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Air quality modelling for local authority life course assessment tool: 2035 modelling

Final report

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CERC

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1 Summary

Cambridge Environmental Research Consultants Ltd (CERC) was commissioned by Oxfordshire County Council to carry out detailed dispersion modelling in order to generate high-resolution air quality maps for the whole of the county. The modelled concentrations will be used as input to the University of Birmingham's Air Quality Lifecourse Assessment Tool (AQ-LAT)[1] which estimates air quality impact on mortality, morbidity and the associated healthcare costs.

This report describes model verification and baseline results along with the further air quality modelling carried out for a range of Net-Zero and policy scenarios for 2035.

The modelling was carried out using the ADMS-Urban[2] model using modelled traffic data and emissions data for other sources from the National Atmospheric Emissions Inventory (NAEI) 2021.

Traffic emissions were calculated using the latest set of Department for Transport (DfT) emission factors, taking into account uncertainties in real-world NO_x emissions. PM_{10} and $PM_{2.5}$ emissions included contributions from exhaust, brake and tyre-wear, and road-wear and resuspension.

Model verification was carried out by comparing measured and modelled concentrations at monitoring sites across Oxfordshire for 2023.

The model was then updated to 2035 for a future year baseline scenario. Different emission scenarios were then tested for 2035 using adjusted emissions from the future baseline. There were two Phase 1 scenarios, representative of national or regional net-zero strategies, and eight Phase 2 scenarios, each representing a theoretical emissions scenario.

Concentrations of NO_2, PM_{10} and $PM_{2.5}$ were calculated throughout the county and high-resolution contour maps were generated from the modelled concentrations. These maps were used to calculated average concentrations for each Lower Output Super Area and Middle Output Super Area in the county for input to the AQ-LAT tool. They were also used to calculate average concentrations at a district level.

Concentrations were also calculated at locations where the 'OxAria' low-cost sensors were previously installed. For more information please visit: https://oxaria.org.uk/.

Source apportionment for NO_x and $PM_{2.5}$ was carried out for the 2023 base year and for 2035 baseline modelling.

[1] https://wm-air.org.uk/blog/2022/08/09/wm-air-launches-the-air-quality-lifecourse-assessment-tool-aq-lat/
[2] www.cerc.co.uk/ADMS-Urban

2 Introduction

Cambridge Environmental Research Consultants Ltd (CERC) was commissioned by Oxfordshire County Council to carry out detailed dispersion modelling in order to generate high-resolution air quality maps for the whole of the county. Modelled concentrations of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) will be used as input to the University of Birmingham's Air Quality Lifecourse Assessment Tool (AQ-LAT)[3] which estimates air quality impact on mortality, morbidity and the associated healthcare costs.

This report describes the further air quality modelling carried out for a range of Net-Zero and policy scenarios for 2035.

Section 3 sets out the relevant air quality standards and Section 4 describes the modelled area and summarises local air quality across the county.

Model setup and emissions data for the 2023 base year are described in Sections 5 and 6, respectively. Section 7 displays model verification and Section 8 displays the base year results.

Emissions data for a future baseline are described in Sections 9. Descriptions of the future scenarios for 2035 are presented in Section 10. The modelled concentrations aggregated to ward-level averages for the future baseline and all other scenarios for all pollutants are shown in Section 11. Source apportionment results of NO_x and $PM_{2.5}$ for the 2023 base year and the 2035 future baseline are shown in Section 12.

Finally, Appendix A provides details of the monitoring sites and Appendix B summarises the ADMS-Urban model used in the assessment.

[3] https://wm-air.org.uk/blog/2022/08/09/wm-air-launches-the-air-quality-lifecourse-assessment-tool-aq-lat/

3 Air quality standards

3.1 National air quality standards

The EU *Ambient Air Quality Directive* (2008/50/EC) set binding limits for concentrations of air pollutants, which take into account the effects of each pollutant on the health of those who are most sensitive to air quality. The Directive was transposed into English legislation as the *Air Quality Standards Regulations 2010* [4], which also incorporates the provisions of the *Fourth Daughter Directive* (2004/107/EC). *The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020* updated the 2010 regulations to set a new limit value for $PM_{2.5}$ of 20 µg/m³. The limit values are presented in Table 3.1.

Table 3.1: National air quality limits

	Value (µg/m³)	Description of standard
NO_2	200	Hourly mean not to be exceeded more than 18 times a calendar year (modelled as 99.79th percentile)
	40	Annual average
PM_{10}	50	24-hour mean not to be exceeded more than 35 times a calendar year (modelled as 90.41st percentile)
	40	Annual average
$PM_{2.5}$	20	Annual average

The short-term objectives, i.e. those measured hourly or over 24 hours, are specified in terms of the number of times during a year that a concentration measured over a short period of time is permitted to exceed a specified value. For example, the concentration of NO_2 measured as the average value recorded over a one-hour period is permitted to exceed the concentration of 200 µg/m³ up to 18 times per year. Any more exceedences than this during a one-year period would represent a breach of the objective.

It is convenient to model objectives of this form in terms of the equivalent percentile concentration value. A percentile is the concentration below which lie a specified percentage of concentration measurements. For example, taking the NO_2 objective considered above, allowing 18 exceedences per year is equivalent to not exceeding for 8742 hours or for 99.79% of the year. This is therefore equivalent to the 99.79th percentile value. It is important to note that modelling exceedences of short-term averages is generally not as accurate as modelling annual averages.

[4] http://www.legislation.gov.uk/uksi/2010/1001/contents/made

3.2 WHO air quality guidelines

The World Health Organisation has developed air quality guidelines as a global target for national, regional and city governments to work towards improving health by reducing air pollution. Table 3.2 shows the air quality guidelines for NO_2, PM_{10} and $PM_{2.5}$.

Table 3.2: WHO air quality guidelines

	Value ($\mu g/m^3$)	Description of standard
NO_2	25	99^{th} percentile of 24-hour averages
	10	Annual average
PM_{10}	45	99^{th} percentile of 24-hour averages
	15	Annual average
$PM_{2.5}$	15	99^{th} percentile of 24-hour averages
	5	Annual average

4 Local air quality

4.1 Air Quality Management Areas

For the 2023 base year, Oxfordshire had thirteen declared AQMAs across the county, due to high concentrations of NO_2. These are displayed in Figure 4.1. This has since reduced to nine declared AQMAs, due to the revocation of four AQMAs (Cherwell AQMA 2 and 3, Abingdon, Wallingford).

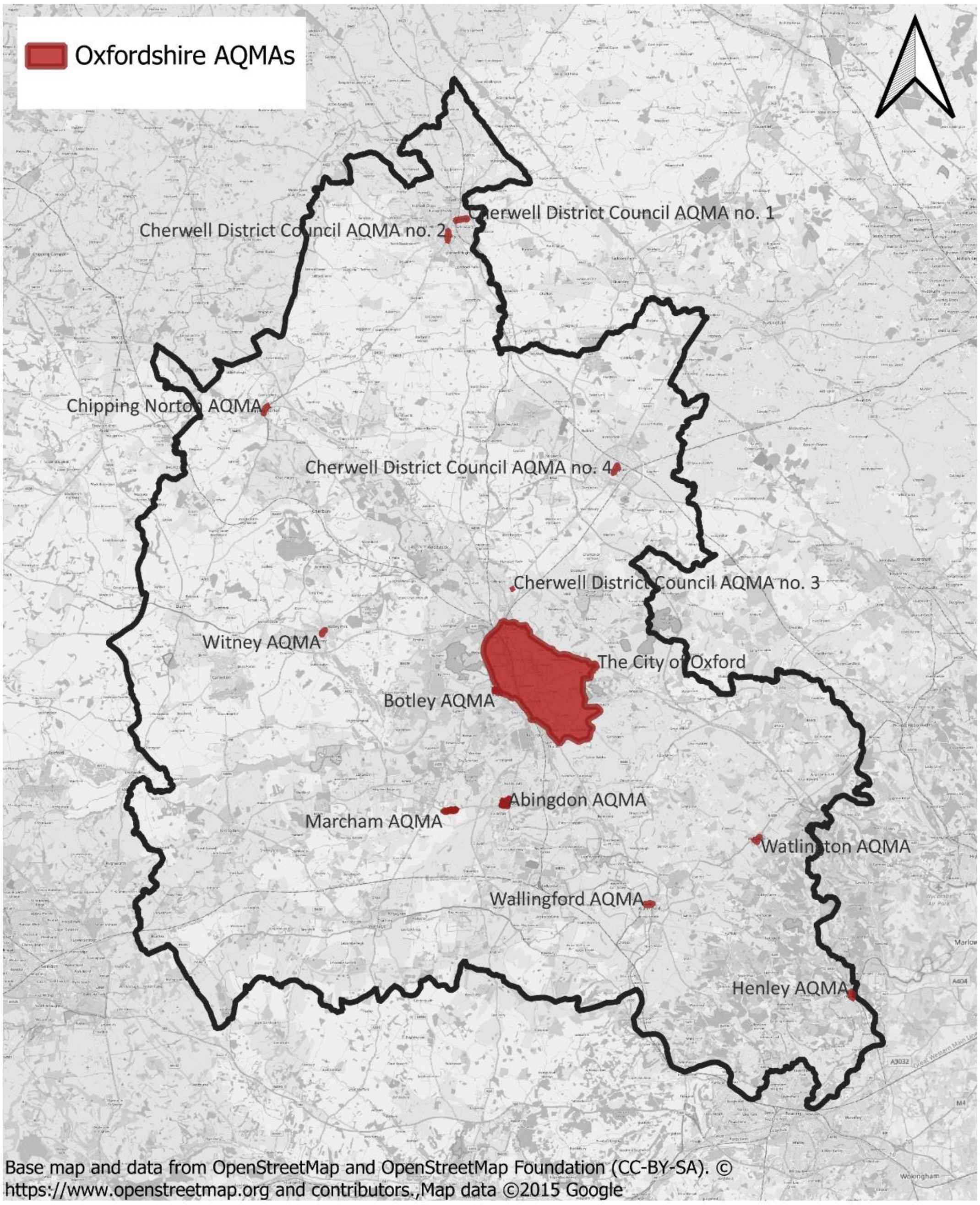

Figure 4.1: Declared AQMAs across Oxfordshire

4.2 Air quality monitoring

Concentrations of NO_2 were monitored across Oxfordshire using 316 diffusion tubes and three continuous monitors. The locations of the monitoring sites and the measured concentrations at each site are shown in Figure 4.2. Where there are overlapping symbols, the higher concentrations are positioned in front of lower concentrations. Full details of all the monitoring sites can be found in Appendix A.

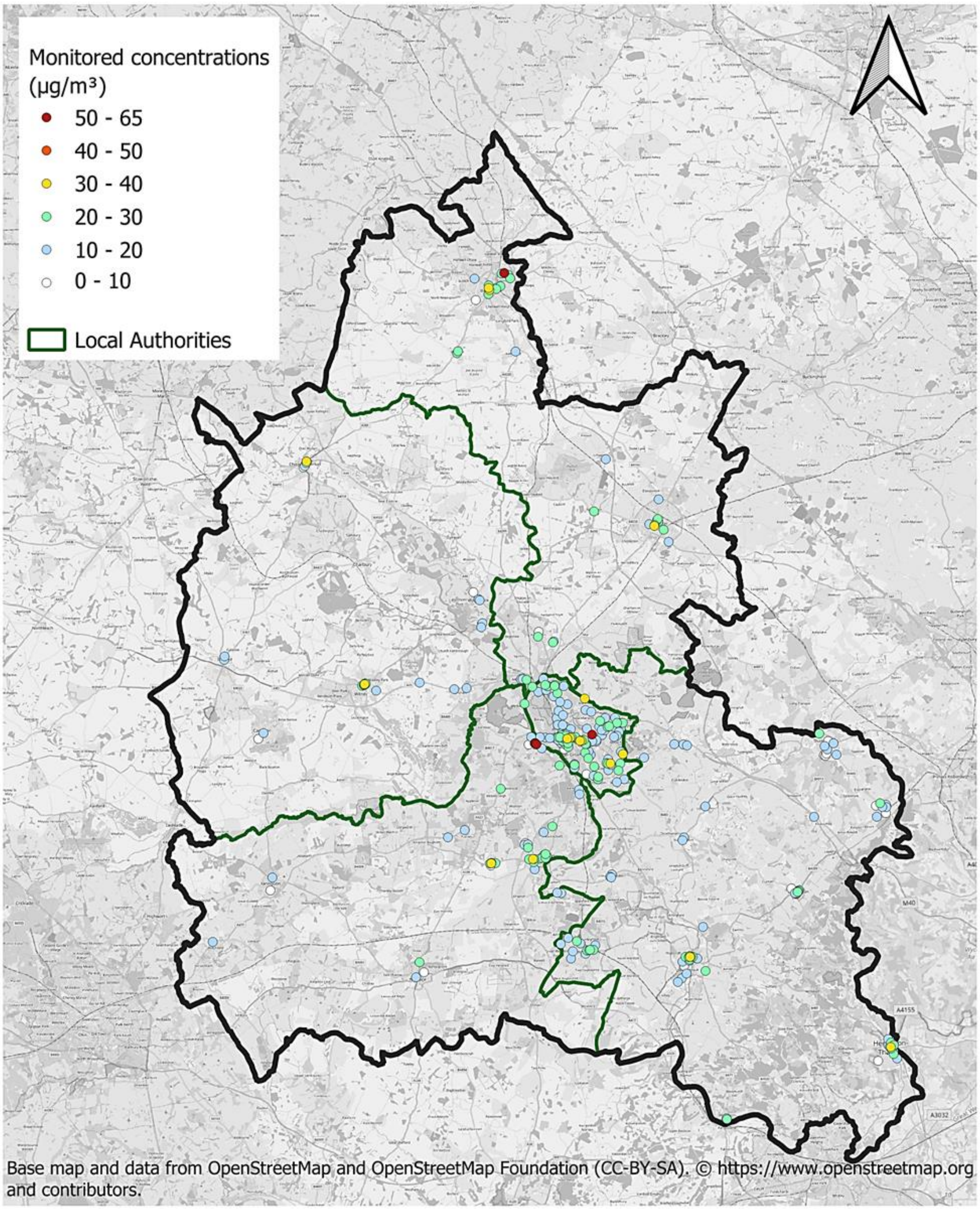

Figure 4.2: Measured NO_2 concentrations (µg/m³) across Oxfordshire, 2023

4.3 Air quality sensors

Air quality measurements were also carried out in Oxford using low-cost sensors. The locations of nine sensors were provided as shown in Figure 4.3.

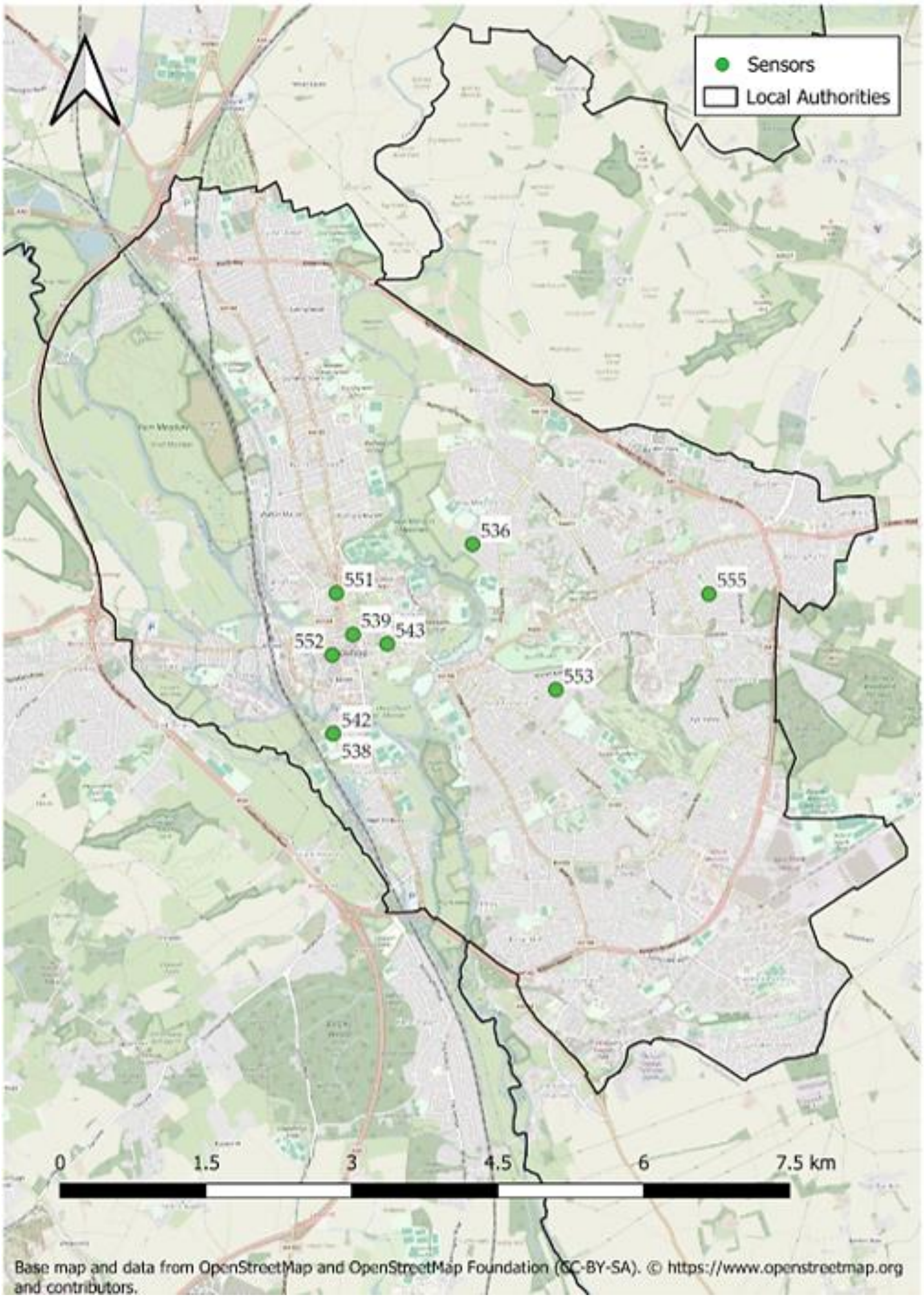

Figure 4.3: Location of Oxford sensors

5 Air quality modelling

5.1 Modelling software

All modelling was carried out using CERC's air quality model ADMS-Urban[5] version 5.0.1; Appendix B provides a summary of the model. The model set-up was consistent between the 2023 base year and all 2035 future scenarios.

5.2 Surface roughness

A length scale parameter called the surface roughness length is used in the model to characterise the study area in terms of the effects it will have on wind speed and turbulence, which are key factors in the modelling. A default roughness length of 0.5 m, which represents mixed land-use, was used for the modelling area.

The difference in land use at the meteorological station compared to the study area was taken into account by entering a different surface roughness for the meteorological station. See Section 5.5 for further details.

5.3 Urban canopy

In areas with taller buildings and higher building densities, the near-ground wind speed is reduced and the turbulent intensity is increased. In contrast, areas with lower building heights and densities, such as large urban parks or outlying residential areas, can show increased near-ground wind speed and reduced turbulent intensity. These changes alter the dispersion of pollutants, especially from near-ground sources such as roads. The urban canopy module calculates a neighbourhood scale variation of wind speed and turbulence based on gridded values of building height, horizontal and vertical area density. These were calculated using Ordnance Survey Mastermap data for the 2023 base year as the impacts of future building developments are unknown.

5.4 Monin-Obukhov length

In urban and suburban areas, a significant amount of heat is emitted by buildings and traffic, which warms the air within and above a city. This is known as the urban heat island and its effect is to prevent the atmosphere from becoming very stable. In general, the larger the area the more heat is generated and the stronger the effect becomes. In the ADMS-Urban model, the stability of the atmosphere is represented by the Monin-Obukhov parameter. The effect of the urban heat island is that, in stable conditions, the Monin-Obukhov length will never fall below some minimum value; the larger the city, the larger the minimum value.

[5] http://cerc.co.uk/environmental-software/ADMS-Urban-model.html

A minimum Monin-Obukhov length of 50 m was used in the modelling of the City of Oxford, while for all surrounding areas a minimum Monin-Obukhov length of 30 m was used. This represents the greater impact of the urban heat island in Oxford compared to the surrounding areas.

5.5 Meteorological data

A year of hourly sequential meteorological data measured at Brize Norton for the 2023 base year was used for future scenario modelling.

Table 5.1 summarises the meteorological data from Brize Norton. To take account of the different surface characteristics compared to the modelled area, a surface roughness of 0.2 m was assumed for the meteorological station.

Table 5.1: Summary of meteorological data

Year	% of hours used	Parameter	Minimum	Maximum	Mean
2023	99.8	Temperature (°C)	-7.1	30.3	11.3
		Wind speed (m/s)	0	10.3	3.2
		Cloud cover (oktas)	0	8	5.4

The ADMS meteorological pre-processor, written by the UK Met Office, uses the data provided to calculate the parameters required by the program. Figure 5.1 presents a wind rose showing the frequency of occurrence of wind from different directions for a number of wind speed ranges for Brize Norton.

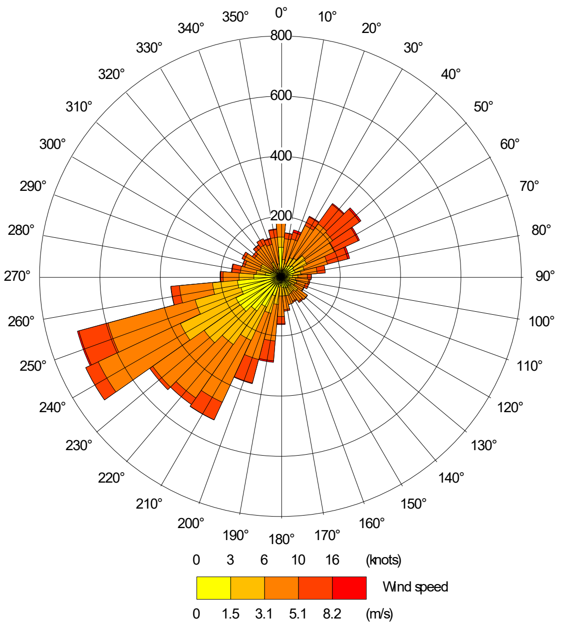

Figure** 5.1**: Wind rose for Brize Norton, 2023

5.6 Chemistry

The ADMS-Urban explicit chemistry scheme was used to model the interconversion between NO and NO_2, using wind dependent background concentrations derived from AURN rural monitoring sites. This approach allows for direct model verification against monitored concentrations for NO_x and NO_2, with simultaneous consideration of source-dependent primary NO_2.

5.7 Background data

Hourly background data for the modelled pollutants, sulphur dioxide (SO_2) and ozone (O_3) were input to the model to represent the concentrations in the air being blown into the area. Measured data for the 2023 base year was used for future scenario modelling. This provides an upper-limit for concentrations originating from outside the modelled region.

All pollutants were taken from the rural background monitoring site at Chilbolton, approximately 40 km south of Oxfordshire. For hours with missing data at Chilbolton, background concentrations were taken from Charlton Mackrell, approximately 90 km south west of Oxfordshire.

Table 5.2 summarises the annual statistics for background data used for the modelling.

Table 5.2: Summary of background data used in the modelling (µg/m^3)

Year	Statistic	NO_x	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2
2023	Annual average	4.1	3.3	57.0	10.1	6.4	0.6
	99.79th percentile of hourly average	52.2	34.3	149.6	-	-	-
	90.41st percentile of 24-hour average	-	-	-	18.0	11.7	-

5.8 Street canyons

The advanced street canyon module option in ADMS-Urban was used to modify the dispersion of pollutants from a road source according to the presence and properties of canyon walls on one or both sides of the road. Building footprint and height information was taken from OS Mastermap data for the 2023 base year. The mean relative building heights were assigned to create the canyon heights.

Verification checks noted that steeply gabled roofs resulted in the mean relative building heights being incorrectly underestimated. For buildings where the maximum relative building height was more than twice the mean height, the maximum relative building height was used instead.

6 Base year emissions

An emissions inventory was compiled for Oxfordshire and the surrounding area for 2023 using CERC's emissions inventory toolkit (EMIT), version 3.9.1.

6.1 Road transport

The air quality modelling included representation of emissions from all roads across Oxfordshire. Emissions from major roads were calculated using modelled traffic flows and speed estimations, together with road traffic emission factors for NO_x, NO_2, PM_{10} and $PM_{2.5}$.

Minor roads were aggregated into 1 km^2 grids; see Section 6.2.

6.1.1 Emission factors

Traffic emissions of NO_x, NO_2, PM_{10}, and $PM_{2.5}$ were calculated from traffic flows using the Emission Factor Toolkit (version 12). The EFT emission factors include speed-emissions data based on the COPERT 5 software tool[6]. The emissions data include primary NO_2 emission factors for each vehicle type resulting in accurate road-by-road NO_x and NO_2 emission rates.

Note that there is uncertainty surrounding the current emissions estimates of NO_x from all vehicle types, in particular diesel vehicles, in these factors. In order to address this discrepancy, the NO_x emission factors were modified based on published Remote Sensing Data (RSD)[7] for vehicle NO_x emissions. Scaling factors were applied to each vehicle category and Euro standard.

The EFT emission factors include PM_{10} and $PM_{2.5}$ emissions both from exhaust and non-exhaust sources, i.e. brake, tyre and road-wear.

6.1.2 Vehicle fleet

The ages and sizes of vehicles on the roads in the county were represented by fleet composition data. For all vehicles except buses, the EFT *England Urban 2023* fleet composition was used. For buses, the fleet composition was taken from data provided by Oxfordshire County Council. Table 6.1 shows the proportion of the bus fleet that were diesel, hybrid and electric and Table 6.2 shows the Euro category split for the diesel and hybrid buses. Note that the traffic counts include buses and coaches combined; the bus fleet data presented here was only applied to the bus component of the traffic flows which was assumed to be 72% of the combined bus and coach flows. The fleet composition for coaches used the standard EFT composition.

[6] http://copert.emisia.com/ 8.1%
[7] Davison, Jack, et al. "Distance-based emission factors from vehicle emission remote sensing measurements." Science of the Total Environment 739 (2020): 139688. https://doi.org/10.1016/j.scitotenv.2020.139688.

Table 6.1: Oxfordshire bus types

Bus type	Percentage of bus fleet
Diesel	90.3%
Hybrid	1.6%
Electric	8.1%

Table 6.2: Oxfordshire bus fleet composition

Euro category	Conventional	Hybrid
Euro III	1.3%	-
Euro IV	1.8%	-
Euro V	44.8%	27%
Euro VI	52.1%	73%

6.1.3 Traffic flows

Oxfordshire County Council have developed a SATURN multi-modal transport model for the county (the Oxfordshire Strategic Model (OSM)) from which traffic flows were taken for 2023. Outputs include annual average daily total (AADT) traffic flows by time period and vehicle type (cars, buses, LGVs and HGVs) on each highway link. The modelled traffic flows were compared to Oxfordshire County Council traffic counts[8], where available. Where there were significant discrepancies, the modelled AADT and traffic flows for each vehicle category were scaled relative to the count data.

6.1.4 Traffic speeds

Average traffic speeds were estimated based on road type, setting, and road width. In particular, in urban areas, speeds were expected to be lower close to junctions and on narrow roads affected by street-side parking. The assumed traffic speeds for each road type were shown in Table 6.3 and Table 6.4.

Table 6.3: Modelled road speeds (kph) in rural areas

Road type	Rural
Motorway	105
A Road	96
B Road	80
Minor Road	64
Residential	32

[8] Annual Average Daily Traffic Map

Table 6.4: Modelled road speeds (kph) in urban areas

Road type	Urban			
	Standard	Junctions with queuing traffic	Road width < 7 m	Road width < 6 m
Motorway	90	90	-	-
A Road	32	20	- 20%	- 40%
B Road	28	20	- 20%	- 40%
Minor Road	24	20	- 20%	- 40%
Residential	20	20	- 20%	- 40%

6.1.5 Time-varying emissions

The variations of traffic flows during the day were taken into account by applying a diurnal profile to the road emissions. The profile based on the average traffic distribution on all roads in Great Britain, as published by the DfT.[9] The profile, shown in Figure 6.1, was applied to all modelled roads.

An hourly profile for grid sources was derived from typical variations by source type taken from European Monitoring and Evaluation Programme (EMEP) data and the total local emissions for each source type. This profile is shown in Figure 6.2.

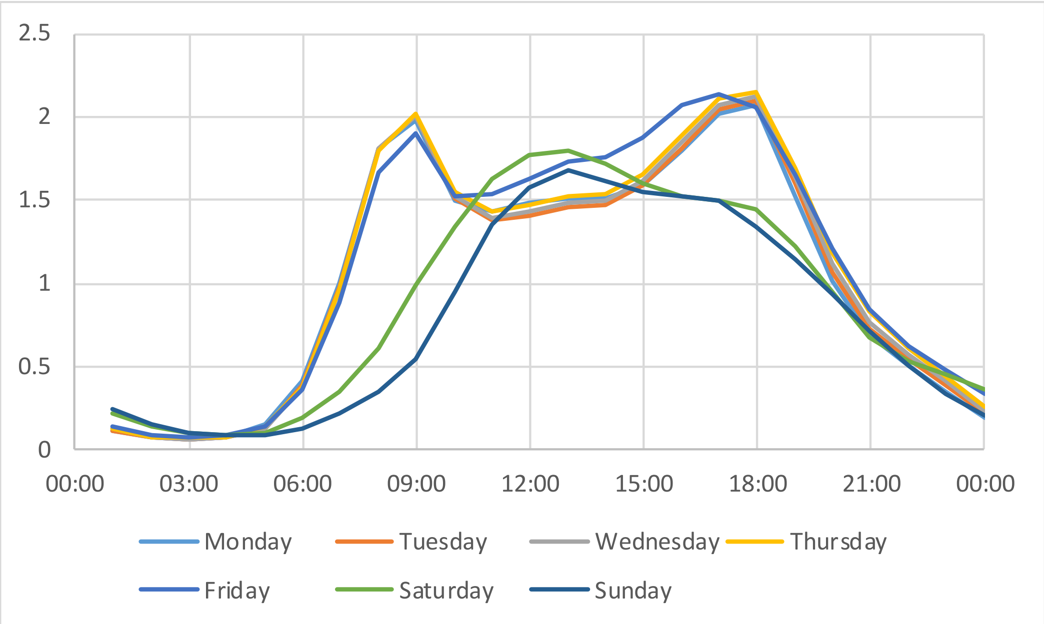

Figure 6.1: Diurnal emission factor profile used for road sources

[9] https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

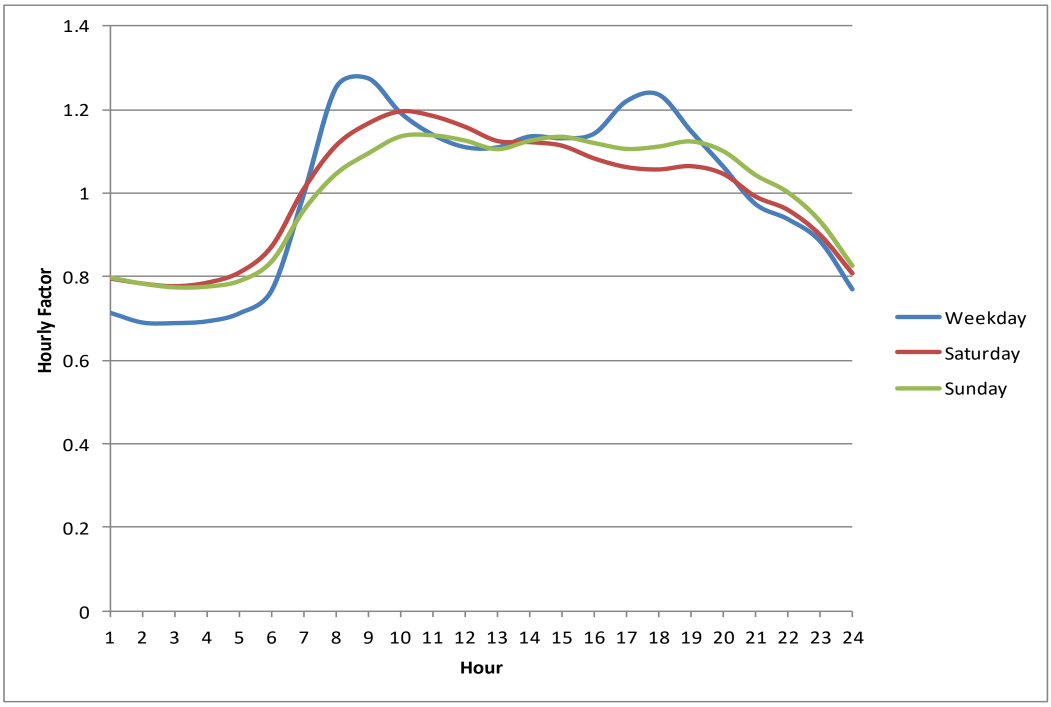

Figure 6.2: Diurnal profile grid sources

6.2 Other emissions

Emissions from other sources across the modelling domain, including domestic emissions and small industrial sources, were taken from the National Atmospheric Emissions Inventory (NAEI) 2021. Minor road emissions were extracted from the NAEI 2021 road transport category by subtracting major road emissions from the total road transport group. Emissions from all source types except major roads and large industrial sources were modelled as an aggregated grid source with a resolution of 1 km.

6.2.1 Industrial sources

Large industrial sources (defined as having a NO_x emission rate greater than 1 g/s) within a 5 km buffer around Oxfordshire were explicitly modelled. Emission rates were taken from the NAEI for 2021. All other industry was defined in the grid sources, as described in Section 6.2.

Table 6.5 shows all the industrial sources included in modelling; emission rates are reported as tonnes per year. Figure 6.3 shows these locations across Oxfordshire. Default source parameters were used in absence of provided stack parameter data.

Table 6.5: Large industrial sites in and surrounding Oxfordshire, emissions reported in tonnes / year

Site ID	Site Name	X (m)	Y (m)	Stack height (m)	NO_x	PM_{10}	$PM_{2.5}$
8128	Didcot B – RWE	450780	191850	85	42	0	0
41361	Ardley ERF – Viridor	454040	226340	82	14	0	0
14484	Banbury – Jacobs	445400	241700	19.12	4	0	0
14425	Banbury – Jacobs	445282	241541	19.12	0	1	1
8836	Bicester Garrison – MoD	461112	217882	8.15	3	0	0
8175	Cowley – BMW	455490	204370	8.15	3	0	0
6806	Sutton Courtney NFFO 5 – waste recycling group	447427	194222	8.15	2	0	0
4118	Sutton Courtney – waste recycling group	450784	192933	8.15	2	0	0
4191	Reading Sewage Treatment Works – Thames water	471400	170800	8.15	2	0	0
40432	Westcott Biogas Generation Plant – Olleco	470420	216650	16	1	0	0
3957	Ardley Power Plant – Viridor	454271	225980	5.4	1	0	0
8872	Churchill Hospital – NHS	454308	206029	5.4	1	0	0
4189	Oxford (Sandford) Sewage Treatment Works – Thames water	454135	201809	5.4	1	0	0
8366	RAF Brize Norton – MoD	428750	207100	5.4	1	0	0
8036	Swindon – Honda	418000	187700	5.4	1	0	0

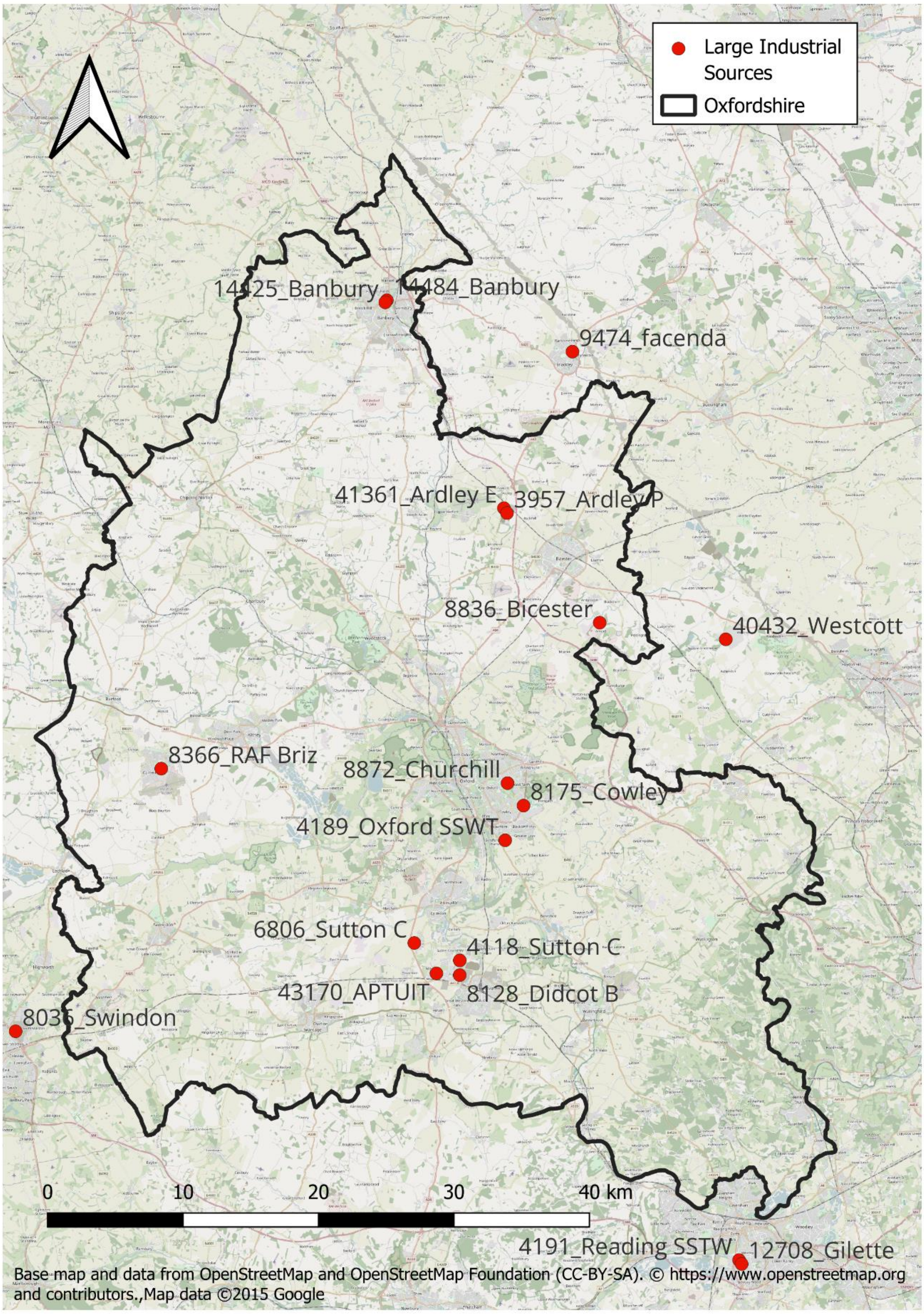

Figure 6.3: Location of large industrial sources in 2023 within 5 km of Oxfordshire

7 Base year model verification

The first stage of a modelling assessment is to model a current case in order to verify that the input data and model set-up were appropriate for the area, by comparing measured and modelled concentrations for local monitoring locations. The monitor locations used for this purpose are described in Section 4.2. Concentrations were calculated at these monitoring locations for 2023.

The model verification involves an iterative process to improve the model set-up, for better agreement between measured and modelled concentrations. Discrepancies between measured and modelled concentrations will always be present in modelling assessments. These can be due to uncertainties in measured concentrations, traffic flows, traffic speeds, other sources such as idling traffic, or local dispersion effects not included in the model.

7.1 NO_2

Figure 7.1 presents the monitored and modelled annual average NO_2 concentrations at the 316 diffusion tubes and 3 automatic monitors operational in Oxfordshire for 2023. Figure 7.2 to Figure 7.11 show scatter plots and maps of model verification agreement compared to air quality monitoring for each local authority in Oxford.

Details of the modelled and measured NO_2 concentrations at each air quality monitor for 2023 are given in Appendix A.

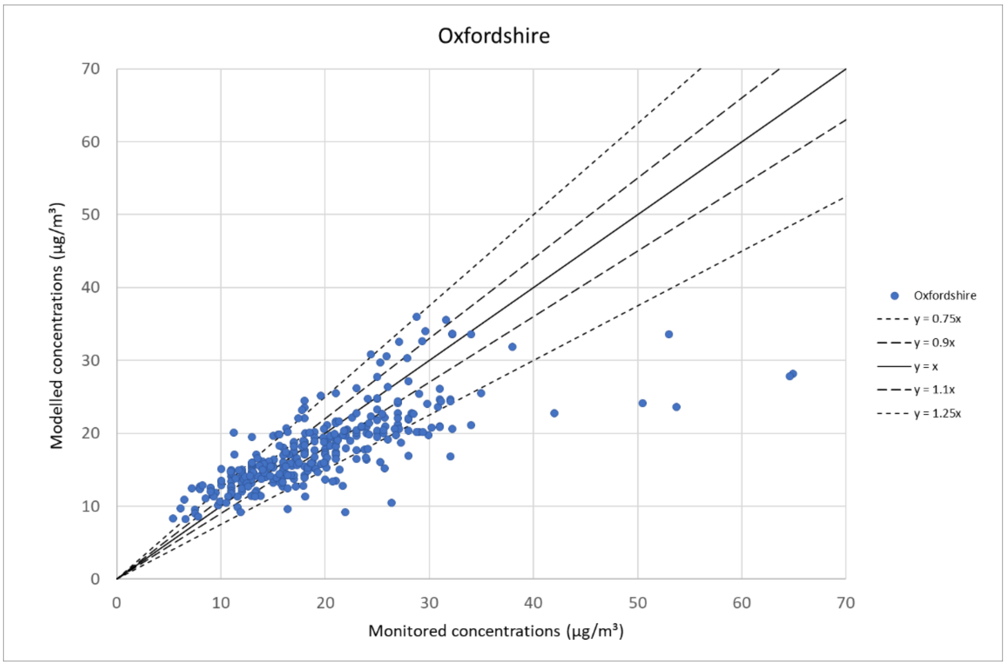

Figure 7.1: Measured and modelled annual average NO_2 concentrations at diffusion tubes and continuous monitors throughout Oxfordshire, 2023 (µg/m³)

Table 7.1 summaries the model agreement statistics for the whole of Oxfordshire.

Modelled annual average NO_2 concentrations were within 10% of the measured value at 99 of the 319 monitoring sites (31%) and within 25% at 237 of the sites (74%).

Table 7.1: Statistical summary of monitored and modelled annual average NO_2 concentrations at diffusion tube locations and continuous monitors.

Statistic	Monitored	Modelled
Average (µg/m³)	19.3	17.7
Standard deviation (µg/m³)	8.20	5.2
Root Mean Square Error (µg/m³)	5.8	
Fractional Bias	- 0.09	
Correlation Coefficient	0.74	

7.1.1 Cherwell

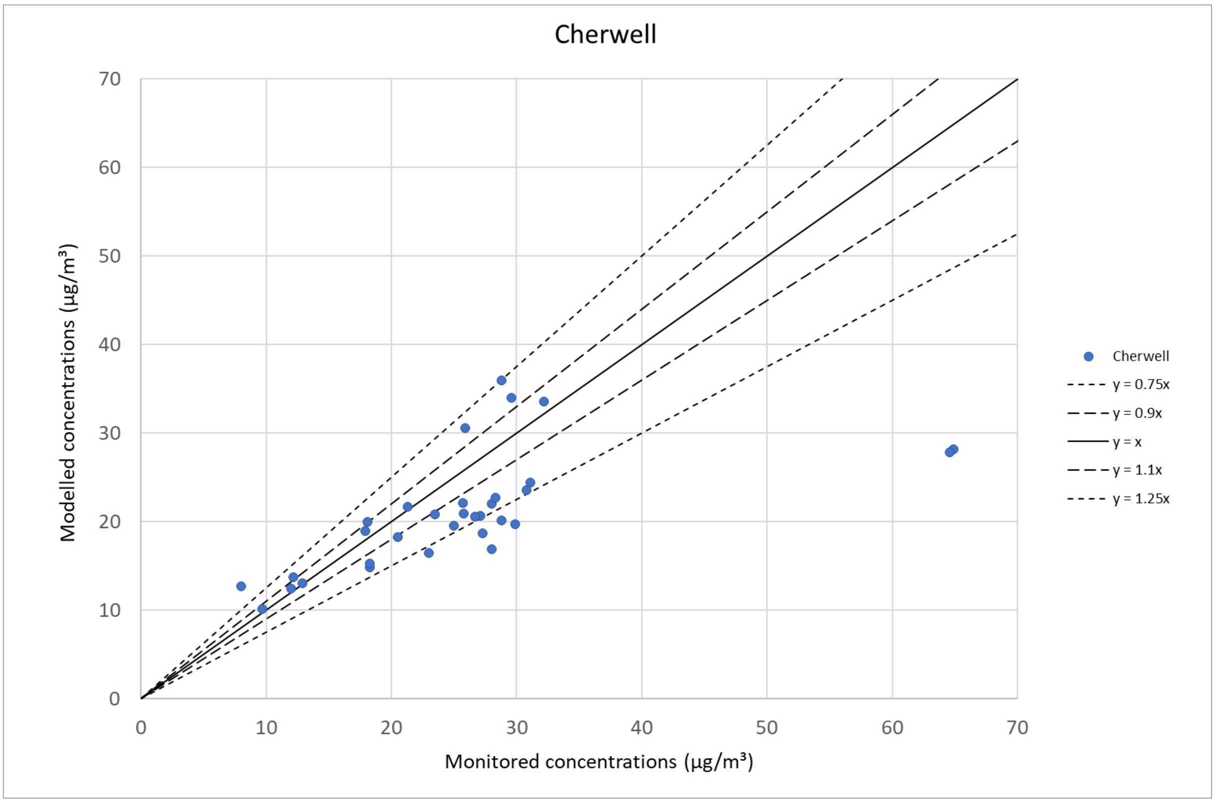

Figure 7.2: Measured and modelled annual average NO_2 concentrations (µg/m³) for Cherwell, 2023

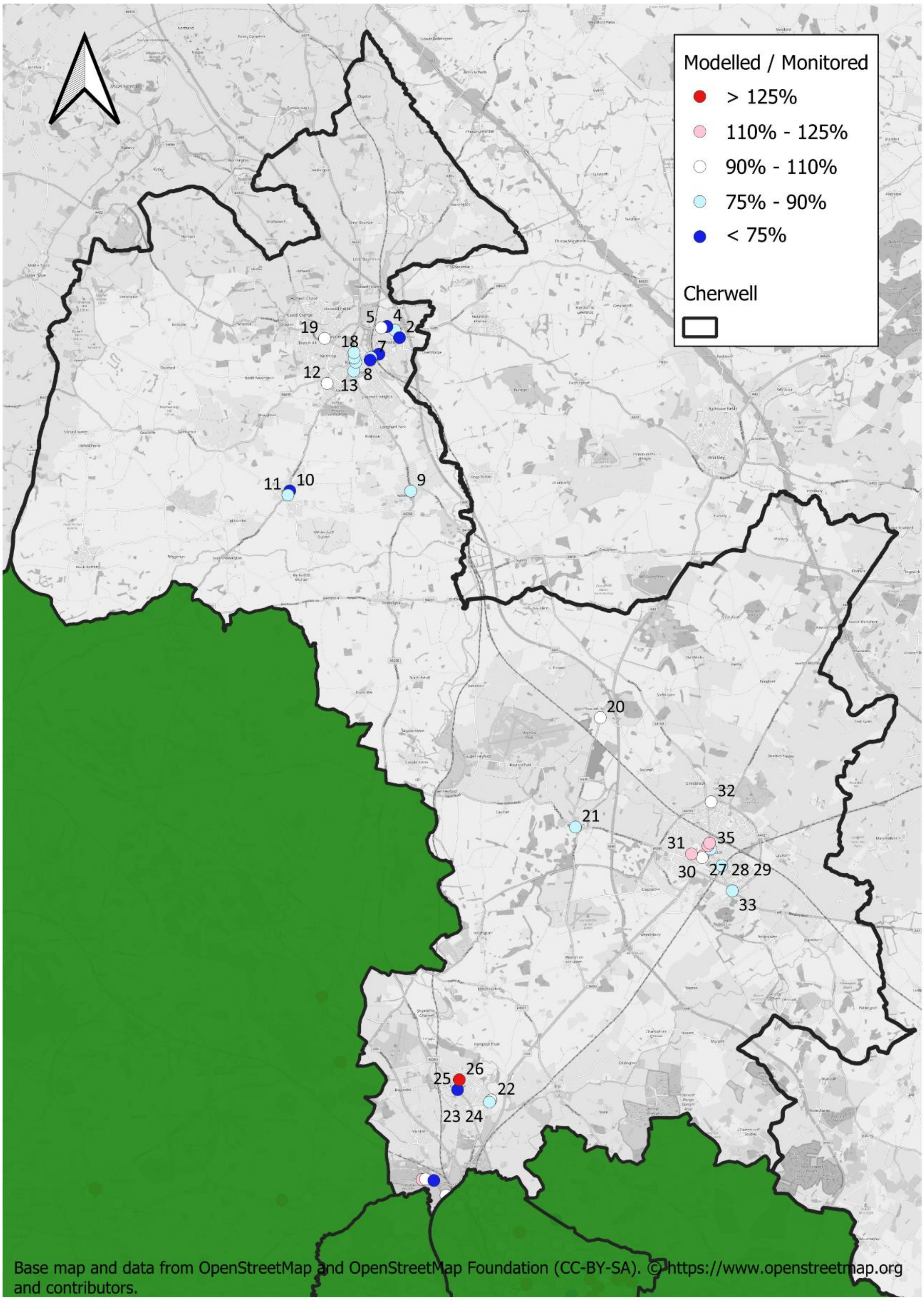

Figure 7.3: Annual average NO_2 model verification for Cherwell

7.1.2 Oxford

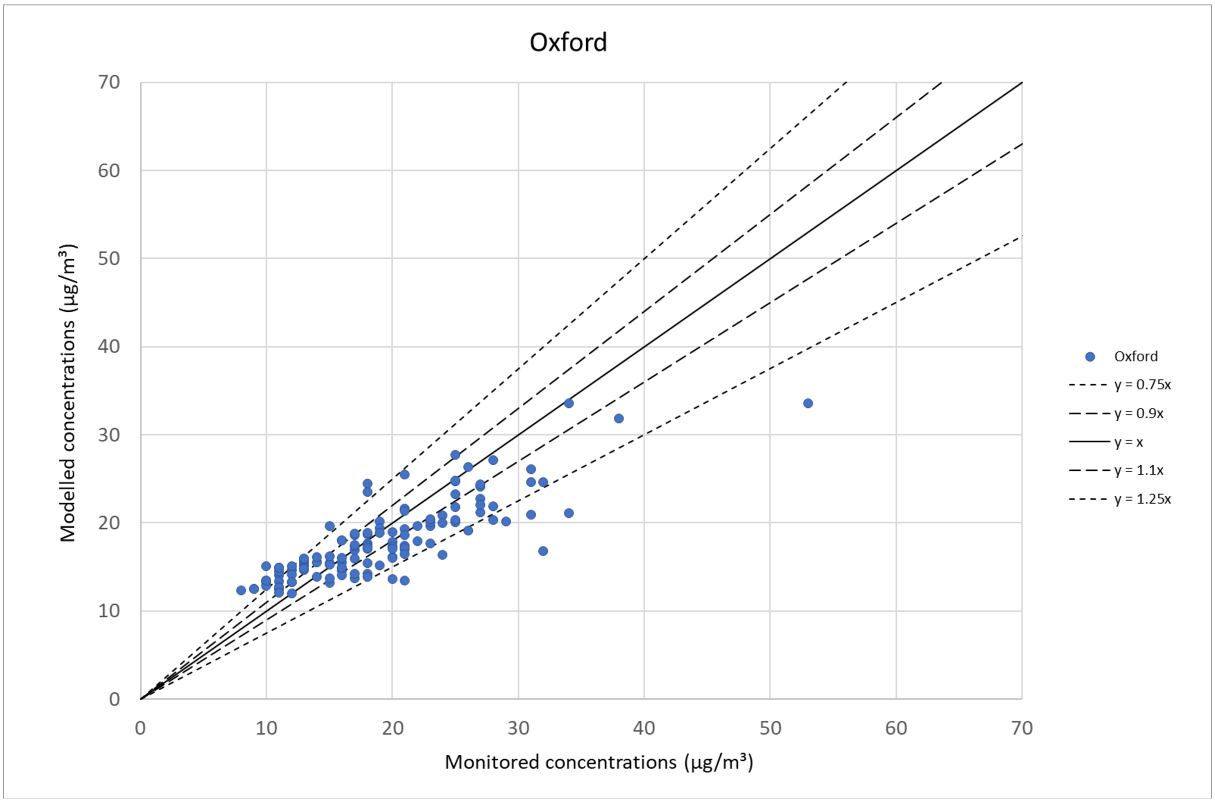

Figure 7.4 Measured and modelled annual average NO_2 concentrations (µg/m³) for Oxford, 2023

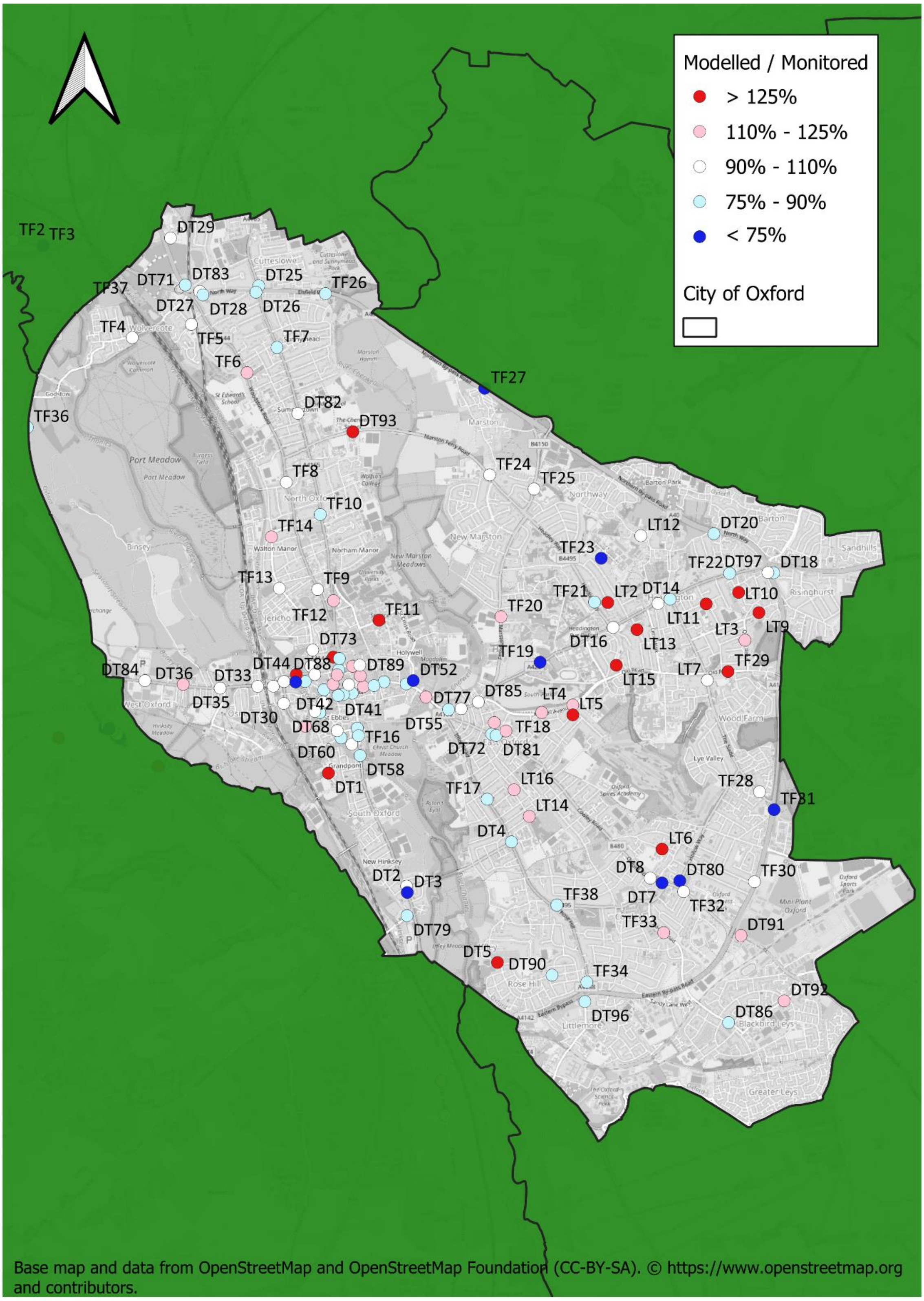

Figure 7.5: Annual average NO_2 model verification for Oxford

7.1.3 South Oxfordshire

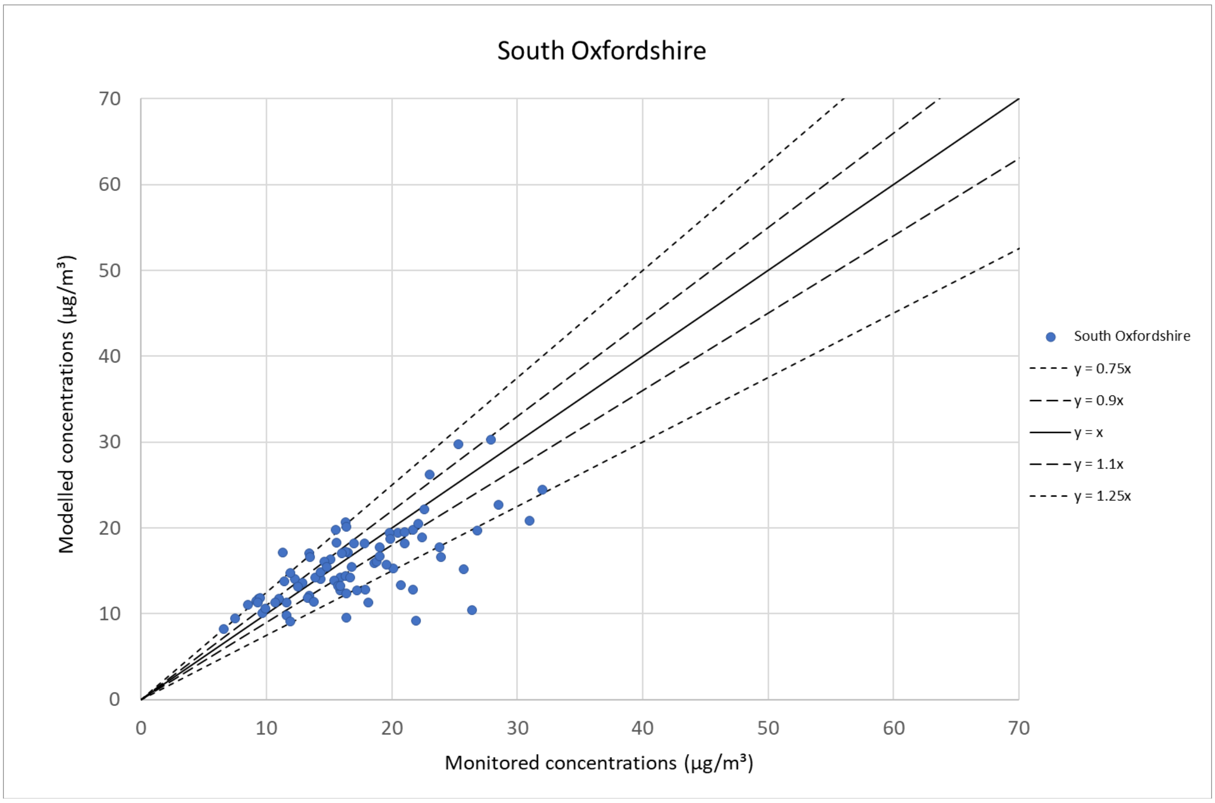

Figure 7.6: Measured and modelled annual average NO_2 concentrations (µg/m³) in South Oxfordshire, 2023

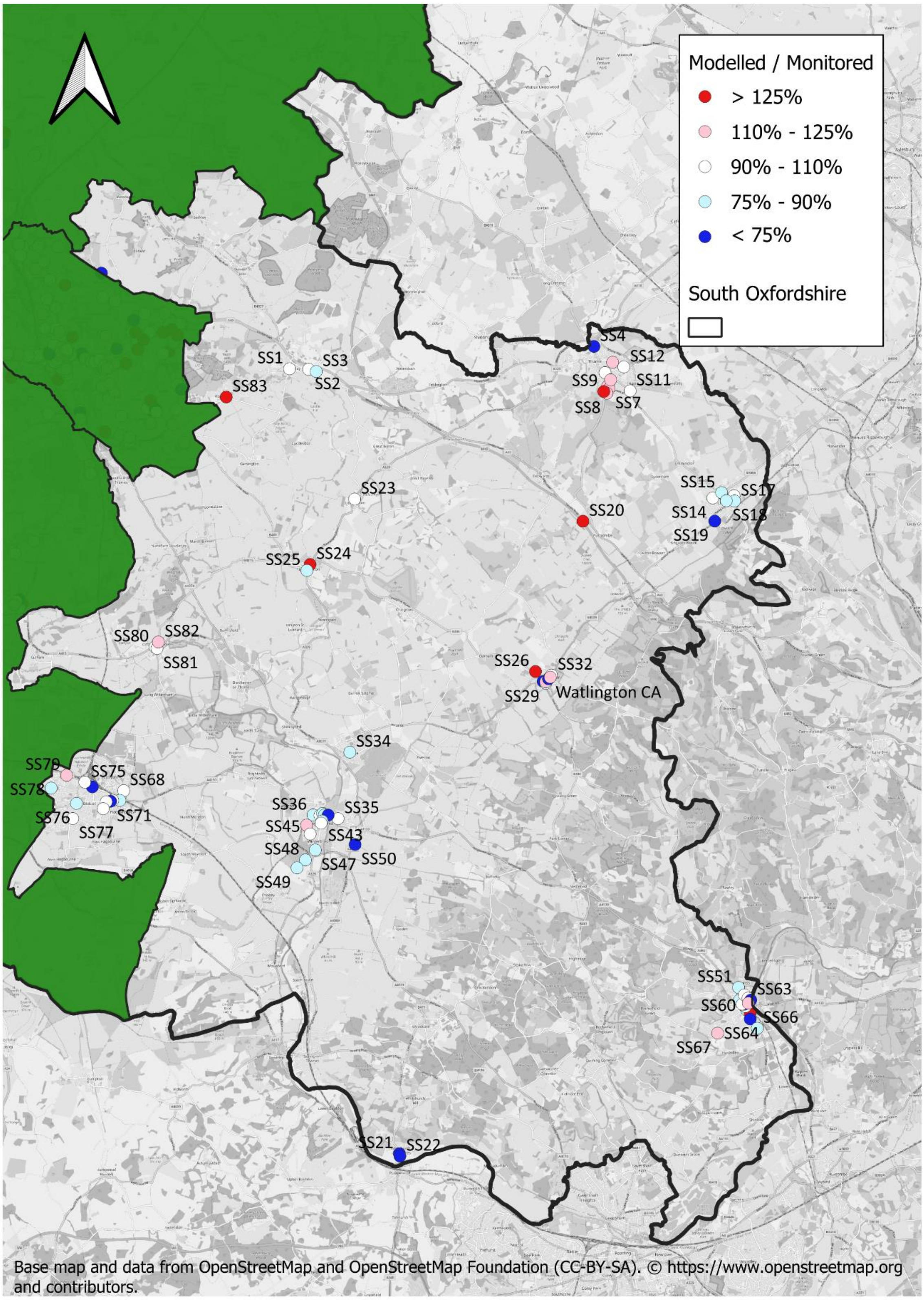

Figure 7.7: Annual average NO_2 model verification for South Oxfordshire

7.1.4 West Oxfordshire

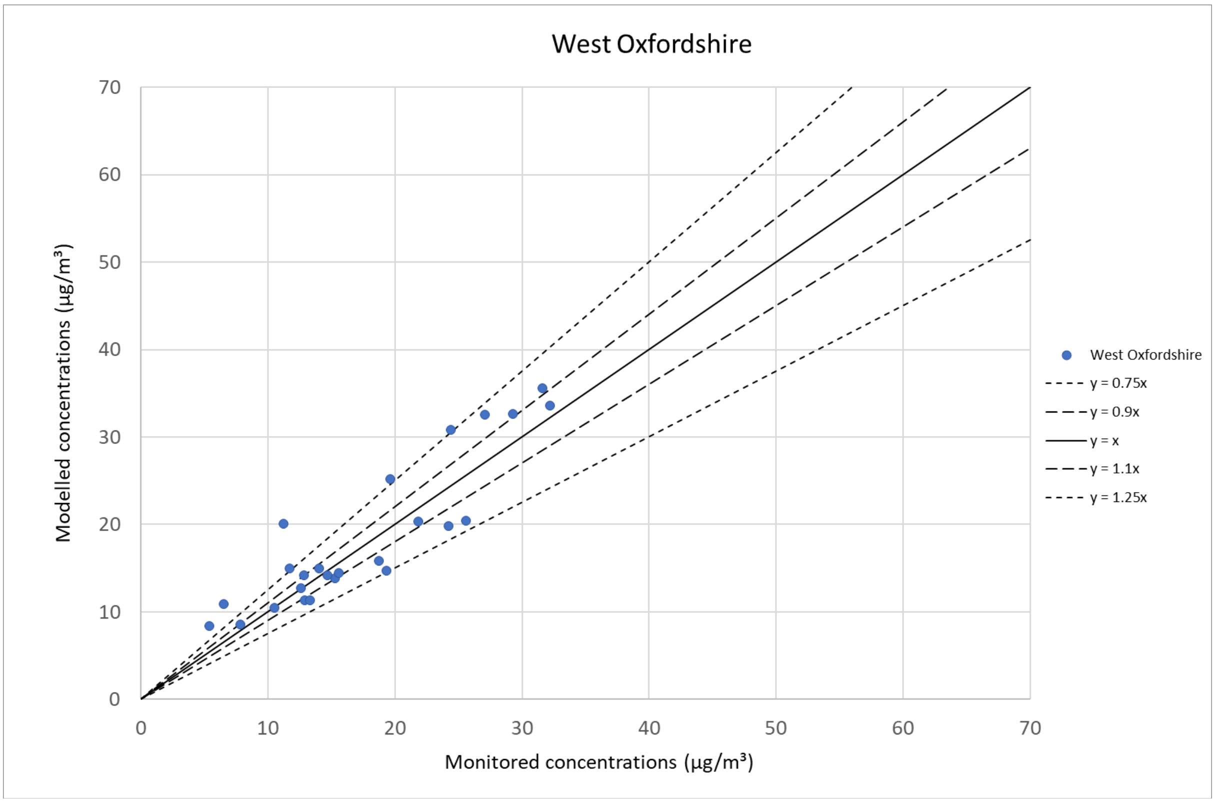

Figure 7.8: Measured and modelled annual average NO_2 concentrations (µg/m³) in West Oxfordshire, 2023

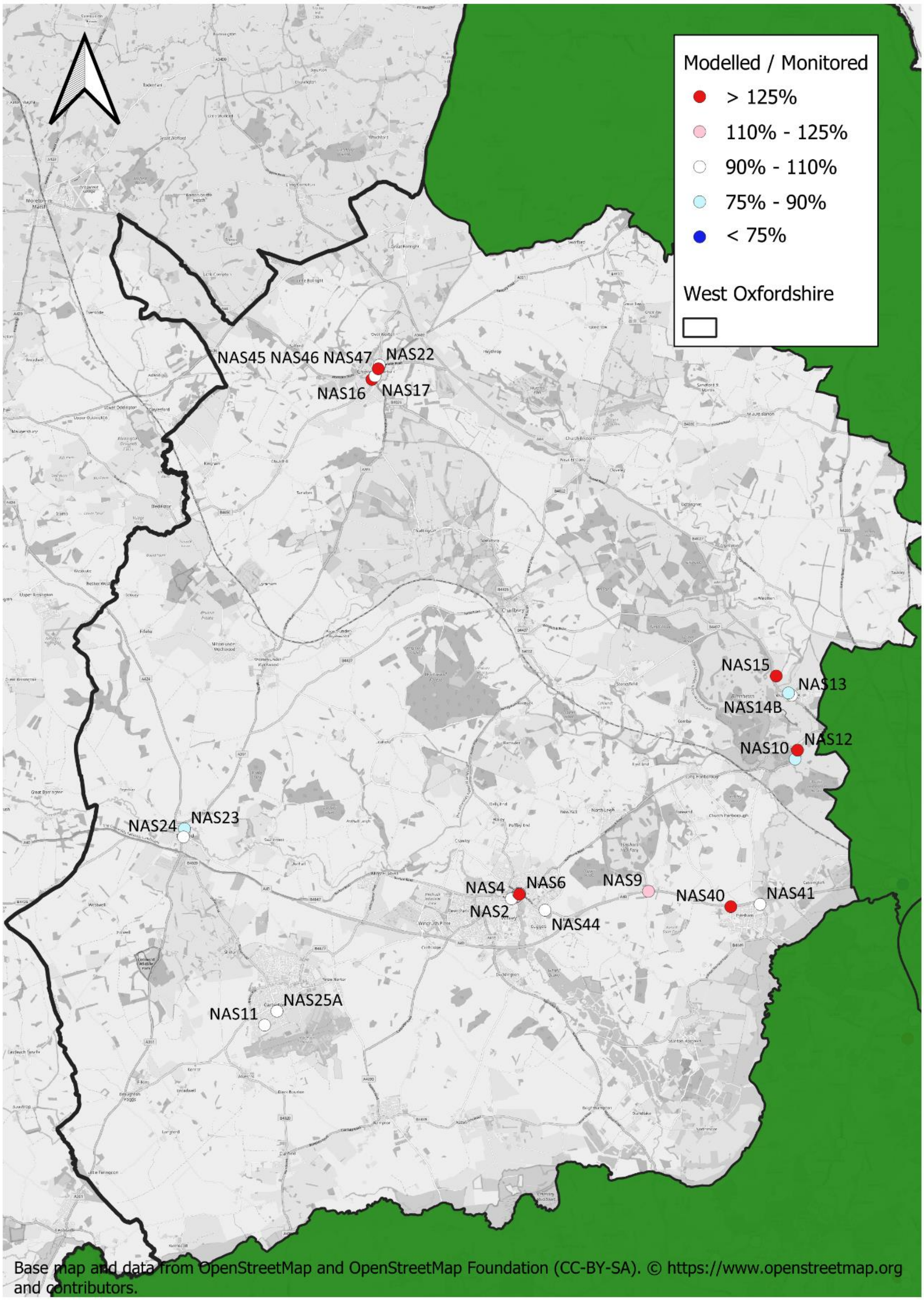

Figure 7.9: Annual average NO_2 model verification for West Oxfordshire

7.1.5 Vale of White Horse

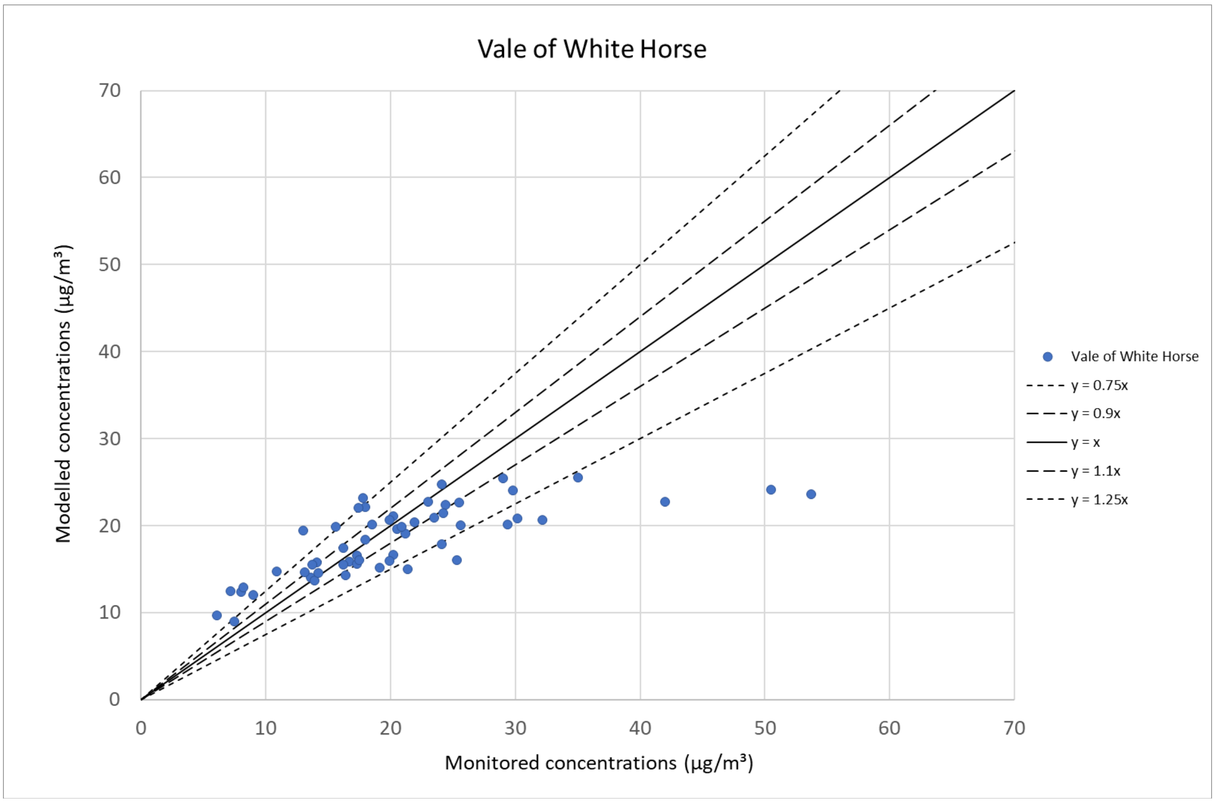

Figure 7.10: Measured and modelled annual average NO_2 concentrations (µg/m³) in Vale of White Horse, 2023

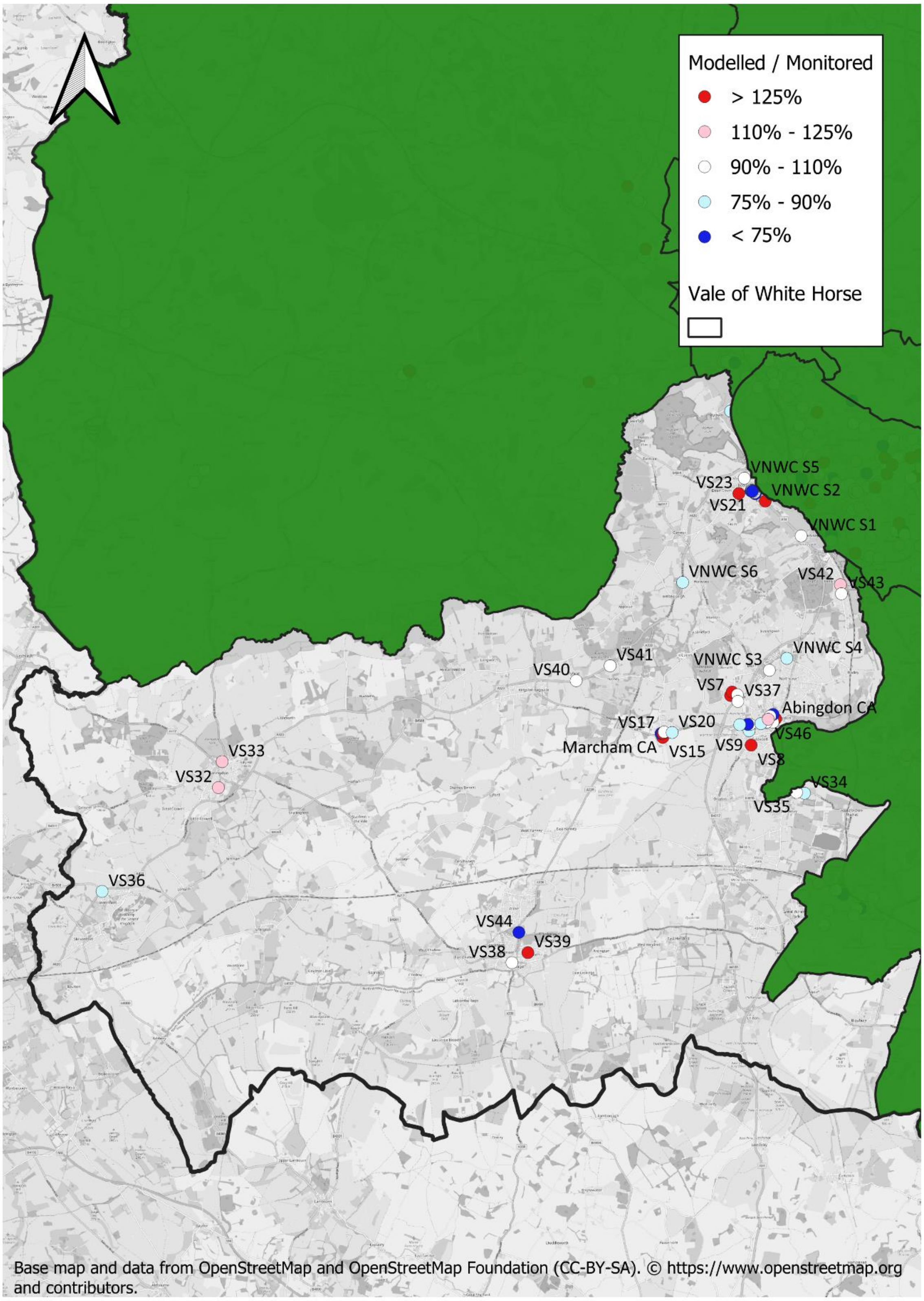

Figure 7.11: Annual average NO_2 model verification for the Vale of White Horse

7.2 Particulate matter

Table 7.2 summarises the modelled concentrations for annual average PM_{10} and $PM_{2.5}$ compared to measured concentrations at roadside and urban background location in Oxford. Note that background concentrations input into the model were 10.1 µg/m³ and 6.4 µg/m³ for PM_{10} and $PM_{2.5}$ respectively (see Section 5.7).

Table 7.2: Monitored and modelled annual average PM_{10} and $PM_{2.5}$ concentrations, 2023 (µg/m³)

Site ID	Site type	Monitored PM_{10}	Modelled PM_{10}	Monitored $PM_{2.5}$	Modelled $PM_{2.5}$
CM2	Roadside	14	17	8	9
CM3	Urban background	9	13	6	8

8 Base year concentrations

Figure 8.1 shows the modelled annual average NO_2 concentrations for Cherwell, South Oxfordshire, Vale of White Horse, and West Oxfordshire local authorities.

Figure 8.2 shows the modelled 99.79th hourly percentile for NO_2 concentrations.

Figure 8.3 shows the modelled annual average of PM_{10} concentrations.

Figure 8.4 shows the modelled 90.41st percentile of 24-hourly average PM_{10} concentrations.

Figure 8.5 shows the modelled annual average $PM_{2.5}$ concentrations.

Table 8.1 shows the modelled concentrations at the OxAria sensor locations described in Section 4.3.

Table 8.1: Modelled concentrations at previous locations where OxAria sensors were deployed, 2023

Sensor name	Location	X(m)	Y(m)	Z(m)	NO_2	PM_{10}	$PM_{2.5}$
536	New Marston	452553	207299	1.5	11.6	13.6	7.9
538	St Ebbe's AURN	451120	205353	2.7	12.5	13.3	7.8
539	Ship St (Jesus College)	451323	206372	3.3	15.7	14.5	8.1
542	St Ebbe's AURN 2	451120	205353	2.7	12.5	13.3	7.8
543	John Radcliffe Hospital	451677	206274	3.3	16.0	14.6	8.1
551	St Giles	451152	206796	5.5	16.6	14.6	8.2
552	County Hall	451110	206162	5	16.9	14.8	8.3
553	Divinity Road	453410	205803	2	12.7	14.3	8.1
555	Windmill school	454981	206787	3	15.5	14.4	8.4

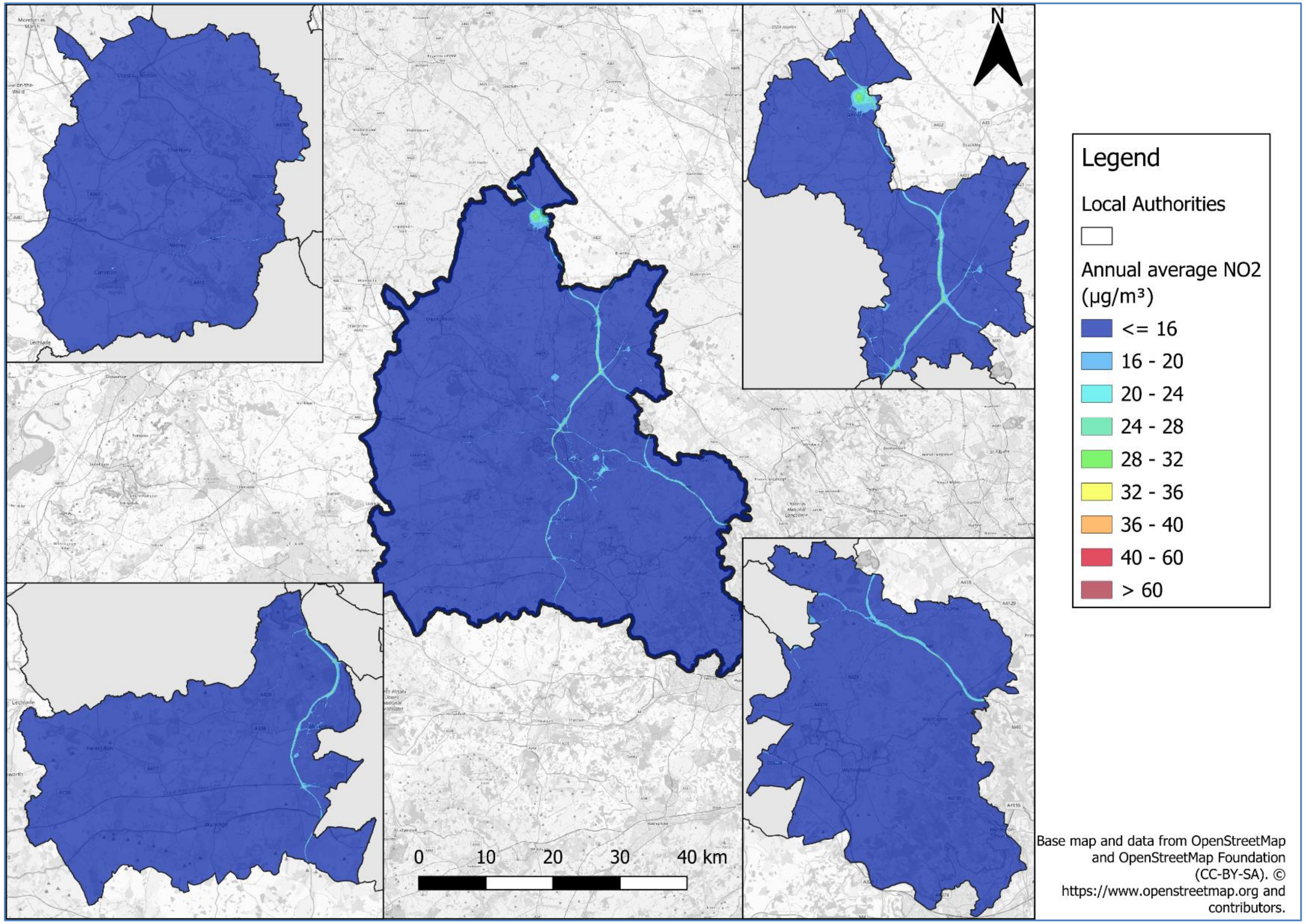

Figure 8.1: Annual Average NO_2 across Oxfordshire, 2023: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

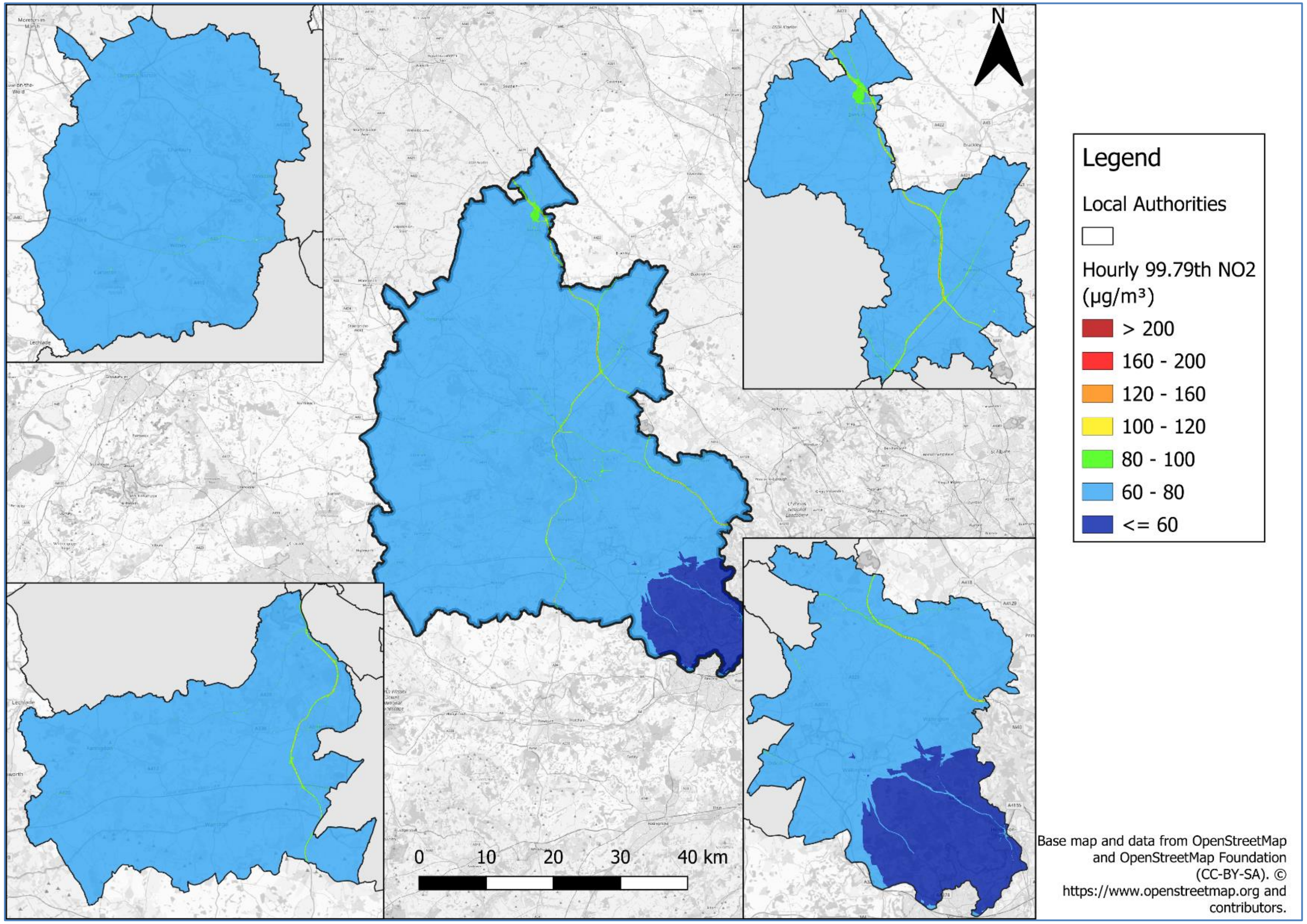

Figure 8.2: Hourly 99.79th percentile of NO_2 concentrations across Oxfordshire, 2023: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

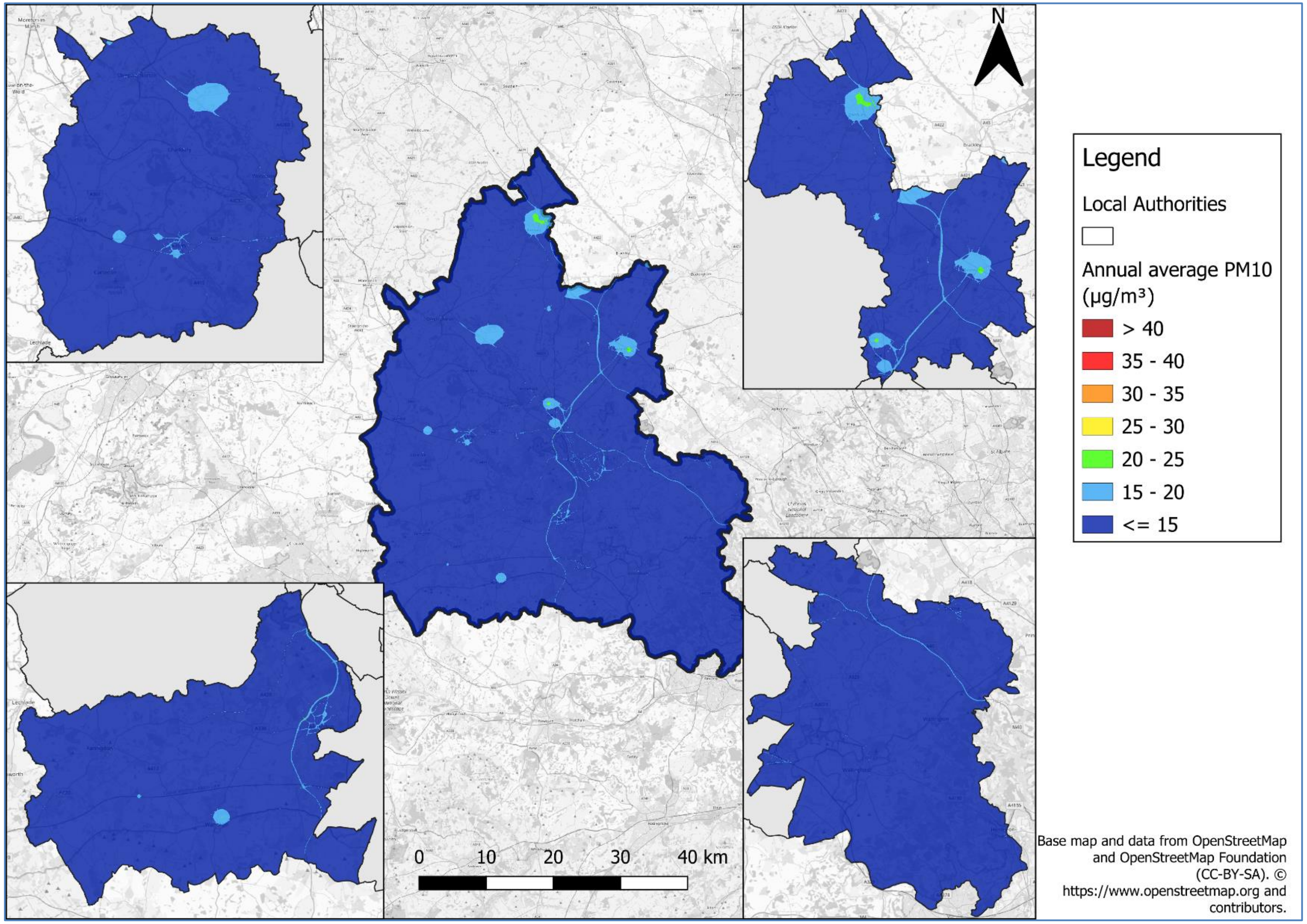

Figure 8.3: Annual average PM_{10} across Oxfordshire, 2023: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

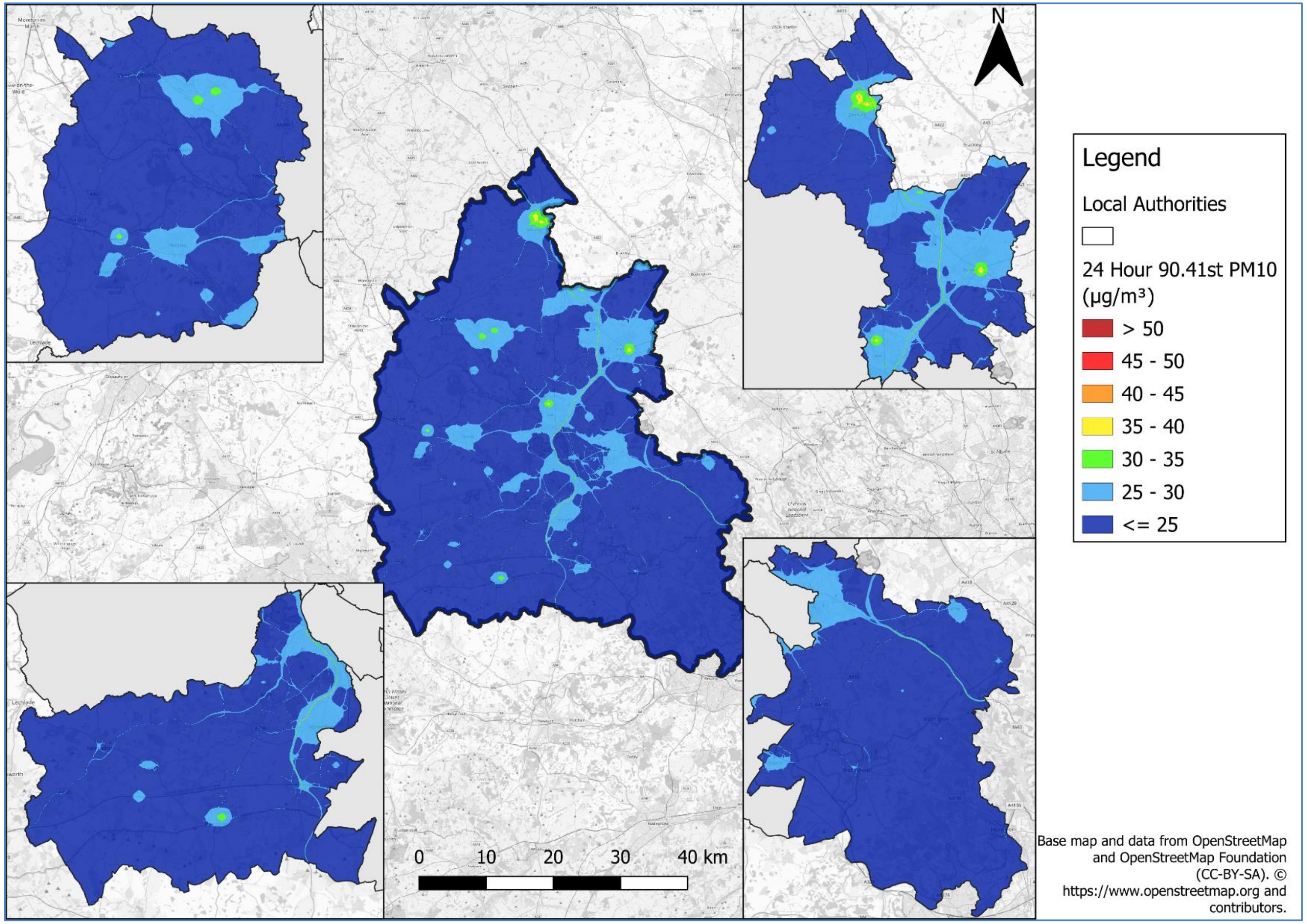

Figure 8.4: 90.41st percentile of 24-hour average PM_{10} concentrations across Oxfordshire, 2023: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

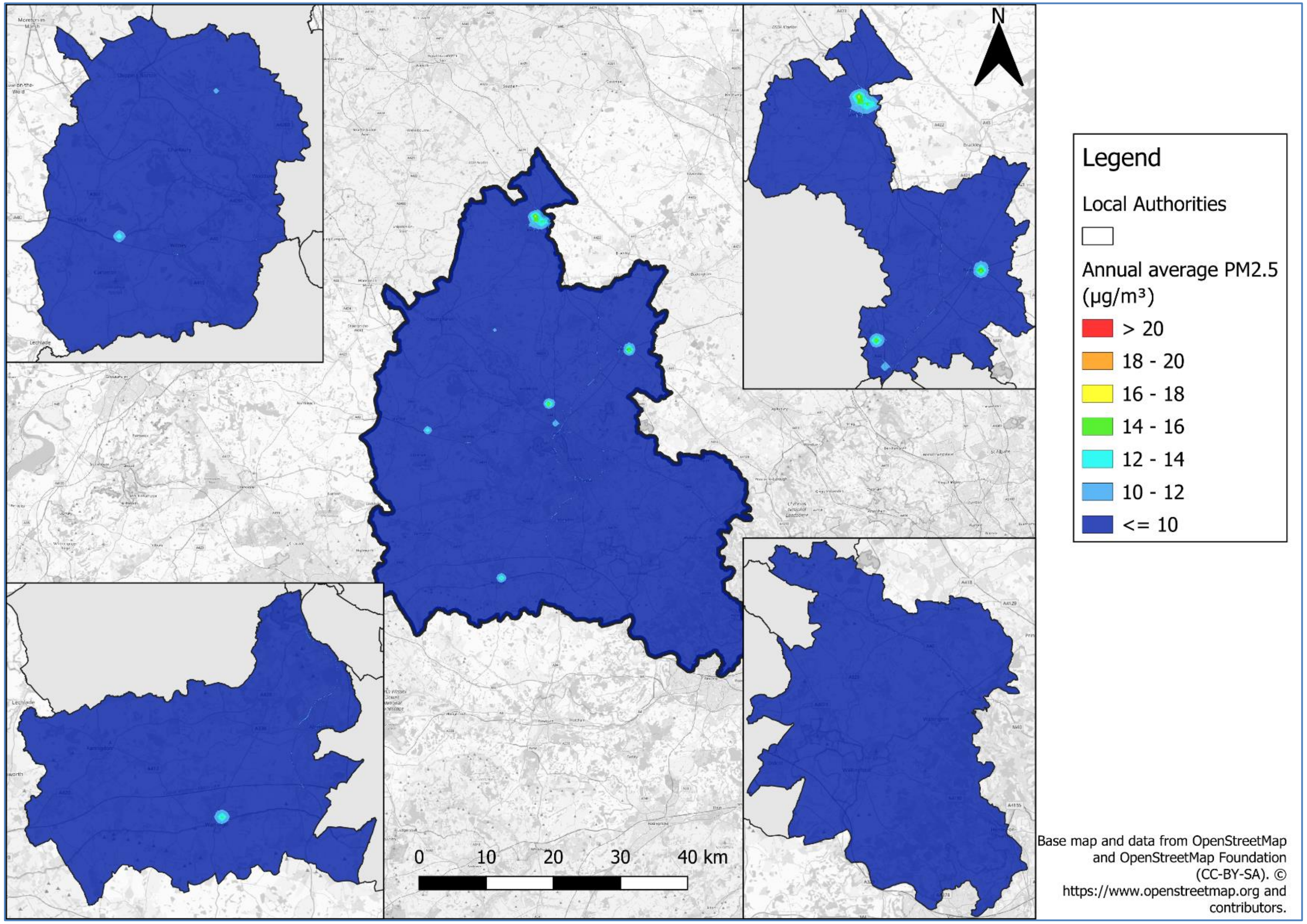

Figure 8.5: Annual average $PM_{2.5}$ across Oxfordshire, 2023: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

9 Future Baseline Emissions

The method for compiling the emissions inventory is described in Section 6. This section details the methodology used to update the emissions inventory from 2023 to the 2035 future baseline scenario for Oxfordshire and the surrounding area.

Adjustments to emissions depending on modelled Phase 1 and Phase 2 scenarios are discussed in Section 10.

9.1 Road transport

The emissions inventory includes representation of emissions from all roads across Oxfordshire based on a traffic model for 2035. Emissions from major roads were calculated as described in Section 6.1.

Minor roads were aggregated into 1 km^2 grids and then projected to 2035; see Section 9.2.

9.1.1 Emission factors

Traffic emissions of NO_x, NO_2, PM_{10}, and $PM_{2.5}$ were calculated from traffic flows using the same emission factors (Emission Factor Toolkit version 12) and adjustments as for the base year, but with the vehicle fleet updated to 2035.

9.1.2 Vehicle fleet

Data for vehicle fleet composition was taken from the EFT *England Urban 2035* for all vehicles except buses. Bus fleet fuel splits were assumed to be consistent with 2023; see Table 6.1. The expectation is that 100% of buses will be Euro VI category or better by 2035.

The fleet composition for coaches used the standard EFT composition; see Section 6.1.2. The coach component of bus flows was also assumed to be consistent with 2023.

9.1.3 Traffic flows

Oxfordshire County Council's SATURN multi-modal transport model generated modelled traffic flows for a future baseline of 2035. The transport model included a *Do something* scenario which accounted for the predicted effects of proposed traffic filters, electrification of the bus fleet, and Oxford City's Zero Emission Zone.

Car flows in the traffic model were based on the uptake of new developments, but did not make allowances for the effects of Covid-19. This led to unrealistic growth projections for cars between the base year and 2035. An adjustment to car traffic flows were made by comparing the increase in car vehicle kilometres per day from the base year to 2035 against the reported 1.7% growth per year in housing development for Oxfordshire. This led to a scaling factor of 0.86 being applied to all car flows in the future baseline traffic model.

Outputs from the transport model include annual average daily total (AADT) traffic flows by vehicle type (cars, buses, LGVs and HGVs) on each highway link. New developments for Eynsham, Bicester, and Didcot were included in the traffic model; new road network geometry was based on planning documents.

9.1.4 Traffic speeds

Average traffic speeds for 2035 were assumed to be consistent with the base year. For new roads, average speeds were estimated based on road type, setting, and road width using the same assumptions as for the base year, as described in Section 6.1.4.

9.1.5 Time-varying emissions

The future baseline used the same diurnal profile for road emissions as the 2023 baseline; profiles are described in Section 6.1.5.

9.2 Other emissions

Emissions from other, non-explicit sources across the modelling domain, were taken from the National Atmospheric Emissions Inventory (NAEI) 2021 and projected to 2035.

Emission sectors were projected to 2035 based on the concentration change of pollutants in the Defra background maps[10] split by sector. Agricultural, waste, and nature sources are not defined in the Defra background maps, so pollutant emissions from these sectors were unadjusted.

Minor roads emissions were disaggregated from the NAEI 2021 road transport category and projected to 2035. Emissions from all source types except major roads and large industrial sources were modelled as an aggregated grid source with a resolution of 1 km.

[10] https://uk-air.defra.gov.uk/data/laqm-background-home

9.2.1 Industrial sources

Large industrial sources were selected using the same criteria as the base year, as described in Section 6.2.1. The John Radcliffe Hospital was included as a large point source in all future scenarios, despite being below the NO_x 1 g/s threshold (see Section 6.2.1), because it was required for certain Phase 2 scenarios. Emission rates were then projected to 2035 using the Defra background maps. All other industrial emissions were defined in the grid sources as described in Section 9.2.

Table 9.1 shows all industrial sources included in the future scenario modelling; emission rates were reported as tonnes per year. Figure 9.1 shows these locations across Oxfordshire.

Table 9.1: Large industrial sites in and surrounding Oxfordshire in 2035, emissions reported in tonnes / year

Site ID	Site Name	X (m)	Y (m)	Stack height (m)	NO_x	PM_{10}	$PM_{2.5}$
8128	Didcot B – RWE	450780	191850	85	1579	1	1
41361	Ardley ERF – Viridor	454040	226340	82	470	1	1
14484	Banbury – Jacobs	445400	241700	19.12	127	0	0
14425	Banbury – Jacobs	445282	241541	19.12	0	41	40
8836	Bicester Garrison – MoD	461112	217882	8.15	84	3	3
8175	Cowley – BMW	455490	204370	8.15	82	1	1
6806	Sutton Courtney NFFO 5 – waste recycling group	447427	194222	8.15	78	3	3
4118	Sutton Courtney – waste recycling group	450784	192933	8.15	53	2	2
4191	Reading Sewage Treatment Works – Thames water	471400	170800	8.15	56	1	1
40432	Westcott Biogas Generation Plant – Olleco	470420	216650	16	48	0	0
3957	Ardley Power Plant – Viridor	454271	225980	5.4	51	2	2
8872	Churchill Hospital – NHS	454308	206029	5.4	38	2	1
4189	Oxford (Sandford) Sewage Treatment Works – Thames water	454135	201809	5.4	40	1	1
8366	RAF Brize Norton – MoD	428750	207100	5.4	35	1	2
8036	Swindon – Honda	418000	187700	5.4	37	0	0
9474	Brackley – Facenda Foods	459100	237900	5.4	33	0	0
12708	Whitely – Gilette UK	471590	170510	5.4	32	3	3
43170	Abingdon – APTUIT	449060	191980	5.4	33	3	3
8873	Oxford – John Radcliffe Hospital	453900	207600	5.4	29	0	0

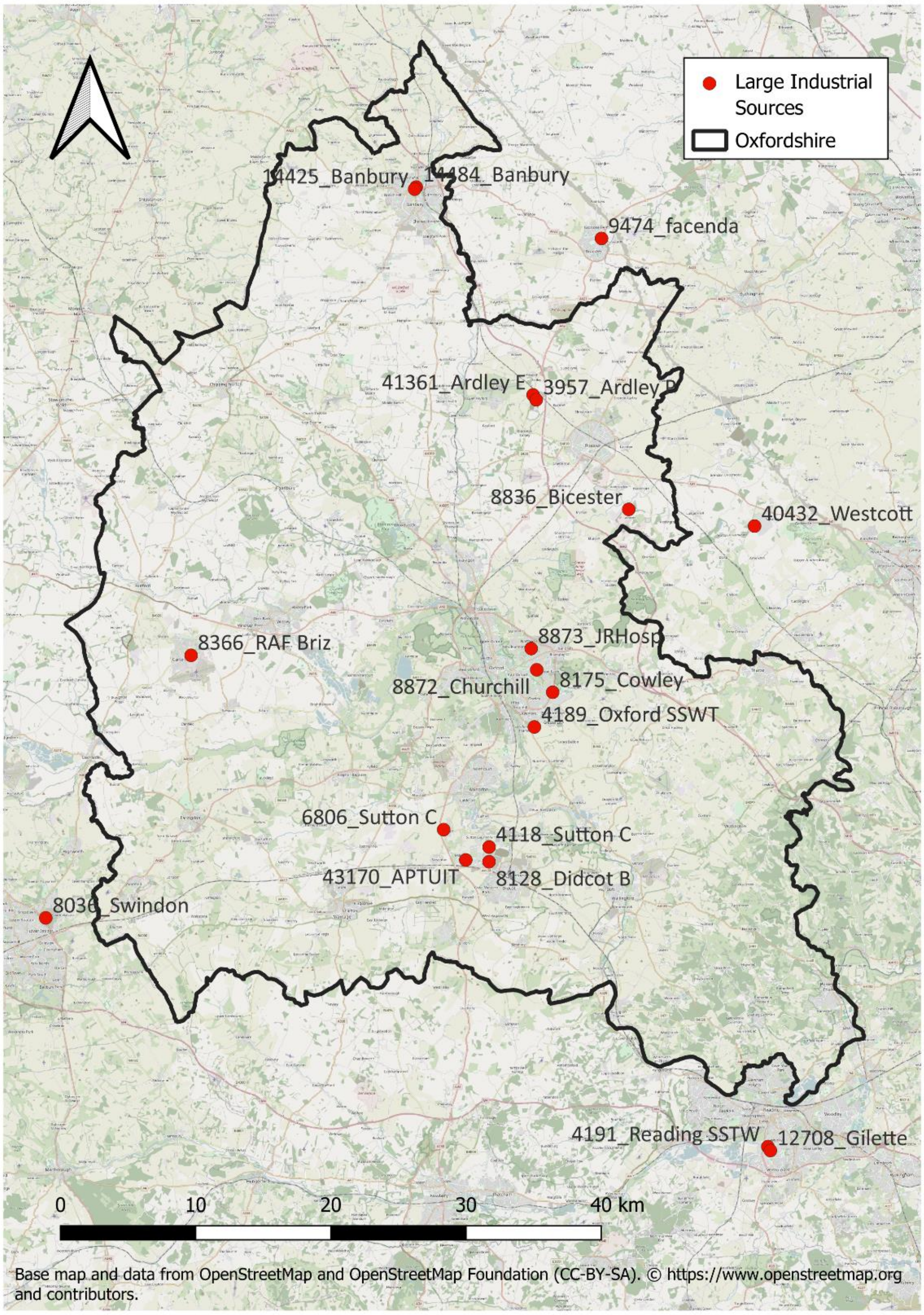

Figure 9.1: Location of large industrial sources in 2035 within 5 km of Oxfordshire

10 Net-Zero and policy scenarios

Oxfordshire County Council and CERC agreed on eleven different future scenarios of varying complexity to test the potential impacts of different policies on human health. These were:

- One future baseline scenario
- Two Phase 1 Scenarios
- Eight Phase 2 Scenarios

Phase 1 scenarios represent national or regional net-zero strategies. Phase 2 scenarios represent theoretical emissions scenarios. Although eight Phase 2 scenarios were run, two of these were run for other organisations, so are not included in this report.

The future baseline is described in Section 9. Sections 10.1 and 10.2 describe scenario adjustments made to the model set-up or emissions in the future baseline scenario for each Phase 1 and Phase 2 scenario. All other emissions and assumptions were kept the same as for the 2035 baseline.

10.1 Phase 1 Scenarios

10.1.1 Oxfordshire Leading the Way Scenario

To achieve Net-Zero emissions by 2050, Oxfordshire presented three potential pathways for reaching this target compared to the Business as Usual scenario. These were: Societal Transformation, Technological Transformation, and Oxfordshire Leading the Way[11].

Oxfordshire's Net-Zero Route Map and Action Plan Final Report[12] was then based on the evidence in the Oxfordshire Leading the Way scenario (OLW). CERC were asked to show the potential impacts on air quality of the OLW scenario compared to the business as usual base case for the year 2035.

Table 10.1 displays the emission adjustments to non-explicit sources for each sector. Emission adjustments for Snap Sectors 1 through 7 were either explicitly stated emission reductions from Sections 3.4 to 3.8 of the Oxfordshire's Net-Zero Route Map and Action Plan Final Report, or derived from the uptake in green energy displayed in the same route maps. There were no actionable adjustments to be applied to Snap Sectors 9 through 11.

Emission reductions were applied spatially uniformly across Oxfordshire, except where explicitly modelled sources were accounted for. Emission sources outside of Oxfordshire were not adjusted.

[11] https://www.eci.ox.ac.uk/sites/default/files/2022-09/PazCo-final.pdf
[12] https://cdn.prod.website-files.com/64bfc2696e3a5a80360d3c60/64fb93ec4927a6fb9023d790_Oxfordshire-NZ-Route-Map-Action-Plan-City-Science-Dec-2022-vFinal.pdf

Table 10.1: Each NAEI Snap Sector and the emissions adjustment for the Oxfordshire Leading the Way scenario

Snap Sector	Description	NO_x adjustment from base case	PM adjustment from base case
SNAP01	Energy production	0.42	0.42
SNAP02	Commercial and domestic	0.55	0.29
SNAP03	Industrial combustion	0.67	0.40
SNAP04	Industrial processes	0.67	0.40
SNAP05	Offshore	N/A	N/A
SNAP06	Solvents	0.67	0.40
SNAP07	Road transport	Calculated from explicitly modelled traffic flows	
SNAP08	Other transport	Calculated from Phase 2 Scenario (See Section 10.2.4)	
SNAP09	Waste	N/A	N/A
SNAP10	Agriculture	N/A	N/A
SNAP11	Nature	N/A	N/A

Explicitly modelled industrial sources were associated to a SNAP sector. Emissions from large industrial sources were reduced by the same factor as the gridded emissions. Table 10.2 displays the reduction to all explicitly modelled industrial sources inside Oxfordshire.

Table 10.2: Emission adjustments to large industrial points sources in Oxfordshire based on their function and SNAP Sector. Sources outside Oxfordshire were not adjusted

Site Name	Type	NOx	PM
Didcot B – RWE	Energy Production	0.42	0.42
Ardley ERF – Viridor	Energy Production	0.42	0.42
Sutton Courtney NFFO 5 – waste recycling group	Energy Production	0.42	0.42
Ardley Power Plant – Viridor	Energy Production	0.67	0.40
Banbury – Jacobs	Industrial	0.42	0.42
Banbury – Jacobs	Industrial	0.67	0.40
Bicester Garrison – MoD	Industrial	0.67	0.40
Cowley – BMW	Industrial	0.67	0.40
Churchill Hospital – NHS	Industrial	0.67	0.40
Oxford (Sandford) Sewage Treatment Works - Thames water	Industrial	0.67	0.40
RAF Brize Norton – MoD	Industrial	0.67	0.40
Abingdon – APTUIT	Industrial	0.67	0.40
Oxford – John Radcliffe Hospital	Industrial	0.67	0.40
Sutton Courtney – waste recycling group	Waste	1	1

Emissions from explicitly modelled road sources were calculated from accurate traffic flows and fleet composition described in the OLW scenario. 1 in 4 car journeys will be removed or replaced from the roads compared to the future baseline. This was modelled by removing 25% of car vehicle flows from all roads across Oxfordshire.

The electrification of the fleet is also described. By 2035, Oxfordshire anticipates that 36.2% of cars, 34.9% of LGVs, 19% of HGVs, and 18.7% of buses will be Zero-emission vehicles (ZEVs). The uptake of hydrogen fuel is not a focal point of the OLW, so ZEVs were assumed to be electric.

Emissions from major roads were calculated on a road-by-road basis. Emissions from minor roads were adjusted by the same rate as the change in major road emissions on a cell-by-cell basis.

10.1.2 National Net-Zero Policy

The Likely Conservative Approach (LCA) taken from BEIS 2021 Net Zero Strategy[13] is a measure of the anticipated reduction in national CO_2 by sector. Reduction in national CO_2 were assumed to apply equally to NO_x and PM. The results by SNAP sector and LCA sector are shown in Table 10.3.

As this is a national scenario, these adjustments were made to all grid cells, including those outside of Oxfordshire.

Table 10.3: Each NAEI Snap Sector and the emissions adjustment for National LCA scenario

SNAP Sector	LCA Sector	Pollutants	NO_x / PM adjustment from base case
SNAP01	Power	All	0.52
SNAP02	Heat and Buildings	All	0.47
SNAP03	Industry	All	0.36
SNAP04	Industry	All	0.36
SNAP06	Industry	All	0.36
SNAP07	Domestic Transport	All	0.38
SNAP08	Domestic Transport	All	0.38
SNAP09	Waste and F-gases	All	0.65
SNAP10	Agriculture and LULUCF	All	0.65
N/A	Fuel supply and Hydrogen	N/A	N/A
N/A	International Aviation and Shipping	N/A	N/A

[13] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1066450/nzs-charts-tables-v1.1.xlsx

10.2 Phase 2 Scenarios

Eight emissions scenarios were evaluated to represent various proposed policies and their potential impact on air quality. Although eight Phase 2 scenarios were run, two of these were run for other organisations, so are not included in this report. The adjusted model set-up for each policy scenario, alongside a description of the policy, is described in Section 10.2.1 to Section 10.2.6.

10.2.1 Electrification of Bus Fleets

To work towards Net-Zero, Oxfordshire aims for intracity routes within Banbury, Bicester, Didcot, Witney and Oxford to be serviced by an all-electric bus fleet by 2035. This scenario will particularly impact exhaust emissions within major towns.

The future baseline scenario accounts for electrification of the bus fleet in Oxford, but bus fleet data for Banbury, Bicester, Didcot and Witney was updated. All other aspects of the model set-up and emissions were taken from the future baseline scenario.

The road links with electrified bus fleet in this scenario, including Oxford, are shown in Figure 10.1.

10.2.2 Local Transport and Connectivity Plan

Oxfordshire's Local Transport and Connectivity Plan (LTCP) includes pathways to decarbonise transport infrastructure. One of the targets is to remove or replace 1 out of 4 car journeys from the roads by 2030.

This scenario was modelled by reducing car traffic flows in the traffic model uniformly by 25% under the basic assumption that no further reduction in car trips would be seen between 2030 and 2035. Emissions from minor road sources were also reduced based on the reductions in major road emissions for NO_x, PM_{10}, and $PM_{2.5}$ and reaggregated into the grid. All other aspects of the model set-up and emissions were taken from the future baseline scenario.

10.2.3 Agricultural emission reduction

The Science Based Targets initiative (SBTi)[14] set targets to reduce forestry, land use and agriculture emissions by at least 72% by no later than 2050. For this scenario it was assumed that the target is achieved by 2035. Resultant emission reductions will particularly impact concentrations at rural locations.

[14] https://sciencebasedtargets.org/sectors/forest-land-and-agriculture

This scenario was modelled by decreasing the emissions from land and agriculture by 72%. The reduction was applied uniformly to all pollutants as no explicit reduction method was tested. Land and agriculture emissions were then reaggregated into the grid. The SBTi target was only assumed to be reached by Oxfordshire, so background concentrations and gridded emissions outside the county were not adjusted. All other aspects of the model set-up and emissions were taken from the future baseline scenario.

Figure 10.2 shows the reduction in non-road $PM_{2.5}$ emissions reductions due to these changes.

10.2.4 Electrification of the railways

This scenario models the planned electrification of existing railways lines and accounts for national targets to increase rail freight by 75%.

Rail emissions were modelled on a 1-km resolution grid to be consistent with the future baseline scenario. An assumption was used that all passenger and freight locomotives will be electric by 2035. Electrification of the railway lines will be expected to extend outside of Oxfordshire, so gridded emissions outside the county were also adjusted.

The 75% increase in rail freight was modelled by removing an equal volume of HGV traffic from the road network. In 2023, 16,950 Megaton kilometres of freight was moved by rail[15]. In comparison, 166,720 Megaton kilometres of freight was moved by road[16]. A 75% in rail freight would be equilibrated by a 7.6% reduction in HGV traffic. To model this, a uniform reduction of 7.6% to the HGV fleet was uniformly applied across the road network. All other aspects of model set-up and emissions were taken from the future baseline scenario.

The change in non-road $PM_{2.5}$ emissions due to the reduction in rail emissions is shown in Figure 10.3; this does not include changes in emissions due to reductions in HGV flows.

10.2.5 Industrial emissions climate scenario

The UK government has set a legally binding net zero target by 2050 and new interim targets to reduce emissions by 78% by 2035.

To model this scenario, emissions from all point sources, and industrial emissions in the aggregated grid, were reduced by 78%. The commitment to this target was assumed to be reached by Oxfordshire only, so background concentrations and gridded emissions from outside the county were unadjusted. All other aspects of the model set-up and emissions were taken from the future baseline scenario. The reductions in non-road $PM_{2.5}$ emissions due to this scenario are shown in Figure 10.4.

[15] https://dataportal.orr.gov.uk/statistics/usage/freight-rail-usage-and-performance/table-1310-freight-moved-by-commodity/

[16] https://www.gov.uk/government/statistical-data-sets/rfs01-goods-lifted-and-distance-hauled#domestic-road-freight-by-commodity

10.2.6 Removal of domestic wood combustion

Oxfordshire are investigating the possible benefits of extending the smoke control area (SCA) to a countywide measure. Wood burning used for domestic uses will be phased out by 2035 under these measures and replaced with clean alternatives.

This scenario was modelled by removing emissions sourced from domestic wood combustion from the gridded emissions. Clean alternatives are expected to replace domestic wood combustion. All other aspects of the model set-up and emissions were taken from the future baseline scenario.

The reductions in non-road $PM_{2.5}$ emissions from domestic sources due to this scenario are shown in Figure 10.5.

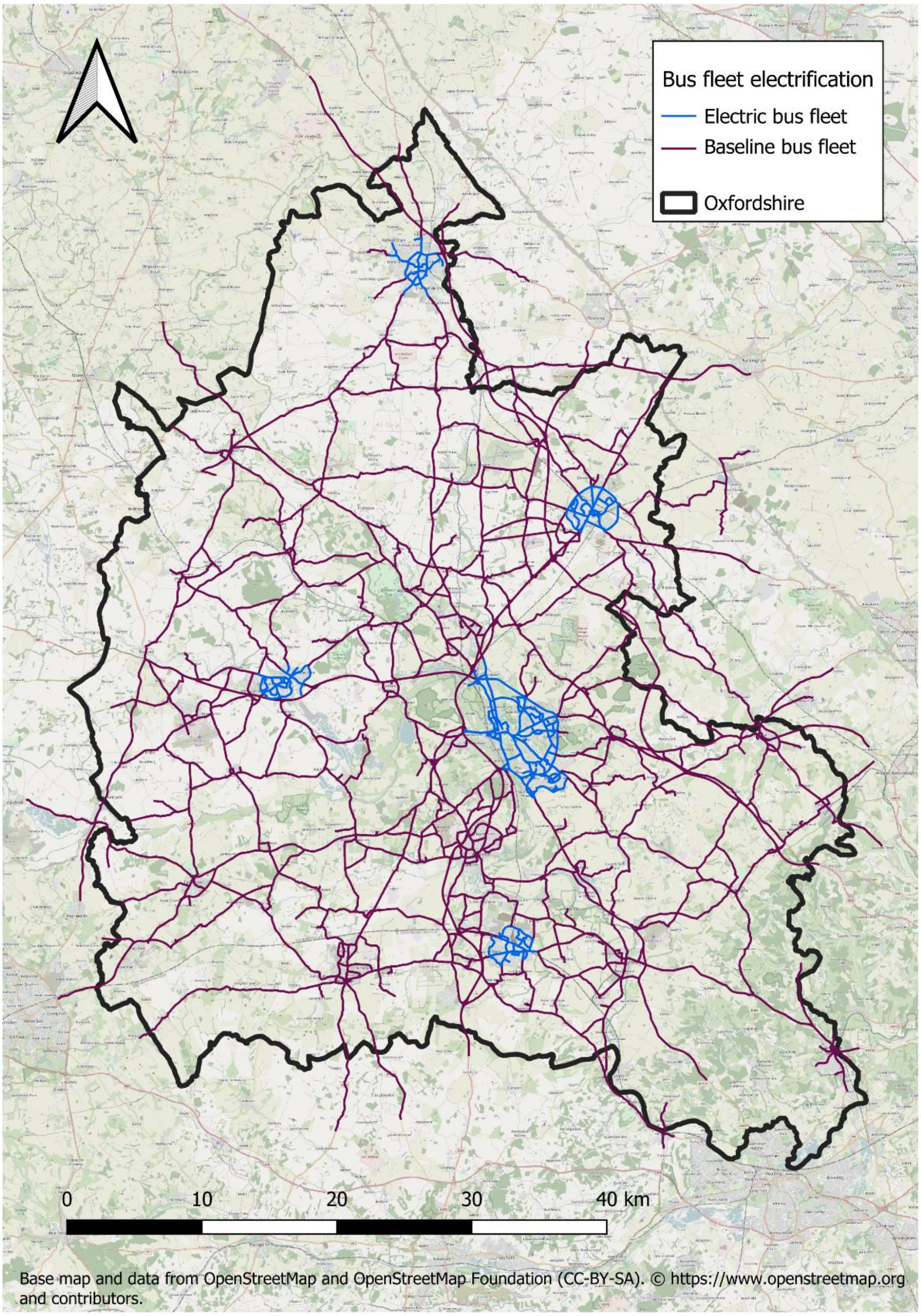

Figure 10.1: Roads links with electrified bus fleet for bus electrification scenario, 2035

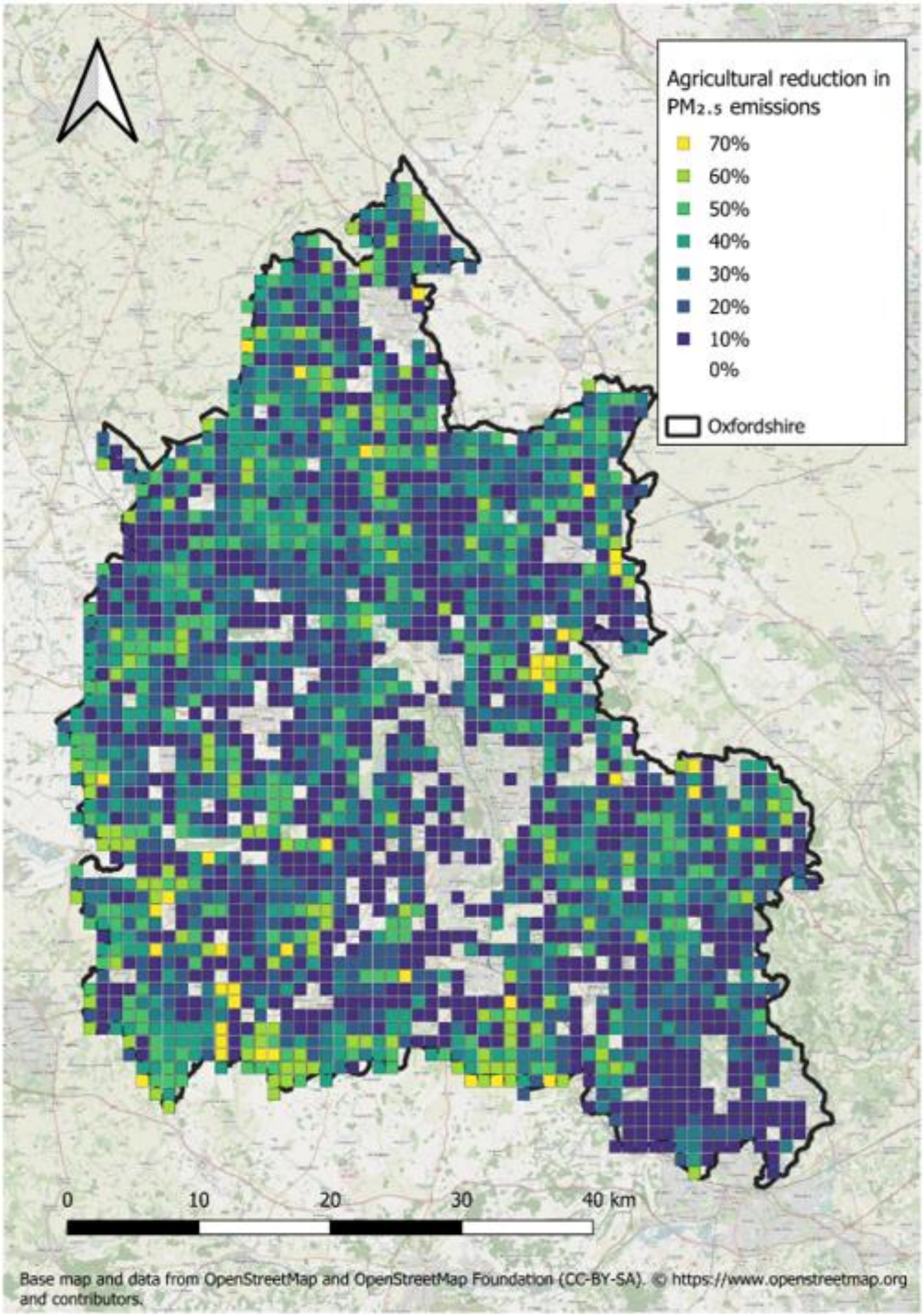

Figure 10.2: Reduction in non-road $PM_{2.5}$ emissions across Oxfordshire due to agricultural scenario

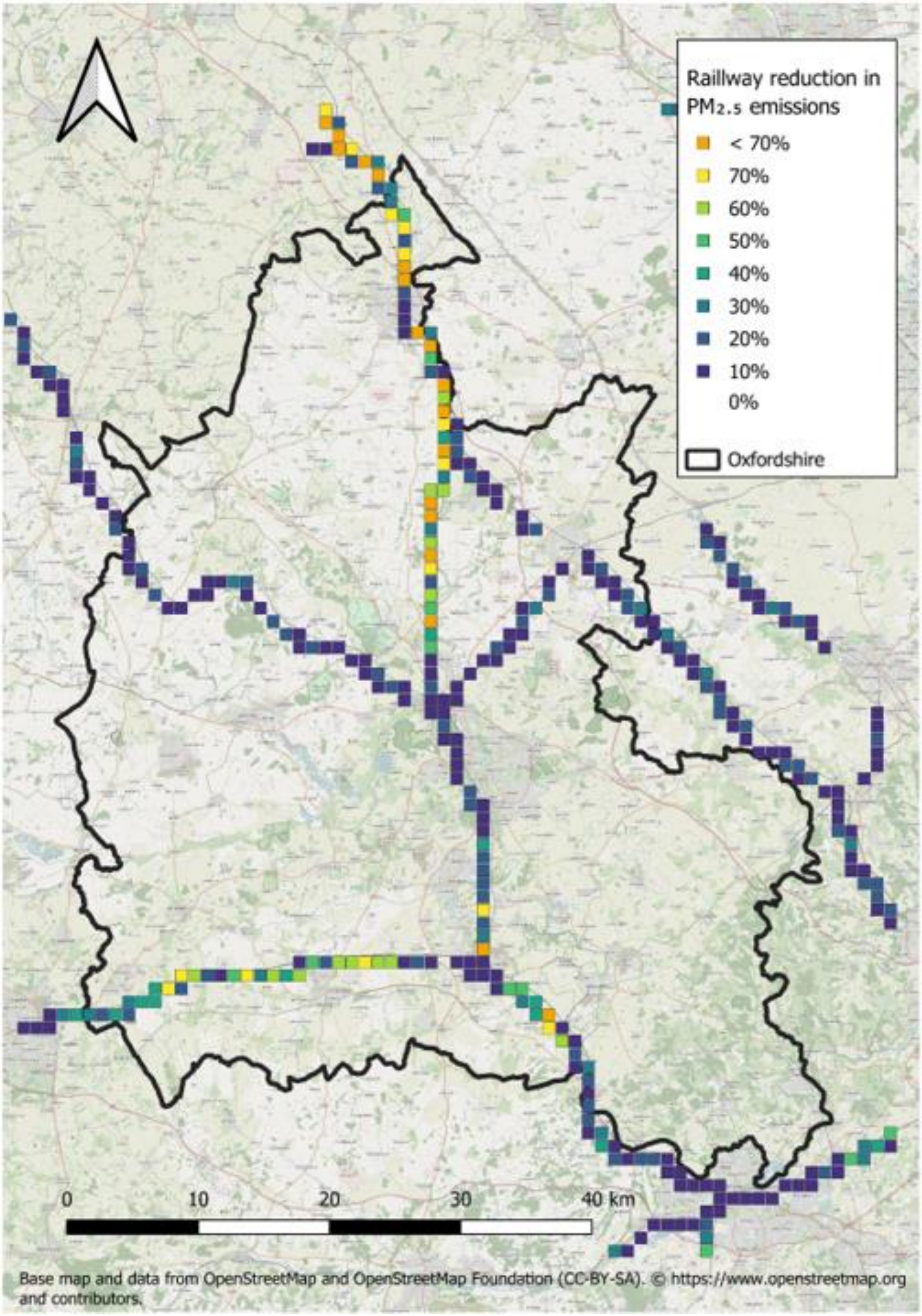

Figure 10.3: Reduction in non-road $PM_{2.5}$ emissions across Oxfordshire and surrounding model extent due to rail electrification scenario

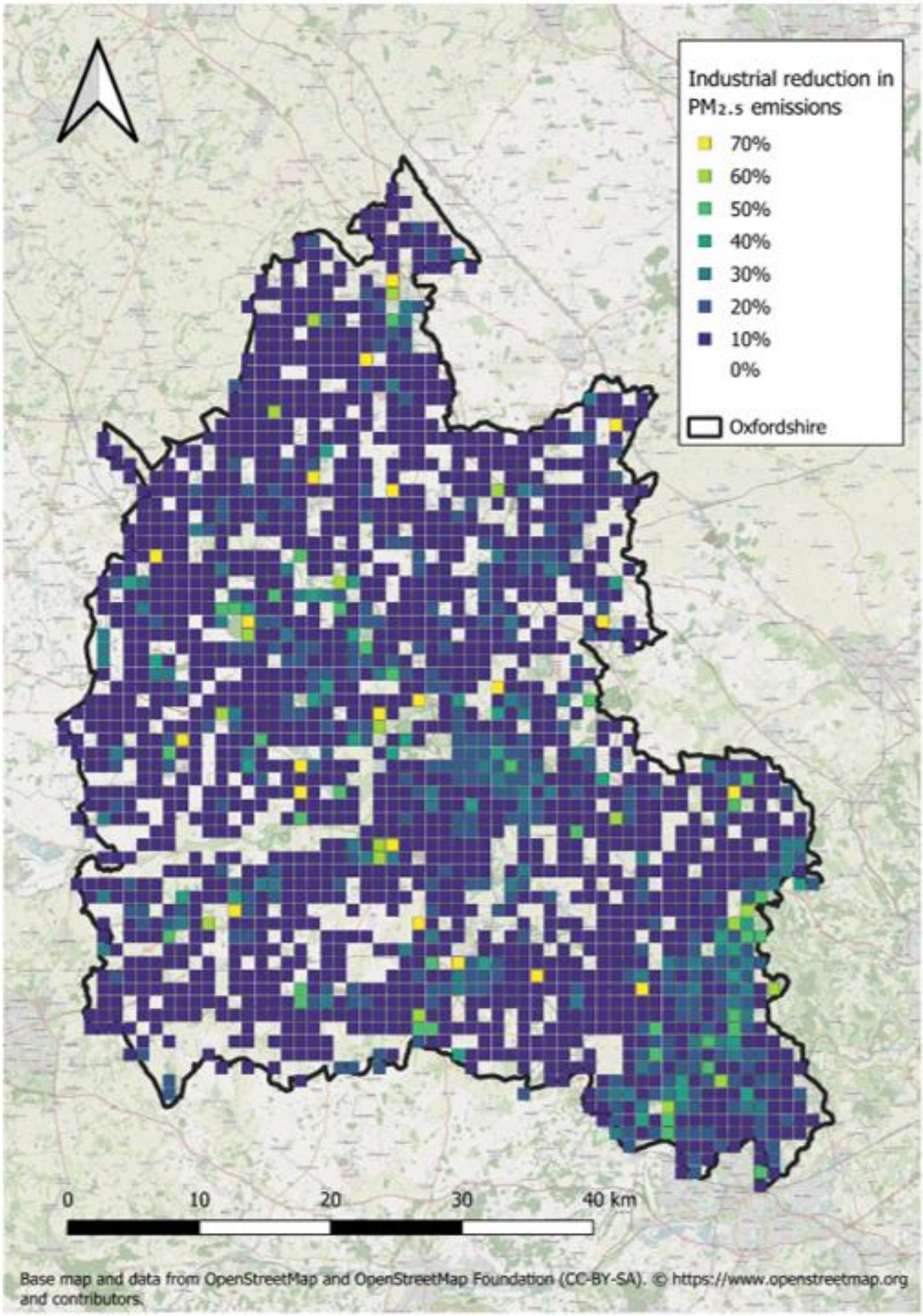

Figure 10.4: Reduction in non-road $PM_{2.5}$ emissions across Oxfordshire to the industrial emission reduction scenario

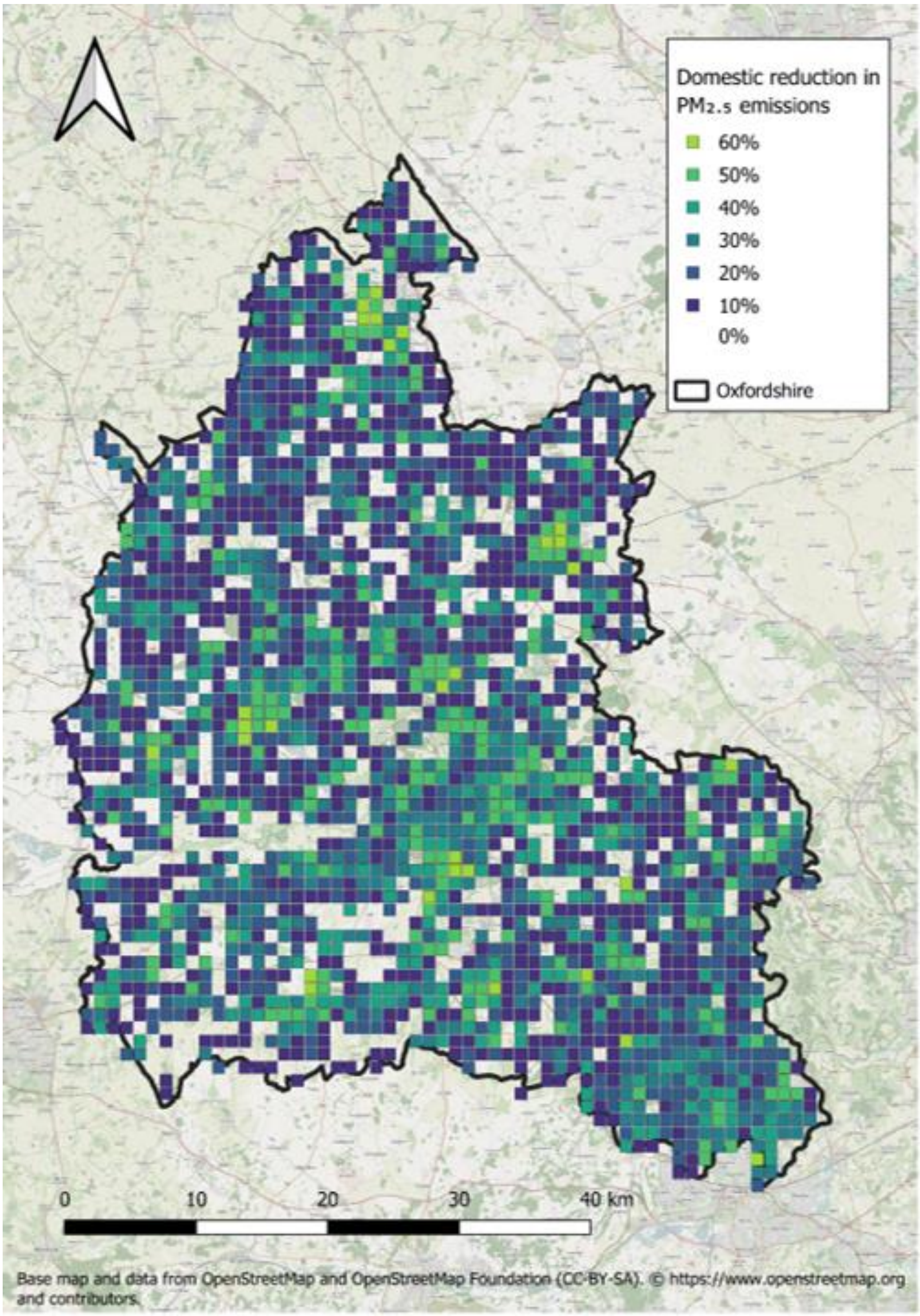

Figure 10.5: Reduction in non-road $PM_{2.5}$ emissions across Oxfordshire due to a no domestic wood combustion scenario

11 Modelled concentrations

This section shows contour maps of total annual average NO_2 and $PM_{2.5}$ concentrations for input into the AQ-LAT. Concentrations were calculated on a regular grid of receptors on a 50 m resolution and on a dense network of roadside, kerbside and building façade points where the concentration gradient is steepest. The modelled concentrations were interpolated onto a 5-metre resolution grid.

Figure 11.1 to Figure 11.3 shows annual average NO_2, $PM_{2.5}$, and PM_{10} concentrations across Oxfordshire for the 2035 baseline. These plots show significant reductions in concentrations in urban areas compared to 2023, particularly in NO_2.

Results were then aggregated by middle super output area (MSOA) in order to output average concentrations of NO_2 and $PM_{2.5}$ for each MSOA for each future year scenario.

Maps of the MSOA-average AQ-LAT input values are summarised below:

- Figure 11.4 to Figure 11.5 display results for the baseline 'Do Minimum' scenario.
- Figure 11.6 to Figure 11.9 display results for Phase 1 scenarios.
- Figure 11.10 to Figure 11.21 display results for Phase 2 scenarios.

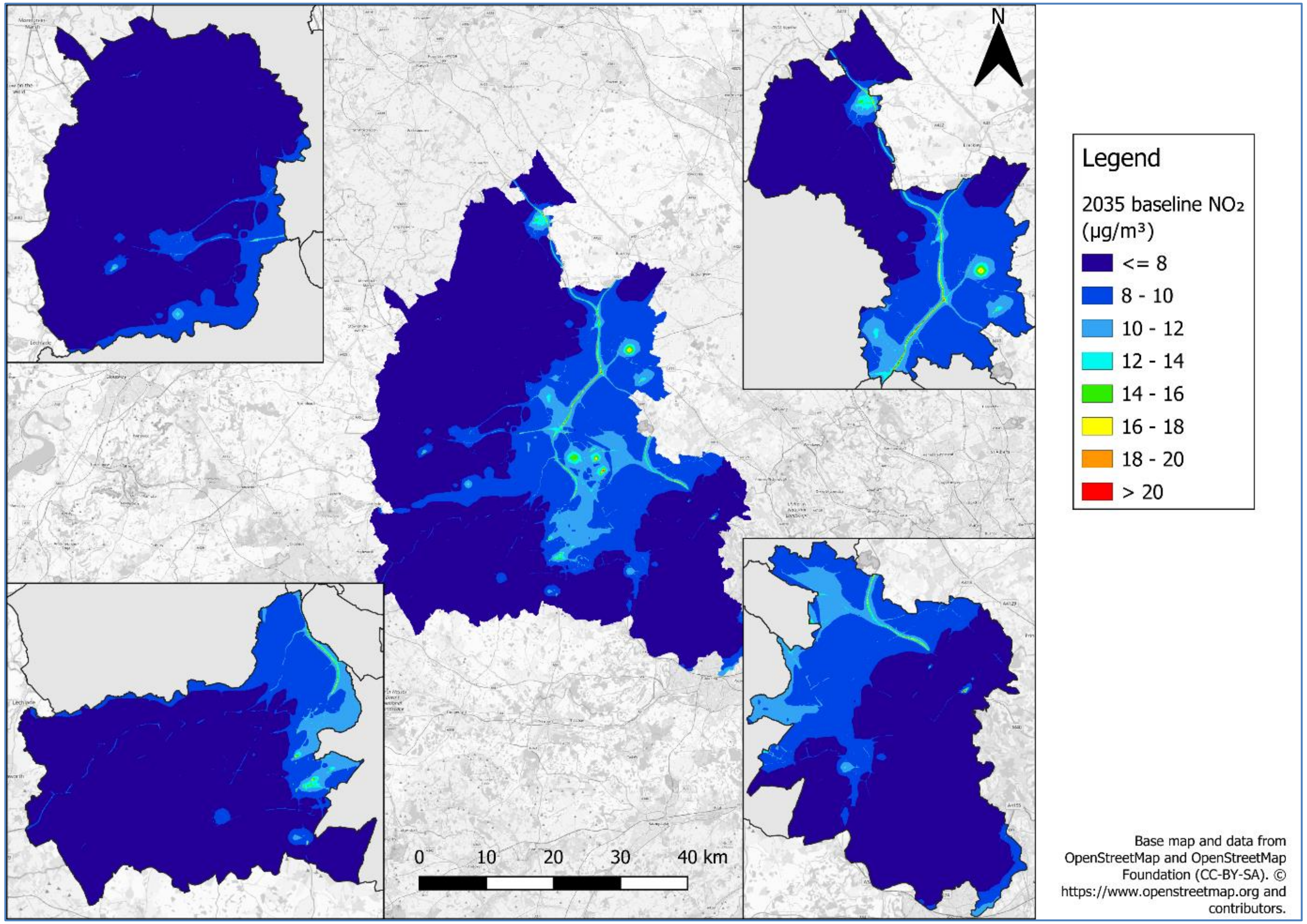

Figure 11.1: Annual average NO_2 across Oxfordshire for the 2035 baseline model: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

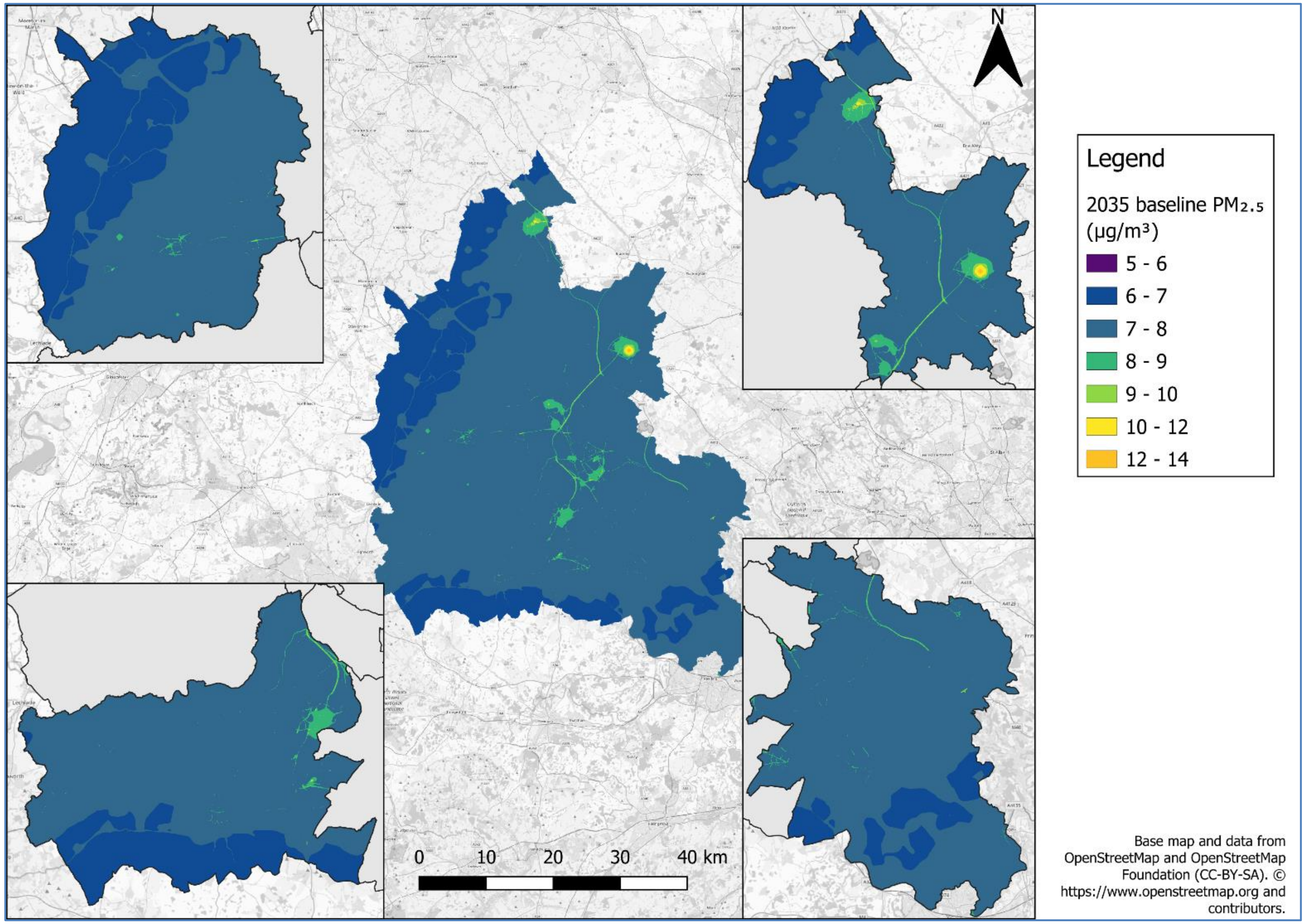

Figure 11.2: Annual average $PM_{2.5}$ across Oxfordshire for the 2035 baseline model: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

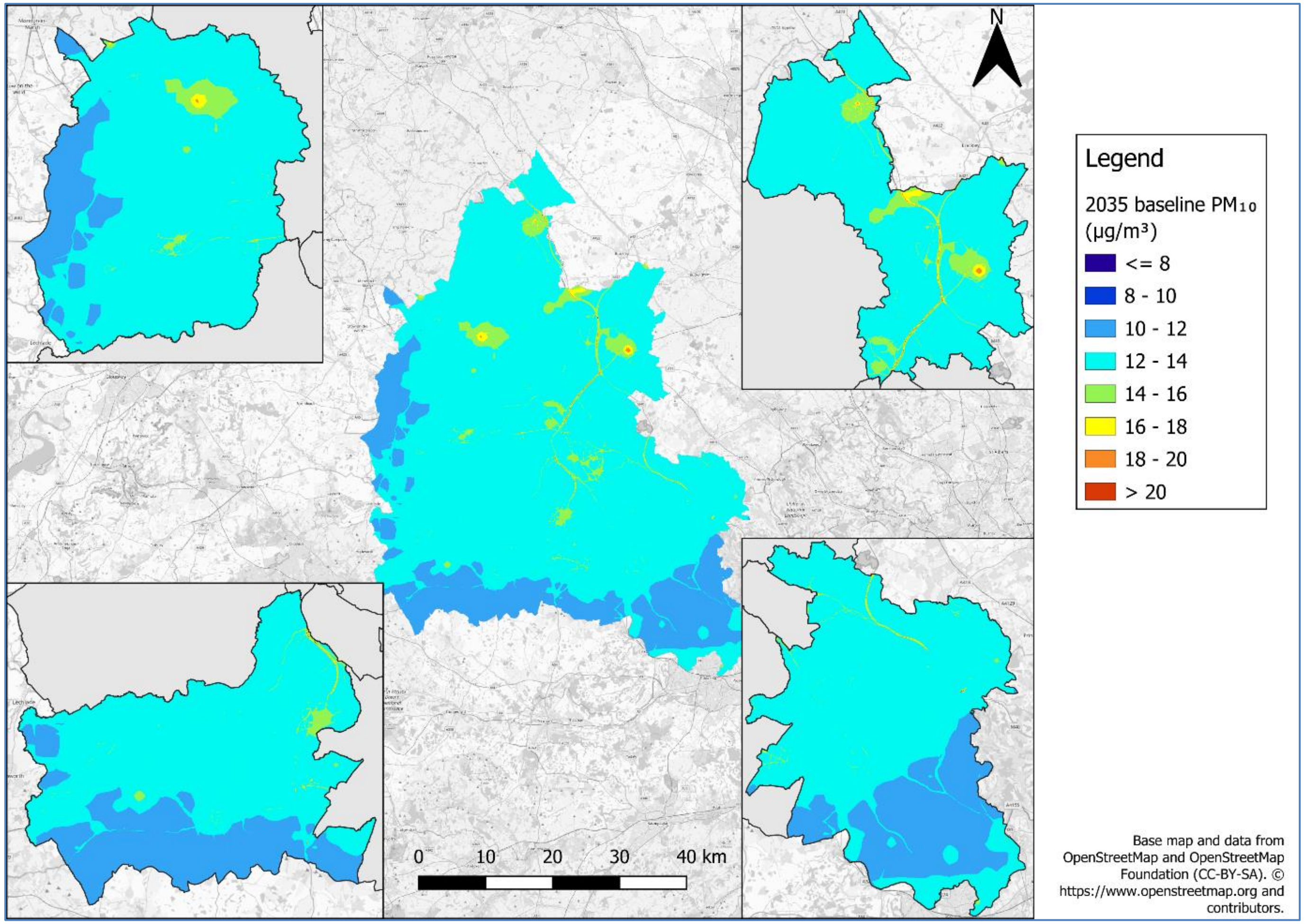

Figure 11.3: Annual Average PM_{10} across Oxfordshire for the 2035 baseline model: West Oxfordshire (top left), Cherwell (top right), Vale of White Horse (bottom left), South Oxfordshire (bottom right)

11.1 Future Baseline maps of AQ-LAT input

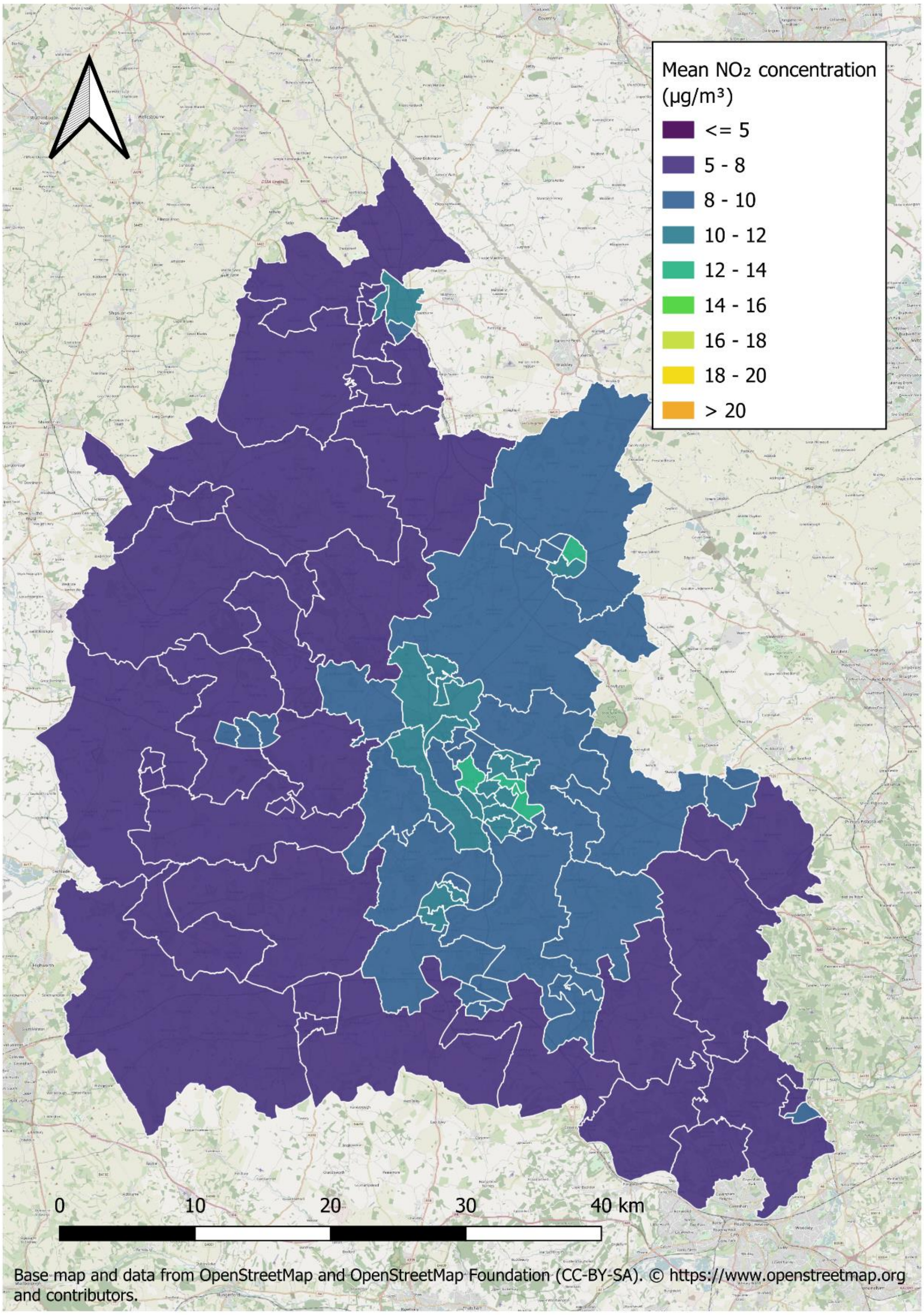

Figure 11.4: 2035 future baseline, MSOA-average NO_2 concentrations

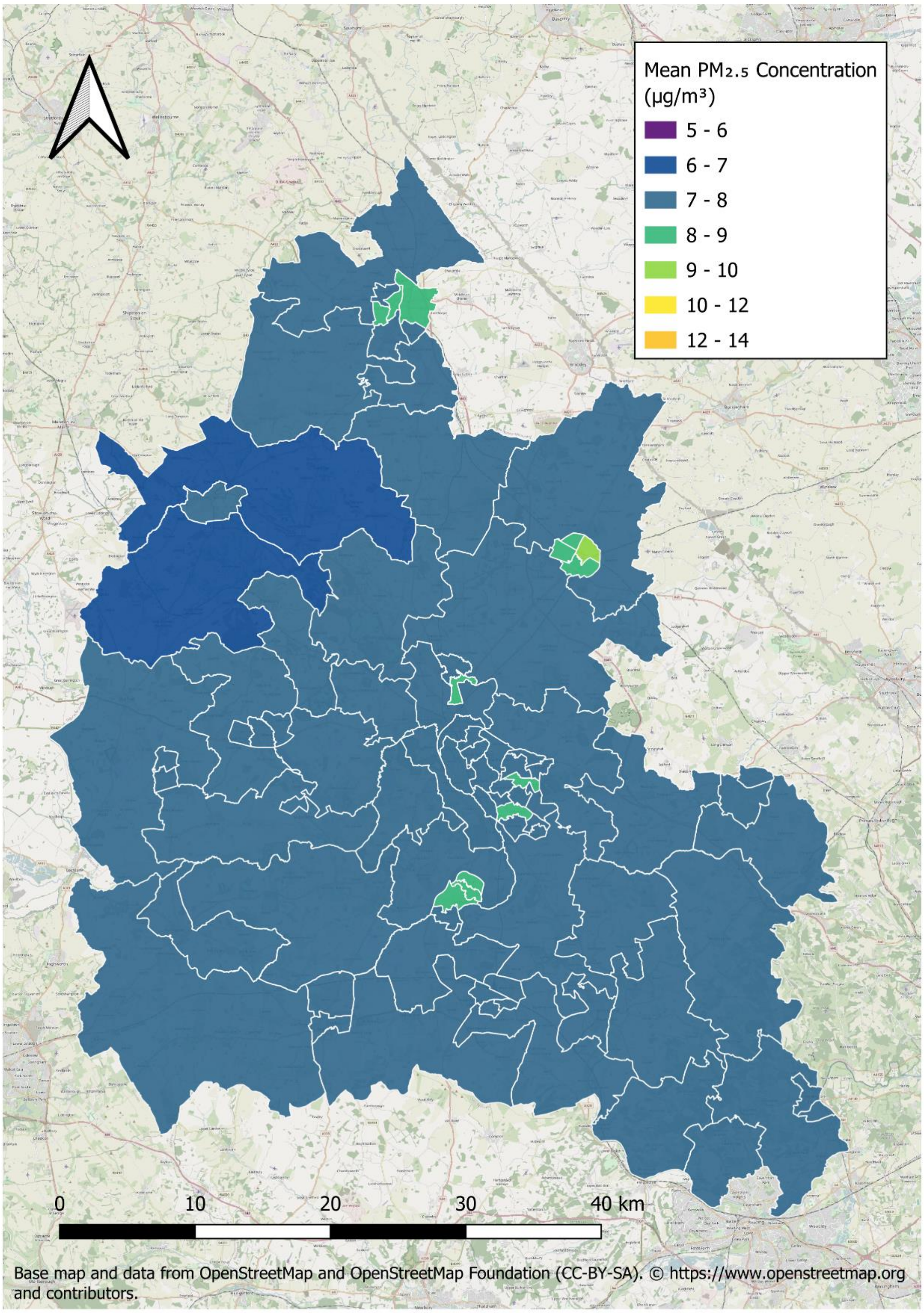

Figure 11.5: 2035 future baseline, MSOA-average $PM_{2.5}$ concentrations

11.2 Phase 1 scenario maps of AQ-LAT input

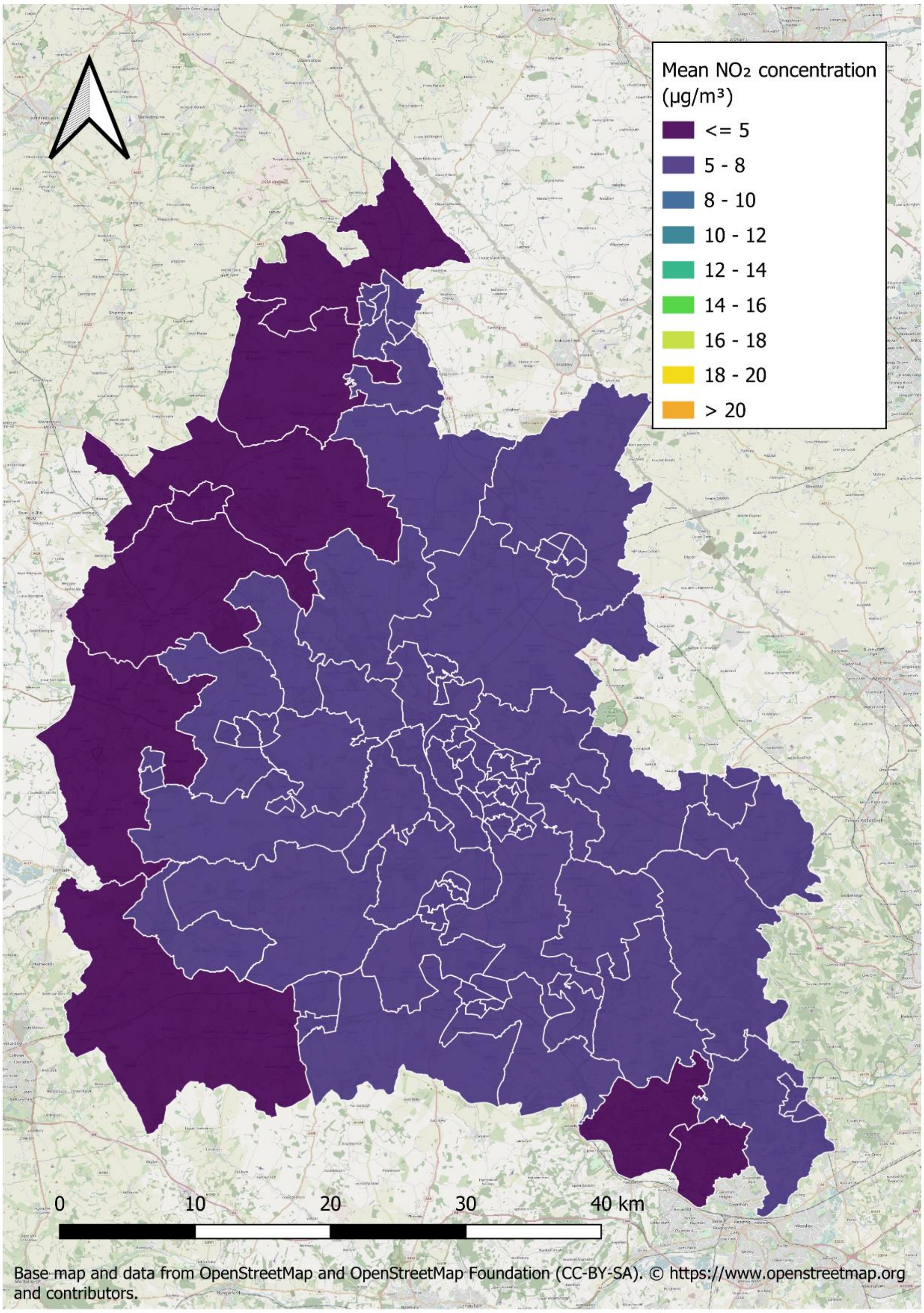

Figure 11.6: National net zero policy scenario, MSOA-average NO_2 concentrations

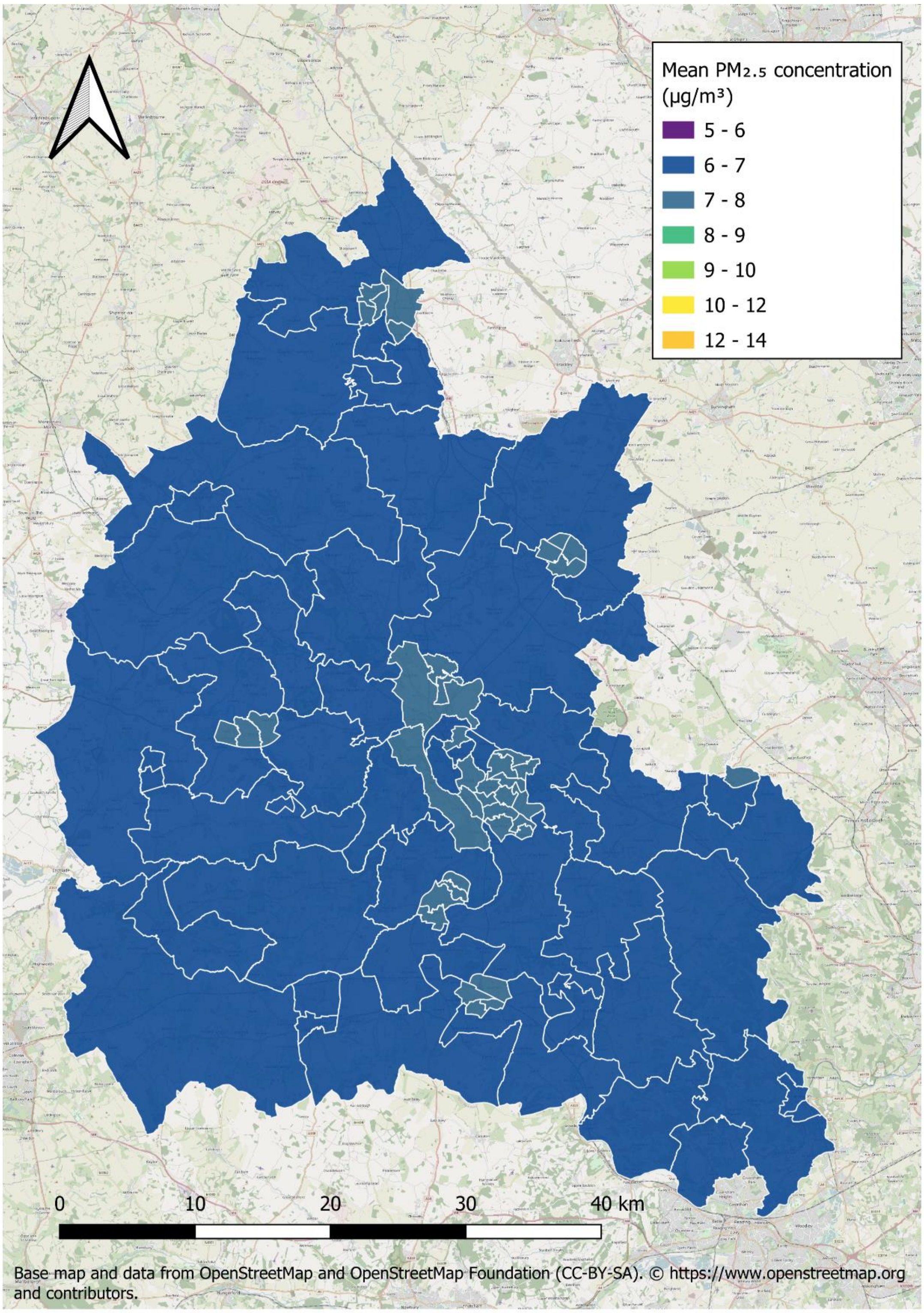

Figure 11.7: National net zero policy scenario, MSOA-average $PM_{2.5}$ concentrations

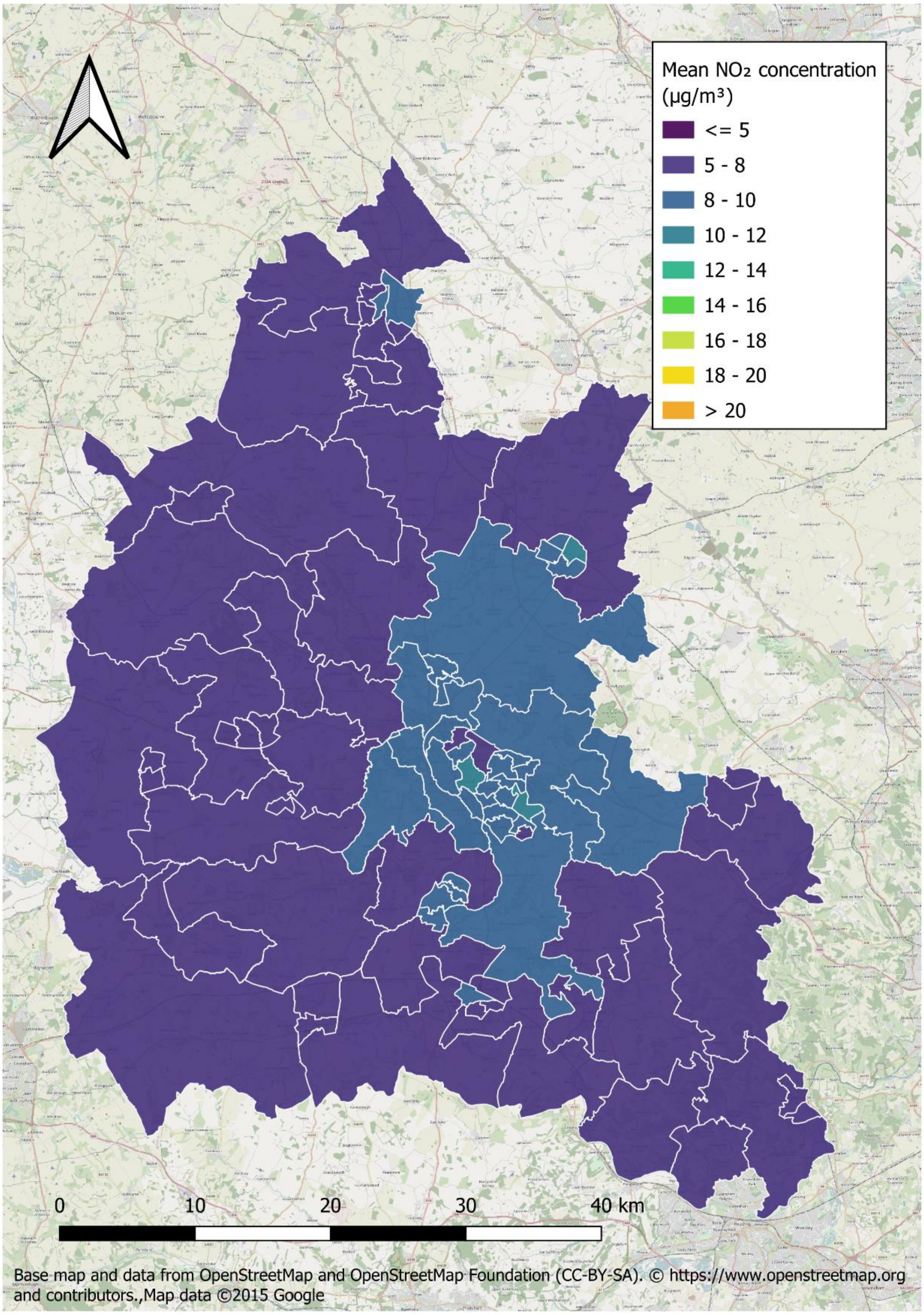

Figure 11.8: Oxfordshire Leading the Way policy scenario, MSOA-average NO_2 concentrations

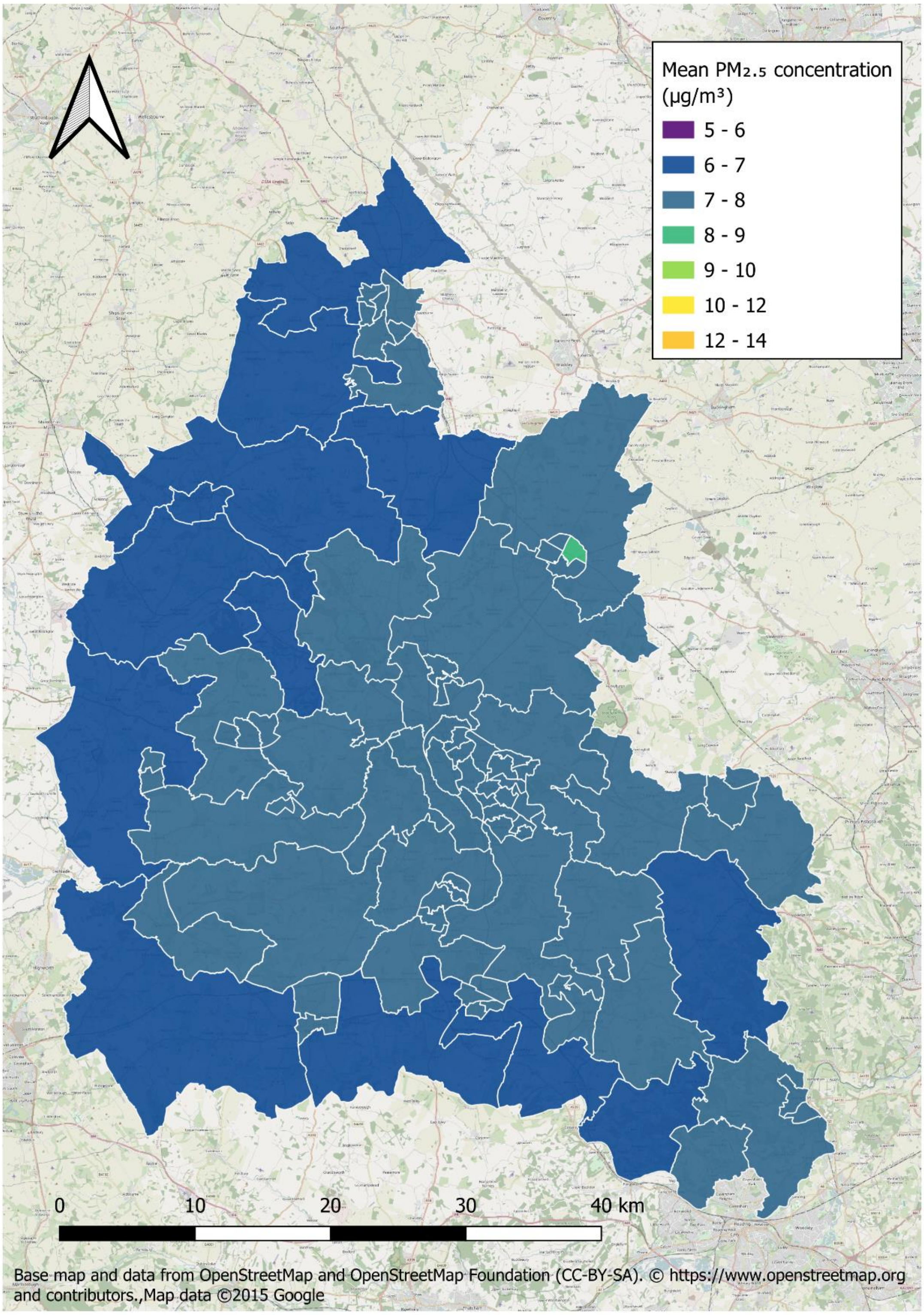

Figure 11.9: Oxfordshire Leading the Way policy scenario, MSOA-average $PM_{2.5}$ concentrations

11.3 Phase 2 scenario maps of AQ-LAT input

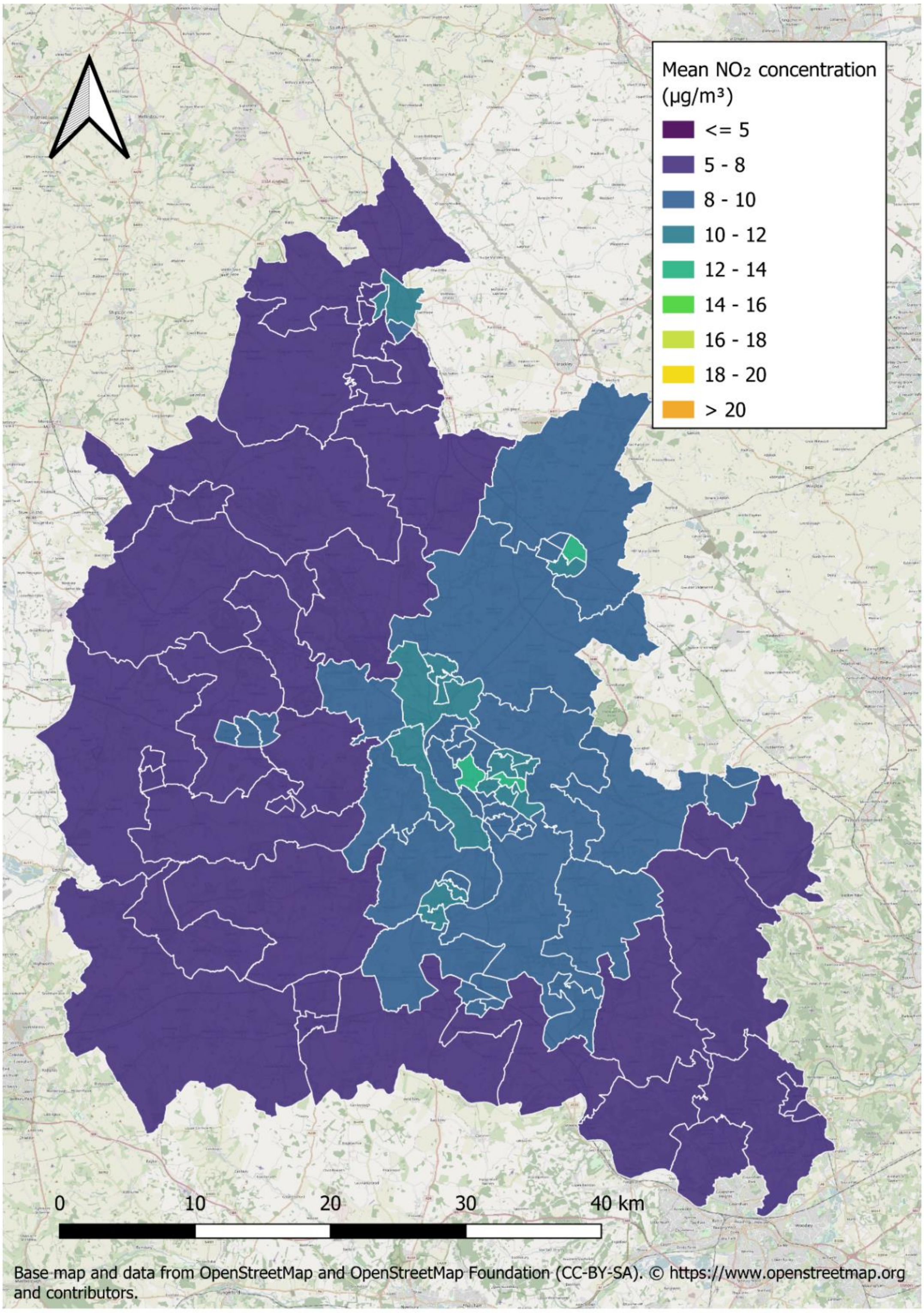

Figure 11.10: Local Transport and Connectivity Plan scenario, MSOA-average NO_2 concentrations

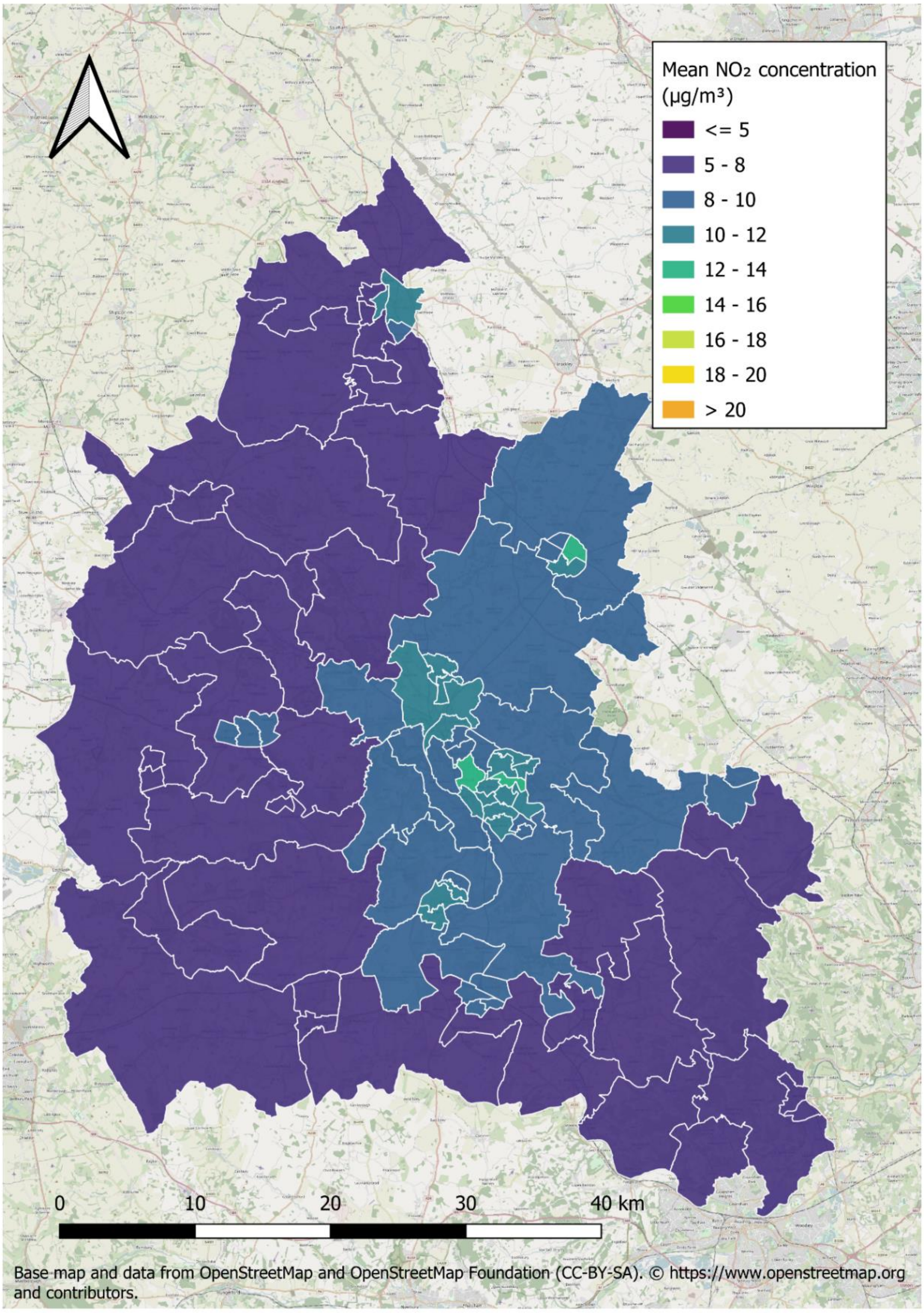

Figure 11.11: Agricultural emission reduction scenario, MSOA-average NO_2 concentrations

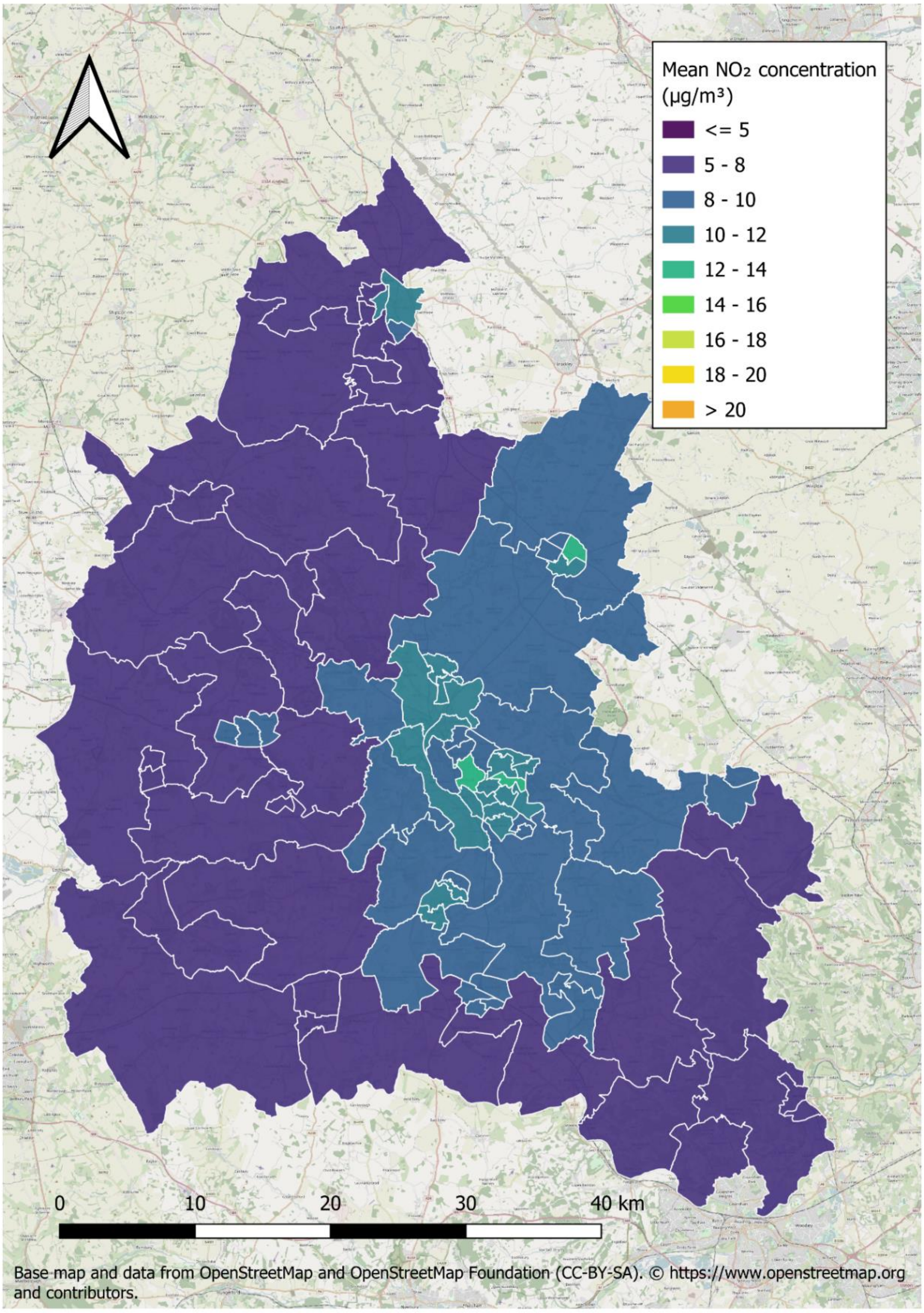

Figure 11.12: Electrification of bus fleets scenario, MSOA-average NO_2 concentrations

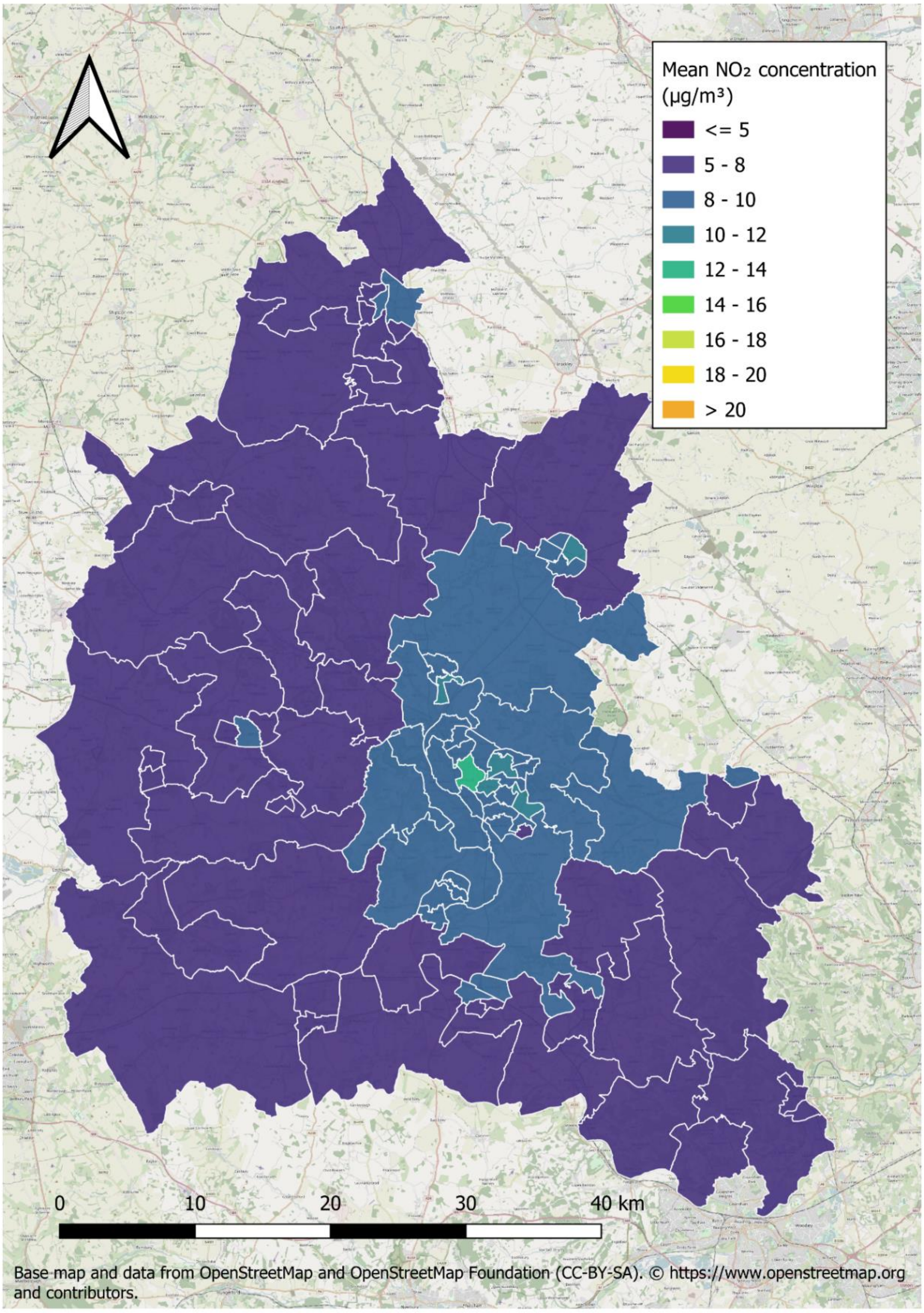

Figure 11.13: Industrial emission reduction scenario, MSOA-average NO_2 concentrations

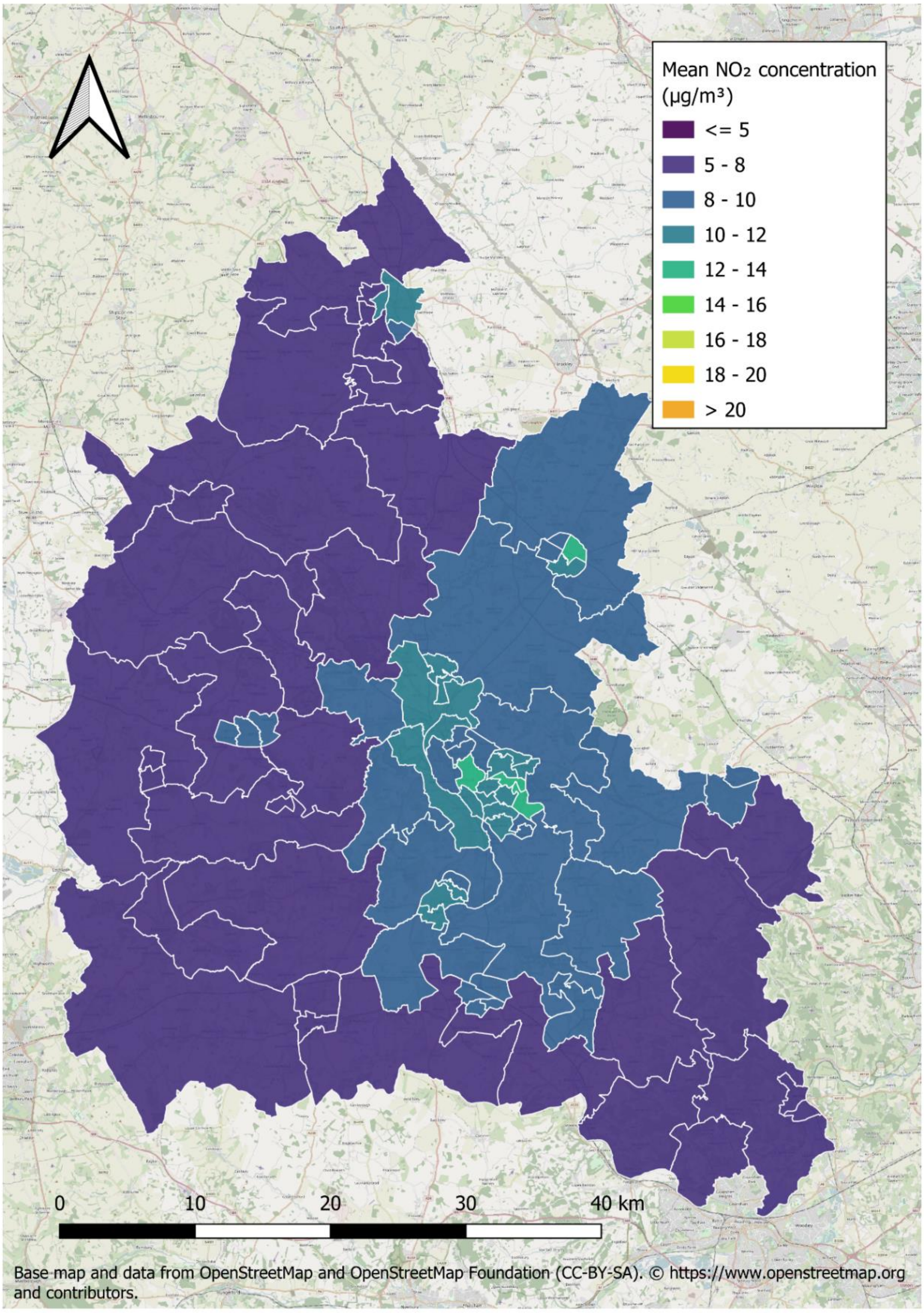

Figure 11.14: Removal of domestic wood combustion scenario, MSOA-average NO_2 concentrations

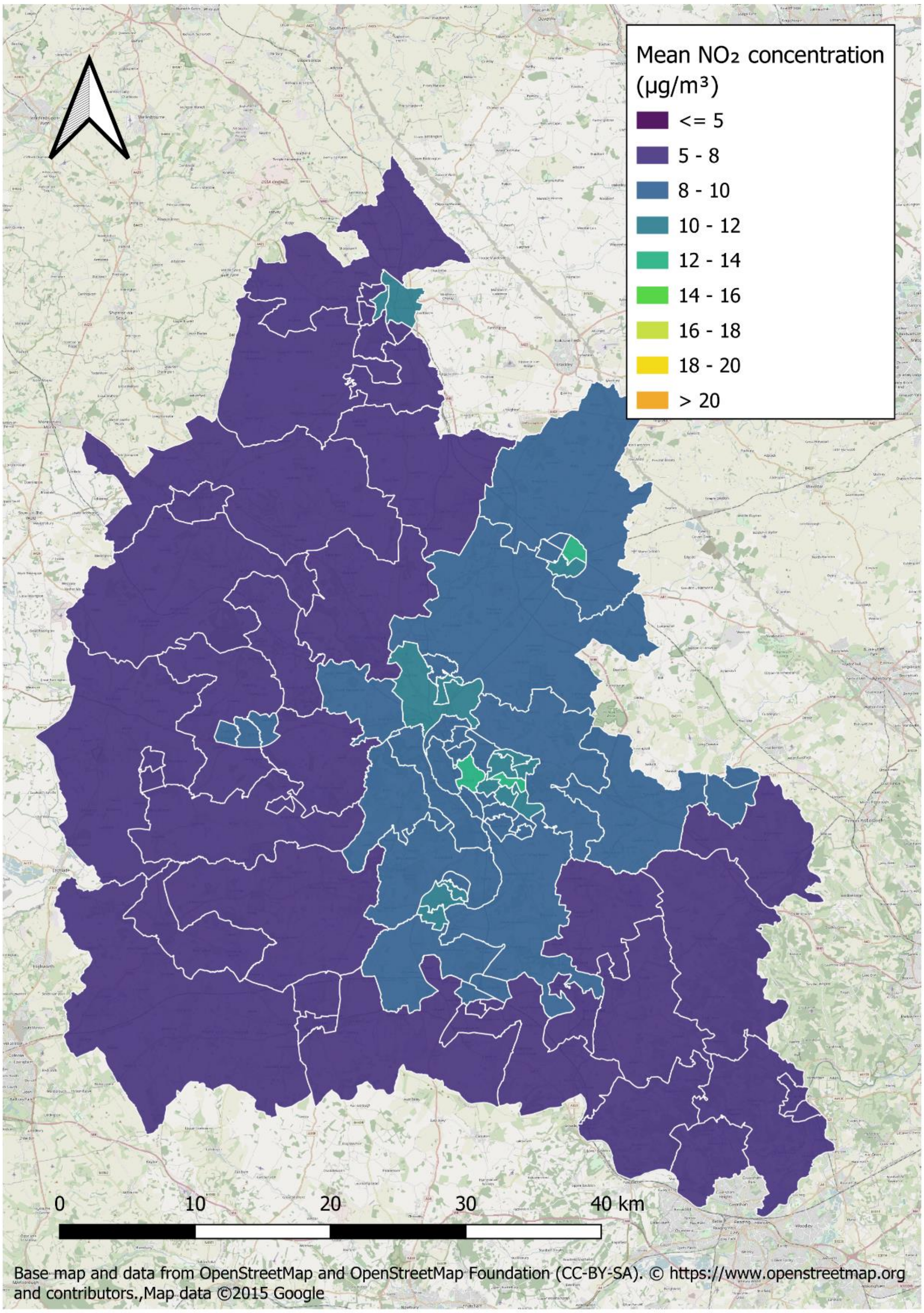

Figure 11.15: Rail electrification and increased rail freight scenario, MSOA-average NO_2 concentrations

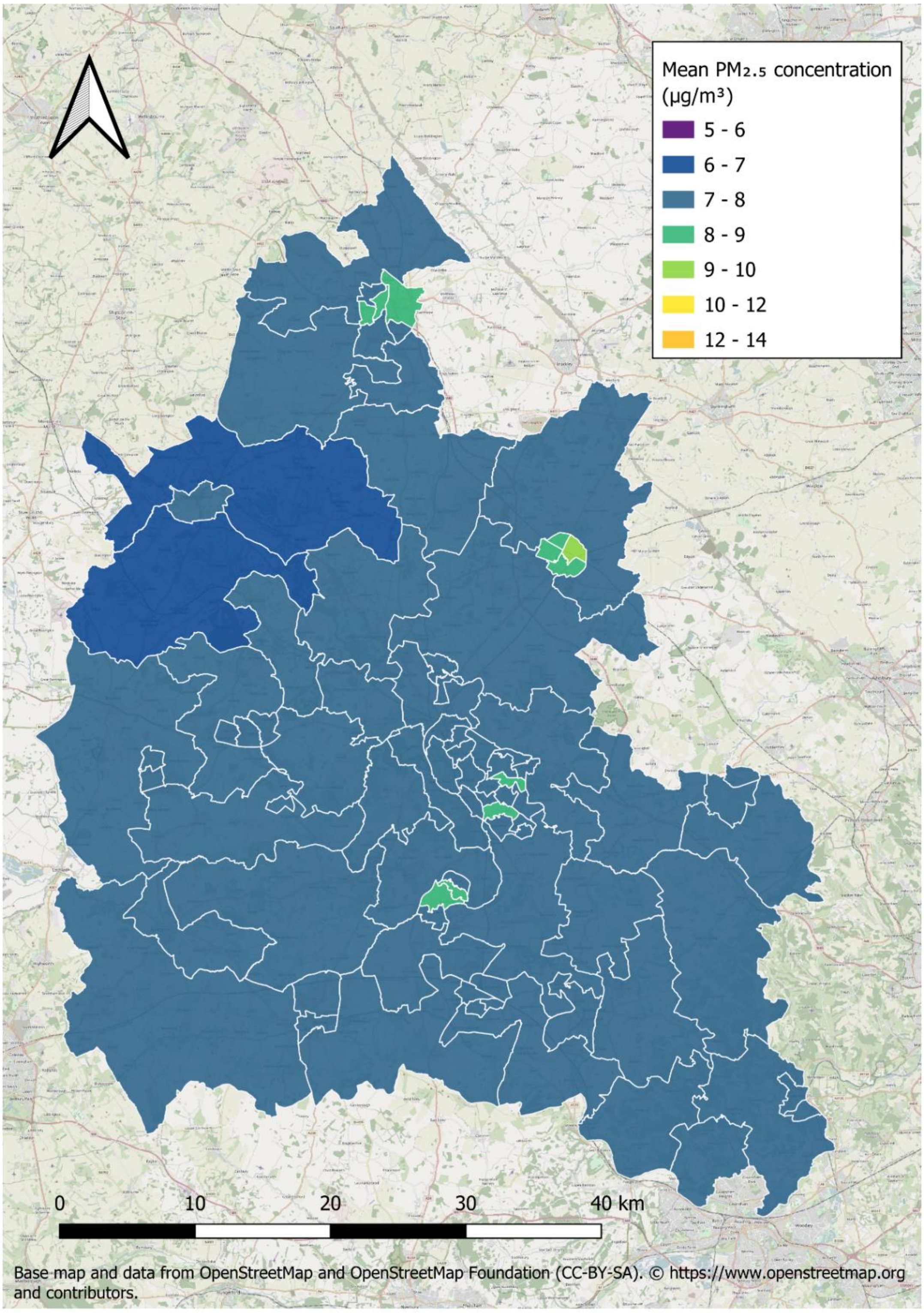

Figure 11.16: Local Transport and Connectivity Plan scenario, MSOA-average $PM_{2.5}$ concentrations

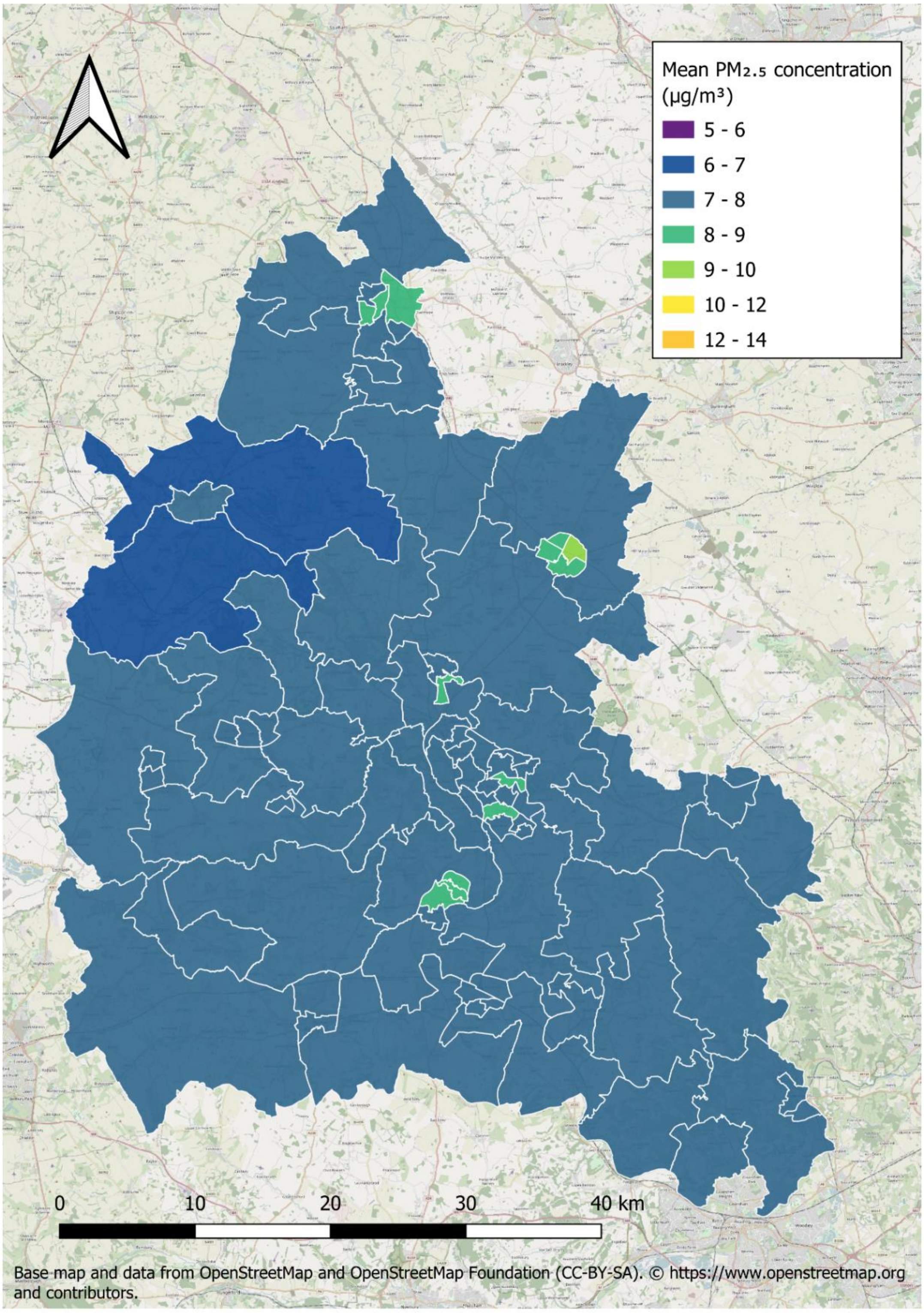

Figure 11.17: Agricultural emission reduction scenario, MSOA-average $PM_{2.5}$ concentrations

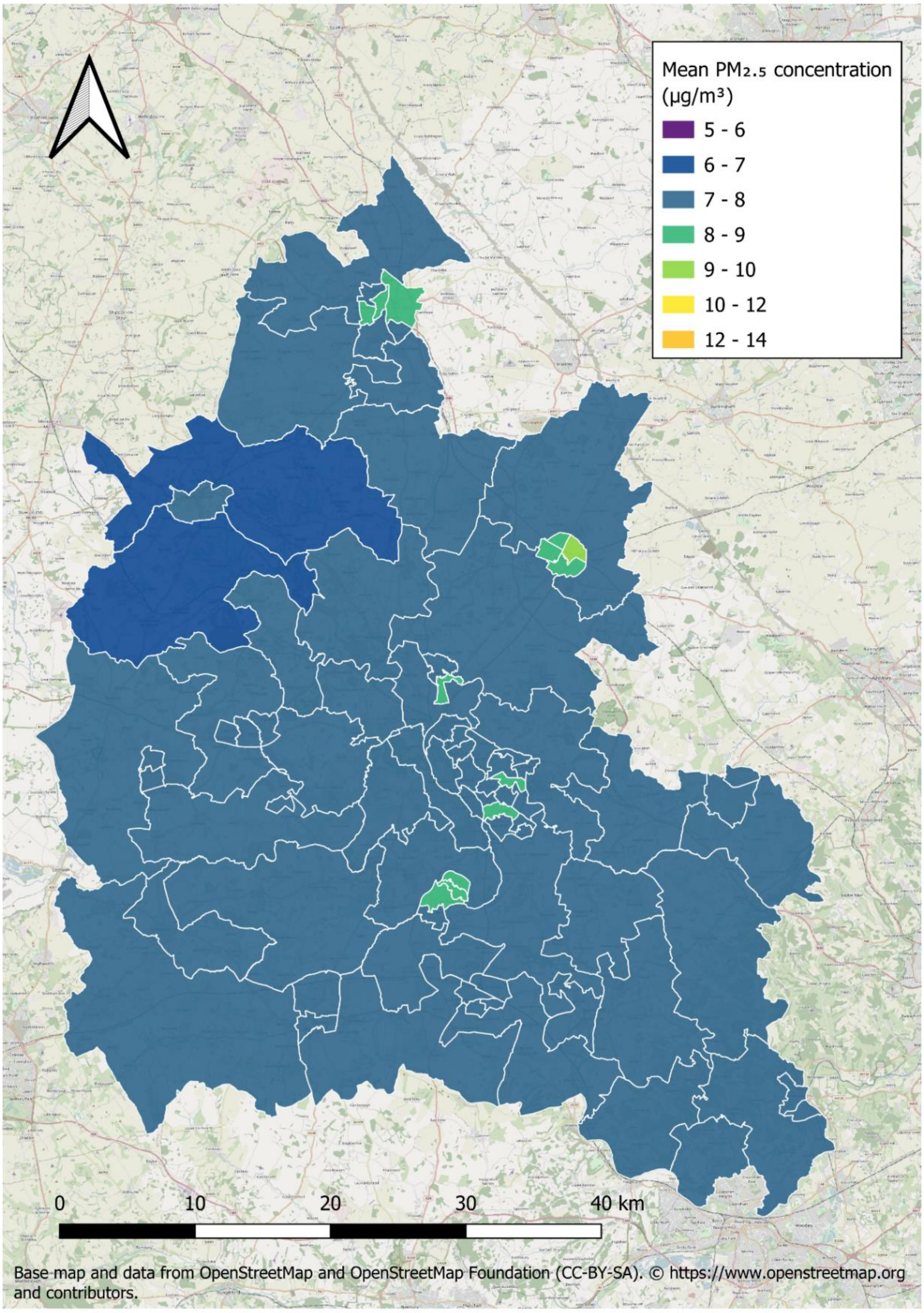

Figure 11.18: Electrification of bus fleets scenario, MSOA-average $PM_{2.5}$ concentrations

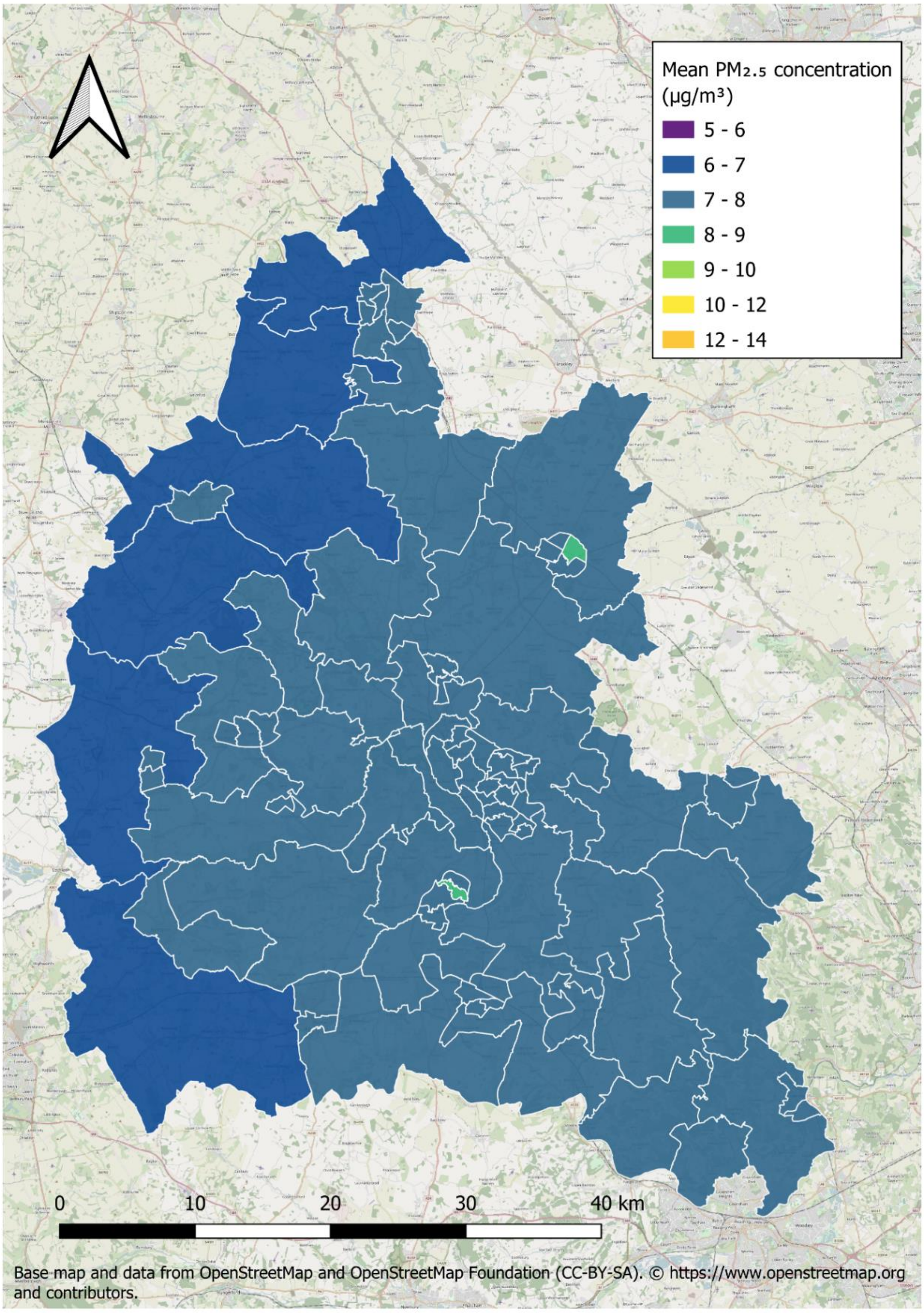

Figure 11.19: Industrial emission reduction scenario, MSOA-average $PM_{2.5}$ concentrations

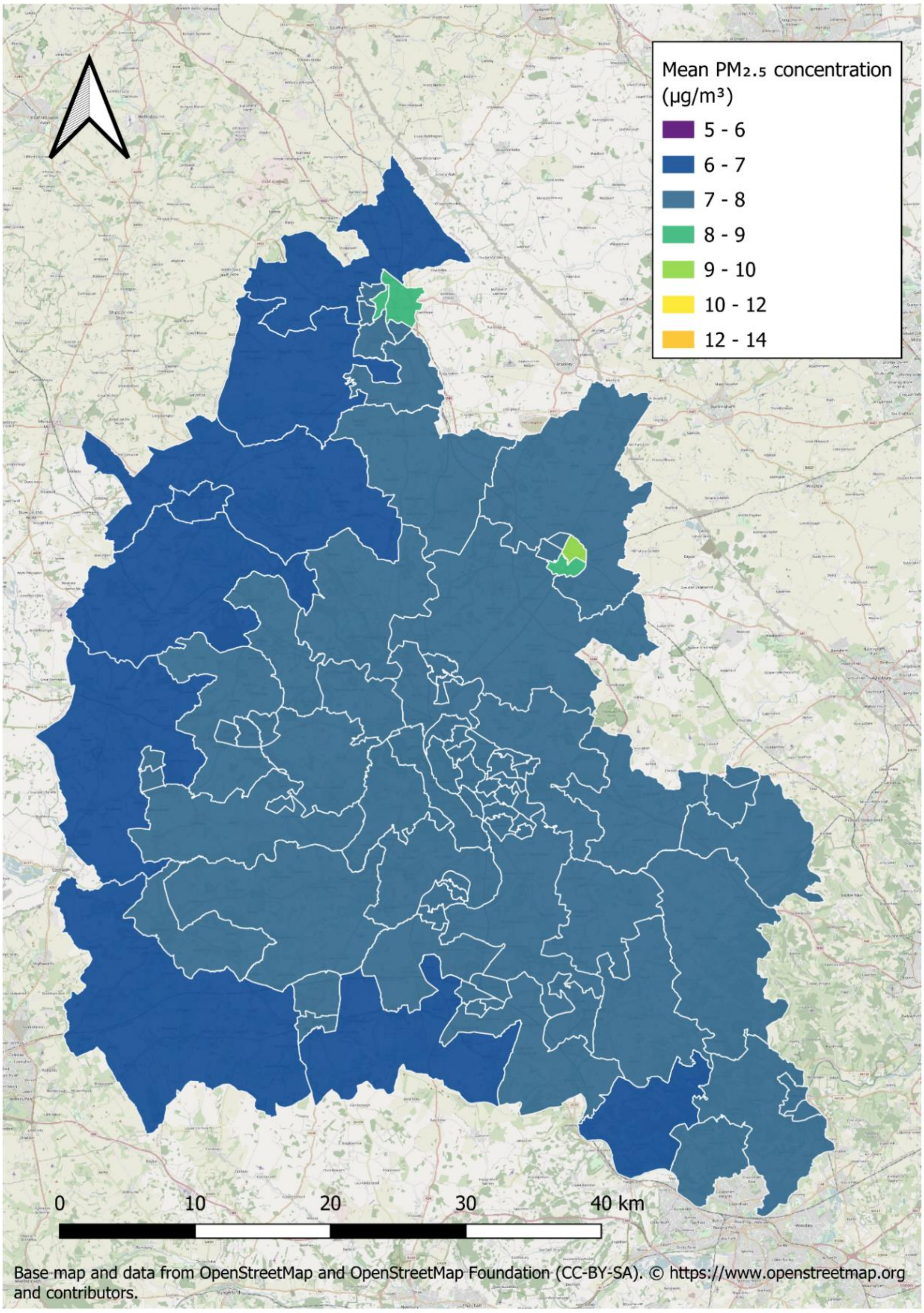

Figure 11.20: Removal of domestic wood combustion scenario, MSOA-average $PM_{2.5}$ concentrations

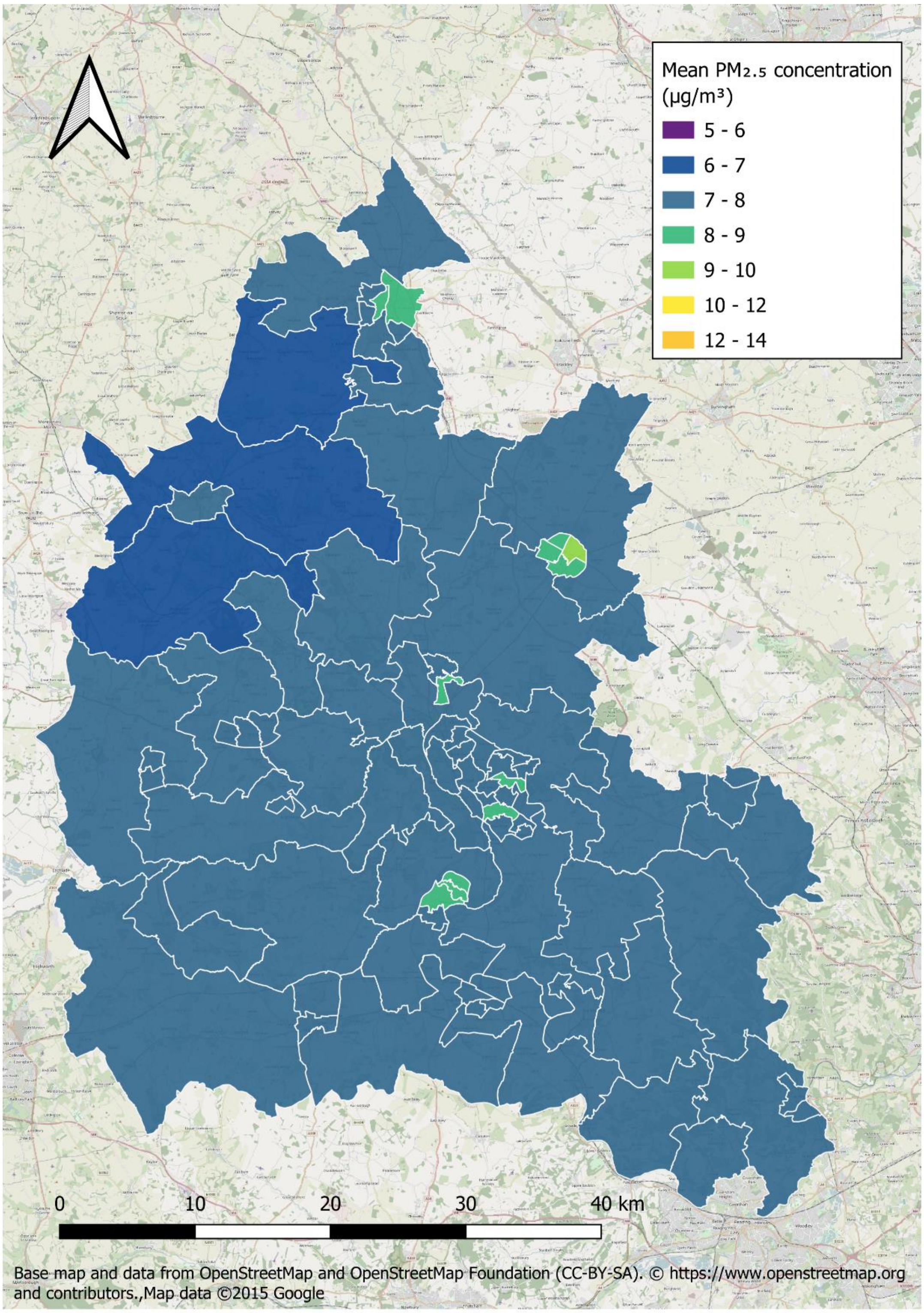

Figure 11.21: Rail electrification and increased rail freight scenario, MSOA-average $PM_{2.5}$ concentrations

12 Source Apportionment

Source apportionment was carried out to establish the contribution to total NO_x and $PM_{2.5}$ concentration at a set of roadside and urban background locations for the 2023 and 2035 baseline scenarios. The monitoring locations are summarised in Table 12.1.

Source apportionment sites were chosen to represent a mixture of air quality environments with relevant human exposure and high pedestrian footfall across multiple towns and villages across Oxfordshire.

Table 12.1: Source apportionment exposure sites

Site ID	Site name	Town	Site type	Easting (m)	Northing (m)
1.1	Horse Fair	Banbury	Roadside	445354	240577
1.2	Horton View Sports Ground		Urban background	445322	239353
2.1	Market Square	Bicester	Roadside	458557	222402
2.2	Kea field		Urban background	457785	222768
3.1	High Street	Abingdon	Roadside	449777	197061
3.2	Margaret Brown Gardens		Urban background	449618	196628
4.1	High Street/Market Square	Witney	Roadside	435592	209720
4.2	Tower Hill Community Primary School		Urban background	435017	210207
5.1	Alvescot Road	Carterton	Roadside	427971	206729
5.2	St John Primary School		Urban background	428634	207976
6.1	Oxford Road	Kidlington	Roadside	449172	213862
6.2	SKIPS pre-school Kidlington		Urban background	449504	213323
7.1	High Street	Thame	Roadside	470537	206000
7.2	Lord Williams lower school		Urban background	471757	205652
8.1	St Martin's Street	Wallingford	Roadside	460715	189441
8.2	Bull Croft play area		Urban background	460623	189539
9.1	Bell Street	Henley	Roadside	476075	182847
9.2	Football club south of meadows		Urban background	476942	181946
10.1	Packhorse Lane	Marcham	Roadside	445504	196633
10.2	Marcham Centre		Urban background	445764	196822

12.1 Nitrogen oxides

Nitrogen dioxide occurs in the atmosphere both as a result of direct emissions and of chemical reactions, in particular those involving NO_2, ozone and nitrogen oxide (NO). Combustion sources including vehicles emit both NO_2 and NO (known together as NO_x). NO_2 concentrations in the city therefore depend on total emissions of NO_x. This section presents source apportionment of total NO_x concentrations.

12.1.1 2023 Nitrogen oxides baseline

Figure 12.1 shows the breakdown of emissions by major source group for 2023 across Oxfordshire. Road transport is the source group with the largest contribution. This is closely followed by industrial sources; however, 53% of industrial emissions were from elevated stacks, which reduces their impact human exposure.

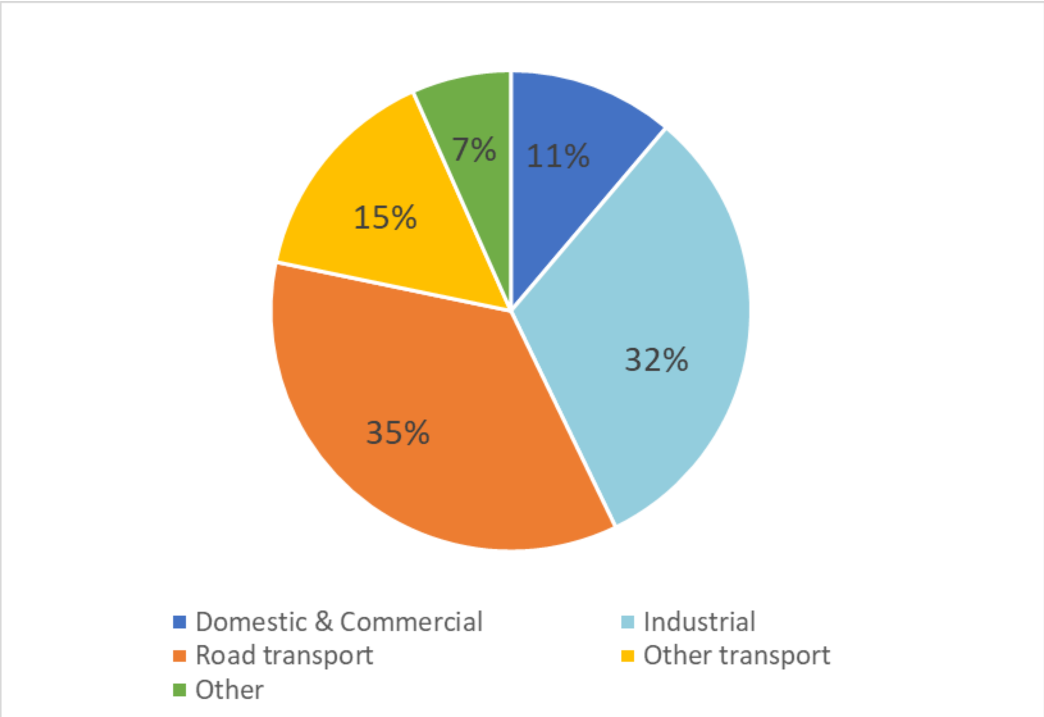

Figure 12.1: Breakdown of NO_x emissions across Oxfordshire for 2023 by source group

Figure 12.2 shows the breakdown of road transport emissions by vehicle type for 2023 across Oxfordshire. About half of NO_x emissions from vehicles is produced by cars, with diesel cars contributing significantly more than petrol cars. Heavy goods vehicles were also a major contributor. Over all of Oxfordshire, emissions from buses were minor, but they have relatively higher impact within urban areas.

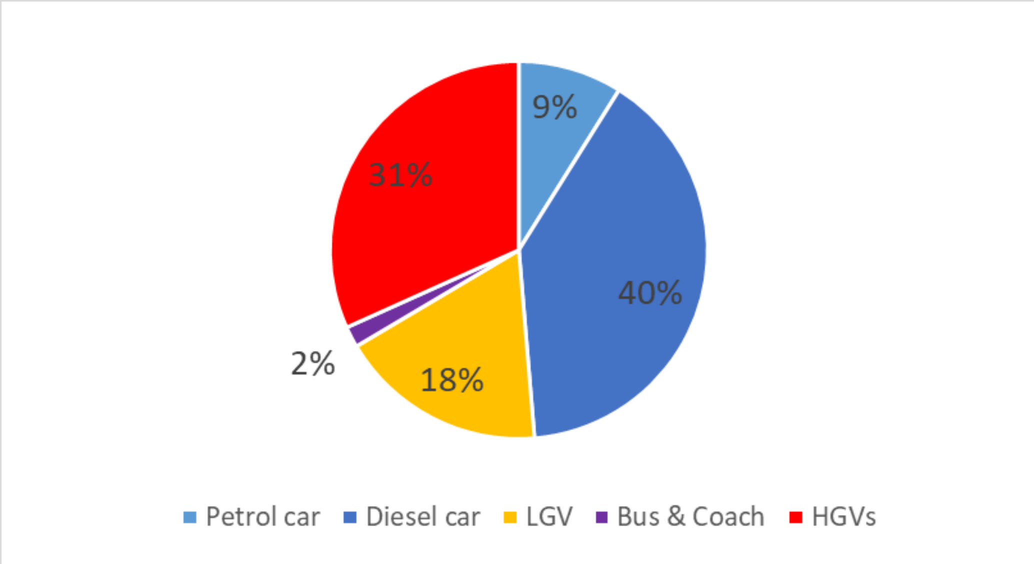

Figure 12.2: Breakdown of NO$_x$ road emissions across Oxfordshire for 2023 by vehicle type

Figure 12.3 shows the breakdown of total NO$_x$ concentrations at selected receptor locations for the 2023 base year. This data is also shown in Table 12.2. At almost all locations, road transport is the largest source, contributing between 19% and 86% of total NO$_x$ concentrations. The receptors with the highest NO$_x$ concentrations were all roadside locations.

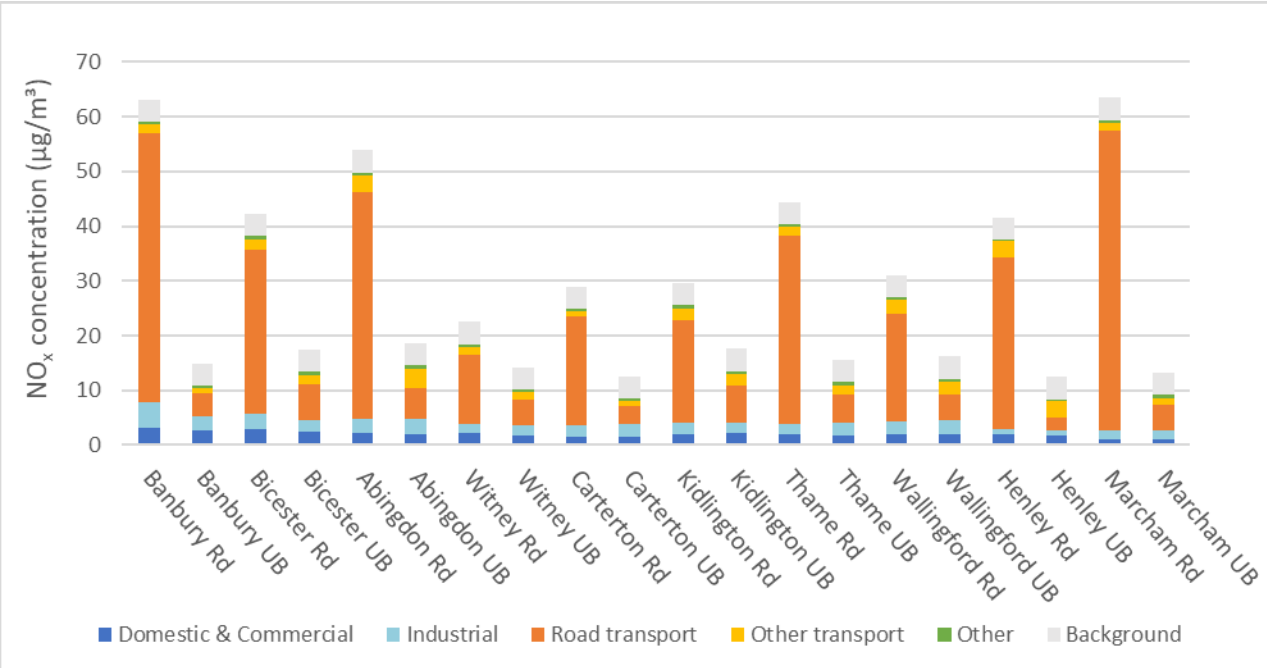

Figure 12.3: Breakdown of total NO$_x$ concentrations (µg/m³) for 2023 at selected receptor locations

Table 12.2: Tabulated breakdown of total NO_x concentrations (µg/m³) for 2023 at selected receptor locations

Receptor name	Domestic & Commercial	Industrial	Road transport	Other transport	Other	Background	Total
Horse Fair	3.1	4.6	49.3	1.6	0.5	4.1	63.2
Horton View Sports Ground	2.7	2.4	4.3	0.9	0.5	4.1	14.9
Market Square	2.9	2.7	30.0	1.9	0.6	4.1	42.3
Kea field	2.5	2.0	6.7	1.6	0.6	4.1	17.4
High Street	2.2	2.5	41.6	3	0.5	4.1	53.9
Margaret Brown Gardens	2.0	2.6	5.8	3.6	0.5	4.1	18.6
High Street/Market Square	2.2	1.7	12.6	1.3	0.5	4.1	22.5
Tower Hill Community Primary School	1.8	1.8	4.7	1.3	0.5	4.1	14.2
Alvescot Road	1.4	2.2	19.7	1.0	0.4	4.1	28.9
St John Primary School	1.5	2.4	3.2	0.9	0.5	4.1	12.6
Oxford Road	1.9	2.2	18.7	2.3	0.5	4.1	29.6
SKIPS pre-school Kidlington	2.1	1.9	6.8	2.1	0.5	4.1	17.6
High Street	1.8	1.9	34.6	1.5	0.5	4.1	44.4
Lord Williams lower school	1.8	2.3	5.2	1.7	0.5	4.1	15.6
St Martin's Street	1.9	2.3	19.7	2.5	0.5	4.1	31.1
Bull Croft play area	2.0	2.5	4.7	2.4	0.5	4.1	16.2
Bell Street	2.0	0.9	31.4	2.9	0.3	4.1	41.6
Football club south of meadows	1.8	0.9	2.3	3.0	0.3	4.1	12.4
Packhorse Lane	1.1	1.5	54.9	1.2	0.6	4.1	63.5
Marcham Centre	1.0	1.6	4.8	1.2	0.6	4.1	13.3

Figure 12.4 shows the breakdown of NO_x concentrations due to road emissions for the 2023 base year. This data is also shown in Table 12.3. Diesel cars were the primary source, followed by HGVs. For the receptors selected in Witney, buses were shown to be the largest contributor.

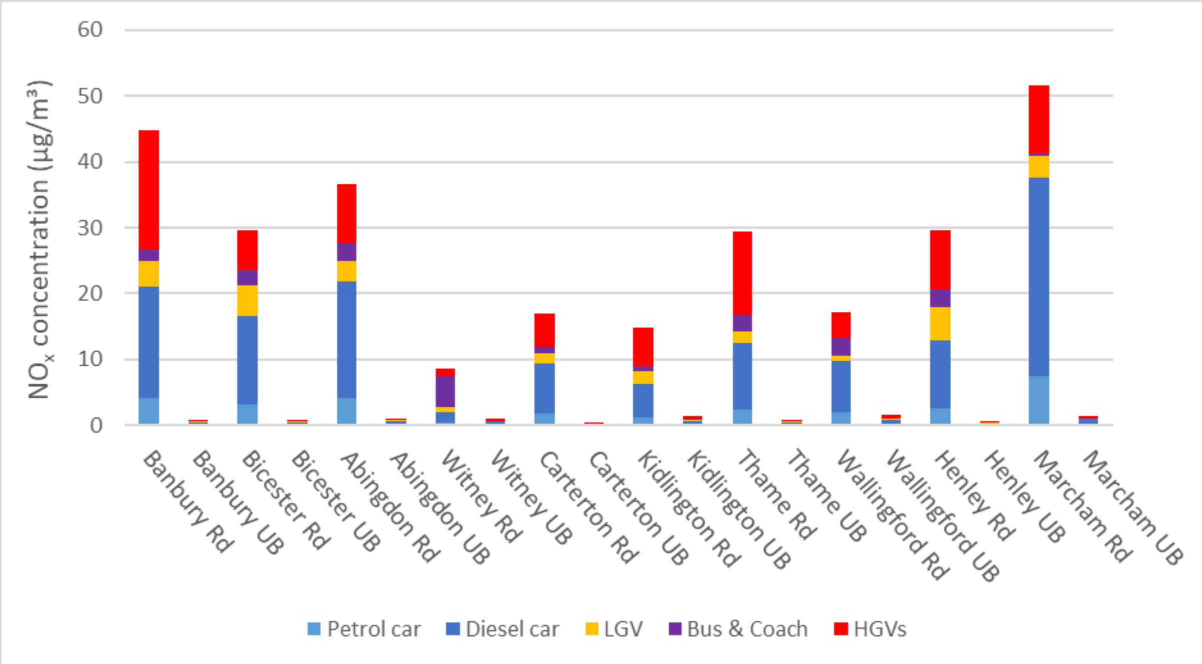

Figure 12.4: Breakdown of NO_x concentrations (µg/m³) from road vehicles for 2023 at selected receptor locations

Table 12.3: Tabulated breakdown of NO_x concentrations (µg/m³) from road vehicles for 2023 at selected receptor locations

Receptor name	Petrol car	Diesel car	Electric car	LGV	Bus & Coach	HGVs	Total
Horse Fair	4.0	17.0	0.0	3.8	1.8	18.2	44.8
Horton View Sports Ground	0.1	0.4	0.0	0.1	0.0	0.3	0.9
Market Square	3.2	13.4	0.0	4.5	2.4	6.0	29.6
Kea field	0.1	0.3	0.0	0.1	0.0	0.2	0.8
High Street	4.2	17.6	0.0	3.3	2.7	8.9	36.6
Margaret Brown Gardens	0.1	0.5	0.0	0.1	0.0	0.2	0.9
High Street/Market Square	0.4	1.6	0.0	0.8	4.7	1.2	8.7
Tower Hill Community Primary School	0.1	0.4	0.0	0.1	0.0	0.3	1.0
Alvescot Road	1.8	7.5	0.0	1.7	0.9	5.1	16.9
St John Primary School	0.0	0.1	0.0	0.0	0.0	0.0	0.2
Oxford Road	1.2	5.1	0.0	1.9	0.9	5.7	14.7
SKIPS pre-school Kidlington	0.1	0.5	0.0	0.2	0.1	0.5	1.4
High Street	2.4	10.0	0.0	1.7	2.6	12.6	29.4
Lord Williams lower school	0.1	0.3	0.0	0.1	0.0	0.2	0.7
St Martin's Street	1.9	7.8	0.0	0.9	2.6	3.8	17.1
Bull Croft play area	0.1	0.6	0.0	0.3	0.0	0.6	1.7
Bell Street	2.5	10.4	0.0	5.0	2.7	9.1	29.7
Football club south of meadows	0.1	0.2	0.0	0.1	0.0	0.1	0.5
Packhorse Lane	7.3	30.2	0.0	3.4	0.3	10.3	51.6
Marcham Centre	0.2	0.8	0.0	0.1	0.0	0.3	1.3

12.1.2 2035 Nitrogen oxides baseline

Figure 12.5 shows the breakdown of emissions by major source group for 2035 across Oxfordshire. The contribution from road sources has dropped significantly compared to 2023, with industrial source and other transport being the main source groups of importance.

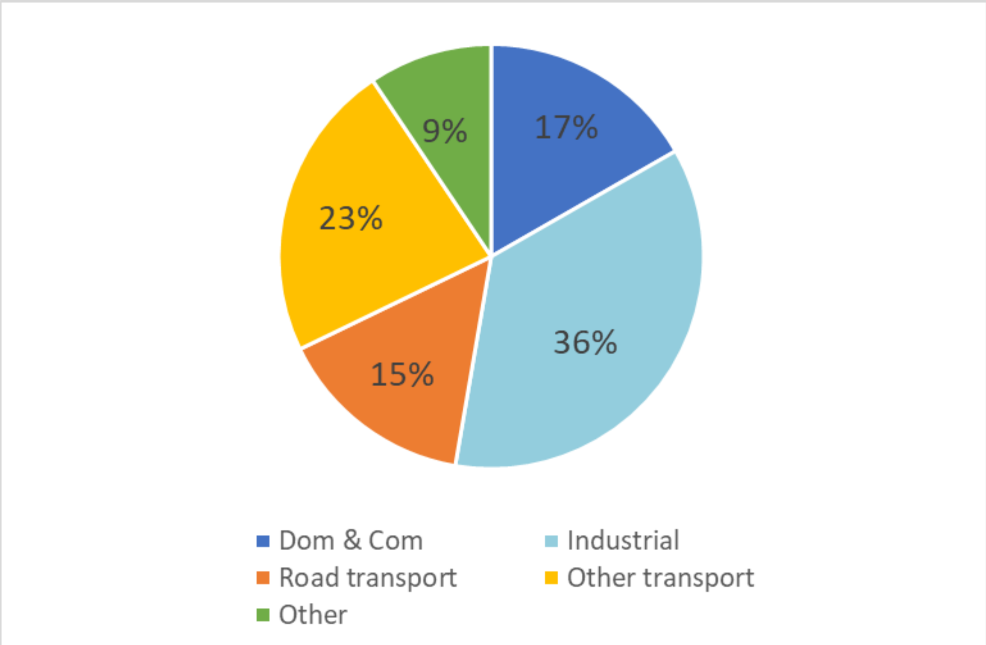

Figure 12.5: Breakdown of NO_x emissions across Oxfordshire for 2035 by source group

Figure 12.6 shows the breakdown of road transport emissions by vehicle type for 2035 across Oxfordshire. HGVs were the largest source of NO_x, contributing over 50% to all road transport emissions.

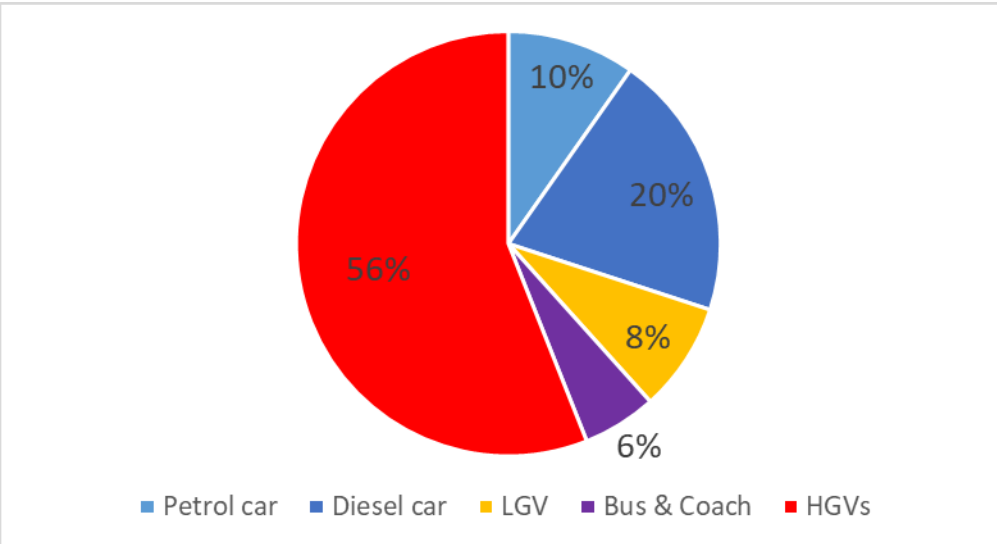

Figure 12.6: Breakdown of NO_x road emissions across Oxfordshire for 2035 by vehicle type

Figure 12.7 shows the breakdown of total NO_x concentrations at selected receptor locations for the 2035 base case. This data is also shown in Table 12.4.

The overall concentrations have dropped at all locations. Despite having a relatively moderate contribution to NO_x emissions, road transport is still the main contributor to NO_x concentrations at locations of human exposure. This is seen at roadside locations in particular. The contribution from background sources is also relatively more important in 2035 compared to the 2023 base year.

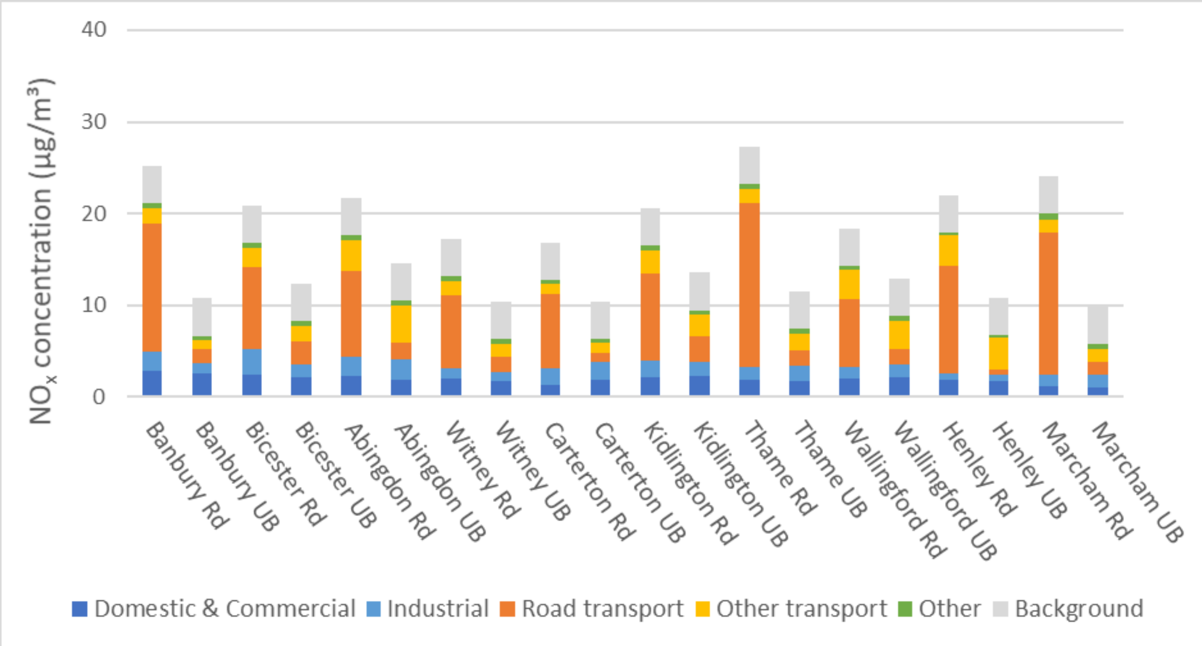

Figure 12.7: Breakdown of total NO_x concentrations (µg/m³) for 2035 at selected receptor locations

Table 12.4: Tabulated breakdown of total NO_x concentrations (µg/m³) for 2035 at selected receptor locations

Receptor	Domestic & Commercial	Industrial	Road transport	Other transport	Other	Background	Total
Horse Fair	2.9	2.1	13.9	1.8	0.5	4.1	25.2
Horton View Sports Ground	2.6	1.1	1.4	1.0	0.5	4.1	10.7
Market Square	2.4	2.8	8.9	2.1	0.6	4.1	20.9
Kea field	2.1	1.5	2.5	1.7	0.6	4.1	12.4
High Street	2.3	2.0	9.4	3.4	0.5	4.1	21.7
Margaret Brown Gardens	1.9	2.2	1.8	4.1	0.5	4.1	14.6
High Street/Market Square	2.0	1.1	8.0	1.5	0.5	4.1	17.2
Tower Hill Community Primary School	1.7	1.1	1.6	1.4	0.5	4.1	10.4
Alvescot Road	1.4	1.8	8.1	1.1	0.4	4.1	16.9
St John Primary School	1.8	2.0	1.0	1.0	0.5	4.1	10.4
Oxford Road	2.1	1.9	9.5	2.5	0.5	4.1	20.6
SKIPS pre-school Kidlington	2.3	1.5	2.8	2.3	0.5	4.1	13.6
High Street	1.9	1.3	17.9	1.6	0.5	4.1	27.3
Lord Williams lower school	1.8	1.7	1.7	1.8	0.5	4.1	11.5
St Martin's Street	2.0	1.3	7.3	3.2	0.5	4.1	18.4
Bull Croft play area	2.1	1.4	1.7	3.1	0.5	4.1	12.9
Bell Street	1.9	0.7	11.6	3.4	0.3	4.1	22.0
Football club south of meadows	1.7	0.7	0.6	3.5	0.3	4.1	10.9
Packhorse Lane	1.1	1.2	15.6	1.4	0.6	4.1	24.1
Marcham Centre	1.1	1.3	1.5	1.4	0.6	4.1	9.9

Figure 12.8 shows the breakdown of NO_x concentrations due to road emissions for the 2035 base year. This is also shown in Table 12.5. Due to reductions in car emissions, concentrations from road sources have decreased; HGVs and buses display a higher proportion of contribution.

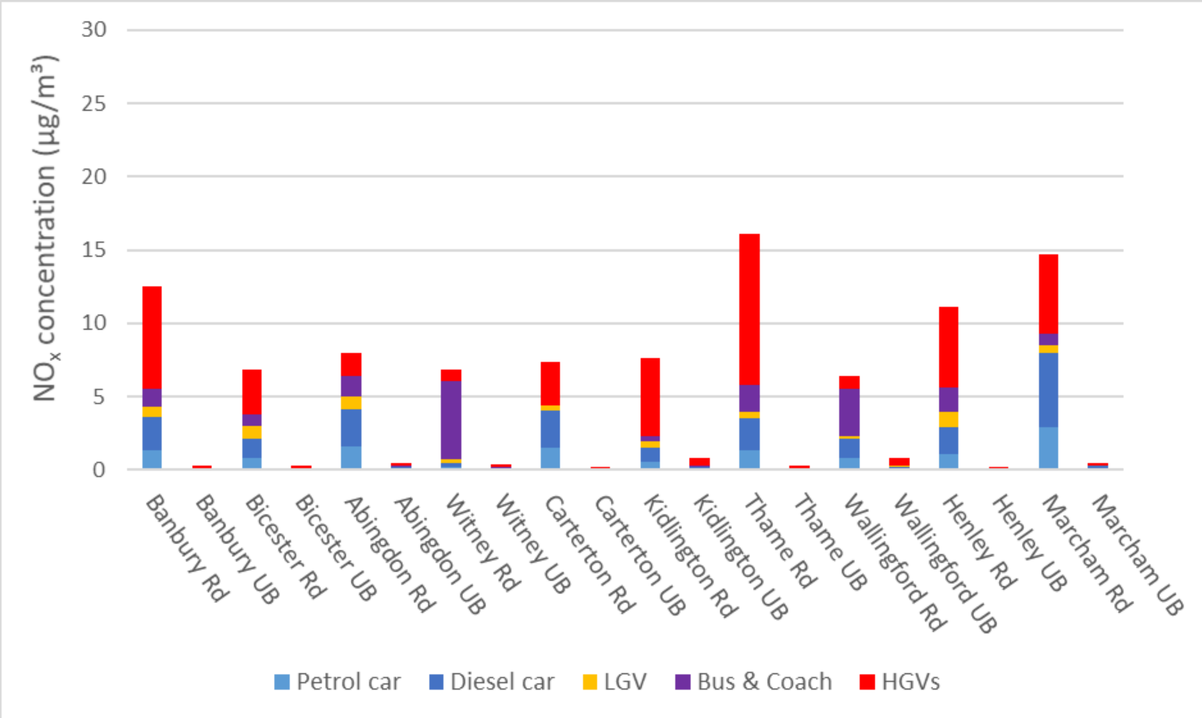

Figure 12.8: Breakdown of NO_x concentrations (µg/m³) from road vehicles for 2035 at selected receptor locations

Table 12.5: Tabulated breakdown of NO_x concentrations (µg/m³) from road vehicles for 2035 at selected receptor locations

Receptor name	Petrol car	Diesel car	Electric car	LGV	Bus & Coach	HGVs	Total
Horse Fair	1.3	2.2	0.0	0.7	1.2	7.0	12.5
Horton View Sports Ground	0.0	0.1	0.0	0.0	0.0	0.1	0.3
Market Square	0.8	1.3	0.0	0.8	0.8	3.0	6.8
Kea field	0.0	0.1	0.0	0.0	0.0	0.1	0.3
High Street	1.6	2.6	0.0	0.9	1.4	1.5	7.9
Margaret Brown Gardens	0.1	0.1	0.0	0.0	0.0	0.2	0.4
High Street/Market Square	0.2	0.3	0.0	0.2	5.3	0.8	6.8
Tower Hill Community Primary School	0.0	0.1	0.0	0.0	0.1	0.2	0.4
Alvescot Road	1.5	2.5	0.0	0.4	0.0	2.9	7.4
St John Primary School	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Oxford Road	0.6	0.9	0.0	0.4	0.4	5.3	7.6
SKIPS pre-school Kidlington	0.1	0.1	0.0	0.0	0.1	0.4	0.8
High Street	1.3	2.2	0.0	0.4	1.8	10.3	16.1
Lord Williams lower school	0.0	0.0	0.0	0.0	0.0	0.2	0.3
St Martin's Street	0.8	1.3	0.0	0.2	3.2	0.9	6.4
Bull Croft play area	0.1	0.1	0.0	0.1	0.1	0.5	0.9
Bell Street	1.1	1.8	0.0	1.1	1.7	5.5	11.2
Football club south of meadows	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Packhorse Lane	2.9	5.0	0.0	0.6	0.8	5.4	14.7
Marcham Centre	0.1	0.2	0.0	0.0	0.0	0.2	0.5

12.2 Particulate matter ($PM_{2.5}$)

12.2.1 2023 $PM_{2.5}$ Baseline

Figure 12.9 shows the breakdown of $PM_{2.5}$ emissions by major source group for 2023 across Oxfordshire. Industrial sources were the main contributor to $PM_{2.5}$ emissions, followed by domestic and commercial sources. Less than 5% of industrial $PM_{2.5}$ emissions were from elevated stacks; meaning industrial sources were likely to impact on human exposure to $PM_{2.5}$.

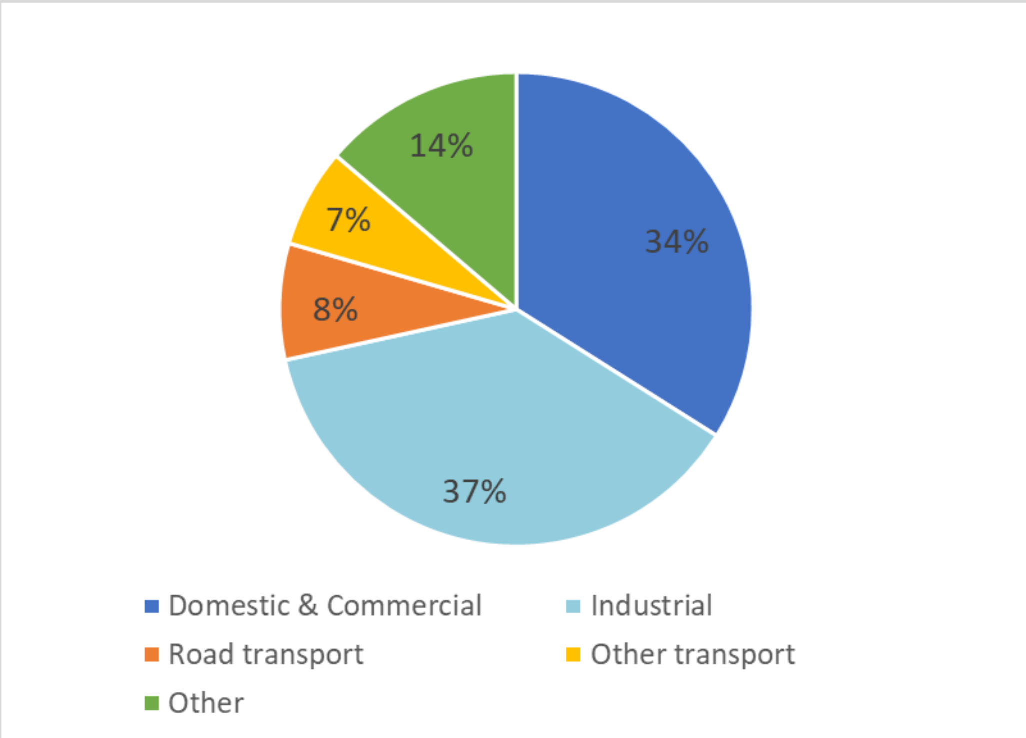

Figure 12.9: Breakdown of $PM_{2.5}$ emissions across Oxfordshire for 2023 by source group

Figure 12.10 shows the breakdown of road transport emissions by vehicle type for 2023 across Oxfordshire. The majority of $PM_{2.5}$ emissions is produced by cars (61%) with a fairly even split between petrol and diesel. Heavy good vehicles were also a large contributor to road emission.

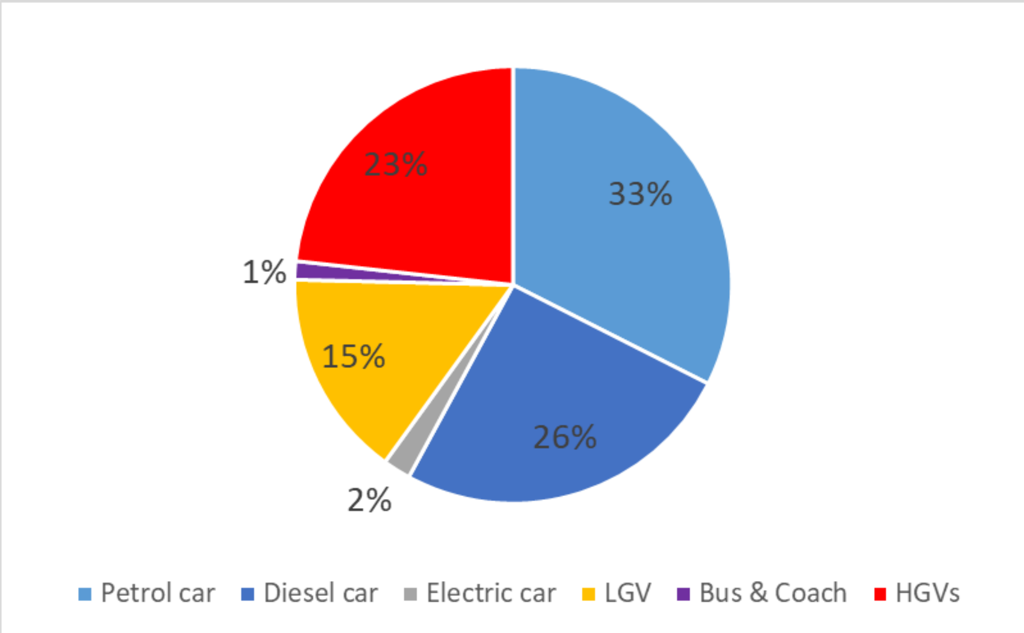

Figure 12.10: Breakdown of $PM_{2.5}$ road emissions across Oxfordshire for 2023 by vehicle type

Figure 12.11 shows the breakdown of road transport emissions by major source type for 2023 across Oxfordshire. The main contributors to road emissions were from road wear and tyre wear, with exhaust emissions and brake wear being of secondary importance overall.

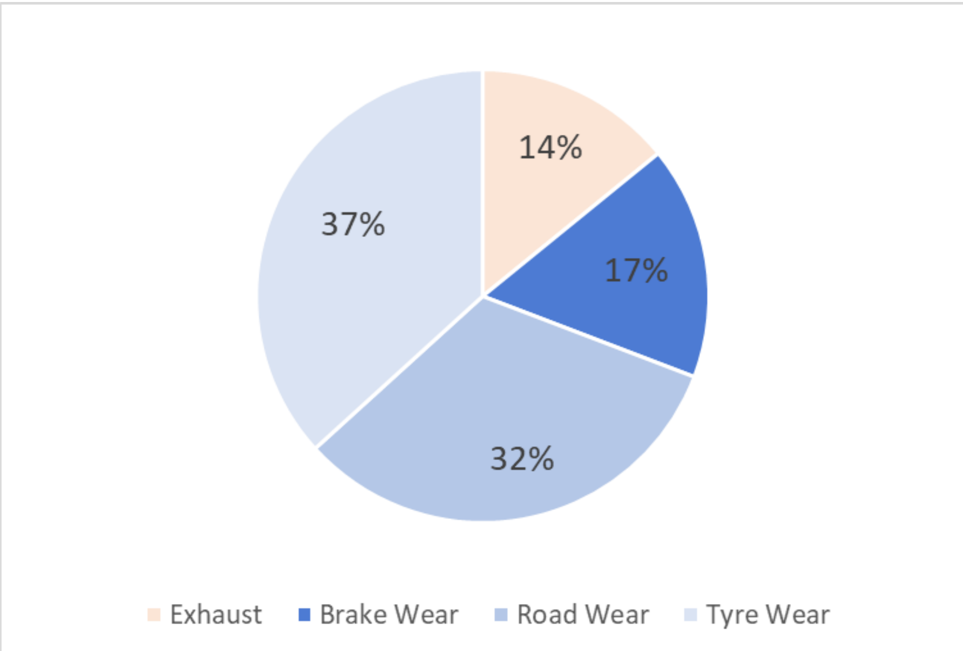

Figure 12.11: Breakdown of $PM_{2.5}$ road emissions across Oxfordshire for 2023 by major source type

Figure 12.12 shows the breakdown of $PM_{2.5}$ concentrations at selected receptor locations for the 2023 base case. This is also shown in Table 12.6.

The contribution from background is the largest source at all locations, contributing between 55% and 84%. Industrial sources or road transport were often the main contributor to $PM_{2.5}$ concentrations arising from sources within Oxfordshire.

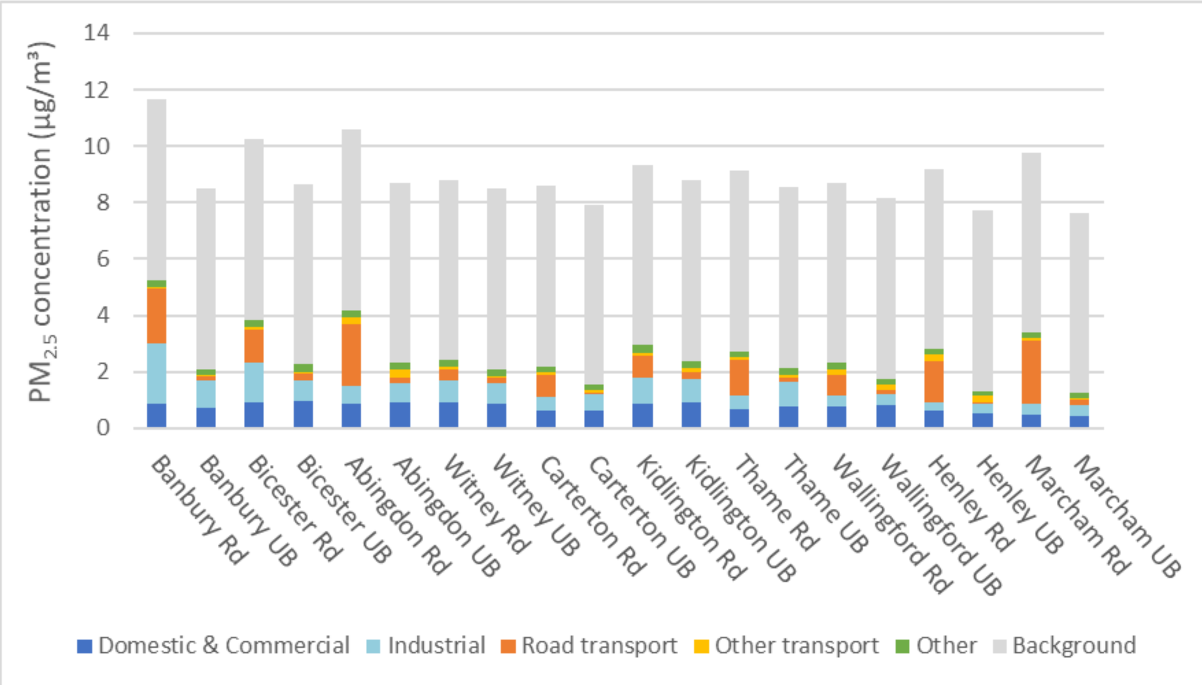

Figure 12.12: Breakdown of total $PM_{2.5}$ concentrations (µg/m³) for 2023 at selected receptor locations

Table 12.6: Tabulated breakdown of total $PM_{2.5}$ concentrations (µg/m³) for 2023 at selected receptor locations

Receptor	Domestic & Commercial	Industrial	Road transport	Other transport	Other	Background	Total
Horse Fair	0.9	2.2	1.9	0.1	0.2	6.4	11.7
Horton View Sports Ground	0.7	0.9	0.1	0	0.2	6.4	8.5
Market Square	0.9	1.4	1.2	0.1	0.3	6.4	10.2
Kea field	0.9	0.7	0.2	0.1	0.3	6.4	8.7
High Street	0.9	0.6	2.2	0.2	0.3	6.4	10.6
Margaret Brown Gardens	0.9	0.7	0.2	0.3	0.3	6.4	8.7
High Street/Market Square	0.9	0.8	0.4	0.1	0.2	6.4	8.8
Tower Hill Community Primary School	0.9	0.7	0.2	0.1	0.2	6.4	8.5
Alvescot Road	0.6	0.5	0.8	0.1	0.2	6.4	8.6
St John Primary School	0.6	0.6	0.1	0.1	0.2	6.4	7.9
Oxford Road	0.9	0.9	0.8	0.1	0.2	6.4	9.3
SKIPS pre-school Kidlington	0.9	0.8	0.2	0.1	0.3	6.4	8.8
High Street	0.6	0.5	1.2	0.1	0.2	6.4	9.1
Lord Williams lower school	0.8	0.9	0.2	0.1	0.2	6.4	8.5
St Martin's Street	0.8	0.4	0.8	0.2	0.2	6.4	8.7
Bull Croft play area	0.8	0.4	0.2	0.2	0.2	6.4	8.2
Bell Street	0.6	0.3	1.5	0.2	0.2	6.4	9.2
Football club south of meadows	0.5	0.3	0.1	0.2	0.2	6.4	7.7
Packhorse Lane	0.5	0.4	2.3	0.1	0.2	6.4	9.8
Marcham Centre	0.4	0.4	0.2	0.1	0.2	6.4	7.6

Figure 12.13 shows the breakdown of $PM_{2.5}$ concentrations from road vehicles for 2023. This is also shown in Table 12.7.

Petrol cars and diesel cars were the primary contributor at almost all receptors, and were equally important.

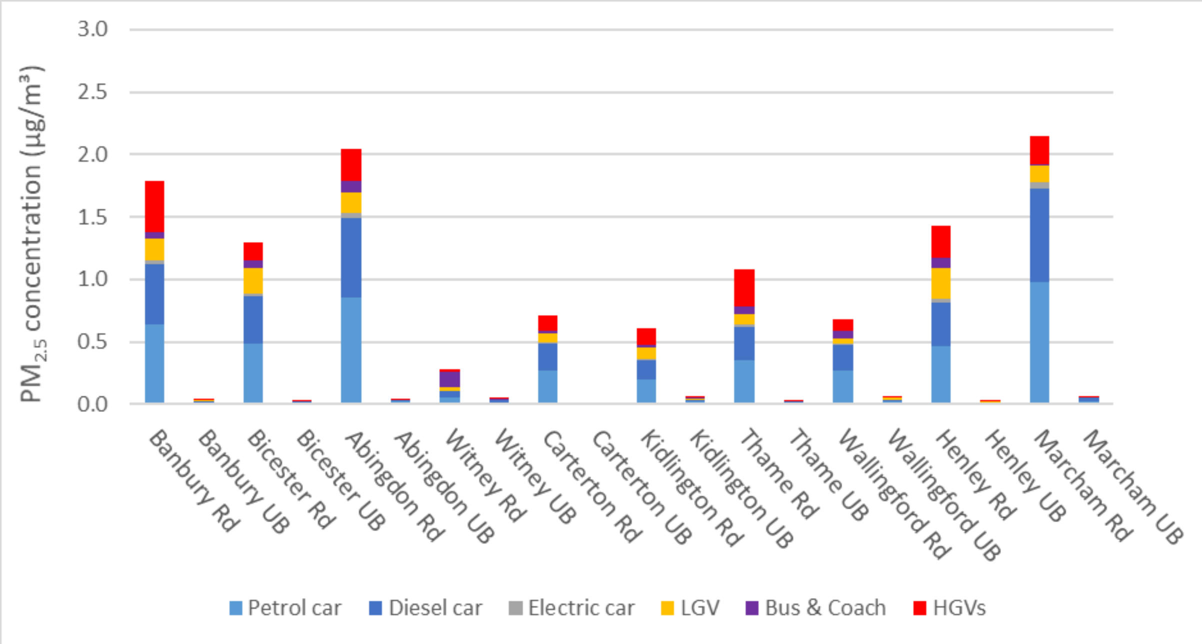

Figure 12.13: Breakdown of $PM_{2.5}$ concentrations (µg/m³) from road vehicles for 2023 at selected receptor locations

Table 12.7: Tabulated breakdown of $PM_{2.5}$ concentrations (µg/m³) from road vehicles for 2023 at selected receptor locations

Receptor name	Petrol car	Diesel car	Electric car	LGV	Bus & Coach	HGVs	Total
Horse Fair	0.60	0.50	0.00	0.20	0.00	0.40	1.80
Horton View Sports Ground	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Market Square	0.50	0.40	0.00	0.20	0.10	0.10	1.30
Kea field	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High Street	0.90	0.60	0.00	0.20	0.10	0.30	2.00
Margaret Brown Gardens	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High Street/Market Square	0.10	0.00	0.00	0.00	0.10	0.00	0.30
Tower Hill Community Primary School	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alvescot Road	0.30	0.20	0.00	0.10	0.00	0.10	0.70
St John Primary School	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxford Road	0.20	0.20	0.00	0.10	0.00	0.10	0.60
SKIPS pre-school Kidlington	0.00	0.00	0.00	0.00	0.00	0.00	0.10
High Street	0.40	0.30	0.00	0.10	0.10	0.30	1.10
Lord Williams lower school	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St Martin's Street	0.30	0.20	0.00	0.00	0.10	0.10	0.70
Bull Croft play area	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Bell Street	0.50	0.40	0.00	0.30	0.10	0.30	1.40
Football club south of meadows	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Packhorse Lane	1.00	0.80	0.10	0.10	0.00	0.20	2.10
Marcham Centre	0.00	0.00	0.00	0.00	0.00	0.00	0.10

Figure 12.14 shows the breakdown of $PM_{2.5}$ concentrations from road emissions from major source types for 2023. This is also shown in Table 12.8.

At all locations, exhaust emissions were the lowest contributor, showing that non-combustion sources were the most important factor for human exposure.

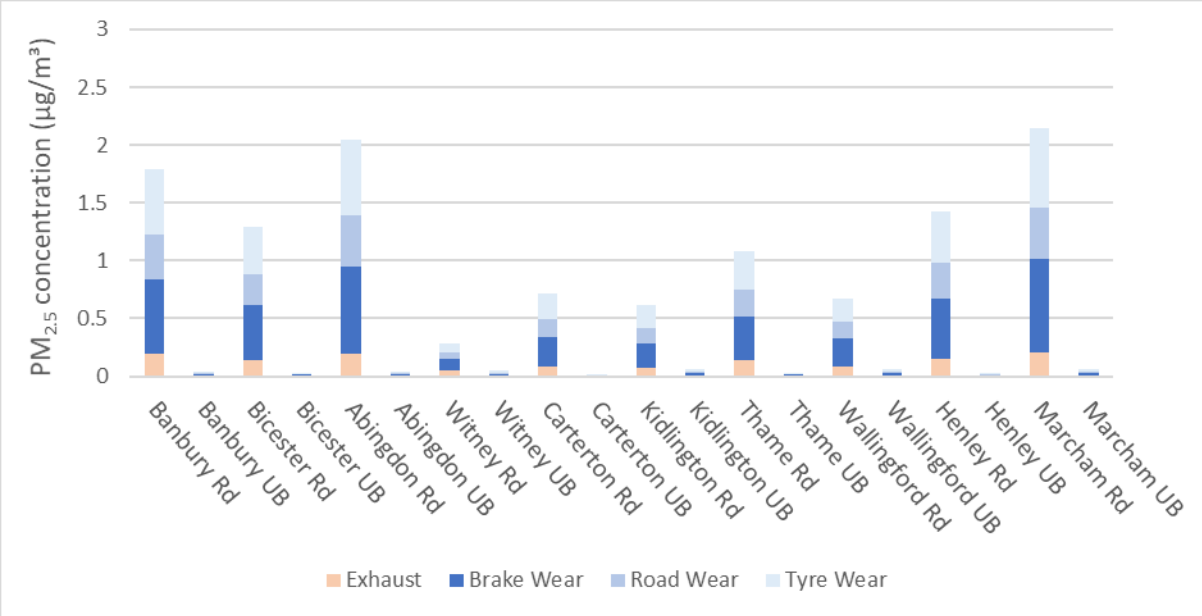

Figure 12.14: Breakdown of $PM_{2.5}$ concentrations (µg/m³) by major source type for 2023 at selected receptor locations

Table 12.8: Tabulated breakdown of $PM_{2.5}$ concentrations (µg/m³) by major source type for 2023 at selected receptor locations

Receptor name	Exhaust	Brake Wear	Road Wear	Tyre Wear	Total
Horse Fair	0.20	0.64	0.38	0.57	1.79
Horton View Sports Ground	0.00	0.01	0.01	0.01	0.04
Market Square	0.14	0.48	0.27	0.41	1.30
Kea field	0.00	0.01	0.01	0.01	0.03
High Street	0.19	0.76	0.44	0.66	2.05
Margaret Brown Gardens	0.00	0.02	0.01	0.01	0.04
High Street/Market Square	0.05	0.09	0.06	0.07	0.28
Tower Hill Community Primary School	0.00	0.02	0.01	0.02	0.05
Alvescot Road	0.08	0.26	0.15	0.23	0.71
St John Primary School	0.00	0.00	0.00	0.00	0.01
Oxford Road	0.07	0.22	0.13	0.19	0.61
SKIPS pre-school Kidlington	0.01	0.02	0.01	0.02	0.07
High Street	0.14	0.37	0.24	0.33	1.08
Lord Williams lower school	0.00	0.01	0.01	0.01	0.03
St Martin's Street	0.08	0.24	0.15	0.21	0.68
Bull Croft play area	0.01	0.02	0.01	0.02	0.07
Bell Street	0.15	0.52	0.30	0.45	1.43
Football club south of meadows	0.00	0.01	0.01	0.01	0.03
Packhorse Lane	0.21	0.80	0.45	0.69	2.15
Marcham Centre	0.01	0.02	0.01	0.02	0.07

12.2.2 2035 $PM_{2.5}$ Baseline

Figure 12.15 shows the breakdown of $PM_{2.5}$ emissions by major source group for 2035 across Oxfordshire. Domestic and commercial sources were the main contributor, followed by industrial sources.

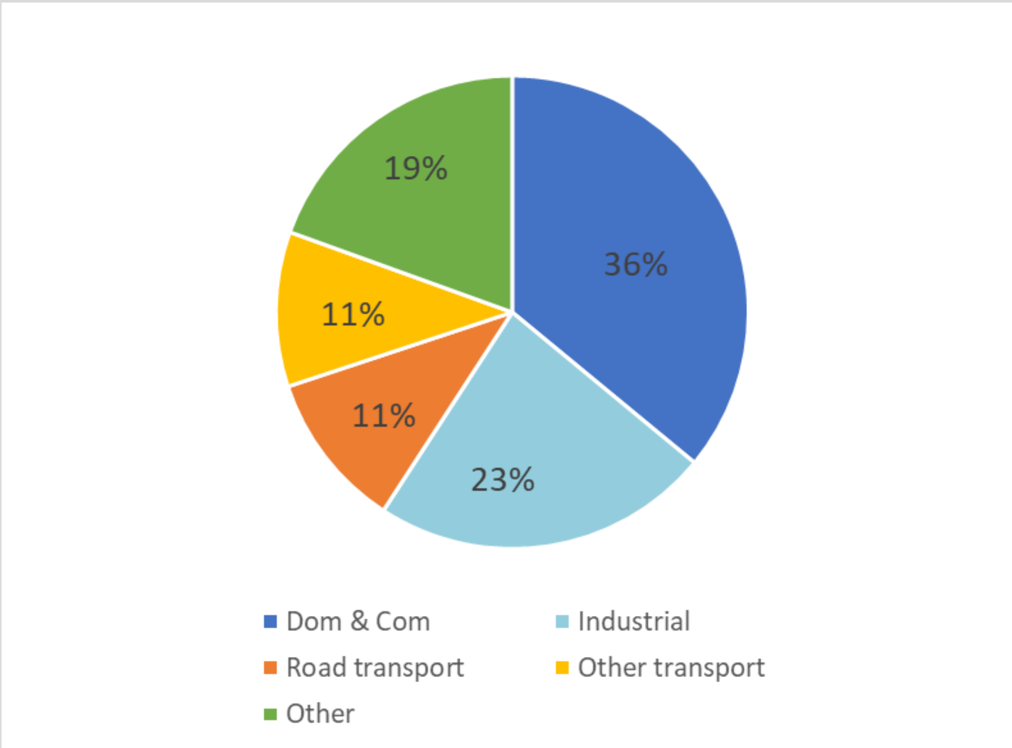

Figure 12.15: Breakdown of $PM_{2.5}$ emissions across Oxfordshire for 2035 by source group

Figure 12.16 shows the breakdown of road transport emissions by vehicle type for 2035 across Oxfordshire. The majority of all road emissions were from cars (67%). While NO_x emissions from cars decreased between 2023 and 2035 due to cleaner engine technology, there was a large increase in $PM_{2.5}$ compared to other road vehicles. This is due to the increase in car flows represented in traffic modelling in 2035 compared to 2023. This increase was significantly higher than any other vehicle type.

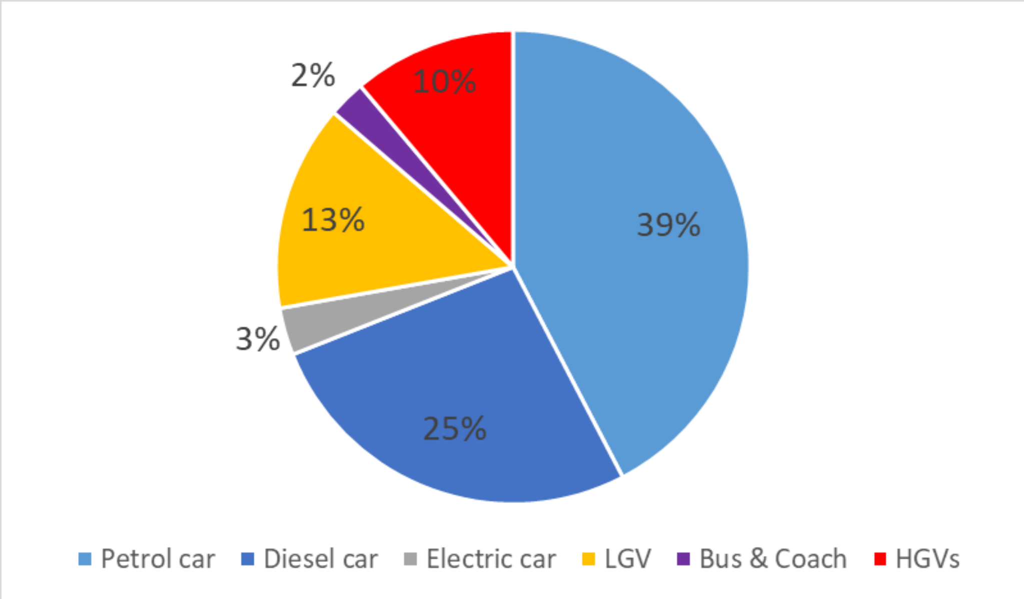

Figure 12.16: Breakdown of $PM_{2.5}$ road emissions across Oxfordshire for 2035 by vehicle type

Figure 12.17 shows the breakdown of road transport emissions by major source type for 2035 across Oxfordshire. Almost all road emissions were from non-exhaust emissions. Total road emissions for $PM_{2.5}$ have risen from 2023 due to the general increase in road traffic.

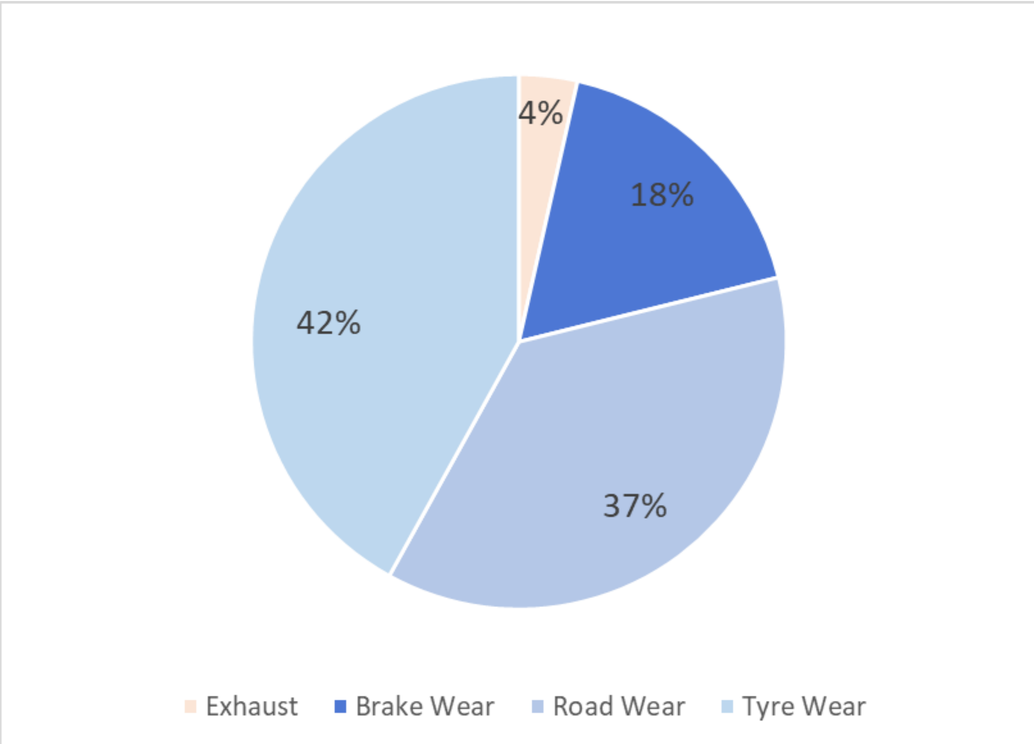

Figure 12.17: Breakdown of $PM_{2.5}$ road emissions across Oxfordshire for 2035 by major source type

Figure 12.18 shows the breakdown of $PM_{2.5}$ concentrations at selected receptor locations for the 2035 base case. This is also shown in Table 12.9.

While overall concentrations have decreased, road transport $PM_{2.5}$ concentrations have grown. This is mostly driven by the increase in non-exhaust emissions related to an increase in overall vehicle traffic. Background sources were the overall primary contributor.

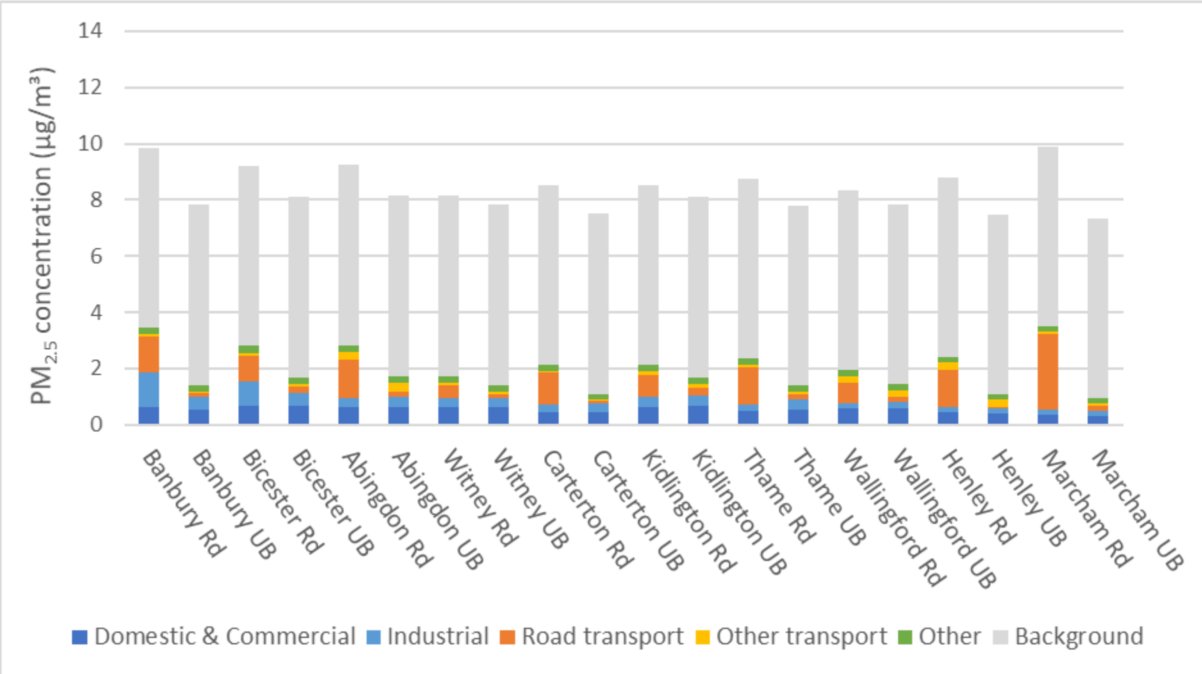

Figure 12.18: Breakdown of total $PM_{2.5}$ concentrations (µg/m³) for 2035 at selected receptor locations

Table 12.9: Tabulated breakdown of total $PM_{2.5}$ concentrations ($\mu g/m^3$) for 2035 at selected receptor locations

Receptor	Domestic & Commercial	Industrial	Road transport	Other transport	Other	Background	Total
Horse Fair	0.6	1.2	1.3	0.1	0.2	6.4	9.9
Horton View Sports Ground	0.5	0.5	0.1	0.0	0.2	6.4	7.8
Market Square	0.7	0.9	0.9	0.1	0.3	6.4	9.2
Kea field	0.7	0.4	0.2	0.1	0.3	6.4	8.1
High Street	0.6	0.3	1.4	0.2	0.3	6.4	9.2
Margaret Brown Gardens	0.6	0.3	0.2	0.3	0.3	6.4	8.1
High Street/Market Square	0.6	0.3	0.5	0.1	0.2	6.4	8.1
Tower Hill Community Primary School	0.6	0.3	0.2	0.1	0.2	6.4	7.8
Alvescot Road	0.5	0.3	1.1	0.1	0.2	6.4	8.5
St John Primary School	0.5	0.3	0.1	0.1	0.2	6.4	7.5
Oxford Road	0.6	0.4	0.7	0.1	0.2	6.4	8.5
SKIPS pre-school Kidlington	0.7	0.4	0.3	0.1	0.3	6.4	8.1
High Street	0.5	0.2	1.3	0.1	0.2	6.4	8.7
Lord Williams lower school	0.6	0.4	0.1	0.1	0.2	6.4	7.8
St Martin's Street	0.6	0.2	0.7	0.2	0.2	6.4	8.3
Bull Croft play area	0.6	0.2	0.2	0.2	0.2	6.4	7.8
Bell Street	0.4	0.2	1.3	0.3	0.2	6.4	8.8
Football club south of meadows	0.4	0.2	0.1	0.3	0.2	6.4	7.5
Packhorse Lane	0.3	0.2	2.7	0.1	0.2	6.4	9.9
Marcham Centre	0.3	0.2	0.2	0.1	0.2	6.4	7.3

Figure 12.19 shows the breakdown of $PM_{2.5}$ concentrations from road vehicles for 2035. This is also shown in Table 12.10.

Petrol cars and diesel cars were the primary contributor at almost all receptors. Road concentrations for $PM_{2.5}$ have not decreased as dramatically as NO_x concentrations from the 2023 base year. This is mainly due to the high contribution from non-exhaust sources.

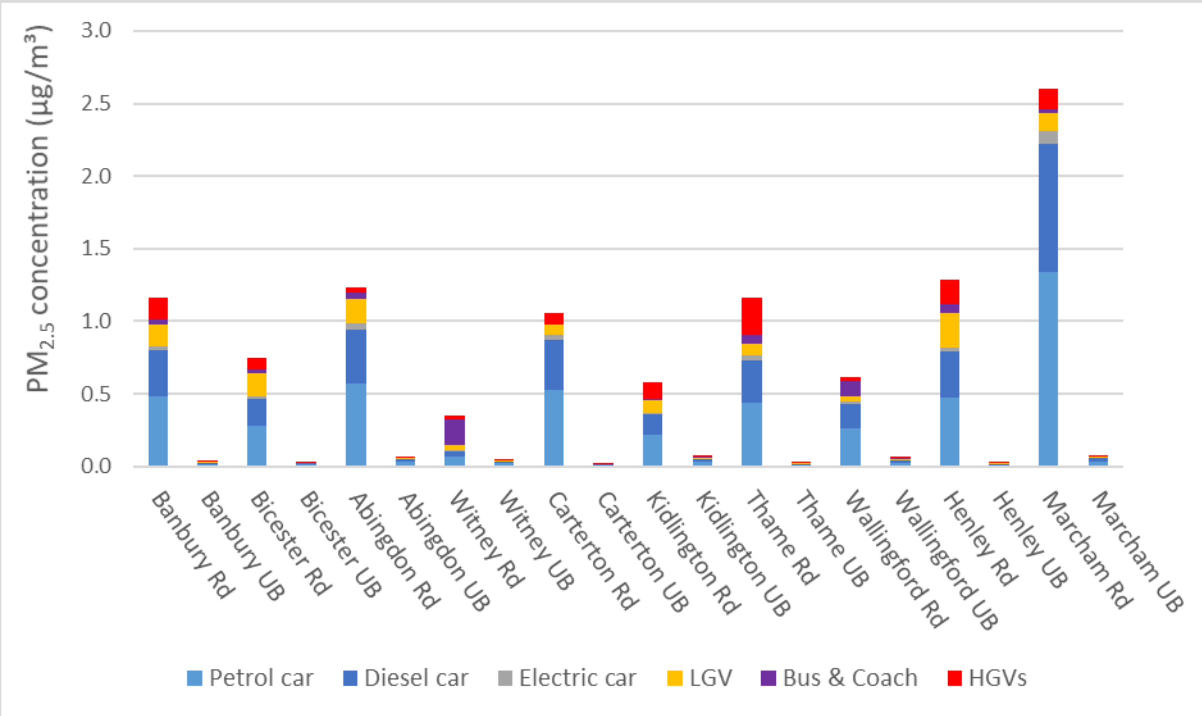

Figure 12.19: Breakdown of $PM_{2.5}$ concentrations (µg/m³) from road emissions for 2035 at selected receptor locations

Table 12.10: Tabulated breakdown of $PM_{2.5}$ concentrations (µg/m³) from road emissions for 2035 at selected receptor locations

Receptor name	Petrol car	Diesel car	Electric car	LGV	Bus & Coach	HGVs	Total
Horse Fair	0.48	0.32	0.03	0.15	0.04	0.14	1.16
Horton View Sports Ground	0.02	0.01	0.00	0.00	0.00	0.00	0.03
Market Square	0.28	0.19	0.02	0.15	0.03	0.08	0.74
Kea field	0.01	0.01	0.00	0.00	0.00	0.00	0.03
High Street	0.57	0.38	0.04	0.17	0.05	0.03	1.23
Margaret Brown Gardens	0.03	0.02	0.00	0.00	0.00	0.00	0.06
High Street/Market Square	0.06	0.04	0.00	0.04	0.18	0.02	0.35
Tower Hill Community Primary School	0.02	0.01	0.00	0.01	0.00	0.01	0.05
Alvescot Road	0.53	0.35	0.03	0.07	0.00	0.07	1.05
St John Primary School	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Oxford Road	0.21	0.14	0.01	0.09	0.01	0.11	0.58
SKIPS pre-school Kidlington	0.03	0.02	0.00	0.01	0.00	0.01	0.08
High Street	0.44	0.29	0.03	0.08	0.06	0.26	1.16
Lord Williams lower school	0.01	0.01	0.00	0.00	0.00	0.00	0.02
St Martin's Street	0.26	0.17	0.02	0.04	0.11	0.02	0.61
Bull Croft play area	0.02	0.02	0.00	0.01	0.00	0.01	0.07
Bell Street	0.47	0.31	0.03	0.24	0.06	0.17	1.28
Football club south of meadows	0.01	0.01	0.00	0.00	0.00	0.00	0.02
Packhorse Lane	1.34	0.88	0.09	0.13	0.03	0.14	2.60
Marcham Centre	0.04	0.02	0.00	0.00	0.00	0.00	0.07

Figure 12.20 shows the breakdown of $PM_{2.5}$ concentrations from road emissions from major source types for 2035. This is also shown in Table 12.11.

At all locations, exhaust emissions were the lowest contributor. Reductions of non-exhaust concentrations from the 2023 base year were small.

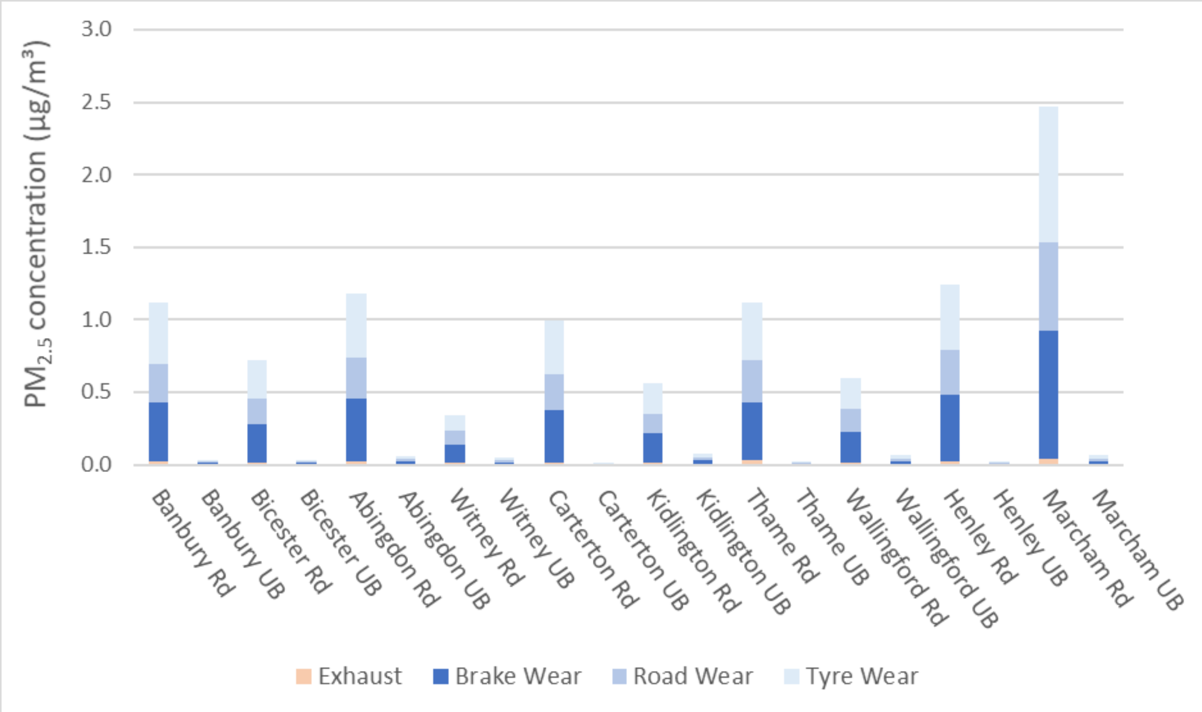

Figure 12.20: Breakdown of $PM_{2.5}$ concentrations (µg/m³) by major source type for 2035 at selected receptor locations

Table 12.11: Tabulated breakdown of $PM_{2.5}$ concentrations (µg/m³) by major source type for 2035 at selected receptor locations

Receptor	Exhaust	Brake Wear	Road Wear	Tyre Wear	Total
Horse Fair	0.02	0.40	0.27	0.42	1.12
Horton View Sports Ground	0.00	0.01	0.01	0.01	0.03
Market Square	0.01	0.27	0.17	0.27	0.72
Kea field	0.00	0.01	0.01	0.01	0.03
High Street	0.02	0.43	0.28	0.44	1.18
Margaret Brown Gardens	0.00	0.02	0.01	0.02	0.06
High Street/Market Square	0.01	0.12	0.10	0.10	0.34
Tower Hill Community Primary School	0.00	0.02	0.01	0.02	0.05
Alvescot Road	0.02	0.36	0.25	0.37	1.00
St John Primary School	0.00	0.00	0.00	0.01	0.01
Oxford Road	0.01	0.20	0.14	0.21	0.56
SKIPS pre-school Kidlington	0.00	0.03	0.02	0.03	0.07
High Street	0.03	0.40	0.29	0.41	1.12
Lord Williams lower school	0.00	0.01	0.01	0.01	0.02
St Martin's Street	0.01	0.22	0.16	0.21	0.59
Bull Croft play area	0.00	0.02	0.02	0.02	0.07
Bell Street	0.03	0.46	0.30	0.46	1.25
Football club south of meadows	0.00	0.01	0.01	0.01	0.02
Packhorse Lane	0.04	0.88	0.61	0.93	2.47
Marcham Centre	0.00	0.02	0.02	0.03	0.07

APPENDIX A: Concentration data tables

Table A.0.1: Monitored concentrations of NO_2, PM_{10}, and $PM_{2.5}$ across Oxfordshire, 2023

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Inlet Height (m)	NO_2 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
CM1	AURN Oxford Centre	RS	451357	206156	2.5	31.0	-	-
CM2	Oxford High Street	RS	451677	206270	1.5	27.0	14	8
CM3	AURN St Ebbes	UB	451118	205353	2.5	9.0	9	6
DT1	St Ebbe's	UB	451118	205353	2.5	9.0	-	-
DT2	Weirs Lne./Abingdon Rd. LP1	RS	451904	204215	3	18.0	-	-
DT3	LP 52 Abingdon Rd.	RS	451911	204152	3	24.0	-	-
DT4	Boundary Brook Rd/ Iffley Rd	RS	452959	204661	3	23.0	-	-
DT5	Lenthall Rd Allotments	UB	452818	203448	1.5	8.0	-	-
DT7	Oxford Rd/ Between Towns Rd	RS	454473	204248	3	28.0	-	-
DT8	Oxford Rd (Cowley) LP13	RS	454355	204296	3	25.0	-	-
DT14	Windmill Rd. W	RS	454554	207102	3	27.0	-	-
DT15	London Rd./BHF	RS	454433	207058	3	21.0	-	-
DT16	Headley Way/London Rd. LP2	RS	453982	206818	3	18.0	-	-
DT18	The Roundway	RS	455596	207367	3	20.0	-	-
DT20	Barton Lane LP2	RS	454994	207760	3	18.0	-	-
DT25	Cuttleslowe Rbout 3 Elsfield Rd.	RS	450417	210253	3	24.0	-	-
DT26	Cuttleslowe 3 Summers Place	RS	450389	210189	3	28.0	-	-
DT27	Wolvercote 78 Sunderland Ave.	RS	449824	210197	3	19.0	-	-
DT28	Wolvercote 51 Sunderland Ave	RS	449856	210162	3	20.0	-	-
DT29	Pear Tree P&R N Gateway	RS	449530	210734	3	18.0	-	-
DT30	Osney Lne/Hollybush Row	RS	450668	206053	3	17.0	-	-
DT31	Beckett St.	RS	450564	206227	3	17.0	-	-
DT32	Royal Oxford Hotel	RS	450671	206273	3	21.0	-	-
DT33	Botley RD/ Mill St	RS	450407	206225	3	16.0	-	-
DT35	Botley Rd /Hillview Rd	RS	450029	206207	3	19.0	-	-
DT36	Botley Rd N (Prestwich Place)	RS	449657	206245	3	13.0	-	-
DT39	St Aldate's	RS	451357	206156	2.5	32.0	-	-
DT40	Queen St.	RS	451270	206144	3	21.0	-	-
DT41	Bonn Square	RS	451216	206133	3	20.0	-	-
DT42	New Rd.	RS	451073	206191	3	22.0	-	-

DT43	Park End St.	RS	450884	206274	3	24.0	-	-
DT44	Hythe Bridge St.	RS	450795	206343	3	18.0	-	-
DT45	Worcester St.	RS	450942	206424	3	25.0	-	-
DT46	Beaumont St.	RS	451167	206519	3	18.0	-	-
DT47	George St. / Magdalen St.	RS	451222	206389	3	25.0	-	-
DT48	George St.	RS	450981	206344	3	21.0	-	-
DT49	Cornmarket St.	RS	451322	206242	3	16.0	-	-
DT50	High St. / Turl St.	RS	451470	206221	3	21.0	-	-
DT51	50 High St.	RS	451900	206249	3	25.0	-	-
DT52	Longwall St.	RS	451971	206283	3	26.0	-	-
DT53	Magdalen Bridge	RS	452099	206117	3	16.0	-	-
DT55	St Clements	RS	452326	205992	3	38.0	-	-
DT56	High St.	RS	451576	206232	3	31.0	-	-
DT57	Speedwell St. / St. Aldate's	RS	451408	205805	3	27.0	-	-
DT58	Folly Bridge	RS	451436	205529	3	23.0	-	-
DT59	Thames St.	RS	451353	205643	3	17.0	-	-
DT60	New Butterwyke P./ Thames St.	RS	451245	205707	3	20.0	-	-
DT64	Thames St. / Oxpens Rd.	RS	450887	205824	3	13.0	-	-
DT65	Speedwell St. / Littlegate	RS	451206	205779	3	20.0	-	-
DT68	Norfolk St.	RS	451031	205962	3	22.0	-	-
DT69	Paradise Square	RS	450982	205973	3	16.0	-	-
DT70	Castle St.	RS	451062	206067	3	18.0	-	-
DT71	BP City Motors	RS	449617	210216	3		-	-
DT72	Cowley Rd./ James Street	RS	452759	205745	3	23.0	-	-
DT73	Walton Street LP18	RS	450960	206590	3	15.0	-	-
DT76	St Gilles	RS	451228	206504	3	23.0	-	-
DT77	St Clements 2	RS	452453	206000	3	34.0	-	-
DT79	Old Abingdon Rd.	RS	451908	203918	3	17.0	-	-
DT80	Hollow way Road	RS	454651	204270	3	31.0	-	-
DT81	Cowley Rd/ Union Street	RS	452805	205731	3	16.0	-	-
DT82	Summertown Parade	RS	450810	208970	3	17.0	-	-
DT83	A44 Woodstock Rd.	RS	449678	210261	2	27.0	-	-
DT84	226 Botley Rd.	RS	449273	206282	3	15.0	-	-
DT85	St Clements 3	RS	452625	206068	3	28.0	-	-

DT86	72 Blackbird Leys	RS	455142	202843	2	15.0	-	-
DT87	New Inn Hall St	RS	451164	206246	2	13.0	-	-
DT88	St Michaels St	RS	451205	206341	2	13.0	-	-
DT89	Turl St/Market St	RS	451439	206330	2	13.0	-	-
DT90	Rose Hill (Ashhurst Way)	RS	453367	203321	2.5	17.0	-	-
DT91	Garsington Rd (Premier Place)	RS	455267	203719	2	25.0	-	-
DT92	BB Leys (Cuddesdon Way)	RS	455702	203062	2.5	14.0	-	-
DT93	Marston Ferry Rd	RS	451363	208785	2.5	11.0	-	-
DT94	Broad St LP6	RS	451360	206427	2.2	13.0	-	-
DT95	Broad S -Lbay	RS	451433	206438	2.2	16.0	-	-
DT96	45 Oxford Road	RS	453697	203055	2.6	25.0	-	-
DT97	14 Green Road flats	RS	455538	207370	2.4	18.0	-	-
TF1	Oxey Mead Lake 1	UB	447817	210695	1.5	11.0	-	-
TF2	Oxey Mead Lake 2	RS	447945	210711	1	14.0	-	-
TF3	Oxey Mead Lake 3	RS	448247	210661	2	21.0	-	-
TF4	Wolvercote Village	RS	449145	209732	3	11.0	-	-
TF5	Wolvercote Primary School	RS	449740	209866	2.5	12.0	-	-
TF6	306 Woodstock Road	RS	450300	209379	3	13.0	-	-
TF7	339 Banbury Road	RS	450601	209633	3	21.0	-	-
TF8	191 Woodstock Road	RS	450694	208277	2.5	17.0	-	-
TF9	48 Woodstock Road	RS	451009	207199	2.5	18.0	-	-
TF10	99 Banbury Road	RS	451035	207953	2.5	18.0	-	-
TF11	9 S. Park Road	RS	451626	206890	2.5	15.0	-	-
TF12	15 Banbury Road	RS	451169	207086	3	14.0	-	-
TF13	Walton Street 76	RS	450625	207211	3	16.0	-	-
TF14	69 Kingston Road	RS	450545	207728	2.5	11.0	-	-
TF15	Park End Street	RS	450788	206268	2.5	29.0	-	-
TF16	St Aldates 61	RS	451420	205729	2	21.0	-	-
TF17	23 Iffley Rd/Stanley Rd	RS	452715	205090	2.5	20.0	-	-
TF18	143 Morrell Avenue	RS	453263	205962	2.5	13.0	-	-
TF19	Headington Hill	RS	453247	206468	2	53.0	-	-
TF20	Marston Rd/St Michaels Primary	RS	452853	206925	2.5	12.0	-	-
TF21	189 Headley Way	RS	453794	207073	2.5	18.0	-	-
TF22	255 London Rd/Gladstone Rd	RS	455153	207361	2.5	21.0	-	-

TF23	JR Hospital	RS	453861	207513	2	20.0	-	-
TF24	Marston Ferry Rd/Cherwell Drive	RS	452739	208351	2.5	12.0	-	-
TF25	39 Marsh Lane	RS	453186	208209	2.5	15.0	-	-
TF26	Northway/Cutteslowe Park	RS	451089	210174	1.5	19.0	-	-
TF27	Northern Bypass/Phillips Tyres	RS	452689	209222	1.5	32.0	-	-
TF28	Horspath Driftway	RS	455454	205164	2	18.0	-	-
TF29	109 Old Road	RS	455137	206374	2.5	13.0	-	-
TF30	99 Oliver Road	RS	455403	204260	2.5	25.0	-	-
TF31	Brasenose Farm/Eastern Bypass	RS	455600	204985	2	34.0	-	-
TF32	22 Garsington Road	RS	454690	204160	3	17.0	-	-
TF33	119 Barns Road	RS	454490	203748	2.5	16.0	-	-
TF34	Oxford Road/Newmans Road	RS	453717	203250	2.5	27.0	-	-
TF35	67 Southern Bypass Rd	RS	448987	205733	2.5	42.0	-	-
TF36	Wolvercote Meadows 1	RS	448091	208830	1.5	29.0	-	-
TF37	Wolvercote Meadows 2	RS	448689	210122	2	26.0	-	-
TF38	Church Cowley Rd	RS	453416	204025	2	21.0	-	-
LT1	26 Prince St	RS	452786	205860	2.5	11.0	-	-
LT2	1A Woodlands Rd	RS	453927	207068	2.5	10.0	-	-
LT3	47 Quarry Rd	RS	455307	206689	2.5	12.0	-	-
LT4	138-146 Morrell Av	RS	453575	206037	2.5	12.0	-	-
LT5	189 Divinity Rd	RS	453576	205938	2.5	10.0	-	-
LT6	St Christophers school	UB	454473	204588	2.5	10.0	-	-
LT7	126 The Slade	RS	454929	206286	2.5	19.0	-	-
LT8	East Oxford Primary School	UB	452903	205776	2.5	12.0	-	-
LT9	4 Quarry school	RS	455447	206966	2.5	11.0	-	-
LT10	23 Gladstone Rd	RS	455243	207170	2.5	10.0	-	-
LT11	19 Wharton Rd	RS	454917	207054	2.5	11.0	-	-
LT12	Ruskin Hall	RS	454260	207740	2.5	15.0	-	-
LT13	21 Latimer Rd	RS	454221	206796	2.5	11.0	-	-
LT14	94 Howard St	RS	453138	204917	2.5	11.0	-	-
LT15	96 Valentia Rd	RS	454013	206437	2.5	10.0	-	-
LT16	103-139 Hurst St	RS	452985	205185	2.5	11.0	-	-
1	Banbury - Ermont Way 1	RS	446828	241589	2.5	23.5	-	-
2	Banbury - Ermont Way 2	RS	446997	241315	2.5	27.3	-	-

3	Banbury - Hennef Way 1	RS	446540	241723	2.0	64.9	-	-
4	Banbury - Hennef Way 2	RS	446540	241723	2.5	64.6	-	-
5	Banbury - Stroud Close 1	RS	446334	241676	2.5	21.3	-	-
6	Banbury - Middleton Road	KS	446248	240715	2.2	28.8	-	-
7	Banbury - Bridge Street	KS	445960	240594	2.0	25.8	-	-
8	Banbury - Cherwell Street	RS	445931	240499	2.2	29.9	-	-
9	Adderbury - The Green	KS	447404	235735	2.0	18.3	-	-
10	Bloxham - Bloxham Hill	RS	443006	235746	2.2	28.0	-	-
11	Bloxham - Church Street	KS	442940	235593	2.2	27.1	-	-
12	Banbury - Cranleigh Close	UB	444366	239654	2.0	9.7	-	-
13	Banbury - Oxford Road/South Bar	KS	445332	240100	2.2	28.0	-	-
14	Banbury - High Street	KS	445406	240423	2.0	30.8	-	-
15, 16, 17	Banbury - Horsefair/North Bar 3	RS	445353	240577	2.9	31.1	-	-
18	Banbury - North Bar	KS	445346	240770	2.5	28.3	-	-
19	Banbury - Sinclair Avenue	UB	444274	241289	2.0	12.0	-	-
20	Ardley	RS	454302	227497	2.0	17.9	-	-
21	Middleton Stoney	RS	453397	223515	2.0	25.0	-	-
22	Kidlington - Bramley Close	RS	450322	213587	2.5	18.1	-	-
23, 24	Kidlington - Bicester Road 2	RS	450267	213511	2.5	26.7	-	-
25	Kidlington - Oxford Road	RS	449110	213962	2.5	23.0	-	-
26	Kidlington - Benmead Road	UB	449172	214325	2.5	8.0	-	-
27, 28, 29	Bicester - Queens Avenue/Kings End 3	KS	458028	222471	2.5	29.6	-	-
30	Bicester - Kings End South	RS	458007	222404	2.5	32.2	-	-
31	Bicester - Villiers Road	UB	457619	222535	2.7	12.2	-	-
32	Bicester - Tamarisk Gardens	UB	458333	224432	2.5	12.9	-	-
33	Bicester - Aylesbury Rd	RS	459102	221193	2.5	18.3	-	-
34	Bicester - London Road	RS	458720	222113	2.5	20.5	-	-
35	Bicester - St Johns	KS	458311	222721	2.5	25.7	-	-
36	Bicester - Field Street	KS	458214	222836	2.5	25.9	-	-
37	Bicester - North Street	KS	458274	222935	2.5	28.8	-	-
NAS1	25 Bridge Street, Witney	RS	435871	210319	2.3	31.6	-	-
NAS2	10 Bridge Street, Witney	RS	435820	210244	2.6	27.1	-	-
NAS3	20 Bridge Street, Witney	RS	435848	210280	2.3	29.3	-	-
NAS4	9 Mill Street, Witney	RS	435682	210195	2.7	21.8	-	-

NAS5	4A West End, Witney	RS	435913	210364	2.3	24.2	-	-
NAS6	Woodgreen Hill,Witney	RS	435952	210360	2.3	25.6	-	-
NAS7	Newland, Witney	RS	435935	210341	2.3	24.4	-	-
NAS9	A40 j/w Southleigh Turn	RS	440082	210435	2.2	12.8	-	-
NAS10	Park Street, Bladon	RS	444789	214678	2.7	18.7	-	-
NAS11	Heath Lane, Bladon	Rural	427758	206141	2.2	7.8	-	-
NAS12	Grove Rd, Bladon	RS	444864	214966	2.3	11.2	-	-
NAS13	3 Hensington Road, Woodstock (New from 1/1/19)	UB	444675	216726	2.7	14.0	-	-
NAS14B	42 Oxford Street, Woodstock (new 06/01/2022)	RS	444576	216800	2.5	12.9	-	-
NAS15	Woodstock, Rosamund Drive	UB	444182	217345	2.3	6.5	-	-
NAS16	Withers Way, Chipping Norton	UB	431203	226866	2.4	5.4	-	-
NAS17	West St , Chipping Norton	RS	431302	226974	2.7	15.3	-	-
NAS21	7 Horsefair, Chipping Norton	RS	431442	227283	2.7	13.3	-	-
NAS22	Horsefair (opp No.7), Chipping Norton	RS	431440	227325	2.4	32.2	-	-
NAS23	Lower High Street, Burford	RS	425184	212443	2.3	19.3	-	-
NAS24	High Street (Near Barclays Bank),Burford	RS	425152	212178	2.2	15.6	-	-
NAS25A	Black Bourton Road, Carterton (new 06/01/2022)	UB	428154	206588	2.5	10.5	-	-
NAS40	Witney Road, Eynsham (New 1/5/19)	RS	442725	209942	2.4	11.7	-	-
NAS41	Hanborough Road, Eynsham. (New 1/5/19)	RS	443663	210018	2.3	12.6	-	-
NAS44	83 Oxford Hill, Witney (New from 06/01/21)	RS	436759	209828	2.3	14.7	-	-
NAS45, NAS46, NAS47	23 High St Chipping Norton (new 06/05/2021)	RS	431406	227207	2.3	19.6	-	-
Abingdon CA	Masons 39 Stert St Abingdon	RS	449790	197180	3	18	-	-
Wallingford CA	Wallingford 83 High St	RS	460735	189493	1.5	32	-	-
Henley CA	Henley 45 Duke St	RS	476115	182531	1.5	17	-	-
Watlington CA	Watlington Town hall	KS	468975	194486	1.5	23	-	-
Marcham CA	10 Packhorse Lane, Marcham	KS	445550	196640	1.5	35	-	-
SS1	SS1 - Wheatley- 50 High Street	KS	459532	205740	2.0	15.1	-	-
SS2	SS2 - Wheatley- 2 Old London Road	KS	460228	205720	2.0	13.9	-	-

SS3	SS3 - Wheatley- 16 Old London Road	KS	460503	205642	1.5	15.4	-	-
SS4	SS4 - Thame- 41 Aylesbury Road	RS	470606	206554	2.0	25.7	-	-
SS5	SS5 - Thame- 16 Park Street	KS	471009	205599	2.0	16.3	-	-
SS6	SS6 - Thame- 2 Youens Drive (Jane Morbey Rd)	RS	471103	205107	2.0	9.2	-	-
SS7	SS7 - Thame- 3 Massey Road	KS	471155	205016	2.0	9.5	-	-
SS8	SS8 - Thame- 2 Robin Gibb Road	KS	471078	204851	2.0	9.3	-	-
SS9	SS9 - Thame- 12 Markus Avenue	KS	470964	204914	2.0	8.5	-	-
SS10	SS10 - Thame- 1 Thame Park Road (The Falcon)	KS	471213	205340	2.0	12.3	-	-
SS11	SS11 - Thame- Opp 1 Howland Road	KS	471923	204937	2.0	14.3	-	-
SS12	SS12 - Thame- Churchill Crescent, Kingsey Road	RS	471693	205810	2.0	12.9	-	-
SS13	SS13 - Thame- 1 Ludlow Drive	RS	471283	205977	2.0	9.4	-	-
SS14	SS14 - Chinnor- 49 Mill Lane	KS	474930	201039	2.0	9.7	-	-
SS15	SS15 - Chinnor- 3 Lower Road	RS	475250	201231	2.0	15.9	-	-
SS16	SS16 - Chinnor- 35 High Street	KS	475703	201120	2.0	11.6	-	-
SS17	SS17 - Chinnor- 20 Church Road	KS	475720	200930	2.0	13.4	-	-
SS18	SS18 - Chinnor- 31 Station Road	RS	475420	200939	2.0	15.9	-	-
SS19	SS19 - Chinnor- Plum Cottage, Crowell Road	KS	475001	200196	2.0	18.1	-	-
SS20	SS20 - Whitchurch - 1Duchess Close	RS	470207	200190	2.0	16.3	-	-
SS21	SS21 - Whitchurch - Hawthorn House	KS	463527	177174	2.0	16.4	-	-
SS22	SS22 - 10 Adwell Cottages, OX9 7DF	KS	463549	177081	2.0	21.9	-	-
SS23	SS23 - Little Milton- 63 High Street, Plumtree Cottage	KS	461901	200997	2.0	19.0	-	-
SS24	SS24 - Stadhampton- 2 Cratlands Close	KS	460279	198618	2.0	13.4	-	-
SS25	SS25 - Stadhampton- Holme Cottage, Newington Road	KS	460163	198400	2.0	16.3	-	-
SS26	SS26 - Watlington- 17 St Leonards Close	UB	468479	194721	2.0	7.5	-	-
SS27	SS27 - Watlington- 27 Brook Street	KS	468757	194361	2.0	17.9	-	-
SS28	SS28 - Watlington- 57 Brook Street	RS	468856	194293	2.0	16.4	-	-
SS29	SS29 - Watlington- 9 Couching Street	RS	468852	194343	2.0	16.4	-	-
SS30	SS30 - Watlington- 41 Couching Street	KS	468951	194457	2.0	27.9	-	-
SS31	SS31 - Watlington- 48-52 Couching Street	KS	468962	194458	2.0	26.4	-	-
SS32	SS32 - Watlington- 23 Shirburn Street	KS	469061	194590	2.0	20.5	-	-
SS33	SS33 - Watlington- 8 Shirburn Street	KS	469017	194514	2.0	25.3	-	-
SS34	SS34 - Benson- 11A Watlington Road	KS	461726	191784	2.0	18.6	-	-
SS35	SS35 - Wallingford- 3A The Street (Crowmarsh Gifford)	KS	461298	189367	2.0	14.3	-	-
SS36	SS36 - Wallingford- 2 Station Road	RS	460390	189500	2.0	20.1	-	-

SS37	SS37 - Wallingford- 68 High Street	KS	460640	189483	2.0	21.7	-	-
SS38	SS38 - Wallingford- 33 Castle Street	KS	460736	189558	2.0	22.4	-	-
SS39, SS40, SS41	SS41 - Wallingford, George Hotel, High Street	RS	460799	189500	1.5	28.5	-	-
SS42	SS42 - Wallingford- 102 High Street	RS	460938	189496	2.0	23.8	-	-
SS43	SS43 - Wallingford- 52 St Marys Street	RS	460715	189279	2.0	21.0	-	-
SS44	SS44 - Wallingford- 10 St Martins Street	RS	460680	189202	2.0	16.5	-	-
SS45	SS45 - Wallingford- 19 St Johns Road	KS	460152	189130	2.0	11.4	-	-
SS46	SS46 - Wallingford- 57 Brookmead Drive	UB	460282	188807	2.0	9.9	-	-
SS47	SS47 - Wallingford- Bartlett Close, Reading Road	UB	460470	188224	2.0	13.3	-	-
SS48	SS48 - Wallingford- The Lodge, Wallingford Rd OX10 9HB	RS	460110	187863	1.0	11.6	-	-
SS49	SS49 - Wallingford- Willow Cottage, 68 Wallingford Road OX10 9LA	RS	459805	187574	2.0	11.9	-	-
SS50	SS50 - Wallingford- Newnham Manor Farm, A4070	RS	461917	188424	1.5	21.7	-	-
SS51	SS51 - Henley- 82 Northfield End	RS	475868	183221	2.0	15.7	-	-
SS52	SS52 - Henley- 39 Kings Road	KS	475900	182756	2.0	13.8	-	-
SS53	SS53 - Henley- 2 Greys Road	KS	476111	182508	2.0	22.6	-	-
SS54	SS54 - Henley-35 Reading Road	RS	476174	182396	2.0	18.8	-	-
SS55	SS55 - Henley- Imperial Court, Station Road	RS	476287	182288	2.0	15.5	-	-
SS56, SS57, SS58	SS58 - Henley- 45 Duke Street	RS	476114	182532	1.5	17.8	-	-
SS59	SS59 - Henley- 4 Duke Street	KS	476076	182612	2.0	31	-	-
SS60	SS60 - Henley- 23 Market Place	RS	475997	182614	2.0	14.6	-	-
SS61	SS61 - Henley- 82 Bell Street	KS	476080	182951	2.0	21	-	-
SS62	SS62 - Henley- 33 New Street	KS	476209	182831	2.0	16	-	-
SS63	SS63 - Henley- 23 Thameside	RS	476310	182760	2.0	23.9	-	-
SS64	SS64 - Henley- 40 Hart Street	RS	476291	182074	2.0	20.7	-	-
SS65	SS65 - Henley- Upton Close, St Andrews Road	RS	476223	182651	2.0	15.6	-	-
SS66	SS66 - Henley- 178 Reading Road	RS	476549	181736	2.0	16.7	-	-
SS67	SS67 - Henley- 15 Lovell Close	UB	475104	181557	2.0	6.6	-	-
SS68	SS68 - Didcot- 8 Lune Close	UB	453499	190384	2.0	11	-	-

SS69	SS69 - Didcot- Marsh Play Area	KS	453357	190030	2.0	19	-	-
SS70	SS70 - Didcot- 55 Broadway	RS	453099	190031	2.0	22.1	-	-
SS71	SS71 - Didcot- 77 Broadway	RS	453023	189999	2.0	26.8	-	-
SS72	SS72 - Didcot- 110 Broadway	RS	452865	189979	2.0	19.8	-	-
SS73	SS73 - Didcot- 18 Mereland Road	KS	452753	189729	2.0	10.7	-	-
SS74	SS74 - Didcot- 4 Cronshaw Close	KS	452358	190521	2.0	17.2	-	-
SS75	SS75 - Didcot- 8 Great Western Drive, Station Road	RS	452084	190694	2.0	19.9	-	-
SS76	SS76 - Didcot- 20 Wantage Road	KS	451780	189920	2.0	19.6	-	-
SS77	SS77 - Didcot- 100 Park Road	KS	451643	189369	2.0	12.5	-	-
SS78	SS78 - Didcot- 1 Blackthorn Road	KS	450860	190477	2.0	15.9	-	-
SS79	SS79 - Didcot-6 Mendip Heights	RS	451424	190943	1.5	11.9	-	-
SS80	SS80 - Clifton Hampden- Bus stop, Abingdon Road	RS	454637	195614	2.0	14.8	-	-
SS81	SS81 - Clifton Hampden- Marsh Cottages, Post Office	RS	454710	195562	2.0	16.8	-	-
SS82	SS82 - Clifton Hampden- 52 Oxford Road	RS	454760	195794	2.0	13.5	-	-
SS83	SS83 - Horspath	RS	457228	204710	2.0	11.3	-	-
SS84	SS84 - Chinnor- Station	Other	449793	197175	1.0	-	-	-
VS1, VS2, VS3	VS3: Co-location, Masons Stert Street, Abingdon	RS	449695	197049	3.0	17.4	-	-
VS4	VS4: High Street, Abingdon	RS	449452	197047	2.5	23	-	-
VS5	VS5: Ock Street Baptist Church, Abingdon	RS	449699	197342	2.5	19.9	-	-
VS6	VS6: Stratton Way, Abingdon	RS	448091	198059	2.5	30.2	-	-
VS7	VS7: Barrow Road Shippon	RS	448869	196180	2.5	10.9	-	-
VS8	VS8: Turner Road, Abingdon	UB	448791	196725	2.5	8.2	-	-
VS9	VS9: Drayton Road LP 7, Abingdon	RS	448829	196965	2.5	23.5	-	-
VS10	VS10: Ock Street Drama Club, Abingdon	RS	448738	196967	2.5	20.5	-	-
VS11	VS11: Marcham Road LP 5, Abingdon	RS	449236	196993	2.5	29.4	-	-
VS12	VS12: 97 Ock Street LP 12, Abingdon	RS	448150	198190	2.5	21.2	-	-
VS13	VS13 Whitehorse Close Shippon	UB	448349	198086	2.5	8	-	-
VS14	VS14 Faringdon Road Shippon	RS	445522	196470	2.5	16.2	-	-
VS15	VS15: 24 Mill Road, Marcham	UB	445550	196640	1.8	6.1	-	-
VS16	VS16: 10 Packhorse Lane, Marcham	KS	445456	196623	2.5	29.8	-	-
VS17	VS17: 4 Frilford Road, Marcham	RS	445528	196628	2.5	25.3	-	-
VS18	VS18: 4 Packhorse Lane, Marcham	KS	445571	196675	2.5	17.8	-	-
VS19	VS19: 13 Packhorse Lane, Marcham	RS	445875	196657	2.5	24.1	-	-

VS20	VS20: Rafters B&B Abingdon Road, Marcham	KS	448913	205813	2.5	19.9	-	-
VS21	VS21: Stanley Close, Botley	KS	448866	205807	2.5	32.2	-	-
VS22	VS22: Westminster Way, Botley	RS	448403	205709	2.5	24.1	-	-
VS23	VS23: Hutchcomb Road, Botley	UB	449028	205704	2.5	9.0	-	-
VS24	VS24: 4 Yarnells Road The Willows Downpipe, Botley	RS	449026	205701	2.5	-	-	-
VS25	VS25: 4 Yarnells Road The Willows Fence, Botley	RS	448894	205826	2.0	53.7	-	-
VS26	VS26: 61 Southern Bypass, Botley	RS	448917	205804	2.0	25.5	-	-
VS27	VS27: 63 Southern Bypass, Botley	RS	448991	205745	2.0	24.4	-	-
VS28	VS28: 71 Southern Bypass (Flats), Botley	RS	448946	205780	2.5	21.9	-	-
VS29	VS29: 65 Southern Bypass (Timbers), Botley	RS	448914	205798	2.0	24.2	-	-
VS30	VS30: 63 Southern Bypass (fence), Botley	RS	449585	197273	2.5	50.5	-	-
VS31	VS31: Bath Street, Abingdon	KS	428682	194571	2.5	18.5	-	-
VS32	VS32: Folly View Road, Faringdon	UB	428826	195554	2.5	7.5	-	-
VS33	VS33: Town Hall / Central Faringdon, Faringdon	KS	450886	194359	2.5	14.1	-	-
VS34	VS34: Sutton Courtenay Junction, Sutton Courtenay	KS	450588	194391	2.0	17.3	-	-
VS35	VS35: Sutton Courtenay Mill House downpipe, Sutton Courtenay	KS	424275	190640	2.5	17.3	-	-
VS36	VS36: Watchfield / Shrivenham, Watchfield	KS	448364	197836	2.5	16.4	-	-
VS37	VS37: Copenhagen Drive, Abingdon	KS	439807	187941	2.5	20.9	-	-
VS38	VS38: Market Square / Central Wantage, Wantage	KS	440409	188319	2.5	17.5	-	-
VS39	VS39: Hampden Road, Wantage	UB	442239	198622	2.1	7.2	-	-
VS40	VS40: Fyfield A420, Fyfield & Tubney	RS	443526	199184	2.5	13.6	-	-
VS41	VS41: Tubney bus stop A420, Fyfield & Tubney	KS	452253	202255	2.0	13.9	-	-
VS42	VS42: St Swithun Church Kennington Post 35, Botley	KS	452290	201912	2.5	13.7	-	-
VS43	VS43: St Swithun School Kennington LP68, Botley	UB	440068	189087	2.5	14.2	-	-
VS44	VS44: Grove Rd/ Wolage Dr, Wantage	RS	448437	196955	2.5	21.4	-	-
VS45	VS45: Henry Liddon House, Abingdon	RS	449518	197160	2.5	25.6	-	-
VS46	VS46: CYPS (Stratton Way), Abingdon	RS	450764	204105	2.5	13.1	-	-
VNWC S1	VNWCS1: Manor Rd S. Hinksey, Botley	KS	449404	205422	2.0	20.2	-	-
VNWC S2	VNWCS2: N. Hinksey La speed sign, Botley	RS	449558	199016	2.5	15.6	-	-
VNWC S3	VNWCS3: Lamppost 35 Dunmore Rd, Abingdon	KS	450222	199464	2.5	16.7	-	-
VNWC S4	VNWCS4: Lamppost 9 Dunmore Rd, Abingdon	RS	448612	206290	2.5	19.1	-	-
VNWC S5	VNWCS5: Botley Primary School, Botley	RS	446273	202345	2.5	16.2	-	-
VNWC S6	VNWCS6: Rockley Cottages A420, Botley	KS	451357	206156	2.0	20.2	-	-

Table A.0.2: Model verification for annual average NO_2 concentrations, 2023

Site ID	Site Type	Inlet Height (m)	Modelled NO_2 (µg/m³)	Monitored NO_2 (µg/m³)	Modelled / Monitored
CM1	RS	2.5	24.6	31	79%
CM2	RS	1.5	24.2	27	89%
CM3	UB	2.5	12.5	9	139%
DT1	UB	2.5	12.5	9	139%
DT2	RS	3	17.4	18	97%
DT3	RS	3	16.4	24	68%
DT4	RS	3	19.7	23	85%
DT5	UB	1.5	12.3	8	154%
DT7	RS	3	20.3	28	73%
DT8	RS	3	23.2	25	93%
DT14	RS	3	21.2	27	79%
DT15	RS	3	21.6	21	103%
DT16	RS	3	17.7	18	98%
DT18	RS	3	16.1	20	81%
DT20	RS	3	14.2	18	79%
DT25	RS	3	20.9	24	87%
DT26	RS	3	21.9	28	78%
DT27	RS	3	20.2	19	106%
DT28	RS	3	17.8	20	89%
DT29	RS	3	17.0	18	95%
DT30	RS	3	18.7	17	110%
DT31	RS	3	16.9	17	99%
DT32	RS	3	21.4	21	102%
DT33	RS	3	14.9	16	93%
DT35	RS	3	19.4	19	102%
DT36	RS	3	16.0	13	123%
DT39	RS	2.5	24.6	32	77%
DT40	RS	3	17.4	21	83%
DT41	RS	3	17.3	20	86%
DT42	RS	3	17.9	22	81%
DT43	RS	3	20.0	24	83%
DT44	RS	3	24.5	18	136%
DT45	RS	3	24.7	25	99%
DT46	RS	3	23.5	18	131%
DT47	RS	3	20.1	25	80%
DT48	RS	3	19.4	21	92%
DT49	RS	3	15.5	16	97%
DT50	RS	3	25.5	21	121%
DT51	RS	3	21.8	25	87%
DT52	RS	3	19.1	26	74%
DT53	RS	3	18.0	16	113%
DT55	RS	3	31.8	38	84%
DT56	RS	3	26.1	31	84%
DT57	RS	3	22.7	27	84%
DT58	RS	3	20.1	23	87%
DT59	RS	3	17.4	17	102%
DT60	RS	3	16.1	20	80%
DT64	RS	3	15.2	13	117%
DT65	RS	3	18.9	20	95%
DT68	RS	3	19.7	22	89%
DT69	RS	3	14.6	16	91%
DT70	RS	3	18.7	18	104%

DT71	RS	3	19.1	-	-
DT72	RS	3	20.4	23	89%
DT73	RS	3	15.5	15	103%
DT76	RS	3	17.7	23	77%
DT77	RS	3	33.5	34	99%
DT79	RS	3	13.7	17	81%
DT80	RS	3	20.9	31	67%
DT81	RS	3	14.1	16	88%
DT82	RS	3	15.9	17	94%
DT83	RS	2	24.4	27	90%
DT84	RS	3	15.3	15	102%
DT85	RS	3	27.1	28	97%
DT86	RS	2	13.2	15	88%
DT87	RS	2	15.5	13	119%
DT88	RS	2	15.7	13	121%
DT89	RS	2	15.9	13	122%
DT90	RS	2.5	14.2	17	84%
DT91	RS	2	27.7	25	111%
DT92	RS	2.5	15.5	14	111%
DT93	RS	2.5	14.0	11	128%
DT94	RS	2.2	16.0	13	123%
DT95	RS	2.2	16.0	16	100%
DT96	RS	2.6	20.4	25	82%
DT97	RS	2.4	17.2	18	95%
TF1	UB	1.5	12.7	11	115%
TF2	RS	1	13.9	14	99%
TF3	RS	2	13.5	21	64%
TF4	RS	3	12.1	11	110%
TF5	RS	2.5	12.0	12	100%
TF6	RS	3	14.9	13	114%
TF7	RS	3	16.5	21	79%
TF8	RS	2.5	17.5	17	103%
TF9	RS	2.5	18.3	18	102%
TF10	RS	2.5	15.4	18	86%
TF11	RS	2.5	19.6	15	131%
TF12	RS	3	16.1	14	115%
TF13	RS	3	14.9	16	93%
TF14	RS	2.5	12.7	11	115%
TF15	RS	2.5	20.1	29	69%
TF16	RS	2	17.0	21	81%
TF17	RS	2.5	17.1	20	85%
TF18	RS	2.5	14.7	13	113%
TF19	RS	2	33.6	53	63%
TF20	RS	2.5	14.2	12	118%
TF21	RS	2.5	13.9	18	77%
TF22	RS	2.5	18.6	21	89%
TF23	RS	2	13.6	20	68%
TF24	RS	2.5	13.3	12	110%
TF25	RS	2.5	16.2	15	108%
TF26	RS	1.5	15.2	19	80%
TF27	RS	1.5	16.8	32	53%
TF28	RS	2	18.9	18	105%
TF29	RS	2.5	19.5	13	150%
TF30	RS	2.5	24.9	25	99%
TF31	RS	2	21.2	34	62%
TF32	RS	3	18.8	17	110%

TF33	RS	2.5	18.0	16	113%
TF34	RS	2.5	22.0	27	82%
TF35	RS	2.5	22.8	42	54%
TF36	RS	1.5	25.4	29	88%
TF37	RS	2	26.4	26	101%
TF38	RS	2	17.1	21	82%
LT1	RS	2.5	13.4	11	121%
LT2	RS	2.5	13.4	10	134%
LT3	RS	2.5	14.7	12	122%
LT4	RS	2.5	15.1	12	125%
LT5	RS	2.5	12.8	10	128%
LT6	UB	2.5	13.4	10	134%
LT7	RS	2.5	18.9	19	99%
LT8	UB	2.5	13.3	12	111%
LT9	RS	2.5	14.9	11	136%
LT10	RS	2.5	13.3	10	133%
LT11	RS	2.5	14.5	11	132%
LT12	RS	2.5	13.7	15	91%
LT13	RS	2.5	15.0	11	136%
LT14	RS	2.5	12.6	11	114%
LT15	RS	2.5	15.1	10	151%
LT16	RS	2.5	12.6	11	115%
1	RS	2.5	20.9	23.5	89%
2	RS	2.5	18.7	27.3	68%
3	RS	2	28.2	64.9	43%
4	RS	2.5	27.8	64.6	43%
5	RS	2.5	21.7	21.3	102%
6	KS	2.2	20.2	28.8	70%
7	KS	2	20.9	25.8	81%
8	RS	2.2	19.7	29.9	66%
9	KS	2	14.8	18.3	81%
10	RS	2.2	16.9	28	60%
11	KS	2.2	20.6	27.1	76%
12	UB	2	10.1	9.7	105%
13	KS	2.2	22.1	28	79%
14	KS	2	23.6	30.8	77%
15, 16, 17	RS	2.9	24.4	31.1	78%
18	KS	2.5	22.7	28.3	80%
19	UB	2	12.4	12	104%
20	RS	2	19.0	17.9	106%
21	RS	2	19.5	25	78%
22	RS	2.5	20.0	18.1	110%
23, 24	RS	2.5	20.6	26.7	77%
25	RS	2.5	16.5	23	72%
26	UB	2.5	12.7	8	159%
27, 28, 29	KS	2.5	34.0	29.6	115%
30	RS	2.5	33.6	32.2	104%
31	UB	2.7	13.7	12.2	113%
32	UB	2.5	13.1	12.9	101%
33	RS	2.5	15.3	18.3	83%
34	RS	2.5	18.3	20.5	89%
35	KS	2.5	22.1	25.7	86%
36	KS	2.5	30.6	25.9	118%
37	KS	2.5	36.0	28.8	125%
NAS1	RS	2.3	35.6	31.6	113%
NAS2	RS	2.6	32.6	27.1	120%

NAS3	RS	2.3	32.7	29.3	111%
NAS4	RS	2.7	20.4	21.8	93%
NAS5	RS	2.3	19.8	24.2	82%
NAS6	RS	2.3	20.4	25.6	80%
NAS7	RS	2.3	30.8	24.4	126%
NAS9	RS	2.2	14.2	12.8	111%
NAS10	RS	2.7	15.9	18.7	85%
NAS11	Rural	2.2	8.6	7.8	110%
NAS12	RS	2.3	20.1	11.2	179%
NAS13	UB	2.7	15.0	14	107%
NAS14B	RS	2.5	11.4	12.9	88%
NAS15	UB	2.3	10.9	6.5	168%
NAS16	UB	2.4	8.4	5.4	155%
NAS17	RS	2.7	13.9	15.3	91%
NAS21	RS	2.7	11.3	13.3	85%
NAS22	RS	2.4	33.6	32.2	104%
NAS23	RS	2.3	14.7	19.3	76%
NAS24	RS	2.2	14.4	15.6	93%
NAS25A	UB	2.5	10.5	10.5	100%
NAS40	RS	2.4	15.0	11.7	128%
NAS41	RS	2.3	12.7	12.6	101%
NAS44	RS	2.3	14.2	14.7	97%
NAS45, NAS46, NAS47	RS	2.3	25.2	19.6	128%
Abingdon CA	RS	3	22.1	18	123%
Wallingford CA	RS	1.5	24.4	32	76%
Henley CA	RS	1.5	18.2	17	107%
Watlington CA	KS	1.5	26.2	23	114%
Marcham CA	KS	1.5	25.5	35	73%
SS1	KS	2	16.4	15.1	108%
SS2	KS	2	14.2	13.9	102%
SS3	KS	1.5	13.9	15.4	90%
SS4	RS	2	15.2	25.7	59%
SS5	KS	2	17.2	16.3	106%
SS6	RS	2	11.5	9.2	125%
SS7	KS	2	11.8	9.5	125%
SS8	KS	2	11.3	9.3	122%
SS9	KS	2	11.1	8.5	130%
SS10	KS	2	14.0	12.3	114%
SS11	KS	2	14.0	14.3	98%
SS12	RS	2	13.6	12.9	105%
SS13	RS	2	11.8	9.4	125%
SS14	KS	2	10.1	9.7	104%
SS15	RS	2	12.7	15.9	80%
SS16	KS	2	11.3	11.6	98%
SS17	KS	2	12.1	13.4	90%
SS18	RS	2	14.2	15.9	89%
SS19	KS	2	11.4	18.1	63%
SS20	RS	2	20.7	16.3	127%
SS21	KS	2	9.6	16.4	59%
SS22	KS	2	9.2	21.9	42%
SS23	KS	2	17.7	19.0	93%
SS24	KS	2	17.0	13.4	127%
SS25	KS	2	14.4	16.3	88%
SS26	UB	2	9.5	7.5	127%
SS27	KS	2	12.8	17.9	72%

SS28	RS	2	12.4	16.4	76%
SS29	RS	2	20.2	16.4	123%
SS30	KS	2	30.3	27.9	109%
SS31	KS	2	10.4	26.4	40%
SS32	KS	2	19.4	20.5	95%
SS33	KS	2	29.7	25.3	117%
SS34	KS	2	15.9	18.6	85%
SS35	KS	2	14.8	14.3	104%
SS36	RS	2	15.3	20.1	76%
SS37	KS	2	19.8	21.7	91%
SS38	KS	2	18.9	22.4	85%
SS39, SS40, SS41	RS	1.5	22.7	28.5	80%
SS42	RS	2	17.8	23.8	75%
SS43	RS	2	18.2	21.0	87%
SS44	RS	2	17.1	16.5	104%
SS45	KS	2	13.8	11.4	121%
SS46	UB	2	10.6	9.9	107%
SS47	UB	2	11.8	13.3	89%
SS48	RS	1	9.8	11.6	85%
SS49	RS	2	9.2	11.9	77%
SS50	RS	1.5	12.8	21.7	59%
SS51	RS	2	13.2	15.7	84%
SS52	KS	2	11.4	13.8	83%
SS53	KS	2	22.2	22.6	98%
SS54	RS	2	16.1	18.8	86%
SS55	RS	2	19.8	15.5	128%
SS56, SS57, SS58	RS	1.5	18.2	17.8	102%
SS59	KS	2	20.9	31	67%
SS60	RS	2	16.1	14.6	110%
SS61	KS	2	19.5	21	93%
SS62	KS	2	17.0	16	106%
SS63	RS	2	16.7	23.9	70%
SS64	RS	2	13.4	20.7	65%
SS65	RS	2	18.3	15.6	117%
SS66	RS	2	14.2	16.7	85%
SS67	UB	2	8.2	6.6	125%
SS68	UB	2	11.8	11	107%
SS69	KS	2	16.7	19	88%
SS70	RS	2	20.5	22.1	93%
SS71	RS	2	19.7	26.8	74%
SS72	RS	2	19.4	19.8	98%
SS73	KS	2	11.3	10.7	106%
SS74	KS	2	12.7	17.2	74%
SS75	RS	2	18.8	19.9	94%
SS76	KS	2	15.8	19.6	80%
SS77	KS	2	13.1	12.5	105%
SS78	KS	2	13.3	15.9	84%
SS79	RS	1.5	14.7	11.9	124%
SS80	RS	2	15.5	14.8	105%
SS81	RS	2	15.5	16.8	92%
SS82	RS	2	16.6	13.5	123%
SS83	RS	2	17.1	11.3	151%
SS84	UB	1	8.4	-	-
VS1, VS2, VS3	RS	3	22.1	17.4	127%

VS4	RS	2.5	22.7	23	99%
VS5	RS	2.5	20.6	19.9	104%
VS6	RS	2.5	20.8	30.2	69%
VS7	RS	2.5	14.7	10.9	135%
VS8	UB	2.5	12.9	8.2	157%
VS9	RS	2.5	20.9	23.5	89%
VS10	RS	2.5	19.6	20.5	96%
VS11	RS	2.5	20.2	29.4	69%
VS12	RS	2.5	19.1	21.2	90%
VS13	UB	2.5	12.4	8	155%
VS14	RS	2.5	15.5	16.2	96%
VS15	UB	1.8	9.7	6.1	159%
VS16	KS	2.5	24.0	29.8	81%
VS17	RS	2.5	16.1	25.3	63%
VS18	KS	2.5	23.2	17.8	130%
VS19	RS	2.5	24.7	24.1	103%
VS20	KS	2.5	15.9	19.9	80%
VS21	KS	2.5	20.6	32.2	64%
VS22	RS	2.5	17.9	24.1	74%
VS23	UB	2.5	12.0	9.0	134%
VS24	RS	2.5	19.4	-	-
VS25	RS	2	23.6	53.7	44%
VS26	RS	2	22.7	25.5	89%
VS27	RS	2	22.4	24.4	92%
VS28	RS	2.5	20.4	21.9	93%
VS29	RS	2	21.4	24.2	89%
VS30	RS	2.5	24.1	50.5	48%
VS31	KS	2.5	20.1	18.5	109%
VS32	UB	2.5	9.0	7.5	120%
VS33	KS	2.5	15.8	14.1	112%
VS34	KS	2	15.6	17.3	90%
VS35	KS	2.5	16.6	17.3	96%
VS36	KS	2.5	14.3	16.4	87%
VS37	KS	2.5	19.9	20.9	95%
VS38	KS	2.5	16.0	17.5	91%
VS39	UB	2.1	12.5	7.2	173%
VS40	RS	2.5	14.1	13.6	103%
VS41	KS	2	13.7	13.9	99%
VS42	KS	2.5	15.5	13.7	113%
VS43	UB	2.5	14.6	14.2	103%
VS44	RS	2.5	15.0	21.4	70%
VS45	RS	2.5	20.0	25.6	78%
VS46	RS	2.5	14.6	13.1	112%
VNWC S1	KS	2	21.1	20.2	105%
VNWC S2	RS	2.5	19.8	15.6	127%
VNWC S3	KS	2.5	15.9	16.7	95%
VNWC S4	RS	2.5	15.1	19.1	79%
VNWC S5	RS	2.5	17.5	16.2	108%
VNWC S6	KS	2	16.6	20.2	82%

Table A.0.3: Average concentrations (µg/m³) for each MSOA in Oxfordshire

MSOA name	Average NO_2 (µg/m³)	Average PM_{10} (µg/m³)	Average $PM_{2.5}$ (µg/m³)
Cherwell 001	8.6	12.8	7.4
Cherwell 002	13.3	15.9	9.8
Cherwell 003	19.0	18.3	11.6
Cherwell 004	20.1	18.1	11.4
Cherwell 005	11.4	15.1	8.9
Cherwell 006	10.9	14.2	8.2
Cherwell 007	12.2	14.8	8.6
Cherwell 008	10.2	13.4	7.6
Cherwell 009	7.7	12.8	7.3
Cherwell 010	9.5	13.5	7.5
Cherwell 011	11.7	13.7	7.8
Cherwell 012	14.1	15.7	8.9
Cherwell 013	15.7	17.6	11.0
Cherwell 014	14.2	15.5	8.7
Cherwell 015	16.5	16.5	9.9
Cherwell 016	12.6	13.6	7.9
Cherwell 017	13.3	14.8	8.9
Cherwell 018	15.1	15.1	8.9
Cherwell 019	14.5	14.8	8.9
Oxford 001	15.8	14.0	8.2
Oxford 002	12.8	13.8	8.1
Oxford 003	12.9	13.7	7.9
Oxford 004	12.4	13.6	7.9
Oxford 005	14.9	14.6	8.3
Oxford 006	14.5	14.3	8.2
Oxford 007	15.8	14.9	8.5
Oxford 008	16.0	14.7	8.2
Oxford 009	12.5	13.2	7.8
Oxford 010	15.9	14.6	8.4
Oxford 011	15.8	15.1	8.5
Oxford 012	13.8	13.8	8.1
Oxford 014	13.7	14.2	8.3
Oxford 015	14.8	14.7	8.6
Oxford 016	15.2	14.4	8.5
Oxford 017	14.3	14.2	8.4
Oxford 018	11.3	13.4	7.9
Oxford 019	14.2	14.5	8.4
Oxford 020	16.6	14.7	8.6
South Oxfordshire 001	12.7	14.1	8.3
South Oxfordshire 002	12.7	13.6	7.9
South Oxfordshire 003	11.7	13.6	8.0
South Oxfordshire 004	12.5	13.3	7.8
South Oxfordshire 005	10.2	12.9	7.5
South Oxfordshire 006	11.7	13.1	7.8
South Oxfordshire 007	10.1	12.9	7.6
South Oxfordshire 008	9.1	12.5	7.4
South Oxfordshire 009	12.4	13.9	8.1
South Oxfordshire 010	13.8	14.5	8.4
South Oxfordshire 011	8.7	12.5	7.4
South Oxfordshire 012	10.4	13.0	7.6
South Oxfordshire 013	11.6	14.3	8.3
South Oxfordshire 014	11.0	14.1	8.2
South Oxfordshire 015	8.4	12.4	7.3

South Oxfordshire 016	9.9	13.0	7.8
South Oxfordshire 017	10.5	13.4	8.0
South Oxfordshire 018	7.7	12.0	7.2
South Oxfordshire 019	7.9	12.2	7.4
South Oxfordshire 020	7.6	12.3	7.3
Vale of White Horse 001	10.8	13.4	7.8
Vale of White Horse 002	14.3	14.2	8.2
Vale of White Horse 003	11.9	13.5	7.9
Vale of White Horse 004	14.0	14.8	8.7
Vale of White Horse 005	14.2	14.9	8.8
Vale of White Horse 006	16.0	15.3	8.9
Vale of White Horse 007	9.1	12.7	7.5
Vale of White Horse 008	13.9	14.3	8.4
Vale of White Horse 009	8.7	12.9	7.5
Vale of White Horse 010	11.4	13.1	7.8
Vale of White Horse 011	9.5	13.3	8.1
Vale of White Horse 014	10.9	15.0	9.5
Vale of White Horse 015	8.8	12.4	7.4
Vale of White Horse 016	7.6	12.2	7.3
West Oxfordshire 001	8.6	13.1	7.5
West Oxfordshire 002	8.0	13.2	7.3
West Oxfordshire 003	7.2	12.4	7.2
West Oxfordshire 004	9.5	13.0	7.6
West Oxfordshire 005	8.7	12.9	7.5
West Oxfordshire 006	10.6	13.4	7.9
West Oxfordshire 007	8.8	13.0	7.6
West Oxfordshire 008	12.1	14.6	8.6
West Oxfordshire 009	11.6	14.7	8.5
West Oxfordshire 010	12.4	15.2	8.9
West Oxfordshire 011	10.1	13.1	7.7
West Oxfordshire 012	7.6	12.4	7.3
West Oxfordshire 013	9.9	13.8	8.0
West Oxfordshire 014	9.3	13.3	7.8
West Oxfordshire 015	9.1	12.8	7.5

APPENDIX B: Summary of ADMS-Urban

ADMS-Urban is a scientifically advanced but practical air pollution modelling tool, which has been developed to provide high resolution calculations of pollution concentrations for all sizes of study area relevant to the urban environment. The model can be used to look at concentrations near a single road junction or over a region extending across the whole of a major city. ADMS-Urban is used worldwide to assess air quality impact for a wide range of planning and policy studies, incorporating elements such as Low Emission Zones, traffic management, clean vehicle technologies and modal shift. In the UK, it is used extensively for air quality review and assessment carried out by local government.

The following is a summary of the capabilities and validation of ADMS-Urban. More details can be found on the CERC web site[17].

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which has been developed to investigate the impacts of emissions from industrial facilities. ADMS-Urban allows full characterisation of the wide variety of emissions in urban areas, including an extensively validated road traffic emissions model. It also includes a number of other features, which include consideration of:

- the effects of vehicle movement on the dispersion of traffic emissions;
- the behaviour of material released into street-canyons;
- the chemical reactions occurring between nitrogen oxides, ozone and Volatile Organic Compounds (VOCs);
- the pollution entering a study area from beyond its boundaries;
- the effects of complex terrain on the dispersion of pollutants;
- the effects of the urban canopy on the dispersion of pollutants; and
- the effects of a building on the dispersion of pollutants emitted nearby.

Further details of these features are provided below.

Studies of extensive urban areas are necessarily complex, requiring the manipulation of large amounts of data. To allow users to cope effectively with this requirement, ADMS-Urban runs in Windows environments. The manipulation of data is further facilitated by the ADMS-Urban Mapper, which allows for the visualisation and manipulation of geospatial information, and by the CERC Emissions Inventory Toolkit, EMIT.

[17] https://www.cerc.co.uk/environmental-software/ADMS-Urban-model.html

Dispersion Modelling

ADMS and ADMS-Urban use boundary layer similarity profiles to parameterise the variation of turbulence with height within the boundary layer, and the use of a skewed-Gaussian distribution to determine the vertical variation of pollutant concentrations in the plume under convective conditions.

The main dispersion modelling features of ADMS-Urban are as follows:
- ADMS-Urban is an **advanced dispersion model** in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This method supersedes methods based on Pasquill Stability Categories, as used in, for example, the US models Caline and ISC. Concentrations are calculated hour by hour and are fully dependent on prevailing weather conditions.
- For convective conditions, a **non-Gaussian vertical profile of concentration** allows for the skewed nature of turbulence within the atmospheric boundary layer, which can lead to high concentrations near to the source.
- A **meteorological processor** calculates boundary layer parameters from a variety of input data, typically including date and time, wind speed and direction, surface temperature and cloud cover. Meteorological data may be raw, hourly averaged or statistically analysed data.

Emissions

Emissions into the atmosphere across an urban area typically come from a wide variety of sources. There are likely to be emissions from road traffic, as well as from domestic heating systems and industrial emissions from chimneys. To represent the full range of emissions configurations, the explicit source types available within ADMS-Urban are:
- **Roads**, for which emissions are specified in terms of vehicle flows and the additional initial dispersion caused by moving vehicles is also taken into account.
- **Industrial points**, for which plume rise and stack downwash are included in the modelling.
- **Areas**, where a source or sources is best represented as uniformly spread over an area.
- **Volumes**, where a source or sources is best represented as uniformly spread throughout a volume.

In addition, sources can also be modelled as a regular grid of emissions. This allows the contributions of large numbers of minor sources to be efficiently included in a study while the majority of the modelling effort is used for the relatively few significant sources.

ADMS-Urban can be used in conjunction with CERC's Emissions Inventory Toolkit, EMIT, which facilitates the management and manipulation of large and complex data sets into usable emissions inventories.

Presentation of Results

The results from the model can be based on a wide range of averaging times, and include rolling averages. Maximum concentration values and percentiles can be calculated where appropriate meteorological input data have been input to the model. This allows ADMS-Urban to be used to calculate concentrations for direct comparison with existing air quality limits, guidelines and objectives, in whatever form they are specified.

ADMS-Urban has an integrated Mapper which facilitates both the compilation and manipulation of the emissions information required as input to the model and the interpretation and presentation of the air quality results provided. ADMS-Urban can also be integrated with ArcGIS or MapInfo.

Complex Effects - Street Canyons

ADMS-Urban incorporates two methods for representing the effect of street canyons on the dispersion of road traffic emissions: a basic canyon method based on the *Operational Street Pollution Model (OSPM)*[18], developed by the Danish National Environmental Research Institute (NERI); and an advanced street canyon module, developed by CERC. The basic canyon model was designed for simple symmetric canyons with height similar to width and assumes that road traffic emissions originate throughout the base of the canyon, i.e. that the emissions are spread across both the road and neighbouring pavements.

The advanced canyon model[19] was developed to overcome these limitations and is our model of choice. It represents the effects of channelling flow along and recirculating flow across a street canyon, dispersion out of the canyon through gaps in the walls, over the top of the buildings or out of the end of the canyon. It can take into account canyon asymmetry and restricts the emissions area to the road carriageway.

Complex Effects - Chemistry

ADMS-Urban includes the *Generic Reaction Set (GRS)*[20] atmospheric chemistry scheme. The original scheme has seven reactions, including those occurring between nitrogen oxides and ozone and parameterisations of the large number of reactions involving a wide range of Volatile Organic Compounds (VOCs). In addition, an eighth reaction has been included within ADMS-Urban for the situation when high concentrations of nitric oxide (NO) can convert to nitrogen dioxide (NO_2) using molecular oxygen. In addition to the basic GRS scheme, ADMS-Urban

[18] Hertel, O., Berkowicz, R. and Larssen, S., 1990, 'The Operational Street Pollution Model (OSPM).' *18th International meeting of NATO/CCMS on Air Pollution Modelling and its Applications.* Vancouver, Canada, pp741-749.

[19] Hood C, Carruthers D, Seaton M, Stocker J and Johnson K, 2014. *Urban canopy flow field and advanced street canyon modelling in ADMS-Urban.* 16th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Varna, Bulgaria, September 2014. http://www.harmo.org/Conferences/Proceedings/_Varna/publishedSections/H16-067-Hood-EA.pdf

[20] Venkatram, A., Karamchandani, P., Pai, P. and Goldstein, R., 1994, 'The Development and Application of a Simplified Ozone Modelling System.' *Atmospheric Environment,* Vol 28, No 22, pp3665-3678.

also includes a trajectory model[21] for use when modelling large areas. This permits the chemical conversions of the emissions and background concentrations upwind of each location to be properly taken into account.

Complex Effects - Terrain

As well as the effect that complex terrain has on wind direction and, consequently, pollution transport, it can also enhance turbulence and therefore increase dispersion. These effects are taken into account in ADMS-Urban using the FLOWSTAR[22] model developed by CERC.

Complex Effects – Urban Canopy

As wind approaches an urban area of relatively densely packed buildings, the wind profile is vertically displaced. The wind speed and turbulence levels are also reduced within the area of buildings. These effects are taken into account in ADMS-Urban by modifying the wind speed and turbulence profiles based on parameters describing the amount and size of buildings within an urban area.

Data Comparisons – Model Validation

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which is used throughout the UK by industry and the Environment Agency to model emissions from industrial sources. ADMS has been subject to extensive validation, both of individual components (e.g. point source, street canyon, building effects and meteorological pre-processor) and of its overall performance.

ADMS-Urban has been extensively tested and validated against monitoring data for large urban areas in the UK and overseas, including London, Birmingham, Manchester, Glasgow, Riga, Cape Town, Hong Kong and Beijing, as part of projects supported by local governments and research organisations. A summary of model validation studies is available online[23]. CERC have co-authored[24] a number of papers presenting results from ADMS-Urban, and other organisations have published the outcomes of their applications of the model[25].

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[21] Singles, R.J., Sutton, M.A. and Weston, K.J., 1997, 'A multi-layer model to describe the atmospheric transport and deposition of ammonia in Great Britain.' In: *International Conference on Atmospheric Ammonia: Emission, Deposition and Environmental Impacts. Atmospheric Environment*, Vol 32, No 3.
[22] Carruthers D.J., Hunt J.C.R. and Weng W-S. 1988. 'A computational model of stratified turbulent airflow over hills – FLOWSTAR I.' Proceedings of Envirosoft. In: *Computer Techniques in Environmental Studies,* P. Zanetti (Ed) pp 481-492. Springer-Verlag.
[23] www.cerc.co.uk/Validation
[24] www.cerc.co.uk/CERCCoAuthorPublications
[25] www.cerc.co.uk/CERCSoftwarePublications