2013
Air Quality Progress Report for *The London Borough of Richmond upon Thames*

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

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Executive Summary

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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), for the pollutants nitrogen dioxide ((NO_2)) and PM_{10} particulates. This was because pollutant levels were high at the time and predicted to continue exceeding the relevant limits. The monitoring results in this report, from the calendar year of 2012, confirm that pollution levels are still being exceeded in areas across the Borough. In addition, modelling data also indicates that we can expect pollution levels to continue to be exceeded until at least 2015. In 2012, ozone also continued to exceed the standards, whereas $PM_{2.5}$ particulates continued to comply.

The Report concludes that both nitrogen dioxide (NO_2) and PM_{10} particle concentrations are likely to continue exceeding their relevant air quality standards. It is therefore proposed that the monitoring should continue and that the Borough's AQMA designation should still stand.

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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. This table shows the objectives in units of microgrammes per cubic metre μg/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 μg/m^3	Running annual mean	31.12.2003
	5.00 μg/m^3	Running annual mean	31.12.2010
1,3-Butadiene	2.25 μg/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 μg/m^3	Annual mean	31.12.2004
	0.25 μg/m^3	Annual mean	31.12.2008
Nitrogen dioxide	200 μg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 μg/m^3	Annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)	50 μg/m^3, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 μg/m^3	Annual mean	31.12.2004
Sulphur dioxide	350 μg/m^3, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 μg/m^3, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 μg/m^3, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

1.4 Summary of Previous Review and Assessments

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 (NO_2) and PM_{10} 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 NO_2 and PM_{10} objectives
7. Air Quality Review and Assessment Progress Report 2005 – gave updated monitoring results
8. Air Quality Review and Assessment Progress Report 2007 – the monitoring results indicate air quality did exceed the air quality objectives at some locations in the borough.
9. Air Quality Review and Assessment Progress Report 2008 – the monitoring results showed that NO_2 exceed the air quality objective across the borough and PM10 in parts of the borough.
10. Air Quality Review and Assessment Progress Report 2010 - the monitoring results showed that NO_2 exceed the air quality objective across the borough and PM10 in parts of the borough.
11. Air Quality Review and Assessment Progress Report 2011 - the monitoring results showed that NO_2 exceed the air quality objective across the borough and PM10 in parts of the borough.
12. Update and Screening Assessment 2012 predicted continuing exceedence of the NO_2 objective. The PM10 monitoring results show that the objectives were not exceeded and hence the designation of the AQMA for PM10 will be kept under review.

The reports for the above stages 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 and 2011; USAs for 2004, 2006, 2009 and 2012. Also the 2000 AQMA designation and the resulting AQAP in 2002, with subsequent AQAP progress reports..

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, NO_2 and PM_{10}. 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 then required to undertake a further 'Stage 4' assessment, to refine the detail of the previous assessment and to assist with targeting the action required to improve the air quality. The 'Stage 4' review was completed in May 2002, following a revision of the traffic forecasts and using a new emissions inventory for London.

The Stage 4 report confirmed the Stage 3 findings that the statutory objectives for both NO_2 and PM_{10} would still be exceeded in 2005. The areas predicted to exceed the targets are mainly adjacent to the major through traffic routes. The next phase was to produce an USA in 2006, which confirmed continuing exceedence of the objectives and since the USA in 2006 an Air Quality Review and Assessment, and AQAP Progress Report, was produced in 2007 and 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 PM_{10} (2004) and NO_2 (2005) limits, so the LBRuT is still obliged to try to meet those objectives.

An update of the AQAP is currently being undertaken.

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 62 passive 'diffusion tube' monitoring sites produce results once a month.

The latest (2012) monitoring results confirm that air pollution in the LBRuT still exceeds the 2004/2005 objectives, and the new 2010 objectives for NO_2 and PM10, and therefore there is still a need for LBRuT to be designated as an AQMA and consequently there is still a need to pursue improvements in air quality.

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

Nitrogen dioxide (NO_2) (1-hour mean)
Particulate matter (PM_{10}) (24-hour mean)
Sulphur dioxide (SO_2) (15-minute mean) (monitoring ceased April 2011)
Ozone (O_3) (running 8-hour mean)
Carbon monoxide (CO) (running 8-hour mean) (monitoring ceased April 2012)
Benzene (2-week/month monitoring mean – annual mean limit only) (monitoring ceased Dec 2011)

Table 10 lists the locations of the NO_2 diffusion tube monitors in the LBRuT. The tubes are a relatively cheap way of monitoring, which therefore allows samples to be taken across the whole LBRuT and gives a Borough-wide view. The results obtained give monthly averages, and are not precise but do provide an indication of NO_2 pollution levels. The accuracy of the diffusion tube readings can be increased when their results are compared, and the bias adjusted, with data from the more accurate continuous monitors. Richmond Council has a network of 68 diffusion tubes to monitor NO_2 at 62 locations across the LBRuT (detailed in Table 10). Benzene was monitored up until December 2011 at 5 sites (detailed in Table 13).

At four locations in the LBRuT there are air pollution analysers running continuously (locations given in Table 2 and Table 4 and also 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. The QA/QC procedures 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.

Monitoring sites	Operational since	Pollutants monitored
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 2012 the mobile was located at Hanworth Rd, Whitton, which was a roadside site.	1995	NO_X, NO, NO_2 (high and low), PM_{10} SO_2 (ceased April 2011) and CO (ceased April 2012).
NPL - Teddington AURN. Static suburban (background) site - well away from roads.	1996	NO_X, NO_2, NO, SO_2 (ceased October 2007) $PM_{2.5}$ 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 2010 to 2012. Each set of results is given, starting with NO_2, then PM_{10}, $PM_{2.5}$ O_3, SO_2, CO and benzene. Results in **bold** are ones which exceed the objective limits. Details on the relevant objective limits are given in Table 1.

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

Nitrogen dioxide (NO_2) in the LBRUT

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

Castelnau	2010	2011	2012
Annual mean NO_2 (μg/m^3)	**43**	39	37
Number of exceedences of hourly mean of 200 μg/m^3 [a]	0	0	0
Data capture (%)	98%	100%	80% [b]

Wetlands	**2010**	**2011**	**2012**
Annual mean NO_2 ($\mu g/m^3$)	30	26	25
Number of exceedences of hourly mean of 200 $\mu g/m^3$ [a]	0	0	0
Data capture (%)	100%	97%	99%
Mobile Unit	**2010**	**2011**	**2012** [c]
Annual mean NO_2 ($\mu g/m^3$)	**45**	**48**	**44**
Number of exceedences of hourly mean of 200 $\mu g/m^3$ [a]	0	0	0
Data capture (%)	98%	87%	72%
NPL – Teddington AURN	**2010**	**2011**	**2012**
Annual mean NO_2 ($\mu g/m^3$)	24	21	36
Number of exceedences of hourly mean of 200 $\mu g/m^3$ [a]	0	0	0
Data capture (%)	78%	96%	93%

[a] The hourly mean objective for NO2 is 200ug/m^3 which should not be exceeded more than 18 times per year.
[b] the lower data capture was due to technical problems with the manifold for the period 08/01/12-19/03/12
[c] **2012** data for the Mobile - Due to power supply issues the Mobile unit only commenced monitoring in Hanworth Rd on 15/3/12 resulting in 72% data capture for the year of 2012. Results may not be representative of the full year and should be used for guidance only.

Table 3 shows that the annual mean for Castelnau exceeded the NO_2 objective (40 $\mu g/m^3$) in 2010; in 2011 and 2012 NO_2 was below the objective. The annual mean NO_2 objective (40 $\mu g/m^3$) was not exceeded at the Wetlands and NPL – Teddington AURN sites in 2010, 2011 and 2012. The annual mean at the mobile unit exceeded the NO_2 objective (40 $\mu g/m^3$) in 2010, 2011 and 2012,.The 1-hour objective was not exceeded at any site in 2010, 2011 and 2012.

The results from both the NO_2 diffusion tube sampling and the continuous analysers give good agreement with the modelling done by Kings College London, Environmental Research Group (ERG) for the year 2010, based on the London Atmospheric Emissions Inventory (LAEI) for 2003 and the meteorological year of 2003. It identified that under a repeat of those 2003 meteorological conditions; there would be widespread exceedences of the annual mean NO_2 2010 objective across the LBRuT. Subsequent modelling for 2015 indicates that exceedences are expected to continue.

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 [(a)], SO_2 [(b)] and PM_{10}	TEOM	Y	Changes	Changes	Changes
NPL - Teddington AURN (TD0)	Suburban	515542	170420	NO_X, NO, NO_2, $PM_{2.5}$ and O_3	TEOM	Y	Y (50)	N/A	N/A

(a) CO monitoring ceased at the Mobile in March 2012
(b) SO_2 monitoring ceased at the Mobile in April 2011

Particulate matter (PM_{10}) in the LBRuT

The LBRuT uses a Tapered Element Oscillating Microbalance (TEOM) to continuously monitor PM_{10}. All TEOM results are converted to reference equivalence using the Volatile Correction Method (VCM), which is administered on our behalf by ERG, when they process our monitoring data.. As mentioned in section 1.4, PM_{10} is a specified pollutant for the whole borough AQMA.

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

Castelnau	**2010**	**2011**	**2012**
Annual mean PM_{10} ($\mu g/m^3$)	21	23	21
Number of exceedences of the 24-hour mean	2	15	14
Data capture (%)	98%	99%	99%
Wetlands	**2010**	**2011**	**2012**
Annual mean PM_{10} ($\mu g/m^3$)	19	22	18
Number of exceedences of the 24-hour mean	1	17	13
Data capture (%)	99%	92%	99%
Mobile Unit **	**2010**	**2011**	**2012***
Annual mean PM_{10} ($\mu g/m^3$)	22	27	24
Number of exceedences of the 24-hour mean ******	1	12	10
Data capture (%)	95%	92%	74%

* Due to power supply issues the Mobile unit commenced monitoring in Hanworth Rd on 15/3/12 resulting in 74% data capture for the year of 2012. Results may not be representative of the full year and should be used for guidance only.
** See Table 5a for the exceedence breakdown at each mobile unit deployment.

There were no exceedences of the annual and daily objectives for PM_{10} in 2010, 2011 and 2012 at any site.

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

Mobile Unit location	Start date	End date	2010	2011	2012	Site Total
Hampton Court Rd, Hampton Court	05/01/10	11/01/11	1			1
Lower Mortlake Road, Richmond	11/01/11	04/01/12		12		12
Hanworth Road, Whitton	15/03/12	present			10	10

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

Table 5a shows that, at the Mobile Air Quality Unit, there are no 'exceedences' of the 24-hour mean 2004 objective limit of 50 µg/m^3

2015 annual mean predicted modelled concentrations of PM_{10} (ug/m^3), across the LBRuT, are displayed in the following map - Figure 2.

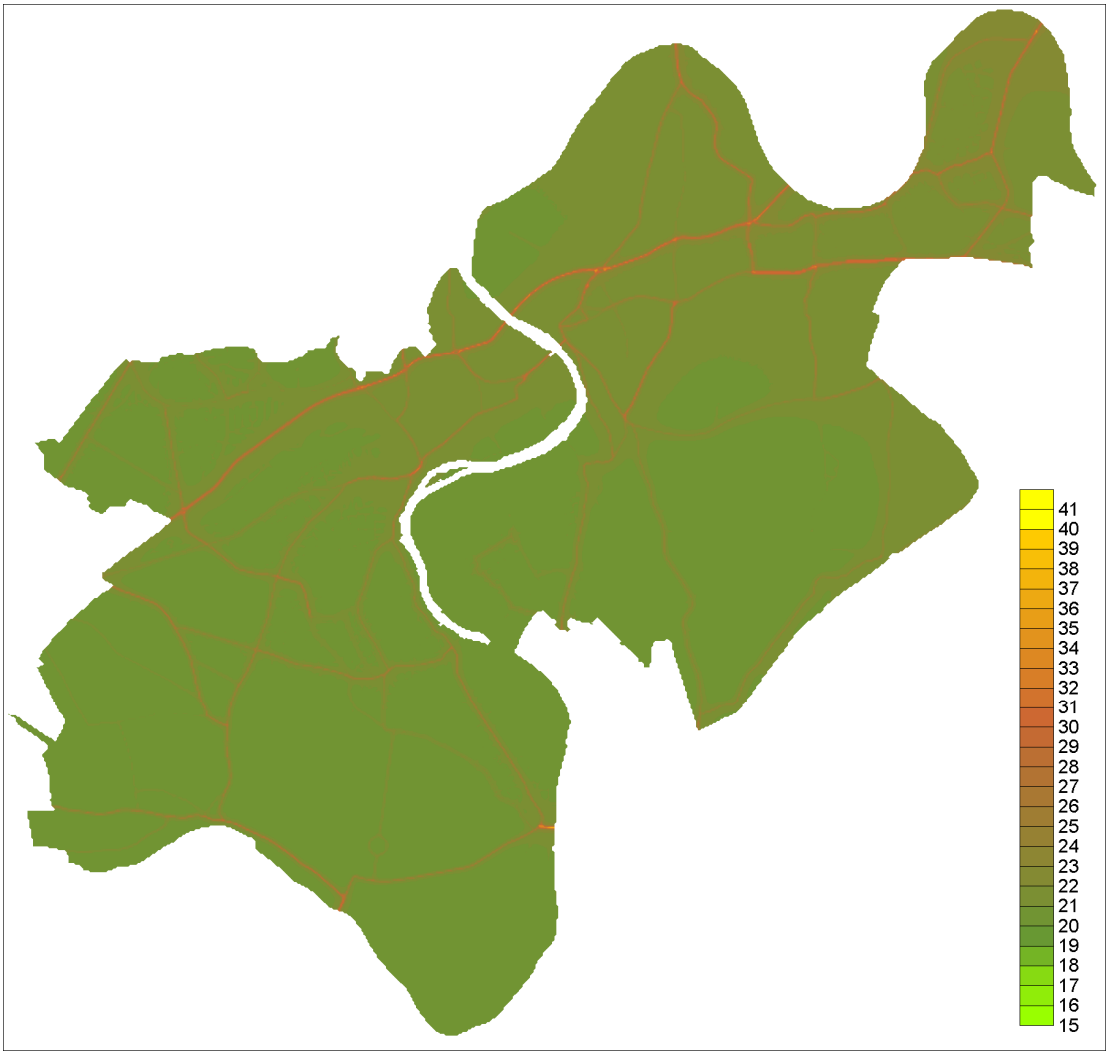

Figure 2: Modelled PM_{10} concentrations in LBRuT for 2015. (Modelled by ERG from 2010 data) Annual Limit = 40ug/m3

Modelling by Kings College ERG for the year 2015 gives similar results to the previous 2010 modelling. The 2015 results show, at some locations, close to road sources, that the objectives are still likely to be exceeded at vulnerable residential receptors. This supports retention of the AQMA PM_{10} 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 the Filter Dynamics Measurement System (FDMS), at their background site.

Table 6 $PM_{2.5}$ levels at NPL

National Physical Laboratory	**2010**	**2011**	**2012**
Annual mean [a]	14	17.5	11.5
Data capture (%)	77%	80%	98%

[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 2010, 2011 and 2012 were below the target value.

Other Pollutants Monitored

Ozone (O_3)
Ozone is continuously monitored at the three sites in the Borough. The results from 2010 to 2012 are shown in Table 7 below. Ozone data are useful for studies of urban background pollution levels within London. As expected, the data below demonstrates that we have higher exceedence levels away from busy roads.

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

Wetlands	**2010**	**2011**	**2012**
Number of exceedences of the running 8-hour mean	6	**12**	**15**
Data capture (%)	97%	97%	95%
Mobile Unit	**2010**	**2011**	**2012**
Number of exceedences of the running 8-hour mean	0	1	2
Data Capture (%)	98%	91%	75%
NPL – Teddington AURN	**2010**	**2011**	**2012**
Number of exceedences of the running 8-hour mean	**16**	**28**	6
Data capture (%)	83%	97%	92%

The 2012 data have been ratified by ERG for Wetlands and the Mobile.
All exceedences of the 8 hour mean limit are in highlighted in bold.

Table 7 shows ozone levels at the Wetlands, Mobile and NPL from 2010, 2011 & 2012.
NPL - Teddington AURN site in 2010 & 2011 did exceed the objective (i.e. more than 10 exceedences of 100 μg/m^3 as the daily maximum of the running 8-hour mean per year), as did Wetlands in 2011 and 2012.
The Mobile was located at a roadside location, so it is not surprising that the ozone levels were low.

Sulphur dioxide (SO_2) (ceased monitoring SO_2 in April 2011).

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

Table 8 SO_2 monitoring at the Mobile Air Quality Unit. Objective limit: 15-minute mean not to exceed 266 μg/m^3 more than 35 times a year.

Mobile Unit	**2010**
Number of exceedences of 15-minute mean	0
Data Capture (%)	98%

[(a)] SO_2 monitoring ceased in April 2011
[(b)] Mobile Unit - Data for 2010 has been ratified.

Carbon Monoxide (CO) (Monitoring of CO ceased in March 2012).

The LBRuT continuously monitored for CO at the Mobile Air Quality Unit. Table 9 shows that the CO limit was not exceeded.

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

Mobile Unit	**2010[a]**	**2011[a]**
Number of exceedences of the running 8-hour mean	0	0
Data Capture (%)	91%	90%

- [a]Mobile Unit –- data has been fully ratified.
- CO monitoring ceased in March 2012

2.1.2 Non-Automatic Monitoring

Nitrogen dioxide (NO_2) monitoring using diffusion tubes.

Table 10 shows the NO_2 diffusion tube monitoring results, with bias corrected values for each year from 2010 to 2012. The results in **bold** indicate an exceedence of the Air Quality Objective. Most of the NO_2 diffusion tubes are located on lamp posts at the kerbside of the road, so that the nearest relevant exposure is residential properties set back between 5 to 10 metres from the kerb. The monitoring site at Holly Lodge in Richmond Park (No. 28) and the static site at Wetlands Centre, Barnes (No. 37) are background sites, set well away from roads. As mentioned in section 1.4 NO_2 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 NO_2 did exceeded the 2005/2010 objective limit in each year from 2005 - 2012, as per the modelling prediction.

It is widely acknowledged that diffusion tubes have lower accuracy than continuous monitors. However, by comparing the diffusion tube data with that from the Borough's 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 (09) (DEFRA, 2009), a yearly bias adjustment factor has been produced for each year from 2002 to 2012, (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, 2011 is 0.92 and 2012 is 1.06.

The level of nitrogen dioxide measured by diffusion tubes has also been 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 NO_2 concentration in micrograms per cubic metre (µg/m^3) (figure 5a), by diffusion tube sampling. The results **in brackets** indicate the exposure estimate, calculated for the nearest residential façade. Concentrations > 60µg/m^3 are **underlined,** The results in **bold** indicate an exceedence of the Air Quality Objective

Site Code	Location	Site type	Grid references	Data Capture for full calendar year 2012[a] %	Relevant exposure (y/n with distance (m) from tube to roadside))	Distance from roadside (metres) to receptor	2010	2011	2012
1	Hampton Court Road, Hampton	Roadside	515824, 168815	100%	Y – 1.7m	1.9	**51 (50)**	**44 (43)**	**45 (46)**
2	Percy Road, Hampton (Nr. Oldfield Road)	Roadside	513229, 169712	100%	Y – 1.3m	3	39 (36)	31 (29)	34 (34)
3	Uxbridge Road, Hampton (Nr. Arundel Close)	Roadside	513850, 171040	92%	N – 0.5m	10.7	**44** (33)	35 (28)	**44 (40)**
4	Hampton Road, Teddington (Nr. Bushy Park Gardens)	Kerbside	514882, 171155	100%	N -0.6m	9.8	39 (31)	38 (30)	**44** (**40**)
5	Sandy Lane, Teddington (Shaef Way)	Kerbside	516391, 170322	100%	N – 0.6m	9.0	38 (31)	32 (27)	33 (33)
6	Kingston Road, Teddington (Nr. Woffington Close)	Kerbside	517266, 170031	100%	N – 0.7m	6.5	**48** (38)	34 (29)	**43 (40)**
7	Broad Street, Teddington (Tesco)	Kerbside	515624, 170975	100%	Y - for 1 hour mean objective and N - for residential 0.8m	2.5	**69 (59)**	**49 (43)**	**59 (54)**
8	Strawberry Vale, Teddington (Clive Road)	Kerbside	516165, 172043	92%	N – 0.4m	8.7	39 (31)	30 (26)	34 (34)
9	Hampton Road, Twickenham	Kerbside	514842, 172346	100%	N – 0.6m	2.0	**55 (48)**	**47 (42)**	**50 (47)**

10	Twickenham Road, Twickenham (opp. Fulwell golf course)	Kerbside	513278, 172199	100%	N – 0.6m	2.0	**47** (37)	36 (33)	**44 (42)**
11	Percy Road, Whitton (nr. Percy Way)	Kerbside	514050, 173189	100%	N – 0.6m	7.2	**52** (38)	**46 (**35)	**54 (46)**
12	Hanworth Road, Whitton	Kerbside	512600, 173404	100%	N – 0.6m	9.1	**52** (39)	**41 (**32)	**45 (41)**
13	Whitton Road, Whitton, (opp. Rugby ground)	Kerbside	515387, 174146	100%	N -0.8m	6.3	**53 (42)**	**42** (34)	**48 (43)**
14	Cross Deep, Twickenham (Poulett Gardens)	Kerbside	516133, 173051	100%	N – 0.3m	2.7	**52 (42)**	38 (32)	**48 (44)**
15	Richmond Road, Twickenham (opp. Marble Hill Park)	Kerbside	517197, 173939	100%	N – 0.6m	1.8	**53 (47)**	**41 (40)**	**44 (42)**
16	St Margarets Road, St Margaret's (Nr. Bridge Road)	Kerbside	517558, 174408	100%	N– 0.6m	3.1	**48 (43)**	38 (35)	**45 (42)**
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	**79 (67)**	**65 (55)**	**70 (59)**
18	Lower Mortlake Road, Richmond (nr.Trinity Road)	Kerbside	518822, 175590	100%	N 0.9m	9.3	**70 (52)**	**66 (47)**	**68 (48)**
19	Kew Road, Kew (nr. Walpole Avenue)	Kerbside	518637, 176161	100%	N - 0.7m	16	**46** (37)	**50** (35)	**56** (38)
20	Mortlake Road, Kew (nr. Kent Road)	Kerbside	519205, 177221	100%	N – 0.6m	2.8	**54 (42)**	**40** (36)	**53 (45)**
21	Lower Richmond Road, Mortlake (nr. Kingsway)	Roadside	520053, 175826	100%	Y- 2m	7.0	**47 (42)**	39 (35)	**43** (38)

22	Castelnau, Barnes (Nr. Hammersmith Bridge)	Kerbside	522845, 177904	100%	N – 0.5m	4.2	**55 (46)**	**46** (38)	**51 (41)**
23[b]	Castelnau Library, Barnes (static site)	Roadside	522502, 177166	100%	Y– 3.3m	9.0	**43 (40)**	35 (32)	38 (35)
24	Lonsdale Road, Barnes (nr Suffolk Road)	Kerbside	521750, 177056	100%	N – 0.30m	6.3	**42** (36)	36 (30)	**40** (33)
25	URRW (nr. Sheen School)	Roadside	521130, 175450	92%	Y- 2.3m	2.5	**42 (42)**	32 (32)	**47 (47)**
26	URRW, Sheen (nr. Courtland Estate)	Roadside	519031, 175021	100%	N – 0.6m	11.8	**46** (37)	**40** (31)	**42** (33)
27	Queens Road, Richmond (Nr. Russell Walk)	Roadside	518745, 174346	100%	Y -2.3m	5.2	**44 (41)**	38 (35)	**41** (38)
28	Holly Lodge, Richmond Park	Urban background	519467, 173993	92%	Y - for 1 hour mean objective 250m	250	24 (24)	20 (20)	22 (22)
29	Petersham Road, Ham. (Nr. Sandy Lane)	Kerbside	517967, 172543	92%	Y – 3.6m	3.6	39 (39)	37 (37)	**43 (43)**
30	German School Petersham Road	Roadside	518003, 173233	100%	Y – 1.9m	1.3	**41 (42)**	33 (34)	36 (36)
31	A316 (near Chuddleigh Rd)	Roadside	515438, 174048	100%	N 1.0m	6.4	**53 (42)**	**50 (40)**	**59 (50)**
32	Kings Street, Twickenham	Kerbside	516226, 173195	100%	Y - for 1 hour mean objective and N - for residential 1.7m	3.8	**102 (88)**	**75 (66)**	**77(70)**
33	Heath Road, Twickenham	Kerbside	515927, 173129	92%	Y - for 1 hour mean objective and N - for residential 0.9m	4.6	**66 (53)**	**47** (39)	**58 (51)**
34	Thames Street, Hampton	Roadside	515927, 173129	100%	Y – 1.4m	1.3	**42 (42)**	36 (36)	39(39**)**
35	High Street, Hampton Wick	Kerbside	517524, 169583	100%	Y – for 1 hour mean objective and for residential 1.3m	1.4	**54 (54)**	**46 (46)**	**50 (50)**

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	**60 (55)**	**46 (42)**	**54 (49)**
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		28	26	25
38[f]	Queen's Road, Teddington (Park Road end)	Kerbside	515777, 170519	100%	N – 0.5m	5.0	**40** (34)	35 (30)	**closed**
39	Richmond Road, Richmond Bridge, East Twickenham	Kerbside	515777, 170519	100%	Y – for 1 hour mean objective and N - for residential 1.2m	2.7	**70 (62)**	**58 (52)**	**62 (58)**
40[g]	Staines Road, Twickenham	Kerbside	514278, 172521	83%	N – 0.4m	11.9	31 (27)	37 (28)	**43** (39)
41	Paradise Road, Richmond	Kerbside	518102, 174854	100%	N– 0.9m	5.6	**49 (42)**	38 (33)	**45** (38)
42	The Quadrant, Richmond	Kerbside	517991, 175075	100%	Y – for 1 hour mean objective and N -for residential (above shops) 2.5m	1.8	**69 (73)**	**53 (55)**	**56 (59)**
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	**82 (73)**	**74 (66)**	**78 (70)**
44	Sheen Road, Richmond (Shops)	Kerbside	518458, 175042	100%	Y – for 1 hour mean objective and N - for residential 0.5m	0.5	**49 (49)**	**42 (42)**	**46 (46)**
45	High Street, Teddington (post office)	Kerbside	516260, 171140	100%	Y - for 1 hour mean objective and N - for residential 0.5m	3.3	**48 (40)**	**44 (37)**	**43 (41)**
46	15 Queen's Road, Teddington	Kerbside	515522, 170927	100%	N – 0.4m	3.3	**48** (39)	36 (31)	**41** (39)
47	Causeway, Teddington	Kerbside	515829, 170967	100%	Y - for 1 hour mean objective and N - for residential 1.8m	2.7	**49 (44)**	33 (32)	**40 (40)**

48	Stanley Road, Teddington (junc Strathmore Road)	Kerbside	515059, 171805	100%	N – 2.4m	7.1	**54 (46)**	**43** (37)	**42 (40)**
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	**50 (45)**	39 (36)	**47 (42)**
50	URRW (nr. Clifford Avenue, Sheen)	Kerbside	519962, 175321	100%	Y - for 1 hour mean objective and N - for residential 0.7m	2.7	**64 (55)**	**49 (42)**	**63 (53)**
51	Sheen Lane (railway crossing), Sheen	Kerbside	520497, 175790	100%	N – 0.4m	1.3	39 (37	32 (30)	36 (34)
52	Clifford Avenue, Chalkers Corner	Kerbside	519776, 175746	92%	N – 0.5m	2.2	**71 (60)**	**52 (45)**	**59 (50)**
53[b]	Mobile Air Quality Site	Roadside	512401, 173103	83%	N – 0.2m	1.6	**55 (45)**	**51 (43)**	**46(43)**
54	Mortlake Rd (adj to West Hill Rd) Kew	Kerbside	519589 176489	100%	Y – 0.6m for residential	1.4	**62 (57)**	**44 (41)**	**55 (50)**
55	Mortlake Rd (adj to cemetery gates), Kew	Kerbside	519800 176142	100%	N – 0.6m	4.1	**59 (49)**	**41** (35)	**48 (40)**
56[e]	A316 (St Margarets R'about)	Roadside	173933 175433	100%	Y – 7.3m	9.6	**41** (39)	35 (30)	**41 (41)**
57[e]	A316 (Lincoln Ave)		172433 173933	100%	Y -12.7m	16.3	35 (29)	24 (23)	38 (38)
58[h]	London Road, Twickenham	Kerbside	519793 176139	100%	N - 0.7m	2.2		**43** (39)	**52 (49)**
RUT 01	Civic Centre, York Street, Twickenham	Roadside	516356, 173365	100%	Y - for 1 hour mean objective 2.9m	3.0	**70 (70)**	**48 (48)**	**53 (53)**
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 (90)**	**93 (78)**	**95 (80)**

RUT 03i	Alexandra Hall, Cromwell Place, Mortlake	Urban background	520348, 175849	100%	Y – 54.3m	1.9	32	26	closed
RUT 04[j]	Side of Elmfield House, Waldegrave Road, Teddington	Urban background	515916, 171118	100%	Y- 18.9	2.2	29	29 (36)	closed
59[k]	Whitton Road, Twickenham,	kerbside	515980, 173758	100%	0.6m	1.4	Not open	Not open	**44 (41)**
60[l]	Front of Elmfield House, Waldegrave Road, Teddington	kerbside	515894, 171148	100%	0.5m	2.2	Not open	Not open	**40 (**39**)**
61[m]	London Road Twickenham (near Waitrose)	Roadside	516224, 173444	100%	1.8m	4.3	Not open	Not open	**55 (47)**

[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 established on 2nd March 2010, thus resulting in only 75% data capture in 2010
[f] site 38, Queens Road, closed 03/01/2012.
[g] site 40 was moved to the opposite side of Staines Road on 29/09/2010
[h] site 58 was established on 29th March 2011, the results for 2011 are based on 9 months data.
[i] Rut 03 Alexandra Hall, Mortlake closed on 03/01/2012
[J] RuT 04 moved from the side to the front of 4 Waldegrave Road, Teddington on 03/01/2012, renamed site 60
[k] Site 59 Whitton Road, Twickenham (opposite Heatham House) opened 03/01/12,
[l] Site 60 pavement near 4 Waldegrave Rd, Teddington opened on 03/01/2012
[m] Site 61 London Road Twickenham (near Waitrose) opened 03/01/2012

From the diffusion tube results in Table 10, many sites still exceed the objective limits at the roadside. The results show that there was a decline in 2011 nitrogen dioxide results compared to 2010. However in 2012 there is an increase in the number of sites that do not comply with the air quality objective of 40ug/m^3.

The following Table 11 is also charted in Figure 3 and shows the trends at the 4 long-term sites. These sites were originally 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 NO_2. The highest recorded exposure was at George Street (RUT 02), (after the Richmond site moved there in 2002) with a bias corrected result of 133 µg/m^3 in 2003. This was a year which experienced higher pollution levels everywhere, due to the meteorological conditions that year.

Table 11 Annual mean NO_2 diffusion tube sampling from 1993 to 2012 in µg/m^3 (bias corrected from 2002 onwards). The results in **bold** indicate an exceedence of the Air Quality Objective

	Twickenham (RUT01)	**Richmond (RUT02)[a]**	**Mortlake (RUT03)[b]**	**Teddington (RUT04)[c]**
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
2011	**48**	**93**	26	29
2012	**54**	**98**		**40**

[a] In 2001 the diffusion tube at RUT 02 moved from the police station rear courtyard on Lewis Road to George Street. Richmond.
[b] Rut 03 ,Alexandra Hall, Mortlake closed on 03/01/2012
[c] Rut 04 was moved from side to the front of Waldegrave Road on 03/01/2012 and was renamed site 60.

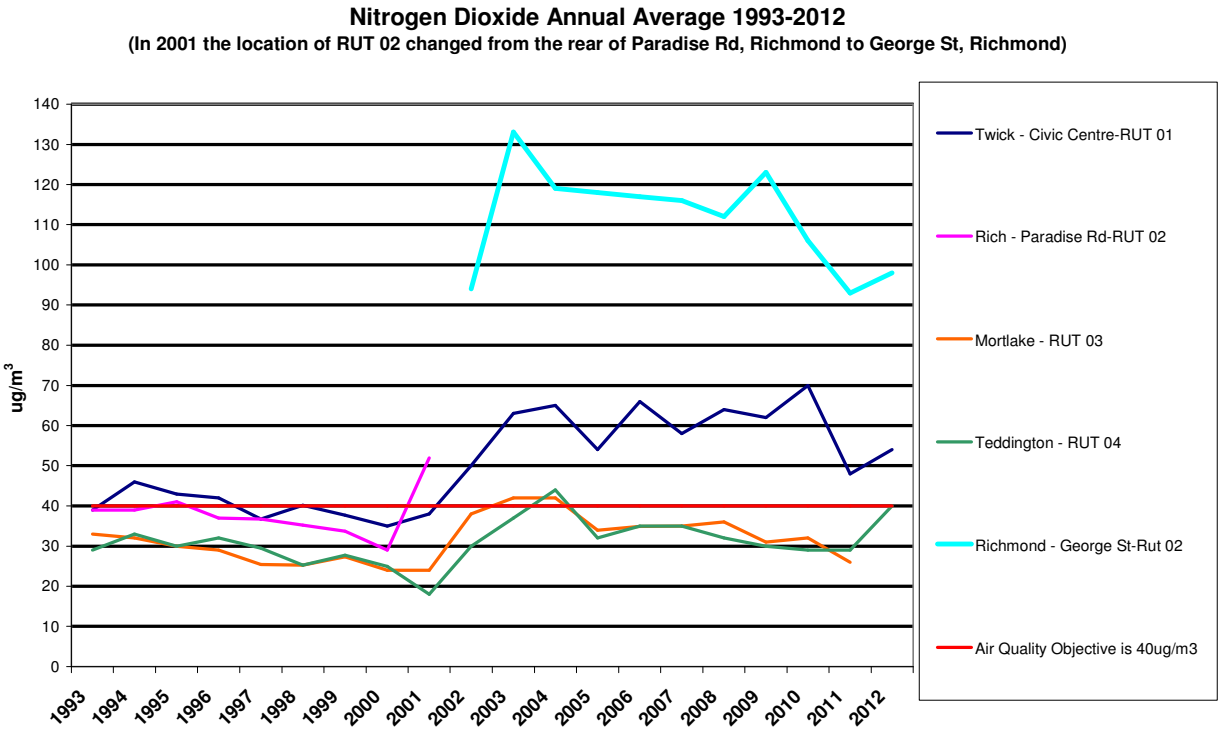

Figure 3: *Annual mean NO_2 from 1993 to 2012 (Chart of Table 11 data. Bias corrected from 2002 onwards, because there was no bias correction data available for the earlier years). Note: the Richmond site moved from the police station rear courtyard on Lewis Road to George Street in 2001. The higher concentrations from 2002 demonstrate the impact of the much heavier local traffic movements at the new site. In 3rd January 2012 site RuT 03, Alexandra Hall, Mortlake was closed and RuT 04 moved from the side to the front of 4 Waldegrave Road, Teddington.*

The results from 1993 – 2001 have not been bias adjusted. From 2002 onwards all the results have been bias adjusted.

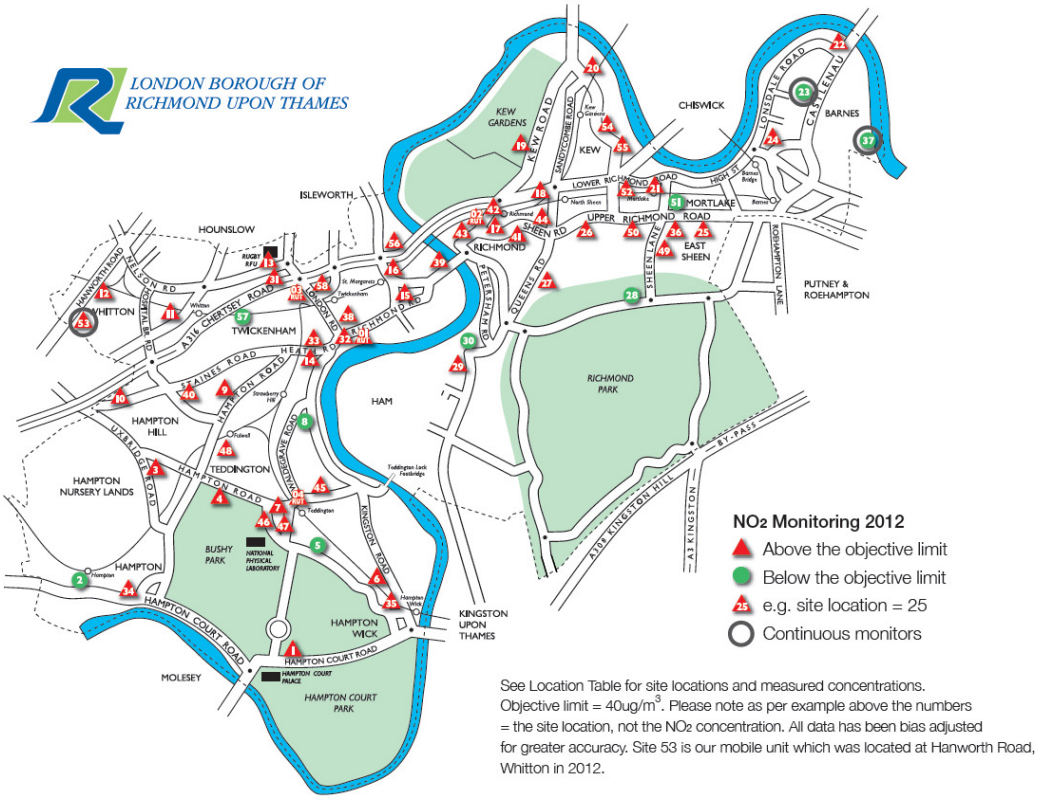

Figure 4: *Map showing the location of the NO_2 diffusion tubes and continuous monitors in 2012. All results have been bias adjusted.*

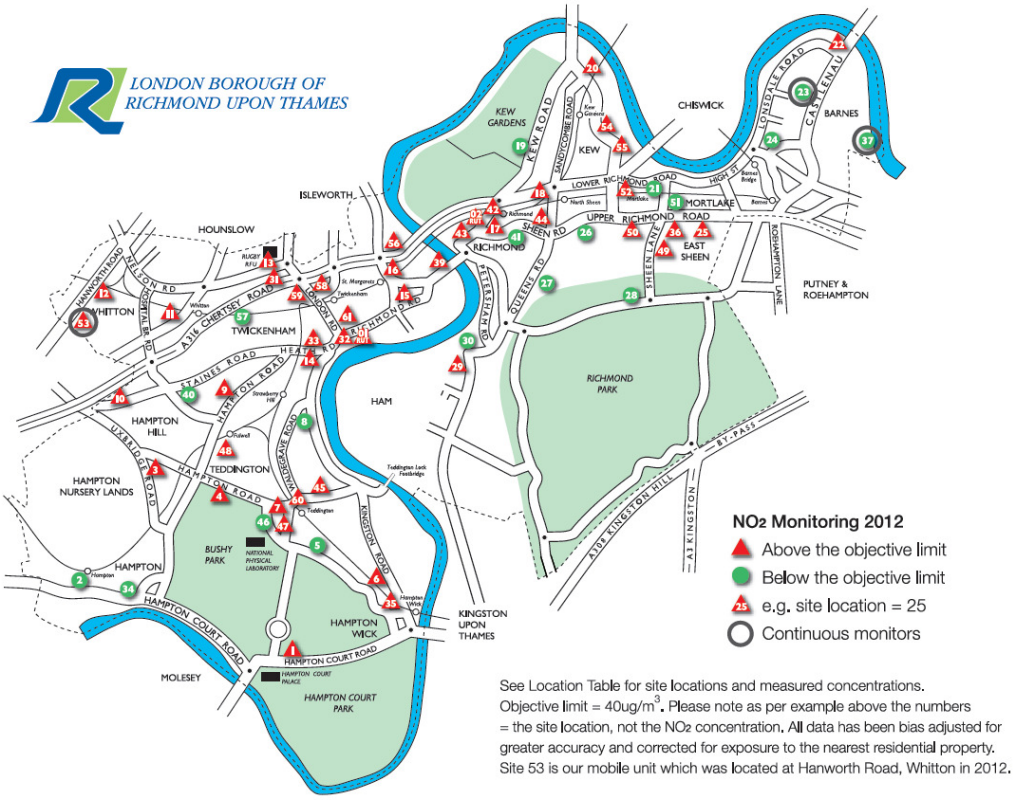

Figure 5: *Map showing the location of the NO_2 diffusion tubes and the continuous monitors in 2012. The results have been bias adjusted and an additional distance adjustment has been calculated to show the estimated concentration at the nearest sensitive receptor*

The following table compares NO_2 annual averages from 2010 to 2012 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	**2010**	**2011**	**2012**
Continuous analysers	**43**	39	36
Diffusion tubes	**43**	35	38
Wetlands	**2010**	**2011**	**2012**
Continuous analysers	30	26	25
Diffusion tubes	28	26	22
Mobile	**2010**	**2011**	**2012**
Continuous analysers	**45**	**48**	**44**
Diffusion tubes	**55**	**51**	**46**

Figures in bold indicate an exceedence of the NO_2 air quality objective of 40ug/m^3
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. However in 2010, at the mobile site, the diffusion tube data was 10ug/m^3 higher than the continuous analyser result.

Benzene (C_6H_6) (Benzene ceased to be monitored in January 2012).

In 2010, LBRuT carried out benzene, diffusion tube monitoring at 5 locations across the borough at the following sites, George St, Richmond, Broad St, Teddington, King St, Twickenham, High St, Hampton Wick and Upper Richmond Road West / Sheen Lane where NO_2 diffusion tubes are also deployed. The locations are shown in Table 13 below and on the map at Figures 4 and 5. Table 13 demonstrates that the benzene objective was met in LBRuT in 2010 and 2011.

Table 13 – 2010 and 2011 annual mean benzene levels

Site ID	Location	AQMA design ation	Proportion of the year with valid data % (2011)	Annual Mean (ug/m^3) Air Quality Objective 5ug/m^3	
				2010	2011
RUT 02	George St Richmond	N	83%	2.05	1.51
7	Broad St Teddington	N	100%	2.06	1.33
32	King St, Twickenham	N	100%	2.11	1.85
35	High St, Hampton Wick	N	100%	1.6	1.47
36	URRW/Sheen Lane	N	100%	2.16	1.56

Benzene monitoring ceased in March 2012

2.2 Comparison of Monitoring Results with Air Quality Objectives

All the monitoring results required by DEFRA in their 2013 Progress Report template for data from 2012 are included in the various tables and charts within this report. A summary of the monitoring results is that NO_2 continues to exceed at many locations across the borough. PM10 has not been monitored to exceed the objectives in 2012 however modelling results indicate that there may be some areas of exceedence.

2.2.1 Nitrogen Dioxide

See Appendix C for the full data set of monthly diffusion tube mean values. Please note sites 23, 37 and 53 are the triplicate sites; all their data are in the table at the bottom of Appendix C.
For the equivalent monthly data from the continuous monitors, please see the ERG website http://www.londonair.org.uk/LondonAir/Default.aspx

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 2012 %	Annual mean concentrations (µg/m^3) Air Quality Objective 40ug/m^3		
				2010	2011	2012
RI1	Castelnau	Y	80% [a]	**43**	39	36
RI2	Wetlands, Barnes	Y	99%	30	26	25
Mobile	Hanworth Road(2012)	Y	72% [b]	**45**	**48**	**44**
TD0	NPL, Teddington	Y	99%	24	21	36

All data has been fully ratified .Figures in bold indicate an exceedence of the air quality objective

[a] the lower data capture was due to technical problems with the manifold for the period 08/01/12-19/03/12
[b] **2012** data for the Mobile - Due to power supply issues the Mobile unit commenced monitoring in Hanworth Rd on 15/3/12 resulting in 72% data capture for the year of 2012. Results may not be representative of the full year and should be used for guidance only.

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

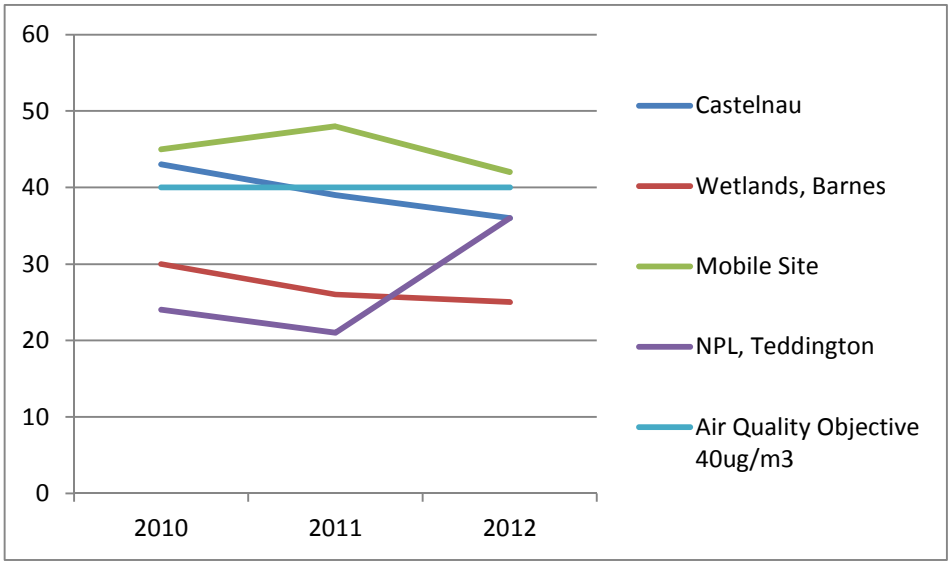

Table 14b Results of Automatic Monitoring for Nitrogen Dioxide: Comparison of 1-hour mean with the 1hr Objective limit.

Site ID	Location	AQMA designation	Data Capture for full calendar year 2012 %	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 99.8th percentile of hourly means in brackets.		
				2010[a]	2011 [a]	2012 [a]
RI1	Castelnau	Y	80% [b]	0 (120.7) [c]	0	0
RI2	Wetlands, Barnes	Y	99%	0	0	0
Mobile	Hanworth Road (2012)	Y	72% [d]	0 (117.4) [c]	0	0
TD0	NPL, Teddington	Y	99%	0 (80.3) [c]	0	0

[a] All the data has been fully ratified
[b] the lower data capture was due to technical problems with the manifold for the period 08/01/12-19/03/12
[c] number in brackets is the 99.8%ile (calculated, as data capture less than 90%) It complies with the 200ug/m^3 99.8%ile limit
(See also Table 3)
[d] 2012 data for the Mobile - Due to power supply issues the Mobile unit commenced monitoring in Hanworth Rd on 15/3/12 resulting in 72% data capture for the year of 2012. Results may not be representative of the full year and should be used for guidance only.

2.2.2 PM_{10}

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.**

The PM10 monitoring results in Table 15a and Table 15b show that annual mean and daily mean PM10 was not exceeded at any site during the last three years.

The results shown are the adjusted values, after checking and correcting by the data collection consultants. The correction involves accounting for the volatile mass which has been lost when the air sample is heated, to drive off water vapour. This correction is known as VCM, for 'volatile correction method'. The final result is thus more accurate than the original raw data result.

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

Site ID	Location	AQMA designation	Data Capture for full calendar year 2012 %	Annual mean concentrations (µg/m^3) Air Quality Objective 40ug/m^3		
				2010 [a]	2011 [a]	2012[a]
RI1	Castelnau	Y	99%	21	23	21
RI2	Wetlands, Barnes	Y	99%	19	22	18
Mobile [b]	Richmond Mobile	Y	74%	22	27	22

[a] All data is fully ratified
[b] In 2012 the mobile was located in Hanworth Road, Whitton
All TEOM data are VCM corrected. See Appendix A p49.

Table 15b Results of PM_{10} Automatic Monitoring: Comparison with 24-hour Mean Objective

Site ID	Location	AQMA designation	Data Capture 2012 %	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 90th percentile of daily means in brackets.		
				2010 [a]	2011 [a]	2012[a]
RI1	Castelnau	Y	99%	2	16	12
RI2	Wetlands, Barnes	Y	99%	1	17	9
Mobile[b]	Richmond Mobile	Y	74%	5	8	7

[a] All data fully ratified
[b] In 2012 the mobile was located at Hanworth Road, Whitton
All TEOM data are VCM corrected. See Appendix A p49.

2.2.3 Sulphur Dioxide (Monitoring ceased in March 2011)

SO_2 was measured at one automatic monitoring station in the LBRuT, at the Richmond Mobile. Table 16 demonstrates that the SO_2 objectives were met in 2010, at the roadside monitoring site in Hampton Court Road, Hampton Court.

Table 16 2010 Results of SO_2 Automatic Monitoring: Comparison with Objectives

Site ID	Location	Within AQMA?	Data Capture 2010[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 not been fully ratified

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

2.2.4 Benzene (Monitoring ceased in January 2012)

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 and 2011.

Table 17 Results of benzene monitoring in 2010 and 2011.

Site ID	Location	Within AQMA?	Proportion of year with valid data in 2011 %	2010 µg/m^3 (2010 Objective 5*u*g/m3)	2011 µg/m^3 (2010 Objective 5*u*g/m3)
7	Broad St, Teddington (Tesco)	Y	100%	2.06	1.51
32	King St, Twickenham	Y	100%	2.11	1.56
35	High St, Hampton Wick	Y	100%	1.63	1.85
36	URRW, Sheen Lane	Y	100%	2.16	1.33
RUT 02	George St, Richmond	Y	100%	2.05	1.47

All the sites are representative of relevant public exposure.

2.2.5 Other pollutants monitored – Ozone.

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, 2011 and 2012, the UK Air Quality Strategy ozone objective was breached in LBRuT at the background site, Teddington (AURN) .

Exceedences of the ozone objectives are highlighted in **bold**. In 2010, there were 6 exceedences of the running 8-hour objective at the Wetlands site, none at the mobile and 16 exceedences at the NPL site. In 2011 there were 12 exceedences of the running 8-hour objective at the Wetlands site, one at the mobile and 28 exceedences at the NPL site The UK objective for protection of human health for ozone is 100μg/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. In April 2012 O_3 monitoring in the Richmond Mobile ceased.

Table 18 Results of 2010 - 2012 ozone monitoring

Location	**Proportion of the year with valid data 2012 %**	**Number of exceedence of the 8 hour running mean (100ug/m^3)**		
		2010	**2011**	**2012**
[a]Wetlands, Barnes	95%	6	**12**	**15**
[a b]Richmond Mobile	75%	0	1	2
[a]NPL (AURN), Teddington	92%	**16**	**28**	6

[a] all data has been fully ratified.
[b] In 2012 the mobile was located at Hanworth Road, Whitton
Limit = 10 exceedences per year

Summary of Compliance with AQS Objectives - 2012

The London Borough of Richmond upon Thames has examined the results from monitoring in the Borough. The results show that concentrations of PM_{10} were below the relevant objective values. NO_2 concentrations exceeded the objectives at a number of locations across the borough. In addition, the latest modelling for 2015 (LAEI, 2010, with worst case 2010 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.

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 new/newly identified 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 5 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) is above the "boundary layer" (variable – around 1000 feet). This layer, together with good dispersion, ensures that the concentrated pollution does not reach the ground, as it becomes too diluted 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 there are no new locations where diesel and steam trains are regularly stationery for 15 minutes or more, with potential for relevant exposure within 15m.

Moving Trains

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

Ports for Shipping

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

3.3 Industrial Sources

New or Proposed Installations

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

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

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

Major Fuel (Petrol) Storage Depots

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

Petrol Stations

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

Poultry Farms

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

3.4 Commercial and Domestic Sources

Biomass Combustion Plants – individual installations

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

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

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

Area where domestic solid fuel burning may be relevant

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

3.5 New Developments with Fugitive or Uncontrolled Sources

Landfill Sites

LBRuT confirms there are no new or proposed landfill sites

Quarries

LBRuT confirms that there are no new or proposed quarries

Unmade haulage roads on industrial site

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

Waste transfer stations etc

LBRuT confirms that there are no new waste transfer stations

Other potential sources of fugitive particulate emissions

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

4 Local / Regional Air Quality Strategy

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

The main aims were:

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

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

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

5 Planning Applications

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

Twickenham Station
Post office site – London Rd, Twickenham

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 the 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 CO_2 emissions from transport.

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

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

A copy of the Authority's Climate Change Strategy can be found at:

http://www.richmond.gov.uk/climate_change_strategy_v2.0.pdf

9 Implementation of Action Plans

The Borough's Air Quality Action Plan is being updated and will be presented separately.

10 Conclusions and Proposed Actions

10.1 Conclusions from New Monitoring Data

In 2012, NO_2 concentrations were found to exceed the objective of 40ug/m^3 at most of the locations monitored. In addition, the borough-wide modelling for 2015 (LAEI, 2010, with worst case 2010 'met' year and including any benefits from the LEZ) also confirmed these widespread exceedences. Both of these NO2 conclusions indicate the continuing need for the Borough to remain designated as a borough-wide AQMA, for NO_2. 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/m^3 or above, exceedences of the one hour NO_2 objective are also likely to occur. The 2012 NO_2 monitoring data indicates that at some locations the annual mean NO_2 did exceed 60ug/m^3. Once again, the conclusion remains true when façade level corrections are made, indicating that there are still likely to be exceedences of the 1-hour objective at a number of sites, when assessed for vulnerable receptors.

The PM_{10} monitoring results show that the annual mean PM_{10} and daily mean PM_{10} limits were not exceeded at any site in the Borough during the last three years. However, the 2015 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.

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

From the 2012 monitoring data, it can be concluded that there is no need to proceed to a detailed assessment. The next course of action is to prepare and submit the 2014 Progress Report, presenting 2013 monitoring data.

Following a gap analysis, the number of NO_2 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 were from February 2010. In 2011 an additional site was set up London Rd, Twickenham. The first result for this site was from March 2011. The tubes locations represent 'relevant exposure', without further correction, as they are placed at locations equivalent to the facades of their nearest residential properties.

A further review of the NO_2 diffusion tube locations was undertaken in 2011. This resulted in several NO_2 locations being moved on 3/1/12 to represent relevant exposure, these sites are:

Site 38 was moved from Queens Rd, Teddington to 44 London Road, Twickenham, and renamed site 61.
RuT 3 was moved from Alexandra Road, Mortlake to Whitton Road, renamed site 59
RuT 4 was moved from the side of 4 Waldegrave Rd, Teddington to the roadside in front, renamed site 60.

The Authority as a matter of course will continue to review and evaluate its NO_2 diffusion tube locations.

Reductions of air pollution levels in the Borough will be progressed through the development of the Borough's AQAP.

11 References

Department for the Environment, Food and Rural Affairs (DEFRA), 2003. Technical Guidance for Local Air Quality Management LAQM. TG (09) HMSO, London.
The report can be found at: http://www.defra.gov.uk/publications/files/pb13081-tech-guidance-laqm-tg-09-090218.pdf

Department for the Environment, Food and Rural Affairs (DEFRA), 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. HMSO, London.
The report can be found at:
http://archive.defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-qualitystrategy-vol1.pdf

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

All data undergoes quality assurance and quality control (QA/QC) procedures to ensure that the data obtained are of a high quality.

QA/QC for Continuous monitoring

Each continuous analyser is checked manually, every two weeks, by the Council's Local Site Operator (LSO). A detailed record is made of the performance status of each analyser, for validation purposes. For PM_{10} maintenance matters, see the section below. The nitrogen dioxide (NO_2) and ozone analysers are subjected to overnight and fortnightly calibration checks, with span and zero gases. The NO_2 calibration requires the use of certified bottled gas (see NO_2 section below) whereas the ozone analyser generates its own calibration ozone, as it is too reactive to store it. The zero air is produced by a zero air generator. The results of the overnight calibrations are then checked each day by ERG, Kings College London, as part of their quality control and ratification procedures. Any issues found can then be rectified by calling out an engineer, as soon as possible, in pursuit of maintaining maximum data capture, so that we get robust quality assured data.

Every analyser is also subjected to additional calibration checks at the routine six monthly engineer's service. The analyser performance is also audited every six months by an independent auditor, from the National Physical Laboratory (NPL).

Following are the general stages of the data ratification process, as carried out by ERG, 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 (currently - www.londonair.org.uk) 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.

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. A minimum of 75% data capture is best, for a good quality annual average.

The analytical methods used by the continuous analysers are: NO_2 (chemiluminescence); PM_{10} (TEOM); $PM_{2.5}$ (FDMS); ozone (UV absorption); SO_2 (fluorescence); CO (infrared).

All data in this report for Castelnau, Wetlands, Mobile and NPL have been fully ratified.

QA/QC for NO_2 Continuous monitoring

Each NO_2 continuous analyser is automatically calibrated every night and also manually checked and calibrated every two weeks. There is a need is for frequent calibration adjustments as the gradual build-up of dirt within the analyser reduces the response rate. This fall off in response needs appropriate

correction, to ensure the recording of the true concentrations. The calibration process involves checking the monitoring accuracy against a known concentration of span gas. The span gas used is nitric oxide and is certified to an accuracy of 5%. Both the automatic and manual calibrations use this same certified span gas (i.e. the automatic overnight one does not use the less accurate permeation tube method).

For the first month of every year, the monthly data capture for the Richmond Mobile is reduced, when the Mobile changes its location. In 2012, due to power supply difficulties at the new site, the mobile Richmond RHE (Mobile), was not moved to Hanworth Road, Whitton until 15th March 2012. This resulted in a lower data capture of 72% for that year.

In 2012 the Castelnau site's good data capture rate was reduced to 80%, when the ratification process discovered issues with the manifold, spanning the period 08/01/12-19/03/12. Although TG (09) would prefer a data capture rate of over 90%, the result is still acceptable, for the calculation of an annual average, as it was over 75%.

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 for PM_{10} Particulate Monitoring

PM_{10} particulates are measured using Tapered Element Oscillating Microbalance (TEOM) analysers, with the data presented as the gravimetric equivalent.

No automatic or fortnightly calibrations are carried out on TEOMs. Calibrations are only carried as part of the routine servicing and regular independent audits. The on-going performance of the monitor is checked on-line, by the Kings College ERG Duty Officer. The role of the LSO at the fortnightly visits is to make more detailed performance checks. The LSO is also on standby at other times, to change the TEOM's monitoring filter as required, depending on the filter loading.

Since 2009, TEOM data have been improved by routine adjustments, using the volatile correction method (VCM). This corrects for the loss of any volatile mass, which has been driven off by the heat applied in the TEOM's inlet column. The VCM adjustments are carried out by ERG, prior to dissemination of the data.

The TEOM 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 ratifies the data periodically, viewing data over longer time periods and using the results from fortnightly checks, equipment services and equipment audits.

QA/QC for NO_2 Diffusion Tubes

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

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

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

For example, Gradko perform their own laboratory blank exposures that serve as a quality control check on the tube preparation procedure, as well as providing 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 NO_2 diffusion tube scheme which uses artificially spiked diffusion tubes to test each participating laboratory's analytical performance on a quarterly basis. Every quarter, (in January, April, July and October each year) each laboratory receives four diffusion tubes doped with an amount of nitrite known to HSL but not the participants (HSL, 2004). This is a Defra recognised performance-testing programme for laboratories undertaking NO_2 diffusion tube analysis in the UK. The scheme is designed to help laboratories meet the European Standard. Gradko demonstrated good laboratory performance in 2008 and the laboratory precision was rated 'good' in every month. The latest available assessment up to January 2013 indicated that the laboratory precision remains 'satisfactory'.

AEA field inter-comparison scheme

Gradko also takes part in the field inter-comparison scheme operated by AEA, which complements the WASP scheme in assessing sampling and analytical performance of NO_2 diffusion tubes under normal operating conditions. This involves the regular exposure of triplet tubes at an Automatic Urban Network site (AUN) site, where real-time NO_2 levels are also measured using a chemiluminescent analyser. AEA have established performance criteria for participating laboratories. The bias relative to the chemiluminescent analyser gives an indication of accuracy and a measure of precision is determined by comparing the triplet co-located tube measurements. Table A.2 demonstrates that the accuracy and precision for Gradko are within the performance targets. These values are useful for assessing the uncertainty of results due to sampling and analytical techniques.

Table A.2 2010 to2012 network field intercomparison results

Year	Annual mean bias		Precision	
	Performance target	Gradko performance	Performance target	Gradko performance
2010	+/- 25%	- 3%	10%	5%
2011	+/- 25%	- 25%	10%	3%
2012	+/- 25%	4%	10%	7%

The NO_2 diffusion tubes are kept in a refrigerator prior to being deployed and prior to being sent off for analysis.

NO_2 diffusion tube analysis method

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

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

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

Diffusion Tube Bias Adjustment Factors

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

Richmond 1 Castelnau (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 two background sites, 28 and 37.

Richmond Mobile: a roadside site, located at Hanworth Road from 15/3/12.The triplicate NO_2 diffusion tube result for 2012 was 46ug/m3 against the continuous monitoring mean of 44ug/m3 for the same period.

The 2012 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 2012 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.

Discussion of Choice of Factor to Use

The local bias adjustment factors for the Borough are provided in Table A.1 for 2010 to 2012. From 2010 to 2012 all kerbside and roadside sites in the Borough are bias adjusted using the factor from the local roadside co-location site at Richmond 1 Castelnau. All background sites in the Borough are bias adjusted using the factor from the local suburban co-location site at the Richmond 2 Barnes Wetlands.

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.

Table A.1 2010 to 2012 NO_2 diffusion tube bias adjustment factors for the Borough

Source of bias adjustment factor	2010	2011	2012
Local roadside co-location study at Richmond 1 Castelnau	1.06	0.92	1.06
Local background co-location study at Richmond 2 Wetlands Barnes	1.02	1.03	1.04
National factor (not used)	1.03	0.95	1.01

QA/QC for Benzene Diffusion Tubes

Benzene tubes are analysed using gas chromatography/mass spectrometry.

METHOD STATEMENT from Gradko Environmental

(Extract from Gradko Environmental Lab. Procedure)

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

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

METHOD PERFORMANCE

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

CALIBRATION SOLUTIONS

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

DEVELOPING THE CALIBRATION CURVE

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

QUALITY CONTROL

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

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

INSTRUMENT CALIBRATION

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

ANALYSIS PROCEDURE

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

optimization and integration and display chromatograph QC standards are run every 10 exposed tube samples.

EXPRESSION OF RESULTS

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

MEASUREMENT UNCERTAINTY

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

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

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

Appendix B:

Nitrogen Dioxide Distance Calculation Methodology

The concentration of nitrogen dioxide, as measured by the diffusion tubes, is calculated for the nearest residential façade, by using the following Air Quality Consultants distance calculator:

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

One of the inputs for the distance calculator is the relevant NO_2 background concentration. Please find below the range of background values used.

In 2010 the mean background data was taken from the Wetlands NO_2 annual average i.e. 30ug/m^3 and used for all sites located in the northern section of the borough. The NPL NO_2 annual average i.e. 24ug/m^3 was used for all sites in the southern section of the borough.

In 2011 the mean back ground data for Wetlands was 26ug/m^3 whilst for NPL it was 34ug/m^3.

In 2012 the mean background for Wetlands was 25ug/m^3 and for NPL it was 34ug/m^3.

Appendix C

2012 NO2 Diffusion Tubes - monthly mean values

2012 NO_2 data ug/m^3 monthly non bias adjusted results

Site Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Annual mean	Castlenau bias adjustment factor 1.06 Revised Bias	Wetlands bias adjustment factor 1.04 Bias adjusted	UK AQ Objective (ugm^{-3})
1	54.83	49.67	60.33	43.62	33.01	35.16	37.71	37.02	22.21	48.10		48.04	469.72	43	45		40
2	37.59	38.95	47.13	29.17	23.51	24.19	21.09	24.20	27.98	33.12	43.84	30.05	380.82	32	34		40
3	45.72						26.92	32.70		47.33	54.64	40.44	247.76	41	44		40
4	44.14	49.57	53.46	47.97	34.43	32.99	28.26	32.40	33.80	46.87	55.15	40.05	499.09	42	44		40
5	40.05	36.82	46.97	25.60	22.98	22.61	22.82	24.44	27.90	33.63	40.12	34.54	378.49	32	33		40
6	41.88	40.97	37.92	42.16	42.64	35.88	32.97	32.38	40.12	47.00	52.15	43.79	489.85	41	43		40
7	61.87	52.33	77.57	62.43	58.66	45.28	38.92	44.72	49.58	66.07	61.99	47.17	666.60	56	59		40
8	48.06	43.70	21.37	35.97	28.01	23.28	20.59	23.26	24.15	40.94	41.33	33.76	384.41	32	34		40
9	55.30	51.78	57.83	43.21	39.61	37.27	36.33	38.41	37.81	55.62	66.69	45.75	565.62	47	50		40
10	47.50	44.82	55.60	40.43	37.88	34.42	30.66	33.30	34.66	43.36	53.93	37.25	493.80	41	44		40
11	58.78	58.33	72.99	45.79	37.78	40.59	30.34	37.82	54.68	46.21	65.56	60.64	609.50	51	54		40
12	51.49	50.25	56.83	37.67	40.02	21.18	31.92	33.64	43.37	47.22	53.92	36.55	504.07	42	45		40
13	57.98	46.97	55.11	39.50	38.14	32.34	35.14	37.54	38.75	50.77	60.04	56.48	548.77	46	48		40
14	50.89	49.18	55.19	39.99	39.30	31.31	33.65	35.04	39.11	48.33	56.16	60.27	538.42	45	48		40
15	49.81	44.83	54.90	44.78	32.47	31.07	31.84	35.20	38.89	43.59	51.48	44.48	503.34	42	44		40
16	50.70	50.37	55.66	42.69	38.64	29.23	28.29	34.87	38.92	47.68	54.64	37.44	509.14	42	45		40
17	74.69	66.25	47.86	72.05	68.07	54.84	54.98	64.31	69.73	72.84	81.87	63.42	790.94	66	70		40
18	62.23	61.85	81.03	68.61	62.79	21.01	59.62	58.05	66.27	83.11	104.47	41.16	770.19	64	68		40
19	60.91	67.93	83.79	53.21	49.43	40.30	42.37	42.96	31.25	52.99		57.87	583.02	53	56		40
20	57.51	52.41	78.81	45.70	36.49	29.47	38.10	45.11	51.67	49.39	67.33	44.72	596.72	50	53		40
21	52.91	47.68	58.19	41.22	33.21	29.00	21.88	27.03	31.97	43.75	55.70	46.37	488.89	41	43		40
22	53.85	46.27	61.91	44.00	36.65	37.38	40.13	47.32	46.28	56.00	63.00	42.72	575.49	48	51		40
23													-	36	38		40
24	43.41	48.17	48.78	34.35	30.66	27.28	23.69	27.35	33.30	43.38	45.17	42.01	447.55	37	40		40
25	45.23	42.72	54.62				27.12	34.38	41.48	52.58	53.38	45.85	397.37	44	47		40
26	48.49	44.71	53.48	38.29	32.03	29.66	29.67	30.46	36.27	40.66	49.22	42.70	475.63	40	42		40
27	41.98	42.21	53.13	41.99	33.50	30.97	28.38	32.88	36.18	40.88	47.66	33.69	463.45	39	41		40
28	25.69	26.53	34.07	22.10	15.67	12.55	10.38	12.50	15.88	22.58	24.50	26.68	249.12	21		22	40
29	45.50	41.12	49.84	42.93	33.78	29.39		31.28	32.66	43.52	50.52	46.36	446.91	41	43		40
30	37.41	37.29	46.96	36.21	32.07	22.76	22.27	27.67	28.05	40.23	43.31	31.32	405.56	34	36		40
31	65.70	55.61	79.71	52.88	47.28	48.76	37.04	44.77	46.31	59.43	73.38	60.21	671.07	56	59		40

2012 NO_2 data **ug/m^3 monthly non bias adjusted results**

Site Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Annual mean	Castlenau bias adjustment factor 1.06 Revised Bias	Wetlands bias adjustment factor 1.04 Bias adjusted	UK AQ Objective (ugm^{-3})
32	95.48	58.08	114.45	74.84		35.79	54.31	69.16	65.59	85.80	87.72	58.09	799.31	73	77		40
33	69.17	58.21	72.35	58.48	60.27	38.29	37.30	41.91	50.69	70.84	55.28	40.49	653.27	54	58		40
34	47.27	46.91	45.94	34.89	32.03	24.39	25.56	29.69	30.64	40.89	43.74	41.84	443.79	37	39		40
35	55.14	52.39	59.47	58.20	37.83	45.72	46.11	45.50	0.21	47.51	67.92	46.86	562.87	47	50		40
36	57.24	52.98	72.57	51.67	63.00	49.12	36.37	46.41	41.07		55.04	39.37	564.84	51	54		40
37													-	24		25	40
38(now 61)	58.79	62.36		58.84	48.72	43.79	42.14	45.15	36.31	66.46	67.09	44.08	573.73	52	55		40
39	70.96	57.02	76.68	69.25	54.57	45.28	44.96	50.65	56.93	61.04	67.46	44.41	699.23	58	62		40
40	52.82	55.22	56.27	35.01	32.03	28.26	27.40	29.32	32.20	46.65	50.43	41.51	487.13	41	43		40
41	49.07	45.23	54.62	45.41	33.05	38.73	27.67	31.71	39.56	52.18	48.85	45.54	511.63	43	45		40
42	52.66	62.45	63.24	57.82	47.99	42.74	36.15	42.91	41.50	68.34	59.26	64.35	639.40	53	56		40
43	80.87	85.09	45.89	79.83	78.91	37.44	80.48	80.87	88.70	41.00	109.41		808.49	73	78		40
44	53.49	54.18	59.29	47.65	33.89	30.60	29.83	32.60	40.07	46.87	52.11	41.67	522.24	44	46		40
45	51.59	50.67	24.00	40.90	40.48	37.33	45.13	43.72	46.84	51.40	15.16		447.22	41	43		40
46	41.98	45.46	59.21	36.84	38.69	33.73	24.46	27.66	29.16	41.57	49.02	31.12	458.90	38	41		40
47	54.29	49.00	50.65	37.10	33.16	27.99	23.98	30.63	34.50	39.94	41.92	28.86	452.02	38	40		40
48	52.80	46.78	54.21	48.19	36.77		34.86	34.04	39.69	41.96	9.12	41.43	439.86	40	42		40
49	47.98	42.36	57.90	42.23	45.37	39.38	25.73	31.22	39.45	49.84	50.19	55.96	527.61	44	47		40
50	68.26	61.16	75.65	59.21	57.60	53.17	40.04	55.40	55.68	66.60	75.66	45.39	713.83	59	63		40
51	38.92	43.63	49.73	31.89	26.87	21.57	22.57	25.84	28.66	37.37	46.95	31.56	405.54	34	36		40
52	60.89	56.26	68.14	71.89	53.62	46.06	36.24	48.49	48.22	60.02	65.83	48.33	664.00	55	59		40
53													-	46			40
54	60.34	32.74	81.27	47.76	44.40	34.14	40.04	45.37	50.72	54.07	65.37	61.72	617.92	51	55		40
55	55.84	51.08	64.59	48.65	48.98	38.89	40.79	48.43	44.44	51.82			493.49	45	48		40
56	50.61	45.62	48.23	37.25	34.35	29.89	23.25	28.06	35.35	43.78	43.80	45.44	465.63	39	41		40
57	48.42	45.53	47.49	36.35	26.70	24.47	24.38	30.13	31.53	41.23	41.36	33.71	431.30	36	38		40
58	58.64	52.98	70.06	49.32	47.36	39.76	35.60	39.00	43.58	57.30	57.92	34.68	586.20	49	52		40
Rut 01	50.88	46.95	76.64	42.16	45.89	41.31	47.56	40.55	43.36	48.94	61.89	49.00	595.15	50	53		40
Rut 02	113.22	102.08	86.50	110.67	65.81	90.93	91.91	106.45		104.53	113.61	92.31	1,078.03	90	95		40
Rut 03(59	42.72	41.77	41.35	45.45	34.77	37.58	34.02	38.61	39.50	51.20	55.02	38.10	500.10	42	44		40
Rut 04	37.84	35.59	118.38	29.92	21.07	22.32		20.14	26.74	30.93	44.48	30.49	417.89	38	40		40

Triplicate NO2 diffusion tubes, co located with continuous analysers.

Site Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Annual mean
23	46.52	40.19	43.72	38.02	31.96	24.72	27.96	29.12	33.01	39.38	43.59	34.45	432.64	36.05
23/2	36.92	40.43	47.33	34.41	31.87	31.18	26.95	29.16	29.50	38.15	44.59	38.64	429.14	35.76
23/3	43.02	36.41	44.05	37.72	28.37	29.56	28.53	30.65	27.84	39.74	46.10	45.12	437.10	36.42
Average														36.08
37	31.32	27.37	34.98	25.84	16.93	14.09			17.92	29.75	28.88	25.89	252.98	25.30
37/2	30.38	30.71	38.78	22.82	16.61	14.89	12.98	13.55	18.06	27.24	28.58	26.48	281.08	23.42
37/3	31.21	28.88	36.41	19.29	16.75	15.10	13.32	16.42	16.88	27.50	28.80	25.98	276.54	23.05
Average														23.92
53			45.45	43.11	42.51	42.99	38.46	49.77		52.13	54.58	39.11	408.12	45.35
53/2			44.39	51.90	42.73	39.82	40.85	46.40	42.86	51.35	62.50	34.50	457.30	45.73
53/3			47.79	49.18	48.14	39.59	37.77	44.13	42.88	53.24	54.44	45.06	462.23	46.22
Average														45.77

For site locations see Table 10