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A630 Thrybergh Key Route – Mushroom Roundabout Improvement Option Analysis

South Yorkshire Passenger Transport Executive

May 2010

SOUTH YORKSHIRE PASSENGER TRANSPORT EXECUTIVE

Rotherham Metropolitan Borough Council

WSP

QM

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1 Introduction

1.1 BACKGROUND

1.1.1 WSP UK Ltd (WSP) has been commissioned by South Yorkshire Passenger Transport Executive (SYPTE) to undertake a Study of Mushroom Roundabout on the A630 Key Route in Rotherham.

1.1.2 The Study focuses on improving the flow of traffic to reduce congestion and the subsequent delay currently experienced on the approaches to Mushroom Roundabout, whilst also considering potential improvements to existing pedestrian and cycle movements.

1.1.3 The preferred solution resulting from option analysis of the Mushroom Roundabout Study will contribute to a wider focus of potential improvements on the A630 Thrybergh Corridor, seeking to improve journey time reliability for public transport and reduce overall journey times.

1.1.4 The A630 Thrybergh Corridor is one of over 50 key routes identified in the overall Local Transport Plan strategy as providing important links to support economic and social development.

1.1.5 Mushroom roundabout is one of three key junctions on the A630 Thrybergh Corridor which contribute to journey time delay and reliability issues. The roundabout has been highlighted by bus operators as the main cause of congestion on the key route and by RMBC as the number one hotspot in the congestion reduction plan. The two other junctions are:

- St Ann's Roundabout – junction between A630 and A633; and
- Oldgate Lane junction with A630.

1.1.6 As highlighted in the Client Brief, there are a number of potential future external factors which may impact on Mushroom Roundabout, these are outlined below:

- Potential Parkgate Retail Park extension;
- Development of Corus site; and
- Aspirations for an outer ring road.

1.1.7 Although the above are key factors, given the uncertainty over the timescales and impact on the junction they are excluded from this Study.

1.2 SITE LOCATION

1.2.1 Located approximately 1.5 miles to the east of Rotherham Town Centre, the A630 forms a junction with A6123 at Mushroom Roundabout. The Roundabout is a four arm priority junction providing for all movements between Aldwarke Lane, Doncaster Road, Herringthorpe Valley Road and Fitzwilliam Road. The A630 provides a strategic east-west road route between Sheffield, Rotherham and Doncaster and is a primary route for traffic within Rotherham and beyond.

1.2.2 A site location plan is provided as Figure A1 of Appendix A to this report.

1.2.3 Mushroom Roundabout has been identified by the Local Highway Authority as a site of concern for the accessibility and safe movement of pedestrians and cyclists. It is also considered an area of significant congestion within the local network for all vehicles, particularly public transport. A specific issue is noted of evening peak congestion at the entrance to the outbound Fitzwilliam Road bus lane.

1.2.4 There is a mix of residential, retail and commercial land use surrounding the junction. This results in a high demand for safe pedestrian and cycle facilities, of which there is currently limited provision at the junction.

1.2.5 Toucan Crossings are located approximately 100 metres from the roundabout on both Herringthorpe Valley Road and Doncaster Road, and there is a pedestrian subway under Fitzwilliam Road. Aldwarke Lane currently has no formal pedestrian or cycle crossing facilities.

1.2.6 For bus users arriving from the west to access the Supermarket, the current options available are to alight on Fitzwilliam Road and cross uncontrolled over the Aldwarke Lane arm or use the subway and formal crossing facilities of Herringthorpe Valley Road and Doncaster Road; or to alight on Doncaster Road at the stop located 350m after Mushroom Roundabout and return.

1.3 SOUTH YORKSHIRE POLICY OBJECTIVES

1.3.1 The second Local Transport Plan for South Yorkshire (LTP2) has been produced as a joint plan by the four Councils in South Yorkshire and the Passenger Transport Authority (PTA). The document identifies a new Transport Strategy and Action Plan for the 5 year period (2006/7 – 20010/11) and defines the longer term vision for transport in supporting the aspirations for transformational economic growth in the sub-region.

1.3.2 In 2002 the Government and Local Government Association (LGA) agreed a set of seven Shared Priorities for Local Government that would form the basis for improving public services. There are four Shared Priorities, now considered by Department for Transport (DfT) to have been replaced by DaSTS (Delivering a Sustainable Transport System), for transport that forms the basis of the LTP's transport strategy. The identified priorities are:-

- Congestion;
- Accessibility;
- Road Safety; and
- Air Quality.

1.3.3 The introduction of successful economic policies, particularly arising from the infusion of European Regional Development Fund (ERDF) Objective 1 has led to higher levels of economic activity and car ownership in the region. As traffic volumes have increased, over the same period the dominant public transport mode, the bus, has experienced patronage decline.

1.3.4 In view of the above a South Yorkshire Congestion Strategy was developed in support of the South Yorkshire Vision. The Strategy recognises the need to stem the current level of private car use by addressing the issues of delay and congestion within South Yorkshire, particularly on the Key Route Network.

1.3.5 The Key Route Network is an integral component of the overall LTP2 Strategy, with over 50 routes having been identified that provide important links in supporting economic and social development. The Key Route Network was derived from the main arterial routes of accessibility between the principal urban centres of South Yorkshire. These arterial routes also connect to other centres external to the County.

1.3.6 The primary focus of the Strategy is to reduce congestion by encouraging increased levels of patronage to public transport through improvement of the core services and by enhancing the performance of the existing highway network through introduction of active management techniques, specifically the use of UTMC (Urban Traffic Management and Control) systems.

1.3.7 LTP2 forecasts predict that even with interventions car ownership and use is predicted to rise, resulting in increased congestion on the Key Routes. The Key Routes are integral to the delivery of the South Yorkshire LTP2 Strategy to deliver improvements in each Shared Priority area. Congestion will be addressed as follows:-

- Improved operating conditions for bus operators;
- Tackling delays and unpredictable journey times on Key Routes and improving the balance between competing demands of different road users;
- Achieving modal shift from the private car by promoting public transport services;
- Managing demand and reducing the need to travel through integrated transport, land use and parking policies;
- Provide new infrastructure or facilities to enhance network performance but lock-in the benefits for public transport users; and
- Development of a freight strategy.

1.3.8 It is acknowledged that resources available over the remaining LTP2 period are limited, however, utilising the Key Route Network as a focus for prioritisation will maximise the benefits of further investment.

1.3.9 The targets identified in LTP2 were set on the basis that no additional funding would be made available to South Yorkshire for new major schemes, as directed by DfT. However, SYPTE has significant aspirations to deliver infrastructure and facilities improvements through the major scheme program that will contribute to the targets of LTP2.

1.3.10 This project relates specifically to a review of the existing operation of Mushroom Roundabout and focuses on identifying a solution to provide increased provision for pedestrians and cyclists whilst also delivering journey time reliability and savings for all modes of transport.

1.4 REPORT STRUCTURE

1.4.1 The following Report will be structured as detailed below:

- Micro-Simulation Base Model;
- Initial Option Identification and Modelling
- Option Development
- Final Option Analysis;
- Sensitivity Testing; and
- Recommendations and Way Forward.

2 Micro-Simulation Base Model

2.1 INTRODUCTION

2.1.1 On behalf of SYPTE a Paramics model has previously been developed by WSP to assess the A630 Thrybergh Corridor. The Paramics model was constructed to assess the impact of background traffic growth and scheme proposals on bus journey times.

2.1.2 Agreement was reached from SYPTE and Rotherham MBC (RMBC) in terms of the validity of the previous Paramics model being fit for purpose to assess the proposed improvements at Mushroom Roundabout, as identified in this Study.

2.2 MODEL DESCRIPTION

S-Paramics Micro-Simulation Modelling Software

2.2.1 Paramics is a micro-simulation modelling package that simulates the individual components of traffic flow and congestion, presenting its output as a real time visual display in addition to statistical output.

2.2.2 As well as the physical description of the road network, other driver features such as bus operations, traffic signal settings, driver behaviour characteristics such as aggression, and vehicle kinematics such as acceleration profiles are all represented. Through combination of these factors a model can be produced which gives an accurate representation of the variable circumstances that face drivers on the network.

2.2.3 In addition, the use of statistical distributions enables the user to model and replicate variances in day to day travel and to assess the significance of this variance to assist in decision making.

2.2.4 The Paramics software suite also contains a matrix estimation module, which was used for this corridor model. The trip matrix was constructed from traffic counts and surveys, queue surveys, visual inspection of the network and finally matrix estimation.

2.2.5 The model was calibrated to queue length surveys and validated against turning counts and journey time surveys.

Modelled Network

2.2.6 The Paramics model consists of a number of junctions along the A630 Corridor, from the signalised junction formed between the A630 and the A6021 Centenary Way flyover to the west and the priority junction formed between the A630 and Park Lane to the east.

2.2.7 The area outlined by the Paramics model cordon is illustrated on Figure A2 of Appendix A to this report.

2.2.8 A screenshot of the Paramics model is provided as Figure A3 of Appendix A.

2.2.9 The model was developed to contain morning and evening peak periods. The morning peak period is modelled by the time period 07:00 – 10:00 hrs with 08:00 – 09:00 hrs representing the peak hour. The evening peak period is modelled by time period 16:00 – 19:00 hrs with 17:00 – 18:00 hrs representing the peak hour.

2.3 EXISTING SITUATION

Degree of Congestion

2.3.1 Under its current design Mushroom Roundabout operates reasonably well during the morning peak period. All approaches see maximum queue lengths in the region of 40 – 80 meters throughout the three hour peak period (07:00 – 10:00 hrs).

2.3.2 The evening peak period (16:00 – 19:00 hrs) sees more variation in maximum queue length by approach. Doncaster Road and Herringthorpe Valley Road see queue lengths in the region of 50 – 90 meters and 30 – 70 meters respectively, a similar level to that experienced in the morning peak period.

2.3.3 Fitzwilliam Road sees a maximum queue length of approximately 400 meters between 16:45 and 18:15 hrs. This level of delay impacts significantly on the reliability of buses on the A630 corridor as a queue of 400 meters in length restricts access to the outbound (eastbound) bus lane on the approach to the roundabout.

2.3.4 Aldwarke Lane sees the most significant level of queuing in the evening peak period with a maximum queue length in the region of 500 meters being sustained throughout the modelled period.

2.3.5 A key contributing factor to the delay on both Fitzwilliam Road and Aldwarke Lane is the ability for vehicles to enter the roundabout as a direct result of insufficient gaps being available in the circulating traffic flow.

Existing Bus Services

2.3.6 There are currently three services which operate with a frequency of 15 minutes or better through the junction. These are:

- X78: Doncaster – Sheffield;
- 15: Rotherham – East Herringthorpe Circular; and
- 37: Rotherham – Thrybergh.

2.3.7 Further services operate less frequently. These are:

- 4: Rotherham – Ravenfield; and
- 11: Rotherham – East Dene.

2.3.8 In total there are 19 services per hour passing through the junction during Monday to Friday daytime. All services currently see journey time reliability issues which can partly be attributed to delay experienced approaching Mushroom roundabout.

3 Initial Option Identification and Modelling

3.1 SCOPING OF INITIAL OPTIONS

3.1.1 Following discussions between SYPTE, RMBC and the public transport operators First Group, WSP was issued with a brief outlining eight options to improve the flow of traffic around Mushroom Roundabout requiring modelling. These options were:

- Option 1 (a) – Metering of flow from Herringthorpe Valley Road on to Mushroom Roundabout using traffic signals;
- Option 1 (b) – Closure of the right turn from the Herringthorpe Valley Road exit from the roundabout into Doncaster Road, combined with a Toucan Crossing across Herringthorpe Valley Road;
- Option 2 – Improvements to Fitzwilliam Road including closure of the subway and replacement pedestrian crossings and extension of the bus lane towards Mushroom Roundabout;
- Option 3 – Acquisition of the land to the front of a property on the inbound Doncaster Road approach to Mushroom Roundabout, to allow carriageway widening to benefit the outbound traffic movement;
- Option 4 (a) – Full signalisation of Mushroom Roundabout;
- Option 4 (b) – Full signalisation of Mushroom Roundabout with pedestrian crossing facilities across the centre of the roundabout or should it prove more beneficial, across the arms of the junction;
- Option 5 (a) – Change lane destinations on exit to Doncaster Road to allow nearside lane to be left only into ASDA or a left lane for ASDA and buses; and
- Option 5 (b) – Change lane destinations on exit to Doncaster Road to allow nearside lane to be left only into ASDA or a left lane for ASDA and buses. In addition, change lane markings on eastern circulatory carriageway to allow three lanes.

3.1.2 RMBC supplied WSP with scheme drawings for each of the options listed above to enable option testing models to be developed in Paramics.

3.1.3 On the receipt of the scheme drawings WSP held discussions with SYPTE and RMBC from which it was agreed that Option 3, Option 4 (a) and Option 5 (a) and (b) should to be removed from the brief due to:

- Issues having arisen with respect to the acquisition of land required to implement Option 3;
- The need to provide pedestrian facilities in a full signalisation scheme of Option 4 (a); and
- Options 5 (a) and (b) would imbalance vehicle flows on the Fitzwilliam Road approach to Mushroom Roundabout leading to reduced capacity for the main flow of west to east traffic.

3.1.4 The short length of the internal links means the roundabout is not capable of incorporating pedestrian crossings across the centre of the roundabout without an unacceptable impact on queue space available to accommodate vehicles. Therefore the Option 4 (b) design included pedestrian crossings across the arms of the junction.

3.1.5 Following the alteration to the brief SYPTE requested that WSP model an additional option which would include the best performing option from Option 1 (a) and 1 (b) combined with Option 2.

3.2 LIMITATIONS OF DESIGN & MODELLING

3.2.1 WSP has developed option testing models in Paramics based on the designs supplied by RMBC assuming that they are suitable for use.

3.2.2 No topographical surveys have been supplied with the designs. Therefore all designs have been developed based on Ordinance Survey map bases.

3.2.3 No Lane widths have been measured on site by WSP. RMBC has advised that they are happy with the dimensions of the designs supplied.

3.2.4 RMBC has advised that AutoTrack runs have been undertaken to ensure three circulating lanes are viable on the roundabout within its current dimensions

3.2.5 Only the options agreed between SYPTE and RMBC have been modelled. Further options have been considered but not progressed to modelling stage due to assumptions being made on the suitability.

3.2.6 No statutory undertaker's plans have been supplied to WSP. RMBC have highlighted that one service may be affected at Mushroom Roundabout incurring an approximate cost of £6,000 to divert.

3.3 INITIAL MODELLING

3.3.1 Utilising the scheme drawings supplied by RMBC as overlays, the following option models were developed in Paramics:

- Option 1 (a) – Traffic Metering;
- Option 1 (b) – Toucan Crossing;
- Option 2 – Bus Lane Extension; and
- Option 4 – Full Signalisation with Fixed Time Operation.

3.3.2 Each of the options listed are discussed below in more detail including a summary of the modelled findings.

Option 1 (a) – Traffic Metering

3.3.3 A sketch of this option can be found at Figure B1 of Appendix B.

3.3.4 Option 1 (a) utilises a set of traffic signals located 20 metres from the roundabout giveway line to meter the flow of traffic from Herringthorpe Valley Road on to Mushroom Roundabout.

3.3.5 The location of the stopline for the metering signals is restricted by the junction of Herringthorpe Valley Road and old Doncaster Road. The left turn out of and right turn in to Doncaster Road combined with the need to locate the stopline at a safe distance from the roundabout, fixed the stopline at the location seen in Figure B1.

3.3.6 Modelling of Option 1 (a) indicated that the traffic signals created more suitable gaps in the traffic on the circulatory carriageway to allow vehicles on the Fitzwilliam Road approach to move out on to the roundabout thus reducing the level of queuing seen on the approach. The length of queue can be reduced such that it does not impact

on the operation of the existing bus lane on Fitzwilliam Road therefore minimising the delay experienced by buses.

3.3.7 By metering the flow of traffic on Herringthorpe Valley Road fewer gaps are available in the traffic for vehicles wishing to make the right turn in to old Doncaster Road. The existing length of right turn provision is not sufficient to cope with the queue formed; therefore the queue was seen to extend back on to the roundabout impacting on its operation. This is an intermittent issue which was mainly seen in the morning peak period.

3.3.8 Regardless of the signal timings used at the metering signals there is an increase in the level of queuing on Herringthorpe Valley Road compared to the existing situation. This is something which can not be avoided due to the nature of metering signals; the basic principle being to distribute overall delay to an alternative location to benefit another.

3.3.9 To balance the queues in line with objectives, the signal timings can be varied. We have modelled a balanced situation leading to queues on Fitzwilliam Road just shorter than the bus lane and queues on Herringthorpe Valley Road extending, at worst, slightly beyond Mowbray Street

Option 1 (a) – Conclusions

3.3.10 This option provides an effective solution to reducing the queuing experienced on Fitzwilliam Road. The metering of traffic on Herringthorpe Valley Road creates sufficient gaps in the traffic on the circulatory carriageway for traffic waiting on Fitzwilliam Road to enter the roundabout. The queuing predicted on Fitzwilliam Road could potentially delay buses if general traffic is higher than that modelled, as the queue is almost as long as the bus lane.

3.3.11 The close spacing of the traffic signals and the roundabout giveway leads to a potential safety concern as drivers may incorrectly perceive that the signals also indicate that they can enter the roundabout without giving way to circulating traffic. In general, to mitigate this risk, metering stop lines would be set further from the roundabout and signals would only operate at busy times of day. Due to the proximity of the Doncaster Road junction, there is extremely limited scope to vary the position of the stop line.

3.3.12 If this solution were adopted, we recommend the metering signals should operate in the evening peak period only. This would then deliver the benefits from metering traffic in the evening peak when it is needed to reduce queuing seen on Fitzwilliam Road but it would not cause unnecessary delay to vehicles on Herringthorpe Valley Road at other times. Appropriately targeted part time operation reduces the risk that drivers may believe the signals give them priority to enter the roundabout. This safety issue cannot be replicated in the model and needs careful consideration.

3.3.13 There is the potential to utilise queue detection on Fitzwilliam Road to adjust signal timings to minimise overall delay and manage queues in line with strategic objectives.

Option 1 (b) – Toucan Crossing

3.3.14 A sketch of this option can be found at Figure B2 of Appendix B.

3.3.15 Option 1 (b) utilises the stopline position from Option 1 (a) but further develops the method of control to include a Toucan Crossing facility across the northbound and

southbound carriageway. To accommodate the Toucan Crossing the right turn from Herringthorpe Valley Road in to Doncaster Road must be closed.

3.3.16 The closure of the right turn in to Doncaster Road from Herringthorpe Valley Road requires the re-routing of vehicles wishing to gain access to the Doncaster Road area. It is not a feasible option to send all vehicles down Herringthorpe Valley Road to make a right turn in to Mowbray Street, nor is it sensible to allow U-turns on Herringthorpe Valley Road. Therefore it was considered most suitable to route vehicles along Fitzwilliam Road to make a left turn in to Mowbray Street.

3.3.17 To ensure the Mowbray Street junction with Fitzwilliam Road is suitable for use by all vehicles it will require improvement to accommodate the larger vehicles including buses.

3.3.18 Some initial assumptions were made by RMBC regarding the level of traffic reassignment expected due to the closure of the right turn in to Doncaster Road. Modelling with these assumptions showed an adverse affect on the operation of St Ann's roundabout due to the increase in number of vehicles arriving at the roundabout on Fitzwilliam Road.

3.3.19 The impact modelled at St Ann's prompted RMBC to commission a number plate survey to capture the current level of use and destinations of the vehicles travelling on Doncaster Road. The results of the number plate survey suggested that a high percentage (approximately 70%) of the traffic accessing Doncaster Road has a final destination within the Doncaster Road area and would therefore not reassign to Fitzwilliam Road to make their journey.

3.3.20 Using the findings of the number plate survey Option 1 (b) was remodelled with the impact at St Ann's roundabout being removed, and following the changes queues were observed at a similar level to existing.

3.3.21 The interaction of the Toucan Crossing on Herringthorpe Valley Road and the junction with Doncaster Road caused significant issues in the modelling carried out.

3.3.22 The Toucan Crossing causes delay for vehicles on Herringthorpe Valley Road which queue across the priority junction with Doncaster Road. Due to the vehicles on the main road having priority, the vehicles on Doncaster Road have insufficient gaps to exit the junction. The inability to gain access to Herringthorpe Valley Road results in a excessive queue forming on Doncaster Road extending back to, and through, the roundabout formed at the junction with Mowbray Street.

3.3.23 The queue on Herringthorpe Valley Road is exacerbated by both the operation of the Toucan Crossing and the difficulties in entering Mushroom Roundabout once vehicles are through the crossing.

3.3.24 As mentioned above the closure of the right turn in to Doncaster Road requires the diverting of vehicles along Fitzwilliam Road to Mowbray Street. The resulting queue on Herringthorpe Valley Road caused by the Toucan Crossing restricts the ability for the re-routing vehicles to access the Mowbray Street roundabout. This conflict quickly creates a delay of its own resulting in a queue extending from Mowbray Street on to Fitzwilliam Road.

3.3.25 Alternative signal timings for the Toucan Crossing were tested by varying the green time for the traffic phase. None of the options tested removed the problems highlighted by the modelling.

Option 1 (b) – Conclusions

3.3.26 The modelling undertaken illustrates that this option has no material benefit in terms of the practical performance of Mushroom Roundabout. Congestion is experienced during the peak periods irrespective of signal plans utilised for the Toucan Crossing. However there is scope for the option to be developed to a workable solution by reviewing the lane destinations on the Herringthorpe Valley Road approach to the roundabout as described later in this report.

3.3.27 As with Option 1 (a), the close spacing of the Toucan Crossing and the roundabout giveway leads to a potential safety concern as drivers may incorrectly perceive that the signals also indicate that they can enter the roundabout without giving way to circulating traffic.

3.3.28 In addition to this, if there is insufficient pedestrian demand for the Toucan Crossing, to make it effective as a metering system, then artificial demand would have to be generated.

Option 2 – Fitzwilliam Road Bus Lane Extension

3.3.29 A sketch of this option can be found at Figure B3 of Appendix B.

3.3.30 This option extends the existing bus lane towards Mushroom Roundabout allowing buses to gain a further advantage over queuing traffic. It also includes the removal of the existing subway with the provision of staggered Toucan Crossings across the bus lane and eastbound and westbound carriageways in its place, providing a more attractive facility for pedestrians and cyclists.

3.3.31 To provided greater benefits to buses the stop located within the bus lane has been relocated to maximise the opportunity for earlier detection on the approach to the signals.

Option 2 – Conclusions

3.3.32 This option clearly delivers benefits to pedestrians in terms of increased perception of personal safety through crossing provision. The model also indicates an additional slight benefit to buses due to the extension of the bus lane through a reduction in time for buses to access the roundabout from the bus lane.

3.3.33 However, this option in isolation does little to alleviate the queuing witnessed on Fitzwilliam Road. Hence, as buses are delayed prior to entering the bus lane, the overall benefits to buses are minimal.

Option 4 – Full Signalisation with Fixed Time Control

3.3.34 A sketch of this option can be found at Figure B4 of Appendix B.

3.3.35 In the scheme design supplied by RMBC they have indicated that the current roundabout alignment can accommodate three circulating lanes with minor widening on the north east corner only. Hence the inclusion of three circulating lanes in the scheme designs.

3.3.36 For Option 4 to be viable it requires three circulating lanes on each internal link within the roundabout. RMBC has advised that swept path analysis has been carried out on this layout to confirm the suitability of the scheme. The exact scope of works required to the roundabout would need to be considered if the scheme is progressed to detailed design stage.

3.3.37 Option 4 provides full signalisation of Mushroom roundabout incorporating pedestrian crossings across the entry and exits of the Aldwarke Lane and Herringthorpe Valley Road approaches. To facilitate the pedestrian crossing on Aldwarke Lane Option 4 requires the closure of the right turn from Herringthorpe Valley Road as in Option 1 (b).

3.3.38 Option 4 also includes all aspects of Option 2 detailed and discussed above. This provides pedestrian facilities on three of the four arms of the roundabout with an existing Toucan Crossing located approximately 100m to the east on Doncaster Road.

3.3.39 The full signalisation scheme was initially developed and modelled in Linsig Version 3 collaboratively between RMBC and WSP to gain a suitable set of initial timings for inclusion in the Paramics model.

3.3.40 The Linsig analysis predicted that the scheme should provide adequate capacity, although the junction would be sensitive to small changes in either demand or signal timings due to the short internal links on the roundabout.

3.3.41 The Paramics modelling showed the full signalisation to operate well during the morning peak period with the internal links being cleared of vehicle queues in each cycle.

3.3.42 In the evening peak the interaction between the pedestrian crossing on Doncaster Road and the signalised roundabout creates operational issues. This was due to vehicle behaviour on the exit of the roundabout on to Doncaster Road. Vehicles generally use one lane only to exit the roundabout due to the issues caused by the merge from two lanes to one directly after the pedestrian crossing.

3.3.43 The Linsig model utilised two full lanes on the Doncaster Road exit from the roundabout towards the pedestrian crossing. This however is contradicted by the observations made on existing traffic movements. Due to the merge to one lane which is located directly after the pedestrian crossing on the crest of the road, vehicles exit the roundabout mostly using one lane only so to avoid having to merge further along Doncaster Road.

3.3.44 This effective reduction in lanes to a single lane, replicated in the Paramics model causes queuing traffic blocking back from the crossing, quickly impacting on the operation of the roundabout.

3.3.45 As in Option 1 (b), the closure of the right turn in to old Doncaster Road from Herringthorpe Valley Road requires the re-routing of vehicles wishing to gain access to the Doncaster Road area. To ensure the Mowbray Street junction with Fitzwilliam Road is suitable for use by all vehicles it will require amendment to the existing kerb line to facilitate the movements of large vehicles.

3.3.46 Again, as for Option 1 (b) the same initial assumptions regarding the level of reassignment were made with the same impact of increased queues witnessed at St Ann's roundabout. The findings of the number plate survey were modelled with the impact at St Ann's roundabout being removed, and queuing levels then being observed at a similar level to existing.

Option 4 – Conclusions

3.3.47 When implementing on site observations within the model it became apparent that the pedestrian crossing on Doncaster Road is a substantial constraint to optimum network performance when considering a full signalisation scheme for Mushroom Roundabout.

3.3.48 The additional demand reaching the crossing as a result of the improvement of the roundabout causes the traffic capacity of the crossing to be exceeded. Therefore any scheme to fully signalise Mushroom Roundabout would require further consideration on the location of the existing Toucan Crossing to ensure efficient operation of both the crossing and the roundabout.

3.4 SUMMARY OF INITIAL MODELLING AND AGREED NEXT STEPS

3.4.1 From the initial modelling carried out Option 1 (a) was identified as a viable option in terms of its operational performance and controlling the level of delay experience for vehicles on Fitzwilliam Road.

3.4.2 However, due to the safety concerns surrounding the design of Option 1 (a) for both pedestrians and vehicles it was agreed with SYPTE and RMBC that WSP would further develop Option 1 (b) in a bid to improve its performance as it was perceived as providing improved safety over Option 1 (a).

3.4.3 The full signalisation of Mushroom Roundabout in Option 4 provides a suitable solution in the morning peak but the interaction between the remote Toucan Crossing on Doncaster Road and the signalised roundabout leads to extensive queues to building rapidly in the evening peak.

3.4.4 WSP carried out an additional site visit with RMBC to observe the interaction of the existing Toucan Crossing on Doncaster Road and the uncontrolled Mushroom Roundabout. Following the site visit was agreed that an amended full traffic signal control option, incorporating improved pedestrian facilities would be developed and tested in Linsig and Paramics by WSP. This option is described and discussed in the following chapter.

4 Option Development

4.1 OPTION DEVELOPMENT

Option 1 (b) – Toucan Crossing and reassigned lane destinations on Herringthorpe Valley Road

4.1.1 A sketch of this option can be found as Figure C1 of Appendix C.

4.1.2 Having modelled the initial option and evaluated the reasons for its failure to deliver a viable solution it became apparent that there was scope to further develop Option 1 (b) to ensure it delivered the required benefits for all users.

4.1.3 In the initial option the lane destinations on Herringthorpe Valley Road did not make optimum use of the road space available. The number of left turning vehicles from Herringthorpe Valley Road is low, hence having a dedicated left turn lane is considered inefficient in terms of capacity.

4.1.4 Altering the lane destinations on the approach to the Mushroom Roundabout to promote left and ahead movements from lane one, ahead and right from lane two and right only from lane three increases the capacity of the approach without the need for additional widening of the carriageway.

4.1.5 The alteration of lane destinations on the approach to the roundabout requires the roundabout to be converted to three circulating lanes. As previously discussed for Option 4 it has been demonstrated by RMBC that the roundabout can accommodate three circulating lanes within its existing alignment.

Option 1 (b) – Conclusions

4.1.6 The Paramics modelling indicates that the additional capacity created at the roundabout stopline allows a clear benefit to be given to the queuing on Fitzwilliam Road without adversely affecting vehicles on Herringthorpe Valley Road or Doncaster Road.

4.1.7 In addition to this, the Toucan Crossing is modelled to simulate a demand every cycle so to ensure a ‘worst case’ scenario for Herringthorpe Valley Road is shown.

4.1.8 The level of pedestrian demand will impact on the success of this option in reducing queues on Fitzwilliam Road unless it is decided to incorporate a mechanism for artificially demanding the crossing phase on Herringthorpe Valley Road to create sufficient gaps in the circulatory traffic for vehicles on Fitzwilliam Road to move out in to.

4.1.9 The close proximity of the stop and give way lines and using artificial demand to call the pedestrian phase on the crossing leads to safety concerns. If vehicles are held at a crossing point with no pedestrians crossing the road then there is a risk that drivers will assume the signals control the roundabout entry and therefore fail to give way.

4.1.10 This option does not address the issue of excessive queuing on Aldwarke Lane although it does not exacerbate the existing queuing.

Option 4 – Relocated Toucan Crossing on Doncaster Road and provision of pedestrian crossing at Mushroom roundabout

4.1.11 A sketch of this option can be found as Figure C2 of Appendix C.

4.1.12 Based on the findings from the full signalisation scheme and site observations this option relocates the existing Toucan Crossings on Doncaster Road to a point 120 meters to the east at the site of an existing pedestrian refuge. This location follows the merge from two lanes and therefore ensures more efficient lane usage on the exit of the roundabout.

4.1.13 To ensure sufficient provision for pedestrians there is also a staggered crossing incorporated in to the Doncaster Road arm of the roundabout. Provision of two separate crossings is considered appropriate to meet the pedestrian desire lines observed.

4.1.14 Having modelled both MOVA and fixed cycle control for the crossing it is the recommendation of WSP that the relocated Toucan Crossing be operated on MOVA (Microprocessor Optimised Vehicle Actuation) control. This will deliver the optimum performance for all users by allowing more responsive changes when a pedestrian demand is placed under uncongested conditions, and also extending green time for all traffic when needed to help avoid congestion and prevent any significant and sustained vehicle queues. MOVA control of the crossing is included in the final model, even when the roundabout is modelled with fixed time plans.

4.1.15 The amended design sees a significant reduction in queuing on Fitzwilliam Road compared to the existing situation. In addition to this, the reduced level of queuing that is still observed does not extend back past the start of the bus lane. This delivers an improvement for all traffic compared to the existing situation with buses still receiving a benefit over other vehicles due to the extended bus lane on Fitzwilliam Road, which is the targeted aim during the peak periods.

4.1.16 Herringthorpe Valley Road and Doncaster Road experience no significant adverse affect as a consequence of the signalisation with the added benefit of the provision of pedestrian facilities across identified desire lines.

4.1.17 As a result of fixed time signalisation being focused on prioritising the A630 Corridor, Aldwarke Lane experiences some increased delay in the current evening peak model; this is due to the signal timings used to accommodate the issues caused on the Doncaster Road exit of the roundabout.

4.1.18 There is a need to evaluate the likely level of demand for the Toucan Crossings and optimise the signal operation both at the crossing and the roundabout accordingly.

Option 4 – Conclusions

4.1.19 This amended full signalisation option demonstrates that benefits can be achieved to both traffic and pedestrians, improving journey times on the corridor in the evening peak hour compared with the base situation..

4.1.20 This option does not address the issue of excessive queuing on Aldwarke Lane.

4.2 SUMMARY OF OPTION DEVELOPMENT

4.2.1 The further modelling resulting from the development of Option 1 (b) and Option 4 delivered two potential solutions which require low and high levels of intervention.

4.2.2 These options were presented to the steering group, using video clips from the Paramics models for acceptance and agreement that the options should be progressed for option analysis.

4.2.3 Option 1 (b) will be tested in conjunction with Option 2 in an attempt to improve pedestrian facilities around the roundabout whilst improving the operation of the roundabout for vehicular traffic.

4.2.4 Although Option 4 appears to deliver benefits to general traffic and public transport in the modelled situation, a fixed time solution does not account for daily

variance in demand and traffic arrival patterns and may create delay that could be avoided by a more responsive control strategy.

4.2.5 WSP advised the steering group that it would be beneficial to develop a MOVA solution to allow more responsive control of Mushroom Roundabout and to compare the outputs of the model with fixed time operation.

4.3 FURTHER MODELLING

Option 2 + Option 1 (b) – Toucan Crossing plus Bus Lane Extension

4.3.1 The combination of Option 2 and Option 1 (b) delivers similar traffic benefits as the schemes individually. However, the increased provision of crossing facilities on Fitzwilliam Road and Herringthorpe Valley Road provides a significant benefit to pedestrians and cyclists.

4.3.2 The queue of vehicles on Fitzwilliam Road is managed such that it does not extend back past the start of the bus lane, although traffic is held at the stopline for the Toucan Crossing which allows buses to gain priority over traffic on the approach to the roundabout.

4.3.3 Queues build up on both Herringthorpe Valley Road and Doncaster Road but they clear within two cycles.

4.3.4 This option does not address the issue of excessive queuing on Aldwarke Lane although it does not exacerbate the existing queuing.

Option 4 – Full Signalisation with MOVA Control

4.3.5 Following presentation at a steering group meeting of the fixed time solution for full signalisation it was agreed that WSP would develop an additional MOVA control option to establish the benefits that could be derived.

4.3.6 Development of the MOVA control option focused on the evening peak period due to its current poor performance in the existing base model. For the purpose of the model the same MOVA datasets are used in the morning peak, which is sufficient to avoid any significant queuing or delays. Additional benefits may be derived for the morning peak period though detailed design.

4.3.7 The MOVA strategy was developed based on a two stage operation, which appeared every cycle, with the north – south movement being in Stage 1 and the east – west movement in Stage 2. Phase delays are used to ensure progression through the internal links on normal operation. This minimises the detection requirements on the short internal links and suits the overall geometry and traffic demands at the junction.

4.3.8 A third stage was created to allow bus priority on the Fitzwilliam Road approach. This stage will only operate when MOVA is in Stage 2 and a bus demands the stage change.

4.3.9 To ensure the roundabout could operate effectively a stage which runs all the circulatory links was set up to run as Stage 4, if called by queue detectors on the internal links. This is effectively a clear out stage which operates when there have been a high number of right turns through Stages 1 and 2 to ensure the internal links on the roundabout do not become congested.

4.3.10 Operating under MOVA control Mushroom Roundabout delivers a responsive solution capable of managing the level of queuing and consequently the overall delay on

all approaches. The current model has all pedestrian crossings appearing every cycle and further benefits could be obtained if crossings only appeared when demanded.

4.3.11 Aldwarke Lane sees significant benefits under MOVA control with a large reduction in queue length. This is due to the ability of MOVA to respond to a changing situation and allow appropriate levels of green time to be allocated to alleviate the delay experienced.

4.3.12 As MOVA responds to changing demands, this is achieved without disadvantaging other approaches. This contrasts with the fixed time solution which fails to clear the existing queues on Aldwarke Lane as priority is permanently given to the A630.

4.4 FINAL OPTIONS FOR ANALYSIS

4.4.1 Through the option development process and via stakeholder consultation it was agreed that the following options would be progressed forward for option analysis:

- Option 1 (a) – Traffic Metering;
- Option 2 + Option 1 (b) – Toucan Crossing plus Bus Lane Extension;
- Option 4 – Full Signalisation with Fixed Time Operation; and
- Option 4 – Full Signalisation with MOVA control.

5 Final Option Analysis

5.1 INTRODUCTION

5.1.1 The four schemes progressed for option analysis vary in the level of intervention required to deliver them. It was therefore important to establish the advantages and disadvantages from each of the schemes so to advise on the most appropriate solution to carry forward.

5.1.2 The schemes have been analysed in three ways:

- Queue Length;
- Journey Time; and
- Journey Time Reliability.

5.1.3 In addition to the numeric analysis, account is taken of the un-quantified benefits to pedestrians and cyclists from the provision of new and improved crossing facilities.

5.1.4 A final comparison of the four schemes based on the monetised benefits to be derived was carried out to establish the value for money of each scheme.

5.2 QUEUE LENGTH ANALYSIS

5.2.1 Queue length analysis was carried out for each of the four schemes and then compared to the base situation on each of the four approaches to Mushroom Roundabout in both the morning and evening peak periods.

5.2.2 The following text describes the level of queuing experienced in the option models. Graphs indicating the maximum queue length in five minute intervals through the peak periods can be found as Appendix D.

Morning Peak Period

5.2.3 All of the schemes maintain the level of queued vehicles on Fitzwilliam Road between 40 and 60 metres which is consistent with the existing situation on this approach.

5.2.4 Due to the way in which queue lengths are reported by the model, being measured from the roundabout entry and not from any stopline on the approach, it appears that fixed time operation leads to zero queues. Observation of the simulation shows that the queues are of a similar length in these periods to other within the model.

5.2.5 The two schemes which include full signalisation of Mushroom Roundabout see slightly increased levels of queuing on Aldwarke Lane over both the existing base and partial signalisation schemes. This is due to the addition of signal control creating slight delay where currently the approach is uncontrolled. The partial signal control schemes operate at a similar level to the existing base situation.

5.2.6 The Doncaster Road approach follows a similar pattern to Aldwarke Lane with the full signalisation schemes seeing a minor increase in queue length over the existing base and partial signalisation schemes. The partial signal control schemes operate at a similar level to the existing base situation.

5.2.7 All of the schemes deliver similar levels of queuing on the Herringthorpe Valley Road approach with the queue length fluctuating between 40 and 80 meters.

Evening Peak Period

5.2.8 The base model replicates a clear peak in delay on the Fitzwilliam Road approach. This is caused by the difficultly vehicles have entering the roundabout due to insufficient gaps in traffic on the circulatory carriageway.

5.2.9 Option 1 (b) + 2 delivers the largest reduction in maximum queue length, approximately 150 metres, with a flattening out of the queue profile over the peak period.

5.2.10 Fixed time operation and MOVA control reduce the current level of queuing by approximately 100 metres. MOVA control has the additional benefit over fixed time operation that it can react to variance in traffic demand and arrival patterns, and thus further reduces delay, although queue lengths are not necessarily reduced.

5.2.11 Option 1 (a) improves the situation slightly by reducing the queue by approximately 50 metres. However this option does not address the peak in the queue profile over the peak period.

5.2.12 The existing base situation on Aldwarke Lane sees queuing back to the extents of the modelled network. The only scheme to make a significant impact on the queuing experienced on Aldwarke Lane is MOVA control. MOVA understands there is a queuing issue developing on this approach and takes proactive action before it becomes excessive utilising its ability to vary the length of green time given to each stage.

5.2.13 The three other schemes follow the same queuing pattern on Aldwarke Lane as the existing base situation due to their inability to respond to the queuing issue as it develops.

5.2.14 The full signalisation schemes see a slight increase in queue length on the Doncaster Road approach over the existing base situation and the partial signalisation schemes, as small queues are created on this approach to allow capacity to be given to other approaches enabling larger queues to be reduced.

5.2.15 All of the schemes have similar levels of queuing on Herringthorpe Valley Road compared to the existing base situation with the two full signalisation schemes seeing a slight increase over the partial signalisation options.

5.2.16 A balance between all four approaches would be gained through detailed design to ensure one approach does not suffer significantly to the benefit of another.

5.3 JOURNEY TIME ANALYSIS

5.3.1 Journey time analysis was carried out for each of the four schemes and compared to the base situation on the four approaches to Mushroom Roundabout in both the morning and evening peak periods.

5.3.2 The graphs presented below indicated the average journey time in five minute intervals through the peak periods. Within each peak period, each graph uses the same scale so that it is easier to make fair comparisons between changes in journey time on different routes.

5.3.3 Graphs comparing the journey times across the peak hour and peak period can be found as Appendix E to this report.

Morning Peak Period

5.3.4 Fixed time traffic signal control sees an increase in journey time for non-public transport (Non-PT) vehicles on Fitzwilliam Road over the existing base situation and the three other schemes, with the longest journey time taking three minutes to negotiate the junction.

5.3.5 The other schemes deliver a similar journey time to the existing base situation at around one minute 40 seconds.

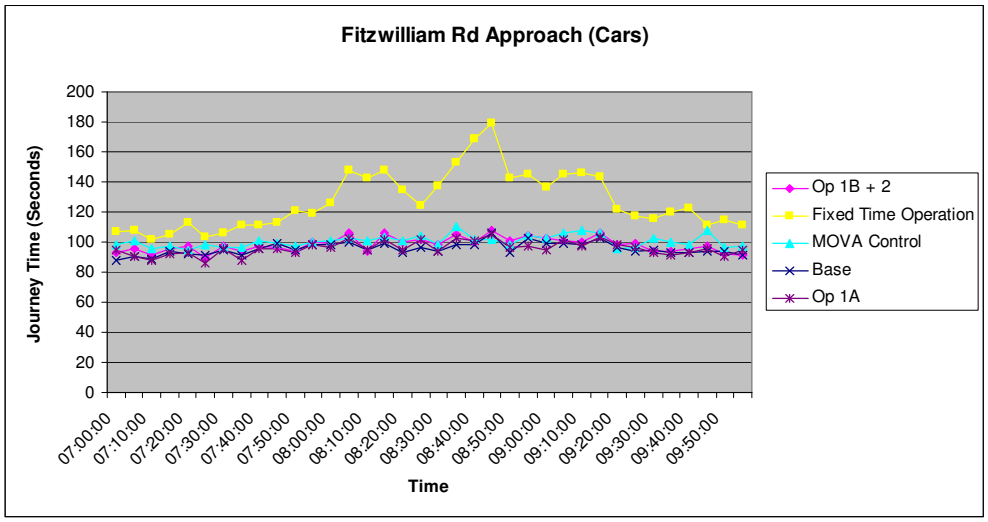

Figure 5.1 – Morning Peak Fitzwilliam Road average journey time (Non PT) by option

5.3.6 For buses on Fitzwilliam Road all schemes other than Option 1 (a) see a slight reduction in journey time of approximately 30 seconds. This is due to the reduction in queue length on Fitzwilliam Road allowing quicker access to the bus lane.

5.3.7 Option 1 (a) has little impact on the journey time for buses over the existing base situation.

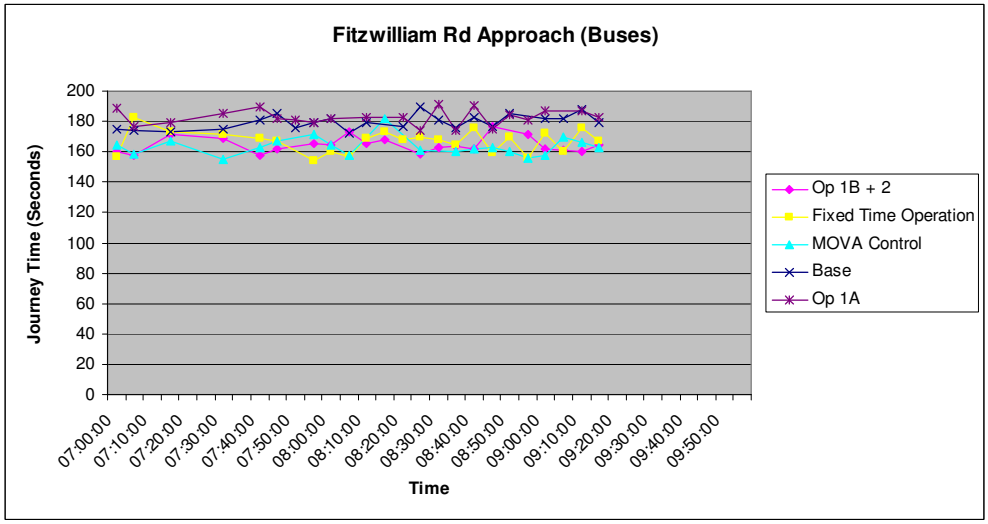

Figure 5.2 – Morning Peak Fitzwilliam Road average journey time (PT) by option

5.3.8 The full signalisation schemes see approximately a 10 – 20 second increase in journey time on Aldwarke Lane over the existing base situation and the partial signalisation schemes. This increase can be attributed to the change in method of control.

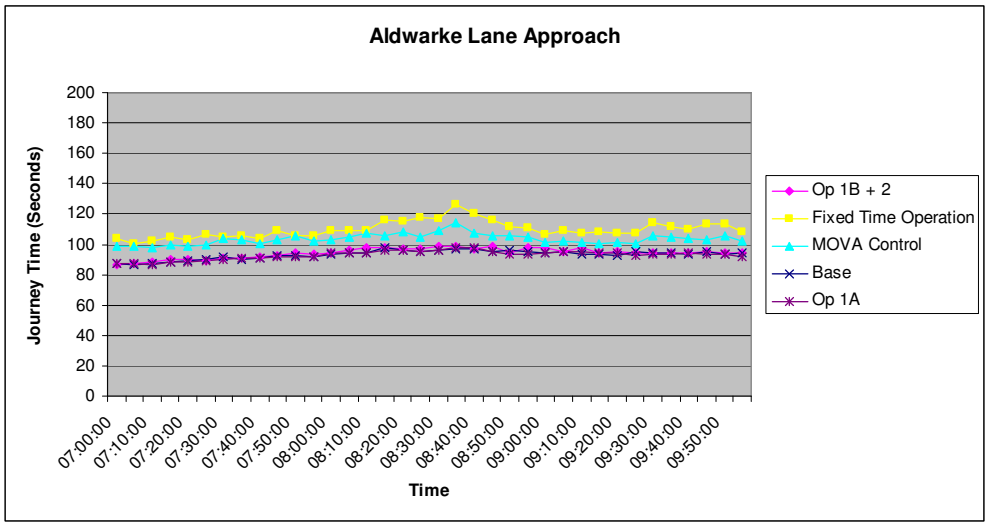

Figure 5.3 –Morning Peak Aldwarke Lane average journey time by option

5.3.9 All of the schemes have a similar journey time of around one minute 20 seconds on the Doncaster Road approach when compared to the existing base situation.

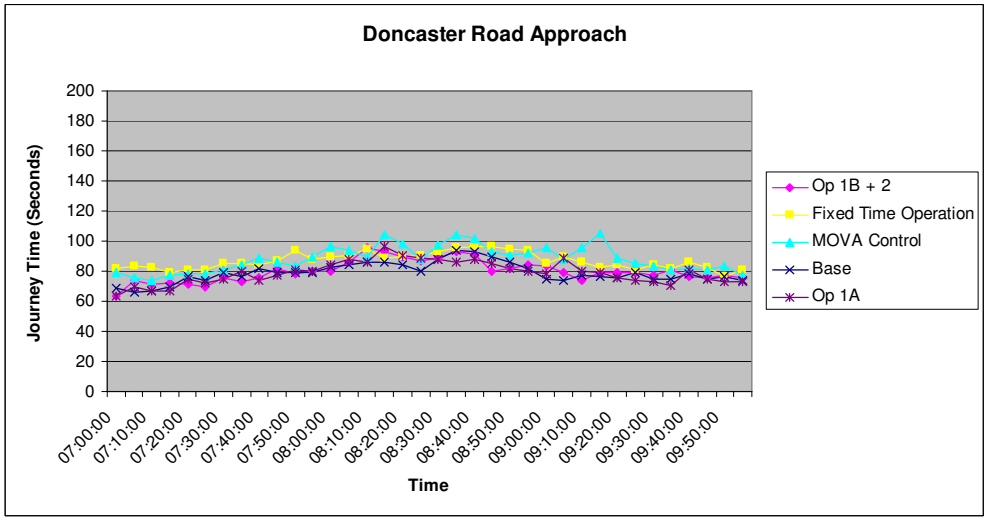

Figure 5.4 – Morning Peak Doncaster Road average journey time by option

5.3.10 Herringthorpe Valley Road sees an increase in delay in all schemes proposed by approximately 10 seconds with Option 1 (a) seeing the largest increase over the existing base situation at approximately 20 seconds increase in delay.

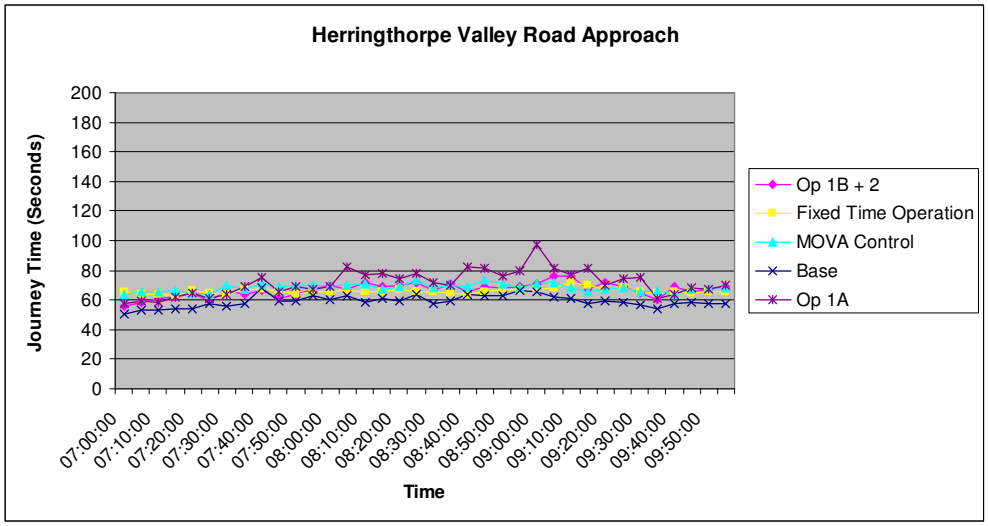

Figure 5.5 –Morning Peak Herringthorpe Valley Road average journey time by option

Evening Peak Period

5.3.11 The existing base situation sees a clear peak in journey time for Non PT vehicles on the Fitzwilliam Road approach from 16:40 to 18:10. This increase is due to the difficulty for vehicles to enter the roundabout.

5.3.12 Option 1 (a) improves the situation for Non PT vehicles slightly by metering traffic on Herringthorpe Valley Road, delivering approximately two minutes and 30 seconds reduction in journey time.

5.3.13 The three other options see a much flatter journey time profile throughout the peak period with approximately five minutes reduction for the worst journey time. This equates to a journey time of approximately three minutes and 20 seconds.

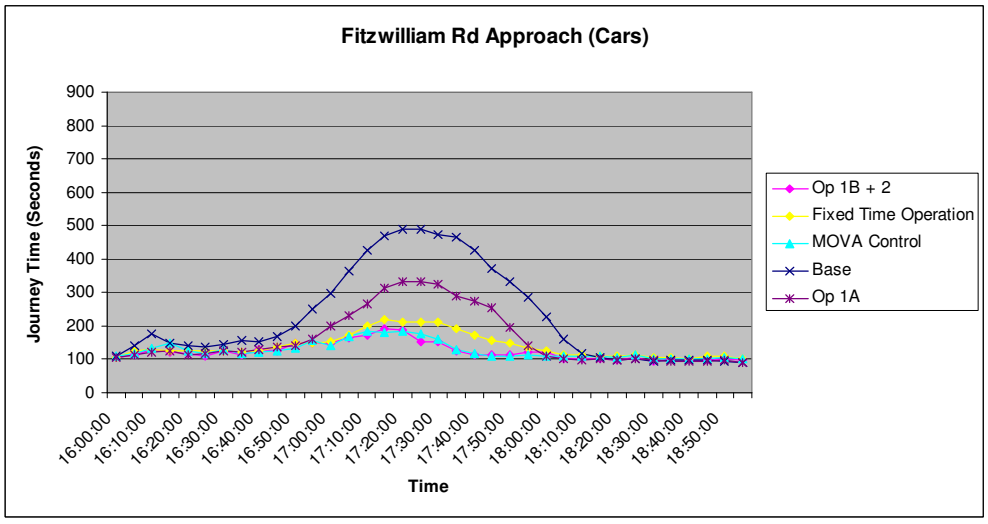

Figure 5.6 – Evening Peak Fitzwilliam Road average journey time (Non PT) by option

5.3.14 As for Non PT vehicles on the Fitzwilliam Road, buses also see a clear peak in journey time in the existing base situation. Although there is significant provision of bus lane currently in place on Fitzwilliam Road buses experience delay accessing the bus lane due to queuing traffic blocking the entry point as a result of vehicles being unable to gain access on to Mushroom Roundabout due to insufficient gaps in circulatory traffic.

5.3.15 All of the schemes remove the peak in journey time for buses by reducing the level of queuing on Fitzwilliam Road to a length which has minimal impact on the operation of the bus lane.

5.3.16 MOVA control, fixed time operation and Option 1 (b) + 2 deliver the most significant benefits by reducing the journey time below three minutes and 20 seconds.

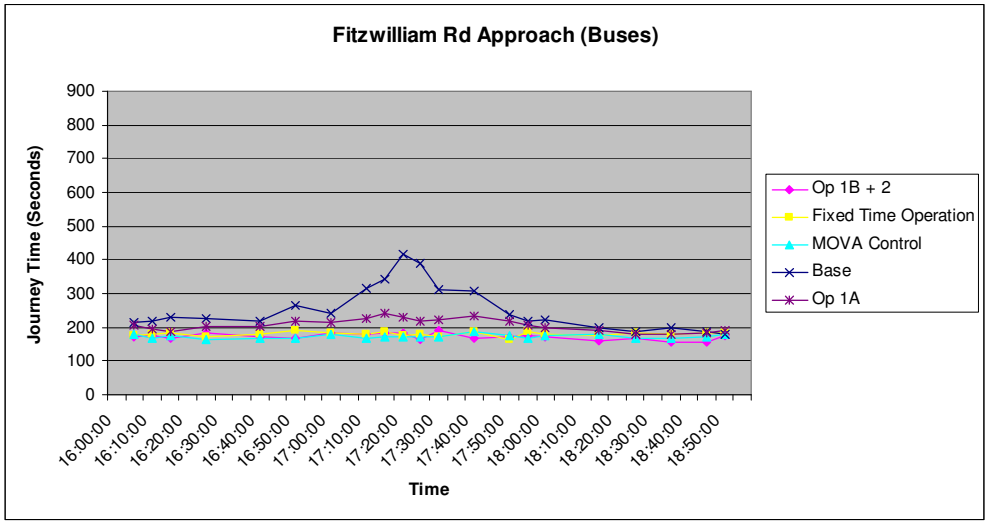

Figure 5.7 – Evening Peak Fitzwilliam Road average journey time (PT) by option

5.3.17 The existing base situation and all scheme options other than MOVA control see an excessively high journey time on the Aldwarke Lane approach to the roundabout.

5.3.18 Fixed time operation achieves a constant journey time throughout the peak period which is higher than the existing base journey time.

5.3.19 Option 1 (b) + 2 sees a reduction in journey time about 30 minutes earlier in the peak period than the base situation.

5.3.20 MOVA control of the roundabout manages the delay before it becomes excessive and sees a significant reduction in journey time over the existing base situation and the three other schemes.

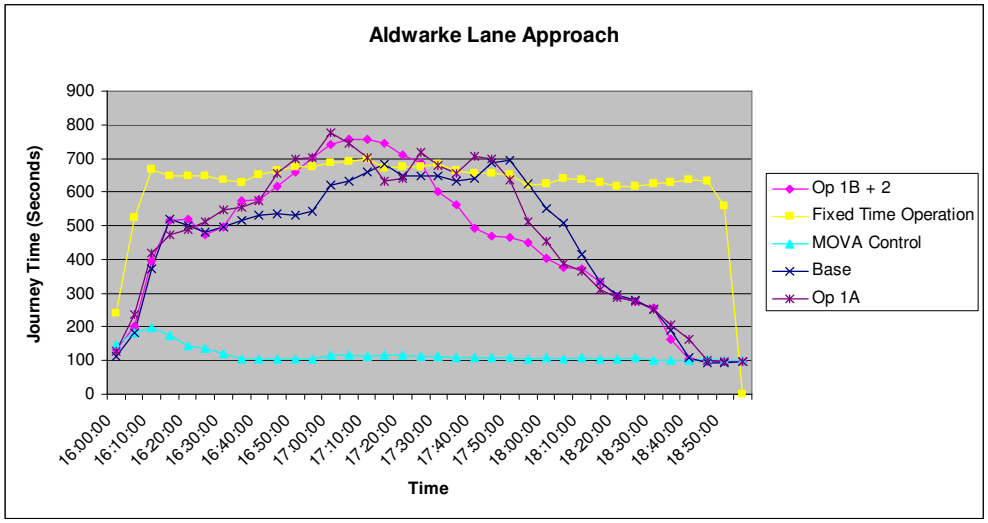

Figure 5.8 – Evening Peak Aldwarke Lane average journey time by option

5.3.21 All of the proposed schemes deliver a very similar journey time on the Doncaster Road approach with no major increases or decreases in journey time over the existing base situation.

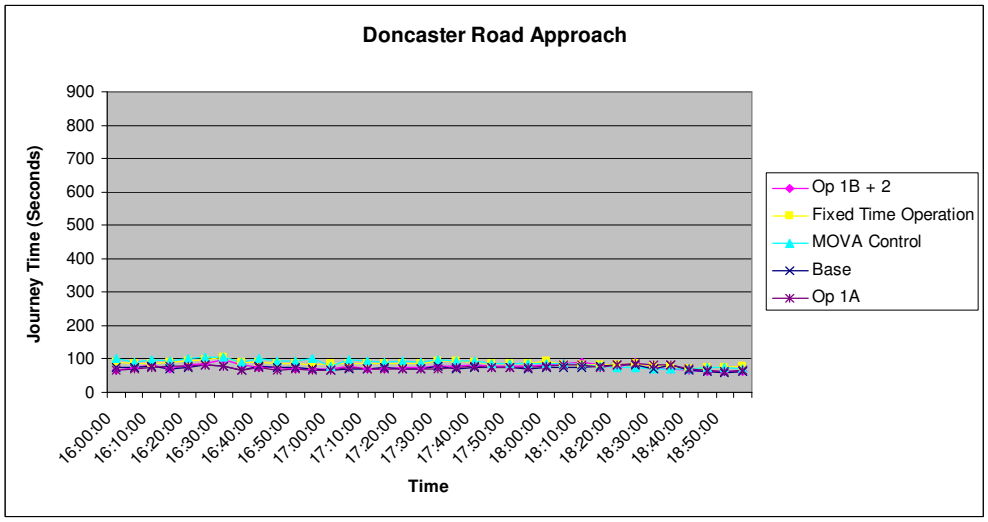

Figure 5.9 – Evening Peak Doncaster Road average journey time by option

5.3.22 Herringthorpe Valley Road currently experiences a fairly constant journey time throughout the peak period. None of the proposed schemes deliver significant changes in journey time over the existing situation.

5.3.23 Option 1 (a) sees a slight increase in journey time of approximately 40 seconds over the existing situation.

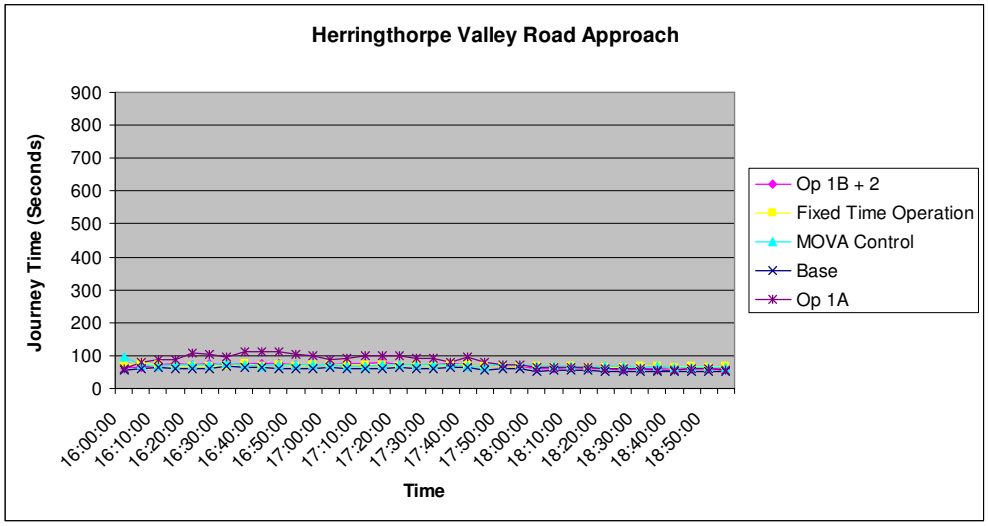

Figure 5.10 – Evening Peak Herringthorpe Valley Road average journey time by option

5.3.24 In summary, considering all routes, full signalisation of the roundabout with MOVA control provides the greatest overall journey time benefit.

5.4 JOURNEY TIME RELIABILITY

5.4.1 Journey time reliability has been assessed on the X78 northbound service for all option models. The X78 is considered representative of the bus services on the corridor.

5.4.2 Bus journey time reliability has been assessed using the journey time for the whole route in the modelled network rather than segmenting the route to assess bus journey times specifically through Mushroom Roundabout.

5.4.3 This method allows a view to be taken on the impact of the intervention at Mushroom roundabout, and the journey time through the junction, and also how the rest of the network impacts on the journey time. Thus, indicating that not all reliability issues for buses are caused at the roundabout.

5.4.4 Option 4 with MOVA control delivers the most significant journey time benefits on the approaches and through the roundabout and is therefore presented below. Figures indicating the journey time reliability for all the option can be found as Appendix F of this report.

5.4.5 Figure 5.11 below indicates the existing journey time variability in the evening peak period for the X78 service on the A630 corridor, compared to full signalisation with MOVA control.

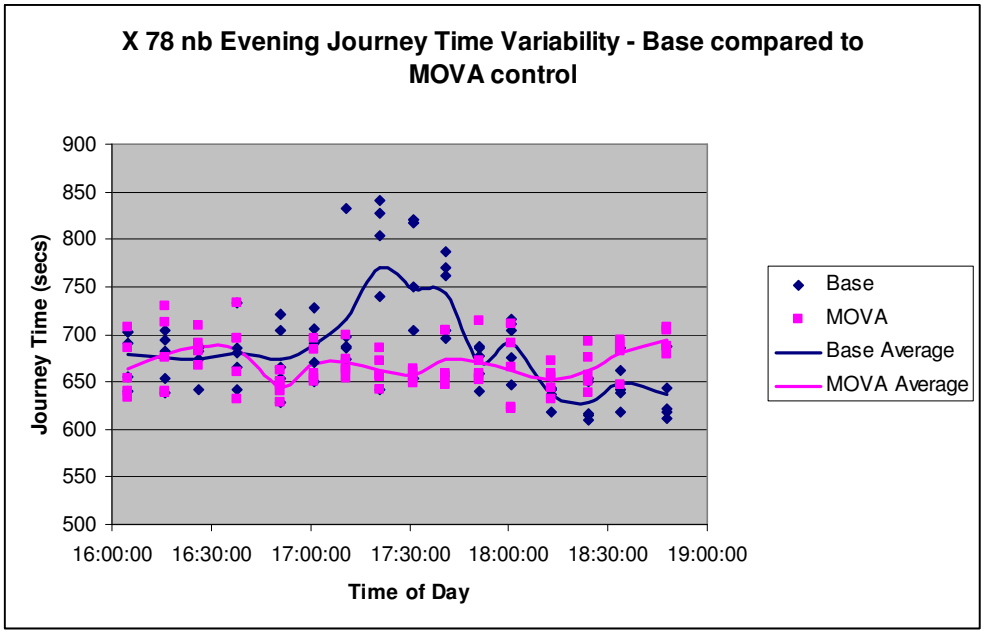

Figure 5.11 – X78 northbound service reliability impact

5.4.6 The graph indicates that under MOVA control Mushroom Roundabout contributes to a significant reduction in journey time variability particularly between 17:00 and 18:00 hrs where there is currently higher journey times with greater variability.

5.4.7 MOVA control sees the profile of bus journey times flattened considerably compared to the existing situation. This is a benefit to bus operators as it allows them to have more confidence in the service timetable; consequently it becomes a more attractive option for potential bus users.

5.5 MONETISED BENEFITS OF SCHEMES

5.5.1 Following Webtag Unit 3.5.6 Values of Time and Operating Costs, a resource value of time figure of £4.29 for all vehicle occupants was used to undertake a simple value for money exercise on the four proposed schemes.

5.5.2 Taking the total vehicle hours from the modelled outputs and converting them to person hours, using the figures presented in Table 5.1 below, the monetised benefits of each scheme compared to the existing situation have been derived.

Table 5.1 – Vehicle occupancy per trip

Trip	Weekday Average Occupancy
Work Car	1.21
PSV	12.20

5.5.3 The results of the value for money exercise have been presented in two ways:

- Whole network impact indicated by benefits to all vehicles on all trips made within each modelled time period; and
- Whole network impact indicated by benefits to public transport (PT) and non-public transport (Non-PT) vehicles within the peak hour within each modelled time period.

Whole Network Impact within Peak Periods

5.5.4 The figures in Table 5.2 below indicate that over the first year Option 4 with MOVA control would deliver £568,307 of benefits over the existing situation.

Table 5.2 – Whole network benefits for peak periods (annualised)

Scheme	AM	PM	Total
Op 1 (a)	**£ 5,297.82**	- £ 89,760.59	- £ 84,462.77
Op 2 + 1 (b)	- £ 66,938.02	**£ 31,087.56**	- £ 35,850.46
Option 4 – Fixed Time	- £ 131,769.74	- £ 482,110.78	- £ 613,880.53
Option 4 - MOVA	- £ 110,213.37	**£ 678,521.07**	**£ 568,307.70**

5.5.5 Of the four schemes analysed Option 4 with MOVA control is the only scheme to deliver a positive monetary benefit to the whole network.

5.5.6 The morning peak period is currently indicating a dis-benefit under MOVA control, although smaller than predicted with fixed time control. This can be attributed to a number of factors:

- The existing uncontrolled base situation sees minimal delay in the morning peak; and
- The MOVA model incorporates Toucan Crossings called every cycle, which would not realistically be the case; and
- The MOVA design has currently been developed to specifically suit the evening peak.

5.5.7 Whilst fixed time signal control of the roundabout addresses the delay to buses in the key route, it incurs unnecessary delay to other vehicles.

5.5.8 The net benefit of MOVA control over fixed time operation exceeds £1million annually.

Whole Network Impact within Peak Hours

5.5.9 Table 5.3 indicates that all the schemes deliver benefits to Non–PT vehicles in the evening peak hour. With Option 1 (a) and Option 4 with MOVA control also delivering benefits to Public Transport (PT).

Table 5.3 – Whole network benefits for peak hour (annualised)

Scheme	AM Peak Hour (08:00 – 09:00)		PM Peak Hour (17:00 – 18:00)		Total
	Non – PT	PT	Non – PT	PT	
Op 1 (a)	- £ 1237.49	£ 172.14	£ 2,424.06	£ 114.02	£ 2,472.73
Op 2 + 1 (b)	- £ 11,955.82	- £ 989.44	£ 4,251.80	- £ 1,154.22	- £ 9,847.68
Option 4 – Fixed Time	- £ 26,285.43	- £ 3,419.99	£ 5,643.24	- £ 390.62	- £ 24,452.81
Option 4 – MOVA	- £ 24,596.31	- £ 1,190.46	£ 240,330.78	£ 592.93	£ 214,416.93

5.5.10 The morning peak hour sees disadvantages for Non–PT vehicles in all the proposed schemes. This arises from the increase in level of control over the existing situation. All of the schemes introduce some new signal control on at least one approach to Mushroom Roundabout.

5.5.11 Mushroom Roundabout currently operates reasonably well in the morning peak period with out any major points of delay. The evening peak currently sees high levels of delay on at least two approaches which impacts on all vehicle users.

5.5.12 To alleviate the evening peak delay some form of signal control is required, hence the increase in delay experienced in the morning peak period.

5.5.13 Option 1 (a) offers the opportunity to operate metering traffic signals on a part time basis (i.e. evening peak period only), but it does not deliver the increase safety and pedestrian provision of the three other options. Traffic signals must operate at all times where controlled pedestrian facilities are provided.

5.6 OPTION ANALYSIS SUMMARY

5.6.1 Based on queue length reduction, journey time savings and journey time reliability Option 4 with MOVA control has been identified as the preferred solution, providing the greatest overall benefits, when buses, general traffic, pedestrians and cyclists are considered across both peak periods.

5.6.2 To support this, the monetised benefits indicate only full signalisation with MOVA control, of the options tested, would deliver positive benefits in terms of value for money across the peak periods.

6 Sensitivity Testing

6.1 OPTION 4 – MOVA CONTROL

6.1.1 Due to the significant benefits derived from MOVA control for Aldwarke Lane, specifically in the evening peak, a sensitivity test was carried out to establish if Mushroom roundabout could cope with an increased level of demand on Aldwarke Lane.

6.1.2 There are concerns over the potential for suppressed demand on the Aldwarke Lane approach to Mushroom roundabout due to the existing high levels of delay. An increase in the level of demand for the left turn from Aldwarke Lane to Doncaster Road could potentially cause operational issues due to the interaction of traffic with the pedestrian crossing on the Doncaster Road exit.

6.1.3 The following sensitivity tests were carried out on the evening peak period in the Paramics model:

- Increased left turn demand by 150 vehicles (5%) in the peak;
- Increased left turn demand by 300 vehicles (11%) in the peak; and
- Increased left turn demand by 450 vehicles (16%) in the peak.

6.1.4 The following text describes the findings of each of the sensitivity tests.

6.2 SENSITIVITY TESTING CONCLUSIONS

6.2.1 Under all scenarios tested MOVA manages to control the roundabout in such a way that the internal links do not suffer. However, dependant on the level of increase in demand the impact on the approaches varies.

6.2.2 With 150 vehicles added there is minimal change over the initial demand modelled. With 300 vehicles added in the peak period Fitzwilliam Road does see a slight increase in the level of queuing. However this does not extend to the bus lane entrance. Therefore it will not impact on bus journey time or reliability.

6.2.3 With 450 vehicles added to the demand on Aldwarke Lane the queue on Fitzwilliam Road extends past the bus lane entrance. This has an impact on bus journey time and reliability by limiting access in to the bus lane. There are also occasional issues of blocking back on the roundabout internals due to the two pedestrian crossings on the Doncaster Road exit. These issues are infrequent and MOVA controls the flow of vehicles on to the roundabout to allow the internal links to clear.

6.2.4 To combat the queuing issue experienced on Fitzwilliam Road the setup of MOVA could be altered so to give additional priority to the A630 corridor movements over Aldwarke Lane, although this is unlikely to be necessary as increases in demand of this scale are not expected.

7 Recommendations and Way Forward

7.1 RECOMMENDATIONS

7.1.1 Following option analysis and via consultation with SYPTE, RMBC and First Group, WSP recommend that Option 4 – Full Signalisation with MOVA control is taken forward as the preferred option for improvements at Mushroom Roundabout.

7.1.2 Although the preferred scheme requires the highest level capital investment of all the options considered, it delivers journey time improvements and reliability improvements for all vehicles, whilst also providing facilities for pedestrians and cyclists on all arms of the junction.

7.1.3 The marginal additional expenditure required to provide MOVA control over fixed time operation, for the full signalisation scheme, delivers significant benefits by providing a method of control capable of substantially reducing queuing and delay overall.

7.1.4 Options 1 (a) and 1 (b) + 2, the metering options, requiring a lower level of expenditure but show dis-benefits that are significant compared with the expected benefit. They also raise safety concerns on a number of levels, thus rendering the options unsuitable.

7.2 WAY FORWARD

7.2.1 A prioritisation appraisal tool should be utilised to consider the findings of this report and other identified corridor wide interventions. This will ensure that any investment in either a single scheme or combination of schemes is targeted at achieving maximum benefit and therefore overall value for money.

7.2.2 Should the above identify signalisation of mushroom to be the preferred scheme funding should be sought by SYPTE and RMBC to progress the scheme, taking account of cost estimates being prepared by RMBC.

7.2.3 The scheme should be progressed through detailed design, taking account of the conceptual design of both the physical and operational aspects, and the findings of the modelling carried out to date by WSP,

7.2.4 Consideration should be given to the wider corridor and potential interventions to further improve the situation for all vehicles and journey time reliability for buses, with particular attention paid to St Ann's Roundabout and Oldgate Lane.

Appendices, Figures & Tables

Appendix A Figures

Appendix B Initial Option Sketches

Appendix C Developed Option Sketches

Appendix D Queue Length Graphs

Appendix E Journey Time Graphs

Appendix F Journey Time Reliability Graphs