



**Department of the Environment, Transport and the Regions**

**MULTI-MODAL STUDY  
A453 NOTTINGHAM TO M1 JUNCTION 24**

**WORKING PAPER No 32**

**M1 JUNCTIONS 23a AND 24**

**OPERATIONAL ASSESSMENT**

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*(In this version of the working paper TRANSYT and ARCADY summary results only are shown. The full length numerical analysis of the TRANSYT and ARCADY outputs have been omitted)*

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## 1. Introduction

- 1.1 This working paper reports on the operational assessment of the M1 junctions 23a (roundabout) and 24 under existing and proposed strategy conditions. The Preferred Option D proposes several improvements to the junctions in order to accommodate the forecast 2021 traffic flows.
- 1.2 The output from the analysis is presented in the appendices to this paper.
- 1.3 Base Case travel demand forecasts for 2021 incorporate approximate doubling of air passenger patronage of East Midlands Airport (circa 4mppa) with commensurate growth in employment. Substantial increases in airfreight movements were also incorporated.

## 2. Junction 23a Roundabout

- 2.1 This junction provides access from the M1 and A42 to the East Midlands Airport via the A453 South and the A50 via the A453 North. A motorway service area has access from this roundabout junction.
- 2.2 To assess the operation of this junction, forecast flows have been extracted from the A453 Multi-mode transport model for the preferred option, Option D, for the assessment year of 2021. The forecast flows are presented on Table 2.1 below :-

**Option D - AM Peak 2021**

	A	B	C	D
A	-	398	10	1200
B	2193	49	50	302
C	10	50	-	10
D	714	220	10	-

**Option D - PM Peak 2021**

	A	B	C	D
A	-	410	10	924
B	2874	105	50	162
C	10	50	-	10
D	1630	304	10	-

- A A453 North
- B M1/A42
- C Service area
- D A453 South

**Table 2.1 - Option D 2021 Forecast Traffic Flows**

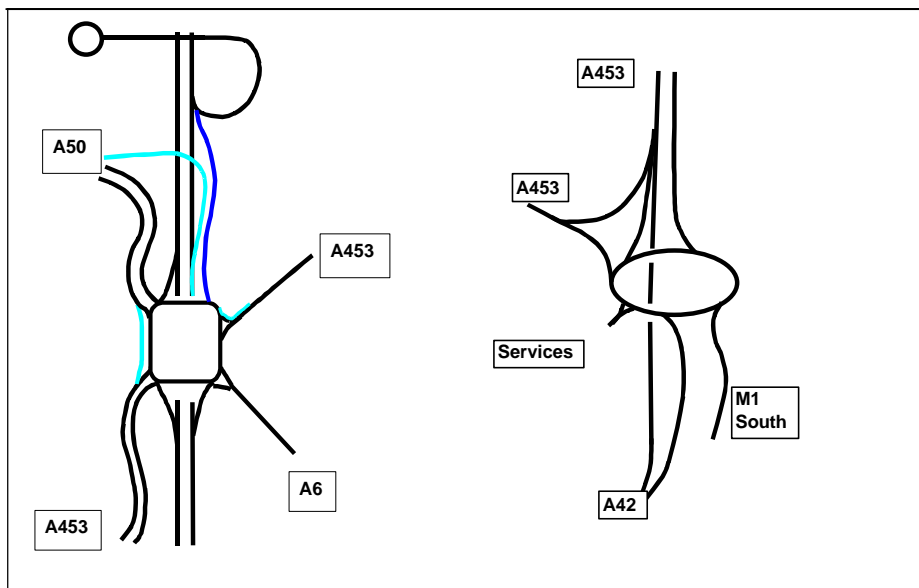
- 2.3 In order to replicate existing and likely future routeing through Junctions 23a and 24, vehicles leaving the M1 at Junction 24 heading for the A50 have been manually reassigned to leave the M1 at Junction 23a and access the A50 via the A453.
- 2.4 The Junction 23a roundabout has been assessed using the ARCADY5 computer software. Detailed roundabout geometry was not available and therefore typical carriageway widths and approach geometry has been applied to the analysis. The traffic movements associated with the service area were not available and therefore estimated flows have been input. However, note that some service area traffic was included in the roadside interview survey data and therefore is included in the model.
- 2.5 The initial test applied the Option D 2021 flows to the existing layout for the AM and PM peak periods. The junction failed on two approaches, the A42 and the A453 west. To remove the A453 west/A453 north conflict, a dedicated free running left turn lane has been assessed and modelled by removing the D-A movement from the demand matrix. The junction continued to fail on the A42 approach.
- 2.6 In order to remove the excessive queuing on the A42 approach, an underpass carrying traffic from the A42/M1 to the A453 North is proposed. This would require an enlarged roundabout to accommodate the underpass. However, for the purposes of this exercise, the existing geometry has again been tested with the B-A movement removed from the demand matrix.

2.7 The results of the analysis are presented on Table 2.2.

Approach	Time Period	Existing Layout		Dedicated Left Turn		Dedicated Left Turn + Underpass	
		RFC (%)	Max Q (Vehs)	RFC (%)	Max Q (Vehs)	RFC (%)	Max Q (Vehs)
A453 North	AM Peak	72.4	2.6	72.8	2.6	73.2	2.7
	PM Peak	59.5	1.5	62.9	1.7	63.7	1.7
M1 South/A42	AM Peak	158	716	158	716	24.4	0.3
	PM Peak	175	1231	176	1237	17.5	0.2
A453 West	AM Peak	109	55	26.5	0.4	15.0	0.2
	PM Peak	264	1516	42.6	0.7	20.9	0.3

**Table 2.2 – ARCADY5 Option D 2021 Results Summary**

2.8 The results demonstrate that, with the provision of the dedicated left turning lane from the A453 West to A453 North and the underpass from M1 South and A42 to the A453 North the junction will operate efficiently on the basis of the Option D preferred strategy in 2021. Figure 2.1 illustrates the proposed improvements.



**Figure 2.1 Improvement schemes for Junctions 23a and 24**

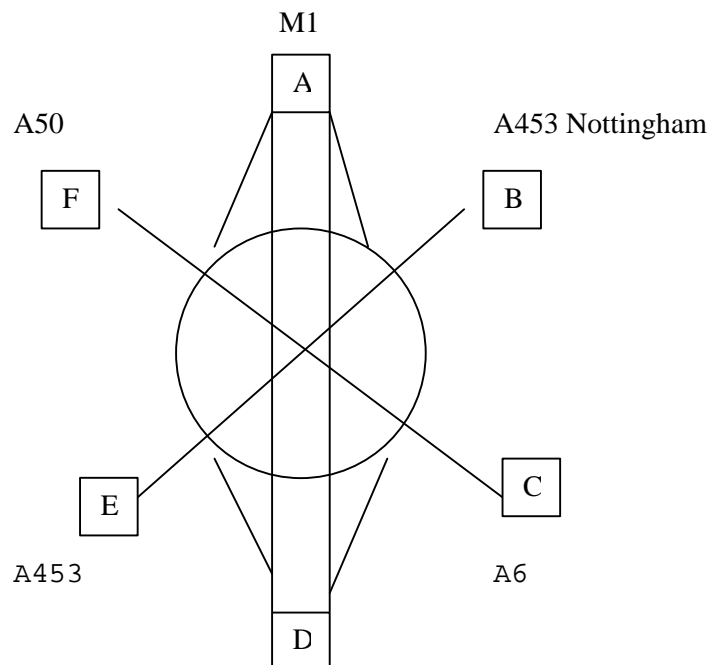
### 3. Junction 24

3.1 Junction 24 of the M1 with the A453 and A50, linking Derby and Nottingham with Junction 23a, is a very busy intersection, which currently suffers excessive queuing to all arms during peak periods.

3.2 The junction has been assessed firstly for the Do Minimum scenario in 2021, and secondly for the Option D scenario in 2021. Again, the traffic flows have been extracted from the Multi mode transport model.

#### **Do Minimum Scenario**

3.3 The Do Minimum 2021 traffic flow patterns for the AM and PM peak periods for this junction are presented in Table 3.1, the schematic of the junction is presented on Figure 3.1.



**Figure 3.1 – Junction 24 Schematic**

**Do Minium 2021 AM Peak**

	A	B	C	D	E	F
A	-	8	205	0	982	0
B	23	-	0	189	364	484
C	400	0	-	1	4	755
D	0	318	0	-	0	1,662
E	797	219	0	0	-	1,077
F	23	818	910	2,024	656	-

**Do Minimum 2021 PM Peak**

	A	B	C	D	E	F
A	-	44	416	0	989	0
B	7	-	0	469	144	852
C	206	0	-	90	160	680
D	0	251	0	-	0	1,495
E	1,023	325	0	0	-	1,641
F	7	540	973	2,073	275	-

**Table 3.1 - 2021 Do Minimum Traffic Flows**

3.4 It can be seen from Table 3.1 that the key traffic movements for the Do Minimum scenario are:-

- i) traffic originating from the A50 travelling to M1 southbound movement F to D with some 2024 vehicles in the AM and 2073 vehicles in the PM peak periods;
- ii) northbound traffic on the A453 to the A50, movement E to F, where there are some 1077 and 1641 vehicles in the AM and PM peaks respectively;
- iii) traffic movement north west from the A6 to the A50 (C to F) accounting for 755 and 680 vehicles in the AM and PM peaks;
- iv) traffic leaving the M1 northbound is effectively split between that heading to the A50 and that heading to Nottingham via the A453 where the movement to the A50 accounts for 1,077 and 1,641 in the AM and PM peaks respectively. Heading to Nottingham the flows amount to 318 and 251 in the AM and PM peaks;
- v) All other traffic movements are minor apart from the A453 approach from Nottingham heading for the M1 south, which consists of some 189 and 469 vehicles in the AM and PM peaks.

3.5 On initial inspection of the roundabout arrangement a number of inconsistencies were identified as follows:-

- i) Only two lanes on the southern bridge spanning the M1 whilst the northern bridge was marked as three lanes;
- ii) Only the A453 approach from Nottingham was arranged as a priority junction. This junction currently experiences long tailbacks due to the lack of storage capacity for the number of lanes at the point of priority and the speed of approaching vehicles on the roundabout.

- 3.6 After reviewing the flows, a TRANSYT model of the proposals was developed, featuring the complete signalisation of the roundabout. This model was created with the saturation flows of internal arms of the junction being reduced by 10%, whilst external arms generally reflecting RR67. It is considered that the in the Do Minimum scenario, full signalisation of the roundabout would be carried out prior to 2021.
- 3.7 The TRANSYT model output for the Do Minimum scenario demonstrates that the junction will operate beyond its capacity in the AM and PM peaks in 2021. Table 3.2 presents a summary of the TRANSYT analysis. The node/link diagram can be found at Appendix B.

<b>Approach</b>		<b>Degree of Saturation (%)</b>	<b>Max queue (Vehicles)</b>
M1 Southbound Off	AM Peak	109	20
	PM Peak	153	112
A453 Southbound	AM Peak	216	130
	PM Peak	131	84
A6 Northbound	AM Peak	82	13
	PM Peak	90	18
M1 Northbound Off	AM Peak	139	133
	PM Peak	120	97
A453 Northbound	AM Peak	124	103
	PM Peak	132	84
A50 Southbound	AM Peak	128	242
	PM Peak	119	171

**Table 3.2 – Do Minimum TRANSYT Results Summary**

**Option D Scenario**

3.8 The traffic flows for Option D 2021 are presented on Table 3.3.

**Option D 2021 AM Peak**

	A	B	C	D	E	F
A	-	49	238	57	350	0
B	124	-	0	288	465	1,017
C	259	0	-	1	45	563
D	0	625	0	-	0	1,244
E	195	481	0	0	-	1,304
F	31	1,327	871	69	726	-

**Option D 2021 PM Peak**

	A	B	C	D	E	F
A	-	17	361	0	323	0
B	0	-	0	1,110	575	978
C	128	0	-	0	12	927
D	0	436	0	-	0	1,235
E	1,019	582	0	0	-	1,607
F	0	1,019	737	108	373	-

**Table 3.3 - Traffic Flows at Junction 24 : Option D**

- 3.9 Following inspection of the Do Minimum TRANSYT assessment and the forecast flows for the Option D scenario, a dedicated free running left turning lane is proposed for traffic travelling from the A453 South to the A50. Some 1,304 and 1,607 vehicles have therefore been removed from the demand matrices for movements E to F, resulting in less demand for green for this approach and providing greater opportunity for co-ordination of internal traffic on the roundabout.
- 3.10 It is proposed that the carriageway markings on the southern bridge crossing the M1 should be mark with white lines to three lanes to the approach. This will again provide higher capacity and ability to discharge traffic.
- 3.11 The M1 southbound off slip was widened in the model to reflect a four-lane approach splitting into two lanes separated by a central island. This provides the ability to spread traffic between the A453 and A6 and the A453 / A42 and A50 Derby Road.
- 3.12 The A453 approach from Nottingham has been modelled with full signalisation as provided in the Do Minimum scenario.

3.13 It can be seen from Table 3.3 that the movement from F to D is significantly less than the Do Minimum scenario. This is due to the proposed flyover from the A50 southbound to the M1 south removing a strong traffic movement from the Junction 24 roundabout which is included in the Option D Multi mode transport model network.

3.14 With the proposed dedicated left turn lane from the A453 South to the A50 north, and the proposed improvements at Junction 23a described in Section 2, it is considered that traffic from the M1 south to the A50 will be signed to exit the M1 at Junction 23a and travel to the A50 via the A453. Thus movement D to F has been removed from the demand matrix. The proposals are illustrated on Figure 2.1.

3.15 Table 3.4 presents a summary of the TRANSYT output.

<b>Approach</b>		<b>Degree of Saturation (%)</b>	<b>Max queue (Vehicles)</b>
M1 Southbound Off	AM Peak	93	8
	PM Peak	84	6
A453 Southbound	AM Peak	70	8
	PM Peak	89	17
A6 Northbound	AM Peak	63	6
	PM Peak	83	9
M1 Northbound Off	AM Peak	78	7
	PM Peak	74	6
A453 Northbound	AM Peak	67	5
	PM Peak	98	20
A50 Southbound	AM Peak	91	20
	PM Peak	92	18

**Table 3.4 – Option D TRANSYT Results Summary**

3.16 It can be seen from Table 3.2 that with the inclusion of the proposals described above, the junction will operate efficiently in 2021 assuming the implementation of the Option D strategy. The TRANSYT node/link diagram can be found at Appendix C.

**Option D Scenario Including Kegworth Bypass**

3.17 The proposed Kegworth Bypass would provide relief to the A6 through the town, located astride the A6 to the Southeast of M1 Junction 24. The bypass would link M1 Junction 23a with the A6 to the south of Kegworth, with traffic utilising the A453 between Junctions 23a and 24 to complete the bypass of Kegworth.

3.18 The bypass has been included in a transport model network, and the assigned flows at Junction 24 for the Option D scenario are presented on Table 3.5.

**Option D 2021 AM Peak**

	A	B	C	D	E	F
A	-	26	25	1,012	704	0
B	127	-	0	256	454	1,001
C	37	0	-	0	0	161
D	0	779	0	-	0	1,226
E	403	374	0	0	-	1,658
F	28	1,365	225	764	763	-

**Option D 2021 PM Peak**

	A	B	C	D	E	F
A	-	17	34	0	937	0
B	0	-	0	1,107	454	1,106
C	6	0	-	0	0	67
D	0	392	0	-	0	1,943
E	1,193	594	0	0	-	1,685
F	0	997	157	604	511	-

**Table 3.5 - Traffic Flows at Junction 24 : Option D including Kegworth Bypass**

3.19 Junction 24 has been assessed assuming the identical proposals as the Option D scenario. The results, presented in summary on Table 3.6, demonstrate that the junction would operate over capacity on the M1 Southbound off slip approach to the junction. The remaining approaches offer a marginal improvement in operational efficiency over the Option D scenario. It is considered that with minor modifications, the junction would operate satisfactorily in 2021 assuming the Option D scenario and a proposed Kegworth Bypass. The TRANSYT node/link diagram and output can be found at Appendix D.

<b>Approach</b>		<b>Degree of Saturation (%)</b>	<b>Max queue (Vehicles)</b>
M1 Southbound Off	AM Peak	111	28
	PM Peak	105	26
A453 Southbound	AM Peak	80	12
	PM Peak	89	17
A6 Northbound	AM Peak	44	2
	PM Peak	83	9
M1 Northbound Off	AM Peak	83	9
	PM Peak	74	6
A453 Northbound	AM Peak	66	5
	PM Peak	98	20
A50 Southbound	AM Peak	92	22
	PM Peak	74	10

**Table 3.3 – Option D including Kegworth Bypass TRANSYT Results Summary**

#### **4. Conclusions**

4.1 An operational assessment of M1 Junctions 23a (roundabout) and 24 has been carried out for the A453 Multi Modal Study Preferred Option D.

4.2 The assessment of Junction 23a roundabout has demonstrated that the following improvements will be required at this junction prior to 2021:-

- A dedicated left turning lane from the A453 West to the A453 North
- An underpass providing a free flow link from the M1 South/A42 to the A453 North
- Corresponding enlargement of the roundabout to accommodate the underpass

4.3 The assessment of Junction 24 has demonstrated that to provide sufficient capacity in 2021 the following improvements will be required:-

- Full signalisation of the roundabout
- Re-marking of the south overbridge to 3 traffic lanes
- Four lane approach from the M1 North
- Dedicated left turning lane from A453 South to A50
- Flyover from A50 to M1 South removing conflict from the roundabout.

4.4 The proposed Kegworth Bypass would result in the removal of through traffic from the A6 onto the A453 between Junctions 23a and 24. The proposed bypass would result in queuing on the M1 southbound approach but a marginal improvement in the operation of the Junction 24 roundabout. It is considered that with minor modifications to the Option D proposals, the junction would operate satisfactorily. Any further improvements required at Junction 23a would be the subject of further detailed investigation carried out as part of the Bypass scheme development.

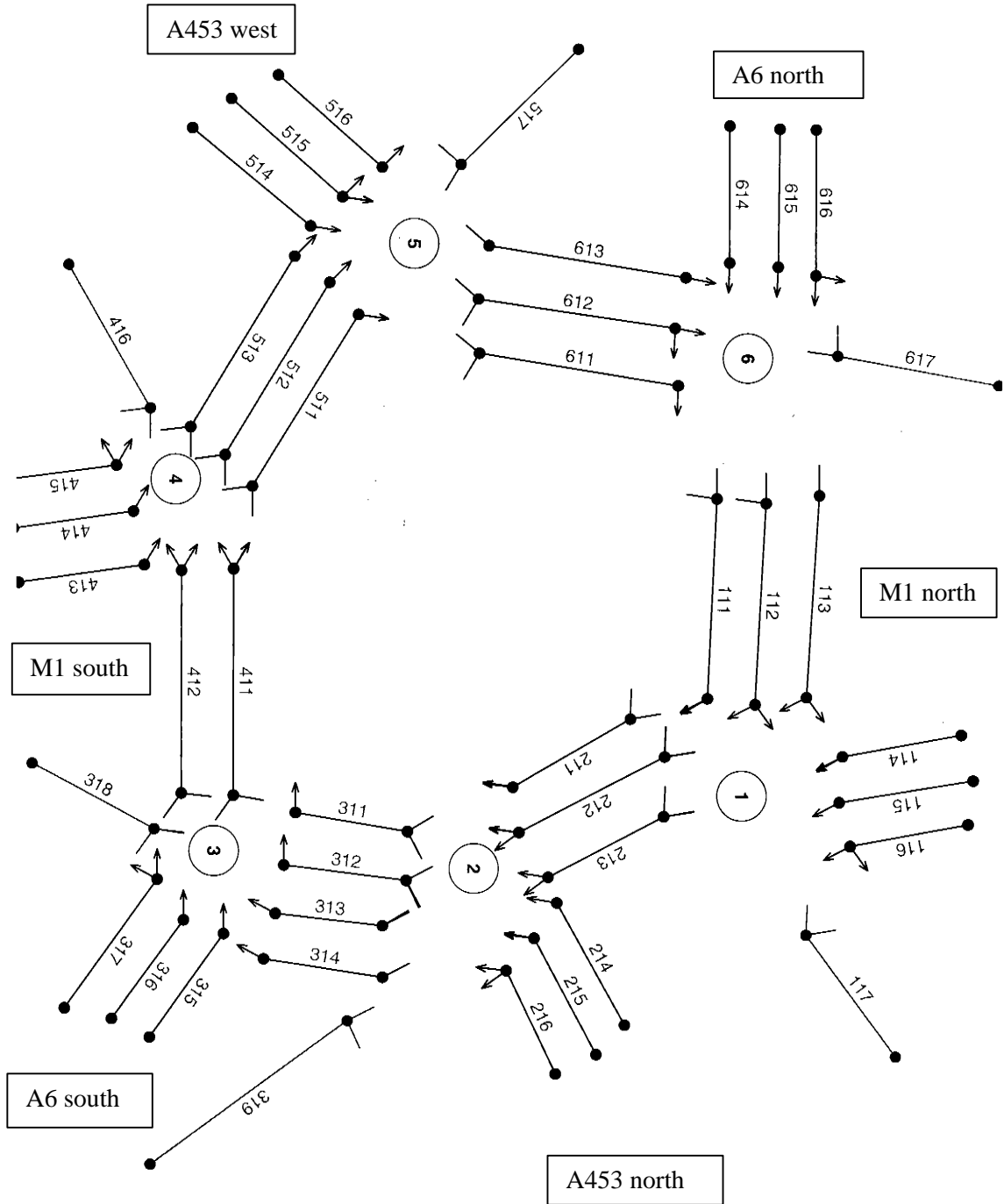


**APPENDIX A**

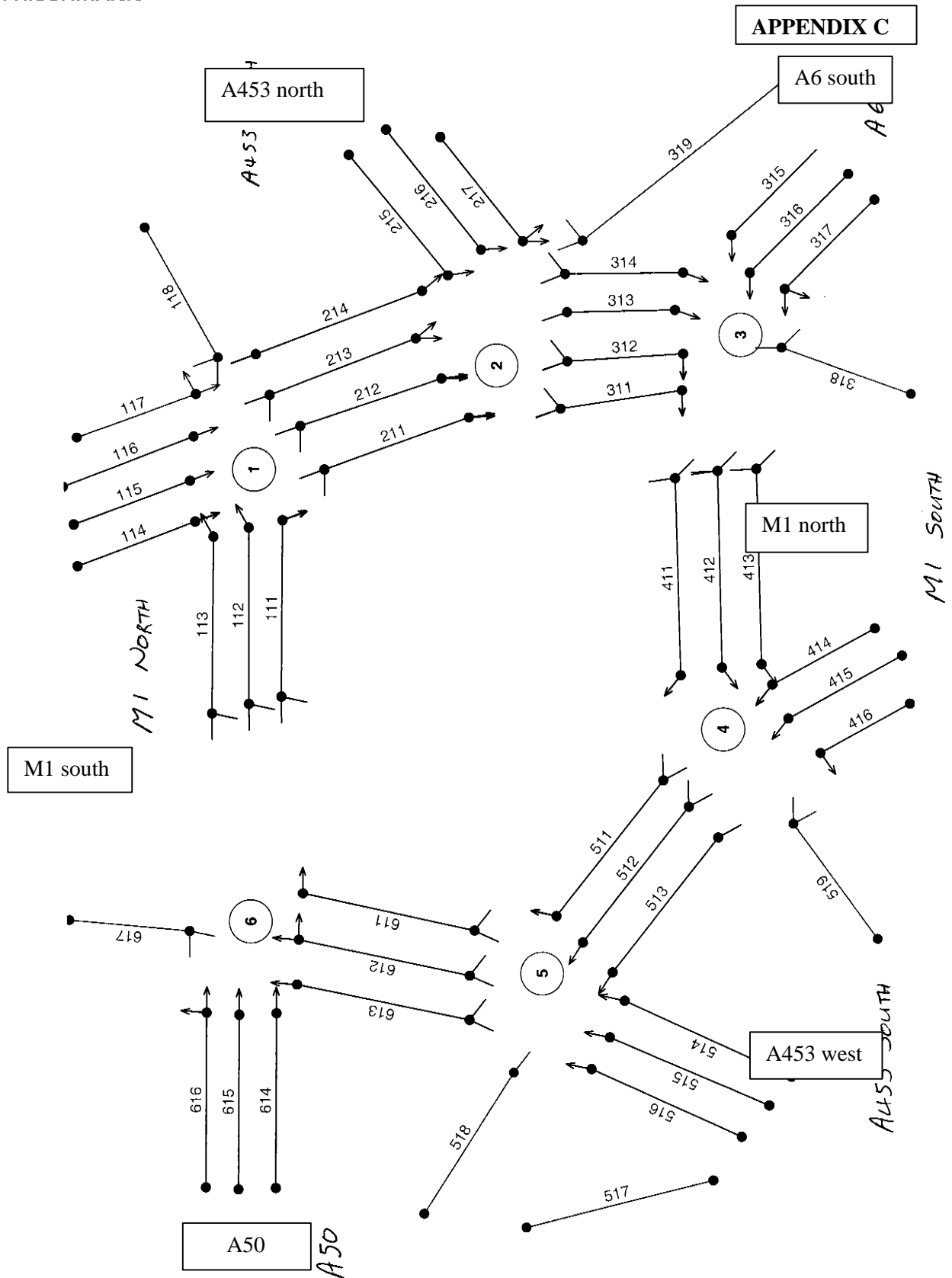
**Junction 23a – ARCADY 5 Output**

(24 pages of ARCADY data and calculations  
not included in website version)

APPENDIX B

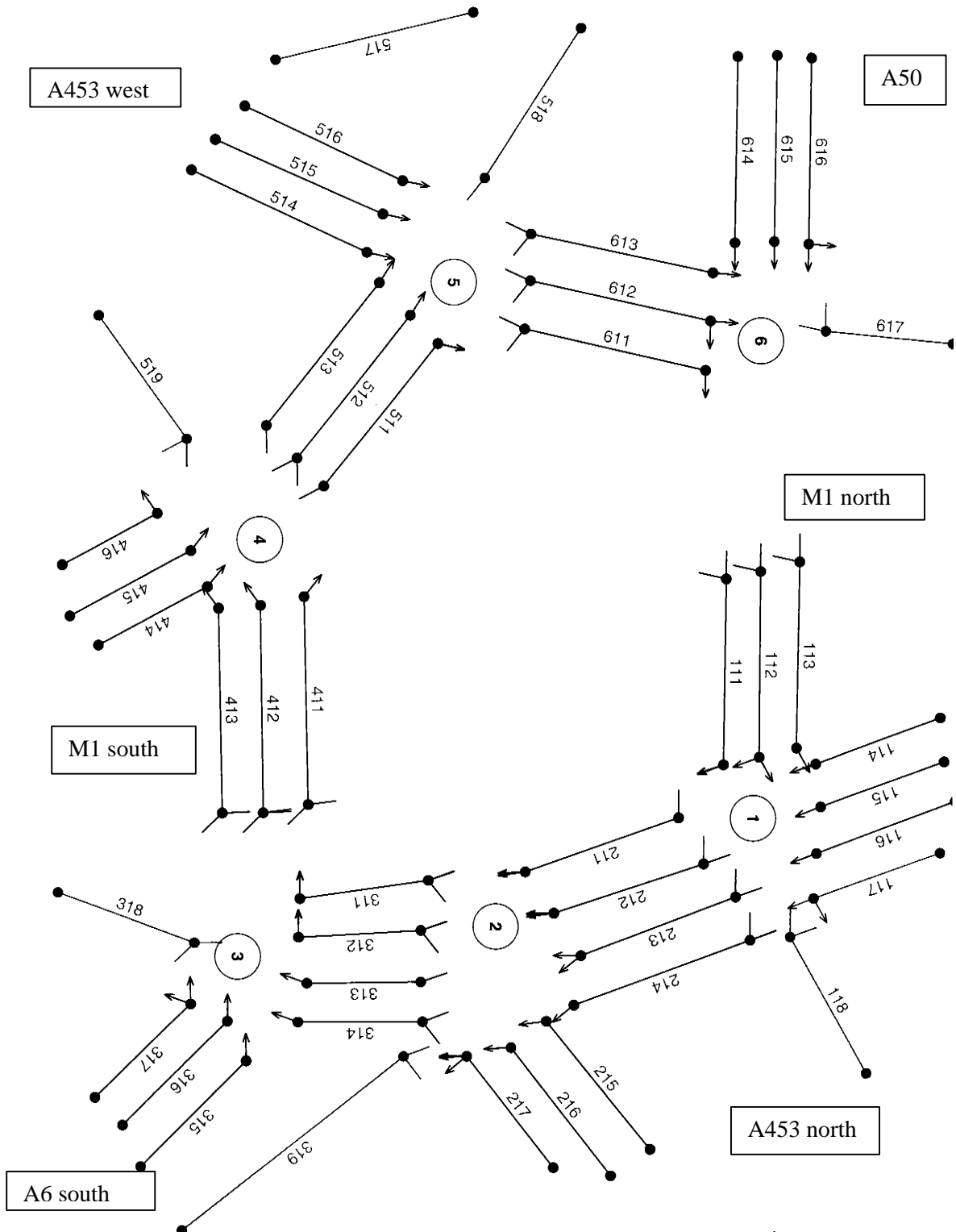


Junction 24 – 2021 Do Minimum TRANSYT Node/Link Diagram and Output



**Junction 24 – 2021 Option D TRANSYT Node/Link Diagram and Output**

APPENDIX D



Junction 24 – 2021 Option D inc. Kegworth Bypass TRANSYT Node/Link Diagram and Output