

M4 Junction 17 Major Road Network Outline Business Case

Vissim Forecasting Report

Wiltshire Council

August 2022

M4 J17- Vissim Forecasting Report



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1. Introduction

1.1. Background

Atkins has been commissioned by Wiltshire Council to develop an Outline Business Case (OBC) for an M4 Junction 17 improvement scheme for submission to the Department for Transport under the Major Road Network (MRN) fund.

The option development process for the M4 Junction 17 scheme was informed by an operational assessment, undertaken in conjunction with National Highways (formerly Highways England). The operational assessment was undertaken using a microsimulation traffic model, using the Vissim software. The base Vissim model was developed by Jacobs, on behalf of National Highways, supported by a Local Model Validation Report (M4 J17 VISSIM Model LMVR_v3.0_Mar 2021), which incorporated comments after review by Atkins. Key findings from the operational assessment were presented in the Operational Assessment Report, prepared by Atkins and submitted to Wiltshire Council and National Highways in September 2021.

The economic appraisal for the OBC was originally planned to be undertaken using the strategic Wiltshire Transport Model (a SATURN model). This model was used to derive the traffic growth forecasts for the Vissim operational assessment. However, during OBC preparation a review of the modelling and appraisal approach was undertaken and it was concluded that reliance on the SATURN model alone presented some limitations with regards to the economic appraisal. Similarly, use of the Vissim model alone would also present limitations – primarily due to the lack of re-routing impacts across the wider network. Hence, a hybrid modelling approach was developed utilising both the Vissim model and the SATURN model.

1.2. Purpose of this Report

This report documents the key approach, inputs and outputs related to the forecasting exercise using the Vissim model as part of the hybrid modelling approach informing the economic appraisal for the OBC. It therefore forms part of a suite of technical documents supporting the OBC submission.

Full details of the hybrid modelling approach are provided within other supporting documentation to the OBC, principally the Economic Appraisal Report (WC_M4J17-ATK-GEB-XX-RP-TB-000005).

Further documentation supports the Wiltshire Transport Model, including the Local Model Validation Report (WC_M4J17-ATK-GEN-XX-RP-TR-000001) and the Forecasting Report (WC_M4J17-ATK-GEB-XX-RP-TR-000003).

1.3. Structure of this Report

The remainder of this report is structured as follows:

- Chapter 2 sets out the modelling approach and summarises the approach of forecasting within the Vissim model;
- Chapter 3 summarises the operational modelling results/analysis; and
- Chapter 4 presents a summary and conclusions.

2. Modelling Approach

2.1. Model Background

A 2019 based Vissim model of M4 Junction 17 was prepared by Jacobs on behalf of National Highways and made available for use on this project. The model was developed to cover a morning and evening peak time period, of 0700-1000 and 1600-1900 respectively. The extents of the base Vissim network is shown in Figure 2-1.

Figure 2-1 – Base Model Extents



The 2019 Vissim model, and its accompanying Local Model Validation Report (LMVR) have been reviewed by Atkins to determine the model's suitability for use on this project. The model review identified concerns with the model development, which were presented to the model developer, Jacobs, who in turn have provided an updated model for use on the project. Atkins confirm that the updated model is deemed suitable for use on this project.

An initial submission of Do Minimum (DM) model was also received from Jacobs which was refined further by Atkins for updated Chippenham Gateway Scheme (presented in section 2.4 below) and additional demand scenarios.

2.2. Wiltshire Transport Model

The Wiltshire Transport Model (WTM) has been used to provide traffic forecasting. The peak period Do Minimum (DM) and Do Something (DS) SATURN model used for economic assessment core scenario includes only committed development and network changes; details are provided in the Forecasting Report (WC_M4J17-ATK-GEB-XX-RP-TR-000003).

2.3. Demand Forecast Methodology

The Vissim forecast matrices were developed from the WTM peak period forecasts, with the WTM cordoned around the M4 Junction 17, providing a five-zone matrix to align with the Vissim zoning system. The SATURN model has five user classes, with user class 1 to 4 mapped to the light vehicle matrix in Vissim, and user class

5 mapped to the heavy vehicle matrix. The user class 5 demand was divided by 2.5 to convert from Passenger Car Units (PCU) to vehicles.

The Vissim model demands cover three-hour periods, split into 15-minute matrices, whilst the SATURN cordon matrices only cover the peak period. To convert these flows into full Vissim demands, the base Vissim 3 hour proportions were used to uplift the peak period SATURN matrices to peak hour, forecasted to future year and then profiled into 15 minute matrices for each future year. The growth in the SATURN model, as mapped and profiled to the Vissim system, has been added to the Vissim base demands using the general formula:

Vissim output flow (by 15min interval) = (Vissim 15min / Vissim peak hr) x [(SATURN (forecast) average hour) x (Vissim peak hour / Vissim average hour) + (the difference between survey and SATURN (base))]

The 2018 survey data, which the Vissim model is primarily based on, was used to pivot the traffic growth from rather than the 2019 Vissim base matrix, as the SATURN model is a 2018 based model.

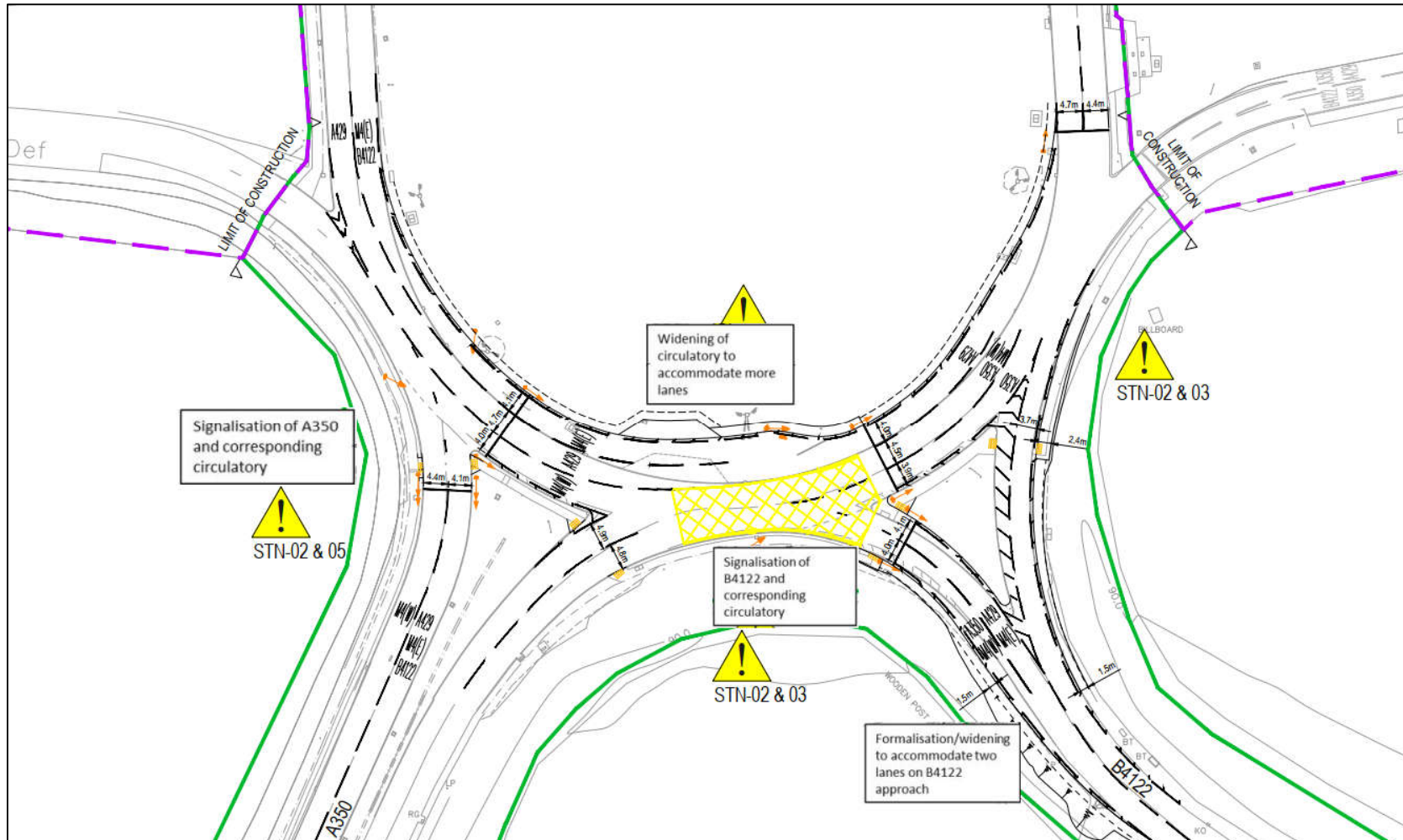
An iterative process was undertaken to align the SATURN and Vissim model, in terms of the traffic conditions at M4 Junction 17. The resultant final SATURN runs (reflecting traffic re-routing) informed the demand inputs to the final Vissim runs.

All demand inputs to Vissim are detailed in Appendix A.

2.4. Do Minimum Scheme

The Do Minimum model has been coded with a committed scheme associated with the Chippenham Gateway development. The scheme is predominantly focused upon the southern half of the M4 Junction 17, which is shown in **Figure 2-2**.

Figure 2-2 - Do Minimum Scheme



2.5. Proposed Scheme (Do Something) Modelling

The forecast Do Something 'with scheme' models have been used to test the predicted operational impacts of the M4 Junction 17 MRN scheme compared to the Do Minimum scenario. The preferred option (refined Option B+) has been modelled, which comprises:

- Widen approaches to M4 Junction 17;
- Deliver full signalisation of the roundabout;
- Include an additional lane on the entirety of the gyratory. The lane widths are narrowed to avoid the need for widening of the bridge;
- Changes to off and on-slips.

A drawing of the preferred option is provided in **Figure 2-3** and **Figure 2-4**, showing the northern half and southern half of the roundabout respectively.

A summary of key design features of the preferred scheme option is provided in the table below.

Table 2-1 DS Refined B+ scheme features

Scheme	Refined Option B+
Number of lanes on M4 Westbound and Eastbound off-slip approaches	3
Length of flare from two lanes to stopline- M4 Westbound off-slip	135m
A350 northbound lanes to M4 westbound on-slip	2
Length of A429 southbound two-lane section to stopline	180m
Length of A429 southbound three-lane approach	130m
Westbound on-slip two lane section length	200m
Eastbound on-slip merge	Taper
Length of flare from two lanes to stopline- M4 Eastbound off-slip	135m

Figure 2-3 - Refined Option B+ Scheme (northern half)

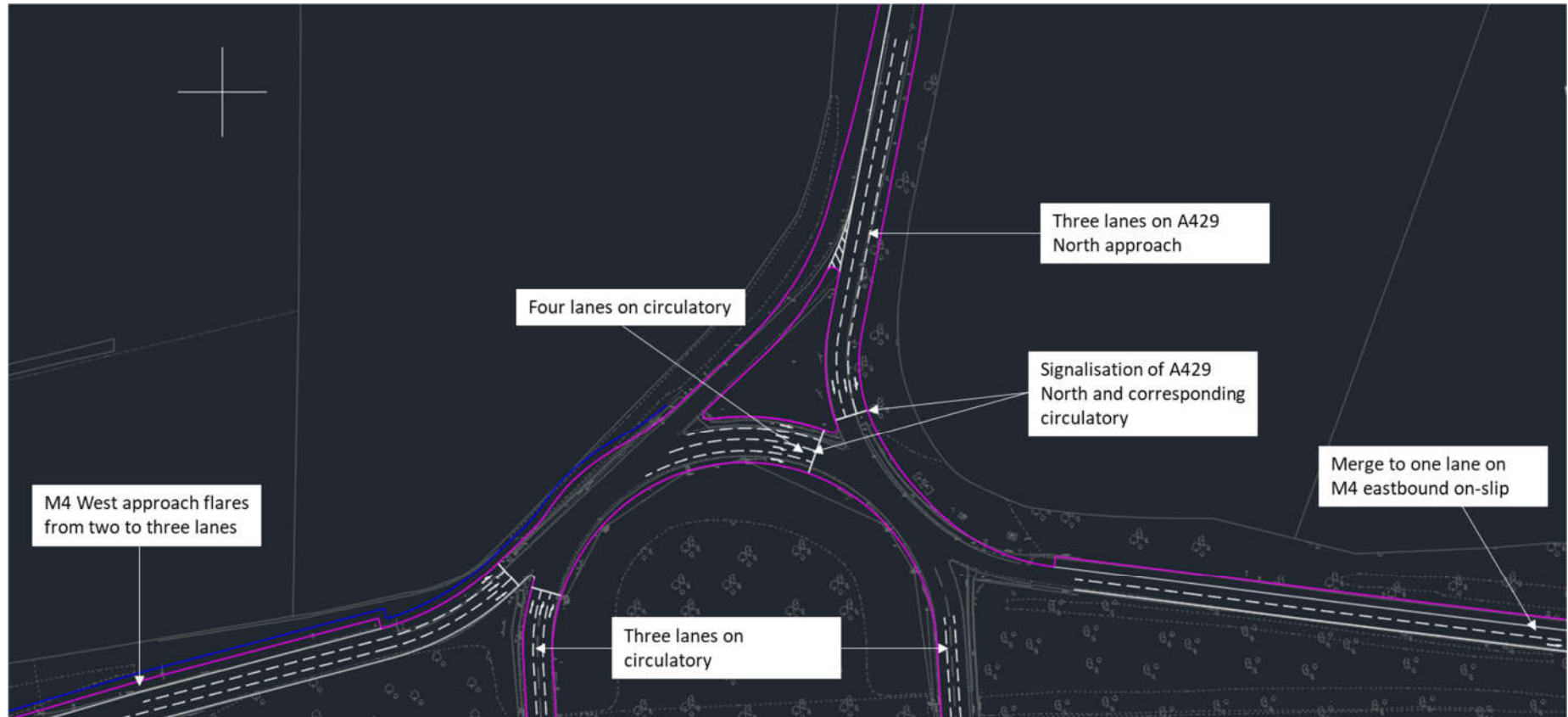


Figure 2-4 - Refined Option B+ Scheme (southern half)



2.5.1. Lane Width Modelling

Refined Option B+ involves the use of 3-metre-wide lanes on the two overbridges as part of the MRN scheme proposals (in the form of three narrow lanes). Vissim does not automatically take into account lane widths, and the potential operational impact of vehicles travelling closely side-by-side (i.e. side friction). Consequently, to include this within the Vissim model, a new driving behaviour was introduced for the bridges to reflect this. The changes include the following updates to the lateral settings:

- Minimum lateral distance standing increase from 0.2m to 1.0m; and
- Exceptions for overtaking vehicles of the following user classes- car and LGV.

The lane width coding has been removed in a sensitivity scenario in an attempt to understand the impacts of this coding, and the three-metre-wide lanes, on the modelling results. Details of Sensitive tests were presented in the Operational Assessment Report – September 2021.

2.5.2. Signal Coding

The received base model was coded with a linkage to PCMOVA, however the scheme testing has been undertaken with fixed timings. Atkins suggest that once the scheme has progressed sufficiently (to preliminary design) that the final design has a MOVA dataset produced and is assessed in the Vissim model.

The fixed timings for use in the Vissim model have been derived from a representative LinSig model. The LinSig model reflects the proposed scheme, and the forecast flows have been input into LinSig. The signal timings and offsets have been extracted from the LinSig model for use within the forecast Vissim model. This process is same as presented in the Operational Assessment Report – September 2021.

2.5.3. Vehicle Loading

Upon watching the forecast year model running, congestion was observed on the A350 (south) arm due to vehicles changing lanes to ensure they were in the required lane on approach to the M4 Junction 17. As a result, this reduced the capacity of the A350, and consequently the level of traffic arriving at the M4 Junction 17. To ensure a robust analysis of the operation of the M4 Junction 17, the zone loading point has been modified to be one lane. This ensures that all vehicles load in this one lane, and then can move into the correct lane for the approach to the junction, thereby removing the lane changing conflict and its associated predicted congestion issues. It is recommended that as the scheme progresses the level of demand in the network is reviewed, to ensure that the weaving congestion is not considered unreasonable. This is the same model setup used for tests presented in the Operational Assessment Report – September 2021.

2.5.4. Scenarios Modelled

The following modelling scenarios has been developed, to support the economic assessment. Forecasted flows from the final Do Minimum SATURN runs are used for 2024 and 2036 Do Minimum Vissim runs, following the iterative feedback process between Vissim and SATURN (see section 2.3). Do Something Vissim scenarios utilise the flows derived from the 2024 and 2036 Do Something SATURN runs.

- 2024 Do Minimum - The 2024 baseline model with the Chippenham Gateway proposed scheme and with flows derived from final iterated SATURN DM runs.
- 2036 Do Minimum - The 2036 baseline model with the Chippenham Gateway proposed scheme and with flows derived from final iterated SATURN DM runs.
- 2024 Do Something Refined Option B+ - the scheme runs with 2024 demand from SATURN DS.
- 2036 Do Something Refined Option B+ - the scheme runs with 2036 demand from SATURN DS.

3. Traffic impacts

The Do Minimum and Do Something Refined B+ models have been run 10 times, accounting for microsimulation modelling seed variance, for the morning and evening peak periods. The following results have been extracted from the model for all scenarios:

- Network Performance Summary
- Average (Avg) and Maximum (max) Queue lengths;
- Origin-Destination journey times;
- Acceptable Speed Plots.

The network performance summary provides an average delay per vehicles (total delay/number of vehicles), average network speed (total distance travelled/ total travel time) and throughput.

For the queue length results, the approximate available queue has been measured from the stop line to the upstream location where vehicles are likely to interact with other movements (i.e. next upstream junction). For example, for the M4 off-slips, this would be at/near the M4 mainline.

The Origin-Destination journey times are produced in a matrix, with the results provided in minutes and seconds (m,s).

The Origin-Destination journey times have been produced to understand the potential impact on journey times between each of the zones within the Vissim network.

Acceptable speed plots have been developed for the Do Minimum and the Do Something versions of the M4 Junction 17 scheme. Acceptable speed plots show where the model is predicting that there will be congestion within the network.

3.1. M4 Junction 17: 2024 Do Minimum and 2024 Do Something Refined Option B+

3.1.1. Context

The Do Minimum and Do Something scenario outputs for the peak hours in 2024 are compared in the sections below. Outputs for the entire simulation period of 3 hours is included Appendix B.

3.1.2. Network Performance Comparison

The network summary outputs for 2024 Do Minimum and Do Something is presented in **Table 3-1** below.

Table 3-1 – Network Performance Summary- 2024 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
Average Delay Time (s)	68.81	65.47	44.56	54.75	-24.25	-10.72
Average Network Speed (km/hr)	73.5	74.69	79.78	77.2	6.28	2.51
Throughput (vehicles)	8823	9727	9309	10268	486	541

3.1.3. Modelled Queues

The queue results for Do Something are shown in **Table 3-2** for the average queue and **Table 3-3** for the maximum queue, including a comparison to the Do Minimum. A negative value indicates an improvement in queues in the Do Something B+ scenario compared against the Do Minimum 3-minute penalty runs.

Table 3-2 - Average Queue Results- 2024 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	15	18	24	19	8	1
A429 North	240	79	15	20	15	-59	1
M4 East Off-slip	400	11	15	13	15	1	0
B4122	630	629	701	10	276	-619	-425
A350 South	400	37	46	22	22	-15	-24

Table 3-3 - Maximum Queue Results- 2024 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	87	90	100	96	13	5
A429 North	240	448	101	107	100	-341	0
M4 East Off-slip	400	67	72	61	64	-7	-8
B4122	630	881	908	53	752	-828	-156
A350 South	400	198	212	184	138	-13	-74

Results show that there is predicted improvement in average and maximum queue in DS scenarios.

3.1.4. Origin-Destination Journey Times

The comparison in Origin-Destination journey times between the DM and DS has been calculated and is summarised in **Table 3-4** and **Table 3-5** for the morning and evening peak respectively. A negative value indicates a lower O-D journey time in the DS scenario, whilst a positive value indicates a higher O-D journey time in the DS scenario.

Table 3-4 - Origin-Destination Journey Time Difference (s) 2024 DS vs DM: Morning Peak

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	12s	0s	10s	4s
A429 North	-29s	0s	-1m 1s	-60s	-43s
M4 East	0s	16s	0s	4s	3s
B4122	-7m 42s	-8m 49s	-8m 54s	0s	-7m 20s
A350 South	-15s	1s	31s	15s	0s

Table 3-5 - Origin-Destination Journey Time Difference (s) 2024 DS vs DM: Evening Peak

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	10s	1s	15s	11s
A429 North	-3s	0s	0s	-2s	-3s
M4 East	0s	20s	0s	6s	-2s
B4122	-4m 23s	-4m 26s	-4m 13s	0s	-3m 26s
A350 South	-17s	3s	33s	16s	0s

The results show that there are generally large predicted benefits in O-D journey time with the DS scheme, in both the morning and evening peak.

3.1.5. Acceptable Speed Comparison

Acceptable speed plots have been produced for the 2024 DM and DS scenarios, for the morning and evening peak hour. The morning peak plots are shown in **Figure 3-1** and **Figure 3-2** for the DM and DS scenarios respectively, whilst the evening peak plots are shown in **Figure 3-3** and **Figure 3-4** for the DM and DS scenarios respectively.

With the DS option the acceptable speed plots show improved levels of congestion in both the morning and evening peak, and in both peaks there is predicted to not be interaction between the westbound off-slip and the mainline.

Figure 3-1 - 2024 Do Minimum Acceptable Speed: Morning Peak

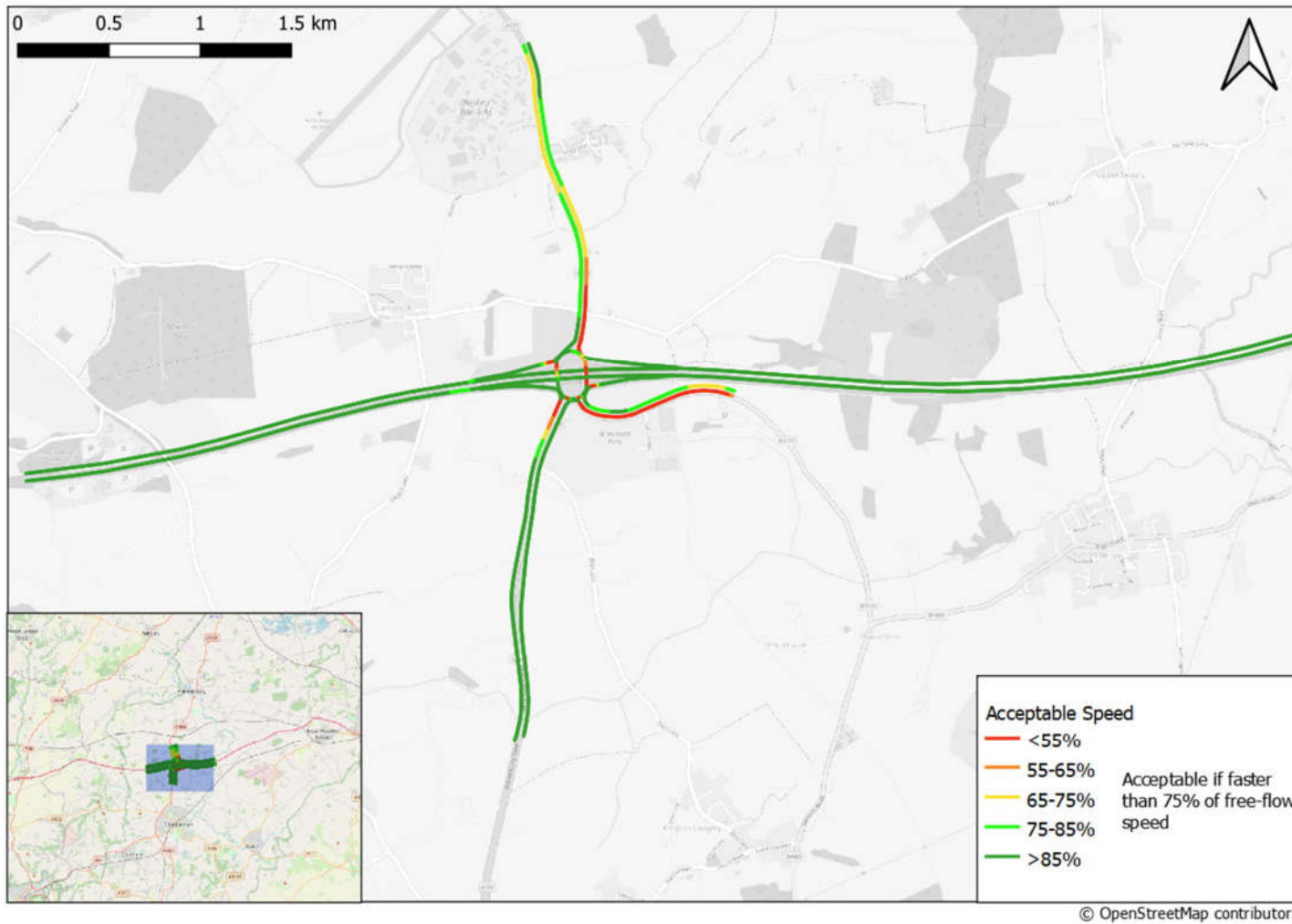


Figure 3-2 - 2024 Do Something Acceptable Speed: Morning Peak

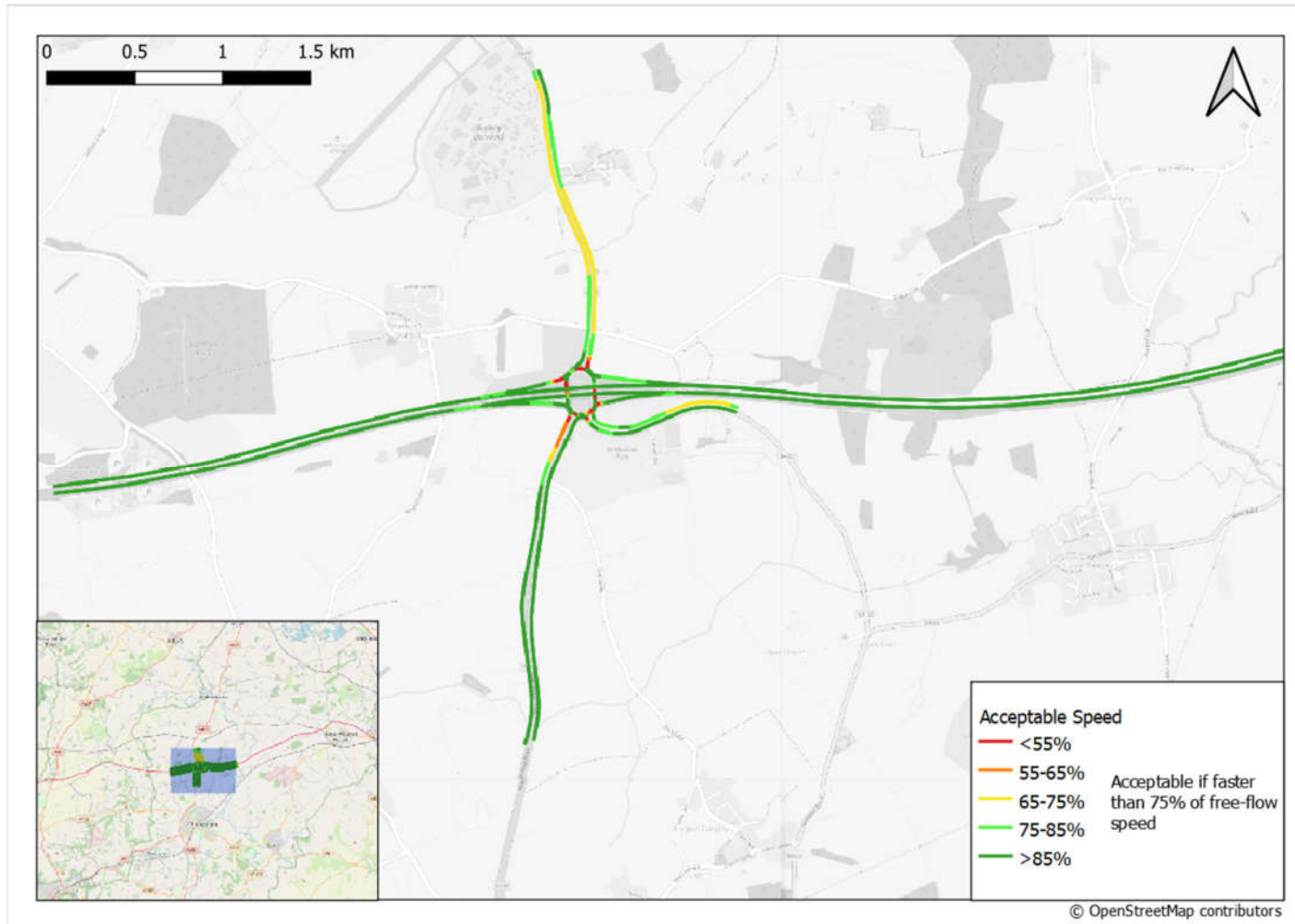


Figure 3-3 - 2024 Do Minimum Acceptable Speed: Evening Peak

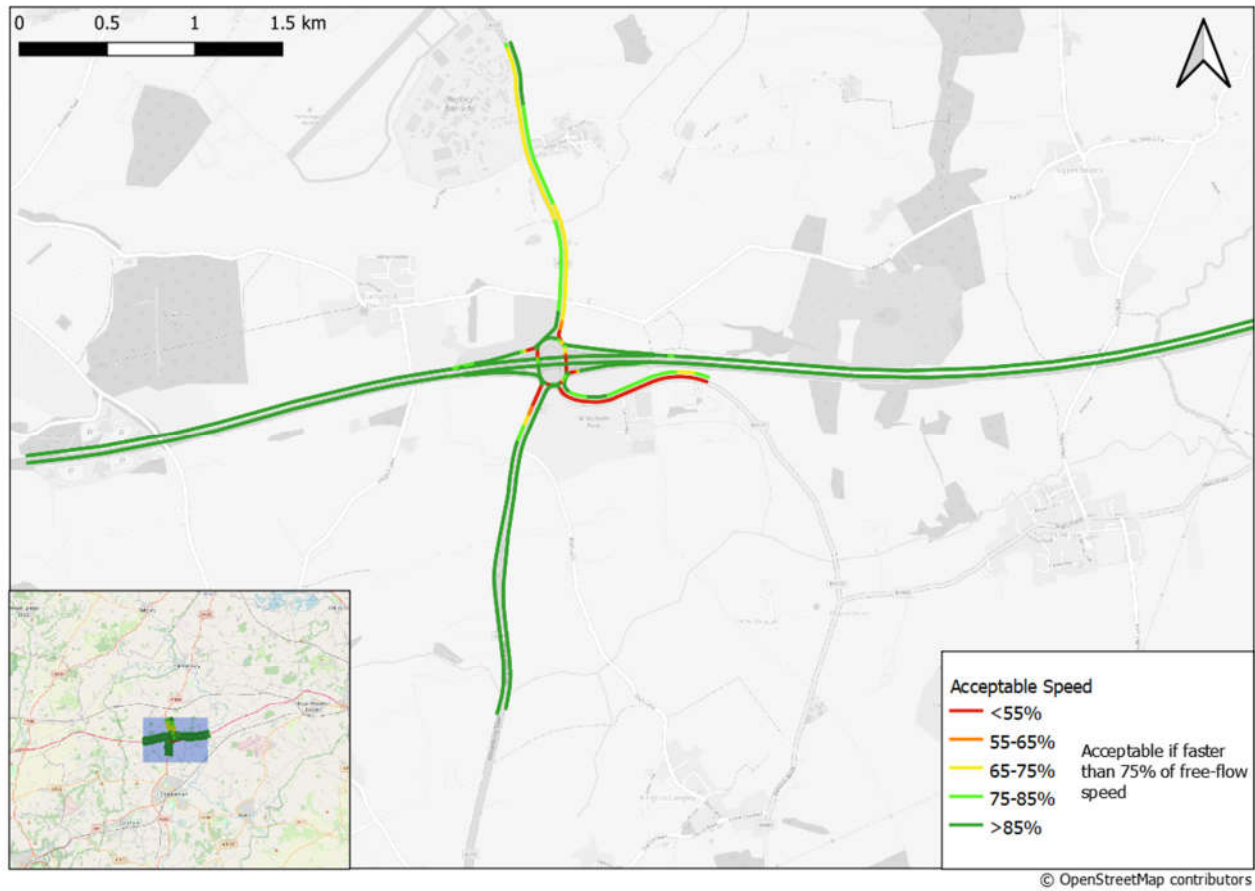
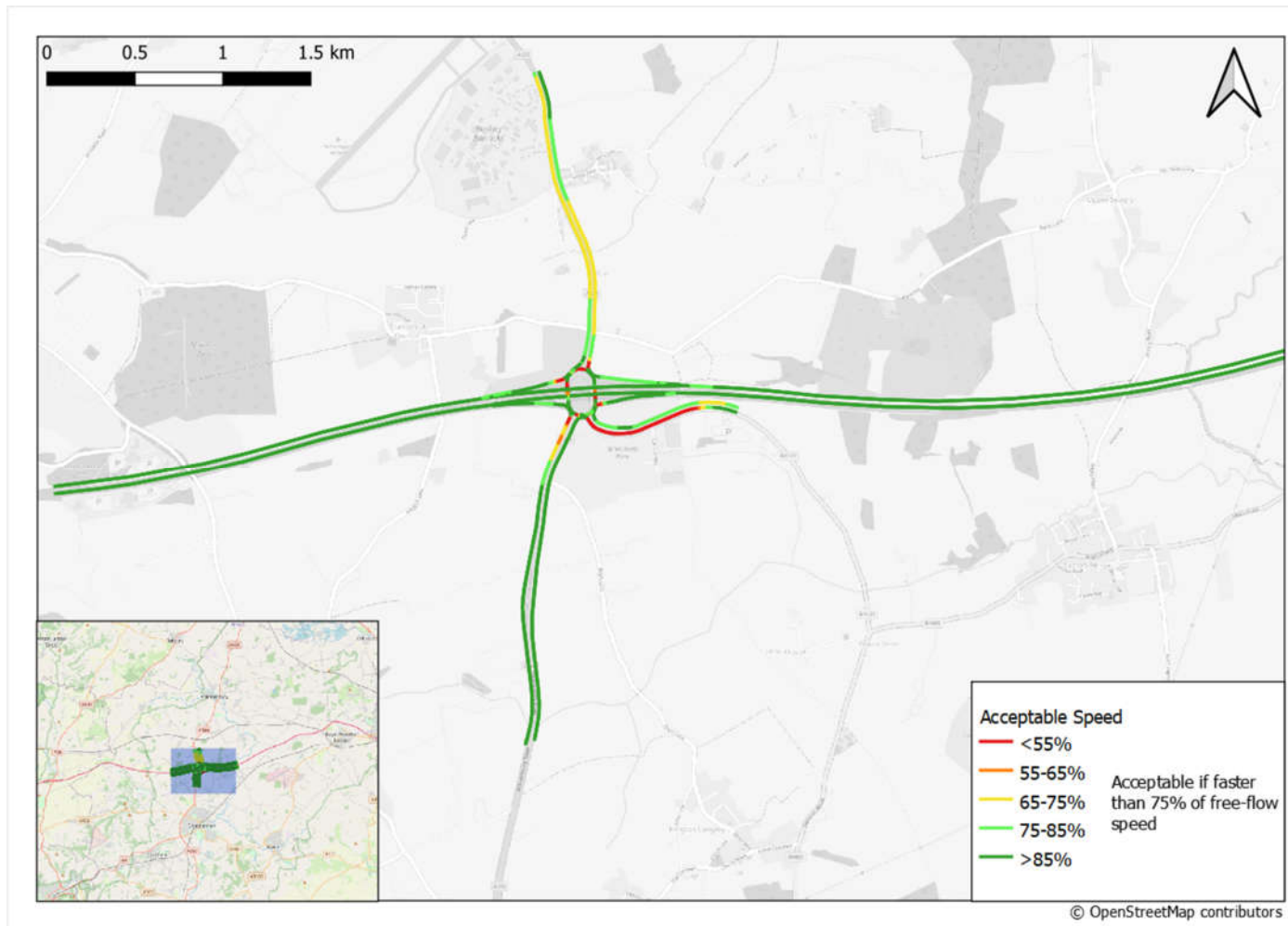


Figure 3-4 - 2024 Do Something Acceptable Speed: Evening Peak



3.2. M4 Junction 17: 2036 Do Minimum and 2036 Do Something Refined Option B+

3.2.1. Context

The Do Minimum and Do Something scenario outputs for the peak hours in 2036 are compared in the sections below. Details for the entire simulation period of 3 hours is included in Appendix B.

3.2.2. Network Performance Comparison

The network summary outputs for 2036 DM and DS is presented in **Table 3-6** below.

Table 3-6 – Network Performance Summary- 2036 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
Average Delay Time (s)	116.78	92.88	55.28	60.49	-61.5	-32.39
Average Network Speed (km/hr)	62.84	68.29	76.9	75.95	14.06	7.66
Throughput (vehicles)	10399	11547	11023	12224	624	677

3.2.3. Modelled Queues

The average queue results for the DS are shown in **Table 3-7**, with the maximum queue results included in **Table 3-8**.

A negative value indicates a predicted improvement in queueing with the DS scheme, whilst a positive value indicates a predicted worsening in queueing with the DS scheme.

Table 3-7 - Average Queue Results- 2036 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	27	26	83	23	56	-3
A429 North	240	505	104	31	20	-474	-83
M4 East Off-slip	400	18	207	22	25	4	-182
B4122	630	842	630	11	287	-830	-343
A350 South	400	1,159	488	37	36	-1,122	-452

Table 3-8 - Maximum Queue Results- 2036 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	120	123	279	109	159	-14
A429 North	240	1,131	384	145	108	-986	-276
M4 East Off-slip	400	100	316	94	94	-6	-222
B4122	630	910	905	57	793	-853	-112
A350 South	400	1,807	766	255	214	-1,552	-552

Results show that there is predicted improvement in average and maximum queue in DS scenarios.

3.2.4. Origin-Destination Journey Times

The comparison in Origin-Destination journey times between the DM and DS is summarised in **Table 3-9** for the morning peak and **Table 3-10** for the evening peak. A negative value indicates a lower O-D journey time in the DS scenario, whilst a positive value indicates a higher O-D journey time in the DS scenario.

Table 3-9 - Origin-Destination Journey Time Difference (s) 2036 DS vs DM: Morning Peak

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	17s	1s	50s	45s
A429 North	-4m 31s	0s	-5m 5s	-5m 4s	-4m 44s
M4 East	-1s	19s	0s	10s	10s
B4122	-10m 38s	-11m 45s	-11m 49s	0s	-10m 18s
A350 South	-4m 48s	-4m 41s	21s	-3s	0s

Table 3-10 - Origin-Destination Journey Time Difference (s) 2036 DS vs DM: Evening Peak

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	6s	0s	10s	8s
A429 North	-1m 20s	0s	-1m 8s	-1m 21s	-1m 17s
M4 East	0s	-2m 48s	0s	-2m 54s	-3m 3s
B4122	-3m 50s	-3m 57s	-3m 45s	0s	-2m 50s
A350 South	-2m 23s	-2m 0s	27s	8s	0s

The results show that there are generally large predicted journey time benefits in the morning and evening peak with the Do Something scheme. This is particularly the case for origins of the A429 North, A350 South and B4122.

3.2.5. Acceptable Speed Comparison

Acceptable speed plots have been produced for the 2036 DM and 2036 DS scenarios, for the morning and evening peak hour. **Figure 3-5** and **Figure 3-6** show the morning peak acceptable speed plots for DM and the DS respectively, whilst **Figure 3-7** and **Figure 3-8** show the evening peak acceptable speed plots DM and the DS respectively.

The DS scenarios show an improved picture compared to the DM.

Figure 3-5 - 2036 Do Minimum Acceptable Speed: Morning Peak

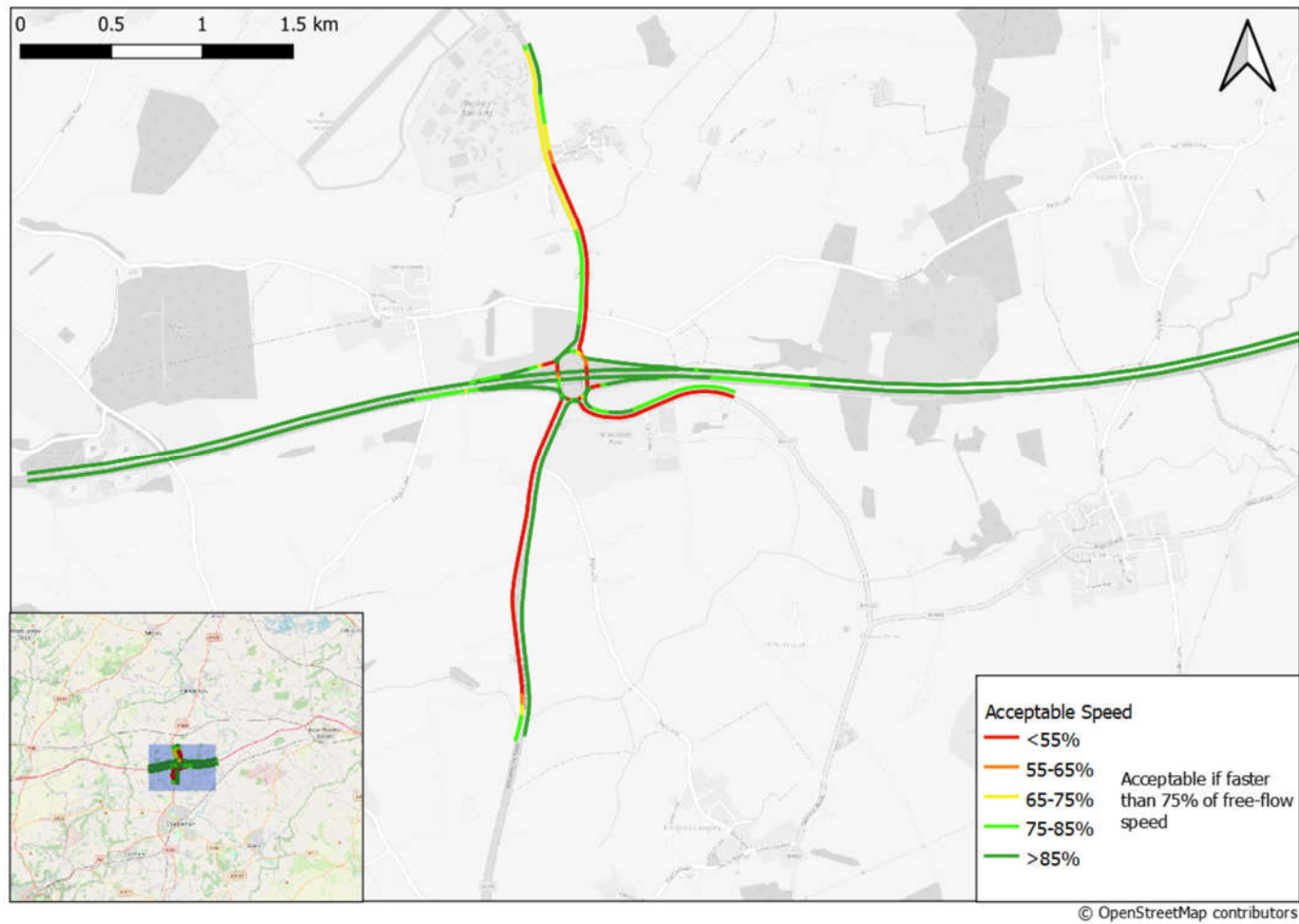


Figure 3-6 - 2036 Do Something Acceptable Speed: Morning Peak

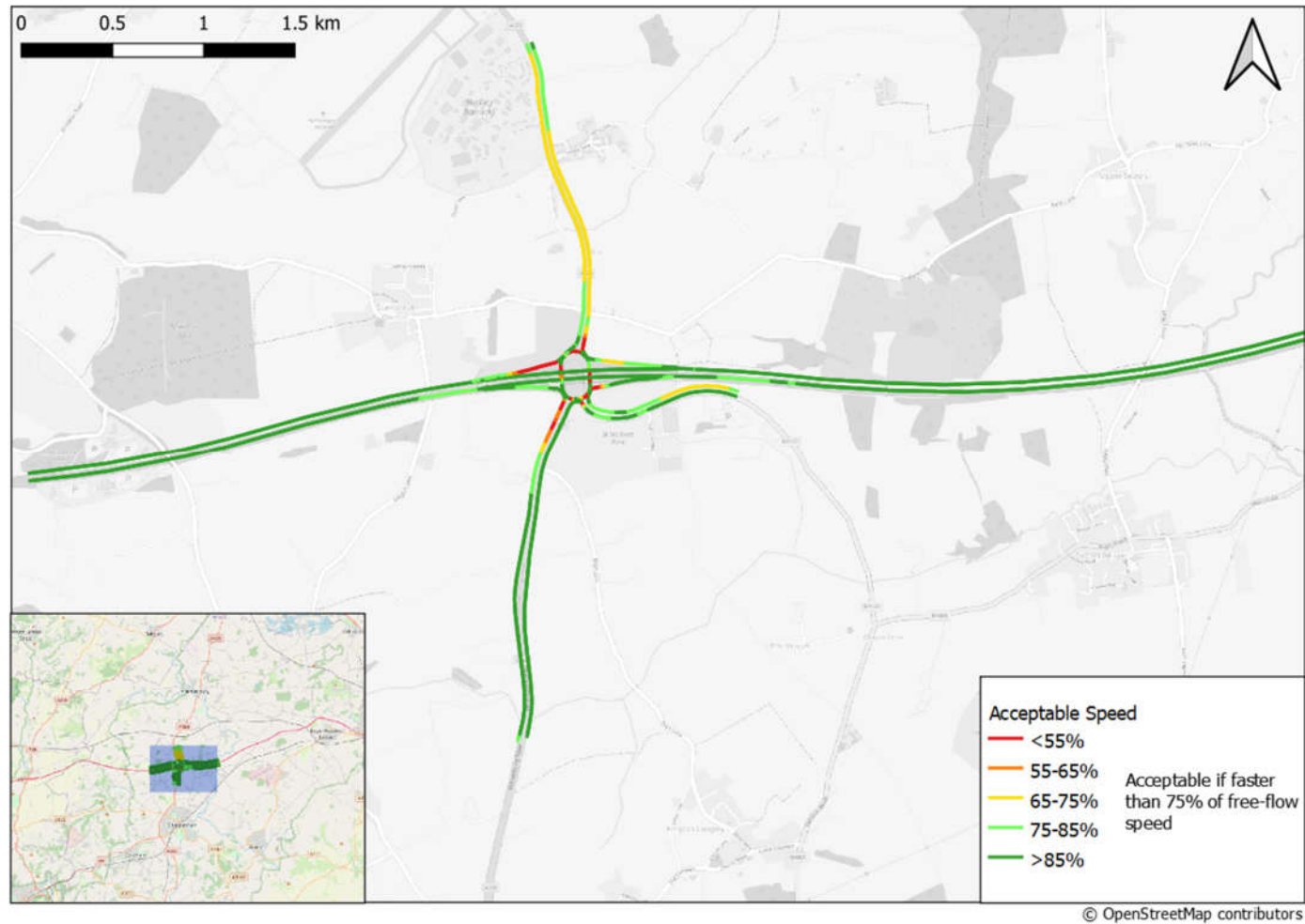


Figure 3-7 - 2036 Do Minimum Acceptable Speed: Evening Peak

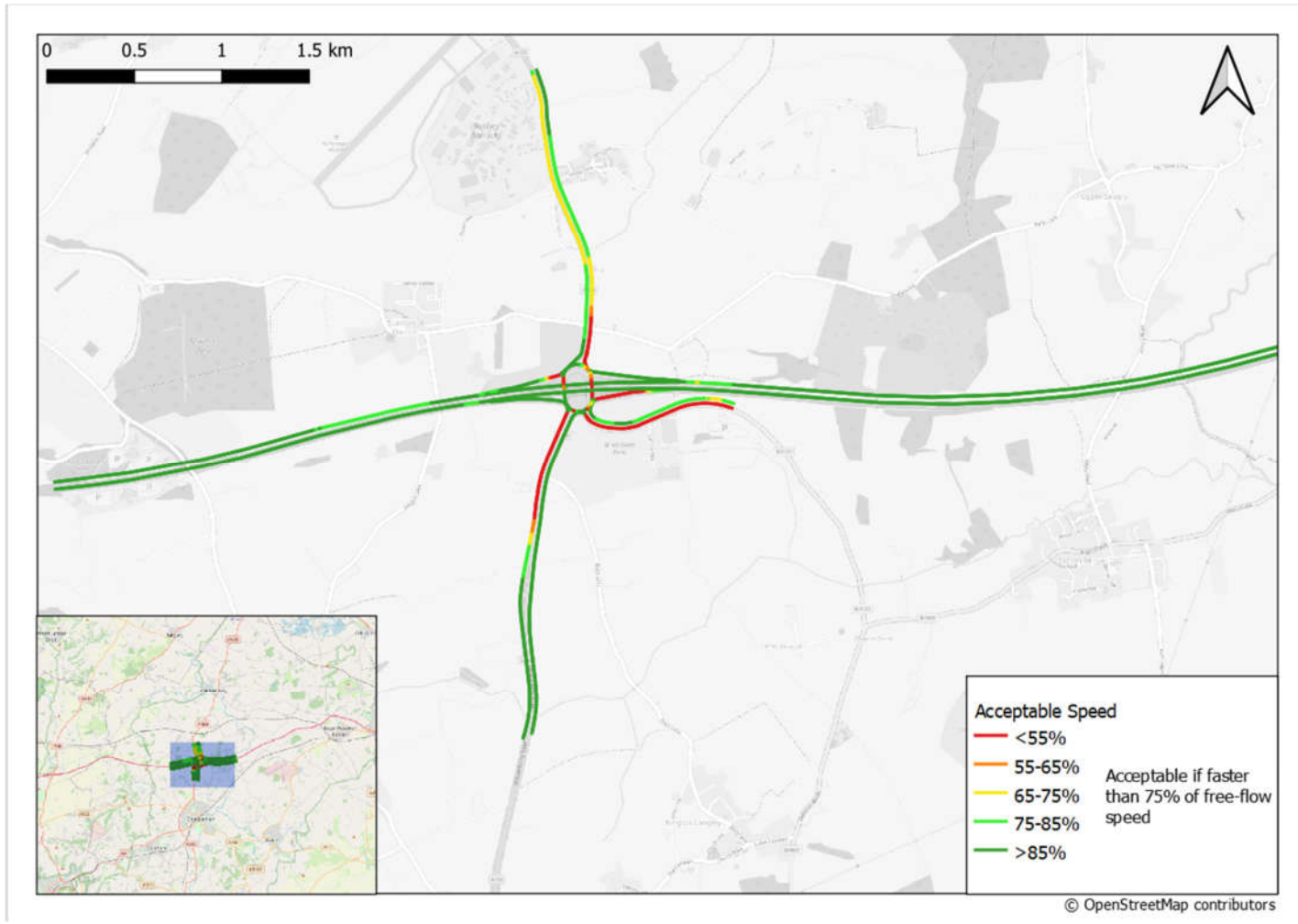
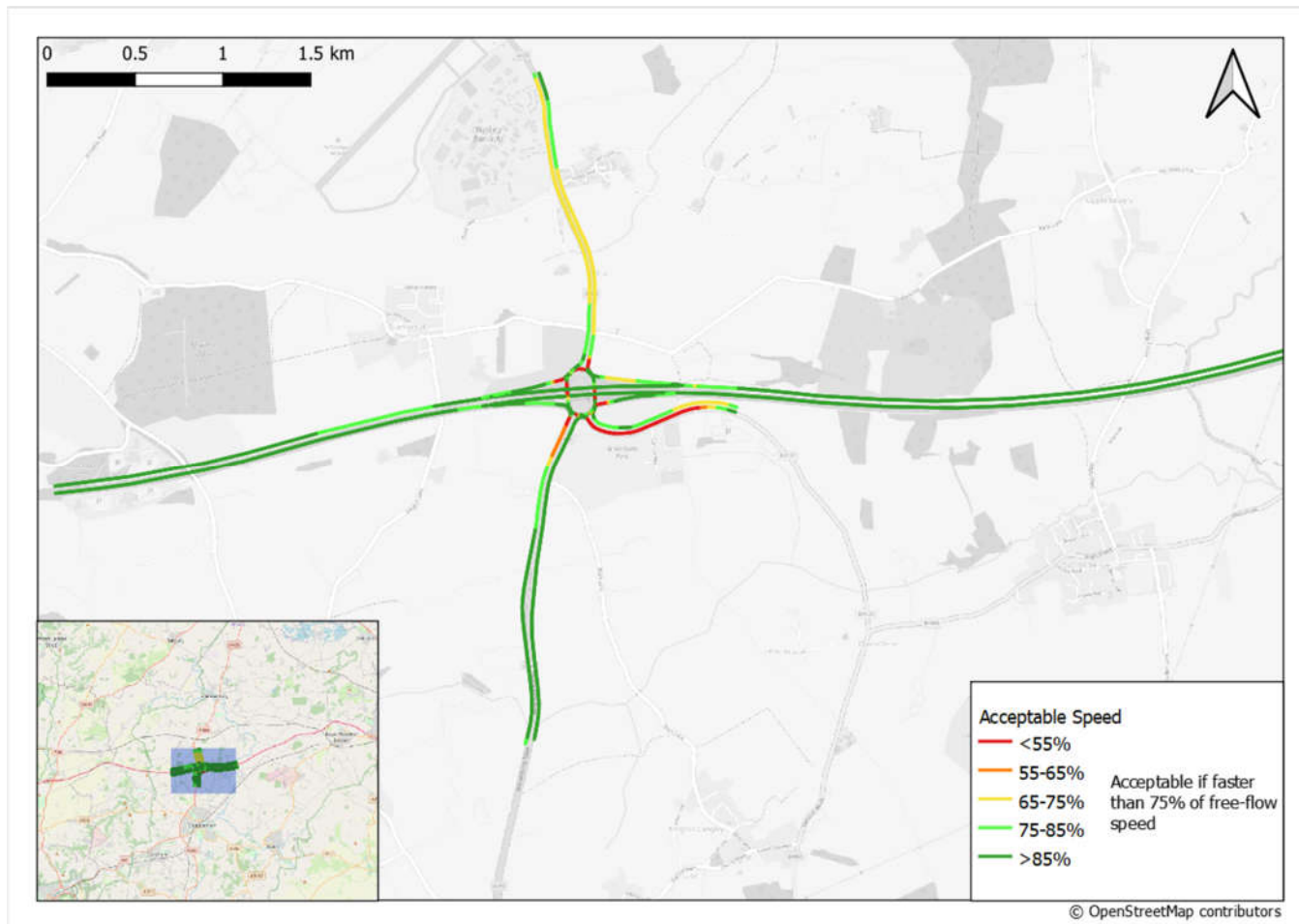


Figure 3-8 - 2036 Do Something Acceptable Speed: Evening Peak



3.2.6. Inputs to Economic Assessment

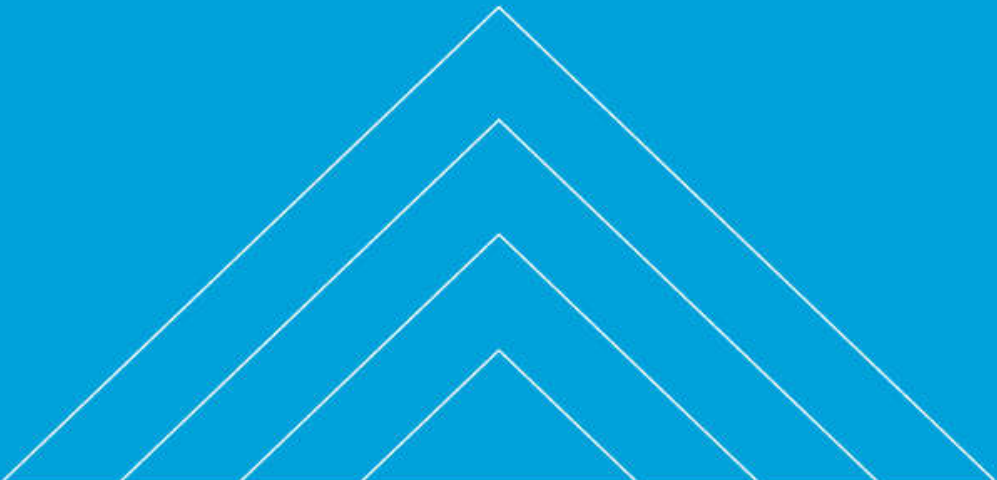
Data from the final Vissim DM and DS model runs were extracted for passing into the economic assessment, which combined the SATURN and VISSIM outputs through a TUBA assessment. Standard outputs were provided from Vissim in the form of matrix skims by vehicle type for each origin to destination pair in the Vissim model, in relation to:

- Journey times;
- Traffic volume; and
- Travel distance.

4. Summary and Conclusions

The M4 Junction 17 Vissim model has been used to support the economic assessment of the proposed MRN improvement scheme as part of an Outline Business Case submission. The methodology involves a hybrid approach making use of both the SATURN model (Wiltshire Transport Model) and Vissim model. The forecast traffic inputs to the Vissim model have been derived from SATURN, reflecting predicted impacts of traffic rerouting under more congested traffic conditions (in the Do Minimum). Outputs from the final Vissim Do Minimum and Do Something model runs for 2024 and 2036 have been input to the combined TUBA assessment. Full details of the process are provided within further supporting documentation to the Outline Business Case, including the Economic Appraisal Report and the SATURN Forecasting Report. This note has documented the key approach, inputs and outputs related to the forecasting exercise using the Vissim model.

Appendices



Appendix A. Traffic input to Vissim

For 2024 DM:

Lights 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	389	1753	217	338
A429 North	182	0	125	55	98
M4 East	2982	104	0	111	531
B4122	128	115	210	0	20
A350 South	550	347	324	306	0

Lights 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	199	1468	263	418
A429 North	221	0	148	69	118
M4 East	2857	91	0	127	459
B4122	90	80	137	0	92
A350 South	392	305	274	315	0

Lights 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	98	1481	178	272
A429 North	162	0	89	49	88
M4 East	2186	64	0	42	345
B4122	44	43	83	0	68
A350 South	297	252	239	220	0

Heavies 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	126	32	50
A429 North	5	0	1	0	30
M4 East	135	2	0	10	40
B4122	14	4	17	0	12
A350 South	30	27	19	12	0

Heavies 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	89	29	43
A429 North	4	0	0	0	40
M4 East	131	3	0	5	28
B4122	17	7	12	0	11
A350 South	48	27	29	9	0

Heavies 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	26	97	31	48
A429 North	7	0	1	0	29
M4 East	168	0	0	9	37
B4122	7	2	11	0	10
A350 South	34	21	17	8	0

Lights 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	202	3223	279	417
A429 North	293	0	90	75	170
M4 East	2277	106	0	60	535
B4122	87	83	186	0	117
A350 South	372	291	269	184	0

Lights 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	212	2989	321	483
A429 North	278	0	96	70	163
M4 East	1940	110	0	47	584
B4122	72	65	147	0	377
A350 South	345	346	310	207	0

Lights 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	137	2337	228	331
A429 North	200	0	48	52	115
M4 East	1613	100	0	43	507
B4122	50	49	110	0	91
A350 South	239	230	206	140	0

Heavies 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	12	182	27	31
A429 North	6	0	2	2	25
M4 East	202	0	0	22	3
B4122	10	6	17	0	7
A350 South	41	34	21	6	0

Heavies 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	10	138	30	36
A429 North	2	0	2	4	13
M4 East	176	0	0	20	0
B4122	8	1	7	0	1
A350 South	44	22	18	6	0

Heavies 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	8	107	17	17
A429 North	2	0	0	1	5
M4 East	168	0	0	18	0
B4122	6	1	5	0	4
A350 South	20	29	22	4	0

For 2024 DS:

Lights 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	367	1736	206	330
A429 North	241	0	120	71	232
M4 East	2941	100	0	111	524
B4122	115	107	173	0	20
A350 South	625	494	481	389	0

Lights 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	188	1454	248	408
A429 North	295	0	142	89	278
M4 East	2817	87	0	127	454
B4122	83	74	114	0	94
A350 South	445	434	406	399	0

Lights 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	94	1466	168	266
A429 North	216	0	85	64	208
M4 East	2154	64	0	42	340
B4122	40	42	69	0	70
A350 South	337	357	353	278	0

Heavies 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	126	32	50
A429 North	5	0	1	0	35
M4 East	131	2	0	10	37
B4122	15	4	13	0	12
A350 South	33	31	32	12	0

Heavies 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	89	29	43
A429 North	4	0	1	0	44
M4 East	128	3	0	5	26
B4122	18	7	9	0	11
A350 South	54	32	47	9	0

Heavies 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	26	97	31	48
A429 North	7	0	4	0	32
M4 East	165	0	0	9	35
B4122	7	2	8	0	10
A350 South	38	24	28	8	0

Lights 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	197	3189	275	414
A429 North	331	0	85	104	310
M4 East	2264	106	0	60	533
B4122	50	74	159	0	117
A350 South	446	396	411	207	0

Lights 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	206	2958	317	479
A429 North	314	0	91	96	295
M4 East	1930	110	0	47	581
B4122	41	59	125	0	377
A350 South	415	468	476	233	0

Lights 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	133	2312	223	327
A429 North	227	0	47	72	207
M4 East	1605	100	0	43	507
B4122	27	45	95	0	91
A350 South	287	312	315	156	0

Heavies 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	12	183	27	31
A429 North	8	0	3	2	29
M4 East	202	0	0	22	0
B4122	8	6	16	0	7
A350 South	49	36	28	6	0

Heavies 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	10	138	30	36
A429 North	2	0	4	4	15
M4 East	176	0	0	20	0
B4122	6	1	7	0	1
A350 South	52	25	26	6	0

Heavies 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	8	107	17	17
A429 North	3	0	0	1	6
M4 East	168	0	0	18	0
B4122	6	1	5	0	4
A350 South	25	32	30	4	0

For 2036 DM:

Lights 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	454	2247	242	408
A429 North	197	0	131	55	140
M4 East	3542	123	0	128	689
B4122	128	117	228	0	18
A350 South	675	354	429	249	0

Lights 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	233	1881	293	504
A429 North	242	0	154	69	168
M4 East	3394	108	0	146	596
B4122	90	81	148	0	85
A350 South	480	311	364	255	0

Lights 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	116	1899	198	328
A429 North	177	0	93	49	125
M4 East	2596	78	0	49	448
B4122	44	45	89	0	62
A350 South	364	256	317	178	0

Heavies 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	142	32	82
A429 North	5	0	1	0	33
M4 East	158	2	0	10	49
B4122	12	4	17	0	12
A350 South	34	27	24	12	0

Heavies 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	100	29	71
A429 North	4	0	1	0	40
M4 East	154	3	0	5	33
B4122	14	7	12	0	11
A350 South	56	27	36	9	0

Heavies 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	26	109	31	79
A429 North	7	0	4	0	30
M4 East	197	0	0	9	45
B4122	6	2	11	0	10
A350 South	38	21	21	8	0

Lights 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	220	3797	292	500
A429 North	296	0	93	75	192
M4 East	3010	120	0	69	672
B4122	92	86	196	0	106
A350 South	482	322	385	175	0

Lights 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	229	3520	337	579
A429 North	281	0	102	70	183
M4 East	2566	125	0	54	734
B4122	75	69	154	0	338
A350 South	448	379	445	198	0

Lights 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	148	2753	237	396
A429 North	204	0	51	52	128
M4 East	2134	113	0	49	639
B4122	51	53	116	0	82
A350 South	310	253	295	132	0

Heavies 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	12	195	28	35
A429 North	6	0	2	2	25
M4 East	219	0	0	22	11
B4122	8	6	17	0	7
A350 South	52	36	21	6	0

Heavies 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	10	146	33	39
A429 North	2	0	2	4	13
M4 East	192	0	0	20	5
B4122	6	1	7	0	1
A350 South	56	25	21	6	0

Heavies 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	8	113	17	19
A429 North	2	0	0	1	5
M4 East	182	0	0	18	4
B4122	6	1	5	0	4
A350 South	25	32	23	4	0

For 2036 DS:

Lights 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	438	2234	232	404
A429 North	279	0	136	68	279
M4 East	3484	121	0	128	685
B4122	177	107	173	0	18
A350 South	697	535	592	391	0

Lights 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	223	1873	280	500
A429 North	339	0	161	85	334
M4 East	3338	106	0	146	593
B4122	126	74	113	0	89
A350 South	497	470	498	402	0

Lights 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	111	1887	190	325
A429 North	250	0	97	61	248
M4 East	2552	77	0	49	446
B4122	61	42	68	0	66
A350 South	376	388	437	281	0

Heavies 07:00 to 08:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	142	32	78
A429 North	7	0	1	0	35
M4 East	156	2	0	10	49
B4122	16	4	13	0	12
A350 South	37	32	35	12	0

Heavies 08:00 to 09:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	17	101	29	67
A429 North	6	0	1	0	46
M4 East	152	3	0	5	33
B4122	18	7	9	0	11
A350 South	61	34	54	9	0

Heavies 09:00 to 10:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	26	110	31	75
A429 North	10	0	4	0	33
M4 East	193	0	0	9	45
B4122	8	2	8	0	10
A350 South	42	27	30	8	0

Lights 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	221	3747	292	495
A429 North	366	0	101	87	381
M4 East	2978	120	0	68	673
B4122	106	76	169	0	116
A350 South	528	459	540	207	0

Lights 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	232	3473	337	573
A429 North	346	0	109	81	362
M4 East	2539	126	0	54	734
B4122	86	61	133	0	370
A350 South	491	542	624	233	0

Lights 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	149	2716	237	391
A429 North	250	0	55	59	255
M4 East	2112	113	0	49	639
B4122	58	45	100	0	90
A350 South	340	361	414	156	0

Heavies 16:00 to 17:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	12	195	28	35
A429 North	8	0	2	2	31
M4 East	219	0	0	22	11
B4122	10	6	16	0	7
A350 South	54	40	28	6	0

Heavies 17:00 to 18:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	10	146	33	39
A429 North	2	0	2	4	16
M4 East	190	0	0	20	5
B4122	8	1	7	0	1
A350 South	59	26	26	6	0

Heavies 18:00 to 19:00

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0	8	115	17	19
A429 North	3	0	0	1	6
M4 East	182	0	0	18	4
B4122	6	1	5	0	4
A350 South	27	34	30	4	0

Appendix B. Network Performance Results

For 2024:

Hour 1

Network Performance Summary- 2024 M4 Junction 17 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0700-0800	1600-1700	0700-0800	1600-1700	0700-0800	1600-1700
Average Delay Time (s)	61.35	43.29	46.15	44.66	-15.2	1.37
Average Network Speed (km/hr)	76.45	82.77	80.19	81.74	3.74	-1.03
Throughput (vehicles)	8732	9194	9279	9586	547	392
Travel time total (hr)	722.91	718.74	718.62	750.62	-4.29	31.88

Hour 2

Network Performance Summary- 2024 M4 Junction 17 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
Average Delay Time (s)	68.81	65.47	44.56	54.75	-24.25	-10.7
Average Network Speed (km/hr)	73.5	74.69	79.78	77.2	6.28	2.51
Throughput (vehicles)	8823	9727	9309	10268	486	541
Travel time total (hr)	720.56	787.9	688.81	791.98	-31.75	4.08

Hour 3

Network Performance Summary- 2024 M4 Junction 17 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0900-1000	1800-1900	0900-1000	1800-1900	0900-1000	1800-1900
Average Delay Time (s)	27.38	35.2	33.71	35.28	6.33	0.08
Average Network Speed (km/hr)	87.26	84.88	84.05	84.32	-3.21	-0.56
Throughput (vehicles)	7004	7589	7416	7864	412	275
Travel time total (hr)	489.53	542.71	529.57	561.94	40.04	19.23

For 2036:

Hour 1

Network Performance Summary- 2036 M4 Junction 17 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0700-0800	1600-1700	0700-0800	1600-1700	0700-0800	1600-1700
Average Delay Time (s)	90.46	58.01	54.62	52.02	-35.84	-5.99
Average Network Speed (km/hr)	69.53	78.85	78.05	79.9	8.52	1.05
Throughput (vehicles)	10203	10861	11000	11454	797	593
Travel time total (hr)	945.62	906.28	884.55	926.29	-101.1	20.01

Hour 2

Network Performance Summary- 2036 M4 Junction 17 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
Average Delay Time (s)	116.78	92.88	55.28	60.49	-61.5	-32.4
Average Network Speed (km/hr)	62.84	68.29	76.9	75.95	14.06	7.66
Throughput (vehicles)	10399	11547	11023	12224	624	677
Travel time total (hr)	1008.5	1037.12	855.59	968.95	-152.9	-68.2

Hour 3

Network Performance Summary- 2036 M4 Junction 17 DM and DS

Measures	Do Minimum		Do Something		Difference	
	0900-1000	1800-1900	0900-1000	1800-1900	0900-1000	1800-1900
Average Delay Time (s)	36.57	54.54	38.04	40.11	1.47	-14.4
Average Network Speed (km/hr)	84.42	79.1	83.06	83.1	-1.36	4
Throughput (vehicles)	8490	9109	8860	9423	370	314
Travel time total (hr)	614.84	703.99	645.23	688.01	30.39	-16

Queue Results

For 2024:

Hour 1

Average Queue Results- 2024 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0700-0800	1600-1700	0700-0800	1600-1700	0700-0800	1600-1700
M4 West Off-slip	370	21	14	22	16	1	1
A429 North	240	7	13	12	17	4	4
M4 East Off-slip	400	13	14	13	14	0	0
B4122	630	220	82	12	14	-208	-68
A350 South	400	428	37	31	18	-397	-19

Maximum Queue Results- 2024 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0700-0800	1600-1700	0700-0800	1600-1700	0700-0800	1600-1700
M4 West Off-slip	370	120	87	115	93	-4	7
A429 North	240	59	103	83	118	24	15
M4 East Off-slip	400	84	76	61	64	-23	-12
B4122	630	676	321	60	77	-615	-243
A350 South	400	818	221	257	126	-561	-95

Hour 2

Average Queue Results- 2024 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	15	18	24	19	8	1
A429 North	240	79	15	20	15	-59	1
M4 East Off-slip	400	11	15	13	15	1	0
B4122	630	629	701	10	276	-619	-425
A350 South	400	37	46	22	22	-15	-24

Maximum Queue Results- 2024 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	87	90	100	96	13	5
A429 North	240	448	101	107	100	-341	0
M4 East Off-slip	400	67	72	61	64	-7	-8
B4122	630	881	908	53	752	-828	-156
A350 South	400	198	212	184	138	-13	-74

Hour 3

Average Queue Results- 2024 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0900-1000	1800-1900	0900-1000	1800-1900	0900-1000	1800-1900
M4 West Off-slip	370	9	10	12	12	4	2
A429 North	240	3	3	11	9	8	6
M4 East Off-slip	400	7	13	9	13	2	0
B4122	630	8	116	6	16	-2	-100
A350 South	400	17	15	12	14	-5	-1

Maximum Queue Results- 2024 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0900-1000	1800-1900	0900-1000	1800-1900	0900-1000	1800-1900
M4 West Off-slip	370	63	71	68	73	5	2
A429 North	240	54	54	81	71	27	17
M4 East Off-slip	400	47	71	45	61	-2	-11
B4122	630	92	770	40	203	-51	-568
A350 South	400	128	138	110	113	-18	-25

For 2036:

Hour 1

Average Queue Results- 2036 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0700-0800	1600-1700	0700-0800	1600-1700	0700-0800	1600-1700
M4 West Off-slip	370	55	19	47	18	-8	-1
A429 North	240	16	29	15	22	-1	-7
M4 East Off-slip	400	33	66	20	20	-13	-46
B4122	630	298	103	13	15	-284	-88
A350 South	400	1,388	211	87	27	-1,301	-184

Maximum Queue Results- 2036 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0700-0800	1600-1700	0700-0800	1600-1700	0700-0800	1600-1700
M4 West Off-slip	370	247	104	257	96	10	-8
A429 North	240	80	207	94	121	14	-86
M4 East Off-slip	400	161	175	84	82	-76	-93
B4122	630	843	361	60	74	-783	-287
A350 South	400	1,941	538	394	195	-1,547	-343

Hour 2

Average Queue Results- 2036 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	27	26	83	23	56	-3
A429 North	240	505	104	31	20	-474	-83
M4 East Off-slip	400	18	207	22	25	4	-182
B4122	630	842	630	11	287	-830	-343
A350 South	400	1,159	488	37	36	-1,122	-452

Maximum Queue Results- 2036 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0800-0900	1700-1800	0800-0900	1700-1800	0800-0900	1700-1800
M4 West Off-slip	370	120	123	279	109	159	-14
A429 North	240	1,131	384	145	108	-986	-276
M4 East Off-slip	400	100	316	94	94	-6	-222
B4122	630	910	905	57	793	-853	-112
A350 South	400	1,807	766	255	214	-1,552	-552

Hour 3

Average Queue Results- 2036 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0900-1000	1800-1900	0900-1000	1800-1900	0900-1000	1800-1900
M4 West Off-slip	370	11	12	16	15	4	2
A429 North	240	42	6	14	11	-29	5
M4 East Off-slip	400	9	175	11	18	2	-157
B4122	630	57	66	6	19	-50	-48
A350 South	400	45	121	15	17	-29	-104

Maximum Queue Results- 2036 M4 Junction 17 DM and DS

Location	Available Queue (m)	Do Minimum		Do Something		Difference	
		0900-1000	1800-1900	0900-1000	1800-1900	0900-1000	1800-1900
M4 West Off-slip	370	76	78	76	88	-1	10
A429 North	240	562	85	88	90	-474	5
M4 East Off-slip	400	59	331	57	74	-2	-258
B4122	630	502	583	36	228	-466	-354
A350 South	400	455	618	140	139	-314	-478

OD Journey Time- results

For 2024:

Hour 1

Origin-Destination Journey Time Difference (s) DS vs DM: Morning Peak 2024

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	11s	0s	4s	-5s
A429 North	12s	0s	3s	7s	9s
M4 East	0s	5s	0s	5s	2s
B4122	-3m 17s	-4m 24s	-4m 16s	0s	-38s
A350 South	-1m 50s	-1m 38s	25s	15s	0s

Origin-Destination Journey Time Difference (s) DS vs DM: Evening Peak 2024

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	10s	1s	16s	14s
A429 North	6s	0s	2s	0s	3s
M4 East	0s	17s	0s	4s	-1s
B4122	-51s	-1m 29s	-1m 20s	0s	-57s
A350 South	-14s	4s	27s	20s	0s

Hour 2

Origin-Destination Journey Time Difference (s) DS vs DM: Morning Peak 2024

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	12s	0s	10s	4s
A429 North	-29s	0s	-1m 1s	-60s	-43s
M4 East	0s	16s	0s	4s	3s
B4122	-7m 42s	-8m 49s	-8m 54s	0s	-7m 20s
A350 South	-15s	1s	31s	15s	0s

Origin-Destination Journey Time Difference (s) DS vs DM: Evening Peak 2024

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	10s	1s	15s	11s
A429 North	-3s	0s	0s	-2s	-3s
M4 East	0s	20s	0s	6s	-2s
B4122	-4m 23s	-4m 26s	-4m 13s	0s	-3m 26s
A350 South	-17s	3s	33s	16s	0s

Hour 3

Origin-Destination Journey Time Difference (s) DS vs DM: Morning Peak 2024

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	11s	1s	5s	-6s
A429 North	21s	0s	14s	18s	17s
M4 East	0s	18s	0s	4s	5s
B4122	2s	-7s	-1s	0s	3s
A350 South	-8s	12s	35s	28s	0s

Origin-Destination Journey Time Difference (s) DS vs DM: Evening Peak 2024

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	7s	1s	19s	13s
A429 North	13s	0s	14s	20s	14s
M4 East	0s	11s	0s	3s	-3s
B4122	-1m 12s	-1m 28s	-1m 20s	0s	-43s
A350 South	-6s	5s	27s	20s	0s

For 2036:

Hour 1

Origin-Destination Journey Time Difference (s) DS vs DM: Morning Peak 2036

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	12s	1s	-1s	-15s
A429 North	7s	0s	-9s	-16s	-6s
M4 East	0s	1s	0s	-7s	-8s
B4122	-4m 47s	-5m 52s	-5m 52s	0s	-1m 10s
A350 South	-5m 28s	-5m 16s	28s	10s	0s

Origin-Destination Journey Time Difference (s) DS vs DM: Evening Peak 2036

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	6s	0s	13s	13s
A429 North	-12s	0s	-11s	-18s	-11s
M4 East	0s	-37s	0s	-40s	-51s
B4122	-1m 10s	-1m 53s	-1m 43s	0s	-1m 7s
A350 South	-1m 6s	-43s	31s	17s	0s

Hour 2

Origin-Destination Journey Time Difference (s) DS vs DM: Morning Peak 2036

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	17s	1s	50s	45s
A429 North	-4m 31s	0s	-5m 5s	-5m 4s	-4m 44s
M4 East	-1s	19s	0s	10s	10s
B4122	-10m 38s	-11m 45s	-11m 49s	0s	-10m 18s
A350 South	-4m 48s	-4m 41s	21s	-3s	0s

Origin-Destination Journey Time Difference (s) DS vs DM: Evening Peak 2036

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	6s	0s	10s	8s
A429 North	-1m 20s	0s	-1m 8s	-1m 21s	-1m 17s
M4 East	0s	-2m 48s	0s	-2m 54s	-3m 3s
B4122	-3m 50s	-3m 57s	-3m 45s	0s	-2m 50s
A350 South	-2m 23s	-2m 0s	27s	8s	0s

Hour 3

Origin-Destination Journey Time Difference (s) DS vs DM: Morning Peak 2036

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	10s	0s	8s	-3s
A429 North	17s	0s	-6s	1s	6s
M4 East	0s	14s	0s	8s	4s
B4122	-34s	-50s	-51s	0s	-30s
A350 South	-15s	5s	36s	26s	0s

Origin-Destination Journey Time Difference (s) DS vs DM: Evening Peak 2036

	M4 West	A429 North	M4 East	B4122	A350 South
M4 West	0s	8s	0s	18s	15s
A429 North	12s	0s	8s	4s	9s
M4 East	0s	-2m 43s	0s	-2m 33s	-2m 46s
B4122	-37s	-56s	-41s	0s	-10s
A350 South	-45s	-26s	31s	19s	0s

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