LONDON BOROUGH OF
RICHMOND UPON THAMES

# 2010
# Air Quality Progress Report for *The London Borough of Richmond upon Thames*

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

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# Executive Summary


**Executive Summary**

This progress report documents the LBRuT air quality monitoring data over the last eight years, for all the pollutants monitored, namely for nitrogen dioxide ($NO_2$), particulates ($PM_{10}$), ozone ($O_3$), sulphur dioxide ($SO_2$), carbon monoxide (CO) and benzene ($C_6H_6$). The results indicate that both $PM_{10}$ and $NO_2$ exceeded the air quality objectives. Dependant on weather conditions, some years have been worse than others. Although emission rates may have not varied much, background pollution received from outside the London area sometimes affects levels significantly. In London $NO_2$ levels have been rising, and the reasons for this are being investigated (i.e. the recent (2008) AQEG Report on direct $NO_2$). It therefore remains as important as ever to find ways to reduce emissions so that air pollution levels actually improve.

In 2002, the detailed Stage 4 modelling assessment indicated that the objectives would be exceeded, mainly along the major road transport corridors. This was again confirmed by the 2009 USA assessment which identified that:

1) There was a risk of exceeding the objectives for $NO_2$ across the LBRuT.
2) There was a risk of exceeding the objectives for $PM_{10}$ in parts of the LBRuT.
3) For CO, benzene, $SO_2$, ozone, lead (Pb) and 1,3-butadiene the risk of exceeding the objectives were not significant.

The results, reported from the monitoring of $NO_2$, show that the annual mean exceeded at Castelnau (roadside) for each of the last seven years. Also, in 2009, the majority of the $NO_2$ diffusion tube monitoring sites exceeded (49 of 59 sites). This was expected, as the tubes are mainly located at roadsides, representing residents who live near busy roads.

Both the modelling for 2010 and the recent monitoring results confirm that there is still a need for the LBRuT to be designated as an AQMA. The Air Quality Action Plan (AQAP) Progress Report table in Appendix B shows that good progress is being made with the majority of the measures.

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# 1 Introduction

## 1.1 Description of Local Authority Area

**The Borough of Richmond upon Thames (LBRuT) as part of London**

The LBRuT is situated in the South West corner of Outer London. In air quality terms, this means that the prevailing south westerly wind (roughly 75% of the year) brings in relatively fresh air to the LBRuT, before it blows towards the centre of London. In practice, the wind blows from all points of the compass and this includes receiving polluted air blowing out from the centre of London. This explains why the Barnes end of the LBRuT receives a higher proportion of London air, with consequent higher background pollution levels. The main source of pollution in the Borough is traffic related. As a result, the LBRuT is keen for the air quality to be improved not just in the LBRuT, but also across the whole of London. Some of the Action Plan actions are cross-Borough, with the West London neighbours, or are cross-London initiatives.


***Figure 1**: Location of LBRuT within Greater London.*

## 1.2 Purpose of Progress Report

Progress Reports are required in the intervening years between the three-yearly Updating and Screening Assessment reports. Their purpose is to maintain continuity in the Local Air Quality Management process.

They are not intended to be as detailed as Updating and Screening Assessment Reports, or to require as much effort. However, if the Progress Report identifies the risk of exceedence of an Air Quality Objective, the Local Authority (LA) should undertake a Detailed Assessment immediately, and not wait until the next round of Review and Assessment.

## 1.3 Air Quality Objectives

The air quality objectives applicable to Local Air Quality Management (LAQM) **in England** are set out in the Air Quality (England) Regulations 2000 (SI 928) and the Air Quality (England) (Amendment)

Regulations 2002 (SI 3043). They are shown in Table 1.1. This table shows the objectives in units of microgrammes per cubic metre $\mu g/m^3$ (for carbon monoxide the units used are milligrammes per cubic metre, $mg/m^3$). Table 1 includes the number of permitted exceedences in any given year (where applicable).

**Table 1** **Air Quality Objectives included in Regulations for the purpose of Local Air Quality Management in England.**

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

## 1.4 Summary of Previous Review and Assessments

Summary of Air Quality progress to date:

1. Stage 1,2 and 3 assessments confirmed a need to tackle air quality in the LBRuT
2. AQMA declared for whole LBRuT, December 2000
3. Stage 4 assessment, May 2002, confirmed that air quality improvements were needed
4. AQAP consulted on and published 2002
5. USA 2004 confirmed continuing exceedence of the objectives
6. Air Quality Review and Assessment Progress Report 2005 to give updated monitoring results
7. AQAP Progress Report 2005 to give update on actions to improve air quality
8. USA 2006 confirmed continuing exceedence of the objectives
9. Air Quality Review and Assessment Progress Report 2007 to give updated monitoring results
10. AQAP Progress Report 2007 to give update on actions to improve air quality
11. Air Quality Review and Assessment Progress Report 2008 to give updated monitoring results
12. AQAP Progress Report 2008 to give update on actions to improve air quality
13. USA 2009 confirmed continuing exceedence of the objectives

The LBRuT AQAP was required under Part IV of the Environment Act 1995. The Council decided to declare the whole of the LBRuT as a single AQMA. This was declared in a formal notice dated 31st December 2000 following a review and assessment of air quality in the LBRuT 'Stage 3'. The Review concluded that the National Air Quality Strategy objectives for 2005 would not be met for two pollutants, $NO_2$ and $PM_{10}$. The standards in the objectives are health based. The objectives can be found in section 1.3.

The purpose of the AQAP is to ensure that the Council can plan and manage appropriate actions to improve air quality within the LBRuT. It is not a legal requirement to actually achieve the National Air Quality Objectives; however the action must be in pursuit of achieving the objectives.

Under the Act, local authorities that have declared an AQMA are 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, 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. The areas predicted to exceed the targets are mainly adjacent to the major through traffic routes. The next phase was to produce an USA in 2006, which confirmed continuing exceedence of the objectives and since the USA in 2006 an Air Quality Review and Assessment, and AQAP Progress Report, was produced in 2007 and a USA in 2009.

In February 2007, the Air Quality Standards Regulations 2007 (OPSI, 2007) came into force with objective limits set for 2010. The limits remain the same as the $PM_{10}$ (2004) and $NO_2$ (2005) limits, so the LBRuT is still obliged to try to meet those objectives.

Progress on the AQAP is reported as Appendix B to this report.

# 2 New Monitoring Data

## 2.1 Summary of Monitoring Undertaken

The monitoring data in this report comes from monitoring surveys undertaken across the LBRuT. The monitoring results confirm that air pollution in the LBRuT still exceeds the 2004/2005 objectives, and the new 2010 objectives for $NO_2$ and PM10, and therefore there is still a need for LBRuT to be designated as an AQMA and consequently there is still a need to pursue improvements in air quality.

In order to assess the air quality against the National Air Quality Objectives, Richmond Council routinely monitors against annual mean objectives and against shorter period objectives, as indicated for the pollutants below:

Nitrogen dioxide ($NO_2$) (1-hour mean)
Particulate matter ($PM_{10}$) (24-hour mean)
Sulphur dioxide ($SO_2$) (15-minute mean)
Ozone ($O_3$) (running 8-hour mean)
Carbon monoxide (CO) (running 8-hour mean)
Benzene (BTEX) (2-week monitoring mean – annual mean limit only)

Table 10 lists the locations of the $NO_2$ diffusion tube monitors in the LBRuT. The tubes are a relatively cheap way of monitoring, which therefore allows samples to be taken across the whole LBRuT and give a Borough-wide view. The results obtained give monthly averages, and are not precise but do provide an indication of $NO_2$ pollution levels. The accuracy of the diffusion tube readings can be increased when their results are compared, and the bias adjusted, with data from the more accurate continuous monitors. Richmond Council has a network of 65 diffusion tubes to monitor $NO_2$ at 59 locations across the LBRuT (detailed in Table 10) and a further 5 sites to monitor for benzene (detailed in Table 10). PAH monitoring ceased at Castelnau Library, Barnes (static site) in spring 2007.

At four locations in the LBRuT there are air pollution analysers running continuously (locations given in Table 2 and shown in the map at Figure 5). The continuous monitors collect real time data, which are stored as 15-minute means and can be converted into the various averages (as above). This type of equipment provides accurate readings of pollution levels but is expensive, so using them for a large coverage of LBRuT is not possible on cost grounds.

All data undergoes quality assurance and quality control (QA/QC) procedures to ensure that the data obtained is of a high quality and is accurate. The QA/QC procedures for both the continuous analysers and diffusion tubes are explained in appendix A.

### 2.1.1 Automatic Monitoring Sites

Table 2, lists the pollutants monitored continuously at each of the four sites (1 mobile and 3 static). Richmond Council has three monitoring sites, and the National Physical Laboratory (NPL) also undertakes monitoring in the LBRuT at Teddington, this site is part of the UK Automatic Urban and Rural Network (AURN).

**Table 2** Locations of the automatic monitoring sites.

| Monitoring sites | Operational since | Pollutants monitored |
|---|---|---|
| **Castelnau** Library, Barnes (Site No. 37). Static site known as Richmond 1 in the London Air Quality Network (LAQN). Roadside site, 3 meters from road | 2000 | $NO_X$, NO, $NO_2$, and $PM_{10}$ |

| | | |
|---|---|---|
| with bus lane. | | |
| **Wetlands** Centre, Barnes (site number 23). Static site known as Richmond 2 in the LAQN. Suburban (background) site - well away from roads. | 2000 | $NO_X$, NO, $NO_2$, $O_3$ and $PM_{10}$ |
| **Mobile** Air Quality Unit (site number 53). Mostly roadside monitoring locations, since 1995. In 2009 it was located at Upper Teddington Road, Teddington, which was a roadside site. | 2009 | $NO_X$, NO, $NO_2$ (high and low) CO, $SO_2$ and $PM_{10}$ |
| **NPL - Teddington AURN**. Static suburban (background) site - well away from roads. | 1996 | $NO_X$, $NO_2$, NO, $SO_2$ $PM_{2.5}$ and $O_3$ |

Note: the map at Figure 5 shows the site locations

The results given below show the annual mean data, for the pollutants monitored, for the years 2002 to 2009. Each set of results is given in turn, starting with $NO_2$, then $PM_{10}$, $PM_{2.5}$ ozone, $SO_2$, CO and benzene. Results in **bold** are ones which exceed the objective limits. Details on the relevant objective limits are given in Table 1.

For Quality Assurance/Quality Control (QA/QC) purposes, all the continuous analysers are manually checked and calibrated every two weeks, serviced every six months and audited by an independent auditor (the National Physical Laboratory) every six months. The analytical methods used by the analysers are: $NO_2$ (chemiluminescence); $PM_{10}$ (TEOM); $PM_{2.5}$ (FDMS); ozone (UV absorption); $SO_2$ (fluorescence); CO (infrared) and benzene (gas chromatography/mass spectrometry). The relevance of quoting the percentage data capture is to demonstrate compliance with the minimum 90% required for a valid comparison with the short-term objective limits. Data for Castelnau, Wetlands and NPL are fully ratified. Data for the Mobile have only been ratified up to 2008.

**Nitrogen dioxide ($NO_2$) in the LBRUT**

**Table 3** $NO_2$ results from the continuous analysers, compared with the annual mean limit of 40 $\mu g/m^3$ and the number of times the levels exceeded the hourly average limit of 200 $\mu g/m^3$.

| **Castelnau** [a] | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|
| Annual mean $NO_2$ ($\mu g/m^3$) | **44** | **48** | **41** | **42** | **42** | **42** | **44** | **45** |
| Number of exceedences of hourly mean of 200 $\mu g/m^3$ | 0 | 0 | 0 | 4 | 0 | 7 | 9 | 3 |
| Data capture (%) | 98% | 96% | 97% | 98% | 99% | 96% | 95% | 98% |
| **Wetlands** [a] | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Annual mean $NO_2$ ($\mu g/m^3$) | 32 | 37 | 31 | 30 | 30 | 30 | 29 | 29 |
| Number of exceedences of hourly mean of 200 $\mu g/m^3$ | 0 [c](70.4) | 0 | 0 | 0 | 0 [c](85.2) | 0 | 1 | 0 |
| Data capture (%) | 71% | 99% | 97% | 93% | 87% | 97% | 99% | 99% |
| **Mobile Unit** [b] | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Annual mean $NO_2$ ($\mu g/m^3$) | | | | | **44** | 38 | **42** | **40** |
| Number of exceedences of hourly mean of 200 $\mu g/m^3$ | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Data capture (%) | | | | | | 99% | 90% | 95% |
| **NPL – Teddington AURN** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Annual mean $NO_2$ ($\mu g/m^3$) | 25 | 28 | 25 | 26 | 23 | 28 | 25 | 22 |
| Number of exceedences of hourly mean of 200 $\mu g/m^3$** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Data capture (%) | 98% | 96% | 94% | 95% | 99% | 95% | 97% | 80% |

***The hourly mean objective for NO2 is 200ug/m3 which should not to be exceeded more than 18 times per year.**

[a] Data for Castelnau, Wetlands and NPL are fully ratified

[b] Mobile data have only been ratified up to 2008

[c] figure in brackets equals 99.8%ile as data capture is less than 90%, with a limit of 200ug/m3. Neither site exceeded the limit.

**See Table 3a for the exceedence breakdown at each Mobile Air Quality Unit deployment. Prior to 2006, the mobile unit was moved to more than one location in a year, hence there are no annual averages for 2002 to 2005.

**Table 3a** Break down of the number of times the $NO_2$ levels exceeded the hourly mean limit of 200 $\mu g/m^3$ at the Mobile Air Quality Unit.

| **Mobile Unit location** | **Start date** | **End date** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | Site Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Richmond Park (background) | 29/04/02 | 11/09/02 | 0 | | | | | | | | 0 |
| George Street, Richmond | 16/09/02 | 19/11/02 | 1 | | | | | | | | 1 |
| Kew Green, Kew | 19/11/02 | 25/02/03 | 0 | 0 | | | | | | | 0 |
| Richmond Road, Twickenham (opp. Orleans School) | 25/02/03 | 20/05/03 | | 0 | | | | | | | 0 |
| Upper Teddington Road, Teddington | 21/05/03 | 03/02/04 | | 2 | 0 | | | | | | 2 |
| Somerset Road, Teddington | 03/02/04 | 23/04/04 | | | 0 | | | | | | 0 |
| St Margaret's Grove, St Margaret's | 27/04/04 | 20/07/04 | | | 0 | | | | | | 0 |
| Petersham Road, Ham | 21/07/04 | 25/05/05 | | | 0 | 0 | | | | | 0 |
| Stanley Road, Twickenham | 27/05/05 | 19/07/05 | | | | 0 | | | | | 0 |
| Richmond Road, Twickenham (York House) | 19/07/05 | 24/07/06 | | | | 0 | 0 | | | | 0 |
| Lincoln Avenue, Twickenham | 28/07/06 | 08/01/08 | | | | | 0 | 0 | | | 0 |
| Mortlake Rd, Kew | 08/01/08 | 08/01/09 | | | | | | | 0 | | 0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Upper Teddington Rd, Teddington | 08/01/09 | 05/01/10 | | | | | | | | 0 | 0 |
| | | **Calendar year total** | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | |

***The hourly mean objective for NO2 is 200ug/m3 which should not to be exceeded more than 18 times per year.**

Table 3 shows that the annual mean for Castelnau exceeded the objective (40 $\mu g/m^3$) every year for the past eight years, there were four exceedences of the 1-hour air quality standard in 2005, 7 exceedences in 2007, 9 exceedences in 2008 and 3 exceedence in 2009 (out of 18 exceedences permitted by the objective, so the 1-hour objective was met). The annual and 1-hour objectives were not exceeded at the Wetlands and NPL – Teddington AURN sites in 2009.

Table 3a shows there was one exceedence of the 1 hour mean limit during the 2002 George Street, Richmond deployment of the Mobile Unit, and 2 during the 2003 Upper Teddington Road, Teddington deployment.

The results from both the $NO_2$ diffusion tube sampling and the continuous analysers correlate with the modelling predictions calculated by Environmental Research Group (ERG) consultants for the year 2005. The map at Figure 2 was taken from the 2002 Stage 4 Review and Assessment report. The map indicated that the Air Quality Objectives would not be met in 2005 in the main road traffic corridors and junctions, and therefore premises close to these areas would be affected by the pollution. These modelling predictions were confirmed by the 2005, 2006, 2007, 2008 and 2009 air quality monitoring data.

Further modelling was done by ERG for the year 2010, based on the London LAEI for 2003 and the meteorological year of 2003. It identified that under a repeat of those 2003 meteorological conditions; there would be widespread exceedences of the annual mean $NO_2$ 2010 Objective across the LBRuT.

## Table 4 Details of Automatic Monitoring Sites

| Site Name | Site Type | OS Grid Ref | | Pollutants Monitored | Monitoring Technique | In AQMA? | **Relevant Exposure?** (Y/N with distance (m) to relevant exposure) | **Distance to kerb of nearest road** (N/A if not applicable) | Does this location represent worst-case exposure? |
|---|---|---|---|---|---|---|---|---|---|
| **Castelnau** Library, Barnes (R1) | Roadside | 522500 | 177165 | $NO_X$, NO, $NO_2$, and $PM_{10}$ | TEOM | Y | N (8) | 3m | Y |
| **Wetlands** Centre, Barnes (R2) | Suburban | 522991 | 176495 | $NO_X$, NO, $NO_2$, $O_3$ and $PM_{10}$ | TEOM | Y | Y – 1 hr mean objective. Children in play area/people attending Wetlands Centre | N/A | N/A |
| **Mobile** Air Quality Unit | Mostly roadside locations | Changes | Changes | $NO_X$, NO, $NO_2$, CO, $SO_2$ and $PM_{10}$ | TEOM | Y | Changes | Changes | Changes |
| **NPL -** Teddington AURN (TD0) | Suburban | 515542 | 170420 | $NO_X$, NO, $NO_2$, $SO_2$[(a)] $PM_{2.5}$ and $O_3$ | TEOM | Y | Y (50) | N/A | N/A |

[(a)] $SO_2$ monitoring ceased at NPL in October 2007

**Particulate matter ($PM_{10}$) in the LBRuT**

The LBRuT uses a Tapered Element Oscillating Microbalance (TEOM) to continuously monitor $PM_{10}$. From 2007 onwards all TEOM results are converted to reference equivalence using the volatile correction method (VCM), 2002 to 2006 results use the old method of multiplying the results by 1.3

**Table 5** Annual mean $PM_{10}$ results against the Objective limit of an annual mean of 40 $\mu g/m^3$ and the number of single days over 50 $\mu g/m^3$ (35 days a year permitted by the Objective).

| **Castelnau** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007[a]** | **2008[a]** | **2009[a]*** |
|---|---|---|---|---|---|---|---|---|
| Annual mean $PM_{10}$ ($\mu g/m^3$) | 25 | 28 | 26 | 26 | 27 | 23 | 21 | 21 |
| Number of exceedences of the 24-hour mean | 4 | 29 | 10 | 6 | 8 | 21 | 12 | 4 |
| Data capture (%) | 92% | 96% | 94% | 99% | 94% | 99% | 99% | 95% |
| **Wetlands** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007[a]** | **2008[a]** | **2009[a]*** |
| Annual mean $PM_{10}$ ($\mu g/m^3$) | 24 | 28 | 22 | 22 | 25 | 22 | 21 | 21 |
| Number of exceedences of the 24-hour mean | 6 | 34 | 5 | 4 | 17 | 19 | 8 | 5 |
| Data capture (%) | 64% | 98% | 97% | 99% | 99% | 96% | 94% | 100% |
| **Mobile Unit** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007[a]** | **2008[a]** | **2009[a]*** |
| Annual mean $PM_{10}$ ($\mu g/m^3$) | | | | | | 23 | 23 | 23 |
| Number of exceedences of the 24-hour mean ** | 2 | **49**[b] | 8 | 7 | 14 | 22 | 12 | 5 |
| Data capture (%) | | | | | | 99% | 66% | 94% |

* Mobile data have only been ratified up to 2008. Castelnau and Wetlands data have been fully ratified
****** See Table 5a for the exceedence breakdown at each mobile unit deployment.
[a] from 2007 to 2009 the results are calculated using the VCM reference equivalent *(VCM corrected TEOM)* (Defra, 2009d)
[b] Note: this is a composite result, from 3 sites – see Table 5a following for details

**All exceedences of the annual and daily objectives are in highlighted in bold.**

**Table 5a** Breakdown of the number of times $PM_{10}$ levels exceeded the 24-hour limit of 50 $\mu g/m^3$ at the Mobile Air Quality Unit.

| Mobile Unit location | Start date | End date | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Site Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Richmond Park (background) | 29/04/02 | 11/09/02 | 1 | | | | | | | | 1 |
| George Street, Richmond | 16/09/02 | 19/11/02 | 0 | | | | | | | | 0 |
| Kew Green, Kew | 19/11/02 | 25/02/03 | 1 | 7 | | | | | | | 8 |
| Richmond Road, Twickenham (opp. Orleans School) | 25/02/03 | 20/05/03 | | 19 | | | | | | | 19 |
| Upper Teddington Road, Teddington | 21/05/03 | 03/02/04 | | 23 | 0 | | | | | | 23 |
| Somerset Rd, Teddington | 03/02/04 | 23/04/04 | | | 1 | | | | | | 1 |
| St Margaret's Grove, St Margaret's | 27/04/04 | 20/07/04 | | | 1 | | | | | | 1 |
| Petersham Road, Ham | 21/07/04 | 25/05/05 | | | 6 | 4 | | | | | 10 |
| Stanley Road, Twickenham | 27/05/05 | 19/07/05 | | | | 0 | | | | | 0 |
| Richmond Road, Twickenham (York House) | 19/07/05 | 24/07/06 | | | | 3 | 7 | | | | 10 |
| Lincoln Avenue, Twickenham | 28/07/06 | 08/01/08 | | | | | 7 | 20 | | | 27 |
| Mortlake Rd, Kew | 08/01/08 | 08/01/09 | | | | | | | 0 | | 0 |
| Upper Teddington Rd, Teddington | 08/01/09 | 05/01/10 | | | | | | | | 5 | 5 |
| | | **Calendar year total** | 2 | **49** [b] | 8 | 7 | 14 | 20 | 0 | 5 | |

[b] 2003 shows a composite 'exceedence'

Table 5 shows that, at Castelnau or the Wetlands, there were no exceedences of either of the $PM_{10}$ objective limits.

Table 5a shows that, at the Mobile Air Quality Unit, when the different deployment exceedences are combined, the results for 2003 show a composite 'exceedence' of the 24-hour mean 2005 objective limit of 50 $\mu g/m^3$

Modelled concentrations of $PM_{10}$, across the LBRuT, are displayed in the following map, at Figure 2.

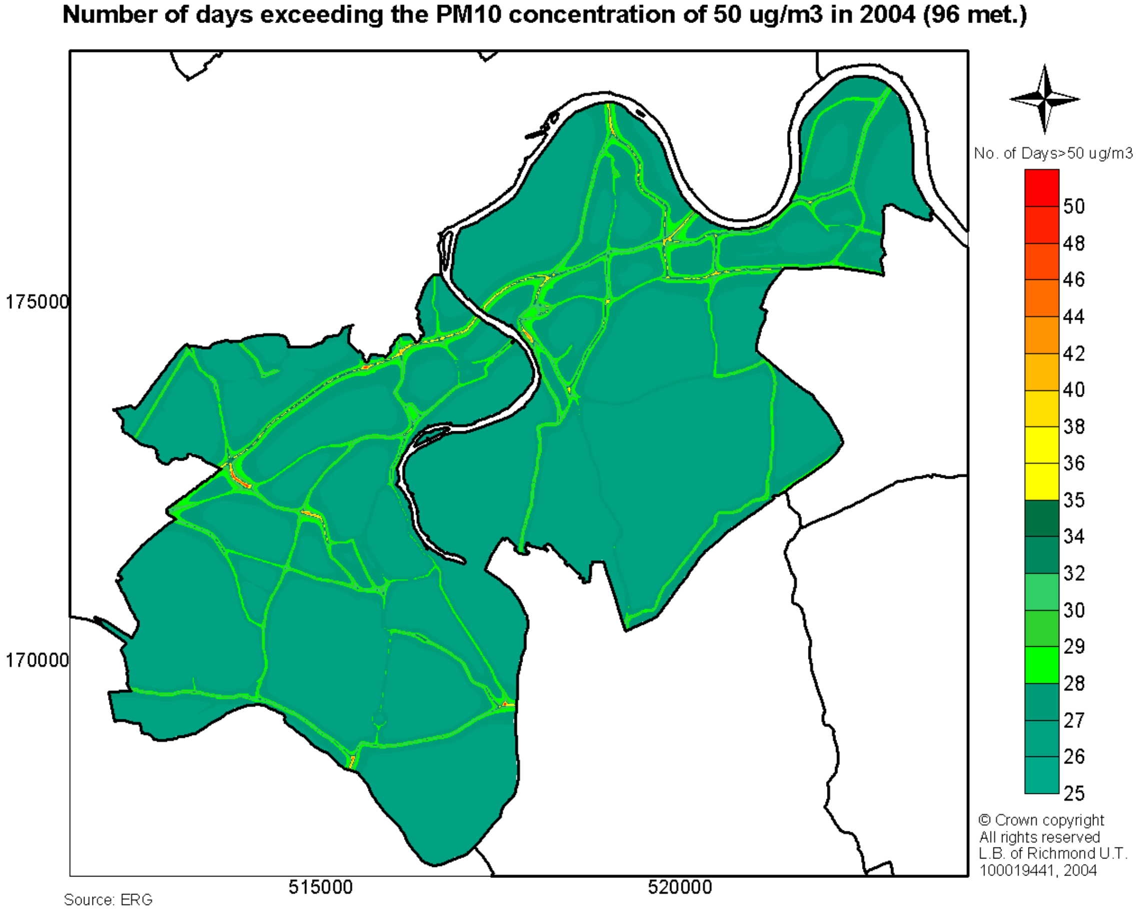



**Figure 2**: Modelled $PM_{10}$ concentrations in LBRuT in 2004. (Modelled by ERG)

Modelling by ERG for the year 2010 (not shown) gives similar results to this 2004 modelling. The 2010 results still show exceedences in the centres of roads, where there are no sensitive receptors. However, at some locations, close to these road sources, the modelling shows that the objectives are still likely to be exceeded at vulnerable residential receptors. This supports retention of the AQMA $PM_{10}$ designation, for the time being.

**Particulate matter less than 2.5 microns ($PM_{2.5}$) in the LBRUT**

Since 2009 $PM_{2.5}$ has been monitored continuously at the National Physical Laboratory (NPL) site using Filter Dynamics Measurement System (FDMS).

**Table 6** $PM_{2.5}$ levels at NPL

| **National Physical Laboratory** | **2009*** [a] |
|---|---|
| Annual mean | 13 |
| Data capture (%) | 99 |

*All data have been fully ratified
[a](i) an annual average target value of 25 µg.m-3 by 2010; (ii) limit value of 25 µg.m-3 by 2015; (iii) exposure reduction target of up to 20% reduction of urban background particulate matter levels from a reference year of 2010, to be achieved by 2020.

The results show that the $PM_{2.5}$ levels for 2009 were below the target value.

## Other Pollutants Monitored

**Ozone ($O_3$)**
Ozone is continuously monitored at the three sites in the Borough. The results from 2002 to 2009 are shown in Table 7 below.

**Table 7** Ozone levels at the Wetlands Centre, the Air Quality Mobile Unit and at NPL - Teddington AURN. The non-legal objective limit is 10 exceedences of 100 μg/m$^3$ as the daily maximum of the running 8-hour mean.

| **Wetlands ** ** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|
| Number of exceedences of the running 8-hour mean | 5 | **49** | **24** | **17** | **29** | **15** | **24** | **14** |
| Data capture (%) | 46% | 100% | 98% | 99% | 96% | 97% | 99 | 98 |
| **Mobile Unit *** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007*** | **2008** | **2009** |
| Number of exceedences of the running 8-hour mean*** | **11** | **14** | 9 | 9 | **24** | 9 | 0 | 2 |
| **NPL – Teddington AURN ** ** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Number of exceedences of the running 8-hour mean | **24** | **50** | **26** | **32** | **42** | **19** | **33** | **20** |
| Data capture (%) | 99% | 99% | 96% | 99% | 99% | 97% | 98 | 99 |

*Data for the Mobile have only been ratified up to 2008.
** all Wetlands and NPL data have been fully ratified
******* See Table 7a below for the exceedence breakdown at each mobile unit deployment.
**All exceedences of the 8 hour mean are in highlighted in bold.**

**Table 7a** Breakdown of the number of times ozone levels exceeded the running 8-hour mean limit of 100 μg/m$^3$ at the Mobile Air Quality Unit.

| **Mobile Unit location** | **Start date** | **End date** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **Site Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Richmond Park (background) | 29/04/02 | 11/09/02 | 11 | | | | | | | | 11 |
| George Street, Richmond | 16/09/02 | 19/11/02 | 0 | | | | | | | | 0 |
| Kew Green, Kew | 19/11/02 | 25/02/03 | 0 | 0 | | | | | | | 0 |
| Richmond Road, Twickenham (opp. Orleans School) | 25/02/03 | 20/05/03 | | 1 | | | | | | | 1 |
| Upper Teddington Road, Teddington | 21/05/03 | 03/02/04 | | 13 | 0 | | | | | | 13 |
| Somerset Rd, Teddington | 03/02/04 | 23/04/04 | | | 1 | | | | | | 1 |
| St Margaret's Grove, St Margaret's | 27/04/04 | 20/07/04 | | | 2 | | | | | | 2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Petersham Road, Ham | 21/07/04 | 25/05/05 | | | 6 | 0 | | | | | 6 |
| Stanley Road, Twickenham | 27/05/05 | 19/07/05 | | | | 7 | | | | | 7 |
| Richmond Road, Twickenham (York House) | 19/07/05 | 24/07/06 | | | | 2 | 22 | | | | 24 |
| Lincoln Avenue, Twickenham | 28/07/06 | 08/01/08 | | | | | 2 | 9 | | | 11 |
| Mortlake Rd, Kew | 08/01/08 | 08/01/09 | | | | | | | 0 | | 0 |
| Upper Teddington Rd, Teddington | 08/01/09 | 05/01/10 | | | | | | | | 2 | 2 |
| **Calendar year total** | | | **11** | **14** | 9 | 9 | **24** | 9 | 0 | 2 | |

Table 7 shows that the ozone levels at the Wetlands and NPL - Teddington AURN site in 2005, 2006 2007, 2008 and 2009 did exceed the objective (ie more than 10 exceedences of 100 $\mu g/m^3$ as the daily maximum of the running 8-hour mean per year). Table 7a shows that the combined exceedences of the running 8-hour limit of 100 $\mu g/m^3$ at the Mobile Air Quality Unit deployments in 2003, 2004 and 2006, resulted in an exceedence of the suggested objective. Care needs to be taken when comparing the number of exceedences at individual Mobile Unit deployments, because the Mobile Unit was not sited at locations for a full calendar year prior to 2007, so seasonal variations may cause one deployment to record higher pollution levels than another. The first deployment at Richmond Park is a background site and would be expected to record higher levels of ozone that the other deployments, which are all roadside. Such a distribution would be typical for ozone.

The high ozone levels at all sites in 2003 were due to the extremely hot summer.

**Sulphur dioxide ($SO_2$)**

$SO_2$ is continuously monitored at our mobile air quality unit and at NPL. Table 8 shows that $SO_2$ monitored within the LBRuT did not exceed the 15-minute mean objective (not to exceed 266 $\mu g/m^3$ more than 35 times a year).

**Table 8** $SO_2$ monitoring was at the Mobile Air Quality Unit and at NPL - Teddington AURN. Objective limit: 15-minute mean not to exceed 266 $\mu g/m^3$ more than 35 times a year.

| **Mobile Unit** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009*** |
|---|---|---|---|---|---|---|---|---|
| Number of exceedences of 15-minute mean | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **NPL – Teddington AURN** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007*** | | |
| Number of exceedences of 15-minute mean | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Data Capture (%) | 99% | 99% | 96% | 99% | 98% | 65% | | |

**Mobile Unit -** Data for the Mobile have only been ratified up to 2008.
**NPL- Teddington AURN** –all data have been- fully ratified. NPL discontinued monitoring $SO_2$ in 2007.

**Carbon Monoxide (CO)**

The LBRuT continuously monitors for CO at the Mobile Air Quality Unit. Table 9 shows that the CO limit has not been exceeded over the past eight years.

**Table 9** CO monitoring at the Mobile Air Quality Unit. Objective limit: running 8-hour mean not to exceed 10 $mg/m^3$.

| Mobile Unit | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009* |
|---|---|---|---|---|---|---|---|---|
| Number of exceedences of the running 8-hour mean | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*** Mobile Unit – Upper Teddington Rd, Teddington** - Data for the Mobile have only been ratified up to 2008.

### 2.1.2 Non-Automatic Monitoring

**Nitrogen dioxide ($NO_2$) monitoring using diffusion tubes.**

Table 10 shows the $NO_2$ diffusion tube monitoring results, with bias corrected values for each year from 2002 to 2009. The results in **bold** indicate an exceedence of the Air Quality Objective. Most of the $NO_2$ diffusion tubes are located on lamp posts at the kerbside of the road, so that the nearest relevant exposure is residential properties set back between 5 to 10 metres from the kerb. The monitoring site at Holly Lodge in Richmond Park (No. 28) and the static site at Wetlands Centre, Barnes (No. 37) are Background sites, set well away from roads.

The Air Quality Standards Regulations 2007 (OPSI, 2007) came into force in February 2007. This has shifted the objective attainment date from 2005 to 2010. The overall monitoring results for the Borough show that $NO_2$ did exceeded the 2005/2010 objective limit in each year from 2005 - 2009, and the modelling prediction is that it will exceed in 2010 also.

It is widely acknowledged that diffusion tubes can have inaccuracies of up to 20-30%. However, by comparing the diffusion tube data with that from the Borough's more accurate continuous monitors, it is possible to calculate an adjustment factor for the diffusion tubes, and hence end up with a more accurate result. To obtain the adjustment factor for the diffusion tubes, three tubes per month are deployed alongside the continuous monitors. Each month the results from the three tubes are then averaged, and complied into an annual average at the end of the year for comparison with the continuous data.

In accordance with Government Technical Guidance for Local Air Quality Management LAQM.TG (03) (DEFRA, 2003b), a yearly bias adjustment factor has been produced for each year from 2002 to 2009. The bias factor for 2002 is 1.44, 2003 is 1.23, 2004 is 0.97, 2005 is 1.00, 2006 is 1.03, 2007 is 0.97, 2008 is 0.99 and 2009 is 1.00.

**Table 10** Annual concentration in micrograms per cubic metre ($\mu g/m^3$) of $NO_2$, by diffusion tube sampling. The data are ranked using the 2004 data, with the most polluted sites at the top. All the data have been bias adjusted. The two following graphs (Figure 3a and Figure 3b) chart the whole of Table 10, but show it split over two graphs, for greater clarity.
**2009 results (in brackets) indicate the exposure estimate, calculated for the nearest residential façade. These data are then plotted on the map at Figure 5, indicating which ones exceed the objective.**

| Site Code | Location | Site type | Grid references | In AQMA | Relevant exposure (y/n with distance (m) to relevant exposure) | Distance from roadside (metres) | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RUT 02 | George Street, Richmond | Kerbside | 517917, 174928 | Y | Y - for 1 hour mean objective and N - for residential | 0.2 | **94** | **131** | **106** | **118** | **115** | **113** | **112** | **123 (100)** |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (above shops) 2m. | | | | | | | | | |
| 32 | Kings Street, Twickenham | Kerbside | 516226, 173195 | Y | Y - for 1 hour mean objective and N - for residential 3m | 0.2 | **78** | **96** | **84** | **91** | **119** | **109** | **106** | **110 (89)** |
| 36 | Upper Richmond Road West (URRW), Sheen Lane | Kerbside | 520510, 175393 | Y | Y – for 1 hour mean objective and N - for residential 2m | 0.2 | **61** | **87** | **68** | **76** | **81** | **59** | **64** | **61 (61)** |
| 18 | Lower Mortlake Road, Richmond (nr.Trinity Road) | Kerbside | 518822, 175590 | Y | N 15m | 0.2 | **68** | **79** | **65** | **62** | **76** | **58** | **67** | **64 (50)** |
| 39 | Richmond Road, Richmond Bridge, East Twickenham | Kerbside | 515777, 170519 | Y | N 2m | 0.2 | **61** | **73** | **61** | **64** | **73** | **69** | **68** | **73 (67)** |
| 7 | Broad Street, Teddington (Tesco) | Kerbside | 515624, 170975 | Y | Y - for 1 hour mean objective and N - for residential 3m | 0.2 | **55** | **86** | **60** | **68** | **88** | **78** | **66** | **69 (57)** |
| 19 | Kew Road, Kew (nr. Walpole Avenue) | Kerbside | 518637, 176161 | Y | N 30m | 0.2 | **65** | **75** | **57** | **58** | **61** | **55** | **56** | **60 (53)** |
| 31 | A316 | Roadside | 515438, 174048 | Y | N 10m | 1.5 | **57** | **69** | **56** | **61** | **70** | **66** | **62** | **60 (57)** |
| 43 | Hill Street, Richmond | Kerbside | 517771, 174701 | Y | Y - for 1 hour mean objective and N -for residential above shops 3m | 0.2 | **58** | **67** | **54** | **62** | **78** | **58** | **62** | **81 (64)** |
| 42 | The Quadrant, Richmond | Kerbside | 517991, 175075 | Y | Y – for 1 hour mean objective and N -for residential (above shops) 2m | 0.2 | **59** | **74** | **53** | **63** | **73** | **60** | **60** | **60 (59)** |
| 50 | URRW (nr. Clifford Avenue, Sheen) | Kerbside | 519962, 175321 | Y | Y - for 1 hour mean objective and N - for residential 5m | 0.2 | **54** | **70** | **52** | **63** | **67** | **70** | **66** | **69 (55)** |
| 25 | URRW (nr. Sheen School) | Roadside | 521130, 175450 | Y | N - 4m | 0.2 | **55** | **65** | **51** | **45** | **53** | **52** | **45** | **46 (45)** |
| 52 | Clifford Avenue, Chalkers Corner | Kerbside | 519776, 175746 | Y | N - 7m | 0.2 | **60** | **64** | **51** | **55** | **64** | **66** | **67** | **70 (66)** |
| 9 | Hampton Road, Twickenham | Kerbside | 514842, 172346 | Y | N - 10m | 0.2 | **49** | **59** | **51** | **52** | **60** | **56** | **59** | **57 (50)** |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | High Street, Hampton Wick | Kerbside | 517524, 169583 | Y | Y – for 1 hour mean objective and for residential 2m | 1.6 | **48** | **68** | **50** | **54** | **51** | **57** | **56** | **54 (53)** |
| RUT 01 | Civic Centre, York Street, Twickenham | Roadside | 516356, 173365 | Y | Y - for 1 hour mean objective and for residential 0m on building façade | 1.2 | **50** | **62** | **49** | **54** | **64** | **57** | **64** | **62 (62)** |
| 15 | Richmond Road, Twickenham (opp. Marble Hill Park) | Kerbside | 517197, 173939 | Y | N - 5m | 0.2 | **46** | **59** | **49** | **49** | **65** | **46** | **57** | **55 (49)** |
| 22 | Castelnau, Barnes (nr. Hammersmith Bridge) | Kerbside | 522845, 177904 | Y | N - 7m | 0.2 | **46** | **61** | **48** | **61** | **71** | **59** | **66** | **60 (57)** |
| 6 | Kingston Road, Teddington (nr. Woffington Close) | Kerbside | 517266, 170031 | Y | N - 13m | 0.2 | **49** | **52** | **47** | **50** | **50** | **48** | **45** | **47 (40)** |
| 20 | Mortlake Road, Kew (nr. Kent Road) | Kerbside | 519205, 177221 | Y | N - 6m | 0.2 | **50** | **65** | **47** | **49** | **59** | **57** | **57** | **58 (54)** |
| 44 | Sheen Road, Richmond (Shops) | Kerbside | 518458, 175042 | Y | Y – for 1 hour mean objective and N - for residential 3m | 0.2 | **47** | **60** | **46** | **51** | **60** | **56** | **53** | **53 (48)** |
| 33 | Heath Road, Twickenham | Kerbside | 515927, 173129 | Y | Y - for 1 hour mean objective and N - for residential 5m | 0.2 | **48** | **65** | **45** | **50** | **67** | **60** | **65** | **63 (56)** |
| 48 | Stanley Road, Teddington (junc Strathmore Road) | Kerbside | 515059, 171805 | Y | N - 4m | 0.2 | **50** | **51** | **45** | **48** | **57** | **50** | **51** | **52 (49)** |
| 49 | URRW War Memorial, Sheen Lane, Sheen | Kerbside | 520505, 175390 | Y | Y - for 1 hour mean objective and N - for residential 5m | 0.2 | **48** | **61** | **45** | **47** | **60** | **49** | **51** | **49 (49)** |
| 4 | Hampton Road, Teddington (nr. Bushy Park Gardens) | Kerbside | 514882, 171155 | Y | N -17m | 0.2 | **47** | **58** | **45** | **47** | **53** | **47** | **50** | **47 (44)** |
| 1 | Hampton Court Road, Hampton | Roadside | 515824, 168815 | Y | Y - 0m | 1.2 | **43** | **59** | **44** | **48** | **51** | **52** | **55** | **53 (53)** |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | URRW, Sheen (nr. Courtland Estate) | Roadside | 519031, 175021 | Y | N - 4m | 2.5 | **50** | **58** | **44** | **48** | **56** | **48** | **50** | **54 (52)** |
| 13 | Whitton Road, Whitton, (opp. Rugby ground) | Kerbside | 515387, 174146 | Y | N -5m | 0.2 | **42** | **60** | **43** | **44** | **60** | **47** | **54** | **50 (44)** |
| 12 | Hanworth Road, Whitton | Kerbside | 512600, 173404 | Y | N - 10m | 0.5 | **40** | **50** | **43** | **51** | **56** | **53** | **52** | **49 (44)** |
| 16 | St Margarets Road, St Margaret’s (nr. Bridge Road) | Kerbside | 517558, 174408 | Y | N - 4m | 0.2 | **47** | **55** | **43** | **47** | **49** | **46** | **50** | **49 (49)** |
| 45 | High Street, Teddington (post office) | Kerbside | 516260, 171140 | Y | Y - for 1 hour mean objective and N - for residential 3m | 0.2 | **52** | **58** | **43** | **47** | **65** | **54** | **51** | **49 (45)** |
| 3 | Uxbridge Road, Hampton (nr. Arundel Close) | Roadside | 513850, 171040 | Y | N - 8m | 1.2 | **47** | **56** | **43** | **45** | **49** | **45** | **46** | **44 (42)** |
| 21 | Lower Richmond Road, Mortlake (nr. Kingsway) | Roadside | 520053, 175826 | Y | N - 5m | 1.2 | **47** | **55** | **42** | **46** | **56** | **47** | **48** | **47 (46)** |
| 47 | Causeway, Teddington | Kerbside | 515829, 170967 | Y | Y - for 1 hour mean objective and N - for residential 2m | 0.2 | **42** | **48** | **42** | **46** | **54** | **51** | **48** | **47 (42)** |
| 27 | Queens Road, Richmond (nr. Russell Walk) | Roadside | 518745, 174346 | Y | Y -4m | 1.2 | **49** | **56** | **41** | **43** | **52** | **46** | **51** | **46 (46)** |
| 10 | Twickenham Road, Twickenham (opp. Fulwell golf course) | Kerbside | 513278, 172199 | Y | N - 5m | 0.2 | 39 | **52** | **41** | **43** | **53** | **44** | **48** | **45 (41)** |
| 11 | Percy Road, Whitton (nr. Percy Way) | Kerbside | 514050, 173189 | Y | N - 6m | 0.2 | **42** | **54** | **40** | **46** | **53** | **48** | **47** | **50 (43)** |
| 41 | Paradise Road, Richmond | Kerbside | 518102, 174854 | Y | Y - 4m | 0.2 | **45** | **55** | **40** | **49** | **52** | **48** | **56** | **48 (44)** |
| 34 | Thames Street, Hampton | Roadside | 515927, 173129 | Y | N - 8m | 1.6 | 37 | **48** | 39. | **40** | **46** | **44** | **47** | **44 (43)** |
| 40 | Staines Road, Twickenham | Kerbside | 514278, 172521 | Y | N - 10m | 0.2 | **42** | **50** | 39 | **42** | **53** | **41** | **46** | **41 (39)** |
| 29 | Petersham Road, Ham. (nr. Sandy | Kerbside | 517967, 172543 | Y | N - 23m | 0.2 | **44** | **51** | 38 | **42** | **52** | **41** | **49** | **45 (41)** |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lane) | | | | | | | | | | | | | |
| 8 | Strawberry Vale, Teddington (Clive Road) | Kerbside | 516165, 172043 | Y | N - 10m | 0.2 | **41** | **43** | 37 | 39 | **42** | **39** | **37** | 38 (37) |
| 46 | 15 Queen's Road, Teddington | Kerbside | 515522, 170927 | Y | N - 3m | 0.2 | 39 | **53** | 37 | 39 | **44** | **41** | **42** | **47 (42)** |
| 24 | Lonsdale Road, Barnes (nr Suffolk Road) | Kerbside | 521750, 177056 | Y | N - 6m | 0.2 | 39 | **53** | 36 | 39 | **50** | **44** | **45** | **46 (43)** |
| 51 | Sheen Lane (railway crossing), Sheen | Kerbside | 520497, 175790 | Y | N - 10m | 0.2 | **44** | **48** | 36 | 39 | **48** | **40** | **41** | **41 (40)** |
| 38 | Queen's Road, Teddington (Park Road end) | Kerbside | 515777, 170519 | Y | N - 4m | 0.2 | **43** | **50** | 36 | **41** | **45** | 38 | 41 | **40 (36)** |
| 5 | Sandy Lane, Teddington (Shaef Way) | Kerbside | 516391, 170322 | Y | N - 15m | 0.2 | **41** | **47** | 34 | **41** | **44** | 36 | 36 | 37 (34) |
| 23* | Castelnau Library, Barnes (static site) | Roadside | 522502, 177166 | Y | N - 8m | 1.5 | **44** | **45** | 34 | **42** | **49** | **41** | **43** | **43 (42)** |
| 2 | Percy Road, Hampton (nr. Oldfield Road) | Roadside | 513229, 169712 | Y | Y - 2m | 1.2 | 38 | **41** | 33 | 38 | **43** | 35 | 39 | 39 (37) |
| 14 | Cross Deep, Twickenham (nr. Poulett Gardens) | Kerbside | 516133, 173051 | Y | N - 7m | 0.2 | **45** | **58** | 33 | **48** | **58** | **53** | **53** | **54 (50)** |
| 53* | Mobile Air Quality Site | Roadside | 519584, 176495b | Y | N - 5m | | | | 32 | 38 | **52** | 38 | 47 | **41 (41)** |
| 30 | German School Petersham Road | Roadside | 518003, 173233 | Y | Y – 0.5m | 2 | **43** | **44** | 32 | 38 | 35 | 39 | 43 | **41 (44)** |
| RUT 04 | Elmfield House, Waldegrave Road, Teddington | Urban background | 515916, 171118 | Y | Y- closer to road than tube | 15 | 30 | 37 | 30 | 30 | 30 | 30 | 32 | 30 |
| RUT 03 | Alexandra Hall, Cromwell Place, Mortlake | Urban background | 520348, 175849 | Y | Y - 5m | 50 | 38 | **42** | 31 | 33 | 31 | 30 | 36 | 32 |
| 17 | Parkshot, Richmond (Court) | Urban background | 517916, 175257 | Y | N - tube in car park to be re-sited | 150 | 34 | 35 | 27 | 30 | **41** | 30 | 32 | 31 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37* | Wetlands Centre, Barnes (static site) | Urban Background | 522989, 176727 | Y | Y – 1 hour mean objective - children in play area/people attending Wetlands Centre | 590 | 35. | 32 | 26 | 29 | 36 | 31 | 29 | 28 |
| 28 | Holly Lodge, Richmond Park | Urban background | 519467, 173993 | Y | Y - for 1 hour mean objective | 300 | 32 | 29 | 23 | 24 | 32 | 27 | 25 | 23 |

* location of triplicate diffusion tubes

Results (in brackets) indicate the calculated exposure at the nearest residential façade. Relevant background concentrations, required for the distance calculation, were assessed from the 2010 ERG modelling maps.

Data for the two Mortlake monitoring sites (54 & 55) have not been included here, as sampling at these locations was not operational in 2004 and so could not be ranked. Data for the two sites are presented in Table 15.

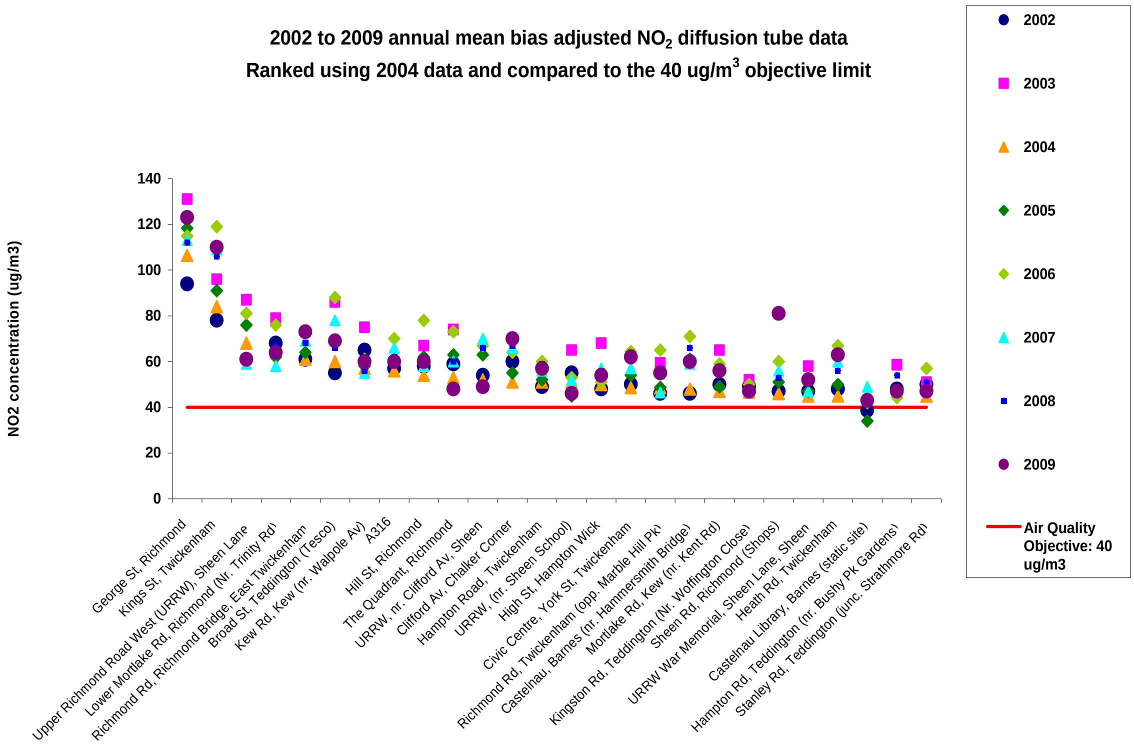



***Figure 3a:*** *Graph comparing $NO_2$ diffusion tube annual means from 2002 to 2009 (first of two graphs – showing the **higher** concentrations).*

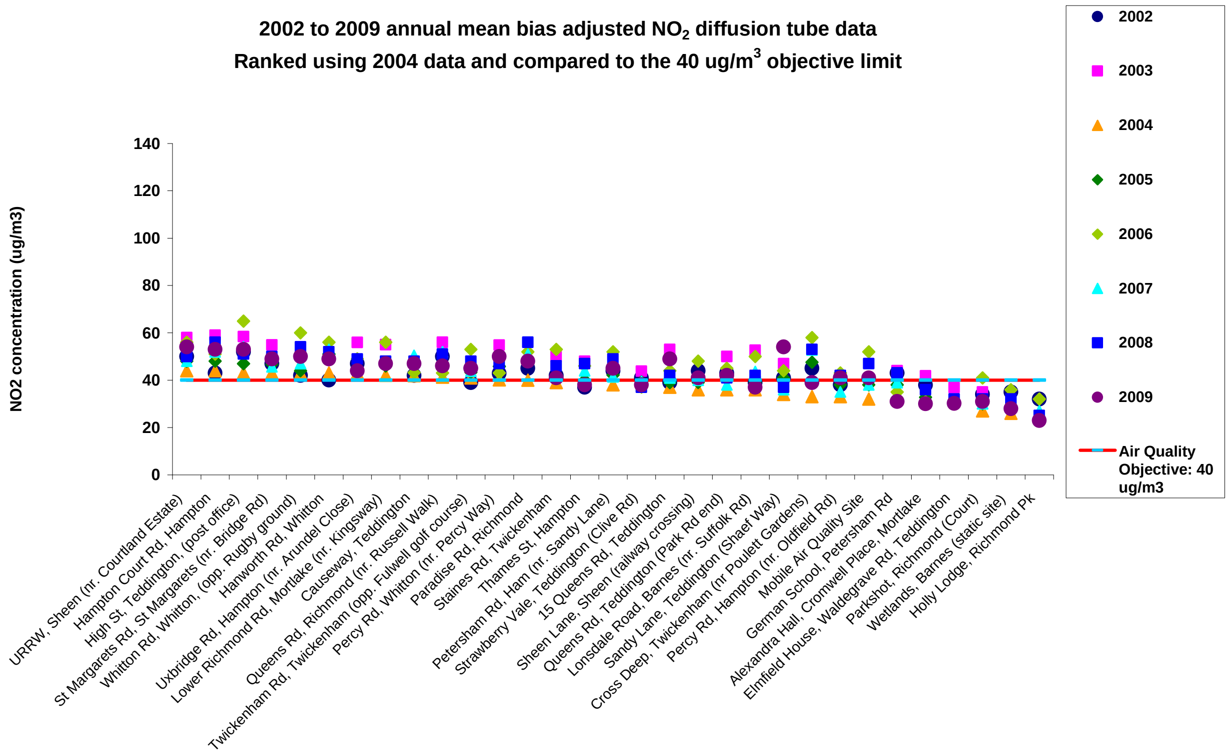



***Figure 3b:*** *Graph comparing $NO_2$ diffusion tube annual means from 2002 to 2009 (second of two graphs – showing the **lower** concentrations).*

From the diffusion tube results in Table 10 and Figures 3a & 3b, we can see that 2003 was the worst of the eight years. 2002 and 2004 were similar, with some improvements showing in 2004. However the

2006, 2007, 2008 and 2009 results show that there was an increase in $NO_2$ concentrations, with as many sites failing the Air Quality Objective as in 2003. Both in 2003 and 2006 only four sites met the Air Quality Objective of 40 $\mu g/m^3$.

Figure 4 shows the long-term trends at just 4 sites in the Borough. These sites were part of a long-term nation-wide monitoring programme and the data pre 2002 have not been bias adjusted, so caution is needed when making comparisons with bias adjusted data. After relatively lower concentrations in 2000/2001, all the sites have demonstrated increases in $NO_{2.}$ The highest recorded exposure was at George Street (RUT 02), with a bias corrected result of 133 $\mu g/m^3$ in 2003. However, 2003 was a year which experienced higher pollution levels, due to the meteorological conditions that year.

**Table 11** Annual mean $NO_2$ diffusion tube sampling from 1993 to 2009 in $\mu g/m^3$ (bias corrected from 2002 onwards.

| | Twickenham (RUT01) | Richmond (RUT02)* | Mortlake (RUT03) | Teddington (RUT04) |
|---|---|---|---|---|
| **1993** | 39 | 39 | 33 | 29 |
| **1994** | 46 | 39 | 32 | 33 |
| **1995** | 43 | 41 | 30 | 30 |
| **1996** | 42 | 37 | 29 | 32 |
| **1997** | 37 | 37 | 25 | 29 |
| **1998** | 40 | 35 | 25 | 25 |
| **1999** | 38 | 34 | 27 | 28 |
| **2000** | 35 | 29 | 34 | 25 |
| **2001** | 38 | 52* | 24 | 18 |
| **2002** | 50 | 94 | 38 | 30 |
| **2003** | 63 | 133 | 42 | 37 |
| **2004** | 65 | 119 | 42 | 44 |
| **2005** | 54 | 118 | 34 | 32 |
| **2006** | 66 | 117 | 35 | 35 |
| **2007** | 58 | 116 | 35 | 35 |
| **2008** | 64 | 112 | 36 | 32 |
| **2009** | 62 | 123 | 31 | 30 |

* In 2001 the diffusion tube at RUT 02 moved from Paradise Road, Richmond to George Street, Richmond.

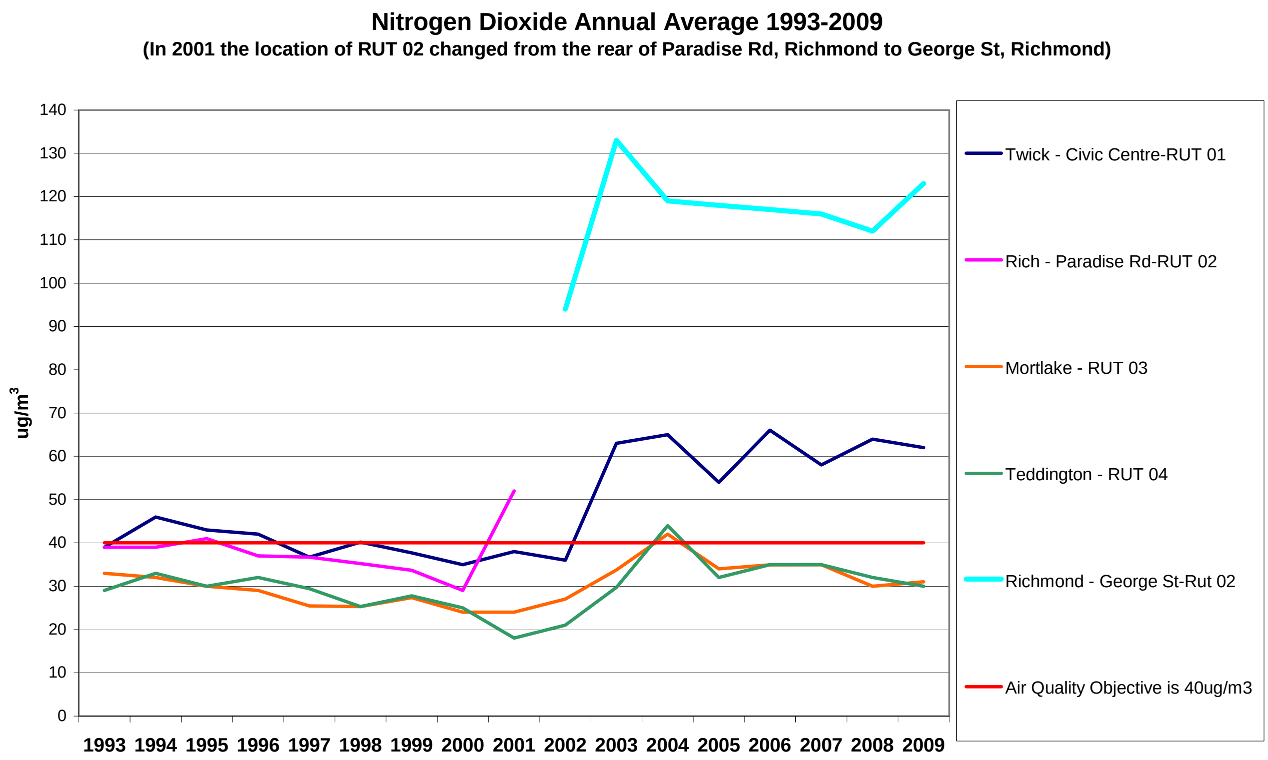



***Figure 4:*** *Annual mean $NO_2$ from 1993 to 2009 (Chart of Table 2 data. Bias corrected from 2002 onwards, because there was no bias correction data available for the earlier years). Note: the Richmond site moved from Paradise Road to George Street in 2001. The higher concentrations from 2002 demonstrate the impact of the much heavier local traffic movements at the new site.*

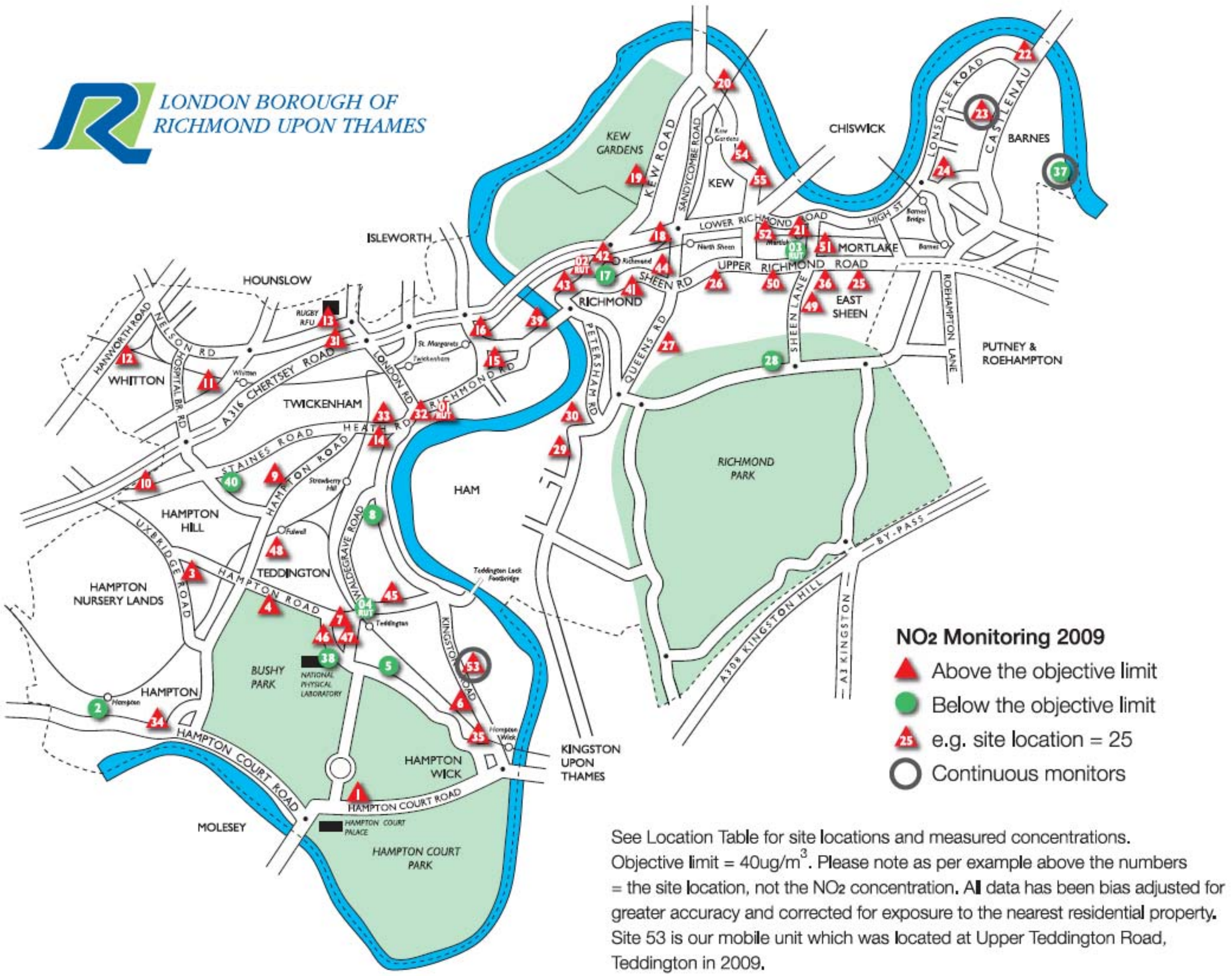



***Figure 5:*** *Map showing the location of the $NO_2$ diffusion tubes and the continuous monitors in 2009. The results have been adjusted to show the estimated concentration at the nearest sensitive receptor.*

The following table compares $NO_2$ annual averages from 2002 to 2009 for both diffusion tubes and the continuous analysers, located at the same sites.

**Table 12** comparison of collocated diffusion tube and continuous analyser results

| **Castelnau** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|
| Continuous analysers | **44** | **48** | **41** | **42** | **42** | **43** | **44** | **45** |
| Diffusion tubes | **44** | **45** | 34 | **42** | **49** | **41** | **43** | **43** |
| **Wetlands** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Continuous analysers | 32 | 37 | 31 | 30 | 30 | 31 | 29 | 29 |
| Diffusion tubes | 35 | 32 | 26 | 29 | 36 | 31 | 29 | 28 |
| **Mobile** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| Continuous analysers | | | | | | 38 | **42** | **40** |
| Diffusion tubes | | | | | | 38 | **47** | **41** |

Figures in bold indicate an exceedence of the $NO_2$ air quality objective of 40ug/m3

The results show, with a few exceptions, that the results from the diffusion tube data are similar to the continuous analyser data. There is one year when there is a significant difference between the diffusion tube data and the continuous analyser data. At Castelnau in 2004 the diffusion tube data are below the AQO while the continuous data are above.

There are four other results that differ by 5ug/m$^3$ or more, Castelnau in 2006, Wetlands in 2003 and 2006 and the Mobile in 2008.

### Benzene ($C_6H_6$)

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, George St, Richmond, Broad St, Teddington, King St, Twickenham, High St, Hampton Wick and Upper Richmond Road West / Sheen Lane where $NO_2$ diffusion tubes are also deployed. The locations are shown in Table 13 below and on the map at Figure 5. Table 13 demonstrates that the benzene objective has been met in LBRuT for the past 7 years. Figure 6 also demonstrates the general downward trend over the years. Measurements of TEX species ceased in March 2009, with just the Benzene measurements 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. .

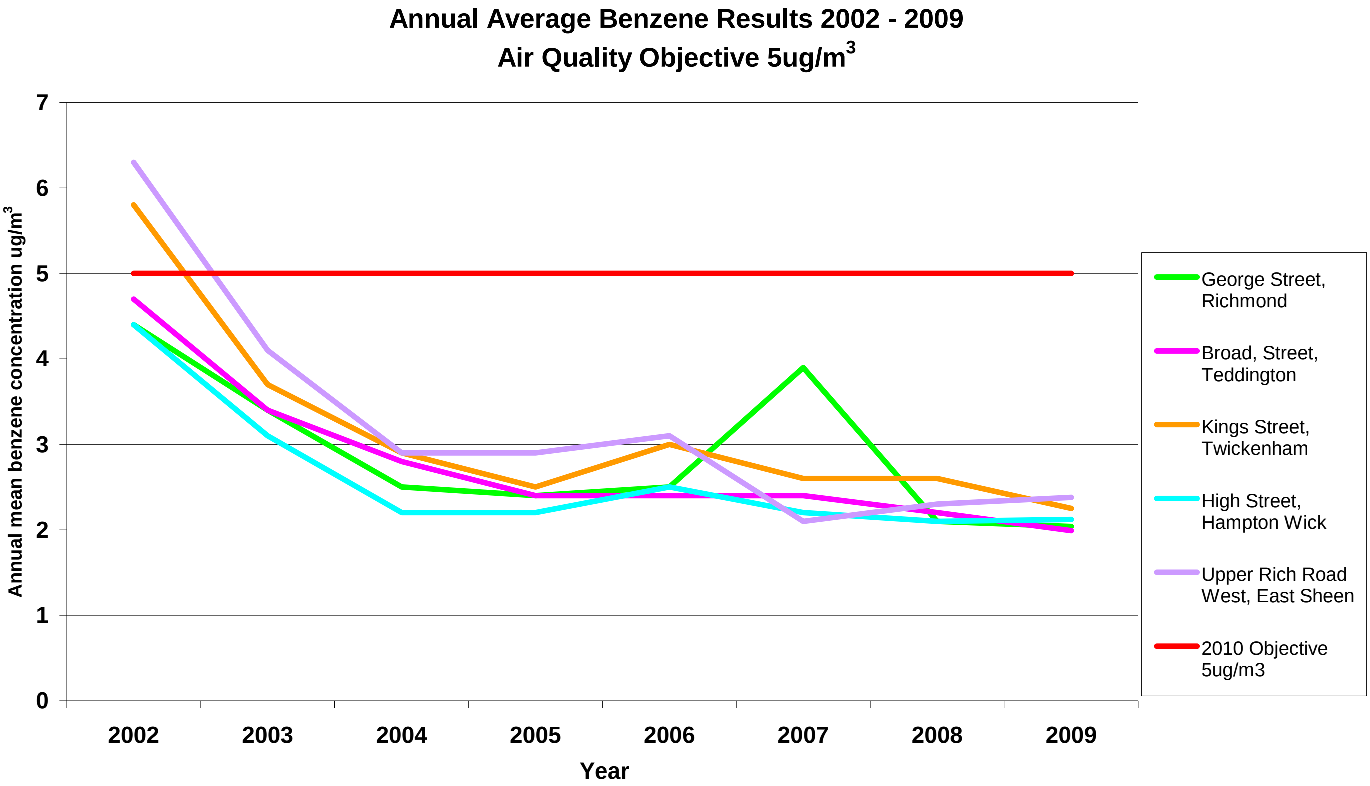
## Table 13 – Annual mean benzene levels from 2002 to 2009

| **Site ID** | **Location** | **Within AQMA?** | **Proportion of the year with valid data 2009 %** | **Annual Mean (ug/m$^3$)** Air Quality Objective 5ug/m$^3$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| **RUT 02** | **George St** | **N** | **100** | 4.4 | 3.4 | 2.5 | 2.4 | 2.5[a] | 2.2 | 2.1 | 2.0 |
| **7** | **Broad St** | **N** | **100** | 4.7 | 3.4[a] | 2.8 | 2.4 | 2.4 | 2.4[a] | 2.2[a] | 1.99 |
| **32** | **King St,** | **N** | **100** | **5.4** | 3.7 | 2.9[a] | 2.5 | 3.0 | 2.6 | 2.6 | 2.2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Twickenham** | | | | | | | | | | |
| **35** | **High St, Hampton Wick** | **N** | **100** | 4.3 | 2.1 | 2.2[a] | 2.2 | 2.5 | 2.2 | 2.1 | 2.1 |
| **36** | **URRW/Sheen Lane** | **N** | **100** | **5.6** | 4.1 | 2.9 | 2.9 | 3.1 | 2.3 | 2.3 | 2.4 |

[a] data capture less than 75%, so these annual average results need to be treated with caution

## Figure 6 Annual mean benzene from 2002 to 2009



## 2.2 Comparison of Monitoring Results with Air Quality Objectives

The following sections provide the LBRuT monitoring results for 2002 to 2009 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 $PM_{10}$ particle objectives were not adopted (Defra, 2003).

$NO_2$ measurements at the roadside Richmond 1 Castelnau automatic monitoring site consistently exceeded the annual mean $NO_2$ objective of 40 $\mu g/m^3$ by 1 to 4 $\mu g/m^3$. In 2003, the continuous monitoring 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). The annual mean $NO_2$ concentration (as estimated for the nearest residential receptor to Richmond 1 Castelnau) exceeded the annual objective from 2002 to 2009. 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). Although the distance from the monitor to a receptor, at any specific monitoring location, would normally result in a fall off in concentration, the monitoring data can still be used to represent receptors nearer to the source in other parts of the Borough. So the roadside monitors do still provides meaningful data, to test for compliance.

Annual means for the Richmond Mobile deployments can only be determined from 2007 onwards, when the Mobile started to be deployed at each site for a full calendar year. When the Mobile was deployed at Mortlake Road, Kew, in 2008, the continuous monitoring annual mean $NO_2$ objective was exceeded by 2$\mu g/m^{3.}$ When the mobile was deployed at Upper Teddington Road, Teddington, in 2009, the annual mean was the same as the air quality objective of 40 $\mu g/m^3$.

At the two background sites, Richmond 2 Barnes Wetlands and NPL Teddington (AURN), there were no exceedences of the annual mean $NO_2$ objective between 2002 and 2009.

The percentage of $NO_2$ diffusion tube sites exceeding the annual mean $NO_2$ objective went from 79% (45 of 57) in 2006, 86% (51 of 59) in 2008 and 83% (49 of 59) in 2009. The majority of sites were expected to exceed the annual mean objective because many are worst-case kerbside and roadsides sites. However, when calculated for the building façades, at a greater distance from the road, only 2 sites changed from above the objective to below the objective (2009 data, Table 10). This demonstrates that $NO_2$ remains an issue across the Borough, at locations where people will breathe it in. 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 $\mu g/m^3$, (see Table 3).

Table 15 shows that there were 16 $NO_2$ diffusion tube sites which had an annual mean >60 $\mu g/m^3$ indicating that the hourly mean could also have been exceeded. Table 10 indicates that at 9 sites, there was relevant population exposure for the short term 1-hour mean objective. Example locations are 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. Note that Table 15 does not give façade/receptor values, using the distance calculator. For those data, see Table 10.

The annual mean PM10 was not exceeded at any monitoring site during the last eight years (Table 5). The daily mean PM10 objective was only exceeded at the Richmond Mobile Monitoring Unit during 2003 (worst case year) when assessed across 3 sites (Table 5a). As discussed in Section 1.4 the whole borough is an AQMA for PM10, so the one recorded exceedence in 2003 falls in the AQMA.

CO, $SO_2$ and benzene concentrations in the Borough met the relevant objectives. (Tables 8, 9 & 13). 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.

Ozone is not a LAQM pollutant because of its regional nature. However, there is a UK Air Quality Strategy ozone objective which has been breached in LBRuT over the past 7 years at the, Richmond 2 Barnes Wetlands, and over the last 8 years at Teddington (AURN), and also at Richmond Mobile roadside sites in 2002, 2003 and 2006 (worst-case air pollution years) (Tables 7 & 7a).

### 2.2.1 Nitrogen Dioxide

$NO_2$ is measured across the Borough at four automatic monitoring stations and 59 diffusion tube sites. Table 3 (for continuous monitoring data) shows that the annual mean $NO_2$ objective has been consistently exceeded at the Richmond 1 Castelnau automatic monitoring site for the years 2002 - 2009. The monitor is 1.5m from the kerb, whereas the closest residential building façade is 8m. When the distance calculator is used, the monitored concentration of 45ug/m3 (2009) is then estimated at the nearest residential receptor to be 45ug/$m^3$. i.e. still over the limit at the sensitive receptor. When the same calculation is carried out for the diffusions tubes at the same site, the monitored concentration of 43ug/m3 (2009) is then estimated at the nearest residential receptor to be 42ug/$m^{3.}$ We would normally expect a drop in concentration away from the road but this location has a high background concentration at the building façade, so it did not reduce much. Relevant background concentrations, required for the distance calculation, were assessed from the 2010 ERG modelling maps.

Table 10 (for diffusion tube data) shows that the annual mean $NO_2$ objective was exceeded by 7$\mu$g/$m^3$ in 2008 for the Richmond Mobile when it was deployed at Mortlake Road. At the same site, the continuous data gave an exceedence of 2$\mu$g/$m^3$. When the mobile was at Upper Teddington Rd, Teddington (2009), the diffusion tubes exceeded the objective by 1 $\mu g$/$m^3$ and the continuous monitor result was exactly on the objective limit of 40 $\mu$g/m3. 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 2009 there were no exceedences of the annual mean $NO_2$ objective recorded at the two background sites, Richmond 2 Barnes, Wetlands and Teddington (AURN).

Table 3 shows that no automatic monitoring sites recorded more than the limit of 18, 1-hour means above 200 $\mu$g/m3 or where the period of valid data was less than 90% of a full year, such as 2002 and 2006 for Richmond 2 Wetlands Table 3 shows that the 99.8th percentile of 1-hour mean concentrations did not exceed 200 $\mu$g/m3 in those years. 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). The number of hourly mean, above 200 $\mu g$/$m^3$ was greatest at the roadside Richmond 1 Castelnau site, as expected, because of the proximity to road transport sources of $NO_2$. In 2009 there were 3 exceedences of the hourly mean limit.

Table 10 shows that the 2009 annual mean $NO_2$ objective of 40 $\mu$g/m3 was exceeded at 49 of the 57 diffusion tube sites. At 52 of the monitoring sites we need to use a distance correction factor. This is because the tubes are not always located where people would be for the right length of time, for either the long or short -term objectives. The distance correction procedure is relevant to estimate for facades of residential buildings and also to non-residential buildings, such as libraries, offices or schools, where occupants may be exposed to >60 $\mu g$/$m^3$ for over one hour.

Table 10 shows that 46 sites were predicted to exceed the annual mean objective of 40 $\mu$g/m3, when calculated for the building façade. At 15 of these sites the annual mean actually exceeds 60 $\mu$g/m3, indicating that the 1-hour objective limit might also have been exceeded, as monitored at the monitoring location. Of these 15 sites, 6 are then estimated to exceed the 1-hour objective limit, when calculated at the relevant distance, for exposure to people. These vulnerable receptor sites include residential properties and all locations where people may spend more than one hour, either working in an office or at high street locations where the public may spend an hour shopping or sitting 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).

Automatic Monitoring Data

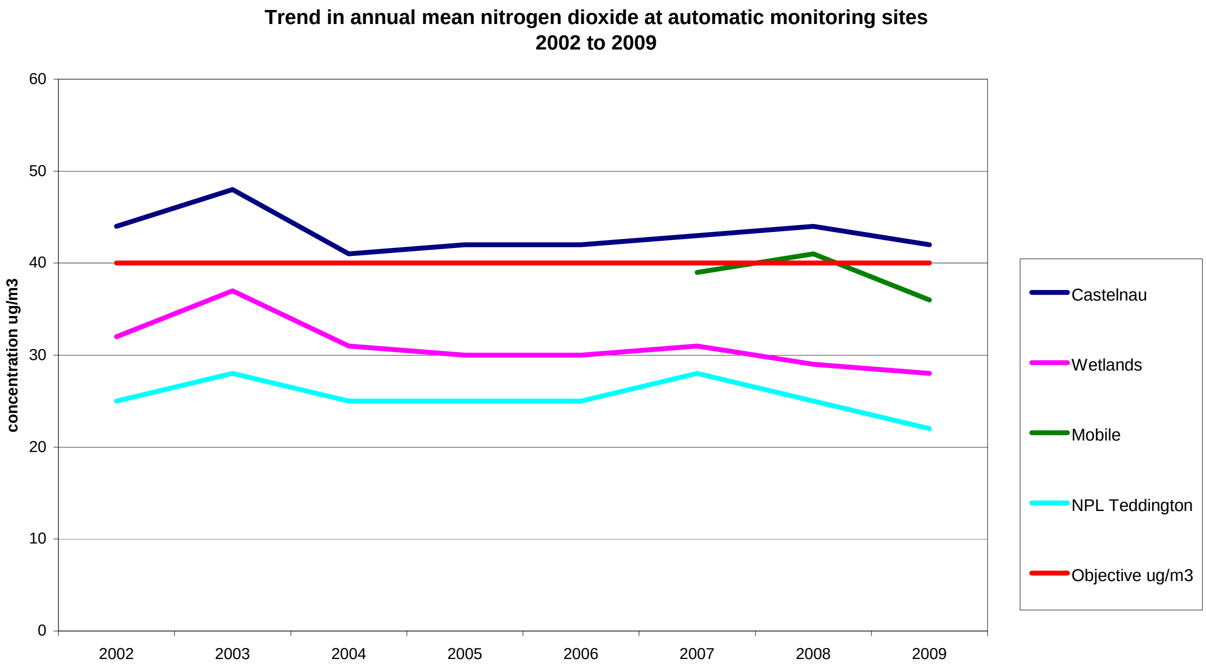
The $NO_2$ results from the four automatic monitoring stations are presented in Table 14a (annual mean objective) and Table 14b (1 hour mean objective). Exceedences of the NO2 objectives are highlighted in **bold**. Table 14b shows the 99.8$^{th}$ percentile of the hourly means when the valid data for the year are less than 90%. The NPL 2009 result of 109$\mu$g/$m^3$ (in brackets) indicates compliance, as it is under the limit of 200 $\mu$g/$m^3$.

## Table 14a Results of Automatic Monitoring for Nitrogen Dioxide: Comparison of annual mean with the Objective limit.

| Site ID | Location | Within AQMA ? | Data Capture for full calendar year 2009 [a] % | Annual mean concentrations (μg/m³) Air Quality Objective 40ug/m³ | | |
|---|---|---|---|---|---|---|
| | | | | 2007 [b] | 2008 [b] | 2009 |
| RI1[c] | Castelnau | Y | 98 | **43** | **44** | **45** |
| RI2[d] | Wetlands, Barnes | Y | 99 | 31 | 29 | 29 |
| Mobile[e] | Upper Teddington Rd | Y | 95 | 38 | **42** | **40** |
| TD0[f] | NPL, Teddington | Y | 82 | 28 | 25 | 22 |

[a] Data capture from the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%.)
[b] 2007 & 2008 included for comparison
[c] Richmond 1 – all data have been fully ratified.
[d] Richmond 2 – all data have been fully ratified
[e] Richmond Mobile Upper Teddington Rd (2009) – data have only been fully ratified up to 2008
[f] Teddington (AURN) NPL – all data fully ratified
Figures in bold indicate an exceedence of the air quality objective

## Figure 7 Trends in Annual Mean Nitrogen Dioxide Concentration Measured at Automatic Monitoring Sites (graph includes data from Table 14a)




There is no annual average data from the mobile unit prior to 2007 as the mobile was historically moved to more than one location in a year.

### Table 14b Results of Automatic Monitoring for Nitrogen Dioxide: Comparison of 1-hour mean with the 1hr Objective limit.

| Site ID | Location | Within AQMA? | Data Capture for full calendar year 2009 [a] % | Number of Exceedences of hourly mean (200 μg/m$^3$) which should not be exceeded more than 18 times per annum. If the period of valid data is less than 90% of a full year, include the 99.8$^{th}$ percentile of hourly means in brackets. | | |
|---|---|---|---|---|---|---|
| | | | | 2007 | 2008 | 2009 |
| RI1[b] | Caselnau | Y | 100 | 7 | 9 | 3 |
| RI2[c] | Wetlands, Barnes | Y | 99 | 0 | 1 | 0 |
| Mobile[d] | | Y | 95 | 0 | 0 | 0 |
| TD0[e] | NPL, Teddington | Y | 81[f] | 0 | 0 | 0 (109) |

[a] Data capture from the full calendar year
[b] Richmond 1 – all data have been fully ratified
[c] Richmond 2 – all data have been fully ratified
[d] Richmond Mobile Upper Teddington Rd (2009) – data have only been fully ratified up to 2008
[e] Teddington (AURN) NPL – all data have been fully ratified
[f] 99.8%ile equals 109 ug/m3 (calculated, as data capture less than 90%) i.e. it complies with the 200ug/m3 99.8%ile limit

## Diffusion Tube Monitoring Data

Table 15 shows a comparison of the 2008 and 2009 diffusion tube monitoring results. Exceedences of the annual mean $NO_2$ objective are highlighted in **bold**. Concentrations > 60µg/m$^3$ are underlined, to indicate that the hourly objective may also have been exceeded (as estimated from the annual mean).

### Table 15 Results of Nitrogen Dioxide Diffusion Tubes (in site number order)

| Site ID | Location | Within AQMA? | Data Capture for full calendar year 2009[a] % | 2008[b] | 2009[c] |
|---|---|---|---|---|---|
| 1 | Hampton Court Rd, Hampton | Y | 92 | **55** | **53** |
| 2 | Percy Rd, Hampton (nr. Oldfield Rd) | Y | 100 | 39 | 39 |
| 3 | Uxbridge Rd, Hampton (nr. Arundel Close) | Y | 100 | **51** | **49** |
| 4 | Hampton Rd, Teddington (nr Bushy park Gardens) | Y | 100 | **50** | **47** |
| 5 | Sandy Lane, Teddington (Shaef Way) | Y | 100 | 36 | 37 |
| 6 | Kingston Rd, Teddington (nr. Woffington Close) | Y | 100 | **45** | **47** |
| 7 | Broad St, Teddington (nr. Tesco) | Y | 100 | **66** | **<u>69</u>** |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Strawberry Vale, Teddington (Clive Rd) | Y | 100 | 37 | 38 |
| 9 | Hampton Rd, Twickenham | Y | 100 | **59** | **57** |
| 10 | Twickenham Rd, Twickenham (opposite Fulwell Golf Course) | Y | 100 | **48** | **45** |
| 11 | Percy Rd, Whitton (nr Percy Way) | Y | 100 | **47** | **50** |
| 12 | Hanworth Rd, Whitton | Y | 100 | **52** | **49** |
| 13 | Whitton Rd, Whitton (oppo rugby ground) | Y | 100 | **54** | **50** |
| 14 | Cross Deep, Twickenham | Y | 92 | **53** | **54** |
| 15 | Richmond Rd, Twickenham (oppo Marble Hill Park) | Y | 100 | **57** | **55** |
| 16 | St Margaret's Rd, St Margaret's (nr. Bridge Rd) | Y | 100 | **50** | **49** |
| 17 | Parkshot, Richmond (court) | Y | 100 | 32 | 31 |
| 18 | Lower Mortlake Rd, Richmond (nr Trinity Rd) | Y | 100 | **67** | **64** |
| 19 | Kew Rd, Kew (nr. Walpole Avenue) | Y | 100 | **56** | **60** |
| 20 | Mortlake Rd, Kew | Y | 92 | **57** | **58** |
| 21 | Lower Mortlake Rd, Mortlake (nr. Kingsway) | Y | 100 | **48** | **47** |
| 22 | Castelnau, Barnes (nr. Hammersmith Bridge) | Y | 100 | **66** | **60** |
| 23[d] | Castelnau Library, Barnes (static site) | Y | 100 | **43** | **43** |
| 24 | Lonsdale Rd, Barnes (nr. Suffolk Rd) | Y | 100 | **45** | **46** |
| 25 | URRW (nr Sheen School) | Y | 100 | **45** | **46** |
| 26 | URRW, Sheen (nr Courtland Estate) | Y | 100 | **50** | **54** |
| 27 | Queens Rd, Richmond (nr Russell Walk) | Y | 100 | **51** | **46** |
| 28 | Holly Lodge, Richmond | Y | 100 | 25 | 23 |
| 29 | Petersham Rd, Ham (nr Sandy Lane) | Y | 100 | **49** | **45** |
| 30 | German School, Petersham Rd | Y | 100 | **43** | **41** |
| 31 | A316 | Y | 100 | **62** | **60** |
| 32 | Kings Rd, Twickenham | Y | 100 | **106** | **110** |
| 33 | Heath Rd, Twickenham | Y | 100 | **65** | **63** |
| 34 | Thames St, Hampton | Y | 100 | **47** | **44** |
| 35 | High ST, Hampton Wick | Y | 100 | **56** | **54** |
| 36 | URRW, Sheen Lane | Y | 92 | **64** | **61** |
| 37[d] | Wetlands, Barnes (static site) | Y | 100 | 29 | 28 |
| 38 | Queens Rd, Teddington (Park Rd end) | Y | 100 | **41** | **40** |
| 39 | Richmond Rd, Richmond Bridge, East Twickenham | Y | 100 | **68** | **73** |
| 40 | Staines Rd, Twickenham | Y | 92 | **46** | **41** |
| 41 | Paradise Rd, Richmond | Y | 100 | **56** | **48** |
| 42 | The Quadrant, Richmond | Y | 92 | **60** | **60** |

| | | | | | |
|---|---|---|---|---|---|
| 43 | Hill St, Richmond | Y | 92 | **62** | **<u>81</u>** |
| 44 | Sheen Rd, Richmond (shops) | Y | 100 | **53** | **53** |
| 45 | High St, Teddington (nr post office) | Y | 100 | **51** | **49** |
| 46 | 15 Queens Rd, Teddington | Y | 100 | **42** | **47** |
| 47 | Causeway, Teddington | Y | 100 | **48** | **47** |
| 48 | Stanley Rd, Teddington (junc Strathmore Rd) | Y | 100 | **51** | **52** |
| 49 | URRW War Memorial, Sheen Lane, Sheen | Y | 100 | **51** | **49** |
| 50 | URRW, nr Clifford Ave, Sheen | Y | 100 | **66** | **<u>69</u>** |
| 51 | Sheen Lane, Sheen (railway crossing) | Y | 100 | **41** | **41** |
| 52 | Clifford Ave, Chalkers Corner | Y | 92 | **67** | **<u>70</u>** |
| 53[d] | Mobile Air Quality Site | Y | 100 | **47** | **41** |
| 54 | Mortlake Rd, adjacent to West Hall Rd, Kew | Y | 100 | **60** | **<u>62</u>** |
| 55 | Mortlake Rd, adjacent to cemetery gates, Kew | Y | 100 | **58** | **56** |
| RUT01 | Civic Centre, York St, Twickenham | Y | 92 | **64** | **<u>62</u>** |
| RUT 02 | George St, Richmond | Y | 100 | **112** | **<u>123</u>** |
| RUT 03 | Alexander Hall, Cromwell Place, Mortlake | Y | 100 | 36 | 32 |
| RUT 04 | Elmfied House, Waldergrave Road, Teddington | Y | 100 | 32 | 30 |

[a] Data capture for the full calendar year (e.g. if monitoring was carried out for six months the maximum data capture for the full calendar year would be 50%.)
[b] the bias adjustment for 2008 is 0.99
[c] the bias adjustment for 2009 is 1.00
[d] the result given is the mean from the three tubes exposed together

Table 15 does not show the distance correction to the nearest façade. Those data are given in Table 10.

### 2.2.2 $PM_{10}$

PM10 is measured by TEOM at three automatic monitoring stations in the LBRuT, these results are presented in Tables 16a and 16b. If there were any exceedences of the PM10 objectives they would be highlighted in **bold.** Table 16b show that, when the period of valid data was less than 90% of a full year (in 2008), the 90th percentile of the 24- hour mean is given in brackets.

The PM10 monitoring results in Table 16a show that annual mean and the daily mean PM10 was not exceeded at any site during the last three years.

### Table 16a Results of PM10 Automatic Monitoring: Comparison with Annual Mean Objective

| Site ID | Location | Within AQMA? | Data Capture for full calendar year 2009 [a] % | Annual mean concentrations ($\mu g/m^3$) Air Quality Objective 40ug/m$^3$ | | |
|---|---|---|---|---|---|---|
| | | | | 2007 | 2008 | 2009 |
| RI1[c] | Castelnau | Y | 95 | 20 | 21 | 21 |
| RI2[c] | Wetlands, Barnes | Y | 100 | 23 | 19 | 20 |
| Mobile[b] | Richmond Mobile | Y | 94 | 23 | 25 | 23 |

[a] Data capture for the full calendar year
[b] Mobile data have only been fully ratified up to 2008
[c] Data for Castelnau and Wetlands are fully ratified for 2009.
TEOM data presented as reference equivalent *(VCM corrected TEOM)* (Defra, 2009d). 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.

### Table 16b Results of $PM_{10}$ Automatic Monitoring: Comparison with 24-hour Mean Objective

| Site ID | Location | Within AQMA? | Data Capture 2009 [a] % | **Number of Exceedences of daily mean objective (50 $\mu g/m^3$) not to be exceeded more than 35 times per annum.** If data capture < 90%, include the 90th percentile of daily means in brackets. | | |
|---|---|---|---|---|---|---|
| | | | | 2007[e] | 2008[e] | 2009[e] |
| RI1[c] | Castelnau | Y | 98 | 21 | 12 | 4 |
| RI2[c] | Wetlands, Barnes | Y | 98 | 19 | 8 | 5 |
| Mobile[b] | Richmond Mobile | Y | 94 | 22 | 11[d] (41) | 5 |

[a] Data capture for the full calendar year
[b] Mobile data have only been fully ratified up to 2008.
[c] 2009 Data for Castelnau and Wetlands are fully ratified.
[d] Data capture less than 90%, so the percentile given in brackets for 2008 indicates that the objective was probably not exceeded.
[e] all TEOM data are VCM corrected.

The Wetlands site is a background site so there is no local residential exposure.

### 2.2.3 Sulphur Dioxide

$SO_2$ was measured at one automatic monitoring station in the LBRuT, at the Richmond Mobile. Table 17 demonstrates that the $SO_2$ objectives were met in 2009, at the roadside monitoring site in Upper Teddington Road, Teddington.

**Table 17 2009 Results of $SO_2$ Automatic Monitoring: Comparison with Objectives**

| Site ID | Location | Within AQMA? | Data Capture 2009 [a] % | Number of Exceedences of: (μg/m³) 15-minute Objective (266 μg/m³) | 1-hour Objective (350 μg/m³) | 24-hour Objective (125 μg/m³) |
|---|---|---|---|---|---|---|
| RI1[b] | Richmond Mobile | Y | 94 | 0 | 0 | 0 |

[a] Data capture for the full calendar year
[b] Mobile data have only been fully ratified up to 2008.

The 15 minute objective is most relevant to public exposure, for the Teddington roadside site.

### 2.2.4 Benzene

LBRuT measured benzene at 5 town centre locations:- Broad Street (Teddington); Kings Street (Twickenham); High Street (Hampton Wick); URRW (Sheen Lane); George Street (Richmond). Table 18 demonstrates that the benzene objective was met across LBRuT in 2009.

**Table 18 Results of benzene monitoring in 2009**

| Site ID | Location | Within AQMA? | Proportion of year with valid data in 2009 % | 2009 μg/m³ (2010 Objective 5*u*g/m3) |
|---|---|---|---|---|
| 7 | Broad St, Teddington (Tesco) | Y | 100 | 1.99 |
| 32 | King St, Twickenham | Y | 100 | 2.25 |
| 35 | High St, Hampton Wick | Y | 100 | 2.12 |
| 36 | URRW, Sheen Lane | Y | 100 | 2.38 |
| RUT 02 | George St, Richmond | Y | 100 | 2.04 |

All the sites are representative of relevant public exposure

### 2.2.5 Other pollutants monitored

Ozone is measured at three of the four automatic monitoring stations in the LBRuT, ie Richmond 2 Wetlands in Barnes, 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.

Table 19 shows that, in 2009, the UK Air Quality Strategy ozone objective was breached in LBRuT at the background sites, Richmond 2 Barnes Wetlands and Teddington (AURN) but not at the Mobile monitor, when it was at a more polluted roadside site, in the Upper Teddington Road, Teddington.

Exceedences of the ozone objectives are highlighted in **bold**. In 2009, the 14 exceedences of the running 8-hour objective at the Wetlands site and 20 exceedences at the NPL site. The UK objective for protection of human health for ozone is 100$\mu g/m^3$. 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 19 Results of 2009 ozone monitoring**

| **Location** | **Proportion of the year with valid data 2009 %** | **Number of exceedence of the 8 hour running mean (100$ug/m^3$)** |
|---|---|---|
| Wetlands, Barnes | 98 | **14** |
| Richmond Mobile | 95 | 2 |
| NPL (AURN), Teddington | 99 | **20** |

## Summary of Compliance with AQS Objectives

The London Borough of Richmond upon Thames has examined the results from monitoring in the Borough. The results show that concentrations of PM10, CO, $SO_2$ and benzene were below the relevant objective values. $NO_2$ concentrations exceeded the objectives at a number of location across the borough and the latest modelling for 2010 (LAEI, 2004, with worst case 2003 met year and LEZ) confirms that there is still a need for the LBRuT to be designated as a borough-wide AQMA for $NO_2$. The position with PM10 designation is more borderline, with exceedences at vulnerable receptors still possible at some vulnerable receptor locations (as indicated by modelling). It therefore seems sensible to retain the boroughwide AQMA designation for the present, to accommodate a poor meteorological year, rather than revoke the designation just yet.

# 3 New Local Developments

The London Borough of Richmond confirms that there are no new/ newly identified road traffic sources that will have an impact on air quality.

## 3.1 Road Traffic Sources

**Narrow congested streets with residential properties close to the kerb**

LBRuT confirm that there are no new/ newly identified congested streets with residential properties close to the kerb

**Busy Streets where people may spend one hour or more close to traffic.**

LBRuT confirm that there are no new/ newly identified streets where people spend an hour or more.

**Roads with high flow buses and/or HGV's**

LBRuT confirms that there are no new/ newly identified roads with high bus flows and/or HGV's.

**Junctions**

LBRuT confirms that there are no new/newly identified junctions and busy roads in the Local Authority area.

**New roads constructed or proposed since the last Updating and Screening Assessment**

LBRuT confirms that there are no new/proposed roads.

**Roads with significantly changed traffic flows**

LBRuT confirms that there are no significantly changed traffic flows.

**Bus or coach stations**

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

## 3.2 Other Transport Sources

**Airports**

LBRuT confirms that there are no new airports within the Local Authority's boundary. Heathrow is approximately 3 miles away and planes do fly over the borough, on both take offs and landings. Although significant pollution emissions from aircraft do occur over the borough, the height of the aircraft (over 1500 feet) ensures good dilution and dispersion before the pollution reaches the ground, so that the concentrations are too low to be detected with our monitoring equipment.  The other noteworthy source of airport related pollution in the Borough comes from the road traffic which is related to airport operations. At the Terminal 5 Inquiry, this traffic was modelled to constitute 5% of traffic on major roads and 3% on minor roads, for the parts of the Borough nearest to Heathrow.

**Railways (Diesel and Steam) Trains**

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

**Moving Trains**

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

**Ports for Shipping**

LBRuT confirms that there are no ports for shipping within the Local Authority boundary,

## 3.3 Industrial Sources

**New or Proposed Installations**

LBRuT confirms that there are no new or proposed installations since the last Update and Screening Assessment

**Existing installations where emissions have increase substantially or new relevant exposure has been introduced**

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.

**Major Fuel (Petrol) Storage Depots**

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

**Petrol Stations**

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

**Poultry Farms**

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

## 3.4 Commercial and Domestic Sources

**Biomass Combustion Plants – individual installations**

LBRuT confirms that there are no new individual biomass combustion installations in the Local Authority area, since the last Updating and Screening Assessment.

**Area where the combined impact of several biomass combustions sources may be relevant**

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

**Area where domestic solid fuel burning may be relevant**

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

## 3.5 New Developments with Fugitive or Uncontrolled Sources

**Landfill Sites**

LBRuT confirms there are no new or proposed landfill sites

**Quarries**

LBRuT confirms that there are no new or proposed quarries

**Unmade haulage roads on industrial site**

LBRuT confirms that there are no new unmade roads on industrial sites

**Waste transfer stations etc**

LBRuT confirms that there are no new waste transfer stations

**Other potential sources of fugitive particulate emissions**

LBRuT confirms that there are no established sources of fugitive particulate matter emissions in the Local Authority area. (Construction/demolition site activities are by nature transitory, with some controlled better than others)

# 4 Local / Regional Air Quality Strategy

The Mayor of London in 2002 published an air quality strategy for London ‘Cleaning London’s Air’. The strategy was a commitment by the Mayor to improve air quality in London in line with the national air quality standards and outlined proposals how this would be achieved.

The main aims were:

- Work to reduce the pollution from transport use by reducing the amount of traffic and reducing emissions from individual vehicles
- Reduce emissions from air travel
- Work to achieve a reduction in emissions from buildings
- Work to reduce pollution from industry and construction

A draft revision of the strategy was produced for consultation in October November 2009 and a second draft published in March 2010. In December 2010 a final version of the new Mayor’s Air Quality Strategy was published.

The aim of the strategy is to make London one of the cleanest and greenest cities in the world by improving the air quality and includes measures at reducing emissions from transport, homes, offices and new developments.

# 5 Planning Applications

There are no planning applications for new developments which may have an impact on air quality.

# 6 Air Quality Planning Policies

**Biomass boilers**

The LBRUT, in line with the Mayor's approach, will discourage all applications for biomass boilers if they do not meet the standards required for air quality protection in the urban environment.

**Considerate Constructors Scheme**

The London Borough of Richmond encourages contractors to sign up to the 'The Considerate Constructors Scheme'. This is a national initiative set up by the construction industry to improve compliance with the law and complete construction works with the minimum of disturbance.

Registered companies should do all they can to reduce any negative effect they have on the environment. They should work in an environmentally conscious, sustainable manner. All dirt and dust from the site should be controlled and hence emissions to atmosphere should be kept to a minimum.

# 7 Local Transport Plans and Strategies

The London Borough of Richmond upon Thames has produced a Local Implementation Plan for Transport which introduces a Borough School Travel Plan Strategy. This Strategy is a government initiative to reduce traffic and improve safety in the vicinity of schools.

The aim of the school transport plan was to reduce the number of cars that travel to school. Currently the school run comprises 20% of traffic on the roads in the morning peak and so School Travel Plans which aim to reduce car usage to schools will help. There are currently School Travel Plans at 99% of the schools in the Borough.

There are 6 established walking buses at 5 schools in the Borough with an overall number of 75 children participating in the scheme. The walking buses are currently all at LEA primary schools.

The Borough's Safety Education Team with input from the Transport Planners also run an annual Walk to School Week in encourages pupils and parents to walk to school if possible and promotes the associated health benefits. Around 50 schools (both LEA, VA and independent) participate every year during the May campaign.

The Borough Safety Education team also deliver cyclist training across the Borough to Year 6 pupils. The training will prepare the pupils to cycle on the roads.

**Green Travel Plan**

The Green Travel Plan is a collection of initiatives and benefits developed to help staff adopt healthier and greener travel habits.

The plan has been developed based on the findings from a staff travel survey conducted in 2008. It will help us lead by example, as well as improve the fitness and mental health of the Council's workforce and local community.

The Plan ties in closely with the Smarter Travel Richmond upon Thames programme, being implemented in partnership with Transport for London over the next two and a half years. This programme aims to offer borough residents, visitors and employees all the information and support they need to use quicker, cheaper and more efficient forms of transport.

# 8 Climate Change Strategies

In 2006 Richmond pledged to take action on Climate Change and signed the Nottingham declaration on Climate Change. In 2008 a Climate Change Policy was adopted as a commitment to reduce emissions on greenhouse gases.

Richmond Council's vision is to lead by example to achieve high standards for energy efficiency both by reducing its own carbon footprint and support individuals and organisations to also take action. The authority will focus on:

1. Energy efficiency: Improve the fabric of the existing housing and building stock and uptake of energy efficient boilers, controls and appliances to reduce energy demand and fuel poverty.

2. Energy supply: Accelerate the installation of low-carbon micro-generation technologies and reduce the distance between sources of energy production and consumption.

3. Transport: Promote car free mobility, choice of travel modes and new models of car ownership, and explore use of greener fuels to reduce the $CO_2$ emissions from transport.

4. Risks and opportunities: Adapt to climate change and reduce the impact of extreme weather events by identifying risks, developing appropriate management plans and realising opportunities.

The authority has calculated baseline information on energy consumption and $CO_2$ emissions through National Indicators: 185, 186 and 188 which set targets to be achieved.

# 9 Implementation of Action Plans

A description of the action plans is set out in Appendix B. The Air Quality Action Plan consists of 33 actions to improve local air quality. The actions include regional, local and borough wide measures.

There are several different sections across the Council which contribute to implementation of the Air Quality Action Plan measures.

# 10 Conclusions and Proposed Actions

## 10.1 Conclusions from New Monitoring Data

The results from monitoring in 2009 show that the concentrations of PM10, CO, $SO_2$ and benzene were each below their relevant objective limits.

$NO_2$ concentrations were found to exceed the objective of 40ug/$m^3$ at most of the locations monitored. In addition, the borough-wide modelling for 2010 (LAEI, 2004, with worst case 2003 met year and LEZ) also confirmed these widespread exceedences. Both of these conclusions indicate the continuing need for the LBRuT to remain designated as a borough-wide AQMA for $NO_2$. This conclusion remains true when façade level corrections are made, indicating that there are still exceedences, when assessed for vulnerable receptors.

The TG(09) guidance advises that where annual mean concentrations are 60ug/$m^3$ or above, exceedences of the one hour $NO_2$ objective are also likely to occur. The 2009 $NO_2$ monitoring data indicates that at some locations the annual mean $NO_2$ did exceed 60ug/$m^3$ in some areas, with George St, Richmond and Kings St, Twickenham recording levels of more than 100ug/$m^3$. Once again, the conclusion remains true when façade level corrections are made, indicating that there are still likely to be exceedences of the 1-hour objective, when assessed for vulnerable receptors.

The PM10 monitoring results show that the annual mean PM10 and daily mean PM10 limits were not exceeded at any site in the Borough during the last three years. However, the 2010 modelling indicates that we should expect the objectives to be exceeded at a few vulnerable receptor sites. On that basis it is thought best to retain the AQMA designation for PM10, for the time being.

## 10.2 Conclusions relating to New Local Developments

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

## 10.3 Other Conclusions

Richmond Council is in the process of implementing the actions designated within the AQMA to achieve air quality improvements within the borough. Progress has been made in implementing the various measures. The AQMA Progress Report (Appendix B) has identified that the LBRUT is making good progress in implementing ‘The School Travel Plan’ with 99% of schools now having a school travel plan and approximately 50 schools participating in the ‘Walk to School’ week in May. There are 33 actions within the AQMA. The vast majority of these actions are ongoing and have no time limit. Progress on these actions is reviewed annually and good progress is being made on implementing all of them.

Along with the plans indicated in the AQMA (Appendix B), the LBRut is further reducing the emissions from PM10’s by ensuring that any biomass boilers have the best available technology fitted and by encouraging developers to participate in the ‘Considerate Constructor Scheme’.

The LBRut continues to support the Mayor of London’s plan to reduce emissions in his London Air Quality Strategy.

## 10.4 Proposed Actions

From the new monitoring data there is no need to proceed to a detailed assessment. The next course of action is to prepare and submit the 2011 Progress Report.

Following a gap analysis, we increased monitoring for $NO_2$ in 2010. Two additional diffusion tube sites were installed next to the A316 - one at St Margaret's roundabout and one near Lincoln Avenue. The first results are from February 2010. The tubes locations represent 'relevant exposure', without further correction, as they are placed at locations equivalent to the facades of their nearest residential properties.

Work will continue to reduce air pollution in the Borough through the development and progress of the AQMA. The AQAP Progress Report in Appendix B indicates that progress has been made over the last year, over a wide range of actions.

# 11 References

Department for the Environment, Food and Rural Affairs (DEFRA), 2003a. LAQM.PRG (03) Progress Report Guidance. HMSO, London.
The report can be found at: www.defra.gov.uk/environment/airquality/local/guidance/pdf/progress-report.pdf

Department for the Environment, Food and Rural Affairs (DEFRA), 2003b. Technical Guidance for Local Air Quality Management LAQM. TG (03) HMSO, London.
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Department for the Environment, Food and Rural Affairs (DEFRA), 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. HMSO, London.
The report can be found at :www.defra.gov.uk/environment/airquality/strategy/index.htm

Department for the Environment, Food and Rural Affairs (DEFRA), 2008. Air Pollution - what it means for your health.
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www.defra.gov.uk/environment/airquality/publications/airpoll/index.htm

Office of Public Sector Information (OPSI), 2007. Statutory Instruments 2007 No. 64 environmental protection. The Air Quality Standards Regulations 2007.
The regulations can be found at: www.opsi.gov.uk/si/si2007/uksi_20070064_en_1

# Appendices

# Appendix A: QA:QC of data

## Diffusion Tube Bias Adjustment Factors

**$NO_2$ 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 is accredited by UKAS for the analysis of $NO_2$ diffusion tubes. It undertakes the analysis of the exposed diffusion tubes by ultra violet spectrophotometry.

**Diffusion Tube Bias Adjustment Factors from Local Co-location Studies**
LBRuT undertakes co-location studies at three continuous $NO_2$ monitoring sites, together with 3x $NO_2$ diffusion tubes at each of the following the locations:

**Richmond 1 Castelnau:** a roadside site, used to bias adjust all other kerbside and roadside sites in the borough.

**Richmond 2 Barnes Wetlands:** a suburban site used to bias adjust the few background sites (17, 28, 37, RUT3 and RUT4).

**Richmond Mobile:** at various roadside locations, used to calculate a bias adjustment factor for the $NO_2$ diffusion tubes 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

The 2009 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 was good.

The 2009 bias adjustment factor for all background sites in the LBRuT was calculated from the collocation study at the Richmond 2 Barnes Wetlands site. The overall precision and data capture for this co-location study was good.

The 2009 bias adjustment factor from the co-location study at Richmond 29 (Mobile) Upper Teddington Road, Teddington. The overall precision and data capture for this co-location study was good.

## Discussion of Choice of Factor to Use

The local bias adjustment factors for the LBRuT are provided in Table A.1 for 2002 to 2009. From 2002 to 2007 all sites were bias adjusted using the factor calculated from the TG (03) equation using the results of the co-location study at Castelnau. From 2008 to 2009 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 methodology for calculating the bias adjustment was changed from the equation in TG (03) guidance to the AEA spreadsheet, as the spreadsheet has a greater degree of accuracy.

For the 2008 & 2009 factors, the local factors were chosen in calculating the bias adjustment as the data capture from the local co-location study is good, data capture is above 75%.

The local roadside and suburban factors are generally higher than the national factor (UWE) resulting in higher bias adjusted results, so these factors are more conservative than the national factor.

**Table A.1 2006 to 2009 $NO_2$ diffusion tube bias adjustment factors for LBRuT**

| Source of bias adjustment factor | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| TG(03) equation using Castelnau roadside data | 1.44 | 1.23 | 0.97 | 1.00 | 1.03 | 0.97 | | |
| **Local roadside** co-location study at Richmond 1 Castelnau | | | | | | | 0.99 | 1.00 |
| **Local background** co-location study at Richmond 2 Wetlands Barnes | | | | | | | 1.05a | 1.02 |
| **UWE** national factor (not used) | 1.27 | 1.11 | 1.10 | 1.10 | 1.01 | 0.98 | 0.93 | 0.99 |

## QA/QC of $NO_2$ diffusion tube monitoring

### 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 ±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. 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.2 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. For 2008, the analytical measurement of uncertainty for Gradko's analysis of diffusion tubes was +/-5.98%; this good performance demonstrates a high level of accuracy and precision.

**Table A.2 2007 and 2008 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% | |

The NO2 diffusion tubes are kept in a refrigerator prior to being deployed and prior to being sent off for analysis.

## PM Monitoring Adjustment

PM10 were measured using the Tapered Element Oscillating Microbalance (TEOM) and the data are now presented as the gravimetric equivalent using the Volatile Correction Method (VCM).

## QA/QC of PM10 automatic monitoring by TEOM

Automatic calibrations are carried out every night by the TEOMs at Richmond 1 Castelnau, Richmond 2 Barnes Wetlands and the Richmond Mobile. These are supplemented with fortnightly checks by LBRuT officers. The equipment is serviced every six months and also audited by NPL every six months as part of the LAQN QA/QC procedure, 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 ratify the data periodically, viewing data over longer time periods and

using the results from fortnightly checks, equipment services and equipment audits.

Here are the general stages of the data ratification process, carried out by ERG for the Richmond 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 have been ratified.

For the first month of every year, the monthly data capture for the Richmond Mobile is reduced because the Mobile changes its location. The January 2009 monthly data capture for all pollutants at the Richmond 29 (Mobile) Upper Teddington Road, Teddington is therefore 78% or lower because the Mobile moved to the site on the 5th January 2009. This loss of days is shown in the lower data capture rate, but should still work out above the 90% rate when taken over the year.

A faulty TEOM in the Mobile was replaced on 28th January 2009, but then gave good data capture for the rest of 2009 (94%). Table 3 gives the full picture of the data capture achievements.

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 Benzene Diffusion Tubes

**METHOD STATEMENT from Gradko Environmental**

(Extract from Gradko Environmental Lab. Procedure)

This method is applicable to the determination of benzene (C6H6) on solid sorbent passive diffusion tube monitors. This method is based on the requirements of MDHS 80 (Health and Safety Laboratory Method).

Volatile organic compounds in the form of Benzene, are absorbed on to Chromasorb 106, a polymeric sorbent i.e. Cross Linked Polystyrene packed into a stainless steel tube. The absorbed compounds are removed from tube by thermal desorption and the resultant vapour transported by carrier gas into a Gas Chromatography System which measures the concentration on tube in nanograms. Quantification measure as nanograms on tube is carried out by reference to a calibration of external standards taking into account any contribution from the blank.

METHOD PERFORMANCE

The method covers the analysis of Benzene collected on passive diffusion tubes in the range 10ng to 3000ng. The limit of detection for the analytical method is 2ng. Precision measurements i.e. measurement uncertainty shall be determined as specified in UKAS procedure M303,

**CALIBRATION SOLUTIONS**

Benzene standard solutions are used to set up a calibration curve covering the range 10 – 3000nano grams. The solution are prepared and run each month.
The acceptable working range of retention times is: Benzene: 6.0 – 8.0 minutes

**DEVELOPING THE CALIBRATION CURVE**

The calibration curves shall be Linear or a polynominal regression fitted such that
$R^2$ = 0.995 or better.

QUALITY CONTROL

At the start of each session, a 50 ng Benzene standard prepared from a separate source than those prepared for the calibration curve shall be run as a quality control to check the resolution, peak shape and retention times of the Benzene calibration curves and also the weight Benzene on tube.. The acceptance criteria for this check is that the recorded weight on tube shall lie between +/- 3 Standard Deviations from the mean value derived from the validation run

Control charts displaying warning and action limits plotted against +/- 2 and 3

**INSTRUMENT CALIBRATION**

Bi - Monthly calibration of the Thermal Desorption /Gas Chromatography Instruments shall be carried out using a certified standard Benzene tube traceable to National Standards. Acceptance criteria shall be set at the certified mean weight on the tube plus /minus the combined measurement uncertainties from the calibration certificate and the instrument.
ANALYSIS PROCEDURE

Load tubes into the sample slot on the thermal desorption unit and then load a conditioned blank tube into the control sample slot, (this tube can be used to rerun the chromatogram in the event of problem with the customers sample). At the end of its 22 minute run, the sample will automatically carry out optimization and integration and display chromatograph QC standards are run every 10 exposed tube samples.

EXPRESSION OF RESULTS

Results are predominately expressed as parts per billion in air of each compound although some customers may require the results expressed on nanograms on tube or ugm3.

**MEASUREMENT UNCERTAINTY**
The uncertainty of measurement is calculated as the sum of the squares of the values of all of the individual errors such as sampling, instrument precision, procedural precision and accuracy of standards. Estimates of the Thermal Desorption / Gas Chromatography analysis can be given from injections of a Benzene standard on a tube.

Twenty samples each having a 50ng Benzene injection are ran over a period of time and the Standard Deviation (Combined Uncertainty) calculated. The Coefficient of Variation is calculated and the measurement bias determined. From this precision data it can be estimated that the expanded uncertainty at 95% confidence level is obtained by adding the highest % bias reading to the highest coefficient of variation value and multiplying by 2 thus taking into consideration the effect of systematic and random errors on the uncertainty of measurement.

The benzene diffusion tubes are kept in the team refrigerator prior to being deployed and prior to being sent off for analysis.