

# A4 Bristol to A4175 Link Study, Keynsham: S-Paramics Modelling

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## 1.0 Introduction and Background

The West of England Joint Transport Plan (JTS) identified the need for a new highway link from the A4, crossing the railway to connect to Avon Mill Lane or the A4175 north of Keynsham (the 'Link Road'). CH2M, working on behalf of the West of England Combined Authority (WECA), have produced a short list of potential alignments and interfaces with the existing highway network to be taken forward to operational assessment, which will also provide changes in travel times to inform the economic appraisal of the Link Road options.

The purpose of this Technical Note is to present modelling work examining the forecast operation of the Keynsham highway network under a Do-Nothing and range of Link Road alignment options. This has been carried out using the Keynsham S-Paramics micro-simulation traffic model. The Link Road proposals are detailed in the next section. This is followed by an explanation of the modelling approach and forecasting assumptions, and the results of the testing. Finally, some conclusions are provided based on the modelling work.

## 2.0 A4-A4175 Link Road Options

Four options have been shortlisted for operational assessment in the Options Assessment Report (OAR). These are Option 2A, 2C, 3A and 3C which can be broadly described as follows:

- **Option 2A:** as shown in Drawing No. 674726.BP.41/002, connects the A4 at Pixash Lane to Avon Mill Lane at Brassmills. An improved signal controlled junction would be provided between the A4 and Pixash Lane, and the A4175/Avon Mill Lane junction would be converted to a roundabout (as shown in 674726.BP.41/009). A one-way northbound linkage would be provided from Broadmead Roundabout to the new Link Road vis the existing under-bridge to the GWML;
- **Option 2C:** as shown in Drawing No. 674726.BP.41/002, connects the A4 at Pixash Lane to the A4175 to the north via a new river bridge. The eastern alignment is the same as Option 2A, with the same one-way northbound linkage from Broadmead Roundabout. The alignment in the vicinity of the sewage works turns north crossing the River Avon to connect with the A4175 via a new roundabout. This latter section is assumed to be 40mph;

- **Option 3A:** as shown in Drawing No. 674726.BP.41/003, connects the A4 from a new roundabout near Broadleaze Nursery to Avon Mill Lane at Brassmills. As with option 2A, the A4175/Avon Mill Lane junction would be converted to a roundabout (as shown in 674726.BP.41/009). A one-way northbound linkage would also be provided from Broadmead Roundabout to the new Link Road; and
- **Option 3C:** as shown in Drawing No. 674726.BP.41/003, connects the A4 A4 from a new roundabout near Broadleaze Nursery to the A4175 to the north via a new river bridge. The eastern alignment is the same as Option 3A, with the same one-way northbound linkage from Broadmead Roundabout. The alignment in the vicinity of the sewage works turns north, crossing the River Avon to connect with the A4175 via a new roundabout. This latter section is assumed to be 40mph

## 3.0 Modelling Methodology

### 3.1 Modelling Approach

The forecast assessment of Link Road options has been carried out using the Keynsham S-Paramics micro-simulation traffic model. This model covers the main routes within the town centre, as well as the main radial routes into the town and the A4 Keynsham bypass from the A4/A4174 Avon Ring Road ('Hicks Gate') Roundabout to the A4/Broadmead Lane Roundabout (see Figure 3.1). The model is based to 2011 traffic volumes and network conditions, and is configured to simulate weekday morning (7:00-10:00 am) and evening (3:00-7:00 pm) peak periods. Details of the model calibration and validation can be found in the Local Model Validation Report (revision 1.2) dated 22 April 2013.



Figure 3.1: Keynsham S-Paramics Model, Network Extents

### 3.2 Forecasting Assumptions

Committed and agreed land use development assumed in the forecast year S-Paramics model testing includes the following:

- Somerdale (Policy KE2A): 700 dwellings and 10,000 square metres of B1;
- Riverside and Fire Station Site (Policy KE2B): Mixed use retail/residential;
- Land Adjoining East Keynsham (Policy KE3A): 250 dwellings;
- Land Adjoining East Keynsham (Policy KE3A): Worlds End Lane Masterplan Option C (B1/B2/B8);
- Safeguarded Land at East Keynsham (Policy KE3B): EXCLUDED;
- Land Adjoining South West Keynsham (Policy KE34): 200 dwellings;
- Bilbie Green (Site K2A): 266 dwellings (planning permission granted February 2015 (12/00049/FUL); and
- The Meadows (Site K2B): 285 dwellings (planning permission granted July 2011 (09/04351/FUL).

The 2011 model matrices for the 7:00-10:00 am and 3:00-7:00 pm periods includes total calibrated demands of 22,447 and 34,488 vehicle trips respectively. TRICS analyses of the various 'committed' developments listed above results in predicted demands of 24,392 vehicle trips in the AM period and 37,571 vehicle trips in the PM period. This equates to development growth changes of +8.66% and +8.94% respectively.

The latest version of TEMPRO (version 7.2) was then examined to ascertain predicted car driver trip growth over the period 2011-2029 within Keynsham. The mean growth forecasts obtained for the AM and PM periods were +7.40% and +7.24%. In view of this there was no requirement to apply additional background growth to that expected by the 'committed' developments. Instead, and in line with WebTAG guidance, the overall growth was 'capped' to the TeMPRO forecast for each period by applying a global reduction factor to each 2029 demand matrix.

### 3.3 Network Assumptions

Infrastructure works included in the S-Paramics network for the future year testing includes the following changes from the 2011 base model network:

- Highway network changes to Bath Hill East and Temple Street associated with the 'Town Centre Re-development', including a replacement PUFFIN crossing on Temple Street and a new PUFFIN crossing in Rock Road – 'as installed';
- High Street one-way southbound scheme from Charlton Road to Bath Hill/Temple Street and associated changes at the junction with Temple Street/Bath Hill East - 'as installed';
- A4175 Station Road/Somerdale Entrance: signalisation improvement (KE2A);
- A4175 Station Road/Avon Mill Lane junction: signalisation improvement (KE2A) as per Section 278 Agreement, i.e. with a single lane on the A4175 southbound approach (Reference Case Only)
- Conversion of the Bath Road/Chandag Road junction to a mini-roundabout, and the introduction of an adjacent Zebra crossing – 'as installed';
- Bath Hill/Avon Mill Lane mini-roundabout: widening improvement to Avon Mill Lane (KE2A);
- Bath Hill/Wellsway mini-roundabout: no change; and
- A4/A4174 Hicks Gate Roundabout: no change.

### 3.4 Scenarios Assessed

The resulting model incorporating the above traffic growth and network changes provided the 2029 'Do-Nothing' situation against which the Link Road options would be assessed. The various Link Road alignments were coded into the model as new scenarios for the AM and PM periods. The following

2029 Do-Nothing and Link Road scenarios were then run for 30 seeds runs to provide output results from the model:

- 2029 Do-Nothing Network (AM and PM);
- 2029 Link Road Option 2A (AM and PM);
- 2029 Link Road Option 2C (AM and PM);
- 2029 Link Road Option 3A (AM and PM); and
- 2029 Link Road Option 3C (AM and PM).

## 4.0 Option Testing Results

### 4.1 Network Performance

Tables 4.1 and 4.2 compare the network performance statistics from the five scenarios modelled for the AM and PM peak periods, respectively.

**Table 4.1: Network Performance Outputs, Morning Peak Period (7:00-10:00am)**

<b>Output</b>	<b>DN</b>	<b>OP2A</b>	<b>OP2C</b>	<b>OP3A</b>	<b>OP3C</b>
Total Travel Time (hrs)	2122	1943	1908	1953	1992
Mean Delay per Vehicle (s)	319	292	286	295	299
Total Distance Travelled (m)	72,303,908	72,359,480	71,936,608	72,133,244	72,116,431
% Network Demand Satisfied	99.5%	99.5%	99.5%	99.2%	99.5%
Network Mean Speed (mph)	21	23	23	23	22

**Table 4.2: Network Performance Outputs, Evening Peak Period (3:00-7:00pm)**

<b>Output</b>	<b>DN</b>	<b>OP2A</b>	<b>OP2C</b>	<b>OP3A</b>	<b>OP3C</b>
Total Travel Time (hrs)	6471	5775	5523	5885	5686
Mean Delay per Vehicle (s)	715	585	551	609	572
Total Distance Travelled (m)	151,096,375	155,341,703	156,167,962	154,118,725	155,989,728
% Network Demand Satisfied	97.7%	98.6%	99.5%	98.2%	99.4%
Network Mean Speed (mph)	13	16	17	16	17

The results show all four options provide a substantive saving in overall network travel time over each period considered, especially in the PM. In general, the savings with the Variant C alignment connection to the A4175 perform better than those connecting via Avon Mill Lane (Variant A). This is not unexpected as this routing to the A4175 avoids conflict and interaction with other traffic still using Avon Mill Lane. The results also show that alignments based on an Option 2 connection to Pixash Lane at the eastern end perform better than the longer route to the east created with Option 3. This is most likely due to Option 3 being less attractive to drivers routing from the A4175 North to East Keynsham.

### 4.2 Traffic Flows

Table 4.3 compares two-way traffic volumes during the AM peak period at a range of selected locations throughout the modelled network. Table 4.4 provides the same comparison for the PM peak period.

**Table 4.3: Modelled Traffic Volumes (Two-Way), Morning Peak Period (7:00-10:00am)**

Location	DN	OP2A	OP2C	OP3A	OP3C
1. High Street: Charlton Road to Temple Street (SB one-way section);	466	530	499	524	496
2. High Street: Station Road to Charlton Road;	2876	2769	2861	2781	2819
3. Ashton Way: just south of Charlton Road mini-roundabout;	2615	2487	2636	2472	2567
4. Bath Hill: Avon Mill Lane to Temple Street;	3698	3692	3742	3667	3728
5. B3116 Bath Road: Broadmead Roundabout to Unity Road;	3821	3494	3650	3527	3698
6. B3116 Bath Road: Chandag Road to Wellsway;	3937	3619	3592	3648	3633
7. Bath Hill: Wellsway to Avon Mill Lane;	4881	4442	4278	4483	4314
8. Avon Mill Lane: Bath Hill to Vandyke Avenue;	2079	1728	1453	1785	1520
9. Avon Mill Lane: A4175 to Brassmills;	1965	2134	1340	2124	1407
10. A4 Bath Road: Pixash Lane to Broadmead Roundabout;	6719	6539	6460	6496	6476
11. A4 Keynsham Bypass;	5899	5847	5913	5816	5937
12. LINK ROAD: North of Broadmead Lane under-bridge;	0	533	798	464	734
13. LINK ROAD: Broadmead Lane to Pixash Lane;	0	185	299	143	241
14. LINK ROAD: Pixash Lane to A4 Bath Road (Options 3A and 3C Only)	0	0	0	143	240

**Table 4.4: Modelled Traffic Volumes (Two-Way), Evening Peak Period (3:00-7:00pm)**

Location	DN	OP2A	OP2C	OP3A	OP3C
1. High Street: Charlton Road to Temple Street (SB one-way section);	921	1088	1139	1042	1089
2. High Street: Station Road to Charlton Road;	4120	4308	4445	4233	4347
3. Ashton Way: just south of Charlton Road mini-roundabout;	3353	3154	3230	3203	3281
4. Bath Hill: Avon Mill Lane to Temple Street;	5575	5818	5877	5727	5831
5. B3116 Bath Road: Broadmead Roundabout to Unity Road;	5758	5270	5456	5359	5575
6. B3116 Bath Road: Chandag Road to Wellsway;	5564	5102	5174	5178	5299
7. Bath Hill: Wellsway to Avon Mill Lane;	6773	6350	6316	6412	6445
8. Avon Mill Lane: Bath Hill to Vandyke Avenue;	3108	2697	2420	2817	2598
9. Avon Mill Lane: A4175 to Brassmills;	3102	3516	2477	3448	2651
10. A4 Bath Road: Pixash Lane to Broadmead Roundabout;	9211	9164	9042	9126	9289
11. A4 Keynsham Bypass;	8563	8579	8821	8525	8845
12. LINK ROAD: North of Broadmead Lane under-bridge;	0	828	1057	669	844
13. LINK ROAD: Broadmead Lane to Pixash Lane;	0	187	477	186	293
14. LINK ROAD: Pixash Lane to A4 Bath Road (Options 3A and 3C Only)	0	0	0	187	283

The results for the both the AM and PM periods show that none of the link road options are expected to reduce flows along the High Street, Ashton Way, Station Road or the section of Bath Hill between Avon Mill Lane and Temple Street. This is not unexpected, as the route used now by drivers for the movement between the A4 East and A4175 North is principally Avon Mill Lane, which is just east of the Town Centre. As expected, all link road options offer relief here, as well as the section of Bath Hill between Avon Mill Lane and Wellsway and the B3116 Bath Road. This is consistent with previous work looking at the likely operating impact of such a potential link road in 2015.

The results for the Link Road (Locations 12-14) show that the Variant C options (2C and 3C) attract more traffic than options using Avon Mill Lane at the western end. Comparison of locations 12 and 13 show that a significant flow joins the route via the Broadmead Lane under-bridge (northbound only), as there would otherwise be no change in the two-way figures in these two locations. During the AM peak this amounts to anything between 62-69% of the total two-way traffic expected to use the Link Road section immediately north of the underbridge, and 55-77% of the two-way flow in the PM peak period. The results show clearly that potential utility of the Link Road is very dependent on how attractive it is to drivers making the movements between East Keynsham and the A4175 North, accepting that 'through' traffic between the A4 East and the A4175 North will transfer as all route options will be more attractive to these drivers the current route of Avon Mill Lane and the B3116.

### 4.3 Route Journey Times

Tables 4.5 and 4.6 compare the modelled journey times for the AM and PM peak hours, respectively, for the Do-Nothing and four Link Road options. These are compared along a series of routes through the model network. Plans showing the routes used for journey time analysis are shown in **Appendix A**.

**Table 4.5: Modelled Journey Times (s), Morning Peak Hour (8:00-9:00am)**

Route	DN	OP2A	OP2C	OP3A	OP3C
1. Charlton Rd to Hicks Gate: via St Ladoc's Rd	251	261	227	258	252
2. Hicks Gate to Charlton Rd: via St Ladoc's Rd	186	187	187	185	186
3. Charlton Rd to A4175/A431 Mini-Roundabout	400	393	341	397	394
4. A431/A4175 Mini-Rbt to Charlton Rd	467	337	339	340	379
5. Charlton Rd to A4 Broadmead Rbt: via Ashton Way	416	364	319	367	362
6. A4 Broadmead Rbt to Charlton Rd: via Ashton Way	379	286	303	286	304
7. A4: Pixash Lane to Hicks Gate Rbt - via Bypass	326	322	323	312	315
8. A4: Hick Gate Rbt to Pixash Lane - via Bypass	178	178	188	174	191
9. A4: Pixash Lane to A4175/A431 Mini-Rbt - via Avon Mill Lane	614	478	500	475	526
10. A4: A4175/A431 Mini-Rb to Pixash Lane - via Avon Mill Lane	545	401	465	411	470
11. A4: Bath Road to A4175/A431 Mini-Rbt - via LINK RD	-	405	346	435	407
12. A4: A4175/A431 Mini-Rb to Bath Road - via LINK RD	-	410	268	511	364

The results for the AM peak show that journey time are largely unchanged on most routes. Route 4 between the A431/A4175 Roundabout and Charlton Road shows a reduction across all options. There is also an improvement in journey times on Routes 5 and 6 most likely reflecting the notable drop in traffic on B3116 Bath Road and Bath Hill. The results also show large reductions in journey time on Routes 9 and 10 using Avon Mill Lane, which is commensurate with the relief of part of these routes by the new Link Road. These benefits appear to be greatest under the Variant A options potentially reflecting the

improved operation of the A4175/Avon Mill Lane junction following its proposed conversion to a roundabout. Unsurprisingly, given that it avoids the network around Avon Mill Lane and comprises a more direct route, comparison of the Route 11 and 12 results shows that the Variant C options provide the fastest connection between the A4175 to the north and the A4 Bath Road.

**Table 4.6: Modelled Journey Times (s), Evening Peak Hour (5:00-6:00pm)**

Route	DN	OP2A	OP2C	OP3A	OP3C
1. Charlton Rd to Hicks Gate: via St Ladoc's Rd	237	249	245	243	246
2. Hicks Gate to Charlton Rd: via St Ladoc's Rd	289	296	293	271	290
3. Charlton Rd to A4175/A431 Mini-Roundabout	420	425	415	424	409
4. A431/A4175 Mini-Rbt to Charlton Rd	789	427	434	516	543
5. Charlton Rd to A4 Broadmead Rbt: via Ashton Way	426	364	365	383	384
6. A4 Broadmead Rbt to Charlton Rd: via Ashton Way	515	363	420	374	406
7. A4: Pixash Lane to Hicks Gate Rbt - via Bypass	421	405	409	387	412
8. A4: Hick Gate Rbt to Pixash Lane - via Bypass	148	171	232	142	148
9. A4: Pixash Lane to A4175/A431 Mini-Rbt - via Avon Mill Lane	831	528	624	581	618
10. A4: A4175/A431 Mini-Rb to Pixash Lane - via Avon Mill Lane	717	474	579	493	561
11. A4: Bath Road to A4175/A431 Mini-Rbt - via LINK RD	-	425	484	502	774
12. A4: A4175/A431 Mini-Rb to Bath Road - via LINK RD	-	437	294	1850	2124

During the PM peak hour, the changes in journey times with the Link Road options show a similar pattern of benefits to that in the AM peak hour. Some benefits, such as the improvement in journey time on Route 4 are much more notable than in the AM reflecting the more congested condition of the Town Centre network in the PM. The results for Route 12, however, highlight a large journey time from the A431/A4175 Roundabout to the A4 Bath Road under Options 3A and 3C. Examination of the model simulation suggests that this is associated with difficulty in the egress movement from the Link Road onto the A4 at the proposed roundabout in this location because of limited gap opportunities in the dominant A4 eastbound traffic flow.

## 5.0 Summary and Conclusions

This Technical Note has presented modelling work assessing the forecast operation of the Keynsham highway network under a Do-Nothing and range options for a new Link Road connecting the A4 Bath Road to either Avon Mill Lane, or the A4175 to the north. This has been carried out using the Keynsham S-Paramics micro-simulation traffic model for a forecast year of 2029. The model has included traffic growth associated with committed developments within Keynsham with growth constrained to TEMPRO projections. All recent and committed highway works have also been included in the network.

The modelling predicts that all four options provide a substantive saving in overall network travel time over each period considered, especially in the PM. In general, the savings with the Variant C alignment connection to the A4175 perform better than those connecting via Avon Mill Lane (Variant A). This reflects faster connection between the A4 and A4175 provided by this route and hence the greater usage of the Link Road under the Variant C alignment. Examination of traffic flows shows that much of the volume using the route is drawn through Broadmead Lane and through the one-way northbound connection under the railway. All options provide similar journey time benefits with improvement in

journey times on routes where the Link Road abstracts traffic, such as the B3116 Bath Road and Avon Mill Lane. Traffic flows and delays within the Town Centre, including High Street, appear to be largely unchanged.

The modelling suggests that all four Link Road options are viable in operating terms and provide benefit over the Do-Nothing situation. The Variant C alignments may be preferred, as these appear to have the greatest scope for attracting traffic and hence relieving routes expected to be congested in future, such as the B3116 Bath Road and Avon Mill Lane. The results also highlight, however, that if Option 3A or 3C, are to be considered further, some form of positive control at the terminal connection with the A4 Bath Road will be necessary given the expected volumes on A4 and the limited gap opportunities likely under a give-way arrangement.



# Appendix A: Modelled Journey Time Routes





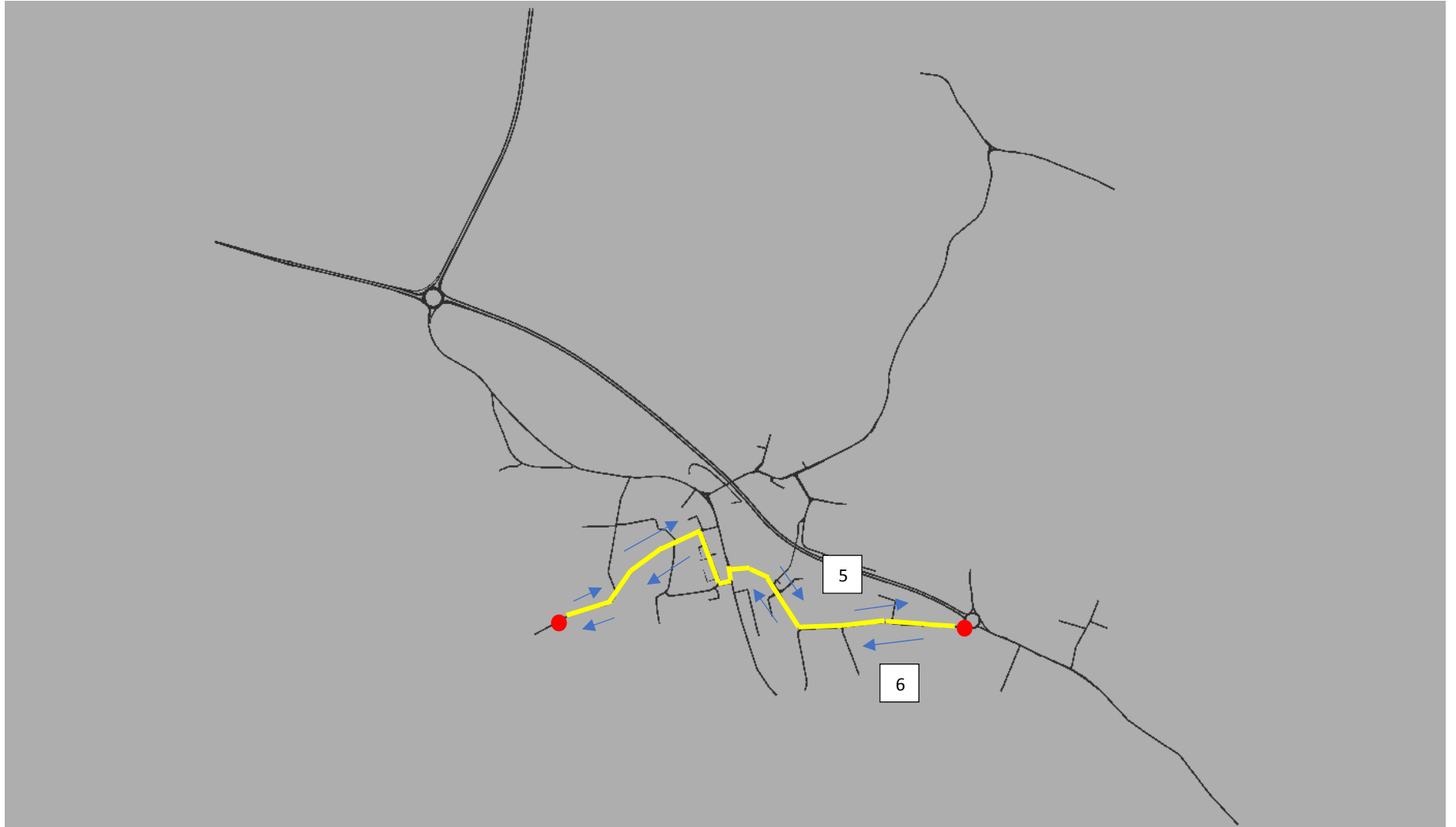


Figure A3: Journey Time Routes 5 and 6



Figure A4: Journey Time Routes 7 and 8

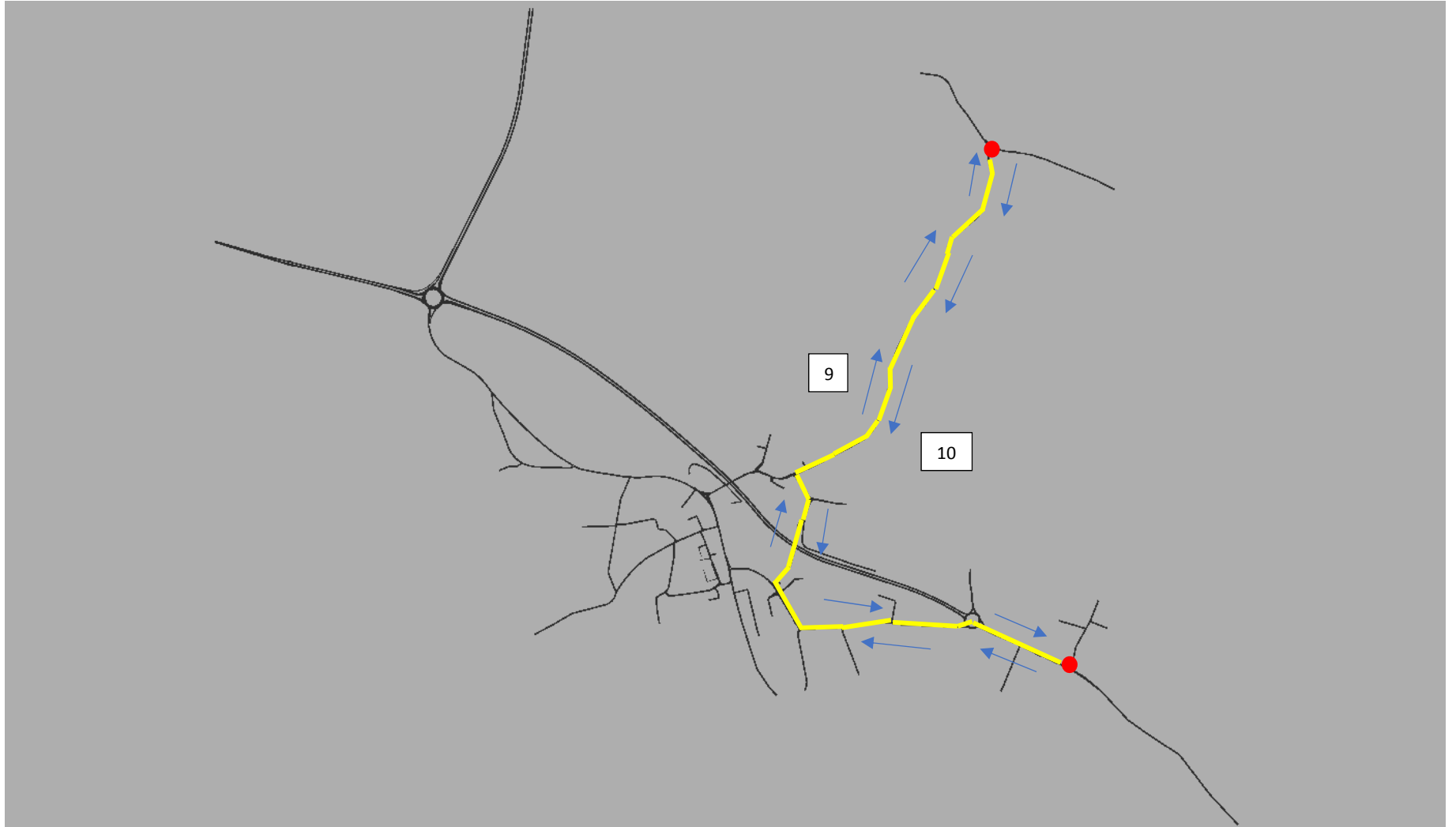


Figure A5: Journey Time Routes 9 and 10



**Figure A6: Journey Time Routes 11 and 12**

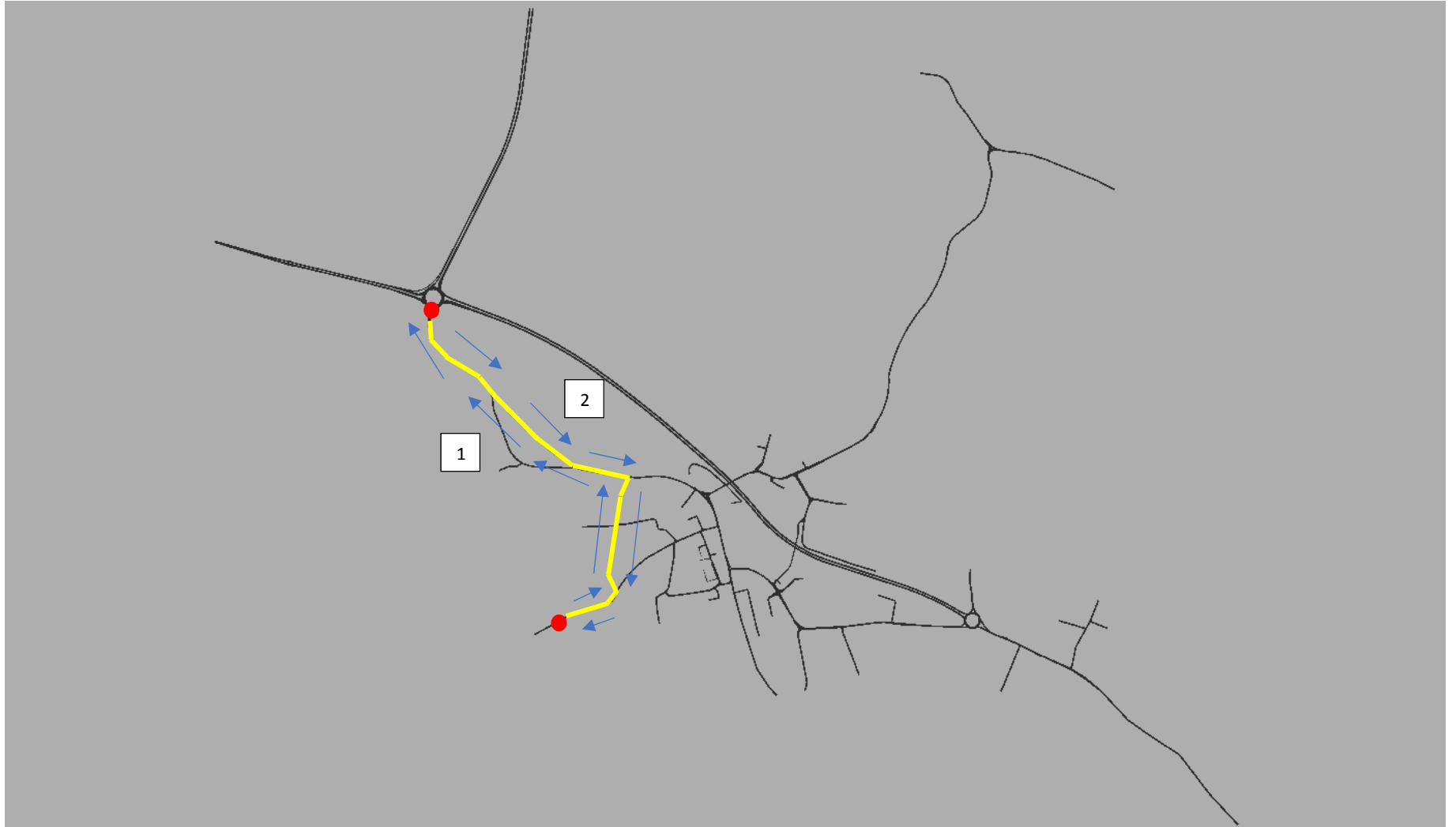


Figure A1: Journey Time Routes 1 and 2





Figure A2: Journey Time Routes 3 and 4





Figure A4: Journey Time Routes 7 and 8

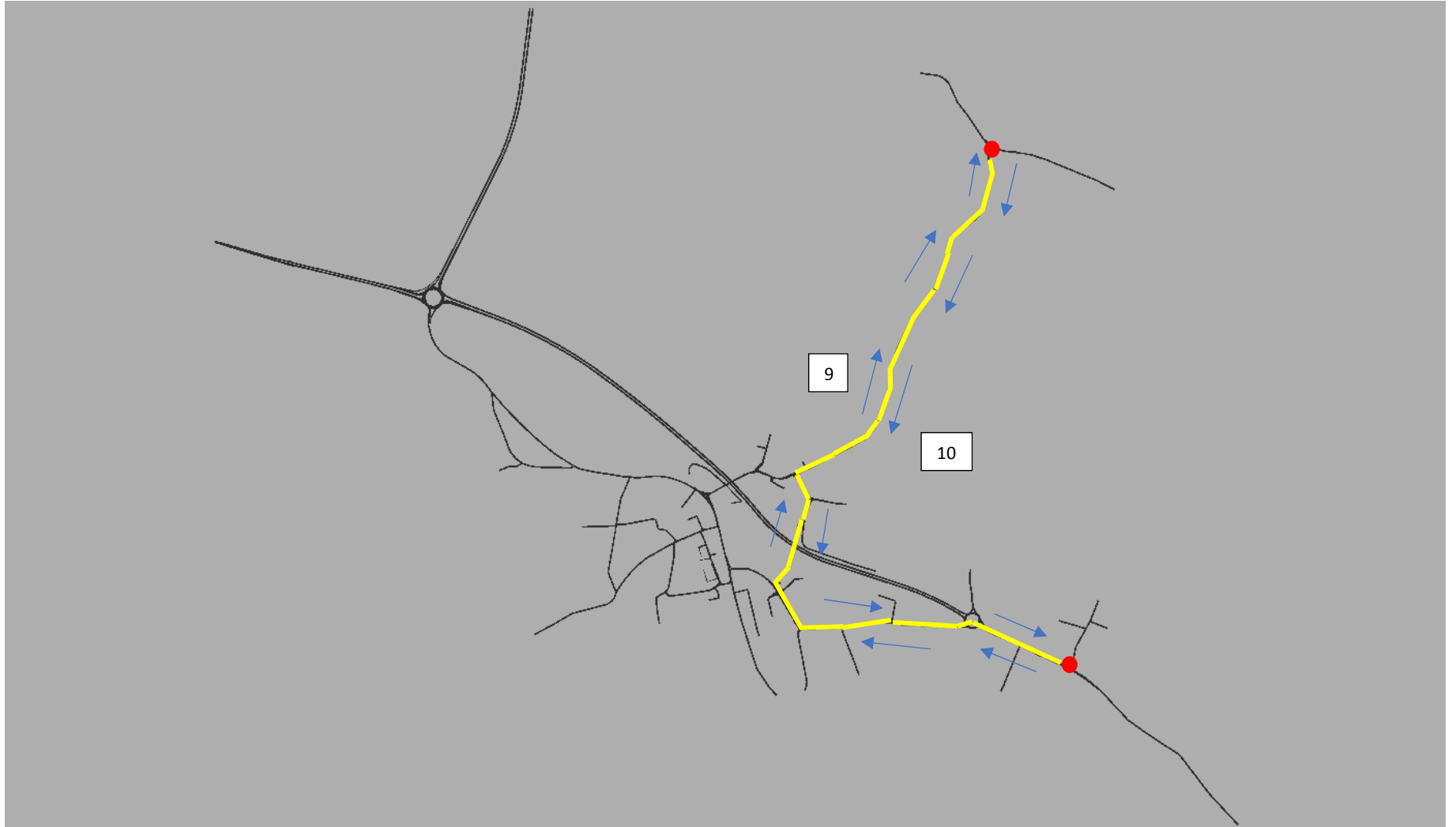


Figure A5: Journey Time Routes 9 and 10



**Figure A6: Journey Time Routes 11 and 12**