Environment and Transport Commissioning Framework

Kibworth Microsimulation Model Applications Report

Modelling Report

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Leicestershire County Council

Document Sign-off

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Whilst the modelling work outlined in this report has been carried out using the Leicester and Leicestershire Integrated Transport Model (LLITM), its findings and any conclusions do not necessarily represent the views of Leicestershire County Council as the Highway Authority.

Leicestershire County Council

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1. Executive Summary

1.1.1. Leicestershire County Council has been commissioned by Harborough District Council to produce a peak hour microsimulation traffic model for the villages of Kibworth Harcourt and Kibworth Beauchamp.

1.1.2. The microsimulation model produced simulated the AM and PM peak periods (defined as 08:00-09:00 and 17:00-18:00 hrs respectively) for a base year of 2018. This is defined as the base model.

1.1.3. This base model has then been recoded to simulate a number of different options to test a number of schemes within Kibworth. These options are outlined in table 1.1.

Option	Description
A	*2018 Base model with* schemes at two junctions along the A6. (Junctions being Wistow Road and Church Road)
B	*2018 Base model with* schemes at three junctions along the A6. (Junctions being Wistow Road, Church Road and New Road)
C	*2018 Base model with* a southward extension of the current 30mph zone on the A6 to the village boundary
D	*2018 Base model with* schemes at three junctions along the A6. (Junctions being Wistow Road, Church Road and New Road) and a new housing estate north of Wistow Road included

Table 1.1 Options tested within the Kibworth microsimulation model.

1.1.4. These options have then been run to provide comparison between each other and the base model over a number of parameters to assess the traffic situation if the given option was to be adopted.

1.1.5. Note that these options are tested in the same modelled year as the base and therefore vehicle volumes and route choices will remain broadly similar.

1.1.6. When considering trips across the whole A6, journey times generally increase in all options tested in the AM peak period. The whole A6 route in the PM is also subject to increased journey times with the exception of Option A which sees a reduction in journey time in both directions.

1.1.7. The client has also identified Air Quality as an area of interest, and as such the software EnViVer has been employed to provide insight into how Air Quality would be effected by the proposed options. As there is an Air Quality Management Area

(AQMA) within Kibworth, statistics for this area has also been reported. Emissions of CO_2, NOx, and PM10 have been reported.

1.1.8. Results of the Air Quality modelling show that the impact of options tested relies upon the time of day. In all options, the AM peak period sees an increase in emissions, both across the modelled area and within the AQMA area. The PM peak however sees reductions across the whole model for Option A and C, and reductions within the AQMA area for all options. These results are summarised in Table 1.2.

	Whole Model				AQMA Area			
	A	B	C	D	A	B	C	D
AM	↑	↑	-	↑	↑	↑	-	↑
PM	↓	↑	↓	↑	↓	↓	↓	↓

Table 1.2 Summary of Air Quality Results, effect of options tested on total NOx emission

2. Introduction

2.1. Background

2.1.1. Leicestershire County Council has been commissioned by Harborough District Council to produce a peak hour microsimulation traffic model for the villages of Kibworth Harcourt and Kibworth Beauchamp.

2.1.2. The microsimulation model has been developed in PTV VISSIM 10-06.

2.1.3. The model has been developed to enable planning and assessment of developments and transport infrastructure. It has utilised model output from the Leicester and Leicestershire Integrated Transport Model (LLITM) suite, to ensure that planned strategic network changes, the DELTA planning data forecasts, and forecast wider traffic growth are taken into account within the detailed microsimulation model.

2.1.4. LLITM was commissioned by LCC and is a suite of models containing highway and public transport assignment models, a demand model (including parking models of Leicester City and Loughborough town centre), and a land-use model.

2.1.5. LLITM has been developed to forecast from a base year of 2014 up to a future horizon of 2051 (consistent with the NTEM 7.2[1]), having as a primary purpose the identification of emerging transport issues and land-use impacts over this time. LLITM is recognised and agreed as the main tool in development of major scheme funding, transport policy or core strategies in Leicestershire, but it would benefit from a complementary local assessment tool. This should be an operational tool which will provide detailed testing and understanding of detailed impacts of strategic cumulative growth, urban network simulation and detailed operational assessment of highway schemes. The models could also inform any future Community Infrastructure Levy (CIL) negotiations with developers.

[1] National Trip End Model 7.2

2.2. Scope of Model

2.2.1. The spatial coverage of the Kibworth microsimulation model is shown in Figure 2.1.

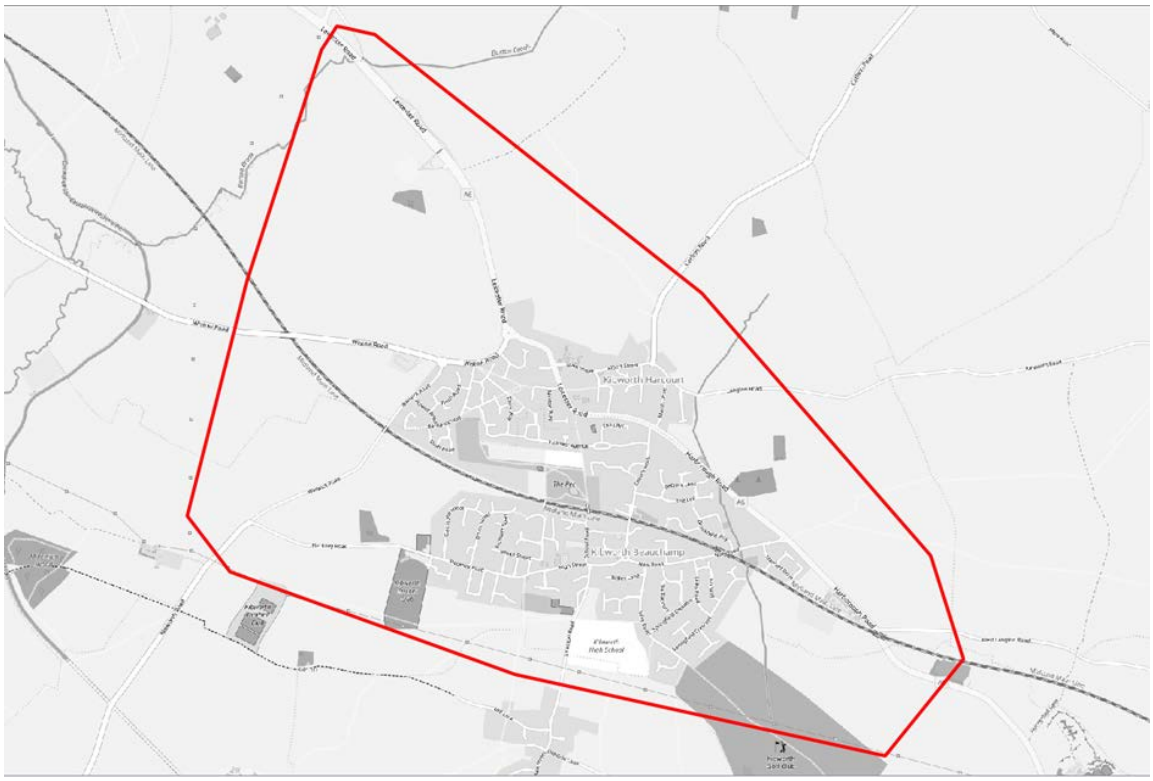


Figure 2.1 Kibworth microsimulation model extent

2.3. Simulation Periods

2.3.1. The model has been developed for a 2018 base year and specifically simulates the morning and evening peak hours of a typical working weekday defined as 08:00-09:00hrs and 17:00-18:00hrs respectively. Quarter hour “warm-up” and “cool-down” periods have also been modelled to saturate the network with traffic and also to allow journeys to complete after the peak hour period.

2.4. Modelled Year

2.4.1. The base year of the model is 2018 and has used corresponding observed flow and journey time data to build and validate it. The prior demand and input for the Matrix Estimation process was taken from the 2016 LLITM forecast[2] as its strategic model trip patterns are considered a reasonable proxy for 2018 base year demand. The matrix estimation process then uses the 2018 observed counts to adjust the 2016 prior matrix to its 2018 micro-simulation equivalent.

[2] The LLITM base year is 2014

2.5. Model Purpose

2.5.1. The model can be used for the following purposes:

- highway development control of small scale land-use developments;
- testing and understanding the more detailed impacts and scale of strategic cumulative development impacts assessment;
- detailed testing and understanding of levels and types of mitigation needed to accommodate growth;
- junction design purposes;
- assessment of traffic management, town centre studies and strategy development;
- assessment of small scale local schemes;
- visual aid to public consultations and exhibitions;
- testing of Air Quality Management policies

2.6. Model Validity

2.6.1. The models have been fully calibrated and validated to observed counts and largely meet TAG Unit M3-1 Highway Assignment Modelling criteria typically used for microsimulation models (flow calibration and journey time validation). Details of this can be found in the Local Model Validation Report.

2.7. Report Overview

2.7.1. This document defines the option testing undertaken (Section 2) and reports on their local impact (Section 3) with particular attention payed to changes in forecast:

- Traffic flows
- Journey times
- Air Quality

3. Applications to assess

3.1. Overview

3.1.1. The client has instructed LCC to test a range of options using the microsimulation model to assess a number of performance parameters, including journey time, traffic flow and in some cases effect on air quality.

3.1.2. The options which have been tested are listed in table 3.1 and shown in figure 3.1.

Option	Description
A	*2018 Base model with* schemes at two junctions along the A6. (Junctions being Wistow Road and Church Road)
B	*2018 Base model with* schemes at three junctions along the A6. (Junctions being Wistow Road, Church Road and New Road)
C	*2018 Base model with* a southward extension of the current 30mph zone on the A6 to the village boundary
D	*2018 Base model with* schemes at three junctions along the A6. (Junctions being Wistow Road, Church Road and New Road) and a new housing estate north of Wistow Road included

Table 3.1 Options tested within the Kibworth microsimulation model.

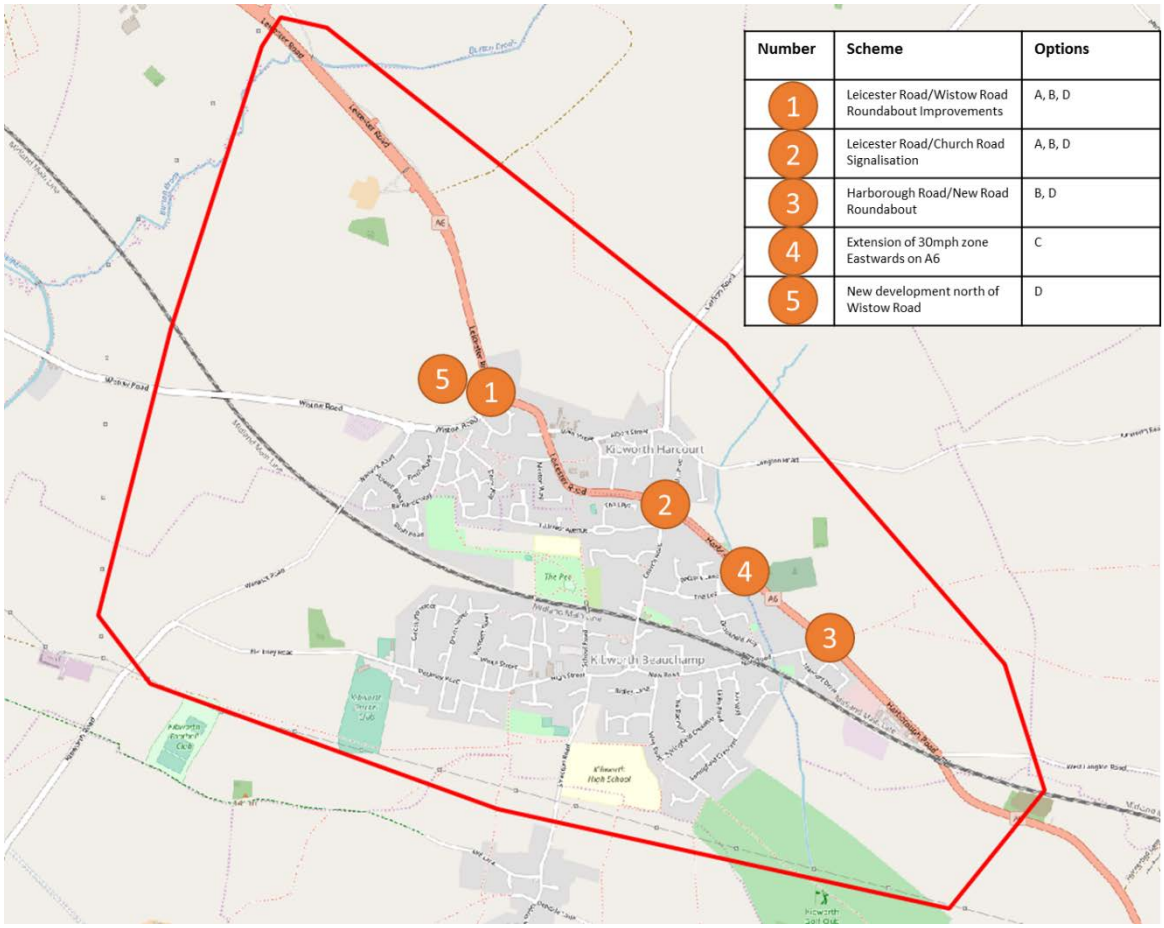


Figure 3.1 Options tested within the Kibworth microsimulation model

3.2. Modelling approach

3.2.1. The following simple modelling approach has been adopted to produce comparable and tangible results. This methodology has been applied for each option in each of the peak period models.

- Step 1
  - Run Base model 5 times (using different seeds) to ascertain average baseline conditions

- Step 2
  - Run the given 'With Option' model 5 times (using different seeds) to ascertain the average conditions with the option applied.

3.2.2. The results are then reported comparing 'with Option' against baseline conditions.

This approach assumes that overall traffic demand remains constant, regardless of the option being implemented, with the exception of option D where additional trips, associated with the new housing estate north of Wistow Road, are included.

3.2.3. Although the travel demand is a constant it is worthy of note that trip routing through the modelled network is able to occur in response to the impedance effects of congestion.

4. Option A

4.1. Assumptions

4.1.1. Option A is comprised of schemes implemented at the following two junction locations on the A6 corridor within Kibworth:

- A6/Church Rd/Marsh Drive (Figure 4.1)
- A6, Leicester Rd/Wistow Rd (Figure 4.2)

4.1.2. The scheme specifics are fully detailed in the 2017 Jacobs Cumulative Development Traffic Impact Study in Fleckney, Great Glen and the Kibworths (B2274700). This report was jointly commissioned by Harborough District Council and Leicestershire County Council.

4.1.3. The proposed scheme at the junction with A6, Church Road and Marsh Drive introduces traffic signals and additional traffic management measures. Marsh Drive will become left in and left out only, but will continue to operate as a priority give way junction (any right turning movements associated with this junction are not permitted). Traffic signals are installed in both directions on the A6 and on the Church Road arm of the junctions. The sequence timing are those used in the Jacobs study in 2017.

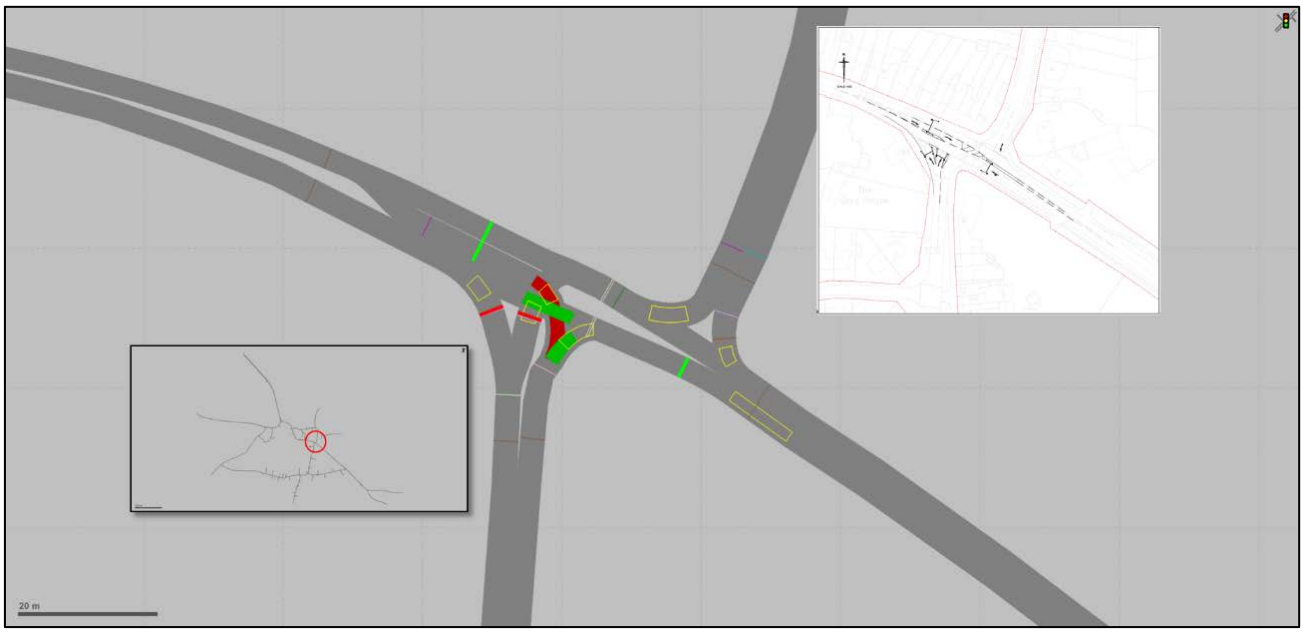


Figure 4.1 Proposed signalised junction at the A6/Church Road/Marsh Drive junction.

4.1.4. The proposed scheme at the existing roundabout junction with the A6 Leicester Road and Wistow Road is comprised of capacity improvements associated with some widening of its footprint. These have been implemented within the microsimulation and the trip paths in the vicinity reviewed through the junction.

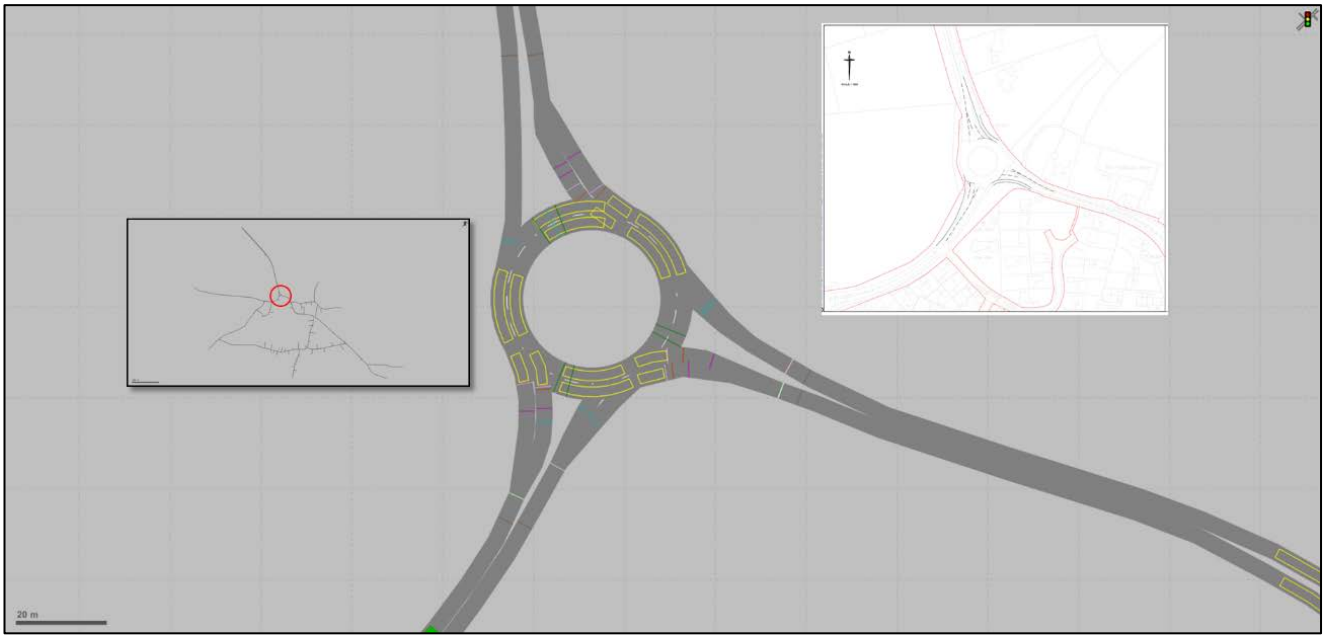


Figure 4.2 Proposed roundabout upgrade at the A6/Wistow Road junction.

5. Option B

5.1.1. Option B has A6 junction improvements with the following roads:

- New Road (Figure 5.1)
- Church Road (Figure 4.1)
- Wistow Road (Figure 4.2)

5.1.2. The schemes are fully detailed in the 2017 Jacobs Cumulative Development Traffic Impact Study in Fleckney, Great Glen and the Kibworths (B2274700). This report was jointly commissioned by Harborough District Council and Leicestershire County Council.

5.1.3. The scheme at the junction with A6 and New Road replaces the existing priority junction with a roundabout. The roundabout approaches are comprised of two lane entries whilst exit points are all single lane. The actual scheme coded into the model is shown in Figure 4.1.

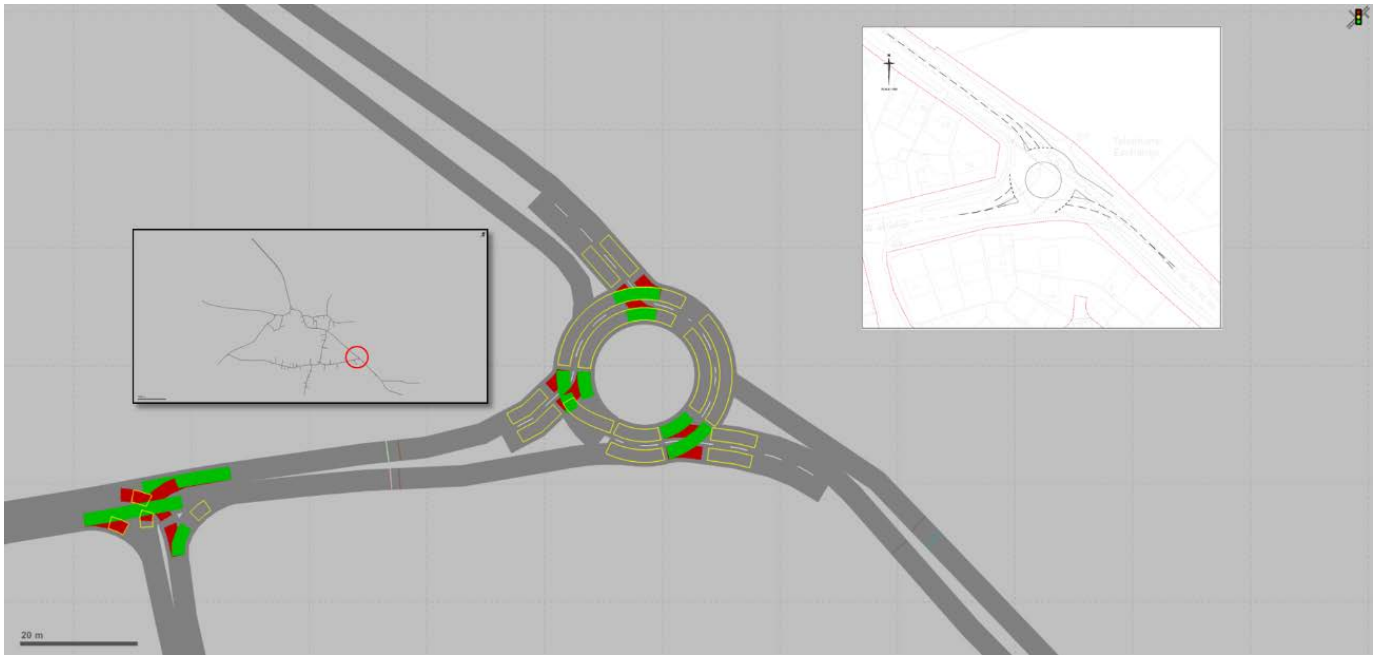


Figure 5.1– Proposed creation of a roundabout at the A6/New Road junction.

5.1.4. The proposed scheme at the junction with A6, Church Road and Marsh Drive is the same as described in Option A above and depicted in Figure 3.1.

5.1.5. The proposed scheme at the current roundabout junction with the A6 Leicester Road and Wistow Road is as described in Option A above and depicted in Figure 3.2.

6. Option C

6.1. Assumptions

6.1.1. Option C features an extension to the existing 30mph zone on the A6 through Kibworth. Under the proposal the 30mph zone will extend southwards to the village boundary (defined as the railway bridge close to the junction with West Langton Road).

6.1.2. The Option C scheme is depicted in Figure 6.1 below.

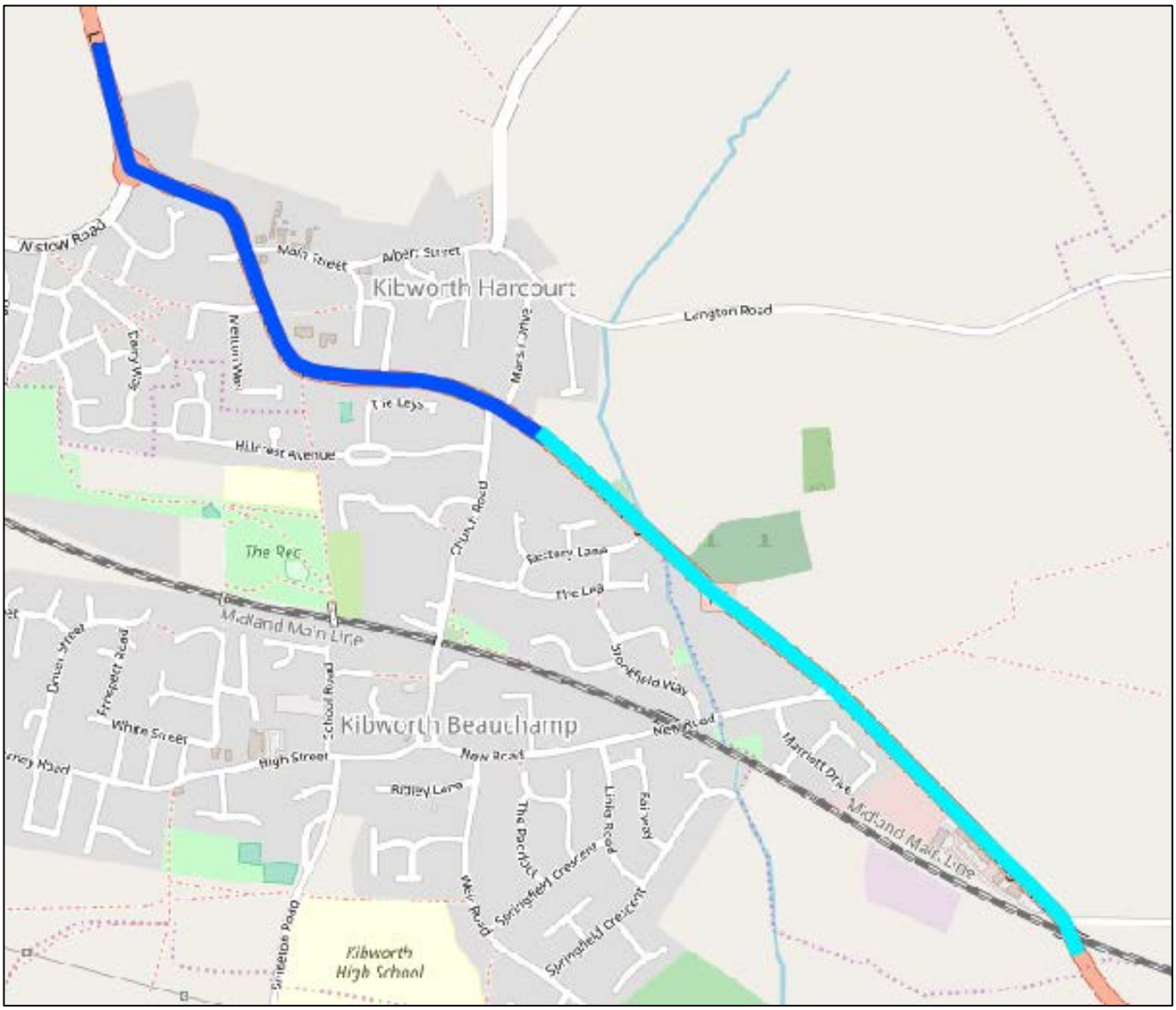


Figure 6.1 Extension of 30mph zone on the A6 in Kibworth (Existing=Blue, Proposed= Light Blue)

7. Option D

7.1. Assumptions

7.1.1. Option D assumes the road network as in Option B. To summarise, this comprises of the existing network with alterations at New Road, Church Road and Wistow Road.

7.1.2. Option D also includes a new development situated to the north of Wistow Road (HDC reference number 14/01641/OUT). The development, which is presently not fully built out, is planned to comprise of 66 dwellings. This development will load onto Wistow Road, and the purpose of this option scenario is to assess the impact of this application on the local highway network.

7.1.3. As planning permission has already been granted and building work on site is in progress, this is a retrospective test to demonstrate the model functioning in a with development environment.

7.1.4. Traffic levels have been sourced from the sites transport assessment and are shown in Table 7.1 below.

	AM Peak (0800-0900)			PM Peak (1700-1800)		
Mode	Arrivals	Departures	Total	Arrivals	Departures	Total
Car	23	64	88	43	25	68
On Foot	3	7	10	5	3	8
Car Passenger	1	3	4	2	1	3
Bus	1	2	3	1	1	2
Train	1	1	2	1	1	1
Bicycle	0	1	1	1	0	1
Motorbike	0	1	1	0	0	1

Table 7.1 Proposed Trip numbers by mode.

7.1.5. Trip distribution has been assumed to be identical to that of the housing development immediately south of the site (the development at Barnards Way)

7.1.6. The development masterplan is shown in Figure 7.1 below and shows its connectivity with Wistow Road.

Figure 7.1 Plan of new development to the north of Wistow Road in Kibworth

8. Results

8.1. Traffic Flows

8.1.1. As the demand matrices remain largely identical to that used in the base model, traffic flows across the model are largely expected to remain at a similar level.

8.1.2. For the purpose of this study the validation screenline/cordon have been used to provide model wide coverage for which analysis to be undertaken.

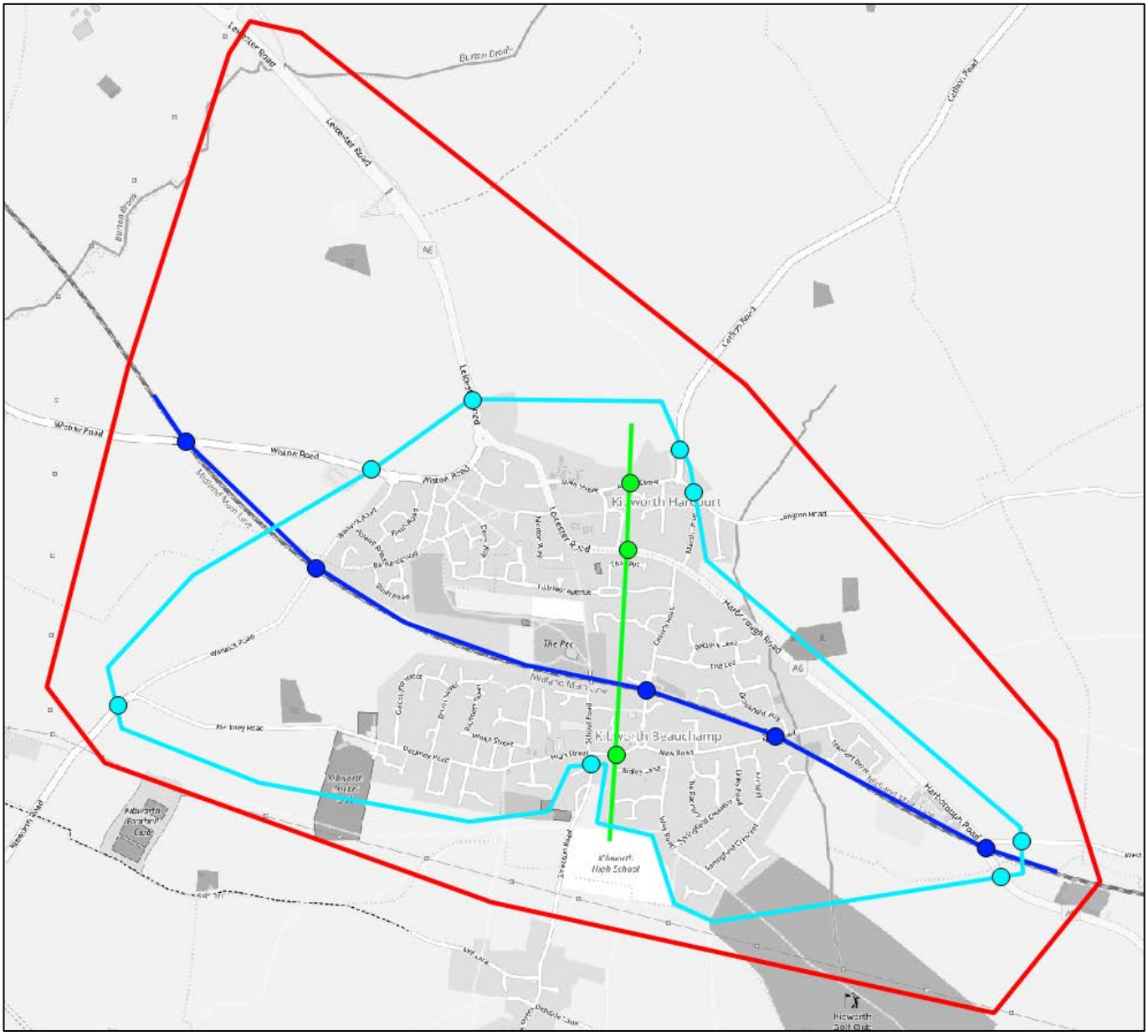
- Screenline 1 monitors trips crossing the railway line, at 5 locations across the model.
- Screenline 2 shows trips travelling across the heart of the model and includes 3 counter points (including the A6 in between the Church Road and Main Street).
- The cordon screenline is a count of movements in and out of Kibworth.

8.1.3. In general terms, on a screenline/cordon scale an increase in traffic flow is indicative of a less congested network, a decrease in traffic flow is systematic of the network becoming more congested.

8.1.4. Within the screenline we see fluctuations between trips using different points; this could be to avoid congestion or because of forced re-routing as a result of a road closure.

8.1.5. Results are reported as a percentage change in comparison to the base and are shown in table 8.1.

8.1.6. Note that Option D includes additional trips all associated with the Wistow Road development (detailed in table 7.1). The distribution of these trips is identical to that assumed for the development immediately south of the site (at Barnards Way), and as such most trips travel to and from Leicester on the A6. The presence of this development may cause some of the existing trips to change their routing patterns which results in changes to screenline flow volumes within the model.



Screenline Counts % Change		AM Base	AM Option A 2 Jcts	AM Option B 3 Jcts	AM Option C 30mph	AM Option D Wistow R	PM Base	PM Option A 2 Jcts	PM Option B 3 Jcts	PM Option C 30mph	PM Option D Wistow R
Screenline1	Nb	1533	-1%	0%	0%	1%	1777	0%	1%	0%	1%
	Sb	1737	0%	0%	0%	1%	1519	1%	0%	1%	0%
Screenline 2	Eb	1434	1%	-1%	-2%	-1%	1139	1%	-3%	0%	-3%
	Wb	1368	2%	-1%	0%	0%	1469	1%	-3%	0%	-2%
Cordon Screenline	In	2304	-1%	-1%	-1%	0%	2584	0%	0%	0%	0%
	Out	2820	-2%	0%	0%	1%	2465	2%	0%	0%	0%

Table 8.1 Traffic flow comparison between modelled options

8.2. Journey Time

8.2.1. Perhaps a more telling measure of network performance is to monitor journey time which will be affected by changes to vehicle behaviour within a traffic network.

8.2.2. For the purposes of this study the journey time has been monitored on four different routes which pass through Kibworth. This allows for a consistent direct comparison between different options and for examination in line with the base model.

8.2.3. In addition to results given in table 8.2, further analysis can be conducted in Appendix B which features Journey Time / Distance graphs for routes A, B and C.

8.2.4. Journey time results in Option A suggest a mixed picture, with reductions of journey time in the PM peak period, but with increases in the AM peak; this is due to the tidal nature of traffic flow on the A6, with the model suggesting that this option works better in the PM peak (with a predominant northbound flow) compared to AM peak.

The AM peak is slower on all routes in all directions; this is possibly as a result of the introduction of traffic signals in the heart of the model. Also by taking away the right turn option at the Marsh Drive junction forces vehicles to make this movement elsewhere, and as such we see additional delay in the AM peak at the Main Street junction with A6 Leicester Road (both with right turning vehicles on the A6 and on Main Street which sees an increase in trips right turning).

In the PM peak the journey time along the A6 corridor are predicted to decrease, with the traffic signals regulating the traffic through the village, allowing for gaps in traffic for side roads to better turn onto the A6. There is also less congestion associated with the roundabout between A6 and Wistow Road in the north of Kibworth.

8.2.5. Option B is very similar to option A in terms of result however is generally slower than Option A, which is as a result of the additional roundabout in the south of Kibworth with the junction of New Road and A6. As a result this option is never quicker than the base model when considering the A6 route as a whole.

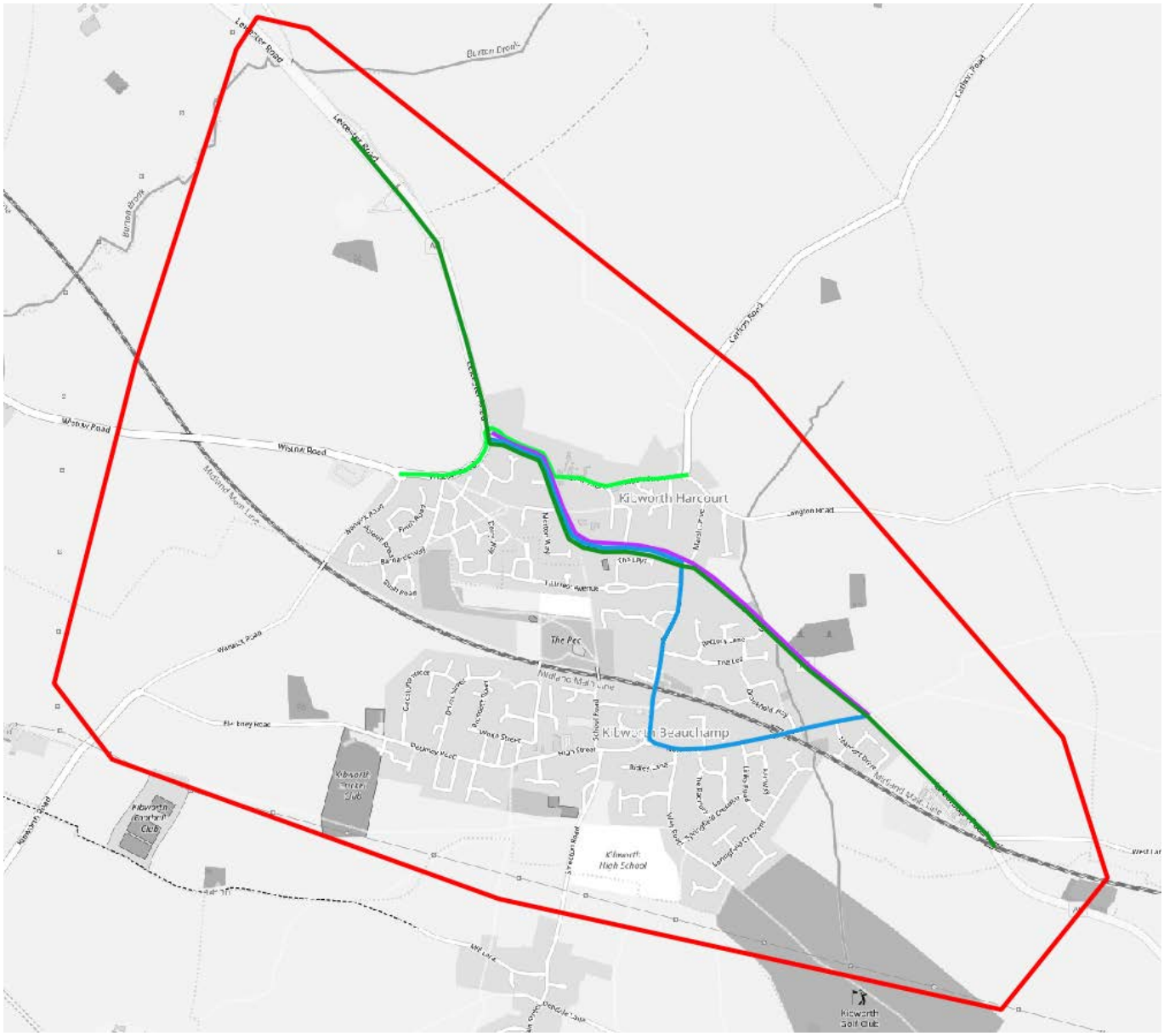
In the AM peak, journey times are generally slower in Option B in comparison to the base model, this is due to the addition of a signalised junction and an additional roundabout on the main A6 through the village. The same right turning issues are also prevalent as discussed in Option A. There is a decrease in journey time eastbound on route C however, this can be attributed to village traffic rerouting away from Wistow Road to take advantage of the other routing options (such as the New Street roundabout).

The PM has generally similar journey times through the village to that in Option A. Exceptions to this include the Route C which sees a large increase in eastbound

journey times with traffic queuing on approach to the Wistow Road/roundabout. There is also increased journey time on route B southbound, and in particular on the approach to the proposed New Street/A6 roundabout. The predominant northbound flow on the A6 causes an issue at both these locations, with vehicles struggling to access the roundabout.

8.2.6. Option C general sees an increase in journey time on trips travelling through Kibworth on the A6, this is due to the reduced speed limit. Route B is slightly quicker; this is because vehicles find it easier to turn onto the A6. Modelling suggests that Route C is slower in the eastbound direction, and faster in the westbound direction.

8.2.7. Option D journey times broadly match those observed in Option B. Route C in the AM model however see's quite some fluctuation, with an increase in journey time eastbound (caused by an increase in traffic levels).



Journey Time % Change		Base	AM Option A 2 Jcts	AM Option B 3 Jcts	AM Option C 30mph	AM Option D Wistow R	Base	PM Option A 2 Jcts	PM Option B 3 Jcts	PM Option C 30mph	PM Option D Wistow R
Route A	Nb	132	13%	5%	9%	14%	180	-13%	-22%	9%	-14%
	Sb	122	5%	8%	8%	28%	141	-4%	-11%	4%	4%
Route B	Nb	216	15%	7%	-1%	7%	308	-30%	-30%	-6%	-29%
	Sb	213	14%	13%	0%	17%	279	-19%	4%	-10%	42%
Route C	Eb	177	16%	-25%	13%	11%	136	4%	51%	15%	51%
	Wb	117	44%	79%	-12%	8%	307	-52%	-73%	-15%	-73%
Full A6	Nb	228	7%	15%	10%	13%	277	-8%	5%	10%	5%
	Sb	619	2%	9%	7%	7%	240	-3%	2%	8%	2%

Table 8.2 Journey time comparison between modelled options

8.3. Air Quality

8.3.1. As this model contains an Air Quality Management Area (AQMA), further emissions modelling has been undertaken to assess the differences between scenarios.

8.3.2. Data from the VISSIM microsimulation model has been extracted and imported into an emission calculation/visualisation software package, EnViVer.

8.3.3. EnViVer models the emissions from individual vehicles travelling within the model, and as such is sensitive to accelerations, braking, traffic congestion and other driver behaviours which are observed in the transport model. EnViVer does not assume any level of background pollution, nor does it consider any emissions from non-road transport sources. Meteorological conditions are not considered in this emissions modelling.

8.3.4. As part of the data collection an Automatic Number Plate Recognition (ANPR) survey was conducted as part of the wider data collection process to develop an understanding of the vehicle fleet composition within Kibworth. This fleet composition is shown in table 8.3 and has then been reflected within the emissions modelling.

Fleet Composition		Car	LGV	HGV
Petrol	%	47%	0%	0%
Diesel	%	52%	100%	100%
LPG	%	0%	0%	0%
Electric	%	0%	0%	0%
Newer than 1 year	%	8%	10%	12%
Average Age	Years	6.5	5.5	5.1

Table 8.3 Vehicle Fleet Composition as observed in Kibworth

8.3.5. For the purposes of this report, the base model has been used to create a comparison between options A, B, C and D, all analysed in the EnViVer software.

8.3.6. For the purpose of this report a flat gradient has been assumed. We have assumed a “basic” topography.

8.3.7. Results for this section are reported as percentage difference between the base and option scenario, this is then shown geographically as emission concentration plots. Results are often quoted in two areas: the whole model and the AQMA area. The whole model gathers data across the entire microsimulation model (as defined in figure 2.1). The AQMA area is defined for the purpose of this report as the area given in figure 8.1, described as the “AQMA area”, note that this area is larger than the HDC

defined AQMA site and includes junctions such as Leicester Road / Wistow Road and the Leicester Road / Church Road.

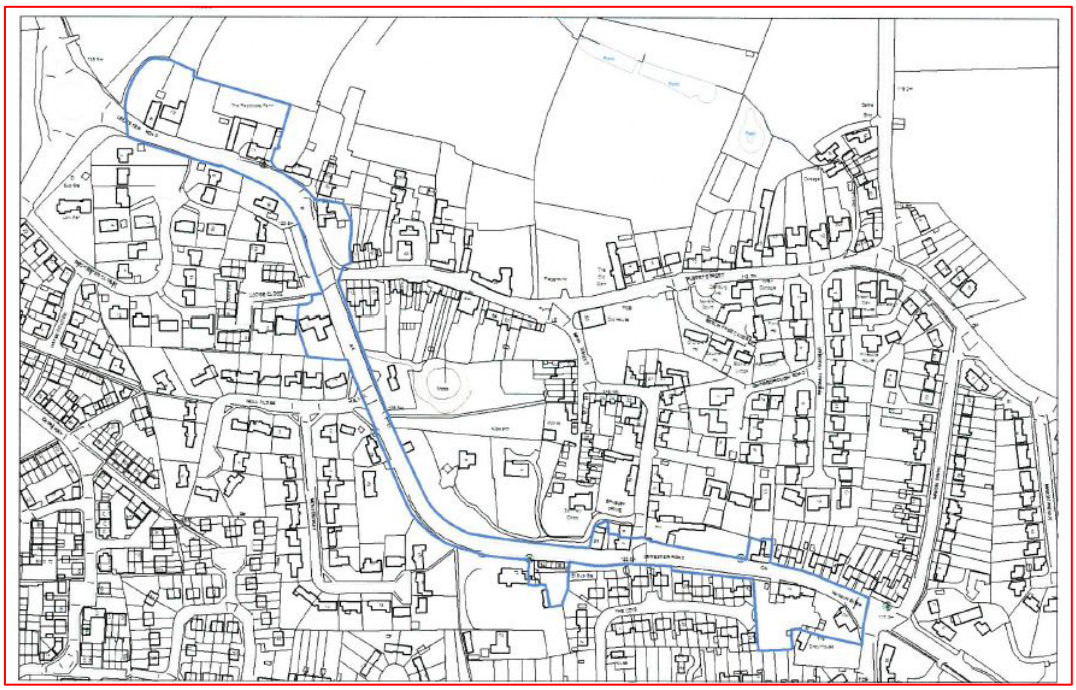


Figure 8.1 Area analysed as "AQMA area" for the purposes of this report (defined as the area within the red rectangle). HDC defined AQMA site shown within blue polygon

8.3.8. Table 8.4 shows the emission by options, presenting a comparison with the Base model. Positive results indicate an increase in emissions, negative results indicate a decrease.

8.3.9. Emission plots for the base and all options can be found in Appendix A.

8.3.10. In Option A, there is expected to be a small rise in emission both within the AQMA and across the modelled area. In the PM there is a slight reduction across the model, with a more significant reduction in the AQAM area. The reduction is emission within the AQMA area is predominantly a result of less vehicles queuing in the Westbound direction, instead they queue on approach to the proposed traffic signals at the Church Road junction (outside of the AQMA area).

8.3.11. Option B sees a general increase in emissions across the model in both AM and PM peak periods. Whilst there is a slight increase in the AM AQMA emissions, there is a decrease predicted in the PM Peak period. The AQMA area PM reduction is once again caused by the signals at the Church Road junction causing traffic to queue outside of the AQMA area.

8.3.12. In Option C there is some fluctuation in emission results, with generally an increase predicted in the AM and a decrease predicted in the PM period. Within the AQMA area there is a noticeable reduction in emissions during the PM peak period. Reduction in

the AQMA area is likely caused by smoother traffic flows as the speeds have been reduced.

8.3.13. Option D sees an overall increase in emissions across the modelled area in both AM and PM peaks. Within the AQMA area the AM peak is predicted to see an increase in emissions, whilst there is a decrease predicted in the PM peak period. The AQMA area PM reduction is once again caused by the signals at the Church Road junction causing traffic to queue outside of the AQMA area.

A		Model Total		
		CO2	Nox	PM10
AM	Total (g)	3%	2%	4%
	g/km	7%	6%	8%
PM	Total (g)	-3%	-3%	-4%
	g/km	-5%	-5%	-6%

A		AQMA Area Estimate		
		CO2	Nox	PM10
AM	Total (g)	4%	4%	5%
	g/km	7%	7%	7%
PM	Total (g)	-16%	-18%	-18%
	g/km	-19%	-21%	-20%

B		Model Total		
		CO2	Nox	PM10
AM	Total (g)	7%	7%	8%
	g/km	7%	7%	8%
PM	Total (g)	2%	2%	1%
	g/km	1%	2%	0%

B		AQMA Area Estimate		
		CO2	Nox	PM10
AM	Total (g)	1%	1%	1%
	g/km	2%	2%	2%
PM	Total (g)	-17%	-17%	-18%
	g/km	-16%	-16%	-17%

C		Model Total		
		CO2	Nox	PM10
AM	Total (g)	2%	0%	5%
	g/km	10%	8%	13%
PM	Total (g)	-2%	-5%	0%
	g/km	-2%	-5%	0%

C		AQMA Area Estimate		
		CO2	Nox	PM10
AM	Total (g)	0%	0%	0%
	g/km	7%	7%	7%
PM	Total (g)	-8%	-10%	-9%
	g/km	-9%	-12%	-10%

D		Model Total		
		CO2	Nox	PM10
AM	Total (g)	8%	9%	9%
	g/km	16%	16%	17%
PM	Total (g)	3%	3%	3%
	g/km	1%	1%	1%

D		AQMA Area Estimate		
		CO2	Nox	PM10
AM	Total (g)	4%	4%	4%
	g/km	12%	12%	13%
PM	Total (g)	-17%	-19%	-18%
	g/km	-18%	-19%	-19%

Table 8.4 Difference in emissions between the base model and options A, B, C and D.

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