Shropshire Council

Shrewsbury Draft Air Quality Action Plan

In fulfilment of Part IV of the Environment Act 1995

Local Air Quality Management

July 2024

Document Control Sheet

Identification	
Client	Shropshire Council
Document Title	Draft Shrewsbury Air Quality Action Plan – 2024
Bureau Veritas Ref No.	AIR15503073

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Configuration

Version	Date	Author	Reason for Issue/Summary of Changes	Status
v1.0	27/02/2024	V Patel	Draft for comment	Draft
v2.0	10/05/2024	V.Patel	Updated with Appraisal Comments	Draft for Consultation
V3.0	25/07/2024	V Patel	Updated following Issue of Technical Note	Draft for Consultation

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Report Reference Number	15503073
Date	July 2024

1 Executive Summary

This Air Quality Action Plan (AQAP) has been produced as part of our statutory duties required by the Local Air Quality Management framework. It outlines the action we will take to improve air quality in Shropshire Council between 2024 and 2029.

This action plan replaces the previous action plan which was developed from detailed modelling in 2000 and the action plan was amended in 2008. Projects delivered through the past action plan include:

- 24 electric vehicle (EV) charging points and two rapid chargers have been installed across 10 towns in the county;
- Increases public transportation and improvements to the park and ride facilities.
    - In 2015 – updates to the existing park and ride facilities were completed which included new efficient buses as well as improved timetables to ensure buses ran more efficiently and frequently.
- Enhancements to existing gyratory and road junctions to improve traffic flow.
- Review of taxi licensing to reduce older and high mileage taxis from the fleet
- Introduction of SCOOT traffic management signalling to the gyratory and surrounding junctions.

Air pollution is associated with a number of adverse health impacts. It is recognised as a contributing factor in the onset of heart disease and cancer. Additionally, air pollution particularly affects the most vulnerable in society: children and older people, and those with heart and lung conditions. There is also often a strong correlation with equalities issues, because areas with poor air quality are also often the less affluent areas[1,2].

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[1] Environmental equity, air quality, socioeconomic status and respiratory health, 2010

[2] Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006

The annual health cost to society of the impacts of particulate matter alone in the UK is estimated to be around £16 billion[3]. Shropshire Council is committed to reducing the exposure of people in Shropshire to poor air quality in order to improve health.

We have developed actions that can be considered under five broad topics:

- Traffic Management
- Alternatives to private vehicle use
- Promoting low emission transport
- Promoting travel alternatives
- Public information

Our priorities are:

- Improving air quality in Castle Foregate by restricting the direction of travel with a gyratory system to improve congestion.
- Reducing the traffic travelling through Shrewsbury following the development of the North West Relief Road (NWRR)
- Increased parking charges within the town centre to discourage the use of central car parks and increase the use of the Park and Rides.
- Promoting sustainable modes of transport following the adoption of the Local Cycling and Walking Infrastructure Plan (LCWIP).

In this AQAP we outline how we plan to effectively tackle air quality issues within our control. However, we recognise that there are a large number of air quality policy areas that are outside of our influence (such as vehicle emissions standards agreed in Europe), but for which we may have useful evidence, and so we will continue to work with regional and central government on policies and issues beyond Shropshire Council's direct influence.

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[3] Defra. Abatement cost guidance for valuing changes in air quality, May 2013

Responsibilities and Commitment

This AQAP was prepared by Bureau Veritas on behalf of Shropshire Council with the support and agreement of the following officers and departments:

Kieron Smith – Environmental Protection Service Manager

Joanne Chanter – Environmental Protection Team

Les Pursglove - Assistant Director of Health, Environmental Protection & Healthy Place

Matt Johnson - Executive Manager - Strategic Projects - Highways and Transportation

Ffion Horton - Service Development Programme Manager Highway Policy and Strategic Infrastructure

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Rose Dovey – Active Travel Manager

Rhiannon Letman-Wade – Sustainable Travel Manager

This AQAP will be approved by:

Rachel Robinson - Executive Director of Health, Wellbeing and Prevention. Director of Public Health.

Tracy Darke - Assistant Director Economy and Place

Andy Wilde - Assistant Director - Infrastructure • Assistant Director Highways and Transport

This AQAP will be signed off by Rachel Robinson, Director of Public Health.

This AQAP will be subject to an annual review, appraisal of progress and reporting to the Cabinet member for Planning and Regulatory Services. Progress each year will be reported in the Annual Status Reports (ASRs) produced by Shropshire Council, as part of our statutory Local Air Quality Management duties.

If you have any comments on this AQAP please send them to Joanne Chanter, Environmental Protection at:

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2 Introduction

This document represents an initial draft action plan for review and comments by DEFRA. Shropshire Council intend to consult on a further-draft action plan as soon as feedback is received (taking into account DEFRA's comments) to the wider public and relevant stakeholders.

This report outlines the actions that Shropshire Council will deliver between 2024 and 2029 in order to reduce concentrations of air pollutants and exposure to air pollution; thereby positively impacting on the health and quality of life of residents and visitors to Shrewsbury and the wider Shropshire area.

It has been developed in recognition of the legal requirement on the local authority to work towards Air Quality Strategy (AQS) objectives under Part IV of the Environment Act 1995 and relevant regulations made under that part and to meet the requirements of the Local Air Quality Management (LAQM) statutory process.

This Plan will be reviewed every five years at the latest and progress on measures set out within this Plan will be reported on annually within Shropshire Council's air quality ASR.

3 Summary of Current Air Quality in Shrewsbury

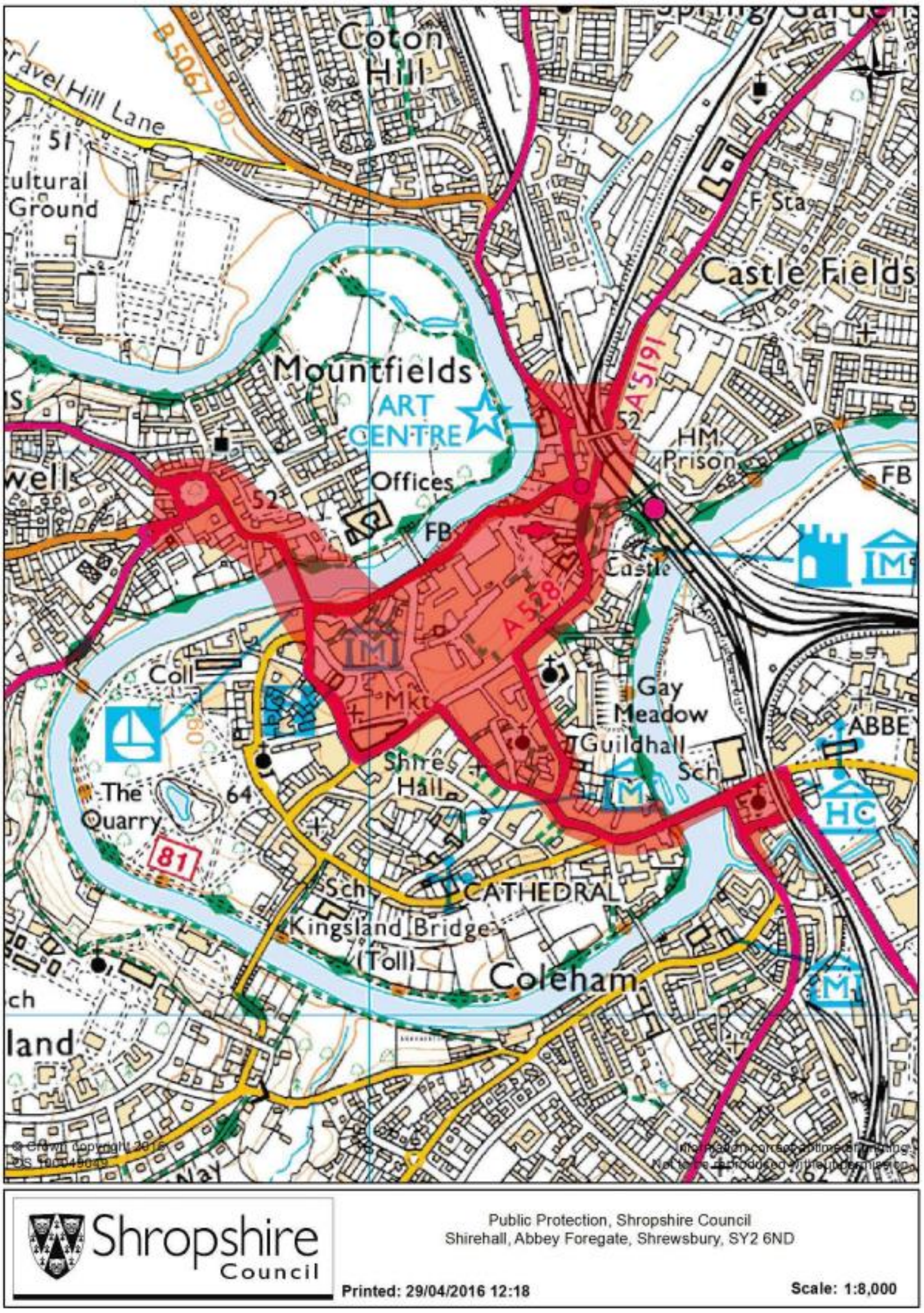
The latest Annual Status Report (ASR) for Shropshire Council is the 2024 ASR[4] which has been submitted to Defra in 2024.

3.1 Summary of AQMA

The Shrewsbury AQMA also known as AQMA No.3 covers the area comprising Frankwell, part of Bridge Street and Smithfield Road Castle Gates and adjacent land, extending to encompass most of the Town Centre including High Street, Wyle Cop, English Bridge and Coleham Head gyratory. The AQMA was designated in 2003 for the exceedance of the annual mean NO_2 air quality objective and amended in 2006. The AQMA is a result of high traffic volumes and congestion associated with unitary authority roads. The highest concentration of NO_2 within the AQMA at the time of declaration was 86µg/m^3. A map of the extent of the AQMA is shown in Figure 3-1.

[4] Shropshire Council (2024) 2024 Annual Status Report

Figure 3-1 – Shrewsbury AQMA



3.1 Air Quality in Shrewsbury

Table 3-1 – Diffusion Tube Monitoring Data 2018 – 2022 in Shrewsbury

Site ID	Location	OS Grid Ref X	OS Grid Ref Y	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
				2018	2019	2020	2021	2022
DF403*	Smithfield Road Corner of Victoria Avenue	348891	312721	30.5	30.8	23.0	23.0	25.0
DF407*	Dogpole (Car Entrance)	349330	312503	24.1	23.4	18.1	19.6	19.8
DF413*	Ravens Meadow, outside 23 Meadow Terrace	349283	312851	29.5	26.3	21.2	22.7	23.1
DF420*	Outside 25 Castle Street	349396	349396	27.8	26.3	21.2	21.9	23.3
DF428A*	Britannia Inn (Post office lamppost)	349445	349445	*38.3*	*36.1*	29.4	30.9	32.4
DF429*	6A Severn Steps adj Lamp Post	349237	349237	-	28.8	21.8	22.7	24.1
DF437*	The Albert (duplicate)	349283	349283	35.6	33.3	25.7	28.1	28.7
DF438*	Station Hotel 4 Castle Foregate (façade)	349400	349400	**58.8**	**53.0**	**40.2**	**43.9**	**43.4 (42.8)**
DF458*	Under Railway Bridge Over Castle Foregate	349426	349426	**55.0**	**48.6**	*38.5*	**42.2**	**42.6**
DF459*	Post in car park outside railway station	349424	312936	**42.1**	35.6	26.6	29.2	29.8
DF460*	On Bellstone opposite the Junction with Claremont St	348952	312495	25.7	24.2	18.5	-	-
DF461*	Junction of Dogpole with High St/Wyle Cop	349327	312389	30.9	26.2	18.7	20.1	21.3
DF476*	Chester Street on street parking bay height sensor post	349360	312962	33.1	29.1	22.5	24.4	25.0
DF477*	Bus opp Community Church, Chester St	349299	349299	31.3	29.8	23.1	23.9	24.8
DF480*	lamp post by takeaway near Britannia Inn	349466	349466	31.8	31.6	24.8	27.9	28.3
DF482*	Royal Mail Lamp column by Traffic Lights	349436	313064	**45.7**	*38.2*	32.2	32.9	31.7
DF485*	Frankwell Terrace	348815	312854	30.9	26.1	20.3	22.4	22.9
DF487*	English Bridge by St Julian Friars (No Entry Sign)	349529	312328	22.7	21.9	17.5	17.5	17.9
DF501*	Corner of 25 Chester Street/Cross Street	349349	313071	*38.2*	33.5	24.6	27.8	28.5
DF502*	Post outside Cambrian House	349364	312998	31.2	26.3	18.4	22.1	22.0
DF503	Downspout 68-69 Frankwell	348611	312969	-	-	-	26.1	23.6
DF606,607*	Railway station car park opp DF438 duplicate	349411	312944	-	-	28.7	-	-
DF608,609*	Post in front of Olive Tree, Frankwell duplicate	348676	312955	-	-	22.1	-	-
*Within Shrewsbury AQMA (Value within Brackets)– Distance Corrected Value								

Table 3-1 details the monitoring locations within Shrewsbury and those within the Shrewsbury AQMA. Exceedances of the annual mean air quality objective for NO_2 are highlighted in bold.

Shropshire Council report on air quality within the administrative area through the ASR through the LAQM process. The latest ASR from 2023 reports on air quality in Shropshire in 2022.

Shropshire Council do not undertake any automatic monitoring within the local authority area however, passive monitoring through a network of diffusion tubes was undertaken in 2022 at 57 sites; 20 of the sites are within the Shrewsbury AQMA.

In 2022 there were two exceedances of the annual mean air quality objective of NO_2 within the Shrewsbury No. 3 AQMA above 40µg/m^3, both of these locations were along Castle Foregate. Monitoring location DF438 located on Castle Foregate within the AQMA recorded the highest concentration in Shrewsbury in 2022. The concentrations for the past five years show an overall decreasing trend from 54.0 µg/m^3 in 2017 to 42.8 µg/m^3 in 2022 after distance correction. It should be noted that within the detailed modelling of the AQMA within Appendix C, the baseline 2022 modelled result for this monitoring site was 50.2µg/m^3, as the receptor was modelled closer to the junction at the hotel as a worst-case location. It should be noted that the difference is likely due to the model unable to accurately represent the microclimate and canyon road effects that are observed on Castle Foregate.

Monitoring location DF458, located under the railway bridge on Castle Foregate, has exceeded the annual mean NO_2 air quality objective in the past five years with the exception of 2020 during the COVID-19 lockdowns. In 2022 the concentration was 42.6 µg/m^3 and shows a decreasing trend from 55µg/m^3 in 2018. Due to the location of the monitoring site, distance correction was not undertaken.

Overall, the detailed modelling of the AQMA, as shown in Appendix C, indicates that the highest concentrations of annual mean NO_2 are along Castle Foregate. This is mainly due to the current geometry of the road network where all vehicles entering Shrewsbury from the north will pass through this road and junction. This area is also the access to the Railway Station. It should be noted that although the boundary of the AQMA is across the entire of the Shrewsbury Town, the exceedances for the last four years have only been observed along Castle Foregate. As such the measures detailed will look to tackle this issue.

These two diffusion tubes are the only monitoring locations within the Shrewsbury AQMA which are exceeding the NO_2 air quality objective or within 10% of the objective in the 2022.

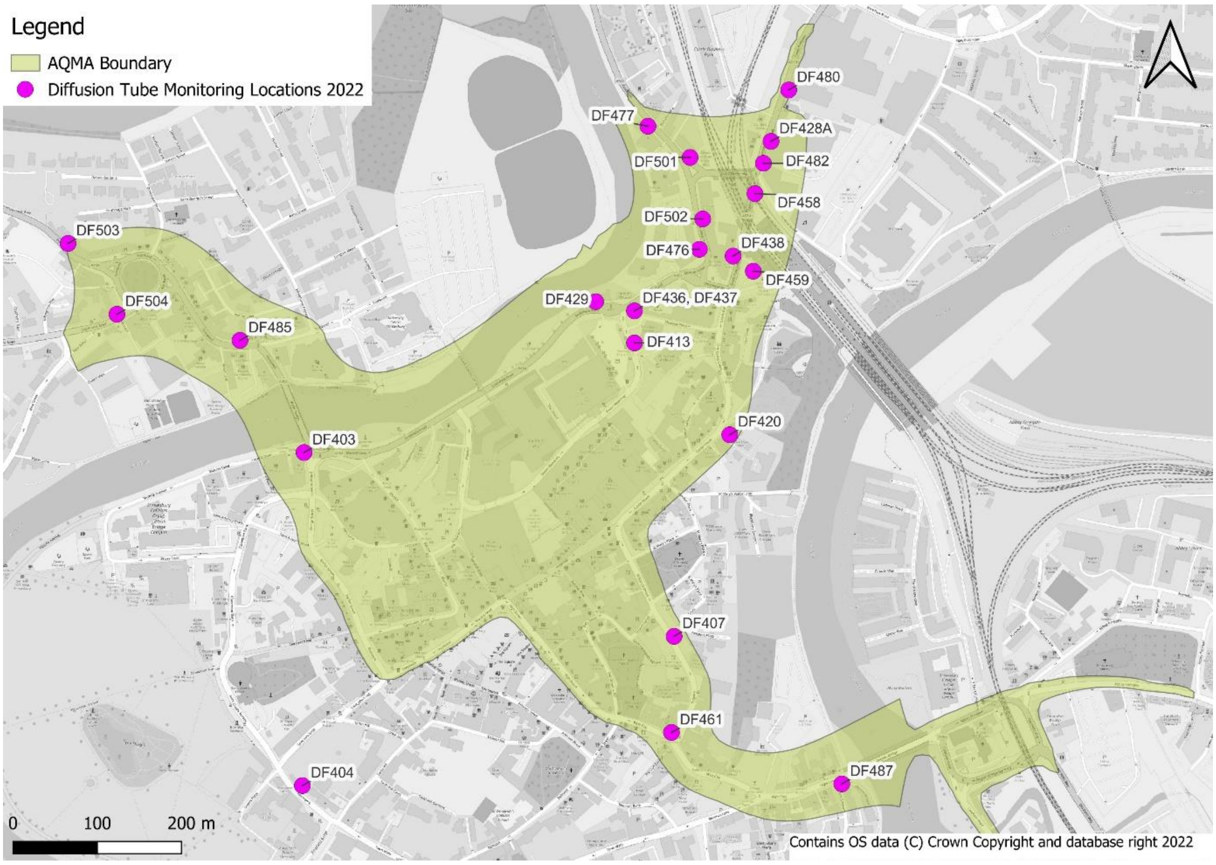
Pollutant concentrations in 2020 and 2021 were affected by COVID-19 lockdown restrictions and therefore are not considered suitable ground for the revocation of an

AQMA, however elevated concentrations were still recorded and concentrations within the AQMA were still above the annual mean NO_2 air quality objective in 2022 in two locations. The overall trend of NO_2 concentrations within the Shrewsbury AQMA is a decreasing trend which is encouraging, however there is still scope to improve air quality further.

With the decreasing trend in NO_2 concentrations within the AQMA, using the Roadside NO_2 projection factors[5] it is expected that in 2029, the highest modelled receptor along Castle Foregate, which is currently modelled at 50.2µgµ/m^3 will be below 10% of the Air Quality Objective. This is through a natural decreasing trend in NO_2 concentrations and not as a result of the measures to improve air quality in Shrewsbury which are detailed within this AQAP.

[5] https://laqm.defra.gov.uk/air-quality/air-quality-assessment/roadside-no2-projection-factors/

Figure 3-2 Monitoring Locations with Shrewsbury AQMA



4 Shropshire Council's Air Quality Priorities

4.1 Public Health Context

The Air Quality Indicator in the Public Health Outcomes Framework (England) (PHOF) provides further impetus to join up action between the various local authority departments which can impact on the delivery of air quality improvements. The "Air Quality – A Briefing for Directions of Public Health[6]" document published in March 2017 provides a one-stop guide to the latest evidence on air pollution, guiding local authorities to use existing tools to appraise the scale of the air pollution issue in its area. It also advises local authorities how to appropriately prioritise air quality alongside other public health priorities to ensure it is on the local agenda.

The latest Public Health Outcomes Framework Indicator number D01 - Fraction of mortality attributable to particulate air pollution (New Method) for Shropshire was noted to be 4.4% in 2022, down from 5.8% in 2019 but slightly increased from 4.3% in 2020/2021. This is the mortality lowest percentage in the West Midlands Area and below the average for England at 5.5% attributable to air pollution.

To further understand the number of the population of Shrewsbury exposed to poor air quality, a review of the Indices of Multiple Deprivation (IMD) are also included. This has been completed using the Office for National Statistics 'Lower Super Output Area' (LSOA) information.

The number for the IMD are based on deciles of multiple factors of deprivation. The larger the score, the more deprived the area. Shrewsbury has a IMD of 7 out of possible 10 with the 10th indices being the least deprived areas of England. Shrewsbury has a IMD of 6 out of possible 10 with the 10th indices being the least deprived areas of England. Shrewsbury is in the 6th indices for deprivation in England and therefore lower than the median for England.

[6] https://laqm.defra.gov.uk/assets/63091defraairqualityguide9web.pdf

Following a review of the LSAO information, as well and the national population statistics for areas within Shrewsbury [7], it was calculated that the population that were living within the Shrewsbury AQMA is approximately 1,850 people.

4.2 Planning and Policy Context

4.2.1 Shropshire Local Plan

The Shropshire Local Plan was adopted on 24 February 2011 and informs strategic development until 2026. There are no air quality specific policies, however there are policies focusing on promoting sustainable transport methods where developments are expected to generate significant traffic levels.

The draft Shropshire Local Plan was submitted to the Secretary of State for examination on 3 September 2021. The plan once examined this will be adopted and sets out the strategies and policies 2016 to 2038. The draft Local Plan includes the following policies specific to air quality and the AQAP. Policy SP6 states

> *"8. Protect against exposure to pollution in line with policy DP18 by:*
>
> *a. Minimising exposure to airborne pollutants in the location and design of new development and securing the implementation of the Council's Air Quality Action Plans, having regard to national and international obligations; and*
>
> *b. Safeguarding against the environmental impacts of new development in terms of community/public safety, noise, vibrations and odour and the legacy of contaminated land."*

Policy DP18 Pollution and Public Amenity sets out the council's focus on prioritising the environment and amenity for residents. Specifically, the policy states:

> *"Opportunities to improve air quality through the provision of green infrastructure in accordance with Policy DP14, industry relevant best available techniques, traffic and travel management (including linking to active travel networks) and the provision of electric charging facilities for vehicles should be*

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[7] Population density - Census Maps, ONS

> *maximised. Proposals which would lead to an unacceptable risk from air pollution or prevent sustained compliance with limit values or national objectives for air pollutants will be refused unless they can be practicably amended to avoid that risk."*

Additionally, policy DP28 Communications and Transport encourages the use of sustainable transport modes which will benefit air quality.

> *"Responding positively to changes in our climate will require access to better communications infrastructure and more sustainable travel options and services offering choices about the need to travel and the best transport modes. This will help to manage the environmental impacts of travel on climate change, air quality, network noise and public health contributing to the sustainability of communities and protecting our environment."*

4.2.2 Shropshire Local Transport Plan Strategy 2011 – 2026

The current LTP3 Local Transport Plan Strategy details the transport objectives, policies and programmes for Shropshire. Some of the proposed plans and objectives within this strategy align with those improvements in traffic management within the Shrewsbury AQMA and as such improvements in Air Quality. LTP3 looks to focus on areas such as encouraging more sustainable modes of transport, adoption or new park and rides, considering site specific measures within Shropshire's AQMAs. Shropshire Council are currently in development of the LTP4 which is planned to run into 2038.

4.2.3 Shropshire Council Corporate Climate Change Strategy and Action Plan

The Shropshire Corporate Climate Change Strategy and Action Plan was adopted in December 2020. This strategy aims to reduce the carbon footprint of Shropshire Council. Measures includes in the action plan include the installation of EV charging, replacing council fleet vehicles with ultra low emission vehicles and increasing the reliance on renewable energy sources.

4.2.4 Shropshire Local Cycling and Walking Infrastructure Plan (LCWIP)

The LCWIP aims to increase cycling and walking in Shropshire by improving safety and accessibility to these transport methods. In Shrewsbury only 13% of commuters walk or cycle. Barriers include steep inclines and the ability to cross the River Severn so the LCWIP aims to improve safety and access across the river to improve the use cycling or walking to work.

4.2.5 Clean Air Strategy 2019

The Clean Air Strategy sets out the case for action at a national level, identifying a number of sources of air pollution within the UK including road transportation (relevant in terms of the AQMAs currently present within Shropshire). It also sets out the actions required to reduce the impact upon air quality from these sources. It has been developed in conjunction with three other UK Government Strategies; the Industrial Strategy, the Clean Growth Strategy, and the 25 Year Environment Plan.

Key actions that are detailed within the strategy aimed at reducing emissions from transportation sources include the following:

- The publication of the Road to Zero strategy, which sets out plans to end the sale of new conventional petrol and diesel cars and vans by 2040
- New legislation to compel vehicle manufacturers to recall vehicles and non-road mobile machinery for any failures in emission control systems, and to take effective action against tampering with vehicle emissions control systems
- Develop new standards for tyres and brakes to reduce toxic non-exhaust particulate emissions from vehicles. [NB: This action would not necessarily target reductions in NO_2 for which the AQMAs have been declared].
- The encouragement of the cleanest modes of transport for freight and passengers
- Permitting approaches for the reduction of emissions from non-road mobile machinery, especially in urban areas

4.2.6 Air Quality Strategy 2023

In April 2023, the Air Quality Strategy, which supersedes the Air Quality Strategy (2008) was published. The strategy plans to set out a framework to enable local authorities to deliver for their communities and contribute to the governments long term air quality goals, this includes the new targets for $PM_{2.5}$.

The Air Quality Strategy is designed for local authorities in England to focus on actions to reduce three main pollutants, $PM_{2.5}$, NOx and NH_3. The Air Quality Strategy is also designed to support and provide relevant information to those local authorities that are preparing AQAPs.

The Air Quality Strategy develops and encourages local authorities to collaborate on the development of measures to improve Air Quality. This includes involving Directors of Public Health at all stages throughout the discussions of Air Quality Action as Air Quality is a public health concern. The Air Quality Strategy also pushes for measures to detail the costs and benefits to help determine the feasibility of a measure.

More emphasis on the dates that measures within an Air Quality Action Plan are also detailed to ensure that measures are carrier out and will help to achieve compliance in a reasonable timeframe.

To promote effective local action, a wider range of bodies are ideally brought into the process of the Air Quality Action Plan, this includes any neighbouring local authorities, The Environment Agency and National Highways. These are denoted as Air Quality Partners. Where a source is controlled by an Air Quality Partner and contributing toward exceedances of the AQO resulting in and AQMA to be declared, the relevant body can be declared an Air Quality Partner. Air Quality Partners must propose measures they will take to contribute to the AQAP and the dates they will be carried out.

4.3 Source Apportionment

The AQAP measures presented in this report are intended to be targeted towards the predominant sources of emissions within the Shrewsbury AQMA. A source apportionment exercise was carried out by Shropshire Council using a baseline year of 2022, which is considered the new baseline following the vehicular restrictions associated with COVID-19. The pollutant of concern within the Shrewsbury AQMA has been identified as nitrogen dioxide (NO_2) predominantly from road traffic.

A source apportionment exercise was carried out by Bureau Veritas in 2024. The following vehicle classes were modelled:

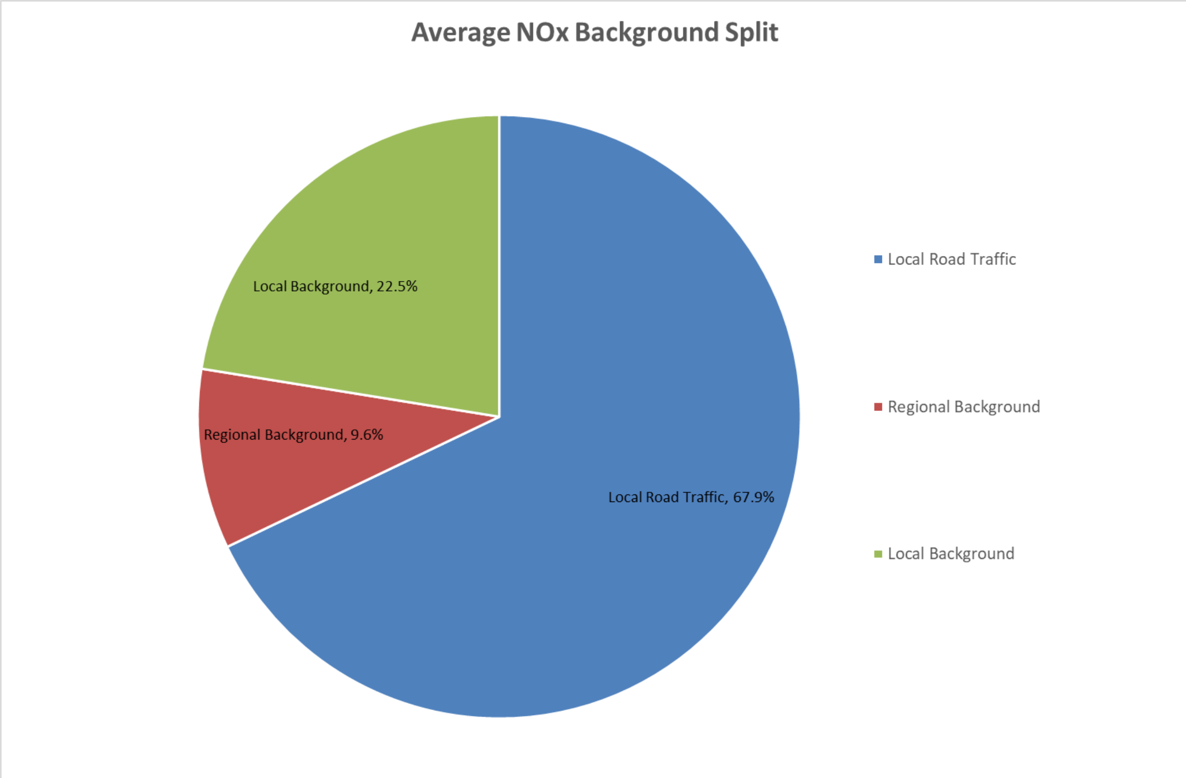
- Petrol and Diesel Cars

- Petrol and Diesel LGVs
- Rigid and Artic HGV
- Buses
- Motorcycle
- Full Hybrid Petrol Cars
- Plug-in Hybrid Petrol Cars
- Full Hybrid Diesel Cars
- EV Cars

Receptors were modelled within and within 20m of the boundary of the AQMA using ADMS Roads 5.1, Emissions Factors Toolkit (EFT) version 12.0[1] and road traffic data provided by Shropshire Council Highways Team[2] and Department for Transport (DfT) Road Traffic Statistics[3]. The full modelling methodology is available within the Shrewsbury AQMA Technical Report produced by Bureau Veritas[4] included in Appendix C.

The source apportionment modelling undertaken, identified that within the AQMA, the predominant source contributions were apportioned to local road traffic, specifically 68% when compared to regional and local background concentrations.

Figure 4-1 - Average NOx Background Split



From source apportionment analysis for the Shrewsbury AQMA, diesel cars account for the largest amounts of road NO_x (around 46%) with diesel LGVs and buses the next largest contributors (21.5% and 19.9% respectively). As such, measures contained within the AQAP look to focus on reducing emissions from these vehicle classes. The concentrations are detailed in Table 4-1.

Figure 4-2 - NOx Source Apportionment Average Across All Modelled Receptors

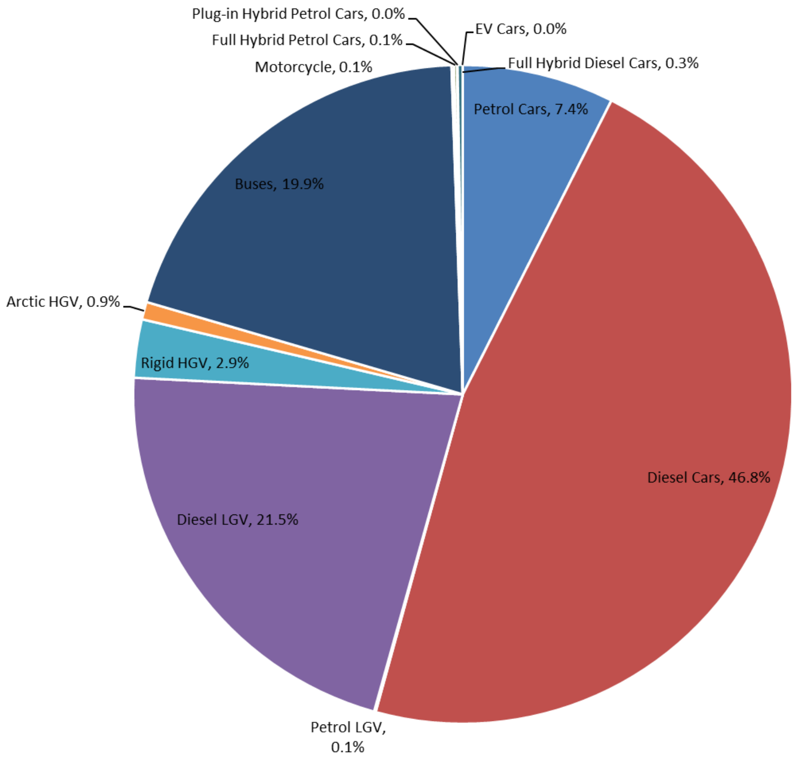


Table 4-1 – NOx Source Apportionment Results

Results	All Vehicles	Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Rigid HGV	Arctic HGV	Buses	Motorcycle	Full Hybrid Petrol Cars	Plug-in Hybrid Petrol Cars	Full Hybrid Diesel Cars	EV Cars	Background
Average Across All Modelled Receptors														
NOx Concentration (µg/m³)	22.0	1.6	10.3	0	4.7	0.6	0.2	4.4	0.0	0.0	0.0	0.1	0.0	10.4
Percentage of Total NOx	67.9%	5.1%	31.8%	0.1%	14.6%	1.9%	0.6%	13.5%	0.1%	0.1%	0.0%	0.2%	0.0%	32.1%
Percentage Contribution to Road NOx	100.0%	7.4%	46.8%	0.1%	21.5%	2.9%	0.9%	19.9%	0.1%	0.1%	0.0%	0.3%	0.0%	-
At Receptor with Maximum Road NOx (11)														
NOx Concentration (µg/m³)	88.7	6.0	40.4	0.1	17.7	2.8	0.9	21.0	0.1	0.1	0.0	0.2	0.0	11.3

Percentage of Total NOx	88.7%	6.0%	40.4%	0.1%	17.1%	2.8%	0.9%	21.0%	0.1%	0.1%	0.0%	0.2%	0.0%	11.3%
Percentage Contribution to Road NOx	100.0%	6.8%	45.5%	0.1%	19.2%	3.2%	1.0%	23.7%	0.1%	0.1%	0.0%	0.2%	0.0%	-

Table 4-2 – NO_2 Source Apportionment Results

Results	All Vehicles	Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Rigid HGV	Arctic HGV	Buses	Motorcycle	Full Hybrid Petrol Cars	Plug-in Hybrid Petrol Cars	Full Hybrid Diesel Cars	EV Cars	Background
Average Across All Modelled Receptors														
NO_2 Concentration (µg/m^3)	11.6	0.9	5.4	0.0	2.5	0.3	0.1	2.3	0.0	0.0	0.0	0.0	0.0	8.1
Percentage of Total NO_2	59.0%	4.4%	27.6%	0.0%	12.7%	1.7%	0.5%	11.7%	0.1%	0.1%	0.0%	0.1%	0.0%	41.0%

Percentage Contribution to Road NO_2	100.0%	7.5%	46.8%	0.1%	21.5%	2.8%	0.9%	19.9%	0.1%	0.1%	0.0%	0.3%	0.0%	-
At Receptor with Maximum Road NO_2 (11)														
NO_2 Concentration (µg/m^3)	41.5	2.8	18.9	0.0	8.0	1.3	0.4	9.8	0.0	0.1	0.0	0.1	0.0	8.7
Percentage of Total NO_2	82.6%	5.6%	37.6%	0.1%	15.9%	2.6%	0.8%	19.6%	0.1%	0.1%	0.0%	0.2%	0.0%	17.4%
Percentage Contribution to Road NO_2	100.0%	6.8%	42.5%	0.1%	19.2%	3.2%	1.0%	23.7%	0.1%	0.1%	0.0%	0.2%	0.0%	-

The above Table and Figures detail the source apportionment results for NOx and NO_2 concentrations at modelled receptors for two scenarios:

- The average NOx and NO_2 contributions across all modelled locations representative of sensitive human exposure (called 'receptors'). This provides useful information when considering possible action measures to test and adopt.
- The location where the maximum road NOx and NO_2 concentrations have been predicted within the AQMA. This is likely to be in the area of most concern within the proposed AQMA and so a good place to test and adopt action measures. Any gains predicted by action measures are likely to be greatest at this location and so would not represent gains across the whole modelled area.

When considering average NOx concentration across all modelled receptors locations, the following observations were found:

- Road traffic accounts for 67.9% (22.0µg/m^3) of the total average NOx, with background concentrations accounting for 32.1% (10.4µg/m^3)
- Diesel cars account for 31.8% (10.3µg/m^3) of the total NOx and 46.8% of all the road traffic.
- Diesel LGVs account for 14.6% (4.7µg/m^3), the second largest contributor of the vehicle categories.

When considering average NO_2 concentration across all modelled receptors locations, the following observations were found:

- Road traffic accounts for 59.0% (11.60µg/m^3) of the total average NO_2, with background concentrations accounting for 41.0% (8.1µg/m^3)
- Diesel cars account for 27.6% (5.4µg/m^3) of the total NOx and 46.8% of all the road traffic.
- Diesel LGVs account for 12.7% (2.5µg/m^3), the second largest contributor of the vehicle categories.
- Buses closely follow Diesel LGVs and account for 11.7% (2.3µg/m^3).

When considering average NOx concentration at the max receptor (2 Castle Foregate), the following observations were found:

- Road traffic accounts for 88.7% (88.7µg/m^3) of the total NOx with background concentrations accounting for 11.3% (11.3µg/m^3)
- Diesel cars account for 40.4% (40.4µg/m^3) of the total NOx and 45.5% of all the road traffic.
- Buses exceed Diesel LGVs at receptor 11 and account for 17.7% (17.1µg/m^3).
- Diesel LGVs account for 21.0% (21.0µg/m^3), the third largest contributor of the vehicle categories.

When considering average NO_2 concentration at the max receptor (2 Castle Foregate), the following observations were found:

- Road traffic accounts for 59.0% (11.6µg/m^3) of the total NO_2 with background concentrations accounting for 41.0% (8.1µg/m^3)
- Diesel cars account for 27.6% (5.4µg/m^3) of the total NO_2 and 42.5% of all the road traffic.
- Buses exceed Diesel LGVs at receptor 11 and account for 19.6% (9.8µg/m^3) NO_2.
- Diesel LGVs account for 15.9% (8.0µg/m^3), the third largest contributor of the vehicle categories.

Source apportionment analysis of the Shrewsbury AQMA demonstrates that diesel cars account for the largest amount of road NOx (46.8%) with diesel LGVs and buses the next largest contributors (21.5% and 19.9% respectively). As such, measures contained within the AQAP should focus on reducing emissions from these vehicle classes.

4.4 Required Reduction in Emissions

In line with the methodology presented in Box 7.6 of TG(22)[5], the necessary reduction in Road NOx emissions required to bring the current AQMA into compliance is shown in Table 4-3. This has been completed at the maximum annual mean concentration location which is receptor 11. The TG(22) procedure calculates the required reduction of road NOx to achieve a total NO_2 concentration of 40µg/m^3. We have used a figure of 36.0µg/m^3 for total NO_2 concentration to account for the uncertainty associated with modelling. Receptor 11 is located on Castle Foregate, at the Smithfield Road junction where the canyon effects are observed due to the high buildings.

Table 4-3 – NOx Reduction Required

Metric	Concentration µg/m^3
Maximum Modelled NO_2 Concentration (µg/m^3)	50.2
Road NOx Concentration (µg/m^3)	100.0
Required Road NOx Reduction (µg/m^3)	43.2
Required Percentage Reduction	43.2%

4.5 Key Priorities

4.5.1 Priority 1 – Traffic Management at Castle Foregate

The receptor with the maximum predicted road NOx is located on Castle Foregate. Shropshire Council proposed changes at Castle Foregate to simplify the road layouts and create a one-way gyratory system which is expected to reduce congestion through the town centre and improving free flowing traffic. The gyratory system will include A5191 Castle Foregate, A5191 Castle Gates, A528 Cross Street, A528 Chester Road and A458 Smithfield Road, which are all located within the AQMA.

The proposals include moving Castle Foregate to a single lane road with the second lane changed to a cycle lane. This is expected to encourage more cyclist movements within Shrewsbury. Chester Street, which was previously a one-way road going north, has now been proposed to be a two-way road. This will alleviate the amount of traffic travelling on Castle Foregate North from the two main roads travelling into Shrewsbury, the A528 and A5191, to just the A5191.

In addition to the source apportionment modelling shown above, an additional modelling study was undertaken by WSP[8] to understand the impact of the proposed infrastructure improvements to the gyratory at Castle Gates, this has been funded through the UK Government Levelling Up (LUF2) Schemes planned by Shropshire Council. The study also considered the North West Relief Road, in combination with the gyratory scheme and separately.

The modelling study undertaken by WSP predicts maximum annual mean NO_2 concentrations of 35.5µg/m^3 at the façade of Castle Gates (north of Smithfield Road). This is the area of the AQMA with the highest modelled and monitored NO_2 concentrations. WSP have modelled a worst-case opening year of 2023. This assumes that future vehicle exhaust emissions rates will not reduce in accordance with DEFRA predictions and is considered a conservative approach. As such it is likely that emissions in 2025 after the construction of the gyratory will be further reduced below the AQO from the modelled 35.5µg/m^3.

It should be noted that whilst the gyratory will reduce NO_2 concentrations to below the AQO at the worst-case modelled receptors along Castle Gates North of Smithfield, there are some increases in NO_2 concentrations associated with the gyratory at other areas within the AQMA. These increases are due to the redistribution of traffic associated with the gyratory and are observed at, Castle Gates South of Smithfield Road, Meadow Place, The Alb and Chester Street. These locations can be seen in the technical note produced by WSP shown in Appendix C. It should be noted that whilst the gyratory is resulting in increases to the annual mean NO_2 concentrations at these receptors, they are all still below the annual mean AQO for NO_2, with only once receptor within 10% of the AQO, Castle Gates South of Smithfield Road.

As mentioned above, modelling undertaken by WSP presents a worst-case conservative assessment of the impact on the wider receptors associated with the gyratory. The expected opening year of the gyratory is 2025 whereas the modelling undertaken by WSP assumes a 2023 opening year. As such emisisons will likely

[8] WSP (2024), Technical Note 1 – LUF2 and NWRR

further reduce from those calculated by WSP in 2025. Similarly, receptors at Castle Gates South of Smithfield Road where annual mean NO_2 concentrations are within 10% of the AQO with the gyratory in place have been modelled at ground floor. It is understood that all receptors at Castle Gates South of Smithfield Road are at 1st Floor height, and as such it is likely that the concentrations for annual mean NO_2 concentrations will further reduce.

As the highest modelled NO_2 annual mean concentration is below 60µg/m^3, it is considered unlikely that there will be any exceedances of the hourly NO_2 objective.

Shropshire Council propose to deploy additional diffusion tubes at these receptor points which indicate increases in annual mean NO_2 concentrations..

4.5.2 Priority 2 – North West Relief Road

The North West Relief Road (NWRR) is also a priority for Shropshire Council in improving air quality in Shrewsbury. The bypass road will divert traffic out of the centre of Shrewsbury and link the north and west of the town directly. This will reduce traffic through the AQMA and improve air quality within Shrewsbury. Planning permission was granted in October 2023 and the Secretary of State agreed to fund the project.

Modelling undertaken by WSP as detailed above for the gyratory was also undertaken for the impacts on the surrounding receptors following the implementation of the NWRR. This modelling indicates that the annual mean NO_2 concentrations at all surrounding receptors at the worst-case area of the AQMA will reduce following the implementation of the NWRR.

4.5.3 Priority 3 – Increase Parking Charges

Within the town centre parking charges will be revised to increase charges within the river loop and decrease charges outside the loop. E-bikes, scooters and rickshaws will be available outside the river loop to travel into the town centre. Park and Ride sites will be the cheapest parking option to encourage the use of these facilities and additional cycle and walking links will be provided.

4.5.4 Priority 4 – Promoting Sustainable Modes of Transport

Following the adoption of the LCWIP in 2023, many of the proposed cycling and walking infrastructure projects are proposed to be introduced within Shrewsbury which will encourage the use of sustainable mode of transport. Some of these cycle lanes are proposed to be introduced along Castle Foregate where NO_2 concentrations are the highest in the AQMA.

In addition to the LCWIP, the encouragement of buses and local transport will be continued. Proposals are in place for the development of a new Park and Ride facility located in the northwest of Shrewsbury. This will help to further reduce the private motor vehicles within the town centre that account for the majority of vehicle trips and NO_x emissions.

5 Development and Implementation of Shrewsbury AQAP

5.1 Consultation and Stakeholder Engagement

In developing/updating this AQAP, we have worked with other local authorities, agencies, businesses and the local community to improve local air quality. Schedule 11 of the Environment Act 1995 requires local authorities to consult the bodies listed in Table 5-1.. In addition, we will undertake the following stakeholder engagement of the draft AQAP:

- Website
- Articles in local newspaper
- Letters inviting views to those currently affected by exceedances in the AQMA.

Consultation on the draft Air Quality Action Plan is expected to take place between March – June 2024. Details of the communication methods and stakeholder engagement will be detailed within the Final AQAP.

The response to our consultation stakeholder engagement is given in Appendix A: Response to Consultation.

Table 5-1 – Consultation Undertaken (TBC)

Consultee	Consultation Undertaken
The Secretary of State	Yes
The Environment Agency	Yes
The highways authority	Yes
All neighbouring local authorities	No
Other public authorities as appropriate, such as Public Health officials	Yes

Consultee	Consultation Undertaken
Bodies representing local business interests and other organisations as appropriate	Yes

5.2 Steering Group

A steering group was established with officers from Shropshire Council to identify and agree measures for inclusion within the AQAP which would benefit air quality within the Shrewsbury AQMA. The steering group includes officers which special interests in Environmental Protection, Climate Change, Highways, Communication, Policy, Economic Growth and Passenger Transport. These specialities all have an influence on air quality within Shrewsbury and therefore it is important to evaluate the most effective measures.

An initial steering group meeting was held on 12th January 2023 to discuss possible measures and modelling undertaken for Shrewsbury town centre. Topics discussed included the bus fleet and possible improvements, one way movement of vehicles through the town centre and possible funding options to support further measures.

Throughout 2023 and 2024 discussions with the steering group have been ongoing to discuss the potential measure options and other ongoing strategies to collaborate with the Air Quality Action Plan.

The most recent discussions with the steering group were in February 2024 to discuss the progress of AQAP and the measures which should be implemented within Shrewsbury. Some of the key parties involved in these discussions were

- Passenger Transport (Buses)
    - Discussions regarding the potential uptake of EV buses or retrofitting of existing buses was undertaken. Initial costs of EV buses and retrofitting were provided.
- Active Travel
    - LCWIP Measures have been discussed and the potential implementation within the Shrewsbury area.
- Highways Authorities

- Ongoing discussions regarding feasible highway improvements to reduce congestion. Particularly looking at the Castle Foregate Gyratory

It is the aim for this steering group to continue to communicate at regular intervals following the adoption of the AQAP. This is essential to provide progress reports on individual actions in relation to the AQAP measures, discuss any key lessons learnt from the continual implementation of the measures and to continue to discuss any new ideas in terms of future measures and actions within the borough.

The steering group will continue to meet prior to the submission of the Final Air Quality Action Plan to detail some of the key areas regarding costs and timescales for the implementation of some of the measures detailed below.

Having members within the steering group from different areas and departments allows a collaborative approach to improving air quality and provides a wider scope of measures that can be implemented.

6 AQAP Measures

Table 6-1 shows the Shrewsbury AQAP measures. It contains:

- a list of the actions that form part of the plan
- the responsible individual and departments/organisations who will deliver this action
- estimated cost of implementing each action (overall cost and cost to the local authority)
- expected benefit in terms of pollutant emission and/or concentration reduction
- the timescale for implementation
- how progress will be monitored

NB: Please see future ASRs for regular annual updates on implementation of these measures

6.1.1 Timescales of the AQAP Measures

Many of the measures set out in Table 6-1 are at the Planning stage, however the Castle Foregate Gyratory and North West Relief Road are planned for 2024 to be completed in 2025 and 2027 respectfully. Both these measures will likely result in the main reduction in emissions as detailed below. The other measures are in their infancy and, while there is every ambition to implement these to achieve reductions in pollutant concentrations within Shrewsbury, they will require investigation and planning before a realistic timescale can be set.

However finalised details on the timescales that measures will be implemented will be better understood when the final AQAP is submitted and the Shropshire 2024 Air Quality Annual Status Report will continue to detail the progression of these measures

6.1.2 Air Quality Partners

One of the key Air Quality Partners that Shropshire Council have consulted with are the Highways Authorities. Due to the planned gyratory and NWRR improvements under the Highways Authority, discussions on these infrastructure projects have been undertaken. These have been successful with the implementation of both expected to commence in 2024.

6.1.1 Future Measures to Maintain the Objective

The key measures associated with the Castle Foregate Gyratory and North West Relief Road are planned to result in a combined reduction of NO_2 concentrations just below 20 µg/m^3. This would place the worst-case monitoring location well below the Air Quality Objective for NO_2. Alongside the measures regarding the uptake of more sustainable modes of transport and the general expected improvements in vehicle euro fleets and more electric vehicles expected in the general fleet, it is expected that the Air Quality Objective for NO_2 will continue to be achieved.

It should also be noted that following compliance of the Air Quality Objective for annual mean NO_2 then Shropshire Council will develop an Air Quality Strategy detailing the ongoing measures to continue to keep NO_2 concentrations below the AQO.

Table 6-1– Air Quality Action Plan Measures

Measure No.	Measure	Category	Classification	Estimated Year Measure to be Introduced	Estimated / Actual Completion Year	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Target Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Potential Barriers to Implementation
1	Castle Foregate Gyratory	Traffic Management	Strategic Highways Improvements	2024	2025	Shropshire Council, WSP, Highways	Levelling Up Fund 2	No	Fully Funded	> £10m.	Planning	15.2µg/m^3 NO_2 Concentration reduction at worst case modelled location. It should be noted that the gyratory will increase NO_2 concentrations by 4.3µg/m^3 however annual mean concentrations will still be below the Air Quality Objective.	Review of monitoring location results after measure is implemented	The development of the Castle Foregate gyratory is due to commence in June 2024 and completion is expected in June 2025.	None Identified - funding confirmed, planning permission not required for Highways development.
2	Northwest Relief Road (NWRR)	Traffic Management	Strategic Highways Improvements	2024	2027	Shropshire Council, WSP, Highways	Government Capital Grant, Marches LEP, SC Match Funding	No	Partially Funded	> £10m.	Planning	4.95 µg/m^3 NO_2 Concentration reduction at worst case receptor location	Review of monitoring location results after measure is implemented	Planning permission for the development of the North West Relief Road was granted in February 2024.	Potential barrier with funding and finalisation. Awaiting confirmation of overall funding from Central Government
3	Increased Parking Charge	Alternatives to Private Vehicle Use	Other	2024	2024	Shropshire Council	Shropshire Council	No	N/A	<£10k	Planning	<0.5 µg/m^3 Concentration reduction at worst case	Review of monitoring data and use of E-bikes,		Subject to Full Council approval –

Measure No.	Measure	Category	Classification	Estimated Year Measure to be Introduced	Estimated / Actual Completion Year	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Target Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Potential Barriers to Implementation
												receptor location	scooters and pedestrians compared to private vehicle movements		February 2024.
4	Park and Ride	Alternatives to Private Vehicle Use	Bus based Park and Ride	TBC	TBC	Shropshire Council	TBC	No	TBC	£1 million - £10 million	Planning	0.5-1µg/m³ µg/m³ Concentration reduction at worst case receptor location		Review of the number of private vehicles movements changes and uptake of bus movements on new park and ride	
5	LCWIP	Promoting Travel Alternatives	Promotion of Walking and Cycling	2024	N/A	Shropshire Council	Shropshire Council, Active Travel England, DfT	No	Different interventions funded independently.	£50k - £100k/	Planning	<0.5 µg/m³ Concentration reduction at worst case receptor location	Review of private vehicle movements on Castle Foregate and uptake of cyclists. Review of monitoring data too.	LCWIP Plan has been adopted in 2023, with some of the key cycling paths proposed as part of the Castle Foregate Gyratory	Subject to funding availability, Highway capacity.
6	Smithfield Re-development	Promoting Travel Alternatives	Promotion of Walking and Cycling	2028	N/A	Shropshire Council	XXX	No	TBC	> £10m.	Planning	To be measured through monitoring	Review of monitoring concentrations along Smithfield Road following	Initial plans out for consultation	Planning permission.

Measure No.	Measure	Category	Classification	Estimated Year Measure to be Introduced	Estimated / Actual Completion Year	Organisations Involved	Funding Source	Defra AQ Grant Funding	Funding Status	Estimated Cost of Measure	Measure Status	Target Reduction in Pollutant / Emission from Measure	Key Performance Indicator	Progress to Date	Comments / Potential Barriers to Implementation
													roadworks and increases pedestrianisation		
7	Anti-Idling Signage outside of Station	Traffic Management	Anti-Idling Enforcement	2025	2025	Shropshire Council	Shropshire Council	No	TBC	<£10k	Planning	<0.5 µg/m^3 Concentration reduction at worst case receptor location	Review of compliance with vehicles anti-idling.	Discussions held with stakeholders	Subject to Full Council approval

7 Quantification of Measures

7.1 Assumptions

Some of the larger measures including the Castle Foregate Gyratory, North West Relief Road and the Park and Ride have been modelled to help determine the impact of the measure. The methodology and detail behind each measure is discussed below. However, for measures such as the LCWIP and Parking Charges, a review of the literature and professional judgment has been considered to determine the potential reductions in emissions. These measures can be considered soft measures as they are the indirect interventions that focus on behavioural change and do not directly affect infrastructure.

7.1.1 - Measure 1 Quantification – Castle Foregate Gyratory

As part of the development of the traffic management design and plan of the Castle Foregate Gyratory, Shropshire Council appointed WSP to undertake the Air Quality Modelling works to demonstrate the impacts of NO_2 concentrations following the adoption of the Castle Foregate Gyratory.

WSP undertook detailed dispersion modelling using ADMS Roads (5.0.0.1) to calculate the emissions associated with the development of the gyratory. The model used detail information regarding traffic flows on the local road network for each diurnal period of the day (AM Peak period, Inter-peak period (IP), PM Peak Period and Off-Peak period (OP)).

Due to the nature of the gyratory, advanced canyon modelling was included to replicate the dispersion modelling conditions. The Emissions Factor Toolkit (EFT) v12.0.1 was used to calculate vehicle emissions and the Defra Background maps for the background concentrations.

A model verification using the 2023 monitoring data was calculated and the monitoring sites within the gyratory area used in the model verification. Monitoring sites outside of the gyratory were not included in the model verification.

Overall, the model results when comparing the baseline current gyratory and the implementation of the LUF2 new gyratory design resulted in a maximum NO_2

concentration decrease of 15.2µg/m^3. This decrease was observed at the worst case monitoring site DF458. It should be noted that the introduction of the gyratory does not only result in reduced congestion, but an increase in alternative modes of transport and reduction in speed limits from 30mph to 20mph.

The modelling also indicates that there will be some increases in NO_2 concentrations at other surrounding receptors. The maximum increase was modelled at 4.3µg/m^3 at The Alb. It should be noted that despite some increases in annual mean NO_2 concentrations associated with the gyratory, all concentrations at the surrounding receptors will still be below the air quality objective.

7.1.2 Measure 2 Quantification – North West Relief Road

As part of the development of the traffic management design and plan of the North West Relief Road, Shropshire Council appointed WSP to undertake the Air Quality Modelling works to demonstrate the impacts of NO_2 concentrations following the adoption of the North West Relief Road.

As detailed above in the measure 1 quantification WSP undertook modelling to demonstrate the impacts of the reduction in NO_2 concentrations following the adoption of the Gyratory as well as the North West Relief Road. The same model and methodology as detailed above was used to calculate the impacts of the North West Relied Road on the worst case receptors and monitoring locations within the Shrewsbury AQMA.

Overall, the model impacts of just the North West Relief Road at the worst case monitoring sites within the AQMA resulted in a 4.95µg/m^3 reduction in NO_2 concentrations.

7.1.3 Measure 4 Quantification – Park and Ride

Following a review of the capacity and movements of the existing Park and Ride facilities operated in Shrewsbury and the understanding of the capacity of the new Park and Ride facility, the quantification of the reduction in NO_2 emissions was calculated. It was assumed that the capacity of the Park and Ride facility could result in a reduction of 500 private motor vehicles within the AQMA. Under this assumption, a reduction of 500 private motor vehicles was applied to the road link with the worst case receptors and monitoring, Castle Foregate as a conservative estimate. After calculating the updated emissions using EFT v12.0, this was then modelled using ADMS-Roads and resulted in a reduction of 0.90 µg/m^3 decrease in annual mean NO_2 concentrations.

This modelling was on the basis on the reduction of 500 private motor vehicles within the AQMA. It was also assumed that the buses that would operate at the Park and Ride facility would be electric buses, hence the conservative method of removing 500 private vehicles and not increasing the proportion of buses. An estimation method of adding 10 new buses to the vehicle fleet as well at the reduction in 500 private motor vehicles was also undertaken. This resulted in a 0.82 µg/m^3 reduction in NO_2 concentrations at the worst case receptor at Castle Foregate.

7.2 Cost Benefit Analysis of Measures

7.2.1 Methodology

Using the above assumptions around the quantitative pollution reduction and assumed costs, each measure was given a score as set out below.

Table 7-1 – Cost Score

Estimated Cost of Measure	Score
< £10k	7
£10k - £50k	6
£50k - £100k	5
£100k - £500k	4
£500k - £1m	3
£1m - £10m	2
> £10m	1

Table 7-2 – Benefit Score

Estimated Reduction in Pollutant Concentrations	Score
>0.5µg/m^3	1
0.5-1µg/m^3	2
1-2µg/m^3	3
2-3µg/m^3	4
3-4µg/m^3	5
4-5µg/m^3	6
>5µg/m^3	7

Using the scores above, the below matrix was implemented to work out the cost-benefit. Higher scores are awarded for those measures which are cheapest with the greatest effect, with the lowest scores awarded for those which will be costly with limited reduction in pollution.

Table 7-3 – Cost Benefit Scoring Matrix

		Estimated Reduction in Pollutant Concentrations						
		>0.5µg/m^3	0.5-1 µg/m^3	1-2 µg/m^3	1-2 µg/m^3	2-3 µg/m^3	3-4 µg/m^3	>4 µg/m^3
Cost of Measure	< £10k	8	9	10	11	12	13	14
	£10k - £50k	7	8	9	10	11	12	13
	£50k - £100k	6	7	8	9	10	11	12
	£100k - £500k	5	6	7	8	9	10	11
	£500k - £1m	4	5	6	7	8	9	10
	£1m - £10m	3	4	5	6	7	8	9
	> £10m	2	3	4	5	6	7	8

The analysis should also account for the feasibility of implementing the measures, with those likely to progress given a higher priority than those which are acknowledged to be a challenge to implement. The feasibility score factors in local influences such as political backing, accessibility to funding options and resources available. As such, each measure was assigned a 'Feasibility score based on the table below. The score from the matrix was multiplied by this score.

Table 7-4 – Feasibility Scores

Feasibility Score	Score
Measure has already been started and just requires progressing	7
Very easy to implement, and political support, sufficient resources	6
Relatively easy to implement, resources available	5
Possible to implement but may require some learning/campaigning, moderately time intensive	4
Challenging but still feasible, may require additional support and resources	3
Difficult to implement, no political appetite, time and resource intensive	2
Very difficult to implement, no political appetite, time and resource intensive	1

7.2.2 Cost-Benefit Analysis

Following the above assessment, it has been possible to rank the measures by cost, benefit and feasibility, this is shown in Table 7-5 below. With the feasibility weighting meaning that measures which are the easiest to progress are scored higher, these are prioritised.

Table 7-5 – Cost Benefit Analysis of Measures

Measure No.	Measure	Cost Score	Air Quality Effect Score	Feasibility Score	Overall Score
1	Castle Foregate Gyratory	1	7 (15.2 µg/m³)	4	12
2	Northwest Relief Road (NWRR)	1	6 (4.95 µg/m³)	3	10
3	Increased Parking Charge	7	1(<0.5 µg/m³)	5	13
4	Park and Ride	2	2 (0.5-1 µg/m³)	2	6
5	LCWIP	5	1(<0.5 µg/m³)	5	11
6	Smithfield Redevelopment	1	1(<0.5 µg/m³ as it is unknown)	1	3
7	Anti-Idling Signage	7	1(<0.5 µg/m³)	5	13

7.3 Year of Objective Compliance

The Detailed modelling report has used the assessment methodology within TG(22) to provide an estimated year of compliance with only national measures being taken into account of 2029 based on the 2022 modelling. This was undertaken using the NO_2 projection factor tool provided by Defra

Shropshire Council aims that the implementation of the outlined measures will result in the relevant objective(s) being attained by 2025

8 Appendix A: Response to Consultation

Table A.1 – Summary of Responses to Consultation and Stakeholder Engagement on the AQAP

Consultee	Category	Response
<Insert consultee e.g. Chamber of Commerce>	<Insert category e.g. Business>	<Insert text e.g. Disagree with plan to remove parking on High Street in favour of buses and cycles; consider it will harm business of members>

9 Appendix B: Reasons for Not Pursuing Action Plan Measures

Table B.1 – Action Plan Measures Not Pursued and the Reasons for that Decision

Action category	Action description	Reason action is not being pursued (including Stakeholder views)
Alternatives to Private Vehicle Use	Previously had 5 pool cars and added one hybrid vehicle in 2018 with 64,521 miles carried out in the fleet in 2018. Additional vehicles added in 2019 taking the number of available cars to 13 with over half being hybrids. Increased usage of the fleet with 130,378 miles of use in 2019. Reduced impact in 2020/21 due to Covid-19, Homeworking and relocation of fleet to Park & Ride Hubs due to vandalism on council premises.	Following COVID-19 and the move to more home working, the measures to encourage car sharing or pooling is not considered feasible or desirable
Update of Electric Buses and Retrofitting of Euro 6	Update of new EV buses or retrofitting to Euro 6 buses to add to vehicle fleet	Review of the current measures proposed including the Gyratory and North West Relief Road as well as the additional cost

		proved this measure to be difficult to implement, particularly due to the implementation within the bus operators. The quantification of the uptake of a wide range of EV buses was calculated to determine whether this was also feasible and it was considered that the overall cost and benefit within the AQMA did not make this a feasible measure. In addition, it was considered that the North West Relief Road and the gyratory would reduce the bus movements along Castle Foregate where the highest NO_2 concentrations were observed.
Traffic Regulation Order for HGVs and LGVs	Review of the time periods and size of vehicle being HGV or LGV that would travel through Castle Foregate	A review of the LGV and HGV movements through the area of the AQMA of highest NO_2 concentrations, Castle Foregate was undertaken. As detailed within the source apportionment, LGVs are the second highest contributing vehicle type for NOx emissions at the

		worst case receptor. It should be noted that with the gyratory works that are set to be completed this will in turn reduce the overall traffic at the worst case receptors, including reducing the number of LGV movements. With the change in the orientation of traffic, all traffic including LGVs will have a reduced impact at the worst case receptor. A review of the effect of a Traffic Regulator order for LGVs and HGVs was undertaken, however due to the other measures implemented, it was considered this was not needed at the current point in time.

10 Shrewsbury AQMA Technical Modelling Report

Shropshire Council AQAP – Shrewsbury AQMA

Detailed Modelling Study

May 2024

Move Forward with Confidence

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Document Control Sheet

Identification	
Client	Shropshire Council
Document Title	Shropshire Council AQAP – Shrewsbury AQMA
Bureau Veritas Ref No.	AIR15503073

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Configuration

Version	Date	Author	Reason for Issue/Summary of Changes	Status
1.0	25/01/2024	V Patel	First Draft	Issued
2.0	10/05/2024	V Patel	Updated following comments from Appraisal	Issued

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Executive Summary

Shropshire Council has commissioned Bureau Veritas to complete a review of one of the Council's existing Air Quality Management Areas (AQMAs) to help in the development of a new Air Quality Action Plan. The Council currently has two AQMA designations, both of which have been declared for exceedances of the annual mean for Nitrogen Dioxide (NO_2). This detailed assessment focuses on the 'Shrewsbury AQMA', described as 'The area comprising Frankwell, part of Bridge Street and Smithfield Road Castle Gates and adjacent land, extending to encompass most of the Town Centre including High Street, Wyle Cop, English Bridge and Coleham Head gyratory'.

The aim of this Technical Note is to identify the extent to which the annual mean objective for NO_2 is exceeded within the AQMA, and to determine the exposure at sensitive receptors. The Technical Note also identifies the contribution from different vehicle classes so that the measures adopted can be targeted towards the main pollutant sources.

A dispersion modelling assessment has been completed and NO_2 concentrations have been predicted across all relevant areas at both specific receptor locations, and across a number of gridded areas, to allow the production of concentration isopleths. This has been used to supplement local monitoring data to provide a clear picture of the NO_x and NO_2 pollutant conditions within the Shrewsbury AQMA.

Following the completion of the analysis of both monitoring data and modelled concentrations across the assessed area, the following conclusions have been made for the Shrewsbury AQMA.

- Detailed modelling has predicted exceedances within the Shrewsbury AQMA of a maximum NO_2 concentration of 50.2 µg/m^3. This exceedance and the two others were observed at the Castle Foregate, Smithfield junction. It should be noted that no receptors exceed the 1-hour Air Quality Objective (AQO).

- No exceedances of the NO_2 annual mean objective of 40 µg/m^3 were predicted outside of the current AQMA boundary.

- Overall, diesel cars accounted for the majority of NO_x emissions in the AQMA, followed by diesel LGV's and Buses.

The next steps upon completion of this Technical Note are to develop, through consideration of merit, a defined set of achievable measures to be brought forward into the revised action plan document.

1 Introduction

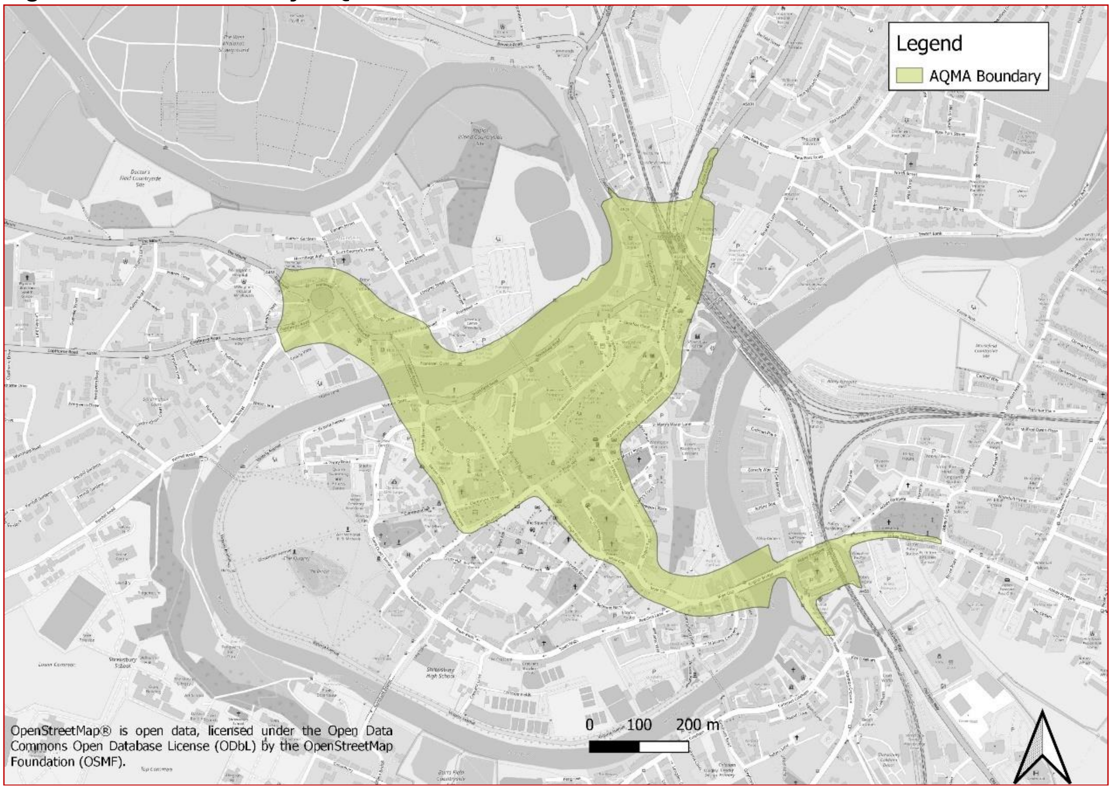
Shropshire Council ("the Council") has commissioned Bureau Veritas to complete a review of one of the Council's existing Air Quality Management Areas (AQMAs) to help in the development of a new Air Quality Action Plan (AQAP). The AQMA which this detailed study is related to is the Shrewsbury AQMA which is described as 'The area comprising Frankwell, part of Bridge Street and Smithfield Road Castle Gates and adjacent land, extending to encompass most of the Town Centre including High Street, Wyle Cop, English Bridge and Coleham Head gyratory'. This AQMA was originally declared in May 2003 and amended in 2006, and Local Air Quality Management Policy Guidance (22)[1] recommends that as a minimum, Local Authorities should revise their AQAP every 5 years.

The current AQAP that covers both the Bridgnorth and the Shrewsbury AQMA was published in September 2008. Therefore, although work has been ongoing since the declaration of the AQMA, a detailed assessment has been undertaken to provide further information in support of preparation of the new AQAP.

The geographical extent of the AQMA included in this assessment is shown in Figure 1-1. Details of the Shrewsbury AQMA are as follows:

- **Extent**: The area comprising Frankwell, part of Bridge Street and Smithfield Road Castle Gates and adjacent land, extending to encompass most of the Town Centre including High Street, Wyle Cop, English Bridge and Coleham Head gyratory.
- **Declared:** May 2003 (Amended: March 2006).
- **Pollutant:** Nitrogen Dioxide (NO_2) Annual Mean.

Figure 1-1 - Shrewsbury AQMA



[1] Local Air Quality Management Policy Guidance LAQM PG(22) – August 2022. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

1.1 Scope of Report

This technical note seeks, with reasonable certainty, to predict the magnitude and geographical extent of any exceedances of the Air Quality Strategy (AQS) objectives, providing the Council with updated modelling data that can be utilised for the development and/or updates to specific measures that are to be included within the updated AQAP.

The areas considered as part of this study are illustrated in the figures presented throughout. The following are the main objectives of this technical note:

- To assess the air quality at selected locations (receptors) at areas of relevant exposure, representative of worst-case exposure within, and close to the existing AQMA boundary, based on modelling of emissions from road traffic on the local road network.
- To determine the geographical extent of any potential exceedances of the annual mean AQS objective for NO_2.
- To determine the relative contributions of separate vehicular source types to the overall pollutant concentrations through the completion of a source apportionment study.
- To put forward recommendations as to the extent of any changes to the current AQMA boundary and any changes to the declaration of the specific AQMA.

The approach adopted in this assessment to determine the impact of road traffic emissions on air quality utilised the atmospheric dispersion model ADMS-Roads version 5.0.1, focusing on emissions of oxides of nitrogen (NO_x), which comprise nitric oxide (NO) and NO_2.

In order to provide consistency with the Council's own work on air quality, the guiding principles for air quality assessments as set out in the latest guidance and tools provided by Defra for air quality assessment (LAQM Technical Guidance (22)[2]) have been utilised.

[2] Local Air Quality Management Technical Guidance LAQM TG(22) – August 2022. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

2 Assessment Methodology

To predict the pollutant concentrations emitted from road traffic sources, atmospheric modelling was carried out using ADMS Roads version 5.0.1, developed by Cambridge Environmental Research Consultants (CERC). The approach used was based upon the following:

- Prediction of NO_2 concentrations to which existing receptors may be exposed and comparison with the relevant AQS objectives.
- Quantification of relative NO_2 contribution attributable to separate vehicular sources in relation to overall NO_x and NO_2 pollutant concentration.
- Determination of the geographical extent of any potential exceedances in regard to the existing AQMA boundary.

Concentrations of NO_2 have been predicted for a base year of 2022, with model inputs relevant to the assessment based upon the same year. The use of 2022 data was based on professional judgement that the impacts on road traffic that occurred as a result of the COVID-19 pandemic are no longer as significant as that observed throughout 2020 and 2021. To demonstrate, the Air Quality Expert Group (AQEG)[3] estimated that during the initial lockdown period in 2020, within urbanised areas of the UK, reductions of between 20-30% were observed in the NO_2 annual mean concentration. However, with no restrictions on travel in place during 2022, it has been determined that the traffic data of 2022 is likely to be similar to that observed prior to the COVID-19 pandemic, reflecting normal vehicle activity.

2.1 Traffic Inputs

Traffic counts for the road links included within the model have been completed by PJA Consultants. This data source was originally undertaken as vehicle traffic counts during 2022, which have been provided in an AADT format for the relevant road link in terms for a number of vehicle types; cars, LGVs (light goods vehicles), HGVs (heavy goods vehicles), buses and coaches, and motorcycles.

Full details of the traffic data used in the dispersion model are shown in Appendix A.

Traffic speeds were modelled at the relevant speed limit for each road. However, in accordance with LAQM.TG(22), where appropriate, traffic speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues or slower traffic are known to occur.

The Emissions Factors Toolkit (EFT) version 12.0[4] has been used to determine vehicle emissions factors for input the ADMS-Roads model. The emissions factors are based upon the traffic data inputs used within the assessment.

2.2 General Model Inputs

A site surface roughness value of 1m was entered into the ADMS-roads model, consistent with the city's nature of the modelled domain. In accordance with CERC's ADMS Roads user guide[5], a minimum Monin-Obukhov Length of 30 m was used for the ADMS Roads model to reflect the urban topography of the model domain.

One year of hourly sequential meteorological data from a representative synoptic station is required by the dispersion model. For the completion of the modelling, 2022 meteorological data from the Shawbury weather station has been utilised within this assessment. This site has been chosen due to it being the nearest site with a complete data set for 2022 and is representative of the Shropshire Council area.

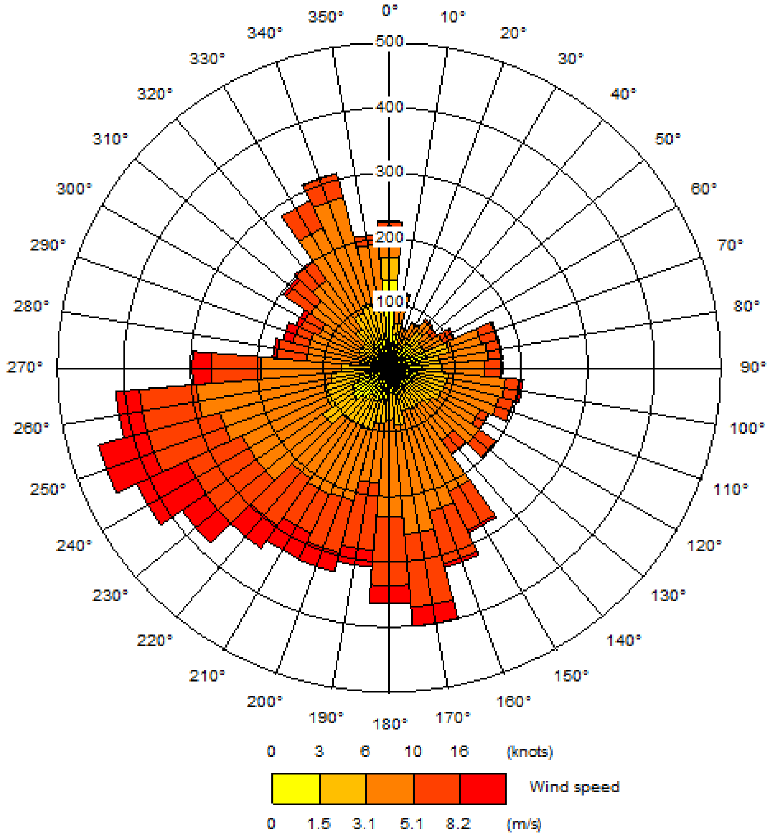
[3] Air Quality Expert Group, Estimation of changes in air pollution emissions, concentrations and exposure during the COVID-19 outbreak in the UK, June 2020

[4] Defra, Emissions Factors Toolkit – version 12.0 (2023), available at: https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/

[5] CERC (2020), ADMS-Roads User Guide Version 5.

A wind rose for this site for the year 2022 is presented in Figure 2-1. From this wind rose, it is evident that the prevailing wind within Shropshire is from the south-west, with an average wind speed of 4.1 m/s.

Figure 2-1 - Wind Rose for Shawbury 2022 Meteorological Data



2.3 Modelled Road Sources

A total of 22 road sources were included throughout the model domain, including junctions or approaches to junctions (slow downs). No point sources have been included within the model under the assumption that road traffic is the primary source of NO_2 emissions. The road links modelled are presented in Figure 2-2 and include the main roads that pass through the AQMA.

Street canyons were also included along Castle Foregate on the approach to the Rail Station as this stretch of road is surrounded by buildings/walls on both sides.

2.4 Modelled Sensitive Receptors

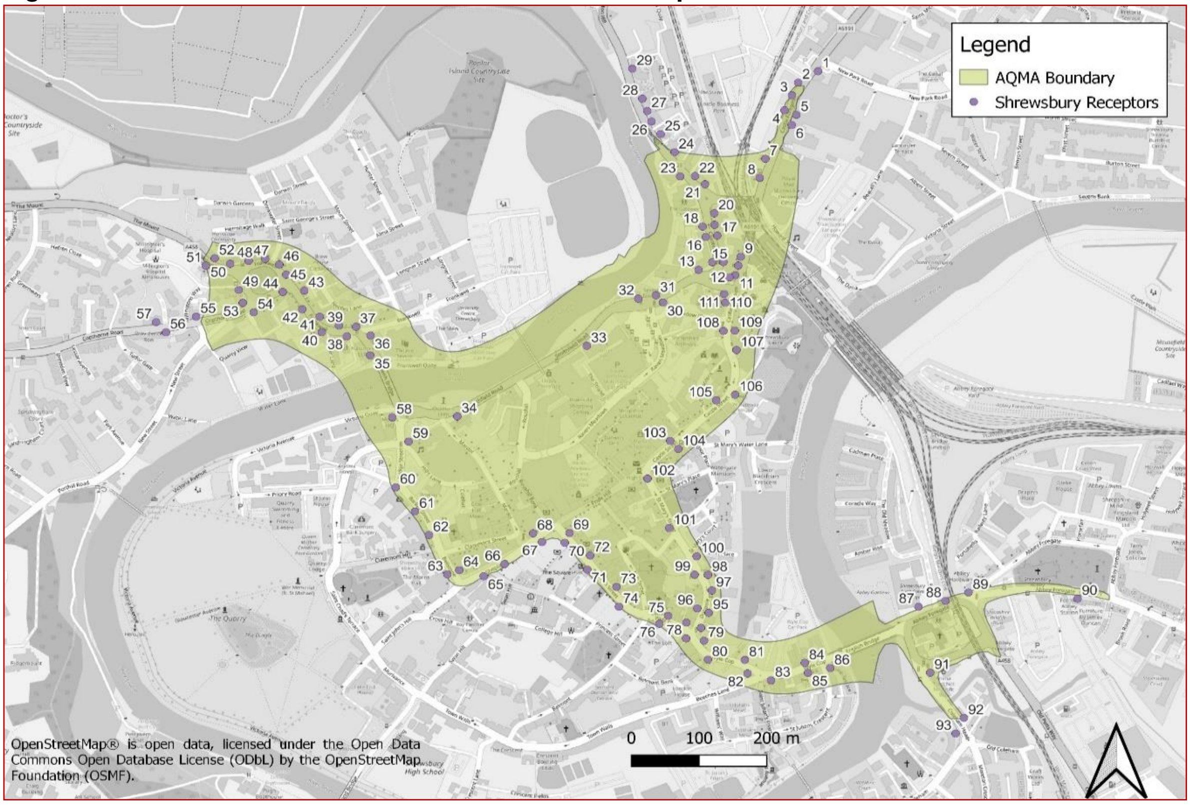
A total of 111 discrete receptors were included within the assessment to represent locations of relevant exposure. The locations were identified through completion of a desktop study, and included places such as residential properties, care homes, and schools. Receptors were modelled at 1.5 m to represent the typical breathing zone height and 4 m to represent first floor properties for certain receptors to cover the AQMA. A description of the receptors is provided in Table 2-1, with their locations shown in Figure 2-2.

Table 2-1 - Modelled Receptor Locations

Receptor ID	Receptor Description	Receptor ID	Receptor Description
1	55 Castle Foregate	**57**	3 Copthorne Road
2	50 Castle Foregate,	**58**	Morris HQ, Bridge Street
3	47 Castle Foregate	**59**	17a, Hill's Lane
4	42 Castle Foregate	**60**	Saint Austin's Street

5	71 Castle Foregate	**61**	8 Barker Street
6	69 Castle Foregate	**62**	1 Barker Street
7	27 Castle Foregate	**63**	1 Bellstone
8	16 Castle Foregate	**64**	Market Hall, Shoplatch
9	6, Castle Foregate	**65**	10 Shoplatch
10	4, Castle Foregate	**66**	7 Shoplatch
11	2, Castle Foregate	**67**	6 Mardol Head
12	2, Castle Foregate	**68**	10 Mardol Head
13	3b Chester Street	**69**	26 High Street
14	7b Chester Street	**70**	32 High Street
15	1 Chester Street	**71**	33 High Street
16	10a Chester Street	**72**	18 High Street
17	6 Chester House	**73**	4 High Street
18	10a Chester Street	**74**	44 High Street
19	Cambrian House	**75**	85, Wyle Cop
20	Cambrian House	**76**	86, Wyle Cop
21	25 Chester Street	**77**	8 Wyle Cop
22	21a Chester Street	**78**	77 Wyle Cop
23	4 Chester Street	**79**	10 Wyle Cop
24	2 Broome Place	**80**	70 Coleham
25	76 Coton Hill	**81**	22 Wyle Cop
26	73 Coton Hill	**82**	60 Wyle Cop
27	87 Benbow Quay	**83**	58 Wyle Cop
28	81 Benbow Quay	**84**	36 Wyle Cop
29	25 Benbow Quay	**85**	49-50 Wyle Cop
30	14 Smithfield Road	**86**	77 Saint Julians Crescent
31	1,2,3,4, Smithfield Road	**87**	Shrewsbury Sixth Form College
32	5 Smithfield Road	**88**	8 Abbey Foregate
33	Riverside Chambers Smithfield Road	**89**	14 Abbey Foregate
34	31 Smithfield Road	**90**	191 Abbey Foregate
35	1 Frankwell	**91**	Animal Trust Not for Profit Vets
36	165 Frankwell	**92**	5 Coleham Head
37	127 Frankwell	**93**	14 Longden Coleham Head
38	4 Frankwell	**94**	Kenneth Court
39	120a-123a, Frankwell	**95**	21 Dogpole
40	9 Frankwell	**96**	5 Dogpole
41	114 Frankwell	**97**	19 Dogpole
42	19 Frankwell	**98**	Newport House, Dogpole
43	106;107 Frankwell	**99**	11, Dogpole
44	2 New Street	**100**	16 St Mary's Street
45	97 Frankwell	**101**	18 St Mary's Street
46	94 Frankwell	**102**	27 Pride Hill
47	88/89 Frankwell	**103**	11 Castle Street
48	84 Frankwell	**104**	38 Castle Street
49	5 Saint George's Court	**105**	21a Castle Street
50	78 Frankwell	**106**	24 Castle Street
51	53 Frankwell	**107**	21-22 Castle Gates
52	71 Frankwell	**108**	1A Castle Gates
53	9-11 Saint George's Court	**109**	18 Castle Gates
54	10 Copthorne Road	**110**	5, Castle Gates
55	15 Copthorne Road	**111**	9-10, Castle Gates
56	13 Copthorne Rise		

Figure 2-2 - Modelled Road Sources & Sensitive Receptors



2.5 Model Outputs

Background pollutant values for 2022, derived from Defra Background Maps[6], have been used in conjunction with the concentrations predicted by the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_x.

For the prediction of annual mean NO_2 concentration for the modelled scenarios, the output of the ADMS-Roads model for road NO_x contributions have been concentrated to total NO_2 following the methodology in LAQM.TG(22), using the NO_x to NO_2 conversion tool developed on behalf of Defra. This assessment has utilised the most up-to-date version of the NO_x to NO_2 conversion tool, v8.1[7].

Verification of the model has been carried out using the majority of local authority NO_2 passive monitoring locations within the Shrewsbury AQMA, in accordance with the methodology detailed within LAQM.TG(22). A zone verification was undertaken for those receptors and monitoring locations located along Castle Foregate where there are observed street canyons towards the rail station. This was undertaken to best represent the monitoring locations that were exceeding the AQO of 40 µg/m^3 within the AQMA. The remaining monitoring sites within the AQMA were used for the wider Shrewsbury AQMA receptors.

Sensitivity testing was undertaken to determine the most suitable verification that should be used for the assessment, whether a zonal verification was used as detailed above or a single factor for the whole AQMA. The reason behind the zone verification was due to the model under-representing the elevated concentrations along Castle Foregate. This was the only area within the AQMA where exceedances of the AQO were observed and was not representative of the whole AQMA. In addition, due to the nature of the canyon effects along castle foregate it did not seem appropriate to use the same factor across the AQMA. Further details behind the sensitive testing of both zonal and non-zonal verification are presented in Appendix B.

[6] https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

[7] Defra, NO_x to NO_2 Calculator. (2020). Available at: https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator/

Compared to 2019, the diffusion tube monitoring network in Shrewsbury increased by two sites in 2022, with the removal of one site and the addition of three new sites. Of the 27 sites in Shrewsbury, 19 were used for model verification. Of the eight sites that were excluded, the majority (six) were outside of the AQMA boundary, whilst the remaining two sites (DF413 and DF459) were removed for the following reasons. Site DF413 was located on Raven Meadows where there was only coach and bus access only, no traffic data was available for this road link. Site DF459 was similarly excluded due to no traffic data available, the site is also located within the Shrewsbury train station car park.

Overall, of the monitoring locations within the Shrewsbury AQMA. the locations and heights of these tubes have been adjusted within the model and validated where required via a desktop study.

2.6 Source Apportionment

To help inform the development of measures as part of the action plan stage of the project, a source apportionment exercise was undertaken for the following vehicle classes.

- Petrol and Diesel Cars;
- Petrol and Diesel LGV's;
- Rigid and Artic HGV;
- Buses;
- Motorcycle;
- Full Hybrid Petrol Cars;
- Plug-in Hybrid Petrol Cars;
- Full Hybrid Diesel Cars; and
- EV Cars

This provides vehicle contributions of NO_x as a proportion of the total NO_x concentration, which will allow the Council to develop specific AQAP measures targeting a reduction in emissions from specific vehicle types. A breakdown of vehicle class was provided by the appointed transport consultant (PJA Consultants) completing the traffic counts on each road link included within the model.

It should be noted that emission sources of NO_2 are dominated by a combination of direct NO_2 (f-NO_2) and oxides of nitrogen (NO_x), the latter of which is chemically unstable and rapidly oxidised upon release to form NO_2. Reducing levels of NO_x emissions therefore reduces concentrations of NO_2. Consequently, the source apportionment study has firstly considered the emissions of NO_x, which are assumed to be representative of the main sources of NO_2, and secondly emissions of NO_2.

With regards to the discrete receptor locations, consideration has been given to the following groups of receptors located within, and within 20 m of the boundary, of the AQMA. The source apportionment study has evaluated the following receptor combinations:

- The average NO_x and NO_2 contributions across all modelled locations (i.e., all locations covered by the model, both within and outside of the AQMA boundary). This provides useful information when considering possible action measures to test and adopt. It will however understate road NO_x concentrations in problem areas as results are averaged out across areas with higher and lower concentrations.
- The NO_x and NO_2 contributions at the receptor with the maximum road NO_x and NO_2 contribution. This provides a comparison to the previous two groups, with the identification of the most prominent vehicle source at receptor with the highest predicted NO_2 concentration.

3 Modelling Results

The following section provides a detailed assessment of the ‘Shrewsbury AQMA’, comparing monitoring completed over an 8-year period (2015-2022) with the modelled concentrations of annual mean NO_2. Details of each monitoring location and the monitoring results have been provided by Shropshire Council. Analysis of receptor locations has been completed both within and outside of the existing AQMA designation to determine the level of exceedance within the AQMA and also if there are any areas outside of the current boundary where the annual mean concentration of NO_2 is predicted to exceed the annual mean objective.

In line with the standardised LAQM reporting, the tabulated results present any exceedance of the annual mean AQS objective of 40 µg/m^3 in **bold**, and any predicted concentrations in exceedance of 60 µg/m^3 <u>underlined</u> and in **bold**. Additionally, annual mean concentrations that are predicted to be within 10% of the objective are presented in *italics*.

In addition, the NO_x source apportionment results which have been split across the vehicle classifications detailed in Section 2.6 are presented in both tabular and pie chart formats. This allows the main vehicular sources to be identified within the ‘Shrewsbury AQMA’, therefore aiding the development of measures that are of specific relevant to the AQMA.

3.1 Shropshire Council Monitoring Data

Table 3-1 presents the monitoring data collected by Shropshire Council. This table presents the data for the diffusion tubes within the Shrewsbury AQMA, as well as those surrounding the AQMA to provide a wider context for the monitoring results.

Table 3-1 - Passive NO_2 Monitoring Within and Around Shrewsbury AQMA

Site ID	Location	OS Grid Ref X	OS Grid Ref Y	Annual Mean NO_2 Concentration ($\mu g/m^3$)							
				2015	2016	2017	2018	2019	2020	2021	2022
DF403	Smithfield Road Corner of Victoria Avenue	348891	312721	31.7	31.0	29.3	30.5	30.8	23.0	23.0	25.0
DF407	Dogpole (Car Entrance)	349330	312503	27.5	27.4	24.8	24.1	23.4	18.1	19.6	19.8
DF413	Ravens Meadow, outside 23 Meadow Terrace	349283	312851	31.8	31.7	28.6	29.5	26.3	21.2	22.7	23.1
DF420	Outside 25 Castle Street	349396	349396	29.1	29.2	28.0	27.8	26.3	21.2	21.9	23.3
DF428A	Britannia Inn (Post office lamppost)	349445	349445	-	-	-	*38.3*	*36.1*	29.4	30.9	32.4
DF429	6A Severn Steps adj Lamp Post	349237	349237	31.4	27.5	28.2	-	28.8	21.8	22.7	24.1
DF437	The Albert (duplicate)	349283	349283	*37.3*	*37.6*	34.8	35.6	33.3	25.7	28.1	28.7
DF438	Station Hotel 4 Castle Foregate (façade)	349400	349400	**60.8**	**58.5**	**54.0**	**58.8**	**53.0**	**40.2**	**43.9**	**43.4**
DF458	Under Railway Bridge Over Castle Foregate	349426	349426	**52.4**	**53.9**	**53.6**	**55.0**	**48.6**	*38.5*	**42.2**	**42.6**
DF459	Post in car park outside railway station	349424	312936	35.9	*37.4*	*38.6*	**42.1**	35.6	26.6	29.2	29.8
DF460	On Bellstone opposite the Junction with Claremont St	348952	312495	25.3	26.4	30.5	25.7	24.2	18.5	-	-
DF461	Junction of Dogpole with High St/Wyle Cop	349327	312389	32.7	31.7	30.5	30.9	26.2	18.7	20.1	21.3
DF476	Chester Street on street parking bay height sensor post	349360	312962	28.7	30.6	31.2	33.1	29.1	22.5	24.4	25.0
DF477	Bus opp Community Church, Chester St	349299	349299	31.0	31.2	33.5	31.3	29.8	23.1	23.9	24.8
DF480	lamp post by takeaway near Britannia Inn	349466	349466	33.0	34.2	32.7	31.8	31.6	24.8	27.9	28.3
DF482	Royal Mail Lamp column by Traffic Lights	349436	313064	-	-	31.6	**45.7**	*38.2*	32.2	32.9	31.7
DF485	Frankwell Terrace	348815	312854	-	-	28.4	30.9	26.1	20.3	22.4	22.9
DF487	English Bridge by St Julian Friars (No Entry Sign)	349529	312328	-	-	-	22.7	21.9	17.5	17.5	17.9
DF501	Corner of 25 Chester Street/Cross Street	349349	313071	-	-	-	*38.2*	33.5	24.6	27.8	28.5
DF502	Post outside Cambrian House	349364	312998	-	-	-	31.2	26.3	18.4	22.1	22.0
DF503	Downspout 68-69 Frankwell	348611	312969	-	-	-	-	-	-	26.1	23.6
DF606,607	Railway station car park opp DF438 duplicate	349411	312944	-	-	-	-	-	28.7	-	-
DF608,609	Post in front of Olive Tree, Frankwell duplicate	348676	312955	-	-	-	-	-	22.1	-	-

The data shows that the NO_2 annual mean objective of 40 µg/m³ has been exceeded at two diffusion tube sites within the Shrewsbury AQMA in 2022.

The areas of the AQMA that exceed the AQO based on the monitoring data above are situated close to junctions and where there are slight road canyon effects due to the narrow streets on Castle Foregate adjacent to the Shrewsbury Rail Station. The observed exceedances are therefore likely the result of the stopping and starting/idling of vehicles as traffic builds up along the road where the diffusion tube is located on approach to the junction, as well as the street canyon effects, reducing the dispersion of pollutants.

3.2 Modelled Receptor Concentrations, Annual Mean NO_2

Table 3-2 provides the modelled annual mean NO_2 concentrations predicted at existing receptor locations in 2022. Of the 111 receptors included in the assessment, 102 are located within the AQMA boundary whilst the remaining are situated on the modelled roads that lead into the AQMA. Those receptors located in Zone 1 are in the Castle Foregate zone verification (adjustment factor 4.174), those in Zone 2 are within the wider Shrewsbury AQMA zone verification (adjustment factor 3.892).

Table 3-2 - Modelled Receptor Concentrations, Annual Mean NO_2

Receptor ID	OS Grid X	OS Grid Y	Height (m)	In AQMA?	AQS objective (µg/m³)	Verification Zone	2022 Modelled Annual Mean NO_2 (µg/m³)	% of AQS objective
1	349517	313252	1.5	N	40	1	21.84	54.60
2	349487	313234	1.5	N	40	1	19.43	48.58
3	349478	313214	1.5	Y	40	1	19.39	48.48
4	349467	313191	1.5	Y	40	1	18.97	47.43
5	349485	313184	4.0	Y	40	1	17.14	42.85
6	349478	313168	4.0	Y	40	1	17.4	43.50
7	349439	313116	4.0	Y	40	1	18.11	45.28
8	349431	313086	4.0	Y	40	1	20.35	50.88
9	349403	312963	4.0	Y	40	1	**46.70**	116.75
10	349399	312950	1.5	Y	40	1	**48.77**	121.93
11	349394	312935	1.5	Y	40	1	**50.24**	125.60
12	349386	312931	1.5	Y	40	2	29.99	74.98
13	349340	312943	1.5	Y	40	2	28.90	72.25
14	349361	312955	1.5	Y	40	2	28.37	70.93
15	349377	312955	1.5	Y	40	2	28.38	70.95
16	349351	312994	1.5	Y	40	2	21.07	52.68
17	349368	312996	1.5	Y	40	2	25.66	64.15
18	349346	313010	1.5	Y	40	2	20.25	50.63
19	349364	313013	4.0	Y	40	2	20.93	52.33
20	349364	313031	4.0	Y	40	2	24.65	61.63
21	349350	313076	1.5	Y	40	2	25.10	62.75
22	349335	313089	1.5	Y	40	2	22.83	57.08
23	349313	313088	1.5	Y	40	2	19.13	47.83
24	349305	313126	1.5	Y	40	2	18.49	46.23
25	349284	313154	1.5	N	40	2	18.34	45.85
26	349271	313174	1.5	N	40	2	19.50	48.75
27	349265	313190	1.5	N	40	2	18.62	46.55
28	349257	313209	1.5	N	40	2	18.34	45.85
29	349243	313256	1.5	N	40	2	16.56	41.40
30	349288	312892	1.5	Y	40	2	27.90	69.75
31	349277	312904	1.5	Y	40	2	28.34	70.85
32	349251	312898	1.5	Y	40	2	25.81	64.53
33	349175	312825	1.5	Y	40	2	19.17	47.93
34	348984	312715	4.0	Y	40	2	16.50	41.25
35	348856	312810	4.0	Y	40	2	16.87	42.18
36	348856	312841	4.0	Y	40	2	18.41	46.03

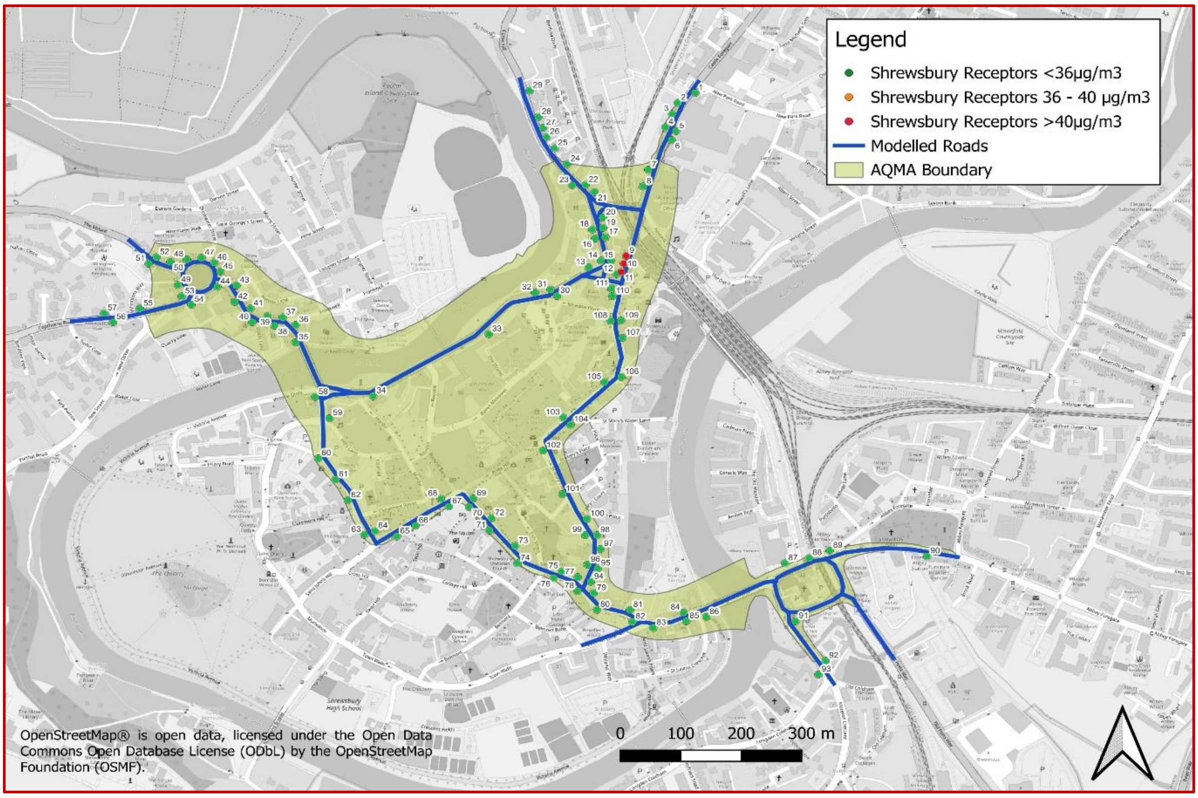
Receptor ID	OS Grid X	OS Grid Y	Height (m)	In AQMA?	AQS objective ($\mu g/m^3$)	Verification Zone	2022 Modelled Annual Mean NO_2 ($\mu g/m^3$)	% of AQS objective
37	348835	312855	4.0	Y	40	2	19.32	48.30
38	348821	312840	4.0	Y	40	2	17.89	44.73
39	348809	312856	1.5	Y	40	2	26.07	65.18
40	348784	312846	4.0	Y	40	2	16.25	40.63
41	348781	312870	4.0	Y	40	2	18.82	47.05
42	348755	312882	4.0	Y	40	2	17.59	43.98
43	348758	312911	1.5	Y	40	2	26.55	66.38
44	348726	312909	1.5	Y	40	2	30.47	76.18
45	348731	312936	1.5	Y	40	2	31.54	78.85
46	348721	312951	1.5	Y	40	2	27.10	67.75
47	348700	312960	1.5	Y	40	2	30.31	75.78
48	348676	312957	1.5	Y	40	2	23.05	57.63
49	348661	312912	1.5	Y	40	2	21.37	53.43
50	348649	312953	1.5	Y	40	2	20.25	50.63
51	348613	312950	1.5	Y	40	2	14.82	37.05
52	348626	312961	1.5	Y	40	2	18.30	45.75
53	348667	312892	1.5	Y	40	2	20.41	51.03
54	348683	312877	1.5	Y	40	2	18.25	45.63
55	348599	312870	1.5	N	40	2	14.70	36.75
56	348554	312846	1.5	N	40	2	12.84	32.10
57	348539	312862	1.5	N	40	2	13.82	34.55
58	348888	312714	4.0	Y	40	2	16.94	42.35
59	348912	312676	4.0	Y	40	2	14.66	36.65
60	348893	312605	4.0	Y	40	2	11.83	29.58
61	348922	312568	4.0	Y	40	2	12.41	31.03
62	348942	312531	4.0	Y	40	2	12.56	31.40
63	348969	312470	4.0	Y	40	2	11.63	29.08
64	348987	312476	4.0	Y	40	2	13.17	32.93
65	349023	312467	4.0	Y	40	2	12.91	32.28
66	349054	312486	4.0	Y	40	2	12.80	32.00
67	349109	312520	4.0	Y	40	2	13.18	32.95
68	349096	312533	4.0	Y	40	2	13.14	32.85
69	349150	312534	4.0	Y	40	2	13.65	34.13
70	349143	312519	4.0	Y	40	2	13.18	32.95
71	349176	312477	4.0	Y	40	2	12.75	31.88
72	349180	312499	4.0	Y	40	2	13.26	33.15
73	349219	312450	4.0	Y	40	2	13.55	33.88
74	349223	312420	4.0	Y	40	2	12.37	30.93
75	349295	312405	4.0	Y	40	2	14.54	36.35
76	349283	312393	4.0	Y	40	2	13.70	34.25
77	349322	312395	4.0	Y	40	2	16.41	41.03
78	349322	312370	4.0	Y	40	2	16.37	40.93
79	349348	312367	4.0	Y	40	2	20.63	51.58
80	349354	312337	4.0	Y	40	2	17.95	44.88
81	349409	312337	4.0	Y	40	2	21.10	52.75
82	349413	312316	4.0	Y	40	2	19.65	49.13
83	349447	312305	4.0	Y	40	2	16.91	42.28
84	349497	312332	4.0	Y	40	2	18.58	46.45
85	349502	312317	4.0	Y	40	2	16.85	42.13
86	349535	312324	1.5	Y	40	2	17.36	43.40
87	349665	312419	1.5	Y	40	2	20.56	51.40
88	349705	312429	4.0	Y	40	2	21.08	52.70
89	349739	312442	4.0	Y	40	2	21.41	53.53
90	349900	312432	1.5	Y	40	2	21.55	53.88
91	349682	312317	1.5	Y	40	2	22.01	55.03
92	349732	312247	1.5	Y	40	2	13.95	34.88

Receptor ID	OS Grid X	OS Grid Y	Height (m)	In AQMA?	AQS objective (µg/m³)	Verification Zone	2022 Modelled Annual Mean NO_2 (µg/m³)	% of AQS objective
93	349720	312222	1.5	Y	40	2	12.23	30.58
94	349344	312386	1.5	Y	40	2	23.28	58.20
95	349355	312410	1.5	Y	40	2	19.70	49.25
96	349338	312417	4.0	Y	40	2	16.19	40.48
97	349360	312445	1.5	Y	40	2	18.72	46.80
98	349354	312469	1.5	Y	40	2	20.29	50.73
99	349335	312469	4.0	Y	40	2	15.07	37.68
100	349337	312498	1.5	Y	40	2	20.08	50.20
101	349297	312542	1.5	Y	40	2	16.87	42.18
102	349265	312619	4.0	Y	40	2	14.16	35.40
103	349298	312677	4.0	Y	40	2	15.42	38.55
104	349310	312665	4.0	Y	40	2	15.44	38.60
105	349366	312740	4.0	Y	40	2	15.93	39.83
106	349394	312749	1.5	Y	40	2	19.26	48.15
107	349396	312818	4.0	Y	40	2	16.86	42.15
108	349377	312848	4.0	Y	40	2	16.51	41.28
109	349394	312849	4.0	Y	40	2	17.04	42.60
110	349380	312892	4.0	Y	40	2	18.65	46.63
111	349378	312905	4.0	Y	40	2	20.53	51.33

From the modelled concentrations presented within Table 3-2, it is evident that the AQS annual mean NO_2 objective of 40 µg/m³ is not predicted to be exceeded at any site outside of the existing AQMA boundary. Indeed, the predicted concentration at receptors outside of the AQMA was not within 10% of the annual mean objective at any location, with the maximum predicted NO_2 annual mean concentration being 24.2 µg/m³ at Receptor 1.

Within the AQMA, the annual mean was exceeded at three receptor sites, all along Castle Foregate, with the highest annual mean NO_2 concentration of 50.2µg/m³ being modelled at receptor 11. This receptor is located on Castle Foregate, located at the Castle Foregate, Smithfield Road junction where the canyon effects are observed due to the high buildings. Figure 3-1 illustrates the spatial location of those receptors that exceeded the AQO.

Figure 3-1 - Shrewsbury AQMA Receptors against AQO



3.3 Source Apportionment

Source apportionment has been carried out for the modelled receptors along the road links that are either within the AQMA or lead into the AQMA. Apportionment for both NO_x and NO_2 concentrations has been completed for the vehicle classes listed in Section 2.6. It's worth noting that NO_x concentrations are always higher than those for NO_2 since NO_x is made up of NO and NO_2. There is no air quality limit for human health for NO_x but is nevertheless a useful indicator when considering source apportionment. Results are tabulated in Table 3-4 and Table 3-5 and illustrated in Figure 3-1 to Figure 3-5

The apportionment between road NO_x and background NO_x has also been detailed in Figure 3-3 and Table 3.3. Local Background NO_x, which is considered to be the emissions a local authority has influence over, including building, road, and rail emissions etc., accounts for just over 22% of the total NO_x concentration on average at all receptor locations. Regional background NO_x concentrations account for those emissions that the local authority has no influence over, these emissions account for just under 10% of total NO_x concentrations on average at all modelled receptors. With a total 68% of NO_x emissions on average within the Shrewsbury AQMA deriving from local road traffic. The higher proportion of local background NO_x emissions is likely a result of the Shrewsbury Rail Station located within the AQMA.

The source apportionment results provide the relative contribution (as a percentage) of each vehicle type towards a specific pollutant. Therefore, when considering the average NO_x concentration across all modelled receptors, road traffic is responsible for 67.9% of emissions (22.0 µg/m^3). Of the total road NO_x, diesel cars are the biggest contributor accounting for 46.8% of emissions, followed by diesel large-good vehicles (21.5%) and buses/coaches (19.9%).

When considering the modelled receptor location at which the maximum road NO_x concentration is observed. Road traffic is responsible for 88.7% of total NO_x emissions, of the road traffic proportion, 45.5% is from diesel cars, 19.2% from diesel LGV's and 23.7% from buses. These numbers only differentiate from the average across all modelled receptors, likely due to the traffic proportions on different road links. As this site is located adjacent to a junction approaching the station and prior to the entrance of the high street area there is a higher proportion of diesel cars and LGVs, however overall, the distribution of vehicles is similar across the AQMA.

3.4 Modelled NO_2 Concentration – Contour Plot

The contour plot in Figure 3-2 indicates that there are exceedances of the NO_2 annual mean from the main junction within the Shrewsbury AQMA around Castle Foregate, Cross Street and Smithfield Road where there is a high volume of traffic and congestion due to the number of traffic lights and junctions. Most of these exceedances are only observed on the road and not at the surrounding receptors. This can be seen along the A458 where exceedances of the AQO are observed but not at any receptor locations. Concentrations greater than 60 µg/m^3 are predicted at the Castle Foregate and Smithfield junction where there are observed street canyons, with concentrations over 60 µg/m^3 observed at two receptor locations, however further analysis detailed that these receptors did not exceed the 1-hour AQO.

From the plot it is evident that the predicted exceedances of the annual mean objective are strictly constrained to the road network, therefore come in close range to any residential properties that are located close to the road. The street canyons observed on Castle Foregate also have residential properties on the eastern side, and it is here where the main exceedances of the AQO are observed, as shown in Figure 3-1.

There are minimal receptors of relevant exposure that come into contact with the 40 µg/m^3 limit contour within the AQMA. However due to some other works occurring across the AQMA included additional developments, Shropshire council propose to review monitoring data across the AQMA prior to reducing the extent of the AQMA. In combination with Figure 3-1, there are no receptors outside of the AQMA designation that exceed the AQO.

Figure 3-2 - Contour Plot of Modelled NO_2 Concentrations

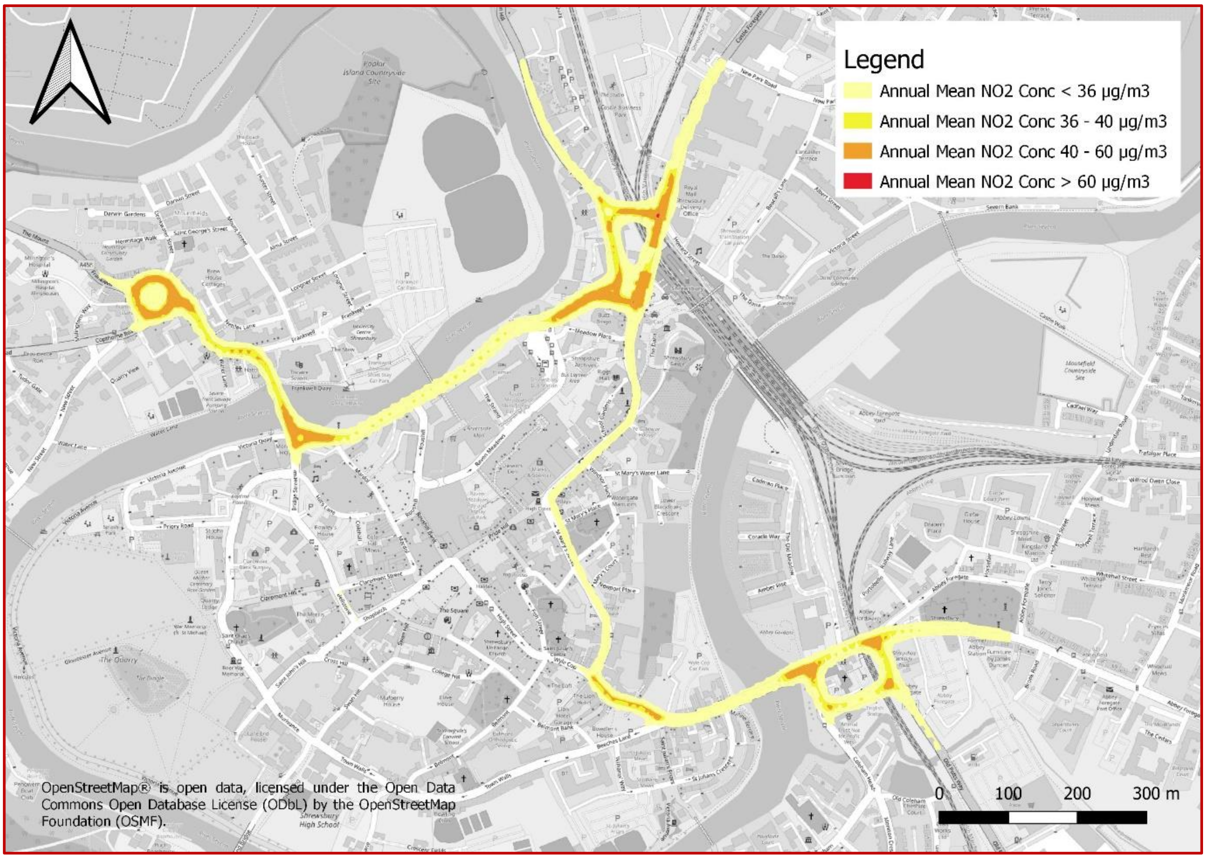


Table 3-3 - Total NO_x Source Apportionment Across All Receptors

Results	Local Background NO_x	Regional Background NO_x	Local Road NO_x
NO_x Concentration (µg/m^3)	7.3	3.1	22.0
Percentage of total NO_x	22.5%	9.6%	68.0%

Table 3-4 - NO_x Source Apportionment Results

Results	All Vehicles	Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Rigid HGV	Arctic HGV	Buses	Motorcycle	Full Hybrid Petrol Cars	Plug-in Hybrid Petrol Cars	Full Hybrid Diesel Cars	EV Cars	Background
Average Across All Modelled Receptors														
NO_x Concentration (µg/m^3)	22.0	1.6	10.3	0.0	4.7	0.6	0.2	4.4	0.0	0.0	0.0	0.1	0.0	10.4
Percentage of Total NO_x	67.9%	5.1%	31.8%	0.1%	14.6%	1.9%	0.6%	13.5%	0.1%	0.1%	0.0%	0.2%	0.0%	32.1%
Percentage Contribution to Road NO_x	100.0%	7.4%	46.8%	0.1%	21.5%	2.9%	0.9%	19.9%	0.1%	0.1%	0.0%	0.3%	0.0%	-
Max Modelled Receptor (11)														
NO_x Concentration (µg/m^3)	88.7	6.0	40.4	0.1	17.1	2.8	0.9	21.0	0.1	0.1	0.0	0.2	0.0	11.3
Percentage of Total NO_x	88.7%	6.0%	40.4%	0.1%	17.1%	2.8%	0.9%	21.0%	0.1%	0.1%	0.0%	0.2%	0.0%	11.3%
Percentage Contribution to Road NO_x	100.0%	6.8%	45.5%	0.1%	19.2%	3.2%	1.0%	23.7%	0.1%	0.1%	0.0%	0.2%	0.0%	-

Table 3-5 - NO_2 Source Apportionment Results

Results	All Vehicles	Petrol Cars	Diesel Cars	Petrol LGV	Diesel LGV	Rigid HGV	Arctic HGV	Buses	Motorcycle	Full Hybrid Petrol Cars	Plug-in Hybrid Petrol Cars	Full Hybrid Diesel Cars	EV Cars	Background
Average Across All Modelled Receptors														
NO_2 Concentration (µg/m^3)	11.6	0.9	5.4	0.0	2.5	0.3	0.1	2.3	0.0	0.0	0.0	0.0	0.0	8.1
Percentage of Total NO_2	59.0%	4.4%	27.6%	0.0%	12.7%	1.7%	0.5%	11.7%	0.1%	0.1%	0.0%	0.1%	0.0%	41.0%
Percentage Contribution to Road NO_2	100.0%	7.5%	46.8%	0.1%	21.5%	2.8%	0.9%	19.9%	0.1%	0.1%	0.0%	0.3%	0.0%	-
Max Modelled Receptor (11)														
NO_2 Concentration (µg/m^3)	41.5	2.8	18.9	0.0	8.0	1.3	0.4	9.8	0.0	0.1	0.0	0.1	0.0	8.7
Percentage of Total NO_2	82.6%	5.6%	37.6%	0.1%	15.9%	2.6%	0.8%	19.6%	0.1%	0.1%	0.0%	0.2%	0.0%	17.4%
Percentage Contribution to Road NO_2	100.0%	6.8%	45.5%	0.1%	19.2%	3.2%	1.0%	23.7%	0.1%	0.1%	0.0%	0.2%	0.0%	-

Figure 3-3 - Average NO_x Background Split

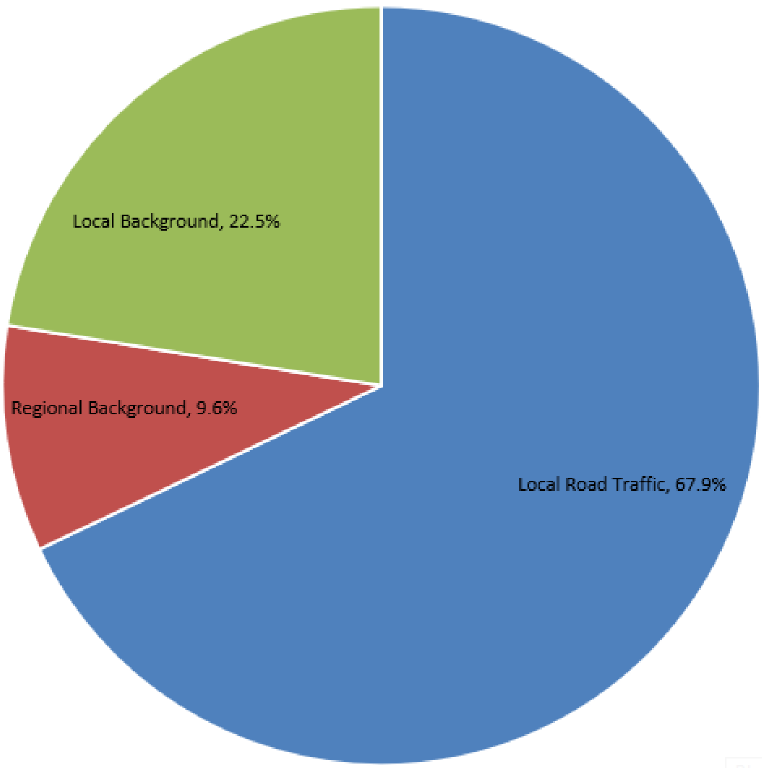


Figure 3-4 - NO_x Source Apportionment Average Across All Modelled Receptors

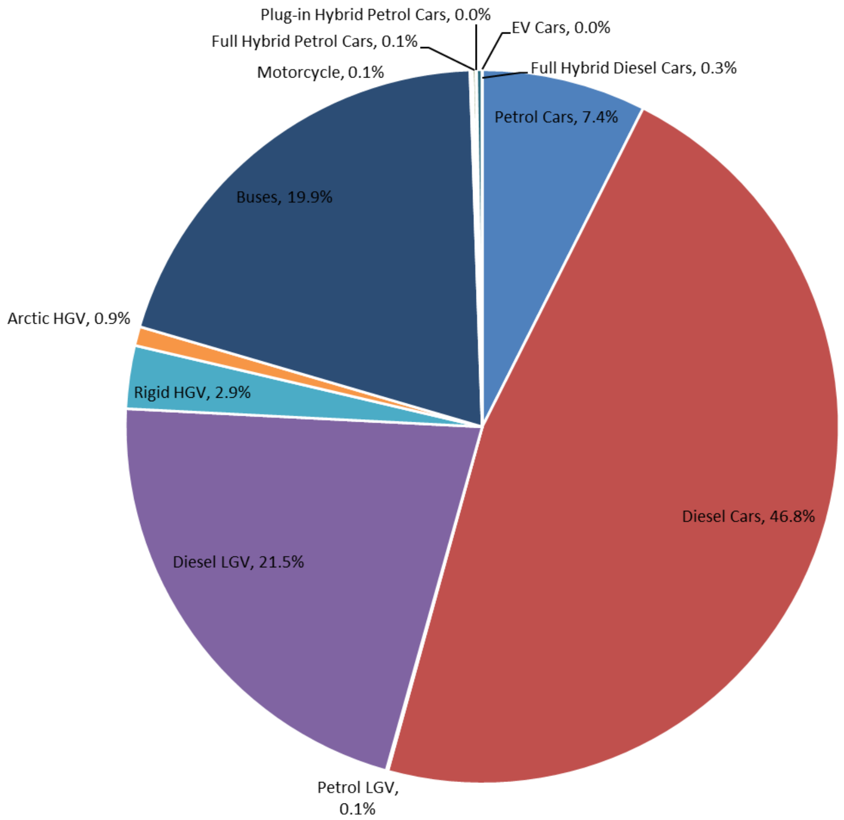
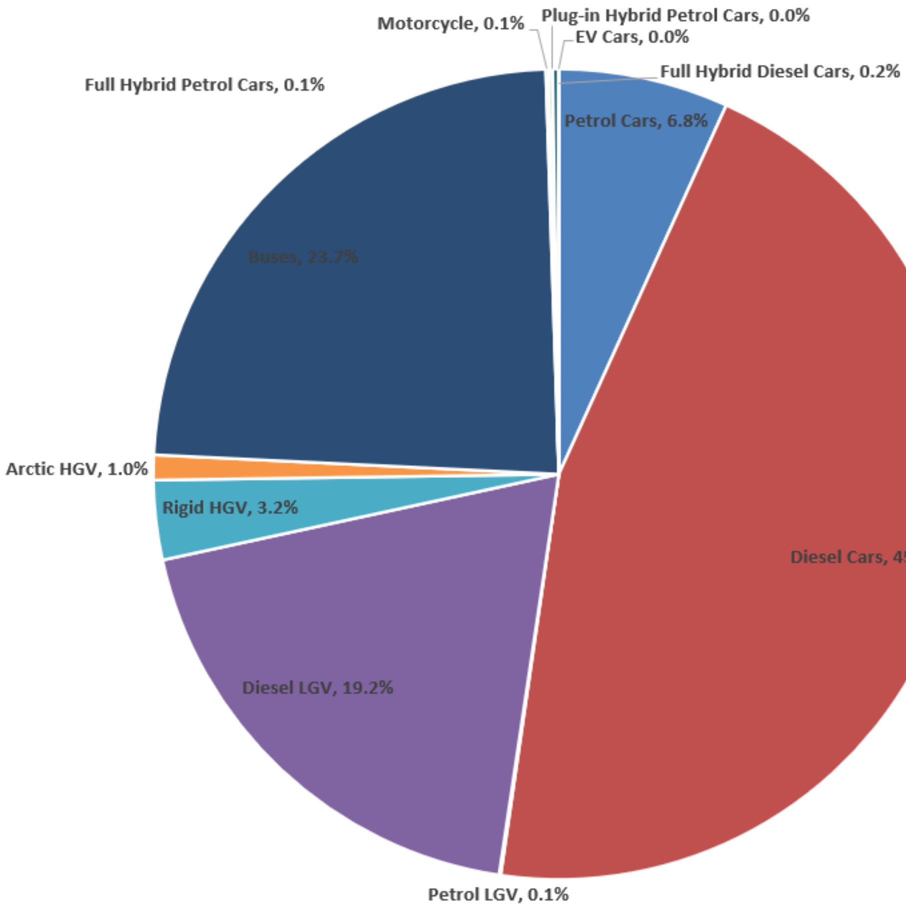


Figure 3-5 - NO_x Source Apportionment at Max Modelled Receptor (11)



4 Conclusions and Recommendations

Following the completion of the analysis of both monitoring data and modelled concentrations across the modelled area, in particular the current Shrewsbury AQMA, the following conclusions and recommendations are made.

4.1 Shrewsbury AQMA

The Shrewsbury AQMA is currently designated for exceedances of the NO_2 annual mean, with two of the diffusion tube monitoring locations exceeding the NO_2 Annual Mean AQO of 40 µg/m^3 within the AQMA in 2022. All other diffusion tube sites within the AQMA were below 10% of the AQO.

Detailed modelling has predicted areas of exceedance in line with the Shrewsbury AQMA boundary with the highest modelled exceedance 50.2 µg/m^3 at receptor 11, which is located at the Castle Foregate, Smithfield junction where there is not only a street canyon from high rise buildings on the easter site of the road, but there is expected to be slowing down of vehicles. Exceedances of the AQO are only observed at 3 of the 111 receptors all located on Castle Foregate. This is also where the only monitored exceedances of the AQO are observed.

4.2 Source Apportionment

An initial review of the road NO_x and background NO_x apportionment indicated that road NO_x accounted for 67.9% of emissions on average across all modelled receptors and background concentrations 32.1% of emissions. This details that road contribution is the primary cause of the exceedances of the AQO within the Shrewsbury AQMA, however the is some smaller influence from local background concentrations, likely to be the Shrewsbury Rail Station.

Source apportionment analysis of the Shrewsbury AQMA demonstrates that diesel cars account for the largest amounts of road NO_x (46.8%) with diesel LGVs and buses the next largest contributors (21.5% and 19.9% respectively). As such, measures contained within the AQAP should focus on reducing emissions from these vehicle classes.

Appendix A – Traffic Data

Table A.1 – Annual Average Daily Traffic (AADT) Data

Source ID	Source Name	Speed (kph)	Traffic Flow (AADT)	HGV %	Bus %	LGV%	Cars%	Motorbike%
1a	Castle Foregate North of Cross Street	25	10367	80.93	13.16	1.05	3.78	1.08
1asd1	Castle Foregate North of Cross Street	10	10367	80.93	13.16	1.05	3.78	1.08
2asd1	Castle Foregate South of Cross Street	32	13114	80.66	13.18	0.99	3.77	1.40
2a	Castle Foregate South of Cross Street	32	13114	80.66	13.18	0.99	3.77	1.40
2asd2	Castle Foregate South of Cross Street	20	13114	80.66	13.18	0.99	3.77	1.40
3a	Chester Street North of Cross Street	48	11702	80.93	13.16	1.05	3.78	1.08
3asd1	Chester Street to Cross Street	20	5851	80.93	13.16	1.05	3.78	1.08
4asd1	Cross Street	20	12537	80.93	13.16	1.05	3.78	1.08
5a	Chester Street south of cross street	32	13371	80.93	13.16	1.05	3.78	1.08
5asd1	A458 turning to Chester Street south of cross street	20	6686	80.93	13.16	1.05	3.78	1.08
5asd2	Chester Street to Chester Street south of cross street	20	6686	80.93	13.16	1.05	3.78	1.08
5asd3	Chester Street south of cross street to Cross Street	20	6686	80.93	13.16	1.05	3.78	1.08
6asd1	A458 slowdown junction	20	12519	81.51	13.06	1.01	3.30	1.13
7asd1	A458 Smithfield Road to Chester Street south of cross street	20	9625	83.50	12.73	0.93	1.87	0.96
7asd2	A458	20	19250	83.50	12.73	0.93	1.87	0.96
7a	A458	48	19250	83.50	12.73	0.93	1.87	0.96
7b	A458	48	19250	83.50	12.73	0.93	1.87	0.96
7bsd1	A458 to A5191	20	9625	83.50	12.73	0.93	1.87	0.96
7bsd2	A458 to A458 Bridge	20	9625	83.50	12.73	0.93	1.87	0.96
8asd1	A5191 between Main Road and A458	20	12627	79.56	14.49	0.99	3.80	1.16
9asd1	A458 north of River Severn	20	19250	83.50	12.73	0.93	1.87	0.96
9a	A458 north of River Severn	48	19250	83.50	12.73	0.93	1.87	0.96
9asd2	A458 north of River Severn	32	19250	83.50	12.73	0.93	1.87	0.96
9b	A458 north of River Severn	48	19250	83.50	12.73	0.93	1.87	0.96
9bsd1	A458 north of River Severn	20	19250	83.50	12.73	0.93	1.87	0.96
R1	A458 Roundabout North of River Severn	32	19250	83.50	12.73	0.93	1.87	0.96
R1a	A458 Roundabout North of River Severn	32	19250	83.50	12.73	0.93	1.87	0.96
10asd1	Copthorne Road	20	7469	81.19	15.28	1.39	1.31	0.83
10a	Copthorne Road	48	7469	81.19	15.28	1.39	1.31	0.83
11asd1	The Mount	20	7469	81.19	15.28	1.39	1.31	0.83
11a	The Mount	32	7469	81.19	15.28	1.39	1.31	0.83
12asd1	St Marys Street A5191 South of A458 junction	20	7940	80.66	13.18	0.99	3.77	1.40
12a	St Marys Street A5191 South of A458 junction	32	7940	80.66	13.18	0.99	3.77	1.40
13a	Abbey Foregate East of River Severn and English Bridge	48	15212	79.88	12.78	1.11	5.13	1.10
13asd1	Abbey Foregate East of River Severn and English Bridge	20	15212	79.88	12.78	1.11	5.13	1.10
14a	Old Potts Way	48	12536	87.14	10.19	1.03	1.16	0.48
14asd1	Old Potts Way	20	12536	87.14	10.19	1.03	1.16	0.48
15a	Coleham Head	48	5294	81.79	15.58	0.77	0.93	0.91
15asd1	Coleham Head	20	5294	81.79	15.58	0.77	0.93	0.91
R2	English Bridge Roundabout	48	15212	79.88	12.78	1.11	5.13	1.10
R2a	English Bridge Roundabout	48	15212	79.88	12.78	1.11	5.13	1.10
16asd1	A5191 West of River Severn East of Beeches Lane	20	15212	79.88	12.78	1.11	5.13	1.10
16a	A5191 West of River Severn East of Beeches Lane	48	15212	79.88	12.78	1.11	5.13	1.10
17asd1	Beeches Lane	20	3286	80.93	13.16	1.05	3.78	1.08
17a	Beeches Lane	32	3286	80.93	13.16	1.05	3.78	1.08
18a	A5191 West of Beeches Lane and East of St Marys Street	32	15212	79.88	12.78	1.11	5.13	1.10

19a	A5191 West of St Mary Street and East of Fish Lane	32	4818	78.46	14.26	0.90	5.51	0.88
20a	A5191 High Street West of Fish Lane	32	4818	78.46	14.26	0.90	5.51	0.88
21a	Barker Street	32	6005	78.18	15.82	0.93	3.81	1.25
21asd1	Barker Street	20	6005	78.18	15.82	0.93	3.81	1.25
21asd2	Barker Street	20	6005	78.18	15.82	0.93	3.81	1.25

Appendix B – Model Verification

Model Setup

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in the LAQM TG(22) guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the specific modelled area. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise the modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including uncertainties associated with:

- Background concentration estimates;
- Source activity data such as traffic flows and emissions factors;
- Monitoring data, including locations; and
- Overall model limitations.

Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all these aspects.

Model setup parameters and input data were checked prior to running the models in order to reduce these uncertainties. The following were checked to the extent possible to ensure accuracy:

- Traffic data;
- Distance between sources and monitoring as represented in the model;
- Speed estimated on roads; and
- Background monitoring and background estimates.

NO_2 Verification Calculations

The verification of the model output was performed in accordance with the guidance provided in Chapter 7 of LAQM.TG(22).

As mentioned within the report, a zone verification was undertaken producing two verifications for different areas within the model. Zone 1 – Castle Foregate – this area focused on 5 of the highest monitored diffusion tubes within the Shrewsbury AQMA all located along Castle Foregate. Zone 2 – Shrewsbury AQMA – this area focused on the remaining diffusion tubes across the Shrewsbury AQMA, all these monitoring locations were below the AQO for NO_2.

As mentioned above sensitivity testing was undertaken to determine the most suitable verification factor that should be used in the assessment, zonal or non zonal.

Using a non-zonal verification, with the same factor applied across the AQMA resulted in a higher RMSE of 5.77. This is greater than the two individual factors detailed below, demonstrating a higher uncertainty in the modelled output. In addition, at the highest monitoring sites, within Castle Foregate, DF458 and DF438, both sites were underpredicting within the model above 10%. This resulted in both sites modelling below 40µg/m^3 and as such not being considered representative of Castle Foregate. As such for these reasons the zonal verification detailed below was used in the model.

NO_2 Verification Calculations – Zone 1 – Castle Foregate

Relevant monitoring locations within the Council's jurisdiction (those adjacent to modelled roads) have been used in the verification. For the Zone 1 Verification at Castle Foregate, only the diffusion tubes sites along Castle Foregate were used, 5 in total. These were also the highest monitored NO_2 diffusion tubes across the Shrewsbury AQMA and are detailed in Table 3-1. Only one monitoring site in this area was excluded, DF459, this was due to the monitoring site being located within the Shrewsbury Station car park where no traffic data was available.

Table B.1 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2022, in order to determine if verification and adjustment was required.

Table B.1 – Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Background NO_2 ($\mu g/m^3$)	Monitored Total NO_2 ($\mu g/m^3$)	Unverified Modelled Total NO_2 ($\mu g/m^3$)	% Difference (Modelled vs. Monitored)
DF428A	7.6	32.4	13.2	-59.3
DF438	8.7	42.8	19.3	-55.0
DF458	7.6	42.6	16.7	-60.8
DF480	7.6	28.3	11.7	-58.6
DF482	7.6	31.7	13.2	-58.5

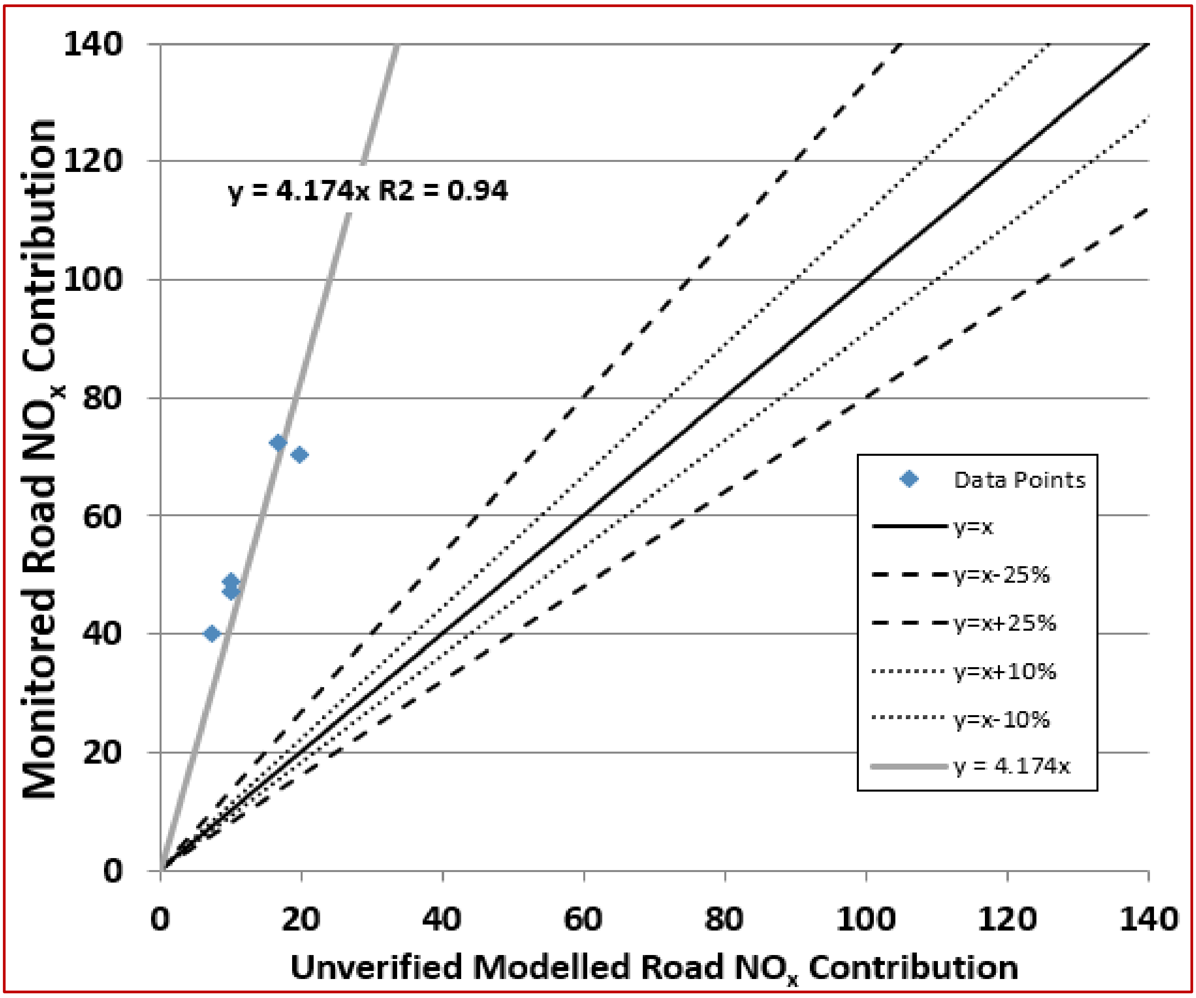
The data in Table B.1 shows that the model was under predicting at all monitoring locations. At this stage, all model inputs were checked to ensure their accuracy; this includes road and monitoring site geometry, traffic data, link emission rates, 2022 monitoring results, background concentrations and modelling features such as street canyons. Following a level of QA/QC completed upon the model, no further improvement of the modelled results could be obtained on this occasion. The difference between modelled and monitored concentrations was greater than -25% at the majority of locations therefore adjustment of the results was necessary. The relevant data was then gathered to allow the adjustment factor to be calculated. Table B.2 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x.

Table B.2 – Data Required for Adjustment Factor Calculation

Site ID	Monitored Total NO_2 ($\mu g/m^3$)	Monitored Total NO_x ($\mu g/m^3$)	Background NO_2 ($\mu g/m^3$)	Background NO_x ($\mu g/m^3$)	Monitored Road Contribution NO_2 (Total - Background) ($\mu g/m^3$)	Monitored Road Contribution NO_x (Total - Background) ($\mu g/m^3$)	Modelled Road Contribution NO_x (Excludes Background) ($\mu g/m^3$)
DF428A	32.4	58.6	7.6	9.7	24.8	48.9	10.2
DF438	42.8	81.8	8.7	11.3	34.1	70.5	19.7
DF458	42.6	82.1	7.6	9.7	35.0	72.4	16.8
DF480	28.3	49.8	7.6	9.7	20.7	40.1	7.4
DF482	31.7	57.1	7.6	9.7	24.1	47.4	10.1

Figure B.1 provides a comparison of the modelled road contribution NO_x versus monitored road contribution NO_x, and the equation of the trend line based on linear regression through zero. The total monitored NO_x contribution has been derived by back-calculating NO_x from the NO_x/NO_2 empirical relationship using the spreadsheet tool available from Defra's website. The equation of the trend lines presented in Figure B.1 gives an adjustment factor for the modelled results of 4.174.

Figure B.1 – Unverified Modelled Road NO_x Contribution



Model adjustment needs to be undertaken for NO_x rather than NO_2. For the monitoring results used in the calculation of the model adjustment, NO_x was derived from NO_2, using the NO_x to NO_2 calculator (V8.1) spreadsheet tool available from the LAQM website.

The results of the final verification factor are presented in Table B.3. All diffusion tube locations are within the ±25% acceptance level. Alongside this, the RMSE for this verification is 3.4. The verification factor used for the receptors in this AQA is 4.174.

Table B.3 – Final Verification Calculation

Site ID	Ratio of Monitored Road Contribution NO_x / Modelled Road Contribution NO_x	Adjustment Factor for Modelled Road Contribution NO_x	Adjusted Modelled Road Contribution NO_x (µg/m³)	Adjusted Modelled Total NO_x (Including Background NO_x) (µg/m³)	Modelled Total NO_2 (Based upon Empirical NO_x / NO_2 Relationship) (µg/m³)	Monitored Total NO_2 (µg/m³)	% Difference (Adjusted Modelled NO_2 vs. Monitored NO_2)
DF428A	4.81	4.174	42.4	52.1	29.4	32.4	-9.3
DF438	3.59		82.0	93.3	47.5	42.8	10.9
DF458	4.32		70.0	79.7	41.6	42.6	-2.3
DF480	5.39		31.1	40.8	24.0	28.3	-15.4
DF482	4.69		42.1	51.9	29.3	31.7	-7.7

Figure B.2 – Verified Modelled Road NO_x Contribution

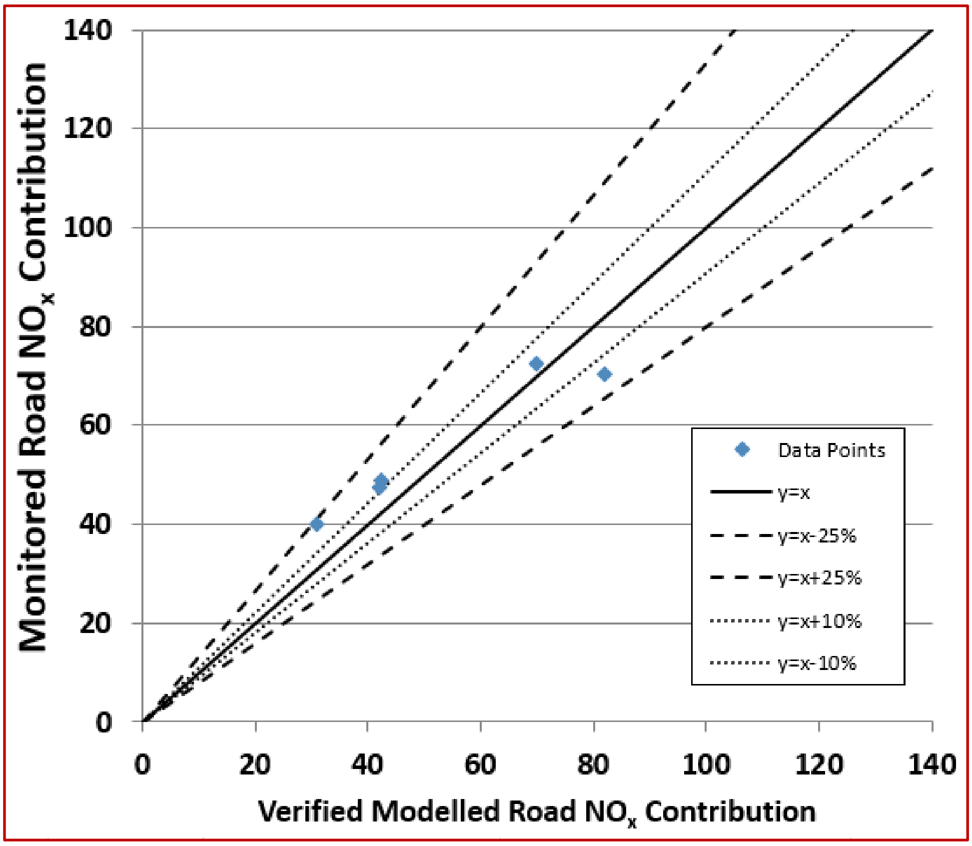
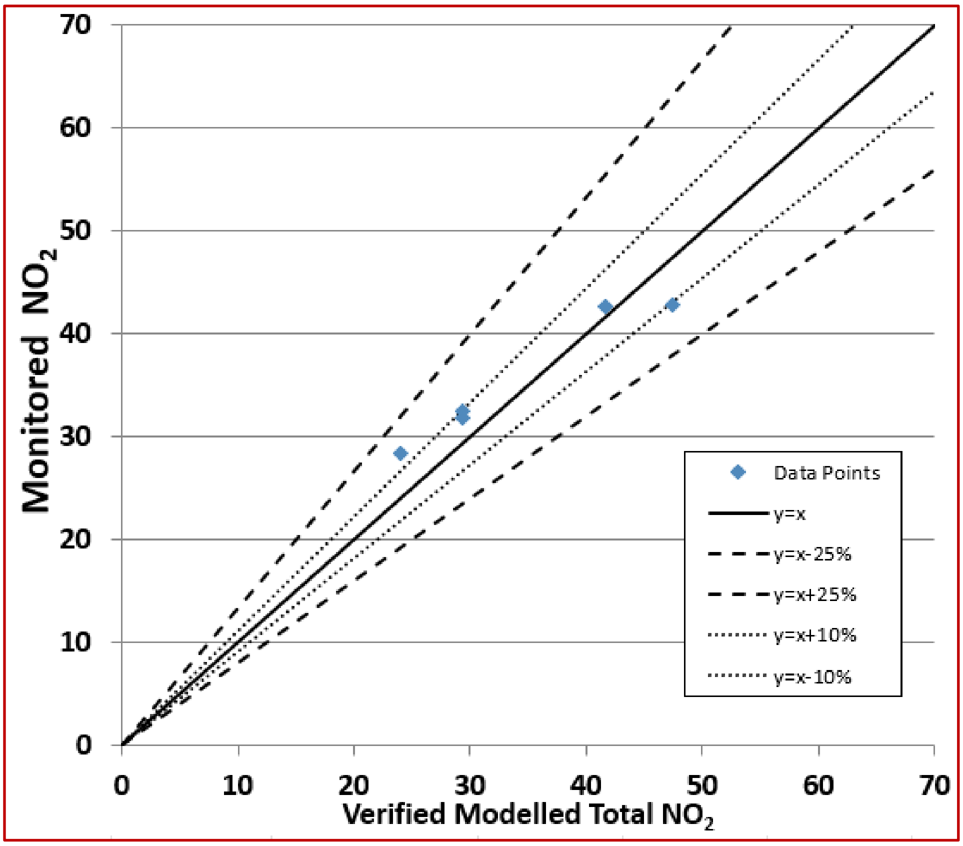


Figure B.3 – Verified Modelled Total NO_2



NO_2 Verification Calculations – Zone 2 – Wider Shrewsbury AQMA

Relevant monitoring locations within the Council's jurisdiction (those adjacent to modelled roads) have been used in the verification. For the Zone 2 Verification across the wider Shrewsbury AQMA, 14 sites were used in total and are detailed in Table 3-1. Only one monitoring site in this verification was excluded (DF413). Site DF413 was located on Raven Meadows where there was only coach and bus access only, no traffic data was available for this road link.

Table B.2 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2022, in order to determine if verification and adjustment was required.

Table B.4 – Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Background NO_2 (µg/m^3)	Monitored Total NO_2 (µg/m^3)	Unverified Modelled Total NO_2 (µg/m^3)	% Difference (Modelled vs. Monitored)
DF403	7.1	25.0	12.0	-52.2
DF407	8.7	19.8	12.4	-37.5
DF420	8.7	27.3	12.7	-53.6
DF429	8.7	24.1	12.8	-47.0
DF437	8.7	28.7	13.4	-53.3
DF461	8.7	21.3	11.8	-44.6
DF476	8.7	25.0	14.1	-43.6
DF485	7.1	22.9	11.8	-48.5
DF487	8.7	17.9	11.7	-34.7
DF501	7.6	28.5	12.6	-55.9
DF502	8.7	22.0	13.3	-39.6
DF477	7.6	24.8	11.1	-55.1
DF503	7.1	23.6	11.0	-53.5
DF504	7.1	23.0	12.0	-48.0

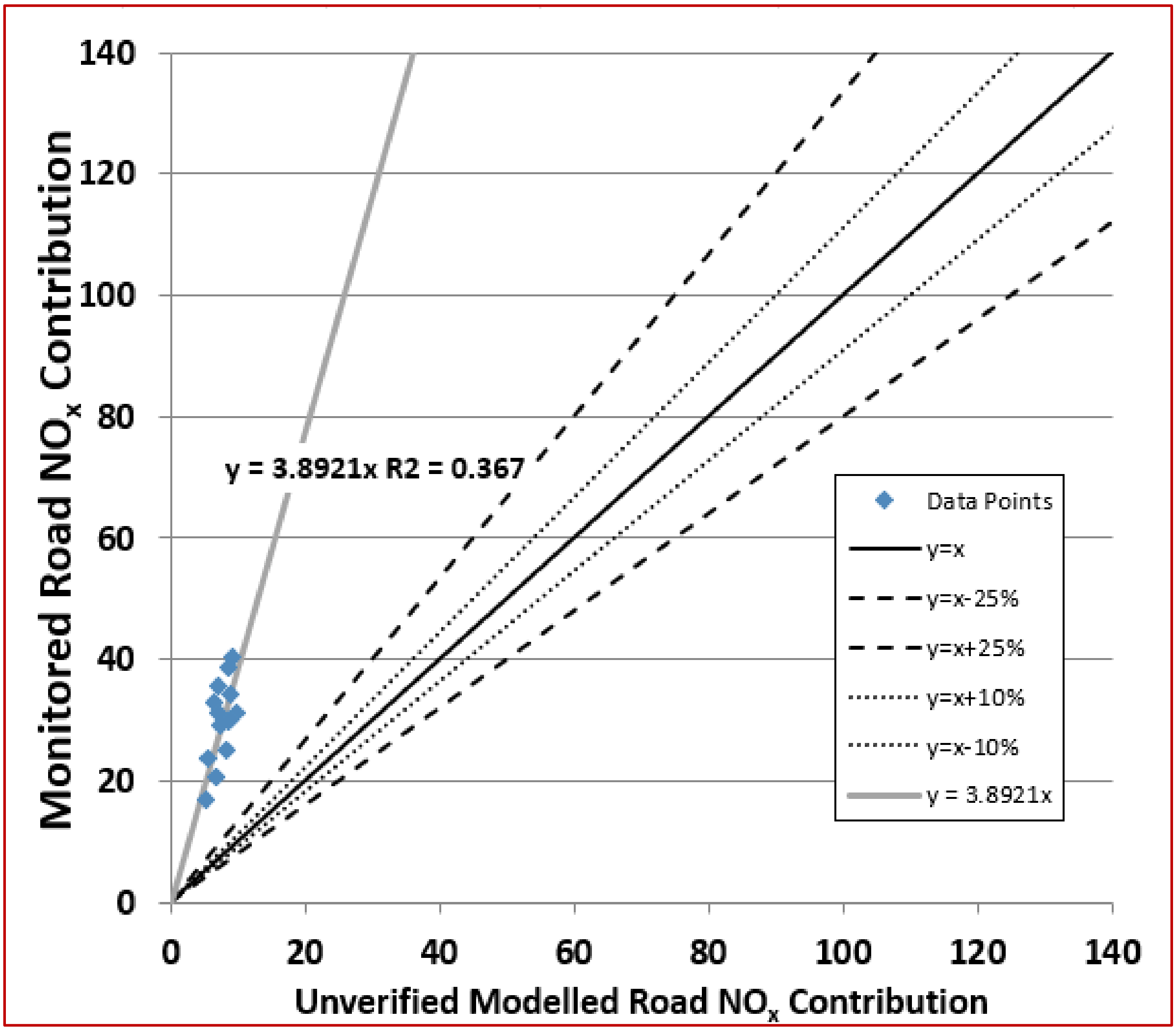
The data in Table B.4 shows that the model was under predicting at all monitoring locations. At this stage, all model inputs were checked to ensure their accuracy; this includes road and monitoring site geometry, traffic data, link emission rates, 2022 monitoring results, background concentrations and modelling features such as street canyons. Following a level of QA/QC completed upon the model, no further improvement of the modelled results could be obtained on this occasion. The difference between modelled and monitored concentrations was greater than -25% at the majority of locations therefore adjustment of the results was necessary. The relevant data was then gathered to allow the adjustment factor to be calculated. Table B.5 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x.

Table B.5 – Data Required for Adjustment Factor Calculation

Site ID	Monitored Total NO_2 (µg/m^3)	Monitored Total NO_x (µg/m^3)	Background NO_2 (µg/m^3)	Background NO_x (µg/m^3)	Monitored Road Contribution NO_2 (Total - Background) (µg/m^3)	Monitored Road Contribution NO_x (Total - Background) (µg/m^3)	Modelled Road Contribution NO_x (Excludes Background) (µg/m^3)
DF403	25.0	43.2	7.1	9.1	17.9	34.1	8.8
DF407	19.8	31.9	8.7	11.3	11.1	20.7	6.6
DF420	27.3	47.1	8.7	11.3	18.6	35.8	7.2
DF429	24.1	40.5	8.7	11.3	15.4	29.2	7.4
DF437	28.7	50.0	8.7	11.3	20.0	38.7	8.5
DF461	21.3	34.9	8.7	11.3	12.6	23.6	5.6
DF476	25.0	42.3	8.7	11.3	16.3	31.0	9.8
DF485	22.9	38.9	7.1	9.1	15.8	29.9	8.5
DF487	17.9	28.3	8.7	11.3	9.2	17.0	5.4
DF501	28.5	50.2	7.6	9.7	20.9	40.5	9.0
DF502	22.0	36.3	8.7	11.3	13.3	25.0	8.3
DF477	24.8	42.5	7.6	9.7	17.2	32.8	6.4
DF503	23.6	40.3	7.1	9.1	16.5	31.3	7.0
DF504	23.0	39.1	7.1	9.1	15.9	30.1	8.8

Figure B.4 provides a comparison of the modelled road contribution NO_x versus monitored road contribution NO_x, and the equation of the trend line based on linear regression through zero. The total monitored NO_x contribution has been derived by back-calculating NO_x from the NO_x/NO_2 empirical relationship using the spreadsheet tool available from Defra's website. The equation of the trend lines presented in Figure B.4 gives an adjustment factor for the modelled results of 3.892.

Figure B.4 – Unverified Modelled Road NO_x Contribution



Model adjustment needs to be undertaken for NO_x rather than NO_2. For the monitoring results used in the calculation of the model adjustment, NO_x was derived from NO_2, using the NO_x to NO_2 calculator (V8.1) spreadsheet tool available from the LAQM website.

The results of the final verification factor are presented in Table B.6. All diffusion tube locations are within the ±25% acceptance level. Alongside this, the RMSE for this verification is 2.6, which according to TG(22) as the RMSE is below 4, indicates that this final verification is performing accurately. The verification factor used for the receptors in this AQA is 3.892.

Table B.6 – Final Verification Calculation

Site ID	Ratio of Monitored Road Contribution NO_x / Modelled Road Contribution NO_x	Adjustment Factor for Modelled Road Contribution NO_x	Adjusted Modelled Road Contribution NO_x (µg/m³)	Adjusted Modelled Total NO_x (Including Background NO_x) (µg/m³)	Modelled Total NO_2 (Based upon Empirical NO_x / NO_2 Relationship) (µg/m³)	Monitored Total NO_2 (µg/m³)	% Difference (Adjusted Modelled NO_2 vs. Monitored NO_2)
DF403	3.90	3.892	34.1	43.2	25.0	25.0	-0.1
DF407	3.12		25.8	37.1	22.4	19.8	13.1
DF420	5.00		27.9	39.1	23.4	27.3	-14.2
DF429	3.97		28.6	39.9	23.8	24.1	-1.2
DF437	4.56		33.0	44.3	26.0	28.7	-9.5
DF461	4.24		21.7	33.0	20.3	21.3	-4.6
DF476	3.16		38.2	49.5	28.5	25.0	13.9
DF485	3.53		33.0	42.0	24.4	22.9	6.6
DF487	3.17		20.9	32.2	19.9	17.9	11.2
DF501	4.49		35.1	44.9	25.9	28.5	-9.0
DF502	3.01		32.3	43.6	25.6	22.0	16.5
DF477	5.15		24.8	34.5	20.8	24.8	-16.0
DF503	4.49		27.1	36.2	21.5	23.6	-8.8
DF504	3.42		34.2	43.3	25.0	23.0	8.9

Figure B.5 – Verified Modelled Road NO_x Contribution

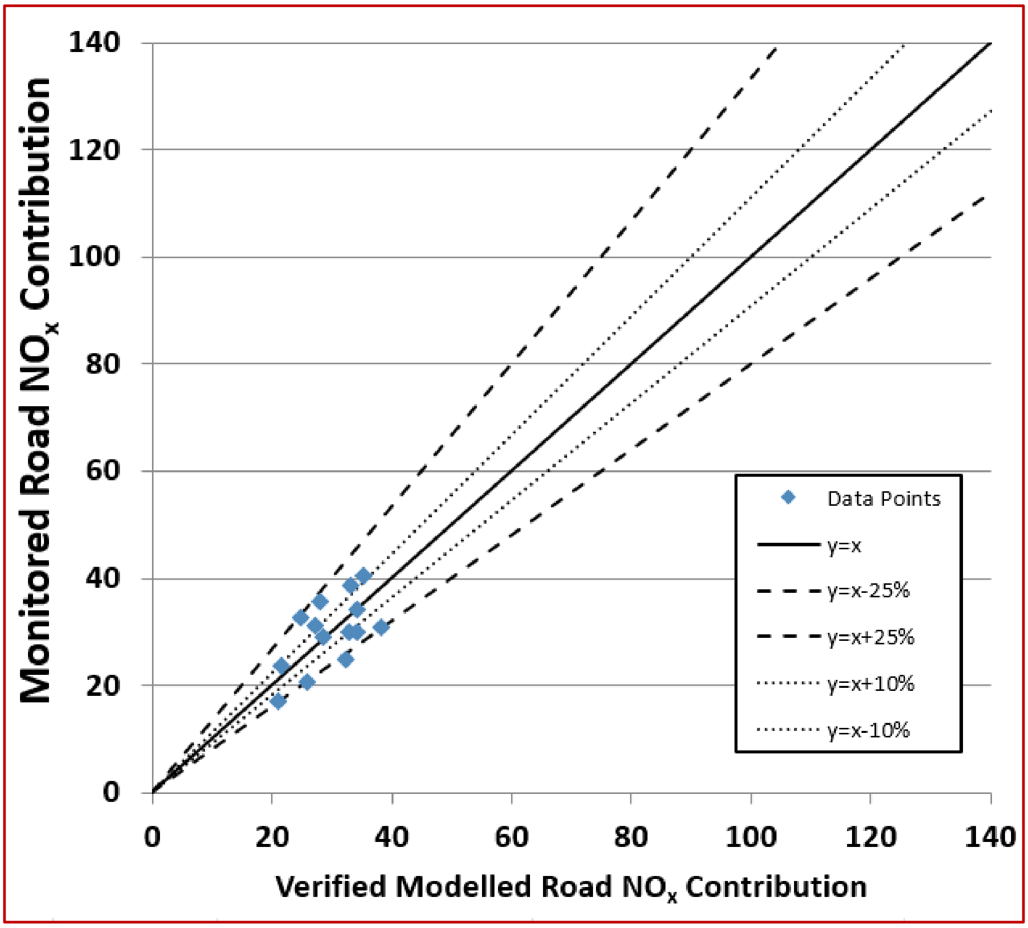
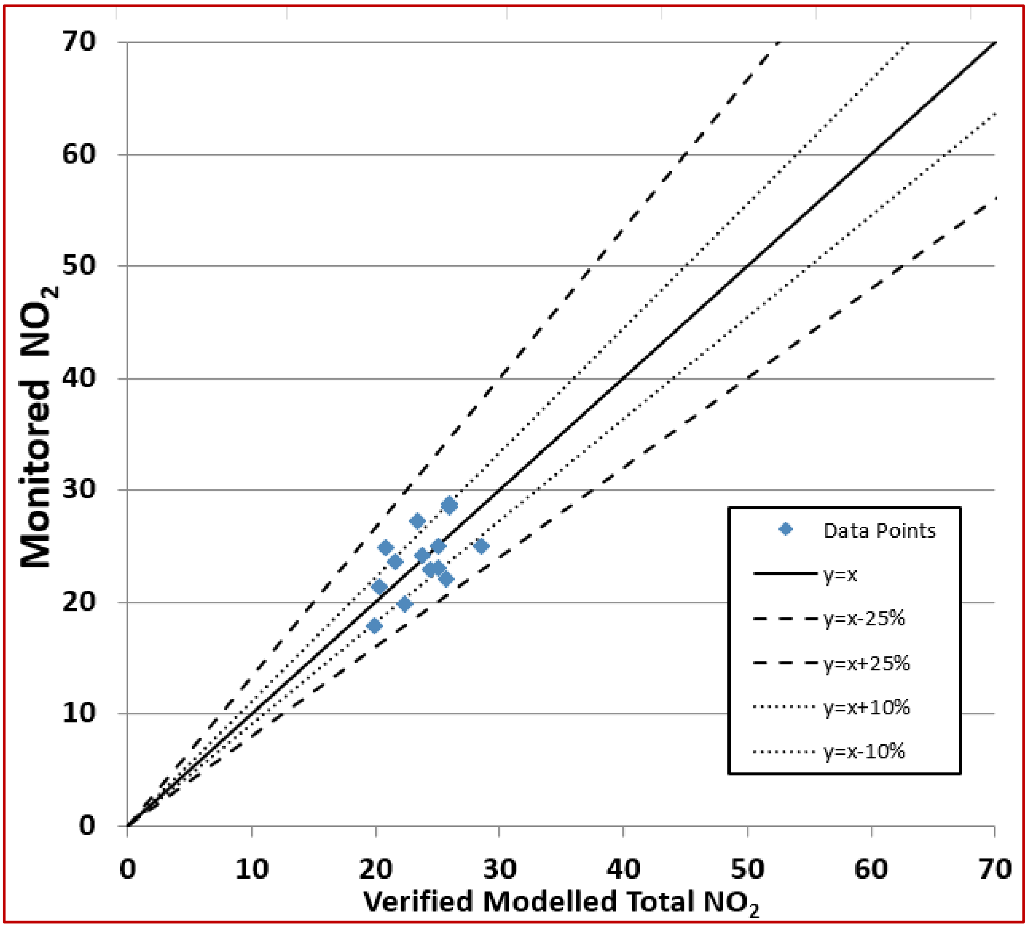


Figure B.6 – Verified Modelled Total NO_2



11 WSP LUF2 Gyratory Air Quality Technical Note

TECHNICAL NOTE 1

DATE:	07 June 2024	**CONFIDENTIALITY:**	
SUBJECT:	Air Quality Technical Methodology		
PROJECT:	LUF2	**AUTHOR:**	Harry Price
CHECKED:	Sioni Hole	**APPROVED:**	Bethan Tuckett-Jones

PROJECT OVERVIEW

WSP has been commissioned by Shropshire Council (SC) to assess measures to improve air quality around the Shrewsbury town centre gyratory. Specifically, this note covers air quality impacts/improvements arising from changes to the town centre gyratory made using the UK Government Levelling Up Funding (LUF2), and the North West Relief Road (NWRR).

Figure 1: LUF2 Scheme Overview

This project aims to deliver improvements on the overall air quality of the Station Gyratory, by enhancing cycling and walking facilities. The scheme will introduce a segregated cycle lane that will eventually connect Shrewsbury Town Centre to the Flaxmill Malting, enhanced public spaces in the Station Gyratory through the use of vegetation and street furniture.

One of the aims of the funding was to improve air quality within Shrewsbury. In particular, the focus of the Scheme was to reduce pollutant concentrations where there are existing exceedances of annual mean air quality standards. Air Quality dispersion modelling has been undertaken to quantify the impact of the Scheme on pollutant concentrations affected by the Scheme.

Latterly, at the request of SC, this model has also been used to provide both a process contribution and predicted environmental concentration at specified receptors from the LUF2 Scheme, the NWRR scheme, and both Schemes in combination. This technical note covers the detailed modelling parameters and methodology used within the production of the dispersion modelling and presents the results of the model at selected receptors for each scenario.

AIR QUALITY WITHIN SHREWSBURY

In 2003, SC declared an Air Quality Management Area (AQMA) across the entirety of Shrewsbury town centre (later amended in 2006). Air quality has improved throughout the AQMA since 2003, although monitored concentrations indicate that the annual mean air quality standard for NO_2 continues to be exceeded along Castle Gates. This is likely due to a combination of traffic congestion levels and restricted airflow along Castle Gates. The latest published SC monitoring is shown in **Figure 2**, below.

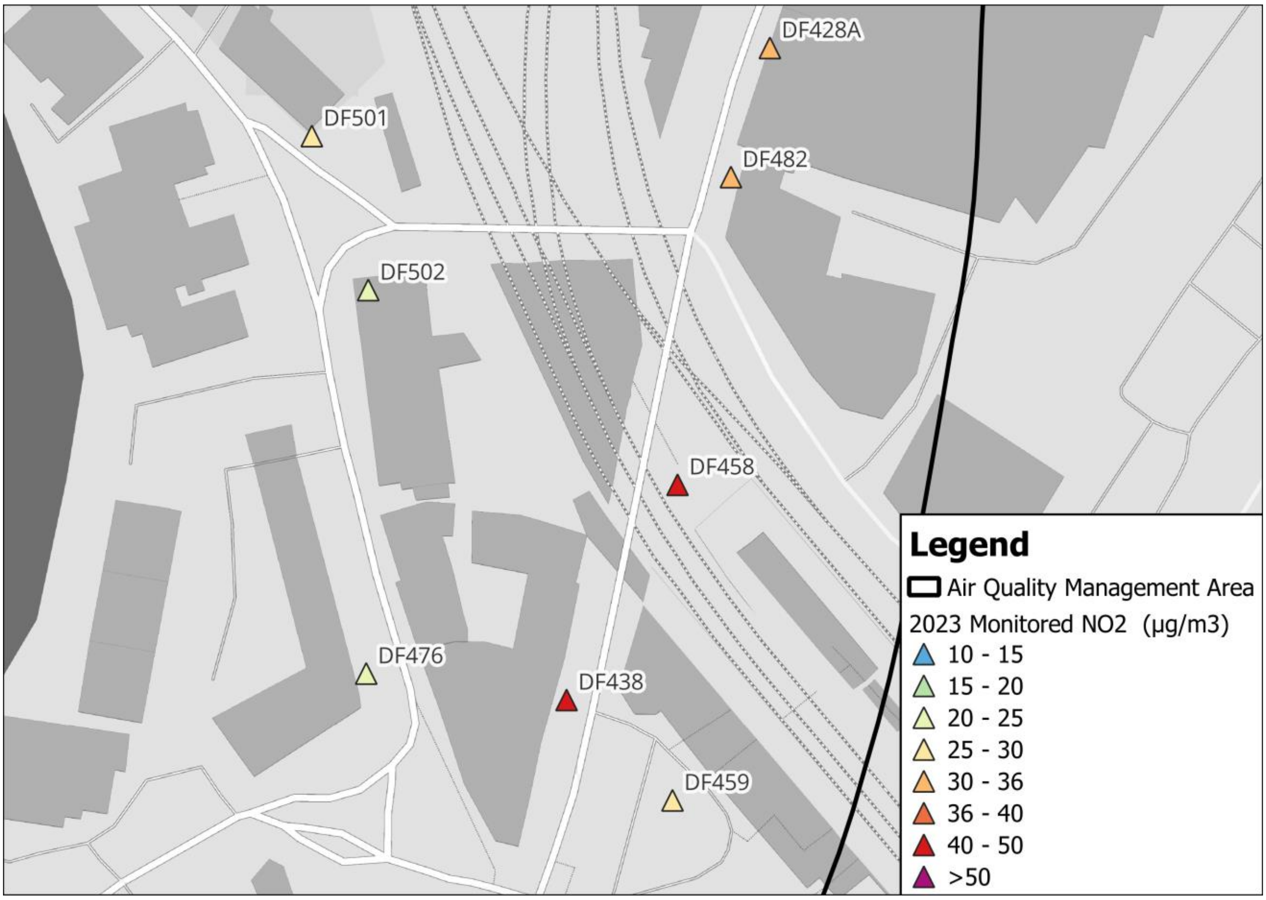


Figure 2: Locations of NO_2 monitoring points undertaken by SCC around the Shrewsbury gyratory.

The range (and standard deviation) of monitored concentrations at locations monitored by SC within Shrewsbury town centre are shown in **Figure 3**. The monitoring undertaken by SC at various locations within Shrewsbury town centre indicates a generally decreasing trend in NO_2 concentrations over time. The monitored concentrations at points on Castle Gates (SC monitoring ID DF438 and DF458) consistently show the highest recorded concentrations within Shrewsbury town centre, and also follow the decreasing trend over time. Concentrations monitored within 2020 are notably lower than expected due to the impact of lockdowns on traffic movements and have not been considered within the above analysis.

The latest data show that monitored concentrations at DF438 and DF458 (42.0 µg/m^3 and 40.1 µg/m^3) exceed the 40 µg/m^3 standard[1] in 2023, irrespective of the LUF2 development or the NWRR.

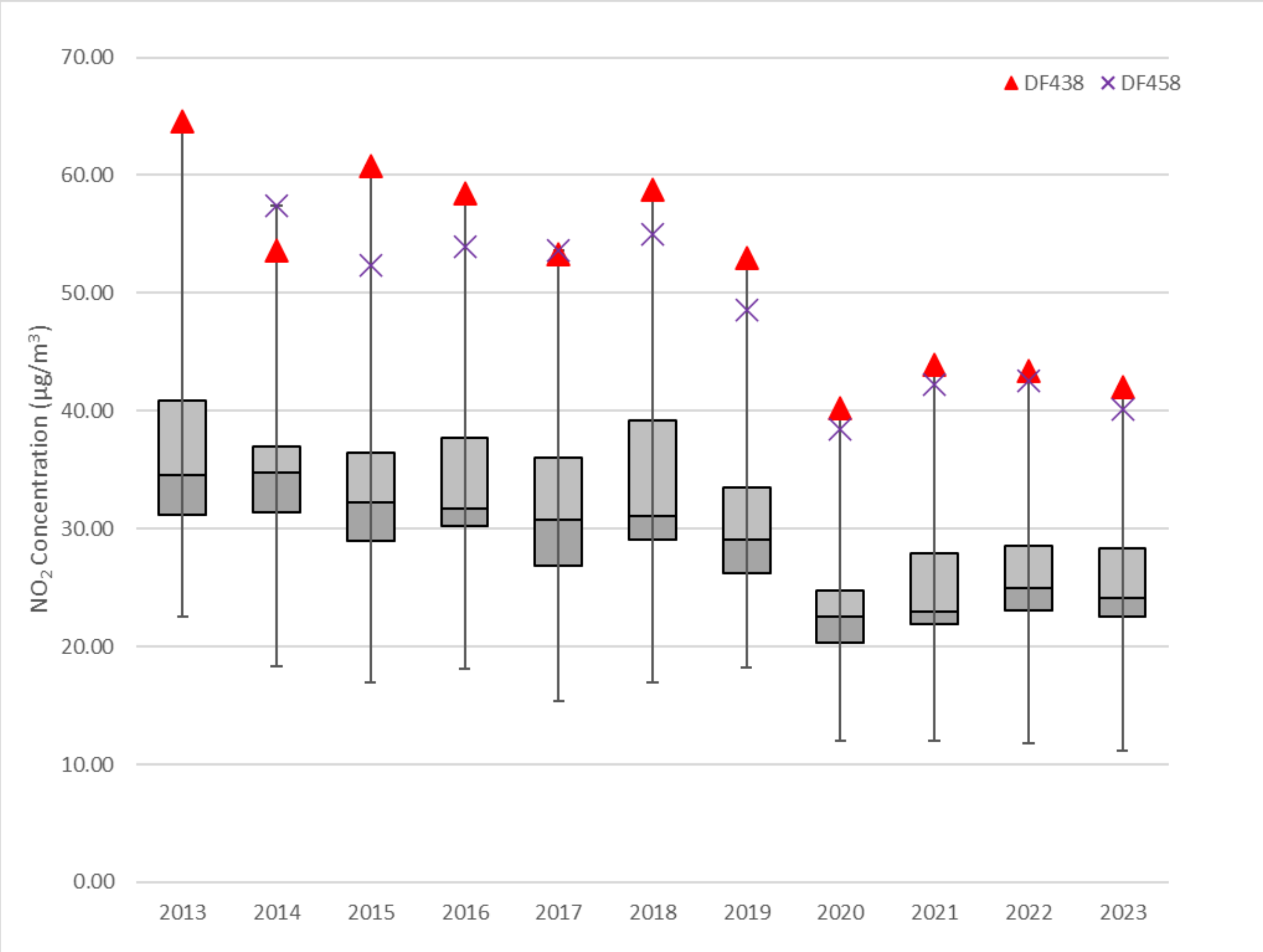


Figure 3: Box and Whisker plot showing monitored NO_2 trends in Shrewsbury town centre. The whiskers represent the highest and lowest monitored concentrations, and the box represents the median value and upper and lower quartiles.

[1] Concentrations were monitored at the location of the diffusion tube, not necessarily indicative of human exposure.

METHODOLOGY

For the prediction of potential impacts due to emissions arising from road traffic, the dispersion model ADMS Roads (version 5.0.0.1) was used. This model uses detailed information regarding traffic flows on the local road network for each diurnal period of the day (AM peak period, Inter-peak period (IP), PM peak period, and Off-peak period (OP)), surface roughness, and local meteorological and topographical conditions to predict pollutant concentrations at specific receptor locations. The model considers the dispersion of NO_x (and subsequent conversion to NO_2) only.

Traffic data has been taken from the assessment undertaken for the Shrewsbury NWRR [***planning application reference 21/00924/EIA***] and re-run using parameters to represent the LUF2 scheme.

The air quality modelling undertaken for the NWRR ES was adapted and refined to reflect the detailed dispersion modelling required for the LUF2 scheme as shown in **Figure 4**. The focus of the area of modelling includes Frankwell Roundabout, across Welsh Bridge and Smithfield Road, through the gyratory and up Coton Hill. Where elements of the dispersion modelling undertaken for the NWRR assessment have been updated to reflect the latest available information, further information on the amendments are provided below.

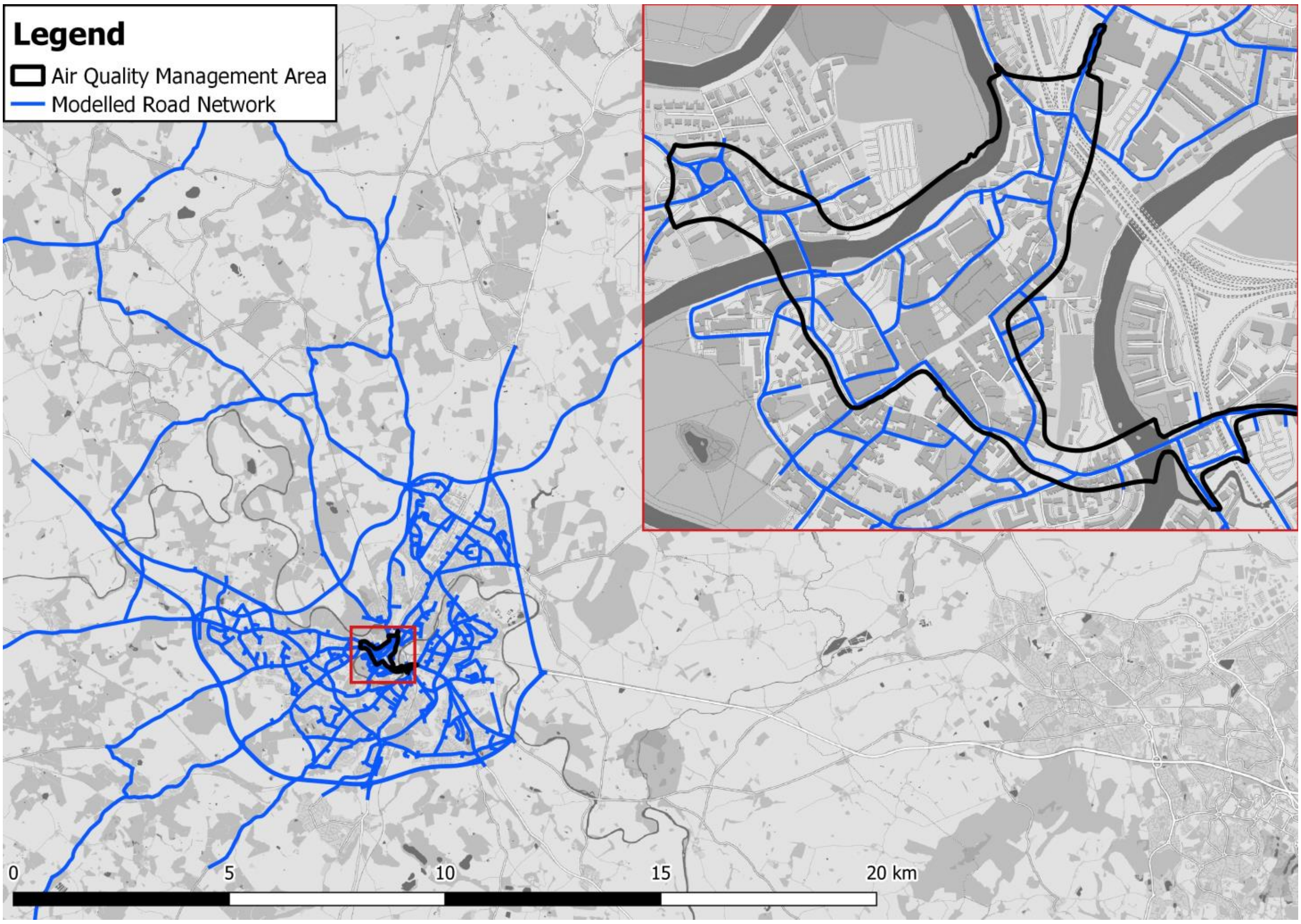


Figure 4: The modelled road network used in the air quality dispersion modelling.

SCENARIOS

Traffic flows were provided for the following modelled scenarios:

- Baseline 2023 – for model verification and baseline concentrations;
- "NWRR" 2023 – model with the Shrewsbury North West Relief Road in place;
- "LUF2" 2023 – model with the proposed scheme in place; and
- "In-Combination" 2023 – model with the proposed scheme and the Shrewsbury North West Relief Road in place.

The difference from these traffic scenarios to the originally modelled NWRR traffic data is the introduction of the LUF2 scheme, directly impacting the road infrastructure of the gyratory to improve air quality through traffic flow/congestion relief and increased uptake in active travel and public transport.

ADDITIONAL MODEL INPUTS

Due to the complex nature of dispersion parameters, particularly around the gyratory, the advanced canyon module and road tunnel module for ADMS Roads was used to replicate the dispersion conditions in the centre of Shrewsbury. The locations of advanced canyons and tunnels used in the modelling are shown in **Figure 5** below.

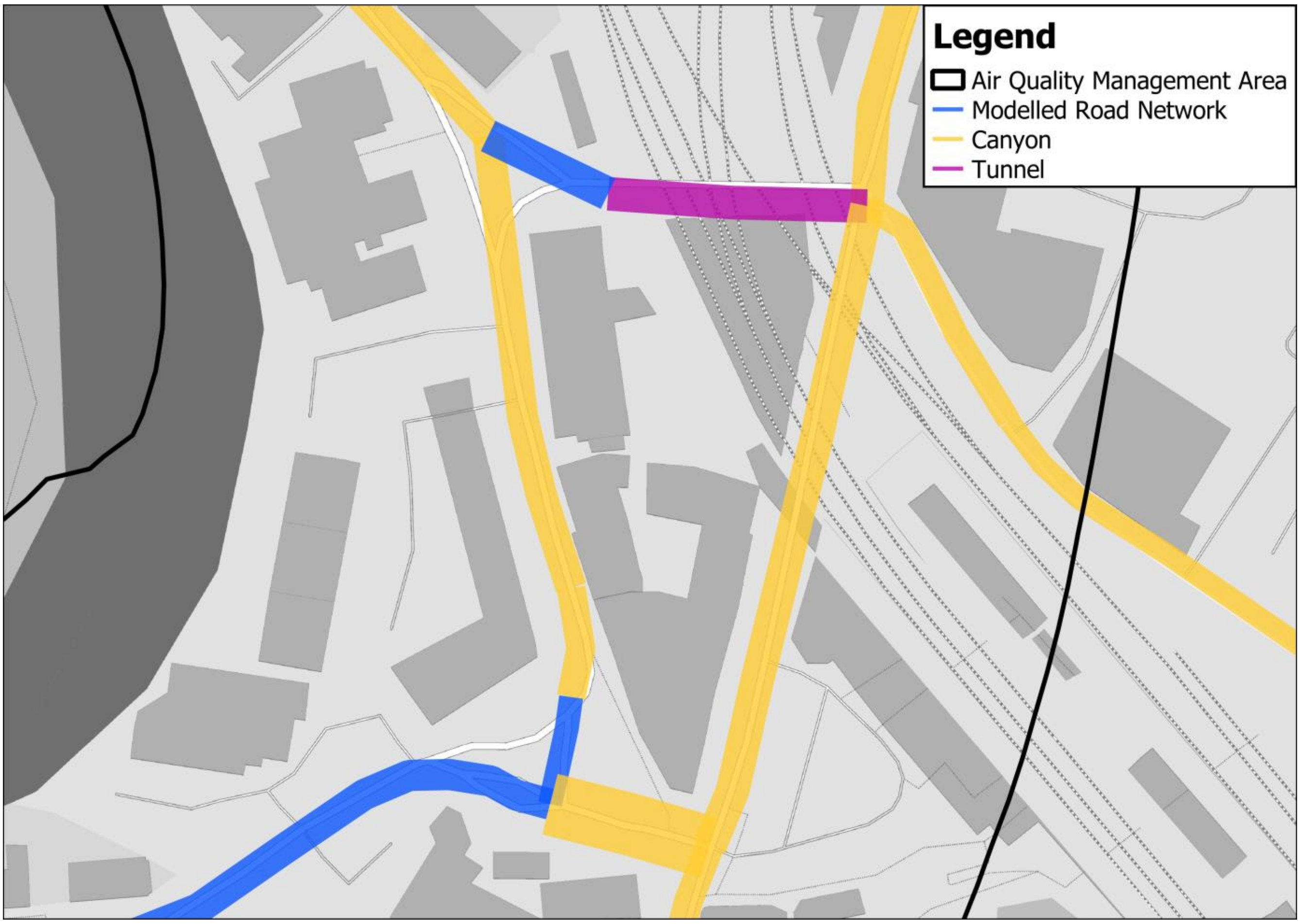


Figure 5: Modelled road canyons through the Shrewsbury gyratory using the Advanced Canyon module in ADMS Roads.

VEHICLE EMISSION FACTORS

Vehicle emission factors used in the assessment have been obtained using the Emission Factor Toolkit (EFT) version 12.0.1 available on the Defra website. The EFT allows for the calculation of emission factors for NOx and PM_{10} arising from road traffic for all years between 2018 and 2030. For the predictions of future year emissions, the toolkit considers the latest available COPERT factors to account for anticipated advances in vehicle technology and changes in vehicle fleet composition.

SELECTION OF BACKGROUND CONCENTRATIONS

Background pollutant concentrations used in the assessment have been taken from the national maps provided on the Defra website (issued in 2020 based on a 2018 reference year), where background concentrations of those pollutants included within this assessment have been mapped at a grid resolution of 1x1km for the whole of the UK. Estimated concentrations are available for all years between 2018 and 2030. The maps assume that background concentrations would improve (i.e. reduce) over time, in line with the predicted reduction in vehicle emissions and emissions from other sources.

It should be noted that for NO_x the background maps present both the 'total' estimated background concentrations and the individual contributions from a range of emission sources (for example, motorways, aircraft, domestic heating etc.). When detailed modelling of an individual sector is required as part of an air quality assessment, the respective contribution can be subtracted from the overall background estimate to avoid the potential for 'double-counting'. For this assessment, traffic data for all the motorways, trunk A roads and main A Roads within the relevant grid squares have been included in the local dispersion modelling (there are no motorways within the assessment area). Therefore, contributions from this sector have been removed from the background concentrations for these squares.

RECEPTOR SELECTION

Receptor grids with different resolutions were used to ensure extensive coverage of the Shrewsbury town centre and an appropriate level of detail where required. The grids have a 1m x 1m resolution around the gyratory, and a 10m x 10m resolution for the rest of the town centre, from Frankwell Roundabout to Coton Hill. In addition to these grids, additional receptors were placed using the ADMS source apportioned grids to better capture the decay from the roadside. This coverage allows for extensive investigation of the impacts arising within the town centre.

MODEL VERIFICATION

The ADMS Roads dispersion model has been widely validated for this type of assessment and is fit for purpose. Model validation has been undertaken at a UK-wide level by the software developer, however this would not have included local validation in the vicinity of the Proposed Scheme, nor any assessment of the accuracy of the emission rates used within it. The verification has two stages. The first is a comparison of modelled results (in the form of Road contribution to NOx concentrations) with selected monitored equivalents to determine a model verification factor. The second is a comparison of monitored and verified modelled total NO_2 concentrations, to determine the performance of the model at a local level. This combined process (called "verification") aims to address modelling uncertainty and systematic error by adjusting modelled outputs to gain greater confidence in the final results.

Model Verification was carried out following the methodology specified in Chapter 7, Section 4, of LAQM.TG(22). The receptors used in the comparison of monitored and unverified Road NOx are set out in

Table 1, below. The results of the model verification before (i.e. comparison of modelled and monitored Road NOx) and after the application of a verification factor are shown in **Figure 6** and **Figure 7**, below.

The verification process identified two distinct groups for model verification. The first group (shown in orange) covers two monitoring points on Chester Street (see DF476 and DF502 on **Figure 2**), where conservative assumptions (including the application of canyons within the modelling) have led to a lower verification factor than the other monitoring points included within the model. The second group (shown in blue) consists of all other monitoring points found within the detailed modelling which broadly follow a similar trend. Monitoring points DF438 and DF458 (along Castle Gates) sit within a modelled canyon, indicating that dispersion parameters are exceptionally constrained due to a series of tall buildings and railway tracks, creating a significant canyon effect. With the canyon included, these points fit well within the graph showing typical dispersion conditions within Shrewsbury town centre, indicating that the model is a good representation of airflow on pollutant concentrations in this location.

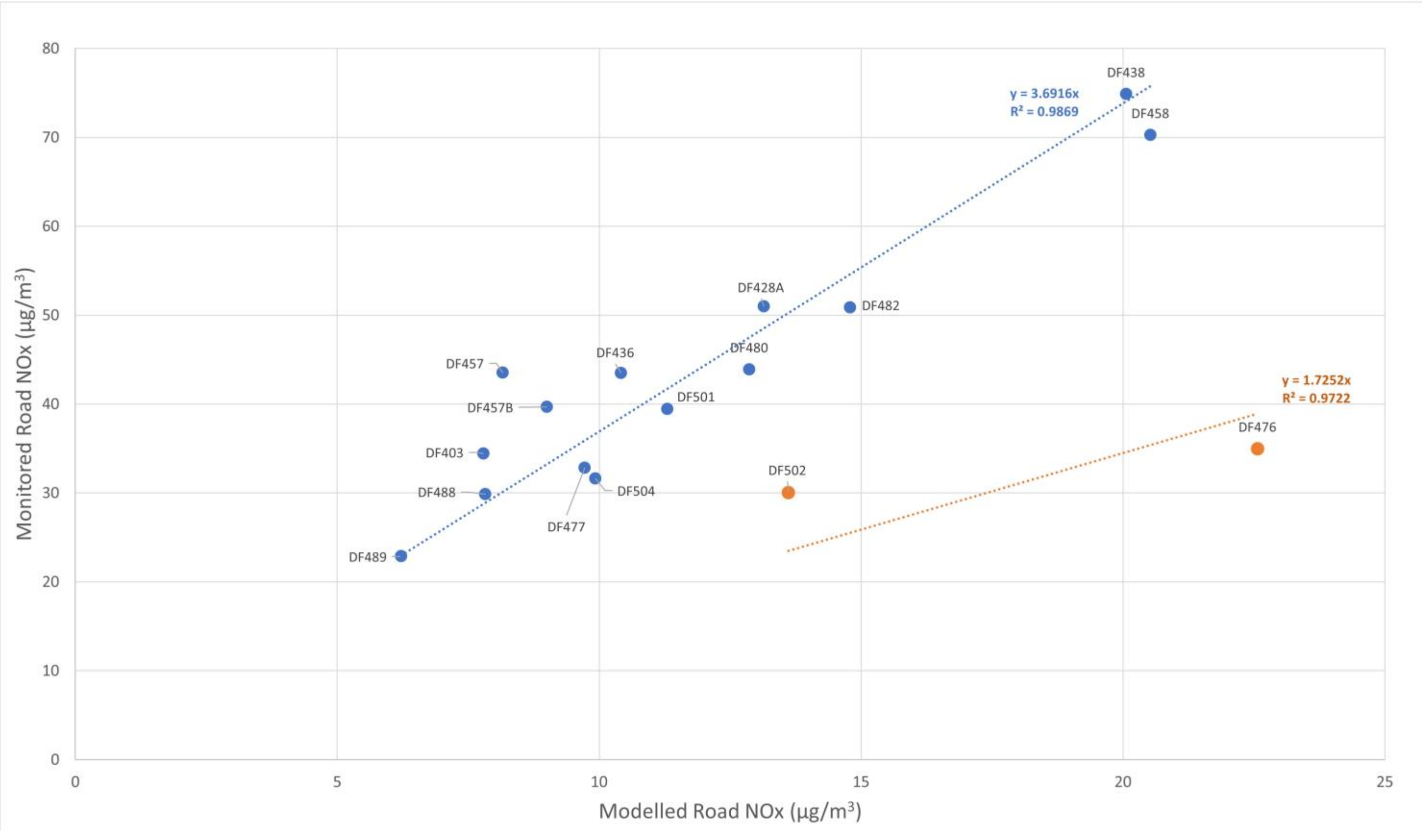


Figure 6: Air quality verification graph, plotting monitored Road NOx against unverified modelled Road NOx.

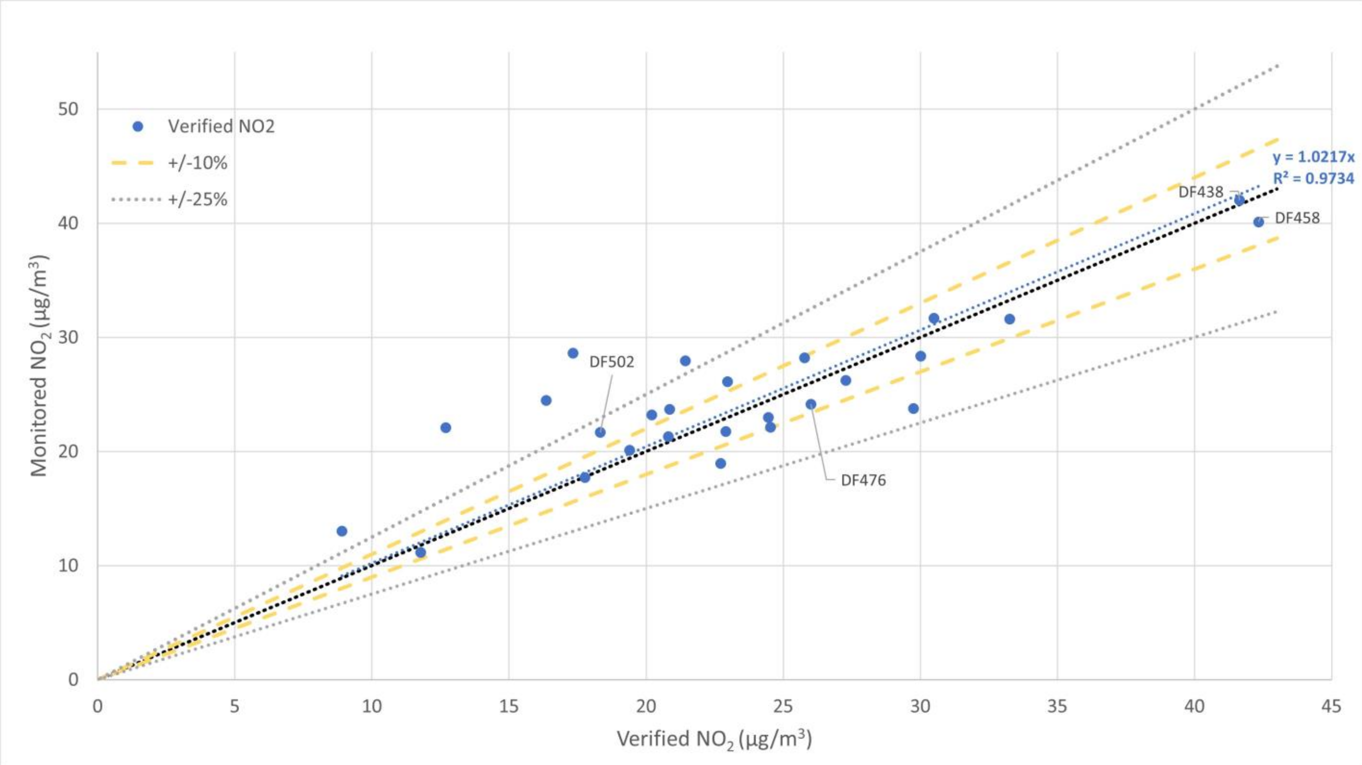


Figure 7: Air Quality verification graph, plotting total NO_2 against verified modelled total NO_2.

The verification factor for both groups indicate that the unverified model is largely under-predicting concentrations (1.73 and 3.69 for group 1 and "General Area" respectively), as shown by **Figure 6**. However, as can be seen in **Figure 7**, the verified model provides a good representation of monitored total NO_2 concentrations across Shrewsbury Town Centre, with the majority of monitored points lying within +/-10% of the monitored total NO_2 concentration, and all but 5 (4 of which were outside of the core model area) of the 26 total locations considered within +/-25%.

Table 1: Monitoring receptors used within model verification

Monitoring ID	2023 Monitored NO_2	Verification Group	Notes
DF403	23.7	General Area	
DF404	11.2	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF407	19.0	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF413	23.2	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF420	22.1	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph

DF428A	31.7	General Area	
DF429	23.8	None	Removed to ensure a conservative assessment
DF436	28.2	General Area	
DF438	42.0	General Area	
DF457	27.9	General Area	
DF457B	26.1	General Area	
DF458	40.1	General Area	
DF459	28.6	None	Located within train station car park. Included within Total NO_2 graph.
DF461	20.1	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF476	24.1	1	Chester Street Verification
DF477	23.0	General Area	
DF480	28.4	General Area	
DF482	31.6	General Area	
DF485	21.7	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF488	21.3	General Area	
DF489	17.7	General Area	
DF490	13.0	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF501	26.2	General Area	
DF502	21.7	1	Chester Street Verification
DF503	24.5	None	Monitoring Point outside of Core Model Area (Gyratory) – included within Total NO_2 graph
DF504	22.1	General Area	

PROCESSING OF RESULTS

The verification factor was applied to the model road-NOx outputs prior to conversion to annual mean NO_2 concentrations utilising the NO_x to NO_2 calculator (version 8.1, released August 2020) provided by Defra.

Table 2: Parameters used within the dispersion model

Model Inputs	Version/Detail	Comments
ADMS Roads	5.0.0.1	
Emissions Factor Toolkit	12.0.1	Released December 2023
NOx to NO2 Calculator	8.1	Released August 2020
Background Concentrations	Defra 2018 Reference Year – 2023 Background Map	Released December 2023
Model Verification Year	2023	Using latest monitoring data provided by Shropshire Council.
Meteorological Data	No change from ES Assessment	No updates to the meteorological parameters have been made from the original assessment. Additional meteorological years were tested however, data validity at the Shawbury site decreases over time, making 2017 the most viable year.
	Scenarios	
Baseline	2023 used as both baseline and opening year	The same traffic data was used in these scenarios as was provided for the original NWRR assessment.
NWRR		
LUF2		These additional scenarios were adapted from the original NWRR traffic model to generate scenarios with only the LUF2 scheme and both the LUF2 scheme and NWRR in operation
In-Combination		
	Receptor Grids	
1m x 1m	300m extent across the gyratory	Variable resolution used across the site – detailed resolution provided across the gyratory and Castle Gates in particular.
10m x 10m	Across entire modelled area	
	Additional Model Inputs	
Advanced Canyon Module	Canyons generated, with a particular focus on the gyratory	Run using Network mode enable – ensures adjoining canyons are modelled together.
Road Tunnel Module	Tunnel under bridge	Represents tunnel along Cross Street

RESULTS

A summary of the results of the air quality modelling is provided below. Due to the quantity of data modelled, results for every grid point are not explicitly provided (although this is available if required) but are visualised within the heat mapping shown in **Figures 9 - 12**. Instead, data will be provided with reference to the monitoring points located in Shrewsbury Town Centre, including the areas of concern – along Castle Gates (DF438, DF458) and Chester Street (DF476 and DF502). All results are presented in **Table 3**, below, as an NO_2 concentration from a 2023 opening year scenario.

Table 3: Air quality modelling results for Shrewsbury Town Centre monitoring locations

SC Monitoring ID	2023 Monitored NO_2 Concentration (µg/m^3)	2023 Modelled NO_2 Concentration (µg/m^3)			
		Baseline	LUF2 Scenario	NWRR Scenario	In-combination Scenario
DF403	23.7	20.9	20.0	18.5	18.2
DF404	11.2	11.8	11.8	11.7	11.7
DF407	19.0	22.7	22.7	22.6	22.6
DF413	23.2	20.2	20.1	19.3	19.2
DF420	22.1	12.7	12.6	12.5	12.4
DF428A	31.7	30.5	26.9	29.1	27.1
DF429	23.8	29.8	27.6	24.4	23.5
DF436	28.2	25.8	26.7	22.5	23.9
DF438	**42.0**	**41.6**	27.8	36.7	26.5
DF458	**40.1**	**42.3**	26.5	37.4	25.6
DF459	28.6	17.3	15.1	15.8	14.3
DF461	20.1	19.4	19.4	19.3	19.3
DF476	24.1	26.0	27.6	22.7	24.4
DF477	23.0	24.5	23.2	21.1	20.1
DF480	28.4	30.0	26.8	28.8	27.0
DF482	31.6	33.3	28.7	31.6	29.1
DF485	21.7	22.9	21.4	18.6	18.2

DF501	26.2	27.3	24.5	23.9	22.3
DF502	21.7	18.3	18.0	16.4	16.6
DF503	24.5	16.4	16.2	15.8	15.7
DF504	22.1	24.5	23.5	20.9	20.3

Additional model results for building facades along key routes in Shrewsbury Town Centre (shown in **Figure 8**) have been provided in **Table 4** below. These results are presented as a maximum modelled concentration along the aforementioned routes at a height of 1.5m above ground level. It should be noted that the maximum modelled concentration presented below may occur at a retail property façade and therefore is not representative of relevant long-term (annual mean) exposure.

Table 4: Maximum modelled concentrations at selected facades

Place Name	DM Scenario	LUF2 Scenario	NWRR Scenario	In-combination Scenario
Meadow Place	20.6	27.1	18.6	26.7
The Alb	31.2	35.5	26.2	30.1
Chester Street	26.4	26.7	23.2	23.9
Severn Terrace	39.7	34.1	32.6	28.9
Castle Gates (North of Smithfield Road)	**56.8**	35.5	**50.1**	34.2
Castle Gates (South of Smithfield Road)	36.8	39.5	35.0	38.6

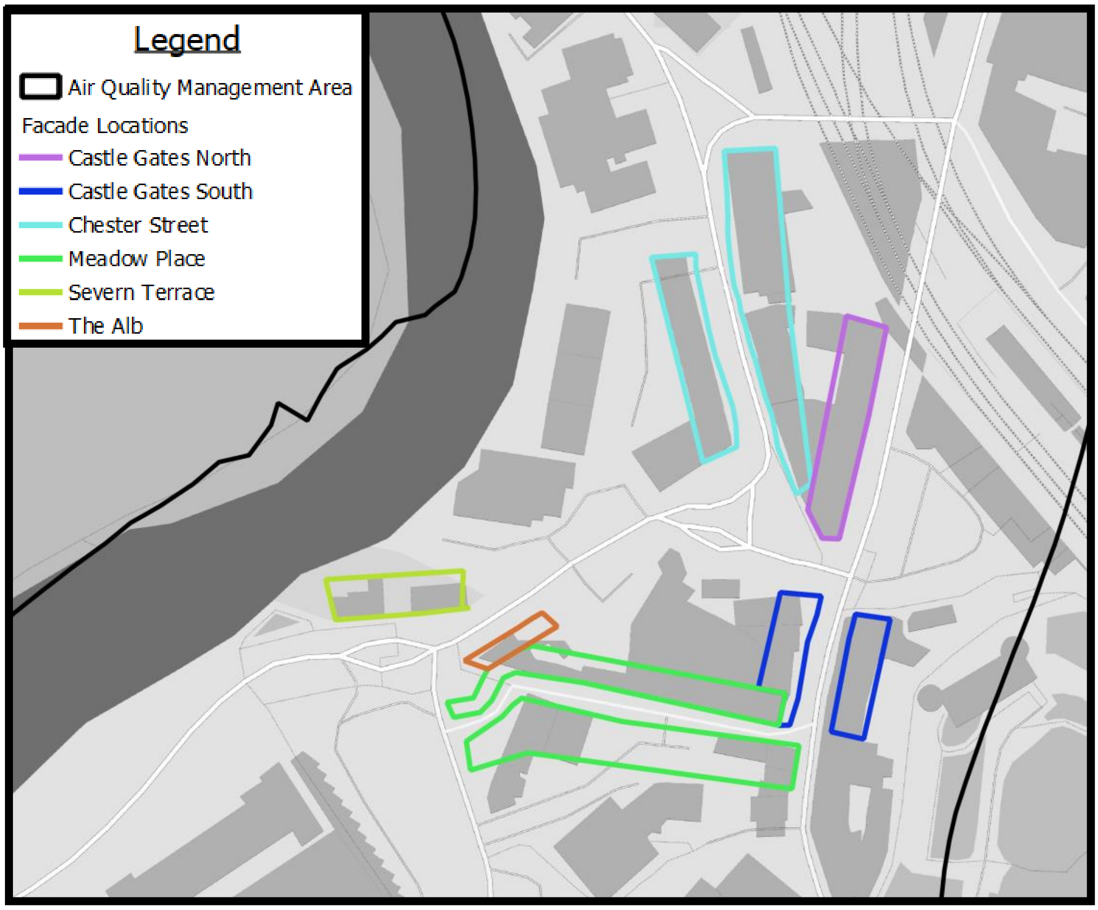


Figure 8: Showing the facades used to provide the maximum modelled concentrations along key routes through the Shrewsbury gyratory

Modelled outputs of all scenarios are shown in **Figures 9 - 11**. These figures present modelled NO_2 concentrations across a Shrewsbury Town Centre and have a focus on the 1mx1m grid over the gyratory. **Figure 12 and 13** present the impact of the LUF2 scheme and the In-Combination scenario.

Complex dispersion around the east of the Shrewsbury gyratory (along Castle Street) limit the dispersion of pollutants leading to elevated concentrations within the street canyons. **Figure 13** shows that the LUF2 scheme decreases NO_2 concentrations substantially along Castle Gates. The large increase shown at the junction of Chester Street and Smithfield Road is as a result of the change in traffic routing following the removal of the dedicated left hand turn link. This is highlighted by the simultaneous increase in concentrations to the south of Smithfield Road, and decrease to the north.

As can be seen in the table above, concentrations at DF476 are predicted to increase for the LUF2 Scheme alone, but decrease with the introduction of the NWRR. This is due to changes in traffic flow along Chester Street with the LUF2 Scheme increasing flows, but the NWRR causing a reduction in flows.

At the point at which Chester Street and Cross Street meet (i.e. DF502), there are competing effects arising from increased traffic along Chester Street offset by decreased flows through Cross Street (as well as dispersion from the tunnel entrance). At DF502, the impact of the reduction in traffic flows through Cross Street (and associated tunnelling) is greater than the increased flow along Chester Street.

It is noted that all modelled concentrations will fall or remain below the relevant standards with the LUF2 and Schemes.

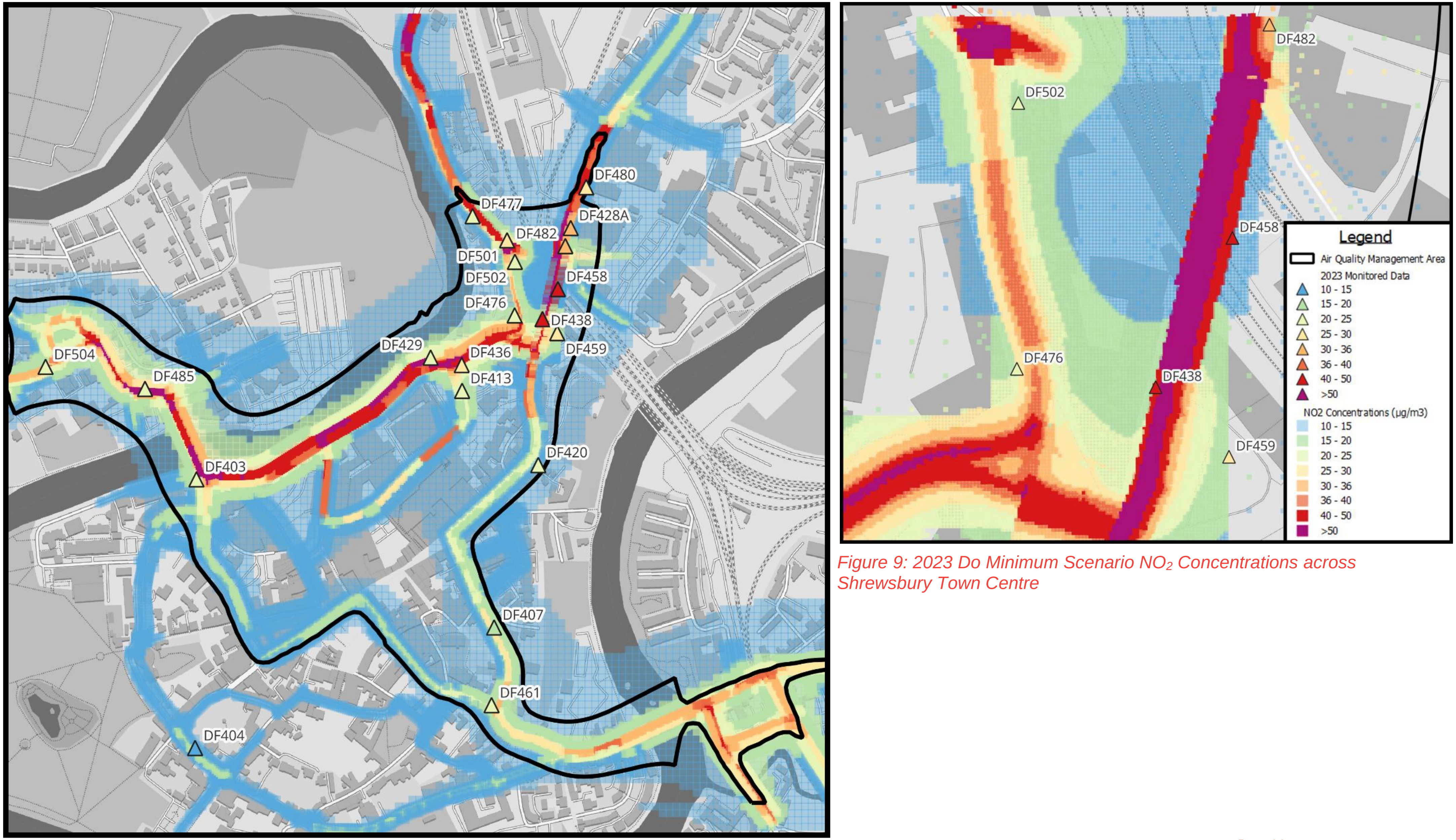


Figure 9: 2023 Do Minimum Scenario NO_2 Concentrations across Shrewsbury Town Centre

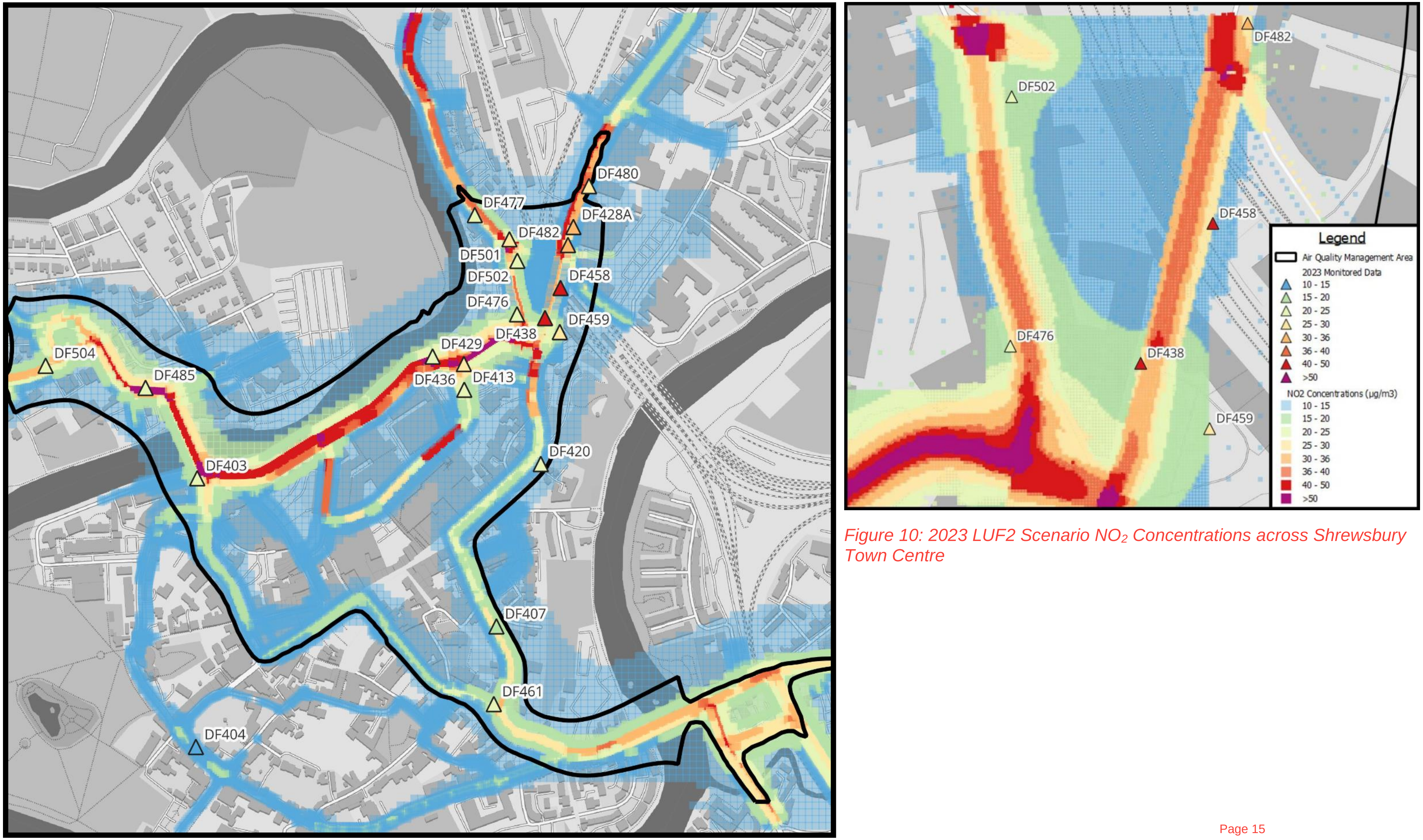


Figure 10: 2023 LUF2 Scenario NO_2 Concentrations across Shrewsbury Town Centre

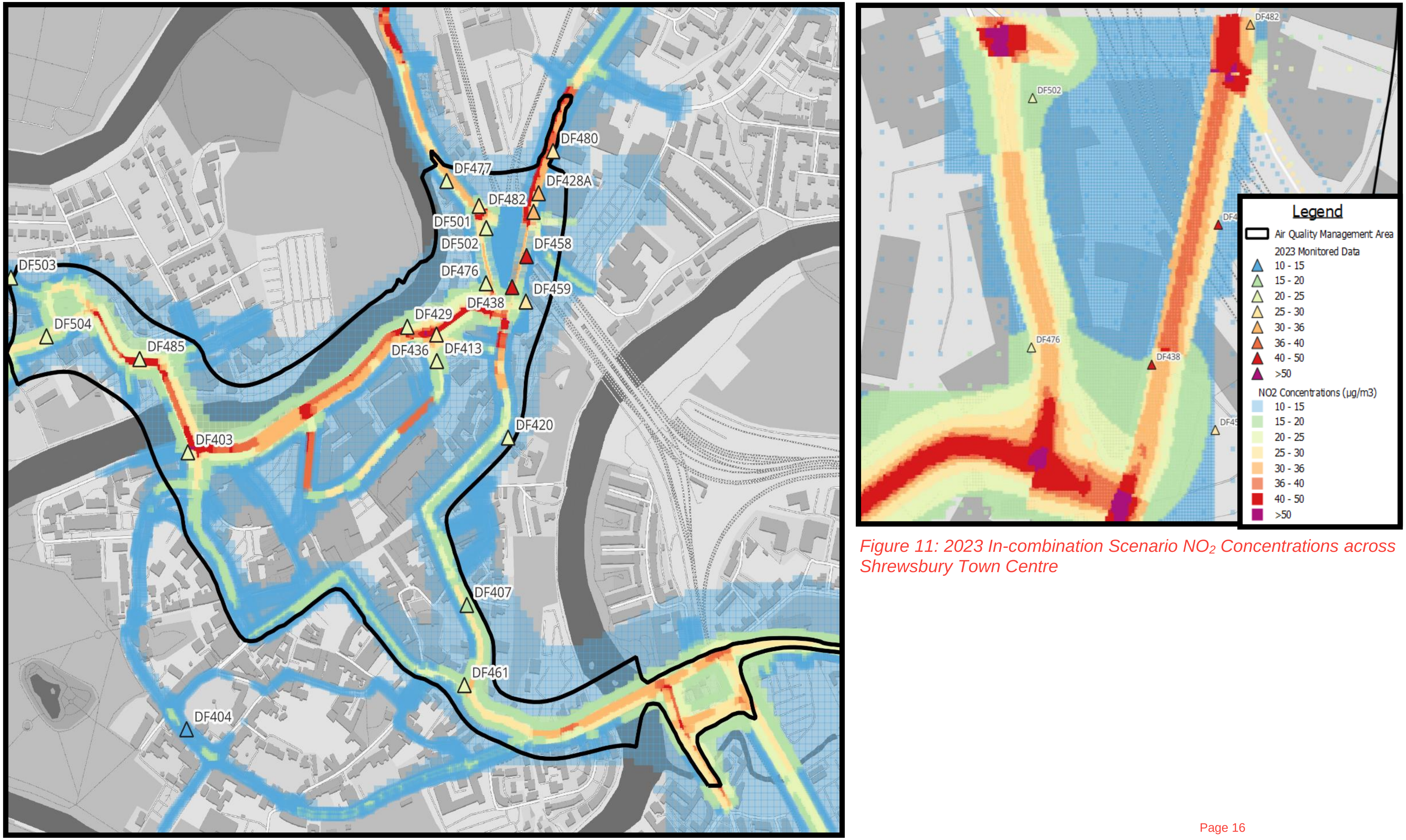
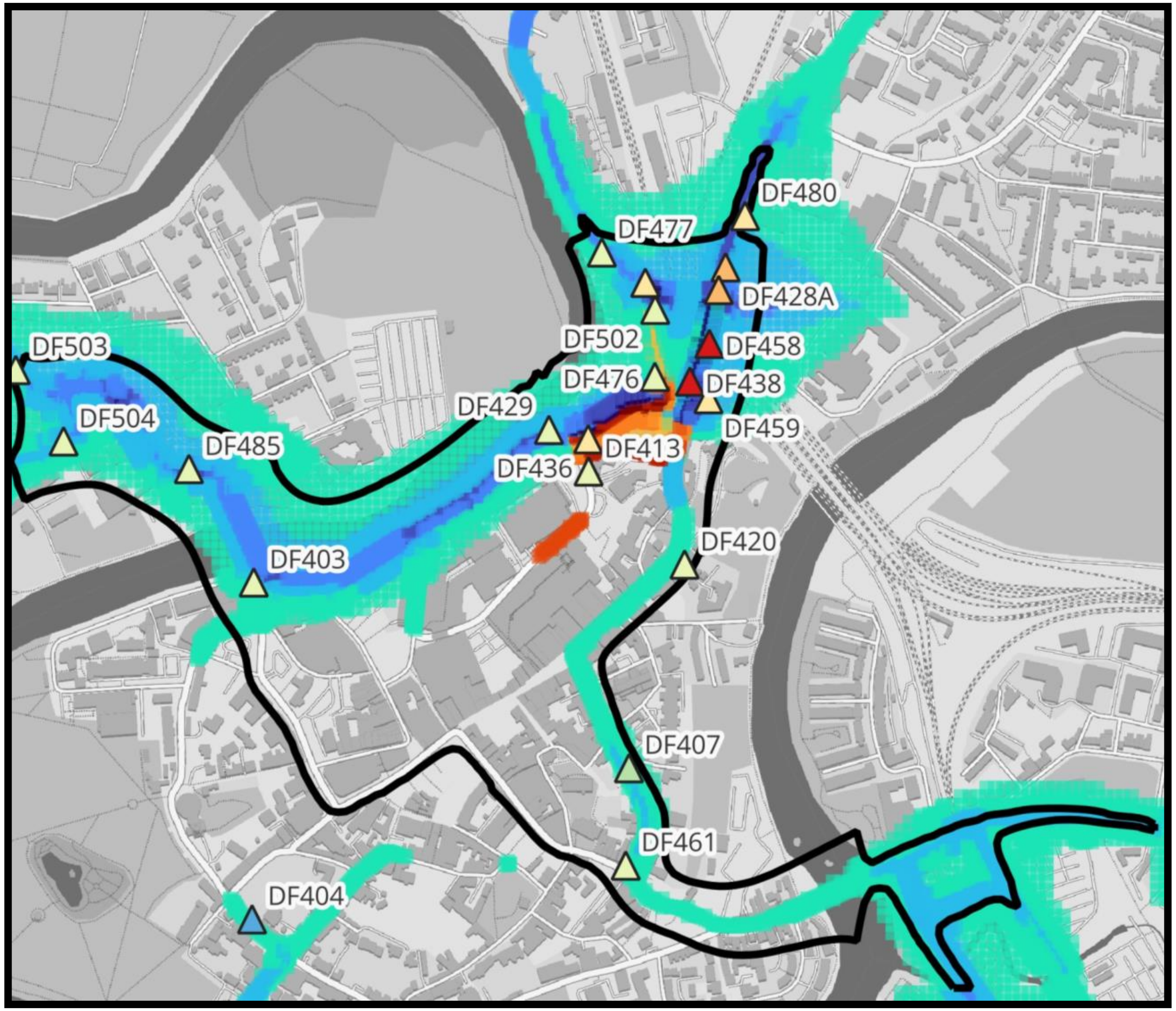


Figure 11: 2023 In-combination Scenario NO_2 Concentrations across Shrewsbury Town Centre



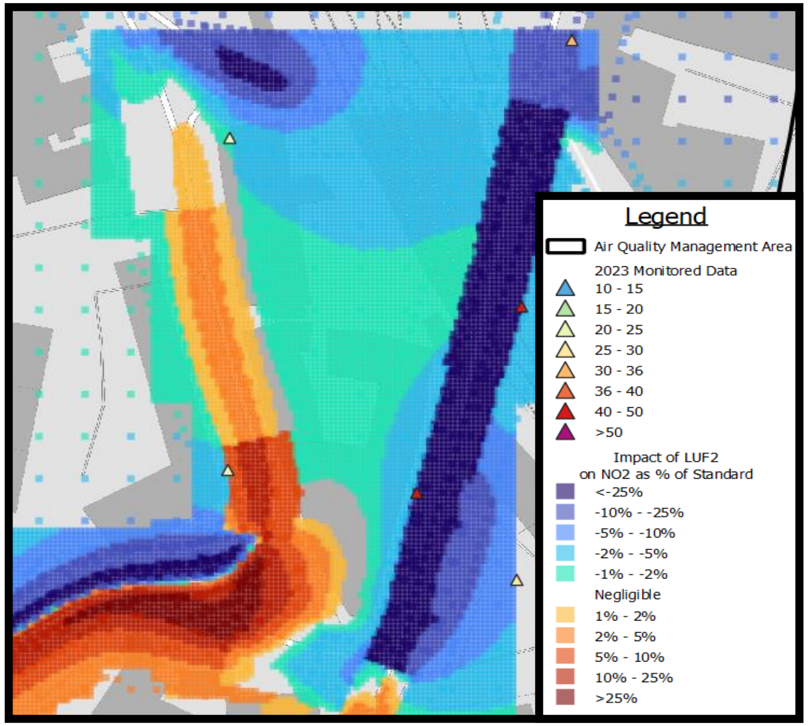


Figure 12: NO_2 Impact of LUF2 Scenario alone as a percentage of air quality standards

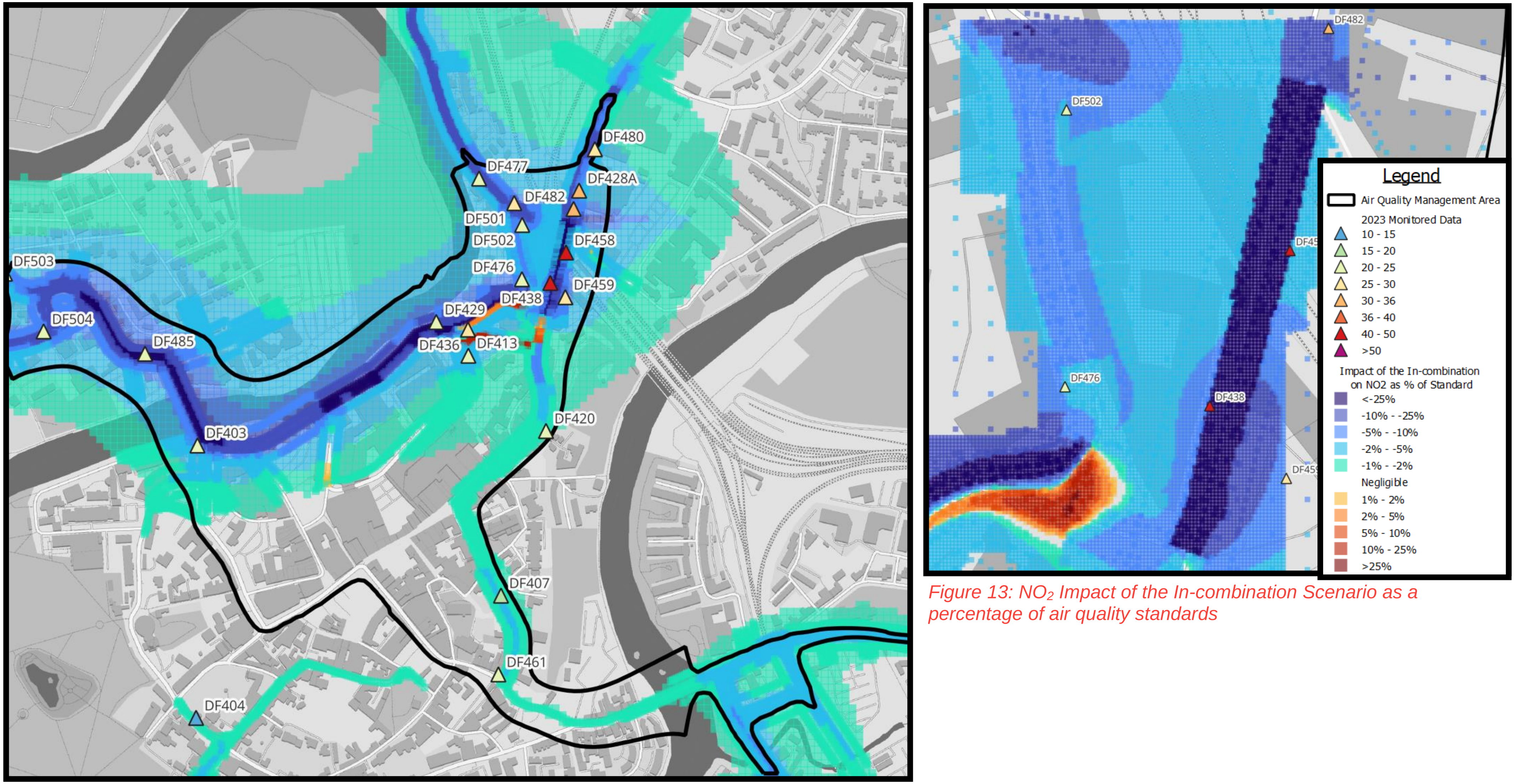


Figure 13: NO_2 Impact of the In-combination Scenario as a percentage of air quality standards

12 Glossary of Terms

Abbreviation	Description
AADT	Annual Average Daily Traffic
ANPR	Automatic Number Plate Recognition
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the local authority intends to achieve air quality limit values’
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed / are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
AQO	Air Quality Objective
AQS	Air Quality Strategy
ASR	Air Quality Annual Status Report
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EFT	Emissions Factor Toolkit
EU	European Union
EV	Electric Vehicle
HGV	Heavy Goods Vehicle
IMD	Indices of Multiple Deprivation

LAQM	Local Air Quality Management
LCWIP	Local Cycling and Walking Infrastructure Plan
LGV	Light Goods Vehicles
LSOA	Lower Super Output Area
LTP	Local Transport Plan
LUF2	UK Government Levelling Up Fund 2
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NH_3	Ammonia
NWRR	North West Relief Road
PG	Policy Guidance
PCN	Penalty Charge Notice
PHOF	Public Health Outcomes Framework
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less
PSV	Passenger Service Vehicle
TG	Technical Guidance

13 References

[1] Defra, Emissions Factors Toolkit – version 11.0 (2021), available at: https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/
[2] Shropshire Council Highways Team Traffic Counts 2023, via internal communications
[3] Department for Transport (DfT) Road Traffic Counts (2023) available at: https://roadtraffic.dft.gov.uk
[4] Bureau Veritas, 2024, Shropshire AQAP Shrewsbury AQMA Technical Report
[5] Defra, 2022, Local Air Quality Management Technical Guidance
[5] Population density - Census Maps, ONS