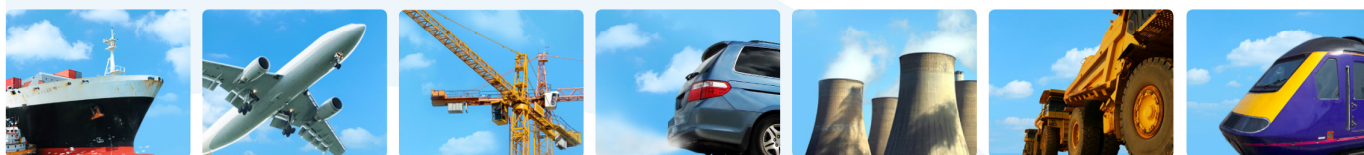# Air Quality
CONSULTANTS

Review of the air quality monitoring network in London:
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Experts in air quality
management & assessment

Document Control

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1235/1/F1	19 April 2011	Final Report	Prof. Duncan Laxen

Contents

1   Introduction

1.1   Air Quality Consultants Ltd (AQC) has been commissioned by the Greater London Authority (GLA) to carry out a review of the automatic air quality monitoring network in London. Three principal objectives were identified for the study:

- To identify the principal roles of the monitoring network in London (both current and future);

- To identify which sites provide the most useful data, taking into account geographical location, site classification, and pollutants monitored; and

- To identify any gaps in the monitoring network which are critical to the delivery of the principal roles.

1.2   Whilst this review focuses on nitrogen dioxide, PM_{10} and $PM_{2.5}$, consideration has also been given to ozone monitoring in the network due to the important role that this pollutant plays in NOx photochemistry. The role of the monitoring network with respect to the health effects of ozone exposure have not been considered, and are beyond the scope of this study.

1.3   This report only covers the automatic monitoring network, and makes no comment on the extensive passive nitrogen dioxide diffusion tube networks operated by some boroughs. It should also be noted that the report includes all sites which were listed as operational on 25th March 2011. Sites which closed before this date are excluded.

Approach

1.4   The approach taken to this review has involved several different activities:

- Discussions were held with network operators and users of the data at a strategic level. AQC is grateful to the support provided by Dr Gary Fuller, Dr David Green, Dr Ben Barrett and Dr David Carslaw at King's College London Environmental Research Group (KCL-ERG) for providing detailed information;

- Discussions were also held with a number of the London Boroughs, focussing on the Air Quality Cluster Groups. AQC is grateful to Rob Gibson (West London AQCG), Kyri Eleftheriou-Vaus (Central London AQCG) and Ed Steadman (South London AQCG) for providing feedback;

- Information on the individual monitoring sites was downloaded from the Automatic Urban and Rural Network (AURN), London Air Quality Network (LAQN) and Heathrow Airwatch websites.

1.5   Summary information about individual sites was derived from the relevant websites[1]. Information was taken from the LAQN in the first instance, and then supplemented with information from the

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[1]   AURN – http://uk-air.defra.gov.uk/; LAQN - http://www.londonair.org.uk; Heathrow Airwatch - http://www.heathrowairwatch.org.uk/

other websites as necessary. Where the different websites assign a different name to the same monitoring station (which is a frequent occurrence), the station name used in this report is consistent with that recorded by the LAQN. Where there were discrepancies regarding the instruments used at a site, information from the AURN was used in preference. Measured concentrations and data capture rates were obtained using the Openair software. This approach was not able to extract information from the Heathrow Airwatch site, and whilst these sites are included in the analysis, the measured concentrations are not reported. Similarly, measured concentrations for Sutton Carshalton and Bexley Manor Road West are not reported as the information was not available via the LAQN Openair interface. All PM_{10} concentrations reported are as obtained via Openair; the TEOM PM_{10} data have been adjusted using the Volatile Correction Model and the BAM data have been adjusted following the approach set out in LAQM.TG(09)[2].

2   Purpose of the Monitoring Network

2.1   The automatic air quality monitoring network in London is funded by a number of different organisations:

- Central Government (Defra), via sites that are fully-funded in the AURN;

- London Boroughs (a small number of these sites have been "affiliated" into the AURN, such that the borough receives funding to support QA/QC and data ratification);

- BAA (for a number of sites in the vicinity of Heathrow Airport).

2.2   The majority of sites in the network are funded by the individual boroughs. TfL has also provided funding to directly provide or upgrade a small number of sites to assist with monitoring the effectiveness of the Low Emission Zone (LEZ).

2.3   Monitoring data collected from the London network are used to fulfil a number of purposes:

- To determine compliance with the objectives and limit values;

- To provide information to research workers in academia and consultancies;

- To provide information to developers to assist with the preparation of Environmental Impact Assessments and/or air quality assessments;

- To identify trends in pollutant concentrations in order to assess the effectiveness of control strategies;

- To evaluate the performance of models at both a local and London-wide scale;

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[2]   Review & Assessment: Technical Guidance (http://archive.defra.gov.uk/environment/quality/air/airquality/local/guidance/documents/tech-guidance-laqm-tg-09.pdf)

- To assist the boroughs in their LAQM duties; and

- To inform the development of future policies and strategies to improve air quality.

2.4   It is important to note that whilst the network plays a vital role in supporting a wide range of strategic assessments at the London-wide scale, it is largely dependant on organisation and funding at the individual borough level.

2.5   There is no evidence to suggest that the purpose of the monitoring network will change significantly in the future, although the requirements are viewed differently by different users. At the borough level, the focus is to provide information to councillors, members of the public, pressure groups, and to support the Local Air Quality Management process. The strategic interest lies with the GLA and with central Government and is served by the network of sites that form the AURN and LAQN.

2.6   It is also important to note that there is no obligation on individual boroughs to report monitoring data to any centralised network or website. Whilst this has potentially important implications for the stragtegic use of the monitoring data by GLA, issues related to data management and disemination are outside the scope of this contract.

3   Identification of the Most Valuable Monitoring Sites

3.1   The identification of those sites within the network that provide the most valuable data, in terms of fulfilling the purposes of the network as defined above, has been based upon:

- The use of the site for specific strategic-level assessments;

- The spatial distribution of different site types[3] (e.g. kerbside, roadside, urban background) across London:

- The extent to which the sites represent hotspots or general urban background concentrations with regard to the critical objective, target or limit value;

- The extent to which the site represents relevant public exposure;

- Whether the site typically achieves good data capture rates;

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[3]   The assessment was carried out on a pollutant-by-pollutant basis, as the siting priorities are different for different pollutants.

- The equipment used for PM_{10} and $PM_{2.5}$ monitoring[4] (e.g. whether it is "reference equivalent");

- The continuity of the site; and

- Whether there are collocated pollutant measurements (e.g. $PM_{10}/PM_{2.5}$, NOx/O_3 etc).

3.2   This assessment is necessarily focused on the value of the network to GLA at the strategic level. It is neither feasible, nor appropriate, to evaluate the importance of individual monitoring stations to individual boroughs within the scope of this project.

Overview of the Network

3.3   Figures 1 to 3 show the spatial distribution of the nitrogen dioxide, PM_{10} and $PM_{2.5}$ monitoring sites respectively, with each site categorised according to site type. Figures 4 and 5 also show the PM_{10} and $PM_{2.5}$ sites, but exclude those locations where the measurement method used is not "reference equivalent". Table 1 summarises Figures 1 to 5, showing the number of sites of each type measuring each pollutant. There are 103 nitrogen dioxide sites, 91 PM_{10} sites, and 31 $PM_{2.5}$ sites; when only "reference equivalent" sites are included for PM_{10} and $PM_{2.5}$, the number of sites falls to 43 and 17 respectively. Table 1 also shows that 60% of the nitrogen dioxide monitoring sites are at roadside and kerbside locations, but only 47% of "reference equivalent" $PM_{2.5}$ sites are similarly categorised.

Nitrogen Dioxide

3.4   Figure 6 shows the recorded annual mean nitrogen dioxide concentration in 2010. Concentrations ranged from 173 $\mu g/m^3$ at the kerbside site at Lambeth Brixton Road, to 21 $\mu g/m^3$ at the suburban Hounslow Cranford site.   There were exceedences of the annual mean objective for nitrogen dioxide (40 $\mu g/m^3$), recorded at a total of 50 sites[5]; 16 of these recorded an annual mean concentration above 60 $\mu g/m^3$ [6]. The concentrations at those sites with the highest levels (>60 $\mu g/m^3$) are tabulated in Table 2.

3.5   The 1-hour mean nitrogen dioxide objective (no more than 18 hours above 200 $\mu g/m^3$) was exceeded at 14 sites (Figure 7). The numbers of 1-hour mean exceedences are also set out in Table 3.

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[4]   For strict comparison with the UK objectives and EU limit values, concentrations of PM_{10} and $PM_{2.5}$ must be measured using a method that has been demonstrated to be equivalent to the European reference sampler. The concentrations measured by such samplers are termed "reference equivalent". In the London network, PM_{10} instruments that are equivalent to the reference sampler include the FDMS, Partisol and BAM; for $PM_{2.5}$, equivalent instruments include the FDMS and Partisol (NB the latter does not have formal equivalence status, but is included in the Defra AEI network).

[5]   Exceedences of the limit values which are reported by Defra to the European Commission, are restricted to those monitoring sites which form part of the AURN. Sites within the AURN must conform to the Data Quality Objectives and the siting criteria as set out in Annex 1 and Annex III of Directive 2008/50/EC

[6]   60 $\mu g/m^3$ is the Margin of Tolerance not to be exceeded after 2010 if a Time Extension Notice for achieving the limit value is granted by the European Commission.

PM$_{10}$

3.6   Figures 8 and 9 show the measured annual mean PM$_{10}$ concentrations and the number of 24-hour mean PM$_{10}$ concentrations above 50 µg/m^3 during 2010.   Annual mean PM$_{10}$ concentrations ranged from 43 µg/m^3 at Lambeth Bondway Interchange (roadside) to 14 µg/m^3 at Hillingdon Harlington (urban background). The annual mean objective (40 µg/m^3) was only exceeded[5] at two sites as shown in Table 4.   The 24-hour mean objective (which allows no more than 35 exceedences of 50 µg/m^3 as a 24-hour mean) was exceeded at five sites, as shown in Table 5.

PM$_{2.5}$

3.7   Figure 10 summarises the annual mean PM$_{2.5}$ concentrations during 2010.   There were no recorded exceedences of the 2015 limit value for PM$_{2.5}$ (25 µg/m^3).

Strategic Level Assessments

3.8   Data from the London network are used to support a number of assessments and research projects at the national and regional scales. These include:

3.9   *Average Exposure Indicator Reference Sites*: The national exposure reduction target for PM$_{2.5}$ is based on the Average Exposure Indicator (AEI). The AEI is based on measurements at urban background locations in agglomerations throughout the UK, and is assessed as a three-year running mean.   The AEI for the reference year (2010) is being determined from the mean concentration of the years 2009, 2010 and 2011. The exposure reduction target is relative to the 2010 AEI and is to be met by 2020 (the mean concentration of the years 2018, 2019 and 2020). Defra has identified eight sites in London which will contribute to the calculation of the UK's 2010 AEI. Figure 11 shows the AEI sites in London.

3.10   *LEZ Supersites*:   A number of monitoring sites have been established as "LEZ supersites" identified as those locations expected to experience the greatest changes as a result of the introduction of Phases 1 and 2 of the LEZ. One of the sites is wholly funded by TfL with additional equipment provided by TfL at two others.   All of the sites have collocated Automated Traffic Counters and ANPR cameras. Figure 12 shows the LEZ supersites.

3.11   *LEZ Trend Analysis Sites*: These inlcude a number of long-running sites that are used to carry out trend analyses for the LEZ assessment. Figure 12 shows the LEZ rend analysis sites.

3.12   *LEZ Background Sites*:   To assist with the analysis of the LEZ Supersites, a number of background sites have been identified by KCL-ERG.   These are sites which are not subject to strong local sources and can thus be used as background controls. Figure 12 shows the LEZ background sites.

3.13   *LAQN Index*: The LAQN Index was established by KCL-ERG in 1996, and is based on annual mean concentrations at a selected number of long-term monitoring sites. The Index is used to

track long-term trends in pollutant concentrations, and is useful in evaluating the effectiveness of air quality management interventions on a regional scale. The Index is reported by both the Environment Agency and the GLA Group. Figure 13 shows the LAQN Index sites.

3.14   **Oxidative Potential Measurements**: An analysis of the oxidative potential of particulate matter collected at a number of selected monitoring stations across London by KCL-ERG has allowed a comparison between traffic-influenced and background sites to be carried out. The aim of this work is to identify which physical and chemical properties of particles are driving the health effects. Figure 14 shows the Oxidative potential measurements sites.

3.15   **ClearfLo**: The ClearfLo (Clean Air for London) Project is a NERC sponsored collaborative project that has been set up to investigate boundary layer pollution across London with the aim of improving the predictive capability for air quality. It is heavily reliant on pollutant measurements made at the Marylebone Road and London North Kensington monitoring sites. Table 6 shows that there are only two ClearfLO sites, and so these are not shown on a map.

3.16   **AURN:** As explained above, many of the sites are part of the UK monitoring network. Figure 15 shows the AURN sites (both fully funded and affiliated) in London.

3.17   Table 6 summarises the sites that are used for the strategic assesments described above.

Analysis of the Network

3.18   Tables 7 to 11 list the 110 sites which were operational on 25th March 2011 (as reported on the AURN, LAQN and Heathrow Airwatch websites);grouped according to site type (e.g. kerbside, roadside etc) using the conventional classification criteria. The tables also indicate how each site is funded. Each site has then been coded according to various criteria. The intention has not been to portray very detailed information about each site, but to provide an overview of the site characteristics and performance so as to aid identification of those sites which are the most valuable. The categories against which each site has been appraised are:

- **"Strategic"**

This summarises the data from Table 6, but focuses on those sites that have been identified as AEI Reference Sites for $PM_{2.5}$, those which play an impotant role in the evaluation of the LEZ, or those that are part of the AURN, as these are considered to be the most important.

- **"NOx, Ozone, PM_{10} and $PM_{2.5}$"**

There is considerable benefit in having co-located pollutant measurements (e.g. to assist in the understanding of the atmospheric chemistry of nitrogen dioxide formation, and to assist with source apportionment). These columns indicate which pollutants are currently measured and at which site. For PM_{10} the following notation is used:

- o Sites using "reference equivalent" samplers are indicated with an "x"[7]

- o Sites using TEOM instruments are indicated by "T"[8].

For $PM_{2.5}$ the following notation is used:

- o Sites using "reference equivalent" samplers, and Partisols are indicated with an "x"

- o Sites using TEOM instruments are indicated by "T"[9]

- o Sites using BAM instruments are indicated by "B"[10].

- **"Duration"**

Sites which have been operating continually for an extended period of time allow important analyses of pollutant trends to be undertaken. The following notation is used:

- o Sites which have been operating for between 5 and 10 years are indicated by an "x";

- o Sites which have been operating for between 10 and 15 years are indicted by "xx"; and

- o Sites which have been operating for more than 15 years are indicted by "xxx".

NB: due to the changes in instrumentation that have taken place at PM_{10} sites (as they were upgraded from TEOM to FDMS instruments), it is difficult to interpret long-term trends, and the continuity of the site is of lesser importance. Site history for $PM_{2.5}$ concentrations is not recorded as the network is relatively new.

- "**QA/QC**"

Monitoring stations within the network are operated to three standards, "AURN", "LAQN" or "Local". The "Local" standard means that the data are not traceable to national standards. Whilst all of the data are expected to be robust, a greater reliability can be placed upon those sites that conform to the AURN or LAQN standards; these are indicated by an "x".

- **"Data Capture"**

Data from any site will be of reduced importance if the data capture is low. An analysis of the data capture for NO_2, PM_{10} and $PM_{2.5}$ during 2009 and 2010 has been carried out, and the following notation has been used:

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[7] This includes all FDMS, Partisol and BAM sites (KCL-ERG has confirmed that all of the PM_{10} BAMs in the network are unheated and are therefore reference equivalent).

[8] For PM_{10}, the TEOM data can be adjusted using the Volatile Correction Model.

[9] TEOM $PM_{2.5}$ data cannot be adjusted using the Volatile Correction Model and these measurements are necessarily of more limited use as they cannot be directly compared with the objectives or limit values.

[10] The BAM instruments used in the London network have not yet passed an equivalence trial.

- o Sites where >= 75% of annual datasets recorded >=90% data capture are indicated by an "xx";

- o Sites where >= 75% of annual datasets recorded >=75% data capture are indicated by an "x".

- o Sites which have not been operating for a full calendar year (and the BAA sites for which data were not readily available) are marked as "n/a".

- **"Hotspot"**

For the kerbside and roadside sites, an evaluation has been carried out of whether the site represents a particular hotspot for nitrogen dioxide or PM_{10}. The following notation is used:

- o Roadside and kerbside sites with annual mean NO_2 in 2010 > 40 $\mu g/m^3$ are indicated by an "x";

- o Roadside and kerbside sites with annual mean NO_2 in 2010 >60 $\mu g/m^3$, or more than 18 hours with NO_2 >200 $\mu g/m^3$, or more than 35 days with PM_{10} >50 $\mu g/m^3$ in 2010 are indicated by "xx".

- o Sites which have not been operating for a full calendar year (and the BAA sites for which data were not readily available) are marked as "n/a".

Industrial, airport, urban background, and suburban sites have not been included in this analysis.

- **"Exposure"**

For the kerbside and roadside sites, an evaluation has been carried out of whether the site is likely to represent relevant exposure. This analysis was carried out in two separate stages. For the sites listed in Tables 2 to 5 (i.e. those where annual mean nitrogen dioxide concentrations in 2010 were >60 $\mu g/m^3$ and those where the 1-hour nitrogen dioxide, annual mean PM_{10}, or 24-hour mean PM_{10} objectives were exceeded[11]), each site was evaluated as to whether there is relevant long-term or short-term exposure (as defined in LAQM.TG(09)) in the immediate vicinity, and at a similar distance from the road or other source.

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[11] Which is also the set of sites marked as "xx" in the "hotspot" column.

It was also noted whether each of these sites conforms with the siting criteria set out in Annex III of the CAFE Directive[12,13]. The results from this analysis are shown in Tables 2 to 5. For those sites not listed in Tables 2 to 5 (i.e. those where annual mean nitrogen dioxide concentrations in 2010 were <60 µg/m^3 and where none of the other objectives listed above were exceeded), a higher-level analysis was carried out from examination of the maps in order to determine whether they represent relevant exposure for the annual mean and/or 24-hour mean objectives/limit values. The results of this assessment are reported in Tables 7 and 8, using the following notation:

> **Shaded grid cells -** For sites listed in Tables 2, 3, 4 and 5

- o Sites with relevant exposure (in terms of the objective being exceeded) **AND** which are considered to meet the CAFE Directive siting criteria are indicated by an "xx".

- o Sites with relevant exposure (in terms of the objective being exceeded) **OR** which are considered to meet the CAFE Directive siting criteria are indicated by an "x".

> **Unshaded grid cells -** For the remainder of sites

- o Sites where it is judged very likely that there was relevant exposure are indicated by an "xx";

- o Sites where the judgement is less clear cut are indicted by an "x";

- o Sites where it is judged that relevant exposure is unlikely are unmarked.

- • **"Model Verification"**

Monitoring data from kerbside and roadside sites play an important role in evaluating the performance of dispersion models at both the regional and local scales. Each site was examined in terms of how straightforward it would be to predict concentrations from a model, taking into account the overall complexity of the surrounding road network and the availability of traffic data in the LAEI. The following notation is used:

- o Sites where it is judged the data play a very useful role are indicated by an "xx";

- o Sites where it is judged the data play a useful role are indicted by an "x";

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[12] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. Exceedences of the limit values which are reported by Defra to the European Commission, are restricted to those monitoring sites which form part of the AURN. Sites within the AURN are selected by Defra and must conform to the Data Quality Objectives and the siting criteria as set out in Annex 1 and Annex III of Directive 2008/50/EC

[13] Annex III of the CAFE Directive states that compliance with the limit values for the protection of human health shall not be assessed at locations where members of the public do not have access and there is no fixed habitation; on factory premises or at industrial installations to which all relelvant provisions concerning health and safety at work apply; and on the carriageway of roads and the central reservations of roads except where there is normally pedestrian acess to the central reservation. Furthermore, the Annex states that a sampling point must be sited in such a way that the air sampled is representative of air quality for a street segment no less than 100m in length and should be at least 25 m from the edge of major junctions.

o   Sites were it is judged that the data are likely to be of limited use are unmarked.

- **"Represents Background Levels"**

For urban background and suburban sites, an evaluation has been carried out as to whether concentrations measured at the site are likely to be strongly influenced by local pollution sources. The London Atmospheric Emissions Inventory was used to determine whether any of the sites were: within 500 m of a listed industrial process or boiler which emits more than 1 tonne of NOx or PM_{10} per year[14]; within 100 m of any diesel railway line; within 200 m of any road with more than 50,000 vehicles per day; or within 75 m of any road with more than 10,000 vehicles per day. The only criteria which identified any sites were those relating to road traffic. The following notation is used:

o   Sites that represent background levels, i.e. are sufficiently distant from any local source, are indicated by an "x";

o   Sites that may be affected by nearby roads are unmarked, i.e. they are within the distance criteria set.

Numerical Score

3.19   In order to inform the overall site appraisal, each of the criteria described above has been assigned a score. These scores are ultimately based on professional judgement and take account of the perceived importance of each criterion. The scores assigned are:

Strategic   "x" = **15**.

Pollutants measured   the scoring system takes account of the fact that PM monitoring with "reference equivalent" samplers is more valuable. It also takes account of the benefits arising from having co-located monitoring. Each individual pollutant measured receives one of the following scores:

o NO_2 = **2**

o PM_{10} (TEOM) = **1**

o PM_{10} (reference equivalent) = **2**

o $PM_{2.5}$ (reference equivalent) = **2**

o   An additional score of **1** is given if two pollutants are measured (including ozone), **2** if three pollutants are measured and **3** if four pollutants are measured...

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[14]   Emissions from Part A processes are only shown when above 10 tonnes per year and so this criterion was used for Part A processes

For example, if only NO$_2$ and O$_3$ are measured, the total score is 3. If NO$_2$, O$_3$, PM$_{10}$, and PM$_{2.5}$ (both using "reference equivalent" methods) are measured, the total score is 9. PM$_{2.5}$ measured using a non "reference equivalent" method is not scored.

Duration "x" = **5**; "xx" = **8**; and "xxx"; = **10**.

QA/QC "x" = **5**.

Data Capture "xx" = **4;** "x" = **2**.

Hotspot and Exposure wherever there is exposure (i.e. "xx" or "x" in the exposure column), an "xx" in the hotspot column is assigned **10**, and an "x" in the hotspot column is assigned **5**. Wherever there is no exposure, there is no score given to hotspots.

Model verification "x" = **3**; "xx" = **5**.

Represents Background "x" = **10**.

3.20   For each site, these scores are summed to give an overall site appraisal score as shown in Tables 7 to 11. Because the newest sites and the BAA sites received "n/a" for some of the criteria, the score is given as a range, with the lower value representing the calculated score, and the upper value representing the total value if the site scored the maximum possible for each "n/a" entry.

3.21   It should be recognised that the scoring system used is approximate and there is no basis for stating, for example, that a site which scores 35 is more valuable than one which scores 34, however, a site which scores 38 is clearly more valuable than one scoring 10. It should also be recognised that the scoring system is different for the different site types.

3.22   The numerical appraisal scores have been used as the basis for assigning each site a category (A-C). For kerbside, roadside, urban background and suburban sites, a numerical assessment score <15 equates to Category C; an assessment score >=15 but <30 equates to Category B; and an assessment score >=30 equates to Category A. For industrial and airport sites, the total achievable score is lower and a numerical assessment score <8 equates to Category C; an assessment score >=8 but <15 equates to Category B; and an assessment score >=15 equates to Category A.

3.23   Overall, it is considered that the following descriptions can be applied to each site appraisal category:

- o   *Category A:* the data from these sites are considered to be critical to fulfilling the identified purposes of the network

- o   *Category B*: the data from these sites are considered to play an important role in fulfilling the identified purposes of the network; and

       ○   ***Category C:*** the data play a limited role in fulfilling the identified purposes of the network.

Spatial Analysis

3.24   The analysis up until this stage has not taken into account whether the urban background and suburban sites fulfil an important role in terms of defining the spatial distribution of concentrations across London. Consideration of the spatial distribution may therefore justify amending a site, for example from Category C to Category B. Figure 16 shows the urban background and suburban nitrogen dioxide sites, overlaid onto the modelled concentration fields presented in the Mayor's Air Quality Strategy. It is evident from an examination of the spatial distribution that loss of the site at Lambeth Streatham Green (classified as Category C) would leave an obvious "gap" in the network were it to be removed. However, on closer examination, the station is sited relatively near to two busy roads and as such is unlikely to represent general urban background conditions. It is thus considered appropriate for it to remain as a Category C site.

3.25   Figure 16 also shows that some of the Category A and B sites are located relatively close to each other. In particular, two sites within the City of London (Senator House and Sir John Cass School), two sites in Wandsworth (Putney and Town Hall), two sites in northern Bexley (Belvedere and Belvedere West), two sites near the Tower Hamlets/Newham border (Poplar and Wren Close), and several sites in the vicinity of Heathrow Airport. Despite their spatial proximity, each of these sites is considered valuable in its own right, and it is not considered appropriate to re-categorise them. It is thus concluded that there are no urban background or suburban nitrogen dioxide monitoring sites that require re-categorisation based on their spatial distribution.

3.26   Figure 17 shows the urban background and surburban PM_{10} sites. It is concluded that loss of the Category B site at City of London Sir John Cass School would leave a "gap" in the network if it were removed. In the context of central London, the siting of this monitor provides valuable information on local background levels. This site has therefore been re-categorised as a Category A site. As with the NO_2 sites, it is noted that some of these monitors are relatively close to each other - in particular, the Wandsworth Putney and Richmond Barnes Wetlands sites, and two of the Bexley sites (Belvedere and Belvedere West). However, each of these sites is considered valuable in its own right, and it is not considered appropriate to re-categorise them.

3.27   All eight "reference equivalent" urban background and suburban $PM_{2.5}$ sites are already Category A sites and so this analysis has not been carried out for $PM_{2.5}$. Similarly, because the spatial distribution of kerbside, roadside, and industrial sites is determined by specific local factors, an analysis such as this is not appropriate for these sites.

Overall Site Appraisal

3.28   A summary of the categorised sites is shown in Table 12 and in Figures 18, 19 and 20. The majority of sites have been classified as Category A, with a significant number classified as Category B; only a small number classified as Category C.

4   Identification of Gaps in the Network

Urban Background and Suburban Sites

Nitrogen Dioxide

4.1   Figure 21 shows the distribution of urban background and suburban nitrogen dioxide sites across London overlaid on the modelled concentrations in order to provide a frame of reference. The coverage is good and there is no overriding need for any additional sites. There are, however, no sites measuring nitrogen dioxide concentrations at an urban background location in the western half of the City of Westminster, which is an area where modelled concentrations are particularly high. It may thus be beneficial to have an additional site in the area circled in black on Figure 21. It may also be beneficial to have an additional site immediately to the southeast of the central London, within the area identified that encompasses parts of the London Boroughs of Lambeth, Southwark and Lewisham, as well as a site within the larger circled area that largely encompasses the London Borough of Bromley.

PM_{10}

4.2   Figure 22 shows the urban background and suburban PM_{10} sites overlaid on the modelled PM_{10} concentrations in order to provide a frame of reference. There is good coverage, with no overriding nead for additional sites. There would, however, be a benefit to having an additional site in the western half of the City of Westminster, within the area identified in Figure 22.

$PM_{2.5}$

4.3   Figure 23 shows the urban background and suburban "reference equivalent" $PM_{2.5}$ sites, overlaid on the modelled PM_{10} concentrations[15] in order to provide a frame of reference; these are all Category A sites, and have been selected by Defra as AEI reference sites for the London agglomeration. It can be seen from Figure 23 that areas in south and northeast London are poorly represented by monitoring.

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[15]   The Mayor's Air Quality Strategy does not include a map of modelled $PM_{2.5}$ concentraitons but the spatial distribution is expected to be the same as for PM_{10}.

4.4 An analysis of the number of monitoring sites required to provide a robust AEI was carried out by AQC on behalf of Defra[16]. The analysis was necessarily confined to PM_{10} (as there were few operational $PM_{2.5}$ sites at the time the report was completed); the analysis concluded that a minimum of 8 sites woud be required for London, with only marginal improvement in the deviation from the overall average for between 10-15 sites. However, a subsequent report[17] noted that the inclusion of additional sites above the minimum would be advantageous:

- There is the potential for sites to change in nature, or even close;

- It is important to deploy monitoring sites that are as close as possible to, and are representative of, the population area that is being represented. There are also issues of public perception if population exposure is determined by monitoring sites that are remote.

4.5 It is concluded that it would be beneficial to have two additional urban background/suburban sites within the areas identified in Figure 23. However, it should be recognised that if additional sites were to be included at this stage they could not be incorporated into the Defra AEI reference sites, as they would not have been operational over the period 2009-2011. The information would nevertheless support any future $PM_{2.5}$ obligations on the Mayor.

Kerbside and Roadside Sites

Nitrogen Dioxide

4.6 Figure 24 shows the kerbside and roadside nitrogen dioxide sites. A high-level analysis is to identify potential gaps is necessarily limited for kerbside and roadside sites, since local conditions are very spatially variable. With this caveat in mind, Figure 24 suggests that additional sites within the areas identified would be beneficial. It is recognised that one of the areas where additional sites would be beneficial already includes one site (Lambeth Bondway Interchange), but this Category C site is positioned such that it is of limited value as a roadside monitor[18].

PM_{10}

4.7 Figure 25 shows the roadside and kerbside PM_{10} sites. As stated above, a high-level analysis is of limited use due to the degree of spatial variability. However, it would be beneficial to have additional sites within the areas identifed in the Figure. It is noted that this could potentially be achieved in one of the areas by upgrading the Camden Euston Road site to measure PM_{10}, as well as the currently measured nitrogen dioxide.

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[16] Options for an Exposure-Reduction Approach to Air Quality Management in the UK and the EU for Non-Threshold Pollutants. Air Quality Consultants, 2005.

[17] Options for an Exposure-Reduction Approach to Air Quality Management in the UK. Air Quality Consultants, 2006.

[18] This site is located close to a bus station, but does not represent relevant exposure.

PM$_{2.5}$

4.8   Figure 26 shows the roadside and kerbside "reference equivalent" PM$_{2.5}$ sites. It is considered unlikely that the PM$_{2.5}$ limit value will be exceeded even at roadside and kerbside sites, and there is thus no justification for a dense network of PM$_{2.5}$ monitors. However, it is noted that there are no sites in central London, where predicted concentrations are the highest, and it would be beneficial to have an additional site within the area identified in the Figure.

Other Issues

4.9   Whilst this report focuses on monitoring stations, it is also important to consider other information that is often required to support data analysis and interpretation. In particular, the assessment of emissions from road traffic is often hampered by the lack of reliable information on traffic flows and composition. The inclusion of additional Automatic Traffic Counters and ANPR cameras at key road links alongside the monitoring sites would be highly beneficial.

5   Summary and Conclusions

5.1   A review of the automatic nitrogen dioxide, PM$_{10}$ and PM$_{2.5}$ monitoring network in London has been carried out. The principal objectives of the study were:

- To identify the principal roles of the monitoring network in London (both current and future);

- To identify which sites provide the most useful data; and

- To identify any gaps in the monitoring network which are critical to the delivery of the principal roles.

5.2   The principal roles of the network are to: determine compliance with the objectives and limit values; provide information to research workers in academia and consultancies; assist with the preparation of Environmental Impact Assessments and/or air quality assessments; identify trends in pollutant concentrations in order to assess the effectiveness of control strategies; evaluate the performance of models at both a local and London-wide scale; assist the boroughs in their LAQM duties; and inform the development of future policies and strategies to improve air quality. It is important to note that whilst the network plays a vital role in supporting a wide range of strategic assessments at the London-wide scale, it is largely dependant on organisation and funding at the individual borough level.

5.3   The sites of greatest value to the network have been identified. This has taken account of a range of different factors and uses a semi-quantitative scoring system developed for this project. Sites have been categorised as Category A (critical to the network), Category B (important to the network), or Category C (playing a limited role in the network). A summary of the categorised sites is provided in Table 12 and shown in Figures 18, 19 and 20. The majority of sites have been

classified as Category A, with a significant number classified as Category B; only a small number of sites are classified as Category C.

5.4   It is considered that there is relatively good coverage in the network for all pollutants, but a number of locations where additional monitoring would be beneficial have been identified.

Glossary and Abbreviations

AEI	Average Exposure Indicator
ANPR	Automatic Number Plate Recognition
AURN	Automatic Urban and Rural Network
AQCG	Air Quality Cluster Group
BAA	British Airports Authority
BAM	Beta Attenuation Monitor
CAFE	Clean Air for Europe
ClearfLO	Clean Air for London
KCL-ERG	Kings College London Environmental Research Group
FDMS	Filter Dynamics Measurement System
Kerbside	Sites with sample inlets within 1m of the kerb of a busy road. Sampling heights are within 2-3m of the ground.
LAQM	Local Air Quality Management
LAQN	London Air Quality Network
LEZ	Low Emission Zone
NOx	Nitrogen Oxides (includes nitrogen dioxide and nitric oxide)
O_3	Ozone
Openair	Open-source tools for air pollution data analysis
PM	Particulate Matter
PM_{10}	Airborne Particulate matter less than 10 micrometers aerodynamic diameter.
$PM_{2.5}$	Airborne particulate matter less than 2.5 micrometers in aerodynamic diameter
Reference Method	Standard method for measuring concentrations on PM10 and PM2.5 for comparison with the EU limit values, as defined in EN12341 and EN14907 respectively.

Reference Equivalent	Analysers that have been demonstrated to be equivalent to the Reference Method, based on the Guidance for the Demonstartion of Equivalence.
Roadside	Sites with sample inlets between 1m and 5m of the kerbside. Sampling heights are within 2-3m of the ground.
Suburban	Sites typical of residential areas on the outskirts of a town or city.
TEOM	Tapered Element Oscillating Microbalance
Urban Background	Urban locations away from major sources and broadly representative of town/city-wide background concentrations, e.g. urban residential areas.
VCM	Volatile Correction Model

Tables

Table 1: Summary of Sites Operating on 25th March 2011

Site Type	NOx / NO$_2$	Ozone	PM$_{10}$		PM$_{2.5}$	
			All Sites	Ref. Equiv.[a]	All Sites	Ref. Equiv.[b]
Kerbside	12	1	12	8	3	2
Roadside	50	10	42	20	12	6
Urban Background	27	17	20	9	10	6
Suburban	10	7	10	2	4	2
Industrial	3	0	6	4	1	1
Airport	1	1	1	0	1	0
Total	**103**	**36**	**91**	**43**	**31**	**17**

[a] i.e. (unheated) BAMs, FDMS, and Partisol samplers.

[b] i.e. FDMS, and (for the purposes of this report) Partisol samplers.

Table 2: Highest Measured Annual Mean NO$_2$ Concentrations in 2010

Site Name	Annual Mean NO$_2$ in 2010 (µg/m^3)	Relevant Exposure [a]		Nearby Exposure [b]		Relevant for EU Reporting [c]
		AM[d]	1h[d]	AM[d]	1h[d]	
Lambeth - Brixton Road	173		x		x	x
Wandsworth - Putney High Street	166		x		x	x
City of London - Walbrook Wharf	116				x	x
Kensington and Chelsea - Earls Court Rd	109			x	x	x
Westminster - Marylebone Road	97				x	x
Ealing - Hanger Lane Gyratory	89	x	x	x	x	
Kensington and Chelsea - Kings Road	87		x		x	
Camden - Shaftesbury Avenue	86		x		x	
Kensington and Chelsea - Knightsbridge	85		x		x	x
Camden - Swiss Cottage	81		x	x	x	
Lambeth - Bondway Interchange	77				x	
Waltham Forrest - Crooked Billet	74			x	x	
Kensington and Chelsea - Cromwell Road	74			x	x	
Greenwich - Woolwich Flyover	72			x	x	
Tower Hamlets - Blackwall	72					
Sutton - Wallington	71		x		x	
Brent - Ikea	71			x	x	x
Barnet - Tally Ho Corner	70		x		x	
Croydon - Norbury	70		x	x	x	x
Hounslow - Brentford	67			x	x	x
Tower Hamlets - Mile End Road	65		x		x	
Redbridge - South Woodford	61			x	x	

[a]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in the immediate vicinity and at a similar distance from the road (or source).

[b]   i.e. there is relevant exposure (as defined in LAQM.TG(09))nearby, including if this is slightly further from road (or source).

[c]   i.e. relevant in terms of the criteria in Annex III of the CAFE Directive (2008), making a subjective decision about what constitutes a "major" junction.

[d]   AM = locations with relevant exposure in terms of the annual mean objective; 1h includes locations relevant exposure in terms of the 1-hour mean objective.

Table 3: Sites Measuring Exceedences of the 1-hour Mean NO_2 Objective in 2010

Site Name	Number of Hours with NO_2 >200 $\mu g/m^3$ in 2010	Relevant Exposure [a]	Nearby Exposure [b]	Relevant for EU Reporting [c]
Wandsworth - Putney High Street	2,602	x	x	x
Lambeth - Brixton Road	2,563	x	x	x
City of London - Walbrook Wharf	570		x	x
Westminster - Marylebone Road	511		x	x
Kensington and Chelsea - Earls Court Rd	436		x	x
Kensington and Chelsea - Knightsbridge	236	x	x	x
Ealing - Hanger Lane Gyratory	160	x	x	
Camden - Swiss Cottage	128	x	x	
Sutton - Wallington	57	x	x	
Kensington and Chelsea - Kings Road	43	x	x	
Newham - Cam Road	38			
Barnet - Tally Ho Corner	37	x	x	
Greenwich - Woolwich Flyover	37		x	
Waltham Forrest - Crooked Billet	21		x	

[a]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in terms of the 1-hour objective in the immediate vicinity and at a similar distance from the road (or source).

[b]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in terms of the 1-hour objective nearby, including if this is slightly further from road (or source).

[c]   i.e. relevant in terms of the criteria in Annex III of the CAFE Directive (2008). Making a subjective decision about what constitutes a "major" junction.

Table 4: Sites Measuring Exceedences of the Annual Mean PM_{10} Objective in 2010

Site Name	Annual Mean PM_{10} in 2010 $(\mu g/m^3)$	Relevant Exposure [a]	Nearby Exposure [b]	EU Sampling Point [c]
Lambeth - Bondway Interchange	43			
Ealing - Horn Lane	41			x

[a]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in terms of the 24-hour objective in the immediate vicinity and at a similar distance from the road (or source).

[b]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in terms of the 24-hour objective nearby, including if this is slightly further from road (or source).

[c]   i.e. relevant in terms of the criteria in Annex III of the CAFE Directive (2008). Making a subjective decision about what constitutes a "major" junction.

Table 5: Sites Measuring Exceedences of the 24-hour Mean PM$_{10}$ Objective in 2010

Site Name	Number of Days with PM$_{10}$ >50 µg/m^3 in 2010	Relevant Exposure [a]	Nearby Exposure [b]	EU Sampling Point
Ealing - Horn Lane	94			x
Lambeth - Bondway Interchange	80			
Brent - Neasden Lane	62			
City of London - Upper Thames Street	54			
Westminster - Marylebone Road	38			x

[a]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in terms of the 24-hour objective in the immediate vicinity and at a similar distance from the road (or source).

[b]   i.e. there is relevant exposure (as defined in LAQM.TG(09)) in terms of the 24-hour objective nearby, including if this is slightly further from road (or source).

[c]   i.e. relevant in terms of the criteria in Annex III of the CAFE Directive (2008). Making a subjective decision about what constitutes a "major" junction.

Table 6: Sites Used for Strategic Level Assessments

	AEI PM$_{2.5}$ Reference	LEZ Supersite	LEZ Background controls	LAQN Index	LEZ Trend Analysis	ClearFlo	Oxidative Potential	AURN
Bexley - Belvedere			x	x				
Bexley - Slade Green	x		x	x				x
Bexley - Thamesmead			x					
Brent - Ikea		x						
Brent - Kingsbury							x	
Camden - Bloomsbury	x				x		x	x
Camden - Shaftesbury Avenue							x	x
Camden - Swiss Cottage				x	x		x	
City of London - Senator House			x					
Croydon - Purley Way				x	x			
Croydon - Thornton Heath			x					
Ealing - Acton Town Hall				x	x			
Ealing - Ealing Town Hall			x	x				
Ealing - Southall			x					
Greenwich - Eltham	x		x	x			x	x
Greenwich - Westhorne Avenue		x						
Greenwich - Woolwich Flyover		x						
Greenwich and Bexley - Falconwood				x				
Hackney - Clapton				x				
Hackney - Old Street		x						
Haringey - Haringey Town Hall				x	x		x	x
Haringey - Priory Park				x	x			x
Harrow - Stanmore	x							x
Hillingdon - Harlington	x							x
Hillingdon - Sipson Road								x
Kensington and Chelsea - Cromwell Road					x		x	x
Kensington and Chelsea - North Ken	x		x	x		x	x	x
Lewisham - New Cross							x	
Newham - Wren Close			x					
Richmond - Barnes Wetlands			x					
Richmond - Castlenau							x	
Richmond - National Physics Laboratory	x				x			x
Sutton - Carshalton				x	x			
Southwark - A2 Old Kent Road								x
Tower Hamlets - Blackwall		x						
Tower Hamlets - Mile End Road				x	x			x
Tower Hamlets - Poplar			x	x				
Waltham Forrest - Dawlins Road			x					
Wandsworth - Town Hall				x				
Westminster - Horseferry Road	x		x					x
Westminster - Marylebone Road		x		x		x	x	x

Table 7: Description of Kerbside Sites [a]

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	hotspot	Exposure	Model Verification	Numerical Score	Category
Barking and Dagenham - North Street	LA		x		x			x	xx	x	xx	xx	24	B
Barnet - Tally Ho Corner	LA		x		T		xx	x	xx	xx	x	xx	36	A
Camden - Swiss Cottage	LA	x	x		x	x	xx	x		xx	x	x	49	A
Croydon - Norbury	LA		x				xx	x	xx	xx	x	xx	34	A
Kensington and Chelsea - Earls Court Rd	LA		x		x		x	x	xx	xx	x	xx	34	A
Lambeth - Brixton Road	LA		x		x		x		x	xx	xx	xx	27	B
Redbridge - Fullwell Cross	LA		x		x	B	xx	x	xx	x	x		27	B
Sutton - Wallington	LA		x		T		x	x	xx	xx	x	xx	33	A
Sutton - Worcester Park	LA		x		x			x		x	xx	xx	20	B
Waltham Forrest - Crooked Billet	LA		x		T			x	xx	xx			13	C
Wandsworth - Putney High Street	LA		x		T			x		xx	xx	xx	24	B
Westminster - Marylebone Road	AURN	x	x	x	x	x	xx	x	xx	xx	x	xx	56	A
Westminster - Oxford Street	LA				x			x	n/a	n/a		xx	12/26	B/C

[a]   For an explanation of this Table, see paragraph 3.18

Table 8: Description of Roadside Sites [a]

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	hotspot	Exposure	Model Verification	Numerical Score	Category
Brent - Ikea	LA	x	x	x	T	T	x	x	x	xx	x	xx	47	A
Brent - John Keble Primary School	LA		x		T			x	x	x	xx	xx	21	B
Bromley - Harwood Avenue	LA		x		x		xx	x		x	xx	xx	28	B
Camden - Euston Road	LA		x					x	n/a	n/a		xx	12/26	B/C
Camden - Shaftesbury Avenue	AURN(A)	x	x		T		xx	x	x	xx		x	37	A
City of London - Upper Thames Street	LA				T			x	xx	xx		xx	15	B
City of London - Walbrook Wharf	LA		x	x				x	xx	xx	x	xx	27	B
Croydon - George Street	LA		x		T		xx	x	xx	x	x	xx	31	A
Croydon - Purley Way	LA	x	x				xxx	x		x		xx	37	A
Ealing - Acton Town Hall	LA	x	x	x	x	T	xx	x	x	x	xx	xx	46	A
Ealing - Hanger Lane Gyratory	LA		x		T		x	x	x	xx	x		26	B
Ealing - Western Avenue	LA		x		T			x	n/a	n/a	xx	xx	14/28	B/C
Enfield - Bowes Primary School	LA		x		x		x	x	x	x	xx	xx	27	B
Enfield - Derby Road	LA		x		x		xx	x	xx	x			22	B
Greenwich - A206 Burrage Grove	LA		x		x	x	x	x		x		x	21	B
Greenwich and Bexley - Falconwood	LA		x	x	T	T	xx	x		x	xx	xx	28	B
Greenwich - Blackheath	LA		x		x		x	x	xx	x	x	x	27	B
Greenwich - Fiveways Sidcup Rd A20	LA		x		x			x	n/a	n/a	xx	x	13/27	B/C
Greenwich - Plumstead High Street	LA		x	x	x	x	x	x	xx	x	x	xx	33	A
Greenwich - Trafalgar Road	LA		x		T		xx	x	xx	x	x	xx	31	A
Greenwich - Westhorne Avenue	LA		x	x	x	x	x	x	x	x	xx	xx	31	A
Greenwich - Woolwich Flyover	LA	x	x	x	T	T	x	x	xx	xx			34	A

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	hotspot	Exposure	Model Verification	Numerical Score	Category
Hackney - Old Street	LA	x	x	x	T	T	xx	x	xx	x	x		42	A
Haringey - Haringey Town Hall	AURN(A)	x	x		x	x	xxx	x	x	x		xx	45	A
Harrow - Pinner Road	LA		x		T		x	x	xx	x	xx	xx	28	B
Havering - Rainham	LA		x				xxx	x				xx	22	B
Havering - Romford	LA		x		x		xx	x	x			xx	25	B
Hillingdon - Hillingdon Hospital	LA		x		T		x	x	xx			xx	23	B
Hillingdon - Oxford Avenue	LA		x		T		x	x	xx	x	xx	xx	28	B
Hillingdon - South Ruislip	LA		x		T		xxx	x	xx	x	xx	xx	33	A
Hillingdon Hayes	BAA		x		x			x	n/a	n/a	xx	xx	15/29	B
Hounslow - Brentford	LA		x		T		x	x		xx	x		24	B
Hounslow - Chiswick High Road	LA		x		x		xx	x	x	n/a	xx	xx	25/35	A/B
Hounslow - Feltham	LA		x		T			x		x		xx	14	C
Hounslow - Heston Road	LA		x		T			x	x	x	x	x	19	B
Islington - Holloway Road	LA		x		T		xx	x	xx	x	xx	x	29	B
Kensington and Chelsea - Cromwell Road	AURN	x	x		x	x	xx	x		xx		xx	41	A
Kensington and Chelsea - Kings Road	LA		x				xx	x	xx	xx	x	xx	34	A
Kensington and Chelsea - Knightsbridge	LA		x				xx	x	x	xx	xx	xx	32	A
Lambeth - Bondway Interchange	LA		x		x		x		x	xx			12	C
Lewisham - New Cross	LA		x		T		x	x	xx	x		xx	23	B
Merton - Morden Civic Centre	LA		x					x	x	x		x	12	C
Newham - Cam Road	LA		x	x	T		xx	x	x	xx		xx	25	B
Redbridge - Gardner Close	LA		x		x	B	xx	x		x	x	xx	28	B
Redbridge - South Woodford	LA		x		x		x	x	x	xx		xx	22	B
Richmond - Castlenau	LA		x		T		xx	x	xx	x		xx	26	B
Southwark - A2 Old Kent Road	AURN(A)	x	x		x			x	n/a	n/a		xx	30/44	A

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	hotspot	Exposure	Model Verification	Numerical Score	Category
Tower Hamlets - Blackwall	LA	x	x	x	x	x		x	xx	xx		x	36	A
Tower Hamlets - Mile End Road	AURN(A)	x	x				xxx	x	xx	xx		xx	41	A
Waltham Forrest - Leyton	LA		x		x			x	x	x			12	C
Wandsworth - Putney Façade	LA		x					x	n/a	n/a		xx	12/26	B/C

^a   For an Explanation of this Table, see paragraph 3.18

Table 9: Description of Urban Background Sites ^a

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	Represents Background Levels	Numerical Score	Category
Barnet - Finchley	LA		x		T		xx	x	xx	x	31	A
Belvedere West	LA		x	x	T	T		x	n/a	x	20/24	B
Camden - Bloomsbury	AURN	x	x	x	x	x	xxx	x	x		41	A
City of London - Senator House	LA	x	x	x			x	x	x		30	A
City of London - Sir John Cass School	LA		x		x		x	x	xx		19	B
Ealing - Ealing Town Hall	LA	x	x	x			xxx	x	x		35	A
Ealing - Southall	LA	x	x		T		x	x	xx	x	43	A
Hackney - Clapton	LA		x	x		T	xxx	x	xx		22	B
Haringey - Priory Park	AURN(A)	x	x	x	x		xxx	x	xx	x	50	A
Harrow - Stanmore	AURN(A)	x	x		T	x	xx	x	x	x	47	A
Heathrow Greengates	BAA		x		T	T	x	x	n/a	x	24/28	B
Hillingdon - Harlington	AURN(A)	x	x	x	x	x	x	x		x	44	A

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	Represents Background Levels	Numerical Score	Category
Hillingdon - Sipson	BAA		x	x				x	n/a		8/12	C
Hounslow - Hatton Cross	LA		x		T		x	x	x		16	B
Hounslow Oaks Road	BAA		x	x	T	T	x	x	n/a	x	25/29	B
Islington - Arsenal	LA		x		T			x	xx		13	C
Kensington and Chelsea - North Ken	AURN(A)	x	x	x	x	x	xxx	x	xx	x	53	A
Lambeth - Streatham Green	LA		x		x						5	C
Lewisham - Catford	LA		x	x			xx	x	xx		20	B
Newham - Wren Close	LA	x	x	x	T		x	x	x		32	A
Redbridge - Perth Terrace	LA		x	x	x		xx	x	xx	x	33	A
Richmond - National Physics Laboratory	AURN(A)	x	x	x		x	xx	x	x	x	46	A
Tower Hamlets - Poplar	LA	x	x	x	T		xxx	x	xx	x	49	A
Waltham Forrest - Dawlins Road	LA	x	x		T		xx	x	xx	x	46	A
Wandsworth - Putney	LA		x		x			x	n/a	x	20/24	B
Wandsworth - Town Hall	LA		x	x			xxx	x	xx		22	B
Westminster - Horseferry Road	AURN	x	x	x	x	x	x	x		x	44	A

[a]   For an Explanation of this Table, see paragraph 3.18

Table 10: Description of Suburban Sites [a]

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	Represents Background Levels	Numerical Score	Category
Barking and Dagenham - Rush Green	LA		x				xx	x	xx	x	29	B
Barking and Dagenham - Scrattons Farm	LA		x		T		xx	x	xx	x	31	A
Bexley - Belvedere	LA	x	x		T	T	xx	x	x	x	44	A
Bexley - Slade Green	AURN(A)	x	x	x	T	x	xxx	x	xx	x	52	A
Bexley - Thamesmead	LA	x			T	T	xx	x	xx	x	43	A
Brent - Kingsbury	LA		x	x	T		xxx	x	x	x	32	A
Croydon - Thornton Heath	LA	x		x	T		xx	x	x	x	42	A
Greenwich - Eltham	AURN(A)	x	x	x	x	x	xxx	x	x		41	A
Hillingdon - Sipson Road	AURN(A)	x	x	x	T		xx	x			33	A
Hounslow - Cranford	LA		x	x	x		xx	x		x	29	B
Richmond - Barnes Wetlands	LA	x	x		T		xx	x	xx	x	46	A
Sutton - Carshalton	LA	X	x	x			xxx	x	xx		37	A

a   For an Explanation of this Table, see paragraph 3.18

Table 11: Description of Industrial and Airport Sites [a]

Site Name	Funding	Strategic	NOx	Ozone	PM$_{10}$	PM$_{2.5}$	Duration	QA/QC	Data Capture	Numerical Score	Category
Industrial Sites											
Bexley - Manor Road East Gravimetric	LA				x			x	n/a	7/11	B/C
Bexley - Manor Road West Gravimetric	LA				x		xx	x	n/a [b]	15/19	A
Brent - Neasden Lane	LA		x		T		x	x		14	B
Ealing - Horn Lane	LA		x		T		x	x	x	16	A
Greenwich - Millennium Village	LA		x		x	x	x	x	xx	22	A
Lewisham - Mercury Way	LA				x			x		7	C
Airport Site											
Heathrow LHR 2	BAA		x	x	T	T	xxx	x	n/a	20/24	A

[a]   For an Explanation of this Table, see paragraph 3.18

[b]   Although this LAQN site is not new, data were not available from the LAQN.

Table 12: Sites Appraisal

Category A Sites	Category B Sites	Category C Sites
Kerbside Sites		
Barnet - Tally Ho Corner	Barking and Dagenham - North Street	Waltham Forrest - Crooked Billet
Camden - Swiss Cottage	Lambeth - Brixton Road	
Croydon - Norbury	Redbridge - Fullwell Cross	
Kensington and Chelsea - Earls Court Rd	Sutton - Worcester Park	
Sutton - Wallington	Wandsworth - Putney High Street	
Westminster - Marylebone Road	Westminster - Oxford Street [a]	
Roadside Sites		
Brent - Ikea	Brent - John Keble Primary School	Hounslow - Feltham
Camden - Shaftesbury Avenue	Bromley - Harwood Avenue	Lambeth - Bondway Interchange
Croydon - George Street	Camden - Euston Road [a]	Merton - Morden Civic Centre
Croydon - Purley Way	City of London - Upper Thames Street	Waltham Forrest – Leyton
Ealing - Acton Town Hall	City of London - Walbrook Wharf	
Greenwich - Plumstead High Street	Ealing - Hanger Lane Gyratory	
Greenwich - Trafalgar Road	Ealing - Western Avenue [a]	
Greenwich - Westhorne Avenue	Enfield - Bowes Primary School	
Greenwich - Woolwich Flyover	Enfield - Derby Road	
Hackney - Old Street	Greenwich - A206 Burrage Grove	
Haringey - Haringey Town Hall	Greenwich - Blackheath	
Hillingdon - South Ruislip	Greenwich - Fiveways Sidcup Rd A20 [a]	
Hounslow - Chiswick High Road [a]	Greenwich and Bexley - Falconwood	
Kensington and Chelsea - Cromwell Road	Harrow - Pinner Road	
Kensington and Chelsea - Kings Road	Havering - Rainham	
Kensington and Chelsea - Knightsbridge	Havering - Romford	
Southwark - A2 Old Kent Road	Hillingdon - Hillingdon Hospital	
Tower Hamlets - Blackwall	Hillingdon - Oxford Avenue	
Tower Hamlets - Mile End Road	Hillingdon Hayes	
	Hounslow - Brentford	
	Hounslow - Heston Road	
	Islington - Holloway Road	
	Lewisham - New Cross	
	Newham - Cam Road	
	Redbridge - Gardner Close	
	Redbridge - South woodford	
	Richmond - Castlenau	
	Wandsworth - Putney Façade [a]	
Urban Background Sites		
Barnet - Finchley	Belvedere West	Hillingdon - Sipson
Camden - Bloomsbury	Hackney - Clapton	Islington - Arsenal
City of London - Senator House	Heathrow Greengates	
City of London - Sir John Cass School	Hounslow - Hatton Cross	
Ealing - Ealing Town Hall	Hounslow Oaks Road	
Ealing - Southall	Lambeth - Streatham Green	

Category A Sites	Category B Sites	Category C Sites
Haringey - Priory Park	Lewisham - Catford	
Harrow - Stanmore	Wandsworth - Putney	
Hillingdon - Harlington	Wandsworth - Town Hall	
Kensington and Chelsea - North Ken		
Newham - Wren Close		
Redbridge - Perth Terrace		
Richmond - National Physics Laboratory		
Tower Hamlets - Poplar		
Waltham Forrest - Dawlins Road		
Westminster - Horseferry Road		
Suburban Sites		
Barking and Dagenham - Scrattons Farm	Barking and Dagenham - Rush Green	
Bexley - Belvedere	Hounslow - Cranford	
Bexley - Slade Green		
Bexley - Thamesmead		
Brent - Kingsbury		
Croydon - Thornton Heath		
Greenwich - Eltham		
Hillingdon - Sipson Road		
Richmond - Barnes Wetlands		
Sutton - Carshalton		
Industrial and Airport Sites		
Bexley - Manor Road West Gravimetric	Bexley - Manor Road East Gravimetric [a]	Lewisham - Mercury Way
Ealing - Horn Lane	Brent - Neasden Lane	
Greenwich - Millennium Village		
Heathrow LHR 2		

[a] Data were not available for this site and so the numerical score was assigned as a range. The site may belong in alower category than that in which it is shown. For example a A/B site is shown here under the column header A.

Figures
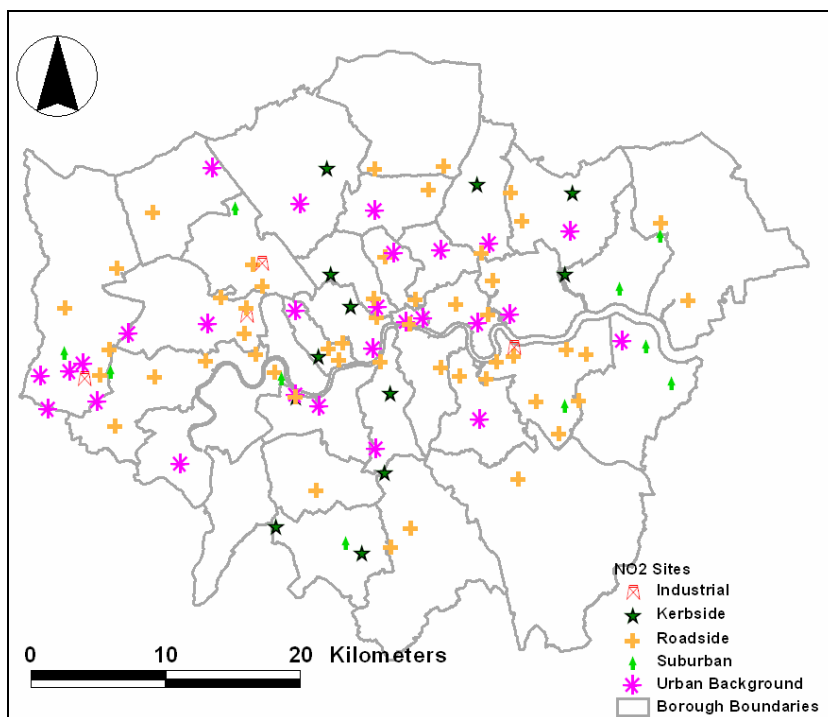
Figure 1:   Nitrogen Dioxide Monitoring Sites
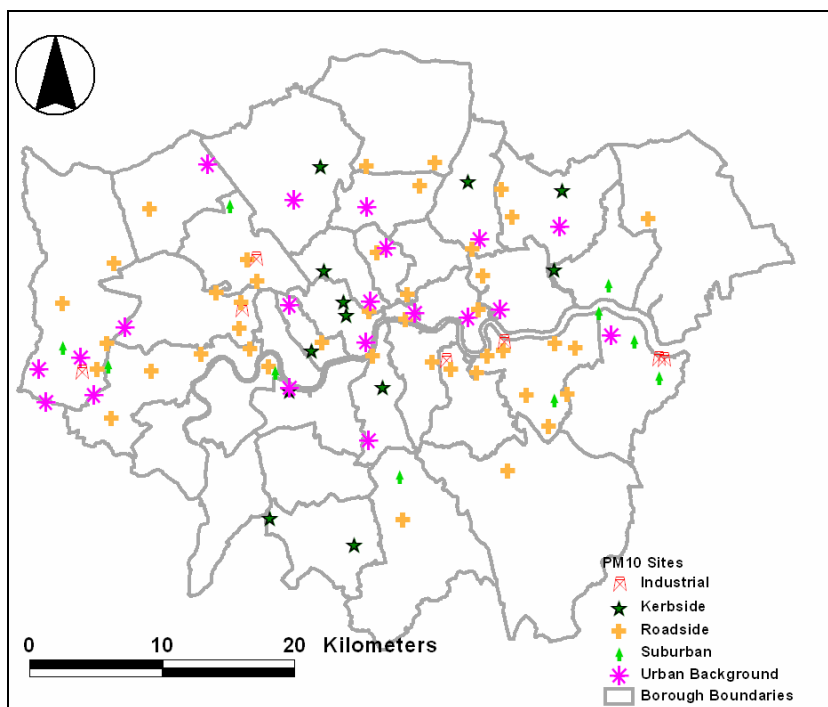
Figure 2:   PM$_{10}$ Monitoring Sites
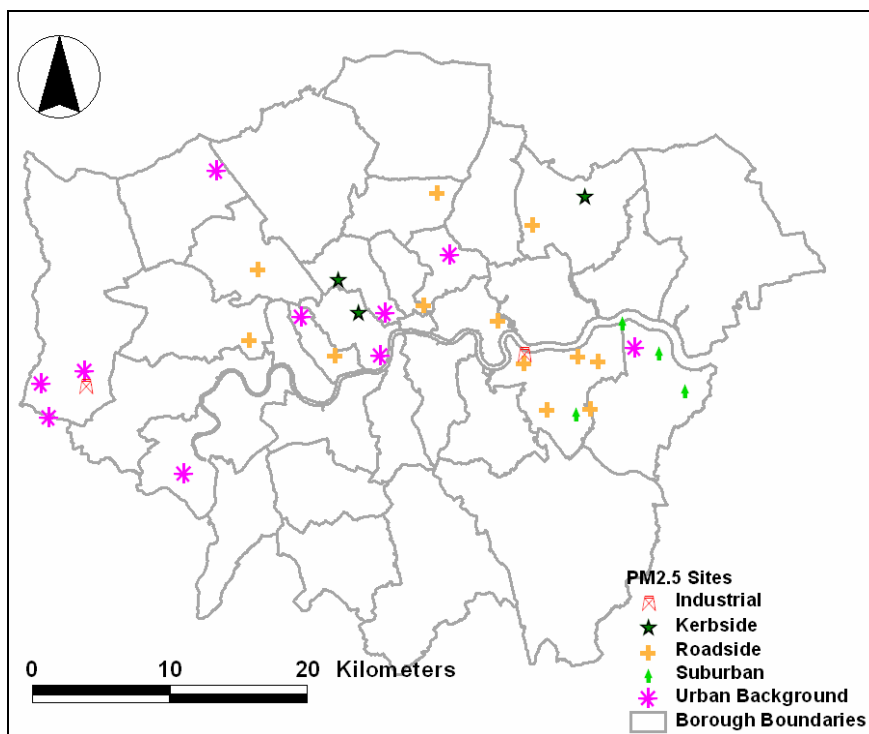
Figure 3: PM$_{2.5}$ Monitoring Sites
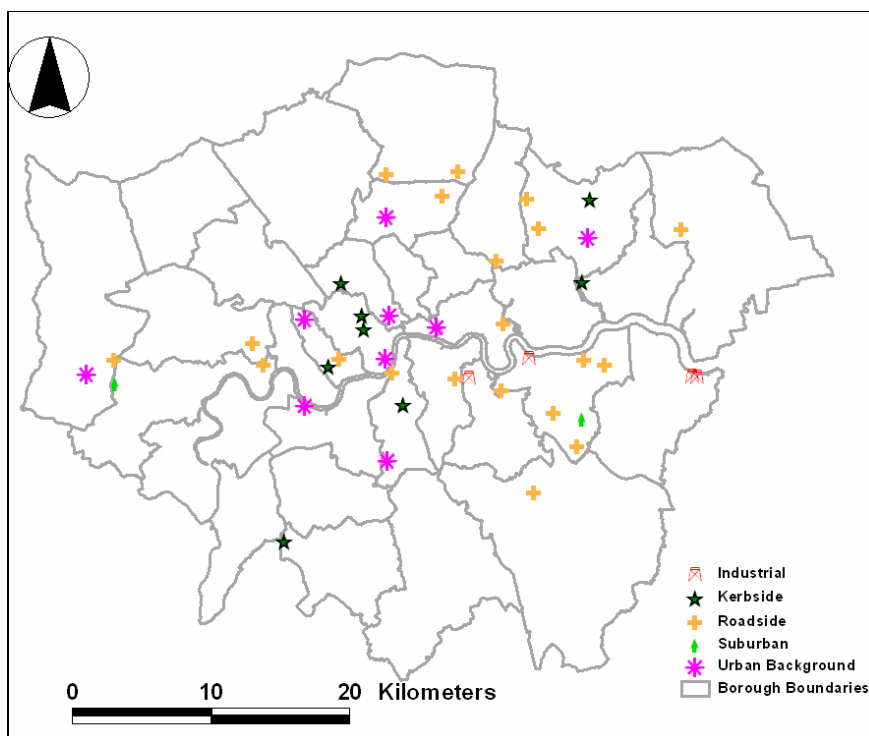
Figure 4: Reference Equivalent PM$_{10}$ Monitoring Sites
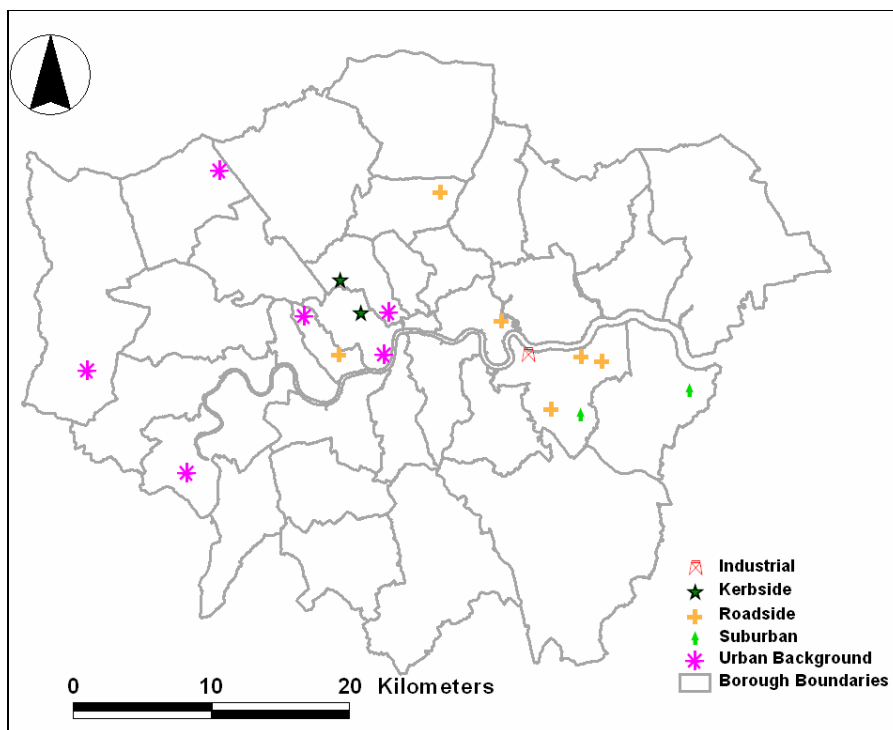
Figure 5: **Reference Equivalent PM$_{2.5}$ Monitoring Sites**
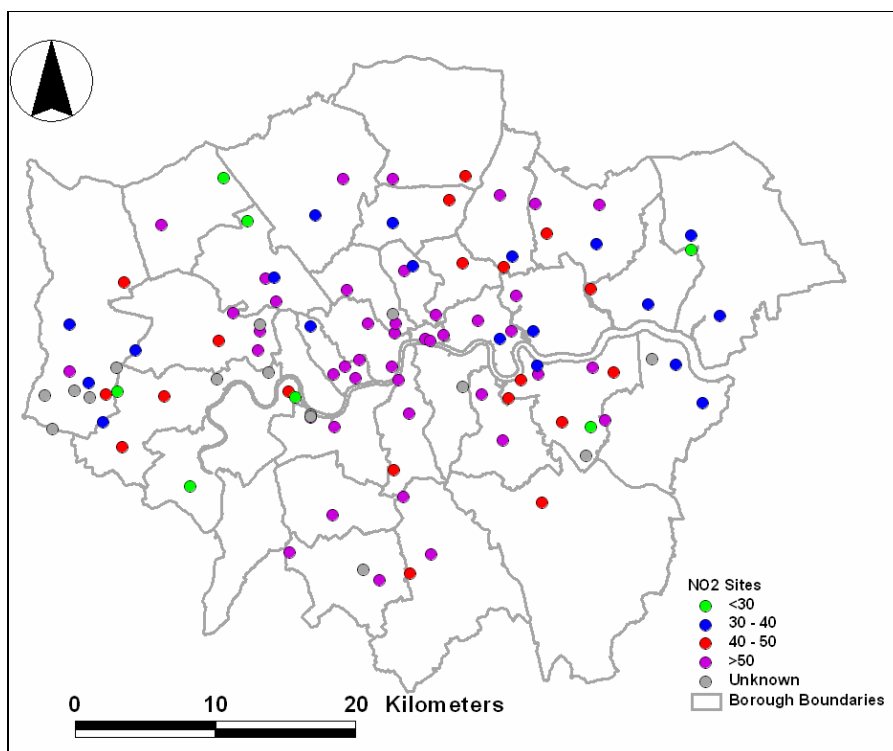
Figure 6: **Measured Annual Mean Nitrogen Dioxide Concentrations in 2010 (μg/m^3)** (not shown for BAA sites or some of the LAQN sites)
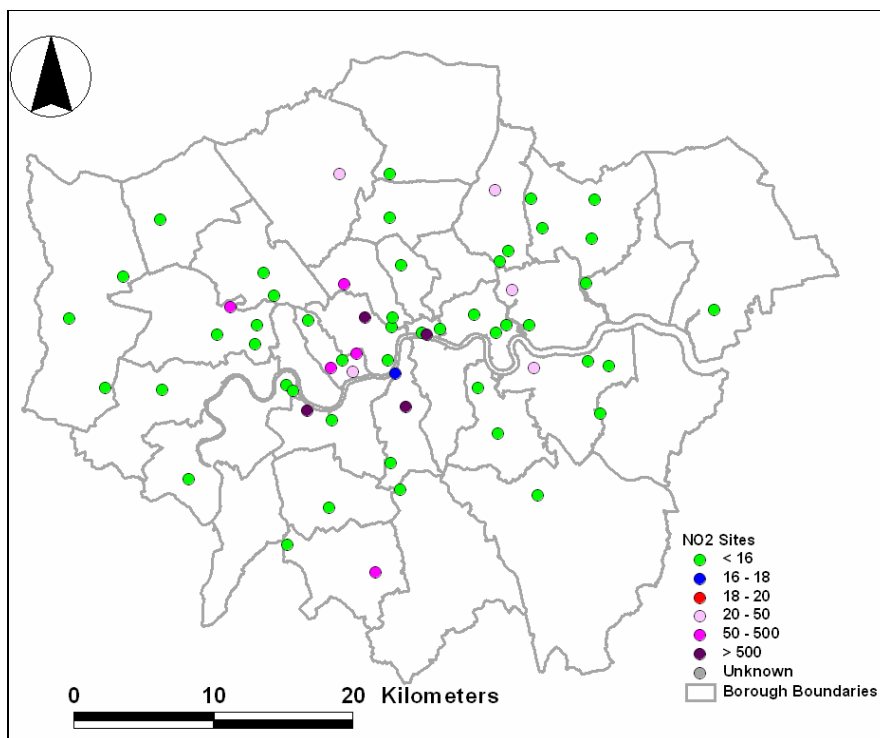
Figure 7: **Number of Hours with Measured NO$_2$ Concentrations > 200 µg/m^3 in 2010** (not shown for BAA sites or some of the LAQN sites)
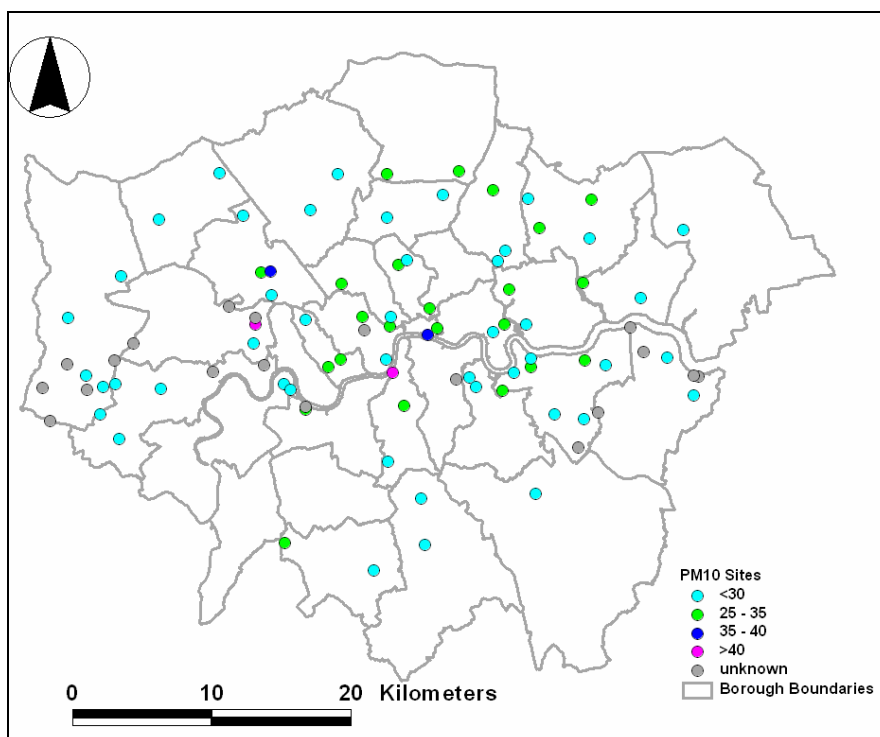
Figure 8: **Measured Annual Mean PM$_{10}$ Concentrations in 2010 (µg/m^3)** (not shown for BAA sites or some of the LAQN sites)
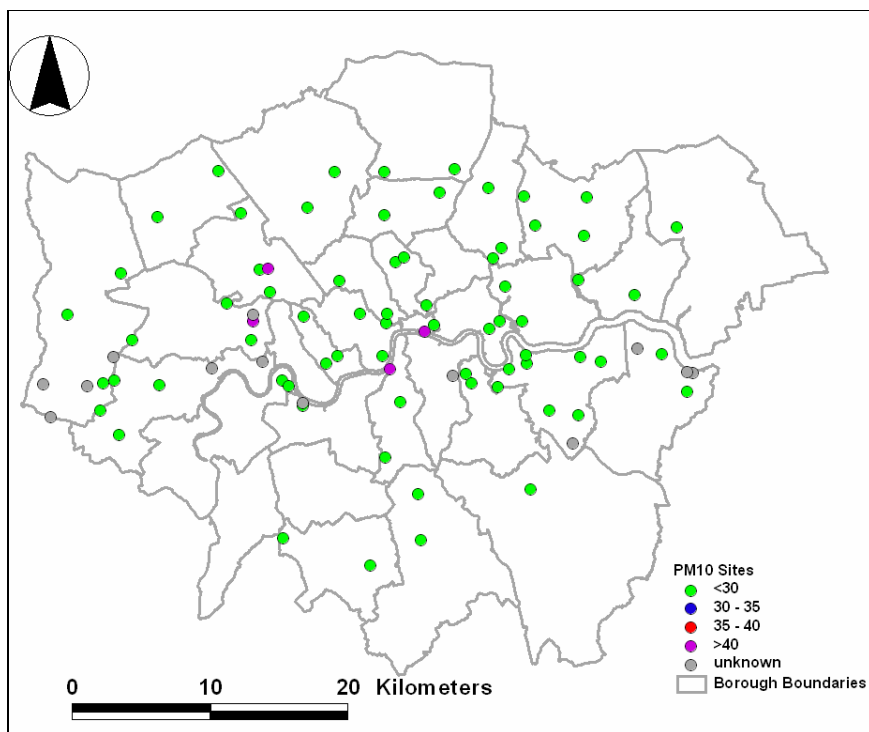
Figure 9: **Number of Days with Measured PM$_{10}$ Concentrations > 50 µg/m^3 in 2010** (not shown for BAA sites or some of the LAQN sites)
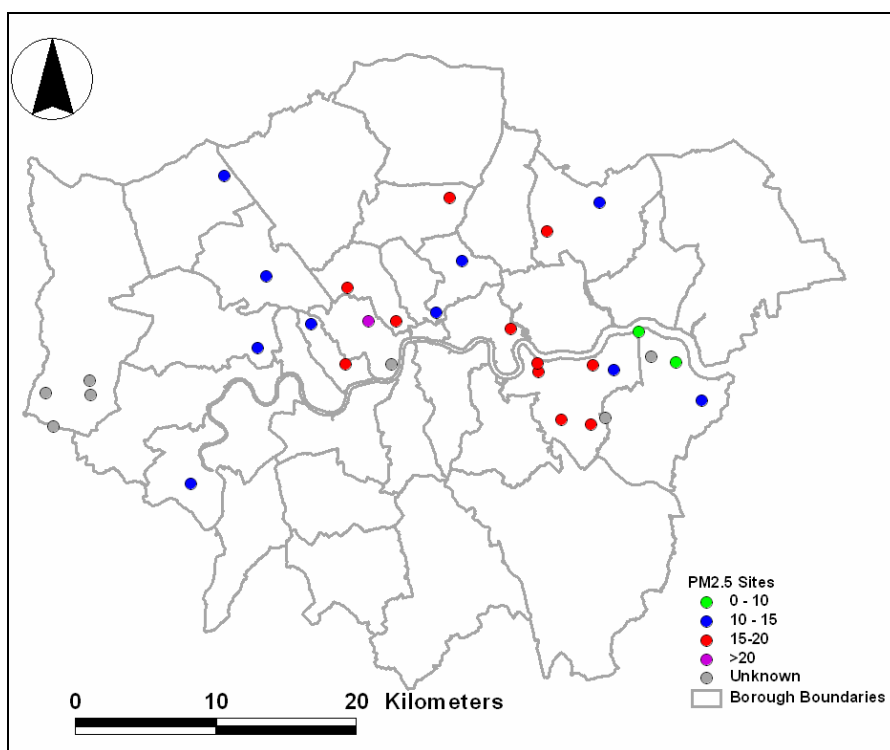
Figure 10: **Measured Annual Mean PM$_{2.5}$ Concentrations in 2010 (µg/m^3)** (not shown for BAA sites or some of the LAQN sites)
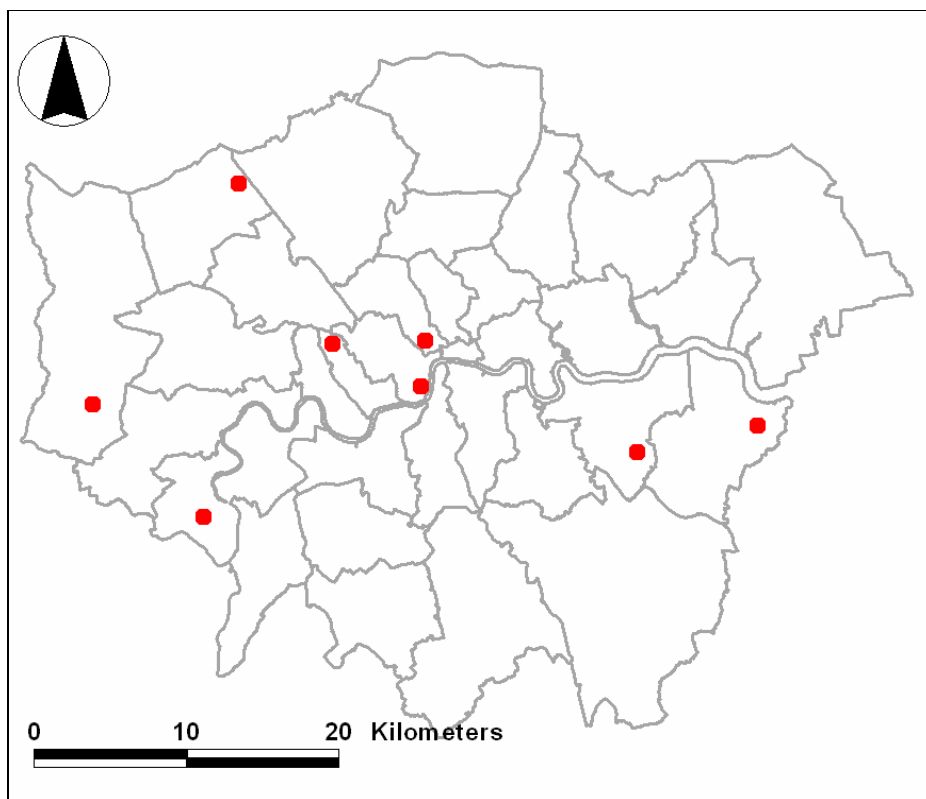
Figure 11: PM$_{2.5}$ **Average Exposure Indicator Sites**

LEZ Sites
- Background
- Super
- Trend
- Borough Boundaries
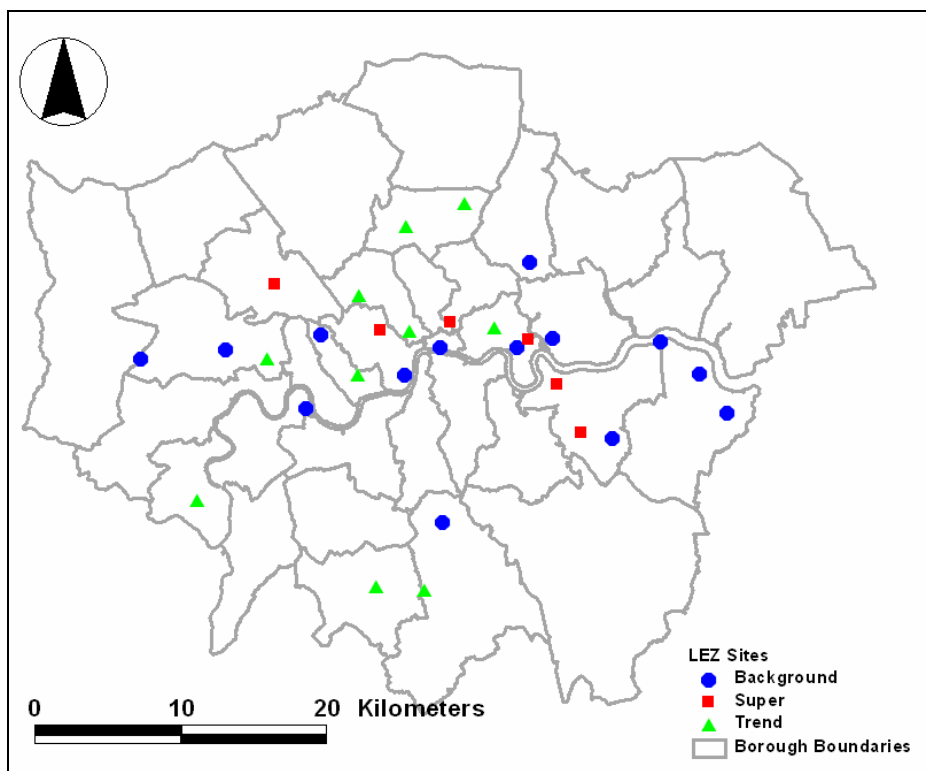
Figure 12: **LEZ Supersites, LEZ Trend Analysis Sites, and LEZ Background Sites**
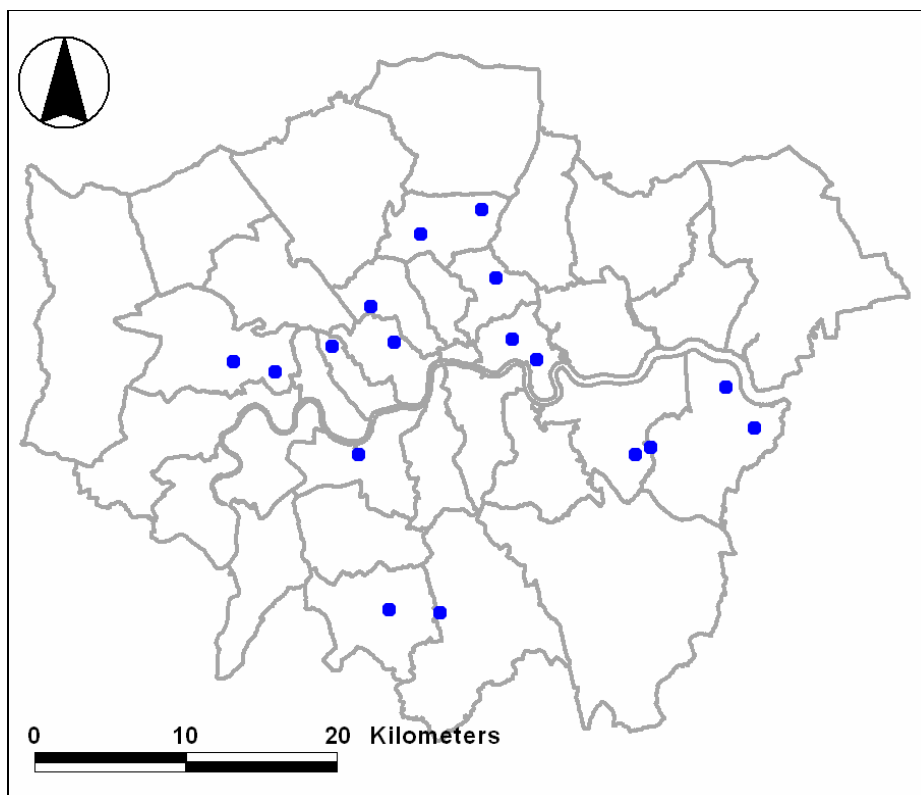
Figure 13:   LAQN Index Sites
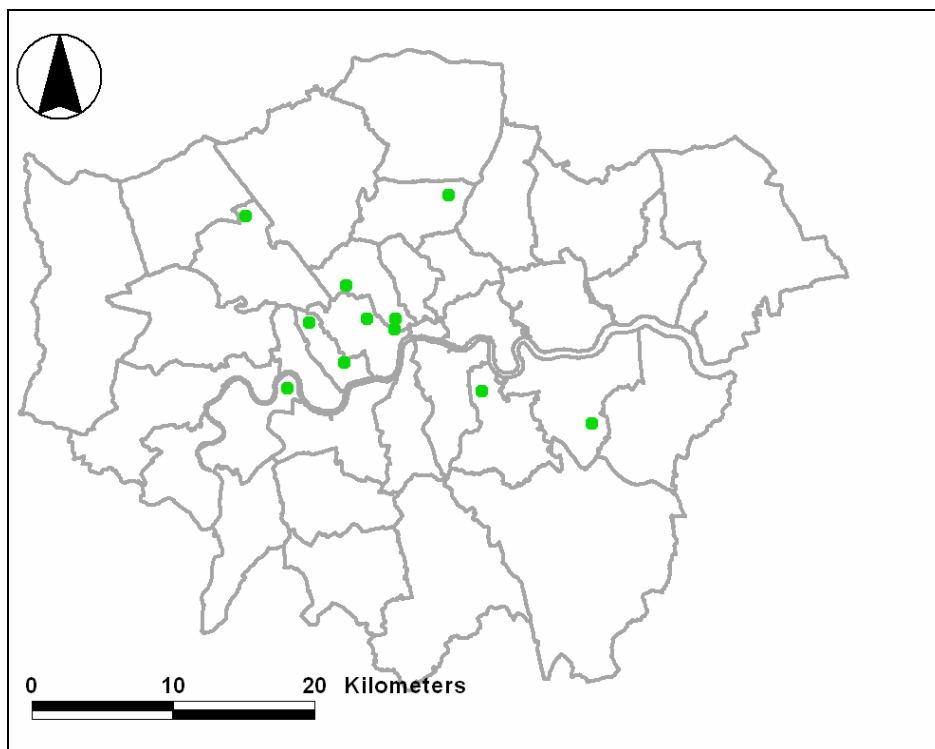
Figure 14:   Oxidative Potential Measurements Sites
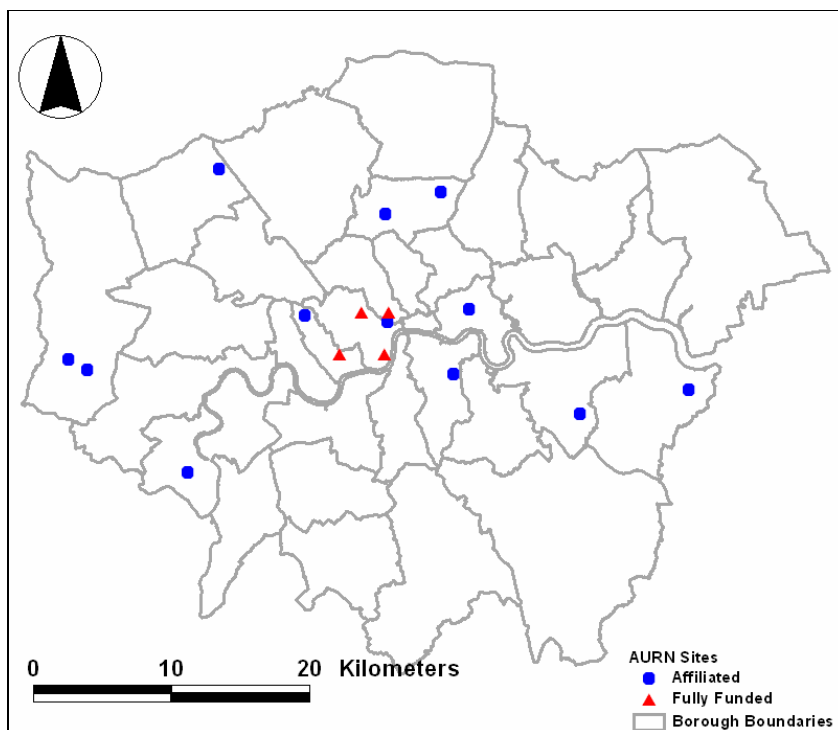
Figure 15:   AURN Sites
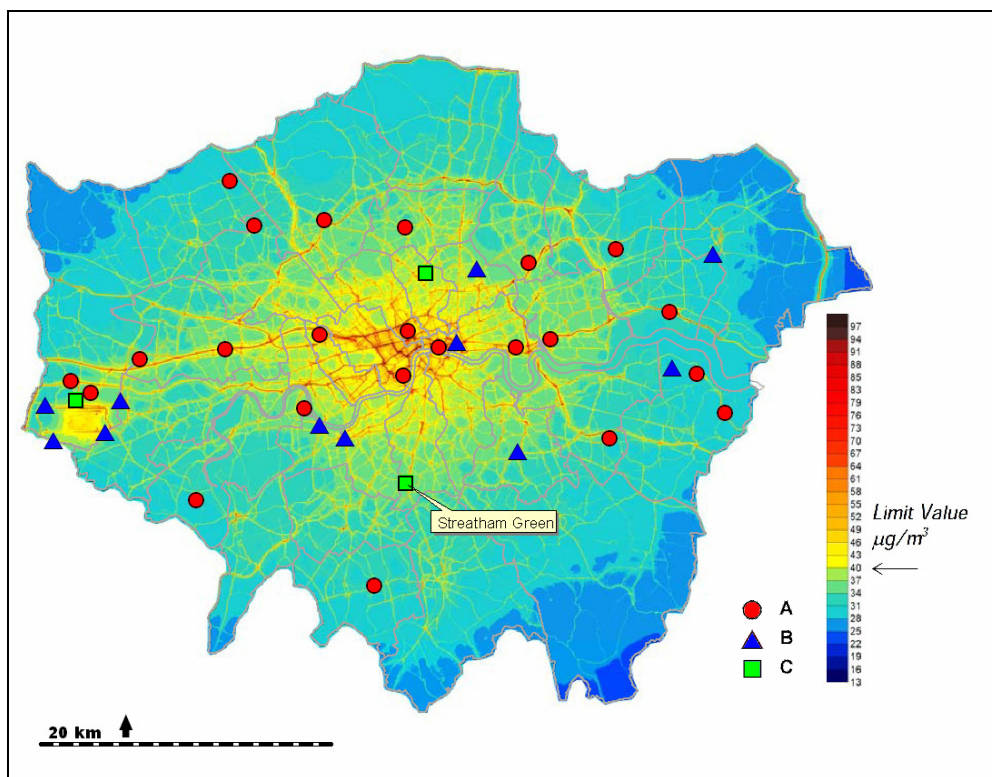
Figure 16:   Urban Background and Suburban NO₂ Sites With Initial Site Categories, Overlaid on the Modelled (2008) Nitrogen Dioxide Concentration Field (derived from 2010 Mayor's Air Quality Strategy)
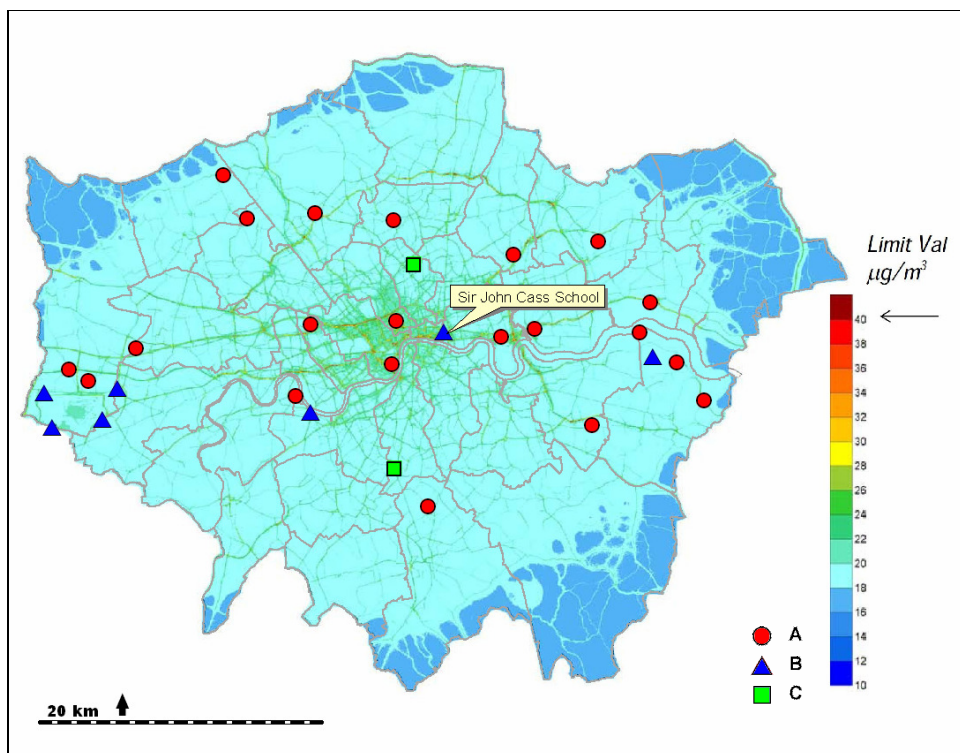
Figure 17: Urban Background and Suburban PM$_{10}$ Sites With Initial Site Categories, Overlaid on the Modelled (2008) PM$_{10}$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)
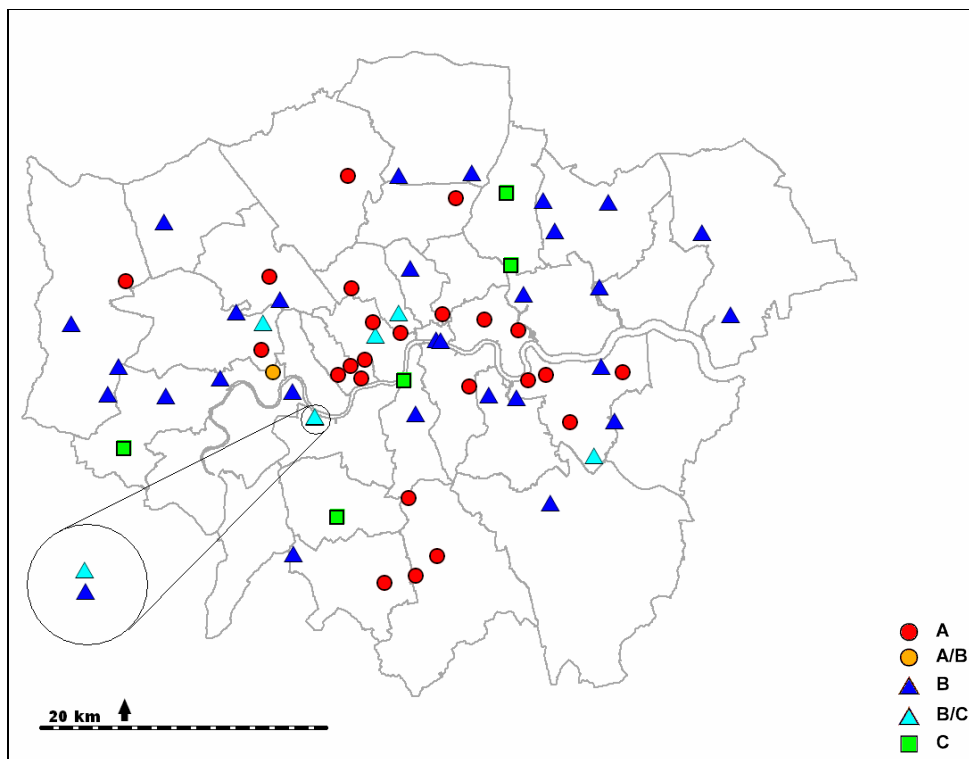
Figure 18: Roadside and Kerbside Sites Classified According to Site Category
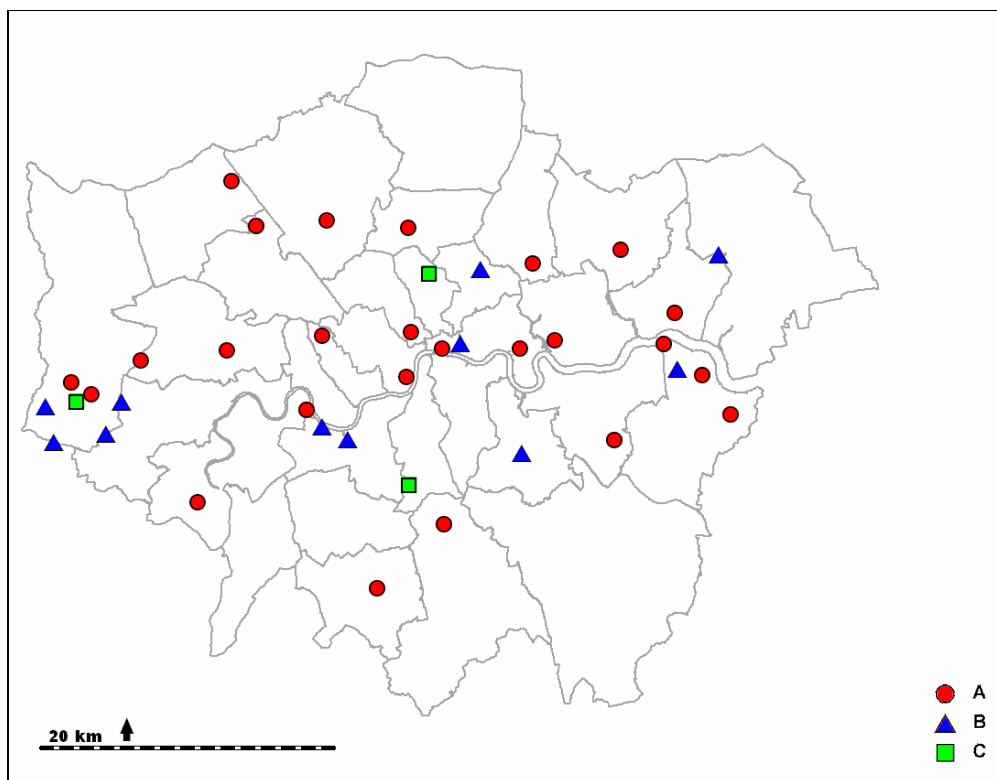
Figure 19:   Urban Background and Suburban Sites Classified According to Site Category
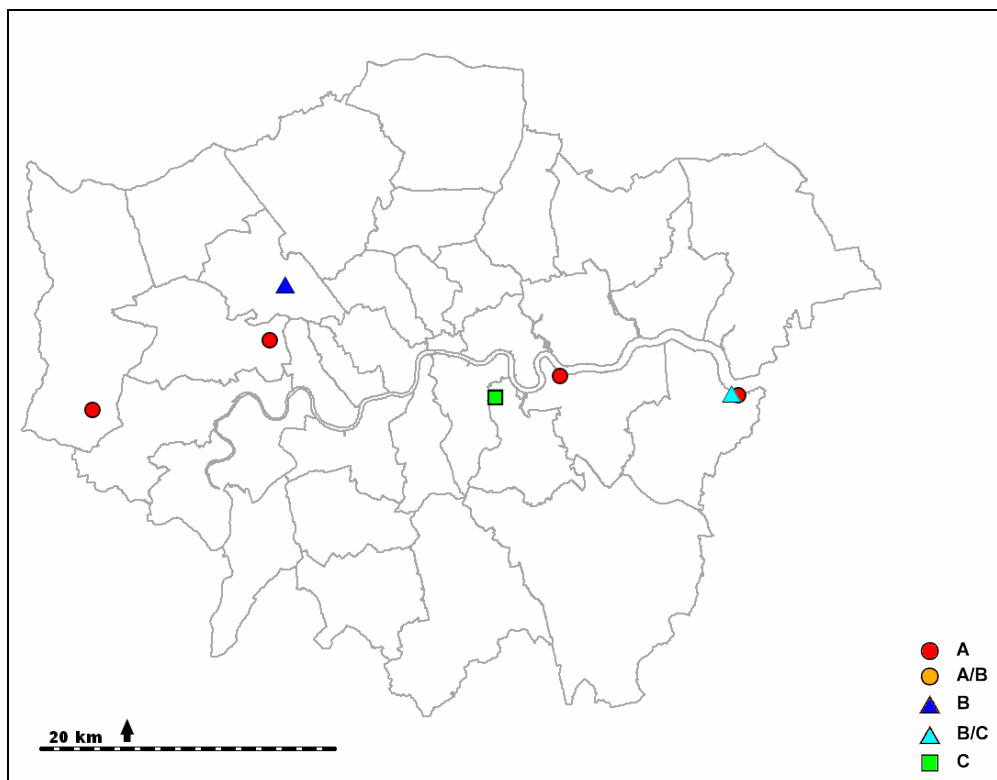
Figure 20:   Industrial and Airport Sites Classified According to Site Category
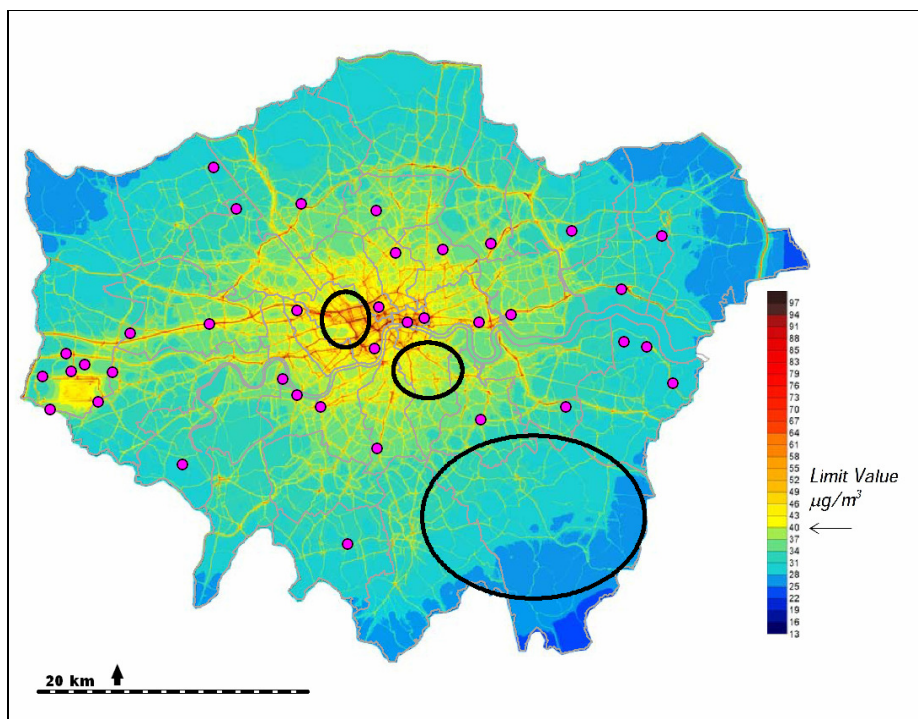
Figure 21: Urban Background and Suburban NO$_2$ Monitoring Sites Highlighting Potential Gaps in the Network - Also Showing the Modelled (2008) NO$_2$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)
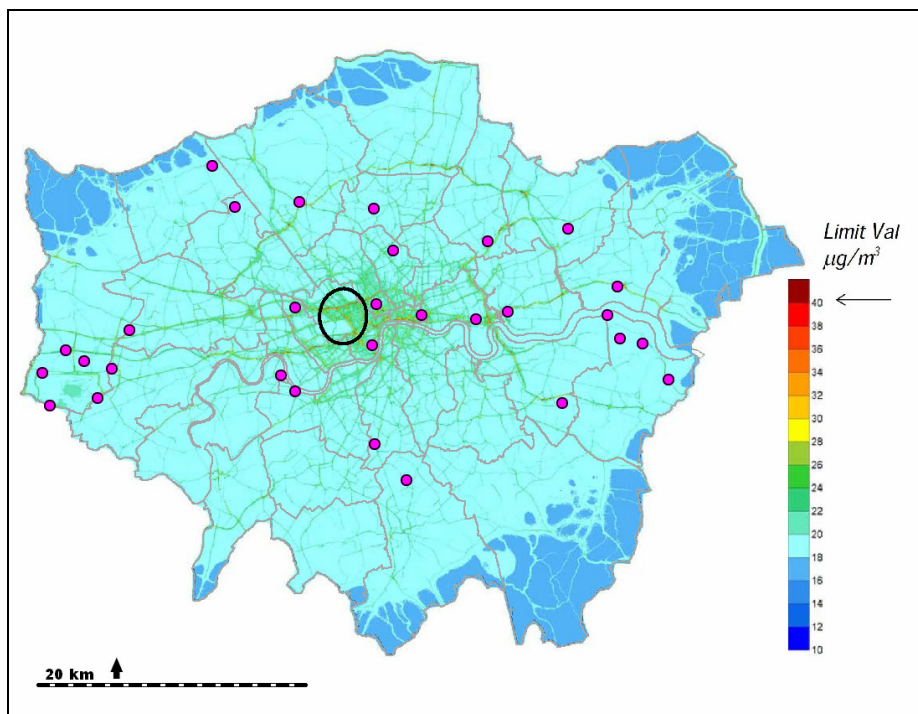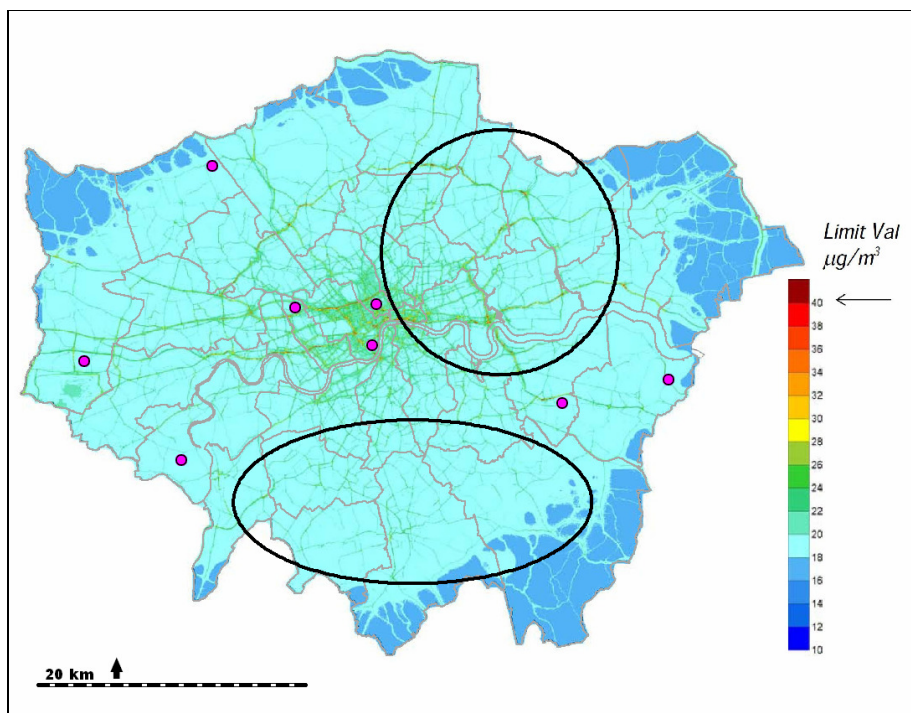

Figure 22: Urban Background and Suburban PM$_{10}$ Monitoring Sites Highlighting Potential Gaps in the Network - Also Showing the Modelled (2008) PM$_{10}$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)
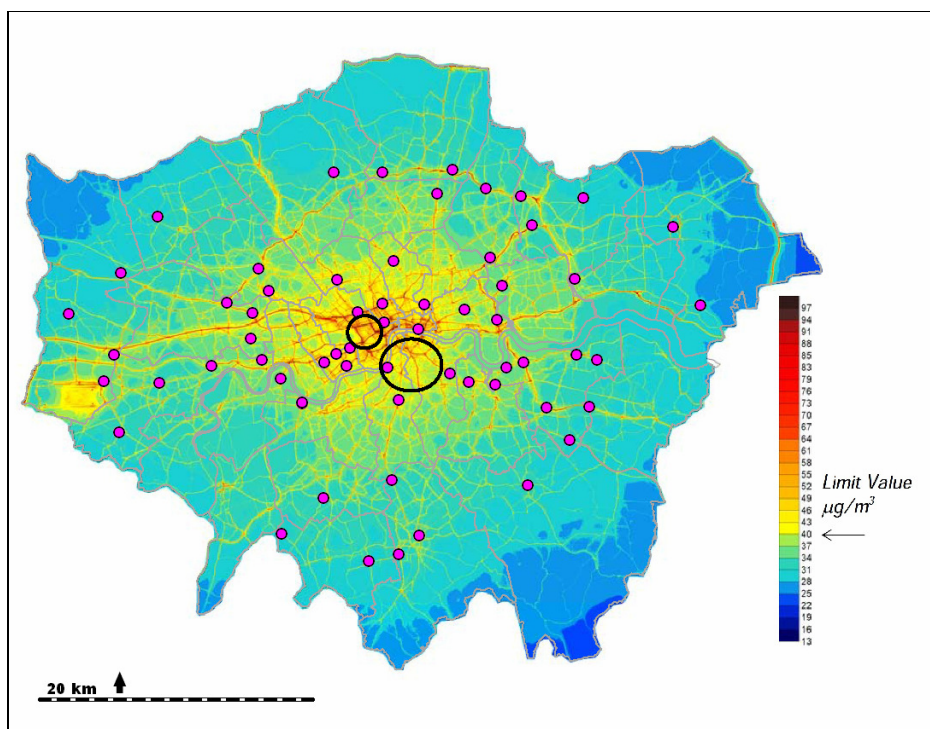
Figure 23: **Urban Background and Suburban PM$_{2.5}$ Monitoring Sites Highlighting Potential Gaps in the Network - Also Showing the Modelled (2008) PM$_{10}$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)**

Figure 24: **Roadside and Kerbside NO$_2$ Monitoring Sites Highlighting Potential Gaps in the Network - Also Showing the Modelled (2008) NO$_2$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)**
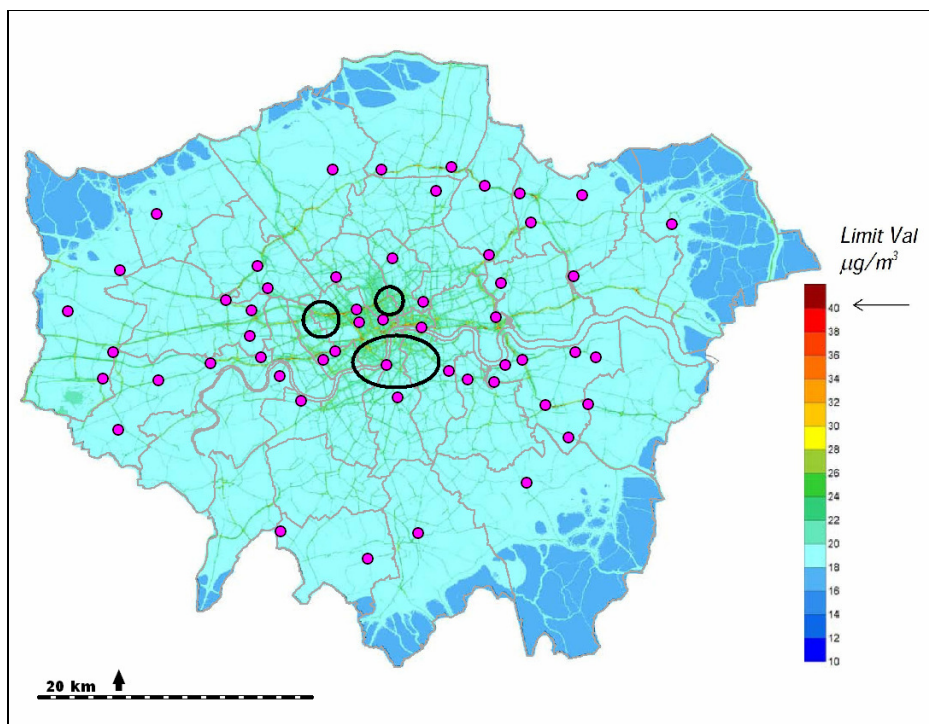
Figure 25: **Roadside and Kerbside PM$_{10}$ Monitoring Sites Highlighting Potential Gaps in the Network - Also Showing the Modelled (2008) PM$_{10}$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)**
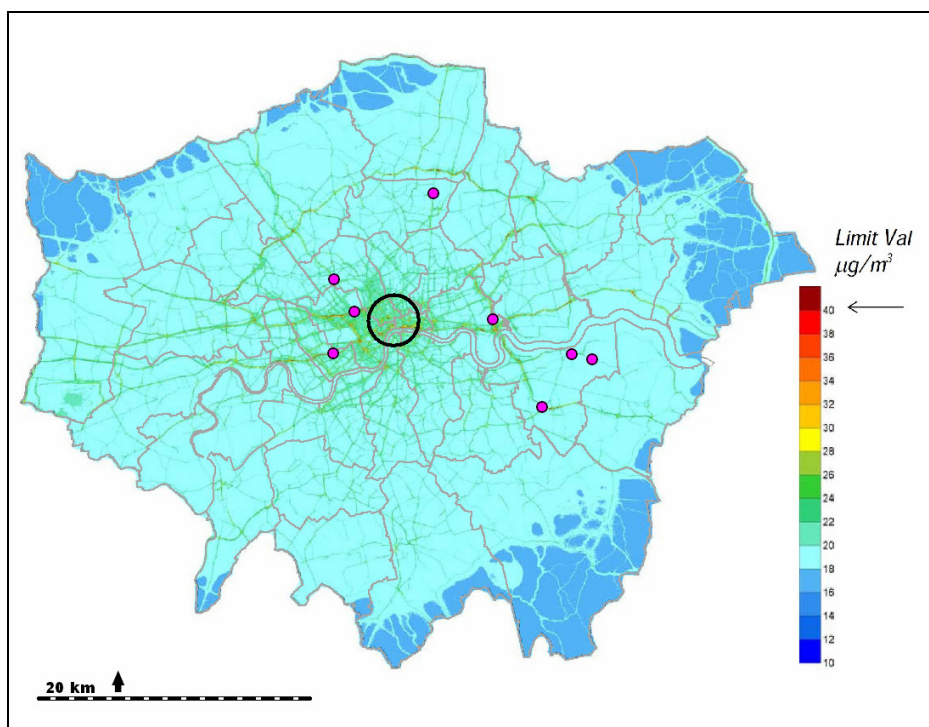

Figure 26: **Roadside and Kerbside PM$_{2.5}$ Monitoring Sites Highlighting Potential Gaps in the Network - Also Showing the Modelled (2008) PM$_{10}$ Concentration Field (derived from 2010 Mayor's Air Quality Strategy)**