2011 Detailed Assessment for London Borough of Lewisham

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

February 2011

CERC

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Executive Summary

This Detailed Assessment report is presented to comply with requirements of the Local Air Quality Management regulations.

The Detailed Assessment is carried out as a result of the findings of the most recent Updating and Screening Assessment (USA), published in June 2009. The purpose of this assessment is to provide more information on exceedences outside of the existing AQMAs and potential exceedences along busy, congested streets identified in the USA.

Conclusions from monitoring data

Brockley Road

There are no diffusion tubes located on Brockley Road. Diffusion tube LWS015 is located very close to the northernmost point of Brockley Road, on Shardloes Road. This monitor, along with a section of Brockley Road, already falls within AQMA 3.

Brockley Rise

Diffusion tube LWS009 is located on Brockley Rise, and represents relevant exposure. The annual average NO_2 concentration in 2009 is 48 $\mu g/m^3$ (calculated using the local bias-adjustment factor) and 57 $\mu g/m^3$ (based on the national bias-adjustment factor). Both values are well above the objective value. The tube is located close to the junction with the A205 (South Circular road).

Honor Oak Park

There are no monitors located on or around Honor Oak Park.

Perry Vale

There are no roadside monitors along Perry Vale, and the nearest diffusion tube to this road is SCH013, which is located in the grounds of Christchurch School. The diffusion tube is located on the school boundary, approximately 5m from the kerbside. The tube's location is in line with or closer to the kerb than the property facades along this road and therefore it represents a worst case scenario.

The annual average NO_2 concentration at SCH013 in 2009 is 26 $\mu g/m^3$ (calculated using the local bias-adjustment factor) and 31 $\mu g/m^3$ (based on the national bias-adjustment factor). Both values are well below the objective value.

Conclusions from modelling study

The dispersion modelling predicts exceedences of the annual average NO_2 objective (and also the hourly average NO_2 objective) around many of the assessed roads. The following sections discuss the areas of exceedence of the annual average objective for each of the roads, and a summary of the resulting relevant population exposure.

Brockley Road

The modelling for 2011 predicts significant areas of exceedence of the annual average NO_2 objective around Brockley Road. The worst affected areas are those around junctions and street canyons, but there are exceedences along the whole length of the road, occurring in areas of relevant exposure, with an estimated 1,900 people being affected on Brockley Road itself, and a further 400 people affected along Stondon Park.

Predicted annual average NO_2 concentrations at building facades along the stretch of Brockley Road between Hazeldon Road and Holdenby Road are around 110 $\mu g/m^3$. Although this section of Brockley Road is a shopping area, with retail premises on the ground floor, there are residential properties on the first floor. This section of Brockley Road does not fall within AQMA 3, or any of the other AQMAs.

Brockley Rise

The modelling predicts significant areas of exceedence of the annual average NO_2 objective around Brockley Rise. The worst affected area is that at the far south of the road, close to the junction with the A205 (South Circular road), with predicted concentrations at building façades of up to 60 $\mu g/m^3$. The areas of exceedence represent relevant exposure, with an estimated 400 people being affected.

Honor Oak Park

There are areas of predicted exceedence around Honor Oak Park, but there is less relevant exposure than at Brockley Road and Brockley Rise, with around 150 people expected to be affected. The highest predicted concentrations at locations of relevant exposure are around 52 $\mu g/m^3$.

Perry Vale

Predicted concentrations do not exceed the objective of 40 $\mu g/m^3$ around Perry Vale, except for along a very small section at the most northerly point, at the junction with the A205 (South Circular Road). At all points except for this small section, the concentrations are well below the 40 $\mu g/m^3$ limit value, even those occurring within the road carriageway. This suggests that is very little risk of the NO_2 annual average objective being exceeded at relevant public exposure locations, and, as a result, the number of people exposed in an area of exceedence is zero for Perry Vale.

Mayow Road

The identification in the 2009 Updating and Screening Assessment of Mayow Road as a congested road, requiring Detailed Assessment, appears to be an anomaly; this conclusion appears to have been based on incorrect interpretation of the location of a traffic screenline count, which had been described as 'Kirkdale / Sydenham Road / Mayow Road'. The location at which the traffic count is carried out is actually on Sydenham Road, between the junctions with Kirkdale and Mayow Road; Sydenham Road is already part of an AQMA.

Mayow Road is not generally known to be a busy, congested road. It is not included in the LAEI, and no traffic flow data could be obtained for this road in order to model it explicitly.

For the reasons described above, Mayow Road was not included in this Detailed Assessment. Although there is congestion at the junction of Mayow Road and Sydenham Road, this is confined to a very small section of Mayow Road, and the exposure to higher concentrations is likely to only extend a few metres back from the junction. A diffusion tube has been located a few metres north of the junction, and can be used to assess the NO_2 concentrations at this location in the future.

Proposed actions

The proposed actions recommended as a result of the findings of this Detailed Assessment are described below.

Based on the findings within the Detailed Assessment, there are exceedences of the NO_2 annual average and hourly objectives occurring outside the existing AQMAs and at locations where there is relevant exposure.

The exceedences of the annual average NO_2 objective (and also the hourly average NO_2 objective) occur at residential properties along the modelled roads of Brockley Road, Stondon Park, Brockley Rise and Honor Oak Park. There is a need, therefore, to amend the current designation of the AQMAs within Lewisham. Given the current arrangement of AQMAs, there are several options for this.

Since the aforementioned areas of exceedence are for NO_2 only, and the existing AQMAs are designated for both NO_2 and PM_{10}, the best option appears to be to declare a new AQMA. This would be named AQMA 6, and designated for NO_2. This could either incorporate the areas of exceedence, in the form of ribbon-roads, as adopted for the existing AQMA 5, or be area-based, as adopted for the existing AQMAs 1 to 4. An area-based AQMA 6 would cover the whole Crofton Park ward.

The council should continue to monitor at strategic locations where the modelling shows that exceedences are likely to occur. The diffusion tube network within Lewisham has been extended as of January 2011, with a new tube being located at

the junction of Honor Oak Park and the B218. The results from this diffusion tube should be considered in future assessments.

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1 Introduction

1.1 Purpose of the Detailed Assessment

An Updating and Screening Assessment (USA) was carried out in 2009 by the Environmental Research Group at King's College London, on behalf of the London Borough of Lewisham. This assessment identified that a Detailed Assessment was required for nitrogen dioxide.

The LAQM Policy Guidance, 2009 (PG(09)) states that a Detailed Assessment is 'required where an air quality objective is, or is likely to be, exceeded outside an existing air quality management area and there is relevant exposure, or where a significant amendment or revocation of the air quality management order is required'. The need for a Detailed Assessment is indicated through a USA. Once the risk of exceeding the objectives has been identified in the USA, the Detailed Assessment allows this to be investigated in more detail, ultimately informing decisions on declaring, amending or revoking AQMAs.

The specific purpose of this Detailed Assessment is to address the conclusions of London Borough of Lewisham's 2009 USA. This identified roads at which the NO_2 annual average objectives were at risk of being exceeded, based on two different methods: analysis of monitoring data; and the assessment of sources.

Based on the analysis of monitoring data, the USA concluded that the Borough should undertake a Detailed Assessment for Brockley Rise which, as a result of the findings of monitoring at the LWS09 diffusion tube site, was found to exceed the annual mean NO_2 objective at a relevant location in 2008.

Based on the assessment of sources, the USA also concluded that there are roads outside the existing AQMAs that fit the new TG(09) guidance criteria for congested roads, which should also be investigated in the Detailed Assessment. The roads named were Perry Vale, Mayow Road and Brockley Road.

Cambridge Environmental Research Consultants Ltd (CERC) was commissioned by the Borough to carry out the Detailed Assessment for these roads. This Detailed Assessment forms part of the fourth round of Review and Assessment of Air Quality, and follows the latest prescribed guidance given in LAQM.TG(09).

The identification of Mayow Road as a congested road requiring Detailed Assessment appears to be an anomaly, based on incorrect interpretation of the location of a traffic screenline count, which had been described as 'Kirkdale / Sydenham Road / Mayow Road'. The location at which the traffic count is carried out is actually on Sydenham Road, between the junctions with Kirkdale and Mayow Road; Sydenham Road is already part of an AQMA.

Mayow Road is not generally known to be a busy, congested road. It is not included in the LAEI, and no traffic flow data could be obtained for this road in order to model it explicitly.

For the reasons described above, Mayow Road was not included in this Detailed Assessment. Although there is congestion at the junction of Mayow Road and Sydenham Road, this is confined to a very small section of Mayow Road, and the exposure to higher concentrations is likely to only extend a few metres back from the junction. A diffusion tube has been located a few metres north of the junction, and can be used to assess the NO_2 concentrations at this location in the future.

Dispersion modelling carried out by CERC as part of a separate study identified a further road that appeared to be at risk of exceeding the NO_2 annual average objective. This road, Honor Oak Park, has therefore been included in this Detailed Assessment.

Air quality modelling, using ADMS-Urban, was used to investigate the resulting four roads (Brockley Rise, Brockley Road, Perry Vale and Honor Oak Park), taking into account the new London Atmospheric Emissions Inventory (LAEI) and Department for Transport (DfT) traffic emission factors.

The model was first verified for the year 2009, by comparing modelled and monitored concentrations at the location of one continuous monitor and 15 diffusion tube locations. Once good agreement at monitor locations was established, giving confidence in the model set-up and therefore lending confidence to the predictions for future years, ground level concentrations were calculated for the year 2011.

1.2 Description of Local Authority Area

The London Borough of Lewisham is situated in southeast London. It is bordered to the west by Southwark, to the east by Greenwich and Bromley to the south. It has a small frontage on to the River Thames in the north. It is an inner London Borough comprising a densely populated area with an estimated population in 2010 of approximately 261,600. The Borough is mostly residential with areas of employment around the main commercial centres of Lewisham, New Cross, Catford, Deptford and Sydenham. However, compared to other London boroughs, Lewisham is relatively green with approximately one fifth of the borough being open space. The Borough has a broad socio-economic range combining a mix of wealthier wards and wards with more concentrated areas of deprivation. Some of the most deprived wards are New Cross, Evelyn, Deptford and Downham. In these areas health and the quality of housing are poorer.

The main sources of air pollutants are the busy and congested roads. Only 31% of the borough workforce is employed in the borough (Lewisham Employment Land Study, 2008) with the majority travelling outside the borough to work (2001 Census). 70 per cent of local people commute out of Lewisham to work, mainly to other parts of London but private vehicle ownership is relatively low. The main roads that run through the Borough include the A2, A20, A21 and the South Circular (A205). There are currently 74 minor industrial processes that are regulated by the Council and one Part A installation (SELCHP) regulated by the Environment Agency.

1.3 Description of Detailed Assessment area

The four roads that require assessment are towards the south west of the Borough of Lewisham. Brockley Rise, Brockley Road and Honor Oak Park lie immediately north of the South Circular road (the A205) and Perry Vale is just to the south of the South Circular road.

Brockley Rise and Brockley Road together form part of the B218 road. Note that there is an additional section of Brockley Rise, which is not part of the busy B218, but instead is a quieter section of street, not represented within the LAEI, and has therefore not been included in the modelling. For the purposes of this Detailed Assessment, 'Brockley Rise' will be taken to mean the section of the Brockley Rise that makes up the B218 only. A small section of the B218, between Brockley Rise and Brockley Road, is called Stondon Park; this has been included in the modelling.

Honor Oak Park is one of the sections of the B238, which forms a junction with the B218 at the Stondon Park section. Perry Vale (along with Perry Rise) is the B227 road.

The locations of the four roads within the borough are shown in Figure 1.1, and in greater detail in Figure 1.2. Note that, in these figures, the Stondon Park section of road has not been highlighted, to better distinguish between the different road sections under assessment. The locations of the roads with respect to existing AQMAs in the Borough are described in Section 1.5.

Figure 1.1: General location of the roads identified for the Detailed Assessment

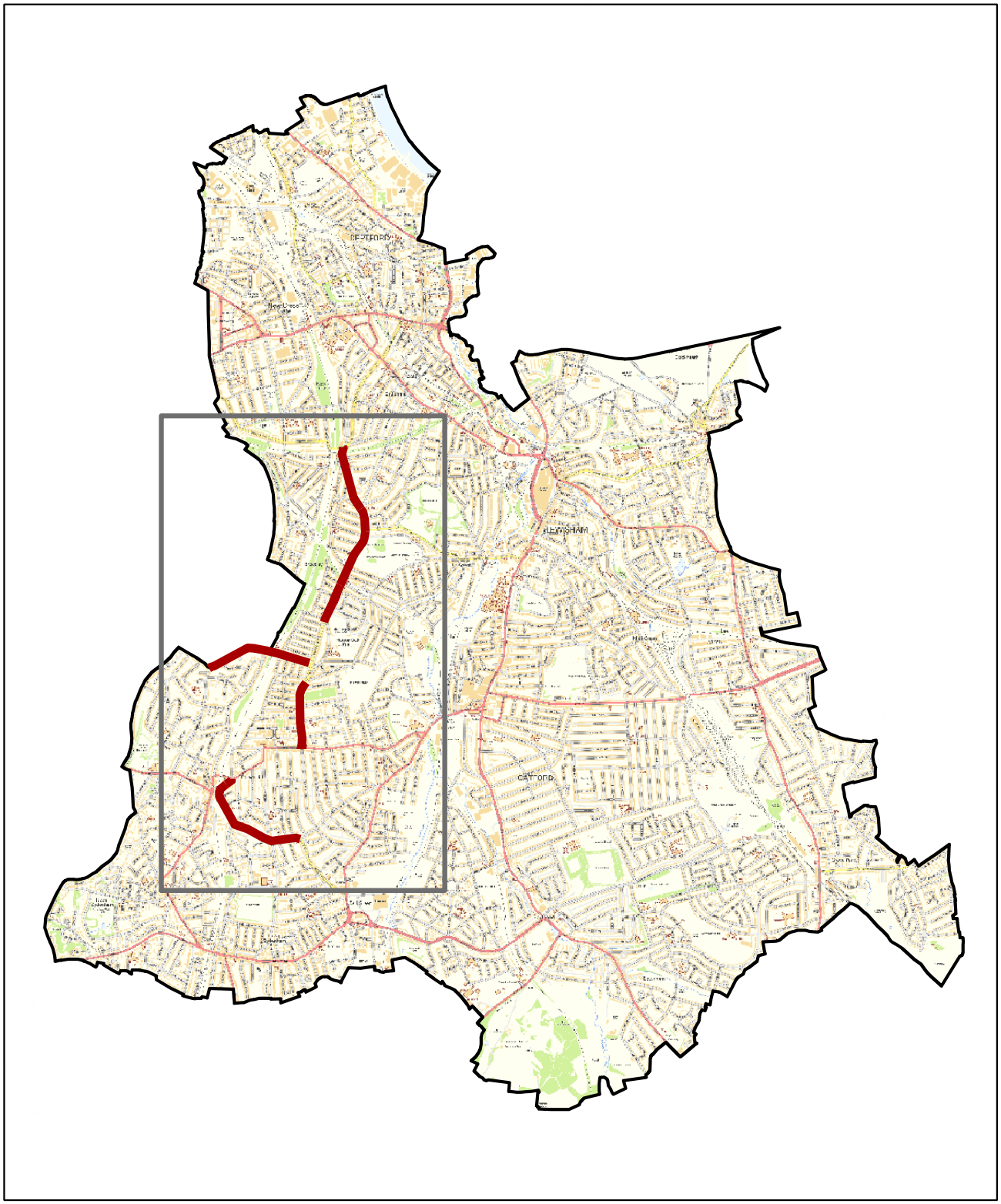

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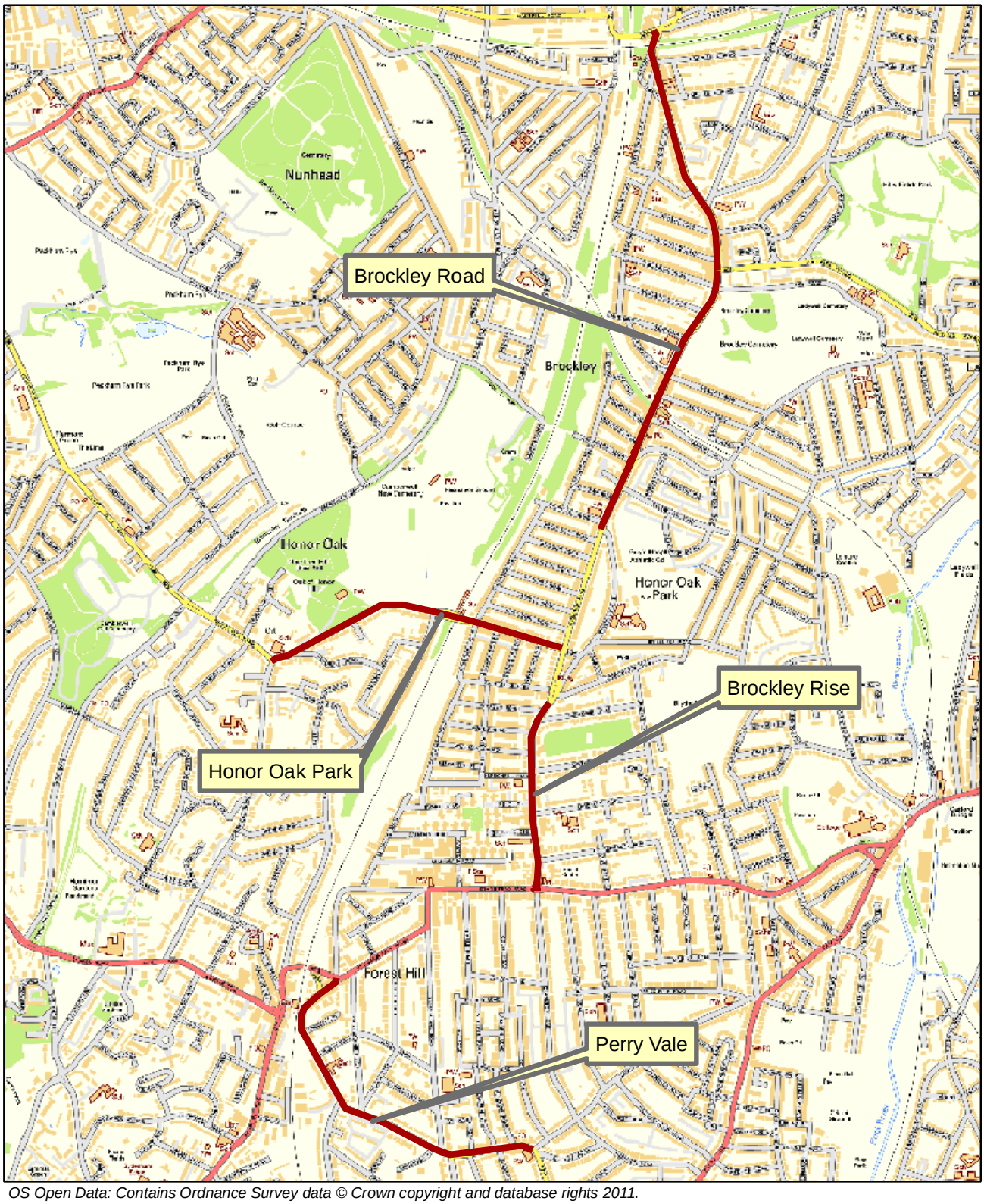
Figure 1.2: Specific locations of the roads identified for the Detailed Assessment



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0 200 400 800 1200 1600 2000 Metres

1.4 Summary of previous Review and Assessments

The Council undertook previous rounds of review and assessment of air quality in line with the system of Local Air Quality Management reporting requirements. The main issue following the first round, with respect to local air quality, was found to be emissions (NO_2 and PM_{10}) emanating from road vehicles. As a result, the Council designated Air Quality Management Areas in parts of the Borough. These are described in Section 1.5.

The conclusions of the Council's subsequent Review and Assessment reports from 2003 to 2009 were that the designation of AQMAs should remain. These were primarily for exceedences of the annual mean objective for NO_2, but also for the daily mean objective for PM_{10} where there is a smaller area that exceeds.

These earlier reports also identified that the proposed redevelopment of Lewisham could result in increased concentrations and that fugitive emissions from industrial sources in the north of the borough required monitoring.

The USA produced in June, 2009, using the guidance contained in TG(09), included monitoring data that showed exceedences of the annual objective for NO_2 were occurring outside of the existing AQMAs. In addition, changes in the guidance resulted in a further three roads being identified as warranting further investigation.

A Progress Report was submitted in 2010, which, in addition to describing the conclusions of the 2009 USA, summarises the general situation across the Borough with respect to NO_2: 'The annual average objective for nitrogen dioxide (NO_2) continues to be exceeded and often by a wide margin at roadside sites… Both objectives for NO_2 are being met at all background sites where monitoring is being carried out, although only slightly below in some cases'.

A list of the recent reports submitted by London Borough of Lewisham under the system of Local Air Quality Management is provided in Table 1.1.

Table 1.1: Recent AQMA reports submitted by the London Borough of Lewisham

Year	Report
2004	Updating and Screening Assessment
2005	Detailed Assessment
2006	Progress Report
2006	Updating and Screening Assessment
2008	Progress Report
2009	Updating and Screening Assessment
2010	Progress Report

1.5 Air Quality Management Areas

The AQMAs in the Borough are shown in Figure 1.3 and consist of four large AQMAs and a series of ribbon roads (called AQMA 5).

Those AQMAs closest to the area covered by this Detailed Assessment are AQMA 3 and AQMA 5. These are shown in more detail in Figure 1.4, along with the four roads that are the subject of this Detailed Assessment.

Figure 1.4 shows that the northernmost section of Brockley Road is within AQMA 3, and Brockley Rise and Perry Vale have junctions with roads that make up AQMA 5. The eastern section of Honor Oak Park is entirely within Lewisham, and not within an AQMA. However, the western section runs along the border of Southwark, the borough of which is almost entirely designated as an AQMA.

Figure 1.3: Map of Lewisham showing all of the AQMA Boundaries

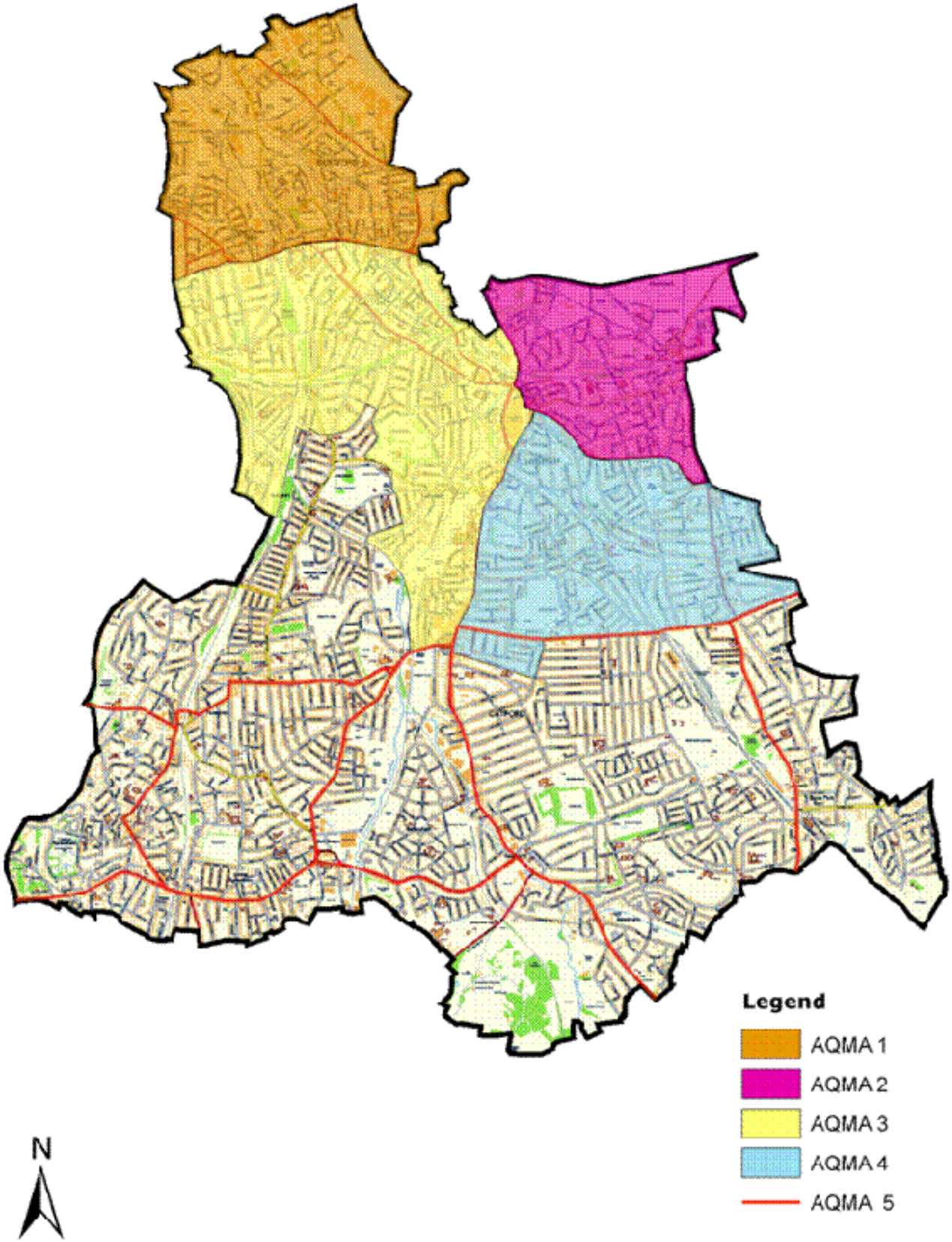
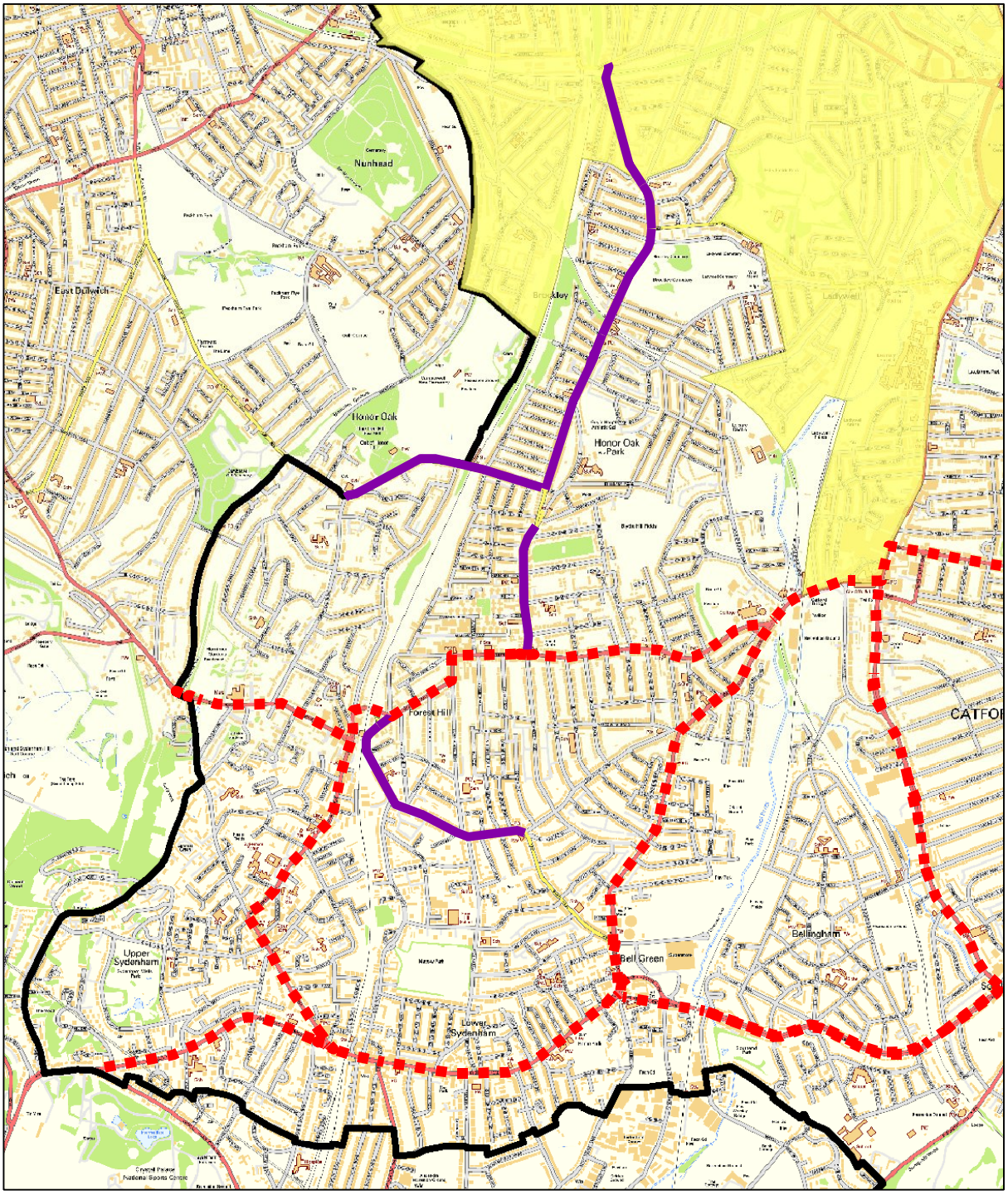


Figure 1.4: Locations of AQMA 3 and AQMA 5 with respect to the Detailed Assessment roads



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1.6 Annual average NO_2 Air Quality Objective

The air quality objectives applicable to Local Air Quality Management (LAQM) in England are set out in the Air Quality (England) Regulations 2000 (SI 928) and the Air Quality (England) (Amendment) Regulations 2002 (SI 3043). This Detailed Assessment concerns the annual average NO_2 objective, shown in Table 1.2.

Table 1.2: UK Air Quality Objective for annual average NO_2

Concentration	Measured as	Date to be achieved by
40 $\mu g/m^3$	Annual mean	31.12.2005

2 Summary of monitors across Lewisham

2.1 Automatic monitoring sites

The Council has undertaken continuous monitoring at three fixed, long-term sites for several years. Two of these sites (Lewisham 1 and Lewisham 2) are owned by the Council. The third site, Crystal Palace 1, was closed on 29th July 2010, but until that date was located on the border of Lewisham and three other neighbouring London boroughs (Southwark, Croydon and Bromley), and jointly owned by the four Boroughs.

At the end of 2009, an additional monitoring station (Lewisham 3) was deployed in the north of the borough at a site identified as being potentially affected by fugitive particulate emissions from nearby industrial processes. Lewisham 3 is therefore classified as an industrial site, and monitors only PM_{10} concentrations.

A map showing the locations of the three automatic monitoring sites within Lewisham is shown in Figure 2.1, with details of sites provided in Table 2.1.

All the above sites are operated to London Air Quality Network (LAQN) standards, which are similar to those of the AURN. The data produced have traceability to national standards and operational procedures defined for the LAQN and are therefore similar to AURN. A contract is in place with King's College Environmental Research Group covering the data collection, validation and ratification as well as to carry out 6-monthly site audits. A contract is also in place with an external provider to carry out the regular servicing and maintenance of the monitoring stations.

Figure 2.1: Automatic monitoring site locations within Lewisham

Table 2.1: Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref		Pollutants Monitored	Monitoring Technique	In AQMA?	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (N/A if not applicable)	Does this location represent worst-case exposure?
Lewisham 1 (Catford Town Hall)	Urban background	537675	173689	NO_2 SO_2 O_3	Chemiluminescent UV fluorescence UV photometer	Y (AQMA3)	Y*	3m	N
Lewisham 2 (New Cross Road)	Roadside	536241	176932	NO_2 SO_2 PM_{10}	Chemiluminescent UV fluorescence TEOM	Y (AQMA3)	Y	6m	Y
Lewisham 3 (Mercury Way)	Industrial	535806	177612	PM_{10}	BAM	Y (AQMA1)	Y	2m	Y
Crystal Palace 1 (Crystal Palace Parade)	Roadside	533901	171290	NO_2 SO_2 PM_{10} CO	Chemiluminescent UV fluorescence TEOM	Y (just outside Borough boundary)	N	2m	Y

** The monitor is located in a shopping precinct in which market stall holders are regularly present. Therefore, there is relevant exposure to all except the annual mean objectives.*

2.2 Non-automatic monitoring

A monitoring survey of nitrogen dioxide, using passive diffusion tubes, was started in 2008.

The survey started with nine sites, plus one triplicate site co-located with the Lewisham 2 continuous monitor. Two of the sites were later relocated, and a further four sites added to this NETCEN network.

In addition, a project to work with various schools in the borough on air quality monitoring was initiated in March 2009. This included siting a diffusion tube at each of the participating schools. The majority of these sites are located in background sites with tubes being located in a mixture of school playgrounds and school boundaries adjacent to residential roads.

The details of the NETCEN and schools networks of diffusion tube sites are given in Tables 2.2 and 2.3, respectively.

Both the NETCEN and schools network of diffusion tubes used are analysed by Gradko International using a preparation method of 50% TEA in water. Gradko International participates in the Workplace Analysis Scheme for Proficiency (WASP), which is an independent analytical performance testing scheme. The scheme is an important QA/QC exercise for laboratories supplying diffusion tubes to Local Authorities for use in the context of Local Air Quality Management (LAQM). The Health and Safety Laboratory (HSL) operate the WASP scheme independently and the cost of operation is borne by the laboratories, which pay an annual fee to HSL. In the most recent round of Annual Performance Criteria for NO_2 Diffusion Tubes used in LAQM (DEFRA, 2010), the laboratory demonstrated good performance in a QA/QC scheme for analysis of NO_2 diffusion tubes.

The non-adjusted results of the diffusion tube monitoring in the Borough are provided in Appendix B. The monitoring began in February 2008 and, as outlined above, is continuing at the majority of the original locations with some minor changes. Therefore, data for a full calendar year is now available.

A local co-location study using triplicate tubes was undertaken over 12 months at the Lewisham 2 roadside site in New Cross. The diffusion tubes were located within 0.5m of the inlet sampler of the chemiluminescent analyser at the continuous site. The study compared equivalent exposure periods, although the continuous results are provisional. The results from the study indicate that there was good precision and also good data capture for the continuous analyser.

Bias adjustment factors are specific to each year, analysing laboratory, method of analysis and location. Using the Air Quality Consultants spreadsheet available from the government's Review and Assessment website, the local factor based on 2009 data was calculated to be 0.84. The national factor in Version 03/10 of the bias adjustment spreadsheet is 0.99 so therefore would be more precautionary. A combined factor using local data and the data from the national spreadsheet was calculated to be 0.98. Further details on the calculations are included in Appendix A.

Table 2.2: Details of Non- Automatic Monitoring Sites (NETCEN Network)

Site Name	Site Type	Easting	Northing	In AQMA	Relevant exposure *(Y/N with distance (m) to relevant exposure)*	Distance to kerb (m) of nearest road *(N/A if not applicable)*	Worst-case location
LWS001	Roadside	540317	174100	Y	Y	10	N
LWS002	Background	538475	175785	Y	Y	1	N
LWS003	Roadside	538220	176100	Y	Y	10	N
LWS004	Roadside	537740	175920	Y	N	1.5	Y
LWS005-007	Roadside	535290	177295	Y	Y	6	Y
LWS008	Roadside	535830	176830	Y	Y	15	Y
LWS009	Roadside	536130	173337	N	Y	3	Y
LWS010	Background	538055	173810	Y	Y	0.5	N
LWS011	Roadside	537180	173370	Y	N	0.5	Y
LWS012	Background	538640	172730	N	Y	10	N
LWS013	Used as control						
LWS014	Background	535536	173192	N	Y	10	N
LWS015	Roadside	536523	175925	Y	Y	0.5	Y
LWS016	Roadside	539640	175934	Y	Y	0.5	Y
LWS017	Roadside	540037	173748	Y	Y	0.5	Y
LWS018	Background	538960	172740	N	Y	2	N
LWS051	Roadside	535751	176985	Y	Y	0.5	Y
LWS052	Roadside	535795	171570	N	Y	0.5	N

Tubes at sites shaded grey have been relocated as follows:
LWS001 → LWS017
LWS008 → LWS051
LWS012 → LWS018

Table 2.3: Details of Non- Automatic Monitoring Sites (non-NETCEN Network)

Site Name	Site Type	Easting	Northing	In AQMA	Relevant exposure *(Y/N with distance (m) to relevant exposure)*	Distance to kerb (m) of nearest road *(N/A if not applicable)*	Worst-case location
SCH001	Background	539250	176402	Y	N	25	N
SCH002	Background	539348	174477	Y	Y	5	N
SCH003	Background	540545	172840	N	Y	5	N
SCH004	Background	540149	171652	N	N	10	N
SCH005	Background	539063	171632	N	Y	8	N
SCH006	Background	539369	172480	N	Y	6	N
SCH007	Background	539089	173398	N	Y	8	N
SCH008	Roadside	537817	173323	Y	Y	5	Y
SCH009	Background	538456	172426	N	N	10	N
SCH010	Background	537453	172410	N	N	20	N
SCH011	Background	536245	171849	N	Y	8	N
SCH012	Background	535055	172357	N	N	20	N
SCH013	Roadside	535563	172740	N	Y	5	Y
SCH014	Background	535862	172685	N	Y	8	N
SCH015	Background	537438	173941	N	Y	5	N
SCH016	Background	536412	175131	N	Y	2	N
SCH017	Background	536118	175119	Y	Y	5	N
SCH018	Background	536924	177707	Y	Y	2	N
SCH019	Background	538311	175304	Y	Y	3	N
SCH020	Roadside	538025	174749	Y	N	2	Y
SCH021	Background	535028	172327	N	Y	5	N

2.3 Monitored NO_2 concentrations

2.3.1 Automatic Monitoring Data

Results for the three continuous sites operated by the London Borough of Lewisham are shown in Table 2.4, for the years 2007 to 2009. Data for all three years are fully ratified. Trends in the data over the period of 2003 to 2009 are illustrated in Figure 2.2.

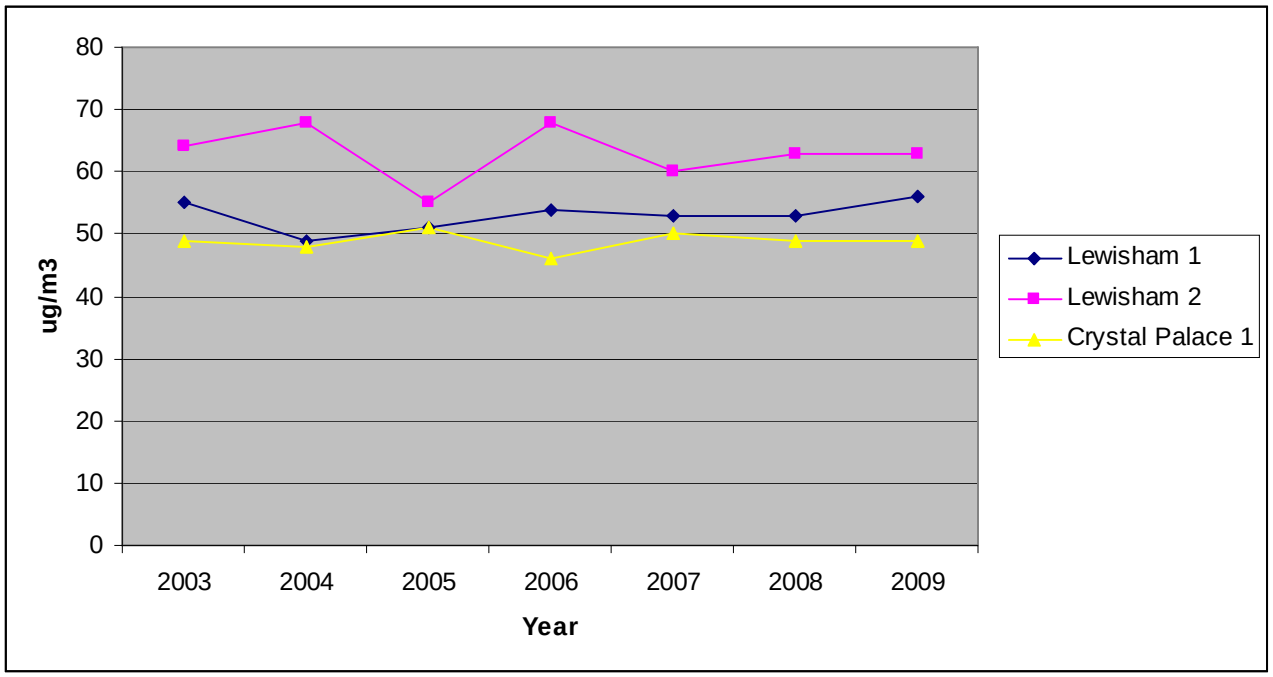
The results show that the annual mean objective was exceeded at all three sites and in each of the years. Furthermore, the concentrations have remained static or slightly increased, contrary to the general downward trend that is often predicted.

As expected, the roadside site in New Cross shows the highest concentrations of annual mean NO_2 but the levels at the urban background site in Catford are not much lower. Although the site meets the definition of urban background, the monitoring station is in a shopping area where vehicular access is restricted to deliveries and access to the commercial premises. It is situated approximately 25m from a busy road and 75m from the South Circular (A205). Therefore, the levels are expected to be slightly higher than some other urban background sites.

Table 2.4: Annual mean nitrogen dioxide concentrations at automatic monitors

Site ID	Location	Within AQMA?	Data capture for full calendar year 2007 (%)	Data capture for full calendar year 2008 (%)	Data capture for full calendar year 2009 (%)	Annual mean concentrations ($\mu g/m^3$)		
						2007	2008	2009
Lewisham1	Broadway Theatre, Catford	Y	91	94	100	**53**	**53**	**57**
Lewisham2	New Cross, Hobgoblin PH	Y	92	94	93	**60**	**63**	**64**
Crystal Palace1	Crystal Palace Parade	Y (outside Borough boundary)	93	93	94	**50**	**49**	**49**

Figure 2.2: Trends in annual mean nitrogen dioxide concentration measured at automatic monitoring sites.



Data capture was below 90% in 2006 at Lewisham 2 and in 2004, 2005 and 2006 at Crystal Palace 1

Table 2.5 shows the hourly mean NO_2 concentrations for the years 2007 to 2009. The objective was not exceeded at any of the sites. The most recent year when the hourly objective was exceeded at the Lewisham 2 site was in 2006, while the standard has not been exceeded at the Crystal Palace site since 2003.

Table 2.5: 1-hour mean nitrogen dioxide concentrations at automatic monitors

Site ID	Location	Within AQMA?	Data capture for full calendar year 2007 (%)	Data capture for full calendar year 2008 (%)	Data capture for full calendar year 2009 %	Number of exceedences of hourly mean (200 µg/m^3)		
						2007	2008	2009
Lewisham 1	Broadway Theatre, Catford	Y	91	94	100	8	2	4
Lewisham 2	New Cross, Hobgoblin PH	Y	92	94	93	11	5	6
Crystal Palace 1	Crystal Palace Parade	Y (outside Borough boundary)	93	93	93	0	0	0

2.3.2 Diffusion Tube Monitoring Data

The results from the tubes are shown in Tables 2.6 and 2.7. The results indicating an exceedence of the National Air Quality Objective are shown in **bold**. As can be seen, the majority of the sites where the diffusion tube data indicates that the objective is being exceeded are located within an existing AQMA. The exception to this is LWS009 located on Brockley Rise, one of the subjects of this Detailed Assessment. This tube is situated close to the junction with the South Circular (A205), which has already been designated as an AQMA.

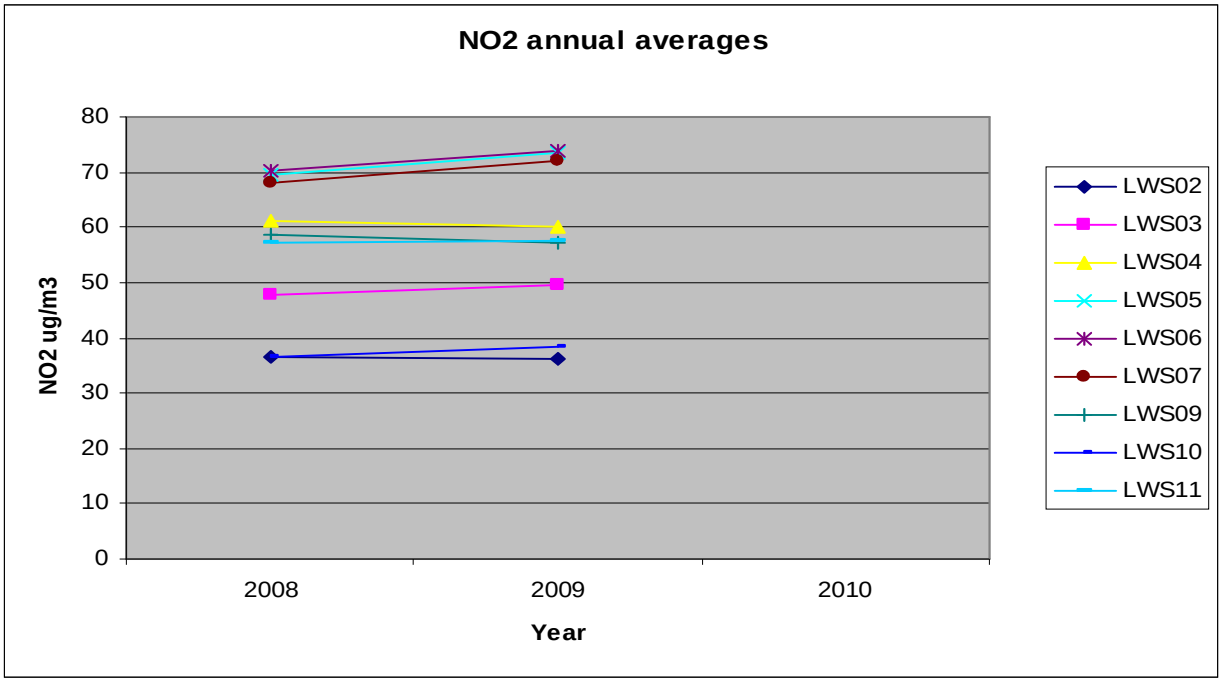
Table 2.6: Results of Nitrogen Dioxide Diffusion Tubes (NETCEN network)

Site ID	Location	Within AQMA?	Data capture for full calendar year 2008 %	Data capture for full calendar year 2009 %	Annual mean concentrations (μg/m^3)			
					2008	2009	2009 data with local factor applied	2009 data with national factor applied
LWS002[a]	Boyne Road	Y	92	92	36.68	36.10	30.32	35.74
LWS003[a]	Lewisham Road	Y	92	92	**47.76**	**49.65**	**41.71**	**49.15**
LWS004[a]	Loampit Vale	Y	92	100	**61.01**	**60.01**	**50.41**	**59.41**
LWS005[a]	New Cross Road	Y	83	92	**69.59**	**73.51**	**61.75**	**72.77**
LWS006[a]	New Cross Road	Y	83	92	**70.23**	**73.88**	**62.06**	**73.14**
LWS007[a]	New Cross Road	Y	92	75	**68.13**	**71.94**	**60.43**	**71.22**
LWS008[a]	Pepys Road	Y	75	n/a	**52.35**	n/a	n/a	n/a
LWS009[a]	Brockley Rise	N	92	100	**58.72**	**57.12**	**47.98**	**56.55**
LWS010[a]	Ringstead Road	Y	92	100	36.59	38.31	32.18	37.93
LWS011[a]	Catford Hill	Y	83	100	**57.10**	**57.72**	**48.48**	**57.14**
LWS012[a]	Penderry Rise	N	83	n/a	24.16	n/a	n/a	n/a
LWS014[b]	Stanstead Road	N	0	100	n/a	27.37	22.99	27.10
LWS015[c]	Shardloes Road	Y	0	92	n/a	**60.63**	**50.93**	**60.02**
LWS016[c]	Lawn Terrace	Y	0	100	n/a	**40.87**	34.33	**40.46**
LWS017[d]	Baring Road	Y	0	75	n/a	**49.60**	**41.66**	**49.10**
LWS018[d]	Hazelbank Road	N	0	58	n/a	31.11	26.13	30.80
LWS051[e]	Hatcham Park Road	Y	0	42	n/a	**59.98**	**50.38**	**59.38**

[a] monitoring started in February 2008
[b] monitoring started in December 2008
[c] monitoring started in January 2009
[d] monitoring started in March 2009
[e] monitoring started in July 2009 and data has been annualised. See Appendix A for details
n/a – tubes not in position in this location during this year

Since the diffusion tube network was only started in 2008, data are currently only available for two years. Consequently, it is too early to provide any detailed analysis of trends in the annual averages. However, Figure 2.3 shows the data to date (without bias adjustment) and has been included as a starting-point for future years' reporting.

Figure 2.3: Trends in annual mean nitrogen dioxide concentration measured at diffusion tube monitoring sites



With the exception of those sites indicated in Table 2.7, monitoring at schools began in March 2009. As the monitoring period was 10 months, these results have not been annualised. For the three schools which had shorter monitoring periods, the results were annualised using the methodology set out in Box 3.2 of TG(09) and using the datasets from the three automatic monitoring stations provided in Table 2.4. Details of the calculations are provided in Appendix A.

Graphs of the monthly average concentrations are shown in Figures 2.4 and 2.5, for the NETCEN and schools diffusion tubes, respectively. The graphs do not show any clear discernible trends over time, apart from the slight variations between the summer and winter months. However, the graphs do clearly show the difference between the concentrations measured at background and at roadside sites. At background locations, the monthly averages recorded using the diffusion tubes are generally below 40 µg/m^3 and therefore meet the annual average Air Quality Objective, whereas at roadside sites the monthly averages are almost always above 40 µg/m^3 so that the Objective is exceeded, often by a significant margin.

The locations of the diffusion tubes across Lewisham are shown in Figure 2.6.

Table 2.7: Results of Nitrogen Dioxide Diffusion Tubes (non-NETCEN network)

Site ID	Location	Within AQMA?	Data capture for full calendar year 2009 %	Annual mean concentrations (μg/m^3)		
				2009	2009 data with local factor applied	2009 with national factor applied
SCH001	All Saints CE Primary. Blackheath Vale SE3	Y	83.33	26.73	22.45	26.46
SCH002	Lee Manor Primary, Leahurst Road SE13	Y	75	28.52	23.96	28.23
SCH003	Cooper's Lane Primary, Pragnell Road, SE12	N	83.33	23.51	19.75	23.27
SCH004	Launcelot Primary, Launcelot Road BR1	N	75	23.23	19.51	23.00
SCH005	Bonus Pastor College, Winlaton Road BR1	N	66.67	22.11	18.57	21.89
SCH006	Forster Park Primary, Boundfield Road SE6	N	66.67	23.10	19.40	22.87
SCH007	Sandhurst Infants and Juniors, Minard Road SE6	N	75	26.76	22.48	26.49
SCH008	Holy Cross Primary, Culverley Road SE6	Y	83.33	31.63	26.57	31.31
SCH009[a]	Catford High, Conisborough Crescent SE6	N	50	23.22	19.50	22.99
SCH010	Athelney Primary, Athelney Street SE6	N	75	22.77	19.13	22.54
SCH011	St Michael's CE Primary, Champion Road SE26	N	66.67	25.46	21.39	25.21
SCH012[a]	St William of York RC School, Brockley Park SE23	N	66.67	28.72	24.13	28.43
SCH013	Christchurch CE School, Perry Vale SE23	N	75	31.27	26.27	30.96
SCH014	Perrymount School, Sunderland Road SE23	N	58.33	26.01	21.85	25.75
SCH015	Holbeach Primary, Doggett Road SE6	N	75	29.33	24.64	29.04
SCH016	St Mary Magdalen's RC School, Howson Road SE4	N	75	28.95	24.32	28.66
SCH017	Turnham Primary Foundation, Turnham Road SE4	Y	83.33	29.11	24.45	28.82
SCH018	Grinling Gibbons Primary, Clyde Street SE8	Y	58.33	33.34	28.01	33.01
SCH019	St Saviour's RC Primary, Bonfield Road SE13	Y	83.33	30.28	25.44	29.98
SCH020	St Mary's CE Primary, Lewisham High St SE13	Y	83.33	**61.33**	**51.52**	**60.72**
SCH021[b]	Sydenham School, Dartmouth Road SE26	N	50	34.62	29.08	34.27

[a] – Monitoring started May 2009 and data has been annualised. See Appendix A.
[b] – Monitoring started July 2009 and data has been annualised. See Appendix A.

Figure 2.4: Trends in monthly averages of nitrogen dioxide from diffusion tube results (NETCEN network)

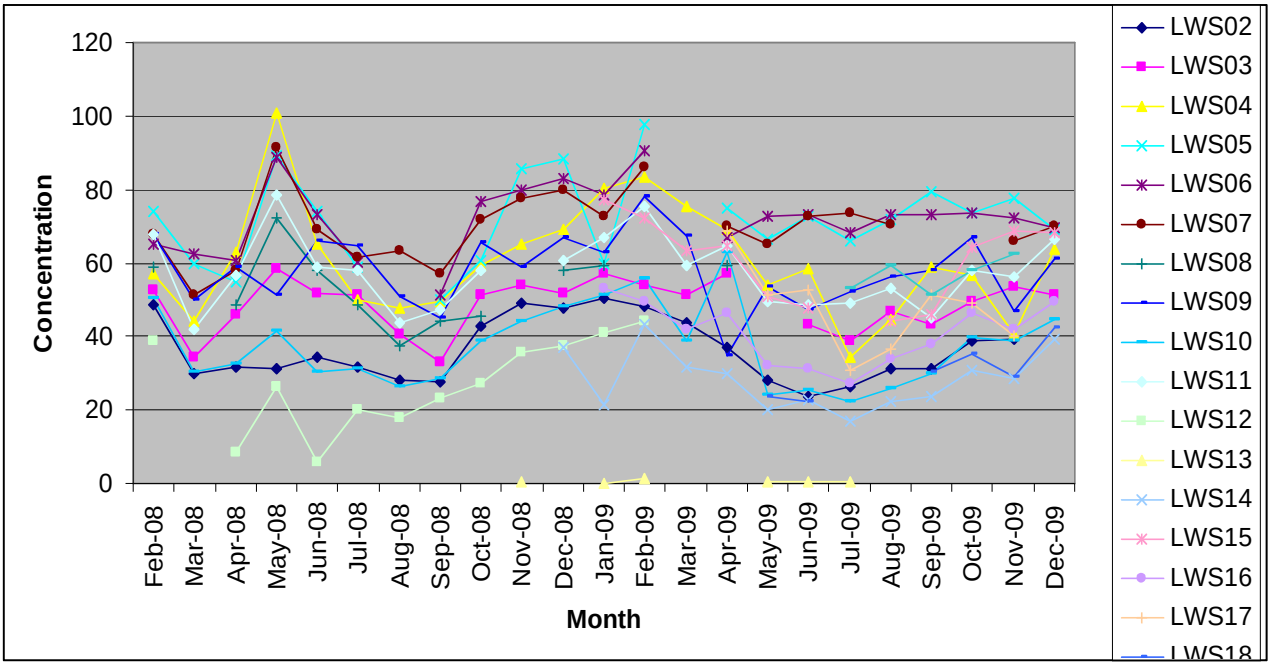


Figure 2.5: Trends in monthly averages of nitrogen dioxide from diffusion tube results (non-NETCEN network)

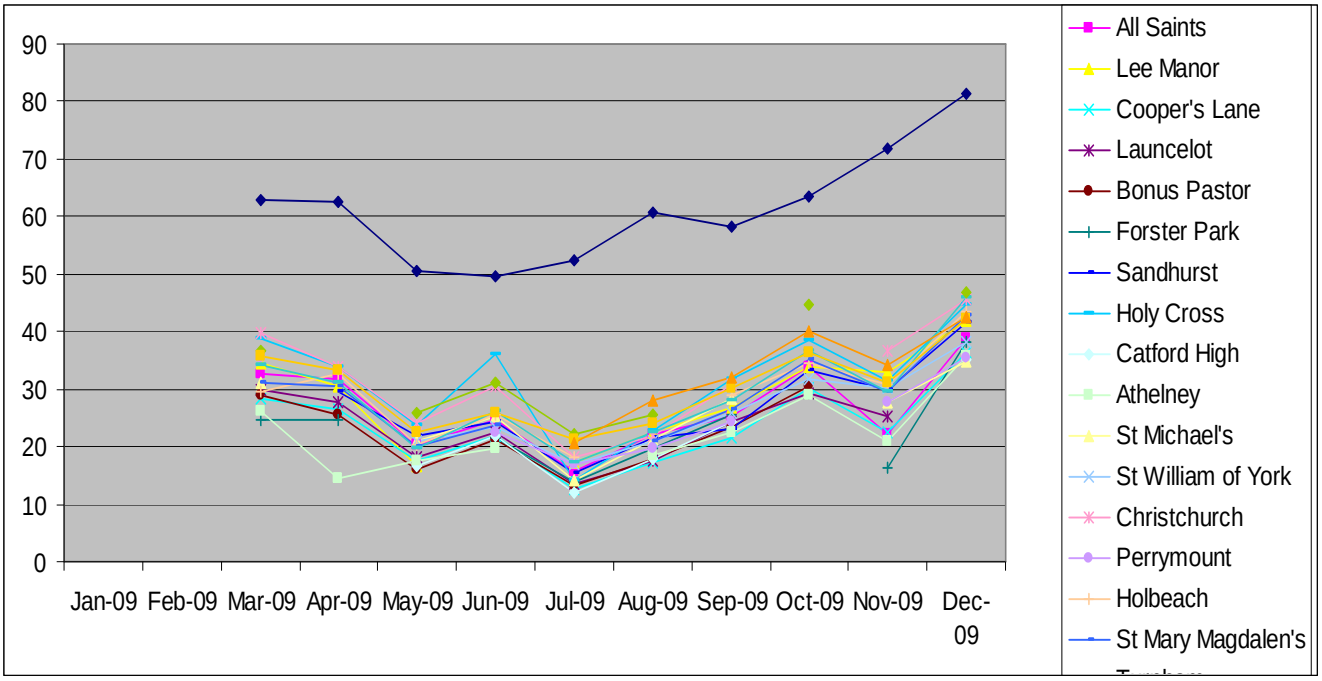
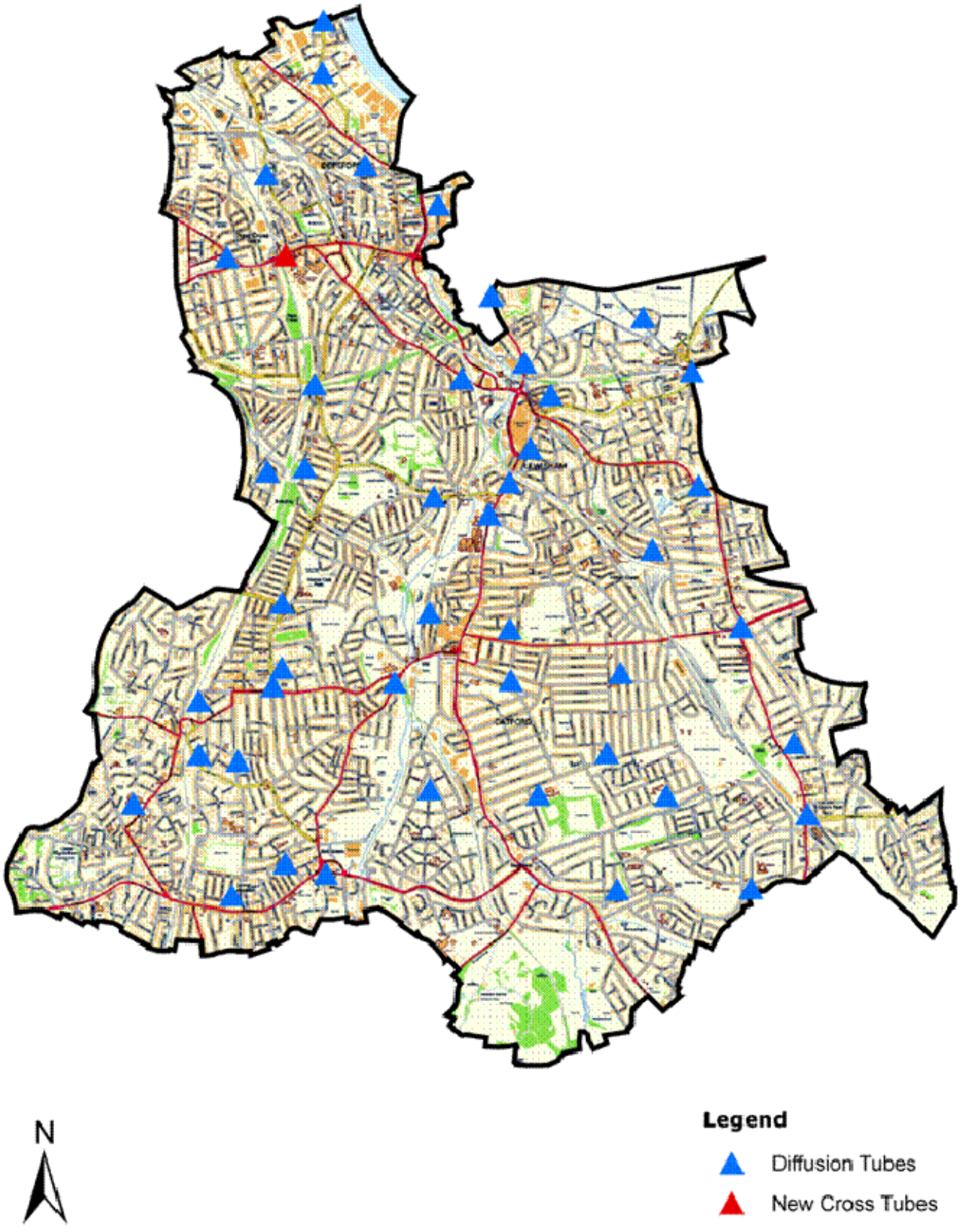


Figure 2.6: Locations of diffusion tubes within Lewisham



3 Modelling overview and setup

In order to assess the risk of exceeding the NO_2 annual average objective along the four roads identified for this Detailed Assessment, modelling was carried out using the ADMS-Urban1 model (version 2.3.3.1). The model uses the detailed emissions data described in Section 5 together with a range of other input data to calculate the dispersion of pollutants. The emissions were calculated using CERC's emissions inventory tool, EMIT.

3.1 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 value of 1 metre was used in the modelling to represent the dispersion site.

The difference in land use at the meteorological site at Heathrow compared to that at the study area was taken into account, as explained in Section 3.3.

3.2 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 urban 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, which has the dimension of length. In very stable conditions it has a positive value of between 2 metres and 20 metres. In near neutral conditions its magnitude is very large, and it has either a positive or negative value depending on whether the surface is being heated or cooled by the air above it. In very convective conditions it is negative with a magnitude of typically less than 20 metres.

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 value of 75 metres was used in the modelling.

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

3.3 Meteorological data

Meteorological data from Heathrow for the year 2009 were used in the modelling. A summary of the data is given in Table 3.1. A wind rose, giving the frequency of occurrence of wind from different directions for a number of wind speed ranges, is shown in Figure 3.1.

The difference in land use at Heathrow compared to the study area was taken into account by entering a different surface roughness length for the meteorological site. The surface roughness length for Heathrow was set to 0.2 metres, compared to 1 metre for Central London.

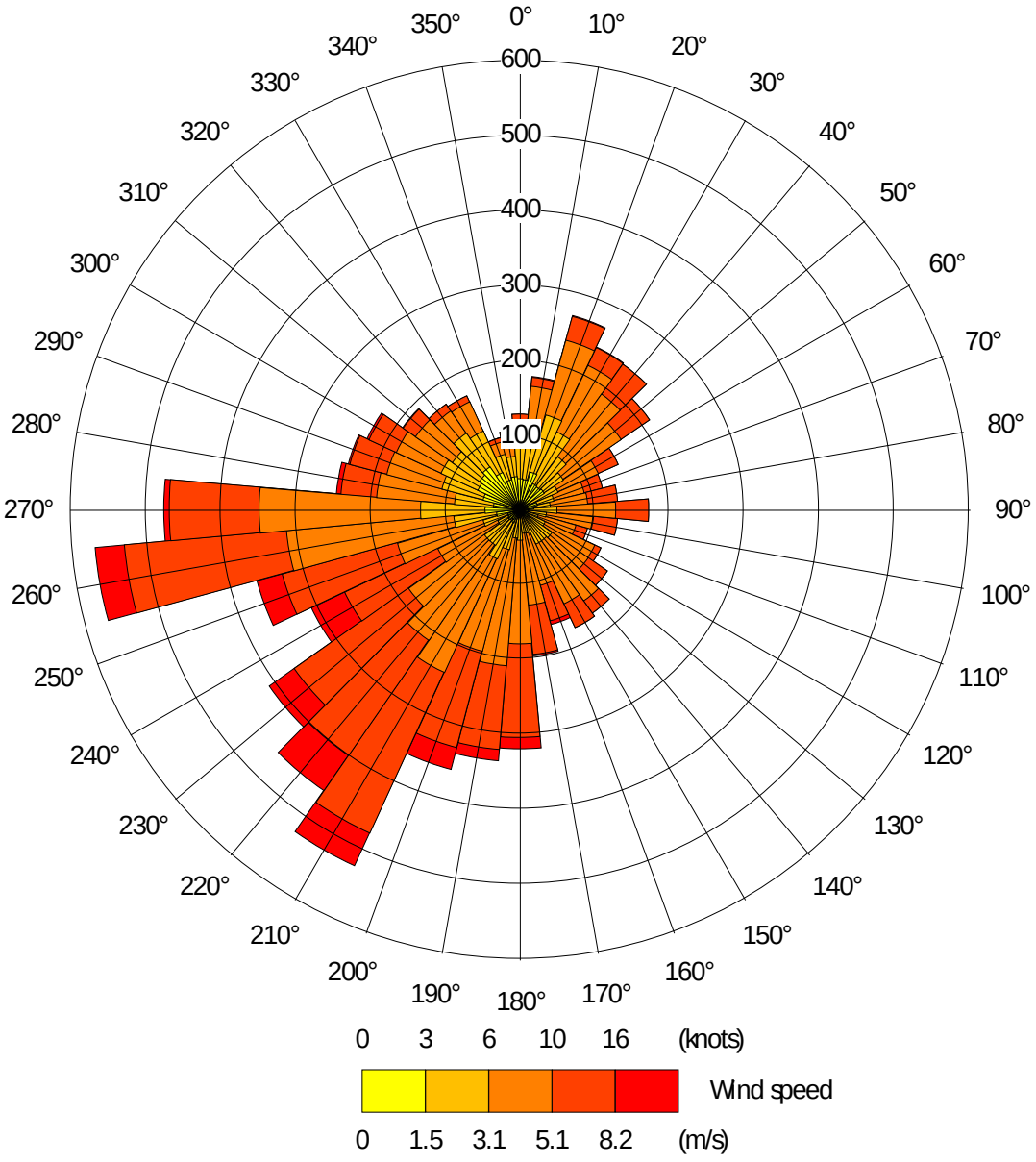
The model log files were checked to ensure that the percentage of missing hours was reasonable. A total of 8585 hours of data was used by the model, which equates to 98% of the possible lines of meteorological data.

ADMS-Urban sets all hours of 'calm' wind speeds (that is, hours where the wind speed measured at a height of 10 m is less than 0.75 m/s) to a value of 0.75 m/s. It was found that 102 hours had wind speeds less than 0.75 m/s, which represents just 1.2 % of the modelled lines of meteorological data.

Table 3.1: Summary of meteorological data

	Minimum	Maximum	Mean
Temperature (°C)	-5.7	31.0	11.5
Wind speed (m/s)	0	14.9	4.2
Cloud cover (oktas)	0	8	4.8

Figure 3.1: Wind Rose for Heathrow, 2009



3.4 NO_x chemistry and background data

Nitrogen dioxide (NO_2) results from direct emissions from combustion sources together with chemical reactions in the atmosphere involving NO_2, nitric oxide (NO) and ozone (O_3). The combination of NO and NO_2 is referred to as nitrogen oxides (NO_x).

The chemical reactions taking place in the atmosphere were taken into account in the modelling using the Generic Reaction Set (GRS) of equations. These use hourly average background concentrations of NO_x, NO_2 and O3, together with meteorological and modelled emissions data to calculate the NO_2 concentration at a given point.

All emissions of NO_x and NO_2 from within the city are included in the modelling. Hourly background data for these pollutants and ozone were input to the model to represent the concentrations in the air being transported into the city. These data were obtained from rural monitoring sites around the city.

For the 2009 verification, NO_x, NO_2 and O_3 concentrations for 2009 from Rochester, Harwell, Lullington Heath and Wicken Fen were input to the model; the monitored concentration used for each hour was dependent upon the wind direction for that hour, as illustrated in Figure 3.2.

For the 2011 modelling, the NO_x, NO_2 and O_3 concentrations were kept the same as the 2009 values.

Table 3.2 summarises the annual statistics of the background concentrations used in the modelling for both the 2009 verification and the 2011 modelling.

Figure 3.2: Wind direction segments used to calculate background concentrations for NO_x, NO_2 and O_3

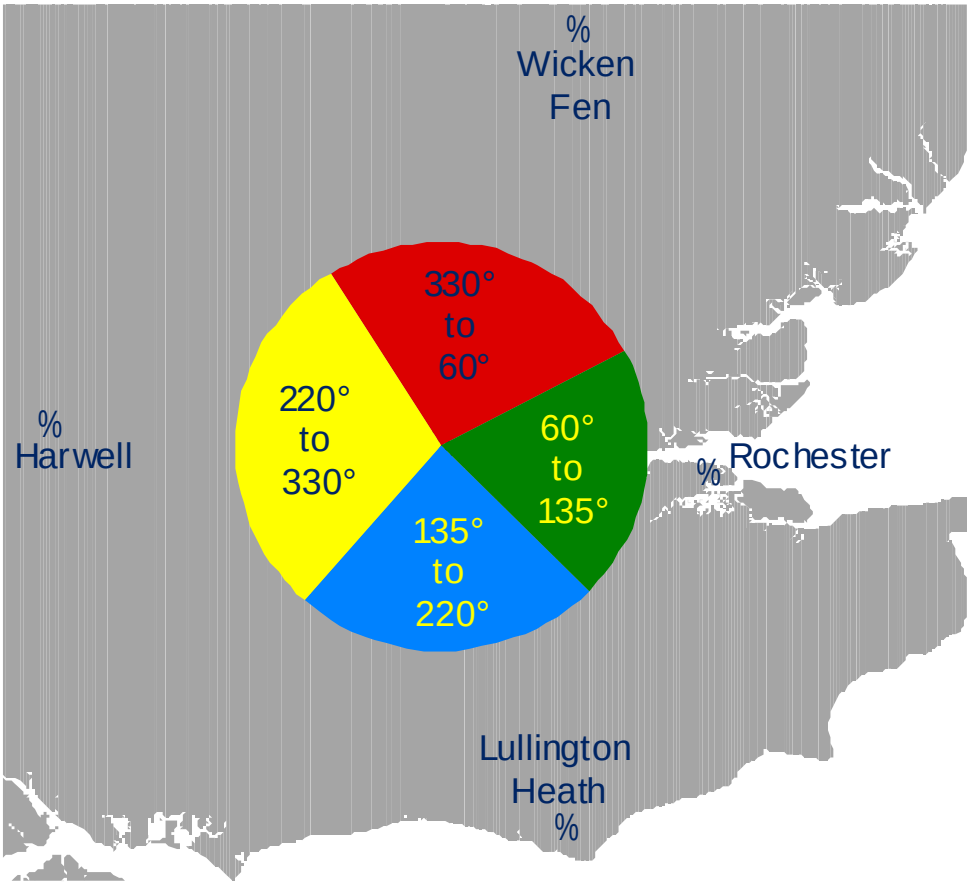


Table 3.2: Background concentrations used for both 2009 and 2011 (µg/m^3)

	NO_x	NO_2	O_3
Annual average	12.7	9.6	52.6
99.79th percentile of hourly average	108	56.3	116

4 Modelled sources

4.1 Sources overview

Data for all of the modelled sources were taken from the London Atmospheric Emissions Inventory (LAEI 2008), which was released by the Greater London Authority (GLA) in 2010. All emission calculations were carried out in EMIT.

All major roads, rail and large industrial sources in the immediate area surrounding the four assessment roads were modelled explicitly; that is, they were represented fully in ADMS-Urban, with detailed geometry and emission parameters. The remaining sources were aggregated, using EMIT, onto a 1-kilometre resolution grid, covering the whole of London, and modelled in ADMS-Urban as grid sources.

The 2008 LAEI has datasets for the years 2008, 2011 and 2015. For the 2009 verification, source data for the year 2008 was used. For the contour output modelling, data from the year 2011 was used.

4.2 Traffic sources

4.2.1 Activity data and geometry

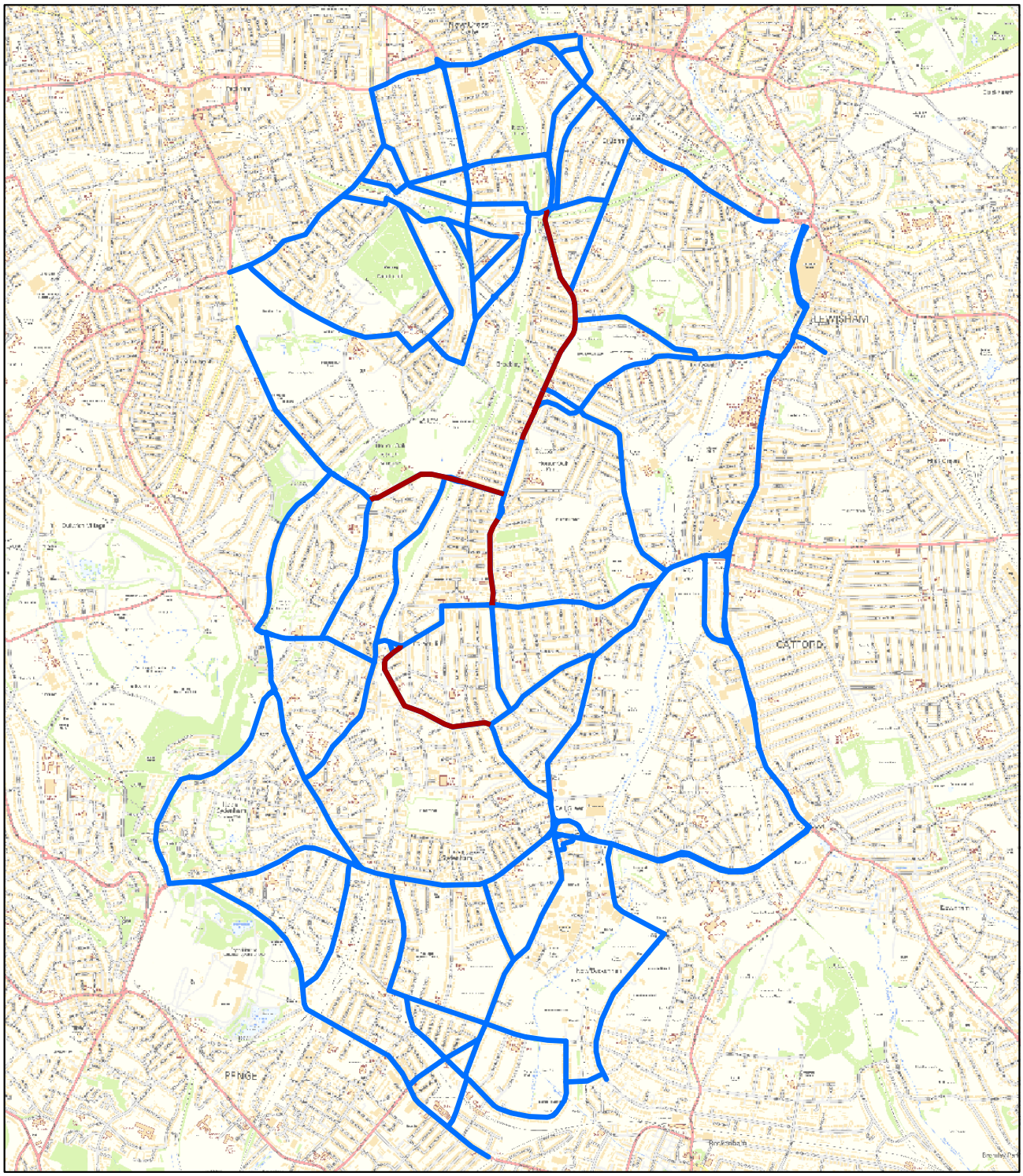
The traffic flows and speeds for all of the modelled major roads were taken from the LAEI. The traffic flows are provided as AADTs for eleven vehicle types, and these were calculated based on a corresponding LAEI Urban Route Type in EMIT.

For both the 2009 model verification and the 2011 modelling, a group of major road sources surrounding the four roads under consideration was selected to be included explicitly in the model, as shown in Figure 4.1. All other roads in London, including minor roads, were modelled as part of the 1-kilometre resolution grid sources.

The road locations and other geometry (width and height) were based on those in the LAEI, with some modifications made. For the 2009 verification run, the 2008 road activity dataset was used. For the 2011 modelling, the 2011 major roads activity dataset was used.

The four roads under consideration, and other relevant road sections nearby, were carefully assessed and modified to ensure that the geometry of the sources represented the actual geometry as accurately as possible, including the presence of street canyons. Details of the sources that make up the four roads are given in Appendix C. The same geometry was used for the verification (2009) and the 2011 modelling.

Figure 4.1: Explicitly-modelled major road sources



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0 500 1000 2000 3000 4000 5000 Metres

Modelled roads

Detailed Assessment roads

4.2.2 Emissions

The emissions of NO_x and NO_2 for the major road sources were calculated using the latest set of DfT emission factors[2] released in 2009. These emission factors include primary NO_2 emission factors for each vehicle type, which allows detailed road-by-road NO_x and NO_2 emission rates to be calculated.

For the 2009 verification run, since the activity data represent the year 2008, emission factors for 2008 were applied. The difference between emissions calculated for these two consecutive years is not expected to be significant, particularly in light of recent findings regarding NO_x emissions from diesel vehicles, as detailed below.

Recent evidence from NO_x and NO_2 monitoring data in urban areas has shown that diesel NO_x emissions are not decreasing at the expected rate, as discussed in a Defra Frequently Asked Question[3] in September 2010.

In line with the above Defra guidance, NO_x emissions from all EURO 2 to EURO 5 diesel vehicles were set to be the same as the equivalent EURO 1 vehicles, by modifying the Route Type (vehicle fleet breakdown information) in EMIT. Primary NO_2 emissions were calculated by applying the primary NO_2 fraction for each vehicle type to the EURO 1-equivalent NO_x emissions. It is expected that emissions from EURO 6 vehicles will meet the expected emission reductions so these emission factors are unchanged. These changes have the effect of increasing NO_x and NO_2 road traffic emission rates for both modelled years.

Data for minor roads are provided in the LAEI in the form of emissions aggregated over 1-kilometre resolution grids; these emissions were imported directly into EMIT.

4.2.3 Daily traffic variation

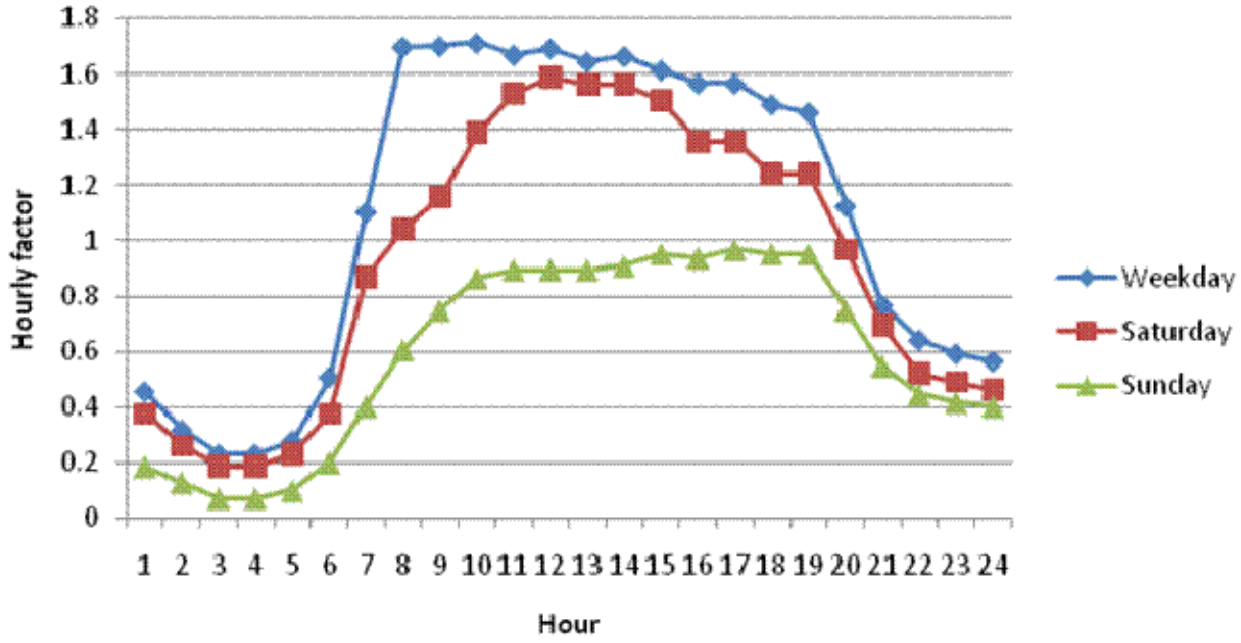
The variation of traffic flow during the day was taken into account by applying a set of diurnal profiles to the road emissions. These profiles, which were used for both the 2009 verification and the 2011 modelling, were taken from the report *Air pollution and emissions trends in London*[4] used in the compilation of the LAEI, and are shown in Figure 4.2.

[2] http://www.dft.gov.uk/pgr/roads/environment/emissions/

[3] *Measured nitrogen oxides (NOx) and/or nitrogen dioxide (NO2) concentrations in my local authority area do not appear to be declining in line with national forecasts. Should I take this into account in my Review and Assessment work?* http://laqm2.defra.gov.uk/FAQs/General/Measured nitrogen oxides (NOx) and-or nitrogen dioxide (NO_2) concentrations do not appear to be declining in line with national forecasts.pdf

[4] *Air pollution and emissions trends in London*, King's College London, Environmental Research Group and Leeds University, Institute for Transport studies http://www.airquality.co.uk/reports/cat05/1004010934_MeasurementvsEmissionsTrends.pdf

Figure 4.2: Traffic diurnal profiles used for the modelling



4.3 Rail sources

A group of rail sources surrounding the four roads was selected to be included explicitly in the model, covering a similar extent as the major roads. The remainder of the rail sources were included in the 1-kilometre grid sources. The explicit rail sources are shown in Figure 4.3.

Emissions for all modelled rail sources were provided in the LAEI for both modelled years.

4.4 Industrial sources

Three industrial sources were included explicitly in the modelling:

1. The South East London Combined Heat and Power Plant (SELCHP), located within Lewisham, which has a relatively high NO_x emission rate of 12g/s;
2. Part B process 'Mobile Plant'; and
3. Part B process 'Bardon Aggregates Aggregate Industries Ltd'.

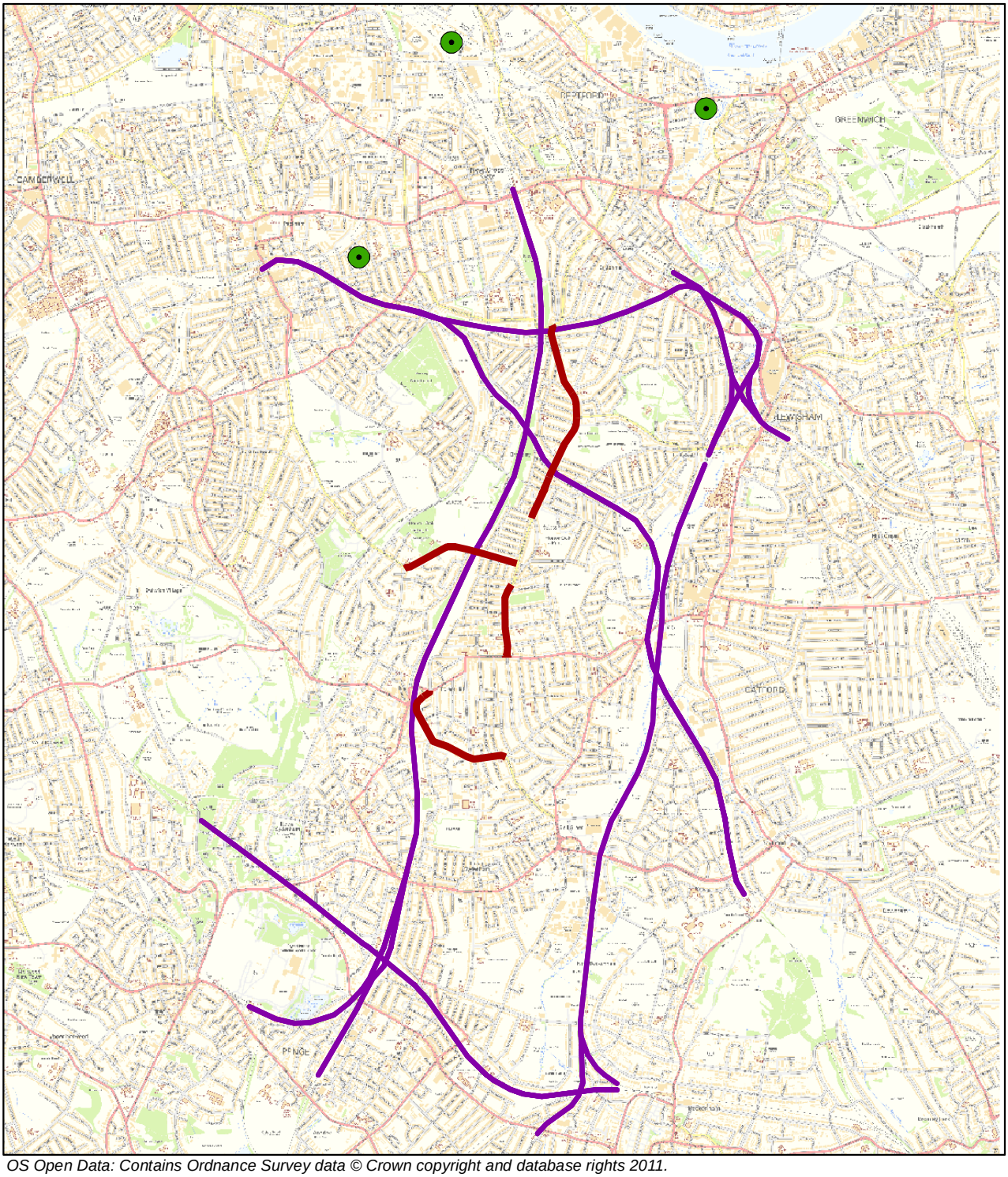
The emissions for the remaining industrial sources across London were included within the grid sources.

Further investigation suggests that, although Source 2 has an address in the LAEI (38 Stanbury Road, Peckham, London SE15 2DB), this is actually a residential address. It is likely that the actual source is located elsewhere.

Similarly, source 3 has an address which falls on the border of Lewisham and Greenwich (3 Copperas Street, Deptford, London SE8 3DA) but further investigation suggests that this source has moved from this address.

The NO_2 emissions from sources 2 and 3 are very low, relatively far from the Detailed Assessment roads, and are modelled as elevated sources. They should, therefore, have a negligible effect on the modelled concentrations. The possible errors in the LAEI locations for these sources are noted here for future reference.

Figure 4.3: Explicitly-modelled rail and industrial sources



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0 500 1000 2000 3000 4000 5000 Metres

Rail sources
Industrial sources
Detailed Assessment roads

4.5 Other sources

Emissions for all other source types were taken from the LAEI and included in the 1-kilometre resolution grid sources. These comprise agriculture, airport, boilers, cold starts, domestic coal, gas and oil, evaporative, gas leaks, industrial coal and gas, natural emissions, shipping and solvent use.

5 2009 verification

5.1 Modelled receptors

The first stage of the dispersion modelling involved modelling a recent year in order to verify that the input data and model set-up were representative of the area. This was carried out by calculating annual average concentrations of NO_2 at selected monitoring sites and comparing the measured and modelled concentrations.

Of the three continuous monitors that measure NO_2, only Lewisham 2 was used for the Detailed Assessment, due to its proximity to the roads under assessment. Lewisham 2 is a roadside site typical of the problem areas along the four Detailed Assessment roads.

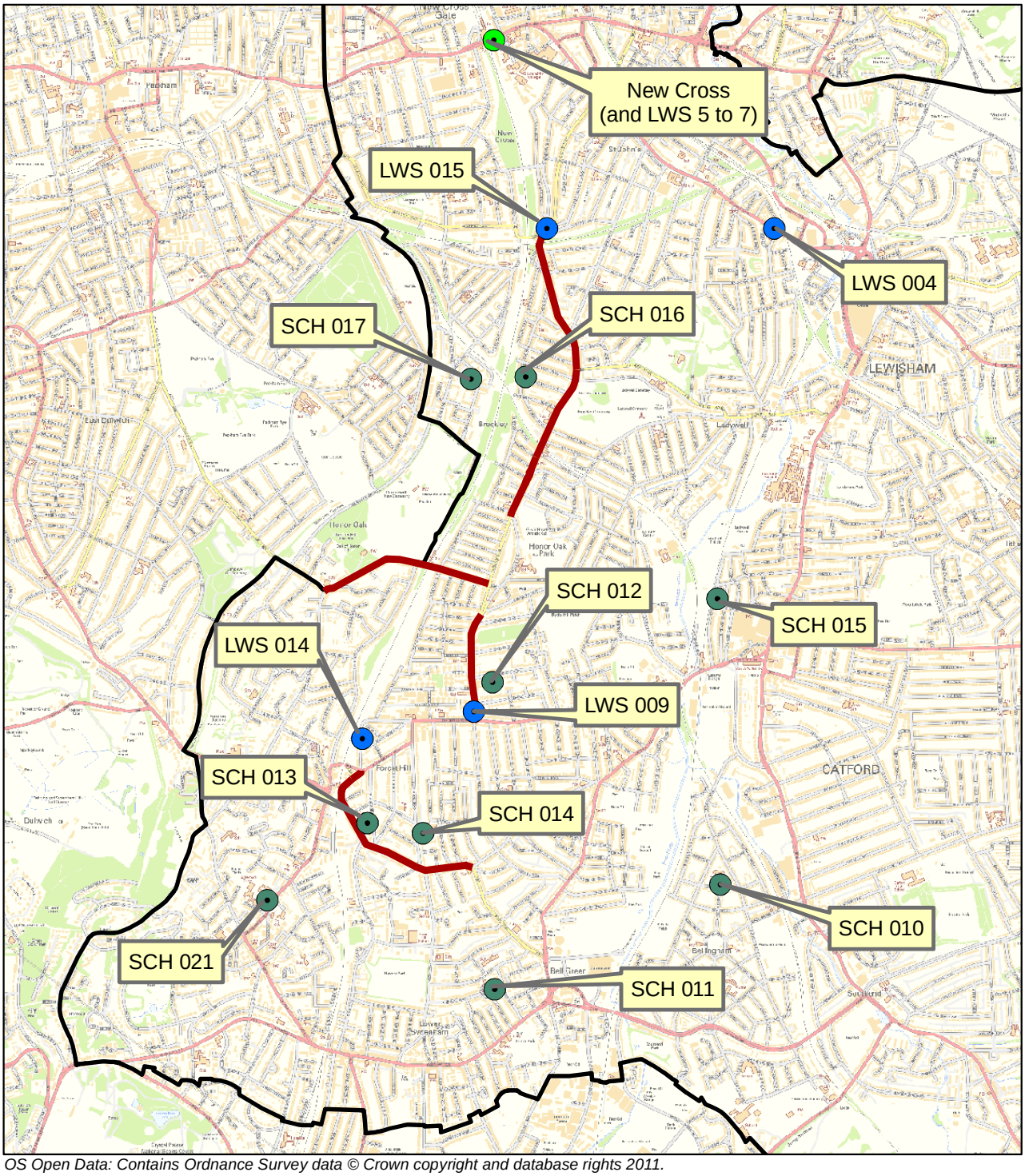
The remaining monitoring locations used for the verification were diffusion tube sites. Fifteen sites closest to the four identified roads were used, comprising a mixture of urban background and roadside sites, and of NETCEN and school locations.

Table 5.1 gives a description of the monitoring locations used for the model verification, the date of their deployment and the coordinates used for the modelling. The monitor locations are shown in Figure 5.1.

Table 5.1: Monitor locations used for the model verification

Name	Type (DT = diffusion tube)	Description	Location (x,y)	Height	Monitoring start date
Lewisham 2 (New Cross)	Continuous	Roadside New Cross Road	536240, 176934	2.5	31 Mar 2002
Diffusion tubes LWS 005 to LWS 007	DT (NETCEN)	Roadside New Cross Road		2.5	1 Feb 2008
LWS004	DT (NETCEN)	Roadside Loampit Vale	537743, 175925	3	1 Feb 2008
LWS009	DT (NETCEN)	Roadside Brockley Rise	536133, 173336	2.5	1 Feb 2008
LWS014	DT (NETCEN)	Urban background Stanstead Road	535536, 173192	3	3 Dec 2008
LWS015	DT (NETCEN)	Roadside Shardloes Road	536525, 175925	3	13 Jan 2009
SCH010	DT (School)	Athelney JMI	537453, 172410	2.5	5 Mar 2009
SCH011	DT (School)	St Michael's CE	536245, 171849	2	5 Mar 2009
SCH012	DT (School)	St William of York	536235, 173493	2.5	29 Apr 2009
SCH013	DT (School)	Christchurch	535563, 172740	2.5	5 Mar 2009
SCH014	DT (School)	Perrymount	535862, 172685	2	5 Mar 2009
SCH015	DT (School)	Holbeach	537438, 173941	2.5	5 Mar 2009
SCH016	DT (School)	St Mary Magdalen's RC	536412, 175131	2	5 Mar 2009
SCH017	DT (School)	Turnham	536118, 175119	2.5	5 Mar 2009
SCH021	DT (School)	Sydenham School	535028, 172327	2	13 Aug 2009

Figure 5.1: Monitoring locations used for the model verification



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5.2 Results

Tables 5.2 and 5.3 show the measured and modelled concentrations of annual average NO_2 for 2009 at the monitoring sites, together with the modelled concentrations expressed as a percentage of the measured concentrations. A value of 100% indicates perfect agreement between measured and modelled data, with values greater than 100% indicating that the model is over-predicting concentrations and values less than 100% showing model under-prediction.

A scatter plot comparing the modelled and monitored annual average NO_2 concentrations is shown in Figure 5.2. The blue diamond data markers correspond to values calculated using the locally-derived bias adjustment factor, while the red square data markers correspond to those values calculated using the factors derived from national factors.

The TG(09) guidance suggests that 'the majority of results should be within 25% of the monitored concentrations, ideally within 10%.' All except one of the modelled values are within 25% of the national factor values, and around half of the values are within 10% of the national factor values. The modelled value at the location of the continuous monitor is within 10% of the measured value.

There is better agreement with the values derived from the national factors than with those from the local factors, but the significance of this is difficult to determine. As discussed in Appendix A, it is not clear which of the two bias adjustment factors may be more appropriate, as there are strong arguments for applying either type of factor.

There is a general trend of over-prediction of monitored concentrations, for which there are several possible reasons. One reason could be the diesel NO_x adjustments described in Section 4.2.2. The extent of the discrepancy between actual and expected NO_x emissions from diesel vehicles is not yet fully understood, and hence a generally-accepted method for treating NO_x emissions from diesel vehicles is not yet available in any guidance. It is possible that the method employed here results in a conservative estimate of NO_x emissions and hence in predicted NO_2 concentrations.

Another possible reason for over-prediction of the measured values might be an underestimation of measured concentrations. The large range in the values obtained following bias-adjustment of the diffusion tubes indicate that there is significant uncertainty in the resulting values, and it is possible that there is a systematic underestimation of these concentrations. Most of the diffusion tubes, for example, were not deployed during January and February, which are months that tend to give slightly higher concentrations (see, for example, Figure 2.3).

In general, the results show good agreement between the measured and modelled concentrations, suggesting that the emissions data and model set-up are appropriate for the area. Furthermore, for both the national and local factor values, the largest differences are at sites that are well below the objective. The agreement between values above or close to the objective is very good, lending confidence to the use of the model set-up and input data for assessing areas of exceedence for 2011.

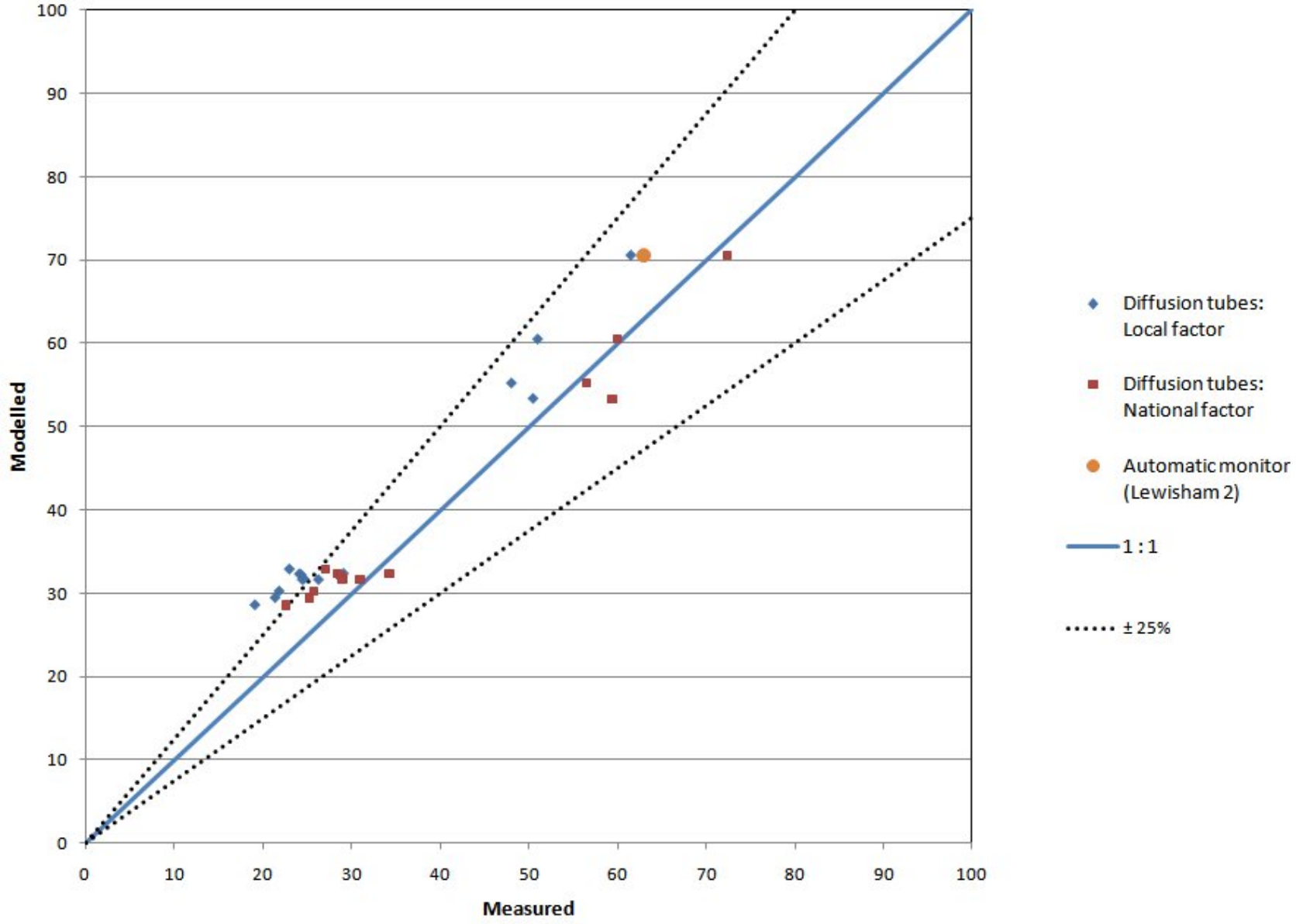
Table 5.2: Annual average NO_2 concentrations (µg/m³) at the Lewisham 2 continuous monitoring site, for 2009

Monitor name	Measured		Modelled	%	
Continuous	64		71	110	
	Local factor	National factor		Local factor	National factor
LWS005	62	73		114	97
LWS006	62	73		114	97
LWS007	60	71		117	99

Table 5.3: Annual average NO_2 (µg/m³) concentrations at the diffusion tube locations, for 2009

Site	Measured		Modelled	%	
	Local factor	National factor		Local factor	National factor
LWS004	50	60	53	106	90
LWS009	48	57	55	115	98
LWS014	23	27	33	143	121
LWS015	51	60	61	119	101
SCH010	19	23	29	149	127
SCH011	21	25	29	138	117
SCH012	24	28	32	134	114
SCH013	26	31	32	120	102
SCH014	22	26	30	138	117
SCH015	25	29	32	129	109
SCH016	24	29	32	132	112
SCH017	25	29	32	129	110
SCH021	29	34	32	111	94

Figure 5.2: Comparison of predicted and monitored annual average NO_2 concentrations ($\mu g/m^3$) for the 2009 model verification



5.3 Modelling for 2011

Ground level concentrations of NO_2 were calculated for the year 2011, on a grid of receptor points extending across an area of 3.5km by 6.4km, with an output grid resolution of approximately 35 m and 64 m (in the x and y directions, respectively).

In addition to this regular grid, concentrations were also calculated at intelligent grid points, in order to enhance the resolution of predicted concentrations in those areas where the pollutant concentration gradients are greatest. These points are automatically added by ADMS-Urban, in sets of four, with two lying just inside and two just outside the road and rail source edges.

Figure 5.3 shows a contour plot of the calculated annual average NO_2 concentrations for the four roads, while Figures 5.4 to 5.7 show the same results, but focusing on each of the Detailed Assessment roads to give more detail.

The contour plots show significant areas of exceedence of the annual average objective around Brockley Rise and Brockley Road (and the section of road linking them, Stondon Park). The areas of exceedence are particularly pronounced around junctions and street canyons, but the entire lengths of these roads are affected. The areas of exceedence extend to residential properties, and hence represent relevant exposure.

Figure 5.6 shows areas of exceedence along Honor Oak Park. Exceedences are limited to small, isolated areas, most notably on the small section between Ballina Street and Lessing Street.

There are no areas of exceedence around Perry Vale, except for a very small section at the most northerly point, where the road forms a junction with the A205 (South Circular Road).

Output was also generated for the 99.79^{th} percentile of hourly average NO_2 concentrations, and Figure 5.8 shows a contour plot of these predicted concentrations. There are areas of exceedence of this objective around Brockley Rise, Brockley Road, Stondon Park and Honor Oak Park. Experience from recent verification studies of Lewisham, carried out by CERC, with a similar model set-up, suggests that there is a tendency to overpredict the hourly average. This is probably at least in part due to the diesel NO_x emissions assumptions described in Section 4.2.2. These predicted concentrations are likely, therefore, to be slight overestimate of the true concentrations.

Figure 5.3: Contour plot showing all modelled roads, annual average NO_2

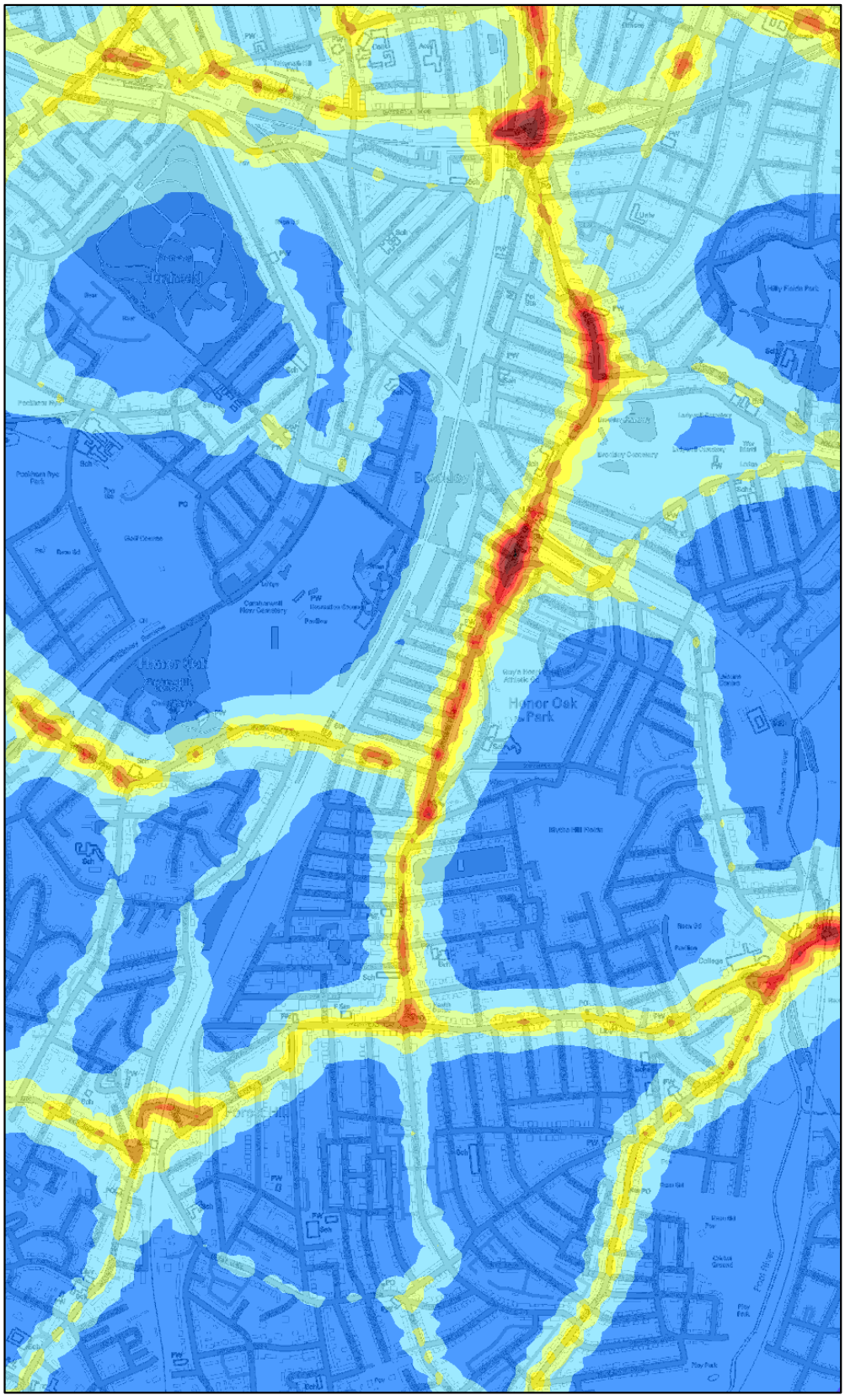


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Figure 5.4: Contour plot for Brockley Road, annual average NO_2

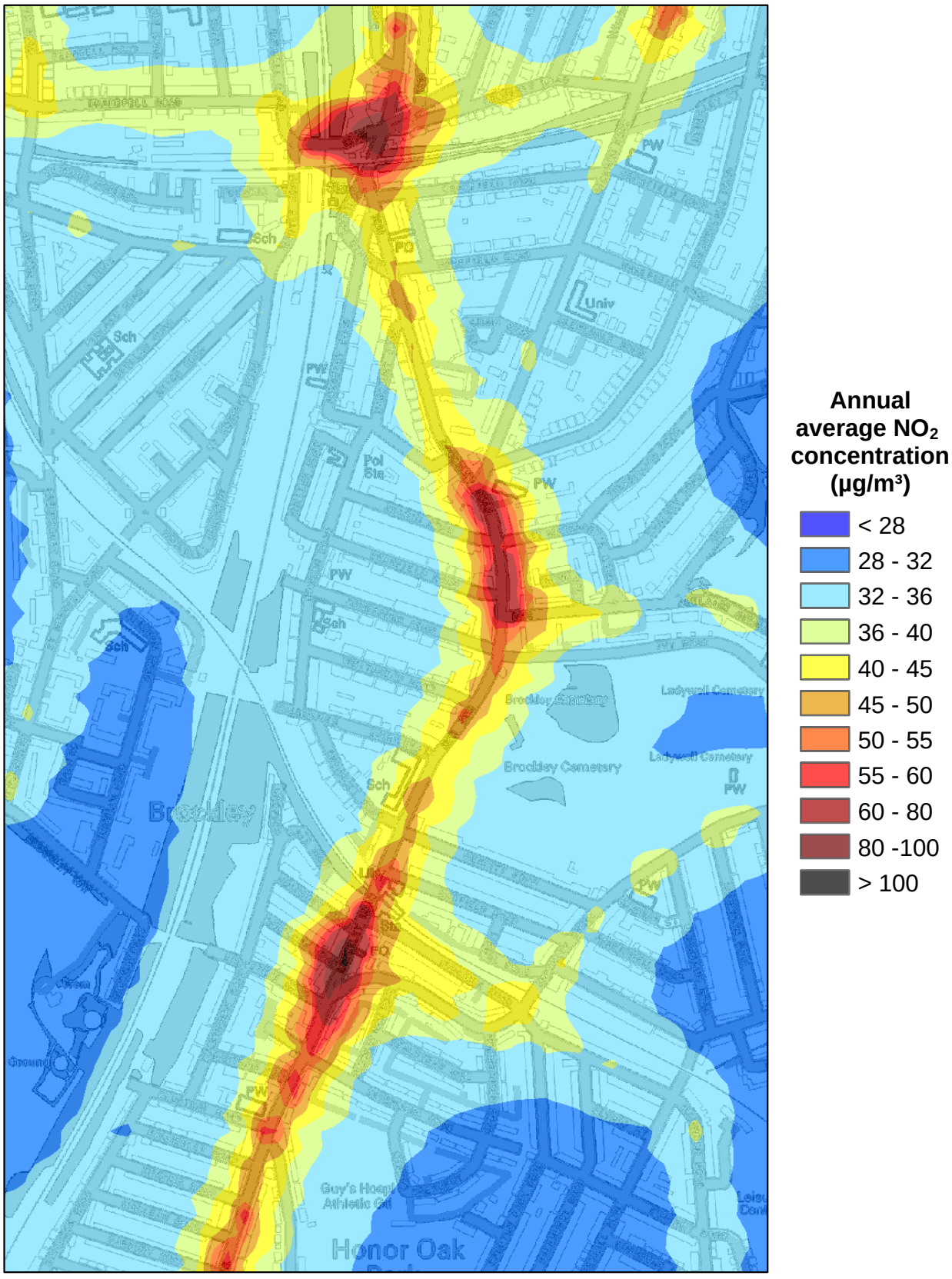

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Figure 5.5: Contour plot for Brockley Rise, annual average NO_2

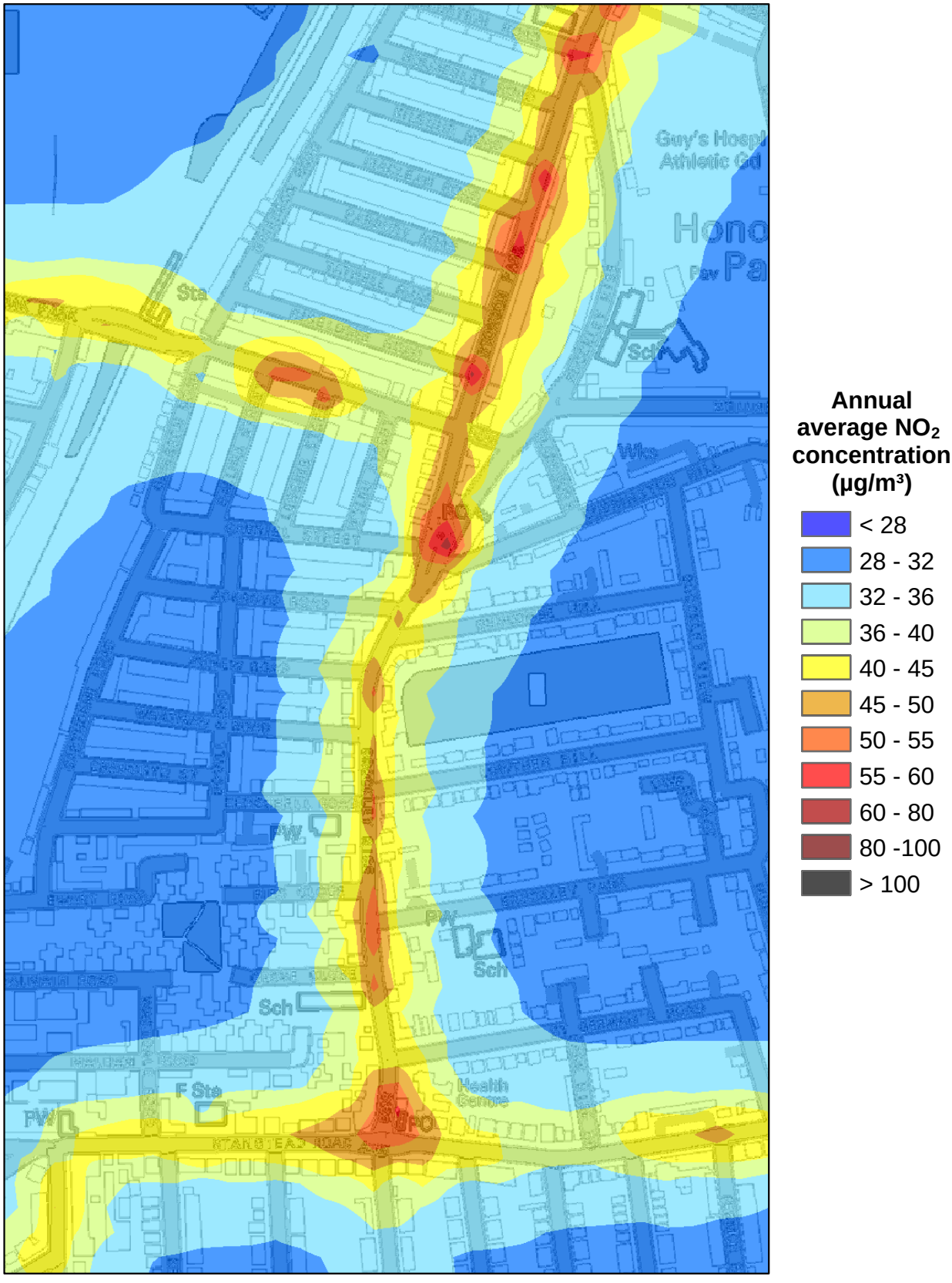

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Figure 5.6: Contour plot for Honor Oak Park, annual average NO_2

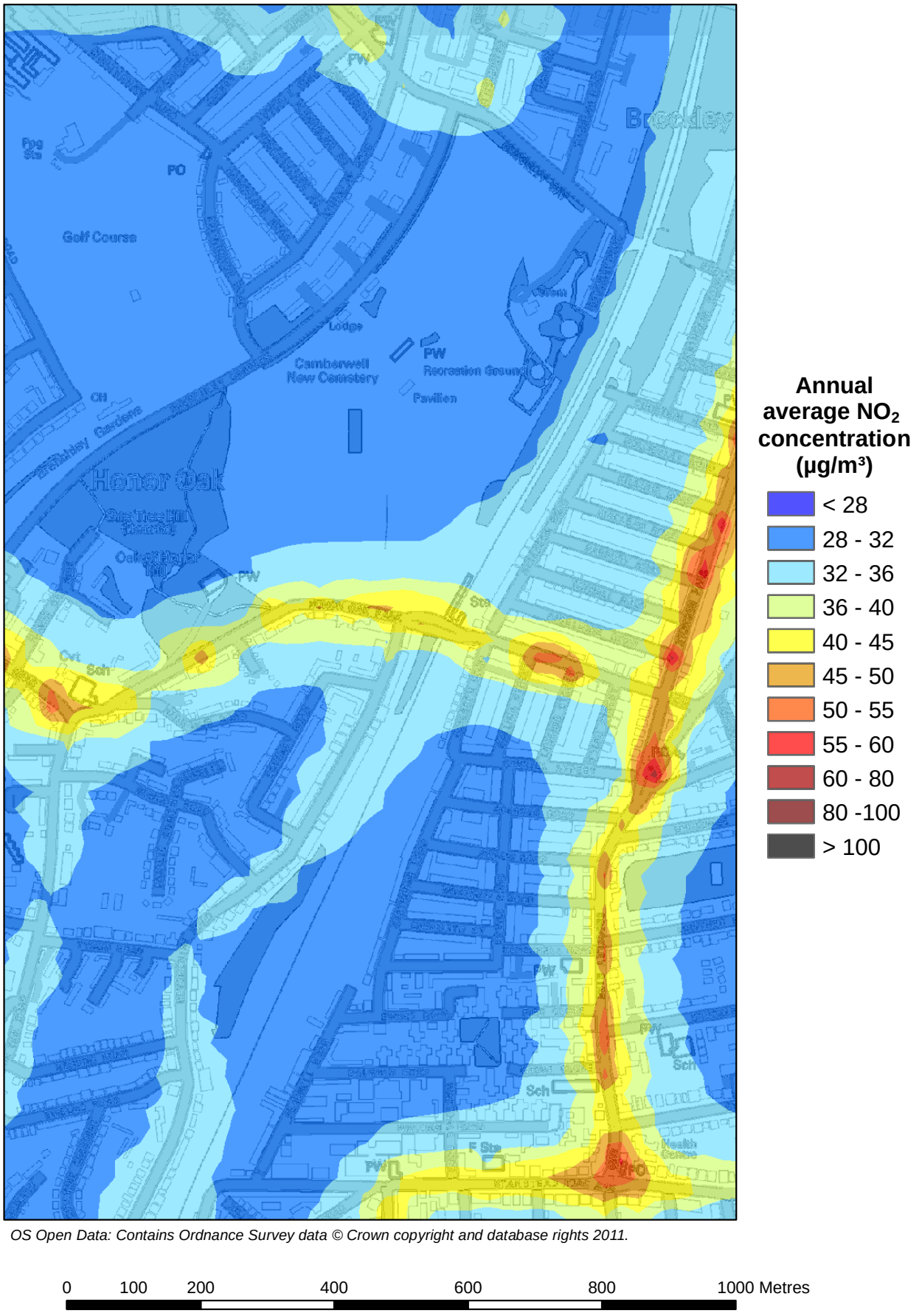

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Figure 5.7: Contour plot for Perry Vale, annual average NO_2

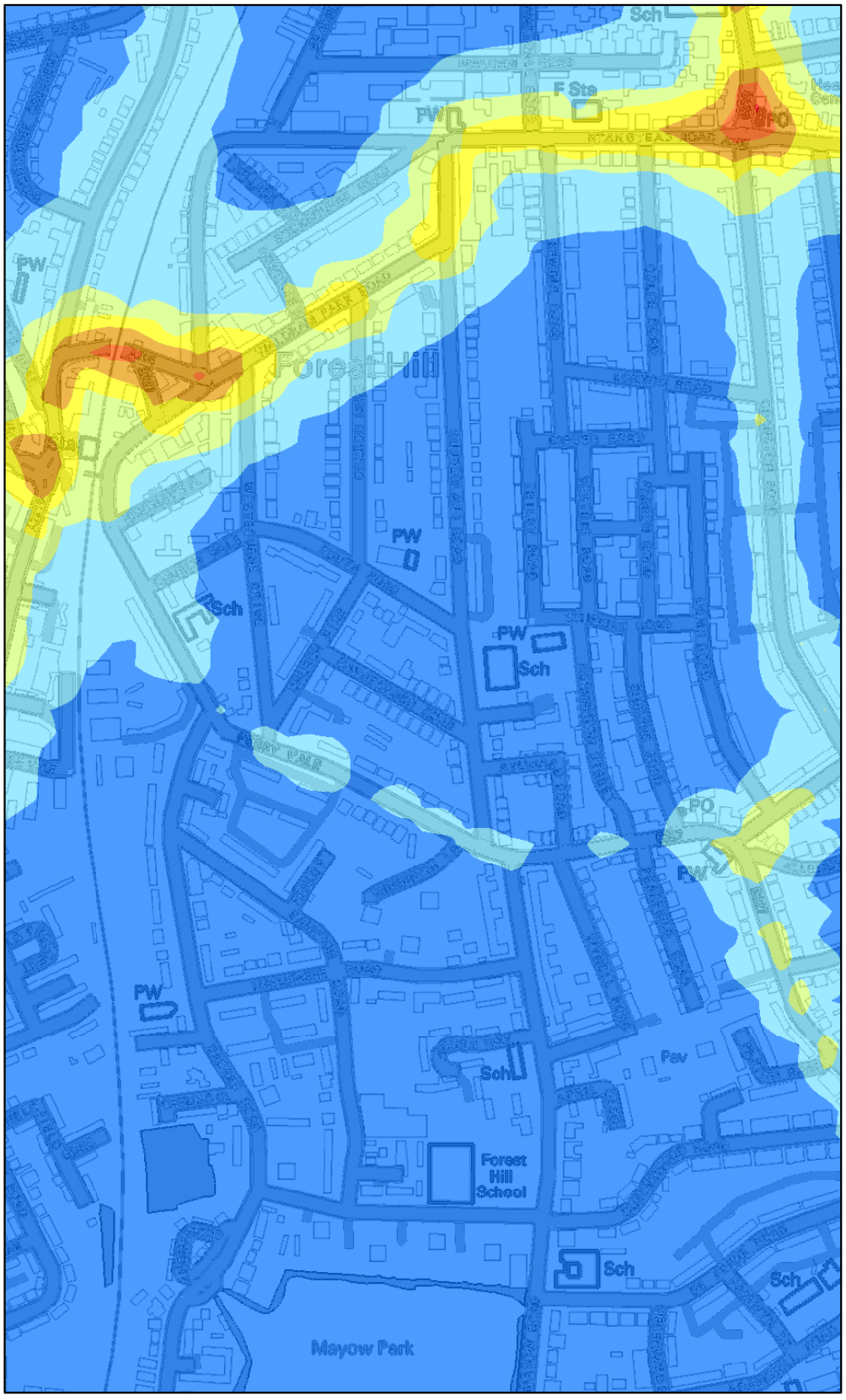
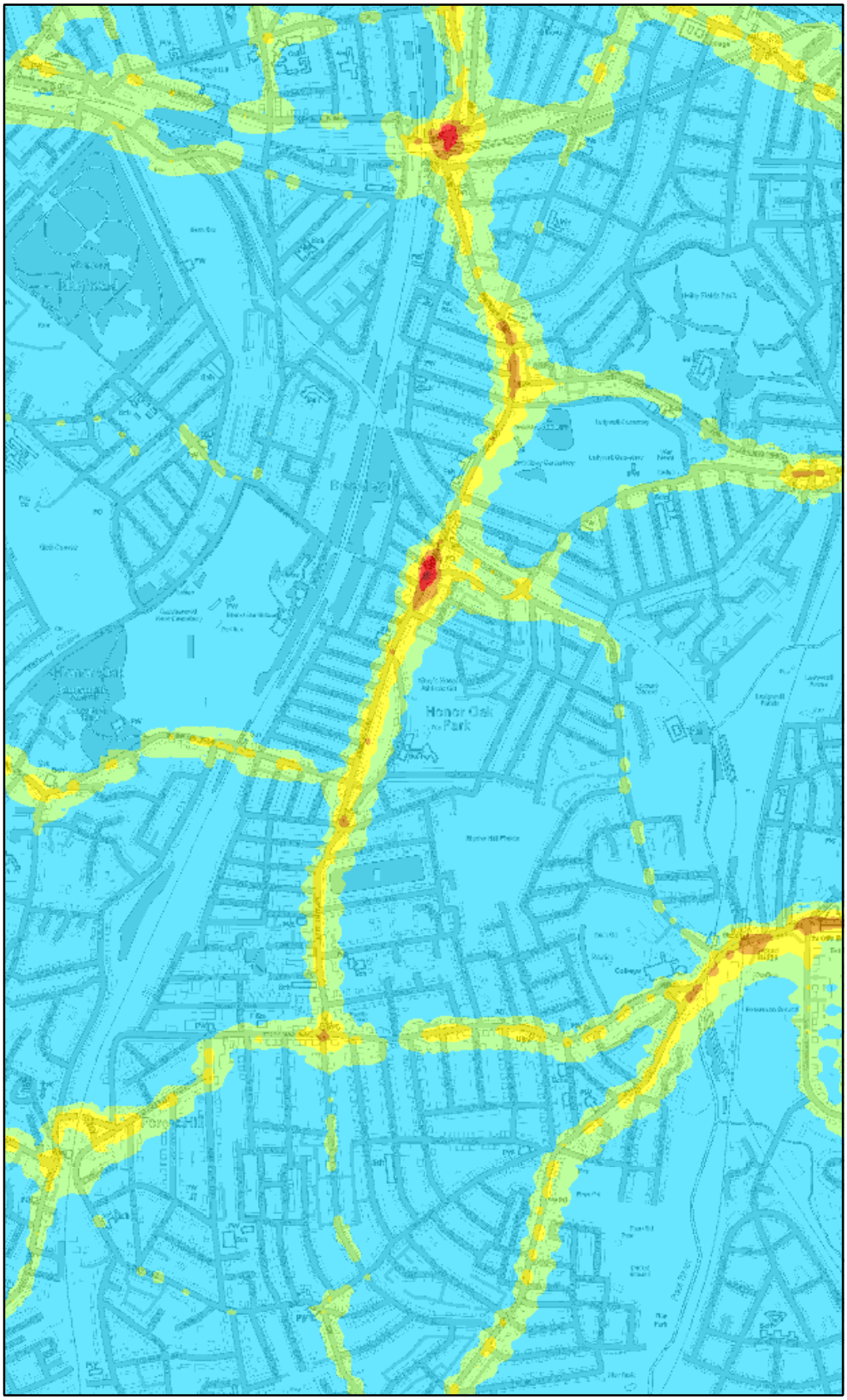


Figure 5.8: Contour plot showing all modelled roads, hourly average NO_2



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6 Population exposure estimates

The TG(09) guidance indicates that a Detailed Assessment should estimate:

- The maximum concentration at a relevant location;
- A timescale for meeting the air quality objective(s); and
- The number of people exposed in the area of exceedence.

The modelled annual average NO_2 concentrations predicted for 2011 were interrogated to determine the location of the maximum concentration at a relevant location. The very highest predicted concentrations across the model output area occur, unsurprisingly, within the carriageways of busy roads.

The highest concentration outside the carriageway of a road is predicted to occur at the façade of buildings along Brockley Road, between Hazeldon Road and Holdenby Road. There are predicted concentrations of around 110 $\mu g/m^3$ at building façades along this stretch of road. Although this section of Brockley Road is a shopping area, with retail premises on the ground floor, there are residential properties on the first floor. This section of Brockley Road does not fall within AQMA 3, or any of the other AQMAs.

The highest predicted concentrations at relevant locations along Brockley Rise are around 60 $\mu g/m^3$. These concentrations occur at building façades in the section of road close to the junction with the A205. This suggests that diffusion tube LWS009 represents an approximate worst-case location for Brockley Rise.

The highest predicted concentrations at locations of relevant exposure on Honor Oak Park are around 52 $\mu g/m^3$. These concentrations only occur for a small area between Ballina Street and Lessing Street.

For Perry Vale, all predicted concentrations are below the limit of 40 $\mu g/m^3$ except for the very small section at the far north of the road, at the junction with the South Circular road. The maximum predicted concentrations elsewhere along the road are around 36 $\mu g/m^3$, and these occur within the road carriageway only. This suggests that there is little risk of the NO_2 annual average objective being exceeded at relevant public exposure locations along Perry Vale.

The uncertainty in predicting future diesel NO_x emissions, as described in Section 4.2.2, and the absence of a clear downward trend in measured NO_2 concentrations, makes it very difficult to estimate a timescale for meeting the NO_2 air quality objective at the above locations.

In order to estimate the number of people exposed in the area of exceedence of the NO_2 annual average objective for each of the roads, the total area of exceedence of 40 $\mu g/m^3$ was calculated for each road. The areas of exceedence are illustrated in Figure 6.1; exceedences of the 40 $\mu g/m^3$ NO_2 objective are shown in red.

The guidance suggests that only the residential population should be considered, as opposed to individuals subject to transient exposure, such as those attending schools. The number of people residing within each of these areas of exceedence was therefore estimated using a value for the number of people per unit area. An average population density value of 71 people per hectare was taken from 2001 Census data for Lewisham[5].

As the predicted area of exceedence is much smaller for Honor Oak Park, the residential population in this area was estimated using a different method. The houses affected by predicted concentrations above 40 $\mu g/m^3$ were counted using aerial images, and the population calculated by using an average household size of 2.3 people per house, also taken from the 2001 Census data for Lewisham.

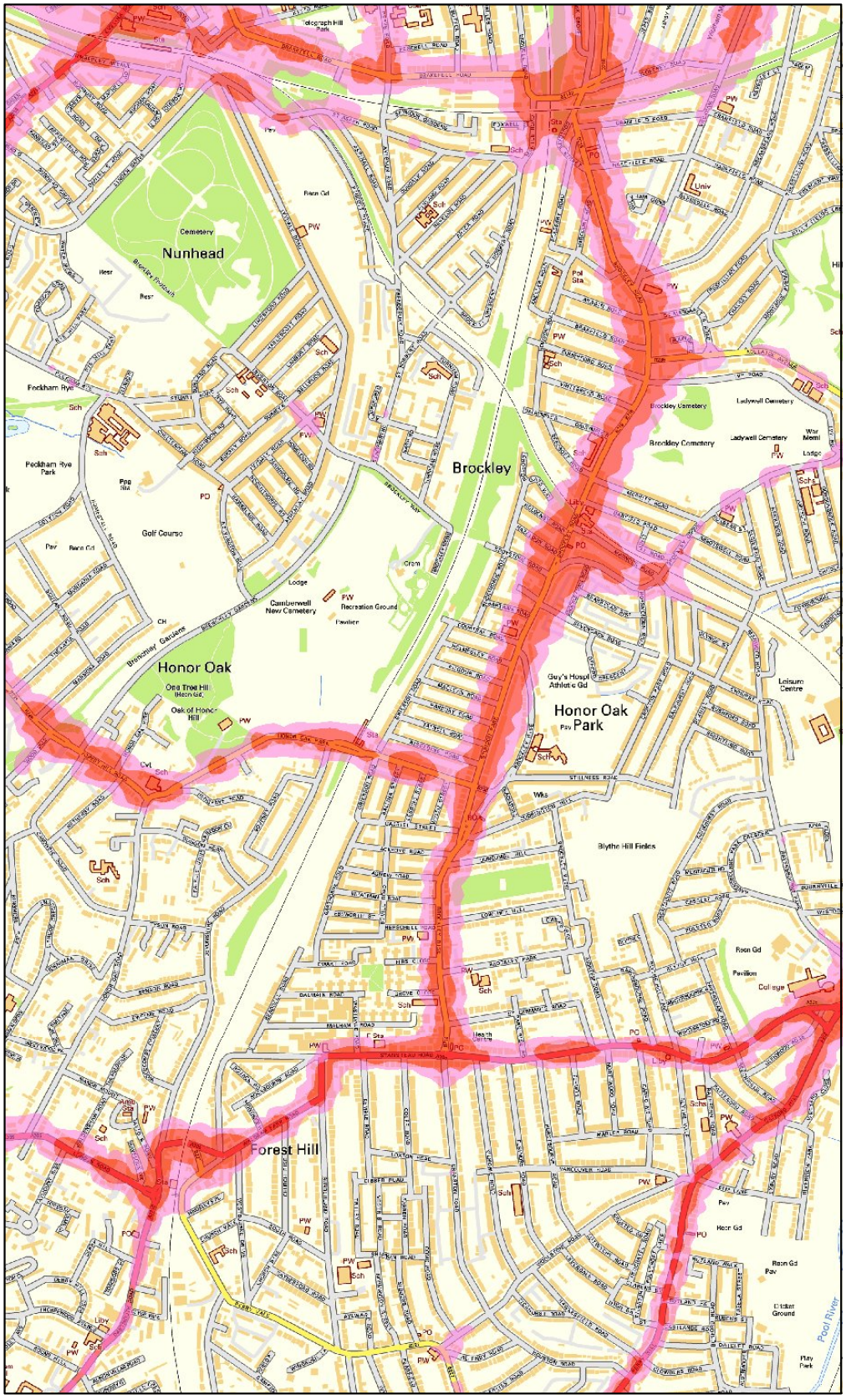
The estimated values of areas of exceedence and number of people exposed are shown in Table 6.1. Note that these values are only an approximation of the affected population. Values are shown separately for each road, including those for the Stondon Park section.

Table 6.1: Population exposure estimates for each road

Road	Approximate area of exceedence		Approximate number of houses affected	Approximate number of people exposed
	m^2	hectares		
Brockley Road	264,200	26.4	-	1,900
Stondon Park	54,500	5.5	-	400
Brockley Rise	55,300	5.5	-	400
Honor Oak Park	-	-	65	150
Perry Vale	0	0	0	0

[5] http://www.statistics.gov.uk/census2001/profiles/00az.asp

Figure 6.1: Contour plot showing areas of exceedence and near-exceedence



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7 Conclusions and proposed actions

7.1 Conclusions from monitoring data

7.1.1 Brockley Road

There are no diffusion tubes located on Brockley Road. Diffusion tube LWS015 is located very close to the northernmost point of Brockley Road, on Shardloes Road. This monitor, along with a section of Brockley Road, already falls within AQMA 3.

7.1.2 Brockley Rise

Diffusion tube LWS009 is located on Brockley Rise, and represents relevant exposure. The annual average NO_2 concentration in 2009 is 48 $\mu g/m^3$ (calculated using the local bias-adjustment factor) and 57 $\mu g/m^3$ (based on the national bias-adjustment factor). Both values are well above the objective value. The tube is located close to the junction with the A205 (South Circular road).

7.1.3 Honor Oak Park

There are no monitors located on or around Honor Oak Park.

7.1.4 Perry Vale

There are no roadside monitors along Perry Vale, and the nearest diffusion tube to this road is SCH013, which is located in the grounds of Christchurch School. The diffusion tube is located on the school boundary, approximately 5m from the kerbside. The tube's location is in line with or closer to the kerb than the property facades along this road and therefore it represents a worst case scenario.

The annual average NO_2 concentration at SCH013 in 2009 is 26 $\mu g/m^3$ (calculated using the local bias-adjustment factor) and 31 $\mu g/m^3$ (based on the national bias-adjustment factor). Both values are well below the objective value.

7.2 Conclusions from modelling study

The dispersion modelling predicts exceedences of the annual average NO_2 objective (and also the hourly average NO_2 objective) around many of the assessed roads. The following sections discuss the areas of exceedence of the annual average objective for each of the roads, and a summary of the resulting relevant population exposure.

7.2.1 Brockley Road

The modelling for 2011 predicts significant areas of exceedence of the annual average NO_2 objective around Brockley Road. The worst affected areas are those around junctions and street canyons, but there are exceedences along the whole length of the road, occurring in areas of relevant exposure, with an estimated 1,900 people being affected on Brockley Road itself, and a further 400 people affected along Stondon Park.

Predicted annual average NO_2 concentrations at building facades along the stretch of Brockley Road between Hazeldon Road and Holdenby Road are around 110 $\mu g/m^3$. Although this section of Brockley Road is a shopping area, with retail premises on the ground floor, there are residential properties on the first floor. This section of Brockley Road does not fall within AQMA 3, or any of the other AQMAs.

7.2.2 Brockley Rise

The modelling predicts significant areas of exceedence of the annual average NO_2 objective around Brockley Rise. The worst affected area is that at the far south of the road, close to the junction with the A205 (South Circular road), with predicted concentrations at building façades of up to 60 $\mu g/m^3$. The areas of exceedence represent relevant exposure, with an estimated 400 people being affected.

7.2.3 Honor Oak Park

There are areas of predicted exceedence around Honor Oak Park, but there is less relevant exposure than at Brockley Road and Brockley Rise, with around 150 people expected to be affected. The highest predicted concentrations at locations of relevant exposure are around 52 $\mu g/m^3$.

7.2.4 Perry Vale

Predicted concentrations do not exceed the objective of 40 $\mu g/m^3$ around Perry Vale, except for along a very small section at the most northerly point, at the junction with the A205 (South Circular Road). At all points except for this small section, the concentrations are well below the 40 $\mu g/m^3$ limit value, even those occurring within the road carriageway. This suggests that is very little risk of the NO_2 annual average objective being exceeded at relevant public exposure locations, and, as a result, the number of people exposed in an area of exceedence is zero for Perry Vale.

7.2.5 Mayow Road

The identification in the 2009 Updating and Screening Assessment of Mayow Road as a congested road, requiring Detailed Assessment, appears to be an anomaly; this conclusion appears to have been based on incorrect interpretation of the location of a traffic screenline count, which had been described as 'Kirkdale / Sydenham Road / Mayow Road'. The location at which the traffic count is carried out is actually on Sydenham Road, between the junctions with Kirkdale and Mayow Road; Sydenham Road is already part of an AQMA.

Mayow Road is not generally known to be a busy, congested road. It is not included in the LAEI, and no traffic flow data could be obtained for this road in order to model it explicitly.

For the reasons described above, Mayow Road was not included in this Detailed Assessment. Although there is congestion at the junction of Mayow Road and Sydenham Road, this is confined to a very small section of Mayow Road, and the exposure to higher concentrations is likely to only extend a few metres back from the junction. A diffusion tube has been located a few metres north of the junction, and can be used to assess the NO_2 concentrations at this location in the future.

7.3 Proposed actions

The proposed actions recommended as a result of the findings of this Detailed Assessment are described below.

Based on the findings within the Detailed Assessment, there are exceedences of the NO_2 annual average and hourly objectives occurring outside the existing AQMAs and at locations where there is relevant exposure.

The exceedences of the annual average NO_2 objective (and also the hourly average NO_2 objective) occur at residential properties along the modelled roads of Brockley Road, Stondon Park, Brockley Rise and Honor Oak Park. There is a need, therefore, to amend the current designation of the AQMAs within Lewisham. Given the current arrangement of AQMAs, there are several options for this.

Since the aforementioned areas of exceedence are for NO_2 only, and the existing AQMAs are designated for both NO_2 and PM_{10}, the best option appears to be to declare a new AQMA. This would be named AQMA 6, and designated for NO_2. This could either incorporate the areas of exceedence, in the form of ribbon-roads, as adopted for the existing AQMA 5, or be area-based, as adopted for the existing AQMAs 1 to 4. An area-based AQMA 6 would cover the whole Crofton Park ward.

The council should continue to monitor at strategic locations where the modelling shows that exceedences are likely to occur. The diffusion tube network within Lewisham has been extended as of January 2011, with a new tube being located at the junction of Honor Oak Park and the B218. The results from this diffusion tube should be considered in future assessments.

Appendix A: QA:QC Data

Annualisation of Data for Short-Term Monitoring

The diffusion tubes have been sited with the intention of collecting long-term data and, therefore, will be exposed for a minimum of 12 months. However, where the start of the monitoring period did not coincide with the start of the calendar year, there are some gaps in the monitoring data. Where monitoring began in April or after, the maximum data capture for the calendar year is limited to 75 per cent or less. In these instances, the data has been annualised using the procedure detailed in Box 3.2 of the Technical Guidance TG(09). This has not been carried out where the data capture is below 75 per cent owing to spurious or missing results as the gaps in the monitoring data are sporadic.

Of the data provided in Table 2.4a, only LWS051 has been annualised. The calculation was carried out using the background locations and values shown in the table below:

Table A1 Figures used in annualisation of NETCEN diffusion tube data

	Lewisham1: Catford	**Lambeth3: Loughborough Junction**	**Tower Hamlets1: Poplar**
2009 Annual Mean (Am) (µg/m^3)	56.1	33.3	35.4
Period Mean (01/07/09 – 05/01/10) (Pm) (µg/m^3)	54.9	29.9	34
Ratio of Annual Mean to Period Mean (Am/Pm)	1.02	1.11	1.04
Average of Ratios (Ra)	1.0567		

For the diffusion tubes located at schools, monitoring at locations SCH012 and SCH021 was initiated later in the year and, therefore, these results have been annualised. The calculation was carried out using the background locations and values shown in Table A2.

Table A2 Figures used in annualisation of non-NETCEN diffusion tube data

	Lewisham1: Catford	Lambeth3: Loughborough Junction	Tower Hamlets1: Poplar
2009 Annual Mean (Am) (µg/m^3)	56.1	33.3	35.4
Period Mean[a] (29/04/09 – 05/01/10) (Pm) (µg/m^3)	53.1	29	32.4
Period Mean[b] (13/07/09 – 05/01/10) (Pm) (µg/m^3)	55.6	30.1	34.5
Ratio of Annual Mean to Period Mean[a] (Am/Pm)	1.06	1.15	1.09
Ratio of Annual Mean to Period Mean[b] (Am/Pm)	1.01	1.11	1.03
Average of Ratios (Ra)[a]	1.1		
Average of Ratios (Ra)[b]	1.05		

Diffusion Tube Bias Adjustment Factors

As discussed in 2.1.2, triplicate tubes are co-located at Lewisham 2, the automatic monitoring station located at the roadside on New Cross Road. The diffusion tubes are located within 0.5m of the inlet sampler of the chemiluminescent analyser at the site. Comparing the data from the two monitoring methods and using the AEA spreadsheet, a local bias adjustment factor was calculated which is shown in the table below with the national bias adjustment factor.

Table A3 2009 Bias Adjustment Factors

2009	Bias adjustment factor
Local	0.84
National	0.99

The co-location study compared equivalent exposure periods, although the continuous results are provisional. Data from the diffusion tubes were available for 11 of the 12 monitoring periods while data capture from the automatic monitoring station was above 80% for all but one of the corresponding periods. The results from the data quality check on the spreadsheet indicate that there was good precision for the diffusion tubes. The term ‘precision’ indicates how well the diffusion tubes produce similar results from the triplicate study undertaken. The criterion is somewhat arbitrary and it reflects both the laboratory’s performance in preparing and analysing the tubes, plus the handling of the tubes in the field. The precision is based on an assessment of the coefficient of variation. ‘Good’ precision is defined as achieving a coefficient of variation less than 20% for eight or more periods in a year and the average is less than 10%.

The local bias adjustment factor indicates that the results over-estimate continuously monitored concentrations by a much larger margin than that seen nationally. The bias adjustment factors are specific to each year, analysing laboratory, method of analysis and location. The factors are therefore also limited to the data supplied. The Review and Assessment website advises that 'in many cases, using an overall correction factor derived from as many co-location studies as possible will provide the 'best estimate' of the 'true' annual mean concentration, it is important to recognise that there will still be uncertainty associated with this bias adjusted annual mean. One analysis has shown that the uncertainty for tubes bias adjusted in this way is ± 20% (at 95% confidence level). This compares with a typical value of ± 10% for chemiluminescence monitors subject to appropriate QA/QC procedures.'

The results of a nation-wide survey of nitrogen dioxide diffusion tube co-location studies were further used to improve current understanding of diffusion tube bias (AQC, 2006). The data suggested that tubes close to a road were more likely to underestimate concentrations, once they have been adjusted for laboratory bias, and conversely tubes further away from roads were more likely to overestimate concentrations. (Note this is the opposite of the local findings reported here).

Further analysis of the results suggested that it was not the distance from roads that mattered; rather it was the different concentrations of nitric oxide, nitrogen dioxide and ozone in the atmosphere. The different concentrations influenced the chemistry taking place within the diffusion tube, in particular the formation of additional nitrogen dioxide from a reaction of ozone with nitric oxide.

Discussion of Choice of Factor to Use

The choice of which bias factor to use is not straightforward; hence the two factors (local and default) are reported above to provide context. Box 3.3 of the TG 09 guidance provides some suggestions as to which factor might be the most appropriate. In this instance, there are reasons for using either. For information, the results using both adjustment factors for 2009 data is shown in the relevant results tables.

Table A4: 2009 Diffusion Tube Collocation Data (Lewisham2)

Diffusion Tube Collocation Data Questionnaire For Local Authorities 2009

Please Read the "Notes" sheet and then fill in the white boxes of this questionnaire
Should you require assistance, email kiribrown@aqconsultants.co.uk or phone 0117 974 1086

	Date form filled in	Name of Local Authority	Your name	Phone number	Contact email
Your Details	21/04/2010	London Borough of Lewisham	Dave Trew	020 8314 9783	dave.trew@lewisham.gov.uk

	Distance from kerb (m)	Site type (e.g. roadside, background). Definitions of site types are given on the "Notes" sheet	Distance from diffusion tube(s) to continuous analyser inlet (m)	Location (site name or a brief description)	Grid Reference of Site (if available)
Site Details	**6**	Roadside	0.5	Lewisham 2, Hobgoblin P.H., New Cross Road	536241, 176932

	Prepared by (if known; e.g. Harwell Scientific Services)	Analysed by (e.g. Kent Scientific Services)	Preparation method (e.g. 50% TEA in acetone; 50% TEA in water)	How are diffusion tubes deployed? (e.g. with a clip, spacer, shelter box, just tape)
Diffusion Tube Details	Bureau Veritas	Gradko International	50% TEA in acetone	with spacer

	Analyser type	QA/QC (e.g. local or network)
Continuous Analyser Details	ML9841B Chemiluminescent analyser	LAQN

Data from the Automatic Analyser (Matching Individual Diffusion Tube Periods)

Period	Start Date (dd/mm/yy)	End Date (dd/mm/yy)	% Data Capture	Ratified / Provisional	NOx (if available) (ug/m^3)	Nitrogen Dioxide (ug/m^3)
1	07/01/2009	03/02/2009	39	R	187.06	68.83
2	03/02/2009	03/03/2009	93	R	238.29	99.46
3	03/03/2009	03/04/2009	80.6	P	171.21	80.02
4	03/04/2009	29/04/2009	100	P	143.03	78.9
5	29/04/2009	03/06/2009	100	P	120.89	66.33
6	03/06/2009	01/07/2009	100	P	138.49	75.3
7	01/07/2009	29/07/2009	93	P	77.17	41.09
8	29/07/2009	02/09/2009	97.1	P	73.66	36.42
9	02/09/2009	30/09/2009	100	P	132.9	59.14
10	30/09/2009	04/11/2009	100	P	138.76	58.94
11	04/11/2009	03/12/2009	100	P	89.73	41.52
12	03/12/2009	05/01/2010	100	P	148.71	59.99
13						

Please express NOx as NO_2 (e.g. ppb x 1.913) or alternatively note the approach / units here:

When you are identifying the automatic monitoring periods that match your diffusion tube exposure periods, please be as precise as possible. It is not, however, necessary to match start times to the exact hour that you put out your tubes.

Individual Period (monthly) Mean Nitrogen Dioxide Data from the Diffusion Tubes (ug/m^3)

Period		Tube 1	Tube 2 (if available)	Tube 3 (if available)	Tube 4 (if available)
1		59.58	78.37	72.74	
2		97.61	90.55	86.21	
3		N/A	N/A	N/A	
4		74.89	67.06	70.18	
5		66.4	72.92	65.12	
6		72.57	73.29	72.87	
7		66.19	68.44	73.45	
8		71.9	73.28	70.59	
9		79.22	73.16	N/A	
10		73.44	73.76	N/A	
11		77.75	72.32	66.18	
12		69.11	69.52	70.08	
13					

	Are the concentrations stated in ug/m^3?	Did the diffusion tube supply or analysis method change during the monitoring period? When, from what, to what?	Were there any significant problems with the continuous analyser during the monitoring period?	Are there any other relevant issues with your data?
Other Information	yes	no	no	no

Please Return Completed Questionnaires to: kiribrown@aqconsultants.co.uk
This questionaire has been compiled and distributed by Air Quality Consultants Ltd on behalf of Defra and the DAs

Appendix B: Monthly Non-adjusted NO_2 Diffusion Tube Results, 2009

Table B1: NO_2 concentrations ($\mu g/m^3$)

	LWS 002	LWS 003	LWS 004	LWS 005	LWS 006	LWS 007	LWS 008	LWS 009	LWS 010	LWS 011	LWS 012	Blank	LWS 014	LWS 015	LWS 016	LWS 017	LWS 018	LWS 051
Feb 08	48.7	52.75	57.16	74.26	65.33	67.95	58.74	67.67	50.61	67.96	39.03							
Mar 08	29.86	34.24	44.02	59.87	62.57	51.42		50.07	30.52	41.72								
Apr 08	31.57	45.89	62.85	54.87	60.86	58.01	48.53	59.00	32.66	56.45								
May 08	31.13	58.47	100.86	89.31	88.97	91.64	72.10	51.22	41.62	78.31	26.28							
Jun 08	34.40	51.80	65.25	74.00	73.31	69.15	57.99	66.19	30.33	58.86	5.75							
Jul 08	31.71	51.25	50.17	58.75	60.02	61.37	48.74	64.88	31.10	57.93	20.25							
Aug 08	28.28	40.61	47.72			63.37	37.28	50.80	26.25	43.75	17.64							
Sep 08	27.87	33.12	49.64	49.90	51.34	57.05	44.23	44.95	28.54	47.27	23.23							
Oct 08	42.97	51.45	59.24	60.81	76.94	71.80	45.37	65.62	38.61	58.10	27.43							
Nov 08	49.26	53.76	64.98	85.85	80.05	77.61		58.79	44.15		35.91	0.32						
Dec 08	47.68	51.97	69.20	88.24	82.89	80.07	58.15	66.78	48.14	60.61	37.37		36.99					
Jan 09	50.34	57.32	80.48	59.58	78.37	72.74	59.36	63.07	51.52	67.08	41.19	0.29	21.28	77.20	52.88			
Feb 09	48.15	54.05	83.52	97.61	90.55	86.21		77.93	55.84	75.59	44.13	1.25	43.31	72.33	49.63			
Mar 09	43.62	51.26	75.43					67.51	38.86	59.12			31.77	63.21	41.72	65.61	34.68	
Apr 09	36.99	56.93	69.10	74.89	67.06	70.18	59.27	34.94	62.74	64.81			29.89	64.64	46.37	68.61		
May 09	27.89		53.93	66.40	72.92	65.12		53.71	23.89	49.72		0.66	20.09	50.64	31.91	51.36	23.44	
Jun 09	23.51	43.41	58.41	72.57	73.29	72.87		47.21	25.53	48.48		0.48	22.66	47.54	31.08	52.78	22.49	
Jul 09	26.29	38.85	34.20	66.19	68.44	73.45	52.89	52.17	22.52	49.06		0.51	17.10		27.04	30.78		
Aug 09	31.12	46.92	44.58	71.90	73.28	70.59		56.03	25.87	53.01			20.22	44.37	34.12	36.71		59.33
Sep 09	31.12	43.27	59.10	79.22	73.16			57.98	29.96	44.92			23.46	46.15	38.08	51.43	30.14	51.15
Oct 09	38.77	49.33	56.72	73.44	73.76			66.70	39.73	58.09			30.92	64.31	46.48	49.04	35.26	58.13
Nov 09	39.33	53.36	40.75	77.75	72.32	66.18		46.98	38.62	56.07			28.65	68.48	41.84	40.09	29.22	62.30
Dec 09		51.44	63.88	69.11	69.52	70.08		61.17	44.68	66.64		0.26	39.14	68.10	49.36		42.57	
Jan 10	44.40	55.22	67.20	72.23	74.44	69.92		61.17		60.84		2.25	35.14	69.30	47.80		39.63	61.05
Feb 10	38.80	55.45	65.94					58.79	38.59			1.43	32.30	65.33	53.11	76.15	38.05	57.12
Mar 10	30.57	47.98	47.43	58.48	59.51	57.12		46.38	30.79	60.36		1.02	26.97	52.97	33.29		26.50	
Apr 10	28.85	46.48	70.91	67.37	69.20	64.23		52.40	30.41	55.73		1.43	25.21	50.98	42.09	65.48	27.37	99.57

Appendix C: Road data

Table C1: Geometry and speed information for the modelled Detailed Assessment roads

Road source	Source length (m)	Width (m)	Canyon height (m)	Speed[6] (m/s)
Brockley Road 1	570	12	0	30
Brockley Road 2	202	25	15	15
Brockley Road 3	168	20	15	25
Brockley Road 4	353	12	0	25
Brockley Road 5	76	20	15	5
*Brockley Road 6	48	10	0	5
Brockley Road 7	9	10	0	5
*Brockley Road 8	87	10	0	20
Brockley Road 9 / Stondon Park	576	25	12	20
Stondon Park	79	25	12	25
Junction 1	55	25	12	25
Junction 2	12	25	12	25
Junction 3	12	25	12	25
Junction 4	5	25	12	25
Junction 5	13	25	12	25
Junction 6	109	25	12	25
Brockley Rise 1	323	12	0	25
Brockley Rise 2	237	16	10	25
*Brockley Rise 3	39	10	0	25
Honor Oak Park 1	540	10	0	25
*Honor Oak Park 2	120	10	0	25
Honor Oak Park 3	285	20	15	25
Perry Vale 1	78	10	0	5
Perry Vale 2	755	10	0	40
Perry Vale 3	253	20	10	40

The sources for Brockley Road, Brockley Rise and Perry Vale are numbered according to their location, from north to south. The road section named 'Brockley Road 1', for example, extends 570m south from the most northerly point of Brockley Road. Honor Oak Park sources are numbered in a similar way, but from west to east. The sources named 'Junction' comprise the small sections of road forming the junction of Brockley Rise, Stondon Park Road and Gabriel Street.

Roads sources marked * are modelled as two-way traffic, and the AADTs for these roads shown in Tables C2 and C3 represent the traffic flow in each direction.

[6] For both the 2009 and 2011 modelling

Table C2: AADTs of each vehicle type, 2008 data

Road	Motorcycle	Taxi	Car	Bus	LGV	Rigid HGVs 2 axles	Rigid HGVs 3 axles	Rigid HGVs 4+ axles	Articulated HGVs 3-4 axles	Articulated HGVs 5 axles	Articulated HGVs 6+ axles
Brockley Road 1	516	961	24138	718	2741	1067	109	162	93	134	0
Brockley Road 2	740	1371	34449	718	3913	1464	149	220	129	181	0
Brockley Road 4	495	915	23060	911	2616	1082	112	163	96	136	0
Brockley Road 3	495	915	23060	911	2616	1082	112	163	96	136	0
Brockley Road 5	406	752	18817	1067	2136	955	99	145	86	120	0
Brockley Road 6	203	376	9409	534	1068	478	50	73	43	60	0
Brockley Road 7	406	752	18817	1067	2136	955	99	145	86	120	0
Brockley Road 8	292	542	13645	534	1548	632	66	94	56	80	0
Brockley Road 9 /Stondon Park	584	1084	27289	1067	3096	1263	131	188	112	159	0
Stondon Park	367	687	17152	677	1948	796	84	120	72	97	0
Junction 1	184	344	8576	339	974	398	42	60	36	49	0
Junction 2	184	344	8576	339	974	398	42	60	36	49	0
Junction 3	184	344	8576	339	974	398	42	60	36	49	0
Junction 4	184	344	8576	339	974	398	42	60	36	49	0
Junction 5	184	344	8576	339	974	398	42	60	36	49	0
Junction 6	184	344	8576	339	974	398	42	60	36	49	0
Brockley Rise 1	367	687	17152	677	1948	796	84	120	72	97	0
Brockley Rise 2	367	687	17152	677	1948	796	84	120	72	97	0
Brockley Rise 3	184	344	8576	339	974	398	42	60	36	49	0
Honor Oak Park 1	349	652	16380	352	1859	728	77	106	63	90	0
Honor Oak Park 2	193	358	8973	79	1018	462	48	69	42	58	0
Honor Oak Park 3	386	715	17946	157	2035	924	96	138	83	115	0
Perry Vale 1	74	136	3406	76	387	129	12	16	12	15	0
Perry Vale 2	121	222	5571	269	634	207	20	32	16	27	0
Perry Vale 2	121	222	5571	269	634	207	20	32	16	27	0

Table C3: AADTs of each vehicle type, 2011 data

Road	Motorcycle	Taxi	Car	Bus	LGV	Rigid HGVs 2 axles	Rigid HGVs 3 axles	Rigid HGVs 4+ axles	Articulated HGVs 3-4 axles	Articulated HGVs 5 axles	Articulated HGVs 6+ axles
Brockley Road 1	522	977	24648	724	2775	1074	110	163	94	135	77
Brockley Road 2	749	1394	35177	724	3961	1474	150	221	129	183	103
Brockley Road 4	501	930	23547	919	2648	1089	113	164	97	137	77
Brockley Road 3	501	930	23547	919	2648	1089	113	164	97	137	77
Brockley Road 5	411	765	19214	1076	2162	961	99	146	87	121	69
Brockley Road 6	206	383	9607	538	1081	481	50	73	44	61	35
Brockley Road 7	411	765	19214	1076	2162	961	99	146	87	121	69
Brockley Road 8	295	552	13933	538	1567	636	66	95	57	80	45
Brockley Road 9 /Stondon Park	590	1103	27866	1076	3134	1272	132	189	113	160	90
Stondon Park	371	699	17515	683	1972	802	85	121	72	98	58
Junction 1	186	350	8758	342	986	401	43	61	36	49	29
Junction 2	186	350	8758	342	986	401	43	61	36	49	29
Junction 3	186	350	8758	342	986	401	43	61	36	49	29
Junction 4	186	350	8758	342	986	401	43	61	36	49	29
Junction 5	186	350	8758	342	986	401	43	61	36	49	29
Junction 6	186	350	8758	342	986	401	43	61	36	49	29
Brockley Rise 1	371	699	17515	683	1972	802	85	121	72	98	58
Brockley Rise 2	371	699	17515	683	1972	802	85	121	72	98	58
Brockley Rise 3	186	350	8758	342	986	401	43	61	36	49	29
Honor Oak Park 1	353	663	16726	355	1882	733	77	106	64	91	50
Honor Oak Park 2	195	364	9163	79	1030	465	49	70	42	58	34
Honor Oak Park 3	390	727	18326	158	2060	930	97	139	84	116	67
Perry Vale 1	75	138	3455	77	391	130	13	16	13	15	9
Perry Vale 2	122	226	5652	272	641	209	20	32	16	27	14
Perry Vale 3	122	226	5652	272	641	209	20	32	16	27	14