2019 Air Quality Annual Status Report (ASR)

In fulfilment of Part IV of the
Environment Act 1995
Local Air Quality Management

June 2019

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Report Reference number	EP/LAQM/ASR19
Date	June 2019

Executive summary: air quality in our area

Air quality in Cheshire West and Chester

Air pollution is associated with a number of adverse health impacts. It is recognised as a contributing factor in the onset of heart disease and cancer. Also, air pollution particularly affects the most vulnerable in society: children and older people, and those with heart and lung conditions. There is also often a strong correlation with equalities issues, because areas with poor air quality are also often the less affluent areas[1,2].

The annual health cost to society of the impacts of particulate matter alone in the UK is estimated to be around £16 billion[3].

This annual status report covers monitoring results for 2018 and action that the Council is taking in a bid to improve local air quality.

In Cheshire West and Chester the main pollutants of concern are nitrogen dioxide (NO_2), particulate matter (PM) and sulphur dioxide (SO_2).

National government has set health-based objectives for a range of pollutants and, where these are not met, the local authority must declare an air quality management area (AQMA) and commit to improving local air quality through action planning. There are four designated AQMAs in the borough. Three of these, located in Chester, Ellesmere Port and Frodsham relate to exceedances of the annual mean NO_2 objective due to road traffic. The fourth, in Thornton-le-Moors, was declared because of exceedances of the 15-minute mean SO_2 objective caused by industrial emissions. Details of the AQMAs and associated action plans can be found on the Council website at www.cheshirewestandchester.gov.uk/aqmanagement .

The NO_2 annual average objective is exceeded at a number of locations in the Chester city centre AQMA. Data from 2018 indicates that the objective was not exceeded at residential properties in the AQMAs in Frodsham and Ellesmere Port. National air quality objectives for PM_{10} (particulate matter less than 10 micrometres in diameter) are complied with in Cheshire West and Chester. There is currently no regulatory standard applied to $PM_{2.5}$ (particulate matter less than 2.5 micrometres in

[1] Environmental equity, air quality, socioeconomic status and respiratory health, 2010
[2] Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006
[3] Defra. Abatement cost guidance for valuing changes in air quality, May 2013

diameter) for local authorities, but European Union (EU) limit values have been set as there are well-documented associations with health effects. Local data suggests that $PM_{2.5}$ levels at background sites are well below the limit value.

At our long-term monitoring sites there is a discernible downwards trend in NO_2 and PM_{10} concentrations over time. Monitoring stations recording the highest levels of SO_2 have not been operational for long enough to determine significant trends.

Actions to improve air quality

Cheshire West and Chester Council has pursued a number of measures with the aim of delivering air quality improvements in the reporting year of 2018 – 2019.
The Low Emission Strategy (LES) was published in September 2018 and work has started on a number of its constituent measures. The strategy covers a broad range of measures focused on modal shift, reduction of emissions from both vehicles and stationary sources and improvement areas such as electric vehicle (EV) charging infrastructure and emissions from public transport / licensed vehicles. It is anticipated that the broad range of measures contained in the LES will deliver significant improvements in local air quality over time.

In support of the aspirations of the LES, the Council has committed significant resources from the Priority Outcomes Fund to undertake a public awareness campaign, accelerate the rollout of EV charging infrastructure, web site development and human resources. The new post of LES Officer has been created and the position filled from February 2019. A feasibility study focused on electric vehicle charge points (EVCP) across a range of local sectors has been completed and the Council is now working on the rollout of EVCPs, commencing with on-street residential / car park infrastructure.

Over the last five years, the Council successfully applied for grant funding to retrofit exhaust treatment technology to local buses operating in areas with some of the highest NO_2 levels in the borough. To build on the success of the above, the Council submitted an application to the latest round of the Clean Bus Technology Fund (CBTF) in 2017 to retrofit 21 further buses with abatement technology for oxides of nitrogen (NOx). Unfortunately this application was unsuccessful.

In 2017 the Council was invited to reapply for the Low Emission Bus Scheme (LEBS). This would have seen the conversion of the entire fleet of park and ride vehicles in Chester to fully electric vehicles. Unfortunately the bid ultimately had to be withdrawn as there were insurmountable contractual issues. However, the park and ride fleet is comprised of the latest Euro VI standard vehicles.

Under a four-year programme from late 2016, 20mph zones are being introduced to some 740km of roads across the borough. While the main impetus for the speed restrictions is road safety, studies show that 20mph speed restrictions can be beneficial in reducing oxides of nitrogen (NOx) from diesel engines and PM_{10} for both diesel and petrol engines. They are also effective in reducing particulate matter due to fewer acceleration / deceleration events. The fourth year of the programme is due to commence in summer 2019.

In 2018 the Council was successful in securing funding under the air quality grant scheme to research the health burdens of particulate matter both within and outside extant Smoke Control Areas (SCA), and gauge the potential benefits and practicalities of expanding the current coverage of SCAs in the borough.

The Council can now issue fixed penalty or parking charge notices to drivers who don't switch off their idling engine when they're asked to do so by an authorised officer. An accompanying media campaign known as 'A breath of fresh air' was launched to coincide with World Environment Day in early June 2019.

The Council supported the National Clean Air Day initiative on 20 June 2019. Alongside an active social media campaign encouraging people to contribute to the improvement of local air quality, the following took place:

- Enforcement officers visited two schools on the day, encouraging parents / carers to switch off their engines while parked
- The road safety team organised a walking bus in Hoole, Chester
- In common with 2018, free travel was provided on Chester's park and ride services

Conclusions and priorities

No exceedances of the NO_2 and PM_{10} objectives were identified outside any existing AQMAs in 2018.

Long term monitoring data shows that there are general downwards trends in ambient NO_2 and PM_{10} across the borough. Annual mean NO_2 in Chester remains significantly above the objective and being developed in the action plan for the area, as well as measures from the Low Emission Strategy, will be required to bring forwards compliance in coming years.

Monitoring results in the Ellesmere Port AQMA are below the air quality objective and it may be appropriate to revoke the AQMA. Also, the annual average NO_2 objective was not exceeded in the Frodsham AQMA in 2018.

In the coming year, the Council's priorities are to complete the Air Quality Action Plan for Chester; make progress with a number of measures in the LES; expand the availability of EVCPs in the borough; tackle emissions from idling vehicles; review the status of the AQMA in Ellesmere Port; complete work on the local SCA study and to take advantage of funding opportunities for the adoption of air quality improvement measures.

Local engagement and how to get involved

The Council's 2018 Notice of Motion on air quality shows cross-party consensus that action needs to be taken to improve local air quality: "this Council ask Cabinet to:

- Review air quality monitoring across the borough
- Work to implement the actions identified in the recently published Low Emissions Strategy, including the enhancement of real time information; and
- Consider measures to improve air quality throughout the borough and in particular, outside of schools following the model of 'Active Streets' and 'Healthy School Streets' initiatives and working with schools, Community Safety Partnership and others to include a programme of education across all schools.
- Appoint a Leader's Champion for Climate Change at the next Cabinet to oversee and drive forward policy in this important area of responsibility

- Set up a cross-party task force for Climate Change, which will be led by the appointed member (as above) to oversee a range of areas of policy across the council to include air quality and will provide political oversight and accountability in this area; and
- To work with partners in the public, private and voluntary sector to improve health outcomes for residents across the borough."

There are many ways that we can all help to reduce outdoor air pollution:

- Leave your car at home and walk, cycle or use public transport instead. Car drivers can be exposed to significantly more air pollution than pedestrians or cyclists using the same streets
- When choosing your next car, consider alternatives to petrol and diesel such as electric cars or hybrids. Tailpipe emissions from these vehicles are much lower (or even zero) and running costs are significantly cheaper
- Switch your car's engine off whenever you're not moving and it's safe to do so. You'll improve air quality for yourself and others
- Keep your car regularly serviced and the tyres correctly inflated
- Adopt an efficient driving style – anticipate the road ahead, change up the gears earlier and brake smoothly. It could save you a lot of money over the course of a year
- Burning wood and other solid fuels produces a lot of air pollutants. If you do intend to buy a wood-burning stove, choose a Department for Environment, Food and Rural Affairs (Defra) approved model or an eco-design ready stove. Make sure that the wood you use meets the 'Woodsure ready to burn' requirements (seasoned dry wood with moisture content below 20%).
- Compost your garden waste or use green wheelie bins rather than burning it

Adults and children with lung problems and adults with heart problems may be particularly affected by air pollution. Information on local air quality is available on the Council's website www.cheshirewestandchester.gov.uk/airquality and further information on forecasting and health advice is available on Defra's UK-air website https://uk-air.defra.gov.uk/ .

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1 Local air quality management

This report provides an overview of air quality in Cheshire West and Chester during 2018. 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 Status Report (ASR) is an annual requirement showing the strategies employed by the Council to improve air quality and any progress that has been made.

The statutory air quality objectives applicable to LAQM in England can be found in Table 16 in Appendix E.

The next scheduled LAQM report will be the 2020 ASR, which is due to be submitted by June 2020.

2 Actions to improve air quality

2.1 Air quality management areas

Air Quality Management Areas (AQMAs) are declared when there is an exceedance or likely exceedance of an air quality objective. After declaration, the authority must prepare an Air Quality Action Plan (AQAP) within 12-18 months setting out measures it intends to put in place in pursuit of compliance with the objectives.

A summary of AQMAs declared by Cheshire West and Chester can be found in Table 1. Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at www.cheshirewestandchester.gov.uk/aqmanagement

Alternatively, see Appendix D: Maps of monitoring locations and AQMAs, which provides maps of air quality monitoring locations in relation to the AQMAs.

The Chester city centre AQMA, which was declared in 2017, has a number of hotspots at which the annual objective of 40 micrograms per cubic metre ($\mu g/m^3$) is not met. An action plan is in the process of being developed for this area. The consultants have carried out a modelling exercise and delivered stakeholder workshops. A public consultation exercise will be carried out over the summer 2019.

Concentrations of NO_2 at all monitoring sites in the Ellesmere Port AQMA were below the annual objective in 2018. This is consistent with recorded levels at residential properties in recent years so it would now be appropriate to determine whether there is a case for revocation of the AQMA.

The AQAP for the Frodsham AQMA was finalised in 2017, subjected to public consultation, submitted to Defra for approval in 2018 and adopted the same year.

The draft Thornton-le-Moors AQAP was also finalised in 2018, sent out for consultation and submitted to Defra. A number of measures have been progressed or completed since then.

Table 1 Declared air quality management areas

AQMA name	Date of declaration	Pollutants and air quality objectives	City / town	One line description	Is air quality influenced by Highways England roads?	Level of exceedance (maximum monitored/modelled concentration at a location of relevant exposure)		Action plan		
						At declaration	Now	Name	Date of publication	Link
Chester city centre	May-17	NO_2 annual mean	Chester	Inner ring road and sections of Liverpool Rd, Parkgate Rd, Hoole Way, Boughton gyratory and Watergate St	No	50.3μg/m^3 (micrograms per cubic metre)	45.8μg/m^3	Chester city centre air quality action plan	Due to be completed in 2019	www.cheshirewestandchester.gov.uk/aqmanagement
Thornton-le-Moors	Sep-16	SO_2 15-minute mean	Thornton-le-Moors	An area around the oil refinery at Stanlow	No	56 exceedances	66 exceedances	Thornton-le-Moors air quality action plan (draft)	2018	
Fluin Lane	Nov-15	NO_2 annual mean	Frodsham	Junction of A56 and Fluin La.	No	41.5μg/m^3	38.0μg/m^3	Frodsham air quality action plan	2018	
Whitby Road / Station Road	May-05	NO_2 annual mean	Ellesmere Port	Residential properties on parts of Whitby Rd, Station Rd and Princes Rd	No	44.5μg/m^3	37.0μg/m^3	Ellesmere Port and Neston BC air quality action plan	2007	

☒ The Council confirms that the information on UK-Air regarding our AQMAs is up to date

2.2 Progress and impact of measures to address air quality in Cheshire West and Chester

2.2.1 Air quality measures

The Council has taken forward a number of measures during the current reporting year of 2018 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.

More detail on some of these measures can be found in their respective action plans. Key completed measures are:

- The Low Emission Strategy was published in September 2018 following a full public consultation exercise. It is anticipated that if fully implemented the broad range of measures contained in the LES will deliver significant improvements in local air quality over time. A summary of key measures is presented in 2.2.2 below
- The supplementary planning guidance on parking standards includes minimum specifications for the provision of on-site electric vehicle charging infrastructure in new developments. Full adoption of these requirements is dependent on production of the Local Plan (Part Two). At the time of writing, it is anticipated that the post-examination version will be adopted in late July
- An electric vehicle charging point (EVCPs) feasibility study has been undertaken and work has commenced on the rollout of EVCPs
- The borough-wide 20mph speed limit programme is progressing well with the final year of a four-year programme commencing in summer 2019
- The Council has approved the use of powers to require drivers of idling vehicles to switch off their engines while stationary. Enforcement officers are now authorised to issue fixed penalty notices / penalty charge notices to drivers refusing to comply
- A number of cycling and walking promotion initiatives are ongoing

- Consultation phases of the AQAPs for both Thornton-le-Moors and Frodsham have been completed and the reports were submitted to Defra for approval in early 2018. The Frodsham AQAP has been finalised.
- Work on the sulphur recovery units at the refinery – which will allow isolation of operation of the paired units for maintenance purposes thereby reducing emissions – was completed in the 2018 turnaround

The Council expects the following measures to be completed over the course of the next reporting year:

- Implementation / progression with a wide range of LES measures
- Commencement of the rollout of a programme of electric vehicle charging infrastructure across a range of sectors
- Implementation of anti-idling enforcement programme to tackle emissions from idling vehicles. Schools and bus stand visits to be scheduled
- Progress with the de-SOx additive trial at the refinery site
- Procurement of a replacement air quality website providing public access to monitoring data and reports

Cheshire West and Chester Council's priorities for the coming year are:

- Local air quality management obligations as set out above
- Progress with a range of measures in the LES
- Completion of AQAP for Chester city centre including full public consultation
- Replacement of the Council's air quality website to improve public access to monitoring data, reports and advice
- To enhance the availability of electric vehicle charging infrastructure across the borough
- Review the status of the AQAP in Ellesmere Port
- Progression of the local smoke control area (SCA) study
- To apply for and take advantage of funding opportunities that will enable the introduction of air quality improvement measures

- To produce the 2020 annual status report

The principal challenges and barriers to implementation that the Council anticipates are: the continued failure of vehicle emission standards to deliver real-world reductions in tailpipe emissions; an increased market share in diesel vehicles in recent years; vehicle idling practices; slow uptake of ultra- low emission vehicles; environmental permitting regime for industrial sources.

Defra's appraisal of last year's ASR concluded that, "The report is well structured, detailed, and provides the information specified in the Guidance using the latest report template." The main points for action were:

- Two Action Plans have been issued for Thornton le Moors and Frodsham and been reviewed by Defra in February 2018. It would be helpful if the Council can make clear whether these AQAPs have now been adopted
- It is understood that a further AQAP is under development for Chester City during 2018. Full public consultation, including review by Defra will be required prior to completion
- It is understood that the Council also expects to complete a Low Emission Strategy in 2018. This is welcomed, and it would be beneficial to include the summary details of the LES within the next ASR
- We agree that the Ellesmere Port AQMA should be reviewed and considered for revocation
- Frodsham AQMA has two results close to objective levels, and should continue to be monitored
- We repeat the comment from the 2016 ASR which remain to be actioned: The ASR includes a detailed list of AQAP measures, but when there are four separate AQMAs, it is important to update Table 2.2 in relation to the measures that relate to each specific AQMA. Thus measures in this table should link back to measures as detailed within each AQAP. Generic measures applying to all AQMAs can be listed together, otherwise AQAP measures need to be listed under each AQAP

- The latest results highlight there may be challenges ahead in relation to achieving the AQ objectives in the city of Chester where eight exceedances are located. It will be important to continue to monitor closely in Chester as a means of identifying pollution hotspots that can be targeted within future action plans
- It will be important to ensure the Council engages closely with the transport authority at the early stages of the development of the action plan in order to consider feasible transport measures to address pollution hotspots within the city
- The development of the Action Plan for central Chester should consider a re-evaluation of the source apportionment, identification of pollution hotspots, and quantification of the degree of emissions reductions required in order to meet air quality objectives, as a basis for developing a targeted set of measures for this area

Addressing each of these points in turn:

- The Frodsham AQAP was adopted in 2018. The Thornton-le-Moors AQAP remains in draft form as the trial of de-SOx additive is ongoing and the environmental permitting implications are to be determined by the EA
- Our appointed consultants are working on development of the AQAP for Chester. Defra will be included in the full public consultation exercise
- As noted elsewhere in this report, the LES has been published and a summary of measures is reproduced here in 2.2.2
- Monitored NO_2 concentrations in the Ellesmere Port AQMA were all below the annual objective in 2018 so the status of the AQMA will be reviewed
- Monitoring has continued in the Frodsham AQMA. In 2018 all results were below the annual objective
- Table 2.2 (known as Table 2 in our report) does include reference to specific AQMAs. However, as agreed with the LAQM helpdesk, this has been made clearer in this year's report. Measures identified in individual AQAPs are referenced alongside the ASR measure numbering

- Monitoring of NO_2 has been maintained across Chester. The number and locations of diffusion tube sites was critically assessed in our regular annual monitoring review which is conducted each December
- Workshops held for the development of the Chester AQAP included representatives from Transport
- The action plan project included a preliminary modelling study, updated from the one carried out prior to declaration of the AQMA in 2016. This includes source apportionment, identification of hotspots and quantification of emissions reductions required to meet the air quality objectives. Targeted measures will be developed taking these factors into account

Whilst the measures stated above and in Table 2 will help to contribute towards compliance, the Council anticipates that further additional measures not yet prescribed will be required in subsequent years to achieve compliance and enable the ultimate revocation of Chester city centre AQMA. The AQAP for Chester is expected to be published towards the end of 2019.

2.2.2 Low emission strategy measures

The Council published its low emission strategy (LES) in September 2019. It includes a wide range of measures and actions that are focussed on the reduction of emissions of NO_2 and particulates across the borough. The majority of these will complement the aims of individual action plans.

The LES is based on three key principles:

- Shift: change mode from cars to public transport, cycling and walking
- Avoid: reduce vehicle kilometres driven, emissions from stationary vehicles, chimneys and construction
- Improve: improve vehicle technology to reduce emissions and focus specifically on low emission vehicles

These are summarised below:

Shift

- Local Plan – Developments should provide access to local services and public transport, and maximise the use of sustainable modes of transport
- Bus service subsidy – Seek to maintain the current level of subsidy and where possible enhance it by exploring other potential funding sources
- Bus priority measures – Undertake an assessment of potential bus priority improvement measures for bus routes within AQMAs. Explore the use of community infrastructure levy (CIL) and other funding for tackling congestion hotspots on major bus routes. Utilise the powers provided under the Bus Services Act and explore the potential for enhanced bus quality partnerships to deliver infrastructure improvements for specific services
- 20mph zones – The existing plan to reduce targeted 30mph roads to 20mph is to be implemented as per the approved schedule. All residential roads in new developments shall have a 20mph speed limit where appropriate. Criteria shall be developed for this purpose
- Cycling initiatives – Review potential cycle priority improvement measures for improving safe access of town centres, employment sites and other local services and prioritise delivery. Explore the use of CIL and other funding streams to enable improvements to be delivered. Develop and promote cycle-friendly culture
- Walking initiatives – Review potential walking measures for improving safe access of town centres, employment sites and other local services and prioritise delivery. Explore the use of CIL and other funding streams to enable improvements to be delivered. Explore integrated travel pass potential
- Awareness raising – Options for raising awareness of LES issues. A sustained Council campaign, providing clear and accurate information is essential

Avoid

- Local Plan – Requirement for air quality impact assessments in major developments in line with Institute of Air Quality Management (IAQM) guidance

- Development mitigation measures – Explore the use of damage cost calculations, best practice and incorporation into detailed policy
- Control of dust during construction and demolition – Developers and contractors should identify and employ appropriate mitigation measures set out in IAQM guidance
- Non-road mobile machinery (NRMM) – Investigate introduction of NRMM standards in line with Stage IIIA of the EU NRMM Regulation
- Exposure reduction – Where new developments are introduced into areas where the air quality objectives are exceeded or are likely to be exceeded, developments should be designed to minimise exposure to poor air quality
- Master planning – Design of developments should not inhibit dispersion of pollutants and should provide adequate, appropriate, and well located green space and infrastructure where possible
- Clean air zones (CAZs) – Explore the feasibility of introducing CAZs within the borough
- Anti-idling – Issue fixed penalty notices to drivers of idling vehicles who refuse request to switch off idling engines. Signage to support initiative
- SCAs – Use of SCAs to reduce PM_{10} and $PM_{2.5}$ emissions. Conduct feasibility study on expansion of SCAs, policy for introduction of SCAs in new developments. Enforce and publicise

Improve

- Public charging network – To increase the availability of EVCPs across the borough through strategic assessment including future projections
- Visitor and workplace charging – Installation of work place EVCPs at Council depot locations for fleet and at Council buildings for staff and visitor usage
- Electric vehicle charging infrastructure in new development – Installation of EV charging infrastructure in new residential and commercial developments as standard in line with the local Parking Standards Guidance
- On-street public charging network – Assessment of barriers to the provision of on-street EV charging infrastructure for residential properties, identify suitable delivery and charging models and implement accordingly

- Public procurement of low emission vehicles – Robust lifetime cost comparison between ultra low emission vehicles (ULEVs) and non-ULEVs as part of the procurement process. Council's evaluation framework for the procurement of vehicles to be revised to reflect total lifetime costs
- Improve emissions from local bus fleet and promote use of ULEV buses – Work with local bus operators to help promote the use of low emission buses. Audit the age profile of local bus fleet
- Electric buses on the park and ride service – Conversion of the park and ride fleet to electric vehicles and installation of associated infrastructure. Introduction of electric vehicles under the new park and ride contract (from 2020 or 2022)
- Promote low emission taxis and private hire – Work with local operators to identify and, where possible, remove barriers limiting the use of ULEVs. Provide incentives to encourage ULEV use and explore funding opportunities
- Business / freight policies – Work with commerce to improve emissions from delivery and service vehicles
- Health in all areas - Explore the lifecycle total cost of ownership approach beyond just vehicle procurement

Table 2 Progress on measures to improve air quality

Measure number[4]	Measure	EU category	EU classification	Organisations involved and funding source	Planning phase	Implementation phase	Key performance indicator	Reduction in pollutant / emission from measure	Progress to date	Estimated / actual completion date	Comments / barriers to implementation
1	Low emissions strategy	Policy guidance and development control	Low emissions strategy	The Council	2014 - 15	2015 -18	Adoption of strategy and implementation of measures	Reduced vehicle emissions borough-wide	Draft report produced. Public consultation completed	2018	Strategy published September 2018. Work on implementation of measures commenced. See section 2.2.2 above
2	Supplementary planning document (SPD) on parking standards	Policy guidance and development control	Air quality planning and policy guidance	The Council	2014	2015-17	EV charging conditions included in planning permissions	Reduced vehicle emissions	SPD complete. Local plan part two adoption pending	Complete	Local plan part two under examination 2018/19. Adoption scheduled for July 2019
3	Electric vehicle charge points across a range of sectors	Promoting low emission transport	Procuring alternative refuelling infrastructure to promote low emission vehicles, EV recharging, gas fuel recharging	The Council	2017 / 2018	2017/18 to 2022/23	Installation of infrastructure	Borough wide reduced vehicle emissions	Feasibility study completed. First staff EVCPs installed 2018	2018 / 2019 main project delivered with ongoing support up to 2022 / 2023	Match capital funding secured for some elements. Grant funding to be sought for on-street charging
4	Clean vehicle technology fund (CVTF) for bus engine retrofits	Vehicle fleet efficiency	Vehicle retrofitting programmes	The Council	2014	2015 / 2016 / 2018/19	Services in operation in Chester	Reduced emissions on services running though Chester AQMA	Complete - seven buses upgraded	2018	Final three retrofits completed end of 2018/19. 2017 bid for an extra 21 retrofits was unsuccessful
5	Bikeability campaign (schools and adults only schemes)	Promoting travel alternatives	Promotion of cycling	The Council	Annual	Ongoing	Increase in number cyclists	Training is delivered borough wide. Benefits for all AQMAs	Ongoing. Subject to annual project review	Ongoing	DfT / Council funded programmes ongoing – road safety team. Local Sustainable Transport Fund (LSTF) schemes complete

[4] Note: in the first column, where applicable, numbers of specific AQAP measures are given alongside numbers for ASR measure

Measure number[4]	Measure	EU category	EU classification	Organisations involved and funding source	Planning phase	Implementation phase	Key performance indicator	Reduction in pollutant / emission from measure	Progress to date	Estimated / actual completion date	Comments / barriers to implementation
6	Let's walk	Promoting travel alternatives	Promotion of walking	The Council	Annual	Ongoing	Improve pedestrian confidence to encourage more sustainable trips	Training is delivered borough-wide. Benefits for all AQMAs	Ongoing. Subject to annual project review	Ongoing	Child training promotes independence
7	Schools crossing patrols	Promoting travel alternatives	Promotion of walking	The Council	Annual	Ongoing	Improve pedestrian confidence to encourage more sustainable trips	Yes, borough-wide. Provided at hazardous school crossing points	Ongoing. Subject to annual project review	Ongoing	Supporting vulnerable road users cross the highway – when arriving and leaving educational establishments
8	Anti-idling enforcement	Traffic management	Anti-idling enforcement	The Council	2018	2018-19	Reduction of idling frequency and complaints	Borough-wide reduced vehicle emissions	Powers to require idling vehicles to switch off approved. Enforcement officers authorised. Signs erected at bus stands, taxi ranks and car parks	Ongoing	Regular patrols by enforcement officers. Exploring potential for targeted patrols at schools, bus stands etc.
9	Taxi and private hire policy - ULEVs	Promoting low emission transport	Taxi licensing conditions	The Council	2019	2019-20	Entry and exit ages of vehicles enforced. ULEV uptake stats	Borough-wide reduced vehicle emissions	Preparatory work 2019	2020	Age policy fully implemented. Policy review in 2019-20 to encourage ultra low emission vehicles via LES
10	Highway cycle improvement scheme at M53 Junction nine	Transport planning and infrastructure	Cycle network	Highways England in partnership with the Council	2016 -17	2017-18 to be constructed	Reduce traffic between the E. Port waterfront developments and town centre via AQMA.	Reduced vehicle emissions in Ellesmere Port	Scheme implemented	Complete	Providing crossing points and shared- use footpaths between residential and employment areas and railway station
11	Improved cycling and walking routes	Transport planning and infrastructure	Cycle network	The Council, Cheshire East, Warrington and Local enterprise partnership (local growth fund)	2016 - 2017	2017-18 to 2019-21	Reduction in car journeys	Reduced vehicle emissions	Phase one commenced 2019	Phase one due for completion 2019-20	Enhanced off-road walking and cycling infrastructure in Ellesmere Port and Chester

Measure number[4]	Measure	EU category	EU classification	Organisations involved and funding source	Planning phase	Implementation phase	Key performance indicator	Reduction in pollutant / emission from measure	Progress to date	Estimated / actual completion date	Comments / barriers to implementation
12	Wales and borders rail. New and enhanced rail services Improved rail station facilities	Alternatives to private vehicle use	Rail based park and ride	Transport for Wales, rail franchise consortium	Oct-18	15-year contract	Increase in bus and rail passengers reduced number of private single occupancy vehicles. Increase in the number of people walking and cycling	Reduce congestion in AQMA by private car. Reduced vehicle emissions	New tender awarded	15 year contract	Station facilities at; Chester, Neston, Helsby and Frodsham to be enhanced. With improved rail services, providing enhanced rail services, route planning, cycle facilities and journey time. Potential for EVCPs in car parks through planning conditions
13	Borough-wide parking strategy	Traffic management	Other	The Council	2016-17	2017 Council adopted strategy	Rebalance parking priorities against supply and demand while promoting sustainable transport modes	Reduced vehicle emissions borough wide	Final parking strategy adopted in 2017. First resultant action plan, focused on Frodsham, commences 2019	2017-32 15-year delivery time frame	Improved off-street enforcement measures. Promote Chester park and ride over other parking offers in Chester. Scope for incentivising EVs
14	20mph limits on residential streets (740km)	Traffic management	Reduction of speed limits, 20mph zones	The Council	2015	2016-20	Successful rollout of scheme over four year programme	Reduced vehicle emissions borough wide	Scheme approved January 2016. Rollout commenced in late 2016	2020	Promotes smoother driving style. Emissions reduction from vehicles should lead to overall emissions reduction. Fourth year of programme commencing summer 2019
15	Smart and integrated ticketing across public transport in the north of England (all rail, tram and bus operators)	Promoting travel alternatives	Other	Transport for the North (TfN), Council lead on behalf of Cheshire and Warrington LEP	2017	2019-23. 2019 – major conurbations bus and light rail. 2020: minor conurbations bus and light rail. 2021: towns and trains. 2022-2023 Full rollout across the north	Successful rollout of scheme throughout the north of England	Yes, borough-wide.	Policy, processes and back office functionality specified, with consultation	2023 roll-out across the whole of the north of England (including Cheshire West and Chester)	TfN working with the DfT, 19 local authorities, five light rail operators, three train operators and over 400 bus operators. Phase one focus on rail followed by buses

Measure number[4]	Measure	EU category	EU classification	Organisations involved and funding source	Planning phase	Implementation phase	Key performance indicator	Reduction in pollutant / emission from measure	Progress to date	Estimated / actual completion date	Comments / barriers to implementation
16	Bus lane enforcement in Chester using automatic number plate recognition (ANPR)	Traffic management	Strategic highway improvements reprioritising road space away from cars, including access management, selective vehicle priority, bus priority, high vehicle occupancy lane	The Council	2017	2017 / 2018 Implemented in phased stages (subject to trial phase/period)	Increase in bus passengers, reduce number of private single occupancy vehicles	Chester-wide	ANPR cameras now installed	2019/20	
17	Bus interchange conditions of use	Traffic management	Anti-idling enforcement	The Council	2016	2017 onwards	Compliance with conditions	Reduced vehicle emissions in Chester AQMA	2017: requirement introduced in conditions of use	Ongoing	Drivers must switch off engines unless a departure is imminent. Signage installed Spring 2019. Chester Bus Interchange (CBI) will be included in regular patrol route by enforcement officers
18 Frodsham AQAP measure number 1	Video survey of the Fluin Lane and Bears Paw junctions	Traffic management	Urban Traffic Control (UTC), congestion management, traffic reduction	The Council	Early 2018	Autumn 2018 Revised: Spring / Summer 2019	Measured annual mean NO_2 concentrations in AQMA	Not applicable	Video camera survey carried out at Fluin / Red Lane junction	2019	A video survey with turning counts on A56 replaces need for video surveys at Fluin and Bears Paw junctions
19 Frodsham AQAP measure number 8	Explore traffic regulation order (TRO) options for restricting HGVs travelling through the AQMA and Church Street	Traffic management	UTC, congestion management, traffic reduction	The Council	2018-19	2019-20	To be determined	1 µg/m3	Signage enhancement scheme commenced	2020	Highways advise that a TRO will not now be required, the preference being for a signage enhancement scheme warning drivers significantly in advance of height / weight restrictions to provide decision of selecting alternative routes

Measure number[4]	Measure	EU category	EU classification	Organisations involved and funding source	Planning phase	Implementation phase	Key performance indicator	Reduction in pollutant / emission from measure	Progress to date	Estimated / actual completion date	Comments / barriers to implementation
20 Frodsham AQAP measure number 9	Undertake Bears Paw junction assessment study with view to improve junction efficiency	Traffic management	UTC, congestion management, traffic reduction	The Council	2018-19	2018-19	Undertake detailed survey of options to improve traffic through flow	Low	Initial assessments confirm widening carriageway is not an option	2019	Highways advise that, subject to measure 18 above (AQAP measure 1), the video survey, counts, modelling of pedestrian phases and modelling Church St left turn to be undertaken
21 Frodsham AQAP measure number 10	Origin and destination survey to identify and liaise with commercial users of the route	Freight and delivery management	Route management plans/ strategic routing strategy for HGVs	The Council	Complete	2018-19	Completion of survey	Yes, along Fluin Lane	Video survey has been completed (see measure 18 / AQAP measure 1 above)	2019	Highways advise that, subject to measure 18 above (AQAP measure 1), the video survey replaces the need for a full origin and destination survey
22 Thornton AQAP measure number 1	Remove sulphur compounds in process	Environmental permits	Measures to reduce pollution through IPPC permits going beyond BAT	Essar refinery	2017	2018 onwards	SO_2 measured at CCU stack	Reduction in 15-min exceedances to less than 35 per year. Potential air quality benefit = medium (in the range of 25-40%)	Trial in progress. New additive dosing kit installed June 2019	To be confirmed	Trial of 'de-SOx' additive on the catalytic cracking unit in progress. New dosing kit should allow improved performance data. Complexity of setup means that the trial needs extended timeframe to prove efficacy
23 Thornton AQAP measure number 2	Schedule maintenance / repair on sulphur-critical plant to suit the weather	Environmental permits	Other	Essar refinery	Ongoing	Ongoing	SO_2 measured at local AQ monitoring stations	Negligible	Measure completed and operational	Ongoing	Refinery uses weather data to plan maintenance / repair on sulphur-critical plant
24 Thornton AQAP measure number 3	Isolation of sulphur recovery units (SRU) to allow independent operation	Environmental permits	Other	Essar refinery	2017	Q1 2018	Reduced sour gas flaring	Negligible	Complete. Installed during 2018 turnaround	Completed	This allows one SRU to be shut down for maintenance while keeping the other online. Reduces sour gas flaring

Measure number[4]	Measure	EU category	EU classification	Organisations involved and funding source	Planning phase	Implementation phase	Key performance indicator	Reduction in pollutant / emission from measure	Progress to date	Estimated / actual completion date	Comments / barriers to implementation
25 Thornton AQAP measure number 4	Fuel gas scrubbing and fuel substitution	Environmental permits	Other	Essar refinery	2017	Q1 2018	Sulphur content in refinery fuel gas	Negligible	Complete. Installed during 2018 turnaround	Completed	Additional capability for removing sulphur from fuel gas (in addition to natural gas switch for some boilers)
26 Thornton AQAP measure number 5	Address fugitive emissions	Environmental permits	Other	Essar	Ongoing	Ongoing	SO2 measured at local AQ monitoring stations	Negligible	Completed. Medium pressure (MP) superheater replaced in 2018 turnaround	Q1 2018	Fugitive emissions are addressed as they are identified, e.g. MP superheater replaced as it was approaching end of life
27 Thornton AQAP measure number 6	Air quality monitoring	Public information	Via the Internet	The Council	Ongoing	Ongoing	Real-time data published on website	Nil	Ongoing	Ongoing	Results published on Council website, updated hourly. Currently posted daily due to system fault. Replacement system to be commissioned 2019
28 Thornton AQAP measure number 7	Real-time data provision to operator (with trigger capability)	Public information	Via the Internet	The Council / Essar	Q3 2017	October – December 2017	Establishment of data sharing	Negligible	Complete. Output data from both SO_2 monitoring stations shared with Essar	Complete. Measure in place from 2018	Supports measure 23 above. Due to be superseded in tandem with measure 27 above

Notes:

The above table does not include Ellesmere Port AQAP measures, nor are additional measures planned, as recent monitoring results indicate the need for review of the status of the AQMA as it may qualify for revocation. However, measures rolled out through the LES will help to improve air quality in the area.

No measures are included for the Chester AQAP as it is currently under development with a view to finalisation later in 2019. The measures will thus be incorporated into next year's ASR for reporting purposes.

2.3 $PM_{2.5}$ – Local authority approach to reducing emissions and/or concentrations

As detailed in policy guidance LAQM.PG16 (Chapter 7), local authorities are expected to work towards reducing emissions and/or concentrations of $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5µm (micrometres) or less). There is clear evidence that $PM_{2.5}$ has a significant impact on human health, including premature mortality, allergic reactions, and cardiovascular diseases. Based on national estimates, the public health outcomes framework indicates that the fraction of mortality attributable to particulate matter in Cheshire West and Chester is 5.2% which is equivalent to some 161 premature deaths. This figure rises to 285 per year when the effects of NO_2 are taken into account. Reductions in air pollution can therefore deliver significant improvements in local health outcomes.

The Council does not monitor $PM_{2.5}$ as it is not currently a requirement of LAQM. However, PM_{10} (particulate matter with an aerodynamic diameter of 10µm or less) is recorded at four monitoring stations in the borough. Because $PM_{2.5}$ is a subset of PM_{10}, it is possible to estimate the probable local levels by considering the ratio of the two fractions of particulate matter – as detailed in the technical guidance LAQM.TG16. Applying the nationally derived correction ratio of 0.7 to local data suggests that local $PM_{2.5}$ levels at local sites lie in the range 8.4 to 14.7$\mu g/m^3$ (micrograms per cubic metre), which is well below the national annual mean objective for background sites of 25$\mu g/m^3$ (to be met by 2020). In recognition of the close association between particulates and health, these figures may be used as a benchmark against which to gauge local improvements over time. There is an EU target value of 15% reduction at background urban locations between 2010 and 2020. Although this is not a requirement placed on local authorities, our long-term PM_{10} monitoring suggests that there has been a reduction of 14% in $PM_{2.5}$ between 2010 and 2017, which is on course to achieve the target.

National policy guidance assumes that local authorities will consider how to address $PM_{2.5}$ alongside other pollutants and that few standalone $PM_{2.5}$ measures will need to be chosen unless they are needed to address a very specific local problem. So action to reduce PM_{10} and NO_2 would usually contribute to the reductions in $PM_{2.5}$. The Council is not, therefore, expected to be required to carry out additional local review and assessment (including monitoring).

The Council is taking the following measures to address $PM_{2.5}$: measures listed in Table 2 above will contribute in general to improvements in levels of $PM_{2.5}$. In September 2019 our low emission strategy (LES) was published. The aims of the strategy include tackling NO_2, PM_{10} and $PM_{2.5}$, with a focus on reducing emissions from road vehicles and supporting more sustainable modes of transport. The ultimate ambition is to improve the health of residents and reduce the number of deaths attributable to poor air quality that arise every year. The action toolbox, Table A.1 in LAQM.TG16 lists a range of measures that can be implemented to tackle $PM_{2.5}$ and many of these are incorporated into the LES. Examples include:

- Smoke control areas are in place in a number of the Borough's urban areas and the LES includes a measure focused on exploring the feasibility of expanding SCAs and publicising health concerns related to domestic burning. A local study of SCAs and health impacts of domestic smoke has been commenced.
- The Council has a policy to reduce speed limits from 30mph to 20mph on residential roads, particularly around schools, one of the benefits of which is to reduce emissions through the encouragement of smoother driving styles.
- A reduction in vehicle idling will deliver an immediate improvement in air quality particularly in urban centres. In January 2019, the Council approved the use of powers to require drivers of idling vehicles to switch off their engines while stationary. Enforcement officers are now authorised to issue fixed penalty notices to drivers who refuse to do so.
- The hackney carriage / private hire vehicle age policy contained within the Council's licensing policy ensures vehicles entering the system must be under five years old and will not be licensed after they have reached 10 years old; or 15 years old in the case of wheelchair accessible vehicles. In the Chester AQMA, all hackney carriages must be new at first registration. This rolling programme delivers a gradual improvement in vehicle emission standards over time. In order to further enhance this, the LES includes a measure looking at the incentivisation for the adoption of ULEVs in the taxi and private hire fleets.

The Environmental Protection team has a close working relationship with the Director of Public Health and will continue to work collaboratively to determine how air quality can be prioritised across a wide range of policy areas as well identifying specific measures to address $PM_{2.5}$.

3 Air quality monitoring data and comparison with air quality objectives and national compliance

3.1 Summary of monitoring undertaken

This section sets out what monitoring has taken place and how it compares with national objectives.

3.1.1 Automatic monitoring sites

The Council undertook automatic (continuous) monitoring at seven sites during 2018. Table 3, Appendix A shows the details of all automatic monitoring sites.

NO_2, NO (nitric oxide) and NOx (oxides of nitrogen) were measured using chemiluminescent analysers at five sites. These comprise three roadside sites: the bus interchange (CBI) in Chester and the roadside sites at Boughton in Chester and Whitby Road in Ellesmere Port (BO and WH); and the two background sites in Frodsham and Thornton-le-Moors (FMH and TLP). NO_2 was also monitored at roof-top level using the Opsis differential optical absorption spectrometer (DOAS) system at the Ellesmere Port urban background site (LR-JG).

Sulphur dioxide (SO_2) was measured using ultra-violet (UV) fluorescence at monitoring stations in Elton (ELT) and Thornton-le-Moors (TLP), and also in Ellesmere Port (LR-JG) using DOAS, as above.

PM_{10} was measured at four sites; two of which, Frodsham (FMH) and Ellesmere Port (LR-JG), use tapered element oscillating microbalances (TEOMs), and two of which, Thornton-le-Moors (TLP) and CBI employ beta attenuation monitors (BAMs).

Note: local authorities do not have to report annually on the following pollutants: 1,3 butadiene, benzene, carbon monoxide and lead, unless local circumstances indicate there is a problem. These pollutants were assessed in detail in earlier rounds of LAQM and it was concluded that there would be no need to declare AQMAs for them. National monitoring results are available at https://uk-air.defra.gov.uk/ , although there are no national network sites actually within the borough of Cheshire West and Chester.

Maps showing the location of the monitoring sites are provided in Appendix D: Maps of monitoring locations and AQMAs. Further details on how the monitors are calibrated and how the data has been adjusted are included in Appendix C.

3.1.2 Non-automatic monitoring sites

The Council undertook non- automatic (passive) monitoring of NO_2 at 85 sites during 2018. Table 4, Appendix A shows the details of these sites. Of the suite of NO_2 diffusion tube sites in use during 2017, five were discontinued and 22 new sites were established during 2018. Ten of the new sites are close to schools across the borough and were established in response to concerns raised by local ward members and school staff. The collocation exercise at the bus interchange, which opened in May 2017, was enhanced with a triplicate set of tubes for 2018.

Maps showing the locations of the monitoring sites are provided in Appendix D.

All tubes are prepared and analysed by Gradko International Ltd. According to the Defra LAQM website, Gradko's performance in the 'AIR-PT' NO_2 proficiency testing scheme scored 100% satisfactory rating for all rounds in 2018. Further details on quality assurance/quality control (QA/QC) for the diffusion tubes, including bias adjustments and any other adjustments applied (for example, annualisation and/or distance correction), are included in Appendix C.

3.2 Individual pollutants

The air quality monitoring results presented in this section are, where relevant, adjusted for bias, annualisation (in instances where the period of monitoring was less than nine months) and distance correction. Further details on adjustments are provided in Appendix C.

3.2.1 Nitrogen dioxide (NO_2)

Table 5 in Appendix A compares the ratified and adjusted monitored NO_2 annual mean concentrations for the past five years with the air quality objective of 40µg/m^3. Note, results in this table show the levels of NO_2 at the point of monitoring and do not take account of distance to relevant receptors.

For diffusion tubes, the full 2018 dataset of monthly mean values, including distance corrections, is provided in Appendix B (Table 10).

Exceedances of the annual mean objective were recorded at a number of relevant locations in 2018, all of which lie within existing AQMAs. As no exceedances were recorded outside of AQMAs, there is no need to declare or extend AQMAs.

In 2018, annual mean NO_2 at the real-time monitoring station CBI in Chester was 40$\mu g/m^3$ and at WH it was 37$\mu g/m^3$. Results for all other automatic monitoring stations were comfortably below the annual objective. It should be noted, however, that real-time monitoring stations are not necessarily in worst-case locations because of siting constraints.

A time series graph of local real-time NO_2 monitoring compared with that from nearby national automatic urban and rural network (AURN) sites is shown in Figure 30.

Diffusion tubes are collocated with the automatic stations at Boughton, Chester (BO); the bus interchange in Chester (CBI) and Whitby Road, Ellesmere Port (WH). With the exception of BO, the collocated tubes are triplicates and the results are submitted to Defra annually to contribute to the calculation of national bias adjustment factors.

Diffusion tubes were used at 85 locations across the borough in 2018. The majority of these, 52, were sited within the Chester, Ellesmere Port and Frodsham AQMAs. Results presented in Table 10 in Appendix B have been annualised (where necessary), adjusted for bias using Defra's national factor, and corrected for distance to relevant exposure (where necessary). The full dataset of monthly averages for 2018 is also displayed. Details of quality control and any adjustments that have been applied are given in Appendix C.

In 2018, at the point of monitoring, 13 tube sites recorded annual averages in excess of 40$\mu g/m^3$, but correcting for distance to the facade of the nearest relevant receptor (i.e. dwelling) there were six locations exceeding the objective although all were below 50$\mu g/m^3$. A further 10 locations were within 10% of the annual objective. Three of these sites; BJ, CBI and WG were only marginally below 40$\mu g/m^3$ and with rounding would be at the objective level.

On the whole, when compared to previous years, 2018 tube results are generally slightly lower. In 2017 eight results were above the objective (following distance correction) as compared to six in 2018. All six of these sites (C11, C36, OB, PG, RM and T6) are within the Chester city centre AQMA. All the remaining sites across the

borough, including those within the Ellesmere Port and Frodsham AQMAs, were below the objective.

Last year's report and the 2017 report made reference to a potential exceedance on the A41 in Christleton (site MCC). The monitoring result for 2018 was below the national objective and it is not necessary to declare an AQMA.

Monitoring results at school premises were mostly in the range of 14 to 25μg/m^3 and therefore well below the national objective. The highest result at the point of monitoring, 42.4μg/m^3 was recorded at RPS near Rudheath Primary School. However, the tube is next to the busy A556 junction with Gadbrook Park and correcting for distance from the carriageway, the result at the school facade was 29.2μg/m^3. In the centre of Chester the annual average at the Love Street facade of the University Church Free School was calculated to be 31.4μg/m^3. The school lies within the existing AQMA so measures to improve air quality within this area will benefit the school.

Monitoring locations adjacent to the M6 motorway in Allostock returned annual results of 25.3μg/m^3 at site AP (southbound) and 19.4μg/m^3 at site AHH (northbound). These tubes were set up in response to long-term roadworks on a stretch of 'smart motorway', which is now completed. Both results remain comfortably below the annual objective.

Table 6, in Appendix A, compares the ratified continuous monitored NO_2 hourly mean concentrations for the past five years with the air quality objective of 200μg/m^3 (not to be exceeded more than 18 times per year). No exceedances of the hourly mean have been recorded in 2018. As stated in the LAQM.TG16 technical guidance, annual mean results from diffusion tubes may indicate a likely exceedance of the hourly objective if the annual mean is over 60μg/m^3. In 2018 no diffusion tube results were above 60μg/m^3 (the highest being 45.8μg/m^3 at a relevant receptor) so on the basis of monitoring it is highly unlikely that the hourly objective is exceeded anywhere in the borough. However, a 2019 modelling study conducted by consultants Bureau Veritas, in preparation for the Chester AQAP, predicted potential exceedances over a small discrete area adjacent to the inner ring road. This will be investigated through the deployment of additional diffusion tubes in the latter half of 2019.

Long term trends of NO_2 monitoring results are shown in the graphs Figure 1 to Figure 4. For the majority of sites there is a discernible downward trend reflecting general improvements in NO_2 concentrations over time. It is also clear from comparison of the graphs that the sites with the highest NO_2 are all in Chester. [Note: the data shown in these graphs has been bias adjusted and annualised where necessary, but hasn't been corrected for distance from kerb.]

3.2.2 Particulate matter (PM_{10})

Table 7 in Appendix A compares the ratified and adjusted PM_{10} annual mean concentrations for the past five years with the air quality objective of 40µg/m^3. In 2018, PM_{10} was below the annual mean objective at all sites. It has not therefore been necessary to declare any AQMAs in respect of PM_{10}. The highest monitored concentrations of PM_{10} are recorded at the recently established roadside site, CBI, sited at the bus interchange in Chester. This site lies within the Chester city centre AQMA. The annual mean of 21µg/m^3 is, however, well below the objective of 40µg/m^3. All 2018 PM_{10} data has been independently ratified.

Table 8 in Appendix A compares the ratified continuous monitored PM_{10} 24-hour mean concentrations for the past five years with the air quality objective of 50µg/m^3. The only monitoring station which recorded exceedances of the daily mean limit value was CBI where the value was exceeded on four days. However, as there is an allowance of 35 days in any calenadr year, the objective itself was not exceeded.

Long term trends in annual PM_{10} monitoring are shown in Figure 5. It can be seen that there is a general downward trend in PM_{10} concentrations over time at some sites although at others the dataset isn't large enough to determine a trend. Figure 6 shows the number of exceedances of the 24-hour mean objective since 2012. Although the number of exceedances is low, and has generally reduced over time, there were four exceedances at the CBI monitoring station in 2018.

A time series graph of daily mean PM_{10} at local monitoring sites is shown in Figure 31. The higher concentrations recorded by the CBI analyser are clearly shown.

3.2.3 Particulate matter ($PM_{2.5}$)

The Council does not monitor $PM_{2.5}$ as it is not currently a requirement of LAQM. However, as $PM_{2.5}$ is a constituent fraction of PM_{10}, it is possible to estimate the probable local levels by considering the ratio of the two fractions of particulate matter, as detailed in the technical guidance LAQM.TG16. Applying the nationally derived correction ratio of 0.7 to local PM_{10} data suggests that local $PM_{2.5}$ levels at monitoring sites lie in the range 8.4 to 14.7 $\mu g/m^3$, which is well below the national annual mean objective of 25$\mu g/m^3$. It should be noted, however, that the highest recording site, CBI, is not a background site.

3.2.4 Sulphur dioxide (SO_2)

Table 9 in Appendix A compares the ratified, automatically monitored SO_2 concentrations for 2018 with the three health-based air quality objectives for SO_2.

In 2018 there were 66 occasions, spread over 14 days, when the 15-minute objective of 266$\mu g/m^3$ was exceeded in the village of Thornton-le-Moors (monitoring site TLP), and 25 such occasions (over a single day) in the village of Elton (monitoring site ELT). The objective allows for 35 exceedances in a calendar year so this remains non-compliant in Thornton-le-Moors. TLP lies within the AQMA and ELT is outside, less than a kilometre from the eastern edge of the AQMA.

The hourly mean standard was exceeded four times in Elton (on the same day as the episode above) and not at all in Thornton-le-Moors. As there is an annual exceedance allowance of 24 hourly periods, the objective was not exceeded.

The 24-hour standard was complied with at all monitoring stations during 2018.

Figure 7 shows long term trends in SO_2 using the 99.9th percentile values for each monitoring station. The graph also shows data for four former monitoring stations in Ellesmere Port, Helsby, Thornton-le-Moors and Frodsham (SG, HE, TLM and FMH), the details for which can be found in earlier LAQM reports. For most sites the monitoring period has not been long enough to determine an overall trend. However, at LR-JG in Ellesmere Port, the 99.9th percentiles have decreased gradually over time and remain comfortably below the national objective. Unlike other local real-time monitoring stations, data for LR-JG is unratified and therefore has provisional status.

Results for Thornton-le-Moors (at both TLM and TLP sites) have been above the national objective in each year of monitoring.

Figure 32 shows how local monitoring sites compare with regional AURN sites. The frequency of elevated SO_2 readings at Thornton-le-Moors and Elton contrasts markedly with other monitoring sites in the region, reflecting the industrial nature of the sites.

Appendix A: Monitoring results

Table 3 Details of automatic monitoring sites

Site code	Site name	Site type	X grid reference	Y grid reference	Pollutants monitored	In AQMA?	Monitoring technique	Distance to relevant exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet height (m)
BO	Boughton	Roadside	341864	366444	NO_2	Yes	Chemiluminescent	25.0	3.0	1.0
CBI	Chester	Roadside	340645	366802	NO_2 PM_{10}	Yes	Chemiluminescent BAM	5.1	6.6	1.6
ELT	Elton	Industrial	345642	375522	SO_2	No	UV-fluorescent	0	not applicable	2.0
FMH	Frodsham	Urban background	352445	378031	NO_2, PM_{10}	No	Chemiluminescent TEOM	24.0	7.0	2.5
LR-JG	Library	Urban background	340258 339947	376602 375889	NO_2 SO_2 PM_{10}	No	DOAS / TEOM	10.0	not applicable	11.0
TLP	Thornton-le-Moors	Industrial	344103	374330	NO_2 SO_2 PM_{10}	Yes	Chemiluminescent UV-fluorescent BAM	38.0	not applicable	2.5
WH	Whitby Rd	Roadside	340197	376363	NO_2	Yes	Chemiluminescent	15.0	2.5	3.5

Notes:

(1) 0m if the monitoring site is at a location of exposure (for example, installed on the facade of a residential property)

Table 4 Details of non-automatic monitoring sites

Site ID	Site name	Site type	X grid reference	Y grid reference	Pollutants monitored	In AQMA?	Distance to relevant exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a continuous analyser?	Height (m)
AHH	Holly House	Other	373255	371475	NO_2	No	0	68	No	2
AP	Pine Cottage	Roadside	373386	371500	NO_2	No	0.0	34.0	No	1.8
BE	Bedward Row	Roadside	340239	366418	NO_2	Yes	0.5	2.4	No	2.4
BJ	Backpackers Jade	Roadside	341401	366512	NO_2	Yes	0.5	2.5	No	2.4
BO	Boughton RTA	Roadside	341864	366444	NO_2	Yes	25.0	2.0	No	2.5
C11	Christleton Road (11)	Roadside	341915	366427	NO_2	Yes	0.0	1.0	No	2.0
C36	Christleton Road (36)	Roadside	342000	366374	NO_2	Yes	0.5	1.4	No	2.5
C75	Christleton Road (75)	Roadside	342056	366354	NO_2	Yes	0.5	2.0	No	2.5
CAN	Canal Street	Roadside	340375	366730	NO_2	Yes	1	1.5	No	3
CBI	Chester Bus Interchange	Roadside	340647	366803	NO_2	Yes	5.1	6.6	Yes	1.6
CFL	Church Street (Lower)	Roadside	351762	377862	NO_2	No	4.8	1	No	2.2
CM	Christleton Mill	Roadside	343761	365528	NO_2	No	0	5	No	2.2
CN	Chesterway (62)	Kerbside	366070	373905	NO_2	No	3.8	1.6	No	3.0
CP3	Canal Place (3)	Roadside	343970	365295	NO_2	No	4	2.3	No	2.4
CPL	Plough Lane	Roadside	344377	365374.6	NO_2	No	1.1	0.7	No	2.1
CVR	Caldy Valley Road	Roadside	342930	365901	NO_2	No	3.5	3	No	2.1
DEL	Delamere School	Roadside	355255	368416	NO_2	No	10	2.1	No	2
DSP	Duddon St Peters	Roadside	351627	364552	NO_2	No	1.9	2.8	No	2
EB	Boughton Edgeley	Roadside	341658	366487	NO_2	Yes	0.0	2.0	No	2.5
FGS	Foregate St	Roadside	340859	366388	NO_2	Yes	50	1	No	2.2

Site ID	Site name	Site type	X grid reference	Y grid reference	Pollutants monitored	In AQMA?	Distance to relevant exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a continuous analyser?	Height (m)
FH	High Street (72)	Roadside	352146	378139	NO_2	Yes	0.2	2.0	No	2.5
FJ	Fluin Junction	Roadside	352171	378140	NO_2	Yes	0.5	2.0	No	2.5
FM	Fluin Lane (Manor Farm)	Roadside	352189	378094	NO_2	Yes	0.3	2.0	No	2.5
FRC	Rock Cottage High Street	Roadside	352023	378121	NO_2	No	1.3	1.6	No	2.5
FT	Fluin Lane (terrace)	Roadside	352176	378105	NO_2	Yes	0.2	1.7	No	2
FTG	Trinity Gardens	Roadside	351993	378102	NO_2	No	4.5	0.8	No	2.5
GB	Greenbank Lane	Roadside	364619	372594	NO_2	No	8	0.7	No	2
GE	George Street (S)	Roadside	340657	366730	NO_2	Yes	1	5	No	2.4
GR	Griffiths Road	Roadside	368634	374714	NO_2	No	0.2	8	No	1.8
GSW	Gorse Stacks (Waterside)	Roadside	340700	366687	NO_2	Yes	1	1.6	No	2.1
GT	George Street (N)	Roadside	340611	366747	NO_2	Yes	0	1.9	No	2.6
HB	Hoole Lane - Boughton	Roadside	341605	366527	NO_2	Yes	3	1.2	No	2.4
HHS	Helsby Hillside School	Roadside	349518	375954	NO_2	No	8	2.3	No	2
HO	Hoole Road	Roadside	341311	367207	NO_2	No	0	7.1	No	1.9
HW	Hoole Way	Roadside	340881	366826	NO_2	Yes	1	1.9	No	2.4
IC	Ingham Close	Roadside	342068	366332	NO_2	Yes	2.0	2.0	No	2.0
KR	King St. Rudheath	Roadside	368432	372988	NO_2	No	4.5	2.2	No	2.0
LH	Lincoln House	Roadside	341126	366540	NO_2	Yes	3.0	2.0	No	3.0
LI2	Liverpool Road	Roadside	340354	367034	NO_2	Yes	7.0	2.5	No	2.2
LU	Lumley Place	Roadside	340838	366215	NO_2	Yes	0	9.4	No	2.1
LVR	Love St Residential	Roadside	340980	366315	NO_2	Yes	0	1.8	No	2.2

Site ID	Site name	Site type	X grid reference	Y grid reference	Pollutants monitored	In AQMA?	Distance to relevant exposure (m) [(1)]	Distance to kerb of nearest road (m) [(2)]	Tube collocated with a continuous analyser?	Height (m)
LVS	Love St School	Roadside	340990	366317	NO_2	Yes	8	1.8	No	2.2
MCC	Mill Cottages (A41)	Roadside	343785	365502	NO_2	No	0.5	2.4	No	2
MOS	Moston Road	Roadside	341245	369610	NO_2	No	1.2	2.2	No	2.1
NCS	New Crane St	Roadside	339857	366460	NO_2	No	0	1.8	No	2
NIN	Nicholas St (North)	Roadside	340284	366199	NO_2	Yes	0	3	No	2.3
NIS	Nicholas St (South)	Roadside	340329	366114	NO_2	Yes	0	4.3	No	2.2
NS	Newsagent Station Rd	Roadside	340406	376724	NO_2	Yes	2.0	4.0	No	2.0
NSR	Station Road	Roadside	366796	373984	NO_2	No	0.6	1.7	No	2
NWH	Winnington Hill	Roadside	365590	373904	NO_2	No	2.4	0.7	No	2.4
OB	Boughton (105)	Roadside	341633	366510	NO_2	Yes	0.6	2.5	No	2.5
OF	St Oswald's - Fountains	Roadside	340453	366853	NO_2	Yes	4	4.8	No	3
OP	Oulton Place	Roadside	340636	366770	NO_2	Yes	0	1.6	No	2.1
OSJ	Over St Johns School	Roadside	363781	366198	NO_2	No	2.3	3.1	No	2.2
OW	St Oswald's Way	Roadside	340623	366823	NO_2	Yes	2.3	2.3	No	2.3
PA	Parkgate Rd (19)	Roadside	340313	367014	NO_2	Yes	2.4	0.8	No	2.4
PG	Parkgate Road (5)	Roadside	340322	366989	NO_2	Yes	0.2	1.8	No	2.0
RM	Rock Mount	Roadside	340291	367108	NO_2	Yes	0.0	3.8	No	2.2
RPS	Rudheath Primary School	Roadside	367856	372667	NO_2	No	19	5.2	No	1.8
RR	Richfield Recruitment	Roadside	340180	376338	NO_2	Yes	3.0	2.1	No	2.5
SA	Samaritans	Roadside	340364	366929	NO_2	Yes	0.2	2.5	No	2.5
SF	Station Road Flats	Roadside	341238	366976	NO_2	No	0	3.2	No	2.2

Site ID	Site name	Site type	X grid reference	Y grid reference	Pollutants monitored	In AQMA?	Distance to relevant exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a continuous analyser?	Height (m)
SM	St Martins Way	Roadside	340224	366599	NO_2	Yes	1.2	2.2	No	2.4
SR	Station Rd	Roadside	340435	376790	NO_2	Yes	0.0	1.6	No	2.5
ST	St Anne's Place	Kerbside	340794	366778	NO_2	Yes	18.4	0.1	No	2.2
SV2	South View Road	Roadside	339836	366620	NO_2	No	0.4	1.5	No	1.9
SV3	South View Road	Roadside	339859	366620	NO_2	No	0.6	1.6	No	2
SZ	Specialized	Roadside	341819	366475	NO_2	Yes	0.5	2.0	No	2.5
T11	Tarvin Road (11 gable)	Roadside	341931	366458	NO_2	Yes	2.7	1.5	No	2.1
T44	Tarvin Road (44)	Roadside	342085	366446	NO_2	Yes	3.5	1.0	No	2.5
T6	Tarvin Road (6)	Roadside	341926	366446	NO_2	Yes	0.2	2.0	No	2.0
TA	Tarvin Road (52)	Roadside	344519	366898	NO_2	No	6.0	2.0	No	2.0
TB	The Bars	Roadside	341202	366470	NO_2	Yes	2.0	1.0	No	2.5
TE	Temple Bar PH	Roadside	340739	366504	NO_2	No	0	1.8	No	2
UCA	U of C Academy	Roadside	339687	375972	NO_2	No	4.6	2.4	No	2.4
UHS	Upton High School	Roadside	342010	369154	NO_2	No	2.9	3.0	No	2.1
UN	Upper Northgate St (44)	Roadside	340357	366960	NO_2	Yes	0.2	3.0	No	2.2
VRC	Village Road	Roadside	344129	365614	NO_2	No	0	2	No	2.1
W23	Whitchurch Road (23)	Roadside	343728.6	365561	NO_2	No	3	5	No	2.5
WCR	Whitchurch Road	Roadside	342951	366029	NO_2	No	7.2	1.5	No	2
WG	Watergate St	Roadside	340217	366209	NO_2	Yes	0.2	1.5	No	2.0
WGW	Watergate - Walls	Roadside	340165	366198	NO_2	Yes	0	2.2	No	2.2
WH	Whitby Road	Roadside	340196	376363	NO_2	Yes	32.0	1.2	Yes	3.5

Site ID	Site name	Site type	X grid reference	Y grid reference	Pollutants monitored	In AQMA?	Distance to relevant exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Tube collocated with a continuous analyser?	Height (m)
WIM	Wimboldsley Primary	Roadside	368933	363614	NO_2	No	6	1.7	No	1.2
XR	Boughton Heath roundabout	Roadside	343117	365949	NO_2	No	4.5	3.2	No	2

Notes:

(1) 0m if the monitoring site is at a location of exposure (for example, installed on/adjacent to the facade of a residential property)

Table 5 Annual mean NO_2 monitoring results

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	NO_2 Annual mean concentration (µg/m^3) [3]				
					2014	2015	2016	2017	2018
BO	Roadside	Automatic	96.1	96.1	32	30	29	27	25
CBI	Roadside	Automatic	99.4	99.4				**40**	**40**
FMH	Urban background	Automatic	99.6	99.6	19	15	16	14	14
LR-JG	Urban background	Automatic	99.8	99.8	22	20	22	20	19
TLP	Industrial	Automatic	95.5	95.5		16	16	13	13
WH	Roadside	Automatic	99.7	99.7	**41**	**40**	**40**	36	37
AHH	Roadside	Diffusion tube	100	100			21.5	17.7	19.4
AP	Roadside	Diffusion tube	83	83			31.2	28.3	25.3
BA	Roadside	Diffusion tube			**41.3**				
BA2	Roadside	Diffusion tube				28.8			
BE	Roadside	Diffusion tube	75	75	**41.9**	38.3	**40.2**	37.5	33.8
BJ	Roadside	Diffusion tube	100	100	38.3	37.5	39.0	38.7	39.5
BO	Roadside	Diffusion tube	83	83	32.5	30.5	30.5	29.2	28.7
BZ	Roadside	Diffusion tube						27.3	
C11	Roadside	Diffusion tube	100	100	**45.4**	**43.0**	**43.3**	**43.0**	**41.1**
C36	Roadside	Diffusion tube	100	100	**54.1**	**50.6**	**51.5**	**50.8**	**47.6**
C75	Roadside	Diffusion tube	92	92	29.0	27.7	30.4	26.9	27.2
CAN	Roadside	Diffusion tube	75	75				25.1	32.6
CBI	Other	Diffusion tube	100	100				**44.6**	39.8
CE	Roadside	Diffusion tube			14.5				
CFL	Roadside	Diffusion tube	100	100	31.9	29.4	31.3	30.4	30.5

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	NO_2 Annual mean concentration ($\mu g/m^3$) [3]				
					2014	2015	2016	2017	2018
CIN	Roadside	Diffusion tube					29.1	29.5	
CIS	Roadside	Diffusion tube					30.9	28.0	
CM	Roadside	Diffusion tube	100	100				30.8	33.9
CN	Roadside	Diffusion tube	75	75					33.0
CP3	Roadside	Diffusion tube	100	100				31.9	31.3
CPL	Roadside	Diffusion tube	100	100					19.0
CVR	Roadside	Diffusion tube	92	92				30.3	30.2
DEL	Roadside	Diffusion tube	100	100					20.2
DSP	Roadside	Diffusion tube	100	100					25.3
EB	Roadside	Diffusion tube	92	92	36.7	34.2	34.8	34.5	31.6
FGS	Roadside	Diffusion tube	75	75			31.7	27.2	28.9
FH	Roadside	Diffusion tube	100	100	**41.9**	39.7	**44.2**	39.4	38.5
FJ	Roadside	Diffusion tube	92	92	**42.6**	**41.3**	**42.2**	**40.5**	38.2
FM	Roadside	Diffusion tube	92	92	36.6	32.9	36.5	33.2	35.0
FRC	Roadside	Diffusion tube	83	83					34.0
FT	Roadside	Diffusion tube	100	100	36.3	33.9	34.9	34.2	32.1
FTG	Roadside	Diffusion tube	83	83					33.2
FV	Roadside	Diffusion tube			21.4	21.3			
FW	Roadside	Diffusion tube			19.1				
GB	Roadside	Diffusion tube	92	92					17.3
GD	Roadside	Diffusion tube			34.1	32.3	33.9		
GE	Roadside	Diffusion tube	92	92		27.4	24.8	26.9	32.0
GI	Roadside	Diffusion tube			35.4	32.6	34.8	33.4	

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	NO_2 Annual mean concentration ($\mu g/m^3$) [3]				
					2014	2015	2016	2017	2018
GR	Roadside	Diffusion tube	100	67					24.1
GSW	Roadside	Diffusion tube	83	83		27.5	27.8	33.3	34.3
GT	Roadside	Diffusion tube	92	92				26.1	34.1
HB	Roadside	Diffusion tube	100	100	37.7	33.6	33.7	32.9	32.0
HC	Roadside	Diffusion tube			**42.2**	35.9			
HHS	Roadside	Diffusion tube	100	100					22.7
HO	Roadside	Diffusion tube	100	100					31.7
HSN	Roadside	Diffusion tube			36.1	32.3			
HT	Roadside	Diffusion tube			22.9				
HW	Roadside	Diffusion tube	100	100	**41.2**	37.8	39.9	36.0	35.8
IC	Roadside	Diffusion tube	92	92	37.1	37.3	38.5	36.7	34.5
KR	Roadside	Diffusion tube	92	92	35.0	33.6	35.2	33.9	32.0
LH	Roadside	Diffusion tube	92	92	38.0	37.0	38.4	39.2	36.9
LI2	Roadside	Diffusion tube	100	100	37.8	35.5	39.4	39.7	38.6
LU	Roadside	Diffusion tube	83	83				27.9	27.0
LVR	Roadside	Diffusion tube	75	75			**40.8**	35.9	36.5
LVS	Roadside	Diffusion tube	83	83			39.1	36.0	31.4
MCC	Roadside	Diffusion tube	100	100	**41.8**	38.1	**44.5**	**40.8**	38.0
MOS	Roadside	Diffusion tube	92	92					28.1
NA	Roadside	Diffusion tube			31.1				
NCS	Roadside	Diffusion tube	100	100					30.5
NIN	Roadside	Diffusion tube	100	100			39.1	39.8	34.7
NIS	Roadside	Diffusion tube	100	100			22.6	28.6	31.7

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	NO_2 Annual mean concentration ($\mu g/m^3$) [3]				
					2014	2015	2016	2017	2018
NS	Roadside	Diffusion tube	92	92	39.4	35.9	36.2	35.0	32.4
NSR	Roadside	Diffusion tube	75	75					38.0
NT	Roadside	Diffusion tube			28.6				
NWH	Roadside	Diffusion tube	100	100					**41.5**
OB	Roadside	Diffusion tube	83	83	**43.2**	**40.7**	**41.2**	39.8	**44.8**
OF	Roadside	Diffusion tube	92	92	37.4	35.7	38.8	35.3	34.3
OP	Roadside	Diffusion tube	92	92				28.3	32.1
OSJ	Roadside	Diffusion tube	92	92					20.8
OW	Roadside	Diffusion tube	75	75	**42.0**	**43.2**	**51.0**	**51.8**	**43.6**
PA	Roadside	Diffusion tube	75	75	**41.8**	**41.1**	**42.3**	**42.7**	**41.2**
PG	Roadside	Diffusion tube	75	75	**48.0**	**42.2**	**46.9**	**46.0**	**45.2**
QS	Roadside	Diffusion tube			30.4	26.8			
RM	Roadside	Diffusion tube	100	100	**45.6**	39.9	**43.1**	**41.3**	**45.7**
RPS	Roadside	Diffusion tube	100	100					**42.4**
RR	Roadside	Diffusion tube	100	100	**42.1**	39.1	39.9	36.8	36.5
SA	Roadside	Diffusion tube	100	100	**42.1**	38.5	39.8	36.9	37.7
SB	Roadside	Diffusion tube			31.8				
SCN	Roadside	Diffusion tube			22.5				
SCS	Roadside	Diffusion tube			34.5	30.8			
SF	Roadside	Diffusion tube	92	92				32.3	33.3
SL	Roadside	Diffusion tube			17.6				
SM	Roadside	Diffusion tube	100	100	30.9	29.5	32.1	27.7	25.2
SR	Roadside	Diffusion tube	100	100	38.4	35.7	36.5	34.3	33.8

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	NO_2 Annual mean concentration ($\mu g/m^3$) [3]				
					2014	2015	2016	2017	2018
ST	Roadside	Diffusion tube	100	100				**44.6**	**42.4**
SV2	Roadside	Diffusion tube	92	92					25.4
SV3	Roadside	Diffusion tube	100	100				24.8	26.0
SZ	Roadside	Diffusion tube	100	100	39.0	36.8	36.3	36.4	36.1
T11	Roadside	Diffusion tube	92	92				32.0	31.8
T25	Roadside	Diffusion tube			30.6				
T44	Roadside	Diffusion tube	92	92	**46.1**	**41.5**	**42.8**	**40.2**	39.2
T6	Roadside	Diffusion tube	100	100	**53.0**	**49.1**	**50.3**	**45.5**	**43.6**
TA	Roadside	Diffusion tube	100	100				**47.4**	**44.5**
TB	Roadside	Diffusion tube	100	100	**41.2**	**40.1**	38.7	36.0	36.7
TE	Roadside	Diffusion tube	83	83				21.7	25.3
TG	Roadside	Diffusion tube			32.8	31.7			
UCA	Roadside	Diffusion tube	100	100					28.6
UHS	Roadside	Diffusion tube	92	92					26.4
UN	Roadside	Diffusion tube	92	92	**41.1**	38.5	**40.1**	36.8	38.1
VRC	Roadside	Diffusion tube	92	92					18.2
W23	Roadside	Diffusion tube	100	100				29.2	33.1
WCR	Roadside	Diffusion tube	92	92				**41.1**	39.0
WG	Roadside	Diffusion tube	100	100	**44.9**	**41.3**	**43.5**	**42.8**	39.8
WGW	Roadside	Diffusion tube	100	100	38.8	33.6	37.1	33.3	33.7
WH	Roadside	Diffusion tube	100	100	36.3	34.7	34.4	32.3	33.7
WIM	Roadside	Diffusion tube	100	100					31.7
WT	Roadside	Diffusion tube			39.7	39.5			

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) (1)	Valid data capture 2018 (%) (2)	NO_2 Annual mean concentration ($\mu g/m^3$) (3)				
					2014	2015	2016	2017	2018
WW	Roadside	Diffusion tube			32.1	28.6			
WXP	Roadside	Diffusion tube					20.1	17.4	
XR	Roadside	Diffusion tube	100	100					31.1

☒ **Diffusion tube data has been bias corrected**

☒ **Annualisation has been conducted where data capture is <75%**

Notes:

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

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 one-hour mean objective are shown in **bold and underlined.**

(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 (if monitoring was carried out for six 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 Boxes 7.9 and 7.10 in LAQM.TG16 if valid data capture for the full calendar year is less than 75%. See Appendix C for details.

(4) Annual mean not reported as data capture was for a single month.

Note, results in the above table show the levels of NO_2 at the point of monitoring and do not take account of distance to relevant receptors.

Figure 1 Long-term trends in annual mean NO_2 at real-time sites

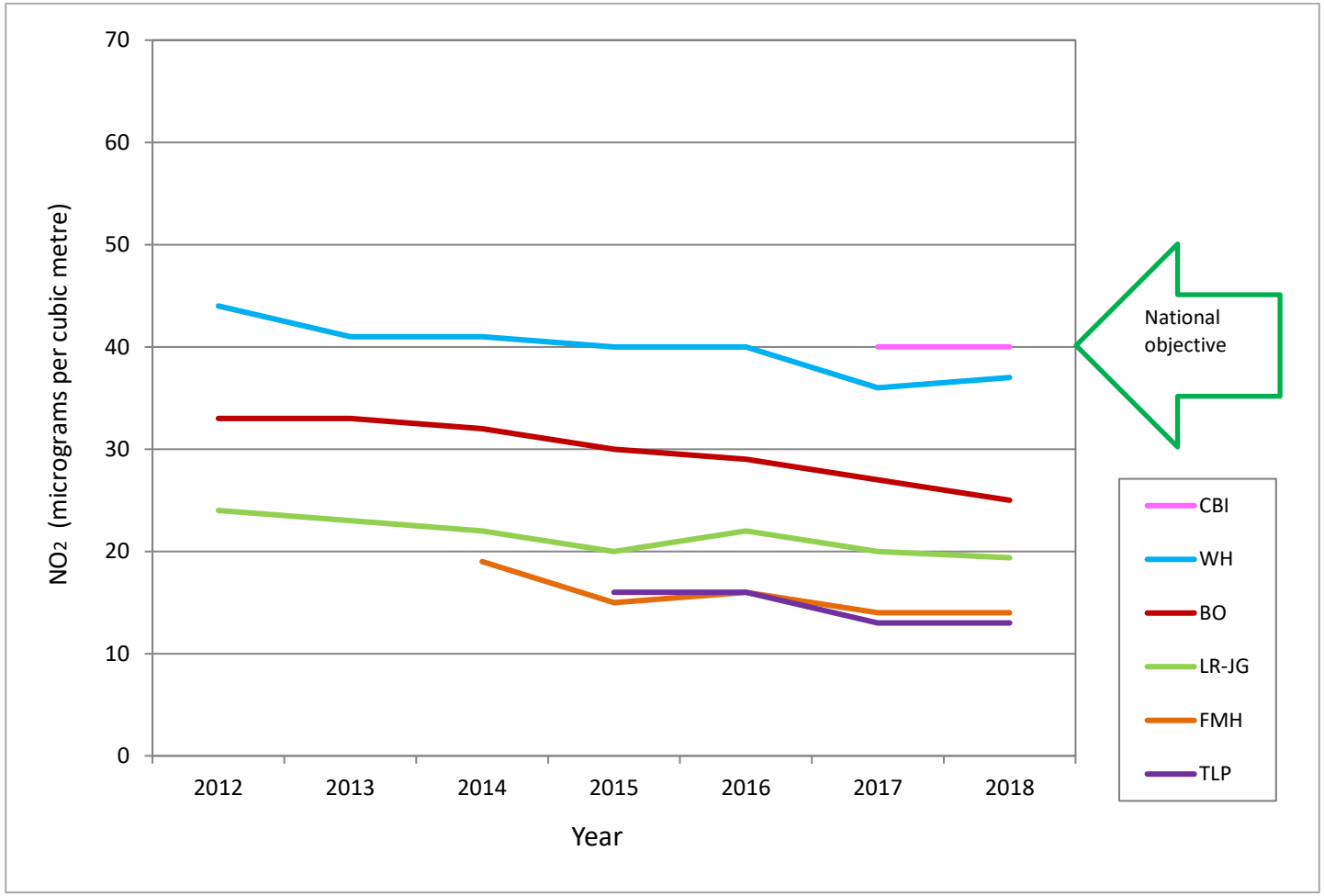


Figure 2 Long-term trends in NO_2 at Chester diffusion tube sites

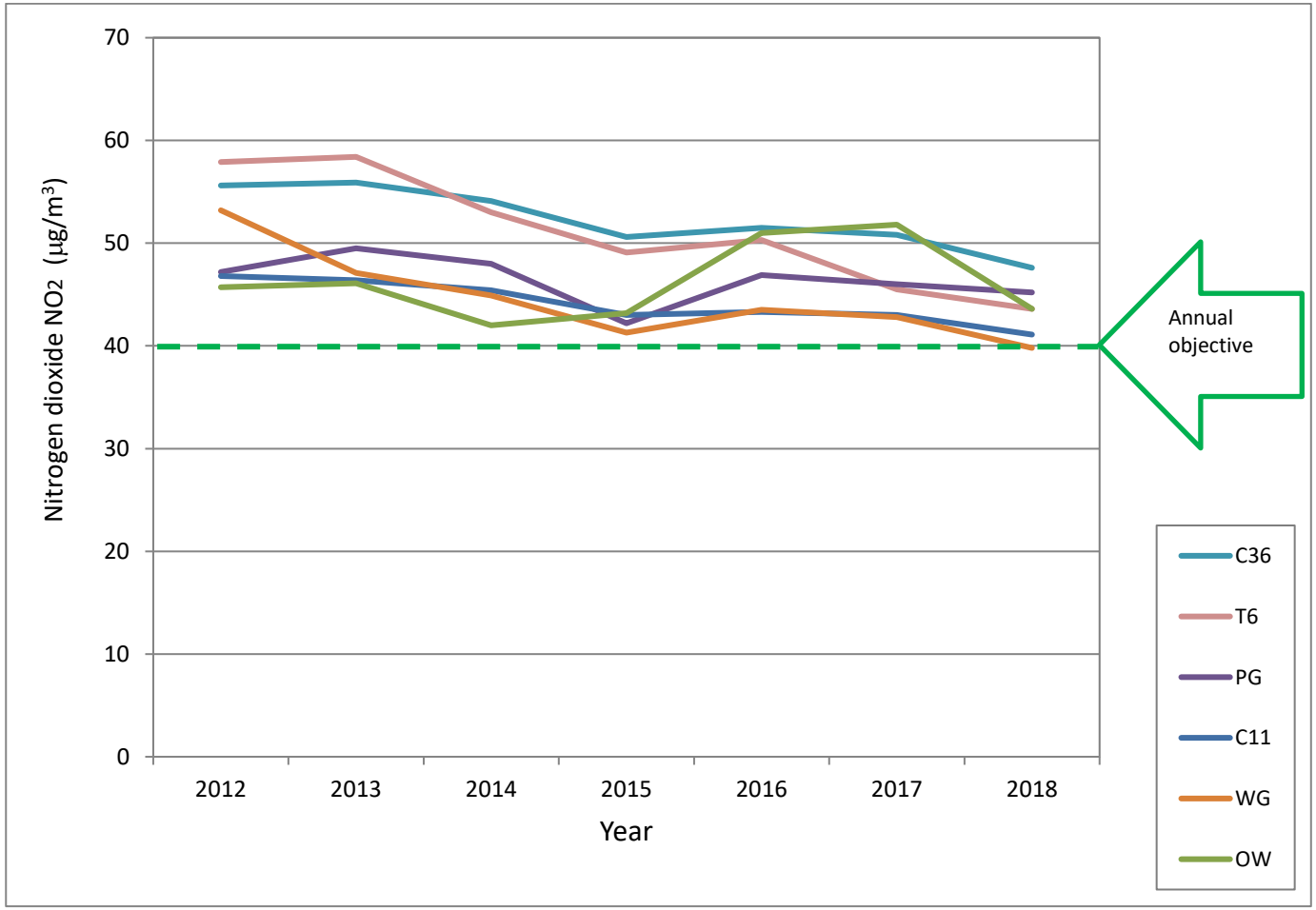


Figure 3 Long-term trends in NO_2 at Ellesmere Port diffusion tube sites

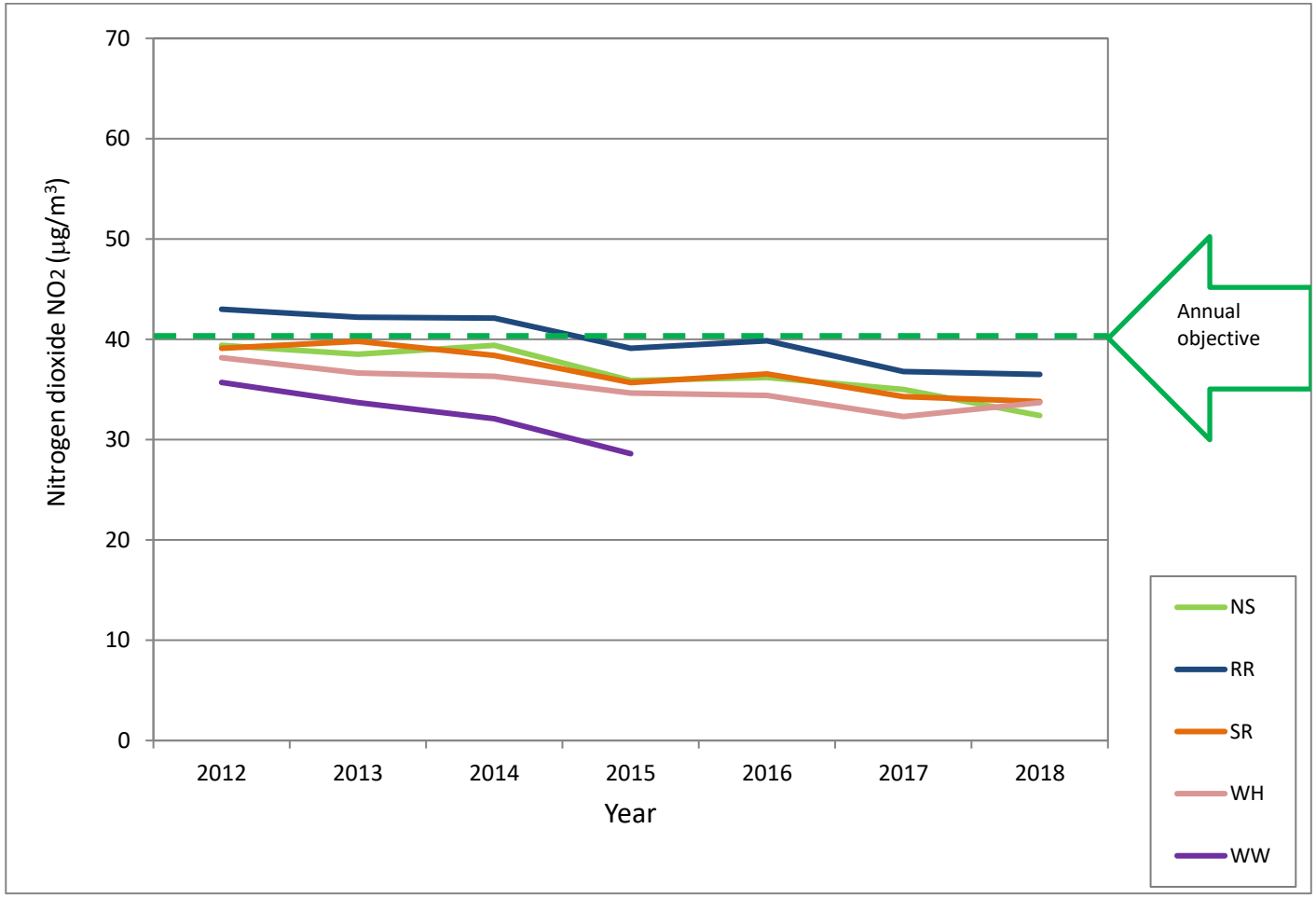


Figure 4 Long-term trends in NO_2 at Frodsham diffusion tube sites

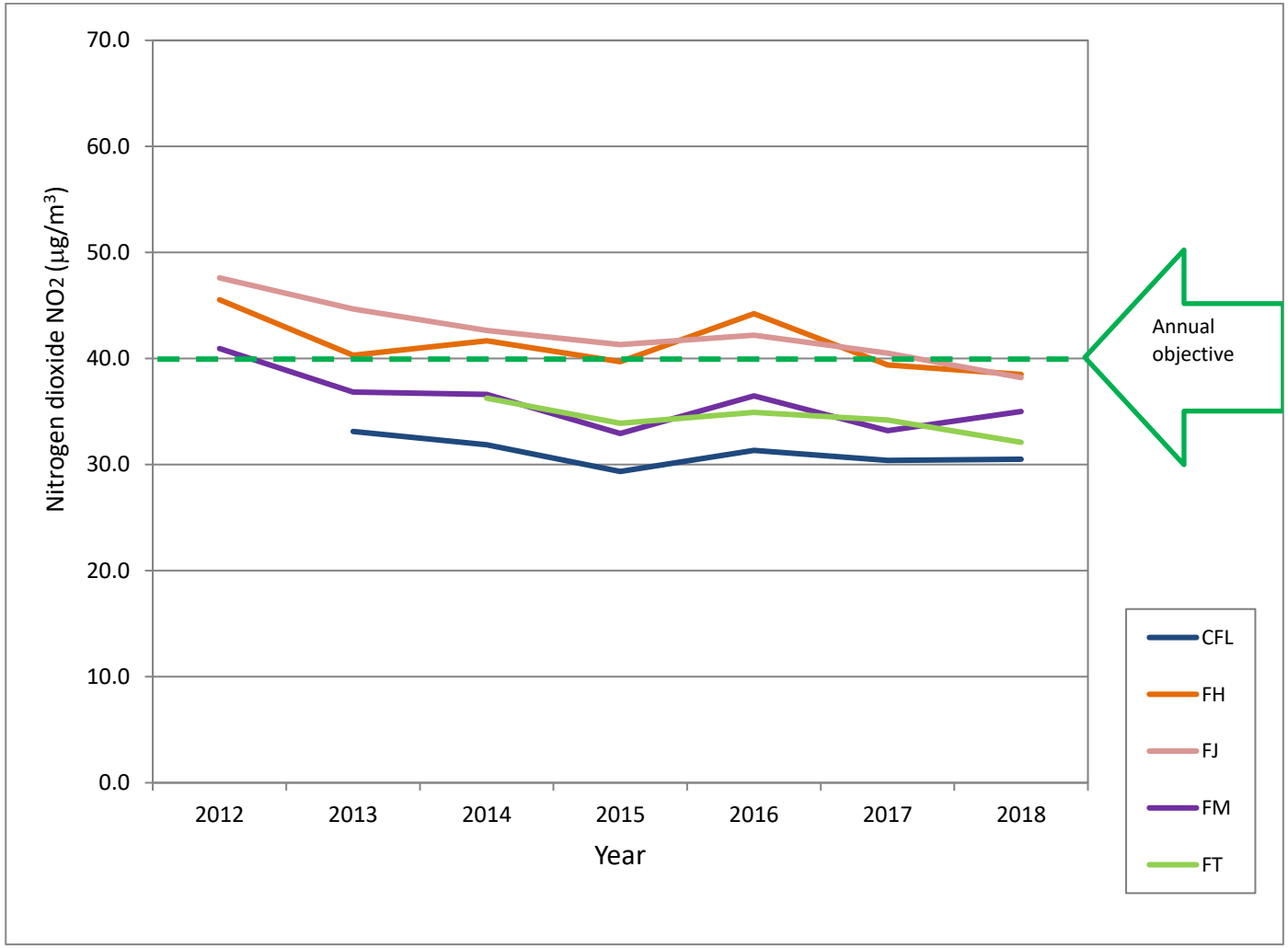


Table 6 One-hour mean NO_2 monitoring results

Site ID	Site type	Monitoring type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	NO_2 1-hour means > 200µg/m^3 [3]				
					2014	2015	2016	2017	2018
BO	Roadside	Automatic	96.1	96.1	0	0	0	0	0
CBI	Roadside	Automatic	99.4	99.4				0	0
FMH	Urban Background	Automatic	99.6	99.6	0 (99.8)	0	0	0	0
LR-JG	Urban Background	Automatic	99.8	99.8	0	0	0	0	0
TLP	Industrial	Automatic	95.5	95.5		0	0	0	0
WH	Roadside	Automatic	99.7	99.7	0	0	0	0	0

Notes:

Exceedances of the NO_2 1-hour mean objective (200µg/m^3 not to be exceeded more than 18 times a year) 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 (if monitoring was carried out for six months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data was less than 85%, the 99.8th percentile of 1-hour means is provided in brackets.

Table 7 Annual mean PM_{10} monitoring results

Site ID	Site type	Valid data capture for monitoring period (%) (1)	Valid data capture 2018 (%) (2)	PM_{10} Annual mean concentration (µg/m^3) (3)				
				2014	2015	2016	2017	2018
CBI	Roadside	91.3	91.3				21	21
FMH	Urban Background	87.2	87.2	15	15	14	13	16
LR	Urban Background	84.7	84.7	16	13	12	12	12
TLP	Industrial	98.1	98.1		15	16	13	13

☒ Annualisation has been conducted where data capture is <75%

Notes:

Exceedances of the PM_{10} annual mean objective of 40µg/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 (if monitoring was carried out for six months, the maximum data capture for the full calendar year is 50%).

(3) All means have been annualised, as per Boxes 7.9 and 7.10 in LAQM.TG16, where valid data capture for the full calendar year is less than 75%. See Appendix C for details.

Figure 5 Long-term trends in PM_{10} at real-time sites

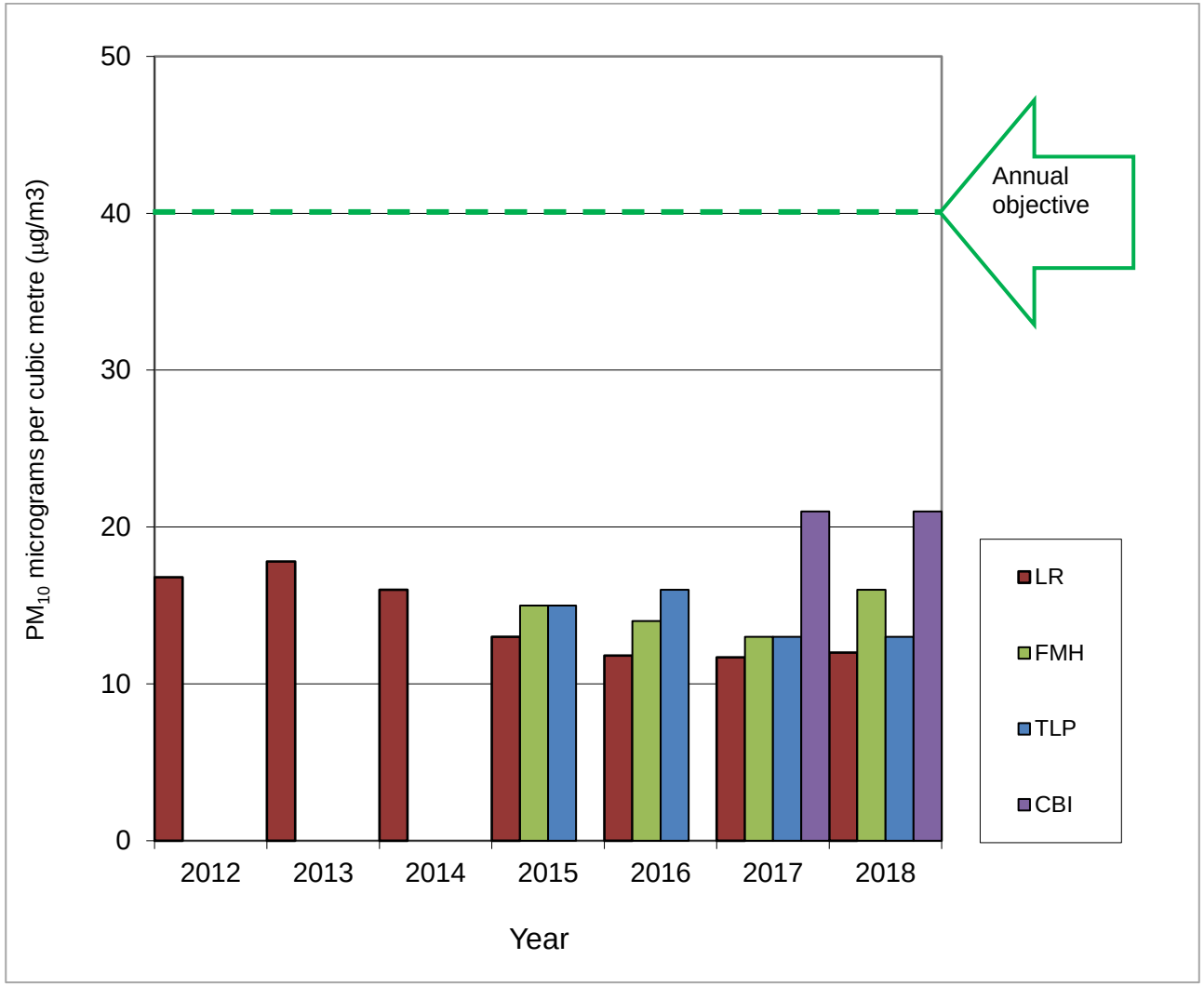


Table 8 24-hour mean PM_{10} monitoring results

Site ID	Site type	Valid data capture for monitoring period (%) (1)	Valid data capture 2018 (%) (2)	PM_{10} 24-hour means > 50µg/m^3 (3)				
				2014	2015	2016	2017	2018
CBI	Roadside	91.3	91.3				8	4
FMH	Urban background	87.2	87.2	0	1	0	0	0
LR	Urban background	84.7	84.7	1	0	0	0	0
TLP	Industrial	98.1	98.1		**0(22)**	0	2	0

Notes:

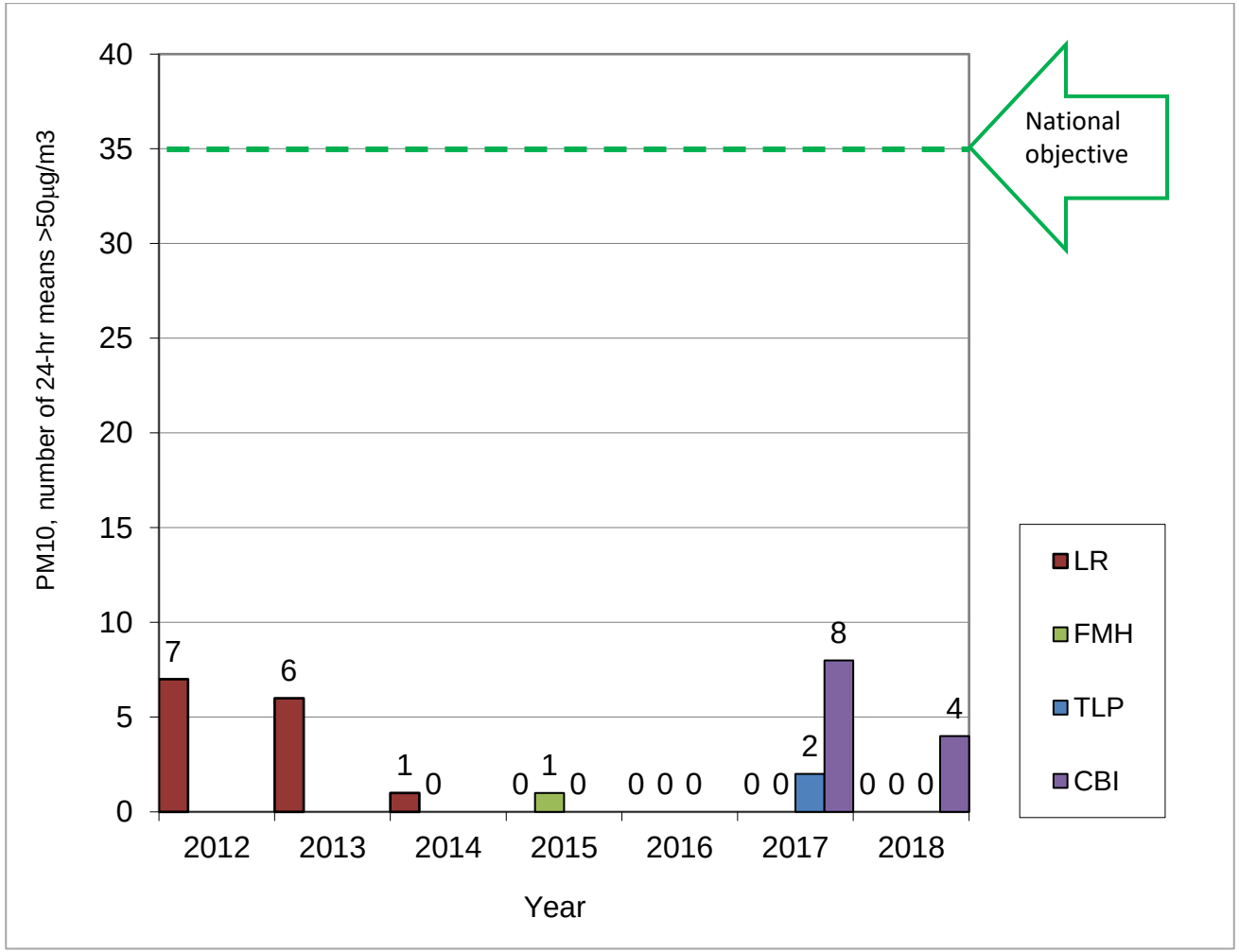
Exceedances of the PM_{10} 24-hour mean objective (50µg/m^3 not to be exceeded more than 35 times a year) are shown in **bold.**

(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 (if monitoring was carried out for six months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 85%, the 90.4th percentile of 24-hour means is provided in brackets.

Figure 6 Trends in the number of 24-hour mean PM_{10} results greater than 50µg/m^3



Note: Objective allows 35 exceedances of 50µg/m^3 per year

Table 9 SO_2 monitoring results

Site ID	Site type	Valid data capture for monitoring period (%) [1]	Valid data capture 2018 (%) [2]	Number of exceedances 2018 (percentile in bracket) [3]		
				15-minute objective (266 µg/m^3)	Hourly objective (350 µg/m^3)	24-hour objective (125 µg/m^3)
ELT	Industrial	87.7	87.7	25	4	0
LR-JG	Urban background	99.8	99.8	0	0	0
TLP	Industrial	97.0	97.0	**66**	0	0

Notes:

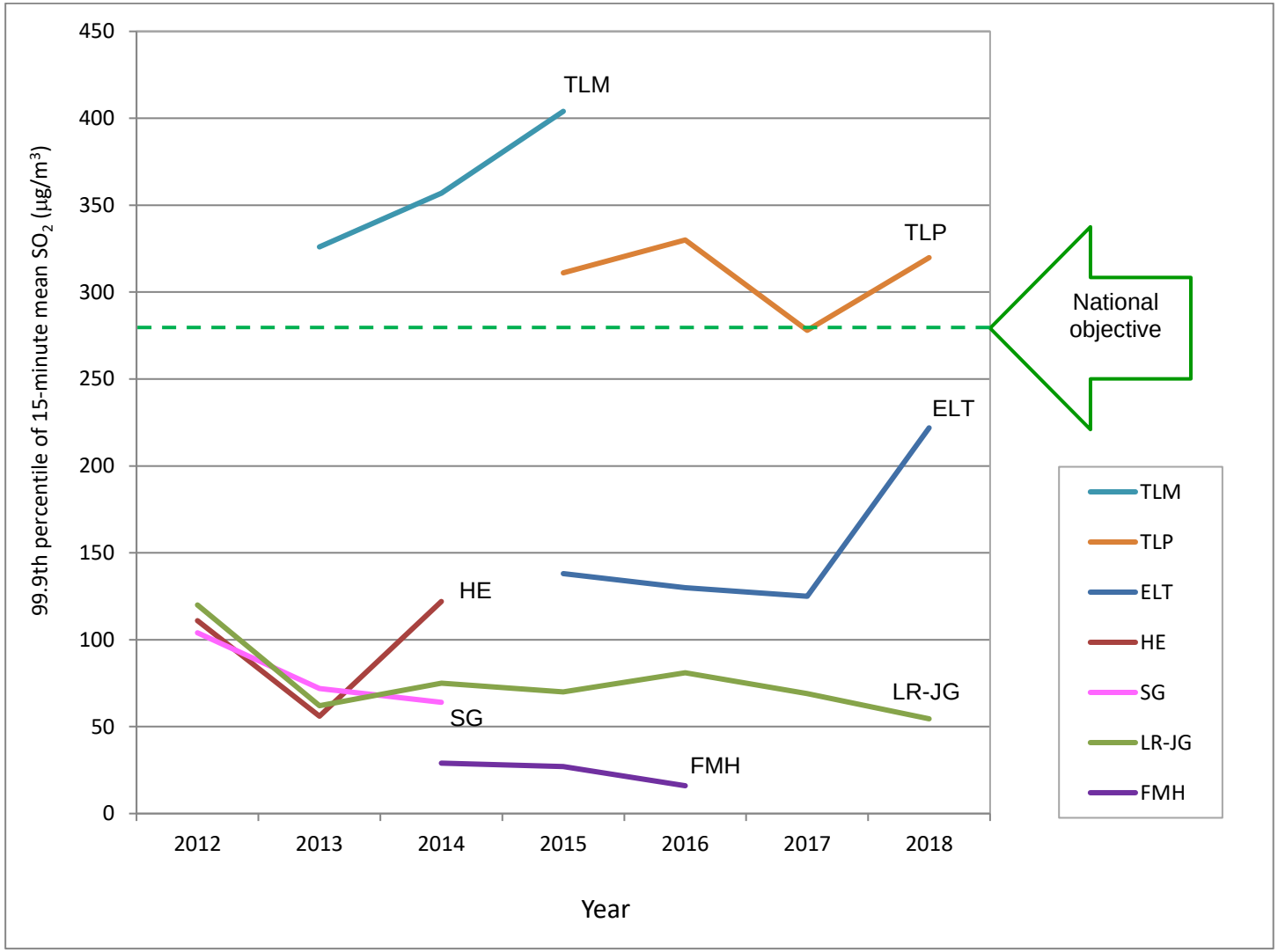
Exceedances of the SO_2 objectives are shown in **bold** (15-min mean = 35 allowed a year, hourly mean = 24 allowed a year, 24-hour mean = three allowed a year)

(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 (if monitoring was carried out for six months, the maximum data capture for the full calendar year is 50%).

(3) If the period of valid data is less than 85%, the relevant percentiles are provided in brackets.

Figure 7 Long-term trends in SO_2 at real-time sites



Appendix B: Full monthly diffusion tube results for 2018

Table 10 NO_2 monthly diffusion tube results – 2018

Site ID	NO_2 mean concentrations (µg/m^3)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean		
													Raw data	Bias adjusted (0.93 factor) and annualised (1)	Distance corrected to nearest exposure (^{2})
AHH	23.4	28.0	23.5	22.7	20.7	13.2	16.2	15.4	14.4	21.3	27.1	24.0	20.8	19.4	19.4
AP	30.3	32.9	17.3	25.0	23.8	23.2	29.5	30.9	void	28.4	void	31.1	27.3	25.3	25.3
BE	40.4	37.3	36.4	37.4	37.9	33.9	missing	29.2	37.0	missing	37.7	missing	36.3	33.8	33.8
BJ	37.0	38.1	46.9	41.1	49.9	45.7	40.5	39.4	41.6	43.8	39.8	46.6	**42.5**	39.5	39.5
BO	36.0	35.4	32.6	26.2	30.3	28.1	27.0	missing	27.9	33.6	31.3	void	30.8	28.7	28.7
C11	38.8	38.8	50.3	45.8	51.6	49.7	40.2	33.1	38.6	48.2	46.4	48.5	**44.2**	**41.1**	**41.1**
C36	72.2	53.1	42.9	44.0	49.2	51.2	46.0	42.2	53.2	52.6	53.0	54.3	**51.2**	**47.6**	**45.8**
C75	30.2	35.8	32.4	26.4	missing	27.7	27.6	19.9	22.4	32.7	36.2	30.4	29.3	27.2	27.2
CAN	missing	missing	missing	31.7	38.1	32.3	30.7	31.6	32.3	35.2	42.1	41.1	35.0	32.6	32.6
CBI1	44.3	52.7	47.2	42.8	39.7	34.9	38.8	35.4	42.1	44.6	43.7	39.4	**42.1**	39.2	39.2
CBI2	46.6	48.8	44.9	40.4	41.8	37.3	40.8	30.3	41.1	47.7	42.6	43.6	**42.2**	39.2	39.2
CBI3	51.7	55.8	47.0	44.4	43.0	38.8	39.1	35.5	42.0	47.2	39.4	43.7	**44.0**	**40.9**	**40.9**
CFL	31.1	38.8	29.4	30.6	37.6	37.3	34.8	25.7	26.6	32.7	33.5	35.6	32.8	30.5	30.5
CM	37.2	38.9	38.3	36.2	38.6	34.7	34.6	30.4	35.0	41.2	34.2	38.0	36.4	33.9	33.9
CN	39.4	40.3	35.2	34.3	30.9	31.0	missing	31.1	30.6	missing	missing	46.4	35.5	33.0	27.1
CP3	32.9	37.3	31.7	11.3	34.3	34.3	37.1	31.2	36.6	46.9	36.4	33.9	33.7	31.3	31.3

Site ID	NO_2 mean concentrations (µg/m^3)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean		
													Raw data	Bias adjusted (0.93 factor) and annualised (1)	Distance corrected to nearest exposure (2)
CPL	21.2	22.8	24.0	18.4	20.4	18.2	19.4	14.3	18.2	23.2	22.9	22.3	20.4	19.0	17.5
CVR	35.0	37.8	30.5	32.9	missing	30.5	30.7	21.2	38.2	33.2	37.2	30.5	32.5	30.2	30.2
DEL	23.0	21.8	26.1	19.0	23.2	22.2	19.5	18.0	15.4	20.9	25.2	26.5	21.7	20.2	14.9
DSP	27.2	26.4	28.9	25.1	28.7	24.5	25.0	22.8	26.2	29.3	28.6	33.4	27.2	25.3	27.0
EB	37.6	40.6	34.3	31.9	32.0	30.5	29.7	27.6	35.0	39.7	34.3	void	33.9	31.6	31.6
FGS	28.2	41.2	35.4	missing	30.9	28.8	26.0	missing	missing	37.5	30.8	20.7	31.1	28.9	28.9
FH	40.8	39.8	37.9	46.9	43.8	42.8	38.8	38.2	39.5	41.7	41.6	44.8	**41.4**	38.5	38.0
FJ	47.1	41.5	38.0	41.7	43.5	39.5	45.9	void	42.5	39.5	37.4	35.2	**41.1**	38.2	37.1
FM	33.9	35.2	38.4	42.1	46.6	missing	37.6	31.4	30.3	35.9	40.0	42.9	37.7	35.0	35.0
FRC	39.5	43.0	37.3	missing	36.8	28.3	missing	31.8	32.7	42.0	34.6	39.3	36.5	34.0	31.8
FT	33.5	32.7	35.2	32.2	37.0	35.2	31.8	38.4	34.3	31.8	30.3	41.9	34.5	32.1	32.1
FTG	38.1	37.0	34.7	37.7	38.7	missing	missing	29.8	29.4	34.9	37.2	39.5	35.7	33.2	28.2
GB	23.5	21.4	19.3	16.3	15.0	missing	16.0	12.5	14.4	18.3	24.1	24.5	18.7	17.3	13.9
GE	37.0	41.8	37.6	37.4	32.9	30.6	27.9	25.3	34.0	35.7	missing	38.6	34.4	32.0	32.0
GR	-	-	-	-	21.1	20.9	22.5	21.6	22.6	24.3	27.5	32.3	24.1	24.1	24.1
GSW	38.2	44.9	36.2	34.9	34.1	32.1	missing	31.5	39.3	36.8	missing	41.3	36.9	34.3	34.3
GT	36.8	47.6	39.9	missing	35.3	34.5	33.9	28.7	34.9	38.6	35.5	38.0	36.7	34.1	34.1
HB	39.9	40.0	33.1	32.0	31.5	30.5	29.7	26.3	33.2	36.8	40.2	39.5	34.4	32.0	32.0
HHS	23.9	28.7	25.7	19.3	25.4	24.1	24.7	19.7	22.5	25.5	26.0	26.7	24.4	22.7	19.0
HO	33.6	35.3	34.3	35.3	36.3	29.6	30.1	27.6	32.5	36.5	38.1	40.0	34.1	31.7	31.7

Site ID	NO_2 mean concentrations (µg/m^3)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean		
													Raw data	Bias adjusted (0.93 factor) and annualised (1)	Distance corrected to nearest exposure (2)
HW	33.4	42.1	43.9	40.2	41.6	34.9	28.4	28.3	44.3	38.5	44.2	42.2	38.5	35.8	35.8
IC	38.2	39.3	39.0	33.5	missing	35.2	39.0	29.6	34.5	42.4	39.0	38.9	37.1	34.5	34.5
KR	34.8	33.2	32.6	28.3	missing	27.2	29.0	34.1	33.7	38.4	40.6	46.8	34.4	32.0	32.0
LH	36.2	41.3	39.3	39.0	47.9	38.7	42.8	33.9	37.8	44.8	34.5	void	39.6	36.9	32.2
LI2	40.4	39.3	40.1	41.3	35.9	38.8	40.5	33.7	39.0	46.1	55.0	48.0	**41.5**	38.6	30.3
LU	30.9	28.5	29.9	26.7	26.7	23.8	missing	void	30.8	30.7	28.4	34.4	29.1	27.0	27.0
LVR	39.2	46.3	missing	missing	34.1	35.6	37.9	missing	39.5	46.4	34.7	40.1	39.3	36.5	36.5
LVS	33.0	40.6	32.7	missing	39.9	28.0	missing	26.3	31.0	39.4	32.4	34.5	33.8	31.4	31.4
MCC	41.2	44.0	39.5	34.6	38.8	40.9	42.5	35.3	39.0	49.5	40.8	44.3	**40.8**	38.0	36.9
MOS	30.7	30.4	34.3	30.5	31.3	25.0	26.8	24.1	26.8	missing	34.3	38.6	30.2	28.1	26.4
NCS	32.7	41.4	38.4	37.1	33.5	26.2	22.9	22.7	25.2	29.9	43.2	40.0	32.8	30.5	30.5
NIN	36.9	35.4	38.5	34.8	40.0	36.0	40.5	33.4	38.1	41.8	34.4	38.0	37.3	34.7	34.7
NIS	31.2	30.9	35.1	37.4	42.0	34.0	31.6	24.4	30.3	42.0	33.5	37.2	34.1	31.7	31.7
NS	35.7	missing	34.7	37.8	41.6	30.9	29.5	29.2	34.5	37.3	33.0	38.6	34.8	32.4	32.4
NSR	32.2	42.5	48.4	42.1	missing	47.6	missing	31.9	35.6	43.9	43.8	missing	**40.9**	38.0	36.2
NWH	44.5	43.5	36.2	42.9	44.2	47.9	50.5	42.6	50.3	40.6	39.6	52.7	**44.6**	**41.5**	33.2
OB	46.0	73.4	48.6	46.0	missing	42.7	51.1	34.6	43.1	missing	48.1	48.7	**48.2**	**44.8**	**43.3**
OF	37.9	42.0	35.3	39.9	missing	33.4	36.5	27.9	34.9	38.1	39.9	40.0	36.9	34.3	34.3
OP	32.1	35.9	33.0	missing	36.6	32.0	31.6	30.4	33.2	41.7	38.5	35.1	34.5	32.1	32.1
OSJ	25.2	24.7	25.0	19.4	21.8	18.5	20.5	18.3	19.6	26.1	27.4	missing	22.4	20.8	19.0

Site ID	NO_2 mean concentrations (µg/m^3)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean		
													Raw data	Bias adjusted (0.93 factor) and annualised (1)	Distance corrected to nearest exposure (2)
OW	49.8	53.1	41.6	32.3	missing	missing	46.9	43.5	53.6	missing	51.9	49.5	**46.9**	**43.6**	39.2
PA	47.5	missing	missing	missing	43.2	36.8	44.7	38.1	40.9	45.8	48.2	53.1	**44.3**	**41.2**	33.8
PG	62.0	missing	missing	43.5	missing	42.6	45.8	38.3	48.9	52.5	53.0	50.8	**48.6**	**45.2**	**45.2**
RM	37.9	84.3	52.8	47.2	53.0	46.0	40.7	33.8	42.0	54.2	49.8	47.8	**49.1**	**45.7**	**45.7**
RPS	54.9	44.9	46.4	44.0	40.1	41.1	40.1	37.9	43.7	38.6	57.3	58.2	**45.6**	**42.4**	29.2
RR	36.1	41.6	44.1	41.8	41.2	36.1	32.9	37.2	38.0	39.0	40.3	41.9	39.2	36.5	32.2
SA	37.1	44.3	45.9	36.2	45.3	36.3	35.3	28.4	34.9	45.9	52.8	44.8	**40.6**	37.7	37.7
SF	32.3	39.0	36.3	34.3	40.0	31.3	missing	26.4	33.3	40.8	38.4	41.3	35.8	33.3	33.3
SM	32.3	27.5	32.3	26.4	25.2	22.4	24.5	22.0	25.1	28.3	28.7	31.1	27.1	25.2	25.2
SR	32.7	36.0	37.2	38.8	44.7	32.8	32.6	33.4	37.7	39.0	32.9	38.1	36.3	33.8	33.8
ST	42.9	44.4	48.3	43.2	51.9	45.1	43.8	38.1	34.8	49.9	55.5	48.7	**45.6**	**42.4**	24.5
SV2	27.9	30.6	32.0	27.0	25.9	24.5	23.2	missing	24.2	28.2	27.5	29.9	27.3	25.4	24.7
SV3	29.4	26.9	31.1	28.5	29.1	24.5	25.4	21.2	25.3	28.6	34.5	30.4	27.9	26.0	26.0
SZ	38.9	43.9	41.7	34.9	43.7	40.7	41.7	29.5	35.3	41.6	37.9	36.4	38.8	36.1	35.0
T11	33.3	40.8	34.7	29.8	28.9	missing	49.3	25.2	28.7	34.9	35.4	35.6	34.2	31.8	31.8
T44	37.9	44.3	41.2	43.5	43.0	46.6	missing	32.6	38.3	41.5	48.0	47.0	**42.2**	39.2	31.4
T6	48.6	53.2	47.1	48.2	44.3	46.9	27.1	34.2	44.6	52.6	57.7	57.6	**46.9**	**43.6**	**43.6**
TA	51.6	50.3	47.8	44.4	51.7	45.9	46.7	37.9	46.5	47.8	47.1	56.0	**47.8**	**44.5**	33.7
TB	36.6	47.8	42.9	40.3	42.1	36.3	34.9	31.0	36.9	44.2	38.9	41.5	39.5	36.7	31.9
TE	29.6	33.0	missing	25.8	27.8	23.5	missing	19.5	24.0	30.3	29.1	29.2	27.2	25.3	25.3

Site ID	NO_2 mean concentrations (µg/m^3)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual mean		
													Raw data	Bias adjusted (0.93 factor) and annualised (1)	Distance corrected to nearest exposure (2)
UCA	29.2	30.0	48.7	32.4	29.1	32.7	23.9	24.1	25.9	31.5	31.7	30.4	30.8	28.6	24.4
UHS	31.6	35.3	31.4	34.9	missing	25.6	10.7	22.6	23.6	29.6	28.9	38.4	28.4	26.4	24.3
UN	31.9	54.5	47.5	41.0	35.2	36.3	39.2	32.5	35.5	missing	52.0	45.3	**41.0**	38.1	38.1
VRC	22.3	25.1	missing	20.0	18.4	15.7	16.7	14.1	16.1	19.6	24.0	23.3	19.6	18.2	18.2
W23	37.7	39.7	34.0	34.3	42.8	33.4	33.4	29.4	28.6	38.3	37.9	37.8	35.6	33.1	33.1
WCR	46.1	47.7	42.6	38.1	44.6	40.5	missing	34.6	26.3	43.9	53.3	43.2	**41.9**	39.0	29.1
WG	44.6	49.5	49.6	40.3	49.7	40.0	42.4	33.9	35.2	45.9	41.1	41.8	**42.8**	39.8	39.8
WGW	36.1	36.6	38.3	34.0	44.6	37.5	39.1	29.3	31.9	38.6	34.9	33.3	36.2	33.7	33.7
WH1	33.9	33.2	39.0	42.0	41.1	40.3	32.7	32.8	33.3	39.9	34.8	32.7	36.3	33.8	33.8
WH2	missing	36.3	44.1	40.0	42.6	39.7	35.5	31.9	33.4	36.1	33.6	37.1	37.3	34.7	34.7
WH3	missing	31.1	missing	39.0	39.0	33.4	31.8	32.2	33.8	38.6	34.8	37.0	35.1	32.6	32.6
WIM	38.7	34.1	28.2	32.7	34.4	34.1	34.4	28.8	32.9	34.0	39.2	37.1	34.0	31.7	23.7
XR	35.1	35.2	37.0	30.2	35.8	24.2	29.5	30.1	33.8	35.0	38.2	36.6	33.4	31.1	28.3

☐ Local bias adjustment factor used ☒ Annualisation has been conducted where data capture is less than 75%

☒ National bias adjustment factor used ☒ Where applicable, data has been distance corrected for relevant exposure

Notes:

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

NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 one-hour mean objective are shown in **bold and underlined.**

(1) See Appendix C for details on bias adjustment and annualisation.

(2) Distance corrected to nearest relevant public exposure. Only applied to sites where annualised and bias-adjusted tube results were within 10% of the annual mean objective (ie: >36µg/m^3), and to all sites new in 2018 for information.

Appendix C: Supporting technical information / air quality monitoring data QA/QC

Quality control procedures

Council staff follow a set of internal QA/QC procedure notes relating to the use of diffusion tubes for the purpose of air quality monitoring. These cover key stages in the monitoring process including storage, deployment, record keeping and management of NO_2 diffusion tube data.

Data ratification, bias adjustments and distance corrections

Automatic gas monitoring

In-house staff perform fortnightly span and zero calibrations on the chemiluminescent analysers at the BO, CBI and WH roadside sites, and four-weekly span and zero calibrations on the remaining chemiluminescent and UV-fluorescent analysers, using BOC spectra-seal certified gas standards. The resultant span and offset values are used in the ratification of datasets. Automated internal zero checks are run overnight daily. Data from different sites is compared on a regular basis for the purposes of QA/QC. Data management and ratification is performed by an independent contractor, AQDM Ltd. This includes production of weekly, quarterly and annual summaries as well as ad hoc notifications of any exceedance episodes where necessary. The ratification process also involves comparison against national network sites to identify regional patterns and trends. In 2018 the analysers were serviced and calibrated at six-monthly intervals by Easy Technical Services Ltd (LR and LR-JG) and Enviro Technology Services plc (all other sites).

Automatic particulate monitoring

PM_{10} monitoring data recorded by the BAM analysers at Thornton-le-Moors (TLP) and Chester bus interchange (CBI) has been adjusted by the factor (0.96618), to give the indicative gravimetric equivalent figure.

The volatile correction model (VCM) was used to correct TEOM monitoring data to produce a gravimetric equivalent figure for each site.

Short-term to long-term data adjustment (annualisation)

Monitoring studies should ideally be in situ for at least a year in order to compare the results against the annual mean objectives. Monitoring sites with less than nine months' worth of data should be annualised using short-term to long-term adjustments as set out in section 7.171 of LAQM.TG16. Just one site required annualisation in 2018. The calculated adjustment factor, Ra, in Table 11 has been applied to the result for site GR in Table 10 above. [Note: raw data for GR in Table 10 is 24.1μg/m^3 but application of the Ra of 1.073 and the bias adjustment factor of 0.93 results in an adjusted figure which is also 24.1μg/m^3]

Table 11 Annualisation factor 2018 (location GR)

Site	Site Type	Annual Mean 2018 (Am)	Period Mean 2018 (Pm)	Ratio (Am/Pm)
Liverpool Speke	Urban Background	17.56	16.44	1.068
Stoke centre	Urban Background	23.45	22.52	1.041
Warrington	Urban Background	21.38	19.70	1.085
Wirral (Tranmere)	Background	17.51	15.92	1.100
			Average (Ra)	1.073

Diffusion tube bias adjustment factors

Triplicate sets of diffusion tubes are collocated with the real-time analysers CBI in Chester and WH in Ellesmere Port. Data from this exercise is used for checking diffusion tube precision and accuracy against real-time results in both a local comparison and to contribute to the national bias adjustment programme. Bias adjustment factors derived from collocation studies undertaken at various locations across the country are available on the Defra website.

Results from 30 national collocation studies, which use the 20 percent triethanolamine (TEA) in water preparation are shown in Table 12 below. The national bias adjustment factor for 2018 is 0.93. The local comparisons of diffusion

tubes against the real-time data are shown in Table 13 and Table 14 below. The local bias adjustment factors for 2018 were 1.01 at WH and 0.94 at CBI.

Discussion of choice of bias factor to use

The overall accuracy and precision results of the two local studies were good, as were real-time data capture rates. There were 11 periods of good precision for site WH and 12 periods at CBI. At CBI, the local bias adjustment factor of 0.94 compares favourably with the national bias adjustment factor of 0.93. The factor for WH is not as close however and this reflects the findings of these exercises at this location in previous years. It should be noted that the monitoring station WH is situated within a street canyon so the bias adjustment may not be applicable to sites with a more open aspect. Given how close the factor for CBI is to the national factor it would be acceptable to apply either of these to diffusion tube adjustment, but, as in previous years, and in line with the guidance notes in section 7.175 of LAQM.TG16, it has been decided to use the national bias adjustment factor (0.93) for the adjustment of all diffusion tube data as it is likely to be more statistically reliable.

Distance correction

LAQM.TG16 recommends that distance correction to relevant exposure be applied to all annual mean tube results (following annualisation and bias adjustment) that exceed the objective level of 40µg/m^3, and that it should also be considered for locations where results are within 10% of the objective, i.e. above 36µg/m^3, to account for uncertainties.

Distance corrections have been applied to all locations that exceed 36µg/m^3 (following annualisation and bias adjustment), as well as to all locations new in 2018 where the diffusion tube is separated from the relevant exposure.

Distance corrections, made using the multiple tube calculator within version 4.2 of the Bureau Veritas 'NO_2 fall-off with distance calculator' (March 2018), have been applied to annual results at the following locations: C36, CN, CPL, DEL, DSP, FH, FJ, FRC, FTG, GB, HHS, LH, LI2, MCC, MOS, NSR, NWH, OB, OSJ, OW, PA, RPS, RR, ST, SV2, SZ, T44, TA, TB, UCA, UHS, WCR, WIM and XR. An extract of the distance calculator is shown in Table 15 and the adjusted data in Table 10.

Consideration has previously been given to applying distance correction to the annual result for tube location CBI. However, it was considered that because the separation distance between CBI and the road is greater than the distance between the facade of the nearest relevant exposure and the kerb of the same road at diffusion tube location OW, distance correction should not be applied to CBI. This approach was put to the LAQM helpdesk, who agreed that, in this circumstance, diffusion tube OW will be used to represent relative exposure at the facade of the residential building after distance correction has been applied.

Table 12 National bias adjustment factor (v0319)

Analysis	Method	Year	Site	Local authority	Length of study	Tube mean (Dm)(µg/m^3)	Auto mean (Cm)(µg/m^3)	Bias (%)	Tube precision	Bias factor (Cm/Dm)
Gradko	20% TEA in water	2018	R	Ards and North Down	11	36	29	27.4%	G	0.78
Gradko	20% TEA in water	2018	R	Gedling	12	33	32	5.6%	G	0.95
Gradko	20% TEA in water	2018	R	Lisburn Castlereagh	12	32	24	32.1%	G	0.76
Gradko	20% TEA in water	2018	R	Monmouthshire	12	38	36	4.7%	G	0.96
Gradko	20% TEA in water	2018	UB	Northampton	12	16	13	26.8%	G	0.79
Gradko	20% TEA in water	2018	R	Bedford	11	32	29	9.2%	G	0.92
Gradko	20% TEA in water	2018	R	King's Lynn	12	26	24	6.0%	G	0.94
Gradko	20% TEA in water	2018	R	Cheshire West and Chester	12	36	37	-2.5%	G	1.03
Gradko	20% TEA in water	2018	R	Cheshire West and Chester	12	43	40	6.1%	G	0.94
Gradko	20% TEA in water	2018	R	Fareham	12	28	34	-17.5%	G	1.21
Gradko	20% TEA in water	2018	R	Fareham	12	37	34	8.9%	G	0.92
Gradko	20% TEA in water	2018	R	Fareham	12	32	28	12.6%	G	0.89
Gradko	20% TEA in water	2018	R	Nottingham	12	35	34	0.3%	G	1.00
Gradko	20% TEA in water	2018	R	Bracknell Forest	12	44	37	19.4%	G	0.84
Gradko	20% TEA in water	2018	R	Brighton and Hove	9	48	50	-3.7%	G	1.04
Gradko	20% TEA in water	2018	R	Eastleigh	11	28	32	-12.0%	G	1.14
Gradko	20% TEA in water	2018	R	Eastleigh	12	42	38	10.2%	G	0.91
Gradko	20% TEA in water	2018	UB	Eastleigh	12	27	28	-4.4%	G	1.05
Gradko	20% TEA in water	2018	R	Gateshead	12	29	25	13.9%	G	0.88
Gradko	20% TEA in water	2018	R	Gateshead	12	32	29	10.8%	G	0.90
Gradko	20% TEA in water	2018	R	Gateshead	9	40	41	-1.8%	G	1.02
Gradko	20% TEA in water	2018	R	Wokingham	12	38	33	13.2%	G	0.88
Gradko	20% TEA in water	2018	R	Bath NE Somerset	12	40	39	4.0%	G	0.96
Gradko	20% TEA in water	2018	R	Bedford	10	30	27	8.8%	G	0.92
Gradko	20% TEA in water	2018	KS	Marylebone Road Intercomparison	11	93	85	9.3%	G	0.91
Gradko	20% TEA in water	2018	R	South Gloucs	12	21	20	6.3%	G	0.94
Gradko	20% TEA in water	2018	R	Thurrock	12	53	52	2.3%	S	0.98
Gradko	20% TEA in water	2018	R	Thurrock	12	34	30	15.1%	G	0.87
Gradko	20% TEA in water	2018	R	Thurrock	12	31	24	28.8%	G	0.78
Gradko	20% TEA in water	2018	UB	Thurrock	12	27	25	9.2%	S	0.92
				Overall Factor (30 studies)				**Use**		**0.93**

*TEA = triethanolamine

Table 13 Calculation of local bias adjustment – Whitby Road

Diffusion tubes measurements										Automatic method		Data quality check	
Period	Start date dd/mm/yyyy	End date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate mean	Standard deviation	Coefficient of variation (CV)	95% CI of mean	Period mean	Data capture (% DC)	Tubes precision check	Automatic monitor data capture check
1	03/01/2018	01/02/2018	33.9							41.6	99.7		Good
2	01/02/2018	01/03/2018	33.2	36.3	31.1	34	2.6	8	6.5	42.6	99.3	Good	Good
3	01/03/2018	28/03/2018	39.0	44.1		42	3.6	9	32.3	43.9	99.5	Good	Good
4	28/03/2018	01/05/2018	42.0	40.0	39.0	40	1.5	4	3.8	39.2	99.6	Good	Good
5	01/05/2018	06/06/2018	41.1	42.6	39.0	41	1.8	4	4.5	39.1	99.4	Good	Good
6	06/06/2018	04/07/2018	40.3	39.7	33.4	38	3.8	10	9.5	33.3	99.9	Good	Good
7	04/07/2018	01/08/2018	32.7	35.5	31.8	33	1.9	6	4.7	32.1	99.6	Good	Good
8	01/08/2018	05/09/2018	32.8	31.9	32.2	32	0.4	1	1.1	30.5	99.4	Good	Good
9	05/09/2018	04/10/2018	33.3	33.4	33.8	33	0.2	1	0.6	32.9	99	Good	Good
10	04/10/2018	31/10/2018	39.9	36.1	38.6	38	1.9	5	4.7	35.8	99.7	Good	Good
11	31/10/2018	06/12/2018	34.8	33.6	34.8	34	0.7	2	1.8	35.2	99.8	Good	Good
12	06/12/2018	09/01/2019	32.7	37.1	37.0	36	2.5	7	6.3	40.8	99.8	Good	Good
13													
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:	Whitby Road (WH)

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 11 periods of data	
Bias factor A	1.01 (0.95 - 1.08)
Bias B	-1% (-8% - 6%)
Diffusion tubes mean:	36 μgm^{-3}
Mean CV (precision):	5
Automatic mean:	37 μgm^{-3}
Data capture for periods used:	100%
Adjusted tubes mean:	37 (35 - 39) μgm^{-3}

Precision	11 out of 11 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) With all data	
Bias calculated using 11 periods of data	
Bias factor A	1.01 (0.95 - 1.08)
Bias B	-1% (-8% - 6%)
Diffusion tubes mean:	36 μgm^{-3}
Mean CV (precision):	5
Automatic mean:	37 μgm^{-3}
Data capture for periods used:	100%
Adjusted tubes mean:	37 (35 - 39) μgm^{-3}

(Check average CV & DC from accuracy calculations)

Table 14 Calculation of local bias adjustment – Chester Bus Interchange

1	03/01/2018	01/02/2018	44.3	46.6	51.7	48	3.8	8	9.4	46.6	99.7	Good	Good
2	01/02/2018	01/03/2018	52.7	48.8	55.8	52	3.5	7	8.6	46.9	99.7	Good	Good
3	01/03/2018	28/03/2018	47.2	44.9	47.0	46	1.3	3	3.1	44.7	98.8	Good	Good
4	28/03/2018	01/05/2018	42.8	40.4	44.4	43	2.0	5	5.0	38.9	99.4	Good	Good
5	01/05/2018	06/06/2018	39.7	41.8	43.0	41	1.6	4	4.1	38.5	98.7	Good	Good
6	06/06/2018	04/07/2018	34.9	37.3	38.8	37	2.0	5	4.9	33.1	99.3	Good	Good
7	04/07/2018	01/08/2018	38.8	40.8	39.1	40	1.1	3	2.7	33.1	99.5	Good	Good
8	01/08/2018	05/09/2018	35.4	30.3	35.5	34	3.0	9	7.3	32.2	99.6	Good	Good
9	05/09/2018	04/10/2018	42.1	41.1	42.0	42	0.5	1	1.3	37.3	98.8	Good	Good
10	04/10/2018	31/10/2018	44.6	47.7	47.2	46	1.7	4	4.2	42.8	99.5	Good	Good
11	31/10/2018	06/12/2018	43.7	42.6	39.4	42	2.2	5	5.5	42.5	99.3	Good	Good
12	06/12/2018	09/01/2019	39.4	43.6	43.7	42	2.4	6	6.0	47.1	99.4	Good	Good
13													
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:	Chester Bus Interchange (CBI)	Precision	12 out of 12 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy	(with 95% confidence interval)		Accuracy	(with 95% confidence interval)	
without periods with CV larger than 20%			With all data		
Bias calculated using 12 periods of data			Bias calculated using 12 periods of data		
Bias factor A	0.94 (0.9 - 0.99)		Bias factor A	0.94 (0.9 - 0.99)	
Bias B	6% (1% - 11%)		Bias B	6% (1% - 11%)	
Diffusion tubes mean:	43	µgm^{-3}	Diffusion tubes mean:	43	µgm^{-3}
Mean CV (precision):	5		Mean CV (precision):	5	
Automatic mean:	40	µgm^{-3}	Automatic mean:	40	µgm^{-3}
Data capture for periods used	99%		Data Capture for periods use	99%	
Adjusted tubes mean:	40 (38 - 42)	µgm^{-3}	Adjusted tubes mean:	40 (38 - 42)	µgm^{-3}

Table 15 Calculation of distance from roads correction

Site code	Distance (m)		NO_2 Annual mean concentration (µg/m^3)		
	Monitoring site to kerb	Receptor to kerb	Background	Monitored at site	Predicted at receptor
C36	1.5	1.9	13.4	**47.6**	**45.8**
CN	1.6	5.4	11.3	33.0	27.1
CPL	0.7	1.8	10.7	19.0	17.5
DEL	2.1	12.1	7.5	20.2	14.9
DSP	2.8	1.9	7.2	25.3	27.0
FH	2.0	2.2	17.6	38.5	38.0
FJ	2.0	2.5	17.6	38.2	37.1
FRC	1.6	2.9	17.6	34.0	31.8
FTG	0.8	5.3	19.4	33.2	28.2
GB	0.7	8.7	10.1	17.3	13.9
HHS	2.3	10.3	12.7	22.7	19.0
LH	2.0	5.0	15.1	36.9	32.2
LI2	2.5	9.5	13.5	38.6	30.3
MCC	2.4	2.9	13.5	38.0	36.9
MOS	2.2	3.4	11.4	28.1	26.4
NSR	1.7	2.3	11.3	38.0	36.2
NWH	0.7	3.1	11.8	**41.5**	33.2
OB	2.5	3.1	15.1	**44.8**	**43.3**
OSJ	3.1	5.4	8.4	20.8	19.0
OW	2.3	4.6	17.4	**43.6**	39.2
PA	0.8	3.2	13.5	**41.2**	33.8
RPS	5.2	24.2	13.9	**42.4**	29.2
RR	2.1	5.1	16.2	36.5	32.2
ST	0.1	18.4	17.4	**42.4**	24.5
SV2	1.5	1.9	12.1	25.4	24.7
SZ	2.0	2.5	15.1	36.1	35.0
T44	1.0	4.5	13.4	39.2	31.4
TA	2.0	8.0	11.4	**44.5**	33.7
TB	1.0	3.0	15.1	36.7	31.9
UCA	2.4	7.0	12.5	28.6	24.4
UHS	3.0	5.9	14.1	26.4	24.3
WCR	1.5	8.7	13.4	39.0	29.1
WIM	1.7	7.7	8.4	31.7	23.7
XR	4.5	7.7	13.5	31.1	28.3

Appendix D: Maps of monitoring locations and AQMAs

Figure 8 Location of automatic monitoring station BO in Chester

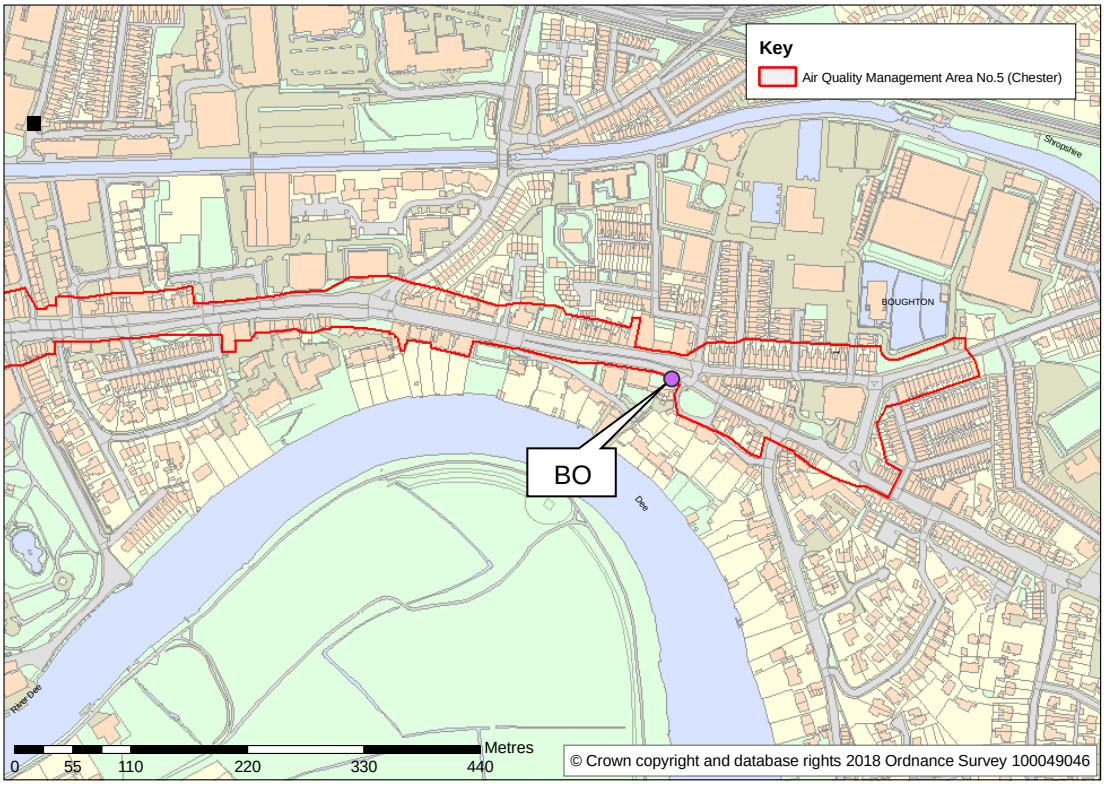


Figure 9 Location of automatic monitoring station CBI in Chester

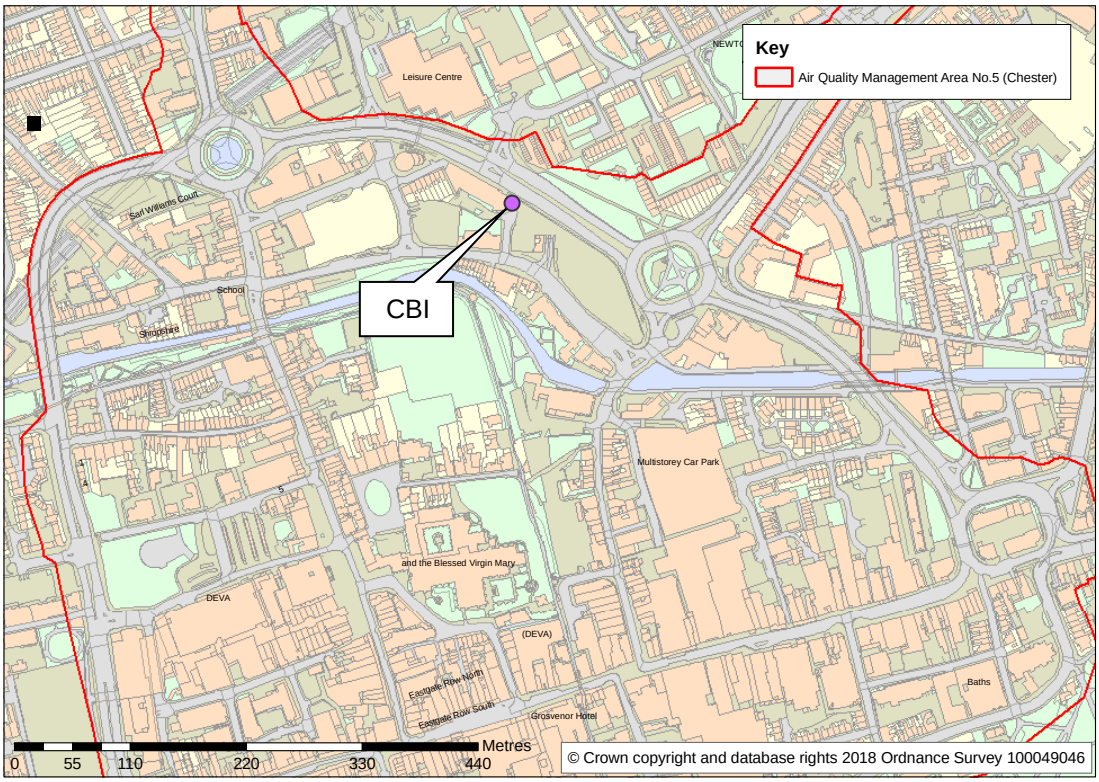


Figure 10 Location of automatic monitoring stations in Ellesmere Port

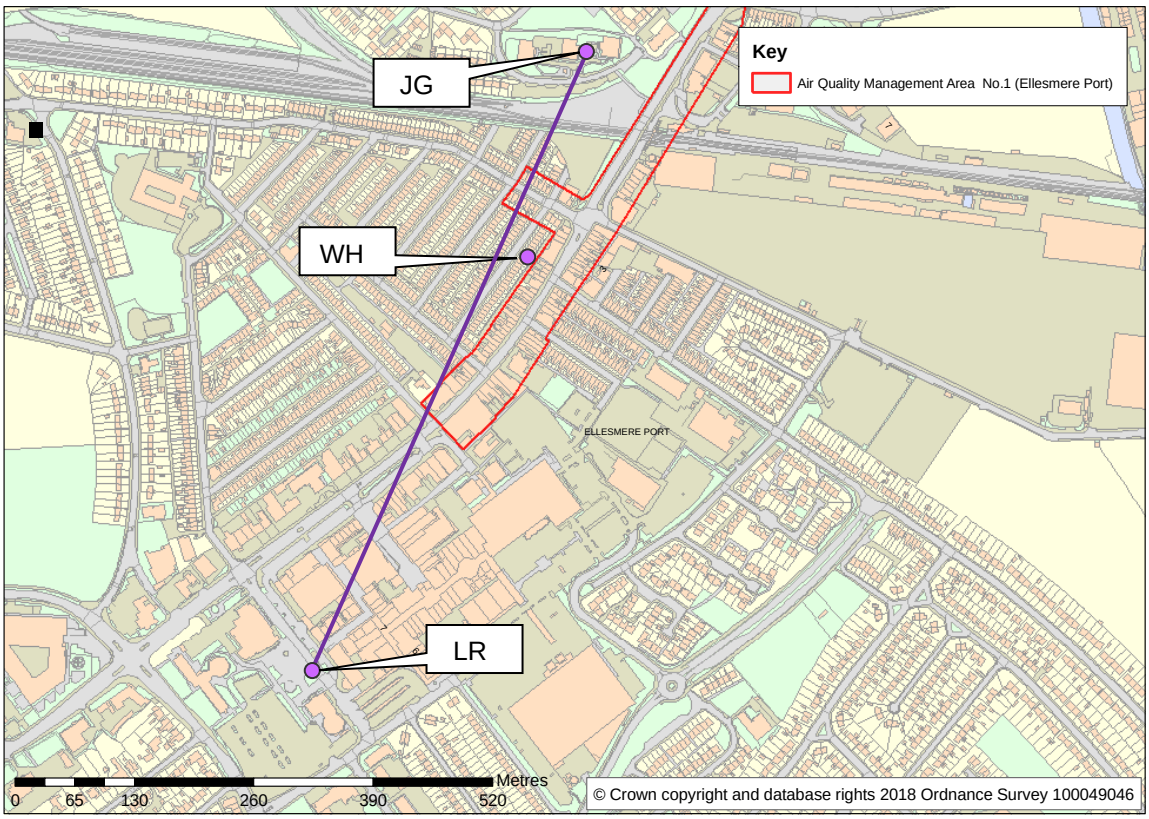


Figure 11 Location of automatic monitoring station in Frodsham

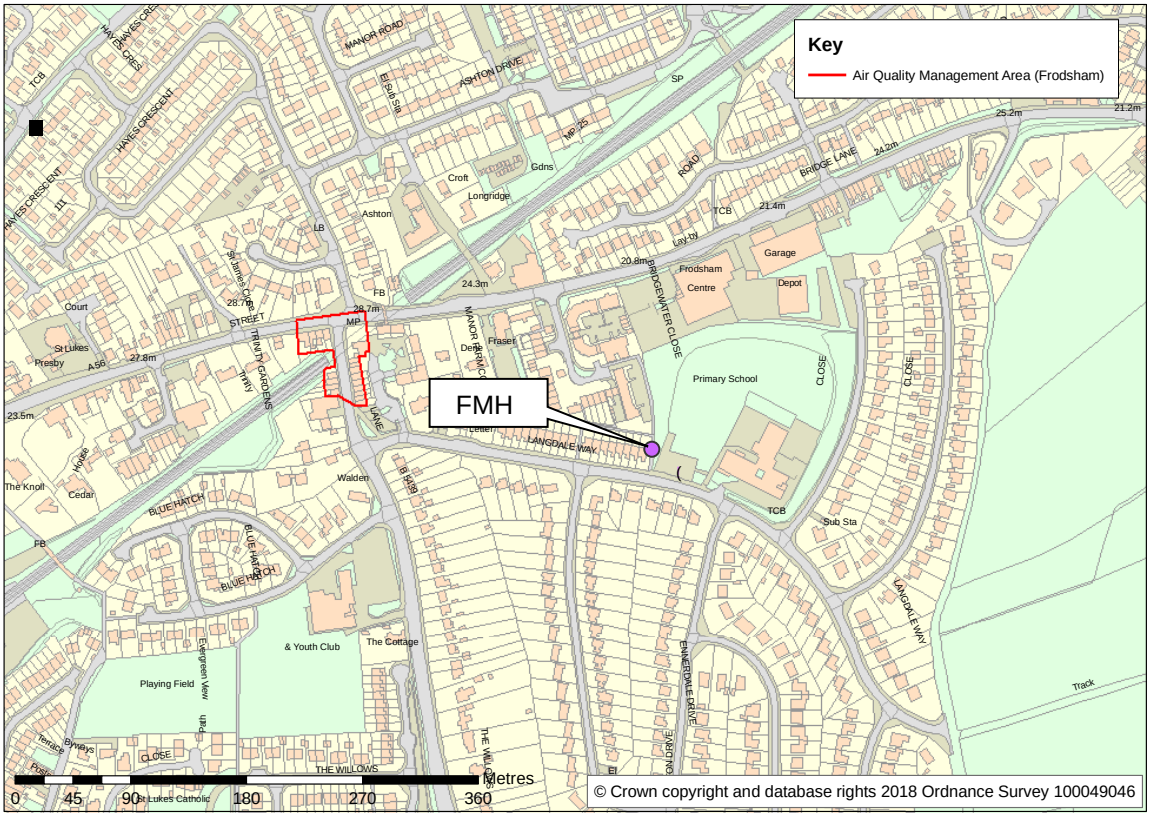


Figure 12 Location of automatic monitoring station in Thornton-le-Moors

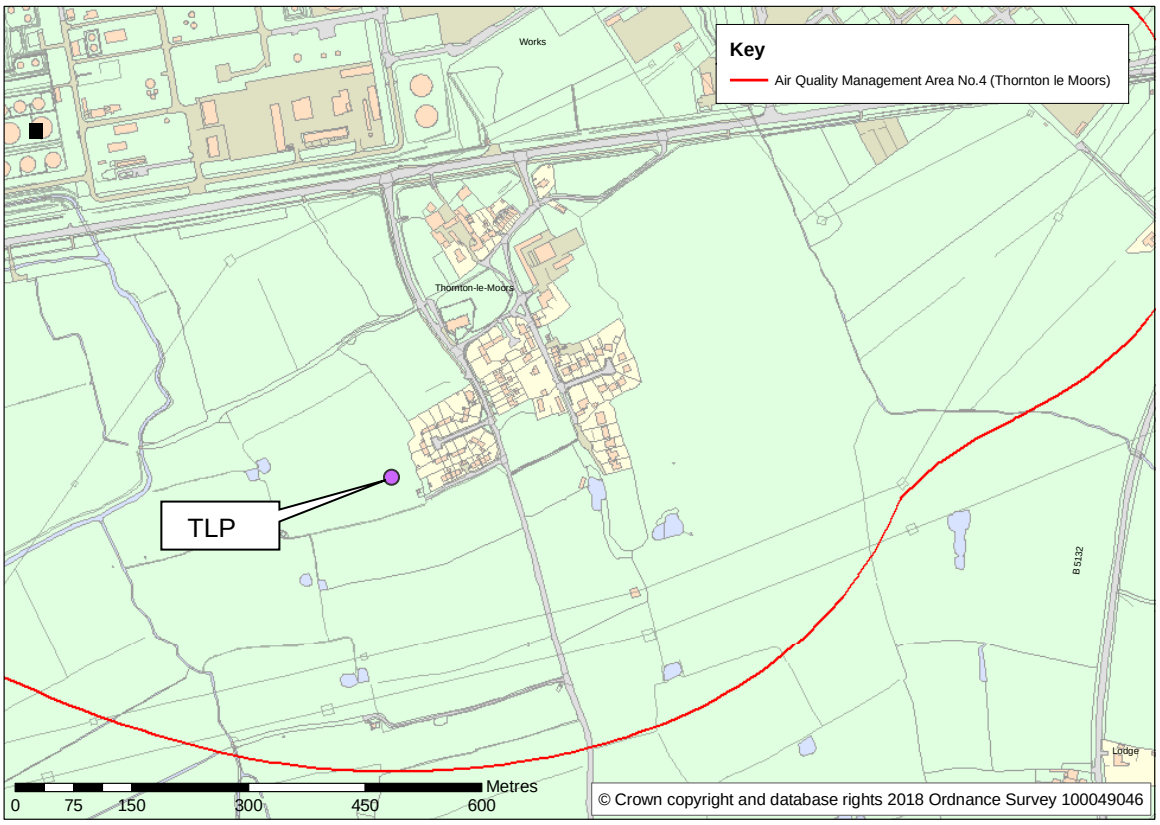


Figure 13 Location of automatic monitoring station in Elton

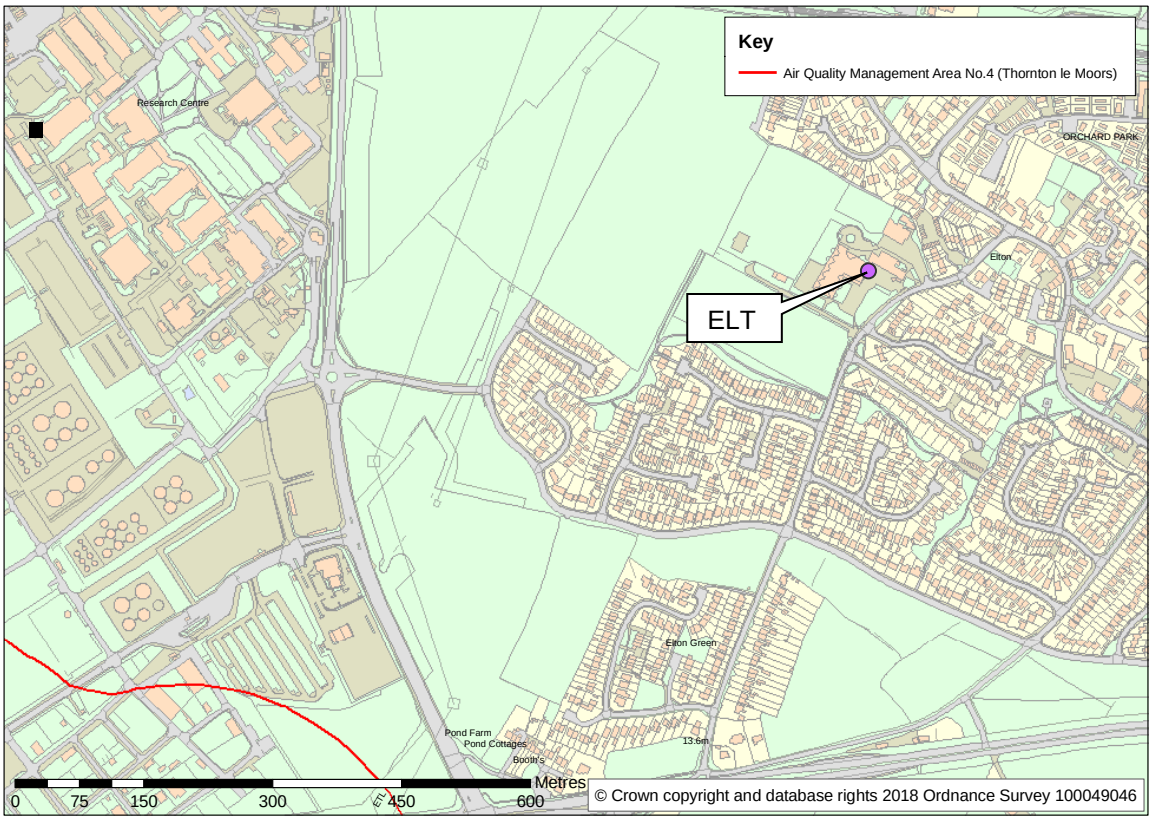


Figure 14 Locations of diffusion tubes in Chester

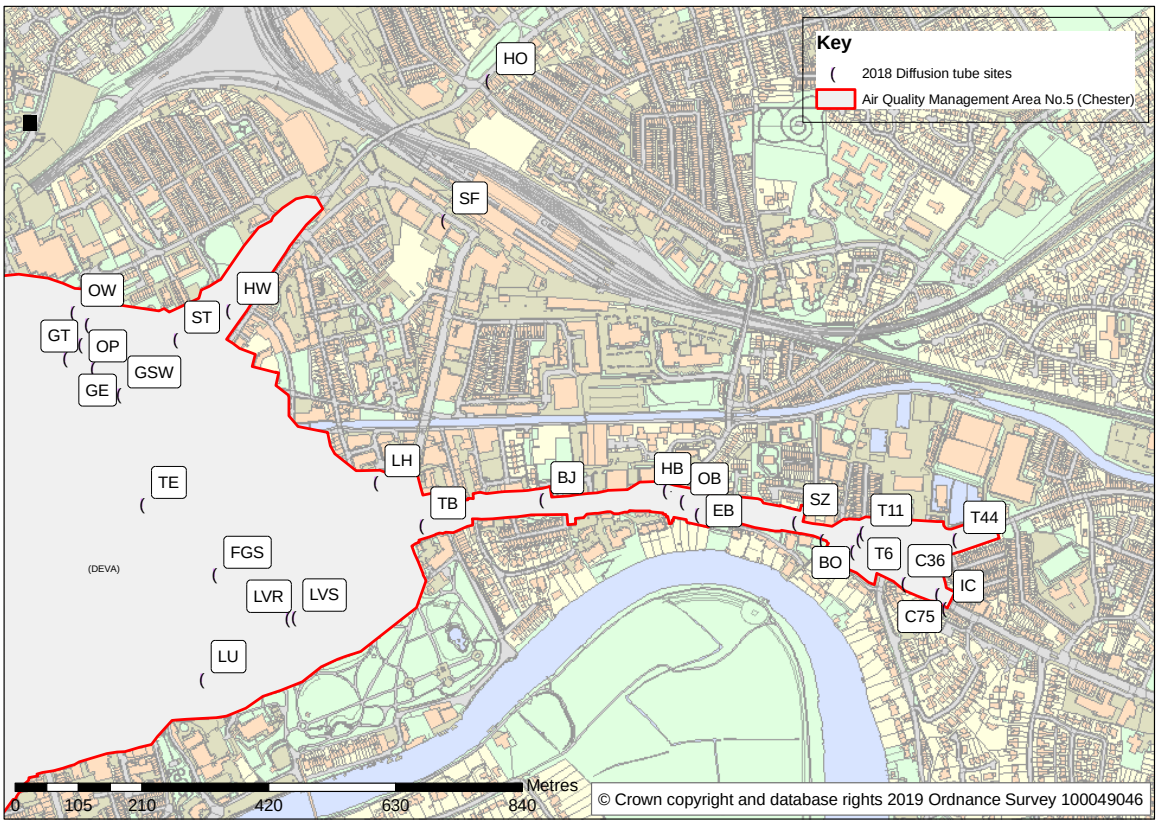


Figure 15 Locations of diffusion tubes in Chester

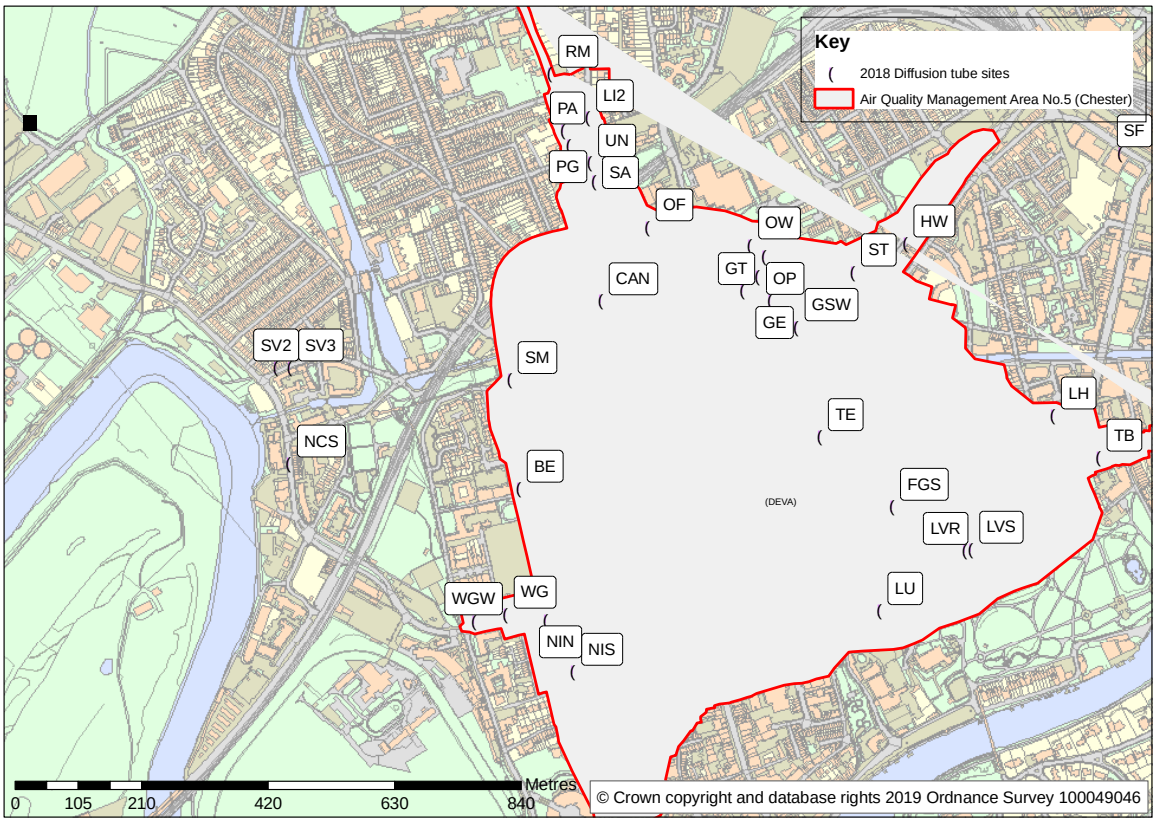


Figure 16 Location of diffusion tubes in Upton, Chester

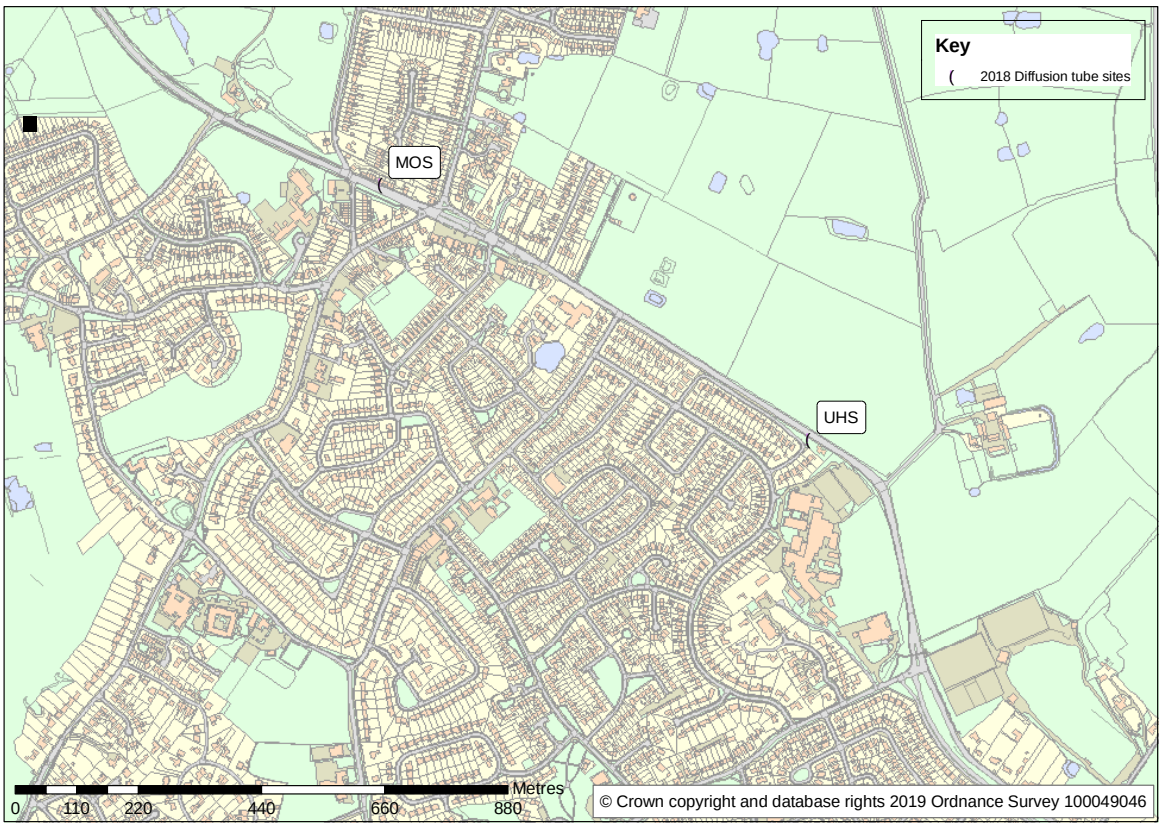


Figure 17 Location of diffusion tubes in Christleton / Boughton

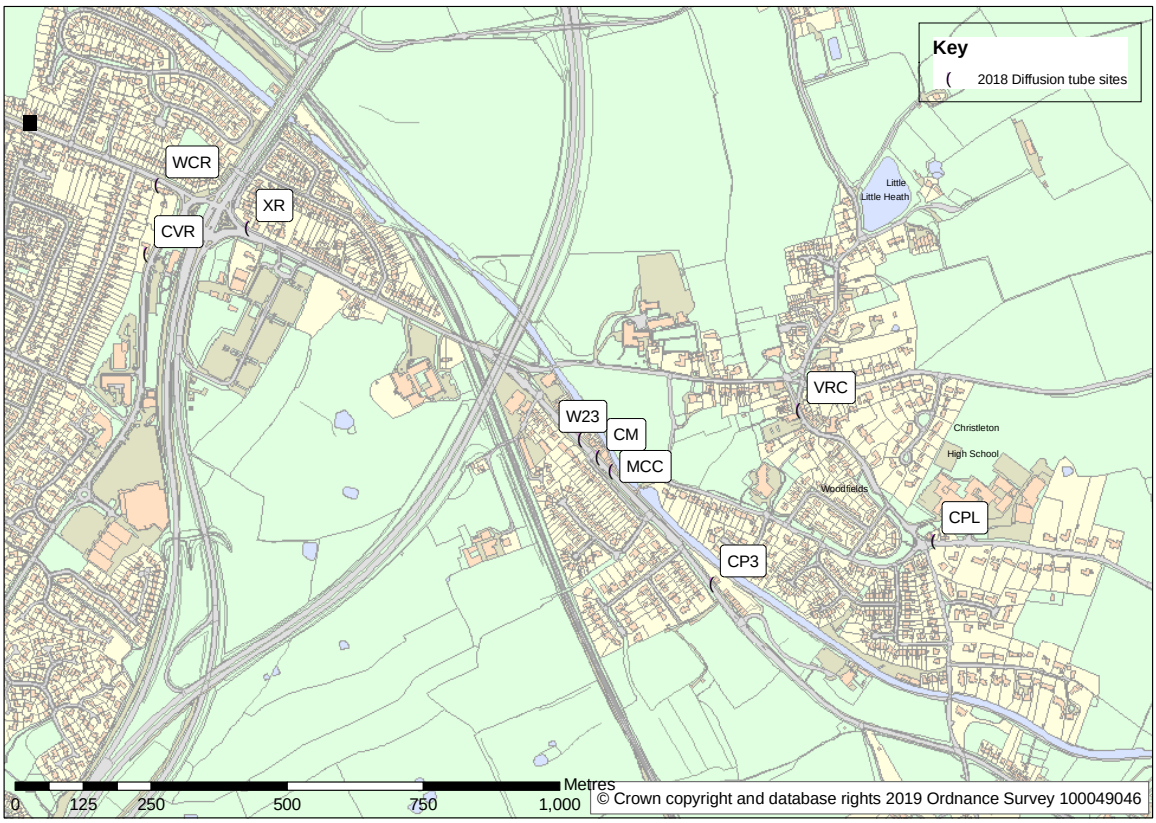


Figure 18 Location of diffusion tube in Littleton

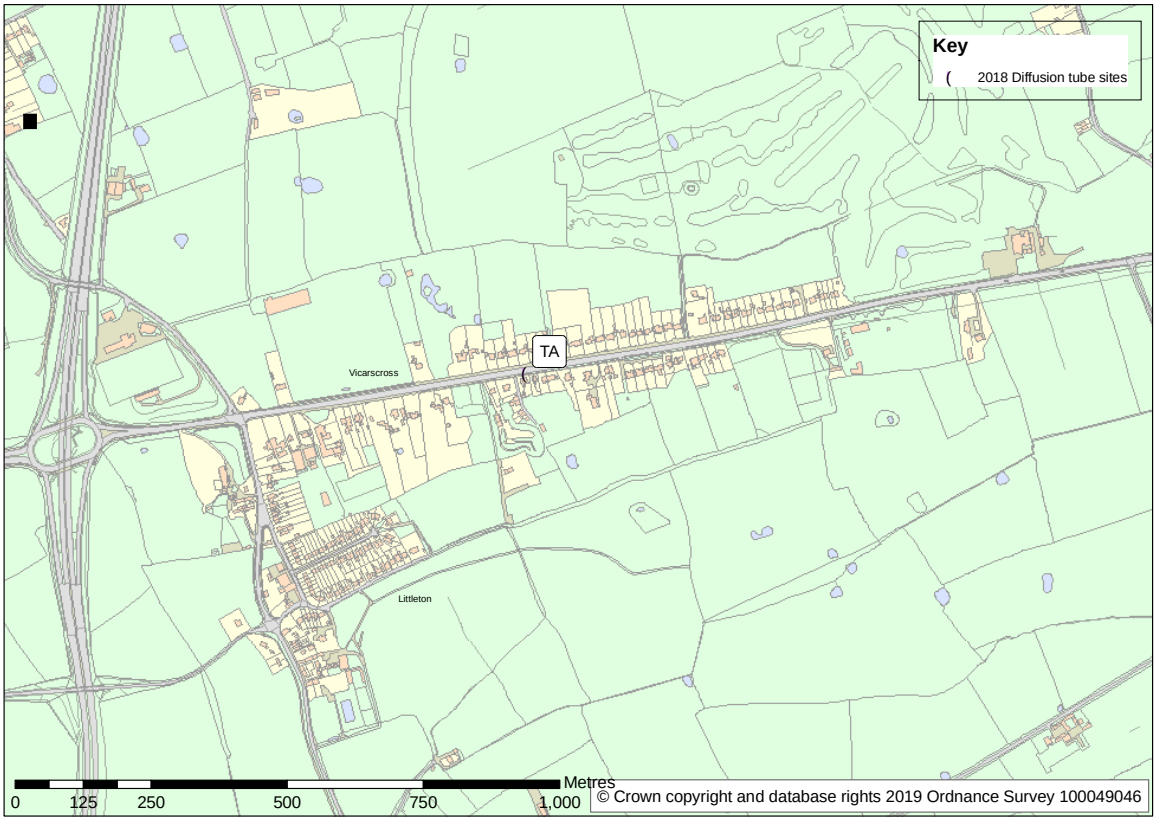


Figure 19 Location of diffusion tubes in Ellesmere Port

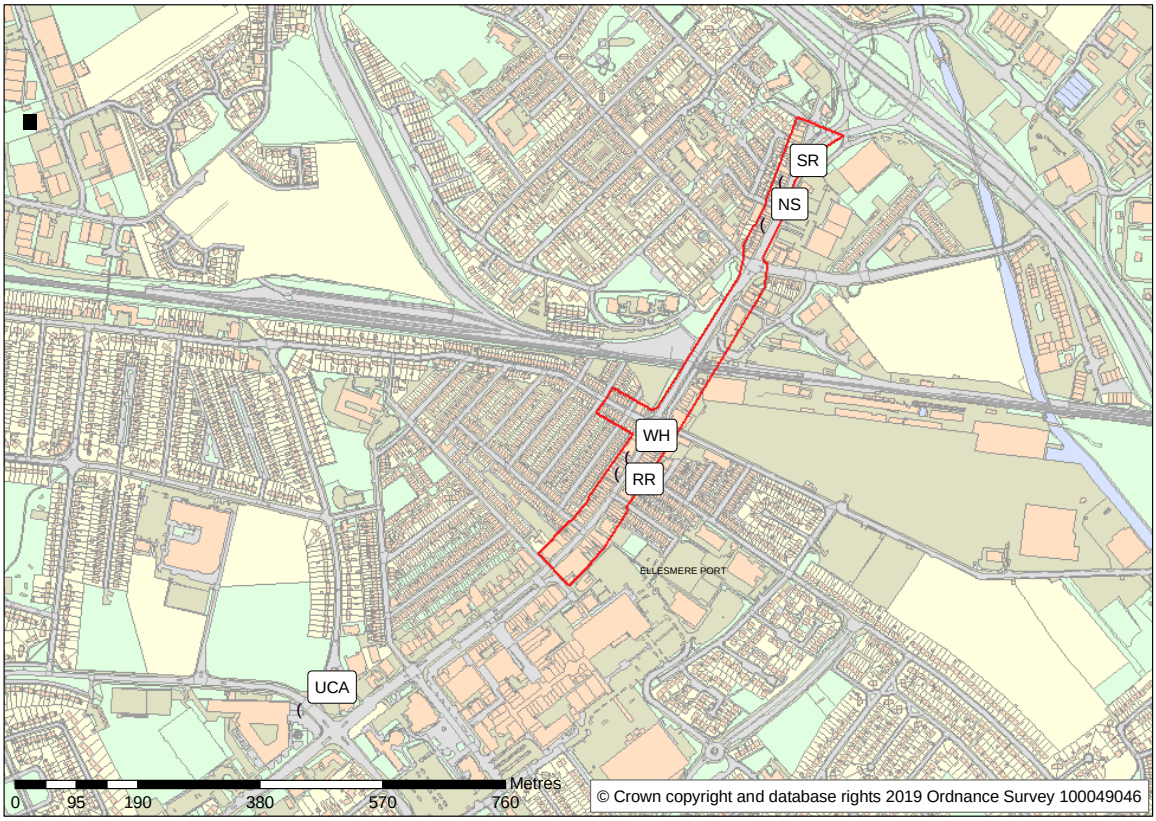


Figure 20 Location of diffusion tubes in Frodsham

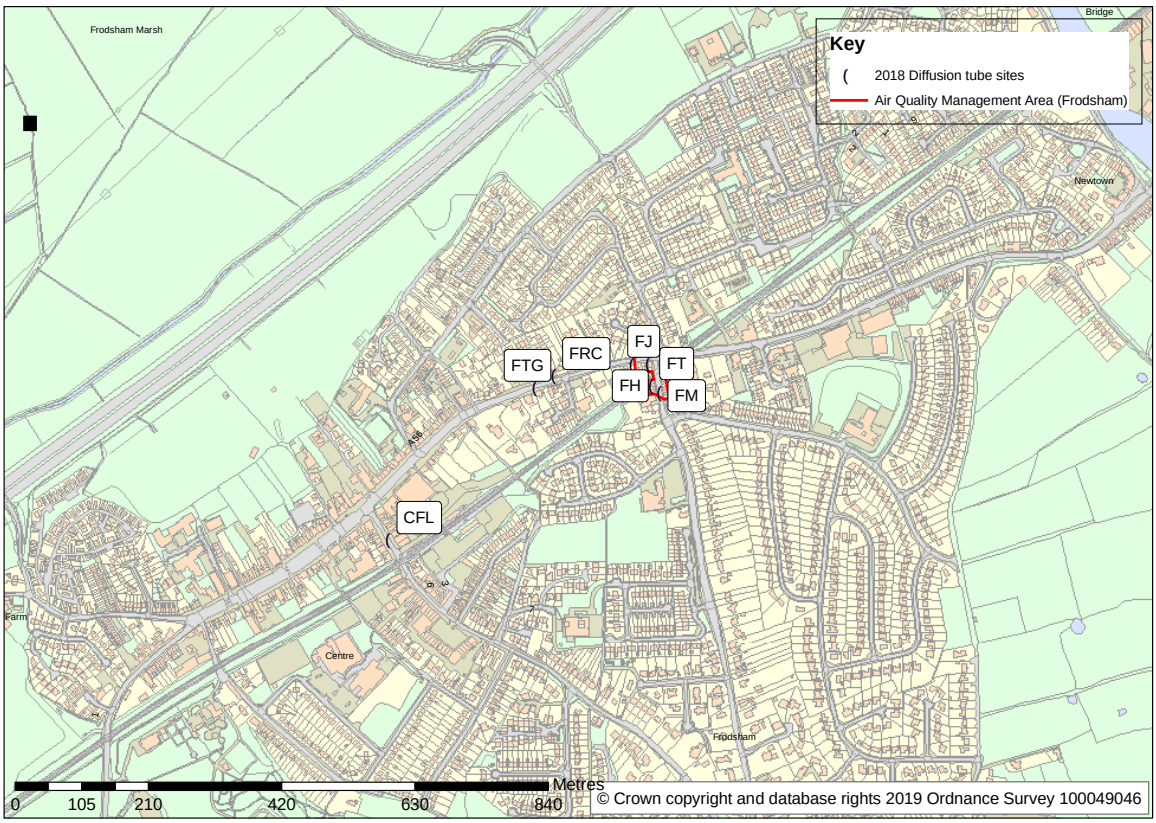


Figure 21 Location of diffusion tubes Northwich

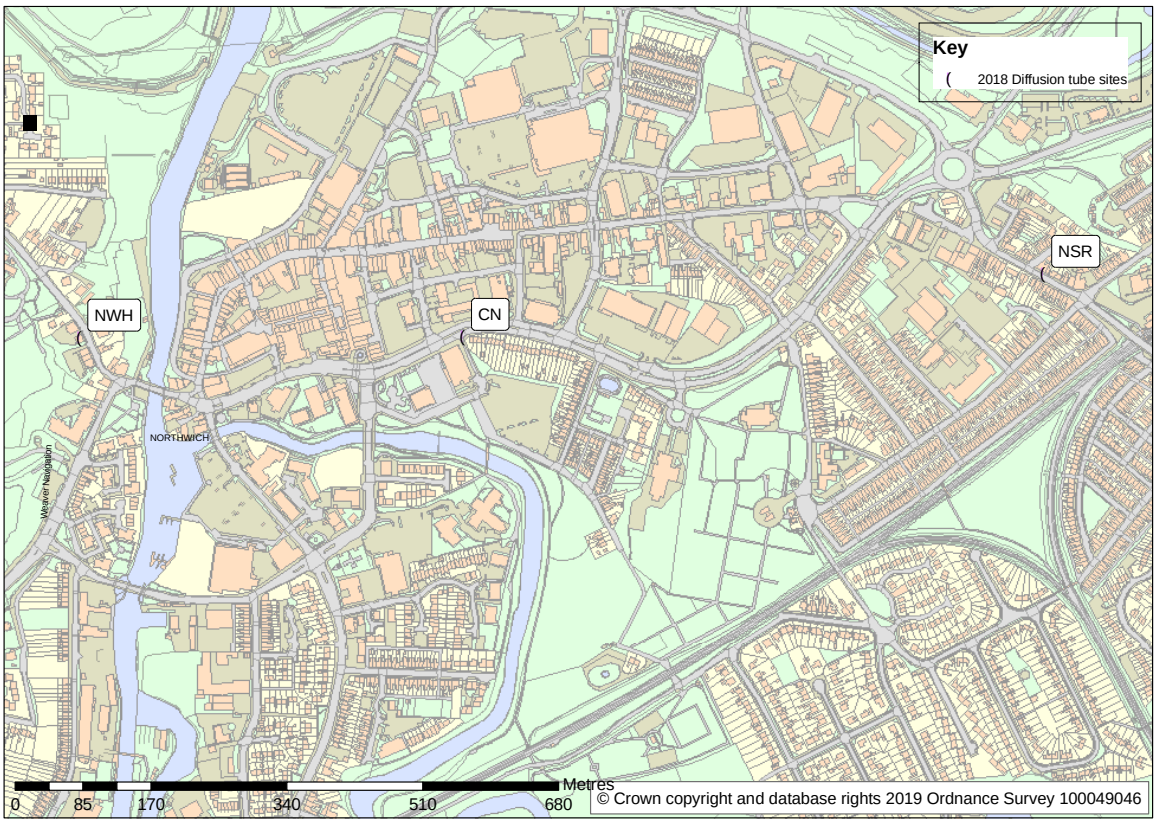


Figure 22 Location of diffusion tube in Rudheath

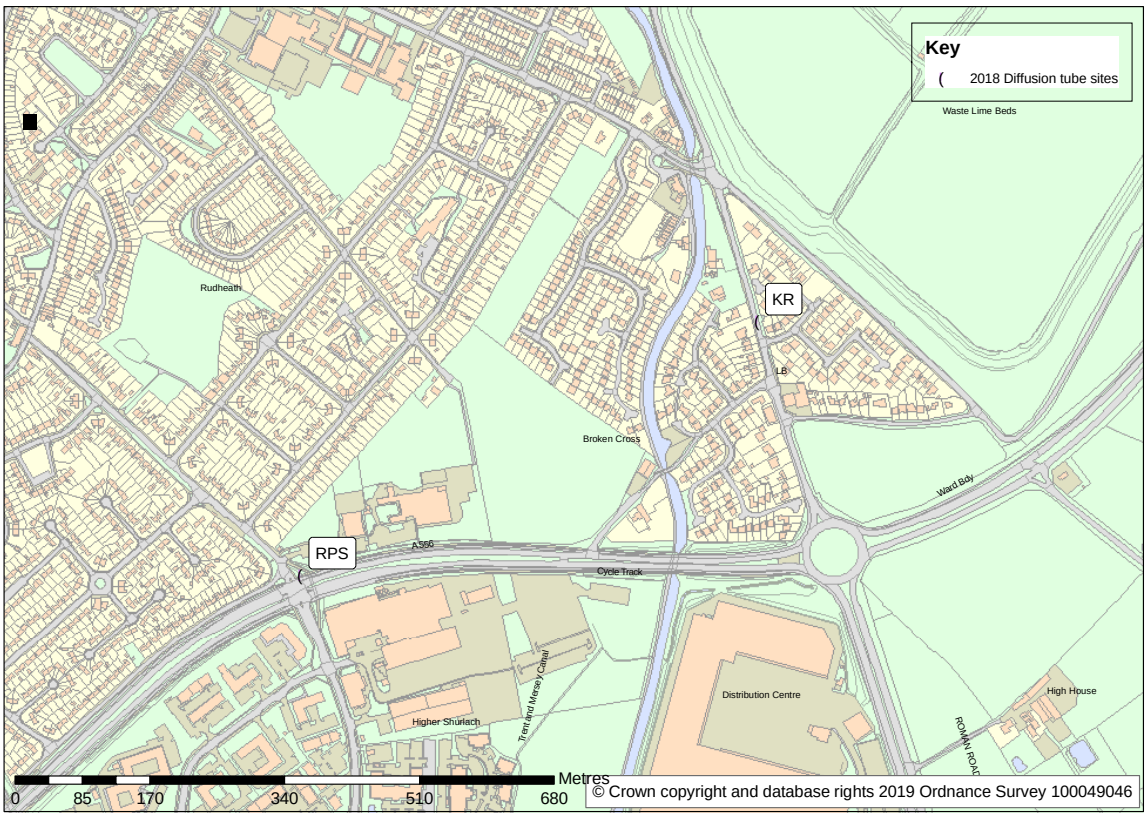


Figure 23 Location of diffusion tube in Winsford

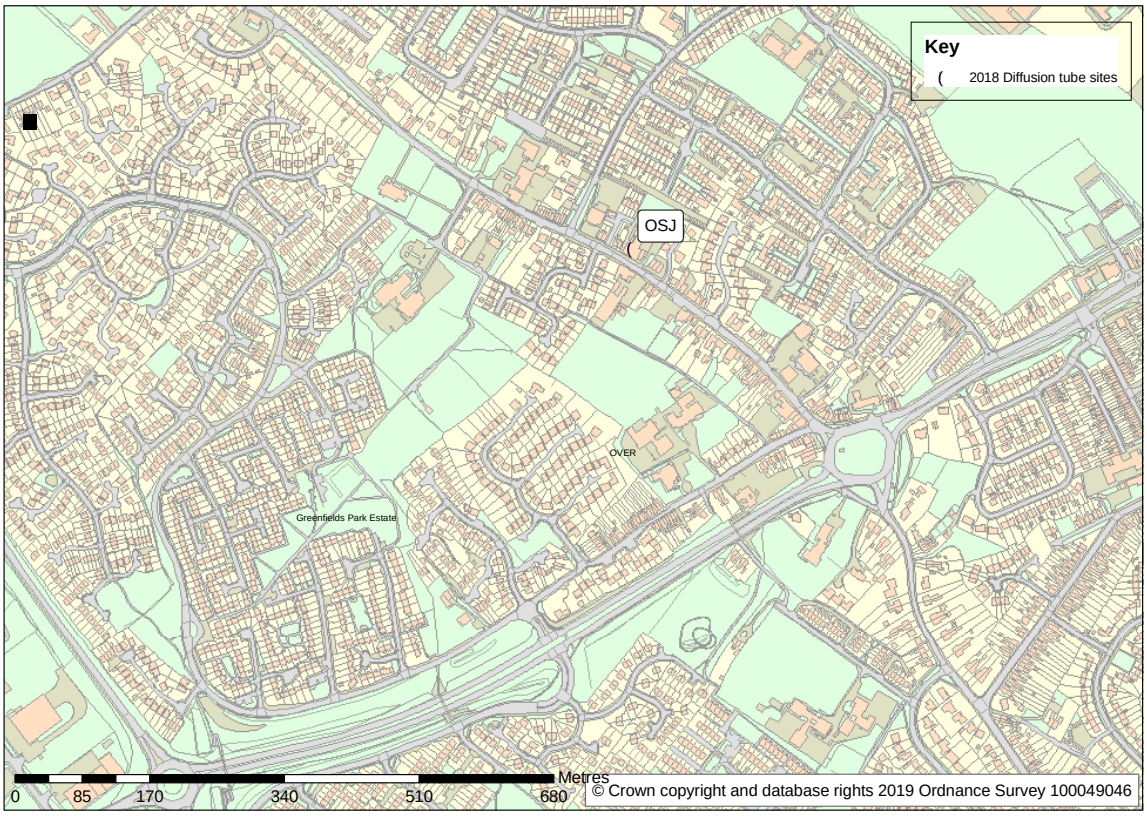


Figure 24 Location of diffusion tube Hartford

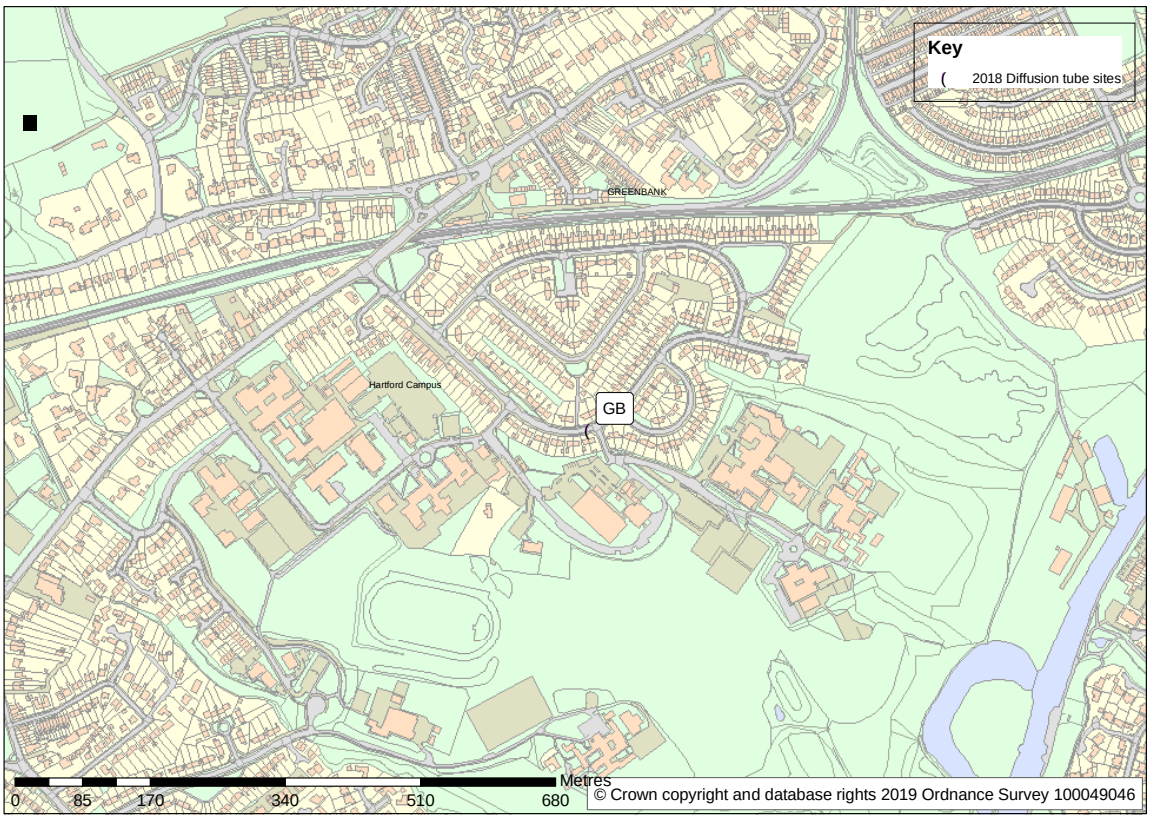


Figure 25 Location of diffusion tube in Lostock

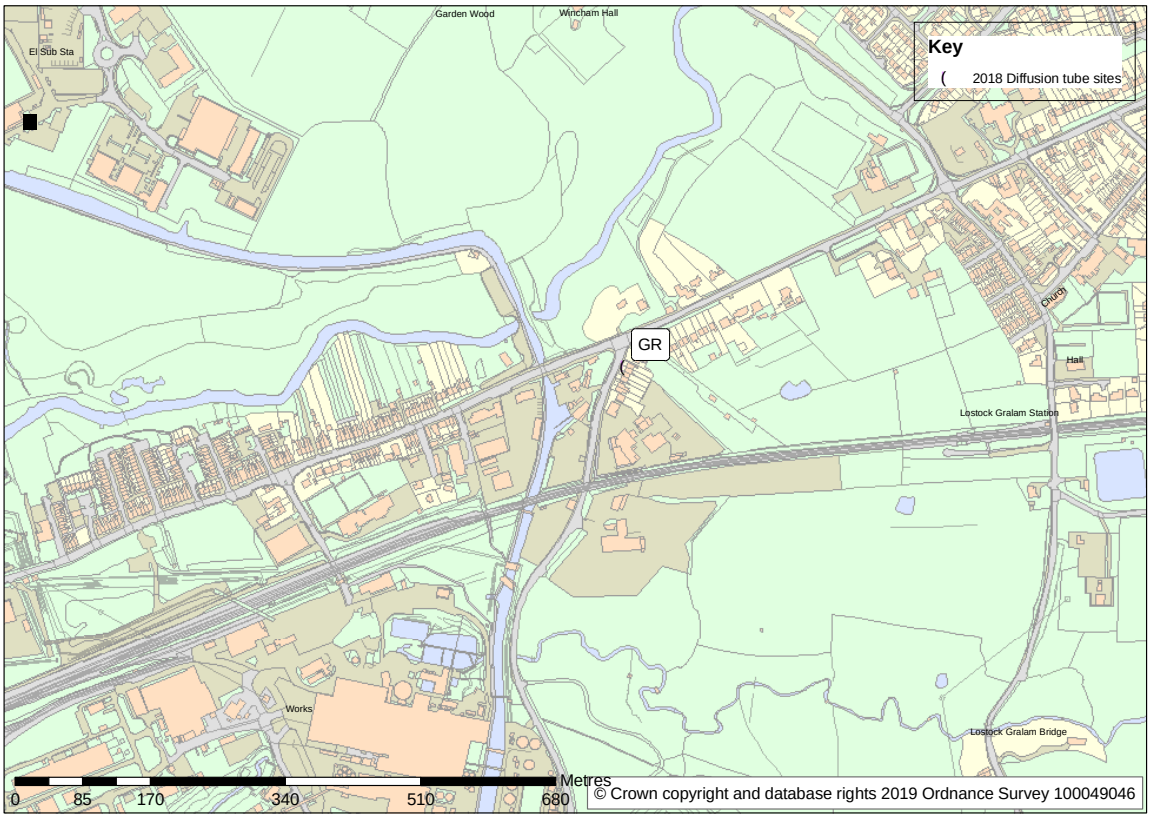


Figure 26 Location of diffusion tubes in Allostock

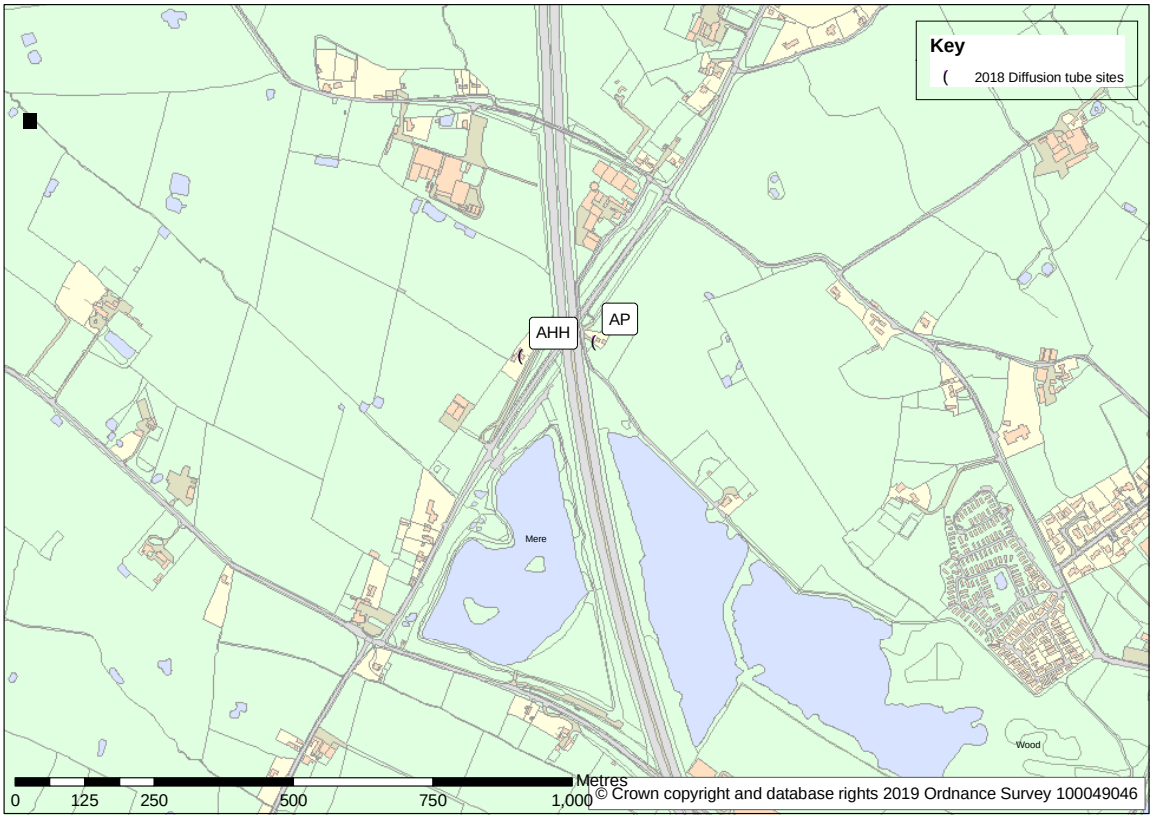


Figure 27 Location of diffusion tube in Delamere

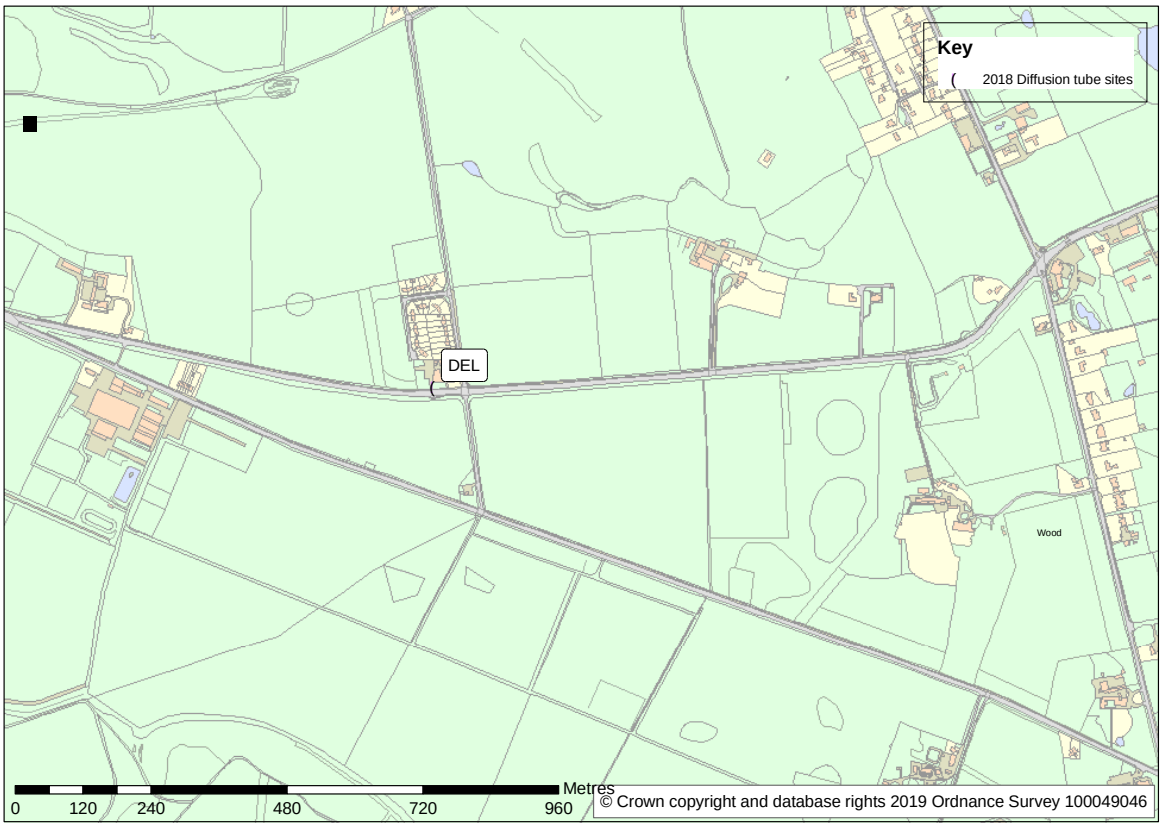


Figure 28 Location of diffusion tube in Duddon

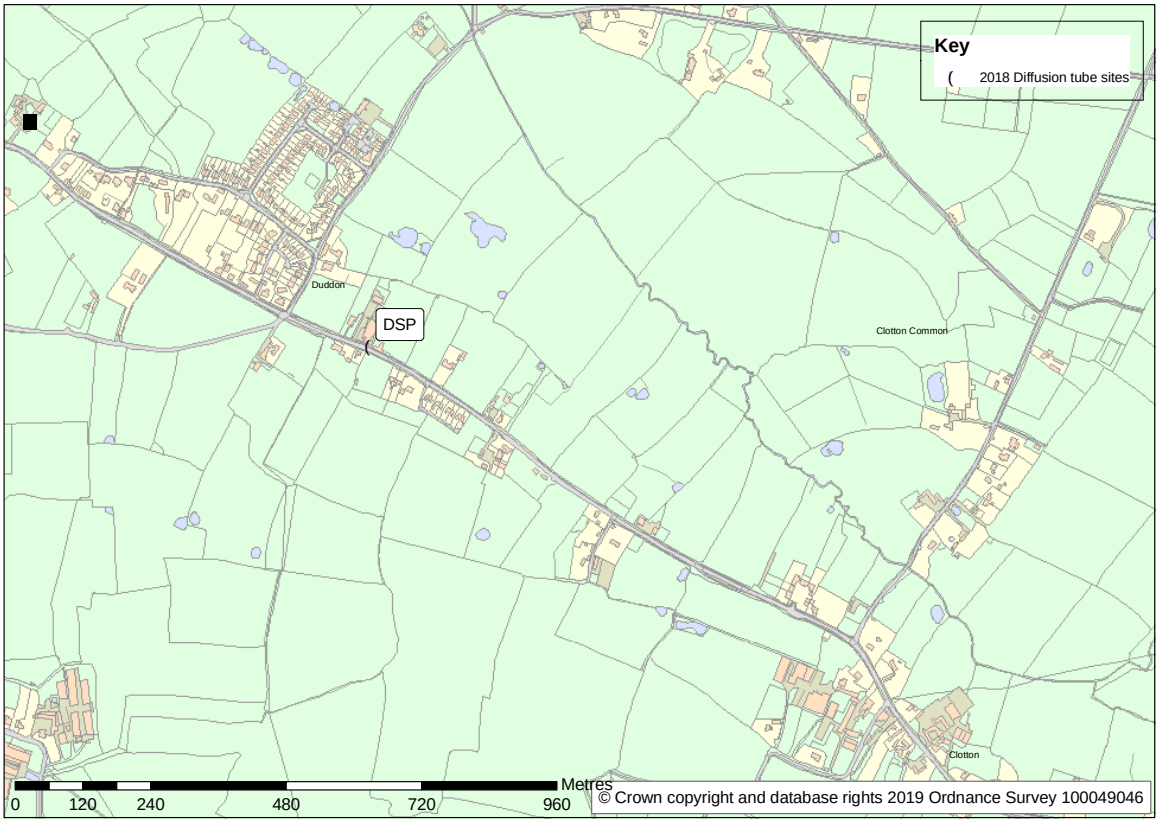
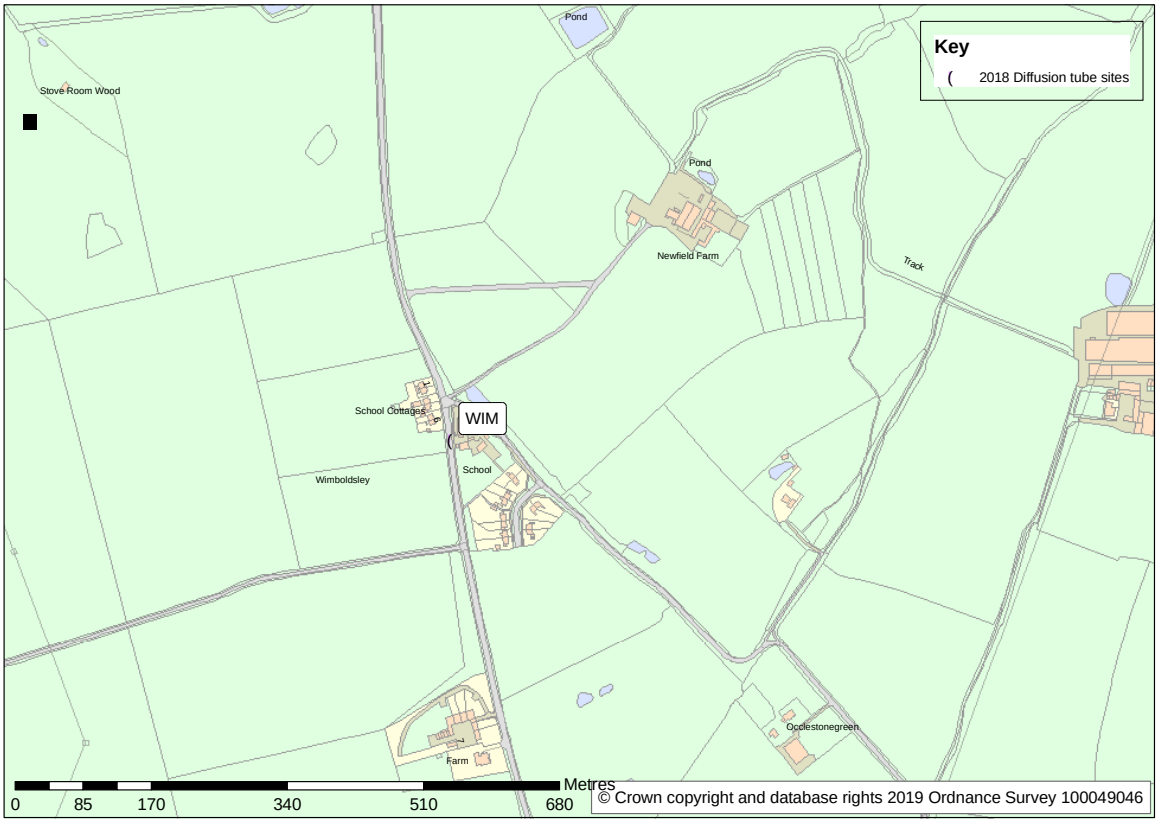


Figure 29 Location of diffusion tube in Wimboldsley



Appendix E: Summary of air quality objectives in England

Table 16 Air quality objectives in England

Pollutant	**Air quality objective[5]**	
	Concentration	**Measured as**
Nitrogen dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean
	40 µg/m^3	Annual mean
Particulate matter (PM_{10})	50 µg/m^3, not to be exceeded more than 35 times a year	24-hour mean
	40 µg/m^3	Annual mean
Sulphur dioxide (SO_2)	350 µg/m^3, not to be exceeded more than 24 times a year	1-hour mean
	125 µg/m^3, not to be exceeded more than 3 times a year	24-hour mean
	266 µg/m^3, not to be exceeded more than 35 times a year	15-minute mean

[5] The units are in micrograms of pollutant per cubic metre of air (µg/m^3).

Appendix F: Inter-site comparisons

Figure 30 Inter-site hourly NO_2 comparisons 2018 (AQDM Ltd.)

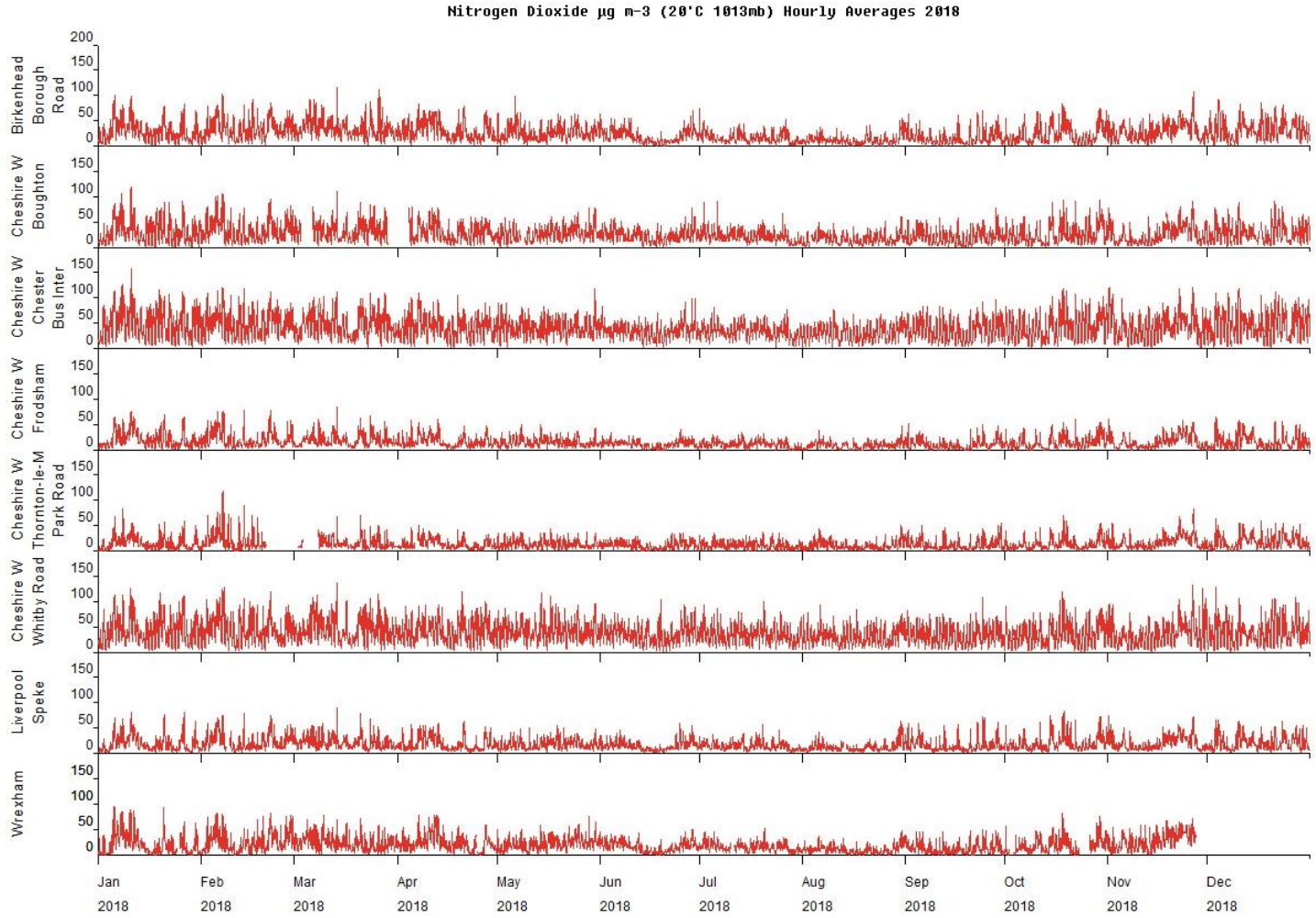


Figure 31 Inter-site daily PM_{10} comparisons 2018 (AQDM Ltd.)

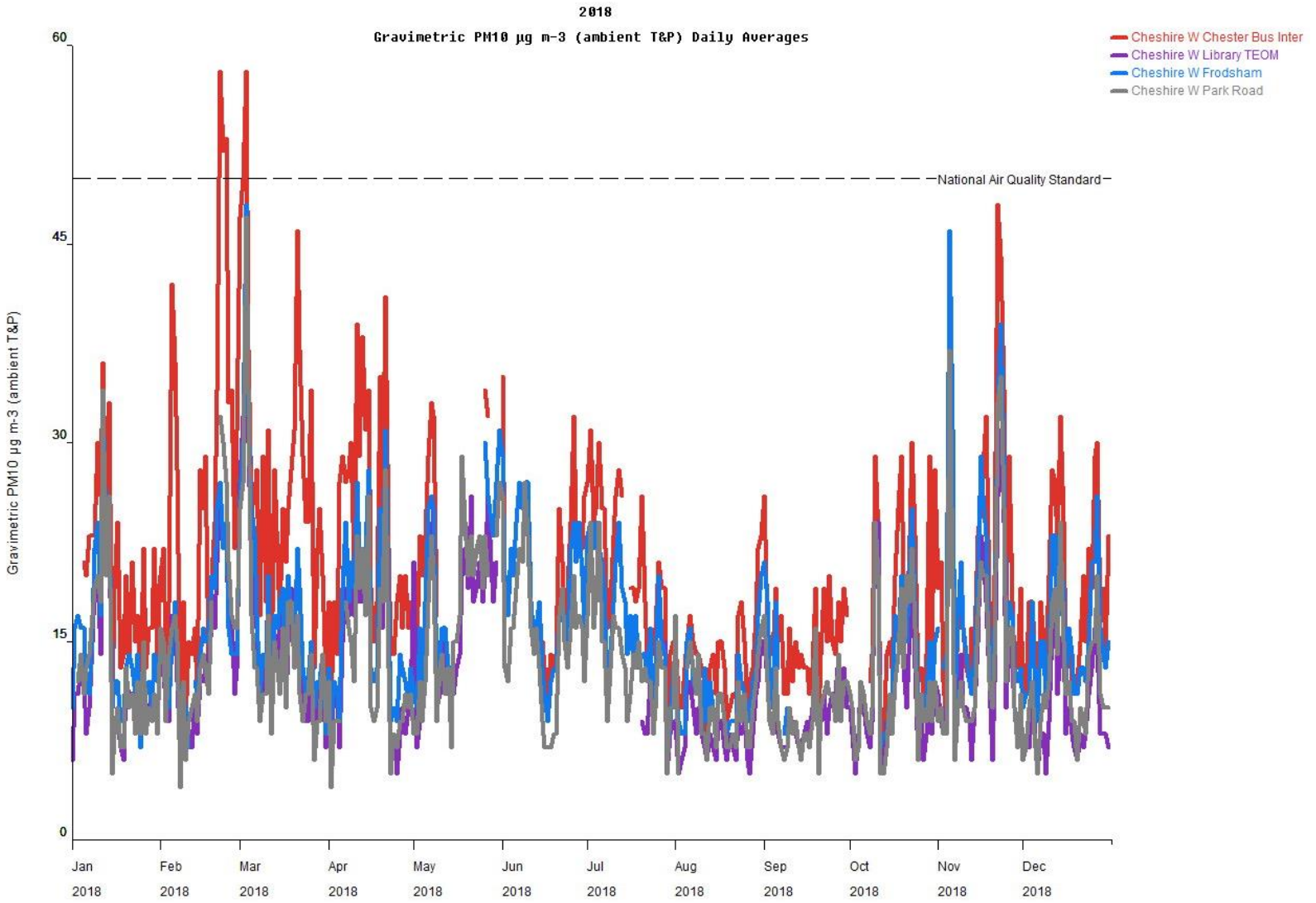
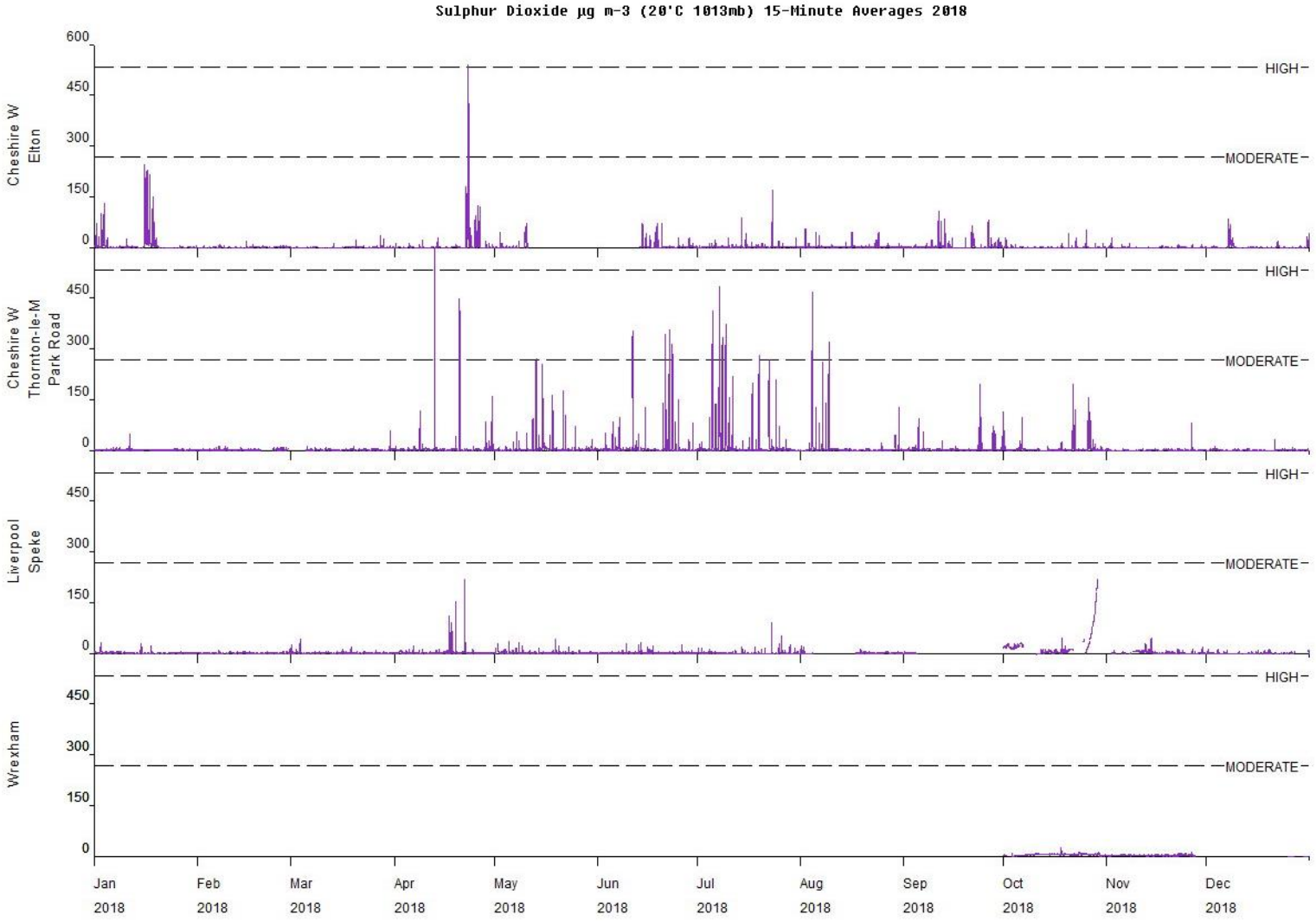


Figure 32 Inter-site 15-minute SO_2 comparisons 2018 (AQDM Ltd.)



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
ASR	Annual status report for air quality
AURN	Automatic urban and rural network
Defra	Department for environment, food and rural affairs
CBTF	Clean bus technology fund
EU	European Union
EV	Electric vehicle
LAQM	Local air quality management
LES	Low emission strategy
NICE	National Institute for Health and Care Excellence
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
PM_{10}	Airborne particulate matter with a diameter of 10µm (micrometres/microns) or less
$PM_{2.5}$	Airborne particulate matter with a diameter of 2.5µm or less
QA/QC	Quality assurance and quality control
SO_2	Sulphur dioxide
TEA	Triethanolamine
$\mu g/m^3$	micrograms per cubic metre

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