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Air Pollution in Scotland 2023

RICARDO

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Introduction

This brochure has been produced as part of the Scottish Air Quality Database (SAQD) project on behalf of the Scottish Government. The 2023 brochure is the 17th in an annual series. It aims to provide a summary of the local air quality monitoring and associated work carried out by and on behalf of the Scottish Government and local authorities during 2023.

The SAQD project was developed as a comprehensive centralised resource to provide high-quality harmonised data and information to help government (both national and local) and the Scottish public tackle the issue of air pollution. The data generated by the SAQD serves to improve research and analysis and support the development of air quality policy in Scotland.

While air quality in Scotland is generally good, levels of some air pollutants still exceed air quality objectives, for example a small number of nitrogen dioxide passive diffusion tubes and ozone at several sites.

Therefore, continued efforts to reduce air pollution are vital, coupled with appropriate monitoring to assess progress. For more information on air quality in Scotland and more specifically, your area, please visit the Air Quality in Scotland website (https://www.scottishairquality.scot). A more detailed Annual Report on the SAQD project is available on the Air Quality in Scotland website.

2

Air Quality Standards and Objectives

In the UK, air quality is a devolved matter, with the Scottish Government having responsibility for the development of air quality policy and legislation for Scotland. Table 2.1 shows the air quality objectives adopted for Scotland. It should be noted that Scotland has adopted more stringent objectives than the rest of the UK for PM_{10} and $PM_{2.5}$.

Table 2.1 Summary of air quality in Scotland

Air quality objective and pollutant	Concentration	Measured as	Date to be achieved by
Nitrogen dioxide (NO_2)	200 µg m^{-3}, not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 µg m^{-3}	Annual mean	31.12.2005
Particulate matter (PM_{10})	50 µg m^{-3}, not to be exceeded more than 7 times a year	24-hour mean	31.12.2010
	18 µg m^{-3}	Annual mean	31.12.2010
Particulate matter ($PM_{2.5}$)	10 µg m^{-3}	Annual mean	31.12.2020
Sulphur dioxide (SO_2)	350 µg m^{-3}, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 µg m^{-3}, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 µg m^{-3}, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005
Benzene (C_6H_6)	3.25 µg m^{-3}	Running annual mean	31.12.2010
1,3 Butadiene (C_4H_6)	2.25 µg m^{-3}	Running annual mean	31.12.2003
Carbon monoxide (CO)	10.0 mg m^{-3}	Running 8-Hour mean	31.12.2003
Lead (Pb)	0.25 µg m^{-3}	Annual Mean	31.12.2008
Poly Aromatic Hydrocarbons*	0.25 ng m^{-3}	Annual Mean	31.12.2010
Ozone*	100 µg m^{-3} not to be exceeded more than 10 times a year	Daily maximum 8-hour running mean	31.12.2005

*not required to be monitored or assessed by local authorities under LAQM, however is a UK requirement.

2.1 Cleaner Air for Scotland – The Road to a Healthier Future

The Scottish Government published Scotland's second air quality strategy called "Cleaner Air for Scotland 2 – Towards a Better Place for Everyone" (CAFS2) in July 2021.

CAFS2 sets out how the Scottish Government and its partner organisations propose to further reduce air pollution to protect human health and fulfil Scotland's legal responsibilities over the period 2021-2026. CAFS2 aims to achieve the ambitious vision for Scotland "to have the best air quality in Europe".

The CAFS2 key partner organisations are:

- Scottish Government
- Transport Scotland
- Scottish Environment Protection Agency (SEPA)
- Public Health Scotland
- Local authorities

CAFS2 is shaped around 10 policy themes, these are:

1. Health – A Precautionary Approach.
2. Integrated Policy.
3. Placemaking.
4. Data.
5. Public Engagement and Behaviour Change.
6. Industrial Emissions Regulations.
7. Tackling Non-Transport Emission Sources.
8. Transport.
9. Governance, Accountability and Delivery.
10. Further Progress Review.

2.2 Low Emission Zones

A Low Emission Zone (LEZ) is an area which sets minimum emissions standards for vehicles in a defined area, restricting access for the most polluting vehicles to improve air quality. This helps protect public health within the areas concerned, making them more attractive places in which to live, work and visit. Vehicles that do not meet the emission standards set for a LEZ will be subject to a penalty charge notice, although exemptions may be applied for certain vehicle types or classes.

LEZs were introduced in Aberdeen, Dundee, Edinburgh and Glasgow on 31 May 2022. In Glasgow the LEZ was initially introduced in 2018, applying to buses only.

For more information on LEZs go to the Low Emission Zones Scotland website.

2.3 Local Air Quality Management

The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas to determine if the air quality objectives are likely to be achieved. Where an exceedance is considered likely, the local authority must:

- Declare an AQMA
- Assess and identify the reasons for the problem
- Develop an Air Quality Action Plan (AQAP) to help address the problem

The LAQM policy and technical guidance documents along with other LAQM information and tools are available here https://www.scottishairquality.scot/laqm.

2.4 Air Quality Management Areas

In Scotland, there are 24 AQMAs declared across 12 of the Scottish local authorities. The AQMAs declared in Scotland are presented in Table 2.2. There are currently several AQMAs in the process of being revoked so it is expected that this number will reduce significant over the next 12 months. An interactive map which easily identifies where the AQMAs are in Scotland and provides additional information on the AQMAs can be found here https://www.scottishairquality.scot/laqm/aqma.

Table 2.2 Current AQMAs in Scotland

Local authority	Pollutant (number of AQMAs)	Main Source	AQMAs
Aberdeen	NO_2 and PM_{10}	Roads	3
City of Edinburgh	NO_2 (5) and PM_{10} (1)	Roads	5
Dundee City	NO_2 and PM_{10}	Roads	1
East Dunbartonshire	NO_2 and PM_{10}	Roads	1
East Lothian	NO_2	Roads	1
Falkirk	SO_2 and NO_2	Industry and roads	1
Glasgow City	NO_2 and PM_{10} (1), NO_2 (1)	Roads	1
Highland	NO_2	Roads	1
North Lanarkshire	PM_{10}	Industry and roads	3
Perth and Kinross	NO_2 and PM_{10}	Roads	2
Renfrewshire	NO_2 (2), NO_2 and PM_{10} (1)	Roads	3
South Lanarkshire	NO_2 (1) and PM_{10} (2)	Roads	2

3

Networks and Data

3.1 Automatic monitoring in Scotland

Extensive air quality monitoring is carried out across Scotland. The following AQS pollutants were monitored in Scotland during 2023:

- Benzene (C_6H_6)
- 1,3-butadiene (C_4H_6)
- Carbon monoxide (CO)
- Lead (Pb)
- Oxides of nitrogen (NO_x), comprising nitric oxide (NO) and nitrogen dioxide (NO_2)
- Ozone (O_3)
- Particles (as PM_{10}, $PM_{2.5}$ and black carbon)
- Polycyclic aromatic hydrocarbons (PAH)
- Sulphur dioxide (SO_2)

Data and information on these pollutants and the sites where they are measured can be accessed via the Air Quality in Scotland website (https://www.scottishairquality.scot/latest). Data analysis tools are also available here (https://www.scottishairquality.scot/data/data-selector). Figure 3.1 illustrates the location of automatic sites and Scotland. These stations provide high-resolution, hourly information on a wide range of pollutants. A typical automatic monitoring site is shown in Figure 3.2.

Scotland's automatic monitoring is supplemented by non-automatic monitoring techniques. For example, the non-automatic techniques used to monitor nitrogen dioxide and metals (such as lead), the pumped-tube samplers used to monitor benzene, and the high-volume samplers used to measure PAH.

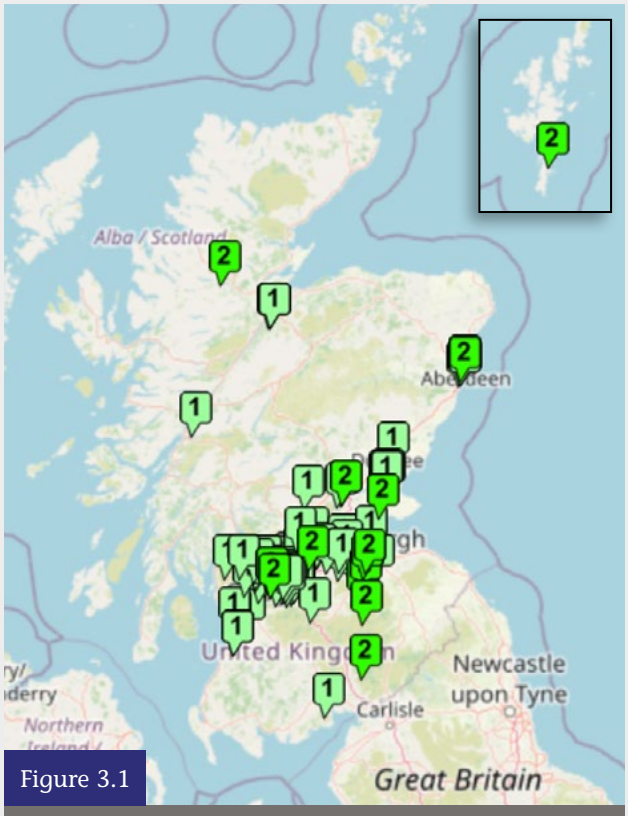


Figure 3.1

Location of automatic monitoring stations

Figure 3.2

Scottish automatic monitoring site

3.2 Passive monitoring in Scotland

In 2023, Scottish local authorities combined had a network of over 1000 passive monitoring diffusion tube sites monitoring NO_2. The Scottish Diffusion Tube Network map (https://www.scottishairquality.scot/latest) provides published bias corrected annual mean diffusion tube data, site type information, location and historical data in a format that is easy to understand. Diffusion tubes are used:

- As a low-cost alternative to automatic monitoring at a greater amount of locations of concern for use within Local Air Quality Management.
- To give an indication of longer-term average NO_2 concentrations.
- For highlighting areas of high NO_2 concentrations where installation of an automatic analyser isn't feasible, or where more detailed investigation may be required.

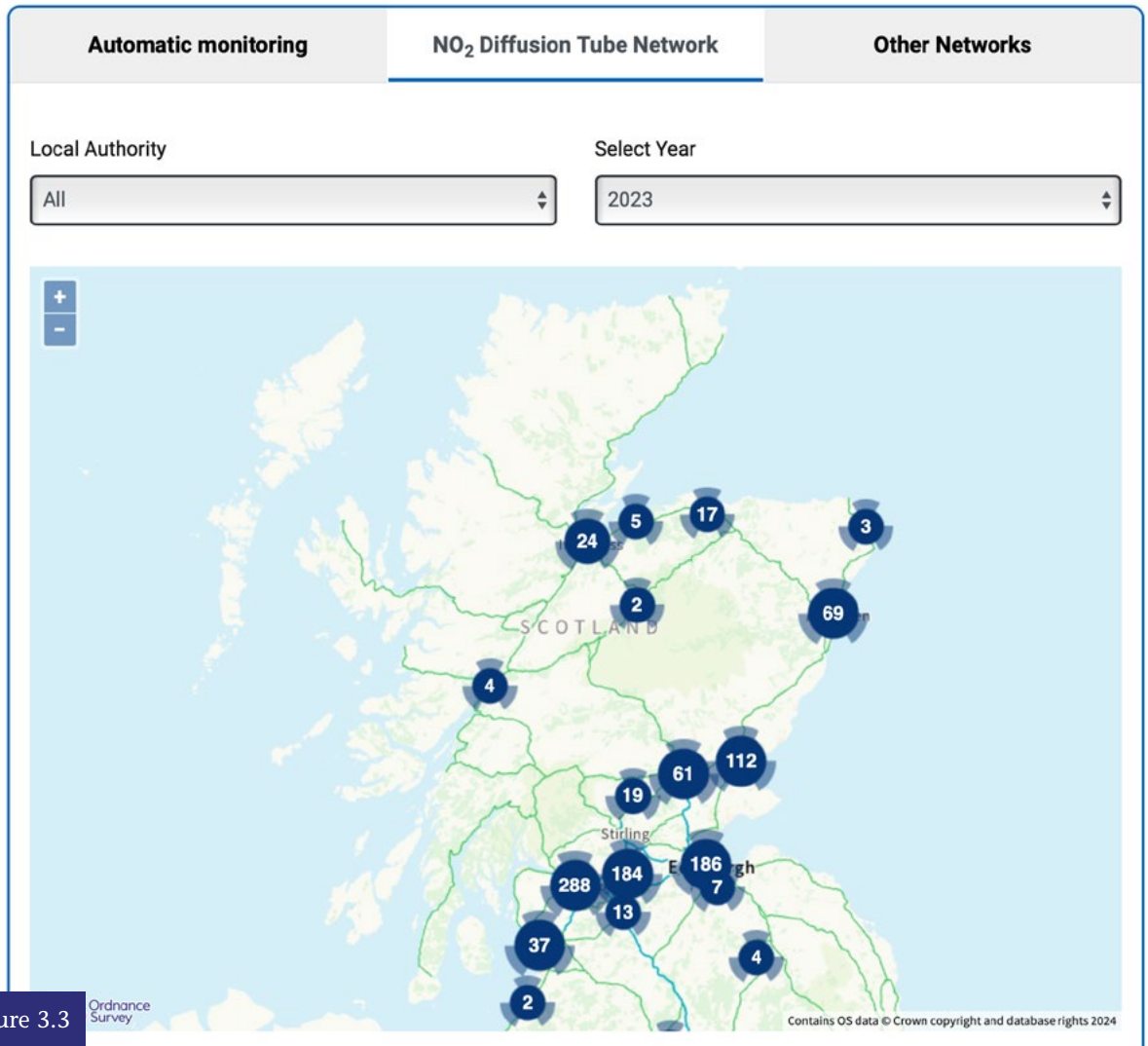


Figure 3.3 Diffusion tube site map

3.3 Key Results for 2023

This section provides a summary of results from automatic and non-automatic monitoring in Scotland in 2023 including compliance with AQS objectives. Further information is provided on the Air Quality in Scotland website. This will be supplemented by further information and data to be published in the full Annual Report.

Benzene

This hydrocarbon is a constituent of vehicle exhaust emissions. Benzene was monitored using a non-automatic pumped-tube sampler at two sites (Glasgow Kerbside and Grangemouth) as part of the UK Non-Automatic Hydrocarbon Network. Benzene was also measured using an automatic technique at the rural supersite at Auchencorth Moss. All sites had annual mean concentrations below the AQS objective for the running annual mean.

1,3-Butadiene

1,3-butadiene is also a constituent of vehicle exhaust emissions. This pollutant was monitored at one rural site (Auchencorth Moss) as part of the UK Automatic Hydrocarbon Network. There were no exceedances of the 1,3-butadiene objective in 2023.

Carbon monoxide

This gas is a product of incomplete combustion, with vehicle exhaust emissions being an important source. It was monitored at one site in Scotland in 2023 - Edinburgh St Leonards. Ambient concentrations of CO were well within the AQS objective, as they have been for many years.

Lead

This toxic metal is emitted from some industrial processes (although emissions are now strictly controlled). Lead is monitored at two sites in Scotland (Auchencorth Moss and Eskdalemuir). There were no exceedances of the lead objectives in 2023.

Nitrogen dioxide – Automatic monitoring

This gas is emitted from most combustion processes, including power generation, domestic heating and vehicle engines. It was monitored at 89 automatic sites in Scotland during 2023. Of these, 17 achieved less than the 75% data capture generally considered necessary to calculate a representative annual mean. Of the remaining 72, no sites

exceeded the annual mean objective for NO_2 (40 µg m^{-3}) in 2023. The hourly mean objective of 200 µg m^{-3} (not to be exceed more than 18 times per annum) was also not exceeded at any site (same as 2022).

Figure 3.4 shows annual mean NO_2 concentrations at each site (with at least 75% data capture) for 2023.

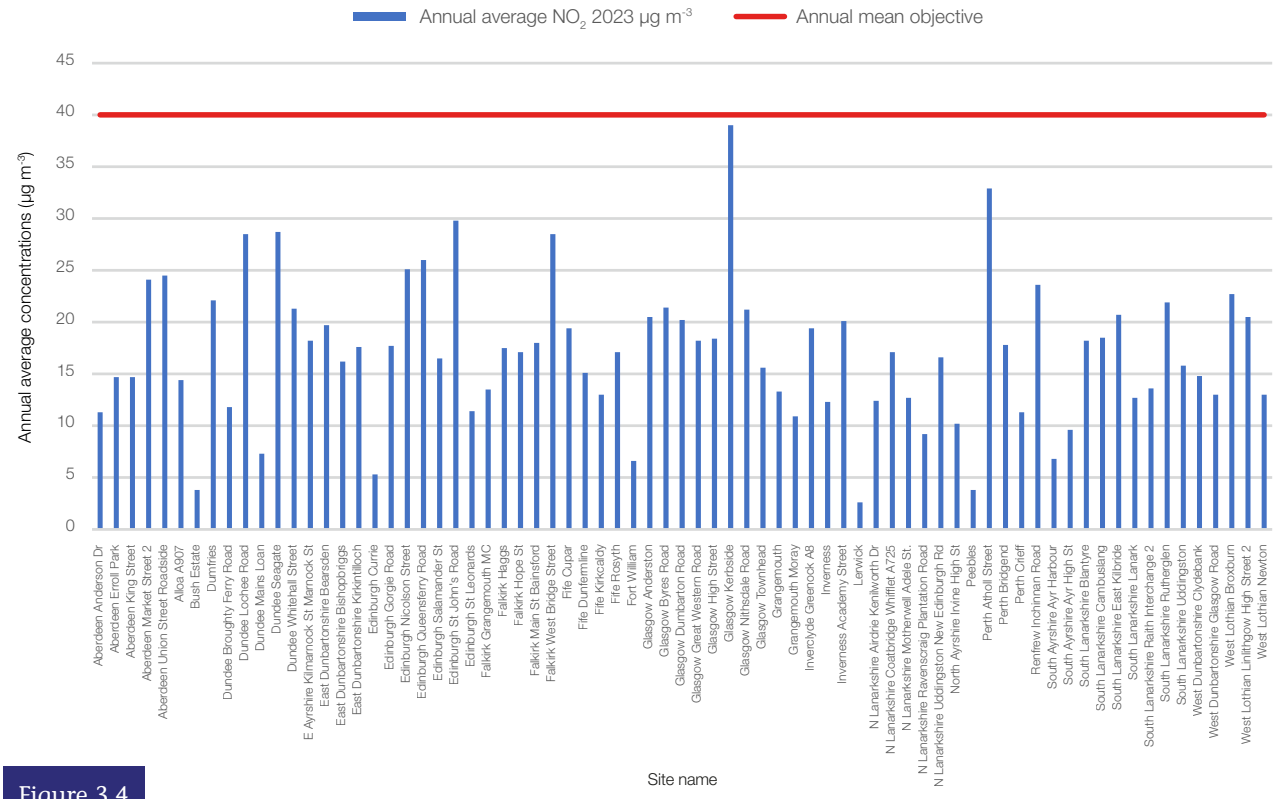


Figure 3.4

Annual mean NO_2 concentrations at sites with >75% data capture (2023)

Nitrogen dioxide – Passive monitoring

In 2023, four NO_2 diffusion tube monitoring sites exceeded the annual mean objective, three less than in 2022. Figure 3.5 illustrates the number of exceeding sites since 2013. The four sites that exceed were located in Glasgow and Edinburgh.

For more information on the 2023 data and historical diffusion tube data, go the Diffusion Tube site map on the Air Quality in Scotland website (https://www.scottishairquality.scot/latest). This diffusion tube data can also now be downloaded via the data selector tool (https://www.scottishairquality.scot/data/data-selector).

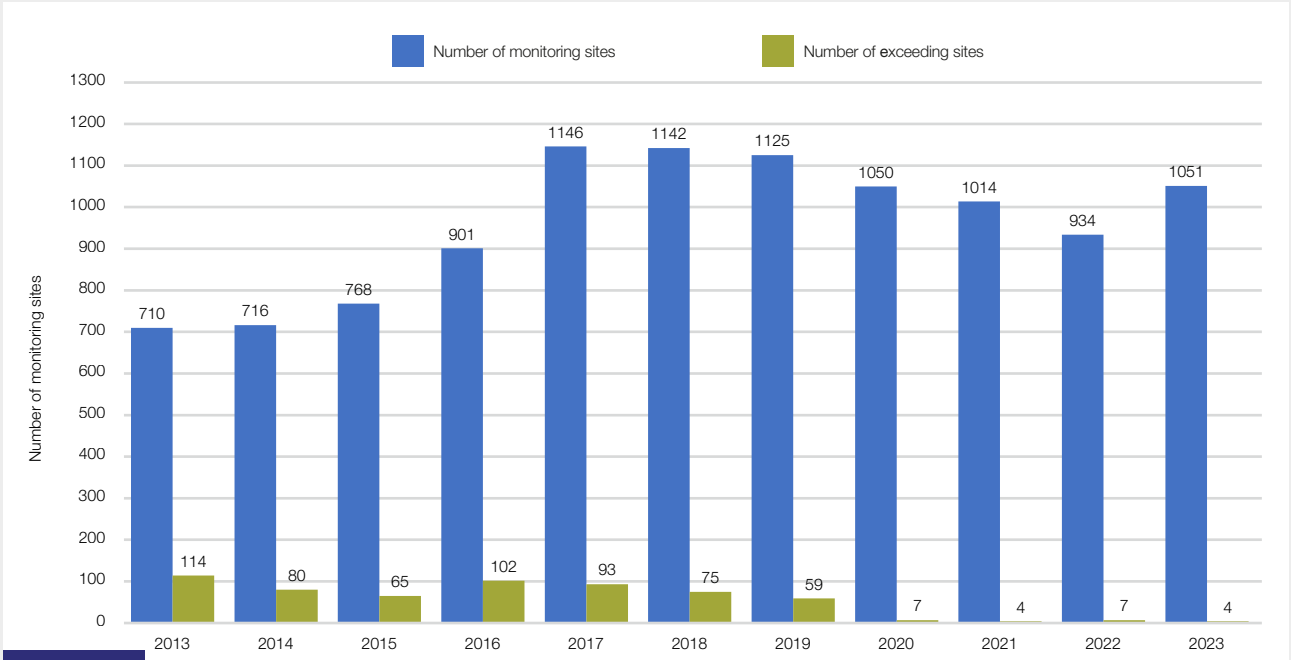


Figure 3.5

Number of NO_2 diffusion tube sites exceeding the annual mean objective since 2013

Sulphur dioxide

This gas is emitted when fuels containing small amounts of sulphur (such as oil and coal) are burned. This pollutant was monitored at eight sites in 2023, though one site (Lerwick) did not achieve a data capture rate greater than 75%. Of the remaining seven sites, all met the requirements of the Air Quality Strategy for the 15-minute (no more than 35 times), 1-hour (no more than 24 times) and 24-hour (no more than three times) mean objectives SO_2 in 2023.

Particulate matter as PM_{10}

Particulate matter arises from many sources. It can be directly emitted from combustion processes or formed from chemical reactions involving other pollutants. Natural sources (e.g. wind-blown dust and sea salt) also contribute. PM_{10} was monitored at 85 Scottish sites in 2023 using automatic monitoring.

Of the 76 sites with 75% or greater data capture, one site exceeded the annual average objective of 18 µg m^{-3}. The Scottish daily mean objective of 50 µg m^{-3} (not to be exceeded more than seven times in a year) was also exceeded at this site.

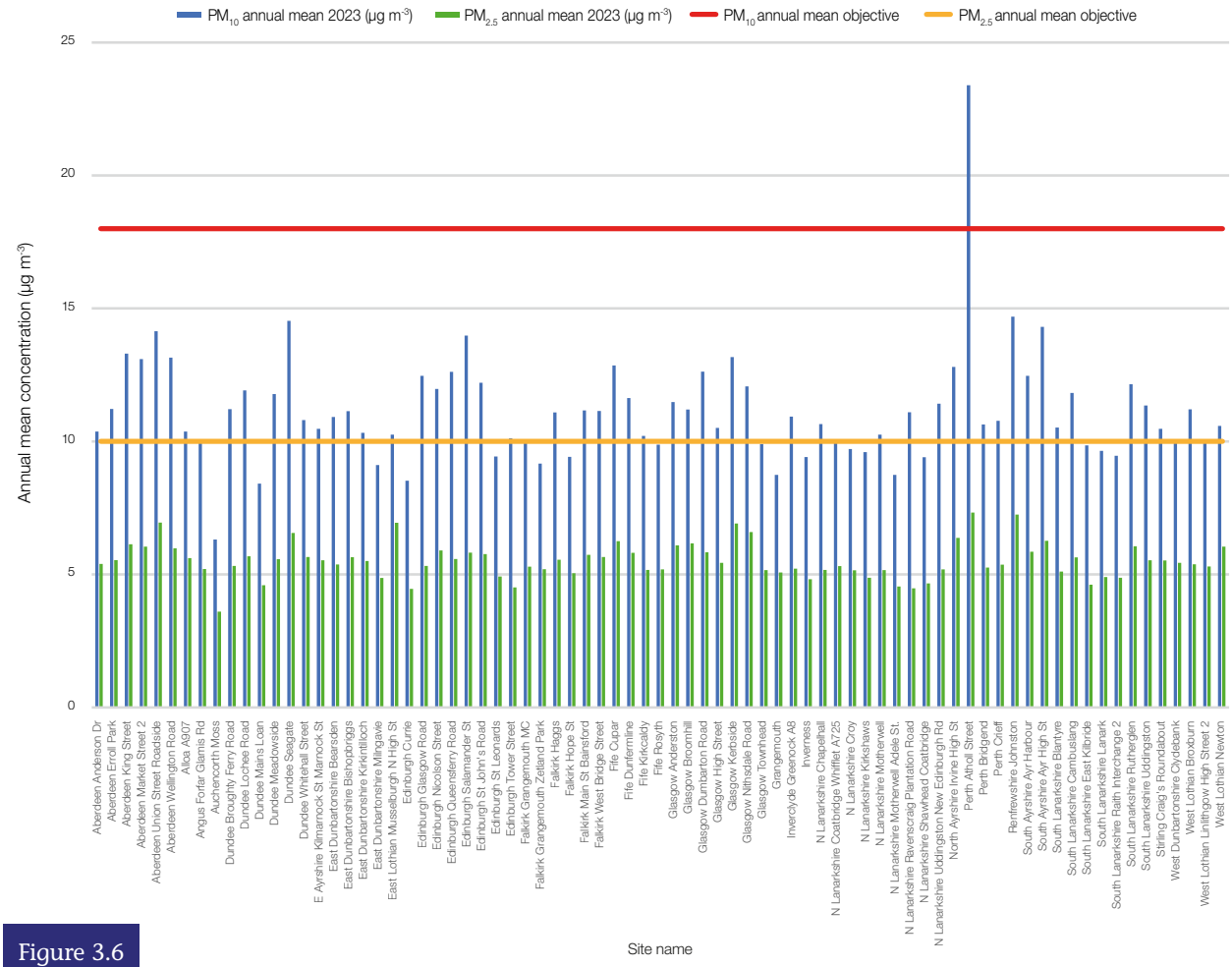


Figure 3.6

Annual mean PM_{10} and $PM_{2.5}$ concentrations at sites with >75% data capture (2023)

Particulate matter as $PM_{2.5}$

During 2023, the finer particle fraction, $PM_{2.5}$ was monitored at 84 Scottish sites. Of the 76 sites with 75% or greater data capture, no sites exceeded the annual average $PM_{2.5}$ Objective of 10 µg m^{-3}.

See Figure 3.6 for annual mean concentrations at all PM_{10} and $PM_{2.5}$ sites (with a data capture of 75% or more) compared to the annual mean objective.

Polycyclic aromatic hydrocarbons

This group of pollutants is monitored at four sites in Scotland (Kinlochleven, Glasgow Townhead, Edinburgh St Leonards and Auchencorth Moss). The AQS objective of 0.25 ng m^{-3} for benzo[a]pyrene was not exceeded at any sites in 2023. More information on these can be found in the "Other Networks" map in the Air Quality in Scotland website (https://www.scottishairquality.scot/latest).

Ozone

This is a secondary pollutant that is formed by reactions involving other pollutant gases in the presence of sunlight and over several hours. Once formed, it may persist for several days and be transported over long distances. This makes it difficult to control by local action. It was monitored at 11 sites in Scotland during 2023. Of these 11 sites, the AQS objective of 100 µg m^{-3} not to be exceeded more than 10 days, was exceeded at six sites. In 2022, no sites exceeded the objective Figure 3.7 below illustrates the sites that exceed the objective.

The AQS objective is not included in LAQM regulations. This is in recognition of the fact that it is transboundary in nature and that local authorities have very little control over concentrations in their areas.

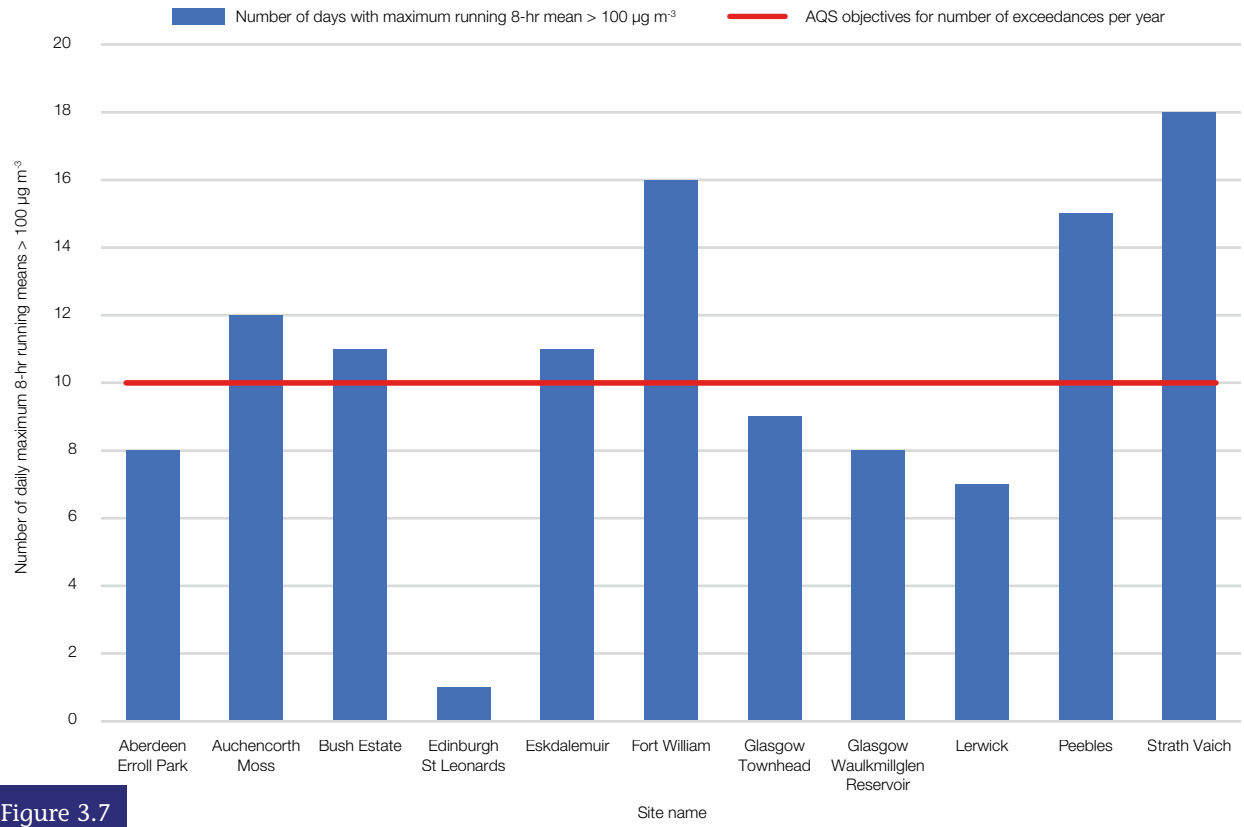


Figure 3.7

Exceedances of the daily maximum 8-hour running mean AQS objective for ozone (2023)

4

Air Quality Trends

This section summarises how air quality in Scotland has changed over recent years. As with previous years, the pollutants of interest are NO_2, PM_{10}, $PM_{2.5}$ and O_3.

All the sites featured in this section have been in operation for a minimum of five consecutive years - considered to be the minimum required to assess long-term trends. In most cases, it is now possible to do trend analysis for longer periods (e.g. 10 years).

The trend analysis presented in this section has been carried out using Openairs TheilSen' tool. This tool uses the Theil-Sen statistical method to determine trends in pollutant concentrations over several years. The data used in these trend graphs has been 'de-seasonalised' (i.e. the data has been statistically modified to remove the influence of seasonal cycles, thus providing a clearer indication of the overall trend over the relevant time).

In these plots, the trend line is shown by a solid red line with 95% confidence intervals for the trend shown by dotted red lines. The trend is given at the top of the plot in green, with confidence intervals shown in square brackets. The trend is given as units (µg m^{-3}) per year, over the period shown. This may be followed by a number of stars:

* indicating that the trend is statistically significant at the 0.05 level

** indicating significance at the 0.01 level

*** indicating highly significance at the 0.001 level

The + symbol indicates that the trend is significant at the 0.1 level.

Further information on air quality trends for a range of pollutants is reported in more detail within the SAQD Annual Report.

4.1 Nitrogen Dioxide

In Scotland the largest number of Air Quality Management Areas (AQMAs) have been declared in response to exceedances of the nitrogen dioxide (NO_2) objectives. Therefore, it is important to understand how concentrations of this pollutant has varied with time.

4.1.1 NO_2 at Urban Non-Traffic Sites

There are relatively few long-running urban non-traffic sites monitoring stations in Scotland due to the nature of the pollutant and its main source (vehicles). However it is important to obtain background levels of NO_2 to help ascertain what concentrations are like away from the source. Five of these sites have been in operation for over 15 years.

Figure 4.1 provides NO_2 trend for these sites from 2007 to 2023. All sites display statistically highly significant negative trends over this time period.

Figure 4.2 takes into consideration analysis from the same sites over the past five years to identify whether the trend is consistent. As can be seen the decreasing trend continues across all sites but at a lesser extent with varying statistical significancy. The exception to this is Grangemouth which is now showing a slight increasing trend.

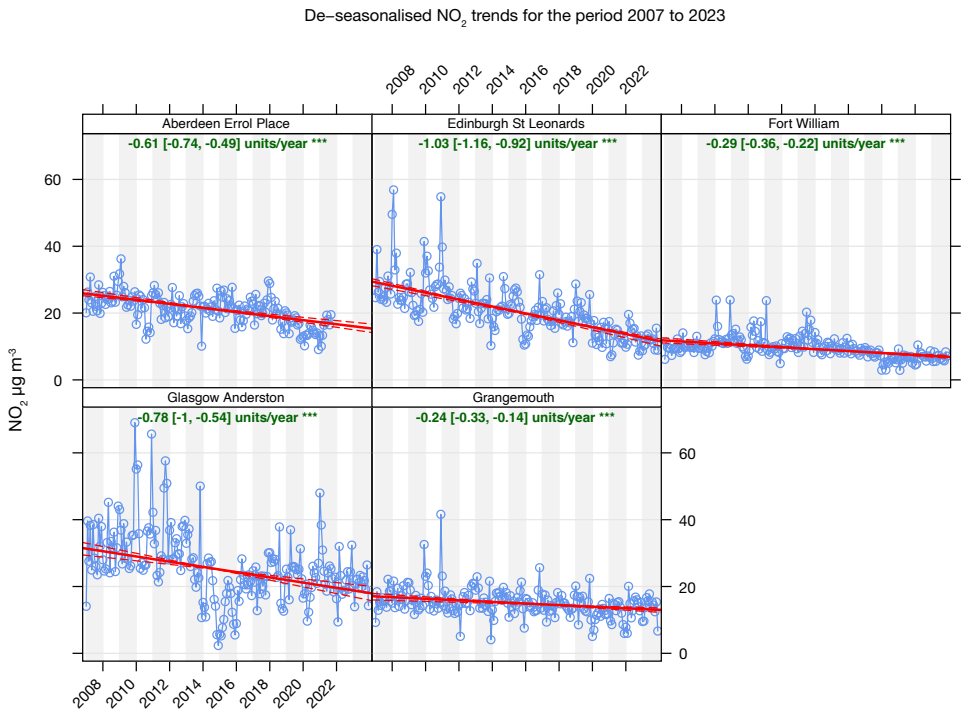


Figure 4.1

Trends in NO_2 concentration at five long-running urban non-roadside sites, 2007-2023

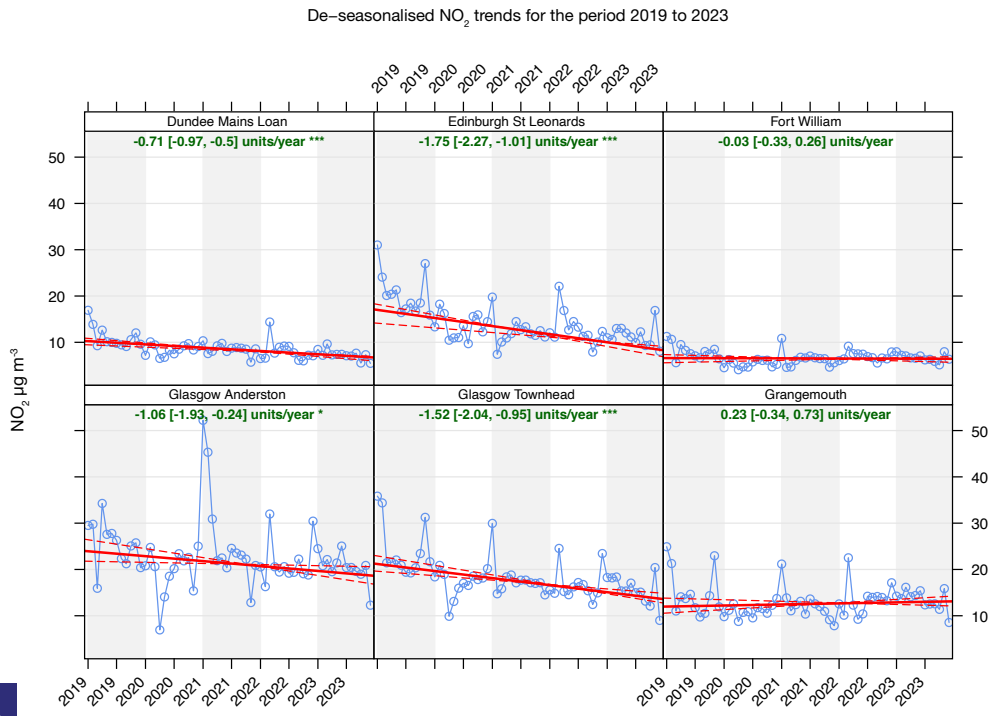


Figure 4.2

Trends in NO_2 concentration at all urban non-traffic sites, 2019-2023

4.1.2 NO_2 at Urban Traffic Sites

There is a large number of Urban Traffic sites, so for the purposes of this brochure we have selected eight long-running sites. These are:

- Aberdeen Union Street,
- Aberdeen Wellington Road,
- Dundee Lochee Road,
- Dundee Seagate,
- Edinburgh St John's Road,
- Glasgow Kerbside (Hope Street),
- N Lanarkshire Chapelhall,
- Perth Atholl Street.

Figure 4.3 shows the trend plots for these sites from 2014 to 2023. As with the previous years' reports, all eight sites show statistically highly significant decreasing trend.

Trends over the most recent five years have also been examined (Figure 4.4). The analysis shows that the sites are still decreasing but to a lesser extent across the board.

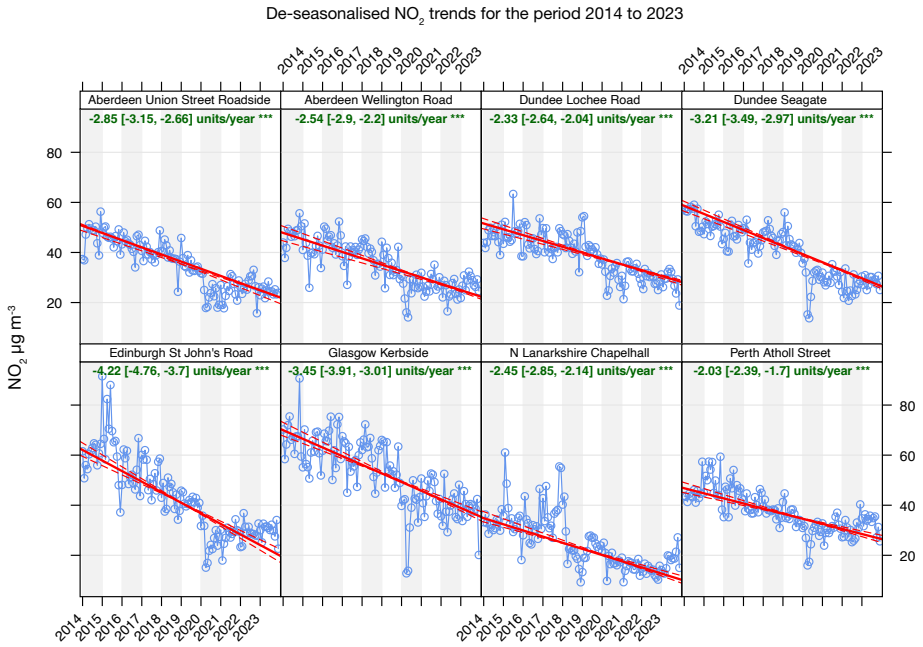


Figure 4.3

Trends in NO_2 concentration at eight Long-running urban traffic sites with exceedances, 2014-2023

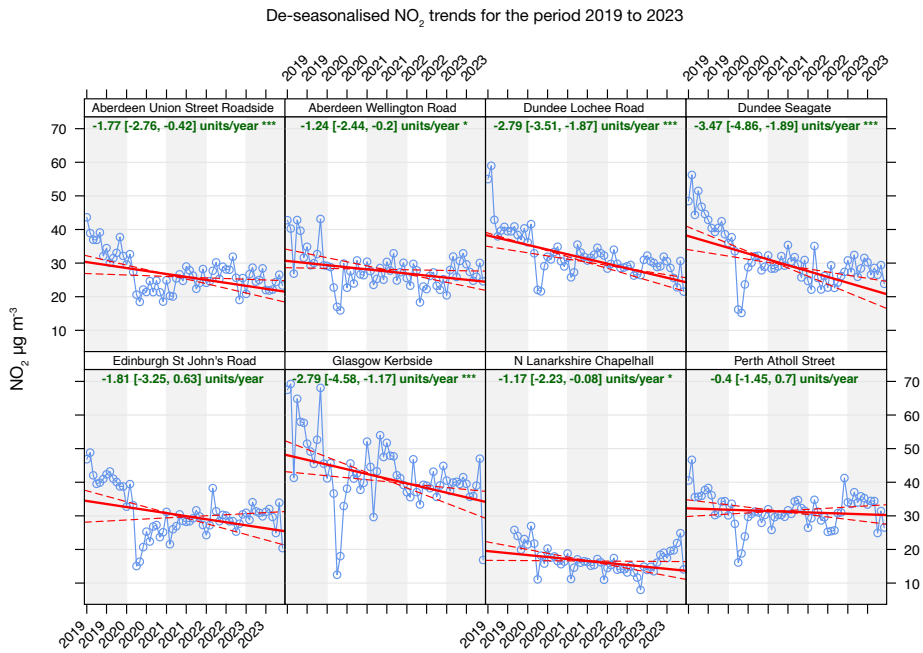


Figure 4.4

Recent trends in NO_2 concentration at eight long-running urban traffic sites with exceedances, 2019-2023

4.2 Particulate Matter (PM_{10} and $PM_{2.5}$)

This pollutant is of particular interest because current evidence suggests that there is no safe level of particulate matter in terms of human health effects.

4.2.1 PM_{10} at Urban Traffic Sites

Trends in monthly mean PM_{10} concentrations for a selection of eight traffic-related sites in operation since 2014 are shown in Figure 4.5. These sites were chosen to be analysed because of historical exceedances of the annual mean objective and geographical coverage. Figure 4.5 illustrates that all sites have statistically highly significant decreasing trends, with the exception of Glasgow Byres Road.

Trend for the same eight sites (plus Edinburgh Queensferry Road), for the most recent five complete years, are shown in Figure 4.6. The analysis shows that the 10-year decreasing trend is plateauing at most sites with some actual showing a slight increasing trend (Bearden, Queensferry Rd and Crieff).

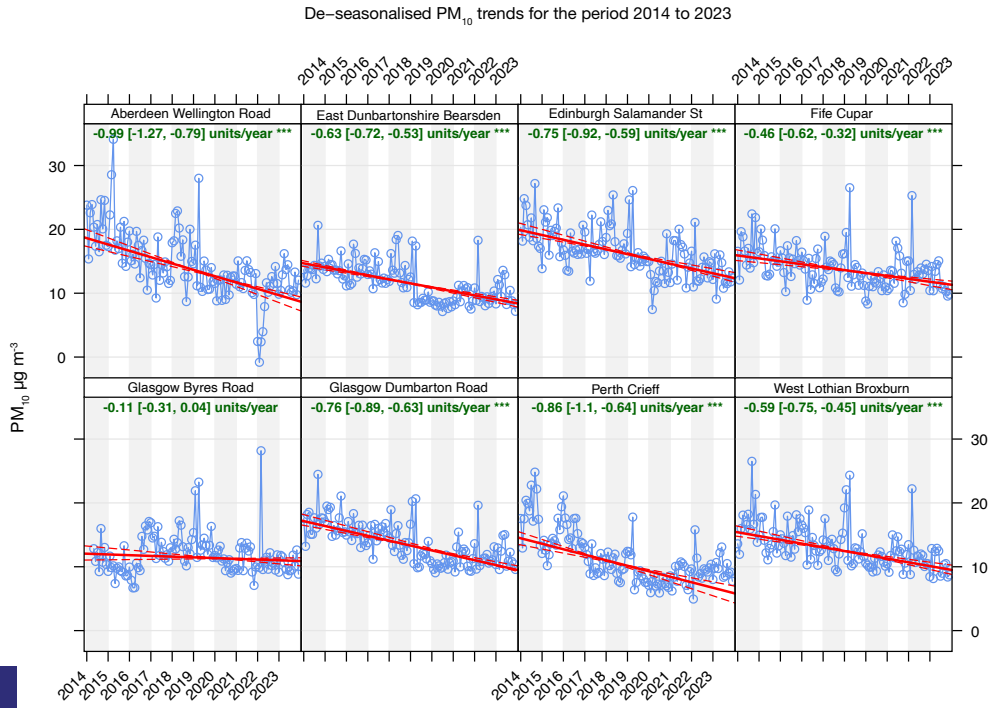


Figure 4.5

Trends in PM_{10} concentration at eight long-running urban traffic sites, 2014-2023

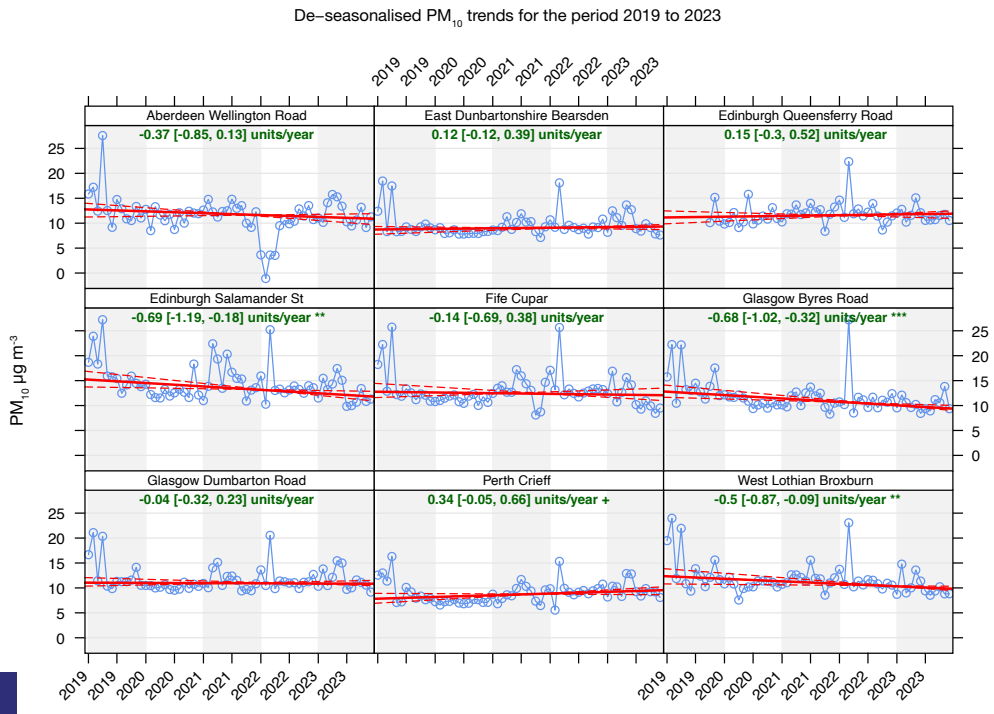


Figure 4.6

Recent trends in PM_{10} concentrations at nine urban traffic sites, 2019-2023

4.2.2 Particulate Matter ($PM_{2.5}$)

By the end of 2023 there were three sites with 10 consecutive years of $PM_{2.5}$ data. The trend plot for these sites is shown in Figure 4.7. The Analysis shows that all sites show a decreasing trend at varying levels of statistical significancy.

As can be seen, all nine sites are very similar with the majority show slight decreasing trends at varying statistical significance. Perth Atholl Street and Renfrewshire Johnston show very slight increasing trends but at no statistical significancy. Figures 4.7 and 4.8 indicate no real change in $PM_{2.5}$ concentrations over the years analysed.

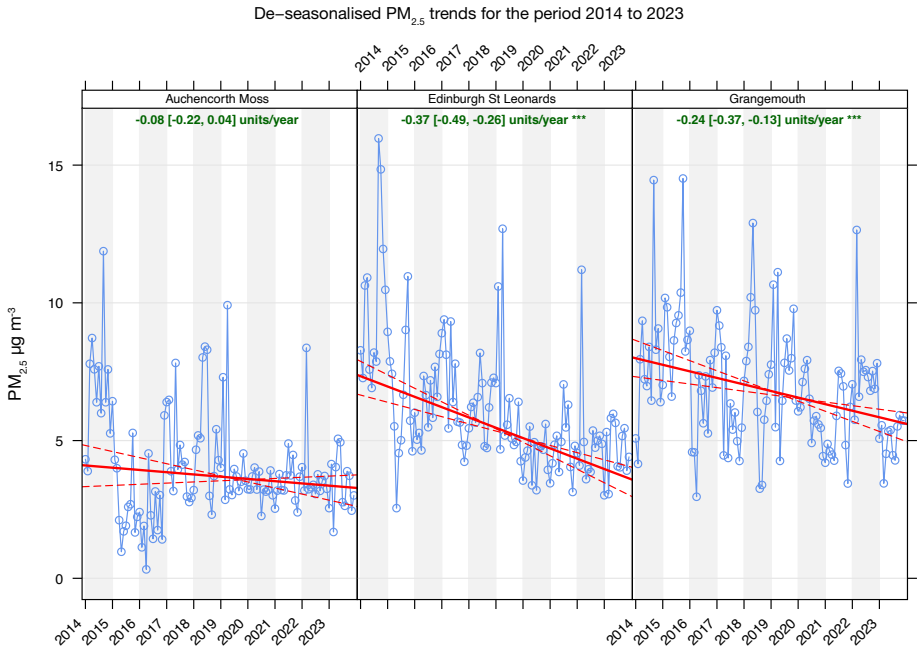


Figure 4.7

Trends in $PM_{2.5}$ concentration at three long-running monitoring sites, 2014-2023

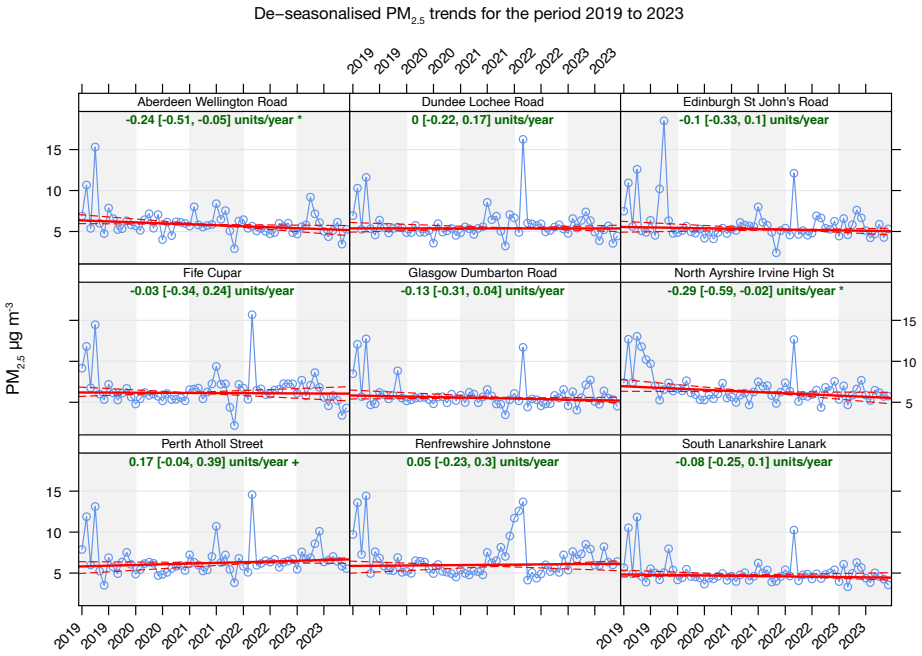


Figure 4.8

Trends in $PM_{2.5}$ concentration at urban traffic sites, 2019-2023

4.3 Ozone (O_3)

4.3.1 Rural Ozone

Three of Scotland's rural air quality monitoring stations have been monitoring ozone for 32 years, 1986 – 2022. These are Bush Estate, Eskdalemuir and Strath Vaich. Figure 4.9 shows long-term trends in de-seasonalised monthly mean ozone concentrations at these three sites. Bush Estate and Eskdalemuir both show small but statistically highly significant increasing trend. For Strath Vaich, there has been neither an increasing or decreasing trend over the same period with concentrations generally staying the same.

Six sites have been in operation for over the last 10 years. Trends in ozone concentration at these sites are shown in Figure 4.10. The ten-year trend analysis shows that four sites have increasing trends in O_3 concentrations at varying levels of statistical significance. The other two sites (Lerwick and Strath Vaich) have slight decreasing trends with no statistical significance.

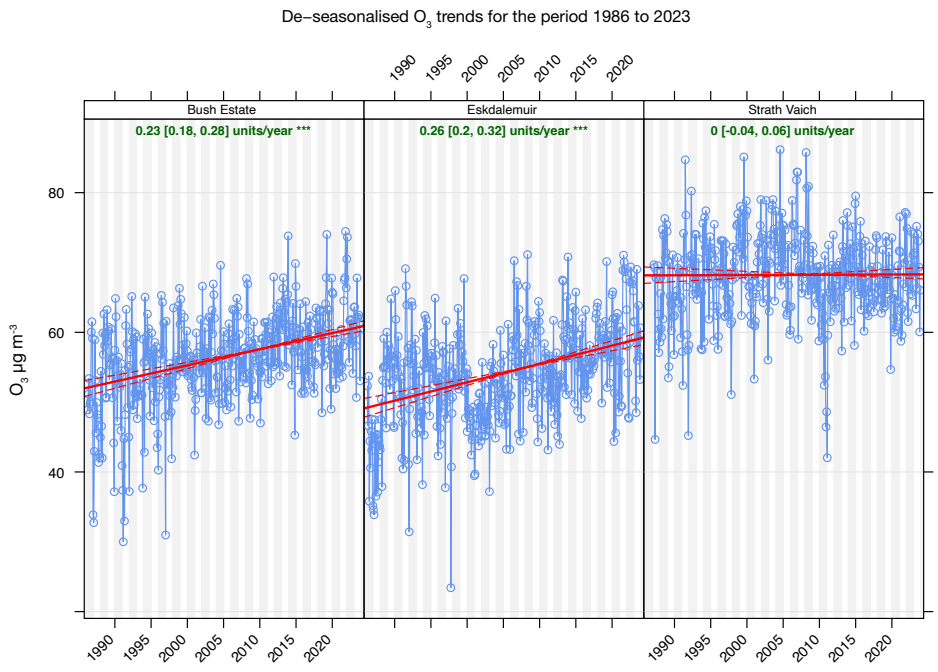


Figure 4.9

Trends in O_3 concentrations at long-running rural sites, 1986-2023

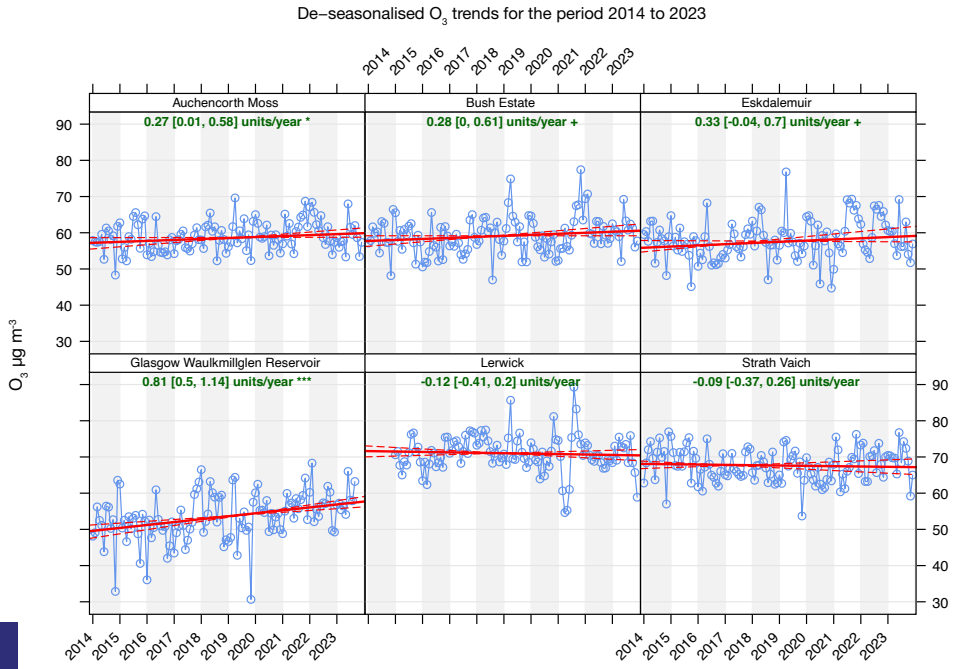


Figure 4.10

Trends in O_3 concentrations at six long-running rural sites, 2014-2023

5

Air Quality Mapping for Scotland

As part of the SAQD project, Ricardo provides mapped concentrations of modelled background air pollutant concentrations on a 1 km x 1 km basis for the whole of Scotland. Modelled roadside air pollutant concentrations are provided for road links in Scotland. The air pollution maps are derived from a combination of:

1. Measurements from Scotland's network of air quality monitoring stations, and
2. Spatially disaggregated emissions information from the UK National Atmospheric Emissions Inventory (NAEI)

The maps provide estimated pollutant concentrations for the whole of Scotland. The methodology for producing the Scottish maps is based on the UK Pollution Climate Mapping (PCM) approach. This is used for producing air pollution maps for the whole of the UK.

The PCM methodology has been applied to provide pollution maps of Scotland for the Scottish Government for 2021 using measurements exclusively from Scottish air quality monitoring sites. The maps provide spatial representation of the annual mean concentrations of:

- PM_{10} (gravimetric equivalent)
- $PM_{2.5}$ (gravimetric equivalent)
- NO_X and NO_2.

Please note the available projections from a base year of 2018 are based on assumptions that were applicable prior to the Covid-19 pandemic, and as such, do not reflect short- or long-term impacts of the pandemic and associated lockdowns on emissions in 2020 and beyond.

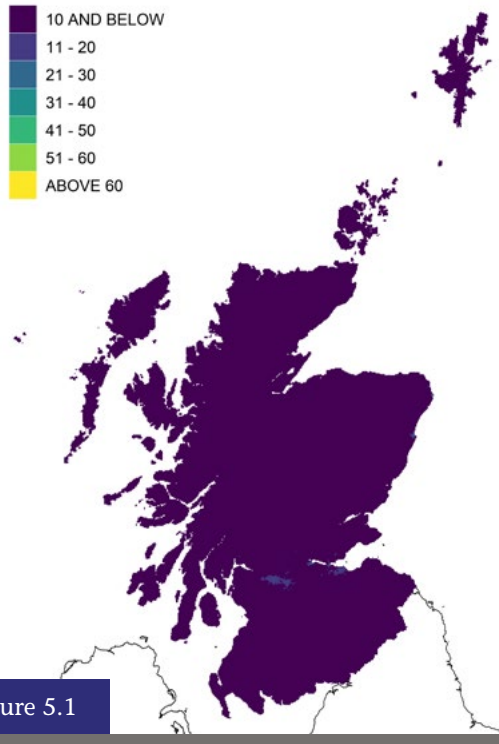


Figure 5.1

Background NO_2 map for 2022, µg m^{-3} (Scotland-specific model)

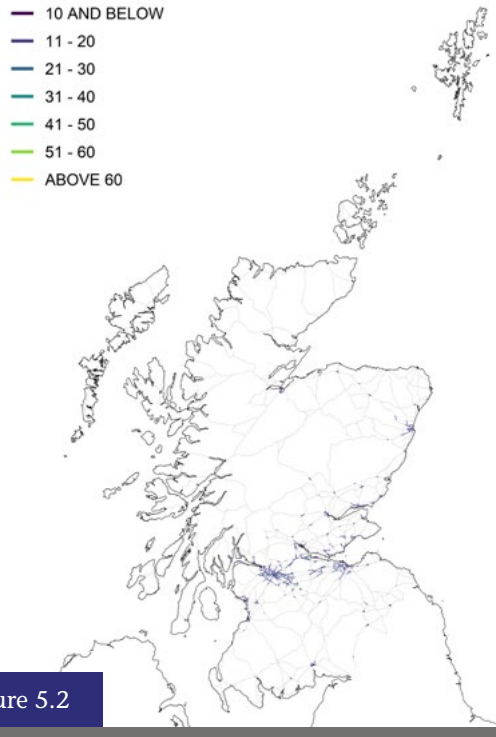


Figure 5.2

Roadside NO_2 map for 2022, µg m^{-3} (Scotland-specific model)

5.1 Air Quality Maps for Scotland 2022

The details of the methodology and full results of the mapping study are provided in a separate report[1]. In this report, we summarise the main findings of this work.

5.1.1 NO_2 Maps for 2022

The 2022 annual mean NO_2 concentrations for Scotland were modelled for background and roadside locations. Figure 5.1 and Figure 5.2 illustrates modelled annual mean concentrations in Scotland, for background and roadside locations respectively. The data shows that there were no modelled exceedances of the Scottish annual mean NO_2 objective of 40 µg m^{-3} at background or roadside locations.

[1] Wareham, J., Pepler, A. Stedman, J., Morris, R. and Hector, D. (2022). Scottish Air Quality Maps. Annual mean NO_X, NO_2, PM_{10} and $PM_{2.5}$ modelling for 2020. https://www.scottishairquality.scot/sites/default/files/orig/assets/documents/Scottish_mapping_report_2020.html

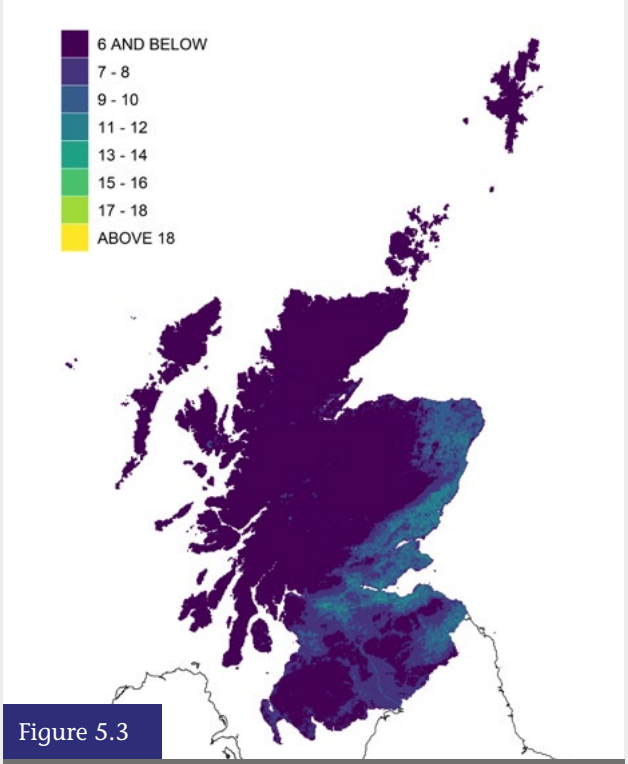


Figure 5.3

Background PM_{10} map for 2022, µg m^{-3} (Scotland-specific model)

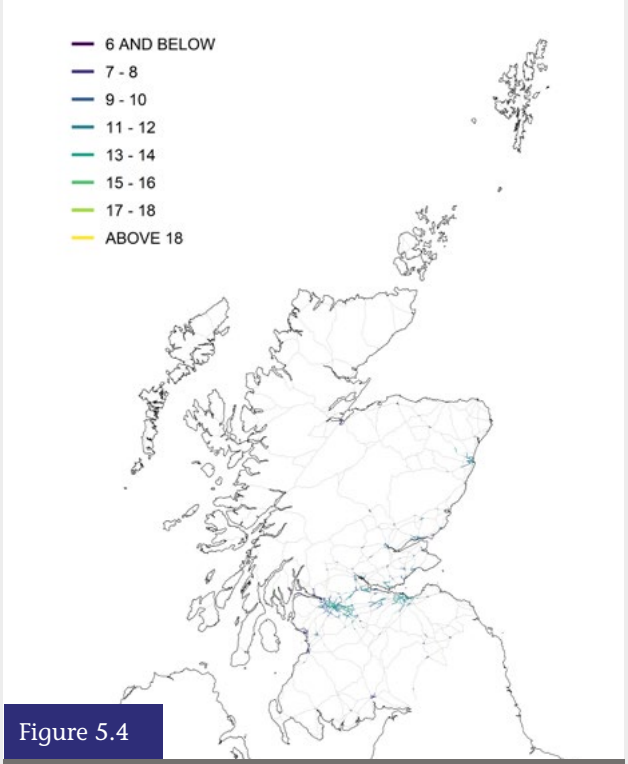


Figure 5.4

Roadside PM_{10} map for 2022, µg m^{-3} (Scotland-specific model)

5.1.2 PM_{10} Maps for 2022

2022 annual mean PM_{10} concentrations for Scotland were modelled for background and roadside locations. The modelling methodology used to calculate the annual mean PM_{10} concentration was similar to that used in previous years and used a mixture of PM_{10} monitoring data. Many of the chemical components of the PM_{10} model are not affected by the Scotland-specific changes to the UK PCM model. This includes the contribution to the total PM_{10} mass from the following components:

- secondary inorganic aerosols (SIA, e.g., sulphate, nitrate, ammonium-based particles)
- secondary organic aerosols (SOA)
- primary particles from long-range transport
- sea salt aerosol, and
- iron and calcium-rich dusts.

Maps of the modelled 2022 annual mean PM_{10} concentrations for Scotland's background and roadside locations are shown in Figures 5.3 and 5.4, respectively. The modelling indicated that there were no modelled exceedances of the Scottish annual mean PM_{10} objective of 18 µg m^{-3} at background and roadside locations.

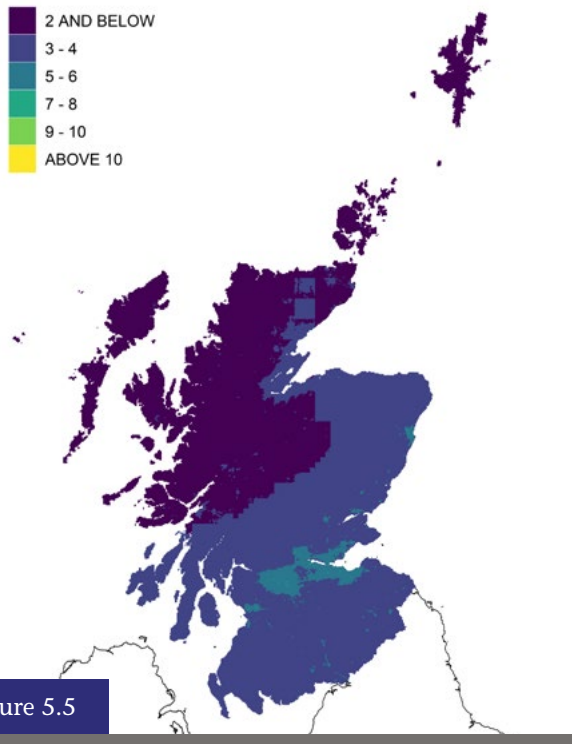


Figure 5.5

Background $PM_{2.5}$ map for 2022, µg m^{-3} (Scotland-specific model)

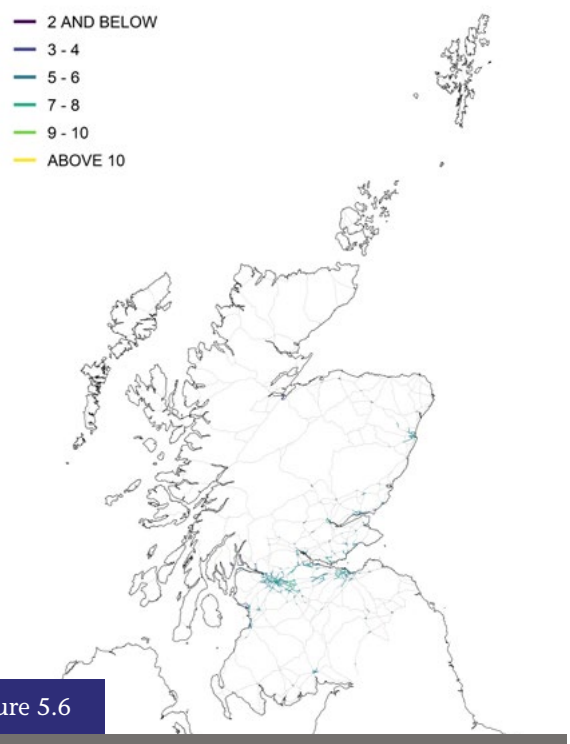


Figure 5.6

Roadside $PM_{2.5}$ map for 2022, µg m^{-3} (Scotland-specific model)

5.1.3 $PM_{2.5}$ Maps for 2022

2022 annual mean concentrations of $PM_{2.5}$ were modelled for Scotland at background and roadside locations. The modelling methodology used is consistent with the PM_{10} model and further detail can be found in the 2022 UK mapping report[2]. The 2022 maps have been calibrated using measurements from sites for which co-located PM_{10} measurements are also available.

Maps of the modelled 2022 annual mean $PM_{2.5}$ concentrations for Scotland's background and roadside locations are shown in Figures 5.5 and 5.6, respectively. The modelling showed that there were no modelled exceedances of the Scottish annual mean $PM_{2.5}$ objective of 10 µg m^{-3} at both background and roadside locations.

[2] Pugsley, K. L., Stedman, J. R., Brookes, D. M., Kent, A. J., Morris, R. J., Whiting, S. L., Wareham, J. V., Pepler, A., Thorp, T. M., Gorji, S. and Marshall, O., 2023. "Technical Report on UK Supplementary Modelling Assessment Under the Air Quality Standards Regulations 2010 for 2022." Ricardo Energy & Environment. https://uk-air.defra.gov.uk/library/reports?report_id=1116.

6

Education

Education has been an ongoing development for air quality in Scotland. Interactive education packages have been developed through the creation of two sections that form part of the Air Quality in Scotland website. The first education website, 'Air Pollution Detectives', was created for schoolchildren in P5 to P7 (8-11 years old). The second website, 'Clear the Air', was developed in partnership with a number of secondary schools for pupils in S1 to S3 (12-15 years old). The education packages can be accessed from the Air Quality in Scotland website (https://children.scottishairquality.scot).

6.1 Air Pollution Detectives

Initially launched in 2011, the Air Pollution Detectives website has been continuously revised and updated. It was designed to introduce air quality issues to primary school pupils between the ages of 8 and 11. The animated, interactive webpages provide an introduction to air pollution sources and how pupils' actions can impact the air quality around them. The website is accompanied by a set of teachers' notes and worksheets to enhance the learning experience.

Visit the Air Pollution Detectives website at https://children.scottishairquality.scot.

Figure 6.1

Education webpage

6.2 Clear the Air

The Clear the Air website was developed following the success of Pollution Detectives. The webpage, provides an interactive learning experience for air quality and citizen science aimed at secondary school age and above.

The Clear the Air package includes a series of interactive webinars and exercises designed to be undertaken by pupils. These interactive exercises include 'What air pollution is like near me', 'Calculating your emissions to school' and a citizen science project that enables classes to monitor air quality around the school by using NO_2 diffusion tubes.

Visit the Clear the Air webpages at https://cleartheair.scottishairquality.scot.

Figure 6.2

Clear the Air webpage

7

Stay Informed

7.1 Scotland Air Pollution Forecast

A five-day forecast for each local authority in Scotland is available on the Air Quality in Scotland website. Forecasts are displayed through a summary table and a map. These are available at https://www.scottishairquality.scot.

7.2 Air Quality in Scotland App

The free Air Quality in Scotland app is available for most mobile devices via the Apple Store and Google Play. The App provides:

- Easy access to the latest pollution levels from the monitoring sites
- Colour coded map showing the pollution forecasts, plus a detailed breakdown
- Approved health advice based on the pollution levels
- Information on AQMA in Scotland in the form of an interactive map
- Subscribe to free notification alerts when moderate, high and very high pollution is measured or forecast.
- Subscribe to free notification alerts when you enter an AQMA

7.3 Know & Respond

Know & Respond is a free service providing alerts when pollution levels are forecast to increase (https://www.scottishairquality.scot/know-and-respond). Users can subscribe to a specific local authority and will receive push notifications directly to their device if 'moderate' or higher air pollution is forecast each day. Users can choose to receive alerts by text, voicemail or email.

7.4 Email Alerts

Sign up to our email bulletins and receive summaries directly to your inbox (https://www.scottishairquality.scot/stay-informed). You can choose how frequently you receive them and what type of summary you are interested in.

7.5 Interactive Mapping and Analytical Tools

Visualisation and data analysis tools are available on the Air Quality in Scotland website (https://www.scottishairquality.scot/data/openair). The tools pull data from the Scottish Air Quality Database and present it in several formats. These tools enable the data to be customised and filtered to meet individual requirements, such as viewing air quality in a particular area or for local authorities when preparing annual reports.

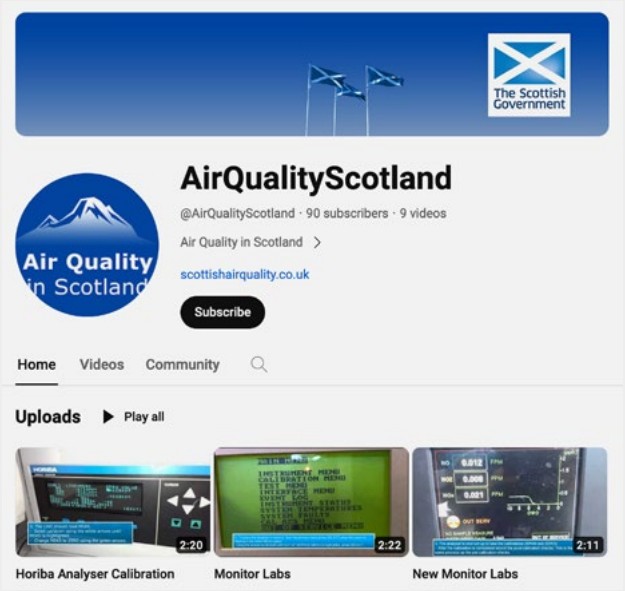
7.6 X

Follow Air Quality in Scotland on X (@scotairquality) for air quality forecasts and summaries of measurements from Scotland. The service enables you to stay informed about current and forecast air quality including the occurrence of air quality episodes. Health advice and information on the UK Air Quality Index should be considered in conjunction with the tweets, particularly when air pollution is elevated.

@scotairquality

7.7 YouTube™

The Air Quality in Scotland YouTube channels provides useful 'How To' videos for the Local Site Operator such as how to calibrate an analyser or clean an inlet head. See https://www.youtube.com/user/AirQualityScotland.



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This report has been produced by Ricardo on behalf of the Scottish Government.

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