Department
for Environment
Food & Rural Affairs

Background Concentration Maps User Guide

July 2016

The Scottish Government
Riaghaltas na h-Alba

Department of
Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Llywodraeth Cymru
Welsh Government

This publication is available at http://laqm.defra.gov.uk

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Change Log

Version	Date	Details of Changes Made
1	July 2016	Released with 2013 reference year background maps

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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]. The purpose of this user guide is to explain the background maps and related tools that are available and 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 projection years (typically 2015, 2020, 2025 and 2030) for a range of pollutants including oxides of nitrogen (NO_x), nitrogen dioxide (NO_2) and particulate matter (PM_{10} 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.

Background maps are updated by Defra periodically due to updates to underlying data including emissions factors. In recent years there have been annual updates due to new information on NO_x emissions from diesel vehicles. Fleet and vehicle activity data have also been updated. Details on the underlying assumptions and input data are provided in this guide to aid understanding.

Local authorities should use the most up-to-date data available. For NO_x, NO_2, PM_{10} and $PM_{2.5}$ the current reference year is 2013. For sulphur dioxide (SO_2), benzene, carbon monoxide (CO), and 1,3-butadiene the current reference year is 2001 as it has not been necessary to update the forecasts because ambient concentrations rarely exceed the Air Quality Strategy (AQS) objectives for these pollutants. For 2010 and 2011 reference years, correction factors are available to counter the effects of unusual meteorology on NO_2 (2010 only) and PM_{10} (2011 only). This guide also details the historic versions of all maps that have been published.

A number of techniques and tools are available to support and to help local authorities use the background maps.

[1] http://www.legislation.gov.uk/ukpga/1995/25/contents

The techniques that are detailed include:

- Removing the Influence of Unusual Pollution Years;
- NO_2 Adjustment for NO_x Sector Removal;
- Using Background Maps to Adjust Monitoring Data;
- Adjusting background maps to take account of the London Ultra Low Emission Zone (ULEZ) impacts;
- Reference Year Queries and Data Availability; and
- Manipulation of Background Maps without GIS.

The tools are:

- NO_x to NO_2 Calculator;
- NO_2 Adjustment for NO_x Sector Removal Tool; and
- Year Adjustment Factors.

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 it 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[2].

Mapped background concentrations for use in LAQM Review and Assessments undertaken by Scottish local authorities are available on the Scottish Air Quality website[3]. These maps are available for NO_X, NO_2 and PM_{10} 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 6.

Pollutants

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

Reference Year	
2013	**2001**
• NO_x • NO_2 • PM_{10} • $PM_{2.5}$	• SO_2 • CO • benzene • 1,3-butadiene

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 2013) contains estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$ for the period 2013 through to 2030.

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

[3] http://www.scottishairquality.co.uk/data/mapping?view=data

For SO_2, CO, benzene and 1,3-butadiene the data are available in the 2001 reference year maps for the years, 2001, 2003 and 2010. Year adjustment factors can be used to adjust this data. Further details showing how to do this can be found on page 20 of this user guide.

Source Sectors

The background maps provide total concentrations of NO_x, PM_{10} and $PM_{2.5}$ by source sector. The source sectors include transport, industry and commercial. For the full list of sectors for each pollutant please see Appendix A.

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?

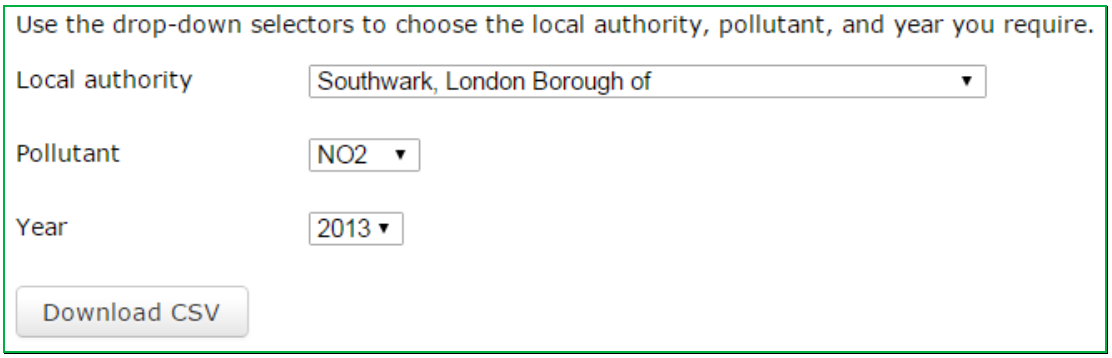
Location	
UK (including England, Wales Scotland and Northern Ireland)	Available from UK-AIR[2]. UK background maps are available for NO_x, NO_2, PM_{10} and $PM_{2.5}$. The modelling methodology is based on the UK Pollution Climate Mapping (PCM) approach, used to model the annual mean background and roadside concentrations for the UK as a whole.
Scotland	Available from the Scottish Air Quality website[3]. Scottish background maps are available for NO_x, NO_2 and PM_{10}. 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.
Northern Ireland	Available from UK-AIR[2]. Northern Ireland background maps are available for NO_x, NO_2, PM_{10} 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. *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.* 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.

How do I Access the Latest Maps?

UK (GBOS)

The current background concentration maps for the England, Wales, Scotland and Northern Ireland (2013 reference year) are available from UK-AIR[4].

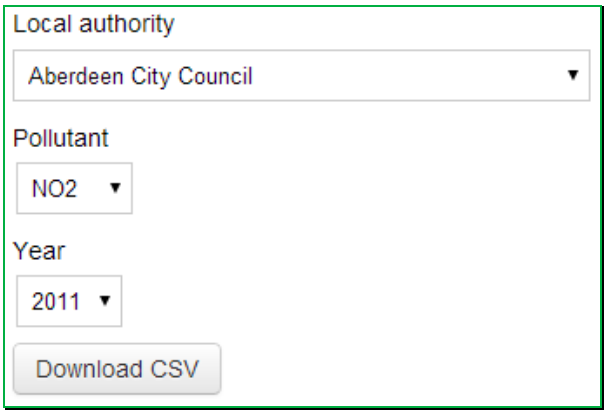
To get the background concentrations, use the drop down selectors to choose the Local Authority, Pollutant and Year required. Then click on the grey 'Download CSV' button.



Scotland

The current background concentration maps for Scotland [incorporating Scotland specific-modelling] (2011 reference year) are available from the Scottish Air Quality website[3].

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



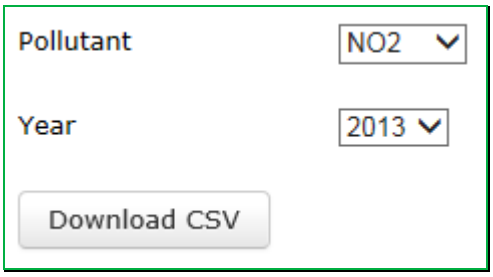
A new link will be generated below the 'Download CSV' button called 'Download selected CSV data'. Click this button to obtain the requested dataset, or right click and 'Save link as'.

[4] https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2013

Northern Ireland (NIOS)

The current background concentration maps for Northern Ireland (2013 reference year) are available from UK-AIR[4]. A file is also available for each year between 2013 and 2030 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 – [Note: all Northern Ireland local authority data are downloaded together]. Then click on the grey 'Download CSV' button.



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?

European Union directives on ambient air quality require member states including the UK to undertake air quality assessments, and to report the findings of these assessments to the European Commission 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 Local Air Quality Management process.

Details of Current Background Maps

NO_x, NO_2, PM_{10} and $PM_{2.5}$

Description and Features

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).

Input data and Assumptions

The methodology of the modelling used to create the background maps is consistent with that employed to support the development of the 2015 air quality plan[5], whilst a full description of the original reference year model for 2013 (as used for the compliance assessment reported in September 2014) is provided in the technical report on UK supplementary assessment for 2013[6].

Emissions estimates based on the UK National Atmospheric Emissions Inventory 2012 (NAEI 2012) are the main source of input data for the background maps; the NAEI emissions mapping method is described elsewhere in detail in the most recent NAEI UK Emissions Mapping Methodology Report[7]. However, the following is provided by way of a

[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492901/aq-plan-2015-technical-report.pdf

[6] 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 2013 https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1511251423_AQ0650_2013_MAAQ_technical_report.pdf

[7] https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1511261130_UK_Emission_Mapping_Methodology_2012_Issue_1.pdf

brief summary of the key input data, assumptions and changes from the 2011-based background maps:

- The 2013 maps are based on ambient monitoring and meteorological data for 2013;
- The emissions projections for non-road traffic sources in the background maps are based on the Updated Energy Projections 2013 from the Department of Energy and Climate Change (DECC);
- The 2013 reference year background maps are based upon the updated COPERT 4v11 NO_x and PM emission factors for road traffic[8]. The release of COPERT 4 v11 provides updated emission factors for Euro 5/V and Euro 6/VI for cars, LGVs, HGVs and buses/coaches. These updated factors are based on further emissions data collected under European Research Group on Mobile Emissions (ERMES), including real-world tests on around 20 early generation Euro 6 diesel cars;
- Outside of London, the background maps are based on a set of traffic activity projections from the Department for Transport (Dft) (RS 2013); and
- The projections in London are based upon bespoke vehicle fleet information for London provided by TfL, developed as part of the London Atmospheric Emissions Inventory (LAEI) 2013 update[9]. However, it should be noted that the 2013-based background maps **do not** include the impact of the Ultra Low Emission Zone (ULEZ) in London. A methodology is provided on page 18 to adjust the 2013-background maps from 2020 onwards to approximate the impact of the ULEZ on background pollutant concentrations.

SO_2, CO, Benzene and 1,3-Butadiene

Background maps for SO_2, CO, benzene and 1,3-butadiene are based on the 2001 reference year. Only data for these pollutants contained within the 2001 reference year background maps should be used.

For NO_x, NO_2, PM_{10} and $PM_{2.5}$ the most current version of the background maps (i.e. 2013) should be used.

[8] COPERT 4 v11.0 released in September 2014. The accompany report "Update of the Air Emissions Inventory Guidebook – Road Transport 2014 Update" is available at http://www.emisia.com/sites/default/files/files/COPERT4_v11_0.pdf

[9] http://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory-2013

Using Background Maps to Adjust Monitoring Data

NO_x, NO_2, PM_{10} 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, NO_2, PM_{10} and $PM_{2.5}$ to a different year, as explained in paragraph 7.72 on page 7-25 of LAQM.TG(16)[10].

SO_2, CO, Benzene and 1,3-Butadiene

For all pollutants, projection should be made forwards from the nearest background map year available to the relevant year. For SO_2, Year Adjustment Factors are not provided as it is considered that, away from specific locations near industrial sources or areas of high domestic coal burning, that SO_2 background concentrations would change very little, i.e. the factor would be close to 1.

Year Adjustment Factors for CO, benzene and 1,3-butadiene can be found in the 2001 Year Adjustment Factors Spreadsheet[11]. If using these factors, the following guidance on the Use of Projection Factors for Background and Roadside Pollutant Concentrations should be adopted.

Users undertaking LAQM Review and Assessments for SO_2, benzene, CO or 1,3-butadiene are advised to first contact the LAQM Helpdesk[12] to seek the latest advice before proceeding with the assessment.

Benzene:

- Year 2011 to 2025: Use the mapped 2010 concentrations and relevant factors for the following year.

CO:

- Year 2002 to 2025: Use the mapped 2001 concentration and relevant factors for following years.

[10] http://laqm.defra.gov.uk/technical-guidance/

[11] http://laqm.defra.gov.uk/documents/yearfactorslaqm2001.xls

[12] http://laqm.defra.gov.uk/helpdesks.html

1,3-Butadiene:

- Years 2004 to 2025: Use the mapped 2003 concentrations and relevant factors for following years.

Details of Historic Background Maps

Reference Year	
2013 **(Current Version)**	The 2013 reference year background maps are the most up-to-date version of the background maps for NO_x, NO_2, PM_{10} 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 2013 to 2030. These 2013 reference year maps have been calibrated using 2013 monitoring and meteorological data.
2011	The 2011 reference year version of the background maps should not be used for new air quality assessments. These 2011 reference year maps are available for 2011 to 2030 and have calibrated using 2011 monitoring and meteorological data.
2010	The 2010 reference year version of the background maps should not be used for new air quality assessments. 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	For new air quality assessments of SO_2, CO, benzene and 1,3-butadiene, the 2001 reference year background maps should be used (note, only for THESE pollutants). Within these maps background concentrations are available for 2001, 2003 and 2010. These 2001 reference year maps have been calibrated using 2001 monitoring and meteorological data.

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

Supporting Tools

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

Previous versions of the tools will be required if you are using previous versions of the background concentration maps.

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

NO_2 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 NO_2 concentrations in proportion to the reductions in NO_x as a result of removing the specific source sector(s).

The LAQM background maps from a reference year of 2013 do not by default include an assessment of the impact of the London ULEZ on background concentrations in 1km grid squares within the ULEZ area[13]. The NO_2 Adjustment for NO_x Sector Removal Tool can also be used to adjust the 2013 reference year background maps for areas within the London ULEZ to be (approximately) inclusive of the impact of the ULEZ from 2020 onwards (see page 18).

The latest version of the tool (Version 5.0) can be downloaded from the LAQM website[14].

Worked Example: NO_2 Adjustment for NO_x Sector Removal Tool – 2013 Reference Year

The following worked example shows a user how to correctly remove a source sector from mapped NO_x concentrations and calculate the equivalent sector removed NO_2 concentration.

[13] The ULEZ boundary corresponds to Central London within the Inner Ring Road, coincident with the Congestion Charging Zone (CCZ).

[14] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxsector

Using values taken from the 2013 reference year background maps enter all details in Steps 1 and 2 of the NO_2 Adjustment for NO_x Sector Removal Tool. 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).

Step 1:

Enter the background year required (2013 - 2030).

Step 1: Enter Year of Data
2014

Step 2:

Enter information from background maps. Concentrations are in µg/m^3.

Step 1: Enter Year of Data	Step 2: Mapped Background Information (concentrations are µg/m^3)					
2014	Mapped Background Grid Square Coordinates		Mapped Total NOx	Mapped NOx Road Traffic Sectors	Mapped NOx Non-Road Sectors	Mapped Total NO_2
	X	Y	Total_Nox	Sum Nox Roads	Sum Nox Non-Roads	Total_No2
	532500	179500	64.80	40.10	24.70	39.20

Step 3:

Enter NO_x concentration (µg/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 in". The original mapped NO_x "Primary A road in" source contribution is 8.38 µg/m^3.

Step 3: NOx to be removed (µg/m^3)	
Enter the Sum of **Road** NOx to be removed	Enter the Sum of **Non-Road** NOx to be removed
8.38	0.00

Step 4:

Run the NO_2 Adjustment for NO_x Sector Removal Tool by clicking on the 'Run Tool' button. Revised NO_x values and total NO_2 following sector removal will then be provided.

Results for Background Year 2014			
Revised NOx Totals (µg/m³)			Revised NO_2 (µg/m³)
Revised NOx Road Traffic Sectors	Revised NOx Non-Road Sectors	Revised Total NOx	Revised Total NO_2 after NOx removal
31.72	24.70	56.42	35.02

IMPORTANT: Where previous reference year background maps are being used (i.e. 2011) the corresponding version of the NO_2 Adjustment for NO_x Sector Removal Tool should be used.

NO_x to NO_2 Calculator

This calculator allows local authorities to derive NO_2 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 NO_2 diffusion tube measurements.

The latest version of the tool (Version 5.1) should only be used with the 2013-based background maps and the Emissions Factors Toolkit (v7 and onwards), and can be used for years 2013 to 2030.

It incorporates the impact of expected changes in the fraction of NO_x emitted as NO_2 (f-NO_2) and changes in regional concentrations of NO_x, NO_2 and O_3.

The latest version of the tool can be downloaded from the LAQM website[15].

General Inputs:

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 O_3, NO_x and NO_2 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 NO_2 (f-NO_2).

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

The dropdown box contains 6 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 recognized 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 many situations you may have sufficiently detailed information to calculate your own *"f-NO_2"* value. You can do this using the “f-NO_2” page of the calculator. As an example, if you are running a dispersion model using traffic data with a detailed fleet composition, you could use the following procedure to generate an emission-weighted f-NO_2:

1) Run the dispersion model (to predict road-NO_x) for each vehicle class independently;
2) Calculate the percentage contribution of each vehicle class to total road-NO_x at each receptor;

3) Note down the f-NO_2 values for each vehicle class from the f-NO_2 page of the calculator;

4) Calculate a weighted average f-NO_2 value using the results from steps 2 and 3;

5) Enter this value directly into the "Fraction emitted as NO_2" column on the "NO_x to NO_2" sheet.

When you enter your f-NO_2 values directly into the calculator, you do not need to specify a traffic mix in under *"General Inputs".*

ULEZ Adjustment Factors

The LAQM background maps from a reference year of 2013 do not by default include an assessment of the impact of the London ULEZ on background concentrations in 1km grid squares within the ULEZ area[13].

A methodology has therefore been developed to adjust the provided NO_x and NO_2 background maps to be (approximately) inclusive of the impact of the ULEZ on the road transport contribution to background NO_x concentrations[16]. It is based upon applying the appropriate scaling factor within the NO_2 Adjustment for NO_x Sector Removal Tool, to account for the reduction on the road transport contribution to background NO_x concentrations brought about by the ULEZ.

Once the appropriate scaling factor has been determined from the table below, the following method should be followed using the NO_2 Adjustment for NO_x Sector Removal Tool:

1) As per steps 1 and 2 of the worked example provided on page 14, input information as usual in to the tool;

2) In step 3 of the worked example provided on page 14, multiply the values in column G (Mapped NO_x Road Traffic Sectors) by the ULEZ scaling factor for the appropriate year in order to calculate the value for the reduction in NO_x to put in column K (Sum of Road NO_x to be removed); leave column L (Sum of Non-Road NO_x to be Removed) blank (or enter 0);

3) As per step 4 of the worked example provided on page 14, run the tool to produce scaled NO_x and NO_2 concentrations reflecting the presence of the ULEZ.

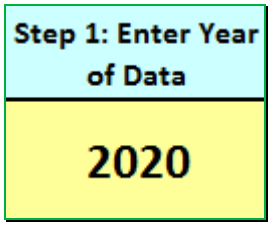
[16] This methodology is only applicable to those background map 1km grid squares contained within the ULEZ – the same approach cannot be applied to estimate impacts in 1km background map grid squares surrounding the ULEZ. No comparable approach is provided to adjust the PM background maps, although the impact of the ULEZ on PM concentrations is likely to be less pronounced than for NO_x and NO_2.

Year	ULEZ Scaling Factor
2013	1.0000
2014	1.0000
2015	1.0000
2016	1.0000
2017	1.0000
2018	1.0000
2019	1.0000
2020	0.5743
2021	0.6139
2022	0.6534
2023	0.6930
2024	0.7326
2025	0.7722
2026	0.7880
2027	0.8038
2028	0.8196
2029	0.8354
2030	0.8513

Worked Example: NO_2 Adjustment for NO_x Sector Removal Tool – Including the Impact of the ULEZ in 2020

Step 1:

Enter the background year required (2020).



Step 2:

Enter information from background maps.

Step 1: Enter Year of Data	Step 2: Mapped Background Information (µg/m^3)					
2020	Mapped Background Grid Square Coordinates		Mapped Total NOx	Mapped NOx Road Traffic Sectors	Mapped NOx Non-Road Sectors	Mapped Total NO_2
	X	Y	Total_NOx	Sum NOx Roads	Sum NOx Non-Roads	Total_NO_2
	531500	180500	64.80	40.10	24.70	39.20

Step 3:

Multiply the Mapped NO_x Road Traffic Sectors concentration (40.10 µg/m^3) by the scaling factor for 2020 (0.5743). The resultant scaled road traffic NO_x concentration (23.03 µg/m^3) should then be entered into the Sum of Road NO_x to be removed.

Step 3: NOx to be Removed (µg/m^3)	
Enter the Sum of **Road** NOx to be removed	Enter the Sum of **Non-Road** NOx to be removed
23.03	0.00

Step 4:

Run the NO_2 Adjustment for NO_x Sector Removal Tool by clicking on the 'Run Tool' button. Revised NO_x and total NO_2 values inclusive of the ULEZ will then be provided.

Results for Background Year 2020			
Revised NOx Totals (µg/m^3)			Revised NO_2 (µg/m^3)
Revised NOx **Road** Traffic Sectors	Revised NOx **Non-Road** Sectors	Revised **Total** NOx	**Revised Total NO_2 after NOx removal**
17.07	24.70	41.77	26.72

Year Adjustment Factors

Year adjustment factors are not required for 2013-based background maps because maps are available for all years 2013-2030.

The Year Adjustment Factors published in the 2003 Technical Guidance LAQM TG(03) may still be used for projecting 2001-based background concentrations of carbon monoxide,

benzene and 1,3-butadiene ONLY. These are available in the 2001 Year Adjustment Factors Spreadsheet[17].

Users are reminded that the factors applied to forecasting measured annual mean roadside NO_2 and PM_{10} concentrations to future years differ to those discussed above. Further information is available on the LAQM website[18].

[17] http://laqm.defra.gov.uk/documents/yearfactorslaqm2001.xls

[18] http://laqm.defra.gov.uk/tools-monitoring-data/year-adjustment-factors.html

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
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
NO_2	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)
PM_{10}	Particulate Matter less than 10µm in aerodynamic diameter
$PM_{2.5}$	Particulate Matter less than 2.5µm in aerodynamic diameter
SO_2	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 Local Air Quality 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 Local Air Quality Management Helpdesk can be found at http://laqm.defra.gov.uk/helpdesks.html.

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)
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 – PM_{10}	
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
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
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 menu toolbar go to ‘data’ then ‘pivot table report’.
5. Where is the data to be analysed?
    a. Select ‘Microsoft Excel list or database.
6. What type of report do you want to create?
    a. Select ‘PivotTable’
7. Click next.
    a. The whole dataset for all pollutants should have automatically been selected, if not, select the data you want to use.
8. Click next.
9. Where do you want to put the PivotTable Report?
    a. Select either new or existing worksheet
10. Click finish
11. Drag the ‘X’ button into the area marked ‘COLUMN’
12. Drag the ‘Y’ button into the area marked ‘ROW’.
13. On the toolbar select ‘field options’
14. Click on the ‘advanced’ button
15. Under ‘Autosort Options’ select ‘descending’.
16. Then click OK.
17. Drag the button with the data you want to map, e.g. NO_2 2011, into the area marked ‘data’.

18. The data should be presented in a grid, as it would be on a map, with values for each 1km x 1km grid square.

19. 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 18.

Appendix C: Historic Information Regarding Background Maps

The 2013 reference year background maps should be used for all new air quality assessments. Previous versions may be useful to review historic assessment predictions.

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 NO_2 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 NO_2 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, PM_{10} 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 PM_{10}; 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, NO_2, PM_{10} 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:

- NO_2: 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
- PM_{10}: 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, NO_2, PM_{10} 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, NO_2, and PM_{10} 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 PM_{10} 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 PM_{10} 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 PM_{10} from the 2011 Reference Year Background Maps

1. Download the PM_{10} or $PM_{2.5}$ data for the year required (2011-2030).

2. Take the Total PM_{10} from the data spreadsheet (in this case 24.39 µg/m^3) and apply the scaling factor of 0.91. This will then give you the corrected Total PM_{10} 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 µg/m^3 x 0.91 = 22.19 µg/m^3 Corrected Total PM_{10} to 2 decimal places

Additionally, you may find it necessary to remove a PM_{10} 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 PM_{10} contribution from “Primary A Rd in" is 0.18 µg/m^3 and for “Primary A Rd out” is 0.37 µg/m^3.

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 contribution also needs to be multiplied by 0.91, and then subtracted from the already corrected Total PM_{10} (i.e. 22.19 µg/m^3 as derived above):

22.19 µg/m^3 – (0.91 x (0.18 µg/m^3 + 0.37 µg/m^3) = 21.69 µg/m^3 Corrected Sector Removed PM_{10} to 2 decimal places

When using the 2010 Reference Year Background Maps – Nitrogen Dioxide

It is widely recognised that concentrations of NO_2 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 NO_2 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/NO_2 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/NO_2 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 NO_2 Adjustment for NO_x Sector Removal Tool, Version 3.1[19].

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.

Worked Example: Removing the Influence of Unusual NO_2 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 NO_2 concentrations in proportion to the reductions in NO_x as a result of removing the specific source sector(s).

The relationship between NO_2 and NO_x is not linear, therefore the adjustment is not

[19] http://laqm.defra.gov.uk/documents/NO2-Background-Sector-Toolv3.1.xls

straightforward and as such the relevant NO_2 Adjustment for NO_x Sector Removal Tool should be used.

The NO_2 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: SO_2, NO_x, NO_2, PM_{10}, $PM_{2.5}$, lead, benzene, CO and ozone[20]'.

The NO_2 Adjustment for NO_x Sector Removal Tool uses the same area specific regional oxidant and f-NO_2 values used in the background concentration mapping process to produce a background NO_2 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 NO_2 Adjustment for NO_x Sector Removal Tool for the reference year used.*

The NO_2 Adjustment for NO_x Sector Removal Tool – 2010 Reference Year (version 3.1) uses the following equation:

$$A = (fNO_2 \times B + OX) \times (-2.423e^{-13} \times B6 + 1.607e^{-10} \times B5 - 4.329e^{-8} \times B4 + 6.132e^{-6} \times B3 - 5.020e^{-4} \times B2 + 2.593e^{-2} \times B) \times ((0.001 \times C) + 1.0126))$$

Where:

A = NO_2 concentration in ppb;

B = NO_x concentration in ppb;

OX = regional oxidant concentration in ppb;

C = NO_x concentration in µg/m^3.

Step 1:

Using values taken from the 2010 reference year background maps enter all details in Steps 1 and 2 of the NO_2 Adjustment for NO_x Sector Removal Tool as in standard operation. Grid square coordinates from the national background maps should be entered,

[20] http://uk-air.defra.gov.uk/library/reports?report_id=697

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/m^3)					
Mapped Background Grid Square Coordinates		Mapped Total NOx	Mapped NOx Road Traffic Sectors	Mapped NOx Non-Road Sectors	Mapped Total NO_2
X	Y	Total_Nox	Sum Nox Roads	Sum Nox Non-Roads	Total_No2
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 NO_2 Adjustment for NO_x Sector Removal Tool. This can be carried out in the NO_2 Adjustment for NO_x Sector Removal Tool by multiplying both the Sum of NO_x Roads (45.7 µg/m^3) and the Sum of NO_x Non-Road Sectors (41.4 µg/m^3) by 0.15.

Step 3: NOx to be removed (µg/m^3)	
Enter the Sum of **Road** NOx to be removed	Enter the Sum of **Non-Road** NOx 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 NO_2 Adjustment for NO_x Sector Removal Tool to produce an NO_2 value (40.5 µg/m^3) corresponding to the 15% reduction in NO_x.

Results for Background Year 2014			
Revised NOx Totals (µg/m^3)			Revised NO_2 (µg/m^3)
Revised NOx **Road** Traffic Sectors	Revised NOx **Non-Road** Sectors	Revised **Total** NOx	**Revised Total NO_2 after NOx removal**
38.8	35.2	74.0	40.5