M5 Junction 10 Improvements Scheme

Traffic Modelling Sensitivity Tests Technical Note

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Rules 8 (k)

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Rev 0	October 2024	Deadline 5
Rev 1	October 2024	Additional submission ahead of Hearing

Change log

The following Revision 1 changes relate to this document:

- A summary was added.
- 'M5 J10 Traffic Modelling Sensitivity Test - 2015 Base Year models' Technical Note was updated (draft stamp removed and title updated, no other changes).
- 'M5 J10 Traffic Modelling Sensitivity Test - Forecast Models' Technical Note was added.

Summary

This document contains results and conclusions of the traffic modelling sensitivity test that has been undertaken, as requested by the Examining Authority at ISH3 (Action Point 3.9), to address concerns with the journey time validation along the A4019 in the Base Year strategic model. The results and conclusions are presented in the following two technical notes:

1. M5 J10 Traffic Modelling Sensitivity Test - 2015 Base Year models
2. M5 J10 Traffic Modelling Sensitivity Test - Forecast Models

AtkinsRéalis

Gloucestershire COUNTY COUNCIL

Technical Note

Project:	M5 Junction 10 Improvements Scheme		
Subject:	M5 J10 Traffic Modelling Sensitivity Test - 2015 Base Year models		
Author:	HF	Reviewed by:	SK
Approved Date and time:	07/10/24	Approved by:	LJ
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1. Introduction

1.1.1. National Highways (NH) has undertaken a review of the traffic models submitted by Gloucestershire County Council (GCC) to support the proposed M5 J10 Scheme. AtkinsRéalis on behalf of GCC provided responses and additional information to the comments arising from this review which were all but one found to be satisfactory by NH. The outstanding comment which NH has asked for additional information on relates to two journey times routes (208A and 209B), that share a common section along A4019 between Kingsditch Roundabout and M5 J10, which lies slightly outside of the TAG threshold for journey time validation in west/northbound direction only.

1.1.2. National Highways has requested that the applicant (GCC) make the necessary changes to the current base year model so that the two northbound Journey Time Routes (JTR) 208A and 209B meet the TAG criteria and investigate if these changes lead to wider impacts on other aspects of the base year model used for the assessment of the Scheme.

1.1.3. This Technical note presents details of the work undertaken to develop a sensitivity test model with JTRs 208 and 209 meeting the TAG criteria in both directions and provides comparisons against the current DCO base year model.

2. Base Year Model Sensitivity Test

2.1.1. The current base year model used for the DCO submission is compliant with TAG and meets the key performance criteria including screenlines, link flows and journey times as well as impact of Matrix Estimation (ME) process within the tolerances recommended by TAG. There are 52 Journey Time Route (JTR) by direction used to validate the current base year model, out of which over 94% meet the TAG criteria across the three modelled time periods.

2.1.2. JTRs 208 and 209 meet the TAG acceptability criteria in the southbound direction in all modelled time periods. In the northbound direction these two routes lie outside the recommended threshold.

2.1.3. It is worth noting that the JTRs 208A and 209B are about 11km to 12km long and it is only along a short section of the A4019 (0.8kms) between Kingsditch Roundabout and Gallagher Retail Park junction where the modelled journey times do not meet the TAG criteria.

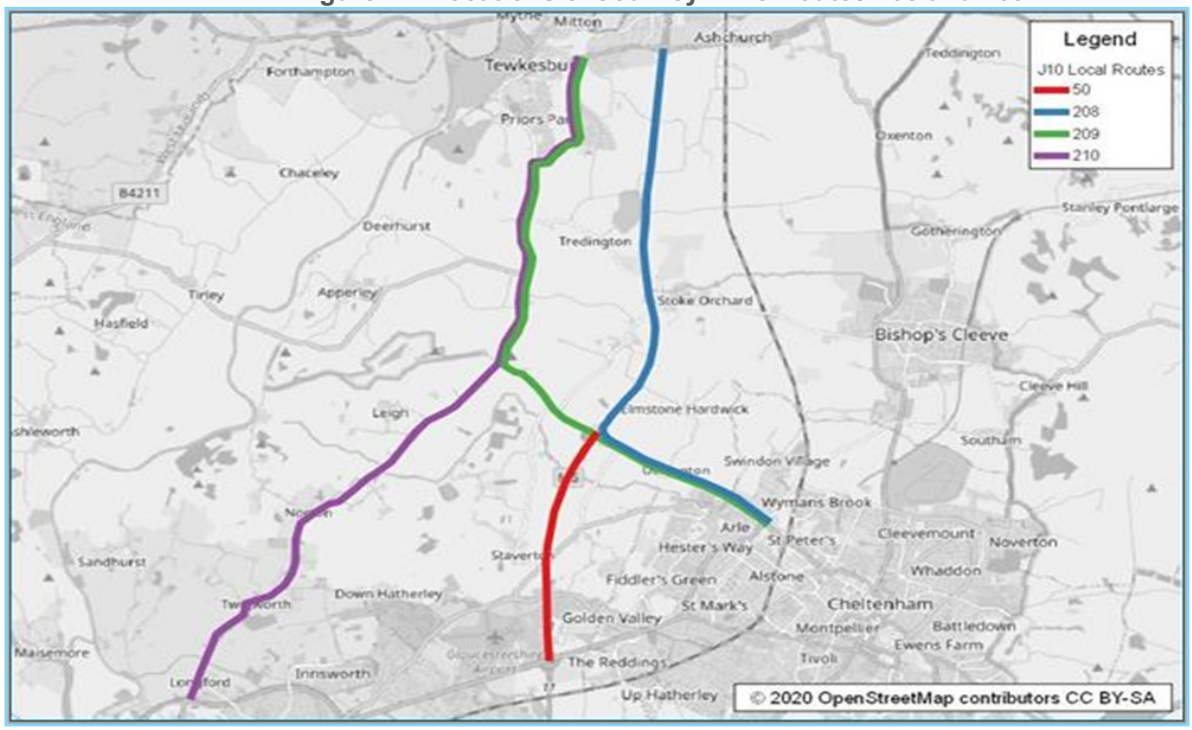
2.1.4. The divergence of the modelled and observed journey times along Routes 208A and 209B occur mainly along 800m section of the A4019 between Kingsditch and Gallagher

Junction. The model attributes along this section were therefore reviewed and appropriate adjustments made to reduce the differences between the modelled and observed journey so routes 208A and 209B meet the TAG criteria, which are defined as modelled journey times lying within +/-15% or 1 minute of the observed time.

2.1.5. National Highways in their review of the base year model recommended revisiting the current coding of the signals for Gallagher and Manor Road junctions with A4019. This recommendation was taken on board and the intergreen values at these two junctions were reduced as suggested by NH. The revised networks were then used to produce the sensitivity test model.

2.1.6. Th journey times produced by the sensitivity test model were compared against the current base year model used for DCO and showed that journey times for Routes 208A and 209B did not still meet the TAG criteria. Figure 2- 1 below shows the locations of routes 208 and 209 whilst Table 1 shows the comparison of modelled and observed journey times along these two routes.

Figure 2-1 Locations of Journey Time Routes 208 and 209



2.1.7. The results in Table 1 show that adjustment of the intergreen values at Gallagher and Manor Road junctions with A4019, whilst moderately reduces the differences between the modelled and observed journey times, does not lead to northbound routes 208A and 209B meet the TAG criteria.

Table 1 – Comparison of DCO and Sensitivity Test (1) Journey Times for Routes 208 and 209

Time Period	Route ID	Direction	Route Description	Observed Journey Time (min)	DCO Base Year Model			Sensitivity Test 1 (Adjustment of Intergreens)		
					Modelled JT (min)	% Diff	Criteria	Modelled JT (min)	% Diff	Criteria
AM	208A	NB	Cheltenham to M5J J9 (via A4019 & M5)	7.64	9.21	20.6%	Fail	9.13	19.5%	Fail
	208B	SB	M5J J9 to Cheltenham (via M5 & A4019)	8.84	10.00	13.1%	Pass	9.91	12.1%	Pass
	209A	SB	Tewkesbury to Cheltenham via A38/A4019	13.03	14.83	13.8%	Pass	14.74	13.1%	Pass
	209B	NB	Cheltenham to Tewkesbury via A4019/ A38	11.68	14.05	20.2%	Fail	13.97	19.6%	Fail
IP	208A	NB	Cheltenham to M5J J9 (via A4019 & M5)	7.88	9.27	17.6%	Fail	9.20	16.8%	Fail
	208B	SB	M5J J9 to Cheltenham (via M5 & A4019)	8.56	9.07	5.9%	Pass	8.98	4.9%	Pass
	209A	SB	Tewkesbury to Cheltenham via A38/A4019	12.63	13.39	6.1%	Pass	13.31	5.4%	Pass
	209B	NB	Cheltenham to Tewkesbury via A4019/ A38	11.82	13.70	15.9%	Fail	13.64	15.4%	Fail
PM	208A	NB	Cheltenham to M5J J9 (via A4019 & M5)	8.04	10.00	24.4%	Fail	9.88	22.8%	Fail
	208B	SB	M5J J9 to Cheltenham (via M5 & A4019)	8.41	9.26	10.1%	Pass	9.17	9.1%	Pass
	209A	SB	Tewkesbury to Cheltenham via A38/A4019	12.70	13.61	7.2%	Pass	13.53	6.5%	Pass
	209B	NB	Cheltenham to Tewkesbury via A4019/ A38	12.31	15.00	21.9%	Fail	14.88	20.9%	Fail

2.1.8. Given the magnitude of the difference between the modelled and observed journey times along northbound routes 208A and 209B in sensitivity test (1), other adjustments were required to produce a sensitivity test model that meets the TAG criteria for validation of JTRs 208A and 209B against observed median journey times.

2.1.9. Several measures were therefore considered for the development of a sensitivity test model where JTRs 208A and 209 meet the TAG criteria to enable comparison with the current base year model.

2.1.10. Having tested a number of options it was found that using a Speed Flow Curve (SFC) along the short section of A4019 between Kingsditch Roundabout and Gallagher junction, that is consistent with the rest of A4019 to M5 J10, in combination with optimising the signal timings at both the Manor Road and Gallagher junctions resulted in journey times along northbound routes 208A and 209B meet the TAG criteria (Details of this comparison are given in Section 2.1 of this note).

2.1.11. It is worth noting that the SFC used for this purpose in sensitivity test (2) has the same capacity (3540 pcu) and minimum speed (35kph) as the SFC used in the current model for A4019, with only higher free flow speeds (78 kph) which the model uses as the starting point to determine the minimum cost routes.

2.1.12. The performance of key criteria for the current and sensitivity test (2) models have been compared including journey times along JTRs 208A and 209B which are reported in Section 2.2 of this note.

2.1. Journey Times Along Routes 208 and 209

2.1.1. The journey times along routes 208 and 209 by direction in sensitivity test (2) have been compared against observed. The results of these comparisons are shown in Table 2 below.

Table 2 – Sensitivity Test (2) Journey Times Routes 208 and 209

Time Period	Route ID	Direction	Route Description	Observed Journey Time (min)	DCO Base Year Model			Sensitivity Test 2		
					Modelled JT (min)	% Diff	Criteria	Modelled JT (min)	% Diff	Criteria
AM	208A	NB	Cheltenham to M5J J9 (via A4019 & M5)	7.64	9.21	20.6%	Fail	8.61	12.6%	Pass
	208B	SB	M5J J9 to Cheltenham (via M5 & A4019)	8.84	10.00	13.1%	Pass	9.39	6.2%	Pass
	209A	SB	Tewkesbury to Cheltenham via A38/A4019	13.03	14.83	13.8%	Pass	14.24	9.3%	Pass
	209B	NB	Cheltenham to Tewkesbury via A4019/ A38	11.68	14.05	20.2%	Fail	13.25	13.4%	Pass
IP	208A	NB	Cheltenham to M5J J9 (via A4019 & M5)	7.88	9.27	17.6%	Fail	8.65	9.9%	Pass
	208B	SB	M5J J9 to Cheltenham (via M5 & A4019)	8.56	9.07	5.9%	Pass	8.58	0.3%	Pass
	209A	SB	Tewkesbury to Cheltenham via A38/A4019	12.63	13.39	6.1%	Pass	12.91	2.3%	Pass
	209B	NB	Cheltenham to Tewkesbury via A4019/ A38	11.82	13.70	15.9%	Fail	12.94	9.5%	Pass
PM	208A	NB	Cheltenham to M5J J9 (via A4019 & M5)	8.04	10.00	24.4%	Fail	9.16	13.9%	Pass
	208B	SB	M5J J9 to Cheltenham (via M5 & A4019)	8.41	9.26	10.1%	Pass	8.59	2.2%	Pass
	209A	SB	Tewkesbury to Cheltenham via A38/A4019	12.70	13.61	7.2%	Pass	12.95	2.0%	Pass
	209B	NB	Cheltenham to Tewkesbury via A4019/ A38	12.31	15.00	21.9%	Fail	13.96	13.4%	Pass

2.1.2. The results in Tables 2 show that overall journey times along routes 208 and 209 in sensitivity test (2) model meet TAG criteria (modelled time being between either +/-15% or 1 minute of the observed journey time) in both directions and across all the three modelled time periods.

2.1.3. It is worth noting that the adjustments made to the network coding as part of developing sensitivity test (2) model did not adversely affect the overall journey time validation reported for the current base year model. Further details of journey time validation are provided in Section 2.2.

2.2. Comparison of Key performance Criteria and Statistics

Key Performance Criteria

2.2.1. The performance of traffic models is measured against observed data based on several key criteria including screenlines, link flows and journey times. Table 3 below provides details of the performance for the current and sensitivity test (2) models against the same observed data and the differences between the models.

2.2.2. The differences in Table 3 show that the two models overall correlate closely in performance of screenlines and also the number of calibration and validation site. The number of validating journey time routes for the sensitivity test (2) model is shown to increase by two routes which is expected as northbound JTRs routes 208A and 209B meet the criteria under this scenario.

Table 3 – Comparison of DCO and Sensitivity Test (2) - Key Model Performance Indicators

DCO Model Key Performance Statistics					
Metric	**Criteria**		**AM**	**IP**	**PM**
Screenlines within 5%	All or nearly all	Calibration	97%	97%	92%
			35/36	35/36	33/36
		Validation	88%	88%	88%
			7/8	7/8	7/8
		Total	96%	96%	91%
			42/44	42/44	40/44
Screenlines GEH <4	DMRB Criteria	Calibration	97%	100%	97%
		Validation	100%	100%	100%
		Total	98%	100%	98%
Flows passing GEH or flow criteria	>85%	Calibration	94%	97%	94%
			285/304	296/304	285/304
		Validation	89%	98%	92%
			116/130	51/52	119/130
		Total	92%	98%	93%
Journey Time Routes (52 Routes by direction)	>85%	Number	50	50	49
		%	96%	96%	94%

Sesnsitivity Test (2) Model Key Performance Statistics					
Metric	**Criteria**		**AM**	**IP**	**PM**
Screenlines within 5%	All or nearly all	Calibration	97%	100%	94%
			35/36	36/36	34/36
		Validation	88%	88%	88%
			7/8	7/8	7/8
		Total	96%	98%	93%
			42/44	43/44	41/44
Screenlines GEH <4	(DMRB criteria)	Calibration	100%	100%	100%
		Validation	100%	100%	100%
		Total	100%	100%	100%
Flows passing GEH or flow criteria	>85%	Calibration	94%	97%	94%
			285/304	295/304	285/304
		Validation	89%	98%	92%
			116/130	51/52	119/130
		Total	92%	97%	93%
Journey Time Routes (52 Routes by direction)	>85%	Number	52	52	51
		%	100%	100%	98%

Difference(%)					
Metric	**Criteria**		**AM**	**IP**	**PM**
Screenlines within 5%	All or nearly all	Calibration	0%	3%	2%
			N/A	N/A	N/A
		Validation	0%	0%	0%
			0	0	0
		Total	0%	2%	2%
			N/A	N/A	N/A
Screenlines GEH <4	(DMRB criteria)	Calibration	3%	0%	3%
		Validation	0%	0%	0%
		Total	2%	0%	2%
Flows passing GEH or flow criteria	>85%	Calibration	0%	0%	0%
			N/A	N/A	N/A
		Validation	0%	0%	0%
			N/A	N/A	N/A
		Total	0%	-1%	0%
Journey Time Routes (52 Routes by direction)	>85%	Number	2	2	2
		%	4%	4%	4%

Traffic Flows Differences

2.2.3. The traffic flows across the highway network were compared between sensitivity test (2) and current base year model for the three modelled time periods. The results of these comparisons are shown in Figures 2-2 to 2-4 by differences in flows and 2-5 to 2-7 by percentage differences.

2.2.4. Comparison of flow difference plots shows that there are generally modest increases along A4019 between Kingsditch Roundabout and M5 J10 reported by sensitivity test (2). These increases are in the range of about 30 to 80 vehicles reported between M5 J10 and Gallagher junction across the three modelled time periods.

2.2.5. There are larger increases in flows reported by sensitivity test (2) scenario along the A4019 between Kingsditch Roundabout and Gallagher junction across the three modelled time periods. Given this section is where the changes to the network attributes have been implemented to reduce the modelled journey times, the larger increases in flow in this location is expected.

2.2.6. The changes in flows in this section of the A4019 is quite local and mainly constrained to the traffic in the westbound direction from Kingsditch Roundabout, which in the current model exits A4019 through Hayden Ave to avoid delay at Manor Road junction for accessing Old Gloucester Road. In sensitivity test (2) model, where delays at Gallagher Junction are reduced by optimisation of the signal timings, this traffic travels a bit further along A4019 to Gallager Road junction for turning into Old Gloucester Road. The amount of traffic accessing the Old Gloucester Road from the A4019, which uses Gallagher junction in the sensitivity test (2) model as opposed to Manor Road junction via Hayden Ave under the current model, ranges from about 160 and 185 vehicles in the modelled periods.

2.2.7. In the eastbound direction, the traffic travelling between A4019 at Gallagher junction to the north of Kingsditch Roundabout which uses Manor Road and Runnings Road in the current model switches route to using the A4019 and access Kingsditch Lane via the roundabout. The volume of traffic which makes this switch ranges from about 65 to 140 vehicles across the three modelled time periods in sensitivity test (2) model.

2.2.8. The reported impact on other key roads in the network is generally modest. Along M5 at either side of M5 J10 i.e. between J9 to 10 and J12 and 11 there is a range of increase in flows of less than 50 vehicles whilst between J11 and 10 there is a similar amount of reduction reported in sensitivity test (2) model compared to the current base year.

2.2.9. The reported changes in flows across the key roads of A38 and A40 are also modest with increases of less than 50 vehicles along A38 southbound and similar decreases of between 25 to 50 vehicles along A40.

Figure 2-2 - Traffic Flow Differences in Vehicles - AM Peak

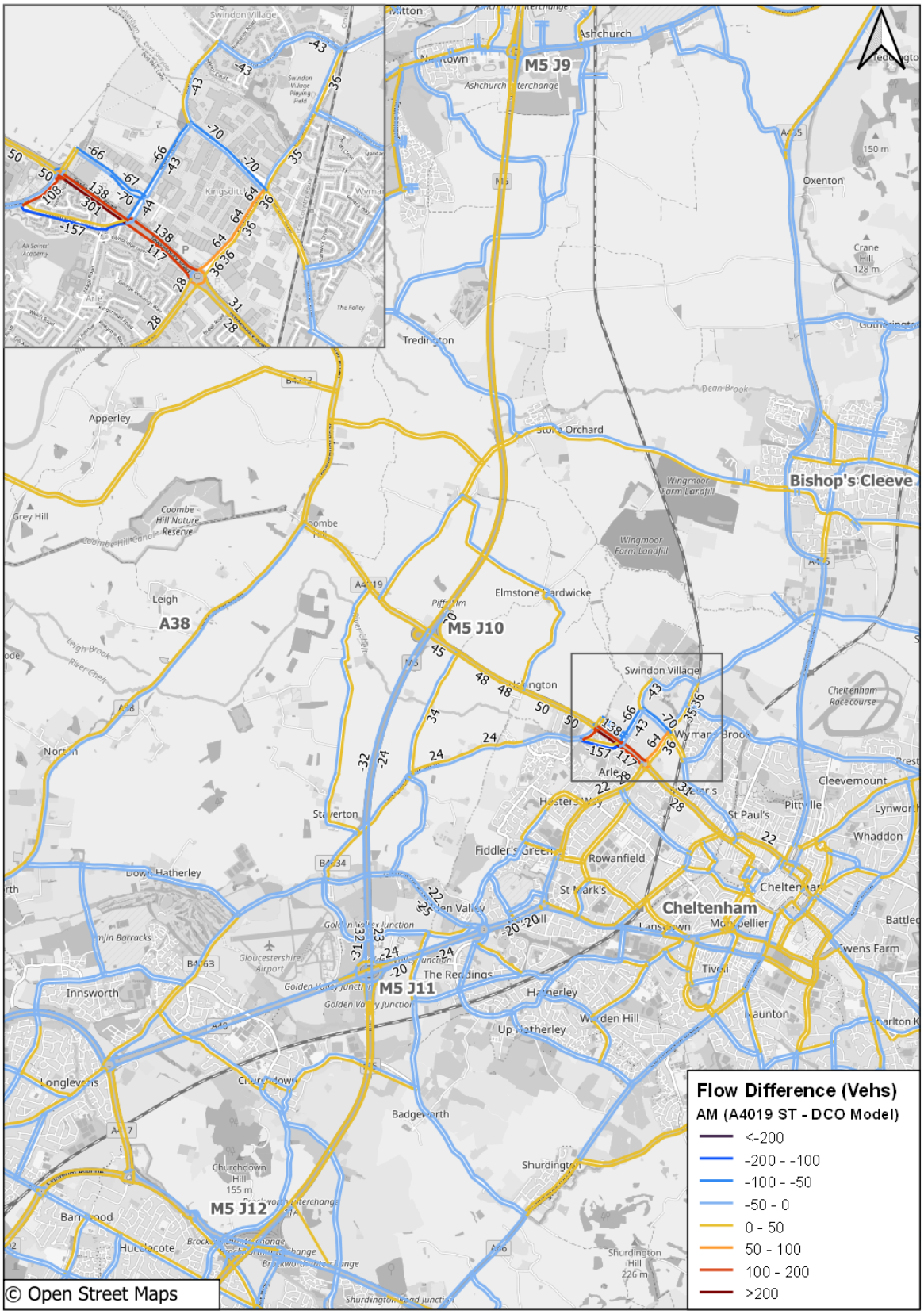


Figure 2-3 - Traffic Flow Differences in Vehicles - Inter Peak

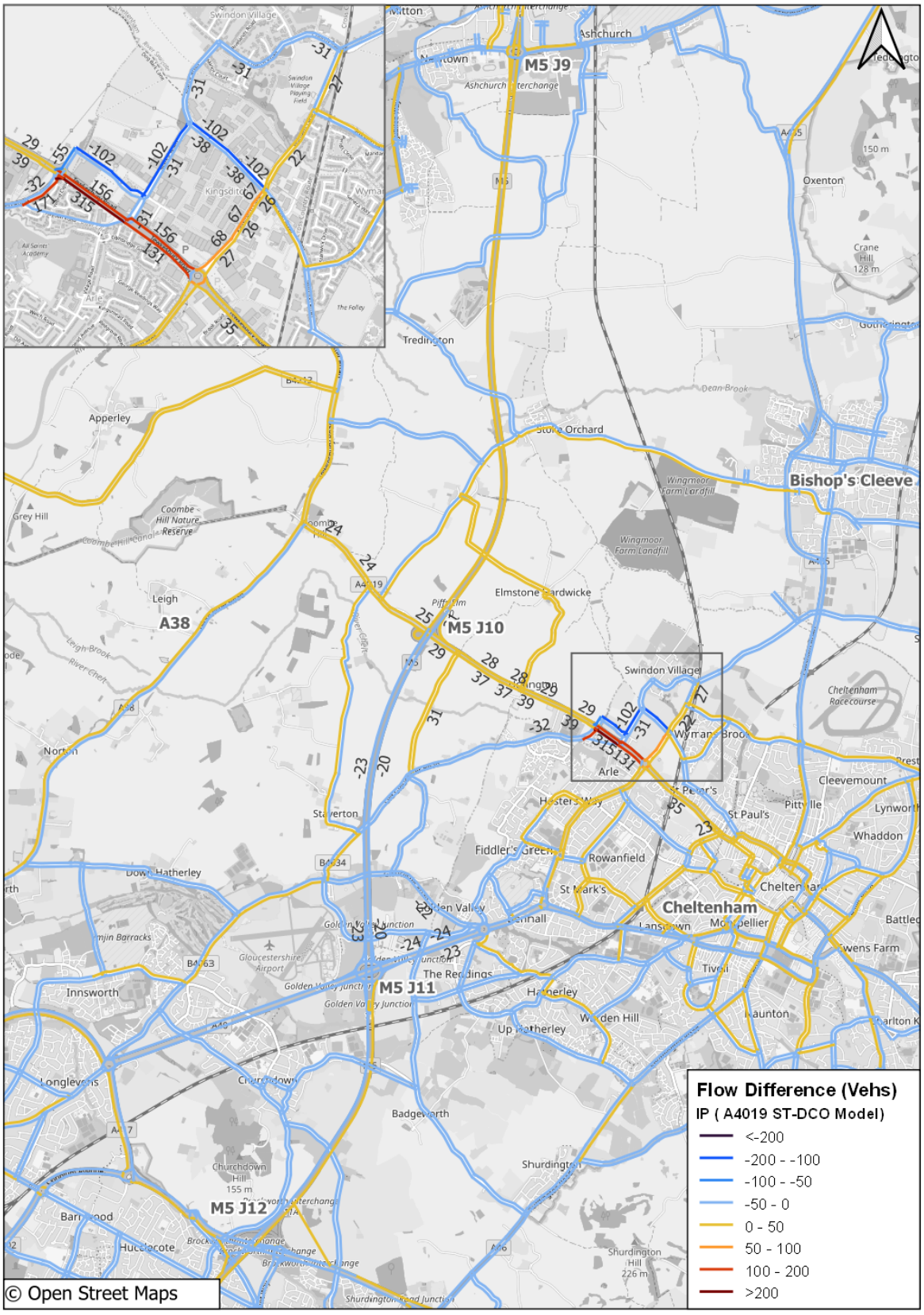


Figure 2-4 - Traffic Flow Differences in Vehicles – PM Peak

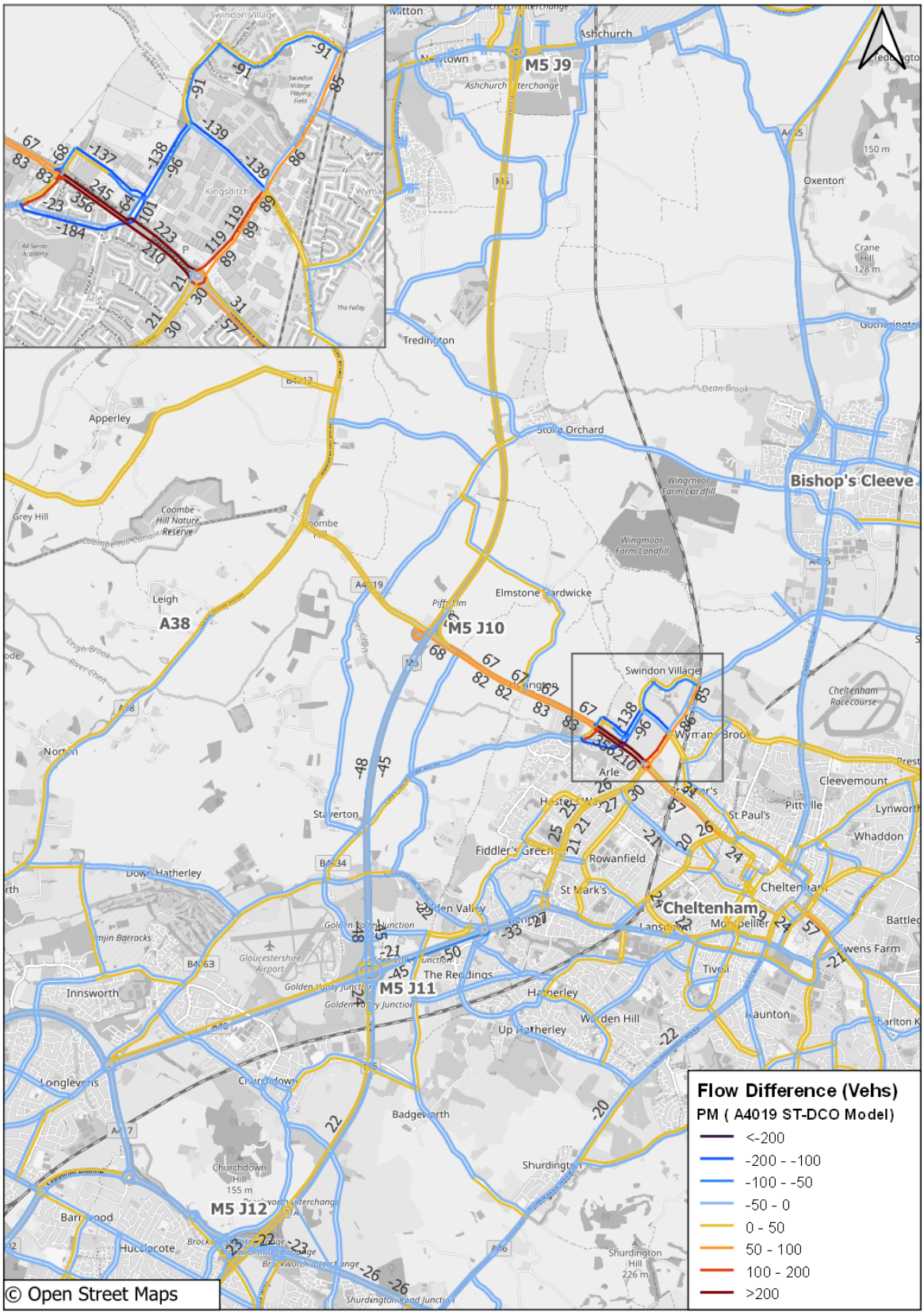


Figure 2-5 - Traffic Flow Difference by Percentage – AM Peak

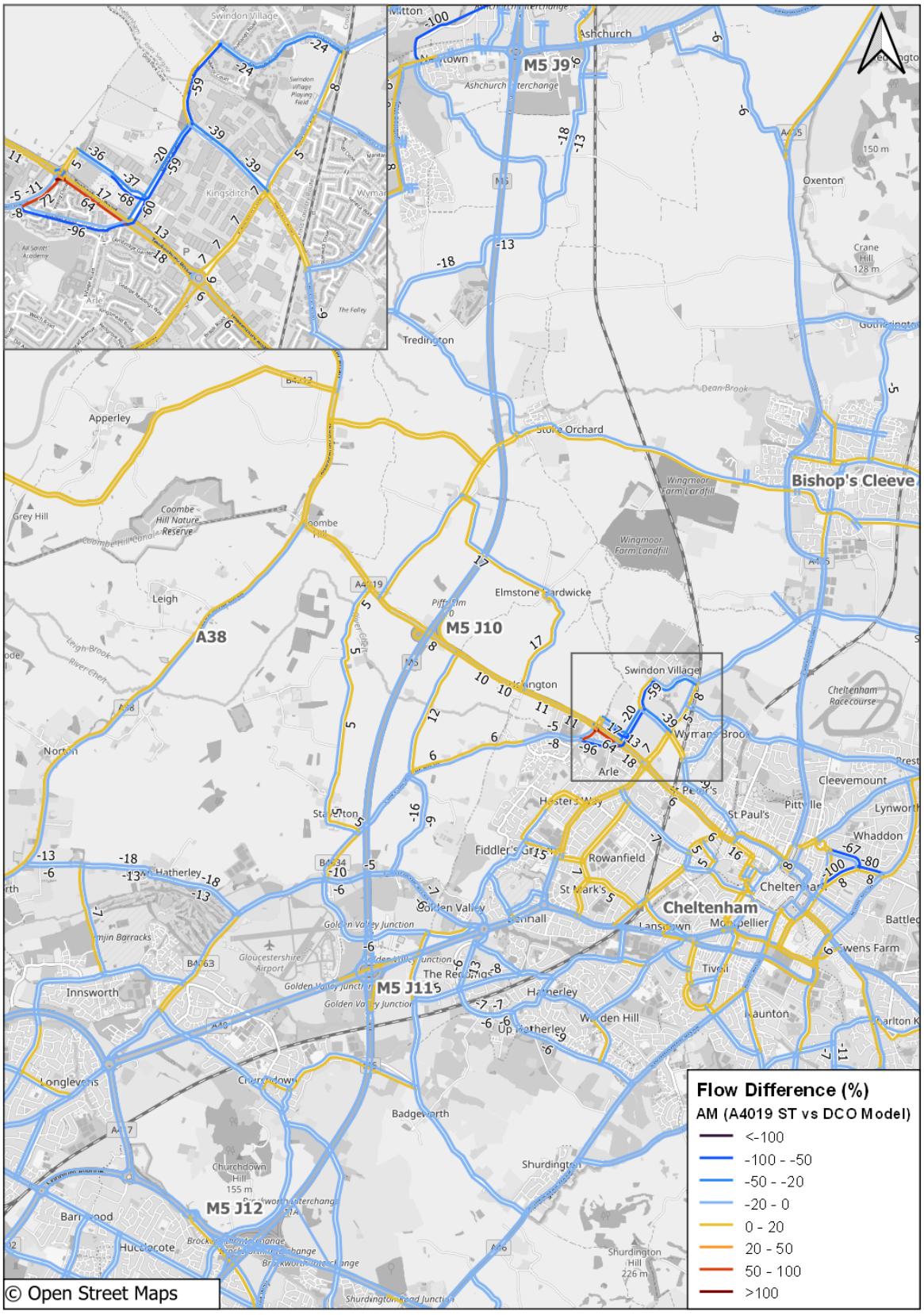


Figure 2-6 - Traffic Flow Difference by Percentage – Inter Peak

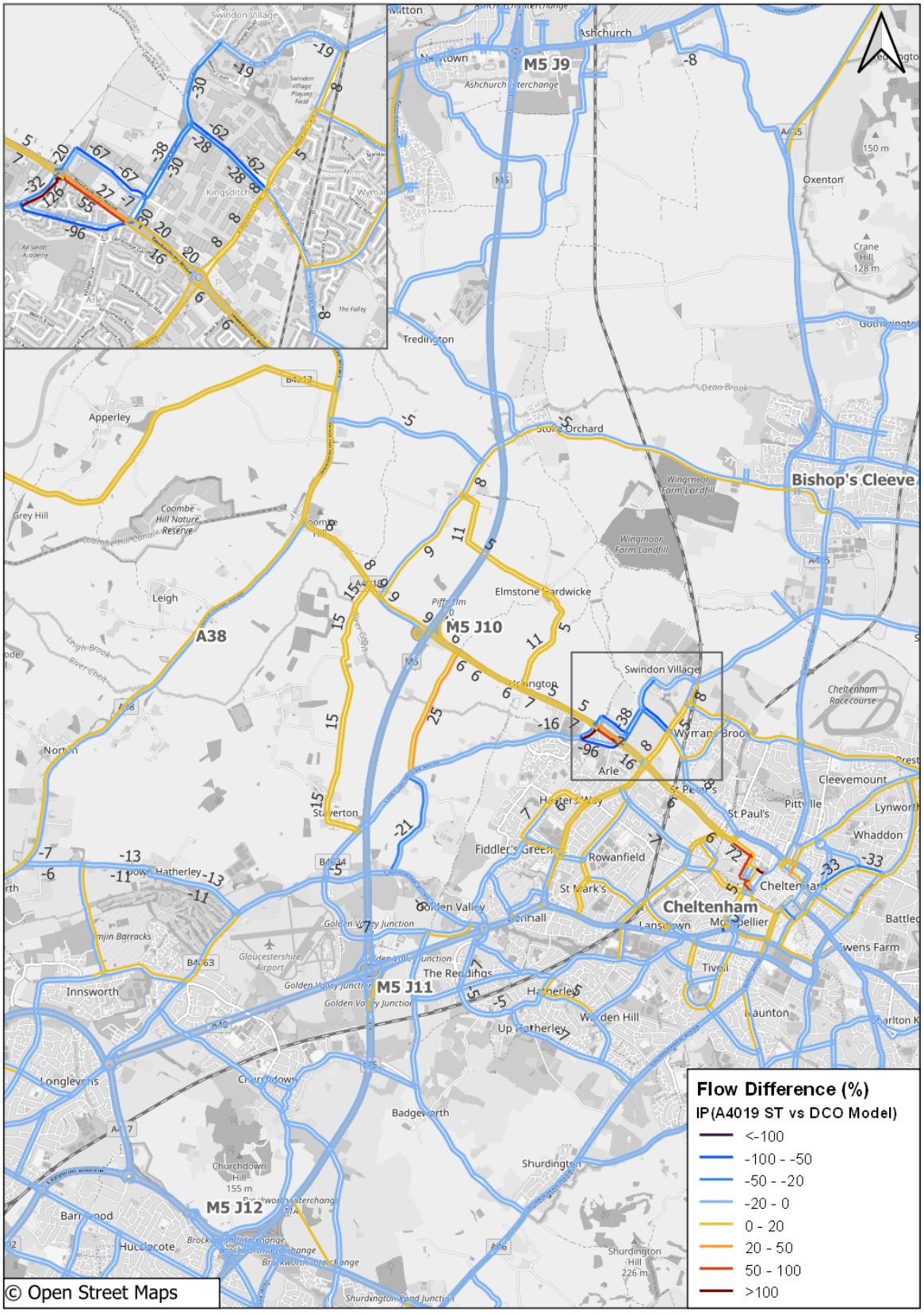
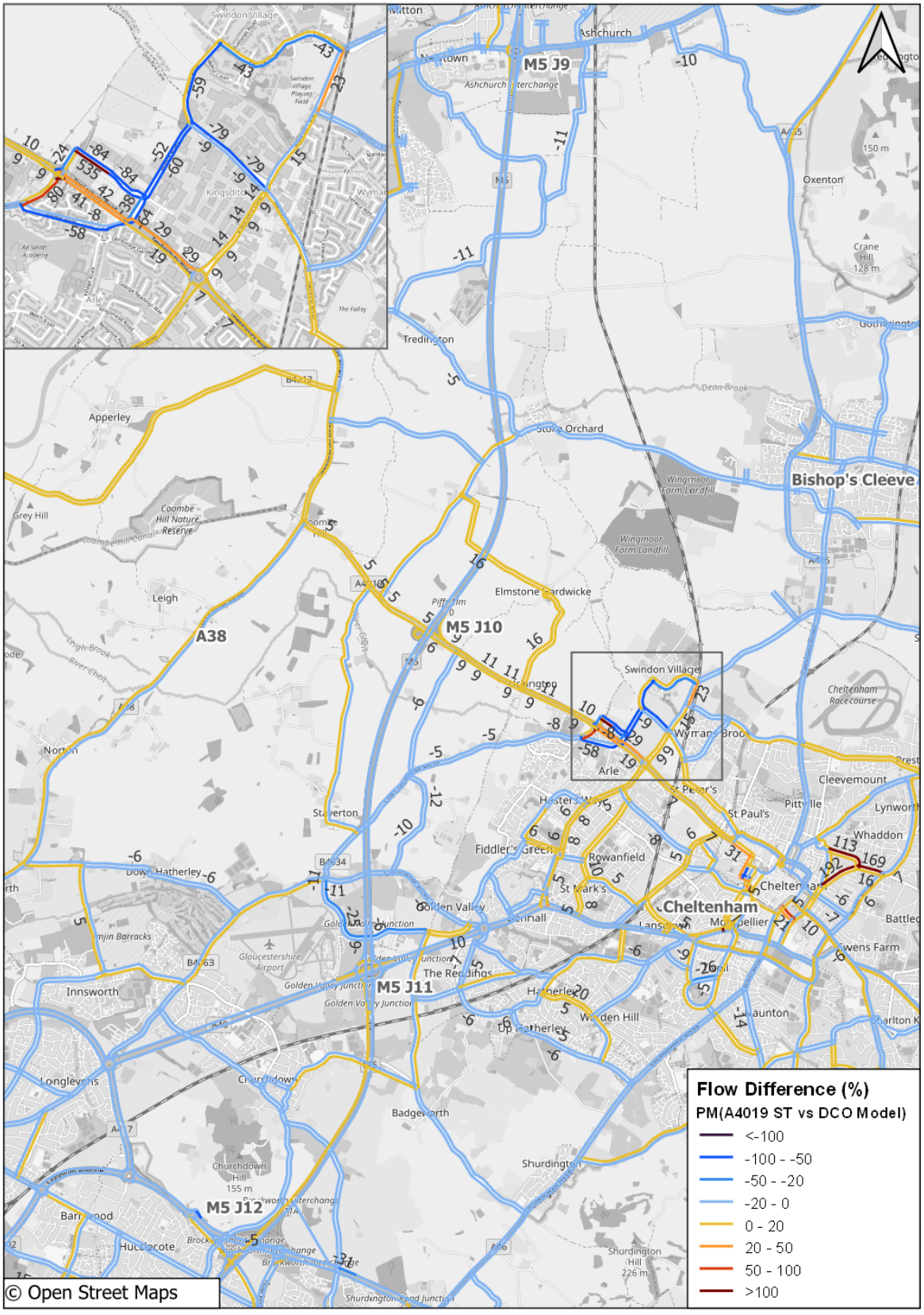


Figure 2-7 - Traffic Flow Difference by Percentage – PM Peak



Model Development Process

2.2.10. The base year model for the M5 J10 Scheme has been developed through the standard process of producing an initial demand based on the observed trip data collected for this purpose, which is then enhanced through the Matrix Estimation (ME) process with the aid of observed count data that has not been used in building the initial demand. The extent of changes to the initial (prior matrices) is controlled by TAG criteria to avoid excessive disturbance of the observed distribution of trips in the prior matrices.

2.2.11. The sensitivity test (2) model was developed using the demand from the current base year matrices without use of the ME. Whilst this was considered a proportionate approach for developing sensitivity test (2), it was deemed appropriate to ensure that the adjustments made to the highway network would not lead to material changes in trip distribution of the current base year matrices.

2.2.12. For this purpose, the ME process was used to develop a set of demand matrices for sensitivity test (2) model using the same prior matrices as the current base year model with no additional demand or traffic data. The impacts of ME on the adjusted network in sensitivity test (2) on demand matrices were then compared against that of the current model.

- Matrix Estimation Measures
- Trip Length Distribution
- Matrix Totals

Matrix Estimation Measures

2.2.13. The impact on cell values and trip ends of the post ME trip matrices are measured in terms of Slope, Intercept and R square and compared against defined thresholds by TAG. Table 4 shows the differences between these measures for the two base year models.

2.2.14. The results in Table 4 display that there are no statistical differences at matrix cell values and negligible differences for both trip ends (origins and destinations) between the two base year models. This provides further indication of high correlation in demand between the current and sensitivity test (2) models.

Table 4 – Differences between the Matrix Cells and Trip Ends

Difference in Cell values							
Time Period	Criteria	User Classes					
		Employer's Business	Commute	Other	LGV	HGV	Total
AM Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	0	0	0	0	0	0
R square	in excess of 0.98	0	0	0	0	0	0
Inter Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	0	0	0	0	0	0
R square	in excess of 0.98	0	0	0	0	0	0
PM Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	0	0	0	0	0	0
R square	in excess of 0.98	0	0	0	0	0	0
Difference in Trip Ends (Origins)							
Time Period	Criteria	User Classes					
		Employer's Business	Commute	Other	LGV	HGV	Total
AM Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	-0.001	-0.013	-0.018	0.001	0.005	-0.005
R square	in excess of 0.98	0	0	0	0	0	0
Inter Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	-0.001	0	-0.012	0.001	-0.004	-0.003
R square	in excess of 0.98	0	0	0	0	0	0
PM Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	-0.002	-0.003	-0.004	0.004	0.003	0
R square	in excess of 0.98	0	0	0	0	0	0
Difference in Trip Ends (Destinations)							
Time Period	Criteria	User Classes					
		Employer's Business	Commute	Other	LGV	HGV	Total
AM Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	-0.001	-0.013	-0.018	0	0.004	-0.027
R square	in excess of 0.98	0	0	0	0	0	0
Inter Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	0	0
Intercept	Near Zero	-0.001	0	-0.011	0.002	-0.004	-0.015
R square	in excess of 0.98	0	0	0	0	0.0001	0
PM Peak							
Slope	Within 0.99 and 1.01	0	0	0	0	-0.001	0
Intercept	Near Zero	-0.001	-0.003	-0.003	0.004	0.003	0
R square	in excess of 0.98	0	0	0	0	0	0

Trip Length Distribution

2.2.15. The impacts of ME process regarding Trip Length Distribution (TLD) on prior matrices have been compared between the two base year models and reported in Table 5. The results of this comparison which are based on the differences across the three modelled time periods show that the TLDs between the two base year models remain consistent and stable.

Table 5 – Differences in Trip Length Distribution

Std Deviation					
Time Period	**Matrix**	**Total Vehicles**	**Car**	**LGV**	**Heavies**
AM Peak	Prior	0.00	0.00	0.00	0.00
	Post	0.00	0.00	0.00	0.00
Inter-Peak	Prior	0.00	0.00	0.00	0.00
	Post	0.00	0.00	0.00	0.01
PM Peak	Prior	0.00	0.00	-0.01	0.00
	Post	-0.01	-0.01	0.00	0.00
Average Trip Length (km)					
Time Period	**Matrix**	**Total Vehicles**	**Car**	**LGV**	**Heavies**
AM Peak	Prior	0.00	0.00	0.00	0.01
	Post	0.01	0.01	0.00	-0.06
Inter-Peak	Prior	0.00	0.00	0.00	-0.01
	Post	0.01	0.01	0.00	0.02
PM Peak	Prior	0.00	0.00	0.00	-0.01
	Post	0.00	0.00	0.00	-0.04

Matrix Sectors and Totals

2.2.16. The trip matrices for the two base year models developed by use of ME have been compared by sectors and by totals across the three modelled time periods. The results of these comparisons, which are reported as differences in Tables 6 and 7, show that the two sets of demand have high correlation with each other, providing further evidence of the current base year model remains suitable as basis for forecasting and assessment of the proposed M5 J10 scheme.

Full Matrix excluding Intra-Zonals Trips	Time Period	No. Cells with >100 trips in prior	5% change	10% change	No. cells with GEH < 5	% of cells with <5% change (Prior trips >100)	% of cells with <10% change (Prior trips >100)	% cells with GEH < 5 (Prior trips >100)
Car	AM	0	0	0	0	0%	0%	0%
	IP	0	0	0	0	0%	0%	0%
	PM	0	0	0	0	0%	0%	0%
LGV	AM	0	0	0	0	0%	0%	0%
	IP	0	0	0	0	0%	0%	0%
	PM	0	0	0	0	0%	0%	0%
HGV	AM	0	0	0	0	0%	0%	0%
	IP	0	0	0	0	0%	0%	0%
	PM	0	0	0	0	0%	0%	0%
Total	AM	0	0	0	0	0%	0%	0%
	IP	0	1	0	0	1%	0%	0%
	PM	0	1	0	0	1%	0%	0%

Table 6 – Differences in Matrix Totals by Sector

	Absloulte Diffeernces (PCU)						% Diffeernces					
Full Model Area	**AM Peak**		**Inter Peak**		**PM Peak**		**AM Peak**		**Inter Peak**		**PM Peak**	
User Class	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**
UC1 - Car Employers Business	0	-6	6	0	-4	4	0.000%	-0.001%	0.153%	0.000%	-0.001%	1.227%
UC2 - Car Commute	0	-34	34	0	-1	1	0.000%	-0.002%	0.164%	0.000%	0.000%	0.080%
UC3 - Car Other	0	-45	45	0	-33	33	0.000%	-0.002%	0.340%	0.000%	-0.001%	1.083%
UC4 - Light Goods vehicles	0	2	-2	0	3	-3	0.000%	0.000%	0.036%	0.000%	0.000%	0.059%
UC5 - heavy Goods vehicles	0	10	-10	0	-9	9	0.000%	0.003%	0.099%	0.000%	-0.003%	-0.106%
Total	0	-73	73	0	-44	44	**0.000%**	**-0.001%**	**0.320%**	**0.000%**	**-0.001%**	**-0.471%**
Simulation Area	**AM Peak**		**Inter Peak**		**PM Peak**		**AM Peak**		**Inter Peak**		**PM Peak**	
User Class	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**	**Prior Matrices**	**Post ME Matrices**
UC1 - Car Employers Business	0	-3	3	0	-1	1	0.000%	-0.004%	0.154%	0.000%	-0.003%	0.512%
UC2 - Car Commute	0	-28	28	0	0	0	0.000%	-0.008%	0.404%	0.000%	0.000%	-0.121%
UC3 - Car Other	0	-41	41	0	-26	26	0.000%	-0.011%	0.924%	0.000%	-0.005%	3.769%
UC4 - Light Goods vehicles	0	1	-1	0	4	-4	0.000%	0.002%	0.063%	0.000%	0.004%	0.160%
UC5 - heavy Goods vehicles	0	9	-9	0	-11	11	0.000%	0.028%	0.259%	0.000%	-0.033%	-0.314%
Total	0	-60	60	0	-34	34	0.000%	-0.007%	0.839%	0.000%	-0.004%	-0.782%

Table 7 – Differences in Matrix Totals by User Class

3. Summary and Conclusion

3.1.1. National Highways (NH) undertook a review of the traffic models submitted to support the proposed M5 J10 Scheme. AtkinsRéalis on behalf of GCC provided responses to the comments made by NH regarding the base year model which satisfactorily addressed all but one issue relating to the northbound journey times routes 208A and 209B that lie slightly outside of the TAG validation threshold. National Highways requested that changes to the current base year model are made so that JTRs 208A 209B meet the TAG criteria and investigate if these changes would lead to wider impacts on other aspects of the base year model used for the assessment of the Scheme.

3.1.2. National Highways recommended revisiting the current signal coding at Gallagher and Manor Road junctions with A4019. This suggestion was taken on board and sensitivity test models were developed using demand from the current base year for the three modelled time periods. However, the journey times reported for JTRs 208A and 209B by this sensitivity test mode did not still meet the TAG criteria.

3.1.3. Having tested a number of options it was found that using a Speed Flow Curve (SFC) along A4019 between Kingsditch Roundabout and Gallagher junction, that is consistent with the rest of A4019 to M5 J10, in combination with optimising the signal timings at both the Manor Road and Gallagher junctions resulted in journey times along northbound routes 208A and 209B meeting TAG criteria.

3.1.4. Sensitivity test (2) model was developed using the demand from the current base year model and the two models then compared using key performance indicators to demonstrate how well they correlate. Comparison of the two base year models showed close correlation regarding key performance criteria including screenlines and calibration/validation link flows. With journey time routes 208A and 209B passing the TAG criteria in sensitivity test (2), there were as expected, two additional journey routes times meeting TAG criteria in this model compared to the current base year model.

3.1.5. The comparison of flow difference plots for the two models showed that there were generally modest increases along A4019 between Kingsditch Roundabout and M5 J10 reported by sensitivity test (2) model. There were differences reported ranging from about 30 to 80 vehicles between M5 J10 and Gallagher Junction across the modelled time periods. There were larger increases reported in the flows between Kingsditch Roundabout and Gallagher Junction which is expected as this is the section where modelled journey times have reduced. However, the change in flows in this section is mainly due to local re-routing of traffic between Manor Rod junction and Old Gloucester Road in the westbound direction and between Gallagher junction and Kingsditch Lane in the eastbound direction.

3.1.6. The reported impact on other key roads in the network was generally modest. Along M5 at either side of M5 J10 i.e. between J9 to 10 and J12 and 11 there was a range of increase reported in flows of less than 50 vehicles whilst between J11 and 10 there was a similar amount of reduction reported in sensitivity test (2) model compared to the current base year model. The changes in flows across the key roads of A38 and A40 were also reported to be modest with increases of less than 50 vehicles along A38 southbound and similar decreases of between 25 to 50 vehicles along A40.

3.1.7. The sensitivity test (2) model was developed using the demand from the current base year matrices. To ensure that the adjustments made to the highway network in sensitivity test (2) would not lead to material changes in distribution of trips in the current base year matrices, the ME process was used to develop a set of demand matrices for sensitivity test (2) model using the same prior matrices as the current base year model with no additional demand or traffic data.

3.1.8. The comparison of impacts of ME process on the two sets of demand matrices showed slight differences which is indicates the changes made to the network in sensitivity test (2) model have not affected distribution of the trips in the current base year model matrices.

3.1.9. It can be concluded from the results of this exercise that the current and sensitivity test (2) base year models are closely correlated and the changes in the traffic flows arising from routes 208A and 209B meeting the TAG criteria do not materially impact the base year model submitted for the DCO process which in turn has been used as basis for developing traffic forecast models.

AtkinsRéalis

Gloucestershire COUNTY COUNCIL

Technical Note

Project:	M5 Junction 10 Improvements Scheme		
Subject:	M5 J10 Traffic Modelling Sensitivity Test - Forecast Models		
Author:	HF	Reviewed by:	SK
Approved Date and time:	07/10/24	Approved by:	LJ
Distribution		Representing:	

1. Introduction

1.1.1. National Highways (NH) has undertaken a review of the traffic models submitted by Gloucestershire County Council (GCC) to support the proposed M5 J10 Scheme. The comments arising from this review were responded to by AtkinsRéalis on behalf of GCC which included additional information and clarifications. The responses addressed all the comments to the satisfaction of NH except for one. The outstanding comment which NH asked for additional information on related to two journey times routes (208A and 209B), that share a common section along A4019 between Kingsditch Roundabout and M5 J10, which lie slightly outside of the TAG threshold for journey time validation in the west/northbound direction only.

1.1.2. National Highways requested that the applicant (GCC) make appropriate changes to the current base year model so that the two northbound Journey Time Routes (JTR) 208A and 209B meet the TAG criteria and investigate if these changes lead to wider impacts on other aspects of the base year model used for the assessment of the Scheme.

1.1.3. This exercise was undertaken, and a revised base year model, termed sensitivity test (2), was developed which resulted in Routes 208A and 209B meeting the TAG criteria. The comparison of the current base year and sensitivity test (2) showed that the two models were closely correlated and the changes in the traffic flows arising from routes 208A and 209B meeting the TAG criteria did not materially impact the base year model submitted for the DCO process.

1.1.4. The results of this sensitivity test were submitted to NH in a Technical Note (REP5-029), which were found acceptable in addressing the issue raised regarding potential impact of changes to the model required such that JTRS 208A and 209B meet the TAG criteria.

1.1.5. National Highways in their review of the traffic model also requested that the potential impact of changes made to the base year model in developing sensitivity test (2) model would be investigated on the current forecast models. For this purpose, it was agreed with NH in a meeting held on 25th September 2024 to use 2042 (design year) forecast models under Scenario P (Do-Minimum) and Scenario R (Do-Something).

1.1.6. This note presents the results of the exercise undertaken to investigate the potential impact on the 2042 current forecast models under scenarios P and R of changes made to the base year model network previously reported.

2. Sensitivity Test Forecast Models

2.1. Strategic Model

2.1.1. The sensitivity tests forecast models were developed for the following scenarios:

- 2042 Scenario P – This is equivalent to Do-Minimum scenario and excludes the proposed M5 J10 scheme and dependent developments on the Joint Core Strategy (JCS) sites.
- 2042 Scenario R – This is equivalent to the Do-Something scenario and includes both the proposed M5 J10 scheme and demand associated with dependent parts of JCS developments.

2.1.2. The 2042 sensitivity test forecast models for the two scenarios (P&R) were developed using the demand matrices from the corresponding current (DCO) forecast models. The highway networks for 2042 sensitivity test models were developed by incorporating the relevant changes used for developing the base year sensitivity test which have been previously reported to NH. These changes were limited to a short section of A4019 between Kingsditch Roundabout and Galagher Junction.

2.1.3. The 2042 sensitivity test forecast models were then compared to the corresponding current forecast models under each scenario and differences reported, informed by the widely used GEH statistics as agreed with NH. The GEH statistics measures the relative differences between the two sets of flows. The results of the comparing the flows between 2042 sensitivity and current forecast models based on GEH statistics are shown in Figures 2-1 to 2-3 for Scenario P and Figures 2-4 to 2-6 for Scenario R.

2.1.4. The differences in flows between the sensitivity and current 2042 forecast models across the three modelled periods (AM, IP and PM) reported under Scenario P show relatively small differences, with GEH values of 0 to 1 in the focus area of the scheme (Figures 2-1 to 2-3). It is worth noting that GEH value of less than 5 is used as the acceptability criteria for comparison of link flows in TAG.

2.1.5. The only part of the highway network which under 2042 scenario P shows GEH values above 5 across the three modelled periods is the short section of A4019 between Manor Road and Gallagher Junction in the westbound direction. This is consistent with the same impact reported in the base year sensitivity test (2) model.

2.1.6. This higher level of GEH statistic above 5 for Scenario P is reported is limited to the short section of about 400m between Manor and Gallagher junctions. This is caused by the A4019 traffic destined for Old Gloucester Road exiting Gallagher junction in the sensitivity test forecast model instead of at the Manor Road junction in the current forecast models. The switching of the exiting traffic from A4019 to Old Gloucester Road between these two junctions is mainly due to the reduced delay at Gallagher junction in the sensitivity test model compared to the current forecast model.

2.1.7. Under Scenario R, the reported differences in flows between the sensitivity and current 2042 forecast models across the three modelled periods (AM, IP and PM) are also relatively small, with GEH values of 0 to 1 in the focus area of the scheme (Figures 2-4 to 2-6).

2.1.8. The only part of the highway network under 2042 scenario R showing GEH values above 5 is on the westbound direction of Hayden Avenue, which is a local road about 485m long. This impact is consistent with that reported for the base year and Scenario P sensitivity tests forecast models which arises from switching of the westbound traffic between the A4019 and Old Gloucester Road to use Gallagher junction in the sensitivity test forecast model, instead of Manor Road junction in the current forecast models.

2.1.9. It is worth noting that the impact of the changes made to the forecast networks to develop sensitivity test models is lower in Scenario R compared to Scenario P. This is thought to be due to the changes in traffic patterns caused under this scenario by presence of the proposed M5 J10 scheme.

2.1.10. The SRN in the forecast sensitivity tests model area under both Scenarios P and R, including M5 between junctions 9 to 12, as well as A38 and A40, experience small changes with GEH values between 0 and 1 across all modelled periods.

2.1.11. In addition to the GEH statistics, the differences in flows between the sensitivity tests and current forecast models under both scenarios (P and R) have also been calculated and are shown in Figures A1 to A12 in Appendix A of this note.

2.1.12. The flow difference plots by vehicles and percentage changes under 2042 Scenario P (Figures A1 to A6 in Appendix A) generally show minimal increases along A4019 between Kingsditch Roundabout and M5 J10 of about 50 vehicles in the sensitivity test models across the three periods. The only part of the network which shows larger increases in the sensitivity test forecast models is a short section of the A4019 between Manor Road and Gallagher junction, which as previously stated, is due to westbound traffic destined for Old Gloucester Road exiting the A4019 at Galagher junction instead of Manor Road. The SRN including the M5 between junctions 9 and 12, as well as the A38 and A40, experience minimal changes (both increases and reduction) of a maximum of 50 vehicles.

2.1.13. Figures A7 to A12 in Appendix A present the differences in flows by vehicles and percentage under 2042 Scenario R between the sensitivity and current forecast models. Under this scenario, the trend and magnitude of flow differences are similar to Scenario P, with A4019 showing small increases of about 50 vehicles between Kingsditch Roundabout and M5 J10 and larger increases reported between the short section of A4019 between Manor Road and Galagher Road junctions. The M5 between junctions 9 and 12 as well as A38 and A40 also show minimal changes in flows between +/-50 vehicles across the three modelled periods.

2.2. Microsimulation Model

2.2.1. The traffic modelling for M5 J10 includes a microsimulation model as well as a strategic model (SATURN), with the former developed using Paramics Discovery software. The Paramics model has a validated 2017 base year and covers a focused area along the A4019 corridor between Coomb Hill and Kingsditch Roundabout which includes M5 J10. The model has been used to assess the operational performance of the proposed scheme under different forecasting scenarios and model results have been reported in the Transport Assessment for the Scheme (REP3-033).

2.2.2. A ‘dynamic’ traffic assignment method was used for all the assessed scenarios undertaken in the Paramics models. The traffic growth for Paramics models was provided by the cordon versions of the SATURN strategic model for each forecast year. For the assessment of M5 J10 scheme, the Paramics base year model (2017) trip matrices were growthed for each forecast year in line with the growth produced by the SATURN strategic forecast models. The Paramics model runs were then undertaken based on dynamic method of assignment, which means the routes between origin-destinations are not pre-determined or fixed and would vary in different time periods depending upon the travel cost in terms of time and distance.

2.2.3. Given the demand matrices used for the DCO and sensitivity test forecast strategic models under the 2042 Scenario R are the same and also minimal differences were reported between the two forecast strategic models, it follows that the 2042 Scenario R cordon matrices produced from the sensitivity test forecast model runs, which are used to provide traffic growth to the Paramics model, would also closely correlate to those used in the DCO model. It is worth noting that the Paramics networks' structure would remain the same between the DCO and sensitivity test forecast model scenarios, and results would only be influenced by the differences in the input demand.

2.2.4. For the exercise reported in this technical note, the cordon matrices were derived from the 2042 Scenario R sensitivity test forecast model, which reflects the full demand from the JCS developments along with the proposed M5 J10 scheme, and have been compared against the matrices used for the DCO model. The results of this comparison are presented in Table 1 and show that the matrix totals are extremely close with a difference of 0.1% across both modelled time periods.

Table 1 – Comparison of 2042 Scenario R Cordon Matrix Totals

Time period	DCO Peak Hour Matrix Totals (Vehicles)	Sensitivity Test Peak Hour Matrix Totals (Vehicles)	Difference (Vehicles)	Difference (%)
AM Peak	20350	20371	21	0.1%
PM Peak	20853	20877	24	0.1%

2.2.5. The cordon matrices from the two forecast models were also compared at zonal levels for both modelled time periods. The results of the comparison at zonal level showed no differences in the demand matrices across most zones. Where there were differences, they were minimal, ranging between 1 to 23 vehicles. This further affirms the closeness of the two sets of the cordon matrices and demonstrates that there are insufficient differences to warrant re-running of the Paramics models using outputs from the sensitivity test SATURN models, since the outputs would not be materially different from the DCO model outputs and any differences would be insufficient to alter the assessment of the Scheme or its design.

Figure 2-1 – Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences Using GEH Statistics - AM Peak

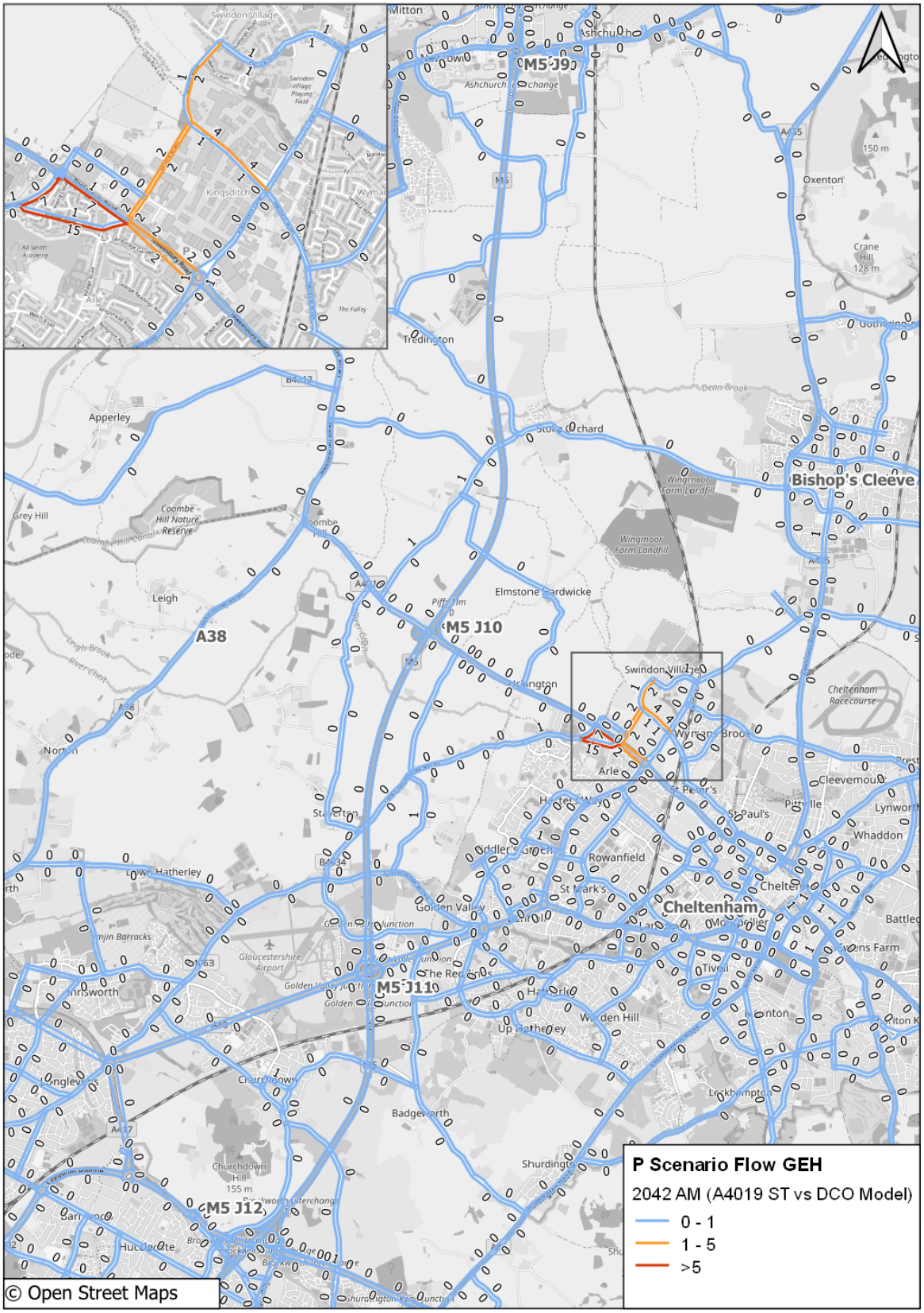


Figure 2-2 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences Using GEH Statistics 2042 - Inter Peak

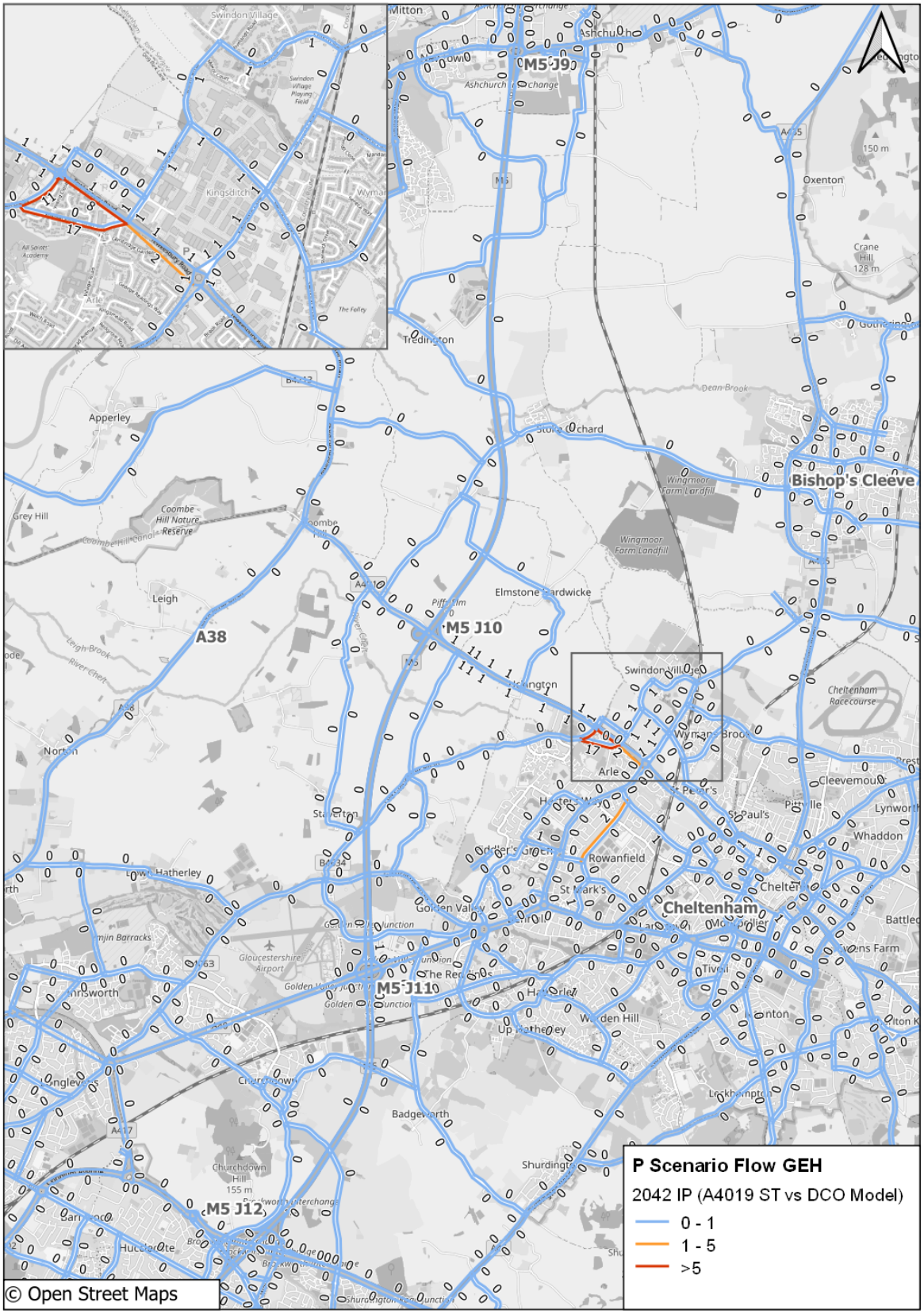


Figure 2-3 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences Using GEH Statistics – PM Peak

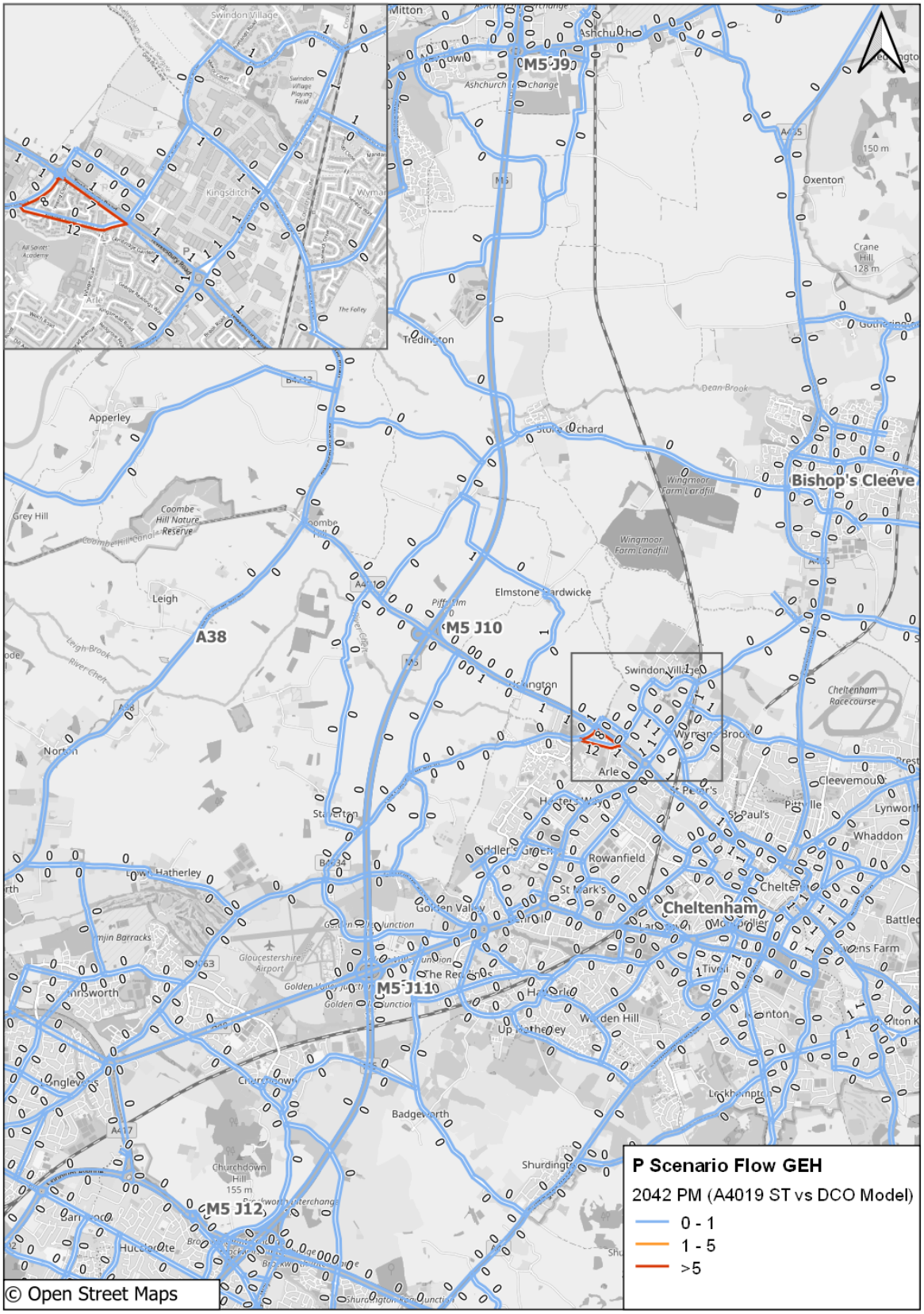


Figure 2-4 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences Using GEH Statistics AM Peak

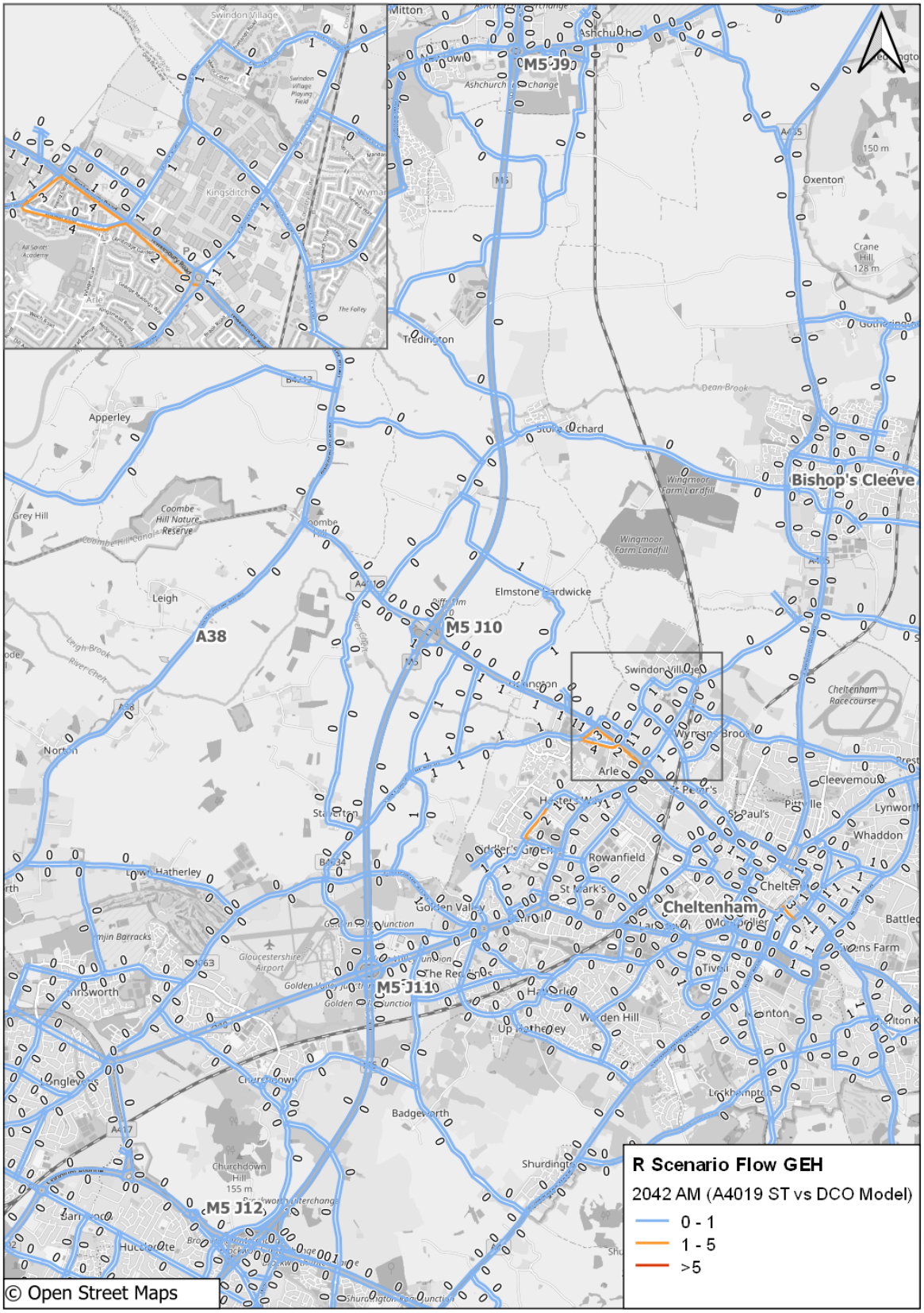


Figure 2-5 — Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences Using GEH Statistics Inter Peak

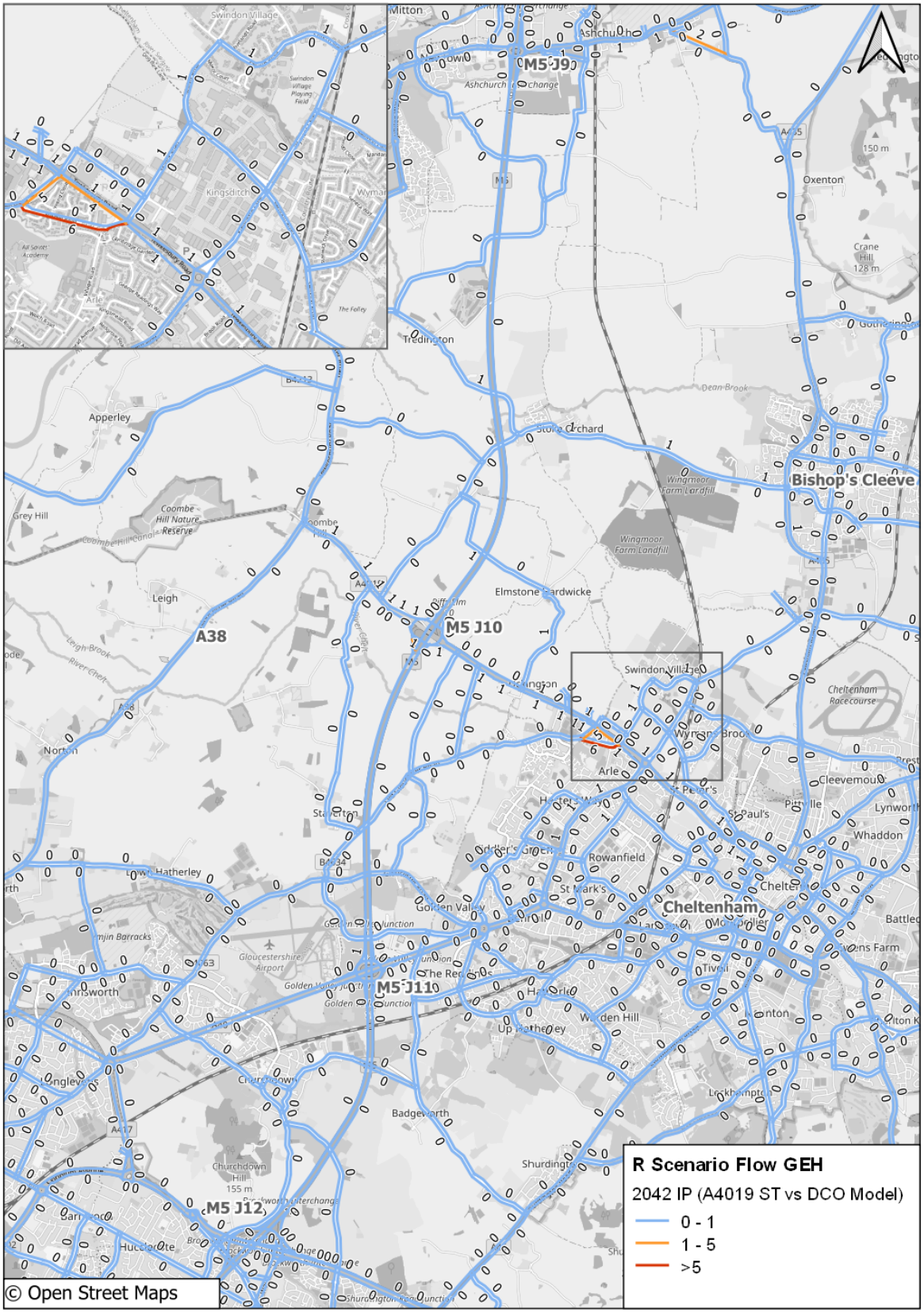
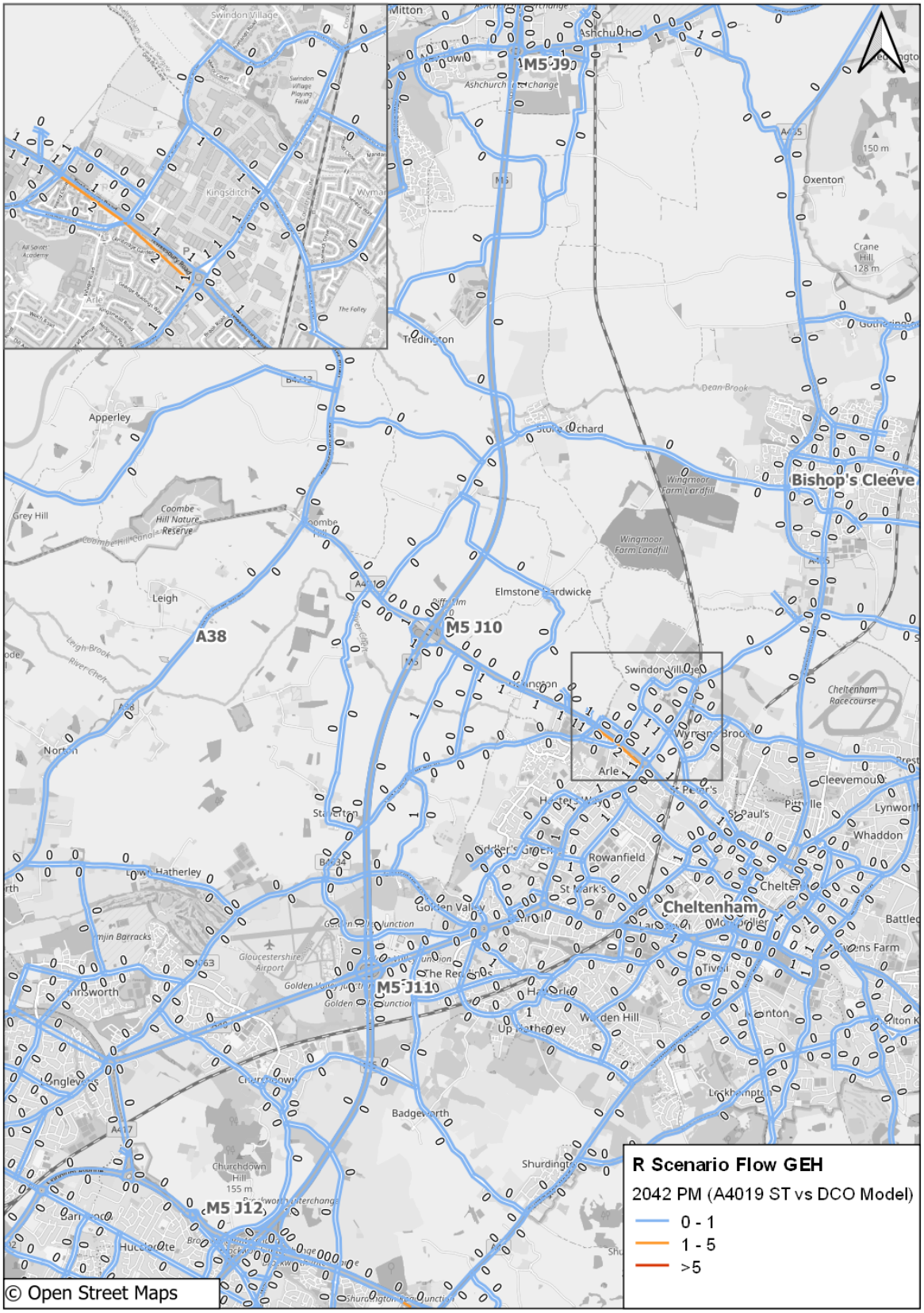


Figure 2-6 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences Using GEH Statistics AM Peak – PM Peak



3. Summary and Conclusion

3.1.1. National Highways (NH) undertook a review of the traffic models submitted to support the proposed M5 J10 Scheme. AtkinsRéalis provided responses on behalf of GCC to the comments arising from this review which successfully addressed all the comments in respect of the base year model except for one issue relating to the northbound journey times routes 208A and 209B that lie slightly outside of the TAG validation threshold.

3.1.2. At the request of National Highways, a revised base year model, termed sensitivity test (2), was developed which resulted in Routes 208A and 209B meeting the TAG criteria. The comparison of the current base year and sensitivity test (2) models showed a high degree of correlation between them. The results of this sensitivity test were submitted to NH in a Technical Note which were found acceptable in addressing the issue relating to JTRS 208A and 209B in the base year model.

3.1.3. National Highways also requested that the potential impacts of changes made in the base year to develop sensitivity test (2) model be investigated on the current forecast models. For this purpose, it was agreed with NH to use 2042 (design year) forecast models under Scenario P (Do-Minimum) and Scenario R (Do-Something) models.

3.1.4. The 2042 sensitivity test forecast models for the two scenarios (P&R) were developed using the demand matrices from the corresponding current (DCO) forecast models, with forecast highway networks reflecting the relevant changes that had been used to develop base year sensitivity test (2) model. These changes to the highway network were introduced on the short section along A4019 between Kingsditch Roundabout and Gallagher junction.

3.1.5. The 2042 Scenarios P and R sensitivity test models were then compared to the current forecast models and differences reported using widely used GEH statistics, which is based on calculating the relative differences between the two modelled flows. It is worth noting that GEH value of less than 5 is used as the acceptability criteria for comparison of link flows in TAG.

3.1.6. The comparisons of the two forecast models showed similar trends and magnitude of differences under both Scenarios P and R with generally low GEH values of 0 to 1 across the focus area of the model including the SRN (M5 junctions 9 to 12, A38 and A40).

3.1.7. The only part of the highway network which showed GEH values above 5, under both scenarios (P & R), was the short section of A4019 between Manor Road and Gallagher Junction in the westbound direction. This is caused by the westbound traffic along A4019 destined for Old Gloucester Road exiting at Gallagher junction in the sensitivity forecast model, instead of at the Manor Road junction in the current forecast model.

3.1.8. The flow differences by vehicles and percentage were also calculated between the 2042 current and sensitivity test forecast models under both scenarios (P & R). The comparisons showed consistent results, with the differences reported using GEH statistics under both P & R scenarios. The size of impacts caused by the changes in the forecast networks was generally minimal across the key links in the network including A4019, M5 (junctions 9 to 12), A38 and A40.

3.1.9. The traffic modelling system for M5 J10 includes a Paramics microsimulation model with a validated 2017 base and a focused area along the A4019 corridor between Coomb Hill and Kingsditch Roundabout which includes M5 J10.

3.1.10. To develop Paramics forecast models, traffic growth was provided by the cordon version of the SATURN strategic models for each forecast year.

3.1.11. For this exercise the cordon matrices were produced from the 2042 Scenario R sensitivity test forecast model and compared against the cordon matrices used for the DCO. The results of comparison showed the matrix totals to be extremely close with a difference of 0.1% across both modelled time periods.

3.1.12. The cordon matrices from the two forecast models were also compared at zonal levels for both modelled time periods and results showed no differences between most of the zones in the demand matrices. The reported differences among the remaining zones were minimal, ranging between 1 to 23 vehicles.

3.1.13. The results of the exercise reported in this technical note confirms that the 2042 current and sensitivity test forecast strategic models, under both Scenarios P and R, are closely correlated and the changes in the traffic flows arising from routes 208A and 209B meeting the TAG criteria do not materially impact the strategic forecast models submitted for the DCO process.

3.1.14. The close comparison of the demand from the two forecast scenarios (DCO and sensitivity test) under 2042 Scenario R Paramics, which reflects the full trips generation by JCS developments as well as the proposed M5 J10, demonstrates that there are insufficient differences to warrant re-running of the Paramics models using outputs from the sensitivity test SATURN models, since the outputs would not be materially different from the DCO model outputs and any differences would be insufficient to alter the assessment of the Scheme or its design. This affirms that the Paramics model submitted for the DCO remains valid and is fit for purpose.

Appendix A.

Flow Difference Plots

2042 Scenarios P and R Plots

Figure A-1 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences in Vehicles - AM Peak

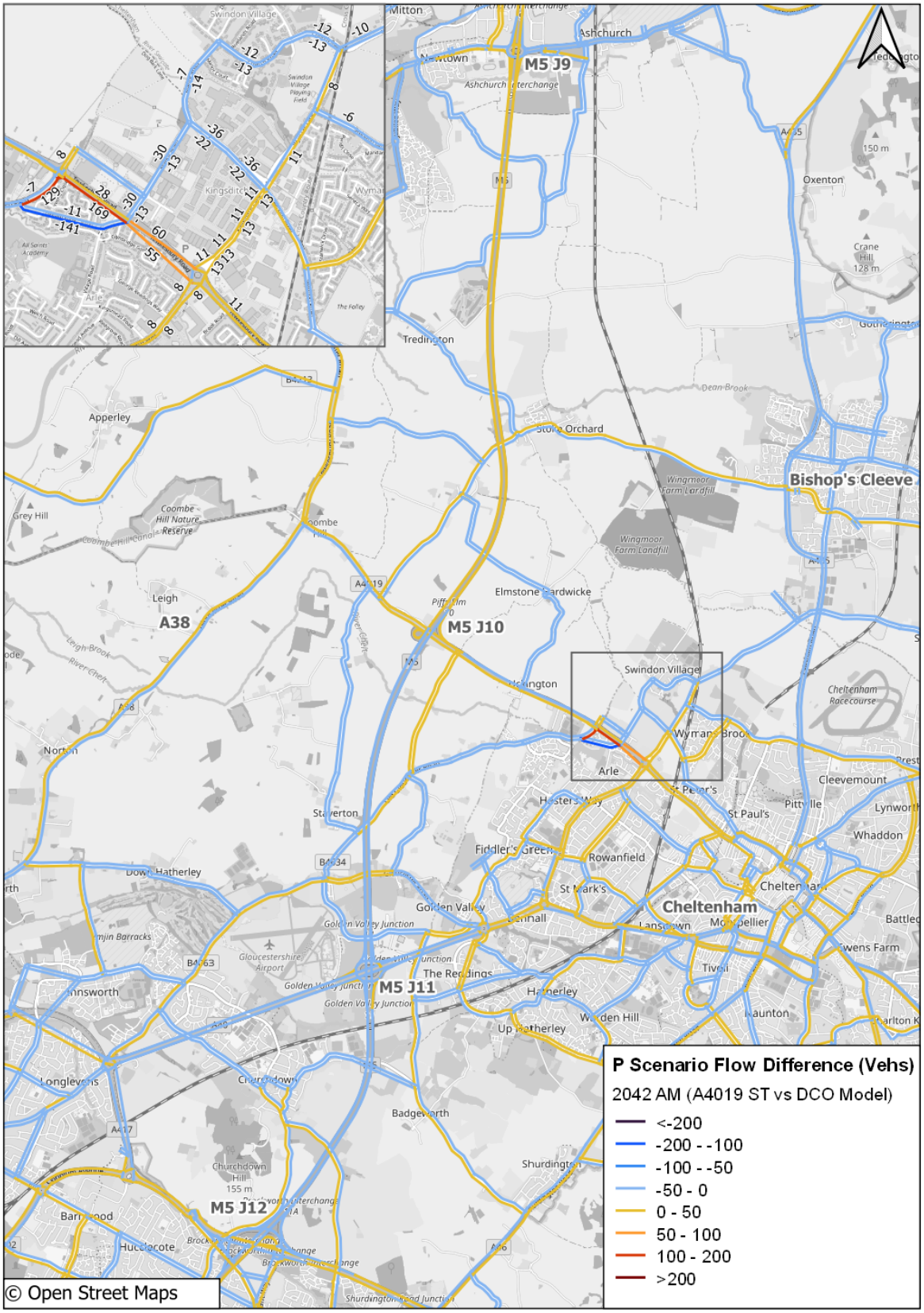


Figure A-2 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences in Vehicles - Inter Peak

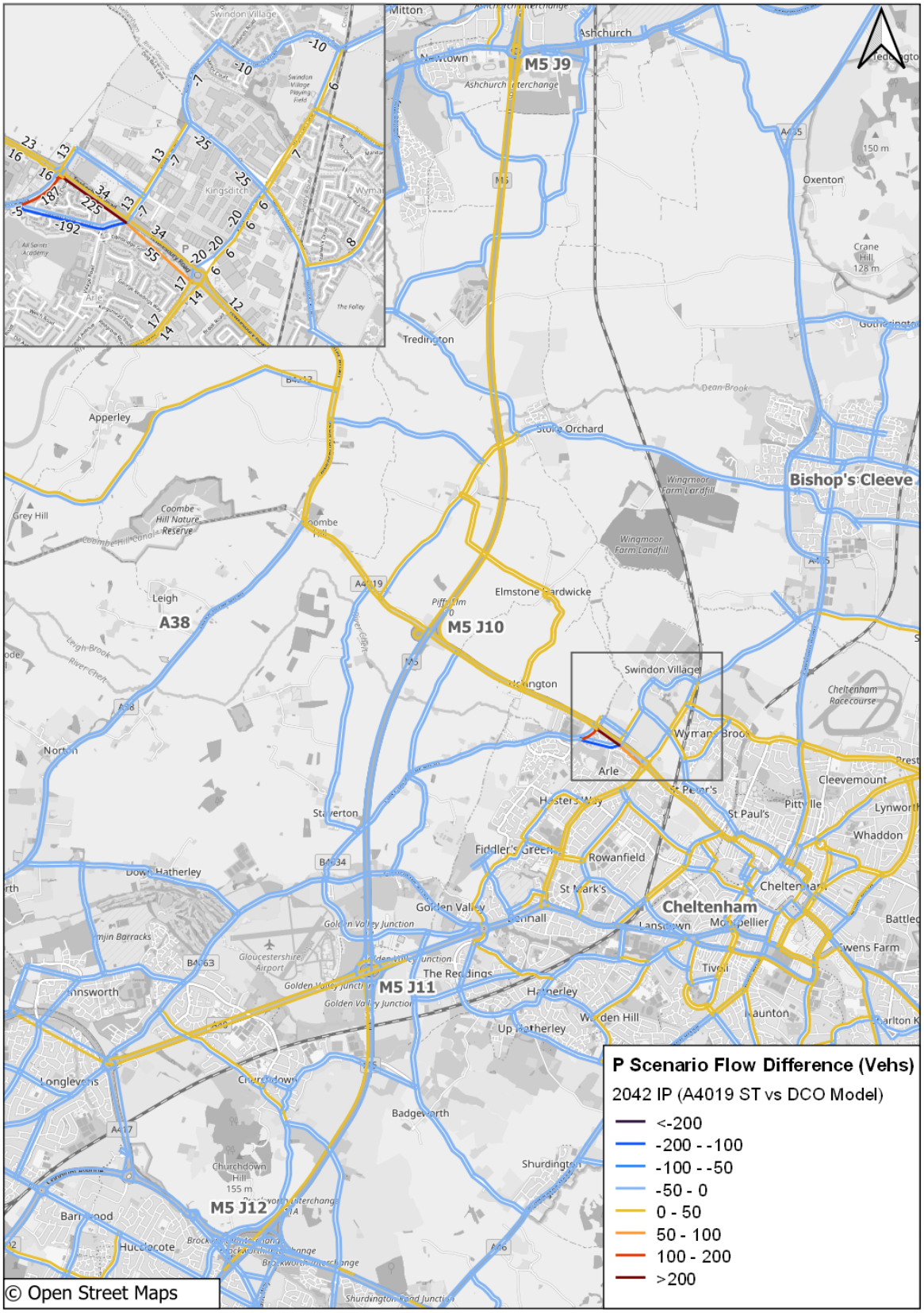


Figure A-3 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences in Vehicles - PM Peak

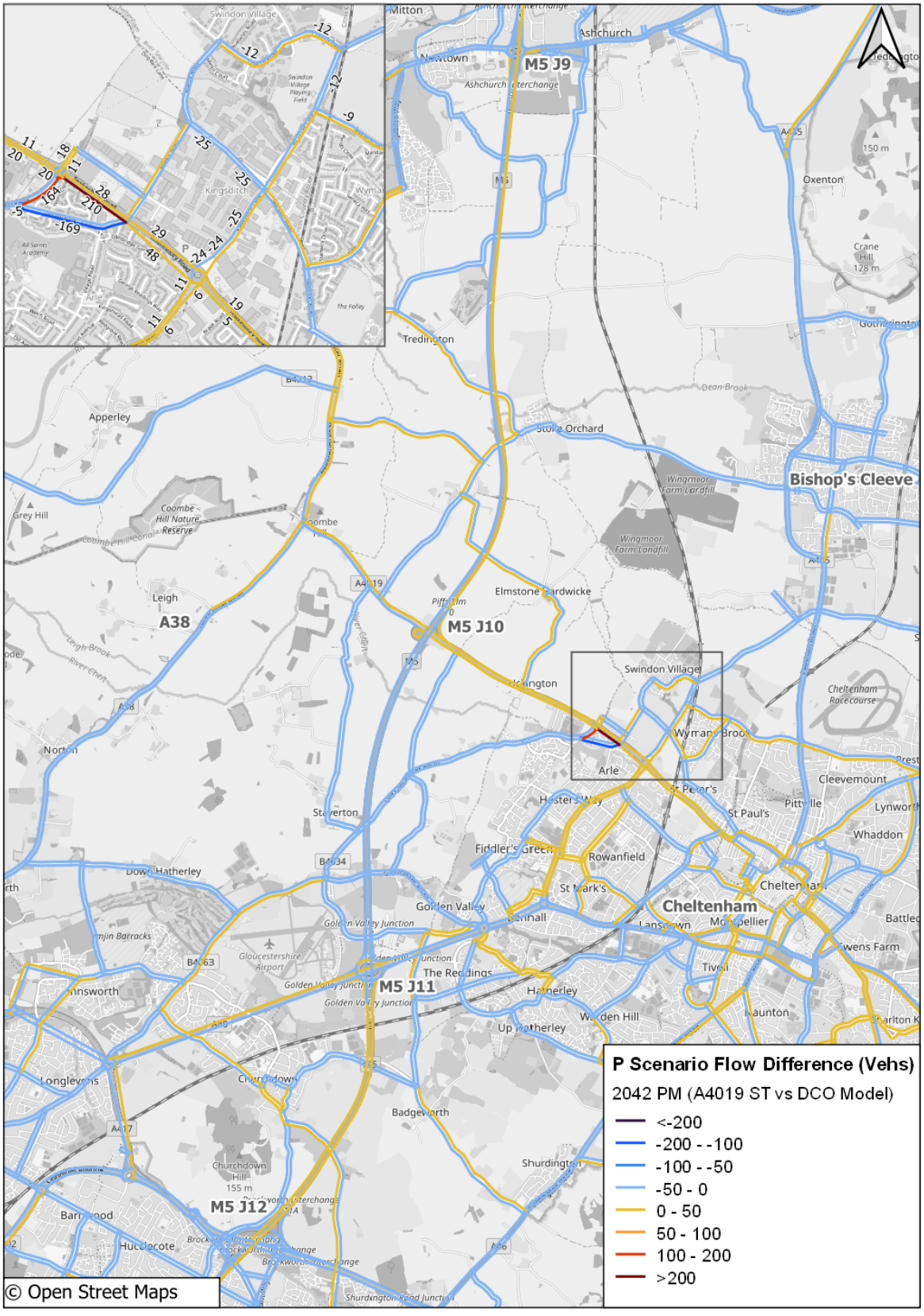


Figure A-4 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences by Percentage (%) - AM Peak

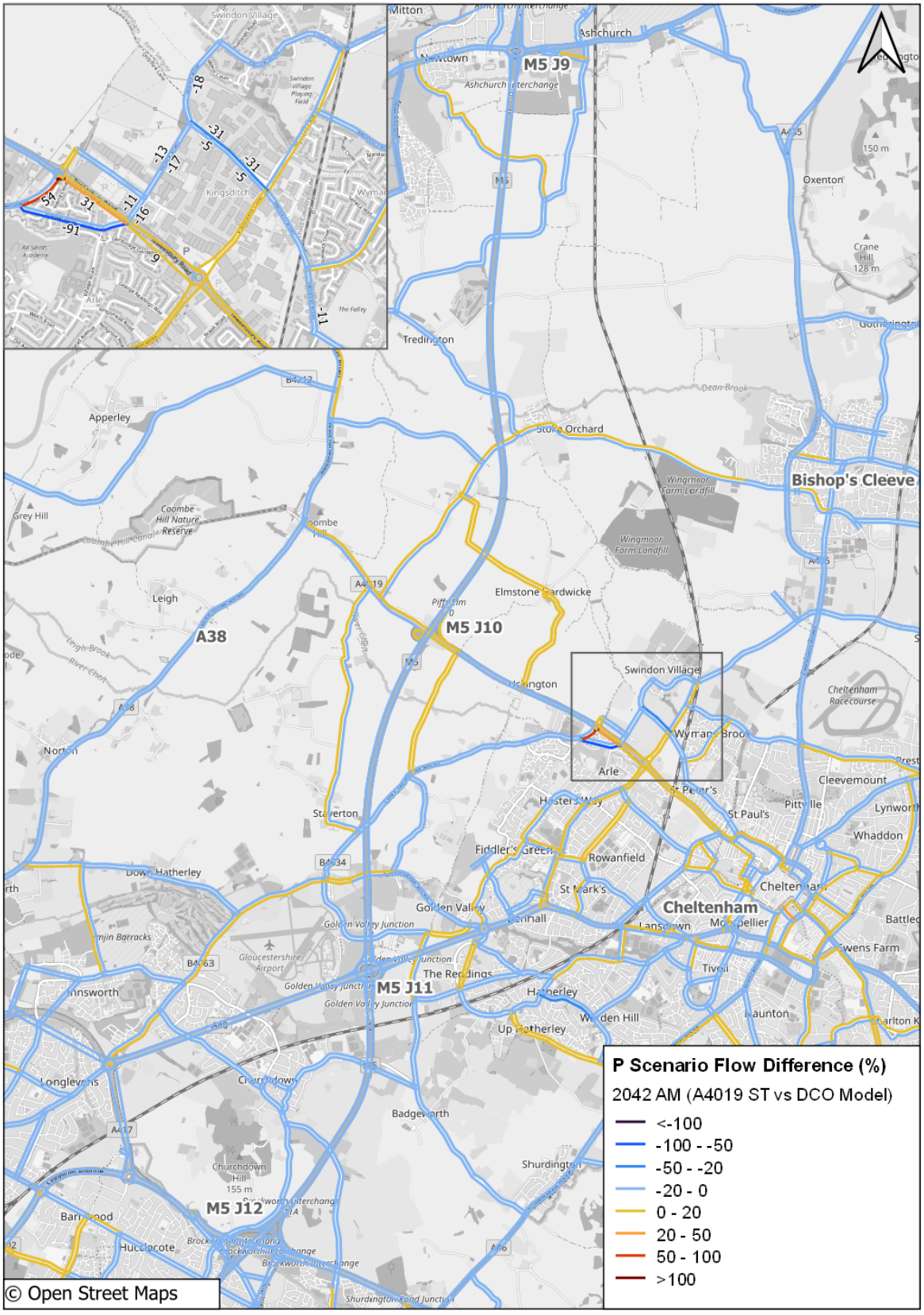


Figure A-5 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences by Percentage (%) - Inter Peak

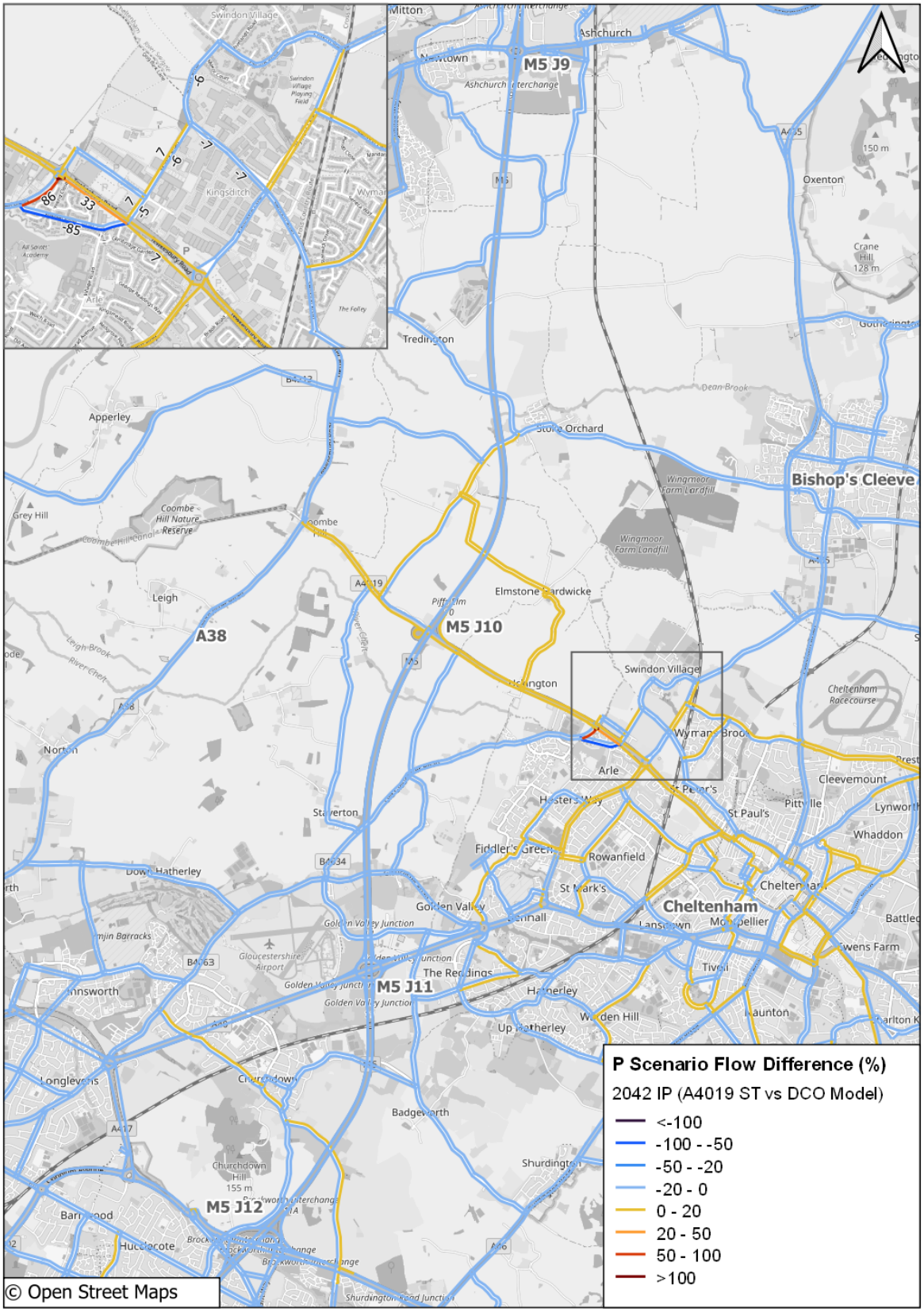


Figure A-6 - Sensitivity Test v DCO Model - 2042 Scenario P: Traffic Flow Differences by Percentage (%) - PM Peak

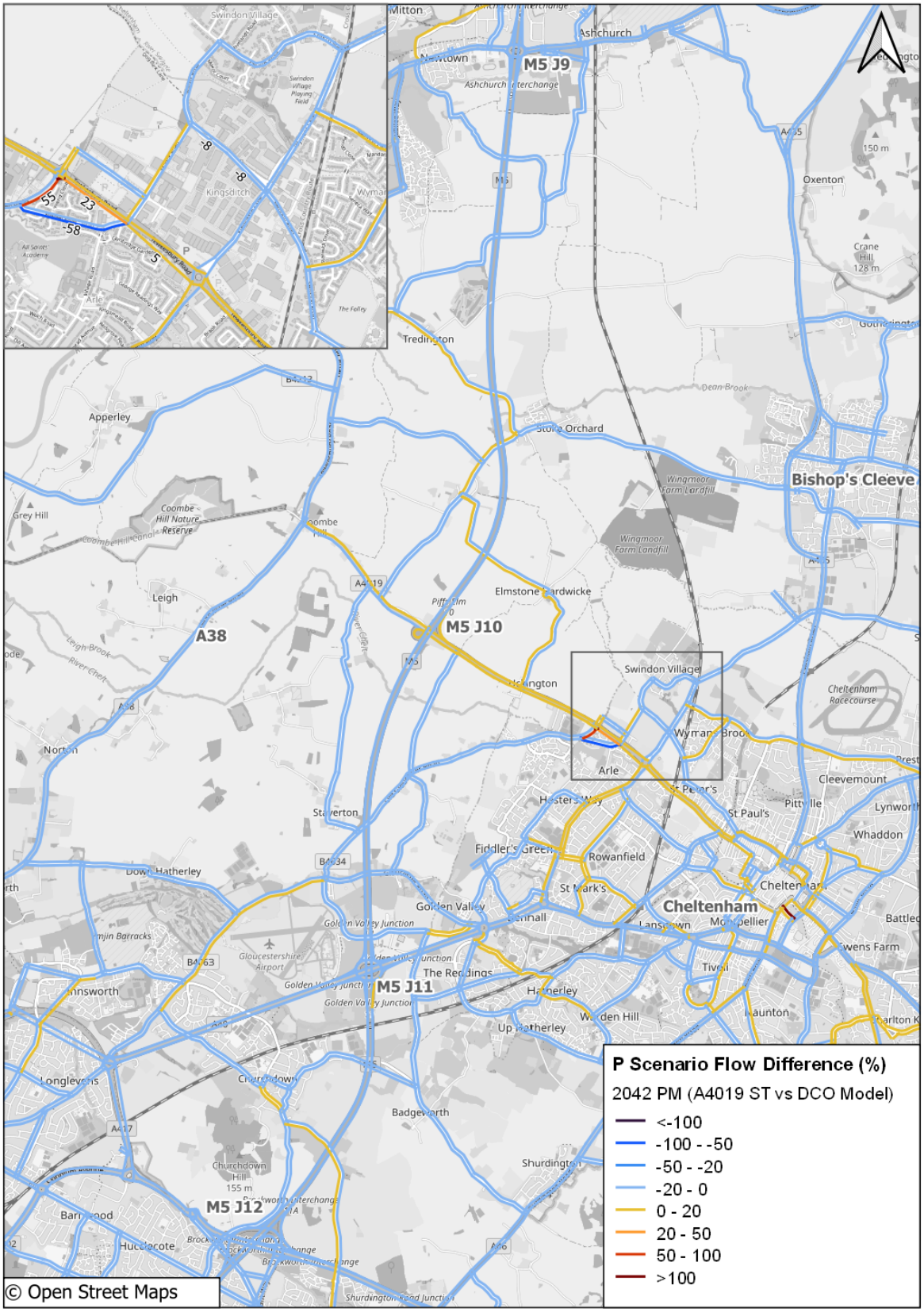


Figure A-7 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences by Vehicles– AM Peak

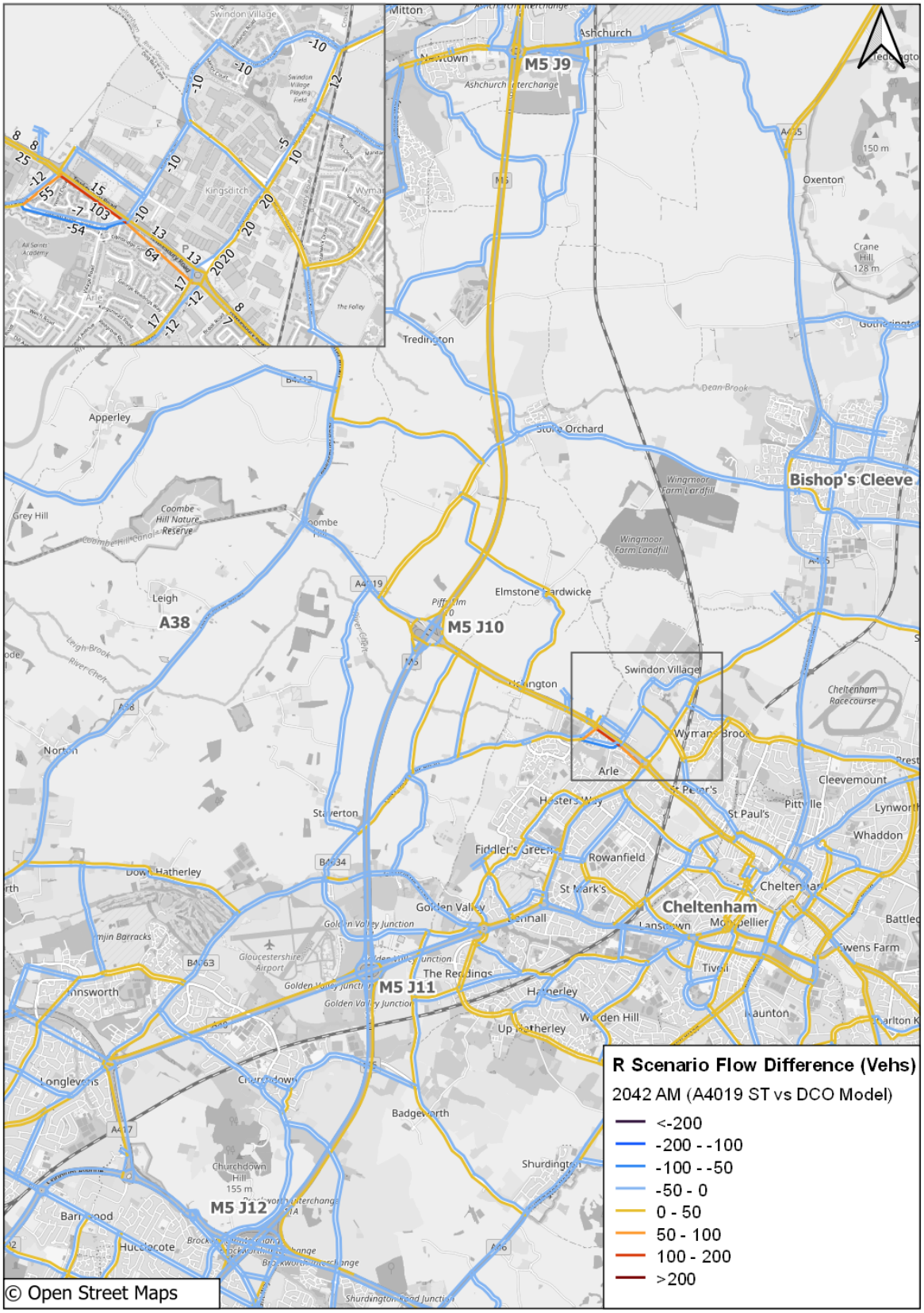


Figure A-8 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences by Vehicles– Inter Peak

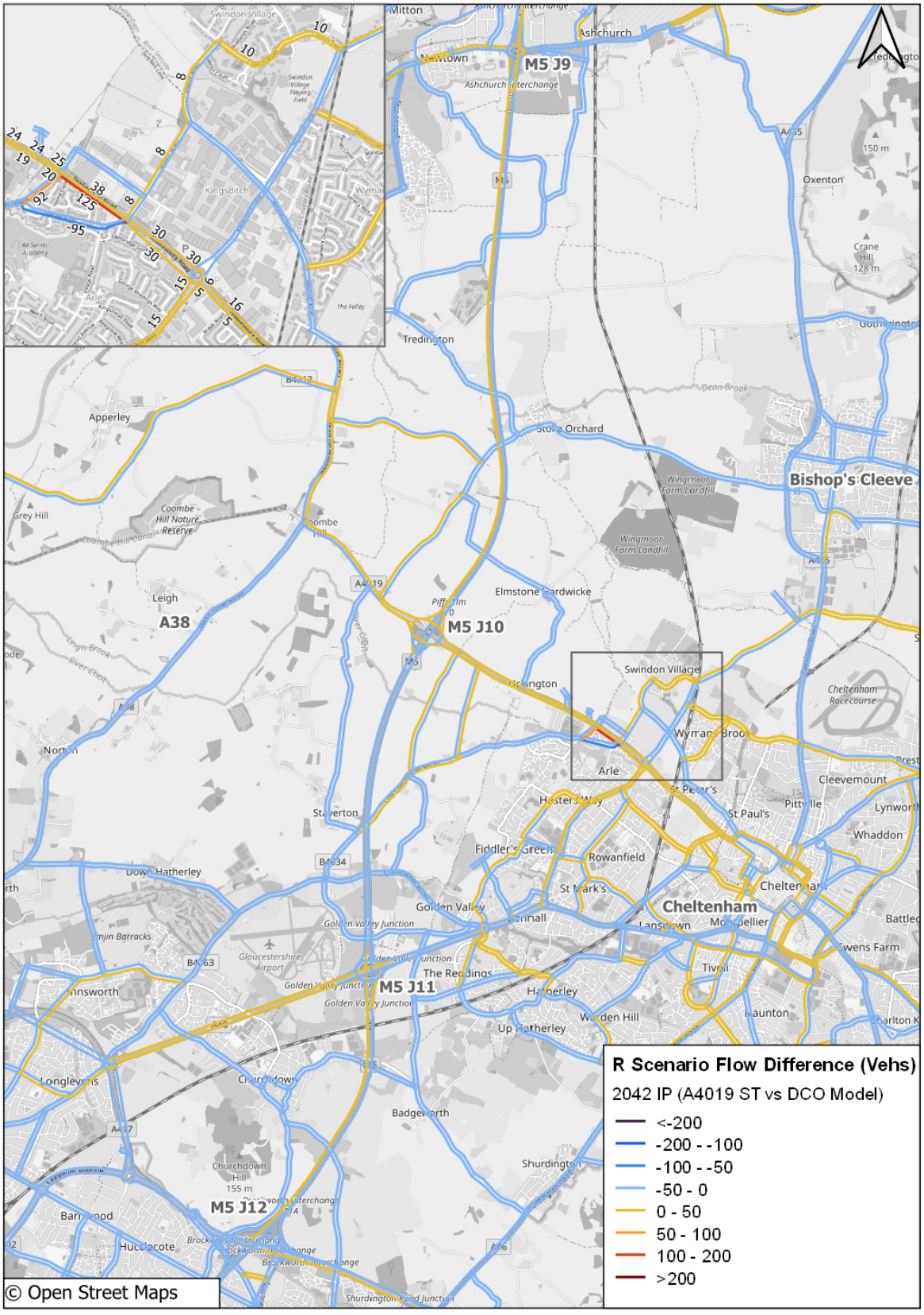


Figure A-9 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences by Vehicles– PM Peak

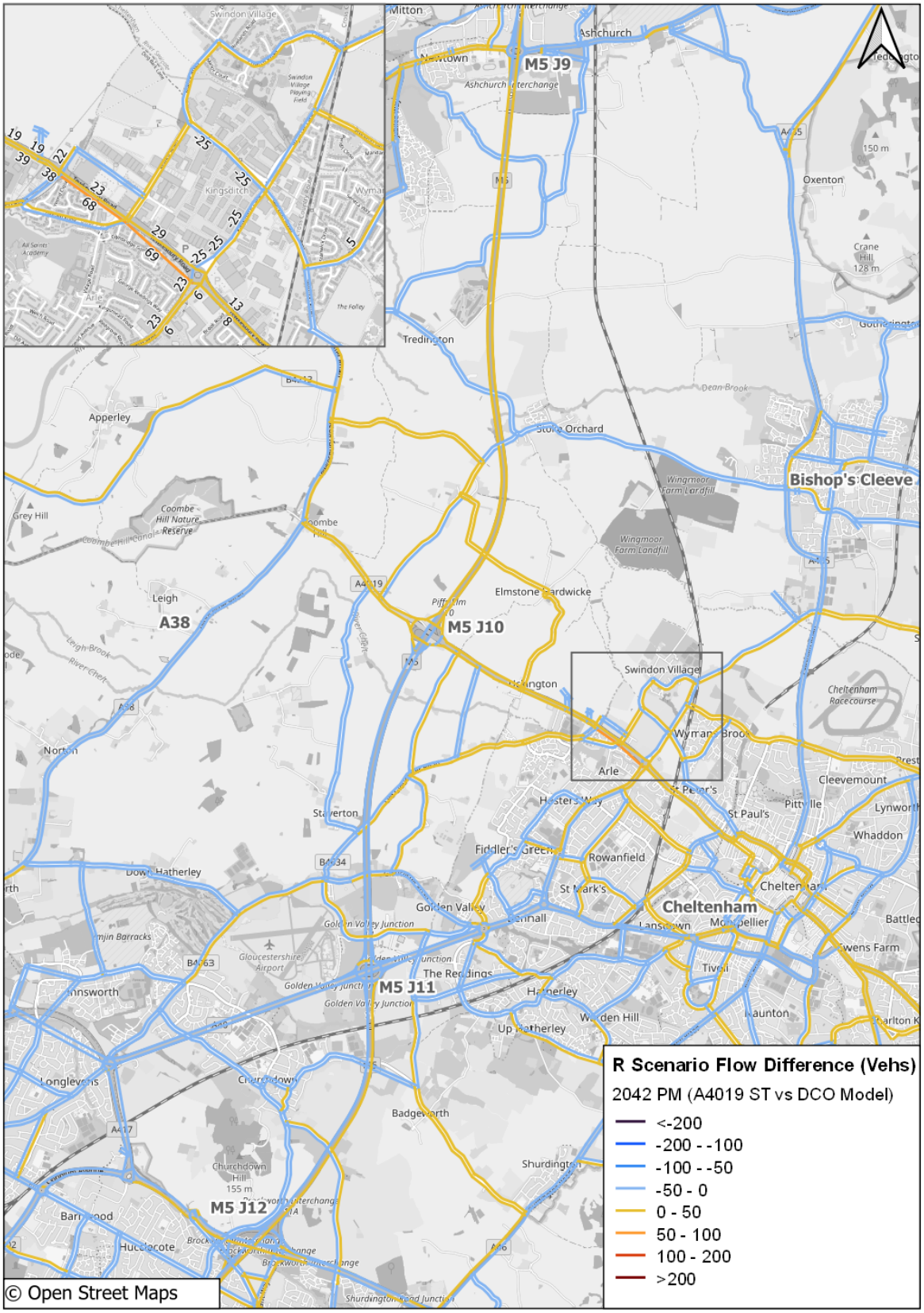


Figure A-10 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences by Percentage (%) – AM Peak

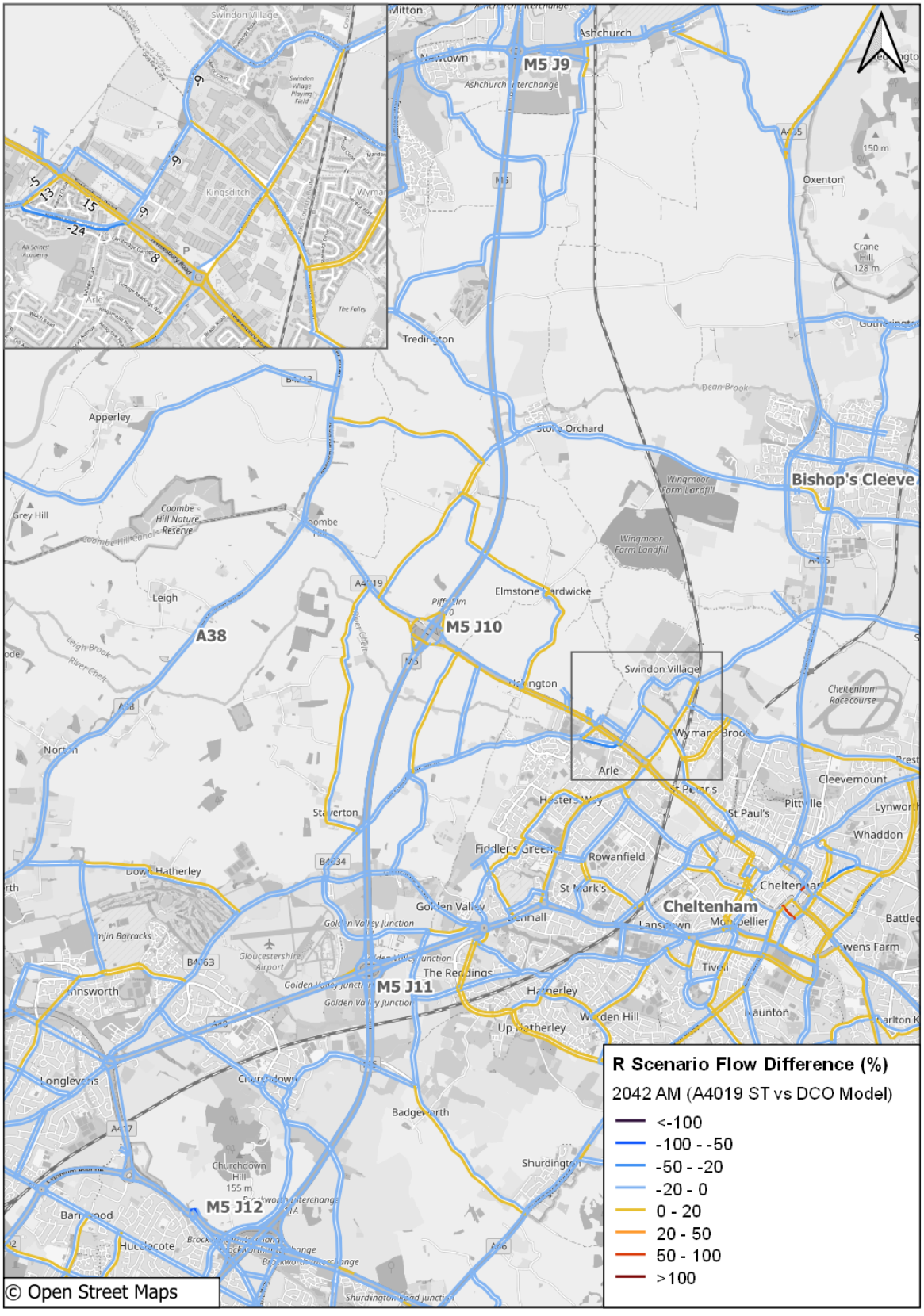


Figure A-11 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences by Percentage (%) – Inter Peak

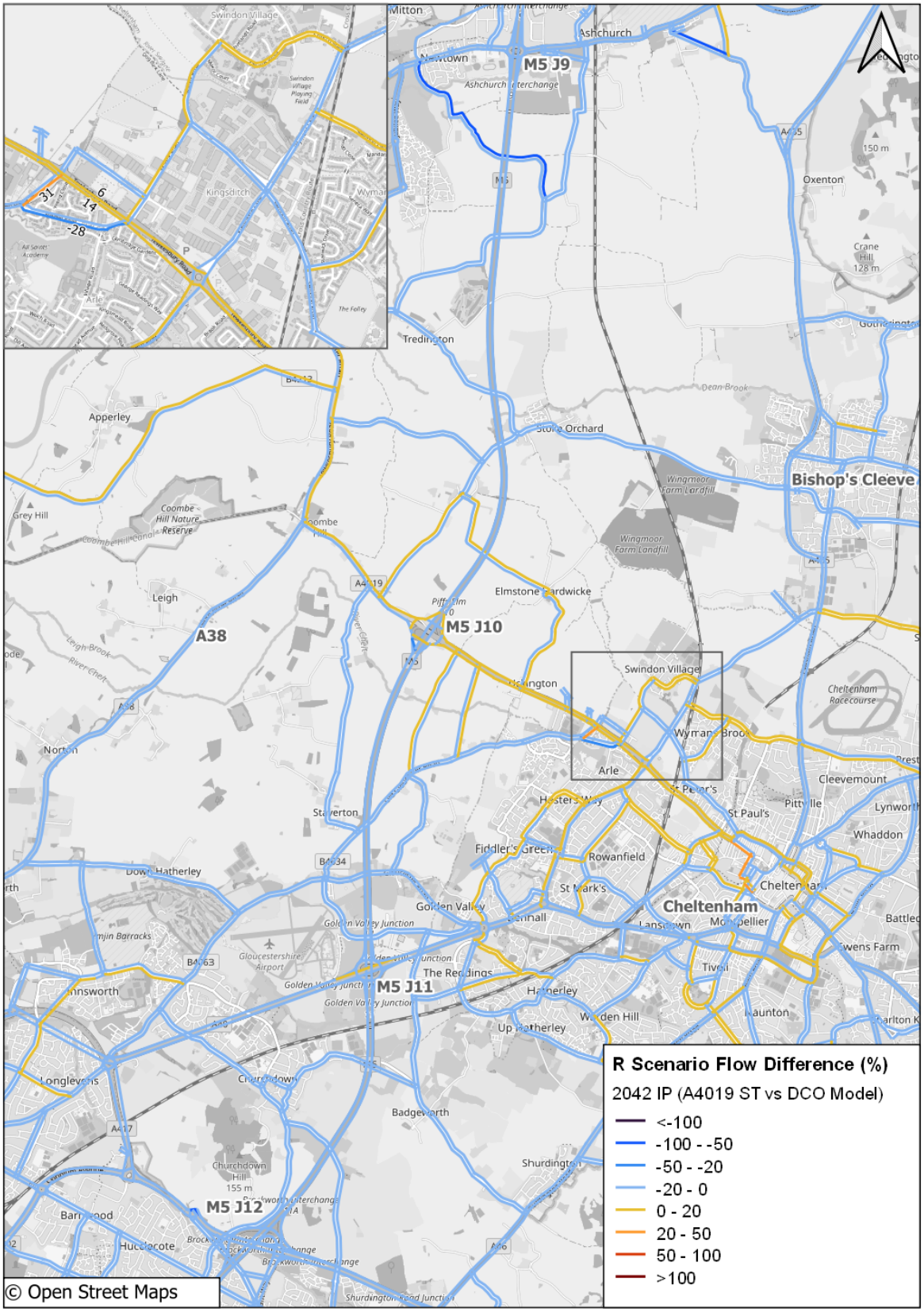
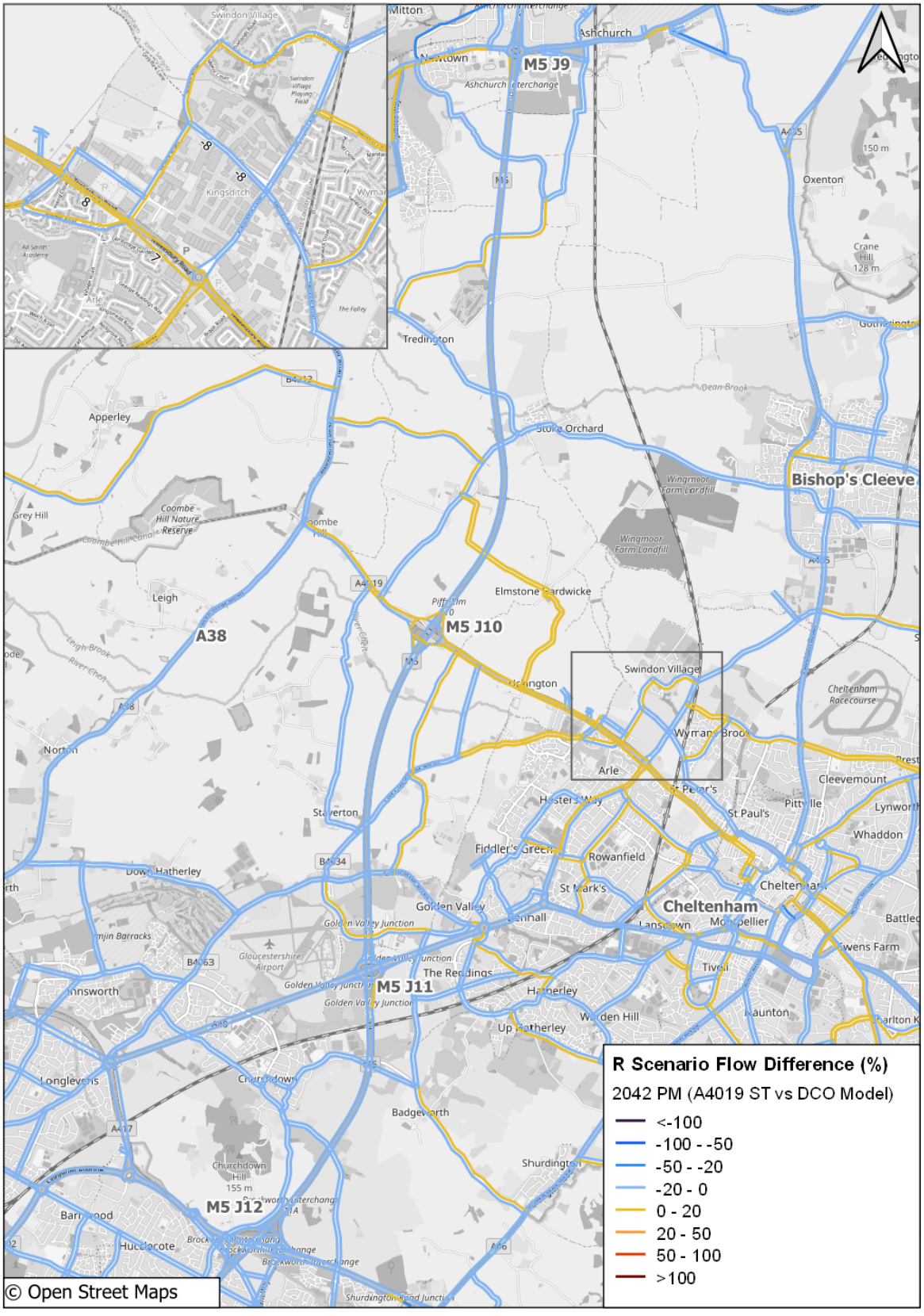


Figure A-12 - Sensitivity Test v DCO Model - 2042 Scenario R: Traffic Flow Differences by Percentage (%) – PM Peak



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