



2011

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

Includes monitoring data from 2010

Local Authority Officer	Mr John Coates
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Department	Special Projects Team
Address	Civic Centre, York Street, Twickenham, TW1 3BZ
Telephone	0208 891 7877
e-mail	j.coates@richmond.gov.uk

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Executive Summary

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In December 2000 the London Borough of Richmond upon Thames Council (LBRUT) declared the whole borough as an Air Quality Management Area (AQMA). The monitoring results in this report, from 2010, confirm that the nitrogen dioxide air quality standard is still being exceeded in areas across the Borough. Modelling data indicates that PM10 might also exceed the standard in parts of the Borough. Although ozone also exceeded the standard, as it is a regional pollutant it was not included in the AQMA designation. Benzene, sulphur dioxide and carbon monoxide were also monitored, but it was found that they did not exceed their relevant standards.

The Report concludes that both nitrogen dioxide (NO₂) and PM10 particles concentrations are likely to continue exceeding the relevant air quality objectives. It is therefore proposed that the AQMA designation for these pollutants should still stand.

An updating and screening assessment (USA) is scheduled for submission to the Department for Environment, Food and Rural Affairs (Defra) and the Mayor, in 2012.

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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 the London region. Some of the Action Plan actions are cross-Borough, some with the West London neighbours, or are cross-London initiatives.



Figure 1: Location of LBRuT within Greater London. The boundary also indicates the extent of the whole borough Air Quality Management Area.

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 $\mu\text{g}/\text{m}^3$ (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 $\mu\text{g}/\text{m}^3$	Running annual mean	31.12.2003
	5.00 $\mu\text{g}/\text{m}^3$	Running annual mean	31.12.2010
1,3-Butadiene	2.25 $\mu\text{g}/\text{m}^3$	Running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m^3	Running 8-hour mean	31.12.2003
Lead	0.5 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2004
	0.25 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2008
Nitrogen dioxide	200 $\mu\text{g}/\text{m}^3$ not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2005
Particles (PM₁₀) (gravimetric)	50 $\mu\text{g}/\text{m}^3$, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 $\mu\text{g}/\text{m}^3$	Annual mean	31.12.2004
Sulphur dioxide	350 $\mu\text{g}/\text{m}^3$, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 $\mu\text{g}/\text{m}^3$, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 $\mu\text{g}/\text{m}^3$, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

1.4 Summary of Previous Review and Assessments

Outline of Air Quality progress to date:

1. Stages 1, 2 and 3 assessments confirmed the need to improve air quality in the Borough.
2. There was a public consultation on Air Quality Management Area designation (AQMA)
3. Decision and declaration of AQMA for whole Borough, December 2000, for nitrogen dioxide (NO₂) and PM₁₀ particles.
4. Stage 4 assessment, May 2002, confirmed that air quality improvements were needed
5. Air Quality Action Plan (AQAP) - consultation and publication, 2002
6. Updating and Screening Assessment (USA) 2004 predicted continuing exceedence of the NO₂ and PM₁₀ objectives
7. Air Quality Review and Assessment Progress Report 2005 – gave updated monitoring results

The reports for the above stages and beyond are available on the Council's web site. http://www.richmond.gov.uk/home/environment/pollution/air_pollution/air_quality_reports.htm, including Stages 1,2,3 and 4; Progress Reports for 2005, 2007, 2008, 2010; USAs for 2004, 2006 and 2009. Also the 2000 AQMA designation, and the resulting AQAP in 2002, with subsequent AQAP progress reports for 2005, 2007, 2008 and 2009.

As indicated in the outline above, once the situation on the existing and future air quality in the borough was understood, the Council decided that it must declare an Air Quality Management Area. The Council held a public consultation so as to come to a view as to what form that Management Area should take. Following this 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, NO₂ and PM₁₀. The standards in the objectives are health based. The objectives limits can be found in Table 1 above .

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 NO₂ and PM₁₀ 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 2010 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 PM₁₀ (2004) and NO₂ (2005) limits, so the LBRuT is still obliged to try to meet those objectives.

Progress updates on the AQAP are produced routinely.

2 New Monitoring Data

2.1 Summary of Monitoring Undertaken

The monitoring data in this report comes from monitoring surveys undertaken across the LBRuT. Monitoring was carried out at 4 'continuous' monitoring sites, with data uploaded to the internet every hour. The 61 passive 'diffusion tube' monitoring sites produce results once a month.

The latest (2010) monitoring results confirm that air pollution in the LBRuT still exceeds the 2004/2005 objectives, and the new 2010 objectives for NO₂ 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 (NO₂) (1-hour mean)
- Particulate matter (PM₁₀) (24-hour mean)
- Sulphur dioxide (SO₂) (15-minute mean)
- Ozone (O₃) (running 8-hour mean)
- Carbon monoxide (CO) (running 8-hour mean)
- Benzene (2-week monitoring mean – annual mean limit only)

Table 10 lists the locations of the NO₂ 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 gives a Borough-wide view. The results obtained give monthly averages, and are not precise but do provide an indication of NO₂ 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 67 diffusion tubes to monitor NO₂ at 61 locations across the LBRuT (detailed in Table 10) and a further 5 sites to monitor for benzene (detailed in Table 10). PAH monitoring ceased in spring 2007 (it had been undertaken at Castelnau Library, Barnes).

At four locations in the LBRuT there are air pollution analysers running continuously (locations given in Table 2 and shown in the maps at Figures 4 and 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. The NPL site is part of the UK Automatic Urban and Rural Network (AURN).

Table 2 Locations of the automatic monitoring sites.

	Operational since	Pollutants monitored

Monitoring sites		
Castelnau Library, Barnes (Site No.23). Static site known as Richmond 1 in the London Air Quality Network (LAQN). Roadside site, 3 meters from road with bus lane.	2000	NO _x , NO, NO ₂ , and PM ₁₀
Wetlands Centre, Barnes (site number 37). 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 2010 it was located at Hampton Court Rd, Hampton Court, 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 maps at Figures 4 & 5 show the site locations

The results given below show the annual mean data, for the pollutants monitored, for the years 2002 to 2010. Each set of results is given, starting with NO₂, then PM₁₀, PM_{2.5} O₃, SO₂, 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: NO₂ (chemiluminescence); PM₁₀ (TEOM); PM_{2.5} (FDMS); ozone (UV absorption); SO₂ (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, Mobile and NPL are fully ratified.

Nitrogen dioxide (NO₂) in the LBRUT

Table 3 NO₂ results from the continuous analysers, compared with the annual mean limit of 40 µg/m³ and the number of times the levels exceeded the hourly average limit of 200 µg/m³.

Castelnau ^a	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual mean NO ₂ (µg/m ³)	44	48	41	42	42	43	44	45	43
Number of exceedences of hourly mean of 200 µg/m ³	0	0	0	4	0	7	9	3	0
Data capture (%)	98%	96%	97%	98%	99%	96%	95%	98%	98%
Wetlands ^a	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual mean NO ₂ (µg/m ³)	32	37	31	30	30	31	29	29	30

Number of exceedences of hourly mean of 200 $\mu\text{g}/\text{m}^3$	0 ^b (70.4)	0	0	0	0	0	1	0	0
Data capture (%)	71%	99%	97%	93%	87%	97%	99%	99%	100%
Mobile Unit^a	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual mean NO ₂ ($\mu\text{g}/\text{m}^3$)					44	38	42	40	45
Number of exceedences of hourly mean of 200 $\mu\text{g}/\text{m}^3$	1	2	0	0	0	0	0	0	0
Data capture (%)						99%	90%	95%	98%
NPL – Teddington AURN	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual mean NO ₂ ($\mu\text{g}/\text{m}^3$)	25	28	25	26	23	28	25	22	24
Number of exceedences of hourly mean of 200 $\mu\text{g}/\text{m}^3$ ^{***}	0	0	0	0	0	0	0	0	0
Data capture (%)	98%	96%	94%	95%	99%	95%	97%	80%	78%

*The hourly mean objective for NO₂ is 200 $\mu\text{g}/\text{m}^3$ which should not be exceeded more than 18 times per year.

^a Data for Castelnau, Wetlands, NPL and the Mobile has all been fully ratified

^b figure in brackets equals 99.8%ile as data capture is less than 90%, with a limit of 200 $\mu\text{g}/\text{m}^3$. 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 NO₂ levels exceeded the hourly mean limit of 200 $\mu\text{g}/\text{m}^3$ at the Mobile Air Quality Unit.

Mobile Unit location	Start date	End date	2002	2003	2004	2005	2006	2007	2008	2009	2010	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)	19/07/05	24/07/06				0	0					0

House)												
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
Hampton Court Rd, Hampton Court	05/01/10	11/01/11									0	1
Calendar year total			1	2	0	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 NO₂ objective (40 µg/m³) every year for the past nine years. There were four exceedences of the 1-hour air quality standard in 2005, with 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, for the Mobile unit, shows there was one exceedence of the NO₂ 1 hour mean limit during the 2002 George Street, Richmond deployment of the Mobile Unit, and 2 during the 2003 Upper Teddington Road, Teddington.

The results from both the NO₂ diffusion tube sampling and the continuous analysers correlate with the modelling done by Kings College London, Environmental Research Group (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 NO₂ 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) SO₂ monitoring ceased at NPL in October 2007

Particulate matter (PM₁₀) in the LBRuT

The LBRuT uses a Tapered Element Oscillating Microbalance (TEOM) to continuously monitor PM₁₀. All TEOM results are converted to reference equivalence using the volatile correction method (VCM), as mentioned in section 1.4 is a specified pollutant for the whole borough AQMA.

Table 5 Annual mean PM₁₀ results against the Objective limit of an annual mean of 40 µg/m³ and the number of single days over 50 µg/m³ (35 days a year permitted by the Objective).

Castelnau	2002	2003	2004	2005	2006	2007	2008	2009*	2010
Annual mean PM ₁₀ (µg/m ³)	25	28	24	25	24	23	21	21	21
Number of exceedences of the 24-hour mean	4	29	10	19	14	21	12	4	2
Data capture (%)	92%	96%	94%	99%	94%	99%	99%	95%	98%
Wetlands	2002	2003	2004	2005	2006	2007	2008	2009*	2010
Annual mean PM ₁₀ (µg/m ³)	24	28	22	22	22	20	19	20	19
Number of exceedences of the 24-hour mean	6	34	8	17	12	19	8	5	1
Data capture (%)	64%	98%	97%	99%	99%	96%	94%	100%	99%
Mobile Unit	2002	2003	2004	2005	2006	2007	2008	2009*	2010
Annual mean PM ₁₀ (µg/m ³)						23	25	23	22
Number of exceedences of the 24-hour mean **	2	49^a	8	7	14	22	13	5	5
Data capture (%)						99%	66%	94%	95%

* Mobile, Castelnau and Wetlands data has been fully ratified.

** See Table 5a for the exceedence breakdown at each mobile unit deployment.

^a Note: this is a composite result, from 3 sites – see Table 5a following for details

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

Table 5a Breakdown of the number of times PM₁₀ levels exceeded the 24-hour limit of 50 µg/m³ at the Mobile Air Quality Unit.

Mobile Unit location	Start date	End date	2002	2003	2004	2005	2006	2007	2008	2009	2010	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	22				27
Mortlake Rd, Kew	08/01/08	08/01/09							13			0
Upper Teddington Rd, Teddington	08/01/09	05/01/10								5		5
Hampton Court Rd, Hampton Court	05/01/10	11/01/11									5	5
Calendar year total			2	49_b	8	7	14	22	13	5	5	

^b 2003 shows a composite 'exceedence'

Table 5 shows that, at Castelnau or the Wetlands, there were no exceedences of either of the PM₁₀ objective limits.

Table 5a shows that, at the Mobile Air Quality Unit, when the different deployment exceedences are combined, the results for 2003 show one composite 'exceedence' of the 24-hour mean 2005 objective limit of 50 µg/m³

Modelled concentrations of PM₁₀, across the LBRuT, are displayed in the following map, at Figure 2.

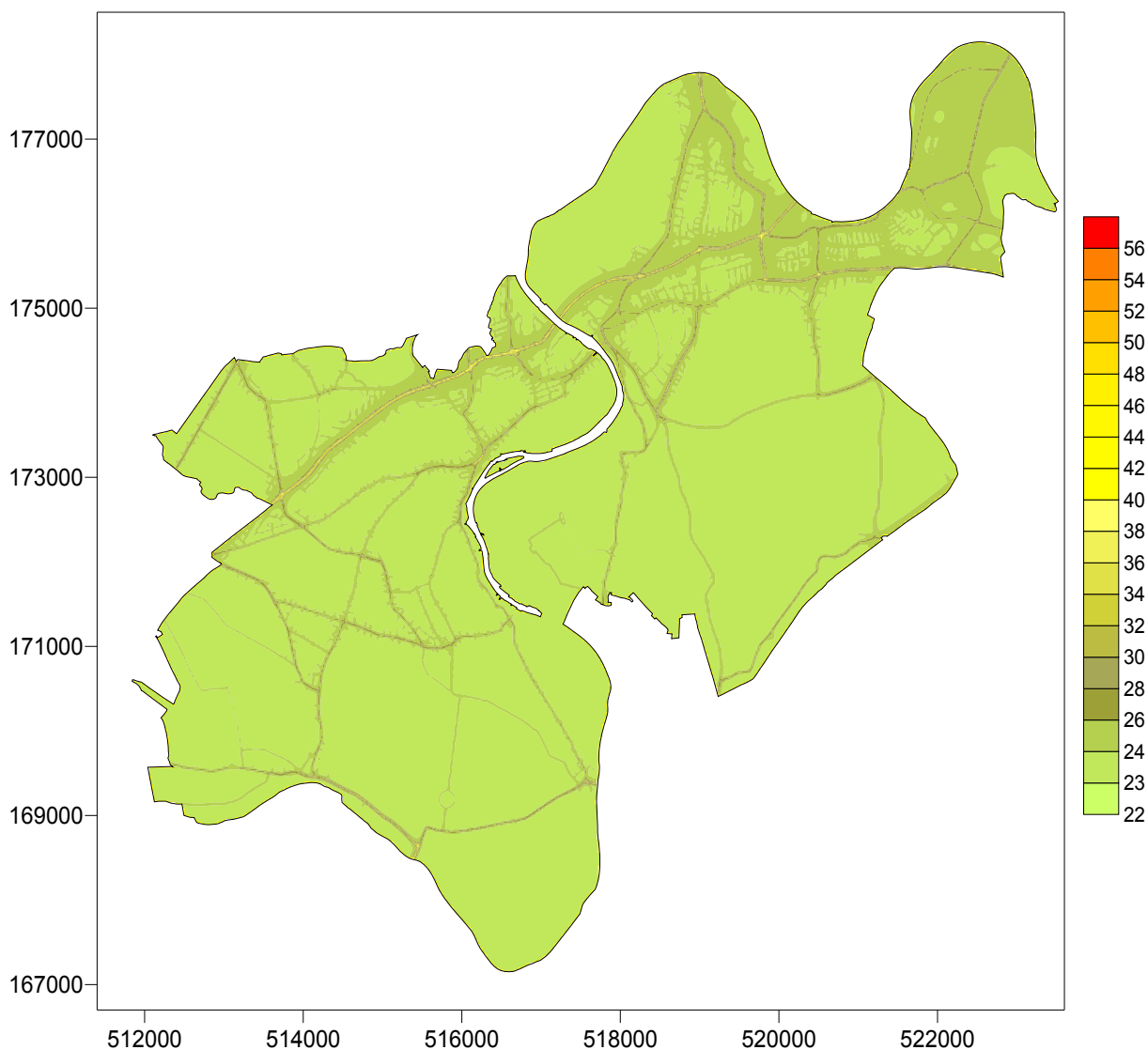


Figure 2: Modelled PM₁₀ concentrations in LBRuT for 2010. (Modelled by ERG)

Modelling by Kings College ERG for the year 2010 gives similar results to the previous 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 PM₁₀ designation.

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*	2010*
Annual mean ^a	13	14
Data capture (%)	99%	77%

*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 and 2010 were below the target value.

Other Pollutants Monitored

Ozone (O₃)

Ozone is continuously monitored at the three sites in the Borough. The results from 2002 to 2010 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/m³ as the daily maximum of the running 8-hour mean.

Wetlands *	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of exceedences of the running 8-hour mean	5	49	24	17	29	15	24	14	6
Data capture (%)	46%	100%	98%	99%	96%	97%	99%	98%	97%
Mobile Unit **	2002	2003	2004	2005	2006	2007*	2008	2009	2010
Number of exceedences of the running 8-hour mean***	11	14	9	9	24	9	0	2	0
Data Capture (%)						99%	95%	96%	98%
NPL – Teddington AURN ***	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of exceedences of the running 8-hour mean	24	50	26	32	42	19	33	20	16
Data capture (%)	99%	99%	96%	99%	99%	97%	98	99	83%

*Data for Wetlands has been fully ratified.

**Data for the Mobile has been fully ratified.

***Data for NPL has 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/m³ at the Mobile Air Quality Unit.

Mobile Unit location	Start date	End date	2002	2003	2004	2005	2006	2007	2008	2009	2010	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,	25/02/03	20/05/03		1								1

Twickenham (opp. Orleans School)	3											
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
Hampton Court Rd, Hampton Court	05/01/10	11/01/11									0	0
Calendar year total			11	14	9	9	24	9	0	2	0	

Table 7 shows that the ozone levels at the Wetlands from 2003 to 2010 and NPL - Teddington AURN site in 2002 to 2010 did exceed the objective (i.e. more than 10 exceedences of 100 µg/m³ 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 µg/m³ at the Mobile Air Quality Unit deployments in 2003, 2004 and 2006, resulted in a 'composite' exceedence of the 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 than 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 and sunny summer.

Sulphur dioxide (SO₂)

SO₂ is continuously monitored at our mobile air quality unit and at NPL. Table 8 shows that SO₂ monitored within the LBRuT did not exceed the 15-minute mean objective (not to exceed 266 µg/m³ more than 35 times a year).

Table 8 SO₂ monitoring was at the Mobile Air Quality Unit and at NPL - Teddington AURN. Objective limit: 15-minute mean not to exceed 266 µg/m³ more than 35 times a year.

Mobile Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Number of exceedences of 15-minute mean	0	0	0	0	0	0	0	0	0
Data Capture (%)						97%	95%	94%	98%
NPL – Teddington AURN	2002	2003	2004	2005	2006	2007**			
Number of exceedences of 15-	0	0	0	0	0	0			

minute mean									
Data Capture (%)	99%	99%	96%	99%	98%	65%			

***Mobile Unit** - Data for the Mobile has been fully ratified..

****NPL- Teddington AURN** –all data have been- fully ratified. NPL discontinued monitoring SO₂ 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/m³.

Mobile Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Number of exceedences of the running 8-hour mean	0	0	0	0	0	0	0	0	0
Data Capture (%)						97%	94%	95%	91%

* **Mobile Unit – Hampton Court Road, Hampton Court** - data has been fully ratified.

2.1.2 Non-Automatic Monitoring

Nitrogen dioxide (NO₂) monitoring using diffusion tubes.

Table 10 shows the NO₂ diffusion tube monitoring results, with bias corrected values for each year from 2002 to 2010. The results in **bold** indicate an exceedence of the Air Quality Objective. Most of the NO₂ 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. As mentioned in section 1.4 NO₂ is a specified pollutant for the whole borough AQMA.

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 NO₂ did exceed the 2005/2010 objective limit in each year from 2005 - 2010, as per the modelling prediction.

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 compiled 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, 2003), a yearly bias adjustment factor has been produced for each year from 2002 to 2010, (Appendix A). The bias factor for 2002 is 1.44, 2003 is 1.23, 2004 is 0.97, 2005 is 1.00, 2006 is 1.05, 2007 is 0.97, 2008 is 0.99, 2009 is 1.00 and 2010 is 1.06.

The level of nitrogen dioxide measured by diffusion tubes is calculated to the nearest façade (results expressed in brackets) by using the Air Quality Consultants distance calculator, as discussed in Appendix B.

Table 10 Annual bias adjusted NO₂ concentration in micrograms per cubic metre (µg/m³) (figure 5a), by diffusion tube sampling. The results in brackets indicate the exposure estimate, calculated for the nearest residential façade (figure 5b).

Site Code	Location	Site type	Grid reference s	Data Capture for full calendar year 2010 ^a %	Relevant exposure (y/n with distance (m) from tube to roadside)	Distance from roadside (metres) to receptor	2004	2005	2006	2007	2008	2009	2010
1	Hampton Court	Roadside	515824,	100%	Y – 1.7m	1.9	44	48	51	52	55	53	51 (50)

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	Road, Hampton		168815										
2	Percy Road, Hampton (Nr. Oldfield Road)	Roadside	513229, 169712	100%	Y – 1.3m	3	33	38	43	35	39	39	39 (36)
3	Uxbridge Road, Hampton (Nr. Arundel Close)	Roadside	513850, 171040	92%	N – 0.5m	10.7	43	45	49	45	46	44	44 (33)
4	Hampton Road, Teddington (Nr. Bushy Park Gardens)	Kerbside	514882, 171155	100%	N -0.6m	9.8	45	47	53	47	50	47	39 (31)
5	Sandy Lane, Teddington (Shaef Way)	Kerbside	516391, 170322	100%	N – 0.6m	9.0	34	41	44	36	36	37	38 (31)
6	Kingston Road, Teddington (Nr. Woffington Close)	Kerbside	517266, 170031	100%	N – 0.7m	6.5	47	50	50	48	45	47	48 (38)
7	Broad Street, Teddington (Tesco)	Kerbside	515624, 170975	100%	Y - for 1 hour mean objective and N - for residential 0.8m	2.5	60	68	88	78	66	69	69 (59)
8	Strawberry Vale, Teddington (Clive Road)	Kerbside	516165, 172043	92%	N – 0.4m	8.7	37	39	42	39	37	38	39 (31)
9	Hampton Road, Twickenham	Kerbside	514842, 172346	100%	N – 0.6m	2.0	51	52	60	56	59	57	55 (48)
10	Twickenham Road, Twickenham (opp. Fulwell golf course)	Kerbside	513278, 172199	100%	N – 0.6m	2.0	41	43	53	44	48	45	47 (37)
11	Percy Road, Whitton (nr. Percy Way)	Kerbside	514050, 173189	100%	N – 0.6m	7.2	40	46	53	48	47	50	52 (38)
12	Hanworth Road, Whitton	Kerbside	512600, 173404	100%	N – 0.6m	9.1	43	51	56	53	52	49	52 (39)
13	Whitton Road, Whitton, (opp. Rugby ground)	Kerbside	515387, 174146	100%	N -0.8m	6.3	43	44	60	47	54	50	53 (42)
14	Cross Deep, Twickenham	Kerbside	516133, 173051	100%	N – 0.3m	2.7	33	48	58	53	53	54	52 (42)

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	(Nr. Poulett Gardens)												
15	Richmond Road, Twickenham (opp. Marble Hill Park)	Kerbside	517197, 173939	100%	N – 0.6m	1.8	49	49	<u>65</u>	46	57	55	53 (47)
16	St Margarets Road, St Margaret's (Nr. Bridge Road)	Kerbside	517558, 174408	100%	N – 1.2m	3.1	43	47	49	46	50	49	48 (43)
17 ^c	Red Lion St, Richmond (Formerly Parkshot Magistrates Courtyard, Richmond)	kerbside	517916, 175257	100%	Y - for 1 hour mean objective and N - for residential 0.5m	2.0	27	30	41	30	32	31	<u>79 (67)</u>
18	Lower Mortlake Road, Richmond (nr.Trinity Road)	Kerbside	518822, 175590	100%	N 0.9m	9.3	<u>65</u>	<u>62</u>	<u>76</u>	58	<u>67</u>	<u>64</u>	<u>70 (52)</u>
19	Kew Road, Kew (nr. Walpole Avenue)	Kerbside	518637, 176161	100%	N 0.7m	16	57	58	<u>61</u>	55	56	<u>60</u>	46 (37)
20	Mortlake Road, Kew (nr. Kent Road)	Kerbside	519205, 177221	100%	N – 0.6m	2.8	47	49	59	57	57	58	54 (42)
21	Lower Richmond Road, Mortlake (nr. Kingsway)	Roadside	520053, 175826	100%	N - 2m	7.0	42	46	56	47	48	47	47 (42)
22	Castelnau, Barnes (Nr. Hammersmith Bridge)	Kerbside	522845, 177904	100%	N – 0.5m	4.2	48	<u>61</u>	<u>71</u>	59	<u>66</u>	<u>60</u>	55 (46)
23 ^b	Castelnau Library, Barnes (static site)	Roadside	522502, 177166	100%	N – 3.3m	9.0	34	42	49	41	43	43	43 (40)
24	Lonsdale Road, Barnes (nr Suffolk Road)	Kerbside	521750, 177056	100%	N – 0.30m	6.3	36	39	50	44	45	46	42 (36)
25	URRW (nr. Sheen School)	Roadside	521130, 175450	92%	N - 2.3m	2.5	51	45	53	52	45	46	42 (42)
26	URRW, Sheen (nr. Courtland Estate)	Roadside	519031, 175021	100%	N – 0.6m	11.8	44	48	56	48	50	54	46 (37)
27	Queens Road, Richmond (Nr. Russell Walk)	Roadside	518745, 174346	100%	Y -2.3m	5.2	41	43	52	46	51	46	44 (41)

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28	Holly Lodge, Richmond Park	Urban background	519467, 173993	92%	Y - for 1 hour mean objective 250m	250	23	24	32	27	25	23	24 (24)
29	Petersham Road, Ham. (Nr. Sandy Lane)	Kerbside	517967, 172543	92%	N – 3.6m	3.6	38	42	52	41	49	45	39 (39)
30	German School Petersham Road	Roadside	518003, 173233	100%	Y – 1.9m	1.3	32	38	35	39	43	41	41 (42)
31	A316	Roadside	515438, 174048	100%	N 1.0m	6.4	56	61	70	66	62	60	53 (42)
32	Kings Street, Twickenham	Kerbside	516226, 173195	100%	Y - for 1 hour mean objective and N - for residential 1.7m	3.8	84	91	119	109	106	110	102 (88)
33	Heath Road, Twickenham	Kerbside	515927, 173129	92%	Y - for 1 hour mean objective and N - for residential 0.9m	4.6	45	50	67	60	65	63	66 (53)
34	Thames Street, Hampton	Roadside	515927, 173129	100%	N – 1.4m	1.3	39.	40	46	44	47	44	42 (42)
35	High Street, Hampton Wick	Kerbside	517524, 169583	100%	Y – for 1 hour mean objective and for residential 1.3m	1.4	50	54	51	57	56	54	54 (54)
36	Upper Richmond Road West (URRW), Sheen Lane	Kerbside	520510, 175393	100%	Y – for 1 hour mean objective and N - for residential 0.9m	2.2	68	76	81	59	64	61	60 (55)
37 ^b	Wetlands Centre, Barnes (static site)	Urban Background	522989, 176727	97%	Y – 1 hour mean objective - children in play area/people attending Wetlands Centre		26	29	36	31	29	28	28
38	Queen's Road, Teddington (Park Road end)	Kerbside	515777, 170519	100%	N – 0.5m	5.0	36	41	45	38	41	40	40 (34)
39	Richmond Road, Richmond Bridge, East Twickenham	Kerbside	515777, 170519	100%	N 1.2m	2.7	61	64	73	69	68	73	70 (62)
40 ^d	Staines Road, Twickenham	Kerbside	514278, 172521	83%	N – 0.4m	11.9	39	42	53	41	46	41	31 (27)
41	Paradise Road,	Kerbside	518102,	100%	Y – 0.9m	5.6	40	49	52	48	56	48	49 (42)

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	Richmond		174854										
42	The Quadrant, Richmond	Kerbside	517991, 175075	100%	Y – for 1 hour mean objective and N -for residential (above shops) 2.5m	1.8	53	<u>63</u>	<u>73</u>	<u>60</u>	<u>60</u>	<u>60</u>	<u>69 (73)</u>
43 ^d	Hill Street, Richmond	Kerbside	517771, 174701	83%	Y - for 1 hour mean objective and N -for residential above shops 0.7m	1.6	54	<u>62</u>	<u>78</u>	<u>58</u>	<u>62</u>	<u>81</u>	<u>82 (73)</u>
44	Sheen Road, Richmond (Shops)	Kerbside	518458, 175042	100%	Y – for 1 hour mean objective and N - for residential 0.5m	0.5	46	51	<u>60</u>	56	53	53	49 (49)
45	High Street, Teddington (post office)	Kerbside	516260, 171140	100%	Y - for 1 hour mean objective and N - for residential 0.5m	3.3	43	47	<u>65</u>	54	51	49	48 (40)
46	15 Queen’s Road, Teddington	Kerbside	515522, 170927	100%	N – 0.4m	3.3	37	39	44	41	42	47	48 (39)
47	Causeway, Teddington	Kerbside	515829, 170967	100%	Y - for 1 hour mean objective and N - for residential 1.8m	2.7	42	46	54	51	48	47	49 (44)
48	Stanley Road, Teddington (junc Strathmore Road)	Kerbside	515059, 171805	100%	N – 2.4m	7.1	45	48	57	50	51	52	54 (46)
49	URRW War Memorial, Sheen Lane, Sheen	Kerbside	520505, 175390	100%	Y - for 1 hour mean objective and N - for residential 0.9m	2.9	45	47	60	49	51	49	50 (45)
50	URRW (nr. Clifford Avenue, Sheen)	Kerbside	519962, 175321	100%	Y - for 1 hour mean objective and N - for residential 0.7m	2.7	52	<u>63</u>	<u>67</u>	<u>70</u>	<u>66</u>	<u>69</u>	<u>64 (55)</u>
51	Sheen Lane (railway crossing), Sheen	Kerbside	520497, 175790	100%	N – 0.4m	1.3	36	39	48	40	41	41	39 (37)
52	Clifford Avenue, Chalkers Corner	Kerbside	519776, 175746	92%	N – 0.5m	2.2	51	55	<u>64</u>	<u>66</u>	<u>67</u>	<u>70</u>	<u>71 (60)</u>
53 ^b	Mobile Air Quality	Roadside	515513 168799	100%	Y – 0.2m	1.6	32	38	52	38	47	41	55 (45)

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54	Mortlake Rd (adj to West Hill Rd) Kew		519589 176489	100%	Y – 0.6m for residential	1.4						60	62	62 (57)
55	Mortlake Rd (adj to cemetery gates), Kew		519800 176142	100%	N – 0.6m	4.1						57	56	59(49)
56 ^e	A316 (St Margarets R'about)		173933 175433	75%	Y – 7.3m	9.6								41 (39)
57 ^e	A316 (Lincoln Ave)		172433 173933	75%	Y -12.7m	16.3								35 (29)
RUT 01	Civic Centre, York Street, Twickenham	Roadside	516356, 173365	100%	Y - for 1 hour mean objective 2.9m	3.0	49	54	64	57	64	62	70 (70)	
RUT 02	George Street, Richmond	Kerbside	517917, 174928	92%	Y - for 1 hour mean objective and N - for residential (above shops) 0.7m.	2.2	106	118	115	113	112	123	106 (90)	
RUT 03	Alexandra Hall, Cromwell Place, Mortlake	Urban background	520348, 175849	100%	Y – 54.3m	1.9	31	33	31	30	36	32	32	
RUT 04	Elmfield House, Waldegrave Road, Teddington	Urban background	515916, 171118	100%	Y- 18.9	2.2	30	30	30	30	32	30	29	

^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 Location of triplicate diffusion tubes

^c The Parkshot diffusion tube, Number 17, was moved on 1st December 2009 to Red Lion Street, Richmond.

^d Lower data capture is a result of problems during laboratory analysis

^e New sites 56 & 57 only established on 2nd March 2010, thus resulting in only 75% data capture

From the diffusion tube results in Table 10, comparing 2004 and 2010, we can see that most sites have increased between the two years, with a very few decreasing. There has generally been some variation between those two years. Many sites still exceed the objective limits at the roadside. The increase at location 17, Parkshot was due to the tube being moved on 1st December 2009 from a background location to a roadside location.

Figure 3 shows the trends at the 4 long-term sites. These sites were part of a 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 NO₂. The highest recorded exposure was at George Street (RUT 02), with a bias corrected result of 133 µg/m³ in 2003. This was a year which experienced higher pollution levels everywhere, due to the meteorological conditions that year.

Table 11 Annual mean NO₂ diffusion tube sampling from 1993 to 2010 in µg/m³ (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
2010	70	106	32	29

* In 2001 the diffusion tube at RUT 02 moved from the police station rear courtyard on Lewis Road to George Street, Richmond.

Nitrogen Dioxide Annual Average 1993-2010
 (In 2001 the location of RUT 02 changed from the rear of Paradise Rd, Richmond to George St, Richmond)

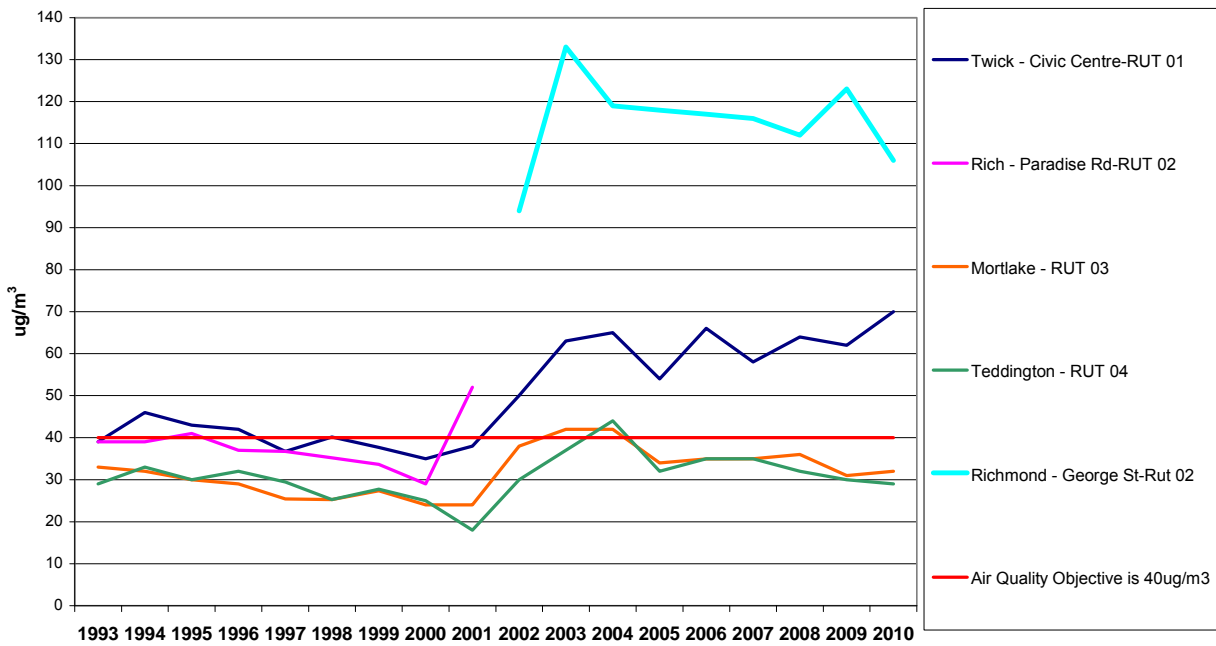


Figure 3: Annual mean NO₂ from 1993 to 2010 (Chart of Table 11 data. Bias corrected from 2002 onwards, because there was no bias correction data available for the earlier years). Note: the Richmond site moved from the police station rear courtyard on Lewis Road to George Street in 2001. The higher concentrations from 2002 demonstrate the impact of the much heavier local traffic movements at the new site.

1993 – 2001 not biased adjusted

2003 – 2010 bias adjusted

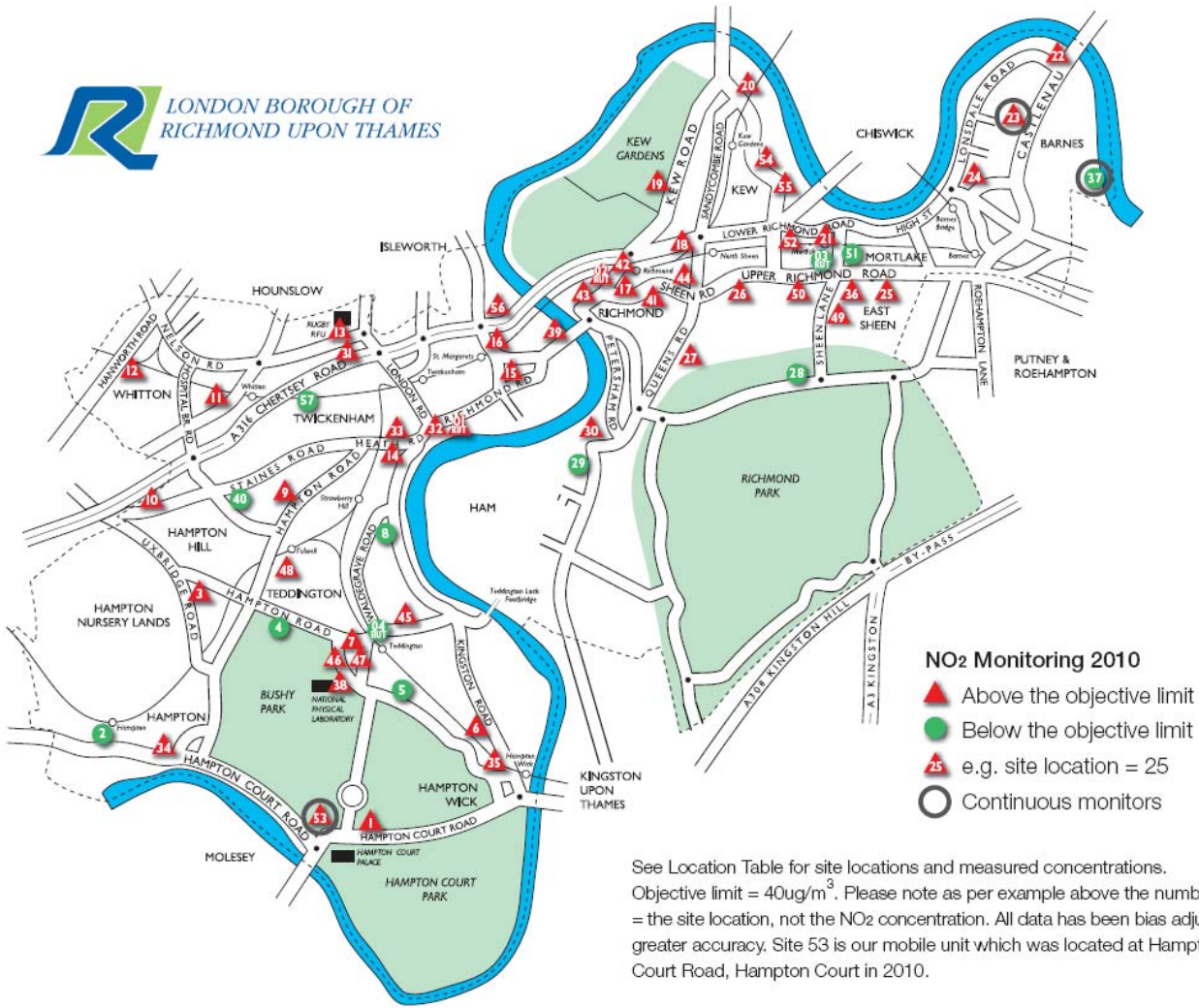


Figure 4: Map showing the location of the NO₂ diffusion tubes and continuous monitors in 2010. All results have been bias adjusted.

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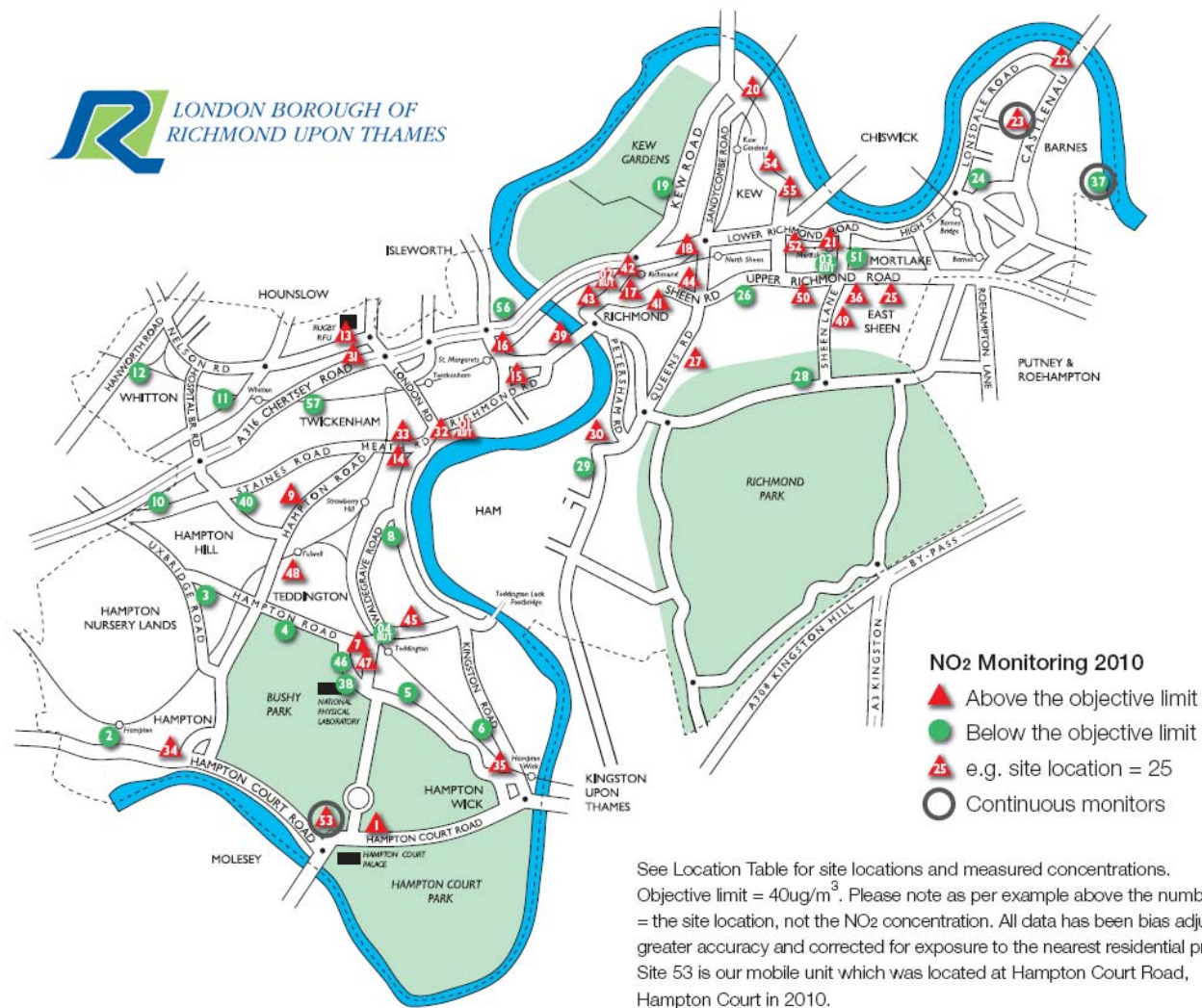


Figure 5: Map showing the location of the NO₂ diffusion tubes and the continuous monitors in 2010. The results have been bias adjusted and an additional distance adjustment has been calculated to show the **estimated concentration at the nearest sensitive receptor**.

The following table compares NO₂ annual averages from 2002 to 2010 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	2010
Continuous analysers	44	48	41	42	42	43	44	45	43
Diffusion tubes	44	45	34	42	49	41	43	43	43
Wetlands	2002	2003	2004	2005	2006	2007	2008	2009	2010
Continuous analysers	32	37	31	30	30	31	29	29	30
Diffusion tubes	35	32	26	29	36	31	29	28	28
Mobile	2002	2003	2004	2005	2006	2007	2008	2009	2010
Continuous analysers						38	42	40	45
Diffusion tubes						38	47	41	55

Figures in bold indicate an exceedence of the NO₂ air quality objective of 40ug/m³
The diffusion tube data have been bias adjusted

The results show, with a few exceptions, that the results from the diffusion tube data are similar to the continuous analyser data.. There are two years when there is a significant difference between the diffusion tube data and the continuous analyser data. At Castelnau in 2004 the diffusion tube data was below the AQO while the continuous data was above and at the Mobile in 2010, the diffusion tube data was 10ug/m³ higher than the continuous analyser result.

There are four other results that differ by 5ug/m³ or more, Castelnau in 2006, Wetlands in 2003 and 2006 and the Mobile in 2008.

Benzene (C₆H₆)

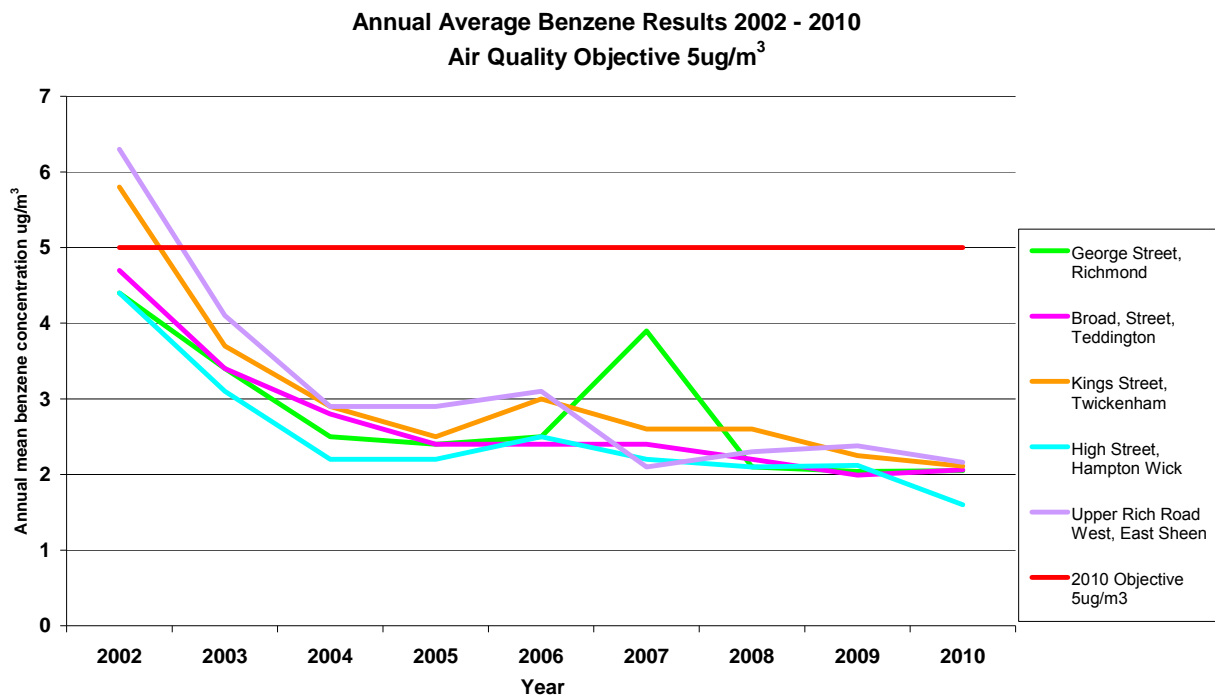
From 2002 to 2008, LBRuT carried out BTEX (benzene, toluene, ethyl benzene, xylene) diffusion tube monitoring at 5 locations across the borough at the following sites, George St, Richmond, Broad St, Teddington, King St, Twickenham, High St, Hampton Wick and Upper Richmond Road West / Sheen Lane where NO₂ diffusion tubes are also deployed. The locations are shown in Table 13 below and on the map at Figures 4 and 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 2011

Site ID	Location	AQMA designation	Proportion of the year with valid data % (2011)	Annual Mean (ug/m ³) Air Quality Objective 5ug/m ³								
				2002	2003	2004	2005	2006	2007	2008	2009	2010
RUT 02	George St Richmond	N	100%	4.4	3.4	2.5	2.4	2.5 ^a	3.9	2.1	2.0	2.05
7	Broad St Teddington	N	100%	4.7	3.4 ^a	2.8	2.4	2.4	2.4 ^a	2.2 ^a	1.99	2.06
32	King St, Twickenham	N	100%	5.8	3.7	2.9 ^a	2.5	3.0	2.6	2.6	2.2	2.11
35	High St, Hampton Wick	N	100%	4.4	3.1	2.2 ^a	2.2	2.5	2.2	2.1	2.1	1.6
36	URRW/Sheen Lane	N	100%	6.3	4.1	2.9	2.9	3.1	2.1	2.3	2.4	2.16

Bold = over Air Quality Objective of 5ug/m³

Figure 6 Annual mean benzene from 2002 to 2011



2.2 Comparison of Monitoring Results with Air Quality Objectives

The following sections provide the LBRuT monitoring results for 2002 to 2010 in relation to the relevant air quality objectives.

Previous rounds of review and assessment have established that the annual mean NO₂ objective is the most stringent of the objectives that need to be met (LBRuT, 2004), since the proposed tighter 2010 PM₁₀ particle objectives were not adopted (Defra, 2003).

NO₂ measurements at the roadside Richmond 1 Castelnau automatic monitoring site consistently exceeded the annual mean NO₂ objective of 40 µg/m³ by 1 to 4 µg/m³. In 2003, the continuous monitoring annual mean NO₂ was noticeably higher at 48 µg/m³. The year 2003 was known to be an exceptional year for air pollution due to the meteorological conditions (ERG, 2009). The annual mean NO₂ concentration (as estimated for the nearest residential receptor to Richmond 1 Castelnau) exceeded the annual objective from 2002 to 2009. In 2010 the estimated concentration at the nearest residential receptor was 40ug/m³, which is equal to the air quality objective of 40ug/m³. In 2010 the background concentration used for Castelnau was 30ug/m³. 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 provide 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 NO₂ objective was exceeded by 2µg/m³. In 2009 the mobile was located at Upper Teddington Road, Teddington and the annual mean was 40ug/m³. When the mobile was deployed at Hampton Court Road, Hampton Court, in 2010, the annual mean was 45ug/m³. This reduces to 39 ug/m³ when estimated for the nearest residential building façade.

At the two background sites, Richmond 2 Barnes Wetlands and NPL Teddington (AURN), there were no exceedences of the annual mean NO₂ objective between 2002 and 2010.

The percentage of NO₂ diffusion tube sites exceeding the annual mean NO₂ objective went from 79% (45 of 57) in 2006, 86% (51 of 59) in 2008, 83% (49 of 59) in 2009 and 80% (49 of 61) in 2010. 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). In 2010 this increased to 10 sites below the objective. This demonstrates that although the estimate is that there was an improvement in number of sites that complied with the NO₂ air quality objective at the building façade, NO₂ remains an issue at many locations across the Borough.. 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 NO₂ limit of 18 1-hour means above 200 µg/m³ 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 µg/m³, (see Table 3).

Table 10 shows that there were 14 NO₂ diffusion tube sites (not estimated at the nearest residential facade) in 2010 which had an annual mean >60 µg/m³ indicating that the hourly mean could also have been exceeded, and that for 11 of these sites, there was relevant population exposure for the short term 1-hour mean objective. Example locations of this 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 NO₂ so all exceedences discussed above fall within in the AQMA.

The annual mean PM10 was not exceeded at any monitoring site during the last nine 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, SO₂ 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 from 2003 to 2009 at the, Richmond 2 Barnes Wetlands, and over the last 9 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

NO₂ is measured across the Borough at four automatic monitoring stations and 61 diffusion tube sites. Table 3 (for continuous monitoring data) shows that the annual mean NO₂ objective has been consistently exceeded at the Richmond 1 Castelnau automatic monitoring site for the years 2002 - 2010. The monitor is 3.3m from the kerb, whereas the closest residential building façade is 9.0m. When the distance calculator is used, the concentration of 43µg/m³ (2010 continuous monitor) is then estimated at the nearest residential receptor to be 40µg/m³. As the diffusion tube concentration is also 43µg/m³, the same concentration at the closest residential façade is applicable. The relevant background concentration, of 30µg/m³ from the Wetlands site was used in the distance calculation.

Table 10 (for diffusion tube data) shows that the annual mean NO₂ objective was exceeded by 7µg/m³ in 2008 for the Richmond Mobile when it was deployed at Mortlake Road. At the same site, the continuous data gave an exceedence of 2µg/m³. When the mobile was at Upper Teddington Rd, Teddington (2009), the diffusion tubes exceeded the objective by 1 µg/m³ and the continuous monitor result was exactly on the objective limit of 40 µg/m³. In 2010 when the mobile was located on Hampton Court Road the diffusion tube reading was 55µg/m³, whilst the analyser results was 45µg/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 2010 there were no exceedences of the annual mean NO₂ 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 µg/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 µg/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 µg/m³ was greatest at the roadside Richmond 1 Castelnau site, as expected, because of the proximity to road transport sources of NO₂. In 2010 there were no exceedences of the hourly mean limit.

Table 10 shows that the 2010 annual mean NO₂ objective of 40 µg/m³ was exceeded at 49 of the 61 diffusion tube sites. At 58 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 µg/m³ for over one hour.

Table 10 shows that 39 sites were predicted to exceed the annual mean objective of 40 µg/m³, when calculated for the building façade. At 8 of these sites the annual mean actually exceeds 60 µg/m³, indicating that the 1-hour objective limit might also have been exceeded, as monitored at the monitoring location. Of these 8 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 NO₂ 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 99.8th percentile of the hourly means when the valid data for the year are less than 90%. The NPL result in 2009 was 109µg/m³ (in brackets) and in 2010, 101µg/m³ which indicates compliance, as they are under the limit of 200 µg/m³.

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

Site ID	Location	AQMA designation	Data Capture for full calendar year 2010 ^a %	Annual mean concentrations ($\mu\text{g}/\text{m}^3$) Air Quality Objective 40 $\mu\text{g}/\text{m}^3$			
				2007 ^b	2008 ^b	2009	2010
RI1 ^c	Castelnau	Y	98%	43	44	45	43
RI2 ^d	Wetlands, Barnes	Y	100%	31	29	29	30
Mobile ^e	Hampton Court	Y	98%	38	42	40	45
TD0 ^f	NPL, Teddington	Y	78%	28	25	22	24

^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 Castelnau – all data have been fully ratified.

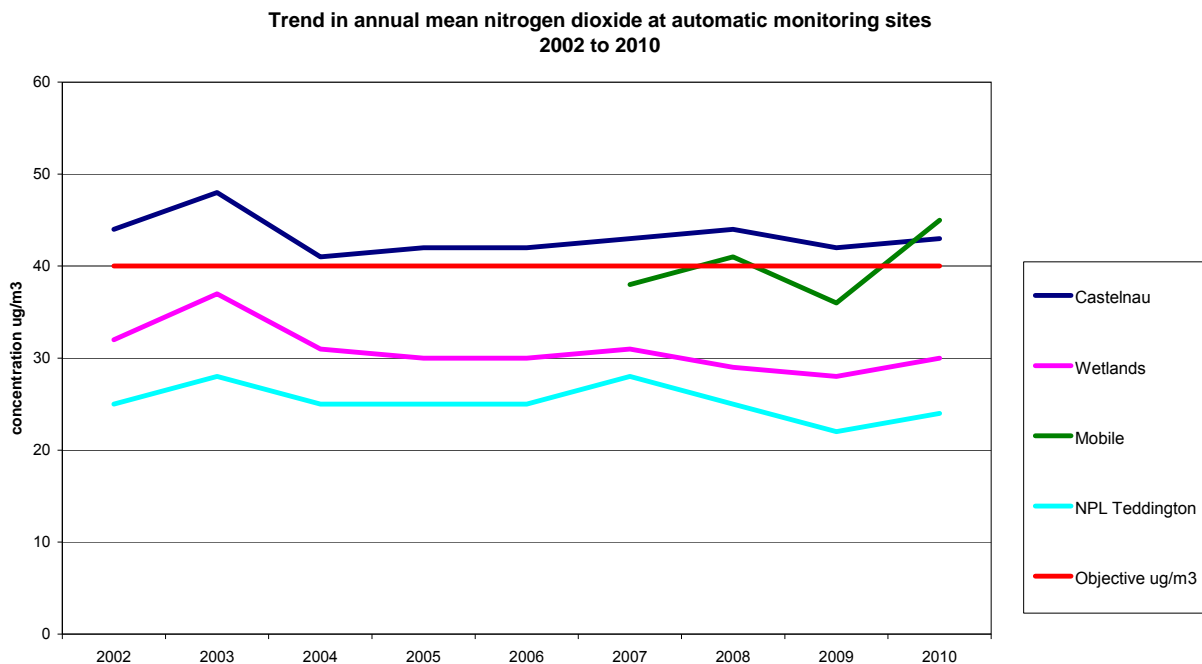
^d Wetlands – all data have been fully ratified.

^e Mobile Hampton Court Rd, Hampton Court (2010) – all data have been fully ratified.

^f Teddington (AURN) NPL – all data have been 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	AQMA designation	Data Capture for full calendar year 2010 ^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	2010
RI1 ^b	Castelnau	Y	98%	7	9	3	0
RI2 ^c	Wetlands, Barnes	Y	100%	0	1	0	0
Mobile	Hampton Court Road (2010)	Y	98%	0	0	0	0
TD0 ^e	NPL, Teddington	Y	78%	0	0	0 (109)	0 (98) ^f

^a Data capture from the full calendar year

^b Castelnau – all data have been fully ratified

^c Wetlands – all data have been fully ratified

^d Mobile Hampton Court Road, Hampton Court (2010) – all data fully ratified

^e Teddington (AURN) NPL – all data have been fully ratified

^f 99.8thile equals 98 ug/m³ (calculated, as data capture less than 90%) i.e. it complies with the 200ug/m³ 99.8thile limit

(See also Table 3)

Diffusion Tube Monitoring Data

Table 10 shows a comparison of the 2004 to 2010 diffusion tube monitoring results. Exceedences of the annual mean NO₂ objective are highlighted in **bold**. Concentrations > 60µg/m³ are underlined, to indicate that the hourly objective may also have been exceeded (as estimated from the annual mean). The results in brackets indicate the exposure estimate, calculated for the nearest residential façade and this is displayed in the map at figure 5.

2.2.2 PM₁₀

PM₁₀ is measured by TEOM at three automatic monitoring stations in the LBRuT, these results are presented in Tables 15a and 15b. If there were any exceedences of the PM₁₀ objectives they would be highlighted in **bold**. Table 15b 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 15a show that annual mean and the daily mean PM₁₀ was not exceeded at any site during the last three years.

Table 15a Results of PM₁₀ Automatic Monitoring: Comparison with Annual Mean Objective

Site ID	Location	AQMA designation	Data Capture for full calendar year 2010 ^a %	Annual mean concentrations (µg/m ³) Air Quality Objective 40µg/m ³			
				2007	2008	2009	2010
RI1 ^c	Castelnau	Y	98%	23	21	21	21
RI2 ^c	Wetlands, Barnes	Y	99%	20	19	20	19
Mobile ^b	Richmond Mobile	Y	98%	23	25	23	22

^a Data capture for the full calendar year

^b Mobile data is fully ratified

^c Data for Castelnau and Wetlands is fully ratified

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 15b Results of PM₁₀ Automatic Monitoring: Comparison with 24-hour Mean Objective

Site ID	Location	AQMA designation	Data Capture 2010 ^a %	Number of Exceedences of daily mean objective (50 µg/m ³) not to be exceeded more than 35 times per annum. If data capture < 90%, include the 90 th percentile of daily means in brackets.			
				2007 ^e	2008 ^e	2009 ^e	2010 ^e
RI1 ^c	Castelnau	Y	98%	21	12	4	2
RI2 ^c	Wetlands, Barnes	Y	99%	19	8	5	1
Mobile ^b	Richmond Mobile	Y	98%	22	13 ^d (41)	5	5

^a Data capture for the full calendar year

^b Mobile data is fully ratified.

^c Castelnau and Wetlands is fully ratified.

^d Data capture was 66% i.e. less than 90%, so the percentile given in brackets for 2008 indicates that the objective of 50µg/m³ 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

SO₂ was measured at one automatic monitoring station in the LBRuT, at the Richmond Mobile. Table 16 demonstrates that the SO₂ objectives were met in 2010, at the roadside monitoring site in Upper Teddington Road, Teddington.

Table 16 2010 Results of SO₂ Automatic Monitoring: Comparison with Objectives

Site ID	Location	Within AQMA?	Data Capture 2009 ^a %	Number of Exceedences of: (µg/m ³)		
				15-minute Objective (266 µg/m ³)	1-hour Objective (350 µg/m ³)	24-hour Objective (125 µg/m ³)
RI1 ^b	Richmond Mobile	Y	98%	0	0	0

^a Data capture for the full calendar year

^b Mobile data has been fully ratified.

The 15 minute objective is most relevant to public exposure, for the Hampton Court 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 17 demonstrates that the benzene objective was met across LBRuT in 2010.

Table 17 Results of benzene monitoring in 2010

Site ID	Location	Within AQMA?	Proportion of year with valid data in 2010 %	2010 µg/m ³ (2010 Objective 5 µg/m ³)
7	Broad St, Teddington (Tesco)	Y	100%	2.06
32	King St, Twickenham	Y	100%	2.11
35	High St, Hampton Wick	Y	100%	1.63
36	URRW, Sheen Lane	Y	100%	2.16
RUT 02	George St, Richmond	Y	100%	2.05

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, i.e. 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 18 shows that, in 2010, the UK Air Quality Strategy ozone objective was breached in LBRuT at the background site, Teddington (AURN) but not at the Mobile monitor, when it was at a more polluted roadside site, in the Hampton Court Road, Hampton Court.

Exceedences of the ozone objectives are highlighted in **bold**. In 2010, there were 7 exceedences of the running 8-hour objective at the Wetlands site, none at the mobile and 16 exceedences at the NPL site. The UK objective for protection of human health for ozone is $100\mu\text{g}/\text{m}^3$. 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 18 Results of 2010 ozone monitoring

Location	Proportion of the year with valid data 2010 %	Number of exceedence of the 8 hour running mean ($100\mu\text{g}/\text{m}^3$)
^a Wetlands, Barnes	97%	6
^a Richmond Mobile	98%	0
^a NPL (AURN), Teddington	83%	16

^a all data has been fully ratified.

Limit = 10 exceedences per year

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 PM_{10} , 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 PM_{10} designation is more borderline, with exceedences still possible at some vulnerable receptor locations (as indicated by modelling). It therefore seems sensible to retain the borough wide AQMA PM_{10} designation for the present, to accommodate a poor meteorological year, rather than revoke the designation just yet.

It is intended to undertake modelling of NO_2 for 2015. The anticipation is that we should expect to see areas of the Borough where the objectives will still be exceeded, including locations where there are sensitive receptors.

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, the road traffic was modelled for when T5 would be fully operational (2016), and it was estimated that the T5 traffic would 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 stationary for 15 minutes or more, with potential for relevant exposure within 15m.

Moving Trains

LBRuT confirms that there 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

Planning applications are assessed for any air quality impacts on neighbouring sensitive receptors, during both the development phase and the end use phase.

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

7.1 Second Local Implementation Plan (2011-2014)

The Second Local Implementation Plan (LIP2) for transport outlines how the London Borough of Richmond will implement the Mayor of London's Transport Strategy. Richmond's LIP2 covers the same period as the revised Mayors Transport Strategy (up to 20 years) and includes delivery proposals for the period 2011/12 – 2013/14.

As well as the Mayors Transport Strategy, the LIP2 is also informed by the South London Sub-Regional Transport Plan that was published during the writing of the LIP2. It also is in line with Richmond's Community Strategy and other relevant Richmond policy documents.

It has been developed in accordance with TfL's Guidance on Developing the Second London Implementation Plans (TfL, 2010) and the Plan sets out to serve three key purposes:

- To set out the Council's long term goals in regards to transport priorities, policies and programmes.
- To demonstrate how Richmond upon Thames will help support the London Mayor achieve the objectives set out in the Mayor's Transport Strategy.
- To outline the Borough's own transport objectives and a broad programme of investment covering the period 2011 to 2014 and beyond, including major schemes to improve Richmond, Twickenham and Whitton Town Centres.

View the Second Local Implementation (LIP2) at
Planhttp://www.richmond.gov.uk/second_local_implementation_plan.pdf

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 CO₂ 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 CO₂ emissions through National Indicators: 185, 186 and 188 which set targets to be achieved.

9 Implementation of Action Plans

An update of the boroughs Air Quality Action Plan is presented separately.

10 Conclusions and Proposed Actions

10.1 Conclusions from New Monitoring Data

The results from monitoring in 2010 show that the concentrations of PM₁₀, CO, SO₂ and benzene were each below their relevant objective limits.

NO₂ concentrations were found to exceed the objective of 40ug/m³ at most of the locations monitored. In addition, the borough-wide modelling for 2010 (LAEI, 2004, with worst case 2003 'met' year and including any benefits from the LEZ) also confirmed these widespread exceedences. Both of these conclusions indicate the continuing need for the Borough to remain designated as a borough-wide AQMA for NO₂. This conclusion remains true for many of the sites 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/m³ or above, exceedences of the one hour NO₂ objective are also likely to occur. The 2010 NO₂ monitoring data indicates that at some locations the annual mean NO₂ did exceed 60ug/m³ in some areas, with George St, Richmond and Kings St, Twickenham recording levels of more than 100ug/m³. 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 at a number of sites, 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 seven 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, and to do a modelling assessment.

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 actions within its Air Quality Action Plan (AQAP). These actions are designed to achieve air quality improvements across the borough. Progress has been made in implementing the 33 measures. The vast majority of these measures are ongoing and have no time limit, but progress on them is reviewed annually and is reported separately in the AQAP Progress Report.

The Council is further reducing the emissions by encouraging developers to participate in the 'Considerate Constructor Scheme'.

At the regional level, the Borough continues to work with the Mayor of London's plan to reduce emissions in his London Air Quality Strategy.

10.4 Proposed Actions

London Borough of Richmond upon Thames

From the 2010 monitoring data it can be concluded that there is no need to proceed to a detailed assessment. An updated modelling assessment would indicate the position with the evolving air quality situation in the borough. The next course of action is to prepare and submit the 2012 Update and Screening Assessment (USA).

Following a gap analysis, the number of NO₂ monitoring sites was increased 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 AQAP.

11 References

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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

Local Air Quality Management – Policy Guidance (PG09)

<http://www.defra.gov.uk/publications/2011/06/17/pb13566-laqm-policy-guidance-pg09/>

Useful Tools and Technical Guidance

<http://www.defra.gov.uk/environment/quality/air/air-quality/laqm/guidance/policy/>

Appendices

Appendix A: QA:QC of data

Diffusion Tube Bias Adjustment Factors

NO₂ diffusion tube analysis method

NO₂ 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). NO₂ 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 NO₂ 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 NO₂ diffusion tubes are labelled and kept refrigerated in plastic bags prior to and after exposure.

Gradko is accredited by UKAS for the analysis of NO₂ 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

The Borough undertakes co-location studies at three continuous NO₂ monitoring sites, together with 3x NO₂ diffusion tubes at each of the following the locations:

Richmond 1 Castelnau (site 23): a roadside site, used to bias adjust all other kerbside and roadside sites in the borough.

Richmond 2 Barnes Wetlands (site 37): 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 NO₂ 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

2010 – RIY Hampton Court Road, Hampton Court

The 2010 bias adjustment factor for all kerbside and roadside sites in the Borough 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 2010 bias adjustment factor for all background sites in the Borough 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 2010 bias adjustment factor from the co-location study at Richmond RIY (Mobile) Hampton Court Road, Hampton Court. 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 Borough are provided in Table A.1 for 2002 to 2010. 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 2010 all kerbside and roadside sites in the Borough 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 Borough 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 2010 NO₂ diffusion tube bias adjustment factors for the Borough

Source of bias adjustment factor	2002	2003	2004	2005	2006	2007	2008	2009	2010
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	1.06
Local background co-location study at Richmond 2 Wetlands Barnes							1.05	1.02	1.02
UWE national factor (not used)	1.27	1.11	1.10	1.10	1.01	0.98	0.93	0.99	1.03

QA/QC of NO₂ 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 NO₂ along with other pollutants. Under the Directive, annual mean NO₂ concentration data derived from diffusion tube measurements must demonstrate an accuracy of $\pm 25\%$ to enable comparison with the NO₂ air quality objectives of the Directive.

In order to ensure that NO₂ 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 NO₂ 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 NO₂ 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 The Borough 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 NO₂ 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 NO₂ 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 NO₂ 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 NO₂ 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 to2010 network field intercomparison results

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

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 The Borough's 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 2010 monthly data capture for all pollutants at the Richmond R1Y (Mobile) Hampton Court Road, Teddington is therefore 85% or lower because the Mobile moved to the site on the 12th January 2010. This loss of days is shown in the lower data capture rate, but still works out above the 90% rate when taken over the year.

.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 – 3000 nano grams. The solutions 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 polynomial 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 a problem with the customer's 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 $\mu\text{g}/\text{m}^3$.

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 run 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.

Appendix B:

Nitrogen Dioxide Distance Calculation Methodology

The level of nitrogen dioxide measured by diffusion tubes is calculated to the nearest façade by using the following Air Quality Consultants distance calculator:

<http://laqm.defra.gov.uk/documents/NO2withDistancefromRoadsCalculatorIssue4.xls>

In 2010 the mean background data is taken from the Wetlands NO₂ annual average i.e. 30ug/m³ and used for all sites located in the northern section of the borough whilst the NPL NO₂ annual average i.e. 24ug/m³ is used for all sites in the southern section of the borough.