



Department
for Environment
Food & Rural Affairs

Background Concentration Maps User Guide

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Department of
**Agriculture, Environment
and Rural Affairs**

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Welsh Government



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Any enquiries regarding this document/publication should be sent to us at:

laqmhlpdesk@bureauveritas.com

Change Log

Version	Date	Details of Changes Made
1	November 2024	Released with 2021 reference year background maps

Table of Contents

Introduction	1
Background Maps	3
About the Background Maps	3
Details of Available Historic Versions of the Background Maps	9
Details of Current Background Maps.....	11
Supporting Tools and Processes	14
NO ₂ Adjustment for NO _x Sector Removal	15
NO _x to NO ₂ Calculator	17
Using Background Maps to Adjust Monitoring Data	22
Glossary	23
Local Air Quality Management Helpdesk	24
Appendices	25
Appendix A: Background Maps Sectors	25
Appendix B: Manipulation of Maps without a GIS	31
Appendix C: Historic Information Regarding Background Maps.....	32
Appendix D: Impacted Grid Squares (2021 - 2040 inclusive) Identified in 2021 Reference Year Background Maps	42

Introduction

This user guide has been compiled by Bureau Veritas in the role of Project Manager for the Local Air Quality Management (LAQM) Helpdesk.

Air pollution background concentration maps are published by Defra and the Devolved Administrations to assist local authorities in carrying out Review and Assessment of local air quality as part of their duties under the [Environment Act 1995](#)¹, as amended in [2021](#)². The purpose of this user guide is to explain the background maps and the related tools that are available, and to provide guidance on their use. This user guide consolidates previously available information and guidance to local authorities on background concentration maps and supporting tools.

UK background maps are made available for a reference year and projected future years for a range of pollutants including oxides of nitrogen (NO_x), nitrogen dioxide (NO₂) and particulate matter (PM₁₀ and PM_{2.5}). The Scottish Government publishes separate maps for use by Scottish authorities and these are also mentioned in this guide. Maps with Northern Ireland coordinate references are also available.

New background maps are released by Defra periodically due to updates to the underlying data, including emissions factors. Details on the supporting assumptions and input data are provided in this guide to aid understanding.

Local authorities should use the most up-to-date data and supporting tools made available, which have been updated for their use with the 2021 reference year maps.

For NO_x, NO₂, PM₁₀ and PM_{2.5} the current reference year is 2021. For 2010 and 2011 reference years, correction factors are available to counter the effects of unusual meteorology on NO₂ (2010 only) and PM₁₀ (2011 only). This guide also details the historic versions of all maps that have been published.

For carbon monoxide (CO) the current Pollution Climate Mapping (PCM) background maps extend to 2010 inclusive. The PCM background maps extend to 2023 inclusive for sulphur dioxide (SO₂) and benzene. These maps differ to those for NO_x, NO₂, PM₁₀ and PM_{2.5} in so far that they do not provide source sector contributions to the total background pollutant concentration, nor are projections available for future assessment years (the latest year for which background concentrations are available is presently 2023). No background concentration maps are presently available for 1,3-butadiene.

¹ <https://www.legislation.gov.uk/ukpga/1995/25/contents>

² <https://www.legislation.gov.uk/ukpga/2021/30/contents>

A number of techniques and tools are available to support and help local authorities in their use of the background maps. The techniques that are detailed include:

- Removing the Influence of Unusual Pollution Years;
- NO₂ Adjustment for NO_x Sector Removal;
- Using Background Maps to Adjust Monitoring Data;
- Reference Year Queries and Data Availability; and
- Manipulation of Background Maps without GIS (Geographical Information System).

The supporting tools are:

- NO_x to NO₂ Calculator; and
- NO₂ Adjustment for NO_x Sector Removal Tool.

The previous year adjustment factors provided for projecting 2001 reference year background concentrations of carbon monoxide, benzene and 1,3-butadiene have been removed and are no longer considered relevant. An alternative methodology for estimating background concentrations of these pollutants is now provided.

Further details on these are provided as part of this user guide.

Background Maps

About the Background Maps

Main Purpose

The main purpose of the background maps is to provide estimates of background concentrations for specific pollutants. These can then be used in air quality assessments to better understand the contribution of local sources to total pollutant concentrations. They provide information on how pollutant concentrations change over time and across a wide area. They also provide an estimated breakdown of the relative sources of pollution.

The maps allow for the assessment of new pollutant sources that are introduced into an area and the impact they may have upon local air quality.

Definition of Background Concentrations

The total concentration of a pollutant comprises those from explicit local emission sources such as roads, chimney-stacks, etc., and those that are transported into an area by the wind from further away. If all the local sources were removed, all that would remain is that which comes in from further away; it is this component that is called 'background'.

In many situations the background contribution may represent a significant or dominant proportion of the total pollutant concentration, so it is important that authorities give this careful consideration. A good understanding of background concentrations is important when completing air quality assessments as this in turn allows for a good understanding of local pollutant sources.

Data Content and Format

The following provides details on the data content of the background maps and the format in which the data are available.

Local Authorities

Background maps are available for each local authority in England, Wales, Scotland and Northern Ireland. It is possible to select the preferred pollutant and the year desired using the data selector drop-down on the background maps area of the [UK-AIR website](https://uk-air.defra.gov.uk/data/laqm-background-home)³.

Mapped background concentrations for use in LAQM Review and Assessments undertaken by Scottish local authorities are available on the [Scottish Air Quality website](https://www.scottishairquality.scot/data/mapping/data)⁴. These maps

³ <https://uk-air.defra.gov.uk/data/laqm-background-home>

⁴ <https://www.scottishairquality.scot/data/mapping/data>

are available for NO_x, NO₂ and PM₁₀ only, together with a document setting out the methodology. Further detail on the differences between the background maps for Scotland provided on the UK-AIR website and those on the Scottish Air Quality website is provided on page 5.

Pollutants

The background maps contain estimates of pollutant concentrations based on an average over a year (annual average) for the following pollutants:

Reference Year
2021
<ul style="list-style-type: none">• NO_x• NO₂• PM₁₀• PM_{2.5}

Spatial and Temporal Resolution

The background pollutant concentration maps are presented in 1km x 1km grid squares across England, Wales, Scotland and Northern Ireland. The current version of the background maps (reference year 2021) contains estimates for NO_x, NO₂, PM₁₀ and PM_{2.5} for the period 2021 through to 2040.

For SO₂, PCM background maps are available for the period 2002 to 2023 inclusive. For benzene, PCM background maps are available for the period 2003 to 2023 inclusive. For CO, PCM background maps are available for the period 2002 to 2010 inclusive. No background concentration maps are presently available for 1,3-butadiene. If assessing these pollutants, users are advised to follow the steps on page 22 of this user guide.

Source Sectors

The background map total concentrations for NO_x, PM₁₀ and PM_{2.5} are made up of contributing source sectors. The source sectors include transport, industry and commercial. For the full list of sectors for each pollutant please see [Appendix A: Background Maps Sectors](#).

Source sectors are also split into those emitted from within a grid square and those that enter the grid square from outside. In presenting the data in this way, the individual sectors can be subtracted from the total background where a more detailed local assessment is to be carried out for that sector. This approach reduces the risk of double counting pollutant concentrations by avoiding the inclusion of both the estimated background component and the detailed sector component being evaluated.

What Maps are Available?

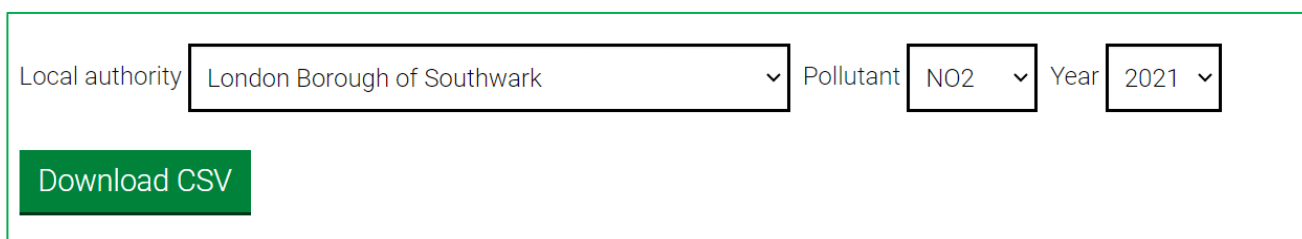
Location	
<p>UK (including England, Wales Scotland and Northern Ireland)</p>	<p>Available from UK-AIR³.</p> <p>UK background maps are available for NO_x, NO₂, PM₁₀ and PM_{2.5}. The modelling methodology is based on the UK Pollution Climate Mapping (PCM) approach, used to model the annual mean background and roadside concentrations for the UK as a whole.</p>
<p>Scotland</p>	<p>Available from the Scottish Air Quality website⁴.</p> <p>Scottish background maps are available for NO_x, NO₂ and PM₁₀. Scotland specific maps are not currently available for PM_{2.5}. The Scotland specific-model differs from the UK PCM model, only in that it uses Scottish monitoring data and Scottish meteorological data exclusively to model the annual mean background and roadside concentrations for Scotland.</p>
<p>Northern Ireland</p>	<p>Available from UK-AIR³.</p> <p>Northern Ireland background maps are available for NO_x, NO₂, PM₁₀ and PM_{2.5}. These files are based on the same information as those provided in the UK version which is based on grid squares from the Great Britain OS (GBOS), except they are calculated based on area weighted averages of the GBOS data.</p> <p><i>Note: Some coastal grid squares are missing in this data set, or have much lower concentration values than adjacent squares as a result of the data conversion. Values for adjacent grid squares may be used if required.</i></p> <p>These data are likely to be appropriate for analyses in which the background concentrations will be combined with other geographical information on the Northern Ireland OS (NIOS) grid.</p>

How do I Access the Latest Maps?

UK (GBOS co-ordinates)

The current background concentration maps for England, Wales, Scotland and Northern Ireland (2021 reference year) are available from [UK-AIR](#)⁵.

To get the background concentrations, use the drop-down selectors to choose the Local Authority, Pollutant and Year required. Then click on the 'Download CSV' button.

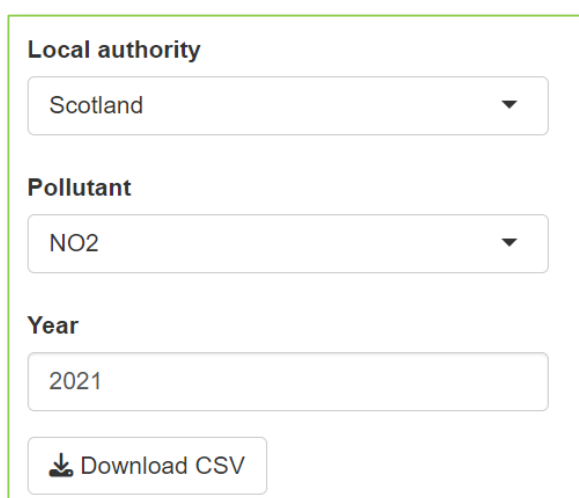


Local authority: London Borough of Southwark
Pollutant: NO2
Year: 2021
[Download CSV](#)

Scotland (GBOS co-ordinates)

The current background concentration maps for Scotland (using a 2018 reference year), which incorporate Scotland specific-modelling, are available from the [Scottish Air Quality website](#)⁴.

To get the background concentrations use the drop-down selectors to choose the Local Authority, Pollutant and Year required. Then click on the 'Download CSV' button.



Local authority: Scotland
Pollutant: NO2
Year: 2021
[Download CSV](#)

⁵ <https://uk-air.defra.gov.uk/data/lqgm-background-maps?year=2021>

IMPORTANT: The current Scottish specific maps are based on a 2018 reference year. In the interim period whilst these are updated, users are advised to continue to use the 2018 reference year Scottish background maps for Scottish Local Authorities, in preference to the 2021 reference year UK-wide background maps.

IMPORTANT: Users should not use the Scottish specific maps with the NO₂ Adjustment for NO_x Sector Removal Tool as the underlying assumptions vary between the two (there is an alternative version of this tool for the Scottish specific maps - see Supporting Tools and Processes for more information).

Northern Ireland (NIOS co-ordinates)

The current background concentration maps for Northern Ireland (2021 reference year) are available from [UK-AIR](#)⁵. A file is also available for each year between 2021 and 2040 covering all of Northern Ireland that provides the maps for Northern Ireland on the NIOS grid.

To get the background concentrations use the drop-down selectors to choose the Pollutant and Year required. Then click on the 'Download CSV' button.

Download Northern Ireland Data Sets based on NIOS co-ordinates

These files are based on the same information as those provided in the GBOS version, except they are calculated based on area weighted averages of the GBOS data.

Pollutant Year

Note that all Northern Ireland local authority data are downloaded together.

IMPORTANT: Users should not use the Northern Ireland specific maps with NIOS co-ordinates with the NO₂ Adjustment for NO_x Sector Removal Tool as the co-ordinate systems are incompatible (see Supporting Tools and Processes for more information).

How do I Visualise the Latest Maps?

Once downloaded from the relevant websites you may wish to review the background concentration map data visually. This is traditionally completed using a GIS. Where a GIS is not available, the background maps can be manipulated using the Excel function 'pivot table'. Further details of this function are provided in Appendix B.

How are they Generated?

The Air Quality Standards Regulations 2010 (as amended) on ambient air quality require the UK to undertake air quality assessments, and to report the findings of these assessments on an annual basis.

As part of this reporting, background pollution maps at 1km x 1km resolution are modelled. These background pollution maps form the basis of the local authority background maps. The total modelled background concentrations are split by source sector and projected to future years to aid the LAQM process.

Details of Available Historic Versions of the Background Maps

Reference Year	
2021 (Current Version for NO_x, NO₂, PM₁₀ and PM_{2.5})	<p>The 2021 reference year background maps are the most up-to-date version of the background maps for NO_x, NO₂, PM₁₀ and PM_{2.5} and should be used for all new air quality assessments of these pollutants. Within these maps, background concentrations are available for 2021 to 2040.</p> <p>These 2021 reference year maps have been calibrated using 2021 monitoring and meteorological data.</p>
2018	<p>The 2018 reference year version of the background maps should not be used for new air quality assessments.</p> <p>These 2018 reference year maps are available for 2018 to 2030 and have been calibrated using 2018 monitoring and meteorological data.</p>
2017	<p>The 2017 reference year version of the background maps should not be used for new air quality assessments.</p> <p>These 2017 reference year maps are available for 2017 to 2030 and have been calibrated using 2017 monitoring and meteorological data.</p>
2015	<p>The 2015 reference year version of the background maps should not be used for new air quality assessments.</p> <p>These 2015 reference year maps are available for 2015 to 2030 and have been calibrated using 2015 monitoring and meteorological data.</p>
2013	<p>The 2013 reference year version of the background maps should not be used for new air quality assessments.</p> <p>These 2013 reference year maps are available for 2013 to 2030 and have been calibrated using 2013 monitoring and meteorological data.</p>
2011	<p>The 2011 reference year version of the background maps should not be used for new air quality assessments.</p> <p>These 2011 reference year maps are available for 2011 to 2030 and have been calibrated using 2011 monitoring and meteorological data.</p>
2010	<p>The 2010 reference year version of the background maps should not be used for new air quality assessments.</p>

Reference Year	
	The 2010 reference year maps are available for 2010 to 2030 and have been calibrated using 2010 monitoring and meteorological data.
2008, 2006 and 2004	Older versions of the background pollutant concentration maps exist with 2008, 2006 and 2004 reference years. These maps are no longer available for use in air quality assessment as they have been superseded by the current maps.
2001	<p>The 2001 maps were inclusive of SO₂, CO, benzene and 1,3-butadiene. Within these maps background concentrations were available for 2001, 2003 and 2010, with year adjustment factors provided up to and including 2025.</p> <p>These 2001 reference year maps were calibrated using 2001 monitoring and meteorological data.</p> <p>These maps have been superseded and are no longer available for use in air quality assessment.</p>

For further details on the 2018, 2017, 2015, 2013, 2011, 2010, 2008, 2006 and 2004 reference year background maps, please see Appendix C.

Details of Current Background Maps

NO_x, NO₂, PM₁₀ and PM_{2.5}

The 2021 reference year background maps are based on monitoring and meteorological data for 2021. They have been produced to incorporate more up to date information. A full description of the reference year model for 2021 is provided in the [technical report on UK supplementary assessment for 2021](#)⁶.

Emissions estimates based on the UK [National Atmospheric Emissions Inventory \(NAEI\)](#)⁷ 2020 are the main source of input data for the 2021 reference year background maps. The NAEI emissions mapping method is described elsewhere in detail in the NAEI UK Emission Mapping Methodology 2021 Report⁶. However, the following is provided by way of a brief summary of the key input data, assumptions and changes relative to the 2018 reference year background maps:

- The 2021 reference year background maps are based on ambient monitoring and meteorological data for 2021;
- The emissions projections for non-road traffic sources in the 2021 reference year background maps are based on [Updated Energy & Emissions Projections 2021](#)⁸ from the Department for Business, Energy and Industrial Strategy (BEIS);
- The 2021 reference year background maps are based upon the COPERT 5.4 NO_x and PM emission factors for road traffic, as taken from the European Environment Agency (EEA) [COPERT 5.4 emission calculation tool](#)⁹ (October 2020 version), inclusive of Euro 6 sub-categories;
- Outside of London, the 2021 reference year background maps road transport emissions are based on projections within NAEI 2020¹⁰, car sales and vehicle km split projections from DfT (January 2022), LGV sales from DfT (2018) and LGV vehicle km split from DfT (January 2022). Vehicle km projections for 2022 onwards for GB use DfT's traffic estimates received in December 2022 (core scenario)¹¹;

⁶ Tsagatakis, I., Richardson, J., Evangelides, C., Pizzolato, M., Richmond, B., Hows, S-M., Pearson, B., Passant, N., Pommier, M. & Otto, A. (2022) UK Spatial Emissions Methodology: A report of the National Atmospheric Emission Inventory 2021. Retrieved from: <https://naei.energysecurity.gov.uk/reports/uk-spatial-emissions-methodology-report-national-atmospheric-emission-inventory-2021>

⁷ <https://naei.beis.gov.uk/>

⁸ <https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2018>

⁹ <https://copert.emisia.com/>

¹⁰ <https://naei.beis.gov.uk/>

¹¹ <https://www.gov.uk/government/publications/national-road-traffic-projections>

- Within London, the 2021 reference year background maps are based on bespoke vehicle fleet information and projections for London provided by Transport for London (TfL) in 2019. The 2021 reference year background maps are inclusive of the impact from 2019 onwards of the ULEZ in central London, the TfL bus fleet meeting the ULEZ requirements London-wide in 2020 and all new taxis registered from 2018 onwards being Zero Emissions Capable (ZEC). They are also inclusive of the extension of the ULEZ into the whole of London in August 2023;
- Localised projections are derived from reference year Automatic Number Plate Recognition (ANPR) data for Leeds, Birmingham Clean Air Zone (CAZ) and Bath CAZ. Projections are derived from NAEI inclusive of the impact of CAZs for Bradford CAZ, Portsmouth CAZ, Bristol CAZ, Sheffield CAZ, Newcastle and Gateshead CAZ;
- For secondary inorganic aerosol precursor emissions, UK emissions are consistent with NAEI projections. Non-UK emissions are taken from National Air Pollution Control Programme (NAPCP) projections found in Table 3.1 of 'Support to the development of the second Clean Air Outlook'¹².

For NO_x, NO₂, PM₁₀ and PM_{2.5}, the most current version of the background maps (i.e. 2021) should be used.

Analysis of the 2021 reference year background maps has identified a small number of grid squares for all years (i.e. 2021 to 2040 inclusive) with unexpectedly high background NO_x and NO₂ concentrations. This appears to be related to 'SNAP 2' commercial area emissions. For the full list of the impacted grid squares, please see Appendix D.

The background NO_x and NO₂ concentration data for these grid squares has therefore been removed and are instead labelled as 'MISSING'. For users undertaking LAQM studies in the affected areas, it is recommended that background concentrations from a nearby grid square are used instead. Due care should be taken to ensure that the selected nearby grid square to be used as an alternative is a reasonable proxy for the affected grid square, e.g. it would not be sensible to select a nearby grid square that has a significant contribution from motorway sources if no motorways are present within the affected square.

Please note, the PM₁₀ and PM_{2.5} background concentrations for these grid squares are not impacted and can be used in the usual manner.

SO₂, CO, Benzene and 1,3-Butadiene

PCM background concentration maps are available for SO₂, CO and benzene. The PCM background concentration maps are a separate resource to the background concentration maps developed for LAQM purposes.

SO₂:

- Year 2002 to 2023 maps available.

¹² <https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/fd58ae9b-6b7d-44bb-ba55-4e982390928b/details>

Benzene:

- Year 2003 to 2023 maps available.

CO:

- Year 2002 to 2010 maps available.

1,3-Butadiene:

- No PCM background map data is available for 1,3-Butadiene. Users are advised to contact the [LAQM Helpdesk](#) to seek advice before proceeding with assessment of 1,3-Butadiene.

In the absence of any background concentration mapped estimates for years after the most recent year available, as a conservative approach it is advised to use the most recent year PCM background concentrations of SO₂, benzene and CO.

Users undertaking LAQM Review and Assessments for SO₂, benzene, CO or 1,3-butadiene are advised to first contact the [LAQM Helpdesk](#)¹³ to seek the latest advice before proceeding with the assessment.

If assessing these pollutants, users are advised to follow the steps on page 22 of this user guide.

¹³ <https://laqm.defra.gov.uk/helpdesk/>

Supporting Tools and Processes

The tools listed below may be required to support the use of the air pollution background concentration maps in air quality assessments. When undertaking an assessment, please ensure to use the tools that correspond with the version of the background concentration maps being used.

IMPORTANT: If and when previous reference year background maps are being used (i.e. 2018 and previous years) the corresponding version of the Supporting Tools should also be used. If not publicly available, these can be requested from the LAQM Helpdesk.

For further details on how to use these tools, please refer to the relevant section within this user guide.

NO₂ Adjustment for NO_x Sector Removal

The background maps for NO_x concentrations are split into source sectors. When removing sectors from the background NO_x concentrations to avoid double counting in the modelling process, it is necessary to adjust the NO₂ concentrations in proportion to the reductions in NO_x as a result of removing the specific source sector(s).

The latest version of the tool (Version 9.0), which replaces Version 8.1, can be downloaded from the [LAQM website](#)¹⁴.

IMPORTANT: This tool should only be used with the UK-wide GBOS co-ordinate background maps, and not with either the Scottish specific or the NIOS co-ordinate background maps. This tool is presently not compatible with these two data sets.

Users of the Scottish specific background maps should instead use the NO₂ Adjustment for NO_x Sector Removal Function published on the [Scottish Air Quality website](#)⁴. Use of the Scottish specific function is comparable to that described below, the main difference being that the tool is embedded on the website, with the user selecting options via a series of drop-down menus and calculations taking place behind-the-scenes. A separate user guide for the Scottish specific function is available via the above link.

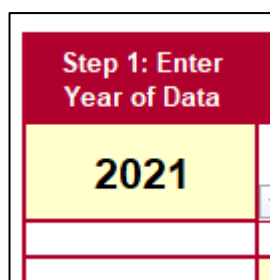
A worked example covering the application of the NO₂ Adjustment for NO_x Sector Removal Tool is presented below.

Worked Example: Removing Road Traffic Sectors from NO_x and NO₂ Background Maps

The procedure for removing road traffic sectors from the mapped background NO_x and NO₂ concentrations to avoid the issue of double counting in the modelling process is undertaken as follows:

Step 1:

Enter the background year required (2021 - 2040).



Step 2:

¹⁴ <https://laqm.defra.gov.uk/air-quality/air-quality-assessment/no2-adjustment-for-nox-sector-removal-tool/>

Enter the information from the background maps. Concentrations are in $\mu\text{g}/\text{m}^3$.

Step 2: Mapped Background Information ($\mu\text{g}/\text{m}^3$)					
Mapped Background Grid Square Coordinates		Mapped Total NO_x	Mapped NO_x Road Traffic Sectors	Mapped NO_x Non-Road Sectors	Mapped Total NO_2
X	Y	Total_ NO_x	Sum NO_x Roads	Sum NO_x Non-Roads	Total_ NO_2
578500	162500	21.02	7.25	13.77	15.27

Step 3:

Enter NO_x concentration ($\mu\text{g}/\text{m}^3$) to be removed. This concentration should either be input into the 'Road' or 'Non-Road' box depending on the source type. In this example, the source sector that is to be removed from the maps is "Primary A road out". The original mapped NO_x "Primary A road out" source contribution is $1.24\mu\text{g}/\text{m}^3$.

Step 3: NO_x to be Removed ($\mu\text{g}/\text{m}^3$)	
Enter the Sum of Road NO_x to be removed	Enter the Sum of Non-Road NO_x to be removed
1.24	0.00

Step 4:

Run the NO_2 Adjustment for NO_x Sector Removal Tool by clicking on the 'Run Tool' button, to obtain revised mapped background NO_x and NO_2 concentrations following sector removal. In this example the revised total NO_2 is $14.55\mu\text{g}/\text{m}^3$.

Results for Background Year 2021			
Revised NO_x Totals ($\mu\text{g}/\text{m}^3$)			Revised NO_2 ($\mu\text{g}/\text{m}^3$)
Revised NO_x Road Traffic Sectors	Revised NO_x Non-Road Sectors	Revised Total NO_x	Revised Total NO_2 after NO_x removal
6.01	13.77	19.78	14.55

NO_x to NO₂ Calculator

This calculator allows local authorities to derive NO₂ from NO_x wherever NO_x is predicted by modelling emissions from roads. The calculator can also be used to calculate the road component of NO_x from roadside NO₂ concentrations.

The latest version of the tool (Version 9.1), which replaces Version 8.1, includes updated estimates of regional concentrations of NO_x, NO₂ and O₃ above the surface layer, and fractions of vehicle NO_x emissions emitted directly as NO₂ (f-NO₂), consistent with the NAEI. It also provides the ability to include user defined f-NO₂ values (e.g. those estimated by the Primary NO₂ Fraction Advanced Option of the latest version of the [Emissions Factors Toolkit](#)¹⁵), in place of the provided default values¹⁶.

Version 9.1 of the tool should only be used with the 2021 reference year background map concentrations and can be used for years 2021 to 2040. The latest version of the tool can be downloaded from the [LAQM website](#)¹⁷.

General Inputs:

This spreadsheet allows the user to specify input parameters that generally apply throughout the calculation. These include the regional concentrations of ozone, oxides of nitrogen and nitrogen dioxide above the surface layer and the fraction of oxides of nitrogen emitted as nitrogen dioxide.

1) Specify year of modelling assessment or monitoring.
Use the scroll bar to scroll the year up or down.

2021

2) Specify the local authority.
Use the combobox to select your local authority.

Southwark

3) Estimated regional concentrations above the surface layer.

Ozone	48.8	µg m ⁻³
Oxides of nitrogen	22.8	µg m ⁻³ as NO ₂
Nitrogen dioxide	16.6	µg m ⁻³

4) Specify the traffic mix.
Use the combobox bar to select your traffic mix.

All London traffic

Fraction NO_x emitted from local road vehicles as NO₂: 0.171751

Regional fraction NO_x emitted as NO₂: 0.171751

¹⁵ <https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/>

¹⁶ Providing a user defined f-NO₂ value replaces the fraction of NO_x emitted from local road vehicles as NO₂ and does not impact the regional fraction NO_x emitted as NO₂. In such circumstances, the regional fraction will remain as per the default value specified on the General Inputs tab.

¹⁷ <https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator/>

1. Specify the year of the modeling assessment or diffusion tube measurements.
2. Select the local authority: the spreadsheet will provide an estimate of the regional O₃, NO_x and NO₂ concentrations above the surface layer. These provide information about the amount of oxidant available in the atmosphere.
3. Specifying a representative traffic mix: the spreadsheet will estimate the fraction of vehicle NO_x emissions emitted as NO₂ (f-NO₂).

The traffic mix dropdown box contains six options:

- All UK traffic;
- All London traffic;
- All other urban UK traffic;
- All non-urban UK traffic;
- Buses outside London; and
- Buses in London.

The descriptors “urban” and “non-urban” are based upon the DfT’s definition: an urban road is a road within an urban area with a population of 10,000 or more. However, traffic on motorways within urban areas, including London, should be considered separately. It is also recognised that study areas (and roads) which cross more than one area definition are difficult to include. The following is advised:

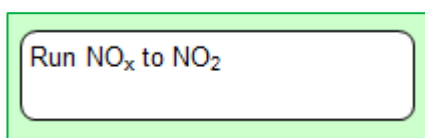
- “*All UK traffic*” should only be used if none of the other options given below are suitable for your data.
- “*All London traffic*” can be used anywhere in London except adjacent to motorways or where buses dominate the vehicle fleet.
- “*All other urban UK traffic*” is an average of all urban roads outside of London, excluding motorways in urban areas. If your receptors or diffusion tubes are in an urban area and not near to motorways, you can use this option.
- “*All non-urban UK traffic*” gives a national average of traffic on non-urban roads and all motorways. If your receptors or diffusion tubes are outside of urban areas or near to any motorway, even in urban areas, you can use this option.
- “*Buses outside London*” can be used outside London where buses dominate your local fleet.
- “*Buses in London*” can be used inside London where buses dominate your local fleet.

In some situations, you may have sufficiently detailed information to calculate your own "f-NO₂" value. The latest version of the EFT¹⁵ provides an estimate of the Primary Fraction of NO₂ (f-NO₂) using the Primary NO₂ Fraction Advanced Option. f-NO₂ values are provided at the individual link level and also as a weighted average according to the contribution each vehicle type makes to total NO_x emissions from traffic associated with all links as entered into the EFT. The f-NO₂ values for each vehicle type that are employed as part of the calculation are consistent with those applied on the NAEI.

When you enter user defined f-NO₂ values directly into the calculator, a traffic mix must be specified in "General Inputs" to account for the appropriate regional f-NO₂.

NO_x to NO₂ Tab:

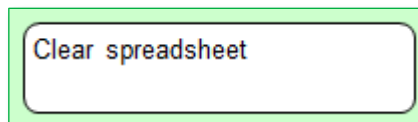
- 1) Confirm that the General inputs spreadsheet has been completed.
- 2) Type in:
 - A Receptor ID and its Easting and Northing (Optional);
 - The modelled contribution from roads to oxides of nitrogen concentrations (Road increment NO_x); and
 - The local background concentration as NO₂ (2 decimal places). You may alternatively enter the local background as NO_x, as the calculations are faster if you input background NO_x rather than background NO₂. Leave the redundant background NO_x or NO₂ columns blank as appropriate. If both NO_x and NO₂ background concentrations are entered, the calculations will be based on the entered background NO₂ concentration.
- 3) The default set-up is to use the fraction of oxides emitted as NO₂ from the General Inputs spreadsheet. We recommend that the majority of users therefore leave the "Fraction emitted as NO₂" column empty to use the default set-up. However, you can overwrite the defaults by typing appropriate values (0-1) into this column. The f-NO₂ tab provides additional values.
- 4) Click the 'Run NO_x to NO₂' button to run the tool, which will then calculate:
 - The total nitrogen dioxide concentration at the receptor (Total NO₂); and
 - The incremental contribution to nitrogen dioxide concentrations from the road vehicle emissions (Road Increment NO₂).



An example of indicative inputs and output results is provided below (note these values are for the purposes of this example only):

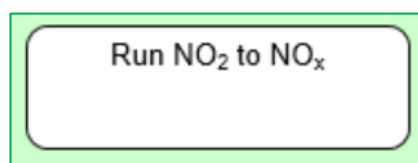
Local Authority: Southwark			Year: 2021				Traffic Mix: All London traffic		
Receptor ID	Easting, m	Northing, m	Road increment NO _x µg m ⁻³	Background NO _x	µg m ⁻³ NO ₂	User defined local traffic mix fraction emitted as NO ₂ (fNO ₂)	Total NO ₂ µg m ⁻³	Road increment NO ₂ µg m ⁻³	Notes
1	531500	180500	46.13		43.71		57.87	14.16	

Click on the 'Clear spreadsheet' button to clear the spreadsheet to run new results.



NO₂ to NO_x Tab:

- 1) Confirm that the General inputs spreadsheet has been completed.
- 2) Type in:
 - *The site identifier (Site ID) [Optional];*
 - *The nitrogen dioxide concentration measured by the diffusion tube or modelled (Total NO₂); and*
 - *The local background concentration as NO₂. You may alternatively enter the local background as NO_x. Leave the redundant background NO_x or NO₂ columns blank as appropriate.*
- 3) Hit the 'Run' button to run the tool. The tool will calculate the incremental contribution to oxides of nitrogen concentrations from the road vehicle emissions (Road Increment NO_x).



4) See below an example of indicative results (note these values are for the purposes of this example only):

Local Authority: Southwark			Year: 2021				Traffic Mix: All London traffic		
Site ID	Total NO ₂ , µg m ⁻³	Background µg m ⁻³		Road increment NO _x µg m ⁻³	User defined local traffic mix fraction emitted as NO ₂ (fNO ₂)	Notes			
		NO _x	NO ₂						
1	59.24		43.71	51.39					

5) Hit the 'Clear spreadsheet' button to clear the spreadsheet to run new inputs.

Clear spreadsheet

Using Background Maps to Adjust Monitoring Data

NO_x, NO₂, PM₁₀ and PM_{2.5}

The most up-to-date background maps can be used to adjust annual mean background monitoring data values for NO_x, NO₂, PM₁₀ and PM_{2.5} to a different year, as explained in paragraph 7.75 on page 100 of [LAQM.TG\(22\)](#)¹⁸.

SO₂, CO, Benzene and 1,3-Butadiene

For the pollutants SO₂, CO and benzene only, in the absence of any background concentration mapped estimates for years after the most recent year available, as a conservative approach it is advised to use the most recent year PCM background concentrations. The PCM background maps are available for download in (CSV) format.

Users should note that the PCM background concentration maps are a separate resource to the background concentration maps developed for LAQM purposes. The PCM background concentrations maps should be used for the pollutants SO₂, CO and benzene only.

PCM background maps for SO₂, CO and benzene can be found in the [Modelled background pollution data published on the UK-Air website](#)¹⁹. The PCM models are routinely reviewed and methods improved, with the associated PCM background maps updated on an annual basis. The PCM modelling methodology for the reference year 2022 is discussed within the following [Technical Report](#).

No PCM background concentration maps are presently available for 1,3-butadiene.

Users undertaking LAQM Review and Assessment studies for SO₂, benzene, CO or 1,3-butadiene are advised to first contact the [LAQM Helpdesk](#)²⁰ to seek the latest advice before proceeding with the assessment.

¹⁸ <https://laqm.defra.gov.uk/air-quality/featured/uk-regions-exc-london-technical-guidance/>

¹⁹ <https://uk-air.defra.gov.uk/data/pcm-data>

²⁰ <https://laqm.defra.gov.uk/helpdesk/>

Glossary

Term	Definition
1,3-Butadiene	1,3-Butadiene is a VOC emitted into the atmosphere principally from fuel combustion of petrol and diesel vehicles. 1,3-butadiene is also an important chemical in certain industrial processes, particularly the manufacture of synthetic rubber.
AURN	Automatic Urban and Rural Network
Benzene	Benzene is a volatile organic compound (VOC) which is a minor constituent of petrol. The main sources of benzene in the atmosphere in Europe are the distribution and combustion of petrol. Of these, combustion by petrol vehicles is the single biggest source (70% of total).
CO	Carbon monoxide (CO) is a colourless, odourless poisonous gas produced by incomplete, or inefficient, combustion of fuel. It is predominantly produced by road transport, in particular petrol-engine vehicles.
DfT	Department for Transport
f-NO₂	Primary NO ₂ Fraction
GIS	Geographical Information System
HGV	Heavy Goods Vehicles
HDV	Heavy Duty Vehicles. It encompasses Rigid and Artic Heavy Goods Vehicles and Buses/Coaches
LAQM	Local Air Quality Management
LDV	Light Duty Vehicles. It encompasses cars, taxis (black cabs London), and vans
LGV	Light Goods Vehicles
Local pollutant sources	Emissions from sources such as roads, chimney-stacks, etc.
NAEI	National Atmospheric Emissions Inventory
NO₂	Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. NO is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidized, mainly by ozone (O ₃), to nitrogen dioxide (NO ₂), which can be harmful to health
NO_x	NO ₂ and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO _x)
PM₁₀	Particulate Matter less than 10µm in aerodynamic diameter
PM_{2.5}	Particulate Matter less than 2.5µm in aerodynamic diameter
SO₂	Produced when a material, or fuel, containing sulphur is burned. Globally, much of the sulphur dioxide (SO ₂) in the atmosphere comes from natural sources, but in the UK the predominant source are power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO ₂ .
Source sectors	Emissions from sectors such as industrial processes, combustion, transport and residential and commercial combustion

Local Air Quality Management Helpdesk

This Helpdesk has been set up on behalf of Defra and the Devolved Administrations to offer assistance to local authorities in managing air pollution in their area. The Helpdesk provides:

- answers to local authorities' questions on air quality monitoring, modelling and emissions inventories;
- information and guidance to assist local authorities in carrying out the LAQM Review and Assessment process required under Part IV of the Environment Act 1995; and
- information and guidance to assist local authorities in preparing and implementing Air Quality Action Plans for improvement of local air quality.

Contact details for the LAQM Helpdesk can be found at:

<https://laqm.defra.gov.uk/helpdesk/>

Appendices

Appendix A: Background Maps Sectors

Background Maps Headers and Sectors – NO _x	
Header	Description
Local_Auth_Code	Unique code for each local authority
X	Easting of centre of grid square (meters)
Y	Northing of centre of grid square (meters)
Geo_area	Unique code for each DA, inner and outer London
EU_zone_agglom	Unique code for each EU reporting zone and agglomeration
Total_NOx	Total concentration (sum of all sectors)
Motorway_in	Motorway in square sources
Motorway_out	Motorways out square sources
Trunk_A_Rd_in	Trunk A roads in square sources
Trunk_A_Rd_out	Trunk A roads out square sources
Primary_A_Rd_in	Primary A roads in square sources
Primary_A_Rd_out	Primary A roads out square sources
Minor_Rd+Cold_Start_in	Minor roads and cold start in square sources
Minor_Rd+Cold_Start_out	Minor roads and cold start out square sources
Industry_in	Industry area in square sources (combustion in industry, energy production, extraction of fossil fuel and waste)

Background Maps Headers and Sectors – NO_x

Industry_out	Industry area out square sources (combustion in industry, energy production, extraction of fossil fuel and waste)
Domestic_in	Domestic, institutional and commercial space heating in square sources
Domestic_out	Domestic, institutional and commercial space heating out square sources
Aircraft_in	Aircraft in square sources
Aircraft_out	Aircraft out square sources
Rail_in	Rail in square sources
Rail_out	Rail out square sources
Other_in	Other in square sources (ships, off-road and other emissions)
Other_out	Other out square sources (ships, off-road and other emissions)
Point_Sources	Point sources
Rural	Regional rural concentration

Background Maps Headers and Sectors – PM₁₀

Header	Description
Local_Auth_Code	Unique code for each local authority
X	Easting of centre of grid square (meters)
Y	Northing of centre of grid square (meters)
Geo_area	Unique code for each DA, inner and outer London
EU_zone_agglom	Unique code for each EU reporting zone and agglomeration
Total_PM10	Total concentration (sum of all sectors)
Motorway_in	Motorway in square sources
Motorway_out	Motorways out square sources
Trunk_A_Rd_in	Trunk A roads in square sources
Trunk_A_Rd_out	Trunk A roads out square sources
Primary_A_Rd_in	Primary A roads in square sources
Primary_A_Rd_out	Primary A roads out square sources
Minor_Rd+Cold_Start_in	Minor roads and cold start in square sources
Minor_Rd+Cold_Start_out	Minor roads and cold start out square sources
Brake+Tyre_in	Brake and Tyre wear emissions in square sources
Brake+Tyre_out	Brake and Tyre wear emissions out square sources
Road_Abrasion_in	Road Abrasion emissions in square sources
Road_Abrasion_out	Road Abrasion emissions out square sources

Background Maps Headers and Sectors – PM₁₀

Industry_in	Industry area in square sources (agriculture, combustion in industry, construction, energy production, extraction of fossil fuel, processes in industry, quarries, solvents and waste)
Industry_out	Industry area out square sources (agriculture, combustion in industry, construction, energy production, extraction of fossil fuel, processes in industry, quarries, solvents and waste)
Domestic_in	Domestic, institutional and commercial space heating in square sources
Domestic_out	Domestic, institutional and commercial space heating out square sources
Rail_in	Rail in square sources
Rail_out	Rail out square sources
Other_in	Other in square sources (aircraft, ships, off-road and other emissions)
Other_out	Other out square sources (aircraft, ships, off-road and other emissions)
PM_secondary	Secondary PM (inorganic and organic)
Residual+Salt	Sea salt, calcium and iron rich dusts and regional primary PM and residual non-characterised sources (residual is 1.0µg m ⁻³)
Point_Sources	Point sources

Background Maps Headers and Sectors – PM_{2.5}

Header	Description
Local_Auth_Code	Unique code for each local authority
X	Easting of centre of grid square (meters)
Y	Northing of centre of grid square (meters)
Geo_area	Unique code for each DA, inner and outer London
EU_zone_agglom	Unique code for each EU reporting zone and agglomeration
Total_PM2.5	Total concentration (sum of all sectors)
Motorway_in	Motorway in square sources
Motorway_out	Motorways out square sources
Trunk_A_Rd_in	Trunk A roads in square sources
Trunk_A_Rd_out	Trunk A roads out square sources
Primary_A_Rd_in	Primary A roads in square sources
Primary_A_Rd_out	Primary A roads out square sources
Minor_Rd+Cold_Start_in	Minor roads and cold start in square sources
Minor_Rd+Cold_Start_out	Minor roads and cold start out square sources
Brake+Tyre_in	Brake and Tyre wear emissions in square sources
Brake+Tyre_out	Brake and Tyre wear emissions out square sources
Road_Abrasion_in	Road Abrasion emissions in square sources
Road_Abrasion_out	Road Abrasion emissions out square sources

Background Maps Headers and Sectors – PM_{2.5}

Industry_in	Industry area in square sources (agriculture, combustion in industry, construction, energy production, extraction of fossil fuel, processes in industry, quarries, solvents and waste)
Industry_out	Industry area out square sources (agriculture, combustion in industry, construction, energy production, extraction of fossil fuel, processes in industry, quarries, solvents and waste)
Domestic_in	Domestic, institutional and commercial space heating in square sources
Domestic_out	Domestic, institutional and commercial space heating out square sources
Rail_in	Rail in square sources
Rail_out	Rail out square sources
Other_in	Other in square sources (aircraft, ships, off-road and other emissions)
Other_out	Other out square sources (aircraft, ships, off-road and other emissions)
PM_secondary	Secondary PM (inorganic and organic)
Residual+Salt	Sea salt, calcium and iron rich dusts and regional primary PM and residual non-characterised sources (residual is 1.0µg m ⁻³)
Point_Sources	Point sources

Appendix B: Manipulation of Maps without a GIS

The background pollution concentration maps can be manipulated using the Excel function 'pivot table' to allow the visualisation of grid squares without the use of a GIS.

The below instructions provide details for how to 'map' background pollutant concentrations by grid square using Excel.

1. Download the background concentrations.
2. Save the file and open in Excel.
3. Select a cell within the data.
4. On the ribbon toolbar go to 'Insert' then 'Tables - PivotTable' then 'Insert Pivot table'.
5. Ensure the 'Table/Range' and 'Location' information is correct on the 'Create PivotTable' screen and select 'OK'.
6. Using the 'PivotTable Field List', drag the 'X' field into the field area marked 'Column Labels'.
7. Using the 'PivotTable Field List', drag the 'Y' field into the field area marked 'Row Labels'.
8. On the 'Row Labels' dropdown filter list, select 'Sort Largest to Smallest'.
9. Drag the required field for the data you want to map, e.g. Total_NO₂_2021, into the field area marked 'Values'.
10. The data should be presented in a grid, as it would be on a map, with values for each 1km x 1km grid square.
11. This process can be repeated for each pollutant and year that needs to be visualised. Go back to the data sheet and repeat steps 3 to 10.

Appendix C: Historic Information Regarding Background Maps

The 2021 reference year background maps should be used for all new air quality assessments. Previous versions may be useful to review historic assessment predictions.

2018 Reference Year Background Maps

The 2018 reference year background maps are based on monitoring and meteorological data for 2018. They have been produced to incorporate more up to date information. A full description of the reference year model for 2018 is provided in the [technical report on UK supplementary assessment for 2018](#)²¹.

Emissions estimates based on the UK National Atmospheric Emissions Inventory 2017 are the main source of input data for the 2018 reference year background maps. The NAEI emissions mapping method is described elsewhere in detail in the [NAEI UK Emission Mapping Methodology 2017 Report](#)²². However, the following is provided by way of a brief summary of the key input data, assumptions and changes relative to the 2017 reference year background maps:

- The 2018 reference year background maps are based on ambient monitoring and meteorological data for 2018;
- The emissions projections for non-road traffic sources in the 2018 reference year background maps are based on [Updated Energy & Emissions Projections 2018](#)²³ from the Department for Business, Energy and Industrial Strategy (BEIS);
- The 2018 reference year background maps are still based upon the COPERT 5 NO_x and PM emission factors for road traffic, as taken from the European Environment Agency (EEA) [COPERT 5 emission calculation tool](#)⁹ (July 2018 version), inclusive of Euro 6 sub-categories;

²¹ Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2018, https://ukair.defra.gov.uk/assets/documents/reports/cat09/2005130902_2018_PCM_technical_report.pdf

²² Tsagatakis, I., Ruddy, M., Richardson, J., Otto, A., Pearson, B. & Passant, N. (2019) UK Emission Mapping Methodology: A report of the National Atmospheric Emission Inventory 2017. Retrieved from: https://naei.beis.gov.uk/reports/reports?report_id=997

²³ <https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2018>

⁹ <https://copert.emisia.com/>

- Outside of London, the 2018 reference year background maps are based on a set of traffic activity projections from the Department for Transport (DfT) ([RTF 2018](#), rebased to 2017 NAEI)²⁴ and DfT car sale projections (April 2019) including the uptake of low carbon passenger cars and LGVs with electric and hybrid electric propulsion systems; and
- Within London, the 2018 reference year background maps are based on bespoke vehicle fleet information and projections for London provided by Transport for London (TfL) in early 2018. The 2018 reference year background maps are inclusive of the impact from 2019 onwards of the ULEZ in central London, the TfL bus fleet meeting the ULEZ requirements London-wide in 2020 and all new taxis registered from 2018 onwards being Zero Emissions Capable (ZEC). They do not include the impact of the full ULEZ expansion to the North and South Circular Roads in 2021, nor the tightening of the Low Emission Zone standards for heavier vehicles in 2021.

It should be noted that the projections in the 2018 LAQM background maps are based on assumptions which were current before the Covid-19 outbreak in the UK. In consequence these maps do not reflect short or longer term impacts on emissions in 2020 and beyond resulting from behavioural change during the national or local lockdowns.

For NO_x, NO₂, PM₁₀ and PM_{2.5}, the most current version of the background maps (i.e. 2018) should be used.

2017 Reference Year Background Maps

The 2017 reference year background maps are based on monitoring and meteorological data for 2017. They have been produced to incorporate more up to date information on emissions. A full description of the reference year model for 2017 is provided in the [technical report on UK supplementary assessment for 2017](#)²⁵.

Emissions estimates based on the UK National Atmospheric Emissions Inventory 2016 are the main source of input data for the 2017 reference year background maps. The NAEI emissions mapping method is described elsewhere in detail in the [NAEI UK Emissions Mapping Methodology Report](#)²⁶. However, the following is provided by way of a brief summary of the key input data, assumptions and changes from the 2015 reference year background maps:

- The 2017 reference year background maps are based on ambient monitoring and meteorological data for 2017;

²⁴ <https://www.gov.uk/government/publications/road-traffic-forecasts-2018>

²⁵ Technical report on UK supplementary assessment under the Air Quality Directive (2008/50/EC), the Air Quality Framework Directive (96/62/EC) and Fourth Daughter Directive (2004/107/EC) for 2017, https://uk-air.defra.gov.uk/library/reports?report_id=965

²⁶ https://uk-air.defra.gov.uk/library/reports?report_id=973

- The emissions projections for non-road traffic sources in the 2017 reference year background maps are based on [Updated Energy Projections 2016](#)²⁷ from the Department for Business, Energy and Industrial Strategy (BEIS);
- The 2017 reference year background maps are still based upon the COPERT 5 NO_x and PM emission factors for road traffic²⁸, as taken from the European Environment Agency (EEA) [COPERT 5 emission calculation tool](#)²⁹ (first released September 2016), including Euro 6 subcategories;
- Outside of London, the 2017 reference year background maps are based on a set of traffic activity projections from the Department for Transport (DfT) (RTF 2015, rebased to 2016 NAEI) and DfT car sale projections (2018); and
- Within London, the 2017 reference year background maps are based on bespoke vehicle fleet information and projections for London provided by Transport for London (TfL) in early 2018, taking account of the Mayor's recent announcement to bring the Ultra-Low Emission Zone (ULEZ) forward to 2019. The 2017 reference year background maps are therefore inclusive of the impact from 2019 onwards of the ULEZ in central London.

2015 Reference Year Background Maps

The 2015 reference year background maps are based on monitoring and meteorological data for 2015. They have been produced to incorporate more up to date information on emissions.

The main changes from the 2013 reference year maps are as follows:

- The 2015 reference year background maps are based on ambient monitoring and meteorological data for 2015;
- The emissions projections for non-road traffic sources in the 2015 reference year background maps are based on Updated Energy Projections 2015 from the Department for Business, Energy and Industrial Strategy (BEIS);
- The 2015 reference year background maps are based upon the updated COPERT 5 NO_x and PM emission factors for road traffic, as taken from the European Environment Agency (EEA) COPERT 5 emission calculation tool (first released September 2016), including Euro 6 subcategories. The main revisions in comparison to the 2013 reference year background maps include a new set of Euro 6 NO_x emissions factors for passenger cars and light goods vehicles (LGVs) and updated

²⁷ <https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2016>

²⁸ The accompanying report "Methodology for the calculation of exhaust emissions – SNAPs 070100-070500, NFRs 1A3bi-iv" is available here: <http://emisiam.com/utilities/copert/documentation>

²⁹ <https://copert.emisia.com/>

NO_x emission factors for Euro 5 LGVs. The emission factors for HGVs, buses and motorcycles have also been updated;

- Outside of London, the 2015 reference year background maps are based on a set of traffic activity projections from the Department for Transport (DfT) (RTF 2015); and
- Within London, the 2015 reference year background maps are based on bespoke vehicle fleet information for London provided by Transport for London (TfL), developed as part of the London Atmospheric Emissions Inventory (LAEI) 2013 update. The 2015 reference year background maps are inclusive of the impact from 2020 onwards of the Ultra-Low Emission Zone (ULEZ) in central London - users no longer need to adjust the data to account for the ULEZ.

2013 Reference Year Background Maps

The 2013 reference year background maps are based on monitoring and meteorological data for 2013. They have been produced to incorporate more up to date information on emissions from Euro 5 and Euro 6 vehicles.

The main changes from the 2011 reference year maps are as follows:

- The 2013 maps are based on ambient monitoring and meteorological data for 2013;
- The projections use new NO_x and PM emission factor assumptions for Euro 5 and 6 vehicles, based on the European Environment Agency (EEA) COPERT 4v11 emission calculation tool; and
- Updated fleet composition data, accounting for updates to traffic and fleet projections in London, based on information provided by Transport for London (TfL).

2011 Reference Year Background Maps

The 2011 reference year background maps are based on monitoring and meteorological data for 2011. They have been produced in order to avoid the inclusion of the impact of the unusually cold weather in 2010 on the projections of NO_x and NO₂ and to incorporate more up to date information on emissions from Euro 5 and Euro 6 light duty vehicles.

The likely overestimation was due to the high NO_x and NO₂ concentrations recorded in 2010, the reference year the previous set of maps were produced from. The 2011 background maps are available with sector detail for NO_x, PM₁₀ and PM_{2.5} from 2011 to 2030.

The main changes from the 2010 reference year maps are as follows:

- The 2011 maps are based on ambient monitoring and meteorological data for 2011;
- The 2011 maps are based on the assumptions underlying the latest (base 2013) NO_x emissions projections for road transport;

- The projections use new NO_x emission factor assumptions for Euro 5 and 6 diesel cars and LGV based on COPERT 4 v10.0;
- The maps are based on new assumptions for the Department of Transport, based on updated Road Transport Forecasts (RS 2013); and
- In London, specific information from TfL (2013) on the projected bus and taxi fleets have been considered.

2010 Reference Year Background Maps

The 2010 reference year background maps are based on monitoring and meteorological data for 2010. The emissions inventory data used in the modelling of the background concentrations was taken from the NAEI for 2009, with emission estimates for area and point sources scaled forward from 2009 to 2010.

The dispersion modelling required in producing the maps was completed using ADMS 4.2. UK national network monitoring data has been used to calibrate the background and roadside models.

The main changes from previous reference year maps are as follows:

- The revised maps incorporate new information on the age distribution of vehicles and emissions factors for NO_x for road vehicles;
- Improved spatial resolution of underlying information on regional oxidant (OX) concentrations used with the 2010 maps;
- The revised maps for particulate matter incorporate updated information on secondary inorganic aerosols and proportions of PM_{2.5} and PM₁₀; and
- Measured concentrations in 2010 at AURN background stations were higher in 2010 than in 2008 and this is reflected in the 2010 reference maps.

2008 Reference Year Background Maps

Background concentrations were available for NO_x, NO₂, PM₁₀ and PM_{2.5} from 2008 to 2020 and calibrated using 2008 monitoring and meteorological data.

The background maps were calculated using the 2007 NAEI and associated projections, incorporating UEP37 energy projections current road traffic emission factors. Euro 5 and Euro 6 measures for LDVs and Euro VI measures for HDV are included in the projections.

The main changes observed between the 2008 and 2006 background maps are as follows:

- NO₂: The 2008 maps show higher concentrations in much of Scotland, Northern Ireland and the west of Wales, but much of England the predicted concentrations are

lower. The majority of urban areas show significantly higher background concentrations;

- NO_x: Across the majority of the country the background concentrations are higher; and
- PM₁₀: Clear difference in emissions between the east and the west of the UK, with concentrations in the east higher and the west lower.

2006 Reference Year Background Maps

Background concentrations were available for NO_x, NO₂, PM₁₀ and PM_{2.5} from 2006 to 2020 and calibrated using 2006 monitoring and meteorological data.

Background maps calculated using the 2005 NAEI and associated projections, incorporating UEP30 energy projections current road traffic emission factors. Euro 5 and Euro 6 measures for LDVs and Euro VI measures for HDV are included in the projections.

2004 Reference Year Background Maps

Background concentrations were available for NO_x, NO₂, and PM₁₀ from 2004, 2005 and 2010 and calibrated using 2004 monitoring and meteorological data.

Background maps calculated using the 2003 NAEI and associated projections, incorporating UEP12 energy projections current road traffic emission factors. Euro 4 and Euro 5 measures are included in the baseline.

Removing the Influence of Unusual Pollution Years

When using the 2011 Reference Year Background Maps – Particulate Matter

There are indications from national monitoring data that 2011 was an unusually high year for PM₁₀ and PM_{2.5}. Therefore, scaling factors have been derived to calculate a more typical case estimate for projections calculated from a reference year of 2011 for these pollutants.

A single factor of 0.91 for PM₁₀ and PM_{2.5} has been derived by comparing measured concentrations in 2011 with those for 2008, 2009, 2010 and 2012.

Worked Example: Removing the Influence of Unusual PM₁₀ from the 2011 Reference Year Background Maps

1. Download the PM₁₀ or PM_{2.5} data for the year required (2011-2030).
2. Take the Total PM₁₀ from the data spreadsheet (in this case 24.39µg/m³) and apply the scaling factor of 0.91. This will then give you the corrected Total PM₁₀ for the year required.

ID	x	y	geo_area	EU_zone	Total_PM10_14
353	531500	180500	4	1	24.69
353	532500	180500	4	1	25.08
353	531500	179500	4	1	24.69
353	532500	179500	4	1	24.39

$$24.39\mu\text{g}/\text{m}^3 \times 0.91 = 22.19\mu\text{g}/\text{m}^3 \text{ (Corrected Total PM}_{10} \text{ to 2 decimal places)}$$

Additionally, you may find it necessary to remove a PM₁₀ sector source. In this example, the source sectors that are to be removed from the maps are “Primary A Rd in” and “Primary A Rd out”. The original mapped PM₁₀ contribution from “Primary A Rd in” is 0.18µg/m³ and for “Primary A Rd out” is 0.37µg/m³.

ID	x	y	geo_ar	EU_zor	Total_PM10_11	Motorway	Motorway	Trunk_A_R	Trunk_A_R	Primary_A_Rd_in_11	Primary_A_Rd_out_11
353	531500	180500	4	1	24.69	0.01	0.01	0.01	0.01	0.33	0.43
353	532500	180500	4	1	25.08	0.01	0.01	0.01	0.01	0.31	0.40
353	531500	179500	4	1	24.69	0.01	0.01	0.01	0.01	0.27	0.40
353	532500	179500	4	1	24.39	0.01	0.01	0.01	0.01	0.18	0.37

To remove these sectors from the scaled map, the sum of these sector contributions also needs to be multiplied by 0.91, and then subtracted from the already corrected Total PM₁₀ (i.e. 22.19µg/m³ as derived above):

$$22.19\mu\text{g}/\text{m}^3 - (0.91 \times (0.18\mu\text{g}/\text{m}^3 + 0.37\mu\text{g}/\text{m}^3)) = 21.69\mu\text{g}/\text{m}^3 \text{ (Corrected Sector Removed PM}_{10} \text{ to 2 decimal places)}$$

When using the 2010 Reference Year Background Maps – Nitrogen Dioxide

It is widely recognised that concentrations of NO₂ were generally elevated in 2010 compared to more recent years. Analysis across the AURN suggests that NO_x concentrations were, on average 15% higher in 2010 than other recent years. Corresponding NO₂ concentrations have been estimated to be around 10% higher in 2010.

However, concentrations vary across various monitoring station types with Urban Industrial, Suburban and Urban Background, and Urban Traffic stations tending to be higher in 2010, whereas Rural Background stations tended to have lower NO_x/NO₂ concentrations in 2010.

As the 2010 reference year background maps are based on and validated using 2010 monitoring data, the effect of the higher concentrations in 2010 mean that projected background concentrations for NO_x/NO₂ may be higher than expected.

To allow results which are more characteristic of a typical year, you may wish to consider removing the influence of projecting from the 2010 year from the background maps by scaling them. This can be completed using the 2010 reference year NO₂ Adjustment for NO_x Sector Removal Tool, [Version 3.1](#)³⁰.

You should assess the type of area being considered when scaling background maps as the method is unlikely to be suitable to use in areas representing rural background locations as it may result in underestimation of background concentrations.

³⁰ <https://laqm.defra.gov.uk/documents/NO2-Background-Sector-Toolv3.1.xls>

Worked Example: Removing the Influence of Unusual NO₂ from the 2010 Reference Year Background Maps

The background maps for NO_x concentrations are split into source sectors. When removing sectors from the background NO_x concentrations to avoid double counting in the modelling process, it is necessary to adjust the NO₂ concentrations in proportion to the reductions in NO_x as a result of removing the specific source sector(s).

The relationship between NO₂ and NO_x is not linear, therefore the adjustment is not straightforward and as such the relevant NO₂ Adjustment for NO_x Sector Removal Tool should be used.

The NO₂ Adjustment for NO_x Sector Removal Tool uses an equation taken from the report on '[UK modelling under the Air Quality Directive \(2008/50/EC\) for 2010 covering the following air quality pollutants: SO₂, NO_x, NO₂, PM₁₀, PM_{2.5}, lead, benzene, CO and ozone](#)³¹.

The NO₂ Adjustment for NO_x Sector Removal Tool uses the same area specific regional oxidant and f-NO₂ values used in the background concentration mapping process to produce a background NO₂ value corresponding to the NO_x value when either a 'road' or 'non-road' NO_x source has been removed.

It is therefore important to avoid producing invalid results that you ensure to:

- 1) use the correct reference year background maps;
- 2) enter the correct coordinates for background information being processed; and
- 3) use the correct NO₂ Adjustment for NO_x Sector Removal Tool for the reference year used.

The NO₂ Adjustment for NO_x Sector Removal Tool – 2010 Reference Year (version 3.1) uses the following equation:

$$A = (f\text{NO}_2 \times B + \text{OX}) \times (-2.423\text{e}^{-13} \times B6 + 1.607\text{e}^{-10} \times B5 - 4.329\text{e}^{-8} \times B4 + 6.132\text{e}^{-6} \times B3 - 5.020\text{e}^{-4} \times B2 + 2.593\text{e}^{-2} \times B) \times ((0.001 \times C) + 1.0126))$$

Where:

A = NO₂ concentration in ppb;

B = NO_x concentration in ppb;

OX = regional oxidant concentration in ppb;

C = NO_x concentration in µg/m³.

³¹ https://uk-air.defra.gov.uk/library/reports?report_id=697

Step 1:

Using values taken from the 2010 reference year background maps enter all details in Steps 1 and 2 of the NO₂ Adjustment for NO_x Sector Removal Tool as in standard operation. Grid square coordinates from the national background maps should be entered, however the tool will estimate the nearest grid square for the coordinates provided (so these must be correct).

Please remember to ensure the correct year is chosen (2010-2030).

Step 1: Enter Year of Data
2014

Step 2: Mapped Background Information (concentrations are µg/m³)					
Mapped Background Grid Square Coordinates		Mapped Total NO _x	Mapped NO _x Road Traffic Sectors	Mapped NO _x Non-Road Sectors	Mapped Total NO ₂
X	Y	Total_No _x	Sum No _x Roads	Sum No _x Non-Roads	Total_No ₂
532500	179500	87.1	45.7	41.4	45.5

Step 2:

Remove 15% of the background NO_x using the 'NO_x to be removed' box in Step 3 of the NO₂ Adjustment for NO_x Sector Removal Tool. This can be carried out in the NO₂ Adjustment for NO_x Sector Removal Tool by multiplying both the Sum of NO_x Roads (45.7µg/m³) and the Sum of NO_x Non-Road Sectors (41.4µg/m³) by 0.15.

Step 3: NO_x to be removed (µg/m³)	
Enter the Sum of Road NO _x to be removed	Enter the Sum of Non-Road NO _x to be removed
6.9	6.2
45.7 x 0.15 = 6.9	41.4 x 0.15 = 6.2

Step 3:

Run the NO₂ Adjustment for NO_x Sector Removal Tool to produce an NO₂ value (40.5µg/m³) corresponding to the 15% reduction in NO_x.

Results for Background Year 2014			
Revised NO _x Totals (µg/m ³)			Revised NO ₂ (µg/m ³)
Revised NO _x Road Traffic Sectors	Revised NO _x Non-Road Sectors	Revised Total NO _x	Revised Total NO ₂ after NO _x removal
38.8	35.2	74.0	40.5

Appendix D: Impacted Grid Squares (2021 - 2040 inclusive) Identified in 2021 Reference Year Background Maps

Local Authority	X	Y
Clackmannanshire	288500	692500
North Ayrshire	229500	650500
Barrow-in-Furness	320500	469500
Leeds	431500	432500
Wakefield	450500	423500
Kirklees	415500	418500
Barnsley	434500	406500
Doncaster	460500	406500
Trafford	378500	397500
Newark and Sherwood	479500	355500
Wrexham	328500	338500
Broxtowe	453500	337500
Rushcliffe	455500	327500
King's Lynn and West Norfolk	566500	297500
West Suffolk	586500	265500
Newham	542500	180500
Bexley	550500	179500