Fife Air Quality Annual Progress Report 2021

Fife Council

Report for Fife Council
ED14794

2021 Air Quality Annual Progress Report (APR) for
Fife Council

In fulfilment of Part IV of the
Environment Act 1995

Local Air Quality Management

July 2021

Customer:

Fife Council

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Executive summary

Air Quality in Fife

Air quality is generally good in most parts of Fife, but there are a few specific areas within town centres where hotspots of pollution have been identified and action is required. The main pollutants of concern in these hotspot areas are nitrogen dioxide (NO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$) mainly sourced from road vehicle emissions. This Annual Progress Report has been undertaken to fulfil Fife Council's duty to annually review and assess air quality. The report provides the latest monitoring results and discusses the implications for air quality management in the Fife area.

The Annual Progress Report utilises monitoring data collected throughout 2020. Fife Council carry out monitoring of nitrogen dioxide (NO_2) at four automatic stations in Cupar, Dunfermline, Kirkcaldy and Rosyth. Non-automatic monitoring of NO_2 was carried out using diffusion tubes at 42 sites (total of 58 tubes). All NO_2 concentrations measured during 2020 were below the annual mean objective of 40 µg m^{-3}.

PM_{10} and $PM_{2.5}$ is measured at the four automatic sites within Fife at Cupar, Dunfermline, Kirkcaldy and Rosyth. During 2020 all concentrations were below the annual mean objective of 18 µg m^{-3} for PM_{10} and 10 µg m^{-3} for $PM_{2.5}$.

The review of all available data relating to carbon monoxide (CO), sulphur dioxide (SO_2) and benzene monitoring during 2020 indicates that it is unlikely that any air quality objectives relating to these pollutants were exceeded during 2020.

The review of all other local developments has not identified any locations where there may be a risk of the air quality objectives being exceeded and so no additional air quality assessment is recommended at this time.

There are currently two Air Quality Management Areas (AQMAs) for NO_2 and PM_{10} located within the Fife Council boundary, these are:

- Bonnygate, Cupar, declared in October 2008 for NO_2 and PM_{10}.
- Appin Crescent, Dunfermline, declared in November 2011 for NO_2 and August 2012 for PM_{10}.

During 2020, Fife Council started the process of revoking the NO_2 element of both AQMAs after recommendations from the Scottish Government and SEPA.

The Air Quality Action Plan (AQAP) for the Bonnygate, Cupar AQMA was last updated in 2015 and is in the process of being updated in 2021. These updates are still going through the approval process and are due to be released later in 2021. The AQAP has been successful in reducing both NO_2 and PM_{10} concentrations within the Bonnygate area for a number of years now. During 2020 all annual mean concentrations were below the objective level of 40 µg m^{-3} for NO_2 and 18 µg m^{-3} for PM_{10}.

The AQAP for Appin Crescent, Dunfermline was last updated in 2015 and is in the process of being updated in 2021. These updates are still going through the approval process and are due to be released later in 2021. The AQAP has been successful in reducing both NO_2 and PM_{10} concentrations within the Appin Crescent area for a number of years now. During 2020 all annual mean concentrations were below the objective level of 40 µg m^{-3} for NO_2 and 18 µg m^{-3} for PM_{10}.

Three AQMesh sensor units were installed in December 2017 to seek to further understand pollutant concentrations and trends in the Appin Crescent, Dunfermline and Bonnygate, Cupar AQMAs. Data is managed and processed by Ricardo Energy and Environment (Ricardo) who carry out the appropriate Quality Assurance/Quality Control (QA/QC) procedures. The data available for 2020 showed no exceedances.

The Air Quality Strategy for Fife (2015–2020) was developed from the guidance of the Scottish Government and aims not only to raise awareness of air quality issues but also to promote some of the existing best practice work that the Council has undertaken within existing AQMAs to other parts of Fife.

It recognises that no one single authority or Council service can have all the solutions and consequently a collaborative approach with key partners and stakeholders is considered essential in order to bring about improvements in air quality. An Air Quality Steering Group (including various Council services, SEPA, NHS Fife and representatives of local communities) aims to meet regularly to ensure that the aims and objectives of Fife's Air Quality Strategy and Air Quality Action Plans are being progressed. Progress in implementing the aims and objectives of Fife's Air Quality Strategy was acknowledged at the COSLA excellence awards in 2017 where Fife Council received a bronze award in the category of "Tackling Inequalities and Improving Health". The Air Quality Strategy for Fife and associated Appin Crescent and Bonnygate Action Plans are in the process of being updated as appropriate.

Following the review of all available data it is recommended that Fife Council carry out the following actions:

- Continue to monitor NO_2, PM_{10} and $PM_{2.5}$ concentrations throughout Fife.
- Produce an Annual Progress Report in 2022, reporting concentrations measured during 2021.
- Continue to implement the measures outlined in the action plans for Appin Crescent, Dunfermline and Bonnygate, Cupar.
- Produce a Fife Air Quality Strategy for 2021-2025 and associated updated action plans for Appin Crescent, Dunfermline and Bonnygate, Cupar.

Actions to Improve Air Quality

Measures outlined in the AQAPs for Bonnygate, Cupar and Appin Crescent, Dunfermline have been implemented throughout 2020. This includes the ongoing implementation of the Fife ECO Stars scheme which is a free, voluntary scheme that provides recognition, guidance and advice on operational best practice to operators of goods vehicles, buses and coaches, taxis and private hire vehicles. It is being rolled out in Fife to help fleet operators improve efficiency, reduce fuel consumption and reduce emissions - all helping to improve local air quality and at the same time, make cost savings.

As of June 2021, there were 257 fleet operator members, who operate 9,266 vehicles in and around Fife. Recruitment of new members continues to reflect the full spectrum of fleets operating in Fife. The requirement for all school and social work contract operators to become members of ECO Stars has resulted in a significant increase in membership numbers for the ECO Stars Taxi and Private Hire scheme. The scheme now has 146 members, operating 596 vehicles.

Fife Council has started the process of updating their Air Quality Action Plans for both AQMAs and also their Air Quality Strategy.

Local Priorities and Challenges

Fife Council has been awarded its grant funding from the Scottish Government for 2021-22. The funding will be used to carry out the following air quality initiatives and studies, which aim to work towards and further enhance the measures set out in the action plans for Bonnygate, Cupar and Appin Crescent, Dunfermline:

Bonnygate, Cupar:

Fife Council will continue to implement the measures set out in the Bonnygate AQAP during 2021. Fife Council's priorities within the designated AQMA over the forthcoming year include:

- Finalise the updates of the Bonnygate AQAP and Fife Council's Air Quality Strategy with both to cover 2021 to 2025;
- Continue the implementation of Fife Council's travel plan including encouraging walking and cycling infrastructure and associated initiatives;
- Fife ECO Stars schemes for Fleet and Taxis operators will continue to encourage and promote 'clean fleet operations';
- Continue with the interrogation of monitoring data from the AQMesh unit in the Bonnygate to further understand pollutant concentrations and trends within the Bonnygate AQMA;

- Undertake a background PM source apportionment study with a view towards identifying additional opportunities for PM reductions within the Bonnygate AQMA.

Appin Crescent, Dunfermline:

Fife Council will continue to implement the measures set out in the Appin Crescent AQAP during 2021. Fife Council's priorities within the designated AQMA over the forthcoming year include:

- Finalise the updates of the Appin Crescent AQAP and Fife Council's Air Quality Strategy with both to cover 2021 to 2025;
- Continue the implementation of Fife Council's travel plan including encouraging walking and cycling infrastructure and initiatives;
- Fife ECO Stars schemes for Fleet and Taxis operators will continue to encourage and promote 'clean fleet operations';
- Continue with the interrogation of monitoring data from the AQMesh units in Appin Crescent to further understand pollutant concentrations and trends within the Appin Crescent AQMA;
- Undertake a background PM source apportionment study with a view towards identifying additional opportunities for PM reductions within the Appin Crescent AQMA.

In addition to the above, air quality educational packages have already been delivered in 2021 at certain schools within Fife (two in Glenrothes) as part of the annual Clean Air Day events. This will be described in the 2022 APR. This follows on from the successful delivery of such educational packages as part of Clean Air Day on the 8th October 2020 at schools in Dunfermline, Dairsie and Cowdenbeath.

How to Get Involved

Members of the public can find information related to air quality on the Fife Council website. Actions that members of the public can take to help reduce air pollution include:

- Car sharing
- Reducing car journeys by choosing to walk, cycle or take public transport instead
- Maintain and look after your vehicle properly
- Consider switching to an electric vehicle

Further information is available on the dedicated Fife Council air quality web pages at www.fife.gov.uk/airquality.

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1 Local Air Quality Management

This report provides an overview of air quality in Fife during 2020. It fulfils the requirements of Local Air Quality Management (LAQM) as set out in Part IV of the Environment Act (1995) and the relevant Policy and Technical Guidance documents.

The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where an exceedance is considered likely the local authority must declare an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) setting out the measures it intends to put in place in pursuit of the objectives. This Annual Progress Report (APR) summarises the work being undertaken by Fife Council to improve air quality and any progress that has been made.

Table 1.1 below summarises the Air Quality Objectives applicable to Scotland.

Table 1.1 Summary of Air Quality Objectives in Scotland

AQ Objective-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	3.25 µg m^{-3}	Running annual mean	31.12.2010
1,3 Butadiene	2.25 µg m^{-3}	Running annual mean	31.12.2003
Carbon Monoxide	10.0 mg m^{-3}	Running 8-Hour mean	31.12.2003
Lead	0.25 µg m^{-3}	Annual Mean	31.12.2008

1.1 Summary of Previous Review and Assessment

1.1.1 Previous Review and Assessment Reports

Fife Council have carried out a number of reviews and assessments in relation to air quality since 2007. All reports can be accessed via the Fife Council website[1] and Air Quality in Scotland websites[2].

The 2007 APR and 2008 APR concluded that a detailed assessment should be carried out for Bonnygate, Cupar (NO_2), Appin Crescent, Dunfermline (PM_{10}) and Admiralty Road, Rosyth (PM_{10}). These reports concluded that an AQMA should be declared for NO_2 and PM_{10} at Bonnygate, Cupar and increased monitoring should be carried out at Appin Crescent, Dunfermline. This monitoring was increased and an additional assessment in 2010 suggested an AQMA should be declared in Appin Crescent for NO_2. A further detailed assessment resulted in the amendment of the Appin Crescent AQMA to include PM_{10}. Subsequent AQAPs have been put into place.

The 2013 APR concluded that an AQMA was not required at Admiralty Road, Rosyth at that time.

A traffic management options appraisal was carried out in 2014 at Appin Crescent to assess if changes to the traffic management would have a significant impact. This was not the case. The Cupar Streetscene dispersion model was also carried out in 2014 to assess the traffic management changes proposed for Cupar. Two options were deemed to have a positive impact and were implemented in 2014. The 2014 APR concluded that the traffic management changes in Cupar were a success and concentrations in the Bonnygate AQMA had reduced.

A modelling assessment was carried out in 2015 to determine the effects of the Cupar North Development Zone and Relief Road. The report concluded that the results for each approach were very similar but when considering the cumulative impacts of the development without the relief road it is recommended that mitigation measures are considered to counteract the impact of additional development traffic.

An additional Appin Crescent traffic management appraisal was carried out in 2015 to investigate the potential impact of traffic management scenarios which aimed to improve traffic flow through Appin Crescent. It concluded that two out of the three options assessed did not provide air quality benefits however the third option (removal of a bus stop) did provide improvements.

The 2016 APR indicated exceedances within the current Appin Crescent AQMA at Appin Crescent (2) and Appin Crescent (6 ABC). The Air Quality Action Plan for Appin Crescent presents actions that will be implemented to address these exceedances. No exceedances were measured in the Cupar AQMA.

The 2017 APR highlighted a marginal exceedance within St Andrews as the result of new monitoring deployed within the town centre which commenced in 2016. This monitoring location was however some distance from the nearest receptor. In accordance with TG.16, the result was therefore corrected for NO_2 drop off using the LAQM NO_2 fall off with distance calculator. This resulted in an annual mean concentration of 33 µg m^{-3} at the nearest receptor which is below the objective. Measured 2016 concentrations of PM_{10} and $PM_{2.5}$ were below the annual mean objectives at all sites. The review of all available data relating to carbon monoxide (CO), sulphur dioxide (SO_2) and benzene monitoring during 2016 indicated that it is unlikely that any AQS objectives relating to these pollutants were exceeded during 2016. A review of industrial sources reported that Longannet Power Station ceased operation in March 2016.

The 2018 APR indicated NO_2, PM_{10} and $PM_{2.5}$ concentrations were below the annual mean objectives in 2017. The review of all available data relating to CO, SO_2 and benzene monitoring during 2017 indicated that it was unlikely that any AQS objectives relating to these pollutants were exceeded.

Fife Council carried out a number of surveys in 2018 including an emissions tracer survey and a mobile air quality survey in St Andrews measuring NO_2, PM_{10} and $PM_{2.5}$. The emissions tracer survey sampled a section of the Council vehicle fleet to determine if fleet renewals would yield tangible air quality

[1] https://www.fife.gov.uk/kb/docs/articles/environment2/environmental-health/air-quality

[2] http://www.scottishairquality.scot/news/reports?view=laqm

benefits in the AQMAs and areas of concern. A number of locations with high GPS count points and emissions were established in Kirkcaldy, Methil and Glenrothes, which coincide with the location of Council depot facilities. Fife Council will look to potentially extend the survey to include all fleet vehicles and over a long period of time. This would provide a more accurate estimate of the affect the fleet has on overall emissions levels.

The aim of the mobile monitoring was to demonstrate how air pollution concentrations vary within St Andrews and in turn to review the current NO_2 diffusion tube monitoring locations. Hotspots were identified along Links Crescent and North Street (A917) and along City Road. Increased concentrations were also measured along South Street and Bell Street for NO_2, PM_{10} and $PM_{2.5}$ confirming that the main source of pollution is likely to be road traffic.

An updated air quality impact assessment was carried out in 2018 for the Cupar North Development Zone and Relief Road. Two future 'with development' traffic scenarios were assessed by comparison with future baseline conditions for both annual mean NO_2 and PM_{10} concentrations: Phase 1 2024 (when 600 residential units are in use just prior to opening of the relief road) and completed development 2030 (when all residential and mixed use aspects of development are complete, and the Cupar Relief road is operational). No exceedances of the 40 µg m^{-3} NO_2 annual mean objective were predicted in 2024 Phase 1. The annual mean NO_2 concentrations were not predicted to be in excess of the annual mean objective in the Bonnygate AQMA. PM_{10} exceedances of the 18 µg m^{-3} Scottish annual mean objective were predicted at three 1st floor and two ground floor height receptors where relevant human exposure might be present. The model results indicated that additional emissions from vehicle trips generated by the Cupar North Development would contribute to what could be considered a significant increase in annual mean PM_{10} concentrations within the Bonnygate AQMA in 2024, prior to the relief road becoming operational.

No exceedances of the 40 µg m^{-3} NO_2 annual mean objective were predicted in the 2030 completed development scenario. The predicted impact was classified as either beneficial or negligible at all receptors. PM_{10} exceedances of the 18 µg m^{-3} Scottish annual mean objective were predicted at three 1st floor and two ground floor height receptors where relevant human exposure might be present. The model results indicate that the relief road will have a beneficial effect on PM_{10} concentrations within the Bonnygate AQMA; the reduction will not however be sufficient to achieve compliance with the 18 µg m^{-3} Scottish PM_{10} annual mean objective.

Ricardo prepared a regional scale dispersion model on behalf of Fife Council to model emissions from road transport. Concentrations of NO_2, PM_{10} and $PM_{2.5}$ were modelled for 2016 at 3m resolution over the whole of the Council area using a novel modelling framework (RapidAir) developed by Ricardo. The concentrations predicted from RapidAir were validated against roadside measurements made in Fife where emissions data was available. In addition, local validations were carried out for each of the main towns in Fife for NO_2 (Cupar, Dunfermline, Kirkcaldy, Rosyth and St Andrews) and the remaining tubes locations in combination.

The 2019 APR indicated NO_2, PM_{10} and $PM_{2.5}$ concentrations were below the annual mean objectives in 2018. The review of all available data relating to CO, SO_2 and benzene monitoring during 2018 indicated that it was unlikely that any AQS objectives relating to these pollutants were exceeded. Additional indicative monitoring of NO_2, PM_{10} and $PM_{2.5}$ was carried out using AQMesh sensor units within the Bonnygate and Appin Crescent AQMAs. No exceedances were measured for any of the pollutants.

Further information on any of these reviews and assessments can be found by contacting Fife Council directly at air.quality@fife.gov.uk or looking on the website for a copy www.fife.gov.uk/airquality

1.1.2 2020 Annual Progress Report

The 2020 APR utilised monitoring data collected throughout 2019. Fife Council carried out monitoring of NO_2 at four automatic stations in Cupar, Dunfermline, Kirkcaldy and Rosyth. Non-automatic monitoring of NO_2 was carried out using diffusion tubes at 55 sites (total of 71 tubes). During 2019 two additional monitoring locations commenced monitoring, one was marginally relocated, and two monitoring sites were removed as these were duplicate sites. In addition, monitoring also ceased at 11

sites due to continuously low readings over recent years. All NO_2 concentrations measured during 2019 were below the annual mean objective of 40 µg m^{-3}.

PM_{10} and $PM_{2.5}$ was measured at the four automatic sites within Fife at Cupar, Dunfermline, Kirkcaldy and Rosyth. During 2019, all concentrations were below the annual mean objective of 18 µg m^{-3} for PM_{10} and 10 µg m^{-3} for $PM_{2.5}$.

Additional indicative monitoring of NO_2, PM_{10} and $PM_{2.5}$ was carried out using AQMesh sensors units within the Bonnygate and Appin Crescent AQMAs. For the Bonnygate monitoring location, the data showed that there were no exceedances of the NO_2 objectives, however there were exceedances of PM_{10} (both annual and daily objectives) and $PM_{2.5}$ objectives during 2019. For the two Appin Crescent locations there were no exceedances measured for the NO_2, PM_{10} or $PM_{2.5}$ objectives.

The review of all available data relating to CO, SO_2 and benzene monitoring during 2019 indicated that it was unlikely that any AQS objectives relating to these pollutants were exceeded.

2 Actions to Improve Air Quality

2.1 Air Quality Management Areas

A summary of the AQMAs declared by Fife Council can be found in Table 2.1. Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at http://www.scottishairquality.co.uk/laqm/aqma. The boundaries of the AQMA's declared by Fife Council are shown in Figure 2-1 (Bonnygate, Cupar) and Figure 2-2 (Appin Crescent, Dunfermline). A steering group including key representatives from relevant services of Fife Council was formed to develop the AQAPs for both Bonnygate and Appin Crescent using the findings of the Further Assessment reports and the wide range of potential options for improving air quality. The steering group meet regularly to discuss and review the progress of the action plan measures outlined in the AQAPs.

Following a review of the 2020 Annual Progress Report, SEPA and the Scottish Government both recommended that Fife Council strongly consider revoking both AQMA's. Whilst concentrations of NO_2 and PM_{10} have improved significantly and now meet the Scottish air quality objectives for both pollutants, due to the current uncertainty regarding PM_{10} concentrations reported by different analysers and the Particular Matter concentrations indicated by the Bonnygate AQMesh monitoring in 2019, Fife Council do not propose to implement the revocation procedure for the PM_{10} element of the AQMAs at this time. However, the NO_2 element of the AQMAs is in the process of being revoked at both Bonnygate and Appin Crescent.

Fife Council proposes to continue to implement both AQAPs and monitor NO_2 and PM_{10} concentrations within the AQMAs to ensure that the Scottish air quality objectives continue to be achieved, and public health continues to be protected. This will include the continued consideration of monitoring data collected by the AQMesh sensors within Bonnygate and Appin Crescent which allow for concentrations of PM to be measured at locations of concern where previously it was not possible.

Fife Council will review the 2021 monitoring data obtained for both AQMAs in the 2022 APR and will also take guidance from the current Particulate Matter Measurement study that has been commissioned by the Scottish Government before a decision is made regarding the potential revocation of both PM_{10} AQMAs.

Table 2.1 Declared Air Quality Management Areas

AQMA Name	Pollutants and Air Quality Objectives	City/Town	Description	Action Plan
Bonnygate, Cupar	NO_2 annual mean PM_{10} annual mean	Cupar	An area comprising of Bonnygate (A91), Crossgate (A914) and St Catherine Street (A91). There are a number of residential properties within the area close to the road at1st floor height above commercial properties.	Bonnygate Cupar, AQAP is in the process of being updated and will be published later in 2021
Appin Crescent, Dunfermline	NO_2 annual mean PM_{10} annual mean	Dunfermline	An area comprising of Appin Crescent, Dunfermline. There are a number of residential properties within the area close to the road at both ground level and 1st floor height.	Appin Crescent, AQAP is in the process of being updated and will be published later in 2021

Figure 2-1 Bonnygate, Cupar AQMA Boundary

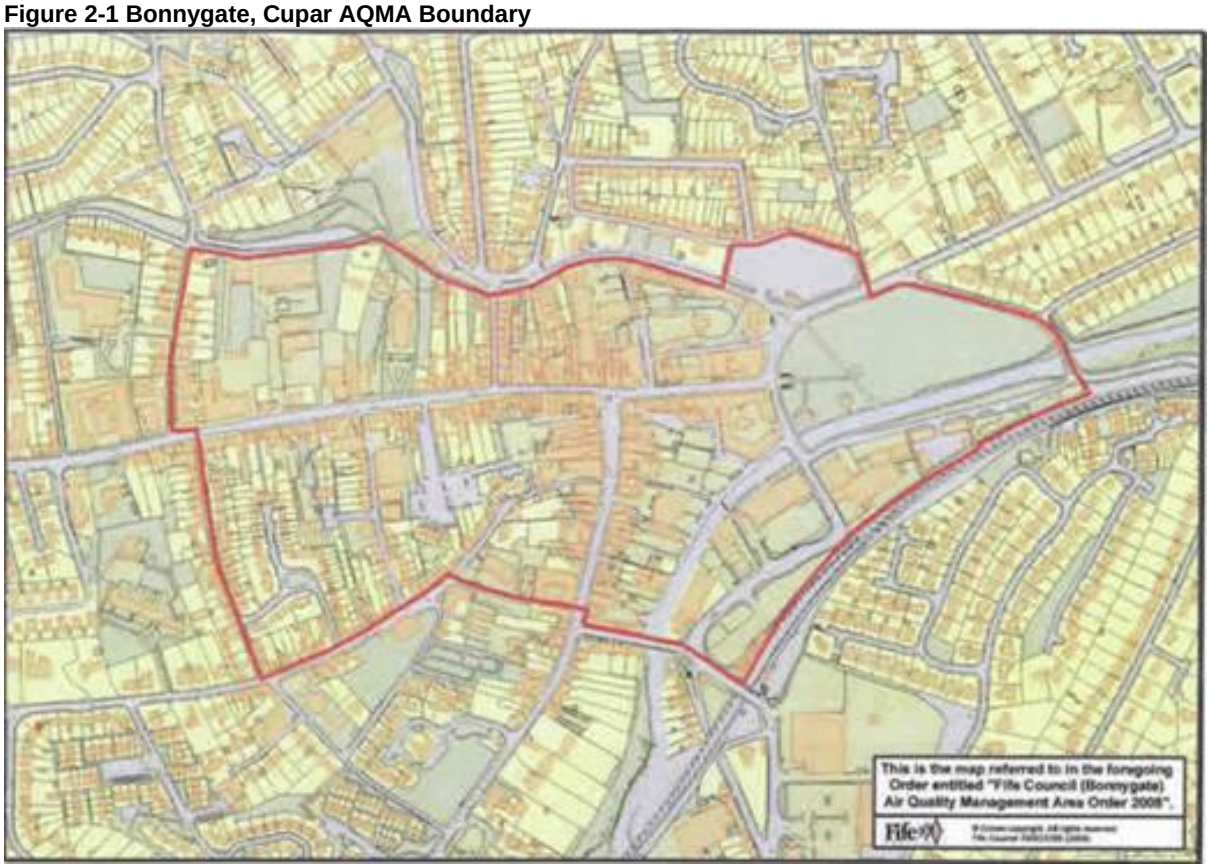
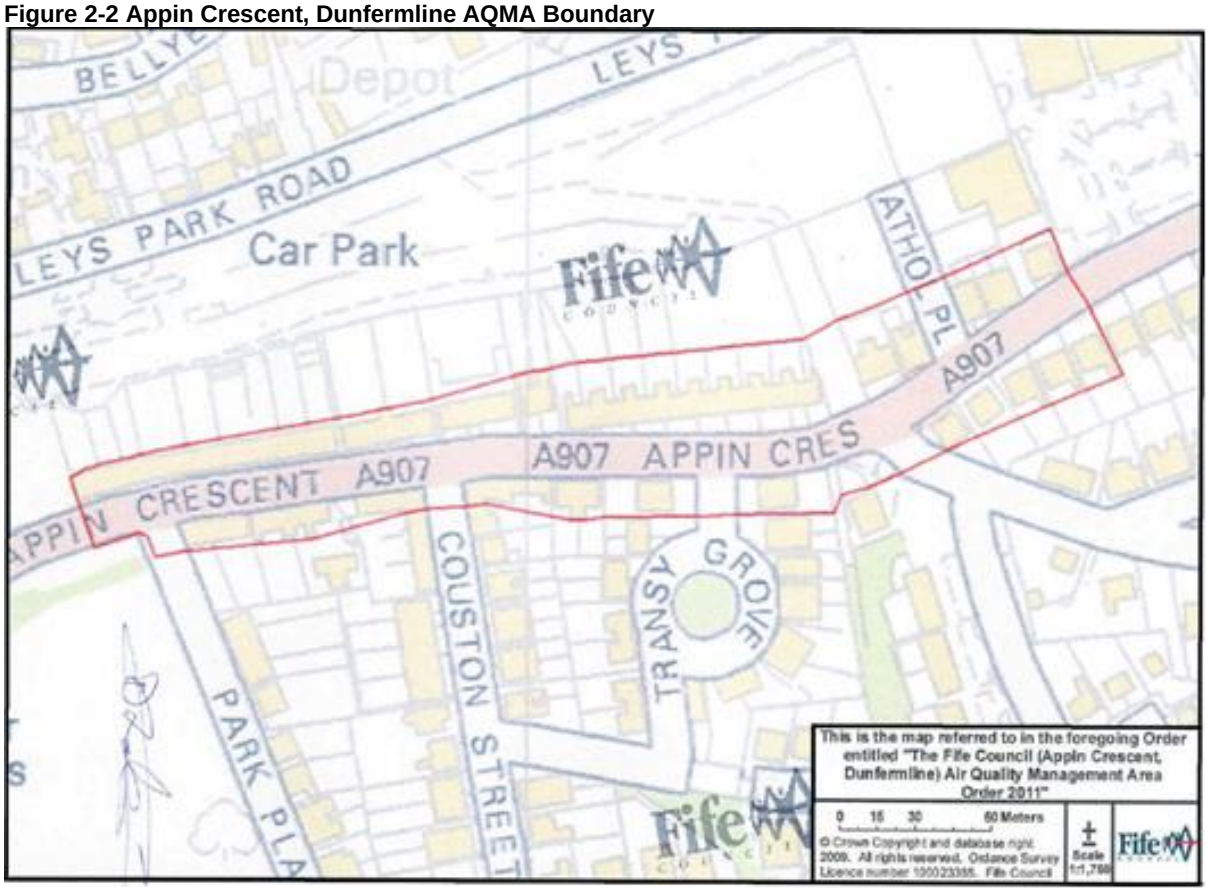


Figure 2-2 Appin Crescent, Dunfermline AQMA Boundary



2.2 Cleaner Air for Scotland

Cleaner Air for Scotland – The Road to a Healthier Future (CAFS) is a national cross-government strategy that sets out how the Scottish Government and its partner organisations propose to reduce air pollution further to protect human health and fulfil Scotland's legal responsibilities as soon as possible. A series of actions across a range of policy areas are outlined, a summary of which is available at http://www.gov.scot/Publications/2015/11/5671/17.

Progress by Fife Council against relevant actions within this strategy is demonstrated below.

2.2.1 Transport-Avoiding Travel-T1

"All local authorities should ensure that they have a corporate travel plan (perhaps within a carbon management plan) which is consistent with any local air quality action plan." **(CAFS T1 2015)**

Fife Council was the first Local Authority in Scotland to write a travel plan back in 1999 and to monitor how things are changing an Employee Travel Survey is carried out every two years. The Fife Council Travel Plan promotes sustainable travel with a hierarchy of walking, cycling, public transport and car share which is consistent with the key aims and objectives of Fife Council's Air Quality Strategy and the Appin Crescent, Dunfermline and Bonnygate, Cupar Air Quality Action Plans.

Fife Council have several initiatives in place, which include:

- TripshareFife.com - allowing travelling to similar locations via car sharing https://liftshare.com/uk/community/fifetripshare
- Cycle to Work Scheme – providing an opportunity to purchase a new bike and/or safety accessories therefore encouraging cycling to work
- Working with Schools to assist them in producing school travel plans
- WOW (Walk Once a Week)
- Hands Up Scotland Survey
- Active Schools Fife
- Bikeability – providing cycle training to primary school children P4 -7 (Discussed below in Section 2.2.5)

The "Walk Once a Week" Campaign has continued over 2020 (and into 2021) despite the associated Covid-19 related impacts. WOW is a partnership between Fife Council and Living Streets Scotland that is now in its sixth year and it continues to progress the active travel agenda in Fife Primary schools and increase the uptake of active travel. Due to the Covid-19 impacts the maximum number of schools to take part was only 26 which was lower than would be expected during an ordinary academic year but given all the associated restrictions and difficulties it was encouraging that some schools were still able to take part.

The Hands Up Scotland survey is a project funded by Transport Scotland and is a joint survey between Sustrans and all 32 local authorities across Scotland whereby each September schools across Scotland complete the survey by asking their pupils 'How do you normally travel to school?' and the results provide a valuable annual snapshot of typical school travel habits. The results for 2020 show that there has been a significant increase in active travel within Fife Primary schools from 49.7% in 2019 (42.8% walking, 3.2% cycling and 3.7% scooter/skate) to 59.4% in 2020 (50.1% walking, 4% cycling and 5.3% scooter/skate).

Fife's Active Schools team work with primary, secondary and additional support needs schools to:

- Increase the quality and range of opportunities to participate in sport before school, during lunchtime and after school
- Recruit and develop a network of volunteers & coaches to deliver sport and build capacity

- Increase the number of young people accessing leadership roles encouraging and supporting them to reach their potential
- Support and develop pathways to improve the transition for participants from schools to clubs

As part of Active Schools 555 pedometers have been recently issued to schools across Fife to support a Fife wide step challenge competing against North Ayrshire Council. Although the project will run mainly through schools it will also be open to community sports clubs, organisations, individuals and families and will therefore encourage active travel within local communities. An update will be provided within the 2022 APR.

2.2.2 Climate Change-Effective co-ordination of climate change and air quality policies to deliver co-benefits-CC2

The Scottish Government 'expect any Scottish local authority which has or is currently developing a Sustainable Energy [Climate] Action Plan to ensure that air quality considerations are covered, (Clean Air for Scotland – The Road to a Healthier Future 2015, P21)'.

On February 6th 2020 Fife Council's Environment and Protective Services Committee approved the Sustainable Energy Climate Action Plan - Climate Fife.
[https://www.fife.gov.uk/kb/docs/articles/environment2/climate-change,-carbon-and-energy].

Climate Fife includes a practical action plan for mitigation activities and a Risk and Vulnerability Assessment to outline the challenge for adaption action.

The response to Covid-19 has limited the full scale of action planned for the first year of Climate Fife. Work is continuing to strengthen how the Climate Emergency is addressed in the Plan for Fife - the Local Outcome Improvement Plan, with a revised version anticipated late 2021. As part of the response to Covid-19 the Council is undertaking work on Reform and Recovery, with responding to the Climate Emergency as an agreed theme. Additionally, the Climate Change and Zero Waste team have moved into the Planning Service to further strengthen action in this area. This demonstrates how responding to the Climate Emergency is seen as core to the work moving forward in Fife.

Air Quality and linked low carbon emissions actions are covered under the Sustainable Transport theme in the Climate Fife Action Plan. Fife Council is progressing early actions for Climate Fife.

Fife Councils Land & Air Quality Team continues to work closely with the Council's Climate Change team to ensure air quality is considered.

2.2.3 NHS Boards and their Local Authority Partners will include reference to air quality and health in JHPP-H2

"NHS boards and their local authority partners will include reference to air quality and health in the next revision of their Joint Health Protection Plans, which should identify and address specific local priority issues." **(CAFS H2 2015)**

Fife Council has in partnership with NHS Fife updated its Joint Health Protection Plan (JHPP) which now covers the period 1st April 2020 to 31st March 2022 and includes specific reference to air quality in terms of the existing AQMAs and Fife Council's Air Quality Strategy and highlights the importance of a collaborative approach to tackling air quality issues.

2.2.4 Planning Authorities – Planning authorities to review the Local Development Plan-P2

"Expect planning authorities to review the Local Development Plan and revise at the next scheduled update to ensure policies are consistent with CAFS objectives and any local authority air quality action plans." ***(CAFS P2 2015)***

The Low Carbon Fife Supplementary Guidance was adopted in January 2019 and now forms a statutory part of the Local Development Plan (FIFEplan) which was adopted in September 2017. This guidance incorporates the air quality development guidelines which are designed to assist developers in considering and meeting the relevant air quality requirements. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan).

2.2.5 Cycling Action Plan-T3

"We will work with partners to deliver our shared vision in the Cycling Action Plan for Scotland that by 2020, 10% of everyday journeys will be made by bike." **(CAFS T3 2015)**

Fife has one of the UK's most comprehensive cycling networks. Over 350 miles of sign posted cycle network including a variety of leisure and commuting routes. Terrain varies from off road disused railway tracks to routes in forests and from networks in towns and networks in quiet country lanes.

Cycling is promoted through encouraging active schools and as discussed above in the Hands Up Scotland survey which shows an increase of Primary school age children cycling to school (from 3.2% in 2019 to 4% in 2020). Cycling is further promoted within schools via the Bikeability scheme. Due to the impacts of Covid-19 different ways of promoting active travel and improving awareness of Bikeability training at schools had to be sought. Up to March 2020 the number of pupils signed up to take part across Levels 1, 2 and 3 were:

- Level 1 – 1,372 pupils from 29 schools (1,372 pupils have completed)
- Level 2 – 766 pupils from 24 schools (766 pupils have completed)
- Level 3 – 0 pupils

CTA training was offered in 2019/20 and has now been replaced by Bikeability Scotland Instructor (BSI) Training which is offered to all schools within Fife and delivered at specific schools who request it. Up to March 2021 the number of pupils signed up to take part in BSI Training was:

- 36 pupils from 6 schools

2.2.6 Work with key partners to investigate the use of hydrogen as a transport fuel-T10

"Work with key partners to investigate the use of hydrogen as a transport fuel, as well as exploring wider environmental and economic opportunities of using hydrogen for energy applications – especially in promoting renewables, energy balancing and storage." **(CAFS T10 2015)**

Hydrogen and fuel cell (HFC) technologies can provide services throughout Scotland's energy system and is becoming widely recognised as a key catalyst to decarbonising Scotland's energy production and use, with an emphasis on an integrated approach to transport as well as heat and power.

One of Scotland's leading forces behind making this a reality is Fife through its pioneering Levenmouth Community Energy Project, a collaborative initiative which is being led by Bright Green Hydrogen and supported by a number of partners including Fife Council and Toshiba.

There continues to be issues with the funding available for Bright Green Hydrogen and as such there have been issues with the supply of hydrogen for vehicle refuelling purposes.

Alternative uses for the hydrogen are however continuing to be explored in terms of it potentially being used to heat local homes. SGN is looking to progress the feasibility of zero carbon hydrogen generation from offshore wind in Fife through the Hydrogen 100 project which aims to lay the foundations for this change while giving residents in the Levenmouth area the opportunity to be at the leading edge of the low-carbon economy. These proposals (H100) have now been approved by Ofgem and SGN says that customers in Fife will be the first in the world to heat their homes and cook their food using 100% zero-

carbon hydrogen. Participating customers will use hydrogen boilers, heaters and cooking appliances during the 4.5 year initial trial and phase one of the project will connect an initial 300 homes in Levenmouth to a new hydrogen supply network from the end of 2022, with the potential expansion of up to 1,000 homes following a successful completion of phase one of the project. H100 hope to deliver the critical evidence to prove hydrogen as a viable and zero-carbon alternative to heat the roughly 23 million homes across the UK currently fitted with natural gas boilers.

Below is a link to a useful video that discusses the H100 project proposals
https://youtu.be/MDS6NFBrGX4

2.2.7 Freight Quality Partnerships-T12

"Encourage each local authority with an AQMA to create a Freight Quality Partnership (or utilise an existing RTP Freight Quality Partnership) and consider appropriate measures for local air quality improvement by 2017." **(CAFS T12 2015)**

Fife Council continues to explore the potential to develop Freight Quality Partnerships through the on-going implementation of the Fife ECO Stars Fleet and Taxi schemes which includes the running of future workshop events with key stakeholders.

2.3 Progress and Impact of Action Plan Measures

The Bonnygate AQAP aims to work towards reducing transport emissions of NOx and PM_{10} in the AQMA by approximately 53% and 33% respectively; using a wide range of measures such as road and traffic signalling improvements combined with other measures, for example behaviour-change.

The Appin Crescent AQAP aims to work towards reducing transport emissions of NOx and PM_{10} in the AQMA by approximately 18% and 40% respectively; and as with the Bonnygate AQAP will involve a combination of road layout and traffic signalling improvements combined with many other measures.

In April 2015 a review and update of both the Appin Crescent and Bonnygate Air Quality Action Plans was completed by Fife Council. A brief summary of the new measures incorporated into both action plans as a result of the AQAP review are provided in Table 2.2 and Table 2.3. Further details of the AQAP's and their progress are detailed in Table 2.6 and Table 2.7.

Fife Council are in the process of updating both AQAPs which will allow new measures to be considered for implementation. These AQAP updates will align with the Air Quality Strategy (also in the process of being updated) as well as the recently completed NLEF LEZ screenings undertaken for both AQMAs. The updated AQAPs and Air Quality Strategy are due for release later in 2021 and will run from 2021 to 2025 in accordance with LAQM guidance.

Table 2.2 New measures included within the Bonnygate Air Quality Action Plan (2015)

No.	Measure	Timescale
1	Fife ECO Stars	Short Term
2	Fife Council Air Quality Strategy 2015-2020	Short Term
3	Air Quality and Planning Toolkit	Short Term

Table 2.3 New measures included within the Appin Crescent Air Quality Action Plan (2015)

No.	Measure	Timescale
1	Fife ECO Stars	Short Term
2	Fife Council Air Quality Strategy 2015-2020	Short Term
3	Air Quality and Planning Toolkit	Short Term
4	Cost-Benefit-Analysis of options to improve air quality within Appin Crescent	Short Term
5	Proposed air dispersion modelling study of the potential Dunfermline Northern Link Road	Short Term

2.3.1 Completed Measures

Fife Council has taken forward a number of measures during the current reporting year of 2020 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.6 for Bonnygate, Cupar and Table 2.7 for Appin Crescent, Dunfermline. The tables summarise progress to date on each of the measures within the AQAP. More details on these measures can be found in the relevant AQAP and Fife Council's Air Quality Strategy 2015-2020 available on the Council's website at www.fife.gov.uk/airquality . The AQAPs and the Air Quality Strategy are in the process of being updated.

Key completed measures include the installation of new traffic management systems within Bonnygate, Cupar which began in 2009. This included a new pedestrian crossing on the Bonnygate and a new twin mini roundabout system implemented at St Catherine Street/East Bridge to ease the flow of traffic through Cupar, thus reducing congestion.

Within the Appin Crescent AQMA, revised lane markings and signage were introduced in March 2013. These measures have resulted in a reduction in NO_2 concentrations on the south side of Appin Crescent. The AQAP outlines the consideration of a bypass and a feasibility study was commissioned to determine if this would be an option to reduce pollutant concentrations within Appin Crescent. The feasibility study suggested that the proposed bypass would achieve the reduction required in pollutant

concentrations to reach the statutory annual mean objectives. However, no funding is currently available for this option and Fife Council are considering alternative traffic management options that will result in similar reductions whilst being more cost effective and practicable to apply.

As progress on the action plan measures for Cupar and Dunfermline continues to advance, a number of measures have now been completed - these are summarised in Table 2.4. Similarly, as the action plan measures have been advanced, certain measures have been discounted from further consideration. Details on discounted measures are summarised in Table 2.5.

Table 2.4 Completed AQAP Measures

No.	Measure	Comments
Bonnygate, Cupar		
4	Implementation of new Urban Traffic Management and Control system and changes to pedestrian crossings	New pedestrian crossing installed at Bonnygate and twin mini roundabout scheme implemented at St Catherine Street/East Bridge.
Appin Crescent, Dunfermline		
2	Feasibility study	Feasibility studies (2015 and 2016) and a Cost Benefit Analysis report in 2016 have been produced and considered by the AQ Steering Group. It has been concluded from these studies that the options considered to date are not cost effective, feasible or acceptable as defined in AQAP evaluation criteria. Focus is now on the delivery of the Northern Link Road to the north of Dunfermline in terms of seeking air quality improvements in the Appin Crescent AQMA.
6	Traffic Management optimisation (dependent on feasibility study)	
15	Cost-benefit analysis of traffic management options to improve air quality within Appin Crescent.	

2.3.2 Discounted Measures

Table 2.5 Discounted AQAP Measures

No.	Measure	Justification
Bonnygate, Cupar		
8	AQMA Awareness Signs	Measure has been discounted based on the grounds of cost effectiveness, practicability feasibility and acceptability to members of the public.
Appin Crescent, Dunfermline		
12	Consideration of development of Appin Crescent bypass (Dependent upon feasibility study)	Based on the findings of the feasibility study, the Air Quality Steering Group considers that this option is not as cost effective, practicable and feasible relative to the introduction of the Northern Link Road in Dunfermline

Table 2.6 Progress on Measures to Improve Air Quality- Bonnygate, Cupar

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
1	Liaise with Scottish Government to encourage the consideration of national measures Implementation Phase: Ongoing	Policy guidance and development control	Increase focus on background concentrations of PM and encourage national action	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Maintain contact with the Scottish Government regarding the adoption of national air quality measures.	Low KPI's to be developed in liaison with Scottish Government	Fife Council continues to attend and contribute to air quality seminars, training events and pollution liaison group meetings where national air quality measures are discussed.
2	Improving links with Local Transport Strategy/ Area Transport Plan Implementation Phase: Ongoing	Policy guidance and development control	Measures to ensure the air quality in the AQMA is improved where possible and to avoid future problems are implemented via the Local Transport Strategy.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Reference to Bonnygate AQMA and measures included in Air Quality Action Plan. Integration of plan with Local Transport Strategy.	Low	Fife Council Air Quality Steering Group outputs continue to contribute to the development of Fife Council's Local Transport Strategy/Area Transport Plan and are to be incorporated in future revisions of these strategies/plans.
3	Improving Air Quality Links with local Planning and Development Framework Implementation Phase: Ongoing	Policy guidance and development control	Local planning considerations aim to mitigate the cumulative negative air quality impacts of new development	Fife Council	Fife Council Air Quality Steering Group outputs are contributing to the development of Fife Council Local Transport Strategy/Area Transport Plan and are to be incorporated in future revisions of these strategies/plans.	Ensure that development proposals with the potential to exert an impact on the Bonnygate AQMA are assessed for air quality impacts and where necessary, appropriate mitigation measures considered.	Medium	The Low Carbon Fife Supplementary Guidance was adopted in January 2019 and now forms a statutory part of the Local Development Plan (FIFEplan). This guidance incorporates the Fife Council Air Quality Developers Guide. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan). Fife Council Air Quality Developers Guide has recently been updated and is available at www.fife.gov.uk/airquality. Fife Council Protective Services intends to run air quality training sessions for planning colleagues. The Fife Council Air Quality Strategy is in the process of being finalised and will cover from 2021 to 2025.
4	Integrate AQ with other Council Strategies Implementation Phase: Ongoing	Policy guidance and development control	Encourage opportunity for contributions towards improving local air quality and minimising negative impacts from existing and future Council strategies. Increase awareness of local air quality	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Continue and enhance joint working between Council Services and other Partnership Organisations to encourage potential air quality implications of existing and future Council strategies. Implementation of the relevant AQS objectives	Low	Submission of AQ grant application for 2021-2022 includes submissions for climate change related measures. The Scottish Government '*expect any Scottish local authority which has or is currently developing a Sustainable Energy [Climate] Action Plan to ensure that air quality considerations are covered, (Clean Air for Scotland – The Road to a Healthier Future 2015, P21*)'. On February 6th 2020, Fife Council's Environment and Protective Services Committee approved the Sustainable Energy Climate Action Plan - *Climate Fife*. https://www.fife.gov.uk/kb/docs/articles/environment2/climate-change,-carbon-and-energy Climate Fife includes a practical action plan for mitigation activities and a Risk and Vulnerability Assessment to outline the challenge for adaption action. The response to Covid-19 has limited the full scale of action planned for the first year of Climate Fife. Work is continuing to strengthen how the Climate Emergency is addressed in the Plan for Fife - the Local

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
								Outcome5Improvement Plan, with a revised version anticipated late 2021. As part of the response to Covid-19 the Council is undertaking work on Reform and Recovery, with responding to the Climate Emergency as an agreed theme. Additionally, the Climate Change and Zero Waste team have moved into the Planning Service to further strengthen action in this area. This demonstrates how responding to the Climate Emergency is seen as core to the work moving forward in Fife. Air Quality and linked low carbon emissions actions are covered under the Sustainable Transport theme in the Climate Fife Action Plan. Fife Council is already progressing early actions for Climate Fife. Fife Councils Land & Air Quality Team continues to work closely with the Council's Climate Change team to ensure air quality is considered.
5	Implementation of new Urban Traffic Management and Control system and changes to pedestrian crossings Implementation Phase: Completed and monitoring ongoing	Policy guidance and development control	Improve efficiency of transit through Cupar Town Centre and reduce emissions from road traffic sources within the Bonnygate street canyon. Installation of traffic management system.	Fife Council	2009	Pollutant reduction in AQMA. AQ monitor will continue to confirm the effectiveness of the measures.	Decline in NO_2 and PM_{10} concentrations within Bonnygate, monitoring to continue until trend has emerged. Pollutant concentrations can vary annually due to meteorological influences.	Completed and monitoring ongoing
6	Travel Plans for Large Institutions and Businesses Implementation Phase: Ongoing	Promoting travel alternatives	To encourage a shift to more sustainable forms of travel or reducing the need for travel.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Continue the implementation of Fife Council's travel plan. Undertake Council Travel surveys	Low	Transportation department continuing to support schools in updating and developing School specific travel plans. Education and Children's Services now a member of Fife Core Air Quality Steering Group. Continue to actively promote sustainable travel to school, including initiatives such as Bikeability and WOW (Walk Once a Week) although Covid-19 has created some issues with uptake levels over 2020. Continue the implementation of Fife Council's Travel Plan.
7	Promotion of Travel Choices Implementation Phase: Ongoing	Promoting travel alternatives	Discourage long stay commuter parking as part of the Fife Council's Parking Strategy. To increase awareness of travel choices and encourage changes in behaviour that will contribute to improving local air quality.	Fife Council	As outlined in the aims and objectives of Councils Air Quality Strategy	To improve integration between cycling, walking and public transport. To continue to liaise with Scottish Government in the production of KPIs for this action plan measure.	Low	Grant application for 2021-22 includes 9 new traffic counters with 9 obtained in 2020-21 through grant funding also. The provision of these traffic counters will further aid in tracking changes in vehicle use throughout Fife. Adopted FIFEplan policy 11 requires new development to encourage and facilitate the use of sustainable transport appropriate to the development, promoting in the following order of priority: walking, cycling, public transport, cars. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan). Continue to actively promote sustainable travel to school, including initiatives such as Bikeability and WOW (Walk Once a Week) although Covid-19 has created some issues with uptake levels over 2020.
8	Target reduced localised emissions from freight.	Freight and delivery management	Improve efficiency of transit through the AQMA and facilitate reduced emissions.	Fife Council	As outlined in the aims and objectives of Councils Air Quality Strategy	Pollution reduction in AQMA	Medium	Continue to engage with HDV Fleet operators through the ongoing roll out of the Fife ECO Stars scheme.

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
	Implementation Phase: Ongoing							
9	AQMA Awareness Signs Implementation Phase: N/A	Public information	To increase awareness of the Bonnygate AQMA and encourage behavioural change.	Fife Council	N/A	Authorisation, design, procurement and installation	Low	Measure has been discounted based on the grounds of cost effectiveness, practicability, feasibility and acceptability to members of the public.
10	Provision of Information relating to Air Quality Implementation Phase: Ongoing	Public information	To increase awareness of local air quality issues and encourage changes in behaviour that will contribute to improving local air quality.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Production of booklet – travel pack Publication of LAQM reports	Low	This information is covered by the Low Carbon Fife Supplementary Guidance adopted in January 2019 and now forms a statutory part of the Local Development Plan (FIFEplan). This guidance incorporates the Fife Council Air Quality Developers Guide. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan). Fife Council Air Quality Developers Guide has recently been updated and is available at www.fife.gov.uk/airquality The Fife Council Air Quality Strategy is in the process of being finalised and will cover from 2021 to 2025.
11	Parking Management and Control Implementation Phase: Short – Medium Term	Traffic management	Reduce traffic by discouraging long stay parking and associated commuting movements. Minimise impacts of commercial deliveries on traffic movement.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Pollutant reduction in AQMA	Low	Continue to evaluate parking management measures within the Bonnygate AQMA.
12	Promotion pf Cycling and Walking Implementation Phase: Ongoing	Promoting travel alternatives	To encourage a shift away from the use of private motor vehicles for travelling to more sustainable forms of transport or reducing the need for travel.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Number/length of cycling and walking routes developed.	Low	Adopted FIFEplan policy 11 requires new development to encourage and facilitate the use of sustainable transport appropriate to the development, promoting in the following order of priority: walking, cycling, public transport, cars. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan). Continue to actively promote sustainable travel to school, including initiatives such as Bikeability and WOW (Walk Once a Week) although Covid-19 has created some issues with uptake levels over 2020.
13	Review and support proposed infrastructure changes that will contribute to delivering improvements in local air quality Implementation Phase: Long Term/Ongoing	Transport planning and infrastructure	Support Council proposals for infrastructure changes that will facilitate improvements in vehicle movements within Cupar. (Confirm that proposals will be subject to suitable environmental assessments).	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Pollutant Reduction in AQMA	High	Results from the AQMesh pods installed on the southern side of the Bonnygate in December 2017 to be reported within this 2021 APR. This AQMesh pod continue to provide additional monitoring data from within the AQMA in relation to any recent and future development works in the vicinity. Monitoring from this AQMesh pod will continue over 2021 and will be reported within the 2022 APR.

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
14	Target reductions in emissions from the Council fleet and contract vehicles (including driver training) Implementation Phase: Ongoing	Vehicle fleet efficiency	Target reduced emissions from Council fleet vehicles and Council contract fleet vehicles operating within the Cupar AQMA.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Fife Council tender specification outlines that all new vehicles must have the latest gas recyclable exhaust and catalyst systems fitted. Number of vehicles in fleet. Number of electric and hydrogen powered vehicles in fleet.	Medium	By the end of 2020/21 Fife Council had 52 full electric vehicles and 19 hybrid vehicles in service (either leased or purchased). The size of the Fife Council fleet decreased slightly in 2020 and now stands at 1,518 (was 1,544 in 2019). Total diesel use for 2019/20 was 3,695,117 litres (a reduction of 169,005 litres on 2018/19). Despite a reduced diesel usage the mileage covered by the Council Fleet was shown to have increased over the 2019/20 period with the total mileage covered increasing from 11,715,613 in 2018/19 to 12,352,481 in 2019/20 which will be associated with an increased uptake and use of electric and hybrid vehicles within the Council Fleet.
15	Target reductions in emissions from buses Implementation Phase: Ongoing	Vehicle fleet efficiency	Target reduced emissions from buses operating within the Bonnygate AQMA.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Establish a bus quality partnership Increase in fleet using alternative fuel	Medium	Continue to encourage bus operators to recognise the importance of air quality and climate change issues through the Fife ECO Stars scheme and to explore the potential to set up voluntary bus agreements through interaction with local bus operators through the ongoing Fife ECO Stars recruitment process. As of May 2021 there are now 59 bus operators within the ECO Stars scheme covering 1,336 vehicles.
16	Fife ECO Stars Implementation Phase: Ongoing	Vehicle fleet efficiency	Encourage operators of buses, coaches, HGVs and LDVs to sign up to voluntary scheme which encourages and promotes 'clean operators'	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Develop and promote Fife ECO Stars, a new green recognition scheme aiming to tackle air pollution from transport.	Medium	As of May 2021 the Fife Commercial Membership grew to 254 members covering a total of 9,127 vehicles. The requirement for all school and social work contract operators to become members of ECOStars continues to result in increased membership of the Taxi & Private Hire Membership with the figures now standing at 141 members and 575 vehicles. ECOStars continues to be supported by the Scottish Government.
17	Air Quality and Planning Toolkit Implementation Phase: Short Term 2020	Policy guidance and development control	Facilitate the consideration of the potential air quality impacts of developments across Fife, but notably near existing AQMAs	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Develop a GIS based dispersion modelling toolkit to assist planners and other local authority officers in the consideration of the air quality issues in the development management process.	Medium	The Regional RapidAir™ Dispersion Model was recently updated with local validations carried out for each of the main towns in Fife for NO_2 (Cupar, Dunfermline, Rosyth, Kirkcaldy and St Andrews). This continues to be of use in terms of allowing the Council to consider air quality issues in the development management process.
18	Air Quality Strategy 2015-2020 and 2021-2025 Implementation Phase: Ongoing 2020	Policy guidance and development control	Increase awareness of local air quality issues and promote good practice in reducing emissions of air quality pollutants.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Develop and adopt an Air Quality Strategy that aims to raise awareness of air quality issues and to promote some of the existing best practice work that the Council has undertaken within existing AQMAs to other parts of Fife.	High	See measures 1-16. These are considered to be consistent with the aims/objectives of Scottish Government Cleaner Air Quality Strategy for Scotland 2015 including the List of Actions in Chapter 14 of this document. The Fife Council Air Quality Strategy is in the process of being finalised and will cover from 2021 to 2025. This update will align with the Bonnygate AQAP update which is also in the process of being finalised and will also cover from 2021 to 2025.

Table 2.7 Progress on measures to Improve Air Quality- Appin Crescent, Dunfermline

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
1	Liaise with Scottish Government to encourage the consideration of national measures Implementation Phase: Ongoing	Policy guidance and development control	Increase focus on background concentrations of PM and encourage national action	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Maintain contact with the Scottish Government regarding the adoption of national air quality measures.	Low KPI's to be developed in liaison with Scottish Government	Fife Council continues to attend and contribute to air quality seminars, training events and pollution liaison group meetings where national air quality measures are discussed.
2	Feasibility study Implementation Phase: Completed	Transport planning and infrastructure	To adopt a strategic approach to air quality in Appin Crescent and undertake a detailed assessment of the feasibility and impacts of proposed infrastructure and traffic management measures.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Undertake a feasibility study to assess the potential impact of local infrastructure developments and traffic management optimisation on air quality in Appin Crescent.	Low to Medium	Completed
3	Improving links with Local Transport Strategy/ Area Transport Plan Implementation Phase: Ongoing	Transport planning and infrastructure	Measures to ensure the current poor air quality in the AQMA is improved where possible and to avoid future problems are implemented via the Local Transport Strategy.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Reference to Appin Crescent AQMA and measures included in Air Quality Action Plan. Integration of plan with Local Transport Strategy.	Low	Fife Council Air Quality Steering Group outputs continue to contribute to the development of Fife Council's Local Transport Strategy/Area Transport Plan and are to be incorporated in future revisions of these strategies/plans.
4	Improving Air Quality links with Local Planning and Development Framework Implementation Phase: Ongoing	Policy guidance and development control	Local planning considerations aim to mitigate the cumulative negative air quality impacts of new development	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Integration of Appin Crescent AQAP with future versions of Local Plan. Maintain and make available - air quality guidance notes for developers.	Medium	The Low Carbon Fife Supplementary Guidance was adopted in January 2019 and now forms a statutory part of the Local Development Plan (FIFEplan). This guidance incorporates the Fife Council Air Quality Developers Guide. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan). Fife Council Air Quality Developers Guide has recently been updated and is available at www.fife.gov.uk/airquality Fife Council Protective Services intends to run air quality training sessions for planning colleagues. The Fife Council Air Quality Strategy is in the process of being finalised and will cover from 2021 to 2025.
5	Integrate Air Quality with other Council Strategies Implementation Phase: Ongoing	Policy guidance and development control	Encourage opportunity for contributions towards improving local air quality and minimising negative impacts from existing and	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Maintain regular and ongoing communication between members of the Appin Crescent AQAP steering group.	Low	Submission of AQ grant application for 2021-2022 includes submissions for climate change related measures. The Scottish Government '*expect any Scottish local authority which has or is currently developing a Sustainable Energy [Climate] Action Plan to ensure that air quality considerations are covered, (Clean Air for Scotland – The Road to a Healthier Future 2015, P21*)'.

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
			future Council strategies. Increase awareness of local air quality.					On February 6th 2020 Fife Council's Environment and Protective Services Committee approved the Sustainable Energy Climate Action Plan - *Climate Fife*. https://www.fife.gov.uk/kb/docs/articles/environment2/climate-change,-carbon-and-energy Climate Fife includes a practical action plan for mitigation activities and a Risk and Vulnerability Assessment to outline the challenge for adaption action. The response to Covid-19 has limited the full scale of action planned for the first year of Climate Fife. Work is continuing to strengthen how the Climate Emergency is addressed in the Plan for Fife - the Local Outcome Improvement Plan, with a revised version anticipated late 2021. As part of the response to Covid-19 the Council is undertaking work on Reform and Recovery, with responding to the Climate Emergency as an agreed theme. Additionally, the Climate Change and Zero Waste team have moved into the Planning Service to further strengthen action in this area. This demonstrates how responding to the Climate Emergency is seen as core to the work moving forward in Fife. Air Quality and linked low carbon emissions actions are covered under the Sustainable Transport theme in the Climate Fife Action Plan. Fife Council is progressing early actions for Climate Fife. Fife Councils Land & Air Quality Team continues to work closely with the Council's Climate Change team to ensure air quality is considered.
6	Traffic Management optimization (dependant on feasibility study) Implementation Phase: Completed	Traffic management	Reduce traffic queuing within the AQMA through the optimisation of the Traffic management system.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Optimisation of the traffic management system at Appin Crescent and the surrounding network. Progress of this action is dependent on the conclusions of the feasibility study.	High	Completed
7	Travel Plans for large Institutions and Businesses Implementation Phase: Ongoing	Transport planning and infrastructure	To encourage a shift to more sustainable forms of travel or reducing the need for travel.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Continue the implementation of Fife Council's travel plan Undertake Council travel surveys	Low	Transportation department continuing to support schools in updating and developing School specific travel plans. Education and Children's Services now a member of Fife Core Air Quality Steering Group. Continue to actively promote sustainable travel to school, including initiatives such as Bikeability and WOW (Walk Once a Week) although Covid-19 has created some issues with uptake levels over 2020. Continue the implementation of Fife Council's Travel Plan.
8	Provision of Information and promotion of travel options Implementation Phase: Ongoing	Promoting travel alternatives	To increase awareness of travel choices and encourage changes in behaviour that will contribute to improving local air quality.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	To improve integration between cycling, walking and public transport. Produce Travel Choices facility for Dunfermline. Undertaking Travel Marketing in Dunfermline.	Low	Grant application for 2021-22 includes 9 new traffic counters with 9 obtained in 2020-21 through grant funding also. The provision of these traffic counters will further aid in tracking changes in vehicle use throughout Fife. Adopted FIFEplan policy 11 requires new development to encourage and facilitate the use of sustainable transport appropriate to the development, promoting in the following order of priority: walking, cycling, public transport, cars. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan).

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
								Continue to actively promote sustainable travel to school, including initiatives such as Bikeability and WOW (Walk Once a Week) although Covid-19 has created some issues with uptake levels over 2020.
9	Provision of information relating to Air Quality Implementation Phase: Ongoing	Public information	To increase awareness of local air quality issues and encourage changes in behaviour that will contribute to improving local air quality.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Continue to make information relating to local air quality management available through the Council website.	Low	This information is covered by the Low Carbon Fife Supplementary Guidance adopted in January 2019 and now forms a statutory part of the Local Development Plan (FIFEplan). This guidance incorporates the Fife Council Air Quality Developers Guide. Initial preparatory work is on-going as of May 2021 in relation to reviewing the Local Development Plan (FIFEplan). Fife Council Air Quality Developers Guide has recently been updated and is available at www.fife.gov.uk/airqaulity The Fife Council Air Quality Strategy is in the process of being finalised and will cover from 2021 to 2025.
10	Target reductions in emissions from the Council fleet and contract vehicles (including driver training) Implementation Phase: Ongoing	Vehicle fleet efficiency	Target reduced emissions from Council fleet vehicles and Council contract fleet vehicles.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Monitor and assess viable options for alternative fuels, technologies and fuel additives. Fife Council tender specification outlines that all new vehicles must have exhaust trap and filtration systems. Number of vehicles in Council fleet Number of electric and hydrogen powered vehicles in Council fleet	Medium	By the end of 2020/21 Fife Council had 52 full electric vehicles and 19 hybrid vehicles in service (either leased or purchased). The size of the Fife Council fleet decreased slightly in 2020 and now stands at 1,518 (was 1,544 in 2019). Total diesel use for 2019/20 was 3,695,117 litres (a reduction of 169,005 litres on 2018/19). Despite a reduced diesel usage the mileage covered by the Council Fleet was shown to have increased over the 2019/20 period with the total mileage covered increasing from 11,715,613 in 2018/19 to 12,352,481 in 2019/20 which will be associated with an increased uptake and use of electric and hybrid vehicles within the Council Fleet.
11	Investigate the potential for establishing voluntary bus agreements Implementation Phase: Ongoing	Promoting travel alternatives	Target reduced emissions from buses operating within the Appin Crescent AQMA.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Liaise with bus operators regarding emissions from the bus fleet and improvements to bus service infrastructure. Bus quality agreement similar to P&R at Ferrytoll, link to Forth Road Bridge Replacement crossing.	Low	Continue to encourage bus operators to recognise the importance of air quality and climate change issues through the Fife ECO Stars scheme and to explore the potential to set up voluntary bus agreements through interaction with local bus operators through the ongoing Fife ECO Stars recruitment process. As of May 2021 there are now 59 bus operators within the ECO Stars scheme covering 1,336 vehicles.
12	Consideration of development of Appin Crescent bypass (Dependent upon feasibility study) Implementation Phase: Completed	Transport planning and infrastructure	If determined to be feasible, the development of a bypass at Appin Crescent may be a potential option to facilitate a reduction the traffic volume passing through the AQMA and consequently, contribute to lower emissions.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Development of an Appin Crescent bypass.	High	Completed
13	Fife ECO Stars Implementation Phase: Ongoing	Vehicle Fleet Efficiency in HGV and Taxi Fleets	Encouraging local fleet operators to introduce fleet management systems that improve air quality	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Number of ECO Stars members	Medium	As of May 2021 the Fife Commercial Membership grew to 254 members covering a total of 9,127 vehicles. The requirement for all school and social work contract operators to become members of ECOStars continues to result in increased membership of the Taxi & Private Hire Membership with the figures now standing at 141 members and 575 vehicles.

Measure No.	Measure	Category	Focus	Lead Authority	Planning Phase	Key Performance Indicator	Target Pollution Reduction in the AQMA	Progress to Date (May 2021)
								ECOStars continues to be supported by the Scottish Government.
14	Air Quality and Planning Toolkit Implementation Phase: Ongoing 2020	Development Control	Ensure future development does not compromise achievement of statutory air quality objectives	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Develop a GIS based dispersion modelling toolkit to assist planners and other local authority officers in the consideration of the air quality issues in the development management process.	Medium	The Regional RapidAir™ Dispersion Model was recently updated with local validations carried out for each of the main towns in Fife for NO_2 (Cupar, Dunfermline, Rosyth, Kirkcaldy and St Andrews). This continues to be of use in terms of allowing the Council to consider air quality issues in the development management process.
15	Cost-benefit analysis of traffic management options to improve air quality within Appin Crescent Implementation Phase: Completed	Traffic Management	Evaluation of short to medium term traffic management measures to improve air quality	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	CBA analysis outcomes of two traffic management options	Low to Medium	Completed
16	Proposed Air Dispersion modelling study of the potential Dunfermline Northern Link Road Implementation Phase: Ongoing 2020 (Initial dispersion modelling report produced in 2016 and updated to reflect latest road vehicle emissions factors in 2017).	Traffic Management	Estimate the impact of the proposed northern link road and the proposed Dunfermline strategic land allocation (SLA) zones	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Carry out Air Quality dispersion modelling to quantify the impacts of the proposed Northern Link.	High	Results from the two AQMesh pods installed on the southern side of Appin Crescent in December 2017 are reported within this 2021 APR. These AQMesh pods continue to provide additional monitoring data from within the AQMA in relation to any recent and future developments works in the vicinity. Monitoring from these AQMesh pods will continue over 2021 and will be reported within the 2022 APR. The initial dispersion modelling report which was produced in 2016 and updated to reflect latest road vehicle emissions factors in 2017 can be updated as required should development proposals be subject to change.
17	Air Quality Strategy for Fife 2015-2020 and 2021-2025 Implementation Phase: Ongoing 2020	Strategy	Increase awareness of local air quality issues and promote good practice in reducing emissions of air quality pollutants.	Fife Council	As outlined in the aims and objectives of Council's Air Quality Strategy	Develop and adopt an Air Quality Strategy that aims to raise awareness of air quality issues and to promote some of the existing best practice work that the Council has undertaken within existing AQMAs to other parts of Fife.	High	See measures 1-16. These are considered to be consistent with the aims/objectives of Scottish Government Cleaner Air Quality Strategy for Scotland 2015 including the List of Actions in Chapter 14 of this document. The Fife Council Air Quality Strategy is in the process of being finalised and will cover from 2021 to 2025. This update will align with the Appin Crescent AQAP update which is also in the process of being finalised and will also cover from 2021 to 2025.

2.3.3 Progress in Bonnygate AQMA

NO_2 concentrations at the automatic monitor within Bonnygate, Cupar have been declining steadily since 2007. Between 2015 and 2016 concentrations increased slightly before declining again up to and including 2020. NO_2 concentrations at the automatic monitoring station remain well within the NO_2 annual mean objective. Since 2007 NO_2 concentrations have reduced by 60% from 52 µg m^{-3} to 20.9 µg m^{-3}.

PM_{10} concentrations declined significantly between 2007 and 2009. In 2010 concentrations increased and remained consistent in 2011, before reducing slightly in 2012. From 2012 to 2014, concentrations steadily decreased to below the annual mean objective and continued to decrease until 2017 when they began to increase in 2018-19, but still remain below the objective. Concentrations dropped sharply in 2020 however this is likely due to the Covid-19 lockdown restrictions. Since measurements started in 2007 PM_{10} concentrations have reduced by 51% from 23 µg m^{-3} to 11.3 µg m^{-3}.

Automatic monitoring annual mean concentrations going back to 2007 for NO_2 and PM_{10} are shown in Figure 2-3 and Figure 2-4 respectively.

Figure 2-3 NO_2 Automatic Monitoring Results 2007-2020 – Bonnygate, Cupar

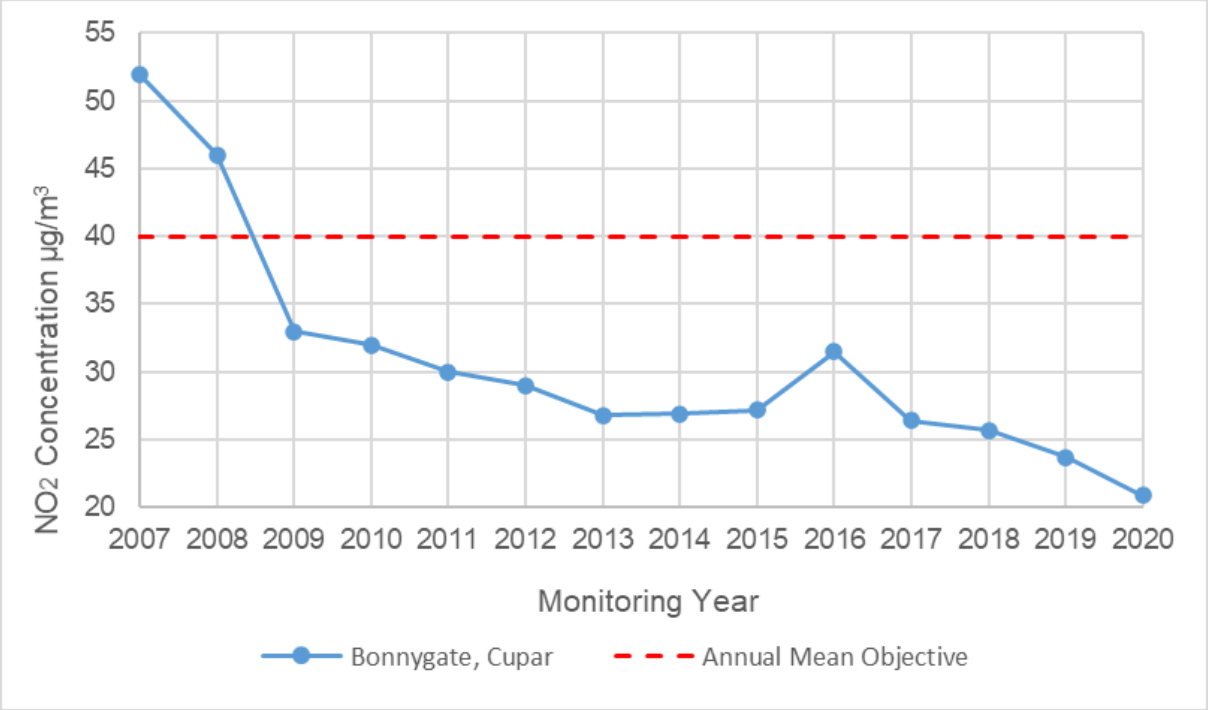
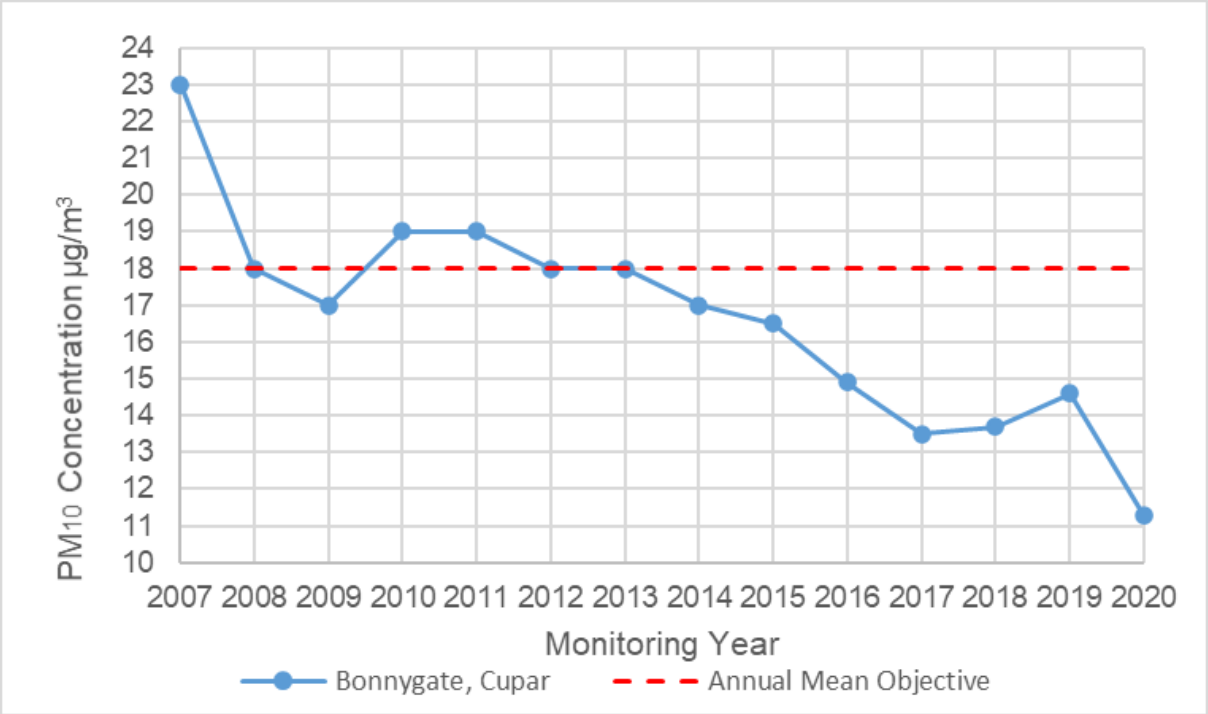


Figure 2-4 PM_{10} Automatic Monitoring Results 2007-2020 – Bonnygate, Cupar



2.3.4 Progress on Appin Crescent AQMA

NO_2 concentrations within Appin Crescent steadily decreased between 2007 and 2010; they increased slightly in 2011 and stayed consistent in 2012. Between 2012 and 2014 NO_2 concentrations dropped significantly. After a minor increase in 2015, concentrations continued to decrease steadily from 2015 until 2019 likely as a result of the Action Plan measures being implemented. Concentrations dropped sharply in 2020 however this sharp decrease is likely due to the Covid-19 lockdown restrictions. Since 2007, NO_2 concentrations have reduced by 52% from 31 µg m^{-3} to 14.8 µg m^{-3}.

PM_{10} concentrations increased from 2008 to 2010 to above the annual mean objective, before declining gradually until 2013. From 2013 until 2015 concentrations increased slightly before reducing significantly between 2015 and 2017. Since 2017 PM_{10} concentrations have increased slightly however staying well below the annual mean objective. Concentrations dropped sharply again in 2020 however this is likely due to the Covid-19 lockdown restrictions. Concentrations have remained below the annual mean objective since 2010. PM_{10} monitoring started in 2008 since then concentrations have reduced by 43% from 16 µg m^{-3} to 8.5 µg m^{-3}.

Automatic monitoring annual mean concentrations going back to 2007 for NO_2 and PM_{10} are shown in in Figure 2-5 and Figure 2-6 respectively.

Figure 2-5 NO_2 Automatic Monitoring Results 2007-2020 – Appin Crescent, Dunfermline

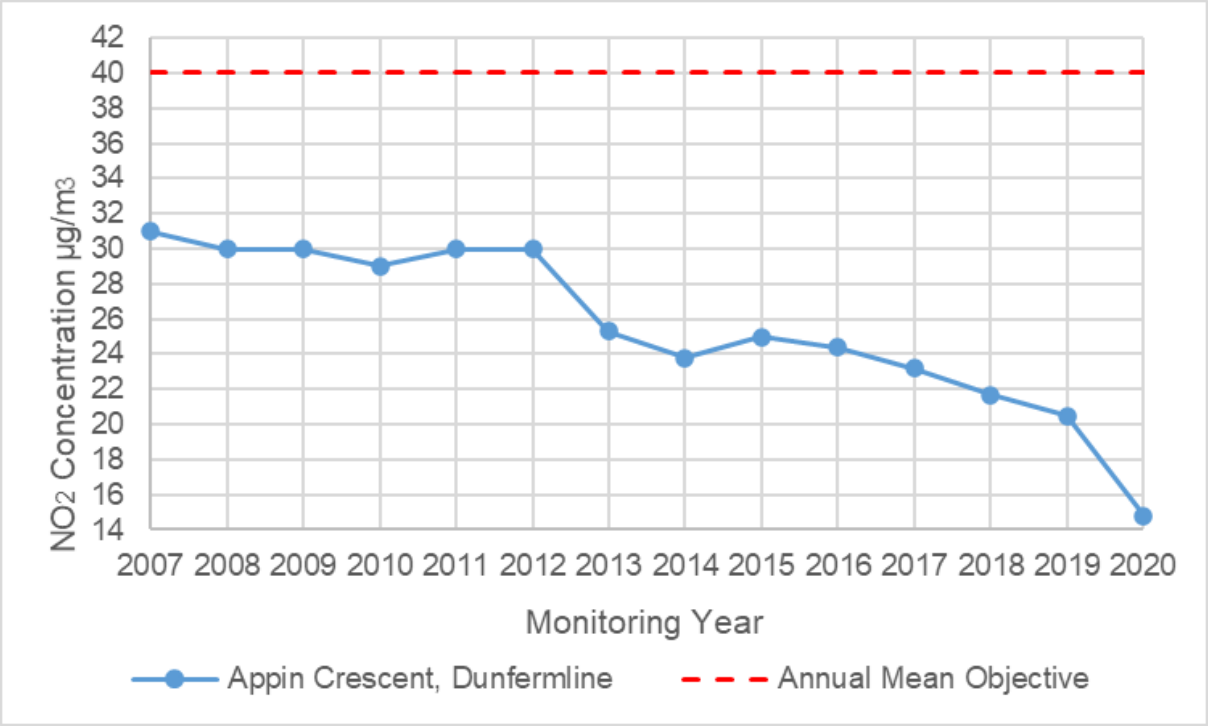
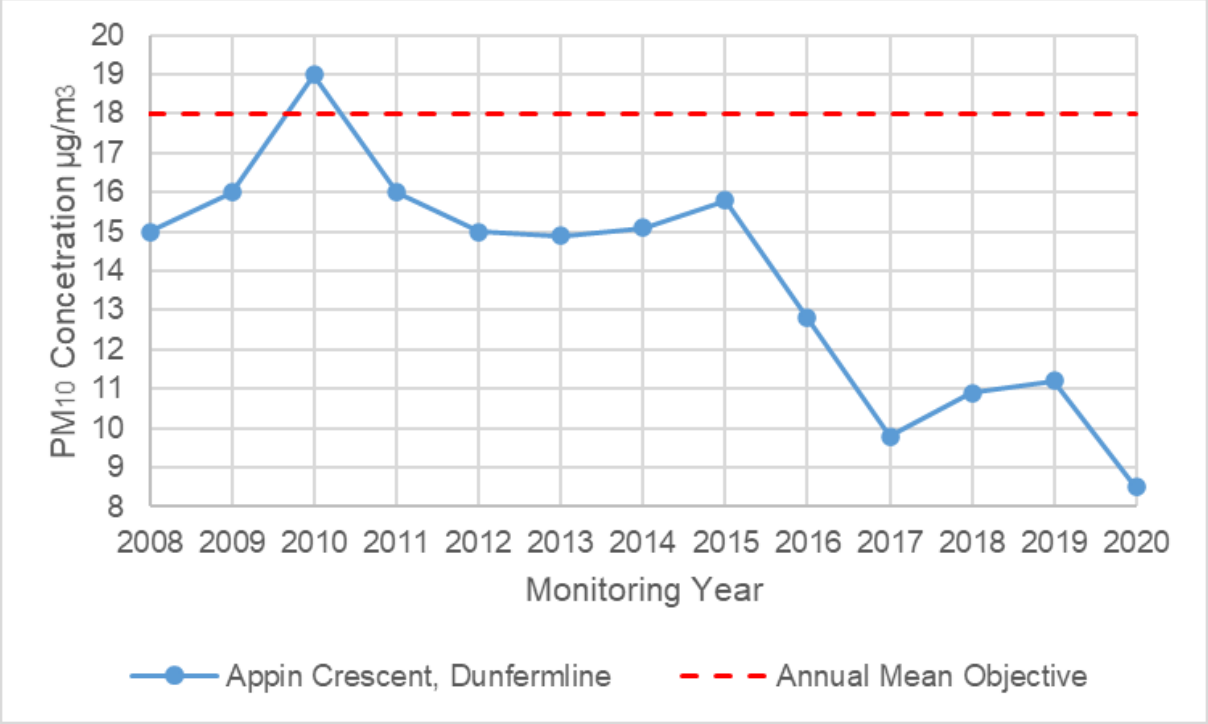


Figure 2-6 PM_{10} Automatic Monitoring Results 2007-2020 – Appin Crescent, Dunfermline



2.3.5 Fife ECO Stars Scheme

Fife's ECO Stars Fleet Recognition scheme and parallel ECO Stars Taxi and Private Hire scheme has continued to grow and expand membership despite the disruption of Covid-19 which has affected the operations of many Fife businesses as well as the ECO Stars recruitment and membership protocols. To continue to deliver the scheme safely and effectively, the ECO Stars team have adapted our processes to hold virtual meetings and communicate with our members via phone, video conferencing, and emails.

Since the Fife fleet scheme was initiated in 2014, membership has steadily increased year on year. Today, the fleet scheme has 257 members, made up of operators in the freight, bus and coach sectors, as well as many van fleets. Fife members operate a total of 9,266 vehicles.

As the scheme matures, there has been opportunity to celebrate milestone members. In 2020, Fife-based charity Furniture Plus was recognised as the scheme's 200th member and is to be awarded a commemorative plaque.

Alongside recruitment, there is an ongoing focus on supporting existing members. This is achieved through sharing relevant updates regarding advances in vehicle technology, local legislation (such as Low Emission Zone updates), case studies of best-practice fleet management, and notifications of useful events and online webinars. Such information is shared with ECO Stars members via email and other social media channels like the ECO Stars membership group on LinkedIn. We also regularly check in with individual members to hear their progress in implementing recommendations from their ECO Stars tailored fuel efficiency Road Map and receiving new fleet lists when vehicles are replaced. Maintaining an ongoing relationship with members is essential in guiding their progress toward fuel efficiency.

The requirement for all school and social work contract operators to become members of ECO Stars has resulted in a significant increase in membership numbers for the ECO Stars Taxi and Private Hire scheme. The scheme now has 146 members, operating 596 vehicles. This sector in particular has been keen to utilise the ECO Stars team's expertise in emerging low emission and low carbon vehicles. This is reflected in that 112 of the vehicles operated by this sector are rated under ECO Stars assessments as "5 Star Gold" or "5 Star Zero Emission Vehicle".

ECO Stars continues to be supported by the Scottish Government as part of its Clean Air Strategy.

2.3.6 Targeting emissions from Council Fleet

Fife Council continues to make good progress towards increasing the number of electric and hybrid vehicles within its Fleet and the installation of publicly available charging points. These actions have direct impacts on both the Bonnygate, Cupar and Appin Crescent, Dunfermline AQMAs and work towards reducing transport emissions as detailed in the AQAPs for both areas. By the end of the 2020/21 period Fife Council's Fleet Operations had 52 full electric vehicles and 19 hybrid vehicles in service including another adapted Nissan ENV200 which was obtained through Scottish Government funding in 2019/20 and will be used for the Meals on Wheels service and replaces an existing diesel vehicle previously used for the delivery and collection of meals for older and vulnerable members of society (Figure 2-7).

Figure 2-7 Photos of exterior and interior of Nissan ENV200 obtained via Scottish Government funding and adapted for use by Meals on Wheels service

In addition several new publicly available charge points were added to the network during 2020, including:

- Inverkeithing Train Station – Another 7kW charger, and;

- Lochore Meadows Country Park – One 22kW charger

The extent of the charging infrastruture within Fife is best viewed using the ChargePlace Scotland website (http://chargeplacescotland.org). Figure 2-8 to Figure 2-12 illustrate the ChargePlace Scotland website. The live map functionality on this site can allow the user to search for the location, type, status and availability of chargers within the Fife Council area. Examples of what can be viewed using the live map functionality is shown below indicating the current position of the network as of June 2021.

Figure 2-8 Extent of free to use chargers across Fife

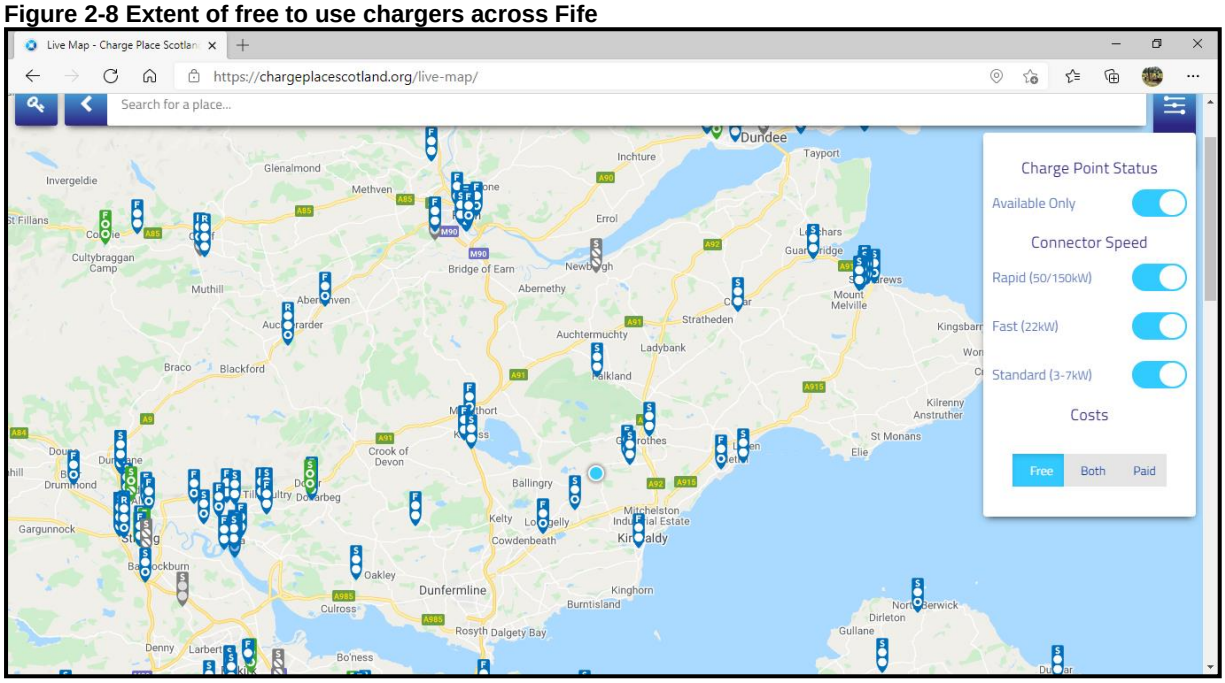


Figure 2-9 Extent of pay to use chargers across Fife

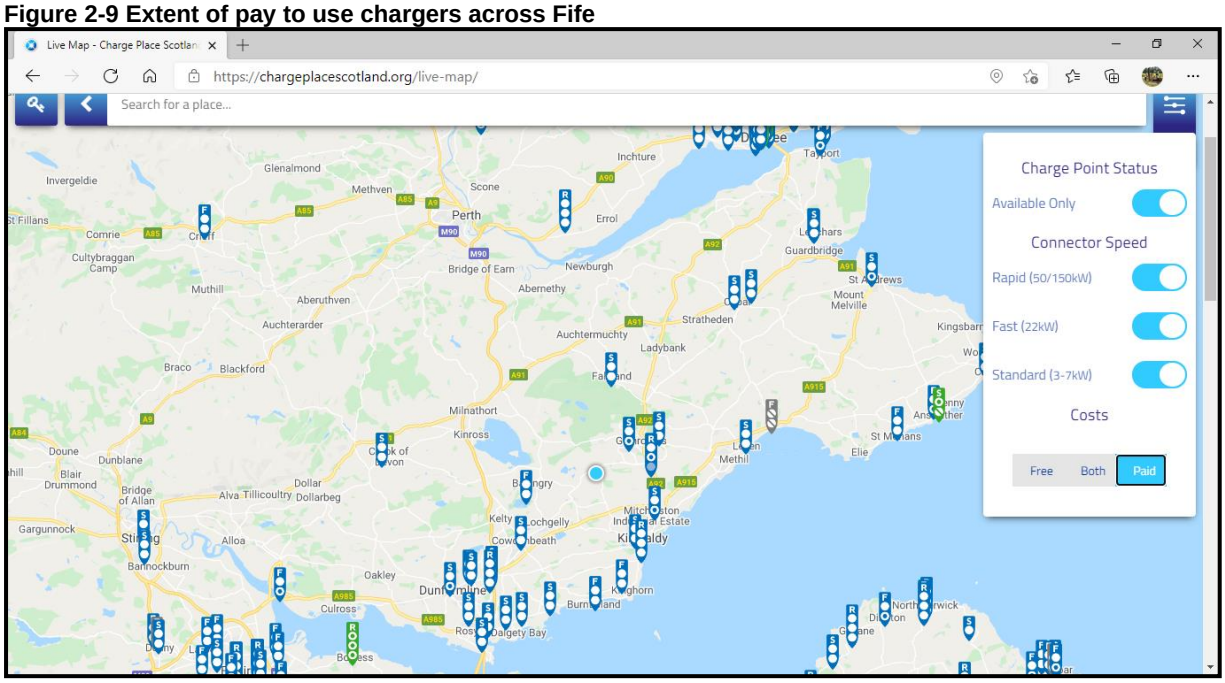


Figure 2-10 Extent of standard chargers (3-7kW) across Fife

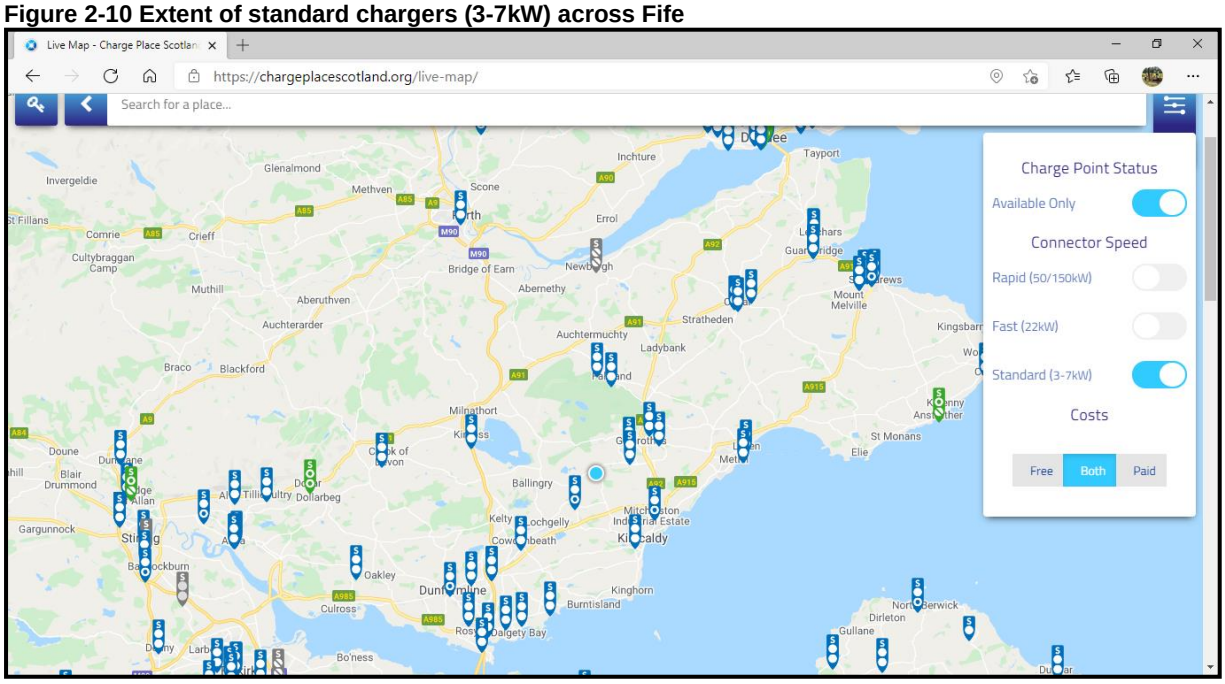


Figure 2-11 Extent of fast chargers (22kW) across Fife

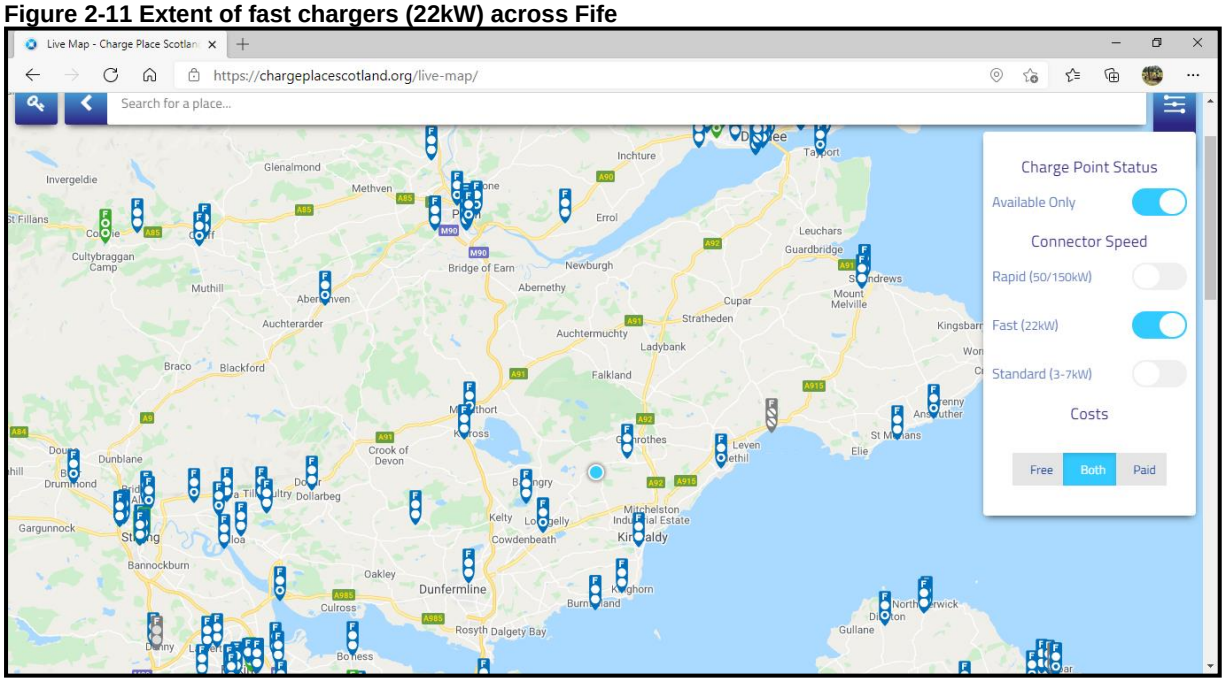
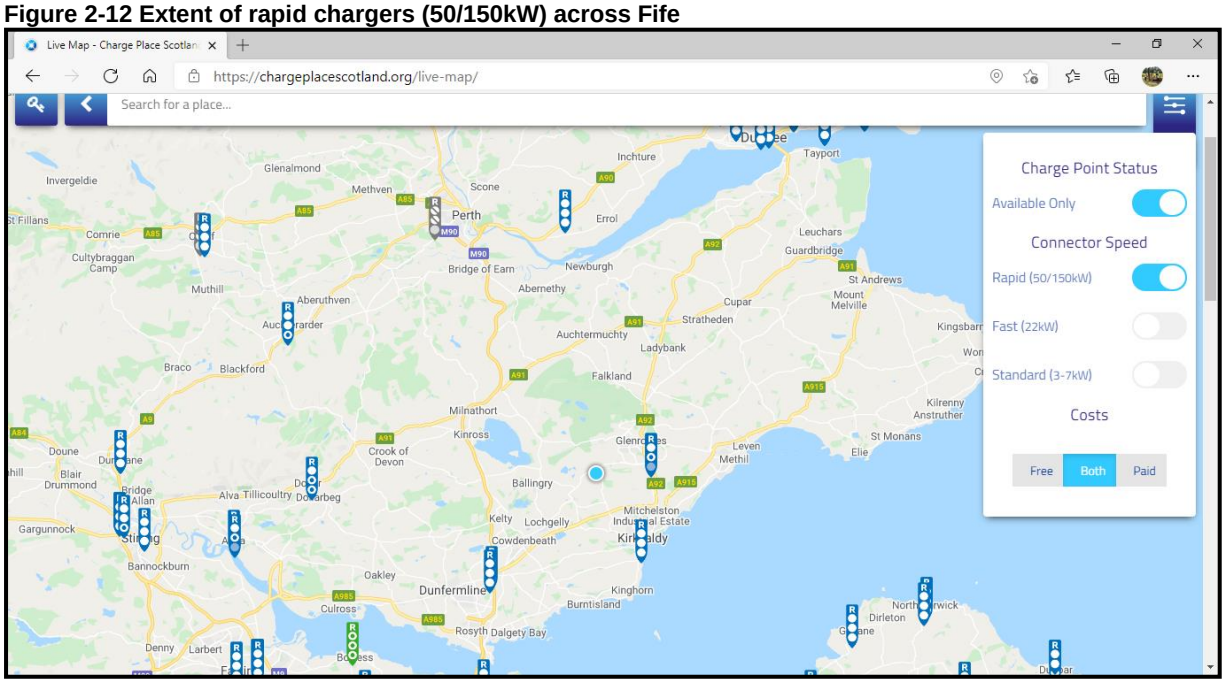


Figure 2-12 Extent of rapid chargers (50/150kW) across Fife



With specific reference to Cupar there were 260 public charge point users in 2020 (up from 230 in 2019 and 164 in 2018). These 260 public charge point users in 2020 accounted for a total of 1,518 charging sessions using 13,021kW of electricity in total. This was down on 2019 when there were 1,888 charging sessions using 15,983kW of electricity. This reduction will be most likely caused by the reduced public vehicle usage due to the various lockdowns associated with Covid-19.

With specific reference to Dunfermline there were 1,432 public charge point users in 2020 (up from 1,120 in 2019 and 707 in 2018). These 1,432 public charge point users accounted for a total of 7,448 charging sessions using 121,048kW of electricity in total. Again this was down on 2019 when there were 9,906 charging sessions using 122,917kW of electricity and will again likely be due to the various lockdowns associated with Covid-19.

Despite the impact of Covid-19 the increased number of public charge point users is encouraging and shows that an increasing number of local residents and/or commuters passing into or through Cupar and Dunfermline (current AQMAs) are now utilising electric or plug-in hybrid vehicles.

Associated with the increased uptake of electric and hybrid vehicles within the Council Fleet is an overall reduction in the size of the Council Fleet and a reduction in the quantity of diesel being used. Since 2011/12 the Fleet Demand Challenge Approach has reduced the Fleet size by 372 vehicles (up to the 2019/20 period). The amount of diesel used by the Council Fleet has reduced significantly from 4,269,548 litres in 2014/15 to 3,695,177 litres in 2019/20 (Figure 2-13). This is an overall reduction of 574,371 litres and equates to a CO_2 reduction of 1,508 tonnes.

Despite a reduced diesel usage the mileage covered by the Council Fleet was shown to have increased over the 2019/20 period (Figure 2-14) with the mileage covered increasing from 11,715,613 in 2018/19 to 12,352,481 in 2019/20 which will again be associated with an increased uptake in electric and hybrid vehicles within the Council Fleet.

Figure 2-13 Quantity of diesel issued by Fife Council

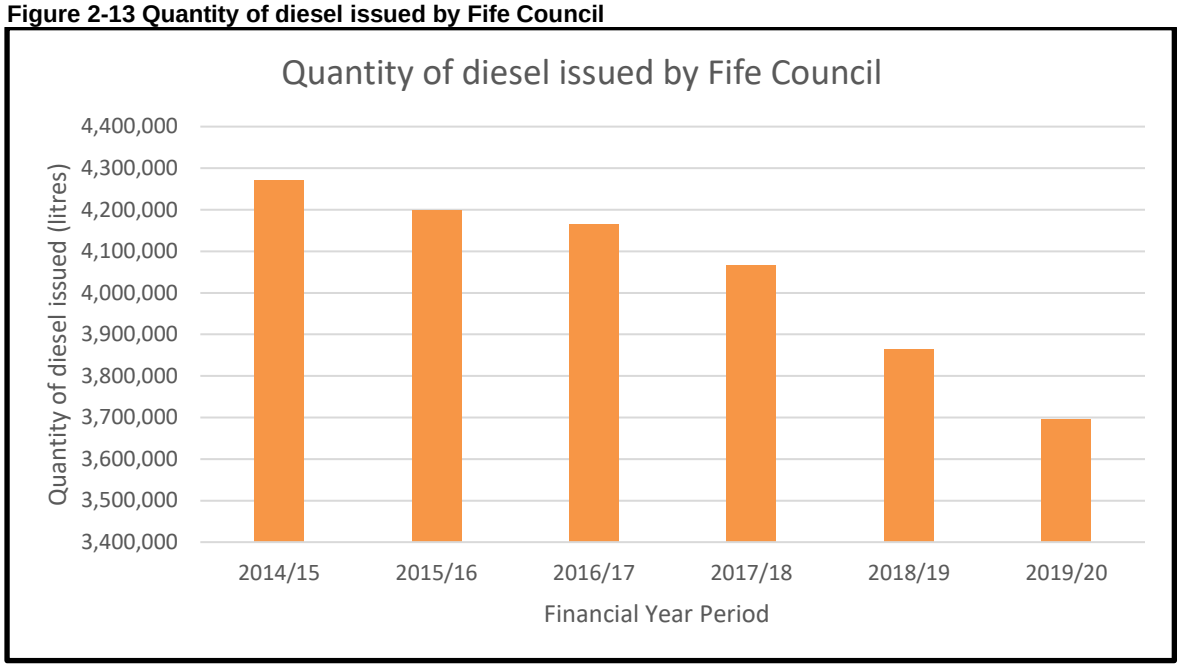
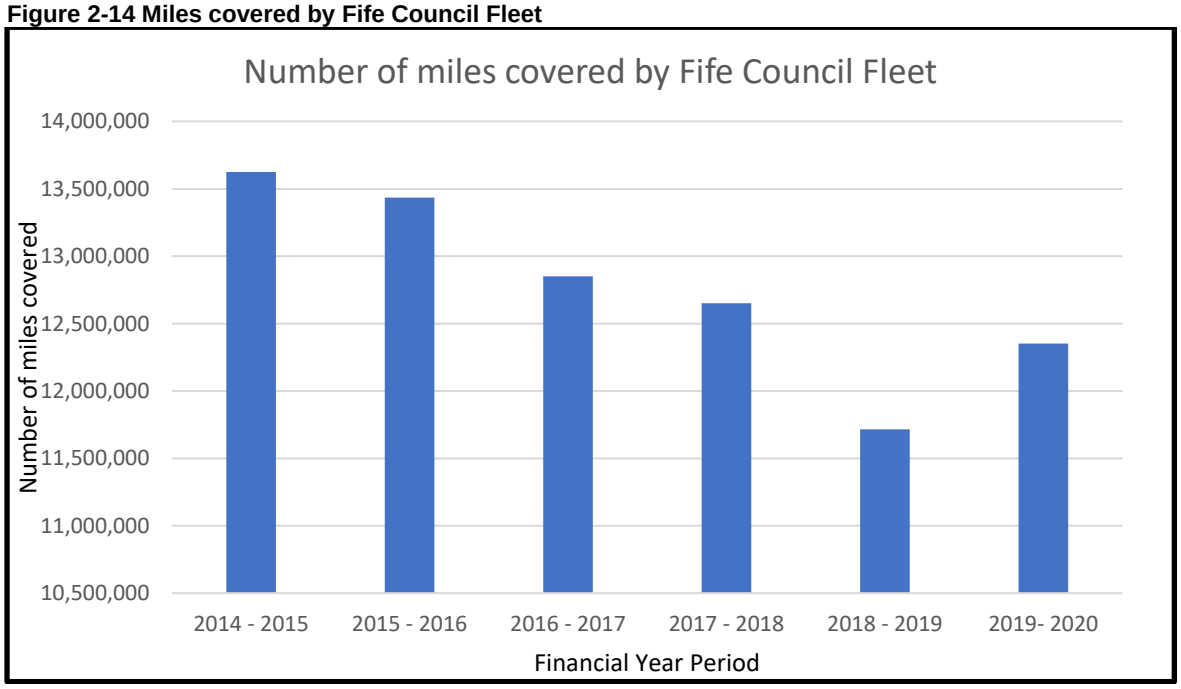


Figure 2-14 Miles covered by Fife Council Fleet



3 Air Quality Monitoring Data and Comparison with Air Quality Objectives

3.1 Summary of Monitoring Undertaken

This section sets out the monitoring that has taken place within Fife during 2020 and how local concentrations of the main air pollutants compare with the relevant objectives.

3.1.1 Automatic Monitoring Sites

Fife Council undertook automatic (continuous) monitoring at four sites during 2020, which measure NO_2, PM_{10}, and $PM_{2.5}$ concentrations. These automatic monitors are located at Cupar, Dunfermline, Kirkcaldy, and Rosyth. Table A.1 in Appendix A provides the site details for all automatic monitoring locations. National monitoring results are also available at: http://www.scottishairquality.scot/data/data-selector.

All PM_{10} analysers were upgraded to FIDAS during 2016 and included monitoring of $PM_{2.5}$, PM_1 and total suspended particles (TSP). However, results for 2020 have only been reported for PM_{10} and $PM_{2.5}$.

Maps showing the location of the automatic monitoring sites in 2020 are provided in Figure 3-1 to Figure 3-5. Further details on the QA/QC of the automatic monitoring sites are included in Appendix C.

Short-period CO monitoring is usually undertaken by Fife Council's Transportation Department however no monitoring was undertaken in 2020 due to Covid-19. Concentrations of 1,3 butadiene, benzene, nitrogen dioxide and sulphur dioxide measured independently in 2020 will be provided in the INEOS Grangemouth Oil Refinery Annual Community Air Quality Monitoring Report once made available to Fife Council.

3.1.2 Non-Automatic Monitoring Sites

Fife Council operates an extensive NO_2 diffusion tube monitoring survey with 42 sites in total throughout the Fife Council area (covering 58 diffusion tubes in total). Of these, eight sites are triplicate sites, with four of these triplicate sites being co-located with the automatic analysers at Cupar, Dunfermline, Kirkcaldy and Rosyth.

There were no diffusion tube sites which commenced or were decommissioned in 2020. However, Appin Crescent 3 moved location slightly to the east, due to being located on a piece of street furniture which was removed.

Table A.2 in Appendix A shows the details of all diffusion tube sites. Maps showing the location of the nitrogen dioxide diffusion tubes are provided in Figure 3-1 to Figure 3-5. These focus on the main monitoring areas of Cupar, Dunfermline, Kirkcaldy, Rosyth and St Andrews. Further details on QA/QC and bias adjustment for the diffusion tubes are included in Appendix C. There were 5 monitoring sites which required to be annualised in accordance with TG.16, details are provided in Appendix D.

Due to Covid-19 restrictions Fife were not able to maintain their diffusion tube monitoring networks (exposure and analysis in-line with the DEFRA calendar) as normal during the 2020 lockdown period. Two tube changeover dates (1st April and 29th April) were missed during the first lockdown. However, diffusion tube monitoring returned to normal in June. Therefore, Fife have data for diffusion tubes that were exposed for 3 months. However, this data has been discounted from the monthly diffusion tube processing in accordance with appropriate technical guidance.

Figure 3-1 Location of automatic monitor and nitrogen dioxide diffusion tubes – Bonnygate, Cupar AQMA

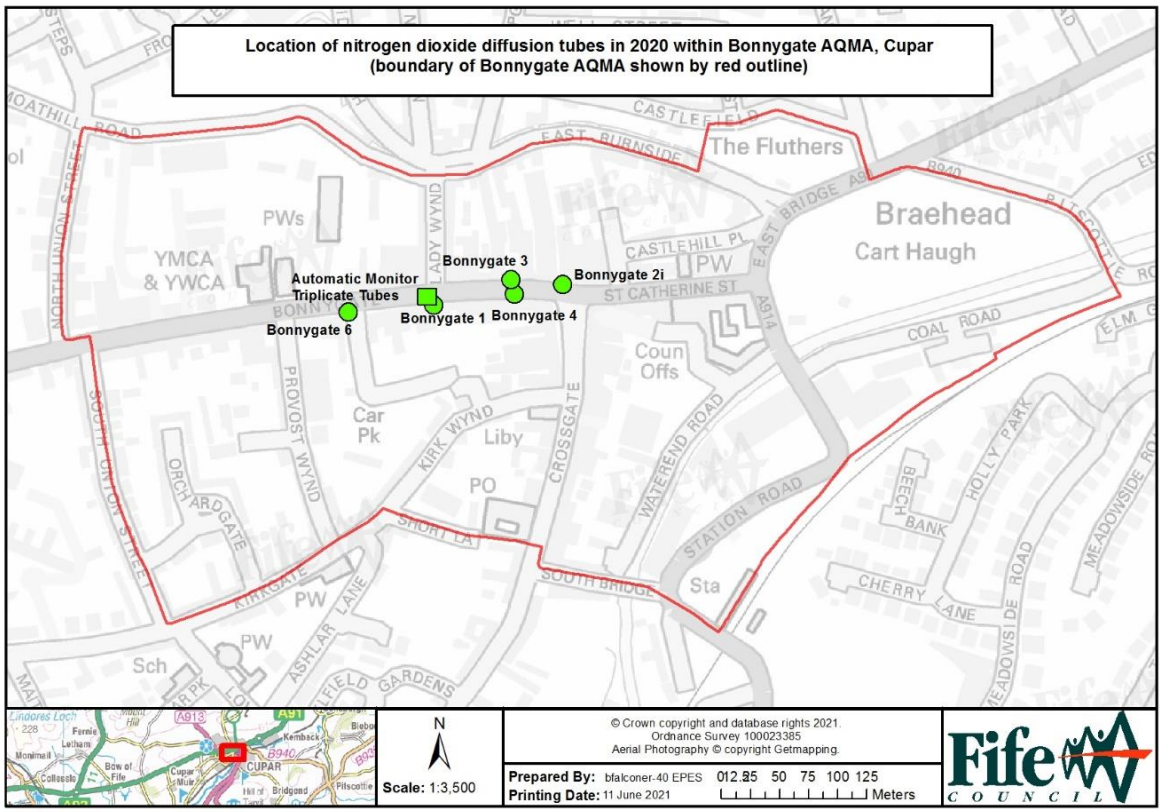


Figure 3-2 Location of automatic monitor and nitrogen dioxide diffusion tubes - Appin Crescent, Dunfermline AQMA

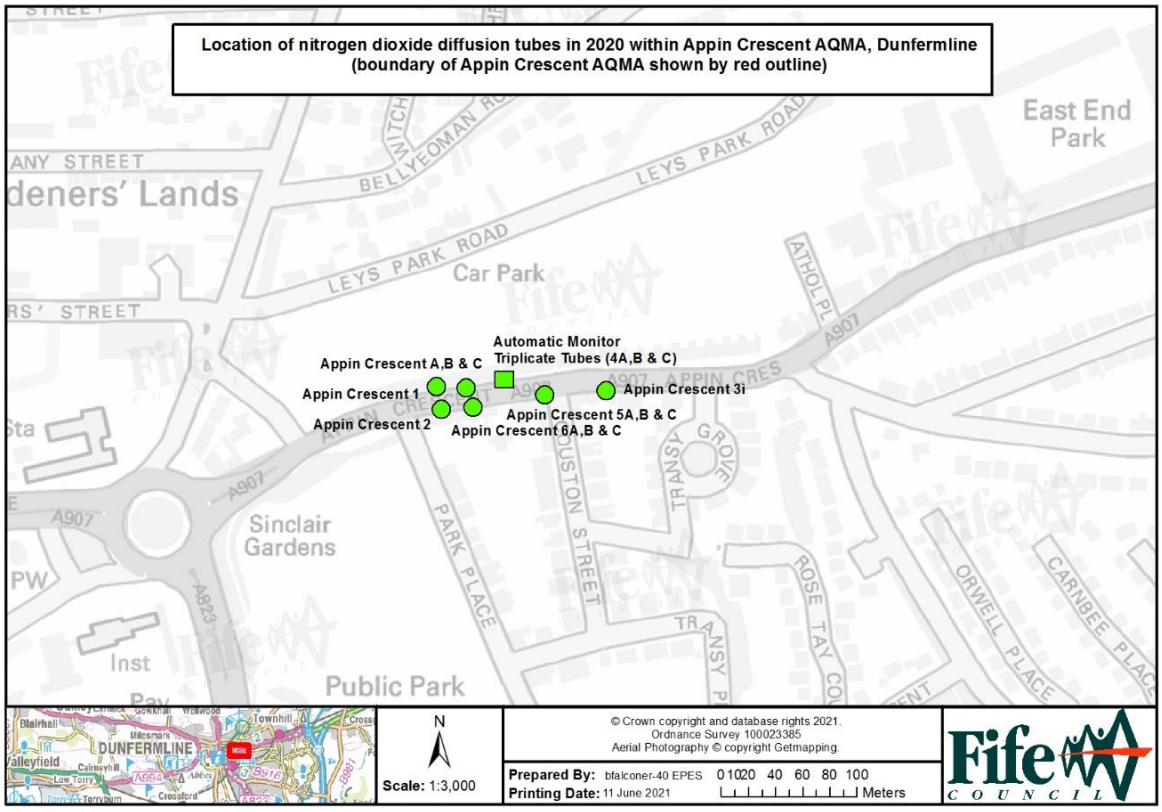


Figure 3-3 Location of automatic monitor and nitrogen dioxide diffusion tubes – St Clair Street, Kirkcaldy

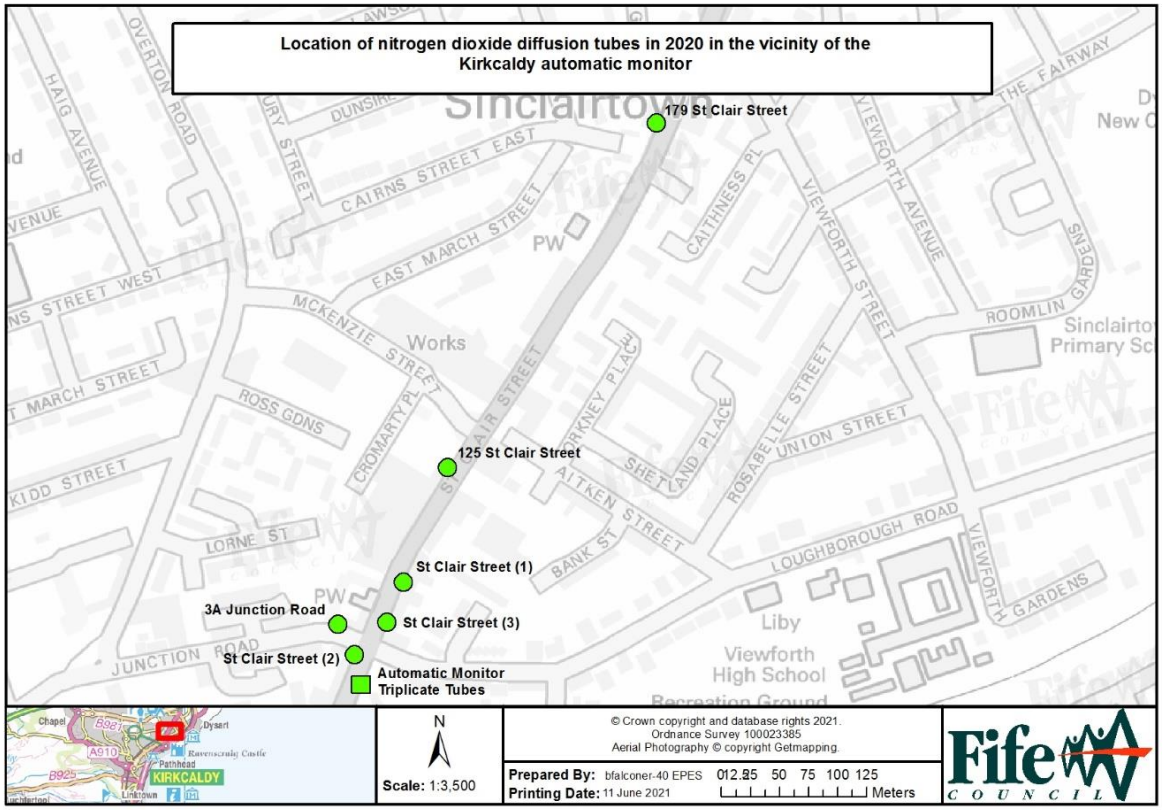


Figure 3-4 Location of automatic monitor and nitrogen dioxide diffusion tubes – Admiralty Road, Rosyth

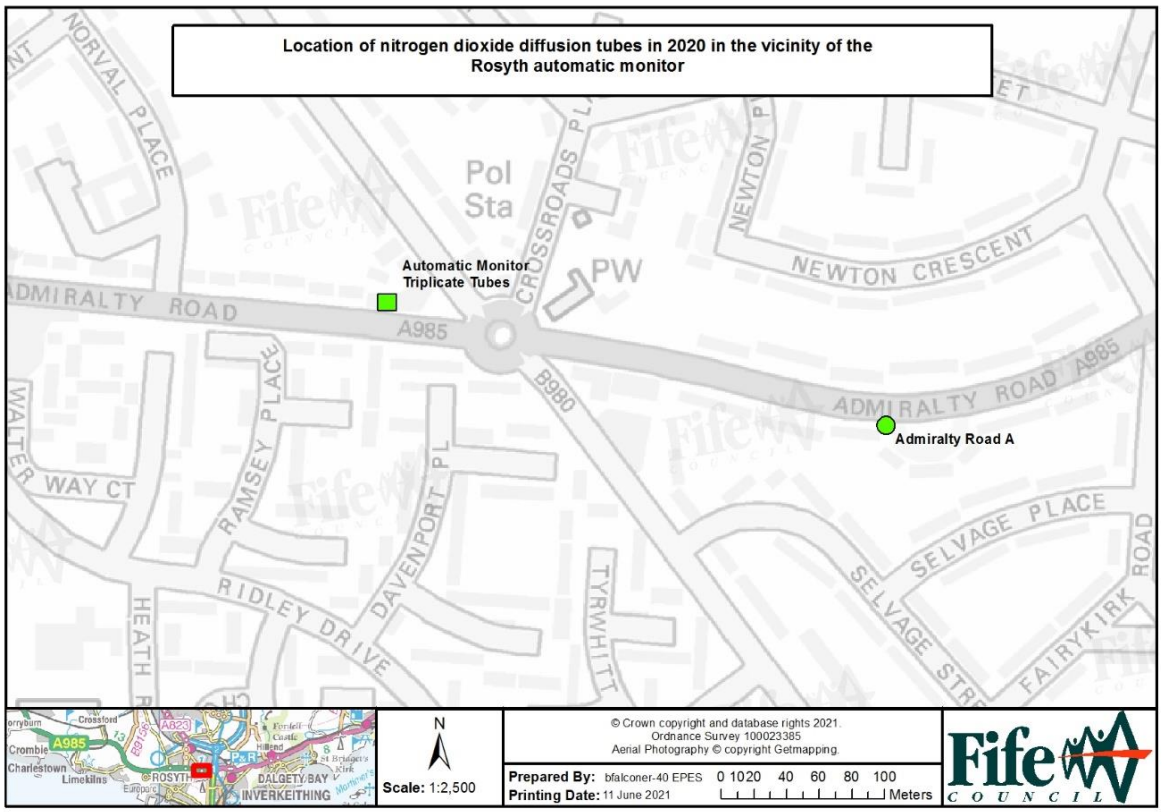
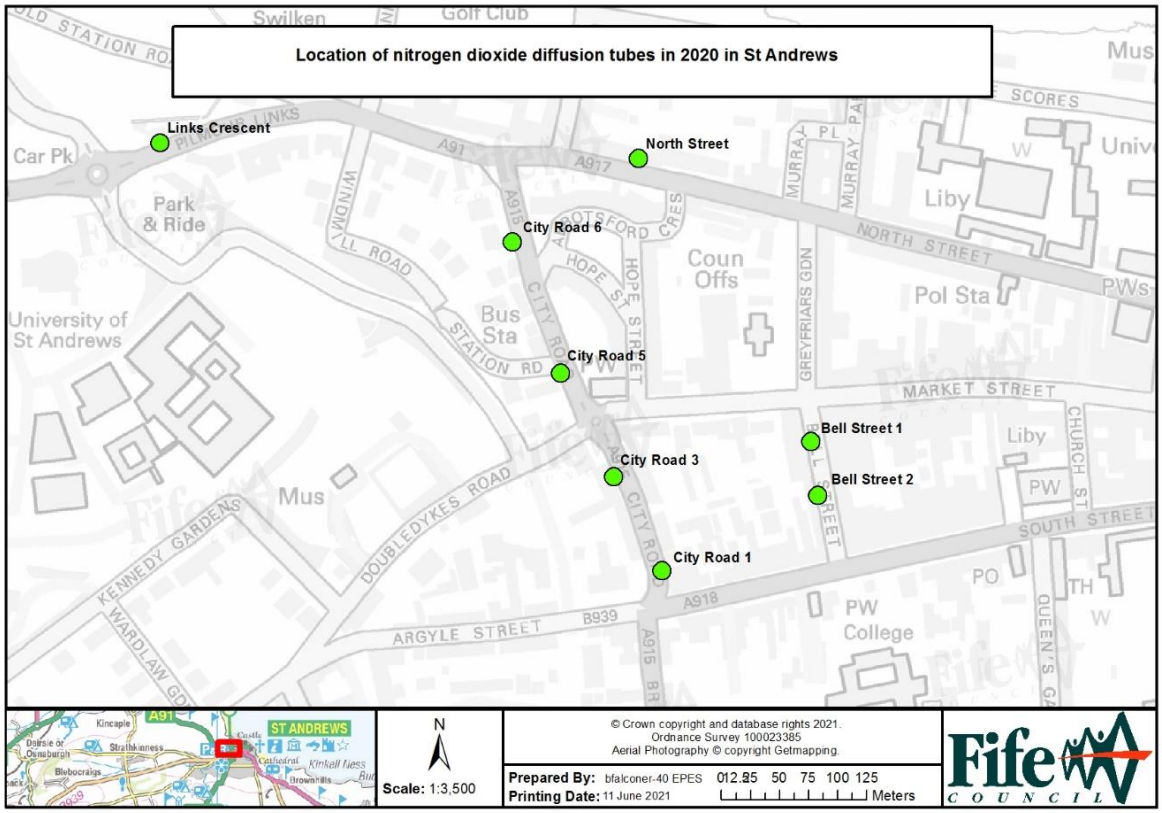


Figure 3-5 Nitrogen dioxide diffusion tube locations – St Andrews



3.2 Individual Pollutants

The air quality monitoring results presented in this section are, where relevant, adjusted for annualisation and bias. Further details on adjustments are provided in Appendix C.

A dynamic style report containing embedded statistical data for Fife can be found here: http://www.scottishairquality.scot/assets/documents//Fife_annual_2020.html. The key areas have been extracted and included below however further detail can be found online. The embedded data allows the reader a level of interaction with some of the report findings, providing additional insight. This approach enables a more easily navigated and streamlined report providing an engaging and intuitive reader experience. The analysis has been carried out for the pollutants NO_2, PM_{10} and $PM_{2.5}$ using the Openair analysis tool. Further figures are provided in Appendix H. This type of analysis helps the Council inform future policy making.

Openair is an innovative tool to analyse, interpret and understand air pollution data using "R". R is a free and open source programming language designed for the analysis of data. The Openair tool can perform complex and innovative analysis of current and archived air pollutant data allowing powerful data visualisation and interrogation. For this report Fife Council has utilised the following analysis tools;

- **Time variation** - This tool produces four separate panes combined into a single plot: The plotted output shows the average variation by day of the week and hour of the day combined (the top-most pane), hour of the day (diurnal variation, shown in the lower left pane), month of the year (seasonal variation in the lower middle pane) and day of week (lower right pane) of one or more variables or at one or multiple sites over a user selected time range. The plots have been created for all four automatic monitoring sites in Fife for the period 1st January – 31st December 2020. The variation of a pollutant by time of day and day of week can reveal useful information concerning the likely sources at a particular site.
- **Polar Plots** – This tool produces polar plots of pollutant concentrations by wind speed and wind direction. Polar plots are useful to gain a quick graphical representation of the relationship between pollutant concentrations and the meteorological conditions. This can be useful in identifying potential sources of pollution affecting the location, for example particle suspension is increased at higher wind speeds come from a specific direction.
- **Calendar Plots** – This tool provides a way of visualising trends in daily pollutant concentrations across a year in the familiar form of a calendar. Concentrations are represented with a colour scale and the meteorological conditions can be represented using arrows giving the vector averaged wind direction, scaled according to the wind speed based on modelled wind speed and direction from data from the UK air quality forecast. In this way pollution episodes can be identified by date and sources potentially indicated by the combination of pollutant and meteorological conditions.
- **Back trajectory Analysis Plots –** The back trajectory plots show data from the HYSPLIT model (NOAA HYSPLIT[3]) run in the analysis mode. This shows the air mass back trajectories for the period cover by this report. Two different kinds of plot are shown. One statistically groups the trajectories into similar clusters and shows the proportion of time during the report period that each represents. This is useful to get an overview of air mass origins during the report period. Plots in Trajectories associated with top ten most polluted days provide information on the trajectory direction associated with the top 10 measured concentrations.

3.2.1 Nitrogen Dioxide (NO_2)

3.2.1.1 Automatic Monitoring Data

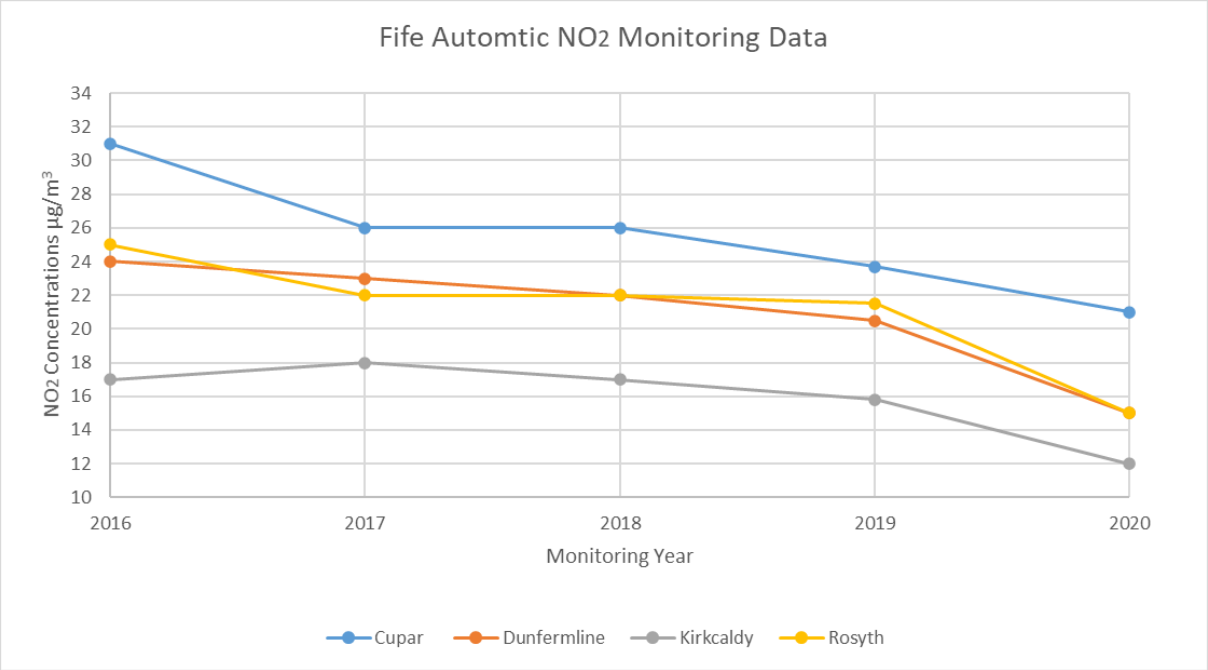
Table 3.1 and Figure 3-6 provides the monitoring results for 2020 and the previous five years. All four automatic monitoring sites did not record any exceedances of the AQS NO_2 annual or 1-hour mean objectives (refer to Table A.4) during 2020 and have been consistently well below the objectives for the past five years.

[3] https://www.arl.noaa.gov/hysplit/hysplit

Table 3.1 Fife automatic monitoring sites NO_2 annual mean concentrations (µg m-3)

Site Name	Site Type	Valid Data Capture 2020 (%)	2016	2017	2018	2019	2020
Cupar	Kerbside	91	31	26	26	24	21
Dunfermline	Roadside	74	24	23	22	21	15
Kirkcaldy	Roadside	100	17	18	17	16	12
Rosyth	Roadside	100	25	22	22	22	15

Figure 3-6 Fife automatic monitoring sites NO_2 annual mean concentrations (µg m-3)



Over the last five years NO_2 concentrations increased slightly at Cupar and Rosyth in 2016 before declining again from 2017 onwards. Dunfermline has been declining gradually since 2015. While Kirkcaldy seen a slight increase in 2017 before declining until 2019. A sharper drop in concentrations in 2020 is likely due to the Covid-19 lockdown and restrictions resulting in less vehicles which has meant reductions in concentrations. Longer NO_2 trends at the two AQMAs can be seen in Figure 2-3 and Figure 2-5 above. The trend of decreasing concentrations seen at Cupar and Dunfermline suggest that the action plan measures introduced have had a positive impact.

Three AQMesh units have been monitoring since December 2017 to seek to further understand the pollutant concentrations and trends in the Appin Crescent, Dunfermline AQMA and Bonnygate, Cupar AQMA. Data is managed and processed by Ricardo who carry out appropriate QA/QC. The data showed that no NO_2 exceedances were measured during 2020. Analysis of the monitoring data from these units is provided in Section 3.3.

3.2.1.2 Diffusion Tube Monitoring Data

The annual diffusion tube data is presented in Appendix A, Table A.3. The data has been bias corrected using the local bias adjustment factor, or a combined factor for areas out with the areas covered by automatic monitors. The following local bias adjustments were calculated – further details are provided in Appendix C:

- Cupar = 0.84

- Dunfermline = 0.77
- Kirkcaldy = 0.61
- Rosyth = 0.76
- Average of Local = 0.69

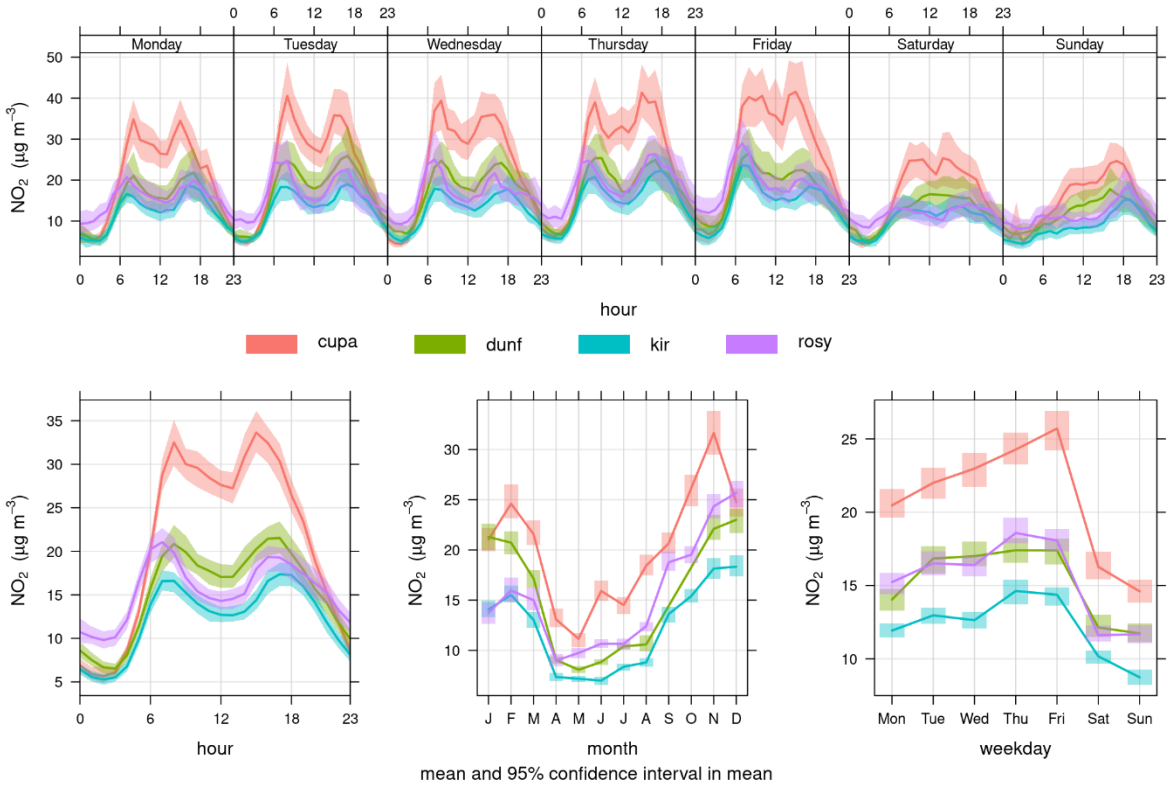
The local bias adjustment factor was applied to all diffusion tubes within the areas covered by the automatic monitors while the average of the local bias adjustment factors was used for all other sites for consistency. The local bias adjustment factor for Cupar and Dunfermline could not be used as both included less than 9 periods of data capture (due to the Covid-19 lockdown), therefore the average was used for these locations. The local bias calculations are outlined in the data QA/QC in Appendix C. The full 2020 data set of monthly mean values is provided in Appendix B.

Details of the diffusion tube bias adjustment are found within Appendix C of this report. Diffusion tube results from 2016 to 2020 are presented in Appendix A, Table A.3. Diffusion tube trend graphs are provided for the different areas of interest within Fife, these are presented in Appendix A, Figure A.1 to Figure A.8. The 2020 diffusion tube results indicate that there were no exceedances of the annual mean objective at any monitoring locations, including locations within Dunfermline and Cupar which have exceeded in previous years. The highest annual mean concentration measured in Appin Crescent, Dunfermline during 2020 was 24 µg m^{-3} at Appin Crescent 6(A,B,C). The highest annual mean measured at Bonnygate, Cupar during 2020 was 22 µg m^{-3} at Bonnygate 4B.

3.2.1.3 NO_2 Trends Analysis 2020

Figure 3-7 compares the time variation plots for NO_2 in 2020 at each of the automatic monitoring stations; Cupar, Dunfermline, Kirkcaldy and Rosyth. All four sites have very similar time variations in data throughout the year, with Cupar being the highest. However, it should be noted that Cupar is located at kerbside (less than 0.5 meters from the kerb) rather than roadside (between 0.5 and 5 meters from the kerb) like the three other sites. This proximity to the source will contribute to the higher concentrations as NO_2 drops off significantly the further you are from the source. The highest concentrations are measured between Monday to Friday with rush hour periods (approximately at 8am and 5pm) showing highest concentrations. This indicates traffic to be the main source of NO_2 for all sites. Concentrations at all four sites significantly drop at the weekend. There is a strong seasonal variation at all sites with winter months seeing significantly higher concentrations than in summer months. This is likely due to a decrease in traffic during summer months and winter conditions providing poor pollution dispersion conditions.

Figure 3-7 NO_2 Time Variation for Fife



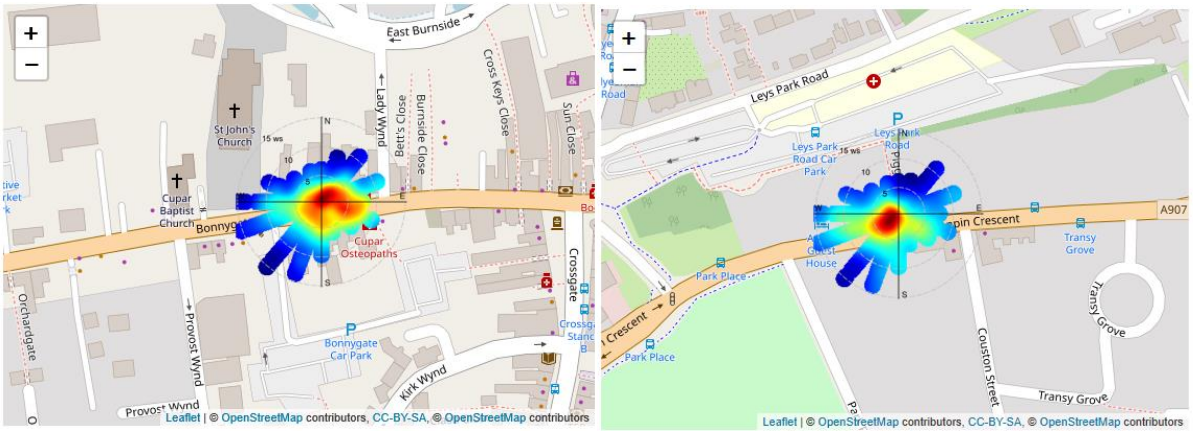
Figures G.1-4 in Appendix G show the NO_2 time series plots for each monitoring site independently.

Figures G.13-16 show NO_2 calendar plots of the date and wind speed for each of the monitoring stations across Fife. Calendar plots show elevated concentrations. As with the time variation figures it can be seen that the lowest concentrations are in summer with higher concentrations throughout the winter months specifically January and February for all sites.

Figures G.25-28 show NO_2 polar plots at each of the monitoring stations. This report will focus on the Polar plots analysis for the AQMAs at Cupar (left) and Dunfermline (right) shown in Figure 3-8. Both plots indicate a broadly east-west signal which is consistent with parallel winds through the street canyon. It also shows that concentrations are highest when wind speeds are low.

It should be noted that the meteorological conditions in the Openair tool on the Scottish Government website are modelled, so there may be some bias in the data and subsequent analysis. However, these polar plots are very similar to last years'.

Figure 3-8 Polar plots of NO_2 concentrations by wind speed and direction



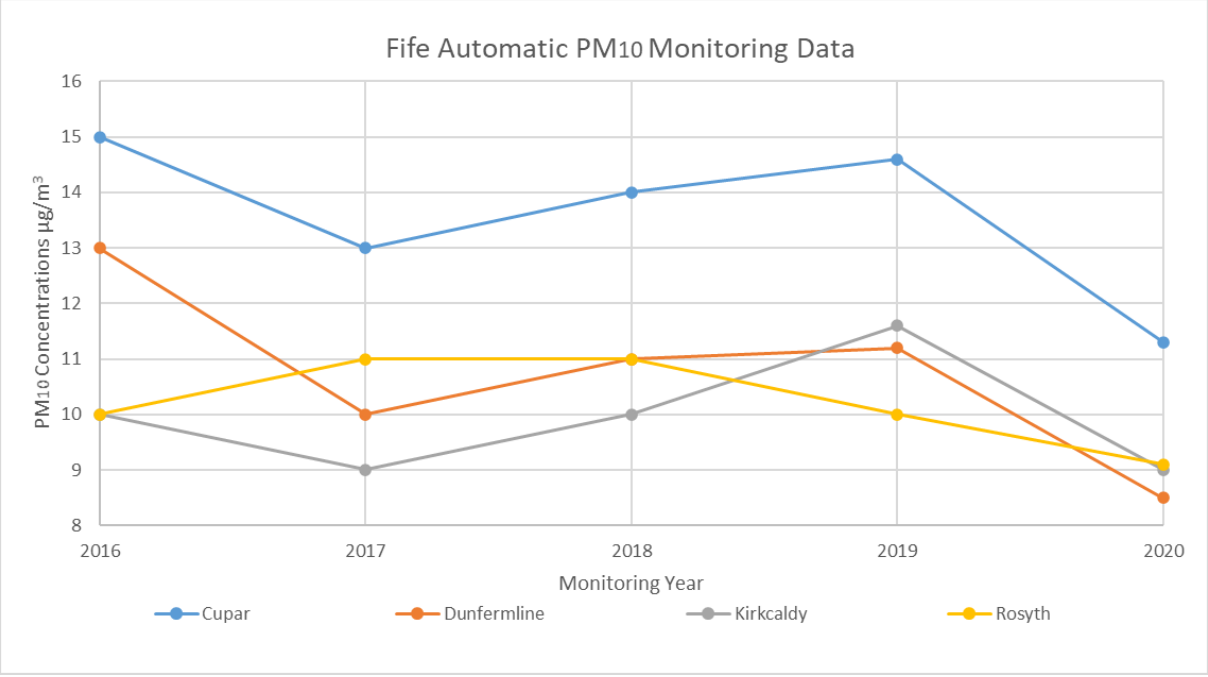
3.2.2 Particulate Matter (PM_{10})

Table 3.2 and Figure 3-9 provides the PM_{10} monitoring results for 2020 and the previous five years. All four automatic monitoring sites did not record an exceedance of the PM_{10} annual or 24-hour mean statutory objectives (refer to Table A.5) during 2020 and have been consistently below the objectives for the past five years.

Table 3.2 Fife automatic monitoring sites PM_{10} annual mean concentrations 2016-2020 (µg m^{-3})

Site Name	Valid Data Capture 2020 (%)	2016	2017	2018	2019	2020
Cupar	97	15	13	14	15	11
Dunfermline	100	13	10	11	11	9
Kirkcaldy	100	10	9	10	12	9
Rosyth	100	10	11	11	10	9

Figure 3-9 Fife automatic monitoring sites PM_{10} annual mean concentrations 2016-2020 (µg m^{-3})



Over the past five years PM_{10} concentrations have declined significantly at both Dunfermline and Cupar. Longer PM_{10} trends at the two AQMAs can be seen in Figure 2-4 and Figure 2-6 above. The decline in

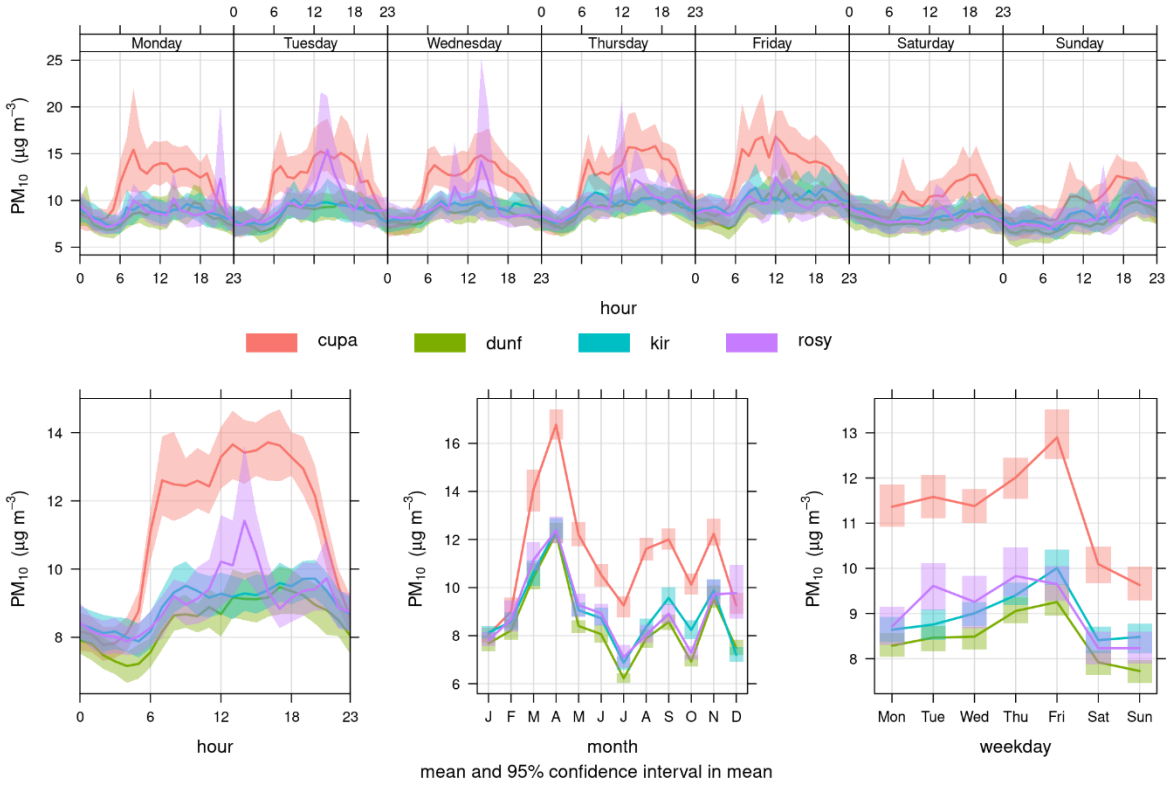
concentrations coincide with implementation of certain AQAP measures and highlights that the action plans can be effective in helping to reduce pollution concentrations in AQMAs. Over the past few years concentrations at all sites have stayed effectively stable within 1 or 2 µg m^{-3} before dropping in 2020 due to the Covid-19 lockdown.

Three AQMesh units have been monitoring since December 2017 to further understand pollutant concentrations and trends in the two AQMAs. The 2020 PM_{10} data showed that no exceedances were measured during 2020. Analysis of the monitoring data from these units is provided in Section 3.3.

3.2.2.1 PM_{10} Trend Analysis 2020

Figure 3-10 compares the time variation plots for PM_{10} in 2020 at each of the automatic monitoring stations. All four sites have very similar time variations in data throughout the year, with Cupar being the highest. The highest concentrations at all sites are measured between Monday to Friday (similar to NO_2 concentrations) with Friday experiencing the high concentrations throughout the week. The analysis suggests that traffic at Cupar has a greater effect on concentrations than the other locations however, this may be due to the location of the site (kerbside rather than roadside). It does however show the contribution traffic has to PM_{10} at kerbside. In addition, Rosyth experiences significantly higher concentrations around 1pm and 3pm, Monday to Friday, compared to other sites. This suggests a source unique to this site. There is again strong seasonal variation at all sites with winter months seeing significantly higher concentrations than in summer months. This yearly profile is common across Scotland.

Figure 3-10 PM_{10} Time Variation for Fife



Figures G.5-8 in Appendix G show the PM_{10} time series plots for each monitoring site individually.

Figures G.17-20 show PM_{10} calendar plots of the date and the wind speed for each of the monitoring stations across Fife. Calendar plots show elevated concentrations. Concentrations are relatively low throughout the year at all sites.

Figures G.29-32 show PM_{10} polar plots at each of the monitoring stations. Polar plots analysis for the AQMAs at Cupar (left) and Dunfermline (right) shown in Figure 3-11. All plots indicate that concentrations are highest when coming from the East or South East. This can suggest that Particulate Matter concentrations in Fife are influenced by transboundary pollution.

Figure 3-11 Polar plots of PM_{10} concentrations by wind speed and direction

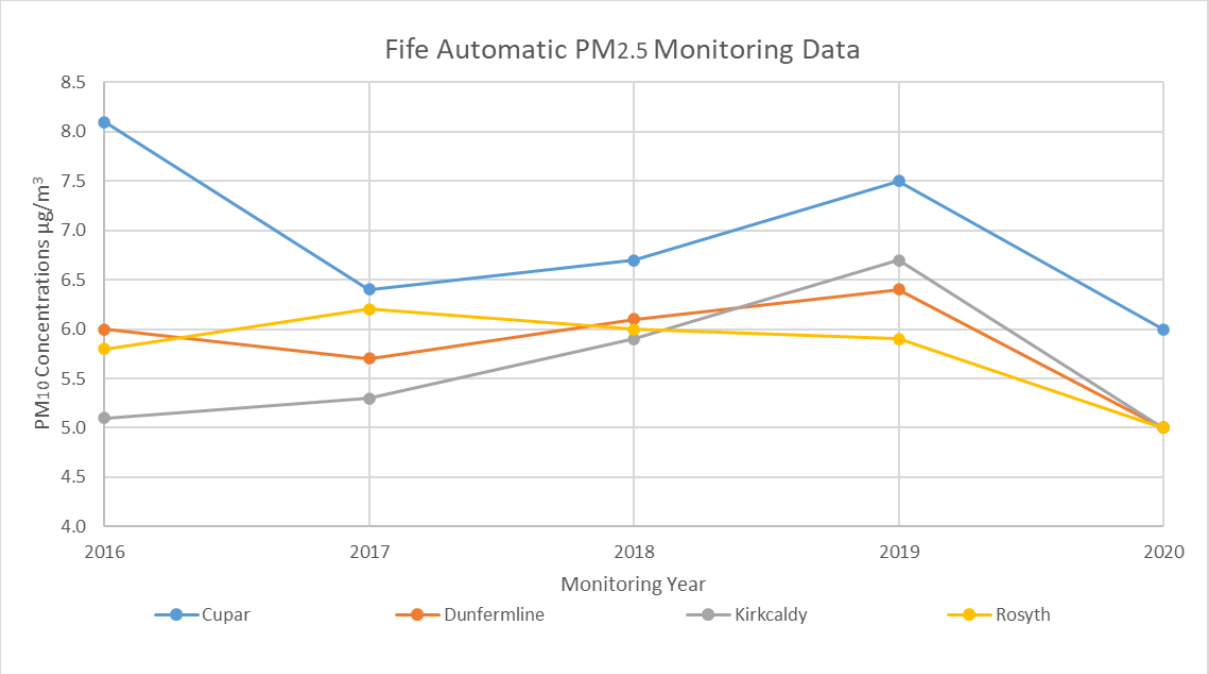
3.2.3 Particulate Matter ($PM_{2.5}$)

Table 3.3 and Figure 3-12 provides the $PM_{2.5}$ monitoring results for 2020 and the previous five years. All four automatic monitoring sites did not record an exceedance of $PM_{2.5}$ annual mean objective during 2020 and have been consistently below the objectives for the past five years.

Table 3.3 Fife automatic monitoring sites $PM_{2.5}$ annual mean concentrations 2016-2020 (µg m^{-3})

Site Name	Valid Data Capture 2020 (%)	2016	2017	2018	2019	2020
Cupar	97	8	6	7	8	6
Dunfermline	100	6	6	6	6	5
Kirkcaldy	100	5	5	6	7	5
Rosyth	100	6	6	6	6	5

Figure 3-12 Fife automatic monitoring sites $PM_{2.5}$ annual mean concentrations 2016-2020 (µg m^{-3})



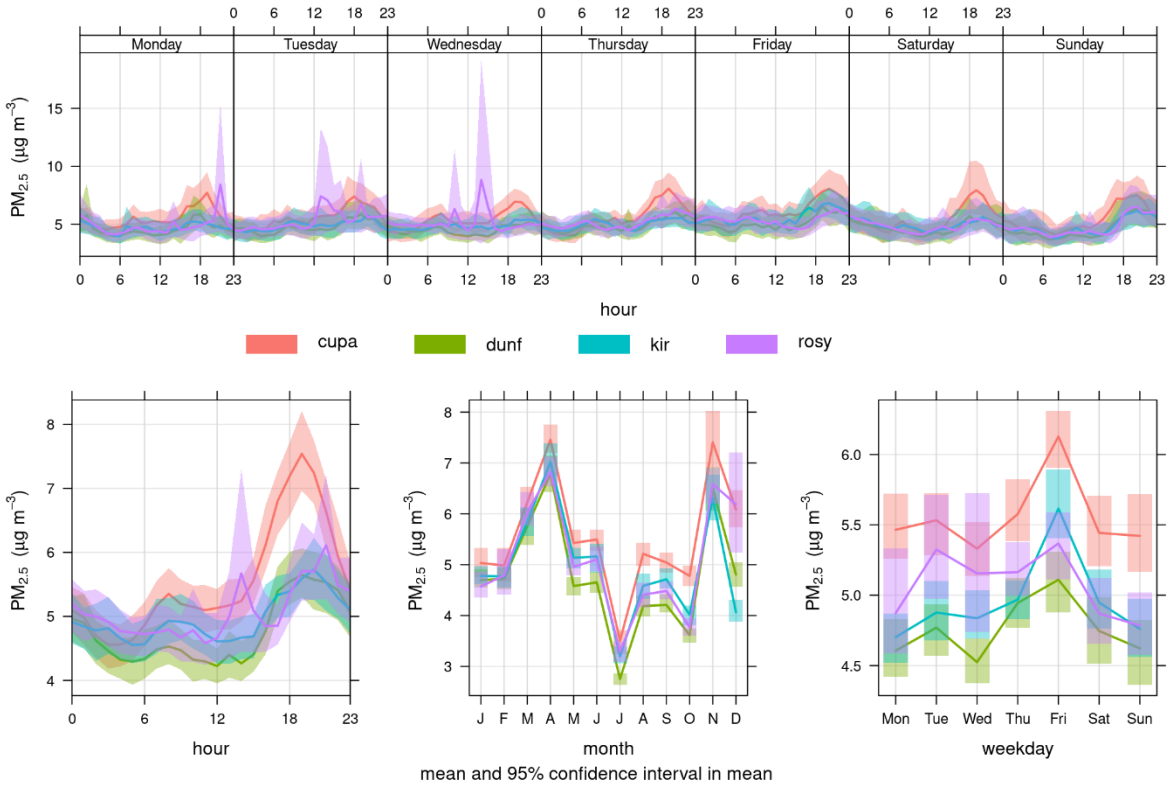
Overall $PM_{2.5}$ concentrations have increased slightly or stayed the same since monitoring commenced. The concentrations declined between 2019 and 2020 however this is likely due to the Covid-19 lockdown restrictions. The most significant increase (excluding 2020 data) has been seen at Kirkcaldy however staying well within the AQS objective.

Three AQMesh units have been monitoring since December 2017 to further understand pollutant concentrations and trends in the two AQMAs. The 2020 $PM_{2.5}$ data showed that no exceedances were measured during 2020. Analysis of the monitoring data from these units is provided in Section 3.3

3.2.3.1 $PM_{2.5}$ Trend Analysis 2020

Figure 3-13 compares the time variation plots for $PM_{2.5}$ in 2020 at each of the automatic monitoring stations. All four sites have very similar time variations in data throughout the year. Concentrations are relatively consistent across the full week. Diurnal variations show that concentrations at all sites appear to increase during the night, especially at Cupar. There is also a strong seasonal variation at all sites with winter months seeing significantly higher concentrations than in summer months. This along with the diurnal plot suggests that traffic is not the main source of $PM_{2.5}$ and more likely domestic fuel burning.

Figure 3-13 $PM_{2.5}$ Time Variation for Fife



Figures G.9-12 in Appendix G show the $PM_{2.5}$ time series plots for each monitoring site individually.

Figures G.21-24 show $PM_{2.5}$ calendar plots of the date and the wind speed for each of the monitoring stations across Fife. Calendar plots show elevated concentrations. Concentrations are relatively low throughout the year at all sites.

Figures G.33-36 show $PM_{2.5}$ polar plots at each of the monitoring stations. Polar plots analysis for the AQMAs at Cupar (left) and Dunfermline (right) shown in Figure 3-14. As with PM_{10}, all plots indicate that concentrations are highest when coming from the East or South East. The $PM_{2.5}$ polar plots however also suggest that at relatively high winds concentrations can increase when winds are from the west. This again indicates the influence transboundary sources have on $PM_{2.5}$ concentrations in Fife.

Figure 3-14 Polar plots of $PM_{2.5}$ concentrations by wind speed and direction

3.2.4 Sulphur Dioxide (SO_2)

Fife Council does not undertake any SO_2 monitoring.

3.2.5 Benzene

There are currently two benzene monitoring programmes carried out within the Fife Council boundary:

- Monitoring in the area of the Grangemouth oil refinery on behalf of INEOS,
- Monitoring along the Fife coastline on behalf of INEOS (associated with Houndpoint).

INEOS Grangemouth Benzene Monitoring
Benzene monitoring is presented for INOES Grangemouth oil refinery in their annual monitoring report for 2020[4]. This report concludes that the annual average concentrations of Benzene are below the Air Quality (Scotland) Regulations 2000 air quality objective of 3.25 µg m^{-3} (1ppb).

INEOS Houndpoint Benzene Monitoring
INEOS FPS Ltd. commissioned National Physical Laboratory (NPL) to monitor the ambient air hydrocarbon levels at 12 locations on the Forth Estuary coastline during 2020 (2nd January 2020 to 1st January 2021). Nine locations on the Estuary North shore between North Queensferry and West Wemyss (including 4 locations between Dalgety Bay and Burntisland) were used, and 3 locations on the Estuary South shore between South Queensferry and Whitehouse Point were used.

The ambient air samples were collected over 2 week periods using passive diffusive tubes. These samples were analysed for iso-butane, n-butane, iso-pentane, n-pentane, n-hexane, n-heptane, benzene, toluene, xylene and total hydrocarbons (C4-C10). These hydrocarbons may be emitted from a variety of sources around the Forth Estuary including INEOS operations at Hound Point Terminal, road traffic, and other industrial sites such as the operations of ExxonMobil and Shell at Braefoot Bay and Mossmorran.

The results of this monitoring indicate that the average concentrations of benzene over the 12 month period were low with the annual means at each location ranging from 0.1 to 0.2 parts per billion volume to volume (ppb v/v). This is below the current annual Air Quality (Scotland) Strategy objective of 1 ppb v/v.

- The concentrations of other hydrocarbons were also low, but there are no Air Quality (Scotland) Strategy objectives for these substances.
- The substance present in the greatest concentrations at all locations was n-butane for which annual mean concentrations ranged from 2.1 to 10.2 ppb v/v.
- Concentrations of n-heptane, toluene and xylene were all below the limit of detection (LOD) of <0.3 ppb v/v at all locations.
- The annual mean concentrations of other individual substances ranged from <0.3 (LOD) to 3.9 ppb v/v.
- The annual mean concentrations of total hydrocarbons (C4 to C10) at different locations ranged from 6 to 18 ppb v/v.

INEOS FPS Ltd., and the previous Hound Point Terminal operator, have commissioned monitoring along the Forth Estuary coastline for many years and there has been an overall reduction in the levels of hydrocarbons, including benzene, present in the ambient air over the last decade. The concentrations at any one locality are highly dependent on the weather. The measurements made in 2020 indicate that concentrations of the monitored substances have reduced when compared to those measured in 2019 at most of the locations.

3.2.6 Carbon Monoxide, Lead and 1,3-Butadiene

[4] Community Air Quality Monitoring Report, Ambient Atmospheric Survey in the Vicinity of Grangemouth – 2020, INEOS April 2021

Transportation Services have advised that due to the Covid-19 restrictions and issues with sourcing calibration gas no roadside Carbon Monoxide monitoring was undertaken during 2020/21. The monitoring programme is set to resume in 2021/2022.

Other hydrocarbons:
Monitored concentrations of propane, n-butane, iso-butane, n-pentane, hexane, heptane, octane, nonane, decane, propylene, toluene, o-xylene, m & p-xylene, styrene and total C4 to C10 hydrocarbons are measured by INEOS as part of their annual reporting requirements at Grangemouth and Houndpoint. The INEOS Grangemouth[4] annual community air monitoring report for 2020 states that there were no significant changes in the annual average concentrations for all hydrocarbon components across all locations, when compared with historical data. The results associated with INEOS Houndpoint have been discussed above in the Benzene section.

At the time of writing, The Mossmorran and Braefoot Bay Independent Air Quality Monitoring Review Annual Report 2020 has not yet been published as this has been delayed. A summary will be added to this report once it is available.

3.2.7 Summary of Compliance with AQS Objectives

New monitoring data measured in 2020 identified no exceedances of the AQS annual mean objective for NO_2 at any of the automatic or non-automatic monitoring locations in Fife. The highest annual mean concentration measured in Appin Crescent, Dunfermline during 2020 was 24 µg m^{-3} at Appin Crescent 6(A,B,C). The highest annual mean concentration in Bonnygate, Cupar during 2020 was 22 µg m^{-3} at Bonnygate B4.

All the automatic monitoring sites in Fife measured PM_{10} concentrations below the annual and daily mean objectives during 2020. Bonnygate, Cupar and Appin Crescent, Dunfermline have both been declared AQMAs for NO_2 and PM_{10}. PM_{10} concentrations within these locations have remained below the annual mean objective consistently since 2014.

Fife Council has examined the results from monitoring in the Fife Council area. Concentrations within the Appin Crescent, Dunfermline AQMA and Bonnygate Cupar AQMA are within the air quality objectives.

In light of the 2020 monitoring results, Fife Council should continue to monitor at locations throughout Fife. Following a review of concentrations Fife Council intend to amend non-automatic monitoring locations as appropriate. The monitoring data for 2021 will be reported in the next Annual Progress Report (2022) which will evaluate the most recent monitoring data.

3.3 Additional AQMesh Sensor Monitoring Study

In December 2017, Fife Council began an AQMesh sensor monitoring study to gain a better understanding of air pollution concentrations in the Bonnygate, Cupar and Appin Crescent, Dunfermline AQMAs. Fife Council then contracted Ricardo to manage and QA/QC the data from this study. This report provides a summary of the data from this study from 1st January – 31st December 2020.

3.3.1 Methodology

In terms of this study, the pollutants of concern that the AQMesh sensor systems is monitoring are NO_2, PM_{10} and $PM_{2.5}$. The AQMesh is an air quality sensor system which is designed to measure real time readings at a resolution as low as 1-minute averages and at locations which have previously been inaccessible to conventional monitoring equipment. For gaseous pollutants the AQMesh uses electrochemical sensors to measure concentrations. For Particulate Matter (PM_{10} and $PM_{2.5}$) it uses an optical particle counter (https://www.aqmesh.com/).

It should be noted that AQMesh pods have not been assessed through the UK equivalence programme (e.g. MCERTS) and so do not currently have a formal equivalence designation. Once the stated quality control processes have been applied, the data should be used for indication purposes only when comparing to the relevant air quality standards.

For this study the AQMesh pods were set to measure 15-minute averages. Two pods were installed at the Appin Crescent AQMA and one at the Bonnygate AQMA. The locations are illustrated in Figure 3-15 and Figure 3-16. These locations had not previously been monitored for Particulate Matter due to accessibility reasons. NO_2 is currently measured at these locations using diffusion tubes, which provide indicative annual averages of NO_2. Photographs of the installed AQMesh units are also shown below in Figure 3-17.

Ricardo used their dedicated data management system (MODUS) to manage and process all data from the AQMesh pods. MODUS is a state-of-the-art, modular platform for robust, reliable and effective management of air quality data. MODUS is the same data management system that is used by the Scottish Air Quality Database (http://www.scottishairquality.scot/), the UK national network (AURN - https://uk-air.defra.gov.uk/interactive-map) Air Quality England Network (http://www.airqualityengland.co.uk/), as well as several other national and international air quality networks.

Ricardo's data management system provided:

- Automatic importing of data from the AQMesh.
- Management and processing of raw data.
- Screening and scaling of raw data.
- Statistical analysis.

QA/QC was applied to this data in line with advice published by AQEG on the Defra UK air website (https://uk-air.defra.gov.uk/library/aqeg/pollution-sensors.php) and included:

- Co-location of the AQMesh sensors at the nearest automatic site for at least one week every 3 months.
- Co-location of the AQMesh sensor after it has been removed from site for repair.
- Where appropriate, the application of correction factors to the raw data using the co-location data acquired.

During processing of the co-location data, orthogonal regression analysis was carried out to help calculate a correction factor. Examples of this analysis is provided in Appendix F of this report. For AQMesh data processing, correction factors are worked out for each individual co-location exercise then either applied as a ramp to the next co-location point (the value of the factor incrementally going up or down each day dependant on the next correction factor value and the amount of time between the co-location exercises), or as a straight line (the value of the correction factor stays the same for

each day) if there is a stop in data before the usable co-location caused by something happening to the sensor during sampling which could affect its sensitivity.

As well as the orthogonal regression analysis, Ricardo also carried out data comparison exercises to ascertain whether the data from the AQ Mesh sensors were representative. Comparisons were made with the local automatic monitoring sites at Bonnygate and Appin Crescent. Both sites use FIDAS analysers to monitor Particulate Matter. Data comparison plots are provided in Appendix F of this report. If poor data was identified from both the orthogonal and comparison analysis this data was removed from the dataset. As with automatic data in the SAQD and AURN networks if erroneous data was identified during the ratification of the data this was also removed from the dataset.

It should be reiterated that the AQMesh sensor is an indicative method of monitoring used by Fife Council to identify air pollution areas of concern where it has previously not been possible to carry out monitoring.

Figure 3-15 Appin Crescent, Dunfermline AQMesh sensor locations

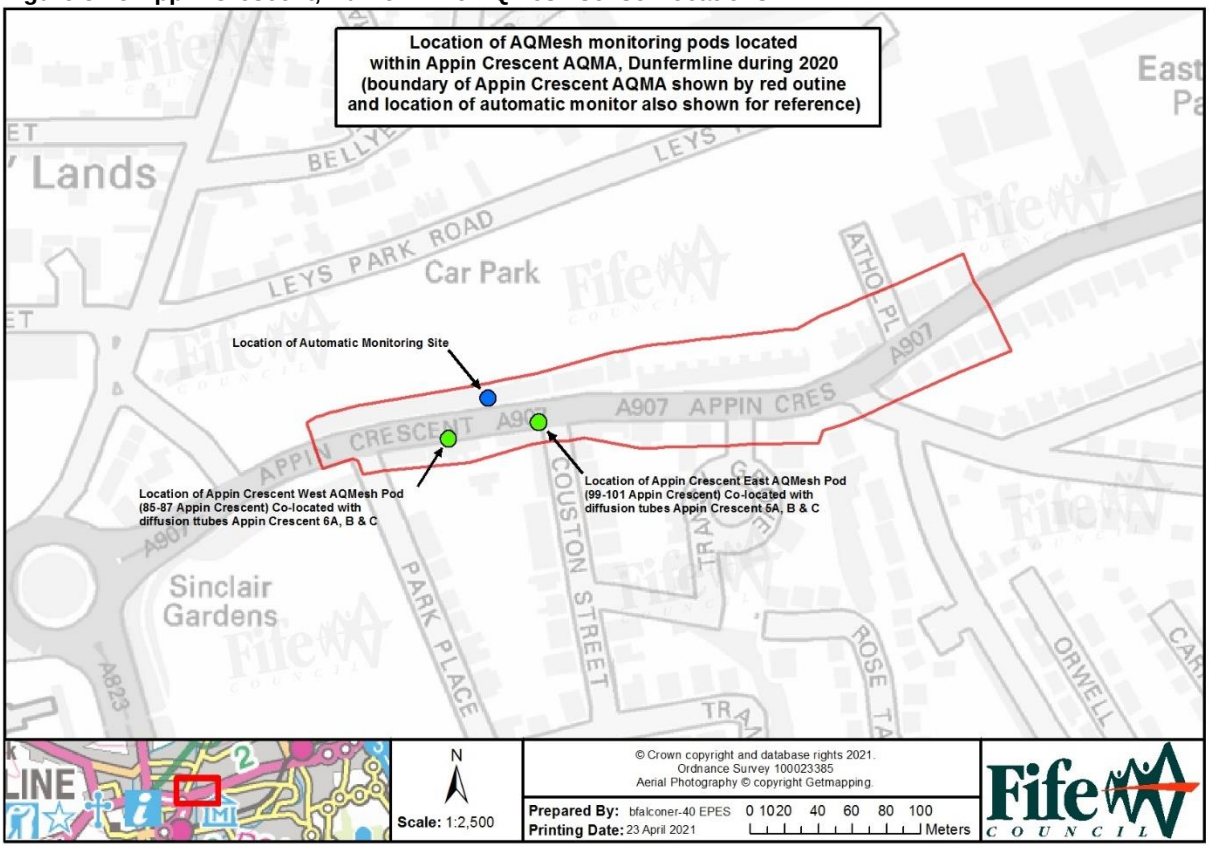


Figure 3-16 Bonnygate, Cupar AQMesh sensor location

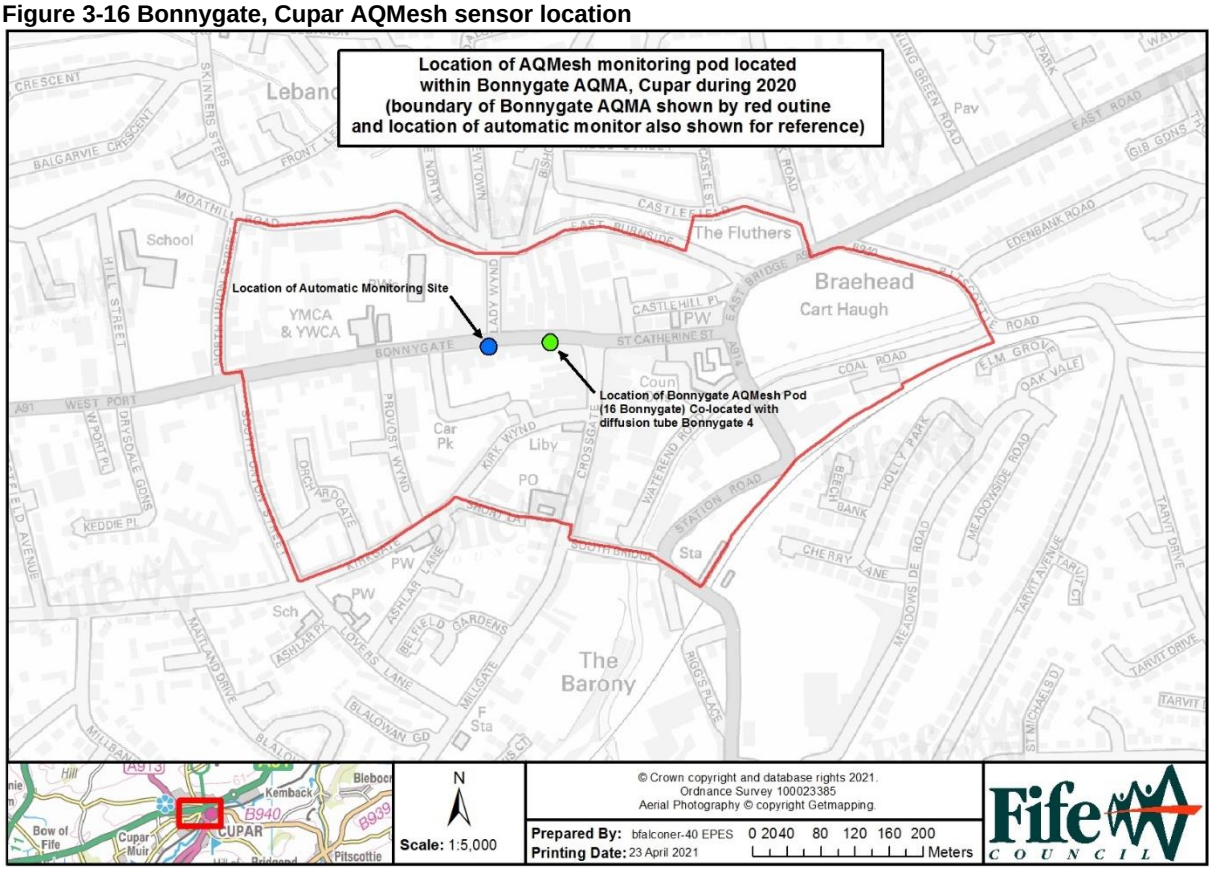


Figure 3-17 Photos of the Fife AQMesh Monitoring Locations

Bonnygate AQMesh sensor
(co-located with diffusion tube Bonnygate B4)

Appin Crescent West AQMesh sensor
(co-located with triplicate diffusion tubes
Appin Crescent 6A,B & C)

Appin Crescent East AQMesh sensor
(co-located with triplicate diffusion
Appin Crescent 5A,B & C)

3.3.2 Data

Table 3.4, Table 3.5 and Table 3.6 provide a summary of statistics for the concentrations measured by the AQMesh sensors from 1st January to the 31st December 2020. Table 3.7 and Table 3.8 provide a summary of statistics for the automatic monitoring sites located in Bonnygate, Cupar and Appin Crescent, Dunfermline for the same time period. More detailed Air Pollution Reports for the AQMesh sensors and automatic sites can be found in the Appendix G of this report. For a direct comparison against annual mean objectives a data capture rate of 75% is required for the year. To compensate for low data capture rates the period mean concentration has been annualised using the calculation described in Box 7.9 of the LAQM Technical guidance (TG16). Annualisation workings can be found in the Appendix D of this report.

As can be seen in Table 3.4, Table 3.5 and Table 3.6 all sensor sites did not measure exceedances for any of the Scottish air quality objectives for all of the pollutants measured. This is similar to previous years for Appin Crescent sites however it is in contrast to last year's Bonnygate measured concentrations for both PM_{10} and $PM_{2.5}$, where exceedances were measured for annual and daily (PM_{10} only) mean objectives. Pollution concentrations across all pollutants measured at all sites were significantly down on previous years due to Covid-19 travel restrictions from March onwards. These restrictions resulted in a significant decrease in traffic (up to 60% for periods) within both AQMAs.

In previous years monitoring, when comparing the AQMesh sensors with the nearby automatic sites, the statistics showed that at both Bonnygate and Appin Crescent, averaged concentrations were found to be higher at the AQMesh pod locations than that measured at the automatic sites for all pollutants (the exception being PM_{10} concentrations at Appin Crescent West). In 2020, at Bonnygate, concentrations were basically the same. A similar situation was seen at both Appin Crescent sites with only the NO_2 at Appin Crescent West showing significantly higher concentrations. The reason for this convergence in concentrations is attributed to the Covid-19 travel restrictions and the associated downturn in traffic through both locations.

Figure 3-19 and Figure 3-20 provide annual mean concentrations compared to AQS Objectives since AQMesh monitoring began and illustrates the difference between the automatic site and AQMesh sensor site locations.

The AQMesh pods were co-located with diffusion tubes (as illustrated in Figure 3-15 and Figure 3-16 and shown in the associated photographs in Figure 3-18). Table 3.9 provides the bias corrected annual mean concentrations for these diffusion tubes. For the Bonnygate and Appin Crescent locations the diffusion tubes measured higher NO_2 concentrations than the AQMesh. This is similar to previous year's measurements. Again, 2020 diffusion tube concentrations are down on previous years due to the Covid-19 travel restrictions.

Table 3.4 Fife Bonnygate AQ Mesh monitoring Statistics 1st January to 31st December 2020

	V High (No. of Days)	High (No. of Days)	Mod (No. of Days)	Low (No. of Days)	Max. Hourly Conc.	Max. Daily Conc.	Max. Running 8 Hour Mean	Max. Running 24 Hour Mean	Period Mean Conc.	Period Data Capture (%)
NO ($\mu g\ m^{-3}$)	0	0	0	0	383	137	254	137	36	81.0
NO_2 ($\mu g\ m^{-3}$)	0	0	0	305	135	56	89	57	21	83.3
PM_{10} ($\mu g\ m^{-3}$)	0	0	0	296	163	42	56	51	10	80.8
$PM_{2.5}$ ($\mu g\ m^{-3}$)	0	0	0	296	109	32	41	36	6	80.8

Table 3.5 Fife Appin Crescent West AQ Mesh monitoring Statistics 1st January to 31st December 2020

	V High (No. of Days)	High (No. of Days)	Mod (No. of Days)	Low (No. of Days)	Max. Hourly Conc.	Max. Daily Conc.	Max. Running 8 Hour Mean	Max. Running 24 Hour Mean	Period Mean Conc.	Period Data Capture (%)
NO (µg m^{-3})	0	0	0	0	227	95	163	98	14	80.8
NO_2 (µg m^{-3})	0	0	0	312	103	46	71	51	21	83.8
PM_{10} (µg m^{-3})	0	0	1	305	155	56	107	63	7	83.7
$PM_{2.5}$ (µg m^{-3})	0	0	0	306	88	32	58	36	5	83.7

Table 3.6 Fife Appin Crescent East AQ Mesh monitoring Statistics 1st January to 31st December 2020

	V High (No. of Days)	High (No. of Days)	Mod (No. of Days)	Low (No. of Days)	Max. Hourly Conc.	Max. Daily Conc.	Max. Running 8 Hour Mean	Max. Running 24 Hour Mean	Period Mean Conc.	Annualised Mean Conc.	Period Data Capture (%)
NO (µg m^{-3})	0	0	0	0	241	74	119	88	19	n/a	82.9
NO_2 (µg m^{-3})	0	0	0	303	161	63	102	65	17	n/a	79.5
PM_{10} (µg m^{-3})	0	0	0	239	124	44	83	50	8	8	65.6
$PM_{2.5}$ (µg m^{-3})	0	0	0	239	83	28	57	36	5	5	65.5

Table 3.7 Fife Cupar Automatic monitoring site statistics 1st January to 31st December 2020

	V High (No. of Days)	High (No. of Days)	Mod (No. of Days)	Low (No. of Days)	Max. Hourly Conc.	Max. Daily Conc.	Max. Running 8 Hour Mean	Max. Running 24 Hour Mean	Period Mean Conc.	Period Data Capture (%)
NO (µg/m^3)	0	0	0	0	324	107	211	107	18	91.3
NO_2 (µg/m^3)	0	0	0	336	165	86	120	87	21	90.8
PM_{10} (µg/m^3)	0	0	0	353	203	43	76	45	11	96.6
$PM_{2.5}$ (µg/m^3)	0	0	0	353	48	21	37	23	6	96.6

Table 3.8 Fife Dunfermline Automatic monitoring site statistics 1st January to 31st December 2020

	V High (No. of Days)	High (No. of Days)	Mod (No. of Days)	Low (No. of Days)	Max. Hourly Conc.	Max. Daily Conc.	Max. Running 8 Hour Mean	Max. Running 24 Hour Mean	Period Mean Conc.	Annualised Mean Conc.	Period Data Capture (%)
NO (µg m^{-3})	0	0	0	0	165	47	84	62	8	7.7	73.5
NO_2 (µg m^{-3})	0	0	0	270	84	48	62	51	15	14.8	73.5
PM_{10} (µg m^{-3})	0	0	0	364	68	25	38	28	8	n/a	99.6
$PM_{2.5}$ (µg m^{-3})	0	0	0	364	50	19	31	22	5	n/a	99.6

Figure 3-19 Appin Crescent Annual mean concentrations compared to AQS Objectives since AQMesh monitoring began

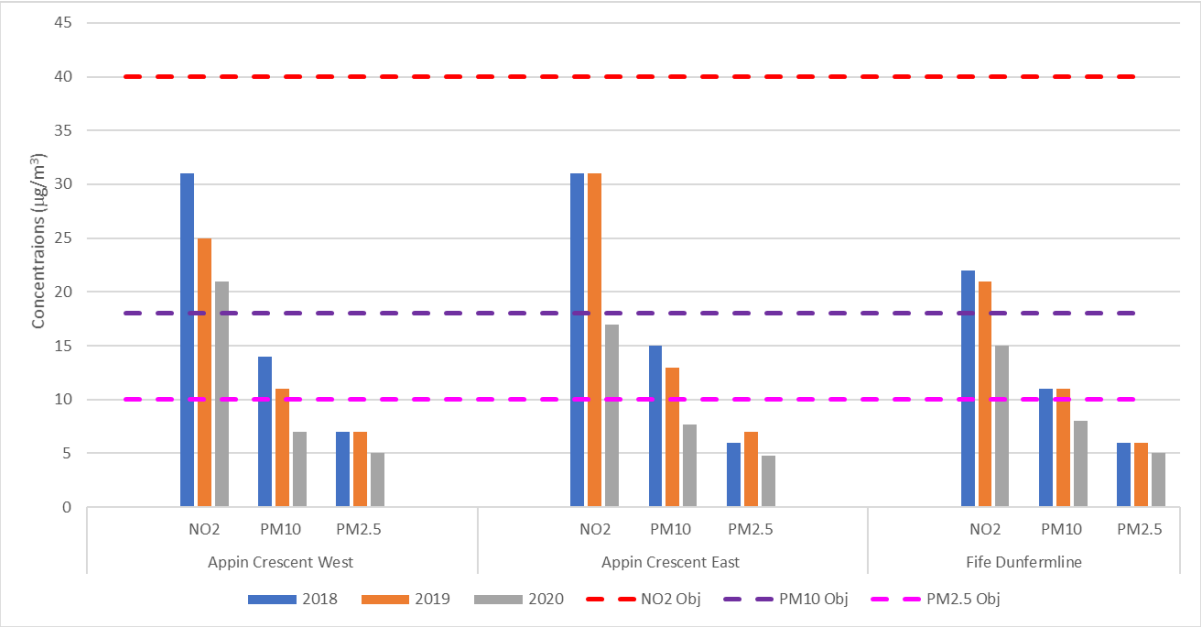


Figure 3-20 Bonnygate Annual mean concentrations compared to AQS Objectives since AQMesh monitoring began

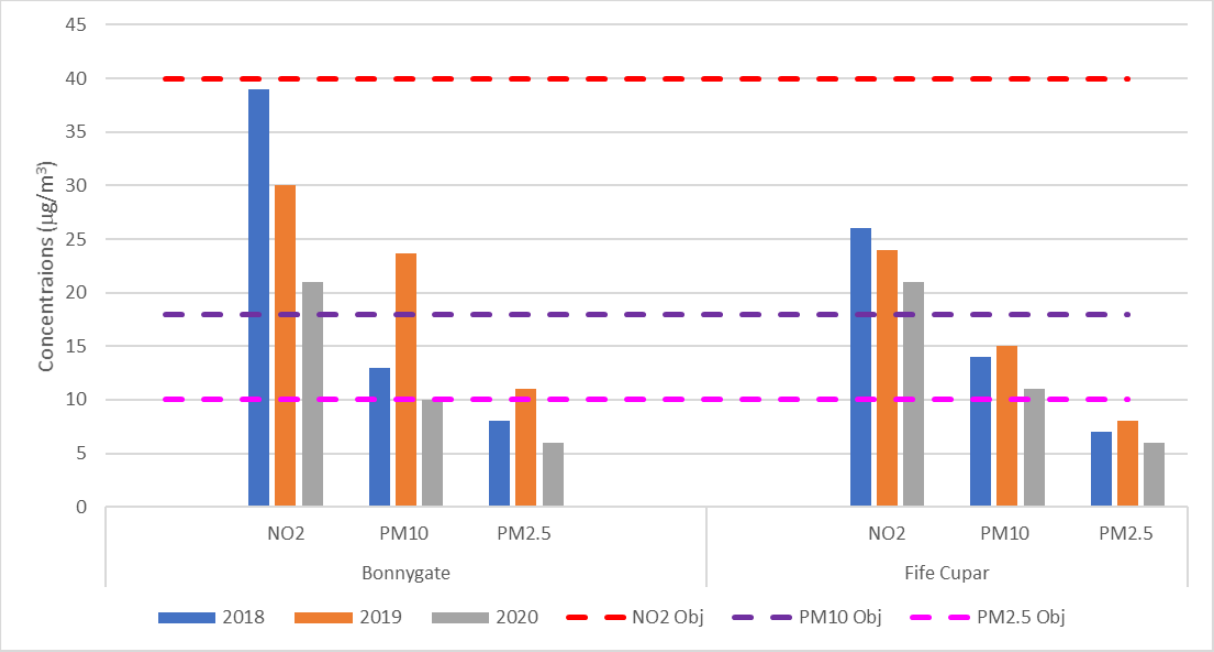


Table 3.9 Co-located Diffusion tube annual concentrations

Diffusion Tube Name	Diffusion Tube Annual NO_2 Concentration for 2020 (µg/m³)	AQ Mesh Annual NO_2 Concentration for 2020 (µg/m³)
Bonnygate 4B	22	21
Appin Crescent 5A,B,C (co-located with AQMesh East)	23	17
Appin Crescent 6A,B,C (co-located with AQMesh West)	24	21

3.3.3 Diurnal Variation Analysis

Diurnal variation analysis shows the hourly average concentrations (in parts per billion) for each hour of the day over the monitoring period in question (1st January 2020 to 31st December 2020). This section compares the respective AQMesh and automatic monitoring (Cupar and Dunfermline) site diurnal variation data.

Figure 3-21 to Figure 3-24 compares automatic and AQMesh sites NO_2 diurnal analysis for 2020 and 2019. In previous years, for the Bonnygate AQMA sites (Figure 3-21 and Figure 3-22), the AQMesh sensor location has measured higher than the automatic site especially during standard working hours (9am to 5pm). In 2020 this is not the case as the concentrations of NO_2 are basically the same throughout the day. This suggests that the Bonnygate AQMesh location is more affected by traffic NO_2 emissions than the Cupar automatic location.

Figure 3-21 NO_2 Diurnal Variation Plot for Fife Bonnygate AQMesh sensor and Fife Cupar automatic monitor 2020

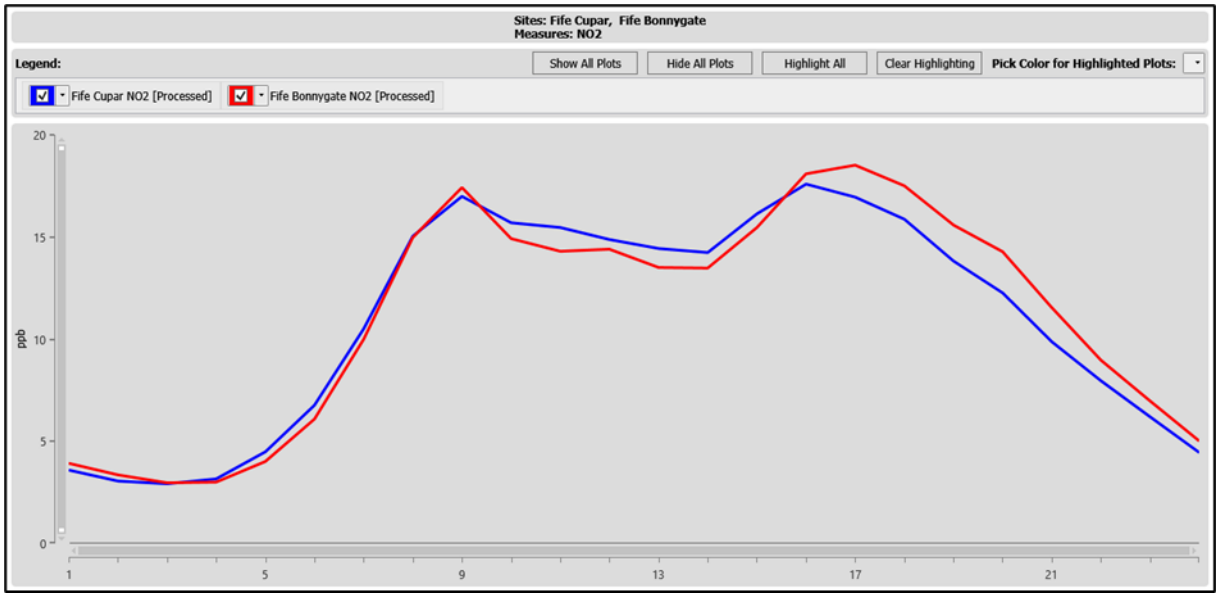


Figure 3-22 NO_2 Diurnal Variation Plot for Fife Bonnygate AQMesh sensor and Fife Cupar automatic monitor 2019

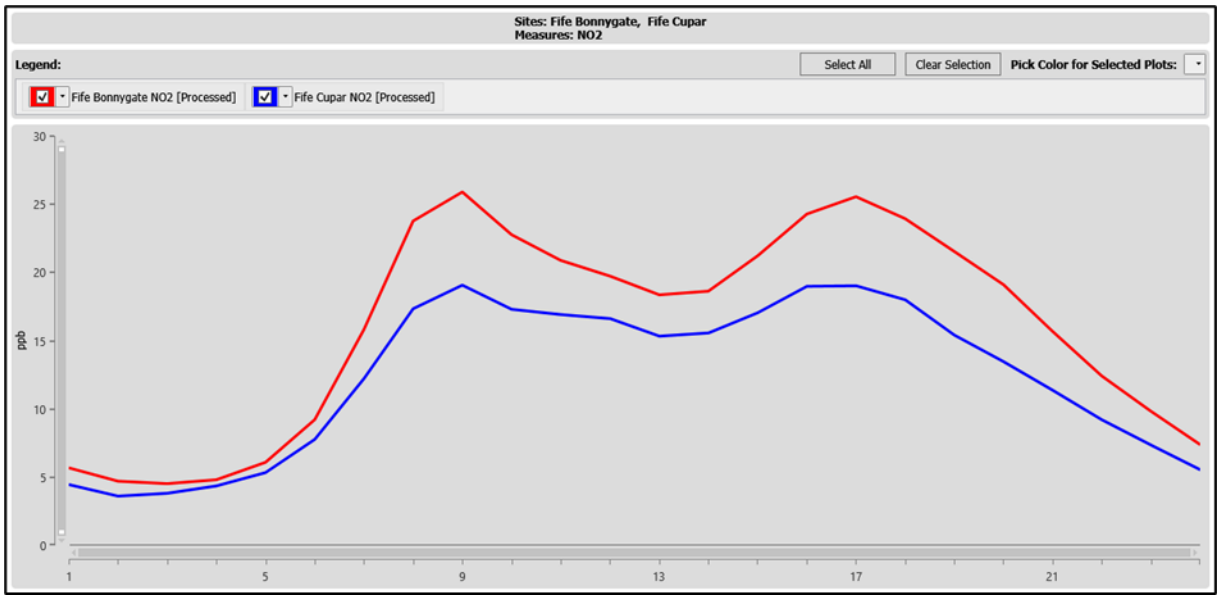


Figure 3-23 NO_2 Diurnal Variation Plot for Fife Appin Crescent West AQMesh sensor and Fife Dunfermline automatic monitor 2020

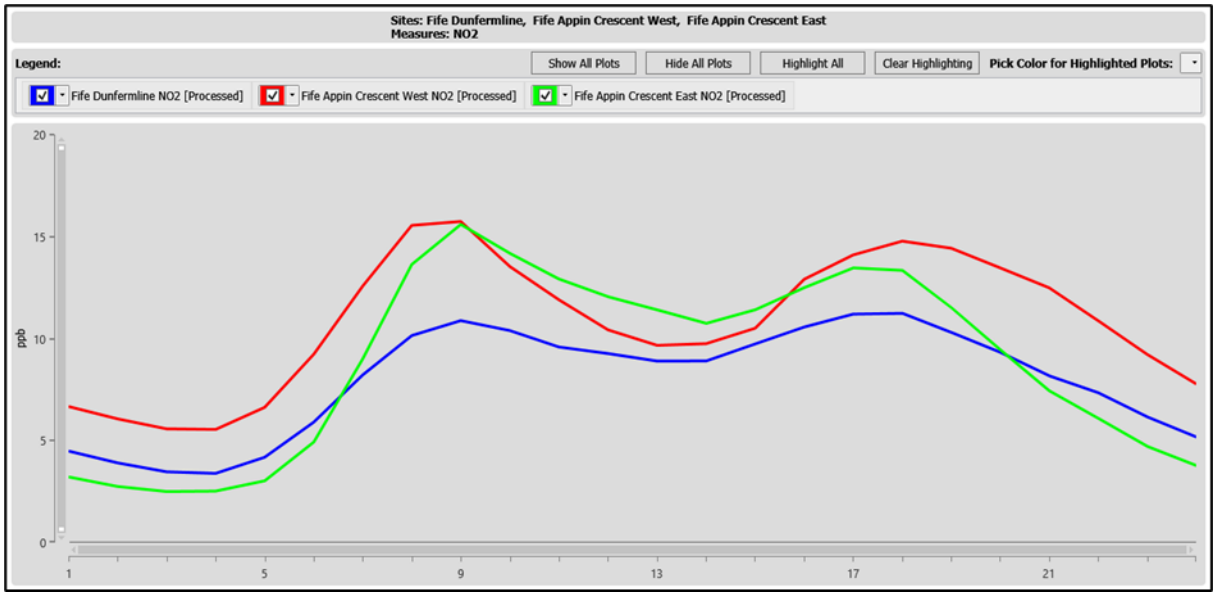
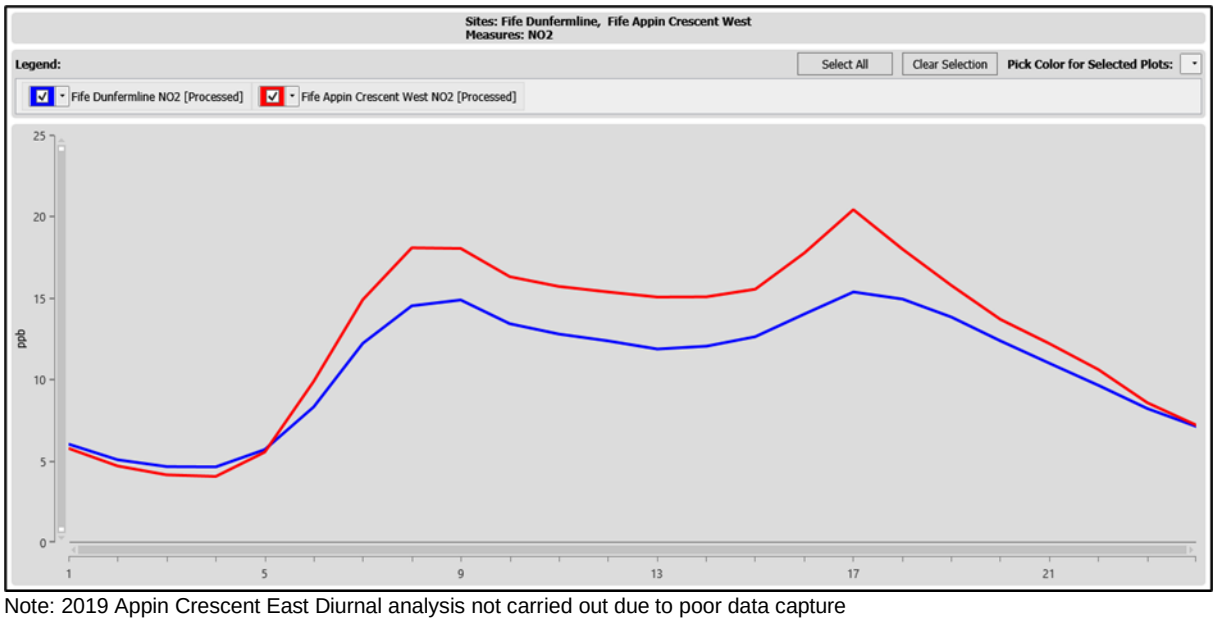


Figure 3-24 NO_2 Diurnal Variation Plot for Fife Appin Crescent West AQMesh sensor and Fife Dunfermline automatic monitor 2019



Note: 2019 Appin Crescent East Diurnal analysis not carried out due to poor data capture

Figure 3-25 to Figure 3-30 compares automatic and AQMesh sites PM_{10} and $PM_{2.5}$ diurnal analyses for 2020 and 2019.

Figure 3-25 and Figure 3-26 compares Bonnygate PM_{10} and $PM_{2.5}$ diurnal variation data for 2020 and 2019. For both PM_{10} and $PM_{2.5}$, in previous years, Bonnygate (AQMesh) was higher than Cupar (Automatic). However, 2020 diurnal variation analysis showed that Bonnygate PM_{10} concentrations dropped below that measured at Cupar. For $PM_{2.5}$, concentrations converge and are basically the same. This would suggest that traffic contributes more to particulate matter concentrations at the Bonnygate AQMesh location than at the Cupar automatic site. However due to the greater number of particular matter sources and its transboundary nature, there is significantly more uncertainty attributed to this hypothesis compared to NO_2 (where the vast majority of the source is vehicles from the adjacent road).

Figure 3-25 PM_{10} and $PM_{2.5}$ Diurnal Variation Plot for Fife Bonnygate AQMesh sensor and Fife Cupar automatic monitor 2020

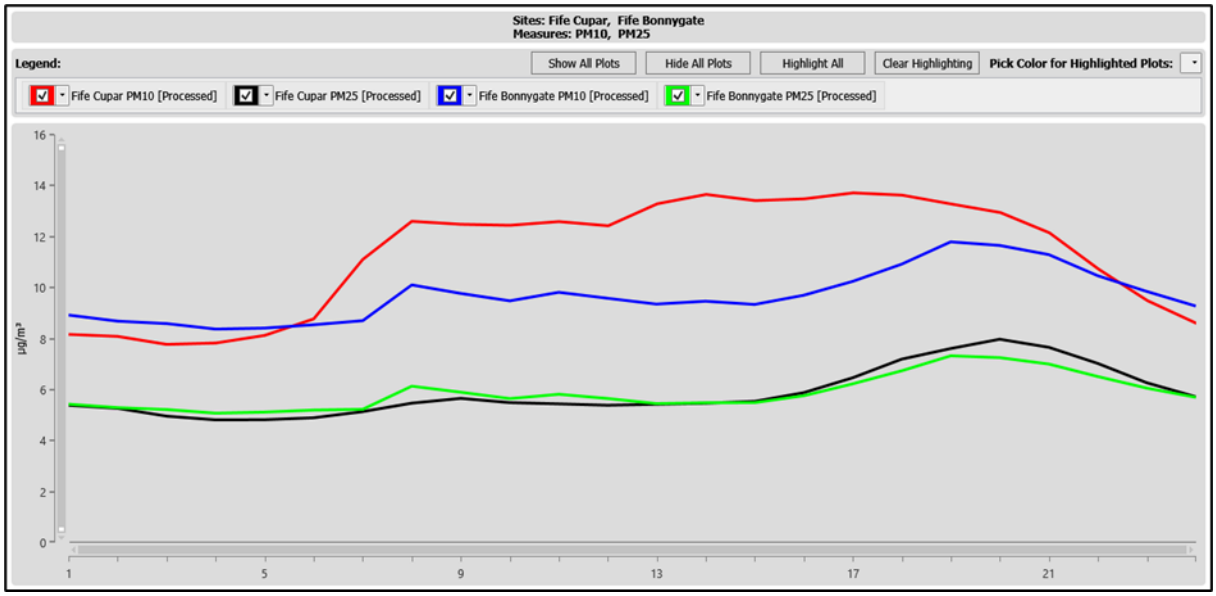


Figure 3-26 PM_{10} and $PM_{2.5}$ Diurnal Variation Plot for Fife Bonnygate AQMesh sensor and Fife Cupar automatic monitor 2019

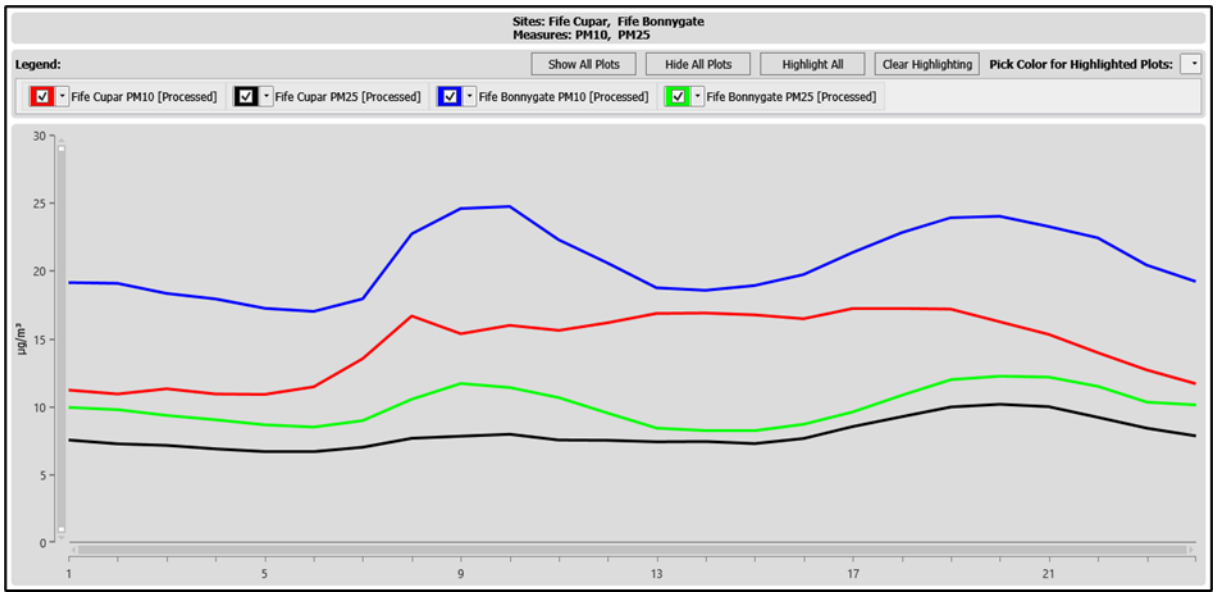


Figure 3-27 to Figure 3-30 illustrates the PM_{10} and $PM_{2.5}$ diurnal variation data for Fife Appin Crescent East and West AQMesh sensors, and the Fife Dunfermline automatic site for 2020 and 2019. As can be seen, the AQMesh sites profile is different to the Dunfermline automatic site for both 2020 and 2019. They are also different to the NO_2 profiles in Figure 3-21 and Figure 3-22 where the contribution from rush hour and working day traffic is obvious. It is also evident that the PM_{10} and $PM_{2.5}$ profiles do not change significantly from 2020 and 2019. This suggests that traffic has a less contributing factor to PM_{10} and $PM_{2.5}$ concentrations at these locations.

Figure 3-27 PM_{10} Diurnal Variation Plot for Fife Appin Crescent East and West AQMesh sensors and Fife Dunfermline automatic monitor 2020

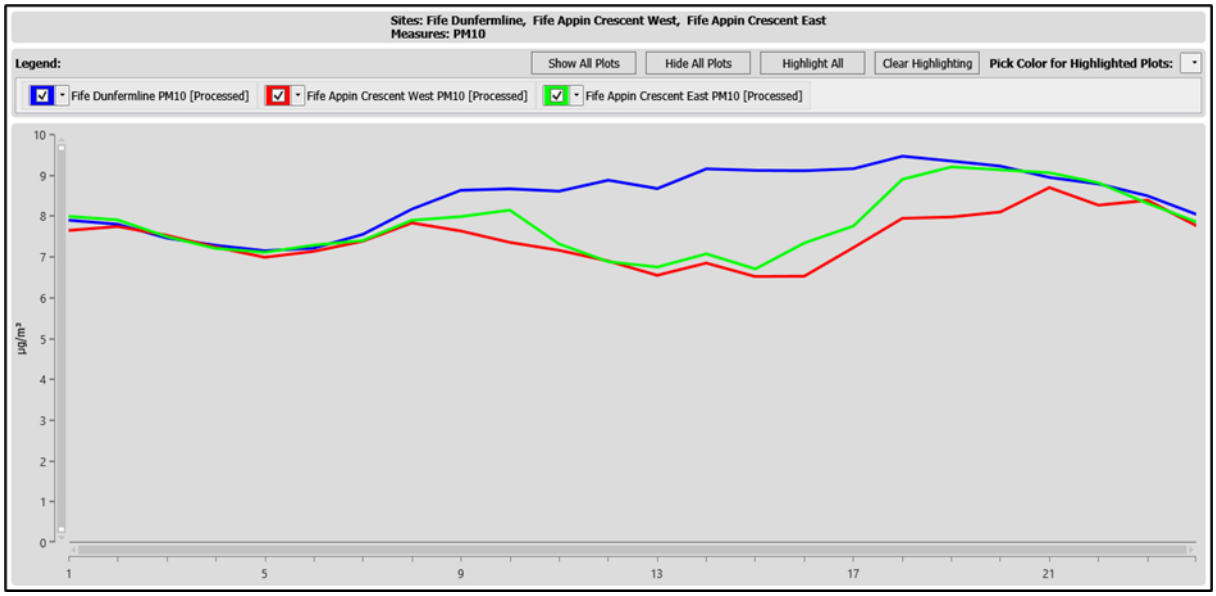


Figure 3-28 PM_{10} Diurnal Variation Plot for Fife Appin Crescent West AQMesh sensor and Fife Dunfermline automatic monitor 2019

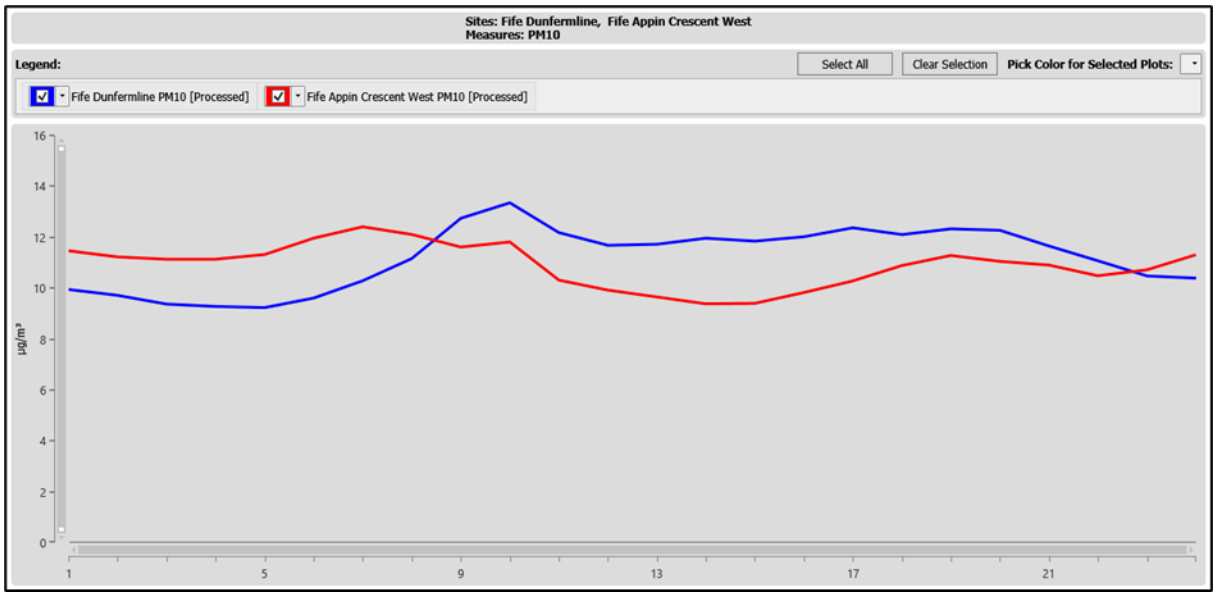


Figure 3-29 $PM_{2.5}$ Diurnal Variation Plot for Fife Appin Crescent East and West AQMesh sensors and Fife Dunfermline automatic monitor 2020

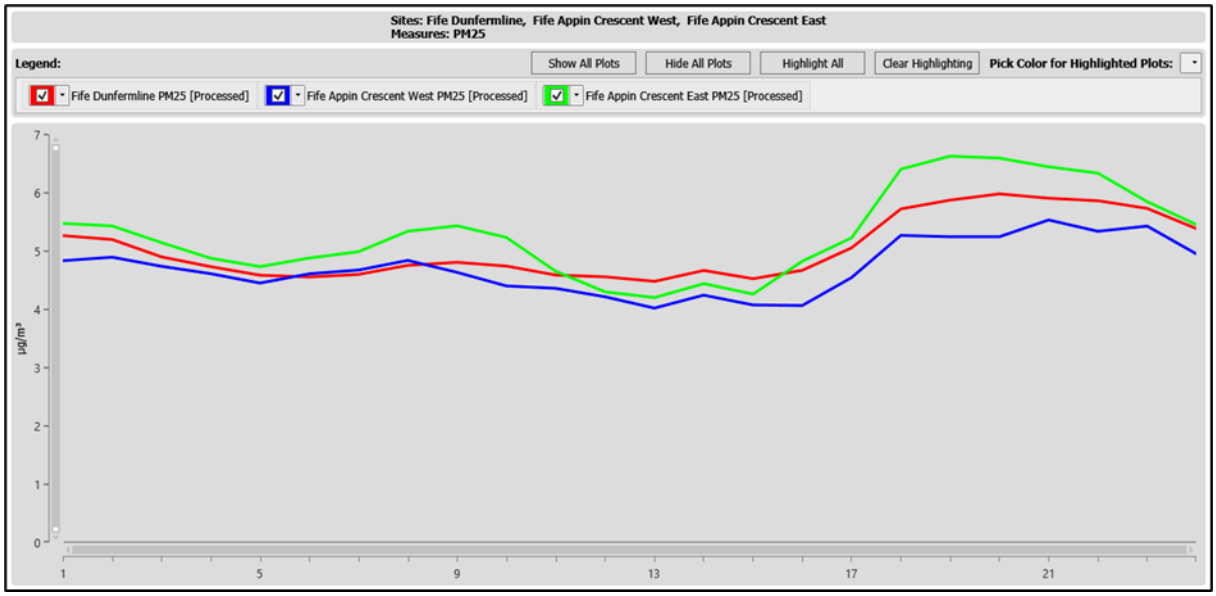
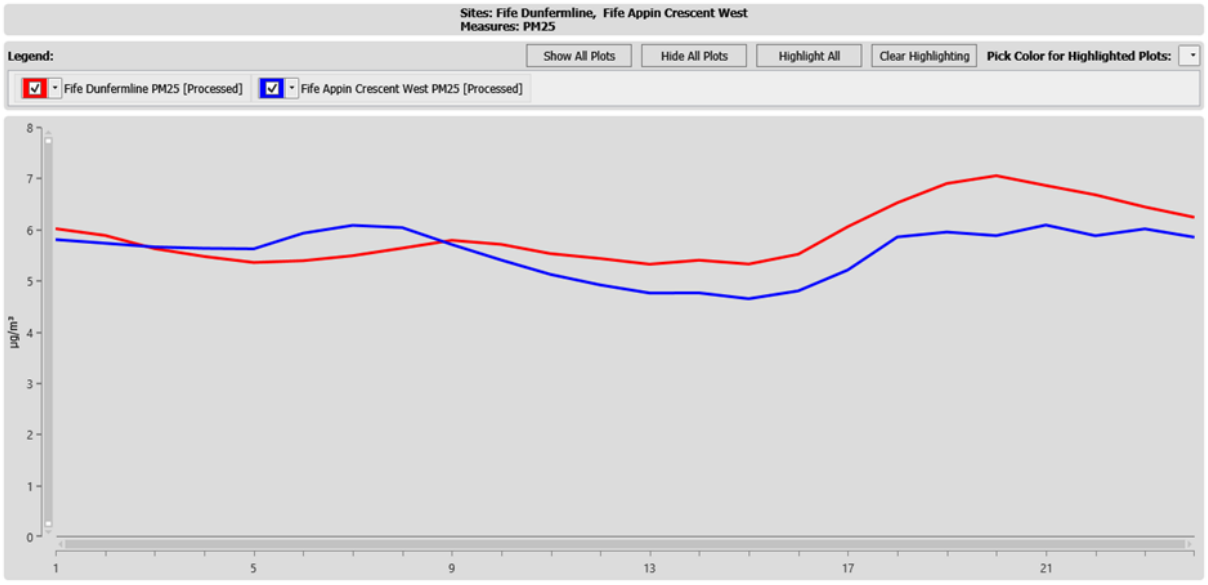


Figure 3-30 $PM_{2.5}$ Diurnal Variation Plot for Fife Appin Crescent West AQMesh sensors and Fife Dunfermline automatic monitor 2019

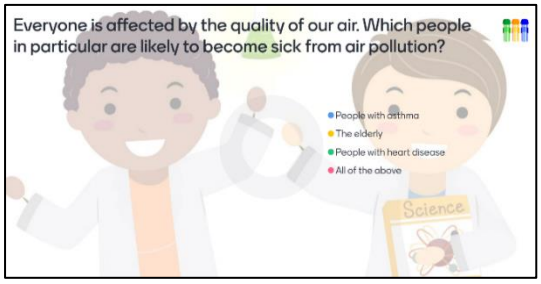


3.4 Clean Air Day Educational Package

For Clean Air Day 2020, Fife Council provided three primary schools with an educational package, including materials to carry out their own Citizen Science Study. Participating primary schools were:

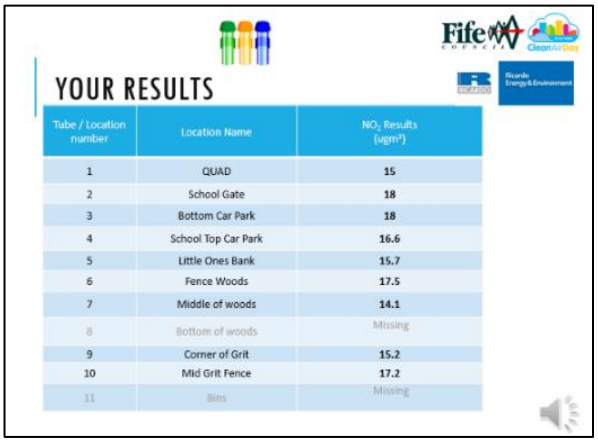
- St Margaret's RC Primary School, Dunfermline
- Cowdenbeath Primary School, Cowdenbeath
- Dairsie Primary School, Dairsie

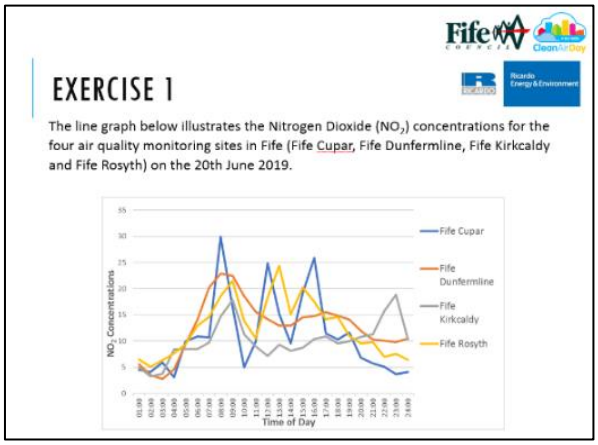
Prior to Clean Air Day, each school was provided with a pack by Ricardo Energy & Environment, on behalf of Fife Council. Pupils used the information from the introductory presentation to design their own Citizen Science Study, placing NO_2 diffusion tubes in locations they had chosen around their school grounds. Additionally, a Plume Lab Flow 2 personal monitor was provided so that mobile measurements could be taken by pupils during breaks and lunch times. This gave them a chance to see what the air quality was like in real time.



For Clean Air Day on the 8th October 2020, all participating schools joined an online webinar to learn more about the different air pollutants, how they are monitored within Fife Council, and their impacts on the health of people and the environment. A live interactive quiz was also hosted, giving all pupils the chance to answer via school tablets and show their air pollution knowledge. Additionally, at the end of the presentation a Q&A session meant pupils could ask any further questions they had on the subject. To help promote the day branded Clean Air Day t-shirts were gifted to pupils by Environmental Protection Scotland (EPS). To encourage active travel, Ricardo Energy & Environment provided pupils with bike bells and hi-visibility snap bands.

After Clean Air Day, primary schools were sent a presentation which allowed pupils to review what they had learned previously about air pollution and the diffusion tube results from their citizen science study. All of the citizen science results were below the annual mean objective of 40 µg m^{-3}. Pupils were encouraged to compare their results with the closest Fife Council diffusion tube data, via the Scottish Governments Air Quality in Scotland website diffusion tube map. Additionally, pupils could work their way through an exercise booklet with questions based on Fife Councils 2019 annual mean data for NO_2 and PM_{10} .





Positive feedback was received following this event. One school said

"*I thought the Clean Air Day event was brilliant. I liked the teams call and being able to see other schools joining in. I know it's usually done in school but this was a good alternative and it kept their interest. The children enjoyed learning about air pollution and had never thought of natural disasters contributing to it. They also liked and appreciated the freebies (especially the material that had various uses) and doing the air quality experiment. I think using the test tubes made them think they were real scientists. The resources and experiment was easy to use and set up and instructions were clear. I would be keen to do it again next year!*"

This is great feedback for Fife and shows that the event was a success. Fife are keen to run something similar in future years.

4 New Local Developments

4.1 Road Traffic Sources

There has been one major change to the existing local and trunk road network in Fife in 2020/2021, which was the signalisation of the Pitreavie Roundabout in Dunfermline including the provision of an additional lane on the Queensferry Road (A823) approach to the roundabout. These works are the first of the adopted 2017 FIFEplan Strategic Transportation Intervention Measures to be delivered and the 2021/2022 period should see the Redhouse Roundabout upgrade and signalisation works in Kirkcaldy being started and completed by Kingdom Park Limited in association with the on-going Kingdom Park development works. The works on the Esplanade in Kirkcaldy (A921) are nearing completion in association with the Waterfront Regeneration Project which is a £1.6 million Council funded project designed to better connect the waterfront and Kirkcaldy town centre as part of wider efforts to regenerate Kirkcaldy town centre. There have also been new additions to the Fife Council List of Public Roads in 2020/2021 with these relating to housing streets with low traffic flows and it is anticipated that the 2021/2022 period should see an increase in adoptions.

4.2 Other Transport Sources

Fife Council confirms that there are no new roads, junctions, bus stations or railway sources that have been identified that meet the associated criteria for further consideration.

4.3 Industrial Sources

Due to the recent cyber-attack experienced by SEPA Fife Council have been unable to source any supporting information.

4.4 Poultry Farms

Due to the recent cyber-attack experienced by SEPA Fife Council have been unable to source any supporting information.

4.5 Commercial and Domestic Sources

Due to the recent cyber-attack experienced by SEPA Fife Council have been unable to source any supporting information.

4.6 New Developments with Fugitive or Uncontrolled Sources

Due to the recent cyber-attack experienced by SEPA Fife Council have been unable to source any supporting information.

5 Planning Applications

5.1 Applications

The relevant planning guidance controls how Fife Council will manage potential air quality impacts from proposed developments. During 2020 the Land & Air Quality Team commented on numerous planning applications in relation to air quality matters with these ranging from proposed wood burning stoves and biomass boilers to large scale residential developments where an Air Quality Impact Assessment (AQIA) was required in support of the application. The types of comments made by the team are summarised in Table 5.1 below:

Table 5.1 Summarised air quality related planning application comments

Comment	Number of planning applications
AQIA advised/submitted for applications located within AQMA's	0
AQIA advised/submitted for applications located outwith AQMA's	69
Biomass boiler/wood burning stove questionnaire provided for completion/submitted (required for details of emissions, fuel type to be used etc)	22
General information provided (e.g. agreeing scope of AQIA, further information required, retain air quality condition(s) etc)	14

From the numerous planning applications submitted the main applications worthy of comment are detailed below as these are either located within, or in the vicinity of, an existing AQMA:

20/02267/PREAPP - Pre-application for restoration, demolition and conversion of listed building into 107 no. residential dwellings at St Margaret's Works, Foundry Street, Dunfermline

Given the nature/scale of the proposed development and the proximity of the Appin Crescent AQMA, the applicant was advised that an Air Quality Impact Assessment (AQIA) will be required. As of February 2021 this AQIA had not yet been submitted for comment/approval.

20/01673/SCO - EIA Scoping Opinion for revised method of working Lomond Quarry, including northern extension, extension to extraction timescale and revised restoration scheme at Lomond Quarry, Falkland Hills Road, Balsillie Avenue, Leslie

The associated Ironside Farrar 'Environmental Impact Assessment Scoping Report' submitted in support of the application states that air quality/dust has been 'Scoped In' and will be discussed further within the forthcoming Environmental Impact Assessment (EIA). As of February 2021 this EIA had not yet been submitted for comment/approval. This site is of interest to Fife Council due to a lengthy history of complaints from the local community due to the general operation of the quarry (mainly blasting) therefore matters relating to air quality/dust will need to be appropriately assessed.

6 Impact of COVID-19 upon LAQM

Covid-19 restrictions during 2020 had an impact on local air quality monitoring within Fife. Fife Council were not able to maintain their diffusion tube monitoring networks (exposure and analysis in-line with the DEFRA calendar) as normal during the 2020 lockdown period. Two changeover periods were missed during the first lockdown (1st April and 29th April). However, diffusion tube monitoring returned to normal in June. Therefore, Fife have data for diffusion tubes that were exposed for 3 months. However this data has been discounted from the monthly diffusion tube processing in accordance with relevant technical guidance.

Automatic monitoring was not affected by the 2020 lockdown as Fife Council have a contract with Ricardo Energy & Environment for Local Site Operator visits and comprehensive servicing which was not affected by the lockdown.

Fife Council carried out low-cost monitoring during 2020 which was impacted by the lockdown. AQMesh monitoring was carried out in Bonnygate and Appin Crescent AQMAs during 2020. However, the three monthly co-locations were impacted by the lockdown. Any disruption encountered by this are summarised in section 3.3.

There are no ongoing issues within the Fife local air quality monitoring network related to the Covid-19 response.

7 Conclusions and Proposed Actions

7.1 Conclusions from New Monitoring data

Nitrogen Dioxide

The 2021 APR has considered the available monitoring data measured during 2020. During 2020 non-automatic, diffusion tube monitoring was undertaken at 42 locations within Fife (covering 58 diffusion tubes in total). NO_2 is also measured at four sites using automatic monitors, Cupar, Dunfermline, Kirkcaldy and Rosyth. There were no exceedances of the NO_2 annual mean objective at any automatic or non-automatic monitoring locations during 2020. The highest annual mean concentration measured in Appin Crescent, Dunfermline during 2020 was 24 µg m^{-3} at Appin Crescent 6(A,B,C). The highest annual mean concentration measured in Bonnygate, Cupar during 2020 was 22 µg m^{-3} at Bonnygate B4.

During 2020, Appin Crescent 3 was moved slightly to the east due to a piece of street furniture being removed. No diffusion tubes were commissioned or decommissioned during 2020.

Three AQMesh sensors were installed in December 2017 to seek to further understand pollutant concentrations and trends in the Appin Crescent, Dunfermline AQMA (two monitoring locations) and Bonnygate, Cupar AQMA (one monitoring location). Data is managed and processed by Ricardo who carry out appropriate QA/QC. The data from all three sites showed that no exceedances were measured during 2020 for NO_2.

The significantly lower concentrations measured in 2020 is attributed to the COVID-19 pandemic lockdown restrictions and consequent reductions in traffic levels. Road traffic is the major source of NO_2 at monitoring locations in Fife.

Particulate Matter

PM_{10} concentrations are measured at four locations in Fife at Cupar, Dunfermline, Kirkcaldy and Rosyth. Measured 2020 concentrations were below the PM_{10} annual mean objective with no exceedances of the annual or daily mean objective at all sites.

During 2020, $PM_{2.5}$ was measured at four automatic monitoring sites in Cupar; Dunfermline, Kirkcaldy and Rosyth. Measured 2020 concentrations were below the $PM_{2.5}$ annual mean objective at all sites.

AQMesh Sensors located at two monitoring locations within Appin Crescent, Dunfermline measured no exceedances of the annual or daily mean objectives for both PM_{10} and $PM_{2.5}$.

The AQMesh Sensor monitoring location within Bonnygate Cupar measured no exceedances of the annual or daily mean objectives for both PM_{10} and $PM_{2.5}$.

The significantly lower concentrations measured in 2020 is attributed to the COVID-19 pandemic lockdown restrictions and consequent reductions in traffic levels. Decreases in concentrations of PM were lower than that seen for NO_2 due to traffic not being the predominant source.

Sulphur Dioxide

No SO_2 concentrations were measured in Fife during 2020. Historical SO_2 monitoring data from the Longannet power station site is available in previous year's APR report for Fife Council.

Carbon Monoxide

There was no short-term monitoring undertaken by Fife Council's Transportation Services department during 2020 due to Covid-19 restrictions. However, the monitoring is set to resume next year.

Benzene and 1,3 Butadiene

Benzene and 1,3 Butadiene monitoring carried out in the area of the INEOS Grangemouth refinery show that it is unlikely that the AQS objective for these pollutants have been exceeded within the Fife Council boundary.

A summary of the monitoring data from INEOS Houndpoint states that concentrations of the monitored substances have reduced when compared to those measured in 2019 at most of the locations.

At the time of writing, The Mossmorran and Braefoot Bay Independent Air Quality Monitoring Review Annual Report 2020 has not yet been published as this has been delayed. A summary will be added to this report once it is available.

7.2 Conclusions Relating to New Developments

Fife Council have not identified any New Local Developments out with the applications previously considered and assessed by Fife Council where there may be a risk of the air quality objectives being exceeded. Therefore, no additional air quality assessment is recommended at this time.

7.3 Proposed Actions

Following the review of all available data it is recommended that Fife Council carry out the following actions:

1. Submit the next Air Quality Progress Report in June 2022.
2. Review the current NO_2 diffusion tube monitoring programme and seek to relocate any tubes where deemed appropriate (i.e. where continuously low readings have been recorded).
3. Finalise revocation of the NO_2 element for the AQMAs at Bonnygate, Cupar and Appin Crescent, Dunfermline.
4. Publish the updated AQAPs for both Bonnygate, Cupar and Appin Crescent, Dunfermline (2021-2025).
5. Publish the updated Fife Air Quality Strategy (2021-2025).
6. Continue to implement the measures outlined in the action plans for Bonnygate, Cuapr and Appin Crescent, Dunfermline.
7. Continue to measure pollution in both AQMAs using AQMesh Sensor units to obtain a better understanding of concentrations in locations previously not monitored.
8. Await the outcomes of the Particulate Matter Measurement Study recently commissioned by the Scottish Government due to the current uncertainty regarding PM_{10} concentrations reported by different analyser types. The outcomes of this exercise will help guide future decision making regarding the possible revocation of the current PM_{10} AQMAs.

Fife Council have confirmed they will undertake these recommended actions.

Appendices

Appendix A: Monitoring Results
Appendix B: Full Monthly Diffusion Tube Results for 2020
Appendix C: Data QA/QC
Appendix D: Annualisation of Data
Appendix E: Technical Specification of Automatic Monitoring Equipment
Appendix F: Example Co-location Data Orthogonal Regression Analysis
Appendix G: Dynamic report Figures

Appendix A – Monitoring Results

Table A.1 - Details of Automatic Monitoring Sites

Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
Cupar	Kerbside	337403	714571	NO_2, PM_{10}, $PM_{2.5}$	Y	NO_x Analyser (Chemiluminescence), FIDAS (since December 2016)	N (1m)	<0.5m	1.9m
Dunfermline	Roadside	309926	687722	NO_2, PM_{10}, $PM_{2.5}$	Y	NO_x Analyser (Chemiluminescence), FIDAS (since September 2016)	Y (1m)	4m	2m
Kirkcaldy	Roadside	329143	692986	NO_2, PM_{10} $PM_{2.5}$	N	NO_x Analyser (Chemiluminescence), FIDAS (since April 2016)	N (10m)	5m	2m
Rosyth	Roadside	311755	683503	NO_2, PM_{10} $PM_{2.5}$	N	NO_x Analyser (Chemiluminescence) FIDAS (since July 2015)	Y (1.5m)	6m	2.1m

Table A.2 - Details of Non-Automatic Monitoring

Site Name	Site Type	X OS Grid Ref	Y OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? (m) [1]	Distance to kerb of nearest road (m) [2]	Tube collocated with a Continuous Analyser?
Central Area								
Glenlyon Road, Levenmouth	K	337357	701318	NO_2	N	N (26.8)	1	N
Asda Roundabout, Kirkcaldy	K	328742	694045	NO_2	N	N (28.0)	1	N
Victoria Road, Kirkcaldy	R(F)	328144	692315	NO_2	N	Y	2.5	N
Dunnikier Road, Kirkcaldy	R(F)	328152	692352	NO_2	N	Y	3.4	N
St Clair Street 1, Kirkcaldy	R	329157	693030	NO_2	N	N (2.0)	1.3	N
St Clair Street 2, Kirkcaldy	R	329131	693008	NO_2	N	N (2.0)	1.8	N
St Clair Street 3 (MS), Kirkcaldy	R(F)	329174	693069	NO_2	N	Y	2	N
125 St Clair Street, Kirkcaldy	R(F)	329208	693163	NO_2	N	Y	1.5	N
179A St Clair Street, Kirkcaldy	R(F)	329310	693326	NO_2	N	Y	1.5	N
St Clair Street ROMON (A,B,C,)* Kirkcaldy	R	329143	692986	NO_2	N	N (10.0)	5	Y
3A Junction Road, Kirkcaldy	R(F)	329123	693029	NO_2	N	Y	1.5	N
Hendry Road Kirkcaldy	R	327437	692270	NO_2	N	N (16.0)	1.7	N

East Area								
Bell Street 1, St Andrews	R(F)	350712	716691	NO_2	N	Y	1.6	N
Bell Street 2, St Andrews	R(F)	350721	716646	NO_2	N	Y	2.1	N
City Road 1, St Andrews	R	350590	716570	NO_2	N	N (1.0)	1.5	Y
City Road 3, St Andrews	R	350538	716682	NO_2	N	N (14.0)	1.5	N
City Road 5, St Andrews	R	350499	716748	NO_2	N	N (5.0)	1.9	N
City Road 6, St Andrews	R	350470	716826	NO_2	N	N (5.0)	2.2	N
Links Crescent, St Andrews	R(F)	350156	716947	NO_2	N	Y	3	N
North Street, St Andrews	R	350519	716935	NO_2	N	N (3.0)	2.2	N
Bonnygate B1, Cupar	R(F)	337409	714570	NO_2	Y	Y	5.3	N
Bonnygate B2, Cupar	R(F)	337507	714584	NO_2	Y	Y	1.7	N
Bonnygate B3 Cupar	R(F)	337480	714586	NO_2	Y	Y	1.6	Y
Bonnygate B4, Cupar	R(F)	337467	714576	NO_2	Y	Y	1.9	N
Ladywynd B5, Cupar	R(F)	337405	714596	NO_2	Y	Y	1	N
Bonnygate West B6, Cupar	R	337333	714559	NO_2	Y	N (4.0)	3	N
Crossgate, Cupar	K	337536	714537	NO_2	Y	N (3.0)	0.5	N
Bonnygate, Cupar, Monitor A, B, C*	K	337403	714571	NO_2	Y	N (4.8)	0.6	Y

West Area								
High Street, Cowdenbeath	K	316527	691742	NO_2	N	N (3.5)	0.5	N
Admiralty Road A, Rosyth	R(F)	312069	683431	NO_2	N	Y	9	N
Admiralty Road (A,B,C) ROMON*	R(F)	311755	683503	NO_2	N	Y	6.5	Y
Appin Crescent 1, Dunfermline	R(F)	309888	687719	NO_2	Y	Y	6.5	N
Appin Crescent 2, Dunfermline	R(F)	309883	687701	NO_2	Y	Y	1.5	N
Appin Crescent 3, Dunfermline	R(F)	309975	687716	NO_2	Y	Y	1.8	N
Appin Crescent 4(A)(B)(C), Dunfermline*	R(F)	309926	687722	NO_2	Y	Y	3.9	Y
Appin Crescent 5(A)(B)(C) Dunfermline*	R(F)	309957	687714	NO_2	Y	Y	1.5	N
Appin Crescent 6(A)(B)(C) Dunfermline*	R(F)	309904	687704	NO_2	Y	Y	1.5	N
Appin Crescent (A)(B)(C), Dunfermline*	R	309900	687716	NO_2	Y	N (5.1)	1.6	N
Carnegie Drive (A,B,C), Dunfermline*	R(F)	309023	687632	NO_2	N	Y	2.3	N
11 Halbeath Road, Dunfermline	R (F)	310245	687784	NO_2	N	Y	14	N
Pilmuir Road, Dunfermline	R	309143	687774	NO_2	N	Y	2	N
Mill Street, Dunfermline	R	308888	687968	NO_2	N	Y	2	N

Rumblingwell, Dunfermline	R	307898	688224	NO_2	N	N (6.3)	1.7	N
102 Baldridgeburn, Dunfermline	K	308447	688068	NO_2	N	N (3.0)	0.5	N

Y= if the monitoring site is at a location of exposure (e.g. installed on/adjacent to the façade of a residential property).
*Triplicate sites
K = Kerbside, 0-1, from the kerb of a busy road.
R =Roadside,1-5m from the kerb. R (F) = Façade of buildings on street.
UB = Urban background, >50m from any busy road.

Table A.3 - Annual mean NO_2 Monitoring Results – Non-Automatic sites (µg m^{-3})

Site Name	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020(%) (2)	2016	2017	2018	2019	2020 BIAS Adjusted (3)
Central Area								
Glenlyon Road, Levenmouth	K	100	75	26	24	24	23	16
Asda Roundabout, Kirkcaldy	K	100	75	28	24	27	22	16
Victoria Road, Kirkcaldy	R(F)	100	67	25	23	25	23	16*
Dunnikier Road, Kirkcaldy	R(F)	100	75	26	21	23	22	16
St Clair Street 1, Kirkcaldy	R(F)	100	75	32	33	30	25	18
St Clair Street 2, Kirkcaldy	R(F)	100	75	37	34	33	29	23
St Clair Street 3 (MS), Kirkcaldy	R(F)	100	75	28	25	26	23	16
125 St Clair Street, Kirkcaldy	R(F)	100	75	32	29	28	23	18
179A St Clair Street, Kirkcaldy	R(F)	100	75	28	26	25	22	18
St Clair Street ROMON (A,B,C) Kirkcaldy	R	100	75	20	19	17	16	13
3A Junction Road, Kirkcaldy		100	75	27	22	23	19	15
Hendry Road, Kirkcaldy	R	100	50	-	26	24	21	16*
East Area								
Bell Street 1, St Andrews	R(F)	100	67	30	27	28	27	14*
Bell Street 2, St Andrews	R(F)	100	75	26	24	23	22	13
City Road 1, St Andrews	R	100	75	24	20	22	22	13
City Road 3, St Andrews	R	100	75	25	22	23	22	16
City Road 5, St Andrews	R	100	75	29	23	22	18	13
City Road 6, St Andrews	R	100	75	33	31	31	27	21
Links Crescent, St Andrews	R(F)	100	75	-	19	21	19	14
North Street, St Andrews	R	100	75	-	-	-	21	13
Bonnygate B1, Cupar	R(F)	100	75	25	24	25	24	18
Bonnygate B2, Cupar	R(F)	100	75	-	-	-	23	21
Bonnygate B3, Cupar	R(F)	100	75	37	31	31	32	20

Site Name	Site Type	Valid Data Capture for Monitoring Period (%) [1]	Valid Data Capture 2020(%) [2]	2016	2017	2018	2019	2020 BIAS Adjusted [3]
Bonnygate B4, Cupar	R(F)	100	75	**41**	33	34	32	22
Bonnygate West B6, Cupar	R(F)	100	75	-	20	18	18	13
Bonnygate, Cupar, Monitor A, B, C	K	100	58	27	26	27	23	16*
West Area								
High Street, Cowdenbeath	K	100	75	21	18	20	19	14
Admiralty Road A, Rosyth	R(F)	100	75	29	26	25	27	20
Admiralty Road (A,B,C) ROMON	R(F)	100	75	25	22	22	22	17
Appin Crescent 1, Dunfermline	R(F)	100	75	25	25	25	26	19
Appin Crescent 2, Dunfermline	R(F)	100	75	38	34	34	31	24
Appin Crescent 3, Dunfermline	R(F)	100	67	32	29	28	28	21*
Appin Crescent 4(A)(B)(C), Dunfermline	R(F)	100	75	24	23	21	21	15
Appin Crescent 5(A)(B)(C), Dunfermline	R(F)	100	75	35	35	31	30	23
Appin Crescent 6(A)(B)(C), Dunfermline	R(F)	100	75	39	37	35	34	24
Appin Crescent (A)(B)(C), Dunfermline	R	100	75	31	29	27	27	20
Carnegie Drive (A,B,C), Dunfermline	R(F)	100	75	30	26	27	26	18
11 Halbeath Road, Dunfermline	R (F)	100	75	17	16	15	15	12
Pilmuir Road, Dunfermline	R	100	75	26	23	24	23	17
Mill Street, Dunfermline	R	100	75	30	30	30	30	22

Site Name	Site Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2020(%) (2)	2016	2017	2018	2019	2020 BIAS Adjusted (3)
Rumblingwell, Dunfermline	R	100	75	22	22	21	21	15
102 Baldridgeburn, Dunfermline	K	100	75	-	-	-	33	16

Notes:

Exceedances of the NO_2 annual mean objective of 40 µg m^{-3} are shown in **bold**.

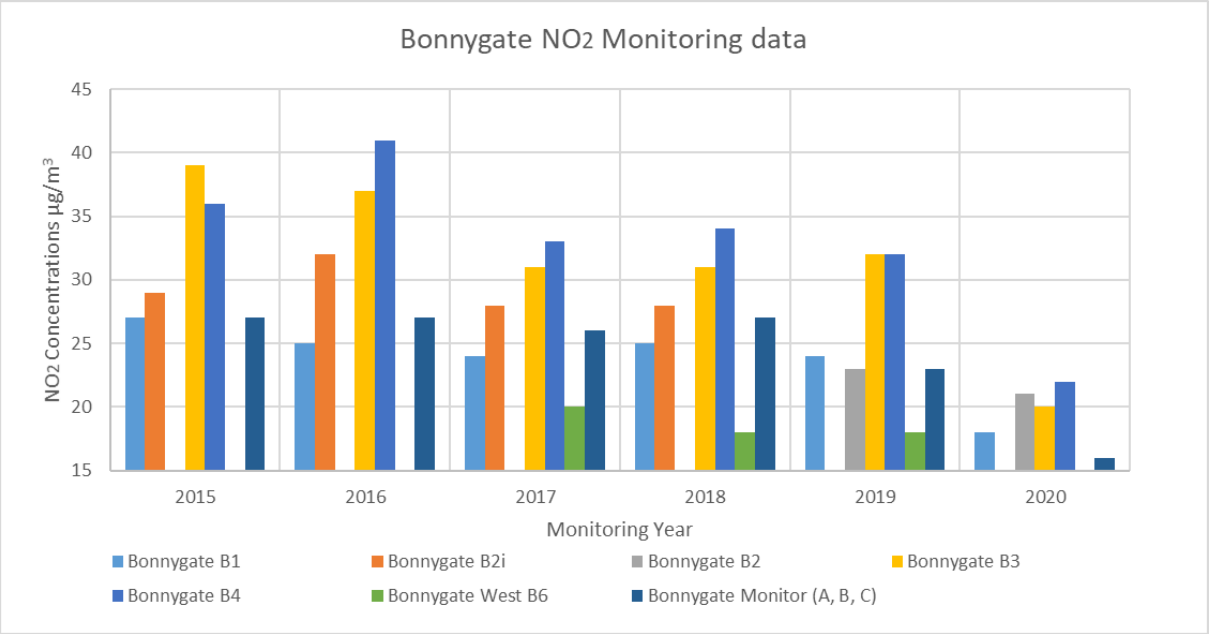
(1) Data capture for the monitoring period, in cases where monitoring was only carried out for part of the year.

(2) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) Means for diffusion tubes have been corrected for bias. All means have been “annualised” as per LAQM.TG(16) if valid data capture for the full calendar year is less than 75%. See Appendix C

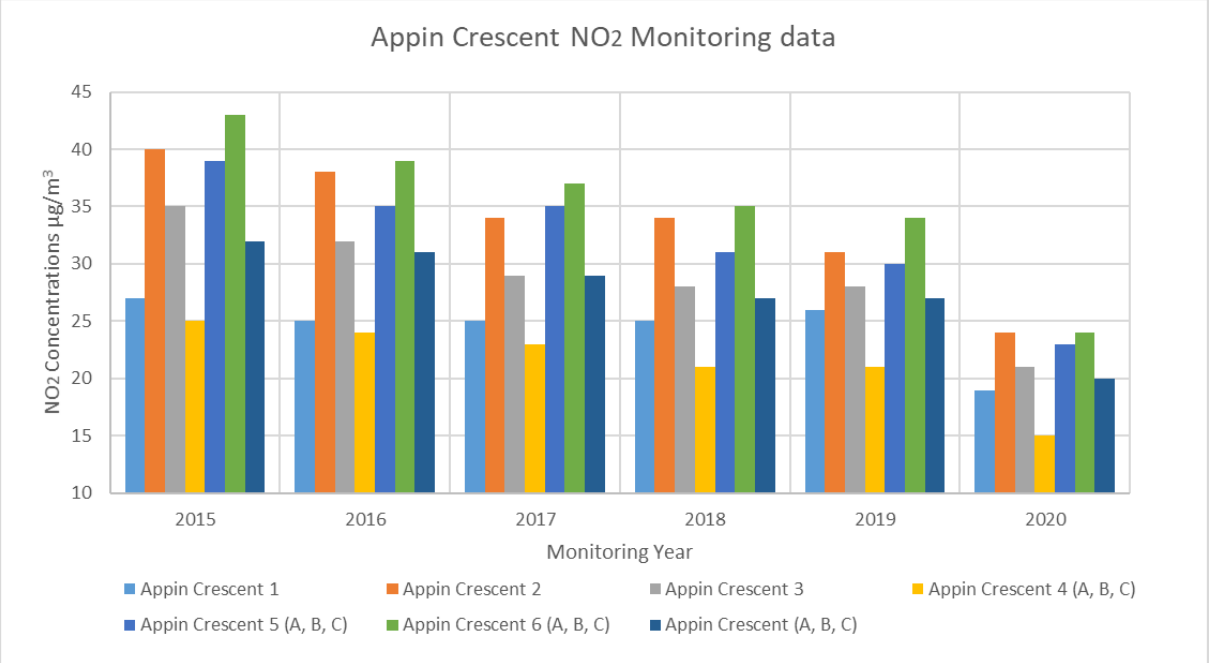
*****Annualised in accordance with TG.16. Full details in Appendix C.

Figure A.1 Bonnygate Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



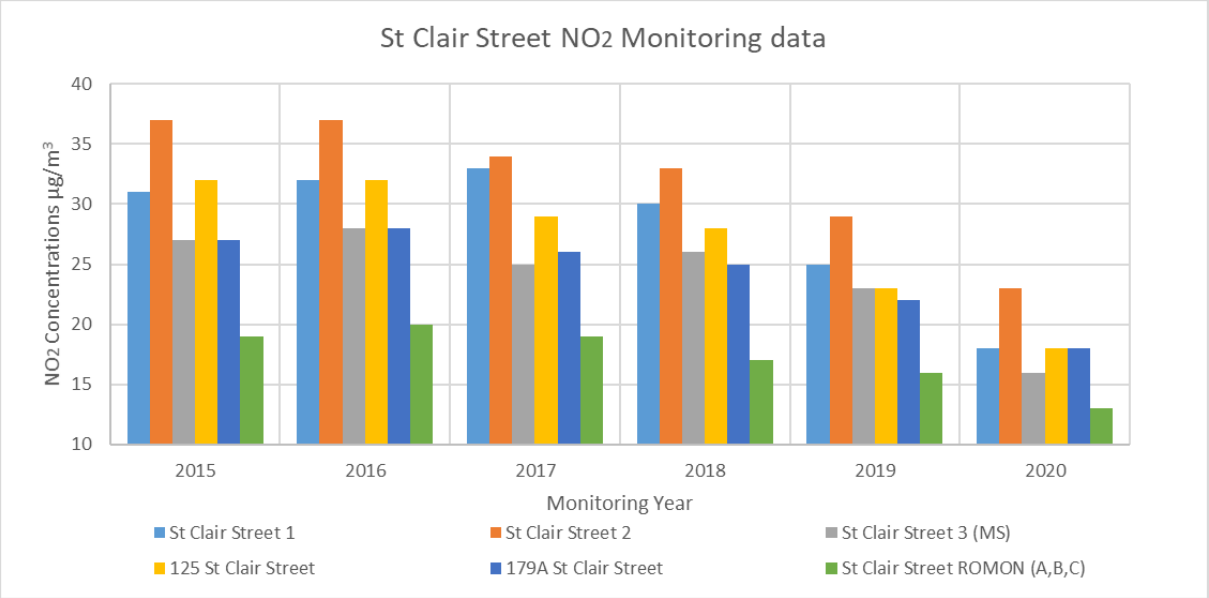
NO_2 annual mean concentrations for the Bonnygate area are presented in Figure A.1. Concentrations increased at all sites between 2015 and 2016 before decreasing slightly from 2016 to 2020.

Figure A.2 Appin Crescent Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



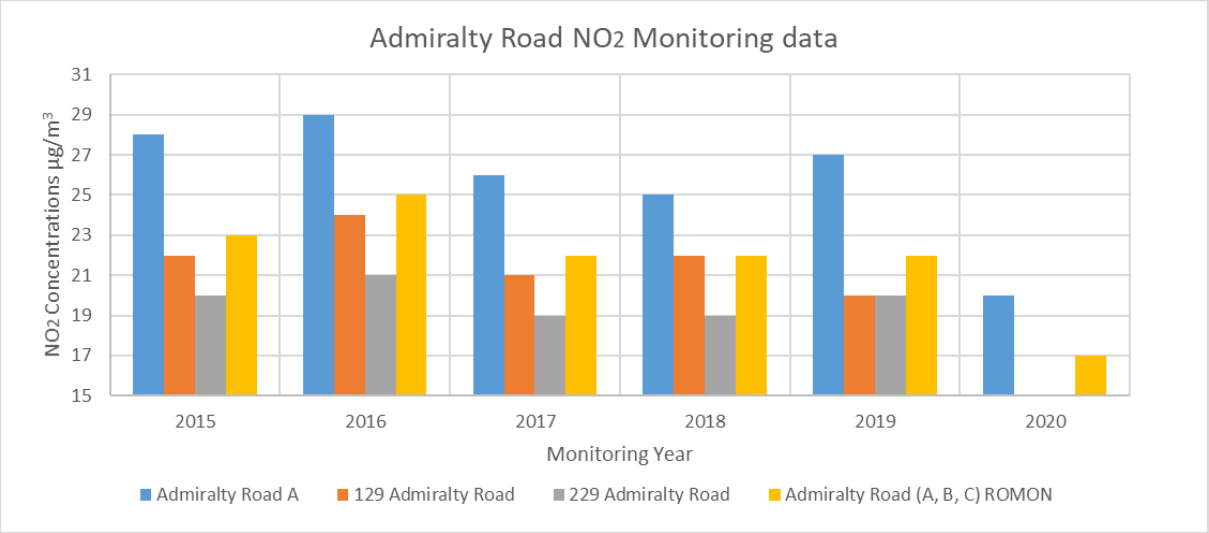
NO_2 annual mean concentrations for the Appin Crescent area are presented in Figure A.2. Since 2015 concentrations have declined steadily at all sites, with the exception of 2016 where there was a slight increase at all monitoring sites.

Figure A.3 St Clair Street Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



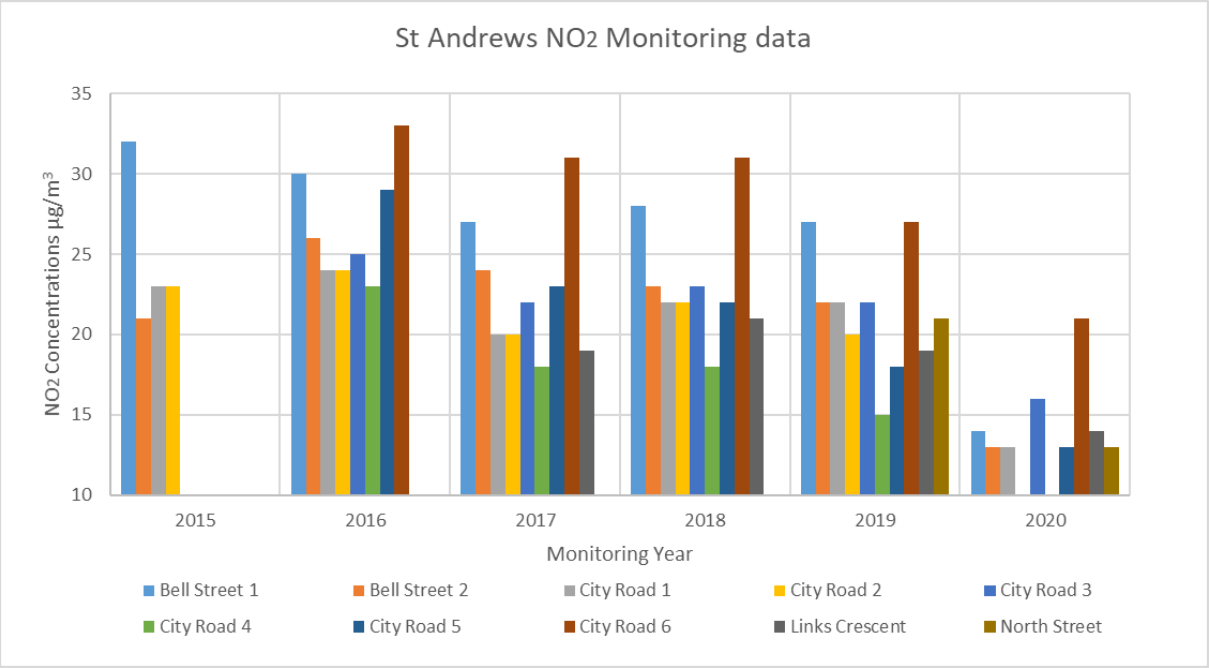
NO_2 annual mean concentrations for the St Clair Street area are presented in Figure A.3. Concentrations stayed fairly consistent between 2015 and 2016, then started to decline steadily from 2016 to 2020.

Figure A.4 Admiralty Road Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



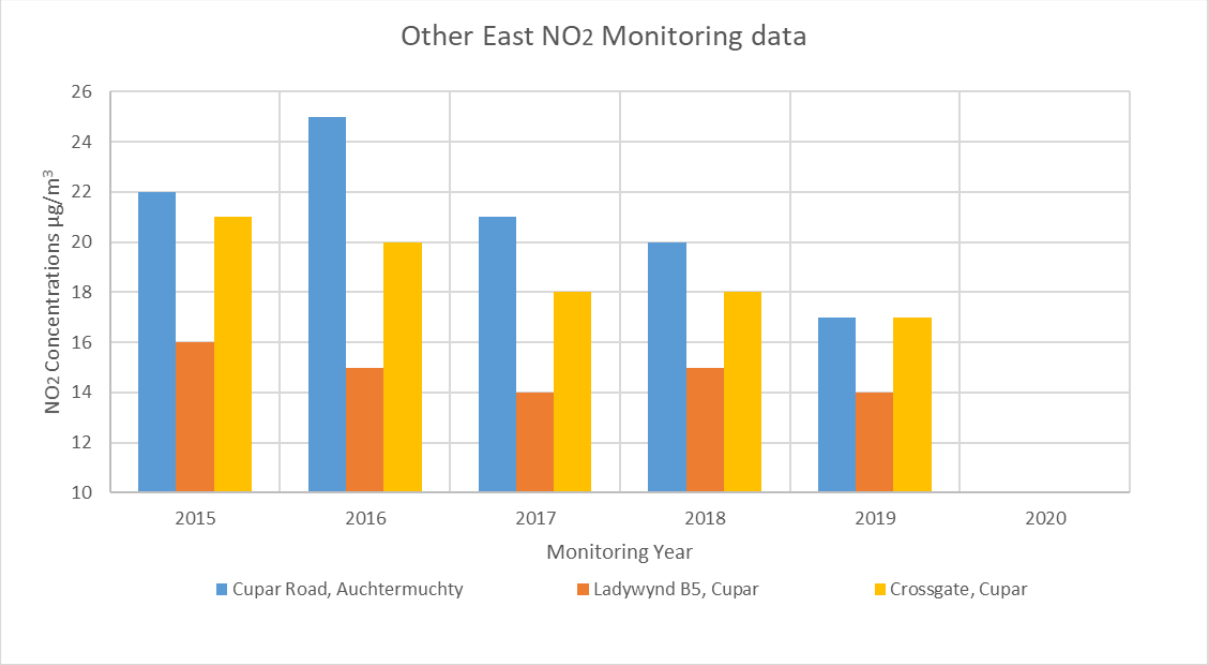
NO_2 annual mean concentrations for the Admiralty Road area are presented in Figure A.4. Concentrations increased slightly in 2016, then gradually declined between 2016 and 2020, with the exception of Admiralty Road A increasing slightly in 2019.

Figure A.5 St Andrews Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



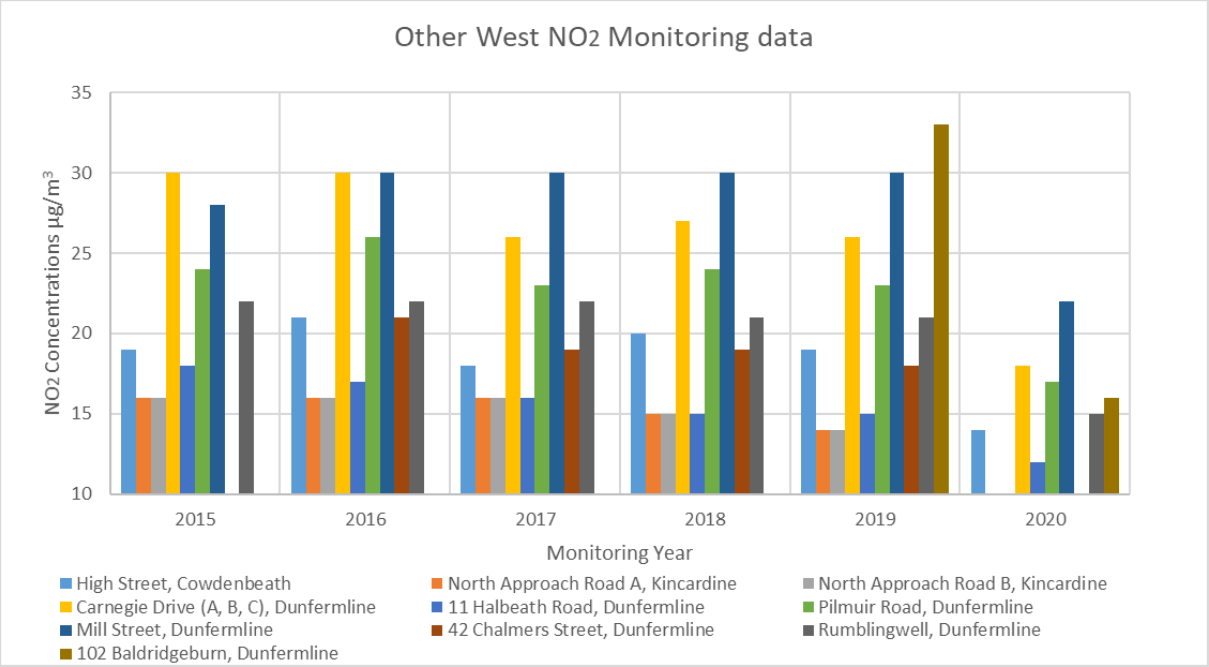
NO_2 annual mean concentrations for the St Andrews area are presented in Figure A.5. Between 2015 and 2020 concentrations declined. An additional four monitoring sites were introduced in 2016. Concentrations decreased at all sites with the exception of Bell Street 1 which increased slightly in 2018 before declining again in 2019.

Figure A.6 Other East Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



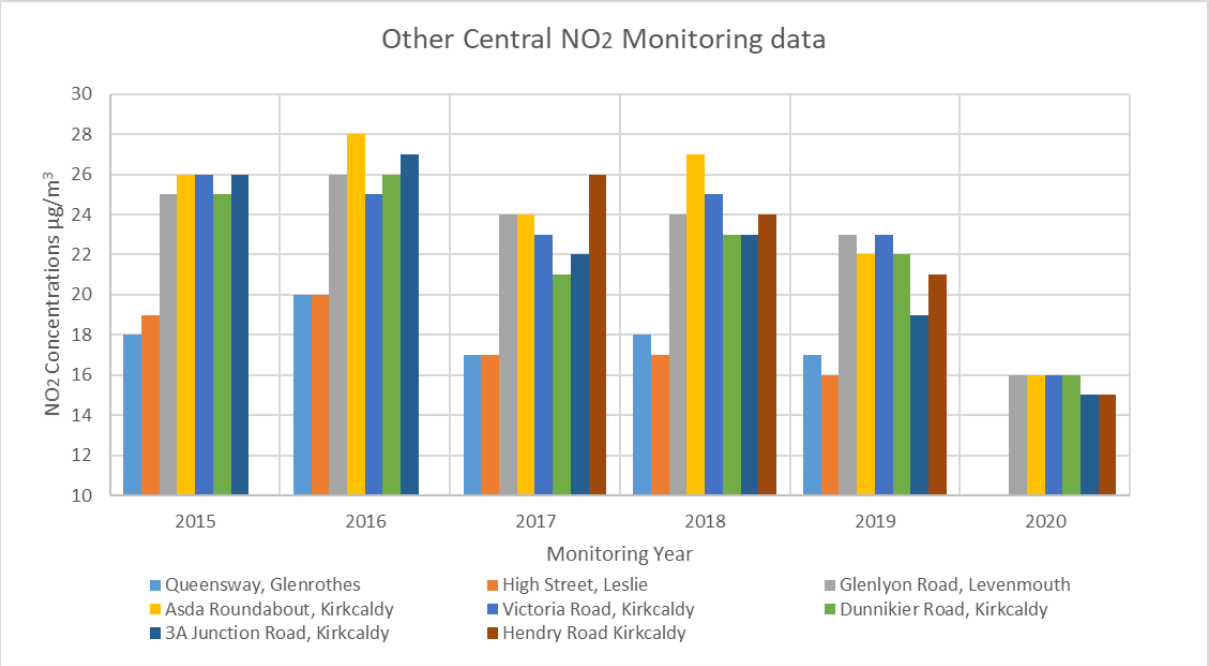
NO_2 annual mean concentrations for other east areas in Fife are presented in Figure A.6. Concentrations increased slightly in 2016 at Cupar Road and Crossgate, then declined steadily until 2019, with the exception of Ladywynd increasing in 2018 before decreasing again in 2019. These sites were removed after 2019 due to consistently low readings.

Figure A.7 Other West Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



NO_2 annual mean concentrations for the other west areas in Fife are presented in Figure A.7. Concentrations increased slightly in 2016 before steadily declining until 2020. 102 Baldridgeburn was added in 2019.

Figure A.8 Other Central Diffusion Tube Annual Mean Concentrations 2015-2020 (µg m^{-3})



NO_2 annual mean concentrations for the other central areas in Fife are presented in Figure A.8. Concentrations have jumped around across the central Fife area increasing in 2016 before declining again in 2017. There were slight increases again in 2018 before a more significant decline in 2019 and 2020 at all monitoring sites.

Table A.4 - 1-Hour Mean NO_2 Monitoring Results (NO_2 1-Hour Means > 200 µg m^{-3})

Site Name	Monitoring Type	Valid Data Capture 2020 (%) (1)	2016(2)	2017(2)	2018(2)	2019(2)	2020(2)
Cupar	Automatic	91	0	0	0	0	0
Dunfermline	Automatic	74	0	0	0	0	0
Kirkcaldy	Automatic	100	0	0	0	0	0
Rosyth	Automatic	100	0	0	0	0	0

Notes:

(1) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(2) If the period of valid data is less than 90%, the 99.8th percentile of 1-hour means is provided in brackets.

Table A.5 – 24-Hour Mean PM_{10} Monitoring Results (PM_{10} 24-Hour Means > 50 µg m^{-3})

Site Name	Valid Data Capture 2020 (%) (1)	2016(2)	2017(2)	2018(2)	2019(2)	2020(2)
Cupar	97	0	1	1	0	0
Dunfermline	100	1	0	0	0	0
Kirkcaldy	100	0	0	0	0	0
Rosyth	100	1	1	0	0	0

Notes:

(1) Data capture for the full calendar year (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(2) If the period of valid data is less than 90%, the 98.1th percentile of 24-hour means is provided in brackets.

Appendix B – Full Monthly Diffusion Tube Results for 2020

Table B.1- NO_2 Monthly Diffusion Tube Results for 2020 (µg m^{-3})

Site Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Raw	Annual Mean Bias Adjusted (1)
Central Area														
Glenlyon Road, Levenmouth	29.1	24.2	-	-	-	15.5	18.1	18.7	24.5	26.7	30.4	25.4	23.6	16.0
Asda Roundabout, Kirkcaldy	37.4	27.6	-	-	-	21.1	15.8	23.5	25.8	27.5	34.3	29.8	27.0	16.5
Victoria Road, Kirkcaldy	-	29.1	-	-	-	19.7	18.8	28.0	28.5	29.4	32.7	32.2	27.3	16.7
Dunnikier Road, Kirkcaldy	27.9	27.1	-	-	-	20.7	14.9	25.2	24.6	30.3	30.3	28.7	25.5	15.6
St Clair Street 1, Kirkcaldy	24.6	29.5	-	-	-	30.3	20.1	33.4	33.1	28.9	35.3	30.5	29.5	18.0
St Clair Street 2, Kirkcaldy	46.5	44.1	-	-	-	23.2	27.0	28.8	40.1	38.6	48.3	42.7	37.7	23.0
St Clair Street 3 (MS), Kirkcaldy	28.6	26.9	-	-	-	24.6	15.7	29.6	28.4	28.4	34.8	25.5	26.9	16.4
125 St Clair Street, Kirkcaldy	43.0	35.2	-	-	-	17.7	23.2	24.1	31.2	35.3	39.1	21.6	30.0	18.3
179A St Clair Street, Kirkcaldy	39.0	35.5	-	-	-	15.6	21.6	22.4	30.2	31.0	36.9	32.8	29.4	18.0
St Clair Street ROMON (A), Kirkcaldy	37.7	24.7	-	-	-	10.4	13.4	14.5	20.9	22.6	31.2	25.9		
St Clair Street ROMON (B), Kirkcaldy	28.8	24.6	-	-	-	11.3	12.5	16.0	23.1	24.5	31.6	25.5	21.8	13.3
St Clair Street ROMON (C), Kirkcaldy	29.3	26.4	-	-	-	10.6	13.3	15.5	21.2	23.1	27.0	24.3		
3A Junction Road, Kirkcaldy	27.7	25.4	-	-	-	22.0	15.7	25.6	26.1	27.0	24.9	28.1	24.7	15.1
Hendry Road Kirkcaldy	33.4	29.6	-	-	-	17.2	-	-	-	27.9	31.4	30.3	28.3	17.3
East Area														
Bell Street 1, St Andrews	34.3	34.2	-	-	-	-	11.1	22.3	23.4	20.2	20.0	18.6	23.0	15.5
Bell Street 2, St Andrews	23.7	30.4	-	-	-	9.1	11.5	17.5	20.5	20.3	20.2	20.9	19.3	13.1

City Road 1, St Andrews	17.5	19.9	-	-	-	12.1	11.2	24.6	20.1	21.4	21.7	24.9	19.3	13.0
City Road 3, St Andrews	29.7	28.2	-	-	-	11.8	14.6	21.3	23.5	23.5	27.5	28.3	23.2	15.6
City Road 5, St Andrews	23.7	21.0	-	-	-	9.5	11.4	18.3	18.9	21.4	24.0	20.1	18.7	12.6
City Road 6, St Andrews	33.9	27.9	-	-	-	22.6	22.3	32.1	33.5	35.9	30.1	35.2	30.4	20.5
Links Crescent, St Andrews	27.4	20.1	-	-	-	13.1	13.3	20.1	21.3	21.7	22.4	21.7	20.1	13.6
North Street, St Andrews	27.0	18.5	-	-	-	8.6	13.6	19.7	20.3	22.8	23.4	23.1	19.7	13.3
Bonnygate B1, Cupar	29.7	26.1	-	-	-	18.2	16.5	26.0	22.9	33.9	27.4	34.8	26.2	17.7
Bonnygate B2, Cupar	38.7	33.3	-	-	-	16.6	17.4	24.9	28.6	33.5	45.9	36.5	30.6	20.7
Bonnygate B3, Cupar	35.6	30.9	-	-	-	23.3	20.1	22.0	30.4	36.9	32.7	29.3	29.0	19.6
Bonnygate B4, Cupar	42.5	22.2	-	-	-	22.2	23.5	31.4	34.8	37.5	38.1	41.3	32.6	22.0
Bonnygate West B6, Cupar	30.5	23.3	-	-	-	9.2	11.7	14.5	18.1	20.0	22.6	25.8	19.5	13.2
Bonnygate Monitor BA, Cupar	28.6	27.2	-	-	-	-	15.2	21.7	22.1	27.6	27.0	26.3		
Bonnygate Monitor BB, Cupar	30.4	28.7	-	-	-	16.2	15.0	21.4	22.6	26.4	26.6	32.1	24.5	16.5
Bonnygate Monitor BC, Cupar	31.5	26.0	-	-	-	17.5	15.7	23.5	-	-	25.6	32.8		
West Area														
High Street, Cowdenbeath	22.0	17.3	-	-	-	15.4	11.5	22.6	19.8	22.6	27.3	27.9	20.7	14.0
Admiralty Road A, Rosyth	26.8	25.8	-	-	-	16.6	19.0	22.7	26.8	29.5	36.1	34.0	26.4	20.0
Admiralty Road A ROMON	22.9	21.2	-	-	-	14.8	14.7	20.1	26.8	25.3	32.7	29.3		
Admiralty Road B ROMON	23.5	19.3	-	-	-	13.8	14.5	18.1	26.5	25.3	32.6	25.6	22.4	17.0
Admiralty Road C ROMON	24.0	21.0	-	-	-	14.7	14.7	20.4	27.3	24.9	29.4	21.8		
Appin Crescent 1, Dunfermline	39.3	36.6	-	-	-	15.0	17.5	21.9	27	30.6	35.7	32.8	28.5	19.2
Appin Crescent 2, Dunfermline	43.9	44.5	-	-	-	21.9	23.0	28.7	34.2	35.5	43.1	41.9	35.2	23.8
Appin Crescent 3, Dunfermline	-	44.2	-	-	-	18.0	20.8	28.0	33.1	36.3	44.4	40.3	33.1	22.4
Appin Crescent 4A, Dunfermline	33.4	24.2	-	-	-	11.7	14.4	16.5	20.7	28.8	31.6	29.0	22.6	15.3
Appin Crescent 4B, Dunfermline	31.8	27.0	-	-	-	13.4	13.1	16.9	19.9	24.5	29.9	28.6		

Appin Crescent 4C, Dunfermline	29.7	26.3	-	-	-	12.4	14.2	15.6	20.5	23.3	29.9	23.9		
Appin Crescent 5A, Dunfermline	49.1	48.6	-	-	-	19.5	23.5	24.4	32.7	34.9	45.4	40.7		
Appin Crescent 5B, Dunfermline	45.2	43.9	-	-	-	17.5	23.6	24.1	32.2	33.1	42.7	38.6	34.5	23.3
Appin Crescent 5C, Dunfermline	47.8	40.8	-	-	-	17.6	23.5	24.7	31.8	40.3	46.6	38.7		
Appin Crescent 6A, Dunfermline	48.3	44.2	-	-	-	21.7	23.3	28.0	33.7	37.0	46.9	39.9		
Appin Crescent 6B, Dunfermline	52.2	49.9	-	-	-	23.4	24.1	29.9	37.7	34.6	50.3	13.3	35.6	24.0
Appin Crescent 6C, Dunfermline	40.9	42.7	-	-	-	21.4	25.5	30.3	36.5	35.9	47.6	41.1		
Appin Crescent A, Dunfermline	41.4	35.7	-	-	-	14.0	17.1	21.7	25.3	29.3	36.7	28.8		
Appin Crescent B, Dunfermline	39.4	32.8	-	-	-	16.0	20.1	22.9	30.7	31.7	41.2	34.6	29.4	19.9
Appin Crescent C, Dunfermline	45.2	38.3	-	-	-	16.2	18.0	23.0	29.9	28.5	39.8	36.1		
Carnegie Drive A, Dunfermline	30.2	28.9	-	-	-	19.2	15.5	30.5	26.1	29.6	35.4	29.2		
Carnegie Drive B, Dunfermline	31.2	15.1	-	-	-	18.8	17.3	29.4	25.7	28.2	36.2	30.3	26.5	17.9
Carnegie Drive C, Dunfermline	29.1	26.4	-	-	-	18.0	16.4	28.3	28.3	29.9	35.0	26.1		
11 Halbeath Road, Dunfermline	25.2	19.0	-	-	-	11.0	9.9	12.6	15.2	17.8	24.5	21.9	17.5	11.8
Pilmuir Road, Dunfermline	30.3	28.6	-	-	-	13.3	13.7	19.8	24.1	31.6	33.9	26.5	24.6	16.7
Mill Street, Dunfermline	37.8	30.9	-	-	-	21.6	22.8	30.1	32.6	31.5	46.7	43.7	33.1	22.3
Rumblingwell, Dunfermline	28.5	23.3	-	-	-	14.4	15.4	19.9	22.5	24.3	28.9	25.6	22.5	15.2
102 Baldridgeburn Dunfermline	28.4	22.7	-	-	-	12.9	13.3	18.4	22.8	25.1	32.9	32.5	23.2	15.7

1. See Appendix C for details on bias adjustment
2. 2020 data annualised, from period mean concentrations as described in TG(16)

Appendix C – Data QA/QC

Diffusion Tube Bias Adjustment Factors

Diffusion tubes may over or under predict NO_2 concentrations when compared to the reference method chemiluminescent analyser. This difference in measurement is described as bias. Accuracy in results can be adjusted in order to account for this. Results are adjusted using a calculated bias adjustment factor.

The diffusion tubes deployed by Fife Council were supplied and analysed by SOCOTEC using a preparation mixture of 20% triethanolamine (TEA) in water.

Figures C1-C4 show the locally derived adjustment factors. Overall the locally derived adjustment factor was 0.68. The local bias adjustment was applied to all diffusion tubes within the area. However, the local bias adjustment factor for Cupar and Dunfermline could not be used as both included less than 9 periods of data capture, therefore the average was used for these locations. While the average of the local was used for all other sites for consistency.

Figure C.1 Local Bias adjustment spreadsheet- Cupar

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yy	Tube 1 µg/m³	Tube 2 µg/m³	Tube 3 µg/m³	Triplicate Mean	Standard Deviation	Coefficient of Variation	95% CI of mean
1	10/01/2020	06/02/2020	28.6	30.4	31.5	30	1.5	5	3.6
2	06/02/2020	05/03/2020	27.2	28.7	26.0	27	1.4	5	3.4
3	06/06/2020	01/07/2020	0.0	16.2	17.5	11	9.8	87	24.2
4	01/07/2020	30/07/2020	15.2	15.0	15.7	15	0.4	2	0.9
5	30/07/2020	01/09/2020	21.7	21.4	23.5	22	1.1	5	2.8
6	01/09/2020	29/09/2020	22.1	22.6	0.0	15	12.9	87	32.1
7	29/09/2020	04/11/2020	27.6	26.4	0.0	18	15.6	87	38.8
8	04/11/2020	02/12/2020	27.0	26.6	25.6	26	0.7	3	1.8
9	02/12/2020	08/01/2021	26.3	32.1	32.8	30	3.6	12	8.9
10									
11									
12									
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Automatic Metho Period Mean	Data Capture (% DC)	Data Quality Check Tubes Precision Check	Automatic Monitor
23.50	100	Good	Good
24.80	100	Good	Good
17.47	61	Poor Precisio	r Data Capture
13.43	95	Good	Good
19.27	99	Good	Good
20.02	100	Poor Precisio	Good
16.17	99	Poor Precisio	Good
20.63	97	Good	Good
25.47	100	Good	Good
overall survey -->		Poor precision	Good Overall

(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Cupar

Precision: 6 out of 9 periods have a CV smaller than 20%

Accuracy with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 6 periods of data
Bias factor A 0.84 (0.79 - 0.89)
Bias B 19% (12% - 27%)
usion Tubes Mean: 25 µgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 21 µgm^{-3}
ata Capture for periods used: 99%
usted Tubes Mean: 21 (20 - 23) µgm^{-3}

Accurad (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 8 periods of data
Bias factor A
Bias B 13% (-4% - 30%)
Diffusion Tubes Mean: 23 µgm^{-3}
Mean CV (Precision): 26 caution
Automatic Mean: 20 µgm^{-3}
Data Capture for periods used: 99%
Adjusted Tubes Mean: 20 (18 - 24) µgm^{-3}

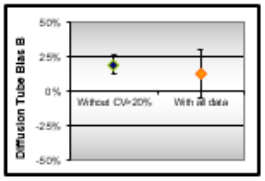


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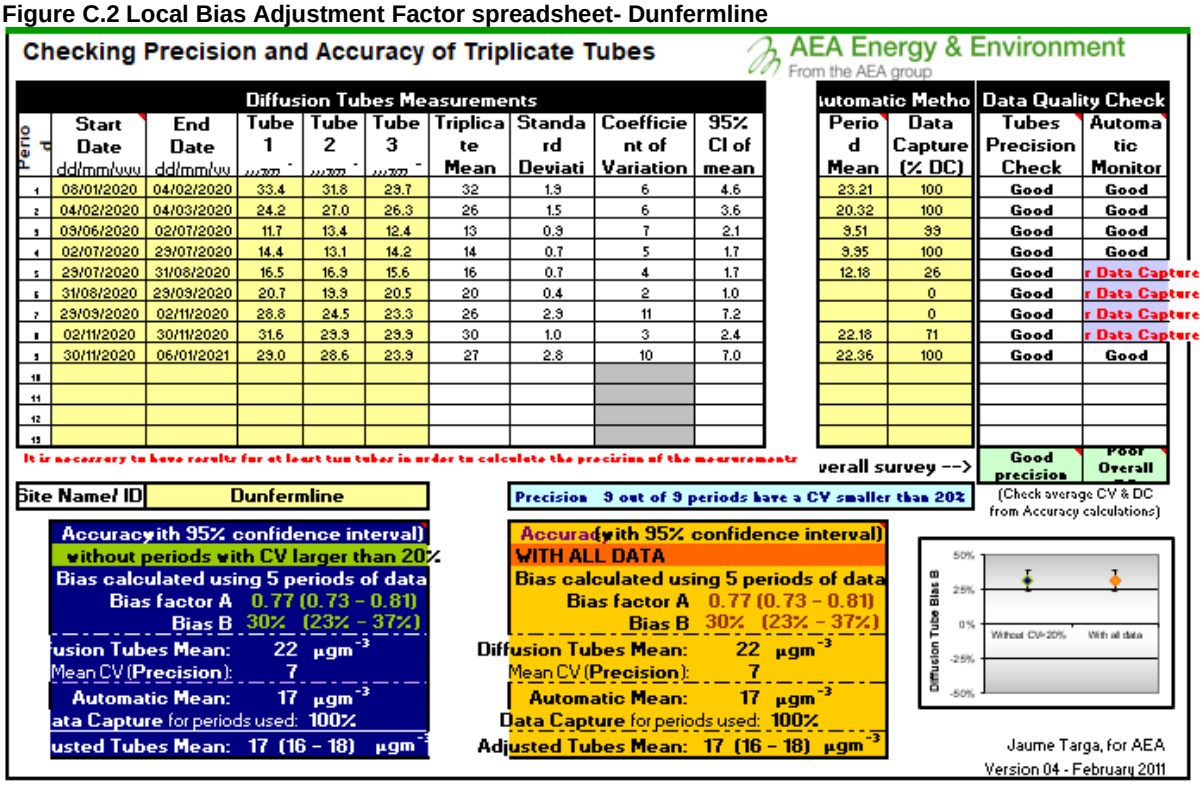
Figure C.2 Local Bias Adjustment Factor spreadsheet- Dunfermline



Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yy	Tube 1 µgm⁻³	Tube 2 µgm⁻³	Tube 3 µgm⁻³	Triplicate Mean	Standard Deviation	Coefficient of Variation	95% CI of mean
1	08/01/2020	04/02/2020	33.4	31.8	29.7	32	1.9	6	4.6
2	04/02/2020	04/03/2020	24.2	27.0	26.3	26	1.5	6	3.6
3	03/06/2020	02/07/2020	11.7	13.4	12.4	13	0.9	7	2.1
4	02/07/2020	29/07/2020	14.4	13.1	14.2	14	0.7	5	1.7
5	29/07/2020	31/08/2020	16.5	16.9	15.6	16	0.7	4	1.7
6	31/08/2020	29/09/2020	20.7	19.9	20.5	20	0.4	2	1.0
7	29/09/2020	02/11/2020	28.8	24.5	23.3	26	2.9	11	7.2
8	02/11/2020	30/11/2020	31.6	29.9	29.9	30	1.0	3	2.4
9	30/11/2020	06/01/2021	29.0	28.6	23.9	27	2.8	10	7.0
10									
11									
12									
13									

Automatic Metho / Data Quality Check

Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor
23.21	100	Good	Good
20.32	100	Good	Good
9.51	99	Good	Good
9.95	100	Good	Good
12.18	26	Good	r Data Capture
	0	Good	r Data Capture
	0	Good	r Data Capture
22.18	71	Good	r Data Capture
22.36	100	Good	Good

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Poor Overall

Site Name/ ID: Dunfermline

Precision: 9 out of 9 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval) without periods with CV larger than 20%
Bias calculated using 5 periods of data
Bias factor A 0.77 (0.73 - 0.81)
Bias B 30% (23% - 37%)
Diffusion Tubes Mean: 22 µgm⁻³
Mean CV (Precision): 7
Automatic Mean: 17 µgm⁻³
Data Capture for periods used: 100%
Adjusted Tubes Mean: 17 (16 - 18) µgm⁻³

Accuracy (with 95% confidence interval) WITH ALL DATA
Bias calculated using 5 periods of data
Bias factor A 0.77 (0.73 - 0.81)
Bias B 30% (23% - 37%)
Diffusion Tubes Mean: 22 µgm⁻³
Mean CV (Precision): 7
Automatic Mean: 17 µgm⁻³
Data Capture for periods used: 100%
Adjusted Tubes Mean: 17 (16 - 18) µgm⁻³

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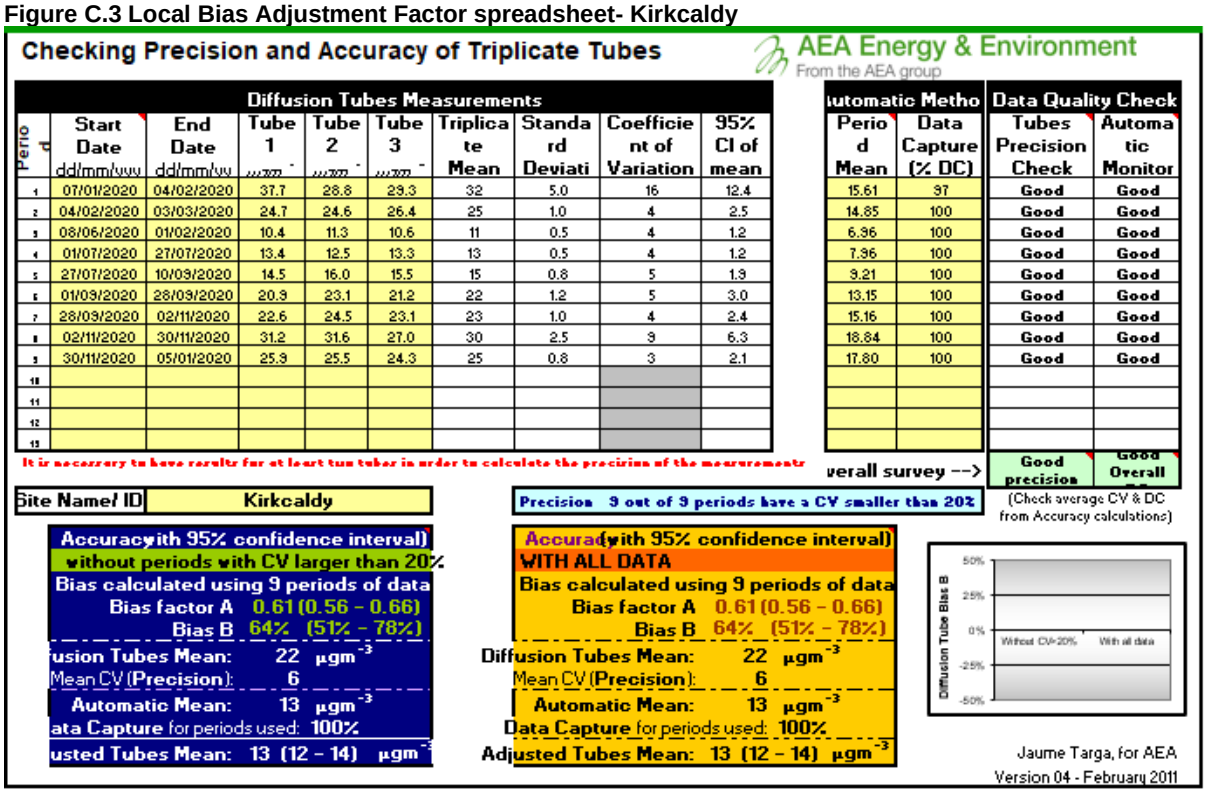
Figure C.3 Local Bias Adjustment Factor spreadsheet- Kirkcaldy



Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yy	Tube 1 µgm⁻³	Tube 2 µgm⁻³	Tube 3 µgm⁻³	Triplicate Mean	Standard Deviation	Coefficient of Variation	95% CI of mean
1	07/01/2020	04/02/2020	37.7	28.8	29.3	32	5.0	16	12.4
2	04/02/2020	03/03/2020	24.7	24.6	26.4	25	1.0	4	2.5
3	08/06/2020	01/02/2020	10.4	11.3	10.6	11	0.5	4	1.2
4	01/07/2020	27/07/2020	13.4	12.5	13.3	13	0.5	4	1.2
5	27/07/2020	10/09/2020	14.5	16.0	15.5	15	0.8	5	1.9
6	01/09/2020	28/09/2020	20.9	23.1	21.2	22	1.2	5	3.0
7	28/09/2020	02/11/2020	22.6	24.5	23.1	23	1.0	4	2.4
8	02/11/2020	30/11/2020	31.2	31.6	27.0	30	2.5	9	6.3
9	30/11/2020	05/01/2020	25.9	25.5	24.3	25	0.8	3	2.1
10									
11									
12									
13									

Automatic Metho / Data Quality Check

Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor
15.61	97	Good	Good
14.85	100	Good	Good
6.36	100	Good	Good
7.36	100	Good	Good
9.21	100	Good	Good
13.15	100	Good	Good
15.16	100	Good	Good
18.84	100	Good	Good
17.80	100	Good	Good

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall

Site Name/ ID: Kirkcaldy

Precision: 9 out of 9 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval) without periods with CV larger than 20%
Bias calculated using 9 periods of data
Bias factor A 0.61 (0.56 - 0.66)
Bias B 64% (51% - 78%)
Diffusion Tubes Mean: 22 µgm⁻³
Mean CV (Precision): 6
Automatic Mean: 13 µgm⁻³
Data Capture for periods used: 100%
Adjusted Tubes Mean: 13 (12 - 14) µgm⁻³

Accuracy (with 95% confidence interval) WITH ALL DATA
Bias calculated using 9 periods of data
Bias factor A 0.61 (0.56 - 0.66)
Bias B 64% (51% - 78%)
Diffusion Tubes Mean: 22 µgm⁻³
Mean CV (Precision): 6
Automatic Mean: 13 µgm⁻³
Data Capture for periods used: 100%
Adjusted Tubes Mean: 13 (12 - 14) µgm⁻³

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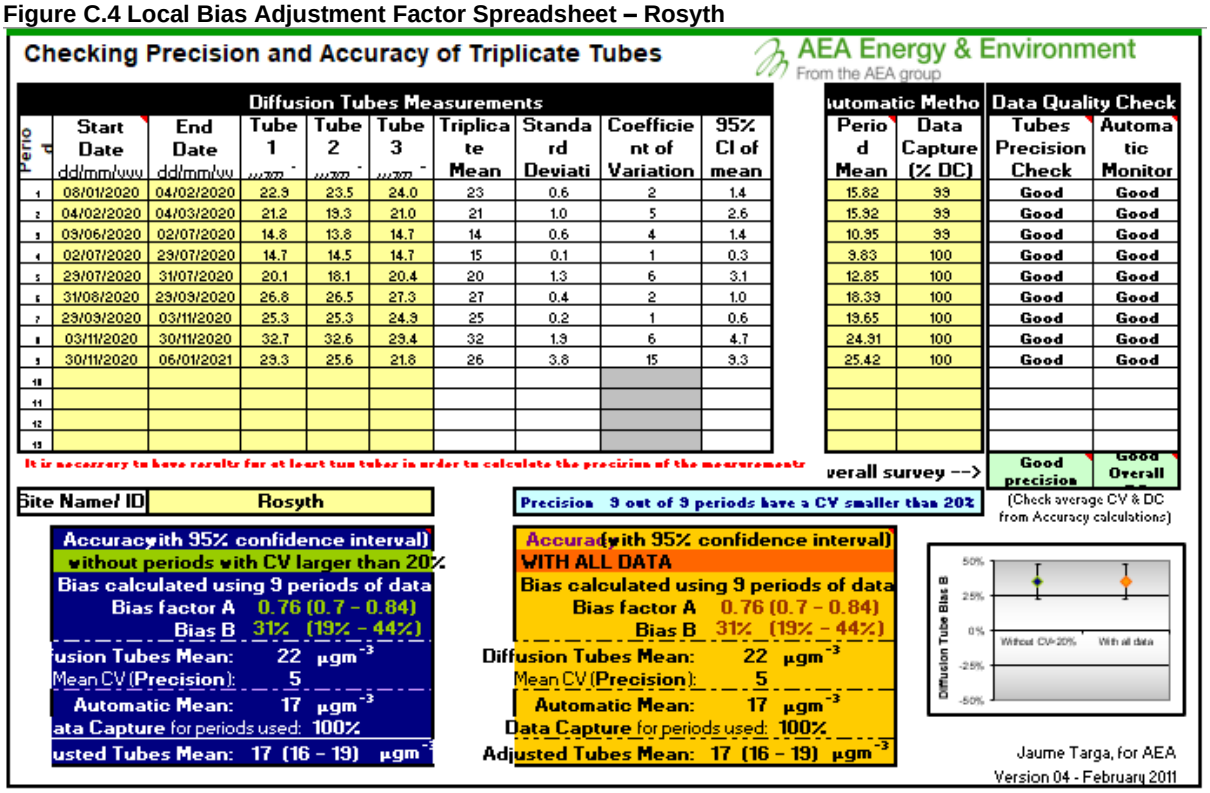
Figure C.4 Local Bias Adjustment Factor Spreadsheet – Rosyth



Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yy	Tube 1 µgm⁻³	Tube 2 µgm⁻³	Tube 3 µgm⁻³	Triplicate Mean	Standard Deviation	Coefficient of Variation	95% CI of mean
1	08/01/2020	04/02/2020	22.9	23.5	24.0	23	0.6	2	1.4
2	04/02/2020	04/03/2020	21.2	19.3	21.0	21	1.0	5	2.6
3	09/06/2020	02/07/2020	14.8	13.8	14.7	14	0.6	4	1.4
4	02/07/2020	29/07/2020	14.7	14.5	14.7	15	0.1	1	0.3
5	29/07/2020	31/07/2020	20.1	18.1	20.4	20	1.3	6	3.1
6	31/08/2020	29/09/2020	26.8	26.5	27.3	27	0.4	2	1.0
7	29/09/2020	03/11/2020	25.3	25.3	24.9	25	0.2	1	0.6
8	03/11/2020	30/11/2020	32.7	32.6	29.4	32	1.9	6	4.7
9	30/11/2020	06/01/2021	29.3	25.6	21.8	26	3.8	15	9.3
10									
11									
12									
13									

Automatic Metho		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor
15.82	99	Good	Good
15.92	99	Good	Good
10.95	99	Good	Good
9.83	100	Good	Good
12.85	100	Good	Good
18.39	100	Good	Good
13.65	100	Good	Good
24.31	100	Good	Good
25.42	100	Good	Good
		Good precision	Good Overall

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey -->

Site Name/ ID: Rosyth

Precision: 9 out of 9 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 9 periods of data
Bias factor A 0.76 (0.7 - 0.84)
Bias B 31% (19% - 44%)
Diffusion Tubes Mean: 22 µgm⁻³
Mean CV (Precision): 5
Automatic Mean: 17 µgm⁻³
Data Capture for periods used: 100%
Adjusted Tubes Mean: 17 (16 - 19) µgm⁻³

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 9 periods of data
Bias factor A 0.76 (0.7 - 0.84)
Bias B 31% (19% - 44%)
Diffusion Tubes Mean: 22 µgm⁻³
Mean CV (Precision): 5
Automatic Mean: 17 µgm⁻³
Data Capture for periods used: 100%
Adjusted Tubes Mean: 17 (16 - 19) µgm⁻³

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QA/QC of Automatic Monitoring

The QA/QC procedures follow the requirements of the Technical Guidance (TG.16) and are equivalent to those used at UK levels for the National Network (AURN) monitoring sites. This gives a high degree of confidence in the data obtained, both for measured concentrations at the automatic sites and for establishing robust bias correction factors for diffusion tubes.

In order to satisfy the requirement in the Technical Guidance (TG.16), the following QA/QC procedures were implemented:

- 3-weekly calibrations of the NOx analyser;
- 6-monthly audits and servicing of the monitoring site;
- Data ratification.

Calibrations of the NOx analyser were carried out using certified compressed gas standards (ISO17025). This ensured that the calibration gas was traceable to national and international standards. FIDAS diagnostics were recorded and cal dust performed.

Audits of the monitoring sites consisted of a number of performance checks to identify any faults with the equipment. The calibration cylinder was also checked against another gas standard in order to confirm the gas concentration. Any identified faults during the audit were forwarded on to the service unit for repair.

The final stage of the QA/QC process was to ratify the data. During ratification, all calibration, audit and service data are collected, and the data are scaled appropriately. Any suspect data identified are deleted therefore ensuring that the data are of a high quality.

Diffusion Tube QA/QC Process

Diffusion tubes used by Fife Council are now supplied and analysed by SOCOTEC. The tube preparation method is 20% TEA in water. SOCOTEC is a participant in the centralised QA/QC services provided by Defra and the devolved administrations. These services compromise of:

- Promotion of the independent AIR-PT scheme, operated by LGC Standards and supported by the health and Safety Laboratory, with yearly assessment against agreed performance criteria. AIR-PT combines two long running PT schemes: LGC Standards STACKS PT scheme and HSL Workplace Analysis Scheme for Proficiency (WASP) PT scheme.
- Provision of quality control standard solutions, free of charge to laboratories that prepare and analyse NO_2 diffusion tubes used by Local Authorities for LAQM purposes.

Bias Correction for Diffusion Tubes

Diffusion tube samplers are a simple and cost effective method of measuring NO_2. However, they are classed as an indicative method and are known to have a systematic bias compared to more accurate results obtained from calibrated automatic analysers. The local bias factor is calculated using sites where a triplicate set of diffusion tubes are co-located with a chemiluminescence analyser. The national bias adjustment factor is derived using the national database co-location studies.

Fife Council has four co-location sites that have been used to calculate the local bias adjustment factor. The local bias adjustment factor for each individual location was calculated using the "LAQM Tool" described in LAQM TG(16). The results are shown in Table C.1 below. The average of the local bias adjustment factors is 0.68.

For this report, the local bias adjustment was applied to all diffusion tubes within the area, with the exception of Cupar and Dunfermline. The average of the local bias adjustment factor was applied to Cupar and Dunfermline as well as all other sites. Cupar and Dunfermline could not be used as both sites included less than 9 periods of data capture, this was due to the Covid-19 lockdown,

The survey consists of tubes exposed over a range of settings, which differ from the co-location site, e.g. the co-location site in a very exposed setting and the tubes being assessed are on building façade in a canyon-like street.

Table C.1 Local BIAS adjustment factors

Source	Bias Adjustment Factors 2020
Cupar	0.84
Dunfermline	0.77
Kirkcaldy	0.61
Rosyth	0.76
Average Local Bias factor	0.68

Appendix D – Annualisation of Data

Data capture for the following sites was less than 75%, therefore the data was annualised in accordance with TG(16) as per Box 7.9.

- Victoria Road, Kirkcaldy – 67%. Periods of valid data = 04/02/20-03/03/20, 08/06/20-05/01/21
- Hendry Road, Kirkcaldy – 50%. Periods of valid data = 07/01/20-03/03/20, 08/06/20-01/07/20, 28/09/20-05/01/21
- Bell Street 1, St Andrews – 67%. Periods of valid data = 10/01/20-05/03/20, 01/07/20-08/01/21
- Bonnygate Monitor C, Cupar – 58%. Periods of valid data = 10/01/20-05/03/20, 08/06/20-01/09/20, 04/11/20-08/01/21
- Appin Crescent 3, Dunfermline – 67%. Periods of valid data = 04/02/20-04/03/20, 09/06/20-06/01/21

Table D.1 Annualisation of NO_2 Diffusion Tubes for Central Area

Automatic Site	Automatic Site Annual Mean 2020 (AM) (Central)	Automatic Site Period Mean 2020 (PM) *(Victoria Road, Kirkcaldy)*	Automatic Site Period Mean 2020 (PM) (Hendry Road, Kirkcaldy)
Bush Estate	3.7	4.0	3.9
Dundee Mains Loan	8.5	9.1	9.7
Edinburgh St Leonards	13.9	14.4	15.4
Average Ratio (Am/Pm) – Victoria Road, Kirkcaldy		**0.94**	
Average Ratio (Am/Pm) – Hendry Road, Kirkcaldy		**0.90**	
Victoria Road, Kirkcaldy – Annual Mean (µg m^{-3})		**25.6**	
Victoria Road, Kirkcaldy – Annual Mean (µg m^{-3}) – BIAS Adjusted		**18.8**	
Hendry Road, Kirkcaldy – Annual Mean (µg m^{-3})		**25.6**	
Hendry Road, Kirkcaldy – Annual Mean (µg m^{-3}) – BIAS Adjusted		**18.7**	

Table D.2 Annualisation of NO_2 Diffusion Tubes for East Area

Automatic Site	Automatic Site Annual Mean 2020 (AM) (East)	Automatic Site Period Mean 2020 (PM) *(Bell Street 1, St Andrews)*	Automatic Site Period Mean 2020 (PM) (Bonnygate Monitor C, Cupar)
Bush Estate	3.7	3.9	3.8
Dundee Mains Loan	8.5	9.7	9.5
Edinburgh St Leonards	14.0	16.1	15.1

Average Ratio (Am/Pm) – Bell Street 1, St Andrews	0.90
Average Ratio (Am/Pm) – Bonnygate Monitor C, Cupar	0.90
Bell Street 1, St Andrews – Annual Mean (µg m^{-3})	**20.7**
Bell Street 1, St Andrews – Annual Mean (µg m^{-3}) – BIAS Adjusted	**15.2**
Bonnygate Monitor C, Cupar – Annual Mean (µg m^{-3})	**23.0**
Bonnygate Monitor C, Cupar – Annual Mean (µg m^{-3}) – BIAS Adjusted	**16.8**

Table D.3 Annualisation of NO_2 Diffusion Tubes for West Area

Automatic Site	Automatic Site Annual Mean 2020 (AM) (West)	Automatic Site Period Mean 2020 (PM) *(Appin Crescent 3, Dunfermline)*
Bush Estate	3.7	4.0
Dundee Mains Loan	8.5	9.2
Edinburgh St Leonards	14.0	14.6
Average Ratio (Am/Pm) – Appin Crescent 3, Dunfermline		0.93
Appin Crescent 3, Dunfermline – Annual Mean (µg m^{-3})		**31.0**
Appin Crescent 3, Dunfermline – Annual Mean (µg m^{-3}) – BIAS Adjusted		**22.7**

Table D.4 Fife Dunfermline Annualisation NO

Site	NO Annual Mean	NO Period Mean	Ratio
Dundee Mains Loan	1	1.06	0.943396
Edinburgh St Leonards	3	3.08	0.974026
		Average	0.958711
		Annual Mean Concentration	8
		Annualised Concentration	7.67

Table D.5 Fife Dunfermline Annualisation NO_2

Site	NO_2 Annual Mean	NO_2 Period Mean	Ratio
Dundee Mains Loan	8	8.288	0.965251
Edinburgh St Leonards	14	13.87	1.009373
		Average Ratio	0.987312
		Annual Mean Concentration	15
		Annualised Concentration	14.81

Table D.6 Fife Appin Crescent East AQMesh Sensor Annualisation PM_{10}

Site	PM_{10} Annual Mean	PM_{10} Period Mean	Ratio
Fife Dunfermline	8	8.66	0.9238
Dundee Mains Loan	7	7.14	0.98039
Edinburgh St Leonards	8	8.3	0.98400
		Average Ratio	0.96273
		Annual Mean Concentration	8
		Annualised Concentration	7.7

Table D.7 Fife Appin Crescent East AQMesh Sensor Annualisation $PM_{2.5}$

Site	$PM_{2.5}$ Annual Mean	$PM_{2.5}$ Period Mean	Ratio
Fife Dunfermline	5	4.87	1.02669
Dundee Mains Loan	4	4.13	0.96852
Edinburgh St Leonards	4	4.5	0.88888
		Average Ratio	0.96136
		Annual Mean Concentration	5
		Annualised Concentration	4.8

Appendix E – Technical Specification of Automatic Monitoring Equipment

Figure E. 1 Appin Crescent, Dunfermline

Station Name:	Appin Crescent, Dunfermline
Easting:	309926
Northing:	687722
Distance to kerb and road name/number	3m + (A907)
Site Classification:	Roadside
Manifold type and height:	Single Teflon tube, inlet height 2m
Network affiliation:	Scottish Air Quality Database
Quality control procedures:	UKAS calibration by Ricardo with Air Liquide gas cylinder
Pollutants measured on site:	PM_{10}, $PM_{2.5}$, PM_1, TSP, NOx, NO, NO_2
Instrument manufacturer:	FIDAS 200 Thermo i-series
Calibration procedure and frequency:	2 weekly manual calibrations
Site service arrangements:	6-monthly service by air monitors
Co-located passive sampler	Triplicate NO_2 tubes installed

Figure E. 2 Bonnygate, Cupar

Station Name:	Bonnygate, Cupar
Easting:	337403
Northing:	714571
Site Classification:	Kerbside (<1m from Kerb)
Distance to kerb and road name/number	0.5m to Bonnygate (A91)
Distance to nearest junction and joining road name/number	Opposite the junction with Ladywynd
Start date of monitoring	19 December 2005
Manifold type and height:	Single Teflon tube, Inlet height 1.9m
Network affiliation:	Scottish Air Quality Database
Quality control procedures:	UKAS calibration by Ricardo with Air Liquide gas cylinder
Pollutants measured on site:	PM_{10}, $PM_{2.5}$, PM_1, TSP, NOx, NO, NO_2
Instrument manufacturer:	FIDAS 200 Thermo i-series
Calibration procedure and frequency:	2-weekly manual calibration
Site service arrangements:	6-monthly service by Air Monitors
Co-located passive sampler	Triplicate NO_2 tubes installed

Figure E. 3 Admiralty Road, Rosyth

Station Name:	Admiralty Road, Rosyth
Easting:	311755
Northing:	683503
Site Classification:	Roadside
Distance to kerb and road name/number	6m (A985(T))
Start date of monitoring	March 2008
Manifold type and height:	Single Teflon tube, Inlet height 2.1m
Network affiliation:	Scottish Air Quality Database
Quality control procedures:	UKAS calibration by Ricardo with Air Liquide gas cylinder
Pollutants measured on site:	PM_{10}, $PM_{2.5}$, PM_1, TSP, NOx, NO, NO_2
Instrument manufacturer:	FIDAS 200 NOx – Thermo 42i
Calibration procedure and frequency:	2-weekly manual calibrations.
Site service arrangements:	6-monthly service by air monitors
Co-located passive sampler	Triplicate NO_2 tubes installed

Figure E. 4 St Clair Street, Kirkcaldy

Station Name:	St Clair Street, Kirkcaldy
Easting:	329143
Northing:	692986
Site Classification:	Roadside
Distance to kerb and road name/number	4.8m, Saint Clair Street/A921
Start date of monitoring	February 2011
Manifold type and height:	Single Teflon tube, Inlet height 2m
Network affiliation:	Scottish Air Quality Database
Quality control procedures:	UKAS calibration by Ricardo with Air Liquide gas cylinder
Pollutants measured on site:	PM_{10}, $PM_{2.5}$, PM_1, TSP, NOx, NO, NO_2
Instrument manufacturer:	FIDAS 200 NOx – Thermo 42i
Calibration procedure and frequency:	2-weekly manual calibration
Site service arrangements:	6-monthly service by air monitors
Co-located passive sampler	Triplicate NO_2 tubes installed

Appendix F – Calculated Sensitivities and Example Co-location Data Orthogonal Regression Analysis

Table F.1 Calculated Processing Sensitivities From Co-location Studies

Colocation Data	NO	NO_2	PM_{10}	$PM_{2.5}$
		Bonnygate		
30/01/2020	0.991080278	0.967117988	2.4691358	1.96078431
30/07/2020	0.938967136	0.793650794	2.96735905	2.38095238
16/10/2020	1.009081736	0.928505107	5.10204082	2.68817204
15/01/2020	0.961538462	0.993048659	2.38095238	2.55754476
		Appin Crescent West		
21/01/2020			0.81824	0.909775
24/02/2020	7.194244604	1.164144354	0.73421439	1.71526587
08/07/2020			0.93457944	0.98425197
23/11/2020	0.999000999	1.461988304	1.07181136	1.19760479
24/03/2020	0.992063492	1.251564456	1.04712042	1.13122172
		Appin Crescent East		
21/01/2020				
24/02/2020	0.889679715	1.838235294	0.5387931	1.11111111
08/07/2020	0.753012048	1.408450704	0.84388186	0.81967213
23/11/2020	0.933706816	2.016129032	1.07991361	1.10741971
24/03/2020	0.848176421	1.926782274	0.81766149	0.82644628

Table F.2 Example Co-location Data Orthogonal Regression Analysis

Summary: Bonnygate NO Oct 2020		
	Uncorrected Data	Uncorrected Data - Outliers Removed
Intercept not forced	-24.895 ± 0.162 (Significant)	-24.929 ± 0.136 (Significant)
Slope not forced	0.986 ± 0.007 (Significant)	0.991 ± 0.006 (Not Significant)
R squared	0.983	0.988
No of Measurements	383	375

Figure F.1

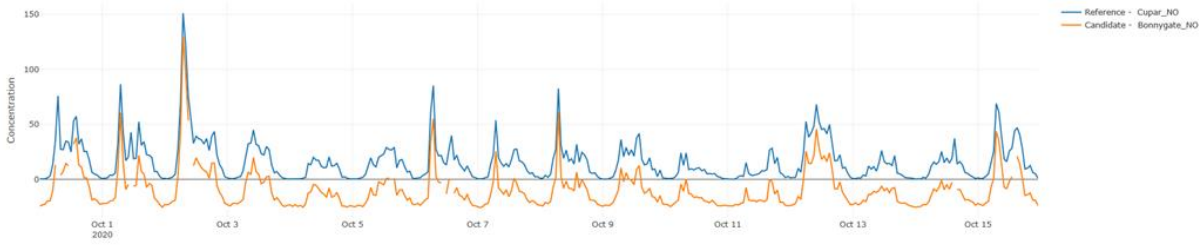
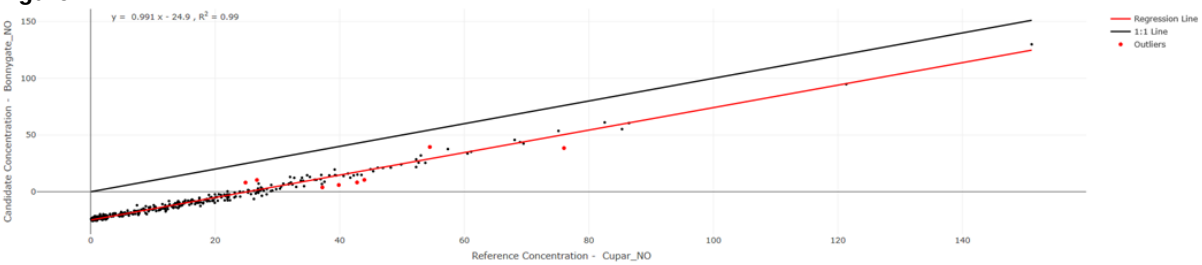


Figure F.2



Appendix G – Dynamic Report

A dynamic style report containing embedded statistical data for Fife can be found here: http://www.scottishairquality.scot/assets/documents//Fife_annual_2020.html. The key areas have been extracted and included below however further detail can be found online. The embedded data allows the reader a level of interaction with some of the report findings, providing additional insight. This approach enables a more easily navigated and streamlined report providing an engaging and intuitive reader experience. The analysis has been carried out for the pollutants NO_2, PM_{10} and $PM_{2.5}$ using the Openair analysis tool. This type of analysis helps the Council inform future policy making.

Openair is an innovative tool to analyse, interpret and understand air pollution data using "R". R is a free and open source programming language designed for the analysis of data. The Openair tool can perform complex and innovative analysis of current and archived air pollutant data allowing powerful data visualisation and interrogation. For this report Fife Council has utilised the following analysis tools;

- **Time variation** - This tool produces four separate panes combined into a single plot: The plotted output shows the average variation by day of the week and hour of the day combined (the top-most pane), hour of the day (diurnal variation, shown in the lower left pane), month of the year (seasonal variation in the lower middle pane) and day of week (lower right pane) of one or more variables or at one or multiple sites over a user selected time range. The plots have been created for all four automatic monitoring sites in fife for the period 1st January – 31st December 2020. The variation of a pollutant by time of day and day of week can reveal useful information concerning the likely sources at a particular site.
- **Polar Plots** – This tool produces polar plots of pollutant concentrations by wind speed and wind direction. Polar plots are useful to gain a quick graphical representation of the relationship between pollutant concentrations and the meteorological conditions. This can be useful in identifying potential sources of pollution affecting the location, for example particle suspension is increased at higher wind speeds come from a specific direction.
- **Calendar Plots** – This tool provides a way of visualising trends in daily pollutant concentrations across a year in the familiar form of a calendar. Concentrations are represented with a colour scale and the meteorological conditions can be represented using arrows giving the vector averaged wind direction, scaled according to the wind speed based on modelled wind speed and direction from data from the UK air quality forecast. In this way pollution episodes can be identified by date and sources potentially indicated by the combination of pollutant and meteorological conditions.
- **Back trajectory Analysis Plots** – The back trajectory plots show data from the HYSPLIT model (NOAA HYSPLIT) run in the analysis mode. This shows the air mass back trajectories for the period cover by this report. Two different kinds of plot are shown. One statistically groups the trajectories into similar clusters and shows the proportion of time during the report period that each represents. This is useful to get an overview of air mass origins during the report period. Plots in Trajectories associated with top ten most polluted days provide information on the trajectory direction associated with the top 10 measured concentrations.

Table G.1 Summary statistics for NO_2 (µg m^{-3})

Site	Mean	Data capture	Hourly max	Daily max	Low	Moderate	High	Hours exceeding	99.8th Percentile	98th Percentile	95th Percentile	50th Percentile
Fife Cupar	20.9	90.8%	164.8	85.9	336	0	0	0	110.8	75.5	59	15
Fife Dunfermline	15.2	73.5%	84.4	47.7	270	0	0	0	69.6	54.2	44.9	10.9
Fife Kirkcaldy	12.2	99.5%	92.4	44	366	0	0	0	67.8	46	35.1	9
Fife Rosyth	15.4	99.6%	105.5	58.4	366	0	0	0	78.6	56.9	44.4	10.8

Table G.2 Summary statistics for PM_{10} (µg m^{-3})

Site	Mean	Data capture	Hourly max	Max 24-hour mean	Low	Moderate	High	Days exceeding	98th Percentile daily	90th Percentile daily	98th Percentile hourly	95th Percentile hourly
Fife Cupar	11.3	97%	203	43.3	353	0	0	0	24.7	18.6	34.1	26.6
Fife Dunfermline	8.5	100%	67.7	25.2	364	0	0	0	18.7	14.1	23.4	18.4
Fife Kirkcaldy	9	100%	60.5	26.2	366	0	0	0	20.3	14.4	23.8	19.4
Fife Rosyth	9.1	100%	299.2	41.5	366	0	0	0	20.5	15	24.8	19.9

Table G.3 Summary statistics for $PM_{2.5}$ (µg m^{-3})

Site	Mean	Data capture	Max 24-hour mean	Low	Moderate	High
Fife Cupar	5.6	97%	21.3	353	0	0
Fife Dunfermline	4.8	100%	19.1	364	0	0
Fife Kirkcaldy	5	100%	17.6	366	0	0
Fife Rosyth	5.1	100%	32.9	366	0	0

Figure G.1 Cupar NO_2 time series

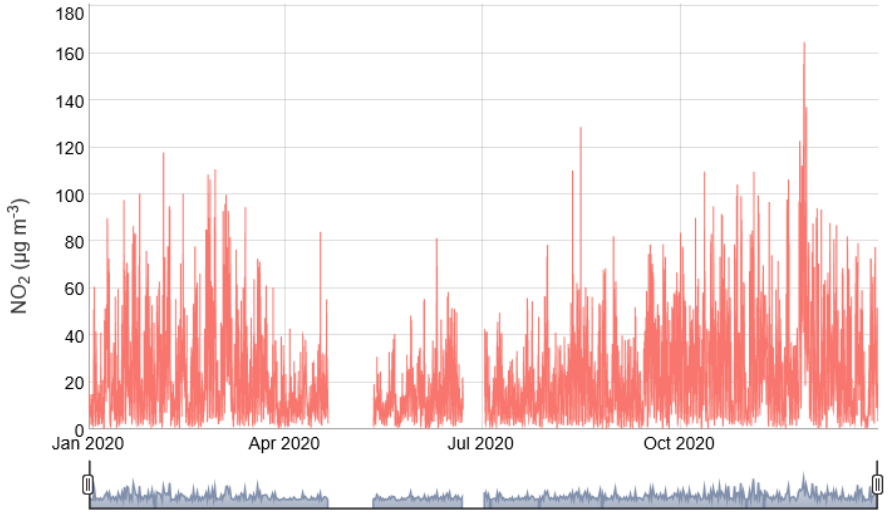


Figure G.2 Dunfermline NO_2 time series

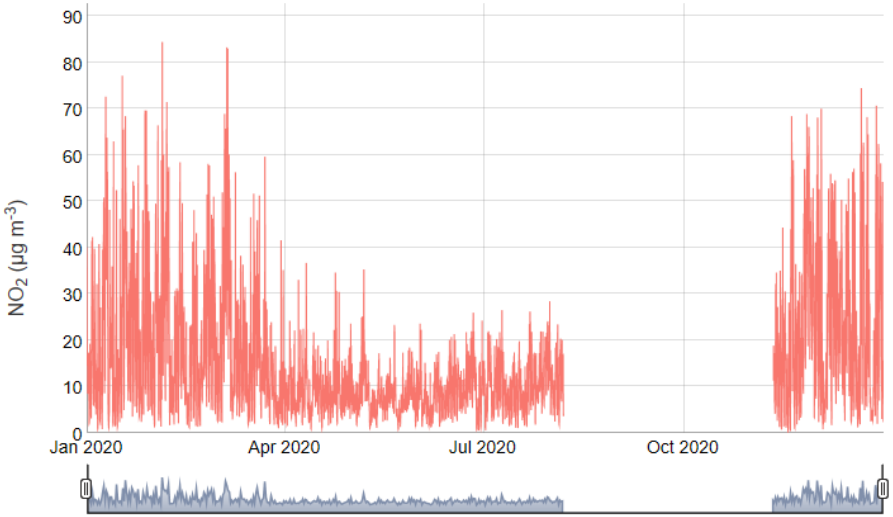


Figure G.3 Kirkcaldy NO_2 time series

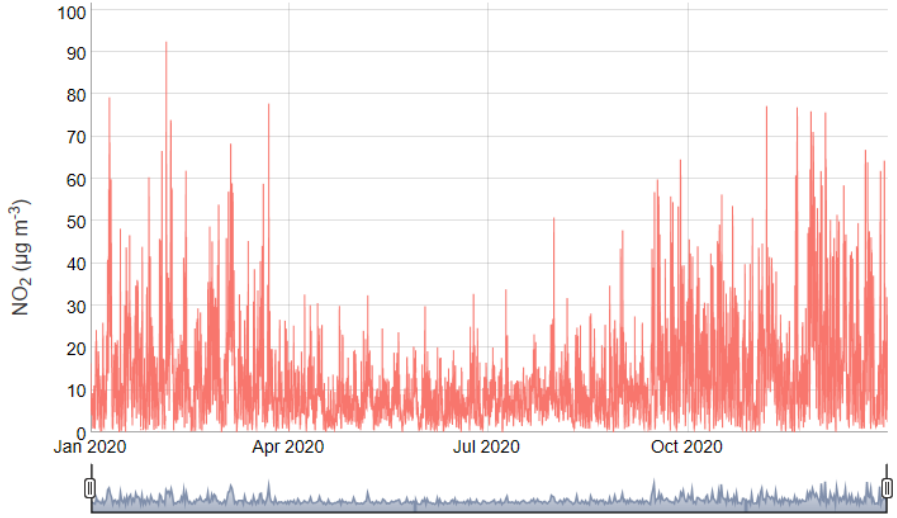


Figure G.4 Rosyth NO_2 time series

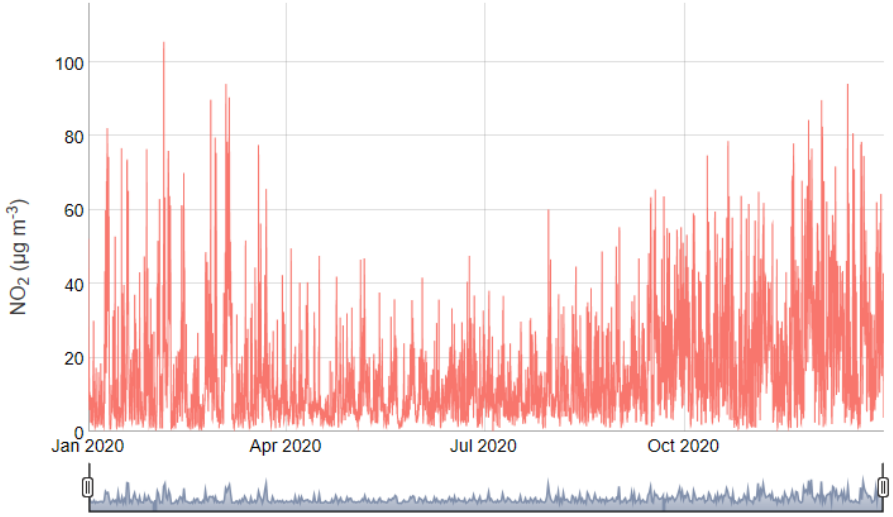


Figure G.5 Cupar PM_{10} time series

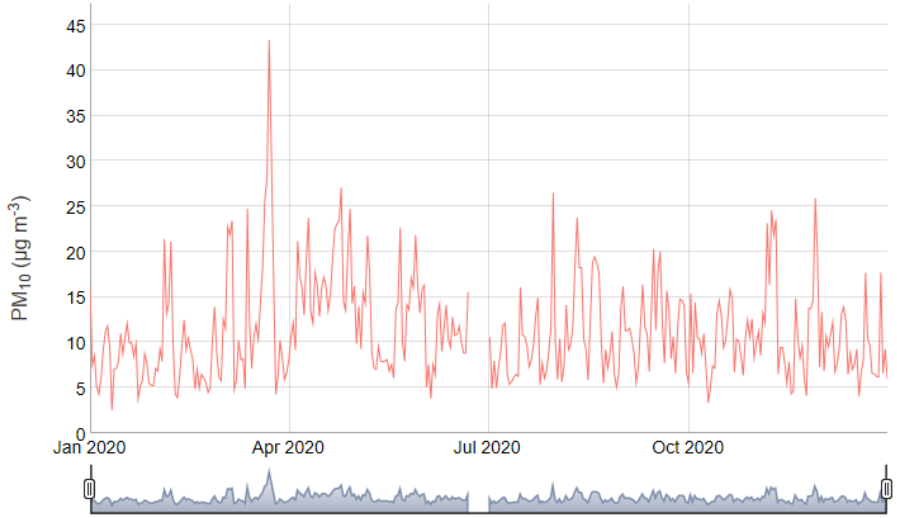


Figure G.6 Dunfermline PM_{10} time series

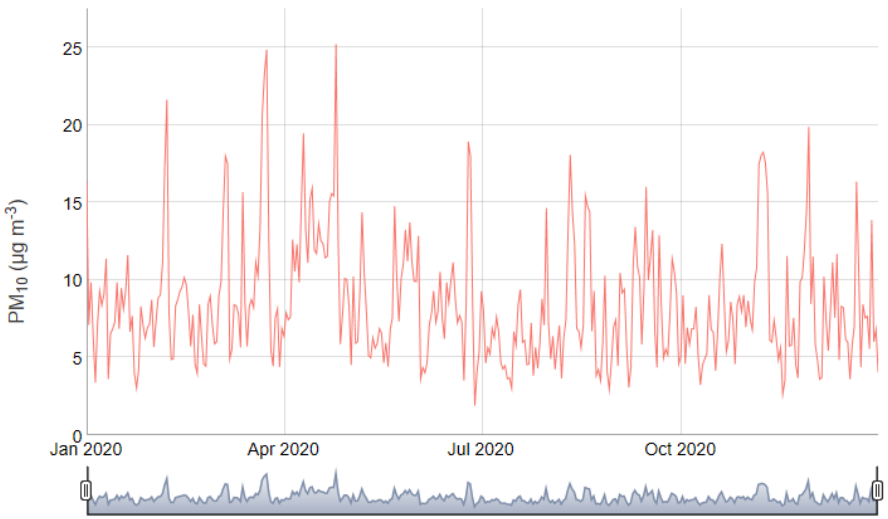


Figure G.7 Kirkcaldy PM_{10} time series

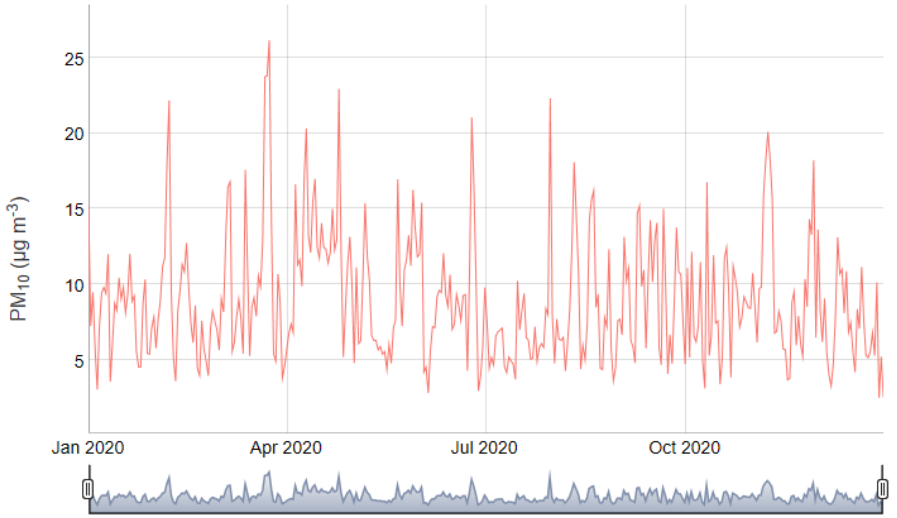


Figure G.8 Rosyth PM_{10} time series

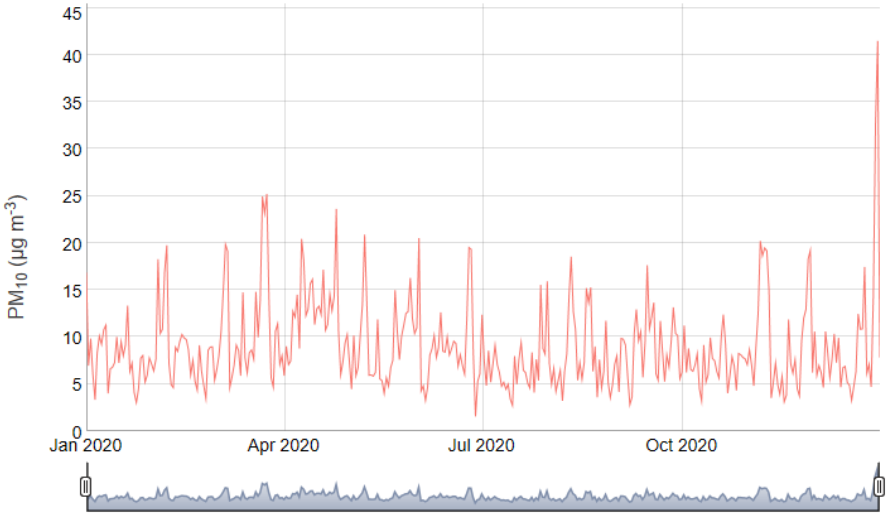


Figure G.9 Cupar $PM_{2.5}$ time series

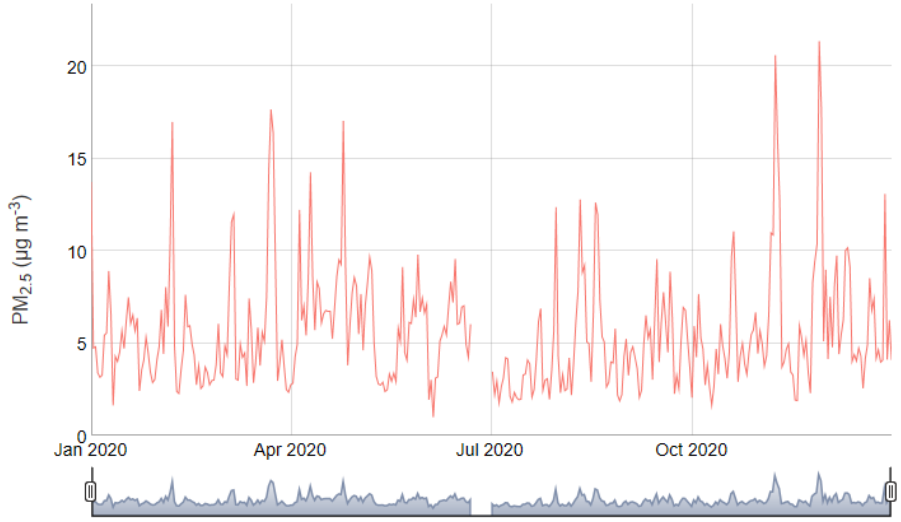


Figure G.10 Dunfermline $PM_{2.5}$ time series

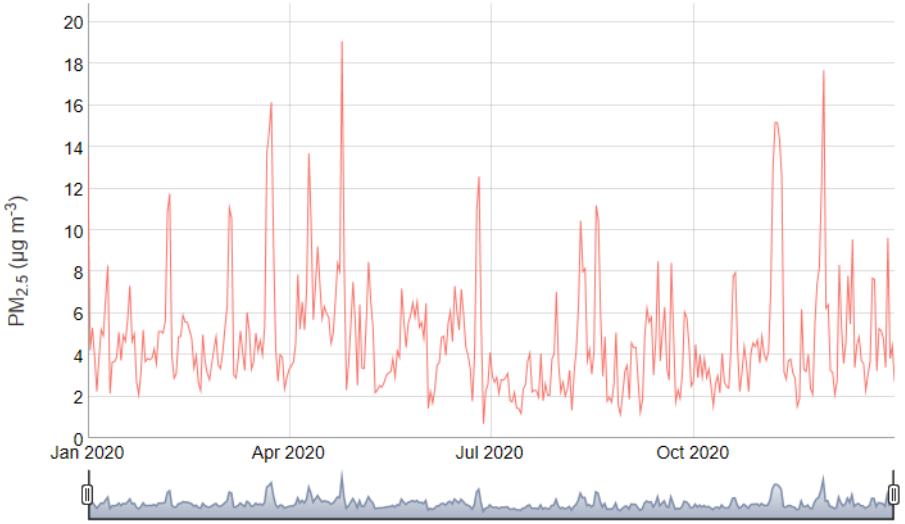


Figure G.11 Kirkcaldy $PM_{2.5}$ time series

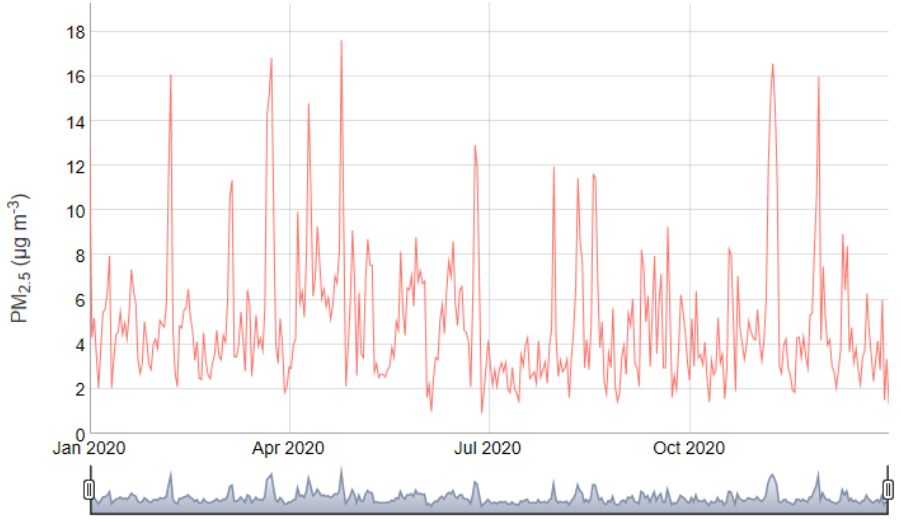


Figure G.12 Rosyth $PM_{2.5}$ time series

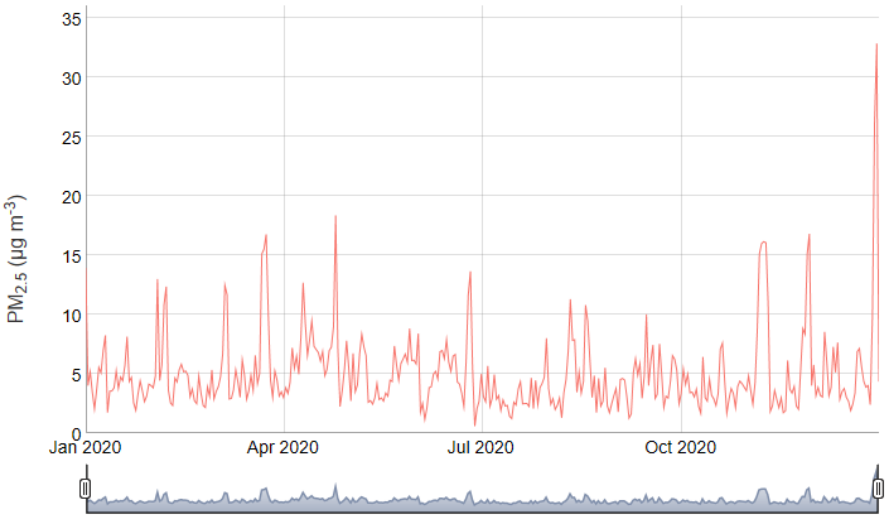


Figure G.13 Cupar NO_2 calendar plots

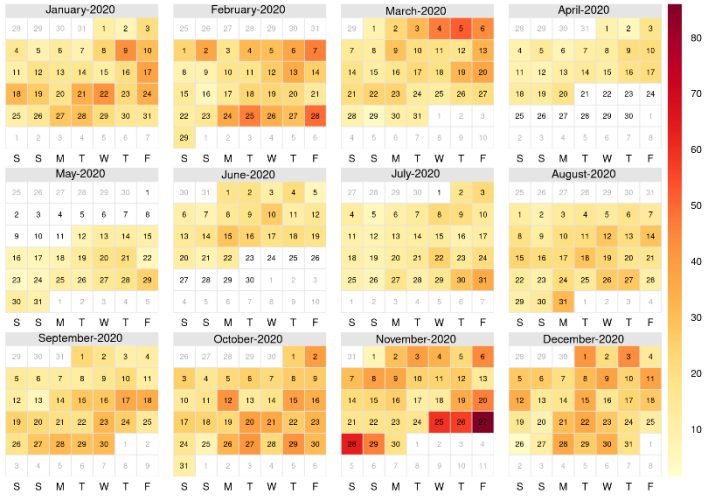


Figure G.14 Dunfermline NO_2 calendar plots

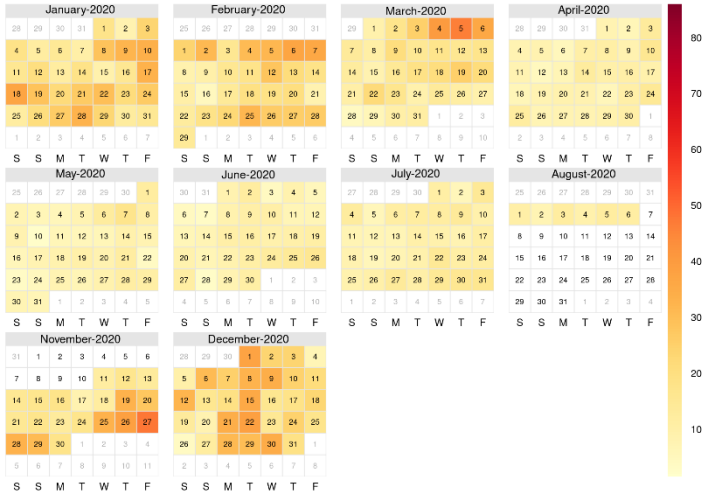


Figure G.15 Kirkcaldy NO_2 calendar plots

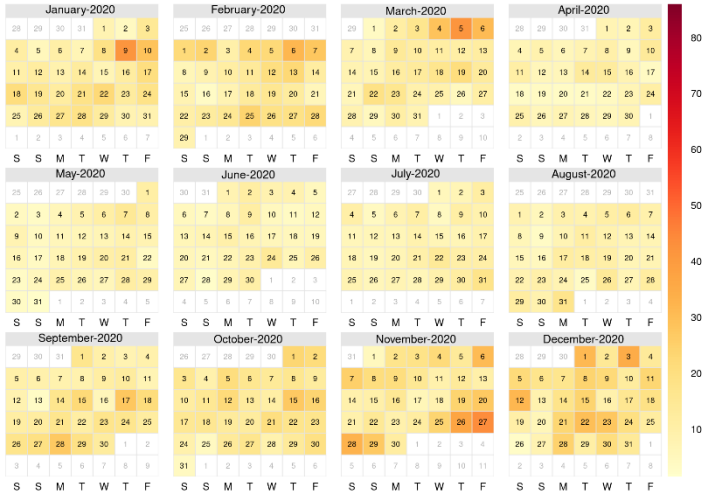


Figure G.16 Rosyth NO_2 calendar plots

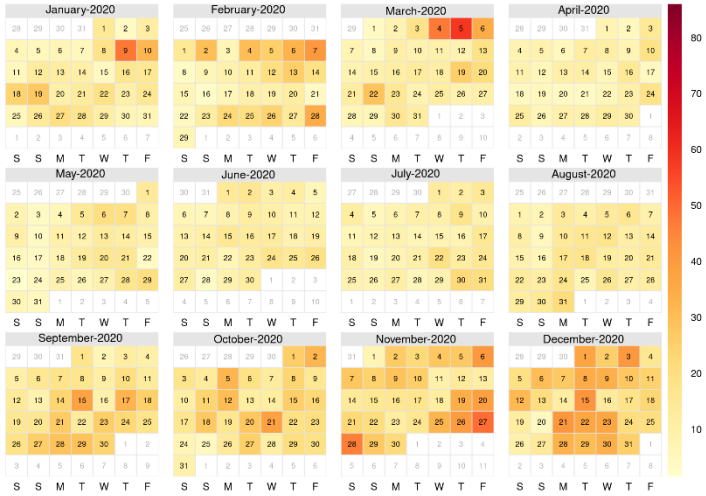


Figure G.17 Cupar PM_{10} calendar plots

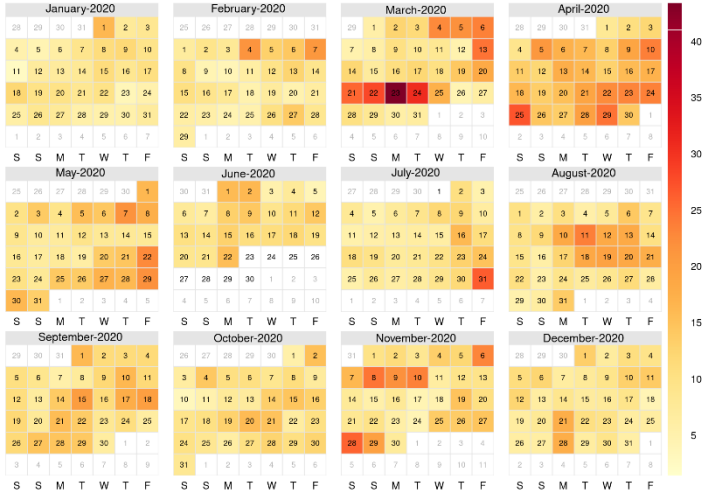


Figure G.18 Dunfermline PM_{10} calendar plots

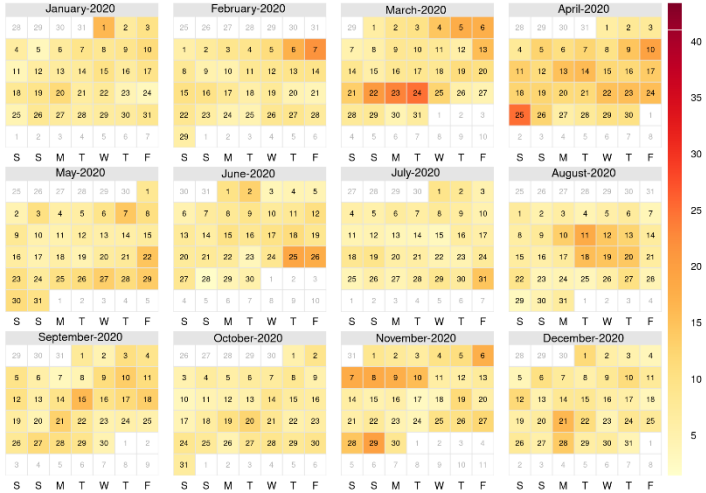


Figure G.19 Kirkcaldy PM_{10} calendar plots

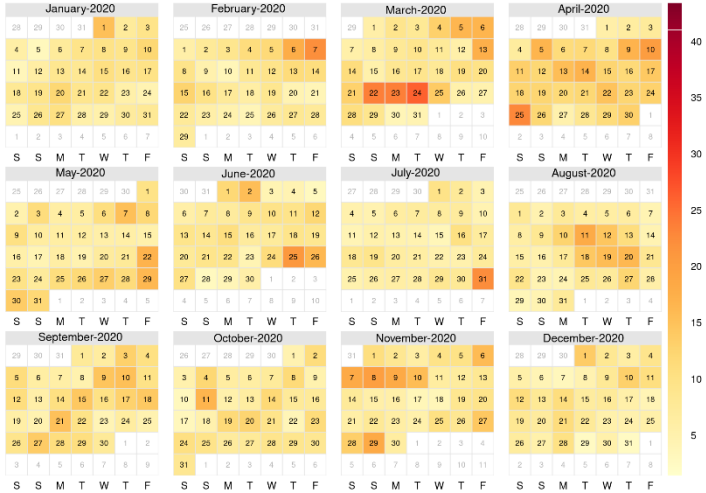


Figure G.20 Rosyth PM_{10} calendar plots

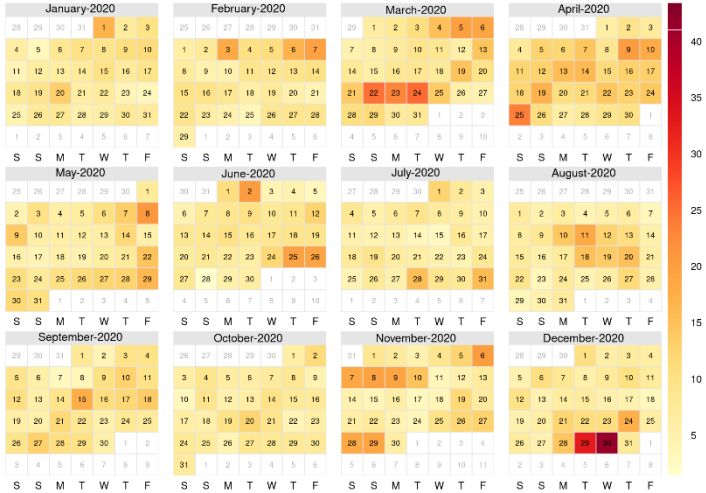


Figure G.21 Cupar $PM_{2.5}$ calendar plots

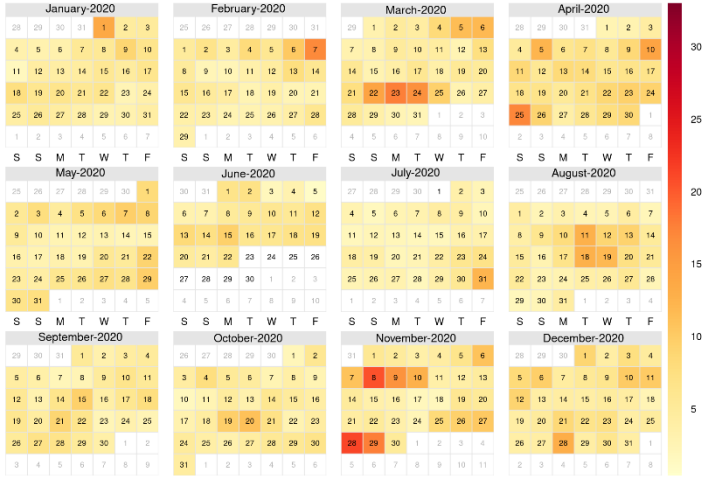


Figure G.22 Dunfermline $PM_{2.5}$ calendar plots

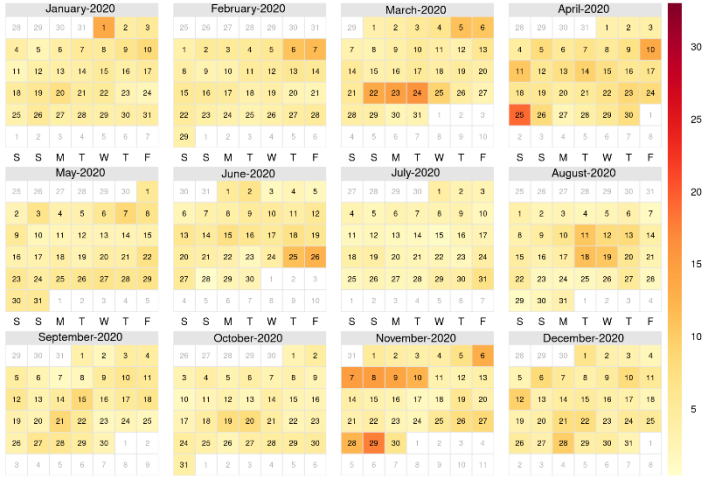


Figure G.23 Kirkcaldy $PM_{2.5}$ calendar plots

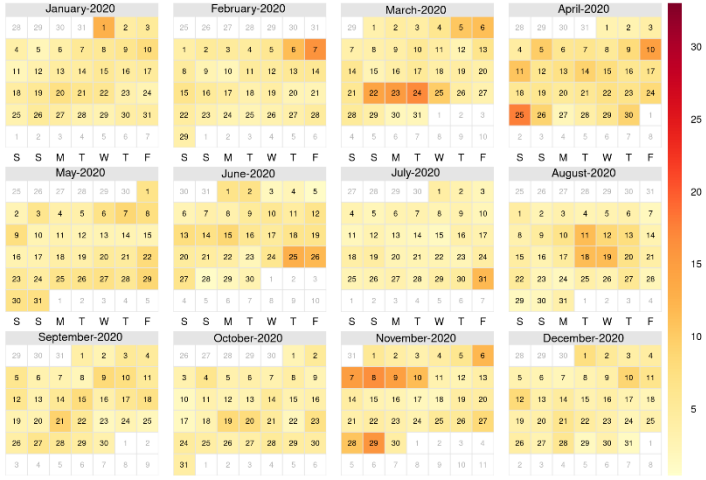


Figure G.24 Rosyth $PM_{2.5}$ calendar plots

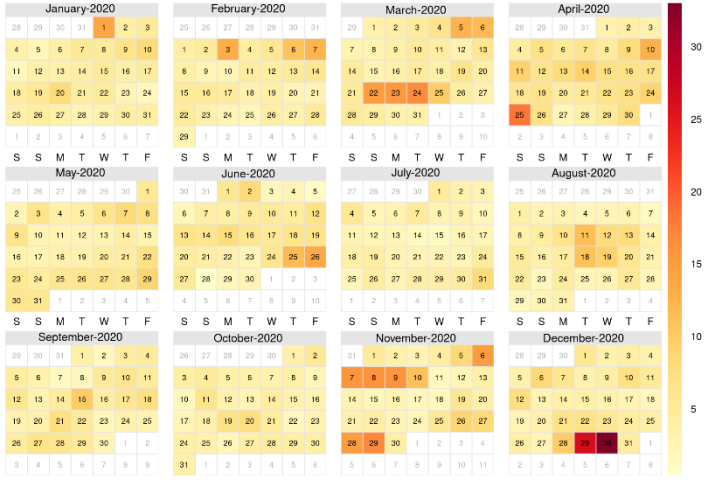


Figure G.25 Cupar NO_2 polar plot

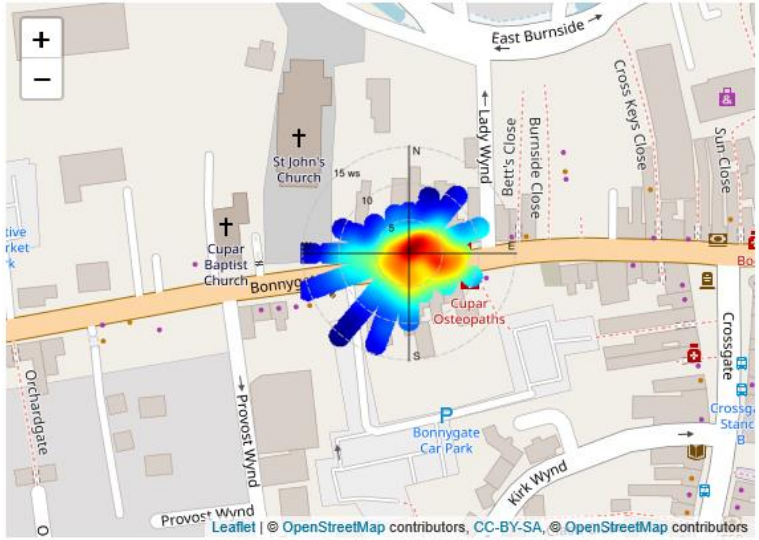


Figure G.26 Dunfermline NO_2 polar plot

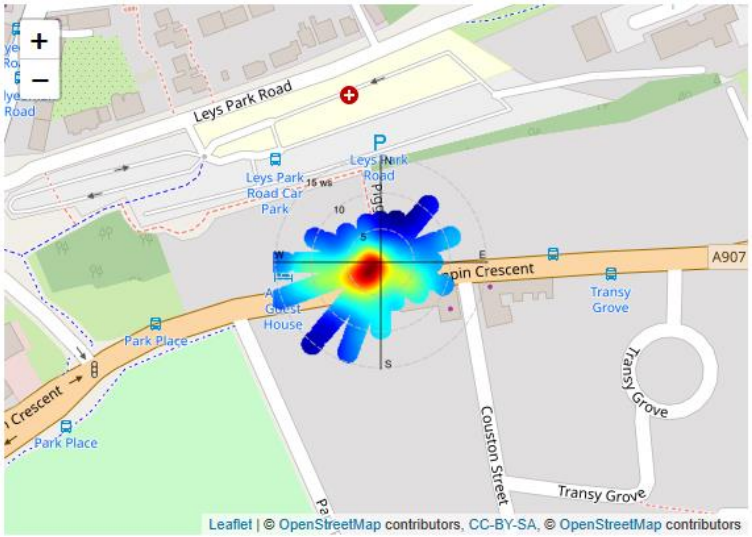


Figure G.27 Kirkcaldy NO_2 polar plot

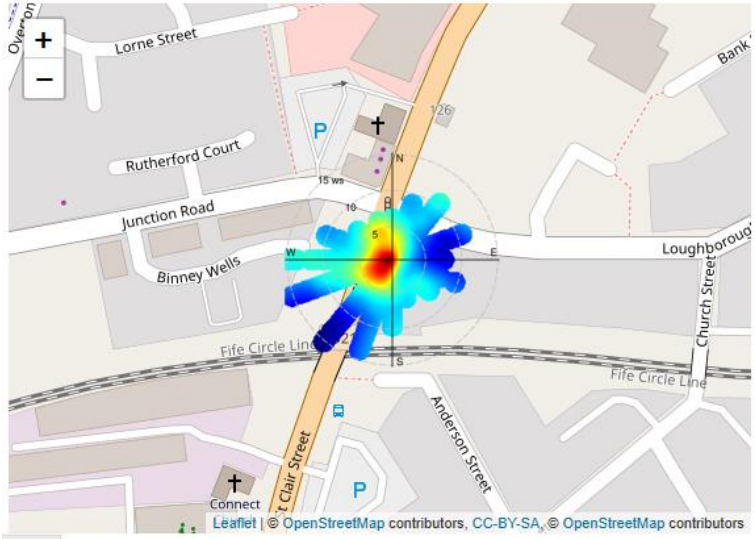


Figure G.28 Rosyth NO_2 polar plot

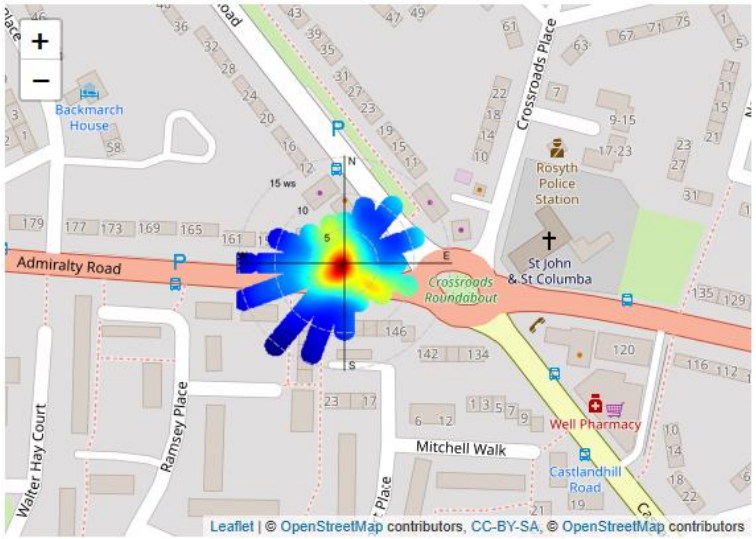


Figure G.29 Cupar PM_{10} polar plot

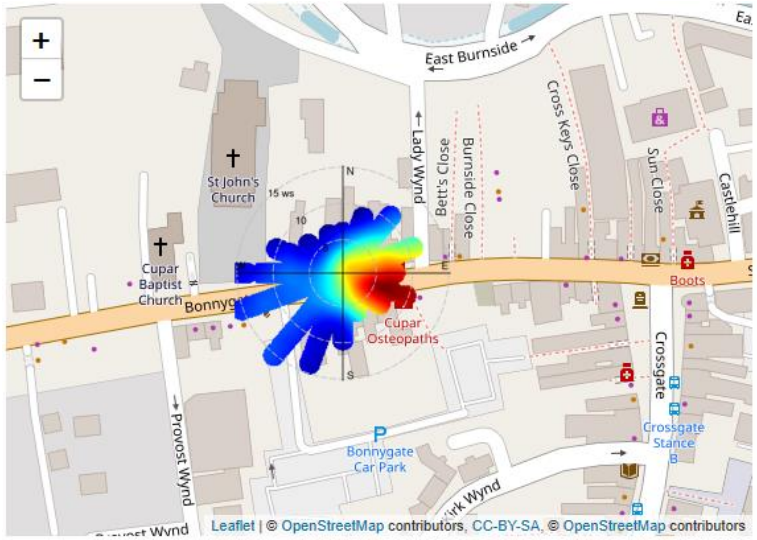


Figure G.30 Dunfermline PM_{10} polar plot

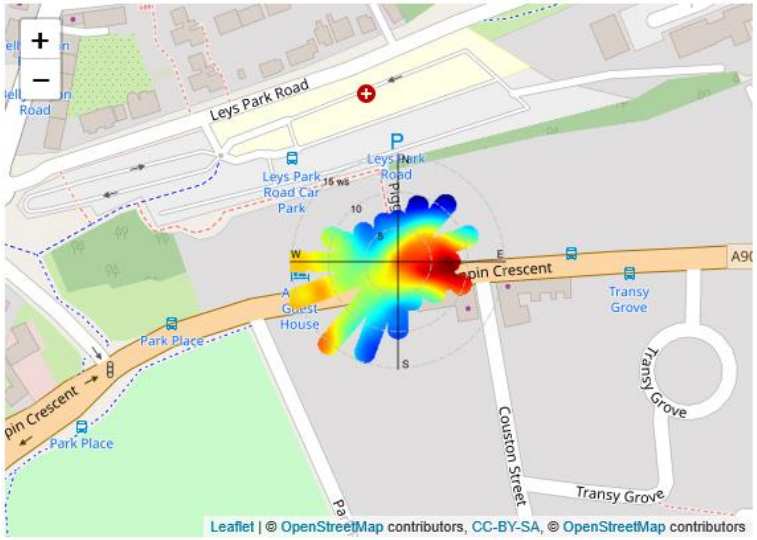


Figure G.31 Kirkcaldy PM_{10} polar plot

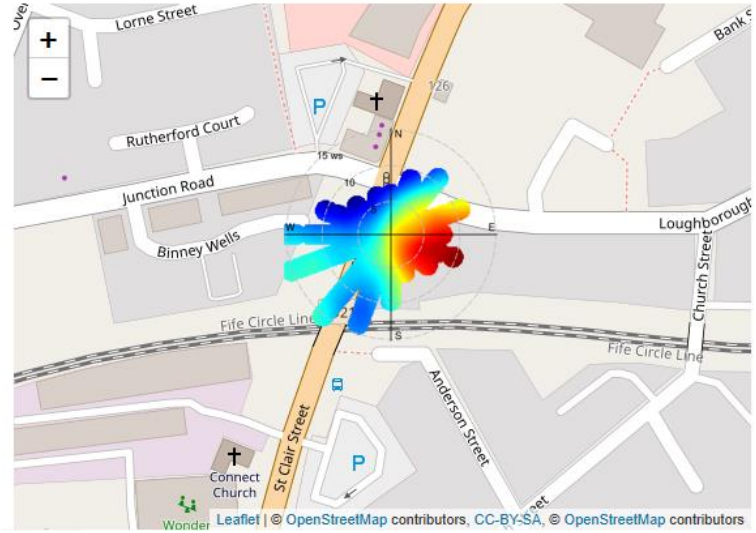


Figure G.32 Rosyth PM_{10} polar plot

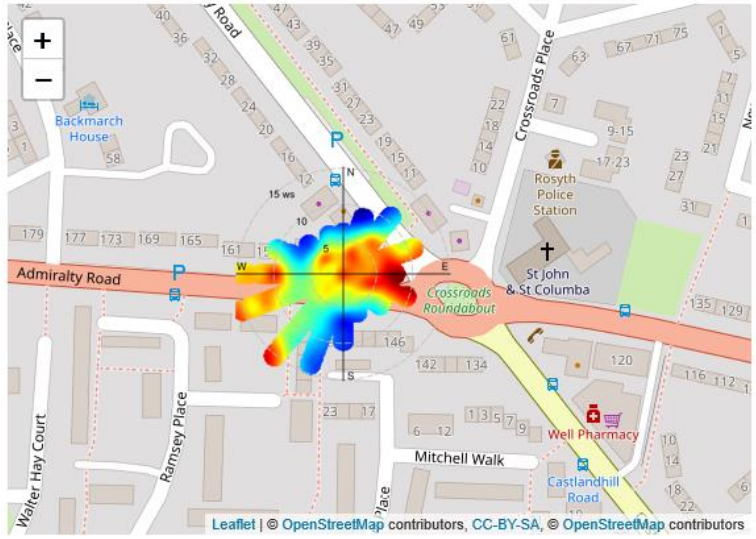


Figure G.33 Cupar $PM_{2.5}$ polar plot

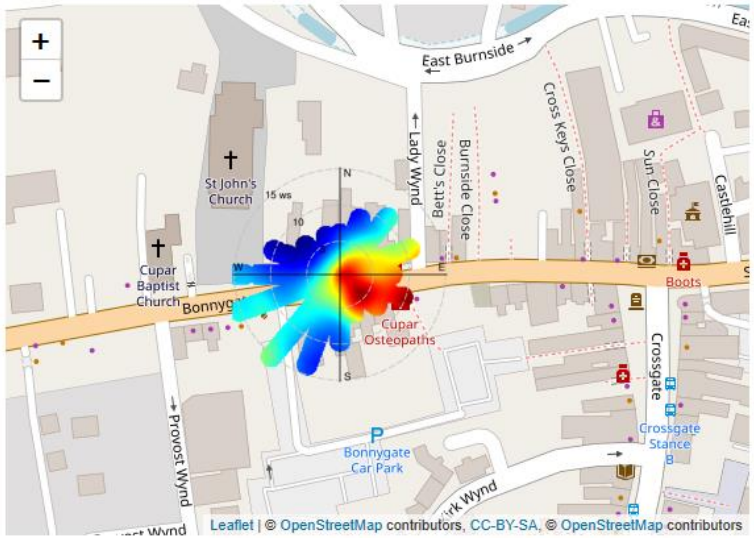


Figure G.34 Dunfermline $PM_{2.5}$ polar plot

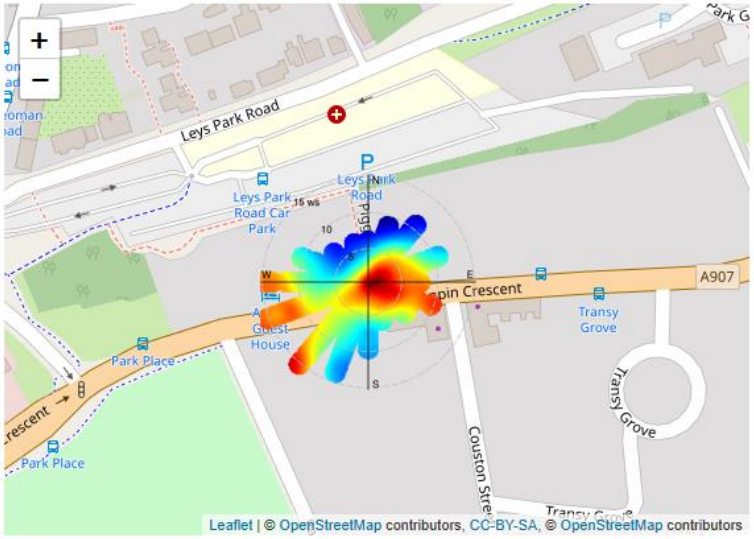


Figure G.35 Kirkcaldy $PM_{2.5}$ polar plot

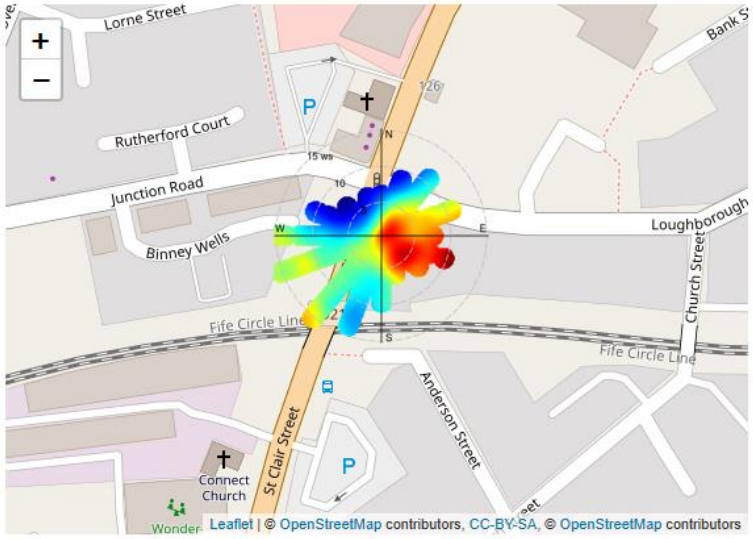


Figure G.36 Rosyth $PM_{2.5}$ polar plot

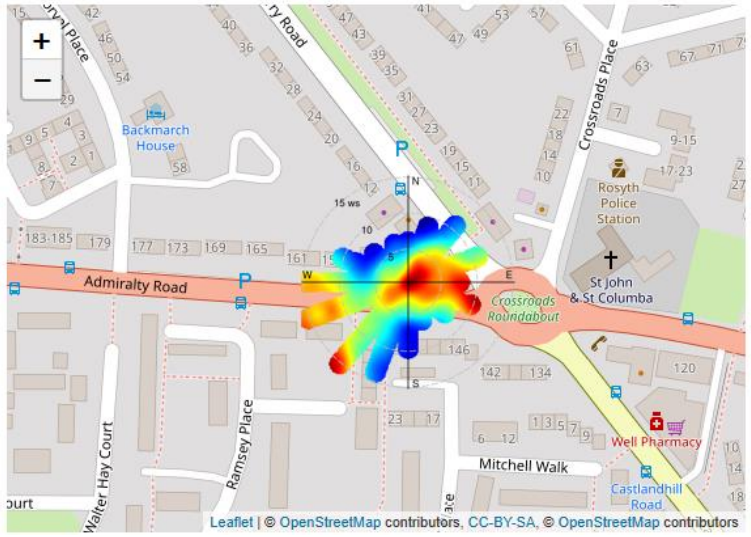


Figure G.37 Trajectory Clusters

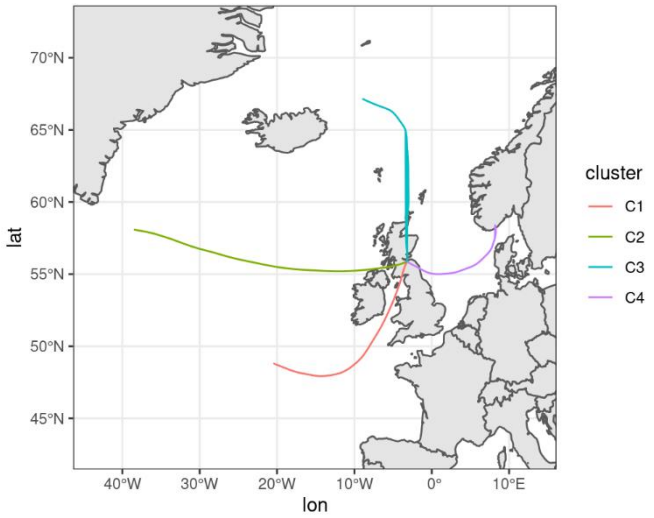


Figure G.38 Trajectory plot for top ten highest daily NO_2 concentration

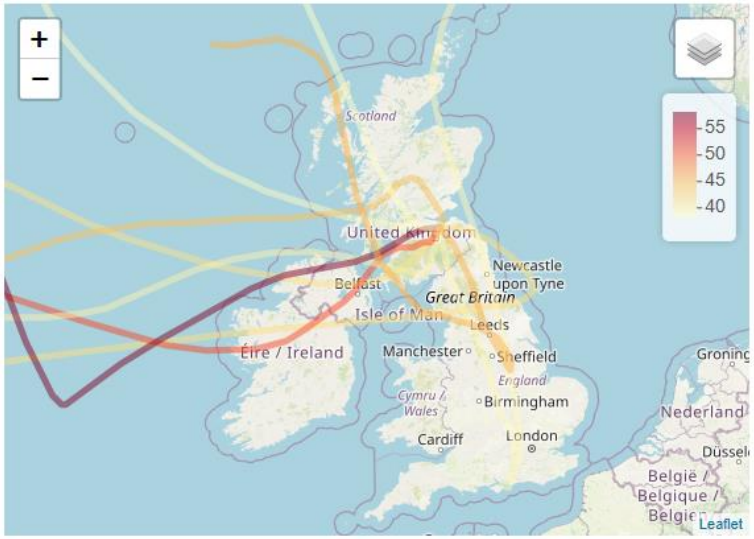


Figure G.39 Trajectory plot for top ten highest daily PM_{10} concentration

Figure G.40 Trajectory plot for top ten highest daily $PM_{2.5}$ concentration

Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan – A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the LA intends to achieve air quality limit values'
AQMA	Air Quality Management Area – An area where air pollutant concentrations exceed/are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives
APR	Air Quality Annual Progress Report
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network (UK air quality monitoring network)
CO	Carbon Monoxide
Defra	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air Quality screening tool produced by Highways England
FMDS	Filter Dynamics Measurement System
LAQM	Local Air Quality Management
LEZ	Low Emissions Zone
NLEF	National Low Emission Framework
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5 µm or less
QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide

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