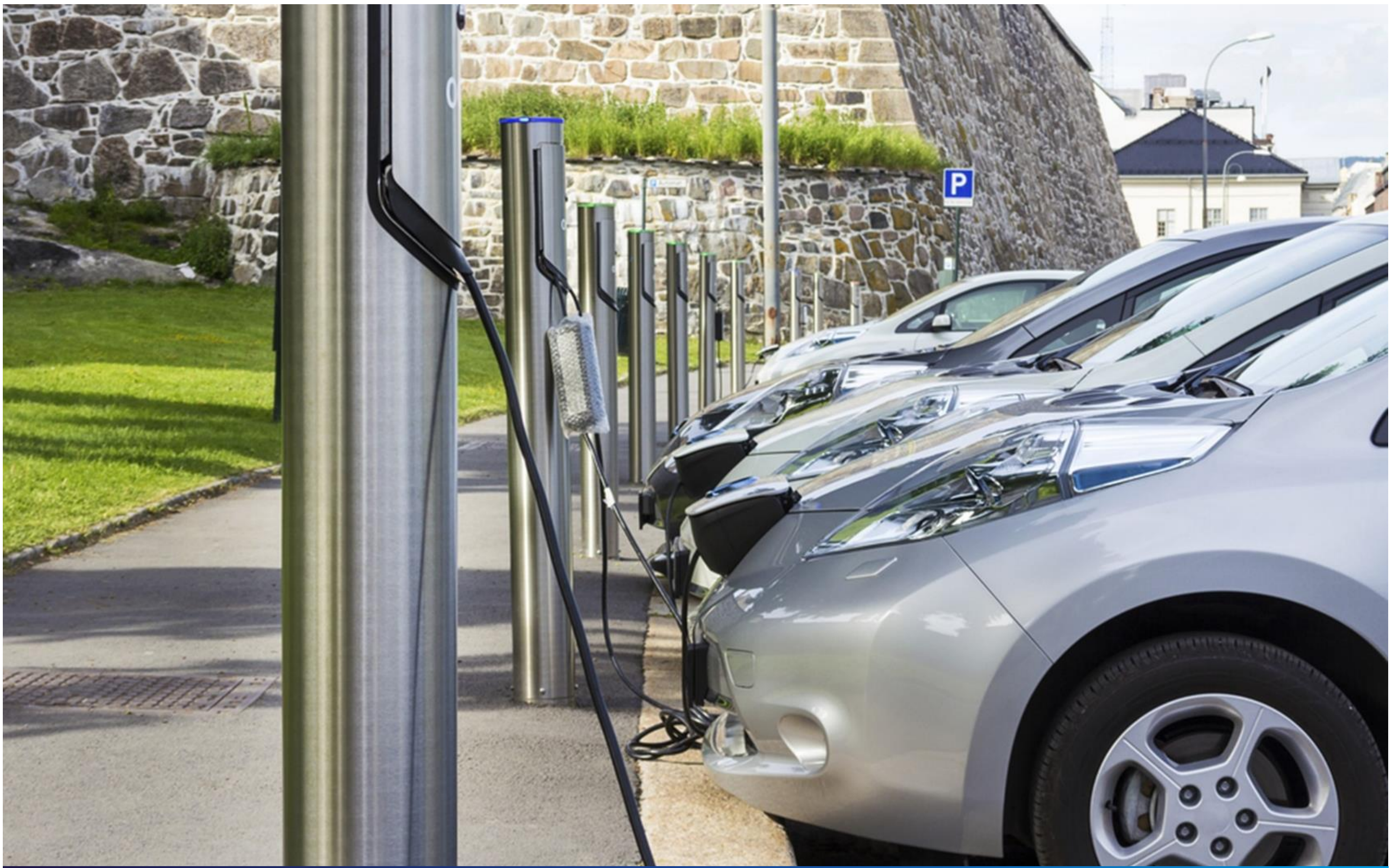

SWAFFHAM AIR QUALITY MANAGEMENT AREA

Detailed assessment

Report for: Breckland Council

Ricardo ref. ED18432110 Issue: 1 09/10/23

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09/10/23

Ricardo is certified to ISO9001, ISO14001, ISO27001 and ISO45001.

EXECUTIVE SUMMARY

Annual mean concentrations of NO_2 measured by monitors in and around the Swaffham Air Quality Management Area (AQMA) have been compliant with the Air Quality Standard since 2018. As NO_2 concentrations have been below 90% of the standard for three successive years, the Council has the option to consider revoking the AQMA. To support this decision, the Council commissioned Ricardo to carry out a Detailed Assessment of NO_2 concentrations in the AQMA.

Ricardo have carried out air quality modelling to assess:

- whether citizens of Swaffham are likely to be impacted by exposure to concentrations of NO_2 at locations where monitoring is not currently undertaken.
- whether citizens are likely to be exposed to higher NO_2 concentrations in the future if fleet renewal rates in 2020 and 2021 have been delayed relative to national projections, or if traffic was to be increased on the road network.

To achieve these goals, modelling was carried out a 2022 Baseline, using a combination of traffic data provided by the Council, and Department for Transport traffic counts, as well as national forecasts for the vehicle fleet composition, and two sensitivity testing scenarios:

1. Sensitivity test 1: The 2022 baseline with slower than expected replacement of older road vehicles as a result of economic conditions leading to a 2-year delay in fleet renewal across the area (2020 fleet split data).
2. Sensitivity test 2: The 2022 baseline with a 25% increase in traffic volumes.

All modelling was carried out following appropriate LAQM technical guidance and best practice.

The conclusions of the study are summarised in Box 1.

Box 1: Key conclusions of the Detailed Assessment

- No relevant receptor is predicted to have an annual mean NO_2 concentration within 10% of the Air Quality Objective for annual mean NO_2 at any location of relevant exposure in 2022.
- Furthermore, no locations of relevant exposure are predicted to exceed the Objective in a number of theoretical emissions scenarios where emissions would be higher than those predicted from forecasted national trends. These scenarios comprised a 25% increase in road traffic on all roads in Swaffham, and a 2-year delay in fleet renewal compared to national fleet projections.
- Based on the data available, the model results indicate the AQMA can be revoked without risk of future exceedances.

CONTENTS

1. INTRODUCTION

Ricardo Energy & Environment (Ricardo) have been commissioned by Breckland Council (BC) to carry out a Detailed Assessment to quantify public exposure to concentrations of Nitrogen Dioxide (NO_2) across the village of Swaffham. Monitoring data across the Swaffham AQMA indicates that concentrations across the AQMA are lower than 90% of the Air Quality Objective for annual mean NO_2 concentrations. Local Air Quality Management guidance LAQM.TG(22)[1] recommends a detailed assessment should therefore be carried out to determine whether the AQMA can be revoked.

To complete this task, Ricardo Energy and Environment have reviewed historic measurements collected by the Council and developed an air dispersion model to predict current exposure at locations where measurements are not collected.

In order to demonstrate the robustness of compliance given uncertainties in model inputs and traffic flows in future years, modelling was also carried out for two “worst-case” 2022 scenarios representing conditions that lead to higher emissions than in the base 2022 model:

1. Sensitivity test 1: The 2022 baseline with slower than expected replacement of older road vehicles as a result of economic conditions leading to a 2-year delay in fleet renewal across the area (2020 fleet split data).
2. Sensitivity test 2: The 2022 baseline with a 25% increase in traffic volumes.

2. AIR QUALITY STANDARDS

The Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland (Defra, 2007) sets out UK policy on air quality including a framework for reducing hazards to health from air pollution and meeting international commitments. It sets standards and objectives for ten main air pollutants (including nitrogen dioxide, PM_{10} and $PM_{2.5}$) to protect health, vegetation and ecosystems. The European Union has also set limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$ (EU Directive 2008/50/EC) and is implemented in UK law through the Air Quality Standards Regulations (2010). The limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$ are the same numerical concentrations as the UK objectives.

The AQOs which are relevant to this air quality impact assessment are detailed in Table 2-1.

Table 2.1: National Air Quality Objectives (AQOs)

Pollutant	Measured As	Objective
Nitrogen dioxide (NO_2)	Annual Mean	40 µg/m^3
	1-hour Mean	200 µg/m^3 not to be exceeded more than 18 times a year
Particles (PM_{10})	Annual Mean	40 µg/m^3
	24-hour Mean	50 µg/m^3 not to be exceeded more than 35 times a year
Particles ($PM_{2.5}$)	Annual Mean	20 µg/m^3

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

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

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.

3. AIR QUALITY IN SWAFFHAM

The UK parliament passed the UK Environment Act (1995, updated 2022) which sets a requirement for competent authorities to undertake routine assessment of the quality of its air. To support compliance with this objective, the UK government also introduced the Local Air Quality Management framework to ensure that Local Authorities routinely undertaking this assessment and that action is undertaken when measured concentrations of air pollutant are above threshold values set for six pollutants in its Air Quality Standards regulation.

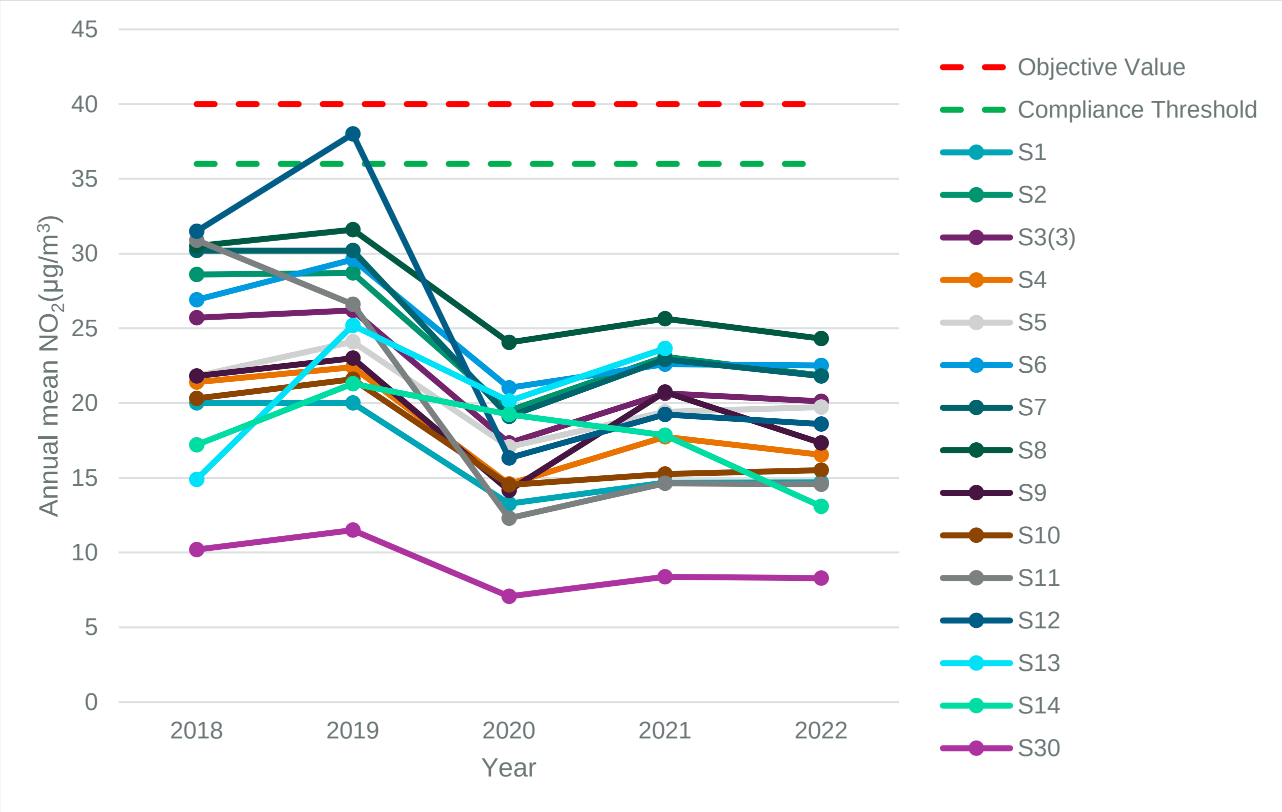
In accordance with the LAQM framework BC has established an air quality monitoring network around Swaffham to monitor concentrations of pollutants at locations where citizens are most likely to have prolonged exposure to the area's most elevated concentrations.

The data collected by the monitoring network identified that concentrations of Nitrogen Dioxide (NO_2) along the High Street exceeded the standard set in the regulation as an annual mean concentration (40µg/m^3). In response, a further investigation was undertaken to fully understand a reason for elevated concentrations in this area of the village and a plan was drawn up to bring NO_2 concentrations into compliance with the standards regulation. As a result, part of the street was declared as an Air Quality Management Area (AQMA) in recognition of the problem in 2005. This AQMA is illustrated in Figure 3-1.

Figure 3-1: Swaffham AQMA

Actions implemented by BC to bring the AQMA into compliance with the standard have been successful as measurements collected by monitors in the AQMA show a long-term reduction trend in NO_2 concentrations, with concentrations at all monitors being compliant with the air quality objective for annual mean NO_2 concentrations in 2019. Trends in monitored concentrations in Swaffham are presented in Figure 3-2.

Figure 3-2: Sampled NO_2 concentrations within the vicinity of the AQMA (2018 – 2022)



Annual mean concentrations of NO_2 measured by monitors placed inside the AQMA have been compliant with the Air Quality Standard since 2018. Annual mean concentrations have declined over the last five years at all locations, and annual mean concentrations have been below 90% of the threshold standard value (36µg/m^3) at all locations since 2020, and at all but S12 since 2018 which was reported to be below the Air Quality Standard during this time, excluding one year in 2019. It must be noted however that S12 is not a location within the AQMA and this has been corrected in 2023's Annual Status Report (ASR).

Following LAQM guidance, as concentrations of NO_2 have been below 90% of the standard for three successive years the Council has the option to consider revoking the AQMA.

4. AIR QUALITY MODELLING

4.1 OVERALL APPROACH AND CHOICE OF MODEL

Air pollutant concentrations were modelled for a baseline year of 2022 to assess current public exposure to NO_2 concentrations. The modelling was carried out following best practice techniques detailed in LAQM Technical Guidance[2] and model guidance published by the model developers.

The latest version of ADMS-Roads (5.1), developed by CERC, was selected as the most appropriate tool for undertaking this study. This is a model that is widely used in assessments for Local Authorities in the UK. CERC models are continually validated against available measured data obtained from real world situations, field campaigns and wind tunnel experiments. The tool includes advanced features for treatment of street canyons and other road geometry.

Ratified measurements collected by the local NO_2 pollutant measurements network were compared to the modelled results at each location; this process is called model verification, and is summarised in Section 6.

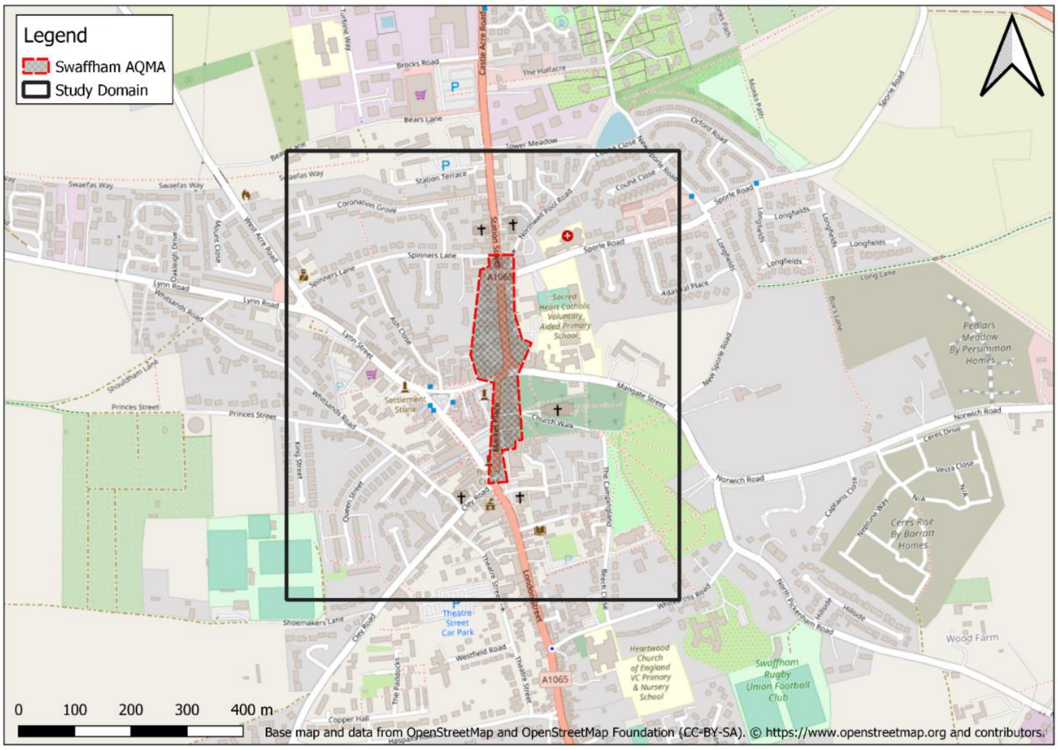
The verified model was then used to predict concentrations at sensitive receptors in and around the Swaffham AQMA. In order to demonstrate the robustness of compliance given uncertainties in model inputs and traffic flows in future years, modelling was also carried out for two “worst-case” 2022 sensitivity test representing conditions that could lead to higher emissions than in the base 2022 model:

- Sensitivity test 1: Traffic volumes across Swaffham increasing by 25%;
- Sensitivity test 2: Slower than expected replacement of older road vehicles as a result of economic conditions leading to a 2-year delay in fleet renewal across the area.

4.2 MODEL DOMAIN

Figure 4-1 shows the chosen study area of the model.This area was selected to include all major road sources in Swffham, and all monitoring locations in the area. The modelled road network extends to the A47 in the north and to the junction between Brandon Road and Redland Road in the south.

Figure 4-1: Study domain region

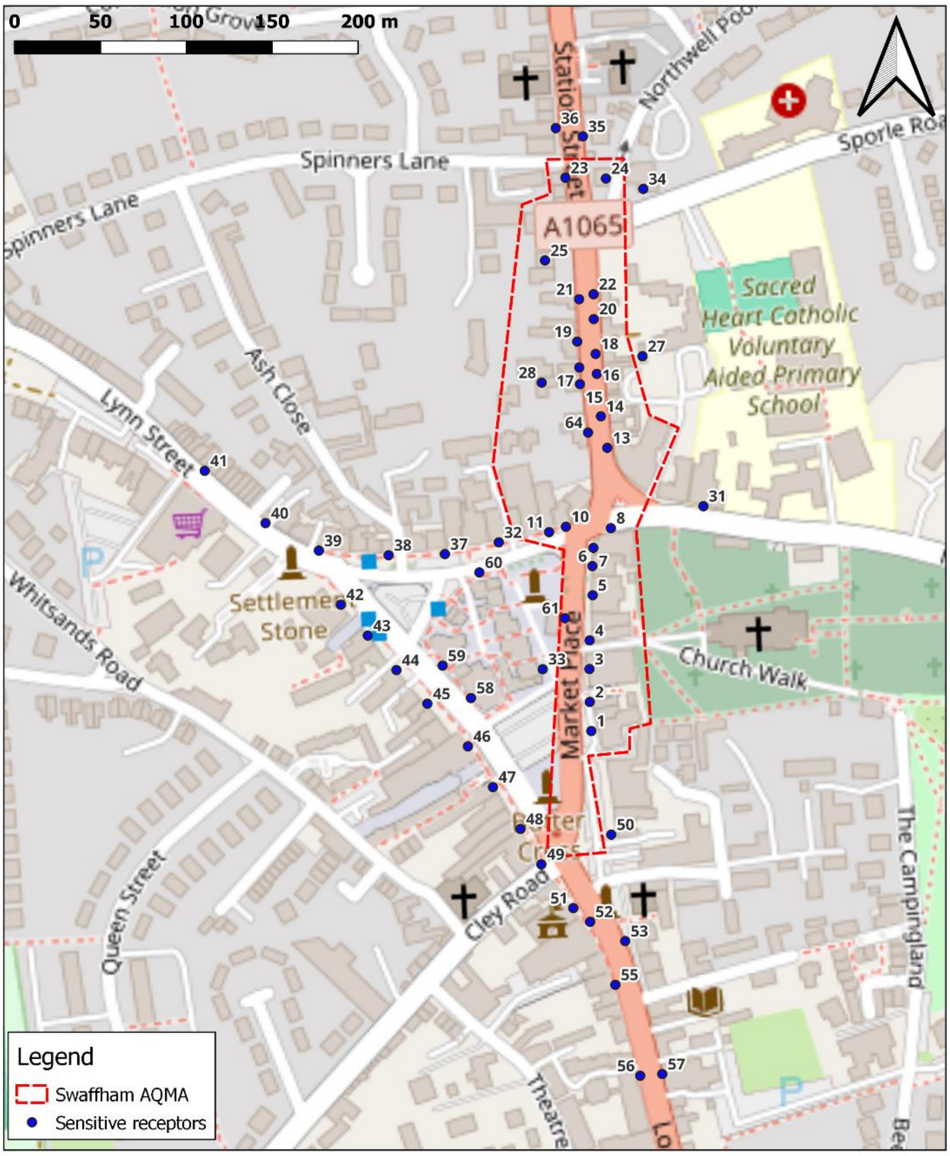


[2] https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf

4.3 SENSITIVE RECEPTORS

Sensitive receptors within and along major roads in the vicinity of the AQMA were identified using aerial imagery. For each relevant building, a point on the building façade facing the nearest road was used to capture worst-case concentrations. Figure 4-2 shows the locations of modelled sensitive receptors; Table 4-1 provides their exact locations. All receptors were modelled at ground level to capture worst case concentrations.

Figure 4-2: Location of modelled sensitive receptors



Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.

Table 4-1: Sensitive receptor locations

ID	Address	x	y
01	The Red Lion, A1605	581985.3	308941.2
02	Starlings, A1605	581984.4	308958.1
03	Iceland, A1605	581984.2	308977.3
04	73, A1605	581984.3	308994.0
05	Margaret's Tea Rooms, A1605	581986.1	309020.3
06	Opticians, A1605	581985.9	309037.3
07	3, A1605	581986.5	309047.9

ID	Address	x	y
08	3, Mangate Street	581996.7	309059.4
10	57, Lynn Street	581970.5	309060.2
11	London Nails, Lynn Street	581960.7	309057.1
13	Best Western George, Station Street	581994.6	309106.2
14	4, Station Street	581990.9	309124.6
15	12, Station Street	581978.7	309143.3
16	3, Station Street	581988.5	309149.3
17	14, Station Street	581978.3	309153.0
18	15, Station Street	581987.8	309160.9
19	16, Station Street	581977.1	309168.1
20	21, Station Street	581986.7	309181.2
21	Orwell House, Station Street	581978.2	309192.8
22	23, Station Street	581986.6	309195.7
23	9, Station Street	581970.2	309263.6
24	Norfolk Yoga Centre, Station Street	581993.8	309263.1
25	26, Station Street	581958.3	309215.4
27	Staines House, Station Street	582015.1	309159.6
28	12, Station Street	581956.4	309144.2
31	7, Mangate Street	582050.6	309072.2
32	43, Lynn Street	581931.4	309051.1
33	14, A1605	581957.0	308977.2
34	25, Station Street	582015.6	309257.1
35	29, Station Street	581980.4	309287.7
36	Baptist Church, Station Street	581964.6	309292.5
37	39, Lynn Street	581900.0	309044.3
38	29, Lynn Street	581867.2	309043.6
39	21, Lynn Street	581826.6	309046.3
40	19, Lynn Street	581795.5	309062.3
41	18, Lynn Street	581760.1	309092.8
42	18, Market Place	581839.4	309014.8
43	20, Market Place	581855.1	308996.8
44	30, Market Place	581871.8	308976.7
45	28, Market Place	581889.8	308957.1
46	36, Market Place	581913.4	308932.2
47	42, Market Place	581928.0	308908.5
48	44, Market Place	581944.0	308884.1
49	48, London Street	581956.2	308863.5
50	97, A1605	581996.9	308880.8
51	4, London Street	581974.8	308838.0
52	6, London Street	581984.6	308830.0
53	7, London Street	582005.0	308818.8
55	18, London Street	581999.3	308793.3
56	36, London Street	582013.8	308740.3
57	Conservative Club, London Street	582026.6	308741.3
58	1, Market Place	581915.2	308960.4
59	59, Market Place	581898.7	308979.3
60	5, Lynn Street	581920.1	309033.6
61	7 (Costa Coffee), A1605	581969.9	309006.9
64	Eversley House, Station Street	581983.4	309115.1

4.4 SURFACE ROUGHNESS

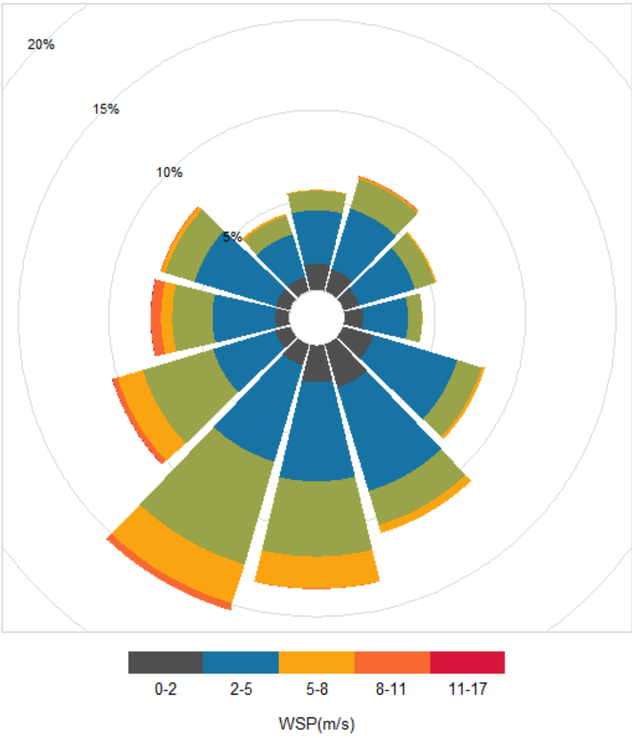
In ADMS-Roads, a length scale parameter called the surface roughness length is used to characterise the study area in terms of its effects on wind speed and turbulence. The modelling used a surface roughness length of 0.5m, to represent a moderately built-up area.

The difference in land use at the meteorological site and the model domain was accounted for by using a surface roughness of 0.2m for the meteorological site.

4.5 METEOROLOGY

One year of meteorological data from the Met Office Marham Airfield site was used in this study. A wind rose for the Marham 2022 dataset is presented in Figure 4-3.

Figure 4-3: Windrose of meteorological data collected at Marham Airfield during 2022



4.6 CHEMISTRY AND BACKGROUND CONCENTRATIONS

The interconversion of NO and NO_2 emissions in the presence of ozone was calculated using the NOx:NO_2 calculator[3] published by Defra, following the approach outlined in LAQM.TG(22). Background concentrations were taken from the background maps published by Defra[4] 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 this study are presented in Table 4-2.

Table 4-2: Annual mean background concentrations, 2022.

Pollutant	Background concentration (µg.m^{-3})
NOx	9.4
PM_{10}	15.3
$PM_{2.5}$	9.0

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

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

4.7 MODEL UNCERTAINTY

Model outputs are subject to a degree of uncertainty, this is through the uncertainty inherent to the models used, and uncertainty in the model inputs. In this study, this uncertainty has been addressed through following best practice approaches and through using worst-case assumptions where appropriate in the model inputs to ensure that the model outputs are conservative with respect to real-world concentrations. Compliance has been assessed against a value of 36 µg.m^{-3}, 10% below the relevant Air Quality Objective following the approach described in LAQM.TG(22).

The air quality modelling has been carried out following all relevant guidance, and the model is calibrated to measured concentrations following the approach outlined in Local Air Quality Management Technical Guidance (LAQM TG(22)).

A direct assessment of uncertainty in the air quality results is carried out for the baseline model as part of the validation process against monitored air quality data. In this process, model performance and uncertainty is assessed using the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations, as detailed in Technical Guidance LAQM.TG(22). In this case the RMSE was calculated at 2.3 µg.m^{-3}, well within the ideal RMSE of 4 µg.m^{-3} recommended in guidance.

However, when assessing options in future years there will also be uncertainty related to the assumptions made in modelling these options. The reliability of the assumptions used in the modelling is summarised in Table 4-3.

Table 4-3: Reliability of assumptions

Assumption	Source	Rating (High/Moderate/Low)
Meteorological data	Marham Airfield	High
Fleet composition and emission factors	EFT version 11	High
Base year traffic flows	Council and DfT	High
Growth in traffic flows	NTEM V8 (Tempro)	Moderate (regional rather than local)
Traffic Speeds	Council count data, 2015	Moderate
Queuing	Council queuing data, 2015	Moderate
Fleet projections (fuel split and Euro standard split)	Projections from the emissions factor toolkit	Moderate
Background concentrations	Defra background maps	Moderate
Measured concentrations	Diffusion tubes	High
Canyon effects	Satellite imagery; ADMS-Roads advanced canyon module	High
Road widths	OS Mastermap	High

5. EMISSIONS INVENTORY

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

1. Collation of local traffic flow, speed and queuing data;
2. Collation of national fleet fuel and technology statistics;
3. The traffic and fleet data were combined with emission factors from the most recent version of the Emissions Factors Toolkit (EFT), version 11[5] to provide total annual emissions of NOx and PM for the modelled road links.
4. Queuing was modelled along road links entering the A1065/Lynn Street/Norwich Road junction.

Further detail on the emissions inventory compilation is provided below.

5.1 TRAFFIC FLOWS AND SPEEDS

A hybrid traffic volume dataset was compiled from data collected by Norfolk Council and from the DfT traffic count network[6]. Traffic flows were provided for vehicle categories including cars, LGVs, HGVs, buses and coaches, and motorcycles. Where detailed vehicle split information was not available, the average vehicle split across other count points in Swaffham was used. Traffic counts from years other than 2022 were projected to 2022 using national projections from the NTEM dataset, published by the Department for Transport[7].

The traffic flows used in the assessment are summarised in Table 5-1. Traffic speeds were estimated based on council traffic count data and local knowledge. Speeds were reduced within 30m of major junctions in the model domain following the approach outlined in LAQM.TG(22).

Table 5-1: Modelled traffic flows, 2022

Route	Traffic flows						Speed (km/h)
	AADT	Mcycle	Car	LGV	HGV	Bus	
Norwich Road	5068	53	2580	2229	192	10	77
A1065 Brandon Road	10787	124	4458	5439	712	44	56
Lynn Road	5824	72	2845	2481	393	29	79
A1065 - Castle Acre Road	10378	130	5706	3958	531	44	60
Watton Road	1782	34	1045	602	91	3	60
London Street	12587	117	10025	1853	482	55	59
Swaffham Road	6683	54	4918	1216	473	18	59
Cley Road	1387	10	1132	185	9	6	59
Greenhoe Place	808	4	707	85	7	2	59
West Acre Road	761	5	574	150	4	0	59
South Pickenham Road	1596	10	1239	302	36	1	59
Norwich Road - DfT	4018	21	3228	530	147	93	59
Margate Street - Junction B	4404	12	3655	499	181	20	59
A1065 - Market Place - Junction C	8108	20	6509	988	534	38	59
Lynn Street	6501	76	3376	2597	392	29	69
Market Place	2824	60	376	2203	262	0	59
Sporle Road	562	11	512	37	2	0	56

[5] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[6] https://roadtraffic.dft.gov.uk
[7] https://www.data.gov.uk/dataset/11bc7aaf-ddf6-4133-a91d-84e6f20a663e/national-trip-end-model-ntem

5.2 EMISSION FACTORS

Emissions from all modelled road traffic sources were calculated using speed-dependent vehicle emission factors for NOx, primary NO_2, and particulates from the Emission Factor Toolkit (EFT) version 11[5]. 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.

5.3 VEHICLE FLEET COMPOSITION

5.3.1 2022

National projections provided by the EFT were used as a data source for vehicle composition in lieu of locally derived data being available. Table 5-2 and Table 5-3 present the derived fleet age split in 2022.

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
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	-	-	-	0%	1%	7%	6%	86%	-
	Plugin Hybrid Petrol Car	-	-	-	-	-	2%	6%	93%	-
	Full Diesel Hybrid Car	-	-	-	-	-	2%	3%	24%	71%

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
National average	Rigid HGV	0%	0%	0%	1%	2%	2%	7%	88%
	Artic HGV	0%	0%	0%	0%	0%	1%	3%	96%
	Buses / Coaches	0%	0%	0%	4%	3%	4%	11%	77%

5.3.2 Fleet renewal delay sensitivity test

The impact of slower than expected replacement of older vehicles in the fleet during 2020 and 2021 was assessed by using the vehicle split for 2020 from national projections. This fleet split is presented in Tables 5-3 and 5-4.

Table 5-4: Fleet age splits for 2020, light vehicles

Region	Vehicle type	Pre-Euro 1	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6	Euro 6c	Euro 6d
National average	Petrol Car	-	-	0%	3%	11%	25%	15%	46%	-
	Diesel Car	-	-	0%	1%	9%	33%	19%	27%	8%
	Petrol LGV	-	-	1%	4%	12%	27%	17%	44%	-
	Diesel LGV	-	-	0%	2%	10%	26%	17%	45%	-
	Full Hybrid Petrol Car	-	-	-	0%	3%	12%	09%	76%	-
	Plugin Hybrid Petrol Car	-	-	-	-	-	5%	17%	79%	-
	Full Diesel Hybrid Car	-	-	-	-	-	3%	6%	48%	43%

Table 5-5: Fleet age splits for 2020, heavy vehicles

Region	Vehicle type	Pre-Euro I	Euro I	Euro II	Euro III	Euro IV	Euro V EGR	Euro V SCR	Euro VI
National average	**Rigid HGV**	-	-	0%	3%	3%	4%	11%	78%
	Artic HGV	-	-	0%	0%	1%	2%	7%	90%
	Buses / Coaches	-	-	1%	7%	5%	6%	17%	64%

5.4 TRAFFIC QUEUES

Traffic queuing was modelled following the methodology outlined in LAQM.TG(22). Queuing was modelled at peak hours at the A1065/Lynn Street/Norwich Road junction, based on queue length data from traffic counts provided by the Council. Queuing was assumed to take place from 07:00 to 18:00 on weekdays.

15-minute mean maximum queue lengths were provided along each road link. The average queue length was assumed to be equal to half the mean maximum queue length for each junction, assuming that the queue is fully cleared in each cycle.

Idling emission factors were derived from emissions for the lowest available speed in the published emission factors described in Section 5.2.

5.5 TIME-VARYING EMISSION FACTORS

The variation of traffic flow during the day has been taken into account by applying national average diurnal profiles published by the Department for Transport[8] to the road emissions.

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

6. MODEL ADJUSTMENT AND VERIFICATION

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. Following this guidance, the adjustment process is carried out for NO_X (NO and NO_2) as NO and NO_2 interconvert in the atmosphere following emission from vehicle exhausts in a non-linear fashion.

Any adjustment factors are then applied to all modelled scenarios. Following this adjustment, model verification is carried out by comparing the total predicted NO_2 concentrations against the measured NO_2 concentrations.

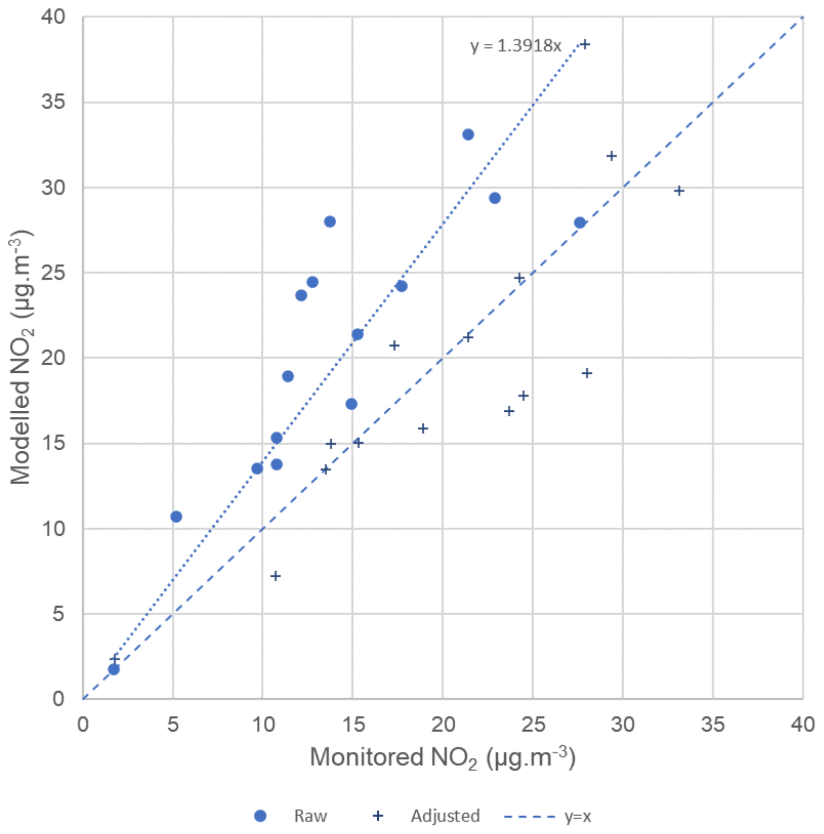
A total of 15 monitoring locations including one triplicate site located within the study area were used for model verification. The road contribution to NO_X concentrations at these sites was estimated using the latest version of the NOx to NO_2 calculator (version 8) published by Defra. Background 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.

Following an initial model verification step, iterative improvements were made to the model to improve model performance in areas where the model was not accurately predicting real-world concentrations. These improvements included refinements to road geometry and street canyon locations in order to more closely reflect real-world dispersion conditions.

6.1 MODEL CALIBRATION AND ADJUSTMENT

Figure 6-1 shows model performance at locations where measurements were collected in 2022.

Figure 6-1: Measured and modelled annual mean road NOx contributions at monitoring sites, 2022, $\mu g.m^{-3}$



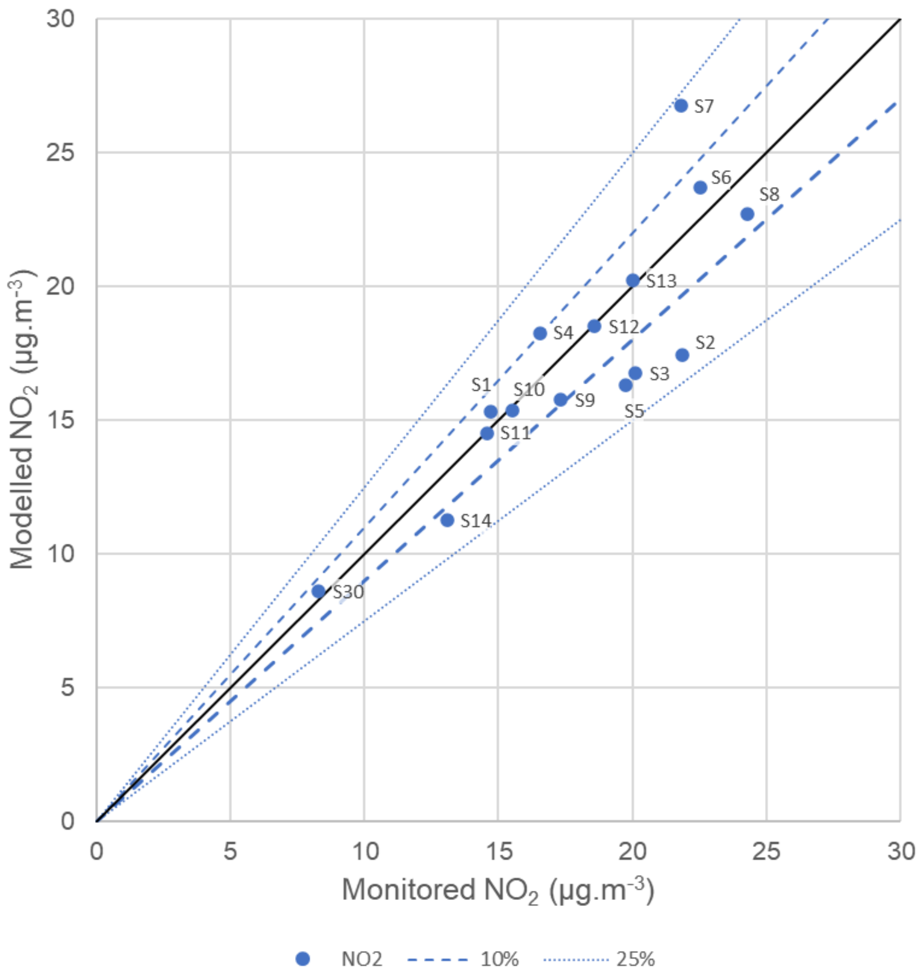
An adjustment factor of 1.39 was used to bias correct the results of each modelled scenario. In the absence of monitoring data for particulate matter, this adjustment factor was also applied to modelled PM_{10} and $PM_{2.5}$ concentrations.

6.2 MODEL VERIFICATION

Figure 6-2 presents the model performance with respect to adjusted modelled NO_2 at monitoring locations in 2022. The model performs within the 25% acceptable threshold for model performance across all monitoring locations, and within the ideal 10% threshold across most sites.

Model performance was evaluated using the Root Mean Square Error, following LAQM.TG(22). The RMSE for this study is 2.32 µg.m^{-3}, well within the 4 µg.m^{-3} ideal threshold identified in the guidance, demonstrating that the model performs well and lending confidence to model predictions of concentrations across the model domain.

Figure 6-2: Measured and modelled annual mean road NO_2 contributions at monitoring sites, 2022, µg.m^{-3}



7. RESULTS

7.1 NO_2

The model described above was used to predict concentrations at buildings within and around the AQMA at sensitive receptors and across a grid of receptors covering the domain described in Section 3.2.

Figure 7-1 presents annual mean NO_2 concentrations in the Swaffham AQMA in the 2022 baseline. Annual average NO_2 concentrations (µg/m^3) at relevant exposure are predicted to be more than 10% below the UK Air Quality Objective of 40 µg/m^3 at all locations of relevant exposure across Swaffham. Some locations within the study area are predicted to exceed this threshold; however, these locations lie within roadways and as such are do not represent relevant exposure.

Figure 7-1: Predicted annual mean NO_2 concentrations, 2022, µg.m^{-3}

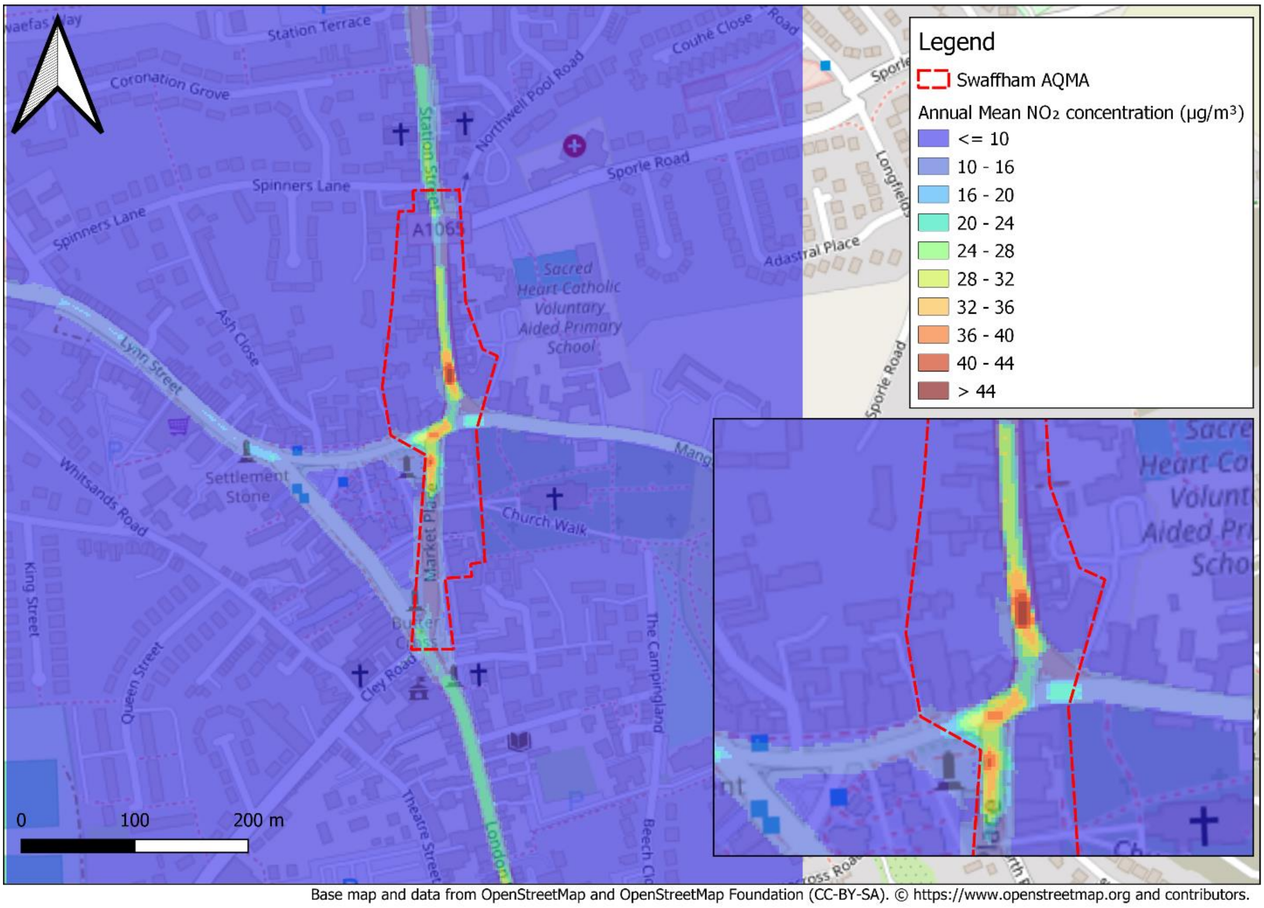


Table 7-1 presents the modelled annual mean NO_2 concentrations at the sensitive receptors described in Section 4.3.

No location is predicted to exceed the Air Quality Objective for annual mean NO_2 concentrations in the 2022 baseline scenario. Furthermore, concentrations are more than 10% below the objective at all receptors. The maximum predicted concentrations (which are 10% below the objective) occur at Best Western George Hotel on Station Street, near to the central junction where queuing traffic gives rise to elevated emissions and therefore concentrations.

No exceedances of the objective are predicted to occur at any receptors in either of the two sensitivity tests, demonstrating that there is substantial headroom to account for potential uncertainty in traffic flows and vehicle fleet composition in future years.

As a result, compliance is highly likely to be maintained in the future.

Table 7-1: Annual average NO_2 concentrations at sensitive receptors in Swaffham, µg.m^{-3}, 2022. For comparison with the Air Quality Objective of 40 µg.m^{-3}

Receptor ID	Address	Annual Mean NO_2 (µ/m^3)		
		2022 Baseline	Sensitivity Test 1 – fleet delay	Sensitivity Test 2 – increased traffic
01	The Red Lion, A1605	10.3	11.1	11.0
02	Starlings, A1605	10.2	11.0	10.9
03	Iceland, A1605	10.3	11.1	11.0
04	73, A1605	10.5	11.3	11.2
05	Margaret's Tea Rooms, A1605	10.5	11.3	11.1
06	Opticians, A1605	8.9	9.3	9.2
07	3, A1605	12.2	13.5	13.3
08	3, Mangate Street	10.8	11.6	11.5
10	57, Lynn Street	15.6	17.3	16.4
11	London Nails, Lynn Street	17.4	19.6	18.8
13	Best Western George, Station St.	34.3	39.8	38.1
14	4, Station Street	28.1	33.0	32.4
15	12, Station Street	8.4	8.7	8.6
16	3, Station Street	19.7	22.7	22.5
17	14, Station Street	8.3	8.6	8.5
18	15, Station Street	19.7	22.7	22.5
19	16, Station Street	8.2	8.5	8.4
20	21, Station Street	19.8	22.9	22.7
21	Orwell House, Station Street	22.4	26.0	25.8
22	23, Station Street	19.5	22.5	22.3
23	9, Station Street	17.3	20.3	19.7
24	Norfolk Yoga Centre, Station Street	8.4	8.7	8.6
25	26, Station Street	8.3	8.6	8.5
27	Staines House, Station Street	8.2	8.5	8.4
28	12, Station Street	8.2	8.4	8.4
31	7, Mangate Street	9.6	10.2	10.2
32	43, Lynn Street	9.4	9.9	9.9
33	14, A1605	9.8	10.4	10.4
34	25, Station Street	8.2	8.4	8.4
35	29, Station Street	16.3	18.9	18.4
36	Baptist Church, Station Street	17.7	20.8	20.2
37	39, Lynn Street	9.1	9.5	9.4
38	29, Lynn Street	8.8	9.3	9.2
39	21, Lynn Street	11.3	12.6	12.3
40	19, Lynn Street	12.5	14.0	13.7
41	18, Lynn Street	12.4	14.0	13.7
42	18, Market Place	8.8	9.2	9.1
43	20, Market Place	10.3	11.3	11.1
44	30, Market Place	9.8	10.6	10.4
45	28, Market Place	9.8	10.7	10.4
46	36, Market Place	10.0	10.9	10.7
47	42, Market Place	10.0	10.9	10.7

Receptor ID	Address	Annual Mean NO_2 (μ/m³)		
		2022 Baseline	Sensitivity Test 1 – fleet delay	Sensitivity Test 2 – increased traffic
48	44, Market Place	9.6	10.3	10.2
49	48, London Street	11.2	12.2	12.1
50	97, A1605	10.8	11.7	11.7
51	4, London Street	11.6	12.7	12.7
52	6, London Street	16.4	18.5	18.5
53	7, London Street	15.5	17.4	17.4
55	18, London Street	16.1	18.2	18.1
56	36, London Street	16.3	18.4	18.4
57	Conservative Club, London Street	15.5	17.5	17.5
58	1, Market Place	9.8	10.6	10.4
59	59, Market Place	9.7	10.4	10.2
60	5, Lynn Street	11.0	11.9	11.8
61	7 (Costa Coffee), A1605	24.6	27.9	25.8
64	Eversley House, Station Street	25.6	29.9	29.5

7.2 PARTICULATE MATTER

Annual average PM_{10} and $PM_{2.5}$ concentrations at sensitive receptors in the 2022 baseline scenario are presented in Table 7-2. No exceedances of the relevant air quality objectives are predicted to occur at any relevant receptors in 2022.

Table 7-2: Annual average NO_2 concentrations at sensitive receptors in Swaffham, μg.m^{-3}, 2022

Receptor ID	Address	PM_{10}	$PM_{2.5}$
	Air Quality Objectve	40	20
1	The Red Lion, A1605	15.8	15.6
2	Starlings, A1605	15.8	15.6
3	Iceland, A1605	15.8	15.6
4	73, A1605	15.8	15.6
5	Margaret's Tea Rooms, A1605	15.8	15.6
6	Opticians, A1605	15.5	15.4
7	3, A1605	15.8	15.6
8	3, Mangate Street	15.7	15.5
9	57, Lynn Street	16.0	15.8
10	London Nails, Lynn Street	16.2	15.9
11	Best Western George, Station St.	18.0	17.0
12	4, Station Street	17.6	16.8
13	12, Station Street	15.4	15.4
14	3, Station Street	17.3	16.5
15	14, Station Street	15.4	15.4
16	15, Station Street	17.3	16.5
17	16, Station Street	15.4	15.4
18	21, Station Street	17.4	16.6
19	Orwell House, Station Street	17.8	16.8
20	23, Station Street	17.3	16.5
21	9, Station Street	16.7	16.2

Receptor ID	Address	PM_{10}	$PM_{2.5}$
22	Norfolk Yoga Centre, Station Street	15.5	15.4
23	26, Station Street	15.4	15.4
24	Staines House, Station Street	15.4	15.4
25	12, Station Street	15.4	15.4
26	7, Mangate Street	15.6	15.5
27	43, Lynn Street	15.6	15.5
28	14, A1605	15.7	15.5
29	25, Station Street	15.4	15.4
30	29, Station Street	16.6	16.1
31	Baptist Church, Station Street	16.8	16.2
32	39, Lynn Street	15.5	15.5
33	29, Lynn Street	15.5	15.4
34	21, Lynn Street	15.9	15.6
35	19, Lynn Street	16.1	15.8
36	18, Lynn Street	16.1	15.8
37	18, Market Place	15.5	15.4
38	20, Market Place	15.7	15.5
39	30, Market Place	15.6	15.5
40	28, Market Place	15.6	15.5
41	36, Market Place	15.6	15.5
42	42, Market Place	15.7	15.5
43	44, Market Place	15.6	15.5
44	48, London Street	15.9	15.7
45	97, A1605	15.6	15.5
46	4, London Street	16.0	15.7
47	6, London Street	16.9	16.3
48	7, London Street	16.8	16.2
49	18, London Street	16.9	16.2
50	36, London Street	16.9	16.3
51	Conservative Club, London Street	16.8	16.2
52	1, Market Place	15.6	15.5
53	59, Market Place	15.6	15.5
54	5, Lynn Street	15.8	15.6
55	7 (Costa Coffee), A1605	17.0	16.3
56	Eversley House, Station Street	17.3	16.6

8. SENSITIVITY TESTING

Following feedback from Defra, sensitivity testing was carried out into the effects of reducing the modelled receptor height to 1.5m. The maximum predicted modelled NO_2 concentration across all receptors included in the assessment increased from 34.3 $\mu g.m^{-3}$ to 35.0 $\mu g.m^{-3}$ when the receptors were modelled at a height of 1.5m in the 2022 baseline scenario, an increase of 2%. The average increase across all modelled receptors was 0.6%. As a result, all modelled concentrations are below the threshold of 10% lower than the Air Quality Objective, and the conclusions of the study would not be changed were the receptor height to be lowered.

9. CONCLUSIONS

Ricardo was commissioned to carry out a Detailed Assessment of NO_2 concentrations in and around the Swaffham AQMA to determine whether compliance with the Air Quality Objective for annual mean NO_2 concentrations is achieved across the area.

This detailed assessment aims to provide evidence to aid the Council in deciding whether it is appropriate to revoke the AQMA at this time.

The review of monitoring data in Swaffham has concluded that:

- Annual mean concentrations of NO_2 measured by monitors placed inside the AQMA have been compliant with the Air Quality Standard since 2018.
- Annual mean concentrations have declined over the last five years at all locations.
- Annual mean concentrations have been below 90% of the Air Quality Standard at all locations since 2020, and at all but S12 since 2018 which was reported to be below the Air Quality Standard during this time, excluding one year in 2019. It must be noted however that S12 is not a location within the AQMA and this has been corrected in 2023's Annual Status Report (ASR).

Modelling was carried out for a 2022 baseline year to assess air quality at locations where monitoring is not currently carried out. The model accurately predicts concentrations at monitoring stations in the Swaffham AQMA in 2022, demonstrating that the model correctly represents real-world conditions.

In addition, to assess model uncertainty in future years, two theoretical worse-case sensitivity tests were modelled to quantify the potential impacts of conditions where emissions from road transport would be higher than expected in 2022:

- Sensitivity test 1: Slower than expected replacement of older road vehicles as a result of economic conditions leading to a 2-year delay in fleet renewal across the area;
- Sensitivity test 2: Traffic volumes across Swaffham growing by 25%.

The modelling undertaken through this study shows that:

- No location is predicted to exceed the Air Quality Objective for annual mean NO_2 at any location of relevant exposure in 2022;
- No location is predicted to have an annual mean NO_2 concentration within 10% of the Air Quality Objective for annual mean NO_2 at any location of relevant exposure in 2022 should changes in traffic volumes and fleet composition follow the forecasted national trends.
- Furthermore, no locations of relevant exposure are predicted to exceed the Objective in two theoretical scenarios where emissions would be higher than those predicted from forecasted national trends, including a 25% increase in road traffic on all roads in Swaffham or a 2-year delay in fleet renewal compared to national fleet projections.

Based on the data available, this Detailed Assessment indicates that the Swaffham AQMA can be revoked without risk of future exceedances.

Although we have attempted to minimise uncertainty in the modelling aspects of this assessment as much as possible, the results should be considered in context with the uncertainties regarding model input data discussed in the report.

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