

# M42 Junction 6 Development Consent Order Scheme Number TR010027

## 8.24 Junction 5A Operational Assessment

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**M42 Junction 6 Development Consent Order**  
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**Junction 5A Operational Assessment**

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# 1 Summary

- 1.1.1 This Technical Note discusses the operational performance of the new southern Junction 5A for the M42 Junction 6 Improvement scheme (the scheme) and the impact upon it caused by the proposed Motorway Service Area (MSA) development scheme.
- 1.1.2 The junction was tested with two scenarios:
- **Scenario 1:** Design year 2041 traffic forecast figures; and
  - **Scenario 2:** Design year 2041 traffic forecast figures + MSA traffic
- 1.1.3 The analysis showed that under Scenario 1, the junction would perform with sufficient capacity using forecast traffic flows for the design year 2041.
- 1.1.4 The junction would exceed its operational capacity in Scenario 2, when the MSA traffic is included with the forecast traffic flows.
- 1.1.5 Further analysis was undertaken to identify the compatibility of the two schemes which would enable both schemes to perform within capacity should the MSA scheme be awarded planning consent.
- 1.1.6 This Technical Note concludes that modifications to the proposed Junction 5A dumb-bell layout would be required to ensure the junction performs within capacity in the design year 2041.
- 1.1.7 It was concluded the proposed scheme, would not preclude future modification for the MSA, should the planning application be approved.

# 2 Introduction

- 2.1.1 As part of the Scheme, the proposed Junction 5A is designed as a dumb-bell junction to facilitate the new connection of the M42 with the new proposed dual carriageway via south-facing slip roads. Figure 1 shows the proposed junction arrangement.

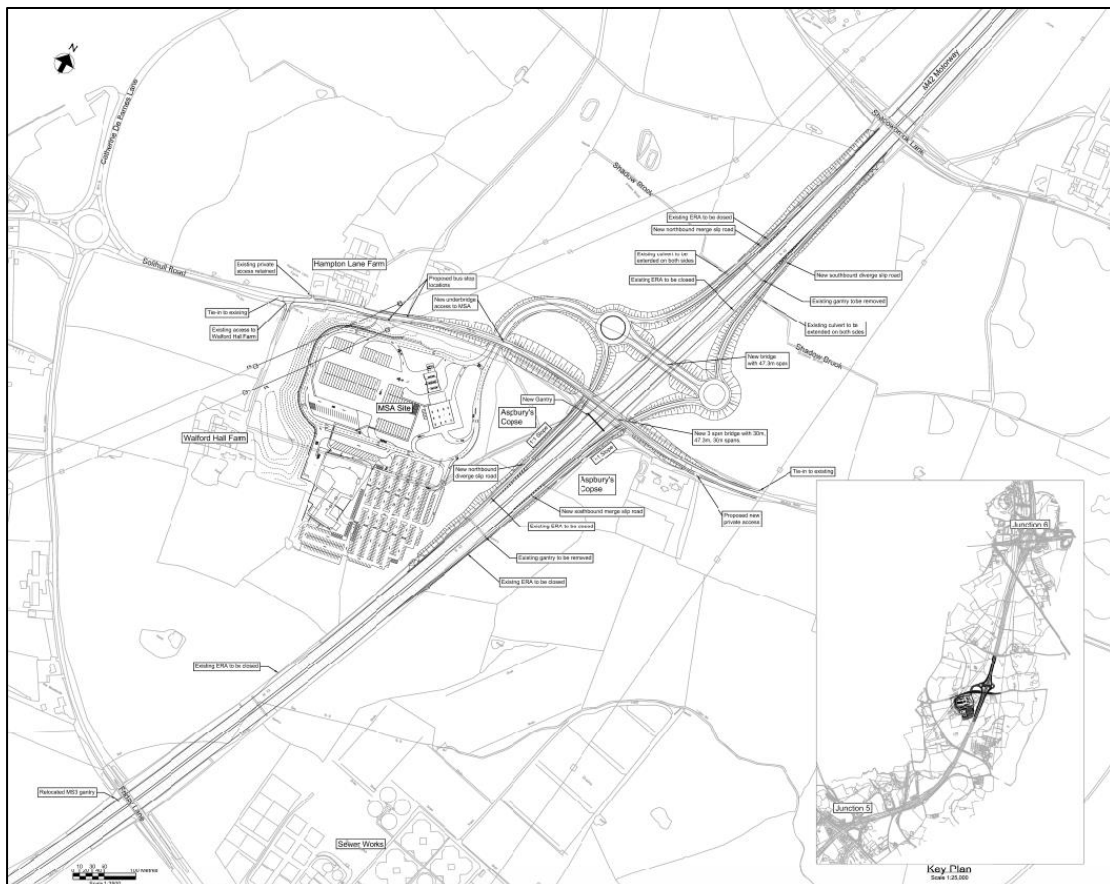
Figure 1 M42 Junction 6 Scheme - Junction 5A (Initial Design)



Source: M42 Junction 6, General Arrangement, Sheet 2 of 8, HE551485-ACM-HGN-M42\_GEN\_ZZ\_ZZ-DR-CH-002, 13/09/2017)

- 2.1.2 The proposed Junction 5A is designed to serve traffic to and from the M42 motorway south of Junction 6 via the Clock Interchange on the A45 dual carriageway. No north-facing slip roads are included in the design.
- 2.1.3 An application for 'Outline application for a motorway service area, new motorway junction and access road from M42 including underpass beneath Solihull Road, demolition of the existing Solihull Road bridge across the M42 and its replacement with a new bridge and associated works (means of access for consideration)' has been submitted to Solihull Metropolitan Borough Council on 30<sup>th</sup> June 2015 (reference: PL/2015/51409/PPOL). This application is currently undetermined at the time of writing (June 2019).
- 2.1.4 The proposed MSA is to be located on land adjacent to the proposed new Junction 5A and south-west of the existing Solihull Road overbridge.
- 2.1.5 The MSA development proposal is to provide its own new Junction 5A, without the mainline dual carriageway link road connecting to Clock Interchange, as shown in Figure 2.

**Figure 2 Proposed Motorway Service Area**



Source: [http://publicaccess.solihull.gov.uk/online-applications/files/6B62EA13B39D9A9CC2E074E463E10FB2/pdf/PL\\_2015\\_51409\\_PPOL-JUNCTION\\_AND\\_ACCESS\\_PLAN-437865.pdf](http://publicaccess.solihull.gov.uk/online-applications/files/6B62EA13B39D9A9CC2E074E463E10FB2/pdf/PL_2015_51409_PPOL-JUNCTION_AND_ACCESS_PLAN-437865.pdf)

- (Note the design of the western roundabout in the MSA application has since been revised in February 2019 to match the recommendations outlined in this Technical Note)

- 2.1.6 The MSA scheme includes both north-facing and south-facing slip roads.
- 2.1.7 The planning application for the MSA development was submitted to Solihull Metropolitan Borough Council (SMBC) in June 2015. The M42 Junction Improvement scheme commenced non-statutory consultation in December 2016. Consequently, the design of Junction 5A as part of the M42 Junction 6 Improvement would require taking cognisance of the proposed MSA application so as not to preclude their application from being considered.
- 2.1.8 The scope of this Technical Note is to assess the operational impact of the proposed MSA development on the new Junction 5A design for the M42 Junction 6 Improvement scheme.

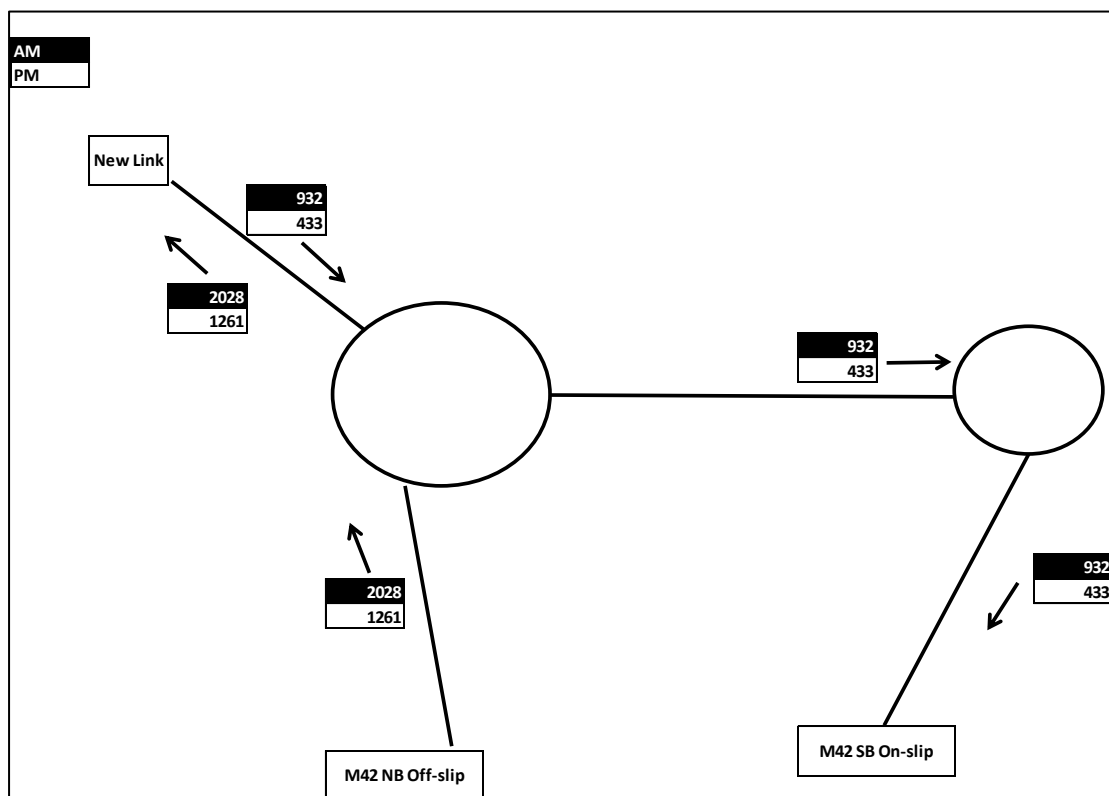
### 3 Assessment Methodology

- 3.1.1 The junction's operational assessment was undertaken between December 2017 and May 2018 using ARCADY software to assess the operational capacity of the roundabouts.
- 3.1.2 ARCADY software is an industry standard software tool used to predict capacities, queues and accident risks at roundabouts. The outputs of the software tool form the basis of designing roundabout geometries including roads approaching and departing from the roundabout.
- 3.1.3 The key inputs into the software include the following properties:
- Proposed roundabout geometry; and
  - Forecast traffic flows with origin and destination figures.
- 3.1.4 ARCADY provides output results in the form of ratios of flow to capacity (RFC), expressed as a decimal, the queue length, expressed in equivalent passenger car units (PCUs) and level of service (LOS) expressed in ratings from 'A' rated as free-flowing traffic to rating 'F' rated as forced or breakdown flow where significant congestion would be experienced. For a new roundabout, a threshold RFC value of 0.85 during a single time segment is preferred as this minimises the chance that queuing will occur at a new junction.
- 3.1.5 To achieve an RFC value of less than 0.85, the proposed geometric properties of the roundabout will be adjusted to ascertain the optimum geometric roundabout design requirements that would incur minimal impact on journey time reliability and queues at the roundabout junction. The selected time segment would be the peak hour in the AM and PM periods.
- 3.1.6 In order to assess the junction, two assessment scenarios were adopted:
- Scenario 1 : 2041 traffic forecast; and
  - Scenario 2 : 2041 traffic forecast + MSA traffic.
- 3.1.7 The geometric properties of the roundabouts were extracted from the Scheme layout as shown in Figure 1. The geometric properties of the spur road off the western roundabout connecting to the proposed MSA development was extracted from the layout shown in Figure 2 which is referenced to SMBC's planning portal website
- [https://publicaccess.solihull.gov.uk/online-applications/files/6B62EA13B39D9A9CC2E074E463E10FB2/pdf/PL\\_2015\\_51409\\_PPOL-JUNCTION\\_AND\\_ACCESS\\_PLAN-437865.pdf](https://publicaccess.solihull.gov.uk/online-applications/files/6B62EA13B39D9A9CC2E074E463E10FB2/pdf/PL_2015_51409_PPOL-JUNCTION_AND_ACCESS_PLAN-437865.pdf)

## 4 Assessment of Scenario 1 – Without MSA

- 4.1.1 Scenario 1 assessed only the western roundabout of the dumb-bell junction as the Eastern roundabout would have no opposing traffic.
- 4.1.2 The traffic forecast shown in Figure 3 is extracted directly from the M42 Junction 6 Local Area Model (LAM) for the 2041 Do-Something Scenario. These figures were input into the ARCADY software along with the geometric properties of the roundabout.
- 4.1.3 Table 1 summarises the output of the ARCADY junction operational analysis results.

**Figure 3 Junction 5A - 2041 Traffic Forecast - Scenario 1**



\*Please Note that all values in PCUs per hour

**Table 1 Western Roundabout ARCADY Results - Scenario 1 (without MSA)**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
East Arm	0.00	0	A	0.00	0	A
M42 NB Off-Slip	0.76	3	A	0.47	1	A
New Link Road	0.33	1	A	0.15	0	A

4.1.4



## 5 Assessment of Scenario 2 – With MSA

- 5.1.1 In order to understand the traffic generation of the proposed MSA, a review of the Transport Assessment (TA) submitted by the MSA developer was carried out. The TA is available at:  
[https://publicaccess.solihull.gov.uk/online-applications/files/C023FFDBDF3E9700732C003E14D4F846/pdf/PL\\_2015\\_51409\\_PPOL-TRANSPORT\\_ASSESSMENT-433712.pdf](https://publicaccess.solihull.gov.uk/online-applications/files/C023FFDBDF3E9700732C003E14D4F846/pdf/PL_2015_51409_PPOL-TRANSPORT_ASSESSMENT-433712.pdf)
- 5.1.2 The TA analysed different methods to determine the “turn-in” rates (traffic turning off the M42) for the proposed MSA. The TA reported that during the motorway AM morning and PM evening peak hours, 6% of the motorway traffic would be considered to represent the “turn-in” rate (Section 5.3, Page 25 of the MSA TA).
- 5.1.3 The Applicant for the MSA development has undertaken further sensitivity tests with higher “turn-in” rates. The highest “turn-in” rate tested was 8% of the motorway traffic.
- 5.1.4 For the purpose of this Technical Note a combined analysis with the Scheme traffic forecast flows would start with the 6% “turn-in” rates, further tests would be undertaken using the 8%.
- 5.1.5 Table 2 lists the motorway traffic as was extracted directly from the M42 Junction 6 LAM 2041 forecast and the assumed MSA traffic based on the 6% assumption.

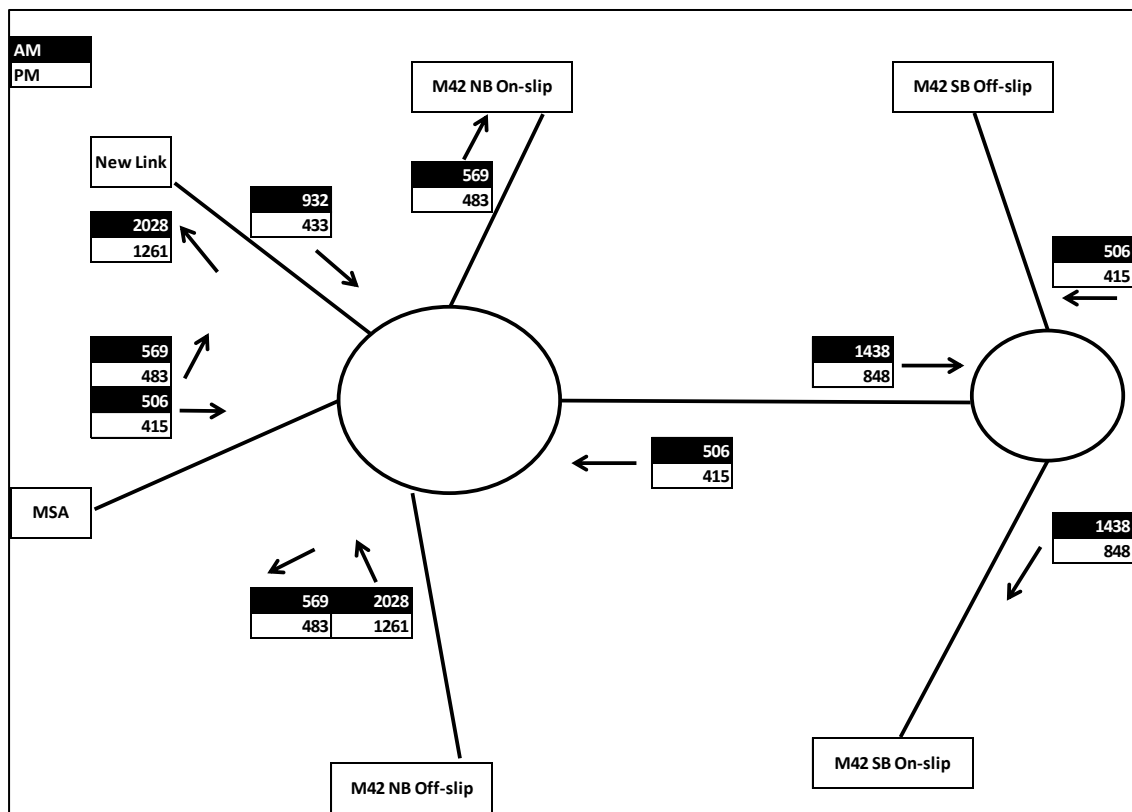
**Table 2 Motorway and MSA (6%) Traffic Forecast - 2041**

<b>Motorway Traffic Forecast</b>	<b>AM</b>	<b>PM</b>
<b>Northbound</b>	9,490	8,049
<b>MSA Northbound Traffic</b>	569	483
<b>Southbound</b>	8,432	6,918
<b>MSA Southbound Traffic</b>	506	415

\*Please note that all values in PCUs per hour

- 5.1.6 It is assumed that all of the traffic forecast to access the MSA development would be associated with the motorway traffic and no traffic entering the MSA would continue onwards onto the mainline dual carriageway link road. This assumption represents a possible ‘worst’ case scenario for junction operational assessment purposes in terms of turning movements and their impact on capacity.
- 5.1.7 Forecast Scenario 2 traffic flows are depicted in Figure 4.

**Figure 4 Junction 5A - 2041 Traffic Forecast - Scenario 2**



\*Please note that all values in PCUs per hour

5.1.8 Table 3 and Table 4 summarise the analysis results for the western and eastern roundabouts.

**Table 3 Western Junction ARCADY Results - Scenario 2 (with MSA 6%)**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
East Arm	0.21	0	A	0.18	0	A
M42 NB Off-Slip	1.11	159	F	0.73	3	A
MSA	0.71	2	A	0.48	1	A
New Link Road	0.44	1	A	0.19	0	A

**Table 4 Eastern Junction ARCADY Results - Scenario 2 (with MSA 6%)**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
M42 SB Off-Slip	0.71	2	B	0.39	1	A
West Arm	0.63	2	A	0.38	1	A

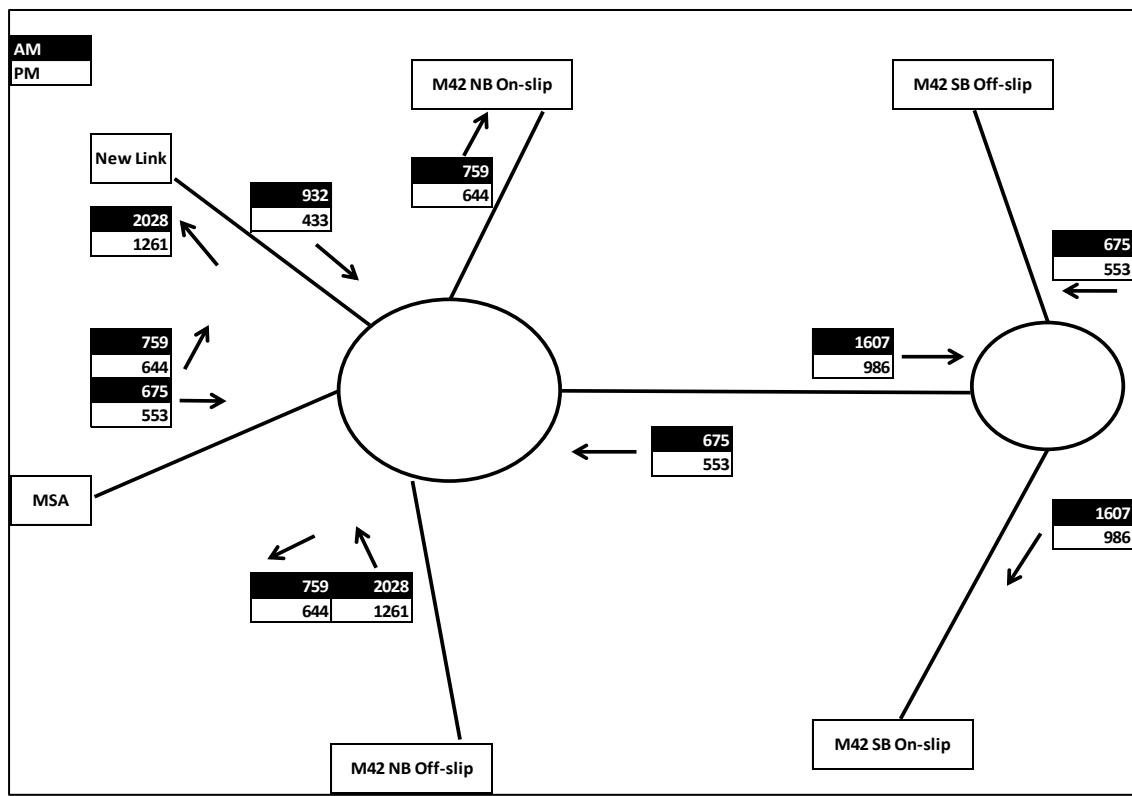
- 5.1.9 The analysis results summarised in Table 3 indicate that the western roundabout is forecast to experience traffic demands in excess of its capacity during the Scenario 2 AM peak hour on the M42 northbound off-slip approach arm. This would incur significant congestion on approach to the roundabout from the M42 northbound carriageway. The LOS is rated as ‘F’ which indicates that congestion would occur.
- 5.1.10 The significant congestion is attributed to the additional traffic associated with the MSA travelling on the M42 northbound off-slip and the additional circulatory traffic heading to the MSA from the east (from M42 southbound), as this would oppose the off-slip traffic.
- 5.1.11 Analysis results shown in Table 4 indicate that the eastern roundabout would perform within its capacity with no congestion observed.
- 5.1.12 Further sensitivity testing was carried out on the western roundabout in order to determine any potential measures that might improve its capacity.
- 5.1.13 The provision of a segregated left turn lane from the M42 northbound off-slip directly into the MSA would mitigate the queue lengths on the slip road, albeit the junction would be operating at maximum capacity during the morning peak hour as summarised in Table 5 below.

**Table 5 Western Junction ARCADY Results – Scenario 2 (with MSA 6%) - With Segregated Left Turn Lane from M42 N/B**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
<b>East Arm</b>	0.21	0.00	A	0.18	0.00	A
<b>M42 NB Off-Slip</b>	<b>0.87</b>	6.00	B	0.53	1.00	A
<b>MSA</b>	0.79	4.00	B	0.48	1.00	A
<b>New Link Road</b>	0.44	1.00	A	0.19	0.00	A

- 5.1.14 Further tests for this potential option were undertaken with higher MSA traffic forecast by adopting the 8% “turn-in” rate which was reported in the MSA TA as a sensitivity test.
- 5.1.15 Figure 5 shows the 2041 traffic forecast with 8% adopted as the MSA “turn-in” rate.

**Figure 5 Junction 5A - 2041 Traffic Forecast - Scenario (MSA 8%)**



\*Please note that all values in PCUs per hour

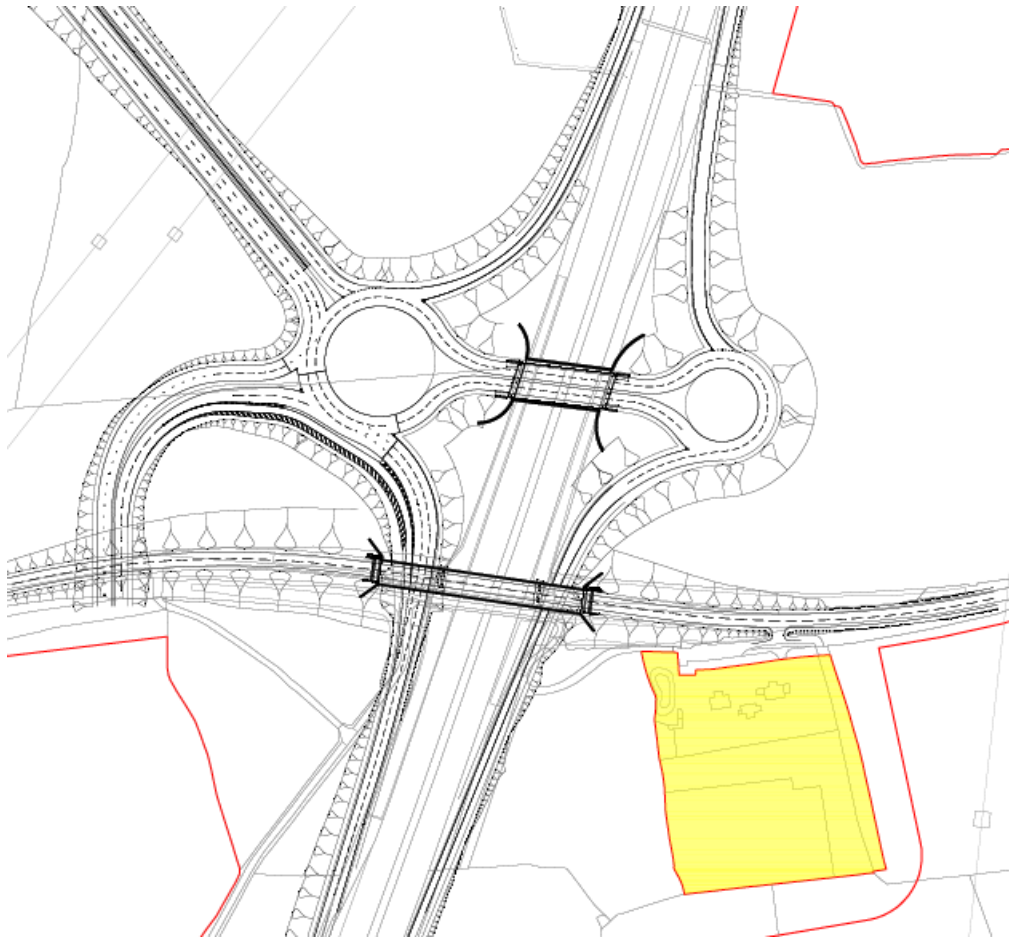
**Table 6 - Western Junction ARCADY Results – Scenario 2 (with MSA 8%) - With Segregated left Turn Lane from M42 N/B**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
East Arm	0.29	0.00	A	0.23	0.00	A
M42 NB Off-Slip	0.91	10.0	C	0.55	1.00	A
MSA	1.05	48.0	F	0.63	2.00	A
New Link Road	0.49	1.00	A	0.21	0.00	A

- 5.1.16 Table 6 indicates that the junction with the segregated MSA left turn would experience traffic demands in excess of its capacity.
- 5.1.17 Given that the MSA TA considers an 8% “turn-in” rate is a possibility, it indicated the Western Junction will require further investigation to ascertain if a suitable design solution could be achieved to accommodate the additional MSA traffic. In addition to the segregated left turning lane from the M42 northbound off-slip into the MSA, consideration may be given to signalised options and possible other alternatives.
- 5.1.18 Further investigations were required in order to achieve an arrangement that would make the junction perform within its capacity.

- 5.1.19 After several design / modelling iterations, a proposed roundabout layout, with partially signalised approach arms was produced. This arrangement would provide sufficient capacity for the junction to perform within its operational capacity including the MSA 8% “turn-in” rate.
- 5.1.20 The proposed arrangement would comprise the following initial key points:
- “Dog Bone” junction layout, preferable to channel and control queues;
  - Three lanes approach at the stop line on the M42 northbound off-slip comprising 2 lanes + 80m short lane. This short lane can be on the inside or the offside;
  - Three lanes on the western side of the gyratory, to accommodate the 3 lanes traffic movements from the south at the M42 off-slip travelling north at the main line;
  - The new Link Road should exit the roundabout with three lanes, then it can merge into two lanes downstream of the junction; and
  - Segregated left turn lane for M42 northbound off-slip into MSA traffic.
- 5.1.21 The proposed modifications as depicted in Figure 6 which incorporates the key points noted above were assessed by the engineering team, to confirm if these modifications are feasible and buildable. Figure 6 shows the additional arrangement in schematic form which can be accommodated should the MSA be granted planning permission.
- 5.1.22 The proposed arrangement shown in Figure 6 could be incorporated into the new Junction 5A design for the Scheme as design modifications when needed, with the minimum amount of works required at the junction, so the disruption to the road users is minimised as far as reasonably practical.

**Figure 6 Junction 5A Proposed Design - With MSA**



5.1.23 The above junction layout was assessed as a partly signalised junction using LINSIG software.

**Table 7 Western Junction LINSIG Results - Scenario 2 (with MSA 8%) - With Segregated Left Turn Lane from M42 N/B**

ARM	AM		PM	
	MMQ	DoS	MMQ	DoS
East Arm	4	40%	4	40%
M42 NB Off-Slip	12	81%	5	46%
MSA	14	85%	8	61%
New Link Road (Give-way)	4	46%	1	22%
PRC%		+6%		+44%

5.1.24 The results indicate that the junction would perform within its operational capacity as there would be 6% capacity remaining in the junction during the morning peak hour.

5.1.25 The phasing for implementing this junction can be considered as a positive point of this arrangement. As without the MSA, the roundabout would have two lanes

approaches and circulatory as shown in Figure 1, should the MSA become operational, all the additional required lanes can be implemented as shown in Figure 6 in addition to the signal controls with a potential for less disruption during the construction of any additional work needed should the MSA come forward.

## 6 Modified Roundabout Design

- 6.1.1 With these proposed layout changes mentioned in paragraph 5.1.20 and shown in Figure 6, there was a need to recheck the operational capacity for the roundabout without the MSA additional measures, to make sure that the roundabout with the geometric design changes would operate well within its capacity as a priority roundabout.
- 6.1.2 To consider a possible MSA development at the new Junction 5A and avoid precluding the MSA scheme should it receive approval from SMBC, the realigned Solihull Road overbridge span was extended by approximately 6m to accommodate the segregated left turn lane which would be required to ensure the two schemes are compatible and could operate within capacity. No other modifications would be required as part of the M42 Junction 6 design. The Junction 5A layout for the M42 Junction 6 Scheme could accommodate all other features specified in paragraph 5.1.20 without incurring any additional changes to the layout issued for Development Consent Order.
- 6.1.3 The revised geometric changes were input into the ARCADY software with the design year 2041 forecast traffic flow for the Scheme only as shown in Figure 3. The output of this assessment is summarised in Table 8 below.

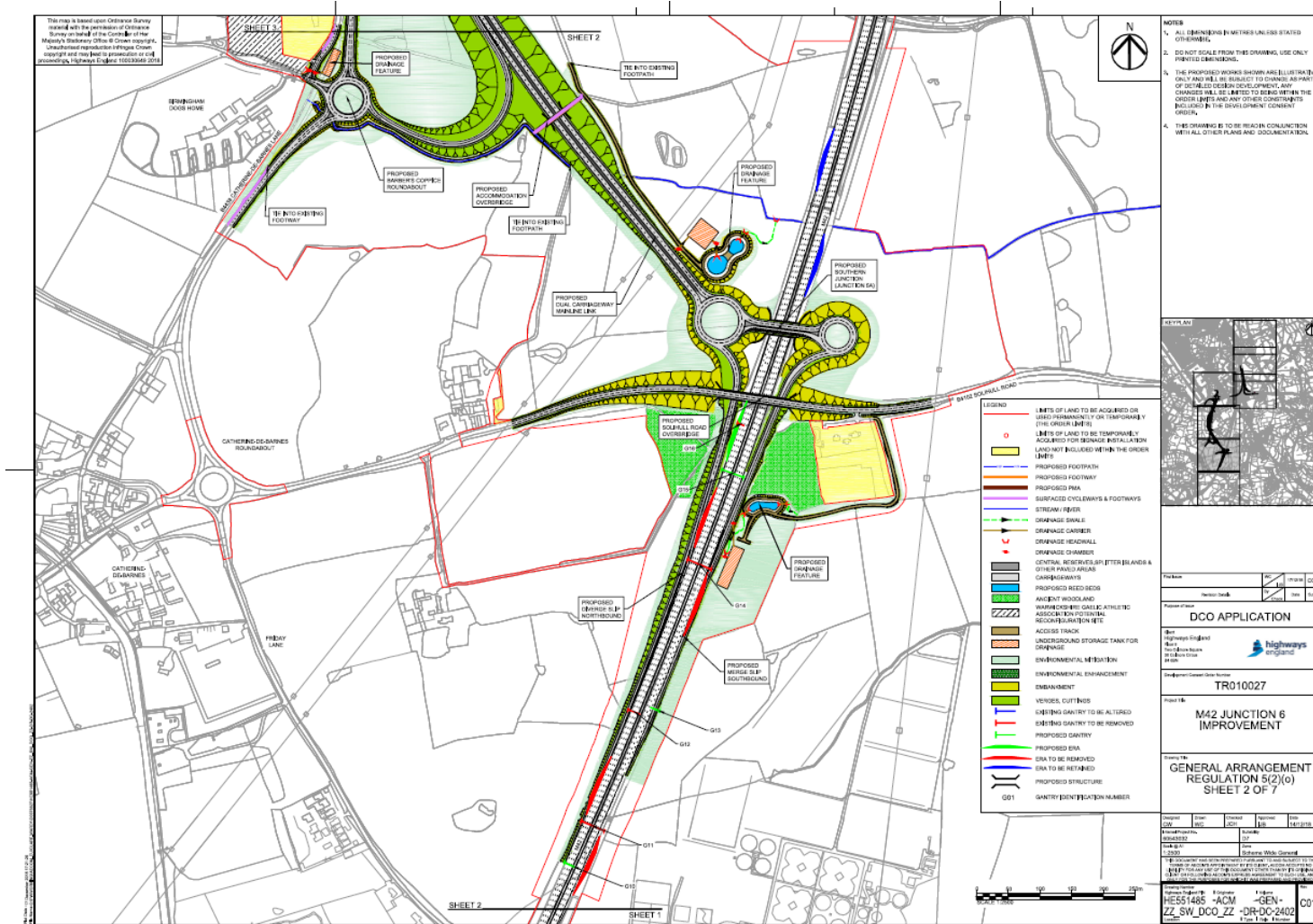
**Table 8 Results Summary - ARCADY Results for the Modified Priority Roundabout**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
<b>East Arm</b>	0.00	0	A	0.00	0	A
<b>M42 NB Off-Slip</b>	0.75	3	A	0.46	2	A
<b>New Link Road</b>	0.42	0	A	0.19	0	A

- 6.1.4 The results indicate that although the junction performance summary slightly changed, the junction would still perform within its capacity with a LOS rating 'A'. The proposed junction layout is shown in **Figure 7**.

6.1.5

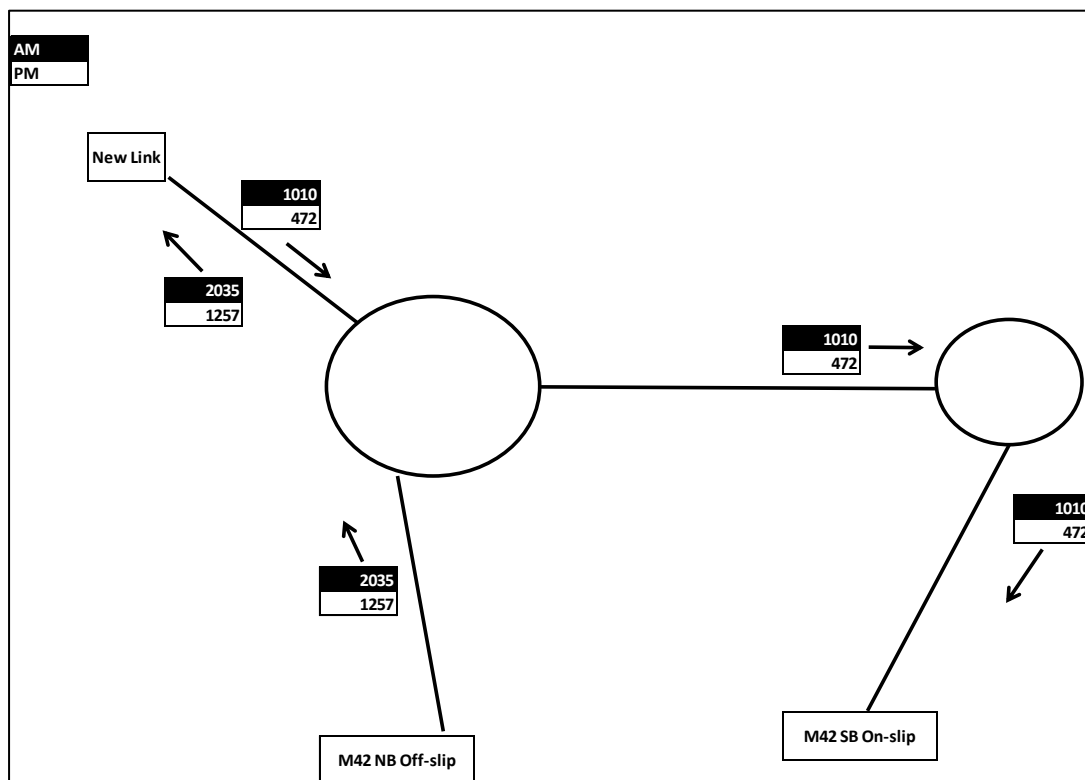
Figure 7 New Junction 5A - Design Fix 3C





- 6.1.6 The proposed design layout for the new Junction 5A was coded in the LAM and a new set of traffic forecasts was produced.
- 6.1.7 To ascertain that the proposed design would perform within its capacity, a final ARCADY modelling was undertaken based on the latest traffic forecast for Design Fix 3C. Figure 8 shows the LAM traffic forecast.

**Figure 8 Junction 5A - Revised 2041 Traffic Forecast**



6.1.8 Table 9 shows the results for the latest design and the revised traffic forecast.

**Table 9 Results Summary - ARCADY Results for the Modified Priority Roundabout**

ARM	AM			PM		
	RFC	Queue	LOS	RFC	Queue	LOS
East Arm	0.00	0	A	0.00	0	A
M42 NB Off-Slip	0.75	3	A	0.46	1	A
New Link Road	0.45	0	A	0.21	0	A

6.1.9 The results indicate that the junction would perform well within its capacity.

## 7 Summary

- 7.1.1 This Technical Note considers the preliminary design operational performance of the new Junction 5A of the Scheme.
- 7.1.2 Initial junction geometries were extracted / measured from drawing: (*M42 Junction 6, General Arrangement, Sheet 2 of 8, HE551485-ACM-HGN-M42\_GEN\_ZZ\_ZZ-DR-CH-002, 13/09/2017*).
- 7.1.3 The junctions were tested with two scenarios:
- Scenario 1 : 2041 traffic forecast; and
  - Scenario 2 : 2041 traffic forecast + MSA traffic.
- 7.1.4 The junctions are forecast to perform within their capacity during Scenario 1 without the additional MSA traffic.
- 7.1.5 Based on the TA, 6% of the motorway traffic was adopted to represent the “turn-in” rate for the MSA.
- 7.1.6 The western roundabout of Junction 5A is forecast to operate over its operational capacity under Scenario 2. This is due to the additional “turn-in” traffic generated by the MSA.
- 7.1.7 A sensitivity test was undertaken to test the provision of a segregated left turn lane for the M42 northbound MSA traffic. The results showed that this would help the junction to improve its operational performance/capacity although the junction would still perform slightly over its capacity.
- 7.1.8 Further Sensitivity test was undertaken with MSA “turn-in” rate of 8%. The analysis showed that the junction would perform over its capacity.
- 7.1.9 Further tests were carried out in order to produce a concept layout for the roundabout to introduce sufficient capacity to accommodate the potential additional traffic that might be generated by the MSA with a “turn-in” rate of 8%. This included provision for a partially signalised junction at Junction 5A.
- 7.1.10 A new layout with some modifications was produced and was fed into the “Design Fix 3C” scheme.
- 7.1.11 Should the MSA be granted planning permission, the new design which forms part of the DCO application does not preclude the MSA scheme. It does require, however, modifications to the MSA Scheme to enable it to proceed installing a spur road into the MSA development and north facing slip roads these Modifications are not part of the Scheme.