Appendix 13B: Air Quality Model Details

Background Concentrations

The DMRB methodology requires the use of background pollutant concentration data, to which the model adds contributions from nearby roads. Background concentrations of NO_x, NO_2, PM_{10}, CO, benzene and 1,3-butadiene are available from the UK Air Quality Archive for the 1 x 1km grid squares.

The UK Air Quality Archive provides background concentration maps for NO_2, NO_x and PM_{10} for assessment years between 2006 and 2020. Updated concentration maps have not been produced for CO, benzene and 1,3-butadiene. Consequently, background concentrations were estimated from previous background maps (2001) projected forward for future years using the adjustment calculator from the AQA as per Local Air Quality Management Technical Guidance LAQM.TG (03)[1] which allows concentration up to 2025 to be calculated.

Background data have been obtained for each grid corresponding to the sensitive receptor location for baseline year of 2009 and for the future 'without development and 'with' scenarios. Due to the fact that Air Quality Archive does not produce mapped background concentrations for 2026 year (future year of assessment), 2020 was used as the latest available for NO_x, NO_2, PM_{10}, while CO, benzene and 1,3-butadiene annual mean concentrations were factored up to 2025, the latest available.

The background data used within the DMRB assessment are presented in Table 1 below presents the background concentrations from the DEFRA maps, removing Motorway source located within the grid to avoid double-counting of this source.

Table 1 Background Concentrations Used within the DMRB Assessment

Pollutant	CO	Benzene	1,3-butadiene	NO_x	NO_2	PM_{10}
Grid 453500, 303500 (Receptor 1)						
2009 Annual Mean	0.2	0.44	0.14	29.03	18.96	19.59
2026 Annual Mean	0.26	0.45	0.16	15.75	11.28	17.86
Grid 452500, 302500 (Receptor 2, 3)						
2009 Annual Mean	0.19	0.4	0.13	21.06	14.54	17.25
2026 Annual Mean	0.25	0.41	0.17	11.47	8.42	15.7
Grid 452500, 300500 (Receptor 4)						
2009 Annual Mean	0.19	0.38	0.13	19.23	13.42	17.42
2026 Annual Mean	0.52	0.39	0.16	10.31	7.62	15.89
Grid 453500, 299500 (Receptor 5)						
2009 Annual Mean	0.2	0.42	0.14	25.19	16.91	17.53
2026 Annual Mean	0.26	0.42	0.17	12.82	9.05	15.84
Grid 454500, 300500 (Receptor 6)						
2009 Annual Mean	0.21	0.44	0.16	27.14	17.95	20.19
2026 Annual Mean	0.27	0.45	0.17	13.83	10.04	18.46
Grid 454500, 302500 (Receptor 7, 8, 11)						
2009 Annual Mean	0.21	0.47	0.15	30.65	19.94	19.62
2026 Annual Mean	0.28	0.48	0.19	15.90	11.37	17.75

Pollutant	CO	Benzene	1,3-butadiene	NO_x	NO_2	PM_{10}
Grid 455500, 302500 , (Receptor 9)						
2009 Annual Mean	0.21	0.53	0.16	30.98	20.19	18.06
2026 Annual Mean	0.28	0.51	0.19	16.22	11.58	16.20
Grid 454500, 301500 (Receptor 10)						
2009 Annual Mean	0.21	0.46	0.15	28.41	18.65	19.41
2026 Annual Mean	0.28	0.47	0.19	14.61	10.55	17.52

Note: Backgrounds for CO, benzene and 1,3-butadiene based on 2025; and 2020 backgrounds for NO_x, NO_2 and PM_{10}

Model Verification

The DMRB Screening Model has been used to assess air quality effects in relation to the Land West of Leicester Masterplan, which is located within the Blaby District Council (BDC) administrative boundary.

The DMRB is not always 'conservative'. It is therefore important to compare the results from the DMRB model against local monitoring data. This would verify the performance of the model, reducing uncertainties and improving confidence in the modelling.

Verification of NOx/NO_2

In this study, the DMRB was used to predict the annual mean NO_2 concentrations at a number of BDC NO_2 diffusion tube monitoring locations, which fall within the transport network available for the assessment. This then allows a comparison between the predicted and monitored data in order to verify the performance of the model. The following monitoring locations were used:

- St Andrews Church, Hinckley Road (453137, 303321);
- 64 Packer Avenue (453488, 303637); and
- Hinckley Road, M1 bridge (453593, 303384).

The latest year of monitoring data available from BDC is for the year 2009 and therefore the verification process was undertaken for 2009. Although, the baseline traffic data for the air quality assessment was available for 2010, the Project Transport Consultants advised that no traffic growth could be assumed between these 2009 and 2010, and therefore, the 2010 traffic data could be applied for the 2009 verification process and 2009 was also modelled as the base year. Annex A presents the traffic data used within the assessment.

Table 1 shows the 2009 monitored and modelled concentrations at the selected diffusion tube locations. The modelled annual mean NO_2 concentration has been calculated from the DMRB NO_x result using the Air Quality Archive NO_x to NO_2 spreadsheet[2] and the 2009 background concentrations taken from the OS grid (453500, 303500). This grid location is representative of the diffusion tubes used in the verification (outlined below). Table 2 below presents the background concentrations from the DEFRA maps, removing Motorway source located within the grid to avoid double-counting of this source. The annual mean NO_2 concentration has been calculated using the Air Quality Archive Background NO_2 Calculator - for Source Apportioned Background NO_x (Version 2.1).

Table 1: 2008 Annual Mean NO_2 Modelled and Monitored Concentrations

Year	Location	Monitored Annual Mean NO_2 [µg/m^3]	Modelled Annual Mean NO_2 [µg/m^3]*	% Difference
2009	Hinckley Road, M1 bridge	48.00	37.38	**-22.13%**
2009	64 Packer Avenue	44.00	33.9	**-22.95%**
2009	St Andrews Church, Hinckley Road	30.00	24.4	**-18.67%**

* calculated from the modelled annual mean NOx using the Air Quality Archive NOx:NO_2 spreadsheet calculator.

Table 2 Pollutant Background Concentrations (µg/m^3) for Verification from the OS Grid (453500 303500)

Pollutant	2009
NO_X (µg/m^3)	29.03
NO_2 (µg/m^3)	18.96

The results in Table 1 show that the DMRB, with the input data provided, is generally underperforming in this area with the magnitude of around 18% to 23%.

Discrepancies between modelled and measured concentrations can arise for a number of reasons, for example:

- Traffic data uncertainties;
- Background concentration estimates;
- Sources not explicitly included within the model, for example car parks and bus stops; and
- Uncertainty in monitoring data, particularly diffusion tubes.

Verification is the process by which uncertainties such as those described above are investigated and minimised. Disparities between modelling and monitoring results are likely to arise as result of a combination of all of these aspects.

Technical Guidance LAQM.TG (09) suggests that where there is disparity between modelled and monitored results, appropriate adjustment should be undertaken. LAQM. TG (09)[3] presents a number of methods for approaching model verification and adjustment. Example 2, of Annex 3 in the TG (09) guidance document, indicates a method based on diffusion tube monitoring to adjust nitrogen oxides road contribution.

The verification method requires modelled roadside NO_X contributions to be compared to the monitored roadside NO_X contributions. Monitored NOx concentrations were obtained by applying the Air Quality Archive NO_x to NO_2 spreadsheet to the BDC monitoring concentrations.

Figure 1 shows the mathematical relationship between modelled and monitored roadside NO_x (i.e. total NO_x minus background NO_x) at the five locations in a scatter graph (data taken from Table 3 below), with a trendline passing through zero and its derived equation.

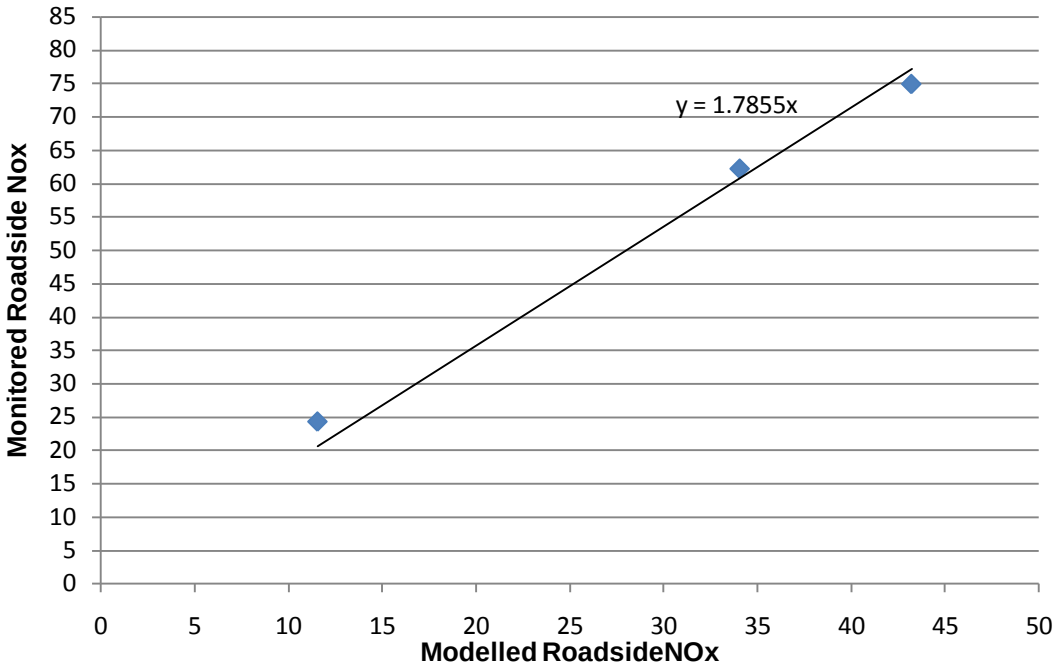


Figure 1 Unadjusted Modelled versus Monitored Annual Mean Roadside NO_x at the Five Monitoring Sites (µg/m^3)

An adjustment of the road NO_x component has therefore been undertaken following the guidance above in order to predict more reliable results for the future scenarios.

Consequently, in Table 3, the adjustment factor (1.7855) obtained from Figure 1 is applied to the modelled NO_x roadside concentrations from the DMRB to obtain improved agreement between monitored and modelled annual mean NO_x. This has then been converted to annual mean NO_2 using the Air Quality Archive NO_x: NO_2 spreadsheet calculator (see: Table 4).

Table 3: Adjustment NO_x Emissions

Monitoring Site	Monitored NOx from Road Emissions*	Modelled NOx from Road Emissions (=[NO_x] TotalMod – Background NO_x)	Adjusted Road Modelled NO_x	Adjusted Total Modelled NO_x	Equivalent Monitored Annual Mean NO_x (µg/m^3)	Difference (adjusted modelled – equivalent monit.) µg/m^3
Hinckley Road, M1 bridge	43.62	43.22	77.18	106.21	104.03	2.18
64 Packer Avenue	25.26	34.07	60.83	89.87	91.34	-1.48
St Andrews Church, Hinckley Road	55.81	11.55	20.63	49.66	53.44	-3.78

Table 4: Adjusted Annual Average NO_2 Concentrations Compared to Measured Annual Mean NO_2 Concentrations (µg/m^3)

Location	Measured Annual Mean NO_2 (µg/m^3)	Adjusted Modelled Annual Mean NO_2 (µg/m^3)	% Difference (modelled adjusted– measured)
Hinckley Road, M1 bridge	48.00	48.66	**1.375**
64 Packer Avenue	44.00	43.51	**-1.11**
St Andrews Church, Hinckley Road	30.00	28.4	**-5.33**

The data in Table 4 indicate an overall improved agreement between monitored and modelled annual mean NO_2 results compared to the unadjusted/unverified model.

The adjustment process was subsequently applied to all of the roadside NO_x modelling results for 2009, which was modelled as the baseline year for the assessment, and 2026 'with' and 'without' the proposed Development in place to predict the concentrations at the selected receptors.

PM_{10}, CO, Benzene and 1,3-Butadiene

No PM_{10} CO, Benzene or 1,3-Butadiene monitoring data is available to compare to the model output. Therefore, the adjustment factor (1.7855) was subsequently applied to all the roadside PM_{10} CO, Benzene and 1,3-Butadiene modelled concentration, before backgrounds were added, at the locations assessed.

In addition, in order to calculate the adjusted number of daily exceedences of 50µg/m^3 PM_{10} the relationship between the number of 24-hour exceedences of 50µg/m^3 and the annual mean PM_{10} concentration from LAQM.TG (09) has been applied as follows, to the adjusted annual mean PM_{10} concentrations:

Number of Exceedences = $-18.5+0.00145 \times (\text{annual mean}^3) + \frac{206}{\text{annual mean}}$.

References

[1] Department for the Environment, Food and Rural Affairs (DEFRA), 2003 'Local Air Quality Management Technical Guidance LAQM.TG(3)'

[2] Air Quality Archive NOx : NO_2 calculator, Version 2.1, January 2010 (http://www.airquality.co.uk/laqm/tools.php)

[3] Department for the Environment, Food and Rural Affairs (DEFRA), 2009, 'Local Air Quality Management Technical Guidance LAQM.TG(09)'

ANNEX A TRAFFIC DATA USED IN THE ASSESSMENT

Table A.1: 2009 Baseline Traffic Data

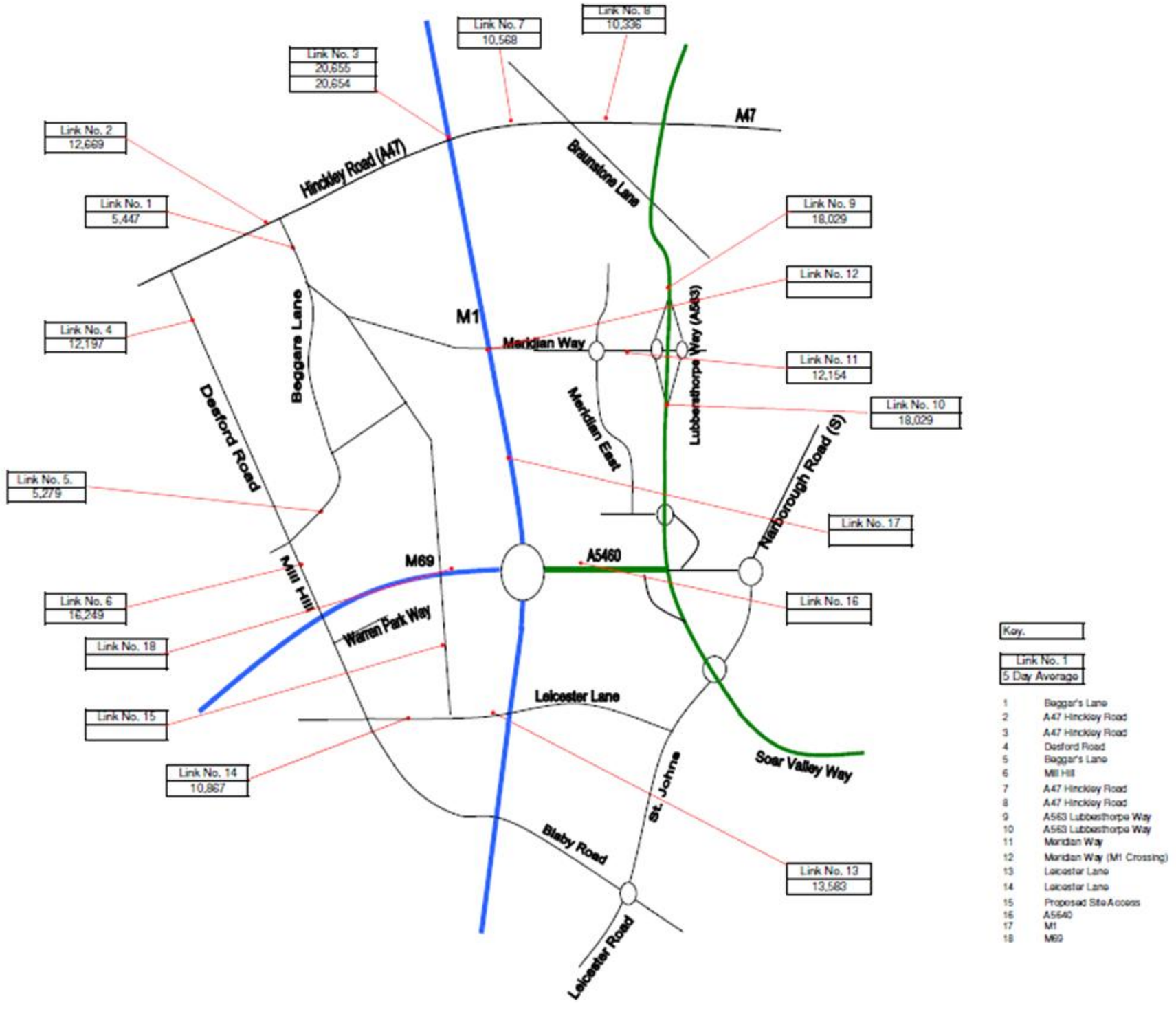


Table A.2: 2026 'Without Development' Traffic Data

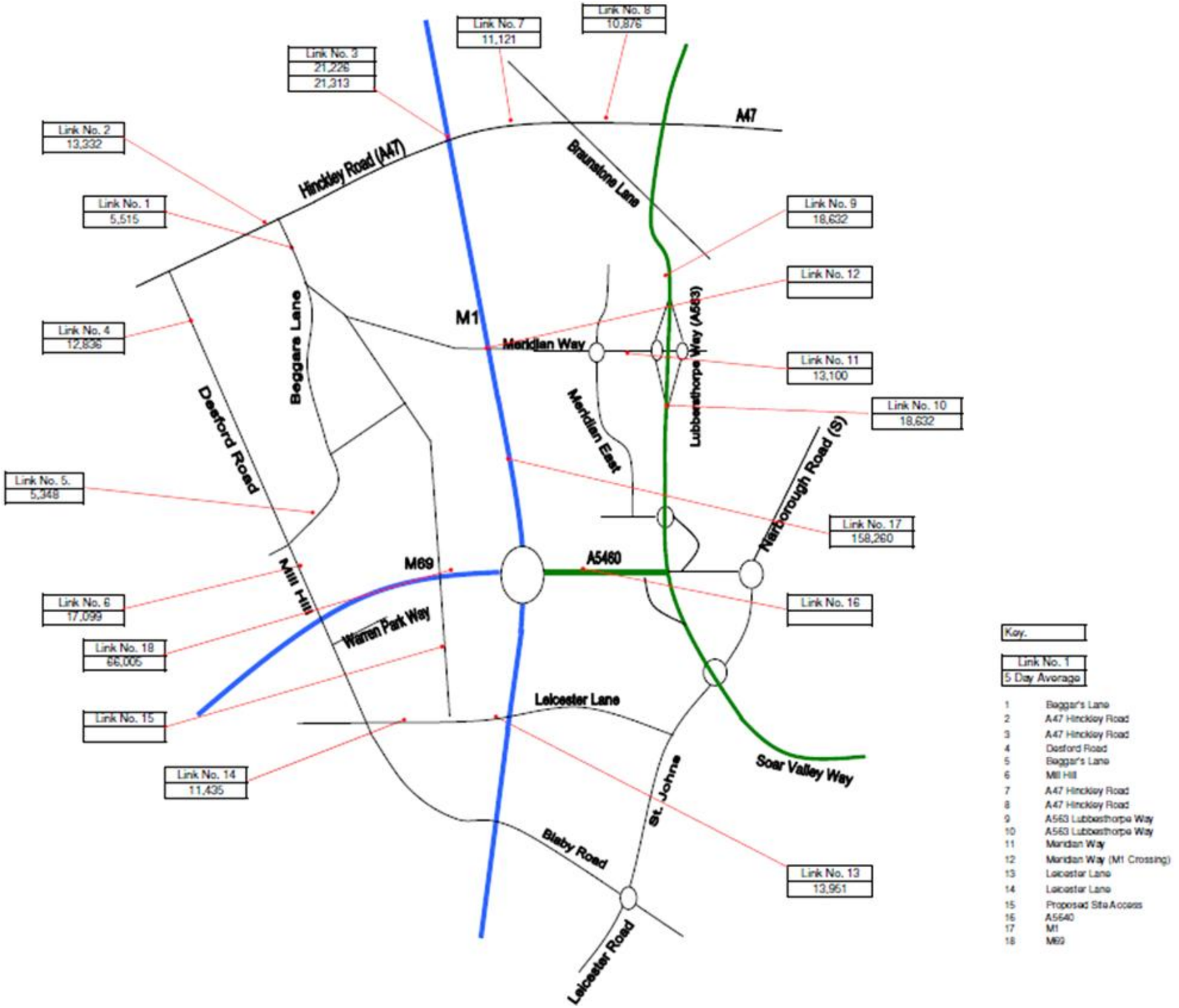
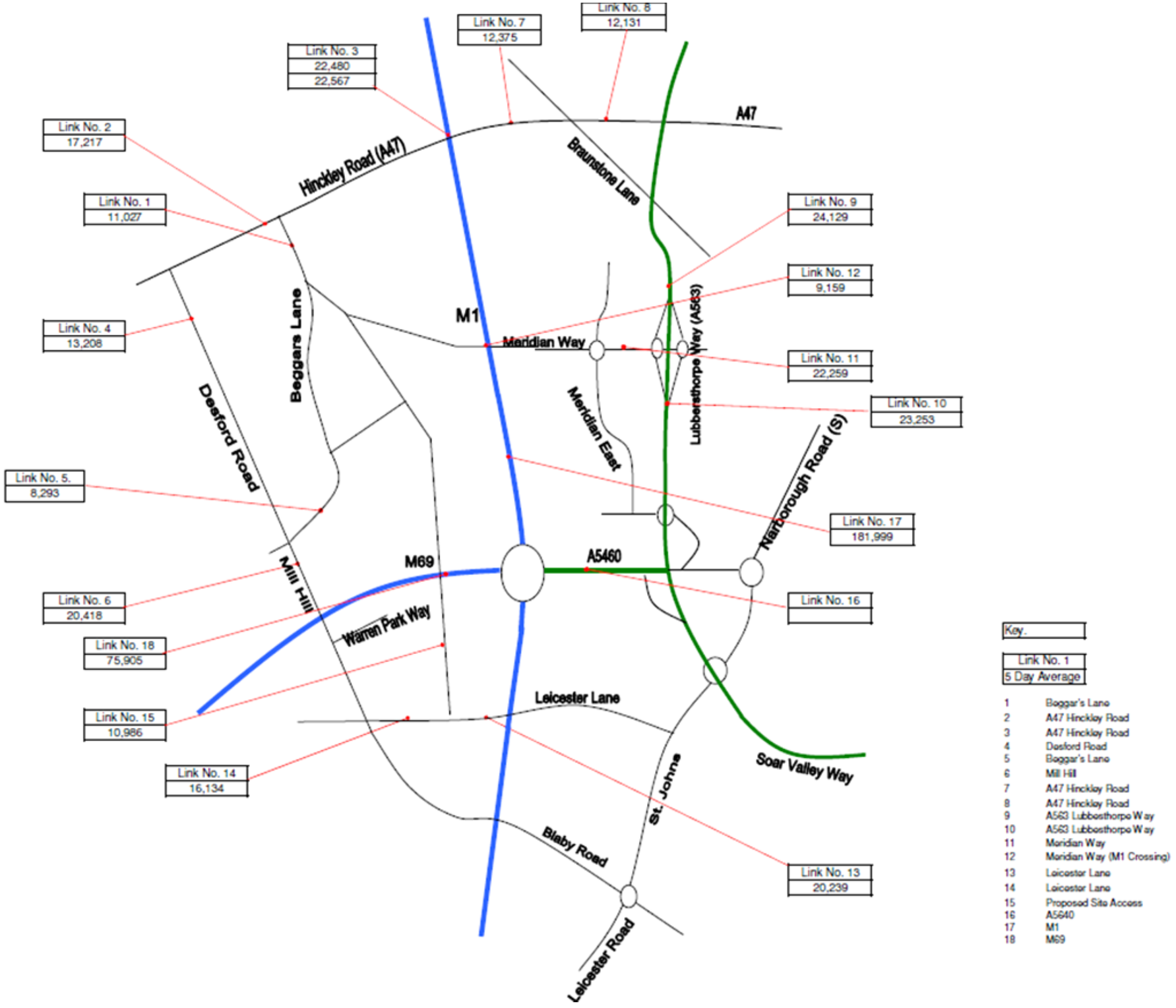


Table A.2: 2026 'With Development' Traffic Data



Key.

Link No. 1
5 Day Average

1	Beggar's Lane
2	A47 Hinckley Road
3	A47 Hinckley Road
4	Desford Road
5	Beggar's Lane
6	Mill Hill
7	A47 Hinckley Road
8	A47 Hinckley Road
9	A563 Lubbesthorpe Way
10	A563 Lubbesthorpe Way
11	Meridian Way
12	Meridian Way (M1 Crossing)
13	Leicester Lane
14	Leicester Lane
15	Proposed Site Access
16	A5640
17	M1
18	M69

Table A.3: 24hr AADT Heavy Duty Vehicles Percentage

Link	Link Name	% of HGV
1	Beggar's Lane	7
2	A47 Hinckley Road	4
3	A47 Hinckley Road	10
4	Desford Road	2
5	Beggar's Lane	7
6	Mill Hill	1
7	A47 Hinckley Road	2
8	A47 Hinckley Road	2
9	A563 Lubbesthorpe Way	^10
10	A563 Lubbesthorpe Way	^10
11	Mweidian Way	11
12	Meridian Way (M1 Crossing)	
13	Leicester Lane	1
14	Leicester Lane	9
15	Proposed Site Access	
16	A5640	
17	M1	10
18	M69	6

^ Estimation

Speed limits on M1 and M69 are 70mph and 30mph on remaining road network. It should be noted that average traffic speeds on the approach to and through junctions and roundabouts were reduced to 20kph (approximately 12.5 mph) to 30kph (approximately 19mph) within all scenarios in the model; to reflect lower speeds that would be experienced in these areas.