LONDON BOROUGH OF
RICHMOND UPON THAMES

2012 Air Quality Updating and Screening Assessment for *London Borough of Richmond upon Thames*

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

Local Authority Officer	John Coates

Department	Special Projects Team, London Borough of Richmond upon Thames
Address	Civic Centre, 44 York Street, Twickenham, Middlesex, TW1 3BZ
Telephone	020 8891 7729
e-mail	j.coates@richmond.gov.uk

Date	2012

Executive Summary

This report presents the findings of London Borough of Richmond upon Thames' (LBRuT) fourth **Updating and Screening Assessment (USA)** of air quality within the Borough. The USA evaluates new and changed sources, which might lead to a **risk** of an air quality objective being exceeded. Results from monitoring within the Borough are also presented and evaluated in relation to the objectives. Where a **risk** of an exceedence is identified at locations with relevant exposure the Council will proceed to a **Detailed Assessment** in accordance with the Local Air Quality Management Technical Guidance (LAQM. TG (09)) (Defra, 2009b). This process accurately assesses the **likelihood** of an air quality objective being exceeded at locations with relevant exposure and is of sufficient detail to allow the designation or amendment of any necessary **Air Quality Management Areas (AQMAs).** Once an AQMA is declared an **Air Quality Action Plan (AQAP)** must be prepared to set out the measures the Council intends to be put in place in pursuit of the air quality objectives and progress with the AQAP is reported annually.

Previous air quality assessments have concluded that concentrations of carbon monoxide (CO), benzene (C_6H_6), 1,3-butadiene, lead (Pb), and sulphur dioxide (SO_2) are compliant with UK objectives. However concentrations of nitrogen dioxide (NO_2) and Particles (PM_{10}) have been found to exceed the objectives at various locations within the Borough.

In December 2000, following the 'Stage 3' review and assessment of air quality in the LBRuT (LBRuT, 2000), the Council declared an AQMA across the whole Borough for the annual mean NO_2 and daily mean PM_{10}. In 2002, the LBRuT published an AQAP (LBRuT, 2002b).

The Council operates three automatic monitoring sites. NO_2 and PM_{10} are measured at all three. The Council also has access to data from one other automatic monitoring site operated by the National Physical Laboratory (NPL). These automatic sites are supplemented by a larger network of diffusion tubes measuring NO_2 at a wide range of kerbside, roadside and background locations. Until 1st April 2012, five NO_2 diffusion tube sites also measured benzene via diffusion tube. Results for 2008 show that PM_{10}, CO, SO_2 and benzene concentrations in the Borough meet the relevant objectives. NO_2 concentrations exceeded the annual mean NO_2 objective in some, but not all, locations (e.g. mainly along the major road transport corridors).

The continuous NO_2 monitoring results show that the annual mean was exceeded at 'Richmond 1' Castelnau, Barnes (a roadside site) from 2002 to 2010, however in 2011 for the first time since monitoring commenced the air quality objective was not exceeded. In 2011, half of the NO_2 diffusion tube monitoring sites exceeded (31 out of 62 sites). This was better than expected because the NO_2 diffusion tubes are mainly located at kerbside and roadsides, representing worst-case locations (i.e. residents who live near busy roads) or relevant public exposure to the 1-hour mean at pavement cafes or on high streets, which can be inferred from an annual mean >60μg/m^3. There are town centres sites where the annual mean is more than 60μg/m^3 and there is relevant exposure for the 1-hour mean. The new calculator tool for "fall-off in NO_2 concentrations with distance from the road" predicted that 20 NO_2 diffusion tube monitoring sites exceeded the annual mean at the building façade distance from the road, which represents relevant long term public exposure of residents that live near busy roads.

The PM_{10} monitoring results show that annual mean PM_{10} was not exceeded at any site during the last ten years. The daily mean PM_{10} objective was only exceeded at the Richmond Mobile Monitoring Unit during 2003, as a composite of the following deployments: Kew Green, Kew; Richmond Road, Twickenham (opposite Orleans School) and Upper Teddington Road, Teddington.

In 2011 even though there was a significant reduction in the levels of NO_2 there remain many areas where the air quality objective is exceeded. Confirming there is still a need for the LBRuT to be designated a borough-wide AQMA for NO_2.

The daily mean PM_{10} objective, based on the current objective levels, was not exceeded. At one time a more stringent health based particle objective was proposed for London (50 μg/m^3 24-hours mean not to be exceeded more than 10 times a year and an annual mean PM_{10} 23 μg/m^3) but this did not come into force (Defra, 2003) and remains at the less stringent 35 times a year. Had it become more

stringent, the areas of exceedence in the Borough would have been much wider. An initial assessment, from the previous modelling, indicates that it may be appropriate to find ways to improve PM_{10} levels at the hot spots, so that we can un-declare the whole Borough as a PM_{10} Air Quality Management Area.

The USA has not identified any new or significantly altered road traffic, industrial, commercial or domestic sources that need to be subjected to a Detailed Assessment.

Emissions from Heathrow were assessed in the Stage 4 'source apportionment' exercise (LBRuT, 2002a). The expansion of the airport with Terminal 5 (T5) was predicted to increase road traffic in the Borough and hence increase pollution emission levels also. If a third runway is built, LBRuT can expect further increases in airport related traffic, and therefore of traffic related emissions. LBRuT would need to rely on modelling to predict whether the traffic emission increases would out weigh the cleaner technology emission reductions. For pollutants with no health threshold, it remains a concern that the benefits of technological emission reductions should not be eroded by traffic increases, even if the resultant pollutant levels did not worsen.

Table of contents

10 List of Tables

11 List of Figures

1 Introduction

1.1 Description of Local Authority Area

LBRuT is an urban area located in southwest London, approximately 9 miles from central London. It shares a boundary with the London Boroughs of Hounslow to the north, Hammersmith and Fulham and Wandsworth to the east, and Kingston upon Thames to the south, and the districts of Elmbridge and Spelthorne to the southwest. LBRuT is the only London borough to straddle the Thames with districts on both sides of the river and has five times more green and open space than any other London borough. There are over 100 parks and open spaces within the Borough, including Richmond Park, Bushy Park, Kew Gardens, and Hampton Court Park and 21 miles (34 km) of river frontage (Wikipedia, 2009).

The principle centres in the Borough are Hampton and Teddington in the south, Twickenham, St Margarets and Whitton in the central area west of the River Thames and the Richmond-Kew-Mortlake-Barnes corridor across the loop of the river. The Borough is served by a number of major transport links, including the A316 (Chertsey Road) and A205 (South Circular Road). . Aircraft fly over the Borough, with westerly arrivals approaching Heathrow airport over the north of the Borough and easterly departures over the south of the Borough

1.2 Purpose of Report

This report fulfils the requirements of the Local Air Quality Management (LAQM) process as set out in Part IV of the Environment Act (1995), the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (Defra, 2007) and the relevant Policy and Technical Guidance documents (Defra, 2009b and c). The LAQM process places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether or not the air quality objectives are likely to be achieved. Where exceedences are considered likely, the local authority must then declare an AQMA and prepare an AQAP setting out the measures it intends to put in place in pursuit of the objectives.

1.3 Air Quality Objectives

The air quality objectives applicable to LAQM in England are set out in the Air Quality (England) Regulations 2000 (SI 928), The Air Quality (England) (Amendment) Regulations 2002 (SI 3043), and are shown in Table 1.1. This table shows the objectives in units of microgrammes per cubic metre $\mu g/m^3$ (for CO it is in milligrammes per cubic metre, mg/m^3) with the number of exceedences in each year that are permitted (where applicable).

The Regulations specify that likely exceedences of the objectives should be assessed in relation to "the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present". Hence, LAQM Review and Assessments should focus on measurements at locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. Exceedences of the objectives at any location where relevant public exposure would not be realistic should not be considered (Defra 2009b).

For the annual mean averaging period all locations should be considered where members of the public might be regularly exposed for a period relevant to the long-term objective, for example building façades of residential properties, schools, hospitals, care homes etc. The following locations should not be considered: building façades of offices or other places of work where members of the public do not have regular access: hotels (unless people live there as their permanent residence); gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

For the 1-hour mean averaging period all locations should be considered where the annual mean and 24 and 8-hour mean objectives apply, plus the following: kerbside sites (for example, pavements of busy shopping streets); car parks, bus stations and railway stations etc., which are not fully enclosed and members of the public might reasonably be expected to spend one hour or more; any outdoor locations where members of the public might reasonably be expected to spend one hour or longer, for example Richmond Park or Kew Gardens. Kerbside sites where the public would not be expected to have regular access should not be considered.

Table 1.1 Air Quality Objectives included in Regulations for the purpose of Local Air Quality Management in England.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene (C_6H_6)			
	16.25 μg/m^3	Running annual mean	31.12.2003
	5.00 μg/m^3	Annual mean	31.12.2010
1,3-Butadiene	2.25 μg/m^3	Running annual mean	31.12.2003
Carbon monoxide (CO)	10.0 mg/m^3	Running 8-hour mean	31.12.2003
Lead (Pb)	0.5 μg/m^3	Annual mean	31.12.2004
	0.25 μg/m^3	Annual mean	31.12.2008
Nitrogen dioxide (NO_2)	200 μg/m^3, not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 μg/m^3	Annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 μg/m^3, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 μg/m^3	Annual mean	31.12.2004
Sulphur dioxide (SO_2)	350 μg/m^3, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 μg/m^3, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 μg/m^3, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

1.4 Summary of Previous Review and Assessments

On 31st December 2000, following the Stage 3 review and assessment of air quality in the LBRuT (LBRuT, 2000), the Council declared the whole of the LBRuT as a single AQMA for NO_2 and PM_{10}. The Council took this decision because areas across the borough were predicted to exceed the annual mean NO_2 and 24-hour PM_{10} objectives.

Once a local authority has declared an AQMA, it is required to undertake a further Stage 4 assessment, to refine the detail of the previous assessment and to assist with targeting the action required to improve the air quality. The Stage 4 review was completed in May 2002 (LBRuT, 2002a), following a revision of the traffic forecasts and using a new emissions inventory for London.

The Stage 4 report confirmed the Stage 3 findings that the statutory objectives for both NO_2 and PM_{10} would still be exceeded in 2005 in the AQMA. The areas predicted to exceed the objectives were mainly adjacent to the major traffic routes through the borough. The area where the daily PM_{10} objective was predicted to exceed was smaller than the area where the annual mean NO_2 objective was predicted to exceed. The Stage 4 modelling confirmed that the annual mean NO_2 was the more stringent of the objectives that needed to be met.

In 2002, following the Stage 4 report the AQAP was subjected to public consultation and published (LBRuT, 2002b). The purpose of the continuing AQAP is to ensure that the Council can plan and manage appropriate actions to improve air quality within the designated AQMA, which in this case is across the whole of the LBRuT.

The USA's for 2004 (LBRuT, 2004), 2006 (LBRuT, 2006) and 2009 (LBRuT, 2007) concluded that no Detailed Assessment was required for any pollutant and no new emissions sources had been introduced between the USA's. Measurements and modelling confirmed the continuing risk of exceedence of the annual mean NO_2 objective across the borough so the borough-wide NO_2 AQMA and AQAP were still justified. For PM_{10} there was a risk of the objectives being exceeded across most of the borough. The (2002) more stringent provisional PM_{10} objectives for 2010 were never adopted (the provisional PM_{10} objectives for London were for the 50 $\mu g/m^3$ 24-hour mean not to be exceeded more than 10 times a year (instead of the existing 35) and a provisional annual mean PM_{10} of 23 $\mu g/m^3$ (instead of the existing 40 $\mu g/m^{3)}$) (Defra, 2003).

Since the 2009 USA, Air Quality Progress Reports were produced in 2010 (LBRuT, 2010) and 2011 (LBRuT, 2011). Both reports support the borough-wide NO_2 AQMA with continuous monitoring data showing exceedences of the annual mean NO_2 objective. No exceedences of the PM10 objectives were measured although modeling indicated that some areas may still exceed the objectives. In spring 2007 PAH monitoring at Castelnau Library, Barnes ceased. Two new NO_2 diffusion tube sites were introduced in October 2007, these were located along Mortlake Road, Kew. In December 2009 the diffusion tube at site 17 was moved from Parkshot, Richmond (background location) to Red Lion St, Richmond (roadside location). In March 2010 another two locations were introduced on the A316 i.e. near St Margaret's roundabout and Lincoln Avenue and in March 2011 a further tube was added to Twickenham, near Twickenham station.

Table 1.2 details the air quality reports that have been published by LBRuT. These reports on can be accessed on the Council web site at:
www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports.htm

Table 1.2 Previous review and assessment reports

Date	Report	Outcome
Jan 1999	Stage 1	Identify the pollutants and localities, which should be the focus of the further stages of air quality review and assessments. No further action needs be taken for benzene, 1,3-butadiene, lead and SO_2. Further investigation necessary for CO, NO_2, and PM_{10}.
Mar 1999	Stage 2	Further assessment of CO, NO_2, and PM_{10}, as the three pollutants deemed to be most significant in terms of air quality in the Council's area. No further action needs be taken for CO. Further investigation necessary for NO_2 and PM_{10}.
Jan 2000	Stage 3	Confirmed findings of Stage 2. Areas identified where NO_2 and PM_{10} are likely to exceed the objectives without remedial action.
Dec 2000	AQMA declaration	AQMA declared for NO_2 and PM_{10} for the whole of the LBRuT. AQMA Order dated 21st December 2000.
Apr 2002	Stage 4 further assessment	Modeling predictions confirmed findings of Stage 3. Risk that objective for annual mean NO_2 and 24-hour PM_{10} will be exceeded in AQMA. Area where 24-hour PM_{10} objective predicted to exceed is smaller than that where the annual mean NO_2 objective is predicted to exceed. Annual mean NO_2 is the more stringent of the objectives that need to be met.
2002	AQAP	Consulted on and published AQAP
Mar 2004	USA	Confirmed continuing risk of exceedence of annual mean NO_2 objective across borough, justifying existing AQMA and AQAP. For the 24-hour PM_{10} objective, risk of exceedence across parts of borough, with long term look towards proposed more stringent 2010 objective, so whole borough AQMA for PM_{10} maintained. No Detailed Assessment required for any pollutant and no new emissions sources introduced between USA's.
Apr 2005	Progress Report	Reported latest monitoring results and progress on actions to improve air quality in AQMA via the AQAP. Monitoring data showed exceedences of NO_2 objective but not exceedences of $PM_{10,}$ unless the provisional more stringent PM_{10} objectives were to be adopted.
July 2006	USA	As above for Mar 2004 USA.
Apr 2007	Progress Report	As above for Apr 2005 Progress Report.
May 2008	Progress Report	Reported latest monitoring results and progress on actions to improve air quality in AQMA via AQAP. Monitoring data showed exceedences of NO_2 objective, but no exceedences of PM_{10} objective. Proposed tighter PM_{10} provisional objectives were not adopted by UK. Revised modeling undertaken to re-assess receptor exposure and whole borough AQMA for PM_{10}. Two new NO_2 diffusion tubes introduced since 2007 Report. PAH monitoring at Castelnau Library, Barnes ceased in Spring 2007.
2009	USA	Confirmed continuing risk of exceedence of annual mean NO_2 objective across borough, justifying existing AQMA and AQAP. PM_{10} levels do not exceed the objective as proposed tighter PM_{10} objectives were not adopted by the UK.
2010	Progress Report	Reported latest monitoring results and progress on actions to improve air quality in AQMA via AQAP. Monitoring data showed exceedences of NO_2 objective, justifying the existing AQMA and AQAP. Monitored PM_{10} levels did not exceed the objective, however modeling concluded that there were a few areas in the borough where relevant exposure was predicted to exceed the objective. Since the 2009 USA one diffusion tube has been moved from a background to a roadside location and two new diffusion tube sites were introduced on Mortlake Road.
2011	Progress Report	Report on the latest monitoring results and on any actions to improve air quality in the AQMA via AQAP. NO_2 continue to exceed the objective, whilst PM_{10} levels are below the objective. Since the 2010 Progress Report two NO_2 diffusion tubes have been introduced along the A316 and in March 2011 one additional NO2 diffusion tube near Twickenham station.

London Borough of Richmond upon Thames

Figure 1.1 Location of LBRuT within Greater London. Area in red defines borough boundary and borough-wide AQMA for NO_2 and PM_{10}

2 New Monitoring Data

2.1 Summary of Monitoring Undertaken

2.1.1 Automatic Monitoring Sites

Four automatic monitoring sites are currently operated in LBRuT. 'Richmond 1' Castelnau and 'Richmond 2' Barnes Wetlands are static sites both in Barnes. Richmond Mobile Air Quality Unit is a mobile monitoring unit, which has mostly been deployed at roadside locations across LBRuT, for various time periods from several months to a calendar year. These three sites are operated by LBRuT and are part of the London Air Quality Network (LAQN) complying with the data quality assurance and quality control requirements of the LAQN (see Appendix A). The fourth monitoring site is in Teddington and operated by NPL and is part of the Automatic Urban and Rural Network (AURN). The air pollutants monitored at the four sites are summarised in Table 2.1. At all sites PM_{10} was monitored using a Tapered Element Oscillating Microbalance (TEOM) instrument and the data is presented as a gravimetric equivalent for both the x 1.3 correction and the Volatile Correction Model (VCM) (Defra, 2009e).

At the Richmond Mobile Air Quality Unit there are two NO_X analyser, one that measures NO_X at the standard air inlet height (3.5 m) and one that measures NO_X at a lower level air inlet (0.9 m). The low level NO_X analyser is being used to investigate NO_2 exposure levels for sensitive receptors (e.g. children). In 2008 an MSc student from Royal Holloway, University of London undertook a Summer Research Project with LBRuT analysing the standard and low level NO_X analyser measurements at the various Mobile deployments around the borough from 2002 to 2007. Appendix B Table B.2 presents exceedences of the hourly NO_2 objective for the standard and low level inlet NO_2 measurements at the Richmond Mobile from 2002 to 2010.

Table 2.1 Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location ?
Richmond 1 Castelnau (RI1)	Roadside	522500, 177165	NO_2, PM_{10}	Y	N (8m)	3m	Y
Richmond 2 Barnes Wetlands (RI2)	Suburban	522991, 176732	NO_2, PM_{10} O_3	Y	Y – 1 hour mean objective - children in play area/people attending Wetlands Centre	N/A	N/A
Richmond [a] (Mobile) Lower Mortlake Road (RHA)	Roadside	518562 175475	NO_2, PM_{10}, O_3, SO_2 [b], CO	Y	Y	1.6m	Y
Teddington [b] (AURN) (TD0)	Suburban	515542, 170420	NO_2, O_3, SO_2 [a]	Y	Y (50m)	N/A	N/A

[a] SO_2 monitoring ceased in March 2011
[b] SO_2 monitoring ceased in March 2011
[c] CO monitoring ceased in March 2012

2.1.2 Non-Automatic Monitoring

LBRuT carries out NO_2 diffusion tube monitoring at 62 locations across the Borough, as shown in Figure 2.1 and described in Table 2.2.

Two new NO_2 diffusion tube monitoring locations were introduced in October 2007:

1. Tube 54, Mortlake Road, adjacent to West Hall Road, Kew.
2. Tube 55, Mortlake Road, adjacent to Cemetery Gates, Kew.

These were introduced following concerns raised by residents that a proposed new bus lane on Mortlake Road, Kew would reduce the capacity for other traffic, resulting in a tail back of queuing traffic from Chalkers Corner, the intersection of the A316 with the A205 (South Circular Road).

A further two new NO_2 diffusion tube locations were introduced in February 2010 :

1. Tube 56, A316 near St Margaret's roundabout, set back from the road, level with houses.
2. Tube 57, A 316, at the end of Lincoln Avenue, set back from the road, level with houses.

These were introduced as the authority felt that there was insufficient monitoring along one of the busiest roads in the borough.

On 1st December 2009 tube 17 was moved from a background location at Parkshot Richmond to a roadside location on Red Lion Street, Richmond.

One further NO2 diffusion tube was introduced on 29th March 2011:

1. Tube 58, London Road, Twickenham (station end) in response to residents' concern over development proposals for Twickenham station.

All LBRuT NO_2 diffusion tubes are prepared using 50% Triethanolamine (TEA) in Acetone and supplied and analysed by Gradko (who are United Kingdom Accreditation Service (UKAS) accredited for the analysis of NO_2 diffusion tubes). LBRuT deploys 68 tubes each month and has one travel blank (in accordance with AEA, 2008). Gradko determine a laboratory blank for the analysis of the tubes, and from January 2009 this has been reported but not routinely subtracted from the results (in accordance with AEA, 2008). Prior to January 2009 it was routine procedure to subtract the laboratory blank from the results. NO_2 diffusion tubes are deployed in triplicate at Richmond 1 Castelnau, Richmond 2 Barnes Wetlands and the Richmond Mobile Air Quality Unit, for precision and accuracy calculations.

A roadside site bias adjustment factor is calculated using data from the co-location study at the Richmond 1 Castelnau site. A background bias adjustment factor is calculated from the co-location study at the Richmond 2 Barnes Wetlands.

A third co-location study is undertaken at the Richmond Mobile Air Quality Unit. This can be compared to the co-location study at Richmond 1 - Castelnau to assess if the site provides a representative co-location study for kerbside and roadside NO_2 diffusion tube sites across the borough.

Both local and national bias adjustment factors are available for LBRuT and are discussed in detail in Appendix A. The Council has taken the decision to use the bias adjustment factor from the local roadside (Castlenau) co-location study for all roadside and kerbside sites and the suburban (Wetlands) co-location study for the four background sites. These factors are higher than the national factor resulting in higher bias adjusted results, so these factors are more conservative than the national factor. The overall precision and data capture for the local co-location studies is good.

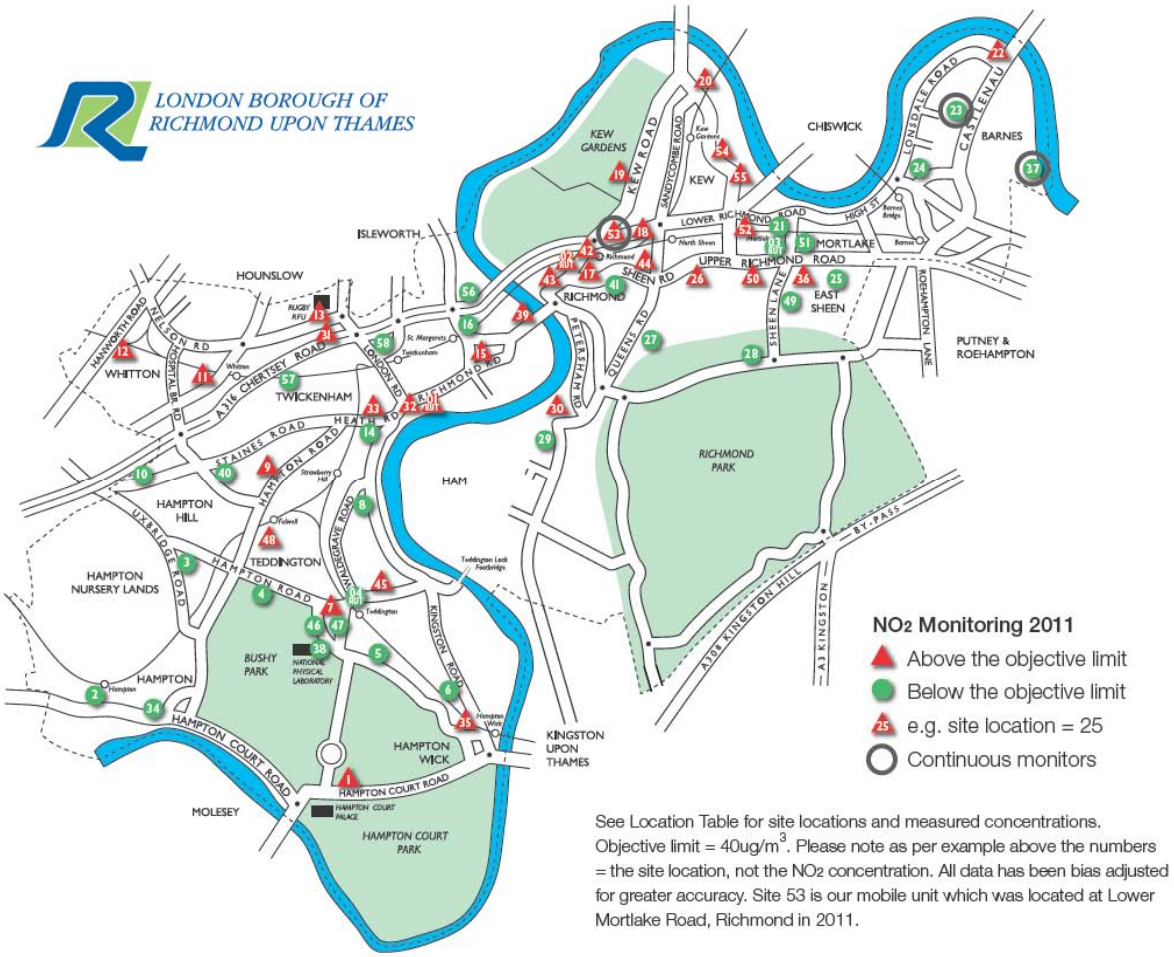
From 2002 to 2008, LBRuT carried out BTEX (benzene, toluene, ethyl benzene, xylene) diffusion tube monitoring at 5 locations across the borough at the following sites, RUT2, 7, 32, 35 and 36 where NO_2 diffusion tubes are also deployed, as shown in Figure 2.1 and described in Table 2.2. Measurements of TEX species ceased in March 2009 with measurements of benzene continuing. The BTEX tubes were supplied and analysed by Gradko, who continue to supply the benzene only tubes. The monitoring regime is to collect a two-week sample at the start of every month. An MSc student from Royal Holloway, University of London has undertaken a Research Project with LBRuT involving trend and source analysis of the BTEX measurements in the borough from 2002 to 2008. The work gives a

summary of the BTEX measurements for this period. From April 2009 Benzene only diffusion tubes have been deployed and monitoring of TEX species has ceased.

Polycyclic aromatic hydrocarbons (PAH) were monitored at Castelnau Library, Barnes from 2002 to Spring 2007. There are currently no national guidelines for total PAH in the UK. The Air Quality Strategy (Defra, 2007) adopted the Expert Panel on Air Quality Standards (EPAQS) recommendation for a limit based on just one of the PAH family called benzo (a) pyrene (B(a)P), which is used as an indicator for all PAHs. The EPAQS annual mean limit for B (a) P is 0.25 ng/m^3 by 2010.

The recommended EPAQS B (a) P standard was met in the LBRuT from 2002 to 2006 and so the LBRuT decided to cease monitoring PAHs in Spring 2007.

Figure 2.1 Monitoring site location map



See Location Table for site locations and measured concentrations. Objective limit = 40ug/m^3. Please note as per example above the numbers = the site location, not the NO_2 concentration. All data has been bias adjusted for greater accuracy. Site 53 is our mobile unit which was located at Lower Mortlake Road, Richmond in 2011.

London Borough of Richmond upon Thames

Table 2.2 Details of Non-Automatic Monitoring Sites

Site ID	Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA ?	Relevant Exposure? *(Y/N with distance (m) to tube to roadside)*	Distance to roadside (metres) to receptor *(N/A if not applicable)*	Worst-case Location ?
1	Hampton Court Rd, Hampton	Roadside	515824, 168815	NO_2	Y	Y (1.7m)	1.9m	N
2	Percy Rd, Hampton (nr. Oldfield Rd)	Roadside	513229, 169712	NO_2	Y	Y (1.3m)	3m	Y
3	Uxbridge Rd, Hampton (nr. Arundel Close)	Roadside	513850, 171040	NO_2	Y	N (0.5m)	10.7m	Y
4	Hampton Rd, Teddington (nr. Bushy Pk Gardens)	Kerbside	514882, 171155	NO_2	Y	N (0.6m)	9.8m	Y
5	Sandy Lane, Teddington (Shaef Way)	Kerbside	516391, 170322	NO_2	Y	N (0.6m)	9.0m	Y
6	Kingston Rd, Teddington (nr. Woffington Close)	Kerbside	517266, 170031	NO_2	Y	N (0.7m)	6.5m	Y
7	Broad St, Teddington (Tesco)	Kerbside	515624, 170975	NO_2, benzene	Y	Y - for 1 hour mean objective and N - for residential 0.8m	2.5m	Y
8	Strawberry Vale, Teddington (Clive Rd)	Kerbside	516165, 172043	NO_2	Y	N (0.4m)	8.7m	N
9	Hampton Rd, Twickenham	Kerbside	514842, 172346	NO_2	Y	N (0.6m)	2.0m	Y
10	Twickenham Rd, Twickenham (opp. Fulwell golf course)	Kerbside	513278, 172199	NO_2	Y	N (0.6m)	2.0m	N
11	Percy Rd, Whitton (nr. Percy Way)	Kerbside	514050, 173189	NO_2	Y	N (0.6m)	7.2m	N
12	Hanworth Rd, Whitton	Kerbside	512600, 173404	NO_2	Y	N (0.6m)	9.1m	Y
13	Whitton Rd, Whitton, (opp. rugby ground)	Kerbside	515387, 174146	NO_2	Y	N (0.8m)	6.3m	N
14	Cross Deep, Twickenham (nr Poulett Gardens)	Kerbside	516133, 173051	NO_2	Y	N (2.7m)	2.7m	Y
15	Richmond Rd, Twickenham (opp. Marble Hill Pk)	Kerbside	517197, 173939	NO_2	Y	N (0.6m)	1.8m	Y
16	St Margarets Rd, St Margarets (nr. Bridge Rd)	Kerbside	517558, 174408	NO_2	Y	N (1.2m)	3.1m	Y
17	Red Lion St, Richmond	Kerbside	517916, 175257	NO_2	Y	0.5	2.0	Y
18	Lower Mortlake Rd, Richmond (nr. Trinity Rd)	Kerbside	518822, 175590	NO_2	Y	N (0.9m)	9.3m	Y
19	Kew Rd, Kew (nr. Walpole Av)	Kerbside	518637, 176161	NO_2	Y	N (0.7m)	16m	Y
20	Mortlake Rd, Kew (nr. Kent Rd)	Kerbside	519205, 177221	NO_2	Y	N (0.6m)	2.8m	Y
21	Lower Richmond Rd, Mortlake (nr. Kingsway)	Roadside	520053, 175826	NO_2	Y	N (2m)	7.0m	Y

Site ID	Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA ?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location ?
22	Castelnau, Barnes (nr. Hammersmith Bridge)	Kerbside	522845, 177904	NO_2	Y	N (0.5m)	4.2m	Y
23 [a]	Castelnau Library, Barnes (static site)	Roadside	522502, 177166	NO_2	Y	N (3.3m)	9m	Y
24	Lonsdale Road, Barnes (nr. Suffolk Rd)	Kerbside	521750, 177056	NO_2	Y	N (0.3m)	6.3m	Y
25	URRW, (nr. Sheen School)	Roadside	521130, 175450	NO_2	Y	N (2.3m)	2.5m	Y
26	URRW, Sheen (nr. Courtland Estate)	Roadside	519031, 175021	NO_2	Y	N (0.6m)	11.8m	Y
27	Queens Rd, Richmond (nr. Russell Walk)	Roadside	518745, 174346	NO_2	Y	Y (2.3m)	5.2m	Y
28	Holly Lodge, Richmond Pk	Urban background	519467, 173993	NO_2	Y	Y - for 1 hour mean objective	NA	NA
29	Petersham Rd, Ham (nr. Sandy Lane)	Kerbside	517967, 172543	NO_2	Y	N (3.6m)	3.6m	N
30	German School, Petersham Rd	Roadside	518003, 173233	NO_2	Y	Y (1.9m)	1.3m	N
31	A316	Roadside	515438, 174048	NO_2	Y	N (1.0m)	6.4m	Y
32	Kings St, Twickenham	Kerbside	516226, 173195	NO_2, Benzene	Y	Y - for 1 hour mean objective and N - for residential 1.7m	3.8m	Y
33	Heath Rd, Twickenham	Kerbside	515927, 173129	NO_2	Y	Y - for 1 hour mean objective and N - for residential 0.9m	4.6m	N
34	Thames St, Hampton	Roadside	515927, 173129	NO_2	Y	N (1.4m)	1.3m	Y
35	High St, Hampton Wick	Kerbside	517524, 169583	NO_2, benzene	Y	Y – for 1 hour mean objective and for residential 1.3m	1.4m	Y
36	Upper Richmond Road West (URRW), Sheen Lane	Kerbside	520510, 175393	NO_2, benzene	Y	Y – for 1 hour mean objective and N - for residential 0.9m	2.2m	Y
37 [a]	Barnes Wetlands (static site)	Urban Background	522989, 176727	NO_2	Y	Y – 1 hour mean objective - children in play area/people attending Wetlands Centre	NA	NA
38	Queens Rd, Teddington (Park Rd end)	Kerbside	515777, 170519	NO_2	Y	N (0.5m)	5.0m	N
39	Richmond Rd, Richmond Bridge, East Twickenham	Kerbside	515777, 170519	NO_2	Y	N (1.2m)	2.7m	Y
40	Staines Rd, Twickenham	Kerbside	514278, 172521	NO_2	Y	N (0.4m)	11.9m	N
41	Paradise Rd, Richmond	Kerbside	518102, 174854	NO_2	Y	N (0.9m)	5.6m	N
42	The Quadrant, Richmond	Kerbside	517991, 175075	NO_2	Y	Y – for 1 hour mean objective and N -for residential (above shops) 2.5m	1.8m	Y

Site ID	Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA ?	Relevant Exposure? *(Y/N with distance (m) to relevant exposure)*	Distance to kerb of nearest road *(N/A if not applicable)*	Worst-case Location ?
43	Hill St, Richmond	Kerbside	517771, 174701	NO_2	Y	Y - for 1 hour mean objective and N -for residential above shops 0.7m	1.6m	Y
44	Sheen Rd, Richmond (Shops)	Kerbside	518458, 175042	NO_2	Y	Y - for 1 hour mean objective and N - for residential 0.5m	0.5m	Y
45	High St, Teddington, (post office)	Kerbside	516260, 171140	NO_2	Y	Y - for 1 hour mean objective and N - for residential 0.5m	3.3m	Y
46	15 Queens Rd, Teddington	Kerbside	515522, 170927	NO_2	Y	N (0.4m)	3.3m	N
47	Causeway, Teddington	Kerbside	515829, 170967	NO_2	Y	Y - for 1 hour mean objective and N - for residential 1.8m	2.7m	N
48	Stanley Rd, Teddington (junc. Strathmore Rd)	Kerbside	515059, 171805	NO_2	Y	N (2.4m)	7.1m	Y
49	URRW War Memorial, Sheen Lane, Sheen	Kerbside	520505, 175390	NO_2	Y	Y - for 1 hour mean objective and N - for residential 0.9m	2.9m	Y
50	URRW, nr. Clifford Av, Sheen	Kerbside	519962, 175321	NO_2	Y	Y - for 1 hour mean objective and N - for residential 0.7m	2.7m	Y
51	Sheen Lane, Sheen (railway crossing)	Kerbside	520497, 175790	NO_2	Y	N (0.4m)	1.3m	Y
52	Clifford Av, Chalkers Corner	Kerbside	519776, 175746	NO_2	Y	N (0.5m)	2.2m	Y
53[a b]	Mobile Air Quality Site	Roadside	518562 175475[b]	NO_2	Y	N (1.6m)	6.1m	Y
54	Mortlake Road, adjacent to West Hall Road, Kew	Roadside	519585, 176492	NO_2	Y	N (0.6m)	1.4m	Y
55	Mortlake Road, adjacent to Cemetery Gates, Kew	Roadside	519793, 176142	NO_2	Y	N (0.6m)	4.1m	Y
56	A316 St Margarets roundabout	Roadside	173933 175433	NO_2	Y	Y (0)	7m	Y
57	A316 Lincoln Avenue	Roadside	172433 173933	NO_2	Y	Y- for 1 hour objective for residential 0m on building façade.	15m	N
58	London Road, Twickenham	Roadside		NO_2	Y			Y
RUT1	Civic Centre, York St, Twickenham	Roadside	516356, 173365	NO_2	Y	Y - for 1 hour mean objective (2.9m)	3.0m	Y
RUT2	George St, Richmond	Kerbside	517917, 174928	NO_2, benzene	Y	Y - for 1 hour mean objective and N - for residential (above shops) 0.7m.	2.2m	Y
RUT3	Cromwell Place, Mortlake	Urban background	520348, 175849	NO_2	Y	Y (54.3m)	1.9	NA
RUT4	Elmfield House, Waldegrave Rd, Teddington	Urban background	515916, 171118	NO_2	Y	Y – 18.9	2.2	NA

[a] Triplicate tubes deployed for precision and accuracy calculations.
[b] For 2011 the Richmond Mobile Air Quality Unit was located at Lower Mortlake Road, Richmond.
[c] Monitoring on London Road, Twickenham commenced on 23rd March 2011**.**

2.2 Comparison of Monitoring Results with AQ Objectives

The following sections provide the LBRuT monitoring results for 2002 to 2011 in relation to the relevant air quality objectives.

Previous rounds of review and assessment have established that the annual mean NO_2 objective is the most stringent of the objectives that need to be met (LBRuT, 2004), since the proposed tighter 2010 particle objectives were not adopted (Defra, 2003).

NO_2 measurements at the roadside Richmond 1 Castelnau automatic monitoring site from 2002 to 2010 consistently exceed the annual mean NO_2 objective of 40 $\mu g/m^3$ generally by 1 to 5 $\mu g/m^3$. In 2003, annual mean NO_2 was noticeably higher at 48 $\mu g/m^3$. The year 2003 was known to be an exceptional year for air pollution due to the meteorological conditions (ERG, 2009). In 2011 the annual average was 35ug/m^3; hence the air quality objective was met. The annual mean NO_2 concentration (as estimated for the nearest residential receptor to Richmond 1 Castelnau) did not exceed the annual objective from 2004, 2005, 2006, 2010 and 2011. In 2007 and 2008 it was at the air quality objective limit and in 2009 it exceeded the objective by 2ug/m^3. Note that results derived in this way will have a greater uncertainty than measured data and are unlikely to be suitable for use in Detailed Assessments (DA) (Defra 2009b).

The annual mean NO_2 objective was exceeded by 3$\mu g/m^3$ in 2011 for the Richmond Mobile when it was deployed at Richmond RHA Lower Mortlake Road, Richmond (an annual mean for the Richmond Mobile deployments can only be determined from 2007 onwards when the Mobile was deployed at one location for each full calendar year). From 2002 to 2011 no exceedences of the annual mean NO_2 objective are recorded at the background sites, Richmond 2 Barnes Wetlands and Teddington (AURN).

The percentage of NO_2 diffusion tube sites exceeding the annual mean NO_2 objective went from 79% (45 of 57) in 2006 to 88% (51 of 59) in 2008 and in 2011 it was significantly lower at 50% (31 of 62). The majority of sites were expected to exceed the annual mean objective because many are worst-case kerbside and roadsides sites; however 53% of sites (33 of 62) are not representative of either short or long term relevant public exposure. 5 of a possible 62 sites that are not representative of relevant long term public exposure, were estimated to exceed the annual mean, when calculated for the building façade distance from the road. Again, these results have a greater uncertainty than the measured data and are unlikely to be suitable for use in DA's (Defra 2009b).

No automatic monitoring sites recorded exceedences of the NO_2 limit of 18 1-hour means above 200 $\mu g/m^3$ or alternatively, where the period of valid data was less than 90% of a full year, such as 2002 and 2006 for Richmond 2 Wetlands, the 99.8th percentile of 1-hour mean concentrations did not exceed 200 $\mu g/m^3$.

5 NO_2 diffusion tube sites had an annual mean >60 $\mu g/m^3$ indicating that the hourly mean could also have been exceeded. 4 of these sites have relevant population exposure for the short term 1-hour mean objective, as for example, they are located on high streets in the town centres of the borough where the public may spend an hour shopping or at a pavement café. As discussed in Section 1.4 the whole borough is an AQMA for NO_2 so all exceedences discussed above fall within in the AQMA.

The annual mean PM_{10} was not exceeded at any site during the last ten years. The daily mean PM_{10} objective was only exceeded at the Richmond Mobile Monitoring Unit during 2003 (worst case year) (see table 2.5b). As discussed in Section 1.4 the whole borough is an AQMA for PM_{10} so the one recorded exceedence in 2003 falls in the AQMA.

CO and benzene concentrations in the Borough meet the relevant objectives. PAHs ceased to be monitored in Spring 2007 because the recommended EPAQS (B (a) P) annual mean concentration

was met in the LBRuT from 2002 to 2006. Monitoring for SO_2 ceased in March 2011 as the air quality objective since 2002 has been achieved.

Ozone is not a LAQM pollutant because of its regional nature. However, there is a UK Air Quality Strategy ozone objective (100ug/m^3 should not be exceeded for more than 10 days per annum) which has been breached in LBRuT from 2003 to 2009 and again in 2011 at the background sites, Richmond 2 Barnes Wetlands from 2002 to 2011, at Teddington (AURN), and at Richmond Mobile roadside sites in 2002, 2003 and 2006 (worst-case air pollution years).

2.2.1 Nitrogen Dioxide

NO_2 is measured across the Borough at four automatic monitoring stations and 62 diffusion tube sites. Table 2.3a shows that the annual mean NO_2 objective has been consistently exceeded at the Richmond 1 Castelnau automatic monitoring site from 2002 to 2010. The annual mean NO_2 objective was exceeded at the Richmond Mobile in 2008 by 1 µg/m^3, at the objective in 2009, by 5ug/m^3 in 2010 and by 3ug/m^3 in 2011. Note that the annual mean for the Richmond Mobile deployments can only be determined from 2007 onwards when the Mobile was deployed at one location for each full calendar year. From 2002 to 2008 no exceedences of the annual mean NO_2 objective are recorded at the background sites, Richmond 2 Barnes Wetlands and Teddington (AURN).

Exceedences of the annual mean objective are measured at Richmond 1 Castelnau; however this site is not representative of relevant long term public exposure because it is a roadside site at 3m from the kerb, whereas the closest residential building façade is 9m. The calculator tool for "fall-off in NO_2 concentrations with distance from the road" in LAQM.TG (09) (Defra 2009b) has been used to estimate the annual mean concentration at the nearest receptor. This figure is given in Table 2.3a in brackets after the measured annual mean and indicates an exceedence of the annual objective after in 2002, 2003, 2007, 2008 and 2009.

Table 2.3b shows that no automatic monitoring sites recorded more than the limit of 18 1-hour means above 200 μg/m^3 or where the period of valid data is less than 90% of a full year, such as 2002 and 2006 for Richmond 2 Wetlands, the 99.8th percentile of 1-hour mean concentrations did not exceed 200 µg/m^3. The number of hourly means above 200 µg/m^3 is greatest at the roadside Richmond 1 Castelnau site as expected because of the proximity to road transport sources of NO_2. However, there was a notable increase in the number of exceedence hours in 2007 and 2008. From 2009 onwards there was a decline with no exceedences in 2010 and 2011.

Table 2.4a shows that the annual mean NO_2 objective is exceeded at 31 of the 62 diffusion tube sites, and at 5 of these the annual mean is >60 μg/m^3 indicating that the hourly mean could be exceeded. There is relevant exposure for the 1-hour mean objective at 4 of the 5 sites where the annual mean is >60 μg/m^3. These sites are on high streets in the town centres of the borough where the public may spend an hour shopping or at a pavement café. These locations include Teddington (Broad Street), Twickenham (Kings Street and Heath Road, York Street), East Twickenham (Richmond Road, Richmond Bridge), Richmond (George Street and Hill Street) and Sheen (URRW, Sheen Lane).

It is expected that the majority of sites would exceed the annual mean because the NO_2 diffusion tubes are mainly located at worst-case locations for long term exposure (i.e. residents who live near busy roads) or short term public exposure to the 1-hour mean at pavement cafes or on high streets, which can be inferred from an annual mean >60μg/m^3 as described above.

A number of the diffusion tube monitoring sites (34) are not representative of relevant public exposure for either the short or long-term objective. For example, site 4 is a kerbside site at 0.6m from the kerb, it is not a town centre high street site with shopping facilities or pavement cafes and the closest residential building façade is 9.8m away). For these sites the "fall-off in NO_2 concentrations with distance from the road" calculator was used to predict which sites would exceed the annual mean NO_2 objective (>40 μg/m^3) at building façade distance from the road.

20 sites were predicted to exceed the annual mean objective at the building façade, which represents relevant public exposure of residents for the long-term objective. Results derived in this way will have a greater uncertainty than the measured data and are unlikely to be suitable for use in Detailed Assessments (Defra 2009b). Given the number of the NO_2 diffusion tube monitoring sites that are not

representative of relevant public and the predicted reduction in the number of exceedences of the annual mean objective at building façade distance from the road for these, a review of the Richmond NO_2 diffusion tube network is proposed.

Automatic Monitoring Data

The NO_2 results from the four automatic monitoring stations are presented in Tables 2.3a and 2.3b. Exceedences of the NO_2 objectives are highlighted in **bold**. The "fall-off in NO_2 concentrations with distance from the road" method in LAQM.TG (09) (Defra 2009b) has been used to estimate the annual mean concentration at the nearest receptor for Richmond 1 Castelnau. This figure is given in brackets after the measured annual mean. In Table 2.3b where the period of valid data is less than 90% of a full year, the 99.8th percentile of the hourly means is given in brackets after the number of exceedences.

Table 2.3a Results of Automatic Monitoring for NO_2: Comparison with Annual Mean Objective

Location	Within AQMA ?	Proportion of year with valid data 2011 %	Annual mean concentrations (μg/m^3)									
			2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011a**
Richmond 1 Castelnau (RI1)	**Y**	100	**44 (41)**[f]	**48 (45)**[f]	**41** (39)[f]	**42** (39)[f]	**42** (39)[f]	**43 (40)**[f]	**44 (40)**[a,f]	**45 (42)**	**43** (34)	35[a] (32)
Richmond 2 Barnes Wetlands (RI2)	**Y**	98	32[e]	37	31	30	30[e]	31	29[b]	29	30	24[b]
Richmond (Mobile)	**Y**	79	**NA**	**NA**	**NA**	**NA**	**NA**	**39**	**41**[c]	40	**45**	**43**[c]
Teddington (AURN) (TD0)	**Y**	96	25	28	25	25	23	28	25[d]	22	24	22[d]
Objective			**40**									

Table 2.3b Results of Automatic Monitoring for Nitrogen Dioxide: Comparison with 1-hour Mean Objective

Location	Within AQMA ?	Proportion of year with valid data 2011 %	Number of Exceedences of hourly mean (200 μg/m^3) (Where the period of valid data is less than 90% of a full year, the 99.8th %ile of hourly means is given in brackets).									
			2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Richmond 1 Castelnau (RI1)	Y	100	0	0	0	4	0	7	9[a]	3	0	0[a]
Richmond 2 Barnes Wetlands (RI2)	Y	98	0[e] (93)	0	0	0	0[e] (107)	0	1[b]	0	0	0[b]
Richmond (Mobile)	Y	79	1	2	0	0	0	0	0[c]	0	0	0[c] (97.2)
Teddington (AURN) (TD0)	Y	96	0	0	0	0	0	0	0[d]	0[e] (76.7)	0[e] (74.2)	0[d]
Objective			**18**									

Source: London Air Quality Network (ERG, 2011).

[a] **Richmond 1 Castelnau:** data after 1st April 2011have been fully ratified.
[b] **Richmond 2 Barnes Wetlands:** data after 1st April 2011 have been fully ratified.
[c] **Richmond Mobile 2 Lower Mortlake Road** data after 1st January 2011 have not been fully ratified. The Richmond Mobile Air Quality Monitoring Unit was located at Richmond RIY Hampton Court Road in 2010, Richmond RIW Upper Teddington Road in 2009, Richmond 29 Mortlake Road, Kew for 2008 and Richmond 27 Lincoln Avenue, Twickenham for 2007. Prior to this the Mobile was in more than one location per calendar year, so it is not possible to calculate an annual mean (NA = not available). Exceedences are determined from a composite of deployments, as detailed in Appendix B.
[d] **Teddington (AURN) NPL:** data after 1st Jul 2011 have not been fully ratified.
[e] Data capture less than 90%

Diffusion Tube Monitoring Data

The NO_2 diffusion tube monitoring results for 2011 are provided in Table 2.4a. Exceedences of the annual mean NO_2 objective are highlighted in **bold**. Concentrations > 60μg/m^3 are underlined as well as **bold** to signify that the hourly objective may be exceeded at these sites based on the annual mean. The "fall-off in NO_2 concentrations with distance from the road" method in LAQM.TG (09) (Defra 2009b) was used to estimate the annual mean concentration in 2011 at the nearest receptor for the sites that do not represent relevant exposure (e.g. site 3 is not representative of relevant public exposure because it is a roadside site at 0.5m from the kerb, whereas the closest residential building façade is 10.7m).

For comparison, the results from the 2011 diffusion tube monitoring are also shown against 2009 and 2010 in Table 2.4b and plotted in Figure 2.2.

London Borough of Richmond upon Thames

Table 2.4a 2011 Results of Nitrogen Dioxide Diffusion Tubes

Site ID	Location	Within AQMA ?	Data Capture 2011 %	Annual mean concentrations 2011 (µg/m^3) Adjusted for bias	
				Measured	Estimated at receptor
1	Hampton Court Rd, Hampton	Y	100	**44**	**43**
2	Percy Rd, Hampton (nr. Oldfield Rd)	Y	100	31	29
3[d]	Uxbridge Rd, Hampton (nr. Arundel Close)	Y	100	35	28
4[d]	Hampton Rd, Teddington (nr. Bushy Pk Gardens)	Y	100	38	30
5[d]	Sandy Lane, Teddington (Shaef Way)	Y	100	32	27
6[d]	Kingston Rd, Teddington (nr. Woffington Close)	Y	92	34	29
7	Broad St, Teddington (Tesco)	Y	100	**49**	**43**
8[d]	Strawberry Vale, Teddington (Clive Rd)	Y	92	30	26
9[d]	Hampton Rd, Twickenham	Y	100	**47**	**42**
10[d]	Twickenham Rd, Twickenham (opp. Fulwell golf course)	Y	92	36	33
11[d]	Percy Rd, Whitton (nr. Percy Way)	Y	92	**46**	35
12[d]	Hanworth Rd, Whitton	Y	100	**41**	32
13[d]	Whitton Rd, Whitton, (opp. rugby ground)	Y	92	**42**	34
14[d]	Cross Deep, Twickenham (nr Poulett Gardens)	Y	92	38	32
15[d]	Richmond Rd, Twickenham (opp. Marble Hill Pk)	Y	100	**45**	**40**
16[d]	St Margarets Rd, St Margarets (nr. Bridge Rd)	Y	100	38	35
17	Red Lion Street, Richmond	Y	100	**65**	**55**
18[d]	Lower Mortlake Rd, Richmond (nr. Trinity Rd)	Y	100	**66**	**47**
19[d]	Kew Rd, Kew (nr. Walpole Av)	Y	100	**50**	35
20[d]	Mortlake Rd, Kew (nr. Kent Rd)	Y	92	**40**	36
21[d]	Lower Richmond Rd, Mortlake (nr. Kingsway)	Y	100	39	35
22[d]	Castelnau, Barnes (nr. Hammersmith Bridge)	Y	100	**46**	38
23[bd]	Castelnau Library, Barnes (static site)	Y	92	35	32
24[d]	Lonsdale Road, Barnes (nr. Suffolk Rd)	Y	100	36	30
25[d]	URRW, (nr. Sheen School)	Y	92	32	32
26[d]	URRW, Sheen (nr. Courtland Estate)	Y	100	**40**	31
27	Queens Rd, Richmond (nr. Russell Walk)	Y	100	38	35
28[a]	Holly Lodge, Richmond Pk	Y	100	20	NA
29[d]	Petersham Rd, Ham (nr. Sandy Lane)	Y	100	37	37
30	German School, Petersham Rd	Y	100	33	34

Site ID	Location	Within AQMA ?	Data Capture 2011 %	Annual mean 2011 (µg/m^3) Adjusted for bias [a]	
				Measured	Receptor [d]
30					
31[d]	A316	Y	100	**50**	**40**
32 [c]	Kings St, Twickenham	Y	100	**75**	**65**
33	Heath Rd, Twickenham	Y	100	**47**	39
34[d]	Thames St, Hampton	Y	100	36	36
35	High St, Hampton Wick	Y	92	**46**	**46**
36	Upper Richmond Road West (URRW), Sheen Lane	Y	100	**46**	**46**
37 [ab]	Barnes Wetlands (static site)	Y	100	26	26
38[d]	Queens Rd, Teddington (Park Rd end)	Y	100	35	35
39 [d]	Richmond Rd, Richmond Bridge, East Twickenham	Y	100	**58**	**52**
40[d]	Staines Rd, Twickenham	Y	100	37	28
41	Paradise Rd, Richmond	Y	100	38	33
42	The Quadrant, Richmond	Y	100	**53**	**55**
43 [c]	Hill St, Richmond	Y	92	**74**	**66**
44	Sheen Rd, Richmond (Shops)	Y	100	**42**	**42**
45	High St, Teddington, (post office)	Y	100	**44**	37
46[d]	15 Queens Rd, Teddington	Y	92	36	31
47	Causeway, Teddington	Y	100	33	32
48[d]	Stanley Rd, Teddington (junc. Strathmore Rd)	Y	100	**43**	37
49	URRW War Memorial, Sheen Lane, Sheen	Y	100	39	36
50	URRW, nr. Clifford Av, Sheen	Y	100	**49**	**42**
51[d]	Sheen Lane, Sheen (railway crossing)	Y	100	32	30
52[d]	Clifford Av, Chalkers Corner	Y	92	**52**	**45**
53 [b]	Mobile Air Quality Site	Y	100	**51**	**43**
54	Mortlake Road, adjacent to West Hall Road, Kew	Y	92	**44**	**41**
55[d]	Mortlake Road, adjacent to Cemetery Gates, Kew	Y	92	**41**	35
56	A316 (St Margarets roundabout)	y	92	31	30
57	A316 (Lincoln Ave)	y	75	24	24
58[d]	London Rd, Twick	y	67	26	26
RUT1	Civic Centre, York St, Twickenham	Y	100	**48**	**48**
RUT2 [c]	George St, Richmond	Y	100	**93**	**78**
RUT3 [a]	Cromwell Place, Mortlake	Y	100	26	[e]NA
RUT4 [a]	Elmfield House, Waldegrave Rd, Teddington	Y	92	29	[e]NA
Annual mean objective				**40**	
1-hour objective may exceed when annual mean				**>60**	

London Borough of Richmond upon Thames

All sites bias adjusted using a factor of, 0.92 except background sites [a] which are bias adjusted using a factor of 0.91. .

[b] Result is the mean of multiple tube exposure.

[c] Site with relevant public exposure for short term 1-hour mean objective and annual mean **>60** $\mu g/m^3$.

[d] Estimated annual mean concentration at nearest receptor for the sites that do not represent relevant exposure. Calculated using the "fall-off in NO_2 concentrations with distance from the road" method in LAQM.TG (09) (Defra 2009b). Results have a greater uncertainty than the measured data and unlikely to be suitable for use in DA.

[e] NA – It is not applicable to estimate the concentration as the background receptor and monitor are at the same location..

Table 2.4b 2009 to 2011 Results of Nitrogen Dioxide Diffusion Tubes

Site ID	Location	Within AQMA ?	Annual mean concentrations ($\mu g/m^3$) Adjusted for bias		
			2009 [a]	2010 [b]	2011 [c]
1	Hampton Court Rd, Hampton	Y	**53**	**51**	**44**
2	Percy Rd, Hampton (nr. Oldfield Rd)	Y	39	39	31
3	Uxbridge Rd, Hampton (nr. Arundel Close)	Y	**46**	**44**	35
4	Hampton Rd, Teddington (nr. Bushy Pk Gardens)	Y	**50**	**47**	38
5	Sandy Lane, Teddington (Shaef Way)	Y	36	37	32
6	Kingston Rd, Teddington (nr. Woffington Close)	Y	**45**	**47**	34
7	Broad St, Teddington (Tesco)	Y	**66**	**69**	**49**
8	Strawberry Vale, Teddington (Clive Rd)	Y	37	38	30
9	Hampton Rd, Twickenham	Y	**59**	**57**	**47**
10	Twickenham Rd, Twickenham (opp. Fulwell golf course)	Y	**48**	**45**	**3**6
11	Percy Rd, Whitton (nr. Percy Way)	Y	**50**	**52**	**46**
12	Hanworth Rd, Whitton	Y	**49**	**52**	**41**
13	Whitton Rd, Whitton, (opp. rugby ground)	Y	**50**	**53**	**42**
14	Cross Deep, Twickenham (nr Poulett Gardens)	Y	**54**	**52**	38
15	Richmond Rd, Twickenham (opp. Marble Hill Pk)	Y	**55**	**53**	**45**
16	St Margarets Rd, St Margarets (nr. Bridge Rd)	Y	**49**	**48**	38
17 [f]	Parkshot, Richmond (Court)	Y	31	**79**	**65**
18	Lower Mortlake Rd, Richmond (nr. Trinity Rd)	Y	**64**	**70**	**66**
19	Kew Rd, Kew (nr. Walpole Av)	Y	**60**	**46**	**50**
20	Mortlake Rd, Kew (nr. Kent Rd)	Y	**58**	**54**	**40**
21	Lower Richmond Rd, Mortlake (nr. Kingsway)	Y	**47**	**47**	39
22	Castelnau, Barnes (nr. Hammersmith Bridge)	Y	**60**	**55**	**46**
23 [d]	Castelnau Library, Barnes (static site)	Y	**43**	**43**	35
24	Lonsdale Road, Barnes (nr. Suffolk Rd)	Y	**46**	**42**	36
25	URRW, (nr. Sheen School)	Y	**46**	**42**	32
26	URRW, Sheen (nr. Courtland Estate)	Y	**54**	**46**	**40**
27	Queens Rd, Richmond (nr. Russell Walk)	Y	**46**	**44**	38
28	Holly Lodge, Richmond Pk	Y	23	24	18
29	Petersham Rd, Ham (nr. Sandy Lane)	Y			37
30	German School, Petersham Rd	Y			33

London Borough of Richmond upon Thames

All

Site ID	Location	Within AQMA ?	Annual mean concentrations ($\mu g/m^3$) Adjusted for bias		
			2009 [a]	2010 [b]	2011 [c]
31	A316	Y	**60**	**53**	**50**
32	Kings St, Twickenham	Y	**110**	**102**	**75**
33	Heath Rd, Twickenham	Y	**63**	**66**	**47**
34	Thames St, Hampton	Y	**44**	**42**	36
35	High St, Hampton Wick	Y	**54**	**54**	**46**
36	Upper Richmond Road West (URRW), Sheen Lane	Y	**61**	**60**	**46**
37 [d]	Barnes Wetlands (static site)	Y	28	28	26
38	Queens Rd, Teddington (by Park Rd)	Y	**40**	**40**	35
39	Richmond Rd, Richmond Bridge, East Twickenham	Y	**73**	**70**	**58**
40	Staines Rd, Twickenham	Y	**41**	**31**	37
41	Paradise Rd, Richmond	Y	**48**	**49**	38
42	The Quadrant, Richmond	Y	**60**	**69**	**53**
43	Hill St, Richmond	Y	**81**	**82**	**74**
44	Sheen Rd, Richmond (Shops)	Y	**53**	**49**	**42**
45	High St, Teddington (post office)	Y	**49**	**48**	**44**
46	15 Queens Rd, Teddington	Y	**47**	**48**	36
47	Causeway, Teddington	Y	**47**	**49**	33
48	Stanley Rd, Teddington (junc. Strathmore Rd)	Y	**52**	**54**	**43**
49	URRW War Memorial, Sheen Lane, Sheen	Y	**49**	**50**	39
50	URRW, nr. Clifford Av, Sheen	Y	**69**	**64**	**49**
51	Sheen Lane, Sheen (railway crossing)	Y	**41**	**39**	32
52	Clifford Av, Chalkers Corner	Y	**70**	**71**	**52**
53 [d]	Mobile Air Quality Site	Y	**41**	**55**	**51**
54 [f]	Mortlake Road, adjacent to West Hall Road, Kew	Y		**62**	**44**
55 [f]	Mortlake Road, adjacent to Cemetery Gates, Kew	Y		**59**	**41**
56	A316 (St Margarets roundabout)	Y		**41**	31
57	A316 (Lincoln Ave)	Y		35	24
58[g]	London Rd, Twick	Y			26
RUT1	Civic Centre, York St, Twickenham	Y	**62**	**70**	**48**
RUT2	George St, Richmond	Y	**123**	**106**	**93**
RUT3	Cromwell Place, Mortlake	Y	32	32	23
RUT4	Elmfield House, Waldegrave Rd, Teddington	Y	30	29	26
Annual mean objective			**40**		
1-hour objective may exceed when annual mean			**>60**		

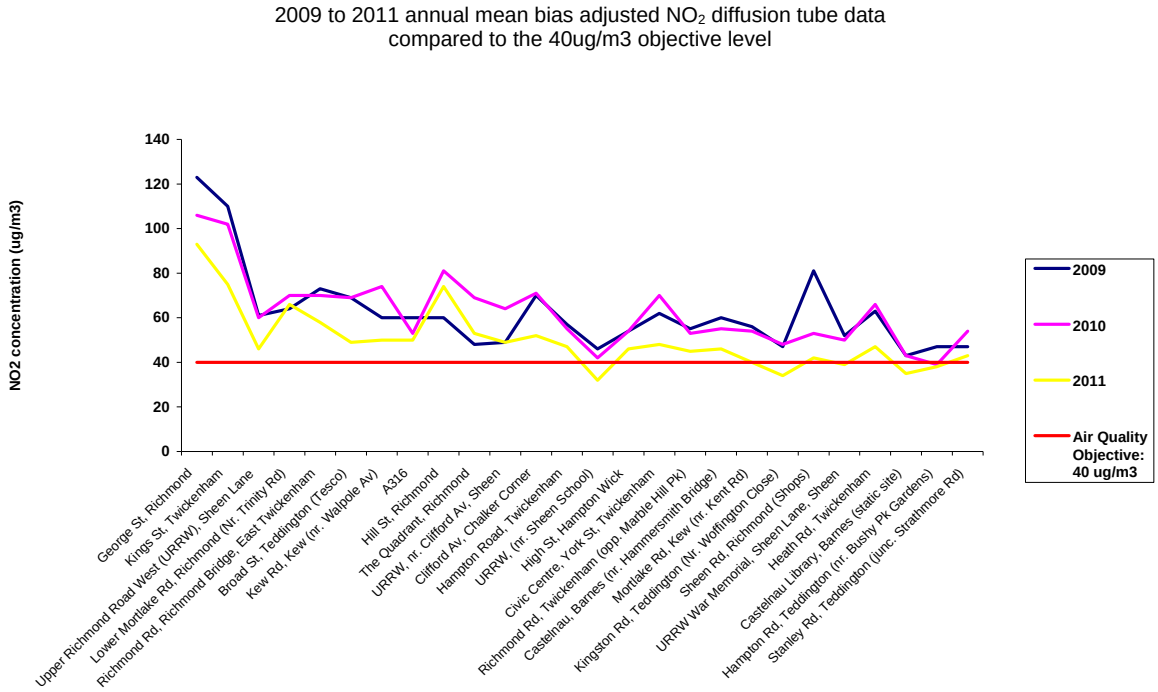
adjusted using a factor of , except sites [a] which are bias adjusted using a factor of Sites [a] also given in brackets and corrected with the national factor of 1.01. See Appendix A for further explanation.

[b] Bias adjusted using a factor of 0.99, except sites [b] which are bias adjusted using a factor of 1.11.

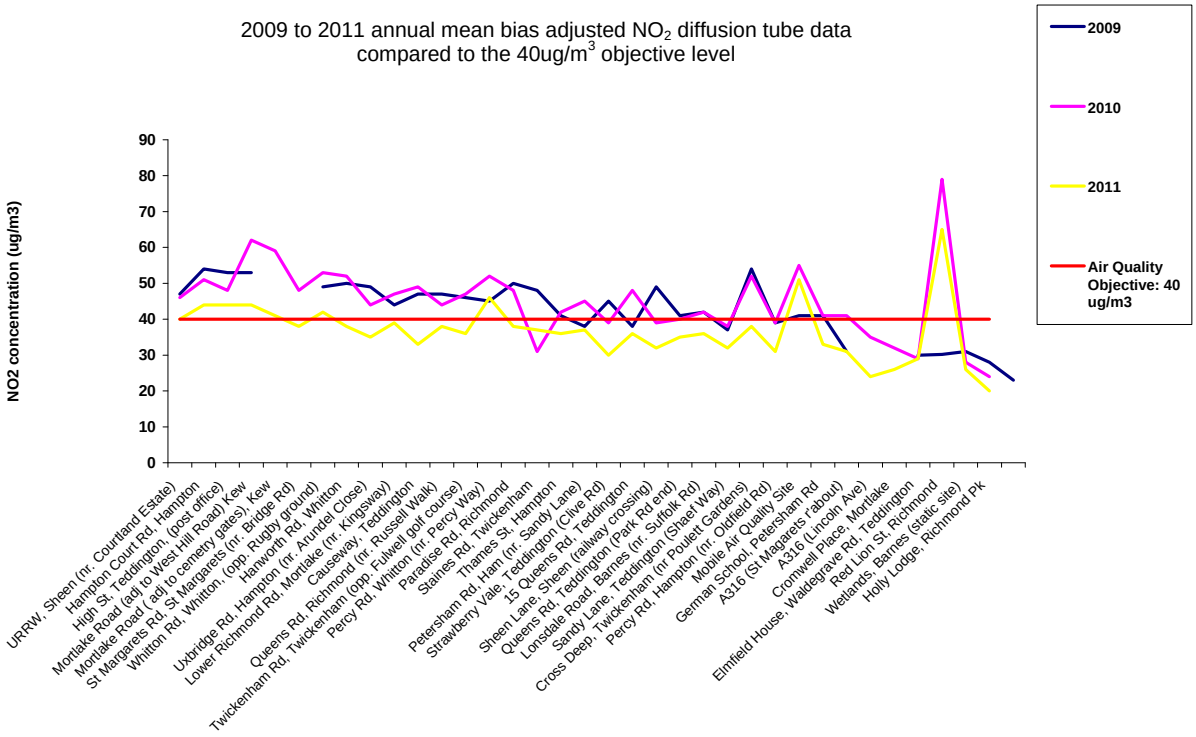
[c] Bias adjusted using a factor of 0.92, except sites [c] which are bias adjusted using a factor of 0.91.
[d] Result is the mean of multiple tube exposure.
[e] Site with relevant exposure for 1-hour mean objective where annual mean **>60** $\mu g/m^3$
[f] The tube was moved on 1st December 2009 from Parkshot, Richmond to Red Lion Street
[g] Site 58 commenced on 29th March 2011, annual averages based on 9 months data.

Figure 2.2a and b 2009 to 2011 Nitrogen Dioxide Diffusion Tube Results

a



b



London Borough of Richmond upon Thames

The increase in NO_2 levels at Red Lion St, Richmond is a result of the diffusion tube relocated from a background site (Parkshot, Richmond) to a roadside location.

2.2.2 PM_{10}

PM_{10} is measured by TEOM at three automatic monitoring stations in the LBRuT, these results are presented in Tables 2.5a and 2.5b. Exceedences of the PM_{10} objectives are highlighted in **bold** and in Table 2.5b where the period of valid data is less than 90% of a full year, the 90th percentile of the 24-hour mean is given in brackets after the number of exceedences.

The PM_{10} monitoring results in Table 2.5a show that annual mean PM_{10} was not exceeded at any site during the last ten years. The daily mean PM_{10} objective (Table 2.5b) was only exceeded at the Richmond Mobile Monitoring Unit during 2003, as a composite of the following deployments: Kew Green, Kew; Richmond Road, Twickenham (opposite Orleans Park School) and Upper Teddington Road, Teddington. As discussed in Section 2.2, the meteorological conditions in 2003 caused particularly elevated air pollution levels in this year. All the monitoring site locations are representative of relevant public exposure, apart from Richmond 1 Castelnau, as discussed in Section 2.2.1.

Table 2.5a Results of PM_{10} Automatic Monitoring: Comparison with Annual Mean Objective

Location	Within AQMA ?	Proportion of year with valid data 2011 %	Annual mean concentrations (μg/m^3) Gravimetric equivalent (TEOM X 1.3) and reference equivalent (VCM corrected TEOM given in **bold**) [d]									
			2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Richmond 1 Castelnau (RI1) [a]	Y	99	25	28	26, **24**	26, **24**	27, **23**	26, **23**	23, **20**	**21**	**21**	**23**[b]
Richmond 2 Barnes Wetlands (RI2) [a]	Y	97	24 [c]	28	22, **21**	22, **22**	25, **22**	22, **20**	21, **18**	**20**	**19**	**22**[b]
Richmond (Mobile) [b]	Y	90	NA	NA	NA	NA	NA	26, **23**	28 [c] **24**	**23**	**22**	**23**[b]
Objective			**40**									

Table 2.5b Results of PM_{10} Automatic Monitoring: Comparison with 24-hour Mean Objective

Location	Within AQMA ?	Prop. of year with valid data 2011 %	Number of Exceedences of daily mean objective (50 μg/m^3)[d] **(Where the period of valid data is less than 90% of a full year, the 90th %ile of daily means is given in brackets)** (VCM corrected TEOM given in **bold**) [d].									
			2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**[e]
Richmond 1 Castelnau (RI1) [a]	Y	99	4	29	10, **10**	6, **17**	8, **13**	17, **21**	9, **11**	**4**	**2**	**13**[b]
Richmond 2 Barnes Wetlands (RI2) [a]	Y	97	6 [c] (36)	34	5, **9**	4, **15**	17 [c], **13**	12, **19**	3, **10**	**5**	**1**	**13**[b]
Richmond Mobile [b]	Y	90	2	**49**[f]	8, **12**	7, **28**	14, **14**	20, **22**	11[c](41), **12 (36)**	**5**	**5**	**12**[b]
Objective			**35**									

Source: London Air Quality Network (ERG, 2011).

[a] **Richmond 1 Castelnau and Richmond 2 Barnes Wetlands:** Data fully ratified to December 2010

[b] **Richmond (RAH) Lower Mortlake Road**: data after 1st January 2011 have not been fully ratified. The Richmond Mobile Air Quality Monitoring Unit was located at Richmond RIY Hampton Court Road in 2010, Richmond RIW Upper Teddington Road in 2009, Richmond 29 Mortlake Road, Kew for 2008 and Richmond 27 Lincoln Avenue, Twickenham for 2007. Prior to this the Mobile was in more than one location per calendar year, so it is not possible to calculate an annual mean (NA = not available). Exceedences are determined from a composite of deployments, as detailed in Appendix B.

[c] Data capture less than 90%, (so percentile also given in Table 2.5b)

[d] TEOM data from 2002 to 2008 is presented as gravimetric equivalent (TEOM X 1.3) and reference equivalent *(VCM corrected TEOM)* (Defra, 2009d) given in ***bold***. VCM correction of TEOM data is possible from 2004 onwards when Filter Dynamics Measurement System (FDMS) were fitted to TEOM's at some sites across LAQN. The TEOM-FDMS is equivalent to the European Gravimetric Standard Method. From 2009 onwards the data is presented as VCM corrected.

[e] data not ratified

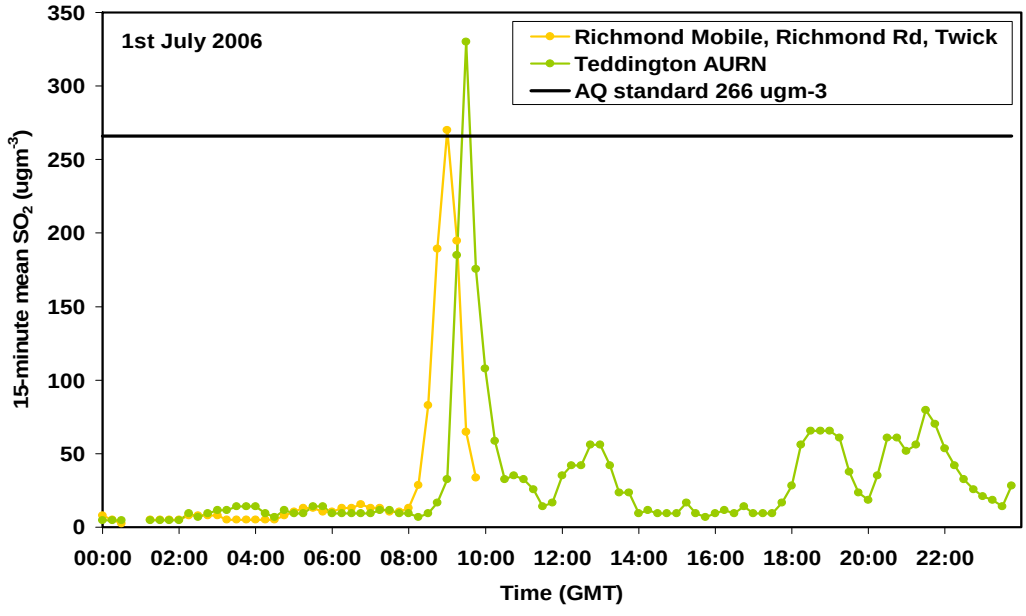
[f] result is above the air quality objective wich states that the daily mean of 50ug/m^3 should not be exceeded more than 35 times a year.

2.2.3 Sulphur Dioxide

SO_2 was measured at two automatic monitoring stations in the LBRuT, the Richmond Mobile until 2010 and the Teddington AURN site until 2007. Table 2.6a to 2.6c demonstrate that the SO_2 objectives have been met in LBRuT for the past 10 years. Where the period of valid data is less than 90% of a full year, the appropriate percentile is given in brackets after the number of exceedences. Section 1.4 shows that SO_2 was found to not need assessment beyond Stage 1 of the LAQM Review and Assessment process because exceedence of the objective was unlikely. However, to provide an idea of SO_2 concentrations, annual means are presented in Table 2.6d from 2002 to 2008.

In July 2006, the Richmond Mobile was at York House, Richmond Road, (Twickenham), one 15 minute mean was recorded above 266 μg/m^3, this event was also recorded at the Teddington AURN site as illustrated in Figure 2.3 and documented by ERG on pollution episodes page of the LAQN website (ERG, 2009). During the 2006 heat wave a combination of power demand in London and maintenance at several north England power stations led to the use of the Littlebrook power station. As a consequence of this, SO_2 plume grounding was seen in London including the breach of the Air Quality Strategy objective concentration in west London around Teddington and Richmond illustrated in Figure 2.3.

Figure 2.3 Exceedence of 15-minute mean Sulphur Dioxide AQS objective concentration (266 μg/m^3), 1st July 2006.



London Borough of Richmond upon Thames

Table 2.6a Results of Automatic Monitoring for Sulphur Dioxide: Comparison with 15-minute Mean Objective

Location	Within AQMA?	Proportion of year with valid data 2011 %	Number of Exceedences of 15 minute mean (266 μg/m^3) (Where the period of valid data is less than 90% of a full year, the 99.9th %ile of 15-minute means is given in brackets).									
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Richmond (Mobile) [a]	N	22	0	0	0	0	1	0	0	0	0	NA
Teddington (AURN) (TD0) [b]	N	NA	0	0	0	0	1	0 [c]	NA	NA	NA	NA
Objective			**35**									

Table 2.6b Results of Automatic Monitoring for Sulphur Dioxide: Comparison with Hourly Mean Objective

Location	Within AQMA?	Proportion of year with valid data 2011 %	Number of Exceedences of hourly mean (350 μg/m^3) (Where the period of valid data is less than 90% of a full year, the 99.7th %ile of hourly means is given in brackets).									
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Richmond (Mobile) [a]	N	22	0	0	0	0	1	0	0	0	0	NA
Teddington (AURN) (TD0) [b]	N	NA	0	0	0	0	0	0(32) [c]	0	NA	NA	NA
Objective			**24**									

Table 2.6c Results of Automatic Monitoring for Sulphur Dioxide: Comparison with 24-hour Mean Objective

Location	Within AQMA?	Proportion of year with valid data 2011 %	Number of Exceedences of24-hour mean (125 μg/m^3) (Where the period of valid data is less than 90% of a full year, the 99th %ile of 24-hour means is given in brackets).									
			2002	2003	2004	2005	2006	2007	2008	2008	2010	2011
Richmond (Mobile) [a]	N	22	0	0	0	0	1	0	0	0	0	NA
Teddington (AURN) (TD0) [b]	N	NA	0	0	0	0	0	0 (14)[c]	0	NA	NA	NA
Objective			**3**									

Table 2.6d Results of Automatic Monitoring for Sulphur Dioxide: Annual Mean

Location	Within AQMA?	Proportion of year with valid data 2011 %	Annual mean (μg/m^3)									
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Richmond (Mobile) [a]	N	22	NA	NA	NA	NA	NA	4	9	4.6	6.6	NA
Teddington (AURN) (TD0) [b]	N	NA	4	5	4	3	4	4[c]	NA	NA	NA	NA
Objective			**No objective for annual mean, values show trend**									

Source: London Air Quality Network (ERG, 2011).

[a] **Richmond (RAH) Lower Mortlake Road**: monitoring ceased in March 2011. The Richmond Mobile Air Quality Monitoring Unit was located at Richmond RIY Hampton Court Road in 2010, Richmond RIW Upper Teddington

Road in 2009, Richmond 29 Mortlake Road, Kew for 2008 and Richmond 27 Lincoln Avenue, Twickenham for 2007**.** Prior to this the Mobile was in more than one location per calendar year and exceedences are determined from a composite of deployments, as detailed in Appendix B.

[b] **Teddington (AURN) NPL:** data has been fully ratified. SO_2 monitoring ceased in October 2007.

[c] Data capture less than 90%.

2.2.4 Benzene

LBRuT measured BTEX (benzene, toluene, ethyl benzene, xylene) via diffusion tube at the following 5 town centre locations across the borough from 2002 to 2009: Broad Street (Teddington); Kings Street (Twickenham); High Street (Hampton Wick); URRW (Sheen Lane); George Street (Richmond). From April 2009 benzene only diffusion tubes were deployed and the monitoring of TEX species ceased. In March 2011 benzene monitoring ceased. NO_2 diffusion tubes are also deployed at these locations. Table 2.7 and Figure 2.4 demonstrate that the benzene objective has been met in LBRuT for the past 9 years and Section 1.4 shows that benzene was found to not need assessment beyond Stage 1 of the LAQM Review and Assessment process because exceedence of the objective was unlikely.

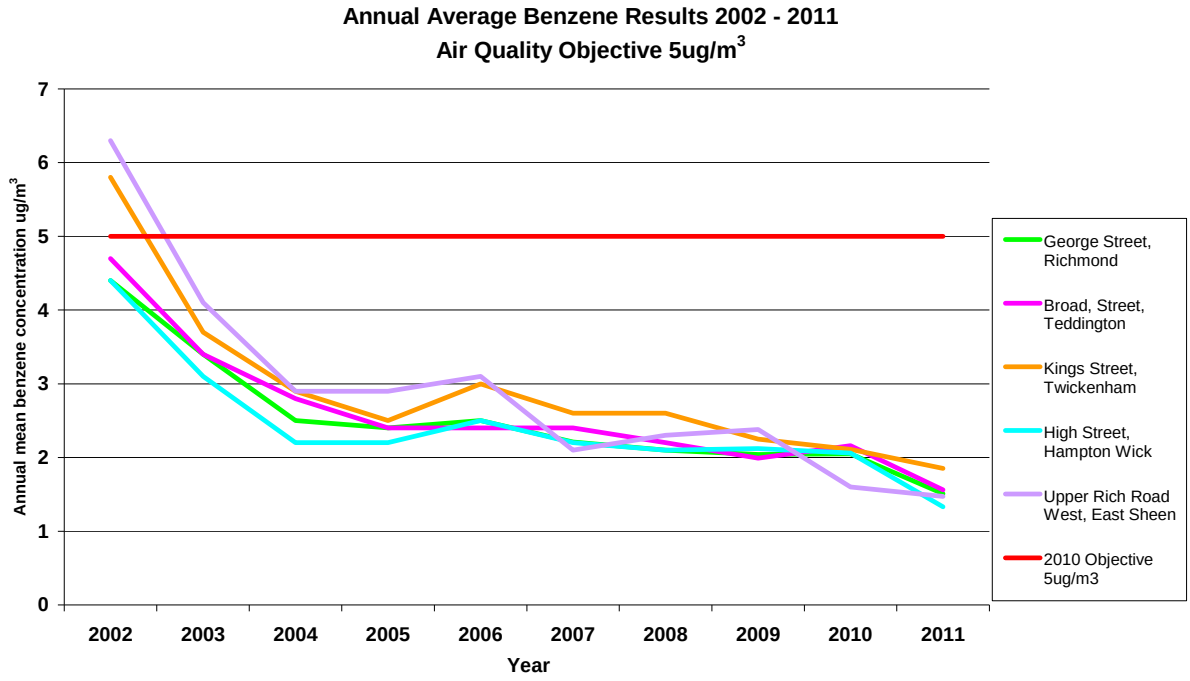
The headline findings from the MSc BTEX monitoring project were that, even though traffic levels have remained fairly constant, ambient benzene concentrations levels have reduced. It is understood that the initial reason for the reduction was due to the introduction of catalytic converters on vehicle exhausts and evaporative canisters on the fuel inlets. A further reduction then came with the reduced content of benzene in petrol. The monitoring results showed seasonal variations, with higher benzene concentrations during the winter months, probably due to the poorer dispersion conditions. Conversely, in the summer months, the strong photolytic sunshine had the effect of reducing benzene levels. A study of the monitored BTEX ratios mostly returned ratios similar to those quoted in LAQM. TG(09) of 1:3.5:1:2:1. However, two matters of interest were discovered from the results. First, it was discovered that deviations from this standard ratio can usefully be used as a quality control indicator for the diffusion tubes, as it indicates when the absorbent should be changed. The other main finding of interest was that one site had unusually high toluene: benzene ratios. On inspection it was discovered that the diffusion tube had inadvertently been sited directly outside a shoe repair shop. Over the seven years of monitoring, whilst the shoe shop toluene solvent levels were roughly double those at a comparable site, the benzene levels there were no higher.

Table 2.7 Results of Automatic Monitoring for Benzene: Annual Mean

Site ID	Location	Within AQMA ?	Proportion of year with valid data 2011 %	Annual mean (ug/m^3)								
				2002	2003	2004	2005	2006	2007	2008	2009	2010
7	Broad St, Teddington (Tesco)	N	100	4.7	3.4 [a]	2.8	2.4	2.4	2.4 [a]	2.2 [a]	2.0	2.06
32	Kings St, Twickenham	N	100	5.4	3.7	2.9 [a]	2.5	3.0	2.6	2.6	2.0	2.11
35	High St, Hampton Wick	N	100	4.3	3.1	2.2 [a]	2.2	2.5	2.2	2.1	2.1	1.60
36	URRW, Sheen Lane	N	100	5.6	4.1	2.9	2.9	3.1	2.3	2.3	1.8	2.16
RUT 02	George St, Richmond	N	100	4.4	3.4	2.5	2.4	2.5 [a]	2.2	2.1	1.9	2.05
Objective				5								

[a] Data capture less than 75%.

Figure 2.4 Annual mean benzene from 2002 to 2011



2.2.5 Carbon Monoxide

CO is only measured at the Richmond Mobile automatic monitoring unit, which moves around roadside sites in the LBRuT. Table 2.8 demonstrates that the CO objective has been met at the Richmond Mobile deployments for the past 10 years. Section 1.4 shows that CO did not need to be assessed beyond Stage 2 of the LAQM Review and Assessment process because exceedence of the objective was unlikely, however to provide an idea of CO concentrations the annual mean of the 8-hour mean in 2007 and 2008 was 0.3 mg/m^3.

Table 2.8 Results of Automatic Monitoring for Carbon Monoxide: Comparison with 8-hour Mean Objective

Location	Within AQMA ?	Proportion of year with valid data 2011 %	Number of Exceedences of 8-hour mean (10 mg/m^3) (Where the period of valid data is less than 90% of a full year, the 99th %ile of 24-hour means is given in brackets).									
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Richmond (Mobile) [a]	N	90	0	0	0	0	0	0	0	0	0	0
Objective			**10**									

Source: London Air Quality Network (ERG, 2011).

[a] **Richmond Lower Mortlake Road** has been ratified up to December 2010. The Richmond Mobile Air Quality Monitoring Unit was located at Richmond RIY Hampton Court Road in 2010, Richmond RIW Upper Teddington Road in 2009, Richmond 29 Mortlake Road, Kew for 2008 and Richmond 27 Lincoln Avenue, Twickenham for 2007**.** Prior to this the Mobile was in more than one location per year and exceedences are determined from a composite of deployments, as detailed in Appendix B.

2.2.6 Ozone

Ozone is measured at three of the four automatic monitoring stations in the LBRuT, Richmond 2 Barnes Wetlands, the Richmond Mobile and the Teddington AURN site. Ozone is not a LAQM pollutant because it is a regional pollutant. It is a secondary air pollutant formed from the chemical

processing of ozone precursors (nitrogen oxides (NO_X) and volatile organic compounds (VOC)) in the presence of sunlight. It is not directly emitted, for example, from a process that can be regulated. Understanding the relationship between ozone and NO_2 (which is a LAQM pollutant) is important for improving overall air quality, for example, as NO_X emissions are successfully reduced in urban areas, urban ozone concentrations are increasing (AQEG, 2009).

Table 2.9 shows that the UK Air Quality Strategy ozone objective was breached in LBRuT for the past 10 years at the background sites, Richmond 2 Barnes Wetlands and Teddington (AURN), and at Richmond Mobile roadside sites in 2002, 2003 and 2006, which are years that experienced meteorological conditions conducive to numerous ozone pollution episodes (ERG, 2009). Exceedences of the ozone objectives are highlighted in **bold**. In 2002, the 11 exceedences of the running 8-hour objective at the Richmond Mobile occurred when the site was deployed in Richmond Park (a background site). The UK objective for protection of human health for Ozone is 100 μg/m^3. This is measured as a daily maximum of a running 8 hour mean, to be achieved by the end of 2005, with no more than 10 exceedences per year.

Table 2.9 Results of Ozone Automatic Monitoring: Comparison with 8-hour running mean Objective

Location	Proportion of year with valid data 2011 %	Number of Exceedences of running 8-hour mean objective (100 μg/m^3)									
		2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Richmond 2 Barnes Wetlands (RI2) [a]	97	NA[d]	**49**	**24**	**17**	**26**	**15**	**24**	**14**	6	**25**
Richmond Mobile [b]	91	**11**	**14**	9	9	**24**	10	6	2	0	0
Teddington (AURN) (TD0)[c]	97	**25**	**49**	**25**	**33**	**42**	**19**	**33**	**20**	**16**	**25**
Objective		**10**									

Source: London Air Quality Network (ERG, 2011).

[a] **Richmond Lower Mortlake Road** has been ratified up to December 2010. The Richmond Mobile Air Quality Monitoring Unit was located at Richmond RIY Hampton Court Road in 2010, Richmond RIW Upper Teddington Road in 2009, Richmond 29 Mortlake Road, Kew for 2008 and Richmond 27 Lincoln Avenue, Twickenham for 2007. Prior to this the Mobile was in more than one location per year and exceedences are determined from a composite of deployments, as detailed in Appendix B.

[c] **Teddington (AURN) NPL:** Data after 01 January 2011 have not been fully ratified.

[d] Data capture only 46% so number of exceedences not available.

2.2.7 Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) were monitored at Castelnau Library, Barnes from 2002 to Spring 2007. There are no national guidelines for total PAH in the UK, however the Air Quality Strategy (Defra, 2007) adopted the EPAQS recommendation for a limit based on just one of the PAH family called benzo(a)pyrene (B(a)P), which is used as an indicator for all PAHs.

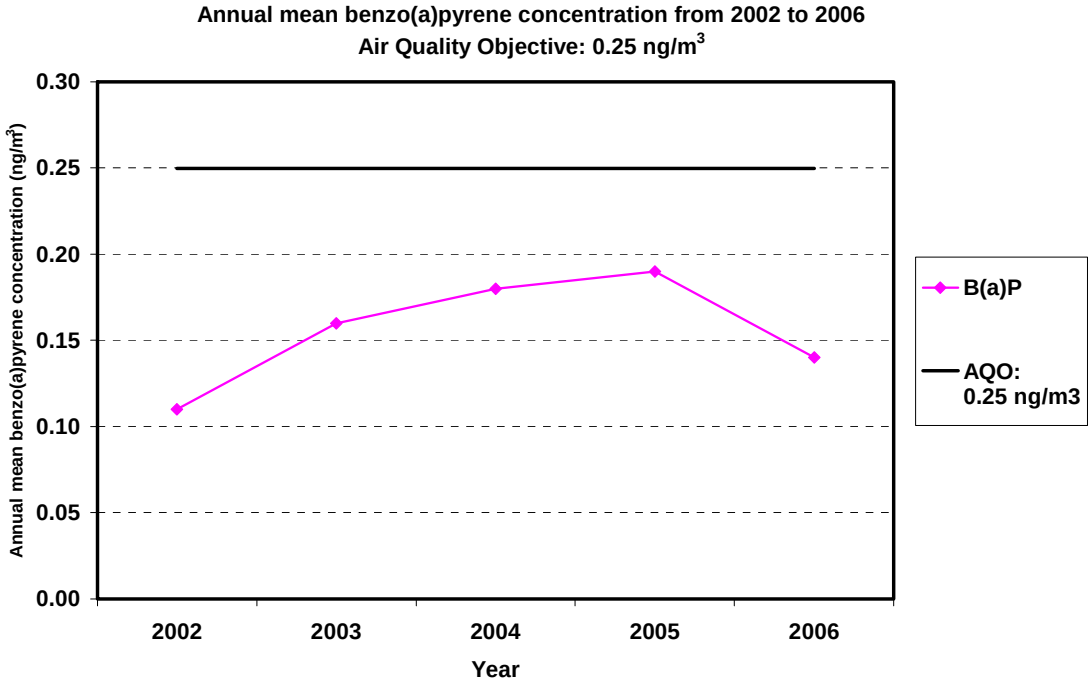
The EPAQS annual mean limit for B (a) P is 0.25 ng/m^3 by 2010. The recommended EPAQS B (a) P annual mean concentration was met in the LBRuT from 2002 to 2006, as illustrated in Table 2.10 and Figure 2.5, and so the LBRuT decided to cease monitoring PAHs in Spring 2007.

Table 2.10 Results of PAH Monitoring: Comparison with EPAQS annual mean B (a) P limit of 0.25 ng/m^3

Location	PAH measured	Annual Mean (ng/m^3)						
		2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Richmond 1 Castelnau	Total	11.5	15.2	20.2	15.7	*16.2*	NA	*NA*

(RI1)	B(a)P	0.11	0.16	0.18	0.19	*0.14*	NA	*NA*
Objective for B(a)P		**0.25**						

Figure 2.5 Annual mean B (a) P from 2002 to 2006



2.3 Modelling of NO_2 and PM_{10} for 2010

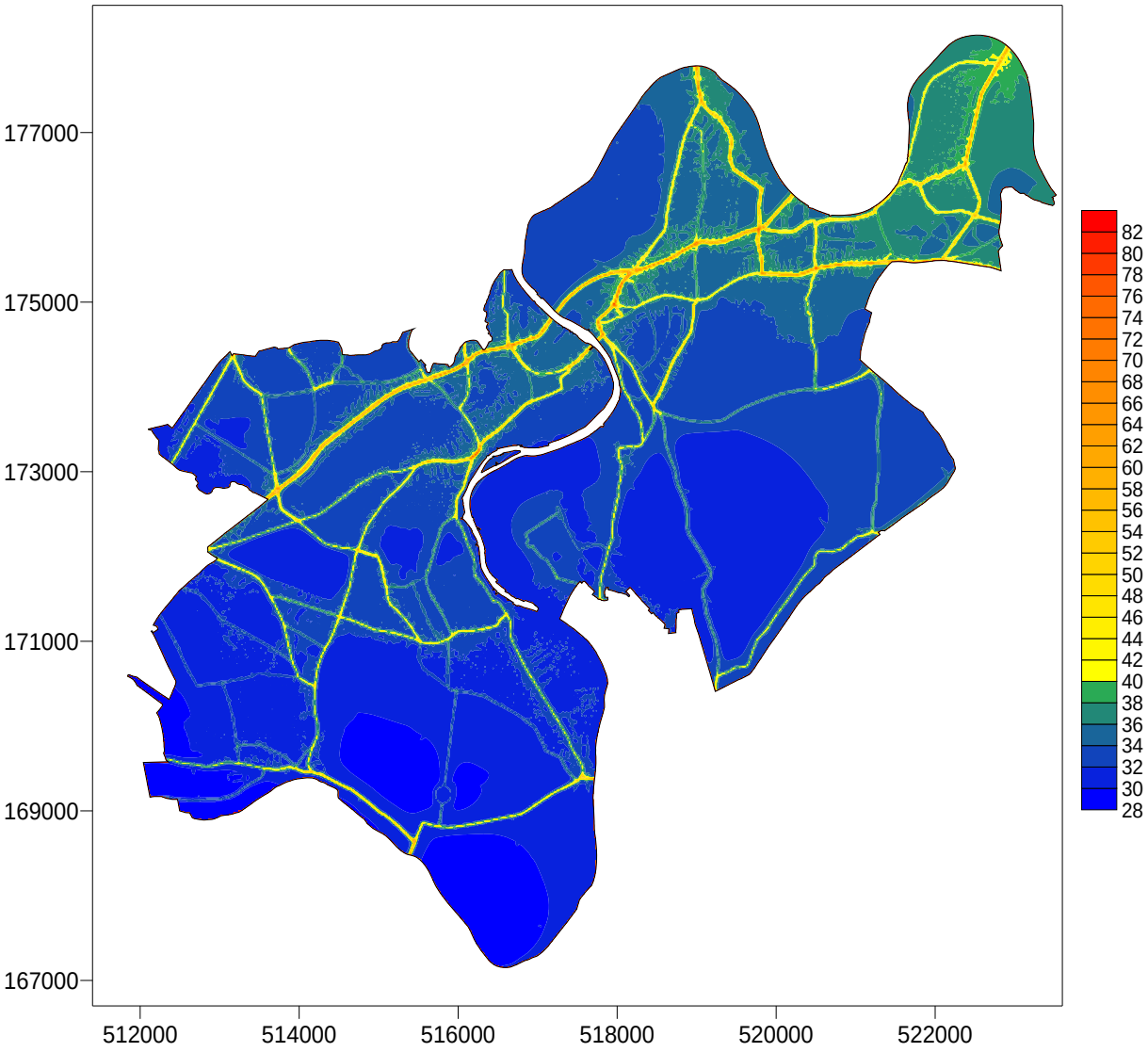
LBRuT commissioned ERG to undertake detailed 2010 modelling of NO_2 and PM_{10} across the LBRuT based on the London Atmospheric Emissions Inventory (LAEI), 2004 (GLA, 2004a), using the meteorological year 2003 (worst case) and taking into account the planned stages of the London Emissions Zone (LEZ). Note that there were some unplanned changes (delays) to the implementation of the LEZ because of the current economic climate (TfL, 2009).

The latest modelling maps, in addition to the monitoring results in this Section, can be used to assess appropriateness of the existing whole borough AQMA for NO_2 and PM_{10}. Both the measured and modelled maps show that the existing borough wide AQMA for NO_2 is justified. Initial assessments of the modelled PM_{10} maps indicate that the boundaries of the existing borough wide AQMA for PM_{10} might usefully be re-assessed to identify more clearly those areas which still do not meet the objectives. Although the areas of the Borough which exceed the objective have reduced, successive annual LAEIs indicate some year by year variation. The annual mean PM_{10} objective is predicted to be met across the whole borough in 2010, other than in the centre of some roads, where we have no receptors (i.e. no one lives there). Likewise, the daily PM_{10} air quality objective is also predicted to exceed in road centre locations, but does include some property facades in a limited number of areas.

The authority is also aiming to model the whole borough for the year 2015 for NO_2 and possibly PM_{10}.

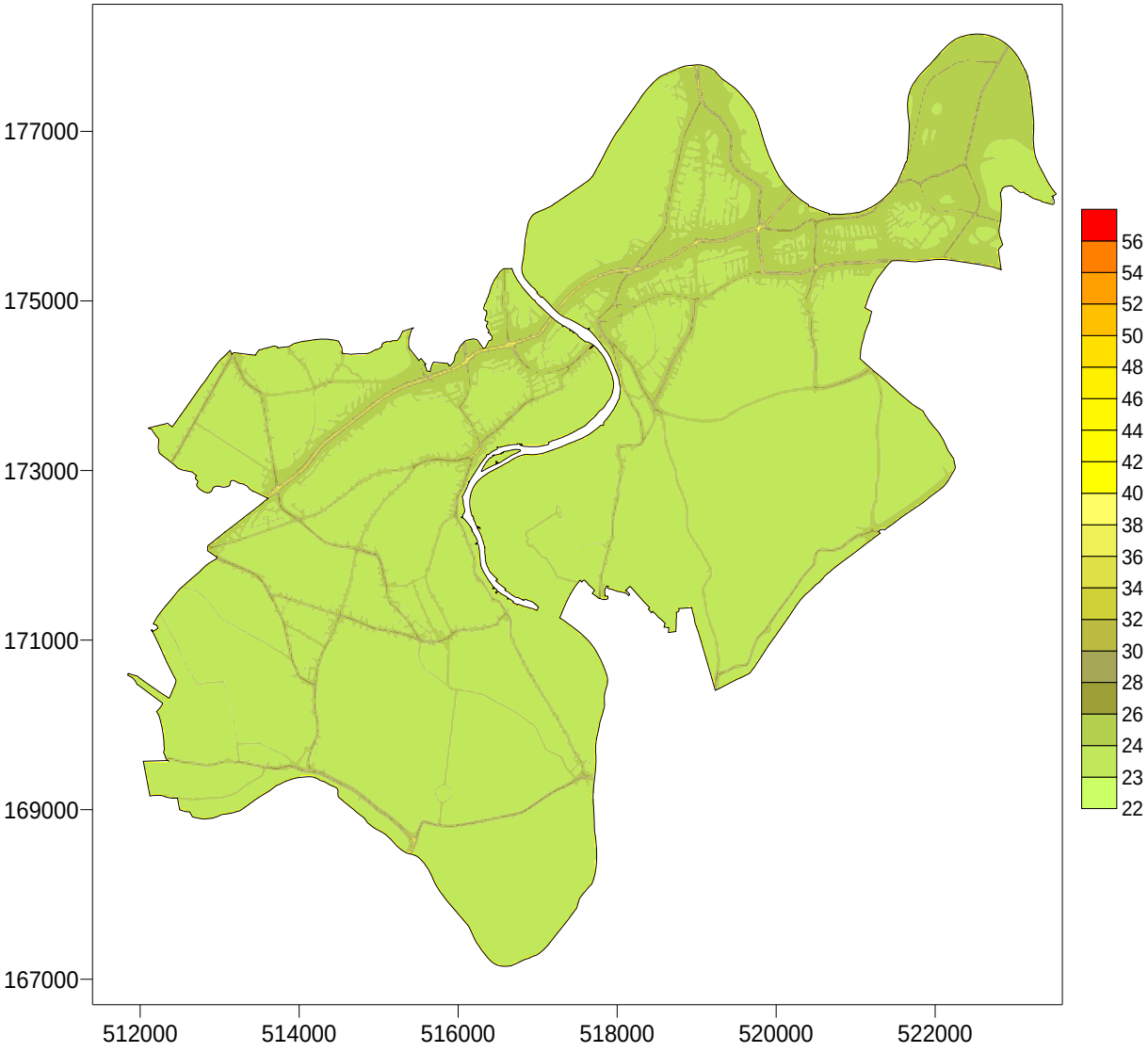
Maps of the areas which were predicted to exceed the objectives in 2010 are shown in Figure 2.6 to 2.8.

Figure 2.6 Predicted annual mean NO_2 across the LBRuT in 2010. Objective Limit 40μg/m^3



Source: ERG

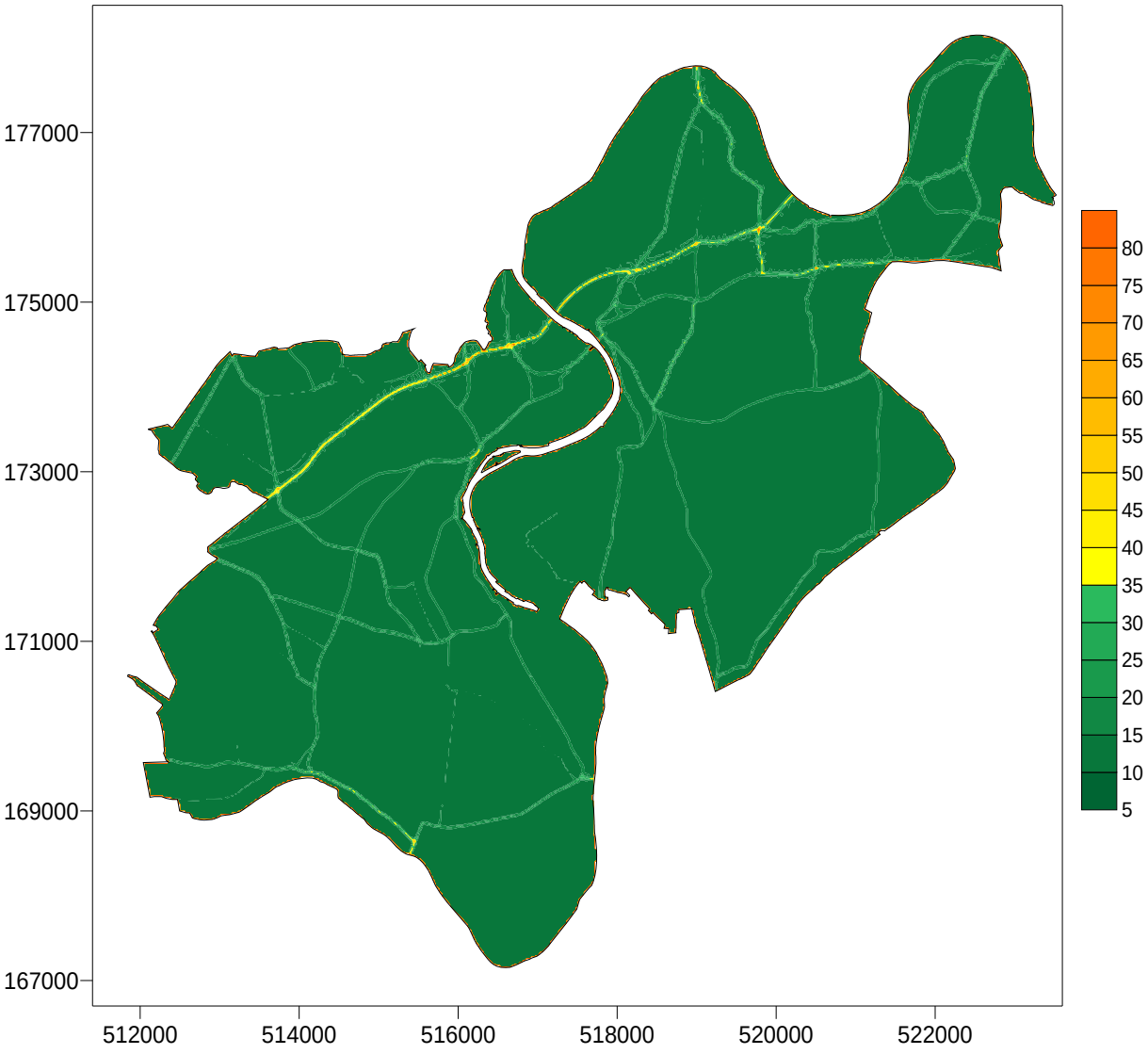
Figure 2.7 Predicted annual mean PM_{10} across the LBRuT in 2010. Objective Limit 40$\mu g/m^3$



Source: ERG

Figure 2.8 Predicted daily PM_{10} exceedences examples, across the LBRuT in 2010.

Objective Limit 35 days over 50$\mu g/m^3$



Source: ERG

2.4 Summary of Compliance with AQS Objectives

The results from monitoring in the LBRuT have shown that concentrations of SO_2, benzene, CO were below the objective values. NO_2 concentrations exceed the objectives at a number of locations justifying the borough-wide NO_2 AQMA. From the monitoring results PM_{10} concentrations only exceeded the daily objective in 2003. PM_{10} concentrations across the borough were re-modelled for 2010 and there were a few areas where the AQO was predicted to exceed at relevant locations. Further modeling for 2015 is planned for NO_2 and possibly PM_{10}.

3 Road Traffic Sources

There have been no new developments in the LBRuT since the last USA (LBRuT, 2009) that has the capacity to affect local road traffic emissions.

3.1 Narrow Congested Streets with Residential Properties Close to the Kerb

The criteria for assessing narrow congested streets are set out in Box 5.3, Section A.1 of LAQM. TG (09). The traffic flow required to trigger a Detailed Assessment has reduced since the last USA from 10,000 vpd to 5,000 vpd. Since the last USA, there are no new streets in LBRuT that are considered narrow, congested and with residential properties within 2m of the kerb. Streets that meet these criteria have already been assessed in earlier rounds of the review and assessment process and although the traffic flow required to trigger a Detailed Assessment has reduced since the last USA (LBRuT, 2006), all streets in LBRuT fall within the whole borough traffic source related AQMA for NO_2.

LBRuT confirms that there are no new/newly identified congested streets with a flow above 5,000 vehicles per day and residential properties close to the kerb, that have not been adequately considered in previous rounds of Review and Assessment.

3.2 Busy Streets Where People May Spend 1-hour or More Close to Traffic

The criteria for assessing busy streets relevant for the hourly NO_2 objective are set out in Box 5.3, Section A.2 of LAQM.TG (09) and are unchanged from previous rounds of Review and Assessment. Busy streets have been assessed in previous rounds of review and assessment and all streets in LBRuT fall within the whole borough traffic source related AQMA for NO_2.

LBRuT confirms that there are no new/newly identified busy streets where people may spend 1 hour or more close to traffic.

3.3 Roads with a High Flow of Buses and/or HGVs.

The criteria for assessing roads with high flows of buses and/ or heavy goods vehicles (HGVs) are set out in Box 5.3, Section A.3 of LAQM. TG (09) and are unchanged from previous rounds of Review and Assessment.

LBRuT confirms that there are no new/newly identified roads with high flows of buses/HDVs.

3.4 Junctions

The criteria for assessing junctions are set out in Box 5.3, Section A.4 of LAQM, TG (09) and are unchanged from previous rounds of Review and Assessment. Busy junctions with greater than 10,000 vehicles per day and relevant exposure within 20m of the kerb were considered in previous rounds of review and assessment.

LBRuT confirms that there are no new/newly identified busy junctions/busy roads.

3.5 New Roads Constructed or Proposed Since the Last Round of Review and Assessment

The criteria for assessing new roads are set out in Box 5.3, Section A.5 of LAQM.TG (09) and are unchanged from previous rounds of Review and Assessment. There are no new roads constructed or proposed since the last round of review and assessment.

LBRuT confirms that there are no new/proposed roads.

3.6 Roads with Significantly Changed Traffic Flows

The criteria for assessing roads with significantly changed traffic flows are set out in Box 5.3, Section A.6 of LAQM.TG (09) and are unchanged from previous rounds of Review and Assessment. The new 2006 LAEI has been used to identify changed flows and an examination of this has confirmed that there are no roads in the area with significant changes.

LBRuT confirms that there are no new/newly identified roads with significantly changed traffic flows.

3.7 Bus and Coach Stations

The criteria for assessing bus and coach stations are set out in Box 5.3, Section A.7 of LAQM, TG (09) and are unchanged from previous rounds of Review and Assessment. Richmond bus station was assessed in previous rounds of Review and Assessment and was found to not need a Detailed Assessment. There has been no change to this position since the 2009 USA (LBRuT, 2006).

LBRuT confirms that there are no relevant bus stations in the Local Authority area.

4 Other Transport Sources

4.1 Airports

The criteria for assessing airports are set out in Box 5.4, section B.1 of LAQM.TG (09) and are less stringent than previous rounds of Review and Assessment, and in the light of new information, the assessment for airports only needs to consider NO_2.

Heathrow Airport lies outside the boundary of LBRuT and so there are no receptors within the Borough boundary, which are within 1000m of the airport. In terms of the criteria for assessing airports LBRuT does not need to assess Heathrow airport, however the airport is only located about 3+ miles to the west of the Borough, with emissions coming from the airport and with additional emissions coming from aircraft flying over the Borough, on both westerly landings and easterly takeoffs. LBRuT had modelling assessments carried out for 2010, which were based on the 2004 LAEI, which itself only included aircraft emissions from ground level up to 1000 feet. Consequently only emissions from the Heathrow boundary have been modelled, even though the aircraft do emit NO_2 as they fly over the Borough. Exactly how much of this over flight pollution reaches the ground is not known but is expected to be zero, due to the downward movement blockage provided by the 'boundary layer'.

The ERG source apportionment exercise in 2002 (LBRuT, 2002) followed the normal practice of modelling NO_X rather than NO_2. It used real traffic data for 1999 and estimated the airport contribution of NO_X to parts of the Borough as being around 1 ppb NO_X. Since the source apportionment work in 2002, there has been the expansion of the airport with opening of T5. In the environmental modelling evaluations at the Terminal 5 (T5) public Inquiry, it was predicted road traffic in the Borough would increase due to T5 and hence there would be an increase in NO_2 pollution emission levels also. If a third runway is built, it is fair to assume that LBRuT can expect further increases in airport related road traffic, and therefore increases of traffic related emissions, as compared with the base case without any further expansion. It would require modelling to predict whether the extra traffic would increase emissions more than the emission reductions that can be anticipated from cleaner technology. For other (non-NO_2) pollutants with no health threshold, it remains a concern that the benefits of technologically based emission reductions should not then be eroded by traffic increases, even if the resultant pollutant levels did not worsen.

LBRuT confirms that there are no airports within the Local Authority's boundary but Heathrow is only about 3 miles from the boundary and the aircraft do fly over the Borough.

4.2 Railways (Diesel and Steam Trains)

4.2.1 Stationary Trains

The criteria for assessing stationary locomotives are set out in Box 5.4, Section B.2. of LAQM.TG (09) (Approach 1) and are unchanged from previous rounds of Review and Assessment. Locations where diesel locomotives may regularly remain stationary for 15 minutes or more were considered in previous Review and Assessments and no such locations were identified.

LBRuT confirms that there are no locations where diesel or steam trains are regularly stationary for periods of 15 minutes or more, with potential for relevant exposure within 15m.

4.2.2 Moving Trains

The criteria for assessing moving locomotives are set out in Box 5.4, Section B.2. of LAQM.TG (09) (Approach 2) and is a new section for the 2009 USA. None of the rail lines listed in Table 5.1 of LAQM.TG (09) travel through the LBRuT and so there are no locations with a 'large number' of movements of diesel locomotives.

LBRuT confirms that there are no locations with a large number of movements of diesel locomotives, and potential long-term relevant exposure within 30m.

4.3 Ports (Shipping)

The criteria for assessing ports are set out in Box 5.4, Section B.3 of LAQM,TG (09) and are unchanged from previous rounds of Review and Assessment. LBRuT has no coastline and therefore no significant shipping to consider.

LBRuT confirms that there are no ports or shipping that meet the specified criteria within the Local Authority area.

5 Industrial Sources

5.1 Industrial Installations

5.1.1 New or Proposed Installations for which an Air Quality Assessment has been Carried Out

The criteria for assessing industrial installations are set out in Box 5.5, Section C.1. of LAQM.TG (09) and are unchanged from previous rounds of Review and Assessment. Since the 2009 USA (LBRuT, 2006) there are 13 new industrial installations in the LBRuT: 12 Dry Cleaners.and 1 Waste Oil Burner.

Appendix C lists the Part A and B industrial installations in the LBRuT.

LBRuT has assessed new/proposed industrial installations for which planning permission has been granted within its area or in a nearby authority, and concluded that it will not be necessary to proceed to a Detailed Assessment.

5.1.2 Existing Installations where Emissions have Increased Substantially or New Relevant Exposure has been Introduced

None of the industrial installations identified in previous USA's have substantially increased emissions and no new exposure has been introduced nearby.

LBRuT confirms that there are no industrial installations with substantially increased emissions or new relevant exposure in their vicinity within its area or nearby in a neighbouring authority.

5.2 Major Fuel (Petrol) Storage Depots

The criteria for assessing major fuel (petrol) storage depots are set out in Box 5.5, Section C.2 of LAQM.TG (09) and are unchanged from previous rounds of Review and Assessment. Major petrol storage depots were considered in the previous Updating and Screening Assessments and no such locations identified.

There are no major fuel (petrol) storage depots within the LBRuT.

5.3 Petrol Stations

The criteria for assessing petrol stations are set out in Box 5.5, Section C.3 of LAQM.TG (09) and are unchanged from previous rounds of Review and Assessment. All petrol filling stations were considered in the previous USA and were found not to be relevant.

LBRuT confirms that there are no petrol stations meeting the specified criteria**.**

5.4 Poultry Farms

The criteria for assessing poultry farms are set out in Box 5.5, Section C.4 of LAQM.TG (09) and is a new section for the 2009 USA. There are no poultry farms within the LBRuT.

LBRuT confirms that there are no poultry farms meeting the specified criteria.

6 Commercial and Domestic Sources

6.1 Biomass Combustion – Individual Installations

There is only one operational biomass boiler known to the local authority within the LBRuT. In line with the Mayor's Air Quality Strategy the Borough applies emission limits for both PM and NO_x for new biomass boilers. All applicants have to complete a detailed biomass application form (available on our website) and must be able to demonstrate no adverse impacts on local air quality.

Table 6.1 Existing biomass boilers in the LBRuT

Location	**Twickenham**
Status	Operational
Thermal output - plant size (kW/MW)	220 kW

LBRuT assesses all potential biomass combustion plants in the borough and proceeds to a Detailed Assessment if necessary.

6.2 Biomass Combustion – Combined Impacts

The criteria for assessing biomass combustion (combined impacts) with regards to PM_{10} are set out in Box 5.8, Section D.2 of LAQM.TG (09) and was a new section for the 2009 USA. A method detailed on the Review and Assessment helpdesk website (Defra, 2009a) was used to estimate the density of biomass combustion necessary to exceed the criteria for a Detailed Assessment of PM_{10}. LBRuT has a PM_{10} background concentration of 20 $\mu g/m^3$ in 2008. Using the nomograms and worst-case emissions factors (e.g. for wood burning) provided in LAQM.TG(09) there would need to be a minimum of 200 households within a 500m by 500m grid square all using wood as their primary fuel to exceed the criteria for a Detailed Assessment of PM_{10} in relation to the combined effects of biomass combustion. Using a worst-case PM_{10} background concentration in 2003 of 28 $\mu g/m^3$, there would need to be a minimum of 75 households within a 500m by 500m grid square, all using wood as their primary fuel to exceed the criteria for a Detailed Assessment. Using this estimation and local knowledge of the borough, it is considered highly unlikely that there are any areas of biomass combustion exceeding these criteria.

LBRuT confirms that there are no areas of significant combined biomass combustion in the Local Authority area.

6.3 Domestic Solid-Fuel Burning

The criteria for assessing domestic solid-fuel burning are set out in Box 5.8, Section D.2 of LAQM.TG (09) and are unchanged from previous Review and Assessments. The whole borough is a Smoke Control Zone. Local knowledge and judgement indicates there is an insufficient density of coal fired homes in the LBRuT to be significant as defined in LAQM.TG (09).

LBRuT confirms that there are no areas of significant domestic fuel use in the Local Authority area.

London Borough of Richmond upon Thames

7 Fugitive or Uncontrolled Sources

The criteria for assessing fugitive or uncontrolled sources is set out in Box 5.10, Section E.1. of LAQM. TG (09) and is unchanged from previous Review and Assessments.

LBRuT confirms that there are currently no sources of fugitive particulate matter emissions in the Local Authority area.

8 Conclusions and Proposed Actions

8.1 Conclusions from New Monitoring Data

The results from monitoring in the Borough have shown that concentrations of PM_{10}, CO, SO_2 and benzene are below the objective values. NO_2 concentrations exceeded the objectives at a number of locations across the borough and the latest modelling for 2010 (LAEI, 2004, with worst case 2003 met year and LEZ) confirm that there is still a need for the LBRuT to be designated a borough-wide AQMA for NO_2.

The PM_{10} monitoring results show that annual mean PM_{10} was not exceeded at any site during the last ten years. The daily mean PM_{10} objective was only exceeded at the Richmond Mobile Monitoring Unit during 2003 (a worst case year). It is therefore recommended that the question of the AQMA designation for PM10 should be kept under review..

8.2 Conclusions from Assessment of Sources

The USA has not identified any new or significantly altered road traffic, industrial, commercial or domestic sources that need to be subjected to a Detailed Assessment. LBRuT will assess proposed biomass combustion plants in the borough of the appropriate size through the Planning System and will proceed to a Detailed Assessment if necessary.

8.3 Proposed Actions

The next course of action is to prepare and submit the 2013 Progress Report, and to update and review the AQAP.

Following a gap analysis, we increased monitoring for NO_2 at additional sites in relevant receptor locations along the A316 Chertsey Road, and also near Twickenham town centre.

Work will continue to reduce air pollution in the Borough through the development and progress of the Air Quality Action Plan.

9 References

AEA, 2008. Diffusion tubes for ambient NO_2 monitoring: practical guidance for laboratories and users. Report prepared by AEA Energy and Environment and Air Quality Consultants for Department for Environment Food and Rural Affairs and the Devolved Administrations. February 2008 www.airquality.co.uk/reports/cat05/0802141004_NO2_WG_PracticalGuidance_Issue1a.pdf

AQEG, 2009. Ozone in the United Kingdom. Report of the UK Air Quality Expert Group. Prepared for the Department for Environment Food and Rural Affairs, the Scottish Executive, the Welsh Assembly and the Department of the Environment in Northern Ireland. http://archive.defra.gov.uk/environment/quality/air/airquality/publications/ozone/documents/aqeg-ozone-report.pdf

Defra, 2003. Air Quality Strategy Addendum for England, Scotland, Wales and Northern Ireland. DEFRA, London.

Defra, 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. HMSO, London. http://archive.defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-qualitystrategy-vol1.pdf

Defra, 2009a. Review and Assessment helpdesk website. http://webarchive.nationalarchives.gov.uk/20060715141954/uwe.ac.uk/aqm/review/

Defra 2009b. Local Air Quality Management: Technical Guidance LAQM.TG (09) February 2009. http://www.defra.gov.uk/publications/files/pb13081-tech-guidance-laqm-tg-09-090218.pdf

Defra 2009c. Local Air Quality Management: Policy Guidance LAQM.PG (09) February 2009. http://www.defra.gov.uk/publications/files/pb13566-laqm-policy-guidance-part4-090302.pdf

Defra, 2009d. UK Air Quality Archive. Prepared by AEA Energy & Environment on behalf of Defra and the Devolved Administrations. www.airquality.co.uk/archive/index.php

Defra, 2009e. Volatile Correction Model. www.volatile-correction-model.info/

EC, 2008. Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe. Official Journal of the European Union L 152, 1-44. faolex.fao.org/docs/pdf/eur80016.pdf

ERG, 2009. London Air Quality Network. Co-ordinated by ERG, Kings College London. www.londonair.org.uk/london/asp/home.asp

GLA, 2004a, London Atmospheric Emissions Inventory (LAEI) 2004. http://static.london.gov.uk/mayor/environment/air_quality/research/emissions-inventory.jsp

GLA, 2004b, London Atmospheric Emissions Inventory (LAEI) 2004 Report. (including air pollution modelling and population exposure in London; 2004 and 2010) December 2008. http://static.london.gov.uk/mayor/environment/air_quality/docs/laei-2004-full-report-dec08.pdf

HSL, 2004 "WASP The Workplace Analysis Scheme for Proficiency - Information for Participants" Buxton.

LBRuT, 2000. Stage 3 Air Quality Report. www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports/air_quality_third_stage_review_and_assessment.htm

London Borough of Richmond upon Thames

LBRuT, 2002a. Stage 4 Air Quality Report. www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports/air_quality_fouth_stage_review_and_assessment.htm

LBRuT, 2002b. Air Quality Action Plan. http://www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports/air_quality_action_plan.htm

LBRuT, 2004. Updating and Screening Assessment for 2004 http://www.richmond.gov.uk/updating_and_screening_assessment_report_2004.pdf

LBRuT, 2005. Air Quality and Action Plan Progress Reports. http://www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports/progress_reports_and_air_quality_action_plans.htm

LBRuT, 2006. Updating and Screening Assessment for 2006 http://www.richmond.gov.uk/updating_and_screening_assessment_2006.pdf

LBRuT, 2007. Air Quality and Action Plan Progress Reports. http://www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports/progress_reports_and_air_quality_action_plans.htm

LBRuT, 2008. Air Quality and Action Plan Progress Reports. http://www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports/progress_reports_and_air_quality_action_plans.htm

LBRuT, 2009, Update and Screening Assessment for 2009 http://www.richmond.gov.uk/usa_richmond_2009_.pdf

TfL, 2009. Low Emission Zone. Transport for London. www.tfl.gov.uk/roadusers/lez/

Wikipedia, 2009. Free encyclopaedia. www.wikipedia.org/

10 Abbreviations

AQ	Air Quality
AQAP	Air Quality Action Plan
AQEG	Air Quality Expert Group
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network
BTEX	Benzene, toluene, ethyl benzene, xylene
CO	Carbon monoxide
Defra	Department for Environment, Food and Rural Affairs
ERG	Environmental Research Group
EPAQS	Expert Panel on Air Quality Standards
EU	European Union
FDMS	Filter Dynamics Measurement System
GLA	Greater London Authority
HGV	Heavy goods vehicles
HDV	Heavy duty vehicles – road vehicles greater than 3.5 tonnes weight (GVW)
KCL	King's College London
LAEI	London Atmospheric Emissions Inventory
LAQM	Local Air Quality Management
LAQN	London Air Quality Network
LBRuT	London Borough of Richmond upon Thames
Pb	Lead
LAEI	London Atmospheric Emissions Inventory
LEZ	Low Emission Zone
LSO	Local Site Operator
µg/m^3	Micrograms per cubic metre of air
mg/m^3	Milligrammes per cubic metre of air
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides (NO + NO_2)
NPL	National Physical Laboratory
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbon
%ile	Percentile is a value that is the rank at a particular point in a collection of data. For instance, a 98.8th percentile of values for a year is the value that 98.8% of all the data in the year fall below, or equal.
PM_{10}	Airborne particulate matter passing a sampling inlet with a 50% efficiency cut-off at 10µm aerodynamic diameter and which transmits particles of below this size.
ppbv	Parts per billion by volume (1,000,000,000)
ppmv	Parts per million by volume (1,000,000)
QA	Quality Assurance
QC	Quality Control
SO_2	Sulphur dioxide
T5	Terminal 5
TEA	Triethanolamine
TEOM	Tapered Element Oscillating Microbalance (instrument used to monitor particulate matter)
UKAS	United Kingdom Accreditation Service
URRW	Upper Richmond Road West
USA	Updating and Screening Assessment
UWE	University of the West of England
VCM	Volatile Correction Model
VOC	Volatile organic compounds
WASP	Workplace Analysis Scheme for Proficiency
WHO	World Health Organisation

Appendices

Appendix A: QA/QC Data

Appendix B: Richmond Mobile Deployments and Exceedences of the Air Quality Objectives

Appendix C: Part A and Part B industrial processes in the LBRuT

Appendix A: QA/QC Data

QA/QC of automatic monitoring

For Richmond 1 Castelnau, Richmond 2 Barnes Wetlands and the Richmond Mobile automatic overnight calibrations are supplemented with fortnightly checks and manual calibrations by LBRuT. The equipment was serviced by ETi (currently serviced by Enviro Technology Services plc) and audited by NPL every six months as part of the LAQN QA/QC procedures to ensure optimum data quality. All three sites are part of the LAQN and ERG is responsible for the daily data collection, storage, validation and dissemination via the LAQN website (www.londonair.org.uk). ERG ratifies the data periodically, viewing data over longer time periods and using the results from fortnightly manual calibrations, equipment services and equipment audits.

Here are the stages of the data ratification process for the Richmond air quality sites as part of the LAQN (adapted from ERG, 2009):

1. **Every 6/12 hours:** data are automatically downloaded from the analysers, checked against a series of protocols and then scaled using results from manual calibrations. Measurements appear on the LAQN website hourly bulletin ('current air quality') once automatic checks have been undertaken.
2. **Daily:** an air quality analysts manually check the data, confirms any automatic checks and flag up any faults that require attention. Measurements appear on the LAQN website daily bulletin and the 7 and 30-day graphs once stage 2 of ratification is undertaken.
3. **3-6 months:** as more information becomes available data can be viewed over longer time periods and the results from fortnightly manual calibrations, equipment services and equipment audits can be considered.

Measurements cannot be considered 'final' until all stages of the ratification process are complete. The time lag is usually between six months and a year and up until this date measurements on the LAQN website may change without warning. The footnote of all tables in this report containing data from the LAQN clearly state whether the data has been ratified.

For the first month of every year the data capture for the Richmond Mobile is reduced because the Mobile changes location. The January 2011 data capture for all pollutants at the RHA (Mobile) Lower Mortlake Road, Richmond is 81% or lower because the Mobile moved to the site on the 11th January 2011. The data capture for the PM_{10} monitor (TEOM) for 2008 at Richmond 29 (Mobile) Mortlake Road, Kew was 66% because the instrument was producing ‘noisy’ data, which had to be excluded. Due to the age of the TEOM it was not possible to source replacement parts to solve the problem, so a replacement TEOM was acquired. The same problem became apparent with this TEOM. Finally, on 28th January 2009, a further replacement TEOM was installed and it has been operating successfully since then.

For the month of October 2008, the data capture for the NO_2 analyser at Richmond 29 (Mobile), Mortlake Road, Kew was 64% because there were problems with the NO_X analyser vacuum pump. This was replaced on 7th November 2008. Overall the data capture for the year was 90%.

For the month of August 2008, the data capture for the NO_2 analyser at Richmond 1 Castelnau was 53% because the cabin over heated as a consequence of a problem with the air conditioning. Overall the data capture for the year was above 90%.

For the month of July 2011, the data capture for the NO_2 analyser at RHA (Mobile), Lower Mortlake Road, Richmond, was 79% this was due to the air conditioning unit braking down. In order to protect the analysers from over heating they were switched off between the 11th and the 20th July.

Teddington (AURN) monitoring station at NPL is part of the AURN and the QA/QC for this station is managed by AEA Technology. For more information go to www.airquality.co.uk/archive/index.php (Defra, 2009d).

QA/QC of diffusion tube monitoring

NO_2 diffusion tube analysis method

NO_2 diffusion tubes are passive monitoring devices. They are made up of a Perspex cylinder, with 2 stainless steel mesh discs, coated with TEA absorbent held inside a polythene cap, which is sealed onto one end of the tube. Diffusion tubes operate on the principle of molecular diffusion, with molecules of a gas diffusing from a region of high concentration (open end of the tube) to a region of low concentration (absorbent end of the tube) (AEA, 2008). NO_2 diffuses up the tube because of a concentration gradient and is absorbed by the TEA, which is present on the coated discs in the sealed end of the tube. All Richmond NO_2 diffusion tubes are prepared by Gradko using 50% v/v TEA with Acetone as the absorbent.

Prior to and after sampling, an opaque polythene cap is placed over the end of the diffusion tube opposite the TEA coated discs to prevent further adsorption. The NO_2 diffusion tubes are labelled and kept refrigerated in plastic bags prior to and after exposure.

Gradko undertakes the analysis of exposed diffusion tubes by ultra violet spectrophotometry and is accredited by UKAS for the analysis of NO_2 diffusion tubes.

Quality assurance and quality control

Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe (EC, 2008) sets data quality objectives for NO_2 along with other pollutants. Under the Directive, annual mean NO_2 concentration data derived from diffusion tube measurements must demonstrate an accuracy of $\pm$25 % to enable comparison with the NO_2 air quality objectives of the Directive.

In order to ensure that NO_2 concentrations reported are of a high quality, strict performance criteria need to be met through the execution of QA and QC procedures. A number of factors have been identified as influencing the performance of NO_2 diffusion tubes including the laboratory preparing and analysing the tubes, and the tube preparation method (AEA, 2008). QA and QC procedures are therefore an integral feature of any monitoring programme, ensuring that uncertainties in the data are minimised and allowing the best estimate of true concentrations to be determined.

Gradko take an active role in developing rigorous QA and QC procedures in order to maintain the highest degree of confidence in their laboratory measurements. Gradko were involved in the production of the Harmonisation Practical Guidance for NO_2 diffusion tubes (AEA, 2008) and have been following the procedures set out in the guidance since January 2009.

For example, Gradko perform their own laboratory blank exposures that serve as a quality control check on the tube preparation procedure, as well as providing LBRuT with a travel blank. In accordance with the latest guidance, blanks have not been routinely subtracted from results since the beginning of 2009 (AEA, 2008).

Workplace Analysis Scheme for Proficiency (WASP)

Gradko participate in the Health and Safety Laboratory (HSL) WASP NO_2 diffusion tube scheme which uses artificially spiked diffusion tubes to test each participating laboratory's analytical performance on a quarterly basis. Every quarter, (in January, April, July and October each year) each laboratory receives four diffusion tubes doped with an amount of nitrite known to HSL but not the participants (HSL, 2004). This is a Defra recognised performance-testing programme for laboratories undertaking NO_2 diffusion tube analysis in the UK. The scheme is designed to help laboratories meet the European Standard. Gradko demonstrated good laboratory performance in 2008 and the laboratory precision was rated 'good' in every month. For the results of the scheme on the Review and Assessment helpdesk website (Defra, 2009a) see:
www.uwe.ac.uk/aqm/review/R&Asupport/Tube%20Precision_2008_(Mar%2009).pdf

The latest available assessment up to January 2010 indicated that the laboratory precision remains 'satisfactory'.

AEA field inter-comparison scheme

Gradko also takes part in the field inter-comparison scheme operated by AEA, which complements the WASP scheme in assessing sampling and analytical performance of NO_2 diffusion tubes under normal operating conditions. This involves the regular exposure of triplet tubes at an Automatic Urban Network site (AUN) site, where real-time NO_2 levels are also measured using a chemiluminescent analyser. AEA have established performance criteria for participating laboratories. The bias relative to the chemiluminescent analyser gives an indication of accuracy and a measure of precision is determined by comparing the triplet co-located tube measurements. Table A.1 demonstrates that the accuracy and precision for Gradko are within the performance targets. These values are useful for assessing the uncertainty of results due to sampling and analytical techniques.

Table A.1 2007 to 2011 network field intercomparison results

Year	Annual mean bias		Precision	
	Performance target	Gradko performance	Performance target	Gradko performance
2007	+/- 25%	-5.3%	10%	6%
2008	+/- 25%	-11%	10%	3%
2009	+/-25%	-1%	10%	
2010	+/-25%	-3%	10%	5%
2011	+/-25%	-2%	10%	3%

Diffusion Tube Bias Adjustment Factors from Local Co-location Studies

LBRuT undertakes three local NO_2 diffusion tube co-location studies at the following locations:

Richmond 1 Castelnau: roadside site used to bias adjust all kerbside and roadside sites.

Richmond 2 Barnes Wetlands: suburban site used to bias adjust background sites (28, 37, RUT3 and RUT4).

Richmond Mobile: roadside locations, used to calculate a bias adjustment factor for the NO_2 diffusion tube at the Richmond Mobile (site 53) for comparison with the factor from the Richmond 1 Castelnau roadside co-location study.

2002 - 2006 - Mobile was deployed at more than one location per calendar year
2007 - RI27 Lincoln Avenue, Twickenham
2008 - RI29 Mortlake Road, Kew.
2009 - RIW Upper Teddington Road, Teddington
2010 - RHY Hampton Court Road, Hampton Court
2011 - RHA Lower Mortlake Road, Richmond

The 2011 bias adjustment factor for all kerbside and roadside sites in the LBRuT was calculated from the co-location study at the Richmond 1 Castelnau site. The overall precision and data capture for this co-location study is good, as shown in Figure A.1.

The 2011 bias adjustment factor for all background sites in the LBRuT was calculated from the co-location study at the Richmond 2 Barnes Wetlands site. The overall precision and data capture for this co-location study is good, as shown in Figure A.2.

Figure A.3 provides the 2011 bias adjustment factor from the co-location study at RHA (Mobile) Lower Mortlake Road, Richmond. The overall precision of this co-location study was good, but the data capture was poor.

Figures A.4–A.6 present 2011 raw and bias adjusted NO_2 diffusion tube results for kerbside and roadside sites (bias adjustment factor from Richmond 1 Castelnau co-location study) and Figure A.7 presents background sites (bias adjustment factor from Richmond 2 Barnes Wetlands co-location study).

Discussion of Choice of Factor to Use

Both local and national bias adjustment factors are available to the LBRuT and are provided in Table A.2 for 2006 to 2011. All kerbside and roadside sites in the LBRuT are bias adjusted using the factor from the local roadside co-location study at Richmond 1 Castelnau because the overall precision and data capture for this co-location study is good. All background sites in the LBRuT are bias adjusted using the factor from the local suburban co-location study at the Richmond 2 Barnes Wetlands because the overall precision and data capture for this co-location study is good. The exception is the year 2006 when the overall data capture was poor for the local suburban co-location study at Richmond 2 Wetlands Barnes. 2 of 12 months have been excluded from the bias adjustment factor calculation due to data capture less than 75%. For 2006, the bias adjusted background results for sites 17, 28, RUT3 and RUT4 are presented using the local and national bias adjustment factor.

The Richmond Mobile roadside co-location study is used as a comparison to the Richmond 1 Castelnau roadside co-location study. In 2007 and 2008 the Mobile co-location study factor was not used because it was lower than both the local (Castelnau) and national factor. In 2008, the Richmond Mobile factor was considerably lower than the Castelnau and national factor. Please note that the overall data capture for the 2008 Richmond Mobile co-location study was poor because 2 of 12 months have been excluded from the bias adjustment factor calculation due to data capture lower than 75%.

In each year the factors from the local roadside and suburban co-location studies have been used, these factors except in 2011 are higher than the national factor resulting in higher bias adjusted results, so these factors are more conservative than the national factor.

Table A.2 2006 to 2011 NO_2 diffusion tube bias adjustment factors for LBRuT

Source of bias adjustment factor	Bias adjustment factor					
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Local roadside co-location study at Richmond 1 Castelnau[a]	1.05	0.99	0.99	1.00	1.06	0.92
Local background co-location study at Richmond 2 Wetlands Barnes	1.18[b]	1.11[a]	1.05[a]	1.02	1.02	0.91
Local roadside co-location study at Richmond Mobile 2006: Mobile deployed at several locations 2007: RI27 Lincoln Avenue, Twickenham 2008: RI29 Mortlake Road, Kew 2009: RIW Upper Teddington Rd, Teddington 2010: RHY Hampton Court Rd, Hampton Court 2011: RHA Lower Mortlake Rd, Richmond	NA	0.96[a]	0.89[c]	0.87	0.77	0.80[d]
[e]**National** factor from UWE study (with results up to 6th May 2009)[d]	1.01	0.98	0.93	0.99	1.03	0.93

[a] Local co-location studies with good overall data capture and precision with 12 out of 12 periods having a coefficient of variation >20%
[b]Richmond 2 Wetlands Barnes overall data capture poor in 2006. Background site results (17, 28, RUT3 and RUT4) presented in Table 2.4b for correction with local and national bias adjustment factor.
[c] RI29 Mortlake Road, Kew overall data capture poor in
[d] RHA Lower Mortlake Road overall data capture was 81%.
[e] National UWE factor for Gradko 50% v/v TEA with Acetone (Defra, 2009a): 2006 - 18 studies, good precision for 14, single tube at 1, poor precision for 3; 2007 - 15 studies, good precision for 8, single tube at 7; 2008 - 14 studies, good precision for all; 2009 – 16 studies, good precision for 13, single tube at 2, poor precision for 1; 2010 – 16 studies, good precision for 14, single tube at 2; 2011 – 20 studies, good precision for 16 and poor precision for 4. .`

Figure A.1 2011 results of the roadside co-location study at the Richmond 1 Castelnau site.

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	29/12/2011	01/02/2011	43	45	44	44	0.8	2	2.0	50	100	Good	Good
2	01/02/2011	01/03/2011	43	41	42	42	0.8	2	1.9	35	100	Good	Good
3	01/03/2011	29/03/2011	56	48	52	52	4.0	8	9.8	47	100	Good	Good
4	29/03/2011	27/04/2011	46	42	21	36	13.1	36	32.6	40	100	Poor Precision	Good
5	27/04/2011	31/05/2011	27	27	28	27	0.6	2	1.5	19	100	Good	Good
6	31/05/2011	27/06/2011	30	35	32	32	2.6	8	6.5	22	100	Good	Good
7	27/06/2011	26/07/2011	35	40	39	38	2.5	7	6.3	28	100	Good	Good
8	26/07/2011	31/08/2011	33	34	37	34	2.3	7	5.8	26	100	Good	Good
9	31/08/2011	27/09/2011	35	30	29	32	3.1	10	7.7	27	100	Good	Good
10	27/09/2011	01/11/2011	40	40	41	40	0.6	1	1.4	45	99	Good	Good
11	01/11/2011	29/11/2011	46	48	47	47	1.0	2	2.5	44	99	Good	Good
12	29/11/2011	03/01/2012	32	32	33	32	0.6	2	1.5	40	100	Good	Good
13													
										Overall survey -->		Good precision	Good Overall DC

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

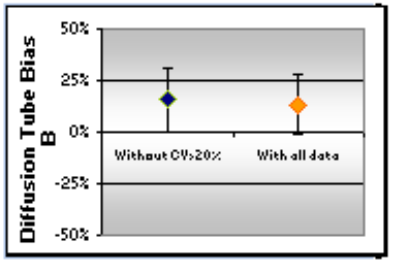
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	23 - Castelnau Library

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

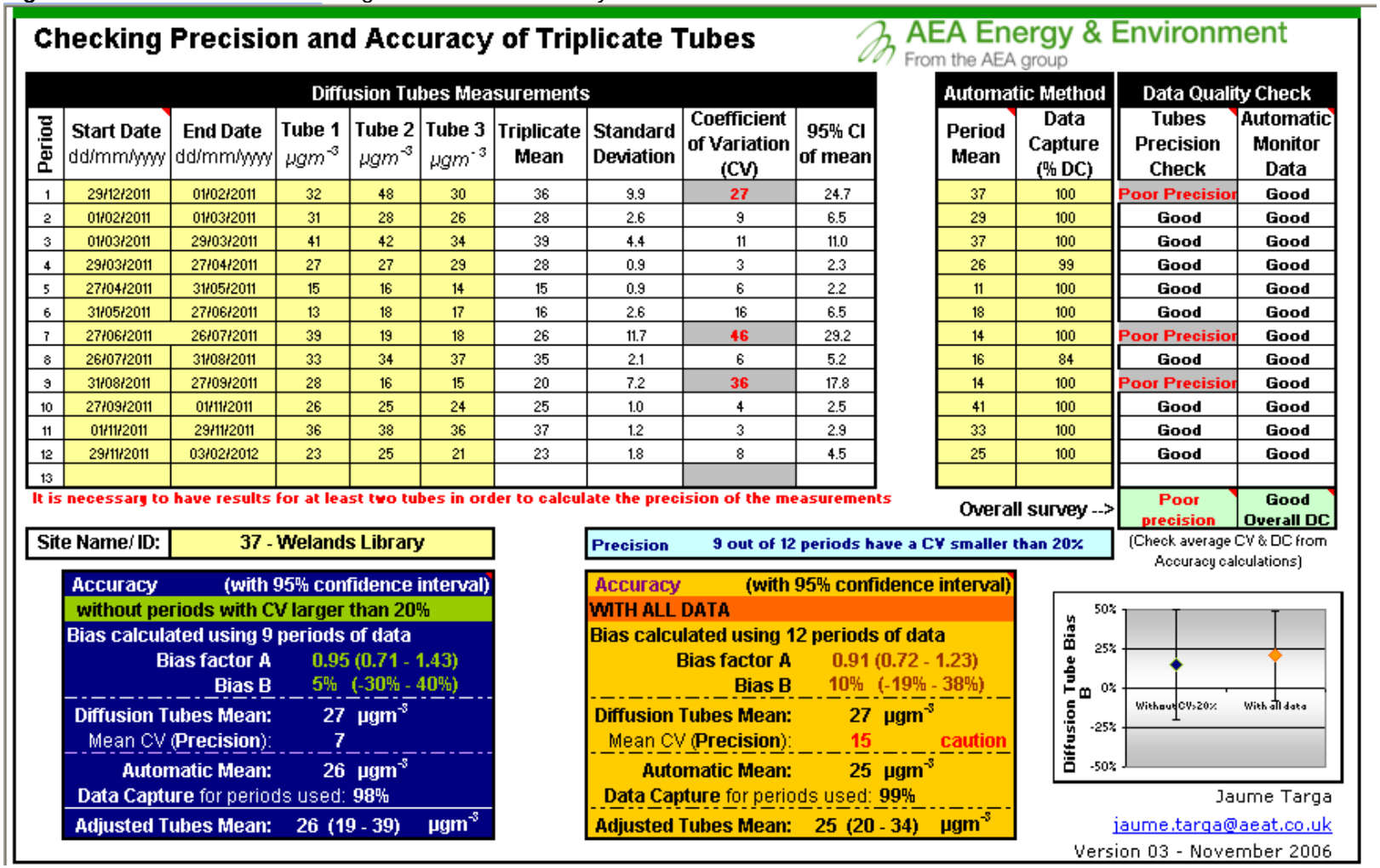
Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 11 periods of data	
Bias factor A	0.91 (0.8 - 1.05)
Bias B	10% (-5% - 25%)
Diffusion Tubes Mean:	38 μgm^{-3}
Mean CV (Precision):	5
Automatic Mean:	35 μgm^{-3}
Data Capture for periods used:	100%
Adjusted Tubes Mean:	35 (31 - 40) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.92 (0.81 - 1.07)
Bias B	8% (-6% - 23%)
Diffusion Tubes Mean:	38 μgm^{-3}
Mean CV (Precision):	7
Automatic Mean:	35 μgm^{-3}
Data Capture for periods used:	100%
Adjusted Tubes Mean:	35 (31 - 41) μgm^{-3}



Jaume Targa
jaume.targa@aeat.co.uk
Version 03 - November 2006

Figure A.2 2011 results of the background co-location study at the Richmond 2 Barnes Wetlands site.



Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm^{-3}	Tube 2 µgm^{-3}	Tube 3 µgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	29/12/2011	01/02/2011	32	48	30	36	9.9	27	24.7
2	01/02/2011	01/03/2011	31	28	26	28	2.6	9	6.5
3	01/03/2011	29/03/2011	41	42	34	39	4.4	11	11.0
4	29/03/2011	27/04/2011	27	27	29	28	0.9	3	2.3
5	27/04/2011	31/05/2011	15	16	14	15	0.9	6	2.2
6	31/05/2011	27/06/2011	13	18	17	16	2.6	16	6.5
7	27/06/2011	26/07/2011	39	19	18	26	11.7	46	29.2
8	26/07/2011	31/08/2011	33	34	37	35	2.1	6	5.2
9	31/08/2011	27/09/2011	28	16	15	20	7.2	36	17.8
10	27/09/2011	01/11/2011	26	25	24	25	1.0	4	2.5
11	01/11/2011	29/11/2011	36	38	36	37	1.2	3	2.9
12	29/11/2011	03/02/2012	23	25	21	23	1.8	8	4.5
13									

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

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
37	100	Poor Precision	Good
29	100	Good	Good
37	100	Good	Good
26	99	Good	Good
11	100	Good	Good
18	100	Good	Good
14	100	Poor Precision	Good
16	84	Good	Good
14	100	Poor Precision	Good
41	100	Good	Good
33	100	Good	Good
25	100	Good	Good
Overall survey -->		Poor precision	Good Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	37 - Welands Library

Precision 9 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 9 periods of data	
Bias factor A	0.95 (0.71 - 1.43)
Bias B	5% (-30% - 40%)
Diffusion Tubes Mean:	27 µgm^{-3}
Mean CV (Precision):	7
Automatic Mean:	26 µgm^{-3}
Data Capture for periods used:	98%
Adjusted Tubes Mean:	26 (19 - 39) µgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.91 (0.72 - 1.23)
Bias B	10% (-19% - 38%)
Diffusion Tubes Mean:	27 µgm^{-3}
Mean CV (Precision):	15 caution
Automatic Mean:	25 µgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	25 (20 - 34) µgm^{-3}

Jaume Targa
jaume.targa@aeat.co.uk
Version 03 - November 2006

Figure A.3 2011 results of the roadside co-location study at the Richmond Mobile (RHA) Lower Mortlake Road, Richmond.

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	29/12/2011	01/02/2011	62	61	59	61	1.5	2	3.6	52	57	Good	Poor Data Capture
2	01/02/2011	01/03/2011	50	49	57	52	4.6	9	11.3	41	97	Good	Good
3	01/03/2011	29/03/2011	76	63	85	74	11.0	15	27.4	57	88	Good	Good
4	29/03/2011	27/04/2011	69	54	63	62	7.4	12	18.4			Good	
5	27/04/2011	31/05/2011	47	39	41	42	4.3	10	10.7	29	51	Good	or Data Capture
6	31/05/2011	27/06/2011	56	47	48	50	5.4	11	13.3	32	98	Good	Good
7	27/06/2011	26/07/2011	71	53	54	59	10.1	17	25.2	33	70	Good	or Data Capture
8	26/07/2011	31/08/2011	51	47	56	51	4.6	9	11.4	41	83	Good	Good
9	31/08/2011	27/09/2011	51	48	43	47	3.8	8	9.6	39	99	Good	Good
10	27/09/2011	01/11/2011	56	50	48	51	4.2	8	10.3	45	99	Good	Good
11	01/11/2011	29/11/2011	60	56	49	55	5.6	10	13.8	49	100	Good	Good
12	29/11/2011	03/02/2012	49	51	62	54	7.0	13	17.4	44	100	Good	Good
13													
											Overall survey -->	Good precision	Poor Overall DC

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

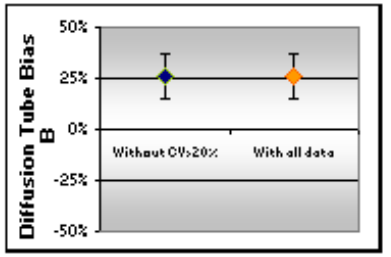
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:	53 - Mobile - Lower Mortlake Rd

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

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 8 periods of data	
Bias factor A	0.8 (0.74 - 0.88)
Bias B	25% (14% - 36%)
Diffusion Tubes Mean:	54 μgm^{-3}
Mean CV (Precision):	10 caution
Automatic Mean:	44 μgm^{-3}
Data Capture for periods used:	96%
Adjusted Tubes Mean:	44 (40 - 48) μgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 8 periods of data	
Bias factor A	0.8 (0.74 - 0.88)
Bias B	25% (14% - 36%)
Diffusion Tubes Mean:	54 μgm^{-3}
Mean CV (Precision):	10 caution
Automatic Mean:	44 μgm^{-3}
Data Capture for periods used:	96%
Adjusted Tubes Mean:	44 (40 - 48) μgm^{-3}



Jaume Targa
jaume.targa@aeat.co.uk
Version 03 - November 2006

Figure A.4 2011 raw and bias adjusted NO_2 diffusion tube results for kerbside and roadside sites 1-23. Bias adjustment factor from Richmond 1 Castelnau co-location study.

Adjustment of SINGLE Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tube Measurements

Site Name/ID	Periods													Raw Mean	Valid periods
	1	2	3	4	5	6	7	8	9	10	11	12	13		
1	50	49	55	52	37	42	48	45	43	45	52	51		47.4	12
2	43	37	49	38	22	28	28	27	26	33	43	30		33.7	12
3.00	46	43	52	47	28	33	15	34	35	39	48	35		37.9	12
4.00	50	45	58	46	29	33	40	35	33	41	54	37		41.7	12
5.00	39	35	46	36	25	25	31	31	27	32	62	29		34.8	12
6.00	50		51	44	34	33	39	35	29	44	51	32		40.2	11
7.00	59	49	65	67	50	45	58	54	43	47	62	42		53.4	12
8.00	40	38	37	36	23	24	31	25	27	33	44	36		32.8	12
9.00	64	54	61	53	38	42	47	47	44	53	60	50		51.0	12
10.00	49	47		48	32	35	42	40	37	43	53	37		42.2	11
11.00	58	47	61	48	37	45	53	47	47	43	58	51		49.6	12
12.00	55	44	58	54	32	36	45	42	42	45	57	22		44.3	12
13.00	51	49	60	53	32	39	39	39	37	50	62	41		45.8	12
14.00	50	46	55	50	33	37		37	37	48	56	42		44.5	11
15.00	55	45	49	53	34	42	35				50	39		44.5	9
16.00	50	45	47	48	23	40	37	36	33	42	50	46		41.4	12
17.00		68	86	79	65	74	81	76	75	84	81	73		76.6	11
18.00	66	55	80	77	53	80	68	69	63	85	84	78		71.6	12
19.00	59	56	55	71	44	51	54	46	53	59	59	50		54.6	12
20.00	47		57	50	38	32	48	51	42	46	59	52		47.4	11
21.00	54	42	61	48	28	32	32	36	35	42	54	41		42.0	12
22.00		56	56	54	39	43	43	46	42	51	62	53		49.7	11
23.00	43	43	57	46	27	30	35	33	35	40	46	32		38.9	12
23f2	45	41	48	42	27	35	40	34	30	40	48	32		38.4	12
23f3	44	42	52	21	28	32	39	37	29	41	47	33		37.0	12

Adjusted measurement (95% confidence interval)
with all the data
12 periods used in this calcuations

Bias Factor A 0.92 (0.81 - 1.07)
Bias B 8% (-6% - 23%)

Tube Precision: 7 Automatic DC: 100%

Adjusted with 95% CI	**44 (38 - 51)**
Adjusted with 95% CI	**31 (27 - 36)**
Adjusted with 95% CI	**35 (31 - 41)**
Adjusted with 95% CI	**38 (34 - 45)**
Adjusted with 95% CI	**32 (28 - 37)**
Adjusted with 95% CI	**37 (33 - 43)**
Adjusted with 95% CI	**49 (43 - 57)**
Adjusted with 95% CI	**30 (27 - 35)**
Adjusted with 95% CI	**47 (41 - 55)**
Adjusted with 95% CI	**39 (34 - 45)**
Adjusted with 95% CI	**46 (40 - 53)**
Adjusted with 95% CI	**41 (36 - 47)**
Adjusted with 95% CI	**42 (37 - 49)**
Adjusted with 95% CI	**41 (36 - 48)**
Adjusted with 95% CI	**41 (36 - 48)**
Adjusted with 95% CI	**38 (34 - 44)**
Adjusted with 95% CI	**70 (62 - 82)**
Adjusted with 95% CI	**66 (58 - 77)**
Adjusted with 95% CI	**50 (44 - 58)**
Adjusted with 95% CI	**44 (38 - 51)**
Adjusted with 95% CI	**39 (34 - 45)**
Adjusted with 95% CI	**46 (40 - 53)**
Adjusted with 95% CI	**36 (31 - 42)**
Adjusted with 95% CI	**35 (31 - 41)**
Adjusted with 95% CI	**34 (30 - 40)**

The bias adjustment factor used in these calculations include all the data and no screening of data due to poor precision has been applied.

Figure A.5 2011 raw and bias adjusted NO_2 diffusion tube results for kerbside and roadside sites 24-46. Bias adjustment factor from Richmond 1 Castelnau co-location study.

Adjustment of SINGLE Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tube Measurements

Site Name/ID	Periods													Raw Mean	Valid periods
	1	2	3	4	5	6	7	8	9	10	11	12	13		
24	44	40	47	43	30	33	39	32	33	37	50	36		38.7	12
25	49	39	41	40	30		31	32	22	34	52	34		36.8	11
26	53	43	73	46	33	41	37	36	38	44	47	38		44.0	12
27	50	39	57	47	38	38	39	36	33	38	47	36		41.5	12
28	30	22	33	25	11	13	17	18		15	28	19		21.0	11
29	47	45	50	45	30	31	34	38	31	41	53	40		40.3	12
30	45	38	50	39	22	27	36	29	24	38	48	30		35.5	12
31	65	59	44	55	47	46	55	43	54	48	71	60		53.9	12
32	71	86	111	99	79	80	80	84	79	94	69	46		81.4	12
33	48	51	77	67	46	46	59	55		52	66	47		57.3	9
34	44	41	57	44	31	36	38	33	28	36	46	35		38.4	10
35	50	50	57	49	36	43	58	52	47	55	55	49		50.0	11
36	45	54	64	59	43	45	47	45	37	52	71	38		50.2	12
37	32	31	41	27	15	13	39		17	26	36	23		27.4	11
37/2	48	28	42	27	16	18	19	19	16	25	38	25		26.8	12
37/3	30	26	34	29	14	17	18	18	17	24	36	21		23.7	12
38	50	46	45	39	29	28	32	33	32	37	48	32		37.7	12
39	76	57	80	74	56	53	68	59	57	55	59	59		62.8	12
40	49	44	57	37	29	35	38	37	28	42	54	39		40.8	12
41	46	42	44	46	34	34	41	37	39	43	47	49		41.7	12
42	57	57	84	72	47	55	56	56	43	54	67	38		57.2	12
43	88	83	96	114	86	93	96	86	47	98		79		87.9	11
44	58	43	49	53	34	41	43	42	41	47	51	44		45.4	12
45	48	54	51	49	43	43	45	40	45	55	56	45		47.8	12
46	46	40	53	41	30	37	31	32	30	39	58	33		39.2	12

Adjusted measurement (95% confidence interval)
with all the data
12 periods used in this calcuations

Bias Factor A 0.92 (0.81 - 1.07)
Bias B 8% (-6% - 23%)

Tube Precision: 7 Automatic DC: 100%

Adjusted with 95% CI	**36 (31 - 41)**
Adjusted with 95% CI	**34 (30 - 39)**
Adjusted with 95% CI	**40 (36 - 47)**
Adjusted with 95% CI	**38 (34 - 44)**
Adjusted with 95% CI	**19 (17 - 22)**
Adjusted with 95% CI	**37 (33 - 43)**
Adjusted with 95% CI	**33 (29 - 38)**
Adjusted with 95% CI	**50 (44 - 58)**
Adjusted with 95% CI	**75 (66 - 87)**
Adjusted with 95% CI	**53 (46 - 61)**
Adjusted with 95% CI	**35 (31 - 41)**
Adjusted with 95% CI	**46 (41 - 54)**
Adjusted with 95% CI	**46 (41 - 54)**
Adjusted with 95% CI	**25 (22 - 29)**
Adjusted with 95% CI	**25 (22 - 29)**
Adjusted with 95% CI	**22 (19 - 25)**
Adjusted with 95% CI	**35 (31 - 40)**
Adjusted with 95% CI	**58 (51 - 67)**
Adjusted with 95% CI	**37 (33 - 44)**
Adjusted with 95% CI	**38 (34 - 45)**
Adjusted with 95% CI	**53 (46 - 61)**
Adjusted with 95% CI	**81 (71 - 94)**
Adjusted with 95% CI	**42 (37 - 49)**
Adjusted with 95% CI	**44 (39 - 51)**
Adjusted with 95% CI	**36 (32 - 42)**

The bias adjustment factor used in these calculations include all the data and no screening of data due to poor precision has been applied.

Figure A.6 2011 raw and bias adjusted NO_2 diffusion tube results for roadside and kerbside sites 47 and RUT04. Bias adjustment factor from Richmond 1 Castelnau co-location study.

Adjustment of SINGLE Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tube Measurements

Site Name/ID	Periods													Raw Mean	Valid periods
	1	2	3	4	5	6	7	8	9	10	11	12	13		
47	50	40	47	44	27	31	5	37	28	35	46	36		35.5	12
48	55	48	59	45	39	46	43	42	43	47	51	44		46.6	12
49	48	43	58	52	34	37	39	37	31	44	54	39		42.9	12
50	38	53	16	70	53	52	66	55	52	64	66	52		53.0	12
51	40	35	46	39	23	26	31	27	27	32	50	36		34.3	12
52	72	56	38	71	52	69	88	71	51	66		45		61.7	11
53	62	50	76	69	47	56	71	51	51	56	60	49		58.1	12
53 (2)	61	49	63	54	39	47	53	47	48	50	56	51		51.3	12
53 (3)	59	57	85	63	41	48	54	56	43	48	49	62		55.4	12
54	54	55	60	64	43	49	55	53	48	57	60	54		54.3	12
55		47	60	57	43	44	53	54	43	44	57	51		50.2	11
56		42	72	44		35	36	33	28	37	43	39		41.0	10
57		40	49	41	14	44	4	38	29	38	44	44		35.0	11
58				52	30	39	42	42	38	49	59	45		43.9	9
RUT 01	60	53	55	66	39	47	45	46	52	53	65	43			
RUT 02	97	103	98	151	91	111	176		104	31	36	150			
RUT 03	38	31	34		17	25	22	23	20	27	35	31		27.5	11
RUT 04	33	29	32	30	17	12	22	22	22	53	105	29		34.7	9

Adjusted measurement (95% confidence interval) with all the data
12 periods used in this calcuations

Bias Factor A 0.92 (0.81 - 1.07)
Bias B 8% (-6% - 23%)
Tube Precision: 7 Automatic DC: 100%

Adjusted with 95% CI	33	(29 - 38)
Adjusted with 95% CI	43	(38 - 50)
Adjusted with 95% CI	39	(35 - 46)
Adjusted with 95% CI	49	(43 - 57)
Adjusted with 95% CI	32	(28 - 37)
Adjusted with 95% CI	57	(50 - 66)
Adjusted with 95% CI	53	(47 - 62)
Adjusted with 95% CI	47	(42 - 55)
Adjusted with 95% CI	51	(45 - 59)
Adjusted with 95% CI	50	(44 - 58)
Adjusted with 95% CI	46	(41 - 54)
Adjusted with 95% CI	38	(33 - 44)
Adjusted with 95% CI	32	(28 - 37)
Adjusted with 95% CI	40	(36 - 47)
Adjusted with 95% CI	25	(22 - 29)
Adjusted with 95% CI	32	(28 - 37)

The bias adjustment factor used in these calculations include all the data and no screening of data due to poor precision has been applied.

Figure A.7 2011 raw and bias adjusted NO_2 diffusion tube results for background sites (28, RUT3 and RUT4). Bias adjustment factor from Richmond 2 Barnes Wetlands co-location study.

Adjustment of SINGLE Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tube Measurements

Site Name/ID	Periods													Raw Mean	Valid periods
	1	2	3	4	5	6	7	8	9	10	11	12	13		
28	30	22	33	25	11	13	17	18		15	28	19		21.0	11
RUT3	38	31	34		17	25	22	23	10	31	36	29		26.8	11
RUT4	33	29	32	30	17	12	22	22	12	27	35	31		25.2	12

Adjusted measurement (95% confidence interval)
with all the data
9 periods used in this calcuations

Bias Factor A 1.03 (0.89 - 1.22)
Bias B -3% (-18% - 12%)
Tube Precision: 10 Automatic DC: 100%

Adjusted with 95% CI	**22 (19 - 26)**
Adjusted with 95% CI	**28 (24 - 33)**
Adjusted with 95% CI	**26 (22 - 31)**

Appendix B: Richmond Mobile Deployments and Exceedences of the Air Quality Objectives

Table B.1 Richmond Mobile Air Quality Unit Deployments from 2002 to 2011

Site ID (LAQN website) [a]	Site ID (ERG database) [b]	Inlet Position	Location	Deployment Start	Deployment End
RI7	RI7	Standard (2.9m)	Richmond Park (background)[c]	29/04/2002	11/09/2002
RI8	RI8	Low (0.9m)			
RI9	RIA	Standard (2.9m)	George Street, Richmond	16/09/2002	19/11/2002
RI10	RIB	Low (0.9m)			
RI11	RIC	Standard (2.9m)	Kew Green, Kew	19/11/2002	25/02/2003
RI12	RID	Low (0.9m)			
RI13	RIE	Standard (2.9m)	Richmond Road, Twickenham (opp. Orleans School)	25/02/2003	20/05/2003
RI14	RIF	Low (0.9m)			
RI15	RIG	Standard (2.9m)	Upper Teddington Road, Teddington	21/05/2003	03/02/2004
RI16	RIH	Low (0.9m)			
RI17	RII	Standard (2.9m)	Somerset Road, Teddington	03/02/2004	23/04/2004
RI18	RIJ	Low (0.9m)			
RI19	RIK	Standard (2.9m)	St Margaret's Grove, St Margaret's	27/04/2004	20/07/2004
RI20	RIL	Low (0.9m)			
RI21	RIM	Standard (2.9m)	Petersham Road, Ham	21/07/2004	25/05/2005
RI22	RIN	Low (0.9m)			
RI23	RIO	Standard (2.9m)	Stanley Road, Twickenham	27/05/2005	19/07/2005
RI24	RIP	Low (0.9m)			
RI25	RIQ	Standard (2.9m)	Richmond Road, Twickenham (York House)	19/07/2005	24/07/2006
RI26	RIR	Low (0.9m)			
RI27	RIS	Standard (2.9m)	Lincoln Avenue, Twickenham	28/07/2006	08/01/2008
RI28	RIT	Low (0.9m)			
RI29	RIU	Standard (2.9m)	Mortlake Road, Kew	10/01/2008	07/01/2009
RI30	RIV	Low (0.9m)			
RI31	RIW	Standard (2.9m)	Upper Teddington Road, Teddington	07/01/2009	05/01/ 2010
RI32	RIX	Low (0.9m)			
RI33	RIY	Standard (2.9m)	Hampton Court Road, Hampton Court	05/01/2010	10/01/2011
RI34	RIZ	Low (0.9m)			

RI35	RHA	Standard (2.9m)	Lower Mortlake Road, Richmond	11/01/2011	04/01/2012
RI36	RHB	Low (0.9m)			

[a] Site ID used to request data from LAQN website.
[b] Site ID used in ERG database and in data output files downloaded from LAQN.
[c] All locations roadside except from Richmond Park which is background.

Table B.2 Results of Automatic Monitoring for Nitrogen Dioxide at the Richmond Mobile: Comparison with 1-hour Mean Objective, at standard and low level monitoring heights.

			Number of Exceedences of hourly mean (200 μg/m^3)										
Location	**Site ID (LAQN website)** [b]	**Site ID (ERG database)** [c]	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
[a]Richmond Park (background)	RI7 (RI8) [d]	RI7 (RI8)	0 (0)										0 (0)
George Street, Richmond	RI9 (RI10)	RIA (RIB)	1 (NA)[e]										(NA)[e]
Kew Green, Kew	RI11 (RI12)	RIC (RID)	0 (0)	0 (0)									0 (0)
Richmond Road, Twickenham (opp. Orleans School)	RI13 (RI14)	RIE (RIF)		0 (24)									0 (24)
Upper Teddington Road, Teddington	RI15 (RI16)	RIG (RIH)		2 (2)	0 (0)								2 (2)
Somerset Road, Teddington	RI17 (RI18)	RII (RIJ)			0 (0)								0 (0)
St Margaret's Grove, St Margaret's	RI19 (RI20)	RIK (RIL)			0 (0)								0 (0)
Petersham Road, Ham	RI21 (RI22)	RIM (RIN)			0 (0)	0 (0)							0 (0)

Stanley Road, Twickenham	RI23 (RI24)	RIO (RIP)				0 (0)							0 (0)
Richmond Road, Twickenham (York House)	RI25 (RI26)	RIQ (RIR)				0 (0)	0 (0)						0 (0)
Lincoln Avenue, Twickenham	RI27 (RI28)	RIS (RIT)						0 (0)	0 (0)				0 (0)
Mortlake Road, Kew	RI29 (RI30)	RIU (RIV)								0 (0)			0 (0)
Upper Teddington Road, Teddington	RI31 (RI32)	RIW (RIX)									0 (0)		0 (0)
Hampton Court Road, Hampton Court	RI33 (RI34)	RIY (RIZ)										0 (0)	0 (0)
Lower Mortlake Road	RI35 (RI36)	RHA (RHB)											
		Calendar year total	1 (0)	2 (**26**)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Objective	**18**										

Source: London Air Quality Network (ERG, 2012).

[a] All locations roadside except from Richmond Park which is background.
[b] Site ID used to request data from LAQN website.
[c] Site ID used in ERG database and in data output files downloaded from LAQN.
[d] Site ID in brackets throughout table is for low height inlet (0.9m) 2003 **(bold)** exceeded objective
[e] No data available for RI10 (low height inlet NO_2 analyser at George Street, Richmond) due to instrument failure.

Table B.3 Results of Automatic Monitoring for PM_{10} at the Richmond Mobile: Comparison with 24-hour Mean Objective

			Number of Exceedences of daily mean (50 μg/m^3)										
Location [a]	**Site ID (LAQN website)** [b]	**Site ID (ERG database)** [c]	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
Richmond Park (background)	RI7	RI7	1										1
George Street, Richmond	RI9	RIA	0										0
Kew Green, Kew	RI11	RIC	1	7									8
Richmond Road, Twickenham (opp. Orleans School)	RI13	RIE											19
Upper Teddington Road, Teddington	RI15	RIG	19		0								23
Somerset Road, Teddington	RI17	**RII**	23										1
St Margaret's Grove, St Margaret's	RI19	RIK											1
Petersham Road, Ham	RI21	RIM				4							10
Stanley Road, Twickenham	RI23	RIO	1	1									0
Richmond Road, Twickenham (York House)	RI25	RIQ					7						10
Lincoln Avenue, Twickenham	RI27	RIS	6	0				20					27
Mortlake Road, Kew	RI29	RIU											11
Upper Teddington Road, Teddington	RI31	RIW	3										1
Hampton Court Road, Hampton Court	RI33	RIY											3
Lower Mortlake Road, Richmond	RI35	RHA										10	10
Calendar year total			2 7	**49**	8	7	14	20	11	1	3	10	

Objective	**35**										

[a] All locations roadside except from Richmond Park which is background.
[b] Site ID used to request data from LAQN website.
[c] Site ID used in ERG database and in data output files downloaded from LAQN.
Bold indicates objective exceedence

Table B.4 Results of Automatic Monitoring for O_3 at the Richmond Mobile: Comparison with 24-hour Mean Objective

			Number of Exceedences of running 8-hour mean (60 μg/m^3)										
Location [a]	**Site ID (LAQN website) [b]**	**Site ID (ERG database) [c]**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
Richmond Park (background)	RI7	RI7	11										11
George Street, Richmond	RI9	RIA	0										0
Kew Green, Kew	RI11	RIC	0	0									0
Richmond Road, Twickenham (opp. Orleans School)	RI13	RIE		1									1
Upper Teddington Road, Teddington	RI15	RIG			0								13
Somerset Road, Teddington	RI17	RII	13										1
St Margaret's Grove, St Margaret's	RI19	RIK		1									2
Petersham Road, Ham	RI21	RIM		2		0							6

Stanley Road, Twickenham	RI23	RIO											7
Richmond Road, Twickenham (York House)	RI25	RIQ		7			22						24
Lincoln Avenue, Twickenham	RI27	RIS						10					12
Mortlake Road, Kew	RI29	RIU											0
Upper Teddington Road, Teddington	RI31	RIW	2										20
Hampton Court Road, Hampton Court	RI33	RIY											0
Lower Mortlake Road, Richmond	RI35	RHA											0
		Calendar year total	**11**	**14**	9	9	**24**	10	6	20	0	0	
		Objective	**10**										

Source: London Air Quality Network (ERG, 2011).

[a] All locations roadside except from Richmond Park which is background.
[b] Site ID used to request data from LAQN website.
[c] Site ID used in ERG database and in data output files downloaded from LAQN.
Bold indicates objective exceedence

Appendix C: Part A and Part B industrial processes in the LBRuT

Table C.1 Part A and Part B industrial processes in the LBRuT

Installation Type	Installation Name	Site Address	Activity
Production of biodiesel from used cooking oil	Proper Energy Limited T/A Proper Oils	37 Hamilton Road, Twickenham, Middlesex, TW2 6SN.	Part A1
Crematorium	Mortlake Crematorium Board	Kew Meadow Path, Richmond, Surrey, TW9 4EN	Part B
Respraying of Road Vehicles	H & L Motors Limited	70-72 Wellington Road, Twickenham, Middlesex, TW2 5NX.	Part B
Respraying of Road Vehicles	Grimshaw & Wake Limited	Oldfield Road, Hampton, Middlesex, TW12 2HR	Part B
Petrol Station	Oak Lane Service Station	5-11 Richmond Road, Twickenham, Richmond, TW1 3AB	Part B
Petrol Station	Texaco East Sheen Service Station	567 Upper Richmond Road West, East Sheen, London, SW14 7ED	Part B
Petrol Station	Total Convenience Store Richmond	22-24 Popham Gardens, Lower Richmond Road, Richmond, Surrey, TW9 4LJ	Part B
Petrol Station	Total Convenience Store Black Horse	174-176 Sheen Road, Richmond, Surrey, TW9 1XD	Part B
Petrol Station	Mortlake Service Station	16-26 Sheen Lane, East Sheen, London, SW14 8LW	Part B
Petrol Station	Sainsburys Service Station	Lower Richmond Road (A316), Richmond, Surrey	Part B
Petrol Station	BP Express Shopping	Lower Mortlake Road (A316), Richmond, London, TW9 2LL	Part B
Petrol Station	Sainsburys Service Station	303 Uxbridge Road, Hampton, Middlesex, TW12 1AW	Part B
Petrol Station	Tesco Express	159-167 Castelnau, Barnes, London, SW13 9EW	Part B
Petrol Station	Staines Road Service Station	110 Staines Road, Twickenham, Middlesex, TW2 5AW	Part B
Petrol Station	Shell Hospital Bridge	353 Staines Road, Twickenham, Middlesex, TW2 5JA	Part B
Petrol Station	Palace Service Station	The Green, Hampton Court Road, East Molesey, Surrey, KT8 9BW	Part B
Petrol Station	Ham Cross Service Station	297 Richmond Road, Kingston Upon Thames, Surrey, KT2 5QU	Part B
Dry Cleaners	Beaucare	146 Heath Road, Twickenham TW1 4BN	Part B
Dry Cleaners	Cathe 2 Dry Cleaners	185 High Street, Hampton Hill TW12 1NL	Part B
Dry Cleaners	Coldell Dry Cleaners	39 Hampton Road, Twickenham TW2 5QE	Part B
Dry Cleaners	Crown Dry Cleaners (Whitton) Ltd	13 High Street, Whitton TW2 7LA	Part B
Dry Cleaners	Divine	424 Richmond Road, Ham KT2 5PU	Part B
Dry Cleaners	Du Cane	2 Westminster House, Kew Road, Richmond TW9 2ND	Part B
Dry Cleaners	Du Cane Dry Cleaning	2 Kew Road, Richmond, Surrey, TW9 2NA	Part B
Dry Cleaners	Express Dry Cleaners	282 Upper Richmond Road West, London	Part B
Dry Cleaners	Gently Clean	92 Station Road, Hampton, Middlesex, TW12 2AX	Part B
Dry Cleaners	Hamlyns	197 Upper Richmond Road West, London, SW14 8QT	Part B
Dry Cleaners	Johnson Cleaners UK Ltd	51 Broad Street, Teddington, Middlesex, TW11	Part B
Dry Cleaners	Junette	90 Kew Road, Richmond, Surrey, TW9 2PQ	Part B
Dry Cleaners	Kings Dry Cleaners	45 King Street, Twickenham, Middlesex, TW1 3SH	Part B

Dry Cleaners	Lime Dry Cleaners	107 North Road, Richmond, Surrey, TW9 4HJ	Part B
Dry Cleaners	M E L Dry Cleaners	24 Heath Road, Twickenham, TW1 4BZ	Part B
Dry Cleaners	Mr Dryclean	2 Broad Street, Teddington TW11 8RF	Part B
Dry Cleaners	Noble Dove Dry Cleaners	374 Richmond Road, Twickenham, Middlesex, TW1 2DR	Part B
Dry Cleaners	Pearl Dry Cleaners	84 High Street, Teddington, Middlesex, TW11 8JD	Part B
Dry Cleaners	Pristine Laudries	37 High Street, Teddington, Middlesex, TW11 8ET	Part B
Installation Type	**Installation Name**	**Site Address**	Part B
Dry Cleaners	Reeves Dry Cleaners	180 Castelnau, London, SW13 9DH	Part B
Dry Cleaners	Regency of Richmond	18 Hill Street, Richmond, Surrey, TW9 1TN	Part B
Dry Cleaners	Richmond Hill	21 Friars Stile Road, Richmond TW10 6NH	Part B
Dry Cleaners	Royal Dry Cleaners	84 Church Road, London, SW13	Part B
Dry Cleaners	Royal Dry Cleaners	455 Upper Richmond Road West, East Sheen, London, SW14 7PR	Part B
Dry Cleaners	Royal Dry Cleaners	106 High Street, Whitton, Middlesex, TW3 2EJ	Part B
Dry Cleaners	The Ryders	Church Road, Ham, Surrey, TW10 5HL	Part B
Dry Cleaners	Sky Dry Cleaners	13 York Street, Twickenham, Middlesex, TW1 3JZ	Part B
Dry Cleaners	Silks	54 Broad Street, Teddington TW11 8QY	Part B
Dry Cleaners	Swiftclean	65 Ham Street, Richmond, Surrey, TW10 7HW	Part B
Dry Cleaners	The Clean Machine	18 Eton Street, Richmond, TW9 1EE	Part B
Dry Cleaners	Tip Top Dry Cleaners	159 St Margaret's Road, Twickenham, Middlesex, TW1 1RD	Part B
Dry Cleaners	Twickenham Green Dry Cleaners	4 Staines Road, Twickenham, TW2 5AH	Part B
Dry Cleaners	White Hart Dry Cleaners	155 White Hart Lane, London, SW13 0JP	Part B
Dry Cleaners	Wick Dry Cleaners	68 High Street, Hampton Wick, KT1 4DQ	Part B
Dry Cleaners	Willow Dry Cleaners	56 High Street, Hampton Hill, Middlesex, TW12 1PD	Part B
Installation Type	**Installation Name**	**Site Address**	Part B
Waste Oil Burner	Jacksons Ford	50 Waldegrave Road, Teddington, Middlesex, TW11 8NY	Part B

Installation Type	**Total number**
Production of biodiesel from used cooking oil	**1**
Crematorium	**1**
Respraying of Road Vehicles	**2**
Petrol Stations	**13**
Dry Cleaners	**35**
Waste Oil Burner	**1**

Total number of Installations	**53**