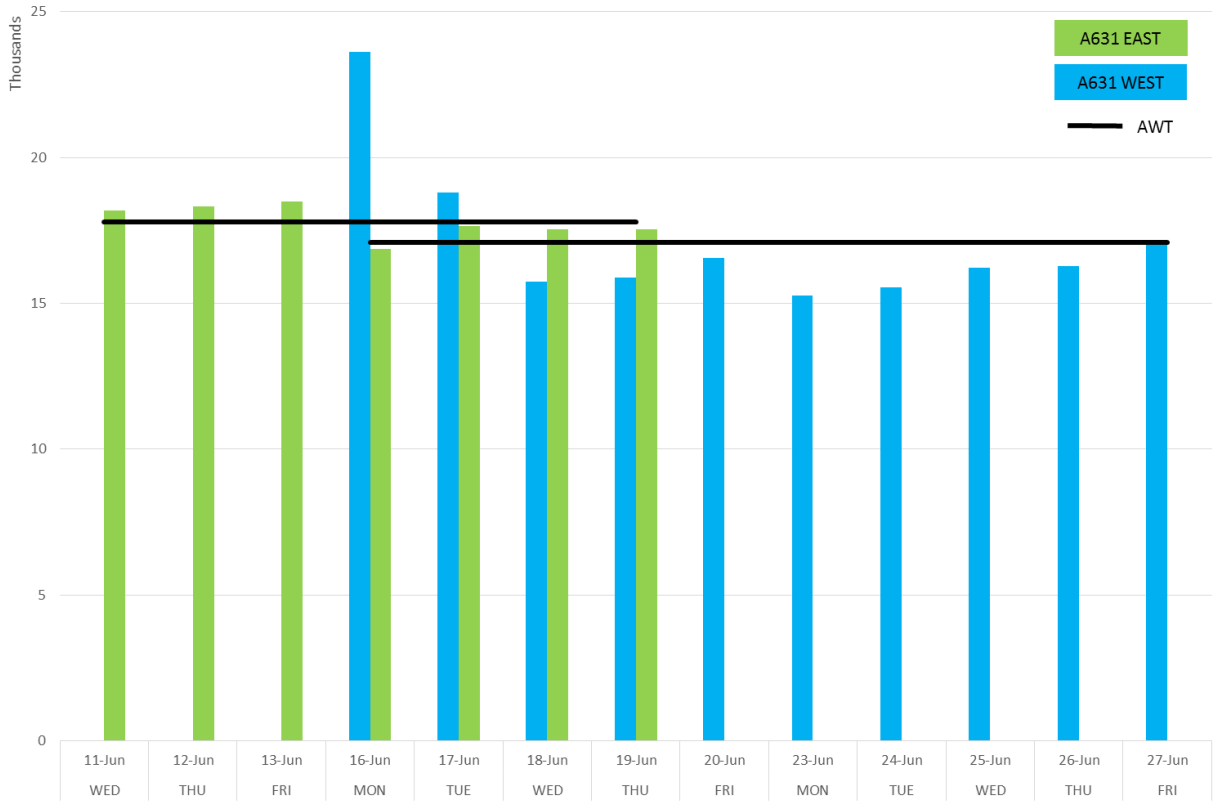
Table 3.2 – Pre & Post-Scheme Change in Average Daily Traffic on M18 J1 Slips

Period	M18 N Slip Road ADT	M18 S Slip Road ADT	Total
January 2011 – December 2011	10606	4454	15060
May 2012 – April 2013	10418	4424	14842
Difference	188	30	218
% Change Before and After Scheme	-1.8%	-0.7%	-1.4%

A631 Approach Arms

3.9. An ATC count was undertaken across a two week period on the A631, either side of the junction. Although data was collected across a 17 day period, issues with the data collection equipment meant that observations for a number of the days was unsuitable for analysis. Robust data to the east of the junction was collected 11th – 19th June 2014 and 16th – 27th June 2014 to the west of the junction. The daytime traffic observed during the two weeks is shown in **Figure 3.2**.

Figure 3.2 Daily Traffic Flow on the A631 Either Side of the Junction



3.10. The data shows traffic entering the junction from the two A631 approach arms is of a similar level across an average 24 hour weekday; between 17,000 and 18,000 vehicles.

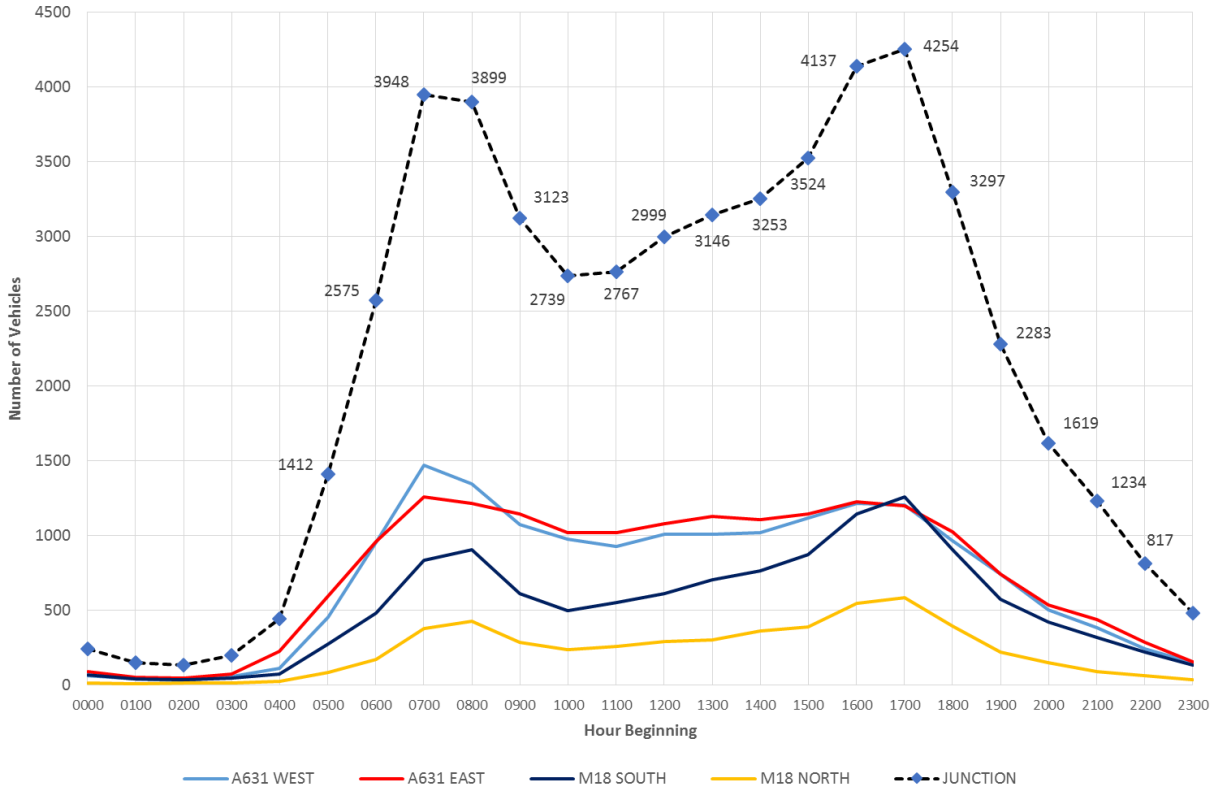
3.11. When compared to the June 2014 traffic flows observed from the TRADS data (presented in **Figure 3.1**), it is evident that the A631 approach arms carry more traffic into the junction than either of the motorway slip road approaches.

Daily Traffic Patterns

3.12. By studying the daily traffic patterns, it is possible to identify peak periods during which the junction is subject to high demand. This will help to understand journey times around the junction and when delays might be expected.

3.13. The HA TRADS sites located on the motorway slip road approaches (June 2014) and the June 2014 ATC counts on the A631 have been interrogated to gain an appreciation of the daily flow profile of traffic into the junction (shown in **Figure 3.3**).

Figure 3.3 Average Weekday Hourly Traffic Flow into the Junction (June 2014)



3.14. In summary:

- **AM Peak traffic through the junction is experienced between 0700 and 0900** - The data demonstrates that the peak traffic through the junction occurs across a two hour AM peak, with the A631 West approach providing the highest traffic flows. The A631 East approach is the second highest demand flow, with the motorway slip road approaches being relatively less well used. This is in line with the traditional AM peak period;
- **PM Peak traffic through the junction is experienced between 1600 and 1800** – The data demonstrates that in excess of 4000 vehicles per hour travel through the junction across a two hour PM peak. Traffic from the two A631 approach arms and the M18 South are all of a similar volume (around

1200 vehicles per hour) with the M18 North approach being relatively less busy; and

- **The junction is at its busiest during the PM Peak**. There are around 300 more vehicles using the junction between 1700 and 1800 than between 0700 and 0800.

3.15. Similar data of traffic using the junction is presented in **Figure 3.4** for Saturdays and **Figure 3.5** for Sundays.

Figure 3.4 Average Saturday Hourly Traffic Flow into the Junction (June 2014)

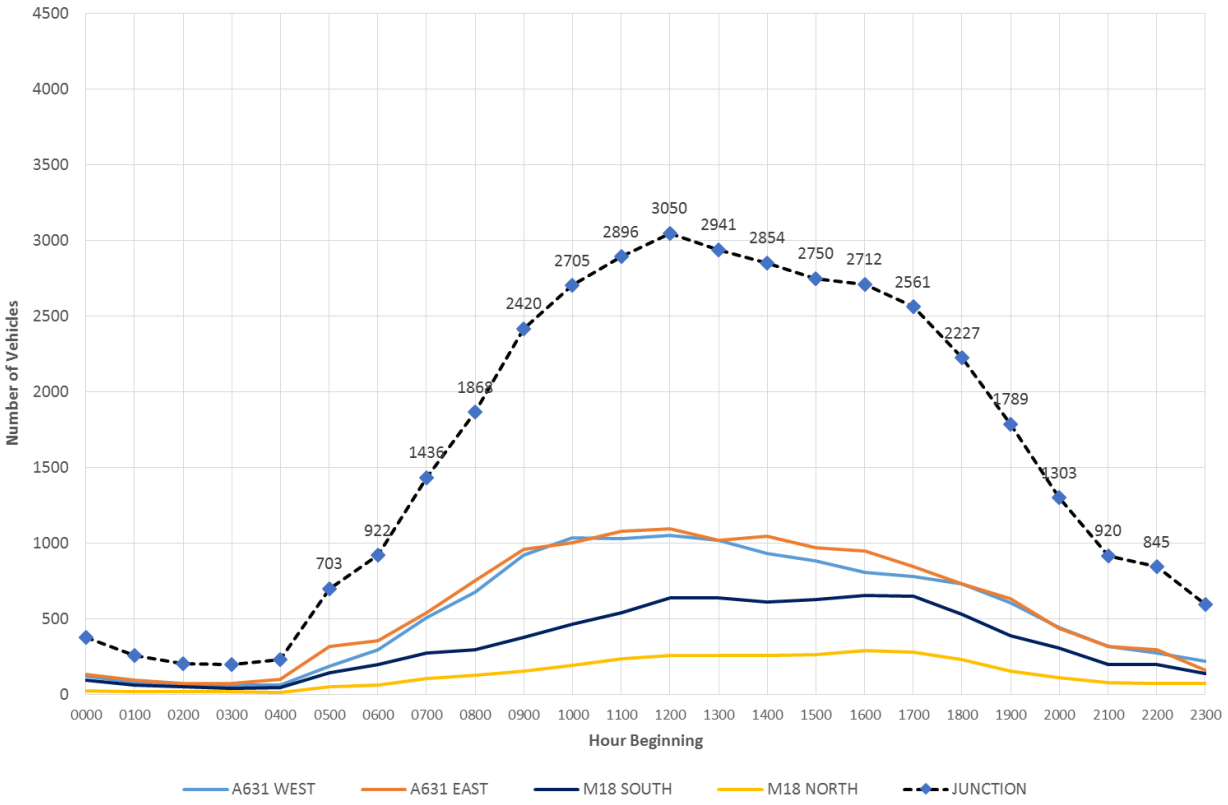
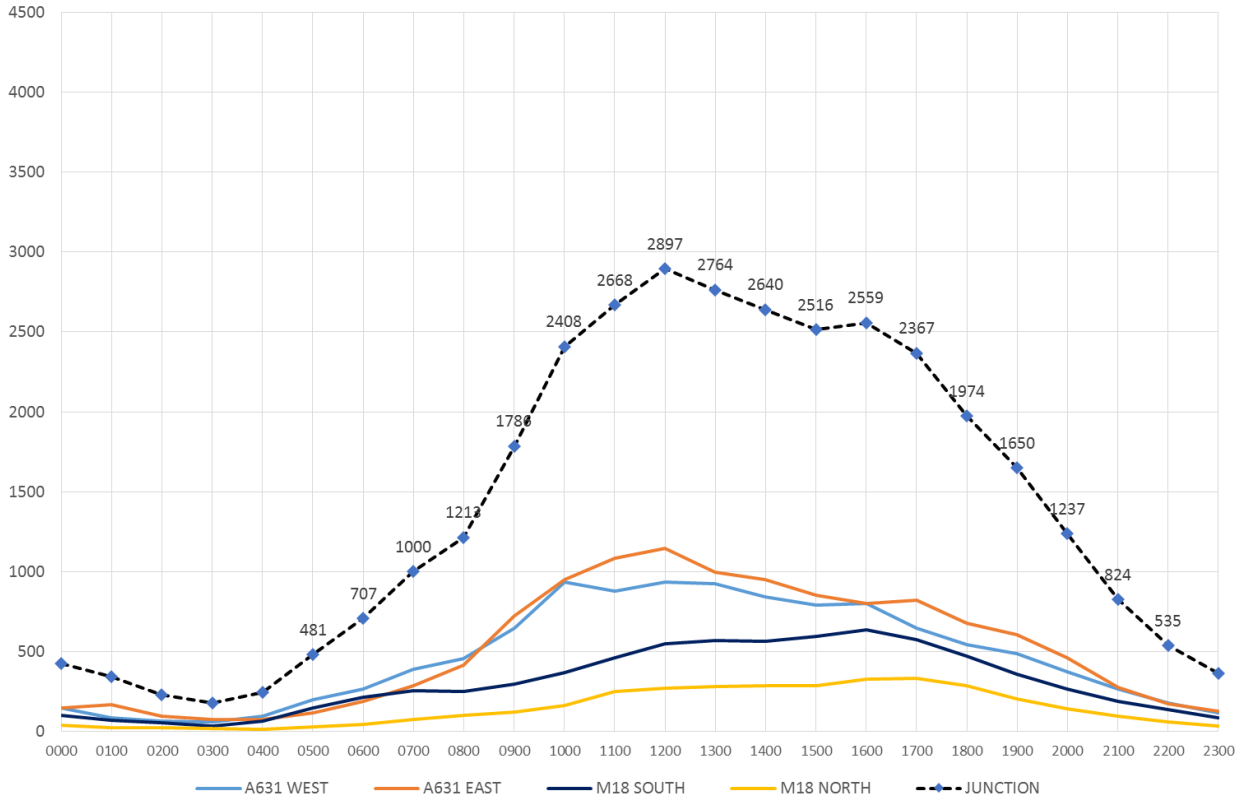


Figure 3.5 Average Sunday Hourly Traffic Flow into the Junction (June 2014)

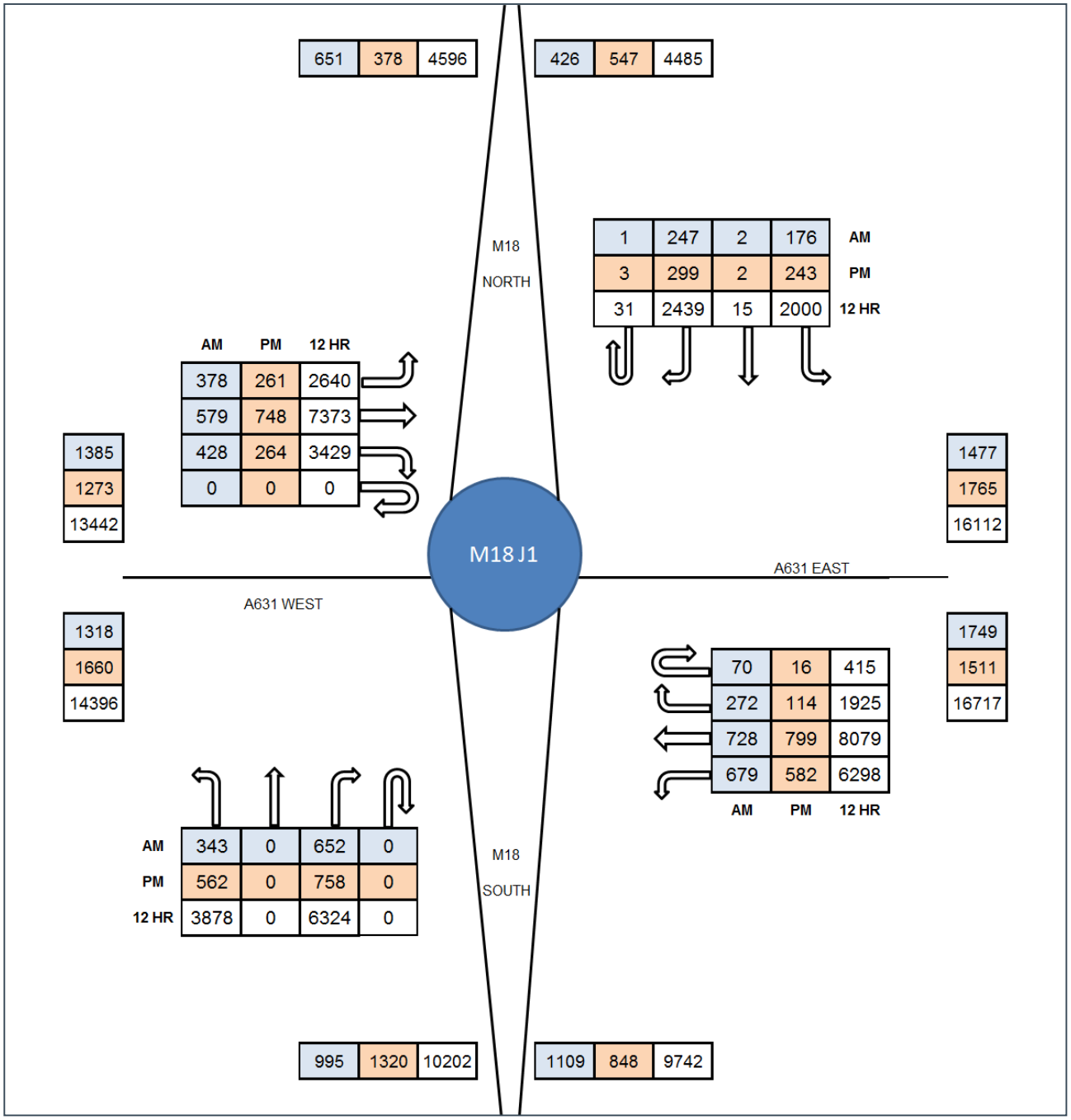


3.16. On Saturdays and Sundays, the peak hour is between 1200 and 1300, with the heaviest traffic flows observed on the two A631 approach arms. Traffic volumes approaching from the motorway slip roads are notably smaller with the M18 North arm carrying the lowest flow.

Traffic Turning Movements

3.17. Vehicle turning movements across the 12 hours covered by the count (0700-1900) have been analysed for the March 2008 turning count alongside the AM peak (0800-0900) and PM peak (1700-1800) hours. Please note that the M18 J1 Economy Improvements Study by A1+ analysed the 2008 turning count data and identified the above two peak periods. As these are broadly in line with those identified when analysing the TRADS data above, we have adopted these time periods for the below analysis. This is presented in **Figure 3.6**.

Figure 3.6 All Vehicle Turning Flows (March 2008)



3.18. Some key observations from the turning count data are:

- Generally there are similar levels of traffic approaching and exiting each arm of the junction across the 12 hour count. This suggests that generally the vehicles use the same routes when travelling to and from their destinations;
- Motorway traffic was shown to turn both directions onto the A631 without a strong preference. For traffic approaching from the north, there is a slightly higher proportion that turned right to travel towards Rotherham than turned left to travel towards Maltby. In contrast, slightly more traffic approaching from the south turned right to travel towards Maltby than turned left to travel towards Rotherham;
- On each of the A631 approach arms, the dominant movement was straight ahead along the A631; and
- More of the A631 traffic uses the junction to turn onto the M18 southbound (towards the M1), than northbound (towards Doncaster).

Summary

- Traffic flows before and after the scheme are of a similar volume;
- The A631 approach arms carry more traffic than the M18 approaches, with the A631 West approach arm carrying the highest traffic flow in the PM Peak;
- Turning count data indicates that for A631 traffic, the predominant movement is straight across the junction; and
- Motorway traffic is turning in both directions onto the A631.

4. Journey Time Analysis

Introduction

4.1. As an economy scheme, the key justification for this LNMS is a journey time benefit for road users. The scheme has introduced signals to three arms of the junction, introduced MOVA and widened the circulatory carriageway to provide additional capacity. These measures were designed to improve journey times for vehicles moving through the junction, especially during peak periods.

4.2. To assess the impact, this report considers evidence from before and after the scheme to ascertain whether there has been a journey time benefit experienced due to the implementation of the M18 J1 Signals LNMS.

Data Source

4.3. For the journey time analysis, Sat Nav data has been used to inform pre and post scheme journey times. This data is available from some motorists who use satellite navigation devices and allow their data to be used anonymously for the purpose of generating travel statistics. This data can provide crucial intelligence on the operation of the highway network. The data also has the benefit of being historic, so that it is possible to retrieve pre-scheme journey time data after the scheme has opened.

4.4. In order to conduct the analysis, seven time periods have been defined using the diurnal flow profiles presented in chapter 3 as a guide. The time periods have been defined to combine similar hours in terms of flow levels and trip purposes (commuting/leisure etc). The seven time periods used are listed in **Table 4.1**.

Table 4.1 – Journey Time Analysis: Time Period Splits

24 Hour Flow	Mon-Fri	Sat-Sun
Weekday AM Peak	0700 - 0900	
Weekday Daytime	0900 - 1500	
Weekday PM Shoulder	1500 - 1600 & 1800 - 1900	
Weekday PM Peak	1600 - 1800	
7-Day Overnight	1900 - 0700	1900 - 0700
Saturday Daytime		0900 - 1800
Sunday Daytime		1000 - 1700

4.5. The periods of the week which are not covered by these seven time periods (Saturdays 0700-0900, Saturdays 1800-1900, Sundays 0700-1000, Sundays 1700-1900) are all considered to have journey times similar to the overnight period, due to the low levels of traffic flow.

4.6. Sat Nav data has been acquired for these time periods over a one year period before and after the scheme. These periods are defined as:

- Pre-scheme: 1st January 2011 to 31st December 2011; and

- Post-scheme: May 2012 to April 2013.

4.7. The post-scheme period allows a month after the scheme has opened to allow for any bedding-in of the scheme and any initial tweaks to the operation of the MOVA equipment.

Journey Time Comparison

4.8. The impact of the scheme during each of these seven time periods has been considered separately. **Table 4.2** presents the change in journey time between the pre-scheme and post-scheme periods for each movement. Negative values indicate a journey time saving and hence a benefit.

4.9. **Table 4.2** shows journey time differences on every movement and every time period, but in reality, some of the small changes may be due to sampling errors or if true, may be unperceivable. As a result, only journey time changes in excess of 10 seconds (positive or negative) are considered when calculating the annual vehicle hours saved.

4.10. The analysis shows that the scheme has reduced journey times on the M18 North approach arm around the peak periods, but has increased journey times on the other arms of the junction.

Table 4.2 – Difference in Before and After Journey Times (seconds per vehicle)

Arm From	Arm To	Wkday AM Pk	Wkday Inter Pk	Wkday PM Shoulder	Wkday PM Pk	7-Day O/night	Sat Daytime	Sun Daytime
M18 N	A631 W	-27.86	-3.51	-21.77	-108.59	-1.05	3.96	3.83
	M18 S	-27.82	-3.73	-24.22	-106.92	1.52	3.06	6.85
	A631 E	-35.65	-11.55	-29.77	-115.93	-5.35	-3.72	-1.60
A631 W	M18 N	-6.79	9.04	18.05	10.14	6.22	10.27	8.83
	M18 S	8.66	20.27	23.13	17.47	10.10	19.61	21.39
	A631 E	0.83	12.45	17.58	8.46	3.24	12.84	12.93
M18 S	M18 N	38.26	3.99	7.96	-0.75	-2.89	9.10	2.29
	A631 W	28.09	-3.34	-2.10	-8.83	-9.98	0.07	-8.59
	A631 E	45.89	7.40	7.49	-2.44	-5.87	11.67	6.39
A631 E	M18 N	11.44	16.51	18.00	17.76	15.32	18.82	12.59
	A631 W	1.27	9.19	7.94	9.68	8.23	9.78	1.72
	M18 S	1.32	8.97	5.49	11.35	10.79	8.88	4.74

Negative values indicate a journey time saving and hence a benefit. Savings > 10 secs are highlighted in Green.

Positive values indicate an increase in journey time and hence a dis-benefit. Increases of > 10 seconds are highlighted in Red.

4.11. The greatest benefits are observed on the M18 North approach in the PM peak when a saving of at least 106 seconds is recorded for all movements. The other

arms do however experience a journey time increase with delays increasing by over 17 seconds for vehicles turning right from the A631 approaches onto the motorway (A631 W - M18 S & A631 E – M18 N). The M18 South approach appears to have slightly benefited in the PM peak, although the scale of any savings are too small to be considered significant.

4.12. In the AM peak, the M18 North is again the only approach that is shown to have benefited. Although the benefits are less than in the afternoon, journey times for vehicles entering from the north are between 27 and 36 seconds quicker depending on the arm-to-arm movement. Dis-benefits are however observed on each of the other three approaches with the M18 South approach experiencing the greatest level of additional delay. This is an expected result as this approach arm was already signalised and so the provision of further signals around the junction means green time is now shared with other locations. Trips from the M18 South are up to 45 seconds slower following the opening of the scheme (right turn: M18 S – A631 E).

4.13. Outside of the peak periods (and PM shoulder peak), there are no periods where journey times have notably improved. However, dis-benefits are observed across the weekday interpeak and at weekends. Traffic on the two A631 approach arms now faces additional delay during all time periods which is in opposition to the pre-scheme forecasts and the scheme's objectives. For example, the right turns from the A631 East to join the M18 northbound is adversely impacted during all periods of the day.

4.14. Whilst **Table 4.2** presents the change in journey times, the actual before and after journey times observed in the Sat Nav data are presented in **Appendix A** and **Appendix B** respectively.

Journey Time Reliability

4.15. The Sat Nav data also allows any change in journey time reliability to be quantified, by using the inter-quartile range journey times and the 5th to 95th percentile journey times. By considering how these ranges have changed from the pre-scheme year to the post-scheme year the reliability of journey times can be assessed.

4.16. The Sat Nav data has been extracted as a series of right turning arm-to-arm vehicle movements which take in the majority of the circulatory carriageway. It is possible to assess the change in journey time reliability for each of these vehicle movements to make a robust assessment of how reliability has been affected.

4.17. The graphs presented in Appendix C show the journey time reliability on the four right turning arm-to-arm vehicle movements assessed:

- M18 North to A631 West;
- A631 West to M18 South;
- M18 South to A631 East; and
- A631 East to M18 North.

4.18. In summary, the reliability graphs show:

- The M18 North to A631 East movement shows improvements in the AM and PM Peak periods with a significant improvement in the PM Peak where 95% of journeys now take up to 198 seconds, compared to 612 seconds

previously. Outside of the peaks, the changes in journey time reliability are small;

- The A631 East to M18 North movement shows a reduction in reliability with journey times more variable following the opening of the scheme in most time periods assessed. The exception is the AM peak where journey time reliability has improved, although with the mean journey time increasing;
- The M18 South to A631 East movement shows a sharp decline in reliability during the AM Peak, but a substantial improvement during the PM peak. Reliability has got worse in most of the other time periods although there is an improvement overnight with the 95% percentile decreasing by 82 seconds; and
- The A631 East to M18 North movement shows an adverse impact on journey time reliability across most time periods, including both AM and PM peaks. In the AM peak, 95th percentile journey times are now 52 seconds slower than previously.

Calculation of annual vehicle hour benefits

4.19. **Table 4.2**, presented earlier in this section, demonstrates how journey times have changed for certain movements and time periods before and after the scheme's construction. It is assumed that these changes are a result of the scheme measures. Therefore, it is necessary to calculate the number of vehicle hours saved in the opening year, in order to understand and quantify the overall impact for this evaluation.

4.20. Post-scheme traffic volumes have been identified using June 2014 data from the TRADS slip-road sites and the ATCs collected on the A631 during June 2014.

4.21. The turning proportions from the June 2008 turning count have been applied to the traffic entering the junction from each arm in 2014 as a robust estimate of the number of vehicles making each arm-to-arm movement for the post-scheme period. Although the 2008 count was collected more than three years prior to the scheme works, traffic volume analysis (presented in **Figure 3.1**) indicates that traffic did not change notably during this period so it was felt to be remain a robust source of traffic information. Furthermore, traffic volumes recorded on the A631 in the 2008 junction turning count has been compared to the June 2014 ATC data for the A631 approaches. This reaffirms that there has not been a significant changes in traffic levels and there is therefore no requirement to include a rule of half adjustment to the vehicle hour savings[1].

4.22. As outlined previously, the journey time assessment focuses on seven time periods and hence it is the vehicle movements during these periods which are relevant to the vehicle hour savings calculations.

4.23. Weekly vehicle movement matrices, factored to Post-Scheme April 2014, are presented in **Table 4.3**. These present the total vehicle movements in each time period.

[1] Note that Rule of Half (RoH) is triggered when the flow changes increases by over 10%. On these occasions we can be confident that the flow difference is related to the scheme and not just traffic survey errors. Under the rule of half, the existing traffic experiences the full benefit, whereas the additional traffic volume only experiences half of the benefit.

Table 4.3 – Total Weekly Arm-to-Arm Vehicle Flow Matrices by Period

Arm From	Arm To	Wkday AM Pk	Wkday Inter Pk	Wkday PM Shoulder	Wkday PM Pk	7-Day O/night	Sat Daytime	Sun Daytime
M18 N	A631 W	2305	3042	3910	1170	983	4638	440
	M18 S	16	32	8	2	2	10	4
	A631 E	1715	2573	3398	1017	854	4030	334
A631 W	M18 N	3936	2298	4802	1431	1029	5084	360
	M18 S	5052	2759	6613	1970	1417	7002	449
	A631 E	5108	7047	17015	5070	3645	18015	1274
M18 S	M18 N	0	0	0	0	0	0	0
	A631 W	2852	5137	7213	1879	1343	6742	734
	A631 E	5854	6892	12852	3348	2393	12014	1044
A631 E	M18 N	2228	999	3501	998	753	3615	177
	A631 W	4480	6205	15980	4557	3435	16500	1174
	M18 S	5165	4769	11165	3184	2400	11528	804
Total		**38711**	**41753**	**86457**	**24626**	**18254**	**89178**	**6794**

4.24. The arm-to-arm vehicle movements outlined in **Table 4.3** are multiplied by the differences in journey times outlined in **Table 4.2** to identify the total weekly vehicle hour savings. As outlined above, only changes in journey time which are greater than 10 seconds are included in the calculation to isolate only the changes which are perceivable and therefore tangible.

4.25. Weekly vehicle hour savings are multiplied by 52 to calculate the annual vehicle hour savings. The annual resulting vehicle hour savings are summarised, by approach arm, in **Table 4.4**.

4.26. A full breakdown of the vehicle hour savings by arm-to-arm movement is presented in Appendix D.

Table 4.4 – Annual Vehicle Hour Savings, by Approach Arm

Arm	Wkday AM Pk	Wkday Inter Pk	Wkday PM Shoulder	Wkday PM Pk	7-Day O/night	Sat Daytime	Sun Daytime	Total
M18 N	-1,817	-429	-2,694	-3,541				**-8,481**
A631 W		2,075	7,782	707	207	6,078	377	**17,226**
M18 S	5,037					2,025		**7,063**
A631 E	368	238	910	778	541	983	32	**3,850**
Total	**3,588**	**1,884**	**5,999**	**-2,056**	**748**	**9,086**	**409**	**19,658**

Negative values indicate a journey time saving and hence a benefit. These are highlighted in Green.
Positive values indicate an increase in journey time and hence a dis-benefit. These are highlighted in Red.

4.27. **Table 4.4** demonstrates:

- Overall the scheme has resulted in an increase in journey times through the junction, producing 19,658 vehicle hours of journey time dis-benefits in the opening year;
- Only traffic entering from the M18 North approach is shown to have reduced journey times; this is the arm which carries the lightest traffic volumes;
- The A631 West approach is shown to be most significantly adversely impacted with 17,226 additional vehicle hours of delay per annum. The largest impacts have been during the PM shoulder peak and on Saturdays;
- The Weekday PM peak is the only time period when the junction is now operating more effectively, in terms of journey times and delay;
- Conditions on Sundays and overnight are similar to previous, albeit with slight additional delay; and
- A significant dis-benefit on Saturdays with over 9,000 more vehicle hours observed. These delays are predominantly from the A631 West approach arm, which has accrued around two thirds of the dis-benefit.

4.28. The PAR only considered the impact of the scheme measures during the AM and PM peaks and had forecast a vehicle hour saving during these time periods. The most significant savings were anticipated for the two A631 approach arms.

4.29. The evidence presented shows that the scheme has been unsuccessful with an overall increase in journey times. This conclusion is drawn from considering all time periods throughout the week as the implementation of new signals has affected traffic movements throughout all hours of each day. If the AM and PM peak hours were to have been evaluated in isolation (in line with the PAR approach), the evidence shows there would still be a net dis-benefit of over 1,500 vehicle hours as a result of the additional delays in the AM peak.

Summary

- The scheme has failed to meet its objective of reducing journey times through the junction and has resulted in 19,658 vehicle hours of journey time dis-benefits in the opening year;
- Only the M18 north approach is shown to have reduced journey times from the scheme;
- The A631 West approach is shown to have significantly more vehicle hours of delay than prior to the scheme;
- The weekday PM peak is the only time period when the junction is now operating more effectively, in terms of journey times and delay;
- There is a significant dis-benefit on Saturdays with the A631 West approach most severely impacted; and
- The impact on journey time reliability is variable. There are some right turning movements where improvements are significant such as from M18 North to A631 East in the AM and PM peaks. Conversely, the A631 East to M18 North and M18 South to A631 East right turning movements have both got worse across most time periods.

5. Safety Impacts

Introduction

5.1. A critical component of any highway scheme is safety. This scheme aimed to reduce the number of accidents occurring at the junction, particularly those involving shunts. This section examines the safety impacts associated with the scheme, and compares the pre and post scheme opening accident rates to determine whether the scheme has resulted in a post opening safety benefit or dis-benefit.

Data Source

5.2. The PAR used accidents[2] from the five year period 1st January 2006 to 31st December 2010 as evidence for the pre-scheme conditions at the scheme site. The PAR stated that there had been 42 accidents during this period and that the scheme aimed to save 3.14 accidents in the opening year. The area over which accidents are considered is highlighted in **Figure 5.1**.

5.3. The PAR covers the evidence used to support the decision to proceed with the scheme, effectively outlining the business case. However, once a PAR has been completed and agreed, there can be a time delay before the start of scheme construction.

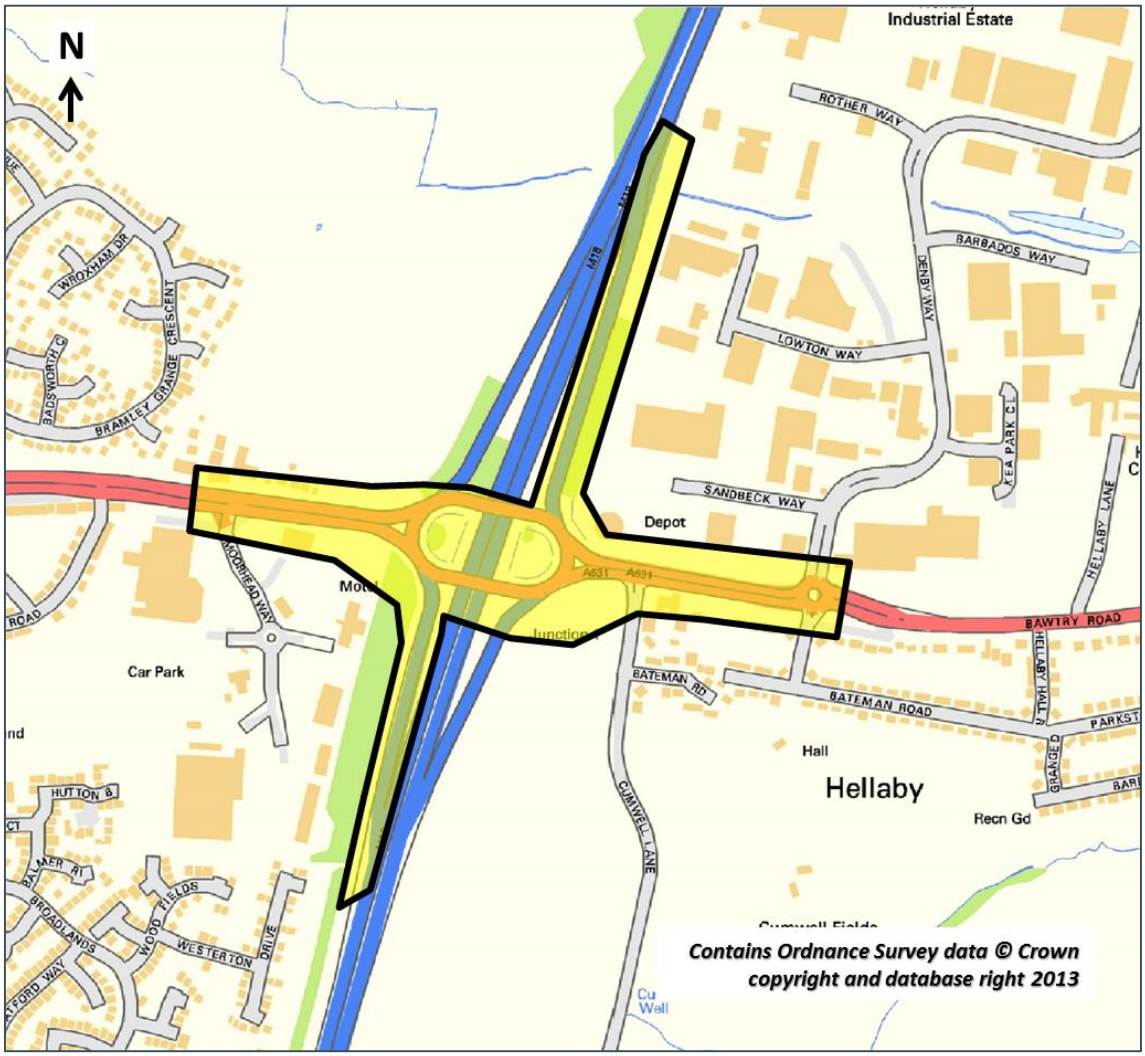
5.4. The delay between collecting evidence for a scheme and starting construction means the accident data used to evidence the situation before the scheme is often dated. As such, to understand just the impact of the scheme, a five year pre-construction accident analysis represents a better comparison to the outturn accident rate, and hence representation of scheme impacts.

5.5. For this scheme, the PAR used accident data up until the end of December 2010. However, scheme construction did not begin until January 2012. Therefore, there are 12 months between the evidence and the scheme, during which time the accident rate could have changed.

5.6. As such, to understand just the impact of the scheme, accident data has been analysed for the same location for a period of five years directly before construction began (1st January 2007 to 31st December 2011).

[2] All references to accidents in this report refer to Personal Injury Collisions (PICs).
The accident data referred to in this report has not necessarily been derived from the national validated accident statistics produced by Department for Transport (DfT). As such, the data may subsequently be found to be incomplete or contain inaccuracies. The requirement for up-to date information and site specific data was a consideration in the decision to use non-validated data and, as it is sourced from Local Processing Units through the Managing Agent Contractors or Asset Support Contractors, it is sufficiently robust for use in this context.

Figure 5.1 Accident Analysis Area



5.7. The results are presented in **Table 5.1** which shows that 40 accidents occurred during this pre scheme opening period (average of eight per year), with two serious accidents and the remainder slight. Please note that in line with current POPE of LNMS methodology, the predicted accident saving of 3.14 has remained unchanged.

Table 5.1 – 5 Year Pre Scheme Accident Rates

Accidents	Dates	Slight	Serious	Fatal	Rate	Severity Index
5yr Pre-Construction	Jan 07 – Dec 11	38	2	0	8.0	5.0%

Construction

5.8. It is important to consider the effect of construction on accidents. While this is not typically monetised in LNMS evaluations, it is informative to consider whether the construction process introduces accidents to the road network.

5.9. For the M18 J1 Signals scheme, the construction period was between the beginning of January 2012 and the middle of March 2012. During this period, there were two accidents recorded in the area affected by the scheme.

5.10. Descriptions of the accidents show that one occurred in icy conditions where a vehicle lost control when braking suddenly as it entered the junction from the A631 West approach and collided with street furniture. The other accident occurred on the M18 northbound on-slip road when a driver lost control of their vehicle when swerving to avoid another vehicle as they re-joined the mainline having already left the junction and the construction works area.

Post-Scheme

5.11. To understand the safety performance of the road network after the scheme implementation, data has been collected for the period since the scheme opened. The scheme opened on 31st March 2012 and data has been collected from this date to as recent a date as possible. For this scheme, data was available until the end of December 2013, meaning that there are 21 months (from the start of April 2012) of data to interrogate post-opening for this scheme.

5.12. The accident data provided is outlined in **Table 5.2**.

Table 5.2 – Post-Scheme Accident Summary

Accidents	Dates	Slight	Serious	Fatal	Rate	Severity Ratio
Post-Scheme	Apr 12 – Dec 13	2	0	0	1.14	0.0%

5.13. The table demonstrates that there have been two personal injury accidents since the scheme opened, which were both recorded as slight severity. The post-scheme accident rate is 1.14 accidents per annum; a significant reduction on the five year pre-scheme accident rate as well as the pre-scheme rate reported in the PAR.

Accident Rate Change

5.14. The key changes in accidents that can result from a scheme are:

- Change in the frequency of accidents; and
- Change in the severity of accidents.

5.15. By understanding the impact the scheme has had on these metrics, it is possible to draw conclusions on the safety aspects of the M18 J1 Signals scheme.

5.16. **Table 5.3** shows the accident rate and severity index for the pre-construction and post-scheme periods.

Table 5.3 – Impact of Scheme on Accident Rates

5yr Pre-Construction Period		Post-Scheme Period		Accident Saving
Accident Rate	Severity Index	Accident Rate	Severity Index	
8.00	5.0%	1.14	0.0%	6.86

5.17. The table shows that the scheme has reduced the accident rate by **6.86** accidents per year. This is substantially greater than the forecast saving of 3.14 accidents per annum which was stated in the PAR.

5.18. The post-scheme severity index of 0.0% (i.e. no serious or fatal accidents) indicates that the scheme has also improved the area's severity index.

Accident Causation

5.19. STATS19 accident data provides a comprehensive record of the accidents that have occurred. This allows us to go beyond the frequency and severity of accidents and consider the reasons why accidents have been occurring. It is possible to consider the scheme's impact on both the vehicle movements which lead to accidents, and the contributory factors recorded during accidents.

5.20. **Table 5.4** and **Table 5.5** demonstrate the before and after frequency of vehicle movements and contributory factors respectively.

Table 5.4 – Impact on Vehicle Movements leading to Accidents per Annum

Movement	5 Year Pre Construction	Outturn
Going Ahead	5.4	1.14
Waiting to go ahead but held up	2.0	1.14
Changing lane to left	1.2	0.0
Moving off	1.2	0.0
Turning left	1.0	0.0

Table 5.5 – Impact on Contributory Factors to Accidents per Annum

Movement	5 Year Pre Construction	Outturn
Failed to look properly	2.6	0.0
Failed to judge other person's speed	2.4	0.0
Loss of control	1.6	0.0
Poor turn or manoeuvre	1.2	0.0
Travelling too fast for conditions	0.2	0.57

5.21. As the scheme has resulted in a reduction in accidents, there is also a large reduction in particular vehicle movements and contributory factors.

5.22. In the 21 month post-scheme period, only two accidents occurred. Both accidents occurred on the M18 South approach arm with vehicles travelling up the slip road colliding into the rear of a vehicle stopped waiting at the signals (rear shunts).

5.23. During scheme development, it was identified that improved lane designation markings would help to improve lane usage and reduce the frequency of accidents occurring where vehicles are changing lanes. The post scheme data

shows there have been no accidents caused where vehicles are changing lanes to the left since the completion of the scheme, compared to 1.2 accidents per annum in the five year pre-scheme period. There were also 0.4 accidents per annum in the five year pre-scheme period caused where a vehicle was changing lane to the right. The scheme has therefore successfully addressed this objective.

5.24. In terms of contributory factors, accidents occurring where a driver has failed to look properly have reduced, with none of these types of accidents observed since the completion of the scheme (compared to 2.6 accidents per annum for the five year pre-scheme period). This is as expected as the introduction of signals eradicates the conflicts between vehicles entering the circulatory carriageway and those already circulating the junction. Accidents where a driver failed to judge another person's speed or a driver lost control have also been prevented since the completion of the scheme.

5.25. The STATS19 analysis gives increased confidence that the scheme measures have not just reduced accidents, but had a direct impact on the types of accidents we would expect to see reduced, e.g. failed to give way, vehicles changing lanes. As the scheme installed new signals, drivers no longer have to judge for themselves when it is safe to enter the junction which explains these reductions.

5.26. The scheme PAR did specifically make reference to there being a problem with shunt type accidents as the junction. The two accidents that have occurred since the introduction of the scheme were both shunts caused by vehicles waiting to go ahead at signals. However, the accidents both occurred on the M18 South approach, which was already signalised prior to this scheme being constructed. Therefore, it could be concluded that following the completion of the scheme, there have been no accidents (shunts or of any other type) to occur in the areas in which the scheme changed the highway layout.

Summary

- The scheme has succeeded in its safety objective, with a reduction of 6.86 accidents per annum, when compared to the five years prior to the scheme being constructed;
- There have been two accidents to occur since the scheme opened. Both occurred on the approach to the stop line on the M18 South approach arm. This arm was previously signalised before this scheme was implemented and so was largely unaffected by the scheme being evaluated. Therefore, it could be concluded that following the completion of the scheme, there have been no accidents to occur in the areas which the scheme changed the highway layout;
- Accident severity index (proportion of KSI) has reduced from 5.0% to 0.0% with no serious or fatal accident occurring since the opening of the scheme; and
- The signalisation has resulted in a notable reduction in accidents occurring where a driver has failed to look properly, failed to judge another person's speed or lost control, allof which are as a result of drivers no longer having to judge themselves when it is safe to enter the roundabout.

6. Economy

Introduction

6.1. This section of the report takes the journey time and safety impacts reported in sections 4 and 5, and considers the monetary value of these impacts. These monetised benefits are then compared to the cost of scheme construction to inform two measures of value for money:

- **First Year Rate of Return (FYRR):** This is a measure of the scheme's first year benefits as a proportion of the scheme cost. It is given as a percentage and informs the percentage of the scheme costs recouped in the opening year. The FYRR given is evidence based and a primary finding of this report;
- **Benefit Cost Ratio (BCR):** This is a measure of all the benefits that the scheme is likely to accrue over its workable life divided by the scheme cost over its life. This can only be a prediction, as this is a one year after opening report and it is not known how the scheme will perform in the future. However, this forecast is revised from that provided in the PAR based on the first year evidence.

6.2. All monetised figures in this section are quoted in 2002 prices, discounted to opening year, unless otherwise specified.

PAR and Outturn Comparison

6.3. The evidence provided in this report has been analysed to evaluate the scheme costs and economic benefits of the scheme provided in the PAR and to calculate the outturn costs and scheme benefits.

6.4. The benefits calculated and discussed in this report can be monetised using standard value of time and accident values from WebTAG. A positive impact is considered to provide a monetary saving. Once monetised in this way, the economy and safety impacts of the scheme are offset against the scheme costs to inform the overall Value for Money of the scheme package in both an opening year, and over a longer scheme life period of 60 years.

6.5. **Table 6.1** summarises this comparison, presenting the PAR and Outturn costs and benefits of the scheme. It also includes opening year and scheme life figures for both costs and benefits of the scheme.

Table 6.1 – PAR and Outturn Economy Comparison

		PAR	Outturn
Opening Year (2012)	Total Cost	£1.042m	£1.132m
	Opening Year Accident Saving (number)	3.14	6.86
	Opening Year Accident Saving (£)	£0.239m	£0.522m
	Opening Year Journey Time Benefits (£)	£2.865m	-£0.118m
	FYRR	298%	36%
Scheme Life (60 years)	Costs	£1.042m	£1.132m
	Safety Benefits	£9.592m	£20.947m
	Journey Time Benefits	£109.065m	-£4.484m
	BCR	113.8	14.5

Summary

6.6. Overall the scheme is shown to have been less successful than was predicted. However, it has still resulted in an overall beneficial impact.

6.7. It was anticipated that the scheme would deliver a large journey time saving, as well as preventing some of the accidents that were occurring at the junction. Overall the benefits were meant to be 92% economy and 8% safety.

6.8. The Sat Nav data has provided evidence that journey times to move through the junction have in fact increased for many movements and in many time periods since the opening of the scheme. Whilst there are some movements that benefit in the AM peak, there is an overall journey time economic dis-benefit of £0.118m per annum, once these impacts are annualised.

6.9. The scheme has however saved considerably more accidents than were forecast and this large accident saving has compensated for the journey time increases. Whilst it was anticipated that 3.14 accidents per annum would be prevented, the actual saving has been 6.86 accidents per annum. As a result the economic safety benefits are more than double those predicted, equal to £0.552m per annum once monetised.

6.10. The outturn scheme costs were also slightly higher than those predicted in the PAR evaluation.

6.11. As the predicted journey times did not materialise at all, and despite accident reduction doubling, the Value for Money is heavily affected. The outturn FYRR and BCR are significantly lower than those forecast in the PAR. However, a 60 year BCR of 14.5 is still significant and indicative of a successful scheme which represents good value for money. This is in line with the typical performance of Large LNMS, where the average BCR is 15.7.

7. Other Impacts

7.1. This section of the report presents information relating to the NATA objectives which are not related to journey times, reliability or safety, as set out in the PAR's AST (as these have already been discussed in previous chapters).

7.2. This information will be compared to the forecasts made in the AST (provided in Appendix E). These comparisons are used to score the scheme against NATA objectives based on the first years observed findings and are recorded in the Evaluation Summary Table (EST). The EST can be found in Appendix F.

7.3. Those impacts which are not detailed below have all been assessed as neutral.

Journey Quality

7.4. Journey Quality is related to traveller care, views and stress. The scheme's PAR did not consider that the scheme would have any impact on journey quality.

7.5. In implementing new lane designation markings, the scheme has reduced route uncertainty for road users. The signalisation of three arms of the junction should also have reduced the fear of a potential accident by providing more control over the decision-making required by drivers when they negotiate the junction. Therefore, these represent a +2 score for journey quality.

7.6. On the other hand, the introduction of traffic signals may have led to increased driver frustration on those movements that were previously free-flow, representing a -1 score for journey quality.

7.7. The combination of these scores aspects has resulted in an overall **slight beneficial** impact for the scheme in terms of journey quality.

Landscape

7.8. The scheme's PAR did not consider that the scheme would have any impact on landscape.

7.9. The nature of the scheme, to install new traffic signal equipment in a rural location, means there has been a **slight adverse** impact on the landscape. This adverse impact was also observed during the site visit.

Physical Activity

7.10. The scheme's PAR did not consider that the scheme would have any impact on physical activity.

7.11. The site visit observed that pedestrians and cyclists were using the controlled crossings implemented as part of the signalisation. The scheme is likely to have had a positive effect on the number of people that walk or cycle for more than 30 minutes per day, by removing a barrier to safe movement that existed previously. There are areas of housing, employment and open land on both sides of the M18 in this location so the scheme could well enable more people to walk or cycle for over 30 minutes between those areas. Therefore it is considered that the

scheme has a **slight beneficial** impact on physical activity in the area by providing a safer route for people to walk and cycle across the junction.

Severance

7.12. The scheme's PAR did not consider that the scheme would have any impact on severance.

7.13. Community severance is defined for PAR 6.1 as "the separation of residents from facilities and services they use within their community caused by substantial changes in transport infrastructure or by changes. Severance will only be an issue where either vehicle flows are significant enough to significantly impede pedestrian movement or where infrastructure presents a physical barrier to movement".

7.14. The M18 J1 Signals LNMS has introduced new traffic signals which include controlled crossing provisions for pedestrians and cyclists. As a result the severance impact can be considered to have improved, with a **slight beneficial** impact.

Noise

7.15. There are sensitive receptors within 300m of the scheme but the traffic volume analysis in Chapter 3 shows that there has been no significant change in traffic volumes travelling through the junction since the scheme was installed. Although there are other factors to be considered in a full noise assessment, this data provides an indication that noise levels have not changed significantly. Therefore, the EST includes a 'Neutral' impact for noise.

Air Quality

7.16. There are no properties within 50m of the scheme so the EST includes a 'Neutral' impact for this sub-objective.

Greenhouse Gases

7.17. The scheme has had no impact on the total distance travelled by traffic so the EST includes a 'Neutral' impact for this sub-objective.

Heritage of Historic Resources

7.18. The scheme has no impact on archaeological or built heritage sites so the EST includes a 'Neutral' score for this sub-objective.

Biodiversity

7.19. The scheme does not impact on biodiversity so the EST includes a 'Neutral' score for this sub-objective.

Water Environment

7.20. The scheme has no impact on highway drainage or discharge so the EST includes a 'Neutral' score for this sub-objective.

Security

7.21. The scheme has no impact on the indicators of security so the EST includes a 'Neutral' score for this sub-objective.

8. Conclusions and Recommendations

8.1. This report presents the POPE of the M18 J1 Signals LNMS, implemented by the Area 12 MAC in early 2012. The scheme evaluation has considered all elements of the NATA criteria. The evaluation team have worked closely with the MAC to ensure the best data possible was used and the scheme thoroughly understood.

8.2. The purpose of this section is to:

- Summarise the key impacts of the scheme and how these compare to forecasts; and
- Consider the lessons learnt and make recommendations to improve future LNMS.

8.3. The M18 Junction 1 Signals LNMS opened in March 2012. The scheme introduced new traffic signals on three approaches of the roundabout, creating a completely signalised junction. The M18 South approach was previously signalised by a separate scheme years before. The signals were integrated with MOVA and additional improvements to road markings and surfacing were made to improve driver conditions. The scheme was initiated due to lengthy delays experienced on the un-signalised approach arms, especially on the A631 during peak periods.

8.4. The journey time analysis identified that the scheme was unsuccessful in reducing journey times with an annual dis-benefit identified. The M18 North approach arm did largely benefit, but the two A631 arms were adversely impacted.

8.5. Although presented as an economy scheme, there was also anticipated to be an accident reduction due to the scheme. In actuality, the evidence shows the accident savings that have been achieved are notably greater than those forecast, which has resulted in a higher than anticipated economic benefit.

8.6. The large accident benefits offset the journey time dis-benefits meaning the scheme overall performs positively with an outturn FYRR of 36% and a BCR of 14.5. Although the results are significantly lower than was forecast in the PAR, it still reflects that the M18 J1 signalisation has been a successful scheme.

8.7. It must however be kept in consideration that the scheme has only returned a positive outcome due to its large accident saving and, as an economy scheme, the journey time impacts should really be beneficial for the scheme to be considered an absolute success.

Scheme Specific Objectives

8.8. Drawing on information presented in this report, a summary of the scheme's success against the scheme specific objectives, listed in the introduction to this report, is provided in **Table 8.1**.

Table 8.1 – Scheme Specific Objectives

Objective	Evaluation Summary	
Economy: Reducing congestion and improving reliability	The scheme has resulted in an increase in journey times with an additional 19,658 vehicle hours in the opening year.	✗
Safety: Reducing accidents	The scheme has had a significant impact in reducing accidents, with the annual accident rate falling from 8.20 in the five year pre-construction period to 1.14 after the introduction of the scheme.	✓

Lessons Learned

8.9. During the course of this evaluation, a number of findings have revealed ways in which the LNMS appraisal process could be adapted to improve the accuracy of pre-scheme forecasting. These are summarised as the following:

- It is evident that when considering journey time benefits, it would be beneficial to consider all time periods, rather than just peak periods. This is especially the case for schemes which MOVA schemes are being introduced. The assessment of the impacts of this scheme indicated that journey times had changed across all time periods of the week, and not solely during the AM and PM peak periods which were assessed in the PAR. The pre-scheme impacts assessment presented in the PAR was therefore misleading in its conclusions; and
- The scheme to introduce traffic signals was developed to address congestion issues which were more prevalent in the peak periods. There was however a resulting dis-benefit in periods of low flow where were not accounted for in the scheme appraisal. Some of the journey time dis-benefits identified could be mitigated by considering 'part-time' operation of signal controls. This would mean during periods of low flow, traffic would not be held up by traffic signals if there was a suitable gap in the circulatory traffic flow.

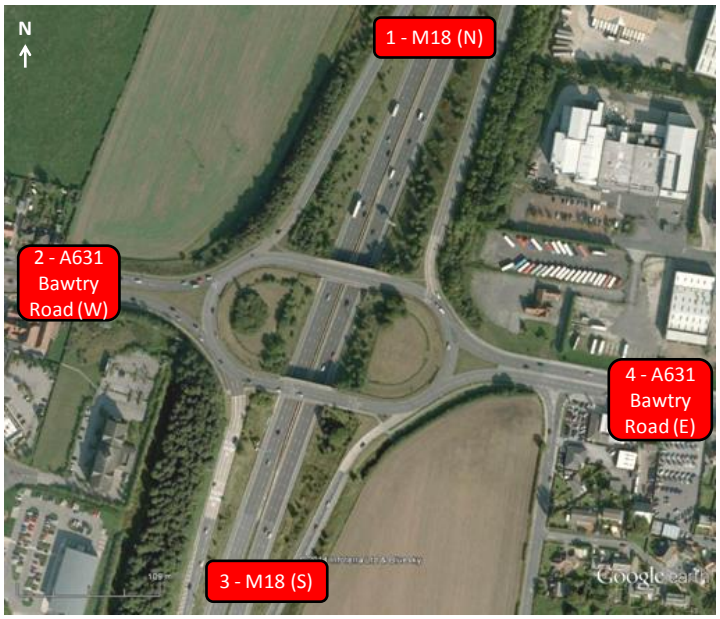
Appendices

Appendix A. Before Scheme Journey Times

Arm	Weekday AM Peak	Weekday Interpeak	Weekday PM Shoulder	Weekday PM Peak	7-Day Overnight	Saturday Daytime	Sunday Daytime	Simple Average
1-1	134.8	105.5	128.0	218.9	88.5	92.9	88.7	**122.5**
1-2	125.7	93.9	119.4	214.0	75.2	82.2	80.1	**112.9**
1-3	109.6	73.2	94.8	181.6	58.6	62.9	58.1	**91.2**
1-4	93.6	65.4	86.9	178.8	50.9	54.0	49.7	**82.8**
2-1	67.1	54.8	55.7	67.9	47.2	50.9	50.7	**56.4**
2-2	114.2	97.4	104.2	127.8	85.1	90.9	91.3	**101.6**
2-3	98.0	76.8	79.6	95.4	68.5	71.7	69.4	**79.9**
2-4	82.1	68.9	71.7	92.6	60.8	62.8	61.0	**71.4**
3-1	78.5	84.7	81.1	98.0	82.8	71.5	78.0	**82.1**
3-2	69.5	73.0	72.6	93.0	69.5	60.8	69.4	**72.5**
3-3	109.5	106.6	105.0	125.5	104.1	92.2	96.7	**105.7**
3-4	93.5	98.8	97.1	122.7	96.4	83.3	88.3	**97.2**
4-1	126.2	95.4	91.5	103.9	89.8	90.9	89.8	**98.2**
4-2	117.1	83.7	82.9	98.9	76.5	80.1	81.1	**88.6**
4-3	101.0	63.1	58.3	66.5	59.9	60.8	59.2	**67.0**
4-4	141.2	109.5	107.4	128.6	103.3	102.7	100.1	**113.2**
Total	**1661.4**	**1351.0**	**1436.3**	**2014.0**	**1217.0**	**1210.5**	**1211.5**	

Arm References (see plan below) - 1 – M18 North; 2 – A631 West; 3 – M18 South; 4 – A631 East

Note: The average value is a simple average, and is not weighted by volume of traffic

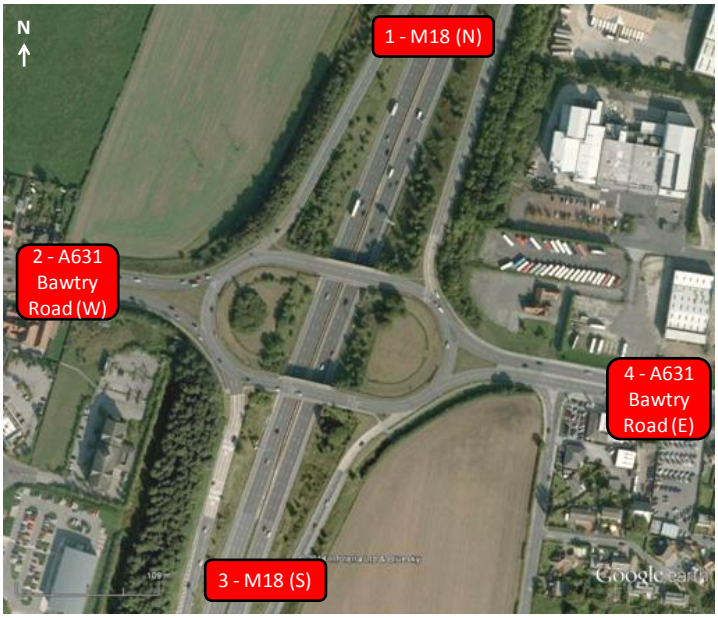


Appendix B. After Scheme Journey Times

Arm	Weekday AM Peak	Weekday Interpeak	Weekday PM Shoulder	Weekday PM Peak	7-Day Overnight	Saturday Daytime	Sunday Daytime	Simple Average
1-1	134.8	105.5	128.0	218.9	88.5	92.9	88.7	**109.3**
1-2	125.7	93.9	119.4	214.0	75.2	82.2	80.1	**90.8**
1-3	109.6	73.2	94.8	181.6	58.6	62.9	58.1	**69.6**
1-4	93.6	65.4	86.9	178.8	50.9	54.0	49.7	**53.7**
2-1	67.1	54.8	55.7	67.9	47.2	50.9	50.7	**64.3**
2-2	114.2	97.4	104.2	127.8	85.1	90.9	91.3	**118.3**
2-3	98.0	76.8	79.6	95.4	68.5	71.7	69.4	**97.1**
2-4	82.1	68.9	71.7	92.6	60.8	62.8	61.0	**81.2**
3-1	78.5	84.7	81.1	98.0	82.8	71.5	78.0	**90.4**
3-2	69.5	73.0	72.6	93.0	69.5	60.8	69.4	**71.9**
3-3	109.5	106.6	105.0	125.5	104.1	92.2	96.7	**123.2**
3-4	93.5	98.8	97.1	122.7	96.4	83.3	88.3	**107.2**
4-1	126.2	95.4	91.5	103.9	89.8	90.9	89.8	**114.0**
4-2	117.1	83.7	82.9	98.9	76.5	80.1	81.1	**95.4**
4-3	101.0	63.1	58.3	66.5	59.9	60.8	59.2	**74.3**
4-4	141.2	109.5	107.4	128.6	103.3	102.7	100.1	**130.8**
Total	**1661.4**	**1351.0**	**1436.3**	**2014.0**	**1217.0**	**1210.5**	**1211.5**	

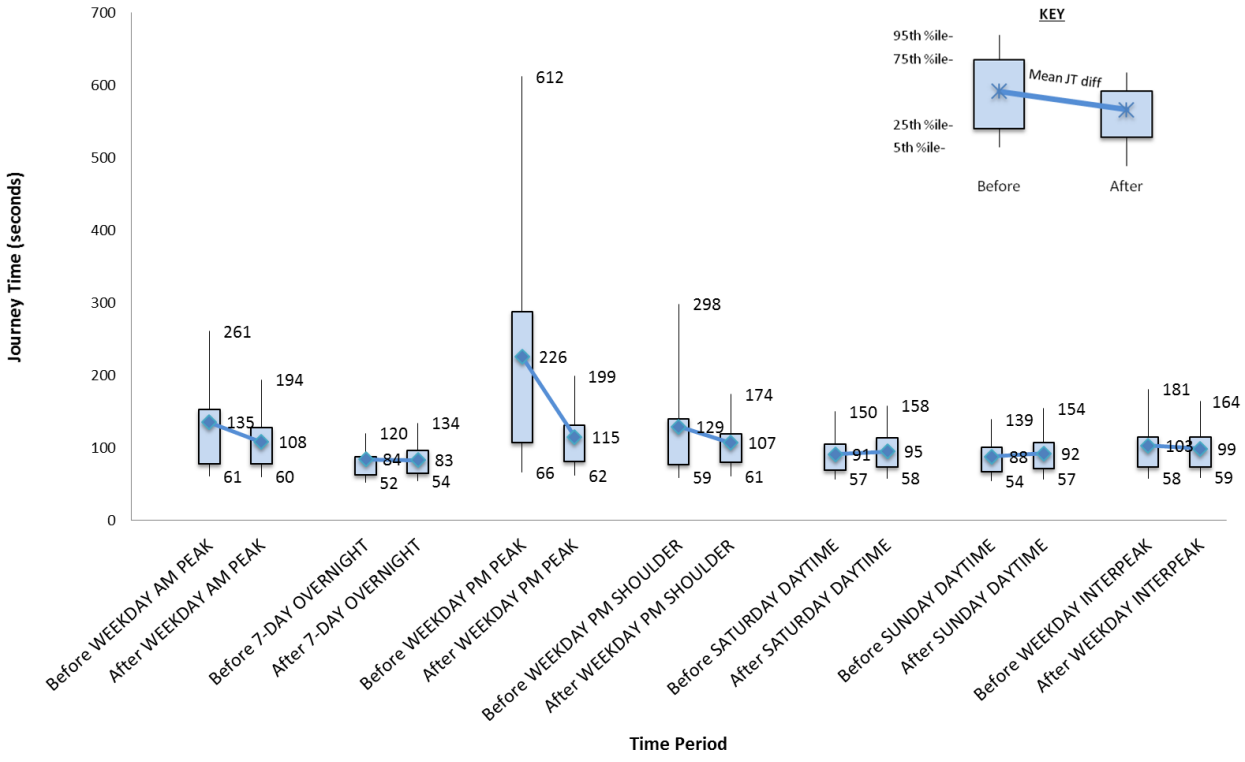
Arm References (see plan below) - 1 – M18 North; 2 – A631 West; 3 – M18 South; 4 – A631 East

Note: The average value is a simple average, and is not weighted by volume of traffic

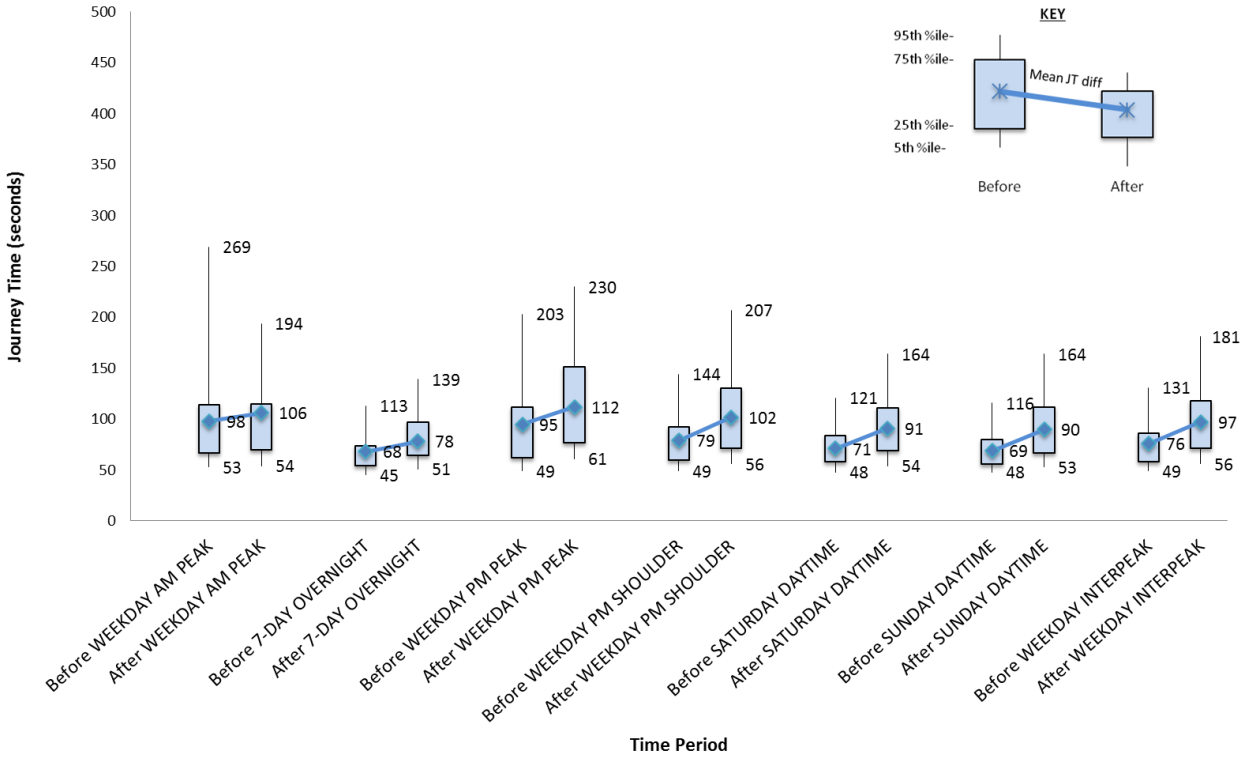


Appendix C. Journey Time Reliability Comparison Graphs

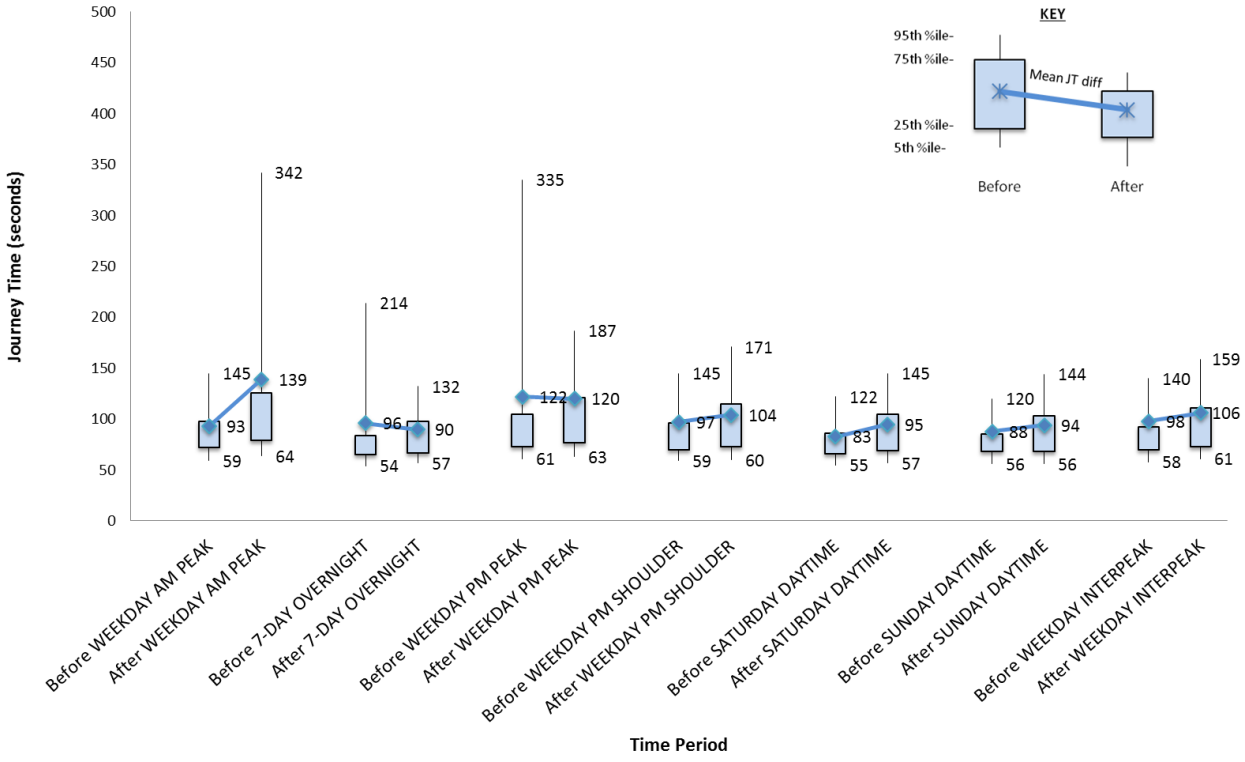
M18 North to A631 West



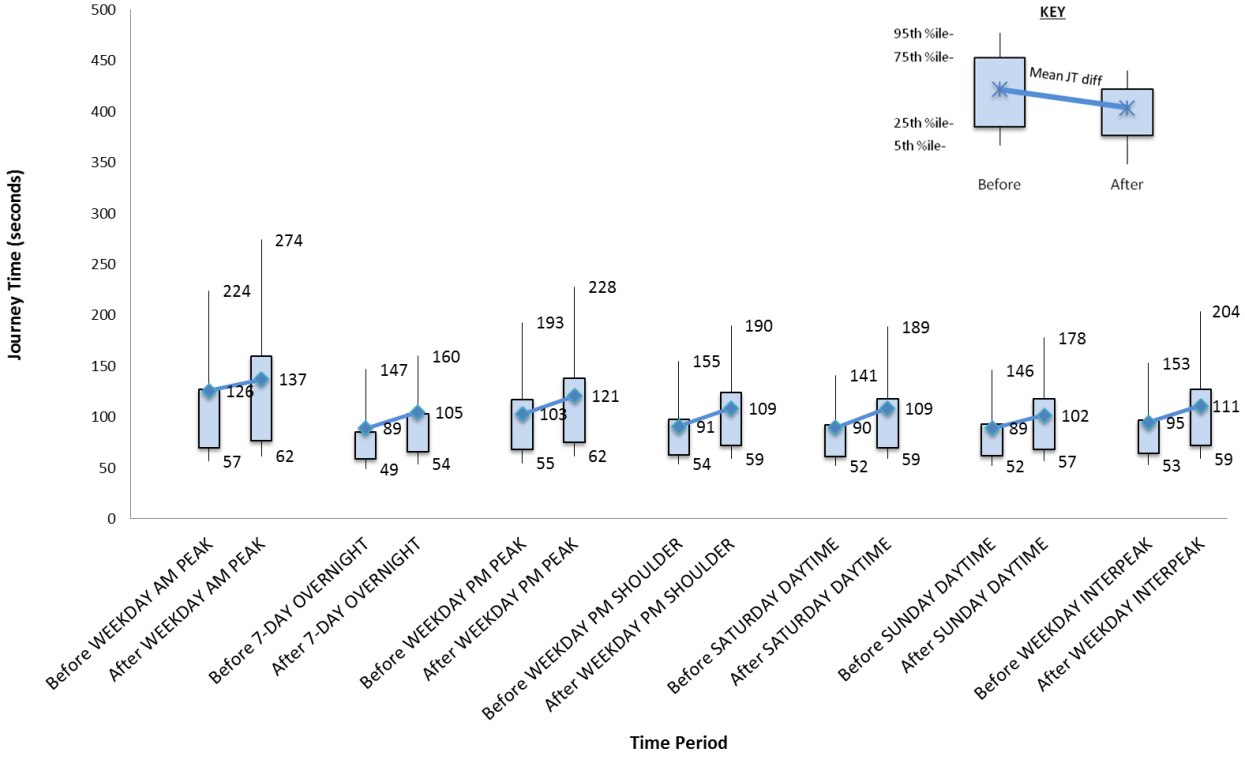
A631 East to M18 North



M18 South to A631 East



A631 West to M18 North



Appendix D. Arm-to-Arm Annual Vehicle Hour Changes

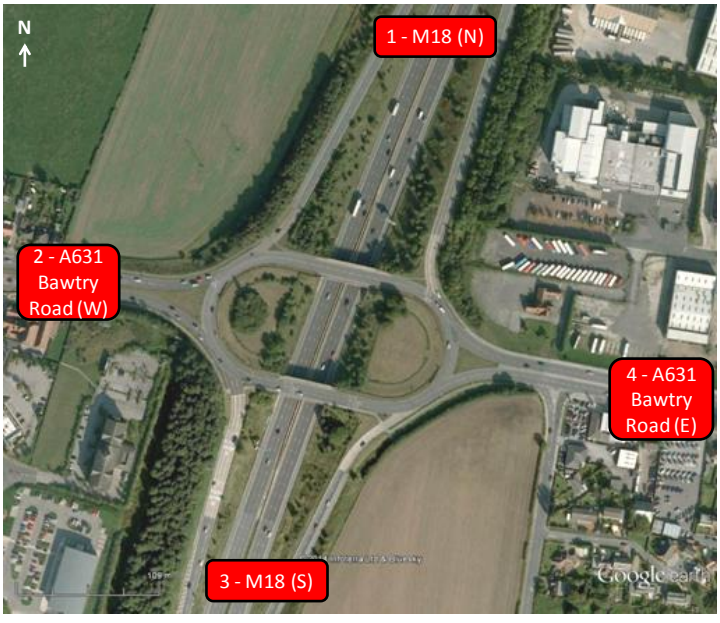
Annual Vehicle Hour Changes by Arm-to-Arm Movement

Arm	Weekday AM Peak	Weekday Interpeak	Weekday PM Shoulder	Weekday PM Peak	7-Day Overnight	Saturday Daytime	Sunday Daytime	Total
1-1								**0**
1-2	-928		-1,230	-1,835				**-3,992**
1-3	-6		-3	-3				**-12**
1-4	-883	-429	-1,461	-1,703				**-4,477**
2-1			1,252	210		754		**2,216**
2-2								**0**
2-3		808	2,209	497	207	1,984	139	**5,844**
2-4		1,267	4,321			3,341	238	**9,167**
3-1								**0**
3-2	1157							**1,157**
3-3								**0**
3-4	3,880					2,025		**5,905**
4-1	368	238	910	256	167	983	32	**2,954**
4-2								**0**
4-3				522	374			**896**
4-4								**0**
Total	**3,588**	**1,884**	**5,999**	**-2,056**	**748**	**9,086**	**409**	**19,658**

Arm References (see plan below) - 1 – M18 North; 2 – A631 West; 3 – M18 South; 4 – A631 East

Negative values indicate a journey time saving and hence a benefit. These are highlighted in Green.

Positive values indicate an increase in journey time and hence a dis-benefit. These are highlighted in Blue.



As detailed in Chapter 5, Table 4.2 shows journey time differences on every movement and every time period, but in reality, some of the small changes may be due to sampling errors or if true, may be unperceivable.

As a result, only journey time changes in excess of 10 seconds (positive or negative) are considered when calculating the annual vehicle hours saved.

Due to this, certain movements in the table above show zero change annual vehicle hours.

Appendix E. Appraisal Summary Table (AST)

	Sub-Objective	Key Points	Metrics	Assessment
ECONOMY	TEE (Business and Commuting Users)	N/A	Total hours saved (Business and Commuting Users) = Unknown	Travel Time & VOC PVB = £45.693M (Net of developer contributions)
	Reliability (Business and Commuting Users)	The benefits are the result of an increase in the capacity of oversaturated traffic lanes and a reduction in accidents.	Not applicable	Large Beneficial
	Regeneration	Not applicable	Not applicable	Not applicable
	Journey Quality	Not applicable	Not applicable	Not applicable
	Wider Impacts	Not applicable	Not applicable	Not applicable
ENVIRONMENT	Noise	Not applicable	Not applicable	Not applicable
	Air Quality	Not applicable	Not applicable	Not applicable
	Greenhouse gases	Not applicable	Not applicable	Not applicable
	Landscape	Not applicable	Not applicable	Not applicable
	Townscape	Not applicable	Not applicable	Not applicable
	Heritage of Historic Resources	Not applicable	Not applicable	Not applicable
	Biodiversity	Not applicable	Not applicable	Not applicable
	Water Environment	Not applicable	Not applicable	Not applicable
SOCIETY	TEE (Other users)	N/A	Total hours saved (Other Users) = Unknown	Travel Time & VOC PVB = £31.584M
	Reliability (Other Users)	The benefits are the result of an increase in the capacity of oversaturated traffic lanes and a reduction in accidents.	Not applicable	Large Beneficial
	Physical Activity	Not applicable	Not applicable	Not applicable
	Accidents	Refer to LNMS Study	189 accidents saved.	Accidents PVB = £6.800M
	Security	Not applicable	Not applicable	Not applicable
	Access to Services	Not applicable	Not applicable	Not applicable
	Affordability	Not applicable	Not applicable	Not applicable
	Severance	Not applicable	Not applicable	Not applicable
	Option Values	Not applicable	Not applicable	Not applicable
PUBLIC ACCOUNTS	Transport Budget	No special considerations	Investment Cost PVC = £0.699M Operating Cost PVC = £0.000M	Total Cost PVC = £0.699M
	Wider Public Finances	No special considerations	Tax Benefit PVB = £0.000M	Tax Benefit PVB = £0.000M

Appendix F. Evaluation Summary Table (EST)

	Sub-Objective	Key Points	Metrics	Assessment
ECONOMY	TEE (Business and Commuting Users)	N/A	Total hours saved (Business and Commuting Users) = Unknown	Net journey time increases across the scheme life = -£3.2M
	Reliability (Business and Commuting Users)	IRV - the assessment is the result of the large reduction in accidents DDV - The adverse impact is as a result of an increase in overall journey times across the year	-	IRV - Large Beneficial, DDV - Slight Adverse
	Regeneration	Not applicable as set out in the PAR 6 TAME ACO Guidance Note	-	Not applicable
	Wider Impacts	Not applicable as set out in the PAR 6 TAME ACO Guidance Note	-	Not applicable
ENVIRONMENT	Noise	Based on a lack of change in traffic volumes, it is considered that the changes in noise are not significant	-	Neutral
	Air Quality	There are no properties within 50m of the scheme	-	Neutral
	Greenhouse gases	No change in the total distance travelled by traffic due to this scheme	-	Neutral
	Landscape	The new signal equipment has an adverse impact on landscape in this location	-	Slight Adverse
	Townscape	Not applicable as the scheme is situated in a rural area	-	Not applicable
	Heritage of Historic Resources	Scheme does not impact on any archaeological or heritage site	-	Neutral
	Biodiversity	Scheme does not impact on biodiversity	-	Neutral
	Water Environment	Scheme does not impact on water environment	-	Neutral
SOCIETY	TEE (Other users)	N/A	Total hours saved (Other Users) = Unknown	Net journey time increases across the scheme life = -£3.2M
	Reliability (Other Users)	IRV - the assessment is the result of the large reduction in accidents, DDV - The adverse impact is as a result of an increase in overall journey times across the year	-	IRV - Large Beneficial, DDV - Slight Adverse
	Physical Activity	The improved crossings are likely to have reduced the barriers to activity	-	Slight Beneficial
	Journey Quality	New lane designation markings have reduced route uncertainty and signalisation has reduced the fear of potential accidents (+2). However the new signals may have increased driver frustration for some movements and times (-1)	-	Slight Beneficial
	Accidents	The benefits are the result of a reduction in accidents.	413 accidents saved.	Accidents PVB = £14.8m
	Security	Scheme does not impact on security	-	Neutral
	Access to Services	Not applicable, as set out in the PAR Standard Impact Assessment page	-	Not applicable
	Affordability	Scheme does not impact on Affordability	-	Neutral
	Severance	The new crossings have reduced severance at the junction	-	Slight Beneficial
	Option Values	Not applicable, as set out in the PAR Standard Impact Assessment page	-	Not applicable
PUBLIC ACCOUNTS	Transport Budget	PVC calculated within evaluation	Outturn Investment Cost = £0.803M, Operating Cost = £0.00M	Outturn PVC = £0.803M
	Wider Public Finances	PVB for wider finances not calculated within evaluation	-	Not assessed