Elmbridge
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2020 Air Quality Annual Status Report (ASR)

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

June 2020

Stantec

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Executive Summary: Air Quality in Our Area

The following Annual Status Report (ASR) was prepared and written by Stantec UK Ltd, on behalf of Elmbridge Borough Council in accordance with Local Air Quality Management (LAQM) Technical Guidance (TG) 2016, published by DEFRA on behalf of the devolved administrations. The 2020 ASR provides the latest information regarding air quality in Elmbridge for the reporting year of 2019. It also provides updates on actions to improve air quality that have occurred since the previous 2019 ASR was published.

Air Quality in Elmbridge

This report is designed to provide a summary for those living and working within the Borough of Elmbridge about the state of air quality in the area. It also provides progress on the actions that Elmbridge Borough Council ('the Council') and others, including the public, are taking, or could take, to improve air quality. Air quality and a healthy environment is important to the Council and measures to improve air quality also feature in our Council Plan[1].

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. Additionally, 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[2,3].

In its most recent report, the Committee on the Medical Effects of Air Pollutants (COMEAP) advised that the range of estimates of the annual mortality burden of human-made air pollution in the UK is estimated as an effect equivalent to 28,000 to 36,000 deaths[4]. A conservative estimate for one type of air pollution (particulates) is that it reduces life expectancy in the UK by six months on average, worth £16 billion per year[5].

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[1] Elmbridge Borough Council. Council Plan 2020/2021. 2020.
[2] Environmental equity, air quality, socioeconomic status and respiratory health, 2010
[3] Air quality and social deprivation in the UK: an environmental inequalities analysis, 2006
[4] COMEAP. Associations of long-term average concentration of nitrogen oxide with mortality, 2018.
[5] DEFRA. Abatement cost guidance for valuing changes in air quality, May 2013

The main air pollutants of concern within Elmbridge are nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$). Monitoring in the Borough shows that there are still breaches of the annual mean objective for NO_2, within three of the Council's seven existing Air Quality Management Areas (AQMAs): Weybridge High Street, Esher High Street and Hampton Court, Molesey. A weak decreasing trend in measured concentrations is apparent at most sites from 2015 to 2019. The air quality objectives relevant to LAQM in England are outlined in Appendix E.

Surrey-wide modelling of pollutant concentrations, undertaken by Cambridge Environmental Research Consultants (CERC), provides source apportionment predictions for nitrogen oxides (NO_x: nitric oxide (NO) plus NO_2) in Elmbridge. The largest contributor to NO_x emissions in Elmbridge is road transport sources (48%), with diesel cars (20%) being the largest contributor within the road transport source group.

Actions to Improve Air Quality

The Council works to understand local air quality through an appropriate monitoring network within its administrative boundary. A review of the CERC modelling data, undertaken by Stantec on behalf of the Council in December 2019, was used to highlight any potential new AQMAs and determine where additional air quality monitoring may be required to further investigate any potential exceedances of the objectives. The CERC modelling data review is presented in Appendix I. The identification of any new AQMAs will allow measures to improve air quality to be targeted within these areas.

Measures to improve air quality have been included in the Council's Development Management Plan and air quality is an important consideration for all planning applications, particularly within the Borough's seven Air Quality Management Areas (AQMAs).

The Council continues to fund and promote the airAlert pollution warning service to people living and working in the Borough. As of May 2020, 279 residents in Elmbridge had subscribed to receive airAlerts.

In July 2019, the Council declared a 'Climate Emergency' and have pledged to take action locally to contribute to national carbon neutral targets through the development of policies and practices, with the aim of making Elmbridge carbon neutral by 2030. In the Council's Service Delivery Plan for 2020/2021, a Council key priority is to respond to the climate change emergency and carbon neutral aim. The Council has created a new post within the Environmental Services Team to assist in the delivery of this commitment. There are number of carbon reduction measures proposed which will also benefit air quality, including the installation of electric car charging points in the Borough, refreshing the air quality action plan for cleaner air and encouraging the use of sustainable transport modes.

Surrey Air Alliance Workplan

The Surrey Air Quality Study Group, formed in May 2016, has developed into the Surrey Air Alliance (SAA) made up of officer representatives from all eleven District and Borough Councils, and Surrey County Council's (SCC) Highways and Public Health services.

The Council continues to be an active member of the Surrey Air Alliance (SAA) and assist in the delivery of the SAA workplan. A key workplan task on which the Council has taken the lead on is the Surrey-wide air quality modelling project. The air quality modelling project, undertaken by CERC, was completed in 2019 and establishes a clear baseline for key pollutants (NO_2, PM_{10} and $PM_{2.5}$) across Surrey. The final reports for Surrey and Elmbridge are provided in Appendix F and Appendix G, and the interactive contour maps of modelled pollutant concentrations are hosted on the SCC website:
https://surreycc.maps.arcgis.com/apps/webappviewer/index.html?id=43910ffb100248ed972115b7a9b49d20

The second workplan project Elmbridge is involved in is directed at raising awareness of air quality within schools close to AQMAs. In Spring 2018 the SAA was awarded

£145,188 from the DEFRA Air Quality Grant Fund to undertake an engagement and behaviour change programme with up to 40 schools across Surrey that were within 2km of an AQMA. The aim of the programme was to give school children an increased awareness of the health impacts of poor air quality and, where the AQMA is close to the school, to understand what they could do to improve local air quality and reduce exposure, seeking to change behaviours. The programme was a success and a total of seven schools within Elmbridge have taken part in a range of activities from theatre performances, cycle training, anti-idling campaigns and workshops on monitoring NO_2.

The project was supported by a successful media campaign that included advertising on local radio. Social media posts were viewed 175,827 times, with 83% of residents saying the campaign discouraged them from using the car. An example of one of the posters promoting "scoot to school" is provided below.

The SAA applied to DEFRA for a further £264,819 of funding to support schools across Surrey close to AQMAs to develop School Travel Plans, develop and pilot a new cycle training course for secondary school children and an overarching media campaign. In

March 2020, DEFRA confirmed that the project scored well, and was put before the final panel, but was unsuccessful on this occasion.

The SAA continues to support SCC in delivering anti-idling campaigns at schools and developing the 'Green Boot Challenge', which is an action outstanding from the 2018 DEFRA Grant Fund. SCC already run a 'Golden Boot Challenge' every June as a month-long mode shift challenge to encourage children to travel to school by sustainable transport. Children compete between schools, as well as intra-school between classes for the greatest mode share by walking, cycling, scooting, and park 'n' stride. They also compete for the greatest mode shift change.

The new Green Boot Challenge will pilot an App (iOS and Android compatible) with 20 schools to enable parents to detail the mode of travel and record a journey to enable an emission saving calculation. Those who are unable to use the App will still be able to compete in a hands-up survey in class. It is hoped that the use of the App will increase reach to and awareness for both parents and children about how their actions can improve local air quality.

Encouraging uptake of Electric Vehicles

The Council's Environmental Services Team continues to use three electric pool cars for staff work travel, which are increasingly being used by other parts of the Council. They also utilise the planning regime to increase the provision of electric vehicle charging points within the Borough.

As part of its commitment to make Elmbridge a sustainable place, the Council is considering extending its fleet of electric staff pool cars and the feasibility of introducing electric vehicle charging points in a number of its car parks. As part of an upgrade to Holly Hedge car park in Cobham the OLEV funded rapid charger, now four years old, will be replaced in 2020 with four fast charging points with infrastructure for a further two: a significant increase in charging provision. Similar upgrades to the charging points in Churchfield Car Park, Weybridge and the Civic Centre Car Park, Esher are planned for 2021 and 2022.

In 2019, the Council implemented 'Green Parking' which allows free parking in council-owned car parks for fully electric vehicles. The Council's Parking Enforcement Contractor has also implemented a move towards an electric and hybrid vehicle fleet with the purchase of four electric bikes, two electric cars and a low emissions van.

Conclusions and Priorities

Air quality monitoring has shown a general decrease in NO_2 concentrations across the Borough since 2015. However, further action is still required as exceedances of the annual mean NO_2 objective have been identified at five monitoring locations in 2019. Four of these sites are located within current AQMAs on Weybridge High Street (Weybridge 7), Hampton Court, Molesey (Hampton Court automatic monitor) and Esher High Street AQMA (Esher 7 and Esher 8). One site (Esher 5) is not within any of the existing AQMAs. The Esher 5 monitoring site is located at the Copsem Lane Roundabout, where Copsem Lane adjoins the A3 Esher Bypass (Figure D.7), and is not represenative of relevant exposure.

Concentrations have remained below the annual mean NO_2 objective at monitoring sites in the Hinchley Wood, Walton-on-Thames High Street and Walton Road, Molesey AQMAs since 2015. Furthermore, measured annual mean NO_2 concentrations in the Molesey AQMA were more than 10% below the objective in 2016, 2017 and 2018. In the Hinchley Wood and Walton-on-Thames High Street AQMAs, measured annual mean NO_2 concentrations were more than 10% below the objective in 2017 and 2018. However, due to elevated concentrations in 2019, the Hinchley Wood, Walton-on-Thames High Street and Walton Road, Molesey AQMAs have not been considered for revocation at this time. Monitoring will continue in the AQMAs until there is robust monitoring evidence to support the revocation of the AQMAs (i.e. concentrations have been more than 10% below the objective for a minimum of three consecutive years).

Measured annual mean NO_2 concentrations within the Cobham High Street AQMA (Cobham 1 and Cobham 7) have been more than 10% below the objective for four consecutive years. The decision has therefore been made by the Council to revoke the AQMA. The report prepared by Stantec to support the revocation of the AQMA is provided in Appendix H.

Following the review of CERC modelling data carried out by Stantec, an additional eight diffusion tube monitoring sites were deployed in January 2020, the monitoring results from which will be reported in the 2021 ASR. The technical review of the CERC modelling data is provided in Appendix I. Stantec was also commissioned by the Council to undertake a review of existing diffusion tubes in April 2020 to advise on any sites that should be relocated to a more suitable location. The technical review of existing monitoring sites is provided in Appendix J. Five diffusion tube monitoring sites were relocated in May 2020 as a result of the review, the results from which will be reported in the 2021 ASR.

The areas prioritised for action in 2020/21 are:

- Revocation of the Cobham High Street AQMA.
- Preparation and adoption of the revised AQAP.
- Deployment of new monitoring sites and relocation of number of existing sites to optimise the Council's monitoring network, based upon the review of the CERC modelling data and existing diffusion tube locations.
- Utilising development management control within the Borough's AQMAs to avoid introducing more people to poor air quality or additional sources of pollution.
- Working collaboratively with other Surrey authorities, SCC Public Health Team, Surrey's Clinical Commissioning Groups, SCC Local Highways and Transport Authority, in addition to actively participating in the SAA.
- Promoting air quality, raising awareness and seeking to change behaviours.
- Increasing electric vehicle charging points in Council car parks and exploring further incentives for electric vehicle users.

Local Engagement and How to get Involved

As part of the approach of local engagement we will use messages like the following:

- As the majority of air pollution is associated with traffic, consider alternatives to using your car; public transport, walking or cycling will help reduce emissions.
- When purchasing a new car, consider vehicles with lower exhaust emissions, such as hybrid or electric vehicles. Information on electric car grants is available at www.gov.uk/plug-in-car-van-grants.
- If you are carrying out building works, consider future-proofing your home by installing an electric vehicle charge point. A fast (7kW) charger is recommended and there are grants available which can bring the cost down to under £300. More information can be found at:

  https://www.gov.uk/government/collections/plug-in-vehicle-chargepoint-grants.

- If installing or replacing an existing wood burning stove, consider purchasing one that has been approved for use in smoke control areas by DEFRA or an Eco-design ready stove to help reduce emissions. More information can be found at:

  https://www.elmbridge.gov.uk/pollution/local-air-quality/

- Air pollution can cause short term (acute) and long term (chronic) health problems. The most sensitive groups are adults and young children with respiratory conditions and adults with heart conditions. If you feel that you are in one of the higher risk groups or have particular concerns regarding air quality, you can sign up to our airAlert information service. For more information visit the airAlert website at: http://www.airalert.info/Surrey/Default.aspx.

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1 Local Air Quality Management

This report provides an overview of air quality in Elmbridge during 2019. 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 Elmbridge 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 E.1 in Appendix E. Summary of Air Quality Objectives in England

2 Actions to Improve Air Quality

2.1 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 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 Elmbridge Borough Council (the Council) can be found in Table 2.1. Further information related to declared or revoked AQMAs, including maps of AQMA boundaries are available online at https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98 and shown in Appendix D.

The Public Health Outcomes Framework data tool, compiled by Public Health England, quantifies the proportion of the population living within an AQMA. The tool is available online at:

https://fingertips.phe.org.uk/profile/public-health-outcomes-framework/data#page/0/gid/1000049/pat/6/par/E12000004/ati/202/are/E06000015/cid/4/page-options/ovw-do-0.

The latest data available for 2017 shows that in England, the proportion of the population living within an AQMA is 0.2%, and in Surrey it is 9.7%. There is no data available for the proportion of the population living within an AQMA in Elmbridge.

The Council proposes to revoke the Cobham High Street AQMA as it has been demonstrated by robust monitoring evidence that there are no longer any breaches of the air quality objectives in the AQMA. Furthermore, future vehicle emissions in the AQMA are estimated to decline, which is anticipated to result in a continued improvement in air quality. The report prepared by Stantec, on behalf of the Council, to support the revocation of the AQMA is provided in Appendix H and will be submitted to DEFRA for approval, alongside the 2020 ASR.

Table 2.1 – Declared Air Quality Management Areas

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	City / Town	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance (maximum monitored/modelled concentration at a location of relevant exposure)				Action Plan		
						At Declaration		Now		Name	Date of Publication	Link
Walton-on-Thames High Street	01/11/2013	NO_2 Annual Mean	Walton-on-Thames	An area encompassing part of the High Street, Walton-on-Thames, between its junction with Hepworth Way/Church Street and Ashley Road/Herhsam Road	YES	42.3	µg/m³	37	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98
Weybridge High Street	17/11/2008	NO_2 Annual Mean	Weybridge	An area encompassing Balfour Road, Church Street, High Street and Monument Hill, Weybridge.	YES	62	µg/m³	45.6	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98
Hampton Court	17/11/2008	NO_2 Annual Mean	Molesey	An area encompassing parts of Hampton Court Way and Riverbank.	NO	50.7	µg/m³	41	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	City / Town	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance (maximum monitored/modelled concentration at a location of relevant exposure)				Action Plan		
						At Declaration		Now		Name	Date of Publication	Link
Cobham High Street	17/11/2008	NO_2 Annual Mean	Cobham	An Area along the High Street, Cobham,	YES	39.5	µg/m³	33.6	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98
Hinchley Wood	17/11/2008	NO_2 Annual Mean	Hinchley Wood	An area encompassing part of the A309 Kingston Bypass between Littleworth Road and Manor Road North.	YES	57.7	µg/m³	37.4	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98
Esher High Street	17/06/2005	NO_2 Annual Mean	Esher	An area extending along the High Street, Church Street and including parts of Esher Green and Lammas Lane.	YES	62.1	µg/m³	46	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98

AQMA Name	Date of Declaration	Pollutants and Air Quality Objectives	City / Town	One Line Description	Is air quality in the AQMA influenced by roads controlled by Highways England?	Level of Exceedance (maximum monitored/modelled concentration at a location of relevant exposure)				Action Plan		
						At Declaration		Now		Name	Date of Publication	Link
Walton Road, Molesey	17/06/2005	NO_2 Annual Mean	Molesey	An area extending 50m either side of the centre line of Walton Road, Molesey between its junction with Tonbridge Road and Esher Road/Bridge Road.	NO	55.8	µg/m³	39.2	µg/m³	Air Quality Action Plan for Elmbridge Borough Council 2011	2011	https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=98

☒ **Elmbridge Borough Council confirm the information on UK-Air regarding their AQMAs is up to date**

2.2 Progress and Impact of Measures to address Air Quality in Elmbridge

DEFRA's appraisal of the 2019 ASR states that the ASR is well structured, detailed and provides the information specified in the Guidance[6]. The following recommendations were made:

- Annual mean NO_2 concentrations have been consistently 10% below the objective in the Cobham and Molesey AQMAs for three years now. The Surrey-wide modelling of pollutants undertaken could be used to inform the detailed assessment of these AQMAs.
- Adoption of a revised Air Quality Action Plan is expected during the next reporting year. This is encouraged as the most recent Air Quality Action Plan was published in 2011 and is now out of date.

The 2020 ASR has addressed these comments in the following ways:

- Due to elevated annual mean NO_2 concentrations (within 10% of the objective) in 2019 in the Molesey AQMA, the AQMA has not been considered for revocation at this time and a detailed assessment has therefore not been undertaken. Monitoring will continue in the AQMA until there is robust monitoring evidence to support its revocation (i.e. concentrations have been more than 10% below the objective for a minimum of three consecutive years).
- The Surrey-wide modelling of pollutants has been used to support the revocation of the Cobham AQMA. The Revocation Report is provided in Appendix H.
- Preparation of the revised Air Quality Action Plan is underway and is expected to be completed by December 2020.

The Council has taken forward a number of direct measures during the current reporting year of 2019 in pursuit of improving local air quality. Details of all measures completed, in progress or planned are set out in Table 2.2. Key completed measures are:

[6] Department for Environment, Food and Rural Affairs (Defra), 2016. Local Air Quality Management Technical Guidance (LAQM.TG16). Available at: http://laqm.defra.gov.uk/supporting-guidance.html

- Assisting in delivery of the SAA workplan and leading on the Surrey-wide modelling project for key pollutants.
- Modelling of target pollutant levels carried out as part of a Surrey-wide exercise (NO_2, PM_{10} and $PM_{2.5}$).
- Using the results of the Surrey-wide modelling project to review existing AQMA's and explore the need to declare any new AQMA's, as well as to review the Council's existing diffusion tube monitoring network.
- Declaration of a 'Climate Emergency' in Elmbridge with a number of actions which are beneficial to air quality.
- Free parking for fully electric vehicles introduced in council pay and display car parks.
- Continued support of the successful engagement and behaviour change programme in Surrey schools.
- Continued funding and promotion of the AirAlert pollution warning service.

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

- Adoption of a revised Air Quality Action Plan.
- Deployment of additional and relocated diffusion tube monitoring locations.
- Upgrades to the electric vehicle charging points in Holly Hedge Car Park, Cobham to provide four fast charging points with infrastructure for two further charging points. Similar upgrades at Churchfield Car Park, Weybridge and the car park at the Civic Centre, Esher will then follow.
- Implementation of the Surrey Climate Change Strategy. This includes actions targeted specifically at transport and air quality.
- Through the SAA, supporting the delivery of SCC's anti-idling campaign at schools and Green Boot Challenge which aims to promote the use of sustainable travel modes.

The Council's priorities for the coming year are:

- preparation and adoption of the revised Air Quality Action Plan;

- revocation of the Cobham High Street AQMA;
- responding to the 'Climate Emergency', included as a priority in the Council Plan 2020/2021[1];
- installation of more electric vehicle charging points in the Borough; and
- supporting the development of the new Local Plan to ensure policies relating to air quality are considered.

The principal challenges and barriers to implementation that the Council anticipates facing in the next reporting year are those associated with COVID-19. In particular, monitoring results for 2020 are likely to be impacted due to the implementation of lockdown measures, and as result measurements may not be considered representative of usual conditions due to significantly decreased traffic.

Experiences and learning through this period may provide opportunities for improvements in local air quality for example modal shift due to increased home working.

The application from the SAA to DEFRA for £264,819 funding to support the development of School Travel Plans, a new cycle training course for secondary school children and an overarching air quality media campaign was unsuccessful. This will therefore be a barrier to the implementation of these measures over the coming year.

Table 2.2 – Progress on Measures to Improve Air Quality

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
1	Produce updated Elmbridge AQAP, compatible with the Local Plan and Development Management Plan.	Policy Guidance and Development Control	Air Quality Planning and Policy Guidance		EBC	EBC funding	Development control consultation on AQAP	Reduction in vehicle emissions	Work commissioned and preparation of the AQAP is underway.	December 2020	Delayed due to staff changes and policy direction. Now due for completion in December 2020.
2	Member of Surrey Air Alliance (SAA) and contributor to the Work Plan	Policy Guidance and Development Control	Regional Groups Co-ordinating programmes to develop Area-wide Strategies to reduce emissions and improve air quality	2016	SAA		Adoption of Work Plan		Constitution adopted and workplan produced. Regular meetings held.	Ongoing	Progress on the rolling Work Plan is dependent on resources.
3	Climate Change Strategy for Surrey	Policy Guidance and Development Control	Low Emissions Strategy		Lead: Surrey County Council	SCC funding		Reduction in vehicle and energy generation emissions	Completed	Adopted in April 2020	Strategy has been considered by 11 Districts and Boroughs. EBC actions to be considered and agreed Autumn 2020
4	Low Emission Transport Strategy for Surrey	Policy Guidance and Development Control	Low Emissions Strategy		Lead: Surrey County Council	SCC funding	Suite of indicators associated with quantum and distribution of air pollution, travel behaviour and delivery of infrastructure for low emission transport options.	Reduction in vehicle emissions	Completed, in use	2018	Those action plans that result from this strategy will necessarily be constrained by funding. In particular, revenue funding constraints will limit what can be achieved with regards travel behaviour and monitoring activities.
5	Support through the SAA, an electric vehicle strategy for Surrey.	Promoting Low Emission Transport	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, gas fuel recharging.		SAA	SCC funding	SCC draft strategy	Reduction in vehicle emissions	Electric Vehicle Strategy produced and adopted by Elmbridge Borough Council	On going implementation	2020 piloting study for on street charging in 4 Surrey authorities.
6	Brooklands Business Park Accessibility Project	Transport Planning and Infrastructure	Other		Lead: Surrey County Council.	Enterprise M3 Local Enterprise Partnership and others	No. of journeys made on foot, by bike and by bus in the Brooklands and Weybridge areas	Reduced and avoided vehicle emissions, from modal shift.	Detailed design and procurement work underway	2021	

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
7	School Air Quality Programme	Public Information	Other		Lead: Surrey Air Alliance	DEFRA grant	No. children reached by promotional / engagement activities.	Reduced vehicle emissions, from modal shift	All elements delivered or in delivery; will complete at close of academic year	Ongoing	Application for 2020 DEFRA funding unsuccessful.
8	Maintain the EV charger in council Cobham car park	Promoting Low Emission Transport	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging		EBC	EBC funding	Charger accessed >30 times a month	Reduction in vehicle emissions	Charger fees reduced Sept 2017.	Ongoing	As part of an upgrade to council, car parks this charger will be replaced with four fast charging points in 2020, with infrastructure in place for a further two.
9	Council Electric vehicles for journeys within the Borough	Promoting Low Emission Transport	Public Vehicle Procurement - Prioritising uptake of low emission vehicles		EBC	EBC funding	Usage of >1900 miles/month to be cost effective	Reduction in vehicle emissions	Jan to Dec 2019 usage 16,497 miles (1,375 average miles per month)	Ongoing	Current plan (2019/20) to increase electric lease cars from 3 to 7 staff. Parking Enforcement contactor moving to electric and low emissions fleet 2020.
10	Install electric vehicle charging points in at least two main town car parks	Promoting Low Emission Transport	Procuring alternative Refuelling infrastructure to promote Low Emission Vehicles, EV recharging, Gas fuel recharging		EBC	EBC funding	Charging points installed	Reduction in vehicle emissions		2022	Churchfield Car Park, Weybridge and Civic Centre, Esher planned for upgrades in 2021 and 2022.
11	Surrey-wide modelling for key pollutants through the SAA.	Policy Guidance and Development Control	Air Quality Planning and Policy Guidance		SAA	DEFRA grant	Modelling completed and final reports produced		Modelling completed and final reports issued by CERC	2019	Data used to inform review of diffusion tube locations across the Borough.
12	Produce Surrey-wide guidance for Private Hire Vehicles and Taxi Licensing policy to encourage lower emission vehicles.	Promoting Low Emission Transport	Taxi Licensing conditions		SAA		Adoption of policy	Reduction in vehicle emissions	Guidance provided for consistent licensing approach	No agreed date	2018 moved on to SAA work plan. See below EBC position on a Council scheme.
13	Use of a tiered fee structure for taxi licensing to benefit operators with lower	Promoting Low Emission Transport	Taxi emission incentives		EBC	EBC funding	Possible Inclusion in Hackney carriage and private hire licensing policy	Reduction in vehicle emissions	Policy review phase	2020	Taxi policy under review. Consultation concluded. Currently in progress.

Measure No.	Measure	EU Category	EU Classification	Date Measure Introduced	Organisations involved	Funding Source	Key Performance Indicator	Reduction in Pollutant / Emission from Measure	Progress to Date	Estimated / Actual Completion Date	Comments / Barriers to implementation
	emission vehicles										
14	Workplace Travel Plans	Promoting Travel Alternatives	Workplace Travel Planning		Lead: Planning applicants; monitoring reports audited by Surrey County Council	Planning applicants	Mode share of single occupancy vehicle trips	Reduced and avoided vehicle emissions, from modal shift	Ongoing	N/A	Surrey County Council works to proactively influence behavioural change.
15	Green Parking - free parking for fully electric vehicles in council car parks	Promoting Low Emission Transport	Priority parking for LEVs		EBC	EBC funding		Reduction in vehicle emissions		Ongoing	All electric vehicles free to park in Council car parks
16	Use of the EBC website to promote public awareness of the Elmbridge AQMAs and air quality in general.	Public Information	Via the Internet		SCC and Surrey Local Authorities		Latest ASR available on website		Standard information compiled by the SAA	Completed. Together with on-going updating.	Completed Summer 2018, ongoing updating required. Love Elmbridge Campaign includes air quality advice and bespoke animation.
17	Staff and fleet transport emissions as part of the Councils Carbon Reduction Strategy	Promoting Carbon reduction	Sustainability	2020	SCC and Local Authorities	EBC funding	Latest carbon reduction action plan updates	Reduction in Carbon Emissions	Initial assessment of emissions completed	Action Plan Autumn 2020	Action plan to reduce carbon to be considered by EBC Autumn 2020

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 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.

The modelling exercise undertaken by CERC quantifies the mortality burden of $PM_{2.5}$, in terms of fraction of deaths attributable to $PM_{2.5}$ pollution, associated total life years lost[7] and economic cost within Elmbridge, and the wider-Surrey area. The Surrey-wide CERC report, provided in Appendix F, details the results on a Surrey-wide and Surrey local authority basis, as well as technical information regarding the methodology for modelling and mortality burden calculations. The estimated total number of deaths attributable to $PM_{2.5}$ pollution in Surrey in 2017 was between 173 – 468, which equated to an estimated economic cost between £87,235,665 – £235,790,256[8]. In Elmbridge, the estimated total number of deaths attributable to $PM_{2.5}$ pollution in 2017 was between 19 - 51, which equated to an estimated economic cost between £9,828,813 – £29,869,995[8].

The CERC modelling report for Elmbridge Borough Council is provided in Appendix G and presents the results of the morality burden calculations for each of the Elmbridge wards.

The CERC modelling reports also contain contour maps for predicted pollutant concentrations across Surrey and Elmbridge in 2017. These maps are also available in an interactive format at the following website:

https://surreycc.maps.arcgis.com/apps/webappviewer/index.html?id=43910ffb100248ed972115b7a9b49d20

The contour map for predicted annual mean $PM_{2.5}$ concentrations in 2017 shows no exceedances of the annual mean $PM_{2.5}$ objective (25 µg/m^3) in Elmbridge.

However, given the implementation of the Technical Guidance LAQM.TG16 and Policy Guidance LAQM.PG16, the Council is working towards defining a strategy to reduce

[7] The years of life lost to the population due to increased mortality risk attributable to long-term exposure to particulate air pollution.
[8] CERC. Detailed Air Quality Modelling and Source Apportionment. Final Report prepared for Surrey Local Authorities. August 2019.

emissions or concentrations of $PM_{2.5}$. Existing measures to improve air quality already in place can help reduce levels of $PM_{2.5}$, such as:

- $PM_{2.5}$ dispersion modelling, funded by the Council, has been carried out to gain a better understanding of the current situation;
- promoting approved wood-burning stoves and burning of approved products.
- encouraging residents to refrain from garden bonfires;
- promoting travel alternatives;
- promoting low emission transport;
- implementing Surrey's Climate Change Strategy (April 2020) which includes measures targeted at reducing vehicle emissions; and
- implementing Surrey County Council's Low Emissions Transport Strategy (2018).

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 in 2019 and how it compares with the objectives outlined in Appendix E.

3.1.1 Automatic Monitoring Sites

The Council undertook automatic (continuous) monitoring at three sites during 2019, Weybridge High Street 1 and 2, and Hampton Court Parade. Table A.1 in Appendix A shows the details of the sites and their locations are shown in Figure D.1.

The Weybridge High Street 2 site was deployed in September 2019 and will replace the Weybridge High Street 1 site which was decommissioned in January 2020. The Weybridge High Street 2 site is a completely new monitoring station installed following a move as part of a High Street redevelopment. In addition, a new analyser was installed at the Hampton Court Parade site in 2019.

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 45 sites during 2019. In 2019, new diffusion tubes were installed to carry out co-location studies with the new Weybridge High Street 2 automatic monitoring site (Weybridge 13-15). In addition, monitoring at Oxshott 1 and 2, along the A244 High Street in Oxshott, began in November 2019 due to concerns raised by members of the public in relation to potential air quality issues in the area. Triplicate diffusion tubes are co-located with the Hampton Court Parade and the two Weybridge High Street automatic monitors. Table A.2 in Appendix A provides the details of the sites and their locations are shown in Figure D.2.

Further details on Quality Assurance/Quality Control (QA/QC) for the diffusion tubes, including bias adjustments and any other adjustments applied (e.g. “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[9], "annualisation" (where the data capture falls below 75%), and distance correction[10]. Further details on adjustments are provided in Appendix C.

3.2.1 Nitrogen Dioxide (NO_2)

Table A.3 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 that the concentration data presented in Table A.3 represents the concentration at the location of the monitoring site, following the application of bias adjustment and annualisation, as required (i.e. the values are exclusive of any consideration to fall-off with distance adjustment).

Table A.4 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.

For diffusion tubes, the full 2019 dataset of monthly mean values is provided in Appendix B. Note that the concentration data presented in Table B.1 includes distance corrected values, only where relevant.

Automatic Monitoring

During 2019, the Council undertook automatic monitoring of NO_2 concentrations at Weybridge High Street 1 and 2 and Hampton Court Parade, within the Weybridge High Street and Hampton Court AQMAs. Annual mean NO_2 concentrations at both automatic monitoring sites on Weybridge High Street met the objective. The measured annual mean concentration at Hampton Court Parade was 41 µg/m^3 and therefore exceeded the objective of 40 µg/m^3. NO_2 concentrations at Weybridge High Street 1 reduced in 2019 compared to previous years, whilst a slight increase occurred at Hampton Court Parade. Data capture during 2019 was good (>90%) at Weybridge High Street 1 and Hampton Court Parade. As monitoring began in September 2019 at Weybridge High Street 2, the data capture during 2019 was 32% and the data has therefore been annualised.

[9] https://laqm.defra.gov.uk/bias-adjustment-factors/bias-adjustment.html
[10] Fall-off with distance correction criteria is provided in paragraph 7.77, LAQM.TG(16)

There were no measured exceedances of the hourly mean NO_2 objective of 200 µg/m^3 at the Weybridge High Street 1 and 2 or Hampton Court Parade monitoring sites. Due to low annual data capture at the Weybridge High Street 2 monitoring site, the 99.8th percentile of hourly mean concentrations has been calculated. The 99.8th percentile of hourly mean concentrations at Weybridge High Street 2 is below the hourly mean objective.

Non-Automatic Monitoring

For diffusion tubes, the full 2019 dataset of monthly mean values is provided in Table B.1, in Appendix B.

In 2019, exceedances of the annual mean NO_2 objective were measured at the Esher 5, Esher 7, Esher 8 and Weybridge 7 monitoring sites. Esher 7 and Esher 8 are both located within the Esher High Street AQMA (shown in Figure D.7), whilst Weybridge 7 is located in the Weybridge High Street AQMA. Esher 5 recorded the highest NO_2 concentration in 2019 (48.1 µg/m^3) and is located outside the Esher AQMA at the Copsem Lane Roundabout, where Copsem Lane adjoins the A3 Esher Bypass (Figure D.7). However, this monitoring site is not considered to be representative of relevant exposure as the closest residential properties are located more than 100 m away.

Distance correction has been carried out in order to estimate concentrations at the nearest locations of relevant exposure in the vicinity of Esher 7, Esher 8 and Weybridge 7 monitoring sites. Once distance corrected, exceedances of the annual mean objective remain at the nearest locations of relevant exposure to Esher 8 (42.1 µg/m^3) and Weybridge 7 (45.2 µg/m^3), whilst concentrations are below the objective (36.9 µg/m^3) at the nearest location of relevant exposure to Esher 7.

During 2019, there were no measured concentrations greater than 60 µg/m^3, and therefore it is considered unlikely that the hourly mean objective is exceeded at monitoring locations within the Borough.

In 2019, NO_2 concentrations worsened at 33 sites, and improved or remained stable at 8 sites in Elmbridge when compared with 2018 concentrations. Data trends for all current sites for the past five years are provided in Appendix A, Figures A.1 – A.7. Overall, between 2015 and 2019, concentrations have fluctuated, however a general decrease in concentrations is evident across the majority of sites since 2015.

Measured annual mean NO_2 concentrations within the Cobham High Street AQMA (Cobham 1 and Cobham 7) have been more than 10% below the objective for four consecutive years. The decision has therefore been made by the Council to revoke the AQMA and evidence to support the revocation of the AQMA will be submitted to DEFRA for approval (Appendix H).

Concentrations have also remained below the objective at monitoring sites in the Hinchley Wood, Walton-on-Thames High Street and Walton Road, Molesey AQMAs since 2015. Measured annual mean NO_2 concentrations in the Molesey AQMA were more than 10% below the objective in 2016, 2017 and 2018. In the Hinchley Wood and Walton-on-Thames High Street AQMAs, measured annual mean NO_2 concentrations were more than 10% below the objective in 2017 and 2018. However, due to elevated concentrations in 2019, the Hinchley Wood, Walton-on-Thames High Street and Walton Road, Molesey AQMAs have not been considered for revocation at this time. Monitoring will continue in the AQMAs until it can be demonstrated that concentrations have been more than 10% below the objective for a minimum of three consecutive years.

3.2.2 Particulate Matter (PM_{10})

PM_{10} monitoring is not required and therefore is not currently carried out by Elmbridge Borough Council. However PM_{10} has been included within the modelling exercise undertaken by CERC. The CERC modelling report for Elmbridge is provided in Appendix G and interactive contour maps of predicted pollutant concentrations can be accessed via the following link:

https://surreycc.maps.arcgis.com/apps/webappviewer/index.html?id=43910ffb100248ed972115b7a9b49d20

The contour map for the predicted annual mean PM_{10} concentrations in 2017 shows no exceedances of the annual mean PM_{10} objective (40 µg/m^3) in Elmbridge. The contour map for the 90.41st percentile of 24-hour mean PM_{10} concentrations shows exceedances of the 24-hour mean concentration (50 µg/m^3) along the A3 Portsmouth Road and the M25. However, these exceedances occur within the road and are therefore not representative of relevant exposure.

3.2.3 Particulate Matter ($PM_{2.5}$)

$PM_{2.5}$ monitoring is not required and therefore is not currently carried out by Elmbridge Borough Council. However, $PM_{2.5}$ has been included within the modelling exercise undertaken by CERC. The CERC modelling report for Elmbridge is provided in Appendix G and interactive contour maps of predicted pollutant concentrations can be accessed via the following link:

https://surreycc.maps.arcgis.com/apps/webappviewer/index.html?id=43910ffb100248ed972115b7a9b49d20

The contour map for the predicted annual mean $PM_{2.5}$ concentrations in 2017 shows no exceedances of the annual mean $PM_{2.5}$ objective (25 µg/m^3) in Elmbridge.

3.2.4 Sulphur Dioxide (SO_2)

Monitoring of SO_2 is not required and is therefore not currently carried out by Elmbridge Borough Council.

Glossary of Terms

Abbreviation	Description
AQAP	Air Quality Action Plan - A detailed description of measures, outcomes, achievement dates and implementation methods, showing how the local authority 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	Air quality Annual Status Report
CERC	Cambridge Environmental Research Consultants
DEFRA	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges – Air quality screening tool produced by Highways England
EU	European Union
LAQM	Local Air Quality Management
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Airborne particulate matter with an aerodynamic diameter of 10µm (micrometres or microns) or less
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of 2.5µm or less
QA/QC	Quality Assurance and Quality Control
SAA	Surrey Air Quality Alliance
SCC	Surrey County Council
SO_2	Sulphur Dioxide
The Council	Elmbridge Borough Council
TEA	Triethanolamine

References

Department for Environment, Food and Rural Affairs (Defra), 2016. Local Air Quality Management Technical Guidance (LAQM.TG16). Available at: http://laqm.defra.gov.uk/supporting-guidance.html

Department for Environment, Food and Rural Affairs (Defra), 2016. Local Air Quality Management Policy Guidance (LAQM PG16). Available at:

http://laqm.defra.gov.uk/supporting-guidance.html

Department for Environment, Food and Rural Affairs (Defra), 2007. Air Quality Strategy for England, Scotland Wales and Northern Ireland, 2007.

Elmbridge Borough Council, 2019. 2019 Air Quality Annual Status Report (ASR). Available at: http://www.elmbridge.gov.uk/pollution/local-air-quality/

Spreadsheet of Diffusion Tube Bias Adjustment Factors, version 03/20. Available at: https://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html

Appendix A: Monitoring Results

Table A.1 - Details of Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Pollutants Monitored	In AQMA?	Monitoring Technique	Distance to Relevant Exposure (m) (1)	Distance to kerb of nearest road (m) (2)	Inlet Height (m)
Weybridge High Street 1	Weybridge High Street 1	Kerbside	507478	164924	NO_2	YES	Chemiluminescence	6.5	0.6	1.7
Weybridge High Street 2	Weybridge High Street 2	Kerbside	507459	164909	NO_2	YES	Chemiluminescence	6.5	0.7	1.8
Hampton Court Parade	Hampton Court Parade	Roadside	515338	168292	NO_2	YES	Chemiluminescence	10	1.9	1.6

Table A.2 – Details of Non-Automatic Monitoring Sites

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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)
Esher										
Esher 1	Church Street, Esher outside Cuvee	Roadside	513840	164693	NO_2	YES	0.4	1.5	NO	2.6
Esher 4	1 Portsmouth Road, Esher Bus Bay/toilet	Roadside	514058	164855	NO_2	NO	41.3	2	NO	2.4
Esher 5	Roundabout, Copsem Lane/A3	Roadside	514150	162470	NO_2	NO	124	1.4	NO	2.4
Esher 7	Outside Blink, 35-37 High Street, Esher	Roadside	513982	164750	NO_2	YES	2.3	0.5	NO	2.1
Esher 8	Outside 9 Church St	Roadside	513832	164684	NO_2	YES	0.1	3	NO	2
Esher 9	Lamp post next to Churchyard, Church St	Kerbside	513821	164712	NO_2	YES	12.5	0.5	NO	2.4
Esher 10	Traffic Sign, outside 15 Esher Green	Roadside	513886	164767	NO_2	YES	4.3	2	NO	2.4
Esher 11	The Bear, 71 High St, Esher	Roadside	518395	164599	NO_2	YES	1.6	1	NO	2.2
Esher 13	Lampost outside Panahar Tandoori, 124-126 High Street	Kerbside	513736	164489	NO_2	YES	2.7	0.7	NO	2.3

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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)
Hinchley Wood										
Hinchley Wood 1	2 Portsmouth Road, Kingston Bypass opp. Fire Station	Roadside	515248	165535	NO_2	YES	20.8	4.5	NO	2.4
Hinchley Wood 2	Lamp post outside front gate, Brooklands, Westmont Road, KT10 9BE	Roadside	515218	165578	NO_2	YES	3.5	9.8	NO	1.7
Molesey										
Molesey 1	Outside 113 Walton Rd.	Kerbside	514450	168134	NO_2	YES	3.5	1.2	NO	2.3
Molesey 8	44-46 Walton Rd	Roadside	514716	167960	NO_2	YES	0.1	2.5	NO	2.4
Molesey 9	Outside Tesco,114-118 Walton Road	Roadside	514507	168086	NO_2	YES	4.2	2.3	NO	2.1
Molesey 10	Molesey Mart 264 Walton Road	Roadside	514169	168152	NO_2	YES	0.1	4.9	NO	2.3
Hampton Court										
Hampton Court 1	Lampost outside Yew Tree Croft, Hampton Ct Wa, North of Summer Road, (Bus Layby)	Kerbside	515379	167946	NO_2	YES	20.9	0.5	NO	2.4

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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)
Hampton Court 2	Air Quality Station, opposite Hampton Court Station, Hampton Court Way	Roadside	515338	168292	NO_2	YES	10	1.9	YES	1.6
Hampton Court 3	Air Quality Station, opposite Hampton Court Station, Hampton Court Way	Roadside	515338	168292	NO_2	YES	10	1.9	YES	1.6
Hampton Court 4	Air Quality Station, opposite Hampton Court Station, Hampton Court Way	Roadside	515338	168292	NO_2	YES	10	1.9	YES	1.6
Hampton Court 5	Traffic Sign, 1 Creek Road	Kerbside	515329	168390	NO_2	YES	13.7	0.4	NO	2.3
Walton-on-Thames										
Walton 3A	Outside Walton Village Pub, High Street, Walton	Kerbside	510140	166328	NO_2	YES	2.7	0.5	NO	2.4
Walton 5	Hersham Road, Walton J/O Adelaide Road, opp 67	Kerbside	510702	165471	NO_2	NO	17.1	0.9	NO	2.3
Walton 8	Leaders, 46 High St	Roadside	510154	166281	NO_2	YES	2	2.9	NO	2.3

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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)
Walton 9	Traffic Sign, Café Nero, 18 High St	Roadside	510082	166379	NO_2	YES	2.2	2.2	NO	2.3
Walton 10	Outside 34 Church Street, Walton	Roadside	510140	166522	NO_2	YES	2	3.3	NO	2.6
Walton 11	Lampost opposite Flour Cafe, The Heart, Hepworth Way	Roadside	510000	166401	NO_2	NO	21	3	NO	2.4
Weybridge										
Weybridge 1	Outside 32/34 High St,	Kerbside	507448	164900	NO_2	YES	3.8	1	NO	2.3
Weybridge 4	Right of 6 Monument Hill	Roadside	507705	164907	NO_2	YES	5	2	NO	2.3
Weybridge 5	Pizza Express, 1 Monument Hill	Roadside	507609	164966	NO_2	YES	0.4	1.6	NO	2.2
Weybridge 6	Street sign outside, 43 High Street	Kerbside	507511	164936	NO_2	YES	5.5	0.6	NO	2
Weybridge 7	Prezzo, 44 Church St	Roadside	507199	164804	NO_2	YES	0.1	1.5	NO	2.4
Weybridge 8	Street sign outside, 62 Church Street	Roadside	507150	164761	NO_2	YES	0.1	4.6	NO	2.4
Weybridge 9	Norfolk House, 39 Portmore Park Road	Roadside	507065	164815	NO_2	YES	0.8	10	NO	1.6

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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)
Weybridge 10	Air Quality Station, outside 42 High Street, Weybridge, KT13 8AB	Kerbside	507478	164924	NO_2	YES	6.5	0.6	YES	1.7
Weybridge 11	Air Quality Station, outside 42 High Street, Weybridge, KT13 8AB	Kerbside	507478	164924	NO_2	YES	6.5	0.6	YES	1.7
Weybridge 12	Air Quality Station, outside 42 High Street, Weybridge, KT13 8AB	Kerbside	507478	164924	NO_2	YES	6.5	0.6	YES	1.7
Weybridge 13	Air Quality Station outside 40a High Street, Weybridge	Kerbside	507459	164909	NO_2	YES	6.5	0.7	YES	1.8
Weybridge 14	Air Quality Station outside 40a High Street, Weybridge	Kerbside	507459	164909	NO_2	YES	6.5	0.7	YES	1.8
Weybridge 15	Air Quality Station outside 40a High Street, Weybridge	Kerbside	507459	164909	NO_2	YES	6.5	0.7	YES	1.8
Cobham										

Site ID	Site Name	Site Type	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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)
Cobham 1	Outside The Lemon Tree, 6 High Street, Cobham	Roadside	510813	160048	NO_2	YES	3.5	2.5	NO	2.3
Cobham 6	Harlequin Dry Cleaners, 2 Anyards Road	Roadside	510814	160099	NO_2	NO	2.2	7.5	NO	2.2
Cobham 7	Exclusively Surrey, 38A High Street	Roadside	510861	159906	NO_2	YES	4.2	2.6	NO	2.2
Downside 3	Lampost Near Island Cottages Downside Rd, Cobham	Suburban	510925	158061	NO_2	NO	15	2.9	NO	2.3
Oxshott										
Oxshott 1	Parking Sign outside Birdshill Farmhouse, Warren lane Oxshott	Roadside	514558	160621	NO_2	NO	20	1.8	NO	2
Oxshott 2	Lamp Post o/s Flats1/2, Braeside House, High Street, Oxshott	Roadside	514574	160493	NO_2	NO	5	3	NO	2.2

Table A.3 – Annual Mean NO_2 Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3) (4)				
							2015	2016	2017	2018	2019
Automatic Monitoring											
Weybridge High Street 1	507478	164924	Kerbside	Automatic	99.8	99.8	38	38	33	32	31
Weybridge High Street 2	507459	164909	Kerbside	Automatic	98.7	32.2	-	-	-	-	31
Hampton Court Parade	515338	168292	Roadside	Automatic	97.3	97.3	**40**	**44**	**41**	38	**41**
Non-Automatic Monitoring											
Esher											
Esher 1	513840	164693	Roadside	Diffusion Tube	92	92	**48.8**	**44.9**	37.1	**43.2**	39.7
Esher 4	514058	164855	Roadside	Diffusion Tube	100	100	**43.4**	39.8	33.4	35.6	35.7
Esher 5	514150	162470	Roadside	Diffusion Tube	100	100	**50.6**	**44.4**	**42.6**	**46.1**	**48.1**
Esher 7	513982	164750	Roadside	Diffusion Tube	92	92	**48.4**	**40.5**	39.2	**41.9**	**46.0**
Esher 8	513832	164684	Roadside	Diffusion Tube	100	100	**44.4**	**42.0**	38.6	**41.9**	**42.4**
Esher 9	513821	164712	Kerbside	Diffusion Tube	100	100	32.1	32.7	28.7	33.4	31.9
Esher 10	513886	164767	Roadside	Diffusion Tube	100	100	33.0	30.2	28.5	28.2	32.3

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3) (4)				
							2015	2016	2017	2018	2019
Esher 11	518395	164599	Roadside	Diffusion Tube	92	92	38.9	32.9	32.7	33.7	35.0
Esher 13	513736	164489	Kerbside	Diffusion Tube	100	100	39.8	35.7	31.5	31.5	35.7
Hinchley Wood											
Hinchley Wood 1	515248	165535	Roadside	Diffusion Tube	83	83	**44.8**	38.3	35.4	34.4	37.4
Hinchley Wood 2	515218	165578	Roadside	Diffusion Tube	100	100	33.0	31.2	30.8	31.0	31.4
Molesey											
Molesey 1	514450	168134	Kerbside	Diffusion Tube	100	100	34.2	32.1	28.2	32.9	34.7
Molesey 8	514716	167960	Roadside	Diffusion Tube	100	100	**41.9**	35.6	31.2	35.7	39.2
Molesey 9	514507	168086	Roadside	Diffusion Tube	100	100	39.1	34.1	32.3	32.5	34.3
Molesey 10	514169	168152	Roadside	Diffusion Tube	100	100	28.5	26.6	27.5	28.5	28.1
Hampton Court											
Hampton Court 1	515379	167946	Kerbside	Diffusion Tube	100	100	**42.2**	36.9	35.4	32.1	34.4
Hampton Court 2	515338	168292	Roadside	Diffusion Tube	100	100	**43.1**	38.0	34.8	37.0	39.6
Hampton Court 3	515338	168292	Roadside	Diffusion Tube	100	100	**43.0**	38.7	35.0	36.3	38.1
Hampton Court 4	515338	168292	Roadside	Diffusion Tube	100	100	**45.2**	38.7	34.7	37.3	39.0
Hampton Court 5	515329	168390	Kerbside	Diffusion Tube	100	100	30.6	28.7	25.3	28.9	27.7

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m³) (3) (4)				
							2015	2016	2017	2018	2019
Walton-on-Thames											
Walton 3A	510140	166328	Kerbside	Diffusion Tube	100	50	-	-	-	-	34.4
Walton 5	510702	165471	Kerbside	Diffusion Tube	100	100	35.4	29.8	27.5	34.4	32.4
Walton 8	510154	166281	Roadside	Diffusion Tube	100	100	38.0	32.3	30.5	33.2	36.2
Walton 9	510082	166379	Roadside	Diffusion Tube	92	92	37.9	31.5	30.2	32.4	33.6
Walton 10	510140	166522	Roadside	Diffusion Tube	100	100	**43.8**	36.8	33.2	34.9	37.0
Walton 11	510000	166401	Roadside	Diffusion Tube	92	92	38.8	33.7	30.5	35.9	39.4
Weybridge											
Weybridge 1	507448	164900	Kerbside	Diffusion Tube	75	75	36.1	31.9	30.1	28.4	36.3
Weybridge 4	507705	164907	Roadside	Diffusion Tube	92	92	36.6	32.4	30.2	32.1	35.5
Weybridge 5	507609	164966	Roadside	Diffusion Tube	75	75	**42.8**	36.4	34.0	34.0	36.2
Weybridge 6	507511	164936	Kerbside	Diffusion Tube	75	75	30.1	30.9	28.1	27.7	32.9
Weybridge 7	507199	164804	Roadside	Diffusion Tube	100	100	**50.8**	**45.0**	**40.6**	39.6	**45.6**
Weybridge 8	507150	164761	Roadside	Diffusion Tube	100	100	37.2	37.4	35.5	31.9	35.2
Weybridge 9	507065	164815	Roadside	Diffusion Tube	100	100	25.1	25.8	22.7	25.4	24.6

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3) (4)				
							2015	2016	2017	2018	2019
Weybridge 10	507478	164924	Kerbside	Diffusion Tube	100	100	35.8	34.4	31.3	32.5	33.5
Weybridge 11	507478	164924	Kerbside	Diffusion Tube	100	100	36.6	34.9	30.9	32.0	32.8
Weybridge 12	507478	164924	Kerbside	Diffusion Tube	100	100	35.8	34.2	32.0	31.7	32.1
Weybridge 13	507459	164909	Kerbside	Diffusion Tube	100	33	-	-	-	-	32.5
Weybridge 14	507459	164909	Kerbside	Diffusion Tube	100	33	-	-	-	-	30.9
Weybridge 15	507459	164909	Kerbside	Diffusion Tube	100	33	-	-	-	-	31.1
Cobham											
Cobham 1	510813	160048	Roadside	Diffusion Tube	100	100	34.9	33.1	30.1	33.3	32.2
Cobham 6	510814	160099	Roadside	Diffusion Tube	100	100	28.4	28.6	24.6	27.0	28.1
Cobham 7	510861	159906	Roadside	Diffusion Tube	100	100	36.4	34.1	32.2	31.6	33.6
Downside 3	510925	158061	Suburban	Diffusion Tube	100	100	26.3	21.3	19.1	20.3	21.1
Oxshott											
Oxshott 1	514558	160621	Roadside	Diffusion Tube	100	17	-	-	-	-	(5)
Oxshott 2	514574	160493	Roadside	Diffusion Tube	100	17	-	-	-	-	(5)

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

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

☒ **Reported concentrations are those at the location of the monitoring site (bias adjusted and annualised, as required), i.e. prior to any fall-off with distance adjustment**

Notes:

Exceedances of the NO_2 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 (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

(3) Means for diffusion tubes have been corrected for bias. All means have been "annualised" as per 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) Concentrations are those at the location of monitoring and not those following any fall-off with distance adjustment.

(5) Only two months (17%) of data available for Oxshott 1 and 2 in 2019 and therefore cannot be annualised. As a result, the annual mean concentration has not been reported.

Figure A.1 – Trends in Annual Mean NO_2 Concentrations at Esher

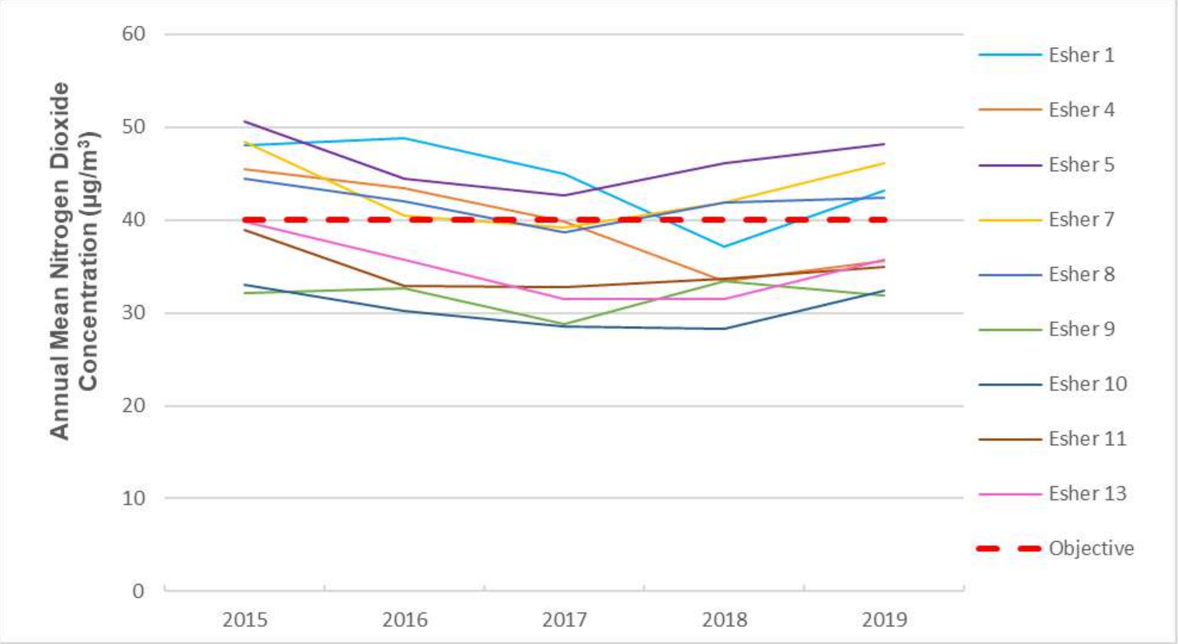


Figure A.2: Trends in Annual Mean NO_2 Concentrations at Hinchley Wood

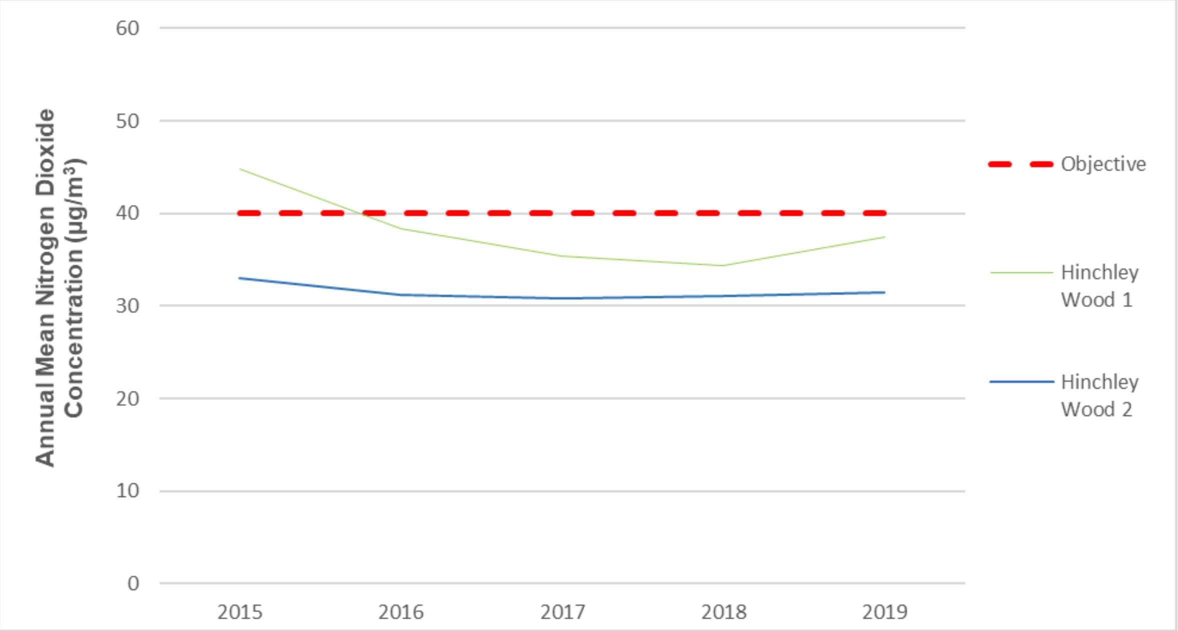


Figure A.3: Trends in Annual Mean NO_2 Concentrations at Molesey

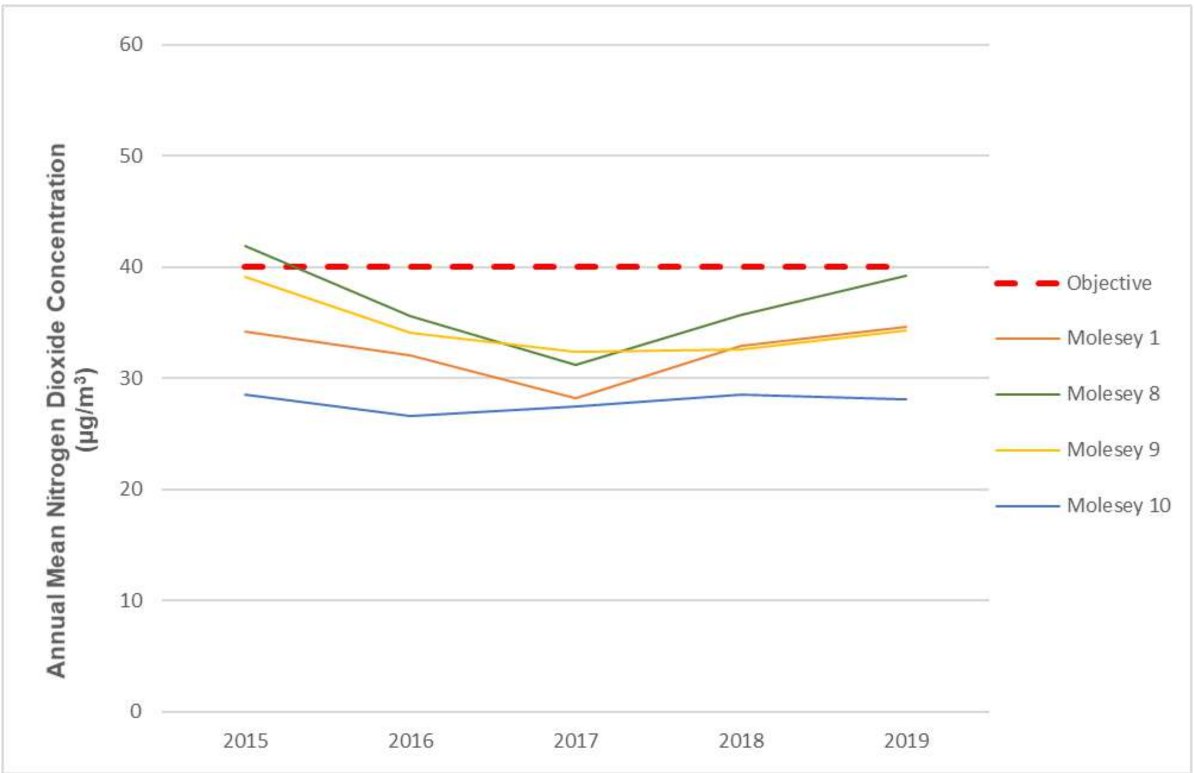


Figure A.4: Trends in Annual Mean NO_2 Concentrations at Hampton Court

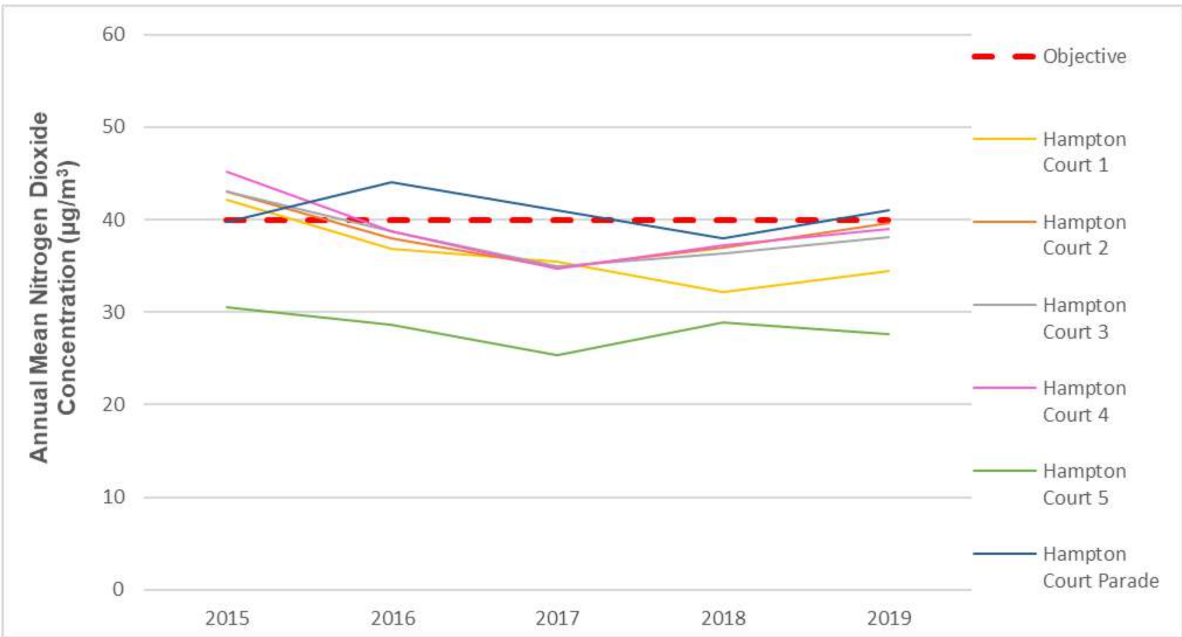


Figure A.5: Trends in Annual Mean NO_2 Concentrations at Walton-on-Thames

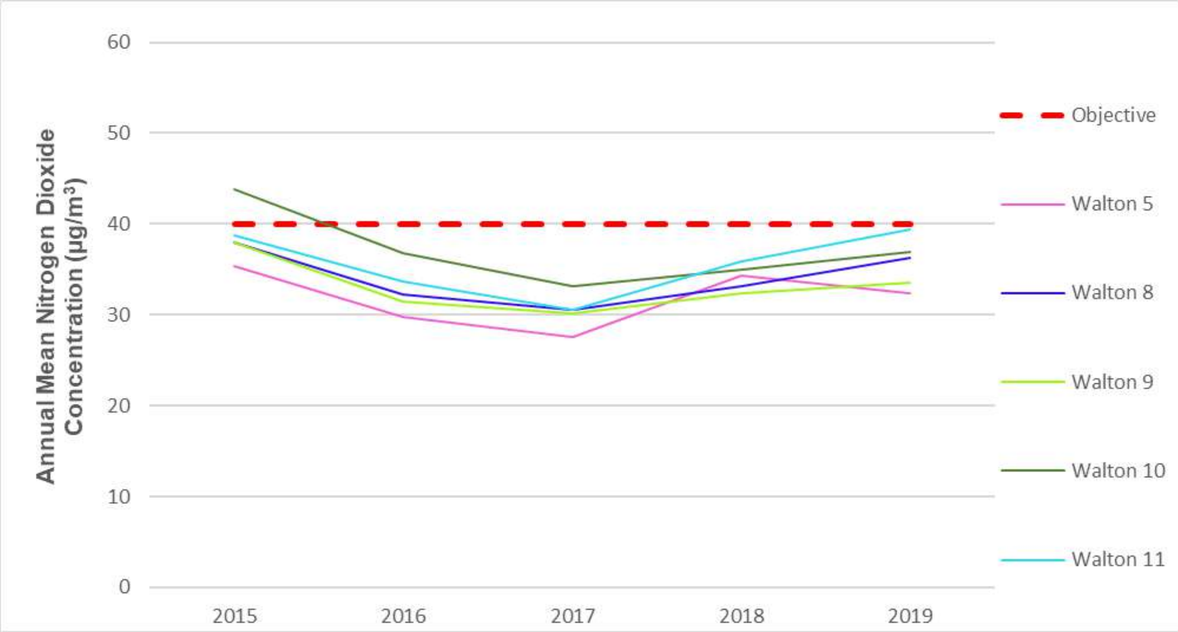


Figure A.6: Trends in Annual Mean NO_2 Concentrations at Weybridge

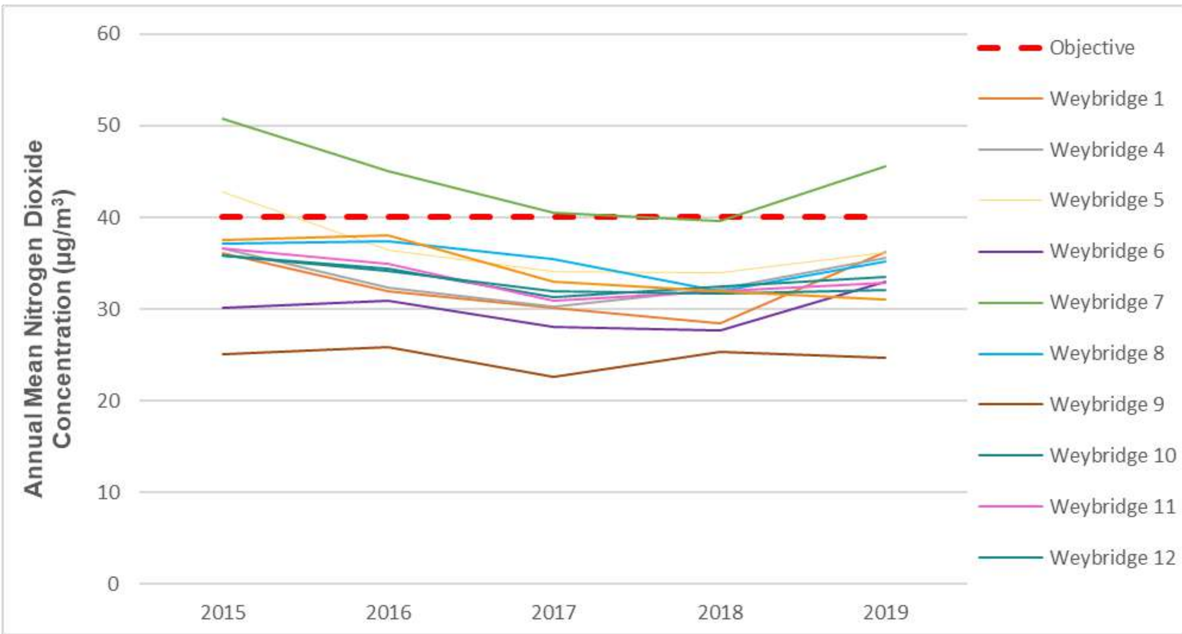


Figure A.7: Trends in Annual Mean NO_2 Concentrations at Cobham

Table A.4 – 1-Hour Mean NO_2 Monitoring Results

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2019 (%) (2)	NO_2 1-Hour Means > 200µg/m^3 (3)				
							2015	2016	2017	2018	2019
Weybridge High Street 1	507478	164924	Kerbside	Automatic	99.8	99.8	0	0	0	2	0
Weybridge High Street 2	507459	164909	Kerbside	Automatic	98.7	32.2	-	-	-	-	0 (103)
Hampton Court Parade	515338	168292	Roadside	Automatic	97.3	97.3	0	2	0	0	0

Notes:

Exceedances of the NO_2 1-hour mean objective (200µg/m^3 not to be exceeded more than 18 times/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 (e.g. if monitoring was carried out for 6 months, the maximum data capture for the full calendar year is 50%).

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

Appendix B: Full Monthly Diffusion Tube Results for 2019

Table B.1 - NO_2 Monthly Diffusion Tube Results - 2019

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO_2 Mean Concentrations (µg/m³)														
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean		
															Raw Data	Bias Adjusted (0.995) and Annualised (1)	Distance Corrected to Nearest Exposure (2)
Esher																	
Esher 1	513840	164693	46	-	43	36	43	42	33	33	34	48	46	35	40	39.7	N/A
Esher 4	514058	164855	31	51	39	36	33	32	27	34	36	37	41	34	36	35.7	N/A
Esher 5	514150	162470	51	64	49	37	48	44	35	39	45	56	63	49	48	**48.1**	N/A
Esher 7	513982	164750	48	52	44	58	48	49	43	-	47	45	40	35	46	**46.0**	36.9
Esher 8	513832	164684	51	58	38	47	44	38	33	44	42	42	39	35	43	**42.4**	**42.1**
Esher 9	513821	164712	33	39	32	43	32	30	25	27	29	33	36	26	32	31.9	N/A
Esher 10	513886	164767	34	42	36	35	32	25	33	29	31	33	32	28	33	32.3	N/A
Esher 11	518395	164599	40	45	31	35	32	31	32	-	40	35	32	34	35	35.0	N/A
Esher 13	513736	164489	49	46	35	38	37	34	28	29	32	39	37	27	36	35.7	N/A
Hinchley Wood																	
Hinchley Wood 1	515248	165535	44	44	39	36	43	-	24	35	38	39	-	34	38	37.4	N/A
Hinchley Wood 2	515218	165578	34	38	34	30	28	30	21	34	32	40	26	32	32	31.4	N/A
Molesey																	
Molesey 1	514450	168134	42	45	28	38	33	28	23	30	33	33	42	43	35	34.7	N/A

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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 (0.995) and Annualised (1)	Distance Corrected to Nearest Exposure (2)
Molesey 8	514716	167960	40	52	34	43	38	39	24	34	37	40	51	41	39	39.2	N/A
Molesey 9	514507	168086	40	39	31	35	33	31	30	30	32	34	44	35	35	34.3	N/A
Molesey 10	514169	168152	37	32	28	32	28	22	19	26	27	26	35	27	28	28.1	N/A
Hampton Court																	
Hampton Court 1	515379	167946	39	42	33	42	35	25	29	31	31	34	40	34	35	34.4	N/A
Hampton Court 2	515338	168292	47	46	41	49	36	38	29	37	38	38	42	37	40	39.6	N/A
Hampton Court 3	515338	168292	46	51	34	45	35	31	21	35	39	38	44	40	38	38.1	N/A
Hampton Court 4	515338	168292	45	46	39	46	37	36	32	35	38	31	46	39	39	39.0	N/A
Hampton Court 5	515329	168390	28	34	25	33	29	26	21	25	24	29	33	27	28	27.7	N/A
Walton-on-Thames																	
Walton 3A	510140	166328	-	-	-	-	37	27	-	30	32	28	37	-	32	34.4	N/A
Walton 5	510702	165471	38	36	36	33	33	32	23	30	29	30	39	32	33	32.4	N/A
Walton 8	510154	166281	44	42	33	38	35	41	29	35	37	34	37	32	36	36.2	N/A
Walton 9	510082	166379	38	40	36	36	33	31	-	29	33	29	35	31	34	33.6	N/A
Walton 10	510140	166522	39	49	35	55	40	30	25	28	29	36	44	36	37	37.0	N/A
Walton 11	510000	166401	37	48	-	44	33	44	32	38	38	39	47	36	40	39.4	N/A

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	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 (0.995) and Annualised (1)	Distance Corrected to Nearest Exposure (2)
Weybridge																	
Weybridge 1	507448	164900	-	-	-	43	39	33	24	37	36	34	47	35	36	36.3	N/A
Weybridge 4	507705	164907	32	39	39	48	-	31	27	37	37	42	35	26	36	35.5	N/A
Weybridge 5	507609	164966	-	-	-	38	36	36	25	43	41	38	35	35	36	36.2	N/A
Weybridge 6	507511	164936	-	-	-	36	33	35	20	31	32	35	42	34	33	32.9	N/A
Weybridge 7	507199	164804	53	49	37	56	50	38	33	49	56	42	47	40	46	**45.6**	**45.2**
Weybridge 8	507150	164761	37	37	40	38	33	34	28	35	33	34	40	35	35	35.2	N/A
Weybridge 9	507065	164815	28	30	24	29	24	22	18	25	25	20	29	23	25	24.6	N/A
Weybridge 10	507478	164924	39	35	30	43	33	32	25	30	33	32	38	34	34	33.5	N/A
Weybridge 11	507478	164924	34	37	35	34	33	31	32	32	33	26	39	30	33	32.8	N/A
Weybridge 12	507478	164924	34	33	30	37	35	31	25	33	33	27	39	30	32	32.1	N/A
Weybridge 13	507459	164909	-	-	-	-	-	-	-	-	33	31	40	34	35	32.5	N/A
Weybridge 14	507459	164909	-	-	-	-	-	-	-	-	34	30	38	29	33	30.9	N/A

Site ID	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	NO2 Mean Concentrations (µg/m3)														
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean		
															Raw Data	Bias Adjusted (0.995) and Annualised (1)	Distance Corrected to Nearest Exposure (2)
Weybridge 15	507459	164909	-	-	-	-	-	-	-	-	36	30	38	28	33	31.1	N/A
Cobham																	
Cobham 1	510813	160048	39	43	33	39	32	24	25	30	31	30	33	29	32	32.2	N/A
Cobham 6	510814	160099	34	29	24	36	28	26	22	30	27	25	33	25	28	28.1	N/A
Cobham 7	510861	159906	42	36	38	34	36	30	28	32	33	28	38	30	34	33.6	N/A
Downside 3	510925	158061	23	24	22	23	18	14	18	21	20	22	27	23	21	21.1	N/A
Oxshott																	
Oxshott 1	514558	160621	-	-	-	-	-	-	-	-	-	-	33	27	30	(3)	N/A
Oxshott 2	514574	160493	-	-	-	-	-	-	-	-	-	-	50	38	44	(3)	N/A

☒ **Local bias adjustment factor used**

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

☒ **Where applicable, data has been distance corrected for relevant exposure in the final column**

Notes:

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

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

(2) Distance corrected to nearest relevant public exposure.

Appendix C: Supporting Technical Information / Air Quality Monitoring Data QA/QC

Nitrogen Dioxide Diffusion Tube Bias Adjustment

Diffusion Tube Bias National Adjustment Factor

The diffusion tubes for 2019 were supplied and analysed by Lambeth Scientific Services and the preparation method used was 50% TEA in acetone. The national bias adjustment factor for Lambeth Scientific Services, 50% TEA in acetone, is 0.85, based on one study (spreadsheet version 03/20).

Diffusion Tube Local Bias Adjustment Factor

There are three triplicated diffusion tube monitoring sites located in Elmbridge which are co-located with the Hampton Court Parade and the two Weybridge High Street automatic monitoring stations. Local bias adjustment factors have been calculated using the ‘Checking Precision and Accuracy of Triplicate Tubes’ spreadsheet (v.04, 2011) available on DEFRA LAQM website. The outputs from the spreadsheet for the Weybridge High Street 1 and Hampton Court Parade co-location sites are provided in Figures C.1 and C.2. Weybridge High Street 2 was not considered suitable for use in obtaining a local bias adjustment factor in 2019 as the site began operating in September 2019 and therefore only four months of monitoring data were available.

For Weybridge High Street 1, the bias adjustment factor calculated using all 12 periods of data has been used as tube precision and automatic monitor data quality are good for all periods. For Hampton Court Parade, the bias adjustment factor calculated using periods with a coefficient of variation less than 20% has been used as one period of data had poor diffusion tube precision. The local bias adjustment factors for Weybridge High Street 1 and Hampton Court Parade monitoring sites are presented in Table C.1.

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

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	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	10/01/2019	06/02/2019	39.0	34.0	34.0	36	2.9	8	7.2	37.8199	99.536321	Good	Good
2	06/02/2019	07/03/2019	35.0	37.0	33.0	35	2.0	6	5.0	36.5122	99.713056	Good	Good
3	07/03/2019	02/04/2019	30.0	35.0	30.0	32	2.9	9	7.2	30.7219	99.839486	Good	Good
4	02/04/2019	01/05/2019	43.0	34.0	37.0	38	4.6	12	11.4	35.5494	99.857143	Good	Good
5	01/05/2019	04/06/2019	33.0	33.0	35.0	34	1.2	3	2.9	24	100	Good	Good
6	04/06/2019	04/07/2019	32.0	31.0	31.0	31	0.6	2	1.4	25	100	Good	Good
7	04/07/2019	08/08/2019	25.0	32.0	25.0	27	4.0	15	10.0	23	99.880952	Good	Good
8	08/08/2019	05/09/2019	30.0	32.0	33.0	32	1.5	5	3.8	21	99.85119	Good	Good
9	05/09/2019	03/10/2019	33.0	33.0	33.0	33	0.0	0	0.0	31	99.404762	Good	Good
10	03/10/2019	07/11/2019	32.0	26.0	27.0	28	3.2	11	8.0	32	99.880952	Good	Good
11	07/11/2019	05/12/2019	38.0	39.0	39.0	39	0.6	1	1.4	46.0015	100	Good	Good
12	05/12/2019	09/01/2020	34.0	30.0	30.0	31	2.3	7	5.7	28.0346	99.880952	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

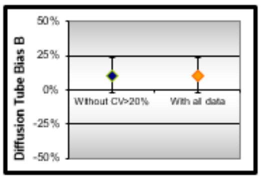
Site Name/ ID: Weybridge High Street 1

Precision 12 out of 12 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 12 periods of data
Bias factor A 0.94 (0.84 - 1.06)
Bias B 7% (-6% - 20%)
Diffusion Tubes Mean: 33 μgm^{-3}
Mean CV (Precision): 7
Automatic Mean: 31 μgm^{-3}
Data Capture for periods used: 100%
Adjusted Tubes Mean: 31 (28 - 35) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 12 periods of data
Bias factor A 0.94 (0.84 - 1.06)
Bias B 7% (-6% - 20%)
Diffusion Tubes Mean: 33 μgm^{-3}
Mean CV (Precision): 7
Automatic Mean: 31 μgm^{-3}
Data Capture for periods used: 100%
Adjusted Tubes Mean: 31 (28 - 35) μgm^{-3}



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Version 04 - February 2011

Figure C.1 – Local Bias Adjustment Factor Correction Output – Weybridge High Street 1

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

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	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	09/01/2019	07/02/2019	47.0	46.0	45.0	46	1.0	2	2.5	44.0821	99.712644	Good	Good
2	07/02/2019	06/03/2019	46.0	51.0	46.0	48	2.9	6	7.2	50.7454	100	Good	Good
3	06/03/2019	03/04/2019	41.0	34.0	39.0	38	3.6	9	9.0	36.7095	97.321429	Good	Good
4	03/04/2019	02/05/2019	49.0	45.0	46.0	47	2.1	4	5.2	42.2723	98.132184	Good	Good
5	02/05/2019	05/06/2019	36.0	35.0	37.0	36	1.0	3	2.5	36	98.402948	Good	Good
6	05/06/2019	02/07/2019	38.0	31.0	36.0	35	3.6	10	9.0	36	98.463902	Good	Good
7	02/07/2019	07/08/2019	29.0	21.0	32.0	27	5.7	21	14.1	32	98.607889	Poor Precision	Good
8	07/08/2019	04/09/2019	37.0	35.0	35.0	36	1.2	3	2.9	36	83.803863	Good	Good
9	04/09/2019	02/10/2019	38.0	39.0	38.0	38	0.6	2	1.4	38	96.577381	Good	Good
10	02/10/2019	06/11/2019	38.0	38.0	31.0	36	4.0	11	10.0	44	98.333333	Good	Good
11	06/11/2019	04/12/2019	42.0	44.0	46.0	44	2.0	5	5.0	55.1012	98.511905	Good	Good
12	04/12/2019	08/01/2020	37.0	40.0	39.0	39	1.5	4	3.8	44.532	98.452381	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

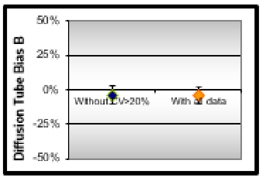
Site Name/ ID: Hampton Court

Precision 11 out of 12 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 11 periods of data
Bias factor A 1.05 (0.98 - 1.13)
Bias B -5% (-11% - 2%)
Diffusion Tubes Mean: 40 μgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 42 μgm^{-3}
Data Capture for periods used: 97%
Adjusted Tubes Mean: 42 (39 - 45) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 12 periods of data
Bias factor A 1.05 (0.99 - 1.13)
Bias B -5% (-11% - 1%)
Diffusion Tubes Mean: 39 μgm^{-3}
Mean CV (Precision): 7
Automatic Mean: 41 μgm^{-3}
Data Capture for periods used: 97%
Adjusted Tubes Mean: 41 (39 - 44) μgm^{-3}



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Version 04 - February 2011

Figure C.2 – Local Bias Adjustment Factor Correction Output – Hampton Court Parade

Table C.1 – Local Bias Adjustment Factors

Location	Diffusion Tube Data Capture (%)	Automatic Monitor Data Capture (%)	Diffusion Tube Annual Mean (µg/m^3)	Automatic Monitor Annual Mean (µg/m$_3$)	Ratio
Weybridge High Street	100	100	33	31	0.94
Hampton Court Parade	100	97	40	42	1.05

Justification for Choice of Factor Applied

The diffusion tube data has been corrected using a bias adjustment factor, which is an estimate of the difference between diffusion tube and continuous monitoring concentrations; the latter is assumed to be a more accurate method of monitoring. The DEFRA Technical Guidance LAQM.TG(16) provides guidance with regard to the application of a bias adjustment factor to correct diffusion tube monitoring. Triplicate co-location studies can be used to determine a local bias factor based on the comparison of diffusion tube results with data taken from NOx/NO_2 continuous analysers. Alternatively, the national database of diffusion tube co-location surveys provides bias factors for the relevant laboratory and preparation method.

The DEFRA Technical Guidance LAQM.TG(16) recommends the use of a local bias adjustment factor where available and relevant to diffusion tube sites.

A local bias adjustment factor of 1.05 has been derived for the Hampton Court Parade site. The measurements obtained from the automatic monitor and diffusion tubes at this site have good data capture and overall data precision.

A local bias adjustment factor of 0.94 has been derived for the Weybridge High Street 1 site. The measurements obtained from the automatic monitor and diffusion tubes at this site also had good data capture and overall data precision.

Given the agreement between the local bias adjustment factors, the good data capture and data precision for the Weybridge High Street and Hampton Court Parade sites, an averaged local bias adjustment factor of 0.995 obtained from these two sites has been used to bias adjust the diffusion tube data for 2019.

Diffusion Tube and Automatic Monitor Annualisation

Where data capture is less than 75% for a full calendar year, the diffusion tube results were 'annualised' following the methodology outlined in LAQM TG (16). Annualisation was carried out for five sites, Walton 3A, Weybridge 13 - 15 and Weybridge High Street 2 automatic monitor.

Continuous monitoring data from the London Hillingdon, London North Kensington London Bloomsbury urban background sites, part of the Automatic Urban and Rural Network (AURN) were used. The monitoring periods for which data were available for Walton 3A, Weybridge 13 - 15 are shown in Table C.2. Details of the annualisation calculations are provided in Tables C.3-C.5 below.

Table C.2 – Monitoring Periods for Sites Requiring Annualisation

Monitoring Site	Monitoring Period
Walton 3A	01/05/2019 - 02/07/2019, 08/08/2019 – 05/12/2019
Weybridge 13 - 15	05/09/2019 – 09/01/2019
Weybridge High Street 2	05/09/2019 – 31/12/2019

Table C.3 – Short-term to long-term adjustment, Walton 3A

Long-term Site	Annual Mean 2019 (AM)	Period Mean 2019 (PM)	Ratio (AM/PM) *
London Hillingdon	44.9	42.0	1.07
London N. Kensington	26.9	24.9	1.08
London Bloomsbury	31.0	28.0	1.11
Average (R_a)			**1.09**

(*) Based on unrounded numbers

Table C.4 – Short-term to long-term adjustment, Weybridge 13 - 15

Long-term Site	Annual Mean 2019 (AM)	Period Mean 2019 (PM)	Ratio (AM/PM) *
London Hillingdon	44.9	45.3	0.99
London N. Kensington	26.9	29.7	0.91
London Bloomsbury	31.0	32.8	0.95
Average (R_a)			**0.95**

(*) Based on unrounded numbers

Table C.5 – Short-term to long-term adjustment, Weybridge High Street 2

Long-term Site	Annual Mean 2019 (AM)	Period Mean 2019 (PM)	Ratio (AM/PM) *
London Hillingdon	44.7	45.4	0.98
London N. Kensington	27.3	30.1	0.91
London Bloomsbury	31.5	32.8	0.96
Average (R_a)			**0.95**

(*) Based on unrounded numbers

Distance Correction Calculations

Two roadside and one kerbside diffusion tube monitoring site which measured exceedances of the annual mean NO_2 objective in 2019 have been distance corrected to determine the estimated concentrations at relevant exposure. The distance correction calculations have been undertaken using DEFRA's 'NO_2 Fall Off with Distance from Roads Calculator Tool v4.2', which requires the following inputs:

- distance of the monitoring site from the kerb (m);
- distance of the receptor from the kerb (m);
- NO_2 annual mean background concentration (obtained from the latest 2017-based DEFRA background maps); and
- measured concentration at the monitoring site.

The calculations are presented in Table C.6 below. Although an exceedance of the annual mean NO_2 objective was measured at Esher 5 monitoring site in 2019, this site has not been distance corrected as it is more than 100m from the nearest relevant exposure.

Table C.6 – Distance Correction Calculations

Site Name	Distance (m)		NO_2 Annual Mean Concentration (µg/m^3)		
	Monitoring Site to Kerb	Receptor to Kerb	Background	Monitored at Site	Predicted at Receptor
Esher 7	0.5	2.8	16.0	46.0	36.9
Esher 8	3.0	3.1	16.0	42.4	42.1
Weybridge 7	1.5	1.6	16.8	45.6	45.2

Workplace Analysis Scheme for Proficiency (WASP)

Lambeth Scientific Service take part in the analytical proficiency testing scheme (AIR-PT), formerly known as the WASP operated by LGC Standards and supported by the Health and Safety Laboratory (HSL). During 2019, 50% of samples were determined to have been satisfactory in the 1st and 3rd quarter, and 100% were determined to have been satisfactory in the 2nd and 4th quarter.

Automatic Monitoring QA/QC

All monitoring data are ratified by Air Quality Data Management (AQDM) in accordance with the LAQM TG (16) standards.

Appendix D: Maps of Monitoring Locations and AQMAs

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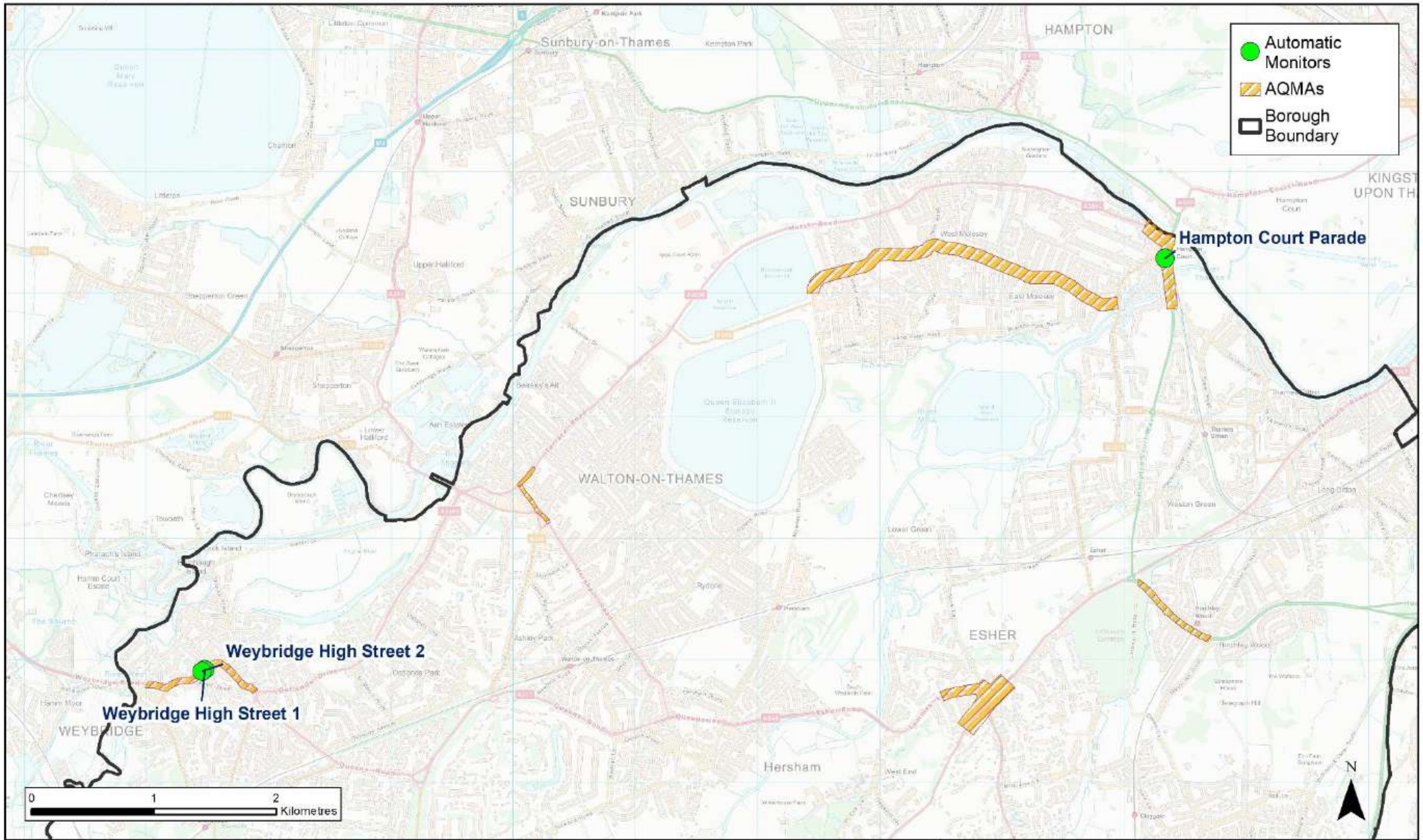

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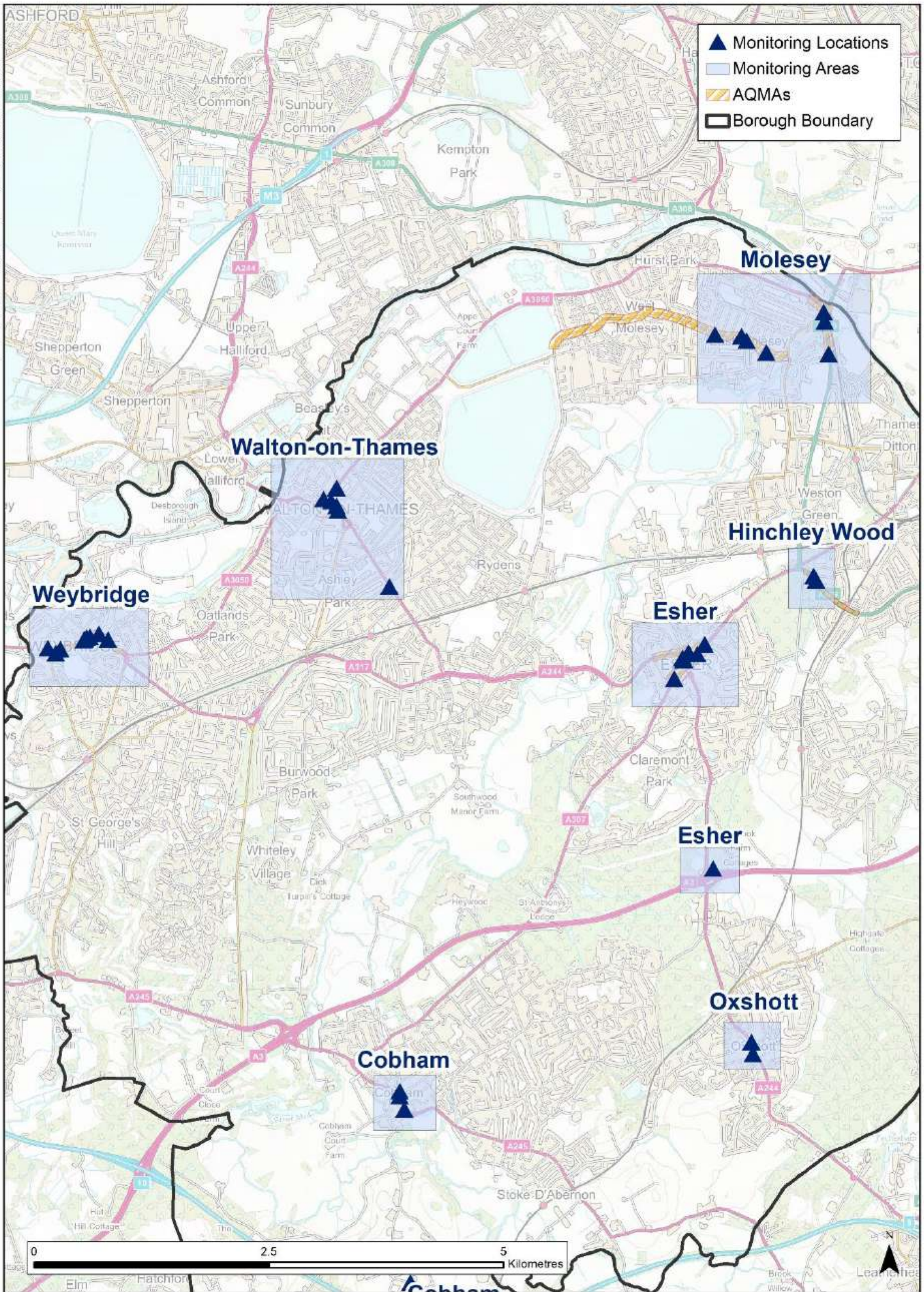
			Checked: KH	Figure D.1 / Rev A



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			Checked: KH	Figure D.2 Rev A

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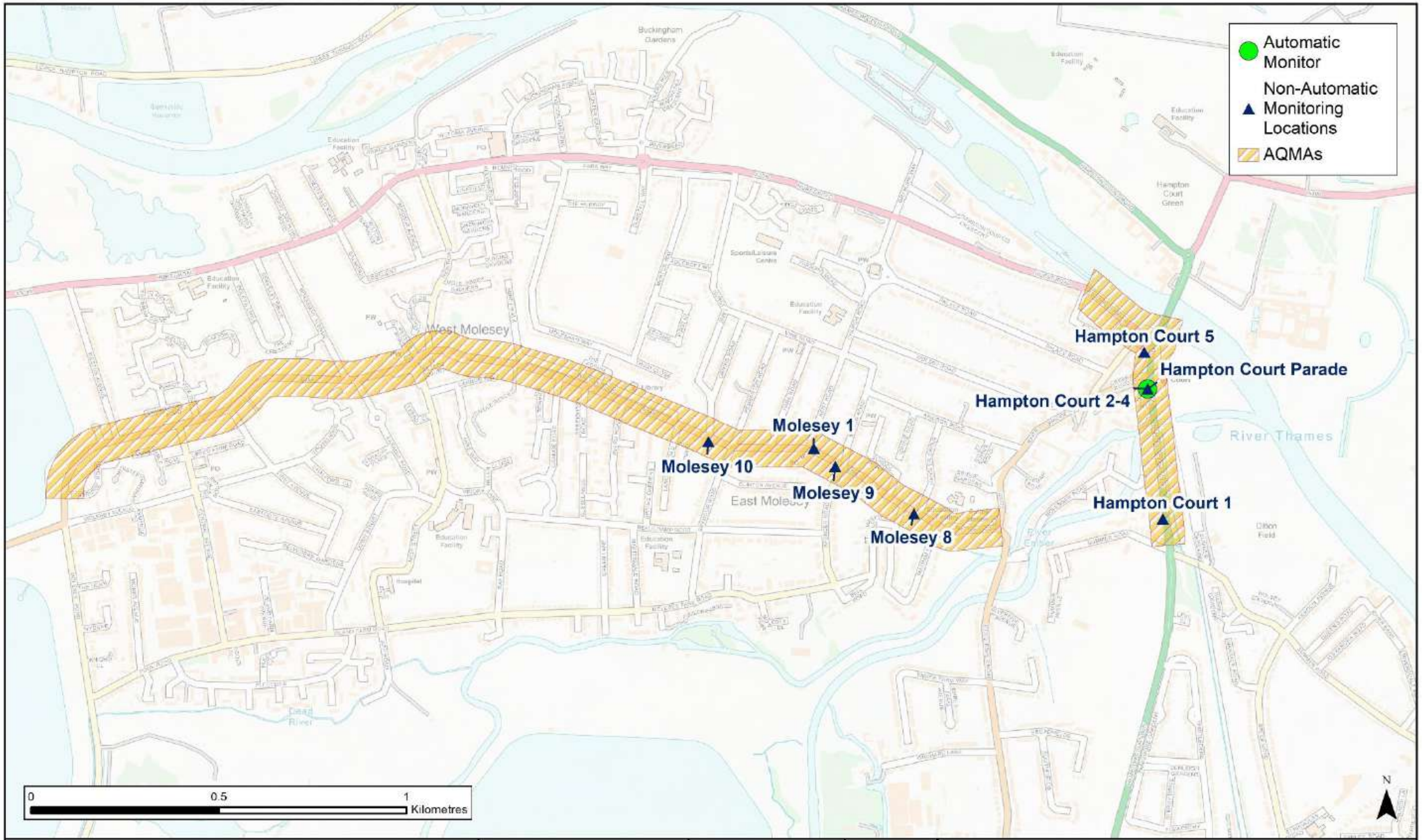

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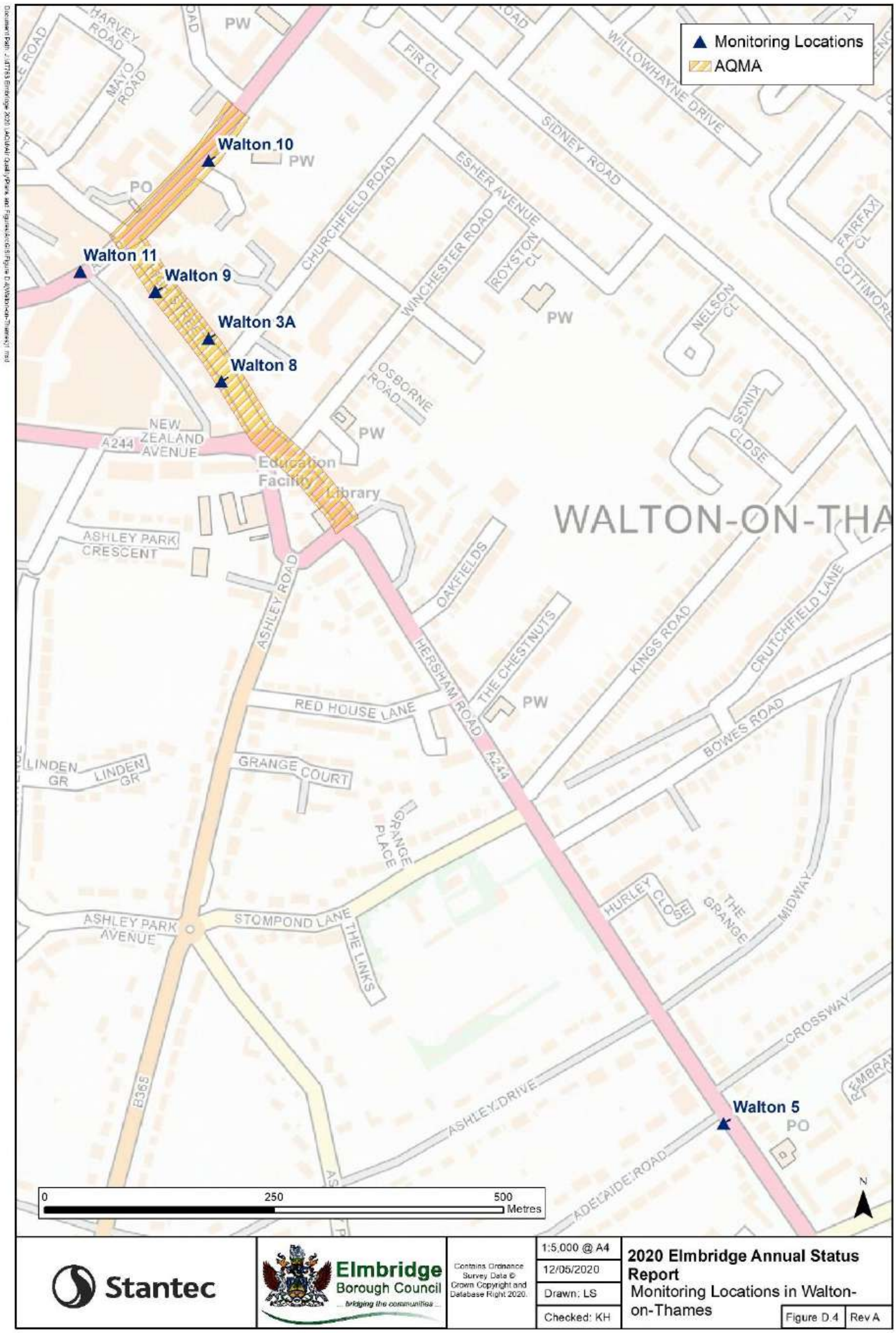
			Checked: KH	Figure D.3 Rev A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AQMA
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Walton 11
Walton 9
Walton 3A
Walton 8
Walton 5
WALTON-ON-THA
HERSHAM ROAD
A244
ASHLEY ROAD
STOMPOND LANE
ASHLEY DRIVE
0
250
500
Metres
1:5,000 @ A4
12/05/2020
Drawn: LS
Checked: KH
2020 Elmbridge Annual Status Report
Monitoring Locations in Walton-on-Thames
Figure D.4
Rev A
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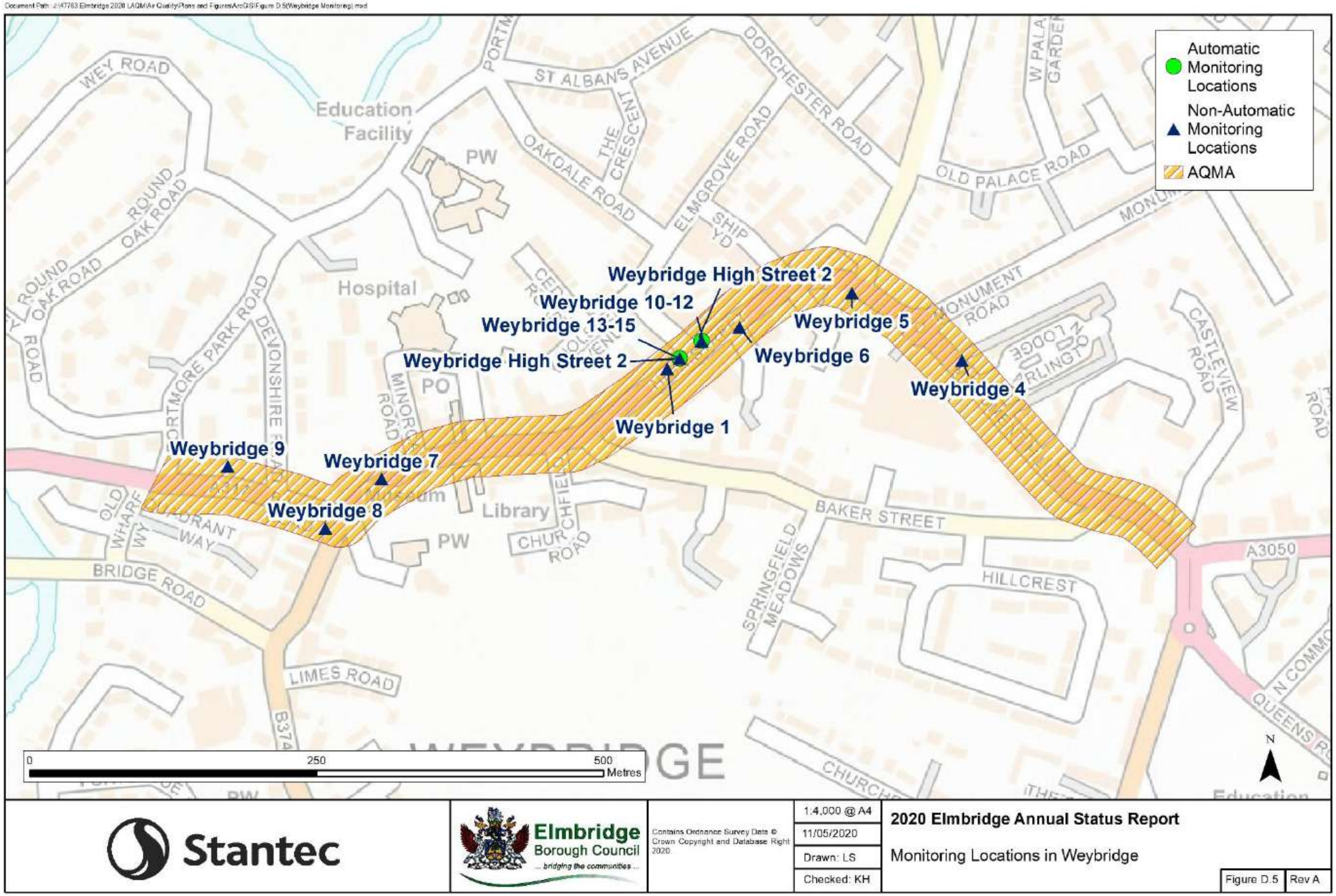
Automatic Monitoring Locations
Non-Automatic Monitoring Locations
AQMA
Weybridge High Street 2
Weybridge 10-12
Weybridge 13-15
Weybridge High Street 2
Weybridge 5
Weybridge 6
Weybridge 4
Weybridge 1
Weybridge 9
Weybridge 7
Weybridge 8
0
250
500
Metres
N
1:4,000 @ A4
11/05/2020
Drawn: LS
Checked: KH
2020 Elmbridge Annual Status Report
Monitoring Locations in Weybridge
Figure D.5
Rev A
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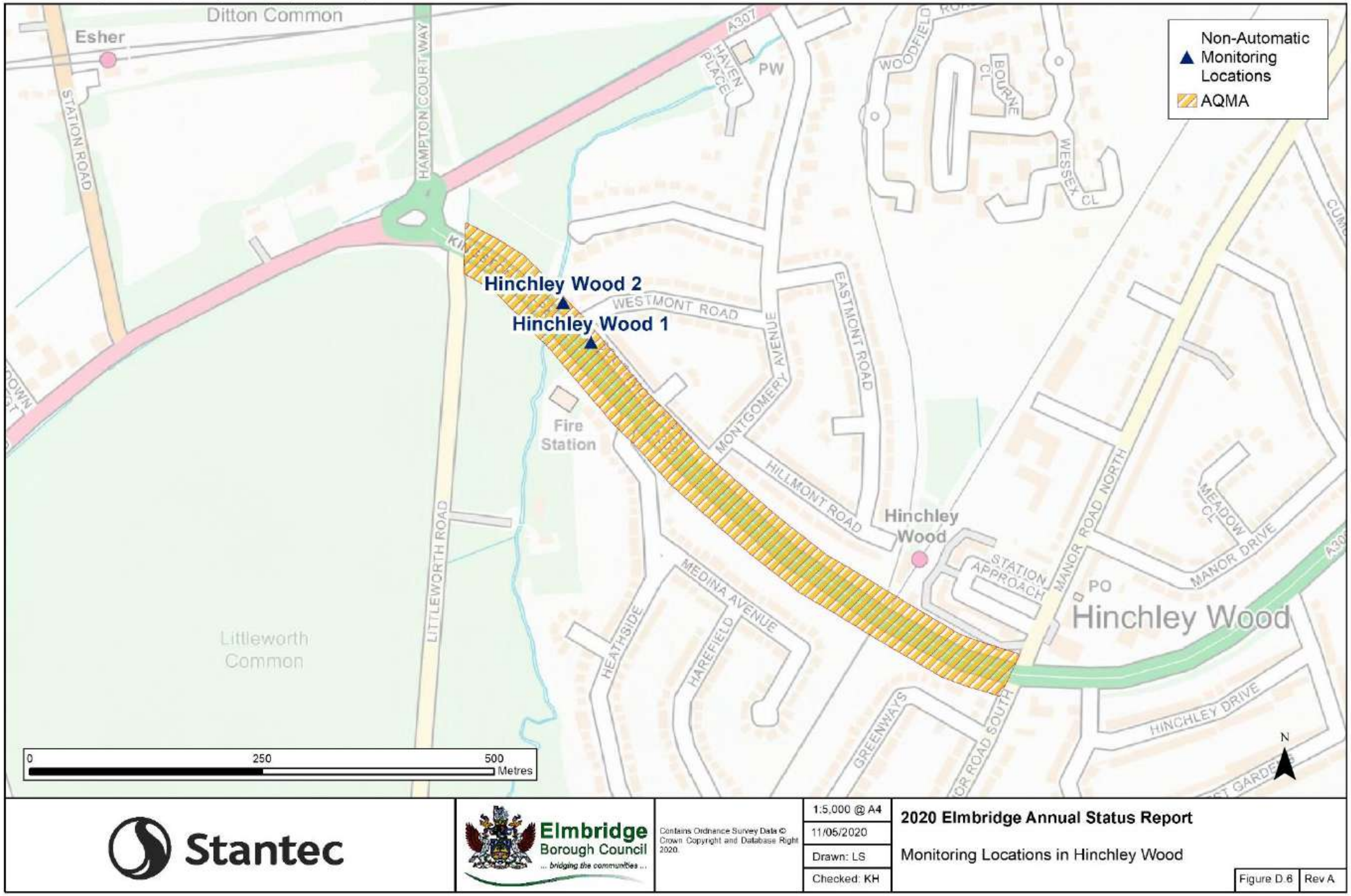

Ditton Common
Esher
STATION ROAD
HAMPTON COURT WAY
A307
HAVEN PLACE
PW
WOODFIELD
BOURNE CL
WESSEX CL
Non-Automatic Monitoring Locations
AQMA
Hinchley Wood 2
Hinchley Wood 1
WESTMONT ROAD
MONTGOMERY AVENUE
EASTMONT ROAD
HILLMONT ROAD
Fire Station
Hinchley Wood
STATION APPROACH
MANOR ROAD NORTH
MEADOW CL
MANOR DRIVE
PO
Hinchley Wood
MEDINA AVENUE
HEATHSIDE
HAREFIELD
GREENWAYS
MANOR ROAD SOUTH
HINCHLEY DRIVE
LITTLEWORTH ROAD
Littleworth Common
0
250
500
Metres
N
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Monitoring Locations in Hinchley Wood
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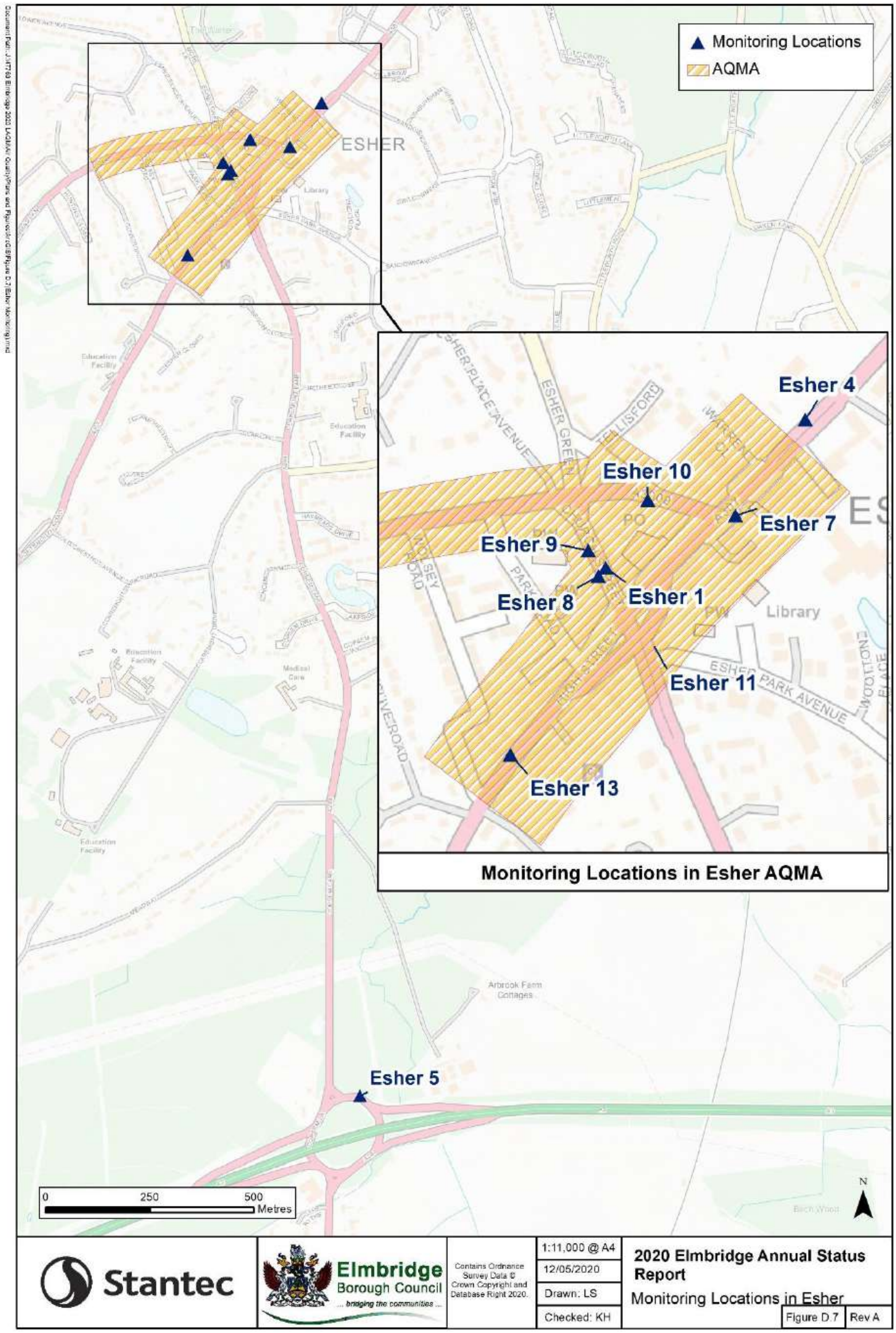
Monitoring Locations
AQMA
ESHER
Esher 4
Esher 10
Esher 7
Esher 9
Esher 1
Esher 8
Esher 11
Esher 13
Library
Monitoring Locations in Esher AQMA
Esher 5
0
250
500
Metres
N
Stantec
Elmbridge
Borough Council
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12/05/2020
Drawn: LS
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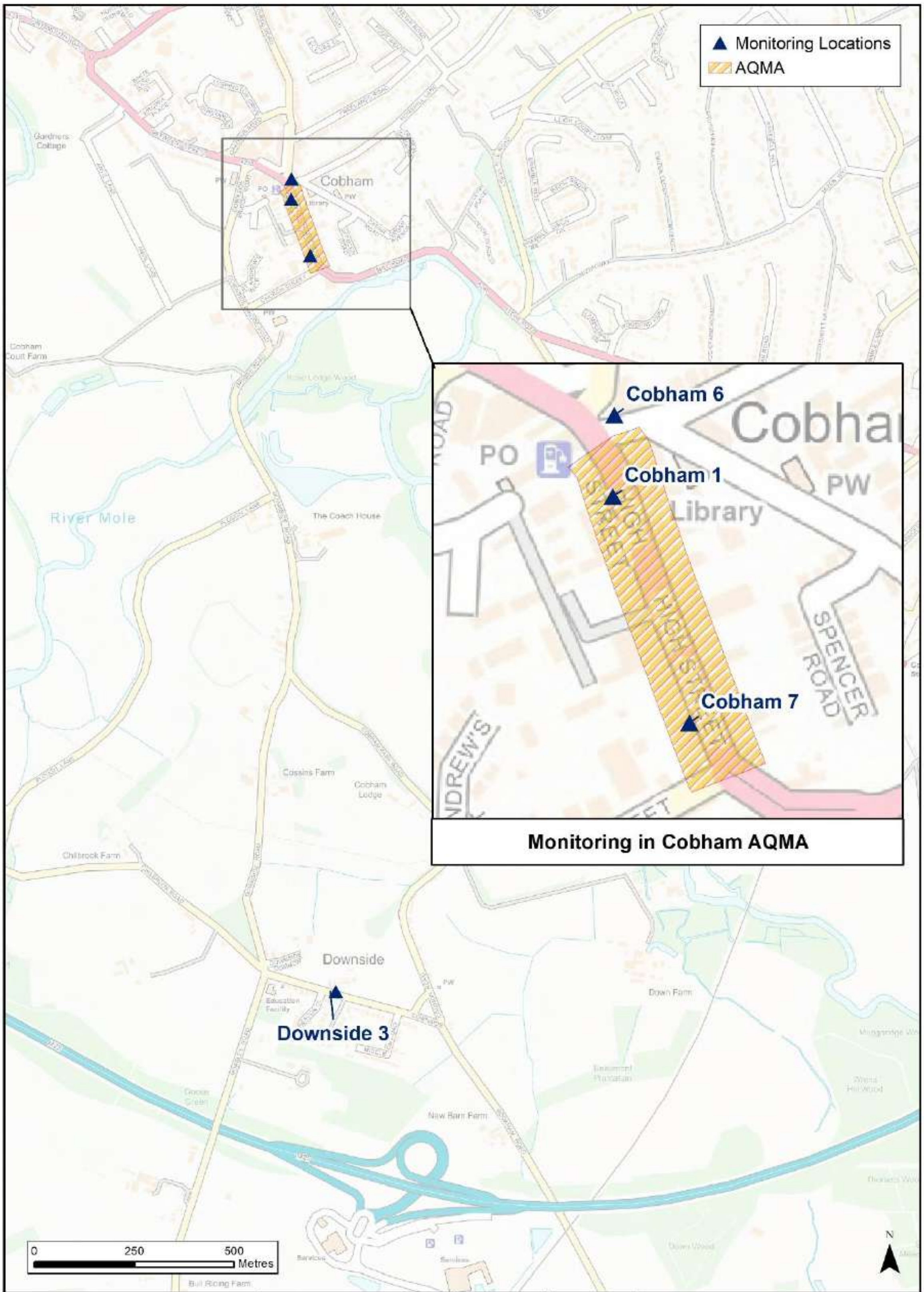
2020 Elmbridge Annual Status Report
Monitoring Locations in Esher
Figure D.7
Rev A



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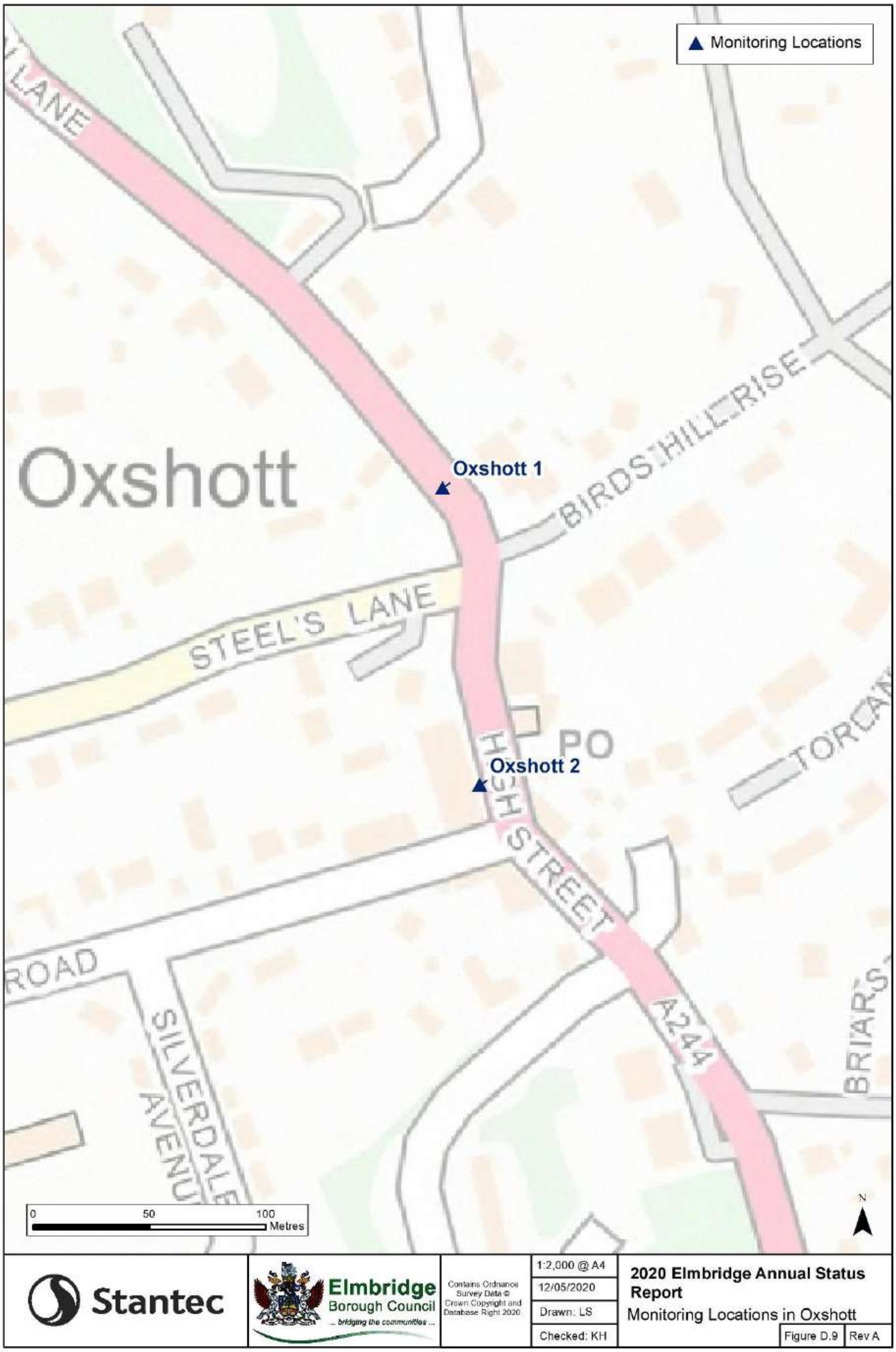
Monitoring Locations in Cobham
Figure D.8 Rev A


Monitoring Locations
LANE
Oxshott
Oxshott 1
BIRDS HILL RISE
STEEL'S LANE
PO
Oxshott 2
HIGH STREET
TORCAS
ROAD
SILVERDALE AVENUE
A244
BRIARS
0
50
100
Metres
N
Stantec
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Monitoring Locations in Oxshott
Figure D.9
Rev A

Appendix E: Summary of Air Quality Objectives in England

Table E.1 – Air Quality Objectives in England

Pollutant	Air Quality Objective[11]	
	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

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

Appendix F: CERC Modelling Report for Surrey

Cambridge
Environmental
Research
Consultants

Detailed air quality modelling and source apportionment

Final report

Prepared for
Surrey Local Authorities

23rd August 2019

CERC

Report Information

CERC Job Number:	FM1183
Job Title:	Detailed air quality modelling and source apportionment
Prepared for:	Surrey Local Authorities
Report Status:	Final
Report Reference:	FM1183/R5/19
Issue Date:	23rd August 2019
Author(s):	Rohan Patel
Reviewer(s):	Sarah Strickland, Chetan Lad

Issue	Date	Comments
1	20/02/19	Draft, verification only
2	26/02/19	Draft, verification only, with minor amendments
3	04/04/19	Full draft report
4	24/05/19	Final report
5	23/08/19	Final report with additions to Section 9

Main File(s):	FM1183_Surrey_CERC_R5_23August19.pdf

Contents

Glossary

AADTs	Annual Average Daily Traffic
AF	Attributable fraction
ATC	Automatic Traffic Count
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area; places designated by local authorities where statutory air quality objectives are not likely to be achieved
CRF	concentration response function
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DT	Diffusion tube
EFT	Emission Factors for Transport
LAQM	Local Air Quality Management; local authorities' process for reviewing and assessing air quality
LSOA	Lower Layer Super Output Area
NAEI	National Atmospheric Emissions Inventory
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides (nitrogen dioxide plus nitric oxide)
O_3	ozone
ONS	Office for National Statistics
PM_{10}	particulates of less than 10µm effective diameter
$PM_{2.5}$	particulates of less than 2.5µm effective diameter
SO_2	sulphur dioxide
TPM	Total Particulate Matter
VOC	Volatile Organic Compound

1 Summary

CERC was commissioned to carry out county-wide air pollution dispersion modelling, source apportionment and local mortality burden calculations for the combined local authorities of Surrey.

The main source of air pollution across Surrey is road traffic emissions from major roads. Eight of the eleven local authorities have declared Air Quality Management Areas (AQMAs) for annual average NO_2 concentrations. Two of these AQMAs are also declared for PM_{10} concentrations, in Runnymede (annual mean and 24-hour mean PM_{10}) and Surrey Heath (annual mean PM_{10}).

The main air quality modelling was carried out with ADMS-Urban (version 4.2) dispersion modelling software, using meteorological data from the Heathrow Airport meteorological station. Additional sensitivity analysis was carried out using meteorological data from the Gatwick Airport meteorological station.

Road traffic emissions input to the dispersion model were calculated from traffic flows provided from the Surrey Traffic Model, supplemented by Department for Transport (DfT) count data and local data from borough council detailed and further assessments. The Emission Factor Toolkit version 8.0.1, published by Defra, was used to calculate emissions from traffic flows. All other emissions data were taken from the NAEI.

Detailed model verification was carried out by comparing modelled concentrations against monitored data across Surrey for the year 2017, with iterative improvements to the model set-up to ensure acceptable agreement between modelled and monitored concentrations.

High resolution air quality maps for concentrations of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$) across Surrey were then generated to determine the extent to which the air quality objectives for these pollutants are exceeded. With exception of some locations close to major roads, the air quality objectives are met throughout the county. There are modelled exceedences of the annual mean NO_2 objective of 40 $\mu g/m^3$ along motorways and other busy roads. Exceedences of short-term NO_2 and PM_{10} objectives are less extensive. The annual mean $PM_{2.5}$ objective of 25 $\mu g/m^3$ is met throughout the county.

Source apportionment was carried out to calculate relative contributions of each source group to pollutant emissions and concentrations. The following source groups were included: road sources, by vehicle type and non-exhaust component for PM; large industrial sources; other emissions sources; and background. Road transport is typically the largest contributor to NO_x concentrations; diesel cars and LGVs are the largest contributors to the road transport NO_x concentrations. Background concentrations, from outside Surrey, are the most significant contributors to concentrations of PM_{10} and $PM_{2.5}$; sources inside Surrey contribute on an average 21% of total PM_{10} concentrations and 24% of total $PM_{2.5}$ concentrations.

Local mortality burden calculations were carried out by coupling population data, by Lower Layer Super Output Areas (LSOA), with the modelled annual mean concentrations of NO_2 and $PM_{2.5}$. This includes deaths attributable to air pollution, the associated life-years lost and economic cost. This was done using the approach set out in Appendix A of the Public Health England guidance *Estimating local mortality burdens associated with particulate air pollution (April 2014)*; the approach used concentration response function (CRF) pairs for NO_2 and $PM_{2.5}$, these CRFs have been taken from the 2018 COMEAP report *Associations of long-term average concentrations of nitrogen dioxide with mortality*.

The combined health impacts of NO_2 and $PM_{2.5}$ for the whole of Surrey have been calculated to be in the range of 6,610 and 8,059 life-years lost, which equates to an economic cost of between £283 million and £345 million in 2017. Using the unadjusted value, the lowest life years lost were calculated to be 5,233, resulting from NO_2 concentrations. This equates to an economic cost of £224 million.

2 Introduction

The combined local authorities of Surrey commissioned CERC to carry out detailed air quality modelling, source apportionment and local mortality burden calculations across the county.

The modelling methodology and county-wide results, including air quality maps, are presented in this report.

Separate accompanying reports present the results for individual boroughs, including: air quality maps; source apportionment; and mortality burden by ward.

The air quality limit values and target values with which the calculated concentrations are compared are presented in Section 3. Section 4 summarises local air quality across the Surrey boroughs. The model setup and emissions data are described in Sections 5 and 6, respectively.

The results of the modelling are then presented: the model verification in Section 7; and the concentration maps for the year 2017 in Section 8. Mortality burden calculations are described in Section 9. Source apportionment is presented in Section 10. A discussion of the results is presented in Section 11.

Model verification was carried out using meteorological data from both Heathrow Airport and Gatwick Airport. The model set-up using Heathrow Airport was used for the main modelling and included in the main section of the report. Appendix A includes a comparison of the model verification using Heathrow Airport against the alternative set-up using Gatwick Airport data, with a summary of this alternative set-up using Gatwick Airport data in Appendix B.

Finally, a summary of the ADMS-Urban model is included as Appendix C.

3 Air quality standards and guidance

The EU *ambient air quality directive* (2008/50/EC) sets binding limits for concentrations of air pollutants. The directive has been transposed into English legislation as the *Air Quality Standards Regulations 2010*[1], which also incorporates the provisions of the *4th air quality daughter directive* (2004/107/EC).

The Air Quality Standards Regulations 2010 include limit values and target values. The NO_2, PM_{10} and $PM_{2.5}$ Air Quality Objectives are presented in Table 3-1.

Table 3-1: Air quality objectives

	Value (µg/m^3)	Description of standard
NO_2	200	Hourly mean not to be exceeded more than 18 times a year (modelled as 99.79th percentile)
	40	Annual average
PM_{10}	50	24-hour mean not be exceeded more than 35 times a year (modelled as 90.41st percentile)
	40	Annual average
$PM_{2.5}$	25	Annual average

The short-term standards considered are specified in terms of the number of times during a year that a concentration measured over a short period of time is permitted to exceed a specified value. For example, the concentration of NO_2 measured as the average value recorded over a one-hour period is permitted to exceed the concentration of 200µg/m^3 up to 18 times per year. Any more exceedences than this during a one-year period would represent a breach of the objective.

It is convenient to model objectives of this form in terms of the equivalent percentile concentration value. A percentile is the concentration below which lie a specified percentage of concentration measurements. For example, consider the 98th percentile of one-hour concentrations over a year. Taking all of the 8760 one-hour concentration values that occur in a year, the 98th percentile value is the concentration below which 98% of those concentrations lie. Or, in other words, it is the concentration exceeded by 2% (100 – 98) of those hours, that is, 175 hours per year. Taking the NO_2 objective considered above, allowing 18 exceedences per year is equivalent to not exceeding for 8742 hours or for 99.79% of the year. This is therefore equivalent to the 99.79th percentile value.

Table 3-2 gives examples from the Defra TG(16) guidance of where the air quality objectives should apply.

[1] http://www.legislation.gov.uk/uksi/2010/1001/contents/made

Table 3-2: Examples of where the air quality objectives should apply

Averaging period	Objectives should apply at:	Objectives should generally not apply at:
Annual average	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
24-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties (where relevant for public exposure e.g. seating or play areas)	Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
Hourly average	All locations where the annual mean and 24-hour mean objectives apply and: Kerbside sites (for example pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. Which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

4 Local air quality

The Local Air Quality Management (LAQM) process, as set out in Part IV of the Environment Act (1995), the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 and the relevant Policy and Technical Guidance documents 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 exceedences are considered likely, the local authority must then 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.

Figure 4.1 shows the eleven local authorities in Surrey. The following subsections describe the AQMAs and monitoring data for each of the local authorities, in alphabetical order.

All monitoring data presented in this section were provided by individual boroughs, with diffusion tube concentrations presented as bias adjusted values. A 0.91 bias adjustment factor was applied to raw diffusion tube data of all boroughs except Spelthorne, for which a bias adjustment factor of 0.99 was used.

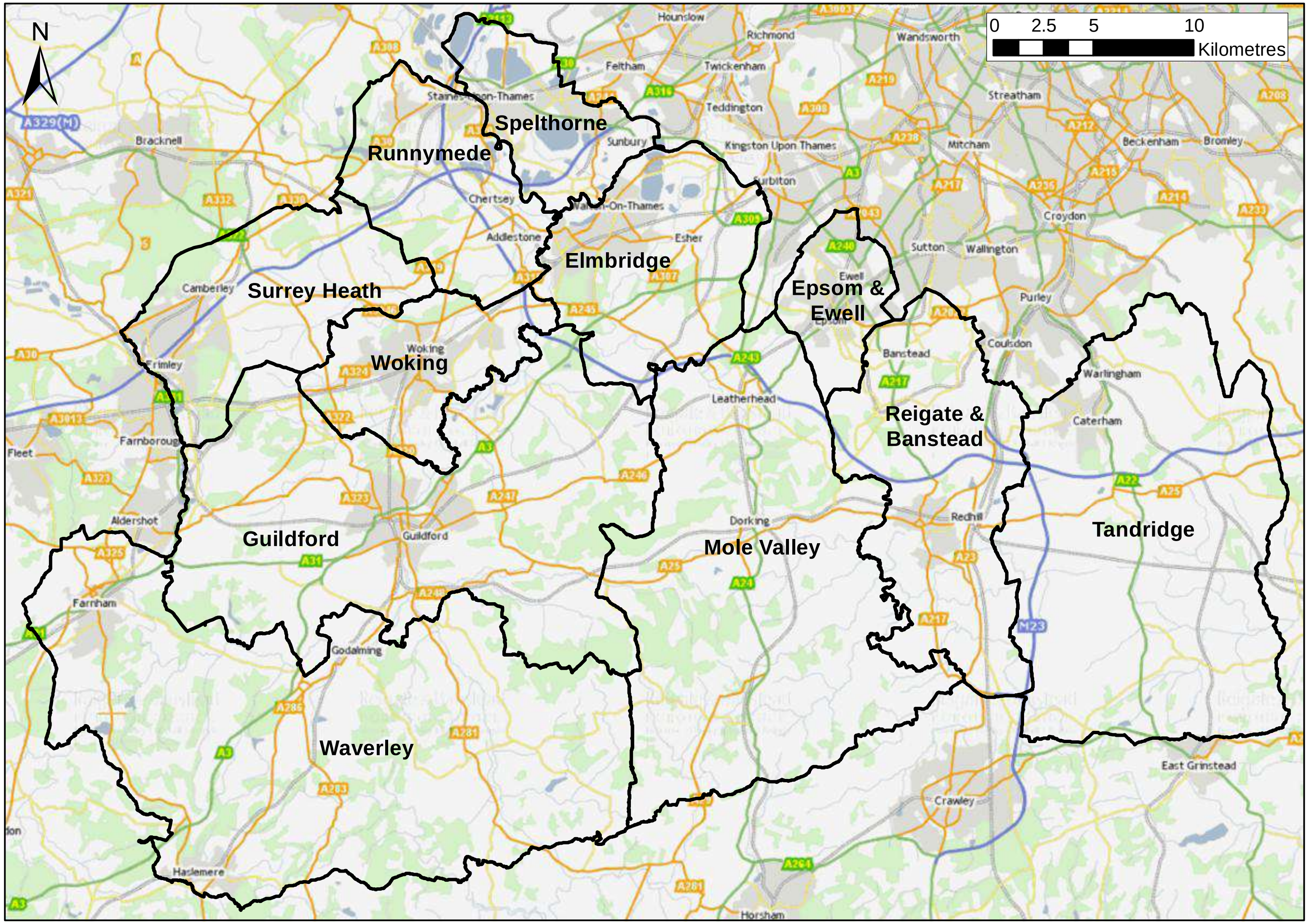

Figure 4.1: Locations of Surrey local authorities

4.1 Elmbridge Borough Council

Figure 4.2 presents the locations of monitoring sites and AQMAs in Elmbridge, comprising 40 diffusion tubes, two continuous monitors and seven AQMAs. The AQMAs are:

- Walton-on-Thames High Street;
- Weybridge High Street;
- Hampton Court;
- Cobham High Street;
- Hinchley Wood;
- Esher High Street; and
- Walton Road, Molesey.

All seven AQMAs were declared for annual mean NO_2 concentrations.

Table 4-1 presents the monitored annual average NO_2 concentrations for Elmbridge in 2017. The table includes annual average NO_x concentrations for continuous monitors. Exceedences of the air quality objective of 40µg/m³ for annual average NO_2 concentrations are highlighted in **bold**.

Two sites include triplicate diffusion tubes, collocated with continuous monitors: Hampton Court 2/3/4 are collocated with Hampton Court Parade; and Weybridge 10/11/12 are collocated with Weybridge High Street.

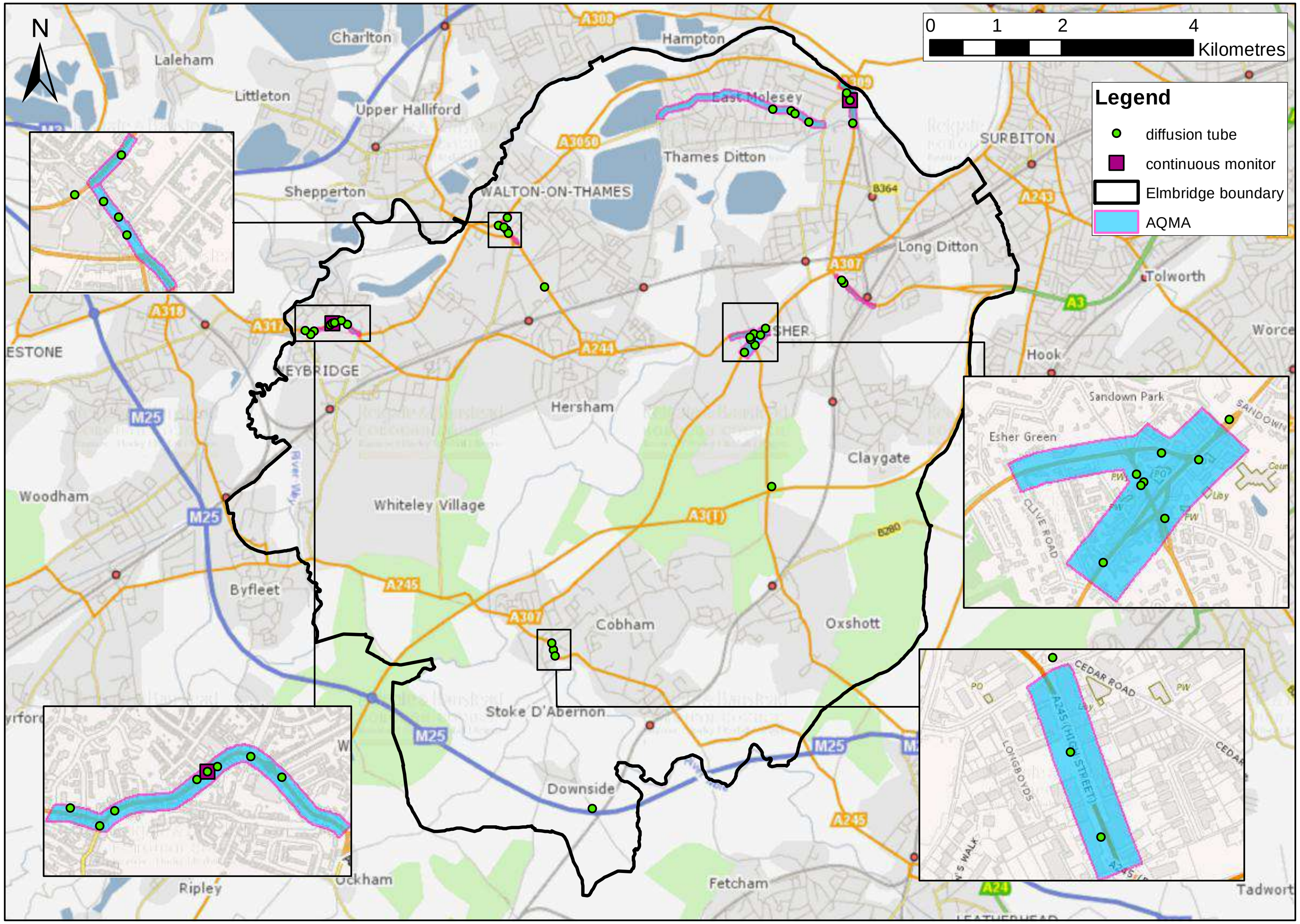

Figure 4.2: Continuous monitoring stations, diffusion tubes and AQMA locations in Elmbridge

Table 4-1: Monitored annual average NO_2 concentrations at Elmbridge continuous monitoring stations and diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (μg/m³)
Hampton Court Parade	Continuous	515342, 168292	1.8	2	**41** [NO_x 108]
Weybridge High Street	Continuous	507480, 164923	1.8	0.6	34 [NO_x 78]
Cobham 1	DT	510833, 159998	2.4	0.6	30
Cobham 6	DT	510814, 160098	2.4	6	25
Cobham 7	DT	510866, 159908	2.4	3.1	33
Downside 3	DT	511429, 157606	2.3	1.1	19
Esher 1	DT	513841, 164693	2.6	1.5	38
Esher 4	DT	514060, 164853	2.4	4.7	34
Esher 5	DT	514148, 162467	2.4	1.4	**43**
Esher 7	DT	513981, 164750	2.3	0.6	**40**
Esher 8	DT	513834, 164685	2.4	3.2	39
Esher 9	DT	513822, 164713	2.6	0.6	29
Esher 10	DT	513886, 164767	2.4	2.1	29
Esher 11	DT	513896, 164600	2.6	5.1	33
Esher 13	DT	513737, 164488	2.4	0.9	32
Hampton Court 1	DT	515384, 167947	2.2	0.9	36
Hampton Court 2	DT	515342, 168292	1.7	1.9	35
Hampton Court 3	DT				35
Hampton Court 4	DT				35
Hampton Court 5	DT	515292, 168406	2.5	0.4	26
Hinchley Wood 1	DT	515247, 165535	2.4	4.5	36
Hinchley Wood 2	DT	515217, 165577	1.9	9.8	31
Molesey 1	DT	514449, 168132	2.5	1.1	29
Molesey 8	DT	514716, 167960	2.5	2.6	32
Molesey 9	DT	514508, 168088	2.4	2.6	33
Molesey 10	DT	514170, 168156	2.4	4.9	28
Walton 3	DT	510132, 166336	2.6	0.4	30
Walton 5	DT	510704, 165473	2.3	0.9	28
Walton 8	DT	510156, 166282	2.6	2.9	31
Walton 9	DT	510086, 166382	2.5	2.6	30
Walton 10	DT	510140, 166522	2.6	3.3	34
Walton 11	DT	509999, 166402	2.4	2.3	31
Weybridge 1	DT	507448, 164900	2.5	1	30
Weybridge 4	DT	507704, 164906	2.4	2	31
Weybridge 5	DT	507610, 164968	2.3	1.6	34
Weybridge 6	DT	507510, 164937	2.3	0.5	28
Weybridge 7	DT	507199, 164805	2.4	1.5	**41**
Weybridge 8	DT	507153, 164760	2.4	4.6	36
Weybridge 9	DT	507065, 164813	1.6	13.1	23
Weybridge 10	DT	507480, 164923	1.8	0.6	32
Weybridge 11	DT				31
Weybridge 12	DT				32

4.2 Epsom and Ewell Borough Council

Figure 4.3 presents the locations of monitoring sites and the AQMA in Epsom and Ewell, comprising 20 diffusion tubes and one AQMA in High Street, Ewell. The AQMA was declared on the basis of annual mean NO_2concentrations.

Table 4-2 presents the monitored annual average NO_2 concentrations for Epsom and Ewell in 2017. Exceedences of the UK Air Quality Objective of 40µg/m³ for annual average NO_2 concentrations are highlighted in **bold**.

Table 4-2: Monitored annual average NO_2 concentrations at Epsom and Ewell diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
EE1	DT	520732, 160765	2.1	2.5	34
EE3	DT	519293, 160026	2	2	17
EE6	DT	520528, 165045	2.1	6.8	32
EE7	DT	520919, 164643	2.3	6.8	36
EE9	DT	519829, 163738	2.4	3.2	23
EE10	DT	521998, 162633	2.1	1.3	**45**
EE14	DT	520887, 161309	2	1.6	26
EE16	DT	522026, 162624	1.7	1.1	31
EE17	DT	522025, 162563	2.2	2	31
EE22	DT	520968, 160864	2.3	0.5	**40**
EE36	DT	521072, 160820	2.1	9.2	27
EE38	DT	520722, 160866	1.8	2.8	25
EE39	DT	520842, 160729	2.1	3.3	28
EE42	DT	521008, 160901	2.1	7.7	29
EE43	DT	521483, 161454	2.3	5.5	29
EE45	DT	522208, 163100	2.1	8.3	23
EE47	DT	520713, 162968	1.9	4.7	25
EE48	DT	522016, 162504	2.1	1.7	29
EE49	DT	520577, 160586	2.2	3.5	29
EE50	DT	521974, 162676	2.1	0.9	37

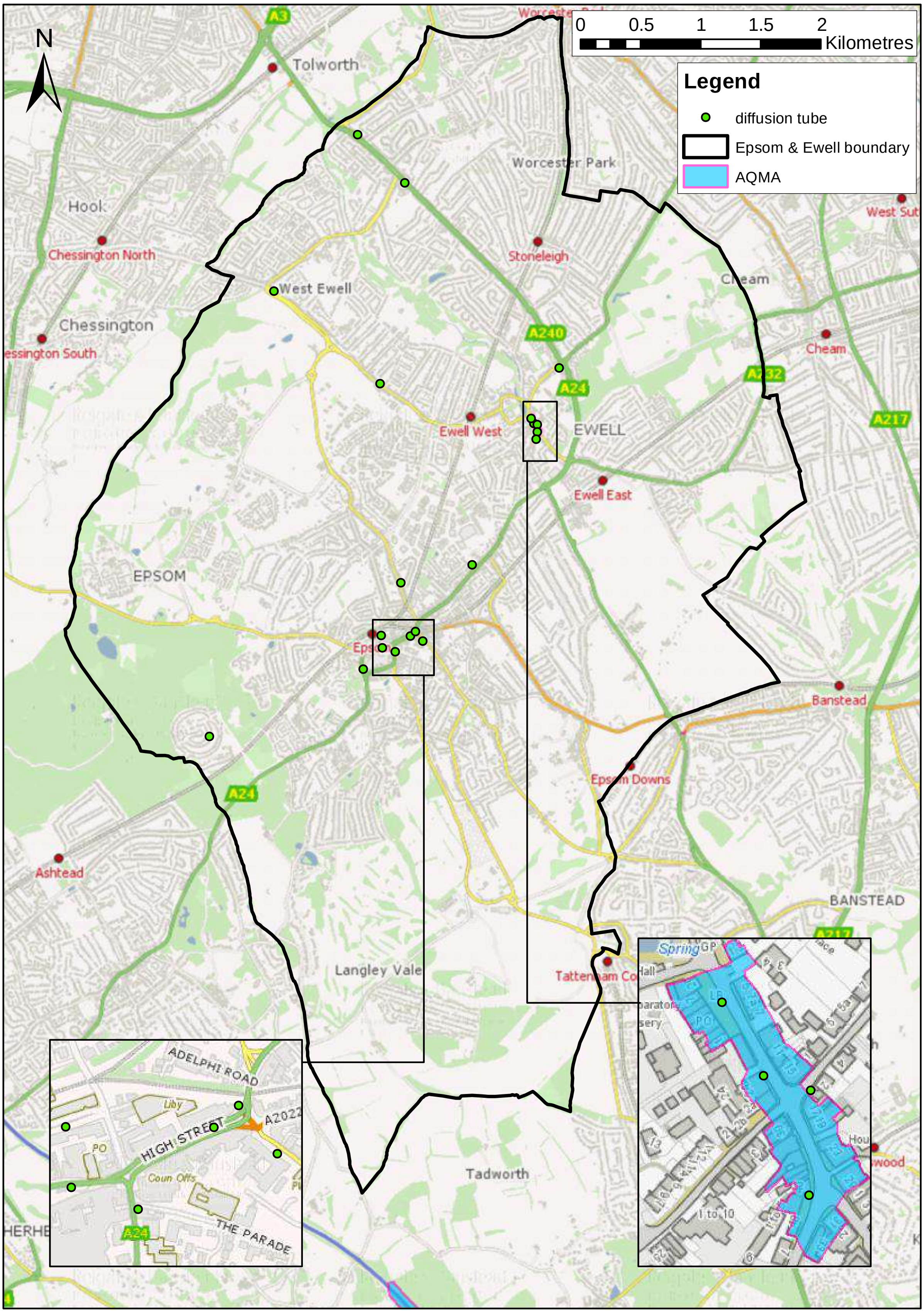

Figure 4.3: Diffusion tube and AQMA locations, Epsom and Ewell

4.3 Guildford Borough Council

Figure 4.4 presents the locations of monitoring sites in Guildford, comprising 26 diffusion tubes. Guildford Borough Council has not declared any AQMAs.

Table 4-3 presents the monitored annual average NO_2 concentrations for Guildford in 2017. Exceedences of the UK Air Quality Objective of 40µg/m³ for annual average NO_2 concentrations are highlighted in **bold**.

Table 4-3: Monitored annual average NO_2 concentrations at Guildford diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
GUL_ASH1	DT	489885, 150767	2.5	10	18
GUL_ASH2	DT	488350, 150078	2.5	N/A	22
GUL_C4	DT	495440, 147289	2.5	1.5	**40**
GUL_C9	DT	495446, 147271	2.5	1	**44**
GUL_C10	DT	495440, 147291	2.5	1	32
GUL_FRH1	DT	499024, 149402	2.5	N/A	34
GUL_GD1	DT	499272, 149524	2.5	5	29
GUL_GD2	DT	499799, 149932	2.5	5	31
GUL_GD3	DT	499658, 150732	2.5	5	17
GUL_GD6	DT	500385, 148342	2.5	120	10
GUL_GD9	DT	488276, 149859	2.5	5	17
GUL_GD10	DT	488629, 150032	2.5	5	15
GUL_GD11	DT	498133, 150648	2.5	8	24
GUL_GD13	DT	499300, 149514	2.5	1	31
GUL_GD14	DT	499800, 149912	2.5	5	32
GUL_GD15	DT	499806, 150792	2.5	8	28
GUL_RP1	DT	505242, 156820	2.5	5	28
GUL_RP2	DT	505090, 156776	2.5	1	24
GUL_send1	DT	502860, 155420	2.5	5	22
GUL_send2	DT	502173, 155846	2.5	1	21
GUL_SH1	DT	500045, 147603	2.5	1	36
GUL_STN	DT	498831, 151473	2.5	1	25
GUL_T1	DT	488637, 148845	2.5	N/A	23
GUL_WCL	DT	504476, 151404	2.5	1	20
GUL_WP1	DT	497971, 152575	2.5	1	25
GUL_WS1	DT	507346, 158005	2.5	NA	14

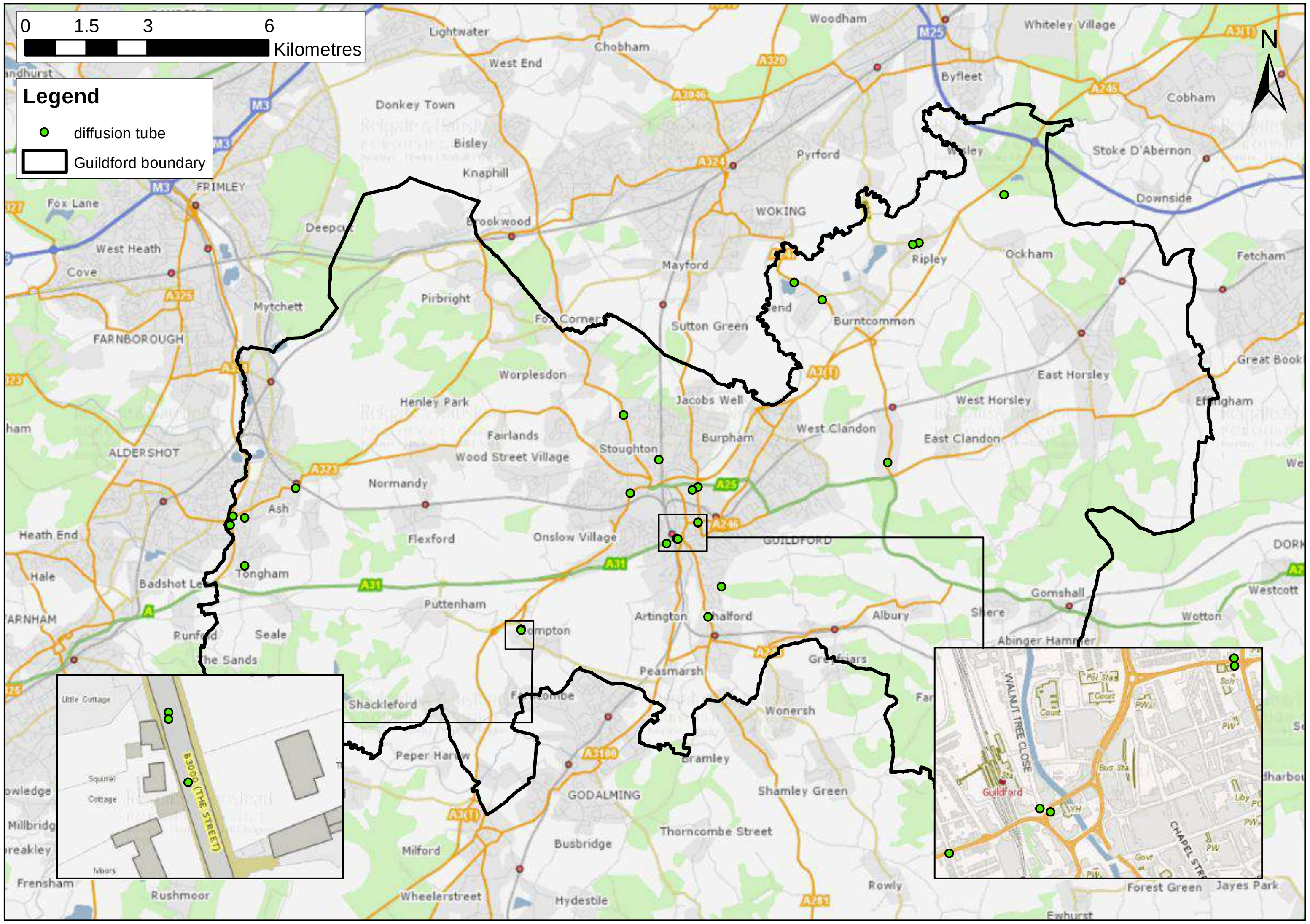

Figure 4.4: Diffusion tubes locations, Guildford

4.4 Mole Valley District Council

Figure 4.5 presents the locations of monitoring sites in Mole Valley, comprising 12 diffusion tubes. Mole Valley District Council has not declared any AQMAs.

Table 4-4 presents the monitored annual average NO_2 concentrations for Mole Valley in 2017. There were no monitored exceedences of the air quality objective of 40µg/m³ for annual average NO_2 concentrations in 2017.

Table 4-4: Monitored annual average NO_2 concentrations at Mole Valley diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
MV1	DT	516388, 149369	2.5	2	24
MV2	DT	516256, 148882	2.5	2	20
MV3	DT	516867, 149800	2.5	27	17
MV4	DT	514123, 155336	2.5	17	14
MV6	DT	517214, 157204	2.5	28	30
MV7	DT	520210, 150565	2.5	13	17
MV8	DT	523419, 140580	2.5	36	18
MV9	DT	526906, 142368	2.5	55	11
MV10	DT	517712, 156744	2.5	2	33
MV12	DT	517674, 156840	2.5	2	30
MV13	DT	516125, 149357	2.5	1	33
MV14	DT	517037, 149800	2.5	15	18

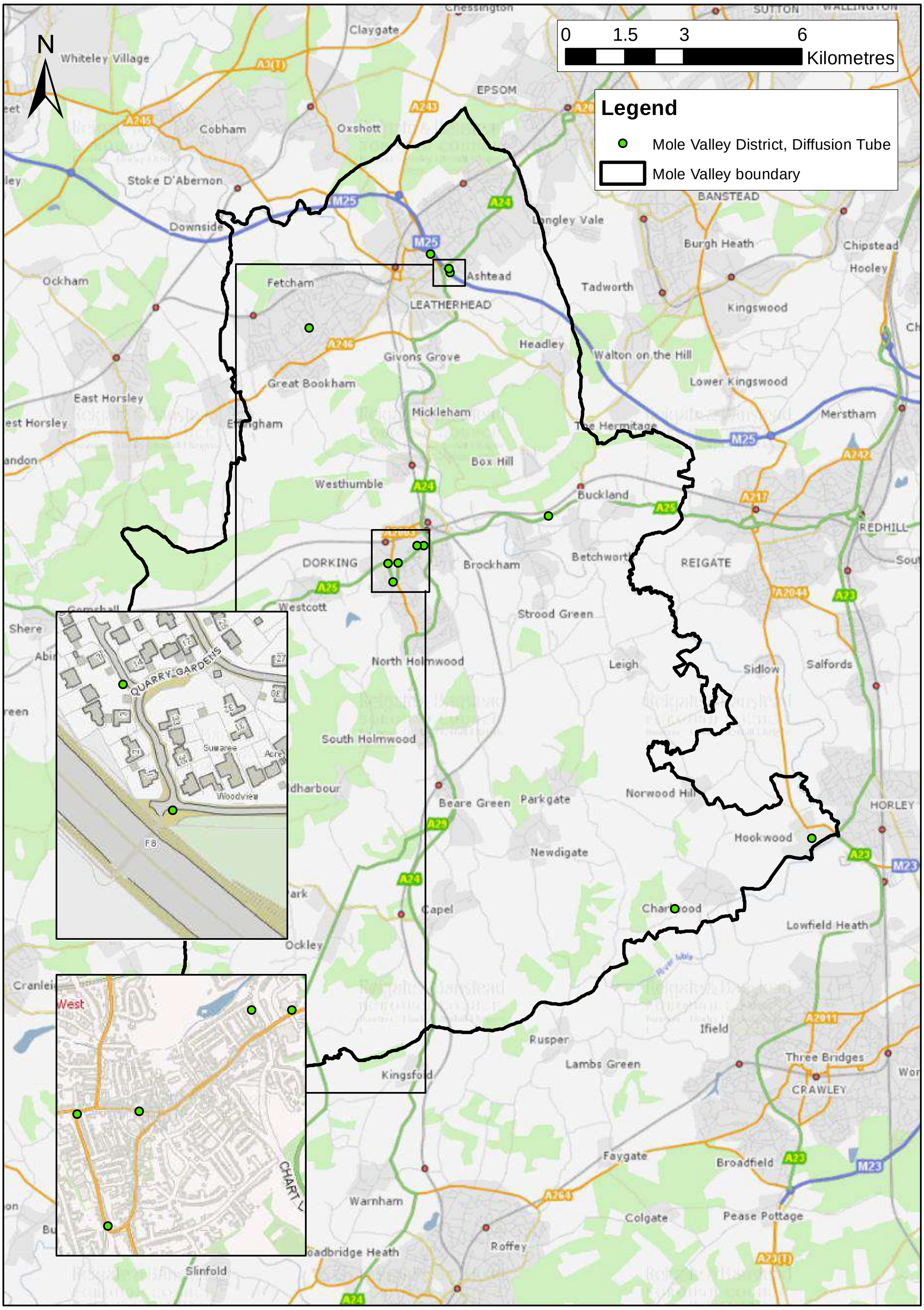

Figure 4.5: Diffusion tubes, Mole Valley

4.5 Reigate and Banstead Borough Council

Figure 4.6 presents the locations of monitoring sites in Reigate and Banstead, comprising 104 diffusion tubes, three continuous monitors and nine AQMAs. The AQMAs are:

- AQMA No. 1 (M25)
- AQMA No. 3 (Horley)
- AQMA No. 6 (Blackhorse Lane)
- AQMA No. 8 (Drift Bridge)
- AQMA No. 9 (Reigate High Street, West Street and Bell Street)
- AQMA No. 10 (Merstham)
- AQMA No. 11 (Reigate Hill)
- AQMA No. 12 (Redhill)
- AQMA No. 13 (Hooley)

All nine were declared on the basis of annual mean NO_2 concentrations.

Table 4-5 presents the monitored annual average NO_2 concentrations for Reigate and Banstead in 2017. The table includes annual average NO_x concentrations for continuous monitors. Exceedences of the air quality objective of 40µg/m³ for annual average NO_2 concentrations are shown in **bold**.

Three sites include triplicate diffusion tubes collocated with continuous monitors:

- RB24, RB25 and RB26 are collocated with RG1;
- RB99, RB100 and RB101 are collocated with RG3.
- RB178, RB179 and RB180 are collocated with RG6; and

Note that RG3, and collocated RB99, RB100 and RB101 diffusion tubes fall outside of Surrey but are managed by Reigate and Banstead. One diffusion tube, RB102 is managed by Reigate and Banstead but falls within Tandridge District Council.

Table 4-6 presents the monitored annual average PM_{10} concentrations at two continuous monitors in Reigate and Banstead in 2017. At the same location, PM_{10} concentrations are measured using both Tapered Element Oscillating Microbalance (TEOM) and Filtered Dynamic Measurement System (FDMS) instruments, at RG1 and RG5 respectively.

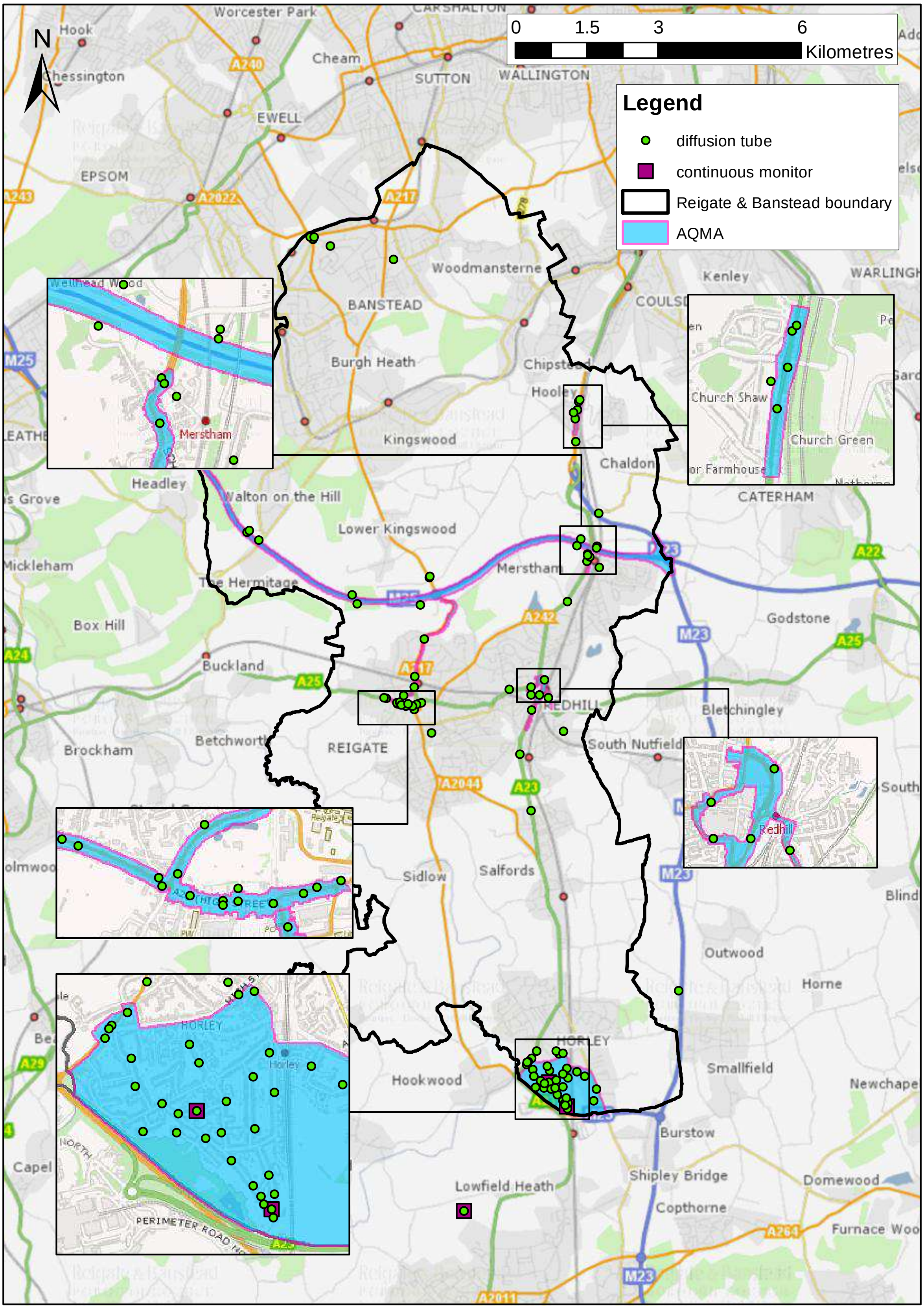

Figure 4.6: Diffusion tubes, continuous monitoring sites and AQMAs, Reigate and Banstead

Table 4-5: Monitored annual average NO_2 concentrations at Reigate and Banstead continuous monitoring stations and diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
RG1	Continuous	528208, 142337	3.5	19.1	20 [NO_x 34]
RG6	Continuous	528591, 141830	1.5	0.7	27 [NO_x 46]
RG3	Continuous	526421, 139639	2	12.6	14 [NO_x 19]
RB1	DT	525246, 150251	3.1	5.1	32
RB3	DT	524944, 159630	3	0.7	18
RB8	DT	525246, 150287	3.7	39.2	18
RB9	DT	525749, 149677	2.5	24.9	17
RB11	DT	528104, 142226	3	1.4	23
RB12	DT	528423, 142935	2.9	0.4	28
RB13	DT	528368, 142996	2.9	30	20
RB17	DT	528511, 149715	2.9	1.7	14
RB18	DT	529262, 153156	3	1.3	23
RB19	DT	529067, 153375	2.9	0.7	24
RB20	DT	529025, 153419	2.9	2.6	33
RB21	DT	523198, 160095	2.9	1.7	34
RB22	DT	523279, 160101	2.9	1.1	20
RB23	DT	523613, 159906	2.7	2.3	16
RB24	DT				21
RB25	DT	528208, 142337	3.5	19.1	22
RB26	DT				21
RB27	DT	521873, 153896	3	5.6	25
RB29	DT	521921, 153937	3	11.7	25
RB30	DT	522112, 153728	3	18.9	24
RB31	DT	525506, 152366	3	19.5	16
RB33	DT	524081, 152580	3	0	21
RB34	DT	524177, 152393	3	45.6	24
RB36	DT	528885, 153759	3	74.8	20
RB37	DT	529217, 153605	3	12	24
RB39	DT	529211, 153572	3	10.9	25
RB40	DT	529252, 154290	3	15	20
RB43	DT	528799, 153616	3	52.4	23
RB44	DT	525534, 150308	3	14.6	31
RB45	DT	525430, 150273	3	0.1	28
RB46	DT	525344, 150245	3	0.4	36
RB47	DT	525111, 150267	3	0.5	35
RB49	DT	525698, 152943	3	3.5	**42**
RB50	DT	525708, 152969	3	24	26
RB51	DT	527873, 142606	3.5	15.1	21
RB52	DT	527893, 142463	3.5	13.7	25
RB53	DT	528030, 142374	3.5	4.3	25
RB54	DT	528112, 142321	3.5	4.2	23
RB55	DT	528254, 142196	3.5	1.1	23
RB56	DT	528386, 142080	3.5	2.6	24
RB57	DT	528499, 141953	3.5	2.6	26

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
RB58	DT	528538, 141897	3.5	2.6	27
RB59	DT	528602, 141789	3.5	2.2	28
RB60	DT	528607, 141910	3.5	2.8	27
RB61	DT	528578, 142006	3.5	1	23
RB64	DT	528608, 142432	3.5	1.6	22
RB65	DT	528581, 142635	3.5	16.8	22
RB66	DT	528499, 142512	3.5	18.5	22
RB68	DT	528505, 142246	3.5	18.5	24
RB69	DT	528335, 142224	3.5	14	26
RB70	DT	528360, 142384	3.5	17.8	24
RB72	DT	528219, 142583	3.5	19.2	22
RB73	DT	528172, 142679	3.5	17.8	22
RB74	DT	529149, 141953	3.5	15.1	23
RB75	DT	529210, 142195	3.5	12.4	24
RB76	DT	528957, 142471	3.5	20.7	20
RB77	DT	528797, 142567	3.5	13	21
RB78	DT	528553, 141857	3.5	2.7	27
RB81	DT	527595, 149235	3.5	5.5	31
RB82	DT	528770, 155798	3.5	18.3	34
RB95	DT	525382, 150639	2	5.9	25
RB98	DT	527931, 142231	2	1	26
RB99	DT	526421, 139639	2	12.4	14
RB100	DT				14
RB101	DT				14
RB102	DT	530936, 144271	2	19.1	21
RB104	DT	525204, 150252	2	4.9	35
RB105	DT	525203, 150240	2	2.8	39
RB106	DT	523254, 160055	2	2.1	29
RB107	DT	525467, 150290	2	2.3	26
RB109	DT	525385, 150178	2	3.6	32
RB110	DT	529016, 153439	2	4.3	29
RB111	DT	525032, 150293	2	4.3	30
RB113	DT	524795, 150406	2	2.1	27
RB115	DT	524750, 150425	2	0.6	30
RB116	DT	525022, 150317	2	2.3	32
RB117	DT	525075, 150327	2	2.9	35
RB118	DT	525152, 150466	2	14.2	31
RB120	DT	528195, 150421	2	2.2	33
RB122	DT	528014, 150475	2	2.9	32
RB123	DT	527838, 150475	2	0.5	36
RB124	DT	529009, 153283	2	1.8	35
RB125	DT	525590, 151655	2	2.7	35
RB136	DT	528812, 156473	2	1	**49**
RB137	DT	528833, 156648	2	6	**42**
RB140	DT	528122, 150799	2	7.2	25
RB141	DT	527372, 150595	2	2.7	24

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
RB145	DT	527850, 150159	2	2.2	34
RB146	DT	528760, 156277	2	3.2	**41**
RB147	DT	528732, 156407	2	51	16
RB148	DT	528855, 156674	2.5	2.1	**63**
RB149	DT	527736, 142710	2.5	1.6	**46**
RB150	DT	525397, 150867	2	3.4	38
RB151	DT	528502, 142952	2.5	1.8	33
RB152	DT	528599, 152439	2.5	1.6	33
RB153	DT	527837, 148046	2.5	2.9	29
RB167	DT	527829, 150643	3	3.1	25
RB174	DT	527851, 142842	2	3	31
RB175	DT	527952, 142999	2.5	2.8	31
RB176	DT	527770, 142777	2	10.2	25
RB177	DT	527757, 142759	2	8.6	25
RB178	DT	528591, 141830	2.5	N/A	26
RB179	DT				25
RB180	DT				26

Table 4-6: Monitored annual average PM_{10} concentrations at Reigate and Banstead continuous monitoring stations, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
RG1	Continuous (TEOM)	528208, 142337	3.5	19.1	16
RG5	Continuous (FDMS)				15

4.6 Runnymede Borough Council

Figure 4.7 presents the locations of monitoring sites throughout Runnymede, comprising 25 diffusion tubes and two AQMAs. The AQMAs are:

- M25 AQMA, declared for annual mean NO_2, annual mean PM_{10} and 24-hour mean PM_{10} concentrations. The AQMA combines 2 area: Area 1 extends 70m east and west of the centre line of the M25 between Junction 11 [and] Junction 13, plus an area where the M25 crosses over Vicarage Road/ High Street Egham; and Area 2 extends 55m east and west of the centre line of the M25 between Junction 11 [and] the southerly boundary of the borough.
- Addlestone AQMA, declared for annual mean NO_2concentrations.

Table 4-7 presents the monitored annual average NO_2 concentrations for Runnymede in 2017. Exceedences of the air quality objective of 40µg/m³ for annual average NO_2 concentrations are shown in **bold**.

Table 4-7: Monitored annual average NO_2 concentrations at Runnymede diffusion tubes and continuous monitoring stations, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
RYMV	DT	505797, 162303	2.3	2	32
RY4	DT	505726, 164626	2	6	17
RY14	DT	504993, 164602	2.3	2	**48**
RY19	DT	505227, 162701	2	2	34
RY21	DT	504260, 166943	2	1	34
RY23	DT	504888, 166786	2.2	1	**51**
RY25	DT	501749, 171325	2.3	13	30
RY26	DT	501715, 171381	2.2	2	**42**
RY33	DT	501679, 171677	2.1	15	31
RY34	DT	499335, 170688	2.3	1	22
RY39	DT	498829, 166213	1.8	10	23
RY40	DT	502037, 165370	2.5	68	16
RY43	DT	504996, 165339	2.3	2	37
RY44	DT	504621, 164433	2.4	2	27
RY45	DT	504844, 166647	2.3	2	37
RY53	DT	504967, 164922	2.4	2	34
RY54	DT	505032, 164552	2.3	2	30
RY55	DT	505592, 164840	2.3	0.2	33
RY59	DT	503012, 171332	2.3	1	32
RY60	DT	504960, 164801	2.4	2	33
RY61	DT	504906, 164558	2.4	2	31
RY62	DT	505081, 164431	2.3	2	34
RY64	DT	505253, 164400	2.3	1	26
RY65	DT	505801, 165041	2.3	2	27
RY66	DT	505705, 164951	2.3	2	25

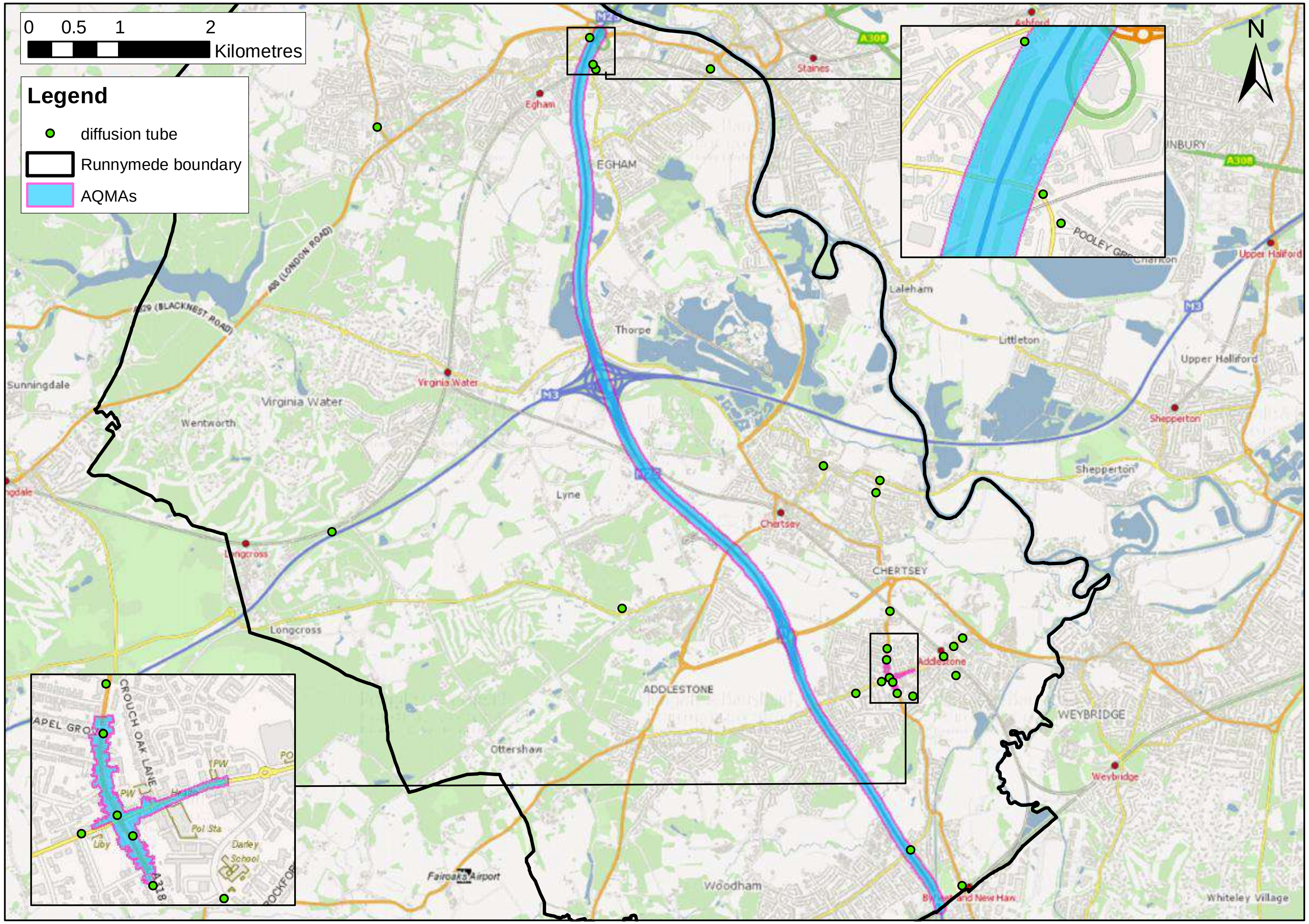

Figure 4.7: Diffusion tubes, continuous monitoring stations and AQMA location, Runnymede

4.7 Spelthorne Borough Council

Figure 4.8 presents the locations of monitoring sites in Spelthorne, comprising 44 diffusion tubes, three continuous monitors and one AQMA encompassing the entire borough of Spelthorne. The AQMA was declared for annual mean NO_2 concentrations.

Table 4-8 presents the monitored annual average NO_2 concentrations for Spelthorne in 2017. The table includes annual average NO_x concentrations for continuous monitors. Exceedences of the UK Air Quality Objective of 40µg/m³ for annual average NO_2 concentrations are highlighted in **bold**.

Table 4-9 presents the monitored annual average PM_{10} and $PM_{2.5}$ concentrations at three continuous monitors in Spelthorne in 2017.

Three sites include triplicate diffusion tubes collocated with continuous monitors:

- SP16/17/18 are collocated with BAA_Oaks; and
- SP43/44/45 are collocated with SUN_01.

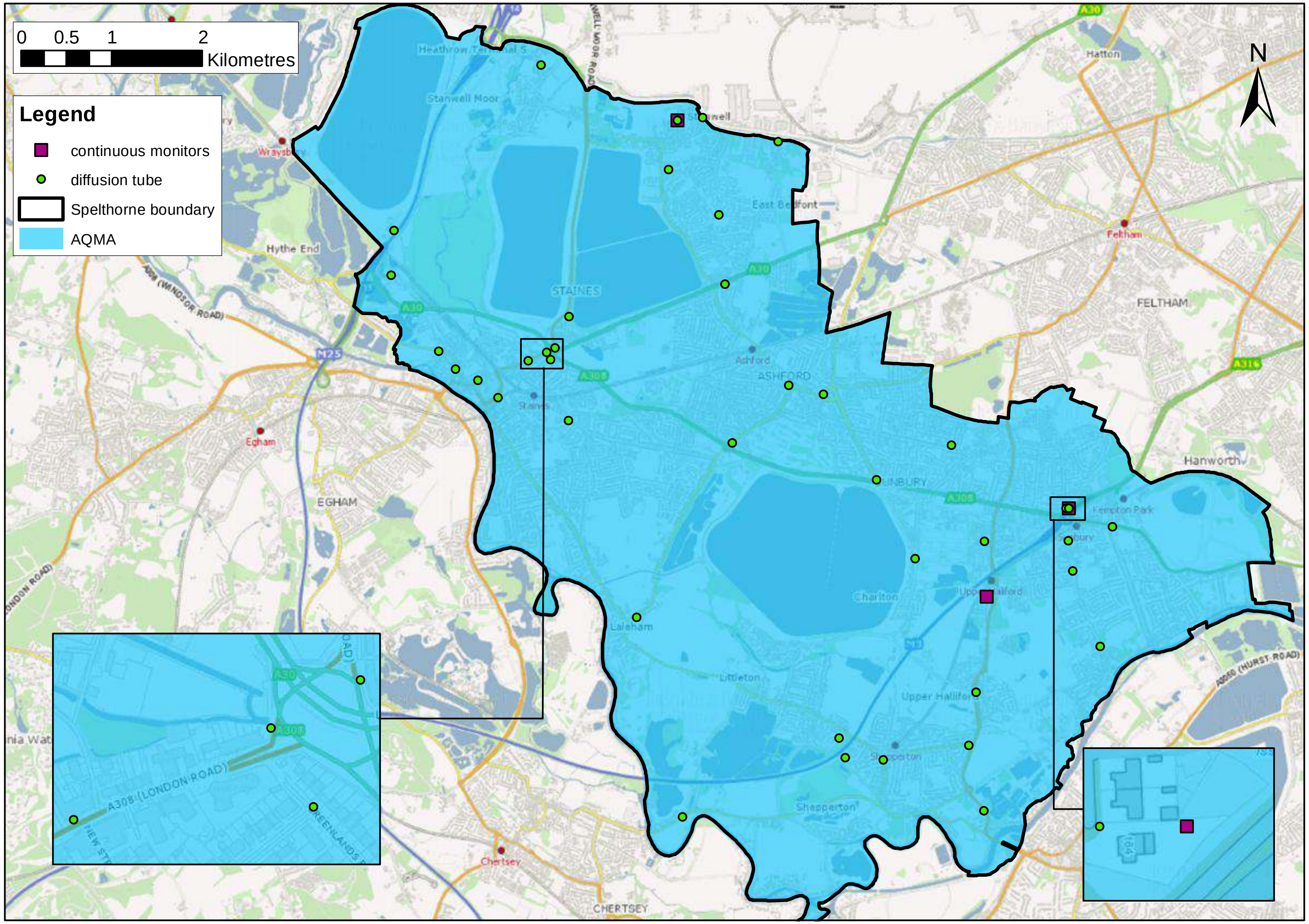

Figure 4.8: Diffusion tubes, continuous monitoring stations and AQMA, Spelthorne

Table 4-8: Monitored annual average NO_2 and NO_x concentrations at Spelthorne continuous monitoring stations and diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (μg/m³)
BAA_Oaks	Continuous	505735, 174489	3.5	1	26 [NO_x 47]
SCC_ECO	Continuous	509155, 169228	2.16	5.5	24 [NO_x 44]
SUN_01	Continuous	510063, 170200	2.06	19	33 [NO_x 59]
SP1	DT	503529, 171619	2.5	N/A	28
SP3	DT	503098, 171935	2.5	0.5	31
SP4	DT	510054, 169843	2.5	2	27
SP5	DT	506967, 171563	2.3	1.5	37
SP6	DT	508763, 170900	2.5	0.5	24
SP10	DT	509124, 166861	2.4	1.5	35
SP11	DT	509034, 168169	2.2	1.8	35
SP12	DT	504538, 172318	2.5	1	31
SP14	DT	504228, 175098	2.8	N/A	25
SP16	DT	505735, 174489	1.7	N/A	26
SP17	DT				26
SP18	DT				27
SP19	DT	506851, 174252	2.5	1.5	32
SP20	DT	504334, 171845	1.7	1	32
SP21	DT	509131, 169840	2.5	N/A	26
SP23	DT	507525, 167662	2.7	1	23
SP24	DT	502577, 172777	2.8	N/A	27
SP26	DT	505635, 173948	2.7	N/A	28
SP27	DT	503286, 171743	2.8	2	31
SP28	DT	504291, 171926	2.4	1.5	35
SP29	DT	504383, 171975	2.4	1	**44**
SP31	DT	506265, 172682	2.4	2	36
SP32	DT	507347, 171462	2.2	1	29
SP33	DT	506339, 170927	2.3	3	34
SP34	DT	507936, 170518	2.2	2	38
SP35	DT	510028, 170200	2.5	10	37
SP36	DT	510104, 169508	2.5	2.2	**40**
SP38	DT	505289, 168996	2.1	2	24
SP39	DT	504532, 171172	2.4	N/A	25
SP41	DT	510407, 168677	2.2	0.5	30
SP43	DT	510063, 170200	2	29	33
SP44	DT				33
SP45	DT				33
SP46	DT	503754, 171428	2.5	1	31
SP47	DT	506193, 173447	2.5	1.5	25
SP48	DT	506012, 174518	2.5	1	30
SP49	DT	502605, 173274	2.15	7.5	29
SP50	DT	508364, 169648	2.6	1.8	33
SP51	DT	504087, 171832	2.1	3.3	37
SP52	DT	510542, 169996	2.1	2.1	32
SP53	DT	505792, 166789	2.44	1.6	29
SP55	DT	508954, 167584	2.3	1	33
SP56	DT	507587, 167445	2	1.6	21
SP57	DT	508008, 167422	2.5	1.7	33

Table 4-9: Monitored annual average PM_{10} and $PM_{2.5}$ concentrations at Spelthorne continuous monitoring stations, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	PM_{10} Concentration (μg/m^3)	$PM_{2.5}$ Concentration (μg/m^3)
BAA_Oaks	Continuous	505735, 174489	3.5	1	14	9
SCC_ECO	Continuous	509155, 169228	2.16	5.5	21	15
SUN_01	Continuous	510063, 170200	2.06	19	13	8

4.8 Surrey Heath Borough Council

Figure 4.9 presents the locations of monitoring sites in Surrey Heath, comprising 36 diffusion tubes, one continuous monitor and one AQMA, extending along the M3 bounded by Frimley Road, Camberley and Ravenswood Roundabout, Camberley. The AQMA was for NO_2 annual mean and PM_{10} 24-hour mean concentrations.

Table 4-10 presents the monitored annual average NO_2 concentrations for Surrey Heath in 2017. The table includes annual average NO_x concentrations for continuous monitors. Exceedences of the UK Air Quality Objective of 40µg/m³ for annual average NO_2 concentrations are highlighted in **bold**. PM_{10} is also monitored at the continuous monitor CM1, in accordance with monitoring the 24-hour mean for PM_{10} within the AQMA.

Table 4-11 presents the monitored annual average for PM_{10} concentrations at the continuous monitor in Surrey Heath in 2017. SH15/22/25, are triplicate diffusion tubes collocated with the continuous monitor CM1.

Table 4-10: Monitored annual average NO_2 concentrations at Surrey Heath continuous monitoring station and diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
CM1	Continuous	488649, 159805	1.5	17	36 [NO_x 66]
SH1	DT	491010, 163344	2.5	1	14
SH2	DT	491063, 163333	1.75	2.5	19
SH3	DT	492810, 164408	1.75	N/A	13
SH4	DT	494764, 159623	1.75	N/A	21
SH5	DT	489463, 160583	1.75	17	19
SH6	DT	494973, 159612	1.75	2.3	19
SH7	DT	496221, 164430	1.75	10	28
SH8	DT	496169, 164464	1.75	62	16
SH9	DT	489617, 161874	1.75	4.8	16
SH10	DT	485860, 160109	1.75	3	21
SH11	DT	486933, 159006	1.75	6	21
SH12	DT	487490, 160788	1.75	2	22
SH13	DT	488740, 159579	1.75	1	20
SH14	DT	488619, 159658	1.75	1	21
SH15	DT	488649, 159805	1.75	17	24
SH22	DT				25
SH25	DT				23
SH16	DT	486834, 158336	1.75	35	24
SH17	DT	495487, 158960	1.75	2	15
SH20	DT	490353, 157214	1.75	2	17
SH21	DT	495134, 161087	1.75	N/A	14
SH23	DT	490781, 160269	1.75	1	17
SH24	DT	497344, 161734	1.75	2	22
SH26	DT	487762, 161392	1.75	N/A	21
SH27	DT	495546, 158848	1.75	3	23

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
SH28	DT	495325, 159055	1.75	5	19
SH29	DT	494222, 163476	1.75	0	14
SH30	DT	487181, 158432	1.75	20	24
SH31	DT	487024, 158415	1.75	20	19
SH32	DT	486982, 158389	1.75	20	21
SH33	DT	486848, 158311	1.75	20	25
SH34	DT	487934, 159132	1.75	50	19
SH35	DT	489189, 160209	1.75	5	19
SH36	DT	489347, 160392	1.75	15	20
SH37	DT	489081, 160271	1.75	5	21
SH38	DT	491706, 163145	1.75	15	24

Table 4-11: Monitored annual average PM_{10} concentration at Surrey Heath continuous monitoring station, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	PM_{10} Concentration (µg/m³)
CM1	Continuous	488649, 159805	1.5	1.7	17

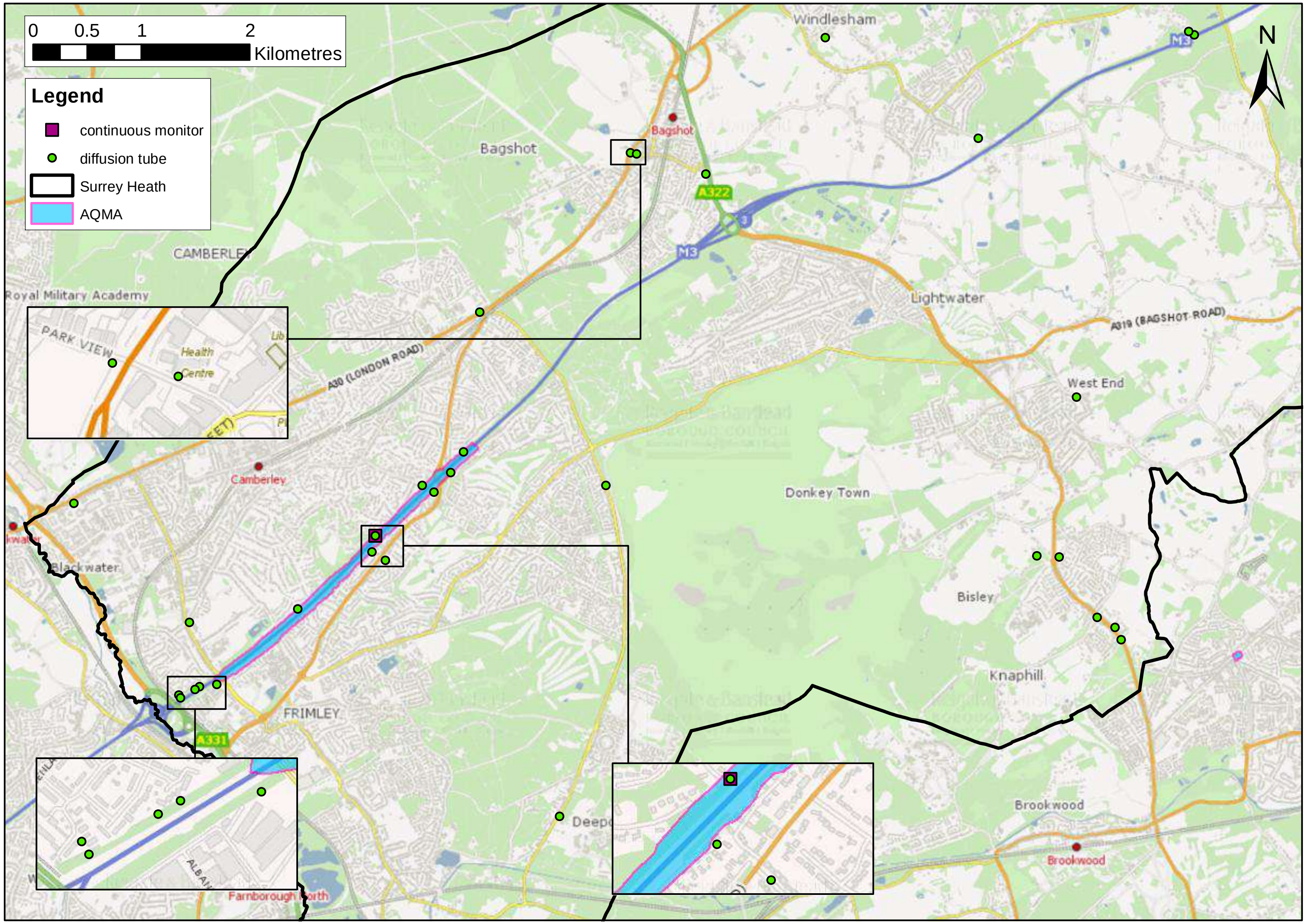

Figure 4.9: Diffusion tubes, continuous monitoring station and AQMA across Surrey Heath

4.9 Tandridge District Council

Figure 4.10 presents the locations of monitoring sites throughout Tandridge, comprising 28 diffusion tubes. Tandridge District Council has not declared any AQMAs.

Table 4-12 presents the monitored annual average NO_2 concentrations in Tandridge in 2017. Exceedences of the air quality objective of 40µg/m³ for annual average NO_2 concentrations are shown in **bold**. Note, there is one diffusion tube in Tandridge managed by Reigate and Banstead Borough Council. Details for this diffusion tube, RB102, are provided in Table 4-5

Table 4-12: Monitored annual average NO_2 concentrations at Tandridge diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (µg/m³)
TANWI_001	DT	534825, 151633	2.5	N/A	23
TANWI_002	DT	534949, 151684	2.5	N/A	31
TANWI_003	DT	535012, 151821	2.5	N/A	**42**
TANWI_004	DT	535002, 151856	2.5	N/A	26
TANWI_005	DT	534993, 152052	2.5	N/A	**41**
TANWI_006	DT	535020, 152269	2.5	N/A	25
TD5	DT	535071, 152659	2.5	2.2	29
TD7	DT	535167, 152200	2.5	152	19
TD8	DT	534883, 152316	2.5	132	19
TD9	DT	539111, 153656	2.5	1.5	17
TD14	DT	534364, 157506	2.5	0.5	27
TD19	DT	531134, 143585	2.5	130	21
TD23	DT	535840, 158430	2.5	1.5	23
TD25	DT	533839, 158847	2.5	1.7	19
TD26	DT	531105, 142939	2.5	133	23
TD27	DT	530719, 150539	2.5	1.3	29
TD28	DT	539881, 152746	2.5	1.5	28
TD30	DT	540258, 153783	2.5	1.5	22
TD31	DT	535186, 159127	2.5	0.5	20
TD32	DT	539684, 152744	2.5	1.5	22
TD33	DT	532790, 155873	2.5	1	25
TD34	DT	539464, 152936	2.5	0.4	20
TD35	DT	531952, 150789	2.5	2.5	27
TD36	DT	534050, 155838	2.5	1	25
TD37	DT	530385, 150477	2.5	1	19
TD38	DT	531840, 150826	2.5	1	25
TD39	DT	536909, 139713	2.5	0.5	26
TD40	DT	530592, 150508	2.5	1.5	33

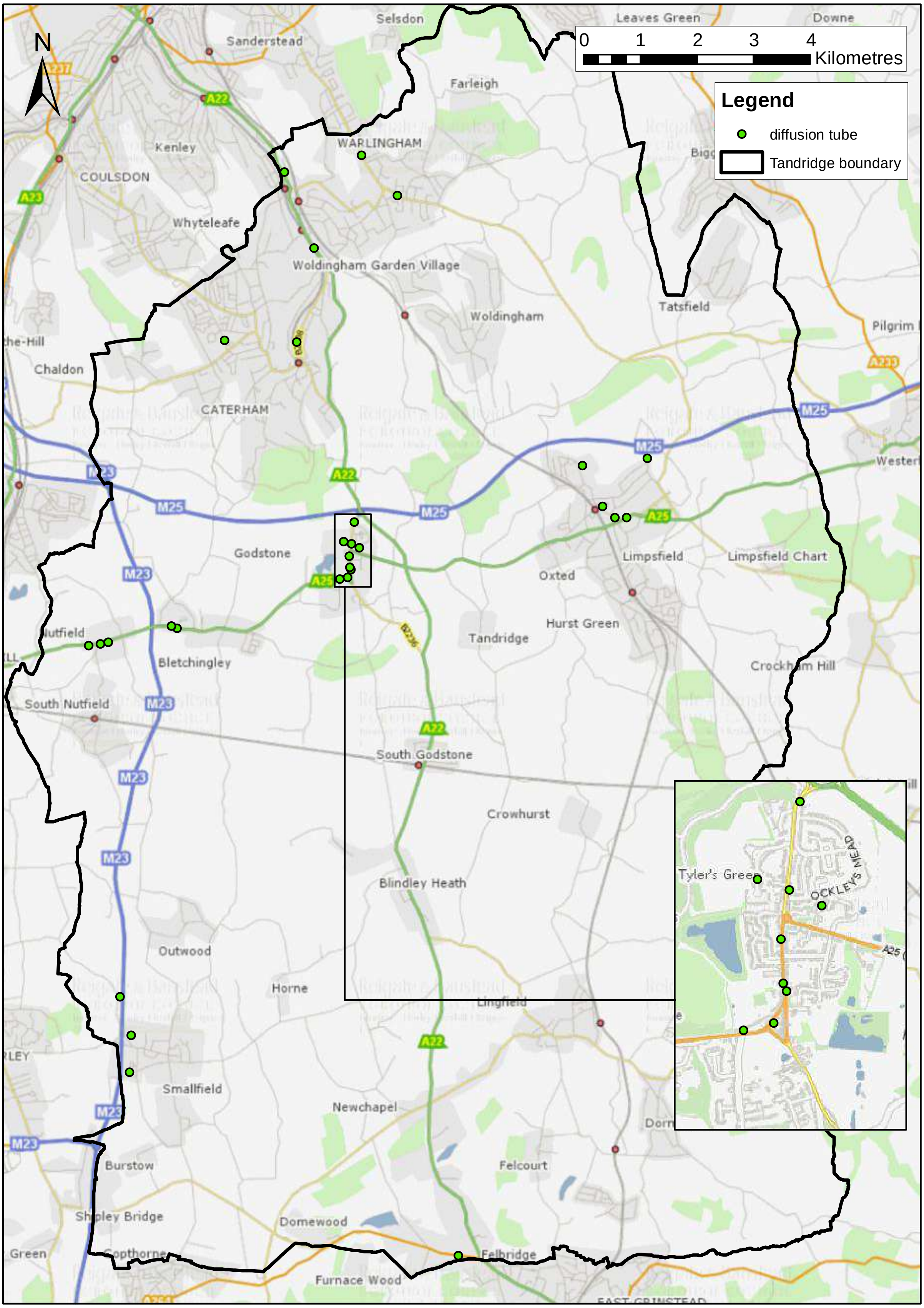

Figure 4.10: Diffusion tube locations, Tandridge

4.10 Waverley Borough Council

Figure 4.11 presents the locations of the two active AQMAs in Waverley. The AQMAs are:

- AQMA No. 1 Farnham
- AQMA No. 2 Godalming

Both AQMAs were declared for annual mean NO_2 concentrations.

Monitoring data for Waverley were not provided.

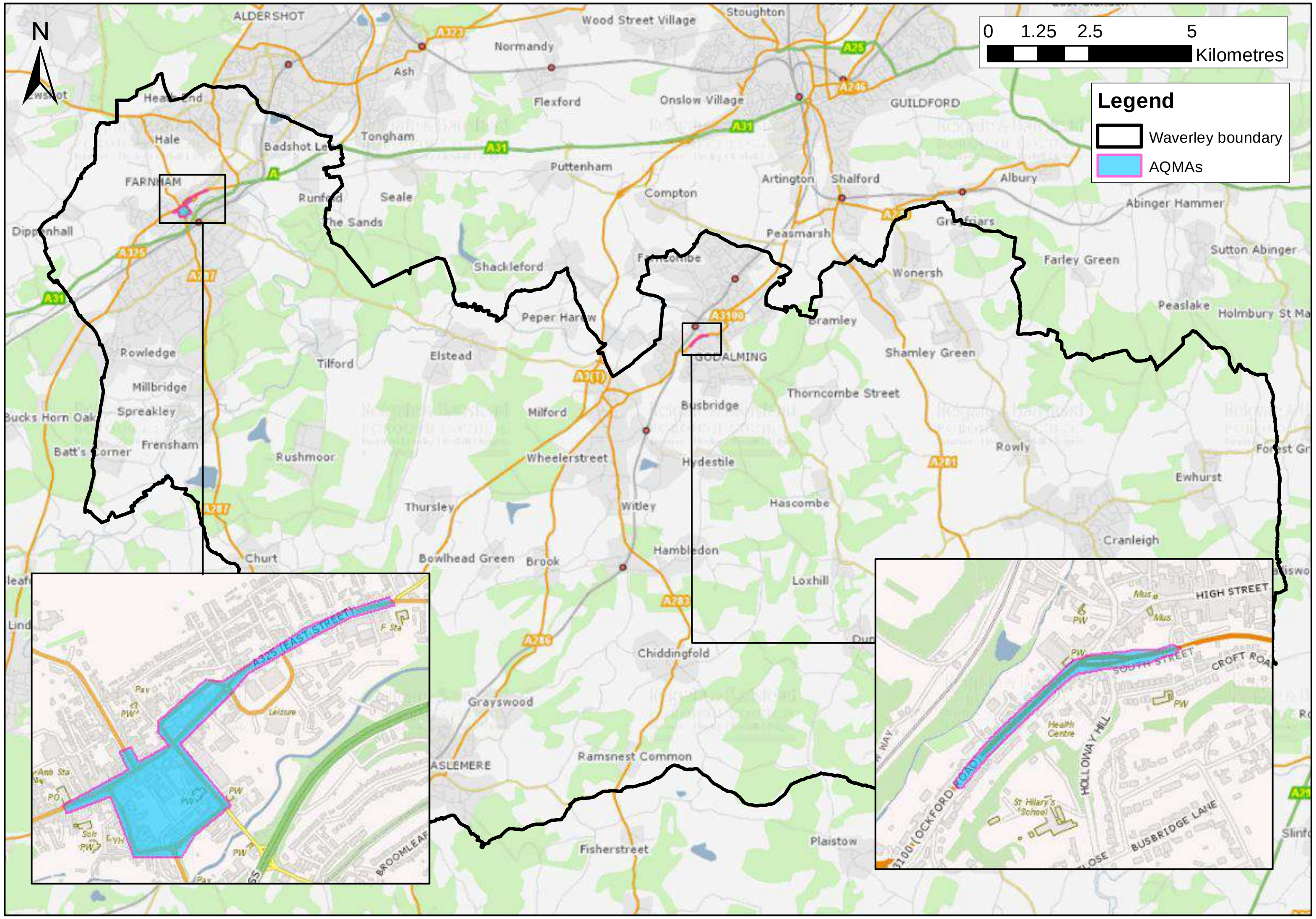

Figure 4.11: AQMA locations: Waverley

4.11 Woking Borough Council

Figure 4.12 presents the locations of monitoring sites throughout Woking, comprising 32 diffusion tubes and two AQMAs. The AQMAs are:

- Anchor Hill
- A small section of Guildford Road

Both AQMA were declared for annual mean NO_2 concentrations.

Table 4-13 presents the monitored annual average NO_2 concentrations for Woking in 2017. Exceedences of the UK Air Quality Objective of 40μg/m³ for annual average NO_2 concentrations are highlighted in **bold**.

Table 4-13: Monitored annual average NO_2 concentrations at Woking diffusion tubes, 2017

Site ID	Monitor type	Location	Height (m)	Distance to kerb (m)	Concentration (μg/m³)
WOK_AH1	DT	496618, 158700	2.5	1	35
WOK_AH2	DT	496615, 158695	2.5	5	32
WOK_AH3	DT	496646, 158750	2.5	5	23
WOK_AH4	DT	496679, 158767	2.5	2	27
WOK_AH5	DT	496594, 158698	2.5	5	26
WOK_AH6	DT	496585, 158688	2.5	2	29
WOK_BD	DT	498025, 158949	2.5	2	15
WOK_BR	DT	495822, 157793	2.5	1	25
WOK_BR1	DT	495850, 157187	2.5	1.5	23
WOK_BW	DT	495875, 157972	2.5	1	22
WOK_CH	DT	500417, 158102	2.5	1.5	37
WOK_CH2	DT	500368, 158072	2.5	1	**42**
WOK_CH3	DT	500332, 158012	2.5	1.5	**42**
WOK_CH4	DT	500332, 157983	2.5	1	38
WOK_CR	DT	506401, 160505	2.5	1	21
WOK_CW	DT	496215, 157991	2.5	2	22
WOK_GR	DT	499950, 158540	2.5	1	26
WOK_LD	DT	503243, 159658	2.5	1	17
WOK_LGR	DT	496601, 158668	2.5	3	24
WOK_LT1	DT	500453, 158100	2.5	1	35
WOK_LTK	DT	500442, 158121	2.5	1	25
WOK_M25	DT	505611, 161179	2.5	0	**43**
WOK_MR	DT	501613, 159646	2.5	2	32
WOK_MR2	DT	501613, 159646	2.5	2	28
WOK_OR	DT	501665, 159161	2.5	3	25
WOK_PR	DT	504925, 161063	2.5	1	23
WOK_RC	DT	500946, 157110	2.5	1	18
WOK_TC	DT	506731, 161230	2.5	4	26
WOK_TW	DT	498435, 159451	2.5	1.5	14
WOK_VW	DT	500515, 159020	2.5	1	32
WOK_YR	DT	500450, 158278	2.5	1	25
WOK_YR1	DT	500451, 158256	2.5	1	25

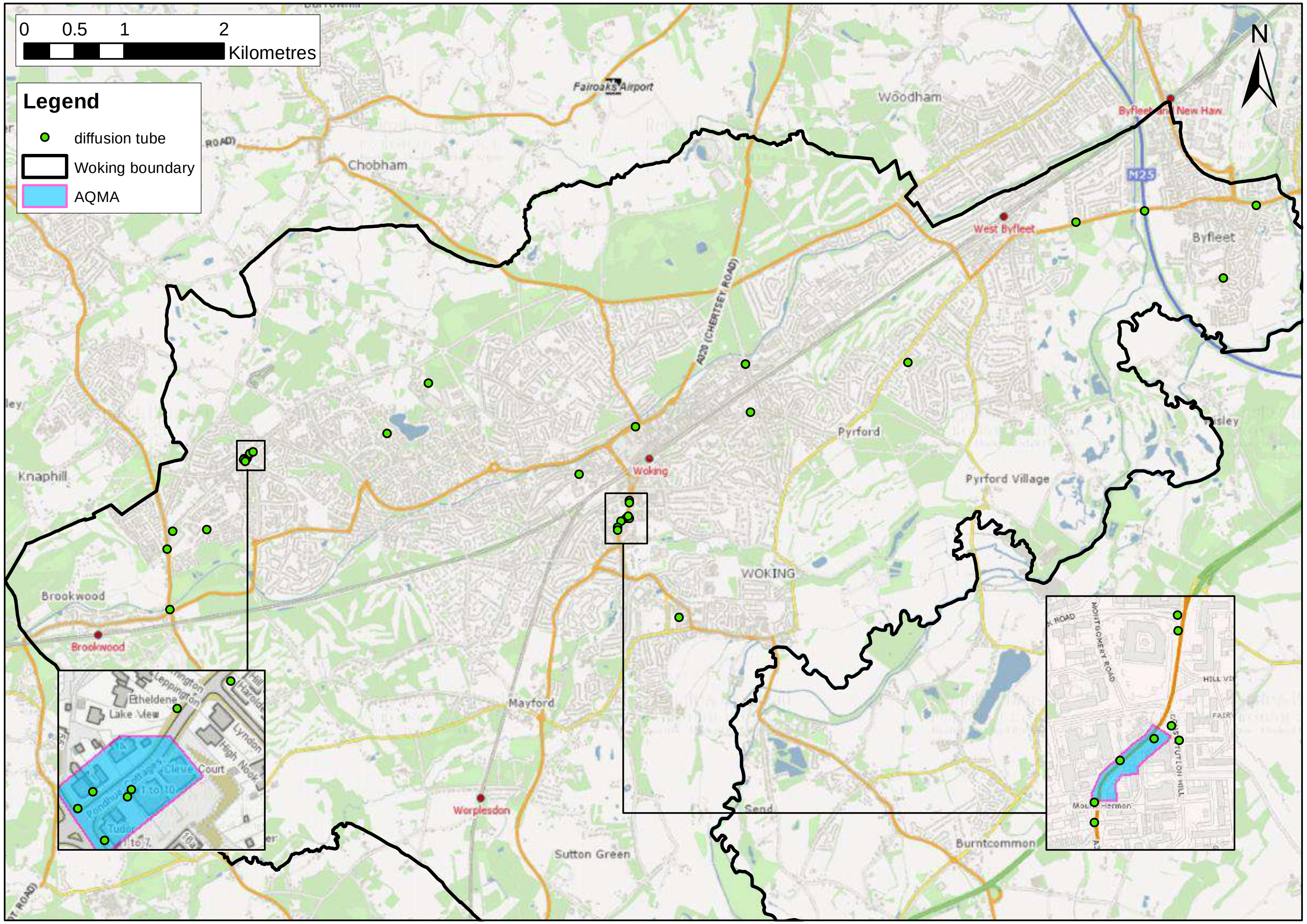

Figure 4.12: Diffusion tubes and AQMAs, Woking

5 Air quality modelling

5.1 Modelling software

All modelling was carried out using ADMS-Urban[2] version 4.2, developed by CERC. This model allows the effects of wider urban areas on local air quality to be taken into account.

5.2 Surface roughness

A length scale parameter called the surface roughness length is used in the model to characterise the study area in terms of the effects it will have on wind speed and turbulence, which are key factors in the modelling. A roughness length of 0.5m was used for the dispersion site throughout the modelling, representing open suburbia.

The difference in land use at the meteorological station compared to the study area was taken into account by entering a different surface roughness for the meteorological station. See Section 5.4 for further details.

5.3 Monin-Obukhov length

In urban and suburban areas, a significant amount of heat is emitted by buildings and traffic, which warms the air within and above a city. This is known as the urban heat island and its effect is to prevent the atmosphere from becoming very stable. In general, the larger the area the more heat is generated and the stronger the effect becomes. In the ADMS-Urban model, the stability of the atmosphere is represented by the Monin-Obukhov parameter. The effect of the urban heat island is that, in stable conditions, the Monin-Obukhov length will never fall below some minimum value; the larger the city, the larger the minimum value. A minimum Monin-Obukhov length of 30 m was used in the modelling.

[2] http://cerc.co.uk/environmental-software/ADMS-Urban-model.html

5.4 Meteorological data

A year of hourly sequential meteorological data measured at Heathrow Airport in 2017 was used for model verification and subsequent modelling.

Table 5-1 summarises the meteorological data from Heathrow Airport. To take account of the different surface characteristics at Heathrow Airport, compared to the modelled area, a surface roughness of 0.2 m was assumed for the meteorological station.

Table 5-1: Summary of Heathrow meteorological data

Year	% of hours used	Parameter	Minimum	Maximum	Mean
2017	99.7	Temperature (°C)	-4	34	12.0
		Wind speed (m/s)	0	17	4.1
		Cloud cover (oktas)	0	8	5

The ADMS meteorological pre-processor, written by the UK Met Office, uses the data provided to calculate the parameters required by the program. Figure 5.1 presents a wind rose showing the frequency of occurrence of wind from different directions for a number of wind speed ranges for Heathrow Airport.

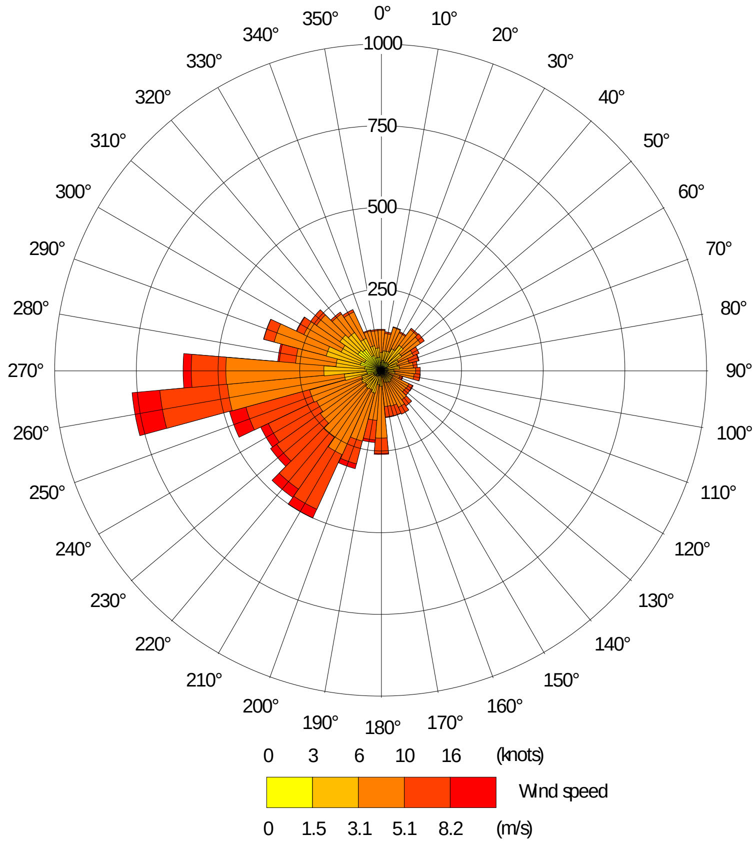

Figure 5.1: Wind rose for Heathrow 2017

5.5 Chemistry

The ADMS-Urban explicit chemistry scheme was used to model the interconversion between NO and NO_2, using wind dependent background concentrations derived from AURN rural monitoring sites. This approach allows for direct model verification against monitored concentrations for NO_x and NO_2, with simultaneous consideration of source dependent primary NO_2.

5.6 Background data

Hourly background data for the modelled pollutants and sulphur dioxide and ozone were input to the model to represent the concentrations in the air being blown into the area. NO_x, NO_2, SO_2, PM_{10}, $PM_{2.5}$ and O_3 concentrations from Rochester Stoke, Chilbolton, Lullington Heath and Haringey Priory Park South for 2017 were input to the model, the monitored concentration used for each hour depending upon the wind direction for that hour, as shown in Figure 5.2.

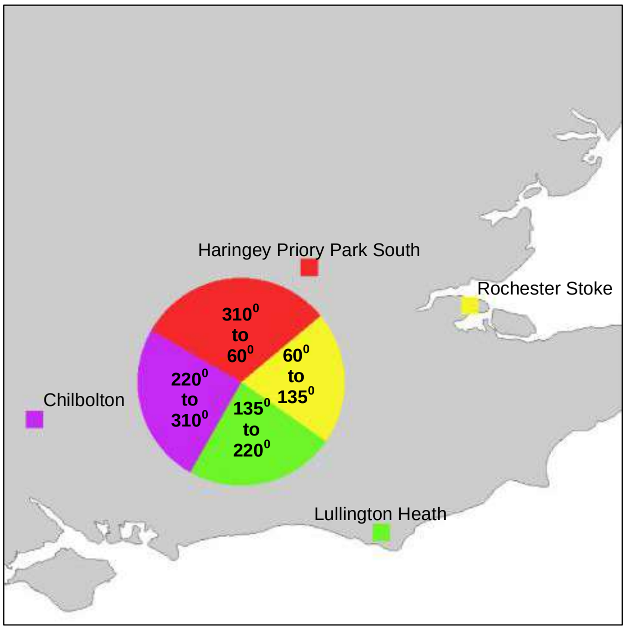

Figure 5.2: Wind direction segments used to calculate background concentrations for NO_x, NO_2, O_3, PM_{10}, $PM_{2.5}$ and SO_2

Table 5-2 summarises the annual statistics for background data used for the modelling, calculated using wind data from Heathrow Airport.

Table 5-2: Summary of 2017 background data used in the modelling (µg/m³)

Statistic	NO_x	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2
Annual average	17.5	12.0	51.3	14.8	8.8	0.9
99.79th percentile of hourly average	392.4	80.0	111.8	-	-	-
90.41st percentile of 24-hour average	-	-	-	26.0	19.0	1.4

5.7 Street canyons

The advanced street canyon module option in ADMS-Urban was used to modify the dispersion of pollutants from a road source according to the presence and properties of canyon walls on one or both sides of the road. Building footprint and height information was taken from OS Mastermap data, provided by Reigate and Banstead Borough Council. At some locations, the properties of canyons were altered due to inconsistencies between the width of the modelled road and the related canyon. Along the M3, street canyon parameters were altered to account for noise barriers on either side of the road, such as fences and hedges. These affect the dispersion of road emissions.

6 Emissions

Emission inventories were compiled for each of the scenarios modelled, using CERC's EMIT[3] emissions inventory tool, version 3.6.

6.1 Road transport

Emissions from road transport were calculated using an activity data approach, whereby Annual Average Daily Traffic flows (AADTs) for each road link were combined with emission factors and speed data to calculate emissions for each road link on a vehicle-by-vehicle basis. This methodology is described below.

6.1.1 Emission factors

Traffic emissions of NO_x, NO_2, PM_{10} and $PM_{2.5}$ were calculated from traffic flows using EFT v8.0.1 emission factors based on Euro vehicle emissions categories. This dataset includes speed-emissions data that are based COPERT 5[4] emission factrors. EFT v8.0.1 include exhaust, brake, tyre and road wear for PM_{10} and $PM_{2.5}$; resuspension emission factors were taken from a report produced by TRL Limited on behalf of Defra[5].

Note that there is large uncertainty surrounding the current emissions estimates of NO_x from all vehicle types, in particular diesel vehicles; refer to, for example, an AQEG report from 2007 [6] and a Defra report from 2011[7]. In order to address this discrepancy, the NO_x emission factors were modified based on published Remote Sensing Data (RSD)[8] for vehicle NO_x emissions in London. Scaling factors were applied to each vehicle category and speed.

6.1.2 Activity data

Traffic activity data were derived the Surrey Traffic Model, supplemented by Department for Transport (DfT) count data and local data from borough council detailed and further assessments. The split between these traffic data sources is illustrated by Figure 6.1.

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[3] http://cerc.co.uk/environmental-software/EMIT-tool.html
[4]http://www.emisia.com/copert/General.html
[5] Road vehicle non-exhaust particulate matter: final report on emission modelling, TRL Limited Project Report PPR110 http://uk-air.defra.gov.uk/reports/cat15/0706061624_Report2__Emission_modelling.PDF
[6] Trends in primary nitrogen dioxide in the UK
[7] Trends in NO_x and NO_2 emissions and ambient measurements in the UK
[8] Carslaw, D and Rhys-Tyler, G 2013: New insights from comprehensive on-road measurements of NO_x, NO_2 and NH_3 from vehicle emission remote sensing in London, UK. *Atmos. Env.* **81** pp 339–347.

Surrey County Council provided AM peak, PM peak and inter-peak traffic flows and speeds, by vehicle type, from the Surrey Traffic Model for major roads across Surrey. The AM and PM peak flows were used to derive AADTs using conversion factors provided by Surrey County Council.

For each road, one of six conversion factors were applied depending on the type of road. Speeds used for the emission calculations for each road were derived by calculating a weighted average speeds, based on the flow of each vehicle throughout the day.

DfT provides traffic count data for the primary and strategic road network for the whole of the UK. Checking of traffic inputs during the model verification stage showed poor agreement between measured daily flows and the values derived from the Surrey Traffic Model on some motorways and major A roads. Therefore for the final emission calculations where DfT traffic counts were available, they were used in preference to values derived from the Surrey Traffic Model outputs.

Traffic inputs were refined, to use traffic flows and / or speeds from previous local assessments, where the values were significantly different to values calculated from the Surrey Traffic Model values. Local adjustments were based on traffic data reported in:

- Guildford Borough Council's Detailed Assessment for Compton Village[9];
- Woking Borough Council's Further Assessment for Anchor Hill[10]; and
- Woking Borough Council's Detailed Assessment for Guildford Road[11].

[9] http://www2.guildford.gov.uk/councilmeetings/documents/s9029/Item%2013%206-%20AQMA%20Compton%20-%20App%206%20-%20Compton%20AQAP%20Guildford_Draft1.pdf
[10] https://www.woking.gov.uk/sites/default/files/documents/environmentalservices/detailedassessmentforguildfordroad.pdf
[11] https://www.woking.gov.uk/sites/default/files/documents/environmentalservices/WBC_Guildford%20Rd_AQAP%20final%20report.pdf

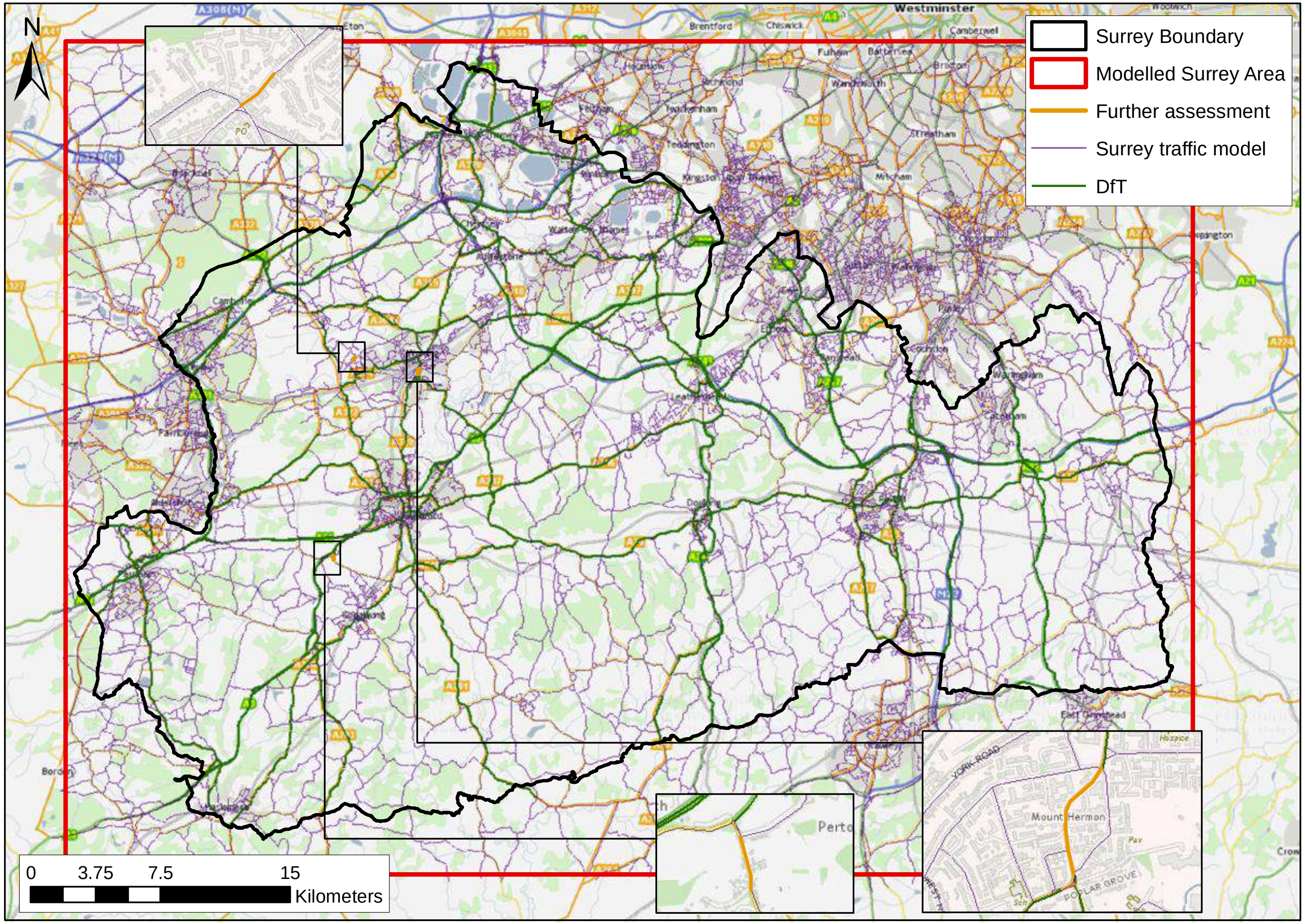

Figure 6.1: Traffic activity data split between Surrey traffic model output and DfT count statistics

6.1.3 Time-varying emissions

The variations of traffic flows during the day were taken into account by applying a diurnal profile to the road emissions. The profile was constructed by combining profiles derived from automatic traffic count (ATC) data for A25 Nutfield Road, provided by Surrey County Council, and average traffic distribution on all roads in Great Britain, as published by the DfT.[12] Averaging these two sets of profiles, generated a profile that was more consistent with the traffic flow conversion factors provided by Surrey County Council for all A & B roads in the county, leading to a greater confidence in the time-varying emissions profile used in the modelling. A comparison between the derived conversion factors for these profiles is shown in Table 6-1.

The calculated profile, shown in Figure 6.2, was applied to all modelled roads and grid sources, representing emissions aggregated on 1-km square basis, as described in Section 6.3.

Table 6-1: Comparison of traffic flow conversion factors for variation of traffic flows during the day

	Weekday to daily		**Weekday**					**AM & PM peak to AADT**
	12hr to 24hr	**24hr to 24hr**	**12hr to 24hr**	**AM peak to 24 hr**	**PM peak to 24 hr**	**AM peak spread**	**PM peak spread**	
DfT: UK roads	1.20	0.94	1.28	14.00	12.89	0.35	0.35	6.31
ATC – A25 Nutfiield Road	1.13	0.94	1.20	10.84	10.87	0.40	0.39	5.12
Diurnal profile used in model	1.16	0.94	1.24	12.22	12.69	0.38	0.36	5.66
Surrey CC: All A & B roads	1.16	0.92	1.26	12.83	12.07	0.36	0.36	5.73

12 https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

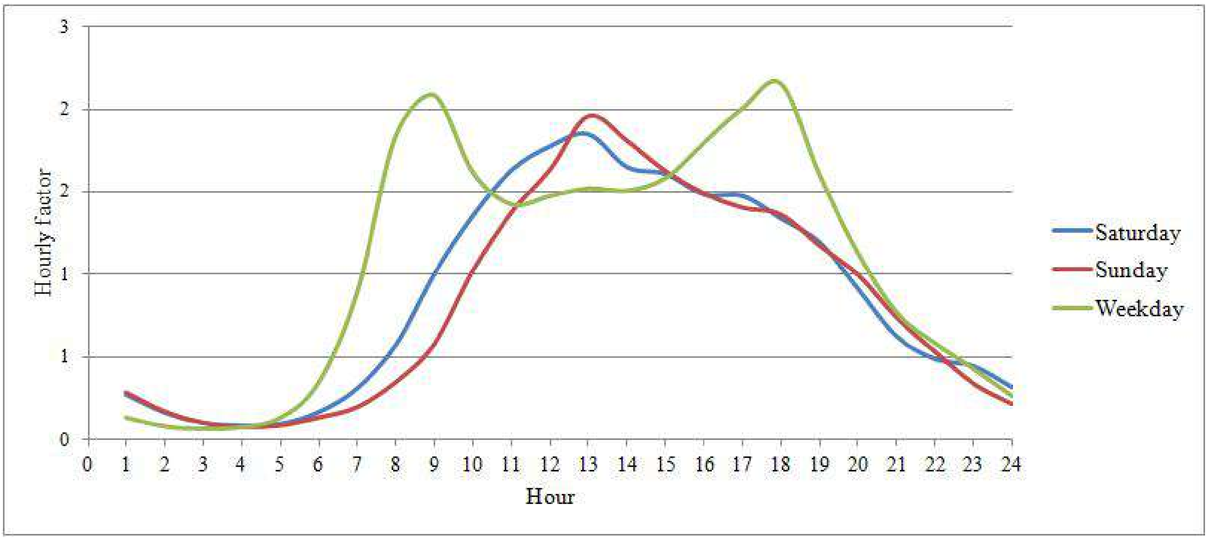

Figure 6.2: Diurnal emission factor profile used for road and grid sources

6.2 Industrial sources

The individual boroughs provided locations and parameters of 47 large industrial sources; including stack height, stack diameter, velocity, temperature and NO_x, PM_{10} and $PM_{2.5}$ emissions. These large industrial sources were modelled as point sources.

6.3 Other emissions

Emissions from other sources across the modelling domain were taken from the National Atmospheric Emissions Inventory (NAEI) 2015. Emissions from all other source types were modelled as an aggregated grid source with a resolution of 1 km. The NAEI data include emissions from Heathrow Airport and Gatwick Airport, located on the border of Surrey. The Surrey modelled area extends from (48000, 12900) to (54500, 17700), this extent is shown in Figure 6.1

7 Model verification

The first stage of a modelling assessment is to model a current case in order to verify that the input data and model set-up are appropriate for the area, by comparing measured and modelled concentrations for local monitoring locations. The monitor locations used for this purpose are described in Section 4. Concentrations were calculated at these monitoring locations for 2017.

The model verification involves an iterative process to improve the model set-up, for better agreement between measured and modelled concentrations. Table 7-1 summarises the main changes made to the model during the model verification process.

Table 7-1: Main changes to the model setup during the verification process

Verification version	Model changes
V1	AADT for all 61,294 road links derived from Surrey Traffic model data. Automated calculation of street canyon parameters on a Surrey-wide basis. Detailed checking and adjustment, where necessary, of the modelled distances between road sources and monitoring locations. Further manual changes to street canyons to ensure that monitoring locations were correctly located inside or outside of them.
V2	AADT changed for 6,633 road links within the Surrey boundary, using DfT 2017 traffic counts.
V3	Street canyon parameters altered to account for the impact of noise barriers (fence and hedges) on the dispersion of emissions from the M3.
V4	AADT changed of 10 road links where local traffic flows have been reported in detailed and further assessments.

Model verification was conducted using meteorological data from both Heathrow Airport and Gatwick Airport. Due to generally better agreement between modelled and monitored concentrations, in particular at continuous monitoring sites, the set-up using Heathrow Airport data was used for the main modelling.

A comparison of model verification results using Heathrow and Gatwick data is included in Appendix A. Full details of the model verification using Gatwick Airport data is provided in Appendix B, including a summary of the meteorological data and the background data calculated using Gatwick wind data.

Figure 7.1 presents a scatter plot of monitored and modelled annual average NO_2 concentrations at the locations of 367 diffusion tubes and nine continuous monitors across the Surrey boroughs using Heathrow Airport meteorological data. Table 7-2 summarises model verification statistics at these locations. These data are also presented as box plots in Figure 7.2, to show the spread of measured and modelled annual average NO_2 concentrations by borough.

A summary of all continuous monitoring data is provided in Table 7-3. Further analysis of monitored and modelled concentrations at continuous monitoring locations are provided in the box plots in Figure 7.3 to Figure 7.6, comparing range of hourly mean concentrations NO_x, NO_2, PM_{10} and $PM_{2.5}$. Note, only hours were there is valid model and monitor output are compared for continuous monitors.

Modelled annual average NO_2 concentrations are within 25% of the monitored value at 277 of 376 locations (74%), showing generally good performance of the model set-up across Surrey.

Some of the highest monitored concentrations, typically representing busy junctions or congested roads, are underpredicted by the model. These underpredictions may be due to complex traffic characteristics, e.g. slow moving stop-start traffic, not being fully represented in the model inputs. Locations where this likely to be the case include RB136, located on the junction between Brighton Road and Star Lane, and RY23, located on the junction between Weir Road and Bridge Road. In addition, CH2, CH3 and LT1 along Guildford Road, Woking will be affected by congestion originating from diversions associated with development in the town centre[13].

Concentrations are overpredicted by the model at three types of locations: background locations where the lowest concentrations in Surrey are measured; some locations close to the M3 and M25 motorways; and close to Gatwick Airport. The model overpredictions at some background locations are due to the background inputs to the model being higher than measured values. Along motorways, the model set-up may not fully capture the shielding impact of noise barriers and other noise abatement features along these roads. Gatwick Airport emissions are included as part of aggregated 1 km grid emissions; this generalised treatment will lead to some overprediction of concentrations close to the airport, affecting modelled concentrations at the RG3 continuous monitor, collocated diffusion tubes RB99, RB100 and RB101, along with MV9.

Discrepancies between modelled and monitored concentrations also represent uncertainty in the monitored values. Diffusion tube measurements are less accurate than measurements from continuous monitors; therefore good model agreement at continuous monitor sites is typically a better indicator of performance than comparisons against diffusion tube measurements.

Overall the model set-up provides a level of agreement that gives confidence for Surrey-wide model outputs.

[13] https://www.woking.gov.uk/sites/default/files/documents/licencing/ASR_WBC_2018_Issued.pdf

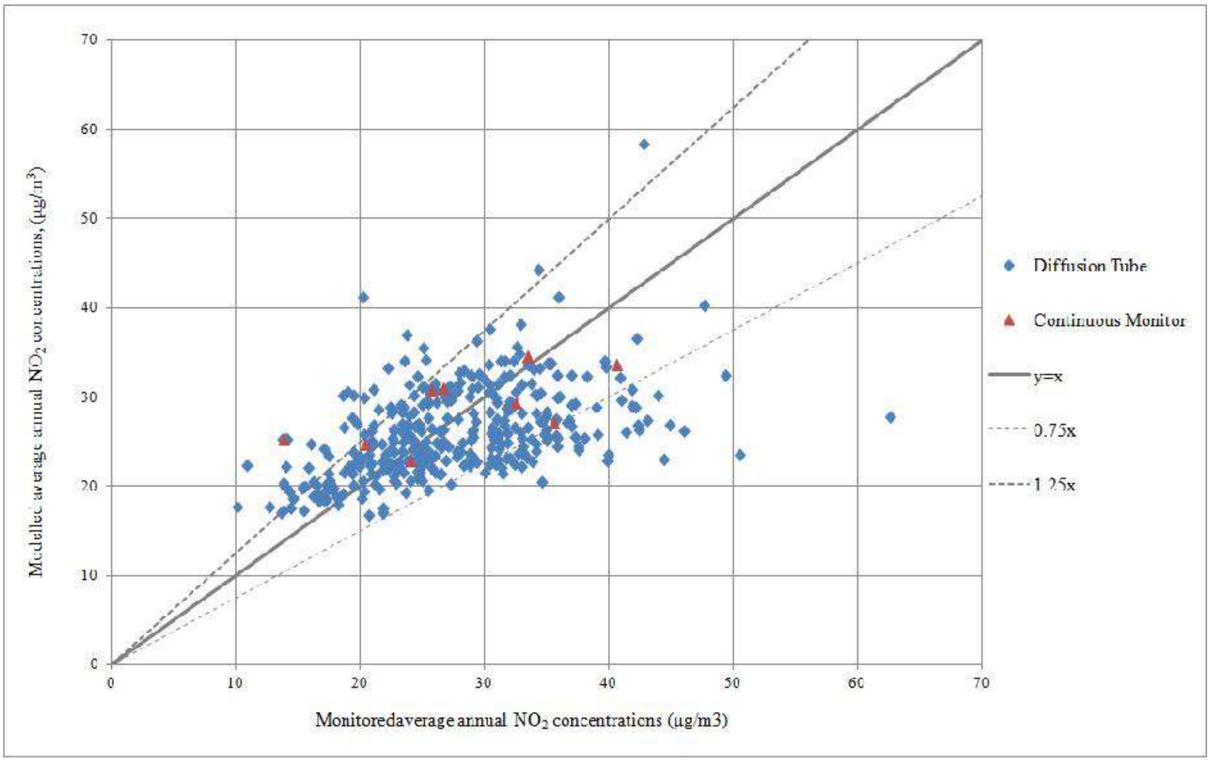

Figure 7.1: Scatter plot of measured and modelled annual average NO_2 concentrations

Table 7-2: Model verification statistics for annual average NO_2 concentrations

Heathrow	Min	Max	Mean	Count	Modelled / Monitored	<0.75	>0.75<1.25	>1.25	% >0.75<1.25
Diffusion tubes	16.7	58.3	26.1	367	1.00	56	269	42	73
Continuous monitors	22.8	34.5	28.8	9	1.09	0	8	1	89
All monitors	16.7	58.3	26.1	376	1.00	56	277	43	74

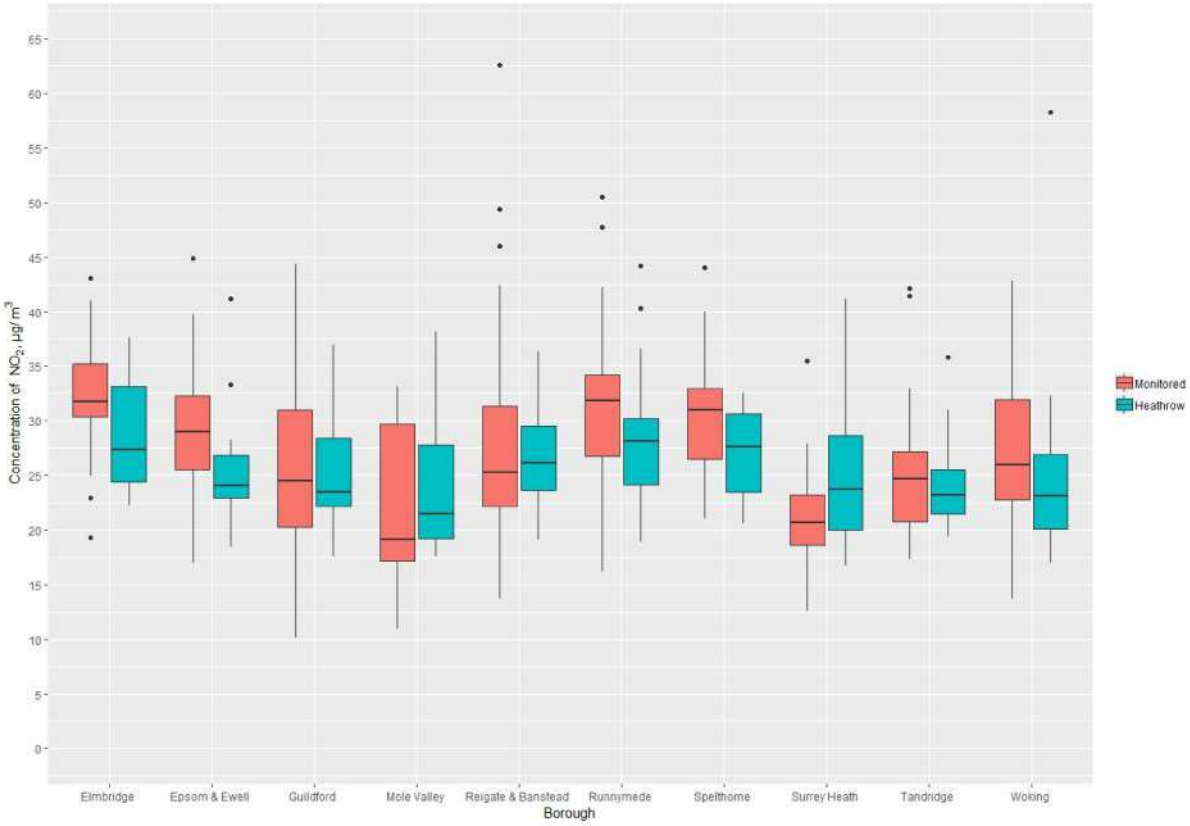

Figure 7.2: Box plots showing the spread of measured and modelled annual average NO_2 concentrations by Surrey borough. In this plot 'outliers', outside the range of -/+ 1.5*(inter-quartile range), are presented as points

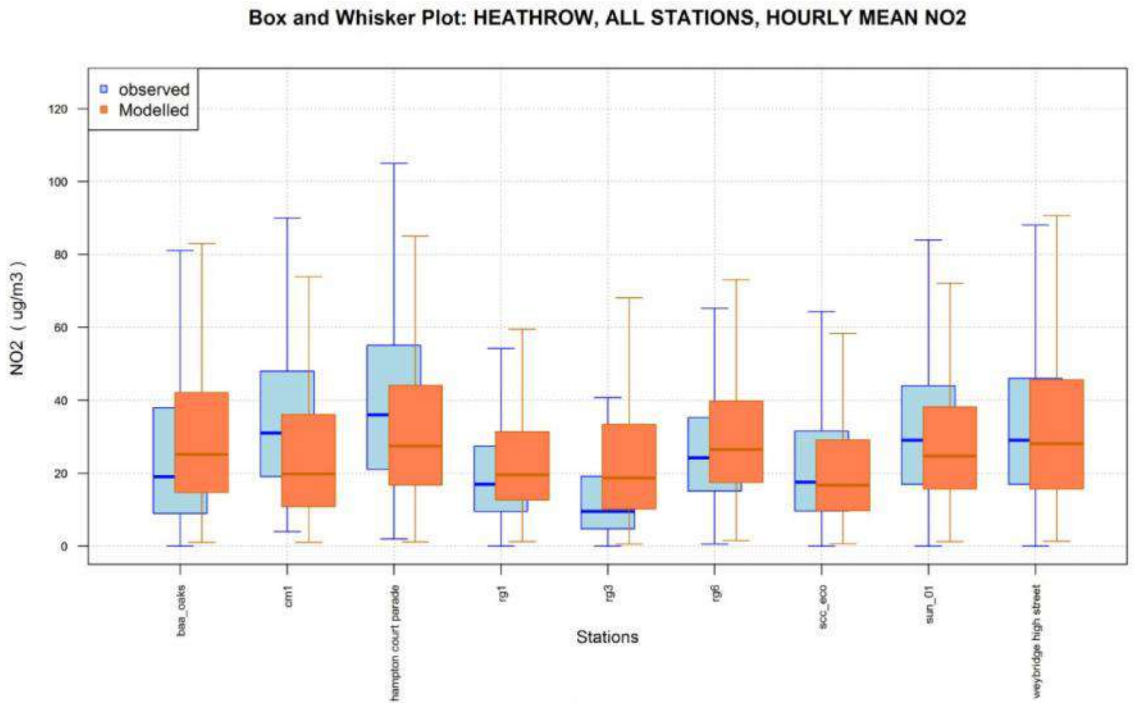

Figure 7.3: Box plots of measured and modelled hourly mean NO_2 concentrations at continuous monitoring sites

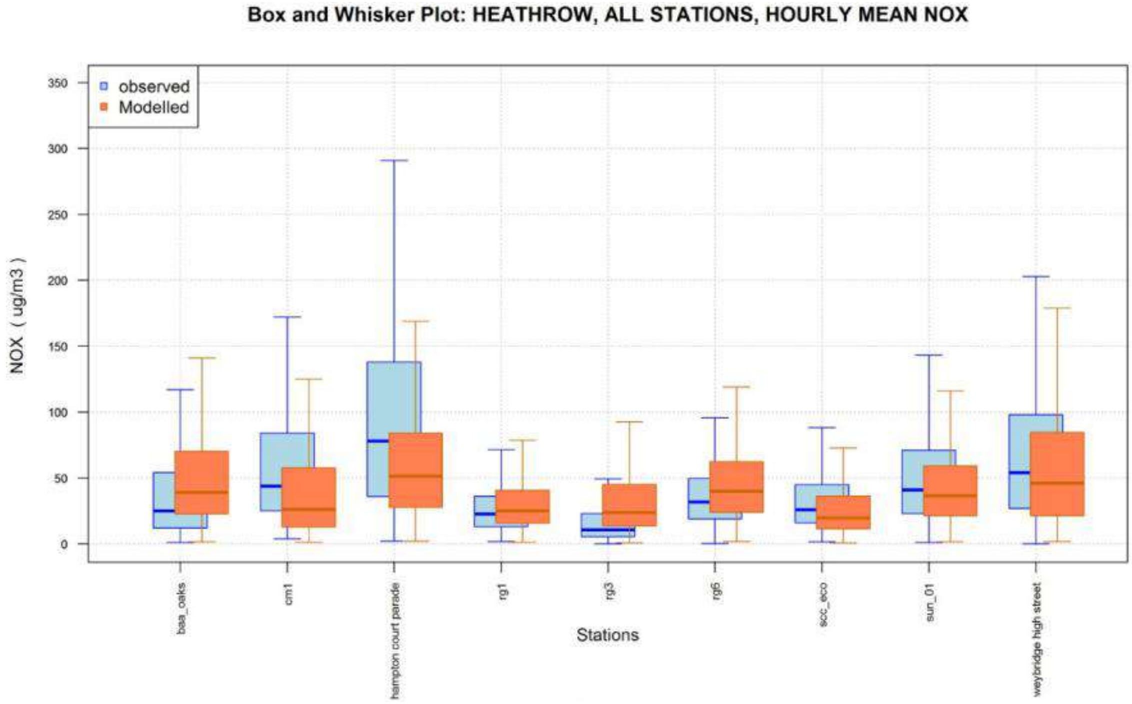

Figure 7.4: Box plots of measured and modelled hourly mean NO_x concentrations at continuous monitoring sites

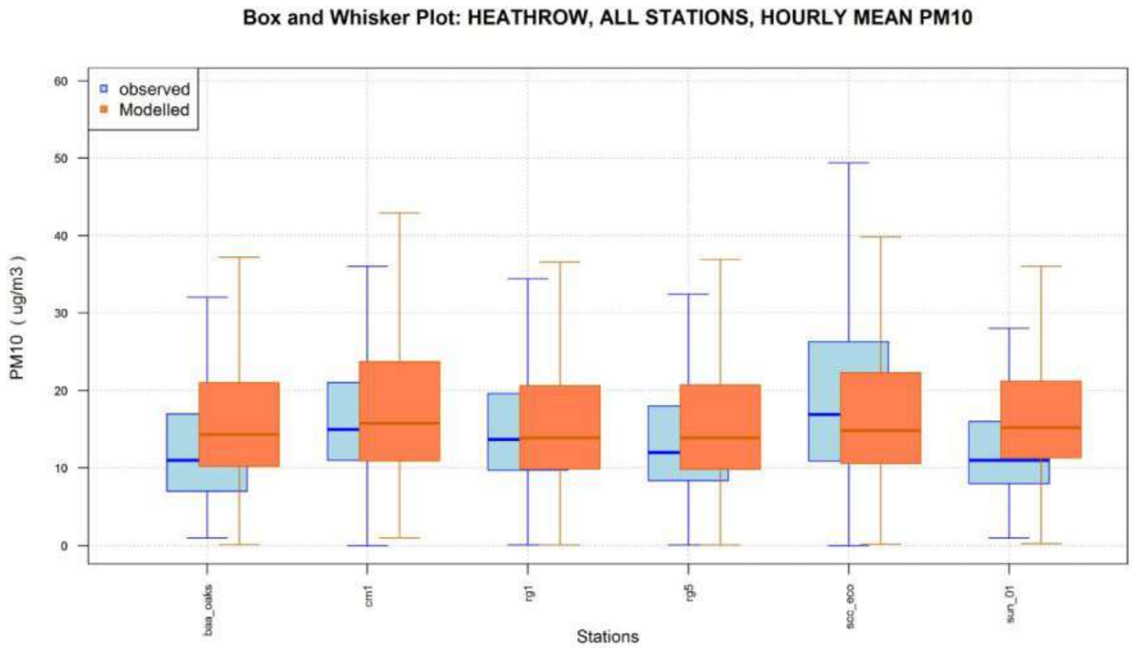

Figure 7.5: Box plots of measured and modelled hourly mean PM_{10} concentrations at continuous monitoring sites

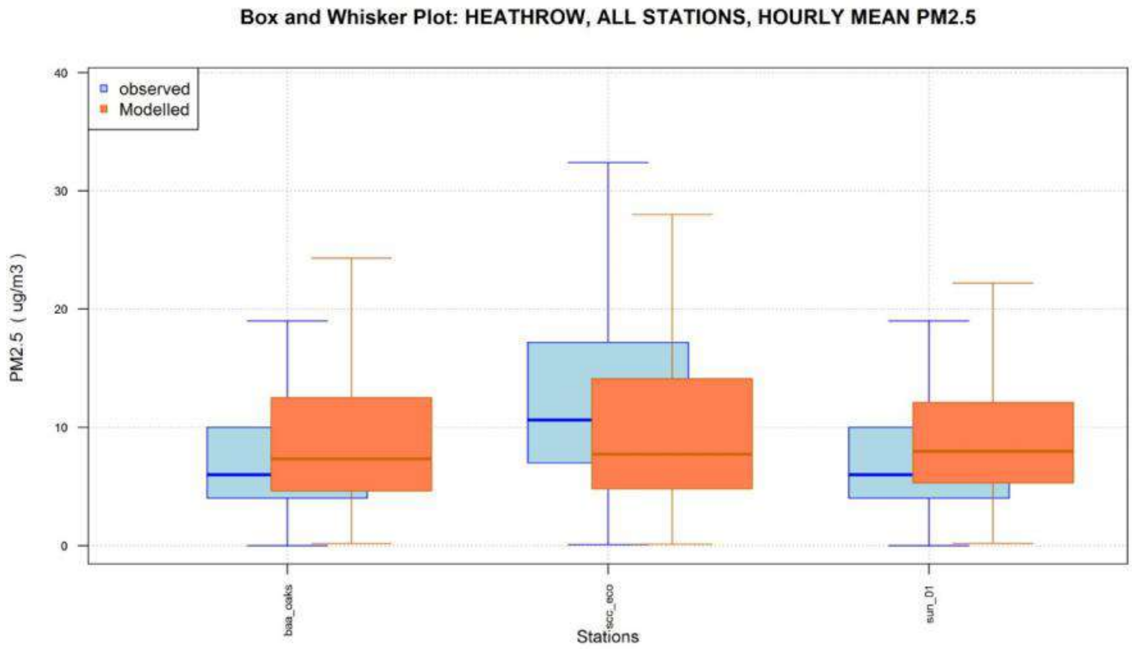

Figure 7.6: Box plots of measured and modelled hourly mean $PM_{2.5}$ concentrations at continuous monitoring sites

Table 7-3: Measured and modelled annual average NO_x, NO_2, PM_{10} and $PM_{2.5}$ concentrations at continuous monitoring sites

Site ID	Monitored concentration, µg/m³				Modelled concentration, µg/m³				Modelled / Monitored (%)			
	NO_x	NO_2	PM_{10}	$PM_{2.5}$	NO_x	NO_2	PM_{10}	$PM_{2.5}$	NO_x	NO_2	PM_{10}	$PM_{2.5}$
BAA_OAKS	47.1	25.8	14.1	9.2	62.0	30.6	17.8	11.0	132	119	126	119
CM1	65.8	35.6	17.0	-	46.7	27.0	19.6	-	71	76	115	-
Hampton Court Parade	108.4	40.6	-	-	69.9	33.7	-	-	65	83	-	-
RG1	34.1	20.4	16.2	-	38.5	24.7	17.5	-	113	121	108	-
RG3	19.3	13.9	-	-	43.0	25.2	-	-	222	182	-	-
RG5	-	-	15.2	-	-	-	17.5	-	-	-	115	
RG6	46.1	26.7	-	-	55.2	30.9	-	-	120	116	-	-
SCC_ECO	44.2	24.1	20.7	14.5	35.3	22.8	18.6	12.1	80	95	90	83
SUN_01	58.6	32.5	13.1	8.0	48.4	29.4	17.8	10.2	83	90	135	127
Weybridge High Street	77.5	33.5	-	-	66.8	34.5	-	-	86	103	-	-

8 Air quality maps

This section comprises county-wide air quality maps, for comparison against air quality objectives for NO_2, PM_{10} and $PM_{2.5}$, outlined in Section 3. Annual mean NO_2, PM_{10} and $PM_{2.5}$ maps for individual boroughs are presented in separate reports.

Contour plots of pollutant concentrations were generated using a model output on a 100 m regular grid across the region, along with additional output points along modelled roads to capture the steep concentration gradients at roadside. These model-calculated concentrations are used to generate 10 m resolution air quality maps in GIS software, using the Natural Neighbour interpolation method.

In the air quality maps, exceedences of the air quality objective are shown in orange and red, and pollutant concentrations below objectives are shown in blue, green and yellow.

Figure 8.1 presents a contour plot of the modelled annual mean NO_2 concentrations across Surrey for 2017. Modelled concentrations show exceedences of the 40 µg/m³ annual mean NO_2 objective along motorways and other busy roads.

Figure 8.2 presents a contour plot of the modelled 99.79th percentile of hourly mean NO_2 concentrations across Surrey for 2017. Modelled concentrations show exceedences of the 200 µg/m³ objective concentration are along the motorways, as well as stretches of other busy roads.

Figure 8.3 presents a contour plot of the modelled annual mean PM_{10} concentrations across Surrey for 2017. There are no exceedences of the 40 µg/m³ annual mean PM_{10} objective outside the footprint of modelled roads.

Figure 8.4 presents a contour plot of the modelled 90.41st 24-hourly mean PM_{10} concentrations across Surrey for 2017. Modelled concentrations show exceedences of the 50 µg/m³ objective along motorways and busy A roads.

Figure 8.5 presents a contour plot of the modelled annual mean $PM_{2.5}$ concentrations across Surrey for 2017. Modelled concentrations show no exceedences of the 25 µg/m³ objective.

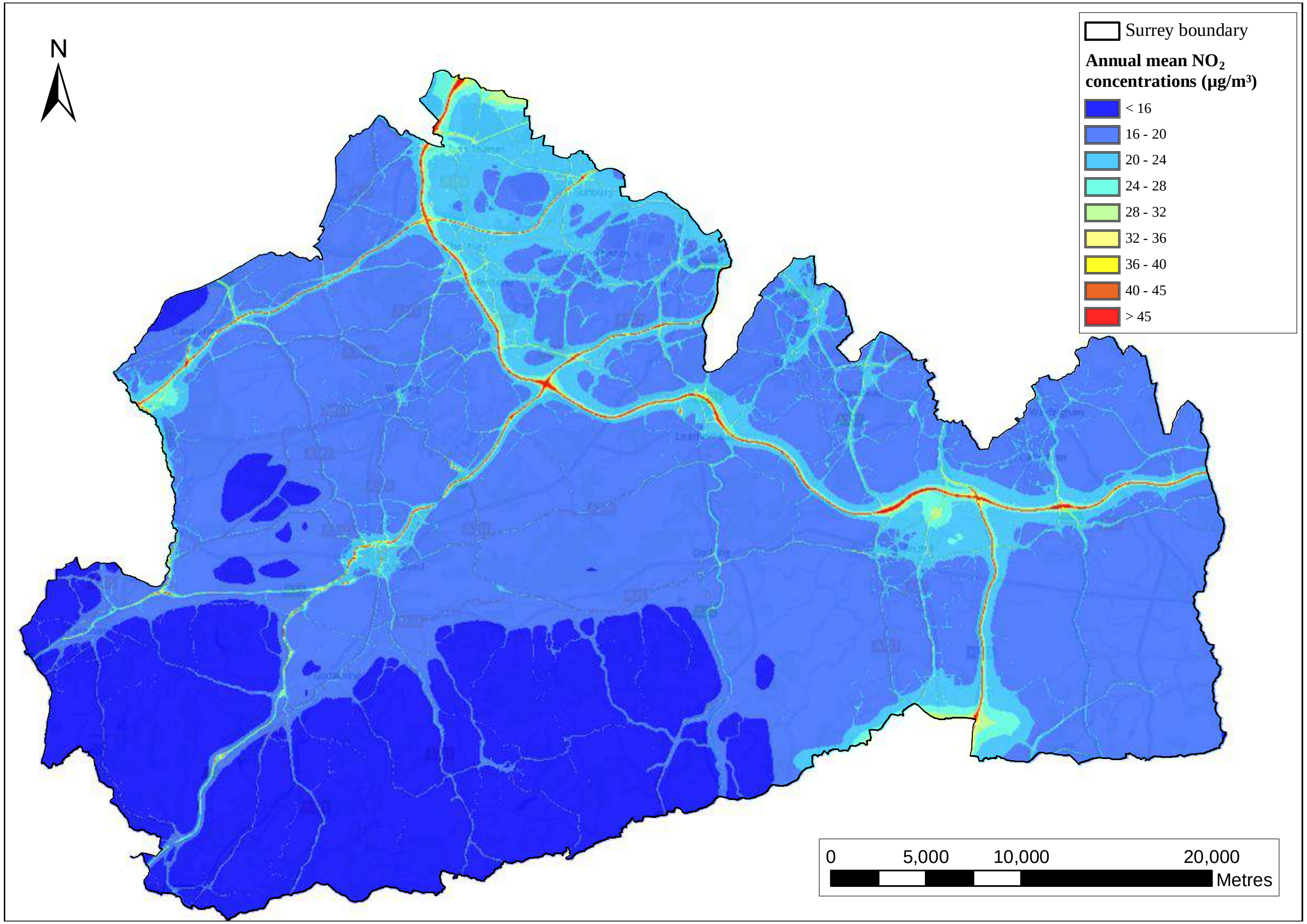

Figure 8.1: Annual mean NO_2 concentrations, 2017 (µg/m³)

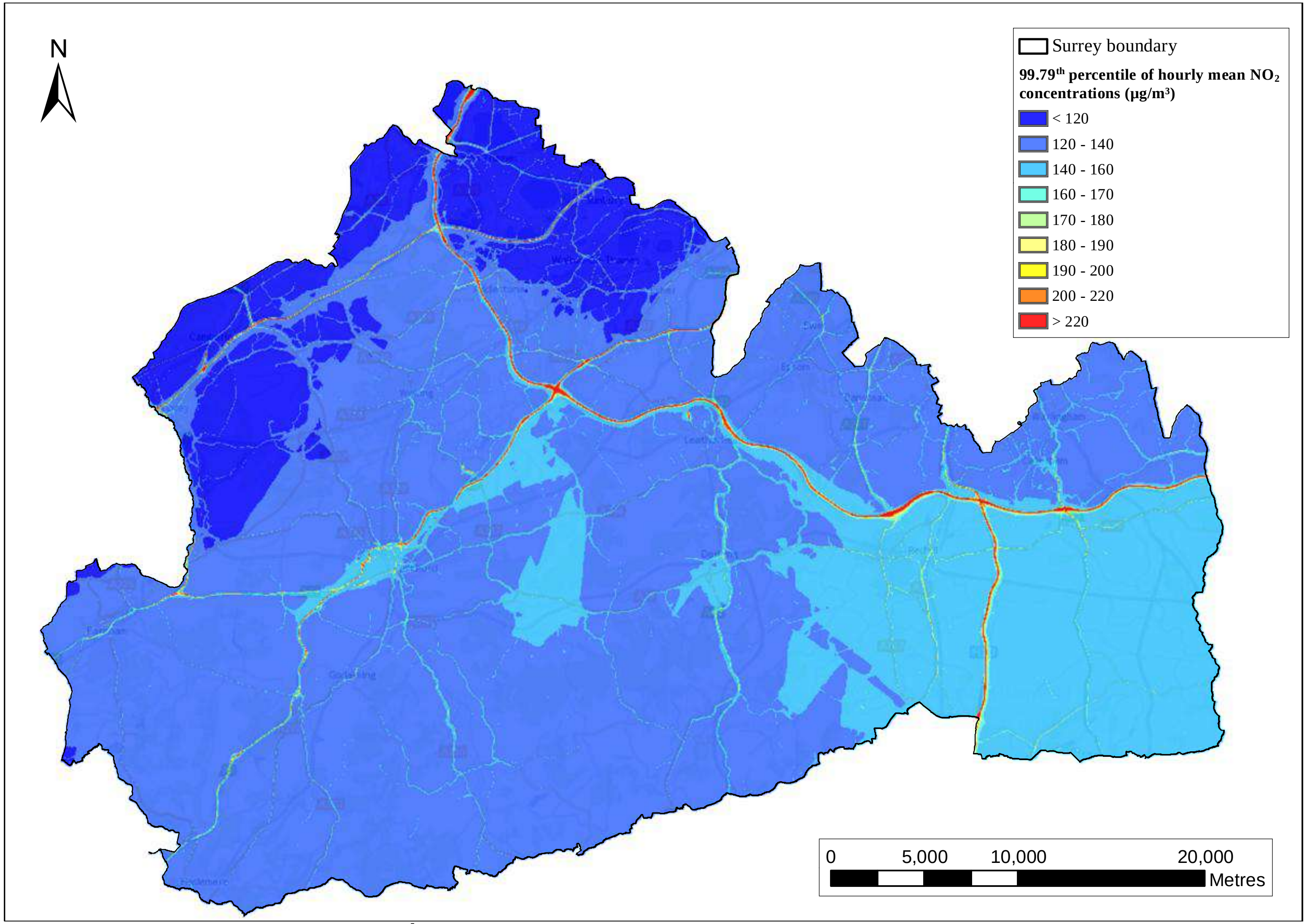

Figure 8.2: 99.79th percentile of hourly mean NO_2 concentrations, 2017 (µg/m³)

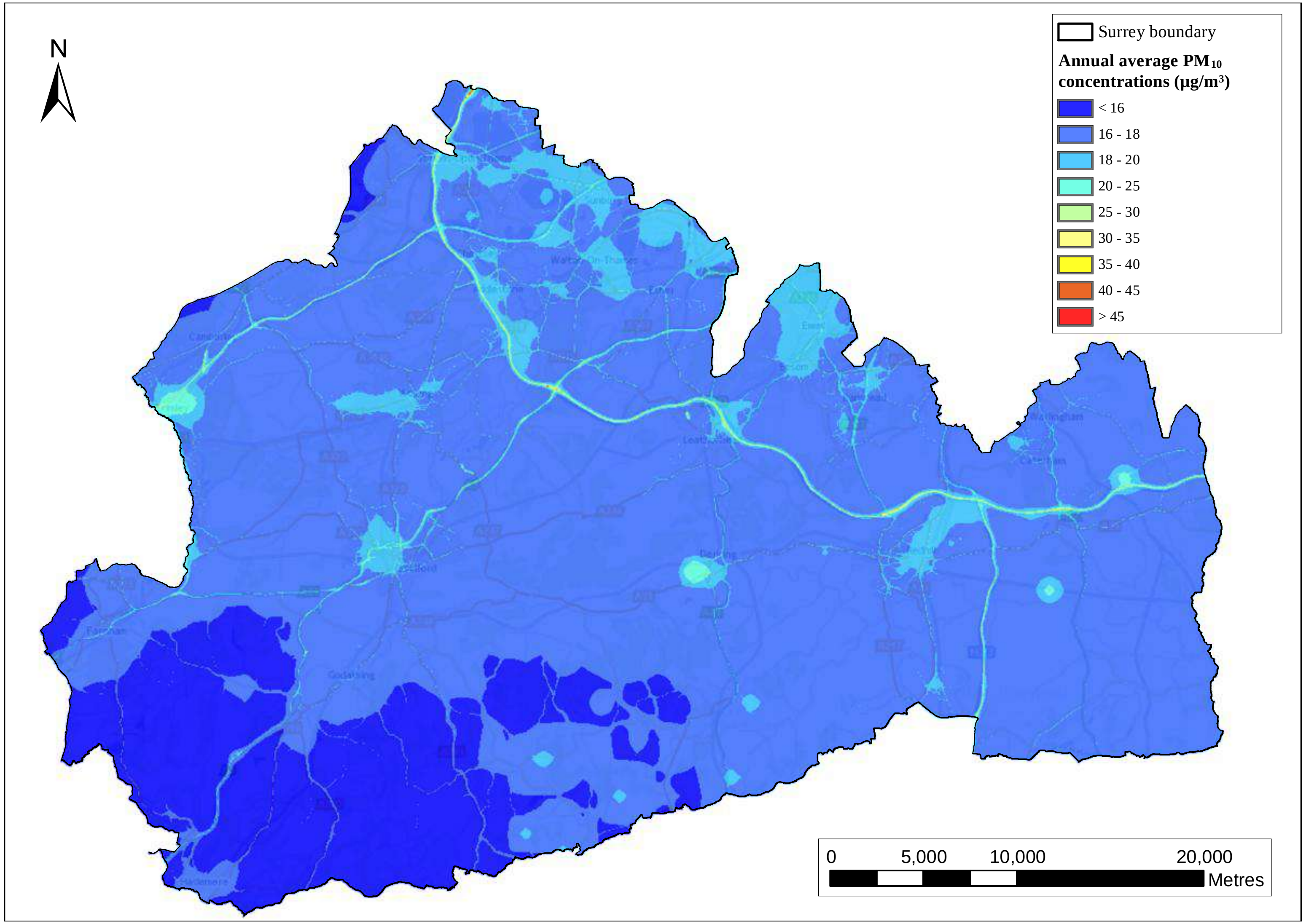

Figure 8.3: Annual mean PM_{10} concentrations, 2017 (µg/m³)

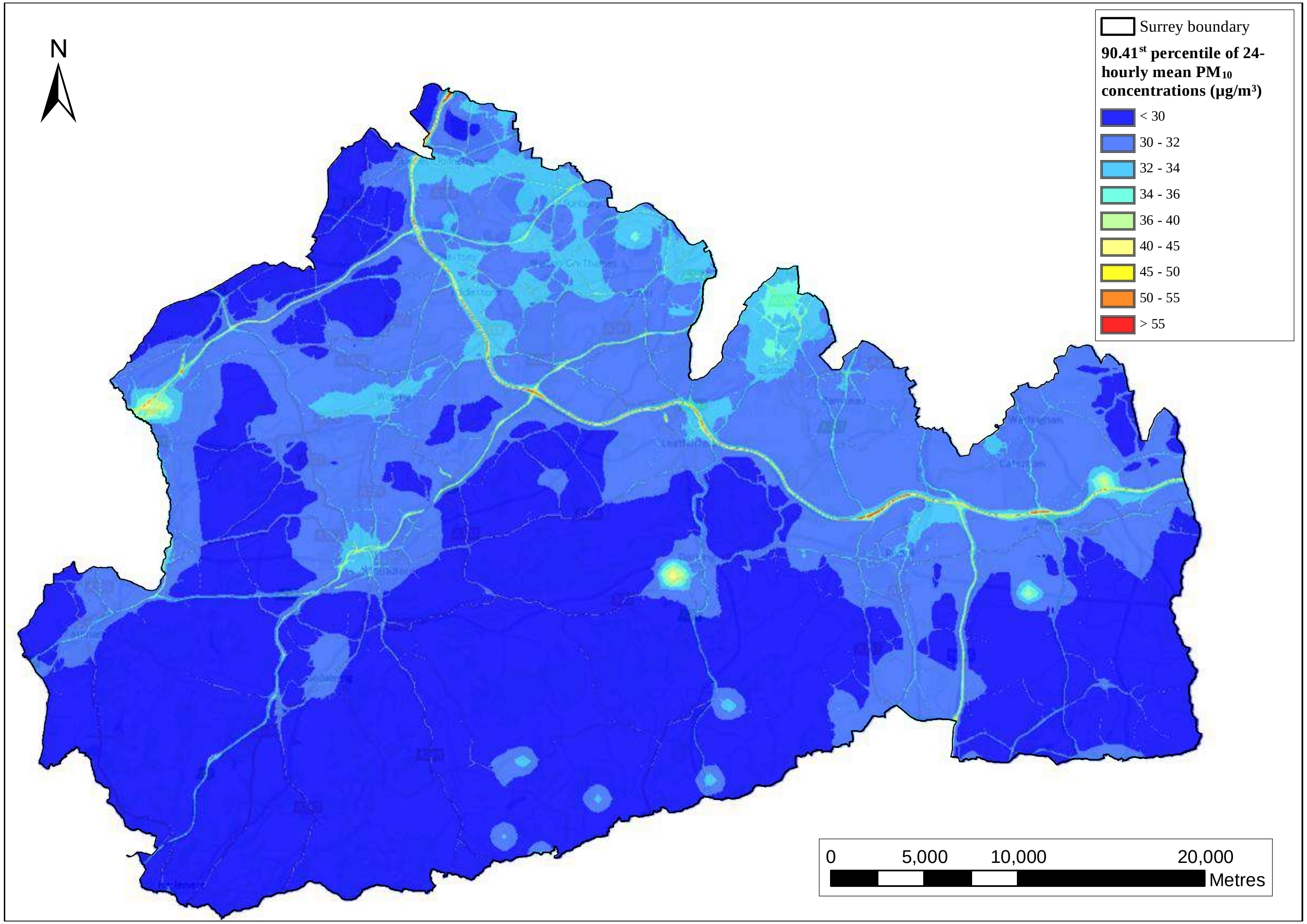

Figure 8.4: 90.41st percentile of 24-hourly mean PM_{10} concentrations, 2017 (µg/m³)

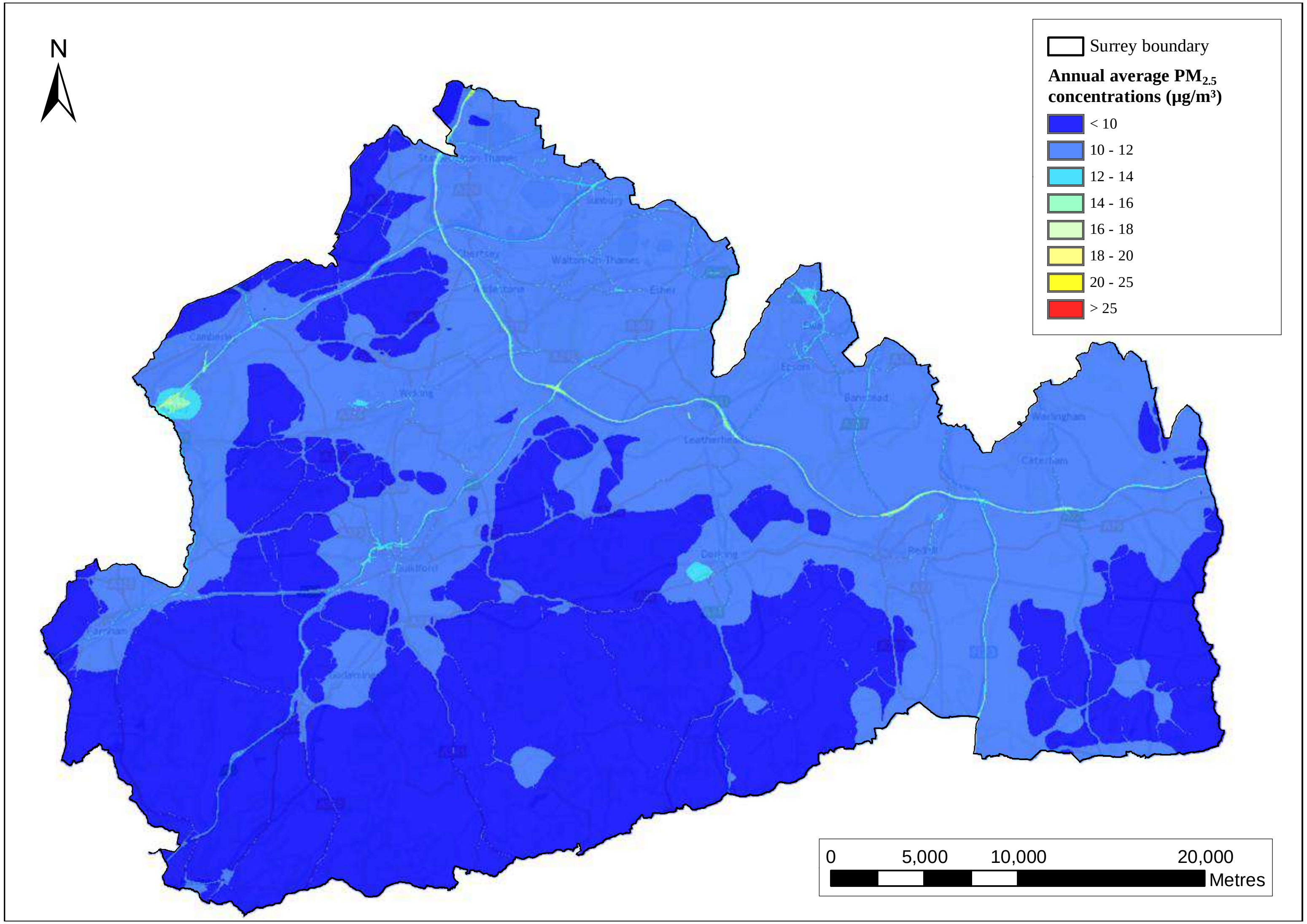

Figure 8.5: Annual mean $PM_{2.5}$ concentrations, 2017 ($\mu g/m^3$)

9 Mortality burden calculations

This section summarises local mortality burden of air pollution calculations. It includes the calculation of the number of deaths attributable to air pollution, the associated life-years lost and economic cost.

The mortality burden is assessed using the approach set out in Appendix A of the Public Health England guidance *Estimating local mortality burdens associated with particulate air pollution (April 2014)*[14]. This guidance uses concentration response functions (CRFs) which relate the increased risk of mortality to a given change in pollutant concentrations; specifically, it assumes that an increment of 10 µg/m³ in the annual concentration of $PM_{2.5}$ will increase the mortality risk by 6%.

The mortality burden of air quality will actually be a consequence of exposure to both NO_2 and $PM_{2.5}$. The 2018 COMEAP report *Associations of long-term average concentrations of nitrogen dioxide with mortality*[15] recommends revised CRFs for anthropogenic $PM_{2.5}$ and NO_2 which are adjusted from the single-pollutant CRFs to avoid double counting air quality effects from different pollutants. The report recommends using pairs of CRFs for $PM_{2.5}$ and NO_2 taken from four studies, as shown in Table 9-1, with the results from the two pollutants added for each study.

Table 9-1: Coefficients for use in burden calculations

Pollutant	Unadjusted coefficient	Jerrett et al (2013)	Fischer et al (2015)	Beelen et al (2014)	Crouse et al (2015)
NO_2	1.023	1.019	1.016	1.011	1.020
$PM_{2.5}$	1.060	1.029	1.033	1.053	1.019

Mortality burdens calculations were carried out for Lower Layer Super Output Areas (LSOAs), each representing an area with a population of approximately 1,500. The Office for National Statistics (ONS) publishes population[16] and death[17] data split by age for each LSOA.

For each LSOA, the relative risk for each pollutant is calculated as

$$RR(c) = R^{c/10}$$

where R is the relative risk, as given in Table 9-1, and c is the average pollutant concentration for that LSOA calculated from the concentration contour maps, presented in Section 8.

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/332854/PHE_CRCE_010.pdf
[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734799/COMEAP_NO2_Report.pdf
[16] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimates
[17] https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/adhocs/009235numberofdeathsregisteredineachlowersuperoutputareabysexandagedeathsregisteredin2017

The attributable fraction is then calculated as

$$AF = (RR-1)/RR$$

The number of attributable deaths in each LSOA was then calculated by multiplying the attributable fraction by the number of deaths over 30 years of age. The total number of attributable deaths for each local authority is the sum of the attributable deaths in each LSOA.

The total loss in life-years due to air pollution for each LSOA was calculated by multiplying the attributable deaths for each 5-year age band by the corresponding expected life expectancy for each age group. The life expectancy data are taken from the Public Health England Life Expectancy Calculator[18], which uses ONS population and deaths data as input.

The economic cost is calculated by multiplying the life-years lost by a value for a life year lost. The recommended value in the Defra guidance[19] of £42,780 at 2017 prices was used.

The mortality burdens by borough, provided in this report, were then calculated by aggregating the results for all LSOAs within each borough. All reported values are rounded to whole numbers. Ward level results are reported separately, for which the LSOAs results were aggregated by ward using ONS best fit lookup[20].

Table 9-2 summarises attributable deaths, life years lost and economic cost through NO_2 and $PM_{2.5}$ concentrations by borough, using unadjusted coefficients for each of the single pollutants. A further calculation relating to the economic cost of life years lost is also included for each of the separate pollutants.

Table 9-3 summarises attributable deaths, life years lost and economic cost through NO_2 and $PM_{2.5}$ concentrations by borough, using Fischer et al (2015) coefficients. A further calculation relating to the economic cost of life years lost is also included.

Table 9-4 summarises attributable deaths, life years lost and economic cost through NO_2 and $PM_{2.5}$ concentrations by borough, using Beelen et al (2014) coefficients. A further calculation relating to the economic cost of life years lost is also included.

Table 9-5 summarises attributable deaths, life years lost and economic cost through NO_2 and $PM_{2.5}$ concentrations by borough, using Crouse et al (2015) coefficients. A further calculation relating to the economic cost of life years lost is also included.

Table 9-6 summarises attributable deaths, life years lost and economic cost through NO_2 and $PM_{2.5}$ concentrations by borough, using Jerrett et al (2013) coefficients. A further calculation relating to the economic cost of life years lost is also included.

[18] https://fingertips.phe.org.uk/.../PHE%20Life%20Expectancy%20Calculator.xlsm
[19] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770649/impact-pathway-approach-guidance.pdf
[20] http://geoportal.statistics.gov.uk/datasets/lower-layer-super-output-area-2011-to-ward-2018-lookup-in-england-and-wales-v3

The calculated total life years lost in Surrey due to NO_2 and $PM_{2.5}$ concentrations range from 6,610 years to 8,059 years. The calculated total economic cost ranges from £283 million to £345 million.

Using the unadjusted coefficients for the separate pollutants, the life years lost resulting from NO_2 and $PM_{2.5}$ concentrations across Surrey are 5233 and 6200, respectively. The equivalent economic costs for NO_2 and $PM_{2.5}$ are £224 million and £265 million, respectively.

Table 9-2: Summary of attributable deaths, life years lost and economic cost for NO_2 and $PM_{2.5}$ concentrations by borough using unadjusted coefficients

Borough	NO_2					$PM_{2.5}$					Total life years lost	Total economic cost (£)
	Concentrations (µg/m³)	Attributable fraction	Attributable deaths	Life years lost	Economic cost (£)	Concentrations (µg/m³)	Attributable fraction	Attributable deaths	Life years lost	Economic cost (£)		
Elmbridge	20.5	0.045	49	593	25,357,526	11.1	0.053	58	698	29,869,955	1,291	55,227,481
Epsom and Ewell	20.1	0.045	27	320	13,700,751	11.5	0.056	33	398	17,034,551	718	30,735,302
Guildford	19.0	0.042	45	558	23,858,735	10.7	0.051	55	678	28,998,352	1,236	52,857,086
Mole Valley	19.0	0.042	36	435	18,591,686	10.7	0.051	44	524	22,396,999	958	40,988,686
Reigate and Banstead	20.6	0.046	64	711	30,421,065	10.9	0.052	72	805	34,454,788	1,516	64,875,853
Runnymede	21.5	0.048	36	394	16,865,480	10.9	0.052	39	426	18,244,557	821	35,110,037
Spelthorne	22.4	0.050	44	525	22,469,203	11.2	0.054	48	570	24,389,831	1,095	46,859,034
Surrey Heath	20.1	0.045	34	394	16,858,630	11.0	0.053	40	469	20,056,469	863	36,915,098
Tandridge	19.5	0.043	35	418	17,882,645	10.5	0.050	41	482	20,602,534	900	38,485,179
Waverley	16.0	0.036	43	495	21,175,301	10.0	0.047	56	655	28,040,798	1,150	49,216,099
Woking	18.8	0.042	33	390	16,680,170	11.1	0.053	41	494	21,149,863	884	37,830,033
Total	-	-	445	5233	223,861,191	-	-	527	6200	265,238,697	11,433	489,099,888

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly

Table 9-3: Summary of attributable deaths, life years lost and economic cost for NO_2 and $PM_{2.5}$ concentrations by borough using Fischer et al (2015) coefficients

Borough	NO_2					$PM_{2.5}$					Total life years lost	Total economic cost (£)
	Concentrations (µg/m³)	Attributable fraction	Attributable deaths	Life years lost	Economic cost (£)	Concentrations (µg/m³)	Attributable fraction	Attributable deaths	Life years lost	Economic cost (£)		
Elmbridge	20.5	0.032	35	417	17,824,921	11.1	0.030	33	394	16,846,034	810	34,670,955
Epsom & Ewell	20.1	0.031	19	225	9,630,009	11.5	0.031	19	225	9,612,179	450	19,242,188
Guildford	19.0	0.030	32	392	16,763,900	10.7	0.029	31	382	16,345,903	774	33,109,804
Mole Valley	19.0	0.030	26	305	13,064,606	10.7	0.029	25	295	12,624,867	601	25,689,473
Reigate and Banstead	20.6	0.032	45	500	21,389,258	10.9	0.030	41	454	19,427,194	954	40,816,452
Runnymede	21.5	0.034	25	277	11,862,444	10.9	0.029	22	240	10,287,053	518	22,149,497
Spelthorne	22.4	0.035	31	369	15,806,811	11.2	0.031	27	322	13,757,475	691	29,564,286
Surrey Heath	20.1	0.031	24	277	11,850,254	11.0	0.030	23	264	11,310,743	541	23,160,997
Tandridge	19.5	0.031	25	294	12,567,679	10.5	0.028	23	271	11,610,548	565	24,178,227
Waverley	16.0	0.025	30	347	14,862,852	10.0	0.027	32	369	15,792,233	717	30,655,084
Woking	18.8	0.029	23	274	11,720,132	11.1	0.030	23	279	11,927,804	553	23,647,936
Total	-	-	313	3,678	157,342,867	-	-	297	3,496	149,542,033	7,174	306,884,900

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly

Table 9-4: Summary of attributable deaths, life years lost and economic cost for NO_2 and $PM_{2.5}$ concentrations by borough using Beelen et al (2014) coefficients

Borough	NO_2					$PM_{2.5}$					Total life years lost	Total economic cost (£)
	Concentrations (µg/m³)	Attributable fraction	Attributable deaths	Life years lost	Economic cost (£)	Concentrations (µg/m³)	Attributable fraction	Attributable Deaths	Life years lost	Economic cost (£)		
Elmbridge	20.5	0.022	24	289	12,346,890	11.1	0.0475	51	621	26,555,749	909	38,902,639
Epsom & Ewell	20.1	0.022	13	156	6,670,048	11.5	0.0494	30	354	15,146,527	510	21,816,575
Guildford	19.0	0.021	22	271	11,608,229	10.7	0.0455	49	603	25,777,396	874	37,385,625
Mole Valley	19.0	0.021	18	211	9,047,391	10.7	0.0455	39	465	19,909,296	677	28,956,687
Reigate and Banstead	20.6	0.022	31	346	14,818,304	10.9	0.0466	64	716	30,630,022	1,062	45,448,326
Runnymede	21.5	0.023	17	192	8,220,312	10.9	0.0463	34	379	16,219,233	571	24,439,545
Spelthorne	22.4	0.024	21	256	10,955,112	11.2	0.0481	42	507	21,684,524	763	32,639,636
Surrey Heath	20.1	0.022	16	192	8,208,181	11.0	0.0470	36	417	17,830,832	609	26,039,013
Tandridge	19.5	0.021	17	203	8,703,922	10.5	0.0446	36	428	18,313,016	632	27,016,937
Waverley	16.0	0.017	21	240	10,284,062	10.0	0.0422	50	583	24,920,582	823	35,204,644
Woking	18.8	0.020	16	190	8,115,712	11.1	0.0473	37	440	18,803,078	629	26,918,790
Total	-	-	217	2547	108,978,162	-	-	468	5512	235,790,256	8,059	344,768,418

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly

Table 9-5: Summary of attributable deaths, life years lost and economic cost for NO_2 and $PM_{2.5}$ concentrations by borough using Crouse et al (2015) coefficients

Borough	NO_2					$PM_{2.5}$					Total life years lost	Total economic cost (£)
	Concentrations (µg/m³)	Attributable fraction	Attributable deaths	Life years lost	Economic cost (£)	Concentrations (µg/m³)	Attributable fraction	Attributable Deaths	Life years lost	Economic cost (£)		
Elmbridge	20.5	0.040	43	518	22,148,554	11.1	0.018	19	230	9,828,813	747	31,977,368
Epsom & Ewell	20.1	0.039	23	280	11,966,481	11.5	0.018	11	131	5,609,791	411	17,576,272
Guildford	19.0	0.037	39	487	20,835,475	10.7	0.017	18	223	9,534,357	710	30,369,831
Mole Valley	19.0	0.037	32	380	16,236,635	10.7	0.017	14	172	7,363,936	552	23,600,571
Reigate and Banstead	20.6	0.040	56	621	26,573,932	10.9	0.017	24	265	11,333,366	886	37,907,298
Runnymede	21.5	0.042	31	344	14,734,858	10.9	0.017	13	140	6,001,204	485	20,736,061
Spelthorne	22.4	0.043	38	459	19,632,227	11.2	0.018	16	188	8,027,452	647	27,659,680
Surrey Heath	20.1	0.039	30	344	14,724,961	11.0	0.017	13	154	6,599,042	498	21,324,003
Tandridge	19.5	0.038	31	365	15,618,115	10.5	0.016	13	158	6,771,424	523	22,389,539
Waverley	16.0	0.031	37	432	18,483,797	10.0	0.016	19	215	9,207,092	647	27,690,889
Woking	18.8	0.037	29	341	14,566,604	11.1	0.018	14	163	6,959,188	503	21,525,792
Total	-	-	389	4570	195,521,638	-	-	173	2039	87,235,665	6,610	282,757,304

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly

Table 9-6: Summary of attributable deaths, life years lost and economic cost for NO_2 and $PM_{2.5}$ concentrations by borough using Jerrett et al (2013) coefficients

Borough	NO_2					$PM_{2.5}$					Total life years lost	Total economic cost (£)
	Concentrations (µg/m³)	Attributable fraction	Attributable Deaths	Life years lost	Economic cost (£)	Concentrations (µg/m³)	Attributable fraction	Attributable Deaths	Life years lost	Economic cost (£)		
Elmbridge	20.5	0.038	41	493	21,072,493	11.1	0.027	29	347	14,860,060	840	35,932,554
Epsom & Ewell	20.1	0.037	22	266	11,384,960	11.5	0.028	17	198	8,479,675	464	19,864,636
Guildford	19.0	0.035	37	463	19,821,949	10.7	0.025	27	337	14,417,750	800	34,239,699
Mole Valley	19.0	0.035	30	361	15,447,070	10.7	0.025	22	260	11,135,650	621	26,582,720
Reigate and Banstead	20.6	0.038	53	591	25,283,706	10.9	0.026	36	401	17,136,317	992	42,420,023
Runnymede	21.5	0.040	30	328	14,020,157	10.9	0.026	19	212	9,073,983	540	23,094,140
Spelthorne	22.4	0.041	36	437	18,680,483	11.2	0.027	24	284	12,135,893	720	30,816,376
Surrey Heath	20.1	0.037	28	327	14,009,495	11.0	0.026	20	233	9,977,234	561	23,986,729
Tandridge	19.5	0.036	29	347	14,858,852	10.5	0.025	20	239	10,240,605	587	25,099,457
Waverley	16.0	0.030	35	411	17,582,034	10.0	0.024	28	326	13,927,537	737	31,509,571
Woking	18.8	0.035	27	324	13,858,042	11.1	0.026	21	246	10,521,603	570	24,379,645
Total	-	-	370	4348	186,019,243	-	-	262	3083	131,906,307	7,432	317,925,550

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly

10 Source apportionment

Apportionment of emissions and concentrations by source group is presented in this section. The first section presents apportionment of emissions from sources within the Surrey modelled area and the second section presents source apportionment of concentrations summarised by borough.

More detailed source apportionment of concentrations is reported separately, to show the concentration breakdown at each of the 222 receptor locations provided by the borough councils.

10.1 Emissions

Figure 10.1 shows the breakdown of Surrey NO_x emissions by each major source group. The majority of NO_x emissions (53%) are from road sources. Other sources, from NAEI data, represent 44% of NO_x emissions in Surrey; this group includes the emissions from sources such as other transport and machinery (65%), combustion in commercial, residential and agricultural sectors (27%) and combustion in industry (7%).

Road transport NO_x emissions by vehicle type is shown in Figure 10.2. The largest contributions to road transport NO_x emissions are from light diesel vehicles (73%), corresponding to the Diesel Cars (34%) and LGV (39%) source apportionment groups; note the LGV group contains both petrol and diesel light goods vehicles, of which 97% are assumed to be diesel in the EFT fleet projections used in the emission calculations.

The proportion NO_x emitted as NO_2, known as primary NO_2, will vary by vehicle type. Primary NO_2 percentages by vehicle type for 2017 are shown in Table 10-1. Highest NO_2 percentages are for the NO_x emissions from light diesel vehicles, which along with Figure 10.2; indicate that these vehicles will have the largest direct contribution to NO_2 concentrations.

Table 10-1: Primary NO_2 percentage for Surrey road transport NO_x emissions by vehicle type

Petrol Cars and Motorcycles	Diesel Cars	LGVs	Buses and Coaches	Rigid HGVs	Articulated HGVs	All vehicles
5%	35%	34%	10%	10%	9%	27%

Figure 10.3 shows the contribution to PM_{10} emissions within Surrey by each major source group. Compared to the NO_x emissions breakdown the proportion of PM_{10} emissions attributed to road emissions is significantly smaller (24%). The largest emissions come from other sources (75%) such as commercial, residential and agricultural sectors (67%), production processes (12%) and other transport and machinery (6%).

A breakdown of road transport exhaust PM_{10} emissions by vehicle type is shown in Figure 10.4; similar to the breakdown of NO_x emissions by vehicle type, exhaust PM_{10} emissions are dominated by light diesel vehicle emissions. However, as shown by Figure 10.5 road transport PM_{10} emissions are dominated by non-exhaust emissions such as brake wear (32%) and tyre wear (23%); only 12% of road transport PM_{10} emissions in Surrey are attributed to exhaust emissions.

The apportionment of $PM_{2.5}$ emissions are shown in Figure 10.6 to Figure 10.8. The breakdown of $PM_{2.5}$ is similar to the breakdown of PM_{10} emissions: 82% of emissions stem from other sources such as commercial, residential and agricultural sectors (79%), other transport and machinery (7%) and other sources and sinks (4%). 17% of Surrey emissions are attributed to road transport, these road transport emissions are dominated by non-exhaust emissions (78%). Road transport exhaust emissions are dominated by light diesel vehicles (74%). Note that resuspension does not contribute to $PM_{2.5}$ emissions.

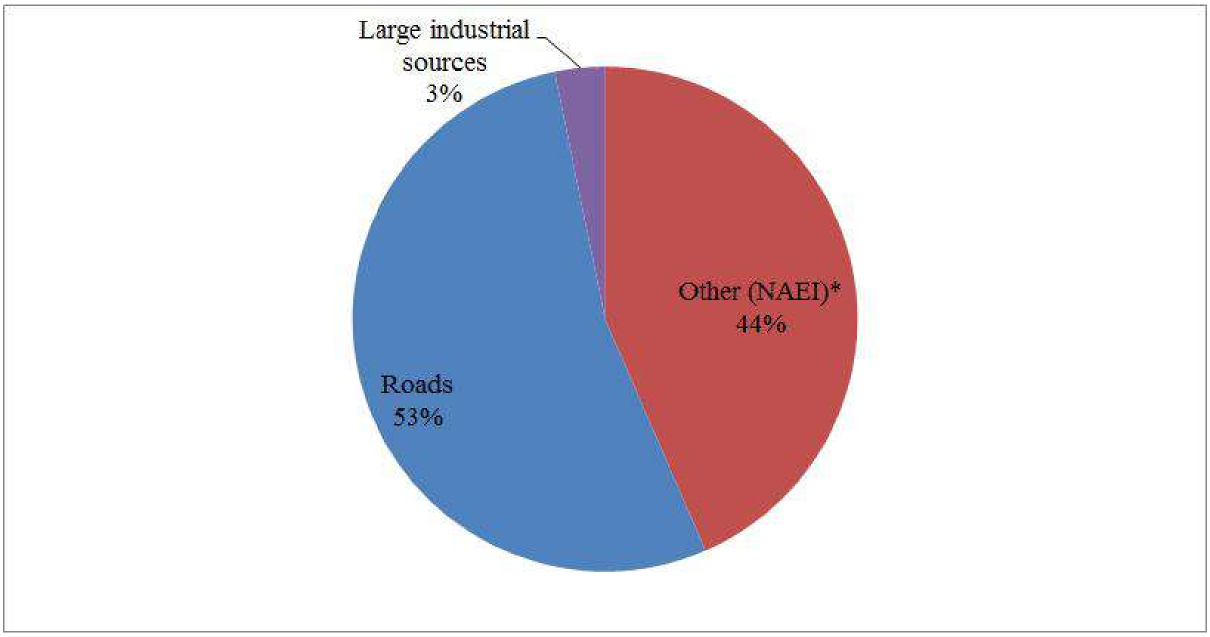

Figure 10.1: Surrey NO_x emissions by major source group. *See Section 10.1 for details of Other (NAEI) group

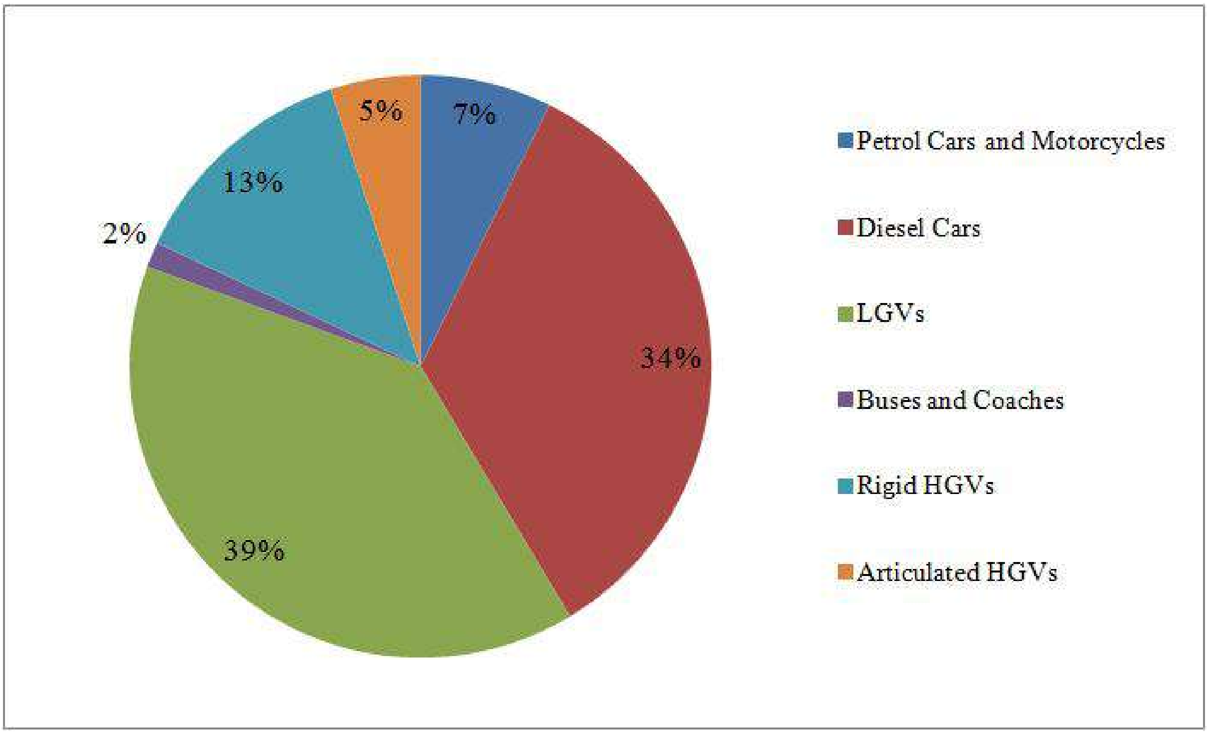

Figure 10.2: Surrey road transport NO_x emissions by vehicle category

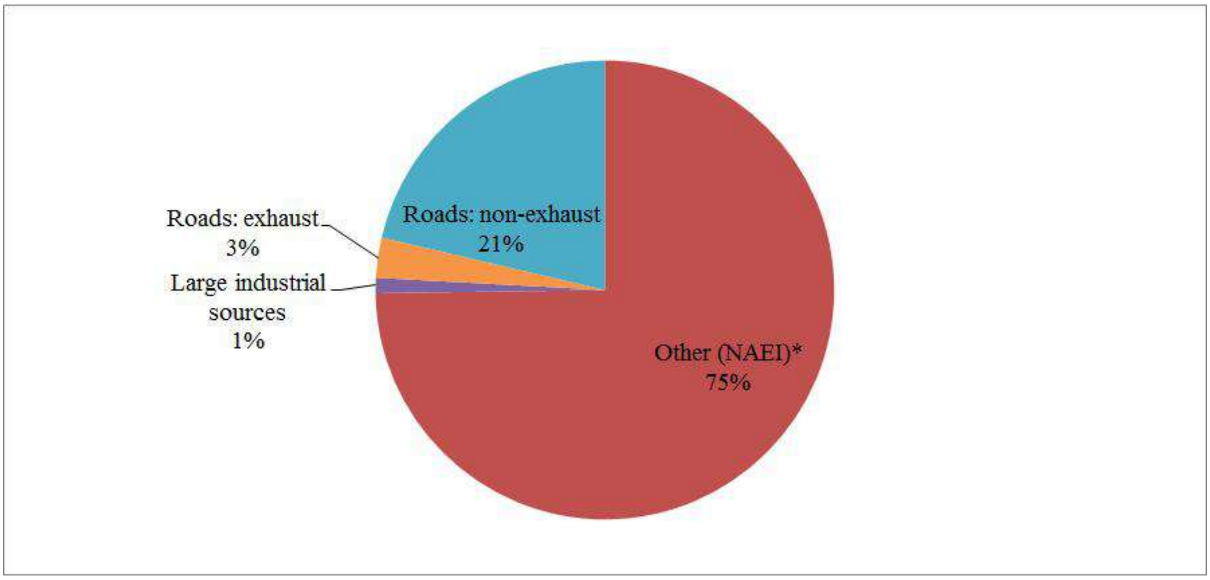

Figure 10.3: Surrey PM_{10} emissions by major source group. *See Section 10.1 for details of Other (NAEI) group

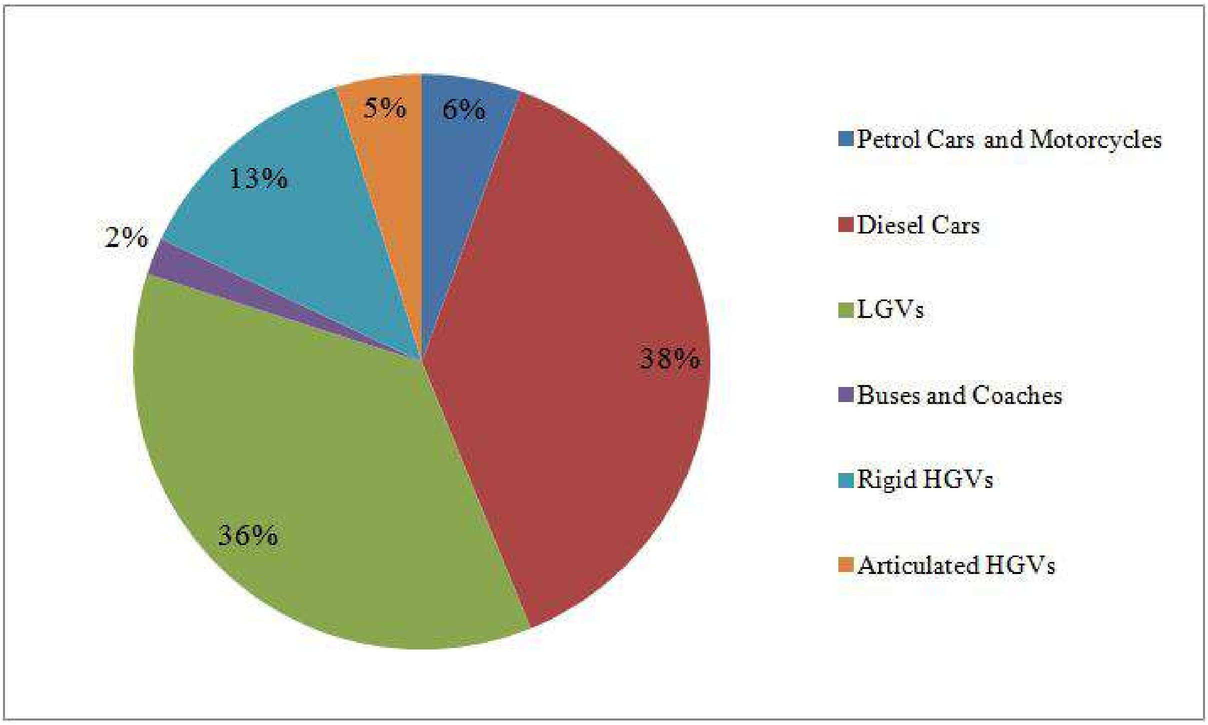

Figure 10.4: Surrey road transport exhaust PM_{10} emissions by vehicle category

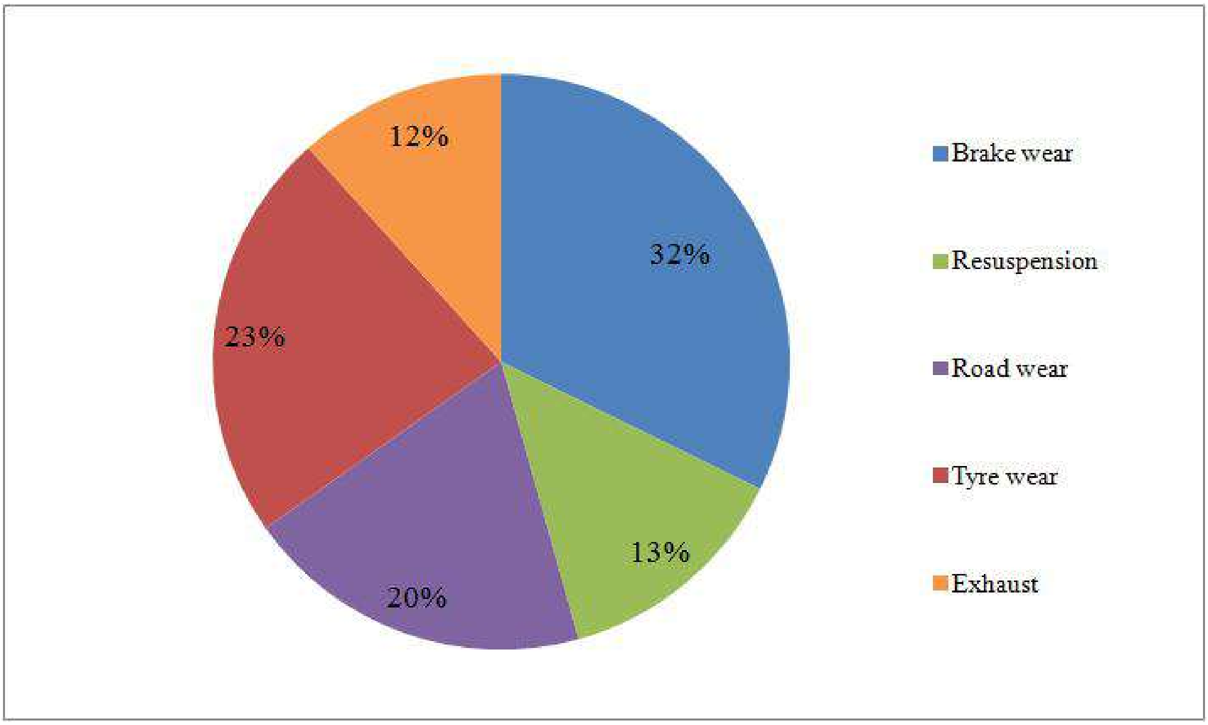

Figure 10.5: Surrey Road transport PM_{10} emissions by exhaust and non-exhaust components

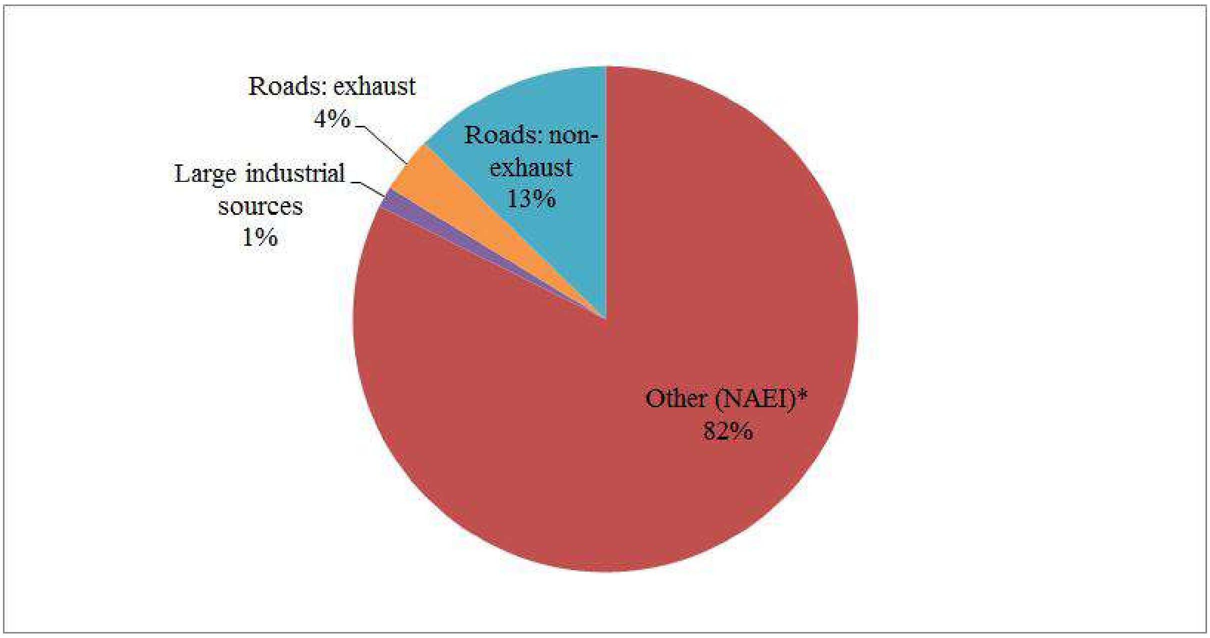

Figure 10.6: Surrey $PM_{2.5}$ emissions by major source group. *See Section 10.1 for details of Other (NAEI) group

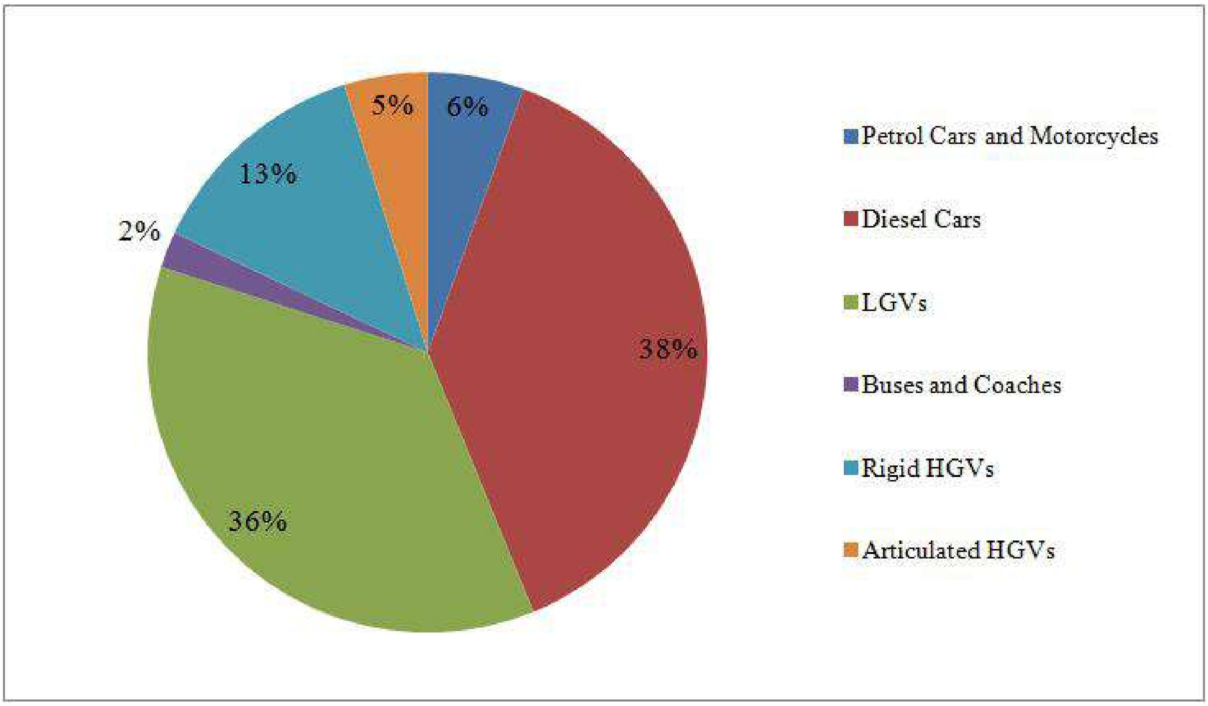

Figure 10.7: Surrey road transport exhaust $PM_{2.5}$ emissions by vehicle category

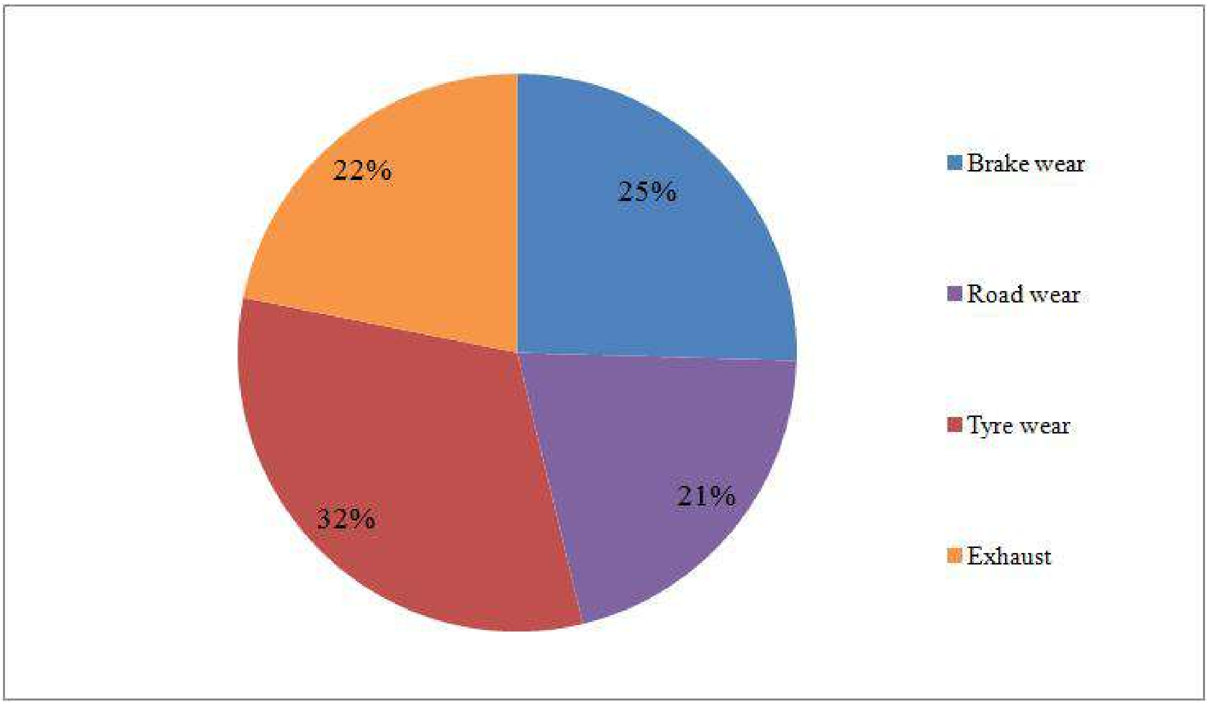

Figure 10.8: Surrey road transport $PM_{2.5}$ emissions by exhaust and non-exhaust components

10.2 Concentrations

The apportionment of modelled concentrations was carried out for 222 receptor locations provided by the borough councils, representing a mixture of roadside and urban background locations. Note that none of these receptor locations are located in Runnymede. It should be further noted that the proportion of site types for each borough is not comparable, for example, some boroughs focused on source apportionment sites by roadsides.

In this report, source apportionment concentrations averaged by borough are presented. Concentrations for individual source apportionment locations are reported in a separate report for each borough.

Figure 10.9 presents total NO_x concentrations by major source group, including background concentrations from outside of Surrey. Of sources within Surrey, road transport is the largest contributor to NO_x concentrations across all boroughs, contributing an average of 49% of total NO_x concentrations.

The average contribution of other sources to NO_x concentrations is higher in Spelthorne (23%) compared to the average of all other boroughs (11%). This is due to the proximity of some of the source apportionment locations to Heathrow Airport.

Road transport NO_x concentrations split by vehicle category are presented in Figure 10.10. The borough average breakdowns of concentrations are largely in line with the Surrey-wide breakdown of emissions by vehicle type shown in Figure 10.2.

A summary of NO_x source apportionment is provided in Table 10-2.

Note that the contribution of different source groups to the total NO_2 concentration cannot be quantified because of the non-linearity nature of the chemical reactions which take place in the atmosphere. The contribution of different source groups to total NO_2 concentrations will be related to the contribution of each group to the total NO_x concentrations and the proportion of NO_x emissions emitted as NO_2 (primary NO_2).

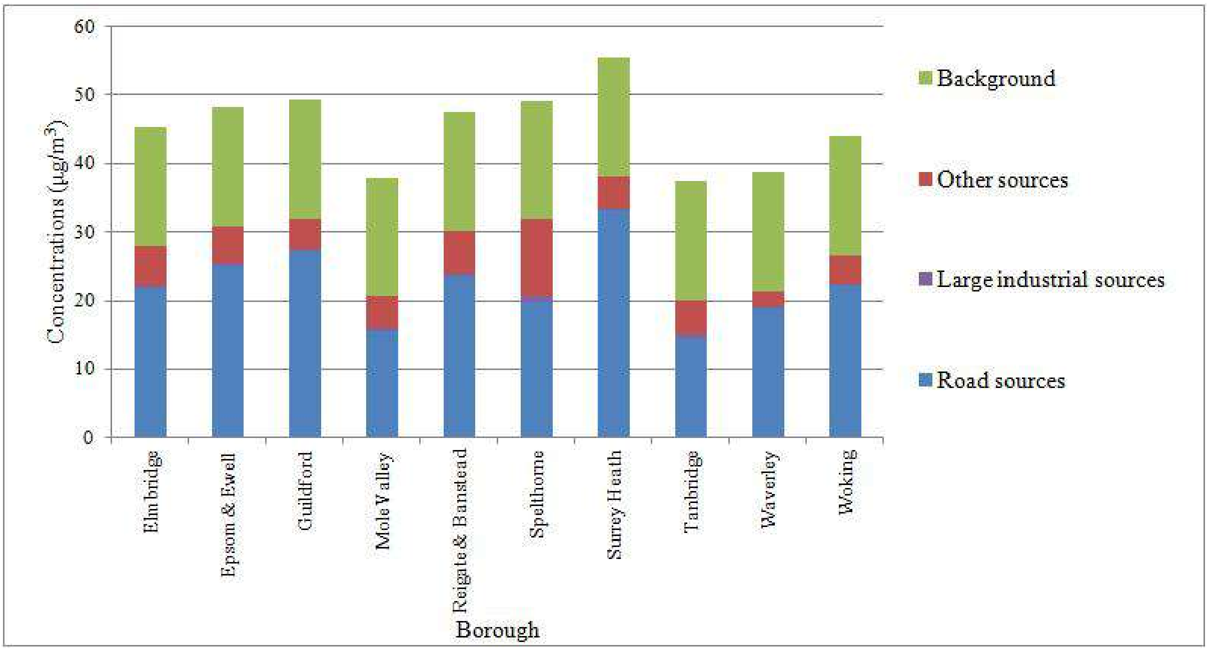

Figure 10.9: NO_x concentrations by major source group, averaged by borough

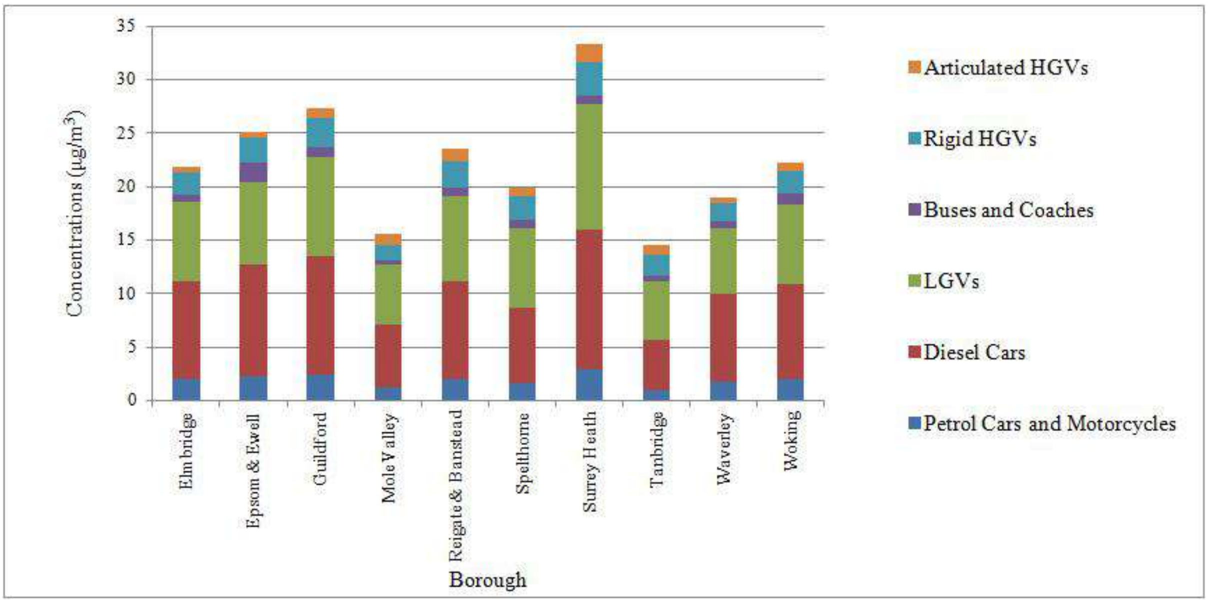

Figure 10.10: Road transport NO_x concentrations by vehicle category, averaged by borough

Table 10-2: Summary of NO_x concentration source apportionment, averaged by borough

NO_x (µg/m³)	Type of source apportionment									
	Source type				Vehicle type					
Borough	**Road sources**	**Other sources**	**Background**	**Large industrial sources**	**Petrol Cars & Motorcycles**	**Diesel Cars**	**LGVs**	**Buses & Coaches**	**Rigid HGVs**	**Articulated HGVs**
Elmbridge	21.9	5.6	17.4	0.4	2.0	9.1	7.4	0.7	2.1	0.5
Epsom & Ewell	25.1	5.4	17.4	0.3	2.3	10.4	7.7	1.8	2.3	0.6
Guildford	27.3	4.4	17.4	0.2	2.4	11.1	9.3	0.9	2.7	0.9
Mole Valley	15.6	4.7	17.4	0.3	1.2	5.8	5.7	0.4	1.4	1.1
Reigate & Banstead	23.6	6.2	17.4	0.5	2.0	9.2	7.9	0.8	2.5	1.2
Spelthorne	19.9	11.1	17.4	0.8	1.5	7.2	7.4	0.8	2.2	0.9
Surrey Heath	33.3	4.6	17.4	0.2	2.9	13.2	11.7	0.8	3.0	1.7
Tandridge	14.6	4.9	17.4	0.5	1.0	4.7	5.4	0.6	2.0	0.9
Waverley	19.0	2.3	17.4	0.1	1.8	8.2	6.2	0.6	1.7	0.5
Woking	22.2	4.2	17.4	0.2	2.0	9.0	7.4	1.0	2.1	0.8

Figure 10.11 presents total PM_{10} concentrations by major source group. For all boroughs, background concentrations from outside the modelled Surrey area are the largest contributor to total PM_{10} concentrations; across the source apportionment locations, sources within Surrey represent an average of 21% of total PM_{10} concentrations.

Exhaust road transport PM_{10} concentrations split by vehicle category are shown in Figure 10.12. Non-exhaust sources are the major contributor (88%) to road transport PM_{10} concentrations, as illustrated by Figure 10.13.

A summary of PM_{10} source apportionment is provided in Table 10-3.

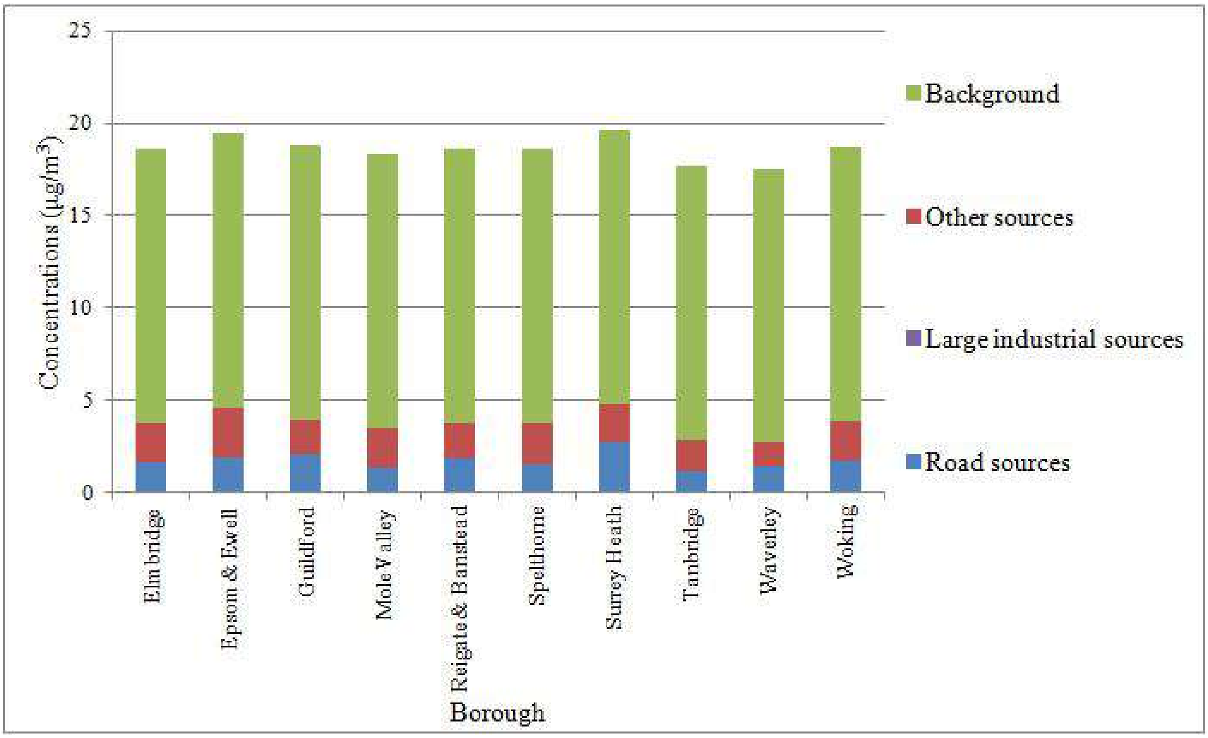

Figure 10.11: PM_{10} concentrations by major source group, averaged by borough

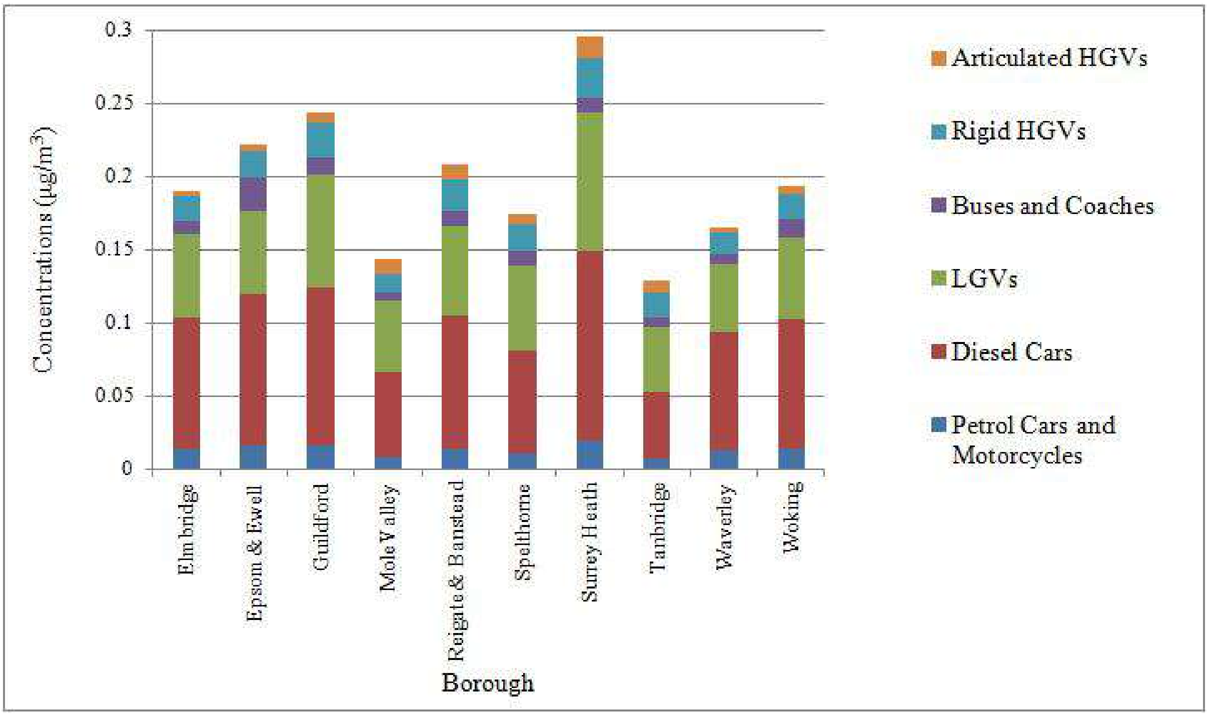

Figure 10.12: Road transport exhaust PM_{10} *concentrations by vehicle category, averaged by borough*

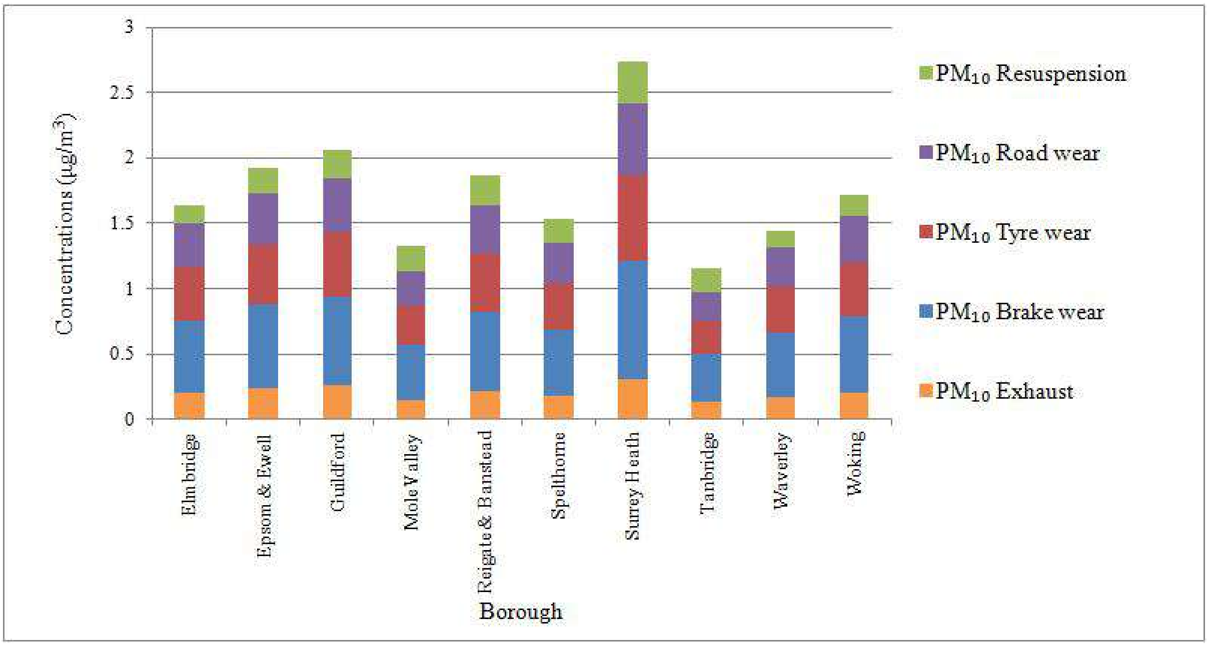

Figure 10.13: Road transport PM_{10} *concentrations by exhaust and non-exhaust components, averaged by borough*

Table 10-3: Summary of PM_{10} concentration source apportionment, averaged by borough

PM_{10} (µg/m³)	**Type of source apportionment**													
	Source type				**Road transport - exhaust by vehicle type**						**Road transport - non-exhaust**			
Receptor	**Road sources**	**Other sources**	**Background**	**Large industrial sources**	**Petrol Cars & Motorcycles**	**Diesel Cars**	**LGVs**	**Buses & Coaches**	**Rigid HGVs**	**Articulated HGVs**	**PM_{10} Brake wear**	**PM_{10} Tyre wear**	**PM_{10} Resuspension**	**PM_{10} Road wear**
Elmbridge	1.6	2.1	14.8	<0.1	0.02	0.09	0.06	<0.01	0.02	<0.01	0.6	0.4	0.1	0.3
Epsom & Ewell	1.9	2.7	14.8	<0.1	0.02	0.11	0.06	0.02	0.02	<0.01	0.6	0.5	0.2	0.4
Guildford	2.1	1.9	14.8	<0.1	0.02	0.11	0.08	0.01	0.02	<0.01	0.7	0.5	0.2	0.4
Mole Valley	1.3	2.1	14.8	<0.1	<0.01	0.06	0.05	<0.01	0.01	0.01	0.4	0.3	0.2	0.3
Reigate & Banstead	1.9	1.9	14.8	<0.1	0.02	0.09	0.07	0.01	0.02	0.01	0.6	0.4	0.2	0.4
Spelthorne	1.5	2.2	14.8	<0.1	0.01	0.07	0.06	0.01	0.02	<0.01	0.5	0.4	0.2	0.3
Surrey Heath	2.7	2.1	14.8	<0.1	0.02	0.14	0.10	0.01	0.03	0.02	0.9	0.7	0.3	0.5
Tandridge	1.2	1.7	14.8	<0.1	<0.01	0.05	0.05	<0.01	0.02	<0.01	0.4	0.3	0.2	0.2
Waverley	1.4	1.3	14.8	<0.1	0.01	0.08	0.05	<0.01	0.01	<0.01	0.5	0.4	0.1	0.3
Woking	1.7	2.1	14.8	<0.1	0.01	0.09	0.06	0.01	0.02	<0.01	0.6	0.4	0.2	0.4

Figure 10.14 presents total $PM_{2.5}$ concentrations by major source group. In line with the breakdown of PM_{10} concentrations, background concentrations from outside Surrey are the largest contributor to total $PM_{2.5}$ concentrations.

Exhaust road transport PM_{10} concentrations split by vehicle category are shown in Figure 10.15. Non-exhaust sources are the major contributor to road transport $PM_{2.5}$ concentrations, as illustrated in Figure 10.16.

A summary of $PM_{2.5}$ source apportionment is provided in Table 10-4.

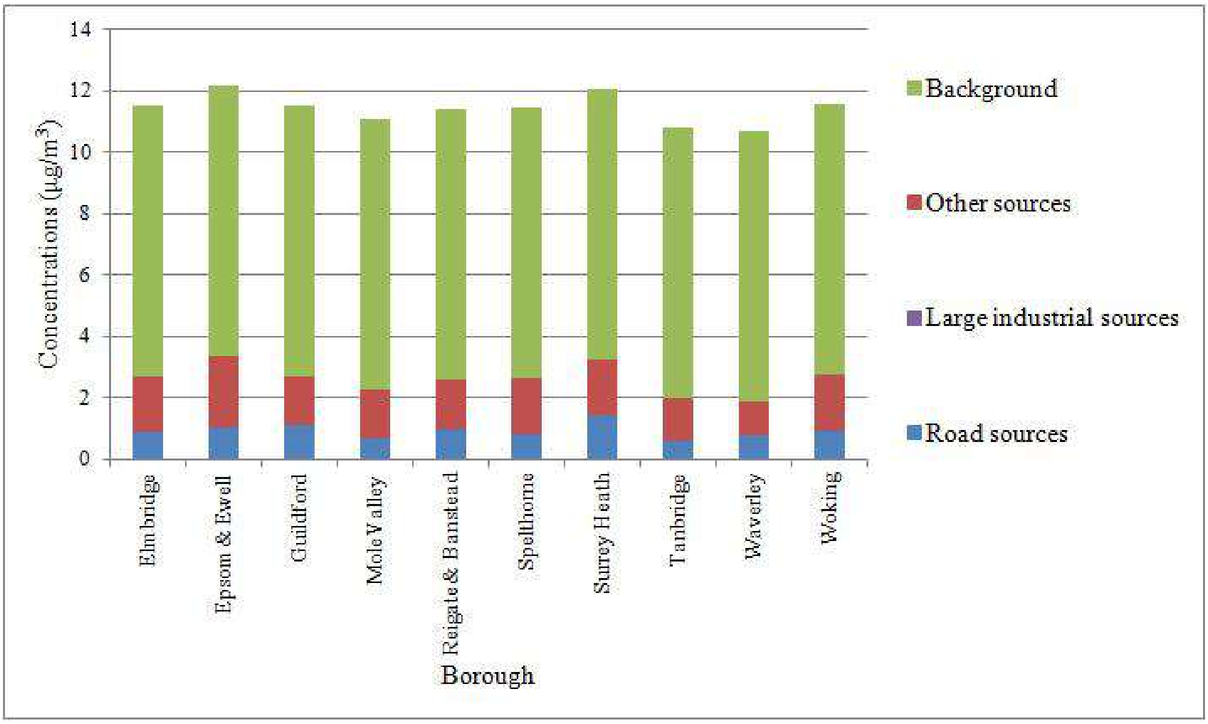

Figure 10.14: $PM_{2.5}$ concentrations by major source group, averaged by borough

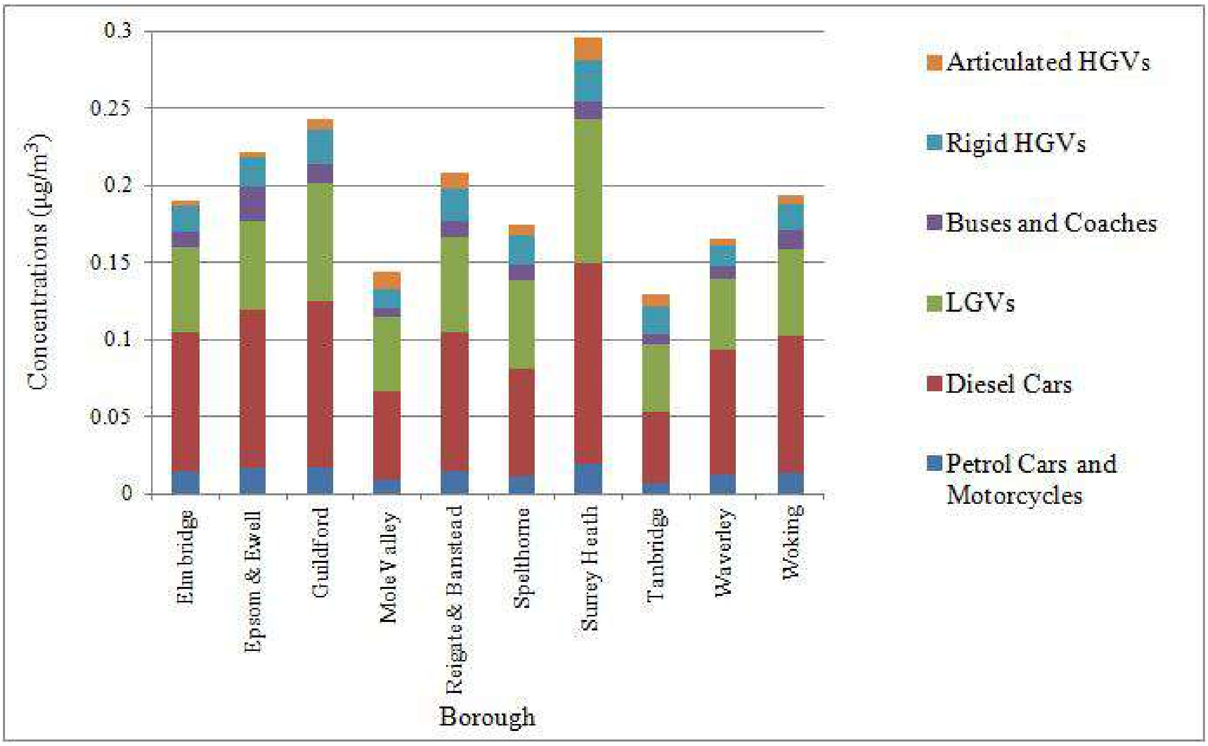

Figure 10.15: Road transport exhaust $PM_{2.5}$ concentrations by vehicle category, averaged by borough

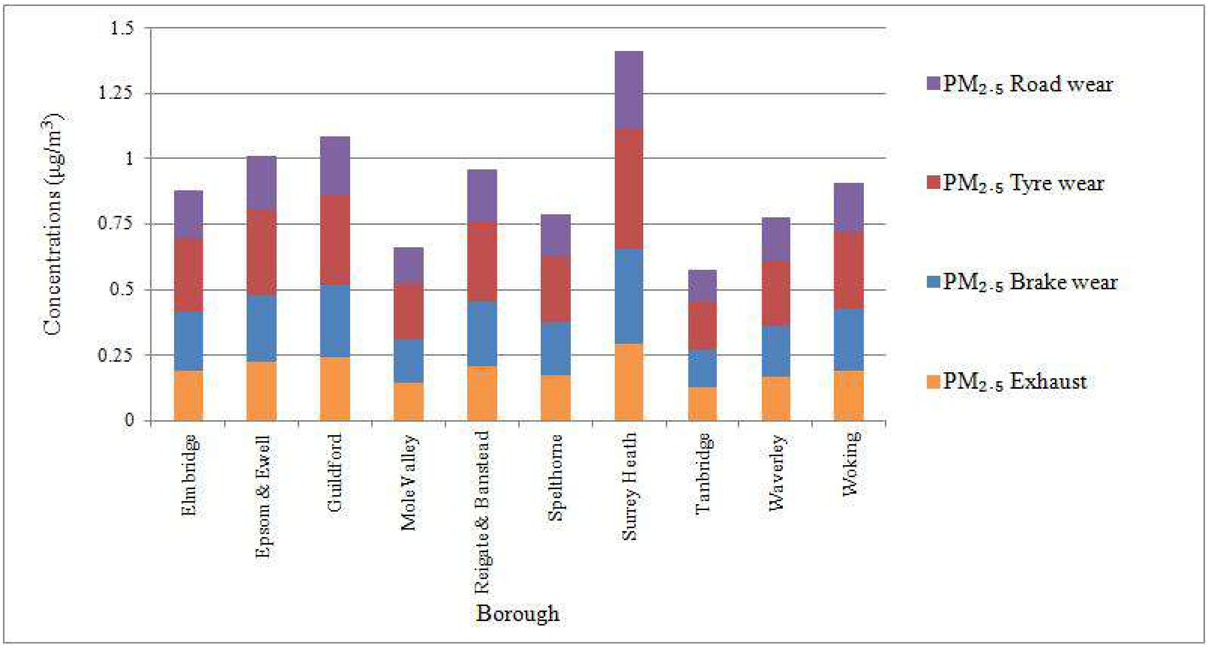

Figure 10.16: Road transport $PM_{2.5}$ concentrations by exhaust and non-exhaust components, averaged by borough

Table 10-4: Summary of $PM_{2.5}$ concentration source apportionment, averaged by borough

$PM_{2.5}$ (μg/m³)	Type of source apportionment												
	Source type				Road transport - exhaust by vehicle type						Road transport - non-exhaust		
Receptor	**Road sources**	**Other sources**	**Background**	**Large industrial sources**	**Petrol Cars & Motorcycles**	**Diesel Cars**	**LGVs**	**Buses & Coaches**	**Rigid HGVs**	**Articulated HGVs**	**$PM_{2.5}$ Brake wear**	**$PM_{2.5}$ Tyre wear**	**$PM_{2.5}$ Road wear**
Elmbridge	0.9	1.8	8.8	<0.1	0.01	0.09	0.06	<0.01	0.02	<0.01	0.2	0.3	0.2
Epsom & Ewell	1.0	2.3	8.8	<0.1	0.02	0.10	0.06	0.02	0.02	<0.01	0.3	0.3	0.2
Guildford	1.1	1.6	8.8	<0.1	0.02	0.11	0.08	0.01	0.02	<0.01	0.3	0.3	0.2
Mole Valley	0.7	1.6	8.8	<0.1	<0.01	0.06	0.05	<0.01	0.01	0.01	0.2	0.2	0.1
Reigate & Banstead	1.0	1.6	8.8	<0.1	0.01	0.09	0.06	<0.01	0.02	0.01	0.2	0.3	0.2
Spelthorne	0.8	1.8	8.8	<0.1	0.01	0.07	0.06	<0.01	0.02	<0.01	0.2	0.3	0.2
Surrey Heath	1.4	1.8	8.8	<0.1	0.02	0.13	0.09	0.01	0.03	0.01	0.4	0.5	0.3
Tandridge	0.6	1.4	8.8	<0.1	<0.01	0.05	0.04	<0.01	0.02	<0.01	0.1	0.2	0.1
Waverley	0.8	1.1	8.8	<0.1	0.01	0.08	0.05	<0.01	0.01	<0.01	0.2	0.3	0.2
Woking	0.9	1.8	8.8	<0.1	0.01	0.09	0.06	0.01	0.02	<0.01	0.2	0.3	0.2

11 Discussion

Air quality modelling has been carried out for NO_2, PM_{10} and $PM_{2.5}$ using ADMS-Urban (version 4.2). This has been carried out to assess relevant pollutant concentrations throughout Surrey in 2017 against the air quality objectives. The detailed modelling is supplemented by mortality burden calculations and source apportionment.

Model verification was carried out to ensure a suitable model set-up for detailed modelling; this was done by comparing modelled concentrations with measured data from diffusion tubes and continuous monitors at a variety of site types throughout Surrey. The model verification shows a generally good performance of the model set-up across Surrey, with modelled annual average NO_2 concentrations falling within 25% of the monitored values at 74% of the locations.

The model was run to produce contour plots of annual mean NO_2, 99.79th percentile of hourly mean NO_2, annual mean PM_{10}, 90.41st percentile of 24-hourly mean PM_{10} and annual mean $PM_{2.5}$ concentrations.

This modelling predicts exceedences for three of the five air quality objectives, along motorways and stretches of busy roads. The exceptions are annual mean PM_{10} concentrations, which has no exceedences outside the footprint of modelled roads and $PM_{2.5}$ which has no exceedences across Surrey.

The health impacts associated with air quality across Surrey and the contributions from each borough and ward have been assessed by calculating the number of attributable deaths and corresponding life-years lost due to NO_2 and $PM_{2.5}$ concentrations. The methodology used for these calculations is outlined in Appendix A of the Public Health England guidance *Estimating local mortality burdens associated with particulate air pollution (April 2014)*. Using this approach along with four studies suggesting a range of CRF pairs, the combined health impacts of NO_2 and $PM_{2.5}$ were calculated to be in a range of 6,610 and 8,059 life-years lost which equates to an economic cost between £283 million and £345 million in 2017. Using the unadjusted value, the lowest life years lost were calculated to be 5233, resulting from NO_2 concentrations. This equates to an economic cost of £224 million.

Source apportionment has been carried out across Surrey, calculating the contributions of each major source group to NO_x, PM_{10} and $PM_{2.5}$ pollutant emissions and resulting concentrations.

NO_x emissions within Surrey are dominated by road transport, specifically light diesel vehicles; in addition the primary NO_2 proportion for these vehicle types is higher than for other vehicles. NO_x concentrations within Surrey are greatest from road transport. The distribution of vehicle type concentrations is in line with breakdown of vehicle type emissions.

PM_{10} and $PM_{2.5}$ emissions within Surrey are largely dominated by other emissions from NAEI data. The largest contributor to both PM_{10} and $PM_{2.5}$ concentrations is background concentrations, from outside Surrey.

APPENDIX A: Model verification data

Appendix A presents a comparison of model verification results using Heathrow Airport and Gatwick Airport meteorological data. Table A.1 is a summary table of monitored and modelled concentrations using the two sets of meteorological data for all monitoring sites.

Table A.1: Monitored and modelled NO_2 concentrations at monitoring locations

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
Hampton Court Parade	40.6	36.8	33.7	91%	83%	Elmbridge
Weybridge High St	33.5	38.6	34.5	115%	103%	Elmbridge
Esher 1	37.5	26.6	24.4	71%	65%	Elmbridge
Esher 4	33.7	29.0	25.2	86%	75%	Elmbridge
Esher 5	43.1	32.9	27.4	76%	64%	Elmbridge
Esher 7	39.6	40.8	34.0	103%	86%	Elmbridge
Esher 8	39.1	28.2	25.8	72%	66%	Elmbridge
Esher 9	29.0	28.6	26.3	99%	91%	Elmbridge
Esher 10	28.8	26.0	23.7	90%	82%	Elmbridge
Esher 11	33.1	26.8	24.5	81%	74%	Elmbridge
Esher 13	31.9	32.4	28.9	102%	91%	Elmbridge
Hampton court 1	35.8	32.9	29.9	92%	84%	Elmbridge
Hinchley wood 1	35.8	26.7	24.4	75%	68%	Elmbridge
Hinchley wood 2	31.2	26.4	24.2	85%	78%	Elmbridge
Molesey 1	28.5	24.3	22.6	85%	79%	Elmbridge
Hampton court 5	25.6	26.7	23.8	104%	93%	Elmbridge
Molesey 8	31.5	29.9	27.3	95%	87%	Elmbridge
Molesey 9	32.7	26.0	23.7	80%	72%	Elmbridge
Molesey 10	27.8	26.2	23.9	94%	86%	Elmbridge
Hampton court 2	35.2	36.9	33.8	105%	96%	Elmbridge
Hampton court 3	35.3	36.9	33.8	105%	96%	Elmbridge
Hampton court 4	35.1	36.9	33.8	105%	96%	Elmbridge
Walton 3	30.4	24.3	22.5	80%	74%	Elmbridge
Walton 5	27.8	30.0	27.5	108%	99%	Elmbridge
Walton 8	30.9	24.6	22.5	80%	73%	Elmbridge
Walton 9	30.5	25.1	23.2	82%	76%	Elmbridge
Walton 10	33.5	30.9	26.6	92%	79%	Elmbridge
Walton 11	30.9	32.6	29.8	106%	96%	Elmbridge
Weybridge 1	30.4	42.4	37.6	139%	124%	Elmbridge

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
Weybridge 4	30.6	28.3	25.9	92%	85%	Elmbridge
Weybridge 5	34.4	37.7	33.2	110%	97%	Elmbridge
Weybridge 6	28.4	39.8	32.9	140%	116%	Elmbridge
Weybridge 7	41.0	32.6	29.6	80%	72%	Elmbridge
Weybridge 8	35.9	27.6	25.4	77%	71%	Elmbridge
Weybridge 9	22.9	24.6	22.2	107%	97%	Elmbridge
Weybridge 10	31.6	38.1	34.0	121%	108%	Elmbridge
Weybridge 11	31.2	38.1	34.0	122%	109%	Elmbridge
Weybridge 12	32.3	38.1	34.0	118%	105%	Elmbridge
Cobham 1	30.4	33.2	31.3	109%	103%	Elmbridge
Cobham 6	24.9	27.6	26.1	111%	105%	Elmbridge
Cobham 7	32.5	32.7	30.5	101%	94%	Elmbridge
Downside 3	19.3	31.6	27.7	164%	144%	Elmbridge
EE1	34.2	26.5	24.7	77%	72%	Epsom & Ewell
EE3	17.0	19.3	18.4	114%	108%	Epsom & Ewell
EE6	31.6	27.9	26.8	88%	85%	Epsom & Ewell
EE7	35.9	43.9	41.2	122%	115%	Epsom & Ewell
EE9	23.4	22.4	21.6	96%	92%	Epsom & Ewell
EE10	44.9	28.5	26.8	63%	60%	Epsom & Ewell
EE14	25.6	24.3	22.9	95%	89%	Epsom & Ewell
EE16	31.0	25.5	23.0	82%	74%	Epsom & Ewell
EE17	30.6	26.0	24.3	85%	79%	Epsom & Ewell
EE22	39.7	34.8	33.3	88%	84%	Epsom & Ewell
EE36	26.5	25.7	24.3	97%	92%	Epsom & Ewell
EE38	25.4	25.9	23.7	102%	93%	Epsom & Ewell
EE39	27.9	25.2	23.7	90%	85%	Epsom & Ewell
EE42	29.1	30.6	28.2	105%	97%	Epsom & Ewell
EE43	28.8	24.4	22.3	85%	77%	Epsom & Ewell
EE45	22.8	25.6	23.8	112%	104%	Epsom & Ewell
EE47	24.8	24.3	23.2	98%	94%	Epsom & Ewell
EE48	29.3	24.7	22.8	84%	78%	Epsom & Ewell
EE49	28.9	26.9	25.2	93%	87%	Epsom & Ewell
EE50	36.8	28.9	27.4	79%	74%	Epsom & Ewell
GUL_GD1	28.9	34.5	32.4	119%	112%	Guildford
GUL_GD2	30.6	27.0	26.1	88%	85%	Guildford

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
GUL_GD3	17.5	24.0	23.4	137%	134%	Guildford
GUL_GD6	10.1	17.5	17.6	173%	174%	Guildford
GUL_GD9	17.1	25.2	24.2	147%	142%	Guildford
GUL_GD10	15.4	20.7	19.8	134%	129%	Guildford
GUL_GD11	24.3	29.7	25.1	122%	103%	Guildford
GUL_GD13	31.1	34.2	31.4	110%	101%	Guildford
GUL_GD14	32.0	30.8	29.0	96%	91%	Guildford
GUL_GD15	27.8	32.5	30.7	117%	110%	Guildford
GUL_C4	39.9	23.1	22.9	58%	57%	Guildford
GUL_C9	44.4	23.3	23.0	52%	52%	Guildford
GUL_C10	31.8	23.4	23.1	74%	73%	Guildford
GUL_SH1	35.8	26.6	25.7	74%	72%	Guildford
GUL_RP1	27.6	35.0	30.3	127%	110%	Guildford
GUL_RP2	23.8	37.8	36.9	159%	155%	Guildford
GUL_WS1	13.8	20.5	20.3	149%	147%	Guildford
GUL_WP1	25.4	24.3	23.0	96%	91%	Guildford
GUL_ASH1	17.6	21.6	20.6	123%	117%	Guildford
GUL_ASH2	22.4	32.7	28.8	146%	129%	Guildford
GUL_send1	22.2	23.1	22.0	104%	99%	Guildford
GUL_send2	20.7	24.9	23.5	120%	114%	Guildford
GUL_WCL	20.1	19.5	18.7	97%	93%	Guildford
GUL_T1	22.9	21.5	20.4	94%	89%	Guildford
GUL_STN	24.7	24.9	22.5	101%	91%	Guildford
GUL_FRH1	34.5	28.7	27.2	83%	79%	Guildford
MV1	24.4	26.8	26.7	110%	109%	Mole Valley
MV2	20.2	20.6	20.5	102%	101%	Mole Valley
MV3	16.9	19.5	19.0	115%	112%	Mole Valley
MV4	14.4	17.7	17.6	123%	122%	Mole Valley
MV6	30.3	34.0	33.6	112%	111%	Mole Valley
MV7	17.2	20.6	19.3	120%	112%	Mole Valley
MV8	18.1	21.0	18.8	116%	104%	Mole Valley
MV9	10.9	25.9	22.4	238%	206%	Mole Valley
MV10	32.9	42.3	38.1	129%	116%	Mole Valley
MV12	29.5	33.9	31.1	115%	105%	Mole Valley
MV13	33.1	24.1	23.7	73%	72%	Mole Valley

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
MV14	17.7	20.5	19.5	116%	110%	Mole Valley
RG1	20.4	28.7	24.7	141%	121%	Reigate & Banstead
RG3	13.9	24.9	25.2	179%	181%	Reigate & Banstead
RG6	26.7	34.8	30.9	130%	116%	Reigate & Banstead
RB1	32.4	26.1	26.6	81%	82%	Reigate & Banstead
RB3	17.6	21.2	20.3	120%	115%	Reigate & Banstead
RB8	17.8	20.3	19.8	114%	111%	Reigate & Banstead
RB9	16.6	19.6	19.1	118%	115%	Reigate & Banstead
RB11	22.8	30.2	26.2	132%	115%	Reigate & Banstead
RB12	28.3	26.2	22.4	93%	79%	Reigate & Banstead
RB13	19.9	25.7	22.2	129%	112%	Reigate & Banstead
RB17	14.0	20.1	19.9	144%	142%	Reigate & Banstead
RB18	22.6	26.9	25.4	119%	112%	Reigate & Banstead
RB19	23.5	30.3	28.8	129%	123%	Reigate & Banstead
RB20	32.8	39.3	34.8	120%	106%	Reigate & Banstead
RB21	34.1	25.2	23.9	74%	70%	Reigate & Banstead
RB22	19.7	28.9	27.0	147%	137%	Reigate & Banstead
RB23	16.2	21.1	20.5	130%	127%	Reigate & Banstead
RB24	21.1	28.7	24.7	136%	117%	Reigate & Banstead
RB25	21.8	28.7	24.7	132%	113%	Reigate & Banstead
RB26	20.9	28.7	24.7	137%	118%	Reigate & Banstead
RB27	25.3	37.2	34.2	147%	135%	Reigate & Banstead
RB29	24.8	29.0	26.7	117%	108%	Reigate & Banstead
RB30	24.3	32.5	30.1	134%	124%	Reigate & Banstead
RB31	16.0	23.2	24.8	145%	155%	Reigate & Banstead
RB33	21.1	29.2	26.8	138%	127%	Reigate & Banstead
RB34	24.1	22.8	23.0	95%	95%	Reigate & Banstead
RB36	20.3	33.4	30.0	165%	148%	Reigate & Banstead
RB37	24.0	35.4	31.4	148%	131%	Reigate & Banstead
RB39	25.1	40.3	35.5	161%	141%	Reigate & Banstead
RB40	20.3	29.3	25.8	144%	127%	Reigate & Banstead
RB43	23.3	29.3	29.0	126%	124%	Reigate & Banstead
RB44	30.8	26.2	25.3	85%	82%	Reigate & Banstead
RB45	28.0	24.6	23.8	88%	85%	Reigate & Banstead
RB46	35.9	34.8	32.4	97%	90%	Reigate & Banstead

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
RB47	35.0	26.4	26.4	75%	75%	Reigate & Banstead
RB49	42.4	29.7	26.3	70%	62%	Reigate & Banstead
RB50	26.1	28.0	24.8	107%	95%	Reigate & Banstead
RB51	20.8	26.2	22.4	126%	108%	Reigate & Banstead
RB52	24.7	27.1	23.2	110%	94%	Reigate & Banstead
RB53	25.3	29.2	25.0	115%	99%	Reigate & Banstead
RB54	23.4	29.0	25.0	124%	107%	Reigate & Banstead
RB55	22.8	30.5	26.4	134%	116%	Reigate & Banstead
RB56	24.0	31.8	27.8	133%	116%	Reigate & Banstead
RB57	26.2	33.3	29.4	127%	112%	Reigate & Banstead
RB58	26.8	33.9	30.0	126%	112%	Reigate & Banstead
RB59	27.8	35.3	31.4	127%	113%	Reigate & Banstead
RB60	27.3	33.4	29.6	122%	108%	Reigate & Banstead
RB61	22.6	32.3	28.5	143%	126%	Reigate & Banstead
RB64	22.1	27.5	23.5	124%	106%	Reigate & Banstead
RB65	22.4	26.5	22.6	118%	101%	Reigate & Banstead
RB66	21.8	26.7	22.7	122%	104%	Reigate & Banstead
RB68	24.0	29.7	25.8	124%	108%	Reigate & Banstead
RB69	26.5	30.1	26.0	114%	98%	Reigate & Banstead
RB70	24.3	28.1	24.1	116%	99%	Reigate & Banstead
RB72	22.2	26.5	22.5	119%	101%	Reigate & Banstead
RB73	22.0	26.1	22.3	119%	101%	Reigate & Banstead
RB74	22.5	31.8	28.2	141%	125%	Reigate & Banstead
RB75	23.9	30.4	26.6	127%	111%	Reigate & Banstead
RB76	20.1	26.9	22.9	134%	114%	Reigate & Banstead
RB77	20.9	26.5	22.5	127%	108%	Reigate & Banstead
RB78	27.0	34.4	30.5	127%	113%	Reigate & Banstead
RB81	30.9	23.1	22.4	75%	72%	Reigate & Banstead
RB82	33.8	24.7	22.7	73%	67%	Reigate & Banstead
RB95	25.2	24.4	23.1	97%	92%	Reigate & Banstead
RB98	25.8	30.6	26.5	119%	103%	Reigate & Banstead
RB99	14.1	24.9	25.2	177%	179%	Reigate & Banstead
RB100	13.7	24.9	25.2	182%	184%	Reigate & Banstead
RB101	14.0	24.9	25.2	178%	180%	Reigate & Banstead
RB102	20.9	27.9	24.5	133%	117%	Reigate & Banstead

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
RB104	34.7	26.8	27.3	77%	79%	Reigate & Banstead
RB105	39.0	29.9	28.8	77%	74%	Reigate & Banstead
RB106	29.3	29.2	27.2	100%	93%	Reigate & Banstead
RB107	26.1	23.6	23.4	90%	90%	Reigate & Banstead
RB109	32.5	23.0	22.4	71%	69%	Reigate & Banstead
RB110	29.3	39.5	36.3	135%	124%	Reigate & Banstead
RB111	30.3	32.5	30.6	107%	101%	Reigate & Banstead
RB113	27.1	32.7	31.2	121%	115%	Reigate & Banstead
RB115	30.5	29.5	30.6	97%	100%	Reigate & Banstead
RB116	31.9	29.0	28.8	91%	90%	Reigate & Banstead
RB117	35.1	27.9	25.5	79%	73%	Reigate & Banstead
RB118	31.5	22.5	21.4	71%	68%	Reigate & Banstead
RB120	32.9	27.0	26.1	82%	79%	Reigate & Banstead
RB122	31.5	34.4	32.3	109%	103%	Reigate & Banstead
RB123	35.8	29.0	27.5	81%	77%	Reigate & Banstead
RB124	34.5	32.6	30.4	94%	88%	Reigate & Banstead
RB125	34.9	27.1	25.8	78%	74%	Reigate & Banstead
RB136	49.4	36.0	32.4	73%	66%	Reigate & Banstead
RB137	42.3	29.4	26.8	70%	63%	Reigate & Banstead
RB140	25.5	29.8	27.6	117%	108%	Reigate & Banstead
RB141	23.7	24.4	22.8	103%	96%	Reigate & Banstead
RB145	33.7	33.1	31.5	98%	93%	Reigate & Banstead
RB146	40.9	34.8	32.2	85%	79%	Reigate & Banstead
RB147	16.5	21.2	20.1	128%	122%	Reigate & Banstead
RB148	62.6	30.5	27.8	49%	44%	Reigate & Banstead
RB149	46.0	31.2	26.1	68%	57%	Reigate & Banstead
RB150	37.5	25.3	24.1	67%	64%	Reigate & Banstead
RB151	33.3	27.0	23.3	81%	70%	Reigate & Banstead
RB152	33.4	37.0	33.6	111%	101%	Reigate & Banstead
RB153	29.0	26.7	26.0	92%	90%	Reigate & Banstead
RB167	24.9	24.9	23.1	100%	93%	Reigate & Banstead
RB174	31.1	30.8	25.9	99%	83%	Reigate & Banstead
RB175	30.6	31.1	26.6	102%	87%	Reigate & Banstead
RB176	25.4	33.7	29.6	133%	117%	Reigate & Banstead
RB177	24.9	35.6	31.1	143%	125%	Reigate & Banstead

Site ID	Concentration, μg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
RB178	25.6	34.7	30.9	136%	121%	Reigate & Banstead
RB179	25.3	34.7	30.9	137%	122%	Reigate & Banstead
RB180	25.9	34.7	30.9	134%	119%	Reigate & Banstead
RY4	17.5	23.5	21.5	134%	123%	Runnymede
RY14	47.7	43.7	40.3	92%	84%	Runnymede
RY19	34.3	50.1	44.2	146%	129%	Runnymede
RY21	34.1	30.1	28.1	88%	82%	Runnymede
RY23	50.5	26.3	23.5	52%	47%	Runnymede
RY25	29.6	36.3	32.5	123%	110%	Runnymede
RY26	42.2	40.6	36.6	96%	87%	Runnymede
RY33	31.0	34.5	29.4	111%	95%	Runnymede
RY34	22.5	26.9	24.1	120%	107%	Runnymede
RY39	23.4	34.2	28.3	146%	121%	Runnymede
RY40	16.2	20.5	18.9	127%	117%	Runnymede
RY43	36.6	29.6	27.1	81%	74%	Runnymede
RY44	27.1	27.2	24.4	100%	90%	Runnymede
RY45	37.3	28.5	25.5	76%	68%	Runnymede
RY53	34.2	33.0	30.2	96%	88%	Runnymede
RY54	30.4	30.3	28.2	100%	93%	Runnymede
RY55	33.1	26.1	23.7	79%	72%	Runnymede
RY59	31.8	31.3	28.7	98%	90%	Runnymede
RY60	32.6	38.5	35.6	118%	109%	Runnymede
RY61	31.4	27.2	24.7	87%	79%	Runnymede
RY62	33.9	36.2	33.1	107%	98%	Runnymede
RY64	25.8	24.4	22.1	95%	86%	Runnymede
RY65	26.7	28.7	25.0	107%	94%	Runnymede
RY66	24.8	25.8	23.6	104%	95%	Runnymede
RYMV	32.1	31.9	28.7	99%	89%	Runnymede
BAA_Oaks	25.8	34.6	30.6	134%	119%	Spelthorne
SUN_01	32.5	36.7	29.4	113%	91%	Spelthorne
SCC_ECO	24.1	24.8	22.8	103%	95%	Spelthorne
SP1	28.0	26.8	24.0	96%	86%	Spelthorne
SP3	31.0	30.7	27.6	99%	89%	Spelthorne
SP4	27.0	30.1	27.6	111%	102%	Spelthorne
SP5	37.0	29.6	26.8	80%	72%	Spelthorne

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
SP6	24.0	23.0	20.6	96%	86%	Spelthorne
SP10	35.0	30.2	27.9	86%	80%	Spelthorne
SP11	35.0	27.8	25.1	79%	72%	Spelthorne
SP12	31.0	25.9	23.0	84%	74%	Spelthorne
SP14	25.0	31.7	29.1	127%	116%	Spelthorne
SP16	26.0	34.7	30.7	133%	118%	Spelthorne
SP17	26.0	34.7	30.7	133%	118%	Spelthorne
SP18	27.0	34.7	30.7	129%	114%	Spelthorne
SP19	32.0	35.9	32.5	112%	102%	Spelthorne
SP20	32.0	25.2	23.1	79%	72%	Spelthorne
SP21	26.0	24.5	21.5	94%	83%	Spelthorne
SP23	23.0	25.5	21.9	111%	95%	Spelthorne
SP24	27.0	33.2	29.5	123%	109%	Spelthorne
SP26	28.0	34.4	31.6	123%	113%	Spelthorne
SP27	31.0	29.0	25.6	94%	83%	Spelthorne
SP28	35.0	31.7	28.3	91%	81%	Spelthorne
SP29	44.0	34.1	30.1	78%	68%	Spelthorne
SP31	36.0	33.4	30.1	93%	84%	Spelthorne
SP32	29.0	29.0	25.4	100%	88%	Spelthorne
SP33	34.0	36.4	30.3	107%	89%	Spelthorne
SP34	38.0	28.5	25.4	75%	67%	Spelthorne
SP35	37.0	35.8	29.1	97%	79%	Spelthorne
SP36	40.0	25.3	23.5	63%	59%	Spelthorne
SP38	24.0	25.8	22.9	108%	95%	Spelthorne
SP39	25.0	25.0	22.3	100%	89%	Spelthorne
SP41	30.0	23.9	21.6	80%	72%	Spelthorne
SP43	33.0	38.4	31.4	116%	95%	Spelthorne
SP44	33.0	38.4	31.4	116%	95%	Spelthorne
SP45	33.0	38.4	31.4	116%	95%	Spelthorne
SP46	31.0	28.0	25.4	90%	82%	Spelthorne
SP47	25.0	24.6	22.4	98%	90%	Spelthorne
SP48	30.0	35.9	31.9	120%	106%	Spelthorne
SP49	29.0	42.1	32.3	145%	111%	Spelthorne
SP50	33.0	31.2	28.2	95%	85%	Spelthorne
SP51	37.0	36.4	32.4	98%	88%	Spelthorne

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
SP52	32.0	32.1	29.5	100%	92%	Spelthorne
SP53	29.0	25.9	23.4	89%	81%	Spelthorne
SP55	33.0	26.4	23.8	80%	72%	Spelthorne
SP56	21.0	25.5	24.7	121%	118%	Spelthorne
SP57	33.0	23.9	22.2	72%	67%	Spelthorne
CM1	35.6	35.3	27.0	99%	76%	Surrey Heath
SH1	14.3	23.2	19.4	162%	136%	Surrey Heath
SH2	18.6	22.2	19.2	119%	103%	Surrey Heath
SH3	12.6	20.3	17.7	161%	140%	Surrey Heath
SH4	20.7	17.6	16.7	85%	81%	Surrey Heath
SH5	18.6	38.6	30.2	208%	162%	Surrey Heath
SH6	19.5	21.6	20.0	111%	103%	Surrey Heath
SH7	27.9	37.3	32.7	134%	117%	Surrey Heath
SH8	15.8	27.4	22.0	173%	139%	Surrey Heath
SH9	15.6	24.3	20.0	156%	128%	Surrey Heath
SH10	21.2	22.2	20.2	105%	95%	Surrey Heath
SH11	21.3	24.0	21.1	113%	99%	Surrey Heath
SH12	21.6	22.0	19.6	102%	91%	Surrey Heath
SH13	20.0	25.4	23.2	127%	116%	Surrey Heath
SH14	21.5	31.3	28.6	146%	133%	Surrey Heath
SH15	23.8	35.3	27.0	148%	113%	Surrey Heath
SH16	24.3	35.2	28.3	145%	116%	Surrey Heath
SH17	14.6	19.8	18.7	136%	128%	Surrey Heath
SH20	16.7	19.7	18.4	118%	110%	Surrey Heath
SH21	13.8	18.3	17.3	133%	125%	Surrey Heath
SH22	24.7	35.3	27.0	143%	109%	Surrey Heath
SH23	17.3	20.8	19.5	120%	113%	Surrey Heath
SH24	22.2	35.6	33.2	160%	150%	Surrey Heath
SH25	23.4	35.3	27.0	151%	115%	Surrey Heath
SH26	21.3	23.3	20.1	109%	94%	Surrey Heath
SH27	23.2	24.7	22.7	106%	98%	Surrey Heath
SH28	19.5	25.8	23.7	132%	122%	Surrey Heath
SH29	14.0	26.7	22.2	191%	159%	Surrey Heath
SH30	23.6	35.1	34.0	149%	144%	Surrey Heath
SH31	19.0	39.3	30.5	207%	161%	Surrey Heath

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
SH32	21.1	39.6	30.8	188%	146%	Surrey Heath
SH33	24.6	41.1	32.3	167%	131%	Surrey Heath
SH34	18.7	33.3	26.6	178%	142%	Surrey Heath
SH35	19.5	32.5	30.1	167%	154%	Surrey Heath
SH36	20.2	44.9	41.2	222%	204%	Surrey Heath
SH37	20.9	32.6	26.1	156%	125%	Surrey Heath
SH38	23.8	28.8	25.3	121%	106%	Surrey Heath
TD5	29.0	31.0	31.0	107%	107%	Tandridge
TD7	19.4	21.6	21.4	111%	110%	Tandridge
TD8	19.3	21.7	21.7	112%	112%	Tandridge
TD9	17.3	20.0	20.3	116%	117%	Tandridge
TD14	26.9	24.8	22.8	92%	85%	Tandridge
TD19	20.9	28.4	25.1	136%	120%	Tandridge
TD23	23.4	25.0	23.9	107%	102%	Tandridge
TD25	18.7	23.0	21.5	123%	115%	Tandridge
TD26	23.4	29.6	26.0	126%	111%	Tandridge
TD27	28.8	30.2	30.0	105%	104%	Tandridge
TD28	27.8	23.9	23.2	86%	84%	Tandridge
TD30	21.8	21.2	21.7	97%	100%	Tandridge
TD31	19.6	24.0	22.5	123%	115%	Tandridge
TD32	22.0	22.2	22.1	101%	101%	Tandridge
TD33	25.0	22.5	20.6	90%	82%	Tandridge
TD34	20.3	19.5	19.4	96%	96%	Tandridge
TD35	26.7	26.8	26.2	100%	98%	Tandridge
TD36	24.8	23.3	21.6	94%	87%	Tandridge
TD37	19.1	22.9	22.1	120%	116%	Tandridge
TD38	25.1	25.2	24.5	100%	98%	Tandridge
TD39	26.5	21.4	21.4	81%	81%	Tandridge
TD40	33.0	25.7	25.4	78%	77%	Tandridge
TANWI_001	23.2	22.6	22.1	97%	95%	Tandridge
TANWI_002	31.4	22.6	22.1	72%	70%	Tandridge
TANWI_003	42.1	30.2	28.9	72%	69%	Tandridge
TANWI_004	26.0	33.2	31.6	128%	121%	Tandridge
TANWI_005	41.4	27.0	26.1	65%	63%	Tandridge
TANWI_006	24.6	24.6	24.0	100%	98%	Tandridge

Site ID	Concentration, µg/m³			Gatwick Modelled / Monitored ratio	Heathrow Modelled / Monitored ratio	Borough
	Monitored	Gatwick	Heathrow			
WOK_LTK	24.6	23.1	21.6	94%	88%	Woking
WOK_LT1	34.6	21.8	20.5	63%	59%	Woking
WOK_M25	42.8	65.7	58.3	154%	136%	Woking
WOK_CR	20.9	23.1	21.4	111%	102%	Woking
WOK_RC	18.2	18.8	17.9	103%	98%	Woking
WOK_AH1	34.6	31.0	27.2	90%	79%	Woking
WOK_AH2	31.9	29.5	25.9	92%	81%	Woking
WOK_AH3	22.8	28.4	25.0	125%	110%	Woking
WOK_AH4	27.3	22.8	20.2	84%	74%	Woking
WOK_AH5	26.4	27.2	24.6	103%	93%	Woking
WOK_AH6	29.1	27.9	25.5	96%	88%	Woking
WOK_LGR	23.7	20.1	19.2	85%	81%	Woking
WOK_LD	17.3	19.6	18.5	113%	107%	Woking
WOK_VW	31.9	30.7	28.4	96%	89%	Woking
WOK_BD	15.5	18.4	17.3	119%	112%	Woking
WOK_BR	24.6	22.2	20.9	90%	85%	Woking
WOK_BR1	22.8	22.2	20.5	97%	90%	Woking
WOK_PR	22.8	23.4	21.2	103%	93%	Woking
WOK_GR	26.4	22.3	21.3	84%	81%	Woking
WOK_MR	31.9	27.2	24.9	85%	78%	Woking
WOK_MR2	28.2	27.2	24.9	96%	88%	Woking
WOK_CH	37.3	33.2	29.2	89%	78%	Woking
WOK_CH2	41.9	31.4	29.0	75%	69%	Woking
WOK_CH3	41.9	33.0	30.8	79%	74%	Woking
WOK_CH4	38.2	34.9	32.3	91%	85%	Woking
WOK_TC	26.4	27.1	26.3	103%	100%	Woking
WOK_OR	25.5	21.0	19.6	82%	77%	Woking
WOK_YR	24.6	28.5	26.8	116%	109%	Woking
WOK_YR1	25.5	31.4	29.2	123%	115%	Woking
WOK_TW	13.7	18.1	17.0	132%	124%	Woking
WOK_CW	21.8	18.0	17.0	83%	78%	Woking
WOK_BW	21.8	18.7	17.6	86%	81%	Woking

Appendix B: Model verification using Gatwick Airport meteorological data

Appendix B presents figures and tables for model verification data using Gatwick Airport meteorological data. Appendix B consists of:

1. Figure B.1: Presents a wind rose showing the frequency of occurrence of wind from different directions for a number of wind speed ranges for Gatwick Airport
2. Table B.1: Summarises the meteorological data from Gatwick Airport. To take account of the different surface characteristics at Gatwick, compared to the modelled area, a surface roughness of 0.2m was assumed for the meteorological station
3. Table B.2: Summarises background data calculated using Gatwick wind data
4. Figure B.2: A scatter plot modelled against monitored NO_2 concentrations at all monitoring sites
5. Table B.3: A summary of statistics by type of monitor
6. Figure B.3: A box plots comparing the spread of modelled against monitored hourly mean NO_2 concentrations at continuous monitoring sites.
7. Figure B.4: A box plots comparing the spread of modelled against monitored hourly mean NO_x concentrations at continuous monitoring sites.
8. Figure B.5: A box plots comparing the spread of modelled against monitored hourly mean PM_{10} concentrations at continuous monitoring sites.
9. Figure B.6: A box plots comparing the spread of modelled against monitored hourly mean $PM_{2.5}$ concentrations at continuous monitoring sites
10. Table B.4: A table summarising monitored and modelled NO_x, NO_2, PM_{10} and $PM_{2.5}$ for all continuous monitoring sites. Using Gatwick meteorological data.

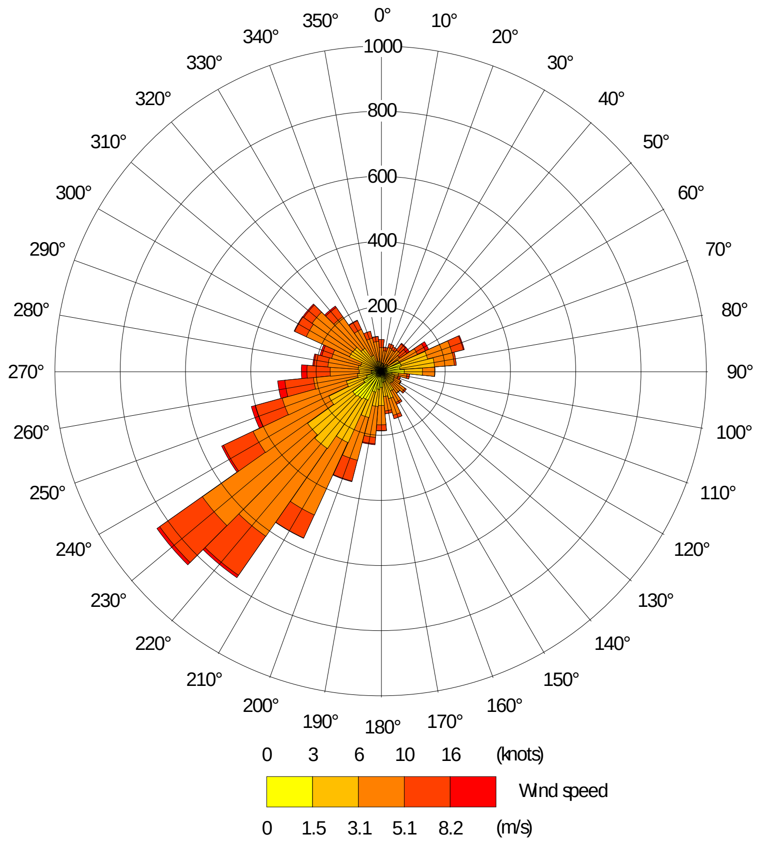

Figure B.1: Wind rose for Gatwick 2017

Table B.1: Summary of Gatwick Airport meteorological data

Year	% of hours used	Parameter	Minimum	Maximum	Mean
2017	99.7	Temperature (°C)	-6	32	11.3
		Wind speed (m/s)	0	16.5	3.5
		Cloud cover (oktas)	0	8	3

Table B.2: Summary of 2017 background data (µg/m³), calculated using wind data from Gatwick Airport

Statistic	NO_x	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2
Annual average	15.5	11.7	52.0	14.7	8.7	0.9
99.79th percentile of hourly average	255.2	74.6	112.4	-	-	-
90.41st percentile of 24-hour average	-	-	-	26.5	18.8	1.4

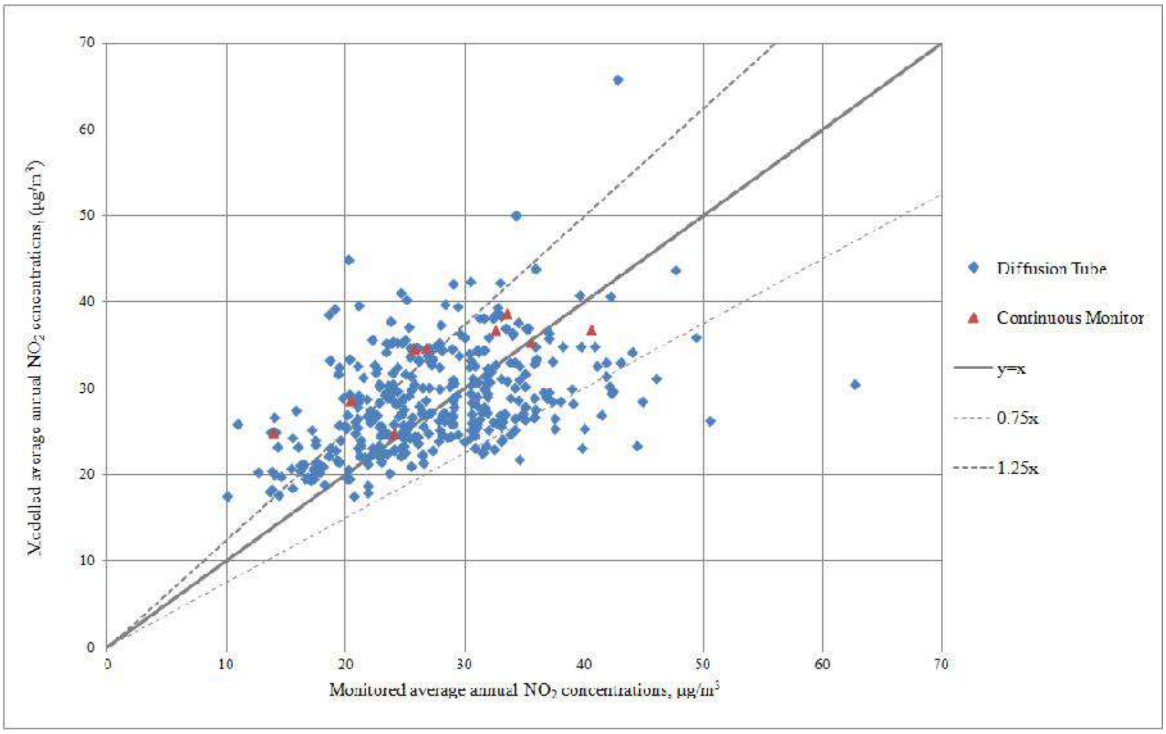

Figure B.2: Surrey measured and modelled annual average NO_2 concentrations using Gatwick meteorological data

Table B.3: Model verification statistics for NO_2 concentrations using Gatwick Airport meteorological data

Gatwick	Min	Max	Mean	Count	Modelled / Monitored	<0.75	>0.75 <1.25	>1.25	% >0.75<1.25
Diffusion tubes	17.5	65.7	28.7	367	1.10	29	245	93	67
Continuous monitors	24.8	38.6	32.8	9	1.23	0	5	4	56
All monitors	17.5	65.7	28.8	376	1.10	29	250	97	67

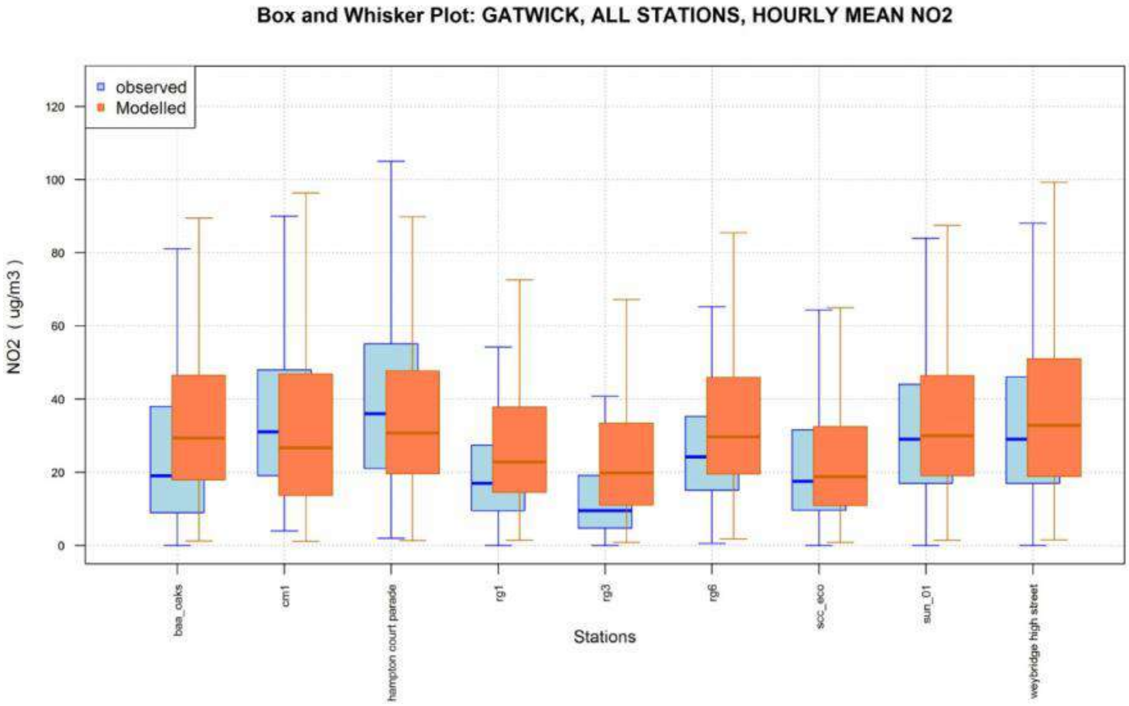

Figure B.3: Surrey measured and modelled annual average NO_2 concentrations at continuous monitoring sites using Gatwick meteorologcial data

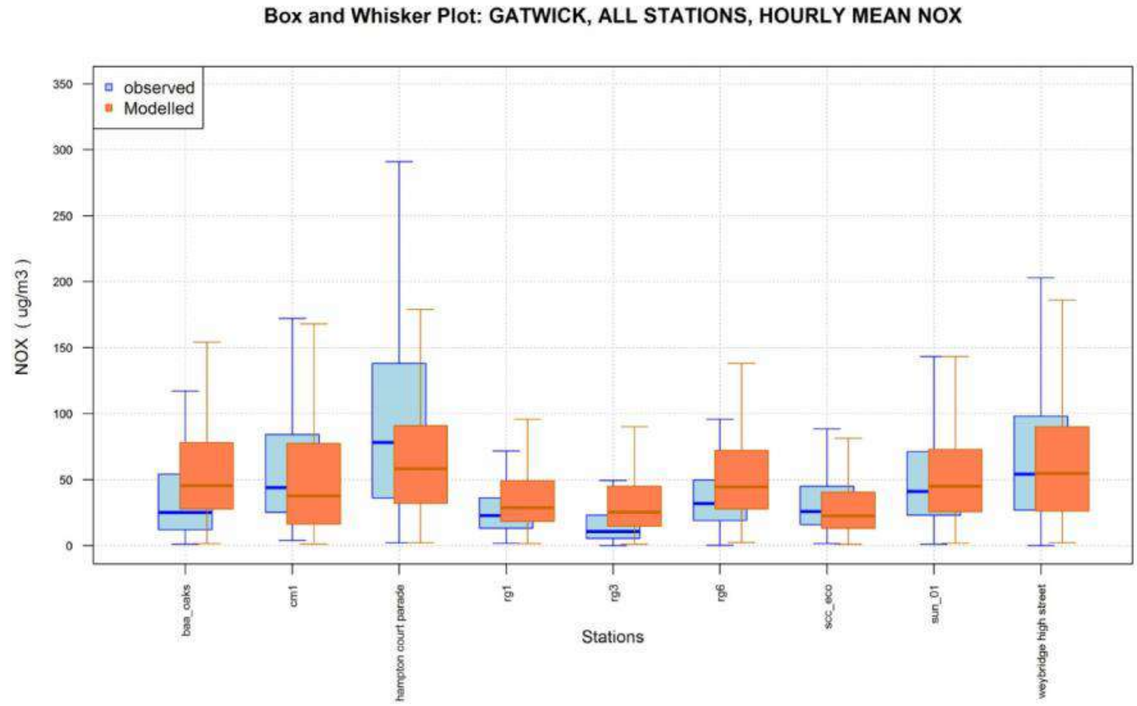

Figure B.4: Surrey measured and modelled annual average NO_x concentrations at continuous monitoring sites using Gatwick meteorologcial data

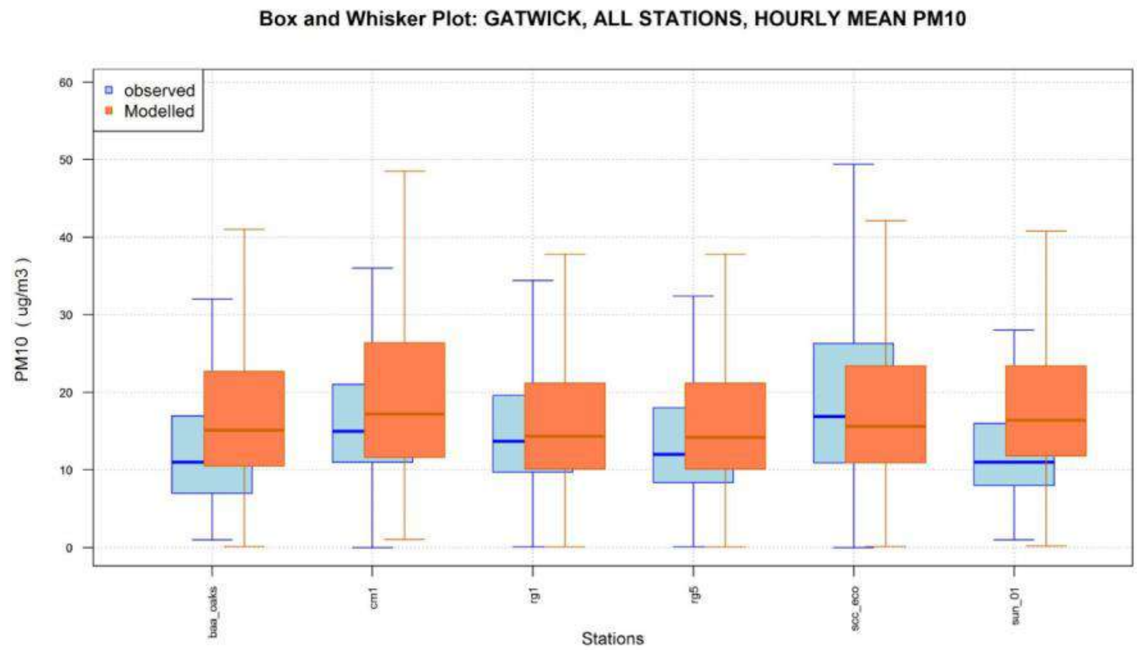

Figure B.5: Surrey measured and modelled annual average PM_{10} concentrations at continuous monitoring sites using Gatwick meteorological data

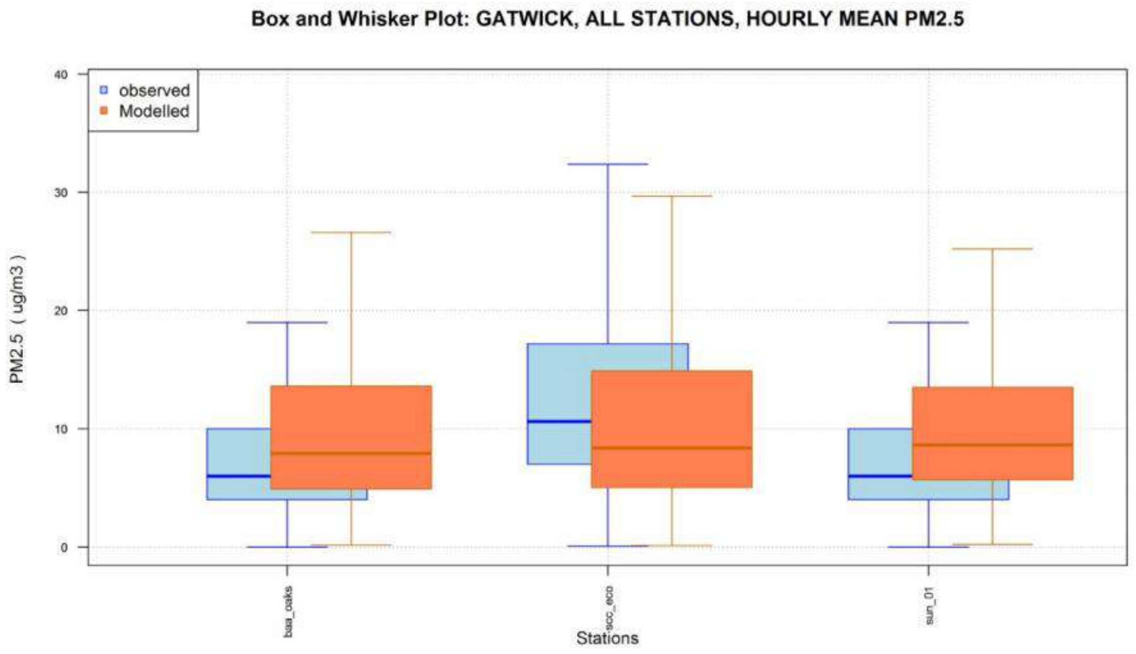

Figure B.6: Surrey measured and modelled annual average $PM_{2.5}$ concentrations at continuous monitoring sites using Gatwick meteorological data

Table B.4: Surrey measured and modelled annual average NO_x, NO_2, PM_{10} and $PM_{2.5}$ concentrations at continuous monitoring sites using Gatwick meteorological data

Site ID	Monitored concentration, µg/m³				Modelled concentration, µg/m³				Modelled / Monitored (%)			
	NO_x	NO_2	PM_{10}	$PM_{2.5}$	NO_x	NO_2	PM_{10}	$PM_{2.5}$	NO_x	NO_2	PM_{10}	$PM_{2.5}$
BAA_Oaks	47.1	25.8	14.1	9.2	67.3	34.6	19.2	12.0	143	134	136	131
CM1	65.8	35.6	17.0	-	61.5	35.3	22.0	-	93	99	129	-
Hampton Court Parade	108.4	40.6	-	-	73.6	36.8	-	-	68	91	-	-
RG1	34.1	20.4	16.2	-	43.8	28.7	17.7	-	128	141	109	-
RG3	19.3	13.9	-	-	39.0	24.9	-	-	202	180	-	-
RG5	-	-	15.2	-	-	-	17.7	-	-	-	116	-
RG6	46.1	26.7	-	-	62.0	34.8	-	-	135	130	-	-
SCC_ECO	44.2	24.1	20.7	14.5	35.8	24.8	19.8	12.9	81	103	95	89
SUN_01	58.6	32.5	13.1	8.0	60.9	36.7	19.6	11.3	104	113	149	141
Weybridge High Street	77.5	33.5	-	-	70.3	38.6	-	-	91	115	-	-

APPENDIX C: Summary of ADMS-Urban

ADMS-Urban is a scientifically advanced but practical air pollution modelling tool, which has been developed to provide high resolution calculations of pollution concentrations for all sizes of study area relevant to the urban environment. The model can be used to look at concentrations near a single road junction or over a region extending across the whole of a major city. ADMS-Urban has been extensively used for the Review and Assessment of Air Quality carried out by Local Authorities in the UK and for a wide range of planning and policy studies across the world. The following is a summary of the capabilities and validation of ADMS-Urban. More details can be found on the CERC web site at www.cerc.co.uk.

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which has been developed to investigate the impacts of emissions from industrial facilities. ADMS-Urban allows full characterisation of the wide variety of emissions in urban areas, including an extensively validated road traffic emissions model. It also includes a number of other features, which include consideration of:

- the effects of vehicle movement on the dispersion of traffic emissions;
- the behaviour of material released into street-canyons;
- the chemical reactions occurring between nitrogen oxides, ozone and Volatile Organic Compounds (VOCs);
- the pollution entering a study area from beyond its boundaries;
- the effects of complex terrain on the dispersion of pollutants; and
- the effects of a building on the dispersion of pollutants emitted nearby.

Further details of these features are provided below.

Studies of extensive urban areas are necessarily complex, requiring the manipulation of large amounts of data. To allow users to cope effectively with this requirement, ADMS-Urban runs in Windows 10, Windows 8, Windows 7 and Windows Vista environments. The manipulation of data is further facilitated by the possible integration of ADMS-Urban with a Geographical Information System (GIS) (MapInfo, ArcGIS, or the ADMS-Mapper) and the CERC Emissions Inventory Toolkit, EMIT.

Dispersion Modelling

ADMS and ADMS-Urban use boundary layer similarity profiles to parameterise the variation of turbulence with height within the boundary layer, and the use of a skewed-Gaussian distribution to determine the vertical variation of pollutant concentrations in the plume under convective conditions.

The main dispersion modelling features of ADMS-Urban are as follows:

- ADMS-Urban is an **advanced dispersion model** in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This method supersedes methods based on Pasquill Stability Categories, as used in, for example, Caline and ISC. Concentrations are calculated hour by hour and are fully dependent on prevailing weather conditions.
- For convective conditions, a **non-Gaussian vertical profile of concentration** allows for the skewed nature of turbulence within the atmospheric boundary layer, which can lead to high concentrations near to the source.
- A **meteorological pre-processor** calculates boundary layer parameters from a variety of input data, typically including date and time, wind speed and direction, surface temperature and cloud cover. Meteorological data may be raw, hourly averaged or statistically analysed data.

Emissions

Emissions into the atmosphere across an urban area typically come from a wide variety of sources. There are likely to be industrial emissions from chimneys as well as emissions from road traffic and domestic heating systems. To represent the full range of emissions configurations, the explicit source types available within ADMS-Urban are:

- **Roads**, for which emissions are specified in terms of vehicle flows and the additional initial dispersion caused by moving vehicles is also taken into account.
- **Industrial points**, for which plume rise and stack downwash are included in the modelling.
- **Areas**, where a source or sources is best represented as uniformly spread over an area.
- **Volumes**, where a source or sources is best represented as uniformly spread throughout a volume.

In addition, sources can also be modelled as a regular grid of emissions. This allows the contributions of large numbers of minor sources to be efficiently included in a study while the majority of the modelling effort is used for the relatively few significant sources.

ADMS-Urban can be used in conjunction with CERC's Emissions Inventory Toolkit, EMIT, which facilitates the management and manipulation of large and complex data sets into usable emissions inventories.

Presentation of Results

The results from the model can be based on a wide range of averaging times, and include rolling averages. Maximum concentration values and percentiles can be calculated where appropriate meteorological input data have been input to the model. This allows ADMS-Urban to be used to calculate concentrations for direct comparison with existing air quality limits, guidelines and objectives, in whatever form they are specified.

ADMS-Urban can be integrated with the ArcGIS or MapInfo to facilitate both the compilation and manipulation of the emissions information required as input to the model and the interpretation and presentation of the air quality results provided.

Complex Effects - Street Canyons

ADMS-Urban incorporates two methods for representing the effect of street canyons on the dispersion of road traffic emissions: a basic canyon method based on the *Operational Street Pollution Model (OSPM)*[21], developed by the Danish National Environmental Research Institute (NERI); and an advanced street canyon module, developed by CERC. The basic canyon model was designed for simple symmetric canyons with height similar to width and assumes that road traffic emissions originate throughout the base of the canyon, i.e. that the emissions are spread across both the road and neighbouring pavements.

The advanced canyon model[22] was developed to overcome these limitations and is our model of choice. It represents the effects of channelling flow along and recirculating flow across a street canyon, dispersion out of the canyon through gaps in the walls, over the top of the buildings or out of the end of the canyon. It can take into account canyon asymmetry and restricts the emissions area to the road carriageway.

Complex Effects - Chemistry

ADMS-Urban includes the *Generic Reaction Set (GRS)*[23] atmospheric chemistry scheme. The original scheme has seven reactions, including those occurring between nitrogen oxides and ozone. The remaining reactions are parameterisations of the large number of reactions involving a wide range of Volatile Organic Compounds (VOCs). In addition, an eighth reaction has been included within ADMS-Urban for the situation when high concentrations of nitric oxide (NO) can convert to nitrogen dioxide (NO_2) using molecular oxygen.

In addition to the basic GRS scheme, ADMS-Urban also includes a trajectory model[24] for use when modelling large areas. This permits the chemical conversions of the emissions and background concentrations upwind of each location to be properly taken into account.

[21] Hertel, O., Berkowicz, R. and Larssen, S., 1990, 'The Operational Street Pollution Model (OSPM).' *18th International meeting of NATO/CCMS on Air Pollution Modelling and its Applications.* Vancouver, Canada, pp741-749.

[22] Hood C, Carruthers D, Seaton M, Stocker J and Johnson K, 2014. *Urban canopy flow field and advanced street canyon modelling in ADMS-Urban.* 16th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Varna, Bulgaria, September 2014. http://www.harmo.org/Conferences/Proceedings/_Varna/publishedSections/H16-067-Hood-EA.pdf

[23] Venkatram, A., Karamchandani, P., Pai, P. and Goldstein, R., 1994, 'The Development and Application of a Simplified Ozone Modelling System.' *Atmospheric Environment,* Vol 28, No 22, pp3665-3678.

[24] Singles, R.J., Sutton, M.A. and Weston, K.J., 1997, 'A multi-layer model to describe the atmospheric transport and deposition of ammonia in Great Britain.' In: *International Conference on Atmospheric Ammonia: Emission, Deposition and Environmental Impacts. Atmospheric Environment*, Vol 32, No 3.

Complex Effects - Terrain

As well as the effect that complex terrain has on wind direction and, consequently, pollution transport, it can also enhance turbulence and therefore increase dispersion. These effects are taken into account in ADMS-Urban using the FLOWSTAR[25] model developed by CERC.

Data Comparisons – Model Validation

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which is used throughout the UK by industry and the Environment Agency to model emissions from industrial sources. ADMS has been subject to extensive validation, both of individual components (e.g. point source, street canyon, building effects and meteorological pre-processor) and of its overall performance.

ADMS-Urban has been extensively tested and validated against monitoring data for large urban areas in the UK and overseas, including London, Birmingham, Manchester, Glasgow, Riga, Cape Town, Hong Kong and Beijing, during projects supported by local governments and research organisations. A summary of published model validation studies is available at www.cerc.co.uk/Validation, with other publications available at www.cerc.co.uk/publications.

[25] Carruthers D.J., Hunt J.C.R. and Weng W-S. 1988. 'A computational model of stratified turbulent airflow over hills – FLOWSTAR I.' Proceedings of Envirosoft. In: *Computer Techniques in Environmental Studies,* P. Zanetti (Ed) pp 481-492. Springer-Verlag.

Appendix G: CERC Modelling Report for Elmbridge

Cambridge
Environmental
Research
Consultants

Detailed air quality modelling and source apportionment

Elmbridge Borough Council

Final report

Prepared for
Surrey Local Authorities

19th November 2019

CERC

Report Information

CERC Job Number:	FM1183
Job Title:	Detailed air quality modelling and source apportionment – Elmbridge Borough Council
Prepared for:	Surrey Local Authorities
Report Status:	Final
Report Reference:	FM1183/Elmbridge/19
Issue Date:	19th November 2019
Author(s):	Rohan Patel
Reviewer(s):	Sarah Strickland

Issue	Date	Comments
1	04/04/19	Draft report
2	24/05/19	Final report
3	23/08/19	Final report with additions to Section 3
4	19/11/19	Final report with changes to Table 3.1

Main File(s):	FM1183_Surrey_CERC_Elmbridge_19Nov19.pdf

Contents

1 Air quality contour plots

A detailed contour plot of annual mean NO_2 concentrations in Elmbridge for the year 2017 is presented in Figure 1.1.

Figure 1.2 presents a contour plot of the modelled annual mean PM_{10} concentrations across Elmbridge for 2017.

Figure 1.3 presents a contour plot of the modelled annual mean $PM_{2.5}$ concentrations across Elmbridge for 2017.

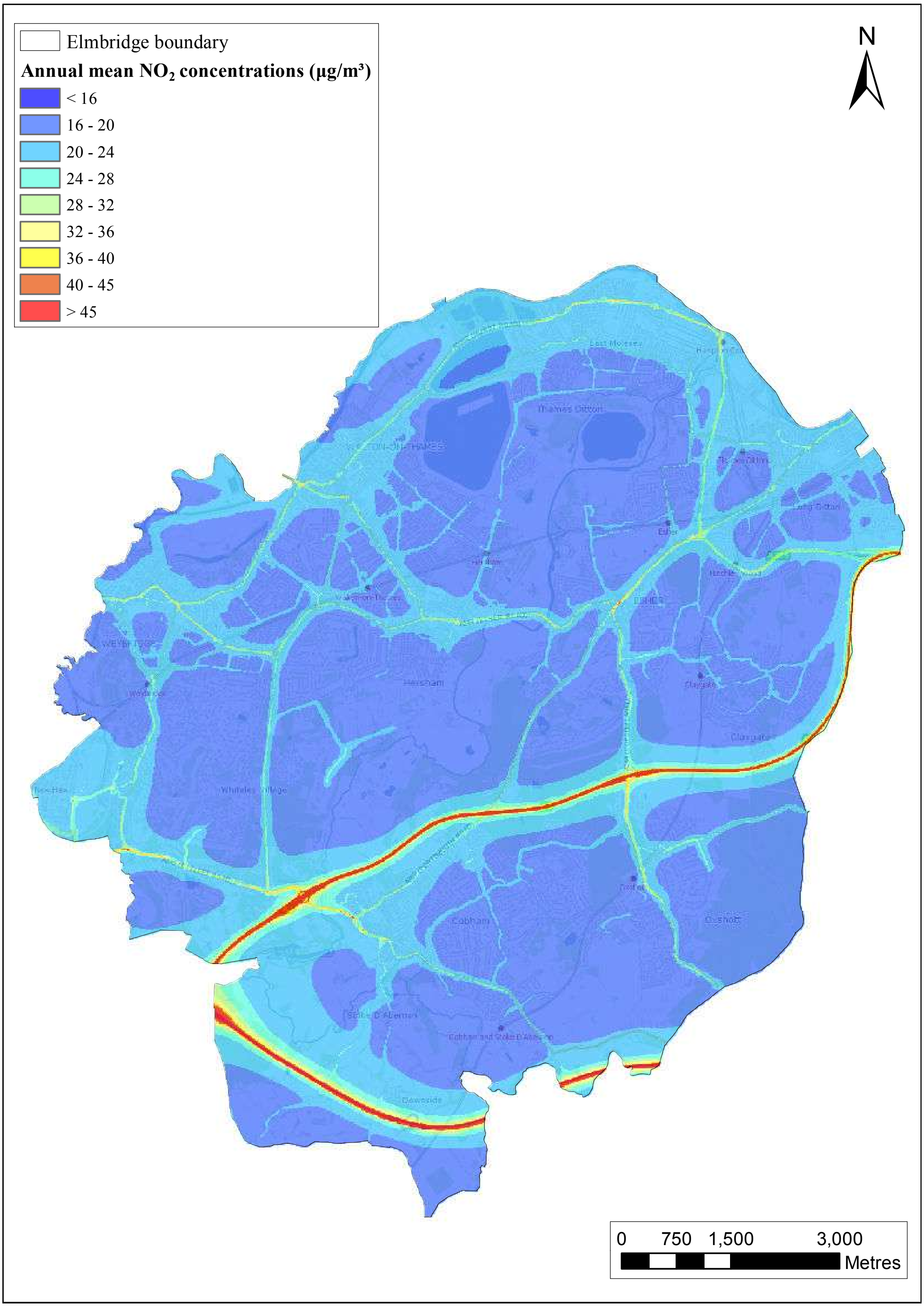

Figure 1.1: Annual mean NO_2 concentrations for Elmbridge, 2017 (µg/m³)

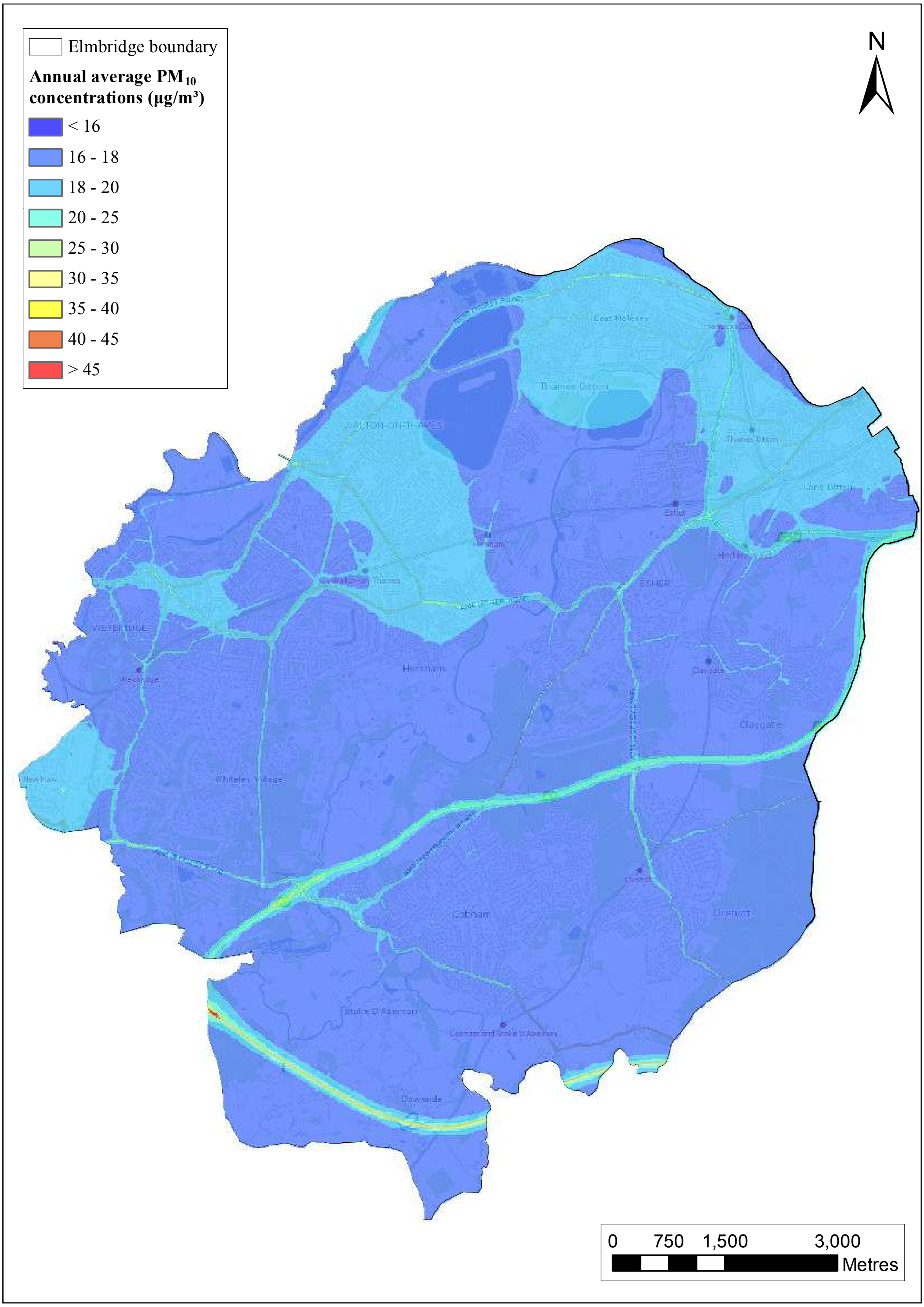

Figure 1.2: Annual mean PM_{10} concentrations for Elmbridge, 2017 (µg/m³)

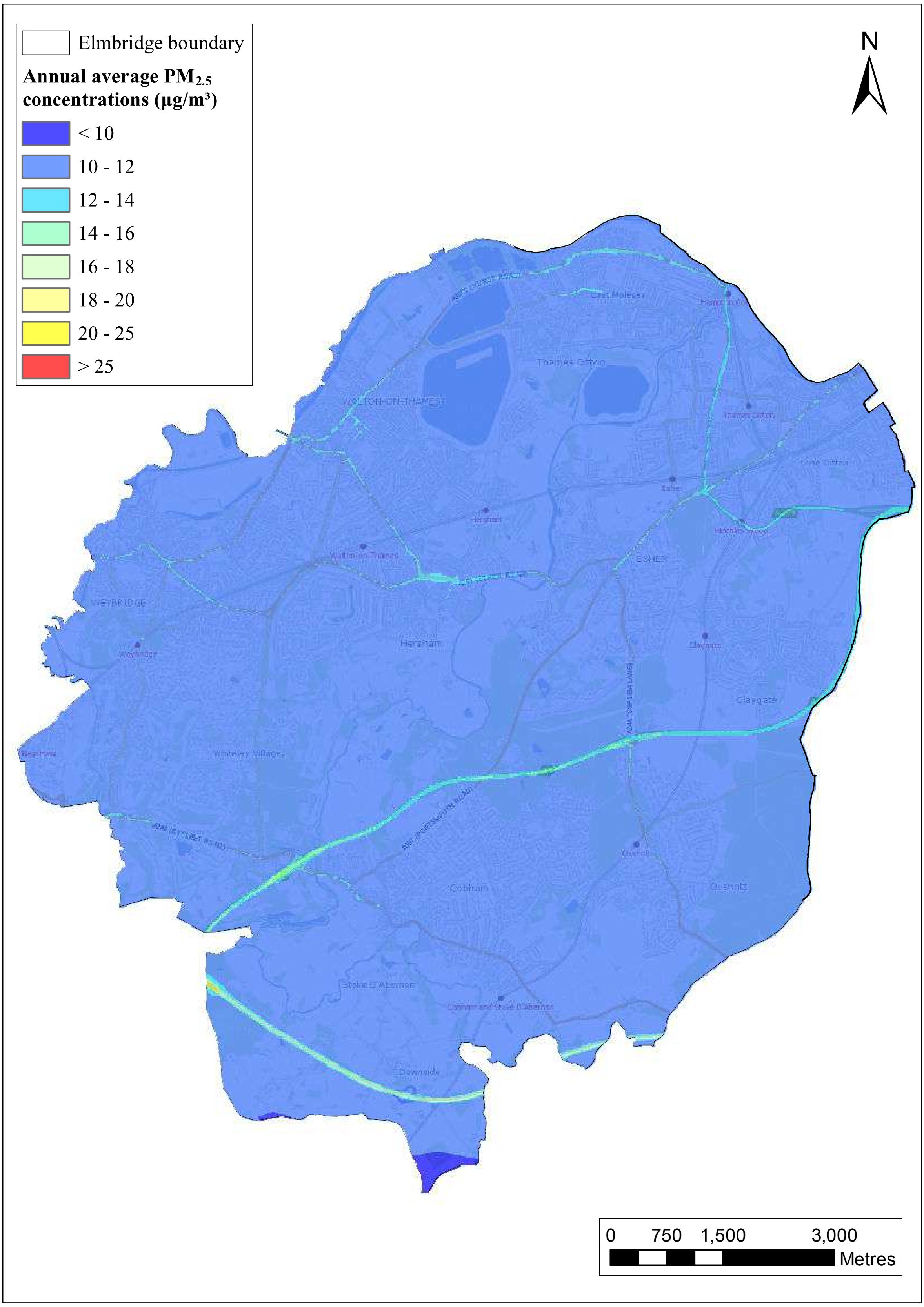

Figure 1.3: Annual mean $PM_{2.5}$ concentrations for Elmbridge, 2017 (µg/m³)

2 Source apportionment

An overview of NO_x, PM_{10} and $PM_{2.5}$ source apportionment for Elmbridge is presented in this section. The pollutants of interest are split into group type, vehicle category and non-exhaust concentrations for particulate matter. The source apportionment locations are detailed in Table 2.1.

Figure 2.1 presents the average NO_x concentrations found within Elmbridge, for each group type. Road traffic sources are further split by vehicle category in Figure 2.2. Finally, a summary of NO_x source apportionment can be found in Table 2.2.

Figure 2.3 presents the average PM_{10} concentrations found within Elmbridge, for each group type. Road traffic sources are further split by vehicle category in Figure 2.4. The majority of road traffic PM_{10} concentrations consist of non-exhaust concentrations, which are illustrated in Figure 2.5. Finally, a summary of PM_{10} source apportionment can be found in Table 2.3.

Figure 2.6 presents the average $PM_{2.5}$ concentrations found within Elmbridge, for each group type. Road traffic sources are further split by vehicle category in Figure 2.7. The majority of road traffic $PM_{2.5}$ concentrations consist of non-exhaust concentrations, which are illustrated in Figure 2.8. Finally, a summary of $PM_{2.5}$ source apportionment can be found in Table 2.4.

Table 2.1: Source apportionment receptor locations throughout Elmbridge

Receptor	XY	Address
ELM_SA_001	515342, 168292	Hampton Court AQ monitoring station
ELM_SA_002	514208, 168138	Walton Road, Molesey
ELM_SA_003	514708, 167988	Walton Road, Molesey
ELM_SA_004	515100, 166500	Hampton Court Way, Thames Ditton
ELM_SA_005	515207, 165512	Kingston By-pass, Hinchley Wood
ELM_SA_006	515600, 165200	Manor Road North, Hinchley Wood
ELM_SA_007	514200, 164000	Milbourne Lane, Claygate
ELM_SA_008	513900, 164600	The Bear, High St, Esher
ELM_SA_009	514148, 162467	Copsem Lane, A3 roundabout
ELM_SA_010	510700, 165500	Queensway, Hersham
ELM_SA_011	510347, 166021	Hersham Rd, Walton-on-Thames
ELM_SA_012	509500, 164700	Cleves School, Oatlands Avenue, Walton-on-Thames
ELM_SA_013	510100, 166500	Church Street, Walton-on-Thames
ELM_SA_014	510132, 166319	High Street, Walton-on-Thames
ELM_SA_015	507200, 164800	Church Street, Weybridge
ELM_SA_016	507472, 164924	Weybridge High Street AQ monitoring station
ELM_SA_017	511839, 161570	Fairmile Lane/Portsmouth Rd junction, Cobham
ELM_SA_018	510100, 160500	Gavell Road, Cobham
ELM_SA_019	510833, 159998	High Street, Cobham
ELM_SA_020	514607, 160447	High Street, Oxshott
ELM_SA_021	515384, 167570	Hampton Ct Way, Thames Ditton KT7 0YQ, UK
ELM_SA_022	514724, 165531	Portsmouth Rd, Esher KT10 9UF, UK
ELM_SA_023	514025, 163700	Copsem Ln, Esher KT10 9HB, UK
ELM_SA_024	514300, 161024	Warren Ln, Oxshott, Leatherhead KT22 0SZ, UK
ELM_SA_025	507583, 163010	Southfield Pl, Weybridge KT13, UK
ELM_SA_026	512183, 165608	Molesey Rd, Walton-on-Thames KT12 3PF, UK
ELM_SA_027	510937, 167354	Rivendell Court, 174 Terrace Rd, Walton-on-Thames KT12 2ED, UK

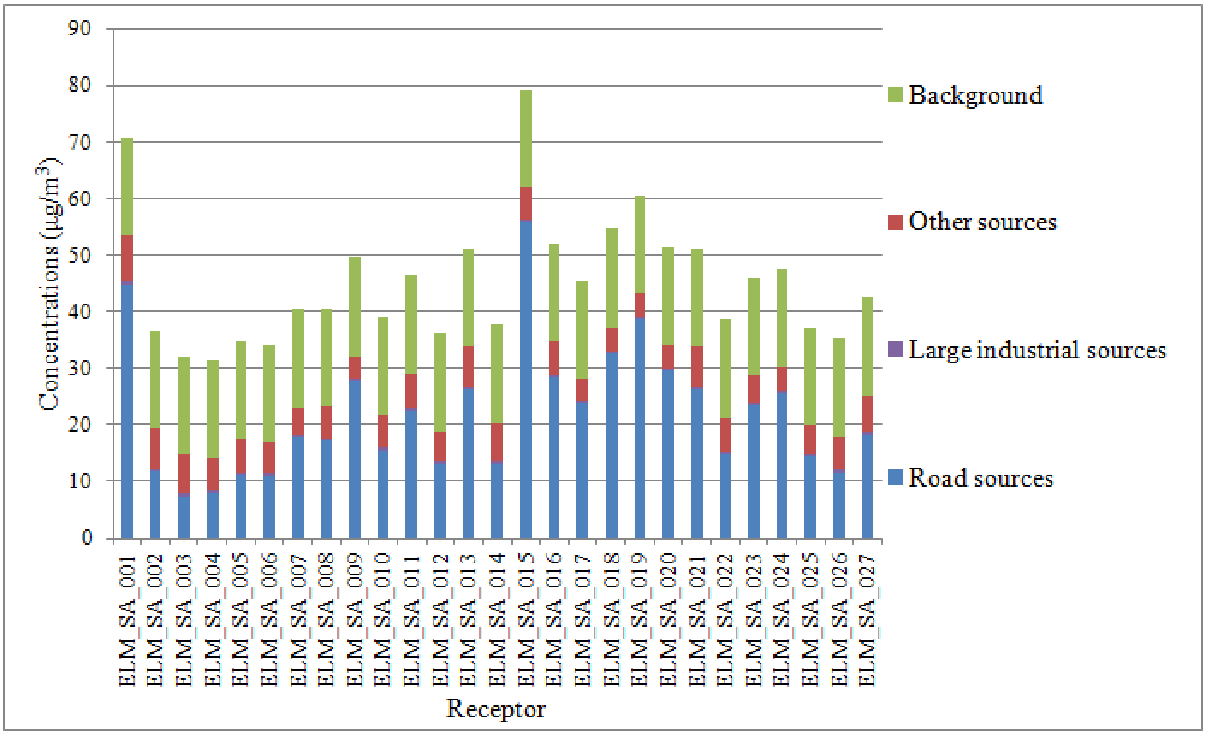

Figure 2.1: NO_x concentrations by major source group, Elmbridge [1]

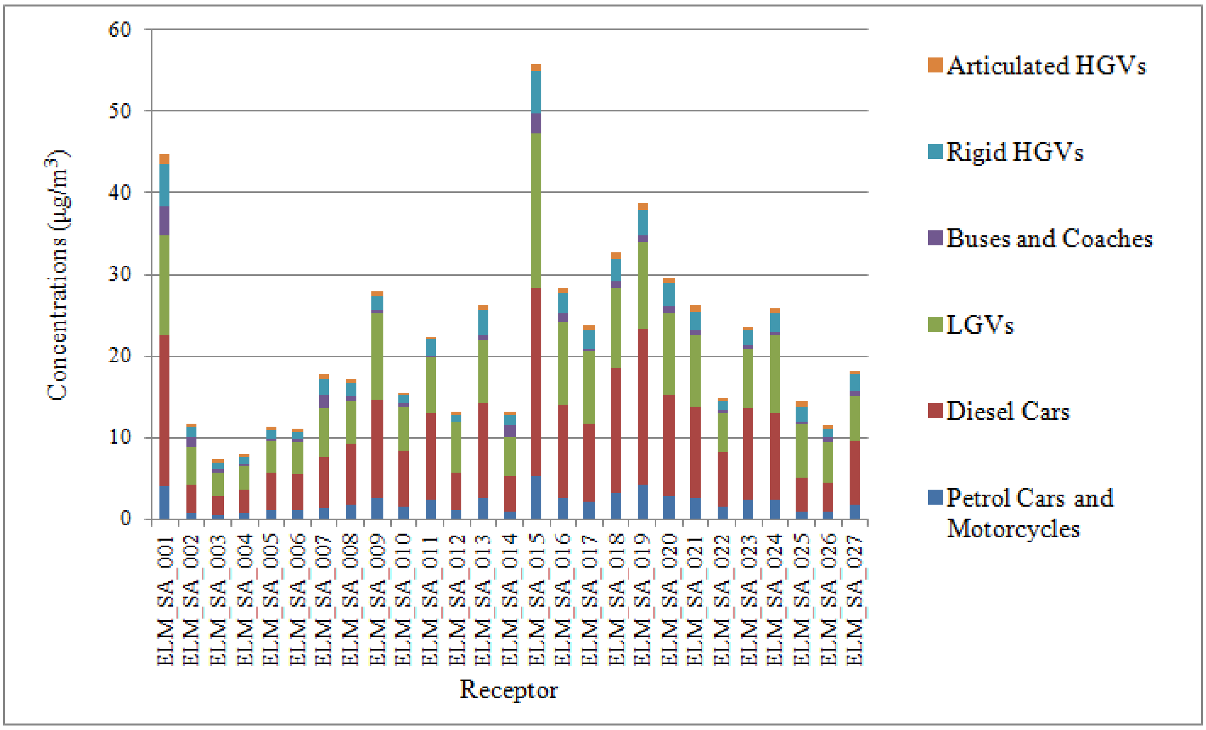

Figure 2.2: Road transport NO_x concentrations by vehicle category, Elmbridge

[1] Other sources include: (1) combustion in commercial, institution and agricultural sectors, (2) combustion in industry, (3) combustion in energy production and transfer, (4) production processes, (5) extraction and distribution of fossil fuels, (6) solvent use, (7) other transport and machinery, (8) waste treatment and disposal, (8) agricultural, forests and land use change, (10) other sources and sinks.

Table 2.2: Summary of NO_x concentration source apportionment, Elmbridge

NO_x (µg/m³)	Type of source apportionment									
	Source type				Vehicle type					
Receptor	Road sources	Other sources	Background	Large industrial sources	Petrol Cars & Motorcycles	Diesel Cars	LGVs	Buses & Coaches	Rigid HGVs	Articulated HGVs
ELM_SA_001	44.8	8.1	17.4	0.5	4.0	18.5	12.1	3.6	5.2	1.3
ELM_SA_002	11.7	7.0	17.4	0.5	0.7	3.4	4.7	1.1	1.4	0.4
ELM_SA_003	7.3	7.0	17.4	0.5	0.5	2.3	2.8	0.4	1.0	0.3
ELM_SA_004	7.9	5.8	17.4	0.5	0.7	3.0	2.9	0.1	0.9	0.3
ELM_SA_005	11.2	5.8	17.4	0.4	1.0	4.6	4.0	0.2	1.0	0.3
ELM_SA_006	11.0	5.4	17.4	0.4	1.0	4.5	4.0	0.2	1.0	0.3
ELM_SA_007	17.8	4.9	17.4	0.4	1.3	6.2	6.2	1.5	2.0	0.6
ELM_SA_008	17.2	5.6	17.4	0.4	1.6	7.6	5.2	0.6	1.8	0.4
ELM_SA_009	27.9	3.8	17.4	0.4	2.6	12.1	10.6	0.3	1.7	0.6
ELM_SA_010	15.5	5.8	17.4	0.4	1.5	6.9	5.5	0.3	1.0	0.3
ELM_SA_011	22.4	6.3	17.4	0.4	2.3	10.5	6.9	0.2	2.0	0.4
ELM_SA_012	13.1	5.3	17.4	0.4	1.0	4.7	6.2	0.1	0.8	0.3
ELM_SA_013	26.3	7.1	17.4	0.5	2.6	11.6	7.7	0.8	3.1	0.6
ELM_SA_014	13.1	6.8	17.4	0.5	0.9	4.4	4.8	1.4	1.2	0.4
ELM_SA_015	55.8	5.6	17.4	0.4	5.2	23.2	18.9	2.5	5.2	1.0
ELM_SA_016	28.3	6.0	17.4	0.4	2.6	11.5	10.1	1.1	2.5	0.6
ELM_SA_017	23.8	3.8	17.4	0.4	2.1	9.7	8.9	0.2	2.2	0.7
ELM_SA_018	32.7	4.3	17.4	0.3	3.2	15.3	9.8	0.8	2.8	0.8
ELM_SA_019	38.7	4.1	17.4	0.3	4.2	19.2	10.6	0.9	3.0	0.8
ELM_SA_020	29.7	4.2	17.4	0.3	2.7	12.4	10.0	0.8	3.0	0.7
ELM_SA_021	26.2	7.1	17.4	0.5	2.6	11.2	8.8	0.5	2.4	0.7
ELM_SA_022	14.8	5.9	17.4	0.4	1.5	6.6	4.9	0.3	1.2	0.4
ELM_SA_023	23.6	4.6	17.4	0.4	2.4	11.1	7.3	0.4	1.9	0.5
ELM_SA_024	25.8	4.0	17.4	0.3	2.3	10.7	9.4	0.4	2.4	0.5
ELM_SA_025	14.4	5.0	17.4	0.5	0.9	4.2	6.6	0.3	1.8	0.6
ELM_SA_026	11.5	6.0	17.4	0.4	0.8	3.7	4.9	0.5	1.2	0.4
ELM_SA_027	18.2	6.5	17.4	0.5	1.7	7.8	5.5	0.5	2.2	0.4

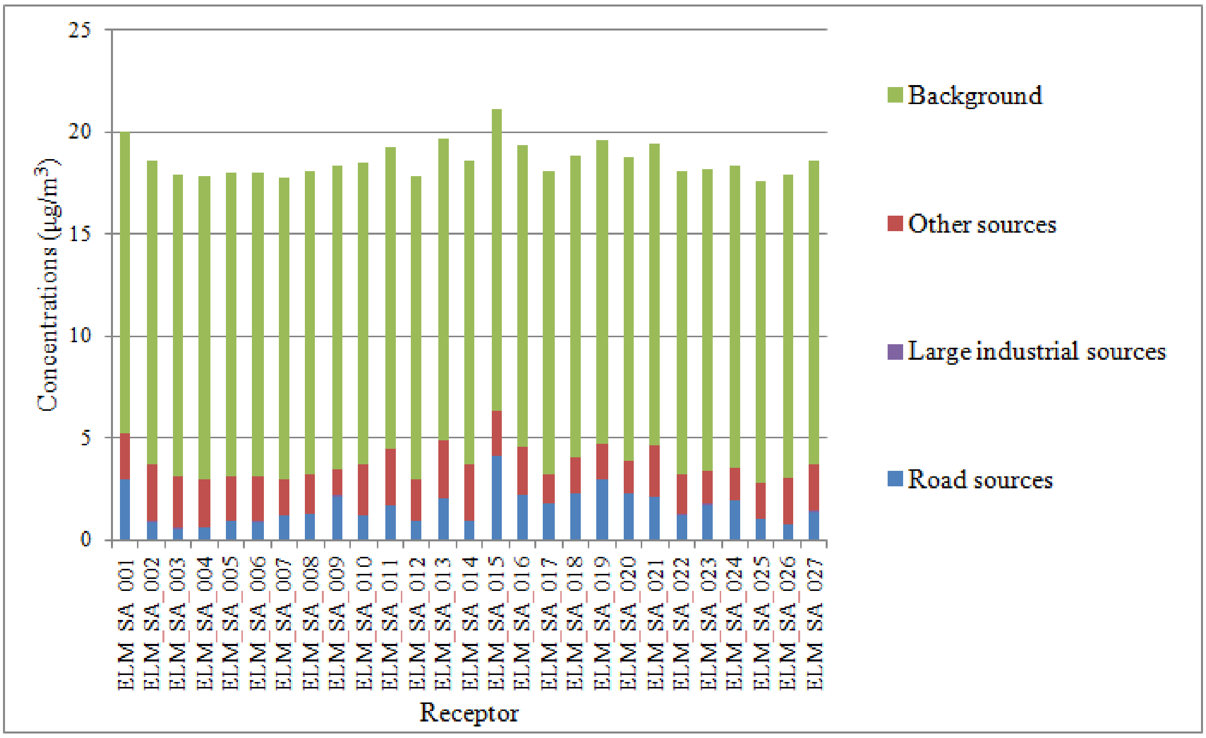

Figure 2.3: PM_{10} concentrations by major source group, Elmbridge

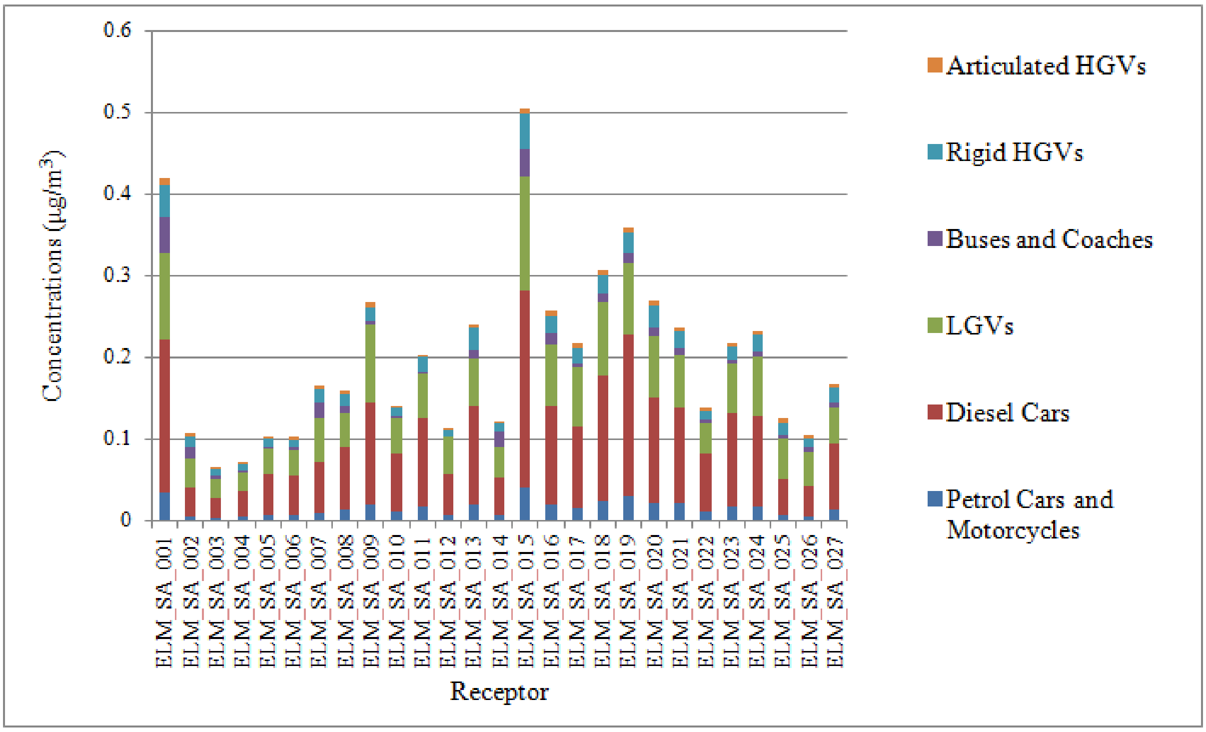

Figure 2.4: Road transport exhaust PM_{10} concentrations by vehicle category, Elmbridge

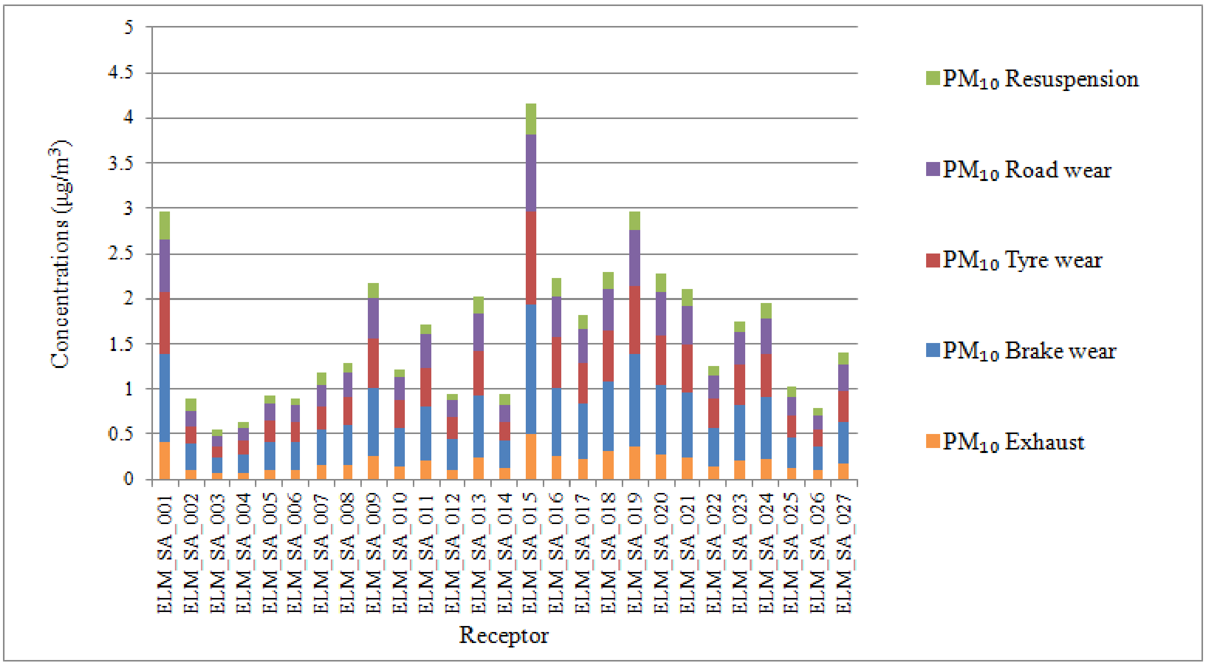

Figure 2.5: Road transport PM_{10} concentrations by exhaust and non-exhaust components, Elmbridge

Table 2.3: Summary of PM_{10} concentration source apportionment, Elmbridge

PM_{10} (µg/m³)	Type of source apportionment													
	Source type				Road transport - exhaust by vehicle type						Road transport - non-exhaust			
Receptor	Road sources	Other sources	Background	Large industrial sources	Petrol Cars & Motorcycles	Diesel Cars	LGVs	Buses & Coaches	Rigid HGVs	Articulated HGVs	PM_{10} Brake wear	PM_{10} Tyre wear	PM_{10} Resuspension	PM_{10} Road wear
ELM_SA_001	3.0	2.2	14.8	<0.1	0.03	0.19	0.11	0.04	0.04	<0.01	1.0	0.7	0.3	0.6
ELM_SA_002	0.9	2.8	14.8	<0.1	<0.01	0.04	0.03	0.02	0.01	<0.01	0.3	0.2	0.1	0.2
ELM_SA_003	0.6	2.5	14.8	<0.1	<0.01	0.02	0.02	<0.01	<0.01	<0.01	0.2	0.1	<0.1	0.1
ELM_SA_004	0.6	2.3	14.8	<0.1	<0.01	0.03	0.02	<0.01	<0.01	<0.01	0.2	0.2	<0.1	0.1
ELM_SA_005	0.9	2.2	14.8	<0.1	<0.01	0.05	0.03	<0.01	<0.01	<0.01	0.3	0.2	<0.1	0.2
ELM_SA_006	0.9	2.2	14.8	<0.1	<0.01	0.05	0.03	<0.01	<0.01	<0.01	0.3	0.2	<0.1	0.2
ELM_SA_007	1.2	1.7	14.8	<0.1	<0.01	0.06	0.05	0.02	0.02	<0.01	0.4	0.3	0.1	0.2
ELM_SA_008	1.3	1.9	14.8	<0.1	0.01	0.08	0.04	<0.01	0.01	<0.01	0.4	0.3	0.1	0.3
ELM_SA_009	2.2	1.3	14.8	<0.1	0.02	0.12	0.10	<0.01	0.02	<0.01	0.7	0.5	0.2	0.4
ELM_SA_010	1.2	2.5	14.8	<0.1	0.01	0.07	0.04	<0.01	<0.01	<0.01	0.4	0.3	<0.1	0.3
ELM_SA_011	1.7	2.7	14.8	<0.1	0.02	0.11	0.05	<0.01	0.02	<0.01	0.6	0.4	0.1	0.4
ELM_SA_012	0.9	2.0	14.8	<0.1	<0.01	0.05	0.05	<0.01	<0.01	<0.01	0.3	0.2	<0.1	0.2
ELM_SA_013	2.0	2.8	14.8	<0.1	0.02	0.12	0.06	0.01	0.03	<0.01	0.7	0.5	0.2	0.4
ELM_SA_014	0.9	2.8	14.8	<0.1	<0.01	0.05	0.04	0.02	0.01	<0.01	0.3	0.2	0.1	0.2
ELM_SA_015	4.2	2.1	14.8	<0.1	0.04	0.24	0.14	0.03	0.04	<0.01	1.4	1.0	0.3	0.9
ELM_SA_016	2.2	2.3	14.8	<0.1	0.02	0.12	0.07	0.01	0.02	<0.01	0.8	0.6	0.2	0.5
ELM_SA_017	1.8	1.4	14.8	<0.1	0.02	0.10	0.07	<0.01	0.02	<0.01	0.6	0.4	0.2	0.4
ELM_SA_018	2.3	1.8	14.8	<0.1	0.02	0.15	0.09	0.01	0.02	<0.01	0.8	0.6	0.2	0.5
ELM_SA_019	3.0	1.8	14.8	<0.1	0.03	0.20	0.09	0.01	0.03	<0.01	1.0	0.7	0.2	0.6
ELM_SA_020	2.3	1.6	14.8	<0.1	0.02	0.13	0.08	0.01	0.03	<0.01	0.8	0.6	0.2	0.5
ELM_SA_021	2.1	2.5	14.8	<0.1	0.02	0.12	0.06	<0.01	0.02	<0.01	0.7	0.5	0.2	0.4
ELM_SA_022	1.2	2.0	14.8	<0.1	0.01	0.07	0.04	<0.01	0.01	<0.01	0.4	0.3	0.1	0.3
ELM_SA_023	1.7	1.6	14.8	<0.1	0.02	0.11	0.06	<0.01	0.02	<0.01	0.6	0.4	0.1	0.4
ELM_SA_024	1.9	1.6	14.8	<0.1	0.02	0.11	0.07	<0.01	0.02	<0.01	0.7	0.5	0.2	0.4
ELM_SA_025	1.0	1.7	14.8	<0.1	<0.01	0.04	0.05	<0.01	0.02	<0.01	0.3	0.2	0.1	0.2
ELM_SA_026	0.8	2.3	14.8	<0.1	<0.01	0.04	0.04	<0.01	0.01	<0.01	0.3	0.2	<0.1	0.2
ELM_SA_027	1.4	2.3	14.8	<0.1	0.01	0.08	0.04	<0.01	0.02	<0.01	0.5	0.3	0.1	0.3

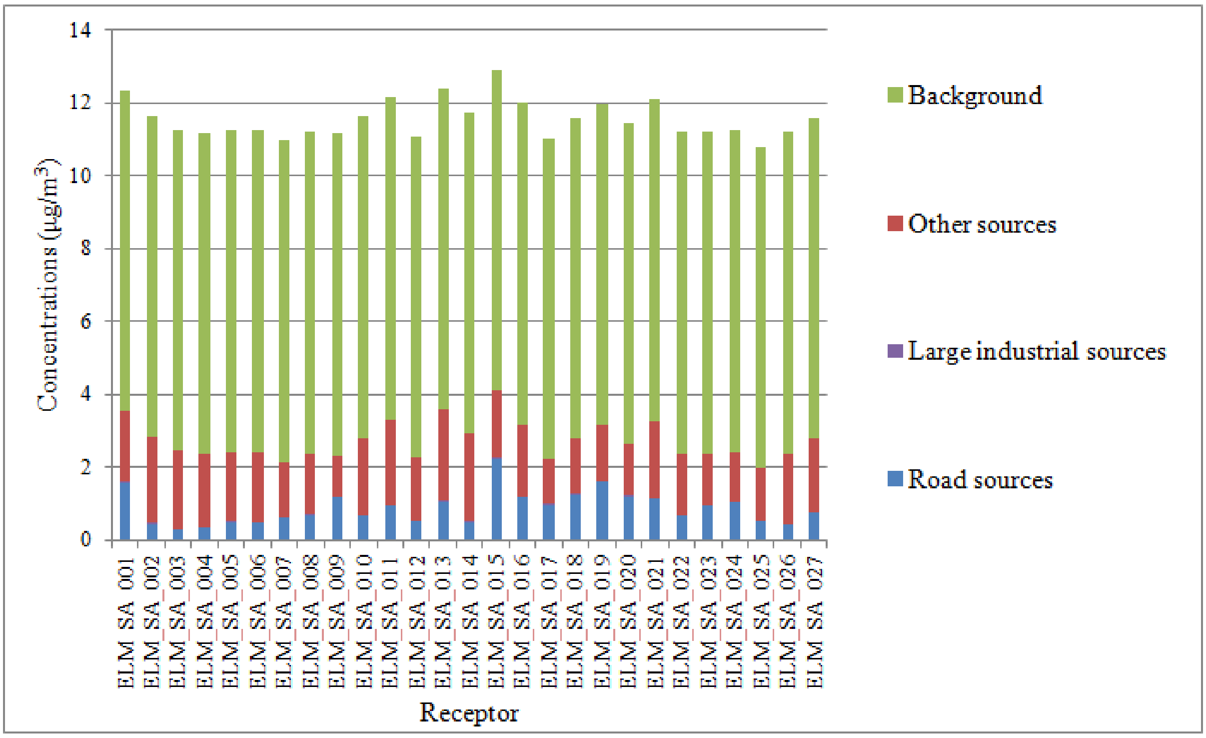

Figure 2.6: $PM_{2.5}$ concentrations by major source group, Elmbridge

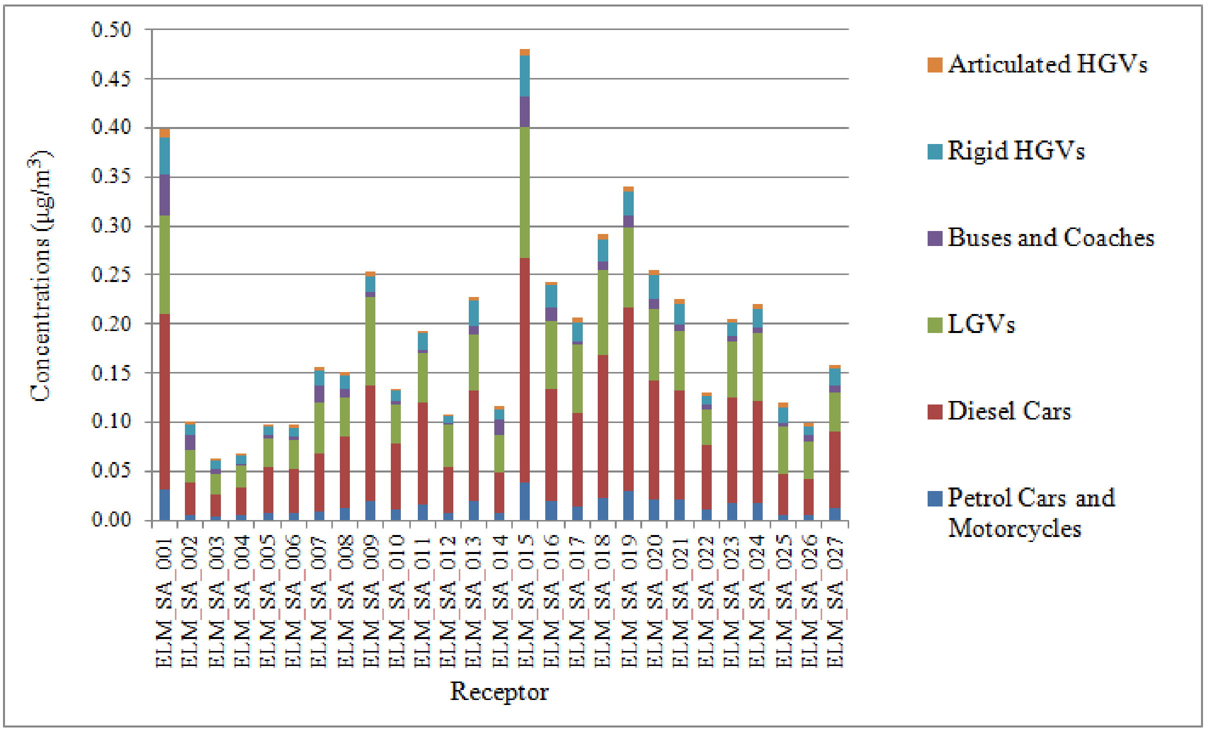

Figure 2.7: Road transport exhaust $PM_{2.5}$ concentrations by vehicle category, Elmbridge

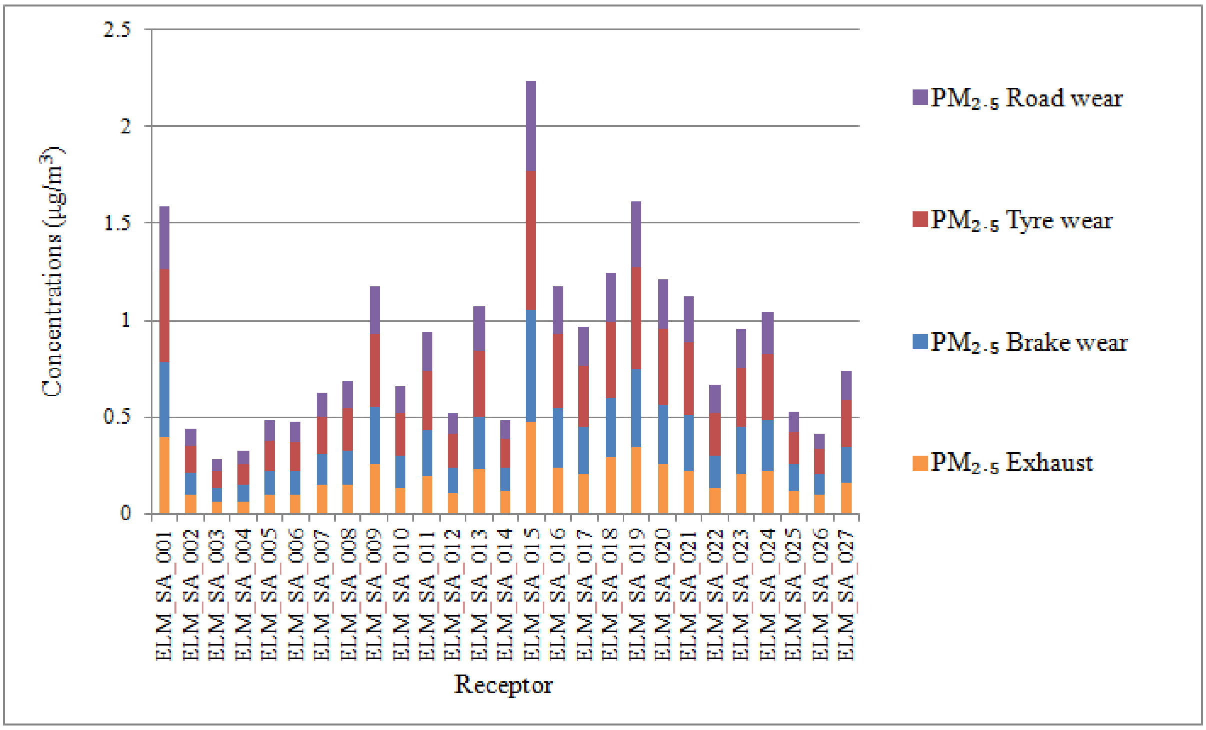

Figure 2.8: Road transport $PM_{2.5}$ concentrations by exhaust and non-exhaust components, Elmbridge

Table 2.4: Summary of $PM_{2.5}$ concentration source apportionment, Elmbridge

$PM_{2.5}$ (µg/m³)	Type of source apportionment												
	Source type				Road transport - exhaust by vehicle type						Road transport - non-exhaust		
Receptor	Road sources	Other sources	Background	Large industrial sources	Petrol Cars & Motorcycles	Diesel Cars	LGVs	Buses & Coaches	Rigid HGVs	Articulated HGVs	$PM_{2.5}$ Brake wear	$PM_{2.5}$ Tyre wear	$PM_{2.5}$ Road wear
ELM_SA_001	1.6	1.9	8.8	<0.1	0.03	0.18	0.10	0.04	0.04	<0.01	0.4	0.5	0.3
ELM_SA_002	0.4	2.3	8.8	<0.1	<0.01	0.03	0.03	0.01	0.01	<0.01	0.1	0.1	<0.1
ELM_SA_003	0.3	2.1	8.8	<0.1	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1
ELM_SA_004	0.3	2.0	8.8	<0.1	<0.01	0.03	0.02	<0.01	<0.01	<0.01	<0.1	0.1	<0.1
ELM_SA_005	0.5	1.9	8.8	<0.1	<0.01	0.05	0.03	<0.01	<0.01	<0.01	0.1	0.2	0.1
ELM_SA_006	0.5	1.9	8.8	<0.1	<0.01	0.04	0.03	<0.01	<0.01	<0.01	0.1	0.2	0.1
ELM_SA_007	0.6	1.5	8.8	<0.1	<0.01	0.06	0.05	0.02	0.02	<0.01	0.2	0.2	0.1
ELM_SA_008	0.7	1.7	8.8	<0.1	0.01	0.07	0.04	<0.01	0.01	<0.01	0.2	0.2	0.1
ELM_SA_009	1.2	1.1	8.8	<0.1	0.02	0.12	0.09	<0.01	0.02	<0.01	0.3	0.4	0.2
ELM_SA_010	0.7	2.1	8.8	<0.1	0.01	0.07	0.04	<0.01	<0.01	<0.01	0.2	0.2	0.1
ELM_SA_011	0.9	2.4	8.8	<0.1	0.02	0.10	0.05	<0.01	0.02	<0.01	0.2	0.3	0.2
ELM_SA_012	0.5	1.7	8.8	<0.1	<0.01	0.05	0.04	<0.01	<0.01	<0.01	0.1	0.2	0.1
ELM_SA_013	1.1	2.5	8.8	<0.1	0.02	0.11	0.06	<0.01	0.02	<0.01	0.3	0.3	0.2
ELM_SA_014	0.5	2.4	8.8	<0.1	<0.01	0.04	0.04	0.02	<0.01	<0.01	0.1	0.2	<0.1
ELM_SA_015	2.2	1.8	8.8	<0.1	0.04	0.23	0.13	0.03	0.04	<0.01	0.6	0.7	0.5
ELM_SA_016	1.2	2.0	8.8	<0.1	0.02	0.11	0.07	0.01	0.02	<0.01	0.3	0.4	0.2
ELM_SA_017	1.0	1.2	8.8	<0.1	0.01	0.09	0.07	<0.01	0.02	<0.01	0.2	0.3	0.2
ELM_SA_018	1.2	1.5	8.8	<0.1	0.02	0.15	0.09	<0.01	0.02	<0.01	0.3	0.4	0.3
ELM_SA_019	1.6	1.5	8.8	<0.1	0.03	0.19	0.08	0.01	0.02	<0.01	0.4	0.5	0.3
ELM_SA_020	1.2	1.4	8.8	<0.1	0.02	0.12	0.07	<0.01	0.02	<0.01	0.3	0.4	0.3
ELM_SA_021	1.1	2.1	8.8	<0.1	0.02	0.11	0.06	<0.01	0.02	<0.01	0.3	0.4	0.2
ELM_SA_022	0.7	1.7	8.8	<0.1	0.01	0.07	0.04	<0.01	0.01	<0.01	0.2	0.2	0.1
ELM_SA_023	1.0	1.4	8.8	<0.1	0.02	0.11	0.06	<0.01	0.02	<0.01	0.2	0.3	0.2
ELM_SA_024	1.0	1.4	8.8	<0.1	0.02	0.10	0.07	<0.01	0.02	<0.01	0.3	0.3	0.2
ELM_SA_025	0.5	1.4	8.8	<0.1	<0.01	0.04	0.05	<0.01	0.01	<0.01	0.1	0.2	0.1
ELM_SA_026	0.4	1.9	8.8	<0.1	<0.01	0.04	0.04	<0.01	<0.01	<0.01	0.1	0.1	<0.1
ELM_SA_027	0.7	2.0	8.8	<0.1	0.01	0.08	0.04	<0.01	0.02	<0.01	0.2	0.2	0.2

3 Mortality burden

Table 3.1 presents a mortality burden associated with NO_2 and $PM_{2.5}$ concentrations by Elmbridge ward.

The range of values given for attributable fraction, life years lost and economic cost for each pollutant were derived from the minimum and maximum values for each of the individual pollutants. These were calculated using pairs of concentration response functions (CRFs) for $PM_{2.5}$ and NO_2 taken from four different studies; see Section 9 of main report for more information.

Total life years lost and total economic cost were derived from the combination of pollutants within each study.

Table 3.1: Summary of life years lost and economic cost resulting from NO_2 and $PM_{2.5}$ concentrations by Elmbridge ward

Ward		NO_2				$PM_{2.5}$				Total life years lost	Total economic cost (£ Million)
Code	**Name**	**Concentrations (µg/m³)**	**Attributable fraction**	**Life years lost**	**Economic cost (£ Million)**	**Concentrations (µg/m³)**	**Attributable fraction**	**Life years lost**	**Economic cost (£ Million)**		
E05011074	Claygate	20.5	0.022-0.040	16-28	0.67-1.20	10.9	0.017-0.046	12-33	0.53-1.43	40-49	1.73-2.10
E05011075	Cobham and Downside	21.9	0.024-0.042	20-36	0.87-1.55	10.8	0.017-0.046	15-40	0.63-1.69	51-60	2.18-2.56
E05011076	Esher	20.1	0.022-0.039	20-36	0.86-1.54	10.9	0.017-0.046	16-43	0.68-1.84	52-63	2.22-2.69
E05011077	Hersham Village	19.9	0.022-0.039	15-27	0.65-1.16	11.3	0.018-0.048	13-34	0.54-1.45	40-49	1.70-2.10
E05011078	Hinchley Wood and Weston Green	20.2	0.022-0.039	10-18	0.42-0.75	11.1	0.018-0.047	8-21	0.33-0.91	25-31	1.09-1.32
E05011079	Long Ditton	20.8	0.022-0.040	14-26	0.62-1.11	11.3	0.018-0.049	12-31	0.5-1.34	38-46	1.61-1.96
E05011080	Molesey East	20.9	0.023-0.040	20-36	0.86-1.55	11.4	0.018-0.049	16-44	0.7-1.89	53-64	2.25-2.75
E05011081	Molesey West	20.4	0.022-0.040	25-44	1.06-1.90	11.4	0.018-0.049	21-55	0.88-2.37	65-80	2.78-3.43
E05011082	Oatlands and Burwood Park	20.1	0.022-0.039	16-29	0.70-1.25	11.1	0.018-0.047	13-35	0.56-1.52	42-52	1.82-2.22
E05011083	Oxshott and Stoke D'Abernon	20.5	0.022-0.040	16-29	0.68-1.22	10.5	0.017-0.045	12-32	0.51-1.39	41-48	1.74-2.07
E05011084	Thames Ditton	20.7	0.022-0.040	19-35	0.82-1.48	11.3	0.018-0.049	16-42	0.66-1.8	50-61	2.14-2.62
E05011085	Walton Central	20.8	0.023-0.040	14-26	0.62-1.11	11.5	0.018-0.049	12-32	0.5-1.35	38-46	1.61-1.97
E05011086	Walton North	20.0	0.022-0.039	16-29	0.69-1.25	11.4	0.018-0.049	14-37	0.58-1.56	43-53	1.82-2.26
E05011087	Walton South	19.7	0.021-0.038	22-39	0.92-1.65	11.2	0.018-0.048	18-49	0.77-2.08	57-70	2.42-3.00
E05011088	Weybridge Riverside	20.4	0.022-0.040	16-28	0.68-1.22	11.0	0.017-0.047	12-34	0.53-1.44	41-49	1.75-2.11
E05011089	Weybridge St George's Hill	20.6	0.022-0.040	29-52	1.23-2.20	10.8	0.017-0.046	22-59	0.93-2.51	73-87	3.13-3.74

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly

Appendix H: Cobham High Street AQMA Revocation Report

Cobham Air Quality Management Area

Revocation Report

On behalf of **Elmbridge Borough Council**

Project Ref: 47763/3003 | Rev: Issued | Date: May 2020

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Document Control Sheet

Project Name: Elmbridge 2020 LAQM

Project Ref: 47763/3003

Report Title: Cobham Air Quality Management Area Revocation Report

Doc Ref: Issued

Date: May 2020

	Name	Position	Signature	Date
Prepared by:	Laura Smart	Air Quality Scientist	*Laura Smart*	March 2020
Reviewed by:	Kiri Heal	Senior Associate	*Kiri Heal*	March 2020
Approved by:	Stefan Boss	Director	*Stefan Boss*	March 2020
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
Draft	March 2020	Draft for client comment	LS	KH	SB
Issued	May 2020	With comments included	LS	KH	SB

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Appendices

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1 Introduction

1.1.1 This report has been prepared by Stantec, on behalf of Elmbridge Borough Council, to provide an assessment to inform the revocation of the Cobham High Street Air Quality Management Area (AQMA) in Elmbridge.

1.1.2 It has been prepared following the receipt of comments from the Department of Food Environment and Rural Affairs (DEFRAs) on the 2019 Air Quality Annual Status Report (ASR). The comment relevant to this assessment is outlined below:

"Annual mean nitrogen dioxide concentrations have been well below the objective in the Cobham AQMA for a number of years now. The Council should consider a detailed assessment of the area to inform possible revocation of the AQMA".

1.2 Report Scope

1.2.1 The report has been prepared to fulfil the requirements of Local Air Quality Management (LAQM) statutory process, as set out in Part IV of the Environment Act 1995 and provides an assessment required in order to revoke the AQMA. As the AQMA was declared due to exceedances of the annual mean nitrogen dioxide (NO_2) national air quality objective (NAQO), this pollutant is therefore the focus of this assessment. The following are included in this assessment:

- Demonstration that the NO_2 concentrations within the AQMA have been more than 10% below the NAQO for a minimum of three consecutive years.
- Demonstration that the NAQO is likely to continue to be met in future years.
- Consideration of national trends in emissions, and local factors such as Air Quality Action Plan (AQAP) measures which may influence air quality in the AQMA.

1.2.2 The report has been prepared in accordance with guidance produced by DEFRA including LAQM Technical Guidance (LAQM.TG (16)) (DEFRA, 2018) and Policy Guidance (LAQM.PG (16)) (DEFRA, 2016).

2 Legislation, Policy and Guidance

2.1 Relevant Legislation and Policy

2.1.1 Part IV of the Environment Act 1995 (Environment Act, 1995) introduced a system of LAQM which requires local authorities to regularly and systematically review and assess air quality within their boundary and appraise development and transport plans against these assessments.

2.1.2 The Air Quality (England) Regulations 2000 and the Air Quality (England) (Amendment) Regulations 2002 define the NAQOs relevant to this assessment; these are summarised in **Table 2.1**.

Table 2.1: Relevant Air Quality Objectives

Pollutant	Time Period	NAQOs
NO_2	1-hour mean	200 µg/m^3 not to be exceeded more than 18 times a year
	Annual mean	40 µg/m^3

2.1.3 Where a NAQO is unlikely to be met, the local authority must designate an AQMA and draw up an AQAP setting out the measures it intends to introduce in pursuit of the NAQOs within its AQMA.

2.1.4 The Local Air Quality Management Technical Guidance 2016 (LAQM.TG (16); DEFRA, 2016), issued by DEFRA for local authorities provides advice as to where the NAQOs apply. These include outdoor locations where members of the public are likely to be regularly present for the averaging period of the objective. **Table 2.2** summarises the relevant locations applicable to the NO_2 NAQOs.

Table 2.2: Relevant Public Exposure

Averaging Period	Relevant Locations	NAQOs should apply at:	NAQOs don't apply at:
Annual mean	At all locations where members of the public might be regularly exposed.	Building facades of residential properties, schools, hospitals, etc	Façades of offices Hotels Gardens of residences Kerbside sites
1-hour mean	Where individuals might reasonably be expected to spend one hour or longer	As above together with locations of regular access, car parks, bus stations, etc	Locations not publicly accessible or where occupation is not regular

2.2 AQMA Revocation Requirements

2.2.1 DEFRA's LAQM TG.16 and PG.16 outline the requirements for revoking an AQMA and these are summarised below.

2.2.2 TG.16 provides information of the technical aspects of revoking an AQMA. Paragraph 3.48 states that *"in most cases, the decision to amend or revoke an AQMA should only be taken following a detailed study…This should set out in detail all the information available used to reach the decision, with the same degree of confidence as was provided for the original declaration."*

2.2.3 However, Paragraph 3.49 then states "*in some instances if compelling evidence exists, detailed modelling to support the decision to amend/revoke an AQMA may not be necessary and an AQMA may be amended or revoked following a screening assessment or on the basis of robust monitoring evidence."*

2.2.4 The monitoring data requirements, to demonstrate that an AQMA can be revoked, are further detailed in Paragraph 3.50:

"…Before revoking an AQMA on the basis of measured pollutant concentrations, the authority therefore needs to be reasonably certain that any future exceedances (that might occur in more adverse meteorological conditions) are unlikely. For this reason, it is expected that authorities will need to consider measurements carried out over several years or more, national trends in emissions, as well as local factors that may affect the AQMA, including measures introduced as part of the Air Quality Action Plan, together with information from national monitoring on high and low pollution years."

2.2.5 PG.16 provides information on the policy aspects of revoking an AQMA. Key points are summarised below:

- The AQMA review should demonstrate that the air quality objectives are not exceeded and will continue to be met in the future.
- A copy of the AQMA Revocation Order should be submitted to DEFRA and other statutory consultees and be made publicly available so the public and local businesses are aware of the situation.
- Once comments on the Order have been received from DEFRA, the local authority should take the relevant action to revoke the AQMA within four months.
- Once revoked, the local authority should implement an air quality strategy to ensure air quality is continually reviewed and any deterioration in air quality can be responded to quickly.

2.2.6 Taking the above into account, it is considered that robust monitoring evidence can be used to demonstrate the current and future compliance with the national air quality objectives within the AQMA and specific detailed air quality modelling is not required. However, Surrey-wide dispersion modelling has been used to supplement this assessment.

3 Local Air Quality Management

3.1 Air Quality Monitoring

3.1.1 The Council undertakes monitoring of NO_2 concentrations across the Borough for LAQM Review and Assessment purposes. The majority of these monitoring sites are located within the Council's seven AQMAs. In 2019, the Council carried out monitoring at three locations using automatic monitoring methods (two on Weybridge High Street and one on Hampton Court Parade), as well as 31 passive (diffusion tube) monitoring locations.

3.1.2 Within the Cobham High Street AQMA, there are two monitoring sites, Cobham 1 and Cobham 7, located on the western side of the High Street, close to the façade of existing properties. In addition, Cobham 6 is located just outside of the northern boundary of the AQMA. These monitoring sites are shown in **Figure 3.1**.

3.1.3 The air quality monitoring data for the Borough has undergone robust QA/QC procedures. Further detail of QA/QC procedures are provided in the Council's ASRs, the latest of which is the 2019 ASR (Elmbridge Borough Council, 2019).

3.2 Cobham AQMA Declaration

3.2.1 The Cobham High Street AQMA was declared in November 2008 due to exceedances of the annual mean NO_2 NAQO and encompasses a section of the High Street and adjacent properties, between Hogshill Lane and Church Street. The AQMA is described as a narrow, busy and congested town centre affected by local traffic. The extent of the AQMA is shown in **Figure 3.1.**

3.3 Local Pollution Sources

3.3.1 Source apportionment of roadside nitrogen oxides (NO_x) emissions has been carried out by Cambridge Environmental Research Consultants (CERC), on behalf of the Surrey Authorities as part of a Surrey-wide dispersion modelling project (CERC, 2019). The source apportionment modelling results for the Cobham AQMA are provided in **Table 3.1** and **Table 3.2**. As NO_2 is a secondary pollutant, formed from NO_x as a result of chemical reactions in the atmosphere, the contribution of different sources is best understood by comparing NO_x concentrations.

3.3.2 Road transport is identified as the principal source of NO_x in the AQMA (64% source contribution). Background sources are defined as those transported into an area by wind and exclude local emissions sources (i.e. roads and chimney stacks); these sources are the second largest contributor (28.8%) to total NO_x concentrations in the AQMA. Diesel cars are the greatest contributor in the road vehicle category, contributing approximately 31.7% of the total NO_x concentration, whilst buses contribute the smallest proportion of NO_x from road transport, approximately 1.5%.

Table 3.1: NO_x Source Apportionment in Cobham AQMA – Source: CERC (2019)

Receptor	NO_x Source Apportionment (µg/m^3)			
	Road Sources	Background	Large Industrial Sources	Other Sources
ELM_SA_019	38.7 (64.0%)	17.4 (28.8%)	0.3 (0.5%)	4.1 (6.8%)

Table 3.2: NO_x Source Apportionment in Cobham AQMA by Vehicle Category – Source: CERC (2019)

Receptor	NO_x Source Apportionment (μg/m^3)				
	Petrol Cars and Motorcycles	Diesel Cars	Light Goods Vehicles	Buses	HGVs (Rigid and Articulated)
ELM_SA_019	4.2 (6.9%)	19.2 (31.7%)	10.6 (17.5%)	0.9 (1.5%)	3.8 (6.3%)

3.4 Elmbridge Air Quality Action Plan (2011)

3.4.1 The Council's AQAP, adopted in 2011, provides measures aimed at improving air quality within the Borough's seven AQMAs. There are no measures specific to the Cobham High Street AQMA, however the AQAP focusses on broader measures based around the following three categories: detailed strategic measures; detailed transport options; and non-transport related measures.

3.4.2 The detailed strategic measures are policy-related and include the integration of the AQAP with local development policies, the Surrey Transport Plan and council strategies.

3.4.3 The detailed transport options category includes a range of measures aimed at reducing emissions specifically from road traffic. Examples of measures in this category include review of traffic control systems in AQMAs, promotion of car sharing clubs, and the implementation of freight/bus quality partnerships.

3.4.4 The non-transport related measures category includes measures such as enforcement of existing statutory instruments (e.g. Environmental Permitting Regulations), energy efficiency and air quality monitoring.

3.4.5 Further measures to improve air quality across Elmbridge are included in the Council's ASRs which report progress on these measures each year. The 2019 ASR includes a measure specific to the Cobham High Street AQMA: the maintenance of the Cobham car park electric vehicle (EV) charging point. In 2019 the EV charging point was upgraded to provide two twin fast-charging points. The charger fees were also reviewed and reduced in 2017 to make the charger more accessible to the public (Elmbridge Borough Council, 2019).

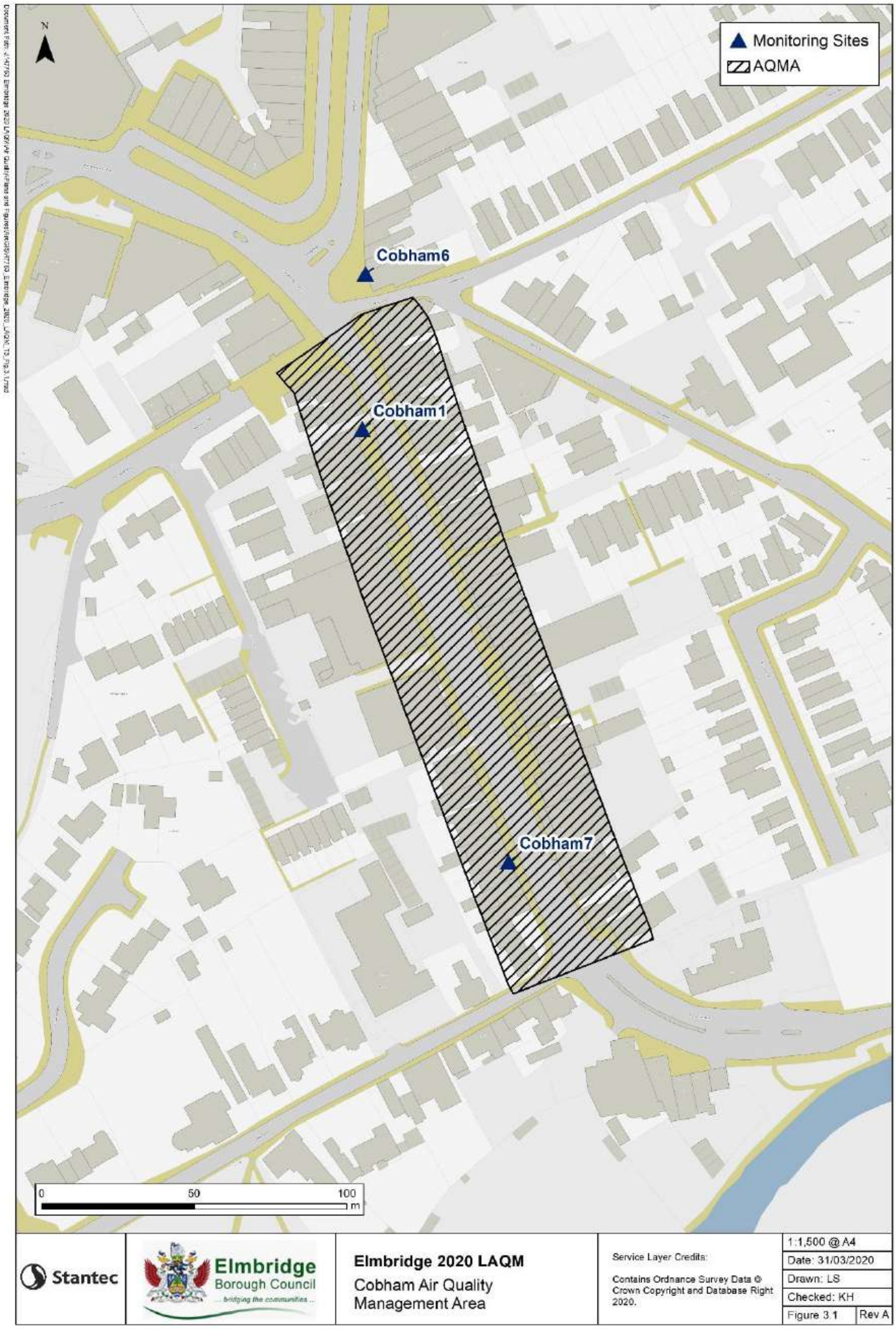

Figure 3.1: Cobham High Street Air Quality Management Area and Monitoring Locations

4 AQMA Revocation Evidence

4.1 Measured NO_2 Concentrations in Cobham

4.1.1 Monitoring data for sites within the AQMA, for the five-year period between 2015-2019, are provided in **Table 4.1**. The details of the diffusion tube monitoring sites are provided in **Appendix A**.

4.1.2 The bias adjusted diffusion tube monitoring data have been compared against the annual mean NO_2 NAQO of 40 µg/m^3. In addition, the data have been compared against an annual mean of 36 µg/m^3 (within 10% of the annual mean NAQO) to account for inherent uncertainty in diffusion tube monitoring data. Trends in annual mean NO_2 concentrations between 2015-2019 are shown in **Figure 4.1** and **Figure 4.2**.

4.1.3 As shown in **Table 4.1**, **Figure 4.1** and **Figure 4.2**, concentrations at Cobham 1 and Cobham 7, within the AQMA, have been well below the annual mean NO_2 NAQO for the past five years. In addition, concentrations have not been within 10% of the NAQO, except for at Cobham 7 in 2015, where the 10% threshold was slightly exceeded by 0.4 µg/m^3.

4.1.4 **Table 4.1** shows that concentrations have fluctuated between 2015 and 2019, however, concentrations in 2019 were lower than in 2015 at both monitoring sites.

4.1.5 Cobham 1 and Cobham 7 monitoring sites are located closer to the road than locations of relevant exposure on Cobham High Street (i.e. the façade of buildings at first floor level). Therefore, the monitoring locations are considered to provide worst-case measurements of NO_2 concentrations within the AQMA, and concentrations where relevant exposure is likely to occur, will be lower than those presented in **Table 4.1** due to their greater horizontal and vertical distance from the road.

Table 4.1: Measured Annual Mean NO_2 Concentrations in the Cobham AQMA – 2015-2019

Site ID	Site Type	Annual Mean (µg/m^3)				
		2015	**2016**	**2017**	**2018**	**2019**
Cobham 1	Roadside	34.9	33.1	30.1	33.3	32.2
Cobham 7	Roadside	36.4	34.1	32.2	31.6	33.6
NAQO		**40**				
Within 10% of the NAQO		**36**				

2015 – 2018 data taken from the 2019 Elmbridge Borough Council Air Quality Annual Status Report (ASR) (Elmbridge Borough Council, 2019).

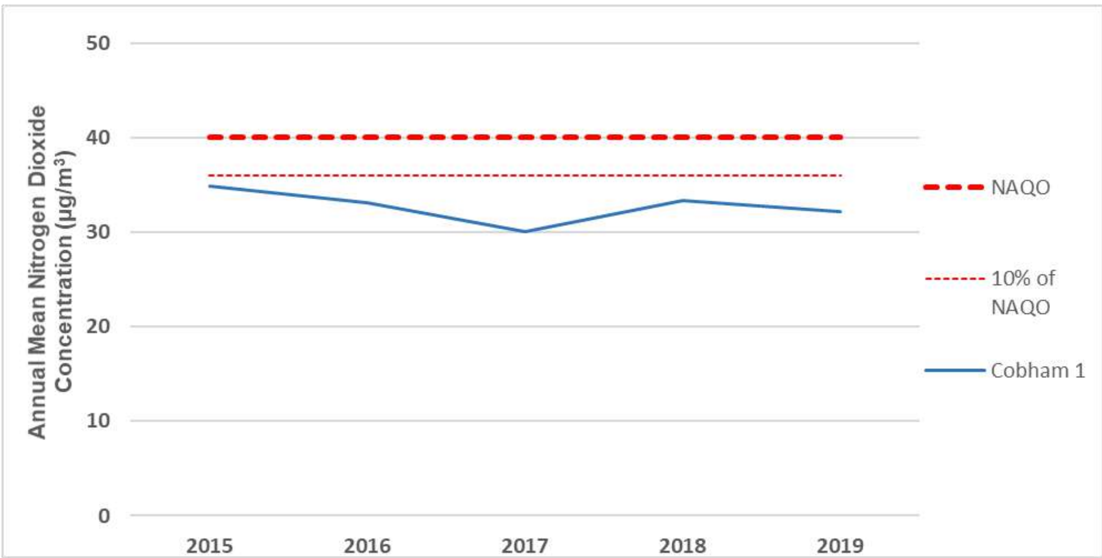

Figure 4.1: Trends in Annual Mean NO_2 Concentrations at the Cobham 1 Monitoring Site

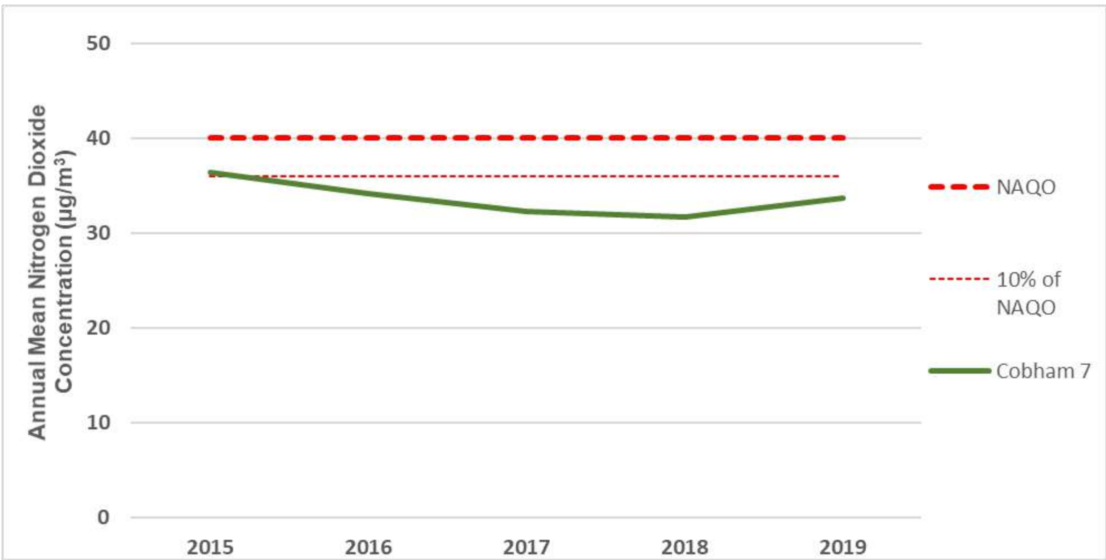

Figure 4.2: Trends in Annual Mean NO_2 Concentrations at the Cobham 7 Monitoring Site

4.2 Dispersion Modelling Data

4.2.1 The Surrey Air Alliance (SAA) is formed from officer representatives from all eleven District and Borough Councils in Surrey, and Surrey County Council's (SCC's) Highways and Public Health services. The Council are an active member of the SAA and assist in the delivery of the SAA Work Plan. A key Work Plan task on which the Council has taken the lead on is the Surrey-wide air quality modelling project. The dispersion modelling, undertaken by CERC, was completed in 2019 and establishes a baseline for key pollutants (NO_2, PM_{10} and $PM_{2.5}$) across Surrey. The dispersion modelling provides predicted annual mean NO_2 concentrations in 2017 within the Cobham AQMA and has been used to inform this assessment.

4.2.2 The CERC modelling reports for Surrey and Elmbridge present the modelling results and contour maps of pollutant concentrations and are provided in Appendix F and Appendix G of the 2020 Air Quality Annual Status Report (ASR), to which this report is appended. The Surrey modelling report (Appendix F of the ASR) also contains details of the modelling methodology: Section 5 of the report provides details of the model inputs and setup, Section 6 provides information relating to the traffic data used in the model, emission factors and time-varying emissions, whilst Section 7 provides details of the model verification.

4.2.3 The contour map showing concentrations of annual mean NO_2 within the AQMA is provided in **Figure 4.3** The contour map shows that the facades of buildings within the AQMA are generally within the 24-28 µg/m^3 contour. There are a couple of locations within the AQMA that are within the 32-36 µg/m^3 contour, however these locations are within the road and therefore not considered to be representative of relevant exposure. The dispersion modelling therefore indicates that there are no predicted exceedances of the annual mean NO_2 NAQO in 2017 within the AQMA, and concentrations are not predicted to fall within 10% of the NAQO at locations of relevant exposure.

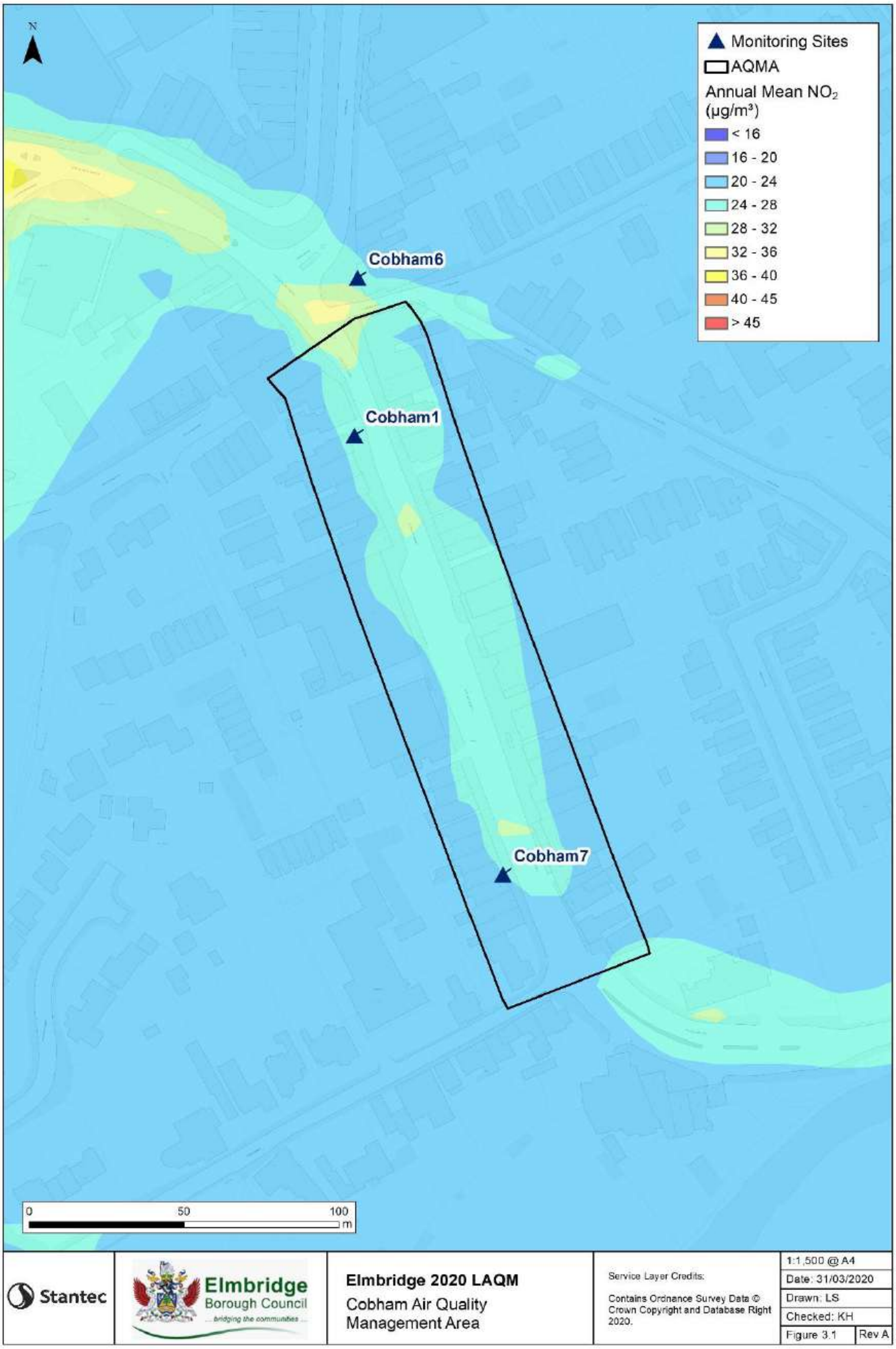

Figure 4.3: Cobham High Street Air Quality Management Area Annual Mean NO_2 Concentration Contours

4.3 National NO_2 Concentration Trends

4.3.1 Concentrations of NO_2 have been declining in recent years nationally and are predicted to continue to decrease. This is largely due to the introduction of more stringent European vehicle emission standards (Euro Standards), and the reduction of older vehicles, and the increase in newer, cleaner vehicles in the fleet mix.

4.3.2 Air Quality Consultants Ltd. prepared a report in 2019 analysing trends in NO_2 concentrations across the UK between 2005 and 2018 (Air Quality Consultants Ltd., 2019). The report demonstrates that significant downward trends were seen across the UK over the period 2005-2018, with the magnitude of reduction for NO_2 being an average of -1.82% per year. When averaged between 2010-2018, the decline in concentrations was even steeper, with an average reduction in NO_2 concentrations of -3.1% per year.

4.4 Future Trends in Emissions

DEFRA Background Concentrations

4.4.1 DEFRA provides estimated background concentrations on a 1 km x 1 km grid basis, the latest of which provide estimated concentrations for a 2017 reference year and projected future years up to 2030 (DEFRA, 2019a). Estimated annual mean NO_2 background concentrations between 2019-2024, for grid squares within the AQMA, are provided in **Table 4.2**.

Table 4.2: Estimated Annual Mean NO_2 Background Concentrations 2019-2024

Grid Reference	Annual Mean NO_2 (µg/m^3)					
	2019	**2020**	**2021**	**2022**	**2023**	**2024**
510_160 (Cobham 1)	17.4	16.6	15.9	15.2	14.6	14.0
510_159 (Cobham 7)	14.0	13.3	12.8	12.2	11.7	11.2
NAQO	**40**					

4.4.2 **Table 4.2** demonstrates that the predicted annual mean NO_2 background concentrations are estimated to decline year on year in the future, with a reduction of 2.8-3.4 µg/m^3 predicted over the next five years. As background concentrations contribute approximately 28.8% to the total NO_2 concentrations in the AQMA (**Table 2.2**), it is expected that the total NO_2 concentration in the AQMA will also continue to decline.

Emission Factor Toolkit

4.4.3 Road traffic emissions have also been calculated for Cobham High Street using the Emission Factor Toolkit (EFT v9.0) produced by DEFRA (DEFRA, 2019b). The EFT utilises NO_x emission factors taken from the European Environment Agency COPERT 5 emission tool. The EFT provides pollutant emission rates for 2017 through to 2030 and takes into consideration the following information available from the National Atmospheric Emissions Inventory (NAEI):

- fleet composition data for motorways, urban and rural roads in London and rest of the UK;
- fleet composition based on European emission standards from pre-Euro I to Euro 6(a-d)/VI;
- scaling factors reflecting improvements in the quality of fuel and some degree of retrofitting; and
- technology conversions in the national fleet.

4.4.4 Publicly available traffic data for Cobham High Street has been obtained from the Department for Transport (DfT, 2020) and is provided in **Appendix B**. The latest available (2018) annual average daily traffic (AADT) data has been factored to each of the corresponding future emission years to account for growth in traffic flows in the future. The National Trip End Model has been used via the TEMPro software to obtain the growth factors for each year. It has been assumed that the heavy-duty vehicle (HDV) split remains constant in future years. The traffic data has been input to the EFT to calculate road vehicle NO_x emissions rates for 2018-2025, for an urban road type, at 32 kph speed (taking into account congestion in the area).

4.4.5 **Figure 4.4** shows the that the emission outputs from the EFT demonstrate a predicted decrease in NO_x emissions between 2018 – 2025 of approximately 40%, taking into account the estimated growth in traffic in future years. It is therefore considered that the contribution of additional vehicles to NO_2 concentrations in the AQMA in the future will be offset by a reduction in vehicle emissions and background concentrations. As a result, it is expected that NO_2 concentrations in the AQMA will continue to decline. It should be noted however, that the analysis of future emission trends is based upon national fleet assumptions in the EFT, which may not be completely reflective of the Cobham area where the vehicle fleet composition may be different, and may also change in a different way to the national fleet in the future.

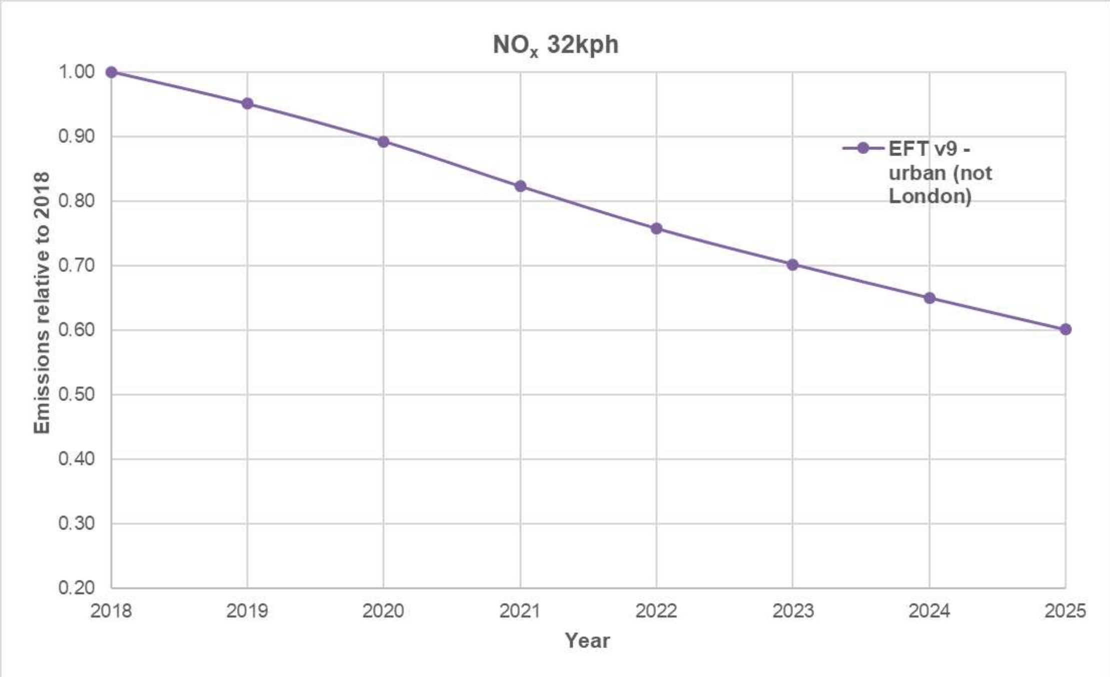

Figure 4.4: Future Trend in NO_x Emissions on Cobham High Street

4.5 Local Factors affecting the AQMA

Major Developments

4.5.1 The only major proposed development identified as having potential material impacts on air quality in the AQMA is the M25 Junction 10/A3 Wisley Interchange. The development proposals include improvements to junction 10 of the M25, in addition to widening of the A3 and A245 between the Painshill Junction and B365 Seven Hills Road junction. The Environmental Statement (Highways England, 2019) for the Development Consent Order (DCO) application has been reviewed to determine the effect of the development on air quality in the AQMA. The closest part of the DCO application boundary is located at the A245, south of the Painshill junction, approximately 1.2 km north of the AQMA.

4.5.2 The AQMA is not within the study area of the air quality assessment as the increase in traffic flows resulting from the development do not exceed the criteria used to identify where potential air quality effects could occur (a change in daily traffic flows of 1,000 AADT or more, or an increase in HDV traffic flow of more than 200 AADT). Therefore, no significant adverse effects on air quality within the AQMA are expected as a result of the proposed development.

Ongoing Action Plan Measures

Surrey-Wide Measures

4.5.3 The Surrey Air Alliance (SAA) is a partnership of local authorities and Surrey County Council (SCC) Highways and Public Health Services, which aims to share best practice and coordinate actions to improve air quality across Surrey. The Council is an active member of the SAA and is involved in the delivery of the SAA's Workplan, which involves a number of projects aimed at reducing air pollution. The Workplan has included the Surrey-wide modelling of pollutants, which has been used to inform this assessment, in addition to the Surrey Schools Air Quality Programme which aims to raise awareness and promote behaviour change in schools within 2 km of an AQMA.

Elmbridge Borough Council Measures

4.5.4 The Council also individually continues to implement actions and initiatives to improve air quality across Elmbridge. Details of these measures are provided in the Air Quality Annual Status Reports (ASRs), in addition to those implemented through the SAA Workplan. The following ongoing measures have been implemented which have the potential to influence air quality in the Cobham AQMA:

- Installation, upgrade and continued maintenance of the Cobham Car Park Electric Vehicle charging point.
- Requiring new development that is likely to affect air quality within the AQMA to submit an air quality assessment and refusing planning permission for developments where a significant adverse effect on air quality within the AQMA is identified.
- The Surrey Transport Plan Low Emission Strategy (SCC, 2018).

4.5.5 Measures targeted at improving air quality within the AQMAs are also provided in the AQAP (2011) (**Section 3.4**). However, a new AQAP will be prepared in 2020 which will include new measures to reduce air pollution across the Borough.

5 Summary and Recommendations

5.1.1 Air Quality within the Cobham High Street AQMA has been reviewed and revocation of the AQMA has been considered. Air quality monitoring and dispersion modelling data, as well as trends in national emissions and measurements of NO_2 have been used to provide evidence to support the revocation.

5.1.2 Measured concentrations of NO_2 at monitoring sites within the AQMA have been below the NAQOs over the past five years. Furthermore, NO_2 concentrations have not been within 10% of the NAQO over the past five years, with the exception of a slight exceedance of the 10% threshold in 2015 at one of the monitoring locations in the AQMA. Concentrations in the AQMA have declined between 2015 and 2019.

5.1.3 Contour maps of annual mean NO_2 concentrations in the AQMA show that there are no predicted exceedances of the annual mean NO_2 NAQO.

5.1.4 National NO_2 concentrations across the UK have shown a downward trend since 2005, and a steeper downward trend is evident in more recent years. Projected future background concentrations and emissions show that road vehicle emissions and background concentrations are expected to decline year on year in the future, and therefore annual mean NO_2 concentrations in the AQMA are also predicted to continue to decrease.

5.1.5 In terms of local factors affecting the AQMA, there are no major developments which are considered likely to significantly affect air quality in the AQMA. There are a number of ongoing action plan measures that will continue to be implemented in the AQMA, including once revoked. It is recommended that air quality monitoring on Cobham High Street is continued once the AQMA is revoked in order to enable quick action should deterioration in air quality be identified.

5.1.6 It is considered that the AQMA revocation requirements outlined in DEFRA's TG.16 and PG.16 have been achieved in the Cobham AQMA. It is therefore recommended that Elmbridge Borough Council apply for the revocation of the Cobham High Street AQMA.

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Appendix A Cobham AQMA Diffusion Tube Details

Site ID	Location	Site Type	X OS Grid Reference	Y OS Grid Reference	Distance to Relevant Exposure (m)	Distance to Kerb of Nearest Road (m)	Tube Co-located with Analyser	Height (m)
Cobham 1	Opposite the Lemon Tree, Cobham High Street	Roadside	510828	159996	2.7	0.6	No	2.4
Cobham 7	Exclusively Surrey, 38A Cobham High Street	Roadside	510861	159906	4.2	3.1	No	2.4

Appendix B Traffic Data for Cobham High Street

Year	Estimation Method	All Motor Vehicles AADT	%HDV
2025	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.0795)	17,269	1.47
2024	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.0676)	17,078	1.47
2023	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.0558)	16,890	1.47
2022	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.044)	16,701	1.47
2021	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.0321)	16,511	1.47
2020	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.0212)	16,336	1.47
2019	Factored from 2018 annual average daily flow (TEMPro growth factor = 1.0107)	16,168	1.47
2018	Estimated using previous year's annual average daily flow on this link	15,997	1.47
2017	Manual Count	16125	1.49
2016	Estimated using previous year's annual average daily flow on this link	18558	2.52
2015	Estimated using previous year's annual average daily flow on this link	18119	2.57
2014	Estimated using previous year's annual average daily flow on this link	17740	2.68

Appendix I: CERC Modelling Data Review

TECHNICAL NOTE

Job Name: Elmbridge 2020 Local Air Quality Management

Job No: 47763

Note No: TN001

Date: December 2019

Prepared By: Laura Smart

Subject: **CERC Modelling Review**

1. Introduction

1.1. Peter Brett Associates, now part of Stantec, has been commissioned by Elmbridge Borough Council (EBC) to undertake a review of air quality modelling data in order to advise on any potential new Air Quality Management Areas (AQMAs) and monitoring locations that might be required within the Borough. EBC currently has seven declared AQMAs: Walton-on-Thames High Street, Weybridge High Street, Hampton Court, Cobham High Street, Hinchley Wood, Esher High Street and Walton Road, Molesey.

1.2. Surrey-wide detailed air quality modelling has been carried out by Cambridge Environmental Research Consultants (CERC) in order to determine predicted nitrogen dioxide (NO_2), and particulate matter (PM_{10} and $PM_{2.5}$) concentrations across Elmbridge and the wider Surrey area. Contour maps of predicted concentrations in 2017 across Elmbridge have been provided by CERC and have been used to inform this review.

1.3. This technical note provides a review of predicted concentrations across Elmbridge and compares these against the National Air Quality Objectives ('the objectives') in order to identify areas of potential exceedances. Locations where additional diffusion tube monitoring is required to further investigate potential exceedances have been identified and any new potential AQMAs have been highlighted.

2. Review of Predicted Concentrations

Nitrogen Dioxide (NO_2)

2.1. The contour maps for predicted annual mean NO_2 and the 99.79th percentile of hourly mean NO_2 concentrations show exceedances of the annual mean NO_2 objective (40 µg/m^3) and hourly mean NO_2 objective concentration (200 µg/m^3) on: the M25 in Downside; the A3 Portsmouth Road in Cobham; the A3 Esher Bypass in Esher; the A245 Byfleet Road in Byfleet; and the A245 Portsmouth Road/Between Streets in Cobham. These exceedances have been identified outside of any of the existing seven AQMAs in Elmbridge. Exceedances of the annual mean NO_2 objective were also identified in the existing Esher AQMA, along the A307 High Street. No exceedances of the annual or hourly mean NO_2 objectives were identified in the remaining six AQMAs in Elmbridge.

Particulate Matter (PM_{10})

2.2. The contour map for the predicted annual mean PM_{10} concentrations shows no exceedances of the annual mean PM_{10} objective (40 µg/m^3) in Elmbridge. The contour map for the 90.41st percentile of 24-hour mean PM_{10} concentrations shows exceedances of the 24-hour mean concentration (50 µg/m^3) along the A3 Portsmouth Road and the M25.

$PM_{2.5}$

2.3. The contour map for the predicted annual mean $PM_{2.5}$ concentrations shows no exceedances of the annual mean $PM_{2.5}$ objective (25 µg/m³) in Elmbridge.

3. Potential AQMAs

3.1. AQMAs are required where there are exceedances of the objectives in an area of relevant public exposure. Relevant exposure includes locations where members of the public are likely to be present over the averaging period of the objective.

3.2. Predicted exceedances of the 24-hour mean PM_{10} objective have been identified along the A3 and M25; however, these exceedances occur within the road and are therefore not representative of relevant exposure.

3.3. In relation to NO_2, the A3 at the A245 Portsmouth Road junction and the A245 Portsmouth Road/Between Streets roundabout in Cobham, and the A245 Byfleet Road/Brooklands Road roundabout in Byfleet, have been identified as areas where there are predicted exceedances of the objectives in the vicinity of relevant exposure. Furthermore, potential exceedances of the NO_2 objectives have also been identified at the A3 Esher Bypass at the A244 Copsem Lane junction in Esher.

3.4. Further monitoring is therefore required in order to determine whether or not the predicted exceedances of the annual and hourly mean NO_2 objectives actually occur at these locations.

4. Proposed Monitoring Locations

4.1. The following table provides the details of monitoring locations required to investigate potential exceedances of the NO_2 objectives, and therefore to determine whether further AQMA(s) should be designated. Proposed monitoring locations are shown in **Figure 1**.

Label	Location Description	X	Y
Byfleet A245	Lamp post next to 'Parvis Road' road sign, Brooklands Road/Byfleet Road roundabout	507158.2	161338.5
Cobham A245 1	Lamp post outside 41, A245 Portsmouth Road, Cobham	510262.1	160454.3
Cobham A245 2	'No Loading' road sign outside Fieldgate Court, A245 Between Streets	510300.8	160375.3
Cobham A245 3	69, A245 Portsmouth Road, Cobham	510325.6	160415.6
Cobham A3 1	Railings on footpath adjacent to A3 eastbound off-slip at A245 Portsmouth Road	509491.5	160659.8
Cobham A3 2	'No Entry' sign, A3 eastbound off-slip, at A245 Portsmouth Road	509532.7	160688.8
Cobham A3 3	Lamp post outside West Lodge, A245 Portsmouth Road	509623.0	160616.4
Esher A3	Lamp post at northern end of 'Sunrise of Esher' carpark, A245 Portsmouth Road/Esher Bypass junction	514034.0	162281.8

5. Conclusions

5.1. Contour maps of predicted concentrations of NO_2, PM_{10} and $PM_{2.5}$ across Elmbridge, provided by CERC, have been reviewed and compared against the relevant objectives.

5.2. The review has highlighted areas where potential exceedances of the annual and hourly mean NO_2 objective may occur in the vicinity of relevant exposure, outside of the existing AQMAs declared in Elmbridge Borough Council's administrative area. There are no exceedances of the PM_{10} and $PM_{2.5}$ objectives in the vicinity of relevant exposure.

5.3. Additional monitoring locations are proposed in order to further investigate potential exceedances of the NO_2 objectives and to inform the declaration of any new AQMAs in Elmbridge.

Appendix A Figure

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
47763/3001/TN001	-	16/12/2019	LS	KH	KH	ER

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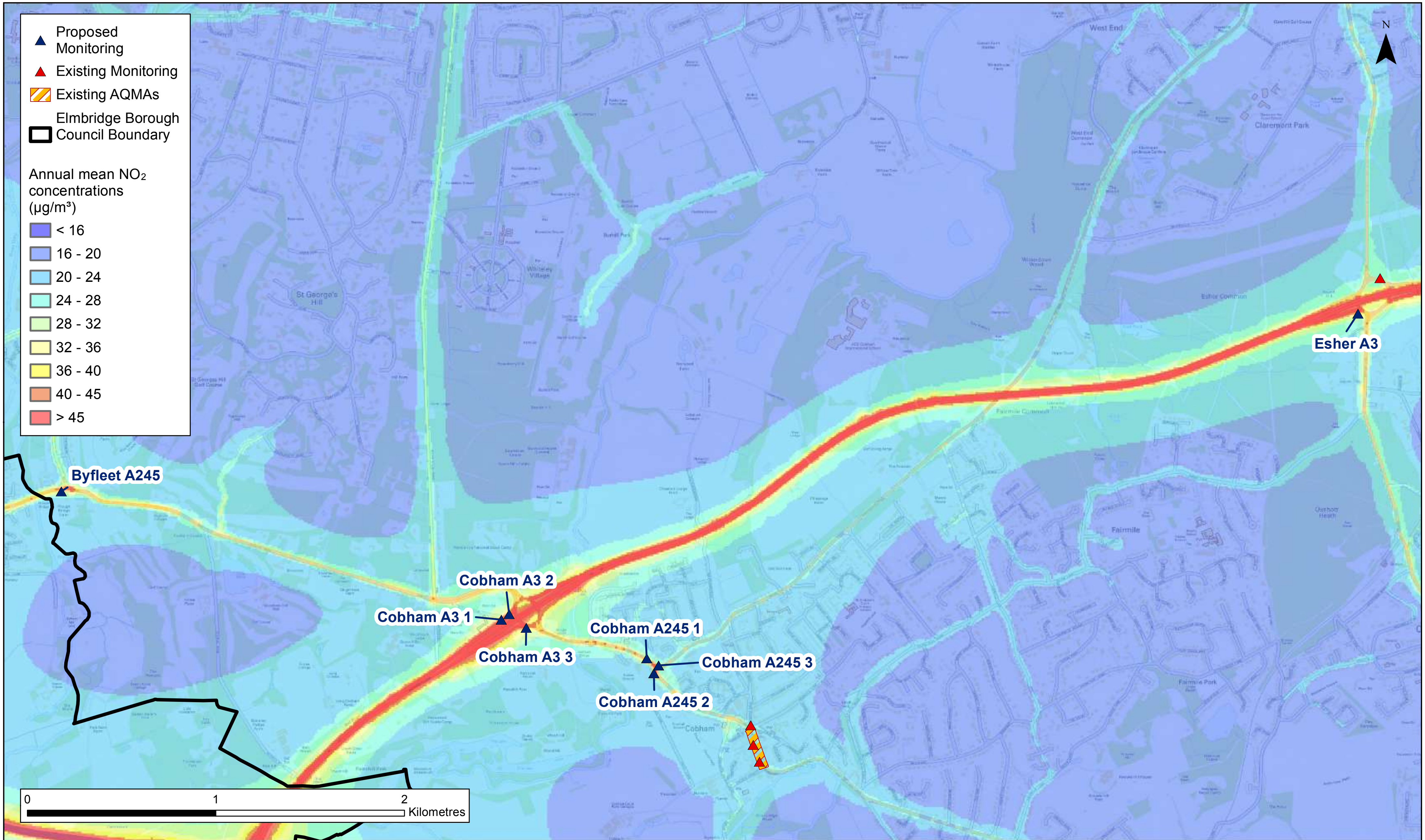

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Proposed Monitoring Locations

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Drawn: LS	Checked: KH
Figure 01	Rev A

Appendix J: Diffusion Tube Review

TECHNICAL NOTE

Job Name: Elmbridge 2020 Local Air Quality Management

Job No: 47763

Note No: TN002

Date: March 2020

Prepared By: Laura Smart

Subject: **Diffusion Tube Review**

1. Introduction

1.1. Stantec has been commissioned by Elmbridge Borough Council (EBC) to undertake a review of the Council's nitrogen dioxide (NO_2) diffusion tube monitoring sites to advise on any sites no longer required or where existing sites should be amended/relocated. A total of fifty diffusion tubes are currently deployed across the Borough.

1.2. The following factors have been considered in the review of diffusion tube locations:

- measured annual mean NO_2 concentrations;
- representativeness of relevant human exposure;
- whether the tubes are in a worst-case location; and
- the suitability of the monitoring site (e.g. air circulation, surrounding vegetation, etc).

1.3. The review takes into account guidance produced by the Working Group commissioned by DEFRA and Devolved Administrations[1] and Local Air Quality Management Technical Guidance (LAQM TG.16) produced by DEFRA[2].

2. Review of Tube Locations in Air Quality Management Areas (AQMAs)

Esher High Street AQMA

2.1. Esher 10 is not considered to be in a worst-case location as congestion is apparent at the southern end of the A244 Esher Green where it meets the A307 High Street. As there is relevant exposure in close proximity to this junction, it is recommended that the Esher 10 monitoring site is relocated to a position closer to the junction (**Figure 1**) to ensure worst-case concentrations are measured in the AQMA. Where diffusion tubes are relocated, it is recommended that the site is given a new name to avoid confusion when interpreting the monitoring data.

2.2. Esher 1 and Esher 8 are located in close proximity to each other on building façades on the east and west side of Church Street. However, neither one of these locations measures consistently higher concentrations than the other; for example, concentrations at Esher 8 were higher than those at Esher 1 in 2019, and vice-versa in 2018. As a result, it is not clear which of these locations is worst-case, and as they are both representative of relevant exposure, they should therefore both be retained.

[1] AEA Energy and Environment (2008). 'Diffusion Tubes for Ambient Monitoring: Practical Guidance for Laboratories and Users'. Issue 1A.
[2] DEFRA (2018). 'Local Air Quality Management Technical Guidance (TG16)'. V1.

2.3. The remaining diffusion tube locations within the Esher High Street AQMA are considered suitable and should be retained.

Walton-on-Thames High Street AQMA

2.4. Since monitoring began in the Walton-on-Thames High Street AQMA, new residential exposure has been introduced on the High Street, adjacent to the A244 New Zealand Road/Ashley Road junction. This represents a worst-case location in the AQMA due to the influence of road traffic emissions from several combined roads at the junction, as well as reduced speeds. It is therefore recommended that a new diffusion tube monitoring site is deployed, or Walton 3 is relocated closer to the junction (**Figure 2**). If Walton 3 is relocated, it should be renamed to avoid confusion.

2.5. The remaining diffusion tube locations within the Walton-on-Thames High Street AQMA are considered suitable and should be retained.

Weybridge High Street AQMA

2.6. Weybridge 9 is not considered to be representative of worst-case exposure as it is located significantly further back from the road than other residential properties in the area and measured concentrations have been well below the National Air Quality Objective (NAQO) for several years. As worst-case exposure is already captured at other monitoring sites in the AQMA in close proximity to Weybridge 9, it is considered that this monitoring site can be removed.

2.7. Monitoring is currently not undertaken adjacent to the Baker Street junction on Weybridge High Street. This is considered to be a worst-case location in the AQMA due to congestion and the combined effect of road traffic emissions from Baker Street and the High Street. Measured concentrations at Weybridge 1 have been below the NAQO for a number of years and therefore it is considered that this location could be relocated (and renamed) further down the road, closer to the Baker Street junction (**Figure 3**).

2.8. The remaining diffusion tube locations within the Weybridge High Street AQMA are considered suitable and should be retained.

Hinchley Wood AQMA

2.9. Hinchley Wood 2 appears to be enclosed by vegetation and Working Group guidance states that vegetation over-hanging or surrounding diffusion tube monitoring sites must be avoided so that air can circulate freely around the tube[1]. As Hinchley Wood 1 is closer to the road and therefore worst-case, it is considered that Hinchley Wood 2 can be removed.

2.10. However, it is recommended that an additional monitoring location is deployed at (or Hinchley Wood 2 relocated to) the southern end of the AQMA, adjacent to the A309 Kingston Bypass/Manor Road junction (**Figure 4**). As a result of the combined effect of road traffic emissions at the junction, as well as congestion and reduced speeds, concentrations at this location are likely to be higher than those currently measured elsewhere in the AQMA. In addition, there is relevant exposure in close proximity to the junction.

Walton Road, Molesey AQMA

2.11. The diffusion tube sites in the Walton Road AQMA have been reviewed and are considered suitable. Monitoring at these sites should therefore continue.

Cobham High Street AQMA

2.12. The diffusion tube sites in the Cobham High Street AQMA have been reviewed and are considered suitable. Monitored concentrations at the monitoring sites in the AQMA support the revocation of the AQMA as they have been more than 10% below the annual mean NO_2 NAQO for four years. Monitoring on Cobham High Street should be continued following the revocation of the AQMA, to enable any deterioration in air to can be responded to quickly.

Hampton Court AQMA

2.13. The diffusion tube sites in the Hampton Court AQMA have been reviewed and are considered suitable. Monitoring at these sites should therefore continue.

3. Review of Tube Locations outside of an AQMA

3.1. Existing diffusion tube locations outside of the seven AQMAs have also been reviewed. It is considered that monitoring at the following sites can be discontinued:

- Walton 5 due to consistently low measured annual mean NO_2 concentrations which are well below the NAQO.
- Esher 5 as it is not representative of relevant exposure, and nearby monitoring has been introduced in 2020 (Esher 14) which is more representative and worst-case.
- Esher 4 is currently located approximately 25 m northeast of the Esher High Street AQMA boundary and annual mean NO_2 concentrations at this site have been more than 10% below the NAQO for several years.
- Downside 3 due to consistently low measured annual mean NO_2 concentrations which are well below the NAQO.

4. Summary and Conclusions

4.1. The current diffusion tube monitoring sites across the Council's administrative area have been reviewed.

4.2. A number of diffusion tube sites have been recommended for removal or amendment. A summary of these changes is provided in the table below. It is recommended that monitoring at the other sites is continued.

Site ID	Recommendation Summary
Esher 4	To be removed.
Esher 5	To be removed.
Esher 10	To be relocated closer to the A244 Esher Green/A307 High Street junction.
Walton 3	To be relocated closer to the High Street/A244 New Zealand Road junction.
Walton 5	To be removed.
Weybridge 9	To be removed.
Weybridge 1	To be relocated closer to the High Street/Baker Street junction.

Site ID	Recommendation Summary
Hinchley Wood 2	To be relocated closer to the A309 Kingston Bypass/Manor Road junction.
Downside 3	To be removed.

4.3. In relation to timescales, it is recommended that the above amendments are made as soon as reasonably practicable.

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
47763/3002/TN002	Draft	March 2020	LS	KH	KH	SB

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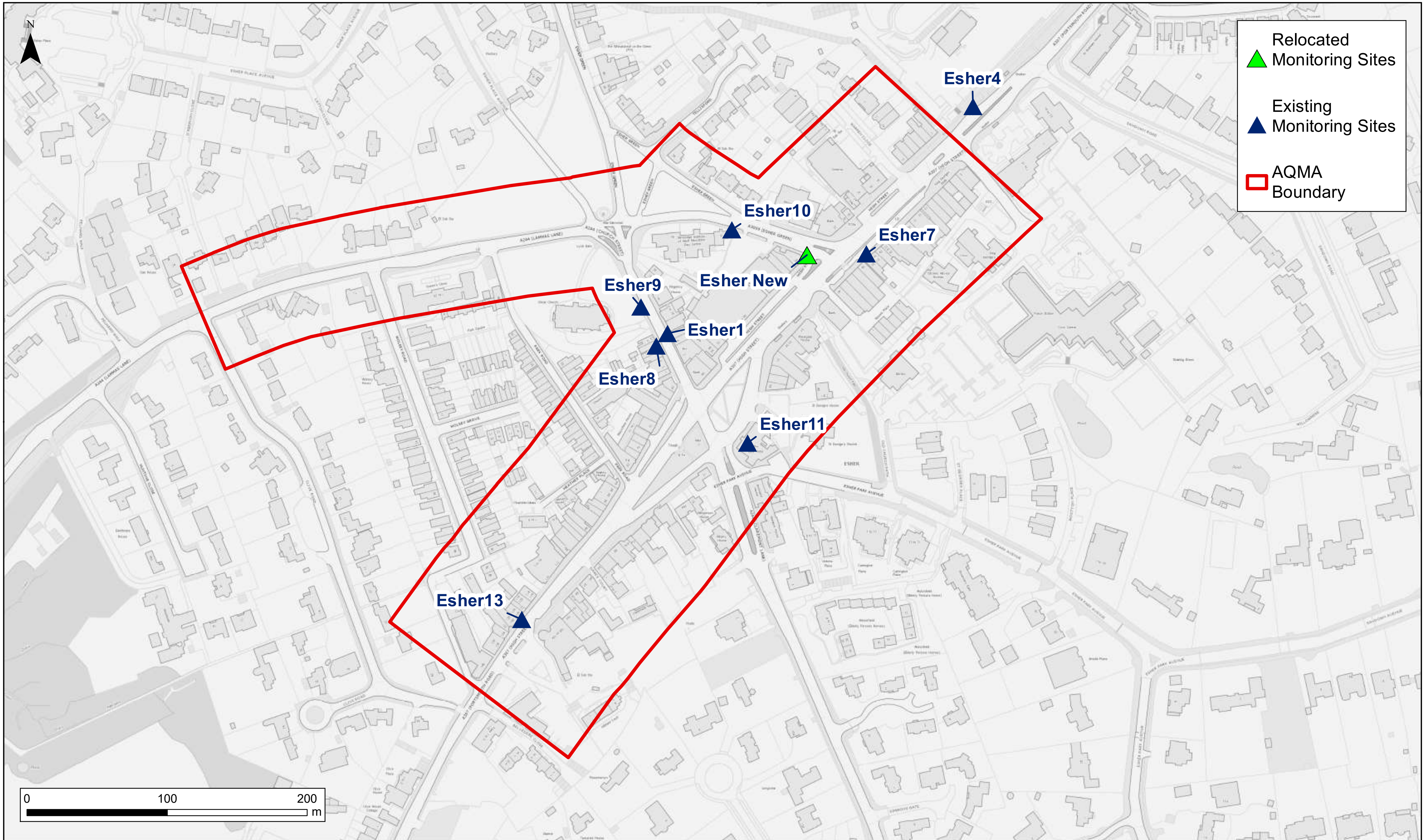

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Diffusion Tube Review - Esher High Street AQMA

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Figure 1	Rev A

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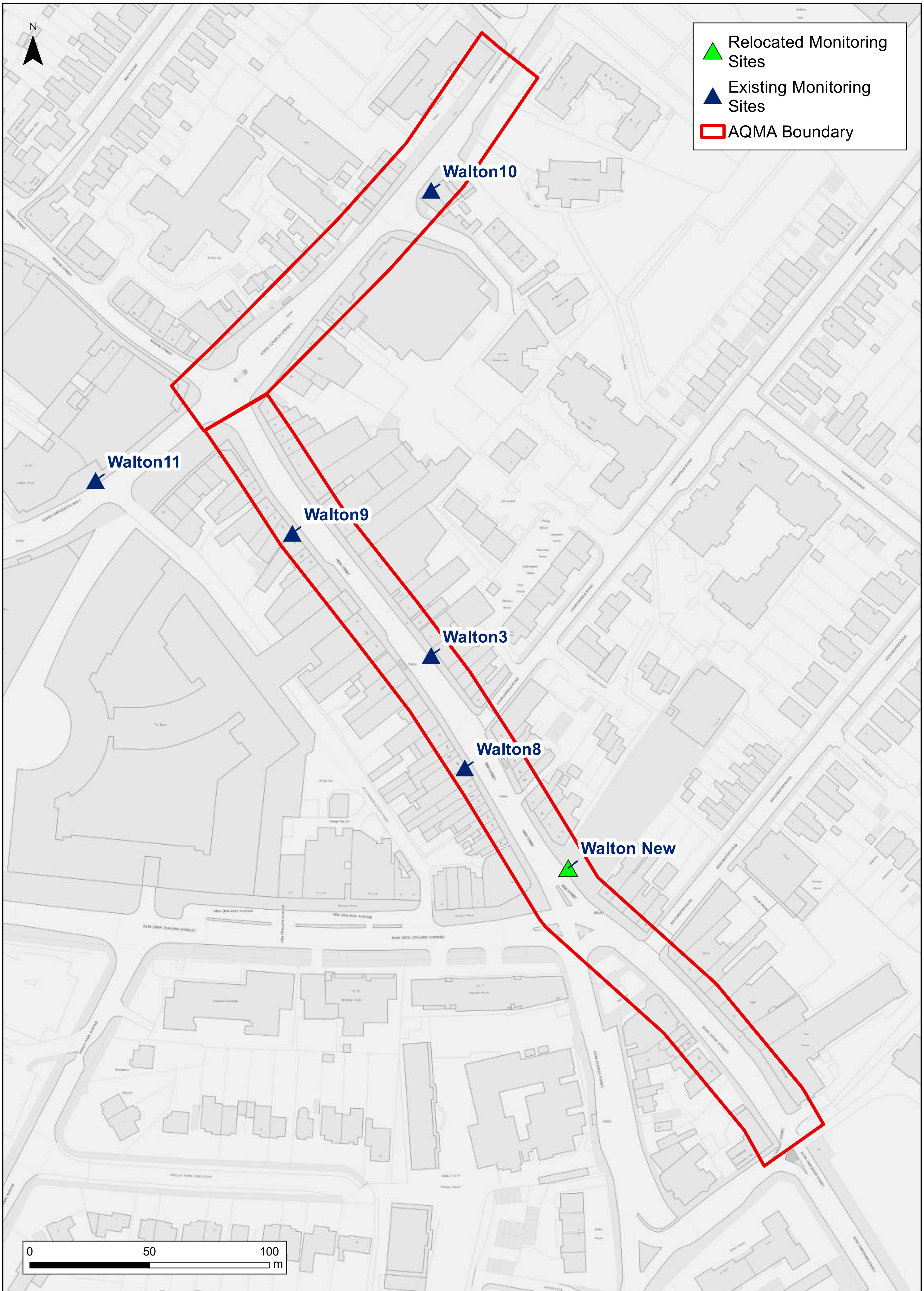

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Diffusion Tube Review - Walton-on-Thames High Street AQMA

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Figure 2	Rev A

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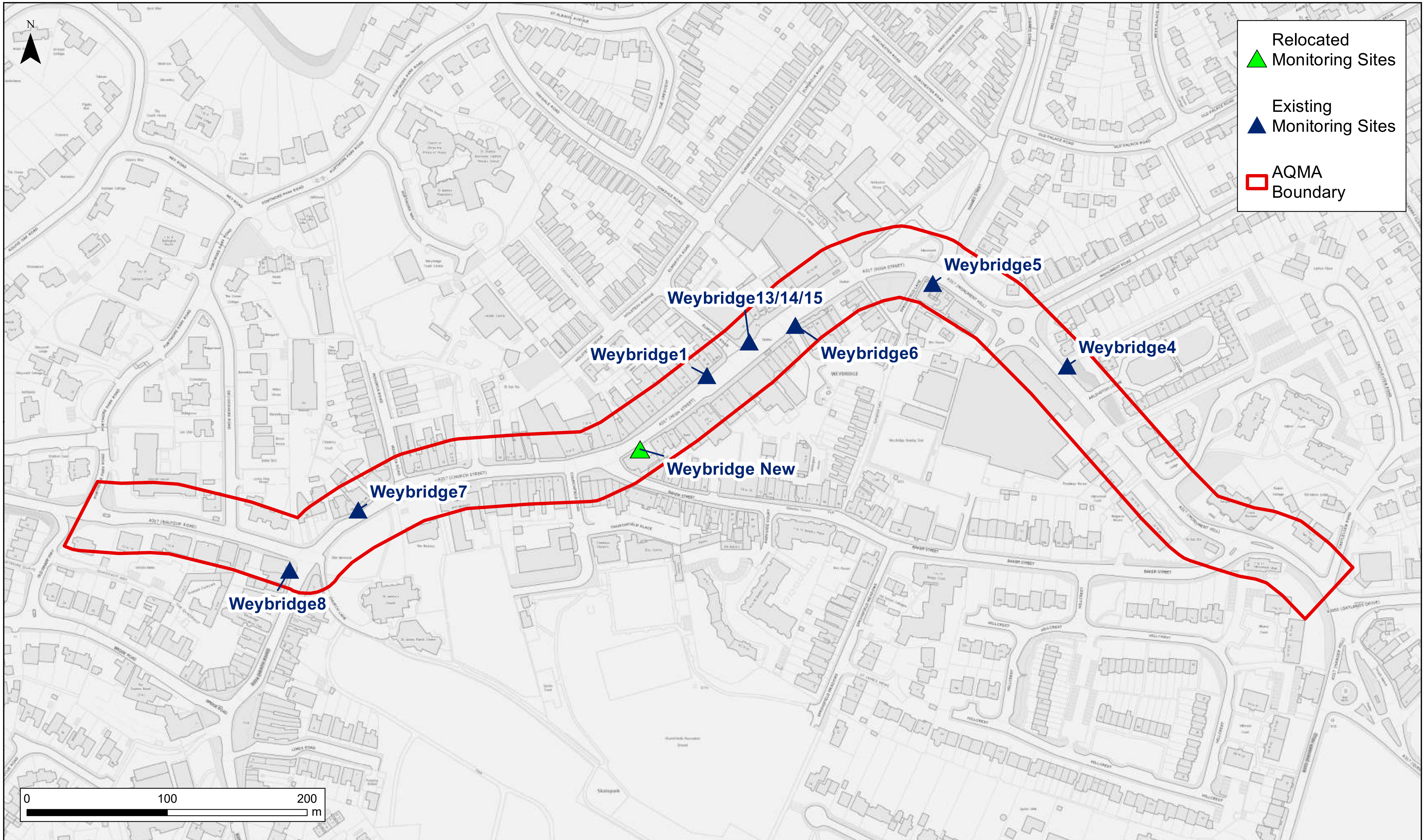

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Diffusion Tube Review - Weybridge High Street AQMA

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Figure 3	Rev A

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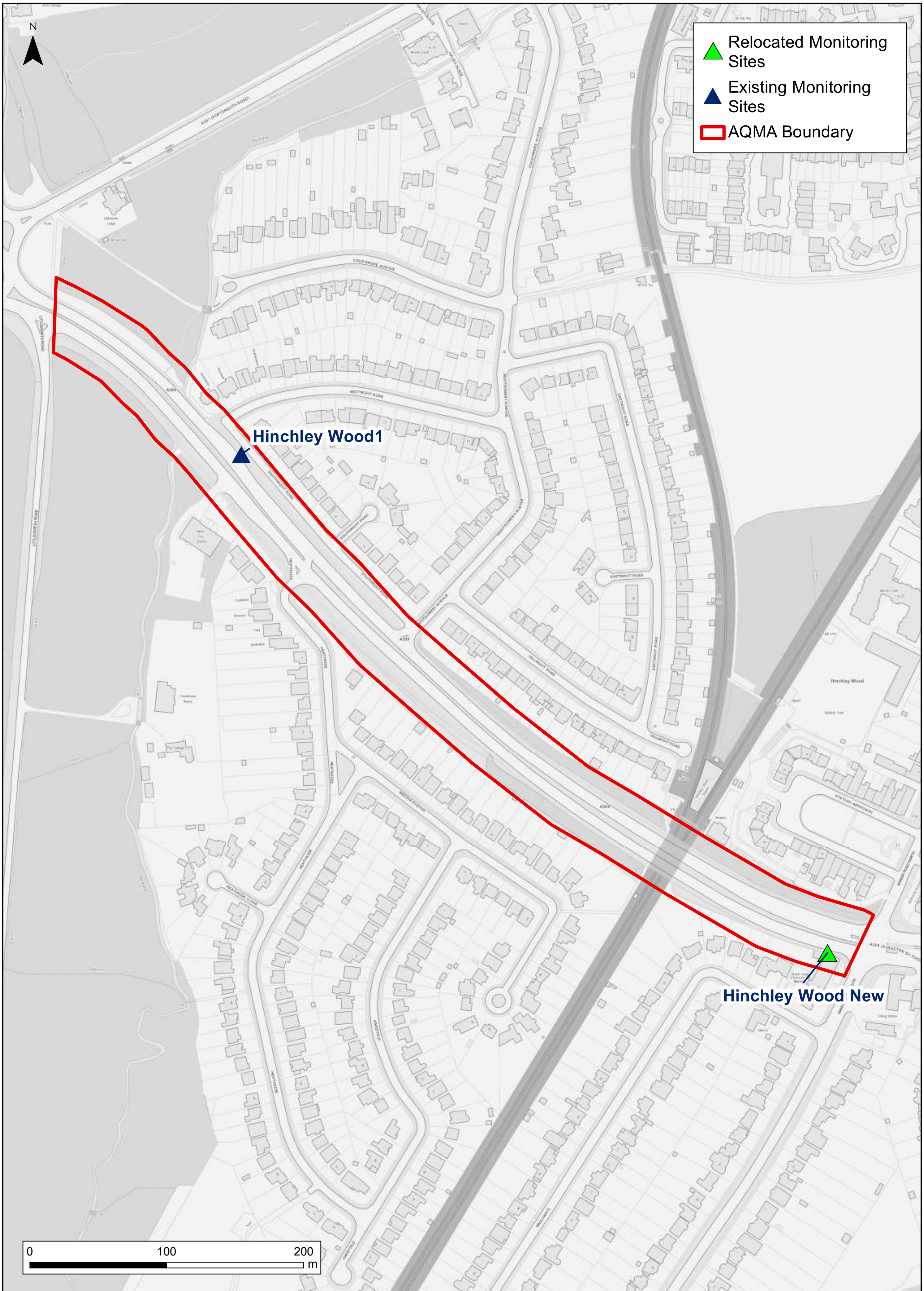

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Diffusion Tube Review - Hinchley Wood AQMA

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Figure 4	Rev A