Lewes District Council (Newhaven Gyratory)

Detailed modelling assessment for nitrogen dioxide for year 2007.

Contents:

1. Introduction:

Modelling of air quality was undertaken for Lewes District Council to identify the air quality concentrations in Newhaven for 2007. This modelling of the Newhaven gyratory was undertaken in March 2010.

The objective of the modelling is to ascertain whether specific residential properties could potentially receive concentrations of pollutants which breach current air quality objectives in the UK for the year 2007.

The modelling involves the use of a complex computerised model called "BREEZE Roads" to derive the annual averaged nitrogen dioxide (NO_2) concentrations at specific receptors (residential properties, schools or hospitals) adjacent to the Newhaven gyratory. BREEZE Roads utilises air emissions sources, in this case from vehicular traffic to determine concentration exposures at relevant receptors. The methodology of modelling and the model results are described in this report.

2. Executive Summary

Modelling of air quality was undertaken in the Newhaven gyratory for the year 2007.

No locations/receptors were identified as likely to have been in exceedance of the UK Air Quality Objectives (AQO) annual average limit of 40µg/m^3 for nitrogen dioxide (NO_2).

The highest modelled receptor concentration was 35.5µg/m^3 at a residential property.

3. Detailed Modelling Methodology

The Sussex Air Quality Partnership (Sussex-air) undertook modelling on behalf of Lewes District Council using the BREEZE Roads model.

3.2. Model:

BREEZE Roads

- BREEZE Roads is an advanced dispersion model, which is based on Gaussian plume theory.

3.3. Input Data:

Modelling Years:

- 2007

Meteorological data source:

- Shoreham (year 2007)

3.4. Traffic data source:

East Sussex County Council

- AADT values were used from manual and automatic traffic counts
- AADT projected growth rates supplied by ESCC
- % HDV derived for traffic data sourced from ESCC
- Average speed estimated from speed limits and local knowledge.

3.5. Background pollutant source:

National Atmospheric Emissions Inventory (NAEI)

- Nitrogen oxides (NOx) and nitrogen dioxide (NO_2) background concentrations were taken from the National Atmospheric Emissions Inventory (NAEI) web-site (www.naei.org.uk) for the grid squares that the relevant road section is located in.

3.6. Emission factors (EF)

Vehicle emission factors were calculated using the "Emission Factors Toolkit" (Final_EF2002 EF Version3a.xls). The emission factor for this road was determined as follows:

The EF inputs were as follows:

- Road type: Urban
- %HDV : %
- Speed: kph

4. Site characteristics:

Additional model inputs required for BREEZE Roads were:

- Road type: Urban

- Road width: relative to road sections
- Road slope: relative to road sections
- Receptor height: 1.8 m

(Specific receptors may be higher or lower dependent upon which floor a residential property may be on. The majority of residential properties are on first floor level.)

- Surface roughness length: 1 m

5. Derivation of modelled NO_2 from modelled NOx.

BREEZE Roads produces a predicted NOx concentration, sourced from the road emissions, from the model runs = NOx (road). To produce an annual averaged concentration of NO2 i.e. NO_2 (total), the NOx (road) results need to be are converted to produce a NO_2 (total) value. This value is then used to compare to the UK Air Quality Objective (AQO) limit to determine whether there is an exceedence or not.

LAQM.TG(09) (Example 2, page A3-48) sets out the methodology for comparing and adjusting model outputs based on diffusion tube measurements. The methodology applied for the verification of the model results is described below, refer to appendix 2: "Model verification and correction factors" for further details.

Steps:

1) Model road-NOx concentrations at the diffusion tube locations within the study area in 2007.

2) Determine the measured road-NOx concentration at these locations from the 2007 measured NO_2 using the new NOx to NO_2 calculator and the new background maps provided on the air quality archive.

3) Compare the measured and modelled road-NOx concentrations (in 2007) to determine adjustment factors. Plotting the modelled road-NOx on the x-axis and the measured road-NOx on the y-axis, and then fitting a linear regression line (forced through zero) to the points, and reading off the slope of the line will give you the adjustment factor (see Graph 2 on page A3-50).

4) NOx on the x-axis and the measured road-NOx on the y-axis, and then fitting a linear regression line (forced through zero) to the points, and reading off the slope of the line will give you the adjustment factor (see Graph 2 on page A3-50).

5) Apply this adjustment factor to the modelled road-NOx concentrations at each of your receptors within the study area (specific points, and /or a grid of receptors to determine contours).

6) Determine the NO_2 concentration from these adjusted road-NOx concentrations using the NOx to NO_2 calculator and background concentrations from the national maps.

7) Compare the modelled NO_2 concentrations at each of the diffusion tubes with the measured concentrations (in 2007). Plotting the modelled NO_2 on the x-axis and measured NO_2 on the y-axis allows another regression line to be fitted to the data (forced through zero). The slope of this line is a secondary (usually very minor) adjustment factor which can then be applied to the modelled NO_2 concentrations (Graph 4, page A3-51).

8) The fully adjusted modelled data for a grid of receptors can then be used to plot concentration contours within the study area, to determine whether any relevant exposure lies within areas which exceed 40µg/m^3.

6. Modelling results

The summary of results outlines the modelling of selected roads and identifies the predicted concentrations of NO_2 at specific receptor locations. The receptor locations are those locations of residential properties adjacent to roads where people may be exposed to pollutants. The modelled predictions are expressed as the annual average concentration in micrograms per cubic meter (µg/m^3). The modelling predictions reflect the relative predicted pollutant levels at each property and identifies if any of these properties were estimated to either breach or be within a certain percentage or near breach of the UK Air Quality Objectives (AQO) for nitrogen dioxide (NO_2). The annual average AQO limit for NO_2 is 40µg/m^3.

No locations/receptors were identified as likely to have been in exceedence of the UK Air Quality Objectives (AQO) annual average limit of 40µg/m^3 for nitrogen dioxide (NO_2).

The highest modelled receptor concentration was 35.5µg/m^3 at a residential property, identified as 26 Southway, Newhaven.

- No residential properties were determined to be within 10% of the AQO.
- Six (6) residential properties were determined to be within 20% of the AQO.

The modelling results for all other sensitive receptors are given in the following table 1.

Table 1: Modelled annual average NO_2concentration ($\mu g/m^3$) for 2007.

Sensitive receptors	NO2 (total) ($\mu g/m^3$)	% AQO
61_C7	20.2	51%
ELEV HSE NORTHWAY #2	29.2	73%
ELEV HSE WESTWAY #3	29.1	73%
RATH.CT FLAT (STH FA	22.9	57%
RATH CT FLATS (E FAC	20.8	52%
NO 15 NORTHWAY	29.4	73%
NO 11 NORTHWAY	31.3	78%
NO 5 NORTHWAY	32.5	81%
NO 1 NORTHWAY	31.1	78%
6 BRGTN RD (B&B)	25.6	64%
ELEV HSE NORTHWAY #1	27.3	68%
8 BRGTN RD	25.3	63%
HSE BRIDGE ST	25.2	63%
FLATS NTH WAY	24.3	61%
HSE ELPHICK RD	19.7	49%
26 BRGTN RD	24.5	61%
16 BRGTN RD	25.2	63%
3 BRGTN RD	24.7	62%
7 BRGTN RD	24.2	61%
HSE CNR SOUTH RD/STH	24.7	62%
B&B SOUTHWAY	26.3	66%
34 SOUTHWAY (VOLTEER	26.8	67%
26 SOUTHWAY	35.5	89%
24 SOUTHWAY	33.9	85%
20 SOUTHWAY	33.2	83%
FALTS12A WESTWAY	34.8	87%
FLATS 14A WESTWAY	35.4	89%
FLATS OPP BRGTN RD J	27.3	68%
ES_SHELTHOME #2	25.2	63%
ES_SHELTHOME	26.9	67%
NOAHS ARK NURSERY	23.7	59%
ES_SHELTHOME#3	23.7	59%
18 SOUTHWAY	25.2	63%
HSE SOUTH RD	21.5	54%
PUB BRIDGE ST	25.0	62%
FLATS BRIDGE ST	23.2	58%
FLATS BRIDGE ST#2	23.2	58%
19 SOUTHWAY	23.1	58%
21 SOUTHWAY	22.4	56%
35_C7	20.3	51%
39_C7	19.8	49%
45_C7	19.6	49%
18_C7	19.9	50%
24_C7	19.7	49%
32_C7	19.6	49%
34_C7	19.6	49%
61_C7	20.2	51%
ELEV HSE NORTHWAY #2	29.2	73%
ELEV HSE WESTWAY #3	29.1	73%

7. Appendices:

Appendix 1. Location and modelled concentration maps.

Figure 1: Location map.

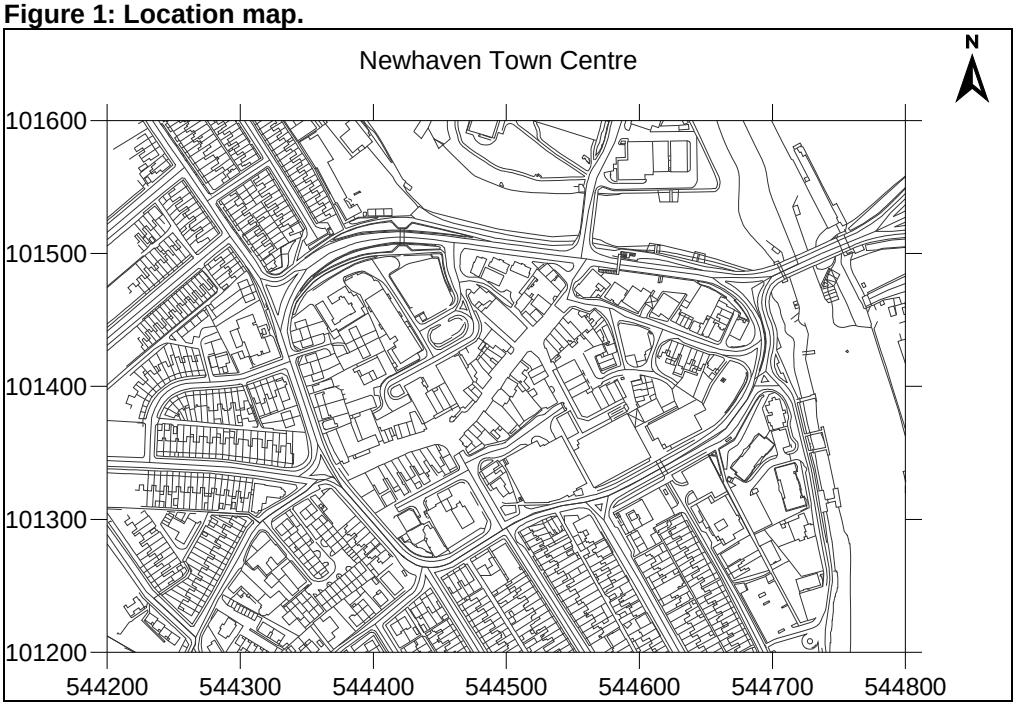


Figure 2: Location of sensitive receptors and NO2 diffusion tubes.

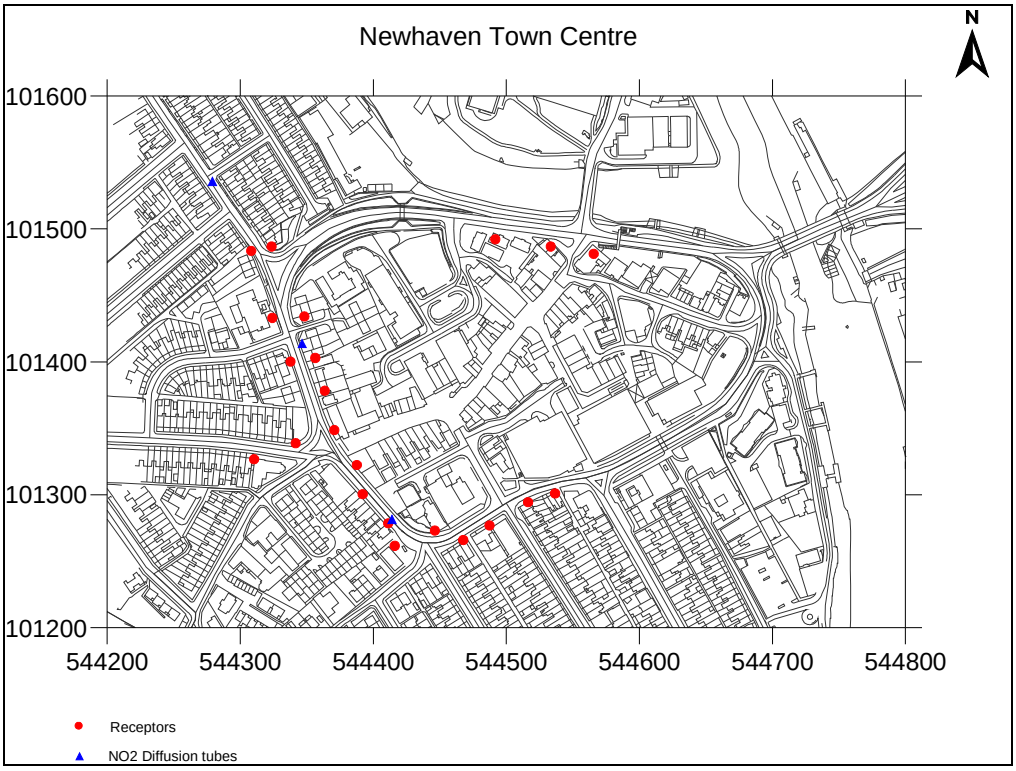


Figure 3: Modelled NO_2 annual average concentrations for 2007.

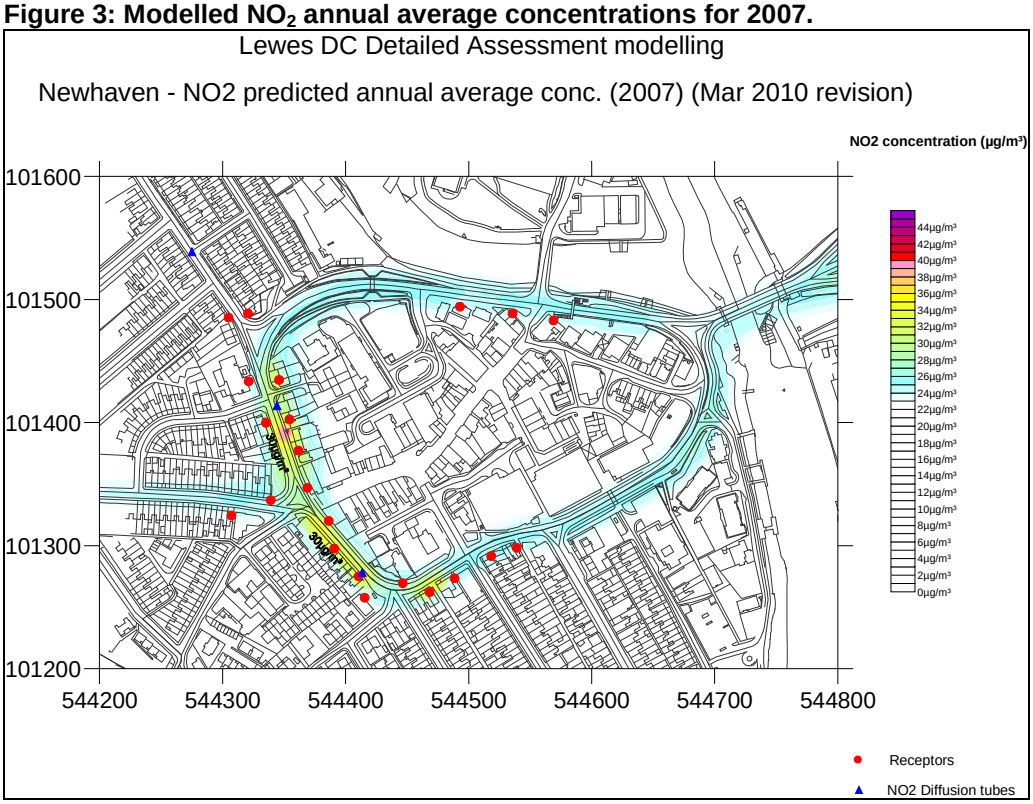
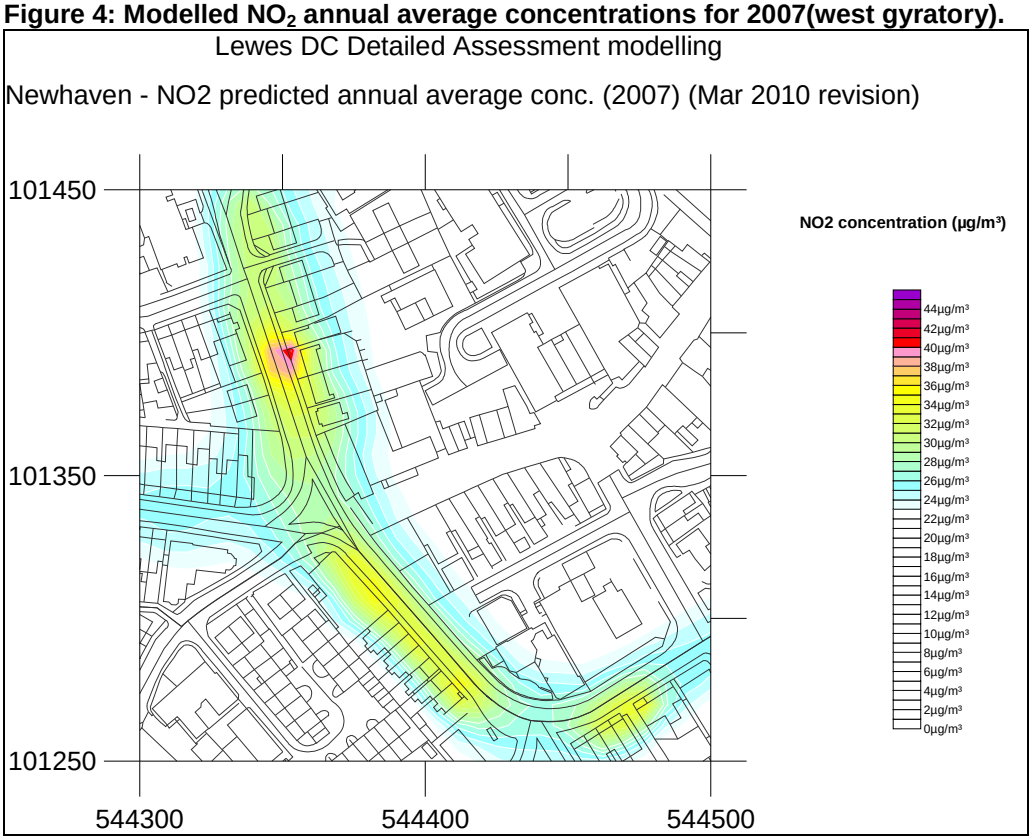


Figure 4: Modelled NO_2 annual average concentrations for 2007(west gyratory).



Appendix 2. Modelled links and receptors.

Table 3: Model links and traffic data for modelling Newhaven gyratory (source: ESCC).

Traffic	Data	AADT	%	Speed		Hourly traffic	
ID	Road	2007	HDV	KPH		2007	
Link 1	BRGTN_RD	23088	6%	32		962	
Link 2	BRGTN_RD_SPUR_EAST	12090	6%	24		504	
Link 3	BRGTN_RD_SPUR_WEST	10998	6%	24		458	
Link 4	BRGTN_RD JNCT	22685	6%	32		945	
Link 5	WESTWAY_RD	34775	6%	40		1449	
Link 6	C3_SPUR_NTHBD	7501	6%	32		313	
Link 7	C3_SPUR_STHBD	8008	6%	32		334	
Link 8	C3	15509	6%	32		646	
Link 9	C3_JNCT	22451	6%	32		935	
Link 10	NTHWAY(W)	23777	6%	32		991	
Link 11	NTHWAY(E)	23777	6%	32		991	
Link 12	BRDG_SPR(EBND)	18122	6%	32		755	
Link 13	BRDG_SPUR(WBND)	17550	6%	24		731	
Link 14	FLY_OVER	35672	6%	48		1486	
Link 15	BRDG_JNCT	4350	6%	24		181	
Link 16	STHWAY(E)	22100	6%	32		921	
Link 17	STH_RD_SPUR(SBND)	4186	6%	24		174	
Link 18	STH_RD_SPUR(NBND)	3900	6%	24		163	
Link 19	STH_RD	8086	6%	32		337	
Link 20	STHWAY(W)	22100	6%	32		921	
Link 21	STHWAY(W)	22100	6%	32		921	
Link 22	STHWAY(W)	22100	6%	32		921	
Link 23	STHWAY(W)	22100	6%	32		921	
Link 24	STHWAY(W)	22100	6%	32		921	
Link 25	STHWAY(W)	22100	6%	24		921	
Link 26	STHWAY(W)	22100	6%	24		921	
Link 27	STHWAY(W)	22100	6%	16		921	
Link 28	STHWAY(W)	22100	6%	16		921	
Link 29	STHWAY(W)	22100	6%	16		921	
Link 30	STHWAY(W)	22100	6%	16		921	
Link 31	STHWAY(W)	22100	6%	16		921	
Link 32	STHWAY(W)	22100	6%	16		921	

Figure 5: BREEZE ROADS modelled links

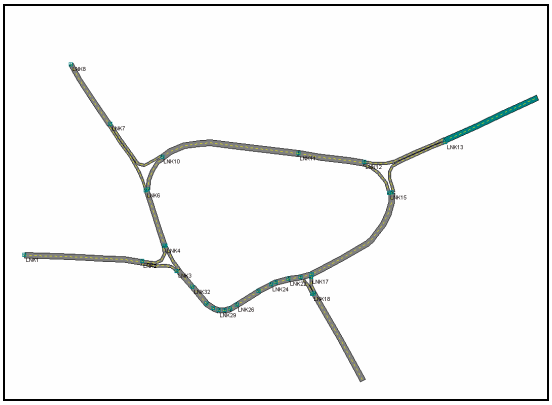


Table 4: Key receptors used in modelling (Newhaven gyratory)

ID	INFO	East	North
LDC 11 (Lewes Rd)	NO2 diffusion tube location	544270.9	101537.9
ELEV HSE NORTHWAY #2		544348.78	101356.69
ELEV HSE WESTWAY #3		544345.69	101366.2
RATH.CT FLAT (STH FA		544340.4	101372.4
NO 15 NORTHWAY		544337.97	101389.92
NO 11 NORTHWAY		544334.9	101399.43
NO 5 NORTHWAY		544331.84	101408.95
NO 1 NORTHWAY		544321.7	101424.9
6 BRGTN RD (B&B)		544314.4	101441.1
ELEV HSE NORTHWAY #1		544338.59	101444.11
LDC (16 Southway)	NO2 diffusion tube location	544341.8	101434.64
8 BRGTN RD		544344.83	101425.68
HSE BRIDGE ST		544350.7	101417.9
16 BRGTN RD		544354	101407.9
3 BRGTN RD		544354.9	101397.5
7 BRGTN RD		544357.72	101385.79
B&B SOUTHWAY		544360.81	101376.28
34 SOUTHWAY (VOLTEER		544363.9	101366.77
26 SOUTHWAY		544338.1	101341.7
LDC 10 (9 Southway)	NO2 diffusion tube location	544336.18	101363.11
FLATS 14A WESTWAY		544338.2	101379.5
SOCIAL CLUB (WESTWAY		544328.45	101386.85
FLATS OPP BRGTN RD J		544325.39	101396.36
ES_SHELTHOME		544322.32	101405.88
AQMS LOCATION	New location of AQMS (2008)	544318.7	101417.11
NOAHS ARK NURSERY		544307.3	101438.3
ES_SHELTHOME#3		544348.06	101447.32
18 SOUTHWAY		544354.35	101428.75
PUB BRIDGE ST		544360.48	101409.72
FLATS BRIDGE ST		544351.9	101391.7
19 SOUTHWAY		544367.23	101388.87
35_C7		544329.8	101343.1
39_C7		544323.57	101369.53
18_C7		544318.94	101383.78

Appendix 3: Model verification methodology and results:

Methodology:

The verification of the modelled or predicted pollutant concentrations is required to ascertain the accuracy of modelled results. A comparison of the measured versus the modelled NOx output from the model is undertaken to determine this. The methodology used to verify the modelled results follows LAQM TG (09) section A3-40. The modelled results are compared to the local measure NO2 diffusion tubes to determine the adjustment factors used for the modelled results.

In 2007 there were 3 locations on the Newhaven Gyratory where nitrogen dioxide (NO2) diffusion tubes monitored throughout the year. These sites were road-side locations adjacent to the kerb. These locations were:

Table 5: 2007 NO2 diffusion tube results

Location	East	North	2007 annual (bias adjusted) NO2 concentrations
LDC10 (9 Southway)	544336	101363	38 µg/m^3
LDC (16 Southway)	544342	101434	44 µg/m^3
LDC 11 (Lewes Rd)	544270	101538	35 µg/m^3

NOx correction factor (CF):

Following LAQM TG (09) guidance, results from the modelled NOx (road contribution) were compared to the monitored NO2 (converted to NOx (road contribution)). The monitored NO2 was converted to NOx using the LAQM "NOx to NO2 conversion spreadsheet" (Vers 1.1, J Abbott, 18 Dec 2008).

The "General inputs" for the spread sheet are as follows:

Year : 2007

Local Authority: Lewes District

Traffic mix: All other urban UK traffic

Determination of "roadside NOx (µg/m^3)" from NO2 diffusion tubes:

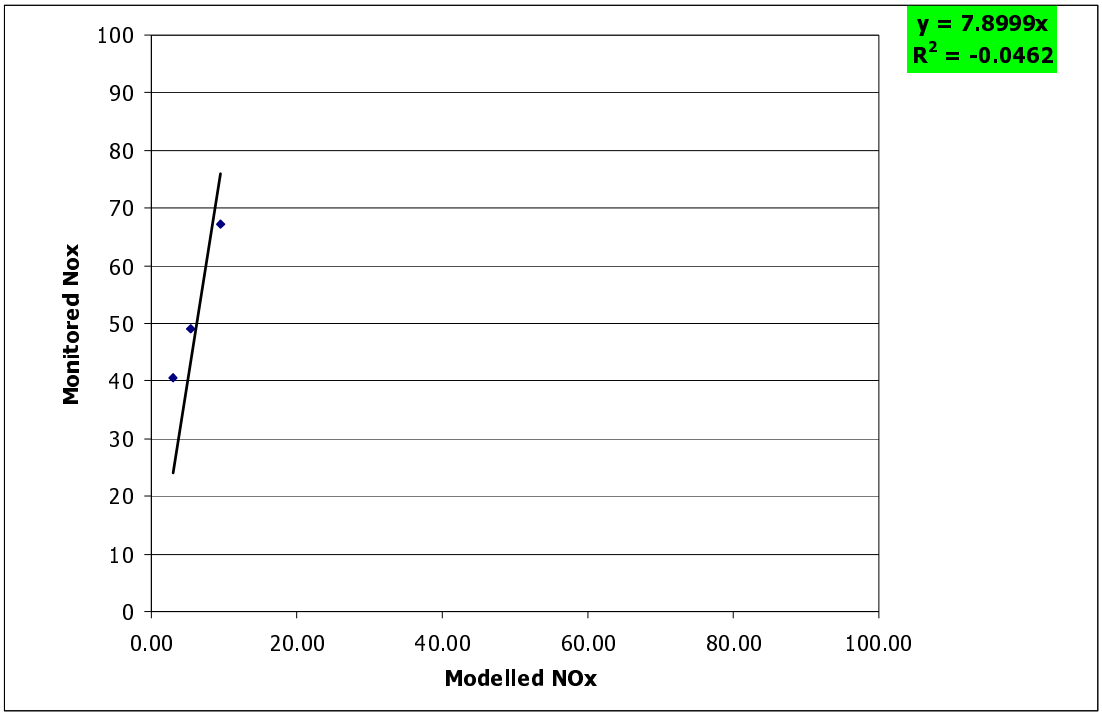
The measured annual averaged Total NO2 concentrations were converted to "roadside Nox" by removing the background NO2 (14.7µg/m^3) concentration and calculating the NOx component using the "NOx to NO2 conversion spreadsheet".

The measured roadside NOx (above) and the modelled roadside NOx was compared to determine the local NOx adjustment figure for 2007

Table 6: Measured NO2 diffusion tube conversion to measured NOx

Site ID	Total NO_2 ($\mu g/m^3$)	Background NO_2 ($\mu g/m^3$)	Road NO_2 ($\mu g/m^3$)	Road NOx ($\mu g/m^3$)	Modelled NOx ($\mu g/m^3$)
LDC10 (9 Southway)	38	17.1	21.2	48.98	5.42
LDC (16 Southway)	44	17.1	27.3	67.25	9.62
LDC 11 (Lewes Rd)	35	17.1	18.2	40.66	3.06

Graph 1: Modelled versus monitored NOx (road) results.



The resulting regression slope in graph 1 determines the adjustment factor for the modelled output to correlate to the actual measured NOx at this location (y = 7.8999x).

The NOx adjustment factor = 7.8999

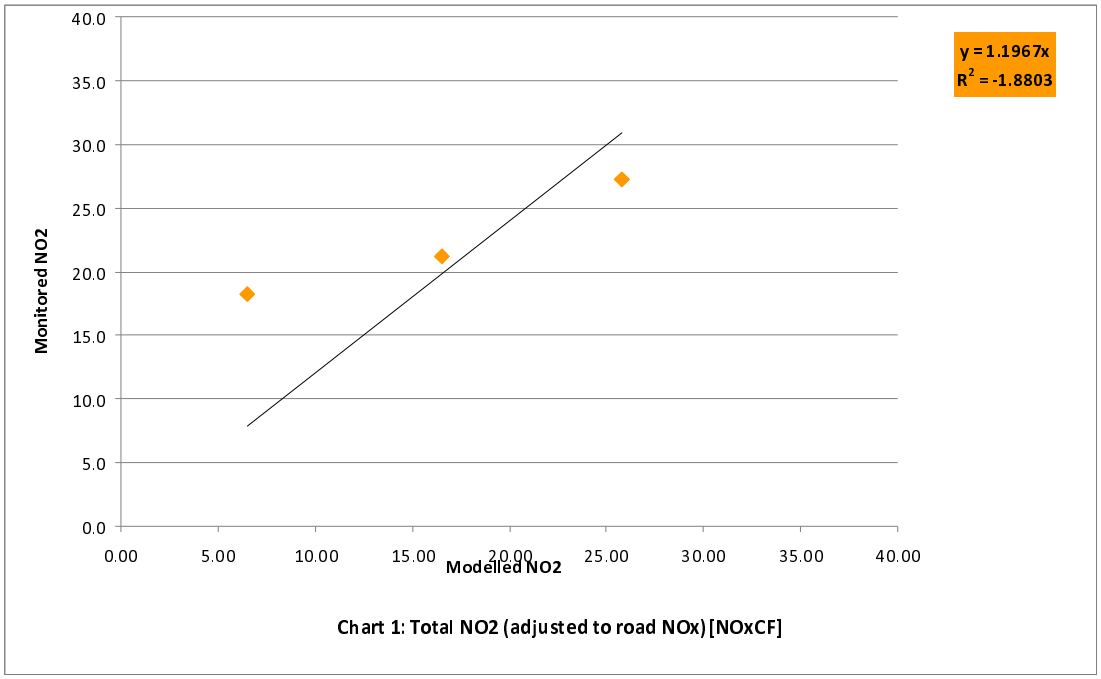
NO2 (secondary) adjustment factor:

The NOx adjustment factor was applied to the modelled output and then compared to the results of the 3 diffusion tubes for final verification. The following results are comparison of "adjusted modelled road NO2" contribution (x-axis) versus "monitored road NO2 contribution"(y-axis).

Table 7: Measured versus (NOx adjusted) modelled NO2 results

Site ID	Measured roadside NO2	Modelled roadside NO2
LDC10 (9 Southway)	21.2	16.5
LDC (16 Southway)	27.3	25.7
LDC 11 (Lewes Rd)	18.2	6.5

Graph 2: Comparison of measured versus (NOx adjusted) NO2 results.



The resulting regression slope in graph 2 determines the adjustment factor for the modelled output to correlate to the actual measured NO2 at this location (y = 1.1967x).

The NO2 (secondary) adjustment factor = 1.1967

Full adjustment calculation

The NOx and NO2 adjustment factors were applied to the modelled output and then compared to the results of the 3 diffusion tubes for final verification. The following results are comparison of the combined adjustment factors in accordance with the methodology set out in LAQM TG(09).

Table 8: Final corrected modelled NO2 results (NOx and NO2 adjusted).

Site ID	Measured roadside NO2	Modelled roadside NO2		Measured TOTAL NO2	Modelled TOTAL NO2
LDC10 (9 Southway)	21.2	19.78		38.35	36.88
LDC (16 Southway)	27.3	30.83		44.35	47.92
LDC 11 (Lewes Rd)	18.2	7.83		35.29	24.92