HICKLETON AQMA FURTHER ASSESSMENT

Report for: City of Doncaster Council

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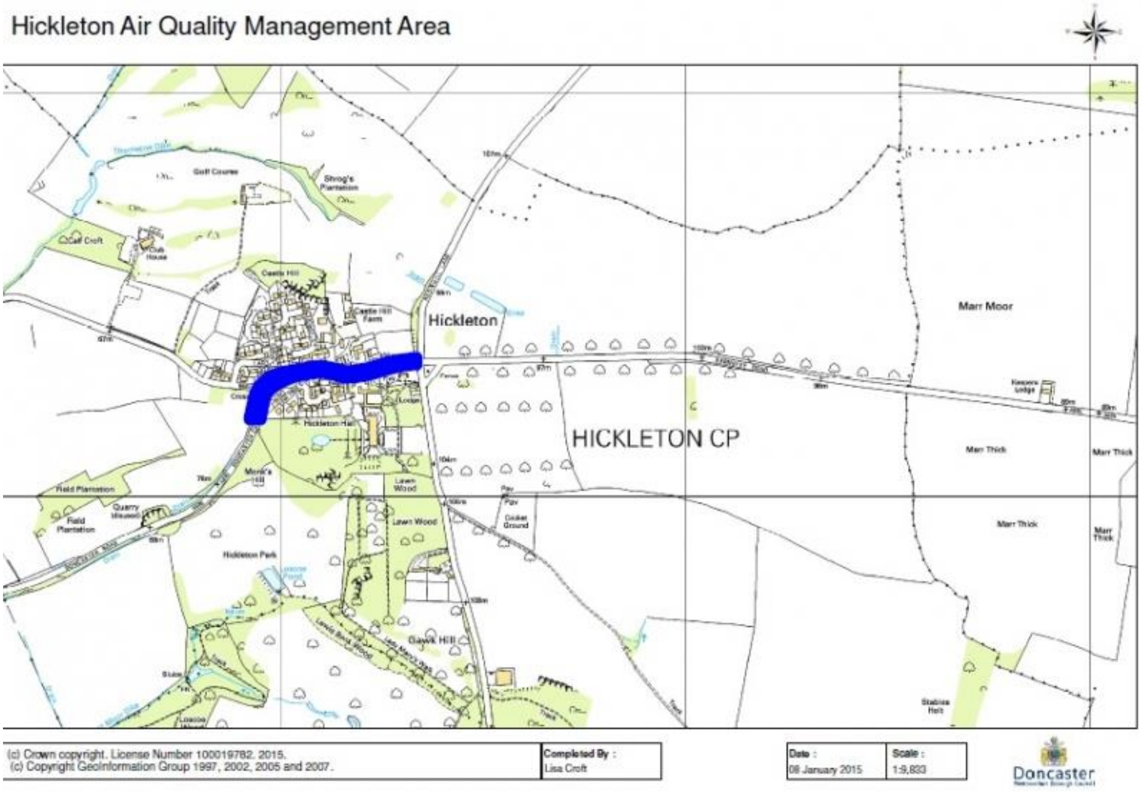
1. INTRODUCTION

City of Doncaster Council has declared an AQMA in the village of Hickleton along A635, Barnsley Road as illustrated in Figure 1-1. This AQMA was declared in 2015 as measured NO_2 concentrations were consistently above the UK national air quality objective for the protection of human health. In recent years, concentrations along this road have remained above the objective; as a result, the Council is considering a redraft of their Air Quality Action Plan. To support this work, Doncaster Council has commissioned Ricardo Energy & Environment to carry out a further assessment to identify the year of natural compliance under a range of projection scenarios.

Figure 1-1: Hickleton AQMA



This report provides the results of this assessment. Modelling has been carried out for 2019 in order to identify areas of exceedance and validate the model. In order to identify the year of compliance, modelling has then been carried out for each year between 2022 and 2034, using national projections to predict future road transport emissions in Hickleton.

The future year modelling has been carried out for a central “baseline” set of future assumptions, and a number of scenarios. These scenarios included both potential measures for emissions reduction and future scenarios in which emissions are higher than predicted.

- Scenario 1: A delay in natural fleet turnover of two years. This situation can arise if the rate at which individuals replace their cars is lower than national predictions suggest, which can occur for example in adverse economic circumstances.
- Scenario 2: The implementation of a 20 mile per hour zone in Hickleton. This would increase average emission rates along road links where traffic speeds are currently above 20mph.
- Scenario 3: Including the potential impacts of the proposed new access road and roundabout off the A635 to the proposed ES10 commercial employment site near Goldthorpe, together with associated development.
- Scenario 4: The implementation of a Class D Charging Clean Air Zone in Hickleton using the charging structure of the London Ultra Low Emission Zone.

Section 2 of this report introduces the relevant air quality objectives for NO_2, PM_{10} and $PM_{2.5}$, and Section 3 describes current air quality in Hickleton. Section 4 describes the model choice and setup, while Section 5 details the way that the emissions inventory for this study was developed. Section 6 presents the model verification. Sections 7, 8 and 9 present the results for the baseline future projection and scenarios respectively; Section 10 discusses these results.

2. AIR QUALITY STANDARDS AND GUIDELINES

The objectives specified in the Air Quality Strategy (AQS) mirror limit values required by EU Framework and Daughter Directives on Air Quality; and have been transposed into UK law through the Air Quality Standards Regulations 2007. A more recent EU Directive 2008/50/EC consolidates the Framework and first three Daughter Directives, and this has been transposed into English law via the Air Quality (Standards) Regulations 2010.

Table 2-1 summarises the air quality objectives relevant to this study.

UK Local Authorities are required under the Environment Act 1995 to assess air quality in their areas on an annual basis against the air quality objectives; and are required to declare an Air Quality Management Area (AQMA) where they have identified that the air quality objectives are not being achieved.

Table 2-1: UK National Air Quality Objectives

Pollutant	Concentration	Measured as
Nitrogen dioxide (NO_2)	200 µg.m^{-3} not to be exceeded more than 18 times a year; equivalent to a 99.8th percentile of hourly means not exceeding 200 µg.m^{-3}	1-hour mean
	40 µg.m^{-3}	Annual mean
Particles (PM_{10})	50 µg.m^{-3} not to be exceeded more than 35 times a year	24-hour mean
	40 µg.m^{-3}	Annual mean
Particles ($PM_{2.5}$)	25 µg.m^{-3}	Annual mean

The Environment Act 2021 established a legally binding duty on government to bring forward at least two new air quality targets in secondary legislation. These targets were entered into law through the Environmental Targets (Fine Particulate Matter) (England) Regulations 2023[1].These targets are:

- Annual Mean Concentration Target ('concentration target') - a maximum concentration of 10µg.m^{-3} to be met across England by 2040;
- Population Exposure Reduction Target ('exposure target') - a 35% reduction in population exposure by 2040 (compared to a base year of 2018).

LAQM.TG(22) sets out that the annual mean AQOs for human health apply at locations where the public may be regularly exposed, such as building facades of residential properties, schools, hospitals and care homes. The 1-hour and 24-hour mean AQOs apply at locations where it is reasonable to expect members of the public to spend at least these periods of time, such as busy shopping streets and school playgrounds for the 1-hour mean, and hotels or residential gardens for the 24-hour mean.

[1] https://uk-air.defra.gov.uk/library/air-quality-targets

3. AIR QUALITY IN HICKLETON

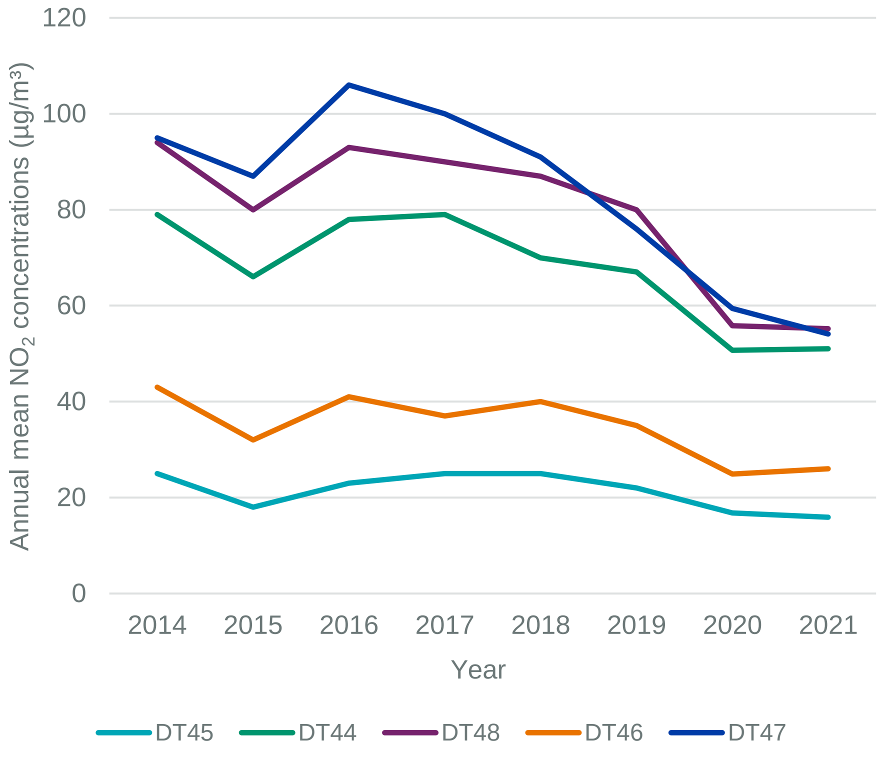
Doncaster Council currently measures NO_2 concentrations in Hickleton using a network of 5 diffusion tubes along the A635. There is currently no monitoring of particulate matter concentrations in Hickleton.

Annual mean concentrations measured at these locations was provided by Doncaster Council. The locations of the measurement sites and recent monitoring data are presented in Table 3-1, and the evolution of concentrations over time is shown in Figure 3-1. The locations of the monitoring sites are presented in Figure 4-1.

Table 3-1: Monitoring locations and monitored annual mean NO_2 concentrations in Hickleton, µg.m^{-3}

ID	x	y	2014	2015	2016	2017	2018	2019	2020	2021
DT45	447966	405303	25	18	23	25	25	22	17	16
DT44	448225	405310	79	66	78	79	70	67	51	51
DT48	448237	405321	94	80	93	90	87	80	56	55
DT46	448150	405299	43	32	41	37	40	35	25	26
DT47	448067	405317	95	87	106	100	91	76	59	54

Figure 3-1: Measured annual mean NO_2 concentrations at diffusion tube locations in Hickleton, 2014 to 2021



While concentrations across all monitoring sites have reduced over the past 8 years, concentrations remain substantially above the objective at DT44, DT47, and DT48, including during the period of reduced traffic flows in 2020 and 2021. These monitoring sites are located close to the kerb along sections of road with tight buildings along one or both sides which give rise to a street canyon, trapping pollutants and leading to elevated concentrations.

Concentrations are below the objective at DT45 and DT46, which are located further from the kerb along sections of the road without street canyons.

4. MODEL SETUP

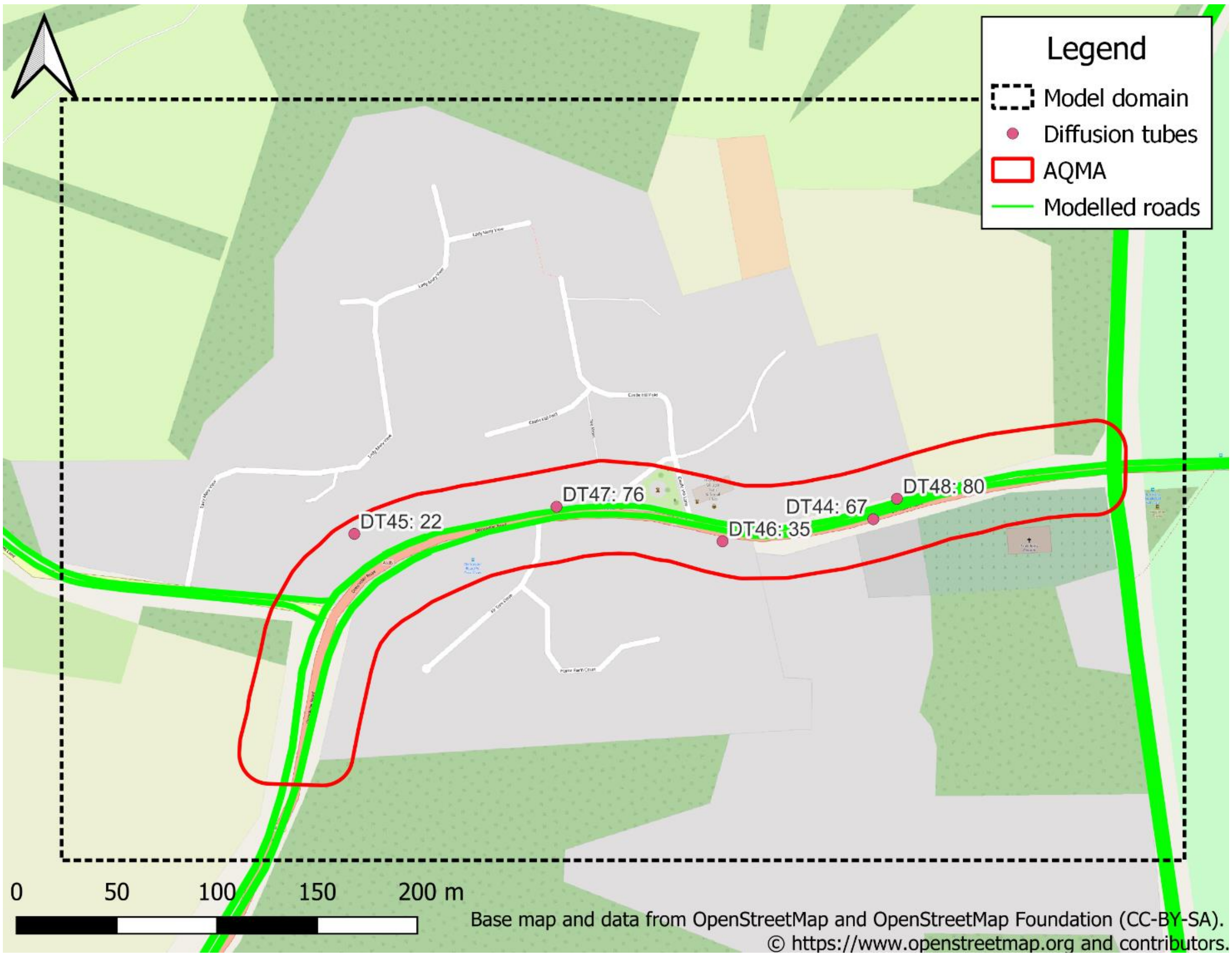
4.1 OVERALL APPROACH AND CHOICE OF MODEL

All modelling was carried out using the latest version of the ADMS-Roads dispersion model[2], developed by CERC. ADMS-Roads is widely recognised as an appropriate model for carrying out assessments for traffic emissions in the UK, and includes advanced algorithms for representing atmospheric conditions and the effects of street geometry on dispersion.

4.2 STUDY AREA

The study area comprises the village of Hickleton, including the entire AQMA. The model domain is shown in Figure 4-1 below, and includes the A635 (Doncaster Road), Lidget Lane, Red Hill Lane and Hickleton Road.

Figure 4-1: Model domain, including locations of monitoring sites



4.3 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 of friction between the air and ground on wind speed and turbulence. A surface roughness of 0.5m was used for this study, representing open suburbia, following the guidance in the ADMS-Roads User Guide.

[2] http://www.cerc.co.uk/environmental-software/ADMS-Roads-model.html

4.4 METEOROLOGY

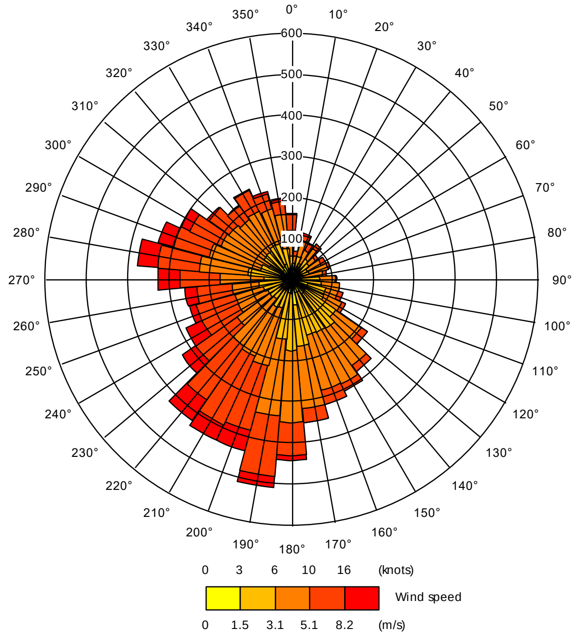
ADMS-Roads requires hourly meteorological data including wind speed, direction, temperature, and cloud cover as inputs. Hourly meteorological data for 2019 was taken from the Doncaster Sheffield meteorological site, located 20km to the southeast of Hickleton. Gaps in this dataset were filled using data from the Emley Moor site, located 26km to the west of Hickleton. The meteorological site surface roughness was set to 0.25m to account for differences in wind speed between the meteorological site and the study area.

Table 4-1 summarises statistics for the site. Figure 4-2 shows a wind rose for the site showing the frequency of occurrence of wind from different directions.

Table 4-1: Statistics for meteorological data

Year	Data capture	Parameter	Minimum	Maximum	Mean
2019	99.9%	Temperature (°C)	-5.5	35.0	10.6
		Wind speed ($m.s^{-1}$)	0.5	16.2	4.2
		Cloud cover (oktas)	0	8	4.4

Figure 4-2: Wind rose for the Doncaster Sheffield meteorological station, 2019



4.5 CHEMISTRY AND BACKGROUND CONCENTRATIONS

The interconversion of NO and NO_2 emissions in the presence of ozone was calculated using the NO_x:NO_2 calculator[3] published by Defra, following the approach outlined in LAQM (TG22). Background concentrations were taken from the background maps published by Defra for use with this tool. To avoid double-counting, contributions from local primary roads were removed from the background maps. The background concentrations used in the study are presented in Table 4-2.

Table 4-2: Background concentrations used in the study, $\mu g.m^{-3}$

Year	NO_X	NO_2	PM_{10}	$PM_{2.5}$
2018	12.8	10.2	13.0	7.8
2019	12.1	9.7	12.8	7.6
2020	11.5	9.3	12.6	7.4

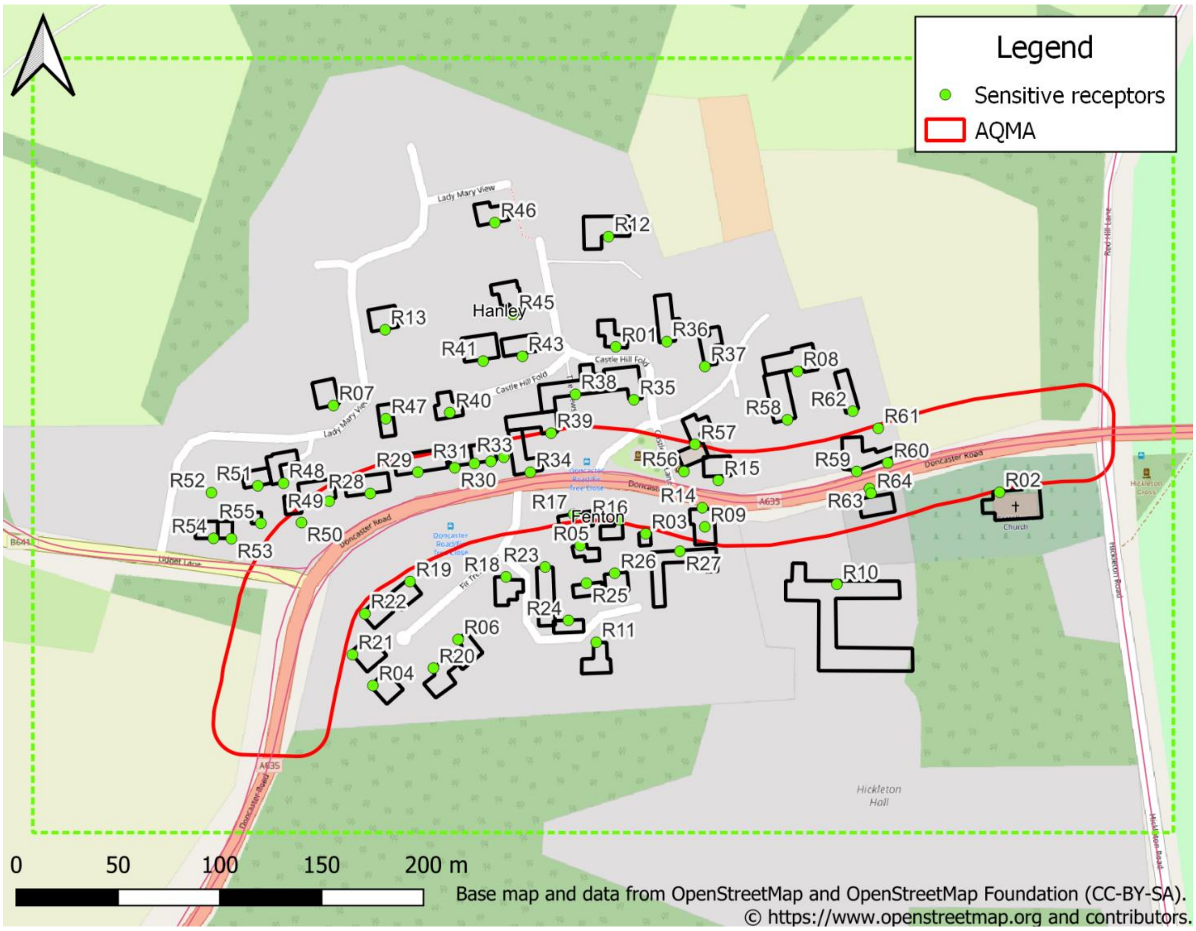
[3] https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator/

Year	NO_X	NO_2	PM_{10}	$PM_{2.5}$
2021	11.1	8.9	12.5	7.3
2022	10.7	8.6	12.3	7.2
2023	10.5	8.4	12.2	7.1
2024	10.0	8.1	12.1	7.1
2025	9.7	7.8	12.0	7.0
2026	9.5	7.7	12.0	7.0
2027	9.3	7.5	12.0	6.9
2028	9.2	7.4	12.0	6.9
2029	9.0	7.2	12.0	6.9
2030	8.9	7.1	11.9	6.9
2031	8.9	7.1	11.9	6.9
2032	8.9	7.1	11.9	6.9
2033	8.9	7.1	11.9	6.9
2034	8.9	7.1	11.9	6.9

4.6 SENSITIVE RECEPTORS

Concentrations were modelled at selected sensitive receptors within the model domain. Concentrations were modelled at the facade nearest to the A365 of all residential buildings within the AQMA, and nearby residences outside the AQMA, as shown in Figure 4-3.

Figure 4-3: Modelled sensitive receptors



5. EMISSIONS INVENTORY

The development of the emission inventory for Hickleton was carried out through the following process:

1. Collation of traffic data;
2. Collation of fleet fuel and technology statistics from various sources;
3. The traffic and fleet data were combined with emission factors from the most recent version of the Emission Factor Toolkit (EFT), version 11[4] to provide total annual emissions of NOx and PM for the modelled road links.

Further detail on the emissions inventory compilation is provided below.

5.1 TRAFFIC FLOWS AND SPEEDS

Recent traffic flows for roads in the area are available from three sources:

1. Traffic count data published by the Department for Transport (DfT);
2. A traffic monitoring study carried out by Ricardo in March and May 2022 on the A635;
3. A traffic modelling study carried out by Aecom for the M1 Junction 36 A6195 Dearne Valley Economic Growth Corridor Goldthorpe Employment Site, published in February 2021

Traffic data from the Goldthorpe Employment Site modelling study was used, as this had the most complete coverage for roads in Hickleton and also provided the highest traffic flows of the three datasets. The lower traffic flows in the Ricardo study may reflect temporary effects from lockdowns in 2020 and 2021, as a result. it is considered that the modelled traffic flows are more likely to represent traffic flows over the next decade. This approach will also provide a worst-case assessment of future pollutant concentrations. The modelled traffic flows are presented in Table 5-1.

Table 5-1: Modelled traffic flows, 2019

Description	AADT	% Car	% LGV	% HGV	% Bus/ Coach	% Mcycle
A635 between Doncaster Road and Hickleton EB	13657	65.35	23.74	9.66	0.25	1.00
A635 between Doncaster Road and Hickleton WB	10577	65.35	23.74	9.66	0.25	1.00
A635 through Hickleton EB	15079	65.35	23.74	9.66	0.25	1.00
A635 through Hickleton WB	12294	65.35	23.74	9.66	0.25	1.00
A635 through Hickleton Total	27373	65.35	23.74	9.66	0.25	1.00
Red Hill Lane (N) off A635	2213	73.15	10.35	15.00	0.47	1.03
Red Hill Lane (S) off A635	801	70.92	12.76	14.96	0.63	0.73
Lidget Lane off A635	1493	73.18	10.35	14.96	0.47	1.03

Traffic counts for future years were calculated using growth factors from the National Trip End Model (NTEM)[5], accessed through the Tempro 7.2 software package.

Traffic speed data was taken from the 2022 Ricardo surveys. Speeds within 50m of junctions were reduced in order to account for congestion and reductions in average speeds in these areas.

5.2 EMISSION FACTORS

Emissions from all modelled road traffic sources were calculated using speed-dependent vehicle emission factors for NO_X, primary NO_2, and particulates from the Emission Factor Toolkit (EFT) version 11[11]. These factors provide emission factors categorised by vehicle size, age, and Euro classification, taking into account average vehicle mileage and engine degradation. Emission factors are provided for roads with uphill or downhill gradients.

[4] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

[5] https://www.data.gov.uk/dataset/11bc7aaf-ddf6-4133-a91d-84e6f20a663e/national-trip-end-model-ntem

5.3 VEHICLE FLEET COMPOSITION

5.3.1 2022

Vehicle fleet composition (including vehicle age and fuel type) was derived from traffic monitoring carried out by Ricardo in March and May 2022. These measurements will include the impacts of the 2020 lockdowns on fleet renewal in the area, and therefore represent a more realistic and up-to-date dataset than national projections published by the Department for Transport, which do not include these effects.

Table 5-2 and Table 5-3 present the derived fleet age split for vehicles in Hickleton in 2022. The projected average fleet split for rural areas in England in the projections published by BEIS are also included for comparison.

Table 5-2: Fleet age splits for 2022, light vehicles

Region	Vehicle type	Pre-Euro 1	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	Euro 6c	Euro 6d
Hickleton	Petrol Car	-	-	-	5%	19%	22%	9%	44%	-
	Diesel Car	-	-	-	4%	16%	37%	11%	16%	16%
	Petrol LGV	-	-	13%	13%	4%	0%	14%	57%	-
	Diesel LGV	-	-	-	4%	10%	28%	10%	22%	26%
	Full Hybrid Petrol Car	-	-	-	-	1%	5%	6%	88%	-
National average	Petrol Car	-	-	-	1%	6%	19%	13%	62%	-
	Diesel Car	-	-	-	1%	5%	28%	17%	24%	24%
	Petrol LGV	-	-	-	2%	6%	18%	14%	60%	-
	Diesel LGV	-	-	-	1%	5%	19%	13%	29%	33%
	Full Hybrid Petrol Car	-	-	-	-	1%	7%	6%	86%	-

Table 5-3: Fleet age splits for 2022, heavy vehicles

Region	Vehicle type	Pre-Euro I	Euro I	Euro II	Euro III	Euro IV	Euro V EGR	Euro V SCR	Euro VI
Hickleton	Rigid HGV	-	-	1%	4%	5%	4%	12%	75%
	Artic HGV	-	-	-	-	1%	2%	6%	92%
	Buses / Coaches	-	-	-	10%	12%	16%	48%	15%
National average	Rigid HGV	-	-	-	1%	2%	2%	7%	88%
	Artic HGV	-	-	-	-	-	1%	3%	96%
	Buses / Coaches	-	-	-	4%	3%	4%	11%	77%

The observed fleet in Hickleton in 2022 is significantly older than the national average projected fleet, resulting in higher emissions. This could be the combined result of delayed fleet renewal resulting from the 2020 and 2021 lockdowns, and differences between the Doncaster and average conditions across England as a whole. A similar pattern has been seen in a large number of cities across the UK.

5.3.2 Projections

The observed vehicle fleet 2022 was projected to future years using the EFT, following the process outlined in LAQM.TG(22). The projected vehicle age split in 2030 is presented in for light and heavy vehicles respectively.

Table 5-4: Projected fleet age splits for 2030, light vehicles

Region	Vehicle type	Pre-Euro 1	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	Euro 6c	Euro 6d
Hickleton	Petrol Car	-	-	-	-	1%	2%	6%	90%	
	Diesel Car	-	-	-	-	1%	12%	13%	20%	54%

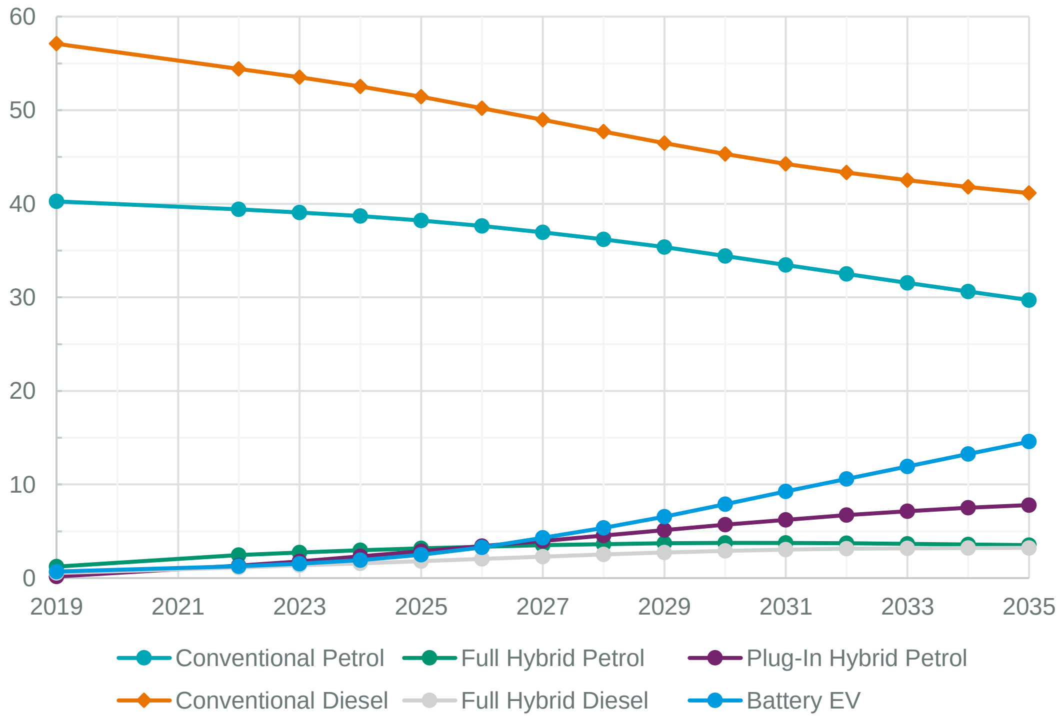
Region	Vehicle type	Pre-Euro 1	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	Euro 6c	Euro 6d
	Petrol LGV	-	-	-	-	-	1%	1%	98%	
	Diesel LGV	-	-	-	-	-	2%	2%	8%	87%
	Full Hybrid Petrol Car	-	-	-	-	0%	0%	1%	99%	-
National average	Petrol Car	-	-	-	-	-	1%	2%	96%	-
	Diesel Car	-	-	-	-	-	3%	4%	11%	83%
	Petrol LGV	-	-	-	-	-	-	1%	99%	-
	Diesel LGV	-	-	-	-	-	2%	2%	8%	87%
	Full Hybrid Petrol Car	-	-	-	-	-	1%	1%	99%	86%

Table 5-5: Fleet age splits for 2030, heavy vehicles

Region	Vehicle type	Pre-Euro I	Euro I	Euro II	Euro III	Euro IV	Euro V EGR	Euro V SCR	Euro VI
Hickleton	Rigid HGV	-	-	-	-	-	-	-	100%
	Artic HGV	-	-	-	-	-	-	-	100%
	Buses / Coaches	-	-	-	-	2%	3%	9%	85%
National average	Rigid HGV	-	-	-	-	-	-	-	100%
	Artic HGV	-	-	-	-	-	-	-	100%
	Buses / Coaches	-	-	-	-	-	-	1%	99%

The fuel use split for cars was projected based on national projections published by the Department for Transport; the projected fuel use between 2019 and 2035 is presented in Figure 5-1. A substantial reduction in diesel and petrol vehicles is projected to occur between 2022 and 2035, as the result of government policy to encourage uptake of hybrid and electric vehicles. However, petrol and diesel vehicles are expected to remain the dominant fuel categories until 2035.

Figure 5-1: Fuel split projections for cars, 2019 to 2035



6. MODEL VERIFICATION AND ADJUSTMENT

Once the base year model has been developed it is verified against monitoring data and adjusted to ensure best fit, following the approach outlined in the LAQM Technical Guidance. Any adjustment factors are then applied to all future modelled years. Following this adjustment, model verification is carried out by comparing the total predicted NO_2 concentrations against the measured NO_2 concentrations.

6.1 MODEL CALIBRATION

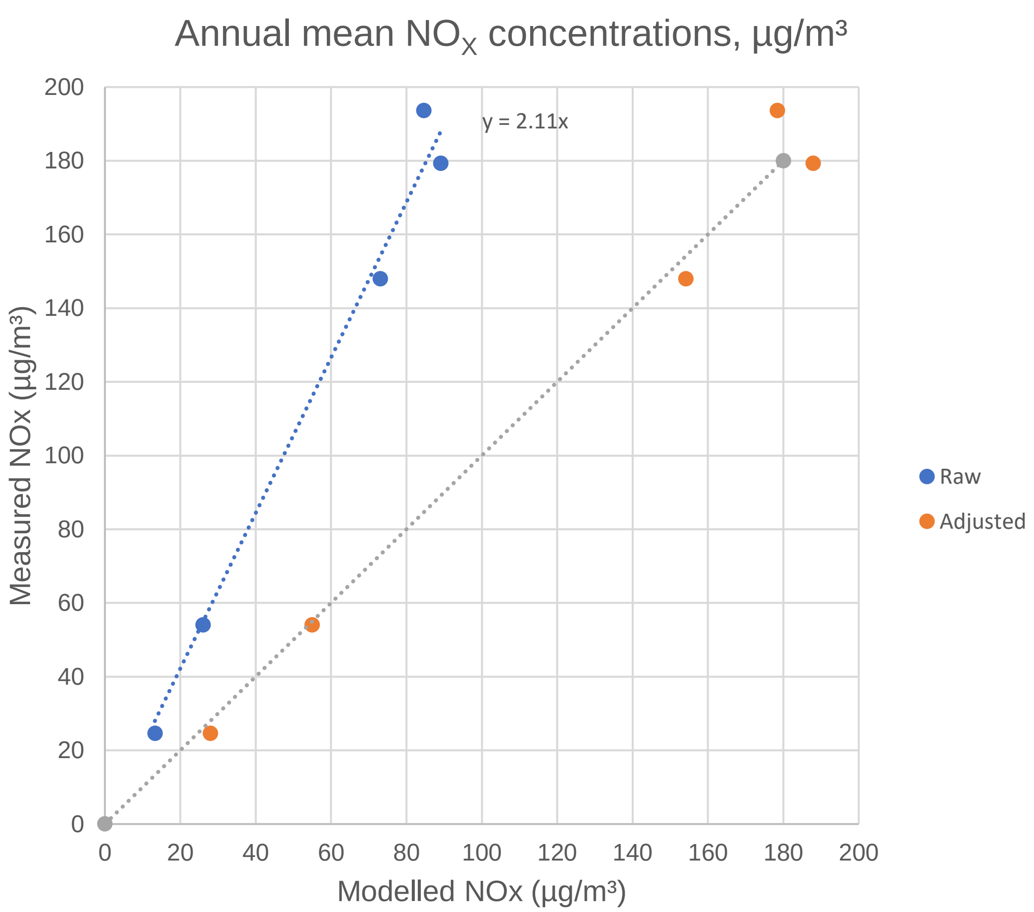
A total of 5 roadside diffusion tube NO_2 measurement sites operated by Doncaster Council have been used for model verification, encompassing all active measurement sites in Hickleton.

Adjustment factors for emissions from roads were derived following the methodology described in LAQM.TG(22)[6], whereby the predicted road contribution to NO_X concentrations was compared with measured values.

Diffusion tubes measure NO_2 rather than NOx; the road contribution to NO_X concentrations at these sites was estimated using the latest version of the NOx to NO_2 calculator (version 8) published by Defra. Background NO_X concentrations for use in this tool were taken from the Defra background maps. This approach uses background concentrations of NO_X as an input.

Figure 6-1 presents measured and modelled annual mean NOx contributions at monitoring sites in 2019.

Figure 6-1: Measured and modelled annual mean road NOx contributions at monitoring sites, 2019, µg.m^{-3}



The gradient of the best fit line for the modelled road NOx contribution vs. measured road NOx contribution was determined using linear regression and used as a domain-wide road NOx adjustment factor. A global

[6] https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf

primary NOx adjustment factor (PAdj) of **2.11** was derived and applied to all modelled road NOx contributions prior to calculating an NO_2 annual mean.

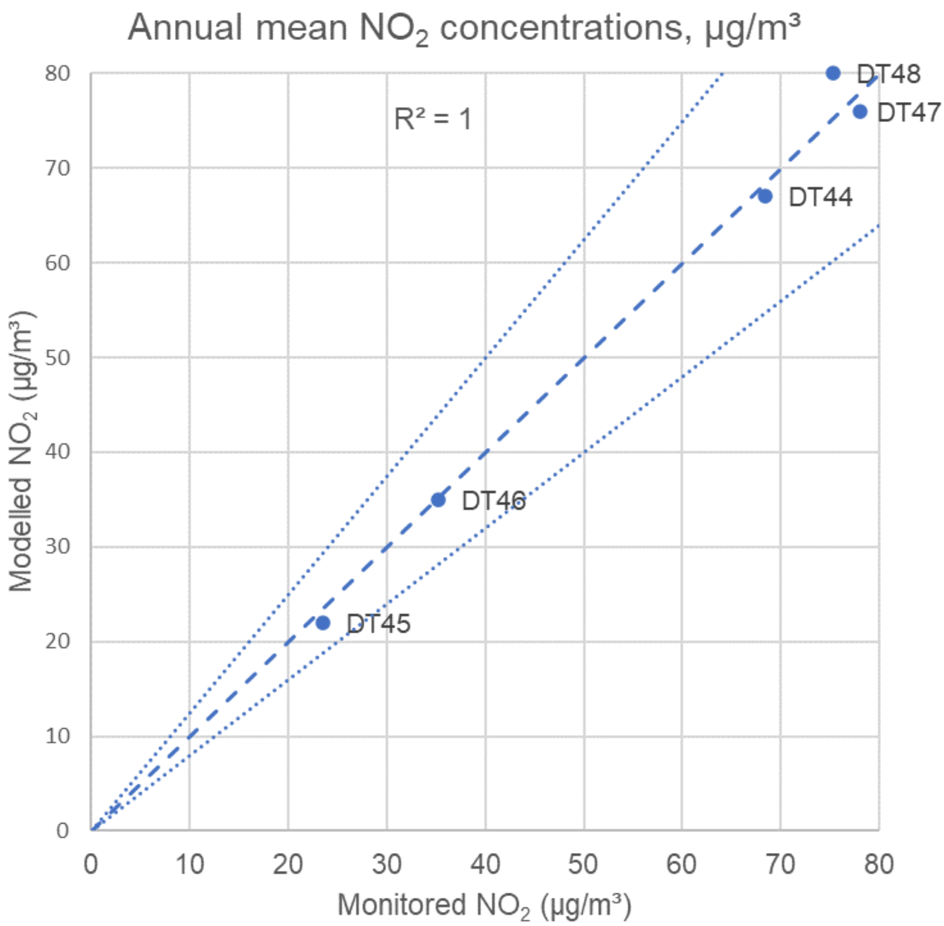
In the absence of monitoring data for PM_{10} and $PM_{2.5}$, this adjustment factor was also applied to PM_{10} and $PM_{2.5}$ concentrations as described in LAQM (TG22).

6.2 MODEL VERIFICATION

The model was verified against annual average NO_2 concentrations using the 2019 baseline emissions inventory described in Section 2. NO_2 concentrations were derived from modelled road NOx contributions, primary NO_2 contributions, and background concentrations using the Defra NOx:NO_2 calculator.

A plot comparing modelled and monitored NO_2 concentrations during 2019 is presented in Figure 6-2.

Figure 6-2: Modelled and measured annual mean NO_2 concentrations, 2018, post adjustment



Following guidance in LAQM.TG(22), the Root Mean Square Error (RMSE) was calculated to define the average error or uncertainty of the model, as described in Box 7.17 of this guidance. The Root Mean Square Error for the model verification is 2.1 $\mu g.m^{-3}$, corresponding to 5% of the Air Quality Objective (AQO). This is well within the 10% ideal threshold specified in LAQM.TG(22), and demonstrates that the adjusted model performs well, lending confidence to predictions of concentrations in future years.

7. BASELINE RESULTS

7.1 NO_2

7.1.1 2019

Figure 7-1 presents predicted annual mean NO_2 concentrations at sensitive receptors in 2019.

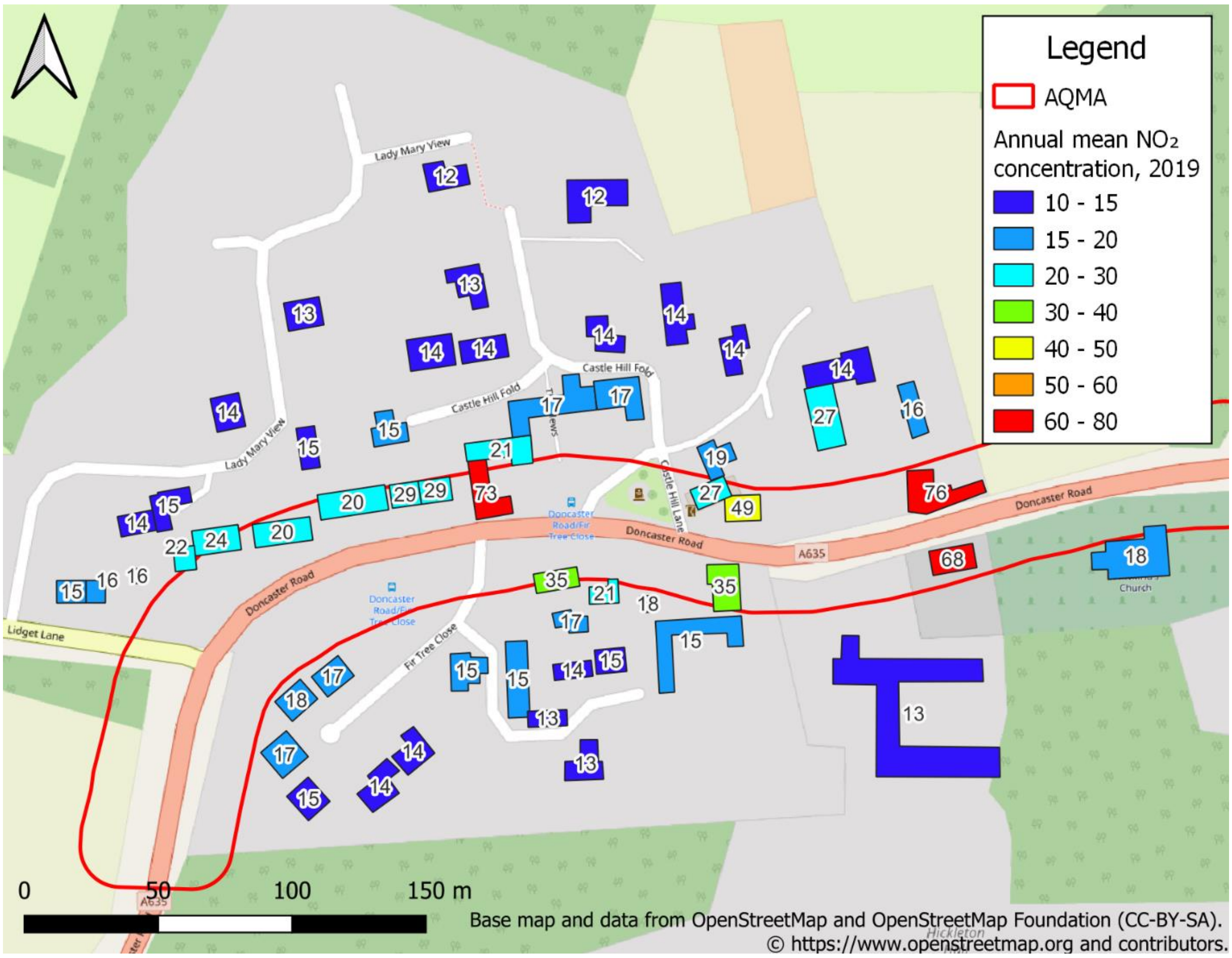
Exceedances of the air quality objective for annual mean NO_2 concentrations result from a combination of high traffic flows, gradients along sections of the road, and street canyons caused by the buildings which flank sections of the A635. As a result, exceedances are highly localised, and are only predicted to occur along building facades which directly face the A635.

In 2019, concentrations are predicted to exceed the objective at 4 locations:

- R59/R60;
- R63;
- R14/15; and
- R34; it is not clear whether ventilation occurs at this location as there are no windows).

Concentrations at R59/R60 and R63 are highly elevated, with concentrations as high as 80µg.m^{-3} predicted in 2019, while concentrations at R14/15 and R34 are lower, albeit still above the AQO.

Figure 7-1: Predicted annual mean NO_2 concentrations at sensitive receptors, 2019, µg/m³



7.1.2 Year of natural compliance

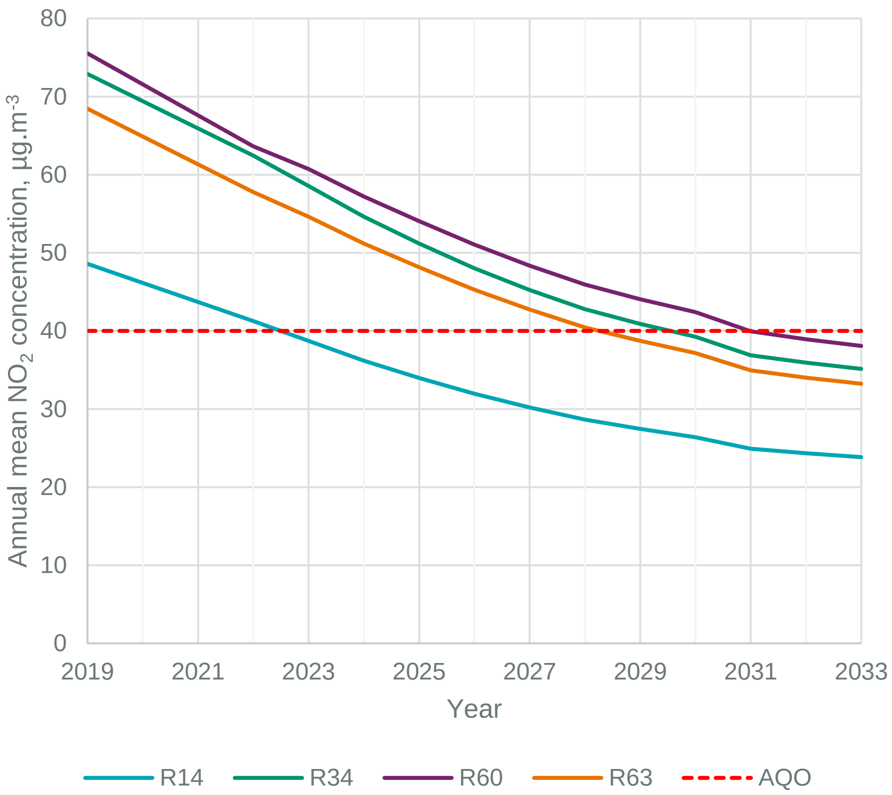
Table 7-1 presents predicted annual mean NO_2 concentrations at the sensitive receptors described in Section 2 for 2019, and each year between 2022 and 2035. Exceedances of the objective are highlighted in red.

Table 7-1: Annual mean predicted NO_2 concentrations at sensitive receptors in Hickleton between 2019 and 2034, $\mu g.m^{-3}$. Exceedances of the objective are highlighted in red.

ID	2019	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
R01	14.4	12.5	11.9	11.3	10.8	10.4	10.0	9.7	9.4	9.2	9.0	9.0	8.9	8.6
R02	17.8	15.3	14.6	13.7	13.1	12.5	12.0	11.6	11.2	10.9	10.6	10.5	10.4	9.9
R03	17.9	15.4	14.6	13.8	13.1	12.6	12.1	11.6	11.3	11.0	10.7	10.6	10.5	9.9
R04	15.0	13.0	12.3	11.7	11.1	10.7	10.3	10.0	9.7	9.4	9.2	9.2	9.1	9.1
R05	16.8	14.5	13.8	13.0	12.3	11.8	11.4	11.0	10.7	10.4	10.2	10.1	10.0	9.5
R06	13.6	11.8	11.3	10.7	10.2	9.9	9.6	9.3	9.0	8.8	8.7	8.6	8.6	8.5
R07	13.5	11.8	11.2	10.6	10.2	9.8	9.5	9.2	9.0	8.7	8.6	8.5	8.5	8.1
R08	14.3	12.4	11.9	11.2	10.7	10.3	9.9	9.6	9.4	9.1	9.0	8.9	8.9	8.7
R09	16.5	14.3	13.5	12.8	12.1	11.7	11.2	10.8	10.5	10.2	10.0	9.9	9.8	9.5
R10	13.1	11.4	10.9	10.4	9.9	9.6	9.3	9.0	8.8	8.6	8.5	8.4	8.4	8.2
R11	12.6	11.0	10.5	10.0	9.6	9.3	9.0	8.7	8.5	8.3	8.2	8.2	8.2	8.0
R12	12.2	10.7	10.3	9.7	9.3	9.1	8.8	8.6	8.4	8.2	8.1	8.0	8.0	7.8
R13	12.7	11.1	10.6	10.0	9.6	9.3	9.0	8.8	8.6	8.4	8.3	8.2	8.2	7.9
R14	48.6	41.3	38.7	36.2	34.0	32.0	30.2	28.6	27.4	26.4	24.9	24.3	23.8	22.3
R15	48.6	41.4	38.6	35.9	33.6	31.6	29.7	28.1	26.9	25.9	24.4	23.8	23.3	21.6
R16	20.6	17.8	16.8	15.8	15.0	14.3	13.7	13.2	12.8	12.4	12.0	11.9	11.8	11.0
R17	22.1	19.1	18.0	16.9	16.0	15.3	14.6	14.0	13.6	13.2	12.7	12.6	12.4	11.6
R18	15.1	13.1	12.4	11.7	11.2	10.7	10.4	10.0	9.7	9.5	9.3	9.2	9.2	8.9
R19	17.5	15.0	14.2	13.4	12.7	12.2	11.7	11.2	10.9	10.6	10.3	10.2	10.1	9.9
R20	13.5	11.8	11.3	10.7	10.2	9.8	9.5	9.2	9.0	8.8	8.6	8.6	8.5	8.5
R21	17.2	14.8	14.0	13.2	12.6	12.0	11.5	11.1	10.8	10.5	10.2	10.1	10.0	9.9
R22	18.5	15.9	15.0	14.1	13.3	12.7	12.2	11.7	11.3	11.0	10.7	10.6	10.4	10.2
R23	15.3	13.2	12.6	11.9	11.3	10.9	10.5	10.2	9.9	9.6	9.4	9.3	9.3	9.0
R24	13.1	11.4	11.0	10.4	9.9	9.6	9.3	9.0	8.8	8.6	8.5	8.4	8.4	8.2
R25	14.3	12.4	11.8	11.2	10.7	10.3	9.9	9.6	9.4	9.1	9.0	8.9	8.9	8.6
R26	14.6	12.7	12.1	11.5	10.9	10.5	10.2	9.8	9.6	9.3	9.2	9.1	9.0	8.7
R27	15.4	13.4	12.7	12.0	11.4	11.0	10.6	10.3	10.0	9.7	9.5	9.4	9.4	9.0
R28	20.2	17.3	16.3	15.3	14.4	13.7	13.1	12.6	12.1	11.8	11.4	11.2	11.1	10.6
R29	20.2	17.4	16.3	15.3	14.4	13.7	13.1	12.6	12.1	11.8	11.4	11.2	11.1	10.7
R30	28.6	24.4	22.7	21.2	19.9	18.8	17.8	16.9	16.3	15.7	15.0	14.7	14.5	13.6
R31	28.7	24.5	22.8	21.3	20.0	18.9	17.9	17.0	16.4	15.8	15.1	14.8	14.6	13.7
R32	29.4	25.2	23.4	21.8	20.5	19.3	18.3	17.5	16.8	16.2	15.5	15.2	14.9	14.0
R33	29.0	24.9	23.2	21.6	20.3	19.2	18.2	17.3	16.7	16.1	15.4	15.1	14.9	13.9
R34	72.9	62.4	58.6	54.6	51.2	48.0	45.2	42.8	40.9	39.3	36.9	35.9	35.1	31.9
R35	17.1	14.8	14.0	13.2	12.5	12.0	11.5	11.1	10.8	10.5	10.2	10.1	10.0	9.8
R36	14.0	12.2	11.6	11.0	10.5	10.1	9.8	9.5	9.2	9.0	8.9	8.8	8.7	8.6
R37	14.5	12.6	12.0	11.3	10.8	10.4	10.0	9.7	9.4	9.2	9.0	9.0	8.9	8.8
R38	16.8	14.6	13.8	13.0	12.4	11.9	11.4	11.0	10.7	10.4	10.1	10.0	10.0	9.5
R39	20.5	17.7	16.7	15.6	14.8	14.1	13.5	13.0	12.6	12.2	11.8	11.7	11.5	10.9
R40	15.5	13.4	12.7	12.0	11.4	10.9	10.5	10.2	9.9	9.6	9.4	9.4	9.3	8.9
R41	14.1	12.3	11.7	11.1	10.6	10.2	9.8	9.5	9.3	9.1	8.9	8.8	8.8	8.4
R43	14.4	12.5	11.9	11.3	10.8	10.4	10.0	9.7	9.4	9.2	9.0	9.0	8.9	8.5
R45	13.2	11.5	11.0	10.5	10.0	9.7	9.4	9.1	8.8	8.6	8.5	8.5	8.4	8.1
R46	11.9	10.4	10.0	9.5	9.1	8.9	8.6	8.4	8.2	8.0	7.9	7.9	7.9	7.6
R47	14.6	12.7	12.1	11.4	10.9	10.4	10.1	9.8	9.5	9.2	9.1	9.0	8.9	8.5
R48	14.8	12.8	12.2	11.5	11.0	10.6	10.2	9.8	9.6	9.3	9.1	9.1	9.0	8.5
R49	23.6	20.1	18.9	17.6	16.6	15.7	15.0	14.3	13.8	13.3	12.8	12.6	12.4	11.4
R50	22.5	19.2	18.0	16.8	15.8	14.9	14.2	13.6	13.1	12.6	12.1	11.9	11.8	10.8
R51	14.2	12.3	11.8	11.1	10.6	10.2	9.9	9.6	9.3	9.1	8.9	8.8	8.8	8.3
R52	13.4	11.7	11.2	10.6	10.1	9.8	9.5	9.2	8.9	8.7	8.6	8.5	8.5	8.1
R53	16.4	14.2	13.5	12.7	12.1	11.6	11.1	10.7	10.4	10.1	9.9	9.8	9.7	9.2
R54	15.4	13.4	12.8	12.1	11.5	11.0	10.6	10.3	10.0	9.7	9.5	9.4	9.3	8.9
R55	16.2	14.0	13.3	12.5	11.9	11.4	11.0	10.6	10.3	10.0	9.7	9.6	9.6	9.0
R56	27.2	23.4	21.9	20.4	19.3	18.2	17.3	16.6	16.0	15.4	14.8	14.5	14.3	14.2
R57	19.0	16.4	15.5	14.5	13.8	13.1	12.6	12.1	11.7	11.4	11.1	10.9	10.8	10.8
R58	15.9	13.7	13.0	12.3	11.7	11.2	10.8	10.4	10.1	9.8	9.6	9.5	9.5	9.3
R59	75.5	63.7	60.7	57.2	54.1	51.1	48.4	45.9	44.1	42.4	40.0	38.9	38.1	37.3
R60	75.1	63.2	60.3	56.9	53.8	50.8	48.1	45.7	43.8	42.2	39.7	38.7	37.9	37.0
R61	17.1	14.7	14.0	13.2	12.5	12.0	11.5	11.1	10.8	10.5	10.2	10.1	10.0	9.9
R62	15.9	13.8	13.1	12.3	11.7	11.3	10.9	10.5	10.2	9.9	9.7	9.6	9.5	9.4
R63	68.5	57.8	54.6	51.2	48.2	45.3	42.7	40.5	38.7	37.2	34.9	34.0	33.2	32.2
R64	68.5	57.8	54.6	51.2	48.2	45.3	42.7	40.5	38.7	37.2	34.9	34.0	33.2	32.2
DT45	23.6	20.1	18.8	17.6	16.6	15.7	14.9	14.3	13.7	13.3	12.8	12.5	12.4	11.4
DT44	68.5	57.8	54.6	51.2	48.2	45.3	42.7	40.5	38.7	37.2	34.9	34.0	33.2	32.2
DT48	75.3	63.5	60.6	57.1	54.0	51.0	48.3	45.8	44.0	42.4	39.9	38.9	38.0	37.2
DT46	35.3	30.2	27.7	25.6	23.8	22.3	21.0	19.8	19.0	18.2	17.3	16.9	16.6	15.7
DT47	78.0	66.7	62.6	58.4	54.7	51.3	48.3	45.7	43.7	41.9	39.4	38.3	37.5	34.1

Figure 7-2 shows how concentrations at each exceedance location develop over time without further action.

Figure 7-2: Annual mean NO_2 concentrations at exceedance locations from 2019 to 2035, µg.m^{-3}



At R60, annual mean NO_2 concentrations are predicted to fall just below the UK Air Quality Objective of 40 µg.m^{-3} in 2032 without further action. However, these predictions are subject to a large degree of uncertainty, particularly with respect to fleet projections and future emissions standards, and therefore these results do not indicate that compliance will definitely be achieved within this timeframe.

At R63 and R34, concentrations are predicted to fall below the objective in 2029 and 2030, respectively. Concentrations at R14 are predicted to fall below the objective in 2023.

7.2 PM_{10}

Table 7-1 presents predicted annual mean NO_2 concentrations at the sensitive receptors described in Section 2 for 2019, and each year between 2022 and 2035. No exceedances of the Air Quality Objective for annual mean PM_{10} concentrations are predicted at any sensitive receptors in Hickleton in any modelled year.

Table 7-2: Annual mean predicted PM_{10} concentrations at sensitive receptors in Hickleton between 2019 and 2034, µg.m^{-3}.

ID	2019	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
R01	13.4	12.9	12.7	12.6	12.5	12.5	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4
R02	13.9	13.4	13.2	13.1	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.8
R03	13.7	13.2	13.1	12.9	12.8	12.8	12.8	12.8	12.7	12.7	12.7	12.7	12.7	12.6
R04	13.5	13.0	12.9	12.8	12.7	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
R05	13.6	13.1	13.0	12.8	12.7	12.7	12.7	12.7	12.7	12.6	12.6	12.6	12.6	12.6
R06	13.3	12.8	12.7	12.6	12.5	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
R07	13.3	12.8	12.7	12.6	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.3
R08	13.4	12.9	12.8	12.7	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.4
R09	13.6	13.1	13.0	12.8	12.7	12.7	12.7	12.7	12.6	12.6	12.6	12.6	12.6	12.6
R10	13.2	12.8	12.6	12.5	12.4	12.4	12.4	12.3	12.3	12.3	12.3	12.3	12.3	12.3
R11	13.2	12.7	12.6	12.4	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.2
R12	13.1	12.7	12.5	12.4	12.3	12.3	12.3	12.2	12.2	12.2	12.2	12.2	12.2	12.2
R13	13.2	12.7	12.6	12.5	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.2
R14	18.8	18.0	17.7	17.5	17.3	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	16.7
R15	18.7	18.0	17.6	17.4	17.2	17.2	17.2	17.1	17.1	17.1	17.1	17.1	17.2	16.5

ID	2019	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
R16	14.0	13.5	13.3	13.2	13.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.8
R17	14.2	13.7	13.5	13.4	13.2	13.2	13.2	13.2	13.1	13.1	13.1	13.1	13.1	13.0
R18	13.5	13.0	12.9	12.7	12.6	12.6	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5
R19	13.8	13.3	13.2	13.1	12.9	12.9	12.9	12.9	12.9	12.8	12.9	12.9	12.9	12.8
R20	13.3	12.8	12.7	12.6	12.5	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
R21	13.8	13.3	13.2	13.1	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.8
R22	14.0	13.5	13.3	13.2	13.1	13.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.9
R23	13.5	13.0	12.9	12.7	12.6	12.6	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5
R24	13.2	12.8	12.6	12.5	12.4	12.4	12.4	12.3	12.3	12.3	12.3	12.3	12.3	12.3
R25	13.4	12.9	12.7	12.6	12.5	12.5	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4
R26	13.4	12.9	12.8	12.6	12.5	12.5	12.5	12.5	12.5	12.4	12.4	12.4	12.4	12.4
R27	13.5	13.0	12.8	12.7	12.6	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.4
R28	14.2	13.7	13.5	13.4	13.3	13.3	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.1
R29	14.2	13.7	13.5	13.4	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.1
R30	15.3	14.8	14.6	14.4	14.3	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	13.9
R31	15.3	14.8	14.6	14.4	14.3	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	13.9
R32	15.4	14.8	14.6	14.5	14.3	14.3	14.3	14.2	14.2	14.2	14.2	14.2	14.3	14.0
R33	15.3	14.7	14.5	14.4	14.2	14.2	14.2	14.2	14.1	14.1	14.1	14.1	14.2	13.9
R34	22.0	21.1	20.4	20.1	19.9	19.8	19.7	19.7	19.7	19.7	19.7	19.7	19.8	18.8
R35	13.7	13.2	13.0	12.9	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.6
R36	13.3	12.8	12.7	12.6	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
R37	13.4	12.9	12.8	12.6	12.5	12.5	12.5	12.5	12.5	12.4	12.4	12.4	12.4	12.4
R38	13.6	13.1	13.0	12.8	12.7	12.7	12.7	12.7	12.7	12.6	12.6	12.6	12.6	12.6
R39	14.0	13.5	13.3	13.2	13.1	13.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.9
R40	13.5	13.0	12.9	12.8	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.5
R41	13.3	12.9	12.7	12.6	12.5	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.3
R43	13.4	12.9	12.7	12.6	12.5	12.5	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4
R45	13.2	12.8	12.6	12.5	12.4	12.4	12.4	12.3	12.3	12.3	12.3	12.3	12.3	12.3
R46	13.1	12.6	12.5	12.4	12.3	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.1
R47	13.4	13.0	12.8	12.7	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.4
R48	13.5	13.0	12.9	12.7	12.6	12.6	12.6	12.6	12.6	12.5	12.6	12.6	12.6	12.4
R49	14.7	14.2	14.0	13.9	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.4
R50	14.6	14.1	13.9	13.7	13.6	13.6	13.6	13.5	13.5	13.5	13.5	13.5	13.5	13.2
R51	13.4	12.9	12.8	12.7	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.4
R52	13.3	12.8	12.7	12.6	12.5	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.3
R53	13.7	13.2	13.1	13.0	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.6
R54	13.6	13.1	13.0	12.8	12.7	12.7	12.7	12.7	12.7	12.6	12.6	12.6	12.6	12.5
R55	13.7	13.2	13.0	12.9	12.8	12.8	12.8	12.8	12.7	12.7	12.7	12.7	12.7	12.6
R56	14.9	14.4	14.1	14.0	13.9	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.7
R57	13.9	13.4	13.2	13.1	13.0	13.0	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
R58	13.6	13.1	12.9	12.8	12.7	12.7	12.7	12.6	12.6	12.6	12.6	12.6	12.6	12.6
R59	24.9	23.9	23.4	23.1	22.9	22.8	22.7	22.7	22.7	22.7	22.7	22.8	22.9	22.6
R60	24.8	23.8	23.2	23.0	22.8	22.7	22.6	22.6	22.6	22.6	22.6	22.7	22.7	22.4
R61	13.8	13.3	13.1	13.0	12.9	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8
R62	13.6	13.1	13.0	12.8	12.7	12.7	12.7	12.7	12.7	12.6	12.6	12.7	12.7	12.6
R63	23.3	22.3	21.8	21.5	21.3	21.2	21.2	21.2	21.1	21.1	21.2	21.2	21.3	20.9
R64	23.3	22.3	21.8	21.5	21.3	21.2	21.2	21.2	21.1	21.1	21.2	21.2	21.3	20.9
DT45	14.7	14.2	14.0	13.9	13.7	13.7	13.7	13.7	13.7	13.6	13.6	13.7	13.7	13.3
DT44	23.3	22.3	21.8	21.5	21.3	21.2	21.2	21.2	21.1	21.1	21.2	21.2	21.3	20.9
DT48	24.9	23.9	23.3	23.0	22.8	22.7	22.7	22.7	22.7	22.7	22.7	22.8	22.8	22.5
DT46	16.2	15.6	15.3	15.1	15.0	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.6
DT47	23.0	22.0	21.3	21.0	20.7	20.6	20.5	20.5	20.5	20.5	20.5	20.5	20.6	19.5

7.3 $PM_{2.5}$

Table 7-1 presents predicted annual mean NO_2 concentrations at the sensitive receptors described in Section 2 for 2019, and each year between 2022 and 2035. No exceedances of the Air Quality Objective for annual mean $PM_{2.5}$ concentrations are predicted at any location in Hickleton in any modelled year. Concentrations exceed the Air Quality Target in 2019, but are predicted to fall below the target before the Target year of 2040.

Table 7-3: Annual mean predicted $PM_{2,5}$ concentrations between 2019 and 2035, $\mu g.m^{-3}$.

ID	2019	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
R01	8.0	7.6	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R02	8.3	7.9	7.7	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.4
R03	8.2	7.8	7.7	7.6	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3
R04	8.1	7.7	7.6	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
R05	8.1	7.7	7.6	7.5	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3
R06	7.9	7.6	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R07	7.9	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1

ID	2019	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
R08	8.0	7.6	7.5	7.4	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R09	8.1	7.7	7.6	7.5	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3
R10	7.9	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1
R11	7.8	7.5	7.4	7.3	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
R12	7.8	7.4	7.3	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.0
R13	7.8	7.5	7.4	7.3	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
R14	11.5	10.9	10.5	10.3	10.2	10.1	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.7
R15	11.5	10.9	10.5	10.3	10.1	10.1	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.6
R16	8.4	8.0	7.8	7.7	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.4
R17	8.5	8.1	7.9	7.8	7.7	7.7	7.7	7.6	7.6	7.6	7.6	7.6	7.6	7.5
R18	8.0	7.7	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2
R19	8.3	7.9	7.7	7.6	7.5	7.5	7.5	7.5	7.5	7.4	7.4	7.4	7.4	7.4
R20	7.9	7.6	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R21	8.3	7.9	7.7	7.6	7.5	7.5	7.5	7.5	7.5	7.4	7.4	7.4	7.5	7.4
R22	8.4	8.0	7.8	7.7	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.5
R23	8.0	7.7	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2
R24	7.9	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1
R25	8.0	7.6	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R26	8.0	7.6	7.5	7.4	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R27	8.0	7.6	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.3	7.2
R28	8.5	8.1	8.0	7.8	7.7	7.7	7.7	7.7	7.7	7.6	7.7	7.7	7.7	7.6
R29	8.5	8.1	7.9	7.8	7.7	7.7	7.7	7.7	7.6	7.6	7.6	7.6	7.6	7.6
R30	9.3	8.8	8.6	8.5	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.2	8.1
R31	9.3	8.8	8.6	8.5	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.2	8.1
R32	9.3	8.8	8.6	8.5	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.1
R33	9.3	8.8	8.6	8.4	8.3	8.3	8.3	8.2	8.2	8.2	8.2	8.2	8.2	8.1
R34	13.9	13.1	12.5	12.2	11.9	11.8	11.7	11.6	11.6	11.6	11.6	11.6	11.6	11.0
R35	8.2	7.8	7.6	7.5	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3
R36	7.9	7.6	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R37	8.0	7.6	7.5	7.4	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R38	8.1	7.7	7.6	7.5	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3
R39	8.4	8.0	7.9	7.7	7.6	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5
R40	8.1	7.7	7.6	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2
R41	8.0	7.6	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1
R43	8.0	7.6	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
R45	7.9	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1
R46	7.8	7.4	7.3	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.0
R47	8.0	7.6	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2
R48	8.0	7.7	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2
R49	8.9	8.4	8.2	8.1	8.0	8.0	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.7
R50	8.8	8.3	8.2	8.0	7.9	7.9	7.9	7.9	7.9	7.8	7.8	7.8	7.8	7.7
R51	8.0	7.6	7.5	7.4	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.2
R52	7.9	7.5	7.4	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1
R53	8.2	7.8	7.7	7.6	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3
R54	8.1	7.7	7.6	7.5	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.2
R55	8.2	7.8	7.7	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.3
R56	9.0	8.6	8.4	8.2	8.1	8.1	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
R57	8.3	7.9	7.8	7.7	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
R58	8.1	7.7	7.6	7.5	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3	7.3
R59	15.4	14.6	14.0	13.7	13.5	13.4	13.3	13.3	13.2	13.2	13.2	13.2	13.3	13.1
R60	15.4	14.5	13.9	13.7	13.4	13.3	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.0
R61	8.2	7.8	7.7	7.6	7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
R62	8.1	7.7	7.6	7.5	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.3
R63	14.4	13.6	13.1	12.8	12.6	12.5	12.4	12.4	12.3	12.3	12.3	12.3	12.4	12.1
R64	14.4	13.6	13.1	12.8	12.6	12.5	12.4	12.4	12.3	12.3	12.3	12.3	12.4	12.1
DT45	8.9	8.4	8.2	8.1	8.0	8.0	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.7
DT44	14.4	13.6	13.1	12.8	12.6	12.5	12.4	12.4	12.3	12.3	12.3	12.3	12.4	12.1
DT48	15.4	14.6	14.0	13.7	13.5	13.4	13.3	13.2	13.2	13.2	13.2	13.2	13.2	13.1
DT46	9.9	9.3	9.1	8.9	8.8	8.7	8.7	8.7	8.7	8.6	8.6	8.7	8.7	8.5
DT47	14.6	13.7	13.0	12.7	12.4	12.3	12.2	12.1	12.1	12.1	12.1	12.1	12.1	11.4

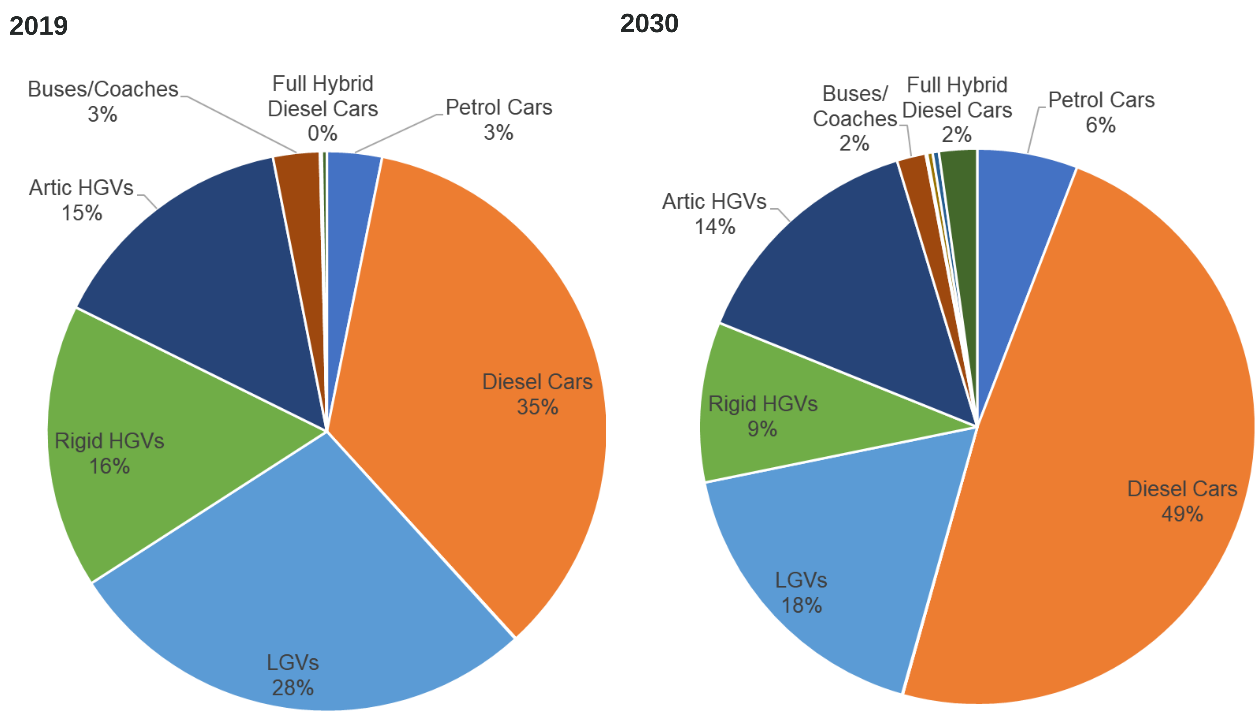
8. SOURCE APPORTIONMENT

Figure 8-1 shows the percentage contribution of different vehicle types to NOx (NO plus NO_2) concentrations at R59/R60 in 2019 and 2030. In both years, diesel cars are the largest contributor to NOx concentrations, contributing 35% of the total local NOx in 2019 and 49% in 2019. This is typical of roadside sites across the UK, as diesel vehicles have greater NOx emissions than petrol vehicles.

LGVs and HGVs also contribute substantially to NOx concentrations at the site, as these diesel vehicles emit high levels of NOx per vehicle.

The contribution of diesel cars relative to other vehicles is predicted to increase over time. This indicates that a greater than anticipated shift from diesel to electric cars could reduce concentrations further than is predicted in this baseline model.

Figure 8-1: Source apportionment of NOx emissions at R59/60 in 2019 and 2030



9. SCENARIO TESTING

9.1 MODELLED SCENARIOS

NO_2 concentrations were also predicted for four scenarios representing potential emissions scenarios in Hickleton. These scenarios included both potential measures for emissions reduction and future scenarios in which emissions are higher than predicted.

Scenario 1: A delay in natural fleet turnover of two years. This situation can arise if the rate at which individuals replace their cars is lower than national predictions suggest, which can occur for example in adverse economic circumstances. Traffic flows and speeds were assumed to be unchanged between this scenario and the baseline.

Scenario 2: Implementation of a 20 mph speed limit across all roads in Hickleton.

Traffic speeds on roads within Hickleton where the modelled speed is greater than 20mph in the baseline model were reduced to 20mph, thereby increasing average emission rates along these roads.

Scenario 3: Including the potential impacts of the proposed new access road and roundabout off the A635 to the proposed ES10 commercial employment site near Goldthorpe, together with associated development.

Traffic flows for this scenario were derived from the transport assessment carried out for this development and described in Section 5.1, which was provided by Doncaster City Council. The additional traffic from this development was assumed to have no impact on average traffic speeds along the A635.

Traffic flows generated by the proposal in 2022 are summarised below:

Table 9-1: Traffic generated by Goldthorpe developments, AADT

Road	AADT generation	HGVs
A635 between Doncaster Road and Hickleton EB	456	65
A635 between Doncaster Road and Hickleton WB	452	68
A635 through Hickleton EB	457	66
A635 through Hickleton WB	452	68
A635 through Hickleton Total	494	133
Red Hill Lane (N) off A635	62	9
Red Hill Lane (S) off A635	81	12
Lidget Lane off A635	0	0

Scenario 4: The implementation of a Class D Charging Clean Air Zone in Hickleton.

The impacts of the CAZ have been calculated using behavioural response assumptions from guidance published by the Joint Air Quality Unit (DfT and Defra) for Clean Air Zone studies.

These assumptions include the proportion of vehicles that will replace their vehicle, cancel the trip, change mode, avoid the zone, and pay the charge. As there are limited alternative routes, only the “replace vehicle” behavioural response was modelled; all journeys that would be expected to change route or cancel the trip were assumed to instead pay the charge and travel as normal. As such, this represents a conservative estimate of the potential impacts of a Clean Air Zone in Hickleton.

Table 9-2: Behavioural response assumptions used in Class D CAZ testing

Vehicle Type	% Replace vehicle (vkm)
Cars	64%
LGVs	64%
HGVs	83%
Buses	94%
Coaches	72%

9.2 RESULTS

Results for the sensitivity testing are presented below for each of the four exceedance locations in Hickleton. Table 9-3 presents annual mean NO_2 concentrations for each scenario for each modelled year, and Figures 9-1 through 9-4 present these results graphically for each receptor in turn.

Table 9-3: Annual mean NO_2 concentrations for the modelled scenarios at 4 exceedance locations, 2019 to 2034, $\mu g.m^{-3}$. Exceedances of the Air Quality Objective are highlighted in red.

Receptor	Year	Baseline	S1: fleet delay	S2: 20mph	S3: Goldthorpe	S4: CAZ D
R14	2019	48.6	-	-	-	-
	2022	41.3	49.3	42.4	42.1	36.6
	2024	36.2	41.3	36.9	36.6	33.0
	2026	32.0	35.9	32.3	32.1	29.8
	2028	28.6	31.6	28.8	28.7	27.1
	2030	26.4	28.1	26.5	26.4	25.3
	2032	23.8	26.1	24.4	24.2	23.6
	2034	23.3	24.0	23.9	23.7	23.1
R34	2019	72.9	-	-	-	-
	2022	62.4	74.6	62.6	63.4	54.5
	2024	54.6	62.6	54.8	55.6	49.7
	2026	48.0	54.8	47.9	48.6	45.0
	2028	42.8	48.2	42.7	43.6	41.0
	2030	39.3	42.9	39.2	40.0	38.3
	2032	35.9	39.6	35.9	36.6	35.5
	2034	35.1	36.2	35.0	35.7	34.8
R60	2019	75.5	-	-	-	-
	2022	63.7	74.8	65.6	64.8	58.9
	2024	57.2	63.8	59.1	58.3	53.8
	2026	51.1	57.4	52.5	51.7	48.8
	2028	45.9	51.2	47.2	46.9	44.5
	2030	42.4	46.1	43.7	43.3	41.6
	2032	38.9	42.8	40.1	39.6	38.6
	2034	38.1	39.2	39.1	38.7	37.7
R63	2019	68.5	-	-	-	-
	2022	57.8	68.5	59.5	58.9	52.5
	2024	51.2	57.9	52.8	52.2	47.6
	2026	45.3	51.3	46.5	46.0	43.0
	2028	40.5	45.4	41.6	41.3	39.1
	2030	37.2	40.6	38.2	38.0	36.4
	2032	34.0	37.5	35.0	34.7	33.7
	2034	32.2	34.3	34.1	33.8	32.9

Figure 9-1: Annual mean predicted NO_2 concentrations at R14 under the baseline future scenario and the four scenarios

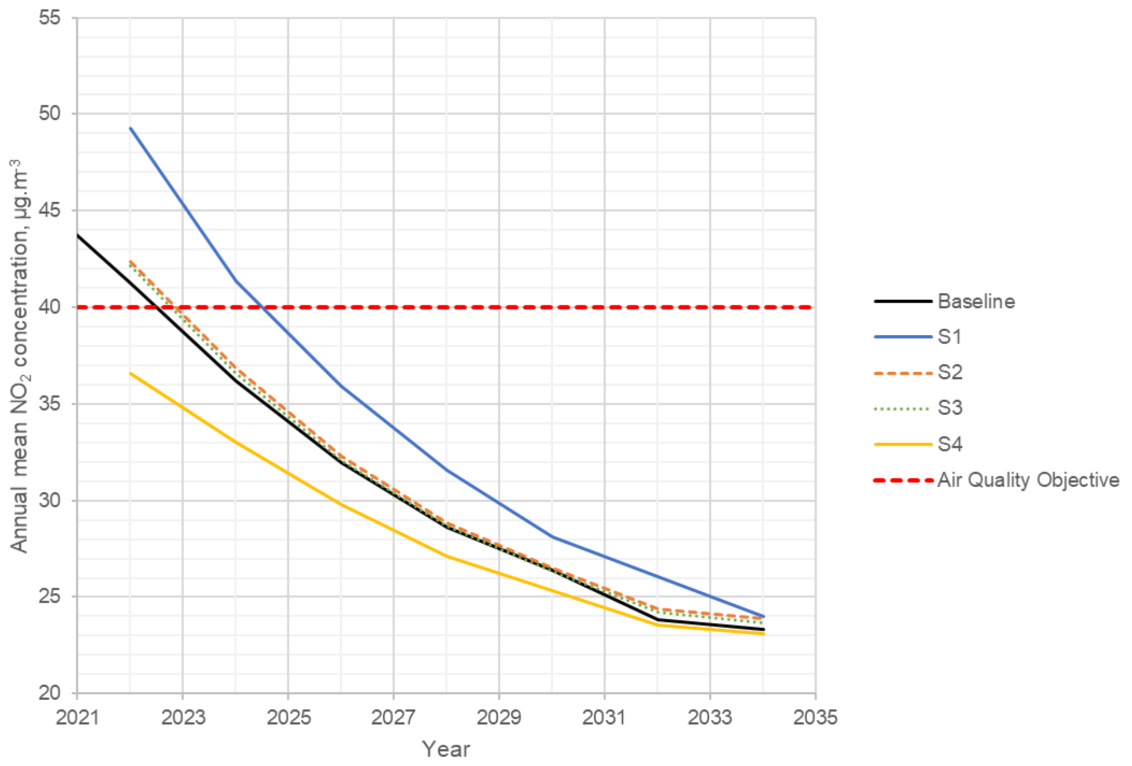


Figure 9-2: Annual mean predicted NO_2 concentrations opposite R34 under the baseline future scenario and the four scenarios

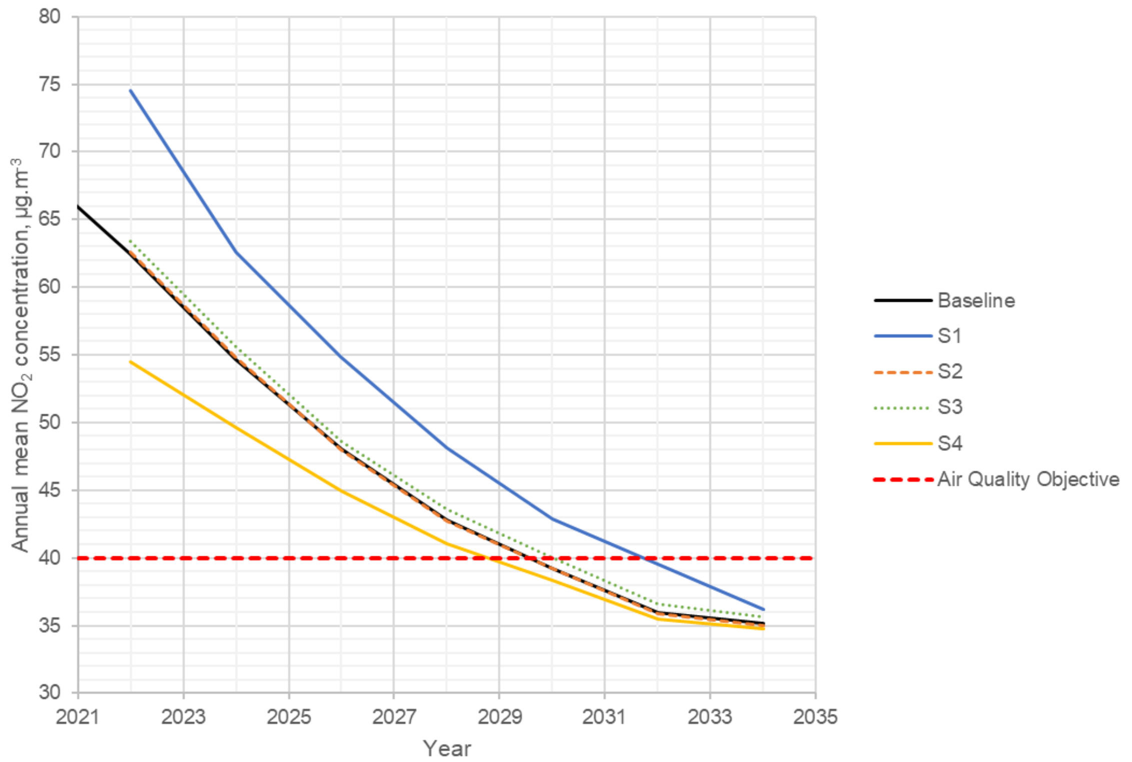


Figure 9-3: Annual mean predicted NO_2 concentrations at R60 under the baseline future scenario and the four scenarios

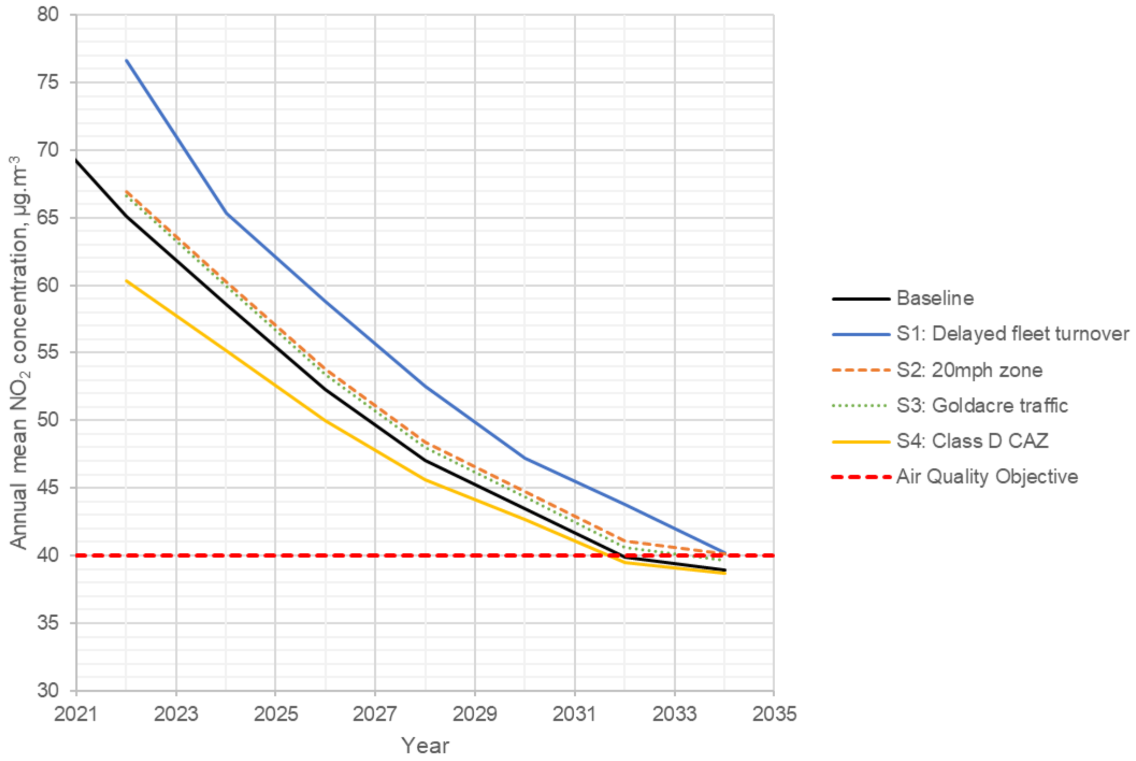
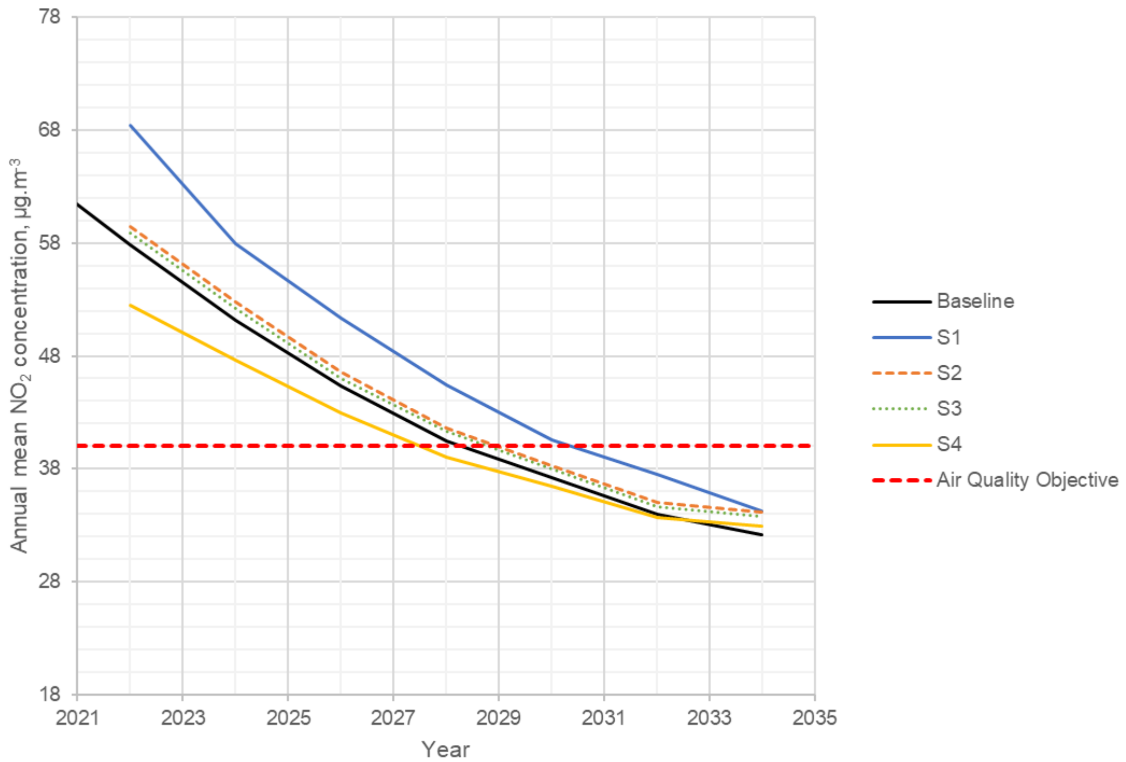


Figure 9-4: Annual mean predicted NO_2 concentrations at R63 under the baseline future scenario and the four scenarios



10. DISCUSSION

Detailed dispersion modelling of emissions from road transport in Hickleton has identified that exceedances of the Air Quality Objective for annual mean NO_2 concentrations occurred at 4 sensitive receptors in Hickleton in 2019:

- R14/15;
- R34;
- R59/R60;
- R63.

These results are aligned with monitoring evidence, which also identifies exceedances at these locations in recent years. Concentrations at R60, R34 and R63 are highly elevated, with concentrations as high as 80 $\mu g.m^{-3}$ predicted in 2019, while concentrations at R14 are lower, albeit still above the AQO.

No exceedances of the Air Quality Objectives for particles (PM_{10} and $PM_{2.5}$) are predicted to occur at any location in Hickleton in 2019. Exceedances of the new Air Quality Target of 10 $\mu g.m^{-3}$ for $PM_{2.5}$ are predicted to occur at roadside sites in 2019, but natural fleet turnover and reductions in regional emissions are predicted to bring concentrations below the target before the target year of 2040.

In order to identify the year of compliance with the Air Quality Objective for annual mean NO_2 concentrations, modelling has been carried out for each year between 2022 and 2034, using national projections to predict future road transport emissions in Hickleton. The predicted year of compliance at each site is presented in Table 10-1. While compliance with the objective will be achieved at the majority of residences in Hickleton by 2030, the exceedance of the Objective at R60 are likely to persist until 2032 if current projections prove accurate.

Table 10-1: Modelled year of compliance for sites of exceedances of the Air Quality Objective for annual mean NO_2 concentrations in Hickleton

Receptor	Annual mean NO_2 concentration, 2019, $\mu g.m^{-3}$	Modelled year of compliance
R14	48.6	2023
R34	72.9	2030
R60	75.5	2032
R63	68.5	2029

Predictions of emissions in future years are highly uncertain, with the level of uncertainty growing with predictions further into the future. As the margin of compliance is small, it is possible that if emissions in future years are greater than current projections predict, compliance may not be achieved within the period modelled for this study.

The level of improvement from implementing a Clean Air Zone reduces over time, as the number of non-compliant vehicles in the fleet naturally reduces. In order to achieve compliance with the Air Quality Objective, almost 100% compliance is required, and as a result compliance is not brought forwards, although concentrations in the intervening years are reducing significantly.

The impact of a 2-year delay to fleet turnover is generally to delay compliance by two years, demonstrating that the improvements from natural fleet turnover are substantially larger than the increase in traffic over time, which has a negligible effect on compliance.

The implementation of a 20mph zone in Hickleton increases annual mean NO_2 concentrations at sensitive receptors by between 0.2 $\mu g.m^{-3}$ and 2 $\mu g.m^{-3}$. This leads to the year of compliance being pushed back by 2 years at R60. However, it should be noted that this study does not include detailed transport modelling of the impacts of such a zone, and reductions in congestion may counterbalance this effect to some extent.

The road infrastructure improvements and developments in the Goldthorpe Plan leads to an increase of approximately 1 $\mu g.m^{-3}$ in NO_2 concentrations at the receptors; this does not result in compliance being pushed back at any receptors in the model, but would decrease the likelihood of compliance being achieved in the modelled years taking into account model uncertainty.

The charging Class D CAZ significantly reduces concentrations in 2022, with the impact of the CAZ reducing over time as more vehicles become naturally compliant. As a result, it would not bring forward compliance at the worst-affected sites in Hickleton as the short-term reductions are not sufficient to deliver compliance. Compliance at R63 would be brought forwards by 1 years (to 2028 compared with 2029).

Low-impact mitigation options along this stretch of road are limited, as the link represents a key route onto the A1 for vehicles in the surrounding area. Furthermore, as R60 is located directly against the road, there is no opportunity for construction of barriers or green walls to restrict dispersion. Instead, measures would need to either improve dispersion along this stretch of road or reduce emissions from vehicles (either by reducing traffic flows or restricting access for polluting vehicles). An alternative approach would be to remove the exposure at the site, for example by repurposing the building.

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