Wiltshire County Council

M4 Junction 16 Improvements

Traffic Modelling: AUDIT Report

Halcrow Group Limited

February 2007

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Contents

1 Introduction

1.1 ***Background***

1.1.1 Halcrow have been appointed by Wiltshire County Council to provide an independent audit of modifications to M4 Junction 16, proposed as part of the SDA development in Swindon, and the associated capacity analyses/conclusions undertaken by WSP. Most of the modelling work undertaken to date has involved the use of the SATURN model of Swindon to obtain predicted network flows in 2019 with/without the SDA development, and the use of TRANSYT to consider the more detailed operational impacts at M4 Junction 16. Past examination of the TRANSYT outputs has revealed that 'blocking back' associated with exit constraints may be an issue, whilst the proposed cross-over layout design incorporates a number of short links where excess queuing could quickly lead to operational problems. These potential 'blocking back' issues are not well handled by TRANSYT, so it was recommended that micro-simulation modelling would be needed to 'prove' that the proposed design could indeed operate satisfactorily. A drawing showing the latest proposed layout of the M4 Junction 16 improvements is included in Appendix A.

1.1.2 WSP have now developed a VISSIM micro-simulation model of M4 Junction 16 and the immediate highway network. This Audit report comments on all the new modelling work undertaken, namely:

- Development of the 'base' models prepared for the morning and evening peak situations in 2006, including consideration of the network structure, modelled lane use behaviour, signal timings, traffic 'demand' and the general operational performance suggested by the model in terms of queuing when compared with the known situation in the periods of interest;

- The revised forecasting for 2019 undertaken using the Swindon SATURN model, and the subsequent inputs to VISSIM;

- The TRANSYT modelling undertaken to derive signal timings for the 2019 'Scheme' scenario, and the subsequent inputs to VISSIM; and

- Comparison of the model outputs obtained with the VISSIM models for the 'Do Nothing' and 'Scheme' scenarios in 2019.

2 VISSIM 'Base' Model Development

2.1 *VISSIM Model Network*

Extent

2.1.1 The extent of the VISSIM model covers the whole of M4 Junction 16, including the merges/diverges with the main-line carriageway of the M4. To the north of the motorway junction the VISSIM model network has been extended to include the traffic signal controlled junction with Lydiard Fields and the A3102/B4534 Blagrove roundabout. The latter two junctions effectively control the potential exit capacity available immediately north of M4 Junction, so network coverage on the A3102 Great Western Way axis is considered sufficient for replicating traffic conditions in this location, notably exit conditions in the morning peak hour.

2.1.2 In the initial VISSIM model submitted for by WSP for audit the length of the A3102 Swindon Road included was relatively short. It was subsequently advised that the length of the A3102 Swindon Road included should ideally extend westwards to the roundabout junction with Bincknoll Lane on the north-east side of Wootton Bassett, as queuing or slow moving traffic can reach this point in the morning peak hour. This change was subsequently made by WSP to the network extent, including the A3102/Binknoll Lane junction.

2.2 *Link/Lane Coding and Usage Behaviour*

2.2.1 Although the VISSIM model includes Blagrove roundabout and intervening junctions on the A3102 Great Western Way, the audit of the network concentrated on the link/lane structure used for M4 Junction 16 and the modelled lane usage behaviour, notably on the internal circulatory links. Auditing this necessarily involved observing the model operation to ensure that drivers making specific movements through M4 Junction 16 were using the appropriate approach and circulatory lanes. Whilst some ambiguity exists in the lane choice for some movements, particularly on the eastern over-bridge and the circulatory section adjacent to Hay Lane, road markings present to direct and channel drivers tend to result in consistent lane choice behaviour for most.

2.2.2 The observations made during the initial audit showed that, in general, the particular lane usage at M4 Junction 16 behaviour was replicated by VISSIM, with excessive lane changing/weaving avoided in the circulating sections. However, lane

changing behaviour in the following areas was considered unrealistic and action recommended:

- Great Western Way approach; and

- A3102 Swindon Road approach, where occasional vehicles making the right turn to either the M4(E) or the B4005 were observed to leave the entry stop-line in the nearside lane and weave across.

2.2.3 On the A3102 Great Western Way approach the three lane section to the east of the Lydiard Fields junction has specific lane usage depending on the downstream exits drivers require at M4 Junction 16. This is reinforced by worded lane markings, resulting in the following lane usage:

- Lane 1: M4(E)
- Lane 2: B4005 - Wroughton; and
- Lane 3: A3102(S)/M4(W) - Wootton Bassett.

2.2.4 On entering the four lane section between the Lydiard Fields junction and the roundabout entry stop-line drivers requiring the exit to the M4(W) will tend to 'fan' to make use of the outside fourth lane. The original VISSIM model used a single link to represent all three westbound approach lanes to the Lydiard Fields junction. Downstream of the junction a separate link was used for the lane for the M4(E), but the other three lanes were modelled as a single link. The effect of this created a lot of lane changing manoeuvres as VISSIM attempted to achieve balanced usage on the approach if possible. Thus, whereas lane usage is biased to the offside in reality, particularly in the evening peak hour, this was not the case in the VISSIM model.

2.2.5 In response to the audit comments WSP redefined the network structure to create two links on the outbound Great Western Way approach to Lydiard Fields, the offside lane to the A3102(S)/M4(W) in effect separated. On the downstream 'short' four lane section between the Lydiard Fields junction and M4 Junction 16 three separate links were specified, representing lane 1, lane 2 and lanes 3-4 respectively. This re-specification reduced unrealistic weaving and produced a better 'fit' with queuing observed queuing behaviour in the evening peak hour.

2.2.6 On the A3102 Swindon Road approach WSP re-specified the 'flaring' by separating the outside lane as a separate link for the right turn to the M4(E). This stopped the erroneous weaving from the other approach lanes.

2.3 ***Traffic Signal Timings***

2.3.1 The morning and evening peak hour traffic signal timings used for the roundabout are those actually defined by current CLF Plans, not TRANSYT analyses. This is appropriate as current Plans may not in fact be optimal. The signal timings used for the adjacent Lydiard Fields access are variable, using VAP logic to mimic the degree of variance in the green times permitted by the existing CLF specification. This is considered appropriate as cyclic green times in this location may not be 'fixed', even though they operate in CLF mode.

2.4 ***Traffic Flow Data***

2.4.1 Traffic flow information used in the 'base' models is derived from comprehensive traffic turning count surveys carried out at M4 Junction 16 and adjacent junctions on the 8th June 2006. Although undertaken in early June it is considered that surveyed volumes should be typical of normal conditions. The specific locations surveyed were as follows:

- M4 Junction 16;
- A3102 Great Western Way/Lydiard Fields access;
- A3102 Great Western Way/Windmill Hill access; and
- A3102 Great Western Way/B4534 Whitehill Way: Blagrove roundabout.

2.4.2 Data was collected in 15 minute intervals between 7:00-10:00am and 4:00-7:00pm, with the resultant model matrices developed from these counts representing quarter hour periods between 7:30-9:30am and 4:30-6:30pm. It is not clear how the count data associated with the three junctions to the east of M4 Junction16 have been 'fused' with the main roundabout count to create 'single' 15 minute matrices. A simple proportioning exercise is likely to have been the adopted methodology, which is acceptable.

2.4.3 It is important to realise that where a junction is operating at or close to capacity, as in the case with M4 Junction 16 in the peak hours, the 'actual' traffic counts obtained crossing a given stop-line in each interval will be dictated by the service capacity available. Thus the 'true' traffic arrival profile at a point upstream of any queuing on a congested approach may be quite different from that counted passing through the stop-line. In order to replicate queuing levels it is important to

ascertain this upstream arrival profile. From examination of the matrices it is apparent that WSP have attempted to do this by adjusting the counted profiles for some movements through M4 Junction 16 to create in effect more of a 'peaked' profile in the middle of the peak hours, subsequently checking maximum queues against observations. This is considered a logical and sensible approach in calibrating/validating the model.

2.4.4 The possibility of the flows levels at M4 Junction 16 being somehow atypical on the day of survey has also been considered. To only way to check this has been to use ATC data from a rotational site operated by Swindon Borough Council on the A3102 Great Western Way between the Windmill Hill access and Blagrove roundabout. The latest continuous data available from this site is the two week period from Thursday 2nd February to Wednesday 15th February 2006. The comparisons with the manual classified count data collected by WSP on the 8th June are shown in Tables 2.1 and 2.2 below.

Table 2.1 Comparison of Count Data: 8:00-9:00am

Direction	Manual Classified Count: WSP	Automatic Traffic Counter: ATC		
		Mean	Maximum	Minimum
A3102 Eastbound	2330vph	2245vph	2367vph	2077vph
A3102 Westbound	1477vph	1436vph	1478vph	1373vph

Table 2.2 Comparison of Count Data: 5:00-6:00pm

Direction	Manual Classified Count: WSP	Automatic Traffic Counter: ATC		
		Mean	Maximum	Minimum
A3102 Eastbound	2394vph	1986vph	2113vph	1764vph
A3102 Westbound	1718vph	1671vph	1789vph	1456vph

2.4.5 The tables show that the flow levels on the A3102 Great Western Way between Blagrove roundabout and M4 Junction 16 are very consistent during the weekday peak hours. Furthermore, the manual classified count data collected by WSP on the 8th June 2006 shows a good correlation with the ATC information. It may thus be concluded that the traffic volumes used for input to the VISSIM model are fairly typical of those occurring in the 'normal' weekday peak periods. Any apparent lack of congestion when visually examining the models is therefore likely to be a problem with the assumed arrival profiles in the respective peak periods, rather that a lower than normal volume of traffic.

2.5 ***Validation***

2.5.1 WSP forwarded a Draft of their 'M4 Junction 16 Base Model Report', which essentially reported on the validation performance of the base peak period models with respect to observed traffic flows and queue lengths. Notwithstanding this, in the course of the audit, the two peak hour models were rerun and traffic volume/queue outputs obtained to verify the quoted figures for M4 Junction 16. With regard to Blagrove roundabout the reported link flow/queue comparisons revealed a very good 'fit' with the observed data, with link flows well within the Design Manual for Roads and Bridges (DMRB) Volume 12, Section 2 acceptability guidelines.

Link Flow Audit

2.5.2 Tables 2.3 and 2.4 show the link flow checks undertaken for M4 Junction 16 for the periods 8:00-9:00am and 5:00-6:00pm respectively. Each table consists of three elements as follows:

- The counted turning volumes at M4 for the relevant time period;
- The turning volumes in the VISSIM 'demand' matrix input for the same period; and
- The 'actual' modelled flows at various points.

2.5.3 The latter are dictated by the position of flow 'measurement points' in the VISSIM model. Unless exclusive to a lane or lanes it is not possible to isolate specific movements.

2.5.4 In the case of both peak hours the overall demand matrix used in VISSIM for each showed an identical match. This is expected, but demonstrated that WSP had not added additional 'demand' into the 8:00-9:00am and 5:00-6:00pm periods to achieve the necessary 'fit' to queue data. This could be argued if substantial queuing on one or more approaches remained after 9:00am and 6:00pm respectively, with vehicles arriving in the relevant period but not getting to the stop-lines. This is not the situation here, with congestion generally the result of a compressed 'peak' profile in the peak hours, but with queuing generally dissipated by the end of each.

2.5.5 The flow measurements taken around M4 Junction 16 also demonstrate a good 'fit' with observed data in both periods of interest. Furthermore, as previously indicated, the vehicle paths/lanes adopted for movements thorough the junction is also considered acceptable. Initially, the only 'visual' exception was the high degree

of lane changing/weaving occurring in VISSIM on the A3102 Great Western Way approach. However, this was subsequently addressed by WSP.

Queue Length Audit

2.5.6 The traffic surveys carried out by SkyHigh Traffic on behalf of WSP on the 8th June included queue length surveys on the following approaches to M4 Junction 16:

- M4 Eastbound Exit Slip-road;
- M4 Westbound Exit Slip-road;
- Hay Lane; and
- A3102 Swindon Road.

2.5.7 The absence of any queue length monitoring on the A3102 Great Western Way approach was somewhat surprising, given that there is generally noticeable queuing on this arm in the evening peak hour.

2.5.8 From survey data supplied the queue measurements were done on a lane by lane basis using 'spot' observations every five minutes, and recorded in metres from the stop-line locations. What was not known is how the traffic survey enumerators defined 'queuing', which is difficult at the best of times when vehicles may be either stationary or slow moving/bunching, particularly when the length so affected is quite long requiring observers to walk back from the stop-line. With VISSIM the criteria for a vehicle classified as 'queuing' can be specified. WSP have adopted the following criteria:

- Speed <5kph: Vehicle 'queuing'; and
- Speed >10kph: Vehicle no longer queuing.

2.5.9 On the basis of the above it is probable that the survey sub-contractor only considered stationary vehicles as the queue, ignoring slow moving traffic.

2.5.10 A comparison of the observed/modelled queues at M4 Junction 16 in the morning and evening peak hours is shown in Tables 2.5 and 2.6 respectively. The results demonstrate that WSP have generally achieved a good correlation with the observed queue length observations, through adjustment of the demand 'profile' in the 15 minute interval matrices where necessary. Notwithstanding this, a concern raised during the audit was that the observed queue lengths against which the VISSIM models had been validated appeared in some cases to be low. This is

particularly the case on the A3102 Swindon Road approach in the morning peak hour where a 'maximum' reported queue of 95m, or about 16 stationary light vehicles seemed inconsistent with user experience of slow moving/stop-start conditions over a much longer length in this period.

2.5.11 It was considered that, if video clips showing the 'base' model were to be presented to third parties, particularly local users of this junction in the peak hours, it would be important to show that the flow density on the A3012 Swindon Road looked realistic, or the credibility of the 'scheme' model will be compromised at the outset. In response to this audit comment WSP adjusted the link behaviour parameters which had the effect of creating a better representation of the 'stop-start' conditions on this approach and, visually, a longer queue.

2.6 ***Overview***

2.6.1 The base VISSIM models prepared for M4 Junction 16 by WSP demonstrate a good fit with the traffic count and queue length data obtained on the 8th June 2006. Furthermore, analysis of longer term ATC data available for the area showed that the manual classified count data used for constructing the VISSIM matrices is generally typical of 'normal' levels in the weekday peak periods. Visual inspection of the modelled routing behaviour on the circulatory and approach sections at M4 Junction 16 also revealed that, in general, the VISSIM model was able to mimic driver routing without evidence of substantive lane changing or weaving manoeuvres due to incorrect lane usage.

2.6.2 As previously discussed, during the 'initial' audit, a number of specific issues were raised with corrective action recommended to improve the 'base' models. These were as follows:

- The A3102 Swindon Road approach needed to be extended back to the roundabout junction with Bincknoll Lane. In the morning peak hour slow moving/stop-start traffic can extend some distance, certainly beyond the curtailed link length in the model;

- Modifications were needed to better reflect actual lane utilisation on the A3102 Great Western Way approach. The single 'link' used initially resulted in a lot of lane changing and weaving. In reality drivers get into the lane they need for the downstream manoeuvre at M4 Junction 16 much earlier, reducing last minute weaving but creating imbalanced lane usage; and

- Whilst it was accepted that the queue length validation was good, the criteria used for defining a queue in both the survey and the VISSIM model tended to underplay the length of the approaches affected by congestion. A 'key' identified location was the A3102 Swindon Road approach in the morning where, in addition to static vehicles on the immediate approach to the stop-line, show moving or stop-start traffic conditions affects a considerably longer length. It is considered important that the VISSIM model reflected this, in order to engender public confidence in its ability to reflect the future base and scheme scenarios.

2.6.3 Following on-going liaison/discussion with WSP these anomalies were rectified, and 'base' models considered sufficiently robust for use in future scenario testing produced.

3 Forecasting: Swindon SATURN Model

3.1 ***Methodology***

3.1.1 The forecast year used by WSP to assess the future operation of the existing signalled roundabout against that with the improvement and the Southern Development Area (SDA) is 2019. The reason why this particular forecast year was selected is unknown. It is understand that the forecasting 'base' is the work undertaken by Halcrow in 1999, and not the latest update produced for the Blunsdon Bypass Study in 2003. It is thus possible that some developments now considered 'committed', but not known or anticipated in the forecasting work done in 1999, are not included in the forecasts being used now to assess the M4 Junction 16 improvements. However, a detailed audit of the forecasting work undertaken by WSP, notably developments included other than the SDA, has NOT been undertaken in the course of this work.

3.2 ***Network Checking***

3.2.1 Previous examination of the SATURN models revealed a problem with the network coding used to represent the SDA improvement scheme at M4 Junction 16. This was down to the use of 'dummy' nodes to represent particular diverge/merge points in the layout. Furthermore, the 'critical' merge point from two lanes to one on the Hay Lane exit was not previously modelled, thus over-estimating the exit capacity on this arm.

3.2.2 The specific problems with the previous SATURN coding for the SDA improvement scheme at M4 Junction 16 were detailed in an Addendum Audit Report dated, November 2005. These are reiterated here for completeness:

- The A3102 Great Western Way approach was modelled as a full four lane approach, with no 'reduced' saturation flows used to take account of flaring. This was deemed acceptable if the proposed modifications to this approach extend the four lane main-line section back to the right turning lane into Lydiard Fields. It should be noted that SATURN is not sufficiently sophisticated to model signalised roundabouts as well as TRANSYT, in that it cannot determine the specific capacities at entry for particular downstream movements, other than the first left turn. For example, in the case of the three lanes available for either the B4005, A3102 or M4(W), it is not possible to specify individual lane movements

without very complex coding, only the total saturation flow for 'ahead' traffic. In view of this, greater caution in the saturation flows is warranted;

- On the A3102 Swindon Road approach, 'dummy' nodes were used to specify the network associated with the cross-over. This leads to a problem in SATURN if queuing associated with downstream links is likely to extend through this points, as will be the case here, as any 'blocking back' and associated delay effects are not transferred upstream through 'dummy' nodes. The net result was that inbound delay along most of Swindon Road was ignored by SATURN, and thus these time costs were not considered when determining the routing of traffic. A further problem was that the capacities of the main stop-line on the A3102 Swindon Road approach, and that of the cross-over link, were seen by SATURN as 'independent'. In other words, any 'excess' queuing associated with the cross-over link would never impede flow accessing the main stop-line, and vice-versa; and

- On the A3102 Swindon Road approach a full three lane saturation flow of 5700pcu/hr was employed for the main stop-line, and a full two lane saturation flow of 3800pcu/hr for the cross-over link. In consequence, neither value took account of the flaring effects in both these locations. Furthermore, as explained above, the use of a 'dummy' node to represent the upstream dividing point made the operation of both stop-lines mutually independent in the model, whereas in practice there will a high level of interaction between them.

3.2.3 Revised 'Scheme' SATURN networks/assignments for 2019 were forwarded by WSP for audit following these comments. Some of the deficiencies were resolved by changes to the design of the improvement scheme on the A3102 Swindon Road approach, where the cross-over link was provided with a 'dedicated' approach lane. Other problems associated with the use of 'dummy' nodes, flaring effects and capacities at merge points were also satisfactorily resolved.

3.3 ***Comparison of SATURN results: 2019***

3.3.1 During the course of the Audit a comparison of the link flows in the area around M4 Junction 16 was made for the 'Do Nothing' and 'Scheme' scenarios in 2019, namely to establish what level of predicted diversion had occurred, and where. The changes in the inflows into the local area defined by the VISSIM models were also checked, and the relevant VISSIM matrices examined for each scenario to ensure

that they remained consistent with SATURN after reformatting. Tables 3.1 to 3.5 for the morning peak hour show the following:

- Table 3.1 Comparison of Forecast Traffic Volumes: AM - STM;
- Table 3.2 Cordon Inflows: VISSIM Model Area: AM - STM;
- Table 3.3 VISSIM Model Matrix Inputs: AM - Do Nothing;
- Table 3.4 VISSIM Model Matrix Inputs: AM - SDA/Improvements; and
- Table 3.5 M4 Junction 16: Changes in Traffic Demand: AM.

3.3.2 Tables 3.6 to 3.10 show the corresponding analyses/checks for the evening peak hour.

3.3.3 Findings arising from these analyses were used at the public meeting in Wootton Bassett on the 31st October 2006, and in a pre-cabinet presentation to County Council members on the 22nd November 2006. In respect of the morning peak hour the comparative analyses revealed that:

- With the SDA in place the inbound link capacity of the A3102 Swindon Road to the east of Wootton Bassett reaches capacity: set at 1860pcu/hr. SATURN predicts overcapacity/queuing problems at the roundabout junction with Bincknoll Lane due to this exit constraint;

- With the SDA in place predicted two-way traffic on the A3102 Swindon Road increases from around 2600vph to 2950vph (+14%);

- The effect of the SDA/M4 Junction 16 improvements results in an inflow increase of around 2170vph into the local area. The increased inflow directly associated with the SDA is nearly 2400vph, suggesting that diversion/displacement to surrounding routes is around 200-300vph. Examination of the SATURN model shows that most of constrained inflow is locked up in over-capacity queuing around the Swindon Road/Bincknoll Lane roundabout. Around 100 vehicles are encouraged to rat-run via Hook Street;

- The relative increase in traffic demand at M4 Junction 16 with the SDA is 2050vph, or 36%;

- With the SDA in place the eastbound exit flow to Hay Lane reaches the merge capacity where two lanes funnel to one at the railway bridge: set at 2100pcu/hr;

- Despite congestion/queuing around the Swindon Road/Bincknoll Lane junction there appears to be marginal diversion to Hook Street to avoid this problem. The reason for this is that any drivers choosing to re-route must, for destinations other than West Swindon, join Great Western Way. The Whitehill Way, Tewkesbury Way and Mead Way approaches to Great Western Way are themselves congested in the morning peak hour, such that rat-running offers no significant overall journey time benefit.

3.3.4 The corresponding analyses for the evening peak hour in 2019 showed that:

- The effect of the SDA/M4 Junction 16 improvements results in an inflow increase of around 1980vph into the local area;

- The increased inflow directly associated with the SDA is nearly 2520vph, suggesting that diversion/displacement of 'background' traffic to surrounding routes is more significant;

- Examination of the SATURN model shows the increased traffic using Hook Street as a diversionary route to cross the M4 is very low: <50vph;

- Summary statistics show that the 'overall' network impact of the SDA is much greater in the evening peak hour, with over-capacity queuing increasing by around 33% compared to about 20% in the morning peak hour. The absence of notable traffic increases on local roads west of Swindon is thus likely to be the widespread effect of congestion in the central part of Swindon, preventing traffic from reaching this part of the network.

4 Comparative Assessment: VISSIM

4.1 ***Scheme Signal Timings***

4.1.1 The proposed highway scheme with the cross-over is relatively complex, and good co-ordinated signal timings will be absolutely critical to its operation. WSP supplied TRANSYT derived signal timings used in the VISSIM models for audit. A check showing the timings used and their co-ordination in each peak period are included in Appendix B.

4.1.2 Somewhat surprisingly the examination of the two TRANSYT models revealed different stage structures for the 'nodes' on the south side of M4 Junction 16 in the two peak hours; this is not easily achieved in practice. For example, the Hay Lane/cross-over link junction has a three stage Method of Control in the morning peak hour, but one with five stages in the evening peak hour, although it operates on a 70 second cycle in both periods. Further examination showed that the differences were in fact due to the insertion of very short stages to mimic phase delays, strictly unnecessary. The timing 'sets' subsequently used in the VISSIM models demonstrated good co-ordination when the operation of the models was observed.

4.2 ***Comparison of VISSIM Results***

4.2.1 It is worthy noting that no analyses/comment on the impact of the SDA /improvement scheme using the VISSIM model has been made. As such, this part of the audit is more an independent assessment of what the models show. Tables 4.1 and 4.2 show a comparative assessment of the traffic turning flows actually accommodated by M4 Junction 16 under each scenario, in the morning and evening peak hours respectively. Tables 4.3 and 4.4 show the respective queue length predictions. In addition to the figures extracted and presented in these tables operation of the models was observed to identify any surrounding problem areas or 'bottlenecks'.

4.2.2 In the morning peak hour model observations/analyses revealed that:

- A 29% increase in traffic throughput is achieved by the improvement scheme at M4 Junction 16. This compares with a 36% increase in inflow 'demand' to the local area. This mismatch is not due to an inability of the

improved M4 Junction 16 to absorb more traffic, bur rather 'bottleneck' constraints around it;

- Blagrove roundabout experiences considerable congestion in both the 'Do Nothing' and 'Scheme' scenarios. This is worsened with the SDA, with traffic effectively prevented from reaching M4 Junction 16;

- The eastbound link capacity along the A3102 Swindon Road becomes a constraint with the improvement scheme in place, with the 'bottleneck' displaced from the entry to M4 Junction 16 to the A3102/Bincknoll Lane junction; and

- The 'actual' volume of traffic reaching the Hay Lane exit is nearly 2000vph, leading to a maximum queue of around 350m associated with the merge. This was not observed to 'block back' into M4 Junction 16 in VISSIM, but clearly this flow is close to its limiting capacity.

4.2.3 In the evening peak hour model observations/analyses revealed that:

- A 33% increase in traffic throughput is achieved by the improvement scheme at M4 Junction 16. This compares with a 46% increase in inflow 'demand' to the local area. This mismatch is again not necessarily due to an inability of the improved M4 Junction 16 to absorb more traffic, but rather 'bottleneck' constraints around it. These surrounding 'bottleneck' problems are more severe in this period;

- Blagrove roundabout is again a key 'bottleneck' junction, experiencing considerable congestion in both the 'Do Nothing' and 'Scheme' scenarios. This is worsened with the SDA, more so than in the morning peak scenario, with traffic effectively prevented from reaching M4 Junction 16;

- The Wharf Road/SDA access roundabout is also a surrounding 'bottleneck'. The high volume of traffic leaving the SDA has a right-of-way over westbound traffic using Wharf Road. The limiting 'gaps' available in this circulating flow are predicted to lead to queuing and delay on the westbound Wharf Road approach. As a result westbound traffic on this arm is expected to reduce as drivers seek alternative diversionary routes; and

- The 'actual' volume of traffic reaching the Swindon Road exit is nearly 1800vph, leading to a maximum queue of around 100m at the merge point to one lane. This was not observed to 'block back' into M4 Junction 16 in VISSIM, but again this flow is close to the limiting capacity of the single lane section of Swindon Road.

5 Overview

5.1 ***Conclusions***

5.1.1 The main conclusions/findings arising from all the auditing of work undertaken by WSP may be summarised as follows:

- Following suggested modifications the VISSIM 'base' models validate sufficiently well, reflecting existing queuing conditions;
- The traffic survey data collected on the 8th June 2006, and used to develop the VISSIM models, shows good correlation with longer term ATC data available for the section of the A3102 Great Western Way between the Windmill Hill access and Blagrove roundabout;
- The SATURN model 'runs' undertaken for the 2019 situation show that the effect of the SDA/improvements will increase inflows into the local area around M4 Junction 16 by 2200vph and 2000vph in the morning and evening peak hours. Corresponding increases directly associated with the SDA are 2400vph and 2500vph, suggesting that some displacement of existing traffic is likely to take place;
- Displacement to Hook Road and roads through Lydiard Millicent is relatively low, and mainly occurs in the morning peak hour scenario;
- A 29% increase in traffic throughput is achieved by the improvement scheme at M4 Junction 16 in the morning peak hour. This compares with a 36% increase in inflow 'demand' to the local area. The corresponding figures for the evening peak hour are 33% and 46% respectively. These mismatches are not necessarily due to an inability of the improved M4 Junction 16 to absorb more traffic, bur rather 'bottleneck' constraints around it;
- Blagrove roundabout is a major 'bottleneck' limiting traffic flow in the area, with operating conditions worsened by the SDA. The A3102/Bincknoll Lane and the Wharf Road/SDA access junctions will also become constraints in the future, as will the single lane (S2) capacity of the A3102 Swindon Road. The merging capacity on the Hay Lane exit

from M4 Junction 16 will also impose a constraint on what level of traffic the M4 Junction 16 improvement could 'potentially' accommodate in 2019.