
# AURN Annual Technical Report 2020

Report for the Environment Agency
21316

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**Contact:**

Alison Loader
Ricardo Energy & Environment
Gemini Building, Harwell, Didcot, OX11 0QR, United Kingdom

t: +44 (0) 1235 753632

e: alison.loader@ricardo.com

Ricardo is certificated to ISO9001, ISO14001 and OHSAS18001

Author:

Stewart Eaton

Approved By:

Alison Loader

Date:

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# Executive summary

Ricardo Energy & Environment carries out the quality assurance and quality control (QA/QC) activities for the Automatic Urban and Rural Monitoring Network (AURN) on behalf of the Environment Agency, the UK Department for Environment, Food and Rural Affairs (Defra), the Scottish Government, Welsh Government and Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland.

This annual report summarises the QA/QC activities carried out over the period 1st January to 31st December 2020. It summarises the key data capture and data quality statistics and highlights any issues that have been identified relating to the QA/QC activities associated with the AURN during this period.

The number of AURN monitoring stations in operation during part or all of this period was 172 separate locations. There were also three co-located Partisol gravimetric particulate samplers, one located at Port Talbot Margam (measuring $PM_{10}$) and two at London Marylebone Road (measuring $PM_{2.5}$ and $PM_{10}$). These are counted as two separate stations for the purpose of this report.

During this year, two full intercalibration exercises (winter and summer) were carried out, involving comprehensive performance tests on every analyser in the network. In addition, two ozone-only intercalibration exercises (spring and autumn) were carried out. This allows the accuracy of the measured results to be determined, and a measurement uncertainty for each analyser to be calculated, as required by the Data Quality Objectives of the Air Quality Standards Regulations. (These regulations were the means by which the provisions of the European Union's Air Quality Directive (2008/50/EC) were transposed into UK legislation in 2010. All the provisions of the above Directive remain part of UK law following the UK's exit from the EU on 31st January 2020).

The mean data capture for ratified hourly average data was 93.03% (averaged over all pollutants $O_3$, $NO_2$, $SO_2$, CO, $PM_{10}$ and $PM_{2.5}$), for the 12-month reporting period January to December 2020.

The data capture target of the Air Quality Standards Regulations is 90% (excluding periods of planned maintenance e.g. calibrations, audits and servicing). An allowance of 5% is made for this, hence a target of 85%. Mean data captures for individual pollutants were as follows: $NO_2$ 92.83%, $PM_{10}$ 94.02%, $PM_{2.5}$ 93.60% CO 88.35% $O_3$ 91.92%, and $SO_2$ 83.66%. Hence, the mean data captures for all pollutants except $SO_2$ met this target in calendar year 2020. Average data capture for $SO_2$ was below the target of 85%: this was affected by problems with new analysers introduced to the network and in some instances because the analysers are operating close to their limit of detection.

The national coronavirus lockdown started on 23rd March 2020, and restrictions continued across the UK during the rest of 2020. Whilst most AURN activities continued, the travel restrictions meant that the spring 2020 ozone audits could not be carried out on any of the Northern Ireland sites, Mace Head or Lerwick; Mace Head could not be audited in summer or autumn of 2020. Face-to-face LSO training was also postponed in 2020 due to social distancing requirements. Ricardo produced a series of LSO training videos to help LSOs maintain their skill levels until restrictions were lifted.

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# 1 Introduction

## 1.1 Background

The UK Automatic Urban and Rural Network (AURN) was established to provide information on air quality throughout the UK for a range of pollutants. The primary function of the AURN is to provide data in compliance with the requirements of the Air Quality Standards Regulations. The data and information from the AURN are also used by scientists, policy makers and planners to enable them to make informed decisions on managing and improving air quality for the benefit of health and the natural environment.

A number of organisations are involved in the day-to-day running of the network. In 2020, the role of Central Management and Co-ordination Unit (CMCU) for the AURN was contracted to Bureau Veritas. The Environmental Research Group (ERG) of King's College London (KCL) was Management Unit for the AURN monitoring stations that are also part of the London Air Quality Network (LAQN). The ERG became part of Imperial College London as of 1$^{st}$ July 2020. Ricardo Energy & Environment undertook the role of Quality Assurance and Quality Control Unit (QA/QC Unit) for all stations within the AURN. The responsibility for day-to-day operation of individual monitoring stations is assigned to Local Site Operators (LSOs): local organisations with relevant experience in the field under the direct management of (and contract to) CMCU. New calibration gases for the network were supplied by BOC during 2020 and were provided with an ISO17025 certificate of calibration by Ricardo Energy & Environment. The monitoring equipment was serviced and maintained by a number of Equipment Support Units, under contract to the CMCU in the case of fully EA funded stations.

Data from the AURN are disseminated to the public, the scientific community and other users via UK-AIR (the online UK Air Information Resource, http://uk-air.defra.gov.uk/ ) and other media such as social media and freephone services. This is the responsibility of the Data Dissemination Unit (DDU) under a separate contract. The DDU is also responsible for producing a summary report of the data from this and other UK air quality monitoring networks. This is published annually as the "*Air Pollution in the UK*" series of reports, available on UK-AIR.

Approximately half of the stations in the AURN are fully funded by the Environment Agency, and the management of all aspects of these stations is carried out by the CMCU. The remainder are owned by third parties (mostly local authorities) but affiliated to the AURN; and the stations and monitoring equipment remain the responsibility of local authorities or other organisations. This includes servicing and maintenance, and LSO activities. The distinction between fully-funded and affiliate monitoring stations is no longer clear-cut, as a number of otherwise LA-owned affiliate stations have one or more fully-funded analysers installed. However, all AURN stations benefit from centralised data ratification, six-monthly QA/QC audits, certified gas mixtures for analyser calibrations, and centralised data collection and dissemination. A total of 172 monitoring stations in the AURN operated during part or all of the year 2020. This does not include the two stations where Partisol gravimetric particulate samplers were co-located with automatic particulate analysers. (The gravimetric data have historically been used in validating the performance of the automatic analysers). For data processing purposes, in these cases the gravimetric sampler is treated as a separate station; and they are shown, and counted, separately in the data capture tables in section 3.

This report includes information on performance of the AURN site at London Harlington although the QA/QC work is not conducted on behalf of the Environment Agency and Defra.

Mace Head is a remote monitoring station on the western coast of the Republic of Ireland: it is included in the UK AURN to provide information on background ozone levels unaffected by local pollution sources.

## 1.2 Changes to Legislation

In previous years, one of the main objectives of the AURN was to monitor compliance with the Directive 2008/50/EC of 21st May 2008, on Ambient Air Quality and Cleaner Air for Europe (European Parliament and Council of the European Union, 2008), referred to in previous reports as 'the Air Quality Directive'. As a Member State of the European Union (EU) at the time this and other Directives relating to air quality came into force, the UK was required to incorporate or 'transpose' the requirements of the Directives into its own national law within a specified period. This was done by the following UK legislation:

- The Air Quality Standards Regulations 2010 in England [1], and their December 2016 amendment [2]
- The Air Quality Standards (Scotland) Regulations 2010 in Scotland [3], and their December 2016 amendment [4]
- The Air Quality Standards (Wales) Regulations 2010 in Wales [5]
- The Air Quality Standards Regulations (Northern Ireland) 2010 [6] and their December 2016 amendment [7]

The UK formally left the EU on 31st January 2020, and air quality in the UK is now regulated by the Air Quality Standards Regulations above. These Regulations, together with the European Union (Withdrawal) Act of 2018, [8] ensure that all the requirements of the Air Quality Directives remain part of UK law.

## 1.3 What the AURN Data are Used For

The AURN and its forerunners has been in operation since 1992, although some automatic air quality monitoring has been undertaken in the UK since 1973. The network has expanded and developed over many years. Provisional data are disseminated hourly (i.e. in near real time) by the Data Dissemination Unit (DDU) via UK-AIR. The QA/QC Unit carries out data ratification quarterly in arrears, and reports the ratified dataset quarterly, also via UK-AIR,

The major objectives of the network are as follows:

- Monitoring compliance with relevant statutory air quality standards, objectives, limit values and target values (e.g. the Air Quality Standards Regulations and the UK Air Quality Strategy);
- Informing the public about air quality;
- Providing information for local air quality management within the UK Air Quality Strategy;
- Identifying long-term trends in air pollution concentrations; and
- Assessing the effectiveness of policies to control pollution.

The data from the AURN are used for:

- Reporting compliance with the Air Quality Standards Regulations.
- Comparison with air quality objectives as laid out in the Air Quality Strategy.
- Providing the public with information through air quality bulletins.
- Forecasting future air quality levels.
- Policy development for human health and ecosystem protection.
- The European Monitoring & Evaluation Programme (EMEP).
- The UK Local Air Quality Management regime under Part IV of the Environment Act 1995.
- National Indicators on environmental quality.

## 1.4 What this Report Covers

This report explains and reports the main QA/QC activities carried out over the twelve-month period 1st January to 31st December 2020, including a summary of QA/QC methodology applied, and an overview of data capture.

## 1.5 Where to Find More Information

Further information on the AURN can be found in the following:

- UK-AIR at https://uk-air.defra.gov.uk/, which contains information on individual stations along with real-time hourly data, graphs and statistics.
- The "*Air Pollution in the UK*" series of annual reports, available on UK-AIR.

A glossary of commonly used terms is given in Appendix 1.

## 1.6 Changes to the Network During 2020

Table 1-1 shows the changes to the AURN, i.e. monitoring stations started up or closed down, during 2020:

**Table 1-1 AURN Stations that Started Up or Closed Down During 2020**

| Station | Start date | Close date | Pollutants measured |
|---|---|---|---|
| Cwmbran | - | 7th Aug 2020 | NOx, $O_3$ |
| Cwmbran Crownbridge | 1st Oct 2020 | - | NOx, $O_3$ |

The above change is effectively a relocation of a monitoring site due to the needs of the landowner for the site to be re-located.

## 1.7 Changes to Instrumentation

A programme of upgrade and renewal of particulate analysers was started in 2018 and continued through 2019 and 2020. The FDMS instruments, which used to be widely used in the AURN for monitoring PM, were approaching the end of their useful lives, and nearing the point at which they would no longer be supported by the manufacturer. The upgrade programme, which is now almost complete, aims to remove obsolete FDMS analysers from the network and replace them with new instruments. The new instruments are a mixture of Beta Attenuation Monitors (BAMs) and Fidas 200 instruments. There have been BAMs in the AURN for many years, but the Fidas is a relatively new addition. The Fidas is an aerosol spectrometer that uses a light scattering method to detect airborne particles in a range of size fractions. The sample inlet system is heated to prevent interference by water vapour. Data are reported as hourly averages.

As Fidas analysers are capable of measuring several size fractions at the same time, where a single FDMS analyser (measuring either $PM_{10}$ or $PM_{2.5}$) is replaced by a Fidas (which measures both fractions), both $PM_{2.5}$ and $PM_{10}$ will be reported from the date of installation of the Fidas.

A list of replacement particulate analysers is given in Table 1-2.

**Table 1-2 Network Changes January-December 2020**

| Station | Existing Pollutants | Replacement analyser type | Effective date |
|---|---|---|---|
| Manchester Piccadilly | $PM_{2.5}$ | Fidas 200 | 7th Jan 2020 |
| London Teddington Bushy Park | $PM_{2.5}$ $PM_{10}$ | Fidas 200 | 7th Jan 2020 |
| Leicester University | $PM_{2.5}$ | Fidas 200 | 10th Jan 2020 |
| Port Talbot Margam | $PM_{2.5}$ | BAM (heated) | 24th Jan 2020 |
| Armagh Roadside | $PM_{10}$ | BAM (heated) | 7th Feb 2020 |
| Reading London Road | $PM_{10}$ | BAM (heated) | 10th Feb 2020 |
| Brighton Preston Park | $PM_{2.5}$ | BAM (heated) | 19th Feb 2020 |
| Southampton A33 | $PM_{10}$ | BAM (heated) | 21st Feb 2020 |
| London Bloomsbury | $PM_{2.5}$ $PM_{10}$ | BAM (heated) | 21st Feb 2020 |
| Leeds Centre | $PM_{2.5}$ $PM_{10}$ | Fidas 200 | 4th Mar 2020 |
| York Bootham | $PM_{2.5}$ $PM_{10}$ | BAM (heated) | 9th Mar 2020 |
| Middlesbrough | $PM_{2.5}$ $PM_{10}$ | BAM (heated) | 9th Mar 2020 |
| Leeds Headingley Kerbside | $PM_{2.5}$ $PM_{10}$ | BAM (heated) | 19th Mar 2020 |
| Newcastle Centre | $PM_{2.5}$ $PM_{10}$ | BAM (heated) | 23rd Mar 2020 |
| Cardiff Centre | $PM_{2.5}$ $PM_{10}$ | BAM (heated) | 14th Sep 2020 |
| Port Talbot Margam | $PM_{10}$ (Gravimetric) | SEQ 47/50 | 3rd Dec 2020 |

# 2 Methodology

## 2.1 Overview of QA/QC Activities

The QA/QC activities consist of the following key parts:

- QA/QC audits of all analysers in the network every six months (three months for ozone).
- Ratification of the data on a three-monthly basis, and upload of ratified data to the Data Dissemination Unit.
- Assessment of new station locations in conjunction with the CMCU, and assessment of compliance with the siting criteria in the Air Quality Standards Regulations.
- Investigation of instances of suspected poor-quality data.

# 2.2 QA/QC Audits

## 2.2.1 Purpose of Intercalibration

The QA/QC intercalibration audits fulfil a number of important functions:

- Validation of the production of provisionally scaled data, which is rapidly disseminated to the public soon after collection.
- Identification of poorly-performing analysers and infrastructure (for example housings and air conditioning units), together with recommendations for corrective action.
- A measure of network performance, by examining for example, how different NOx analysers around the network respond to a common gas standard. This test checks how “harmonised” UK measurements are; i.e. that a 200ppb $NO_2$ pollution episode at any given monitoring station would be reported in exactly the same way at every other station in the UK, regardless of the location or the analyser used to record the event.
- Assessment of the area around the monitoring station: has the environment changed in the last six months? Is the location still representative of the station classification?

The QA/QC audits test the following aspects of analyser performance:

1. Analyser accuracy and precision. These are basic checks to ensure analysers respond to known concentrations of gases in a reliable manner.
2. Instrument linearity. This test refines the response checks on analysers, by assessing whether doubling a concentration of gas to the analyser results in a doubling of the analyser signal response. If an analyser’s response characteristics are not linear, data cannot be reliably scaled into concentrations.
3. Instrument signal noise. This test checks that an analyser responds to calibration gases in a stable manner with time. A “noisy” analyser may not provide high quality data which may be difficult to process at lower concentrations.
4. Analyser response time. This test checks that the analyser responds quickly to a change in gas concentrations. If analyser response is too slow, data may not accurately reflect ambient concentrations.
5. Leak and flow checks. These tests ensure that ambient air reaches the analysers, without being compromised in any way. Leaks in the sampling system can affect the ability of the analyser to sample ambient air reliably.
6. NOx analyser converter efficiency. This test evaluates the ability of the analyser to measure $NO_2$. An inefficient converter severely compromises the data from the analyser.
7. FDMS $k_0$ evaluation, for the small number of FDMS remaining in the AURN during 2020. The analyser uses this factor to calculate mass concentrations, so the value is calculated to determine its accuracy compared to the stated value. This is only required for FDMS particulate monitoring instruments: it is not relevant to the BAM or Fidas as these operate in a different way.
8. Particulate analyser flow rate checks. These tests ensure that the flow rates through critical parts of the analyser are within specified limits. There are specific analyser flow rates that are set to make sure particle size fractions and mass concentration calculations are performed correctly.
9. Evaluation of station cylinder concentrations. These tests use a set of certified cylinders that are taken to all the stations. The concentrations of the station cylinders are used to scale pollution datasets, so it is important to ensure that the concentrations of gases in the cylinders do not change.

10. Competence of Local Station Operators (LSOs) in undertaking calibrations. As it is the calibrations by the LSOs that are used to scale pollution datasets, it is important to check that these are undertaken competently.
11. Zero "calibration" of all automatic PM analysers. This test allows the baseline performance of PM analysers to be evaluated, to determine whether any remedial action is required to the analyser or baseline to be corrected during ratification. In the case of BAM and FDMS instruments this is carried out by placing a high efficiency particulate absorbing (HEPA) filter on the instrument's inlet, usually for a period of a few days.

Once all data have been collected, a "Network Intercalibration" is conducted. This utilises the audit gas cylinders transported to each station in the Network. These cylinders will have been recently calibrated by the Calibration Laboratory at Ricardo Energy & Environment. This exercise allows us to examine how different station analysers respond when they are supplied with the same gas used at other stations. For ozone analysers, the calibration is undertaken with recently calibrated ozone photometers.

The technique used to process the intercalibration results is broadly as follows:

- The analyser responses to audit gas are converted into concentrations, using provisional calibration factors obtained from the Management Units on the day of the intercalibration. These factors are also used for the provisional data supplied to UK-AIR.
- These individual results are tabulated, and statistical analyses undertaken (e.g. network average result, network standard deviation, deviation of individual stations from the network mean etc.).

These results are then used to pick out problem stations, or "outliers", which are investigated further to determine reasons and investigate possible remedies for the outliers. The definition of an outlier is an analyser result that falls outside the following limits:

- ±10% of the network average for NOx, CO and $SO_2$ analysers,
- ±5% of the reference standard photometer for ozone analysers,
- ±2.5 % of the stated $k_0$ value for FDMS analysers,
- ±10% for particulate analyser flow rates,
- Particulate analyser average zero response within ±3.0 µg $m^{-3}$.
- ±10% for the recalculation of station cylinder concentrations.

Thus, the intercalibration investigates the quality of provisional data output by the Management Units for use in forecasting, interactive television services and the web. It also provides input into the ratification process by highlighting stations where close scrutiny of datasets is likely to be required. Any outliers that are identified are rigorously checked to determine the cause, and any required corrective action to be taken, if necessary. There are a number of likely main causes for outlier results, as discussed below:

- Drift of an analyser between scheduled LSO calibrations. This is by far the most common cause of an outlier result, and one that is simply corrected for during ratification of data.
- Drift of station cylinder concentrations between intercalibrations. Station cylinders can sometimes become unstable, especially at low pressures. All station cylinder concentrations are checked every six months and are replaced as necessary.
- Erroneous calibration factors. It can occasionally happen that an analyser calibration is unsuccessful, and results in unsuitable scaling factors being used to produce pollution datasets. These are identified and corrected during ratification.
- Pressurisation of the sampling system at the audit. Occasionally, an analyser can be very sensitive to small changes in applied flow rates of calibration gas. This is more difficult to identify and correct and may have consequences for data quality.

- Leaks, sample switching valves, etc. Outliers can be generated if an analyser is not sampling ambient air properly. It is likely that if a leaking analyser is identified, data losses will result.

Full audits of all analysers are carried out at six-monthly intervals in the winter (January-March) and summer (July-September). In addition, audits of ozone analysers are also carried out in spring (April) and autumn (October).

### 2.2.2 Baseline Checks for FDMS and BAM Particulate Analysers

As part of the routine QA/QC audits, particulate analysers (FDMS and BAM) have zero checks carried out every six months using HEPA filters on the inlets for a few days. This allows identification of analysers which have high baseline responses to air containing no particulate matter, often due to inefficient driers (for FDMS). The CEN standard method for ambient particulate matter EN16450 states that action must be taken when baseline response is higher than 3 µg $m^{-3}$ but does not state what the action should be. Originally, the only agreed action was to delete the data. However, as part of ongoing improvement activities a protocol was agreed in 2015 to enable baselines to be corrected where baseline responses exceed 3 µg $m^{-3}$. (The zero baseline check for the Fidas instrument is carried out using a different testing procedure: zero baseline correction is not applicable to the Fidas).

### 2.2.3 Uncertainties of Measurement

The measured uncertainties of measurement are determined at each QA/QC audit, and the results for the winter and summer 2020 audits are given in Appendix 2.

The European Committee for Normalisation (CEN) has prepared a series of documents prescribing how analysers must be operated, to produce datasets that conform to the Data Quality Objectives of the EC Directives. These Data Quality Objectives continue to apply in the UK, via the Air Quality Standards Regulations. The CEN documents for operation of air pollution analysers; BS EN14211:2012 (NOx), BS EN14212:2012 ($SO_2$), BS EN14626:2012 (CO) and BS EN14625:2012 ($O_3$) set out a series of performance criteria for analysers which must be achieved, both in the field and under laboratory conditions. The test requirements have been extensively reported in previous intercalibration summaries and should be referenced for further information. To this end, the procedures used for the intercalibrations have been fully compliant with the CEN protocols since January 2006.

To comply with the Data Quality Objectives, the uncertainty for gaseous analyser measurements must be less than ±15%. For PM analysers, the required measurement uncertainty is less than ±25%. For stations that have CEN-compliant instrumentation, it is possible to calculate the overall uncertainty of measuring air quality.

In 2020, there were a small number of analysers where the calculated uncertainty was higher than that stipulated by the Data Quality Objectives. The most common cause of this is noisy response as measured during the audit. This is generally an indication of poor instrument performance, and these cases are reviewed at the Quality Circle to assess the impact on reported data. High noise levels on particulate analysers are reported to CMCU and ESUs prior to each service to ensure the necessary repair procedures are carried out by the engineer.

It should be noted that these uncertainties are applicable ***only on the day of test***. They are therefore a snapshot only, and it should not necessarily be inferred that these values apply to the entire year's dataset. In particular, a high uncertainty measured at audit may be as a result of a fault, and this results in an ESU visit to repair the instrument. The QA/QC Unit then decides whether to report the data for the affected period or delete them, as appropriate.

The following analysers were outside the maximum uncertainties during 2020:

- Winter: 1 ozone, 2 NOx
- Summer: 1 NOx, 1 $PM_{10}$, 1 $PM_{2.5}$

In these cases, analyser faults were identified, and some data rejected during ratification.

Ricardo have undertaken an investigation to quantify the impact on performance of FDMS PM analysers in use in the Automatic Urban and Rural Monitoring Network (AURN), following a series of undocumented design changes on a critical consumable component. These changes to the replaceable measurement filter on Tapered Element Oscillating Microbalance (TEOM) Filter Dynamics Measurement System (FDMS) analysers, caused a significant increase in the number of poor performance tests identified during routine quality control audits undertaken by Ricardo. The worsening of performance was first observed in January 2017. It is not possible to determine which sites used these filters, nor over which time periods. During 2020, the number of FDMS analysers continued to fall as these obsolete instruments were replaced with other analyser types. By the end of 2020, FDMS analysers remained in use at only three sites in the AURN.

### 2.2.4 Certification and Accreditation

The QA/QC Unit holds ISO/IEC17025 accreditation for the field calibration of gaseous analysers, performance tests of particulate analysers and calibration of the gas mixtures used for regular LSO calibrations. Ozone analysers receive quarterly multipoint calibrations from a certified photometer, as required by the Air Quality Standards Regulations.

Certified calibrations of ozone photometers used by the ESUs are provided by the QA/QC Unit prior to six-monthly service schedules.

## 2.3 Overview of Data Ratification

Data for each station are supplied monthly by the CMCUs. Once initial monthly data files have been received, checked and loaded into Ricardo Energy & Environment's data handling system, the process of data ratification begins. This process is required to refine data scaling based on all the calibration and audit data available, and to identify, withdraw or flag anomalous data due to instrument or sampling faults or where data fall outside the Uncertainties or Limits of Detection defined by the Data Quality Objectives (DQOs) of the Air Quality Standards Regulations.

## 2.4 Impacts of Covid-19 Pandemic on QA/QC Activities

The Covid-19 coronavirus pandemic led to an initial national lockdown, which started on 23rd March 2020, and ongoing restrictions which continued for the rest of the year. Most AURN activities continued uninterrupted. However, the following audits could not be carried out, due to travel restrictions or other Covid-related reasons:

- spring 2020 ozone audits at all Northern Ireland sites, Mace Head and Lerwick due to travel restrictions.
- Summer and autumn audits at Mace Head in the Republic of Ireland, also due to travel restrictions.

- Winter 2021 audits of all Northern Ireland sites, Lerwick, Mace Head and also Sandy Roadside (the latter due to Covid-related access issues). These were carried out later, in the spring 2021 ozone audit round in April, except Mace Head which could not be visited until August 2021.

Face-to-face LSO training and audits were also paused in 2020 due to social distancing requirements. Ricardo produced a series of LSO training videos to help LSOs maintain their skill levels until restrictions are lifted. These were made available to LSOs on the AURN Hub (an online resource for LSOs). LSO training and audits are to resume now that restrictions have been lifted.

# 3 Data Capture

## 3.1 Overview

Data capture statistics are calculated using the actual data capture as hourly averages (daily for gravimetric analysers) against the total number of hours (or days) in the relevant period; service and maintenance are counted as lost data. It is permissible to discount routine service and calibration from achievable data capture targets, but this is not calculated. The data capture target for the purposes of monitoring compliance with the Air Quality Standards Regulations is 90% excluding planned servicing and maintenance. For practical purposes in the AURN, planned maintenance is assumed to be 5% so a target of 85% data capture is used. Data capture is calculated from the number of valid hourly averages recorded in the year, or from the date of commissioning if the station or analyser is introduced during the year.

## 3.2 Overall Data Capture

The overall data capture for all stations for 2020 is given in Table 3.1. Ratified hourly average data capture for the network averaged 93.03% for all pollutants ($O_3$, $NO_2$, $SO_2$, CO, $PM_{10}$ and $PM_{2.5}$) during the 12-month reporting period January-December 2020. Mean data captures for all pollutants except $SO_2$ met this target in calendar year 2020. Average data capture for $SO_2$ was below the target of 85%: this was affected by problems with new analysers introduced to the network and in some instances because the analysers are operating close to their limit of detection.

**Table 3.1 Summary of Data Capture for the AURN, January-December 2020**

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Number of Stations | 160 | 91 | 81 | 7 | 76 | 28 | 172 |
| Number of stations < 85 % | 22 | 7 | 6 | 2 | 11 | 9 | 21 |
| Number of stations < 90% | 27 | 10 | 13 | 3 | 14 | 13 | 32 |
| **Average** | **92.83%** | **94.02%** | **93.60%** | **88.35%** | **91.92%** | **83.66%** | **93.03%** |

## 3.3 Generic Data Issues

The following generic data quality issues have been identified in 2020:

- Poor performance of some analysers, particularly older $SO_2$ analysers. A number of the $SO_2$ analysers reached the end of their useful lives during 2019, impacting upon data capture. The Environment Agency has purchased replacement $SO_2$ analysers which were installed during 2019 and 2020. However, technical problems with these new instruments resulted in a significant loss at many stations and investigations with the manufacturer are ongoing.
- Leaks in the BAM analysers, where the nozzle does not properly seal against the tape.
- Poor performance of some of the ageing CO analysers. The small number of CO analysers make data loss more significant in the overall data capture.

In some cases, the ESU may choose to avoid significant data loss by removing an instrument for workshop repair and install a temporary loan instrument in station. This is termed a “hotspare” analyser. This may not be of the same type of analyser, which has implications for LSO calibration procedures, and also for the reporting of instrument types in the annual data submission.

The QA/QC audits continued to identify high zero baseline responses for some particle analysers in the network; some data were rejected as a result. These zero tests provide evidence for internal leaks (for BAMs) at some stations. As explained in section 2.2.2, the results of zero baseline tests can be used to apply correction to data where high baselines have been identified.

## 3.4 Data Capture - England (excluding London)

The data capture statistics for stations within England (excluding Greater London) are given in Table 3.2. Note that where an instrument starts or stops measuring during the year, the quoted data capture is that for the part of the year in which the instrument was operating: for example, an instrument commissioned on 30th June which then operated for the rest of the year without interruption would have a data capture of 100% for the year.

**Table 3.2 Data Capture for Stations in England excluding Greater London, January-December 2020**

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Barnsley Gawber | 97.04% | | | | 85.77% | 96.10% | 92.97% |
| Barnstaple A39 | | 92.99% | 94.36% | | | | 93.68% |
| Bath A4 Roadside | 98.47% | | | | | | 98.47% |
| Billingham | 99.54% | | | | | | 99.54% |
| Birkenhead Borough Road | 98.38% | | | | | | 98.38% |
| Birmingham A4540 Roadside | 83.21% | 99.48% | 99.48% | | 99.23% | | 95.35% |
| Birmingham Acocks Green | 55.90% | 98.84% | 98.84% | | 58.57% | | 78.04% |
| Birmingham Ladywood | 97.88% | 99.86% | 99.86% | | 97.59% | 96.54% | 98.35% |
| Blackburn Accrington Road | 95.34% | | | | | | 95.34% |
| Blackpool Marton | 99.07% | 99.32% | 99.28% | | 99.04% | | 99.18% |

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Borehamwood Meadow Park | 93.37% | | | | | | 93.37% |
| Bournemouth | 99.31% | | 94.30% | | 78.47% | | 90.69% |
| Bradford Mayo Avenue | 80.54% | | | | | | 80.54% |
| Brighton Preston Park | 99.21% | | 41.19% | | 95.99% | | 78.80% |
| Bristol St Paul's | 95.92% | 95.88% | 93.84% | | 95.55% | | 95.30% |
| Bristol Temple Way | 99.66% | 95.71% | | | | | 97.68% |
| Burton-on-Trent Horninglow | 98.98% | | | | | | 98.98% |
| Bury Whitefield Roadside | 98.01% | 94.02% | | | | | 96.02% |
| Cambridge Roadside | 83.70% | | | | | | 83.70% |
| Cannock A5190 Roadside | 93.12% | | | | | | 93.12% |
| Canterbury | 98.03% | | | | 97.72% | | 97.88% |
| Carlisle Roadside | 98.96% | 93.26% | 96.85% | | | | 96.36% |
| Charlton Mackrell | 97.43% | | | | 94.13% | | 95.78% |
| Chatham Roadside | 98.27% | 95.83% | 90.13% | | | | 94.74% |
| Chesterfield Loundsley Green | 96.15% | 99.97% | 99.97% | | | | 98.69% |
| Chesterfield Roadside | 95.01% | 99.68% | 99.68% | | | | 98.13% |
| Chilbolton Observatory | 98.67% | 97.30% | 97.30% | | 98.73% | 92.19% | 96.84% |
| Christchurch Barrack Road | 96.44% | | 71.11% | | | | 83.77% |
| Coventry Allesley | 97.54% | 99.68% | 99.68% | | 99.36% | | 99.07% |
| Coventry Binley Road | 99.04% | 96.99% | | | | | 98.02% |
| Crewe Coppenhall | 95.86% | | | | | | 95.86% |
| Derby St Alkmund's Way | 97.28% | | | | | | 97.28% |
| Dewsbury Ashworth Grove | 89.40% | | | | | | 89.40% |
| Doncaster A630 Cleveland Street | 97.52% | | | | | | 97.52% |
| Eastbourne | 51.39% | 98.29% | 98.29% | | | | 82.66% |
| Exeter Roadside | 98.62% | | | | 98.33% | | 98.47% |
| Glazebury | 97.51% | | | | 89.69% | | 93.60% |
| Hartlepool St Abbs Walk | 99.04% | | | | | | 99.04% |
| High Muffles | 46.84% | | | | 53.19% | | 50.01% |
| Honiton | 96.44% | | | | | | 96.44% |
| Horley | 99.08% | | | | | | 99.08% |
| Hull Freetown | 99.24% | 97.77% | 97.77% | | 99.41% | 94.33% | 97.70% |
| Hull Holderness Road | 98.91% | 93.82% | | | | | 96.36% |
| Immingham Woodlands Avenue | 94.62% | | | | | | 94.62% |
| Ladybower | 89.79% | | | | 97.03% | 76.53% | 87.78% |
| Leamington Spa | 99.19% | 99.91% | 99.91% | | 94.69% | | 98.43% |

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Leamington Spa Rugby Road | 95.98% | 99.24% | 99.24% | | | | 98.15% |
| Leeds Centre | 96.61% | 96.85% | 97.10% | 97.73% | 96.94% | 96.64% | 96.98% |
| Leeds Headingley Kerbside | 99.12% | 95.67% | 92.54% | | | | 95.78% |
| Leicester A594 Roadside | 99.16% | 95.84% | | | | | 97.50% |
| Leicester University | 97.64% | 96.60% | 98.74% | | 99.04% | | 98.00% |
| Leominster | 99.42% | | | | 99.53% | | 99.48% |
| Lincoln Canwick Road | 96.94% | | | | | | 96.94% |
| Liverpool Speke | 64.09% | 65.90% | 64.31% | | 64.82% | 60.13% | 63.85% |
| Lullington Heath | 11.25% | | | | 97.35% | 86.33% | 64.97% |
| Luton A505 Roadside | 97.34% | | | | | | 97.34% |
| Manchester Piccadilly | 99.19% | 95.88% | 95.88% | | 99.19% | 98.41% | 97.71% |
| Manchester Sharston | 99.21% | | | | 99.23% | | 99.22% |
| Middlesbrough | 96.55% | 94.16% | 88.81% | | 98.91% | 97.65% | 95.22% |
| Newcastle Centre | 99.21% | 95.16% | 93.29% | | 99.19% | | 96.72% |
| Newcastle Cradlewell Roadside | 99.49% | 92.99% | | | | | 96.24% |
| Northampton Spring Park | 99.25% | | 96.60% | | 99.57% | | 98.47% |
| Norwich Lakenfields | 94.02% | 99.49% | 99.49% | | 99.57% | | 98.14% |
| Nottingham Centre | 98.71% | 99.43% | 99.43% | | 99.06% | 57.30% | 90.79% |
| Nottingham Western Boulevard | 99.16% | 97.77% | | | | | 98.46% |
| Oldbury Birmingham Road | 98.29% | | | | | | 98.29% |
| Oxford Centre Roadside | 99.59% | | | | | | 99.59% |
| Oxford St Ebbes | 99.54% | 99.95% | 99.95% | | | | 99.82% |
| Plymouth Centre | 98.88% | 97.48% | 92.03% | | 99.29% | | 96.92% |
| Plymouth Tavistock Road | 97.92% | | | | | | 97.92% |
| Portsmouth | 15.13% | 15.40% | 15.40% | | 15.39% | | 15.33% |
| Portsmouth Anglesea Road | 98.98% | 91.75% | | | | | 95.36% |
| Preston | 91.35% | 99.40% | 99.40% | | 96.51% | | 96.66% |
| Reading London Road | 90.73% | 94.17% | | | | | 92.45% |
| Reading New Town | 98.20% | 95.22% | 93.40% | | 98.87% | | 96.42% |
| Rochester Stoke | 98.73% | 99.83% | 99.83% | | 96.39% | 54.70% | 89.90% |
| Salford Eccles | 99.64% | 99.91% | 99.91% | | | | 99.82% |
| Saltash Callington Road | | 89.33% | 90.80% | | | | 90.07% |
| Sandy Roadside | 99.11% | 80.93% | 73.57% | | | | 84.54% |
| Scunthorpe Town | 96.38% | 92.25% | | | | 86.75% | 91.79% |
| Shaw Crompton Way | 97.93% | | | | | | 97.93% |
| Sheffield Barnsley Road | 87.09% | | 96.82% | | | | 91.96% |

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Sheffield Devonshire Green | 99.31% | 99.61% | 99.62% | | 94.80% | | 98.34% |
| Sheffield Tinsley | 97.73% | | | | | | 97.73% |
| Sibton | | | | | 99.80% | | 99.80% |
| Southampton A33 | 99.23% | 90.05% | | | | | 94.64% |
| Southampton Centre | 79.16% | 99.41% | 99.41% | | 97.84% | 94.31% | 94.02% |
| Southend-on-Sea | 99.37% | 99.90% | 99.90% | | 99.42% | | 99.65% |
| St Helens Linkway | 99.45% | 95.78% | | | | | 97.62% |
| St Osyth | 95.08% | | | | 99.51% | | 97.30% |
| Stanford-le-Hope Roadside | 98.75% | 81.73% | 96.57% | | | | 92.35% |
| Stockton-on-Tees A1305 Roadside | 99.02% | | 91.50% | | | | 95.26% |
| Stockton-on-Tees Eaglescliffe | 98.76% | 93.78% | 92.53% | | | | 95.03% |
| Stoke-on-Trent A50 Roadside | 90.59% | 95.61% | | | | | 93.10% |
| Stoke-on-Trent Centre | 98.91% | 97.35% | 97.35% | | 98.76% | | 98.09% |
| Storrington Roadside | 94.44% | | | | | | 94.44% |
| Sunderland Silksworth | 70.82% | 99.54% | 99.56% | | 99.17% | | 92.27% |
| Sunderland Wessington Way | 95.81% | | | | | | 95.81% |
| Swindon Walcot | 98.27% | | | | | | 98.27% |
| Telford Hollinswood | 98.17% | | | | | | 98.17% |
| Thurrock | 98.88% | 93.99% | | | 96.93% | 97.43% | 96.81% |
| Walsall Woodlands | 98.93% | | | | 98.94% | | 98.94% |
| Warrington | 99.84% | 96.21% | 95.15% | | | | 97.07% |
| West Bromwich Kenrick Park | 96.04% | | | | | | 96.04% |
| Weybourne | | | | | 99.23% | | 99.23% |
| Wicken Fen | 98.09% | | | | 99.51% | 98.94% | 98.85% |
| Widnes Milton Road | 99.06% | | | | | | 99.06% |
| Wigan Centre | 99.69% | 99.85% | 99.85% | | 99.69% | | 99.77% |
| Wirral Tranmere | 84.27% | 99.44% | 99.44% | | 99.03% | | 95.55% |
| Worthing A27 Roadside | 99.48% | | 97.85% | | | | 98.66% |
| Yarner Wood | 96.12% | | | | 96.37% | | 96.24% |
| York Bootham | 61.44% | 95.16% | 92.59% | | | | 83.06% |
| York Fishergate | 97.83% | 96.89% | 95.74% | | | | 96.82% |
| **Number of stations** | **109** | **60** | **53** | **1** | **49** | **16** | **113** |
| **Number of stations < 85%** | **13** | **4** | **5** | **0** | **5** | **4** | **12** |
| **Number of stations < 90%** | **16** | **5** | **6** | **0** | **7** | **6** | **15** |
| **Average** | **93.08%** | **94.39%** | **92.74%** | **97.73%** | **93.27%** | **86.52%** | **93.75%** |

## 3.5 Data Capture - London

The data capture statistics for stations within London are given in Table 3.3.

**Table 3.3 Data Capture for Stations in London, January-December 2020**

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Camden Kerbside | 93.00% | 97.46% | 98.10% | | | | 96.19% |
| Ealing Horn Lane | | 89.55% | | | | | 89.55% |
| Haringey Roadside | 98.26% | | | | | | 98.26% |
| London Bexley | 96.71% | 24.97% | 88.75% | | | | 70.14% |
| London Bloomsbury | 77.78% | 90.54% | 87.83% | | 95.01% | 72.52% | 84.74% |
| London Eltham | 93.80% | | 95.84% | | 76.20% | | 88.61% |
| London Haringey Priory Park South | 99.72% | | | | 92.28% | | 96.00% |
| London Harlington | 98.71% | 98.83% | 98.83% | | 98.33% | | 98.67% |
| London Hillingdon | 97.61% | | | | 99.36% | | 98.49% |
| London Honor Oak Park | | 99.87% | 99.87% | | | | 99.87% |
| London Marylebone Road | 96.84% | 74.84% | 78.68% | 78.51% | 92.01% | 96.15% | 86.17% |
| London N. Kensington | 99.44% | 99.64% | 99.64% | 99.34% | 85.89% | 91.03% | 95.83% |
| London Teddington Bushy Park | | 96.40% | 96.40% | | | | 96.40% |
| London Westminster | 99.65% | | 95.26% | | | | 97.46% |
| Southwark A2 Old Kent Road | 68.18% | 75.32% | | | | | 71.75% |
| Tower Hamlets Roadside | 99.54% | | | | | | 99.54% |
| **Number of stations** | **13** | **10** | **10** | **2** | **7** | **3** | **16** |
| **Number of stations < 85%** | **2** | **3** | **1** | **1** | **1** | **1** | **3** |
| **Number of stations < 90%** | **2** | **4** | **3** | **1** | **2** | **1** | **6** |
| **Average** | **93.79%** | **84.74%** | **93.92%** | **88.92%** | **91.30%** | **86.57%** | **91.73%** |

## 3.6 Data Capture - Scotland

The data capture statistics for stations within Scotland are given in Table 3.4.

**Table 3.4 Data Capture for Stations in Scotland, January-December 2020**

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Aberdeen | 94.46% | 99.72% | 99.72% | | 60.99% | | 88.72% |
| Aberdeen Union Street Roadside | 98.24% | | | | | | 98.24% |
| Aberdeen Wellington Road | 99.49% | | | | | | 99.49% |
| Auchencorth Moss | | 99.85% | 99.85% | | 99.24% | | 99.65% |
| Bush Estate | 96.15% | | | | 99.34% | | 97.75% |
| Dumbarton Roadside | 99.73% | | | | | | 99.73% |
| Dumfries | 97.89% | | | | | | 97.89% |
| Dundee Mains Loan | 97.40% | | | | | | 97.40% |
| Edinburgh Nicolson Street | 74.32% | | | | | | 74.32% |
| Edinburgh St Leonards | 88.02% | 99.29% | 99.29% | 90.23% | 98.47% | 70.62% | 90.99% |
| Eskdalemuir | 84.56% | | | | 79.06% | | 81.81% |
| Fort William | 99.12% | | | | 99.43% | | 99.28% |
| Glasgow Great Western Road | 98.06% | | | | | | 98.06% |
| Glasgow High Street | 99.25% | 99.17% | 99.17% | | | | 99.20% |
| Glasgow Kerbside | 99.09% | | | | | | 99.09% |
| Glasgow Townhead | 99.12% | 99.40% | 99.40% | | 99.24% | | 99.29% |
| Grangemouth | 98.22% | 97.02% | 94.47% | | | 96.23% | 96.49% |
| Grangemouth Moray | 75.85% | | | | | | 75.85% |
| Greenock A8 Roadside | 97.60% | 99.85% | 99.85% | | | | 99.10% |
| Inverness | 92.94% | 96.12% | 96.11% | | | | 95.06% |
| Lerwick | | | | | 96.58% | | 96.58% |
| Peebles | 99.15% | | | | 99.16% | | 99.15% |
| Strathvaich | | | | | 98.80% | | 98.80% |
| **Number of stations** | **20** | **8** | **8** | **1** | **10** | **2** | **23** |
| **Number of stations < 85%** | **3** | **0** | **0** | **0** | **2** | **1** | **3** |
| **Number of stations < 90%** | **4** | **0** | **0** | **0** | **2** | **1** | **4** |
| **Average** | **94.43%** | **98.80%** | **98.48%** | **90.23%** | **93.03%** | **83.42%** | **94.87%** |

## 3.7 Data Capture - Wales

The data capture statistics for stations within Wales are given in Table 3.5.

**Table 3.5 Data Capture for Stations in Wales, January-December 2020**

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Aston Hill | 98.33% | | | | 98.82% | | 98.57% |
| Cardiff Centre | 83.66% | 89.38% | 87.19% | 68.77% | 95.09% | 89.04% | 85.52% |
| Cardiff Newport Road | 99.08% | 95.37% | | | | | 97.22% |
| Chepstow A48 | 99.28% | 95.56% | 87.44% | | | | 94.10% |
| Cwmbran | 59.59% | | | | 59.80% | | 59.69% |
| Cwmbran Crownbridge | 25.02% | | | | 25.07% | | 25.05% |
| Hafod-yr-Ynys Roadside | 99.01% | | | | | | 99.01% |
| Narberth | 99.04% | 97.91% | 97.91% | | 99.17% | 69.98% | 92.80% |
| Newport | 98.46% | 96.04% | 96.04% | | | | 96.85% |
| Port Talbot Margam | 96.06% | 95.15% | 87.90% | 97.15% | 97.36% | 96.86% | 95.08% |
| Swansea Roadside | 94.48% | 95.61% | 86.02% | | | | 92.03% |
| Wrexham | 99.16% | 99.60% | 99.59% | | | 53.95% | 88.07% |
| **Number of stations** | **12** | **8** | **7** | **2** | **6** | **4** | **12** |
| **Number of stations < 85%** | **3** | **0** | **0** | **1** | **2** | **2** | **2** |
| **Number of stations < 90%** | **3** | **1** | **4** | **1** | **2** | **3** | **4** |
| **Average** | **87.60%** | **95.58%** | **91.73%** | **82.96%** | **79.22%** | **77.46%** | **85.33%** |

## 3.8 Data Capture - Northern Ireland and Mace Head

The data capture statistics for stations within Northern Ireland, plus Mace Head (Republic of Ireland), are given in Table 3.6.

**Table 3.6 Data Capture for Stations in Northern Ireland, plus Mace Head, January-December 2020**

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Armagh Roadside | 95.99% | 95.04% | | | | | 95.51% |
| Ballymena Antrim Road | 89.33% | | | | | | 89.33% |
| Ballymena Ballykeel | 99.29% | | | | | 39.03% | 69.16% |
| Belfast Centre | 67.66% | 99.94% | 99.94% | 86.74% | 77.54% | 86.62% | 86.41% |
| Belfast Stockman's Lane | 97.19% | 97.52% | | | | | 97.35% |
| Derry Rosemount | 98.88% | 97.26% | 97.26% | | 94.25% | 96.10% | 96.75% |
| Lough Navar | | 99.70% | 99.69% | | 99.66% | | 99.69% |
| Mace Head | | | | | 99.66% | | 99.66% |
| **Number of stations** | **6** | **5** | **3** | **1** | **4** | **3** | **8** |
| **Number of stations < 85%** | **1** | **0** | **0** | **0** | **1** | **1** | **1** |
| **Number of stations < 90%** | **2** | **0** | **0** | **1** | **1** | **2** | **3** |
| **Average** | **91.39%** | **97.89%** | **98.96%** | **86.74%** | **92.78%** | **73.91%** | **91.73%** |

## 3.9 Gravimetric Data Capture

Three gravimetric samplers operate within the AURN. These are Partisol samplers at London Marylebone Road ($PM_{2.5}$ and $PM_{10}$) and Port Talbot Margam ($PM_{10}$ only). Data capture for these are given in Table 3.7.

**Table 3.7 Gravimetric Data Capture January-December 2020**

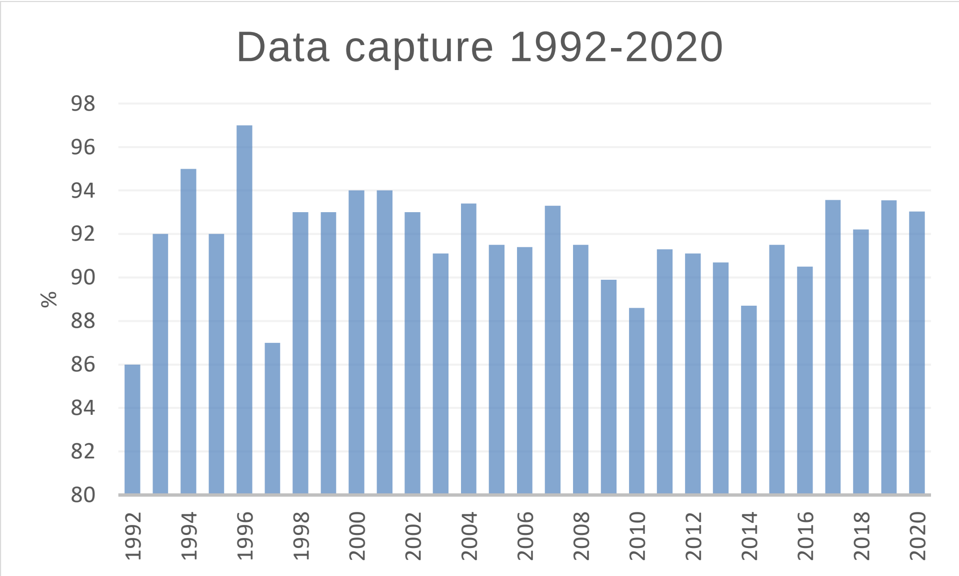
| Site name | $PM_{10}$ | $PM_{2.5}$ | Average |
|---|---|---|---|
| London Marylebone Road | 59.56 | 69.40 | 64.48 |
| Port Talbot Margam | 96.17 | Not measured | 96.17 |
| **Number of Stations** | **2** | **1** | |
| **Number of stations < 85 %** | **1** | **1** | **3** |
| **Number of stations < 90%** | **1** | **1** | **6** |
| **Average** | **77.87** | **69.40** | **80.33** |

The London Marylebone Road samplers ran out of filters in April 2020 and these were not replaced due to Covid restrictions. Later in the year, the $PM_{10}$ sampler developed repeated filter exchange faults resulting in considerable data loss. The Port Talbot Margam Partisol was replaced with a new Leckel SEQ gravimetric sampler at the end of 2020.

## 3.10 Trends in Data Capture

The overall annual AURN data captures from 1992-2020 averaged over all sites and all pollutants, are shown in Figure 3.1.

**Figure 3-1 AURN Overall Annual Data Captures (%) – Mean of All Sites, All Pollutants**




The annual data capture has remained relatively constant over the last 20 or so years, despite an increase in the number of stations, analysers and measurements made in the network. New technologies have been incorporated over this time, which have provided challenges in data capture terms.

# 4 Data Reporting

The ratified dataset has been uploaded to the Data Dissemination Unit on a quarterly basis during the year. These may be viewed on UK-AIR https://uk-air.defra.gov.uk/

# 5 Summary and Conclusions

The number of AURN monitoring stations in operation during part or all of this period was 172. In addition, gravimetric particulate samplers were co-located at two stations; Port Talbot Margam ($PM_{10}$) and London Marylebone Road ($PM_{2.5}$ and $PM_{10}$). The Partisol at Port Talbot was replaced with a Leckel SEQ at the end of 2020.

Full audits were carried out at six-monthly intervals in the winter (January-March 2020) and summer (July-September 2020). In addition, audits of ozone analysers were also carried out in spring (April) and autumn (October). Due to Covid-19 lockdown restrictions, it was not possible to carry out the spring 2020 ozone audits at Lerwick, Mace Head or any sites in Northern Ireland. The ongoing restrictions continued into 2021, preventing any subsequent audits of Mace Head until summer 2021.

Face-to-face LSO training also had to be put on hold due to Covid restrictions: Ricardo produced a series of LSO training videos which are available on the AURN Hub. Other QA/QC activities continued uninterrupted.

The mean data capture for ratified hourly average data was 93.03% (averaged over all pollutants $O_3$, $NO_2$, $SO_2$, CO, $PM_{10}$ and $PM_{2.5}$), for the 12-month reporting period January to December 2020. Mean data captures for individual pollutants were as follows: $NO_2$ 92.83%, $PM_{10}$ 94.02%, $PM_{2.5}$ 93.60% CO 88.35% $O_3$ 91.92%, $SO_2$ 83.66%. Hence, the mean data captures for all pollutants met this target in calendar year 2020 except for $SO_2$. There were 21 stations out of 172 with mean data capture below 85%.

There were only 6 analysers out of 877 which operated in the network (counting Fidas instruments as two at each site), whose measured uncertainty at the summer or winter QA/QC audits was outside the requirement of the Air Quality Standards Regulations.

The main reasons for data loss at the monitoring stations were predominantly due to instrument or air conditioning faults, response instability or problems associated with the replacement of analysers and infrastructure.

The data were reported to UK-AIR on a quarterly basis. The finalised dataset was supplied to the Monitoring of Ambient Air Quality (MAAQ) Team in early June 2021. This enabled them to carry out the annual assessment of compliance with the Air Quality Standards Regulations. The compliance report was submitted by the deadline of 30$^{th}$ September 2021.

# 6 References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[8] UK Government, “European Union (Withdrawal) Act 2018,” 26 June 2018. [Online]. Available: https://www.legislation.gov.uk/ukpga/2018/16/contents/enacted. [Accessed 8 July 2021].

# Appendices

# Appendix 1 – Glossary of terms

- Air Quality Standards Regulations

The UK legislation by which ambient air quality is regulated.

- Air Quality Standards

Standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive sub-groups.

- Air Quality Strategy.

The United Kingdom's National Air Quality Strategy, containing policies for assessment and management of air quality in the UK. This was first published in 1997, as a requirement of The Environment Act 1995. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland describes the plans drawn up by the Government and the devolved administrations to improve and protect ambient air quality in the UK in the medium-term. The Strategy sets objectives for the main air pollutants to protect health. Performance against these objectives will be monitored where people are regularly present and might be exposed to air pollution.

- Air Quality Strategy Objective.

The Air Quality Strategy sets objectives for the maximum concentrations of eight pollutants. These are at least as stringent as the limit values of the Air Quality Standards Regulations and of the EU Directive from which these were derived.

- Beta Attenuation Monitor (BAM).

A type of instrument used for monitoring concentrations of particulate matter. Particulate matter is deposited on a filter paper, and the attenuation of beta rays by the deposited matter is measured to determine the amount of material present.

- Carbon Monoxide (CO)

A colourless, odourless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in adverse health effects.

- ESU-Equipment Support Unit

Commercial organisations contracted by the EA or affiliated station owners to carry out specialist service and repair to the air quality monitoring equipment.

- FDMS.

This stands for 'Filter Dynamic Measurement System' and refers to a type of instrument for monitoring concentrations of particulate matter. The FDMS is a modified form of TEOM. This technique uses a vibrating filter, the vibration frequency changing as mass builds up. This method can measure the concentration of volatile and non-volatile particles.

- Fidas™.

A type of instrument which uses an optical technique for monitoring concentrations of particulate matter. This can measure several size fractions simultaneously.

- ISO/IEC17025

General requirements for the competence of testing and calibration laboratories, is the international reference for testing and calibration laboratories wanting to demonstrate their capacity to deliver reliable results. It enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world.

- LSO - Local site operator.

A nominated individual or organisation who carry out regular instrument calibrations, filter changes and other routine station tasks.

- Oxides of Nitrogen (NOx)

Combustion processes emit a mixture of oxides of nitrogen, primarily nitric oxide (NO) and nitrogen dioxide ($NO_2$), collectively termed NOx. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. Nitrogen dioxide emissions can also be further oxidised in air to acid gases, which contribute to the production of acid rain.

- Ozone ($O_3$)

A pollutant gas which is not emitted directly from any source in significant quantities but is produced by reactions between other pollutants in the presence of sunlight. (This is what is known as a 'secondary pollutant'.) Ozone concentrations are greatest in the summer. $O_3$ can travel long distances and reach high concentrations far away from the original pollutant sources.

- Particulate Matter (PM).

Small airborne particles. PM may contain many different materials such as soot, wind-blown dust or secondary components, which are formed within the atmosphere as a result of chemical reactions. Some PM is natural and some is man-made.

- Partisol™

A particulate sampler which collects aerosol onto pre-weighed filters. The filter changes automatically at midnight, and thus gives daily average concentrations.

- $PM_{10}$

Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter, as defined in ISO 7708:1995, Clause 6. This size fraction is important in the context of human health, as these particles are small enough to be inhaled into the airways of the lung – described as the 'thoracic convention' in the above ISO standard. $PM_{10}$ is often described as 'particles of less than 10 micrometres in diameter' though this is not strictly correct.

- $PM_{2.5}$

Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at 2.5 µm aerodynamic diameter, as defined in ISO 7708:1995, Clause 7.1. This size fraction is important in the context of human health, as these particles are small enough to be inhaled very deep into the lung – described as the 'high risk respirable convention' in the above ISO standard. $PM_{2.5}$ is often described as 'particles of less than 2.5 micrometres in diameter' though this is not strictly correct.

- Sulphur dioxide ($SO_2$)

An acid gas formed when fuels containing sulphur impurities are burned.

# Appendix 2 – Uncertainty of Measurement

This table shows the actual uncertainty of measurement in % as determined by the QA/QC audits in winter and summer 2020.

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| | | | | | | | | | | | | |
| Aberdeen | 11.2 | 11.2 | | | | | 12.2 | 12.2 | 7.5 | 7.5 | 9.3 | 7.5 |
| Aberdeen Union Street Roadside | | | | | | | 12.3 | 12.2 | | | | |
| Aberdeen Wellington Road | | | | | | | 12.3 | 13.5 | 13.1 | | | |
| Armagh Roadside | | | | | | | 12.2 | 12.2 | 9.4 | 9.3 | | |
| Aston Hill | | 8.3 | | | | | | 12.7 | | | | |
| Auchencorth Moss | 11.3 | 11.2 | | | | | | | 9.2 | 7.5 | 9.3 | 7.5 |
| Ballymena Antrim Road | | | | | | | 12.5 | 12.2 | | | | |
| Ballymena Ballykeel | | | | | 12.2 | 12.2 | 12.6 | 12.2 | | | | |
| Barnsley Gawber | 8.3 | 8.3 | | | 11.6 | 11.6 | 11 | 9.8 | | | | |
| Barnstaple A39 | | | | | | | | | 9.3 | 9.3 | 12.6 | 12.6 |
| Bath A4 Roadside | | | | | | | 12.2 | 12.3 | | | | |
| Belfast Centre | 8.3 | 8.3 | 7.5 | 7.5 | 12.9 | 12.2 | 12.3 | 10.2 | 7.5 | 8.5 | 9.3 | 8.5 |
| Belfast Stockman's Lane | | | | | | | 12.3 | 12.3 | 9.3 | 9.8 | | |
| Billingham | | | | | | | 12.2 | 12.3 | | | | |
| Birkenhead Borough Road | | | | | | | 12.5 | 12.3 | | | | |
| Birmingham Acocks Green | 11.4 | 11.2 | | | | | 12.2 | 12.2 | 9.1 | 7.5 | 9.3 | 7.5 |
| Birmingham A4540 Roadside | 11.2 | 11.2 | | | | | 12.4 | 12.3 | 8.3 | 7.5 | 9.3 | 7.5 |
| Birmingham Ladywood | 7.3 | 7.3 | | | 12.5 | 12.4 | 13.1 | 13.2 | 7.5 | 7.6 | 9.3 | 7.6 |
| Blackburn Accrington Road | | | | | | | 12.2 | 12.2 | | | | |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| Blackpool Marton | 8.3 | 8.3 | | | | | 9.8 | 9.8 | 9 | 7.5 | 9.3 | 7.5 |
| Borehamwood Meadow Park | | | | | | | 11 | 9.8 | | | | |
| Bournemouth | 11.2 | 11.2 | | | | | 12.4 | 12.2 | | | 12.6 | 12.6 |
| Bradford Mayo Avenue | | | | | | | 12.2 | 12.2 | | | | |
| Brighton Preston Park | 11.2 | 11.2 | | | | | 12.2 | 12.2 | | | 12.7 | 12.6 |
| Bristol St Paul's | 11.2 | 11.2 | | | | | 12.2 | 12.2 | 9.3 | 9.3 | 12.6 | 12.6 |
| Bristol Temple Way | | | | | | | 12.2 | 13.4 | 9.3 | 9.3 | | |
| Burton-on-Trent Horninglow | | | | | | | 12.2 | 12.7 | | | | |
| Bury Whitefield Roadside | | | | | | | 12.2 | | 9.4 | 10.6 | | |
| Bush Estate | 11.2 | 11.2 | | | | | 12.3 | 13 | | | | |
| Cambridge Roadside | | | | | | | 12.2 | 12.2 | | | | |
| Camden Kerbside | | | | | | | 11.8 | 12.5 | 8.7 | 8.7 | 16.4 | 16.4 |
| Cannock A5190 Roadside | | | | | | | 12.3 | 12.2 | | | | |
| Canterbury | 11.2 | 11.2 | | | | | 12.3 | 12.4 | | | | |
| Cardiff Centre | 11.2 | 11.2 | 7.5 | 7.5 | 12.2 | 12.2 | 12.4 | 14.8 | 8.7 | 8.7 | 17.5 | 16.4 |
| Cardiff Newport Road | | | | | | | 12.2 | 13.3 | 9.8 | 9.3 | | |
| Carlisle Roadside | | | | | | | 12.2 | 12.2 | 9.3 | 22.1 | 17 | 14.6 |
| Charlton Mackrell | 11.2 | 11.2 | | | | | 12.2 | 12.2 | | | | |
| Chatham Centre Roadside | | | | | | | 12.3 | 12.6 | 9.3 | 9.3 | 12.6 | 13 |
| Chepstow A48 | | | | | | | 12.2 | 12.2 | 11.4 | 9.3 | 12.7 | 12.6 |
| Chesterfield Loundsley Green | | | | | | | 12.2 | 12.2 | 7.7 | 7.5 | 9.3 | 7.5 |
| Chesterfield Roadside | | | | | | | 12.3 | 12.2 | 7.8 | 7.6 | 9.3 | 7.6 |
| Chilbolton | 11.2 | 11.2 | | | 10 | 10 | 12.2 | 12.4 | 8.2 | | 9.3 | |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| Christchurch Barrack Road | | | | | | | 12.5 | 12.3 | | | 13.1 | 12.6 |
| Coventry Allesley | 8.3 | 8.3 | | | | | 9.8 | 9.8 | 8.5 | 7.5 | 9.3 | 7.5 |
| Coventry Binley Road | | | | | | | 12.2 | 12.2 | 9.3 | 9.3 | | |
| Crewe Coppenhall | | | | | | | 12.3 | 12.3 | | | | |
| Cwmbran | 8.3 | 8.3 | | | | | 13.2 | 12.2 | | | | |
| Derby St Alkmunds Way | | | | | | | 12.6 | 12.2 | | | | |
| Derry Rosemount | 11.2 | 11.2 | | | 10.6 | 10 | 12.2 | 12.8 | 9.3 | 26.5 | 14.6 | 14.4 |
| Dewsbury Ashworth Grove | | | | | | | 12.3 | 12.2 | | | | |
| Doncaster A630 Cleveland Street | | | | | | | 12.2 | 12.2 | | | | |
| Dundee Mains Loan | | | | | | | 9.8 | 9.8 | 8.3 | | | |
| Dumbarton Roadside | | | | | | | 11.6 | 13.3 | | | | |
| Dumfries | | | | | | | 12.3 | 12.3 | | | | |
| Ealing Horn Lane | | | | | | | | | 9.4 | 9.3 | | |
| Eastbourne | | | | | | | 13 | 12.6 | 7.5 | 7.7 | 9.3 | 7.7 |
| Edinburgh Nicolson Street | | | | | | | 12.2 | 12.2 | 9.4 | | | |
| Edinburgh St Leonards | 11.2 | 11.4 | 8.7 | 7.5 | 12.2 | 12.2 | 12.5 | 12.2 | 10.3 | 8 | 9.3 | 8 |
| Eskdalemuir | 11.3 | 11.5 | | | | | 12.2 | 12.2 | | | | |
| Exeter Roadside | 7.2 | 7.3 | | | | | 13.5 | 13.3 | | | | |
| Fort William | 11.2 | 11.2 | | | | | 12.2 | 12.2 | | | | |
| Glasgow Great Western Road | | | | | | | 12.2 | 12.2 | | | | |
| Glasgow High Street | | | | | | | 12.2 | 12.2 | 11.7 | 7.5 | | 7.5 |
| Glasgow Kerbside | | | | | | | 9.8 | 9.8 | | | | |
| Glasgow Townhead | 11.5 | 8.3 | | | | | 12.2 | 12.2 | 9.6 | 7.5 | 9.3 | 7.5 |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| Glazebury | 11.2 | 11.2 | | | | | 12.2 | 12.2 | | | | |
| Grangemouth | | | | | 12.2 | 12.2 | 12.3 | 12.2 | 9.3 | 9.3 | 12.6 | 12.6 |
| Grangemouth Moray | | | | | 12.5 | 13 | 12.3 | 12.6 | | | | |
| Greenock A8 Roadside | | | | | | | 9.8 | 9.8 | 7.7 | 7.5 | 9.3 | 7.5 |
| Hafod-yr-Ynys Roadside | | | | | | | 12.2 | 12.2 | | | | |
| Haringey Roadside | | | | | | | 13.6 | 11.7 | | | | |
| Hartlepool St Abbs Walk | | | | | | | 12.2 | 12.2 | | | | |
| High Muffles | 11.2 | 11.2 | | | | | 12.2 | | | | | |
| Honiton | | | | | | | 12.2 | 13.3 | | | | |
| Horley | | | | | | | 17.2 | 15.5 | | | | |
| Hull Freetown | 8.5 | 8.3 | | | 12.2 | 12.2 | 9.8 | 9.8 | 10 | 8 | 9.3 | 8 |
| Hull Holderness Road | | | | | | | 12.3 | 12.3 | 9.3 | 9.8 | | |
| Immingham Woodlands Avenue | | | | | | | 12.2 | 12.2 | | | | |
| Inverness | | | | | | | 12.2 | 12.3 | 9.4 | 14.8 | 9.3 | 14.8 |
| Ladybower | 11.2 | 11.2 | | | 12.2 | 12.2 | 12.2 | 12.2 | | | | |
| Leamington Spa | 11.2 | 11.2 | | | | | 12.3 | 12.2 | 8.1 | 7.6 | 9.3 | 7.6 |
| Leamington Spa Rugby Road | | | | | | | 12.2 | 12.4 | 9.6 | 7.5 | 9.3 | 7.5 |
| Leeds Centre | 8.3 | 8.3 | 8 | 7.5 | 11.6 | 11.6 | 10.4 | 9.8 | 8.9 | 7.5 | 9.3 | 7.5 |
| Leeds Headingley Kerbside | | | | | | | 12.2 | 12.2 | 8.9 | 9.7 | 16.4 | 12.6 |
| Leicester A594 Roadside | | | | | | | 12.2 | 12.3 | 9.3 | 9.3 | | |
| Leicester University | 8.3 | 8.3 | | | | | 9.8 | 9.8 | 7.5 | 7.6 | 9.3 | 7.6 |
| Leominster | 11.2 | 11.2 | | | | | 12.3 | 12.3 | | | | |
| Lerwick | 11.2 | 11.2 | | | 10.2 | 10.1 | 12.2 | 12.2 | | | | |
| Lincoln Canwick Road | | | | | | | 12.6 | 12.4 | | | | |
| Liverpool Speke | 8.3 | 8.3 | | | 12.2 | 12.2 | 9.9 | 9.8 | 9.3 | 9.3 | 12.6 | 12.6 |
| London Bexley | | | | | | | 12.3 | 12.2 | | | 16.6 | 17.4 |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| London Bloomsbury | 11.2 | 11.2 | | | 10 | 10 | 12.2 | 12.2 | 13.9 | 9.3 | 16.6 | 17.6 |
| London Eltham | 10.4 | 10.4 | | | | | 12 | 11.5 | | | 17 | 16.4 |
| London Haringey Priory Park South | 10.4 | 10.4 | | | | | 12.2 | 12.2 | | | | |
| London Harlington | 11.2 | 11.2 | | | | | 12.3 | 12.2 | 7.7 | 7.5 | 9.3 | 7.5 |
| London Honor Oak Park | | | | | | | | | 7.6 | 7.5 | 9.3 | 7.5 |
| London Hillingdon | 8.3 | 8.3 | | | | | 9.8 | 9.8 | | | | |
| London Marylebone Road | 11.2 | 11.2 | 7.5 | 7.6 | 10 | 10 | 12.2 | 12.3 | 9.3 | 7.5 | 9.3 | 7.5 |
| London N. Kensington | 11.2 | 11.2 | 7.7 | 7.5 | 10 | 10 | 12.8 | 12.2 | 7.7 | 7.5 | 9.3 | 7.5 |
| London Teddington Bushy Park | | | | | | | | | 8.7 | 7.5 | 9.3 | 7.5 |
| London Westminster | | | | | | | 12.4 | 12.2 | | | 14.4 | 12.6 |
| Lough Navar | 16.1 | 11.6 | | | | | | | 11.5 | 7.8 | | 7.8 |
| Lullington Heath | 11.2 | 11.2 | | | 10 | 10 | 318.3 | 12.3 | | | | |
| Luton A505 Roadside | | | | | | | 12.3 | 12.3 | | | | |
| Mace Head | 8.8 | | | | | | | | | | | |
| Manchester Piccadilly | 8.4 | 8.3 | | | 12.2 | 12.2 | 9.8 | 10 | 8.7 | 9.3 | 16.4 | 13.2 |
| Manchester Sharston | 11.2 | 11.2 | | | 10 | 10 | 12.2 | 12.2 | | | | |
| Middlesbrough | 11.2 | 11.2 | | | 12.2 | 12.8 | 12.2 | 12.6 | 8.7 | 9.3 | 16.5 | 12.6 |
| Narberth | 11.2 | 11.2 | | | 12.2 | 12.2 | 12.9 | 12.2 | 9.6 | 7.5 | | 7.5 |
| Newcastle Centre | 8.3 | 8.3 | | | | | 11.2 | 9.8 | 9.2 | 9.3 | 16.6 | 12.6 |
| Newcastle Cradlewell Roadside | | | | | | | 12.2 | 12.2 | 9.8 | 13.7 | | |
| Newport | | | | | | | 12.2 | 12.2 | 7.5 | 8.2 | 9.3 | 8.2 |
| Northampton Spring Park | 7.2 | 7.2 | | | | | 13.1 | 13.1 | | | 13.2 | 12.6 |
| Norwich Lakenfields | 8.3 | 8.3 | | | | | 10 | 9.8 | 8 | 7.5 | 9.3 | 7.5 |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| Nottingham Centre | 8.3 | 8.3 | | | 12.2 | 12.2 | 11.1 | 11.3 | 7.5 | 7.6 | 9.3 | 7.6 |
| Nottingham Western Boulevard | | | | | | | 12.2 | 12.2 | 9.3 | 9.3 | | |
| Oldbury Birmingham Road | | | | | | | 13 | 13.1 | | | | |
| Oxford Centre Roadside | | | | | | | 12.2 | 12.2 | | | | |
| Oxford St Ebbes | | 10.4 | | | | | 12.2 | 12.2 | 9 | 7.5 | 9.3 | 7.5 |
| Peebles | 11.2 | 12.6 | | | | | 12.3 | 12.2 | | | | |
| Plymouth Tavistock Road | | | | | | | 12.2 | 12.2 | | | | |
| Plymouth Centre | 8.3 | 8.3 | | | | | 9.8 | 10.5 | 8.7 | 9.4 | 16.4 | 16.8 |
| Port Talbot Margam | 8.3 | 8.3 | 11.5 | 11.5 | 11.6 | 11.6 | 9.8 | 9.8 | 8.7 | 8.7 | 16.4 | 12.6 |
| Portsmouth | 8.3 | | | | | | 13 | | 9.7 | | | |
| Portsmouth Anglesea Road | | | | | | | 12.4 | 12.3 | 9.3 | 9.6 | | |
| Preston | 8.3 | 8.3 | | | | | 11.4 | 9.8 | 7.5 | 7.9 | 9.3 | 7.9 |
| Reading London Road | | | | | | | 12.3 | 12.2 | 11.6 | 9.3 | | |
| Reading New Town | 8.3 | 8.3 | | | | | 10 | 9.8 | 9.3 | 9.4 | 12.6 | 12.6 |
| Rochester Stoke | 11.2 | 11.2 | | | 12.2 | 10 | 12.2 | 12.5 | 8.9 | 7.5 | 9.3 | 7.5 |
| Salford Eccles | | | | | | | 12.2 | 12.2 | 7.5 | 7.9 | 9.3 | 7.9 |
| Saltash Callington Road | | | | | | | | | 9.3 | 9.6 | 12.6 | 13.7 |
| Sandy Roadside | | | | | | | 12.3 | 12.2 | 9.5 | 9.3 | 12.6 | 34.2 |
| Scunthorpe Town | | | | | 10.2 | 10 | 12.2 | 12.2 | 9.8 | 9.3 | | |
| Shaw Crompton Way | | | | | | | 12.2 | 12.5 | 9.9 | | | |
| Sheffield Barnsley Road | | | | | | | 12.2 | 9.8 | | | 12.6 | 13.5 |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| Sheffield Devonshire Green | 8.3 | 8.4 | | | | | 9.8 | 9.8 | 7.8 | 7.5 | 9.3 | 7.5 |
| Sheffield Tinsley | | | | | | | 12.2 | 12.2 | | | | |
| Sibton | 11.2 | 11.2 | | | | | | | | | | |
| Southampton Centre | 8.3 | 8.3 | | | 12.2 | 12.2 | 9.8 | 12.5 | 9.8 | 7.5 | 9.3 | 7.5 |
| Southampton A33 Roadside | | | | | | | 12.2 | 12.3 | 8.9 | 9.3 | | |
| Southend-on-Sea | 8.3 | 8.3 | | | | | 11 | 10 | 7.6 | 8.3 | 9.3 | 8.3 |
| Southwark A2 Old Kent Road | | | | | | | 12.3 | | 9.3 | | | |
| St Helens Linkway | | | | | | | 12.2 | 12.2 | 14.1 | 9.3 | | |
| St Osyth | 8.3 | 8.3 | | | | | 10.1 | 9.8 | | | | |
| Stanford-le-Hope Roadside | | | | | | | 12.2 | 12.7 | 9.3 | 12.8 | 12.6 | 13.7 |
| Stockton on Tees A1035 Roadside | | | | | | | 12.2 | 12.6 | | | 13.1 | 12.6 |
| Stockton-on-Tees Eaglescliffe | | | | | | | 12.2 | 13.8 | 9.3 | 10.5 | 12.6 | 12.6 |
| Stoke-on-Trent Centre | 8.3 | 8.3 | | | | | 10.8 | 9.8 | 8.1 | 8.2 | 9.3 | 8.2 |
| Stoke on Trent A50 Roadside | | | | | | | 12.2 | 12.2 | 9.4 | 9.3 | | |
| Storrington Roadside | | | | | | | 9.8 | 9.8 | | | | |
| Strath Vaich | | 11.3 | | | | | | | | | | |
| Sunderland Silksworth | 11.2 | 11.2 | | | | | 12.2 | 12.2 | 7.5 | 7.5 | 9.3 | 7.5 |
| Sunderland Wessington Way | | | | | | | 12.2 | 12.2 | | | | |
| Swansea Roadside | | | | | | | 12.2 | 12.4 | 9.3 | 9.3 | 12.7 | 12.6 |
| Swindon Walcot | | | | | | | 12.2 | 12.2 | | | | |
| Telford Hollinswood | | | | | | | 12.2 | 12.5 | | | | |
| Thurrock | 11.2 | 11.2 | | | 10 | 10 | 12.2 | 12.2 | 9.3 | 10.9 | | |

| Site | $O_3$ | | CO | | $SO_2$ | | $NO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer |
| Tower Hamlets Roadside | | | | | | | 12.2 | 12.2 | | | | |
| Walsall Woodlands | 11.2 | 11.2 | | | | | 12.5 | 12.3 | | | | |
| Warrington | | | | | | | 12.2 | 12.2 | 9.3 | 9.3 | 12.9 | 12.6 |
| Weybourne | 8.3 | 8.4 | | | | | | | | | | |
| Wicken Fen | 11.2 | 11.2 | | | 10.2 | 10 | 12.2 | 12.4 | | | | |
| Widnes Milton Road | | | | | | | 13.7 | 12.2 | 10.6 | 9.7 | | |
| Wigan Centre | 8.3 | 8.3 | | | | | 12.4 | 12.2 | 9 | 8.9 | 9.3 | 8.9 |
| Wirral Tranmere | 8.3 | 8.3 | | | | | 9.8 | 9.8 | 9.7 | 7.5 | 9.3 | 7.5 |
| Worthing A27 Roadside | | | | | | | 12.4 | 12.2 | | | 12.6 | 14.8 |
| Wrexham | | | | | 12.2 | 12.2 | 12.2 | 12.2 | 8.6 | 8 | 9.3 | 8 |
| Yarner Wood | 11.2 | 11.3 | | | | | 14.7 | 12.2 | | | | |
| York Bootham | | | | | | | 12.2 | 12.2 | 8.7 | 9.7 | 16.4 | 12.6 |
| York Fishergate | | | | | | | 12.2 | 12.2 | 9.3 | 9.3 | 12.6 | 12.6 |

Two stations (Crewe Coppenhall and Bath A4 Roadside) commenced operation after the summer 2020 intercalibration exercise and therefore do not appear in the above statistics.

# Appendix 3 – List of Stations with Data Capture below 85%

| Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| London Bloomsbury | 77.78% | 90.54% | 87.83% | | 95.01% | 72.52% | 84.74% |
| Sandy Roadside | 99.11% | 80.93% | 73.57% | | | | 84.54% |
| Christchurch Barrack Road | 96.44% | | 71.11% | | | | 83.77% |
| Cambridge Roadside | 83.70% | | | | | | 83.70% |
| York Bootham | 61.44% | 95.16% | 92.59% | | | | 83.06% |
| Eastbourne | 51.39% | 98.29% | 98.29% | | | | 82.66% |
| Eskdalemuir | 84.56% | | | | 79.06% | | 81.81% |
| Bradford Mayo Avenue | 80.54% | | | | | | 80.54% |
| Brighton Preston Park | 99.21% | | 41.19% | | 95.99% | | 78.80% |
| Birmingham Acocks Green | 55.90% | 98.84% | 98.84% | | 58.57% | | 78.04% |
| Grangemouth Moray | 75.85% | | | | | | 75.85% |
| Edinburgh Nicolson Street | 74.32% | | | | | | 74.32% |
| Southwark A2 Old Kent Road | 68.18% | 75.32% | | | | | 71.75% |
| London Bexley | 96.71% | 24.97% | 88.75% | | | | 70.14% |
| Ballymena Ballykeel | 99.29% | | | | | 39.03% | 69.16% |
| Lullington Heath | 11.25% | | | | 97.35% | 86.33% | 64.97% |
| Liverpool Speke | 64.09% | 65.90% | 64.31% | | 64.82% | 60.13% | 63.85% |
| Cwmbran | 59.59% | | | | 59.80% | | 59.69% |
| High Muffles | 46.84% | | | | 53.19% | | 50.01% |
| Cwmbran Crownbridge | 25.02% | | | | 25.07% | | 25.05% |
| Portsmouth | 15.13% | 15.40% | 15.40% | | 15.39% | | 15.33% |

These data capture statistics are based on the whole year. Cwmbran and Cwmbran Crownbridge did not operate for the entire year - see Section 1.6.

The principal reasons for the data loss are as follows:

**London Bloomsbury (NOx, $SO_2$)**
The station suffered air conditioning failure and was turned off in September. The $SO_2$ analyser was more adversely affected, and most of the data in Q3 were rejected.

**Sandy Roadside ($PM_{10}$, $PM_{2.5}$)**
The BAMs suffered numerous tape faults during the year, and access to the station for remedial action was difficult at times due to Covid restrictions.

**Christchurch Barrack Road ($PM_{2.5}$)**
The BAM suffered from numerous tape faults during the year. In addition, the measured data diverged from the regional average during July and August, and this was rectified at the summer audit; data up to the audit were rejected.

**Cambridge Roadside (NOx)**
The analyser was thought to be internally sampling, and data improved following an engineer visit on 11$^{th}$ May. Data from 20$^{th}$ March to the visit have been rejected.

**York Bootham (NOx)**
The NOx analyser was found to be sampling internally at the summer audit. Data have been rejected from the installation of the BAMs on 3rd March, where a step change in the NOx data was noticed.

**Eastbourne (NOx)**
The LSO was unable to visit the station for routine calibrations for a considerable period during the summer. As a result, data from March to the summer audit in August.

**Eskdalemuir (NOx, $O_3$)**
The ozone analyser had an intermittent flow blockage during the year. A blockage in the NOx converter resulted in data loss up to the installation of a hotspare in November.

**Bradford Mayo Avenue (NOx)**
The main valve in the NOx analyser failed in April. This was repaired, but the tubing became detached from the analyser, resulting in data loss to early July.

**Brighton Preston Park ($PM_{2.5}$)**
Following the installation of the BAM in February, the analyser performance has been very poor, with persistent stability problems. The installation of a hotspare instrument in July did not correct the faults. Data from March to August were rejected.

**Birmingham Acocks Green (NOx, $O_3$)**
The station was inaccessible for LSO visits from March to July; NOx and ozone data were rejected due to the lack of calibrations. The Fidas data were unaffected as the instrument does not require regular intervention.

**Grangemouth Moray (NOx)**
The power to the station was disconnected from July to September whilst asbestos removal works took place in the adjacent school.

**Edinburgh Nicolson Street (NOx)**
The reaction cell suffered damage during the service in January. This was replaced but data still appeared poor. The main valve was found to be faulty; data have been rejected from February to April.

**Southwark A2 Old Kent Road (NOx, $PM_{10}$)**
The analysers were switched off on occasions during the summer due to water ingress in the cabin. The cabin was replaced, and monitoring restored in September.

**London Bexley ($PM_{10}$)**
There were no problems with the site: the measurement of $PM_{10}$ commenced on 1st October when the $PM_{2.5}$ FDMS was replaced with a BAM, which monitors both PM metrics. Data capture is calculated for the whole year in the above table, and was therefore low as $PM_{2.5}$ measurement began late in the year.

**Ballymena Ballykeel ($SO_2$)**
The $SO_2$ analyser was replaced in 2019; however, the performance of the new analyser was very poor, with rapid baseline drift and excessive signal noise. Data have been rejected up to 27th July 2020.

**Lullington Heath (NOx)**
The NOx analyser developed a fault in April, and despite ESU intervention, the NO data were unstable and noisy for the remainder of the year. No clear cause has been identified, though a light leak in the NOx analyser (that is, light getting into the reaction cell, which will affect the chemiluminescence measurements) was diagnosed in May 2020.

**Liverpool Speke (all pollutants)**
The station was switched off from 26th August 2020 following ingress of water in the cabin. The cabin was then replaced and monitoring restarted in September 2021.

**Cwmbran & Cwmbran Crownbridge (NOx)**
The Cwmbran station was relocated to Cwmbran Crownbridge during 2020 - see Section 1.6

**High Muffles (NOx, $O_3$)**
The NOx and ozone data appeared elevated between the winter and summer services, and the summer audit noted a leak in the sampling system. Data have been rejected from 25th February to 12th August.

**Portsmouth (all pollutants)**
The station was closed from the end of February 2020 for replacement of the cabin. Monitoring restarted in April 2021.

Ricardo
Energy & Environment

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom
t: +44 (0)1235 753000
e: enquiry@ricardo.com

ee.ricardo.com