A4031 All Saints Way Vissim Modelling

Forecasting Report

Sandwell Metropolitan Borough Council

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Quality information

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Revision History

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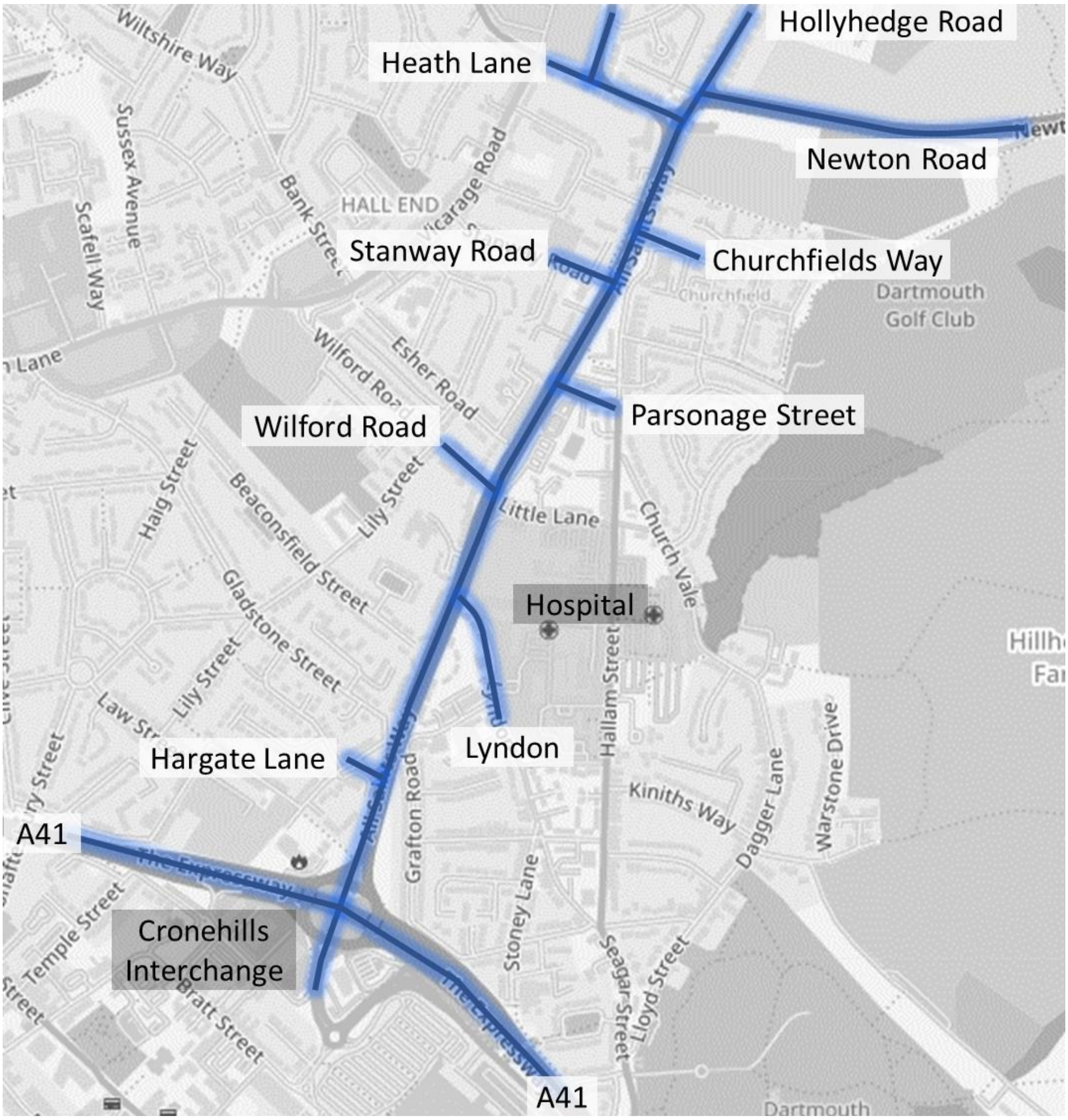
1. Introduction

1.1 Background

AECOM was commissioned by Sandwell Metropolitan Borough Council (SMBC) to build AM, PM, and interpeak period Vissim microsimulation traffic models of A4031 All Saints Way.

The study area is set out in **Figure 1**. It covers the A4031 All Saints Way, extending north from the Cronehills Interchange – which is included with slip roads to ensure realistic traffic arrivals into the study area – and includes junctions with Hargate Lane, Lyndon, Wilford Road, Parsonage Street, Stanway Road, and Churchfields Way, as well as the southern side of the Walsall Road / Hollyhedge Gyratory and Newton Road to the east.

Figure 1: Model extents and areas of interest (*source: Open Street Map*)



All Saints Way is a 40mph urban dual carriageway, with dwellings adjoining or fronting for most of its length. Sandwell General Hospital has access for emergency vehicles onto the road north of Lyndon, which is not modelled since it was observed to have little effect on operation.

The study area includes several signal-controlled junctions and shows some high levels of congestion at peak times. It was suggested that the complex behavioural effects that contribute to high, short-lived traffic emissions spikes could be ameliorated by applying a reduction in speed limit on All Saints Way from 40mph to 30mph.

The study focussed on investigating the impacts of future traffic growth and the proposed reduction in speed limit upon vehicle emissions. This should inform whether the proposed scheme could contribute to the improvement of local air quality. The microsimulation traffic model has been combined with an instantaneous emissions model which is specifically designed to recognise highly variable speeds and stop-start vehicle behaviour that could not be accurately calculated using a simpler model with average speed, flow, and fleet composition data.

The Base model was built using data collected in November 2022 in accordance with TAG guidelines, as detailed in the separate Local Model Validation Report (LMVR), dated April 2023. A Fleet Composition technical note was also issued to SMBC on 23rd February 2023.

1.2 Software

The local model has been developed using the microsimulation software Vissim which allows for the simulation of traffic patterns with a great level of detail, displaying all road users and their interactions in one single model.

The Vissim version used for developing the model is 2023.00-04.

Emissions were calculated using the Bosch emissions module, which is integrated within Vissim[1].

The signals mostly operate via Microprocessor Optimised Vehicle Actuation (MOVA) control and are modelled using PCMOVA 3; version 3.2.0.381.

1.3 Limitations

It is important to note that all traffic models are simplified representations of reality with inherent limitations.

- There has been no re-routing in the future year. The model is based on fixed traffic demand and does not forecast modal shift, peak spreading, or consider alternative routing options outside of the model network.
- The impact of any future changes in congestion beyond the network extents is not considered.
- There have been no adjustments made to the MOVA signal operation based on changes in design speed.

1.4 Report structure

After this introduction, the structure of the report is as follows:

- Section 2 – Methodology, detailing how the future year models were developed,
- Section 3 – Forecast Year Model Operation, presenting the results from the 2027 Reference Case model,
- Section 4 – Proposed Scheme Model Operation, presenting the results from the 2027 Do Something model,
- Section 5 – Traffic Emissions Results, presenting the emissions results for all scenarios, and

  Section 6 – Summary and Conclusions, summarising the findings and covering next steps.

[1] https://company.ptvgroup.com/en/ptv-vissim-emissions-calculation-from-bosch

2. Methodology

2.1 Model scenarios

The LMVR concluded that the 2022 Base microsimulation models are suitable to model future year and scheme scenarios.

The following peak hours, as represented in the Base model, have been modelled in future years:

- AM (08:00-09:00),
- Interpeak (IP) (11:30-12:30), and
- PM (16:45-17:45).

The following future year scenarios have been modelled:

- 2027 Reference Case – 2027 forecast traffic on existing network, and
- 2027 Do Something – 2027 forecast traffic with proposed speed limit reduction.

2.2 Signal operation

The traffic signal control is unchanged from the 2022 Base scenario, where signals are controlled via MOVA. The traffic signals are demand dependent and timings will adjust in response to changes in traffic demand and arrival profiles.

2.3 Results analysis

The following results have been output from Vissim for analysis and comparison:

- Network performance statistics,
- Model error files,
- Journey times, and
- Link segment results.

The link segment assessment effectively divides each lane of each link into 10m segments and logs information about vehicles that pass over that segment, resulting in outputs such as average speed, vehicle density, and total emissions. These results are visualised using heatmaps.

2.4 Fleet breakdown

The emissions model uses vehicle fleet breakdown to estimate traffic emissions based on the vehicle classifications, fuel types, and age. The fleet assumptions were based on an Automatic Number Plate Recognition (ANPR) survey undertaken in November 2022.

Details of the ANPR survey are presented in **Appendix A**.

The emission model assumes there would be no turnover of the traffic fleet in the future year scenarios, which is cautious as it does not account for the expected adoption of newer and alternative-fuelled vehicles, which would contribute to proportionally lower emissions.

3. Forecast Year Model Operation

3.1 Traffic growth

TEMPro (Trip End Model Presentation Program) has been used to estimate future year traffic growth. Factors were obtained from 2022 to 2027 for the Sandwell 017 and 039 MSOAs using TEMPro version 8.0. An average of the two MSOA values has been used, as shown in **Table 1**.

Table 1: TEMPro factors used to scale traffic demand

Peak period	TEMPro factor
AM	1.0541
IP	1.0582
PM	1.0537

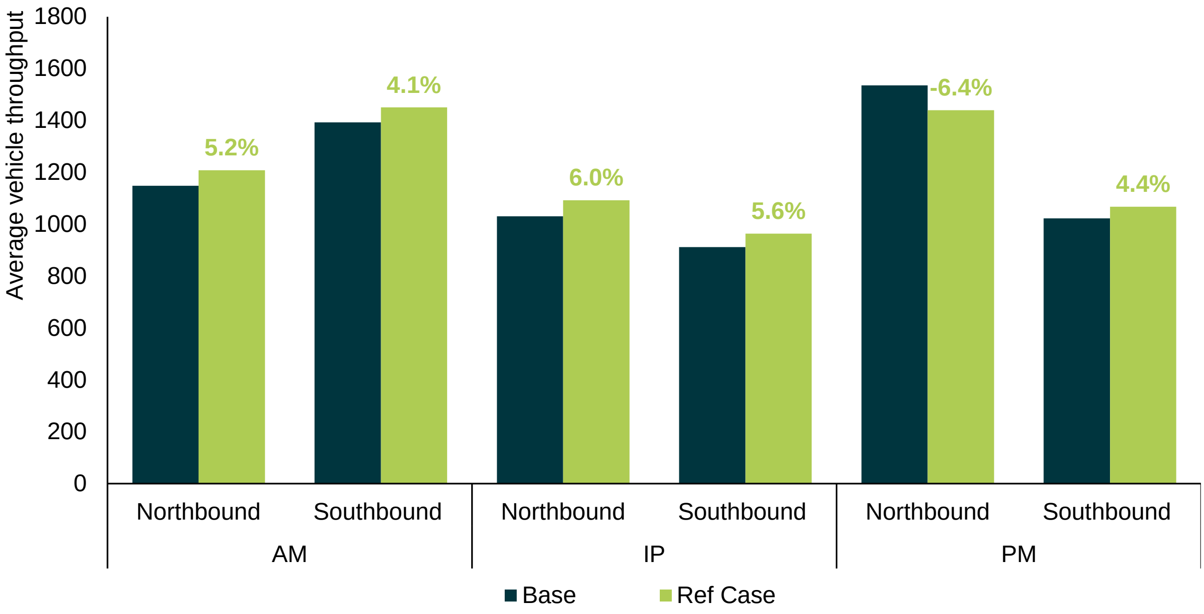
3.2 2027 Reference Case versus 2022 Base

2027 Reference Case models have been created for each peak. The only change between the 2022 Base and 2027 Reference Case models is the increased traffic demand from 2022 to 2027.

3.2.1 Network performance

Vehicle throughput within the peak hour has been averaged along the mainline in both directions and compared between the 2022 Base and 2027 Reference Case models. This is shown in **Figure 2**.

Figure 2: Vehicle throughput with labels showing percentage change from Base to Reference Case

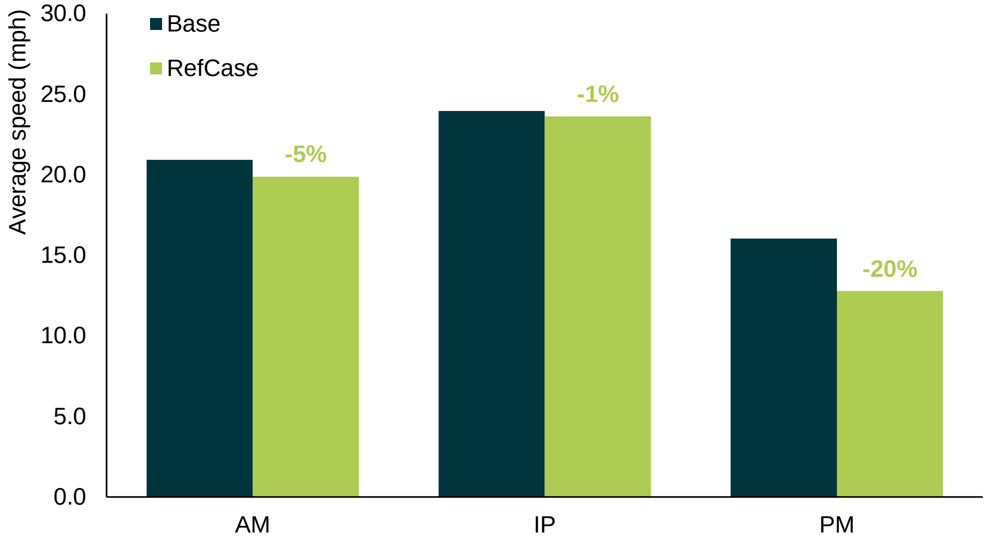


Traffic demand has been increased by around 5% in all peaks as shown in **Table 1**. The impact of the change in demand on throughput for each peak highlights:

- In the interpeak model, where there is no congestion, this translates to a similar increase in throughput.
- In the AM peak, where there is a small amount of congestion southbound, the throughput increases by slightly less than the demand in that direction.
- In the PM, where there is currently a large amount of congestion northbound, throughput decreases in that direction when traffic demand is increased, as vehicles join the back of the existing queue and cannot progress through the network.

The speed of vehicles on the All Saints Way mainline has been averaged across the whole peak hour. This is shown in **Figure 3**.

Figure 3: Average speed of vehicles on All Saints Way with labels showing percentage change from 2022 Base to 2027 Reference Case



Average speed follows a similar trend to throughput. The interpeak shows negligible change while the AM sees a small reduction in speed and the PM a large reduction.

3.2.2 Errors

The Vissim error files have been checked for each model. Unreleased vehicles are an error that indicates that queueing is extending outside the modelled area. They are shown in **Table 2**.

Table 2: Unreleased vehicles in each peak

	AM peak		IP		PM peak	
	2022 Base	2027 Reference Case	2022 Base	2027 Reference Case	2022 Base	2027 Reference Case
Hollyhedge Road	0	18	0	0	0	0
Lyndon	0	0	0	0	0	30
A41 E	0	0	0	0	0	18
Cronehills Linkway	0	0	0	0	0	244

Significant unreleased vehicles are seen in the PM peak in the 2027 Reference Case. These are caused by the increased congestion northbound due to the increased traffic demand.

3.2.3 Journey times

Journey times have been compared along the two routes shown in **Figure 4**. These two routes were chosen because they include the part of the network where speed limit changes occur, rather than the Hollyhedge Road and Heath Lane sections that were included in the Base model journey time routes.

The northbound and southbound journey times are compared in **Figure 5** below.

Figure 4: Northbound and southbound routes used to compare scenarios

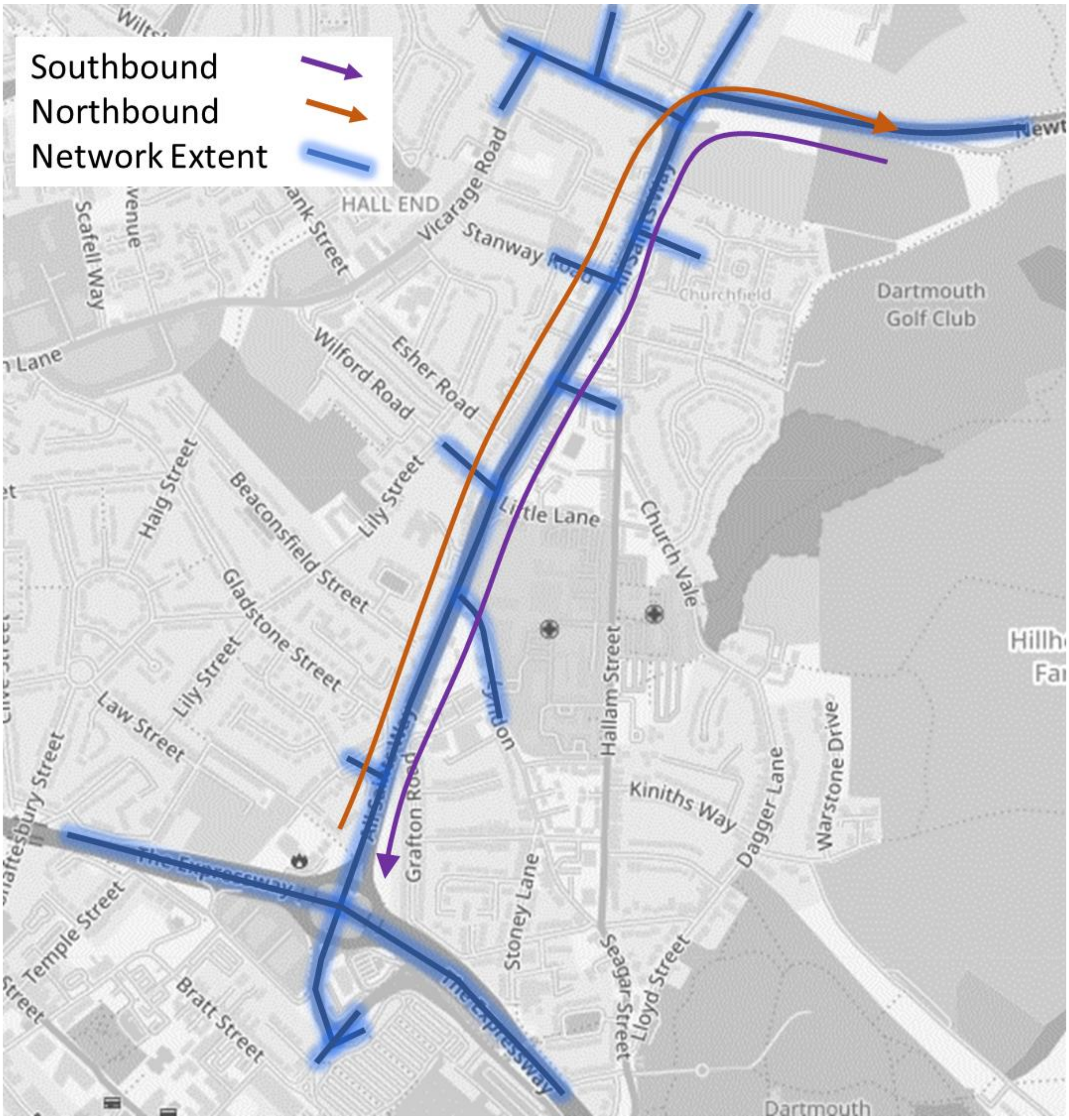
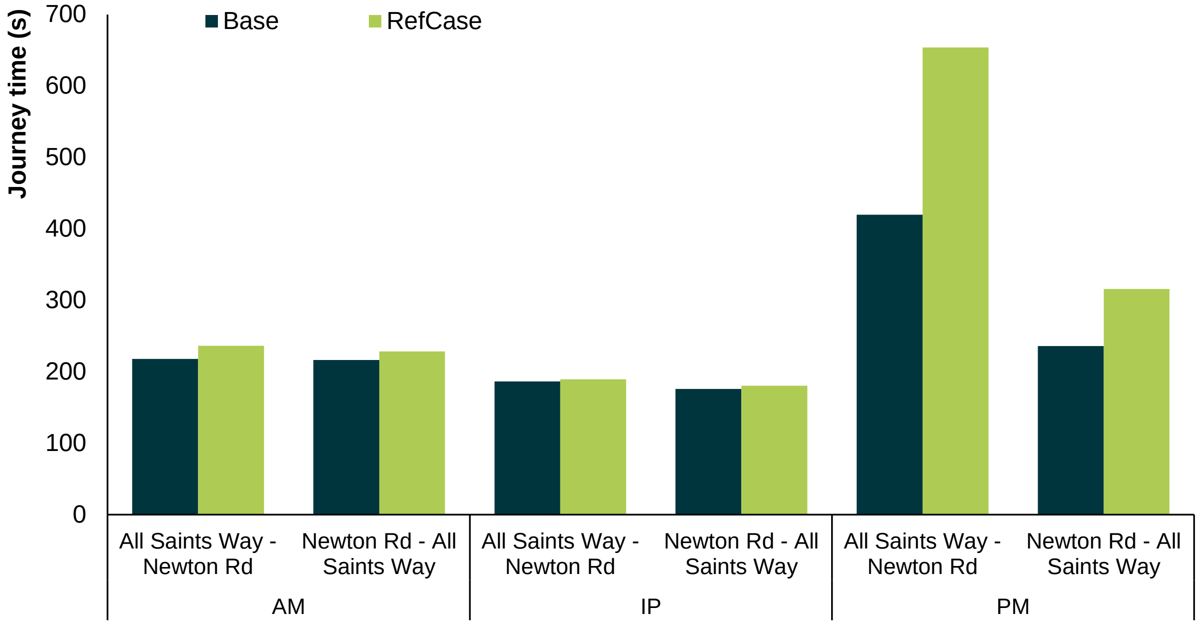


Figure 5: Northbound and southbound journey times – 2022 Base vs 2027 Reference Case



Journey times see a small rise in the AM and a large rise in the PM, especially northbound where queueing magnifies the effect. The southbound also rises significantly in the PM which is caused by changes in traffic signal timing green splits at the All Saints Way / Hollyhedge Road junction in combination with the increase in traffic demand. Journey times see a negligible rise in the interpeak.

3.2.4 Speed and density

Heatmaps are a useful way to visualise link segment results. **Appendix B** provides speed heatmaps comparing the 2027 Reference Case to the 2022 Base, while **Appendix C** provides speed, density, and emissions heatmaps comparing the 2027 Do Something to the 2027 Reference Case.

Figure B40 shows the percentage change in average speed in the AM peak between the 2022 Base and 2027 Reference Case models. **Figure B41** and **Figure B42** show the same for the interpeak and PM respectively.

In the AM peak, there is a small reduction in average speed on the approaches to the All Saints Way / Hollyhedge Road junction as traffic volumes increase, but negligible change elsewhere.

There is negligible change in average speed across the network in the interpeak – vehicles are essentially unhindered by the increased traffic volumes.

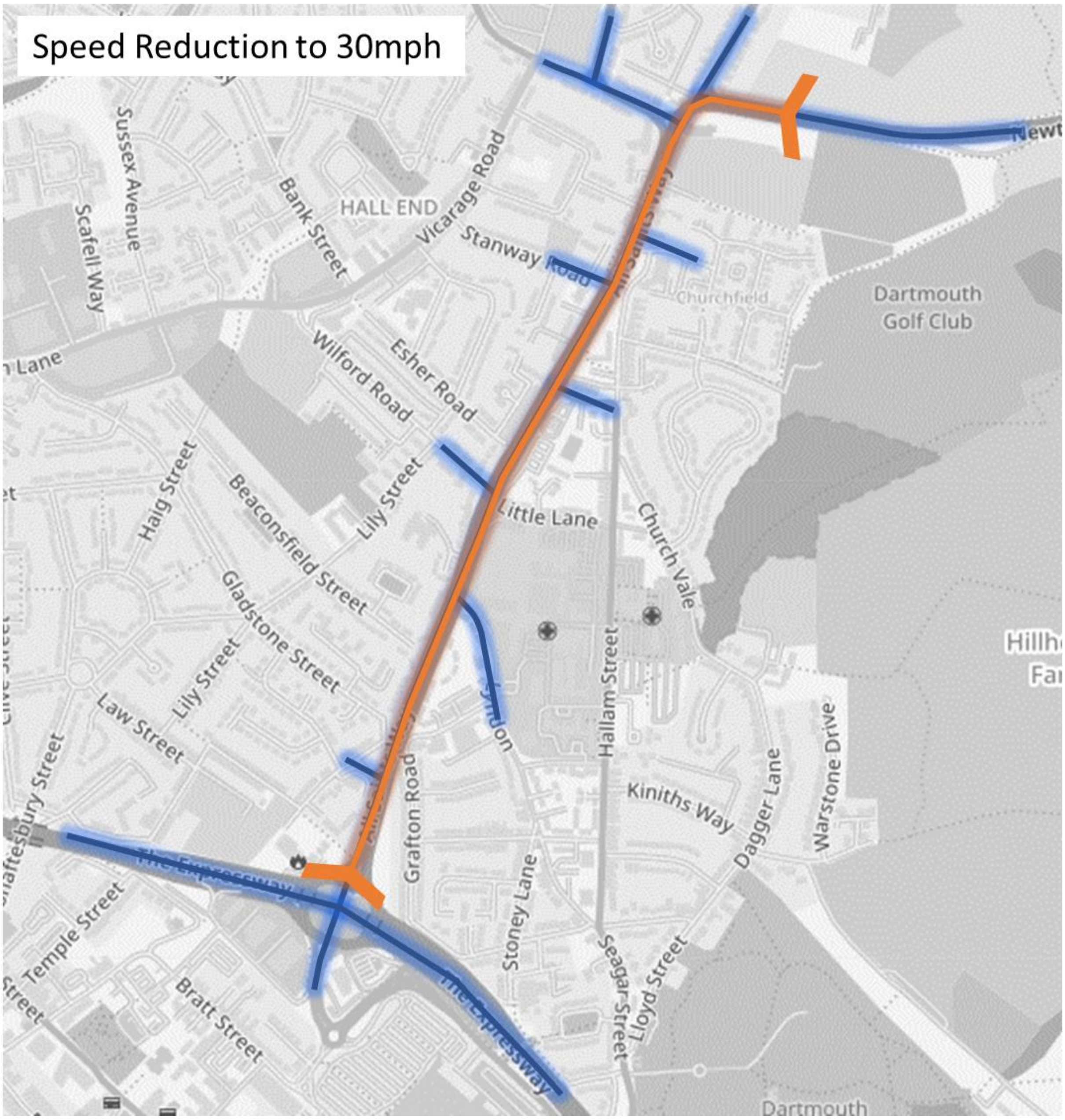
In the PM peak, there is a noticeable reduction in average speed on the northbound mainline. There is little change north of Wilford Road because the existing northbound queue extends to this junction, so average speeds are comparable. Queues northbound extend south of Wilford Road in the 2027 Reference Case model, resulting in decreased speeds on this section.

4. Proposed Scheme Model Operation

4.1 Proposed scheme

The proposed intervention consists of reducing the speed limit on All Saints Way from 40mph to 30mph. The extent of the scheme is shown in **Figure 6**.

Figure 6: Speed limit reduction scheme



This has been implemented in Vissim by adjusting the speed distributions applied on entry to the A4031 mainline. **Table 3** gives the mean and 85th percentile speed of the speed distributions used.

Table 3: Mean and 85th percentile speed for the 30mph and 40mph speed distributions

	40mph	30mph
Mean	37	29
85th percentile	43	36

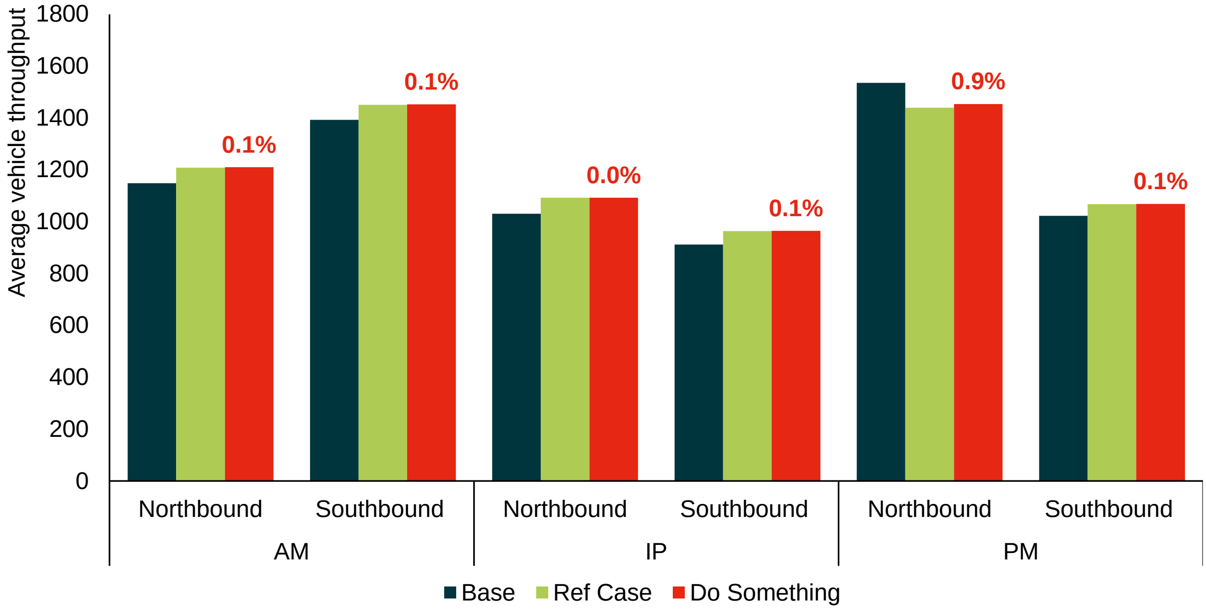
4.2 2027 Do Something versus 2027 Reference Case

Results from the 2027 Do Something scenarios have been compared to those from the 2027 Reference Case scenarios to assess the effect of the proposed speed reduction with 2027 forecast traffic demand. Where useful, results from the 2022 Base model have also been included for comparison.

4.2.1 Network performance

Average vehicle throughput along the All Saints Way mainline is compared between the 2027 Reference Case and 2027 Do Something models, with the 2022 Base data presented for reference. This is shown in **Figure 7**.

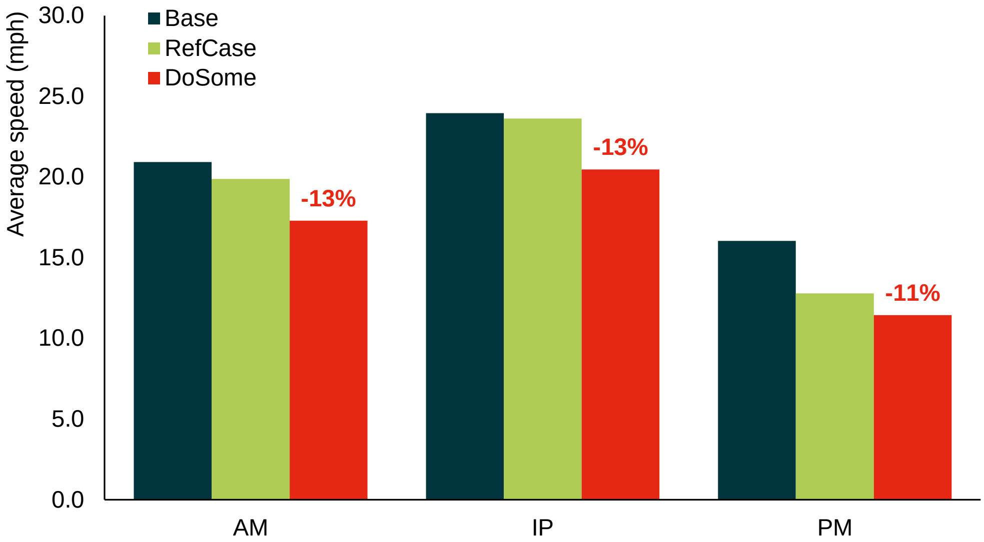
Figure 7: Vehicle throughput with labels showing percentage change from 2027 Reference Case to 2027 Do Something



There is negligible change in throughput with the speed reduction in place, with the largest change being northbound in the PM peak. Analysis of the signal timings indicates that MOVA control at the signals at the Hollyhedge Road junction allocates more green time to the north- and westbound approaches when speeds are reduced.

Average speed on the All Saints Way mainline is compared between the 2027 Reference Case and 2027 Do Something models, with the 2022 Base data present for reference. This is shown in **Figure 8**.

Figure 8: Average speed of vehicles on All Saints Way with labels showing percentage change from Reference Case to Do Somethingg



Average speed reduces in all three peaks due to the speed limit reduction. This change is less significant in the PM peak since the high levels of congestion northbound mean speeds here are less affected as a larger proportion of vehicles are already travelling below 30mph.

4.2.2 Errors

Unreleased vehicles are shown in **Table 4** comparing the 2027 Reference Case and 2027 Do Something models.

Table 4: Unreleased vehicles in the 2027 Reference Case and 2027 Do Something models

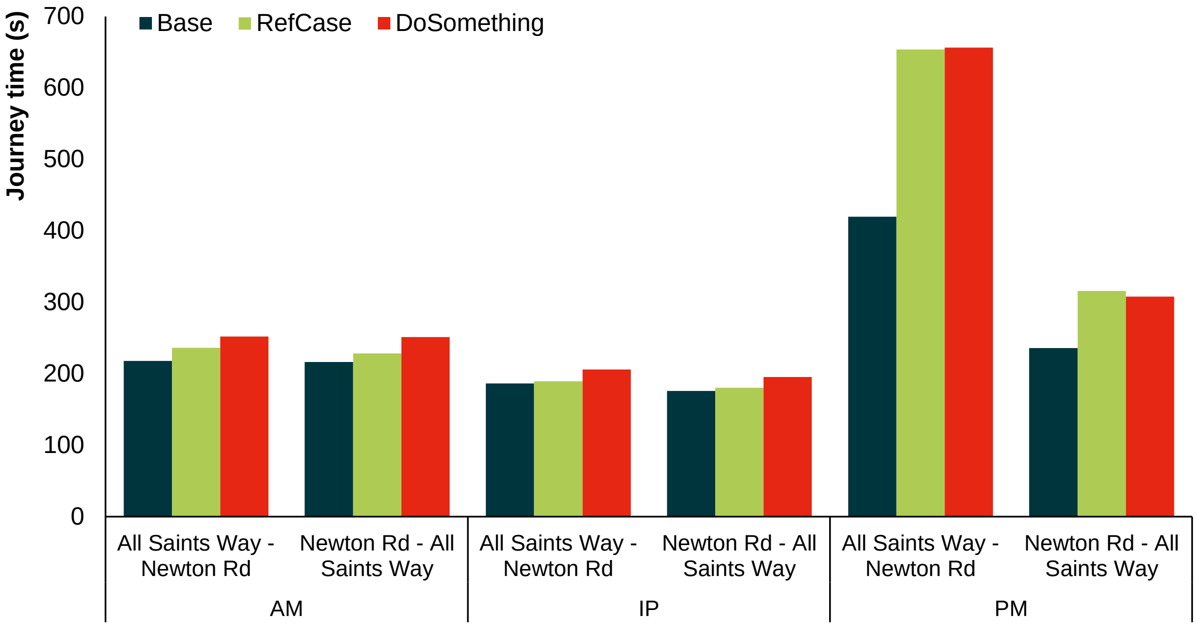
	AM peak		IP		PM peak	
	2027 Reference Case	2027 Do Something	2027 Reference Case	2027 Do Something	2027 Reference Case	2027 Do Something
Hollyhedge Road	18	13	0	0	0	0
Lyndon	0	0	0	0	30	26
A41 E	0	0	0	0	18	0
Cronehills Linkway	0	0	0	0	244	138

Unreleased vehicles are reduced with the proposed scheme because, as indicated by the overall network performance results, the reduced speed limit provides some improvements to vehicle throughput.

4.2.3 Journey times

Journey times along the northbound and southbound mainline have been compared between the 2027 Reference Case and 2027 Do Something models, with the 2022 Base data present for reference. This is shown in **Figure 9**.

Figure 9: Northbound and southbound journey times – 2022 Base vs 2027 Reference Case vs 2027 Do Something



Journey times tend to increase in line with reduced speeds. Where this is not true is southbound in the PM. This is because MOVA has adjusted timings in response to different arrival profiles and increased the overall green time for the westbound approach to the All Saints Way / Hollyhedge Road junction.

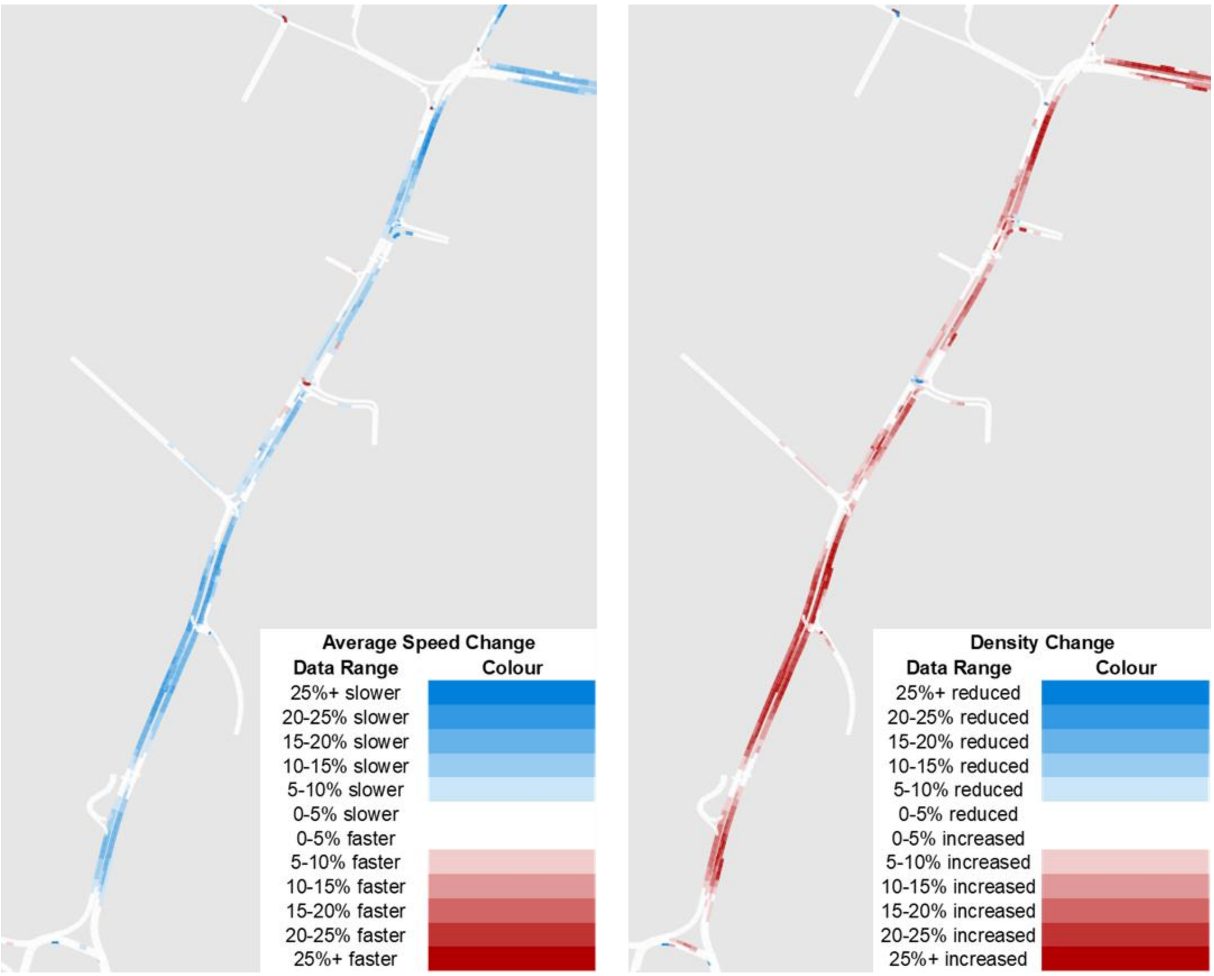
4.2.4 Speed and density

Heatmaps showing the percentage change in average speed and average density have been created to show the difference between the 2027 Reference Case and 2027 Do Something scenarios.

Vehicle density is measured in vehicles per kilometre and gives an indication of how close vehicles are to each other. Density and speed tend to show the opposite of one another, since – all else being equal – a reduction in speed will result in more closely packed vehicles and increased density.

Figure 10, **Figure 11**, **Figure 12** show density and speed change heatmaps for each of the three peak periods.

Figure 10: AM average speed and density change – 2027 Reference Case vs 2027 Do Something

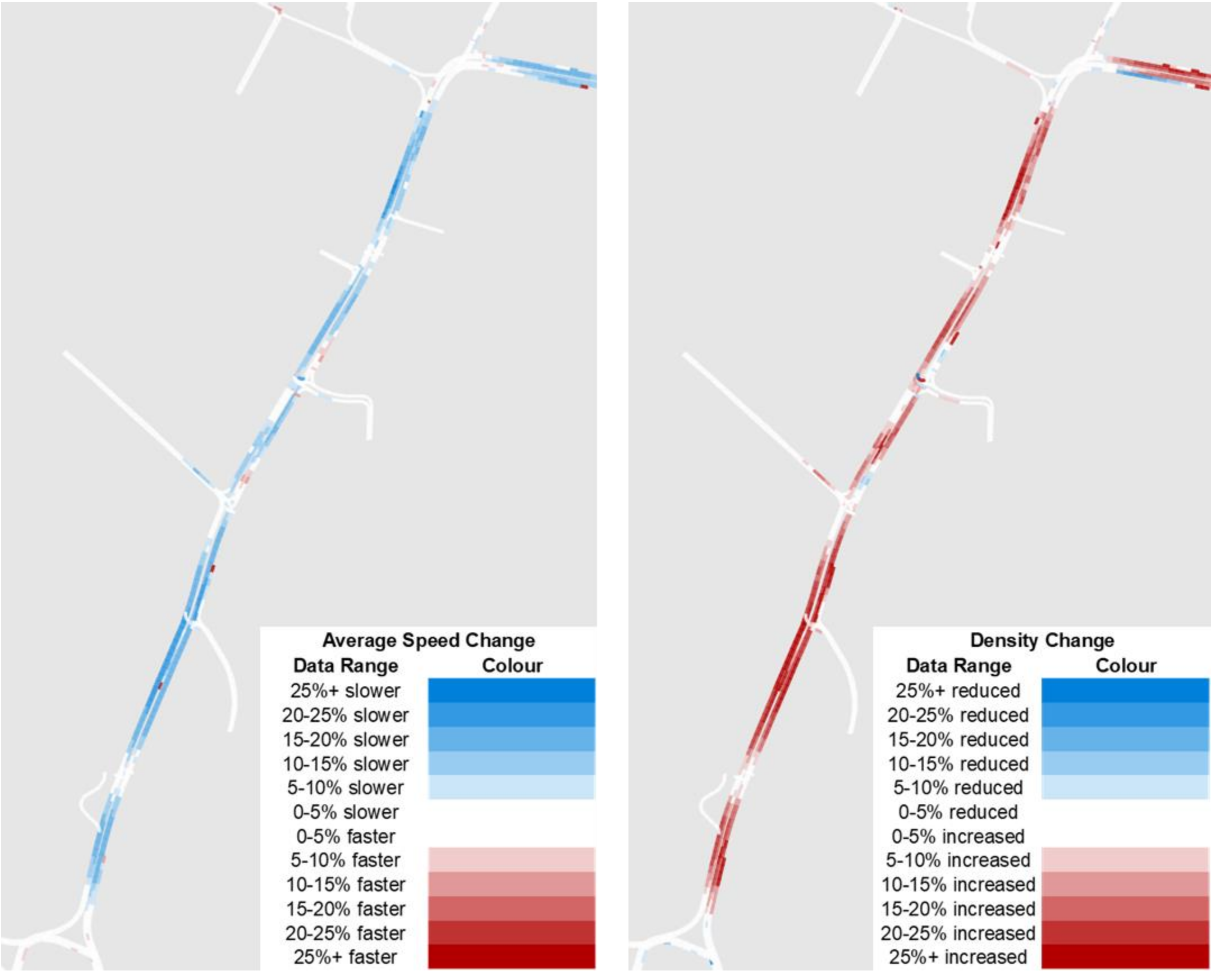


Most notable is the stretch of All Saints Way south of Wilford Road. This is free-flowing in the AM peak and therefore the speed limit reduction has the full effect; cars drive slower and are hence more closely packed.

On Newton Road leaving the modelled area, the 50mph speed limit commences in the same place as in the Base – which is just off the image to the east – so this link also shows the speed reduction.

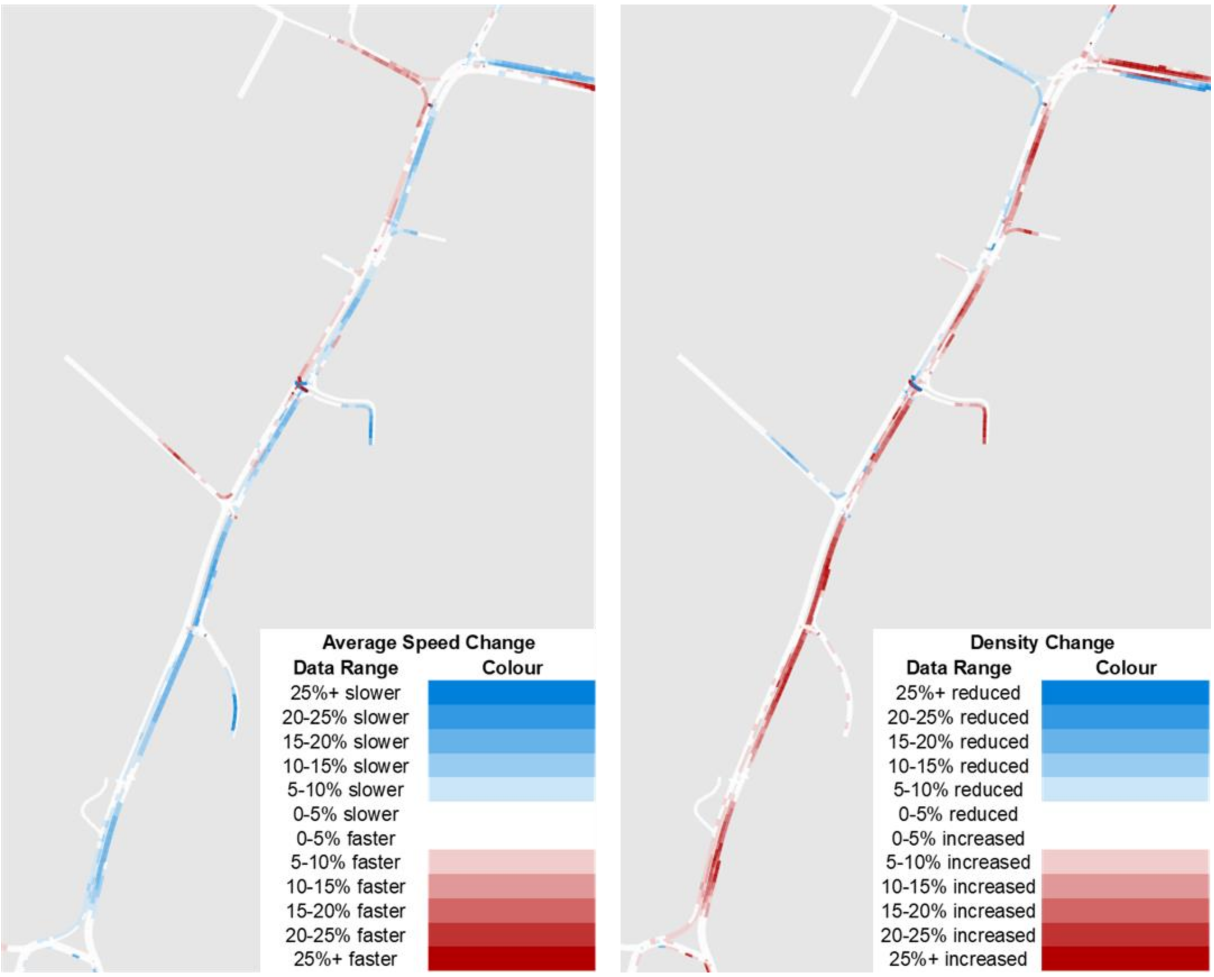
On corners, where vehicles have to slow down anyway, there does not tend to be a change in speed or density.

Figure 11: Interpeak average speed and density change – 2027 Reference Case vs 2027 Do Something



In the interpeak, the network is mostly free-flowing so a large proportion of it shows the impact of the speed reduction.

Figure 12: PM average speed and density change – 2027 Reference Case vs 2027 Do Something



In the PM peak, where there is significant queueing northbound the speed limit change does not affect average vehicle speed. This is because northbound vehicles are, on average, already travelling slower than 30mph.

The southbound mainline still has extensive free-flowing sections, as in the other peaks, where the impact of the speed limit reduction is shown.

Due to signal adjustments made by MOVA at the All Saints Way / Hollyhedge Road junction, increases in average speed can be seen for the northbound left turn and the westbound approach.

5. Traffic Emissions Results

Emissions for nitrogen oxides (NO_x), carbon dioxide (CO_2), and particulate matter of a diameter of <10 µm (PM_{10}) were calculated for the three peak periods (AM, interpeak and PM) for all link segments (≈ 10m stretches of lane) in the modelled network.

The detailed emissions outputs are presented as 'heat maps' in **Appendix B**, showing the relative changes in emissions rates between the different scenarios to indicate the areas with detrimental and beneficial changes.

Specifically, notable features are:

- Reduced emissions on links leaving stop lines, where vehicles accelerate from being stationary up to relatively lower speeds with the proposed speed reduction.
- Increased emissions with the proposed speed reduction in the north-east of the study area, where vehicles accelerate up to the 50mph speed limit from a lower speed.
- Increased emissions on a section of road leading southbound up to the pedestrian crossing in the south-east of the study area where traffic is relatively free-flowing (i.e. is not congested) and so the reduced speed limit leads to a relatively less efficient emissions profile.

5.1 NO_X emissions

Figure 13, **Figure 14**, and **Figure 15** show the total NO_X emissions in each peak hour on the mainline links. Emissions were aggregated over only the links that make up the All Saints Way mainline since this is the focus of the study.

In general, the highest total NOx emissions occurred on the northbound (NB) mainline in the PM peak, and on the southbound (SB) mainline in the AM peak. Total NO_x emissions were very similar in the interpeak in each direction.

In all cases, except for the northbound mainline in the PM peak, total NO_x emissions were lower with the proposed speed reduction than in the 2022 Base scenario. All directions in all peaks showed improvements from the forecast year with no speed reduction (the 2027 Reference Case).

Figure 13: Total NO_x emissions in the AM peak hour on the mainline links

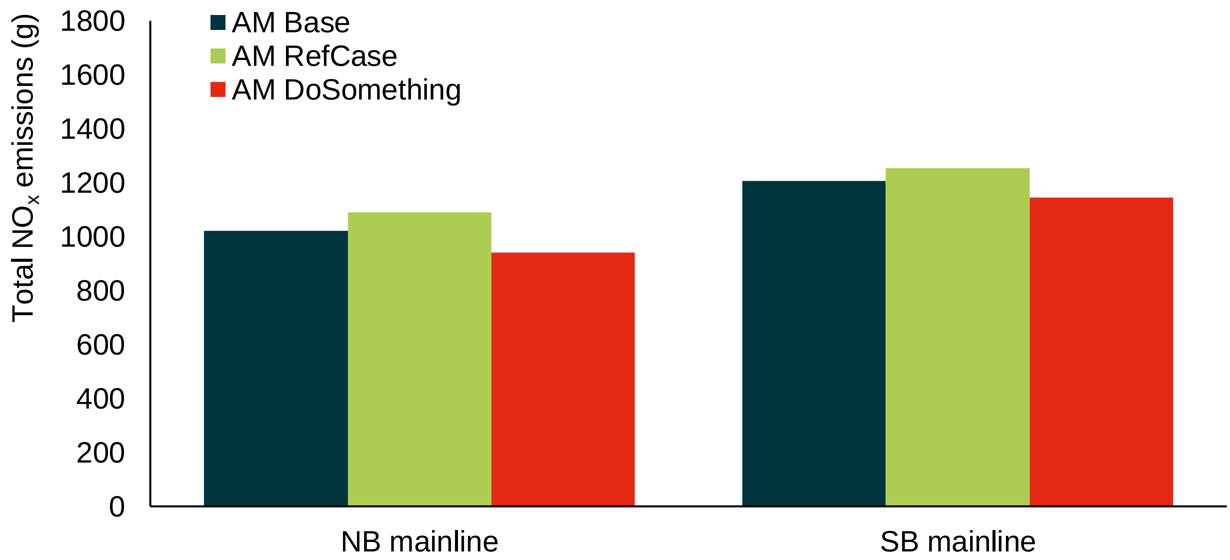


Figure 14: Total NO_x emissions in the interpeak hour on the mainline links

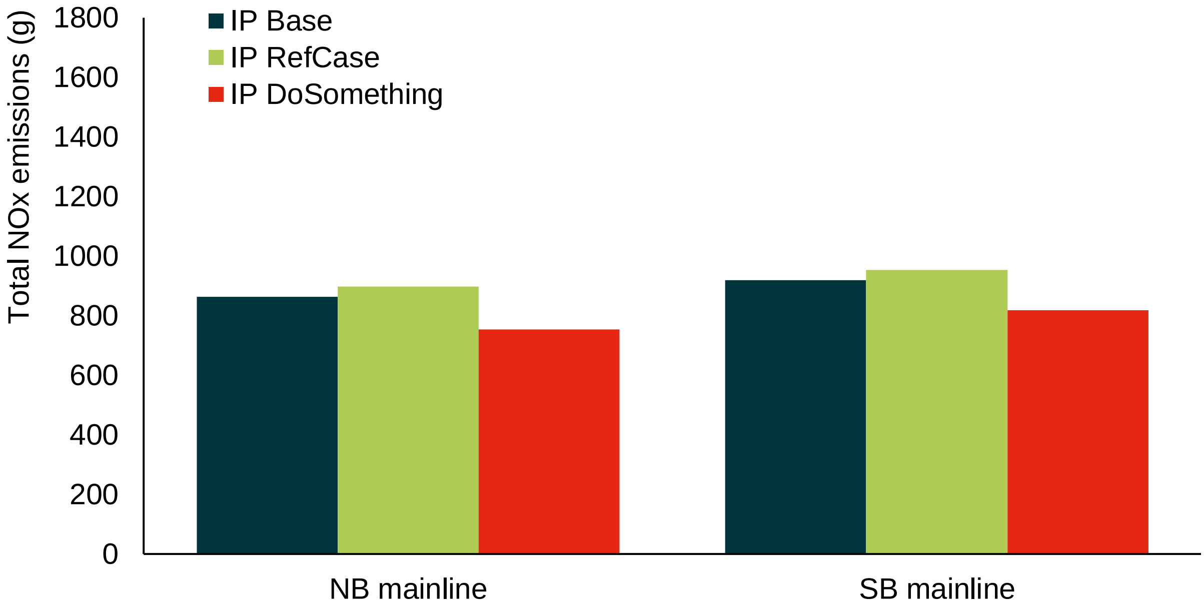
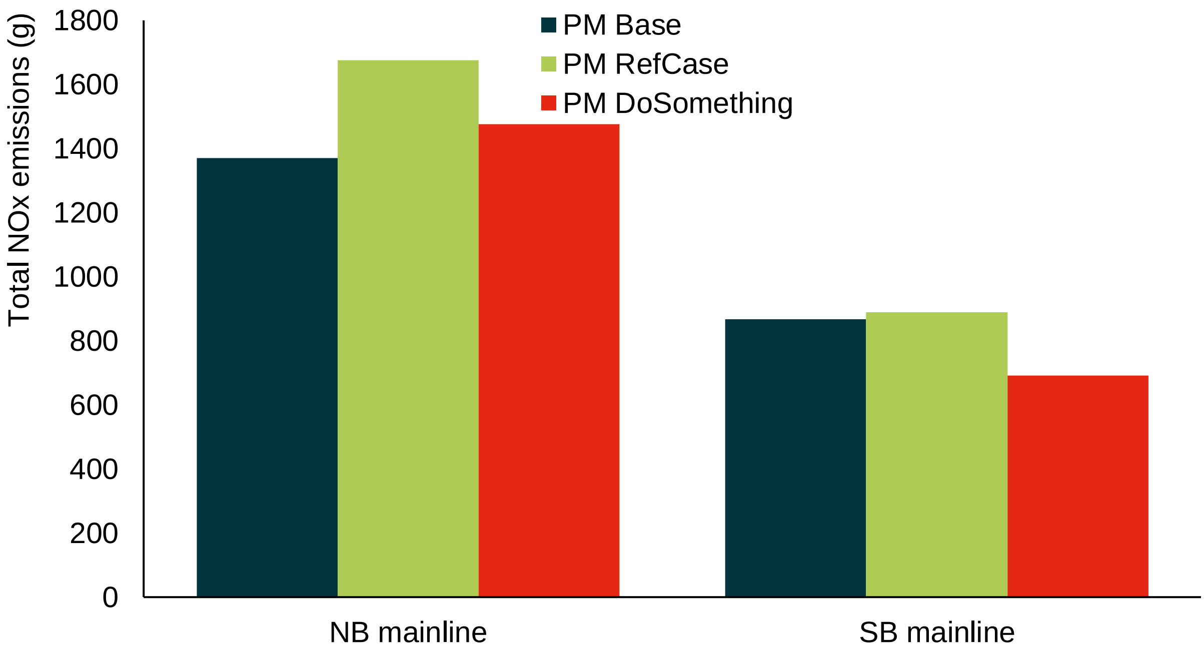


Figure 15: Total NO_x emissions in the PM peak hour on the mainline links



Overall, an increase in NO_x emissions between 4% and 16% was observed in the Reference Case when compared to the Base scenario (**Table 5**). The biggest increase was observed for the PM peak with 16%. However, with the proposed speed limit reduction, a reduction in NO_x emissions between 10% and 15% was predicted. The biggest reduction was observed in the interpeak and the PM peak, of 15%.

Table 5: Change and percentage change in NO_x emissions (g, %)

Period	2022 Base to 2027 Ref. Case	2027 Ref. Case to 2027 Do Something
AM	+115 (+6%)	-222 (-10%)
IP	+64 (+4%)	-255 (-15%)
PM	+322 (+16%)	-350 (-15%)

5.2 Particulate Matter (PM_{10}) emissions

Figure 16, **Figure 17**, and **Figure 18** show the total PM_{10} emissions in each peak hour on the mainline links.

The particulate matter (PM) emissions shown here are from the exhaust only and do not include non-exhaust emissions (NEE), such as tyre abrasion. However, the changes in speed were relatively small, and so it is not expected that a significant change in NEE would occur.

In general, the highest total PM_{10} emissions occur on the northbound mainline in the PM peak, and on the southbound mainline in the AM peak. Total PM_{10} emissions of both mainlines were very similar in the interpeak.

In all cases the 2027 Do Something total PM_{10} emissions are lower than in the 2027 Reference Case scenario. The change between the total modelled PM_{10} emissions in the 2022 Base and 2027 Do Something scenarios varies between time periods:

- AM peak - 2027 Do Something scenario is marginally higher than the 2022 Base in both directions
- Interpeak - 2027 Do Something scenario lower than the 2022 Base scenario in both directions
- PM peak - 2027 Do Something scenario is higher than the 2022 Base northbound and lower southbound

Figure 16: Total PM_{10} emissions in the AM peak hour on the mainline links

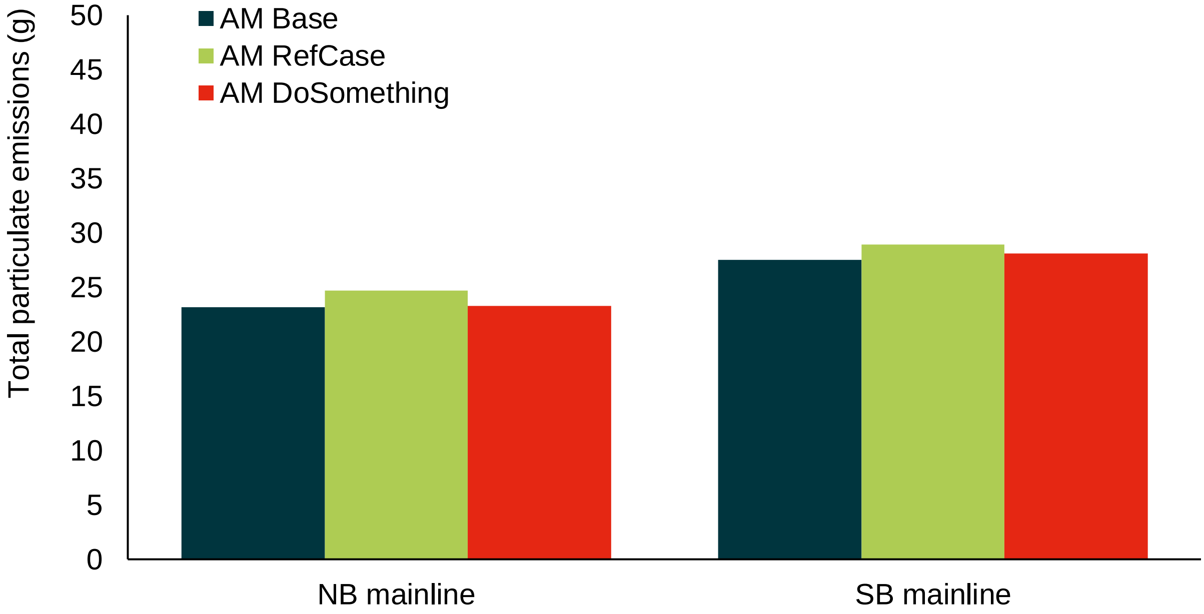


Figure 17: Total PM_{10} emissions in the interpeak hour on the mainline links

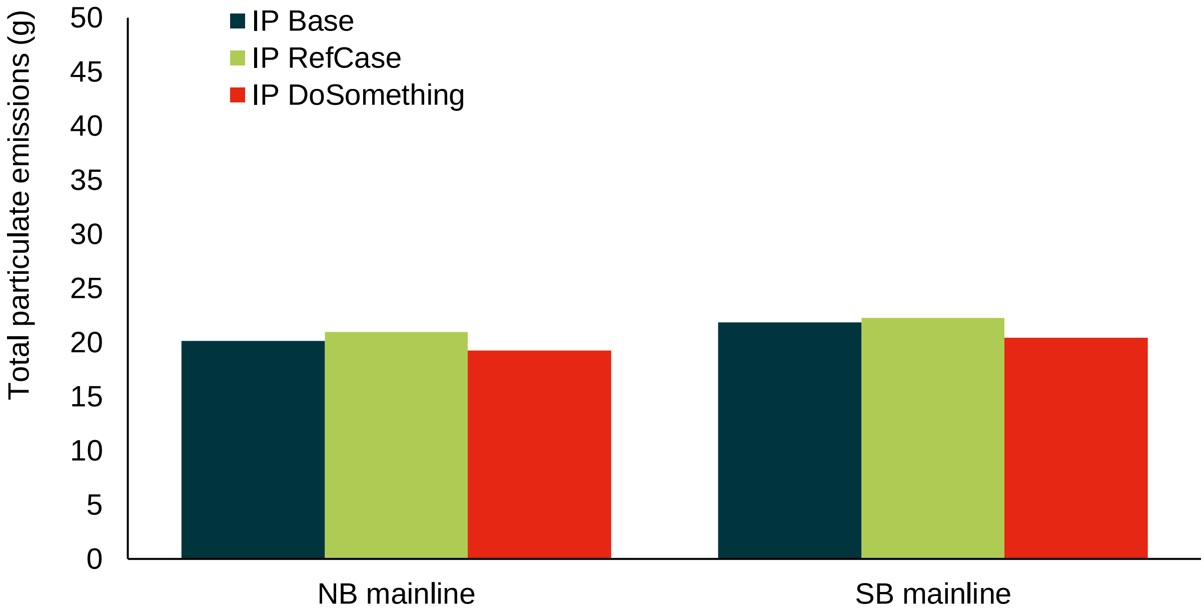
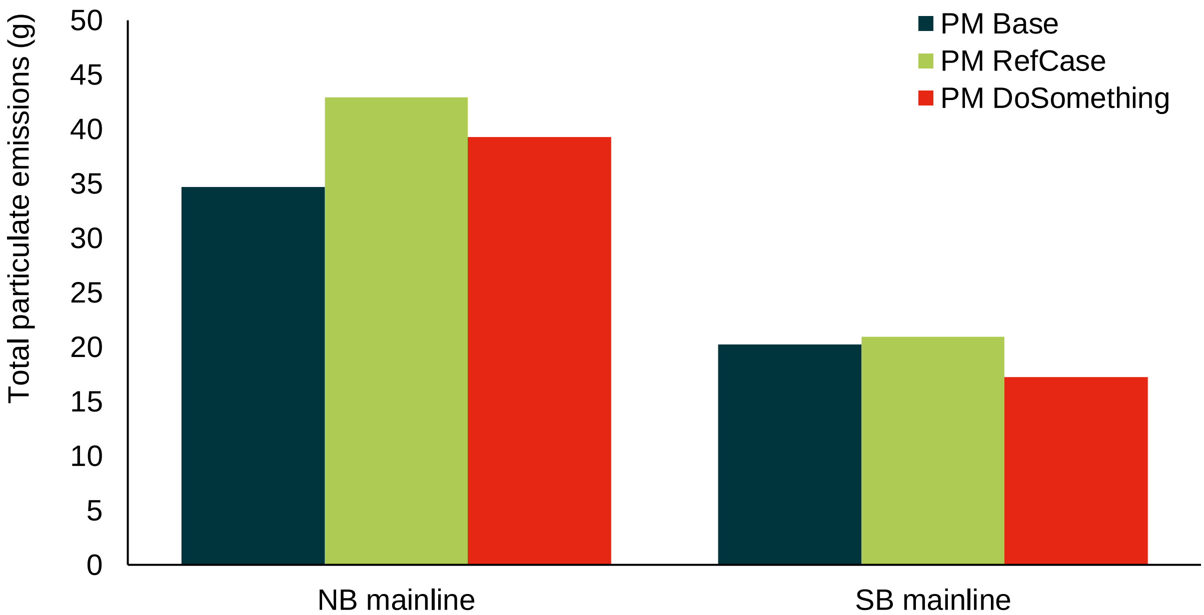


Figure 18: Total PM_{10} emissions in the PM peak hour on the mainline links



Overall, an increase in PM_{10} emissions between 3% and 18% was observed in the 2027 Reference Case when compared to the 2022 Base scenario (**Table 6**). The biggest increase was observed for the PM peak with 18%. However, with the proposed speed limit reduction, a reduction in PM_{10} emissions between 4% and 11% was predicted.

Table 6: Change and percentage change in PM_{10} emissions (g, %)

Period	2022 Base to 2027 Ref. Case	2027 Ref. Case to 2027 Do Something
AM	+2.9 (+6%)	-1.9 (-4%)
IP	+1.1 (+3%)	-3.2 (-8%)
PM	+8.9 (+18%)	-6.7 (-11%)

5.3 CO_2 emissions

Figure 19, **Figure 20**, and **Figure 21** show the total CO_2 emissions in each peak hour on the mainline links.

In general, the highest total CO_2 emissions were predicted to occur on the northbound mainline in the PM peak, and on the southbound mainline in the AM peak. Total CO_2 emissions of both mainlines were very similar in the interpeak.

In all cases, except for the northbound mainline in the PM peak, total CO_2 emissions were predicted to be lower in the 2027 Do Something scenario than in the 2022 Base scenario.

Figure 19: Total CO_2 emissions in the AM peak hour on the mainline links

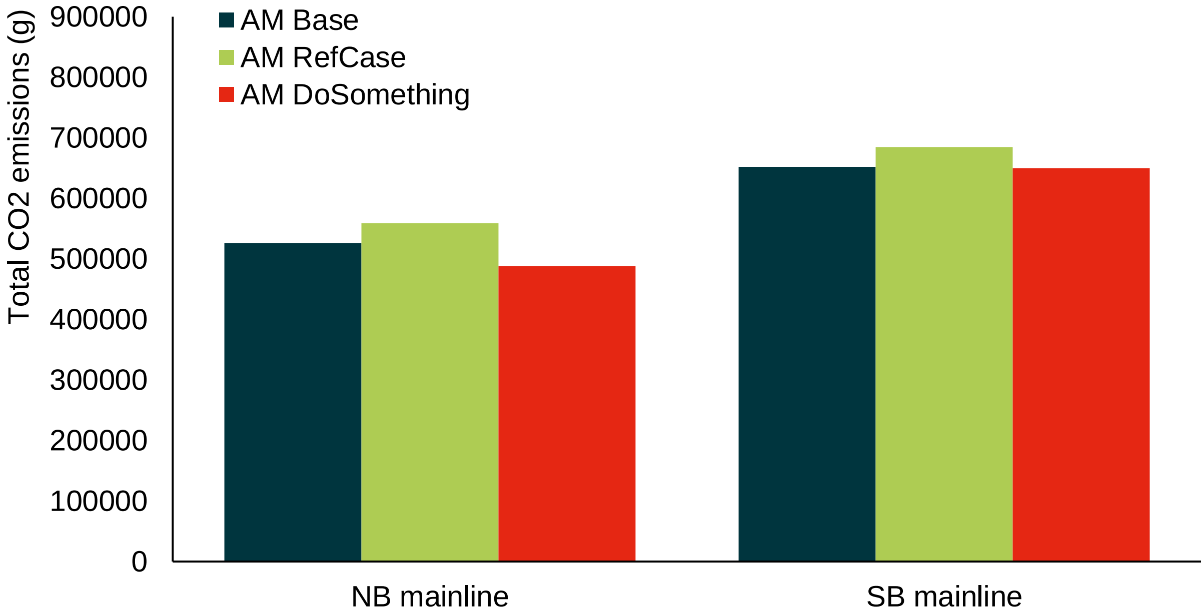


Figure 20: Total CO_2 emissions in the interpeak hour on the mainline links

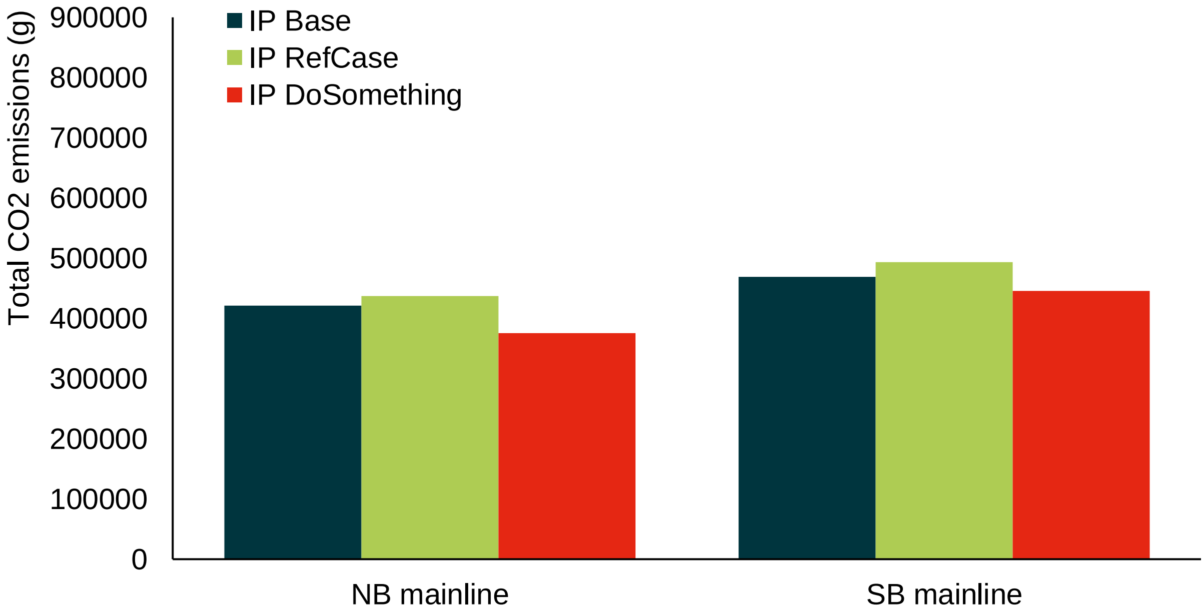
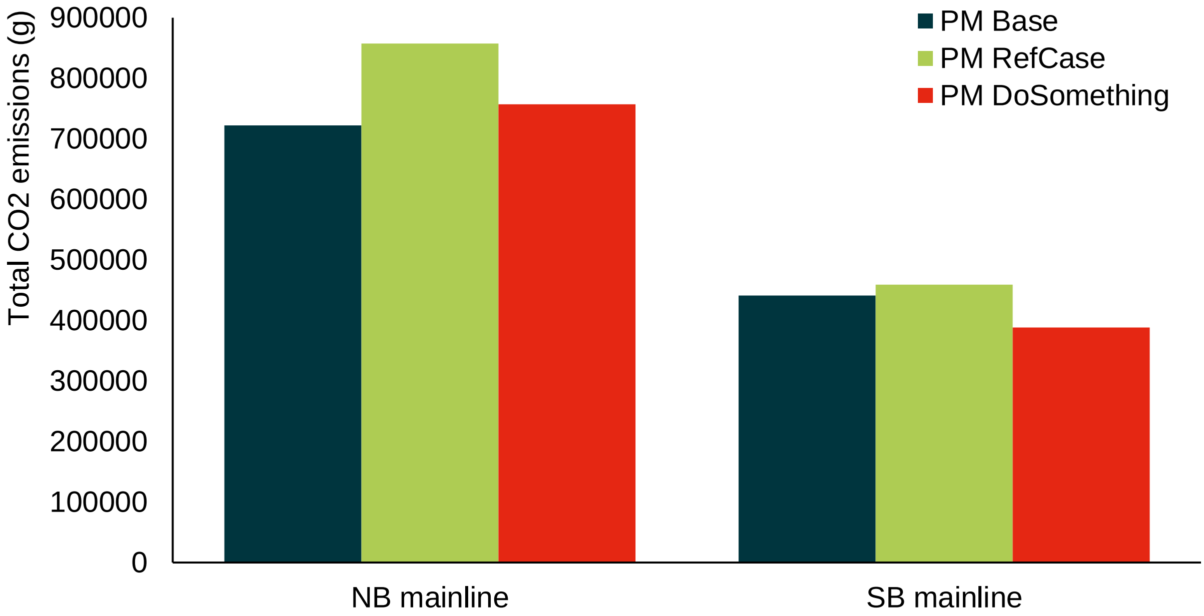


Figure 21: Total CO_2 emissions in the PM peak hour on the mainline links



Overall, an increase in CO_2 emissions between 5% and 14% was observed in the 2027 Reference Case when compared to the 2022 Base scenario (**Table 7**). The biggest increase was again predicted for the PM peak with 14%. However, with the proposed speed limit reduction, a reduction in CO_2 emissions between 8% and 12% was predicted.

Table 7: Change and percentage change in CO_2 emissions (g, %)

Period	2022 Base to 2027 Ref. Case	2027 Ref. Case to 2027 Do Something
AM	+65 (+6%)	-90 (-8%)
IP	+38 (+5%)	-99 (-12%)
PM	+152 (+14%)	-150 (-12%)

5.4 Total annual emissions

Total daily (24-hour) emissions from the modelled network were estimated by scaling the individual periods based on 3-hours for the AM and PM, and 6-hours for the interpeak. A factor for the emissions during the 12-hour off-peak (OP) period was estimated based on the traffic count for the corresponding period in the interpeak and the assumption that traffic conditions would be broadly similar. The total annual emissions were scaled up from the daily emissions.

Figure 22, **Figure 23**, and **Figure 24** show the total annual emissions for NO_x, PM_{10}, and CO_2.

Figure 22: Total annual emissions for NO_x

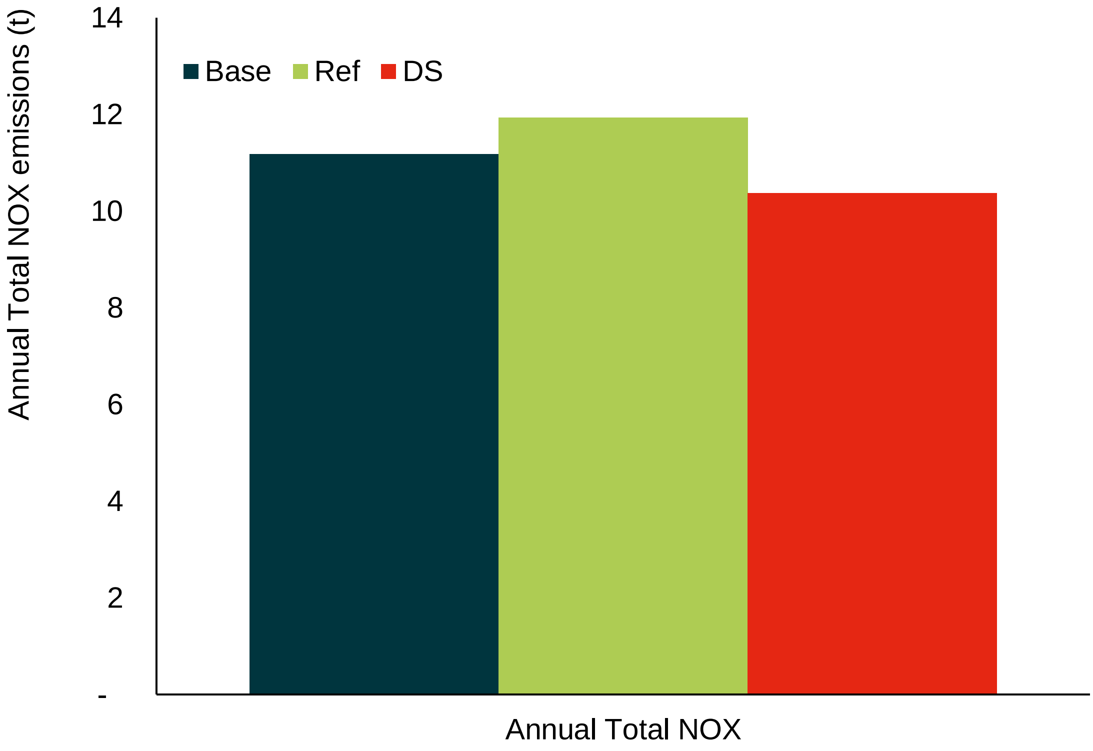


Figure 23: Total annual emissions for PM_{10}

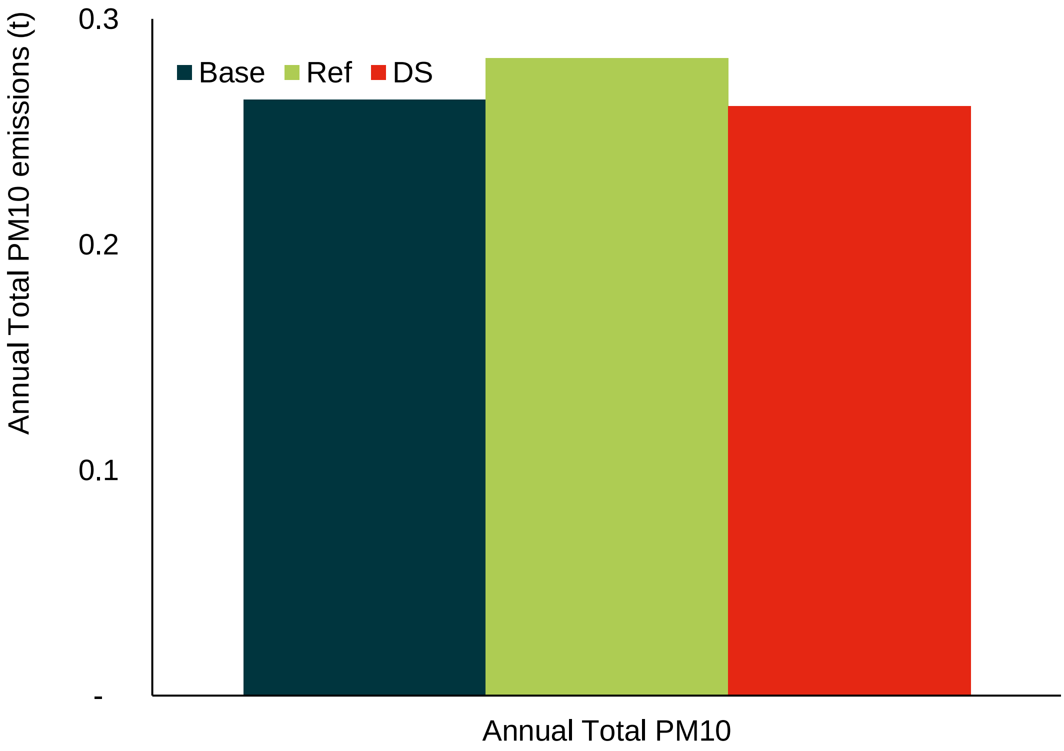
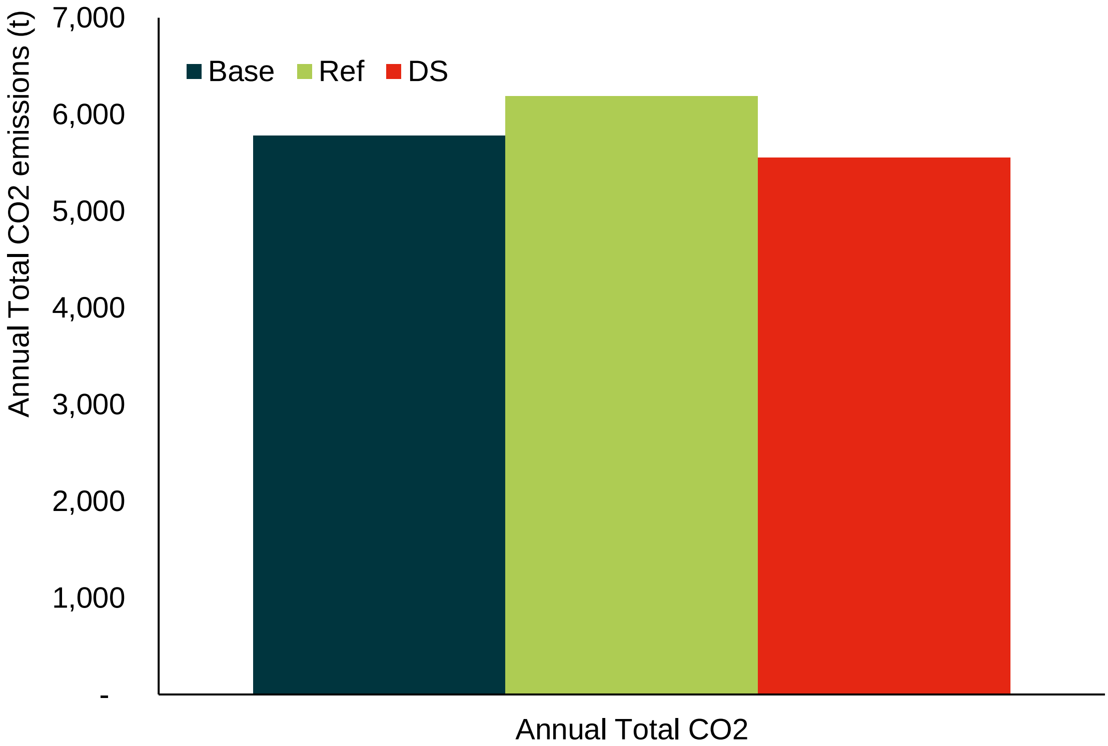


Figure 24: Total annual emissions for CO_2



The 2027 Reference Case scenario showed a 7% increase of total annual emissions for all three pollutants compared to the 2022 Base scenario (**Table 8**). The 2027 Do Something scenario, with proposed speed limit reduction, showed a reduction of between 8% to 13% of total annual emissions compared to the 2027 Reference Case with no speed change. The largest relative reduction of 13% was observed for total annual NO_x emissions.

Table 8: Change in total annual emissions for CO_2, NO_x and PM_{10}

	CO_2	NO_x	PM_{10}
2027 Reference Case vs 2022 Base	107%	107%	107%
2027 Do Something vs 2027 Reference Case	90%	87%	92%

5.5 Emissions source apportionment

The emissions were calculated for subsets of the total vehicle fleet and were disaggregated into the major components to understand more about how these sources contribute to the total emissions:

- Light-duty vehicles (LDVs), comprising cars, vans and motorcycles;
- Buses; and
- Heavies, comprising articulated and rigid heavy goods vehicles (>3.5t, HGV).

Figure 25, **Figure 26**, and **Figure 27** show the overall source apportionment for NO_x, PM_{10} and CO_2.

Overall, the source apportionment showed little variation between the different scenarios. LDVs were predicted to contribute the largest proportion of CO_2, NO_x, and PM_{10} emissions. However, buses and heavies do still have a notable contribution that is disproportionate to their proportion of the study area's fleet. This is due to buses and heavies having higher emission rates per vehicle.

Figure 25: Total emissions – source apportionment for NO_x

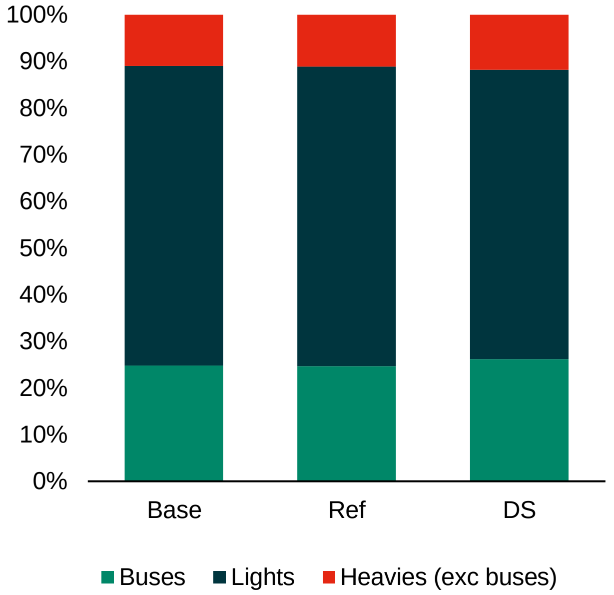


Figure 26: Total emissions – source apportionment for PM_{10}

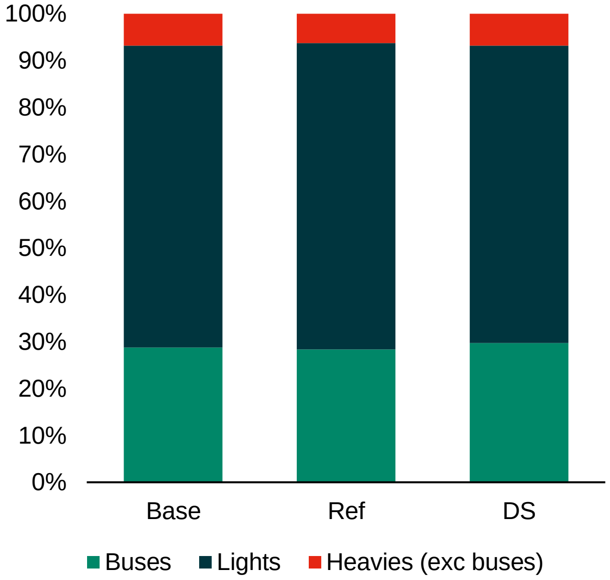
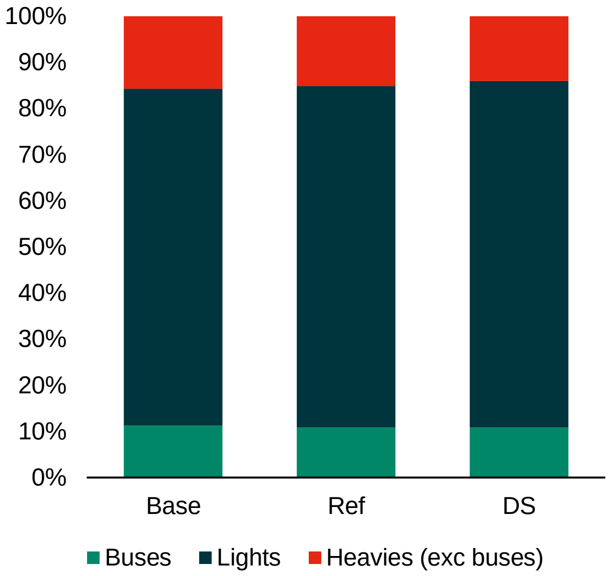


Figure 27: Total emissions – source apportionment for CO_2



The emissions from the overall network were further disaggregated into sections of the mainline carriageway between junctions, to simplify the interpretation compared to the heat-maps.

Figure 28 shows the corridor sections of the mainline links.

The 2022 Base annual total CO_2 emission apportionment showed little variation between the different corridor sections (**Figure 29**). However, the NO_x emission apportionment for buses varied substantially between the different corridor sections (**Figure 30**), this is likely related to bus stops being present in the corridor sections, generating high bus emissions.

Figure 28: Corridor sections of the mainline links

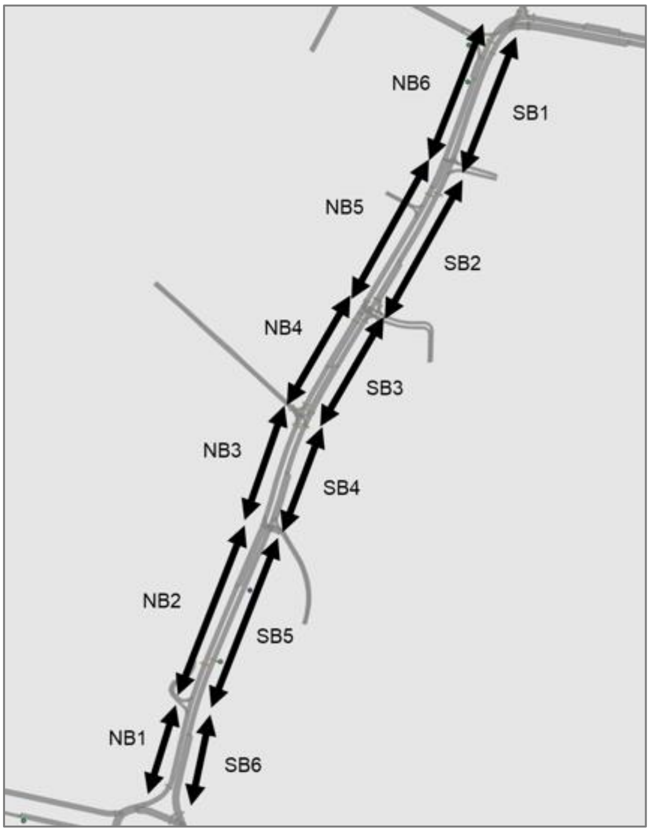


Figure 29: 2022 Base annual total CO_2 emission apportionment for the different corridor sections

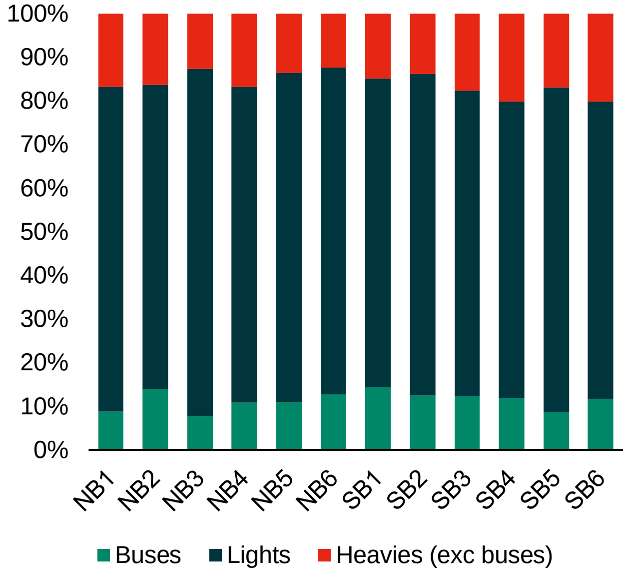


Figure 30: 2022 Base annual total NO_x emission apportionment for the different corridor sections

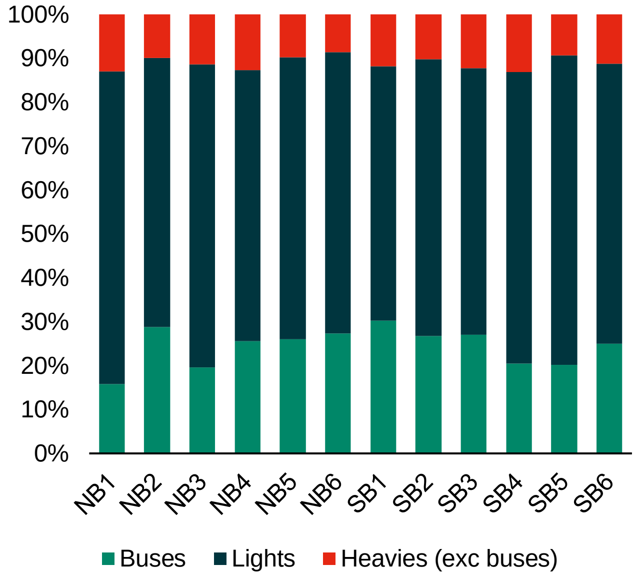


Table 9 shows the change in source apportionment for the different corridor sections between the 2027 Reference Case and the 2027 Do Something.

Overall, the total impacts of CO_2, NO_x and PM_{10} were predicted to be beneficial for all corridor sections except for SB6, which exhibited an overall detrimental impact for all three pollutants and time periods. SB6 comprised southbound traffic leaving the network onto the signal-controlled roundabout.

NB3, SB5 and SB6 also showed detrimental impacts in specific vehicle classes i.e. HGVs, buses and HGVs, and LDVs, respectively.

SB5 indicated complexity in the source apportionment for all three pollutants and time periods in non-congested conditions, where increased emissions likely result from the traffic behaviour at the pedestrian crossing located within SB5. The traffic was relatively free flowing in this section and so the reduced speed limit contributed to a less efficient emissions profile.

Table 9: Change in source apportionment for corridor sections between 2027 Reference Case and 2027 Do Something

	CO_2				NO_X				PM_{10}			
	Buses	LDV	HGV	Total	Buses	LDV	HGV	Total	Buses	LDV	HGV	Total
NB1	0.79	0.82	0.72	0.81	0.82	0.80	0.72	0.80	0.94	0.90	0.86	0.91
NB2	0.75	0.84	0.55	0.79	0.84	0.82	0.69	0.81	0.93	0.91	0.81	0.91
NB3	1.01	0.99	1.07	1.001	0.95	0.96	1.11	0.97	0.97	0.97	1.07	0.98
NB4	0.95	0.89	0.85	0.89	0.96	0.85	0.94	0.89	0.97	0.92	0.96	0.94
NB5	0.90	0.88	0.82	0.87	0.91	0.82	0.93	0.86	0.95	0.89	0.97	0.91
NB6	0.87	0.98	0.88	0.95	0.87	0.93	1.02	0.92	0.93	0.95	0.99	0.95
SB1	0.92	0.88	0.73	0.86	0.95	0.77	0.75	0.82	1.00	0.89	0.94	0.93
SB2	0.93	0.91	0.88	0.90	0.94	0.83	0.96	0.87	0.98	0.85	1.03	0.90
SB3	0.92	0.89	0.81	0.88	0.95	0.80	0.91	0.85	0.96	0.88	0.97	0.91
SB4	0.56	0.77	0.59	0.71	0.58	0.65	0.69	0.64	0.92	0.78	0.94	0.82
SB5	1.09	0.94	1.03	0.97	1.10	0.80	1.23	0.90	1.09	0.84	1.22	0.92
SB6	0.95	1.13	0.96	1.07	0.95	1.03	1.17	1.03	0.99	1.02	1.03	1.01
Sum	0.89	0.90	0.83	0.89	0.91	0.83	0.92	0.86	0.97	0.89	1.00	0.92

5.6 Local air quality

SMBC undertake non-continuous air quality monitoring at locations across the district, including three sites adjacent to All Saints Way.

SMBC also undertake monitoring using a low-cost analyser (**Figure 31**). However, this was undertaken only for part of 2022. It was excluded from the projection due to negative Road NO_x concentrations when adjusted using background concentrations, which was potentially due to the Zephyr under-recording NO_2 concentrations. This conclusion was derived as the Defra background concentrations compare to local urban background concentrations from automatic monitoring stations for 2019.

The oxides of nitrogen (NO_X) include the total concentrations of NO (nitric oxide) and NO_2 (nitrogen dioxide). The conversion between those two species is rapid in the atmosphere and the ratio of NO to NO_2 is determined by the intensity of ultraviolet (UV) light which converts NO_2 to NO and the concentration of ozone which reacts with NO to form NO_2.

The annual mean NO_2 concentrations recorded in 2019 were the last 'typical' year of data prior to the COVID-19 pandemic. The annual mean road-NO_X concentration in 2019 was calculated using Defra backgrounds[2] and the NO_x to NO_2 Calculator v8.1[3].

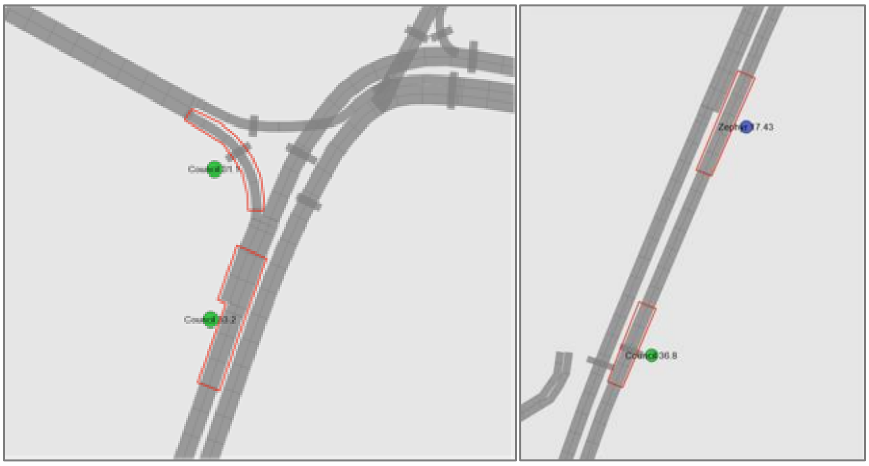
- The 2019 annual mean road-NO_X concentrations were projected forwards to the 2027 Reference Case and 2027 Do Something scenarios using the proportional changes in road-source NO_X emissions on the nearest adjacent links.
- The resultant annual mean NO_2 concentrations in the 2027 future year scenarios were then estimated using the projected background concentrations and the NO_x to NO_2 Calculator v8.1.

These data are shown in **Table 10**.

In the 2027 Do Something scenario a reduction of annual mean roadside NO_2 concentrations between 0.1 and 1.6 µg/m³ was predicted, compared to the 2027 Reference Case scenario.

[2] Department for Environment, Food & Rural Affairs, Background Map. Available at: Background Maps | LAQM (defra.gov.uk) Accessed 30/03/2023
[3] Department for Environment, Food & Rural Affairs, NO_x to NO_2 Calculator. Available at: NOx to NO2 Calculator | LAQM (defra.gov.uk) Accessed 30/03/2023

Figure 31: Location NO_2 monitoring and adjacent model links



Note: Diffusion tube monitoring in green highlight, automatic Zephyr monitoring in blue highlight.

Table 10: Impacts to annual mean NO_2 and road-NO_X concentrations, µg/m^3

	Annual Mean, 2019			Annual Mean Road NO_X, 2027		Annual Mean NO_2, 2027			
ID	Monitored NO_2	Background NO_2	Road NO_X	Ref Case	Do Some	Background	Ref Case	Do Some	Ref Case vs Do Some
C2A	33.2	18.9	28.6	32.1	32.0	14.3	30.3	30.2	-0.1
C2E	31.1	18.9	24.2	24.6	23.7	14.3	26.8	26.3	-0.4
C1D	36.8	22.0	30.0	30.8	27.3	17.3	32.5	30.9	-1.6

6. Summary and Conclusions

6.1 Summary

The 2022 Vissim microsimulation Base models have been used to assess 2027 Reference Case and 2027 Do Something scenarios in the AM peak, interpeak, and PM peak on the A4031 All Saints Way corridor. The purpose of the modelling was to assess the impact of reducing the speed limit along the corridor from 40mph to 30mph.

The 2022 Base model was developed, calibrated and validated, as outlined in the LMVR, for this purpose. The Base model has been used to create 2027 Reference Case models – which include approximately 5% traffic growth – and 2027 Do Something models – which include the 5% traffic growth and proposed speed limit reduction.

Fleet breakdown assumptions used as an input for traffic emissions modelling have been based on analysis of 2022 ANPR survey data. Consistent fleet breakdown assumptions have been retained for all 2022 Base and 2027 future year scenarios. The integrated Bosch emissions module has been used to estimate traffic emissions within Vissim and output for 10 metre segments along the corridor.

6.2 Key outputs

The modelled impact on 2022 Base network operation with the forecast 2027 Reference Case traffic demand is:

- Mainline throughput increases by around 5% except for northbound in the PM, reflecting existing congestion in this time period and direction.
- Average speed reduces in all peaks, most of all in the PM which sees a 20% decrease. This decrease is focused on the northbound mainline south of Wilford Road.
- The PM 2027 Reference Case model shows almost 300 unreleased vehicles, mostly on the approach to Cronehills Interchange, and the AM shows a small number on Hollyhedge Road.
- Journey times see an increase in the 2027 Reference Case model in the PM peak, and more modest increases in the other two time periods.

The models show the proposed reduced speed limit in the 2027 Do Something forecast year results in:

- Negligible effect on mainline throughput which increases by less than 1% in all peaks.
- Reduction in average speeds on the mainline by 13% in the AM and interpeak and by 11% in the PM.
- Unreleased vehicles reduce in the 2027 Do Something model in AM and PM peaks. This is a result of the marginal improvements in junction throughput due to increased traffic density at lower speeds and variability in the operation of MOVA controlled signals.
- Journey times increase in both directions in all peaks due to the reduced vehicle speed.

The emission outputs during each peak period show:

- The highest emissions in all three pollutants were estimated on the southbound mainline in the AM and in the northbound mainline in the PM in all three scenarios.
- For all pollutants, the 2027 Reference Case scenario showed that modelled emissions increase compared to the 2022 Base scenario (between 3% and 18%) with the highest increases always observed in the PM peak.
- The 2027 Do Something scenario showed reduced modelled emissions compared to the 2027 Reference Case scenario of between 4% and 15%, with the highest reductions always observed in the PM peak and for NO_x and CO_2 also in the interpeak.
- The 2027 Do Something scenario indicated reduced modelled emissions compared to the 2022 Base scenario in both directions in AM peak and Interpeak and southbound in the PM peak,

albeit noting the emissions model assumed no change to the future year traffic fleet which may otherwise contribute to an emissions reduction compared to the existing baseline due to the adoption of new, lower-emissions vehicles.

In terms of total annual emissions, a reduction of between 8% to 13% of total annual emissions is estimated when the proposed speed reduction is implemented with forecast 2027 traffic demand, by comparing the 2027 Do Something and 2027 Reference Case scenarios.

The source apportionment showed little variation between the different scenarios:

- Light-duty vehicles were the major source of CO_2, NO_x and PM_{10} emissions.
- For different corridor sections the NO_x emission apportionment for buses varied substantially, which was likely related to bus stops being present in the corridor sections with higher bus emissions.
- The total modelled emissions in the 2027 Do Something scenarios were generally lower than the 2027 Reference Case for every corridor section with the exception of SB6, which comprised southbound traffic leaving the network onto the signal-controlled roundabout.

The effects on local air quality were calculated by using Defra backgrounds and the NO_x to NO_2 calculator v8.1.

In terms of local air quality:

- The impact of the scheme on roadside NO_2 concentrations was estimated to be beneficial in most areas.
- A small reduction of roadside NO_2 concentrations between 0.1 and 1.6 µg/m³ was shown with the 2027 Do Something compared to the 2027 Reference Case scenario.

6.3 Conclusions and next steps

This assessment has indicated that reducing the speed limit on A4031 All Saints Way could result in overall lower traffic emissions in 2027.

Benefits were specifically identified in congested conditions and in acceleration zones, such as after stop lines. Some potential detrimental effects were identified in free-flow conditions where lower speed limits would contribute to less efficient drive cycles and slightly higher emissions but over the full corridor the modelled emissions were consistently lower in the 2027 Do Something than the respective 2027 Reference Case scenarios.

It should be noted that the corridor model is based on fixed traffic demand and does not forecast modal shift, peak spreading, or consider alternative routing options outside of the model network. The impact of a future changes in congestion beyond the network extents has not been considered and there have been no changes to the traffic signal control MOVA database to reflect the changed driving behaviour on the approach to the stop lines.

The generalisation that reducing speed limits reduces emissions would require further testing to determine whether it is true in all possible situations. While it has been shown that – in a corridor model with multiple delay points – emissions savings are easy to achieve, this conclusion cannot be applied to other types of model, such as motorways or rural settings.

Sensitivity tests could be undertaken to further investigate the potential scheme impacts. This could include updated estimates of fleet turnover or testing more distant future projections.

The microsimulation model would be an appropriate tool to support the impact assessment of other potential schemes – such as updated MOVA datasets, signal coordination, alternative traffic flow forecasts, active travel facilities, or carriageway redesign. Any assessment could again consider the impact on both network operation and traffic emissions.

Appendix A – ANPR Fleet Analysis

An Automatic Number Plate Recognition (ANPR) survey was undertaken on A4031 All Saints Way, Sandwell in November 2022 to record the breakdown of vehicle classifications on this road. These data have been used to inform the calculation of exhaust emissions from a microsimulation traffic model.

The survey was undertaken at seven locations and every count recorded was included in the analysis. This means the fleet breakdown will bias those vehicles that passed through more than one count location but this should not alter the validity of the overall fleet breakdown.

The ANPR survey recorded the following fuel types for car, LGV (light good vehicle; i.e. vans), HGV (Heavy Goods Vehicle; i.e. wagons) recorded as Rigid and Articulated, and PSV (Public Service Vehicles; i.e. buses):

- Petrol,
- Diesel,
- Petrol / Hybrid Electric (HEV, including plug-in; PHEV),
- Diesel / Hybrid Electric (HEV, including plug-in; PHEV),
- Petrol / Bioethanol,
- Petrol / LPG (Liquid Petroleum Gas),
- Electric (battery electric vehicle; BEV),
- Other (non-significant fraction of alternative fuel types), and
- Unclassified (partial plate records or otherwise not available in the DVLA database).

There were a significant number of 'unclassified' buses, and so these were classified as 'diesel', which is consistent with a detailed breakdown and expected projections for bus fleets in the wider West Midlands area[4].

Where the ANPR records did not include specific breakdown necessary for inclusion in the microsimulation traffic model, such as LGV size classification, then it was based on the data in the Defra Emissions Factors Toolkit (EFT) v11[5], which is the standard tool for emissions modelling in the UK and includes fleets derived from DfT data[6].

It should be noted the current version (v11) of the EFT was published in 2021 and based on 2019 DfT fleet projections. It does not include the latest effects resultant from post-COVID impacts, nor the fuel technology projections published in the TAG Data Book v1.19[7], nor the scenarios published in the National Road Traffic Projections 2022[8]. Therefore, the national fleet breakdown in the EFT is expected to underestimate the uptake of electrified vehicles.

A.1 Vehicle Classification and Fuel Technology

The majority of vehicles recorded in the survey were cars (83%) followed by LGVs (12.2%).

HGVs comprised 1.5% of counts, and buses 1.7%.

The proportions recorded by the ANPR survey were broadly similar to those published in the EFT, as indicated in **Figure A32**.

[4] WMCA (2019) West Midlands Combined Authority Regional Air Quality Review and Action Plan https://www.sustainabilitywestmidlands.org.uk/wp-content/uploads/2022/11/WMCA_Regional-Air-Quality-Review-and-Action-Plan_v5.pdf

[5] Defra (2021) Emissions Factors Toolkit https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/#:~:text=Emissions%20Factors%20Toolkit%201%20Overview%20The%20Emissions%20Factors,Version%20Documents%20...%203%20Previous%20Version%20Documents%20

[6] NAEI (2019) vehicle fleet composition projections https://naei.beis.gov.uk/data/ef-transport

[7] DfT (2022) TAG Data Book https://www.gov.uk/government/publications/tag-data-book

[8] DfT (2022) National Road Traffic Projections https://www.gov.uk/government/publications/national-road-traffic-projections

In terms of car fuel technology, the majority of counts were petrol (48.5%) and diesel (40.6%), whilst hybrid (HEV and PHEV) comprised 8.9% of counts, which is not insignificant and demonstrates adoption of new technology, although zero-emission BEV were still relatively insignificant.

It should be noted that HEV and PHEV are not zero-emission vehicles as they use both electric and combustion (ICE; internal combustion engine) technologies, albeit tending to favour electric drive at low speeds and for short journeys.

These proportions were also similar to those published in the EFT, as shown in **Figure A33**.

Figure A32: Vehicle classification, ANPR and EFTv11, 2022

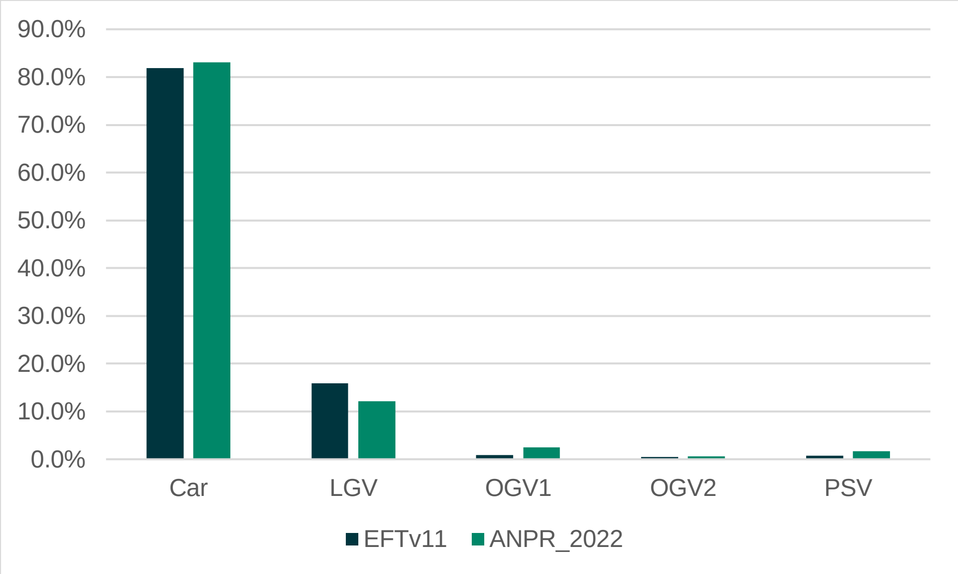
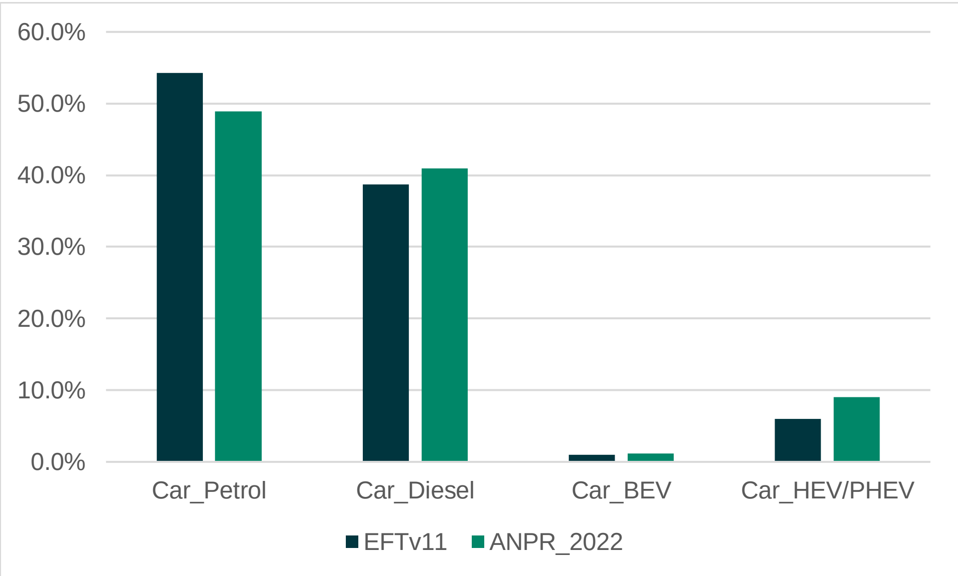


Figure A33: Car fuel technology, ANPR and EFTv11, 2022



A.2 Euro Classification

The Euro classification is based on the vehicle age and reflects compliance with increasingly stringent emissions standards in newer vehicles. Light-engine vehicles (cars and LGV) use a numerical system, whereas heavy-engined vehicles (HGV and PSV) use numerals.

Petrol cars are distributed mostly between Euro 4, 5, and 6, with 46.8% compliant with Euro 6 standards. Diesel cars have a much larger Euro 5 proportion (38.4%) although it is slightly less than Euro 6 (40.1%).

In each case, the proportion of Euro 6 cars was significantly lagging behind the proportions defined in the EFT for the national car fleet, and particularly for the latest Euro 6c classification. The fleet recorded in the count specifically also included a relatively large Euro 4 component for both petrol and diesel.

These data are shown in **Figure A34** and **Figure A35**.

Figure A34: Petrol car Euro classification, ANPR and EFTv11, 2022

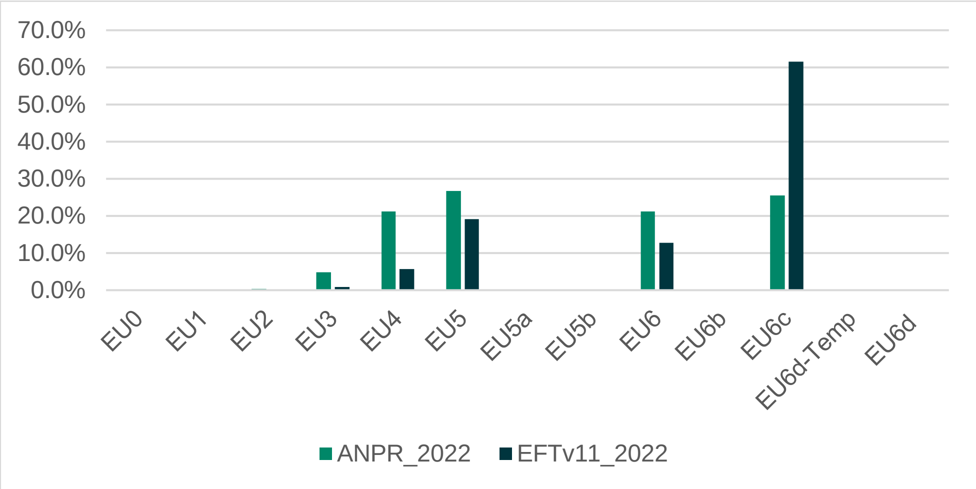
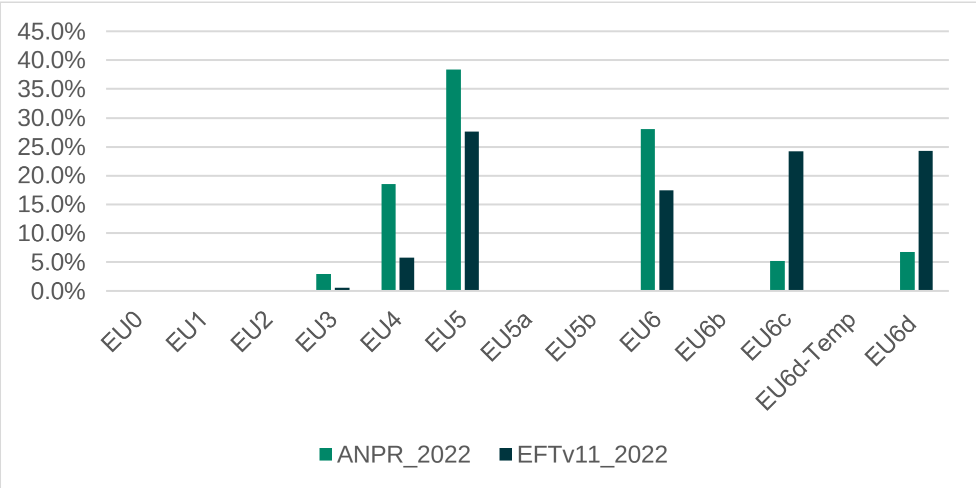


Figure A35: Diesel car Euro classification, ANPR and EFTv11, 2022

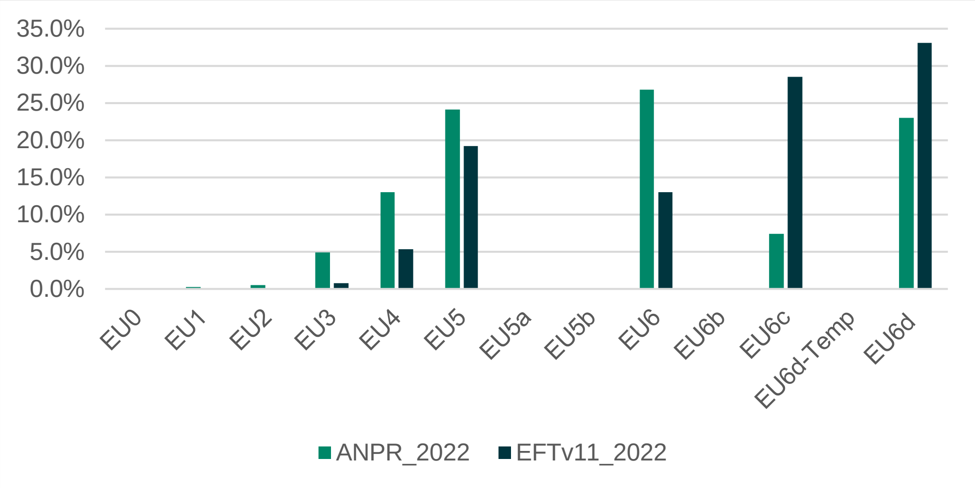


The majority of LGVs were reported as diesel fuelled (96.4%), with 0.3% HEV/PHEV and 1.3% zero-emission BEV. 1.6% of LGV counts were unclassified.

24.1% of LGVs were Euro 5, whereas 57.2% were Euro 6. This indicates the fleet is modernising, albeit still at a slower rate than predicted by the EFT, with a relatively larger proportion of Euro 6 vehicles but fewer Euro 6c and 6d.

These data are shown in **Figure A36**.

Figure A36: Diesel LGV Euro classification, ANPR and EFTv11, 2022



81% of HGV were classified as rigid body, whilst 19% were articulated.

Both the rigid and articulated HGVs were predominantly Euro VI, although the articulated HGVs were compliant with a much higher standard overall; 66.3% and 94% classified as Euro VI, respectively.

The articulated fleet was consistent with the distribution in the EFT, which may be expected as these tend to operate overall larger distances and on the strategic road network, whereas the rigid fleet lagged behind the EFT as they are more likely to operate on local roads over shorter distances and so may be under-represented on the strategic network.

These data are shown in **Figure A37** and **Figure A38**.

Figure A37: Rigid HGV Euro classification, ANPR and EFTv11, 2022

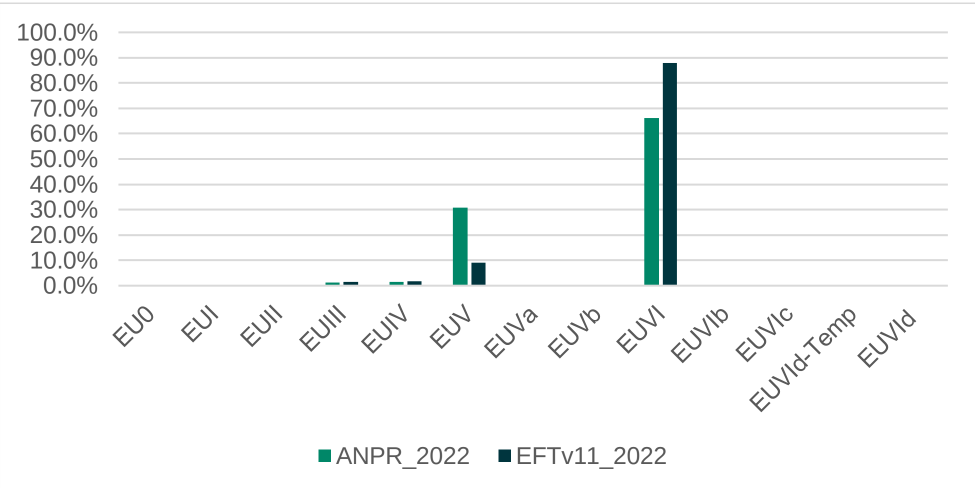
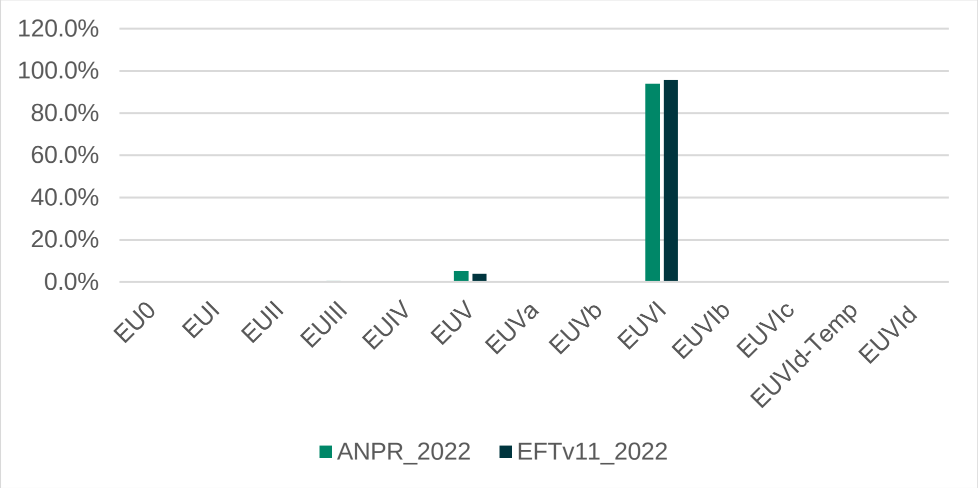


Figure A38: Articulated HGV Euro classification, ANPR and EFTv11, 2022

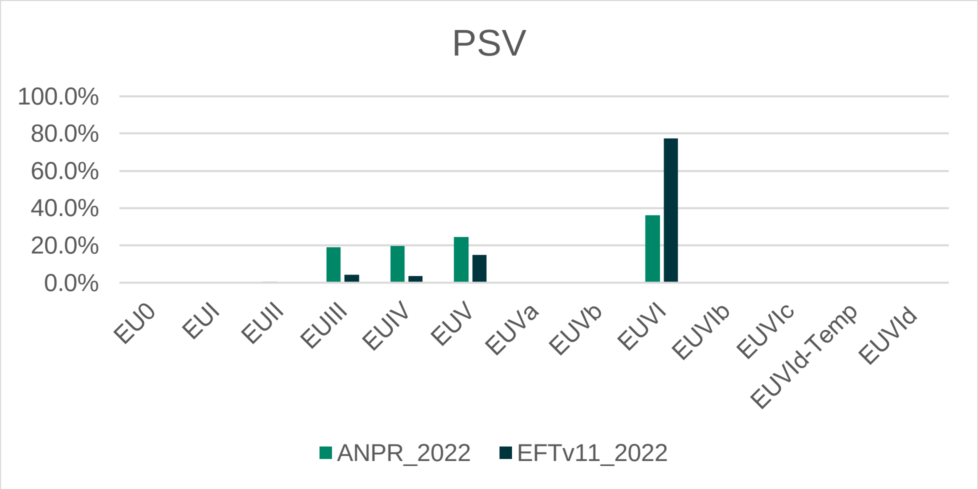


The bus fleet recorded by the survey was all diesel-fuelled, although there was a very large proportion of counts that were assigned as ‘other’ or ‘unclassified’ for fuel type, and which were assumed to be diesel. Whilst non-diesel vehicles, such as hybrid, are likely to be operating in the region, none of these types were explicitly recorded in the data.

The age distribution assigned by the DVLA database included vehicles ranging from Euro III to VI, as shown in **Figure A39**.

The local bus fleet is expected to differ from the nominal fleet published in the EFT as it will be subject to unique commercial operating constraints, as well as funding opportunities and local transport policies, etc. However, when compared to the EFT, it is clear the local fleet recorded in the counts is older, with an even distribution across classes from Euro III to VI rather than the gradual increase towards Euro VI.

Figure A39: PSV Euro classification, ANPR and EFTv11, 2022



Appendix B – Base vs Reference Case average speed plots

Figure B40: AM percentage change in average speed from Base to Reference Case

Figure B41: Interpeak percentage change in average speed from Base to Reference Case

Figure B42: PM percentage change in average speed from Base to Reference Case

Appendix C – Reference Case vs Do Something plots

Figure C43: AM speed change (mph) – Reference Case to Do Something

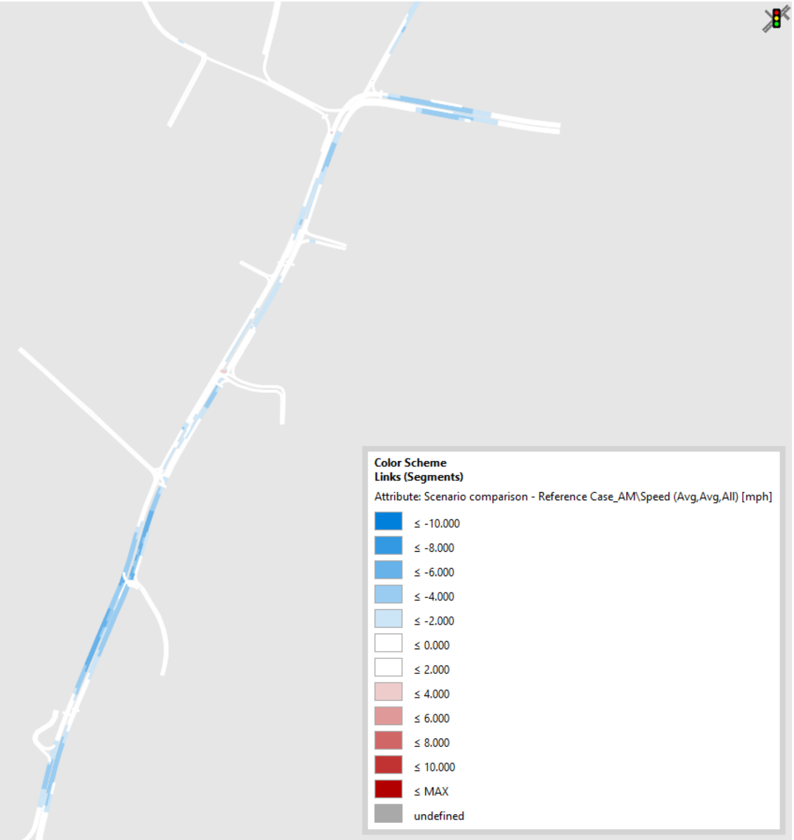


Figure C44: AM density change (veh/km) – Reference Case to Do Something

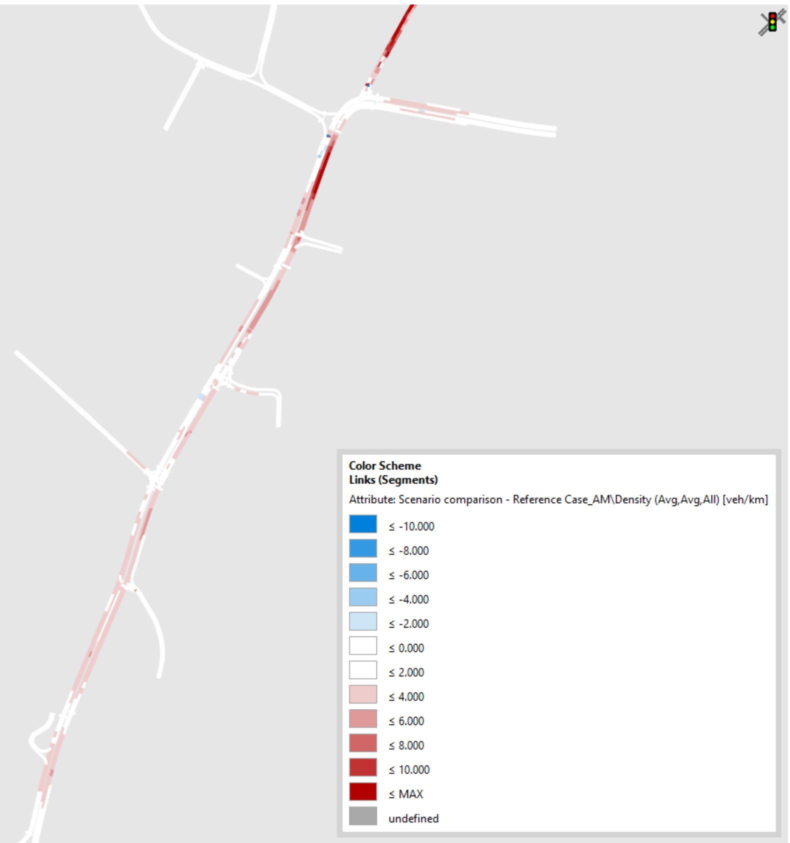


Figure C45: AM change in NOx emissions (g/hr) – Reference Case to Do Something

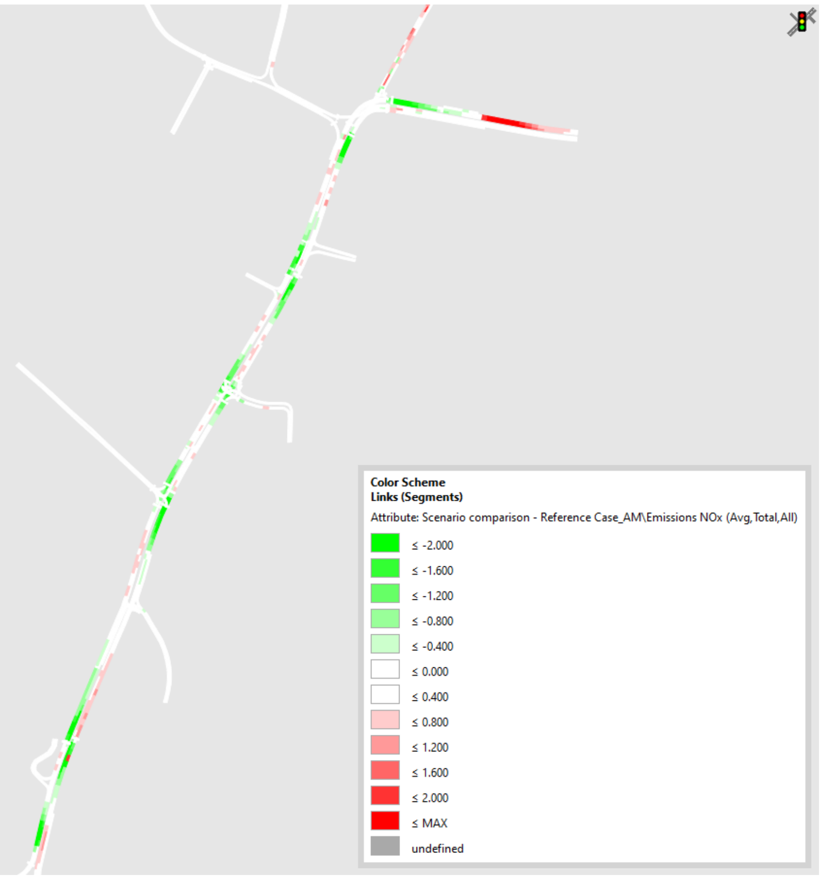


Figure C46: AM change in particulate matter emissions (PM_{10}) (g/hr) – Reference Case to Do Something

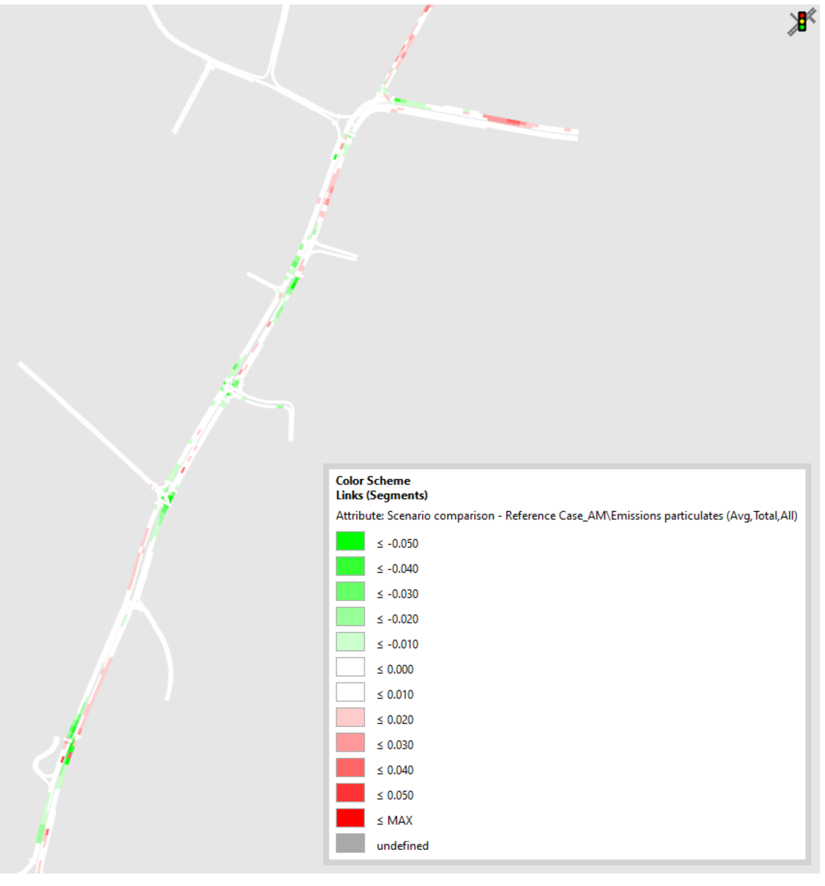


Figure C47: Interpeak speed change (mph) – Reference Case to Do Something

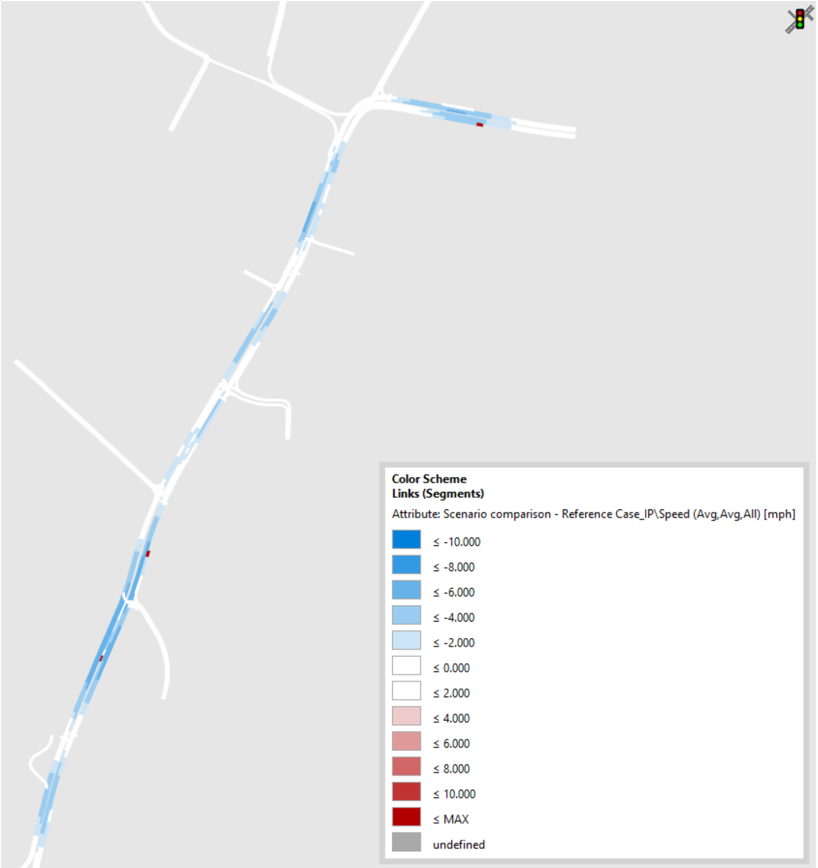


Figure C48: Interpeak density change (veh/km) – Reference Case to Do Something

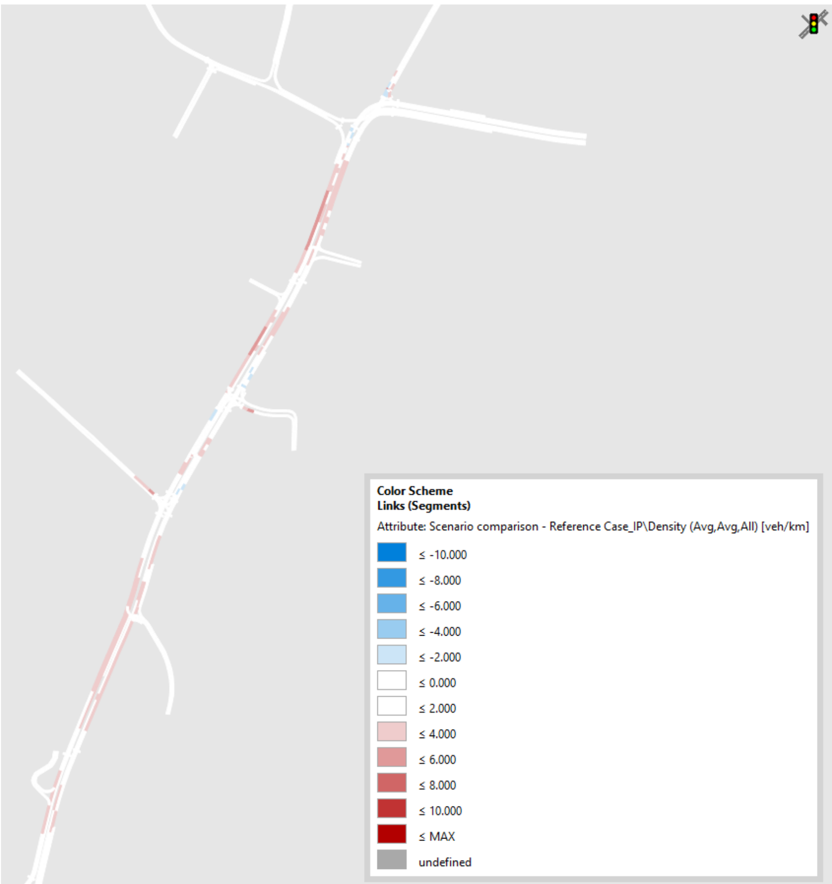


Figure C49: Interpeak change in NOx emissions (g/hr) – Reference Case to Do Something

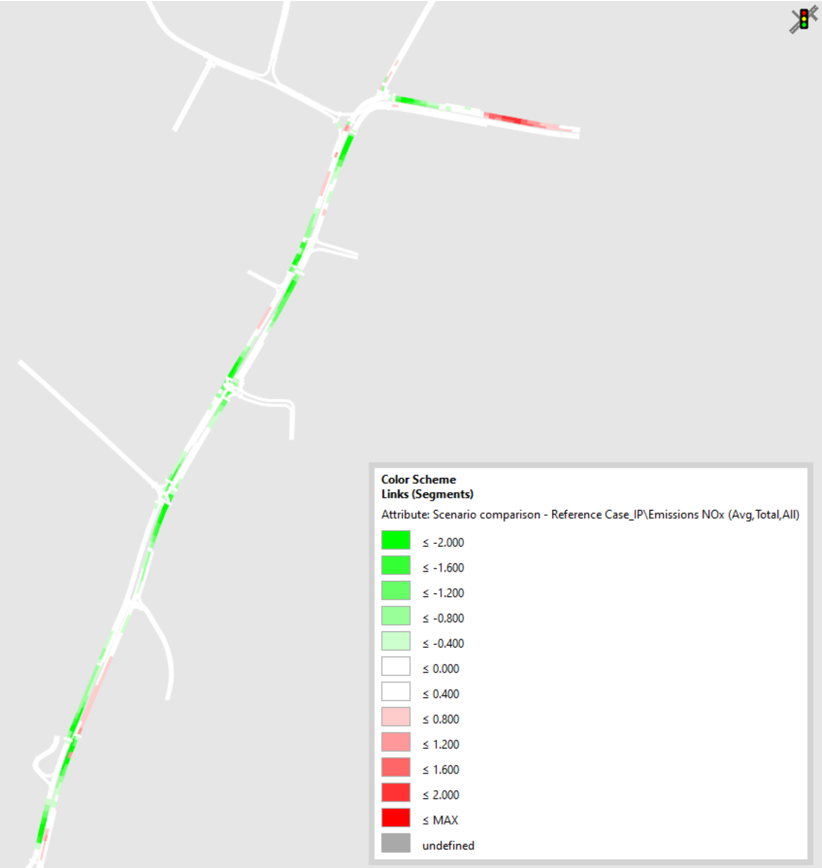


Figure C50: Interpeak change in particulate matter emissions (PM_{10}) (g/hr) – Reference Case to Do Something

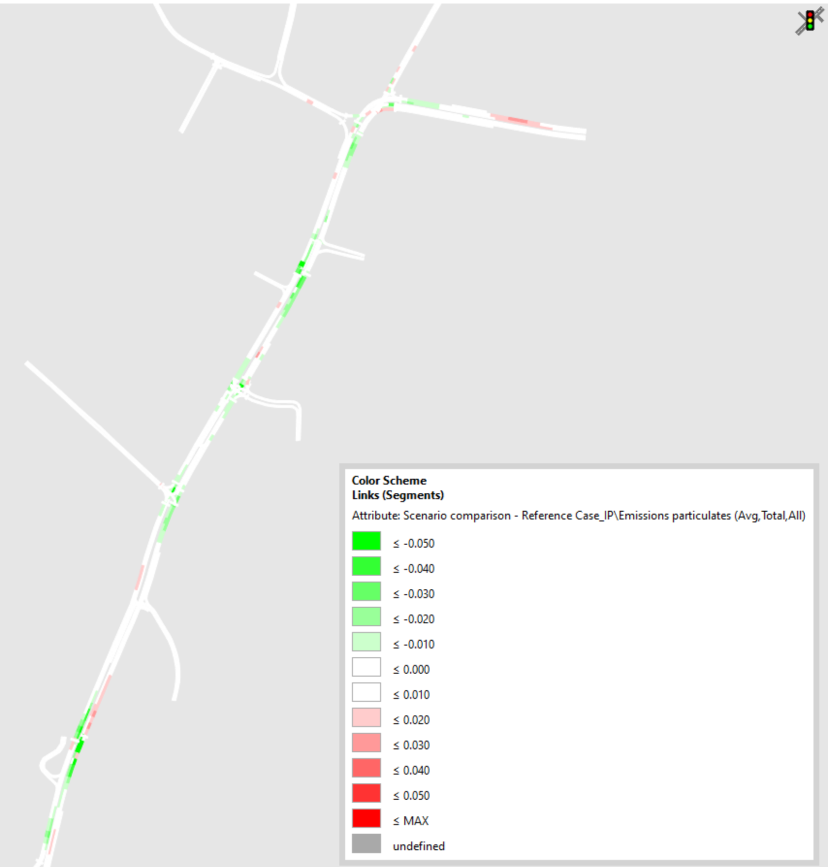


Figure C51: PM speed change (mph) – Reference Case to Do Something

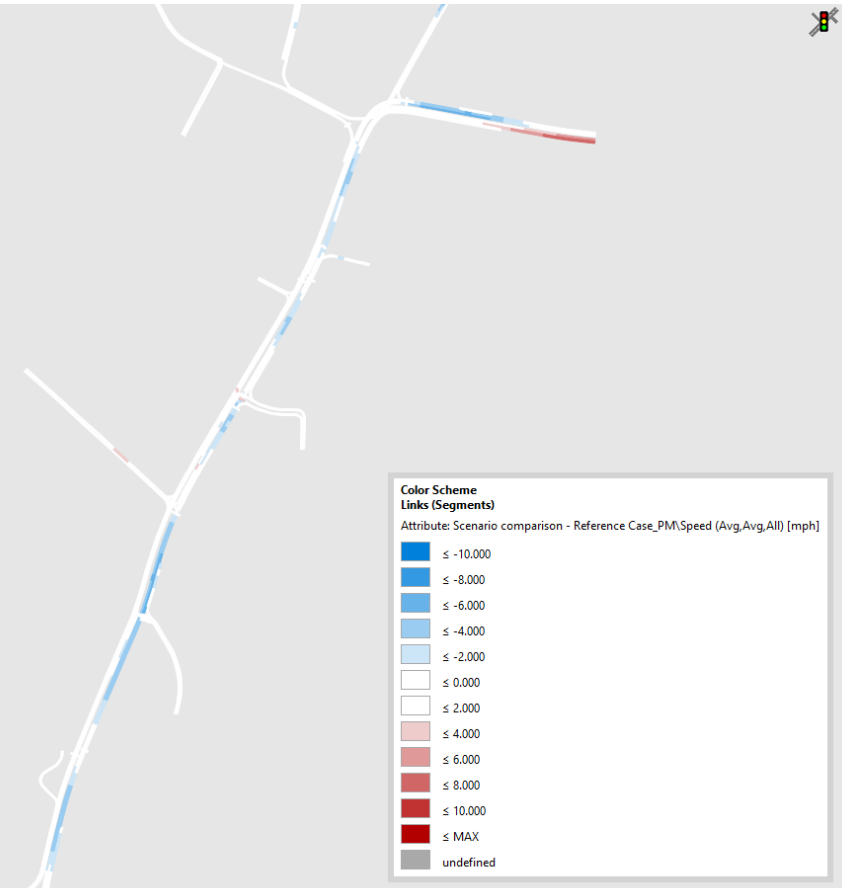


Figure C52: PM density change (veh/km) – Reference Case to Do Something

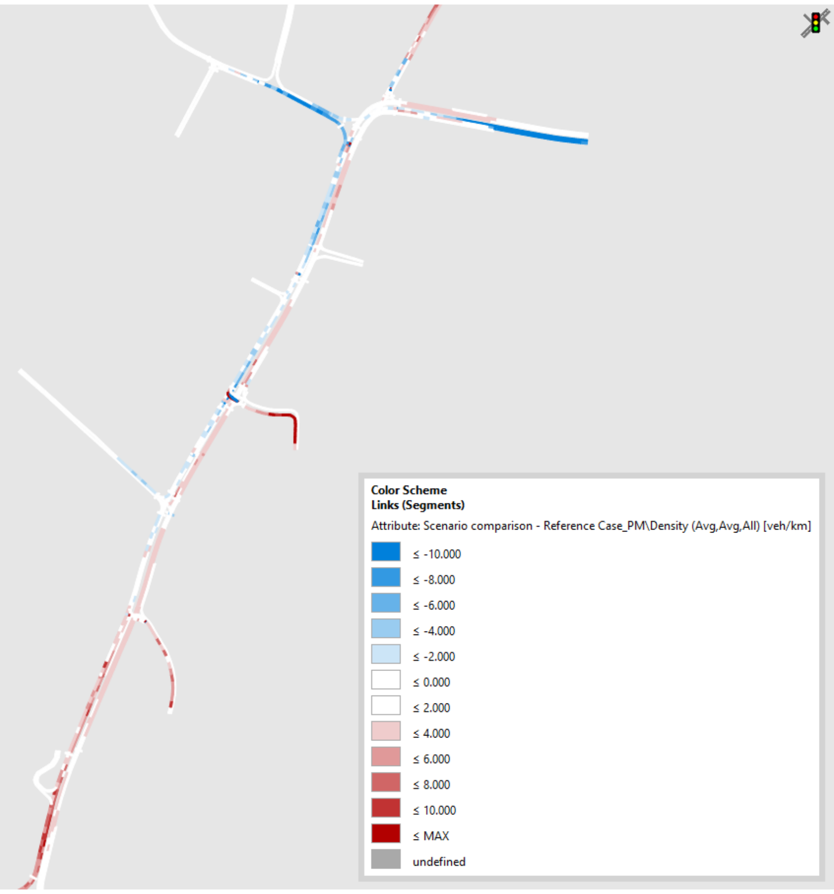


Figure C53: PM change in NOx emissions (g/hr) – Reference Case to Do Something

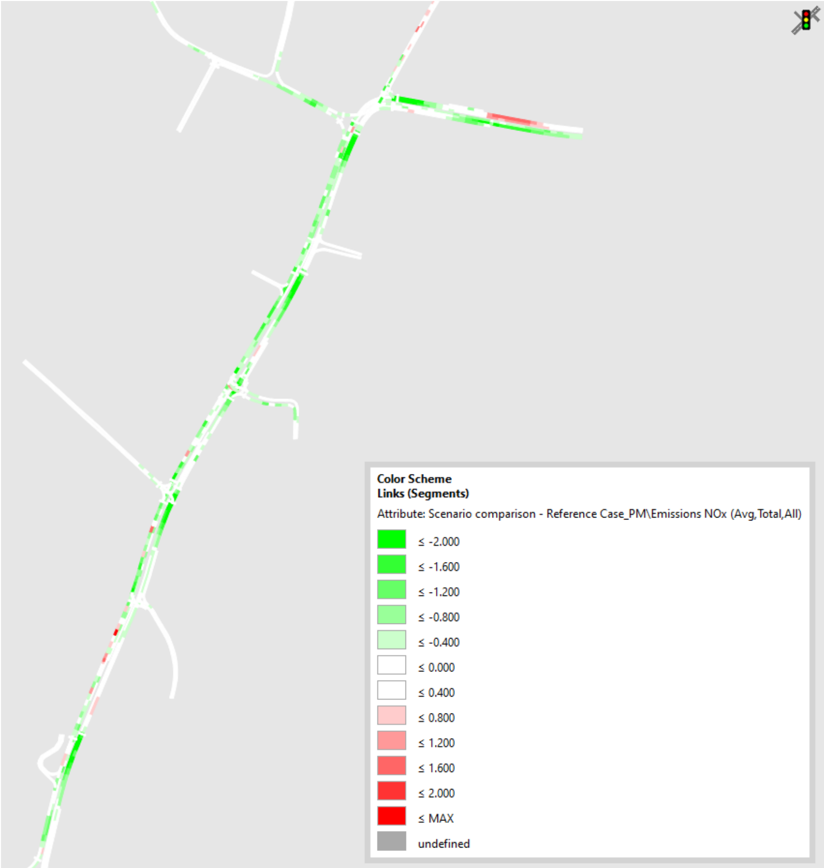
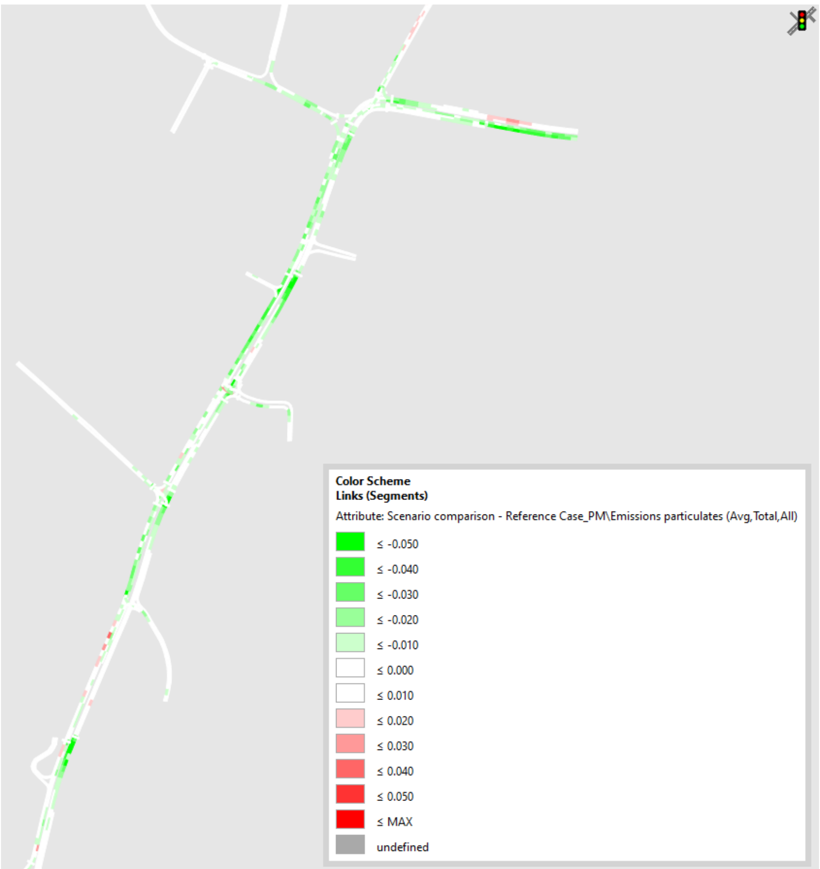


Figure C54: PM change in particulate matter emissions (PM_{10}) (g/hr) – Reference Case to Do Something



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