Creating a world fit for the future

Spelthorne Air Quality Action Plan

2019 baseline dispersion modelling and measures appraisal

Report for Spelthorne Borough Council

ED12941 | Issue number 2 | Date 21/10/2022

Customer:

Spelthorne Borough Council

Customer reference:

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Ref: ED12941

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Executive summary

This report describes an atmospheric dispersion modelling assessment of Nitrogen Dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) concentrations within the Borough of Spelthorne.

The assessment has been undertaken to assist Spelthorne Borough Council with updates to their Air Quality Action Plan (AQAP) to achieve improvements in local air quality; and continue working towards attainment of the air quality objectives.

Spelthorne Borough Council have identified five key study areas within the borough where nitrogen dioxide (NO_2) annual mean concentrations in excess of the air quality objective have been measured in recent years; and where significant traffic activity and congestion is known to occur where there may be public exposure. The assessment includes analysing the impact of air quality measures under consideration for an updated version of Spelthorne Borough Council's Air Quality Action Plan (AQAP).

The five key study areas are:

- Sunbury Cross and surrounding roads, Sunbury-on-Thames
- Thames Street, Sunbury-on-Thames
- London Road and Crooked Billet Roundabout, Staines-upon-Thames
- Church Road, Ashford
- Walton Bridge Road, Lower Halliford

Two additional areas of interest, where residential properties are present close to major roads but there have been no measured exceedances of the NO_2 annual mean objective, have also been included in the assessment at:

- Moor Lane, Staines-upon-Thames
- Georgian Close, Staines-upon-Thames

The aims of the assessment were to:

- Quantify pollutant concentrations within all study areas using both measurements and air quality dispersion modelling for a 2019 baseline year
- Identify locations where pollutant concentrations in excess of the air quality objectives occurred in 2019.
- Conduct source apportionment to identify the principal sources of air pollution, and where to target AQAP measures.
- Test and quantify the likely effectiveness of potential abatement measures vs future baseline projections (2027) for inclusion within the new AQAP.

2019 recent base year results

The 2019 baseline modelling concluded that:

- Exceedances of the NO_2 annual mean objective may be occurring at locations where there is relevant public exposure in:
    - Vicarage Road, Staines Road West, and Green Street in Sunbury
    - Thames Street, Sunbury (please note - these are indicative results only as there are currently no NO_2 measurements here. We recommend that NO_2 diffusion tubes are deployed here)
    - London Road in Staines
    - Walton Bridge Road in Lower Halliford
    - Bridge Street in Staines
- No exceedances of the NO_2 annual mean objective were modelled in Ashford or Georgian Close
- No exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives were predicted in any study area
- Annual mean NO_2 concentrations in excess of 60 $\mu g.m^{-3}$ are not predicted at any locations where anyone is likely to spend an hour or more; which provides a reasonable indication that

the 1-hour mean NO_2 objective is not being exceeded; this includes the A316 bus stop in Sunbury.

Source apportionment 2019

Where annual mean pollutant concentrations close to, or in excess of the respective air quality objectives were modelled in 2019, source apportionment has been conducted at up to three worst-case receptors in each study area. As there were no modelled exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives; source apportionment has been included for total oxides of nitrogen (NOx) only. Source apportionment was not conducted at Thames St, Sunbury as the 2019 baseline model results there are intended to be indicative only.

The outcomes of the source apportionment analysis can be summarised as:

- In all study areas
    - The largest proportions of NOx were attributable to background concentrations (ranging from 30%-68%)
    - diesel cars account for the largest proportion of road NOx concentrations (ranging from 19%-42%).
- In Sunbury
    - Rigid HGVs contributed 8%-13% of NOx emissions.
    - LGV emissions are much less significant than HGVs (2%-3%).
- In Staines
    - Buses contributed 12%-14% of NOx emissions.
    - LGV and HGV emissions are much less significant than other vehicle types
- In Georgian Close
    - The largest proportion of NOx was attributable to background concentrations (68%)
    - Diesel cars account for the largest proportion of road NOx concentrations (19%).
    - LGV and Bus emissions are much less significant than other vehicle types.
- In Ashford
    - LGV emissions contributed 7%-13% of NOx emissions.
    - At Church Road Bus emissions contribute 11%
    - HGV emissions are much less significant than other vehicle types
- In Lower Halliford – Shepperton
    - LGVs contributed to 9%-16% of NOx emissions on Walton Bridge Road and the Upper Halliford Bypass.
    - Bus and HGV emissions are much less significant than other vehicle types.
- In Moor Lane
    - LGVs contributed to 12-23% of NOx emissions on the M25 and Bridge St.
    - Rigid HGVs contributed to 7 – 11% of NOx emissions.
    - Bus emissions are much less significant than other vehicle types.

Source apportionment aims to provides useful insights to inform action plan measures. At most locations assessed, locally targeted traffic management measures could have an impact on reducing emissions in where NO_2 annual mean in excess of the objective are occurring. Whereas at locations where the background contribution is dominant it is not as straightforward to target measures at other sources located in and around the Borough.

Future year appraisal of potential action plan measures

In all study areas, the assessment compares a future baseline year (2027) business as usual/do nothing scenario with NOx emission mitigation scenarios relating to road traffic; the aim being to quantify changes to annual mean pollutant concentrations associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ[1] extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027, then reduced by 5%.

The outcomes of the future year (2027) scenario modelling can be summarised as:

- In all study area the results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be less than the 40 $\mu g.m^{-3}$ objective at all receptor locations identified as worst-case in 2019. All three of the road traffic NOx emission mitigation options tested reduce the predicted NO_2 annual mean further which indicates that they are not required to achieve compliance with the objective in 2027.
- As the results indicate compliance with the NO_2 annual mean objective in 2027, it is useful to understand when compliance may be achieved without any intervention via mitigation options. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year:
    - Sunbury – compliance will be achieved by 2022
    - Staines – compliance will be achieved by 2022
    - Georgian Close – compliance already achieved
    - Ashford – compliance already achieved in 2019
    - Lower Halliford – compliance was expected to be achieved by 2021
    - Moor Lane – compliance was expected to be achieved in 2020

Modelling uncertainty

When interpreting the model results presented, it is important to consider the uncertainty associated with both the inputs and outputs of the modelling process.

Key areas of uncertainty in this assessment relate to:

- **Traffic activity and growth assumptions** – the variety and age of the various traffic activity data sources is a significant source of uncertainty in this modelling assessment. These factors are compounded further when projecting as far forward as 2027. Although we have accounted for traffic growth using a local TEMPRO growth factor, for some roads this has been projected from as far back as 2014, and as such can be considered as a best estimate only based on the available information. An up-to-date borough wide traffic model accounting for the latest local plan and how this is likely to affect traffic activity over the next five years would provide more confidence in the data used to estimate future air quality.
- **Vehicle fleet age projections and emission factors -** Vehicle emission projections used in the assessment are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. The projected average vehicle emission rates in 2027 therefore rely on the vehicle fleet in Spelthorne renewing in line with the national projections. It is currently uncertain if this will be the case as the recent pandemic and subsequent global supply crisis have impacted both car use and vehicle renewal

[1] Ultra Low Emission Zone (ULEZ)

rates. We have therefore included a sensitivity test simulating a delay of 2 years in fleet turnover to estimate a more conservative future vehicle fleet make up.

Fleet renewal sensitivity test

A two year delay in vehicle fleet renewal has been modelled using 2025 predicted fleet age mix in the EFT compared to the 2027 mix.

Although NO_2 concentrations at receptor locations were up to 11% higher across all study areas using the 2025 fleet mix, there were no exceedances of the NO_2 annual mean objective because of a delay in fleet renewal. The delay in fleet renewal had little effect on PM_{10} or $PM_{2.5}$ concentrations.

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1 Introduction

Spelthorne Borough Council declared a borough wide Air Quality Management Area (AQMA) in relation to exceedances of the annual mean NO_2 objective in 1999. In the subsequent preparation of an air quality action plan (AQAP), road traffic was identified as the primary source of emissions leading to exceedances of the objective; whilst emissions associated with Heathrow Airport were also identified as significant.

Spelthorne Borough Council are currently planning to update the AQAP to help achieve improvements in air quality within the AQMA and continue working towards attainment of the air quality objectives. One aspect of the updated AQAP will be to quantify pollutant concentrations across the Borough using both measurements and air quality dispersion modelling; the aim being to:

- Identify areas of exceedance and pollution hotspot locations, to assist with reviewing the extent of the current AQMA boundary
- Conduct source apportionment to identify the principal sources of air pollution, and where to target AQAP measures.
- Predict pollutant concentrations in a future baseline year; and test and quantify the likely effectiveness of potential abatement measures for inclusion within the new AQAP.

To assist with these aims, Ricardo Energy & Environment (Ricardo) has been commissioned by Spelthorne Borough Council to conduct a detailed dispersion modelling assessment at various localised study areas in Spelthorne.

1.1 Study areas

Spelthorne Borough Council identified five key study areas within the borough where nitrogen dioxide (NO_2) annual mean concentrations in excess of the air quality objective have been measured in recent years; and where significant traffic activity and congestion is known to occur where there may be public exposure.

The five key study areas are:

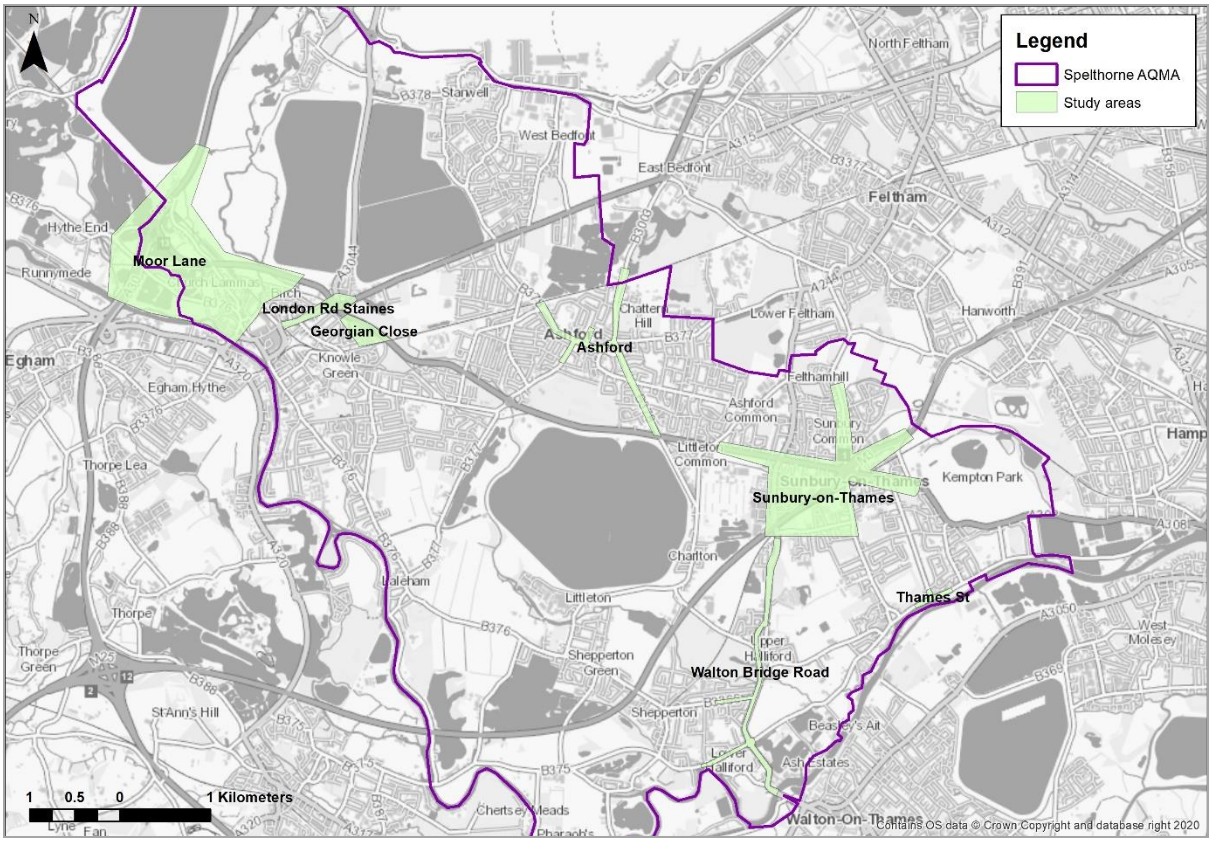
1. Sunbury-on-Thames:
    - Sunbury Cross and the approaching roads including Staines Road West (A308).
    - Vicarage Rd which leads to Sunbury Cross, and Nursery Road, Sunbury
    - A316 bus stop on the eastbound carriageway close to Costco (potential exceedances of the short-term exposure air quality objectives)
2. Thames Street, Sunbury-on-Thames
3. Staines Upon Thames:
    - London Road
    - Crooked Billet Roundabout
4. Church Road Ashford
5. Walton Bridge Road, Lower Halliford

Two additional areas of interest, where residential properties are present close to major roads but there have been no measured exceedances of the NO_2 annual mean objective, have also been included in the assessment at:

- Moor Lane, Staines-upon-Thames
- Georgian Close, Staines-upon-Thames

The extent of each study area (Figure 1.1) was determined based on local knowledge of recent NO_2 measurements and locations where significant traffic activity and congestion is known to occur where there may be public exposure.

Figure 1.1: Spelthorne – Air quality modelling study areas



1.2 Policy background

The Environment Act 1995 placed a responsibility on the UK Government to prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The most recent version of the strategy (2007) sets out the current UK framework for air quality management and includes a number of air quality objectives for specific pollutants.

The 1995 Act also requires that Local Authorities "Review and Assess" air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define areas where the AQS objectives are not being met. In such instances the Local Authority is required to declare an Air Quality Management Area (AQMA), carry out a Further Assessment of Air Quality, and develop an Air Quality Action Plan which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra's Technical Guidance - LAQM.TG(16). Table 1-1 lists the objectives relevant to this assessment that are included in the current UK air quality objectives.

1.3 Locations where the air quality objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be present and are likely to be exposed over the averaging period of the objective. Table 1-2 summarises examples of where the air quality objectives for NO_2 should and should not apply.

Table 1-1: Objectives included in the Air Quality Regulations and subsequent Amendments for the purpose of the Local Air Quality Management

Pollutant	Air Quality Objective Concentration	Measured as
Nitrogen dioxide (NO_2)	200 $\mu g.m^{-3}$ not to be exceeded more than 18 times a year	1-hour mean
	40 $\mu g.m^{-3}$	Annual Mean
Particulate matter (PM_{10})	50 $\mu g.m^{-3}$ not to be exceeded more than 7 times a year	24-hour mean
	40 $\mu g.m^{-3}$	Annual mean
Particulate matter ($PM_{2.5}$)	25 $\mu g.m^{-3}$	Annual mean

Table 1-2: Where the Air Quality Objectives should and should not apply

Averaging Period	Pollutant	Objectives should apply at:	Objectives should not generally apply at:
Annual mean	NO_2, PM_{10}, $PM_{2.5}$	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour mean	PM_{10}	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	NO_2	All locations where the annual mean and: 24-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer	Kerbside sites where the public would not be expected to have regular access

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2 Dispersion Modelling Assessment

The general approach taken to this assessment was:

- Collect and interpret data from previous LAQM reports, as well as recent traffic, monitoring, meteorological and background concentration data for use in a dispersion modelling study
- Use dispersion modelling to:
  - Estimate and visualise the spatial variation in annual mean NO_2, PM_{10}, and $PM_{2.5}$ concentrations in each study area
  - Estimate NO_2, PM_{10}, and $PM_{2.5}$ concentrations at worst-case receptor locations where relevant human exposure is present
  - Conduct source apportionment to identify the principal sources of air pollution and inform appropriate AQAP measures
  - Assess the impact of potential action plan measures in comparison with projected future baseline concentrations.

The modelling methods outlined in Defra Technical Guidance LAQM.TG(16) were applied throughout.

2.1 Modelling method and supporting information

2.1.1 Overview

NO_2, PM_{10} and $PM_{2.5}$ annual mean concentrations have been modelled within the study area using the atmospheric dispersion model ADMS Roads (version 5.0). The model has been verified, and where necessary refined, by comparing modelled with the latest available measured pollutant concentrations.

The modelling methods recommended in the Defra Technical Guidance LAQM.TG(16) have been used throughout this study. It should be noted that any dispersion modelling study has a degree of uncertainty associated with it. All reasonable steps have been taken to reduce this uncertainty. Where relevant, results are presented in context with model uncertainty at that location.

2.1.2 Baseline air quality

2.1.2.1 Recent air quality measurements

Spelthorne Borough Council measures NO_2, PM_{10} and $PM_{2.5}$ across a network of automatic analysers and NO_2 diffusion tube sites. Maps showing the locations of the measurement sites in each study area are presented in Figure 2.1 to Figure 2.6[2].

Please note: There are currently no monitoring locations in the Thames Street, Sunbury modelling domain.

Site details and the NO_2 annual mean concentrations measured during recent years are presented in Table 2-1. To summarise:

- Some diffusion tubes in hotspot locations have repeatedly measured exceedances of the NO_2 annual mean objective (40 $\mu g.m^{-3}$) over last few years, such as SP9 (Staines Road West) in Sunbury and SP29 (London Road) in Staines.
- Other diffusion tubes measured exceedances in 2019 after achieving compliance in previous years, such as SP28 (London Road) in Staines, SP35 (Vicarage Road) in Sunbury.
- Diffusion tubes recently deployed in Sunbury (2019) have measured exceedances near Sunbury Cross (SP58) and on the A316 (triplicates SPEB01-03 and SPWB01-03).

Full details of any short-term to long-term adjustment, bias adjustment factors, and QA/QC procedures are available in the Spelthorne Borough Council 2020 LAQM Annual Progress Report.

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Table 2-1: NO_2 annual mean measurements ($\mu g.m^{-3}$)

ID	Name	Site type	X	Y	Data capture 2019 (%)	2016	2017	2018	2019
SUN_01	Sunbury X	UB	510064	170199	97	-	33	33	33
SCC_ECO	Haslett Road	UB	509155	169228	94	24	24	22	17
SP1	Staines High Street	UC	503529	171619	100	34	28	26	27
SP3	Wraysbury Road	K	503097	171931	100	37	31	29	30
SP4	Benwell Centre, Sunbury	R	510052	169843	92	32	27	25	26
SP5	Church Street, Ashford	R	506967	171562	92	**43**	37	36	**41**
SP8	The Parade, Sunbury Cross	R	509829	170140	8	**51**	**44**	39	-
SP9	Staines Road West, Sunbury	K	509166	170260	100	**47**	**42**	39	**41**
SP10	Walton Bridge Road	R	509125	166862	100	**43**	35	35	37
SP11	Halliford Bypass	K	509033	168169	100	**41**	35	30	34
SP20	Greenlands Rd, Staines	UB	504334	171845	92	36	32	27	31
SP21	Lincoln Way, Ashford	UB	509131	169840	83	31	26	25	24
SP24	Yeoveney Close, Staines	UB	502577	172777	100	35	27	25	28
SP27	Church Street, Staines	R	503287	171744	100	39	31	28	34
SP28	London Road, Staines	R	504291	171926	100	**43**	35	36	**42**
SP29	London Road, Staines	K	504381	171975	100	**51**	**44**	34	**51**
SP32	Feltham Road, Ashford	K	507349	171461	92	36	29	27	31
SP34	School Road, Ashford	R	507936	170518	92	**43**	38	35	39
SP35	Vicarage Road, Sunbury	R	510028	170200	100	**43**	37	37	**42**
SP36	St Ignatius School, Sunbury	R	510104	169508	92	**46**	**40**	35	35
SP43	The Haven, Sunbury	UB	510063	170201	100	39	33	31	34
SP44	The Haven, Sunbury	UB	510063	170201	100	39	33	32	33
SP45	The Haven, Sunbury	UB	510063	170201	100	39	33	30	34
SP49	Runnymede Cottages, Moor Lane, Staines	UB	502605	173274	92	37	29	31	36
SP51	Fairfield Avenue, Staines	R	504087	171832	100	**44**	37	36	**41**
SP52	Staines Road East, Sunbury	R	510542	169997	100	39	32	33	37
SP54	Russell Road, Shepperton	K	508493	166841	83	39	29	32	31
SP55	Green Lane, Shepperton	K	508954	167585	67	38	33	34	39
SP58	Sunbury Cross (East)	K	510090	170100	92	-	-	-	**51**
SPEB01	A316 Eastbound (Costco)	R	510472	170397	100	-	-	-	**56**
SPEB02	A316 Eastbound (Costco)	R	510472	170397	100	-	-	-	**59**
SPEB03	A316 Eastbound (Costco)	R	510472	170397	100	-	-	-	**60**
SPWB01	A316 Westbound	R	510702	170478	83	-	-	-	**48**
SPWB02	A316 Westbound	R	510702	170478	100	-	-	-	**47**
SPWB03	A316 Westbound	R	510702	170478	83	-	-	-	**50**

Exceedances of the annual mean objective in **bold.**
Site types: R (Roadside), K (kerbside), UB (Urban background), UC (Urban centre)

PM_{10} and $PM_{2.5}$ concentrations were also measured at the automatic urban background sites in Sunbury. Annual mean concentrations have been consistently below the objectives in the last few years for both PM_{10} and $PM_{2.5}$. The 2019 measurement data are presented in Table 2-2 and Table 2-3.

Table 2-2: PM_{10} annual mean measurements ($\mu g.m^{-3}$)

ID	Name	Type	X	Y	Data capture 2019 (%)	2016	2017	2018	2019
SUN_01	Sunbury X	UB	510064	170199	100	-	13.1	14.5	15.7
SCC_ECO	Haslett Road	UB	509155	169228	97	19.3	20.7	19.5	24.6

Table 2-3: $PM_{2.5}$ annual mean measurements ($\mu g.m^{-3}$)

ID	Name	Type	X	Y	Data capture 2019 (%)	2016	2017	2018	2019
SUN_01	Sunbury X	UB	510064	170199	100	-	8	9.2	9.9
SCC_ECO	Haslett Road	UB	509155	169228	87	13.5	13.3	11.4	12.9

Figure 2.1: Sunbury NO_2 measurement sites

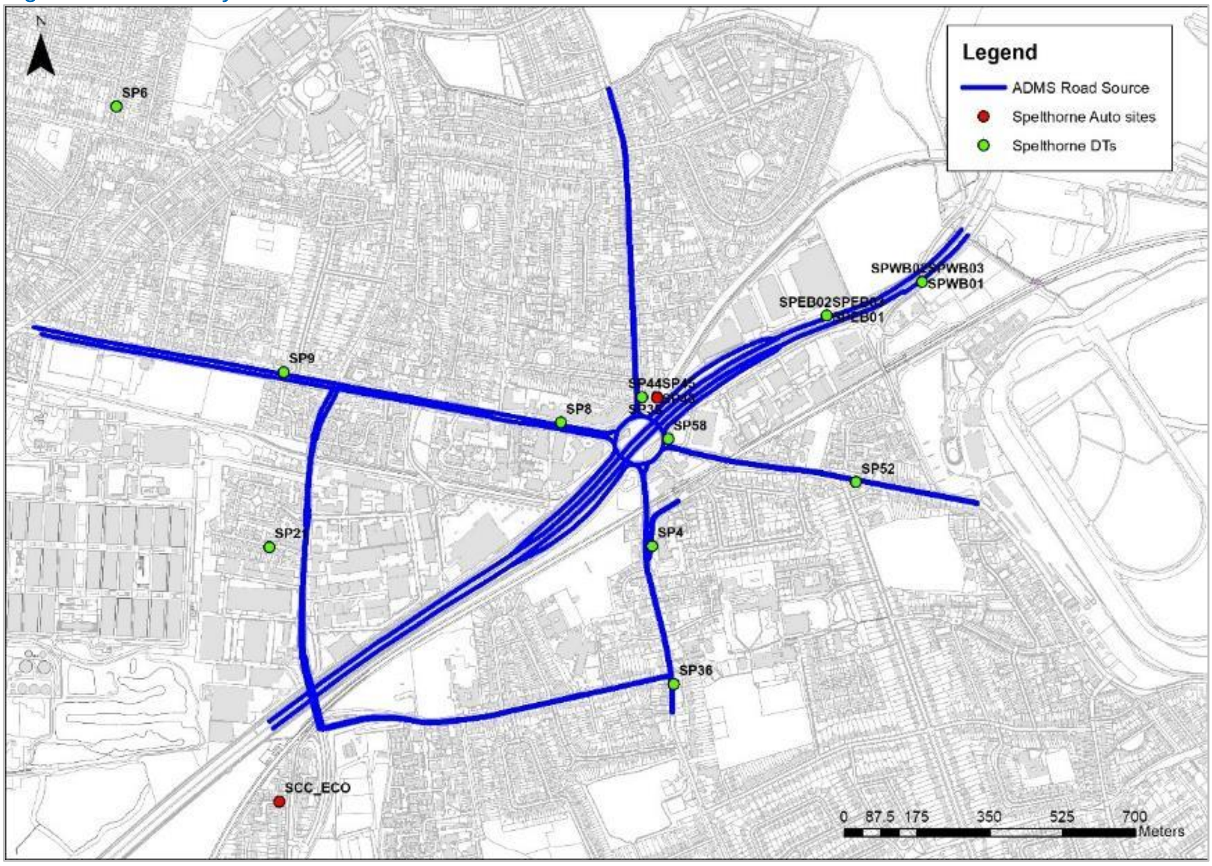


Figure 2.2: Staines NO_2 measurement sites

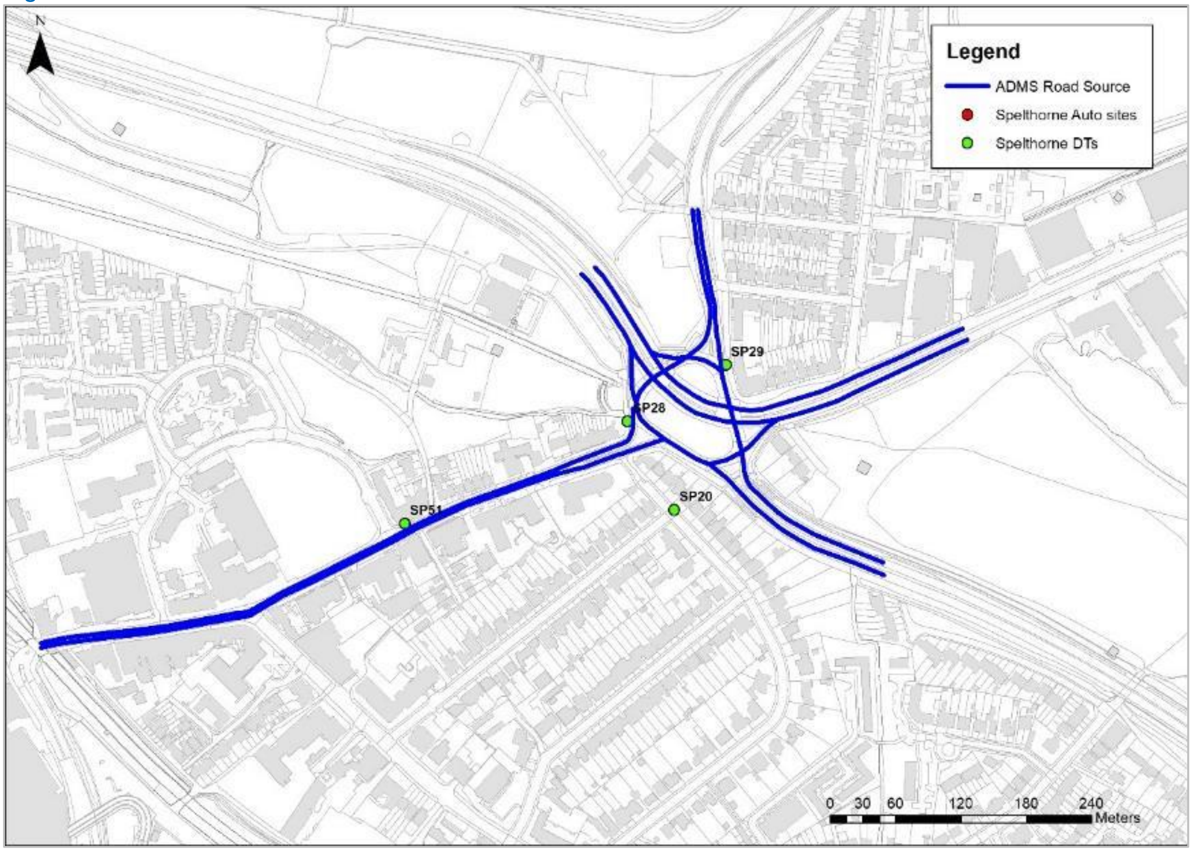


Figure 2.3: Georgian Close NO_2 measurement sites

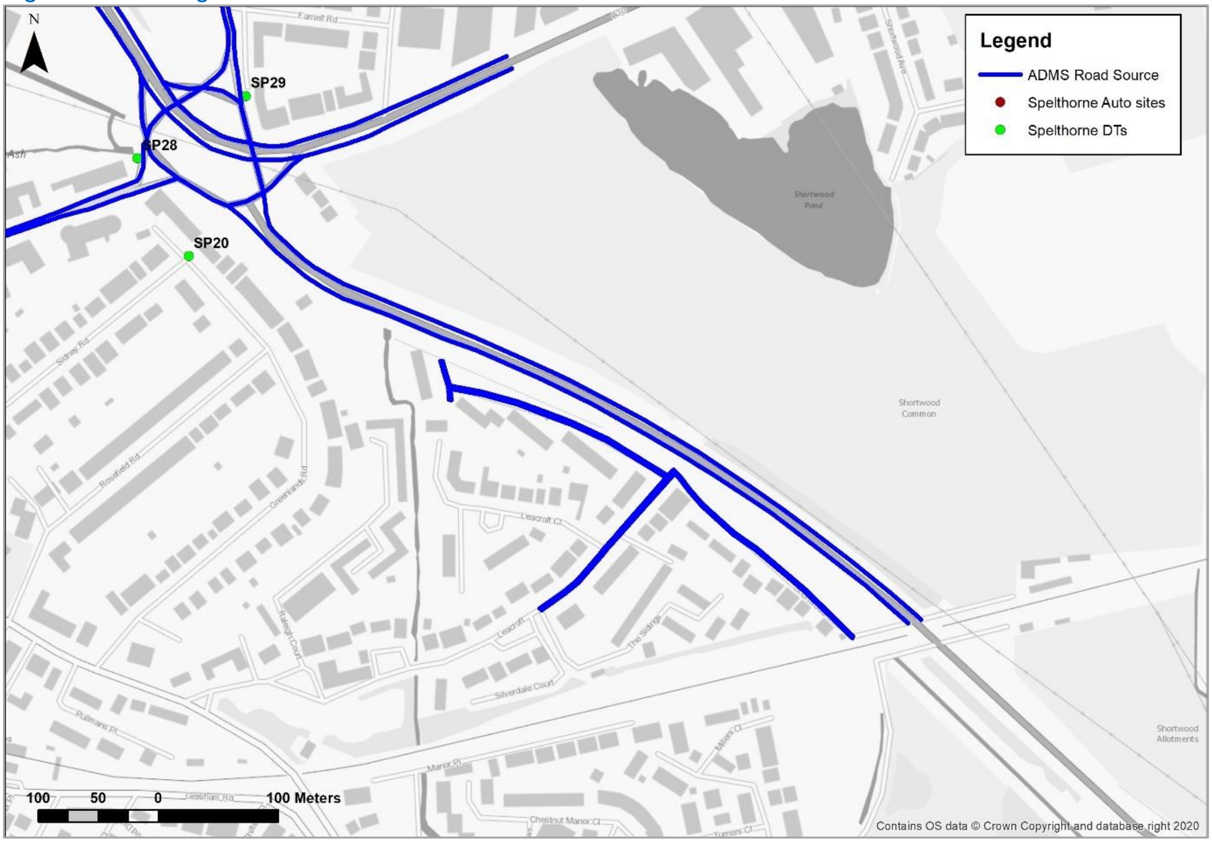


Figure 2.4: Ashford NO_2 measurement sites

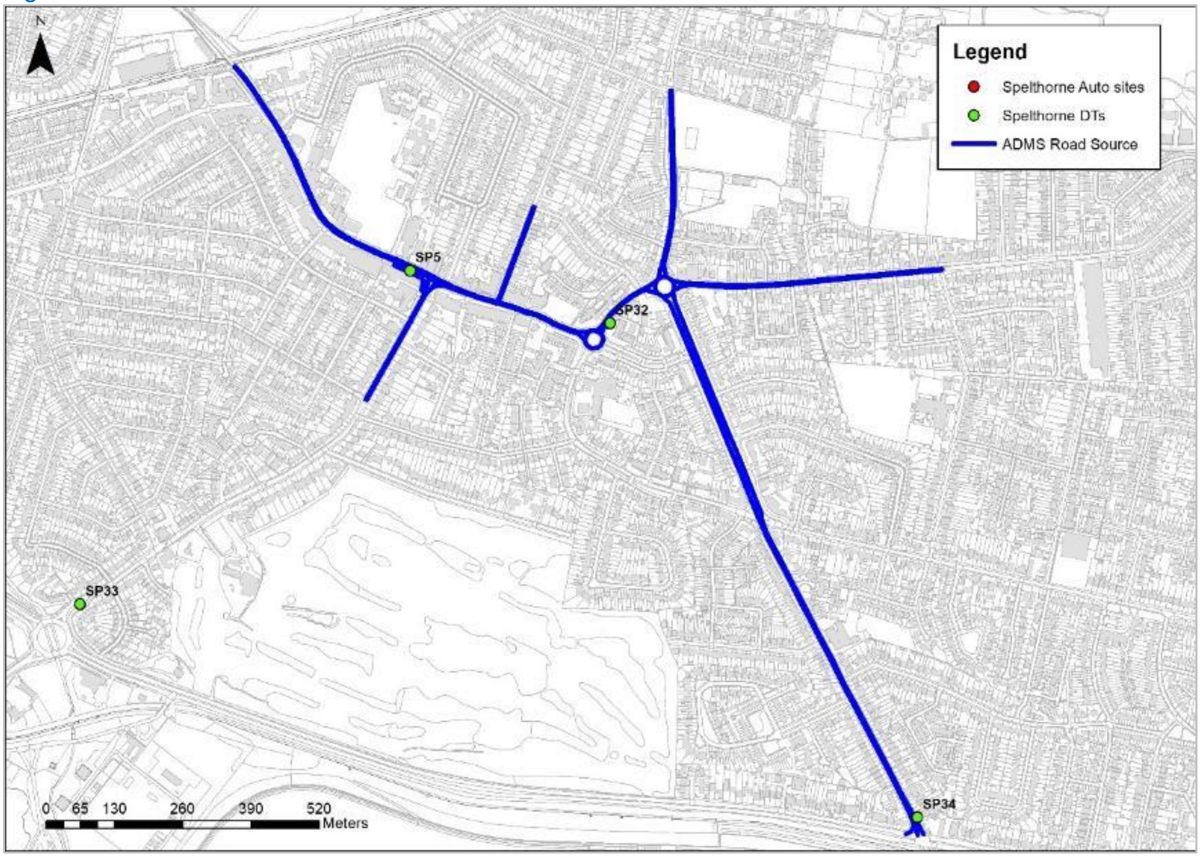


Figure 2.5: Lower Halliford NO_2 measurement sites

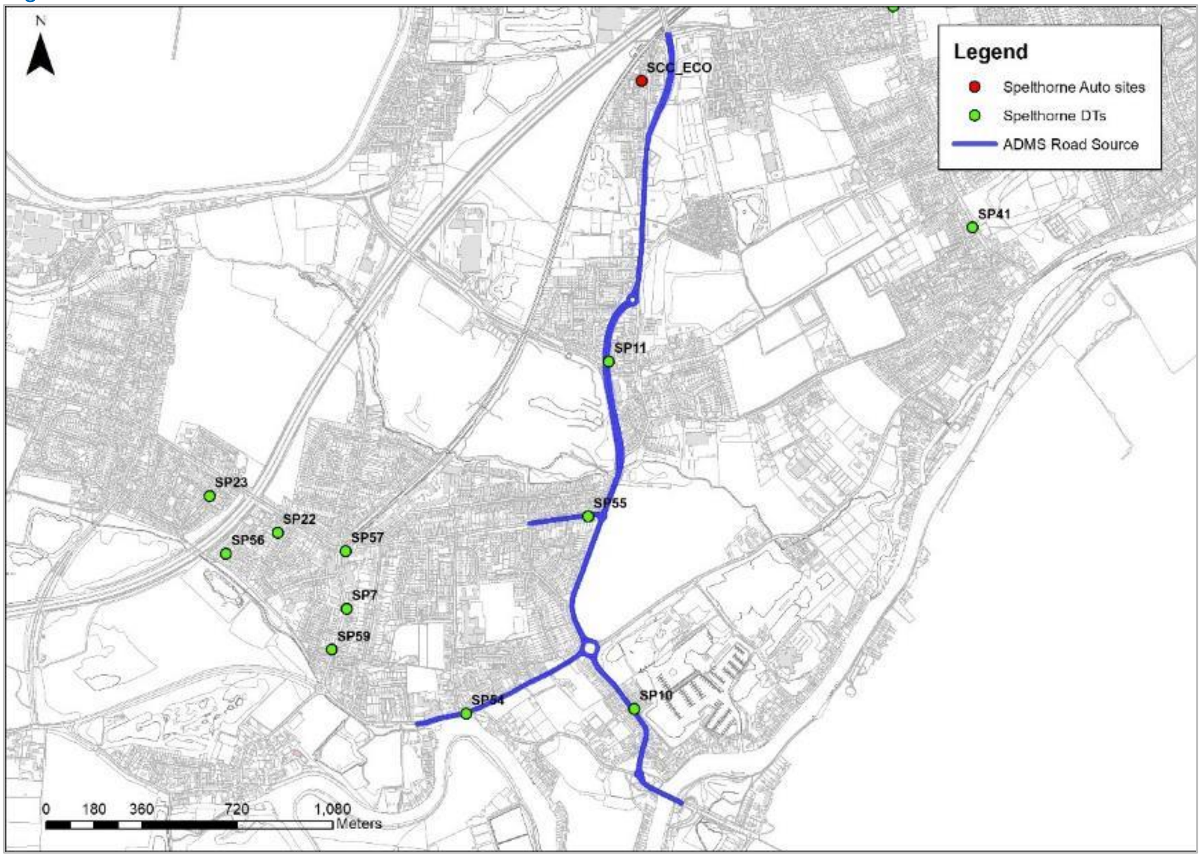
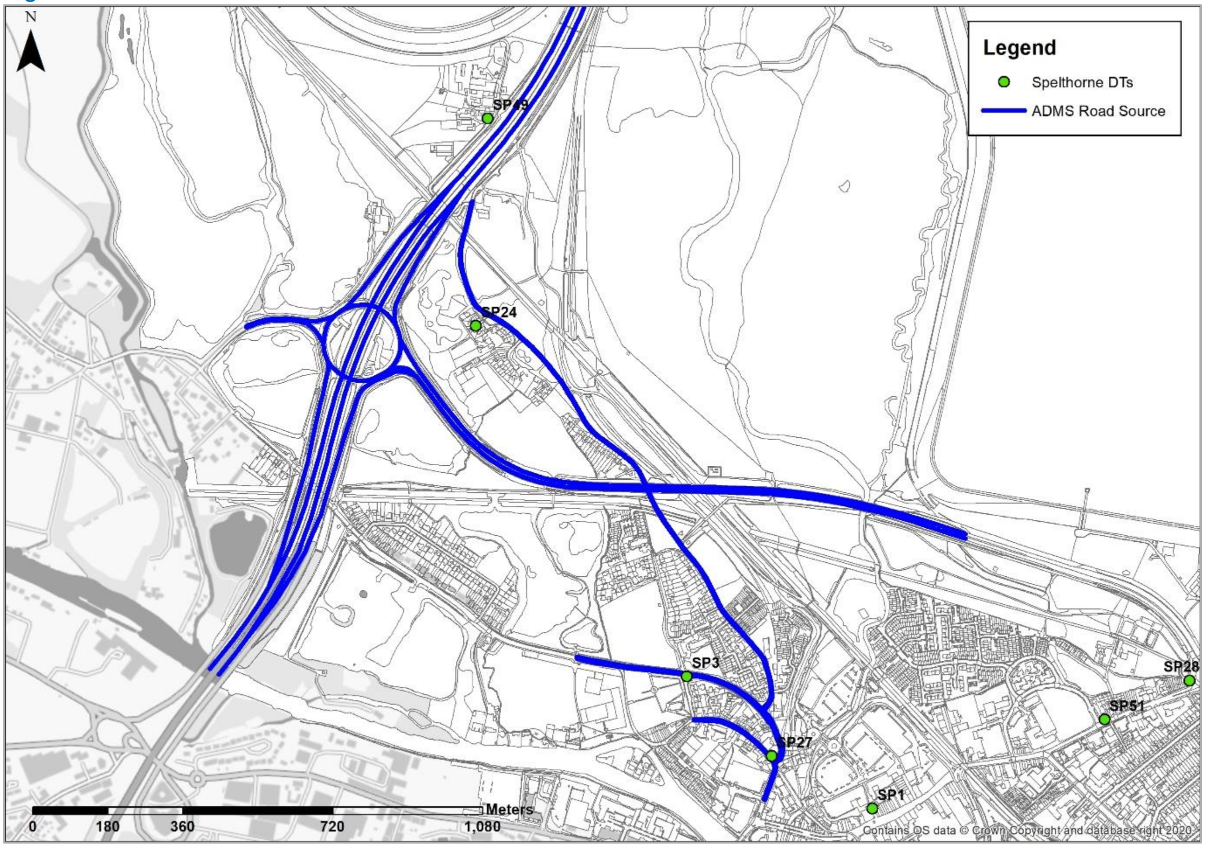


Figure 2.6: Moor Lane NO_2 measurement sites



2.1.2.2 Background concentrations

Background pollutant concentrations for a dispersion modelling study can be sourced from either local urban background measurements, or the background maps provided by Defra.

There are advantages to using the background maps in preference to the local monitoring data for a modelling assessment of this type which covers a large study area.

The Defra background maps provide estimates of annual mean background concentrations of key pollutants at a resolution of 1 x 1km projected from a base year of 2018 and can be projected forward to future years up to 2030. This is useful in this case as there is a requirement to model future year assessment scenarios.

When modelling over a large area the background maps provide an estimate of how background concentrations vary spatially, which is not possible using urban background measurements which are more commonly used in smaller modelling domains.

For total oxides of nitrogen (NOx), PM_{10} and $PM_{2.5}$ the maps are provided as both total annual mean and disaggregated into contributions from various emission source sectors. This allows the contribution of sources being modelled explicitly to be removed to avoid double counting of e.g. road traffic emissions. Background maps for NO_2 are provided as total annual mean concentrations, which is useful for comparison with the local urban background measurements.

Table 2-4 and Table 2-5 compare the available 2019 urban background measurements in Spelthorne with the mapped 1km resolution estimates. It's clear from the comparison that there is much more variability in the urban background NO_2 measurements than the mapped concentrations; and at some locations the mapped concentrations are much lower than measured. The background monitoring locations are in areas with a high density of major roads and roundabouts, so measured concentrations will be influenced by various emission sources at each location. Awareness of the difference in measured vs mapped background concentrations is important when considering model verification (described later), model uncertainty and the source apportionment results.

Table 2-4: Background NO_2 annual mean 2019 - measured vs background maps (µg.m^{-3})

Site ID	Study area	Centroid of 1km background map	Measured NO_2	Mapped NO_2
SUN_01	Sunbury	510500, 170500	33	21
SCC_ECO	Lower Halliford	509500, 169500	17	21
SP1	Moor Lane	503500, 171500	27	22
SP20	Staines	504500, 171500	31	20
SP21	Ashford	509500, 169500	24	21
SP24	Moor Lane	502500, 172500	28	28
SP49	Moor Lane	502500, 173500	36	24

Table 2-5: Background PM_{10} and $PM_{2.5}$ annual mean 2019 - measured vs background maps (µg.m^{-3})

Site ID	Study area	Centroid of 1km background map	Measured PM_{10}	Mapped PM_{10}	Measured $PM_{2.5}$	Mapped $PM_{2.5}$
SUN_01	Sunbury	510500, 170500	15.7	17.0	9.9	11.7
SCC_ECO	Lower Halliford	509500, 169500	24.6	16.6	12.9	11.5
SP1	Moor Lane	503500, 171500	-		-	
SP20	Staines	504500, 171500	-		-	
SP21	Ashford	509500, 169500	-		-	
SP24	Moor Lane	502500, 172500	-		-	
SP49	Moor Lane	502500, 173500	-		-	

For the baseline assessment year of 2019, the background maps were used to provide estimated background annual mean concentrations of each pollutant for the 1km grid squares covering the study areas. The sector contributions from road traffic emissions on Motorway, Trunk, and A Class Roads were subtracted from the total background concentrations to avoid double counting of Road NO_x and PM from the road sources being explicitly modelled.

Figure 2.7 shows the mapped estimates of spatial variation in background NOx concentrations (excluding road contribution) across Spelthorne. The influence of Heathrow Airport on estimated background NOx in the north of the borough is apparent from this map.

The Defra background maps were also used to provide estimated background concentrations in the future assessment year of 2027. Figure 2-8 shows the mapped estimates of spatial variation in background NOx concentrations (excluding road contribution) across Spelthorne.

Figure 2.7: Background NOx 2019 (excluding emissions from major roads (µg.m-3))

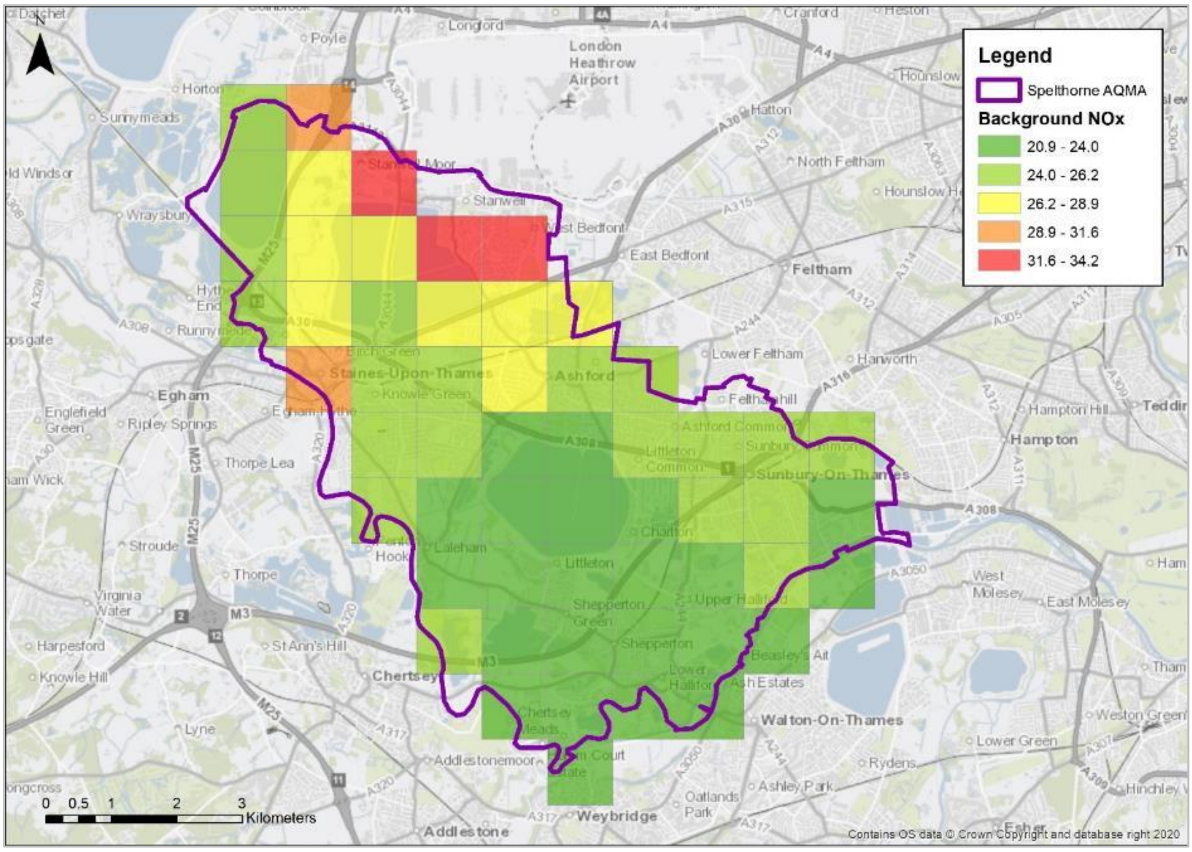
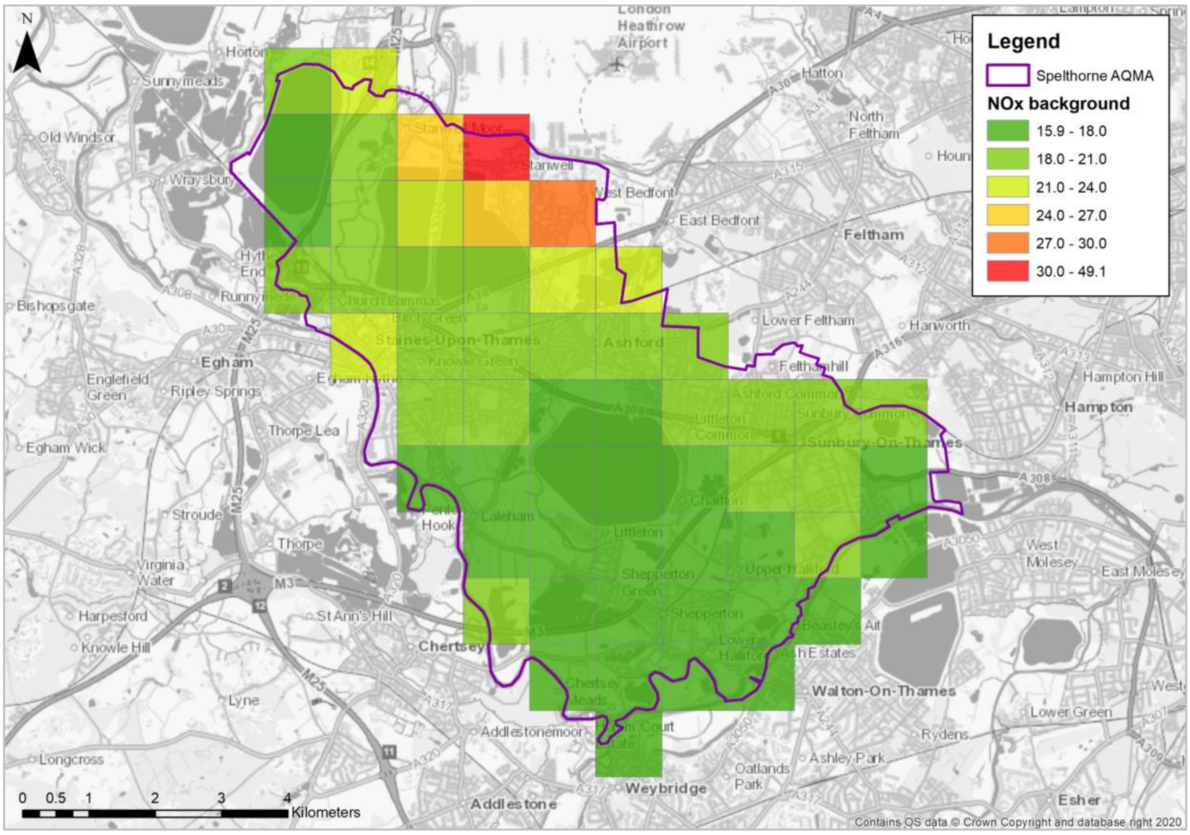


Figure 2-8: Background NOx estimate 2027 (excluding emissions from major roads (µg.m-3))



2.1.3 Road traffic activity data

2.1.3.1 Average flow, speed and fleet split

Average daily traffic flow and vehicle type fleet split data were collated from the following sources:

- Freely available 2019 Department for Transport (DfT) traffic counts.
- Local traffic surveys provided by Surrey County Council (2017 to 2018)
- A regional traffic model from 2014 provided by Surrey County Council

AADT traffic flows from previous years were projected forward to 2019 using a Spelthorne specific growth factor derived using the TEMPro V7.2[3] trip ends model.

The variety and age of the various traffic activity data sources is a significant source of uncertainty in this modelling assessment. Recent data sources such as the 2019 DfT counts and local surveys spanning multiple months in 2019 provided reasonably good datasets; however, some surveys e.g. seven-day counts from 2017 or 2018 may not be as representative of annual averages. It is also uncertain if the 2014 traffic model outputs growth factored forward to 2019 provided an accurate representation of baseline traffic flows.

Average vehicle speed data were provided by Surrey County Council. The speeds were derived from Trafficmaster GPS observations representing average speeds in 2019 over 24 hours from neutral days (i.e., Tuesdays through Thursdays excluding school holidays).

It should be noted that traffic patterns in urban locations are complex and it is not possible to fully represent these in atmospheric dispersion models. By attempting to describe these complex traffic patterns using quite simple metrics (AADT, average speed and vehicle split composition) a degree of uncertainty is introduced into the modelling.

Appendix 1 summarises the traffic flow and fleet split data used for the road links modelled.

2.1.3.2 Congestion

During congested periods, average vehicle speeds reduce when compared to the daily average; the combination of slower average vehicle speeds and more vehicles lead to higher pollutant emissions during peak hours; it's therefore important to account for this when modelling vehicle emissions to estimate pollutant concentrations.

No queue observation data from traffic surveys was available for the assessment. The LAQM.TG(16) guidance states that the preferred approach to representing the increase in vehicle emissions during peak periods is to calculate the emission rate for the affected roads for each hour of the day or week, using average speeds and traffic flow observations for each hour of the day. The hourly specific emission rates can then be used to calculate a 24-hour diurnal emission profile which can be applied to that section of road.

In this case there was insufficient hourly resolution average speed data to calculate a 24-hour diurnal emission profile; we were however able to calculate an average diurnal traffic flow profile using the national traffic statistics TRA0307[4].

2.1.3.3 Vehicle emission factors

The Emissions Factor Toolkit[5] (EFT V10.0) was used in this assessment to calculate pollutant emission factors for each road link modelled. The calculated emission factors were then imported into the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EFT, and an emissions factor in grams of pollutants/kilometre/second is generated for input into the dispersion model. In the latest version of the EFT, NO_x emission factors previously based on DFT/TRL functions have been replaced by factors from COPERT 5 v0.1067. These emission factors are widely used for

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[3] https://www.gov.uk/government/publications/tempro-downloads
[4] https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra
[5] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

the purpose of calculating emissions from road traffic in Europe. Defra recognises these as the current official emission factors for road traffic sources when conducting local, regional and national scale dispersion modelling assessments.

The EFT also includes addition of road abrasion emission factors for particulate matter; and changes to composition of the vehicle fleet in terms of the proportion of vehicle km travelled by each Euro standard, technology mix, vehicle size and vehicle category. Much of the supporting data in the EFT is provided by the Department for Transport (DfT), Highways Agency and Transport Scotland.

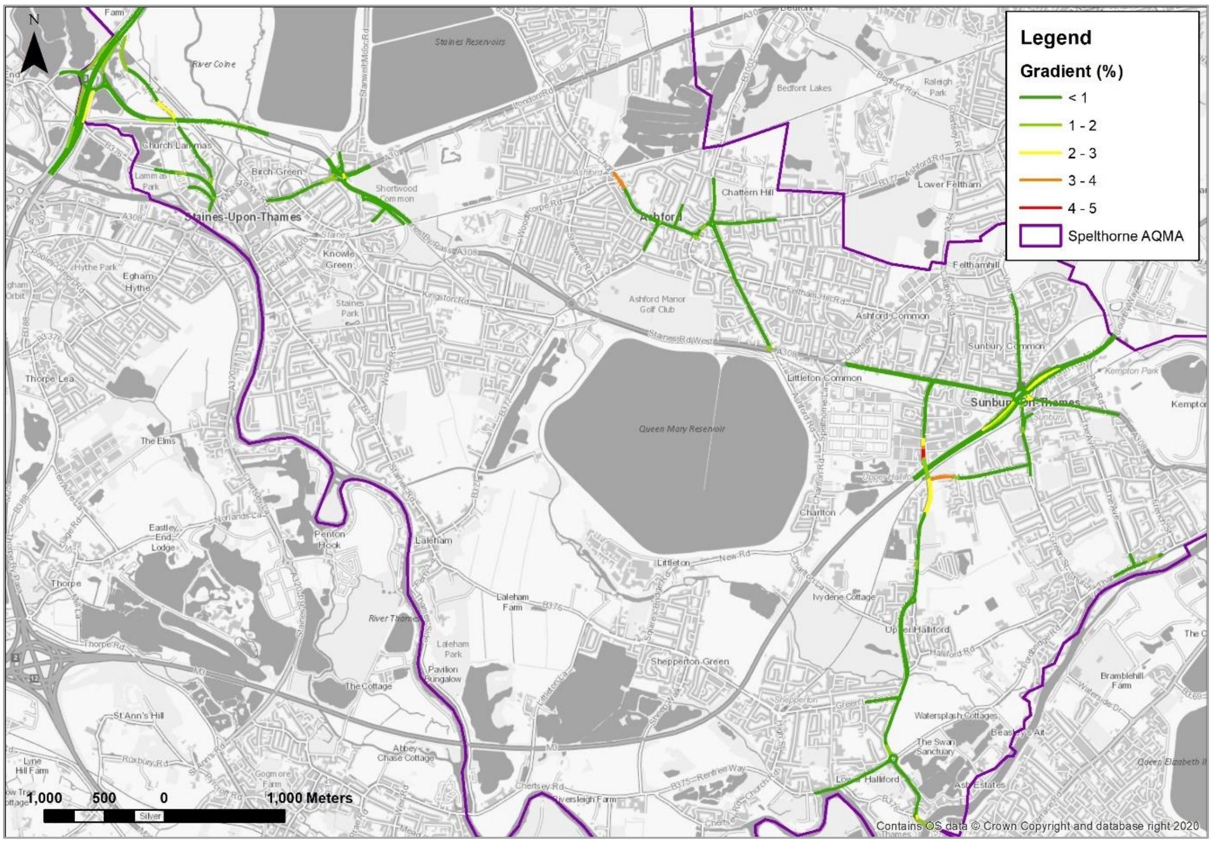
Vehicle emission projections are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. Any inaccuracy in the projections or the COPERT 5 emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

2.1.3.4 Gradients

Vehicle emissions increase and decrease when ascending and descending hills. When calculating vehicle emissions, gradient effects have been included for all road links in the model domain using the gradient input option in the EFT (v10.0).

Gradients for each ADMS road link were calculated using surface elevations sampled from LIDAR Composite Digital Surface Model (DSM) datasets at 0.5m resolution[6]. A map showing the range of calculated link gradients throughout the model domain is presented in Figure 2.9. In general, the topography in each study area is fairly flat with only a few locations where gradients will affect vehicle emissions.

Figure 2.9: Road link gradients calculated using GIS analysis of LIDAR DSM datasets



[6] https://remotesensingdata.gov.scot/data#/map

2.1.4 Surface roughness and street canyons

Surface roughness ranging from 0.5 to 1m was used in the modelling to represent the suburban and urban areas within the model domains. A limit for the Monin-Obukhov length of 30m was applied to represent a large urban area.

To simulate the effect of building adjacent to the roads being modelled; road links were modelled as several street canyons using the advanced street canyon module in ADMS-Roads.

The 'Advanced street canyon' modelling option in ADMS Roads modifies the dispersion of pollutants from a road source according to the presence and properties of canyon wall or one or both sides of the road. It differs from the ADMS Roads 'basic canyon' model in the following ways[7]:

- The model has been formulated to consider a wider range of canyon geometries, including canyon asymmetry;
- the concentrations predicted by the model vary with height within the canyon;
- Emissions may be restricted to a subset of the canyon width so that they may be specified only on road lanes and not on pedestrian areas; and,
- Concentrations both inside and outside a particular street canyon are affected when running this model option.

Accurate and up to date digital representations of building footprints and relative heights were available from the latest Ordnance Survey Mastermap Topography Layer® GIS datasets. Building heights, building footprints, road centreline geometry and road widths from the OS Mastermap data were all used for the advanced canyon calculations.

2.1.5 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2019 from the London Heathrow site was used for the modelling assessment. The meteorological measurement site is located approximately 10km north of each study area and has excellent data quality for the period of interest. Meteorological measurements are subject to their own uncertainty which may unavoidably carry forward into this assessment.

2.1.6 Treatment of modelled NO_x road contribution

It is necessary to convert the modelled NO_x concentrations to NO_2 for comparison with the relevant objectives. The latest version of the Defra NO_x/NO_2 calculator[8] was used to calculate NO_2 for comparison from the NO_x concentrations predicted by ADMS-Roads. The model requires input of the background NO_x, the modelled road contribution and accounts for the proportion of NO_x released as primary NO_2. For the Spelthorne area in 2019 with the "All other UK urban traffic" option in the model, the NO_x/NO_2 model estimates that 29% of NO_x from local road vehicles is released as primary NO_2.

2.1.7 Validation of ADMS-Roads

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out comparison studies on behalf of local authorities and Defra.

2.1.8 Mapping data

Ordnance survey Master Map datasets were used in the assessment. This enabled accurate road widths and the distance of the housing to the kerb to be determined using a GIS.

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[7] CERC(2015) ADMS –Roads Air Quality Management System Version 5.0 User Guide
[8] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

2.2 Model Verification

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. It is considered best practice to verify modelled pollutant predictions from road traffic against local monitoring data (classified as roadside sites) where available. This helps to identify how the model is performing at the various monitoring locations.

The verification process also involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in acceptable agreement with the monitoring results. This can be followed by adjustment of the model results if required to gain good agreement. LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration with which these are combined.

The approach outlined in Box 7.15 of LAQM.TG(16) has been used for model verification in all study areas. Modelled road NO_x concentrations were verified using 2019 measurements within each model domain. Defra's NO_x/NO_2 calculator was used to convert measured NO_2 to NOx.

Verifying modelling data with diffusion tube monitoring data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has notable uncertainty). The model results should be considered in this context. Further information on the verification process including the linear regression analysis is provided in Appendix 3.

NOx adjustment factors were derived for each modelling domain. As there were no roadside measurements of PM_{10} or $PM_{2.5}$ in any of the domains, the NOx adjustment factors were used to adjust modelled concentrations of PM_{10} and $PM_{2.5}$ as well.

Model uncertainty was evaluated by calculating the root mean square error (RMSE) of the modelled vs measured annual mean NO_2 concentrations. The LAQM.TG(16) guidance suggests that an RMSE value of less than 10% of the objective being assessed indicates acceptable model performance.

In general, all of the road NOx adjustment factors derived for each study area are relatively high (between 2.5 and 4.4) which indicates that either traffic activity or background concentrations have been underestimated.

2.2.1 Sunbury

A domain-wide NOx adjustment factor of **2.4784** was derived from six NO_2 measurement sites in Sunbury. The calculated RMSE was 4.28 $\mu g.m^{-3}$ after adjustment.

Two clear outliers were apparent when comparing modelled with measured Road NOx. At the SP35 (Vicarage Road) and at SPEB01-03 (A316), road NOx concentrations were underpredicted by a much larger factor than at other locations within Sunbury. Model performance at these locations was improved slightly by refining road geometry and receptor placement in ADMS. We concluded that uncertainties in the traffic activity data was most likely to be the cause of the significant underestimation of road emissions here. These two monitoring sites were excluded as outliers from the domain-wide verification and site-specific Road NOx adjustment factors were calculated.

At Vicarage Road the 2019 AADT had been calculated from the 2014 traffic model outputs; the low AADT here (under 5,000 vehicles) seemed uncertain. Following investigation of the availability of any updated traffic activity information there were no other options to refine the model inputs further. A site-specific NOx adjustment factor of 4.0 was calculated for Diffusion tube SP35 on Vicarage Road.

At the A316 eastbound triplicate (SPEB01-03) diffusion tube site the site-specific Road NOx adjustment factor was 4.3. At this location there was uncertainty in the NO_2 measurements as the diffusion tubes captured data for six months only (June-November 2019); which were then adjusted to an annual mean by Highways England.

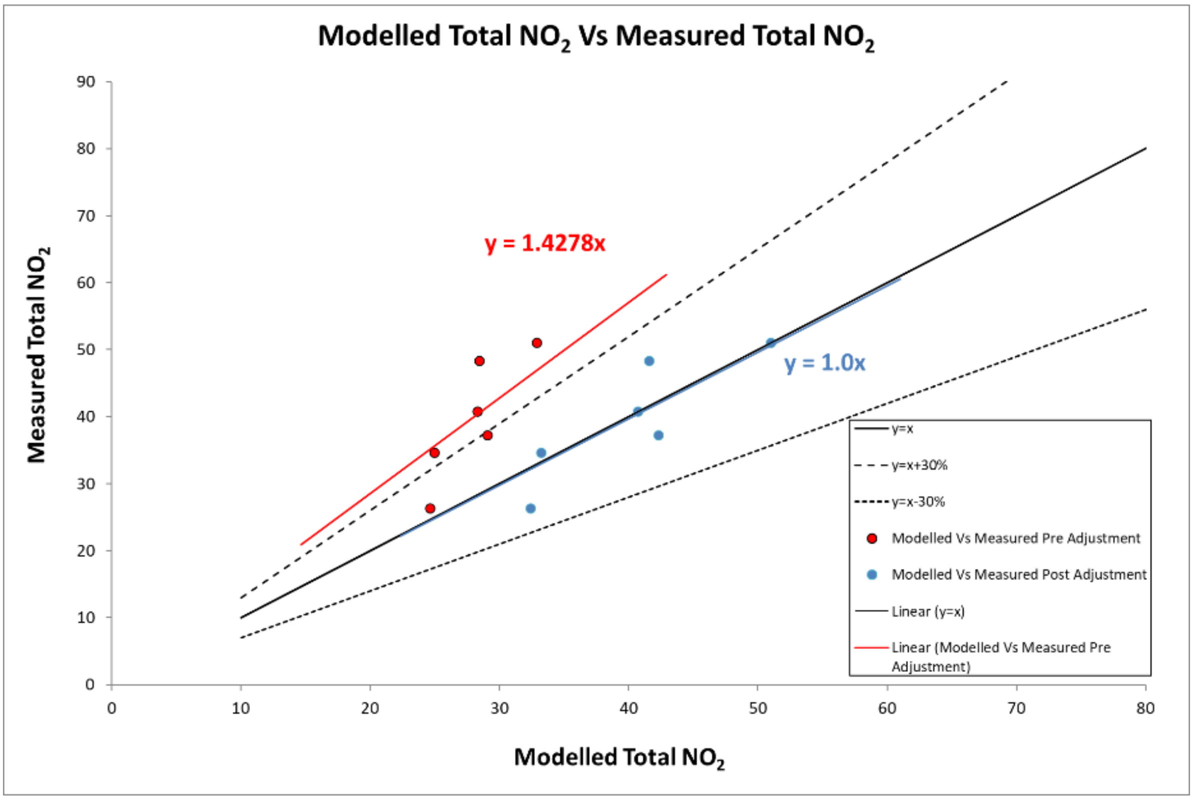
For both locations, the site-specific adjustment factor has been applied to receptor results close to those monitoring sites only.

Table 2-6: Sunbury measured vs modelled NO_2 post adjustment

Measurement site	Site Name	Measured NO_2 (µg m^{-3})	Modelled NO_2 (µg.m^{-3})
SP9	Staines Road West	40.8	40.7
SP36	St Ignatius School, Green St	34.6	33.2
SP4	Benwell Centre	26.3	32.4
SP58	Sunbury Cross (East)	51.1	51.0
SP52	Staines Road East	37.3	42.3
SPWB01-03	A316 Westbound	48.3	41.6
		RMSE	**4.28**
Outliers (site specific Road NOx adjustment applied)			
SP35*	Vicarage Road	41.6	41.6
SPEB01-03*	A316 Eastbound (Costco)	58.5	58.5

***Locations excluded from domain-wide verification**

Figure 2.10: Sunbury modelled vs. measured annual mean NO_2 concentrations 2019



2.2.2 Staines

A domain-wide road NOx adjustment factor of **2.8352** was derived from three NO_2 measurement sites on London Road and at the Crooked Billet Roundabout.

The calculated RMSE of the modelled vs measured annual mean NO_2 concentrations in Staines was 2.09 µg.m^{-3} after adjustment, which is within the suggested value (10% of the objective being assessed). The model has therefore performed well for use within this type of assessment.

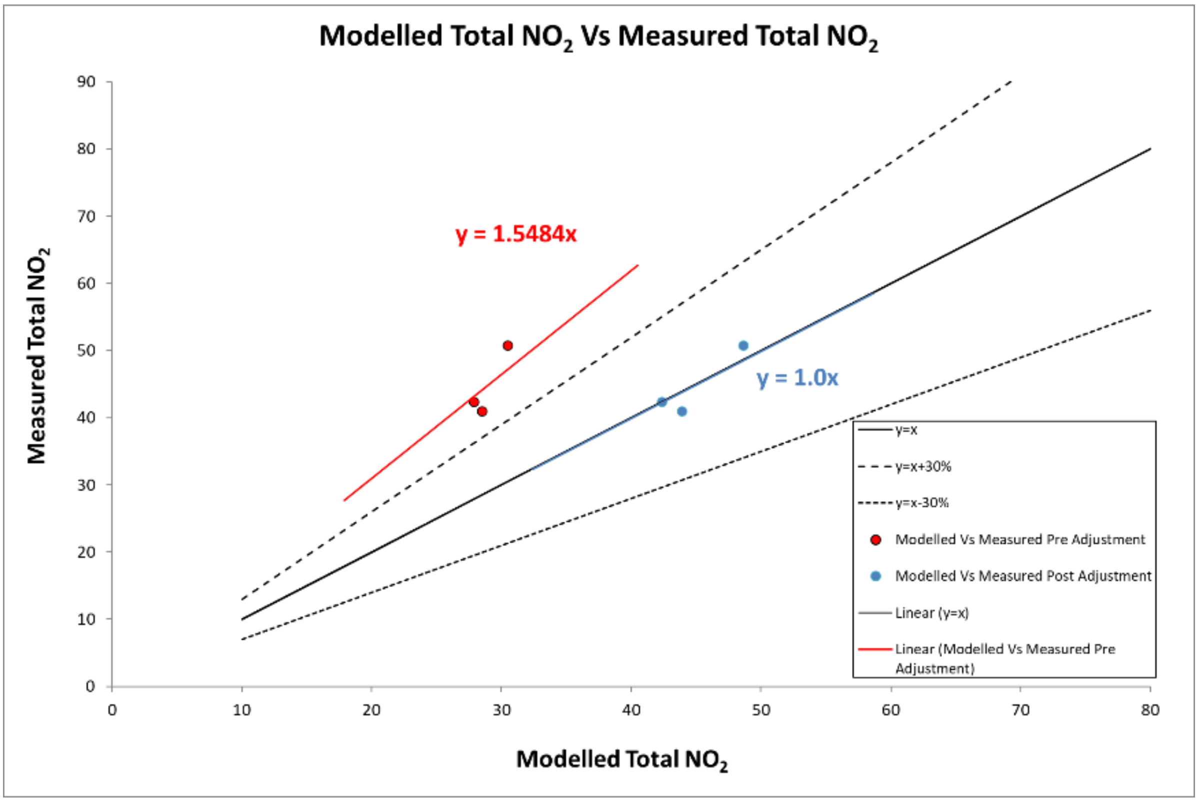
Applying a domain-wide adjustment factor has caused an over-estimation of modelled NO_2 concentrations at SP51 by 2.9 µg.m^{-3}. The model results at this location should be considered in context with this overestimation.

As there were no monitoring locations within the Georgian Close study area, the NOx adjustment factor derived for Staines has also been applied to the Georgian Close model results.

Table 2-7: Staines measured vs modelled NO_2 post adjustment

Measurement site	Name	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
SP51	Fairfield Avenue	41.0	43.9
SP28	London Road	42.4	42.4
SP29	London Road	50.8	48.6
		RMSE	**2.09**

Figure 2.11: Staines modelled vs. measured annual mean NO_2 concentrations 2019



2.2.3 Ashford

A domain-wide NOx adjustment factor of **3.2084** was derived from three monitoring locations in Ashford. The RMSE of the modelled vs measured annual mean NO_2 concentrations after adjustment was 2.93 $\mu g.m^{-3}$. The model has therefore performed well for use within this type of assessment.

Table 2-8: Ashford measured vs modelled NO_2 post adjustment

Measurement site	Name	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
SP5	Church Street	40.7	38.8
SP32	Feltham Road	31.0	35.4
SP34	School Road	38.6	37.1
		RMSE	**2.93**

Figure 2.12: Ashford modelled vs. measured annual mean NO_2 concentrations 2019

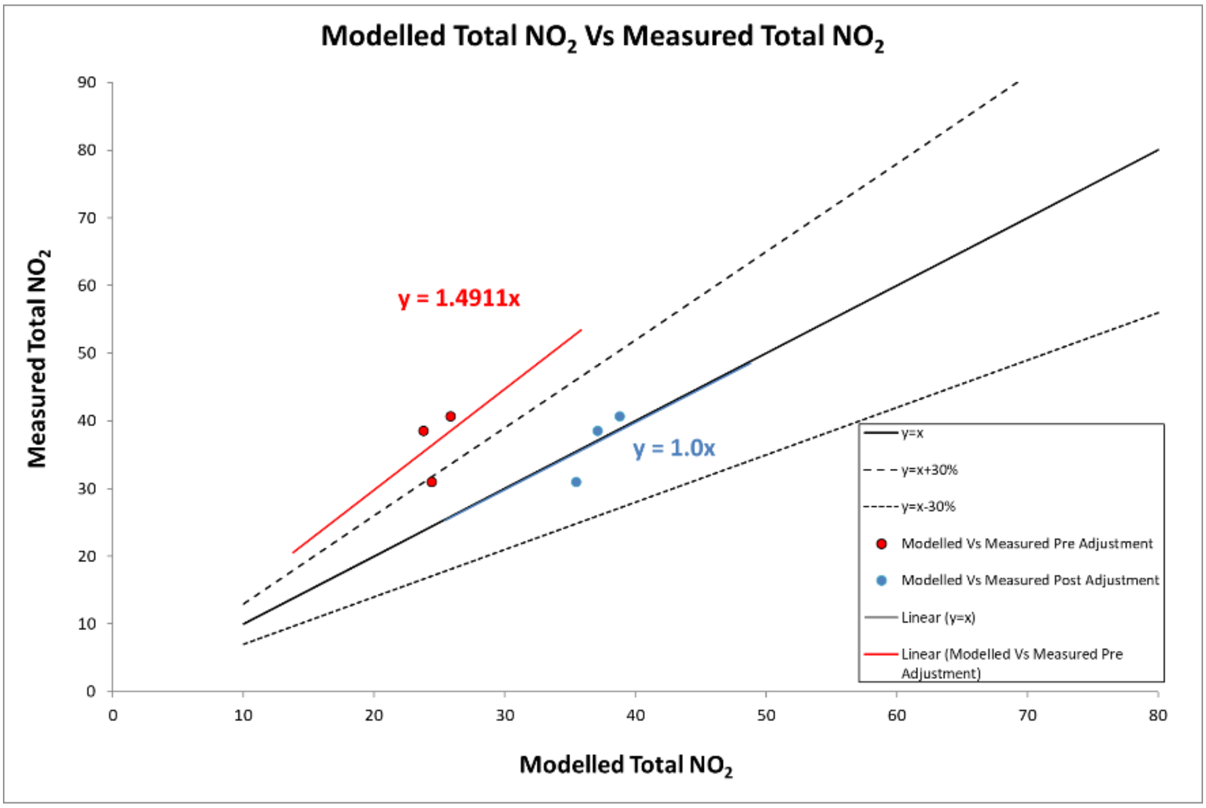


Table 2-9: Ashford measured vs modelled NO_2 post adjustment

Measurement site	Name	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
SP5	Church Street	40.7	38.8
SP32	Feltham Road	31.0	35.4
SP34	School Road	38.6	37.1
		RMSE	**2.93**

2.2.4 Lower Halliford

A domain-wide NOx adjustment factor of **3.3067** was derived from four monitoring locations in Lower and Upper Halliford.

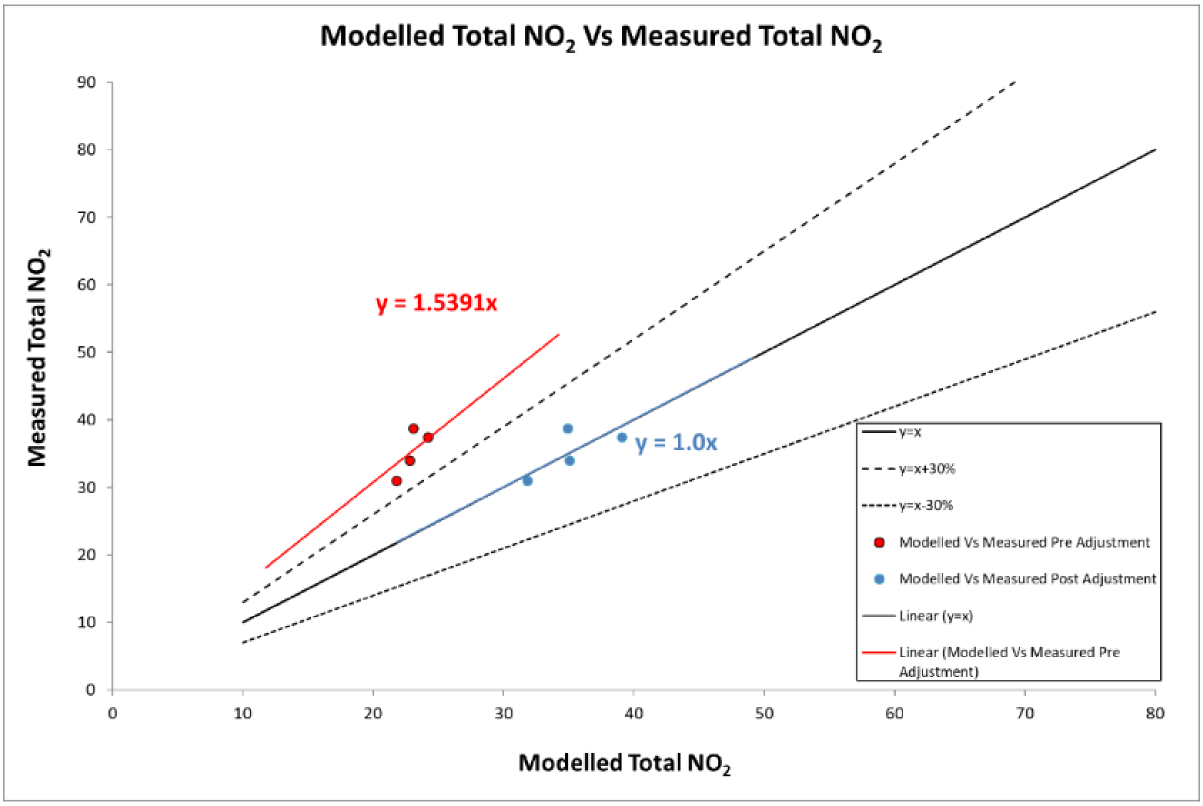
The RMSE of the modelled vs measured annual mean NO_2 concentrations after adjustment was 2.22 $\mu g.m^{-3}$ indicating that the model has performed reasonably well for use within this type of assessment.

As there were no monitoring locations within the Thames Street study area, the NOx adjustment factor derived for Lower Halliford has also been applied to the Thames Street model results.

Table 2-10: Lower Halliford measured vs modelled NO_2 post adjustment

Measurement site	Name	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
SP10	Walton Bridge Road	37.4	39.1
SP54	Russell Road	31.0	31.8
SP55	Green Lane	38.8	34.9
SP11	Halliford Bypass	34.0	35.1
		RMSE	**2.22**

Figure 2.13: Lower Halliford modelled vs. measured annual mean NO_2 concentrations 2019



2.2.5 Moor Lane

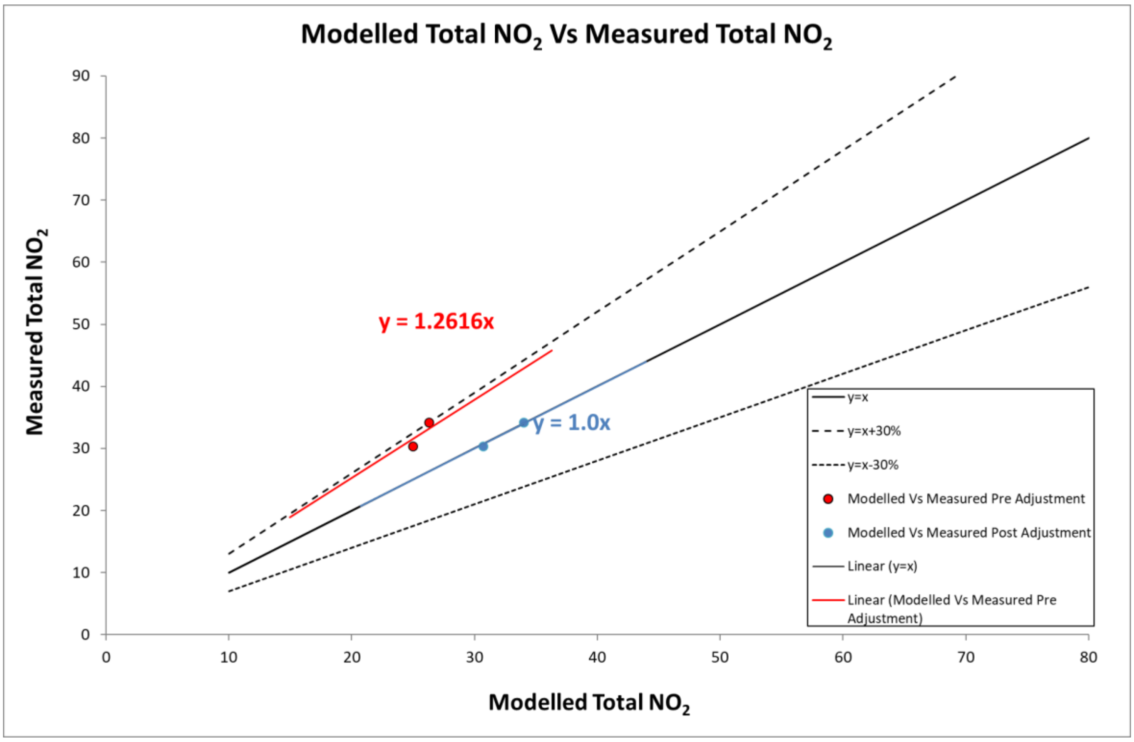
A domain-wide NOx adjustment factor of **2.5974** was derived from two monitoring locations near Moor Lane in Staines.

The RMSE of the modelled vs measured annual mean NO_2 concentrations after adjustment was 0.27 $\mu g.m^{-3}$ indicating that the model has performed well for use within this type of assessment.

Table 2-11: Moor Lane area measured vs modelled NO_2 post adjustment

Measurement site	Name	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
SP3	Wraysbury Road	30.4	30.7
SP27	Church Street, Staines	34.2	34.0
		RMSE	**0.27**

Figure 2.14: Moor Lane modelled vs. measured annual mean NO_2 concentrations 2019



3 Model Results

For all pollutants assessed, modelled annual mean concentrations have been presented using:

- Contours plots representing the modelled spatial variation in annual mean pollutant concentrations; and show where hotspot locations are.
- Tabulated numerical results at specified receptor locations where there is relevant human exposure; these results can be compared with the air quality objectives.

To create the pollutant contours, annual mean pollutant concentrations were predicted across a grid of points. The source-oriented grid option was used in ADMS-Roads, this option provides finer resolution of predicted pollutant concentrations along the roadside, with a wider grid spaced at approximately 5m being used to represent concentrations further away from the road at 1.5m (ground floor) height. The gridded point results are then interpolated to produce contour plots representing the spatial variation of predicted annual mean concentrations across the study area.

The interpolation process calculates average concentrations between each grid point; the contour values should be considered in this context and will not match exactly with the numerical results at specified receptor points. The tabulated model results at specified receptors are most relevant to compare with the air quality objectives.

Model receptors have been placed at the facade of buildings in the model domain where relevant exposure exists within the pollution hotspots identified from the modelled contour plots. The receptors have been modelled at ground level (1.5m); and at first floor height (4m) where residential apartments are above ground level commercial properties.

Assessment of compliance with the NO_2 1-hour mean (short-term) objective

It is difficult to accurately predict if the NO_2 1-hour mean objective is being exceeded using dispersion modelling. LAQM.TG(16) states that if an annual mean NO_2 concentration in excess of $60 \mu g.m^{-3}$ is measured, an exceedance of the 1-hour mean objective may be occurring.

Source apportionment

Where annual mean pollutant concentrations close to, or in excess of the respective air quality objectives have been predicted, source apportionment has been conducted at up to three worst-case receptors within each study area. Source apportionment is the process whereby the contribution of different pollutant sources to annual mean concentrations are quantified. This aims to provide information about which sources are most significant when considering measures to improve air quality.

In this case, the available traffic data and background maps allowed calculation of the proportion of total pollutant concentrations attributable to various vehicles categories using the source apportionment functionality in the emission factors toolkit (EFT).

The following sources were considered:

- Background concentrations
- Petrol Cars
- Diesel Cars
- LGVs
- HGV Rigid
- HGV Artic
- Buses
- Motorcycles

3.1 Sunbury-on-Thames results

3.1.1 Recent baseline (2019) model

3.1.1.1 NO_2 results (2019) Sunbury

Contour plots showing the predicted spatial variation in annual mean NO_2 concentrations at various locations in the Sunbury study area at ground floor level (1.5m) are presented in Figure 3.5 to Figure 3.9.

Maximum ground level concentrations have been predicted at locations approaching the main junctions within the study area and at locations adjacent to the A316 carriageway. The contour plots indicate that NO_2 annual means in excess of the 40 µg.m^{-3} objective may have occurred at various residential properties at these hotspot locations in 2019.

A selection of model receptor points has been placed at the facade of buildings where relevant exposure exists within the pollution hotspots identified from the contour plots. A receptor has also been placed at the bus stop on the A316 eastbound carriageway (close to Costco) to assess if there is a risk of the 1-hour NO_2 objective being exceeded there. Receptors have been modelled at ground level (1.5m) and first floor height (4m) where relevant.

Modelled NO_2 annual mean at the specified receptors points are presented in Table 3-1 and are also shown with locations on maps using graduated colours in Figure 3.1 to Figure 3.4.

NO_2 annual mean in excess of the 40 µg.m^{-3} objective were predicted at both ground level receptor locations at Vicarage Road, Staines Road West and Green St; all of which are located close to junctions where average traffic speeds are likely to be low.

The results should be considered in context with the dispersion model performance at these locations and the associated uncertainty (please see model verification information presented above). As model agreement for diffusion tube SP9 on Staines Road West was good (i.e. the model underpredicted NO_2 the concentration by 0.1 µg.m^{-3}), it is likely that exceedances of the objective did occur at residential properties here during 2019. Similarly, as the model underpredicted at diffusion tube SP36 on Green Street by 1.4 µg.m^{-3}, the modelled exceedance at the nearby Green Street 1 receptor location is also likely.

Annual mean NO_2 concentrations in excess of 60 µg.m^{-3} are not predicted at any locations where anyone is likely to spend an hour or more; which indicates that it is unlikely that the short term NO_2 objective is being exceeded; this includes the A316 bus stop.

Table 3-1: Predicted NO_2 annual mean at specified receptors – Sunbury 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean ($\mu g.m^{-3}$)
Vicarage Rd 1*	510004	170200	1.5	**42.0**
A316 bus stop*#	510602	170453	1.5	58.0
Sunbury Cross 1	509959	170144	4	36.9
Vicarage Rd 2*	510033	170209	1.5	39.6
Staines Rd W 1	509727	170129	1.5	**44.4**
Staines Rd W 2	509577	170189	1.5	38.1
Staines Rd W 3	509302	170203	1.5	**42.4**
Windmill Rd 1	509207	169844	1.5	38.5
Nursery Rd 1	509621	169457	1.5	21.7
Nursery Rd 2	509882	169530	1.5	20.8
Green St 1	510092	169517	1.5	**43.1**
Green St 2	510032	169756	1.5	29.5
Staines Rd E 1	510374	170009	1.5	29.7
Staines Rd E 2	510670	169964	1.5	33.6
Vicarage Rd 3*	509996	170415	1.5	30.0
Staines Rd E 3	510704	169981	1.5	33.7

Exceedances of the annual mean objective are highlighted in bold
*** Zonal/site specific verification applied**
 # 1-hour mean objective applies at the A316 bus stop

Figure 3.1: NO_2 annual mean at receptors – Vicarage Road & A316 Country Way, Sunbury

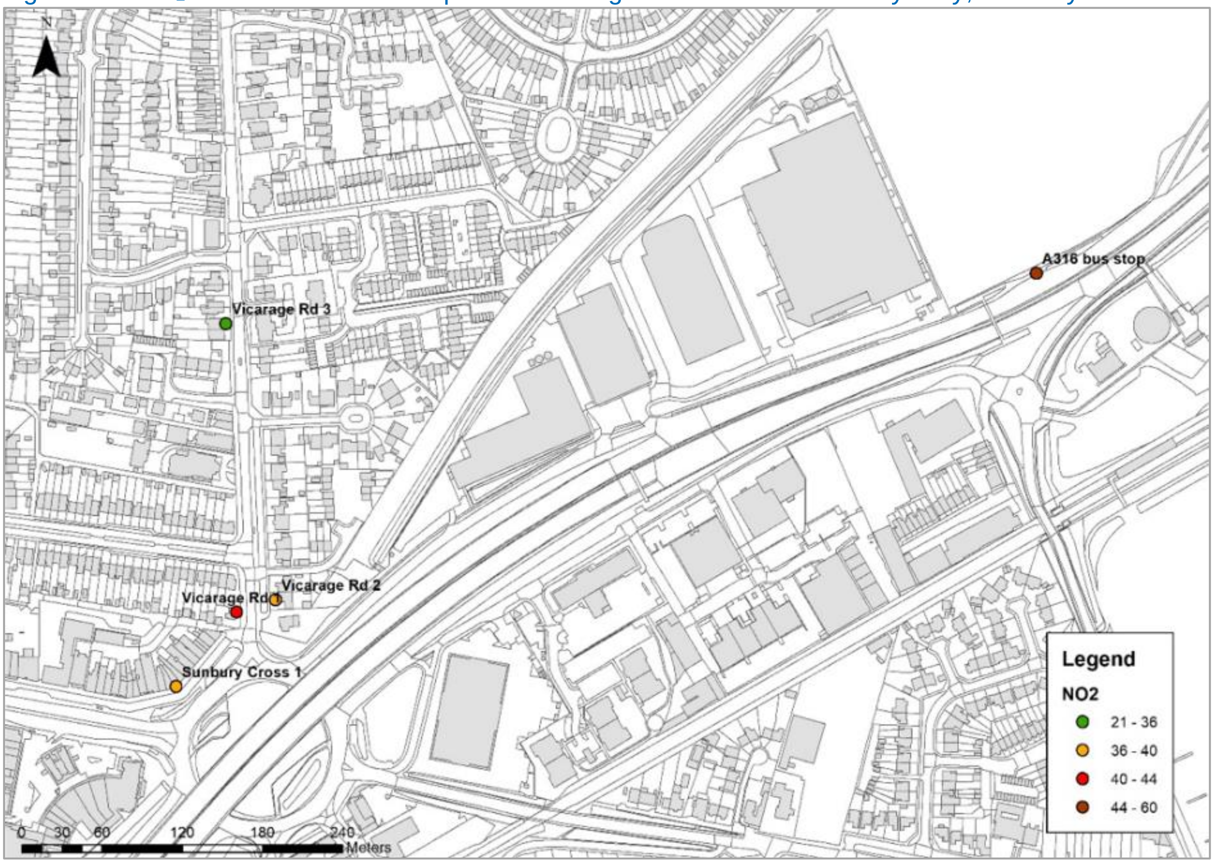


Figure 3.2: NO_2 annual mean at receptors – Staines Road West, Sunbury

Figure 3.3: NO_2 annual mean at receptors – Green Street, Sunbury

Figure 3.4: NO_2 annual mean at receptors Sunbury – Staines Road East, Sunbury

Figure 3.5: Modelled NO_2 annual mean concentrations – Vicarage Road, Sunbury

Figure 3.6: Modelled NO_2 annual mean concentrations – Staines Road West, Sunbury

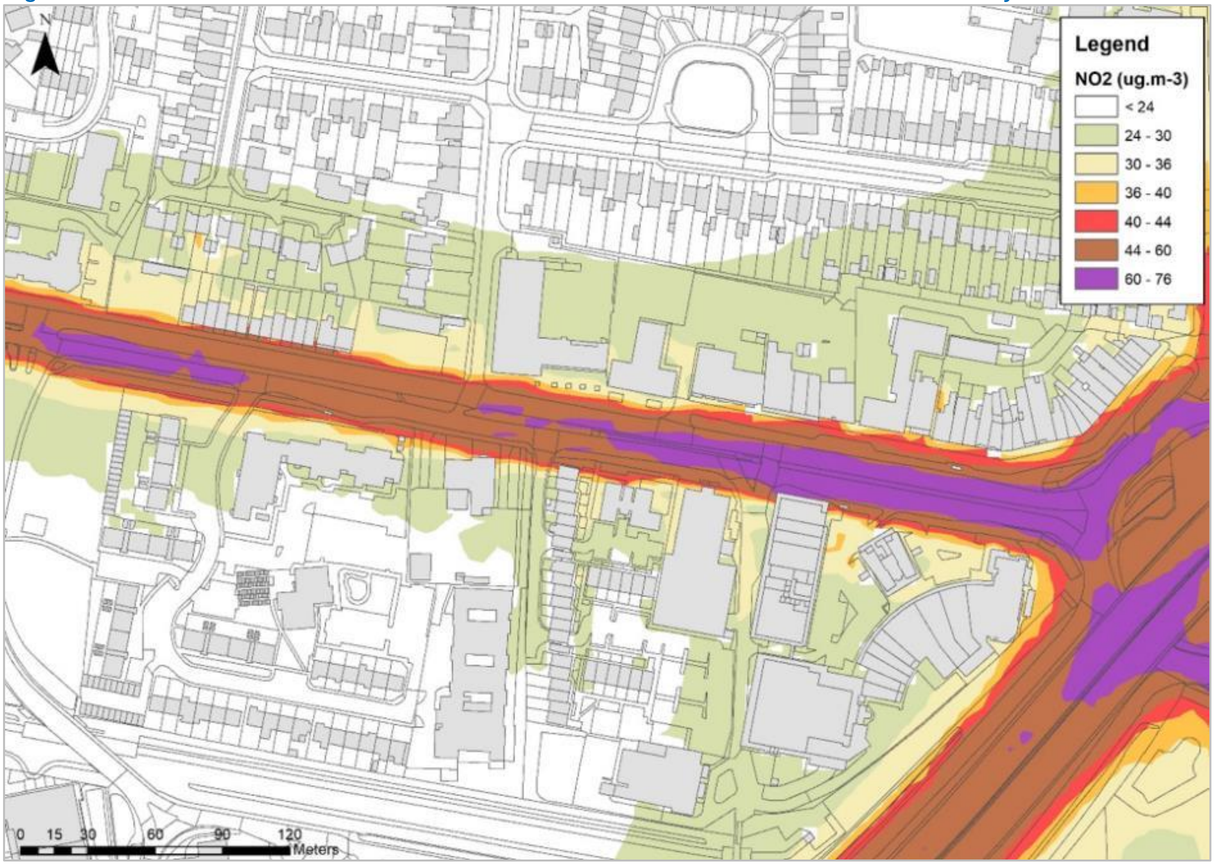


Figure 3.7: Modelled NO_2 annual mean concentrations – Staines Road West & Windmill Road, Sunbury

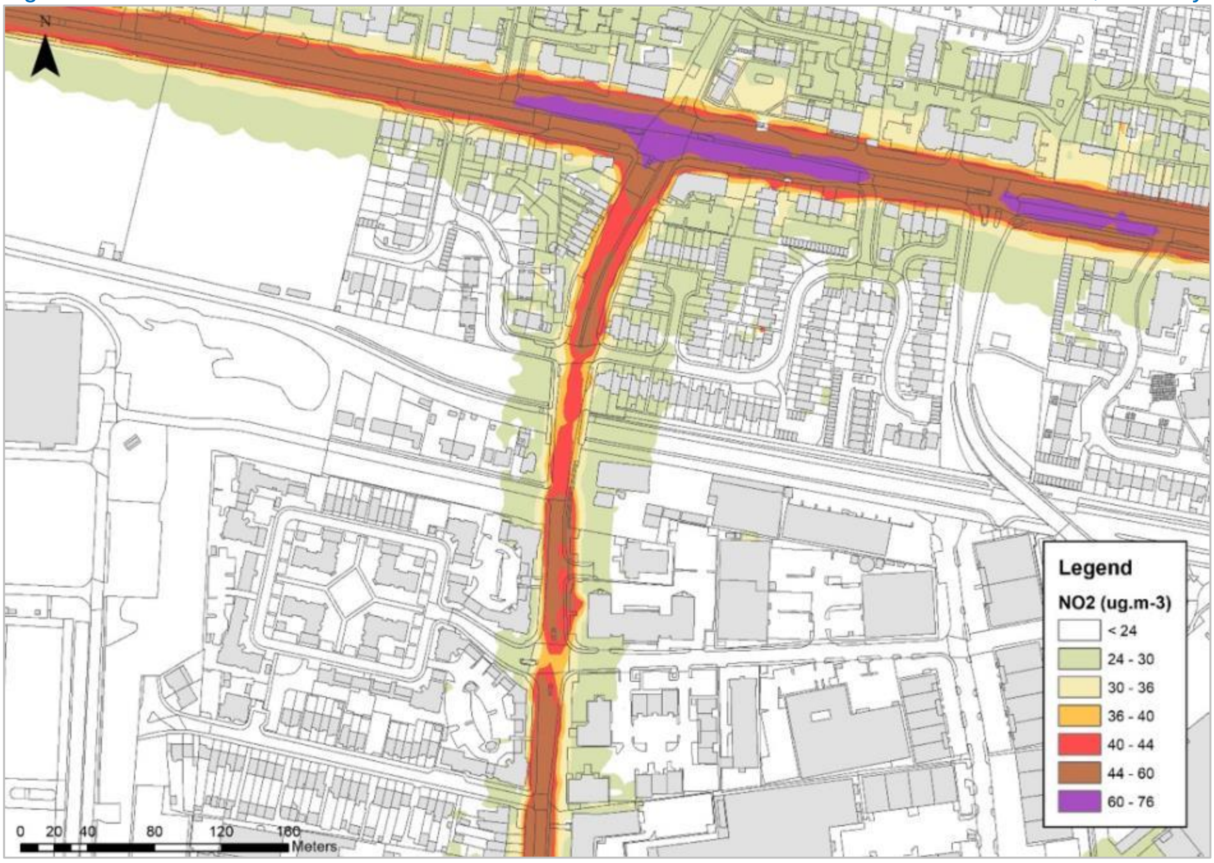


Figure 3.8: Modelled NO_2 annual mean concentrations – Green Street, Sunbury

Figure 3.9: Modelled NO_2 annual mean concentrations – Staines Road East, Sunbury

3.1.1.2 PM_{10} results (2019) Sunbury

Contour plots showing the predicted spatial variation in annual mean PM_{10} concentrations in the Sunbury study area at ground floor level (1.5m) are presented in Figure 3.10 to Figure 3.12. The contours indicate that the 40 µg.m^{-3} annual mean PM_{10} objective is not being exceeded at any locations at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in Table 3-2. No annual mean PM_{10} concentrations in excess of the 40 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-2: Predicted annual mean PM_{10} concentrations at specified receptors 2019 – Sunbury

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
Vicarage Rd 1*	510004	170200	1.5	21.4
A316 bus stop*	510602	170453	1.5	29.9
Sunbury Cross 1	509959	170144	4	20.5
Vicarage Rd 2*	510033	170209	1.5	21.1
Staines Rd W 1	509727	170129	1.5	22.6
Staines Rd W 2	509577	170189	1.5	20.6
Staines Rd W 3	509302	170203	1.5	21.0
Windmill Rd 1	509207	169844	1.5	20.4
Nursery Rd 1	509621	169457	1.5	17.1
Nursery Rd 2	509882	169530	1.5	16.9
Green St 1	510092	169517	1.5	20.3
Green St 2	510032	169756	1.5	18.2
Staines Rd E 1	510374	170009	1.5	18.9
Staines Rd E 2	510670	169964	1.5	19.2
Vicarage Rd 3*	509996	170415	1.5	19.2
Staines Rd E 3	510704	169981	1.5	19.3

Figure 3.10: Sunbury PM_{10} annual mean concentrations – Vicarage Road

Figure 3.11: Sunbury PM_{10} annual mean concentrations along Staines Road West

Figure 3.12: Sunbury PM_{10} annual mean concentrations along Staines Road East

3.1.1.3 $PM_{2.5}$ results

Contour plots showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Sunbury study area at ground floor level (1.5m) are presented in Figure 3.13 to Figure 3.15. The contours indicate that the 25 µg.m^{-3} annual mean $PM_{2.5}$ objective is not being exceeded at any locations at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-3. No annual mean $PM_{2.5}$ concentrations in excess of the 25 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-3: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors 2019 – Sunbury

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean (µg.m^{-3})
Vicarage Rd 1*	510004	170200	1.5	14.4
A316 bus stop*	510602	170453	1.5	19.3
Sunbury Cross 1	509959	170144	4	14.0
Vicarage Rd 2*	510033	170209	1.5	14.2
Staines Rd W 1	509727	170129	1.5	15.2
Staines Rd W 2	509577	170189	1.5	14.1
Staines Rd W 3	509302	170203	1.5	14.4
Windmill Rd 1	509207	169844	1.5	13.8
Nursery Rd 1	509621	169457	1.5	11.8
Nursery Rd 2	509882	169530	1.5	11.7
Green St 1	510092	169517	1.5	13.9
Green St 2	510032	169756	1.5	12.6
Staines Rd E 1	510374	170009	1.5	12.9
Staines Rd E 2	510670	169964	1.5	13.2
Vicarage Rd 3*	509996	170415	1.5	13.2
Staines Rd E 3	510704	169981	1.5	13.3

Figure 3.13: Sunbury $PM_{2.5}$ annual mean concentrations - Vicarage Road

Figure 3.14: Sunbury $PM_{2.5}$ annual mean concentrations along Staines Road West

Figure 3.15: Sunbury $PM_{2.5}$ annual mean concentrations along Staines Road East

3.1.1.4 Source apportionment – Sunbury

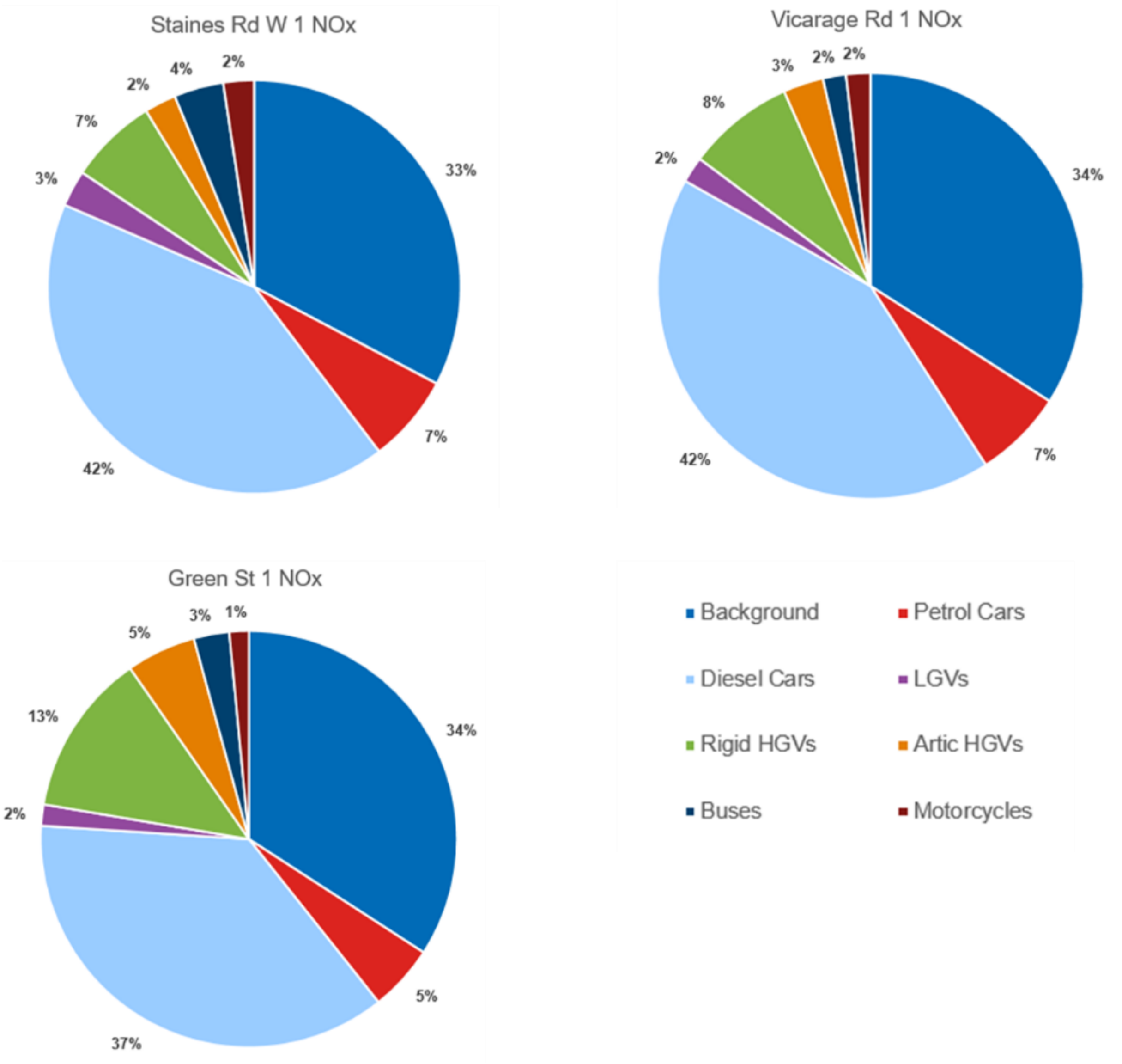
Where annual mean pollutant concentrations in excess of the respective air quality objectives have been predicted, source apportionment has been conducted at up to three worst-case receptors. In this case there were no modelled exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives; source apportionment of NOx only has been conducted.

Source apportionment of NOx was conducted at the three worst-case receptor locations: Staines Road West 1, Vicarage Road 1 and Green Street 1. Pies charts are presented in Figure 3.16.

At all three locations,

- The largest proportions of NOx were attributable to background concentrations (ranging from 37%-42%)
- Diesel cars account for the largest proportion of road NOx concentrations (ranging from 33%-34%).
- Rigid HGVs contributed 8%-13% of NOx emissions.
- LGV emissions are much less significant than HGVs (2%-3%).

Figure 3.16: Sunbury NOx source apportionment



3.1.2 Sunbury future baseline year and measures appraisal

The assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to annual mean pollutant concentration associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only as the 2019 baseline modelling indicated that PM_{10} and $PM_{2.5}$ annual mean were well below the respective objectives at all locations where there is relevant human exposure.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.

- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

3.1.2.1 Future year NO_2 annual mean results

Tabulated NO_2 annual mean results at specified receptor locations for each of the modelled scenario in 2027 are presented in Table 3-4.

Table 3-4: 2027 baseline and mitigation scenarios - NO_2 annual mean ($\mu g.m^{-3}$) at receptors in Sunbury

Receptor	Height (m)	2019 baseline	2027 baseline	2027 Option 1	2027 Option 2	2027 Option 3
Vicarage Rd 1*	1.5	**42.0**	27.0	26.7	26.7	26.3
A316 bus stop*#	1.5	58.0	36.3	35.9	36.0	35.3
Sunbury Cross 1	4	36.9	25.5	25.3	25.2	24.9
Vicarage Rd 2*	1.5	39.6	25.6	25.4	25.3	25.0
Staines Rd W 1	1.5	**44.4**	30.0	29.7	29.6	29.3
Staines Rd W 2	1.5	38.1	25.9	25.7	25.6	25.4
Staines Rd W 3	1.5	**42.4**	28.8	28.6	28.4	28.2
Windmill Rd 1	1.5	38.5	26.3	26.1	26.0	25.7
Nursery Rd 1	1.5	21.7	16.0	16.0	16.0	15.9
Nursery Rd 2	1.5	20.8	15.5	15.4	15.4	15.4
Green St 1	1.5	**43.1**	29.4	29.1	29.0	28.7
Green St 2	1.5	29.5	20.8	20.7	20.7	20.5
Staines Rd E 1	1.5	29.7	20.8	20.7	20.7	20.5
Staines Rd E 2	1.5	33.6	23.3	23.1	23.1	22.9
Vicarage Rd 3*	1.5	30.0	20.3	20.2	20.2	20.0
Staines Rd E 3	1.5	33.7	23.4	23.2	23.2	22.9

The results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be less than the 40 $\mu g.m^{-3}$ objective at all receptor locations identified as worst-case in 2019. The road traffic NOx emission mitigation options reduce the predicted NO_2 annual mean further and, on this basis, are not necessary to achieve compliance with the objective.

3.1.2.2 Compliance year

As the results indicate compliance with the NO_2 annual mean objective in 2027, it is useful to understand when compliance may be achieved without any intervention. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year. The interpolated results are presented in Table 3-5.

It is worth noting that this method of interpolation is likely to overestimate NO_2 annual mean concentrations at receptors during 2020 and 2021, during which traffic activity was reduced significantly because of Covid-19 pandemic restrictions. A further rough adjustment could be made to the interpolated estimates using the relative change in average vehicle flows (AADT) in 2020 and 2021 vs 2019 as a proxy for the change in road traffic emissions. This data is however not currently available. The interpolated results should be considered in context with this, and the other modelling uncertainties described in Section 4.

The simple linear interpolation based on the vehicle fleet and emission projections in the EFTv10.0 indicates compliance will be achieved without any intervention at residential receptors in Sunbury by 2022.

At the A316 bus stop the NO_2 1-hour mean objective is applicable as people may spend 1-hour or longer there. The typical rule of thumb is that if the NO_2 annual mean is greater than 60 µg.m^{-3} there may be a risk of non-compliance with the 1-hour mean objective; the interpolated results indicate that NO_2 annual mean will decline sufficiently for there to be no risk of this.

Table 3-5: Sunbury NO_2 annual mean (µg.m^{-3}) - Simple linear interpolation 2019 to 2027

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
Vicarage Rd 1*	**42.0**	**40.1**	38.3	36.4	34.5	32.6	30.8	28.9	27
A316 bus stop*#	**58.0**	**55.3**	**52.6**	**49.9**	**47.2**	**44.4**	**41.7**	39.0	36.3
Sunbury Cross 1	36.9	35.5	34.1	32.6	31.2	29.8	28.4	26.9	25.5
Vicarage Rd 2*	39.6	37.9	36.1	34.4	32.6	30.9	29.1	27.4	25.6
Staines Rd W 1	**44.4**	**42.6**	**40.8**	39.0	37.2	35.4	33.6	31.8	30
Staines Rd W 2	38.1	36.6	35.1	33.5	32.0	30.5	29.0	27.4	25.9
Staines Rd W 3	**42.4**	**40.7**	39.0	37.3	35.6	33.9	32.2	30.5	28.8
Windmill Rd 1	38.5	37.0	35.5	33.9	32.4	30.9	29.4	27.8	26.3
Nursery Rd 1	21.7	21.0	20.3	19.6	18.9	18.1	17.4	16.7	16
Nursery Rd 2	20.8	20.1	19.5	18.8	18.2	17.5	16.8	16.2	15.5
Green St 1	**43.1**	**41.4**	39.7	38.0	36.3	34.5	32.8	31.1	29.4
Green St 2	29.5	28.4	27.3	26.2	25.2	24.1	23.0	21.9	20.8
Staines Rd E 1	29.7	28.6	27.5	26.4	25.3	24.1	23.0	21.9	20.8
Staines Rd E 2	33.6	32.3	31.0	29.7	28.5	27.2	25.9	24.6	23.3
Vicarage Rd 3*	30.0	28.8	27.6	26.4	25.2	23.9	22.7	21.5	20.3
Staines Rd E 3	33.7	32.4	31.1	29.8	28.6	27.3	26.0	24.7	23.4

3.2 Staines-upon-Thames

3.2.1 Recent baseline (2019) model

3.2.1.1 NO_2 results (2019) Staines

Contour plots showing the predicted spatial variation in annual mean NO_2 concentrations in the Staines study area at ground floor level (1.5m) are presented in Figure 3.18 and Figure 3.19.

The maximum ground level concentrations have been predicted along London Road and near the Crooked Billet Roundabout. These contour plots indicate that NO_2 annual mean concentration in excess of the 40 $\mu g.m^{-3}$ objective may have occurred at some residential properties at these locations in 2019.

Model receptors have been placed at the facade of buildings where relevant exposure exists within the pollution hotspots identified from the modelled contour plots.

Receptors have been modelled at relevant heights. In Staines, there are commercial properties at ground floor level along the western section of London Road, with possible residential properties on the first floor. The eastern section of London Road has ground floor residential properties. Residential properties surrounding Crooked Billet Roundabout are at ground level.

Modelled NO_2 annual mean at specified receptors are presented in Table 3-6 and are also shown on a map using graduated colours in Figure 3.17.

Concentrations predicted at receptor locations are presented in Table 3-6. NO_2 annual mean in excess of the 40 $\mu g.m^{-3}$ objective were predicted at both ground level and first floor height receptor locations at London Road. Predicted concentrations were just less than the objective at receptors close to the Crooked Billet Roundabout

Considering the results in context with the dispersion model performance at these locations and the associated uncertainty (please see model verification information presented above). We know that the model overpredicted NO_2 concentrations at the SP51 diffusion tube site on London Road by 2.9 $\mu g.m^{-3}$; it is a reasonable assumption that concentrations at London Road receptors may also have been overpredicted. The predicted concentrations at the London Rd 2 and London Rd 5 receptors do exceed the 40 $\mu g.m^{-3}$ annual mean objective by more than this value; it is therefore likely that exceedances of the objective did occur at residential properties here during 2019.

The model also under-predicted concentrations at diffusion tube SP29 at the Crooked Billet Roundabout by 2.2 $\mu g.m^{-3}$. The modelled concentrations are therefore likely to have been under-predicted at the Crooked Billet RB 1 receptor, indicating that there may have been concentrations of up to 41.0 $\mu g.m^{-3}$ when model uncertainty at this location is taken into account.

Table 3-6: Predicted NO_2 annual mean at specified receptors – Staines 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean ($\mu g.m^{-3}$)
London Rd 1	503765.9	171731.4	4	**40.5**
London Rd 2	503865.1	171728.5	4	**45.9**
London Rd 3	503890.4	171751.4	4	39.4
London Rd 4	503965.6	171753.6	1.5	**42.1**
London Rd 5	504135.6	171838	1.5	**45.0**
London Rd 6	504144.3	171860.4	1.5	36.2
London Rd 7	504283.3	171911.8	1.5	37.8
Crooked Billet RB 1	504392.6	171961.8	1.5	38.8
Crooked Billet RB 2	504429.8	171913.9	1.5	37.3
Crooked Billet RB 3	504308.3	171892.9	1.5	36.1

Exceedances of the annual mean objective are highlighted in bold

Figure 3.17: Receptor locations and prediction annual mean NO_2 concentrations – Staines

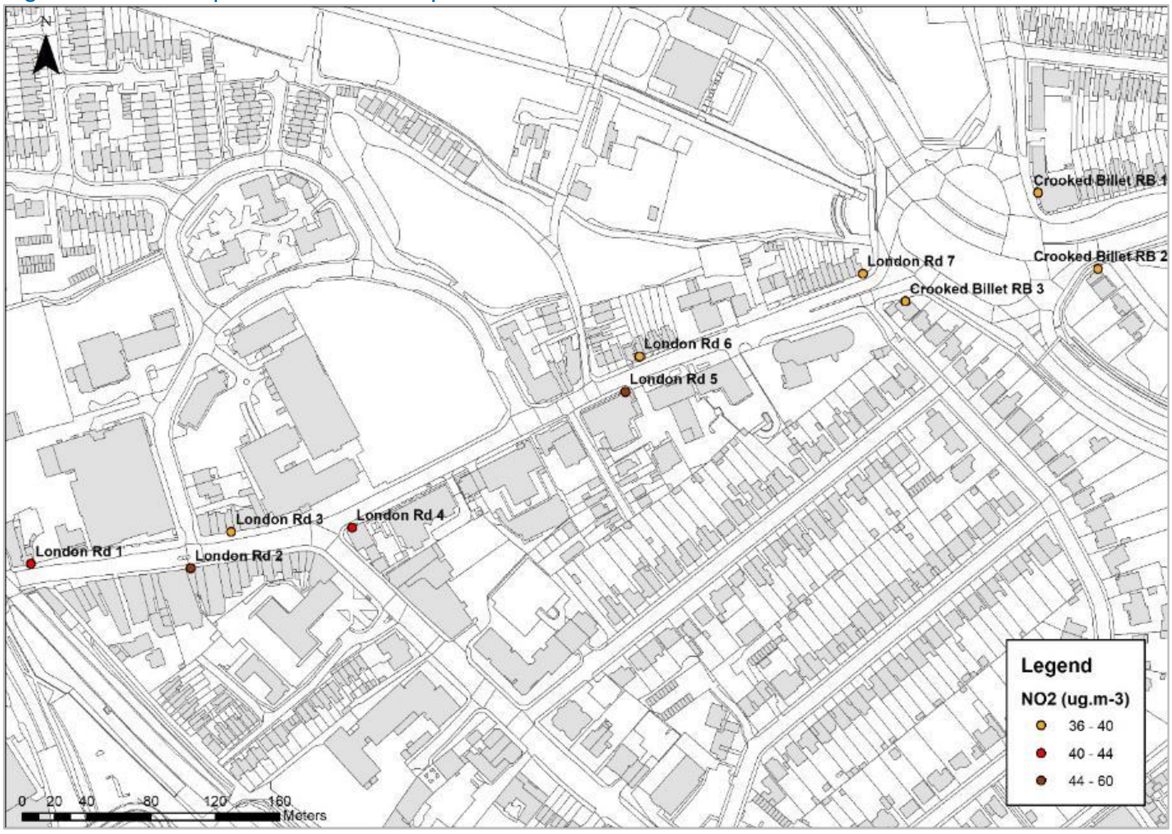
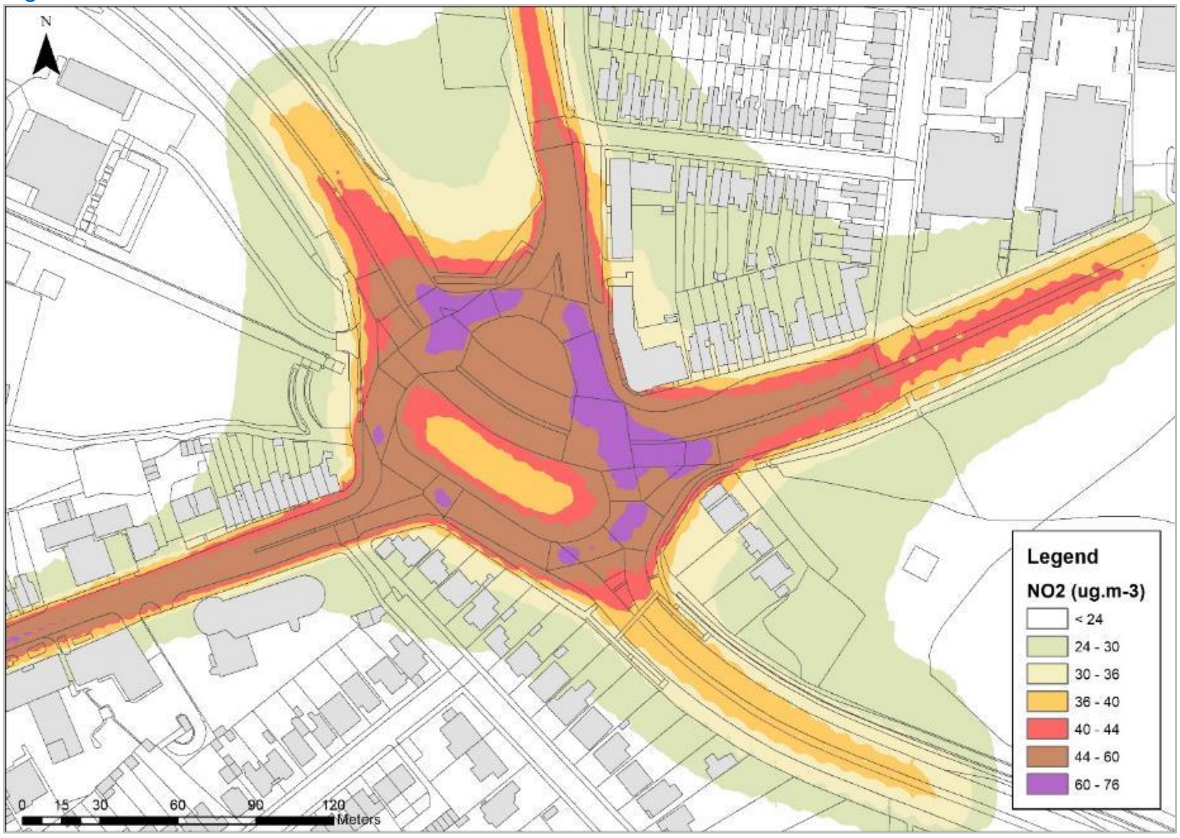


Figure 3.18: Modelled NO_2 annual mean concentrations - London Road, Staines

Figure 3.19: Modelled NO_2 annual mean concentrations - Crooked Billet Roundabout, Staines



3.2.1.2 PM_{10} results (2019) Staines

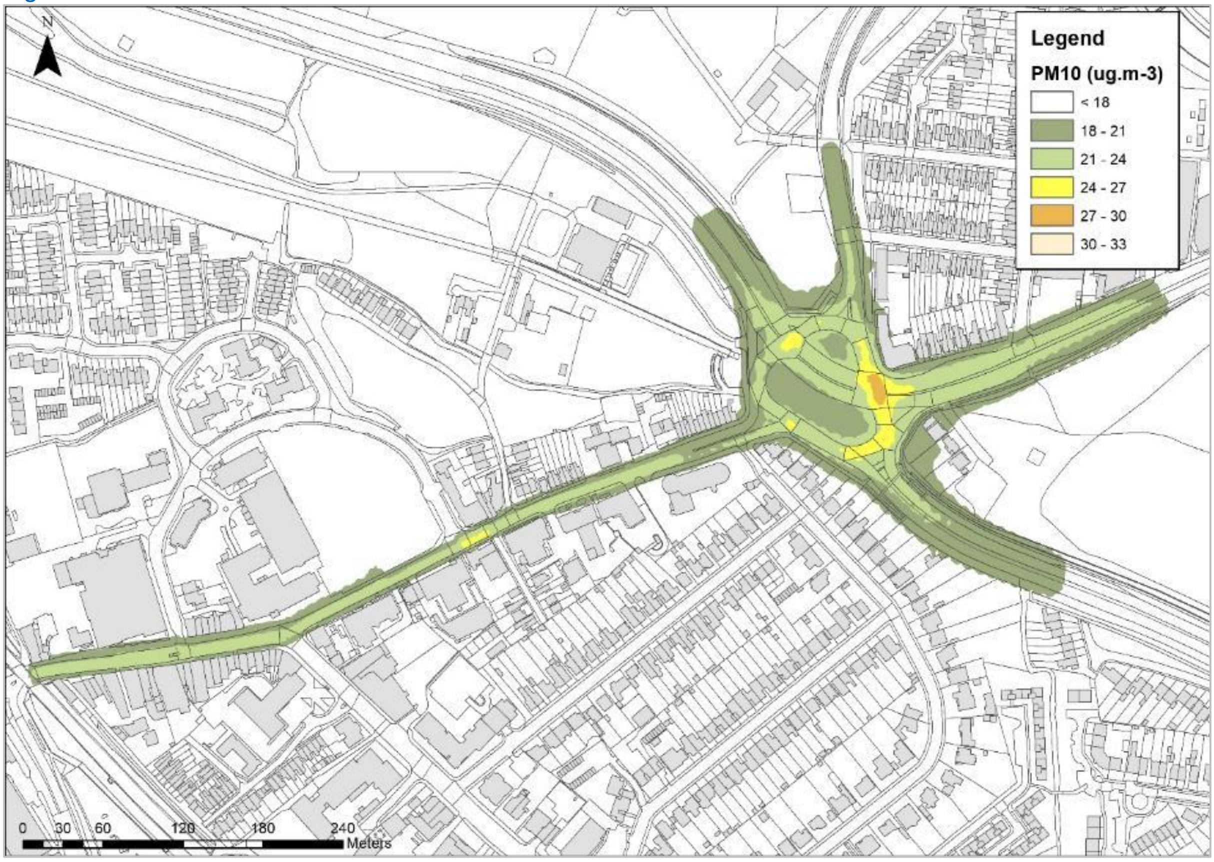
A contour plot showing the predicted spatial variation in annual mean PM_{10} concentrations in the Staines study area at ground floor level (1.5m) is presented in Figure 3.20. The contour indicates that the 40 $\mu g.m^{-3}$ annual mean PM_{10} objective is not being exceeded at any locations at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in Table 3-7. No annual mean PM_{10} concentrations in excess of the 40 $\mu g.m^{-3}$ objective were predicted at any of the modelled receptor locations.

Table 3-7: Predicted annual mean PM_{10} concentrations at specified receptors 2019

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean ($\mu g.m^{-3}$)
London Rd 1	503765.9	171731.4	4	19.0
London Rd 2	503865.1	171728.5	4	20.0
London Rd 3	503890.4	171751.4	4	18.9
London Rd 4	503965.6	171753.6	1.5	19.1
London Rd 5	504135.6	171838	1.5	20.2
London Rd 6	504144.3	171860.4	1.5	18.7
London Rd 7	504283.3	171911.8	1.5	19.0
Crooked Billet RB 1	504392.6	171961.8	1.5	19.5
Crooked Billet RB 2	504429.8	171913.9	1.5	19.5
Crooked Billet RB 3	504308.3	171892.9	1.5	19.2

Figure 3.20: PM_{10} annual mean concentrations – Staines



3.2.1.3 $PM_{2.5}$ results

A contour plot showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Staines study area at ground floor level (1.5m) is presented in Figure 3.21. The contours indicate that the 25 $\mu g.m^{-3}$ annual mean $PM_{2.5}$ objective is not being exceeded at any locations at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-8. No annual mean $PM_{2.5}$ concentrations in excess of the 25 $\mu g.m^{-3}$ objective were predicted at any of the modelled receptor locations.

Table 3-8: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors Staines 2019

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean ($\mu g.m^{-3}$)
London Rd 1	503765.9	171731.4	4	13.1
London Rd 2	503865.1	171728.5	4	13.7
London Rd 3	503890.4	171751.4	4	13.0
London Rd 4	503965.6	171753.6	1.5	13.1
London Rd 5	504135.6	171838	1.5	13.8
London Rd 6	504144.3	171860.4	1.5	12.9
London Rd 7	504283.3	171911.8	1.5	13.1
Crooked Billet RB 1	504392.6	171961.8	1.5	13.3
Crooked Billet RB 2	504429.8	171913.9	1.5	13.3
Crooked Billet RB 3	504308.3	171892.9	1.5	13.2

Figure 3.21: $PM_{2.5}$ annual mean concentrations – Staines 2019

3.2.1.4 Source apportionment – Staines

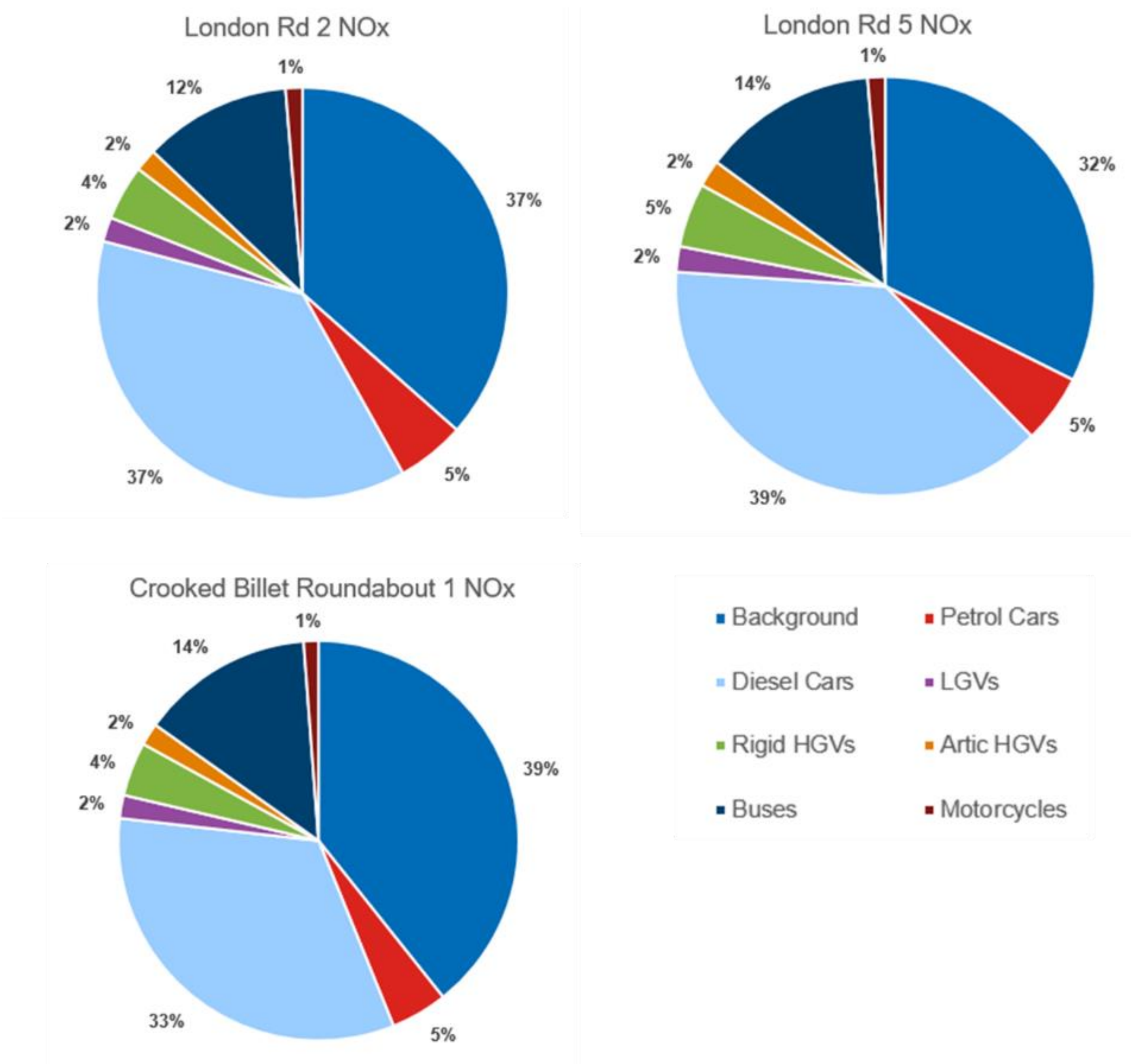
Where annual mean pollutant concentrations in excess of the respective air quality objectives have been predicted, source apportionment has been conducted at up to three worst-case receptors. In this case there were no modelled exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives; source apportionment of NOx only has been conducted.

Source apportionment of NOx was conducted at the three worst-case receptor locations: London Rd 2, London Rd 5 and Crooked Billet RB 1. Pies charts are presented in Figure 3.22.

At all three locations,

- The largest proportion of NOx was attributable to background concentrations (ranging from 19%-39%)
- Diesel cars account for the largest proportion of road NOx concentrations (ranging from 33%-42%).
- Buses contributed 12%-14% of NOx emissions.
- LGV and HGV emissions are much less significant than other vehicle types.

Figure 3.22: Staines NOx source apportionment



3.2.2 Staines-upon-Thames future baseline and measures appraisal

The assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to annual mean pollutant concentration associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only as the 2019 baseline modelling indicated that PM_{10} and $PM_{2.5}$ annual mean were well below the respective objectives at all locations where there is relevant human exposure.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

3.2.2.1 Future year NO_2 annual mean results

Tabulated NO_2 annual mean results at specified receptor locations for each of the modelled scenarios in 2027 are presented in Table 3-9.

Table 3-9: 2027 baseline and mitigation scenarios - NO_2 annual mean ($\mu g.m^{-3}$) at receptors in Staines

Receptor	Height (m)	2019 baseline	2027 baseline	2027 Option 1	2027 Option 2	2027 Option 3
London Rd 1	4	**40.5**	26.3	26.1	25.8	25.8
London Rd 2	4	**45.9**	29.0	28.8	28.4	28.4
London Rd 3	4	39.4	25.4	25.3	24.9	25.0
London Rd 4	1.5	**42.1**	27.6	27.4	27.0	27.1
London Rd 5	1.5	**45.0**	28.2	27.9	27.5	27.5
London Rd 6	1.5	36.2	23.3	23.1	22.8	22.9
London Rd 7	1.5	37.8	24.5	24.4	24.0	24.0
Crooked Billet RB 1	1.5	38.8	25.2	25.0	24.8	24.7
Crooked Billet RB 2	1.5	37.3	24.5	24.3	24.1	24.0
Crooked Billet RB 3	1.5	36.1	23.8	23.6	23.4	23.3

The results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be less than the 40 $\mu g.m^{-3}$ objective at all receptor locations identified as worst-case in 2019. The road traffic NOx emission mitigation options reduce the predicted NO_2 annual mean further and, on this basis, are not necessary to achieve compliance with the objective.

3.2.2.2 Compliance year

As the results indicate compliance with the NO_2 annual mean objective in 2027, it is useful to understand when compliance may be achieved without any intervention. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from

2019 to 2027 provides the estimated rate of change per year. The interpolated results are presented in Table 3-10.

As explained previously, it is worth noting that this method of interpolation is likely to overestimate NO_2 annual mean concentrations at receptors during 2020 and 2021, during which traffic activity was reduced significantly because of Covid-19 pandemic restrictions. The interpolated results should be considered in context with this, and the other modelling uncertainties described in Section 4

The simple linear interpolation based on the vehicle fleet and emission projections in the EFTv10.0 indicates compliance will be achieved without any intervention at residential receptors in Sunbury by 2022.

Table 3-10: Staines NO_2 annual mean at receptors ($\mu g.m^{-3}$) – Simple linear interpolation 2019 to 2027

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
London Rd 1	**40.5**	38.7	36.9	35.2	33.4	31.6	29.8	28.1	26.3
London Rd 2	**45.9**	**43.8**	**41.7**	39.6	37.5	35.4	33.2	31.1	29.0
London Rd 3	39.4	37.6	35.9	34.1	32.4	30.7	28.9	27.2	25.4
London Rd 4	**42.1**	**40.3**	38.5	36.7	34.8	33.0	31.2	29.4	27.6
London Rd 5	**45.0**	**42.9**	**40.8**	38.7	36.6	34.5	32.4	30.3	28.2
London Rd 6	36.2	34.5	32.9	31.3	29.7	28.1	26.5	24.9	23.3
London Rd 7	37.8	36.1	34.5	32.8	31.1	29.5	27.8	26.2	24.5
Crooked Billet RB 1	38.8	37.1	35.4	33.7	32.0	30.3	28.6	26.9	25.2
Crooked Billet RB 2	37.3	35.7	34.1	32.5	30.9	29.3	27.7	26.1	24.5
Crooked Billet RB 3	36.1	34.6	33.0	31.5	29.9	28.4	26.9	25.3	23.8

3.3 Georgian Close, Staines-upon-Thames

3.3.1 Recent baseline (2019) model

3.3.1.1 NO_2 results (2019) Georgian Close

As no monitoring data were available in the Georgian Close study area to verify the model outputs, the Road NOx adjustment factor derived for Staines was used as the best available proxy to adjust the model results. Georgian Close is located within 500m to the southeast of the Crooked Billet roundabout in Staines, so the Staines model adjustment factor is expected to be appropriate.

The contour plot showing the predicted spatial variation in annual mean NO_2 concentrations in the Georgian Close study area at ground floor level (1.5m) is presented in Figure 3.24.

The highest traffic emissions in this area are from the A308, but the contour plot indicates that NO_2 annual mean concentration in excess of the 40 $\mu g.m^{-3}$ objective were not likely to occur at residential properties in 2019.

Model receptors have been placed at the facade of buildings where relevant exposure exists within the areas with the highest pollution concentrations identified from the modelled contour plot. Some of these properties also contain front gardens that border the roads, and it is possible that residents could occupy these front garden areas for more than one hour; comparison of the annual mean with the 60 $\mu g.m^{-3}$ indicative value is relevant here.

Receptors have been modelled at relevant heights. Most residential properties on Georgian Close and Shortwood Common were two or three storeys.

Modelled NO_2 annual mean at specified receptors are presented in Table 3-11 and are also shown on a map using graduated colours in Figure 3.24.

Concentrations predicted at receptor locations are presented in Table 3-6. NO_2 annual mean in excess of the 40 $\mu g.m^{-3}$ objective were not predicted at any receptor locations in the study area, and all were well below the objective. The maximum NO_2 annual mean at a receptor location was 25.4 µg.m^{-3} (Georgian Close 1).

Annual mean NO_2 concentrations in excess of 60 µg.m^{-3} are not predicted at any locations where anyone is likely to spend an hour or more, which indicates that it is unlikely that the short term NO_2 objective is being exceeded in residential gardens.

The modelling results indicate that exceedances of the air quality objectives are unlikely at Georgian Close. We would however recommend that the best way to confirm this is to deploy an NO_2 diffusion tube at this location.

Table 3-11: Predicted NO_2 annual mean at specified receptors – Georgian Close 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean (µg.m^{-3})
Georgian Close 1	504524.3	171766.8	1.5	25.4
Georgian Close 2	504524.3	171766.8	8	21.8
Georgian Close garden 1	504509.2	171772.7	1.5	25.4
Georgian Close garden 2	504669.5	171693.2	1.5	24.1
Georgian Close 3	504710.5	171663.8	1.5	23.3
Shortwood Common 1	504740.2	171652.6	8	21.2
Shortwood Common 2	504740.1	171652.2	1.5	23.8
Georgian Close 4	504647.4	171696	1.5	22.8
Shortwood Common park	504768.3	171699.8	1.5	25.1

Exceedances of the annual mean objective are highlighted in bold

Figure 3.23: Receptor locations and prediction annual mean NO_2 concentrations – Georgian Close

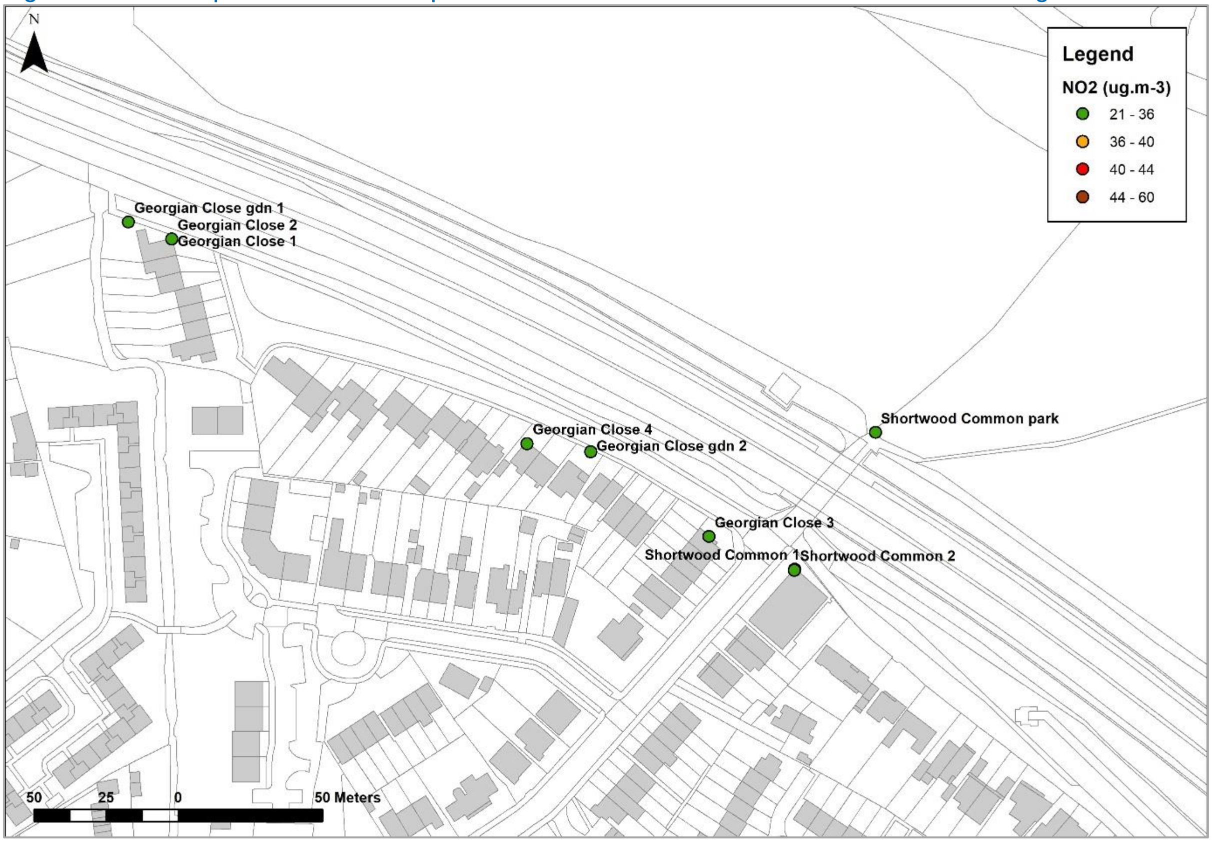
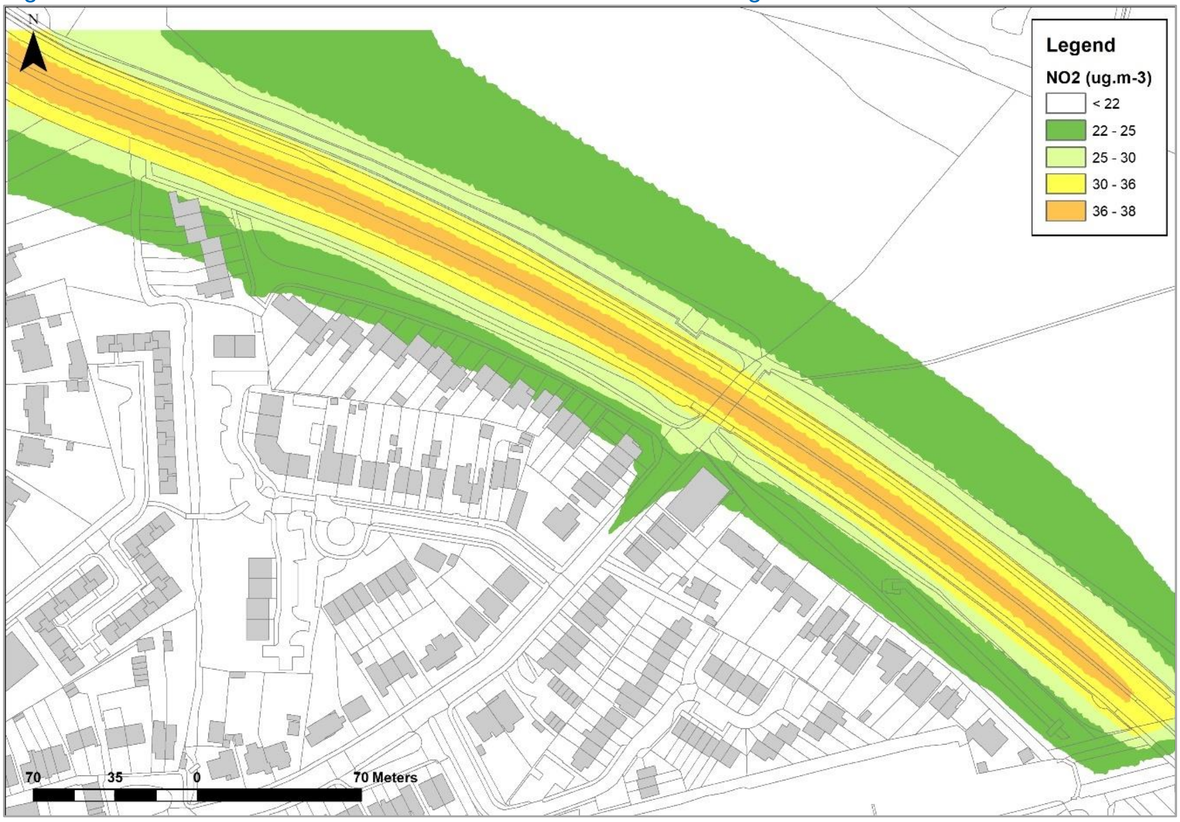


Figure 3.24: Modelled NO_2 annual mean concentrations – Georgian Close



3.3.1.2 PM_{10} results (2019) Georgian Close

A contour plot showing the predicted spatial variation in annual mean PM_{10} concentrations in the Georgian Close study area at ground floor level (1.5m) is presented in Figure 3.25. The contour indicates that the 40 µg.m^{-3} annual mean PM_{10} objective is not being exceeded at any locations at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in **Error! Reference source not found.**. No annual mean PM_{10} concentrations in excess of the 40 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-12: Predicted annual mean PM_{10} concentrations at specified receptors 2019

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
Georgian Close 1	504524.3	171766.8	1.5	17.7
Georgian Close 2	504524.3	171766.8	8	16.7
Georgian Close garden 1	504509.2	171772.7	1.5	17.7
Georgian Close garden 2	504669.5	171693.2	1.5	17.4
Georgian Close 3	504710.5	171663.8	1.5	17.2
Shortwood Common 1	504740.2	171652.6	8	16.6
Shortwood Common 2	504740.1	171652.2	1.5	17.3
Georgian Close 4	504647.4	171696	1.5	17.0
Shortwood Common park	504768.3	171699.8	1.5	17.7

Figure 3.25: PM_{10} annual mean concentrations – Georgian Close

3.3.1.3 $PM_{2.5}$ results

A contour plot showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Georgian Close study area at ground floor level (1.5m) is presented in Figure 3.26. The contours indicate that the 25 $\mu g.m^{-3}$ annual mean $PM_{2.5}$ objective is not being exceeded at any locations at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-13. No annual mean $PM_{2.5}$ concentrations in excess of the 25 $\mu g.m^{-3}$ objective were predicted at any of the modelled receptor locations.

Table 3-13: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors Georgian Close 2019

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean ($\mu g.m^{-3}$)
Georgian Close 1	504524.3	171766.8	1.5	12.2
Georgian Close 2	504524.3	171766.8	8	11.7
Georgian Close garden 1	504509.2	171772.7	1.5	12.2
Georgian Close garden 2	504669.5	171693.2	1.5	12.0
Georgian Close 3	504710.5	171663.8	1.5	11.9
Shortwood Common 1	504740.2	171652.6	8	11.6
Shortwood Common 2	504740.1	171652.2	1.5	12.0
Georgian Close 4	504647.4	171696	1.5	11.8
Shortwood Common park	504768.3	171699.8	1.5	12.2

Figure 3.26: $PM_{2.5}$ annual mean concentrations – Georgian Close 2019

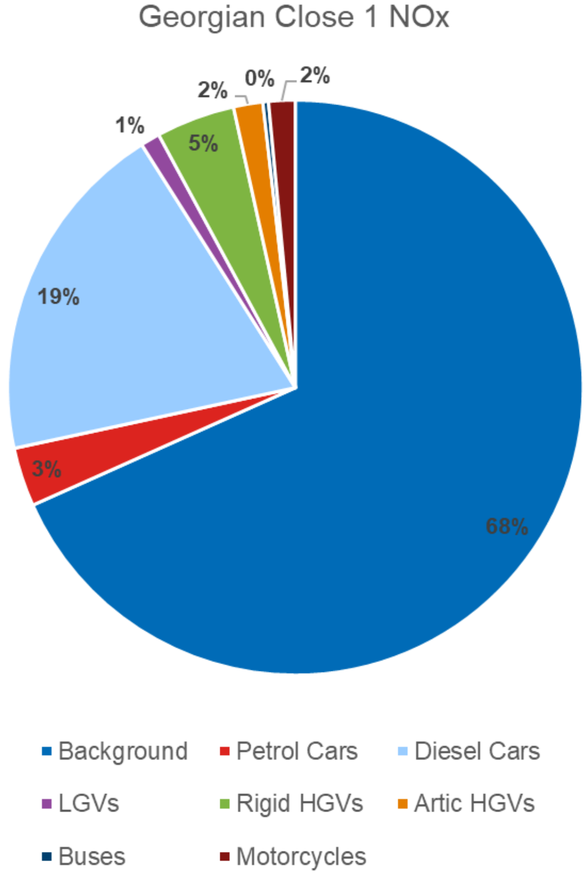
3.3.1.4 Source apportionment – Georgian Close

Source apportionment has been conducted at the receptor location with the highest NO_2 concentration, as there were no exceedances of NO_2, PM_{10}, or $PM_{2.5}$ annual means. All receptor locations are most affected by emissions from the A308. Source apportionment of NOx only has been conducted at Georgian Close 1. A pie chart is presented in Figure 3.27.

At all this location,

- The largest proportion of NOx was attributable to background concentrations (68%)
- Diesel cars account for the largest proportion of road NOx concentrations (19%).
- LGV and Bus emissions are much less significant than other vehicle types.

Figure 3.27: Georgian Close NOx source apportionment



3.3.2 Georgian Close future baseline and measures appraisal

The assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to annual mean pollutant concentration associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only as the 2019 baseline modelling indicated that PM_{10} and $PM_{2.5}$ annual mean were well below the respective objectives at all locations where there is relevant human exposure.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

3.3.2.1 Future year NO_2 annual mean results

Tabulated NO_2 annual mean results at specified receptor locations for each of the modelled scenarios in 2027 are presented in Table 3-14.

Table 3-14: 2027 baseline and mitigation scenarios - NO_2 annual mean ($\mu g.m^{-3}$) at receptors in Georgian Close

Receptor	Height (m)	2019 baseline	2027 baseline	2027 Option 1	2027 Option 2	2027 Option 3
Georgian Close 1	1.5	25.4	18.0	17.9	17.9	17.8
Georgian Close 2	8	21.8	16.1	16.1	16.0	16.0
Georgian Close garden 1	1.5	25.4	18.0	17.9	17.9	17.8
Georgian Close garden 2	1.5	24.1	17.3	17.2	17.2	17.1
Georgian Close 3	1.5	23.3	16.9	16.8	16.8	16.7
Shortwood Common 1	8	21.2	15.8	15.7	15.7	15.7
Shortwood Common 2	1.5	23.8	17.1	17.1	17.1	17.0
Georgian Close 4	1.5	22.8	16.6	16.6	16.6	16.5
Shortwood Common park	1.5	25.1	17.8	17.7	17.7	17.6

The results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be less than the 40 $\mu g.m^{-3}$ objective at all receptor locations identified as worst-case in 2019. The road traffic NOx emission mitigation options reduce the predicted NO_2 annual mean further and, on this basis, are not necessary to achieve compliance with the objective.

3.3.2.2 Compliance year

No exceedances were predicted in Georgian Close in the 2019 baseline, so compliance has already been achieved. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year. The interpolated results are presented in Table 3-15.

As explained previously, it is worth noting that this method of interpolation is likely to overestimate NO_2 annual mean concentrations at receptors during 2020 and 2021, during which traffic activity was reduced significantly because of Covid-19 pandemic restrictions. The interpolated results should be considered in context with this, and the other modelling uncertainties described in Section 4.

Table 3-15: Georgian Close NO_2 annual mean at receptors ($\mu g.m^{-3}$) – Simple linear interpolation 2019 to 2027

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
Georgian Close 1	25.4	24.5	23.5	22.6	21.7	20.8	19.8	18.9	18.0
Georgian Close 2	21.8	21.1	20.4	19.7	19.0	18.2	17.5	16.8	16.1
Georgian Close garden 1	25.4	24.5	23.5	22.6	21.7	20.8	19.8	18.9	18.0
Georgian Close garden 2	24.1	23.2	22.4	21.5	20.7	19.8	19.0	18.1	17.3
Georgian Close 3	23.3	22.5	21.7	20.9	20.1	19.3	18.5	17.7	16.9
Shortwood Common 1	21.2	20.5	19.9	19.2	18.5	17.8	17.1	16.4	15.8
Shortwood Common 2	23.8	23.0	22.1	21.3	20.5	19.6	18.8	18.0	17.1
Georgian Close 4	22.8	22.0	21.2	20.5	19.7	18.9	18.1	17.4	16.6
Shortwood Common park	25.1	24.2	23.3	22.4	21.5	20.5	19.6	18.7	17.8

3.4 Ashford-upon-Thames

3.4.1 Recent baseline (2019) model

3.4.1.1 NO_2 results (2019) Ashford

Contour plots showing the predicted spatial variation in annual mean NO_2 concentrations in the Ashford study area at ground floor level (1.5m) are presented in Figure 3.30 to Figure 3.32.

Maximum ground level concentrations have been predicted at locations approaching the main junctions within the study area. A selection of model receptor points has been placed at the facade of buildings where relevant exposure exists at locations with maximum predicted NO_2 annual mean identified from the contour plots.

Modelled NO_2 annual mean at the specified receptors points are presented in Table 3-16 and are also shown with locations on maps using graduated colours in Figure 3.28 to Figure 3.29.

No exceedances of the 40 $\mu g.m^{-3}$ NO_2 annual mean objective were predicted at any receptor location in Ashford. The maximum predicted NO_2 annual mean was 37.5 $\mu g.m^{-3}$ at the 'Church Road 1' receptor.

The results should be considered in context with the dispersion model performance at these locations and the associated uncertainty (please see model verification information presented above). The average model error (RMSE) in the Ashford study area was 2.9 $\mu g.m^{-3}$. This model uncertainty could mean that there is a marginal risk of an exceedance of the 40 $\mu g.m^{-3}$ objective at the 'Church Road 1' receptor. At all other modelled receptor locations, the predicted NO_2 annual mean is more than 2.9 $\mu g.m^{-3}$ below the 40 $\mu g.m^{-3}$ objective, which provides reasonable evidence that the objective is not being exceeded there.

Table 3-16: Predicted NO_2 annual mean at specified receptors – Ashford 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean ($\mu g.m^{-3}$)
School Rd 1	507892.2	170552.2	1.5	28.6
School Rd 2 - Primary	507764	170867.8	1.5	26.9
School Rd 3	507657.7	171062.3	1.5	33.8
Clockhouse Ln 1	507474.1	171637.7	1.5	32.2
Feltham Rd 1	507354.6	171498	1.5	31.6
Church Rd 1	507176.8	171477.5	1.5	37.5
Church Rd 2	507029.8	171549.6	4	32.5
Fordbridge Rd 1	506913.9	171390.5	1.5	28.3
Church Rd 3	506726.5	171796.6	4	30.1
Church Rd 4	507128.7	171513.3	1.5	27.9
Church Rd 5	506980.9	171545.6	4	27.5

Figure 3.28: Receptor locations and predicted NO_2 annual mean – Church Road, Ashford

Figure 3.29: Receptor locations and predicted NO_2 annual mean – School Road, Ashford

Figure 3.30: Modelled NO_2 annual mean concentrations – Church Road, Ashford

Figure 3.31: Modelled NO_2 annual mean concentrations - Church Road and Clockhouse Lane, Ashford

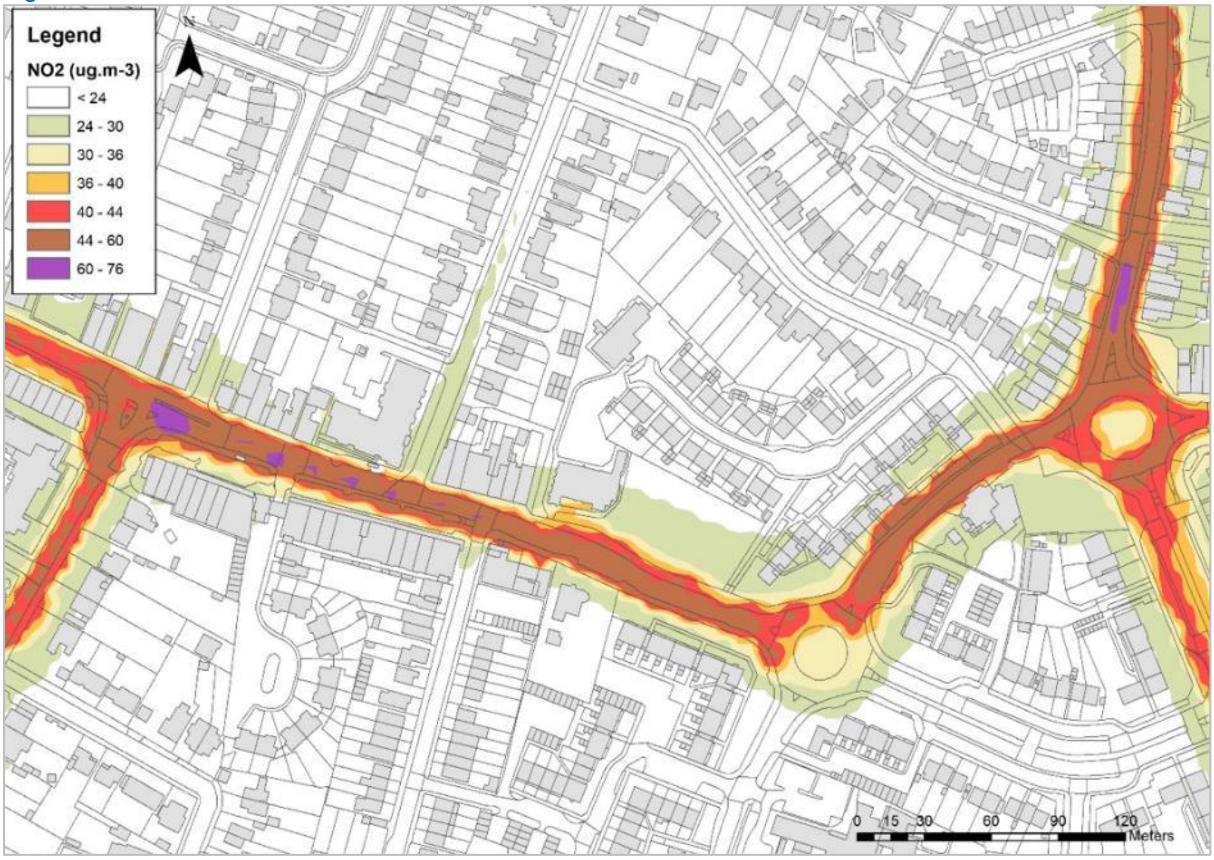


Figure 3.32: Modelled NO_2 annual mean concentrations – School Road, Ashford

3.4.1.2 PM_{10} results (2019) Ashford

Contour plots showing the predicted spatial variation in annual mean PM_{10} concentrations in the Ashford study area at ground floor level (1.5m) are presented in

Figure 3.33 and Figure 3.34. The contours indicate that the 40 µg.m^{-3} annual mean PM_{10} objective is not being exceeded at any locations at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in Table 3-17. No annual mean PM_{10} concentrations in excess of the 40 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-17: Predicted annual mean PM_{10} concentrations at specified receptors Ashford 2019

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
School Rd 1	507892.2	170552.2	1.5	17.6
School Rd 2 - Primary	507764	170867.8	1.5	17.4
School Rd 3	507657.7	171062.3	1.5	18.8
Clockhouse Ln 1	507474.1	171637.7	1.5	18.7
Feltham Rd 1	507354.6	171498	1.5	18.4
Church Rd 1	507176.8	171477.5	1.5	19.2
Church Rd 2	507029.8	171549.6	4	18.1
Fordbridge Rd 1	506913.9	171390.5	1.5	18.1
Church Rd 3	506726.5	171796.6	4	17.7
Church Rd 4	507128.7	171513.3	1.5	17.5
Church Rd 5	506980.9	171545.6	4	17.3

Figure 3.33: PM_{10} annual mean concentrations - Church Road and Clockhouse Lane, Ashford

Figure 3.34: PM_{10} annual mean concentrations – School Road, Ashford

3.4.1.3 $PM_{2.5}$ results

Contour plots showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Ashford study area at ground floor level (1.5m) are presented in Figure 3.35 and Figure 3.36. The contours indicate that the 25 µg.m^{-3} annual mean $PM_{2.5}$ objective is not being exceeded at any locations at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-18. No annual mean $PM_{2.5}$ concentrations in excess of the 25 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-18: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors – Ashford 2019

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean (µg.m^{-3})
School Rd 1	507892.2	170552.2	1.5	12.1
School Rd 2 - Primary	507764	170867.8	1.5	12.0
School Rd 3	507657.7	171062.3	1.5	13.1
Clockhouse Ln 1	507474.1	171637.7	1.5	13.0
Feltham Rd 1	507354.6	171498	1.5	12.8
Church Rd 1	507176.8	171477.5	1.5	13.3
Church Rd 2	507029.8	171549.6	4	12.7
Fordbridge Rd 1	506913.9	171390.5	1.5	12.7
Church Rd 3	506726.5	171796.6	4	12.5
Church Rd 4	507128.7	171513.3	1.5	12.3
Church Rd 5	506980.9	171545.6	4	12.2

Figure 3.35: $PM_{2.5}$ annual mean concentrations – Church Road, Ashford

Figure 3.36: $PM_{2.5}$ annual mean concentrations – School Road, Ashford

3.4.1.4 Source apportionment – Ashford

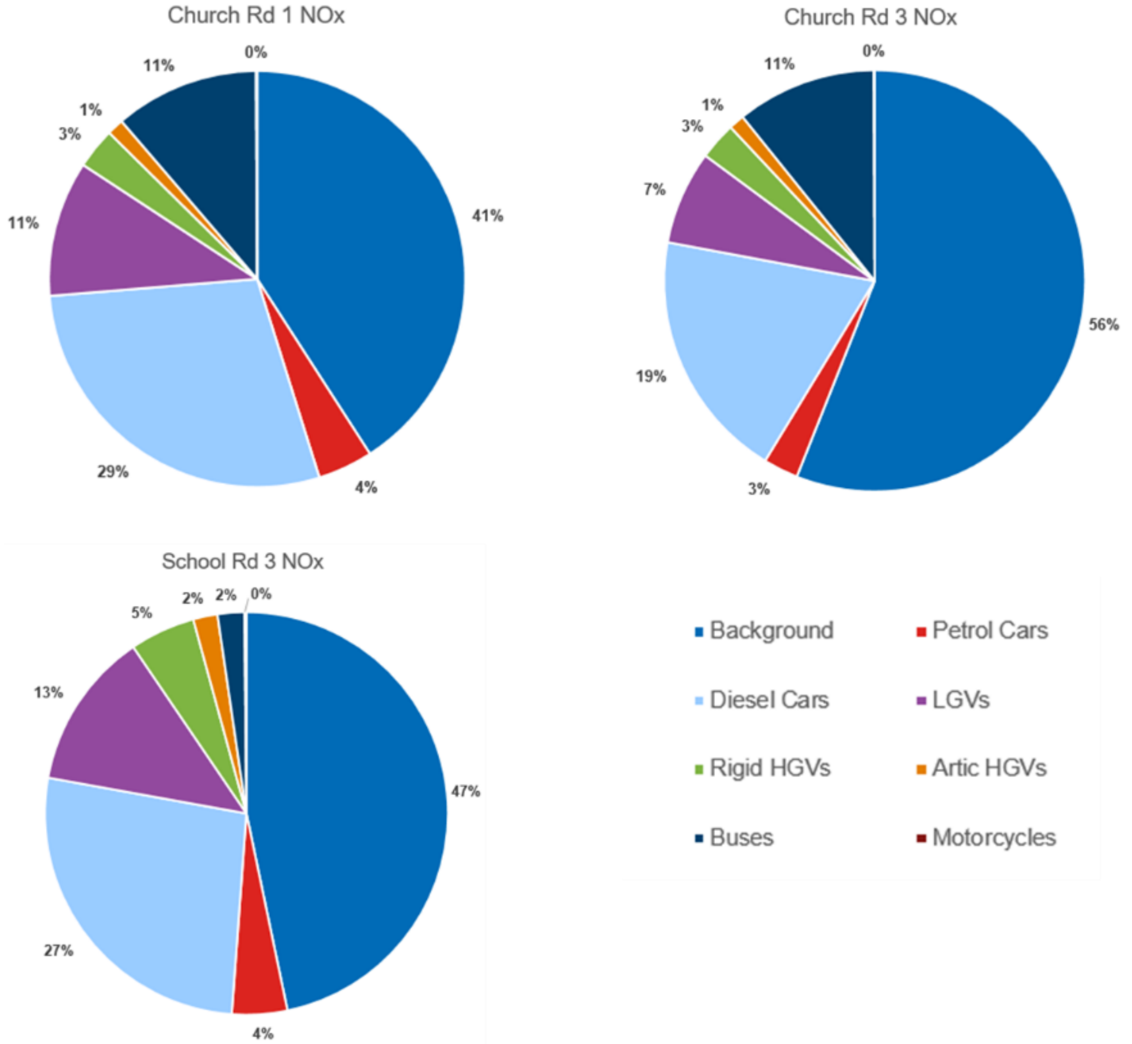
Source apportionment has been conducted at up to three worst-case receptors. In this case there were no modelled exceedances of the NO_2, PM_{10} or $PM_{2.5}$ annual mean objectives. However, as the predicted NO_2 annual mean was close to objective, source apportionment of NOx emissions has been conducted.

Source apportionment of NOx was conducted at the three worst-case receptor locations: Church Road 1, Church Road 3 and School Road 3. Pies charts are presented in Figure 3.37.

At all three locations,

- The largest proportions of NOx were attributable to background concentrations (ranging from 41%-56%)
- Diesel cars account for the largest proportion of road NOx concentrations (ranging from 19%-29%).
- LGV emissions contributed 7%-13% of NOx emissions.
- At Church Road Bus emissions contribute 11%
- HGV emissions are much less significant than other vehicle types.

Figure 3.37: Ashford NOx source apportionment



3.4.2 Ashford future baseline and measures appraisal

The assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to annual mean pollutant concentration associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only as the 2019 baseline modelling indicated that PM_{10} and $PM_{2.5}$ annual mean were well below the respective objectives at all locations where there is relevant human exposure.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

3.4.2.1 Future year NO_2 annual mean results

Tabulated NO_2 annual mean results at specified receptor locations for each of the modelled scenario in 2027 are presented in Table 3-19. The results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be less than the 40 µg.m^{-3} objective at all receptor locations identified as worst-case in 2019. The road traffic NOx emission mitigation options reduce the predicted NO_2 annual mean further and, on this basis, do not appear to be necessary to achieve compliance with the objective.

Table 3-19: 2027 baseline and mitigation scenarios - NO_2 annual mean (µg.m^{-3}) at receptors in Ashford

Receptor	Height (m)	2019 baseline	2027 baseline	2027 Option 1	2027 Option 2	2027 Option 3
School Rd 1	1.5	28.6	18.8	18.7	18.7	18.6
School Rd 2 - Primary	1.5	26.9	18.0	17.9	17.9	17.8
School Rd 3	1.5	33.8	22.0	21.9	21.8	21.7
Clockhouse Ln 1	1.5	32.2	21.2	21.1	21.0	20.9
Feltham Rd 1	1.5	31.6	20.9	20.8	20.6	20.6
Church Rd 1	1.5	37.5	23.8	23.6	23.3	23.3
Church Rd 2	4	32.5	21.6	21.5	21.3	21.2
Fordbridge Rd 1	1.5	28.3	19.6	19.5	19.5	19.4
Church Rd 3	4	30.1	20.1	20.1	19.8	19.9
Church Rd 4	1.5	27.9	18.9	18.9	18.7	18.7
Church Rd 5	4	27.5	19.2	19.2	19.0	19.0

3.4.2.2 Compliance year

Compliance with the 40 µg.m^{-3} NO_2 annual mean objective was achieved at all receptor locations in Ashford in 2019; the future baseline results also indicate compliance with the NO_2 annual mean objective in 2027.

The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year. The interpolated results are presented in Table 3-20.

As explained previously, this method of interpolation is likely to overestimate NO_2 annual mean concentrations at receptors during 2020 and 2021, during which traffic activity was reduced significantly because of Covid-19 pandemic restrictions. The interpolated results should be considered in context with this, and the other modelling uncertainties described later in Section 4.

Table 3-20: NO_2 annual mean (µg.m^{-3}) - Simple linear interpolation 2019 to 2027

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
School Rd 1	28.6	27.4	26.1	24.9	23.7	22.5	21.3	20.0	18.8
School Rd 2 - Primary	26.9	25.8	24.7	23.6	22.5	21.3	20.2	19.1	18.0
School Rd 3	33.8	32.4	30.9	29.4	27.9	26.5	25.0	23.5	22.0
Clockhouse Ln 1	32.2	30.9	29.5	28.1	26.7	25.3	24.0	22.6	21.2
Feltham Rd 1	31.6	30.3	28.9	27.6	26.2	24.9	23.6	22.2	20.9
Church Rd 1	37.5	35.8	34.1	32.3	30.6	28.9	27.2	25.5	23.8
Church Rd 2	32.5	31.1	29.8	28.4	27.0	25.7	24.3	22.9	21.6
Fordbridge Rd 1	28.3	27.2	26.1	25.0	24.0	22.9	21.8	20.7	19.6
Church Rd 3	30.1	28.9	27.6	26.4	25.1	23.9	22.6	21.4	20.1
Church Rd 4	27.9	26.8	25.7	24.6	23.4	22.3	21.2	20.0	18.9

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
Church Rd 5	27.5	26.5	25.4	24.4	23.4	22.3	21.3	20.3	19.2

3.5 Lower Halliford - Shepperton results

3.5.1 Recent baseline (2019) model

3.5.1.1 NO_2 results (2019) Lower Halliford

Contour plots showing the predicted spatial variation in annual mean NO_2 concentrations in the Lower Halliford study area at ground floor level (1.5m) are presented in Figure 3.41 to Figure 3.44. The maximum ground level concentrations have been predicted along Walton Bridge Road. These contour plots indicate that NO_2 annual mean concentration in excess of the 40 $\mu g.m^{-3}$ objective may have occurred at some residential properties at these locations in 2019.

Model receptors have been placed at the facade of buildings where relevant exposure exists within the pollution hotspots identified from the modelled contour plots. There are primarily ground floor residential properties along the roads in Lower and Upper Halliford. Some of these properties also contain front gardens that border the roads, and it is possible that residents could occupy these front garden areas for more than one hour; comparison of the annual mean with the 60 $\mu g.m^{-3}$ indicative value is relevant here.

Modelled NO_2 annual mean at specified receptors are presented in Table 3-21 and are also shown on a map using graduated colours in Figure 3.38 to Figure 3.40.

NO_2 annual means in excess of the 40 $\mu g.m^{-3}$ objective were predicted at one ground level residential receptor locations on Walton Bridge Road. Although the contour plots show elevated concentrations on Gaston Bridge Road and the Upper Halliford Bypass, the houses are located far enough from the road that the NO_2 annual mean objective is not predicted to be exceeded there.

The results should be considered in context with the dispersion model performance at these locations and the associated uncertainty (please see model verification information presented above). We know that the model overpredicted NO_2 concentrations at the SP10 diffusion tube site on Walton Bridge Road by 1.6 $\mu g.m^{-3}$; it is a reasonable assumption that concentrations at Walton Bridge Road receptors may also have been overpredicted. However, the predicted concentration at the Walton Bridge Rd 1 receptor does exceed the 40 $\mu g.m^{-3}$ annual mean objective by more than this value; it is therefore likely that exceedances of the objective did occur at residential properties here during 2019.

Annual mean NO_2 concentrations in excess of 60 $\mu g.m^{-3}$ are not predicted at any locations where anyone is likely to spend an hour or more, which indicates that it is unlikely that the short term NO_2 objective is being exceeded in residential gardens.

Table 3-21: Predicted annual mean NO_2 concentrations at specified receptors – Lower Halliford 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean ($\mu g.m^{-3}$)
Walton Bridge Rd 1	509157.1	166739.5	1.5	**42.3**
Walton Bridge Rd 2	509092.9	166865.2	1.5	36.7
Walton Bridge Rd 3	509087.7	166931.6	1.5	31.6
Russell Rd 1	508729.8	166966.9	1.5	26.4
Gaston Bridge Rd 1	508939.2	167457.8	1.5	26.3
Green Ln 1	508755.9	167552.2	1.5	25.0
Gaston Bridge Rd 2	509047.7	167734.3	1.5	27.5
Upper Halliford Bypass 1	509079.5	167901.3	1.5	29.3
Upper Halliford Bypass 2	509054.6	168359.7	1.5	30.9
Walton Bridge Rd 4	508969.3	167008.5	1.5	26.3

Upper Halliford Rd 1	509159.3	168827.1	1.5	30.5
Walton Bridge Rd 5 garden*	509117.2	166841.5	1.5	41.3

Exceedances of the annual mean objective in bold
*** Short-term objective applies in residential garden**

Figure 3.38: Lower Halliford receptor locations and predicted annual mean NO_2 concentrations- Walton Bridge Road

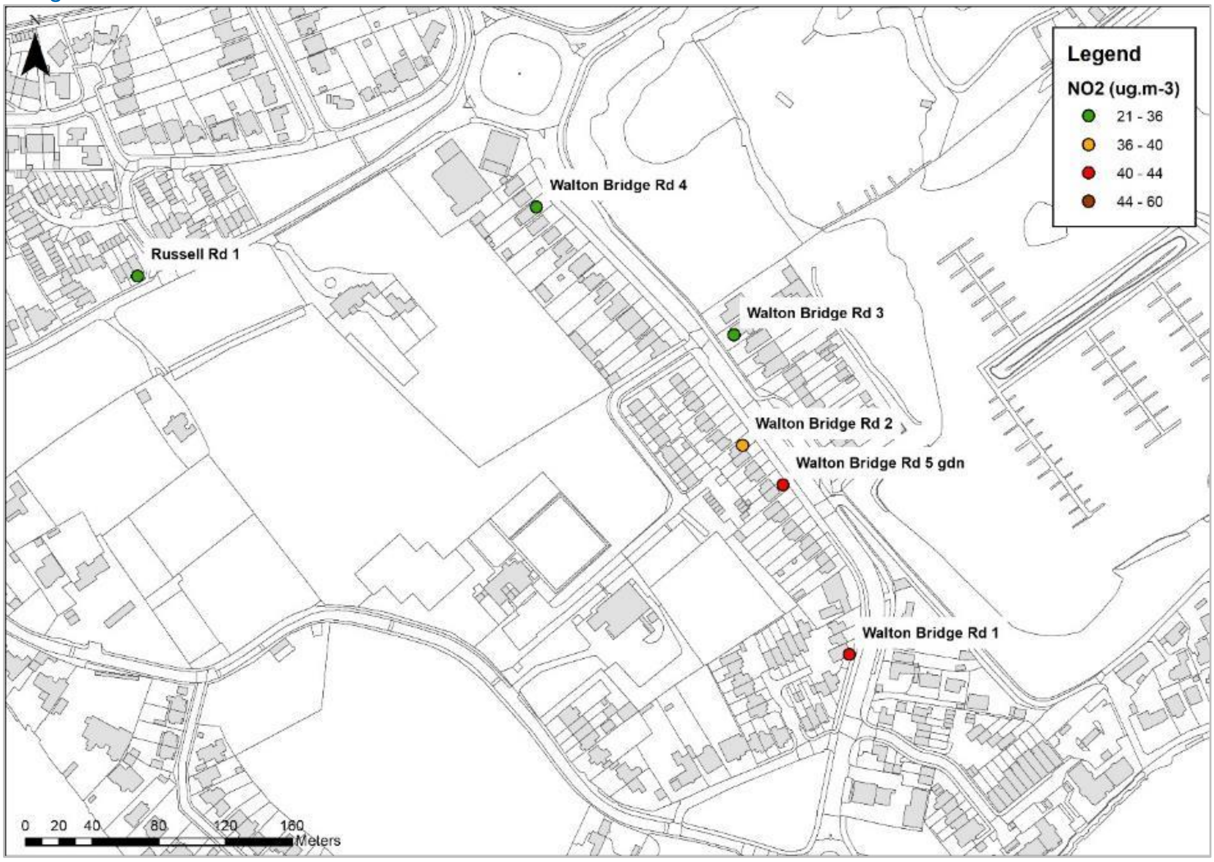


Figure 3.39: Lower Halliford receptor locations and predicted annual mean NO_2 concentrations- Gaston Bridge Road

Figure 3.40: Receptor locations and predicted annual mean NO_2 concentrations- Upper Halliford Bypass 2019

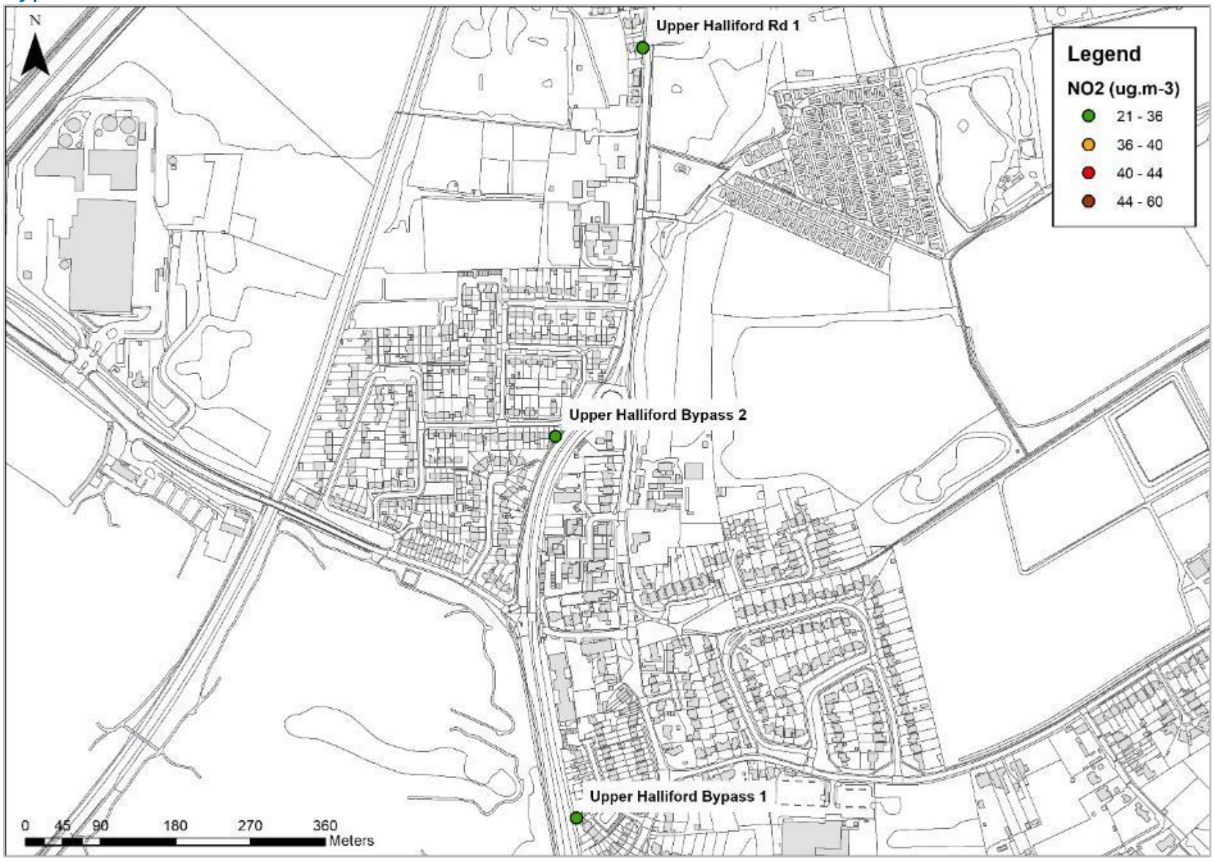


Figure 3.41: NO_2 annual mean concentrations – Walton Bridge Road 2019

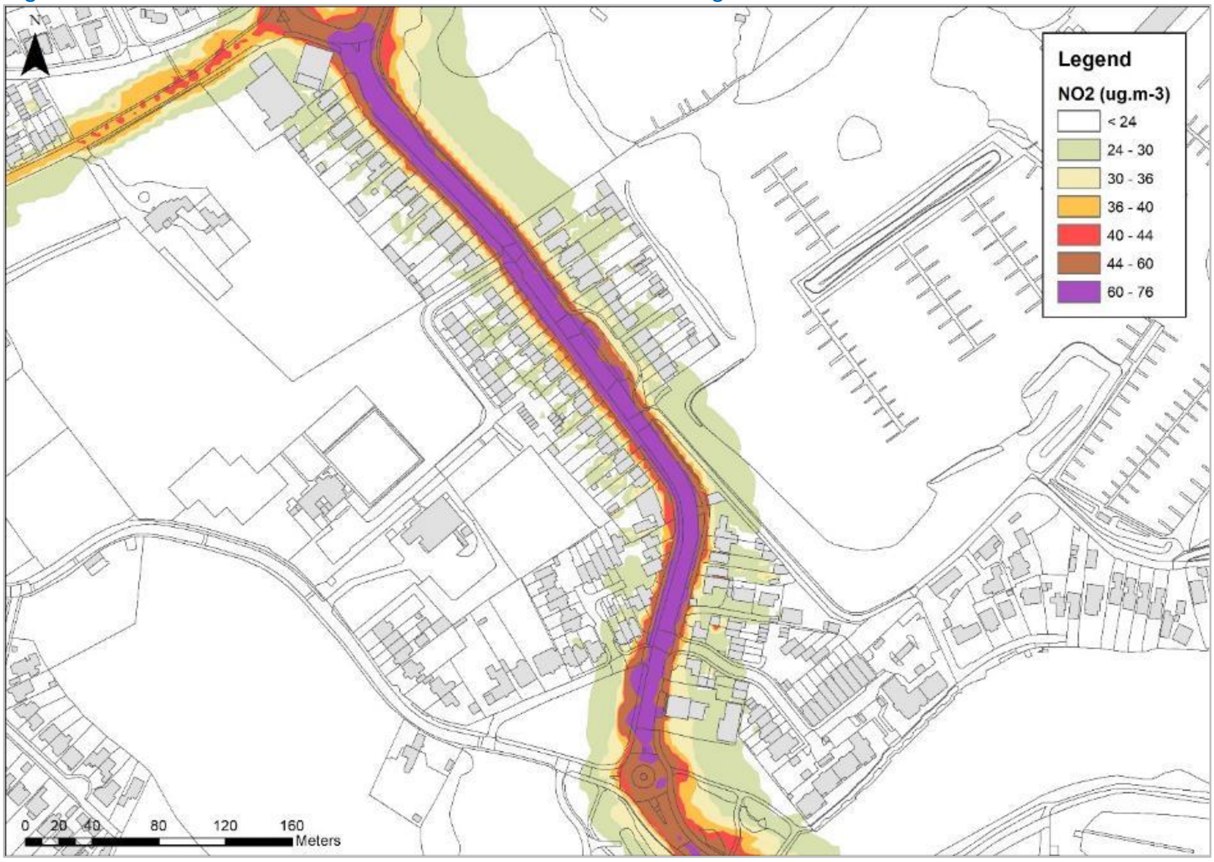
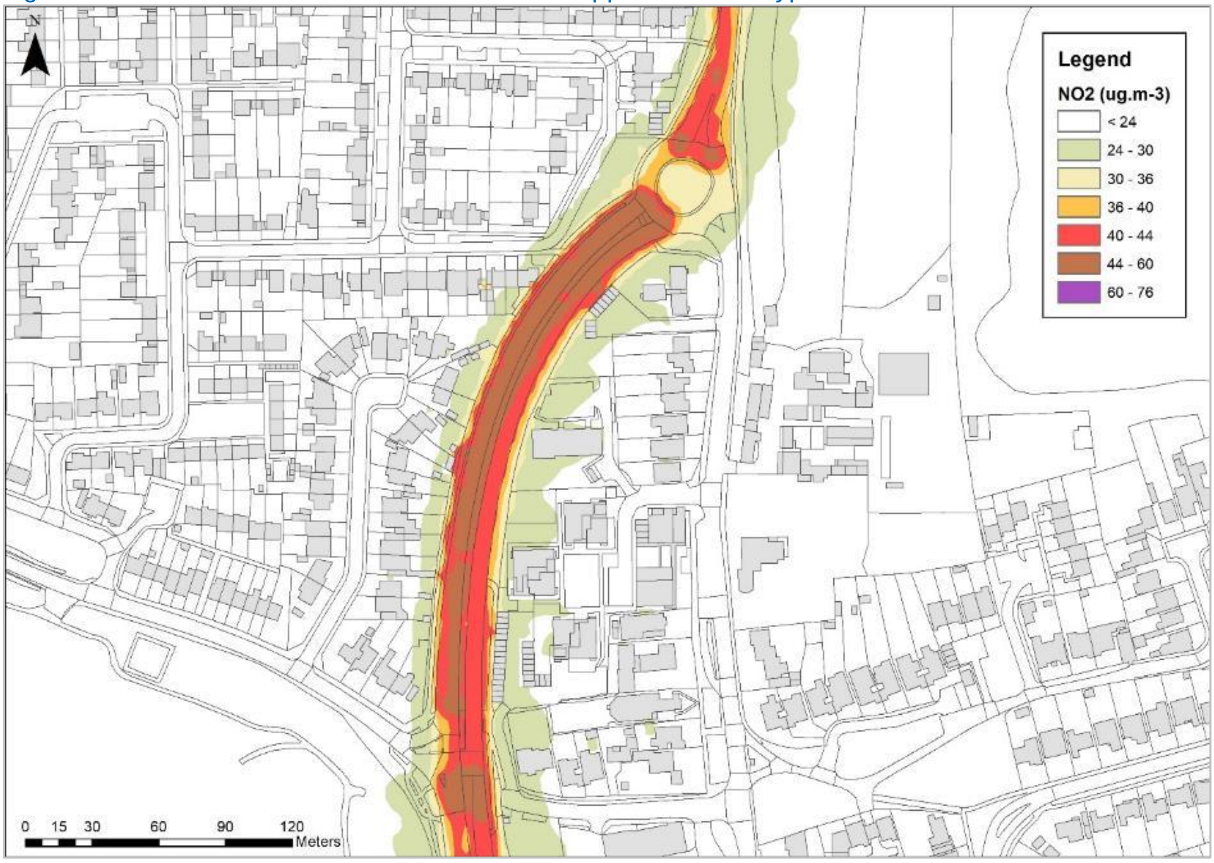


Figure 3.42: NO_2 annual mean concentrations – Gaston Bridge Road 2019

Figure 3.43: Lower Halliford NO_2 annual mean concentrations – Gaston Bridge Road 2019

Figure 3.44: NO_2 annual mean concentrations – Upper Halliford Bypass 2019



3.5.1.2 PM_{10} results (2019) Lower Halliford

Contour plots showing the predicted spatial variation in annual mean PM_{10} concentrations in the Lower Halliford study area at ground floor level (1.5m) are presented inFigure 3.45 to Figure 3.47. The contour indicates that the 40 µg.m^{-3} annual mean PM_{10} objective is not being exceeded at any locations at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in Table 3-22. No annual mean PM_{10} concentrations in excess of the 40 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-22: Predicted annual mean PM_{10} concentrations at receptors – Lower Halliford 2019

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
Walton Bridge Rd 1	509157.1	166739.5	1.5	21.1
Walton Bridge Rd 2	509092.9	166865.2	1.5	19.8
Walton Bridge Rd 3	509087.7	166931.6	1.5	18.5
Russell Rd 1	508729.8	166966.9	1.5	16.9
Gaston Bridge Rd 1	508939.2	167457.8	1.5	17.5
Green Ln 1	508755.9	167552.2	1.5	17.5
Gaston Bridge Rd 2	509047.7	167734.3	1.5	17.5
Upper Halliford Bypass 1	509079.5	167901.3	1.5	17.9
Upper Halliford Bypass 2	509054.6	168359.7	1.5	18.4
Walton Bridge Rd 4	508969.3	167008.5	1.5	17.5
Upper Halliford Rd 1	509159.3	168827.1	1.5	18.8
Walton Bridge Rd 5 garden	509117.2	166841.5	1.5	21.0

Figure 3.45: PM_{10} annual mean concentrations – Walton Bridge Road, Lower Halliford 2019

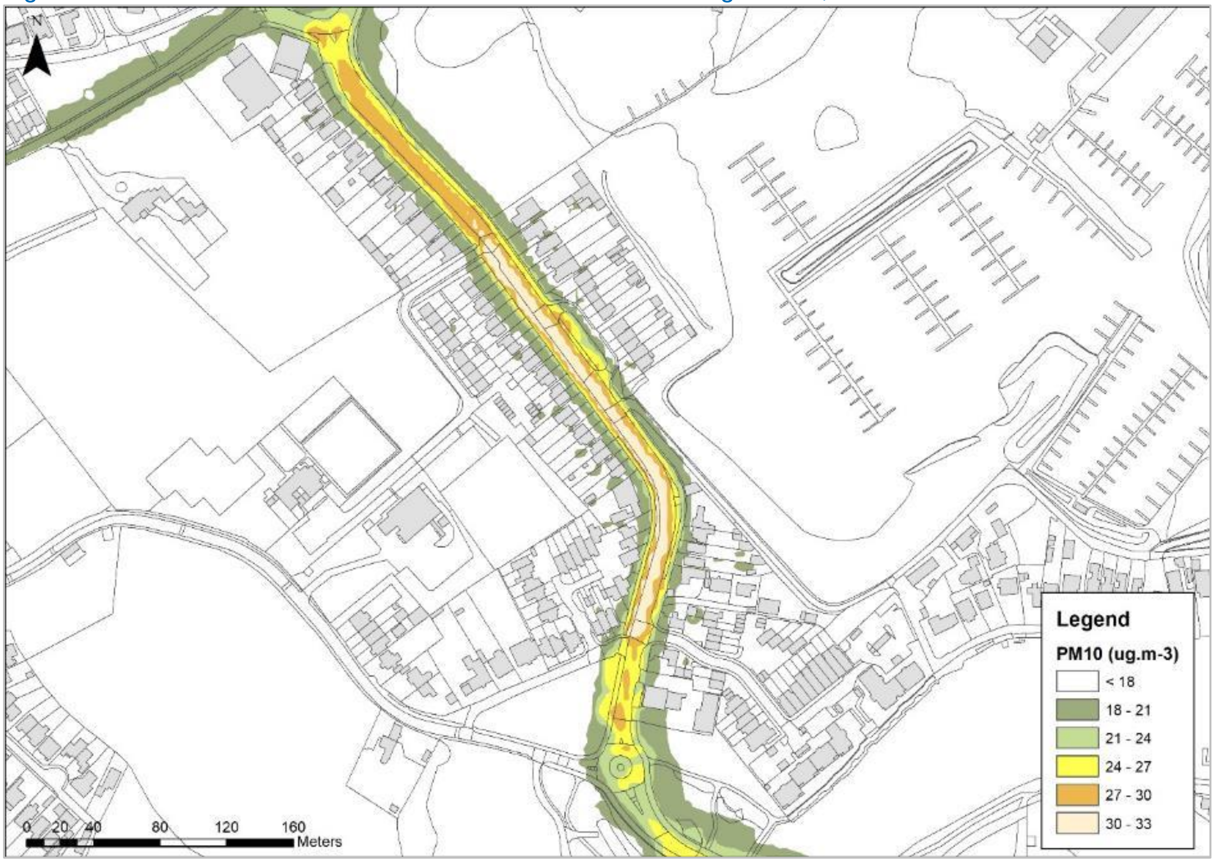


Figure 3.46: PM_{10} annual mean concentrations – Gaston Bridge Road, Lower Halliford 2019

Figure 3.47: PM_{10} annual mean concentrations – Upper Halliford Bypass 2019

3.5.1.3 $PM_{2.5}$ results

Contour plots showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Lower Halliford study area at ground floor level (1.5m) are mapped in Figure 3.48 to Figure 3.50. The contours indicate that the 25 µg.m^{-3} annual mean $PM_{2.5}$ objective is not being exceeded at any locations at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-23. No annual mean $PM_{2.5}$ concentrations in excess of the 25 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-23: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors – Lower Halliford 2019

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean (µg.m^{-3})
Walton Bridge Rd 1	509157.1	166739.5	1.5	14.2
Walton Bridge Rd 2	509092.9	166865.2	1.5	13.4
Walton Bridge Rd 3	509087.7	166931.6	1.5	12.7
Russell Rd 1	508729.8	166966.9	1.5	11.6
Gaston Bridge Rd 1	508939.2	167457.8	1.5	12.1
Green Ln 1	508755.9	167552.2	1.5	12.1
Gaston Bridge Rd 2	509047.7	167734.3	1.5	11.9
Upper Halliford Bypass 1	509079.5	167901.3	1.5	12.2
Upper Halliford Bypass 2	509054.6	168359.7	1.5	12.5
Walton Bridge Rd 4	508969.3	167008.5	1.5	12.1
Upper Halliford Rd 1	509159.3	168827.1	1.5	12.7
Walton Bridge Rd 5 garden	509117.2	166841.5	1.5	14.1

Figure 3.48: $PM_{2.5}$ annual mean concentrations – Walton Bridge Road, Lower Halliford 2019

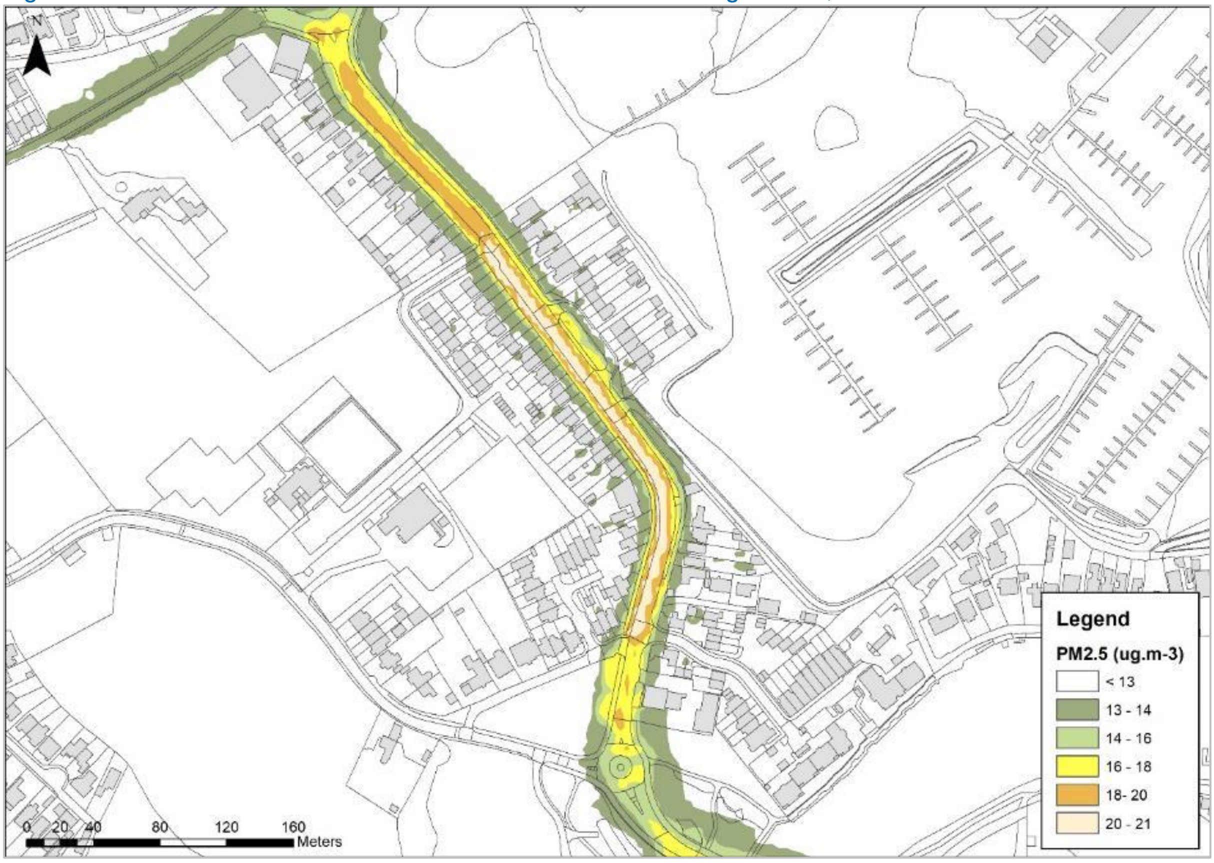


Figure 3.49: $PM_{2.5}$ annual mean concentrations – Gaston Bridge Road, Lower Halliford 2019

Figure 3.50: $PM_{2.5}$ annual mean concentrations – Upper Halliford Bypass 2019

3.5.1.4 Source apportionment – Lower Halliford

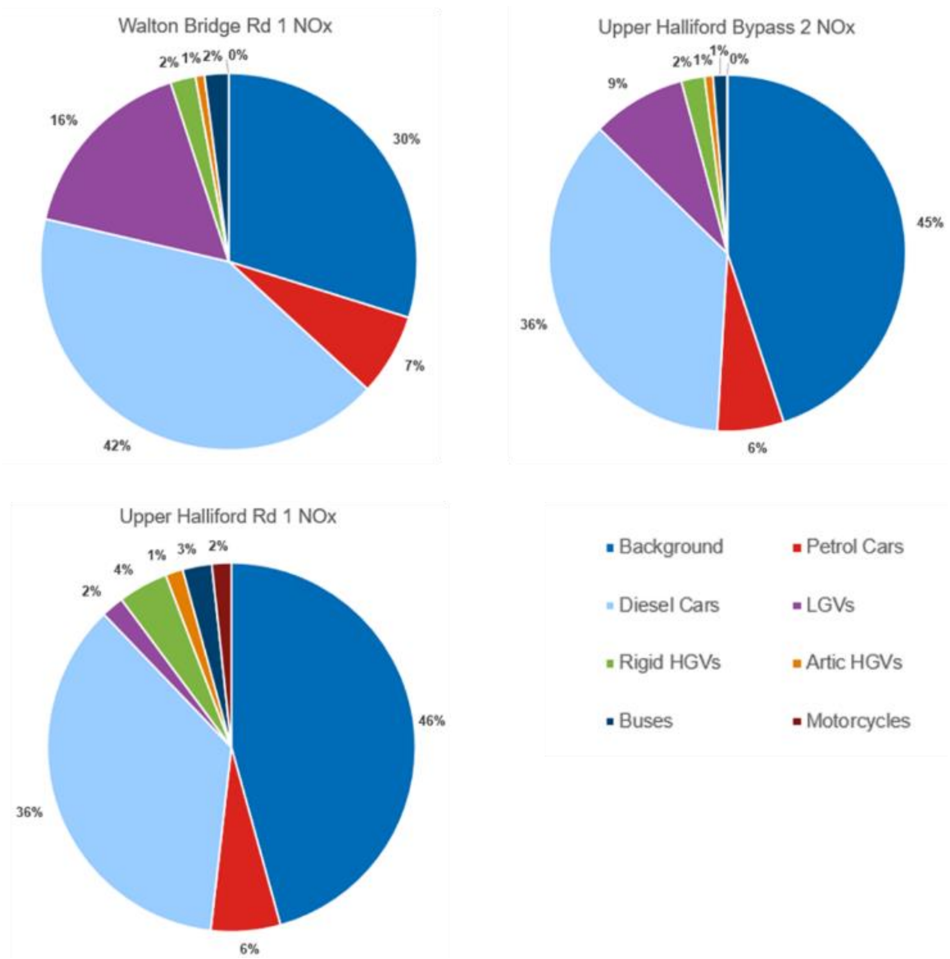
Where annual mean pollutant concentrations in excess of the respective air quality objectives have been predicted, source apportionment has been conducted at up to three worst-case receptors. In this case there were no modelled exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives; source apportionment of NOx only has been conducted.

Source apportionment of NOx was conducted at the three worst-case receptor locations: Walton Bridge Road 1, Upper Halliford Bypass 2, and Upper Halliford Road 1. Pies charts are presented in Figure 3.51.

At all three locations,

- The largest proportions of NOx were attributable to background concentrations (ranging from 30%-46%)
- Diesel cars account for the largest proportion of road NOx concentrations (ranging from 36%-42%).
- LGVs contributed to 9%-16% of NOx emissions on Walton Bridge Road and the Upper Halliford Bypass.
- Bus and HGV emissions are much less significant than other vehicle types.

Figure 3.51: Lower Halliford NOx source apportionment



3.5.2 Lower Halliford future baseline and measures appraisal

The assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to annual mean pollutant concentration associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only as the 2019 baseline modelling indicated that PM_{10} and $PM_{2.5}$ annual mean were well below the respective objectives at all locations where there is relevant human exposure.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

3.5.2.1 Future year NO_2 annual mean results

Tabulated NO_2 annual mean results at specified receptor locations for each of the modelled scenario in 2027 are presented in Table 3-4. The results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be significantly less than the 40 µg.m^{-3} objective at the receptor locations identified as worst-case in 2019. The road traffic NOx emission mitigation options reduce the predicted NO_2 annual mean further and, on this basis, are not necessary to achieve compliance with the objective.

Table 3-24: 2027 baseline and mitigation scenarios - NO_2 annual mean (µg.m^{-3}) at receptors in Lower Halliford

Receptor	Height (m)	2019 baseline	2027 baseline	2027 Option 1	2027 Option 2	2027 Option 3
Walton Bridge Rd 1	1.5	**42.3**	26.7	26.4	26.4	26.0
Walton Bridge Rd 2	1.5	36.7	23.4	23.2	23.2	22.9
Walton Bridge Rd 3	1.5	31.6	20.7	20.6	20.6	20.3
Russell Rd 1	1.5	26.4	17.9	17.8	17.8	17.7
Gaston Bridge Rd 1	1.5	26.3	17.7	17.6	17.6	17.5
Green Ln 1	1.5	25.0	17.2	17.1	17.1	17.0
Gaston Bridge Rd 2	1.5	27.5	18.5	18.4	18.4	18.2
Upper Halliford Bypass 1	1.5	29.3	19.5	19.3	19.4	19.1
Upper Halliford Bypass 2	1.5	30.9	20.3	20.2	20.2	20.0
Walton Bridge Rd 4	1.5	26.3	17.7	17.6	17.6	17.5
Upper Halliford Rd 1	1.5	30.5	20.2	20.0	20.0	19.8
Walton Bridge Rd 5 garden	1.5	**41.3**	26.0	25.8	25.8	25.4

3.5.2.2 Compliance year

As the results indicate compliance with the NO_2 annual mean objective in 2027, it is useful to understand when compliance may be achieved without any intervention. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year.

As explained previously, it is worth noting that this method of interpolation is likely to overestimate NO_2 annual mean concentrations at receptors during 2020 and 2021, during which traffic activity was reduced significantly because of Covid-19 pandemic restrictions. The interpolated results should be considered in context with this, and the other modelling uncertainties described in Section 4.

The simple linear interpolation indicates compliance would be achieved without any intervention in Lower Halliford by 2021.

Table 3-25: Lower Halliford NO_2 annual mean ($\mu g.m^{-3}$) - Simple linear interpolation 2019 to 2027

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
Walton Bridge Rd 1	**42.3**	**40.4**	38.4	36.4	34.5	32.5	30.6	28.6	26.7
Walton Bridge Rd 2	36.7	35.0	33.4	31.7	30.0	28.4	26.7	25.1	23.4
Walton Bridge Rd 3	31.6	30.3	28.9	27.5	26.2	24.8	23.4	22.1	20.7
Russell Rd 1	26.4	25.3	24.3	23.2	22.2	21.1	20.0	19.0	17.9
Gaston Bridge Rd 1	26.3	25.2	24.1	23.1	22.0	20.9	19.8	18.8	17.7
Green Ln 1	25.0	24.0	23.0	22.0	21.1	20.1	19.1	18.2	17.2
Gaston Bridge Rd 2	27.5	26.4	25.2	24.1	23.0	21.9	20.7	19.6	18.5
Upper Halliford Bypass 1	29.3	28.1	26.8	25.6	24.4	23.1	21.9	20.7	19.5
Upper Halliford Bypass 2	30.9	29.6	28.3	27.0	25.6	24.3	23.0	21.7	20.3
Walton Bridge Rd 4	26.3	25.2	24.1	23.1	22.0	20.9	19.8	18.8	17.7
Upper Halliford Rd 1	30.5	29.2	27.9	26.6	25.3	24.0	22.8	21.5	20.2
Walton Bridge Rd 5 garden	**41.3**	39.4	37.5	35.6	33.6	31.7	29.8	27.9	26.0

3.6 Moor Lane results

3.6.1 Recent baseline (2019) model

Contour plots of the Moor Lane study area at ground floor level (1.5m) were created to show the predicted spatial variation in annual mean NO_2 concentrations.

Model receptors have been placed at the facade of buildings where relevant exposure exists within the pollution hotspots identified from the modelled contour plots. There are primarily ground floor residential properties along Moor Lane near the M25 and A30.

Some of these properties also contain gardens that border the roads, and it is possible that residents could occupy these garden areas for more than one hour; comparison of the annual mean with the 60 $\mu g.m^{-3}$ indicative value is relevant here.

Modelled NO_2 annual mean at specified receptors are presented in Table 3-26 and are also shown on maps using graduated colours below. There was one exceedance of the NO_2 annual mean at a first floor residential property at the junction of Church St and Bridge St.

Annual mean NO_2 concentrations in excess of 60 $\mu g.m^{-3}$ are not predicted at any locations where anyone is likely to spend an hour or more, which indicates that it is unlikely that the short term NO_2 objective is being exceeded in residential gardens.

Table 3-26: Predicted annual mean NO_2 concentrations at specified receptors – Moor Lane 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean ($\mu g.m^{-3}$)
Moor Ln 1	502947.1	172416.3	1.5	27.9
Moor Ln 2	502948.7	172432.3	1.5	26.2
Moor Ln 3	502579.1	173056	1.5	39.6
Moor Ln 4	502606.7	173273.6	1.5	40.2
Moor Ln 5	502966	172327	1.5	23.7
Moor Ln 6	502549.9	172804.3	1.5	30.0
Annie Brookes Cl	502915.1	172328.4	1.5	23.7
Moor Ln 7	503075.3	172225.1	1.5	23.6
Moor Ln garden 1*	502592.1	172717.2	1.5	27.4
Moor Ln garden 2*	502871.9	172411.9	1.5	29.7
Church St 1	503282	171733.2	4	24.6
Church St 2	503302.3	171724.9	4	**40.9**
Wraysbury Rd 1	503272.8	171824.9	1.5	30.5

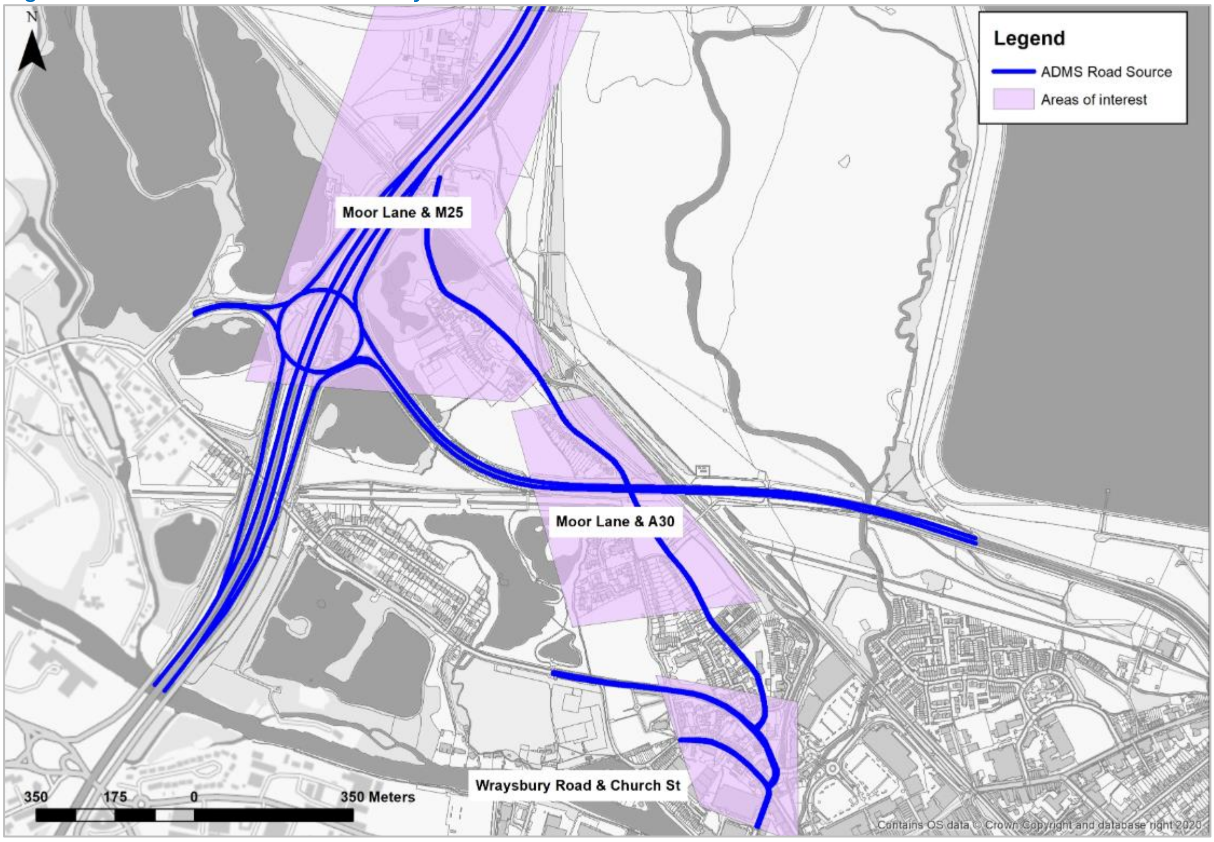
Exceedances of the annual mean objective in bold
*** Short-term objective applies in residential garden**

To aid interpretation, the results have been presented for three sub-areas within the Moor Lane area:

- Moor Lane and the M25
- Moor Lane and the A30
- Wraysbury Road and Church St

A map showing the location of each sub-area is presented in Figure 3.52.

Figure 3.52: Moor Lane – Sub study areas



3.6.1.1 NO_2 results (2019) Moor Lane & M25

The contour plot presented in Figure 3.53 indicates that NO_2 annual mean concentration in excess of the 40 µg.m^{-3} objective may have occurred at some residential properties in the Moor Lane and M25 area in 2019.

NO_2 annual means of 40 µg.m^{-3} were predicted at two ground level residential receptor locations on Moor Lane near the M25 (Moor Lane 3 and Moor Lane 4, see Figure 3.54). Although these NO_2 concentrations nearly exceed the NO_2 annual mean objective, there is an urban background diffusion tube (SP49) at the same location as the Moor Lane 4 receptor. The SP49 2019 measured NO_2 annual mean was 36 µg.m^{-3}, so the model is clearly overpredicting at this location. On this basis, it's reasonable to conclude that exceedances of the NO_2 annual mean objective at residences near the M25 are unlikely.

Table 3-27: Predicted annual mean NO_2 concentrations at specified receptors 'Moor Lane & M25' 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean (µg.m^{-3})
Moor Ln 1	502947.1	172416.3	1.5	27.9
Moor Ln 3	502579.1	173056	1.5	39.6
Moor Ln 4	502606.7	173273.6	1.5	40.2
Moor Ln 6	502549.9	172804.3	1.5	30.0

Exceedances of the annual mean objective in bold
*** Short-term objective applies in residential garden**

Figure 3.53: NO_2 annual mean concentrations – Moor Lane and M25, 2019

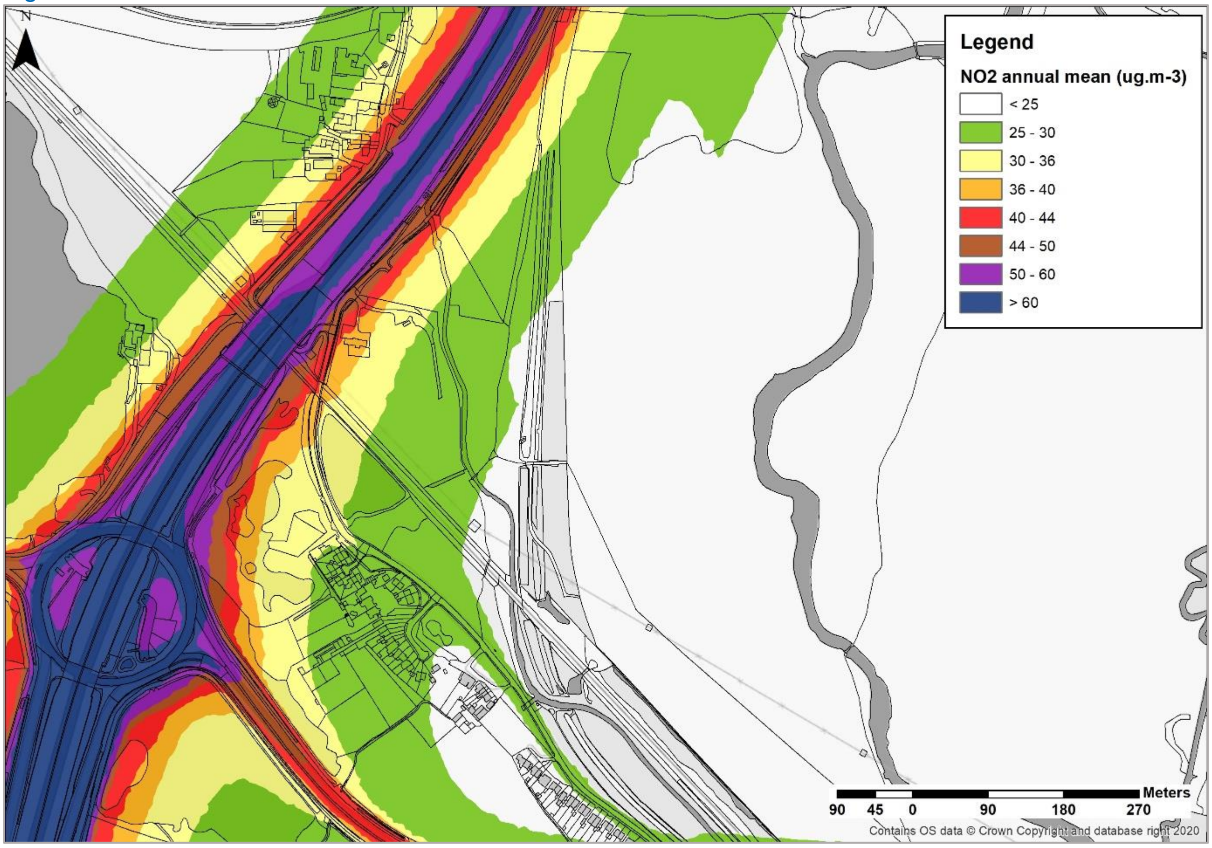
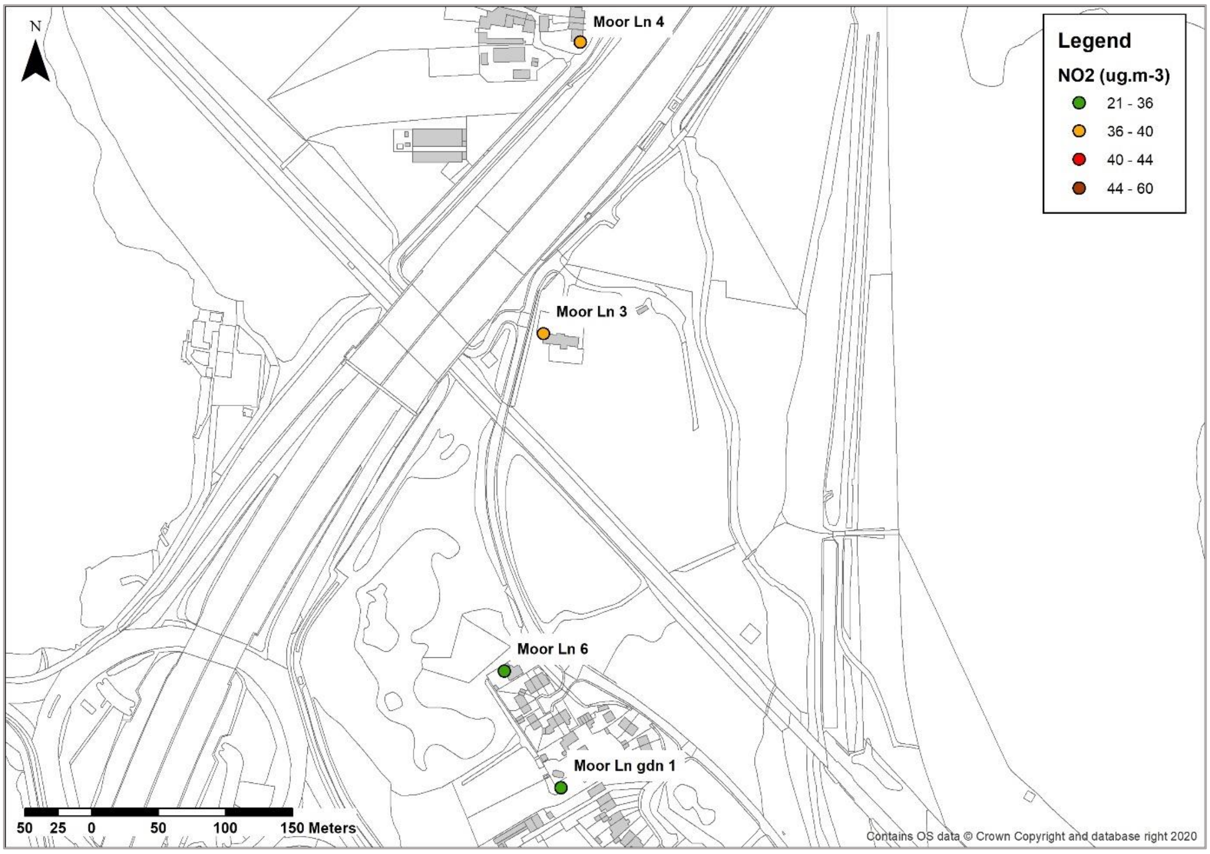


Figure 3.54: Moor Lane receptor locations and predicted annual mean NO_2 concentrations –Moor Lane and M25



3.6.1.2 NO_2 results (2019) Moor Lane & A30

The contour plot of Moor Lane and the A30 (Figure 3.55) in shows maximum NO_2 annual mean concentrations near the A30 and M25.

There were no exceedances of the NO_2 annual mean objective at Moor Lane receptor locations of relevant exposure near the A30 (Figure 3.56). The nearest receptor locations were ground level houses and gardens near the A30.

Table 3-28: Predicted annual mean NO_2 concentrations at specified receptors 'Moor Lane & A30' 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean (µg.m^{-3})
Moor Ln 1	502947.1	172416.3	1.5	27.9
Moor Ln 2	502948.7	172432.3	1.5	26.2
Moor Ln 5	502966	172327	1.5	23.7
Annie Brookes Cl	502915.1	172328.4	1.5	23.7
Moor Ln 7	503075.3	172225.1	1.5	23.6
Moor Ln garden 2*	502871.9	172411.9	1.5	29.7

Exceedances of the annual mean objective in bold
*** Short-term objective applies in residential garden**

Figure 3.55: NO_2 annual mean concentrations – Moor Lane and A30, 2019

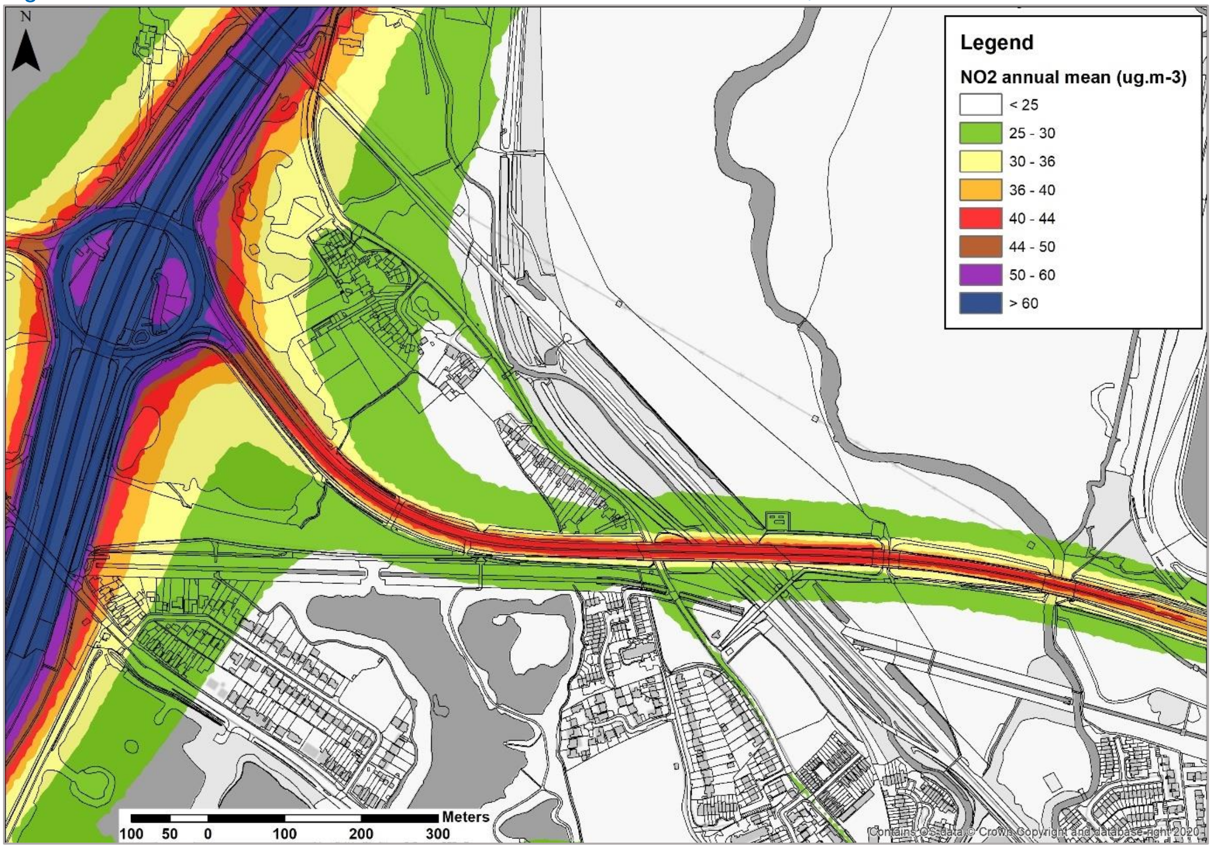
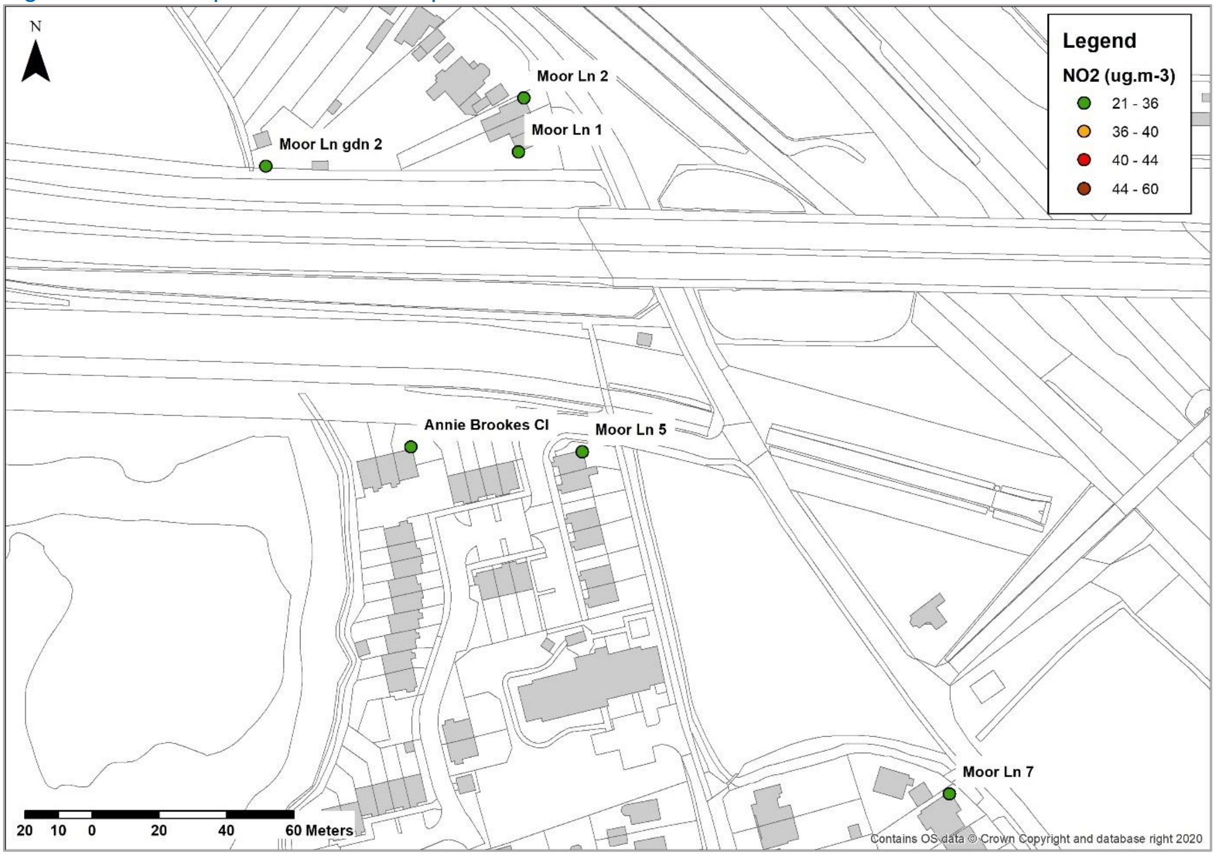


Figure 3.56: Receptor locations and predicted annual mean NO_2 concentrations 'Moor Lane & A30'



3.6.1.3 NO_2 results (2019) Wraysbury Road and Church St

The contour plot presented in Figure 3.57 shows elevated modelled NO_2 annual mean along Bridge St near the junction with Church Street and Wraysbury Road. At this location there are mainly offices and commercial properties at the ground floor; there are however some residential properties at first floor height near the junction.

An exceedance of the 40 µg.m^{-3} objective was predicted at a first-floor residential property (Figure 3.58). Measured average vehicle speeds are low along Bridge St, so there is likely to be congestion along this road. It is recommended to place a diffusion tube on Bridge St/Wraysbury Road to confirm if exceedances occur at this location.

Table 3-29: Predicted annual mean NO_2 concentrations at specified receptors – Moor Lane 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean (µg.m^{-3})
Church St 1	503282	171733.2	4	24.6
Church St 2	503302.3	171724.9	4	**40.9**
Wraysbury Rd 1	503272.8	171824.9	1.5	30.5

Exceedances of the annual mean objective in bold
*** Short-term objective applies in residential garden**

Figure 3.57: NO_2 annual mean concentrations – Moor Lane and Wraysbury Road, 2019

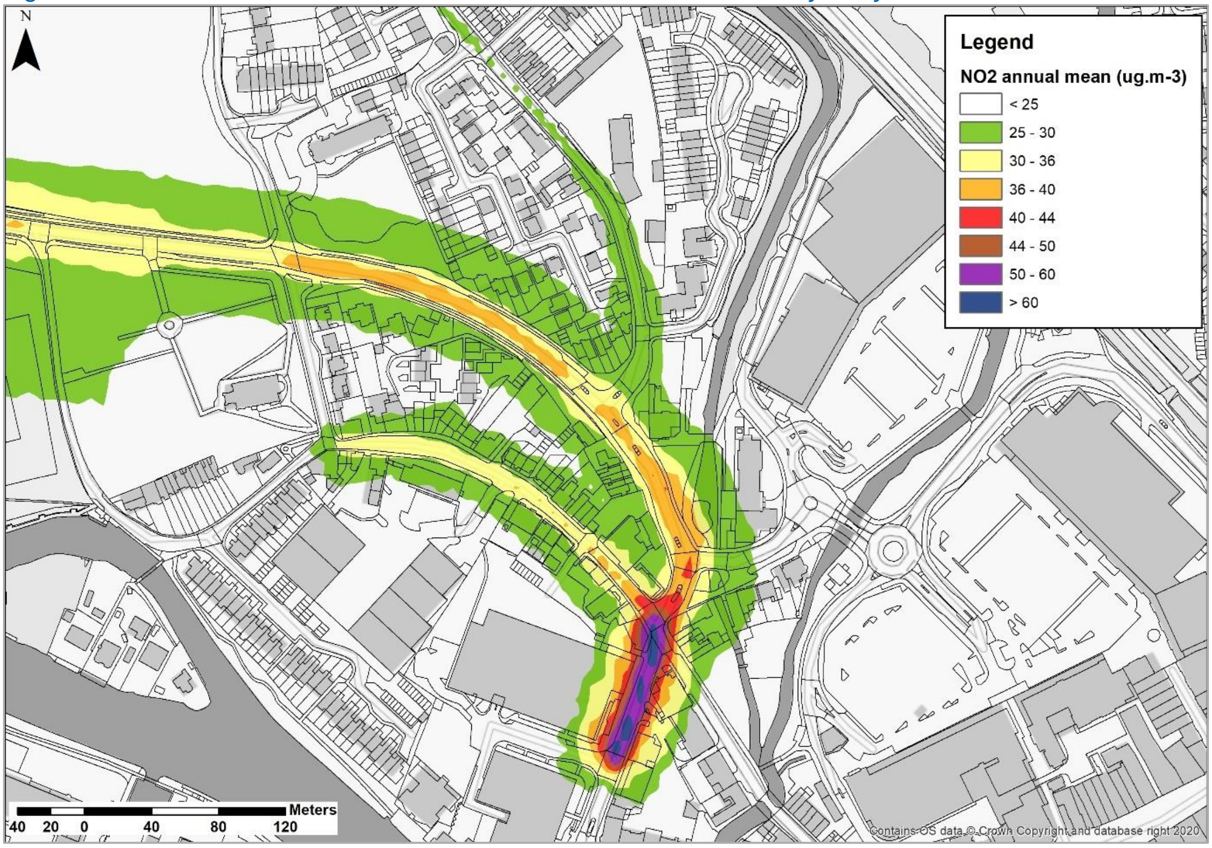


Figure 3.58: Moor Lane receptor locations and predicted annual mean NO_2 concentrations –Wraysbury Road

3.6.1.4 PM_{10} results (2019) Moor Lane

Contour plots showing the predicted spatial variation in annual mean PM_{10} concentrations in the Moor Lane study area at ground floor level (1.5m) are presented in Figure 3.59 and Figure 3.60. The contour indicates that the 40 µg.m^{-3} annual mean PM_{10} objective is not being exceeded at any locations of relevant exposure at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in Table 3-30. No annual mean PM_{10} concentrations in excess of the 40 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-30: Predicted annual mean PM_{10} concentrations at receptors – Moor Lane 2019

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
Moor Ln 1	502947.1	172416.3	1.5	19.0
Moor Ln 2	502948.7	172432.3	1.5	18.4
Moor Ln 3	502579.1	173056	1.5	21.2
Moor Ln 4	502606.7	173273.6	1.5	21.5
Moor Ln 5	502966	172327	1.5	17.7
Moor Ln 6	502549.9	172804.3	1.5	19.0
Annie Brookes Cl	502915.1	172328.4	1.5	17.7
Moor Ln 7	503075.3	172225.1	1.5	16.7
Moor Ln garden 1	502592.1	172717.2	1.5	18.4
Moor Ln garden 2	502871.9	172411.9	1.5	19.6
Church St 1	503282	171733.2	4	16.6
Church St 2	503302.3	171724.9	4	18.8
Wraysbury Rd 1	503272.8	171824.9	1.5	17.8

Figure 3.59: PM_{10} annual mean concentrations – Moor Lane, M25, and A30, 2019

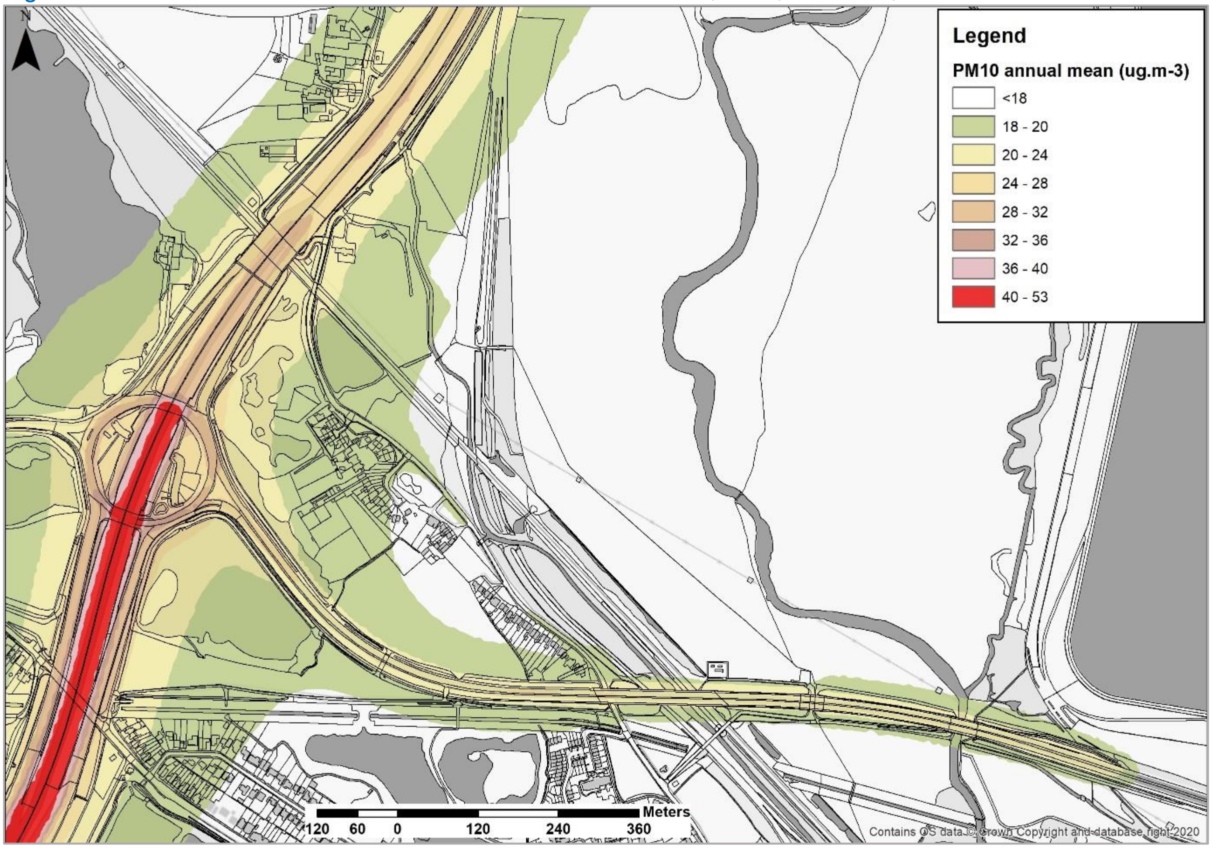
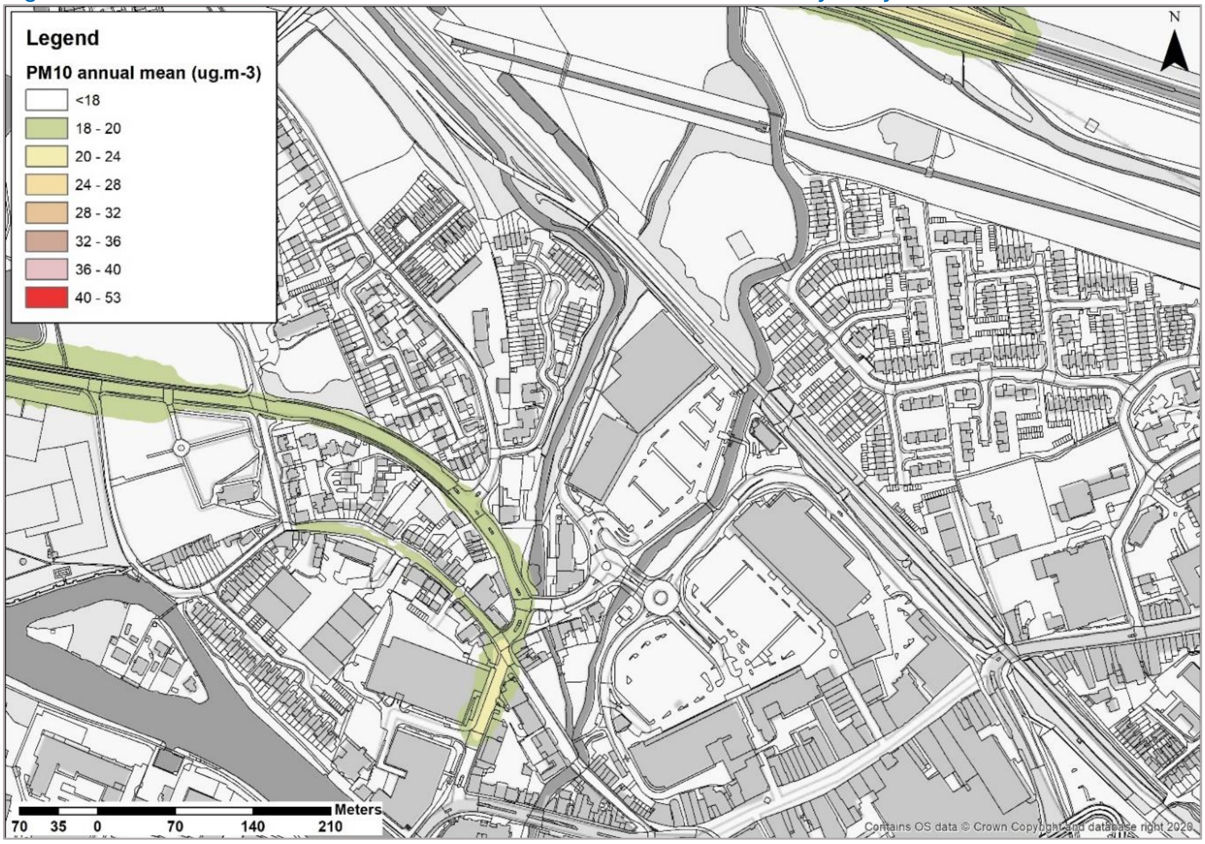


Figure 3.60: PM_{10} annual mean concentrations – Moor Lane and Wraysbury Rd, 2019



3.6.1.5 $PM_{2.5}$ results (2019) Moor Lane

Contour plots showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Moor Lane study area at ground floor level (1.5m) are mapped in Figure 3.61 and Figure 3.62. The contours indicate that the 25 $\mu g.m^{-3}$ annual mean $PM_{2.5}$ objective is not being exceeded at any locations of relevant exposure at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-31. No annual mean $PM_{2.5}$ concentrations in excess of the 25 $\mu g.m^{-3}$ objective were predicted at any of the modelled receptor locations.

Table 3-31: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors – Moor Lane 2019

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean ($\mu g.m^{-3}$)
Moor Ln 1	502947.1	172416.3	1.5	12.7
Moor Ln 2	502948.7	172432.3	1.5	12.4
Moor Ln 3	502579.1	173056	1.5	13.8
Moor Ln 4	502606.7	173273.6	1.5	14.0
Moor Ln 5	502966	172327	1.5	12.0
Moor Ln 6	502549.9	172804.3	1.5	12.7
Annie Brookes Cl	502915.1	172328.4	1.5	12.0
Moor Ln 7	503075.3	172225.1	1.5	11.4
Moor Ln garden 1	502592.1	172717.2	1.5	12.4
Moor Ln garden 2	502871.9	172411.9	1.5	13.0
Church St 1	503282	171733.2	4	11.7
Church St 2	503302.3	171724.9	4	13.0
Wraysbury Rd 1	503272.8	171824.9	1.5	12.3

Figure 3.61: PM2.5 annual mean concentrations – Moor Lane, M25, and A30, 2019

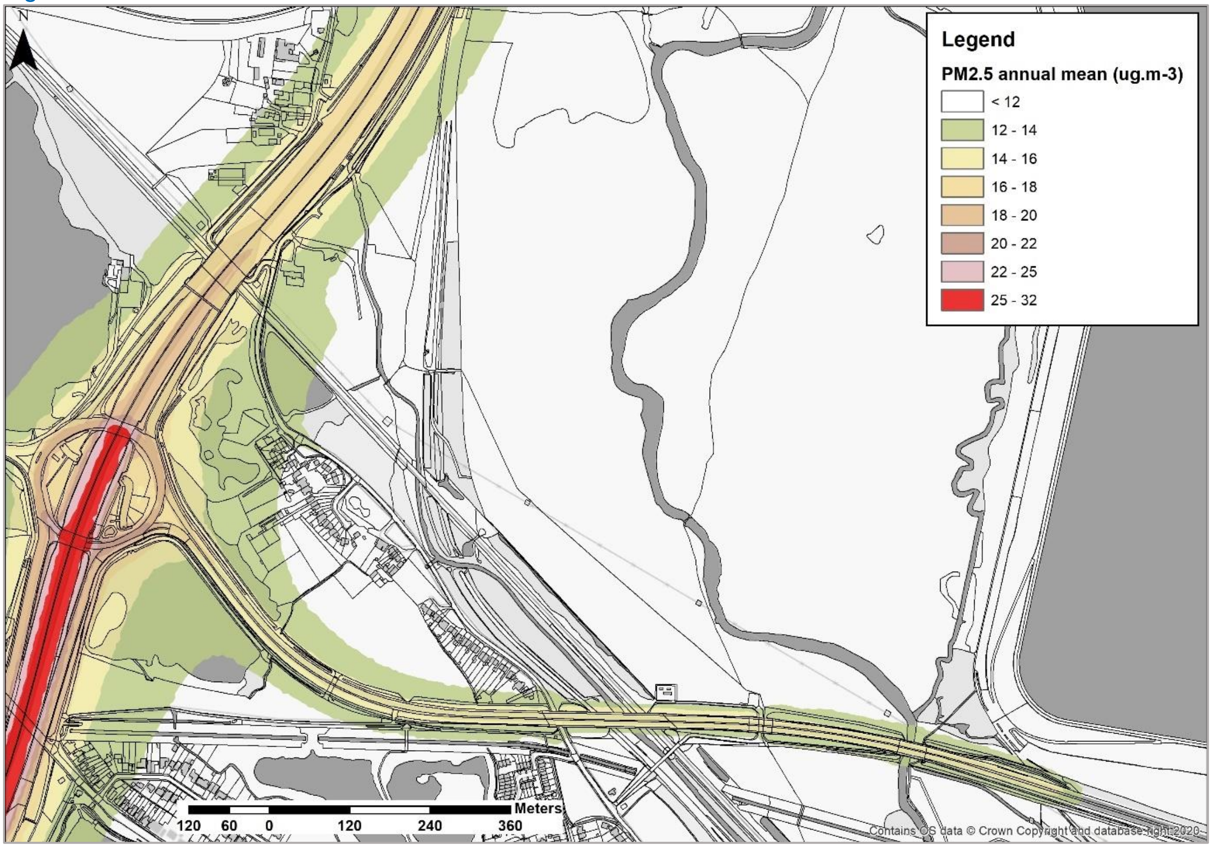
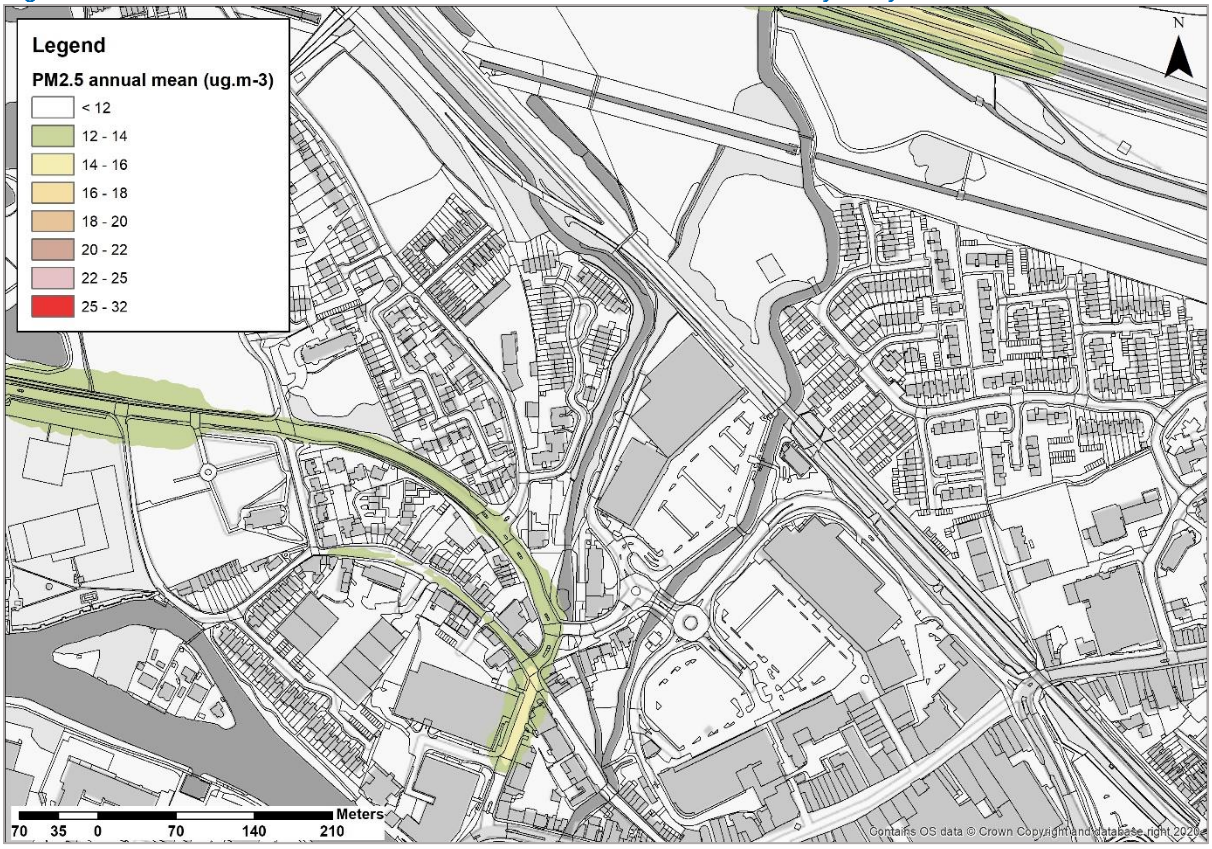


Figure 3.62: PM2.5 annual mean concentrations – Moor Lane and Wraysbury Rd, 2019



3.6.1.6 Source apportionment – Moor Lane

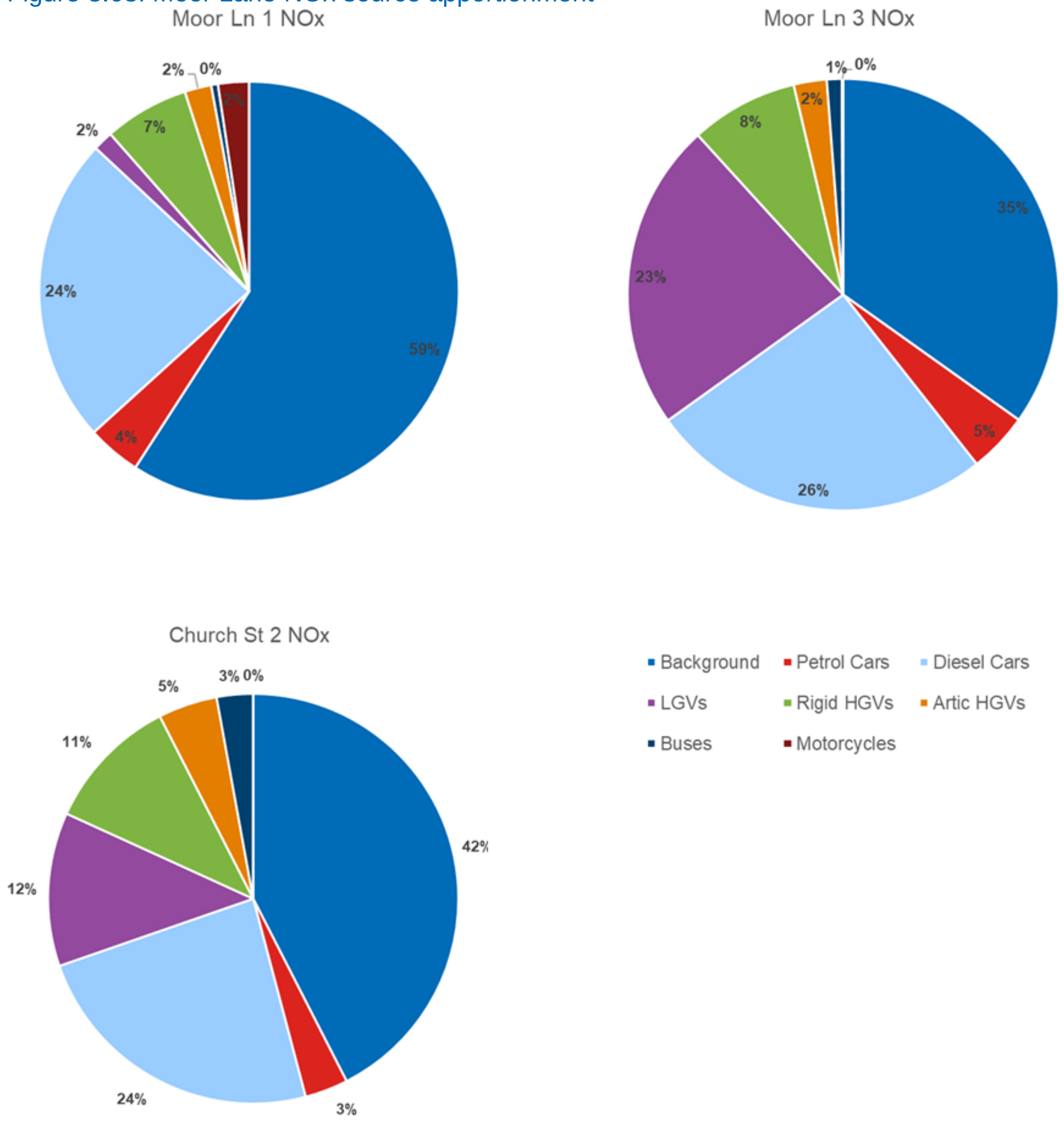
Where annual mean pollutant concentrations in excess of the respective air quality objectives have been predicted, source apportionment has been conducted at up to three worst-case receptors. In this case there were no modelled exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives; source apportionment of NOx only has been conducted.

Source apportionment of NOx was conducted at three worst-case receptor locations: Moor Lane 1, Moor Lane 3, and Church St 2. Pies charts are presented in Figure 3.63.

At all three locations,

- The largest proportions of NOx were attributable to background concentrations (ranging from 35%-59%)
- Diesel cars account for the largest proportion of road NOx concentrations (ranging from 24%-26%).
- LGVs contributed to 12-23% of NOx emissions on the M25 and Bridge St, but only to 2% on the A30.
- Rigid HGVs contributed to 7 – 11% of NOx emissions.
- Bus emissions are much less significant than other vehicle types.

Figure 3.63: Moor Lane NOx source apportionment



3.6.2 Moor Lane future baseline and measures appraisal

The assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to NO_2 annual mean concentrations associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only as the 2019 baseline modelling indicated that PM_{10} and $PM_{2.5}$ annual mean were well below the respective objectives at all locations where there is relevant human exposure.

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

3.6.2.1 Future year NO_2 annual mean results

Tabulated NO_2 annual mean results at specified receptor locations for each of the modelled scenario in 2027 are presented in Table 3-32. The results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual means are predicted to be significantly less than the 40 $\mu g.m^{-3}$ objective at the receptor locations identified as worst-case in 2019. The road traffic NOx emission mitigation options reduce the predicted NO_2 annual mean further and, on this basis, are not necessary to achieve compliance with the objective.

Table 3-32: 2027 baseline and mitigation scenarios - NO_2 annual mean ($\mu g.m^{-3}$) at receptors in Moor Lane

Receptor	Height (m)	2019 baseline	2027 baseline	2027 Option 1	2027 Option 2	2027 Option 3
Moor Ln 1	1.5	27.9	18.8	18.7	18.7	18.6
Moor Ln 2	1.5	26.2	17.9	17.8	17.8	17.7
Moor Ln 3	1.5	39.6	23.8	23.7	23.5	23.3
Moor Ln 4	1.5	40.2	23.9	23.8	23.6	23.4
Moor Ln 5	1.5	23.7	16.6	16.5	16.5	16.5
Moor Ln 6	1.5	30.0	19.5	19.5	19.4	19.3
Annie Brookes Cl	1.5	23.7	16.6	16.5	16.5	16.5
Moor Ln 7	1.5	23.6	16.7	16.7	16.7	16.6
Moor Ln gdn 1	1.5	27.4	18.3	18.2	18.1	18.1
Moor Ln gdn 2	1.5	29.7	19.8	19.7	19.7	19.5
Church St 1	4	24.6	17.9	17.9	17.9	17.8
Church St 2	4	**40.9**	26.2	26.0	25.9	25.7
Wraysbury Rd 1	1.5	30.5	20.8	20.7	20.7	20.6

3.6.2.2 Compliance year

As the results indicate compliance with the NO_2 annual mean objective in 2027, it is useful to understand when compliance may be achieved without any intervention. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation; whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year.

As explained previously, it is worth noting that this method of interpolation is likely to overestimate NO_2 annual mean concentrations at receptors during 2020 and 2021, during which traffic activity was reduced significantly because of Covid-19 pandemic restrictions. The interpolated results should be considered in context with this, and the other modelling uncertainties described in Section 4.

The simple linear interpolation indicates compliance would be achieved without any intervention in Moor Lane by 2020.

Table 3-33: Moor Lane NO_2 annual mean ($\mu g.m^{-3}$) - Simple linear interpolation 2019 to 2027

Receptor	2019	2020	2021	2022	2023	2024	2025	2026	2027
Moor Ln 1	27.9	26.8	25.6	24.5	23.4	22.2	21.1	19.9	18.8
Moor Ln 2	26.2	25.2	24.1	23.1	22.1	21.0	20.0	18.9	17.9
Moor Ln 3	39.6	37.6	35.6	33.7	31.7	29.7	27.8	25.8	23.8
Moor Ln 4	40.2	38.2	36.2	34.1	32.1	30.0	28.0	26.0	23.9
Moor Ln 5	23.7	22.8	21.9	21.0	20.1	19.3	18.4	17.5	16.6
Moor Ln 6	30.0	28.7	27.4	26.1	24.8	23.5	22.2	20.8	19.5
Annie Brookes Cl	23.7	22.8	21.9	21.0	20.1	19.2	18.4	17.5	16.6
Moor Ln 7	23.6	22.8	21.9	21.0	20.2	19.3	18.4	17.6	16.7
Moor Ln garden 1	27.4	26.2	25.1	24.0	22.8	21.7	20.5	19.4	18.3
Moor Ln garden 2	29.7	28.5	27.2	26.0	24.7	23.5	22.3	21.0	19.8
Church St 1	24.6	23.8	22.9	22.1	21.3	20.4	19.6	18.7	17.9
Church St 2	**40.9**	39.1	37.2	35.4	33.5	31.7	29.9	28.0	26.2
Wraysbury Rd 1	30.5	29.2	28.0	26.8	25.6	24.4	23.2	22.0	20.8

3.7 Thames Street results

3.7.1 Recent baseline (2019) model

3.7.1.1 NO_2 results (2019) Thames Street

As no monitoring data were available in the Thames Street study area to verify the model outputs, the Road NOx adjustment factor derived for Lower Halliford was used as the best available proxy to adjust the model results. There is therefore considerable uncertainty, **the results presented for this study area should be considered as indicative only**; and have been included to inform Spelthorne Borough Council if air quality measurements should be deployed here.

A contour plot showing the predicted spatial variation in annual mean NO_2 concentrations in the Thames Street study area at ground floor level (1.5m) is presented in Figure 3.66.

The maximum ground level concentrations have been predicted along the eastern section of the Thames Street junction with The Avenue. Thames Street is very narrow in this section and building facades are located close to the road (see photograph in Figure 3.64). The contour plot indicates that NO_2 annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ objective may have occurred at some residential properties at these locations in 2019.

Model receptors have been placed at the facades of a selection of buildings at Thames Street. There are residential properties at both ground floor height and at first floor height (4m) above commercial properties.

Modelled NO_2 annual mean at specified receptors are presented in Table 3-34 and are also shown on a map using graduated colours in Figure 3.65. NO_2 annual means in excess of the 40 µg.m^{-3} objective were predicted at ground level receptor locations on Thames Street on the south side of the road.

Although there is considerable uncertainty with the model results at this location; these results do indicate that there is a risk that the NO_2 annual mean objective is being exceeded at residential properties. NO_2 measurements should be conducted here and included in Spelthorne Borough Council's LAQM review and assessment programme.

Figure 3.64: Thames Street road width and buildings (Google Earth, 2021)

Table 3-34: Predicted annual mean NO_2 concentrations at specified receptors – Thames Street 2019

Receptor	Easting	Northing	Height (m)	NO_2 annual mean (µg.m^{-3})
Thames St 1	510992.7	168689.3	1.5	**41.6**
Thames St 2	511036.1	168706.3	1.5	**40.7**
Thames St 3	511000.6	168699.8	4	35.6
Thames St 4	510976.9	168681.6	4	25.2
Thames St 5	510943.1	168670.9	1.5	35.7
The Avenue 1	510963.4	168688.5	1.5	33.0

Exceedances of the annual mean objective in bold

Figure 3.65: Receptor locations and predicted annual mean NO_2 concentrations - Thames St 2019

Figure 3.66: Modelled variation in NO_2 annual mean concentrations - Thames Street 2019

3.7.1.2 PM_{10} results

A contour plot showing the predicted spatial variation in annual mean PM_{10} concentrations in the Thames Street study area at ground floor level (1.5m) is presented in Figure 3.67. The contour indicates that the 40 µg.m^{-3} annual mean PM_{10} objective is not being exceeded at any locations at ground level.

The modelled annual mean PM_{10} concentrations at each of the specified receptors are presented in Table 3-35. No annual mean PM_{10} concentrations in excess of the 40 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-35: Predicted annual mean PM_{10} concentrations at specified receptors – Thames Street 2019

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
Thames St 1	510992.7	168689.3	1.5	20.3
Thames St 2	511036.1	168706.3	1.5	20.0
Thames St 3	511000.6	168699.8	4	18.9
Thames St 4	510976.9	168681.6	4	16.8
Thames St 5	510943.1	168670.9	1.5	19.0
The Avenue 1	510963.4	168688.5	1.5	18.2

Figure 3.67: PM_{10} annual mean concentrations - Thames Street 2019

3.7.1.3 $PM_{2.5}$ results

A contour plot showing the predicted spatial variation in annual mean $PM_{2.5}$ concentrations in the Thames Street study area at ground floor level (1.5m) is presented in Figure 3.68. The contours indicate that the 25 µg.m^{-3} annual mean $PM_{2.5}$ objective is not being exceeded at any locations at ground level.

The modelled annual mean $PM_{2.5}$ concentrations at each of the specified receptors are presented in Table 3-36. No annual mean $PM_{2.5}$ concentrations in excess of the 25 µg.m^{-3} objective were predicted at any of the modelled receptor locations.

Table 3-36: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors – Thames Street 2019

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean ($\mu g.m^{-3}$)
Thames St 1	510992.7	168689.3	1.5	13.8
Thames St 2	511036.1	168706.3	1.5	13.5
Thames St 3	511000.6	168699.8	4	12.8
Thames St 4	510976.9	168681.6	4	11.7
Thames St 5	510943.1	168670.9	1.5	13.0
The Avenue 1	510963.4	168688.5	1.5	12.5

Figure 3.68: $PM_{2.5}$ annual mean concentrations - Thames Street 2019

4 Model uncertainty and sensitivity testing

When interpreting the model results presented, it is important to consider uncertainty associated with both the inputs and outputs of the modelling process. Model results should be considered in context with both the wider uncertainties in the modelling process and any known uncertainties specific to this assessment.

Overall model performance for the 2019 baseline year has been assessed by verification of the air quality model outputs against measured concentrations in each study area. Model performance and uncertainty has been quantified using the Root Mean Square Error (RMSE) of observed vs predicted NO_2 annual mean concentrations, as recommended in the LAQM.TG(16) Technical Guidance.

Across all study areas the RMSE has ranged from 2.1 µg.m^{-3} in Staines to 4.3 µg.m^{-3} in Sunbury which indicates greater uncertainty in the model results at Sunbury.

Predicting pollutant concentrations in future years (in this case 2027) introduces additional uncertainty into the modelling process. The key factors in this assessment are described below.

- **Traffic activity** – as described previously in Section 2.1.3.1, the variety and age of the various traffic activity data sources is a significant source of uncertainty in this modelling assessment. Recent data sources such as the 2019 DfT counts and local surveys spanning multiple months in 2019 provided reasonably good baseline datasets; however, some surveys e.g. seven-day counts from 2017 or 2018 may not be as representative of annual averages. It is also uncertain if the 2014 traffic model outputs growth factored forward to 2019 provided an accurate representation of baseline traffic flows.

  These factors are compounded further when projecting as far forward as 2027. Although we have attempted to account for traffic growth using a locally specific TEMPRO growth factor, this has for some roads been projected from as far back as 2014, and as such can be considered as a best estimate based on the only available information. An up-to-date borough wide traffic model accounting for the latest local plan and how this is likely to affect traffic activity over the next five years would provide more confidence in the data used to estimate future air quality.

- **Vehicle fleet age projections and emission factors** Vehicle emission projections in the NAEI/EFT are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. The projected average vehicle emission rates in 2027 therefore rely on the vehicle fleet in Spelthorne renewing in line with the national projections. It is currently uncertain if this will be the case as the recent pandemic and subsequent global supply crisis have impacted both car use and vehicle renewal rates.
  Inclusion of a sensitivity test of fleet turnover is a possible approach to providing a more conservative estimate of future vehicle fleet make up. Results of a sensitivity test of a delay to renewal of the fleet by 2 years to estimate the impact of the pandemic and supply crisis on vehicle renewals are presented below. The actual effect of the pandemic and subsequent supply crisis on fleet turnover is however currently unknown. As such, any sensitivity test will present an uncertain range of possible outcomes. Alternatively, local traffic surveys using automatic number plate recognition (ANPR) would allow a comparison of the actual current fleet make up in Spelthorne with the projection for the current fleet in the NAEI/EFT.

Other general uncertainties in the modelling process applicable to this assessment include:

- **Inter-year meteorology** – weather conditions vary from year to year, which affects dispersion of pollutant emissions. The effect of this can be quantified with a sensitivity test where the dispersion model is run again using multiple annual met datasets.
- **Background concentrations** – When using the Defra projected pollutant background maps, the projected future year outputs are based on NAEI estimates of how emissions will change over time; and are the outputs of a national scale model, outputs from which are also uncertain.

4.1 Fleet renewal sensitivity test

A delay in fleet renewal of 2 years has been considered and modelled using 2025 predicted fleet age mix compared to the 2027 mix. Results comparing maximum NO_2 concentrations at receptor locations for the 2027 BAU using the alternative fleet age projections and to the standard 2027 prediction are presented below. There was little impact on PM_{10} and $PM_{2.5}$ concentrations at all receptor locations in all areas, as the percent change was less than 1%, so only NO_2 results have been presented.

4.1.1 Sunbury-on-Thames fleet sensitivity results

Fleet sensitivity results for Sunbury are presented in Table 4-1. There are no exceedances of the NO_2 annual mean objective using the 2025 fleet mix. The NO_2 concentrations are up to 11% higher at receptor locations. Even with a two-year delay to the fleet renewal, exceedances are not anticipated in Sunbury in 2027.

Table 4-1: Sunbury-on-Thames fleet sensitivity results in 2027 BAU

Receptors	2025 fleet NO_2 ($\mu g.m^{-3}$)	2027 fleet NO_2 ($\mu g.m^{-3}$)	Difference ($\mu g.m^{-3}$)	% difference
Vicarage Rd 1	29.3	27.0	2.3	9%
A316 bus stop	40.2	36.3	4.0	11%
Sunbury Cross 1	27.5	25.5	2.0	8%
Vicarage Rd 2	27.7	25.6	2.1	8%
Staines Rd W 1	32.9	30.0	2.9	10%
Staines Rd W 2	28.1	25.9	2.2	8%
Staines Rd W 3	31.4	28.8	2.6	9%
Windmill Rd 1	28.6	26.3	2.3	9%
Nursery Rd 1	16.4	16.0	0.4	2%
Nursery Rd 2	15.8	15.5	0.3	2%
Green St 1	32.0	29.4	2.6	9%
Green St 2	22.0	20.8	1.2	6%
Staines Rd E 1	22.1	20.8	1.3	6%
Staines Rd E 2	25.0	23.3	1.7	7%
Vicarage Rd 3	21.5	20.3	1.1	6%
Staines Rd E 3	25.1	23.4	1.7	7%

4.1.2 Staines-Upon-Thames fleet sensitivity results

Fleet sensitivity results for Staines are presented in Table 4-2. There are no exceedances of the NO_2 annual mean objective using the 2025 fleet mix. The NO_2 concentrations are up to 9% higher at receptor locations. Even with a two year delay to the fleet renewal, exceedances are not anticipated in Staines in 2027.

Table 4-2: Staines fleet sensitivity results in 2027 BAU

Receptors	2025 fleet NO_2 ($\mu g.m^{-3}$)	2027 fleet NO_2 ($\mu g.m^{-3}$)	Difference ($\mu g.m^{-3}$)	% difference
London Rd 1	28.3	26.3	2.0	8%
London Rd 2	31.6	29.0	2.6	9%
London Rd 3	27.3	25.4	1.9	7%
London Rd 4	29.6	27.6	2.0	7%
London Rd 5	30.8	28.2	2.7	9%
London Rd 6	25.1	23.3	1.8	8%
London Rd 7	26.4	24.5	1.8	8%

Crooked Billet RB 1	27.2	25.2	1.9	8%
Crooked Billet RB 2	26.2	24.5	1.8	7%
Crooked Billet RB 3	25.5	23.8	1.7	7%

4.1.3 Georgian Close fleet sensitivity results

Fleet sensitivity results for Georgian Close are presented in Table 4-3. There are no exceedances of the NO_2 annual mean objective using the 2025 fleet mix. The NO_2 concentrations are up to 4% higher at receptor locations. Even with a two year delay to the fleet renewal, exceedances are not anticipated in Georgian Close in 2027.

Table 4-3: Georgian Close fleet sensitivity results in 2027 BAU

Receptors	2025 fleet NO_2 ($\mu g.m^{-3}$)	2027 fleet NO_2 ($\mu g.m^{-3}$)	Difference ($\mu g.m^{-3}$)	% difference
Georgian Close 1	18.6	18.0	0.6	4%
Georgian Close 2	16.4	16.1	0.3	2%
Georgian Close garden 1	18.6	18.0	0.6	4%
Georgian Close garden 2	17.8	17.3	0.5	3%
Georgian Close 3	17.3	16.9	0.4	2%
Shortwood Common 1	16.0	15.8	0.2	1%
Shortwood Common 2	17.6	17.1	0.5	3%
Georgian Close 4	17.0	16.6	0.4	2%
Shortwood Common park	18.4	17.8	0.6	3%

4.1.4 Ashford fleet sensitivity results

Fleet sensitivity results for Ashford are presented in Table 4-4. There are no exceedances of the NO_2 annual mean objective using the 2025 fleet mix. The NO_2 concentrations are up to 8% higher at receptor locations. Even with a two year delay to the fleet renewal, exceedances are not anticipated in Ashford in 2027.

Table 4-4: Ashford fleet sensitivity results in 2027 BAU

Receptors	2025 fleet NO_2 ($\mu g.m^{-3}$)	2027 fleet NO_2 ($\mu g.m^{-3}$)	Difference ($\mu g.m^{-3}$)	% difference
School Rd 1	20.0	18.8	1.2	6%
School Rd 2 - Primary	19.0	18.0	1.1	6%
School Rd 3	23.6	22.0	1.6	7%
Clockhouse Ln 1	22.7	21.2	1.4	7%
Feltham Rd 1	22.3	20.9	1.4	7%
Church Rd 1	25.8	23.8	2.0	8%
Church Rd 2	23.0	21.6	1.4	7%
Fordbridge Rd 1	20.6	19.6	1.0	5%
Church Rd 3	21.3	20.1	1.2	6%
Church Rd 4	19.9	18.9	1.0	5%
Church Rd 5	20.0	19.2	0.8	4%

4.1.5 Lower Halliford fleet sensitivity results

Fleet sensitivity results for Lower Halliford are presented in Table 4-5. There are no exceedances of the NO_2 annual mean objective using the 2025 fleet mix. The NO_2 concentrations are up to 11% higher at receptor locations. Even with a two year delay to the fleet renewal, exceedances are not anticipated in Lower Halliford in 2027.

Table 4-5: Lower Halliford fleet sensitivity results in 2027 BAU

Receptors	2025 fleet NO_2 ($\mu g.m^{-3}$)	2027 fleet NO_2 ($\mu g.m^{-3}$)	Difference ($\mu g.m^{-3}$)	% difference
Walton Bridge Rd 1	29.5	26.7	2.8	11%
Walton Bridge Rd 2	25.6	23.4	2.2	10%
Walton Bridge Rd 3	22.4	20.7	1.7	8%
Russell Rd 1	19.0	17.9	1.0	6%
Gaston Bridge Rd 1	18.7	17.7	1.0	6%
Green Ln 1	18.0	17.2	0.8	5%
Gaston Bridge Rd 2	19.7	18.5	1.2	7%
Upper Halliford Bypass 1	20.9	19.5	1.4	7%
Upper Halliford Bypass 2	21.9	20.3	1.6	8%
Walton Bridge Rd 4	18.7	17.7	1.0	6%
Upper Halliford Rd 1	21.6	20.2	1.4	7%
Walton Bridge Rd 5 garden	28.7	26.0	2.7	11%

4.1.6 Moor Lane fleet sensitivity results

Fleet sensitivity results for Moor Lane are presented in Table 4-6. There are no exceedances of the NO_2 annual mean objective using the 2025 fleet mix. The NO_2 concentrations are up to 10% higher at receptor locations. Even with a two year delay to the fleet renewal, exceedances are not anticipated in Moor Lane in 2027.

Table 4-6: Moor Lane fleet sensitivity results in 2027 BAU

Receptors	2025 fleet NO_2 ($\mu g.m^{-3}$)	2027 fleet NO_2 ($\mu g.m^{-3}$)	Difference ($\mu g.m^{-3}$)	% difference
Moor Ln 1	19.7	18.8	0.9	5%
Moor Ln 2	18.7	17.9	0.8	4%
Moor Ln 3	26.1	23.8	2.3	10%
Moor Ln 4	26.3	23.9	2.4	10%
Moor Ln 5	17.1	16.6	0.5	3%
Moor Ln 6	20.7	19.5	1.2	6%
Annie Brookes Cl	17.1	16.6	0.5	3%
Moor Ln 7	17.1	16.7	0.4	2%
Moor Ln garden 1	19.1	18.3	0.9	5%
Moor Ln garden 2	20.9	19.8	1.1	6%
Church St 1	18.3	17.9	0.4	2%
Church St 2	28.2	26.2	2.0	8%
Wraysbury Rd 1	21.8	20.8	1.0	5%

5 Summary and conclusions

This report describes an atmospheric dispersion modelling assessment of Nitrogen Dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) concentrations within the Borough of Spelthorne.

The assessment has been undertaken to assist Spelthorne Borough Council with updates to their Air Quality Action Plan (AQAP) to help achieve improvements in air quality; and continue working towards attainment of the air quality objectives.

The aims of the assessment were to:

- Quantify pollutant concentrations within five key study areas using both measurements and air quality dispersion modelling for a 2019 baseline year
- Identify locations where pollutant concentrations in excess of the air quality objectives occurred in 2019.
- Conduct source apportionment to identify the principal sources of air pollution, and where to target AQAP measures.
- Test and quantify the likely effectiveness of potential abatement measures vs future baseline projections (2027) for inclusion within the new AQAP.

2019 recent base year results

The 2019 baseline modelling concluded that:

- Exceedances of the NO_2 annual mean objective were modelled at locations where there is relevant public exposure in:
    - Vicarage Road, Staines Road West, and Green Street in Sunbury
    - Thames Street, Sunbury (please note - these are indicative results only as there are currently no NO_2 measurements here. We recommend that NO_2 diffusion tubes are deployed here)
    - London Road in Staines
    - Walton Bridge Road in Lower Halliford
    - Bridge Street in Staines
- No exceedances of the NO_2 annual mean objective were modelled in Ashford or Georgian Close
- No exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives were predicted in any study area
- Annual mean NO_2 concentrations in excess of 60 $\mu g.m^{-3}$ are not predicted at any locations where anyone is likely to spend an hour or more; which indicates that it is unlikely that the short term NO_2 objective is being exceeded; this includes the A316 bus stop in Sunbury.

Source apportionment 2019

Where annual mean pollutant concentrations in excess of the respective air quality objectives were modelled in 2019, source apportionment has been conducted at up to three worst-case receptors in each study area. As there were no modelled exceedances of the PM_{10} or $PM_{2.5}$ annual mean objectives; source apportionment has been included for total oxides of nitrogen (NOx) only. Source apportionment was not conducted at Thames St, Sunbury as the 2019 baseline model results there are intended to be indicative only.

The outcomes of the source apportionment analysis can be summarised as:

- In all study areas
    - The largest proportions of NOx were attributable to background concentrations (ranging from 30%-68%)
    - diesel cars account for the largest proportion of road NOx concentrations (ranging from 19%-42%).
- In Sunbury
    - Rigid HGVs contributed 8%-13% of NOx emissions.
    - LGV emissions are much less significant than HGVs (2%-3%).

- In Staines
  - Buses contributed 12%-14% of NOx emissions.
  - LGV and HGV emissions are much less significant than other vehicle types
- In Georgian Close
  - LGV and Bus emissions are much less significant than other vehicle types.
- In Ashford
  - LGV emissions contributed 7%-13% of NOx emissions.
  - At Church Road Bus emissions contribute 11%
  - HGV emissions are much less significant than other vehicle types
- In Lower Halliford – Shepperton
  - LGVs contributed to 9%-16% of NOx emissions on Walton Bridge Road and the Upper Halliford Bypass.
  - Bus and HGV emissions are much less significant than other vehicle types.
- In Moor Lane
  - LGVs contributed to 12-23% of NOx emissions on the M25 and Bridge St.
  - Rigid HGVs contributed to 7 – 11% of NOx emissions.
  - Bus emissions are much less significant than other vehicle types.

Source apportionment aims to provides useful insights to inform action plan measures. At most locations assessed, locally targeted traffic management measures could have an impact on reducing emissions in where NO_2 annual mean in excess of the objective are occurring. Whereas at locations where the background contribution is dominant it is not as straightforward to target measures at other sources located in and around the Borough.

Future year appraisal of potential action plan measures

In all study areas, the assessment compares a future baseline year (2027) business as usual/do nothing scenario with three road traffic NOx emission mitigation scenarios; the aim being to quantify changes to annual mean pollutant concentration associated with each mitigation option.

Mitigation scenarios have been assessed for NO_2 annual mean only

The scenarios assessed were:

- **Future baseline** in 2027 (business as usual/do nothing) – future baseline traffic flows were projected from 2019 to 2027 using a TEMPRO growth factor; vehicle fleet age was projected forward using the NAEI fleet projections in the EFT v10.0.
- **Test Option 1:** All diesel cars are Euro 6 by 2027. This aims to roughly simulate the potential impact of the proposed neighbouring London ULEZ extension.
- **Test Option 2:** An improvement in HGV and bus emissions. Assumes all Bus, HGV and diesel LGV will be Euro 6 by 2027.
- **Test Option 3**: Traffic Reduction. A starting scenario of a 5% blanket reduction in traffic flows from pre-pandemic flows to explore the impact of a sustained reduction in traffic flows over time. AADT have had a TEMPRO factor applied to represent projected growth to 2027 then reduced by 5%.

The outcomes of the future year (2027) scenario modelling can be summarised as:

- In all study area the results indicate that NO_2 annual mean concentrations will have reduced significantly by 2027. For the future baseline scenario, NO_2 annual mean are predicted to be less than the 40 $\mu g.m^{-3}$ objective at all receptor locations identified as worst-case in 2019. All three of the road traffic NOx emission mitigation options tested reduce the predicted NO_2 annual mean further which indicates that they are not required to achieve compliance with the objective in 2027.
- As the results indicate compliance with the NO_2 annual mean objective in 2027, it is useful to understand when compliance may be achieved without any intervention via mitigation options. The 2019 base year and 2027 future baseline scenario results have been used to estimate maximum NO_2 annual mean at receptors in the interim years using simple linear interpolation;

whereby the change in modelled NO_2 annual mean from 2019 to 2027 provides the estimated rate of change per year:

- Sunbury – compliance will be achieved by 2022
- Staines – compliance will be achieved by 2022
- Georgian Close – compliance already achieved
- Ashford – compliance already achieved in 2019
- Lower Halliford – compliance was expected to be achieved by 2021
- Moor Lane – compliance was expected to be achieved in 2020

Modelling uncertainty

When interpreting the model results presented, it is important to consider the uncertainty associated with both the inputs and outputs of the modelling process.

Key areas of uncertainty in this assessment relate to:

- **Traffic activity and growth assumptions** – the variety and age of the various traffic activity data sources is a significant source of uncertainty in this modelling assessment. These factors are compounded further when projecting as far forward as 2027. Although we have accounted for traffic growth using a local TEMPRO growth factor, for some roads this has been projected from as far back as 2014, and as such can be considered as a best estimate only based on the available information. An up-to-date borough wide traffic model accounting for the latest local plan and how this is likely to affect traffic activity over the next five years would provide more confidence in the data used to estimate future air quality.
- **Vehicle fleet age projections and emission factors** - Vehicle emission projections used in the assessment are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. The projected average vehicle emission rates in 2027 therefore rely on the vehicle fleet in Spelthorne renewing in line with the national projections. It is currently uncertain if this will be the case as the recent pandemic and subsequent global supply crisis have impacted both car use and vehicle renewal rates. Therefore, a sensitivity test was conducted simulating a delay of 2 years in fleet turnover to estimate a more conservative future vehicle fleet make up.

Fleet renewal sensitivity test

A delay in fleet renewal of 2 years has been considered and modelled using 2025 predicted fleet age mix in the EFT compared to the 2027 mix.

Although NO_2 concentrations at receptor locations were up to 11% higher across all study areas using the 2025 fleet mix, there were no exceedances of the NO_2 annual mean objective because of a delay in fleet renewal. The delay in fleet renewal had little effect on PM_{10} or $PM_{2.5}$ concentrations.

Appendices

Appendix 1: Traffic data

Appendix 2: Meteorological dataset

Appendix 3: Model verification

A1 Traffic Data

Tables A1.1 to A1.5 summarise the Annual Average Daily Flows (AADT) of traffic and fleet compositions used to calculate vehicle emissions for each road link in each modelling domain.

Traffic data for the assessment was available from the combination of DfT traffic counts, survey data provided by Surrey County Council, and a Surrey 2014 traffic model. These sources provided daily average flow and detailed fleet split i.e. cyclist and motorcycle, car, LGV, HGV and buses.

For Georgian Close, there was no survey or traffic model data available for the residential roads (Georgian Close, Leacroft, and Shortwood Common). A survey from a nearby residential road (Rosefield Rd) was used to calculate a ratio between AADT and number of houses on the road (6.5). This value was used to estimate the AADT for the Georgian Close residential roads using the number of houses.

Table A1.1: Sunbury Annual Average Daily Flows and Vehicle Type Split (%)

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
A316 N	NE	34346	79.9	1.9	2.6	0.3	15.3
A316 N	SW	33705	79.2	1.8	2.9	0.2	15.9
M3 between RB	NE	27221	79.5	1.8	2.7	0.3	15.6
M3 between RB	SW	27221	79.5	1.8	2.7	0.3	15.6
A316 S slip	SW	6805	79.5	1.9	2.7	0.3	15.6
A316 N slip	NE	6805	79.5	1.9	2.7	0.3	15.6
M3	NE	26875	77.0	0.8	3.5	0.4	18.2
M3	SW	29509	79.2	0.8	3.3	0.3	16.4
Staines Rd W	E	17150	80.8	1.7	2.4	0.5	14.6
Staines Rd W	W	15773	80.8	1.6	2.7	0.6	14.3
Staines Rd E	E	8883	82.7	1.3	2.8	0.3	12.8
Staines Rd E	W	10334	84.0	1.1	3.2	0.2	11.6
M3 N slip	NE	5426	77.0	0.8	3.5	0.4	18.2
M3 S slip	SW	5958	79.2	0.8	3.3	0.3	16.4
Nursery Rd W	E	2297	83.4	1.2	3.0	0.3	12.2
Nursery Rd W	W	3230	83.4	1.2	3.0	0.3	12.2
Windmill Rd S	N	9507	84.3	1.4	2.4	0.5	11.4
Windmill Rd S	S	6688	84.3	1.4	2.4	0.5	11.4
Nursery Rd E	E	2254	83.4	1.2	3.0	0.3	12.2
Nursery Rd E	W	3138	83.4	1.2	3.0	0.3	12.2
Downside	N	406	83.4	1.2	3.0	0.3	12.2
Downside	S	2103	83.4	1.2	3.0	0.3	12.2
Vicarage Rd N	S	2325	83.4	1.2	3.0	0.3	12.2
Vicarage Rd N	N	1850	83.4	1.2	3.0	0.3	12.2
Vicarage Rd S	N	1972	83.4	1.2	3.0	0.3	12.2
Vicarage Rd S	S	2625	83.4	1.2	3.0	0.3	12.2
Green St	S	7303	83.4	1.2	3.0	0.3	12.2
Green St	N	6778	83.4	1.2	3.0	0.3	12.2
Windmill Rd N	N	7965	84.3	1.4	2.4	0.5	11.4
Windmill Rd N	S	8859	84.3	1.4	2.4	0.5	11.4
M3 RB	RB	26025	83.4	1.2	3.0	0.3	12.2
M3 RB	RB	23646	83.4	1.2	3.0	0.3	12.2
M3 RB	RB	16672	83.4	1.2	3.0	0.3	12.2
M3 RB	RB	26085	83.4	1.2	3.0	0.3	12.2

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
M3 RB	RB	17374	83.4	1.2	3.0	0.3	12.2
M3 RB	RB	27369	83.4	1.2	3.0	0.3	12.2
M3 RB	RB	14850	83.4	1.2	3.0	0.3	12.2

Table A1.2: Staines Annual Average Daily Flows and Vehicle Type Split (%)

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
London Rd W	E	5139	83.6	1.8	1.3	2.1	11.2
London Rd W	W	9604	85.3	1.4	1.3	1.4	10.7
Stanwell Moor	N	9204	78.3	1.0	5.0	0.5	15.2
Stanwell Moor	S	7650	80.8	1.4	3.7	0.5	13.6
A30 E	E	14940	78.3	1.7	2.8	1.0	16.2
A30 E	W	15279	78.0	1.5	2.5	0.9	17.1
A308 S	S	13136	79.3	1.3	4.5	0.1	14.7
A308 S	N	13709	78.5	1.2	4.2	0.1	16.0
A30 N	S	15660	79.3	1.2	5.8	0.2	13.5
A30 N	N	17266	78.7	1.2	4.8	0.1	15.2
Crooked Billet RB	RB	11464	84.7	1.6	1.3	1.6	10.8
Crooked Billet RB	RB	20064	84.7	1.6	1.3	1.6	10.8
Crooked Billet RB	RB	23463	84.7	1.6	1.3	1.6	10.8
Crooked Billet RB	RB	25577	84.7	1.6	1.3	1.6	10.8
Crooked Billet RB	RB	14871	84.7	1.6	1.3	1.6	10.8
Crooked Billet RB	RB	10195	84.7	1.6	1.3	1.6	10.8
Crooked Billet RB	RB	15669	84.7	1.6	1.3	1.6	10.8
A30 N slip	S	7830	79.3	1.2	5.8	0.2	13.5
A30 N slip	N	8633	78.7	1.2	4.8	0.1	15.2
A30 E slip	E	7470	78.3	1.7	2.8	1.0	16.2
A30 E slip	W	7640	78.0	1.5	2.5	0.9	17.1

Table A1.3: Georgian Close Annual Average Daily Flows and Vehicle Type Split (%)

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
Georgian Close	E	84	93.5	5.6	0.5	0.4	0.0
Georgian Close	W	84	93.5	5.6	0.5	0.4	0.0
Leacroft	N	201	84.5	2.6	4.4	0.0	8.5
Leacroft	S	201	84.5	2.6	4.4	0.0	8.5
Shortwood Common	E	42	93.5	5.6	0.5	0.4	0.0
Shortwood Common	W	42	93.5	5.6	0.5	0.4	0.0
A308 S	S	13136	79.3	1.3	4.5	0.1	14.7
A308 S	N	13709	78.5	1.2	4.2	0.1	16.0
Georgian Close	E	84	93.5	5.6	0.5	0.4	0.0
Georgian Close	W	84	93.5	5.6	0.5	0.4	0.0
Leacroft	N	201	84.5	2.6	4.4	0.0	8.5
Leacroft	S	201	84.5	2.6	4.4	0.0	8.5
Shortwood Common	E	42	93.5	5.6	0.5	0.4	0.0
Shortwood Common	W	42	93.5	5.6	0.5	0.4	0.0

Table A1.4: Ashford Annual Average Daily Flows and Vehicle Type Split (%)

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
Church Rd E	E	6453	84.3	11.5	1.6	1.8	0.8
Church Rd E	W	5419	85.4	10.3	1.4	2.0	0.9
Church Rd W	W	3012	85.4	10.3	1.4	2.0	0.9
Church Rd W	E	3051	84.3	11.5	1.6	1.8	0.8
Feltham Rd RB	E	6497	83.9	12.1	2.0	0.8	1.2
Feltham Rd RB	W	5103	82.8	12.5	1.7	2.3	0.8
School Rd N	N	7308	84.0	11.4	2.5	0.5	1.6
School Rd N	S	6947	83.2	11.3	3.5	0.6	1.5
School Rd S	S	6947	83.2	11.3	3.5	0.6	1.5
School Rd S	N	7308	84.0	11.4	2.5	0.5	1.6
Fordbridge Rd	N	5063	86.9	10.4	1.5	0.1	1.1
Fordbridge Rd	S	5375	88.8	8.5	1.4	0.1	1.2
Parkland Grove	N	828	88.2	1.3	0.1	0.0	10.4
Parkland Grove	S	757	87.8	1.3	0.1	0.0	10.7
Clockhouse Ln	N	8372	84.0	11.4	2.5	0.5	1.6
Clockhouse Ln	S	7722	83.2	11.3	3.5	0.6	1.5
Feltham Rd E	E	4159	86.7	8.1	2.2	1.3	1.8
Feltham Rd E	W	3912	86.5	8.4	1.9	1.3	1.9
Clockhouse Ln RB	E	7722	83.2	11.3	3.5	0.6	1.5
Clockhouse Ln RB	W	7308	84.0	11.4	2.5	0.5	1.6
Clockhouse Ln RB	N	6497	83.9	12.1	2.0	0.8	1.2
Clockhouse Ln RB	S	3912	86.5	8.4	1.9	1.3	1.9
Convent Rd	N	7308	84.0	11.4	2.5	0.5	1.6
Convent Rd	S	6947	83.2	11.3	3.5	0.6	1.5
Church Rd W PB	W	1676	85.4	10.3	1.4	2.0	0.9

Table A1.5: Lower Halliford Annual Average Daily Flows and Vehicle Type Split (%)

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
Green Lane	W	4677	85.1	0.8	1.0	1.2	11.9
Green Lane	E	5419	84.3	0.8	1.2	1.0	12.8
Upper Halliford Rd	N	9723	84.8	1.3	2.3	0.5	11.1
Upper Halliford Rd	S	8204	83.7	1.5	2.6	0.5	11.7
Walton Bridge Rd	N	16780	88.9	9.7	1.0	0.4	0.0
Walton Bridge Rd	S	16192	87.5	11.1	1.0	0.4	0.0
Gaston Bridge Rd N	N	12906	92.4	6.2	1.1	0.3	0.0
Gaston Bridge Rd N	S	11443	91.9	6.5	1.1	0.4	0.1
Russell Rd	E	6316	89.1	7.9	1.3	0.4	1.2
Russell Rd	W	3041	88.2	6.9	1.9	0.1	2.9
Gaston Bridge Rd S	N	8840	88.9	9.7	1.0	0.4	0.0
Gaston Bridge Rd S	S	7344	87.5	11.1	1.0	0.4	0.0
Upper Halliford Bypass	N	12906	92.4	6.2	1.1	0.3	0.0
Upper Halliford Bypass	S	11443	91.9	6.5	1.1	0.4	0.1

Table A1.6: Thames Street Annual Average Daily Flows and Vehicle Type Split (%)

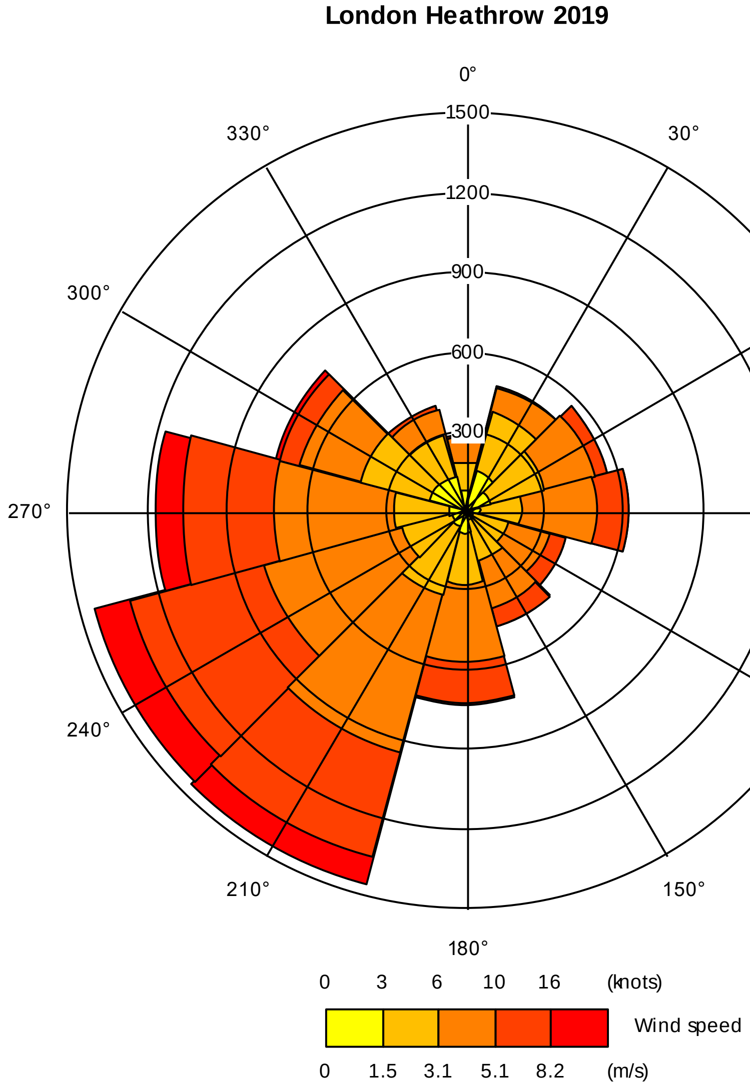
Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
The Avenue	S	1866	91.3	5.6	0.5	0.0	2.6
The Avenue	N	919	91.3	5.6	0.5	0.0	2.6
Thames St E	E	2730	91.3	5.6	0.5	0.0	2.6
Thames St E	W	3094	91.3	5.6	0.5	0.0	2.6
Thames St W	E	3089	91.3	5.6	0.5	0.0	2.6
Thames St W	W	4347	91.3	5.6	0.5	0.0	2.6

Table A1.7: Moor Lane Annual Average Daily Flows and Vehicle Type Split (%)

Road	Direction	2019 AADT	Cars	LGV	HGV	Bus	Motorcycle
A30	E	15660	79.3	1.2	5.8	0.2	13.5
A30	W	17266	78.7	1.2	4.8	0.1	15.2
M25 N	N	78119	74.0	16.2	8.9	0.4	0.5
M25 N	S	91063	76.4	15.5	7.2	0.4	0.5
M25 S	N	93597	75.2	16.0	8.1	0.3	0.4
M25 S	S	92737	75.3	16.6	7.4	0.4	0.4
M25 slip S SB	S	21636	84.5	12.1	2.3	0.2	0.8
M25 slip S NB	N	25081	82.2	13.3	3.3	0.2	1.0
Wraysbury Rd W	W	3655	81.2	15.6	2.4	0.2	0.5
Wraysbury Rd W	E	6018	82.6	14.8	1.8	0.3	0.5
M25 slip N NB	N	18226	74.0	16.2	8.9	0.4	0.5
M25 slip N SB	S	21245	76.4	15.5	7.2	0.4	0.5
M25 mid	N	71760	75.2	16.0	8.1	0.3	0.4
M25 mid	S	71101	72.5	18.0	8.9	0.4	0.2
M25 RB W	RB	40516	79.0	1.2	5.3	0.1	14.4
M25 RB N	RB	19930	79.0	1.2	5.3	0.1	14.4
M25 RB NE	RB	38590	79.0	1.2	5.3	0.1	14.4
M25 RB E	RB	24170	79.0	1.2	5.3	0.1	14.4
M25 RB S	RB	31729	79.0	1.2	5.3	0.1	14.4
Heron Lake Rd	W	7084	79.0	1.2	5.3	0.1	14.4
Heron Lake Rd	E	7191	79.0	1.2	5.3	0.1	14.4
A30 slip	RB	12838	79.0	1.2	5.3	0.1	14.4
Wraysbury Rd mid	W	4334	82.0	14.3	3.5	0.2	0.0
Wraysbury Rd mid	E	3619	83.5	12.7	3.4	0.4	0.0
Wraysbury Rd E	W	3897	82.0	14.3	3.5	0.2	0.0
Wraysbury Rd E	E	2940	83.5	12.7	3.4	0.4	0.0
Bridge St	S	5979	83.5	12.7	3.4	0.4	0.0
Bridge St	N	5565	82.0	14.3	3.5	0.2	0.0
Moor Ln	N	718	75.8	19.7	3.9	0.0	0.6
Moor Ln	S	476	75.8	19.7	3.9	0.0	0.6
Church St	W	1035	68.2	23.8	7.1	0.0	1.0
Church St	E	2494	79.3	17.8	2.4	0.0	0.4

A2 Meteorological dataset

The wind rose for the London Heathrow 2019 meteorological measurement site is presented below.



A3 Model Verification

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. It is considered best practice to verify modelled pollutant predictions from road traffic against local monitoring data (classified as roadside sites) where available. This helps to identify how the model is performing at the various monitoring locations.

The verification process also involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in acceptable agreement with the monitoring results. This can be followed by adjustment of the model results if required to gain good agreement. LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in Box 7.15 of LAQM.TG(16) has been used in this case. Modelled road NO_x concentrations were verified using 2019 measurements at the available roadside diffusion tube measurements and the automatic analyser.

Linear regression analysis of measured vs. modelled NOx concentrations provided the domain-wide NOx adjustment factors for each modelling domain (Figures A3.1 to A3.4). The modelled concentrations after adjustment are presented along with measured concentrations in Tables A3.1 to A3.4.

Figure A3.1: Sunbury - Measured vs modelled Road NO_x before and after adjustment (outliers excluded)

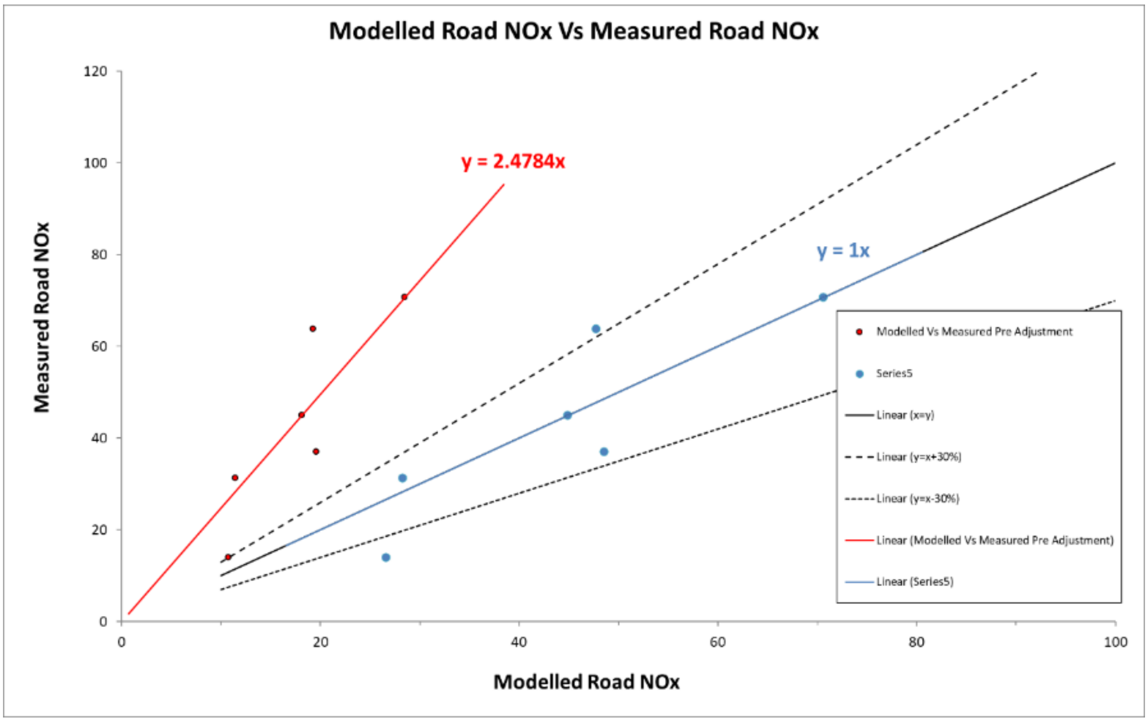


Figure A3.2: Staines - Measured vs modelled Road NO_x before and after adjustment

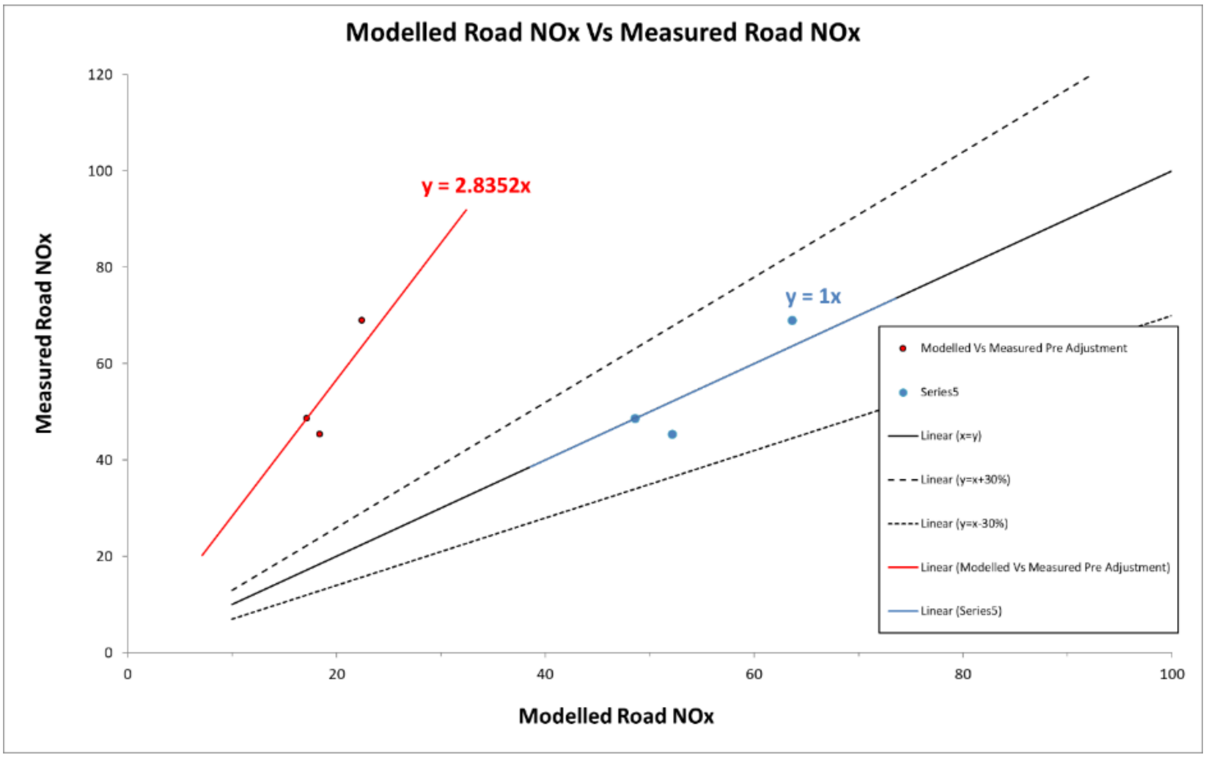


Figure A3.3: Ashford - Measured vs modelled Road NO_x before and after adjustment

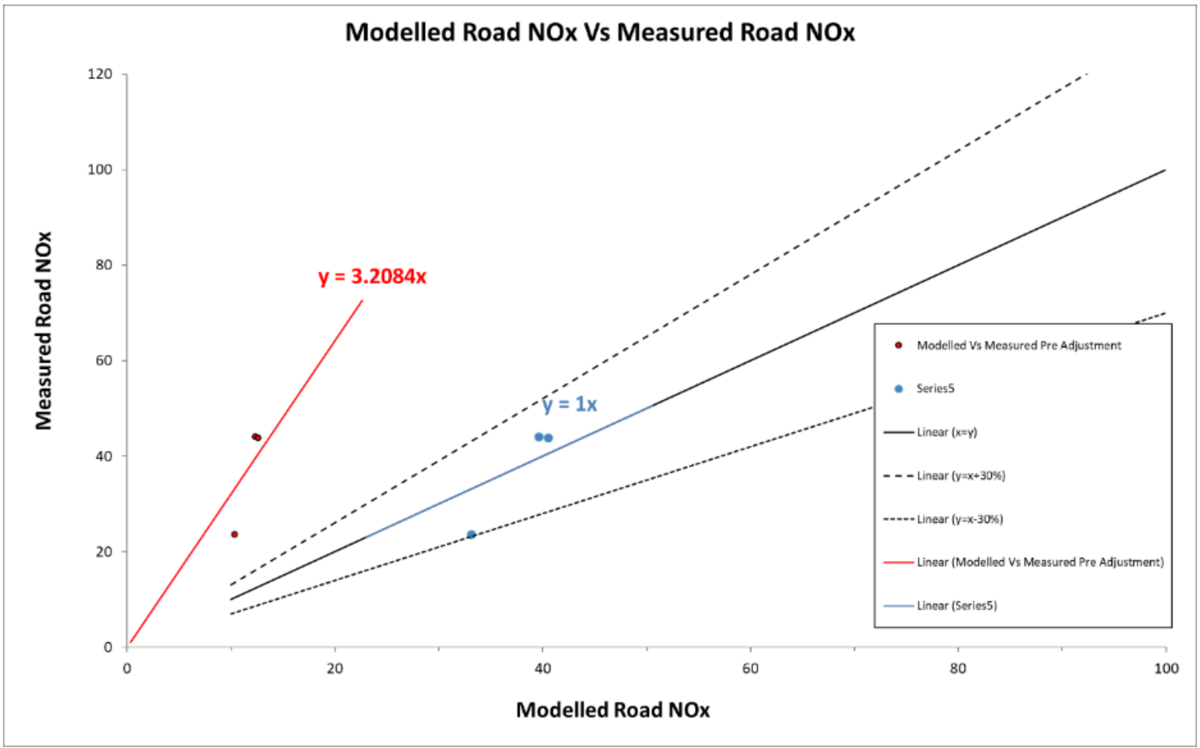


Figure A3.4: Lower Halliford - Measured vs modelled Road NO_x before and after adjustment

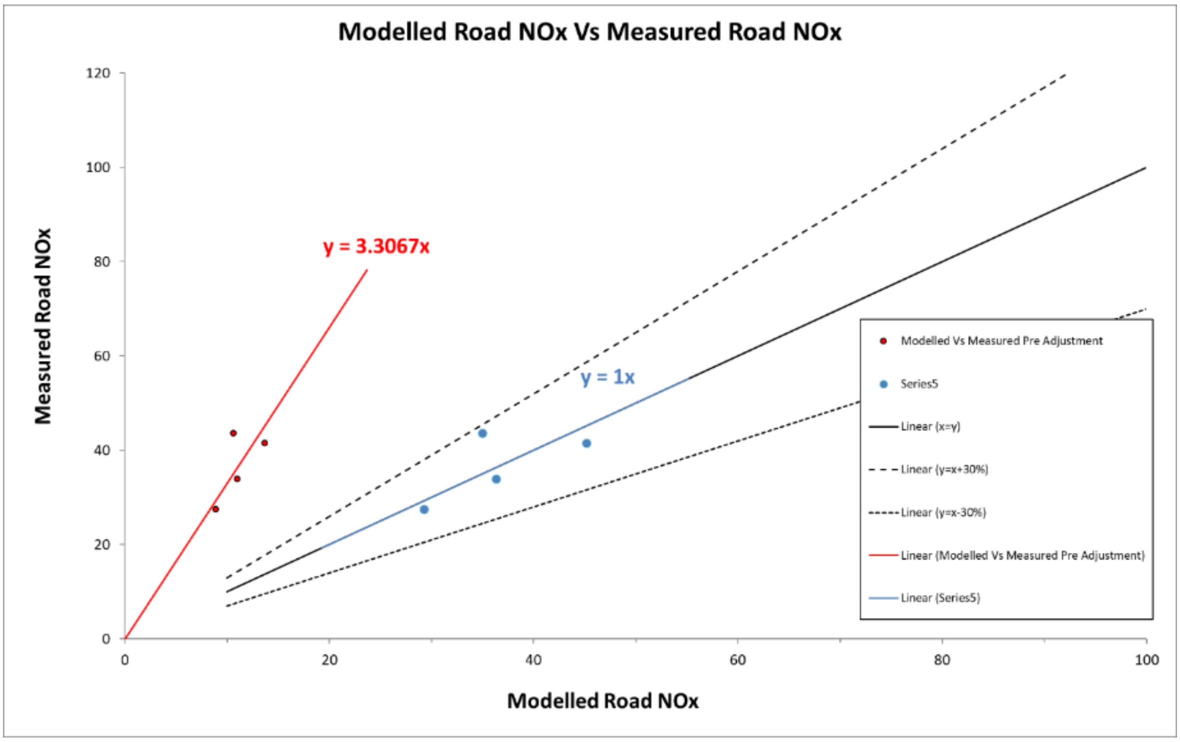


Figure A3.5: Moor Lane - Measured vs modelled Road NO_x before and after adjustment

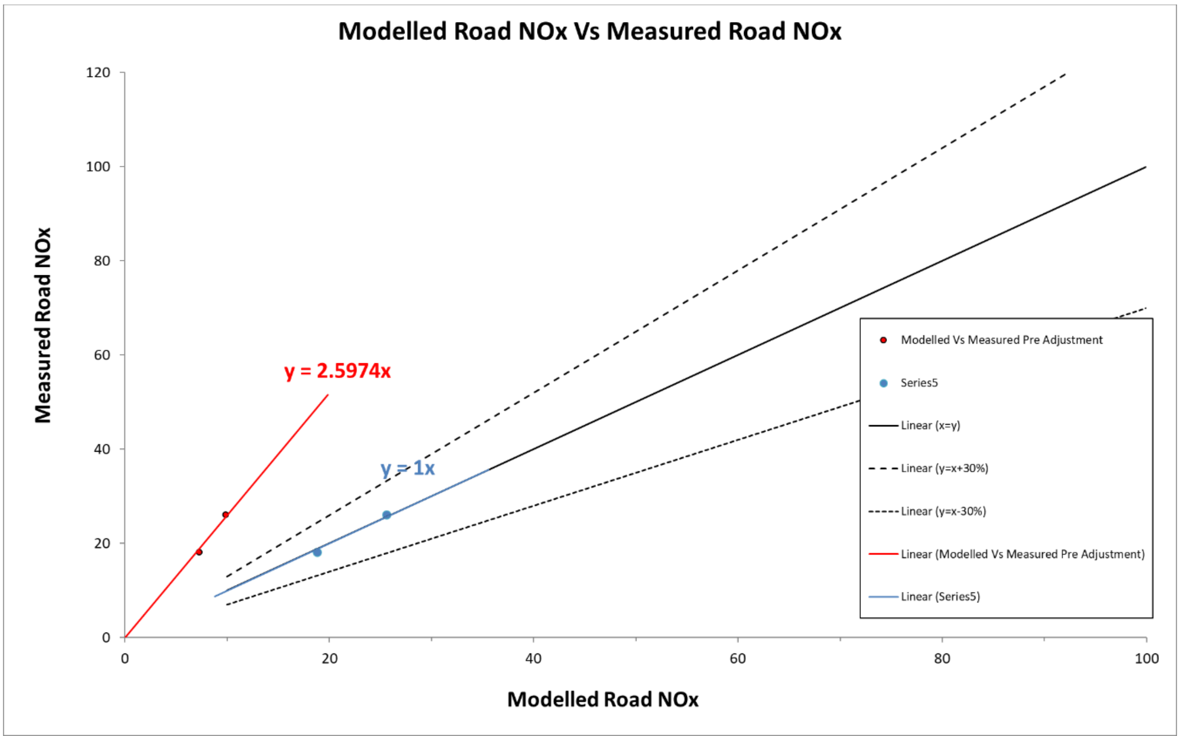


Table A3.1: Sunbury measured vs modelled NO_2 post adjustment

Measurement site	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
SP9	40.8	40.7
SP36	34.6	33.2
SP4	26.3	32.4
SP35*	41.6	

SP58	51.1	51.0
SP52	37.3	42.3
SPEB01*	58.5	
SPWB01	48.3	41.6
	RMSE	**4.28**

***Locations excluded from domain-wide verification**

Table A3.2: Staines measured vs modelled NO_2 post adjustment

Measurement site	Measured NO_2 (µg.m^{-3})	Modelled NO_2 (µg.m^{-3})
SP51	41.0	43.9
SP28	42.4	42.4
SP29	50.8	48.6
	RMSE	**2.09**

Table A3.3: Ashford measured vs modelled NO_2 post adjustment

Measurement site	Measured NO_2 (µg.m^{-3})	Modelled NO_2 (µg.m^{-3})
SP5	40.7	38.8
SP32	31.0	35.4
SP34	38.6	37.1
	RMSE	**2.93**

Table A3.4: Lower Halliford measured vs modelled NO_2 post adjustment

Measurement site	Measured NO_2 (µg.m^{-3})	Modelled NO_2 (µg.m^{-3})
SP10	37.4	39.1
SP54	31.0	31.8
SP55	38.8	34.9
SP11	34.0	35.1
	RMSE	**2.22**

Table A3.5: Moor Lane measured vs modelled NO_2 post adjustment

Measurement site	Measured NO_2 (µg.m^{-3})	Modelled NO_2 (µg.m^{-3})
SP3	30.4	30.7
SP27	34.2	34.0
	RMSE	**0.27**

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