JACOBS

M5 J10-11 Paramics Modelling

Gloucestershire County Council

Forecasting Report

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M5 J10-11 Paramics Modelling

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1. Introduction

Jacobs has been commissioned by Gloucestershire County Council as specialist modelling consultancy to support several major scheme business cases. It is expected that the schemes will open in 2021.

It has been identified that the M5 Junction 10 to Junction 11 Paramics Discovery model, developed by Jacobs on behalf of Highways England, is the best tool for the scheme assessment. This model was developed for a base year of 2017.

This model has been used to develop forecast models for 2021 and 2031 forecast years for a Do Minimum scenario and two Do Something scenarios. The purpose of this report is to detail the development of these forecast models and to assess the impacts that the proposed schemes have on the network.

1.1 Structure of the report

This report is structured as follows:

- Section 2 discusses the development of the base model;
- Section 3 discusses the forecasting methodology;
- Section 4 discusses the network development;
- Section 5 discusses the forecast results; and
- Section 5 summarises the conclusions for the report.

2. Base Model Development

The Paramics model was developed on behalf of Highways England to test development impact and to undertake a scheme testing on the strategic road network. It covers the West of Cheltenham and North of Gloucester as shown in Figure 1. The model comprises 100 zones. 73 zones are internal, 25 zones are external and 2 zones are reserved for the future strategic development sites. The model and demand matrices represent a 3 hour morning peak period (0700 hours -1000 hours) and a 3 hour evening peak period (1600 hours -1900 hours). 3 hour demand matrices have been classified into three groups Car, LGV and HGV. The model is calibrated against the turning counts collected on 28th November 2017.

Figure 1: 2017 Paramics Discovery Model Area

In the Paramics model, demand matrices were developed for 3 hours and assigned using 3-hour demand profiles for individual zones. The profile was obtained from ATC data. The model was calibrated for 0800-0900 hours and 1700-1800 hours. For the purpose of the task the hourly matrix has been obtained from the average profile of internal zones and external zones. The result is shown in Table 1 & Table 2.

Table 1: Calculated AM Hourly Demand Totals of 2017 Paramics Model

Time	Average Profile	Car		All Vehicle	
		O	D	O	D
	Internal Zones				
0700-0800	0.280	4831	5213	5565	5903
0800-0900	0.381	6570	7090	7569	8028
0900-1000	0.339	5843	6305	6732	7140
3-hour Total	**1.000**	**17244**	**18608**	**19866**	**21070**
	External Zones				
0700-0800	0.298	12580	12174	15413	14598
0800-0900	0.403	17038	16488	20876	19772
0900-1000	0.299	12621	12214	15464	14646
3-hour Total	**1.000**	**42240**	**40876**	**51753**	**50549**

Table 2: Calculated PM Hourly Demand Totals of 2017 Paramics Model

Time	Average Profile	Car		All Vehicle	
		O	D	O	D
	Internal Zones				
1600-1700	0.375	7862	6792	8650	7617
1700-1800	0.365	7665	6622	8434	7427
1800-1900	0.260	5462	4718	6009	5291
3-hour Total	**1.000**	**20989**	**18132**	**23093**	**20335**
	External Zones				
1600-1700	0.348	16122	17117	18473	19434
1700-1800	0.365	16909	17954	19376	20384
1800-1900	0.286	13239	14056	15170	15959
3-hour Total	**1.000**	**46270**	**49127**	**53019**	**55777**

3. Forecasting Methodology

3.1 Model Specification

3.1.1 Forecast Years

Forecast models have been developed for an opening year of 2021 and an assessment year of 2031.

3.1.2 Time Periods

Models have been developed for AM and PM peak periods. These periods cover:

- **AM Peak** – 07:00-10:00, with results collected for a peak hour of 08:00-09:00
- **PM Peak** – 16:00-19:00, with results collected for a peak hour of 17:00-18:00

3.2 Growth Factors

It was decided to use the NTEM growth factors for forecasting the future car demands from 2017 base demand. District level factor as shown in Table 3 was applied to the relevant zones. However, National traffic model (NTM) forecast growth used for LGV and HGV. It should be noted the NTEM factors were adjusted with income and fuel factors as per WebTAG unit M4 7.4.13.

Table 3: TEMPRO Growth Factors between 2017 and 2021

Area Description	NTEM 7.2 Growth Factor		NTEM 7.2 Growth Factor with Income & Fuel Adjustment		NTM 2018	
					All_Road	
	Origin	Destination	Origin	Destination	LGV	HGV
	AM					
Gloucestershire	1.042	1.042	1.047	1.048	1.062	0.991
Cheltenham	1.051	1.040	1.057	1.046	1.062	0.991
Gloucester	1.063	1.049	1.069	1.055	1.062	0.991
Tewkesbury	1.036	1.034	1.040	1.038	1.062	0.991
Stroud	1.038	1.046	1.044	1.052	1.062	0.991
	PM					
Gloucestershire	1.038	1.038	1.044	1.044	1.062	0.991
Cheltenham	1.038	1.044	1.044	1.050	1.062	0.991
Gloucester	1.047	1.053	1.053	1.059	1.062	0.991
Tewkesbury	1.032	1.032	1.035	1.036	1.062	0.991
Stroud	1.040	1.035	1.046	1.041	1.062	0.991

Table 4: TEMPRO Growth Factors between 2021 and 2031

Area Description	NTEM 7.2 Growth Factor		NTEM 7.2 Growth Factor with Income & Fuel Adjustment		NTM 2018	
					All_Road	
	Origin	Destination	Origin	Destination	LGV	HGV
	AM					
Gloucestershire	1.055	1.055	1.095	1.095	1.105	1.000
Cheltenham	1.058	1.052	1.099	1.092	1.105	1.000
Gloucester	1.060	1.054	1.100	1.094	1.105	1.000
Tewkesbury	1.079	1.055	1.120	1.095	1.105	1.000
Stroud	1.055	1.055	1.095	1.095	1.105	1.000
	PM					
Gloucestershire	1.057	1.057	1.097	1.098	1.105	1.000
Cheltenham	1.053	1.057	1.093	1.097	1.105	1.000
Gloucester	1.055	1.059	1.095	1.099	1.105	1.000
Tewkesbury	1.063	1.078	1.103	1.119	1.105	1.000
Stroud	1.057	1.057	1.097	1.098	1.105	1.000

4. Network Development

4.1 Do Minimum Network

The Do Minimum scenario consists of the base network with changes at just one junction. This is to reflect the recent changes made to the A40 / Telstar Way / Whittington Road junction which have been implemented since the development of the base model. The drawing for the new layout of this junction can be found in **Appendix A.**

4.2 Do Something 1 Network

The Do Something 1 network consists of the Do Minimum network with improvements implemented at Arle Court Roundabout. The drawing for this scheme can be found in **Appendix B.**

4.3 Do Something 2 Network

The Do Something 2 network consists of the Do Something 1 network with additional improvements implemented along the A40. The improvements are:

- Improvements to the M5 J11 Southbound off-slip – **Appendix C**
- Improvements between M5 J11 and Arle Court Roundabout – **Appendix D**
- Improvements between Arle Court Roundabout and A40 / Telstar Way / Whittington Road junction – **Appendix E**
- Improvements to the A40 / Telstar Way / Whittington Road junction – **Appendix F**
- Improvements to the A40 / Princess Elizabeth Way Roundabout – **Appendix G**
- Improvements between the A40 / Princess Elizabeth Way Roundabout and Griffiths Avenue – **Appendix H**

5. Forecast Results

5.1 Turning Counts

Turn were collected for each of the key junctions along the A40. These turn counts can be seen in Table 5 to Table 8 for the 2021 and 2031 AM and PM peaks.

Table 5: 2021 AM Turn Count Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

			2021 AM Turn Counts (08:00-09:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
M5 J11	M5 (N)	M5 (N)	0	0	0
		A40 (E)	280	277	265
		M5 (S)	3	2	3
		A40 (W)	497	492	487
	A40 (E)	M5 (N)	231	226	224
		A40 (E)	0	0	0
		M5 (S)	904	897	895
		A40 (W)	0	0	0
	M5 (S)	M5 (N)	56	58	60
		A40 (E)	897	896	894
		M5 (S)	0	0	0
		A40 (W)	124	127	126
	A40 (W)	M5 (N)	410	410	410
		A40 (E)	79	77	49
		M5 (S)	72	73	71
		A40 (W)	410	410	410
Arle Court Roundabout	Fiddler's Green Lane (N)	Fiddler's Green Lane (N)	0	0	0
		A40 Gloucester Road (E)	31	43	49
		Hatherley Lane (S)	47	58	62
		A40 Gloucester Road (W)	47	59	56
		B4063 (W)	17	24	23
	A40 Gloucester Road (E)	Fiddler's Green Lane (N)	23	22	23
		A40 Gloucester Road (E)	0	0	0
		Hatherley Lane (S)	356	362	369
		A40 Gloucester Road (W)	1693	1703	1711
		B4063 (W)	194	205	198
	Hatherley Lane (S)	Fiddler's Green Lane (N)	65	61	62
		A40 Gloucester Road (E)	258	236	232
		Hatherley Lane (S)	0	0	0
		A40 Gloucester Road (W)	748	701	696
		B4063 (W)	151	142	139
	A40 Gloucester Road (W)	Fiddler's Green Lane (N)	138	138	139
		A40 Gloucester Road (E)	1804	1806	1788
		Hatherley Lane (S)	427	429	426
		A40 Gloucester Road (W)	0	0	0

			2021 AM Turn Counts (08:00-09:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
		B4063 (W)	144	143	143
	B4063 (W)	Fiddler's Green Lane (N)	67	67	68
		A40 Gloucester Road (E)	406	408	403
		Hatherley Lane (S)	85	90	87
		A40 Gloucester Road (W)	140	143	143
		B4063 (W)	1	1	1
A40 / Telstar Way	Telstar Way (N)	A40 Gloucester Road (E)	50	47	48
		A40 Gloucester Road (W)	374	382	375
	A40 Gloucester Road (E)	Telstar Way (N)	174	176	171
		A40 Gloucester Road (W)	1744	1731	1752
	A40 Gloucester Road (W)	Telstar Way (N)	571	570	571
		A40 Gloucester Road (E)	1941	1924	1912
A40 / Princess Elizabeth Way	A4013 Princess Elizabeth Way (N)	A4013 Princess Elizabeth Way (N)	2	2	1
		A40 Gloucester Road (E)	72	73	65
		A40 Gloucester Road (W)	1037	1050	1043
	A40 Gloucester Road (E)	A4013 Princess Elizabeth Way (N)	193	193	195
		A40 Gloucester Road (E)	45	45	44
		A40 Gloucester Road (W)	950	941	953
	A40 Gloucester Road (W)	A4013 Princess Elizabeth Way (N)	888	891	934
		A40 Gloucester Road (E)	1014	1008	948
		A40 Gloucester Road (W)	81	79	79
Park and Ride / Hatherley Lane / Retail Park / Grovefield Way Roundabout	Car Park (N)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	10	4	4
		Hatherley Lane (SE)	1	0	0
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	0	0	0
	Hatherley Lane (NE)	Car Park (N)	73	82	80
		Hatherley Lane (NE)	5	5	6
		Hatherley Lane (SE)	566	569	579
		Unnamed Road (S)	32	31	31
		Grovefield Way (W)	236	248	243
	Hatherley Lane (SE)	Car Park (N)	7	6	6
		Hatherley Lane (NE)	742	725	711
		Hatherley Lane (SE)	0	0	0
		Unnamed Road (S)	23	21	22
		Grovefield Way (W)	39	39	34
	Unnamed Road (S)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	6	6	6
		Hatherley Lane (SE)	5	4	4
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	3	3	3
		Car Park (N)	54	38	39

			2021 AM Turn Counts (08:00-09:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
	Grovefield Way (W)	Hatherley Lane (NE)	471	412	418
		Hatherley Lane (SE)	56	42	45
		Unnamed Road (S)	9	7	6
		Grovefield Way (W)	0	0	0

For the 2021 AM peak, total junction throughput remains similar in the Do Something 1 and Do Something 2 scenarios, compared with the Do Minimum, for all junctions.

The junction with the greatest change in throughput overall in the 2021 AM peak is the Park and Ride / Hatherley Lane / Retail Park / Grovefield Way roundabout which experiences a 4% decrease in throughput in the Do Something 1 and Do Something 2 scenarios compared with the Do Minimum. This is due to the proposed scheme at Arle Court roundabout favouring the A40, leading to an increase in queueing along Hatherley Lane, which blocks back to this roundabout. This is due to the increased capacity at Arle Court roundabout leading to an increase in traffic on the A40 westbound approach, which opposes the Hatherley Lane approach. As well as this, in the proposed scheme there are two lanes running northbound along Hatherley Lane between the Park and Ride / Hatherley Lane / Retail Park / Grovefield Way roundabout and Arle Court roundabout but the right lane is not used much as the majority of traffic on this approach to Arle Court wishes to turn left.

Table 6: 2031 AM Turn Count Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

			2031 AM Turn Counts (08:00-09:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
M5 J11	M5 (N)	M5 (N)	0	0	0
		A40 (E)	269	259	241
		M5 (S)	3	3	3
		A40 (W)	474	463	444
	A40 (E)	M5 (N)	230	229	227
		A40 (E)	0	0	0
		M5 (S)	927	928	929
		A40 (W)	0	0	0
	M5 (S)	M5 (N)	62	61	62
		A40 (E)	959	964	965
		M5 (S)	0	0	0
		A40 (W)	137	127	130
	A40 (W)	M5 (N)	415	415	414
		A40 (E)	75	80	46
		M5 (S)	73	74	75
		A40 (W)	415	415	414
Arle Court Roundabout	Fiddler's Green Lane (N)	Fiddler's Green Lane (N)	0	0	0
		A40 Gloucester Road (E)	26	38	46
		Hatherley Lane (S)	35	50	61
		A40 Gloucester Road (W)	34	49	58
		B4063 (W)	14	20	25
		Fiddler's Green Lane (N)	22	23	22

			2031 AM Turn Counts (08:00-09:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
	A40 Gloucester Road (E)	A40 Gloucester Road (E)	0	0	0
		Hatherley Lane (S)	362	381	380
		A40 Gloucester Road (W)	1740	1757	1763
		B4063 (W)	199	203	208
	Hatherley Lane (S)	Fiddler's Green Lane (N)	65	59	57
		A40 Gloucester Road (E)	247	228	216
		Hatherley Lane (S)	0	0	0
		A40 Gloucester Road (W)	755	693	680
		B4063 (W)	152	139	133
	A40 Gloucester Road (W)	Fiddler's Green Lane (N)	136	139	141
		A40 Gloucester Road (E)	1814	1840	1821
		Hatherley Lane (S)	432	436	436
		A40 Gloucester Road (W)	0	0	0
		B4063 (W)	151	149	151
	B4063 (W)	Fiddler's Green Lane (N)	66	70	76
		A40 Gloucester Road (E)	381	425	423
		Hatherley Lane (S)	91	96	97
		A40 Gloucester Road (W)	145	154	150
		B4063 (W)	1	1	1
A40 / Telstar Way	Telstar Way (N)	A40 Gloucester Road (E)	52	52	52
		A40 Gloucester Road (W)	405	403	412
	A40 Gloucester Road (E)	Telstar Way (N)	175	177	175
		A40 Gloucester Road (W)	1767	1791	1793
	A40 Gloucester Road (W)	Telstar Way (N)	565	575	570
		A40 Gloucester Road (E)	1911	1948	1942
A40 / Princess Elizabeth Way	A4013 Princess Elizabeth Way (N)	A4013 Princess Elizabeth Way (N)	2	2	2
		A40 Gloucester Road (E)	77	78	68
		A40 Gloucester Road (W)	1072	1074	1066
	A40 Gloucester Road (E)	A4013 Princess Elizabeth Way (N)	196	200	197
		A40 Gloucester Road (E)	47	52	47
		A40 Gloucester Road (W)	952	965	980
	A40 Gloucester Road (W)	A4013 Princess Elizabeth Way (N)	874	902	954
		A40 Gloucester Road (E)	1002	1023	964
		A40 Gloucester Road (W)	76	78	78
Park and Ride / Hatherley Lane / Retail Park / Grovefield Way Roundabout	Car Park (N)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	4	1	0
		Hatherley Lane (SE)	0	0	0
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	0	0	0
	Hatherley Lane (NE)	Car Park (N)	73	82	80
		Hatherley Lane (NE)	4	5	4
		Hatherley Lane (SE)	568	596	607

			2031 AM Turn Counts (08:00-09:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
		Unnamed Road (S)	29	33	32
		Grovefield Way (W)	244	248	249
	Hatherley Lane (SE)	Car Park (N)	6	6	5
		Hatherley Lane (NE)	770	710	689
		Hatherley Lane (SE)	0	0	0
		Unnamed Road (S)	23	18	17
		Grovefield Way (W)	35	28	27
	Unnamed Road (S)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	7	6	6
		Hatherley Lane (SE)	5	4	4
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	4	4	3
	Grovefield Way (W)	Car Park (N)	38	30	28
		Hatherley Lane (NE)	441	403	387
		Hatherley Lane (SE)	42	32	31
		Unnamed Road (S)	7	5	5
		Grovefield Way (W)	0	0	0

For the 2031 AM peak, total junction throughput remains similar in the Do Something 1 and Do Something 2 scenarios, compared with the Do Minimum, for all junctions.

As in 2021, the junction with the greatest change in throughput overall in the 2031 AM peak is the Park and Ride / Hatherley Lane / Retail Park / Grovefield Way roundabout which experiences a 4% decrease in throughput in the Do Something 1 and a 5% decrease in the Do Something 2 scenarios compared with the Do Minimum. This is due to the same reason as in the 2021 AM peak.

Table 7: 2021 PM Turn Count Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

			2021 PM Turn Counts (17:00-18:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
M5 J11	M5 (N)	M5 (N)	0	0	0
		A40 (E)	257	268	258
		M5 (S)	1	1	1
		A40 (W)	487	505	504
	A40 (E)	M5 (N)	288	297	292
		A40 (E)	0	0	0
		M5 (S)	876	892	889
		A40 (W)	0	0	0
	M5 (S)	M5 (N)	69	69	70
		A40 (E)	778	774	779
		M5 (S)	0	0	0
		A40 (W)	147	146	140
	A40 (W)	M5 (N)	484	487	487

			2021 PM Turn Counts (17:00-18:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
		A40 (E)	71	69	41
		M5 (S)	137	141	138
		A40 (W)	484	487	487
Arle Court Roundabout	Fiddler's Green Lane (N)	Fiddler's Green Lane (N)	0	0	0
		A40 Gloucester Road (E)	10	19	18
		Hatherley Lane (S)	23	36	38
		A40 Gloucester Road (W)	67	106	108
		B4063 (W)	6	13	12
	A40 Gloucester Road (E)	Fiddler's Green Lane (N)	83	81	81
		A40 Gloucester Road (E)	0	1	1
		Hatherley Lane (S)	402	419	417
		A40 Gloucester Road (W)	1728	1694	1701
		B4063 (W)	210	213	207
	Hatherley Lane (S)	Fiddler's Green Lane (N)	85	72	70
		A40 Gloucester Road (E)	198	184	178
		Hatherley Lane (S)	0	0	0
		A40 Gloucester Road (W)	716	645	642
		B4063 (W)	132	129	119
	A40 Gloucester Road (W)	Fiddler's Green Lane (N)	99	109	108
		A40 Gloucester Road (E)	1354	1455	1448
		Hatherley Lane (S)	503	539	538
		A40 Gloucester Road (W)	0	0	0
		B4063 (W)	97	101	104
	B4063 (W)	Fiddler's Green Lane (N)	59	78	76
		A40 Gloucester Road (E)	173	217	220
		Hatherley Lane (S)	41	50	50
		A40 Gloucester Road (W)	121	158	156
		B4063 (W)	1	0	0
A40 / Telstar Way	Telstar Way (N)	A40 Gloucester Road (E)	68	69	72
		A40 Gloucester Road (W)	519	530	524
	A40 Gloucester Road (E)	Telstar Way (N)	96	95	100
		A40 Gloucester Road (W)	1769	1713	1729
	A40 Gloucester Road (W)	Telstar Way (N)	201	218	215
		A40 Gloucester Road (E)	1489	1655	1651
A40 / Princess Elizabeth Way	A4013 Princess Elizabeth Way (N)	A4013 Princess Elizabeth Way (N)	4	4	3
		A40 Gloucester Road (E)	217	227	215
		A40 Gloucester Road (W)	992	1003	1019
	A40 Gloucester Road (E)	A4013 Princess Elizabeth Way (N)	146	153	148
		A40 Gloucester Road (E)	11	20	15
		A40 Gloucester Road (W)	952	861	870
	A40 Gloucester Road (W)	A4013 Princess Elizabeth Way (N)	610	677	725
		A40 Gloucester Road (E)	852	955	889

			2021 PM Turn Counts (17:00-18:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
		A40 Gloucester Road (W)	65	77	76
Park and Ride / Hatherley Lane / Retail Park / Grovefield Way Roundabout	Car Park (N)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	110	14	19
		Hatherley Lane (SE)	17	2	3
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	10	4	5
	Hatherley Lane (NE)	Car Park (N)	4	9	9
		Hatherley Lane (NE)	8	8	7
		Hatherley Lane (SE)	607	657	658
		Unnamed Road (S)	10	11	11
		Grovefield Way (W)	338	360	359
	Hatherley Lane (SE)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	658	650	652
		Hatherley Lane (SE)	0	0	0
		Unnamed Road (S)	20	21	20
		Grovefield Way (W)	116	116	113
	Unnamed Road (S)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	33	31	26
		Hatherley Lane (SE)	34	33	26
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	32	32	26
	Grovefield Way (W)	Car Park (N)	1	1	1
		Hatherley Lane (NE)	323	331	314
		Hatherley Lane (SE)	49	49	47
		Unnamed Road (S)	3	4	3
		Grovefield Way (W)	0	0	0

For the 2021 PM peak, total junction throughput remains similar in the Do Something 1 and Do Something 2 scenarios, compared with the Do Minimum, for all junctions.

The junction with the greatest change in throughput overall in the 2021 PM peak is the A40 / Telstar Way signalised junction which experiences a 3% increase in throughput in the Do Something 1 and a 4% increase in the Do Something 2 scenarios compared with the Do Minimum. The approach which experiences the greatest increase in flows in both the Do Something 1 and Do Something 2 scenarios is the A40 Gloucester Road approach from the west. In the Do Something 1 scenario, this is due to an increase in traffic able to reach the junction from Arle Court roundabout due to the improvements made at this roundabout. In the Do Something 2 scenario, this is due to the improvements at Arle Court, as well as the improvements at the A40 / Telstar Way junction itself.

Table 8: 2031 PM Turn Count Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

			2031 PM Turn Counts (17:00-18:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
M5 J11	M5 (N)	M5 (N)	0	0	0
		A40 (E)	167	289	273
		M5 (S)	0	1	1
		A40 (W)	330	575	551
	A40 (E)	M5 (N)	276	289	286
		A40 (E)	0	0	0
		M5 (S)	827	876	842
		A40 (W)	0	0	0
	M5 (S)	M5 (N)	77	77	77
		A40 (E)	844	849	848
		M5 (S)	0	0	0
		A40 (W)	154	146	154
	A40 (W)	M5 (N)	389	478	471
		A40 (E)	56	69	36
		M5 (S)	114	138	136
		A40 (W)	389	478	471
Arle Court Roundabout	Fiddler's Green Lane (N)	Fiddler's Green Lane (N)	0	0	0
		A40 Gloucester Road (E)	11	17	17
		Hatherley Lane (S)	22	38	37
		A40 Gloucester Road (W)	54	104	105
		B4063 (W)	6	8	12
	A40 Gloucester Road (E)	Fiddler's Green Lane (N)	76	83	79
		A40 Gloucester Road (E)	0	0	0
		Hatherley Lane (S)	377	421	410
		A40 Gloucester Road (W)	1665	1729	1637
		B4063 (W)	197	216	203
	Hatherley Lane (S)	Fiddler's Green Lane (N)	84	67	69
		A40 Gloucester Road (E)	195	179	174
		Hatherley Lane (S)	0	0	0
		A40 Gloucester Road (W)	727	633	629
		B4063 (W)	138	127	127
	A40 Gloucester Road (W)	Fiddler's Green Lane (N)	86	109	104
		A40 Gloucester Road (E)	1202	1490	1409
		Hatherley Lane (S)	446	563	539
		A40 Gloucester Road (W)	0	0	0
		B4063 (W)	86	111	106
	B4063 (W)	Fiddler's Green Lane (N)	43	78	73
		A40 Gloucester Road (E)	145	221	198
		Hatherley Lane (S)	37	54	48
		A40 Gloucester Road (W)	102	159	147
		B4063 (W)	1	1	1

			2031 PM Turn Counts (17:00-18:00)		
Junction	From Arm	To Arm	Do Minimum	Do Something 1	Do Something 2
A40 / Telstar Way	Telstar Way (N)	A40 Gloucester Road (E)	67	71	75
		A40 Gloucester Road (W)	500	567	565
	A40 Gloucester Road (E)	Telstar Way (N)	94	92	91
		A40 Gloucester Road (W)	1666	1708	1719
	A40 Gloucester Road (W)	Telstar Way (N)	175	218	220
		A40 Gloucester Road (E)	1345	1683	1673
A40 / Princess Elizabeth Way	A4013 Princess Elizabeth Way (N)	A4013 Princess Elizabeth Way (N)	3	3	3
		A40 Gloucester Road (E)	194	215	198
		A40 Gloucester Road (W)	914	1001	931
	A40 Gloucester Road (E)	A4013 Princess Elizabeth Way (N)	148	151	138
		A40 Gloucester Road (E)	6	16	10
		A40 Gloucester Road (W)	930	862	827
	A40 Gloucester Road (W)	A4013 Princess Elizabeth Way (N)	550	682	659
		A40 Gloucester Road (E)	787	974	839
		A40 Gloucester Road (W)	63	75	68
Park and Ride / Hatherley Lane / Retail Park / Grovefield Way Roundabout	Car Park (N)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	69	4	8
		Hatherley Lane (SE)	11	1	1
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	7	4	4
	Hatherley Lane (NE)	Car Park (N)	3	9	9
		Hatherley Lane (NE)	6	8	7
		Hatherley Lane (SE)	559	678	656
		Unnamed Road (S)	8	11	11
		Grovefield Way (W)	303	372	350
	Hatherley Lane (SE)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	691	668	652
		Hatherley Lane (SE)	0	0	0
		Unnamed Road (S)	21	21	21
		Grovefield Way (W)	117	103	99
	Unnamed Road (S)	Car Park (N)	0	0	0
		Hatherley Lane (NE)	33	11	15
		Hatherley Lane (SE)	35	11	18
		Unnamed Road (S)	0	0	0
		Grovefield Way (W)	32	11	17
	Grovefield Way (W)	Car Park (N)	1	1	1
		Hatherley Lane (NE)	343	313	323
		Hatherley Lane (SE)	52	48	51
		Unnamed Road (S)	3	3	3
		Grovefield Way (W)	0	0	0

For the 2031 PM peak, some junctions experience a significant increase in throughput in the Do Something 1 and Do Something 2 scenarios compared to the Do Minimum.

The junction with the greatest change in throughput overall in the 2031 PM peak is M5 Junction 11 which experiences an 18% increase in throughput in the Do Something 1 and a 14% increase in the Do Something 2 scenarios compared with the Do Minimum. This is because, in the Do Minimum scenario, queues from Arle Court roundabout block back to M5 J11 along the A40. In the Do Something scenarios, the improvements at Arle Court stop this blocking back, allowing more traffic to pass through M5 J11.

5.2 Journey Times

Journey times were collected for two key junctions in the network:

- **Route 1** – A40 between Elmbridge Court Roundabout and A40 / Princess Elizabeth Way Roundabout.
- **Route 2** – A4013 Princess Elizabeth Way between A40 / Princess Elizabeth Way Roundabout and A4019 Tewkesbury Road / Kingsditch Lane / Princess Elizabeth Way Roundabout.

These routes can be seen in Figure 1 and Figure 2.

The journey times for these routes for the 2021 and 2031 AM and PM peaks for the Do Minimum, Do Something 1 and Do Something 2 scenarios are given in Table 9 to Table 12.

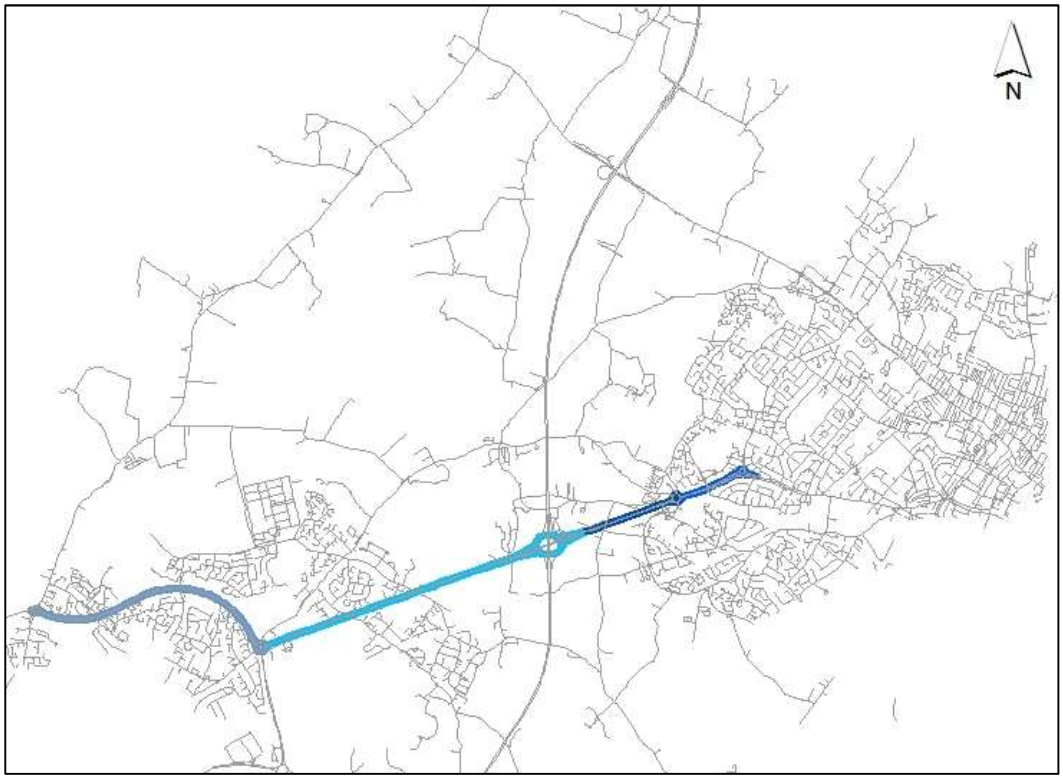

Figure 1: Journey Time Route 1

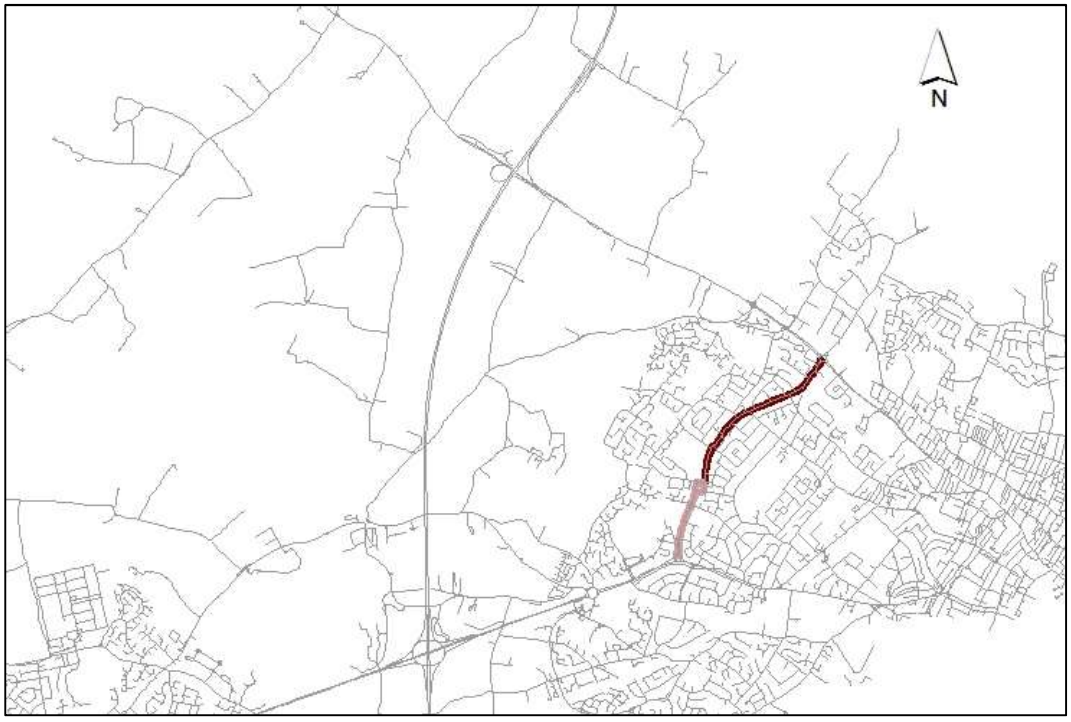

Figure 2: Journey Time Route 2

Table 9: 2021 AM Journey Times for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2021 AM Journey Time		
Route	**Direction**	**Do Minimum**	**Do Something 1**	**Do Something 2**
1	Eastbound	00:10:52	00:10:39	00:09:43
	Westbound	00:11:20	00:10:57	00:11:28
2	Northbound	00:05:58	00:05:56	00:06:04
	Southbound	00:05:33	00:05:30	00:05:39

In the 2021 AM peak, travel times along all routes improve in the Do Something 1 scenario compared with the Do Minimum. The travel times along Route 1 increase by 13 seconds and 23 seconds in the eastbound and westbound directions respectively due to the improvements at Arle Court roundabout in the Do Something 1 scenario. Travel times along Route 2 do not vary much between the Do Minimum and Do Something 1 scenarios, with differences of just 2-3 seconds.

In the Do Something 2 scenario, the Route 1 Eastbound travel time decreases by a further 56 seconds from the Do Something 1 travel time due to the further improvements along the A40 corridor. However, the Route 1 Westbound travel time increases by 31 seconds compared with the Do Minimum. This is due to the A40 schemes prioritising the eastbound congestion due to this being the direction with the highest traffic flow.

Table 10: 2031 AM Journey Times for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2031 AM Journey Time		
Route	Direction	Do Minimum	Do Something 1	Do Something 2
1	Eastbound	00:17:17	00:17:08	00:15:30
	Westbound	00:11:43	00:11:59	00:11:21
2	Northbound	00:06:31	00:06:44	00:07:15
	Southbound	00:06:01	00:05:56	00:06:00

In the 2031 AM peak, the Route 1 Eastbound travel time decreases by 9 seconds in the Do Something 1 scenario compared with the Do Minimum due to the Arle Court roundabout improvements. However, there is a 16 second increase in the Route 1 Westbound travel time.

In the Do Something 2 scenario, both of the Route 1 travel times decrease compared with the Do Minimum and Do Something 1 travel times. The Route 1 Eastbound travel time decreases significantly by 1 minute 38 seconds compared with the Do Something 1 due to the corridor improvements made. The Route 1 Westbound travel time decreases by 38 seconds, making it 22 seconds lower than the Do Minimum also.

Table 11: 2021 PM Journey Times for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2021 PM Journey Time		
Route	Direction	Do Minimum	Do Something 1	Do Something 2
1	Eastbound	00:15:54	00:09:18	00:09:13
	Westbound	00:10:25	00:09:14	00:09:25
2	Northbound	00:05:30	00:06:01	00:07:34
	Southbound	00:07:02	00:06:41	00:06:49

In the 2021 PM peak, the Route 1 Eastbound and Westbound travel times both decrease in the Do Something 1 scenario compared with the Do Minimum due to the Arle Court roundabout improvements. The Route 1 Eastbound travel time decreases significantly, by over 5 minutes.

In the Do Something 2 scenario, the Route 1 Eastbound travel time decreases by a further 5 seconds from the Do Something 1. However, the Route 1 Westbound travel time increases by 11 seconds compared with the Do Minimum. However, the Do Something 2 travel time along this route is still 1 minute lower than the Do Minimum.

Table 12: 2031 PM Journey Times for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2031 PM Journey Time		
Route	Direction	Do Minimum	Do Something 1	Do Something 2
1	Eastbound	00:27:21	00:13:52	00:12:37
	Westbound	00:11:57	00:09:50	00:10:06
2	Northbound	00:05:41	00:07:24	00:10:40
	Southbound	00:09:03	00:08:48	00:08:11

In the 2021 PM peak, the Route 1 Eastbound and Westbound travel times both decrease in the Do Something 1 scenario compared with the Do Minimum due to the Arle Court roundabout improvements. The Route 1 Eastbound travel time decreases significantly, by over 13 minutes.

In the Do Something 2 scenario, the Route 1 Eastbound travel time decreases by a further 1 minute 15 seconds from the Do Something 1. However, the Route 1 Westbound travel time increases by 16 seconds compared with the Do Minimum. However, the Do Something 2 travel time along this route is still almost 2 minutes lower than the Do Minimum.

5.3 Queue Results

Average and maximum queue lengths were collected for each approach to four key junctions along the A40. These queue lengths can be seen in Table 13 to At M5 J11 in the 2021 PM peak, queues decrease on the southbound off-slip in the Do Something scenarios, from a maximum of 280m in the Do Minimum scenario to 138m and 107m in the Do Something 1 and Do Something 2 respectively. This is because the improvements at Arle Court prevent queueing from blocking back to M5 J11. The further decrease in the Do Something 2 scenario is due to the proposed M5 J11 southbound off-slip improvements.

At Arle Court roundabout, the proposed scheme reduces queues on all approaches except for Hatherley Lane. This is due to an increase in opposing traffic on the A40 approach from the east leads to an increase in queueing on this approach in the Do Something scenarios.

At the A40 / Telstar Way / Whittington Road signalised junction, there are decreases in queues on all approaches in the Do Something scenarios compared with the Do Minimum.

At the A40 / Princess Elizabeth Way roundabout, there is a decrease in queues on the A40 West approach in the Do Something scenarios compared with the Do Minimum.

Table 16 for the 2021 and 2031 AM and PM peaks.

Table 13: 2021 AM Queue Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2021 AM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
M5 J11	M5 Northbound off-slip	45	127	44	134	45	134
	M5 Southbound off-slip	37	108	40	134	31	84
Arle Court Roundabout	Fiddler's Green Lane	102	269	53	150	44	131
	A40 East	67	211	53	229	52	227
	Hatherley Lane	67	405	86	981	84	932
	A40 West	53	192	47	178	44	134
	B4063	45	144	42	139	41	126

		2021 AM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
A40 / Telstar Way / Whittington Road	Telstar Way	40	91	40	83	36	60
	A40 East	49	141	44	125	44	130
	Whittington Road	197	283	119	198	126	220
	A40 West	74	193	75	267	54	154
A40 / Princess Elizabeth Way	Princess Elizabeth Way	38	177	39	178	39	161
	A40 East	52	165	49	165	53	171
	A40 West	43	181	42	182	33	88

At M5 J11 in the 2021 AM peak, queues decrease on the southbound off-slip in the Do Something 2 scenario due to the improvements made in this scenario, from a maximum of 108-134m in the Do Minimum and Do Something 1 scenarios to 84m in the Do Something 2 scenario.

At Arle Court roundabout, the proposed scheme reduces queues the most on the Fiddler's Green Lane approach from an average of 102m in the Do Minimum scenario to 53m and 44m in the Do Something 1 and Do Something 2 respectively. Average queues on all other approaches decrease in the Do Something 1 and Do Something 2 scenario, except for the Hatherley Lane approach. An increase in opposing traffic on the A40 approach from the east leads to an increase in queueing on this approach in the Do Something scenarios, from a maximum of 405m in the Do Minimum to 932-981m in the Do Something scenarios.

At the A40 / Telstar Way / Whittington Road signalised junction, there are decreases in queues on most approaches in the Do Something scenarios compared with the Do Minimum. The only approach which does not experience a decrease is the A40 approach from the west in the Do Something 1 scenario. This is due to an increase in traffic from Arle Court in this scenario.

At the A40 / Princess Elizabeth Way roundabout, there is very little change in queues between the Do Minimum and Do Something 1 scenario. There are some decreases in queues on the Princess Elizabeth Way and A40 West approaches in the Do Something 2 scenario with the introduction of the proposed scheme at this junction.

Table 14: 2031 AM Queue Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2031 AM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
M5 J11	M5 Northbound off-slip	47	154	48	167	46	161
	M5 Southbound off-slip	39	122	37	109	31	83
Arle Court Roundabout	Fiddler's Green Lane	131	300	95	277	67	206
	A40 East	70	219	62	280	63	297
	Hatherley Lane	80	985	100	1062	95	1058
	A40 West	83	405	49	188	44	133
	B4063	63	275	46	170	43	156
A40 / Telstar Way / Whittington Road	Telstar Way	42	90	41	94	36	65
	A40 East	48	149	47	160	46	142
	Whittington Road	248	344	179	296	207	314
	A40 West	95	282	121	353	56	154

		2031 AM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
A40 / Princess Elizabeth Way	Princess Elizabeth Way	40	172	39	175	39	160
	A40 East	56	165	58	172	54	165
	A40 West	51	308	49	302	33	90

At M5 J11 in the 2031 AM peak, queues decrease on the southbound off-slip in the Do Something 2 scenario due to the improvements made in this scenario, from a maximum of 109-122m in the Do Minimum and Do Something 1 scenarios to 83m in the Do Something 2 scenario.

At Arle Court roundabout, the proposed scheme reduces queues the most on the A40 West approach from a maximum of 405m in the Do Minimum scenario to 188m and 133m in the Do Something 1 and Do Something 2 respectively. Average queues on all other approaches decrease in the Do Something 1 and Do Something 2 scenario, except for the Hatherley Lane approach. An increase in opposing traffic on the A40 approach from the east leads to an increase in queueing on this approach in the Do Something scenarios, from a maximum of 985m in the Do Minimum to over 1km in the Do Something scenarios.

At the A40 / Telstar Way / Whittington Road signalised junction, there are decreases in queues on most approaches in the Do Something scenarios compared with the Do Minimum. The only approach which does not experience a decrease is the A40 approach from the west in the Do Something 1 scenario. This is due to an increase in traffic from Arle Court in this scenario.

At the A40 / Princess Elizabeth Way roundabout, there is very little change in queues between the Do Minimum and Do Something 1 scenario. There are some decreases in queues on the A40 West in the Do Something 2 scenario with the introduction of the proposed scheme at this junction.

Table 15: 2021 PM Queue Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2021 PM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
M5 J11	M5 Northbound off-slip	43	139	42	125	42	129
	M5 Southbound off-slip	55	280	42	138	34	107
Arle Court Roundabout	Fiddler's Green Lane	82	235	29	52	28	52
	A40 East	82	332	52	183	53	184
	Hatherley Lane	59	241	88	383	87	416
	A40 West	148	751	43	146	38	115
	B4063	88	455	38	83	37	84
A40 / Telstar Way / Whittington Road	Telstar Way	68	134	50	119	38	74
	A40 East	45	167	38	108	38	100
	Whittington Road	306	400	275	350	277	350
	A40 West	136	376	63	189	43	121
	Princess Elizabeth Way	79	340	72	304	70	313

		2021 PM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
A40 / Princess Elizabeth Way	A40 East	39	126	38	123	40	170
	A40 West	87	411	40	218	46	158

At M5 J11 in the 2021 PM peak, queues decrease on the southbound off-slip in the Do Something scenarios, from a maximum of 280m in the Do Minimum scenario to 138m and 107m in the Do Something 1 and Do Something 2 respectively. This is because the improvements at Arle Court prevent queueing from blocking back to M5 J11. The further decrease in the Do Something 2 scenario is due to the proposed M5 J11 southbound off-slip improvements.

At Arle Court roundabout, the proposed scheme reduces queues on all approaches except for Hatherley Lane. This is due to an increase in opposing traffic on the A40 approach from the east leads to an increase in queueing on this approach in the Do Something scenarios.

At the A40 / Telstar Way / Whittington Road signalised junction, there are decreases in queues on all approaches in the Do Something scenarios compared with the Do Minimum.

At the A40 / Princess Elizabeth Way roundabout, there is a decrease in queues on the A40 West approach in the Do Something scenarios compared with the Do Minimum.

Table 16: 2031 PM Queue Results for the Do Minimum, Do Something 1 and Do Something 2 scenarios

		2031 PM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
M5 J11	M5 Northbound off-slip	61	212	44	125	43	125
	M5 Southbound off-slip	363	1423	69	295	35	113
Arle Court Roundabout	Fiddler's Green Lane	125	272	54	134	28	53
	A40 East	89	349	55	194	55	216
	Hatherley Lane	75	405	98	724	93	576
	A40 West	355	1213	69	293	41	123
	B4063	134	567	49	144	37	79
	Telstar Way	76	143	54	132	39	80

		2031 PM Queue Results (m)					
		Do Minimum		Do Something 1		Do Something 2	
Junction	Approach	Average	Maximum	Average	Maximum	Average	Maximum
A40 / Telstar Way / Whittington Road	A40 East	70	317	38	94	38	117
	Whittington Road	342	420	275	351	281	367
	A40 West	162	388	105	272	52	169
A40 / Princess Elizabeth Way	Princess Elizabeth Way	80	352	80	341	83	354
	A40 East	51	200	38	124	45	179
	A40 West	103	419	53	304	80	399

At M5 J11 in the 2031 PM peak, queues decrease significantly on the southbound off-slip in the Do Something scenarios, from a maximum of over 1.4km in the Do Minimum scenario to 295m and 113m in the Do Something 1 and Do Something 2 respectively. This is because the improvements at Arle Court prevent queueing from blocking back to M5 J11. The further decrease in the Do Something 2 scenario is due to the proposed M5 J11 southbound off-slip improvements.

At Arle Court roundabout, the proposed scheme reduces queues on all approaches except for Hatherley Lane. This is due to an increase in opposing traffic on the A40 approach from the east leads to an increase in queueing on this approach in the Do Something scenarios.

At the A40 / Telstar Way / Whittington Road signalised junction, there are decreases in queues on all approaches in the Do Something scenarios compared with the Do Minimum.

At the A40 / Princess Elizabeth Way roundabout, there is a decrease in queues on the A40 approaches in the Do Something scenarios compared with the Do Minimum.

6. Summary and Conclusions

6.1 Summary

Jacobs were commissioned by Gloucestershire County Council to use the M5 J10-11 Paramics Discovery model in order to assess the impacts that several major schemes will have on the network for 2021 and 2031 forecast years.

6.2 Conclusions

In the 2021 AM peak, the proposed schemes along the A40 lead to a 1 minute 9 second improvement in travel time along the A40 in the eastbound direction. The Arle Court scheme leads to an improvement in travel time in the Westbound direction but the implementation of the rest of the schemes leads to an 8 second increase in the westbound travel time in the Do Something 2 scenario compared with the Do Minimum. As the eastbound traffic flow is higher than the westbound along the corridor, and the difference in travel time is greater in the eastbound direction, the improvement in the eastbound direction outweighs the increased delays in the westbound direction. In the 2031 AM peak, the proposed schemes along the A40 lead to an improvement in travel time along the A40 in both the eastbound and westbound directions.

The PM peak network experiences much greater improvements in travel time than the AM peak, especially in the eastbound direction. In the 2021 PM peak, the implementation of the proposed schemes lead to a 6 minute 41 second improvement in travel time in the eastbound direction of the A40 and a 1 minute improvement in the westbound direction. In the 2031 PM peak, the implementation of the proposed schemes lead to a 14 minute 44 second improvement in travel time in the eastbound direction of the A40 and a 1 minute 51 second improvement in the westbound direction.