Ricardo Energy & Environment

Detailed Assessment of Air Quality, Newton AQMA, West Lothian

Report for West Lothian Council

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Executive summary

Ricardo Energy & Environment have been commissioned by West Lothian Council to undertake a Detailed Assessment of Air Quality at Newton, West Lothian.

An Air Quality Management Area (AQMA) encompassing a section of Newton was declared in June 2016 due to exceedances of the Scottish PM_{10} annual mean air quality objective.

Measured PM_{10} concentrations have declined over recent years; On this basis, West Lothian Council are currently considering revocation of the Newton AQMA. This Detailed Assessment aims to provide evidence that will aid the Council in deciding if revocation is appropriate, or if an AQMA is still required in Newton or may be required in the future.

The assessment includes the following main elements:

- A review of measured NO_2, PM_{10} and $PM_{2.5}$ concentrations within the AQMA over recent years.
- Detailed dispersion modelling of PM_{10} and $PM_{2.5}$ concentrations for a baseline year of 2017
- A sensitivity analysis of potential fluctuations in annual mean pollutant concentrations attributable to meteorological conditions.
- Detailed dispersion modelling of PM_{10} and $PM_{2.5}$ concentrations in a future year of 2025 reflecting anticipated changes in traffic levels associated with projected growth or planned local developments.

Dispersion modelling was conducted with ADMS, using traffic data available from the Department for Transport. Model results were verified with available local monitoring data.

The review of pollutant measurements over the last eleven years has concluded:

- NO_2 measurements over a prolonged period provide good evidence that NO_2 concentrations are not an air quality problem in Newton. NO_2 concentrations have been included in this assessment to assist with model verification only.
- For PM_{10}, concentrations in excess of the 18 $\mu g.m^{-3}$ objective have not been measured in Newton since 2014; measured PM_{10} concentrations have declined since 2014.
- During the years 2016 – 2018, as well as most of 2019, an FDMS analyser was used to monitor PM_{10}, and annual mean concentrations were less than 16 $\mu g.m^{-3}$. A Fidas analyser has been in use since October 2019. Due to current uncertainties with particulate measurement techniques (pending ongoing further investigation), the Scottish Government recommends that Local authorities using Fidas analysers within the SAQD network should not consider revoking an AQMA for PM_{10} at this time.
- For $PM_{2.5}$, no concentrations in excess of the 10 $\mu g.m^{-3}$ objective have been measured in Newton since monitoring began in 2019. As $PM_{2.5}$ measurements in 2019 and 2020 were at or above the Scottish Government's uncertainty threshold of 8 $\mu g.m^{-3}$ for Fidas analysers, exceedances of the objective were possible. $PM_{2.5}$ concentrations should continue to be closely monitored in Newton.

The dispersion modelling study of PM_{10} and $PM_{2.5}$ emissions from current and future road traffic and domestic combustion indicated that:

- In 2017, the PM_{10} and $PM_{2.5}$ annual mean objectives were not exceeded at any locations where relevant human exposure is present within the study area.
- Based on a sensitivity analysis of modelled pollutant concentrations using annual meteorological datasets from 2007 to 2017, it is unlikely that the PM_{10} or $PM_{2.5}$ annual mean objectives will be exceeded in a year when poorer than average dispersion occurs due to weather conditions.

- When assessing a future year of 2025 based on projected normal traffic growth, the PM_{10} and $PM_{2.5}$ annual mean objectives were not exceeded at any locations where relevant human exposure is present within the study area. West Lothian Council are not currently aware of any significant planned developments near the Newton study area.

In light of this Detailed Assessment of Air Quality, West Lothian Council may wish to delay revoking the AQMA in Newton for exceedances of the PM_{10} annual mean objective until Scottish Government guidance regarding AQMA revocation and the use of Fidas analysers for particulate measurements is updated.

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1 Introduction

An Air Quality Management Area (AQMA) encompassing a section of Newton, West Lothian was declared in June 2016 due to exceedances the Scottish fine particulate (PM_{10}) annual mean air quality objective.

Measured PM_{10} concentrations have declined over recent years. On this basis, West Lothian Council are currently considering revocation of the Newton AQMA and have commissioned Ricardo Energy & Environment to undertake a Detailed Assessment of Air Quality.

This Detailed Assessment aims to provide evidence that will aid the Council in deciding if revocation is appropriate at this time; or if an AQMA is still required or may be required in the future based on anticipated traffic levels, e.g., when any planned nearby housing and/or commercial developments become operational.

The assessment includes:

- A review of recent trends in pollutant measurements (NO_2, PM_{10} and $PM_{2.5}$) in Newton
- Detailed dispersion modelling of current and future year emissions to establish if PM_{10} concentrations are likely to be in excess of the Scottish annual mean objective at locations where relevant human exposure is present.
- An analysis of potential fluctuations in annual mean pollutant concentrations attributable to meteorological conditions.

Further information on each of these elements of the assessment is provided later in the report.

Please note: The modelling aspects of this detailed assessment were originally conducted in 2019 and verified using 2017 air quality measurements. Delays pending acquisition of information about likely future traffic activity meant that the assessment could not be completed in 2019. As the report has now been finalised in 2022, we have included the most recent air quality measurement data to provide additional evidence. Further information on recent measurement data is provided in Section 3.

1.1 Policy background

The Environment Act 1995 placed a responsibility on the UK Government to prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The most recent version of the strategy (2007) sets out the current UK framework for air quality management and includes several air quality objectives for specific pollutants. The 1995 Act also requires that Local Authorities "Review and Assess" air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define areas where the AQS objectives are not being met. In such instances the Local Authority is required to declare an Air Quality Management Area (AQMA), carry out a Further Assessment of Air Quality, and develop an Air Quality Action Plan (AQAP) which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra's Technical Guidance - LAQM.TG(16)[1]. Table 1 lists the objectives relevant to this assessment that are included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purposes of Local Air Quality Management (LAQM).

[1] Defra and the devolved administrations (2018) Part IV of the Environment Act 1995 Environment (Northern Ireland) Order 2002 Part III; Local Air Quality Management Technical Guidance (TG16); February 2018

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

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

1.2 Locations where the objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be present and are likely to be exposed over the averaging period of the objective. Table 2 summarises examples of where the air quality objectives for NO_2, PM_{10} and $PM_{2.5}$ should and should not apply.

Table 2: Where the NO_2 Air Quality Objectives should and should not apply

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

2 Detailed Assessment Study Area

The Detailed Assessment is concerned with the Newton AQMA which covers the whole village.

The village mainly comprises of residential properties where there is relevant human exposure present at ground level. The study area, including the roads modelled is presented in Figure 1 below. The size of the study area is approximately 0.45 km by 0.33 km.

Figure 1: Detailed Assessment Study Area

3 Pollutant monitoring data in recent years

West Lothian Council currently measure NO_2, PM_{10} and $PM_{2.5}$ concentrations within the Newton AQMA at one continuous analyser and one NO_2 diffusion tube site. A map showing the site locations is presented in Figure 2. Further details regarding annual data capture and QA/QC information are available in the various West Lothian Council LAQM Annual Progress Reports published in recent years[2].

The LAQM guidance recommends; when considering revocation of an AQMA; authorities should examine measurements carried out over several years or more. The minimum requirement as evidence of continued compliance, will normally be three consecutive years where measured concentrations are below the objectives of concern.

Figure 2: NO_2, PM_{10} and $PM_{2.5}$ measurement site locations – Newton

3.1 NO_2 measurements

Measured annual mean NO_2 concentrations from 2010 to 2021 are presented in Table 3 and Figure 3 below. Annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ objective have never been measured in Newton and measured concentrations have in general declined at all sites.

[2] Include link to West Lothian Council LAQM reports webpage

Measured NO_2 annual mean in 2020 reduced fairly significantly due to the effect of COVID-19 restrictions on traffic activity; this effect is also apparent but to a lesser extent in 2021. It is currently unknown if traffic activity will return to pre-pandemic levels in 2022 and future years.

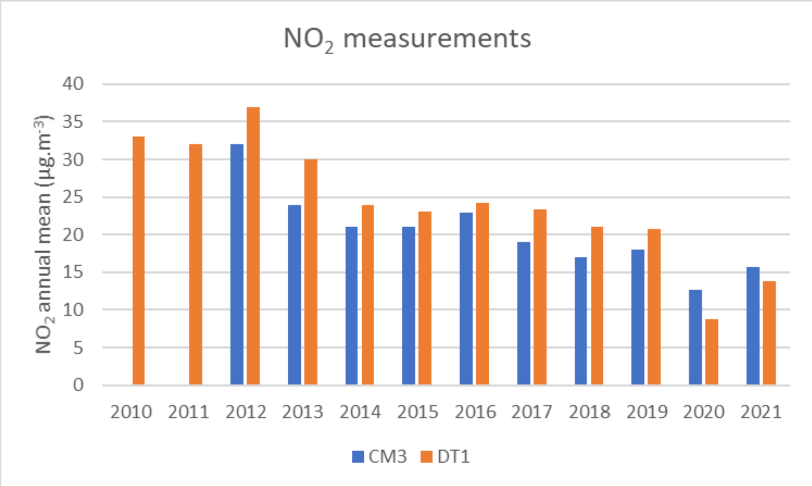
In 2019, however, which can be considered as the most recent pre-pandemic business as usual year, all measured concentrations were less than 52% of the objective.

These measurements over a prolonged period provide good evidence that NO_2 concentrations are not an air quality problem in Newton. NO_2 concentrations have been included in this assessment to assist with model verification only.

Table 3: NO_2 annual mean measurements 2010 to 2021

Site ID	Site Name	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CM3	Newton CNC	-	-	32	24	21	21	23	19	17	18	12.6	15.7
DT1	Newton	33.0	32.0	37.0	30.0	24.0	23.1	24.2	23.3	21.1	20.7	8.7	13.8

Figure 3: NO_2 annual mean concentrations from 2010-2021



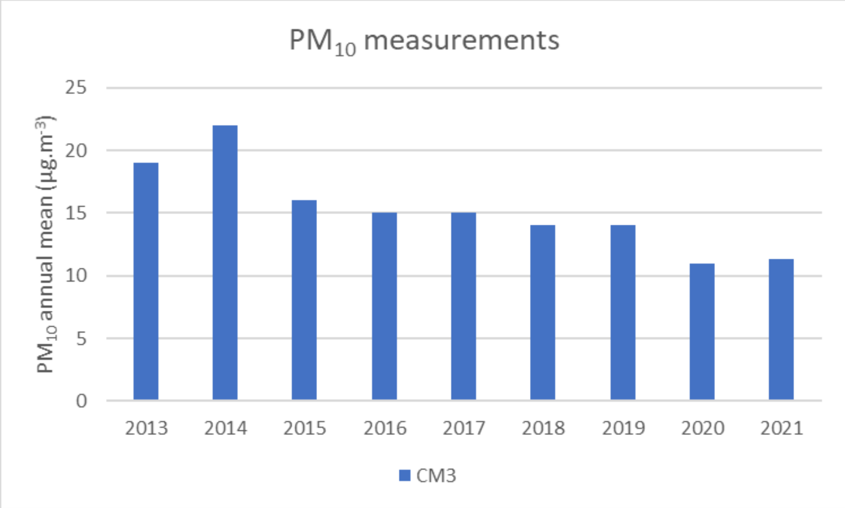
3.2 PM_{10} measurements

Annual mean PM_{10} concentrations measured at the automatic analyser in Newton from 2013 to 2021 are presented in Table 4 and Figure 4. A $PM_{2.5}$ annual mean exceeding the Scottish 18 µg.m^{-3} objective was last measured in Newton in 2014; measured concentrations have declined consistently since then. Similar to NO_2, measured PM_{10} in 2020 reduced fairly significantly due to the effect of COVID-19 restrictions on traffic activity; this effect is also apparent but to a lesser extent in 2021.

Table 4: PM_{10} annual mean measurements 2013 to 2021

Site ID	Site Name	2013	2014	2015	2016	2017	2018	2019	2020	2021
CM3	Newton CNC	19	22	16	15	15	14	14	11	11.3

Figure 4: PM_{10} annual mean concentrations from 2013-2021



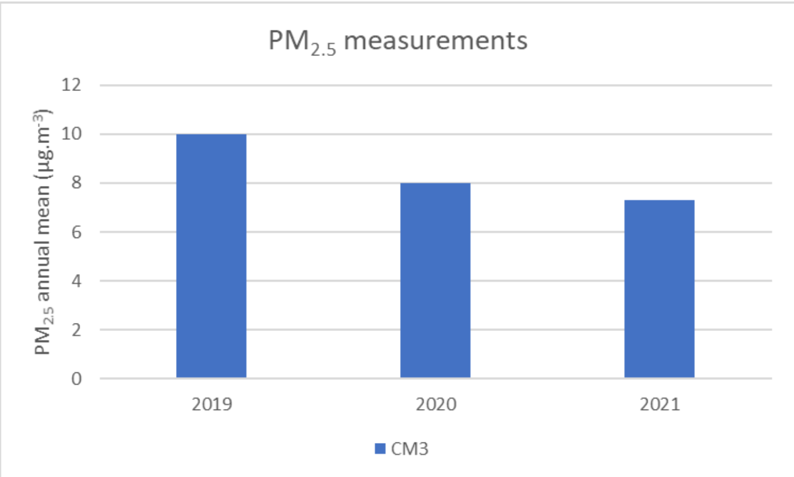
3.3 $PM_{2.5}$ measurements

West Lothian Council began monitoring $PM_{2.5}$ at the Newton automatic analyser in late 2019. Annual mean concentrations from 2019 - 2021 are presented in Table 5 and Figure 5. The annual mean in 2019 was at the 10 $\mu g.m^{-3}$ $PM_{2.5}$ annual mean objective value, though data capture was only 18% in 2019. There have been no exceedances of the 10 $\mu g.m^{-3}$ $PM_{2.5}$ annual mean objective. The effect of COVID-19 restrictions on traffic activity in 2020 and 2021 is also apparent in the $PM_{2.5}$ measurements.

Table 5: $PM_{2.5}$ annual mean measurements 2019 to 2021

Site ID	Site Name	2019	2020	2021
CM3	Newton CNC	10	8	7.3

Figure 5: $PM_{2.5}$ annual mean concentrations from 2019-2021



3.4 Current uncertainty around Particulate Matter Monitoring Techniques in Scotland

The Scottish Government are currently investigating the relationship between automatic particulate matter (PM_{10} and $PM_{2.5}$) measurement techniques used in Scotland and the EU reference method. The requirement for a study of this type was identified following decreases in PM_{10} concentrations observed across Scotland's air quality monitoring network following the introduction of Fidas, which replaced TEOM, FDMS and BAM instruments.

The initial phase of this investigation[3] has indicated that current corrections for equivalence may not be accurately representing how the automatic monitoring methods respond at lower concentration levels and meteorological conditions, such as those observed in Scotland. The latest report makes the following recommendations which are relevant to this Detailed Assessment:

- Local authorities using Fidas within the SAQD network should not consider revoking an AQMA for PM_{10} until the results and recommendations from the next stage of the study are published.
- For $PM_{2.5}$, annual mean concentrations of greater than 8 $\mu g.m^{-3}$ using a Fidas might indicate that the annual mean objective of 10 $\mu g.m^{-3}$ has been exceeded.
- Local authorities using FDMS within the SAQD network should only consider revoking an AQMA for PM_{10} if the measured annual mean is consistently 16 $\mu g.m^{-3}$ or less.

In Newton, PM_{10} was measured up until October 2019 using a TEOM FDMS analyser, and from October 2019 a Fidas analyser has been in use. PM_{10} annual means measured using the TEOM FDMS were consistently less than 16 $\mu g.m^{-3}$ for three years up to 2019, as well as in 2019. The Scottish Government report does however now recommend that Local authorities using Fidas within the SAQD network should not consider revoking an AQMA for PM_{10} at this time. On this basis West Lothian Council may wish to delay revoking the AQMA for exceedances of the PM_{10} annual mean objective.

$PM_{2.5}$ measurements in Newton were at or over the 8 $\mu g.m^{-3}$ threshold recommended in the Scottish Government report in 2019 and 2020; this indicates that there is uncertainty regarding possible exceedances of the 10 $\mu g.m^{-3}$ Scottish $PM_{2.5}$ annual mean objective. Until revised Scottish Government guidance on measurement uncertainty is provided, West Lothian Council should continue to monitor $PM_{2.5}$ concentrations.

[3] Ricardo Energy & Environment (2021) Pilot Research Study to Investigate Particulate Matter Monitoring Techniques in Scotland; Final Report; Report for Scottish Government; ED11195 Issue 1 Date 19/08/2021; Available to download here: https://www.scottishairquality.scot/news/pilot-research-study-investigate-particulate-matter-monitoring-techniques-scotland

4 Dispersion modelling assessment

In addition to the review of pollutant measurement data over recent years. The Detailed Assessment includes a dispersion modelling assessment of both road traffic emissions and domestic combustion in Newton. This aims to establish if PM_{10} or $PM_{2.5}$ concentrations are likely to be in excess of the air quality objectives at locations where pollutant measurements are not being conducted but relevant human exposure is present.

This includes the assessment of emissions associated with traffic generated by planned developments in future years; and an analysis of potential fluctuations and extremes in annual mean pollutant concentrations based on historical variability in meteorological conditions. The aim being to identify if there is a risk of the air quality objectives being exceeded again in Newton in future years.

4.1 Modelling method and supporting data

Annual mean pollutant concentrations have been modelled within the study area using the atmospheric dispersion model ADMS Roads (version 5.0). The model domain covers the study area described in section 2 above. The modelling methodologies provided for Detailed Assessments outlined in Defra Technical Guidance LAQM.TG(16) were used throughout this study.

It should be noted that any dispersion modelling study has a degree of uncertainty associated with it; all reasonable steps have been taken to reduce this where possible.

4.1.1 Background concentrations

Background concentrations for a dispersion modelling study are typically accessed from either local monitoring data conducted at a background site, or from the Scottish Government and Defra background maps[4]. In this case we have also explicitly modelled the contribution of local domestic combustion sources to total background PM_{10} and $PM_{2.5}$ concentrations. This builds on the previous Detailed Assessment which considered domestic combustion in Newton.

Background contribution of PM_{10} and $PM_{2.5}$ emissions from domestic combustion in Newton have been modelled explicitly within the study area using ADMS 5 (version 5.2). Emissions were calculated using a combination of local survey data on fuel use[5], typical household energy usage from national statistics, and NAEI emission factors for each type of fuel. Background contribution of domestic combustion values were used for both the baseline 2017 model and the future year 2025 model, as data for future year emissions were not available. Details of the modelling method for domestic combustion emissions are available in the previous Newton Detailed Assessment report[6].

As there are no urban background measurement sites located near to Newton, the Scottish Government (NOx and PM_{10}) and Defra maps ($PM_{2.5}$) were used to provide an estimate of the remining background components. Baseline modelling of 2017 used the background maps with a base year of 2015, which were the most recent available maps at the time of baseline modelling.

The future year modelling in 2025 used the most recent available background maps with a base year of 2018, as the Scottish background maps with a base year of 2015 are no longer available for download. The background values used in this study are presented in Table 6.

The sector contributions from road traffic emissions on A Class Roads were subtracted from the total background concentrations to avoid double counting of pollutants from the sources being explicitly modelled. The brake & tyre wear and road abrasion contributions were also discounted from the PM_{10} and $PM_{2.5}$ maps as these particulate emissions are calculated along with tailpipe emissions when using

[4] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html
[5] Ricardo Energy & Environment (2016) Newton Detailed Assessment of Air Quality; Report for West Lothian Council; ED59713 Issue 2; 26/02/2016
[6] Ibid.

the emission factor toolkit (EFT) to calculate vehicle emission rates. Domestic combustion was also discounted from the PM_{10} and $PM_{2.5}$ background maps since it was modelled separately.

The Defra and Scottish government equivalent background maps are the outputs of a national scale dispersion model provided at a 1km x 1km resolution and are therefore subject to a degree of uncertainty.

Table 6: Mapped background PM_{10}, $PM_{2.5}$ and NOx concentrations (µg.m^{-3})

Year	Grid Square	NOx	PM_{10}	$PM_{2.5}$
2017	309500, 677500	16.2	11.2	6.7
2025	309500, 677500	10.8	11.1	5.6

4.1.2 Meteorological observations and model parameters

Hourly sequential meteorological data (wind speed, direction etc.) for 2017 from the Edinburgh Airport site was used for the modelling assessment. The meteorological measurement site is located approximately 7km to the east south east of the study area and has excellent data quality for the period of interest. Meteorological measurements are subject to their own uncertainty which will unavoidably carry forward into this assessment.

A surface roughness of 0.5m was used in the modelling to represent the open urban area within the model domain. A limit for the Monin-Obukhov length of 10m was applied to represent a small urban area.

4.1.3 Mapping

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

4.1.4 Treatment of modelled NO_x road contribution

It is necessary to convert the modelled NO_x concentrations for NO_2 for comparison with the relevant objectives.

The Defra NO_x/NO_2 calculator v6.1[7] was used to calculate NO_2 for comparison from the NO_x concentrations predicted by ADMS-Roads. The model requires input of the background NO_x, the modelled road contribution and accounts for the proportion of NO_x released as primary NO_2. For the Newton, West Lothian area in 2017 with the "All other UK urban traffic" option in the model, the NO_x/NO_2 model estimates that 27% of NO_x from local road vehicles is released as primary NO_2.

4.1.5 Validation of ADMS-Roads

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

[7] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

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

4.2 Road traffic data

4.2.1 Average flow, speed and fleet split

The freely available Department for Transport Traffic count data[8] were used for the assessment, this included count point 80372 on the A904 East of Newton. Average daily traffic flow and vehicle type fleet split at the count point were recorded. Average vehicle speeds were estimated using local knowledge.

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

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

4.2.2 Vehicle emission factors

The Emissions Factor Toolkit[9] (EFT V8.0.1) was used in this assessment to calculate pollutant emission factors for each road link modelled. The calculated emission factors were then imported into the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EFT, and an emissions factor in grams of pollutants/kilometre/second is generated for input into the dispersion model. In the latest version of the EFT, NO_x emission factors previously based on DFT/TRL functions have been replaced by factors from COPERT 5 v0.1067. These emission factors are widely used for the purpose of calculating emissions from road traffic in Europe. Defra recognises these as the current official emission factors for road traffic sources when conducting local, regional and national scale dispersion modelling assessments.

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

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

4.3 Model Verification

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

[8] www.roadtraffic.dft.gov.uk
[9] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

The approach outlined in Box 7.15 of LAQM.TG(16) has been used in this case.

The modelled NO_x concentrations in this study were verified using the automatic site and one available roadside diffusion tube measurement. The following Road NO_x adjustment factor was derived**: 1.3578**.

The adjustment factor was applied to the modelled road NO_x concentrations, and the adjusted total NO_2 concentrations were then calculated using the Defra NO_x/NO_2 calculator.

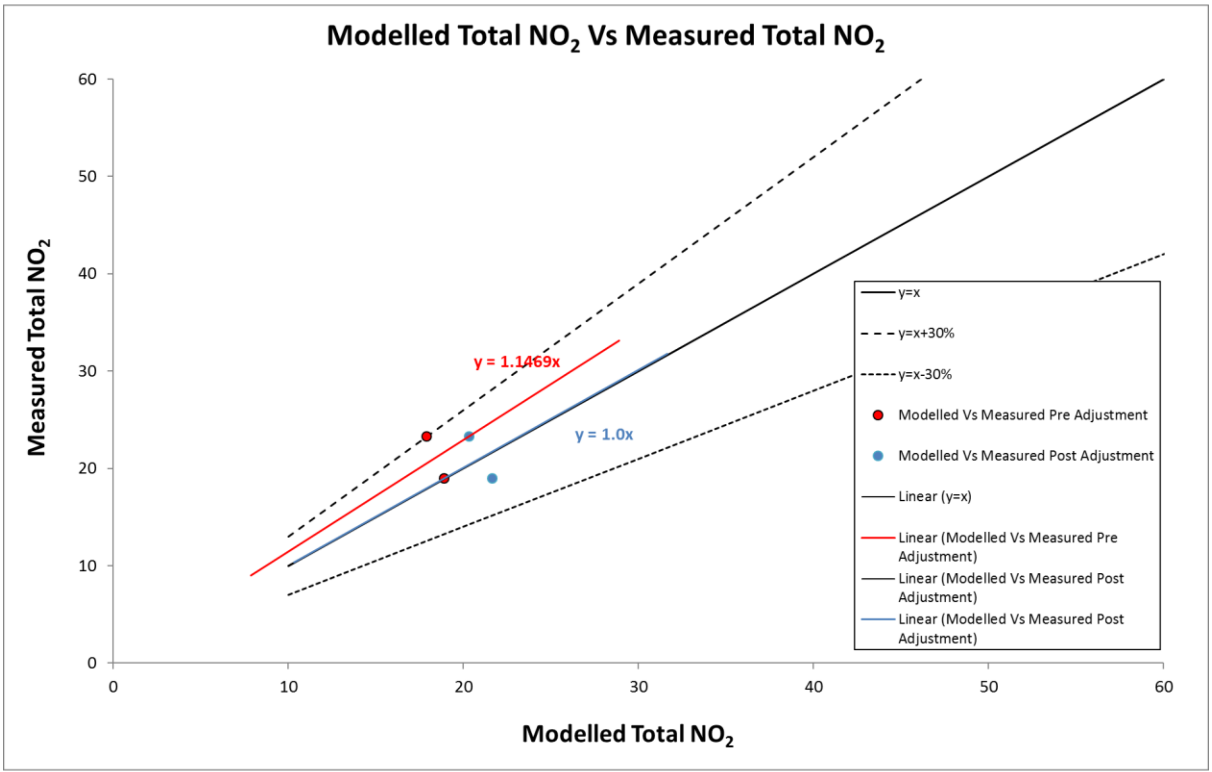
After the NO_x/NO_2 model was run no further adjustments were made to the data. Model agreement for modelled vs measured NO_2 monitoring data after adjustment is presented in Figure 6. Further information regarding model verification is presented in Appendix 3.

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

For PM_{10}, when compared with the one available PM_{10} annual mean measurement from the Newton automatic analyser (minus the background component); the model was found to be underestimating the road component. A Road PM_{10} adjustment factor of 2.251 was derived and applied to all modelled Road PM concentration results prior to adding the background.

No $PM_{2.5}$ measurement data were available in 2017 so a $PM_{2.5}$ specific adjustment factor could not be derived. The PM_{10} adjustment factor was applied to modelled Road $PM_{2.5}$, and background concentrations were then added to the modelled contribution to calculate annual mean results.

Figure 6: Modelled vs. measured annual mean NO_2 concentrations 2017



4.4 Model results

This section of the report presents results for the following aspects of the Detailed Assessment:

- Assessment of the most recent year with available measurements (2017).
- A sensitivity analysis of inter-annual variability in predicted annual mean pollutant concentrations attributable to meteorological conditions at a selection of receptors.
- Future year (2025) assessment of emissions associated with anticipated future traffic levels

The AQMA in Newton has been declared for exceedances of the PM_{10} annual mean objective. The local measurement data described in Section 3.1 provide reasonably good evidence that there is little risk of the NO_2 objectives being exceeded in Newton. On this basis, model results have been presented for PM_{10} and $PM_{2.5}$ only.

Modelled annual mean pollutant concentrations have been presented using two methods.

1. Contour plots showing the spatial variation of predicted concentrations across the study area. Concentrations are predicted across a grid of points covering the entire study area at a resolution of approximately 1.5m and then interpolated to produce contours representing the spatial variation in modelled pollutant concentrations.
2. Sensitive Receptors which represent worst-case locations at the façade of buildings where relevant human exposure is likely to be present close to the road sources being modelled. The receptors (Figure 7) have been modelled at a height representing ground level exposure (1.5m).

Figure 7: ADMS receptor locations

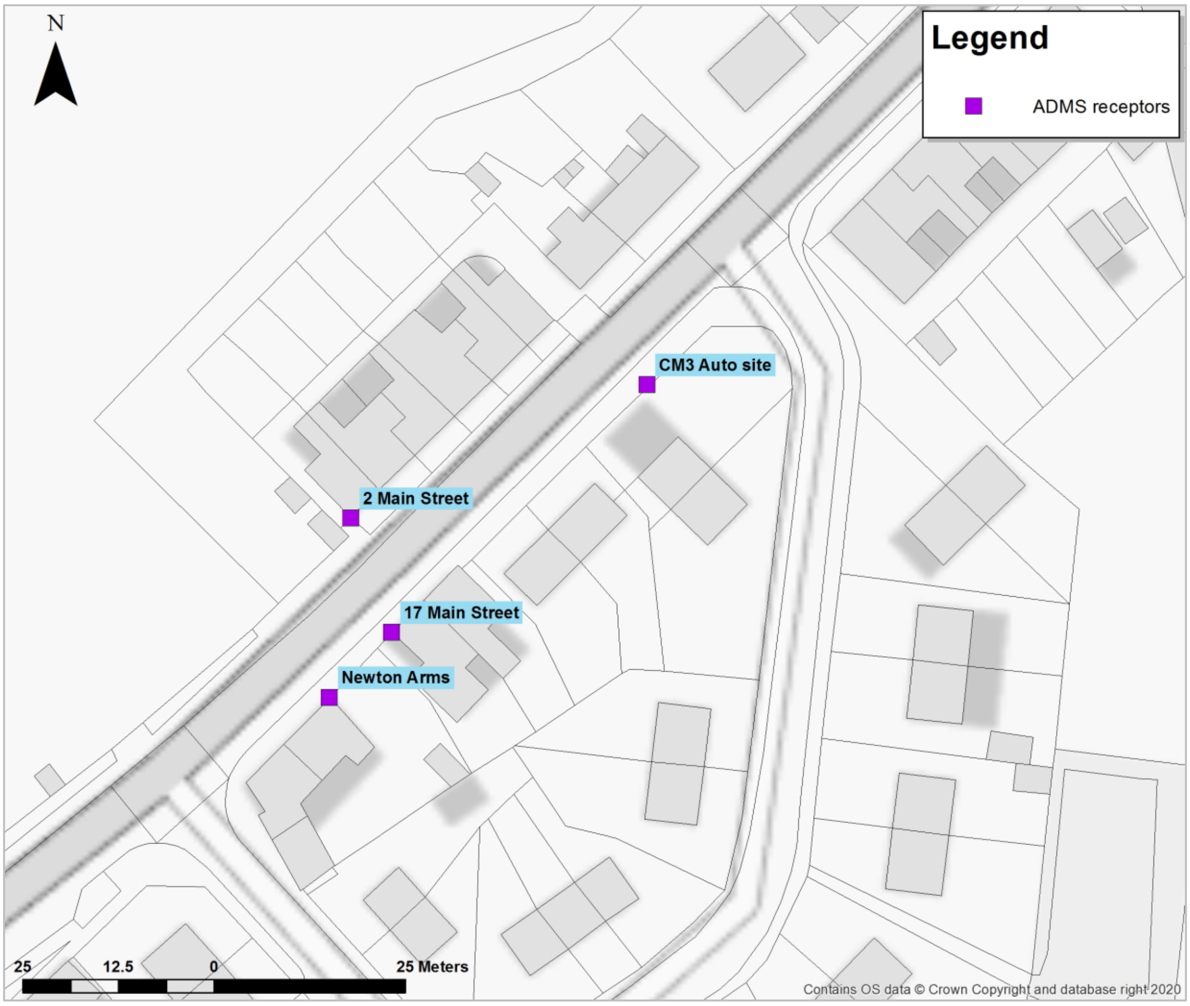


Table 7 includes the background contribution of domestic combustion at each receptor location for PM_{10} and $PM_{2.5}$. These values were added to the adjusted concentrations. The same values were used for 2017 and 2025 as no data were available to calculate estimated future year emissions from domestic combustion.

Table 7: Modelled contribution of domestic combustion at receptor locations

Receptor	PM_{10} (µg.m^{-3})	$PM_{2.5}$ (µg.m^{-3})
Newton Arms	0.53	0.52
17 Main Street	0.53	0.52
2 Main Street	0.44	0.43

4.4.1 Assessment of the most recent year with available measurements (2017)

4.4.1.1 PM_{10} results - 2017

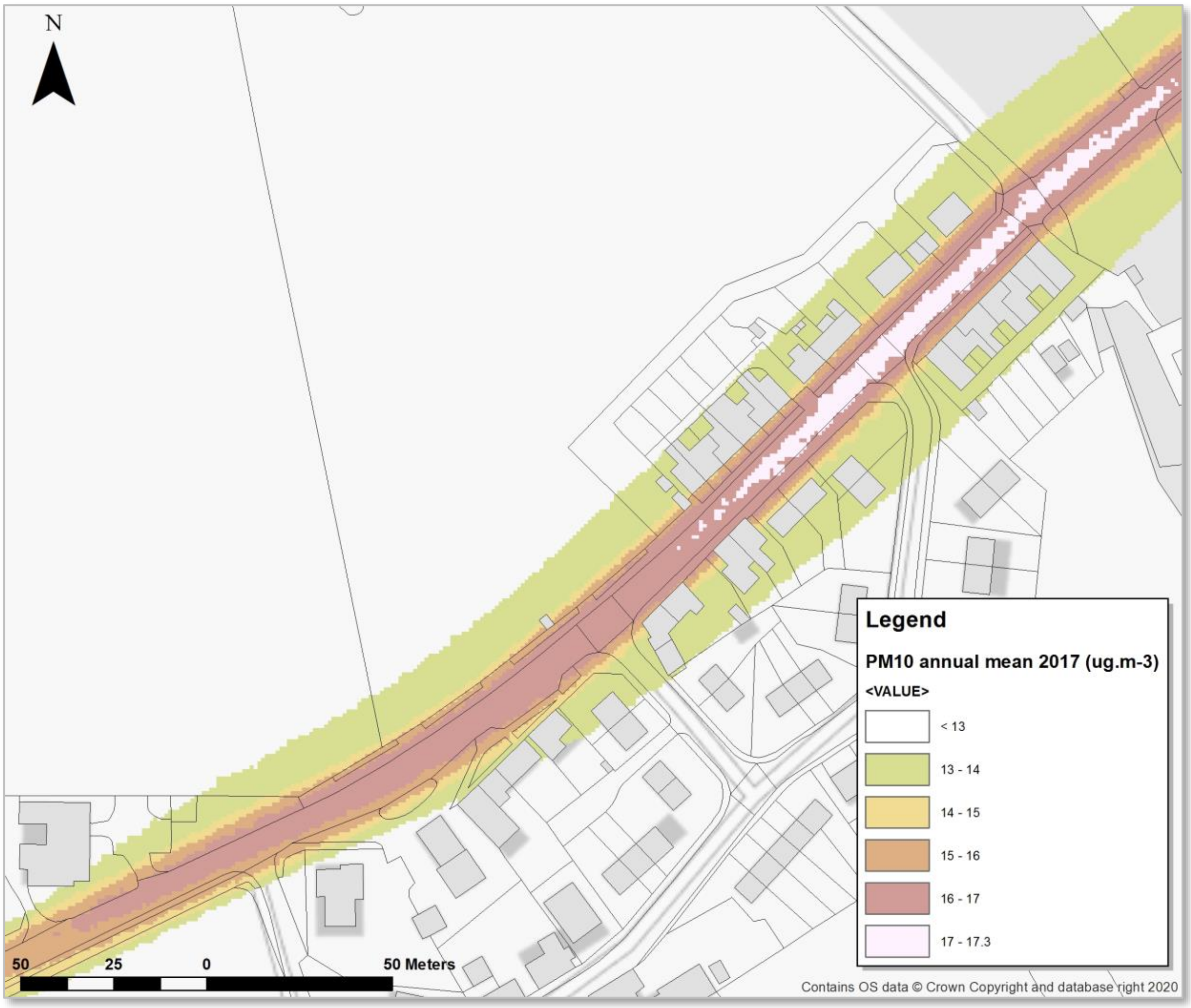
A contour plot showing the spatial variation of the predicted 2017 annual mean PM_{10} concentrations across the study area at ground floor level (1.5m) is presented in Figure 8. Modelled PM_{10} annual mean concentrations at receptor locations are presented in Table 8.

The contours and numerical results indicate that the Scottish 18 µg.m^{-3} annual mean PM_{10} objective was not being exceeded at any locations in Newton during 2017.

Table 8: Predicted annual mean PM_{10} concentrations at ADMS receptors 2017

Receptor	Easting	Northing	Height (m)	PM_{10} annual mean (µg.m^{-3})
Newton Arms	309210.8	677682.9	1.5	14.8
17 Main Street	309218.9	677691.4	1.5	14.9
2 Main Street	309213.7	677706.3	1.5	14.4

Figure 8: Modelled 2017 PM_{10} annual mean concentrations (µg.m^{-3})



4.4.1.2 $PM_{2.5}$ results - 2017

A contour plot showing the spatial variation of the predicted 2017 annual mean $PM_{2.5}$ concentrations across the study area at ground floor level (1.5m) is presented in Figure 9. Modelled $PM_{2.5}$ annual mean concentrations at receptor locations are presented in Table 9.

The contours and numerical results indicate that the Scottish 10 µg.m^{-3} annual mean $PM_{2.5}$ objective was not being exceeded at any locations with relevant exposure in Newton during 2017.

Table 9: Predicted annual mean $PM_{2.5}$ concentrations at ADMS receptors 2017

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean (µg.m^{-3})
Newton Arms	309210.8	677682.9	1.5	9.0
17 Main Street	309218.9	677691.4	1.5	9.1
2 Main Street	309213.7	677706.3	1.5	8.7

Figure 9: Modelled 2017 $PM_{2.5}$ annual mean concentrations ($\mu g.m^{-3}$)

4.4.2 Meteorological Sensitivity Analysis

The TG(16) guidance acknowledges that pollutant concentrations may vary significantly from one year to the next, due to the influence of meteorological conditions. The guidance goes on to state that it is important that authorities avoid cycling between declaring, revoking and declaring again, due simply to these variations. Before revoking an AQMA based on measured pollutant concentrations, the authority needs to be reasonably certain that any future exceedances (that might occur in more adverse meteorological conditions) are unlikely.

To assess the risk of weather conditions potentially leading to exceedances of the air quality objectives in future years, a sensitivity analysis of meteorological conditions measured at Edinburgh Airport from 2007 to 2017 has been included in the dispersion modelling assessment. 2017 baseline traffic activity data was used to calculate emissions. The sensitivity analysis was used to determine the annual dataset that produced the maximum ambient pollutant concentrations, and to quantify the inter-year variability in predicted concentrations attributable to differences in the various annual meteorological datasets.

The results have been presented in accordance with the guidelines for presenting the variability of dispersion modelling results published by the UK Atmospheric Dispersion Modelling Liaison Committee[10] as mean of all met years modelled ± twice the standard deviation. This represents a variability range within which 97.5% of the values are expected to be found over the likely range of annual weather conditions that could occur.

[10] ADMLC (2004) Guidelines for the Preparation of Dispersion Modelling Assessments for Compliance with Regulatory Requirements – an Update to the 1995 Royal Meteorological Society Guidance

The results of the sensitivity test for PM_{10} and $PM_{2.5}$ are presented in Table 10 and Table 11 respectively. More detailed tables containing model results at receptors for all years modelled are presented in Appendix 4.

The sensitivity analysis conducted using the weather conditions observed between 2007 and 2017 indicate that for PM_{10} and $PM_{2.5}$ it is unlikely that the respective annual mean objectives will be exceeded in a year when poorer than average dispersion occurs due to weather conditions.

Table 10: Meteorological sensitivity analysis (2007 to 2017) - PM_{10} annual mean ($\mu g.m^{-3}$)

Receptor	Minimum	Maximum	Mean	Standard Deviation x 2	Mean + Standard Deviation x 2
Newton Arms	14.8	15.8	15.1	± 0.6	15.7
17 Main Street	14.9	15.9	15.2	± 0.6	15.8
2 Main Street	13.9	14.6	14.2	± 0.4	14.6

Table 11: Meteorological sensitivity analysis (2007 to 2017) – $PM_{2.5}$ annual mean ($\mu g.m^{-3}$)

Receptor	Minimum	Maximum	Mean	Standard Deviation x 2	Mean + Standard Deviation x 2
Newton Arms	9.0	9.6	9.2	± 0.4	9.6
17 Main Street	9.1	9.6	9.2	± 0.4	9.6
2 Main Street	8.4	8.9	8.6	± 0.3	8.9

4.4.3 Future Year Development Scenarios

A future year baseline in 2025 has been modelled to assess changes in traffic flows and pollutant concentrations. No developments within the area surrounding Newton are currently anticipated by West Lothian Council, hence an estimate of likely traffic growth has been assessed.

2025 traffic volumes have been projected from the 2017 baseline traffic data using TEMPro[11] growth factors for the West Lothian Council area. Projected vehicle emission factors in 2025 were calculated using the EFT.

4.4.3.1 PM_{10} annual mean results in 2025

The predicted annual mean PM_{10} concentrations in 2025 at each of the specified receptors are presented in Table 12. No PM_{10} annual mean in excess of the 18 $\mu g.m^{-3}$ objective were predicted.

Table 12: Predicted annual mean PM_{10} concentrations at specified receptors 2025

Receptor	Easting	Northing	Height (m)	PM_{10} Annual Mean ($\mu g.m^{-3}$)
Newton Arms	309210.8	677682.9	1.5	14.7
17 Main Street	309218.9	677691.4	1.5	14.8
2 Main Street	309213.7	677706.3	1.5	14.3

4.4.3.2 $PM_{2.5}$ annual mean results in 2025

The predicted annual mean $PM_{2.5}$ concentrations in 2025 at each of the specified receptors are presented in Table 13. No $PM_{2.5}$ annual mean in excess of the 10 $\mu g.m^{-3}$ objective were predicted.

[11] https://www.gov.uk/government/publications/tempro-downloads

Table 13: Predicted annual mean $PM_{2.5}$ concentrations at specified receptors 2025

Receptor	Easting	Northing	Height (m)	$PM_{2.5}$ annual mean ($\mu g.m^{-3}$)
Newton Arms	309210.8	677682.9	1.5	7.8
17 Main Street	309218.9	677691.4	1.5	7.9
2 Main Street	309213.7	677706.3	1.5	7.6

5 Conclusion

This report describes a Detailed Assessment of air quality in Newton, West Lothian. The assessment is primarily concerned with PM_{10} and $PM_{2.5}$ concentrations within the Newton air quality management area (AQMA)

The Detailed Assessment aims to provide evidence that will aid the Council in deciding if revocation of the AQMA is appropriate at this time, or if it is still required, or may be required in the future based on projected traffic activity levels.

The review of pollutant measurements over the last eleven years has concluded:

- NO_2 measurements over a prolonged period provide good evidence that NO_2 concentrations are not an air quality problem in Newton. NO_2 concentrations have been included in this assessment to assist with model verification only.
- For PM_{10}, no concentrations in excess of the 18 $\mu g.m^{-3}$ objective have been measured in Newton since 2014; measured PM_{10} has declined from 2014.
- During the years 2016 – 2018, as well as most of 2019, an FDMS analyser was used to monitor PM_{10}, and annual mean concentrations were less than 16 $\mu g.m^{-3}$. A Fidas analyser has been in use since October 2019. Due to current uncertainties with particulate measurement techniques (pending ongoing further investigation), the Scottish Government recommends that Local authorities using Fidas analysers within the SAQD network should not consider revoking an AQMA for PM_{10} at this time.
- For $PM_{2.5}$, no concentrations in excess of the 10 $\mu g.m^{-3}$ objective have been measured in Newton since monitoring began in 2019. As $PM_{2.5}$ measurements in 2019 and 2020 were at or above the Scottish Government's uncertainty threshold of 8 $\mu g.m^{-3}$ for Fidas analysers, exceedances of the objective were possible. $PM_{2.5}$ concentrations should continue to be closely monitored in Newton.

The dispersion modelling study of current and future road traffic and domestic combustion PM_{10} and $PM_{2.5}$ emissions indicated that:

- In 2017, the PM_{10} and $PM_{2.5}$ annual mean objectives were not exceeded at any locations where relevant human exposure is present within the study area.
- Based on a sensitivity analysis of modelled pollutant concentrations using annual meteorological datasets from 2007 to 2017, it is unlikely that the PM_{10} or $PM_{2.5}$ annual mean objectives will be exceeded in a year when poorer than average dispersion occurs due to weather conditions.
- When assessing a future year of 2025 based on projected normal traffic growth, the PM_{10} and $PM_{2.5}$ annual mean objectives were not exceeded at any locations where relevant human exposure is present within the study area. West Lothian Council are not currently aware of any significant planned developments near the Newton study area.

In light of this Detailed Assessment of Air Quality, West Lothian Council may wish to delay revoking the AQMA in Newton for exceedances of the PM_{10} annual mean objective until Scottish Government guidance regarding AQMA revocation and the use of Fidas analysers for particulate measurements is updated.

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

6 Acknowledgements

Ricardo Energy & Environment gratefully acknowledges the support received from West Lothian Council when completing this assessment.

Appendices

Appendix 1: Traffic data

Appendix 2: Meteorological dataset

Appendix 3: Model verification

Appendix 4: Meteorological Analysis

Appendix 1 – Traffic Data

Table A1.1 summarises the Annual Average Daily Traffic flows (AADT) and fleet compositions used to model each road link.

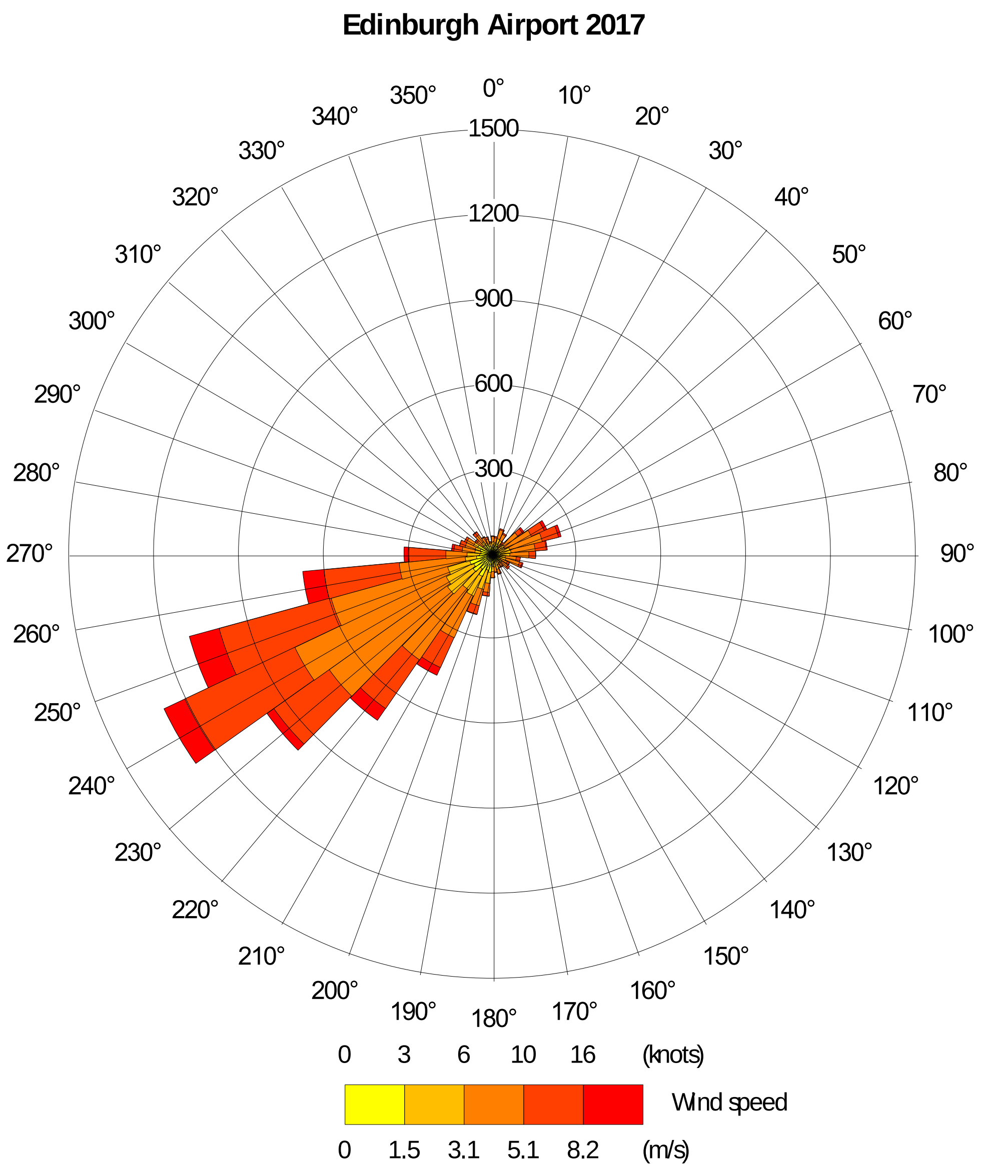
Table A1.1: West Lothian 2017 – Annual Average Daily Flows

Street name	AADT	Car	LGV	Rigid HGV	Artic HGV	Bus	Motorcycle
Main St 1	11840	80.7	15.0	1.5	2.0	0.2	0.6
Main St 2	11840	80.7	15.0	1.5	2.0	0.2	0.6
Main St 3	11840	80.7	15.0	1.5	2.0	0.2	0.6
Main St 4	11840	80.7	15.0	1.5	2.0	0.2	0.6
Main St 5	11840	80.7	15.0	1.5	2.0	0.2	0.6

Appendix 2 – Meteorological Dataset

The wind rose for the Edinburgh Airport 2017 meteorological measurement site is presented below.

Figure A2.1: Meteorological dataset wind rose



Appendix 3 – Model Verification

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in Box 7.15 of LAQM.TG(16) has been used in this case.

The modelled NO_x concentrations in this study were verified using the automatic site and one available roadside diffusion tube measurement. The following Road NO_x adjustment factor was derived**: 1.3578**.

The adjustment factor was applied to the modelled road NO_x concentrations, and the adjusted total NO_2 concentrations were then calculated using the Defra NO_x/NO_2 calculator.

After the NO_x/NO_2 model was run no further adjustments were made to the data. Model agreement for modelled vs measured NOx and NO_2 monitoring data after adjustment are presented below.

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

Model uncertainty was evaluated by calculating the root mean square error (RMSE) of the modelled vs measured annual mean NO_2 concentrations. The LAQM.TG(16) guidance suggests that an RMSE value of less than 10% of the objective being assessed indicates acceptable model performance. In this case multiple measurement were available for NO_2 only; the RMSE for NO_2 was 2.8 $\mu g.m^{-3}$, the model has therefore performed sufficiently well for this type of assessment.

For PM_{10} - when compared with the one available PM_{10} annual mean measurement from the Newton automatic analyser (minus the background component); the model was found to be underestimating the road component. A Road PM_{10} adjustment factor of 2.251 was derived and applied to all modelled Road PM concentration results prior to adding the background.

No $PM_{2.5}$ measurement data were available in 2017 so a $PM_{2.5}$ specific adjustment factor could not be derived. The PM_{10} adjustment factor was applied to modelled Road $PM_{2.5}$, and background concentrations were then added to the modelled contribution to calculate annual mean results.

Table A3.1: Measured vs modelled NO_2 annual mean – Newton 2017

Measurement site	Measured NO_2 ($\mu g.m^{-3}$)	Modelled NO_2 ($\mu g.m^{-3}$)
CM3 – Auto site	19	21.6
DT1 – Diff tube	23.3	20.3
	RMSE	**2.82**

Figure A3.1: Linear regression measured vs modelled Road NOx before and after adjustment - 2017

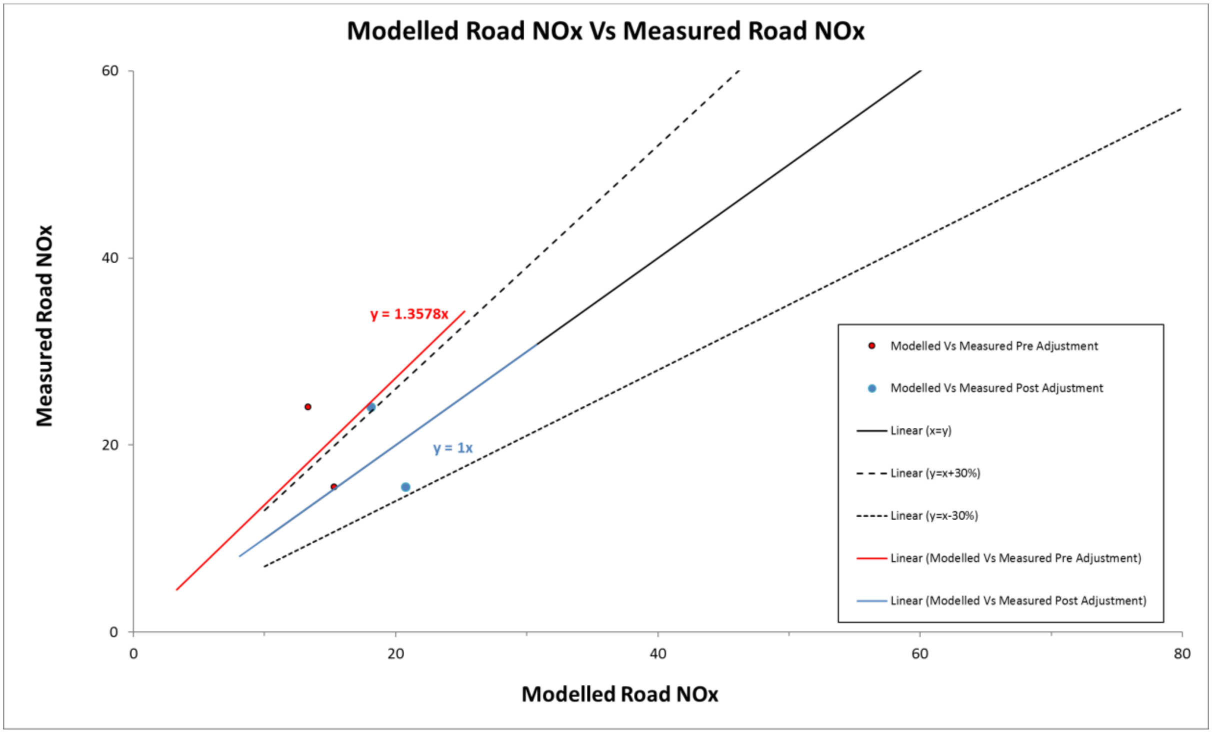
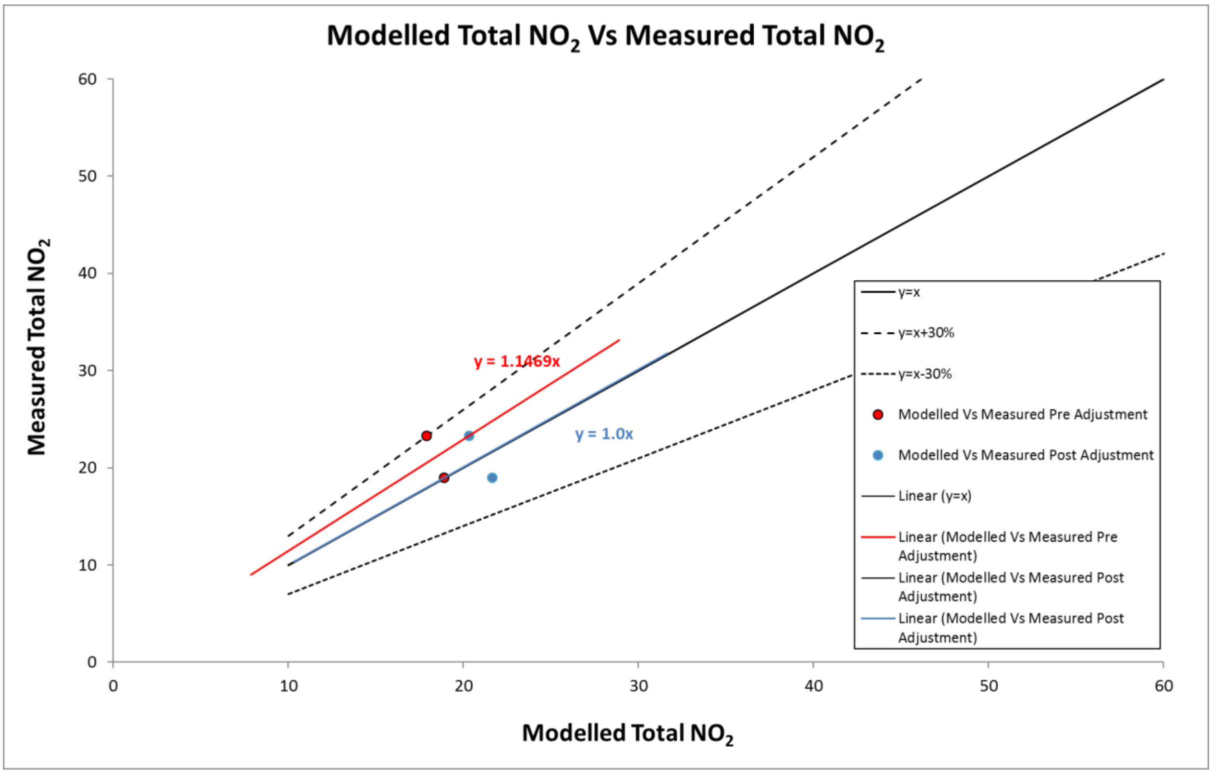


Figure A3.2 Modelled vs. measured annual mean NO_2 concentrations 2017



Appendix 4 – Meteorological Sensitivity Analysis

Table A4.2: PM_{10} meteorological sensitivity analysis results (μg.m^{-3})

Site ID/Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Newton Arms	14.8	15.0	15.2	15.8	14.9	15.3	14.8	15.0	15.1	15.6	14.8
17 Main Street	14.9	15.1	15.2	15.9	15.0	15.3	14.9	15.1	15.1	15.6	14.9
2 Main Street	14.5	14.6	14.1	14.2	14.1	14.2	14.0	14.3	13.9	14.4	14.4

Table A4.3: $PM_{2.5}$ met analysis results (μg.m^{-3})

Site ID/Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Newton Arms	9.0	9.2	9.2	9.6	9.1	9.3	9.0	9.1	9.1	9.5	9.0
17 Main Street	9.1	9.2	9.2	9.6	9.1	9.3	9.1	9.2	9.2	9.5	9.1
2 Main Street	8.8	8.9	8.5	8.6	8.5	8.6	8.5	8.7	8.4	8.7	8.7

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