APPENDIX 12
CAMEL ROAD SOUND SCREEN STUDY REPORT

Bickerdike Allen Partners

LONDON CITY AIRPORT

CAMEL ROAD SOUND SCREEN

2010 STUDY

Report to
London City Airport
City Aviation House
Royal Docks
London
E16 2PB

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8th July 2010

Bickerdike Allen Partners

Contents Page

1.0 EXECUTIVE SUMMARY

As part of London City Airport's Section 106 Planning Agreement dated 9th July 2009, Bickerdike Allen Partners (BAP) have carried out a study of the Camel Road Sound Screen. This screen provides protection to residents of Camel Road from noise of aircraft activities on the ground at the western end of the airfield, particularly in the region of aircraft Stands 12 – 14. The purpose of the study is to ascertain whether any improvements should be made to enhance the noise attenuation properties of the Camel Road Sound Screen.

Ground noise levels arising from aircraft operations on the ground at aircraft Stand 14 in the immediate vicinity of Camel Road have been measured, and an investigation into the sound attenuating properties of the existing sound screen has been used to develop a predictive ground noise model for this area, taking account of actual operations on Stands 12 – 14 over a typical day. The resultant ground noise exposure levels have been determined at the nearest and most affected residential premises in Camel Road.

The results have been compared to the results of the ground noise model for 2006 developed as part of an Environmental Statement[1] to determine whether the magnitude of ground noise exposure levels arising now exceed reasonable levels at Camel Road properties.

The study has found that the dominant noise source at Camel Road properties is road traffic on Hartman Road, with ground noise levels assessed to be at least 10 dB below the prevailing noise environment during most periods making ground noise normally inaudible. This makes the direct measurement of ground noise at Camel Road not possible.

The assessment has therefore been based partly on the results of background noise levels obtained during long term noise monitoring outside 2 Camel Road as well as a survey involving the measurement of the sound attenuating properties of the existing Camel Road Sound Screen during times when aircraft activities were occurring on Stand 14. Noise modelling has then been used, based on the results of this survey, to determine the relative contributions of ground noise received at 2 Camel Road from aircraft activity on Stands 12-14 and also from other areas of the airport.

[1] Issued in 2007 by BAP as part of the Environmental Statement submitted in support of the planning application for 120,000 movements per annum, which received planning approval on 9th July 2009

It has been found that ground noise received at Camel Road results from both aircraft using Stands 12 – 14 as well as ground noise from other aircraft activity around the airport. Whilst the main contributor to ground noise received at Camel Road is from aircraft using Stands 12 – 14, in view of the relatively low usage of these Stands, ground noise levels are found to be significantly lower now than predicted for 2006.

Over a typical day, the ground noise level received at the bedroom window of 2 Camel Road has been calculated as 53 dB $L_{Aeq,16h}$. In 2006, this was predicted to be 58 dB $L_{Aeq,16h}$. The Camel Road Sound Screen is therefore currently controlling ground noise levels in the vicinity of Camel Road to values well below those in 2006.

No improvements are therefore required at this time to enhance the noise attenuation properties of the Camel Road Sound Screen. The ground noise levels in the vicinity of Camel Road, and the need for any further modifications to the Camel Road Sound Screen, will be checked in the future as part of the regular Ground Noise Study undertaken by the airport.

2.0 INTRODUCTION & BACKGROUND

Bickerdike Allen Partners (BAP) have been retained by London City Airport (LCY) to carry out a study of the Camel Road Sound Screen in accordance with the Airport's Section 106 Planning Agreement dated 9th July 2009. The Section 106 Agreement (Fifth Schedule, Part 3) defines the Camel Road Sound Screen Study as:-

"a study of the Camel Road Sound Screen in order to ascertain any improvements that should be made to enhance the noise attenuation properties of the Camel Road Sound Screen"

The timeframe for the preparation and submission of the Camel Road Sound Screen Study to the London Borough of Newham (LBN), and the implementation of any noise mitigation measures that might arise from the Study is set out in the Section 106 Agreement which requires that:-

(a) within 3 months of completing such study (or any other such period as may be agreed in writing with the Council) the Airport Companies shall submit the results of such study for the approval of the Council; and

(b) within six months of receipt of written approval from the Council the Airport Companies shall carry out and complete any improvements to the Camel Road Sound Screen recommended by and within the timeframe specified in the approved study subject to (so far as may be necessary for such improvements and in which case the Airport Companies shall carry out and complete such improvements within three months of the same) the grant of planning permission and any other statutory consents which the Airport Companies shall use reasonable endeavours to obtain.

For this study of the Camel Road Sound Screen, BAP have carried out measurements of the existing ambient and background noise levels at residential properties on Camel Road, and have measured and determined the ground noise exposure levels arising from aircraft operations on Stands 12 – 14 in the immediate vicinity of Camel Road. These results have been used to determine the sound attenuating properties of the existing Camel Road Sound Screen for incorporation into a predictive ground noise model.

The measurement and predictive modelling results have been compared against the noise levels described in the Environmental Statement submitted in support of the planning application for 120,000 movements per annum which received planning permission on 9th July 2009 in order to assess the reasonableness of any exposure to ground noise operations from Stands 12 – 14 and to ascertain any improvements that should be made to enhance the sound attenuation properties of the existing Camel Road Sound Screen.

A description of the existing sound screen and noise environment is given in Section 3.0. A summary of the results and findings presented in the Environmental Statement submitted in support of the 2007 planning application is given in Section 4.0. Survey results of both unattended measurements taken at 2 Camel Road and an investigation into the existing sound attenuating properties of the sound screen are given in Section 5.0. Section 6.0 outlines the modelling procedure undertaken to predict noise levels incident on Camel Road properties due to operations on Stands 12 – 14 and presents the results. An analysis of the performance of the Camel Road Sound Screen and an assessment of its current suitability with regard to reasonableness of noise exposure are given in Section 7.0. Conclusions are given in Section 8.0.

A glossary of acoustic terminology used in this report is presented in Appendix A.

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3.0 THE SITE & EXISTING CAMEL ROAD SOUND SCREEN

London City Airport is located in the London Borough of Newham, north of the River Thames, between the Royal Albert and King George V Docks. The runway is orientated east-west, and the airport terminal, apron and stands are situated to the southern side of the site towards the western end (see Figure 1).

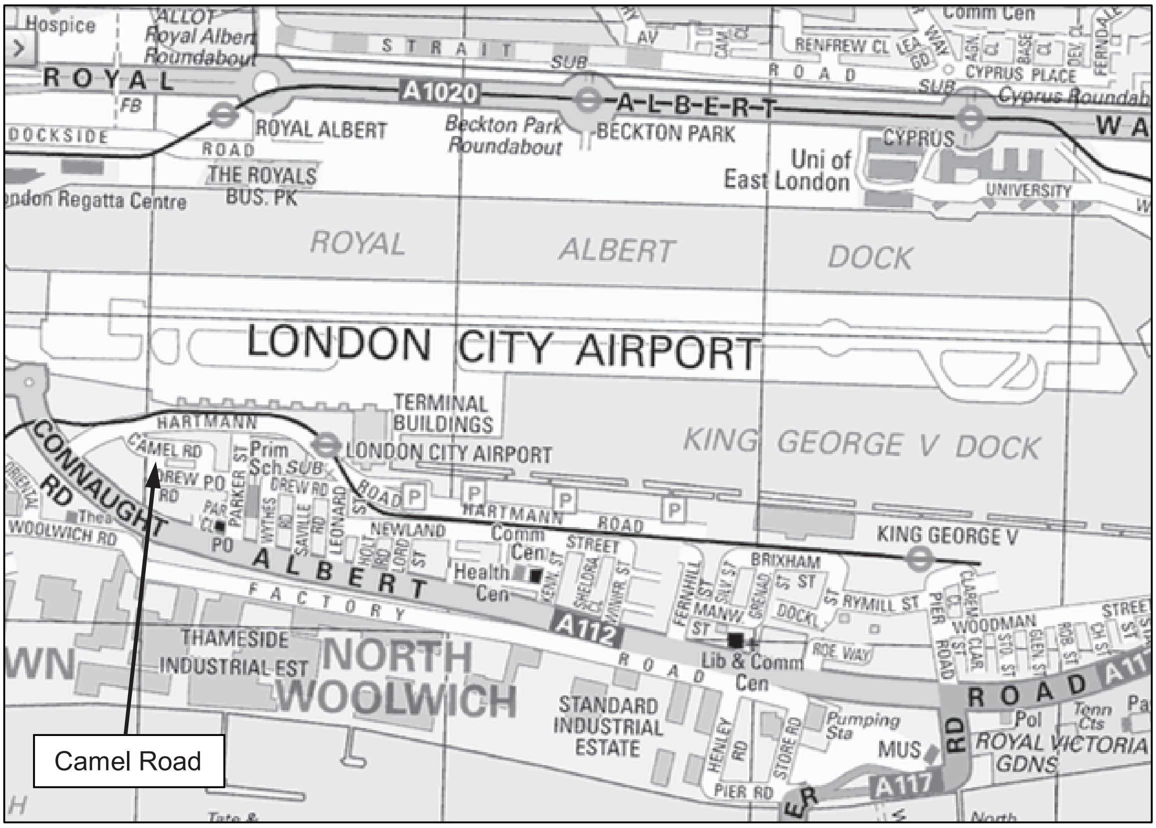

Figure 1 – London City Airport location

As can be seen from Figure 1, Camel Road is located to the south of the south-western end of the airport. The nearest property to the airport site is 2 Camel Road, at a distance of approximately 30 m from the site perimeter. Between Camel Road and the airport is the main access road for the airport terminal, Hartmann Road, and the North Woolwich branch of the Docklands Light Railway (DLR) which is situated on a viaduct at a height of approximately 5.5 metres above local ground level (agl). To the west and south of Camel Road is Connaught Road (A112).

The nearest aircraft stands to 2 Camel Road are Stands 12 – 14, and aircraft on these stands are predominantly shielded from view at this location by the Camel Road Sound Screen as shown in Figure 2. The existing Camel Road Sound Screen is generally 4 m in height and runs from the western edge of Stand 14 (left) to the western end of the airport's fire station building (right).

The remaining stands (1 – 11 and 21 – 24) are located behind the airport's fire station and terminal building to the east of Camel Road.

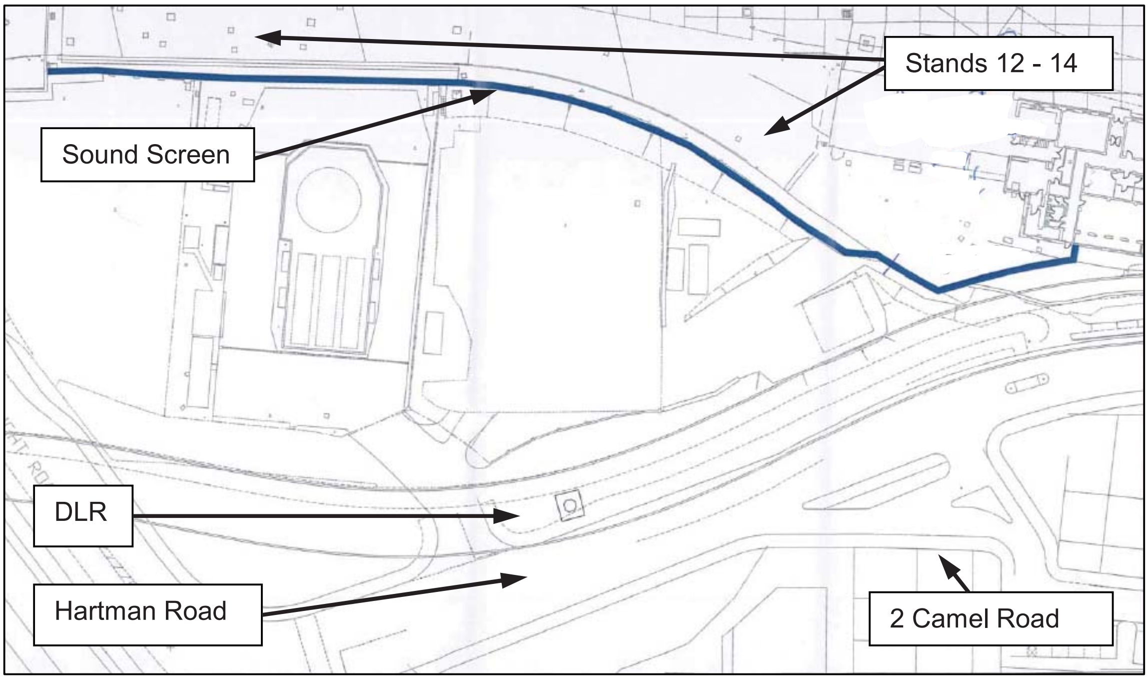

Figure 2 – Camel Road Sound Screen **(Section 106 Agreement, Plan 4 (Atkins) dated 9th July 2010)**

4.0 2006 ENVIRONMENTAL ASSESSMENT

Bickerdike Allen Partners submitted an assessment of the impact of ground noise as a result of airport operations as part of the London City Airport's Environmental Statement[2] in 2007.

This assessment included a noise survey carried out during March of 2007 to investigate both the typical prevailing background noise level around the airport, and also to obtain reference noise data relating to ground operations. The assessment also included the use of the acoustic software noise modelling software package, CADNA, which was used in conjunction with reference noise level data and event duration information in order to calculate the propagation of noise from sources to receivers using the methodology set out in ISO 9613-2 "Attenuation of sound during propagation outdoors – General method of calculation". A brief description of the CADNA modelling methodology is given in Section 6.1.

The impact of ground noise was based on the average mode[3] traffic for the year of 2006 over a 16 hour period. This follows the recognised convention for assessing aircraft noise and community response.

The ground noise model indicated that for average mode operations ($L_{Aeq,16h}$) the noise level at 2 Camel Road, assessed at 4 m above local ground level (agl), was 58.4 dB. It was recognised however that as the airport becomes busier, ground noise levels may rise and that the attenuation provided by the Camel Road Sound Screen may require enhancement in order to protect the amenity of the residents of Camel Road.

The ground noise exposure levels for 2006 as recorded in the Environmental Statement have been found acceptable as part of the planning application process for expansion to 120,000 movements per annum at LCY. The level of activity in 2006 also lies within that consented in 1998 when permission was granted to operate up to 73,000 air transport movements per annum at LCY. The ground noise exposure levels for 2006 therefore form a useful benchmark against which to judge current levels of ground noise in the vicinity of Camel Road.

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2 Issued in 2007 by BAP as part of the Environmental Statement submitted in support of the planning application for 120,000 movements per annum, which received planning approval on 9th July 2009

3 Where the average mode is the split of runway usage, averaged over the assessment period

5.0 SURVEY METHODOLOGY & RESULTS

Noise generated other than by aircraft in flight or taking off or landing is termed ground noise. The main sources of airport ground noise are taxiing and manoeuvring aircraft, operations of aircraft Auxiliary Power Units (APUs), mobile ground equipment such as Ground Power Units (GPUs), ground running (testing) of aircraft engines and construction.

Sources of aircraft related ground noise relevant to activities on Stands 12 – 14 include the use of APUs and the manoeuvring and taxiing to and from the stands. Ground running in these locations is not permitted.

The accurate measurement of these types of aircraft ground noise sources at Camel Road and in the vicinity of Stands 12 – 14 is complicated by the presence of other noise sources such as departing or approaching aircraft, car and train passbys, general street activity etc.

Two survey methodologies were used in this study. Firstly, an unattended noise survey was conducted at 2 Camel Road over a period of 13 days in order to determine the existing ambient and background noise environment from all sources including aviation and road traffic. Secondly, an investigative survey of the sound screen attenuation was conducted in order to obtain measurements to aid the refinement and to enhance the accuracy of noise modelling.

5.1 Unattended environmental noise survey

Measurements of the noise environment at 2 Camel Road were made between the 28th May 2010 and the 9th June 2010, producing 11 full days of results.

5.1.1 Equipment and procedure

The equipment used for this survey consisted of a Norsonic type 118 sound level analyser with a Norsonic type 1251 calibrator. As is good practice, the equipment was calibrated both prior to and after the survey and no significant drift was observed.

During the survey period the weather was generally dry, with light winds.

The measurement position was in the rear garden of 2 Camel Road, overlooking Hartman Road. The meter was placed at a height of approximately 4 m (1st floor window height) and a distance from the property of approximately 3.5 m (see Figure 3).

Noise measurements were taken continuously throughout the survey period recording statistical noise parameters denoting ambient noise levels ($L_{Aeq,T}$) and background noise levels ($L_{A90,T}$) every second. This level of detail in data gathering allows values of the L_{Aeq} and L_{A90} to be determined over any period of time. A slow time weighting was used throughout the survey.

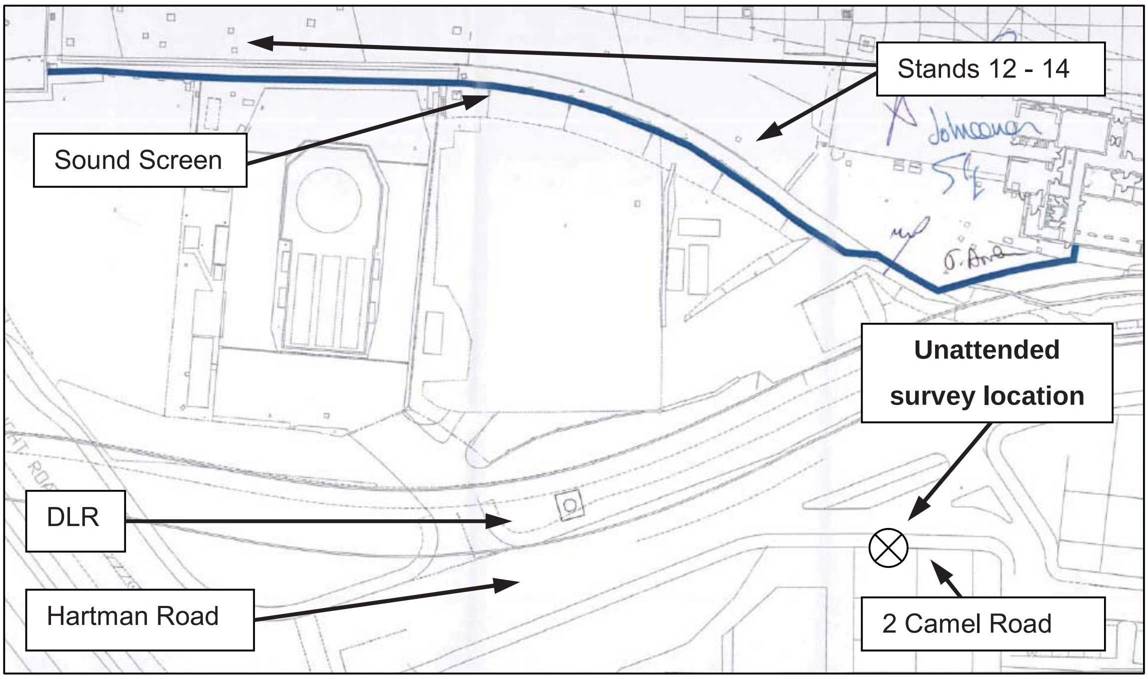

Figure 3 – Unattended environmental noise survey measurement position

Observations made on-site found that the noise environment was significantly dominated by road traffic, primarily on Hartman Road. Maximum noise readings of over 85 dB L_{Amax} were frequently obtained where road traffic, especially buses, passed over loose manhole covers – this was commented on in particular by the resident of 2 Camel Road as a great source of disturbance. Noise from aircraft was rarely audible above the road traffic noise except where aircraft were arriving from or departing to the west.

The duration of the survey (13 days with 11 full days of data) is considered sufficient to obtain a representative measurement of the local noise environment dominated by road traffic.

5.1.2 Results

Table 1 below summarises the results from each full day of the survey in terms of dB $L_{Aeq,16h}$ (07.00 to 23.00 hours) and the maximum and minimum hourly L_{Aeq} and L_{A90} measured during each full 24 hour period. The daily results are also displayed graphically and these have been included in Appendix B.

Date	Day	Measured noise level					
		Max dB $L_{Aeq,1h}$	Max dB $L_{A90,1h}$	Min dB $L_{Aeq,1h}$	Min dB $L_{A90,1h}$	dB $L_{Aeq,16h}$	dB $L_{A90,16h}$
29/05/2010	Saturday	66.1	56.2	55.2	50.6	63.4	53.4
30/05/2010	Sunday	70.6	56.8	53.0	48.3	66.2	52.9
31/05/2010	Monday	70.8	61.3	52.9	48.5	-*	-*
01/06/2010	Tuesday	69.2	63.0	54.7	48.7	66.9	58.7
02/06/2010	Wednesday	69.6	62.5	55.1	47.8	66.2	57.6
03/06/2010	Thursday	67.6	62.2	55.5	48.3	65.5	57.3
04/06/2010	Friday	67.5	62.0	55.7	48.1	65.4	57.4
05/06/2010	Saturday	64.5	56.0	55.4	50.0	61.8	52.8
06/06/2010	Sunday	71.7	57.8	53.5	48.7	67.1	54.2
07/06/2010	Monday	71.6	61.6	53.8	48.0	69.1	57.6
08/06/2010	Tuesday	70.4	66.6	57.5	49.8	68.3	58.8

* Data not obtained between 21.00 and 00.00 hours due to equipment malfunction; therefore the 16 hour L_{Aeq} has not been calculated

Table 1 – Unattended survey results dB L_{Aeq} and L_{A90}.

The results indicate that the daytime L_{Aeq} was on average 66 dB. The maximum hourly L_{Aeq} measured was 71.7 dB, and occurred between 19.00 and 20.00 hours on the 06/06/2010. The minimum hourly L_{Aeq} measured was 52.9 dB, and occurred between 02.00 and 03.00 on the 31/05/2010.

The maximum hourly L_{A90} measured was 66.6 dB, and occurred between 08.00 and 09.00 hours on the 08/06/2010. The minimum hourly LA90 measured was 47.8 and occurred between 02.00 and 03.00 hours on the 02/06/2010.

During the weekend periods, the background noise level between 07.00 and 23.00 hours was typically 55 dB, and on weekdays was measured to be typically 58 dB. The lowest noise levels were recorded during the night, with levels typically dropping from around 20.00 hours, and rising again from approximately 04.00 hours. Noise levels are typically highest between 08.00 and 09.00 hours and 17.00 to 20.00 hours.

5.1.3 Analysis

The purpose of this survey was to seek to obtain an identification of the underlying background noise at 2 Camel Road during lulls in road traffic flow. By this method, it was hoped that it would be possible to measure the general level of ground noise emerging from the airport, due partially to aircraft on Stands 12 – 14.

In practice, from observations made on site and assessment of the results, it is evident that road traffic activity along Hartman Road has been too dominant to determine ground noise levels in this manner. Close inspection of the graphics in Appendix B shows, for example, that at 06.00 hours during the week, prior to any aircraft activity at the airport, the $L_{Aeq,1h}$ at 2 Camel road is generally above 65 dB and around 60 dB $L_{A90,1h}$. These values are therefore totally dominated by road traffic.

As the morning progresses, levels rise slightly during the early morning peak and then fall back late morning to a background level of around 55 dB L_{A90} before rising steadily during the afternoon and peaking around 18.00 hours at similar levels to the morning peak. It is therefore not possible to obtain reliable data on aircraft ground noise exposure levels directly from this data when road traffic levels are so dominant.

The background noise level results, depicted by the L_{A90} index in the graphs of Appendix B, do provide however an upper bound above which ground noise exposure levels from the airport do not rise for a given time of day. Actual ground noise levels will however generally lie well below these values.

Using a worst case conservative assumption that on a weekday the background noise level (L_{A90}) at 2 Camel Road is dominated equally by both ground noise and road traffic, i.e. typically around 58 dB $L_{A90,16h}$, it can be computed that the noise level arising from ground noise at the airport, including Stands 12 – 14, is 55 dB $L_{Aeq,16h}$. This provides an upper bound value for ground noise outside 2 Camel Road.

5.2 Sound screen performance investigation

The ground noise received at Camel Road will arise as a result of aircraft activity on Stands 12 – 14, adjacent to the Camel Road Sound Screen, as well as general aircraft activity on the ground elsewhere around the airport. It is relevant to this study to investigate the relative contributions of these two elements.

An investigation into the sound attenuating performance of the Camel Road Sound Screen was conducted on the 7th July 2010 between 13:45 and 15:00 hours. The survey comprised the simultaneous measurement of noise on both sides of the sound screen (airside and landside) during which a turbo fan aircraft (RJ85) powered up its APU and engines prior to moving off Stand 14.

5.2.1 Equipment and procedure

The equipment used for this investigation consisted of a Norsonic type 118 sound level analyser with a Norsonic type 1251 calibrator and two Brüel & Kjær type 2260 sound level analysers with Brüel & Kjær type 4231 calibrators. All three analysers were calibrated both prior to and after the investigation and no significant drift was observed.

During the survey period the weather was overcast but warm and dry, with little or no wind.

Figure 4 below shows the measurement locations of the sound level analysers, labelled Nor 118, B&K 2260 1 and B&K 2260 2.

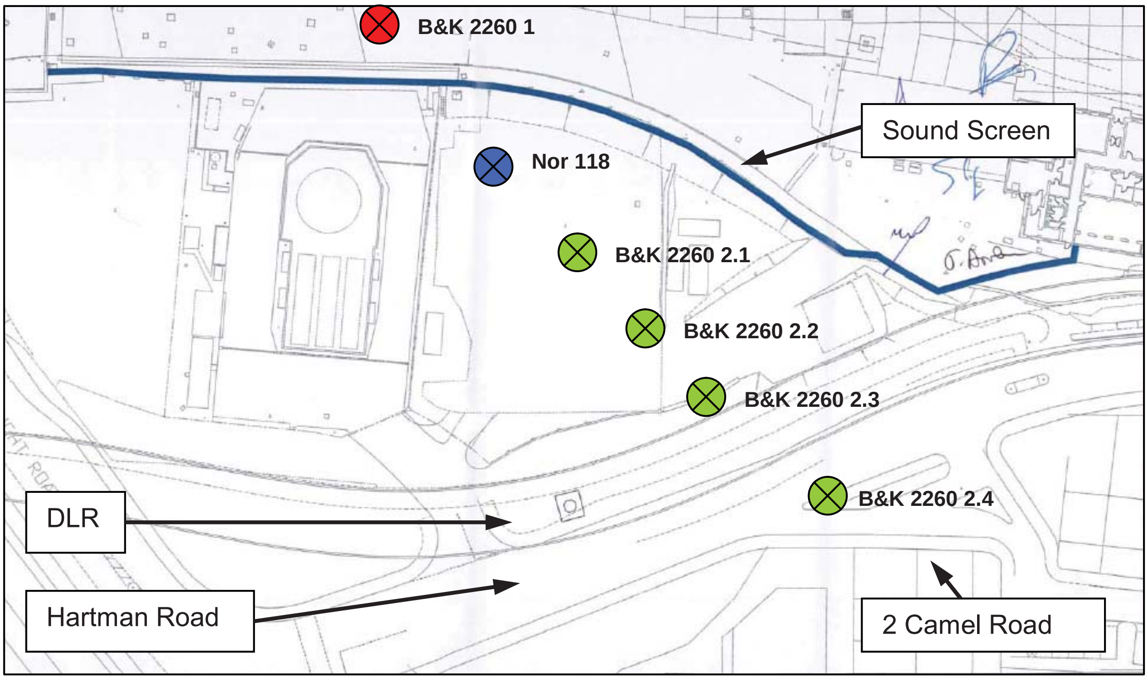

Figure 4 – Sound screen performance investigation measurement positions

The Norsonic type 118 sound level analyser (see Nor 118 shown blue in Figure 4 above) was positioned at a distance of 10 m from the sound screen, landside, at a height of approximately 4 m. At this location it was noted that the dominant source was ground noise from Stand 14, with secondary sources of arriving aircraft, unrelated aircraft overhead and DLR trains.

B&K 2260 1 was positioned primarily at a distance of 15 m from the sound screen, airside, at a height of approximately 1.5 m. At this location the dominant source was ground noise from the aircraft on Stand 14, which was positioned approximately 15 m from the microphone.

Differing heights of microphone positions were used in order to assist in gaining a sufficient spread of noise data to calibrate the ground noise model. Measurements were also taken at intervals during APU usage around the perimeter of Stand 14 (near B&K 2260 1) in order to investigate the directionality effects of the noise, and propagation towards the east, west and north of the Stand.

B&K 2260 2 took measurements at four locations landside. Position 1 (see B&K 2260 2.1) was towards the centre of the staff car park at a distance from the sound screen of approximately 35 m, Position 2 (see B&K 2260 2.2) was towards the right hand edge of the car park, at a distance of approximately 45 m. Position 3 was close to the DLR line at a distance from the sound screen of approximately 55 m. Position 4 was on a traffic island at the junction of Hartman Road with Camel Road, and was a distance of approximately 90 m from the sound screen.

All distances from the sound screen quoted are referenced in a direct line with the noise source (aircraft on Stand 14) in order to assess sound propagation and all measurements were taken at a height of approximately 1.5 m above local ground level.

It was observed that for Positions 1 to 3 that the dominant source of noise was the aircraft APU, with the results also influenced by vehicular traffic on Hartman Road. At Position 4 however, it was noted that noise from the aircraft APU could not be identified above the vehicular traffic noise. At Position 3 the results were affected by reflections from the DLR viaduct.

5.2.2 Results

Table 2 below presents a summary of the measurements taken as part of the sound screen noise attenuation investigation. The noise level in terms of $L_{Aeq,T}$ (time interval is variable, though typically 30 seconds to a minute) measured at each position where applicable is presented, with the time of the measurement and the identified source.

Time (hh:mm)	Source	Measured noise level dB $L_{Aeq,T}$					
		B&K 2260 1	Nor 118	B&K 2260 2.1	B&K 2260 2.2	B&K 2260 2.3	B&K 2260 2.4
13:15:38	APU	83.5	-	-	-	-	70.0
14:06:03	APU	83.4	-	-	-	-	75.1
14:26:01	APU	84.8	67.7	62.7	62.4	-	69.0
14:37:00	Engine x 1	87.8	65.4	-	-	64.6	-
14:46:00	Engine x 4	89.0	68.9	-	-	66.1	-
14:47:56	Departure (St.14)	82.9	65.8	-	-	62.1	-

Table 2 – Sound screen investigation results dB $L_{Aeq,T}$.

Table 3 below presents the above results in terms of noise reduction from the airside measurement position (B&K 2260 1), which encompasses both the attenuation due to the barrier, and distance attenuation.

Time (hh:mm)	Source	Reduction in noise level				
		Nor 118	B&K 2260 2.1	B&K 2260 2.2	B&K 2260 2.3	B&K 2260 2.4
13:15:38	APU	-	-	-	-	13.5
14:06:03	APU	-	-	-	-	8.3
14:26:01	APU	17.1	22.1	22.4	-	15.8
14:37:00	Engine x 1	22.4	-	-	23.2	-
14:46:00	Engine x 4	20.1	-	-	22.9	-
14:47:56	Departure (St.14)	17.1	-	-	20.8	-

Table 3 – Reduction in noise from airside measurement position, dB(A)

At the measurement position immediately south of the barrier (Nor 118) at a distance from the barrier of approximately 10 m the attenuation is 17.1 dB during periods when the APU is in use. This increases with distance further away from the barrier, 22.1 dB at 35 m and 22.4 dB at 45 m.

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The attenuation measured due to distance is affected to varying extents by the contribution of noise from road traffic and, for some positions, reflections from the DLR viaduct. Outside 2 Camel Road (measurement position B&K 2260 2.4), the influence of road traffic noise is evident by the variable reduction of between 8.3 and 15.8 dB at this location, despite the fact that the APU noise source generated a relatively constant noise level. The highest reduction, 15.8 dB, is around 7 dB less than that measured at measurement position B&K 2260 2.3, despite being the farthest location from the aircraft. This result is consistent with the observation that during the survey, noise from the aircraft operating its APU on Stand 14 was generally inaudible outside 2 Camel Road.

During the period in which the aircraft was in the process of powering up its engines prior to departing Stand 14, with the location of the primary noise source (engines rather than APU) moving further away from the barrier, the attenuation at measurement position Nor 118 was at least 20 dB, with approximately 23 dB measured at a distance of 55 m. The attenuation performance reduced slightly with activation of all four engines, and there was a further reduction of around 3 dB observed when the aircraft was departing the stand.

6.0 MODELLING & PREDICTIONS

6.1 CADNA modelling

6.1.1 Methodology

A computer model of the airfield and surroundings was prepared using the environmental noise calculation software CADNA. Incorporating buildings and barriers, the software calculates the propagation of noise from noise sources to receptors using the methodology set out in ISO 9613-2 “Attenuation of sound during propagation outdoors – General method of calculation”. As a worst case, the ground, building and barriers are modelled to be reflective.

The airfield is simplified into a number of noise source locations which represent segments of an aircraft’s taxi route to and from Stand. By assigning a noise level to each source representing the ground activity at that location (i.e. taxiing, manoeuvring, APU, engine start up), the noise at a given receiver is calculated from the contribution of all these sources taking into account propagation and any noise barriers and reflectors.

Specifically, for each source at a given location, a sound power level is determined based on the associated maximum sound level, L_{Amax}, at the reference distance of 152 m. Each source has an associated duration of activity applicable to the source location under consideration. The source sound power level is weighted according to this duration and also to the overall assessment period, which for the purposes of this study is 16 hours.

A further weighting is applied to account for the times the source event will occur in the period of interest, based on the number of aircraft movements. This weighting takes account of the number of westerly and easterly operations whose taxi routes pass through the source location. This information is then fed into the CADNA model to derive by receiver location the overall $L_{Aeq,T}$ ground noise levels.

For the purpose of this study, the model has been adapted to compare and contrast the noise level due to ground noise from different scenarios, for example noise produced by aircraft using Stands 12 – 14 only, noise produced by aircraft using all other stands excluding Stands 12-14, and noise produced from aircraft using all stands as presented in the 2007 Environmental Statement.

6.1.2 Modelling assumptions

The following assumptions have been used in the assessment of noise produced from aircraft ground activity at LCY.

	2006	2009
Total	79,646	75,678
Turbo-fan (%)	30	54
Turbo-prop (%)	52	34
Corporate (%)	18	12

Table 4 – Number of aircraft movements and aircraft mix

Assumptions have also been made with regard to the duration of activities and the reference noise levels of each aircraft type. These assumptions are the same as those used to conduct the 2006 modelling exercise and are presented in the Environmental Statement.

The model for 2009 has incorporated the actual proportion of activity on each stand. In view of the longer travel distances to the terminal building for passengers using Stands 12 – 14, other stands are used in preference when available. This policy has led to the actual usage of Stands 12 – 14 being approximately 2 movements per day, per stand, whereas the average number of movements per stand is around 16 per day. This stand usage information was not available for the 2006 model where each stand was assigned an equal number of aircraft movements over a day.

To account for this uneven use of the airport stands, calculations have been undertaken to identify at 2 Camel Road:-

i) ground noise from aircraft using Stands 12 – 14 only;

ii) ground noise from aircraft using all stands except Stands 12 - 14

iii) ground noise from aircraft using all stands

6.2 Modelling Results

Noise levels incident on 2 Camel Road have been calculated for both the 2006 number and mix of aircraft as presented in the 2007 Environmental Statement and for 2009. The calculations have been undertaken to assess the performance of the Camel Road Sound Screen in relation to all sources of ground noise, and have included the following scenarios:

iv) ground noise from aircraft using Stands 12 – 14 only;

v) ground noise from aircraft using all stands except Stands 12 – 14

vi) ground noise from aircraft using all stands

The results of these models are summarised in Sections 6.2.1 and 6.2.2 for 2006 and 2009 respectively. Graphical representations of the results are attached in Appendix C.

6.2.1 2006

The results of the CADNA modelling of ground noise incident on 2 Camel Road for airfield operations during 2006 are given below in Table 5. These results are given in terms of dB $L_{Aeq,16h}$, and are consistent with those published in the 2007 Environmental Statement. They assume an equal number of aircraft movements at each stand.

2006 Predicted levels due to ground noise	Noise Level, dB $L_{Aeq,16h}$
i) Stands 12 – 14 only	57.3
ii) All stands except Stands 12 – 14	49.9
iii) All stands	58.1*

*This value is comparable to the 58.4 dB value quoted in the Environmental Statement. The difference stems from rounding due to combining results of two separate noise models.

Table 5 – 2 Camel Road, 2006 ground noise levels

The results indicate that the dominant source of ground noise at 2 Camel Road in 2006 was activity on Stands 12 – 14.

6.2.2 2009

The results of the CADNA modelling of ground noise incident on 2 Camel Road for airfield operations during 2009 are given below in Table 6.

2009 Predicted levels due to ground noise	Noise Level, dB $L_{Aeq,16h}$
i) Stands 12 – 14 only	51.1
ii) All stands except Stands 12 – 14	48.9
iii) All stands	53.1

Table 6 – 2 Camel Road, 2009 ground noise levels

The results indicate that while the main contributor to ground noise received at Camel Road is from aircraft using Stands 12 – 14, in view of the relatively low usage of these stands, ground noise levels are found to be significantly lower now than predicted for 2006.

Over a typical day, the ground noise level received at the bedroom window of 2 Camel Road has been calculated as 53 dB $L_{Aeq,16h}$.

7.0 ASSESSMENT OF SOUND SCREEN

From site observations and an inspection of the results of the unattended survey at 2 Camel Road, it has been established that road traffic passing along Hartman Road dominates the noise environment at Camel Road. The average ambient noise level outside 2 Camel Road, at a height of 4 metres, is 66 dB $L_{Aeq,16h}$. Taking a conservative approach, it has been estimated that an upper bound for the contribution of ground noise to this value is around 55 dB $L_{Aeq,16h}$, some 10 dB(A) below the traffic noise contribution. This makes the direct measurement of ground noise at Camel Road not possible.

Ground noise levels arising from aircraft operations on the ground at aircraft Stand 14 in the immediate vicinity of Camel Road have been measured, and an investigation into the sound attenuating properties of the existing sound screen has been used to develop a predictive ground noise model for this area, taking account of actual operations on Stands 12 – 14 over a typical day. The resultant ground noise exposure levels have been determined at the nearest and most affected residential premises in Camel Road.

It has been found that ground noise received at Camel Road results from both aircraft using Stands 12 – 14 as well as ground noise from other aircraft activity around the airport. Whilst the main contributor to ground noise received at Camel Road is from aircraft using Stands 12 – 14, in view of the relatively low usage of these stands, ground noise levels are found to be significantly lower now than predicted for 2006

Over a typical day, the ground noise level received at the bedroom window of 2 Camel Road has been calculated as 53 dB $L_{Aeq,16h}$. In 2006, this was predicted to be 58 dB $L_{Aeq,16h}$. The Camel Road Sound Screen is therefore currently controlling ground noise levels in the vicinity of Camel Road to values well below those in 2006. No improvements are therefore required at this time to enhance the noise attenuation properties of the Camel Road Sound Screen.

The ground noise levels in the vicinity of Camel Road, and the need for any further modifications to the Camel Road Sound Screen, will be checked in the future as part of the regular Ground Noise Study[4] undertaken by the airport.

[4] The Ground Noise Study is undertaken every 3 years; the last was completed in 2010.

8.0 SUMMARY & CONCLUSIONS

A study has been carried out to assess the performance of the Camel Road Sound Screen with regard to the environmental noise impact of ground noise at the nearest noise sensitive property, 2 Camel Road.

The assessment has been based on the results of background noise levels obtained during long term noise monitoring outside 2 Camel Road, as well as a survey involving the measurement of the sound attenuating properties of the existing Camel Road Sound Screen during aircraft activities on Stand 14.

Over a typical day, the ground noise level received at the bedroom window of 2 Camel Road has been calculated as 53 dB $L_{Aeq,16h}$. In 2006, this was predicted to be 58 dB $L_{Aeq,16h}$. The Camel Road Sound Screen is therefore currently controlling ground noise levels in the vicinity of Camel Road to values well below those in 2006.

No improvements are therefore required at this time to enhance the noise attenuation properties of the Camel Road Sound Screen.

Valerie Collingwood	**Peter Henson**
Acoustic Consultant	**Partner**

APPENDIX A
GLOSSARY OF ACOUSTIC TERMINOLOGY

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The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2 x 10-5 pascals) and the threshold of pain is around 120 dB.

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, Lw is expressed in decibels, referenced to 10-12 watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

Noise Rating

The Noise Rating (NR) system is a set of octave band sound pressure level curves used for specifying limiting values for building services noise. The Noise Criteria (NC) and Preferred Noise Criteria (PNC) systems are similar.

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Environmental Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

Statistical Term	Description
$L_{Aeq,T}$	The most widely applicable unit is the equivalent continuous A-weighted sound pressure level (LAeq, T). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound.
L_{AE}	Where the overall noise level over a given period is made up of individual noise events, the LAeq, T can be predicted by measuring the noise of the individual noise events using the sound exposure level, LAE (or SEL or LAX). It is defined as the level that, if maintained constant for a period of one second, would deliver the same A-weighted sound energy as the actual noise event.
L_{A01}	The level exceeded for 1% of the time is sometimes used to represent typical noise maxima.
L_{A10}	The level exceeded for 10% of the time is often used to describe road traffic noise.
L_{A90}	The level exceeded for 90% of the time is normally used to describe background noise.

Table 1: Commonly Used Environmental Noise Descriptors

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. The sound energy radiated is proportional to the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law. In decibel terms, every time the distance from a point source is doubled, the sound pressure level is reduced by 6 dB.

Road traffic noise is a notable exception to this rule, as it approximates to a line source, which is represented by the line of the road. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

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Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, it is reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

Screening and Diffraction

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. This reduction is limited, however, by diffraction of the sound energy at the edges of the screen. Screens can provide valuable noise attenuation, however. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land beyond, typically by around 10 dB(A). The best results are obtained when a screen is situated close to the source or close to the receiver.

Meteorological Effects

Temperature and wind gradients affect noise transmission, especially over large distances. The wind effects range from increasing the level by typically 2 dB downwind, to reducing it by typically 10 dB upwind – or even more in extreme conditions. Temperature and wind gradients are variable and difficult to predict.

APPENDIX B
UNATTENDED SURVEY RESULTS

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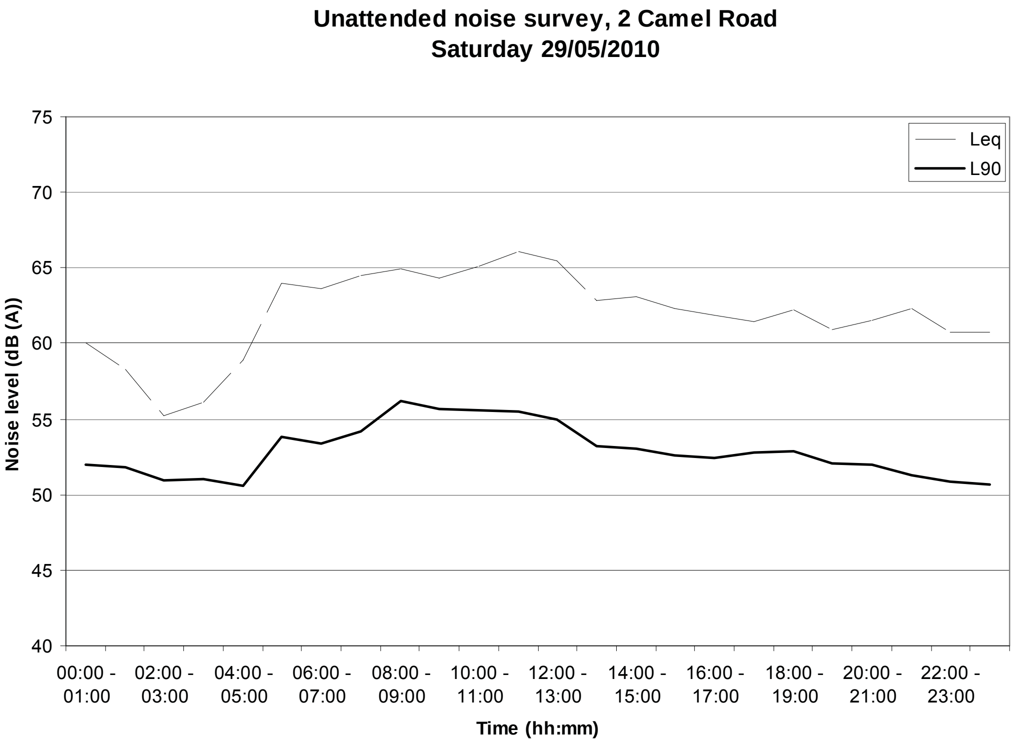

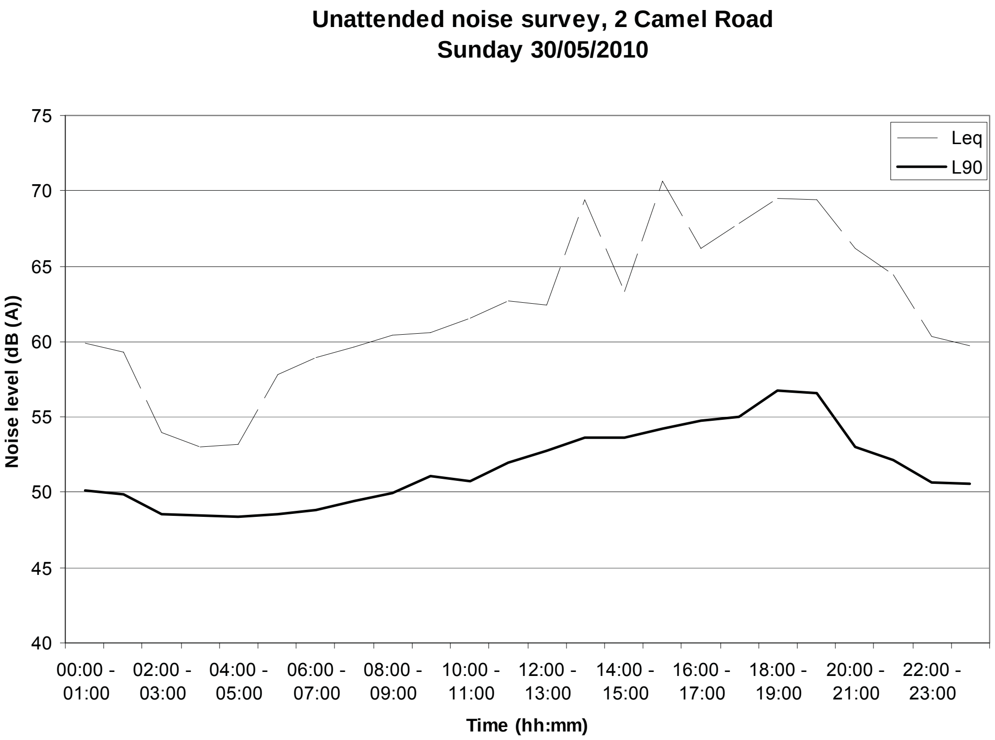

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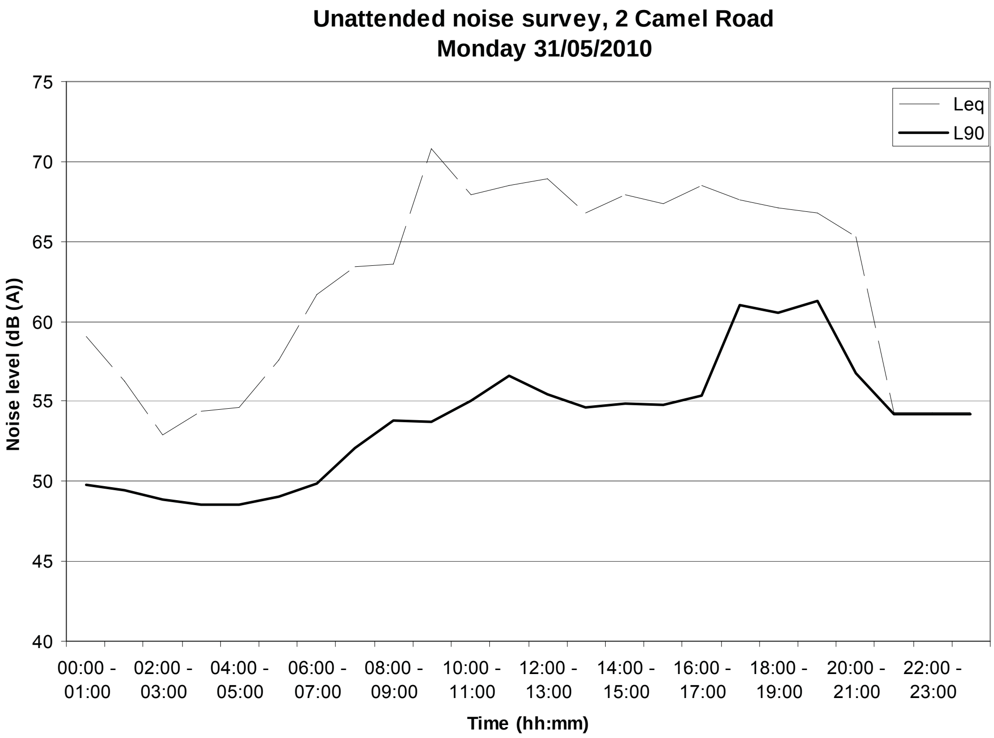

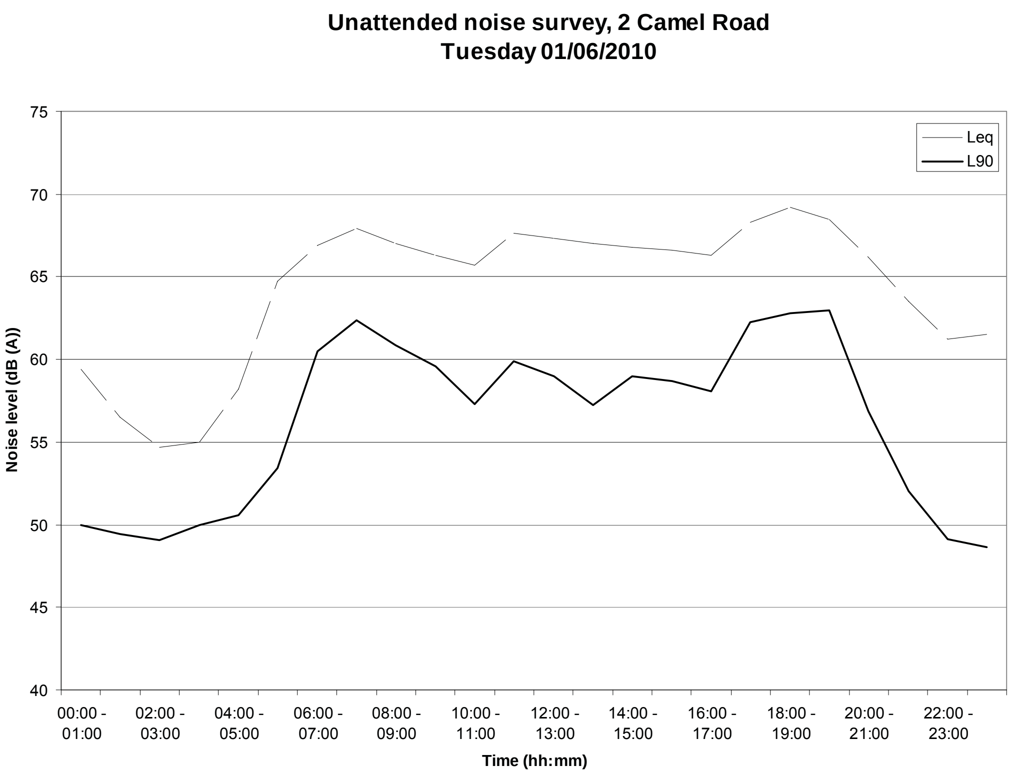

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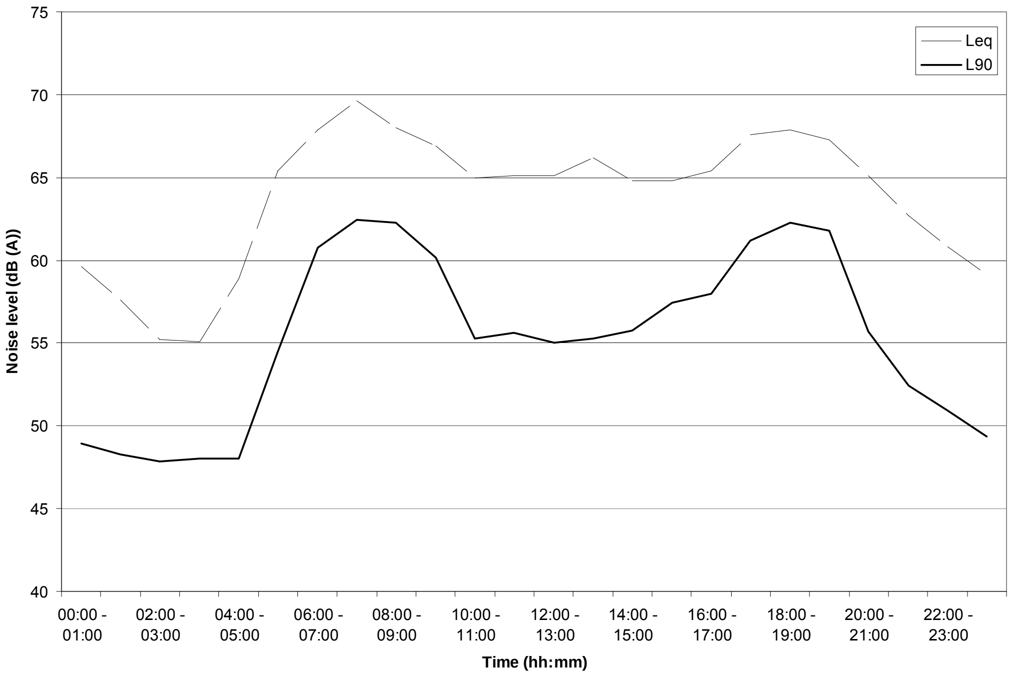
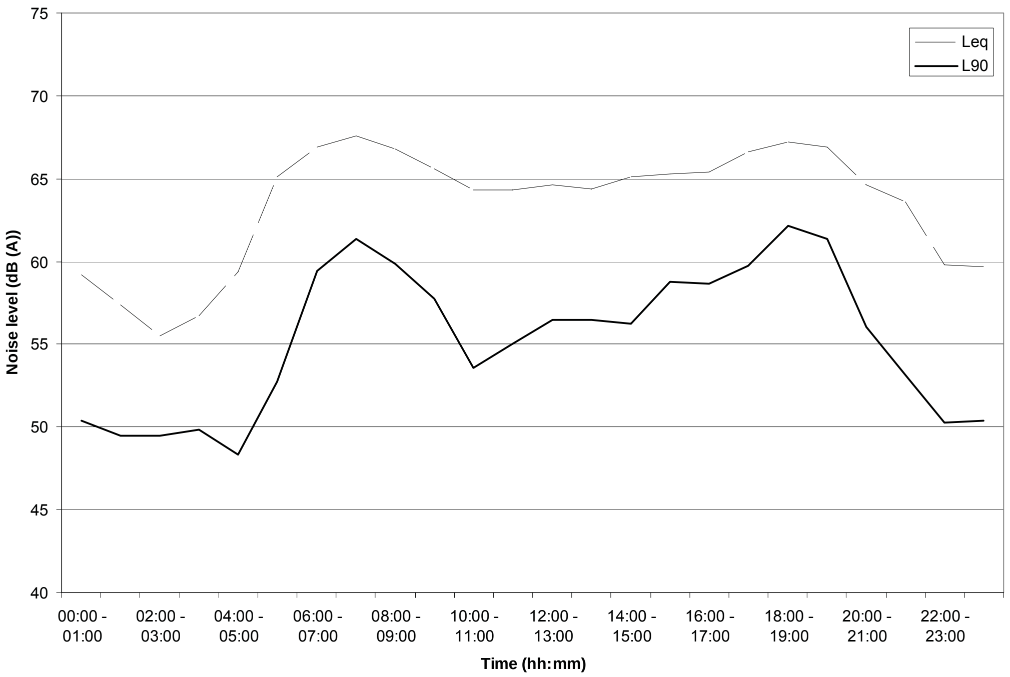
Unattended noise survey, 2 Camel Road
Wednesday 02/06/2010



Unattended noise survey, 2 Camel Road
Thursday 03/06/2010



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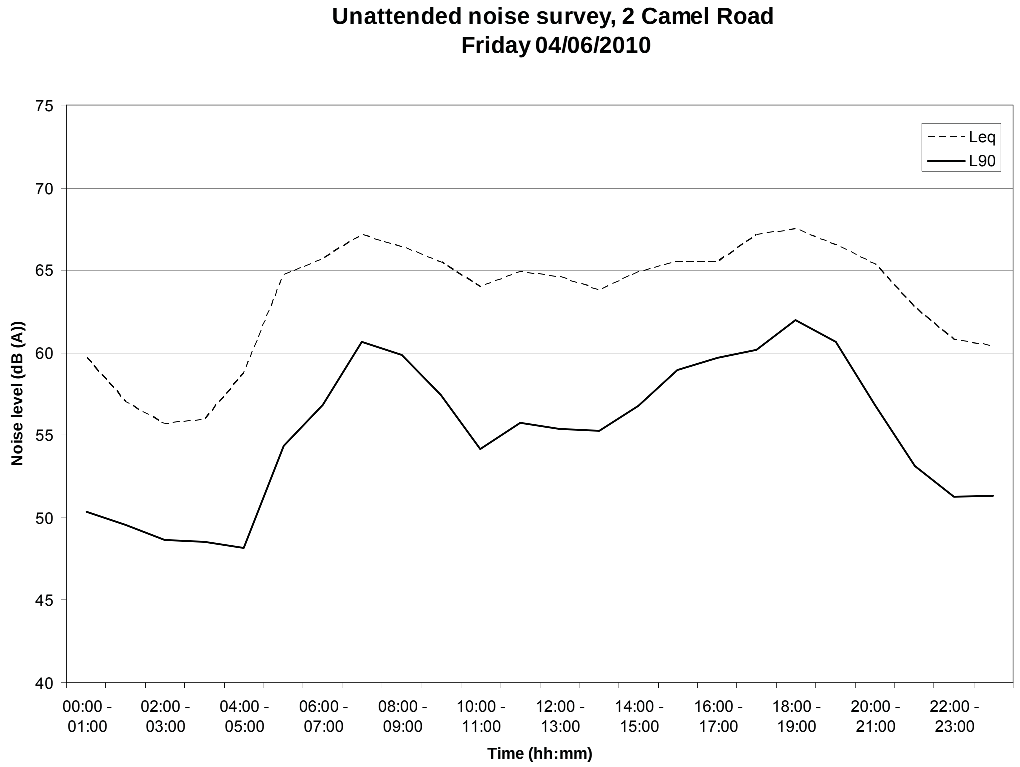

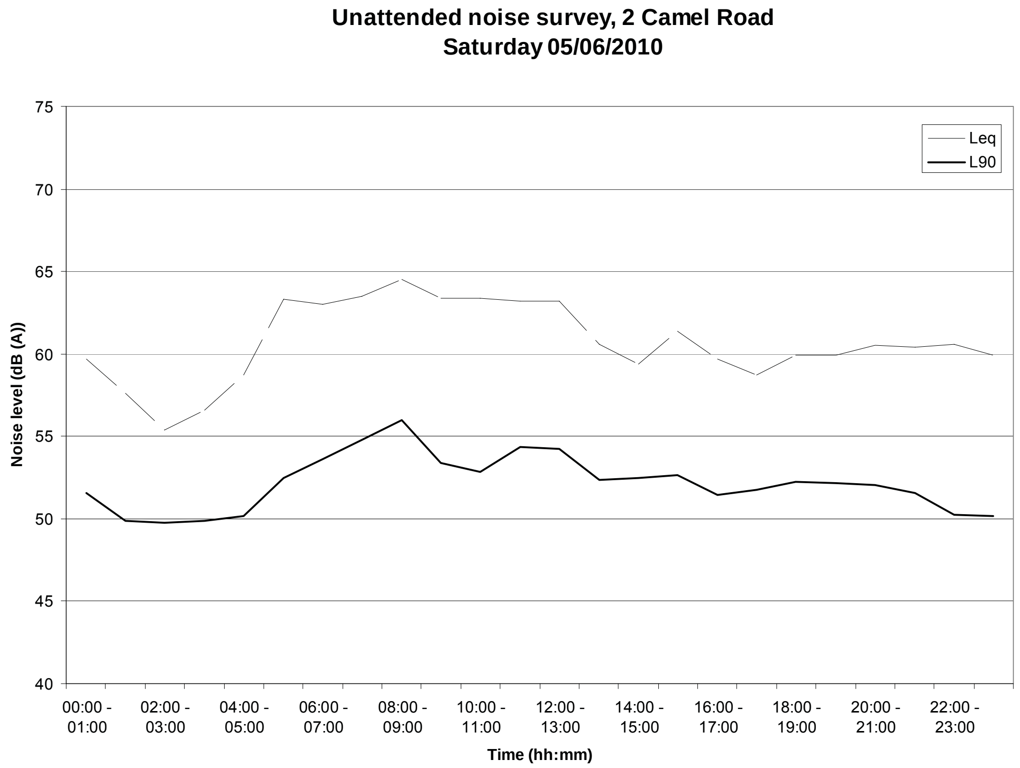

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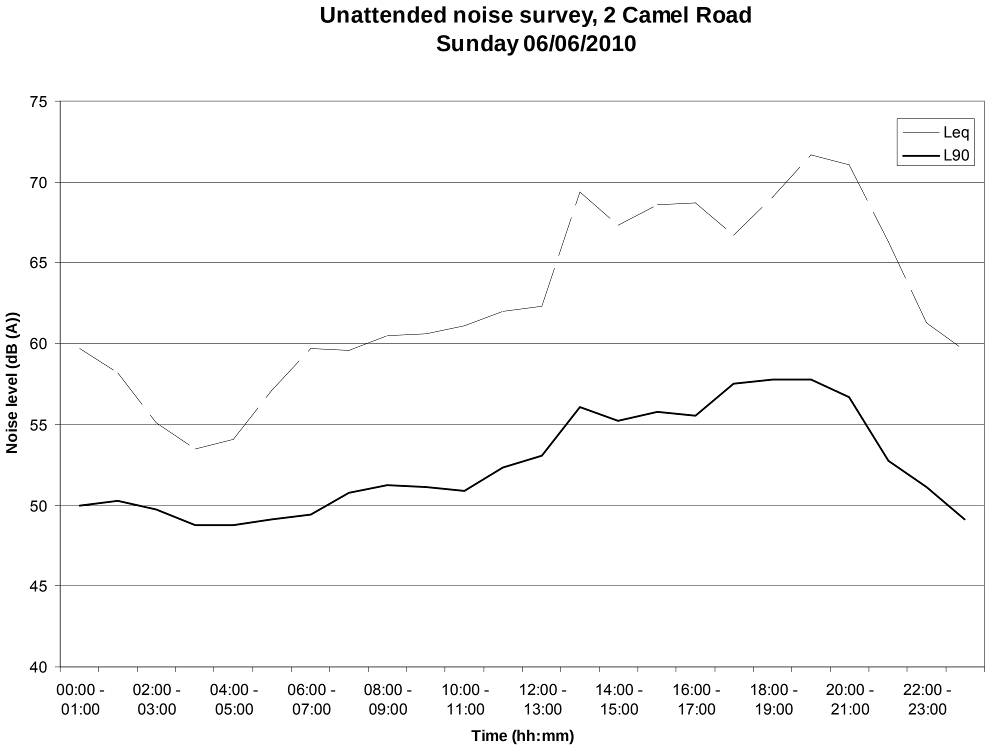

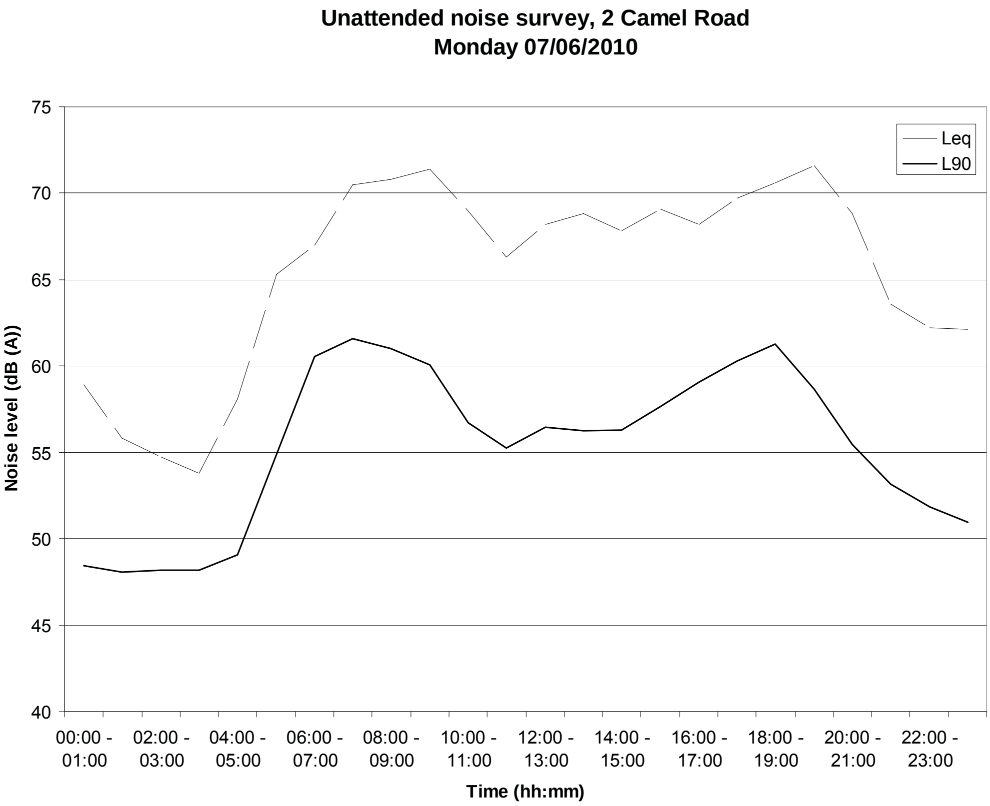

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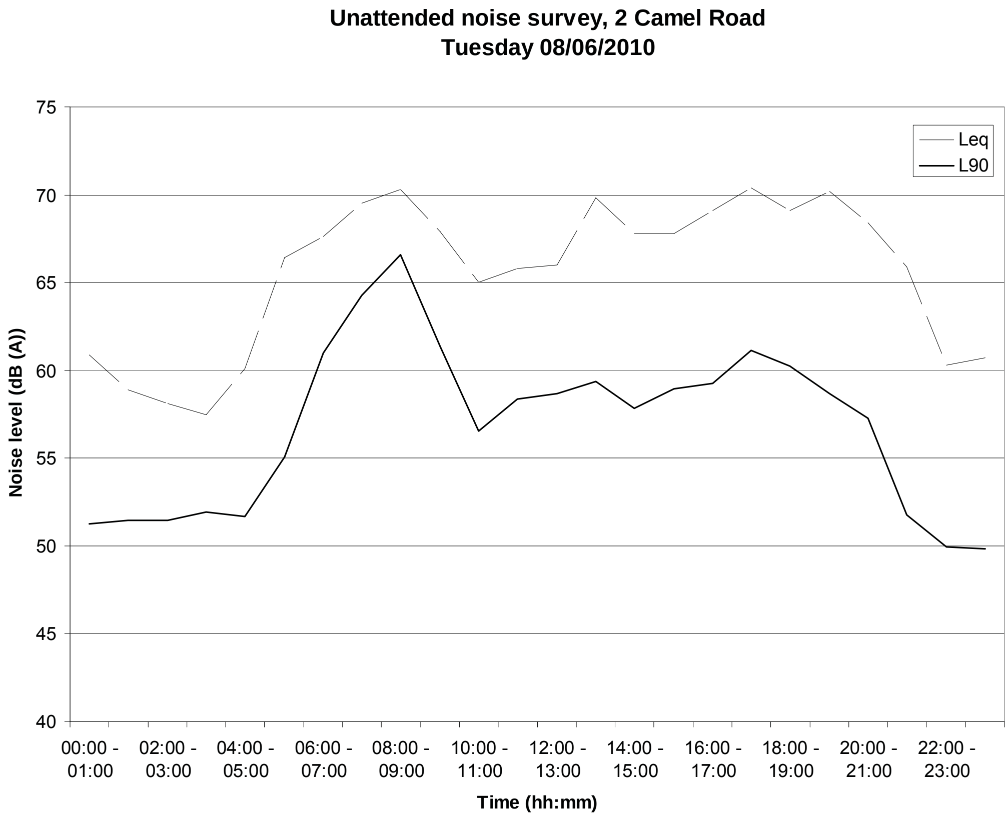

APPENDIX C
CADNA MODELLING RESULTS

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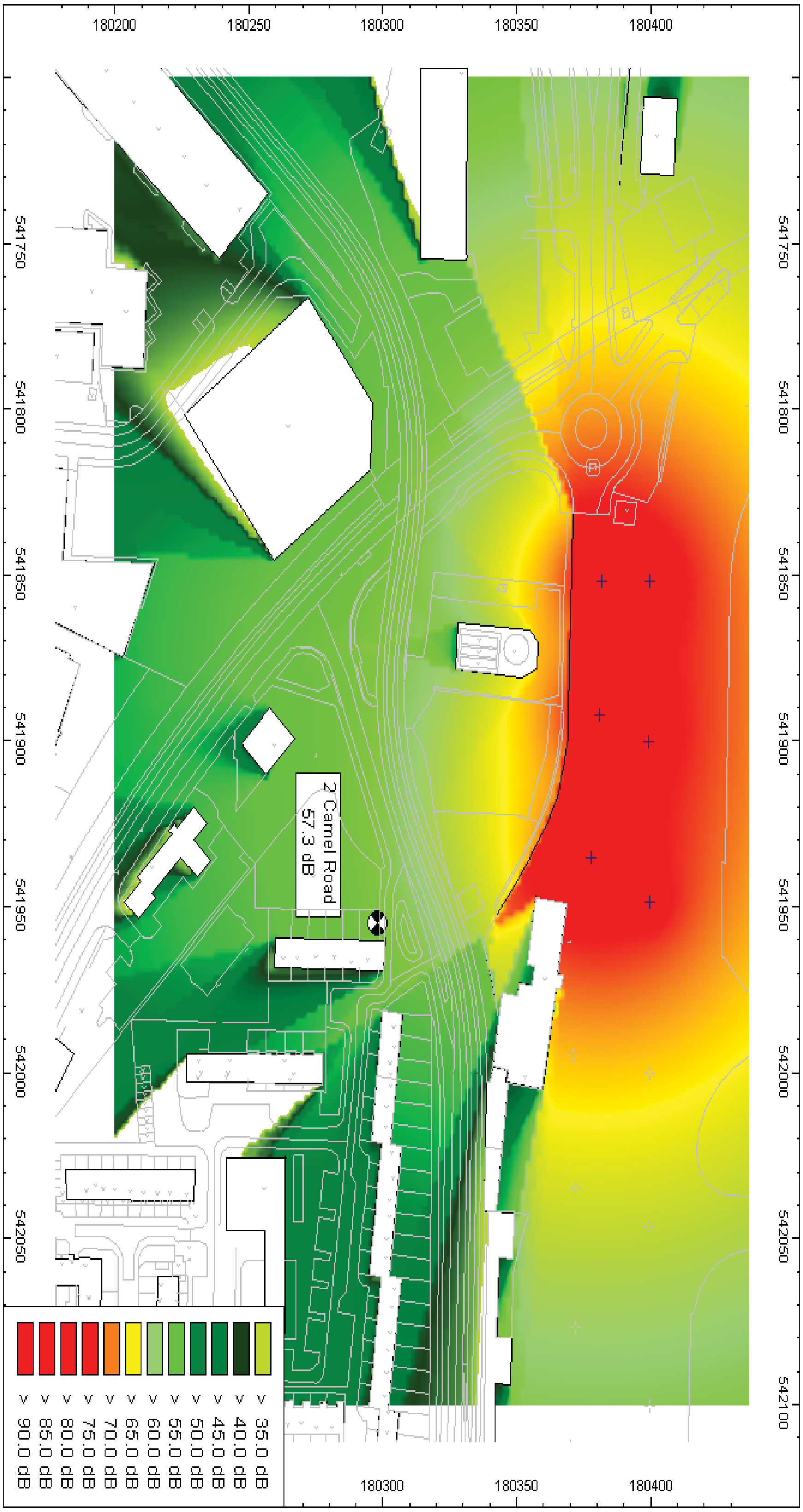
LONDON CITY AIRPORT: Camel Road Sound Screen Study 2006

Source: Stands 12 – 14 only

Noise level predicted at receiver: 57.3 dB $L_{Aeq,16h}$



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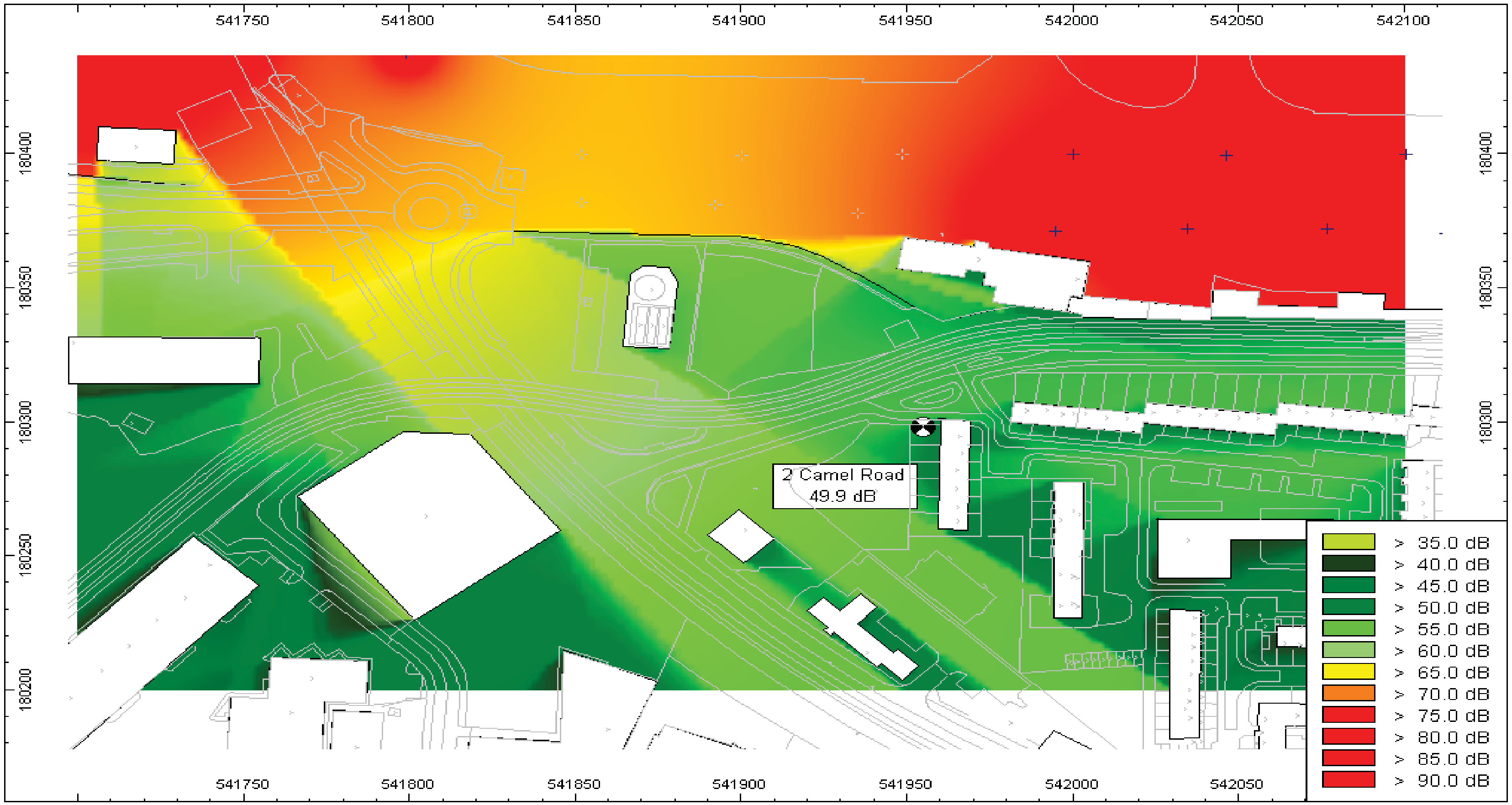
LONDON CITY AIRPORT: Camel Road Sound Screen Study 2006

Source: All stands excluding Stands 12 - 14

Noise level predicted at receiver: 49.9 dB $L_{Aeq,16h}$ at 4 m agl



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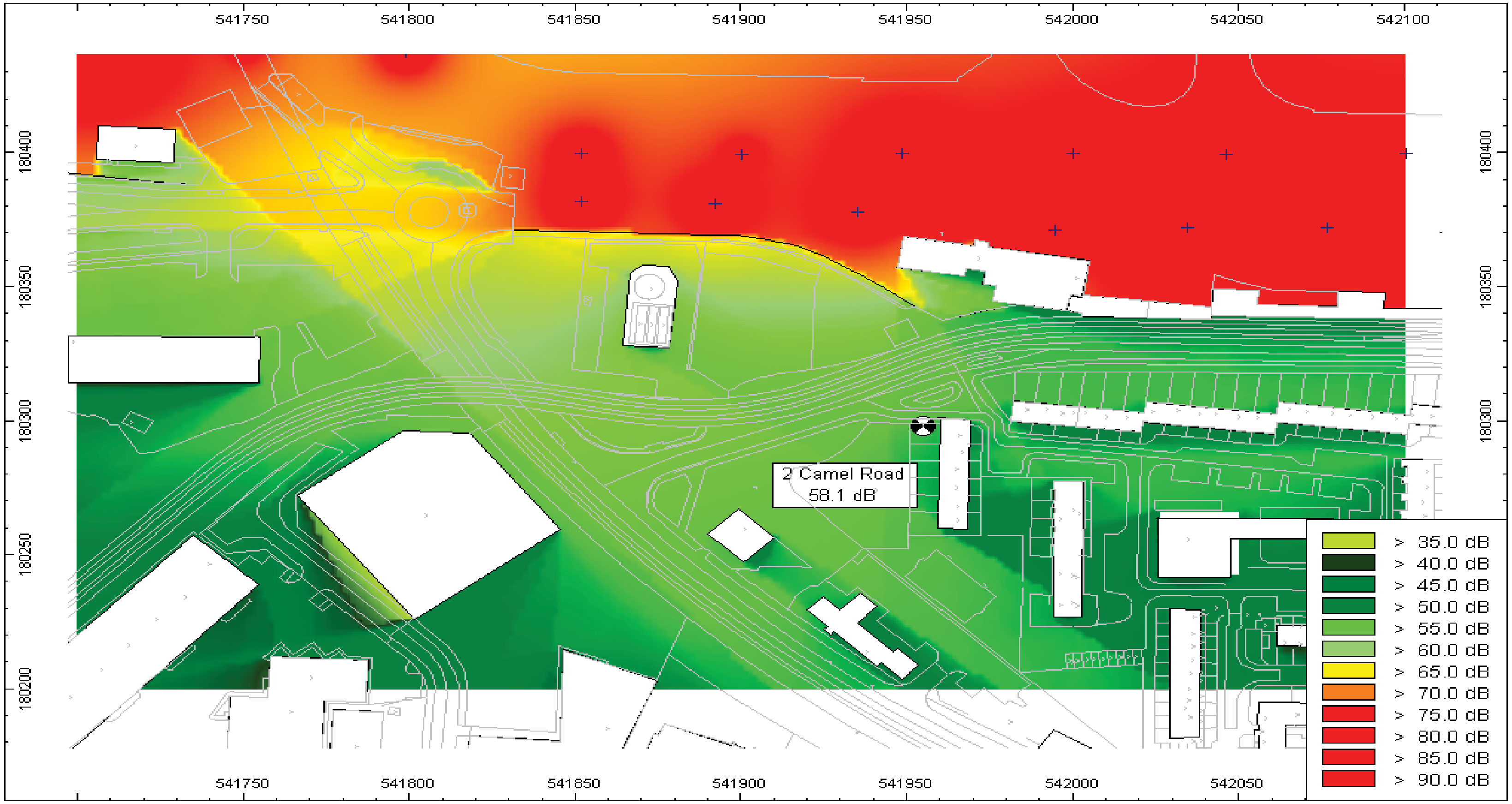
LONDON CITY AIRPORT: Camel Road Sound Screen Study 2006

Source: All stands

Noise level predicted at receiver: 58.1 dB $L_{Aeq,16h}$



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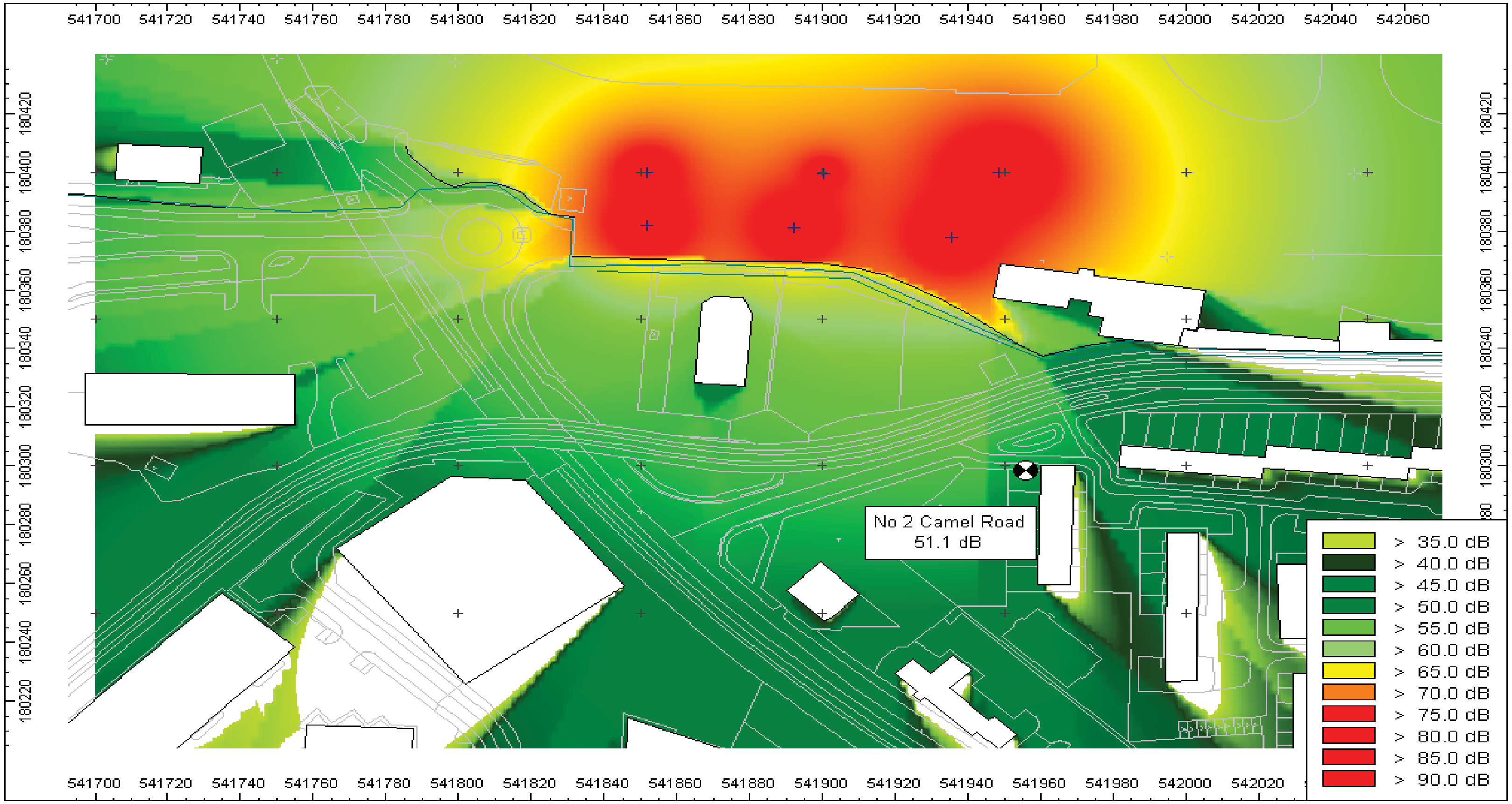
LONDON CITY AIRPORT: Camel Road Sound Screen Study 2009

Source: Stands 12 – 14 only

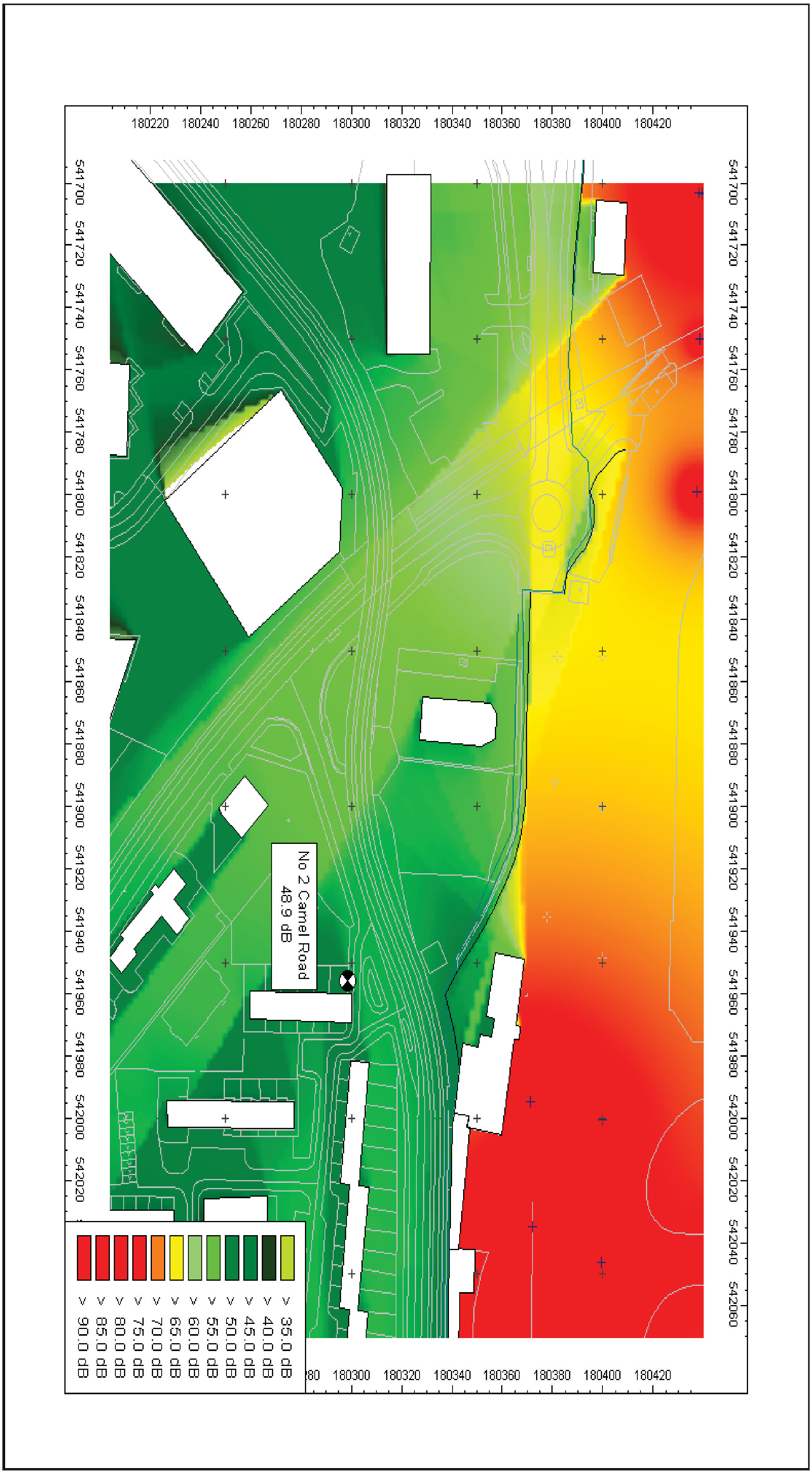
Noise level predicted at receiver: 51.1 dB $L_{Aeq,16h}$



LONDON CITY AIRPORT: Camel Road Sound Screen Study 2009

Source: All stands except Stands 12 - 14

Noise level predicted at receiver: 48.9 dB $L_{Aeq,16h}$ at 4 m agl



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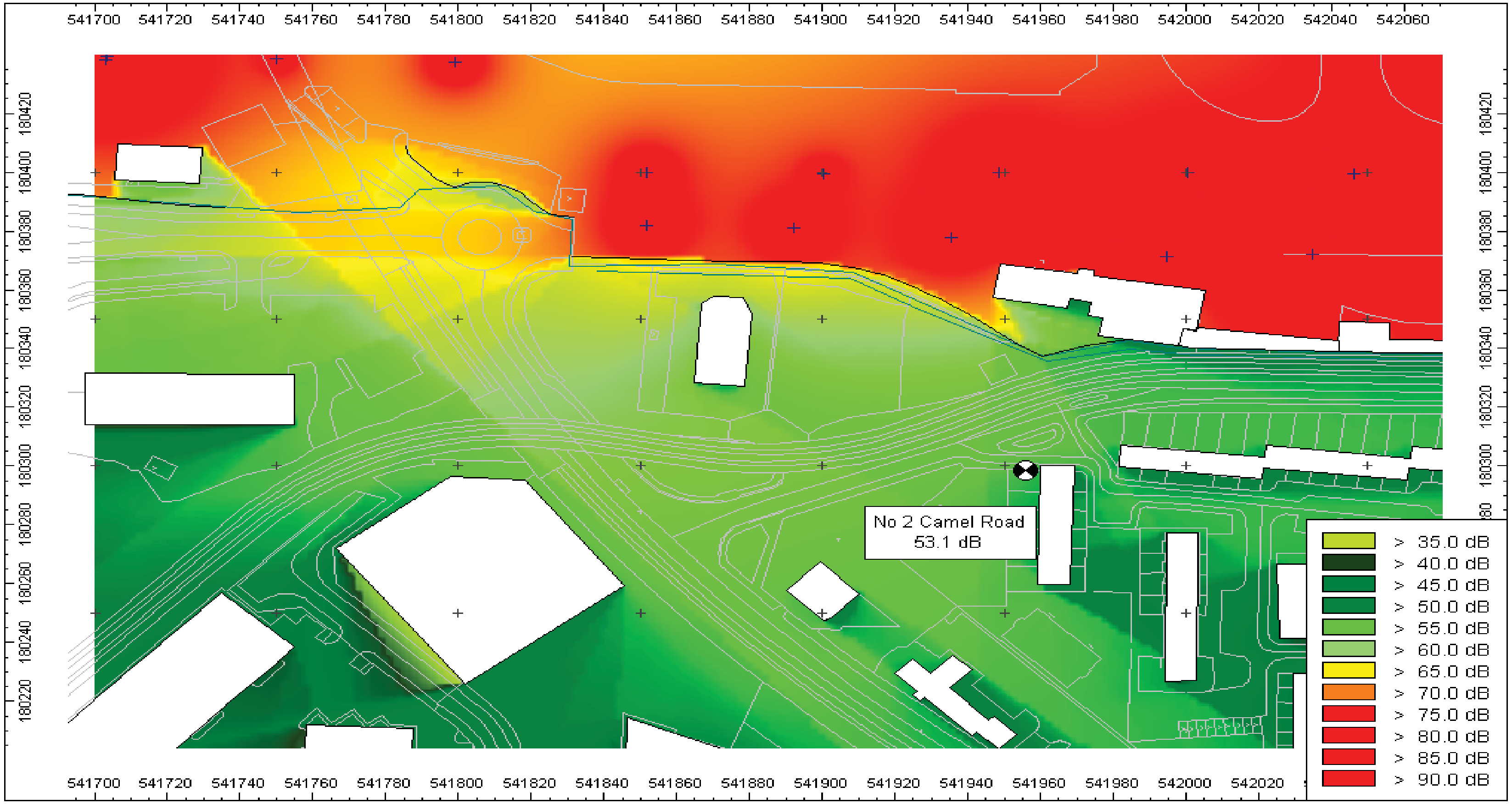
LONDON CITY AIRPORT: Camel Road Sound Screen Study 2009

Source: All Stands

Noise level predicted at receiver: 53.1 dB $L_{Aeq,16h}$



APPENDIX 13
DATA FROM AIR QUALITY MEASUREMENT PROGRAMME

Air Quality
CONSULTANTS

London City Airport
Air Quality Measurement Programme:
Annual Report 2010

April 2011

Experts in air quality
management & assessment

Document Control

Client	London City Airport	Principal Contact	Gary Hodgetts

Job Number	J962 / J1003

Report Prepared By:	Dr Denise Welch, Kieran Laxen and Stephen Moorcroft

Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
962/5/F1	13th April 2011	Final Report	Prof. Duncan Laxen

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Contents

1 Executive Summary

1.1 This document represents the 2010 Annual Report for the Air Quality Measurement Programme (AQMP) that is operated by Air Quality Consultants Ltd on behalf of London City Airport. This programme measures concentrations of nitrogen dioxide (NO_2) and fine particles (the so called PM_{10} fraction, i.e. particles that are less than 10 micrometres in diameter).

1.2 Monitoring is carried out at two automatic monitoring stations. One is situated on the roof of City Aviation House (LCA-CAH) whilst the other is to the north of Royal Albert Dock, adjacent to the Newham Dockside building (LCA-ND). These automatic sites are supplemented by a network of passive monitoring devices (nitrogen dioxide diffusion tubes) located at a further 17 sites in and around the Airport boundary.

1.3 The Government has set a number of air quality objectives to protect human health. These are equivalent to, or are more stringent than the limit values set by the European Union. Both the objectives and the limit values are based on monitoring carried out over the period of a calendar year.

1.4 In some cases, these objectives and limit values refer to average concentrations of pollutants measured over the calendar year (the "annual mean"); in other cases they refer to the number of hours or days on which a specified pollutant concentration should not be exceeded (for example, no more than 35 days in each calendar year on which PM_{10} concentrations exceed 50 µg/m^3, and no more than 18 hours in each calendar year on which nitrogen dioxide concentrations exceed 200 µg/m^3).

1.5 In addition to the objectives and limit values, the Government has established a set of descriptors for the 1-hour mean concentrations of nitrogen dioxide and 24-hour mean concentrations of PM_{10}. Air quality is defined by these descriptors as being Low, Moderate, High and Very High.

1.6 Pollution concentrations measured in and around the Airport are associated with a wide range of sources at the local, regional, national and international scales. On occasions when pollution levels rise, these higher levels are often observed across the whole of London as a "regional pollution episode". To assist with the interpretation of the results, pollution levels measured at other London monitoring sites are included in this report.

Nitrogen Dioxide

1.7 The 2010 annual mean nitrogen dioxide concentration measured at the automatic station on the roof of City Aviation House was 35 µg/m^3 (microgrammes per cubic metre); a slightly higher concentration (39 µg/m^3) was measured at the Newham Dockside site. The annual mean objective (40 µg/m^3) was not exceeded at either site in 2010. There were no recorded exceedences of the 1-hour mean objective, and all hourly concentrations were classified as "Low".

1.8 Annual mean concentrations of nitrogen dioxide at other background sites in London over this period ranged from 23-57 µg/m^3, with similar patterns in levels as seen at the two London City Airport sites. There was a good correlation between observed peaks at the Airport sites and other London sites, suggesting that these occurrences were principally due to regional sources and changing weather conditions that affect the dispersion and dilution of pollutant emissions.

1.9 The annual mean nitrogen dioxide concentrations measured at the diffusion tube sites ranged from 29.3 to 39.9 µg/m^3 compared with the objective value of 40 µg/m^3. There were no recorded exceedences of the annual mean objective.

Fine Particles (PM_{10})

1.10 The annual mean PM_{10} concentration measured at the automatic station on the roof of City Aviation House was 22 µg/m^3 (microgrammes per cubic metre). This compares with the objective value of 40 µg/m^3. There were two recorded exceedences of the 24-hour mean objective (compared with the 35 exceedences allowed in a calendar year). The majority of the running 24-hour concentrations were classified as "Low", with just one period classified as "Moderate".

1.11 Concentrations of PM_{10} at other background sites in London over this period showed similar patterns as seen at the Airport site. There was a good correlation between observed peaks at the Airport site and other London sites, suggesting that these occurrences were principally due to regional sources and changing weather conditions that affect the dispersion and dilution of pollutant emissions.

2 Introduction

2.1 This document represents the 2010 Annual Report for the Air Quality Measurement Programme, operated on behalf of London City Airport (LCA).

2.2 Approval to expand Airport operations to 120,000 aircraft movements per annum was granted in July 2009. A legal agreement between London City Airport and the London Borough of Newham associated with this planning approval sets out a number of obligations, one of which relates to an Air Quality Measurement Programme (AQMP).

2.3 The AQMP, as defined within the legal agreement, comprises an automatic air quality monitoring station situated on the roof of City Aviation House, and a network of nitrogen dioxide diffusion tubes, situated in and around the Airport site. In addition, London City Airport commissioned a second automatic air quality monitoring station at a site adjacent to the Newham Dockside building in September 2008. The operation of this additional site falls outside the AQMP, but the data are included in this Quarterly Report for the sake of completeness.

2.4 The monitoring programme is managed by Air Quality Consultants Ltd (AQC) on behalf of London City Airport. Service support for the automatic monitoring stations is provided by Enviro Technology Services plc, with AEA providing independent audit checks.

2.5 Chapter 3 of this Report sets out the various standards and guidelines against which air pollution concentrations should be compared. Chapter 4 describes the monitoring methodology and provides a summary of the measured concentrations in 2010 with respect to these criteria, and compares the measured concentrations with other local monitoring sites. Chapter 5 then provides some analysis of the monitoring data with respect to trends and source contributions.

3 Assessment Criteria

3.1 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality Regulations, 2000 (Stationery Office, 2000) and the Air Quality (England) (Amendment) Regulations 2002 (Stationery Office, 2002). The relevant objectives for this report are provided in Table 1.

Table 1: Relevant Air Quality Objectives

Pollutant	Time Period	Objective / Value
Nitrogen Dioxide	1-hour mean	200 µg/m^3 not to be exceeded more than 18 times a year
	Annual mean	40 µg/m^3
Fine Particles $(PM_{10})^a$	24-hour mean	50 µg/m^3 not to be exceeded more than 35 times a year[b]
	Annual mean	40 µg/m^3

[a] Measured by the gravimetric method.

[b] Equivalent to a 90th percentile of 24-hour mean concentrations of 50 µg/m^3.

3.2 The objectives for nitrogen dioxide and PM_{10} were to have been achieved by 2005 and 2004 respectively, and continue to apply in all future years thereafter.

3.3 The European Union has also set limit values for both nitrogen dioxide and PM_{10}. Achievement of these values is a national obligation rather than a local one. The limit values for nitrogen dioxide are the same levels as the UK objectives, and are to be achieved by 2010 (Stationery Office, 2007). The limit values for PM_{10} are also the same level as the UK statutory objectives, and were to be achieved by 2005. The objectives are the same as, or more stringent than, the limit values, thus it is appropriate to focus the assessment on the objectives.

3.4 In addition to the objectives and limit values, Defra (2011a) has established a set of descriptors for the 1-hour data for nitrogen dioxide and running 24-hour data for PM_{10}, labelling the levels as low, moderate, high and very high. These bandings are set out in Table 2.

Table 2: Air Pollution Bandings (µg/m^3)

Band	Nitrogen Dioxide Hourly Mean	PM_{10} Running 24 Hour Mean[a]
Low	0 – 286	0 – 62
Moderate	287 – 572	63 – 94
High	573 – 763	95 – 127
Very High	764 or more	128 or more

[a] Reference Equivalent

4 Monitoring Methodology and Results

Automatic Monitoring Stations

4.1 Monitoring was carried out at two automatic stations as follows:

- City Aviation House (LCA-CAH): Nitrogen dioxide and PM_{10}
- Newham Dockside (LCA-ND): Nitrogen dioxide

4.2 The location of the two automatic sites is shown in Figure 1.

4.3 The LCA-CAH automatic monitoring station measures PM_{10} using a Rupprecht and Patashnick TEOM 1400 Particulate Monitor, whilst both automatic stations measure nitrogen dioxide using M200E TAPI chemiluminescence analysers. The data are stored as 15-minute mean concentrations. Before further processing and ratification the raw PM_{10} concentrations have been adjusted to a "reference-equivalent" using the Volatile Correction Model (VCM) as recommended by Defra (2009). This adjusts the TEOM data using the "purge" concentration measured by an FDMS analyser, assuming this represents the volatile component that has been lost. A "VCM web portal" has been established that allows this correction to be derived from the mean of up to three, nearby FDMS analysers in the national network.

4.4 Independent site audits, conducted by AEA, confirmed that both automatic monitoring stations were operating above the minimum standards set for the national networks operated by Government.

4.5 Ratification of the data has been based on calibration factors determined from the calibration reports, along with visual examination of the data and comparison with monitoring data from nearby national network background sites (Bexley, Bloomsbury and Eltham) (Defra, 2011a). Any erroneous data have been flagged and removed from subsequent analysis. 1-hour, daily, and period means have then been calculated. All data reported in this 2010 Annual Report have been fully ratified.

4.6 Pollution concentrations measured at both automatic Airport monitoring stations are associated with a wide range of sources at the local, regional, national and international scales. On occasions when pollution levels rise, these higher levels are often observed across the whole of London as a "regional pollution episode". To assist with the interpretation of the results, comparable data have been obtained from the national Air Quality Archive (Defra, 2011a) for three background sites, Bexley, Bloomsbury and Eltham, and from the London Air Quality Network (KCL, 2011) for two sites within the London Borough of Newham at Wren Close, Canning Town (background) and Cam Road, Stratford (roadside).

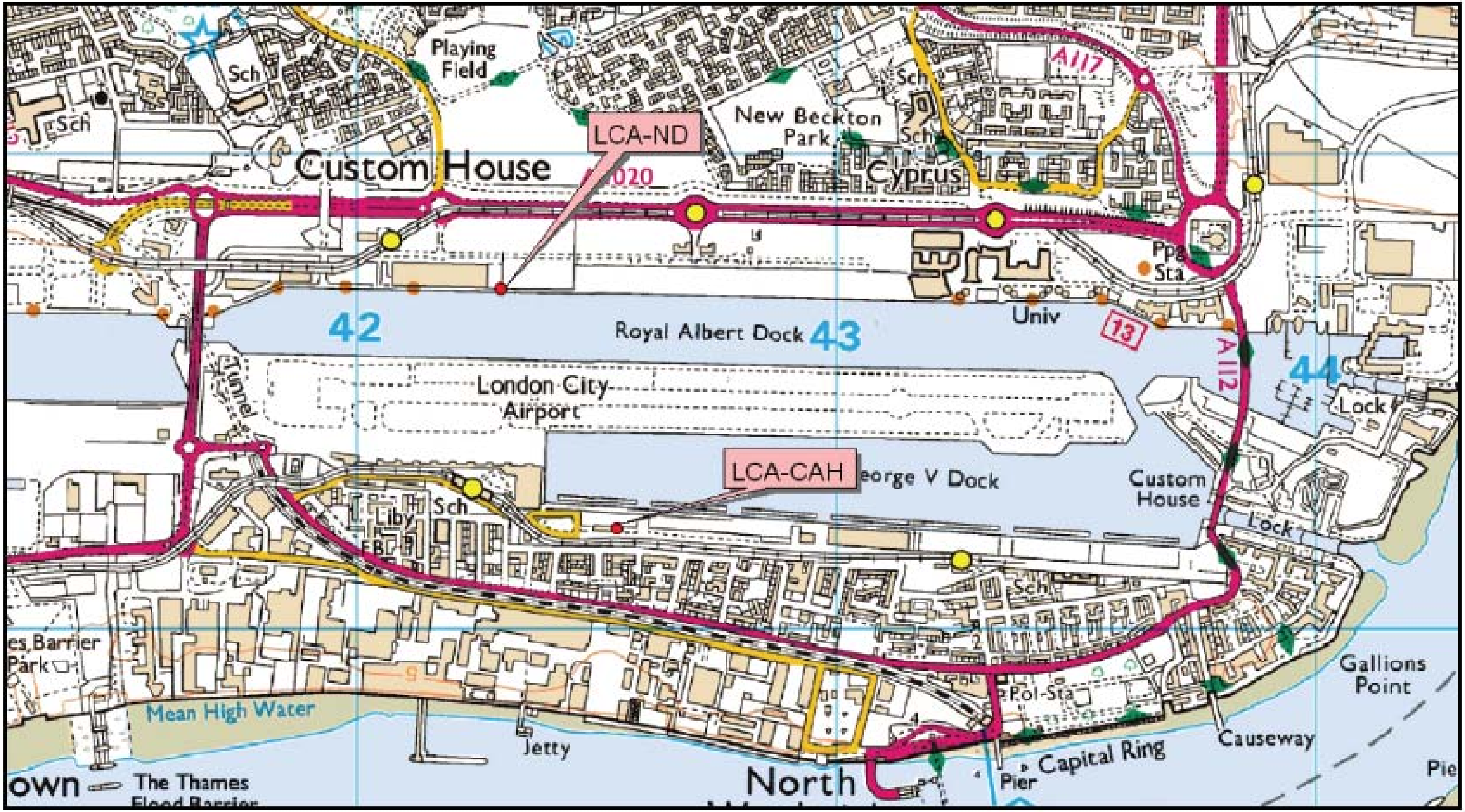

Figure 1: Automatic Monitoring Locations (red dots).

Nitrogen Dioxide

4.7 The 2010 nitrogen dioxide results for the LCA-CAH and LCA-ND automatic monitoring stations are summarised in Table 3. Data capture at both sites was high, and above 98%[1]. The annual mean concentrations did not exceed the objective of 40 µg/m^3 at either site. The 1-hour objective was also not exceeded, with no measured exceedences of the hourly mean objective level (200 µg/m^3), compared with the 18 exceedences allowed. All measured concentrations were 'low' during the year. There were no 'moderate', 'high' or 'very high' concentrations.

Table 3: Nitrogen Dioxide (NO_2) Data Summary for LCA-CAH and LCA-ND, 2010[a]

	LCA-CAH		LCA-ND		
Pollutant	NO_2	Exceedences	NO_2	Exceedences	Objectives
Number Very High[b]	0	-	0	-	-
Number High[b]	0	-	0	-	-
Number Moderate[b]	0	-	0	-	-
Number Low[b]	8549	-	8585	-	-
Maximum 1-Hour Mean	170 µg/m^3	0	177 µg/m^3	0	200 µg/m^3; no more than 18 exceedences
Annual Mean	35 µg/m^3	-	39 µg/m^3	-	40 µg/m^3
Data Capture	98 %	-	98%	-	-

a Nitrogen oxides concentrations are provided in Appendix 1.

b Number of 1-hour values

4.8 Comparable data for five monitoring sites across London in 2010 are set out in Table 4. These sites range from central London (Bloomsbury) to outer London (Bexley). The measured annual mean concentrations at London City Airport (35 µg/m^3 at LCA-CAH and 39 µg/m^3 at LCA-ND) were similar to that measured at Canning Town (38 µg/m^3), lower than those at Bloomsbury and Stratford (57 µg/m^3 and 53 µg/m^3 respectively), and higher than those measured at Eltham and Bexley (23 µg/m^3 and 31 µg/m^3, respectively). This is broadly consistent with the location of London City Airport between the areas of high concentrations in central London and lower concentrations towards the outskirts. The maximum 1-hour mean concentrations recorded at LCA-CAH and LCA-ND were lower than those at Bloomsbury, Canning Town and Stratford, and higher than those at Eltham and Bexley.

1 It is inevitable that a small amount of data will be "lost" in each year due to routine downtime for calibrations and site servicing.

Table 4: Nitrogen Dioxide (NO_2) Data Summary for London Monitoring Sites, 2010[a]

	Site Type	Background				Roadside
Pollutant		Bexley	Bloomsbury	Eltham	Canning Town	Stratford
NO_2	Maximum 1-Hour Mean (µg/m^3)	122	206	151	201	516
	No 1-h >200 µg/m^3	0	2	0	1	38
	Period Mean (µg/m^3)	31	57	23	38	53
Data Capture %		98	99	94	97	97

[a] Includes provisional data. Nitrogen oxides concentrations are provided in Appendix 1.

Particulate Matter PM_{10}

4.9 The 2010 PM_{10} results for the LCA-CAH automatic monitoring station are summarised in Table 5. Data capture was 89% for the full year[2]. The recorded annual mean concentration (22 µg/m^3) was well below the objective of 40 µg/m^3. There were two measured exceedences of the 24-hour mean objective level of 50 µg/m^3, compared with the 35 exceedences allowed. In addition, the 90th percentile of daily mean concentrations (33 µg/m^3)[3] was well below 50 µg/m^3. There was one period with PM_{10} concentrations recorded as 'moderate', with no 'high' or 'very high' concentrations.

Table 5: PM_{10} Data Summary for LCA-CAH, 2010

Pollutant	TEOM, VCM-corrected		PM_{10} Objectives
	PM_{10}	Exceedences	
Number Very High[a]	0	-	-
Number High[a]	0	-	-
Number Moderate[a]	1	-	-
Number Low[a]	7787	-	-
Maximum 24-hour Mean	60 µg/m^3	2	50 µg/m^3; no more than 35 exceedences
90th Percentile	33 µg/m^3	-	50 µg/m^3
Annual Mean	22 µg/m^3	-	40 µg/m^3
Data Capture	89 %	-	-

[a] Number of running 24-hour mean values, updated every hour.

[2] Data capture exceeded the minimum threshold (75%) usually applied. Data loss was associated with software corruption following a power cut.

[3] When data capture is below 90%, Government Technical Guidance (LAQM.TG(09)) recommends that a comparison should be made with the relevant percentile value of the objective.

4.10 Comparable data for three sites across London in 2010 are set out in Table 6[4]. These sites range from central London (Bloomsbury) to east London (Canning Town and Stratford). The measured annual mean concentration at London City Airport (22 µg/m^3) was lower than that at Stratford, (27 µg/m^3), and higher than that measured at Canning Town and Bloomsbury (21 µg/m^3 and 13 µg/m^3, respectively). The number of 24-hour mean exceedences of 50 µg/m^3 were the same as at Bloomsbury and Canning Town, and lower than at Stratford, whilst the 90th percentile at LCA-CAH was higher than those at Bloomsbury and Canning Town, but lower than that at Stratford.

Table 6: PM_{10} Data Summary of London Monitoring Sites, 2010[a]

	Bloomsbury	Canning Town	Stratford
Maximum 24-hour mean µg/m^3	57	57	201
Annual Mean µg/m^3	18	21	27
No. 24-hr mean >50 µg/m^3	2	2	12
90th Percentile	27	32	39
Data Capture %	90	98	77

[a] All values are reference equivalent. Bloomsbury data are derived from an FDMS analyser. Canning Town and Stratford are TEOMs adjusted using the VCM.

Nitrogen Dioxide Diffusion Tube Network

4.11 London City Airport also operates a network of passive diffusion tube samplers for nitrogen dioxide. The intent of this network is to establish the wider spatial pattern of nitrogen dioxide concentrations in the area surrounding the Airport. The locations of the monitoring sites are shown in Figure 2, and are described in Table 7; grid references and the monthly mean data are provided in Appendix 2. The diffusion tubes are exposed for approximately 4-week intervals. They are supplied and analysed by Gradko Environmental, and are prepared using the 20% TEA in water method.

4.12 The diffusion tubes record monthly mean concentrations, which have been averaged to give the annual mean. The results cannot therefore be directly compared with the 1-hour mean objective. However, measurements across the UK have shown that the 1-hour mean nitrogen dioxide objective is unlikely to be exceeded where the annual mean concentration is below 60 µg/m^3 (Defra, 2009).

[4] PM_{10} data are not available for the Eltham and Bexley sites, for which nitrogen oxides data are available.

Table 7: Description of Diffusion Tube Monitoring Sites

Location	Site ID
Lamp post at top of Parker Street, adjacent to housing	LCA 01
Lamp post on Camel Road, adjacent to nearest property on Hartmann Street	LCA 02
Lamp post on access road in Silvertown Quay. Approx. 36 metres from kerbside of main road	LCA 03
Lamp post at waterfront to east end of Newham Dockside	LCA 04
Lamp post on Straight Road, at kerbside	LCA 05
Lamp post on pedestrian walkway adjacent to nearest housing at Gallions Way	LCA 06
Landing Lights	LCA 07
Lamp post on Brixham Street	LCA 08
City Aviation House (triplicate tubes)	LCA 09
Jet Centre – airside	LCA 10
Lamp post at waterfront, eastern end of the University of East London	LCA 11
ILS, to north of runway and south of Royal Albert Dock	LCA 12
Lamp post at north west corner of Newham Dockside	LCA 13
Lamp post on waterfront at western end of Newham Dockside	LCA 14
Lamp post at kerbside (approx 1 m) of Royal Albert Way	LCA 15
Waterfront, approx 180 m east of Newham Dockside	LCA 16
North west of site 16, approx 85 m back from Waterfront	LCA 17

4.13 It is important to note that not all of these monitoring sites represent relevant public exposure for annual mean concentrations of nitrogen dioxide; thus the objectives are not strictly applicable at all of these sites. For instance, the sites at Landing Lights (LCA 07), the Jet Centre (LCA 10) and the ILS (LCA 12) are located on land that is not generally accessible by the public, or is owned by the Airport. The sites at LCA 04 (at the waterfront of Newham Dockside), LCA 11 (at the waterfront of the University of East London) and LCA 13, 14, 15 and 16 (in the vicinity of Newham Dockside and Royal Albert Way) would also not represent relevant exposure for annual mean concentrations according to the criteria defined in LAQM.TG(09)[5], but are relevant for 1-hour concentrations Site LCA 03 is located within an area of land allocated for redevelopment at Silvertown Quay, but public access is currently prohibited. These sites have been included in the study to better understand the spatial pattern of nitrogen dioxide concentrations around the Airport.

4.14 Diffusion tubes are known to show systematic bias in relation to automatic (reference) monitors. For this reason, a co-location study has been carried out, with triplicate tubes exposed alongside the inlet to the automatic monitor at LCA-CH, and a single tube exposed in close proximity to the inlet of the LCA-ND automatic monitor. Comparison of the matched period results shows that the

5 Defra Technical Guidance Note LAQM.TG(09) suggests that in the case of the annual mean objective, a relevant location might be where a member of the public would be exposed for a cumulative period of 6 months in a year.

diffusion tubes were over-reading by an average of 24.8%. An adjustment factor of 0.801 has therefore been applied to all diffusion tube results to ensure that they give the best representation of true concentrations. The results from the triplicate tubes indicate "good" precision (±9.4%) for the study in 2010 (Defra, 2009).

4.15 The bias-adjusted results are summarised in Table 8, and also shown in Figure 3. The results show that the annual mean objective of 40 μg/m^3 was not exceeded at any location during 2010. All measured annual mean nitrogen dioxide concentrations were well below 60 μg/m^3, and it is thus unlikely that the 1-hour mean objective will have been exceeded at any location.

4.16 The highest annual mean concentration (39.9 μg/m^3) was recorded at site LCA 04, which is close to the edge of Royal Albert Dock, with no local sources within 100 m. This has been identified in previous years as the location with the highest concentration. The monitoring site LCA 12, which lies just to the north of the main runway, recorded a much lower concentration (32.4 μg/m^3), suggesting that the Airport is not significantly contributing to the elevated levels at LCA 04.

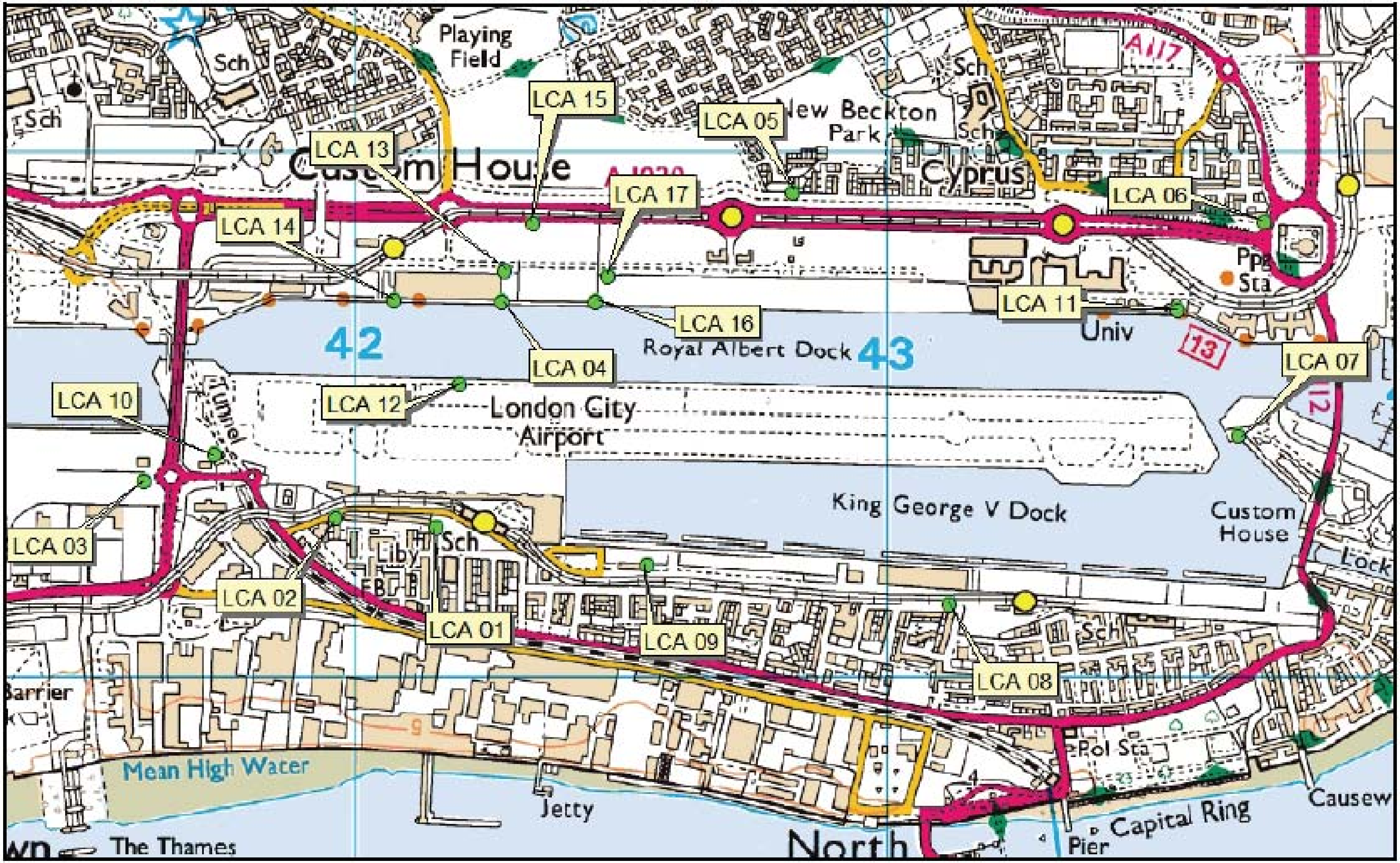

Figure 2: Diffusion Tube Monitoring Locations (green dots).

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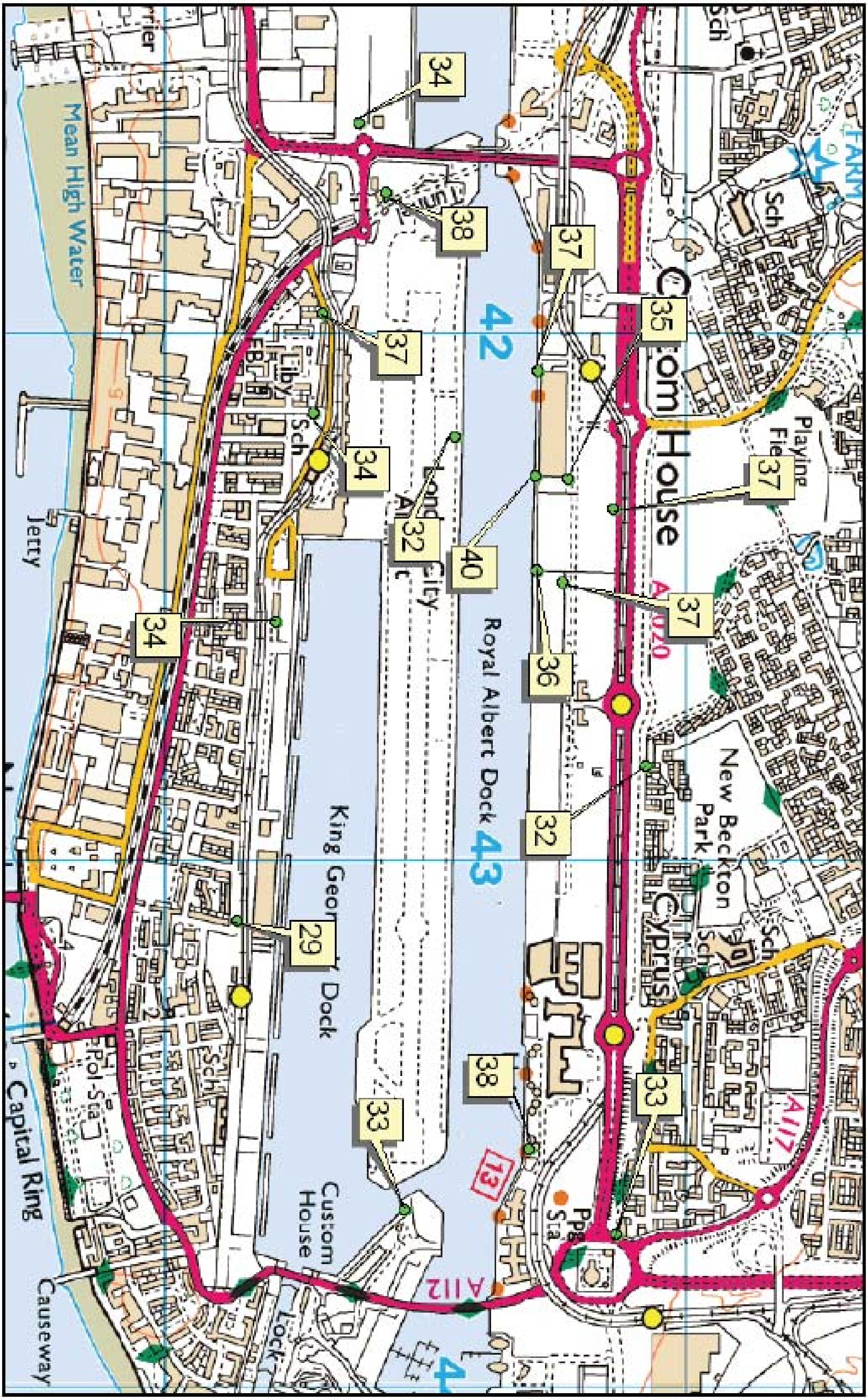

Figure 3: Nitrogen Dioxide Diffusion Tube Results, 2010 ($\mu g/m^3$).

Table 8: Diffusion Tube Data Summary for London City Airport, 2010 (Adjusted for Bias)

Site ID	Adjusted Value (µg/m^3)[a]
LCA 01	34.2
LCA 02	37.2
LCA 03	34.4
LCA 04	39.9
LCA 05	31.7
LCA 06	33.0
LCA 07	33.3
LCA 08	29.3
LCA 09	34.1
LCA 10	38.4
LCA 11	37.7
LCA 12	32.4
LCA 13	35.2
LCA 14	37.4
LCA 15	36.7
LCA 16	35.7
LCA 17	36.9

[a] Data have been adjusted using a local bias adjustment factor for 2010 of 0.801. The co-location studies are carried out at LCA-CAH using triplicate tubes and at LCA-ND with a single tube located at the automatic monitors. Diffusion tubes were exposed for the period between 8th January 2010 and 8th January 2011.

5 Data Analyses

5.1 This chapter provides analyses of the data covering time series, trends and source contributions.

Time Series

5.2 The measured 1-hour mean nitrogen dioxide concentrations at LCA-CAH and LCA-ND, and at Bexley, Bloomsbury, Eltham, Canning Town and Stratford, are shown as a time series in Figures 4 and 5 respectively.

5.3 The concentrations over the monitoring period show similar patterns at all six monitoring sites. The concurrence of periods with elevated concentrations at all sites (excluding the roadside site at Stratford which experienced an elevated period in October), suggests that these episodes were due to regional rather than local sources and that changing weather conditions across the region are affecting the dispersion and dilution of pollutants.

5.4 The measured daily mean PM_{10} concentrations at LCA-CAH and LCA-ND, and at Bloomsbury, Canning Town and Stratford, are shown in Figures 6 and 7 respectively. Once again, the analysis suggests that periods of high pollution were principally due to regional rather than local sources.

Trends in Pollutant Concentrations

5.5 The automatic station at the LCA-CAH site has now been in operation since September 2006, and it useful to identify whether there are any trends in the measured pollutant concentrations over time. Caution should be applied to interpreting any trends that may be apparent, as usually at least 5 years of data is required to provide confidence in any trends.

5.6 Figure 8 shows the trends in measured annual mean nitrogen dioxide concentrations at LCA-CAH and five other monitoring locations. Between 2007 and 2010, there appears to have been a slight downward trend in annual mean nitrogen dioxide concentrations measured at Bexley, Eltham Canning Town and LCA-CAH, but there is no discernable trend at, Bloomsbury or Stratford.

5.7 The trends in annual mean PM_{10} concentrations are shown in Figure 9. There is a slight downward trend between 2007 and 2010 apparent at all four sites, although this is more pronounced at the Bloomsbury site.

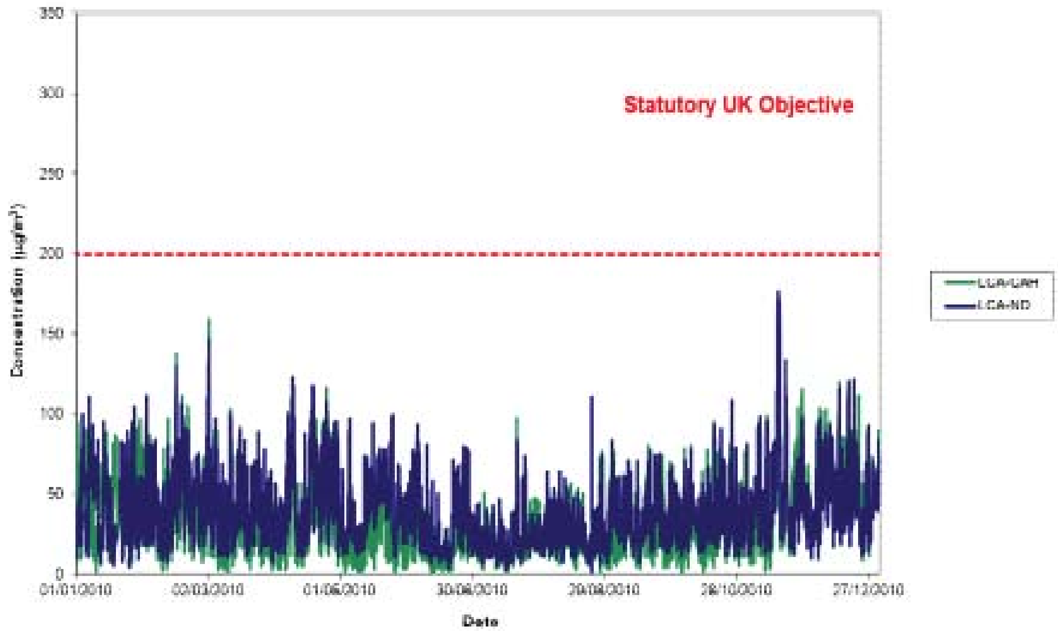

Figure 4: Hourly Nitrogen Dioxide Concentrations at London City Airport, 2010

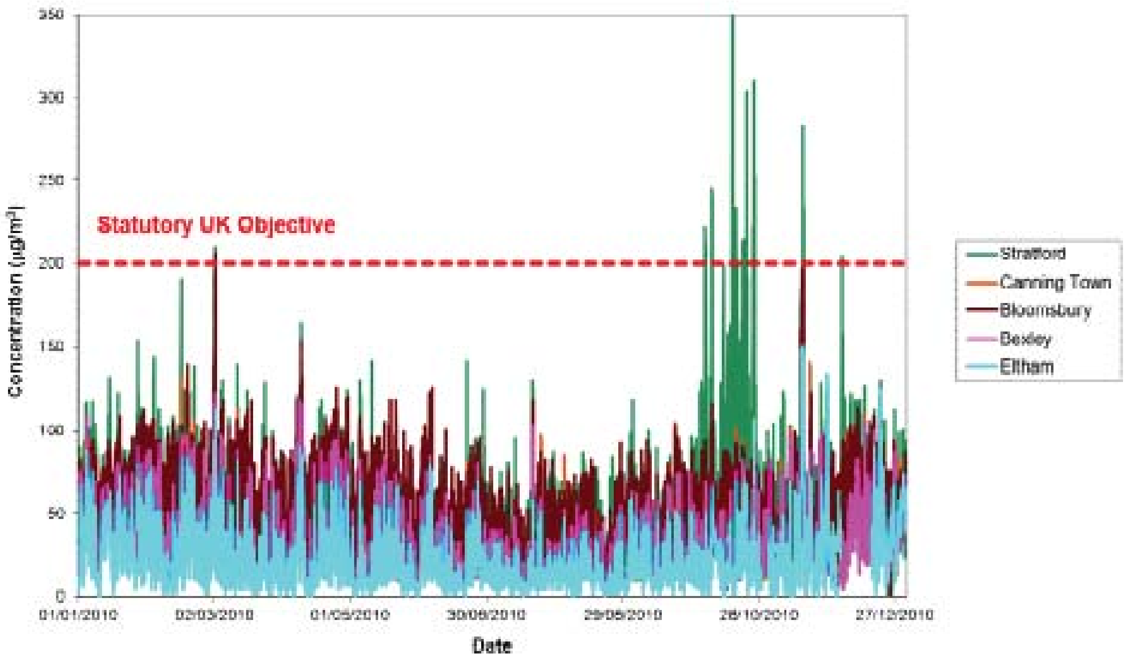

Figure 5: Hourly Nitrogen Dioxide Concentrations at London Monitoring Sites, 2010

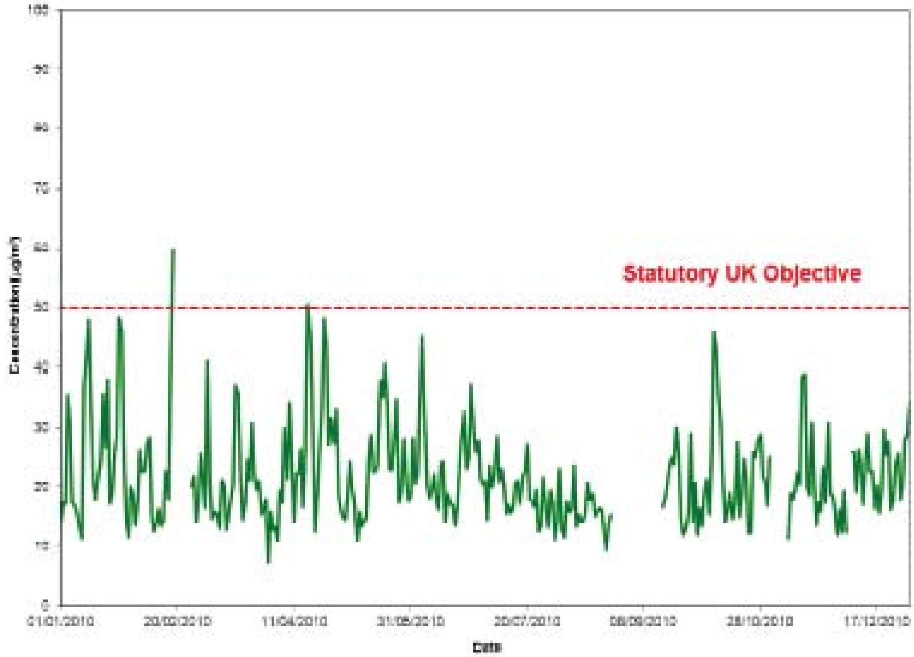

Figure 6: Daily Mean PM_{10} Concentrations at London City Airport (LCA-CAH), 2010.

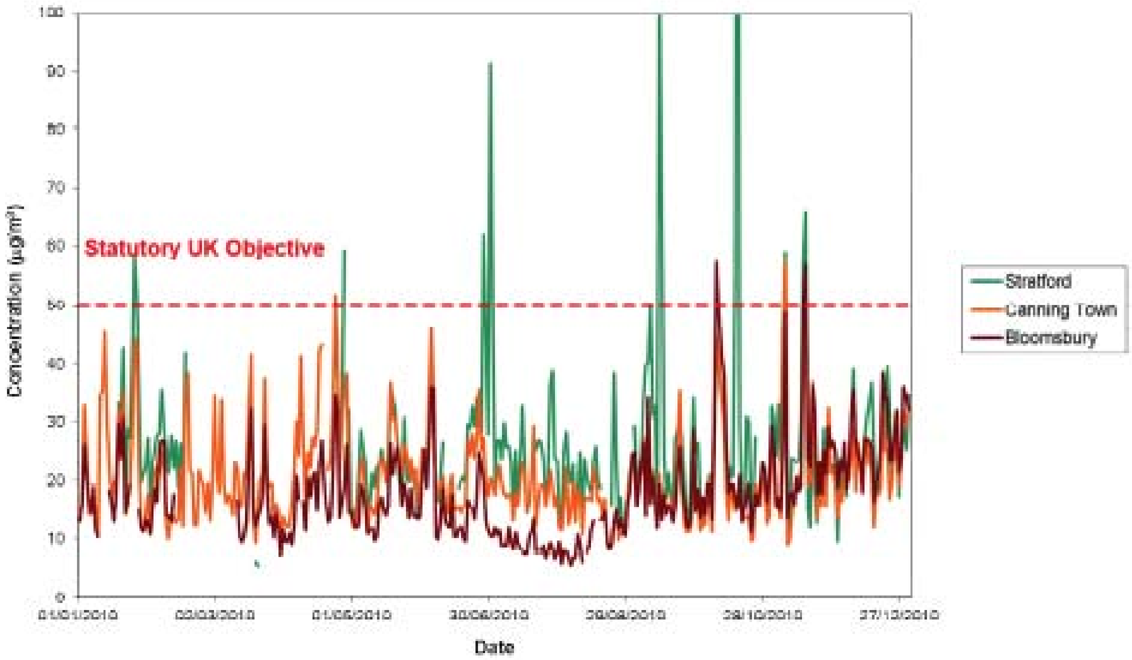

Figure 7: Daily Mean PM_{10} Concentrations at London Monitoring Sites, 2010

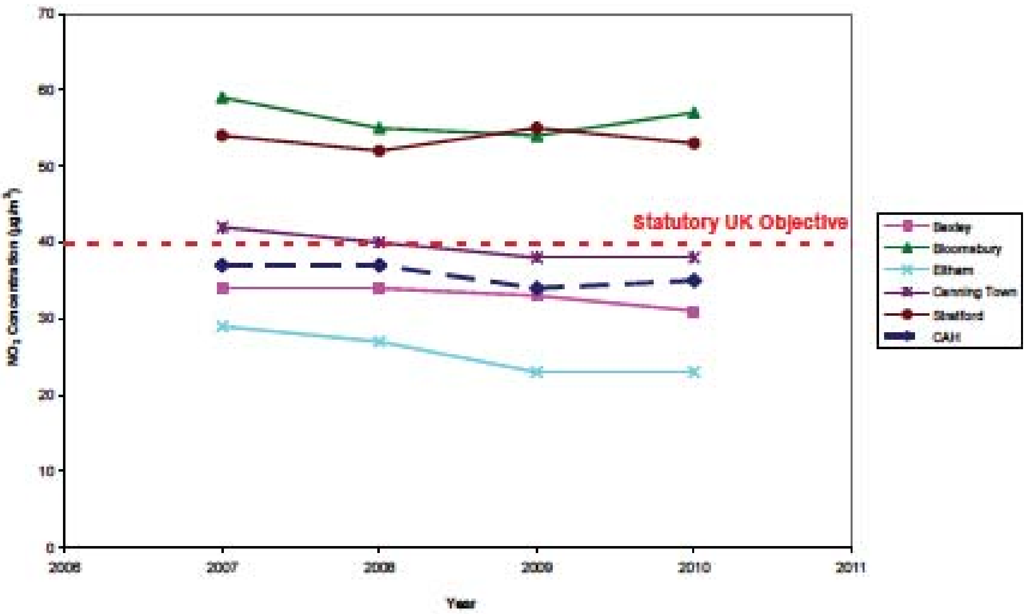

Figure 8: Annual Mean Nitrogen Dioxide Concentrations, 2007 – 2010 ($\mu g/m^3$).

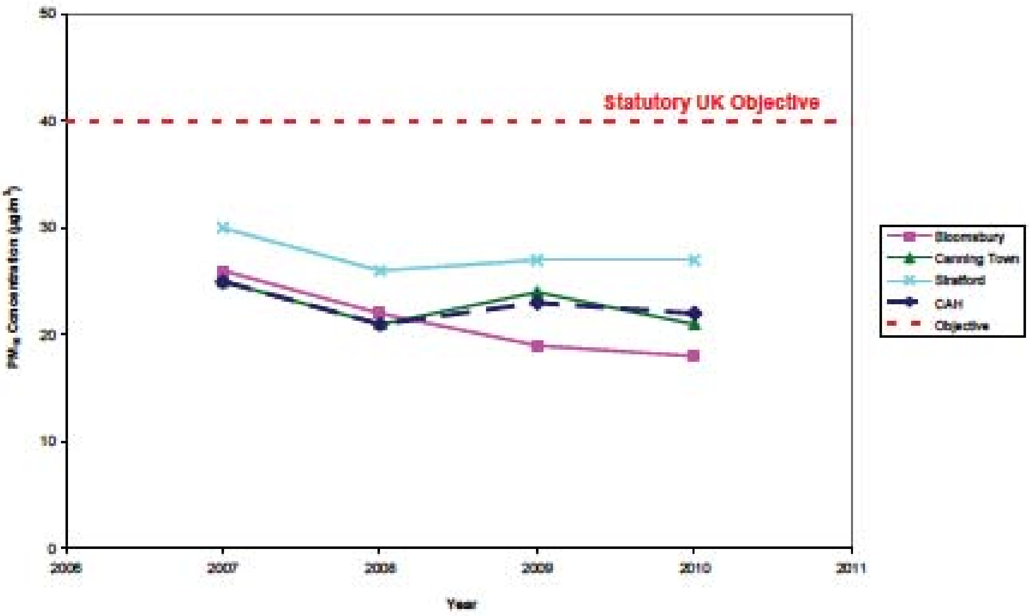

Figure 9: Annual Mean PM_{10} Concentrations, 2007 – 2010 ($\mu g/m^3$).

Bivariate Pollution Roses

5.8 Pollution roses are a useful technique for exploring the influence of different sources of air pollution at a monitoring site. Usually, the data are processed into average concentrations by wind direction, such that it is possible to identify whether elevated pollution concentrations are associated with different wind directions.

5.9 A new range of data analysis tools is now available via the "Openair" website[6], including the preparation of "bivariate pollution roses". These bivariate roses process average pollution concentration data by both wind direction and wind speed. They provide a powerful tool in identifying source contributions to measured concentrations at monitoring sites. The concentrations are shown by colour shading, with the distance from the centre point representing increasing wind speed.

5.10 It is known from both modelling studies and the analysis of empirical data that emissions from different source types behave differently in low and high wind speed conditions. For emissions from ground-level sources (such as road traffic), concentrations are highest during low wind speeds, and decrease rapidly with increasing wind speed. In contrast, emissions released from elevated (e.g. chimney) sources, give rise to higher concentrations at higher wind speeds. Emissions from the buoyant plumes of jet aircraft engines tend to behave in a similar manner to elevated sources. Carslaw et al (2006) showed how these bivariate plots could be used to identify the contribution of aircraft emissions to measured concentrations at Heathrow Airport.

5.11 Figure 10 shows bivariate pollution roses for NOx concentrations in 2010 at the LCA-CAH and LCA-ND sites. It can be seen for both bivariate pollution roses that the highest NOx concentrations occur during low wind speeds (i.e. towards the centre of the rose) indicating that the highest concentrations are associated with ground-level source releases. There is some indication of a contribution to NOx concentrations at LCA-ND with winds from both the east and the west at moderate wind speeds. The former may be associated with boiler emissions from the University. There is no evidence of a significant contribution from Airport operations to measured NOx concentrations at either monitoring site.

6 www.openair-project.org/about_us.php

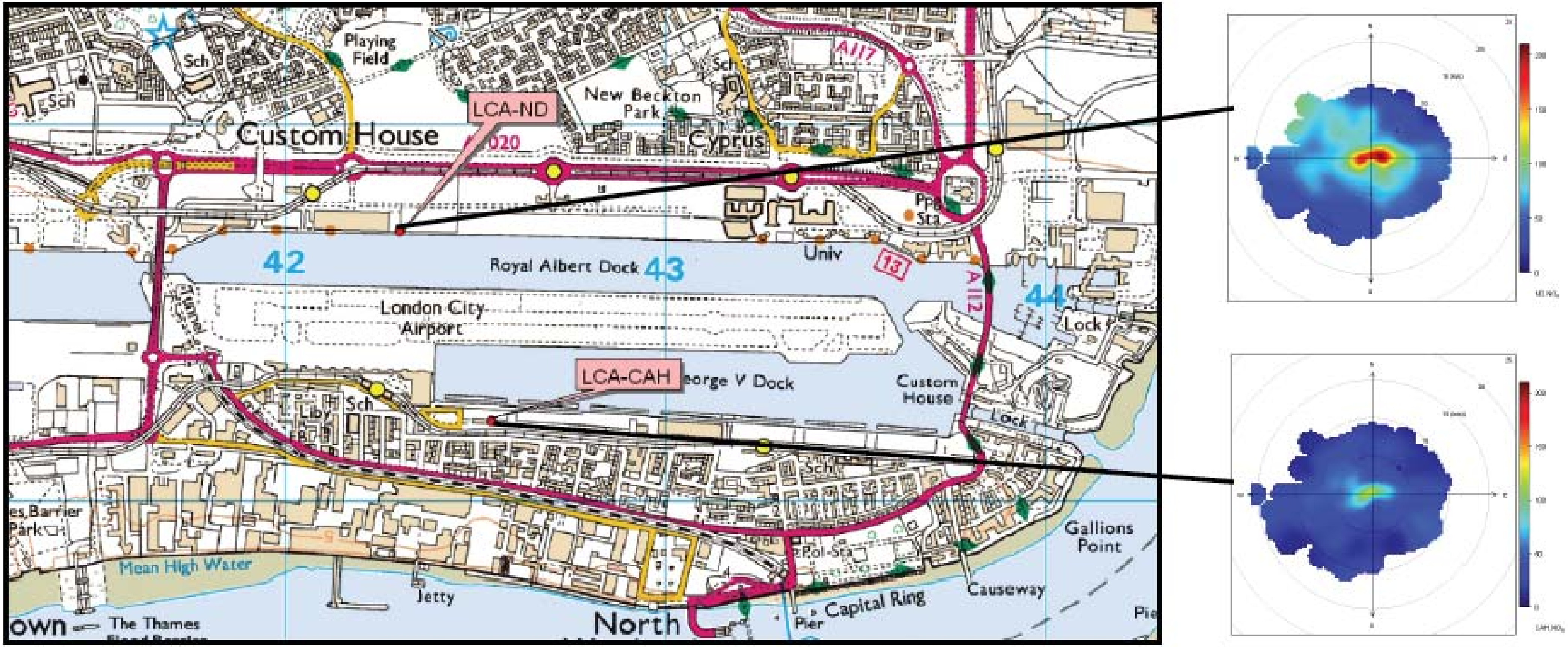

Figure 10: Bivariate Pollution Roses at LCA-CAH and LCA-ND Sites, 2010 (NOx, µg/m³).

6 References

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7 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
FDMS	Filter Dynamics Monitoring System
TEOM	Tapered Element Oscillating Microbalance
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometers in aerodynamic diameter.
NO_2	Nitrogen dioxide.
NOx	Nitrogen oxides (taken to be NO_2 + NO).
NO	Nitric oxide.
µg/m^3	Microgrammes per cubic metre
TEA	Triethanolamine – absorbent for nitrogen dioxide used in diffusion tubes.
VCM	Volatile Correction Model.

A1 Appendix 1 – Nitrogen Oxides Results

A1.1 Nitrogen oxides concentrations, which are essentially the sum of nitrogen dioxide and nitric oxide, are presented in Table A1.1 for the automatic monitoring stations at London City Airport and for 5 sites across east London in Table A1.2. The trends over the last four years are shown in Figure A1.1 and appear to be downward at all sites over the period 2007 to 2010. There are no relevant air quality criteria for nitrogen oxides in an urban area. Nitrogen oxides concentrations are included here for completeness, and because they are relevant for air quality modelling.

Table A1.1 Nitrogen Oxides (NOx) Data Summary for LCA-CAH and LCA-ND, 2010

Site	LCA-CAH	LCA-ND
Maximum 1-Hour Mean	963 μg/m^3	1255 μg/m^3
Annual Mean	58 μg/m^3	99 μg/m^3
Data Capture	98 %	98 %

Table A1.2 Nitrogen Oxides (NOx) Data Summary for London Monitoring Sites, 2010

Site		Bexley	Bloomsbury	Eltham	Canning Town	Stratford
NOx	Maximum 1-Hour Mean (μg/m^3)	875	1012	647	582	888
	Annual Mean (μg/m^3)	52	103	35	14	30
Data Capture %		98	98	93	97	97

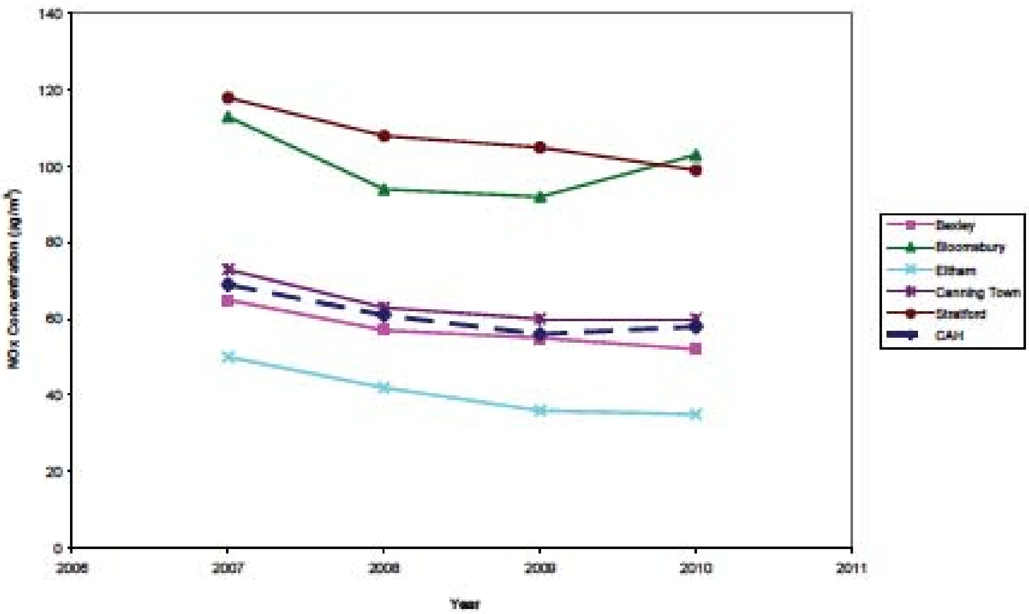

Figure A1.1 Annual Mean NOx Concentrations, 2007- 2010

A2 Appendix 2 – Diffusion Tube Data

A2.1 Raw monthly average diffusion tube data, along with the location details and monitoring periods, are presented in Table A2.1.

Table A2.1 Raw Monthly Diffusion Tube Data, Not Bias Adjusted (µg/m³)

Site ID	Grid ref	08/01/10 – 05/02/10	05/02/10 – 01/03/10	01/03/10 – 09/04/10	09/04/10 – 07/05/10	07/05/10 – 01/06/10	01/06/10 – 08/07/10	08/07/10 – 04/08/10	04/08/10 – 01/09/10	01/09/10 – 07/10/10	01/10/10 – 03/11/10	03/11/10 – 02/12/10	02/12/10 – 08/01/11	Period Mean	Data Capture (%)
LCA 01	542142,180295	46.6	49.1	35.0	N/A	41.5	29.6	25.4	N/A	35.5	51.5	51.7	60.6	42.6	83
LCA 02	541946,180296	53.8	58.4	40.5	48.7	47.1	40.4	N/A	35.1	44.7	42.6	52.9	45.9	46.4	92
LCA 03	541587,180372	54.3	55.1	42.5	45.0	43.3	42.3	28.7	33.7	41.1	36.3	N/A	50.2	43.0	92
LCA 04	542257,180710	73.6	60.2	43.4	41.6	43.0	35.9	41.7	44.1	53.2	N/A	58.8	52.0	49.8	92
LCA 05	542838,180920	43.9	55.1	39.2	40.1	35.9	30.3	30.2	17.7	38.8	43.3	54.5	45.7	39.6	100
LCA 06	543713,180869	53.1	57.5	45.9	49.5	41.8	30.5	33.2	11.9	12.5	50.8	54.2	54.0	41.2	100
LCA 07	543640,180474	58.3	45.0	41.5	36.6	36.8	30.7	29.2	33.8	41.1	50.7	51.6	42.9	41.5	100
LCA 08	543122,180136	48.8	41.2	33.8	33.4	32.8	24.0	26.3	28.8	37.5	39.3	45.4	47.1	36.5	100
LCA 09	542527,180199	58.5	53.7	31.1	43.2	39.9	32.4	23.1	27.4	37.8	41.8	59.7	48.1	41.4	100
		58.0	47.3	33.4	39.4	38.6	30.1	27.0	31.9	40.5	46.3	51.2	68.0	42.6	100
		48.7	47.3	40.6	45.0	37.3	33.5	30.5	30.5	37.9	51.4	65.8	56.4	43.7	100
LCA 10	541731,180419	62.6	50.7	42.4	44.8	48.1	37.4	35.1	41.7	38.9	50.9	67.6	54.9	47.9	100
LCA 11	543560,180687	51.8	52.8	38.3	N/A	40.7	N/A	28.5	N/A	44.2	54.9	63.3	49.3	47.1	75
LCA 12	542181,180561	58.0	43.3	37.6	36.7	36.6	30.0	28.3	29.9	37.6	42.8	60.7	43.4	40.4	100
LCA 13	542291,180770	53.8	52.0	38.2	42.3	37.0	25.6	28.7	36.9	46.6	46.1	65.2	54.9	43.9	100
LCA 14	542075,180714	58.6	52.8	45.5	48.5	39.5	28.4	33.7	34.4	43.9	49.4	65.6	60.0	46.7	100
LCA 15	542430,180857	60.2	53.4	40.1	46.4	37.4	32.8	31.2	32.8	42.3	51.9	68.4	53.6	45.9	100
LCA 16	542452,180710	54.1	48.4	40.4	N/A	19.1	N/A	31.0	37.0	N/A	53.3	65.9	51.7	44.6	75
LCA 17	542483,180784	66.0	61.2	46.5	40.6	33.1	32.0	34.0	24.3	48.1	53.2	66.7	47.7	46.1	100

N/A – not available

A3 Appendix 3 – Bias Adjustment Factor for Diffusion Tubes

A3.1 Diffusion tubes are known to exhibit bias when compared to results from automatic analysers. Therefore diffusion tube results need to be adjusted to account for this bias. One of the main factors influencing diffusion tube performance is thought to be the laboratory that supplies and analyses the tubes. The diffusion tubes exposed at London City Airport are supplied and analysed by Gradko Environmental (20% TEA in water).

A3.2 In order to determine the bias exhibited by these tubes, studies are carried out using triplicate tubes co-located at LCA-CAH and a single tube at LCA-ND. All diffusion tube data presented in this report have been adjusted using the overall factor calculated from the data presented in Table A3.1, with the optimum relationship defined using orthogonal regression.

Table A3.1: Results of Diffusion Tube and Continuous Monitor Co-location Studies in 2010[a]

	Diffusion Tube	Automatic	Adjustment Factor
LCA-CAH	42.6	34.6	0.812
LCA-ND	49.8	39.3	0.791
Overall Factor			**0.801**

[a] Diffusion tubes were exposed for the period between 8th January 2010 and 8th January 2011. The automatic monitoring data correspond to this period.

A3.3 Table A3.2 presents bias adjustment factors applied to the data for the last three years. The factors have remained fairly consistent over this period.

Table A3.2: Previous Bias Adjustment Factors

Year	Factor
2007	0.764
2008	0.786
2009	0.717

A4 Appendix 4 – Diffusion Tube Precision

A4.1 Diffusion tube precision describes the ability of a measurement to be consistently reproduced, i.e. how similar the results of duplicate or triplicate tubes are to each other. It is an indication of how carefully the tubes have been handled in either the laboratory and/or the field. Tube precision is separated into two categories 'Good' or 'Poor' as follows: tubes are considered to have **'Good'** precision where the coefficient of variation (CV) of duplicate or triplicate diffusion tubes for eight or more periods during the year is less than 20%, and the average CV of all monitoring periods is less than 10%. Tubes are considered to have **'Poor'** precision where the CV of four or more periods is greater than 20% and/or the average CV is greater than 10%.

A4.2 Table A4.1 shows that for each of the twelve periods of monitoring there was 'Good' precision, with the average precision of <10% and none of the periods having a CV >20%. Overall, therefore, the precision of the diffusion tubes is 'Good', which is consistent with the performance of 20% TEA in water tubes supplied by Gradko International in other co-location studies (Defra, 2011b).

Table A4.1 Precision of Triplicate Diffusion Tubes

Period	Start Date	End Date	Tube 1	Tube 2	Tube 3	Mean	Standard Deviation	CV	Tube Precision
1	08/01/2010	05/02/2010	58.5	58.0	48.7	55	5.5	10	Good
2	05/02/2010	01/03/2010	53.7	47.3	47.3	49	3.7	7	Good
3	01/03/2010	09/04/2010	31.1	33.4	40.6	35	5.0	14	Good
4	09/04/2010	07/05/2010	43.2	39.4	45.0	43	2.9	7	Good
5	07/05/2010	01/06/2010	39.9	38.6	37.3	39	1.3	3	Good
6	01/06/2010	08/07/2010	32.4	30.1	33.5	32	1.7	5	Good
7	08/07/2010	04/08/2010	23.1	27.0	30.5	27	3.7	14	Good
8	04/08/2010	01/09/2010	27.4	31.9	30.5	30	2.3	8	Good
9	01/09/2010	07/10/2010	37.8	40.5	37.9	39	1.5	4	Good
10	07/10/2010	03/11/2010	41.8	46.3	51.4	46	4.8	10	Good
11	03/11/2010	02/12/2010	59.7	51.2	65.8	59	7.3	12	Good
12	02/12/2010	08/01/2011	48.1	68.0	56.4	57	10.0	17	Good
Average CV								9.4	Good

APPENDIX 14
INDIVIDUAL AIRCRAFT TYPES STUDY REPORT

Air Quality
CONSULTANTS

London City Airport:
Contribution of Individual Aircraft Movements

May 2010

Experts in air quality
management & assessment

Document Control

Client	London City Airport	Principal Contact	Janet Goulton

Job Number	J735

Report Prepared By:	Prof. Duncan Laxen

Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
735/1/F1	27 May 2010	Final Report	Stephen Moorcroft

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Contents

1 Non Technical Summary

1.1 The Section 106 Planning Obligation for London City Airport requires the Airport to submit a report to Newham Council on the outcome of studies to investigate the effects of individual aircraft types on air quality. This investigation has utilised the results of an extended period of measurement of short-duration (2-minute) nitrogen oxides concentrations at a site 200 m from the runway at London City Airport, coupled with the findings of a detailed study of the effect of aircraft emissions on short-duration (10-second) nitrogen oxides concentrations previously carried out at Heathrow Airport.

1.2 The Heathrow Airport study showed that short-duration nitrogen oxides (NOx) concentration peaks can be assigned to individual aircraft based on their emissions during take-off. This has allowed an expected pattern of short-duration peak concentrations to be developed for London City Airport for the mix of aircraft taking-off on Runway 09 to the east.

1.3 A monitoring station located adjacent to the Newham Dockside building (to the north of Royal Albert Dock) was commissioned by London City Airport to support this study. The data from this monitoring station provide evidence that measured short-duration concentrations match the expected pattern. The match is not perfect and is likely to be due to the much lower emissions from the aircraft using London City Airport, and the greater difficulty of measuring the smaller expected concentration changes.

1.4 The assessment has provided clear evidence that aircraft emissions are not associated with the high, peak concentrations that were measured at the Newham Docklands site, and it is concluded that these are associated with other sources, at the local or regional scales.

1.5 It is further concluded that the long-term contribution of aircraft during take-off to nitrogen oxides concentrations at the Newham Docklands site is going to be significantly less than 1 $\mu g/m^3$; the contribution to nitrogen dioxide concentrations would be even smaller, and can be expected to be substantially less than 0.5 $\mu g/m^3$.

1.6 The conclusions of this study support the contention that the effects of individual aircraft types can be related to the internationally-determined nitrogen oxides emission rates during take-off. At London City Airport, these varied during the course of this study from 1 g/s for a Beech 200 to 49 g/s for an Airbus A318; the most common aircraft in use at the Airport, the Avro RJ-100 Avroliner, has an emission rate of 21 g/s.

1.7 It must be borne in mind however, that the overall contribution of aircraft operations at London City Airport to local nitrogen oxides (and nitrogen dioxide) concentrations must also take account of the frequency of individual aircraft movements. Such considerations are fully accounted for within the dispersion modelling studies that were carried out to support the recent approval for expansion of operations.

1.8 The conclusions of this study lend increased confidence to the modelling of emissions from the different aircraft using London City Airport.

2 Introduction

2.1 The Section 106 Planning Obligation for London City Airport requires an investigation of the effects of individual aircraft types on air quality. The specific requirement is as follows:

> *Within 12 months of the date of this Deed the Airport Companies shall submit to the Council a report detailing the outcome of studies which shall be undertaken to investigate the effects of individual aircraft types.* (Third Schedule, Part 3, Item 1 (b)).

2.2 The key pollutant arising from the aircraft operations is nitrogen dioxide, which is closely linked with the emissions of nitrogen oxides[1]. The greatest emission of nitrogen oxides takes place during take-off. The approach used to address the Section 106 Planning Obligation builds on work carried out previously at Heathrow Airport using a fast-response nitrogen oxides monitor located close to the northern runway (Laxen *et al*, 2007). It has also involved the installation of a nitrogen oxides monitor located to the north of London City Airport, adjacent to the Newham Dockside building, to record 2 minute concentrations of nitrogen oxides and nitrogen dioxide. The observations are assessed in relation to wind direction and to the emissions of nitrogen oxides during easterly take-offs from the airport (on Runway 09). Two periods have been examined: Period 1, August 2008 to May 2009 and Period 2, October 2009 to December 2009. The second period was added to allow an examination of data when the Airbus 318 became operational.

1 The term nitrogen oxides (NOx) refers to the combination of nitrogen dioxide (NO_2) and nitric oxide (NO). Emissions from combustion sources, including aircraft, are predominantly in the form of NO, which is transformed to NO_2 by chemical reactions in the atmosphere. There is no health concern associated with exposure to NO.

3 Methodology

Monitoring

3.1 An automatic monitoring station was commissioned at the edge of the northern wall of Royal Albert Dock, alongside the Newham Dockside building in August 2008 (Photo 1 and Figure 1)[2]. The station is 200 m from the edge of the runway (at its closest point) and 219 m from the centreline of the runway. Nitrogen oxides and nitrogen dioxide were measured using a M200E TAPI chemiluminescence analyser, with the instrument set to record 2-minute concentrations. The analyser was calibrated monthly.

3.2 The data have been ratified following procedures set out by Defra (2009). This involved an initial adjustment of the data using the calibration factors determined from the monthly calibration reports, followed by a visual examination of the data. Any erroneous data have been flagged and removed from subsequent analysis. In addition, the site was audited by AEA in November 2009.

Photo 1: Nitrogen Oxides Monitor with London City Airport in the Background

[2] The monitoring station was located at a site in the prevailing downwind direction from the main runway, where the contribution of aircraft emissions on take-off would be expected to be the greatest.

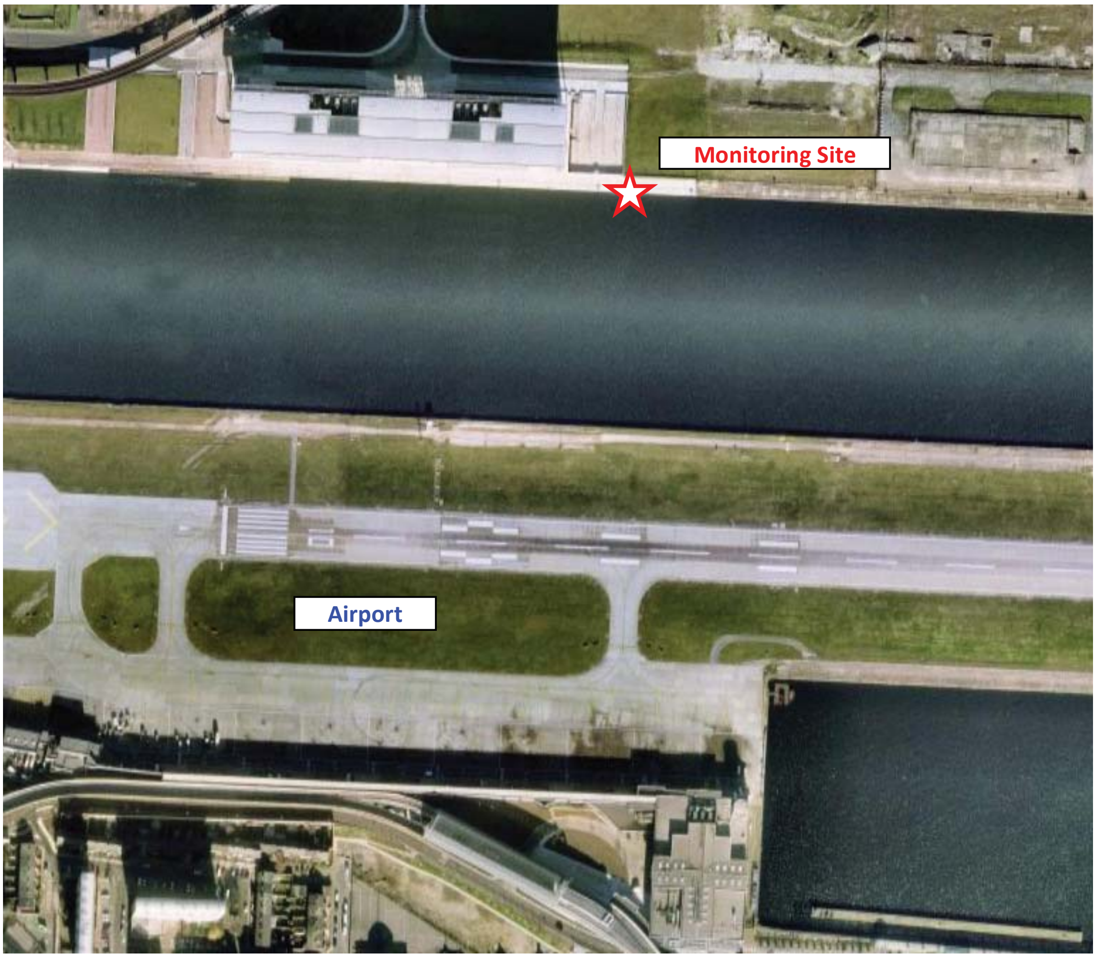


Figure 1: Location of Nitrogen Oxides Monitor at Newham Dockside Building

3.3 This report considers data that were collected over the period August 2008 to May 2009, and October to December 2009.

Aircraft Emissions

3.4 Information on the individual aircraft movements over the period of air quality monitoring has been provided by London City Airport. This included details of the times of all departures and the type of aircraft, as well as information on whether the take-off was on Runway 09 (to the east) or Runway 28 (to the west). The departure times provided were for 'wheels off'.

3.5 Information on aircraft NO_x emissions was obtained from the ICAO database for individual engine types (www.caa.co.uk).

Meteorological Conditions

3.6 Information on wind speed and direction was obtained from the monitoring station operated by London City Airport on the roof of City Aviation House, located to the south-east of the Terminal.

4 Expected Nitrogen Oxides Concentrations

4.1 This section sets out the pattern of 2-minute mean concentrations that might be expected at London City Airport based on the findings of a detailed study with a fast-response monitor at Heathrow Airport. The Heathrow study involved the measurement of nitrogen oxides concentrations averaged over 10-second intervals[3] at a monitoring site (known as LHR2) located 180 m from the centre of the northern runway, towards its eastern end. The data showed sharp peaks in concentrations at times when the northern runway was being used for take-offs to the west and the wind was blowing from the runway to the monitoring station. The average peak shapes for different aircraft are shown in Figure 2, taken from that report (Laxen *et al*, 2007). The peaks are sharp and last essentially for two minutes.

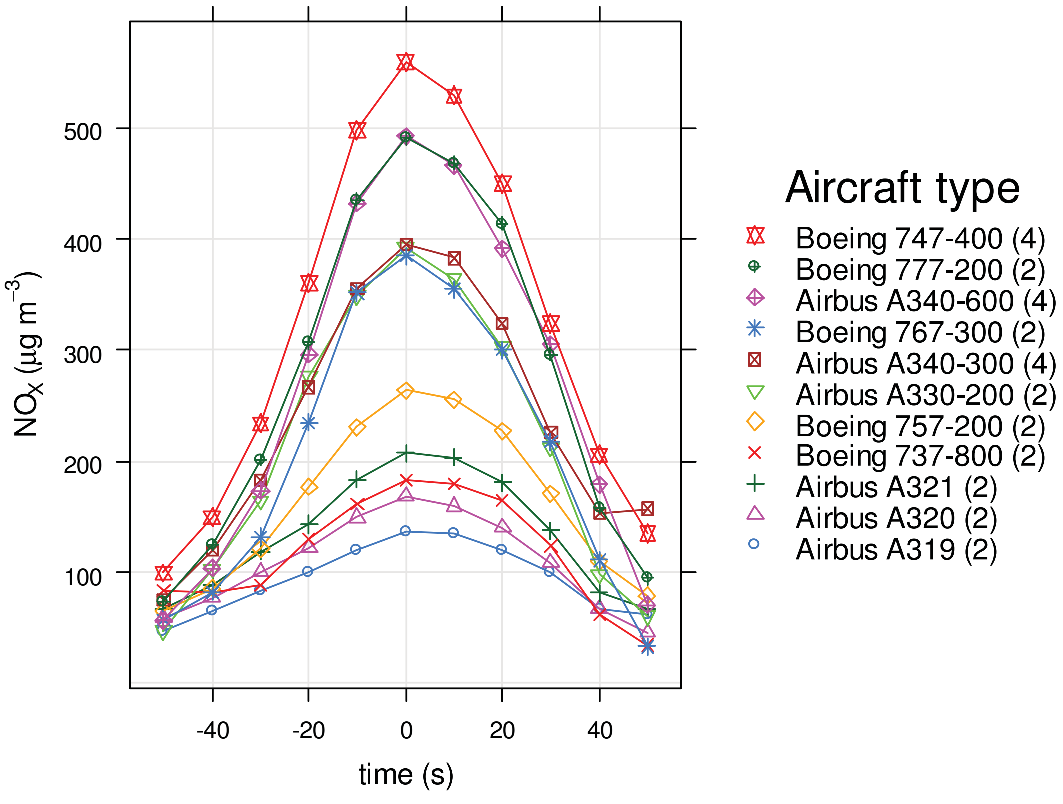


Figure 2: Average 10-Second Nitrogen Oxides Concentrations for Different Aircraft Types at LHR2 Monitoring Site at Heathrow Airport

3 Monitoring was carried out for this study using an Environnement dual-chamber analyser which is no longer manufactured.

4.2 The study also demonstrated a clear relationship between the nitrogen oxides emissions from the aircraft during take-off (using emission rates at 100% thrust) and the average 10-second peak height for that aircraft type. This is illustrated in Figure 3. The data have been fitted with a polynomial relationship as follows:

$$y = (3x10^{-11}xEm^{5}) - (6x10^{-08}xEm^{4}) + (4x10^{-05}xEm^{3}) - (0.0152xEm^{2}) + (3.5632xEm)$$

where Em is the nitrogen oxides emission rate during takeoff, in grammes per second (g/s) at 100% thrust.

4.3 The curved nature of the relationship is likely to be related to the greater plume rise for the larger aircraft (those with higher emissions), with the reverse implication that smaller aircraft are less affected by plume rise[4].

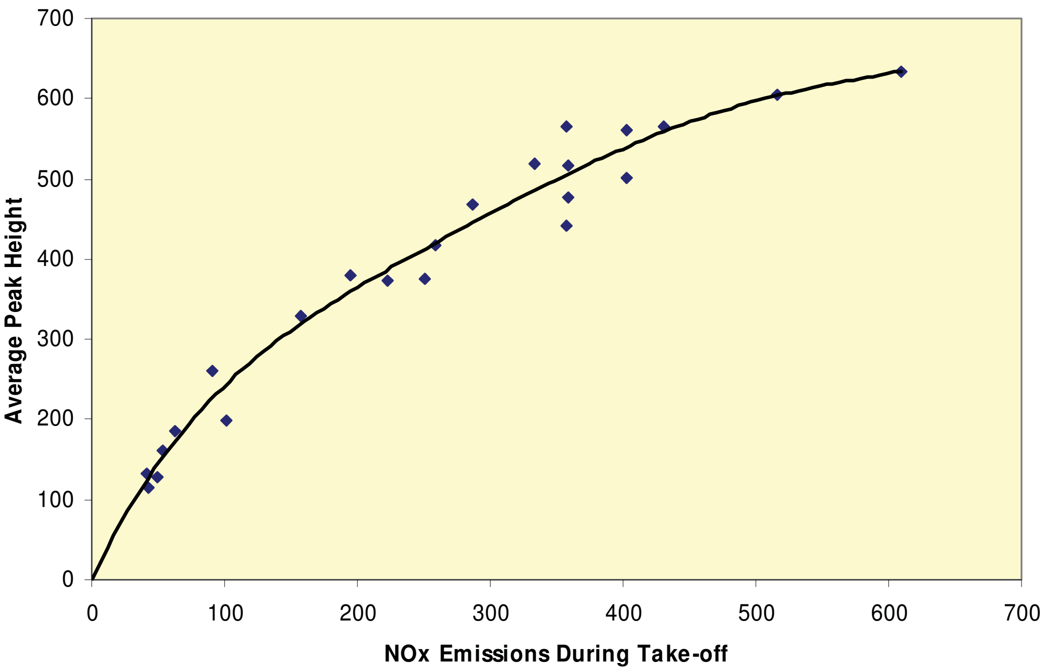


Figure 3: Relationship Between Average NOx Peak Height ($\mu g/m^3$) and NOx Emissions During Take-Off (g/s) at Heathrow Airport

4.4 The Heathrow study showed that the peak height was not strongly dependent on wind direction, as long as the wind was broadly blowing from the runway to the monitoring site. A dependence on wind speed was identified, although this was only strongly evident for the larger aircraft.

[4] The consistency of the relationship shows that the emission rates for the different aircraft types are a reliable indicator of their impact on local air quality. If plume rise is the principal reason for the curved nature of the relationship (with a greater plume rise taking the plume over the monitoring site), then this effect would be expected to diminish with distance, where the plume is fully mixed, and the relationship should eventually become linear.

4.5 The question arises as to whether the findings at Heathrow can be translated to operations at London City Airport. The minimum emission rate for the aircraft in the Heathrow study was 41 g/s, while the aircraft using London City Airport have much lower emissions that only ranged up to 32 g/s during Period 1 and up to 49 g/s during Period 2, when the Airbus A318 was operational (Table 1). There is therefore some increased uncertainty, but nonetheless the relationship appears sufficiently robust to have reasonable confidence in applying the results to the aircraft using London City Airport. The average 10-second peak height for the aircraft using London City Airport are included in the fourth column of Table 1, for an assumed location 180 m from the runway, near to the point of initial roll. The monitor at London City Airport is a little further from the runway than at Heathrow, at 219 m. This means that the peak heights would be expected to be lower at the London City Airport monitoring site than the values in Table 1, which are derived from the Heathrow data (180 m from the runway), although the difference would be expected to be small.

Table 1: Emissions of Nitrogen Oxides from Aircraft during Take-Offs in 2009 and Potential 2-minute Concentrations at London City Airport

Aircraft type	Aircraft Code	Emission rate for aircraft (g/s during takeoff)	NOx Peak Height Concentration (based on 10 sec Heathrow data) ($\mu g/m^3$)	NOx Peak Height Concentration (equivalent 2-minute values at LCY)[a]		Movements During Study Period[b]
				Maximum ($\mu g/m^3$)	Minimum ($\mu g/m^3$)	
AVRO RJ - 85 Avroliner	RJ85	20.8	67.8	33.9	17.0	23.59%
Fokker 50 "Maritime Enforcer"	F50	5.5	19.2	9.6	4.8	17.05%
Dornier 328	D328	12.7	43.0	21.5	10.7	7.71%
ATR-42-400	AT45	3.4	12.1	6.0	3.0	3.17%
ATR 72	AT7 or AT72	6.4	22.0	11.0	5.5	3.17%
Cessna 560X Citation Excel	C56X	13.5	45.6	22.8	11.4	3.03%
DHC-8-Q400	DH8D or DH8CD	5.3	18.3	9.2	4.6	2.53%
BAe-125-700/800	H25B	8.6	29.6	14.8	7.4	2.43%
AVRO RJ-70 Avroliner	RJ70	20.8	67.8	33.9	17.0	1.48%
Embraer 170	E170	16.1	53.5	26.7	13.4	1.20%
DHC-8-Q300	DH8C	5.3	18.3	9.2	4.6	1.04%
DASSAULT Falcon 900	F900	12.9	43.6	21.8	10.9	0.95%
BAe-146-200	B463	19.1	62.9	31.4	15.7	0.79%
Cessna 550 Citation II	C550	3.1	11.0	5.5	2.8	0.76%
Airbus A318	A318	49.2	142.9	71.4	35.7	0.52%[c]

Aircraft type	Aircraft Code	Emission rate for aircraft (g/s during takeoff)	NOx Peak Height Concentration (based on 10 sec Heathrow data) (µg/m³)	NOx Peak Height Concentration (equivalent 2-minute values at LCY)[a]		Movements During Study Period[b]
				Maximum (µg/m³)	Minimum (µg/m³)	
Beech 400 "Beechjet"	BE40	4.6	16.0	8.0	4.0	0.51%
Learjet 45	LJ45	8.6	29.6	14.8	7.4	0.43%
BAe-146-300	B462	19.1	62.9	31.4	15.7	0.41%
Cessna 525A Citation CJ2	C25A	2.2	7.9	4.0	2.0	0.35%
Cessna 525 CitationJet	C525	2.2	7.9	4.0	2.0	0.31%
Dassault Falcon 7X	FA7x	18.8	61.9	31.0	15.5	0.28%
ATR 42-200 / 42-300	AT43	3.4	12.1	6.0	3.0	0.23%
DASSAULT Falcon 50 "MystŠre 50 "	FA50	12.9	43.6	21.8	10.9	0.20%
Cessna 510 Citation Mustang	C510	2.2	7.9	4.0	2.0	0.19%
Cessna 525A Citation CJ3	C25B or CJ3	2.2	7.9	4.0	2.0	0.16%
Cessna 680 Citation Sovereign	C680	12.7	43.0	21.5	10.7	0.14%
Beech 200 "1300 Commuter" or "Super King Air 200"	BE20	1.0	3.6	1.8	0.9	0.14%
Embraer RJ135	ER3 or E135	13.3	44.8	22.4	11.2	0.11%
EMBRAER EMB-190 / EMB-195 / ERJ-190 / ERJ-195	E190	16.1	53.5	26.7	13.4	0.11%
Cessna 560 Citation V Ultra/Ultra Encore	C560	4.3	14.9	7.5	3.7	0.10%
Learjet 40	LJ40	8.6	29.6	14.8	7.4	0.08%
Piaggio P-180 Avanti	P180	1.0	3.5	1.7	0.9	0.05%
AVRO RJ-100 Avroliner	RJ100 or RJ1H	20.8	67.8	33.9	17.0	0.05%
Canadair CL-600 Challenger 601	CL60	10.7	36.6	18.3	9.1	0.05%
Raytheon Beechcraft King Air 300	B350	1.0	3.5	1.7	0.9	0.04%
Gulfstream 150	G150	n/a	n/a[d]	n/a	n/a	0.03%
Dassault Falcon 10	FA10	6.3	21.7	10.8	5.4	0.02%
BAe-146-100	B461	19.1	62.9	31.4	15.7	0.01%

Aircraft type	Aircraft Code	Emission rate for aircraft (g/s during takeoff)	NOx Peak Height Concentration (based on 10 sec Heathrow data) (µg/m³)	NOx Peak Height Concentration (equivalent 2-minute values at LCY)[a]		Movements During Study Period[b]
				Maximum (µg/m³)	Minimum (µg/m³)	
Others[e]						0.03%

[a] Derivation of 2-min value ranges is described in Para 4.6. Values are likely to be slightly lower at Newham Docklands monitoring site (see text).

[b] Refers to percentage of take-offs during 2009

[c] The Airbus A318 was only operational at the end of 2009.

[d] n/a – not available.

[e] Aircraft with fewer than ten flights during 2009.

4.6 The next step in showing the expected patterns to be seen in the monitoring data at London City Airport is to take account of the different timescales of the data, i.e. the 10-second versus 2-minutue sample times[5]. Analysis of the peak for the Boeing 747-400 at Heathrow Airport shows the average concentration over the full 2 minutes of the peak is around 50% of the 10-second peak height[6] (Figure 4). However, the 2-minute sample period at London City Airport may not coincide exactly with the peak. This will reduce the 2-minute concentrations, but only by up to 50%, as illustrated with the lines (A) to (C) in Figure 4. Line A shows the exact coincidence of the 2-minute sampling interval with the peak, and represents the maximum case. The 2-mintute peak in this case would therefore be 50% of the 10-second peak. Line B shows the minimum-case, when the timing of the 2-minute sampling interval means the peak is divided equally between two, 2-minute samples. The 2-minute peak in this case would therefore be half of the value for Line A, i.e. 25% of the 10-second peak. Line C shows an intermediate position, where the alignment of the first 2-mintue period would encompass a small proportion of the peak, while the subsequent 2-mintue period would cover more than half the peak. The highest 2-mintute peak in this case would therefore lie between the values for Line A and Line B, i.e. between 25% and 50% of the 10-second peak. The derived range of 2-min NOx peak heights is shown in columns 5 and 6 of Table 1.

5 As described in Para 4.1, the study at Heathrow Airport was carried out using a dual-chamber analyser that could be configured to record 10-second samples. This analyser is no longer manufactured. It is not practicable to reduce sample times to below about 2 minutes for single-chamber analysers (as located at Newham Dockside).

6 This is considered to be the most reliably measured peak. The methodology for defining the baseline in the Heathrow Airport study means that there will be greatest uncertainty near the base of peak.

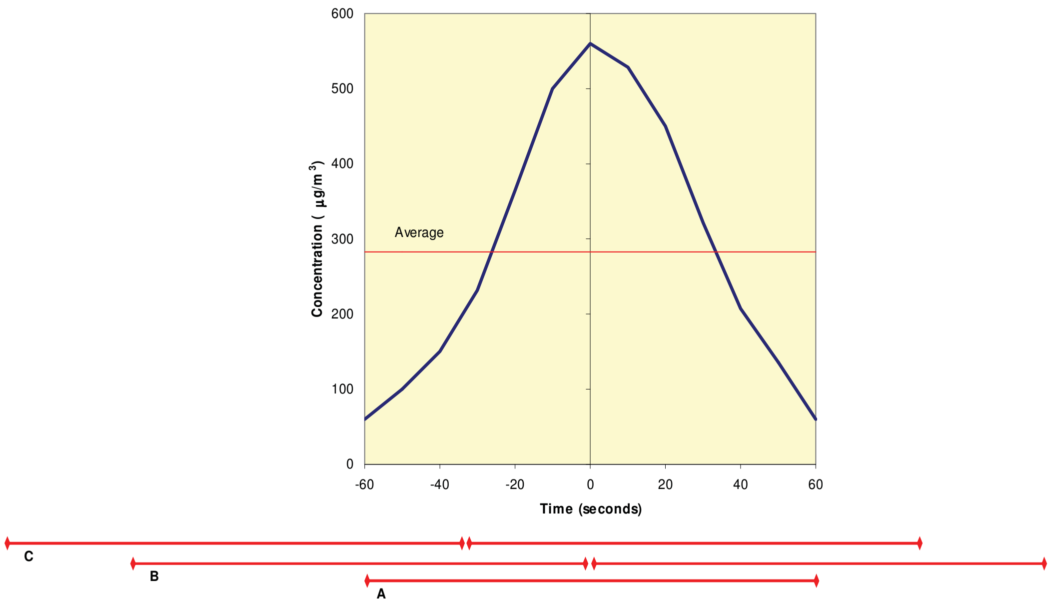


Figure 4: Nitrogen Oxides Peak Shape and Examples of Different 2-minute Averaging Periods. Lines A to C Discussed in the Text.

4.7 Given the information set out above it is possible to illustrate the expected pattern of peaks that might be seen at the London City Airport (Newham Docklands building) monitoring site. This has been carried out for the aircraft movements over a period of roughly 2.5 hours on the morning of 15th January 2009, as illustrated in Figure 5. The winds were blowing towards the monitoring site during this period and aircraft were taking off to the east. The peaks are the worst-case peaks based on exact coincidence of the 2-minute sample period and the peak (example (A) in Figure 4). In practice the peaks would be expected to lie between 50% and 100% of these values, or perhaps 45% and 90% of these values taking into account the greater distance of the monitoring site at London City Airport. Wind speed and wind direction would only be expected to have a minor influence on the sizes of these peaks. The concentration scale used to present the peaks (0 to 1000 µg/m^3) is the same as that used later in the presentation of results. The peaks are shown superimposed on a constant nitrogen oxides background of 40 µg/m^3.

4.8 The results in Figure 5 can be used to calculate the contribution of the aircraft emissions over this period to the average concentration at the monitoring location. The effect is to increase the nominal background nitrogen oxides concentration from 40 µg/m^3 to 45 µg/m^3. Taking into account periods when the wind is not blowing towards the monitoring site, those times of the day when aircraft are not taking off, and those times when aircraft are taking off to the west, then it is clear that the long-term contribution of aircraft during take-off to nitrogen oxides concentrations at the monitoring site is going to be significantly less than 5 µg/m^3, and probably less than about 1 µg/m^3. The contribution of aircraft emissions during take-off to long-term nitrogen dioxide concentrations at the monitoring site would be even smaller, and would be expected to be substantially less than about 0.5 µg/m³.

4.9 The analysis set out above shows that, in principle, it should be possible to identify peaks associated with the aircraft movements at London City Airport assuming a reasonably constant background concentration over the sample period (in this case a few hours). For the aircraft under consideration during this study, these peaks would be expected to range from around 2 to 71 µg/m³ NOx (Table 1). The peaks for nitrogen dioxide would be substantially smaller.

Figure 5 **Simulated Nitrogen Oxides Concentrations at the London City Airport Monitoring Site on the Morning of 15th January 2009 on a Constant Background of 40 µg/m³**

5 Data Analysis - Period 1

5.1 The 2-minute mean concentrations of nitrogen oxides throughout Period 1 are shown in Figure 6. It is clear from these data that some 2-minute mean concentrations approached 1000 µg/m^3, which is very different to the expected aircraft contributions set out above (*cf* Figure 5). However, the apparent short-term peaks in Figure 6 are in fact peaks over several hours, as is evident in Figure 7, which shows the 2-minute mean concentrations for the peak on 17 November 2008 (the largest peak in Figure 6). The high concentrations in Figure 6 are thus not related to aircraft movements, and will be due to other sources, at both the local and regional scales[7]. The detailed examination that follows confirms that aircraft are making no greater contribution than expected (as illustrated in Figure 5).

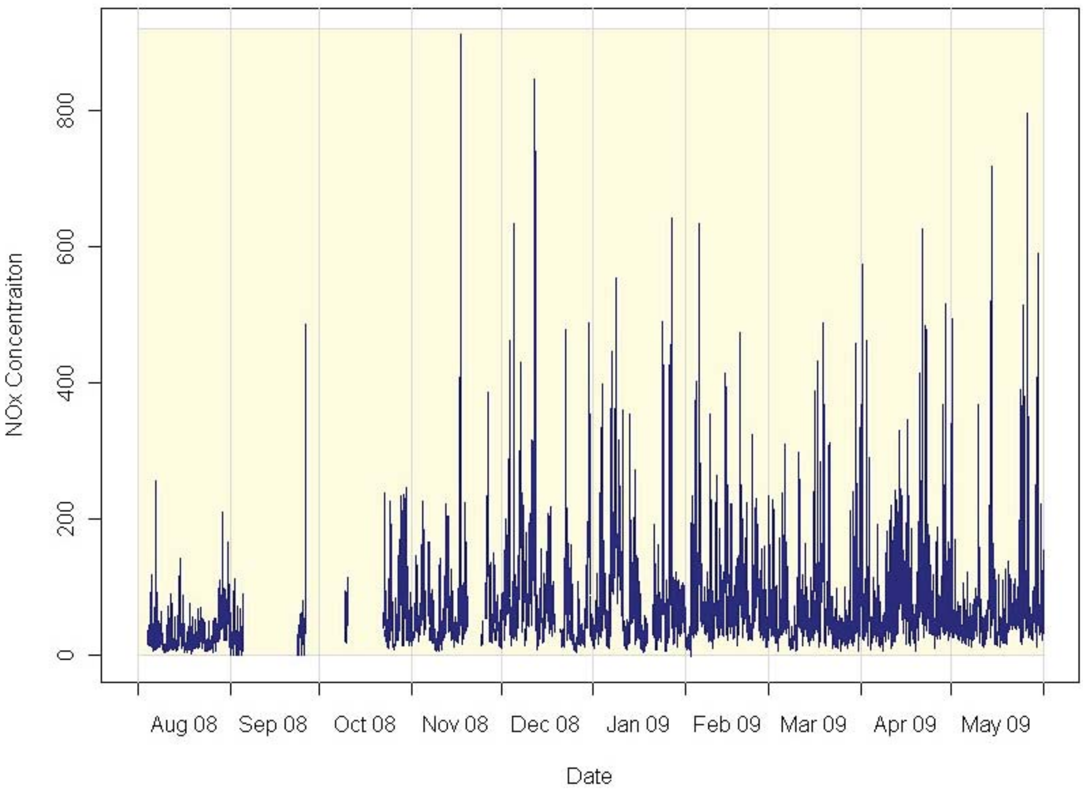


Figure 6 Nitrogen Oxides Concentrations (µg/m^3) Averaged over 2-Minutes at London City Airport Newham Docklands Monitoring Site, August 2008 to May 2009.

[7] This will include road traffic, industry, and transboundary pollution sources

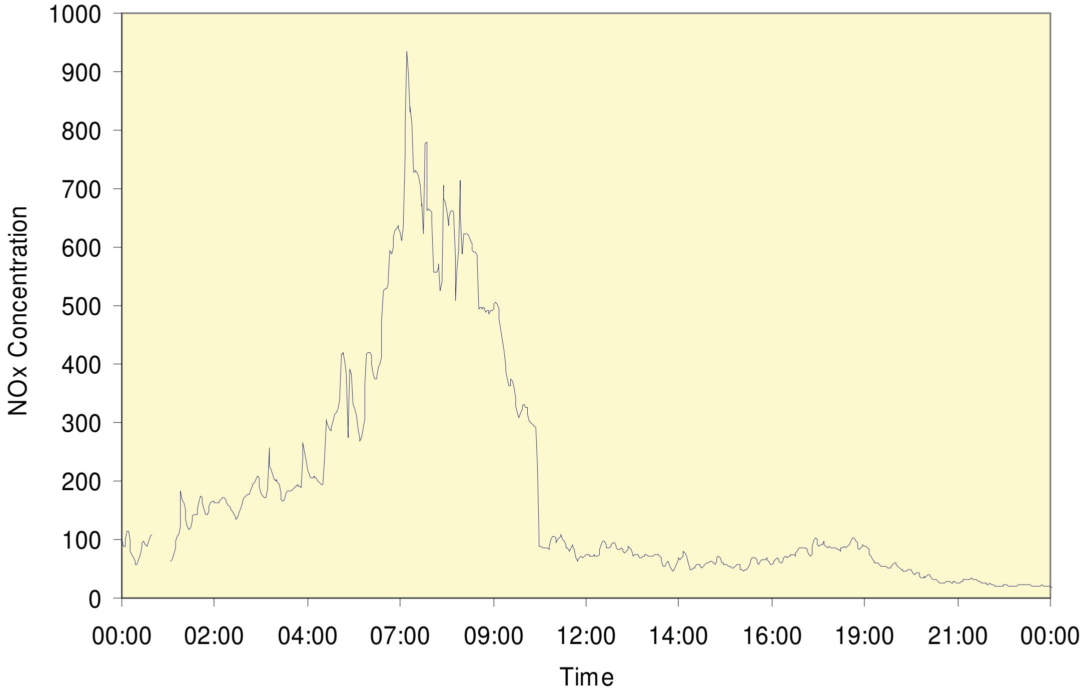


Figure 7 **Nitrogen Oxides Concentrations (µg/m^3) Averaged over 2-Minutes at London City Airport Newham Docklands Monitoring Site, 17 November 2008.**

5.2 The aircraft are only expected to contribute to potentially measurable peaks of NOx at the Newham Docklands monitoring site during take-offs to the east. The data on aircraft movements have therefore been used to identify those days with departures to the east and with winds blowing from the Airport towards the monitoring site. Several days when these conditions arose have been extracted from the data set. The first covers the period used to generate the expected behaviour as shown in Figure 5. This is for the morning of 15 January 2009, when a southerly wind (average direction 175°, range 169°-185°) was blowing towards the monitoring station at an average speed of 3.8 m/s (range 3.2-4.6 m/s) The monitored concentrations for this day are shown in Figure 8A (blue line), together with the expected pattern of contributions from the aircraft taking off (red line); the expected values may lie between 50% and 100% of the values shown in a random way. There is some visual evidence that there are peaks in the data that match the aircraft departures, but the agreement is not perfect. This may well be due to a mismatch in the time base arising from a) the time taken for the plume to reach monitoring site and b) a lack of synchronisation of the clock in the instrument with the aircraft departure time recorded by the Airport.

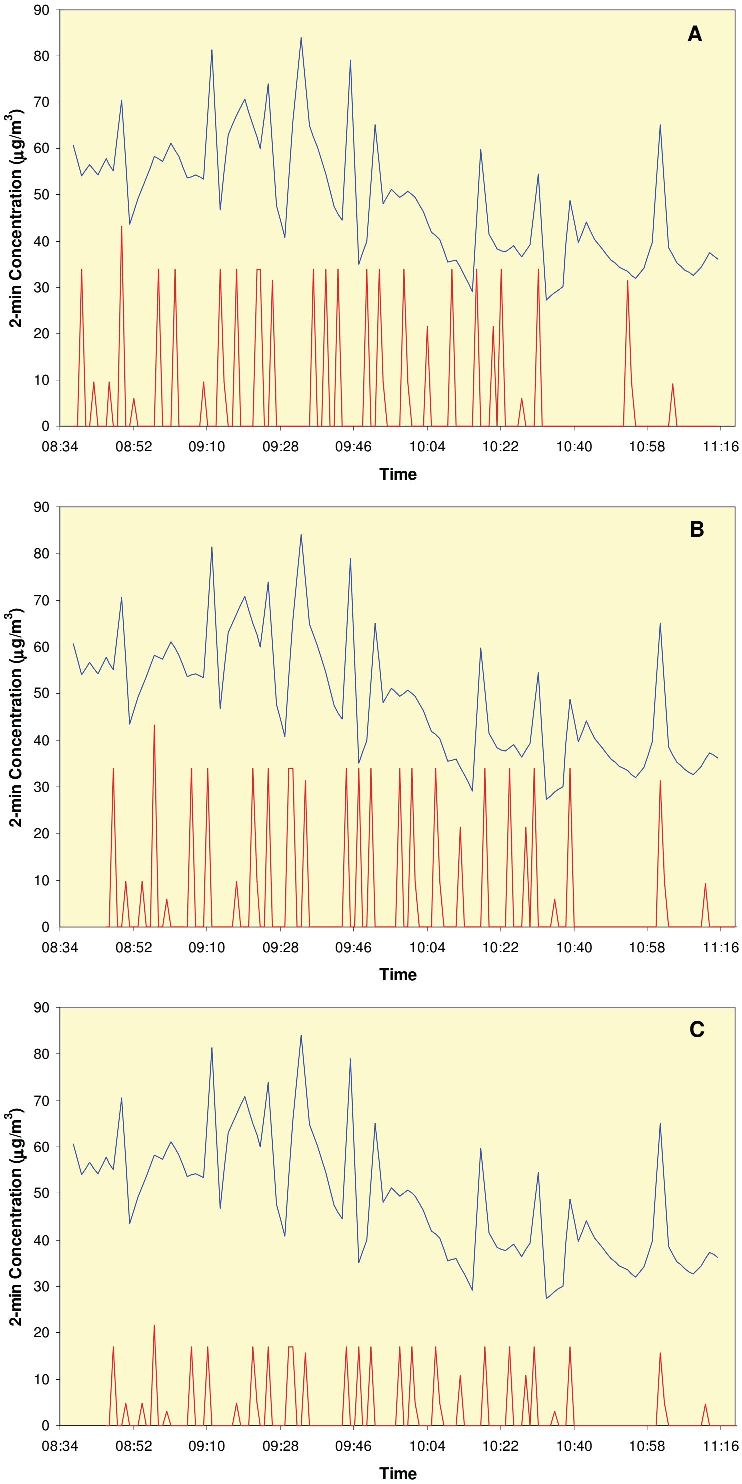


Figure 8 **Measured (blue line) and Simulated (red line) Nitrogen Oxides Concentrations at the London City Airport Newham Docklands Monitoring Site on the Morning of 15 January 2009. A = times as recorded with maxima expected aircraft contributions; B = 8 minute time shift in maxima aircraft peaks; C = 8 minute time shift in minima aircraft peaks.**

5.3 A visual examination of the data suggests a better fit can be achieved if the monitoring time base is shifted by 8 minutes (Figure 8B). A number of monitored peaks then broadly match those expected, although there are also periods when there should be aircraft peaks, but they are not shown in the monitoring data. This may be due to the loss of the relatively small peaks within the noise of the background concentrations. To add to this, as noted above, the expected concentrations will lie in the range 50 to 100% of the maxima which arise when the 2-minute mean sample period aligns directly with the aircraft peak. The aircraft peaks in Figure 8B are the maxima (100%) values. Figure 8C shows the same period with the aircraft peaks at their minima (50%) values.

5.4 Another example is for the evening of 29 October 2008, when a southerly wind (average direction 172°, range 154°-196°) was blowing towards the monitoring station at an average speed of 1.9 m/s (range 1.3-2.2 m/s). The wind direction is broadly similar to that for 15 January, but the wind speed is much lower. The monitored concentrations for this day are shown in Figure 9A, together with the expected pattern (which is shown for the maxima aircraft peaks). The baseline concentrations were much higher, requiring a different scale on the y-axis. There is some visual evidence that there are peaks in the data that match the aircraft departures, but the agreement is less apparent than for the 15 January. It is possible that the lower windspeeds are giving rise to greater spread of the plumes before they reach the monitoring site. In this case, a visual examination of the data suggests a better fit if the monitoring time base is shifted by 10 minutes (Figure 9B).

5.5 A third example is for the afternoon of 12 December 2008, when a southerly wind (average direction 181°, range 177°-193°) was blowing towards the monitoring station with an average wind speed of 5.2 m/s (range 4.8-6.0 m/s). The wind direction was broadly similar to that for 15 January, but the wind speed was higher. The monitored concentrations for this day are shown in Figure 10A, together with the expected pattern (which is shown for the maxima aircraft peaks). The baseline concentrations were similar to those on 15 January. Again, there is some visual evidence that there are peaks in the data that match the aircraft departures, and the agreement is more apparent than for the 29 October data (*cf* Figure 9). In this case, a visual examination of the data suggests a better fit if the monitoring time base is shifted by 6 minutes (Figure 10B). This is particularly evident for the wider expected peak at 16.35 h in Figure 10A, which was associated with two aircraft departing just one minute apart. This peak nominally lines up with a wider peak in the measured concentrations if the time base is shifted by 6 minutes (Figure 10B). It is clear though that there are periods when expected peaks do not show in the monitoring data.

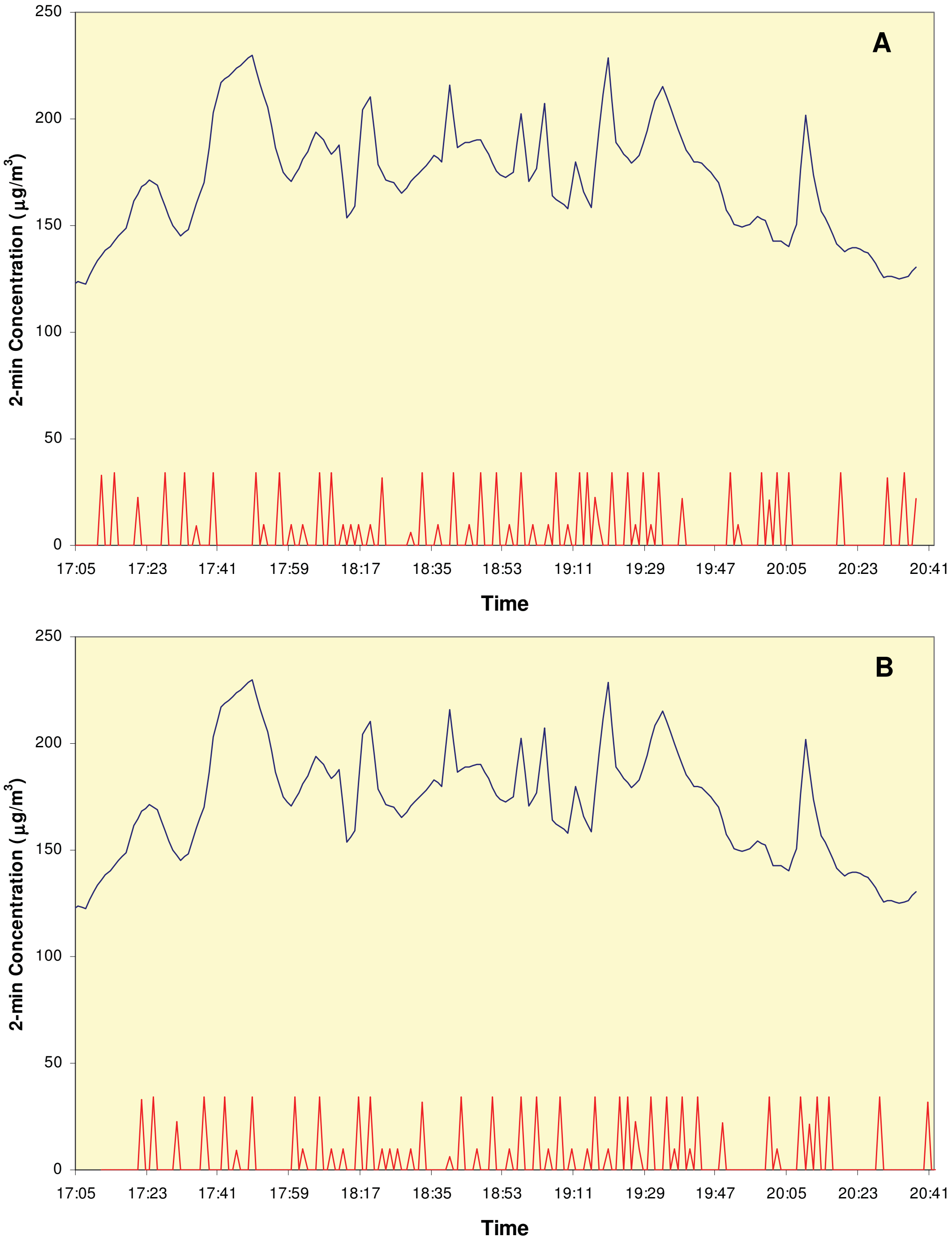
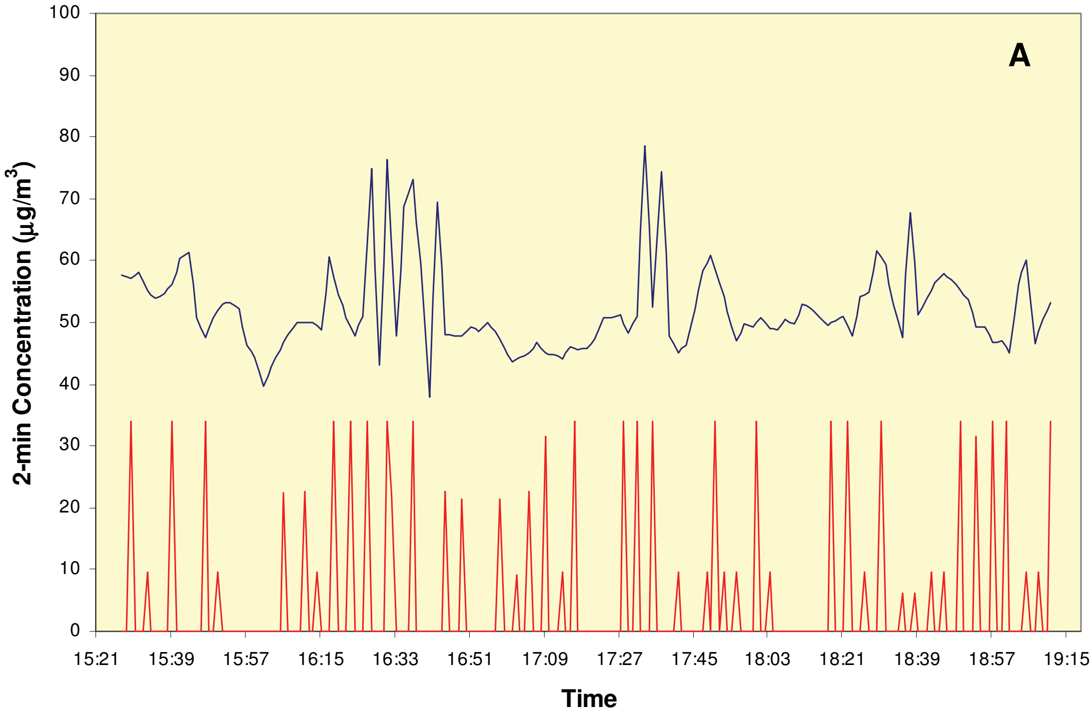


Figure 9 **Measured (blue line) and Simulated (red line) Nitrogen Oxides Concentrations (maxima) at the London City Airport Newham Docklands Monitoring Site on the Morning of 29 October 2008. A = times as recorded. B = 10 minute time shift in aircraft peaks**



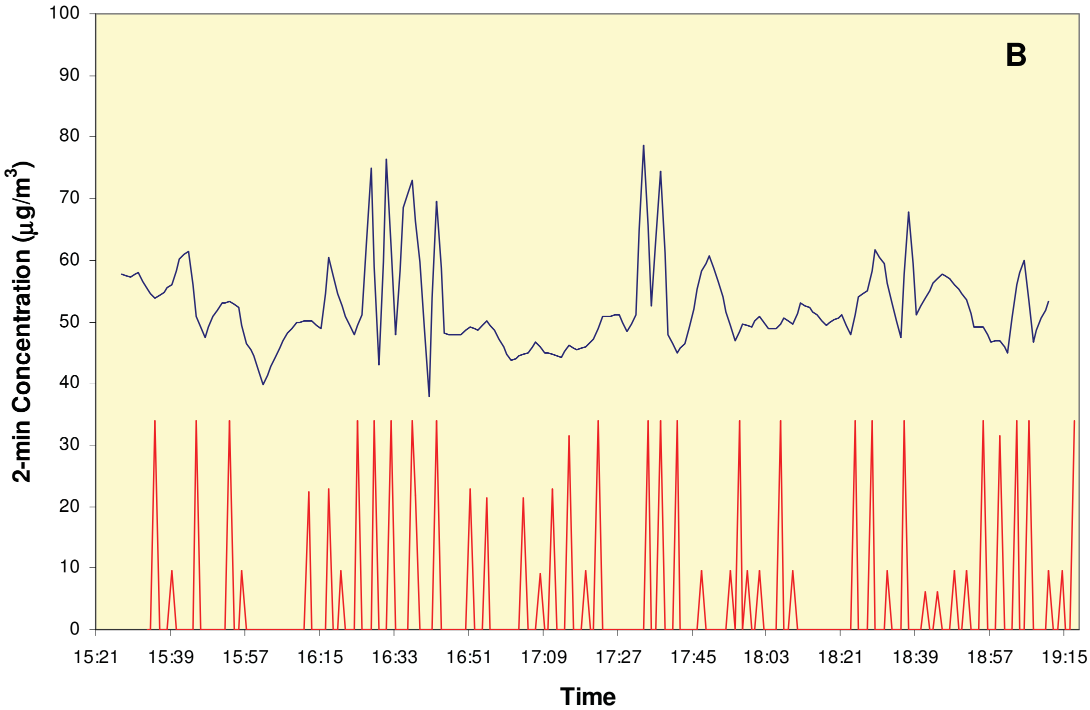


Figure 10 **Measured (blue line) and Simulated (red line) Nitrogen Oxides Concentrations (maxima) at the London City Airport Newham Docklands Monitoring Site on the Morning of 12 December 2008. A = times as recorded. B = 10 minute time shift in Aircraft Peaks**

6 Data Analysis - Period 2

6.1 The 2-minute mean concentrations of nitrogen oxides throughout Period 2 are shown in Figure 11. The pattern is very similar to that in Period 1.

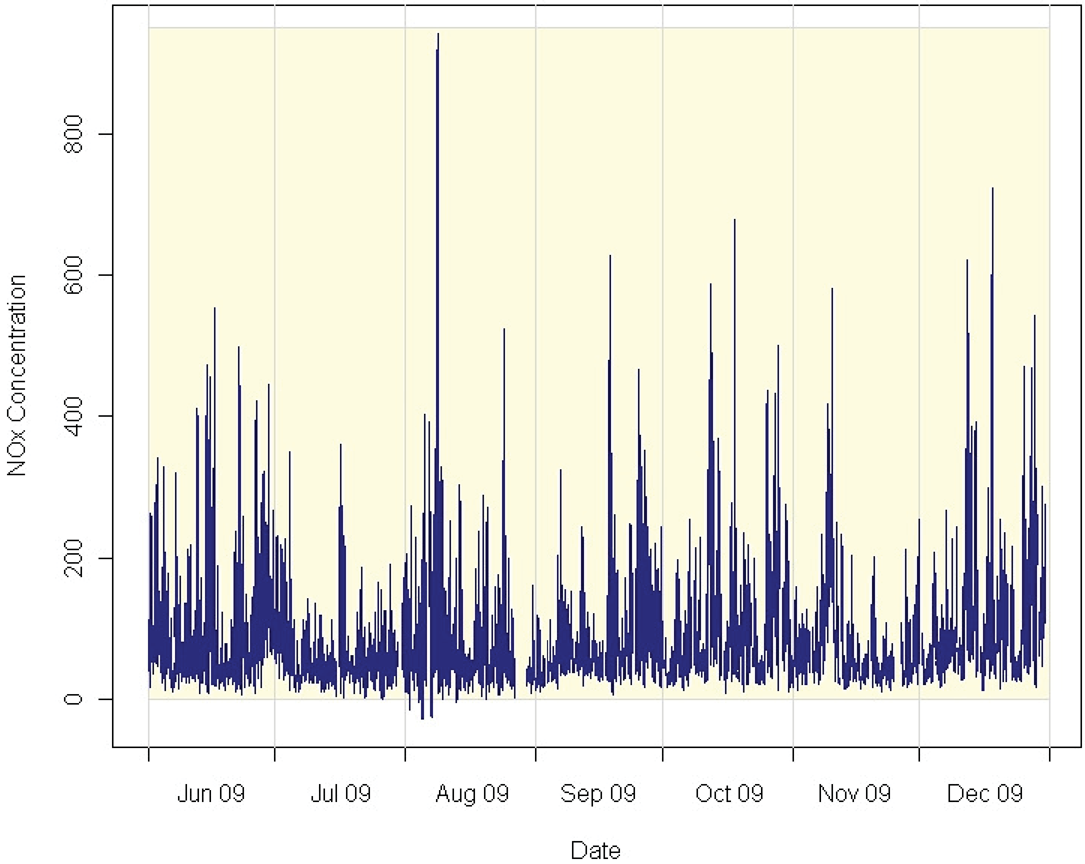
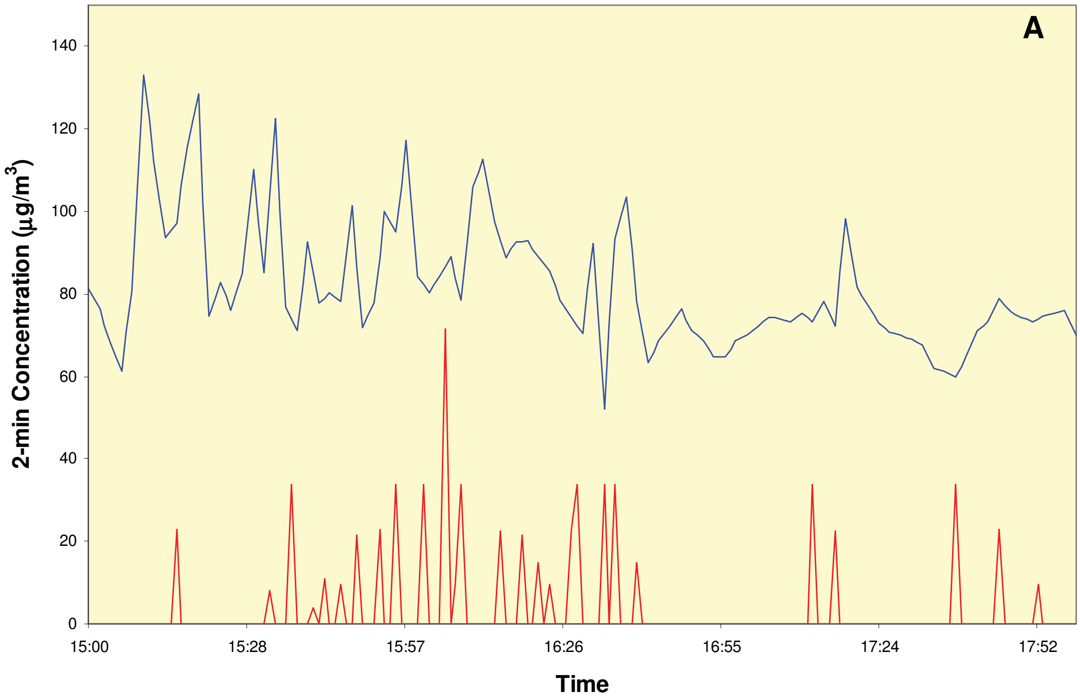


Figure 11 Nitrogen Oxides Concentrations (µg/m³) Averaged over 2-Minutes at London City Airport Newham Docklands Monitoring Site, October to December 2009.

6.2 As for Period 1, the data on aircraft movements have been used to identify those days with departures to the east and with winds blowing from the Airport towards the monitoring site, and when the A318 was taking off. There were 10 days when these conditions arose (>1m/s wind). None of these occasions provided evidence of the expected peaks as strong as that from Period 1. The results for the afternoon of 12 November 2009 provide probably the best evidence (Figure 12). The wind was southerly (average direction 178°, range 175°-185°), blowing towards the monitoring station at an average speed of 4.6 m/s (range 3.9-5.3 m/s) The monitored concentrations for this day are shown in Figure 12A (blue line), together with the expected pattern of contributions from the aircraft taking off (red line); the expected values may lie between 50% and 100% of the values shown in a random way. The tallest simulated peak represents the Airbus A318 departure at 16:05.



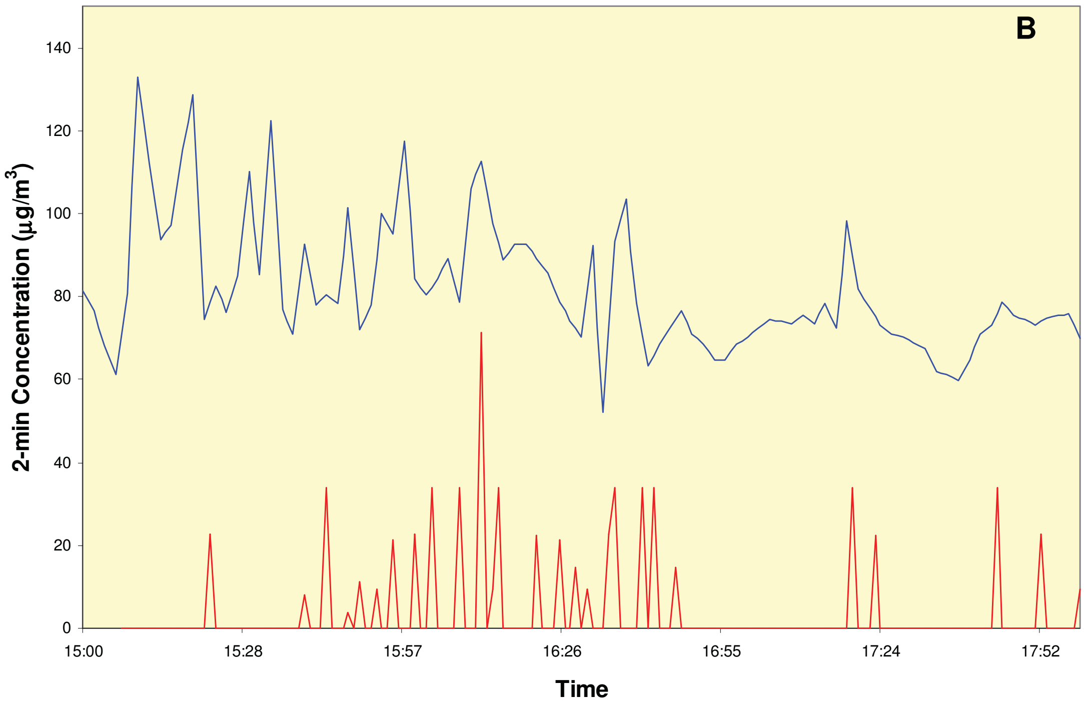


Figure 12 **Measured (blue line) and Simulated (red line) Nitrogen Oxides Concentrations (maxima) at the London City Airport Newham Docklands Monitoring Site on the Afternoon of 12 November 2009. A = times as recorded; B = 7 minute time shift in Aircraft Peaks**

6.3 A visual examination of the data suggests a better fit can be achieved if the monitoring time base is shifted by 7 minutes (Figure 12B). A number of monitored peaks then broadly match those expected, although there are also periods when there should be aircraft peaks, but they are not showing in the monitoring data, and periods with peaks in the monitoring data that are not related to aircraft departures. This may be due to the loss of the relatively small peaks within the noise of the background concentrations, together with the fact that the expected aircraft peaks will lie in the range 50 to 100% of the maxima which arise when the 2-minute mean sample period aligns directly with the aircraft peak. The aircraft peaks in Figure 12B are the maxima (100%) values. There is no evidence of a more significant response in the monitoring data related to the Airbus A318.

6.4 Another less clear cut example is for early afternoon 19 October 2009, when a southerly wind (average direction 181°, range 154°-202°) was blowing towards the monitoring station at an average speed of 3.3 m/s (range 1.6-4.3 m/s). The monitored concentrations for this day are shown in Figure 13, together with the expected pattern (which is shown for the maxima aircraft peaks). There is no evidence of any peaks associated with the aircraft departures.

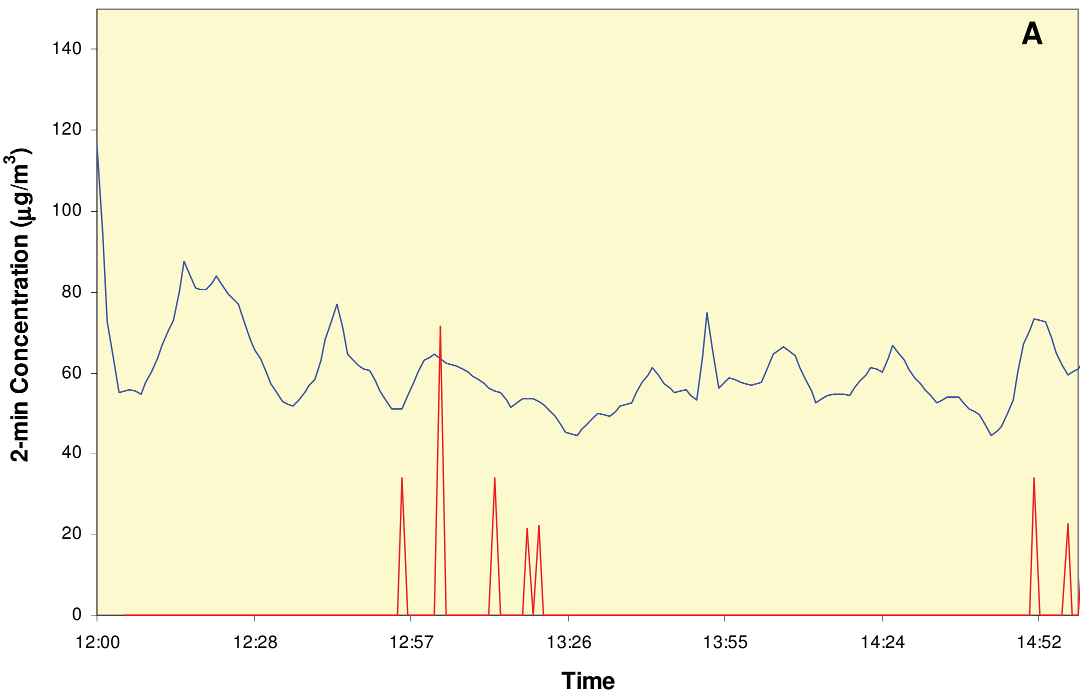


Figure 13 Measured (blue line) and Simulated (red line) Nitrogen Oxides Concentrations (maxima) at the London City Airport Newham Docklands Monitoring Site on the afternoon of 19 October 2009.

7 Summary and Conclusions

7.1 This assessment has been carried out to discharge the S106 obligation upon London City Airport to produce a report detailing the outcome of studies to investigate the effects of individual aircraft types. It utilises the results of an earlier study carried out at Heathrow Airport to define the expected pattern of short-term nitrogen oxides concentrations at a monitoring site established 200 m to the north of the London City Airport runway (adjacent to the Newham Docklands building). The results of measuring 2-minute mean nitrogen oxides concentrations at this monitoring site have been compared with the expected pattern on days when the wind was blowing from the Airport towards the monitoring station at a time when aircraft were taking off to the east.

7.2 This study is predicated on the fact that the principal pollutant associated with aircraft operations at airports is nitrogen dioxide, which is derived directly and indirectly from aircraft emissions[8]. It is also predicated on the fact that nitrogen oxides emissions at airports are dominated by aircraft during take-off.

7.3 The definition of the expected pattern of short-term peaks arising from aircraft during take-off has been based upon the observation at Heathrow Airport that peak concentrations of nitrogen oxides at the monitoring site 180 m from the centre of the runway were closely related to the ICAO published emission factors for the nitrogen oxides emissions of the different aircraft during take-off. This suggests that 2-minute peak concentrations at the Newham Dockside monitoring site might rise to 71 $\mu g/m^3$, but will mostly be a lot smaller than this.

7.4 Two periods have been examined: Period 1, August 2008 to March 2009 and Period 2, October to December 2009, the latter being included to cover consideration of the Airbus A318 which was operational in the second period. Graphs of concentrations on five days are presented, four of which support a link between expected peak concentrations during take-offs and measured concentrations. The match though is not exact and on one occasion was not present at all. This is not surprising given the relatively small peaks expected (compared with the Heathrow Airport study, where much larger aircraft are in service), and that these peaks may have been partially lost within the noise of the analyser and the varying background concentrations. The results do though show that the measured peaks are no higher than those expected.

7.5 The monitoring data at the Newham Docklands site over the period August 2008 to May 2009 show some 2-minute mean concentrations that approached 1000 $\mu g/m^3$, which is very different to the expected aircraft contributions based on simulations. Examination of these high concentrations shows that they were not short lived peaks that might be related to aircraft movements, but

8 As described in Para 2.2, NOx emissions from aircraft are predominantly in the form of nitric oxide (NO), which are transformed to nitrogen dioxide (NO_2) in the atmosphere.

persisted over several hours. They will have been due to other local and regional sources, such as road traffic, industry and transboundary contributions.

7.6 The assessment has also allowed an approximate calculation of the contribution of the aircraft during periods when aircraft are taking off to the east on runway 09 and winds are blowing from the runway towards the monitoring site. The effect is to contribute around 5 $\mu g/m^3$ to the nitrogen oxides concentration. Taking into account periods when the wind is not blowing towards the monitoring site, those times of the day when aircraft are not taking off, and those times when aircraft are taking off to the west, it is concluded that the long-term contribution of aircraft during take-off to nitrogen oxides concentrations at the Newham Docklands monitoring site is going to be significantly less than 5 $\mu g/m^3$, and probably less than about 1 $\mu g/m^3$. The contribution of aircraft emissions during take-off, to long-term nitrogen dioxide concentrations at the monitoring site, would be even smaller, and can be expected to be less than 0.5 $\mu g/m^3$. The contribution of aircraft emissions during take-off at other locations to the north of the Airport would be lower, with increasing distance from the runway.

7.7 The study at London City Airport has provided evidence that supports the findings of the Heathrow Airport study, which showed that the impacts of individual aircraft are closely related to the published emission factors. Table 1 therefore provides a reliable summary of the relative impacts of the different aircraft using London City Airport, in terms of emissions of nitrogen oxides.

7.8 However, it must be emphasised, that the overall contribution of aircraft operations at London City Airport to local nitrogen oxides (and nitrogen dioxide) concentrations must also take account of the *frequency* of individual aircraft movements[9]. Such considerations were fully accounted for within the dispersion modelling studies that were carried out to support the planning application for expansion of operations.

7.9 The conclusions of this study lend increased confidence to the modelling of emissions from the different aircraft using London City Airport.

[9] Aircraft with relatively high NOx emissions on take-off will only make a very small contribution to measured NOx concentrations if these aircraft movements represent only a very small proportion of the total movements. As an example, it can be seen from Table 1 that the NOx emissions on take-off are about 4 times higher for the BAe146 compared with the F50 (19.1 g/s versus 5.5 g/s). However, there are approximately 20 times more F50 flights compared with the BAe146 (17.05% compared with 0.79%). It is clear that *total* NOx emissions on take-off from the BAe146 will be lower than for the F50.

8 References

Defra (2009) Local Air Quality Management Technical Guidance, LAQM TG(09), Defra, London.

Laxen, D, Marner B, Carslaw D & Ropkins K (2007) Analysis of Fast Response NOx measurements at Heathrow Airport, June 2007 (available at www.airquality.co.uk/reports).

9 Glossary

NOx	Nitrogen oxides (taken to be NO_2 + NO).
$\mu g/m^3$	Microgrammes per cubic metre.
g/s	Grammes per second

APPENDIX 15
VOLATILE ORGANIC COMPOUNDS STUDY REPORT

Air Quality
CONSULTANTS

London City Airport:
Measurement of Volatile Organic Compounds (VOC) Concentrations and Odours

July 2010

Experts in air quality
management & assessment

Document Control

Client	London City Airport	Principal Contact	Janet Goulton

Job Number	J1004

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1004/2/D5	08 July 2010	Draft Report	Prof. Duncan Laxen

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Contents

1 Executive Summary

1.1 The 2009 Section 106 Planning Agreement for London City Airport requires that a study be undertaken to measure concentrations of Volatile Organic Compounds (VOCs) and odours in and around the Airport site. This report describes the outcome of this investigation.

1.2 London City Airport has received very few complaints related to odours over the past 10 years, despite the expansion of operations that has taken place over this time. The approach that has been taken for this study is innovative, and has been based on measurements of VOCs carried out using a high sensitivity Photo-Ionisation Detector (PID), whilst completing records of perceived "airport odours" during a number of walk-around surveys in the vicinity of the Airport.

1.3 An important conclusion of this study is that "airport odours" are not primarily related to aviation kerosene, but are probably associated with organic hydrocarbons produced by the pyrolysis of kerosene in the jet engine, i.e. associated with what are sometimes called 'burnt' hydrocarbons. The greatest potential for odour emissions is believed to occur during aircraft taxi movements after landing, when thrust settings are low and the engine components are very hot. By definition, this restricts the frequency of occasions on which "airport odours" will be perceived.

1.4 "Airport odours" were perceived within the residential areas to the south of the Airport, but such occurrences were infrequent, and the duration of events was very short. Such observations are consistent with the very low frequency of odour complaints received by London City Airport. Given that "airport odour" events are infrequent and of such short duration (tens of seconds) there are no health concerns for the general public with regard to exposure to airport odours.

1.5 Stronger "airport odours" and elevated VOC concentrations were recorded at the Airport Roundabout (close to Connaught Bridge, and adjacent to the Jet Centre). This is the closest point that members of the general public can get to the airport operations; it is an "extreme" location and clearly does not represent conditions within the general community. It was observed that the "jet blast screens" erected at this location provide a very effective means of dispersing aircraft emissions, such that odours and elevated VOC concentrations could not be detected at the downwind side of them. It should also be noted that the peak VOC concentrations recorded at this location were no higher than those recorded on occasions to the north of Royal Albert Dock, when the wind was blowing towards the direction of the Airport (i.e. not associated with Airport sources).

1.6 A further important conclusion is that the assessment of potential "airport odour" impacts through modelling of VOC concentrations will be of little benefit, as these odours appear to be unrelated to airport or aircraft-generated total VOC concentrations.

2 Introduction

2.1 The 2009 Section 106 Planning Agreement for London City Airport requires that a three month study to measure Volatile Organic Compounds (VOC) concentrations[1] and odours in and around the site be undertaken. The specific requirement is as follows:

> *Within 12 months of the date of this Deed the Airport Companies shall submit to the Council a report detailing the outcome of studies which shall be undertaken to measure Volatile Organic Compounds concentrations and odours in and around the site.* (Third Schedule, Part 3, Item 1 (b)).

2.2 This report is intended to fulfil this obligation. London City Airport has received very few complaints related to odours over the past 10 years, despite the expansion of operations that has taken place over this time. The purpose of this study is to investigate perceived airport odours, where and when they occur, and whether they can be better quantified in the future. It is important to note that there is no evidence from published studies that this type of measurement programme has been previously carried out in the vicinity of an airport. As such, the approach is innovative, and the measurement programme should be regarded as a pilot study.

2.3 This report sets out the general background, summarising the various approaches that have previously been used to quantify odours associated with airport operations. It then describes the approach taken for this study, and describes the results that were obtained.

2.4 This study has been carried out in association with David Shillito Associates. The field work survey notes completed by David Shillito Associates are provided in Appendix 1 to this report.

[1] VOC's are organic compounds that are able to evaporate under normal ambient conditions so as to exist as a vapour in the atmosphere. VOC's are numerous and ubiquitous, and are derived from both natural and anthropogenic sources. Levels of VOC's in indoor environments are often higher than in the ambient environment, due to a wide range of VOC-emitting sources in buildings. Some, but not all VOC's are odorous.

3 Quantification of Odours at Airports

3.1 The assessment of impacts associated with operations that emit odorous compounds is very difficult, even when the source is well defined (e.g. a chimney stack), and the compounds giving rise to the odour are well characterised (e.g. hydrogen sulphide). Where the sources of emission are disaggregated over a wider area, and the emissions are complex in nature (such that a number of components may be contributing to an odour, none of which can be clearly defined) then any assessments become increasingly difficult.

3.2 The difficulties are further compounded by the manner in which odours are perceived by the human nose. Such responses are subjective and are dependent upon a number of characteristics including the intensity (the perceived strength of the odour) and the hedonic tone (whether it is pleasant or unpleasant). Odours can be detected at very low concentrations of the chemical compounds giving rise to the odours, sometimes down to several parts per billion (ppb). The human nose is also able to respond to rapidly changing concentrations of odour in the air, such that peak concentrations over durations as short as several seconds can be important.

3.3 Various approaches have been taken to study and quantify odours associated with airport operations. These include:

- Odour surveys; and
- Quantification of total hydrocarbon concentrations

3.4 Odour surveys have been carried out at a number of airports, including at Gatwick and Stansted. One of the largest reported surveys was undertaken by Stansted Airport Ltd between August and November 2005[2], during which period the Airport invited some 14,000 local residents to report any incidents of odour annoyance. During the survey period, only 99 responses were received, the majority of these from residents living a relatively large distance from the Airport. The study concluded that:

One of the critical aspects of the work has been the low levels of data and information gathered following requests to the local community. There are no persistent reports of odour as there are with noise for example.

Without further accurate data and information it is not possible to draw many conclusions about correlations between odour and other factors such as meteorological data because any such correlations would not stand up to statistical challenge and would be supposition. So, although general trends have been found that when prompted, a small number of people living locally will

2 BAA (2006) Generation 1 Environmental Statement Regulation 19 Response Appendix A2 (draft) September.

indicate that they have experienced an odour occurrence, it has not been possible to deduce any of the causes or factors related to odour occurrences from this study.

3.5 The assessment work that was carried out for the Stansted Generation 1 Environmental Statement was based on the likely change in the detection of odours associated with the emission of aircraft related VOC emissions. Whilst this has been a commonly-applied approach, there are two principal concerns:

- There is no evidence to correlate total aircraft-related VOC concentrations with the human perception of odours; and
- The modelling studies carried out are based on the prediction of 1-hour average concentrations. Peak concentrations (of less than 30 seconds duration) may be many times higher than the 1-hour mean concentration, but there is no reliable way to calculate these values. As described above, the human nose is able to detect odours over very short time periods.

3.6 As a result of these general concerns, a variation of this modelling approach was undertaken at Copenhagen Airport in 2002[3]. This study quantified odour emissions from aircraft engines using actual fuel flow and emissions measurements, odour panel results, engine specific data and aircraft operational data, and used this information to predict odour concentrations. However, the calculations were carried out for only a limited number of engine types (predominantly the JT8D-219) and the study recognised that "*the uncertainties become large when the experimental data is used to estimate the odour emissions for all aircraft engines*". Furthermore, the aircraft engine odour data were not published, and have not subsequently been applied in other assessments. However, one particularly interesting conclusion of the study was that "*most of the odour emissions come from the taxi phase after landing*". A further conclusion was that the study calculated an odour emission rate from the aircraft engines of 57 Odour Units[4] per milligram of hydrocarbon. This can be readily converted into a more conventional odour threshold value of 2.9 parts per billion (ppb). Such a value is not typical of the odour threshold for aviation fuel, which is in the region of 1-10 parts per million (ppm) (i.e. about 1000 times higher). This suggests that the odour emission rate calculated in this study was not associated with kerosene vapour, but with other organic compounds with much lower odour thresholds. These aspects are discussed in later sections of this report.

3 Winther M, Kousgaard U and Oxbol A (2006) Calculation of odour emissions from aircraft engines at Copenhagen Airport, *Sci Tot Env*, 366, 218-232.

4 In simple terms, olfactometry is the technique used to measure the concentration of an odour by taking samples of odorous air and then evaluating the number of dilutions at which the sample is only detected by 50% of the odour panel. The number of dilutions required to achieve this odour threshold is expressed as odour units per cubic metre.

History of Odour Complaints at London City Airport

3.7 London City Airport operates an environmental complaint handling procedure by which anyone can contact the Airport to register a complaint or request information about Airport operations. Complaints or requests for information can be registered by telephone, post, email or via the Airport website. Each complaint or request for information is registered by the Airport, and then investigated and resolved where appropriate and practical. All environmental complaints and enquiries made to the Airport are reported to the London Borough of Newham and a summary provided to the London City Airport Consultative Committee.

3.8 A summary of the environmental complaints related to air quality issues since April 2000 is shown in Table 1. This confirms that there have only been 9 complaints associated with airport odours over the past 10 years, despite the expansion of the Airport over this period.

Table 1: Summary of Air Quality Complaints

Year	No. Complaints	Nature of Complaint
2000	2	Airport odours
2001	2	Airport odours
2002	1	Smoke
2003	0	
2004	0	
2005	2	Airport odours
2006	1	Airport odours
2007	1	Airport odours
2008	0	
2009	1	Airport odours

Objectives of this Study

3.9 The principal objective of this study was to investigate whether any relationship could be found between measured atmospheric VOC concentrations and perceived “airport-related” odours in the vicinity of London City Airport. There are no published data to suggest that such studies have been undertaken before. The study also investigated whether any specific airport activities could be associated with “airport-related” odours, and the extent and frequency of perceived odours in the general environment.

4 Approach

4.1 The atmosphere contains a mixture of organic compounds. The major component is methane (CH_4) which has no detectable smell. The range of other more minor “non-methane” compounds is large and variable; in total, they typically represent a concentration which is about 10 times lower than methane. In classic monitoring methods, air samples are taken in special bags or adsorption tubes, and are then taken to a laboratory where the components of the sample are separated and analysed by gas chromatography or GCMS. This type of monitoring is suited for monitoring VOC concentrations over periods of several hours to several days. However, this is far from ideal for shorter time periods, where peak concentrations measured over a number of minutes or even seconds are important.

4.2 During the 1990s, the technique of photo-ionisation detection was developed, using high intensity photons in the UV range, to break molecules into positively charged ions, rather than by ionisation in a hydrogen flame. The “broad band” photo ionisation detector ionizes all the hydrocarbons with an ionization energy less than or equal to the lamp output, but is most sensitive for gases which have ionization energies similar to the photons that the detector uses. This selectivity is used to “tune“ the instrument to the components of interest.

4.3 These developments led to the design of a new generation of hand held photo ionisation detector (PID) instruments, which do not suffer interference from methane and which are capable of recording real-time concentration data, with very low detection limits and extremely short response times of a few seconds. These new instruments are ideal for use in “walk-round surveys”, to identify and measure possible sources of VOC emissions, and to map the extent of exposure around potential sources. These new high sensitivity PIDs have become particularly important in environmental work in odour assessment, and provide the only means currently available for measuring peak concentrations of a range of hydrocarbon compounds over a periods as short as a minute.

4.4 This pilot study proposed the use of high sensitivity PID’s to measure the VOC concentrations around London City Airport to examine the contribution made by aircraft and road traffic emissions, against the influence of the local background levels.

4.5 It was intended that a series of “walk round” surveys would be undertaken over a three month period, ideally during different wind directions. Days with different wind direction were selected in order to assess exposures to the north, west and south of the Airport operational areas at the west end of the Airport, concentrating on areas where members of the public might be present. As odour concentrations tend to be inversely proportional to wind strength, the surveys were carried out on days with lighter winds wherever possible.

4.6 The study was carried out during the late spring to mid-summer period, as VOC emissions associated with evaporative sources would be expected to be higher at this time.

4.7 As stated previously, it is important to note that this was intended to be a pilot study that was designed to exploit innovative approaches and new instrumentation not previously used in the vicinity of airports.

Survey Periods and Instrumentation

4.8 In total, six survey periods were carried out on 13-14th April, 25th May, 9-10th June and 30th June 2010. The early part of 2010 was characterised by cold, often rainy weather, and as set out above it was considered important that the study should focus on periods of warmer weather. The onset of the study was therefore necessarily delayed until mid-April. In addition, whilst further surveys were planned for the 15th April onwards (when the weather conditions were "ideal", with light, northerly winds) the Airport was unexpectedly closed for a period of a week due to the volcanic ash problems.

4.9 The identity of those compound(s) responsible for the characteristic "airport odour" have not been established from any studies yet reported in the scientific literature, and it is not known if they are simple hydrocarbons or more complex derivatives. The PID instruments used for this survey cannot distinguish between the various VOC compounds, and cannot specifically identify the compounds that give rise to an odour, but this was not the primary objective of this investigation.

4.10 For the first two periods of the study (13th and 14th April 2010), a RAE Systems PID instrument, a "MiniRAE 3000", with a detection limit of 0.1 ppm (100 ppb), was hired from Ashtead Technology.

4.11 A more sensitive instrument, a "ppb RAE Original" instrument, was later sourced by Ashtead Technology from the USA. This instrument has a much lower detection limit of 0.001 ppm (1 ppb). It was first deployed in a survey carried out on 25th May 2010, but it was considered that the instrument was not functioning reliably, and it was returned to the supplier for servicing. This instrument was later used in the surveys on 9th and 10th June, but the background VOC levels recorded (which were constantly in the range 1.5 – 2.5 ppm) were not considered credible. Subsequent discussions with the instrument manufacturer, RAE Systems, confirmed that the VOC concentrations recorded by this "ppb RAE Original" instrument could not have been correct and the data were necessarily discarded, and are not included in this report.

4.12 Finally, a high sensitivity "RAE 3000" PID was loaned from RAE Systems UK. This instrument is considered to be the best and most up-to-date technology of this type that is currently available anywhere in the world. It has a low detection limit of 0.001 ppm (1 ppb), a redesigned sensor head, and is temperature and humidity corrected. Facilities were also provided to zero-calibrate the instrument on site to counter problems of drift, which is critical for an instrument of such high sensitivity.

4.13 All of the PID instruments were pre-calibrated with iso-butylene, with a correction factor of 0.67, i.e. when exposed to 6.7 ppm of aviation kerosene (JP-8) vapour, the instrument reading would be 10 ppm.

4.14 Meteorological data were also recorded during the surveys using a Kestrel 2500 instrument, indicating wind speed, maximum gust and average speed.

4.15 A description of the field surveys carried out on 13th – 14th April, and 30th June 2010, together with the field survey records completed by David Shillito Associates, are provided in Appendix 1. As set out above, the VOC concentrations recorded on the other three survey days were discarded.

5 Results and Discussion

5.1 VOC concentrations measured on 13th and 14th April were often at, or below the detection limit of the PID instrument (0.1 ppm, or 100 ppb), and it was concluded that the instrument did not provide sufficient sensitivity to fully investigate the potential links between VOC concentrations and perceived "airport odour". However, these walkover surveys did provide two very important findings:

- The Airport operations did not make a major contribution to VOC concentrations in the general area; and
- The odour threshold of the "airport odour" was very low, and below the detection limit of the instrument.

5.2 The surveys carried out on 25th May and the 9th - 10th June confirmed the extent and duration of recognisable "airport odours", but as described earlier, the measured VOC concentrations were thought to be unreliable and have not been reported.

5.3 The survey carried out on 30th June allowed much more reliable VOC concentrations to be mapped. Background VOC concentrations at locations away from roadsides were generally very low, and often close to the detection limit of the instrument (0.001 ppm, or 1 ppb). Typical VOC concentrations close to roads were of the order of 20-30 ppb. Important findings were:

- "Airport odour" could be recognised, lasting for short durations of between 10 and 60 seconds. During such events, VOC concentrations were approximately 20 ppb higher;
- Very high VOC concentrations (above 2.4 ppm or 2,400 ppb) were recorded to the north of Royal Albert Dock, and were believed to be associated with a plume of an "odour masking agent" used by the Williams waste transfer site[5], located at Charles Street (some 800 metres away from the sampling point at the Newham Dockside building);
- VOC concentrations measured within buildings (e.g. the Newham Dockside building) were elevated above the general background, with levels approaching 0.05 to 0.10 ppm (50 to 100 ppb).

[5] Odour masking agents or "deodorisers" are frequently used by waste transfer stations to control odours. They are usually sprayed across the working areas.

General Conclusions

5.4 A number of broad conclusions can be drawn from the Pilot Study work. These are set out below.

Relationship Between VOC Concentrations and Odours

5.5 The relationship between VOC concentrations and "airport odour" was first assessed from the vicinity of the Long Stay car park. Observations were made of aircraft landing on an easterly runway allocation (due to the north east wind), coming to a halt, turning, and then taxiing back to the Terminal. At a location approximately 300 metres from the aircraft turning point, aircraft odours could be detected for brief periods of about 30 seconds. During such periods, no elevated VOC concentrations were recorded on the Mini RAE 3000 PID instrument (i.e. VOC levels were less than 0.1 ppm or 100 ppb).

5.6 The later survey (30th June) carried out with the "high sensitivity" RAE 3000 (with a detection limit 100 times lower) identified VOC concentrations of less than 20 ppb above the background during periods when "airport odour" was detected As the contribution of other VOCs cannot be dismissed, this suggests that the odour threshold of "airport smell" is below 20 ppb. As the odour threshold of aviation kerosene is in the range of 1 to 10 ppm (1000 to 10,000 ppb), kerosene cannot directly be the cause of the perceived "airport odour".

5.7 It is concluded that "airport odours" are not normally related to concentrations of aviation kerosene vapour or to VOC concentrations in general, but are probably associated with organic compounds produced by the pyrolysis of jet fuel in the hot engines. The most likely group of compounds are aldehydes, the simplest being acrolein (or acraldehyde). These aldehydes have very low sensitivity in PID instruments, but are known to be produced when kerosene fuel comes into contact with hot metal. Acrolein has a very low odour threshold (0.038 μg/m^3 or 0.02 ppb)[6].

5.8 This general conclusion is supported from the work of Winther *et al* (2006) (see Section 2 of this report), who found that "most of the odour is associated with aircraft taxi after landing". This would relate to hot engines operating with low thrust settings. It further corresponds with the low odour threshold calculated for the aircraft emission in the Copenhagen study, which is not representative of aviation fuel.

Short-term VOC Concentrations

5.9 In the ambient environment, vehicular traffic on the roads was responsible for non-methane VOC concentrations of around 20 - 30 ppb, with higher concentrations found with higher traffic densities. These levels are relatively low in comparison to the non-methane VOC concentrations that can be

[6] Woodfield and Hall (1994) Odour Measurement and Control – an update. Prepared by AEA Technology of behalf of the Department of the Environment.

found inside buildings, most likely arising from furnishings, food, copying and printing facilities etc. Typical levels of non-methane VOCs can rise to 50 to 100 ppb in buildings.

5.10 Overall the variation in short-term peak hydrocarbon concentrations found in the area of London City Airport is not wide. The survey suggests that the contribution made by the Airport is no greater than that from the local roads. Much higher VOC contributions from the Airport were identified at the eastern pavement of the Airport Roundabout. This is the closest point that members of the general public can get to Airport activities, and the distance between the aircraft and the pavement is only about 50 metres. During periods when aircraft on the Jet Centre apron were being prepared for departure, with engines running, strong “airport odours” were recorded, with VOC concentrations rising to 4 ppm above background. It should be noted this point represents an “extreme location” and is not representative of general public exposure in the vicinity of the Airport. It should also be noted that odours and elevated VOC concentrations were not recorded behind the “jet blast” screens, and it is concluded that these screens strongly enhance the dispersion of the emissions, providing a very effective means of preventing “airport odours”. It should further be noted that the peak VOC concentrations recorded at this location were no higher than those recorded on occasions to the north of Royal Albert Dock, when the wind was blowing towards the direction of the Airport (i.e. not associated with Airport sources).

Observations of Odours in the General Community

5.11 A constant record of any perceived “airport odours” was maintained throughout the walk-around surveys. Whilst “airport odours” were recorded, they were infrequent and usually of very short duration (several seconds to tens of seconds). These observations are consistent with the low level of odour complaints that have been received by the Airport over the past 10 years (as set out in Section 2 of this report).

5.12 Over flat, open areas (e.g. over open expanses of water across the Dock) odours could be detected over distances of approximately 300 - 350 metres. These incidents coincided with aircraft landing during north easterly winds, and specifically with aircraft turning at the end of the runway to taxi back to the Terminal. By definition, such occurrences were infrequent and of short duration (less than 60 seconds).

5.13 Within the residential area to the south of the Airport, “airport odours” were restricted to the area to the north of Albert Road, and for the majority of the time to the north of Drew Road. Such incidents were infrequent and of very short duration. A specific observation was that the buildings and structures that lie between the Airport and residential dwellings to the south appears to enhance the dispersion of the VOCs from Airport operations (as odours were more noticeable when transported over the open waters of the Dock).

6 Conclusions

6.1 A principal conclusion of this Pilot Study is that "airport odours" are not primarily related to aviation kerosene, but are probably associated with organic hydrocarbons produced by the pyrolysis of kerosene in the jet engine, i.e. associated with what are sometimes called 'burnt' hydrocarbons. The greatest potential for odour emissions is believed to occur during aircraft taxi movements after landing, when thrust settings are low and the engine components are very hot. By definition, this restricts the frequency of occasions on which odours would be detected.

6.2 The most likely group of compounds to be associated with "airport odours" are the aldehydes. They are known to be formed as pyrolysis products when aviation kerosene comes into contact with hot metal surfaces, and they are characterised by very low odour thresholds. Aldehydes can only be detected with very low sensitivity by even the most sensitive PID instruments available on the market.

6.3 It is not known with certainty whether aldehydes are responsible for the perceived "airport odour", and if they are, which specific compounds are involved. However, it is a plausible conjecture that acrolein may be involved. Acrolein (or acraldehyde) is one of the simplest aldehydes and has a reported odour threshold of 0.02 ppb. This would suggest that the odour would be strong enough to be recognisable at levels above about 0.2 ppb. The reported Short Term Exposure Limit (STEL)[7] for acrolein[8] is 0.3 ppm (300 ppb), i.e. 1500 times higher than the concentration at which it is likely to be recognisable. Given that "airport odour" events are infrequent and of very short duration (tens of seconds) there are no health concerns for the general public with regard to exposure to airport odours.

6.4 "Airport odours" were detected within the residential areas to the south of the Airport, but such occurrences were infrequent, and the duration of events was very short. Such observations are consistent with the very low level of odour complaints received by London City Airport.

6.5 A further important conclusion is that the assessment of potential odour impacts through modelling of VOC concentrations will be of little benefit, as airport odours appear to be unrelated to airport or aircraft-generated total VOC concentrations.

7 The STEL refers to exposure over a 15 minute period

8 EH40/2005 Workplace exposure limits. www.hse.gov.uk/coshh/table1.pdf

A1 Appendix 1: Field Surveys undertaken by David Shillito Associates

Survey Route

A1.1 The general survey route started from the Long Stay car park to the Terminal, and then either along Hartmann Road or through the residential areas to the south. It then continued to the Hartmann Road traffic lights, the gates to the Jet Centre, and to the Airport Roundabout at the south end of Connaught Bridge. From this location the route continued northwards on the public footpath, behind the jet blast screens at the Jet Centre, to the south west end of the Royal Albert Dock, over the footbridge to the northern side of the dock and eastwards to the Regatta Centre. The route was then retraced back to the Terminal and Short Stay car park. Occasional observations were also made inside buildings, including Newham Dockside for comparative purposes.

A1.2 The general survey route is indicted in Figure A1 below. A wider-scale map (Figure A2) shows the locations of other nearby sources of VOC/odour emissions.

A1.3 Throughout the survey, Airport Kerosene Odour has been recorded as “AKO”.

13th and 14th April 2010

A1.4 The first group of surveys was carried out in mid-April, taking advantage of the forecast period of stable, north easterly winds. Such a wind direction will carry emissions from Airport operations to the closest residential housing, to the south of Hartmann Road.

A1.5 On the afternoon of Tuesday 13th April, and all day on Wednesday 14th April, five “walk round” traverses were made in the areas to the south of the Airport, at locations where the public have access to the perimeter. VOC concentrations were measured continuously and a record made of any “airport smell”.

30th June 2010

A1.6 Meteorological conditions on 30th June were south westerly to southerly winds, which would tend to carry airport emissions to the north of the Royal Albert Dock. A full “walkover” survey was completed in the morning and supplemented by a drive around survey in the afternoon.

Air Quality CONSULTANTS

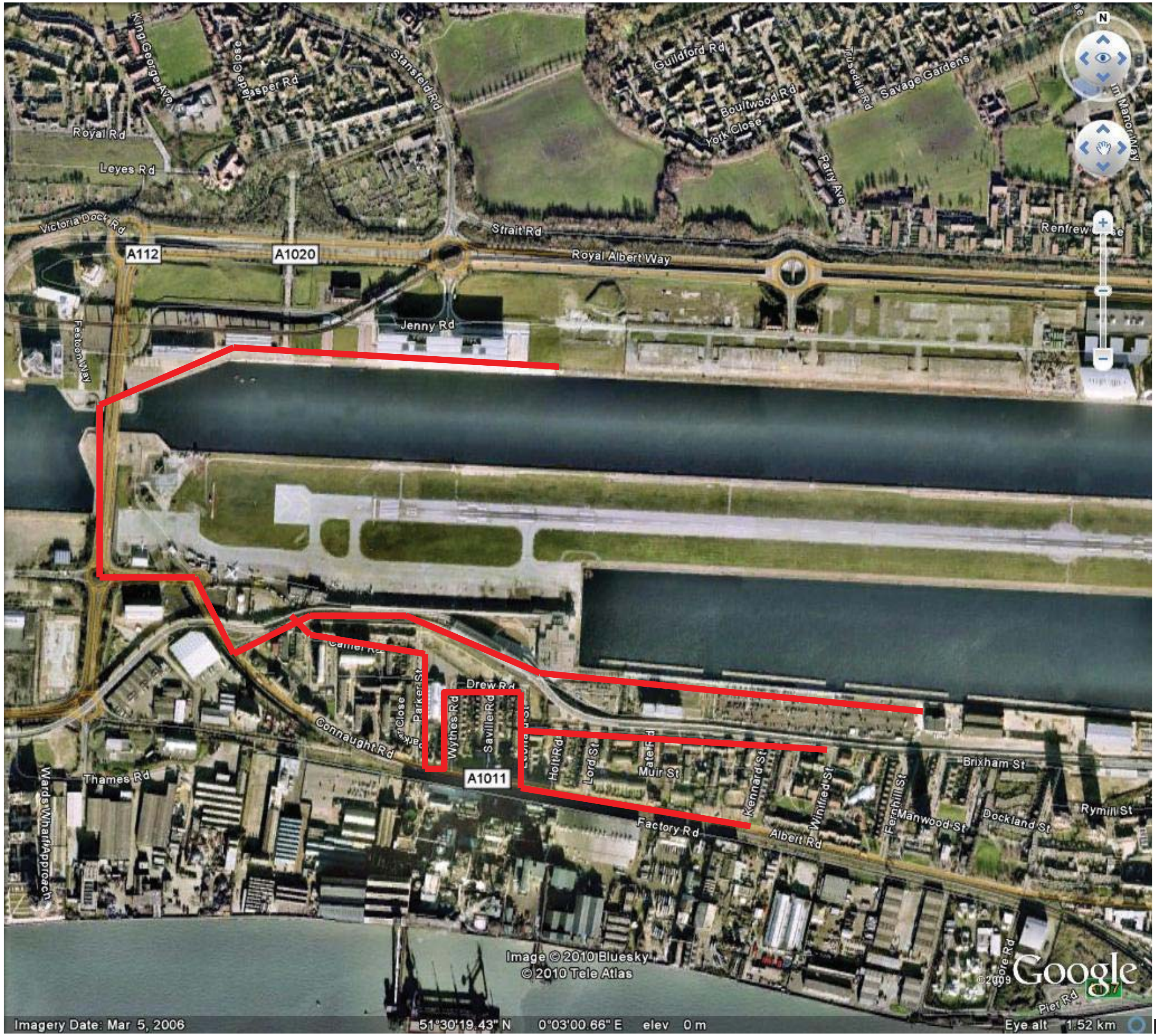
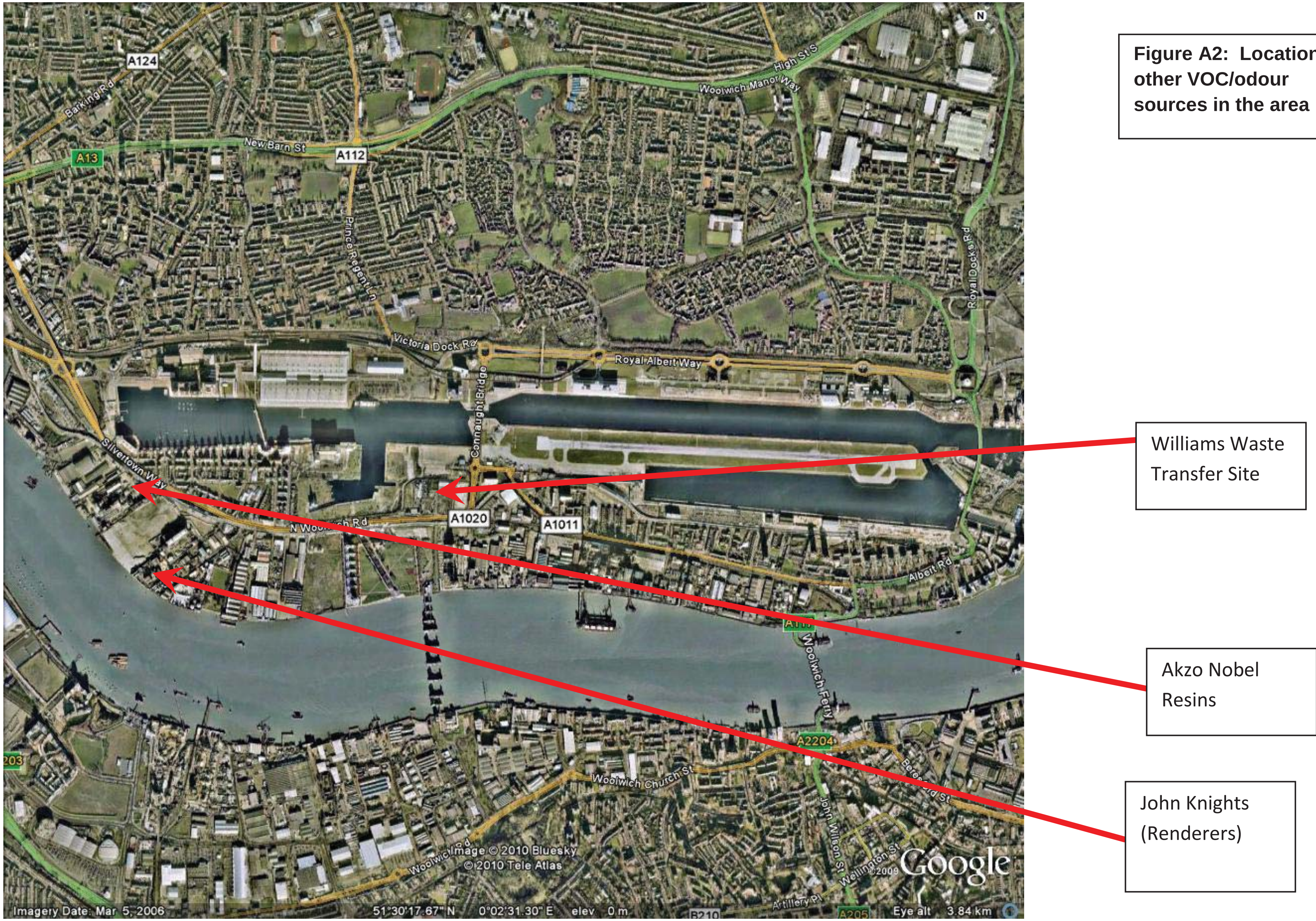


Figure A1: Odour Survey Route, indicated by red lines

Figure A2: Location of other VOC/odour sources in the area



Chronological Observations & Results (Field Notes)

Tuesday 13th April 2010

Arrived at airport at 1315 hours, went to Terminal to check that flight operations were as normal. Went to location at the side of King George V dock, near end of Long-stay car park).

Equipped with RAE Systems MINI RAE 3000 PID

- At 1330, with the wind speed gusting from 5 m/s to 9 m/s, from the N.E. Wind direction and gust condition could be judged by the movements of the surface waters. Temperature 16^{0}C.
- Aircraft were landing and taking off west to east.
- Arriving aircraft were coming to a stop at the completion of their landing and were turning round 180^{0} to taxi back to the Terminal area.
- The monitoring location could be adjusted to stay directly downwind of the turn-round position to allow measurement of greatest VOC concentrations in those wind conditions.
- Several types of airliner observed including RJ 80, Embraer 190, Dornier 328 Fokker 50.
- In wind speeds of 5 m/s to 9 m/s faint kerosene odours were observed from jets with no movement from "0.0" (zero concentration) on PID.

Time	Location/Observations	Odours	PID ppm
1500 hrs	Returned to King George V Dock to check wind conditions much the same as before. Only observable change was a decrease in frequency of stronger wind gusts. Slight AKO smells were observed originating form some aircraft mainly the larger jets as RJs and Embraer. No response was found to PID instruments.	Slight AKO	0.0
1600 hrs	At King George V Dock NE Wind speed significantly reduced: 3 m/s, peak gust 5m/s.		
1615 hrs	Falcon landed and turned on runway, smells of AKO noted but no deflection from "0" on PID. Assume concentrations of non-methane HC was less than 0.1 ppm. (Noted that wind direction still gave exposure)	Slight AKO	0.0
1625 hrs	RJ 80 landing with wind giving peak gust of 7 m/s.	None	0.0
1630 hrs	Started traverse of Airport: Terminal Set-down point, crossed over to Hartman Road pavement, down hill, passed junction will Camel Road, to traffic lights at junction with Connaught Road. Remained on NE side of Connaught Road (caution to road works) to Jet Centre roundabout.	Occasional, faint AKO	0.0
1700 hrs	On road side (W) of brick wall	Strong AKO	0.3-0.4 ppm
1715 hrs	Arrived Airport Roundabout at Connaught Bridge, at the gap between the jet blast screen walls and the building which provides a view of the Jet centre apron and the west end of the airport. This point provides a popular viewing point for plane spotters and other interested parties. Wind speed 4 m/s.	AKO	Up to 0.5 ppm
1725 hrs	RJ landed: no response at Airport Roundabout	None	0.0

1728 hrs	Small Ex Jet landed: No response at Airport Roundabout.	None	0.0
1737 hrs	Small Ex jet moving on Apron of Jet Centre. When jet shut down engines concentrations dropped down 0.2 to 0.1 ppm over about 2 minutes.	AKO	Up to 1.1 ppm
1744 hrs	RJ landed: no response at Airport Roundabout	None	0.0
1745 hrs	Observed an Ex et being fuelled no odour noticed and no detection on PID although down wind.	None	0.0
1805 hrs	Left Airport Roundabout on Connaught Bridge walking back to Jet Centre Gate.	None	0.1 ppm
1810 – 1814 hrs	Walked Connaught Road/ Hartmann Road.	Occasional and faint AKO	0.1 ppm
1815 hrs	At Camel Road/Hartmann Road intersection.	None	Up to 0.5 ppm
1820 hrs	Footpath from down from Hartmann Road to end of Parker Street.	None	0.1 ppm
1825 hrs	Parker Street / Drew Road.	None	0.0
1830 hrs	Newland Street / Holt Road	None	<0.1 ppm
1840 hrs	Return through Terminal set down/pickup point to short stay car park and City Aviation House.	None	0.1 ppm
1903 hrs	Return to Long Stay car park (East end) with no aircraft movements and no action upwind. Re booted PID but still gave a reading of 0.1 ppm Wind gusting to 8 m/s temperatures had fallen to 11.6 0 C still NE direction.	None	0.1 ppm
1915 hrs	Odours at East end of Short Stay car park. PID showing concentrations of 0.1 ppm.	AKO	0.1 ppm
1930 – 1935 hrs	Around short stay car park. Finish at 1935 hrs.	Occasional faint AKO	0.1 ppm

Wednesday 14th April 2010

Arrived at airport at 0740 hours:

Conditions: Pressure 1020 mb, Wind NE 10 mph, 80C Dew point 30C, overcast with cloud base at 3,000 ft.

Time	Location/Observations	Odours	PID ppm
07.50 – 0803 hrs	At side of King George V dock, near mid point of Long-stay car park. PID 0.1ppm faint AKO smells from aircraft as they completed their landings and turned to taxi back to the terminal. Wind NE average 3.6m/s max gust 4.9 m/s Temp 8.3 deg C.	Faint AKO	0.1 ppm
0807 hrs	RJ 80 landing.	Faint AKO	0.0
0810 hrs	Wind 3.5 m/s	Faint AKO	0.0
0820 hrs	Short Stay car park faint AKO PID = 0.1ppm	Faint AK)	0.1 ppm
0822 hrs	Flags area outside Terminal (east side)	None	0.0
0827 hrs	Steps down from Pickup area to Newland Street	None	0.0
0834 hrs	Parker Street / Camel Road	Very faint AKO	0.0
0840 hrs	Hartmann Road traffic lights	Faint AKO	0.1 ppm
0845 hrs	Back eastwards on Camel Road	Faint AKO	0.1 ppm
0855 hrs	Drew Road to Connaught Rd	Faint AKO	0.1 ppm
0857 hrs	Jet Centre Gate Security	None	0.1 ppm
0900 hrs	Airport Roundabout	AKO	<0.2 ppm
0906 hrs	Airport Roundabout with ex jet manoeuvring on apron.	Strong AKO for very short durations	0.3 – 0.7 ppm, peaking at 4 ppm
0920 hrs	Continued down footpath behind the jet blast screens to west end edge of the Royal Albert Dock by swing bridge assembly. Noted that the wind appear to have veered to ENE/E. Progressed over footbridge to North side of Royal Albert Dock. In front of the YI BAN restaurant and boat house. Noted that the PID was now reading 0.1ppm persistently. Temperature still 8 deg C.	None	0.0 ppm
1004 hrs	Hartmann Road Road/ Connaught Road.	None	0.2 ppm
1007 hrs	Hartmann Road Camel Road.	Faint AKO	0.1 ppm
1020 hrs	Inside Terminal Building PID = 0.2 ppm	None	0.2 ppm
1030 hrs	Short Stay car park	AKO	0.1 ppm
1130hrs	Restart PID	None	0.0
1145 hrs	Holt Road / Newland Road	None	0.0
1155 hrs	Camel Road / Hartmann Road	None	0.1 ppm
1200 hrs	Hartmann Road/ Connaught traffic lights	None	0.1 ppm
1205 hrs	Airport Roundabout, Connaught Bridge	None	0.0
1225 hrs	South side of west end of Royal Albert Dock: Wind check max gust 4.9m/s average 2.7 m/s Temperature 9.3 degC	None	0.0
1227 hrs	On the footpath Immediately behind jet blast screens.	None	<0.1 ppm
1231 hrs	Airport Roundabout: arrival of a small Ex jet. PID level dropped down to 0.1ppm after engines had been switched off. Continued back to Terminal	Faint AKO	0.4 ppm

1240 hrs	On Connaught Road, traffic under DLR bridge produced a flip in PID response from 0.1 ppm to 0.2 ppm, peak surges lasted for 15 seconds or so.	None	<0.2 ppm
1245 hrs	Hartmann Road traffic lights.	Faint AKO	0.1 ppm
1255 hrs	Outside Terminal Building. Outside International Arrivals PID = 0.2 ppm, possibly from food area Upstairs PID = 0.1 ppm Downstairs PID = 0.1 ppm	None	0.1 ppm
1300 hrs	Closed down		
1450 hrs	Restart at King George Dock: Wind ENE U = 4m/s Uav = 3 m/s Temperature 9 degC	None	0.0
1500 hrs	Flags area (East of Terminal)	None	<0.1 ppm
1502 hrs	Top of steps down to Newland Road.	None	0.1 ppm
1505 hrs	Leonard Street: no smells	None	0.0
1507 hrs	Saville Road / Drew Road	Faint AKO	0.1 ppm
1509 hrs	Wythes Street, continuing In front of New Drew Road School	None	0.1 ppm
1517 hrs	Camel Road	AKO	0.1 ppm
1520 hrs	Hartmann Road traffic lights	None	0.1 ppm
1524 hrs	Connaught Road under DLR Bridge.	None	<0.2 ppm
1610 hrs	On North side of Royal Albert Dock, West end outside YI BAN Restaurant. Wind easterly.	None	0.0
1617 hrs	Footpath behind Jet Centre blast deflector wall.	None	0.1 ppm
1619 hrs	Airport Roundabout Connaught Bridge.	None	0.1 ppm
1621 hrs	Small Ex jet started engines in front of Jet Blast wall. On foot path immediately behind section of wall (in full vibration) no smells, PID 0.1 – 0.0 ppm. This demonstrated again the efficiency of the Jet Blast wall in dispersing emissions and preventing any detection of “airport odour” directly behind the wall.	None	<0.1 ppm
1630 hrs	Left the Airport Roundabout – return to Terminal.		
1653 hrs	Hartmann Road Traffic lights: PID = 0.1 – 0.2 ppm on passage of lorries and busses, but not taxis or cars.	None	<0.2 ppm
1702 hrs	Newlands Road: smell but PID still 0.1 ppm.	Faint AKO	0.1 ppm
1708 hrs	Back to car in Short Stay car park.	None	0.1 ppm
1800 hrs	Short Stay car park. (Bright Sunshine)	None	0.0
1809 hrs	Hartmann Road above school playground.	Faint AKO	<0.1 ppm
1814 hrs	Camel Road / Hartmann Road.	Faint AKO	<0.1 ppm
1816 hrs	Between Hartmann Road traffic lights and DLR bridge.	AKO	<0.1 ppm
1820 hrs	Jet centre gate	None	0.1 ppm
1822 hrs	Airport Roundabout/Connaught Road.	AKO	0.4 ppm
1825 hrs	Airport Roundabout Connaught Road. Strong AKO but only in the gap between the Jet Blast wall and the building.	Strong AKO	<0.2 ppm
1835 hrs	South west corner of Royal Albert Dock. Wind Umax = 4.4 m/s U average = 3.3 m/s Temperature 11 degC.	None	0.1 ppm
1846 hrs	Footpath to Airport Roundabout and continued back to Terminal.	None	0.1 ppm
1915 hrs	At Short Stay car park PID = 0.1 ppm. Shut down.	None	0.1 ppm

Tuesday 30th June 2010

Equipped with:

- RAE systems ppb RAE 3000 PID,
  (Lowest reading 1 ppb, correction factor for jet fuel A-1 (JP-8) aviation fuel (MW 165) = 0.67
- From XC Weather: Pressure 1020mb, Wind data 14 -15 mph SW to W, 12mph later. Initially Cloud at 2,400 ft, 17^{0}C, with dew point 9^{0}C, later pm no cloud below 5,000 ft and 25^0 C, by 1530 hrs 22^{0}C.

1030 hrs At up-wind position at Quayside ½ way down Long Stay car park Wind SW varying in direction from SW to W, Maximum gust speed Umax= 4.6m/s average wind speed Uav= 3 m/s. Temperature 21.70C. Faint molasses odour detectable, possibly originating from Tate & Lyle Works.

Time	Location/Observations	Odours	PID ppb	PID ppb Zero Drift Corrected
1120	Short Stay car park, zero calibration	None	0	0
1123	City Aviation House, Reception Area (inside)		25	25
1125	City Aviation House Outside front door	None	0	0
1129	Flags Area, fluctuations		0 – 10	<10
1130	Terminal; between outside and inside doors.	None	450	450
	Terminal; booking hall	None	600	600
	Terminal; near the book store		800	800
	Terminal; near International Arrivals door		650	650
	Terminal; outside doors (readings decreased slowly)	None	0	0
1140	Hartmann Road: concentrations at zero until section between wall to south and DLR to north with little cross wind, VOC associated with traffic movements	None	9 – 25	<25
1142	Hartmann Road Camel Road junction (more open situation)	None	0	0
1144	Hartmann Road vehicle queue for traffic lights	None	30	<30
	Trarffic lights with free flow of traffic	None	0	0
1145	Connaught Road (west side) under DLR bridge 50 ppb	None	50	<50
1148	Airport Roundabout pavement east side overlooking Jet Centre apron (still up wind of any aircraft activity)	None	20–100	<100
1150	On footpath west of Jet Blast Screens	None	70	<70
1152	Footpath: north end of Jet Blast Screen	None	<4	0
1154	S. Quayside area Royal Albert Dock, intermittent strong smell of odour masking agent – "Deodorizer"	Deodorizer	76	<70
1155	S. Quayside Royal Albert Dock near RIB recognisable smell	Deodorizer	100	<85
1157	North Quayside west end of Dock	None	<100	<85
1200	Royal Albert Dock north quayside between Regatta Centre and Newham Building. U maximum = 5.3 m/s U average = 4.0 m/s		30	<20
1205	North quayside west of Newham Building: edge of odour plume		70	<60
1205	Newham Building: Outside south doors	None	20	0
	Newham Building: Inside Atrium south side	Building	50	30

	Newham Building: East Wing	Building	120	100
	Newham Building: Toilets (air freshener being used)	Air freshener	200	180
	Newham Building: Atrium (north side)	Building	80	60
	Newham building outside north doors	None	50	30
1214	Newham Building car park east entry gates	None	40	<20
1216	Quayside AQC Air Quality Monitor (back on odour plume)	Deodorizer	28	<10
1220	Eastern limit of quayside footpath Noted that runway wind sock at this time showed wind direction to be WSW (still in the odour plume)	Deodorizer	30-40	<20
1225	Eastern limit of quayside path: U maximum = 5.7 m/s Deodorizer smell persistent Wind swing SW AKO smell of short duration	Deodorizer followed by faint AKO	30-40	<20
1230	Quayside, Newham Building South Doors; short duration During AKO smell	AKO	50	30
1230	Quayside, Newham Building South Doors; short duration Before and After AKO smell (no smell of deodorizer)	None	30	<10
1235	Wind swinging SSW with aircraft landing	None	20	0
1236	Quayside, west end of Newham Building	Deodorizer	60	40
1246	Quayside, west end of Newham Building, Strong smell	Deodorizer	130	120
13001306	Quayside, Belfin's Café Wind swing to W remaining several minutes (background concentrations)	None	30	<10
1307	Quayside, Belfin's Café: inside the deodorizer plume, persistent smell. Short surge of AKO	Deodorizer + AKO	242	<210
1309	Quayside, Belfin's Café: second surge of AKO within deodorizer plume	Deodorizer + AKO		
1312	Quayside, Belfin's Café: inside the deodorizer plume	Deodorizer	2,500	2,470
1314	Quayside outside Newham Building	None	32	0
1325	Quayside AQC Air Quality Monitor	None	30– 32	0
1330	Quayside outside Newham Building	Deodorizer	36	<5
1335	North quayside ventilation house vents	None	32	0
1336	Footbridge,	Deodorizer	47	15
1339	East end of Royal Victoria Dock: quayside	Deodorizer	68	40
1344	Footpath upwind	None	50	20
1345	Airport Roundabout traffic? (no deodorizer smell)	None	80-125	<95
1347	Jet Centre Roundabout south side	Deodorizer	80-100	<95
	Hartmann Road Traffic Lights	None	47	<10
1350	Hartmann Road / Camel Road	None	50	<10
1352	Camel Road near Parker Street	Curry	70	30
	Camel Road / Parker Street	None	45	0
1355	Drew Road Entrance to Airport	None	40	0
1356	Newlands Street	None	40-50	<10
1359	Set down Pick-up area	None	40s	0
1400	Short Stay car park van passing, peak	None	160	<10
1404	Short Stay car park, no vehicle movement,	None	52	10
1407	Zero check for zero drift,	None	<10	<10

Afternoon Survey: "Car drive-around"

Time	Location	Odours	PID ppb	PID ppb Zero Drift Corrected
1440	Newham Building: Regatta Car Park Entry Instrument zeroed	None	0	0
1445	Millman Road (south end barrier)	None	0	0
	University of East London entrance barrier	None	0	0
1503	John Knights Ltd Works (entrance), Knights Road (animal rendering plant) characteristic identifiable odours.	Rendering odours	30	30
1507	Entrance to Nuplex Resins, Akzo Nobel Nippon Paints, Cromadex, PPG Industries (UK) Ltd. Characteristic paint smells.	Paint odours	40	40
1510	NE side of Docks Road by Roundabout: Characteristic landfill gas smells	Landfill odours	40	40
1515	Britannia Village, Rayle Rd (north)	None	0	0
1520	Rayle Rd, Junction with North Woolwich Road	None	20	
1524	North Woolwich Road, Pontoon Dock Traffic lights	None	20	20
1528	Airport Roundabout west side, (upwind of road) strong smell of odour masking agents - deodorizer	Deodorizer	70	60
1534	Williams Environmental Site Vehicle park, Charles Street	Deodorizer	900	890
1538	Williams Environmental Site entrance gate		3,500	3,500
1540	Hartmann Road, outside KVG House, zero calibration	None	10	0

Conclusions

Source of "masking agent" odours was identified as likely to be Williams Environmental Management Ltd, Hazardous Waste Transfer Site, Unit 3, Charles Street Silvertown E16 2BY, producing recognisable odours to distance of over 1,000 m downwind.

Other Potential VOC/odour sources include the sites occupied by: Akzo Nobel Resins and John Knights Ltd (renderers) – see Figure A2.

General background levels in vacant open areas around London City Airport: 0 ppb

Typical values on roads of area: 20 -30 ppb

Odour threshold of AKO: best estimate: <20 ppb.

APPENDIX 16
UNIVERSITY PRIZE SCHEME 2010 ADVERTISEMENT PUBLICATION

Are you planning to go to university this September ?

Then we would like to hear from you!

London City Airport is looking for local people to apply to its University Prize Scheme.

You are invited to apply if you:

- have submitted a UCAS application
- are looking to study a subject related to transport, business, geography or foreign languages
- expect to achieve 240 UCAS points or more
- are in receipt of Education Maintenance Allowance (EMA)
- live in the London Boroughs of Newham, Tower Hamlets or Greenwich

London City Airport will provide the recipients of the University Prize Scheme with financial assistance, business mentors, work placements and additional training throughout their degrees.

To request an application pack or for any queries, please contact Rupal Patel, Community Relations Executive on 020 7646 0041 or email rupal.patel@londoncityairport.com

The closing date for all applications is **Friday 30 July 2010.**

The London City Airport University Prize Scheme is part of the Airport's Education Excellence Programme. For more information, please visit www.londoncityairport.com.

APPENDIX 17
LIST OF ON-SITE EMPLOYERS

COMPANIES ON-SITE AT LONDON CITY AIRPORT	
COMPANY NAME	**BUSINESS**
AA Lovegrove	Building Contractor
Air BP	Aircraft Fuel Supplier
Alitalia	Airline
Aria Logistics	Passenger Handling Agent
ASIG BBA Aviation	Aircraft Fueller
Atkins LCY	Engineering & Design Consultant
Avis	Car Rental
BA CityFlyer	Airline
BA Mainline	Airline
BP Installations	Electrical Engineer
Caffe Nero	Food & Beverage
Carlisle Cleaning	Cleaning
CityJet	Airline
Citynet Catering	Food & Beverage
Cobalt Ground Solutions	Passenger Handling Agent
Derichebourg	Cleaning
ESP	IT Services
Europcar	Car Rental
Execair	Cargo Agent
Execujet	Airline
G4S Justice Services	Security
Gassan Diamonds	Retail
Glistening Jets	Cleaning
Hertz	Car Rental
HMS Host	Food & Beverage
London City Airport Limited	Airport Operator
Lufthansa	Airline
Luxair	Airline
Meteor	Transport Services
Metropolitan Police	Control Authority
NATS	Air Navigation Service Provider
Netjets	Airline
Newrest	Food & Beverage
North Air	Aircraft Fueller
Nuance	Retail
PJ August Decorating	Decorator
Pret a Manger	Food & Beverage
Quay Cars	Transport Services
Reliance Aviation	Security
Scandinavian Airlines	Airline
SCC Technology Solutions	IT Services
Scotairways	Airline
Select Aviation	Aircraft Fueller
Serco Home Affairs	Security
Shine Corp	Retail
Swiss International Airline	Airline
Travelex Worldwide	Retail
UK Border Agency	Control Authority
UK Power Networks	Energy Management
Vehicle Enhancement Services	Transport Services
WH Smith	Retail

APPENDIX 18
LOCAL EMPLOYMENT ENDEAVOURS REPORT

London City Airport
Local Employment Endeavours
2010

Introduction

London City Airport invests substantial resources into ensuring that the jobs and careers available on-site are accessible to local people. The Airport's local recruitment policy and ethos not only ensures that those affected by environmental impacts of the Airport are given an opportunity to share in our business success, but also ensures our employees are reliable and flexible due to living in close proximity to the workplace. In recognition of its commitment to economic regeneration, London City Airport was awarded the prestigious Lord Mayor's Dragon Award and Docklands Business Club Award for Corporate Social Responsibility in 2010.

Achieving Local Employment Aspirations

In order to achieve LCY's aspiration of being recognised as a beacon local employer in East London, the Airport focuses on two main strands of activity in this area. Firstly, the Airport implements recruitment procedures that prevent or reduce barriers to employment for local people. Secondly, the Airport invests in an extensive community engagement programme to ensure local people are aware of jobs available and have access to skills coaching to enable them to gain employment. Some of the processes, initiatives and activities are included in the 2009 Planning Agreement with the London Borough of Newham; others are operated as part of the wider LCY Community Engagement Programme, which is outlined below.

During 2010, the Airport delivered the following programmes and processes to ensure that jobs available on-site were accessible to local people and that barriers to employment were minimised:

Airport Jobsline and Website Information

Reed Specialist manages all recruitment for London City Airport Ltd (LCY Ltd). A dedicated Reed Specialist Account Manager for LCY Ltd is based at 22 Harbour Exchange Square, Isle of Dogs, E14 9GE. A dedicated airport jobs telephone line, 020 7517 3594, is also provided. All jobs are advertised 24 hours a day, 7 days per week at www.reed.co.uk with a further direct link from www.londoncityairport.com/careers and www.londoncityairport.com/recruitment.

External Company Vacancies Webpage

During 2010, an external vacancies web page was created on the LCY website to allow all companies onsite to advertise current job vacancies to local people. This development now makes accessing jobs on-site even easier for local people. Employers were updated on this development during the Employers' Forum meetings in 2010 and now link with the Airport Community Team to ensure the page is kept updated. External job vacancies can be directly accessed at http://www.londoncityairport.com/LandingPage.aspx?Page=External_Job_Vacancies, but can also be linked to via www.londoncityairport.com/recruitment.

Links with Local Employment Organisations

All entry level job vacancies for LCY Ltd are provided to Newham Workplace (Newham), Skillsmatch (Tower Hamlets) and Greenwich Local Labour and Business (GLLaB, Greenwich) for advertisement to local jobseekers. In addition, these vacancies are provided to JobCentre Plus to be uploaded on their jobseekers software, as well as Anchor House (Newham) and Newham College (Newham). In 2010, through the Airport Employers' Forum, LCY has also encouraged other employers on-site to provide their vacancies to Newham Workplace, which has resulted in companies such as WH Smith, Caffe Nero, Gassan Diamonds, Newrest, Nuance, Cobalt Ground Solutions, Hertz, Quay Vennards and others recruiting new staff from this organisation.

LCY Selection Test

LCY Ltd continues to use the LCY Selection Test developed in partnership with Newham Community Education and Youth Services[1] (NewCEYS) in its recruitment process. The test consists of six main questions relevant to the basic skills required for employment in an entry level role at London City Airport. All questions are based on basic literacy, arithmetic, 24 hour clock and European geography. The test questions are set at entry level three and level one of the National Qualifications Framework (equivalent to grade D/E at GCSE level) and candidates must achieve 70% to pass the test. This test allows LCY Ltd to ensure that job applicants will be able to successfully compete the regulated training necessary for roles based on-site at LCY.

During 2010, job applicants that did not pass the LCY selection test are referred by Reed Specialist to courses hosted by NewVIc[2], which enable candidates to brush up their literacy and numeracy skills, before they re-apply to the Airport after six months.

[1] NewCEYS is now part of the London Borough of Newham, falling under the Adult Education Service
[2] NewVIc is Newham Sixth Form College, Prince Regent's Lane, Plaistow

Internal Recruitment

To allow local staff who have achieved employment at LCY to progress, all job roles are advertised internally. This policy has encouraged many LCY employees to progress through the company to more senior positions.

Airport Employers' Forum

In 2008, London City Airport developed an Employers' Forum, which is a quarterly meeting for all employers based at LCY. The purpose of the Forum is to discuss, develop and implement programmes and procedures to support local recruitment, the Airport Travel Plan, sustainability initiatives and other issues relevant to employers operating on-site. The LCY Employers' Forum provides an opportunity for smaller employers to participate in employment programmes with the support of the Airport Owner/Operator to up-skill local people for jobs with their company. LCY also actively encourages all on-site employers to advertise any job vacancies, via the LCY website or via methods aimed at reaching local people.

Airport Careers

Airport Careers is a publication providing an outline of key careers and jobs found on-site at London City Airport. The document, available on the LCY website (www.londoncityairport.com/recruitment) or as a hard copy document, includes key requirements, roles and responsibilities and information to apply for each job role. The booklet was launched as a guide for students, job seekers and employment advisors and is often handed out at career events and workshops attended by the Airport.

Community Engagement Programme

LCY has built robust local recruitment practices to ensure local people are able to access employment at the Airport. However, we recognise that some local residents who would like to work at the Airport do not have the skills (basic and employability) or experience to do so. In addition, LCY understands it can be difficult for those who have not had previous experience of LCY or any other airport to be aware of the different types of jobs, careers or employers at LCY. The LCY Community Programme has the following key priorities:

- Local Employment
- Education Excellence (focusing on: basic skills, raising aspirations, attitude for employment)
- Health and Wellbeing for Work.

This comprehensive programme is carried out by three full-time employees working in the Airport's Community Relations Team, who are in turn supported by four Community Ambassadors. Community Ambassadors work in various departments across the Airport but conduct community based activities for the equivalent of one day per month. Further more, LCY actively encourages employee volunteering from its own staff and other companies based on-site to help assist with these programmes. LCY Ltd's employee volunteering policy is as follows:

All London City Airport Limited employees are encouraged to volunteer for charitable or community causes that form part of the Airport's community programme. Each staff member is entitled to volunteer for at least one day (8 hours) per year at the company's expense, subject to agreement with their Line Manager and depending on operational requirements.

The London City Airport Community Programme is focused on community organisations and education establishments located closest to the Airport to ensure those affected by the Airport's operation benefit from its significant economic and social benefits. All employee volunteering opportunities are advertised by the Community Team by email, poster and via the Community Ambassadors. Every volunteer is eligible for consideration for the annual Employee Volunteer of the Year Award.

Employee Volunteer of the Year 2010

In order to recognise and celebrate the achievements of its staff, including those that have given that bit extra to the local area, the "Employee Volunteer of the Year" Award was launched. Winners receive a £300 cash reward and a trophy for being the staff member that made the most significant contribution to the LCY Community Programme that year. By rewarding exceptional members of staff in this way, the Airport hopes to encourage volunteering throughout the business and engage more employees in community outreach programmes.

Sharon Lee, Employee Volunteer of the Year 2010

London City Airport endeavours to ensure that its community programmes are delivered to a focused geographical area in London Boroughs of Newham, Tower Hamlets and Greenwich, followed by the East London Boroughs included in the Planning Agreement[3]. This ensures that those living closest to the Airport benefit from the social and economic benefits it provides. The Programme does not solely focus on adults as LCY is a business rooted in its local area and unable to move location, so it therefore also invests in young people of primary and secondary school age. This ensures that a

[3] London Boroughs of Hackney, Waltham Forest, Redbridge, Barking & Dagenham, Havering, Bexley, Lewisham, Southwark and Epping Forest District Council.

proactive approach to local employment is taken. LCY believes that prevention of unemployment is better than cure. The table below summarises the projects delivered in the areas of education and employment during 2010:

Local Employment	**Primary Education**
• Delivery of five rounds of Take off into Work- 71 people into work in 2010 • 8 x Airside Airport employment tours (in addition to Take off into Work tours) – 120 people • Attendance at East Thames Training Event • Hosted business breakfast for London Health Commission to encourage businesses to recruit locally • Provided Airport Information Stand at Personal Best Recognition of Achievement Ceremony at the O2 Arena	• LCY Barnaby Bear Programme -17 groups, 812 young people • Reading Volunteers at Old Palace Primary, LBTH -80 hours • 45 Unescorted Tours - c500 young people • Britannia Village School Teachers Insight to Airport Jobs/Skills – 30 people • Sponsorship of Modern Foreign Language Award at Portway Primary school – whole school competition • Sponsorship of languages focused overseas school visit (Britannia Village Primary (LBN)) • St Luke's Primary (LBN) Business Road show for Parents – 100 adults • St Dominic's Primary (LBHackney) 'Jobs on the Move' workshop -60 young people • Berger Primary (LB Hackney) 'Jobs on the Move' Workshop -62 young people • Carpenter's Primary (LBN) 'Career Aspirations' Workshop – 60 young people • Manorfield Primary (LBTH) 'Careers Day' Event-250 young people • Greenwich EBP's 'World of Work' Primary school event – 250 young people

Secondary Education	Further & Higher Education
• Building Opportunities and Skills Seminars (BOSS) in 2 LBN schools - 150 students • Mock Interviews as part of BOSS Days • 10 Airport Educational Tours -120 students • Getting Ahead Conference in Mulberry School (LBTH) for Girls -180 students • 8 Modern Foreign Languages Programmes for 100 students • Represent London Modules delivered to 2 Schools - 26 students • Members of the Rokeby and Eastlea School Business Support Groups (LBN) • Development of 'Plane Business' LCY Secondary School Programme • Lister School 'Transition Day' employability skills event -180 students • King Soloman School (LBR) 'Careers' event - 100 students • Presentation on 'Importance of Customer Service' at Cumberland School -10 students • London Chamber of Commerce's 'Capital Careers Event' – 50 young people • Greenwich EBP's 'Careers in Action' Event - 100 students • Worked with People First to develop eight short videos on the tourism industry • Work experience speech given to young people at Woolwich Polytechnic School – c100 young people • Literacy based competition run at Caterham High School (LB Redbridge) -30 students • Airport Managers attended Caterham High School for 'Transition Day' event -180 young people • 'Cooperation Ireland' Event in partnership with Cityjet for 20 students	• Work experience provided to 44 students • 11 students participating in the LCY University Prize Scheme • 24 Airside Airport educational tours -288 students • Careers presentation on 'Training & Development' to University of East London (UeL) LBN -70 students • Sponsorship of UeL Knowledge Dock (LBN) E-Factor Enterprise competition • Airport volunteers attended UeL 'Employability Tips' Assessment Centre Event (LBN)-50 students • UeL 'Eastern Promise' Graduate Employability Conference • fUeL Employment & Training Fair-100 students • Assisted five UeL MBA Students on final project, based at the airport • Worked with London Metropolitan University to help develop online qualification • NewVic 6th Form College (LBN) 'Employment and Training' Fair-100 students • Sponsorship of NewVic 6th Form College (LBN) Annual Awards Ceremony 'Top Language Student' • NewVic 6th Form College (LBN) European Language Event - 50 students • Woolwich Polytechnic School (LBG) Sixth Form Conference Day – 120 students

During 2010, the Community Relations Team engaged with well over 100 community, employment and educational establishments, including spending more than 1000 man hours delivering education and employment programmes and tours to almost 5000 students and adult learners.

Take Off Into Work

With the aim to encourage even more local residents to successfully apply to job roles at LCY, the Airport has worked in partnership with Newham Workplace and the East London Business Alliance since 2009 to run the LCY 'Take off into Work' programme. This programme, which runs five times per year, invites unemployed Newham residents to take part in a two week airport-specific into work training programme including workshops at the Airport on topics such as airport careers, CV and interview preparation. This is then followed by a work placement opportunity lasting between two and nine weeks across a number of airport departments and other companies based on-site such as Customer Services, Ramp Services, Cobalt Ground Services, WH Smith, HMS Host Airport Catering, Nuance Tax and Duty Free, and the London City Airport Jet Centre. All candidates taking part in the scheme receive a guaranteed job interview at the end of their placement.

The success of Take off into Work during 2010 can be found in **Appendix 19**.

City Interview

This two hour programme aimed at young people who are NEET, involves a tour and presentation based on careers at London City Airport and the recruitment procedures used. Students are supported in practicing the core questions from the London City Airport recruitment application form and potential interview questions. Following this, students take part in a mock interview with an Airport Manager. During 2010, this programme was updated by the Newham Education Business Partnership and then a trial of the updated programme delivered to young people at the Peacock Gym.

Education Excellence

The LCY Education Excellence Programme delivers projects to all age groups from primary to adult education. The main themes outlined earlier in this report ensure that local people are equipped with the skills and knowledge required from business to gain employment at the Airport or elsewhere. During 2010 LCY continued its partnerships with local Education Business Partnership Organisations (EBPOs), with the Airport's Community Relations Manager sitting on the Board of the Newham EBPO (NEBPO) and Advisory Group of the Greenwich EBPO. The Airport also regularly liaises with the Tower Hamlets EBPO on individual projects.

School, College and University Partnerships

LCY works with a number of 'partner' schools in the local area, with which it has a long-standing and productive relationships. These partner schools are listed below:

Newham	Greenwich	Tower Hamlets
Britannia Village Primary School	Linton Mead Primary School	Old Palace Primary School
Drew Primary School	Woolwich Polytechnic Secondary School and Sixth Form	Langdon Park Secondary School
Royal Docks Secondary School		
Eastlea Secondary School		
Rokeby Secondary School		
NewVIc Sixth Form College		
Newham College of Further Education		
University of East London		

Barnaby Bear

The Barnaby Bear Geography Programme is one of most popular primary school workshops from the LCY Education Excellence Programme. Barnaby is a character used to engage Year Two students in learning about geography, transport and travel, and is aimed at making students think about their local geographical area, and the upcoming Olympic Games (skills and knowledge useful for employment at LCY). Each workshop lasts approximately two hours per class and consists of classroom based activities and an airport tour. In 2010, the Airport offered the programme to all schools south of the A13 in Newham and to its partner Primary Schools in Greenwich and Tower Hamlets.

In total, 20 Barnaby Bear workshops were delivered, engaging over 520 students. The Barnaby Bear Programme was updated by the NEBPO late 2009 to keep the programme in line with national curriculum, and LCY has received very positive feedback to these updates.

Reading Volunteers Scheme

The Airport's emphasis on the value of basic skills is supported as early as primary age through two trained reading volunteers spending one lunchtime per week at Old Palace Primary School (London Borough of Tower Hamlets) assisting reading sessions with Year One pupils. This equated to approximately 80 hours of volunteering during 2010.

Reading Volunteer at Old Palace Primary, Tower Hamlets

Getting Ahead Conferences

Getting Ahead is a programme organised by Tower Hamlets EBPO, based on employability skills for young people. Airport Volunteers work with a small group of young people through several workshops across a day long conference. In 2010, Airport Volunteers engaged with over 180 students.

Building Opportunities and Skills Seminars (BOSS Days)

LCY continues to support the NEBPO organised “BOSS” Days which are delivered in almost every secondary school in Newham. The seminars give students in year ten the opportunity to spend the whole day considering jobs and careers. LCY volunteers attended two BOSS Days in 2010, delivering workshops to over 150 students on topics such as first impressions, aspiration building, application form completion and interview technique.

Mock Interviews

During a BOSS Day, NEBPO administers mock interviews for students with company representatives. Following the interview, the Airport Volunteer provides each student with verbal feedback as well as completing a written feedback form which is passed to the form tutor.

Airport Insight Films

In 2010, LCY worked closely with ‘The Travel and Tourism Diploma’ and Sector Skills Council ‘People 1st’ to develop a module for the upcoming diploma course in September 2010. As part of this module, London City Airport spent two days with a film crew constructing eight short films on various areas within the Airport including Customer Service, Marketing and Passenger Handling. The short films can be used as a tool for both teachers and students, with benefiting from the information regarding the Airport’s operation.

Work Experience

LCY continues to enjoy a strong working relationship with Newham Sixth Form College (NewVIc), providing 50% of all work experience placements at the Airport to students of the college. NewVIc administers the work experience programme, which provides a one week taster experience to a student, 48 weeks every year. Students participating in the programme gain experience in the main airport departments of Airfield Operations, Finance, Customer Services, Business Development and the Jet Centre. The work experience programme is open to all students aged 16 years or over, living in local boroughs around the Airport, with specific focus on students within the London Borough of Newham. In 2010, 44 students carried out work experience at the Airport.

Airport Educational Tours

LCY is the only London Airport to offer comprehensive 'behind the scenes' airport tours for groups aged from eight years upwards. Unescorted tours are permitted for children under the age of eight. Tours are often tailored to the group's needs and regularly focus on careers at the airport or a specific department requested by the tour leader. LCY also offers tours to groups of employment advisors to enable them to advise job seekers of employment opportunities available at London City Airport. In 2010 the Airport conducted 82 airport tours for groups in the London Boroughs of Newham, Tower Hamlets and Greenwich, inviting over 1000 people into the airport.

University Prize Scheme (UPS)

University Prize Scheme Students, 2010

The LCY University Prize Scheme currently provides £2,000 per year for three years to seven Newham residents, two Tower Hamlets and two Greenwich residents, who are reading a degree at university relevant to the airport business. Advertising and application packs are distributed annually to all further education establishments in Newham, Tower Hamlets and Greenwich, and students are invited to apply to the Airport, giving reasons why they believe they should receive the prize. Short-listed candidates then participate in a half day assessment session at the airport, from which three successful students are selected.

Young people participating in the University Prize Scheme not only receive financial assistance, but also an airport management mentor, paid work experience placements and access to the Airport's employee development training courses.

LCY Modern Foreign Languages Programme

The LCY Modern Foreign Languages Programme is highly popular amongst local schools. In order to demonstrate the links between the curriculum and working environment, LCY has developed modules for students studying modern foreign languages (MFL).

The LCY MFL Programme lasts for two hours, providing students with the opportunity to meet airport employees who use their own language skills in the workplace. During the session, students receive an airport tour in their relevant language, a presentation from staff, and are able to practice their language skills through role play and written exercises. This programme has been developed to meet all key areas of language development: speaking; listening; reading; and writing. In 2010, the Airport delivered 3 MFL programmes to schools in the London Boroughs of Newham, Tower Hamlets and Greenwich (c.45 students).

Links with the University of East London (UeL)

London City Airport also fosters good working relationships with higher education establishments and is keen to increase management capacity in the London Borough of Newham. The Airport often lacks applications from Newham residents to graduate or senior roles and as such is working with UeL to build business links and add value to its students.

University of East London
E-Factor Winner, 2010

The LCY Community Relations Team works closely with the UeL Employability Team through Student Assessment Centers. LCY and other companies provided information and advice to UeL on how they recruit graduates, and the areas of the recruitment process in which local graduates often struggle. Using this feedback, UeL has developed mock Graduate Assessment Centers to train their students. LCY has participated in Mock Assessment Centers with management volunteers conducting group exercises and mock interviews, giving feedback to students to increase their employability. LCY is also keen to encourage enterprise amongst local young people and as such annually sponsors the UeL Knowledge Dock E-Factor Enterprise Competition, which provides a cash prize and business start-up space to its winner.

For more information on the wider work of the LCY Community Team, please contact Elizabeth Hegarty, CSR Manager, on 020 7646 0042 or elizabeth@lcy.co.uk.

APPENDIX 19
TAKE OFF INTO WORK 2010 STATISTICS

ELBA
Creating Possibilities in East London

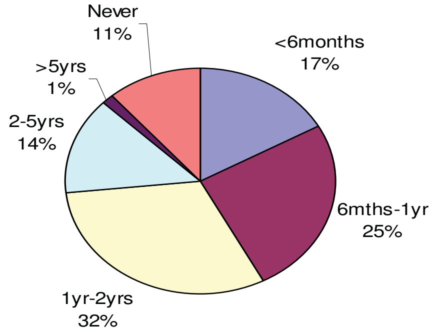
LondonCityAirport

WORKING WITH
workplace
Creating a better future

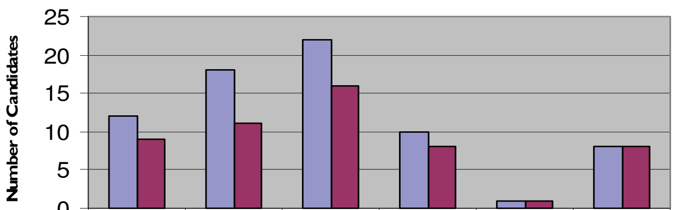
Take Off Into Work – London City Airport/Workplace 2010 Statistics

- 71 into work, 53 at London City Airport (75%)
- Candidates completing placements had an 89% chance of finding work or entering education
- 59% of those employed at London City Airport had been unemployed for one year or longer

Length of Unemployment of Candidates Placed Through Take Off Into Work



Candidate Unemployment Prior to Placement Into Work



	<6months	6mths-1yr	1yr-2yrs	2-5yrs	>5yrs	Never
Total	12	18	22	10	1	8
Placed at London City Airport	9	11	16	8	1	8

Length of Unemployment

James Innes, Project Manager

APPENDIX 20
AIRPORT JOB POLICY

LONDON CITY AIRPORT LIMITED
RECRUITMENT POLICY

2010

London City Airport
City Aviation House
Royal Docks
London
E16 2PB
020 7646 0000

1. Applications

1.1. Recruitment for London City Airport (LCA) is handled by Reed Specialist (22 Harbour Exchange Square, London E14 9EG, Tel: 020 7517 3594). All enquiries should be directed to the LCA Account Manager, Amy Holland.

1.2. Jill Pearman, PA to Managing Director (Tel 020 7646 0011) oversees and co-ordinates the relationship between LCA and Reed.

1.3. Reed has been employed by LCA to ensure that:

- All applicants are dealt with in a courteous, respectful, fair and diplomatic way
- All applicants are properly informed at all stages of the progress of their application.

1.4. In some limited specific instances, vacancies of a specialist nature may be advertised by both Reed Specialist and via specific aviation or other recruitment agency. In this instance, advertising and procedure will remain the same as that for all other vacancies to ensure consistency.

1.5. London City Airport works in partnership with the Local Authority (via Newham Workplace) to deliver into-work training for unemployed Newham residents. In some instances, candidates from this training programme may be recruited directly by London City Airport Limited (Jill Pearman / Elizabeth Hegarty[1]) from Newham Workplace.

1.6. London City Airport endeavours to employ people living in the vicinity of the airport to share its economic and social benefits. Specifically, the airport has agreed targets with the Local Authority to endeavour to employ:

- 70% of its employees from the "local area"[2]
- including 35% from the London Borough of Newham.

1.7. A standard application form is used to assist in filling all vacancies as a way of obtaining the same information from each candidate.

1.8. Speculative applications e.g. CVs are not acceptable.

[1] Elizabeth Hegarty – Community Relations Manager, London City Airport Limited
[2] The "local area" is defined by the London Borough of Newham as the 11 East London Boroughs of Newham, Tower Hamlets, Hackney, Waltham Forest, Redbridge, Barking & Dagenham, Having, Bexley, Greenwich, Lewisham and Southwark.

1.9. Speculative applications are not to be kept on file by the airport and all enquiries should be directed to Reed.

1.10. All documentation relating to selection of new staff (e.g. completed application forms) that is not retained must be disposed of securely (i.e. shredded).

2. Selection

2.1. A candidate will not be appointed without first being interviewed by persons with the authority to select.

2.2. The purpose of the interview is to:

- Assess the skills and knowledge of the applicant
- Assess the attitude of the applicant
- Identify the strengths and weaknesses not apparent from the application form
- Probe details or inconsistencies submitted by the applicant
- Establish suitability for employment
- Give information about the job and working conditions.

2.3. **All interviewers are trained in Recruitment and Selection Skills** and **Employment Law** to be aware of legal requirements and the Company's equal opportunities policy.

2.4. All interviews are conducted by **two or more** authorised people.

2.5. All interviewers are **senior to** the vacant position.

2.6. All interviews are **conducted in private** and in a place without distractions. Where appropriate, the candidate is shown the environment in which he/she will work if successful.

2.7. Interviews reflect Company philosophy, observe legal requirements, are conducted courteously and give full details of terms and conditions of employment and benefits.

2.8. Written records are kept of all short-listing decisions in case of query at a later stage.

2.9. Written records are kept of all interviews conducted using a standard 'Interview Assessment Form'.

2.10. Successful applicants will receive a standard offer of appointment letter. This is arranged by Jill Pearman.

3. Equal opportunities policy

3.1. The recruitment policy will aim to select the most suitable person for the job in respect of experience and qualifications and the Company will comply with its equal opportunities policy in this regard.

3.2. All recruitment publicity positively encourages applications from suitably qualified, experienced people and avoids any stereotyping of roles.

3.3. Vacancies are advertised in a variety of ways to ensure that a fair cross section of potential applicants have access to the advertisement, including via:

- Local Authority “one stop shops” including Newham Workplace, Skillsmatch and Greenwich Local Labour & Business
- Window displays at the Docklands and Stratford branches of Reed
- Reed website which is the second largest recruitment site in the UK
- All Job Centre Plus outlets, via their electronic system, Newham College (CIPS) and Anchor House Homeless Charity (entry level roles only).

3.4. All vacancies are also advertised on London City Airport’s website (www.londoncityairport.com/recruitment).

3.5. The application form only includes those questions that are necessary at the initial stages of selection. All questions on the application form are relevant and non-discriminatory

3.6. At interview, questions or assumptions about a candidate’s personal and domestic circumstances or plans will only be asked where necessary with regard to the role. Where the requirements of the job affect the candidate’s personal life (e.g. shift work, unsociable hours or travel) this will be discussed objectively.

4. Selection criteria

4.1. Only those qualifications and skills that are important to the job are criteria for selection. These include, but are not limited to, education and professional qualifications, experience and physical abilities. However, such formal academic or professional qualification requirements may be waived if candidates can demonstrate their suitability for the job by other means including previous experience and a willingness to undergo further training.

4.2. All applicants will receive from Reed with the application form:

- an outline job description
- a person specification, detailing essential and desirable characteristics

4.3. All applicants short-listed for interview will receive interview details in writing together with a fact sheet about London City Airport (from Reed).

4.4. All candidates who are not short-listed receive a standard rejection letter immediately after the short-listing process has been completed with details of employability skills programmes available locally (from Reed).

4.5. In the event that two candidates, after interview, equally meet the person specification, the candidate living closer to the airport will normally be given priority.

4.6. Positions will only be filled with suitable candidates. Unsuitable candidates will not be appointed.

4.7. All unsuccessful short-listed candidates will receive a letter (from Reed) informing them of the result of their assessment / interview within 7 working days.

4.8. All unsuccessful internal applicants will have a debriefing interview where the reasons for their non appointment will be explained and, where appropriate, general guidance will be given on areas for improvement.

5. Selection tests

5.1. Selection tests are used to ensure that applicants have the skills and aptitude requirements for the job and are administered by Reed.

5.2. All such tests are valid, reliable and free from gender or race bias and are non-discriminatory. Tests are developed in conjunction with education professionals to ensure a level of suitability to the role applied for.

6. Other criteria

6.1. Any requirements in relation to age, ability, experience and qualifications will be applied for the particular vacancy in a non-discriminatory way.

6.2. All concessionaires/service partners at London City Airport have a contractual obligation to London City Airport to use all reasonable endeavours to recruit locally.

6.3. London City Airport has an Employers' Forum in which supports on-site partners with a range of issues, one of which is local recruitment.

Glossary[7]

57 dB Contour
The 57 dB $L_{Aeq, 16h}$ Average Mode summer day contour.

66 dB Contour
The 66 dB $L_{Aeq, 16h}$ Average Mode summer day contour.

69 dB Contour
The 69 dB $L_{Aeq, 16}$ Average Mode summer day contour.

Actual 57 dB Contour
The 57 dB Contour based on actual aircraft movements for the summer period (16 June to 15 September) in the calendar year immediately preceding the due date for submission of the Annual Performance Report.

Actual 66 dB Contour
The 66 dB Contour based on actual aircraft movements for the summer period (16 June to 15 September) in the calendar year immediately preceding the due date for submission of the Annual Performance Report.

Actual 69 dB Contour
The 69 dB Contour based on actual aircraft movements for the summer period (16 June to 15 September) in the calendar year immediately preceding the due date for submission of the Annual Performance Report.

Air Quality Action Plan
An action plan for the management and mitigation of any air quality impacts affecting the local community within the vicinity of the Airport due to the operation of the Airport (including surface access by transport to and from the Airport) including:

(a) Volatile Organic Compounds concentrations odours (known locally as “Airport smell”); and
(b) fallout (known locally as “black smuts, deposits and oily films/patches on ponds”); and
(c) ambient concentrations of fine particulates (PM_{10}) and nitrogen oxides (NO_x).

Air Quality Measurement Programme
A programme to assess the potential air quality impacts of the Airport and to investigate anomalies in any resulting data and in comparison with any other measurements taken by LBN in the vicinity of the Site including:

(a) the continued operation of the monitoring equipment for the purposes of a programme of monitoring of air quality in the vicinity of the Site in a manner which enables comparison of results with other monitoring stations run by the Council for PM10 and NO2 pollutants;
(b) a network of passive diffusion tube samplers for NO2 at locations in and around the Site including locations at Camel Road/Hartmann Road and Camel Road/Parker Street;
(c) a monitoring initiative to investigate the effects of individual aircraft types;
(d) a three month study to measure Volatile Organic Compounds concentrations and odours in and around the Site.

Aircraft Categorisation
The categorisation of aircraft using the Airport according to airborne noise emitted by such aircraft

Aircraft Categorisation Review
A review of Aircraft Categorisation to reassess the methodology, categories, noise reference levels, noise factors and procedures for categorisation with the objective of providing further incentives for aircraft using the Airport to emit less noise

Aircraft Movement
The take-off or landing of an aircraft at the Airport other than for training positioning and/or evaluation

7 For guidance only – please see the Section 106 Planning Agreement for the precise legal meaning for some of these terms.

London City Airport Consultative Committee (LCACC)

The facility for users of the Airport, local authorities and persons concerned with the locality of the Site for consultation with respect to matters that relate to the management or administration of the Airport and affect those parties' interests.

Annual Performance Report (APR)

An annual report to be submitted to the Council by 1 July in each calendar year which shall (to the extent required by the obligations in S106 Planning Agreement) report on the performance of and compliance with the terms of the S106 Planning Agreement in the preceding calendar year and shall include all the annual reporting requirements contained in the S106 Planning Agreement or as agreed with the Council from time to time.

CO_2

Carbon Dioxide.

dB (Decibel)

A measure of sound pressure level.

Deposits Study

Technical investigation into the incidence and origins of black smuts deposits and oily deposits in the vicinity of the Site.

First Tier Works

The First-Tier Scheme will bring eligible dwellings within the 57 dB $L_{Aeq,16h}$ noise contour up to an agreed specified level of sound insulation. Residential premises with existing singleglazing will be offered secondary glazing or a contribution towards the cost of installing double-glazed windows which meet the Airport's sound insulation standards. Residential premises in general will also be offered sound attenuating ventilators to provide background ventilation without the need to open windows.

Further Inspection of Treated Premises

All properties that have been treated under the Sound Insulation Scheme will be inspected on a ten yearly basis after initial installation of glazing elements, mechanical ventilation and/ or modifications to external doors. Provided they have not been altered, rectification works will be carried out as necessary to ensure the sound insulation standard does not decline over time.

Ground Running

The ground running at any power setting of aircraft engines for testing or maintenance purposes.

Ground Running Noise Limit

The noise level arising from Ground Running which shall not exceed the equivalent of 60dB LAeqT (where T shall be any period of 12 hours) free field as measured outside and at 1 metre from any existing residential premises in the vicinity of the Airport.

Judicial Review

A procedure by which the High Court may review the reasonableness of decisions made by local authorities, the first Secretary of State or lower courts, for example a planning decision.

LBN

London Borough of Newham

LCY

London City Airport.

Local Area

The local labour catchment area for the Airport comprising the London Boroughs of Newham, Tower Hamlets, Hackney, Waltham Forest, Redbridge, Lewisham, Southwark, Barking and Dagenham, Greenwich, Bexley, Havering and the area of Epping Forest District Council.

L_{Aeq}
The A-weighted equivalent continuous sound pressure level which is a notional continuous level that, at a given position and over the defined time period, contains the same sound energy as the actual fluctuating sound that occurred at the given position over the same time period.

London Public Transport
Docklands Light Railway, buses, and Transport for London licensed Black Taxis.

Neighbouring Authority Agreements
Two individual binding agreements to be entered into by the Airport Companies - one with the London Borough of Greenwich and the other with the London Borough of Tower Hamlets - which shall include a commitment by the Airport Companies to comply with the obligations in the S106 Planning Agreement.

Noise Contour
Noise contours connect points that have the same average noise exposure. The contours are generated using computer models, based on the known characteristics of aircraft noise generation and attenuation, and calibrated from noise measurement monitors on the ground.

Noise Factor
A numerical factor applied to a noise source, dependent on the time, type or level of noise produced.

Noise Insulation Payments Scheme
A scheme which is intended to accelerate eligibility for the First Tier Works, the Public Buildings First Tier Works, Second Tier Works or the Public Buildings School Second Tier Works as the case may be by compensating landowners and developers for actual construction costs arising from the need for increased insulation against aircraft noise at residential premises and Public Buildings which as a consequence of the Development are situated on land within the Full Use Contours but outside the 1998 57dB Contour and which form part of a development that at the date of this Deed had been granted planning permission but had not been built and that at the time of application for payment under the Noise Insulation Payments Scheme remains capable of being built pursuant to such planning permission or any minor variation or modification to such planning permission resulting in substantially the same development in all material respects.

Noise Management Scheme
The noise management scheme formulated by the Airport and approved by the Council under the 1998 S106 Planning Agreement in consultation with the LCACC and which is operated continuously by the Airport in order to minimise noise disturbance from aircraft using the Airport including:

(a) the combined monitoring of noise and track-keeping in order to identify any deviations from the standard routes that should be followed by aircraft using the Airport and to verify the noise contours;

(b) a system of incentives and penalties which shall include financial penalties (but not in the case of track-keeping infringements) as well as operational penalties in order to:

  (i) minimise noise disturbance from aircraft using the Airport including any aircraft overhaul facility;
  (ii) ensure that track-keeping is maintained by aircraft using the Airport;
  (iii) control maximum noise levels of aircraft using the Airport;

(c) a scheme to encourage airline operators to use quiet operating procedures when conducting aircraft operations and to observe air and ground noise abatement procedures;

(d) the minimising of noise disturbance arising from the operation of any aircraft overhaul facility or from aircraft at the Approved Ground Running Location or generally from any aircraft ground noise source subject to the requirement to ensure the safe operation of aircraft at all times;

(e) regular meetings and consultation with the LCACC and such other statutory body or bodies as may be reasonably nominated by the Council.

Noise Monitoring System
The continuous permanent system for monitoring noise at the Airport.

NOMMS
A noise monitoring and mitigation strategy which is intended to improve and replace both the Noise Management Scheme and the Noise Monitoring System to provide a more robust system of noise monitoring and mitigation including the measurement and monitoring of ground based sources of noise as well as airborne noise and/ or other measures agreed between LCY and the Council from time to time.

Planning Permission
Formal approval sought from a council, often granted with conditions, authorising a proposed development to proceed.

PNdB
Perceived Noise Level; its measurement involves the analyses of the frequency spectra of noise events as well as the maximum level.

Predicted 57 dB Contour
The 57 dB Contour based on forecast Aircraft Movements at the Airport for the summer period (16 June to 15 September) in the calendar year of the due date for submission of the Annual Performance Report.

Predicted 66 dB Contour
The 66 dB Contour based on forecast Aircraft Movements at the Airport for the summer period (16 June to 15 September) in the calendar year of the due date for submission of the Annual Performance Report

Predicted Reduced 57 dB Contour
The 57 dB Contour based on forecast Aircraft Movements at the Airport for the summer period (16 June to 15 September) in the calendar year of the due date for submission of the Annual Performance Report but reduced to take into account likely cancellation of flights and other matters affecting numbers of Aircraft Movements by reference to historical data from the preceding five calendar years.

Predicted Reduced 66 dB Contour
The 66 dB Contour based on forecast Aircraft Movements at the Airport for the summer period (16 June to 15 September) in the calendar year of the due date for submission of the Annual Performance Report but reduced to take into account likely cancellation of flights and other matters affecting numbers of Aircraft Movements by reference to historical data from the preceding five calendar years.

Public Buildings
The following types of public buildings in noise sensitive community use and any other types of public building as agreed between the Airport Companies and the Council: schools (including but not limited to Britannia Village School) colleges doctors' surgeries health centres hospitals nursing homes (including old people's homes) community centres (but not those used only as social clubs) meeting halls village halls churches and other places of religious worship libraries children's and other day centres crèches and nurseries and including any parts of buildings authorised and used for such purposes.

Public Safety Zones
The public safety zones at either end of the runway at the Airport designated as such by the Department for Transport.

Purchase Scheme
A scheme pursuant to which the Airport Companies shall make a Purchase Offer for residential premises the external façade of which is situated within the Actual 69 dB Contour the terms of which shall (unless the prior written approval of the Council is obtained by the Airport Companies) be substantially in accordance with Part 14 of the Ninth Schedule.

Section 106 (S106) Planning Agreement
A legal agreement under section 106 of the 1990 Town & Country Planning Act.

Sound Insulation Scheme
The Sound Insulation Scheme offers the communities living close to the Airport within the Scheme boundaries the opportunity to treat their homes and community buildings against noise. The scheme is split into two tiers depending on the level of aircraft noise. The scheme also includes an obligation to inspect previously treated premises and rectify any damage caused by reasonable wear and tear.

Second Tier Works
The Second-Tier Scheme will offer eligible properties within the 66 dB LAeq,16h noise contour further treatment to bring the dwellings up to a higher standard of sound insulation. Most residential properties within the Second-Tier Scheme will have already been treated under the First-Tier scheme, and should already have secondary or double glazing as a minimum – the scheme will therefore offer secondary glazing to existing double glazed properties and/or contributions towards replacement high performance acoustic laminated glass, and sound attenuating ventilators.

Temporary Noise Monitoring Strategy
A temporary strategy to prevent the loss of noise monitoring data collection either through the failure of the Noise Monitoring System or due to external influences such as construction locally of new development or other noise-reflective surfaces and to ensure maintenance of the existing noise and trackkeeping system until an alternative system is included in the NOMMS and approved by LBN.

Travel Plan
A travel plan aims to promote sustainable travel choices (for example, cycling) as an alternative to single occupancy car journeys that may impact negatively on the environment, congestion and road safety.

Value Compensation Scheme
A scheme which is designed to compensate for loss of value in sites which are yet to be developed caused by any extension of the Public Safety Zones for the Airport, solely as a result of the Development.

Volatile Organic Compounds
A wide range of individual organic compounds of carbon which are of sufficient volatility to exist as vapour in ambient air.