West Lothian Council

ENVIRONMENT ACT 1995

UPDATING AND SCREENING ASSESSMNENT 2006

AIR QUALITY IN WEST LOTHIAN

JULY 2006

www.air-quality.net

Report Compiled by: S Gillespie; AJ Valentine
Report Approved by: AR BLAKE; DL BREWSTER

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1.0 INTRODUCTION

This is an Updating and Screening Assessment of Air Quality in West Lothian.

There are currently no local air-quality management areas in West Lothian.

The Progress report submitted in April 2005 concluded that it would not be necessary for West Lothian to proceed to a detailed assessment for any of the pollutants. The Scottish Environment Protection Agency (SEPA) and the Scottish Executive agreed with the conclusions.

West Lothian has continued to monitor for Carbon monoxide (CO), Oxides of Nitrogen (NOX), Particulate matter (PM_{10}) and Sulphur dioxide (SO_2) using the mobile air-quality monitoring unit (Groundhog).

The Groundhog is currently located at Cairnie Place, Whitburn (Grid Ref: NS 944 641) and has been located there since 31st January 2005 to monitor local air-quality at the open cast activities and reclamation of the burning spoil heaps at the former Polkemmet Colliery. Results for Cairnie Place can be viewed at www.air-quality.net.

Monitoring of Benzene has continued using BTX tubes (Benzene, Toluene and Xylene).

West Lothian purchased a roadside real-time analyser (Romon300) in September 2005 and this unit has been located at Linlithgow High St (Grid Ref: NS 999 771) since 22nd December 2005. The roadside analyser measures NOX and PM_{10} and results can be viewed on pages 22 to 25 and pages 41 to 43.

West Lothian also purchased a Streetbox Gold from Learian Environmental Ltd and West Lothian now has six months of data, which has been validated and assessed by statisticians at SEPA (see Appendix 1.4). West Lothian are now planning to locate the Streetbox either in Broxburn Town Centre or Alderstone Road, Livingston after checking traffic data to establish which would be the best location. However following discussions with SEPA the Streetbox will only be used for monitoring nitrogen dioxide for a monthly and annual mean and will not be used to monitor PM_{10}.

Location maps and photos of both the Groundhog at Cairnie Place, Whitburn and the Romon300 located at Linlithgow High St can be viewed on pages 59 & 60.

2.0 AIR-QUALITY - QA/QC SYSTEM

The Groundhog is a mobile air-quality monitoring unit, which has been with West Lothian Council, Environmental Health since September 1999. The Groundhog is used to house real-time analysers measuring carbon monoxide (CO), nitrogen dioxide (NO_2), oxides of nitrogen (NOX), nitric oxide (NO), sulphur dioxide (SO_2), and particulate matter (PM_{10}).

The Romon300 roadside analyser has been with Environmental Health since December 2005 and this unit houses two real-time analysers measuring nitrogen dioxide (NO_2), oxides of nitrogen (NOX), nitric oxide (NO) and particulate matter (PM_{10}).

Data is downloaded to a stand-alone computer for both units through a modem link using Enview 2000 software twice a day, so that levels can be checked daily and also to make sure that there have been no exceedences. Regular checks are carried out on the analysers to ensure data validity and to ensure that they are working efficiently. A quality control/quality assurance procedure is in place for checking gas levels, which are checked once a week, a record of when new gas cylinders have been installed, filter changes and site visits.
The gases zero air, nitric oxide, carbon monoxide and sulphur dioxide are supplied by Air Liquide for the Groundhog and are used to calibrate the real-time analysers to ensure the data is valid.
Casella Eti supplied West Lothian Council with the Groundhog and Romon300. West Lothian Council has a maintenance contract with Casella Eti and they provide technical support 9am to 5pm, Monday to Friday for the Enview 2000 software and also maintain the equipment with a service carried out every six months. Casella Eti also provide a web-site for displaying our air-quality data and this includes a twice daily data collection and automatic posting of data onto the web-site. Casella carry out daily checks of the ambient data, automatic calibrations and communications. If any anomalies are identified this is reported to West Lothian council. The contract also includes a 48-hour call-out for any equipment breakdown so that the fault can be quickly identified and reported to minimise data loss.

2.1 TEOM (tapered element oscillating microbalance) - PM10 Analyser

The filter in the TEOM is changed before the lifetime of the filter reaches 85%. Before the filter is changed, a pre-calibration checklist is filled in and once the filter has been changed, a post-calibration checklist is filled in one hour later. This reduces the likelihood of faults induced or associated with the filter change. The TEOM Head is also cleaned each time the filter is changed.

2.2 CALIBRATION

The Calibration report in Enview software is checked daily and a report is kept weekly for the gases CO, NO, NOX & SO_2 to identify if there is a drift between the span measured and span reference. The analysers carry out an automatic calibration each day. The calibration factor for each gas is calculated by

dividing the “expected” cylinder concentration and dividing it by the actual “span” response minus the “zero” response concentration shown on the analyser.

West Lothian Council now perform a manual calibration of the Groundhog and Romon300. This is completed once a fortnight and these results are recorded to establish if there is any kind of drift. This information will now be used for scaling the data.
If there is a sudden drift between the span measured and span reference then this can indicate that there may be a fault with the analyser.
If after a manual calibration has been carried out there is still a large drift then Casella Eti will be notified and should investigate the fault within 48 hours. If there appears to be a fault with one of the analysers and Casella are notified then a diagnostics sheet is filled out at the Groundhog and is faxed through to Casella. This gives the engineer an idea of what the problem is before the visit.

2.3 DATA VALIDATION

A Periodic report in Enview software is carried out once a month for the pollutants NO_2, SO_2, CO & PM10. This is to screen the data and to ensure that any large peaks or high concentrations due to breakdowns of the analyser can be invalidated.
There are also strategies in place to minimise data loss. When a periodic report is carried out each month the data is transferred into Excel and saved onto CD-ROM so as to back up the data and the raw data is also saved onto CD-ROM.
The Groundhog has an air-conditioning unit so that a constant temperature can be kept in the Groundhog throughout the year and therefore the analysers are less likely to breakdown. There are also alarm settings on each of the analysers, so that if there is a fault with one of the analysers it can be detected and resolved quickly.

3.0 Review & Assessment of Benzene

3.1 INTRODUCTION

West Lothian has continued to monitor for Benzene since the progress report was submitted in April 2005 using BTX tubes (Benzene, Toluene & Xylene). As mentioned in the last progress report a new site was added at Caroline Park, Mid Calder near to the Shell Petrol station at Lizzie Bryce Roundabout, Livingston. The new site was added on 3rd February 2004 and the study was completed on 31st January 2006. The results for all four sites can be seen below but there were no exceedences for the site at Mid Calder.

3.2 Standard and Objective for Benzene

The Air Quality (Scotland) Regulations 2000 and amendment regulations 2002 set the following objectives:-

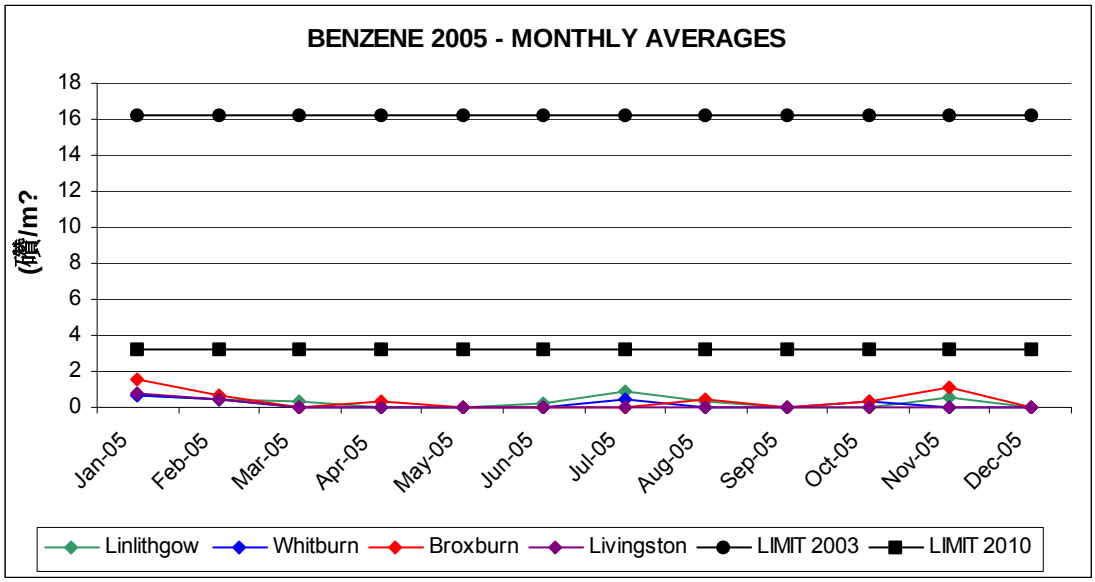
- All authorities:
  Running annual mean of 16.25µg/m³ to be achieved by 31.12.2003

- Authorities in Scotland and Northern Ireland only:
  Running annual mean of 3.25µg/m³ to be achieved by 31.12.2010

3.3 MONITORING RESULTS: 2005

The graph figure 1.1 shows the monthly benzene results for 2005 for the four sites in West Lothian. The four sites are 212 High St, Linlithgow, 15 East Main St, Whitburn, 18-22 East Main St, Broxburn and 12 Caroline Park, Mid Calder.

Figure 1.1 – Monthly Benzene Results (µg/m³) – YEAR 2005



3.4 Table 1.1 & 1.2 – Results for Benzene, Toluene and Xylene – Year 2005 (Results are in ppb for toluene and Xylene)

	Linlithgow			Whitburn		
	Benzene	Toluene	Xylene	Benzene	Toluene	Xylene
Jan-05	0.7	4.1	6.1	0.7	5.9	5.2
Feb-05	0.5	3.8	3.5	0.4	2.8	2.6
Mar-05	0.3	1.1	1.1	~	~	~
Apr-05	<0.2	3.8	14.5	<0.2	0.9	3.5
May-05	<0.2	0.8	3.3	<0.2	0.5	2.2
Jun-05	0.2	1.1	0.9	<0.2	3.1	12.9
Jul-05	0.9	22.8	21.8	0.5	22.2	8.4
Aug-05	0.3	1	2.9	<0.2	0.5	1.6
Sep-05	~	~	~	~	~	~
Oct-05	<0.2	<0.2	0.3	0.3	0.6	0.7
Nov-05	0.6	5.5	3.8	<0.2	1.1	2.1
Dec-05	<0.2	2	1.6	<0.2	0.4	0.5
Average (ppb)	**0.4**	**4.2**	**5.4**	**0.3**	**3.8**	**4**
Average (µg/m³)	**1.3**			**0.98**		

	Broxburn			Livingston		
	Benzene	Toluene	Xylene	Benzene	Toluene	Xylene
Jan-05	1.6	9.3	6.7	0.8	6.4	5.6
Feb-05	0.7	3.7	3.3	0.4	3.1	2.1
Mar-05	<0.2	0.5	1	~	~	~
Apr-05	0.3	1.4	4.5	<0.2	0.5	1.7
May-05	<0.2	0.5	3.3	<0.2	<0.2	0.6
Jun-05	<0.2	0.8	0.9	<0.2	2.3	1.6
Jul-05	<0.2	4.1	21.8	<0.2	0.7	2.6
Aug-05	0.4	1.2	2.9	<0.2	0.7	8.1
Sep-05	<0.2	0.5	~	<0.2	0.2	2
Oct-05	0.3	1.4	0.3	<0.2	2.9	8.6
Nov-05	1.1	2	3.8	~	~	~
Dec-05	<0.2	2.3	1.6	<0.2	2.4	3.4
Average (ppb)	**0.5**	**2.3**	**4.1**	**0.3**	**1.9**	**3.6**
Average (µg/m³)	**1.63**			**0.98**		

3.5 Predictions for Benzene annual mean concentrations in 2010

(Calculation taken from Technical Guidance TG (03) pg3-6, Box 3.4)

Table 1.3 – Prediction for 2010 using 2005 annual average (see table 1.1)

Calculation: 2005 Annual Average x 2010 Correction Factor ÷ 2005 Correction Factor

LOCATION	**2005 Annual Average**	**2010 Correction Factor**	**2005 Correction Factor**	**2010 Prediction**
LINLITHGOW	1.3	0.647	0.771	**1.09µg/m³**
WHITBURN	0.98	0.647	0.771	**0.82µg/m³**
BROXBURN	1.6	0.647	0.771	**1.34µg/m³**
LIVINGSTON	0.98	0.647	0.771	**0.82µg/m³**

3.6 Updating and Screening Assessment Summary Checklist for Benzene

Item	Response
A) Monitoring data outside an AQMA	This authority currently measures Benzene using BTX tubes and the running annual mean of 16.25µg/m³ & 3.25µg/m³ for 2010 has been achieved with no exceedences.
B) Monitoring data within an AQMA	Not applicable as no AQMA for Benzene.
C) Very busy roads or junctions in built up areas	Monitoring of Benzene is carried out in all busy town centres in West Lothian. There are no busy roads, which exceed 80,000 vehicles per day and no Dual carriageway roads with daily flows, which exceed 120,000 vehicles per day. This data was obtained from the Highways Department.
D) New industrial sources.	No new industrial sources identified.
E) Industrial sources with substantially increased emissions, or new relevant exposure	There are no industrial processes of relevance for Benzene in this authority or any of the neighbouring authorities with substantially increased emissions. There has been no change in this position.
F) Petrol stations	There are no petrol stations with an annual throughput of more than 2000m³of petrol or with relevant exposure within 10m of the pumps.
G) Major fuel storage depots (petrol only)	There are no major fuel storage depots that have not been covered by previous review and assessment reports. The nearest to West Lothian are Ross Chemicals & Storage, Grangemouth and at BP Oil (UK) Ltd, Grangemouth.

3.7 CONCLUSION FOR BENZENE

The Benzene tube results show that in West Lothian the air quality standard and objective of 16.25µg/m³ and 3.25µg/m³ is currently being achieved for all four sites in West Lothian. The predictions for 2010 based on the 2005 annual average also show that the objective will be achieved as shown in table 1.3. There are no significant industrial sources of benzene located either within West Lothian or neighbouring areas which are likely to adversely affect air quality, therefore, there is no need to proceed to a detailed assessment again this year.

The Benzene site located at 12 Caroline Park, Mid Calder from February 2004 to January 2006 shows that there were no exceedences with an annual average for 2005 of 0.98µg/m³which is achieving the objective for 2010. Therefore the petrol station is not emitting sufficient benzene to put the 2010 objective at risk of being exceeded.

There is no need for West Lothian to proceed to a detailed assessment for Benzene.

4.0 Review and assessment of 1,3 – Butadiene

4.1 INTRODUCTION

No monitoring of 1,3-Butadiene is carried out in West Lothian. As stated in previous progress reports there are no significant industrial sources of this pollutant within West Lothian. There have been no new developments in West Lothian that are likely to emit 1,3-Butadiene in 2005.

4.2 Standard and Objective for 1,3 – Butadiene

The Air Quality (Scotland) Regulations 2000 and amendment regulations set the following objectives: -

- **Running annual mean of 2.25µg/m³ to be achieved by 31.12.2003**

4.3 Updating and Screening Assessment Summary Checklist for 1,3-butadiene

Item	Response
H) Monitoring data	This authority is currently not monitoring 1,3 - butadiene
I) New industrial sources.	There are no industrial sources of relevance for 1,3 – butadiene in this authority or any of the neighbouring authorites. There has been no change in this position.
J) Industrial sources with substantially increased emissions, or new relevant exposure	There are no industrial sources with substantially increased emissions of 1,3-butadiene and no new relevant exposures.

4.4 CONCLUSION FOR 1,3-BUTADIENE

No monitoring of 1,3-Butadiene is carried out in West Lothian, as it is not considered necessary due to no industrial sources being present within West Lothian.

5.0 Review and Assessment for Carbon monoxide

5.1 INTRODUCTION

Monitoring has continued for carbon monoxide during 2005 and it is measured with the real-time analyser located within the Groundhog. The Groundhog has been at Cairnie Place, Whitburn since 31st January 2005.

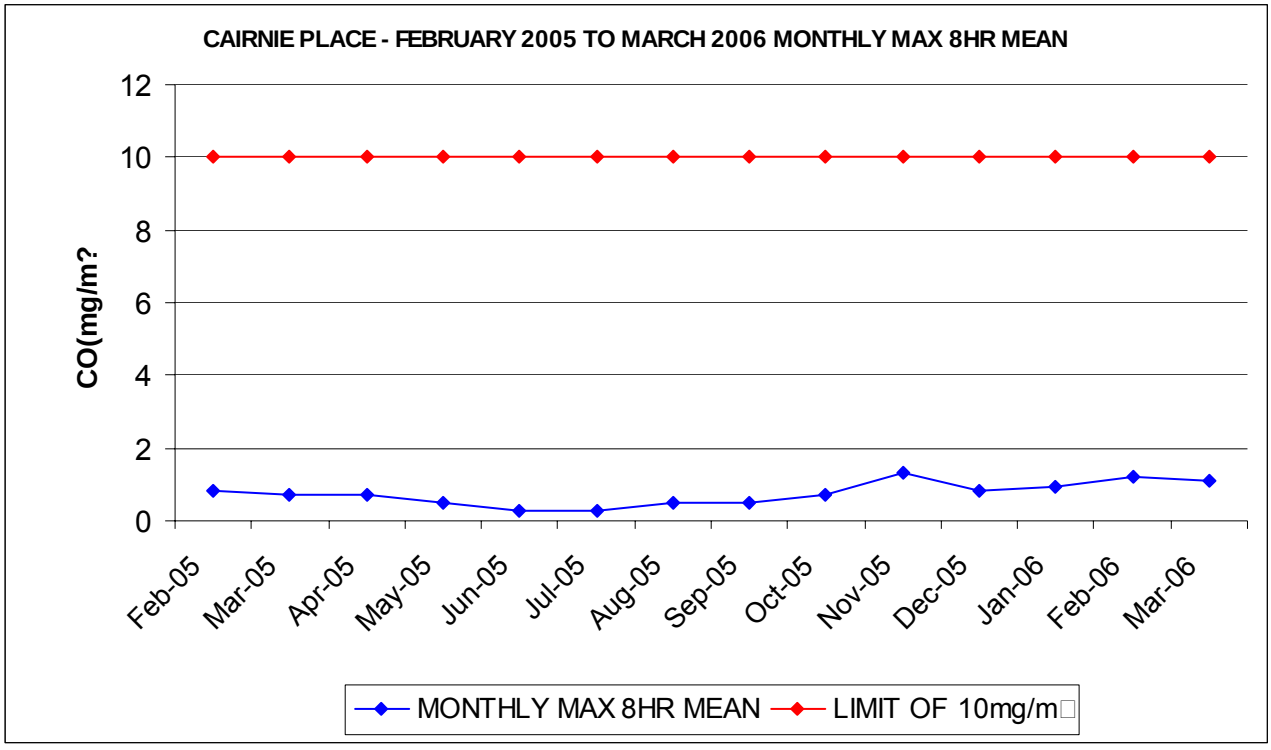
5.2 Standard and Objective for Carbon monoxide

The Air Quality (Scotland) Regulations 2000 and amendment regulations 2002 set the following objectives: -

- Maximum daily 8-hr mean of 10.0mg/m³ to be achieved by 31.12.2003

5.3 MONITORING DATA RESULTS: 2005

Figure 3.1 – Cairnie Place – February 2005 to March 2006 – monthly max 8hr mean



5.4 Updating and Screening Assessment Summary Checklist for Carbon Monoxide

Item	Response
K) Monitoring data	This authority currently has one real-time CO analyser at a roadside location. The maximum running 8-hr mean from February 2005 to March 2006 was 1.3mg/m³ which meets the air quality standard of 10mg/m³
L) Very busy roads or junctions in built-up areas	Not applicable – there are no busy roads where single carriageways exceed 80,000 vehicles per day or dual carriageways, which exceed 120,000 vehicles per day. Information on traffic flows was obtained from the Highways department.

5.5 CONCLUSION FOR CARBON MONOXIDE

In conclusion there have been no exceedences of the air quality standard for carbon monoxide and therefore there is no need to proceed to a detailed assessment.
Since the Groundhog is located at Cairnie Place, Whitburn it will be interesting to monitor any changes in Carbon monoxide due to the reclamation of the burning bing at Polkemmet.

6.0 Review and Assessment for Lead

6.1 INTRODUCTION

Monitoring of Lead is not carried out within West Lothian as there are no significant sources of lead and there have been no new industrial sources identified this year.

6.2 Standard and Objective for Lead

The Air Quality (Scotland) Regulations 2000 and amendment regulations 2002 set the following objectives: -

- Annual mean of 0.5µg/m³ to be achieved by 31.12.2004
- Annual mean of 0.25µg/m³ to be achieved by 31.12.2008

6.3 Industrial Sources

As stated previously in the last progress report there are no new industrial sources of lead in West Lothian that are likely to affect the air quality objective.

6.4 Updating and Screening Assessment Summary Checklist for Lead

Item	Response
M) Monitoring data	This authority is currently not monitoring Lead
N) New industrial sources.	There are no industrial processes of relevance for lead in this authority or any of the neighbouring authorities. There has been no change to this position.
O) Industrial sources with substantially increased emissions, or new relevant exposure	There are no industrial sources with substantially increased emissions of lead.

6.5 CONCLUSION FOR LEAD

No monitoring of lead is carried out in West Lothian and there is no need to proceed to a detailed assessment.

7.0 Review and assessment for Nitrogen dioxide

7.1 INTRODUCTION

Monitoring of nitrogen dioxide in West Lothian is carried out using a real-time analyser located within the air-quality monitoring unit (Groundhog) and also using passive diffusion tubes. There are six sites in West Lothian for diffusion tubes with two tubes co-located at five of the sites and three tubes co-located with the real-time analyser.

There is no longer a U.K Nitrogen dioxide network for diffusion tubes as most local authorities now have real-time NOX analysers. West Lothian have decided to continue with the existing diffusion tube sites and data is regularly entered on a web based data entry system, which is provided by AEA Technology Environment (NETCEN). The locations of the diffusion tube sites are detailed on page 15.

West Lothian recently purchased a Romon roadside NOX analyser. This has been placed on Linlithgow High St at the same site of where the Groundhog was sited. The Romon was installed on 22nd December 2005 and results from this can be seen on pages 22 to 24.

7.2 Standard and Objective for Nitrogen dioxide

- **1-hour mean of 200µg/m³ not to be exceeded more than 18 times a year and to be achieved by 31.12.2005**

- **Annual mean of 40µg/m³ to be achieved by 31.12.2005**

7.3 MONITORING DATA RESULTS

The NOX real-time analyser has been located at Cairnie Place, Whitburn since 31st January 2005 and the Romon roadside NOX real-time analyser has been located at Linlithgow High St since 22nd December 2005. The real-time results for Cairnie Place have been reported from February 2005 to March 2006. There was a problem encountered with the gsm modem in December 2005 and a new modem was installed on 22/12/06 however two weeks of data were lost from 04/12/05 to 20/12/05. Some problems were also encountered with the cooler temp NOX analyser from 17th February 2006 and a spare analyser was installed on 20th March 2006 resulting in four weeks of missing data. The results can be seen on pages 16 –21.
The real-time results for the Romon located at Linlithgow High St have been reported from 22nd December 2005 to 31st March 2006. These results can be seen on pages 22 to 25.

The results for the diffusion tubes for 2005 can be seen on page 15.
The diffusion tubes are prepared and analysed by Analytical & Scientific Services, Edinburgh City Council, 4 Marine Esplanade, Edinburgh. The tubes are prepared using method 1 which is 50% v/v TEA in acetone and the tubes

are exposed for 4 or 5 weeks at a time. The tubes are changed on the dates supplied by AEA Technology Environment although they are not part of a national network.

7.4 Groundhog and Diffusion Tube comparison

Three diffusion tubes have been co-located with the Groundhog since January 2005. The following shows a comparison of the diffusion tubes with the real-time analyser and also how the bias factors have been calculated so they can be applied to the diffusion tube results from other sites in West Lothian.

The bias correction factors for the diffusion tubes were taken from TG.03, Box 6.4, page 6-7 of the technical guidance.

Bias factor Method A:

A = Cm/Dm (Cm = annual mean real-time analyser result)
(Dm = annual mean diffusion tube result)

Bias factor Method B:

B = (Dm – Cm) / Cm

7.5 Cairnie Place, Whitburn – 31st January 2005 to present

The real-time analyser has been located at Cairnie Place, Whitburn since 31st January 2005. Three diffusion tubes have been co-located at this site during this time.

Table 5.2

Whitburn	Groundhog (Real-time)	Co-located diffusion tubes (average)
March 2005	**16.4**	**24**
April 2005	**11**	**11**
May 2005	**10**	**9**
June 2005	**10**	**11**
July 2005	**8.5**	**10**
August 2005	**8.6**	**16**
September 2005	**10.8**	**18**
October 2005	**20.1**	**14**
November 2005	**29.6**	**17**
December 2005	**24.4**	**19**
January 2006	**22.1**	**35**
February 2006	**10**	**24**
Average	**15.1**	**17**

Bias factor method A: 15.1/17 = 0.89

Diffusion tube correction = 0.89 x 17 = **15µg/m³**

Bias factor method B: 17 – 15.1/15.1 = 0.13 (**13% OVER READ**)

During this 12-month period the diffusion tubes were over reading by 13%

Table 5.1 – Diffusion Tube Results – Year 2005 – Results in µg/m³

DATE	WL 1	WL 7	WL 3	WL8	WL4	WL9	WL5	WL10	WL6	WL11	WL12	WL13	WL14
JAN 05	23	20	13	18	26	26	26	37	29	30	-	-	-
FEB 05	29	28	21	25	20	20	60	59	34	32	30	24	27
MAR 05	-	-	13	16	13	16	32	17	26	21	27	19	27
APR 05	22	15	10	10	8	8	31	-	26	21	13	11	10
MAY 05	18	17	11	11	13	11	25	33	22	26	8	10	8
JUN 05	12	21	14	11	9	8	27	33	16	24	16	5	11
JULY 05	19	21	11	10	8	9	32	26	25	26	12	7	11
AUG 05	15	17	12	9	10	11	33	33	30	29	15	17	15
SEP 05	18	22	14	19	12	15	97	57	26	27	16	19	19
OCT 05	24	18	16	21	15	19	9	40	38	36	12	11	18
NOV 05	19	20	16	19	20	19	63	37	25	25	18	17	17
DEC 05	29	36	13	17	22	15	34	50	36	101	28	16	14
AVERAGE	21	20	14	16	15	15	39	35	28	33	16	13	16
Bias correction (0.89)	19	18	13	14	13	13	35	31	25	29	14	12	14

WL 1&7 = 15 EAST MAIN ST, WHITBURN
(Roadside site – Grid Ref NS 948 651)

WL 3&8 = 72 CEDRIC RISE, DEDRIDGE, LIVINGSTON
(Background site – Grid Ref NT 064 664)

WL 4&9 = 59 HIGH ST, BATHGATE
(Background site – Grid Ref NS 978 693)

WL 5&10 = EAST MAIN ST, BROXBURN
(Roadside site – Grid Ref NT 083 722)

WL 6&11 = 212 HIGH ST, LINLITHGOW
(Roadside site – Grid Ref NS 999 771)

WL 12,13 & 14 = GROUNDHOG, WHITBURN (Cairnie Place, Whitburn)
(Co-located with real-time analyser on roof of groundhog – Grid Ref NS 944 641)

7.6 REAL-TIME MONITORING RESULTS: Cairnie Place, Whitburn

Figure 5.1 – Cairnie Place, Whitburn – March 2005 – 1hr average

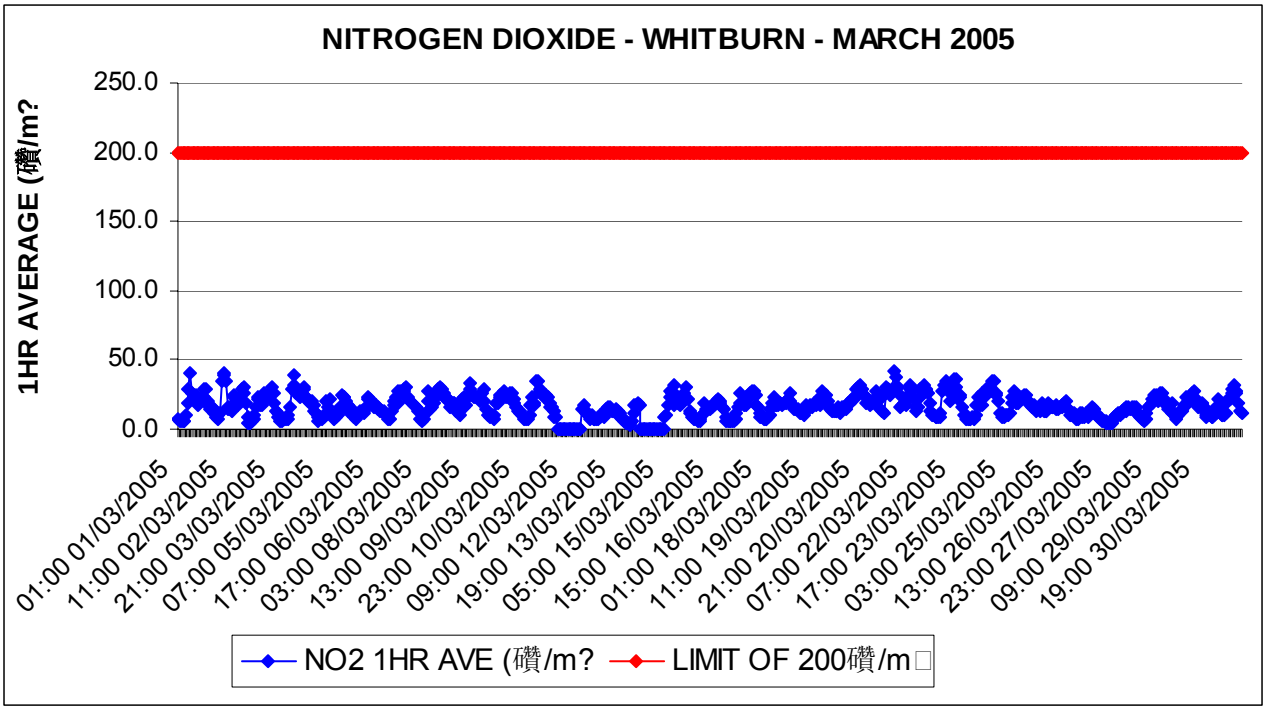


Figure 5.2 – Cairnie Place, Whitburn – April 2005 – 1hr average

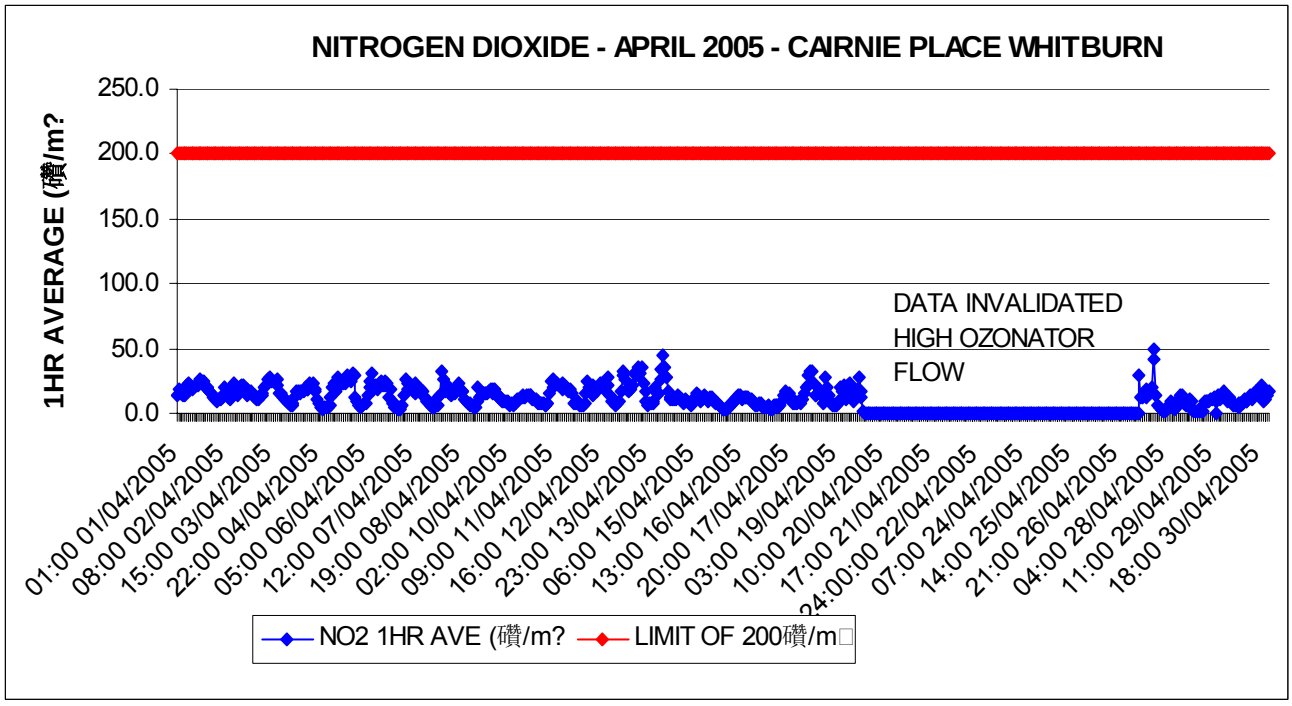


Figure 5.3 – Cairnie Place, Whitburn – May 2005 – 1hr average

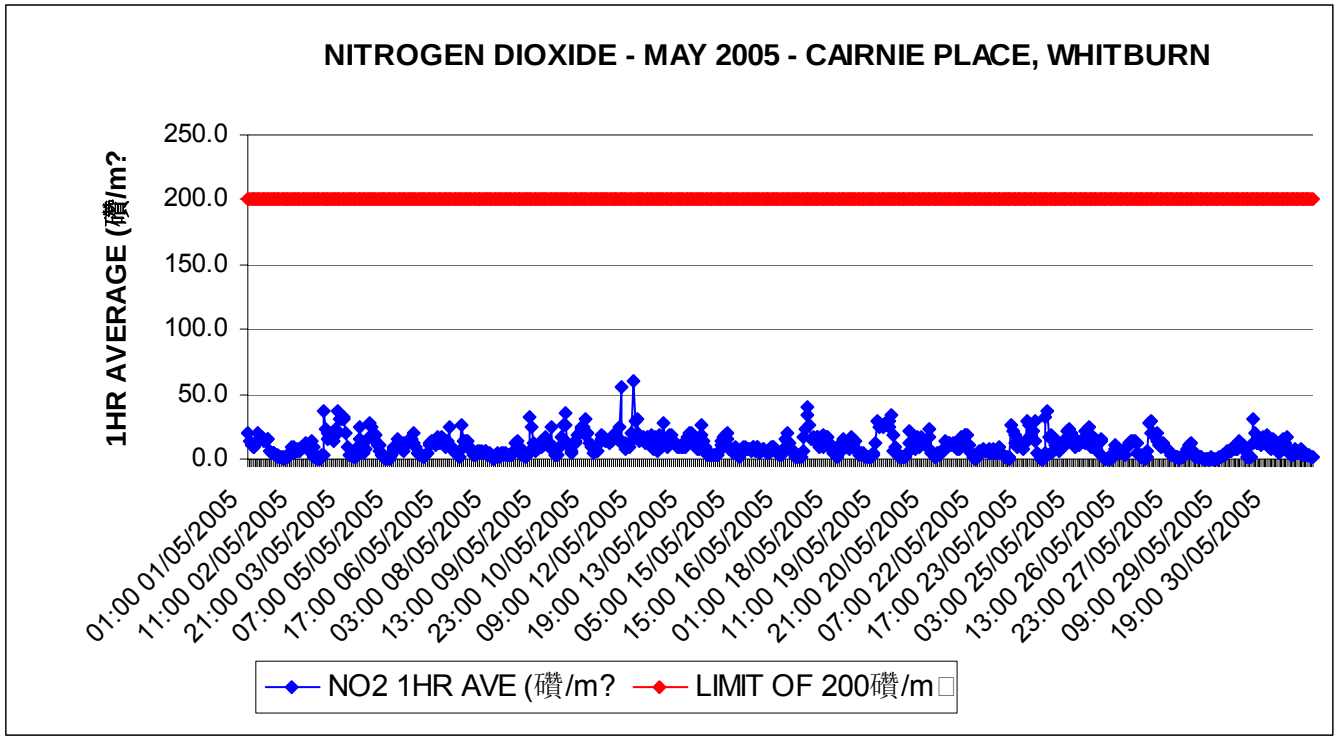


Figure 5.4 – Cairnie Place, Whitburn – June 2005 – 1hr average

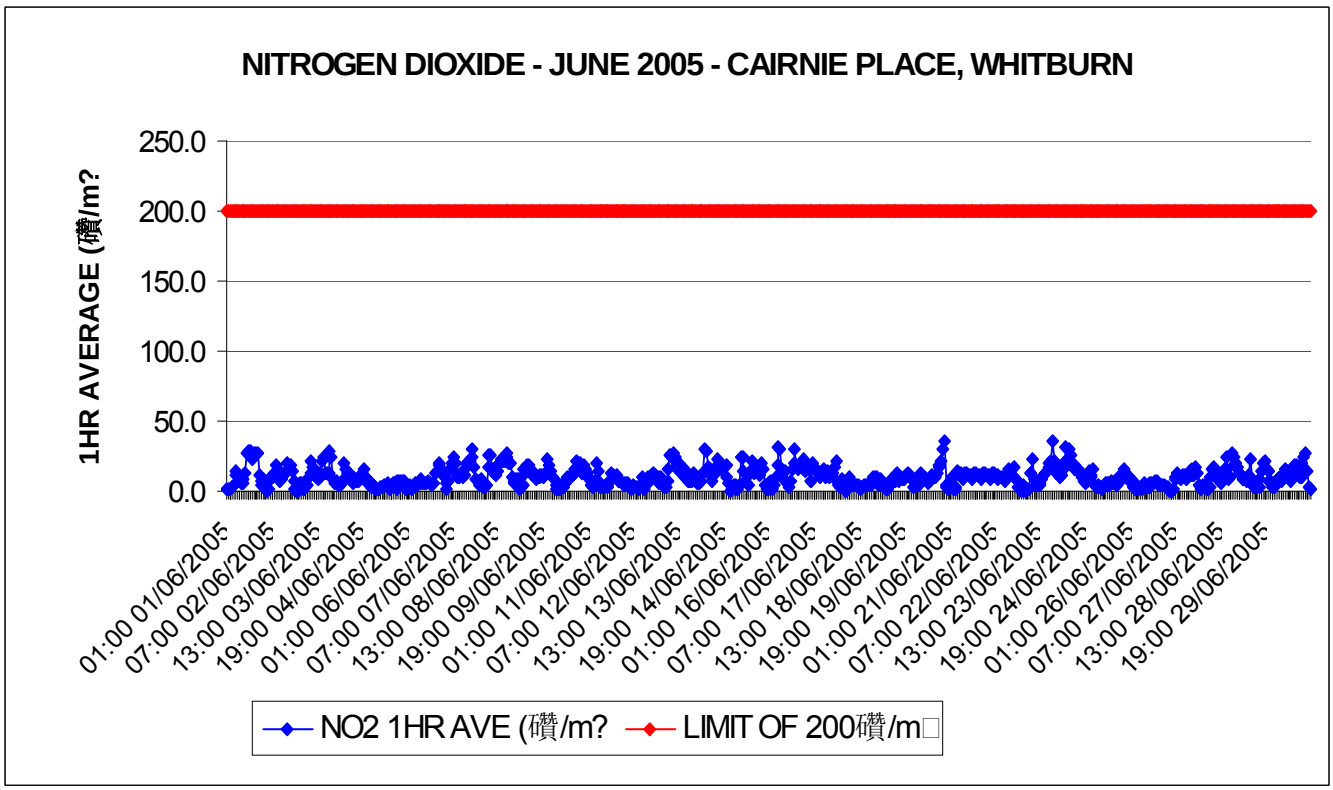


Figure 5.5 – Cairnie Place, Whitburn – July 2005 – 1hr average

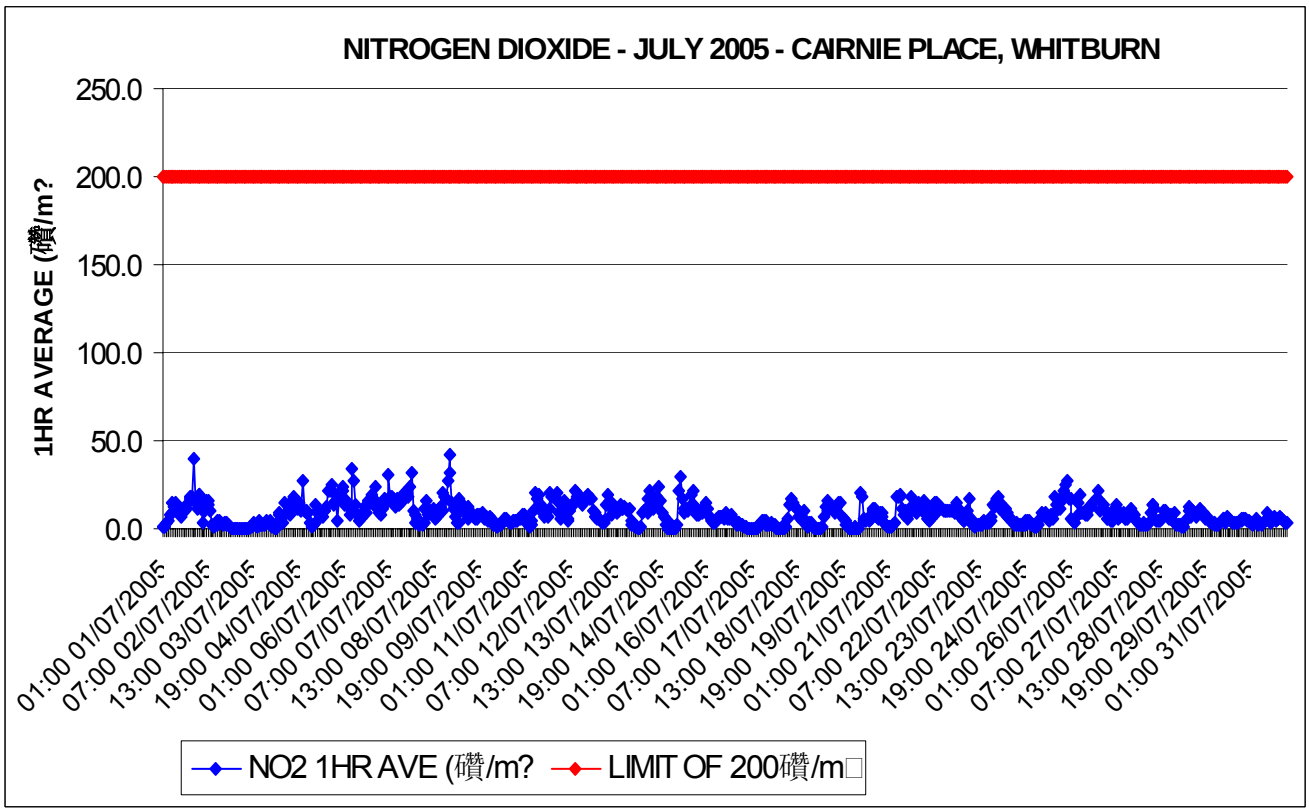


Figure 5.6 – Cairnie Place, Whitburn – August 2005 – 1hr average

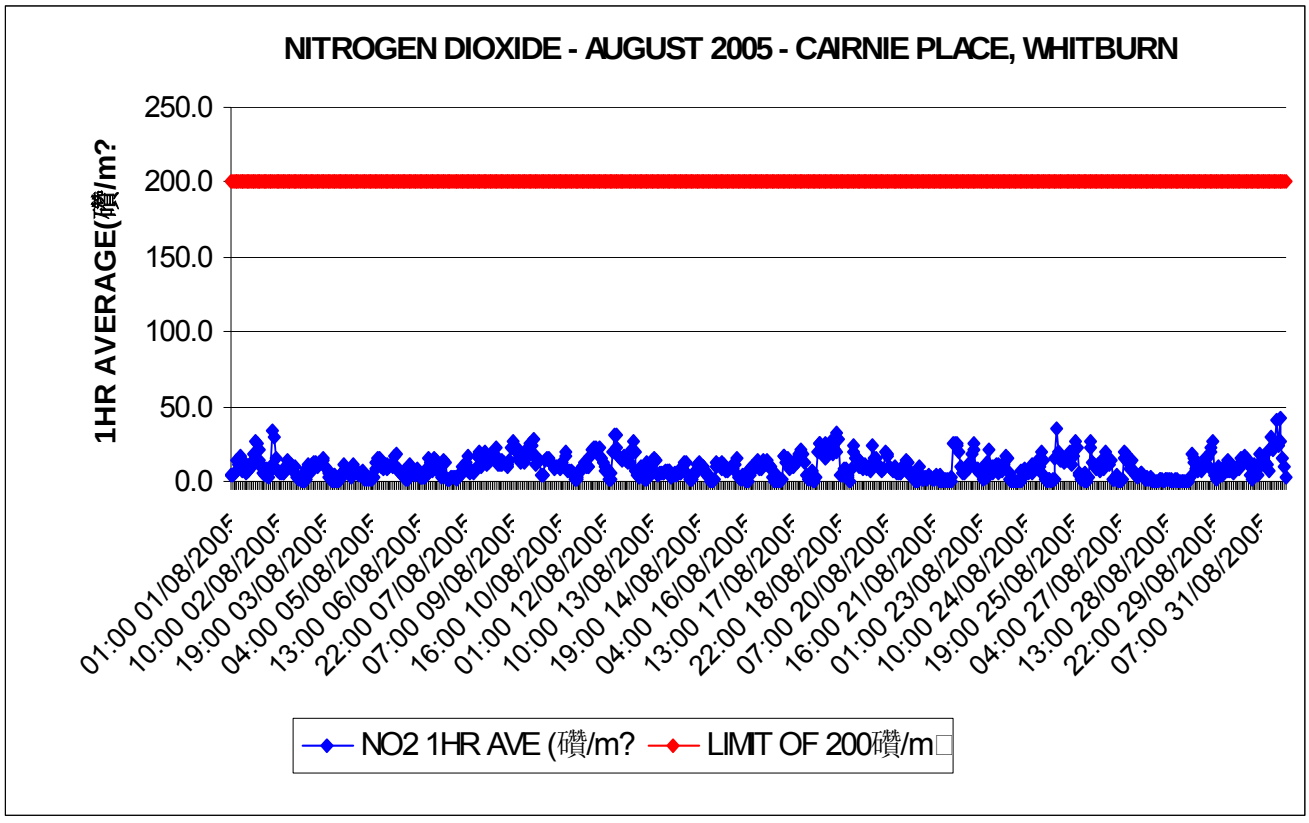


Figure 5.7 – Cairnie Place, Whitburn – September 2005 – 1hr average

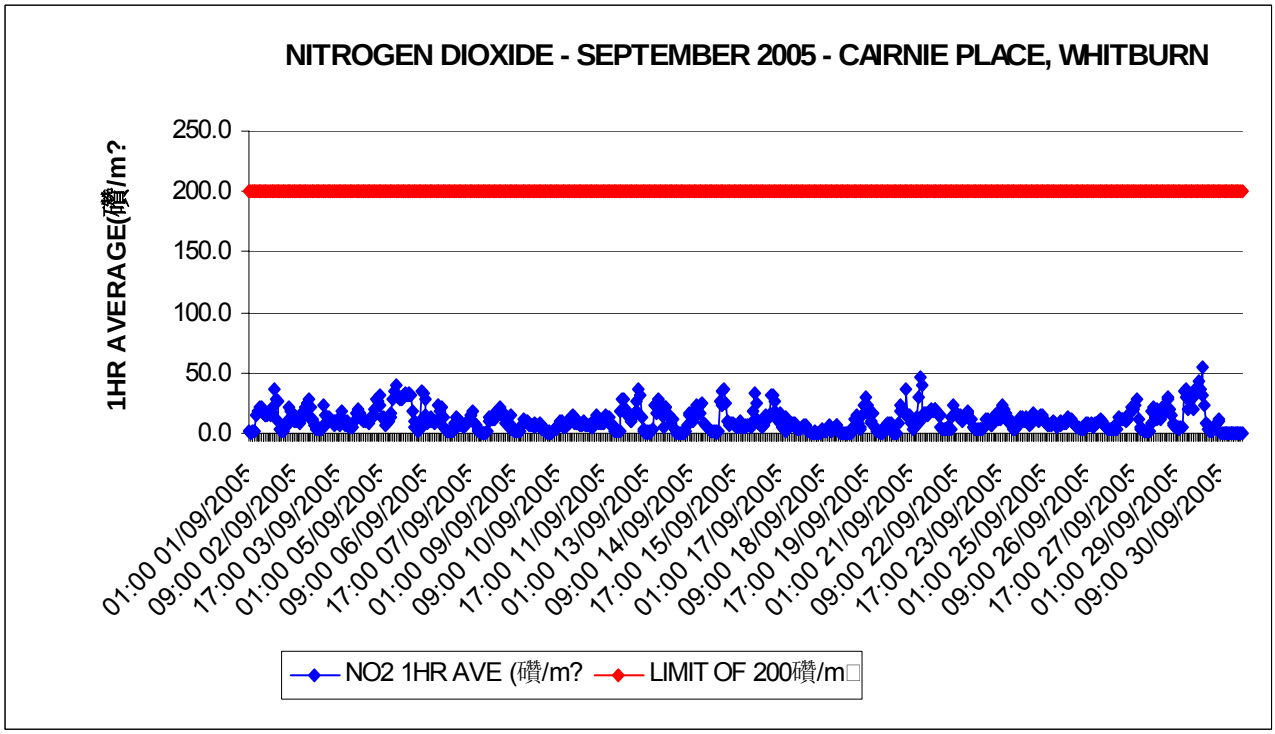


Figure 5.8 – Cairnie Place, Whitburn – October 2005 – 1hr average

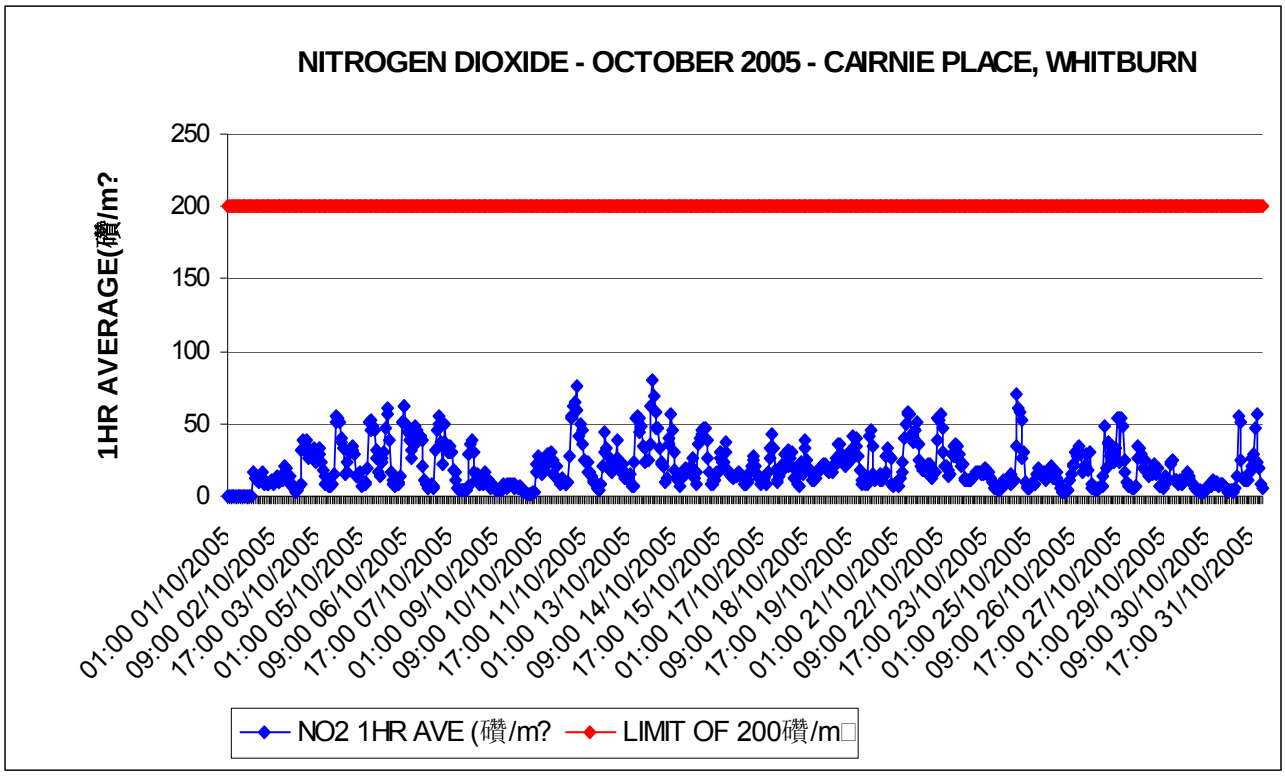


Figure 5.9 – Cairnie Place, Whitburn – November 2005 – 1hr average

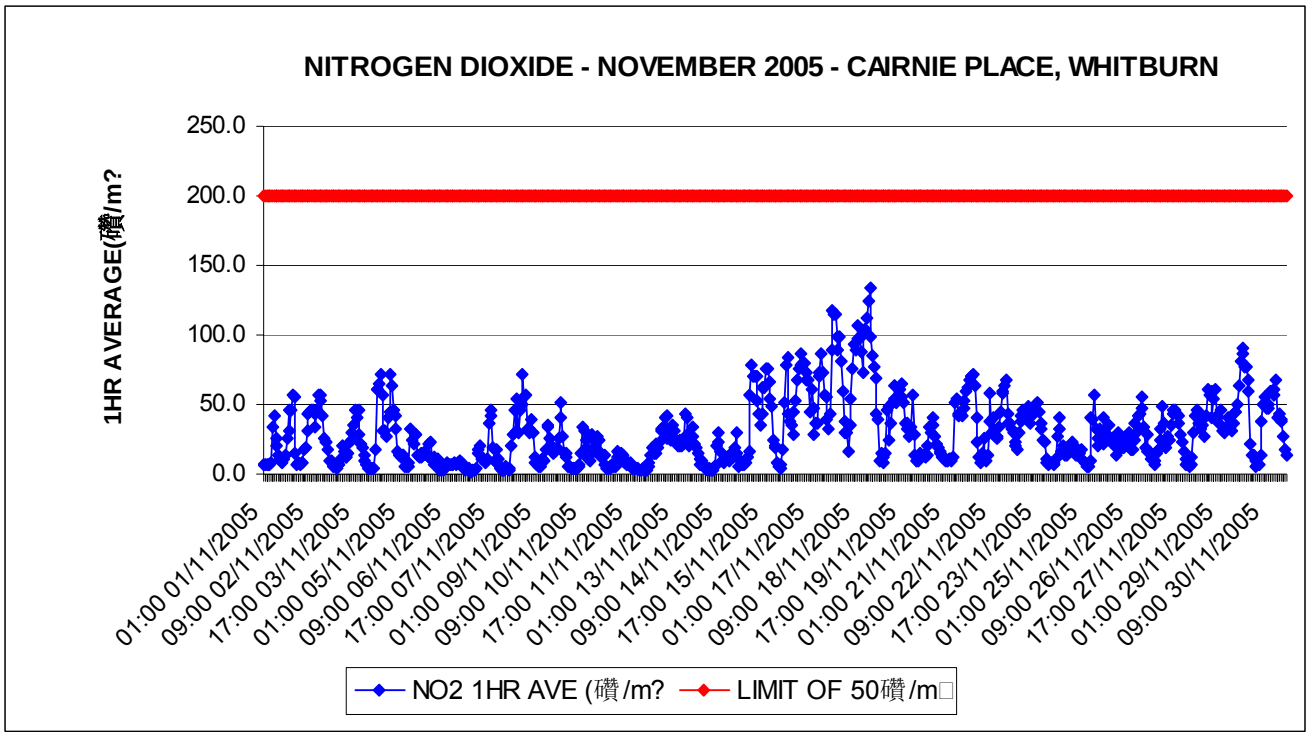


Figure 5.10 – Cairnie Place,Whitburn – December 2005 – 1hr average

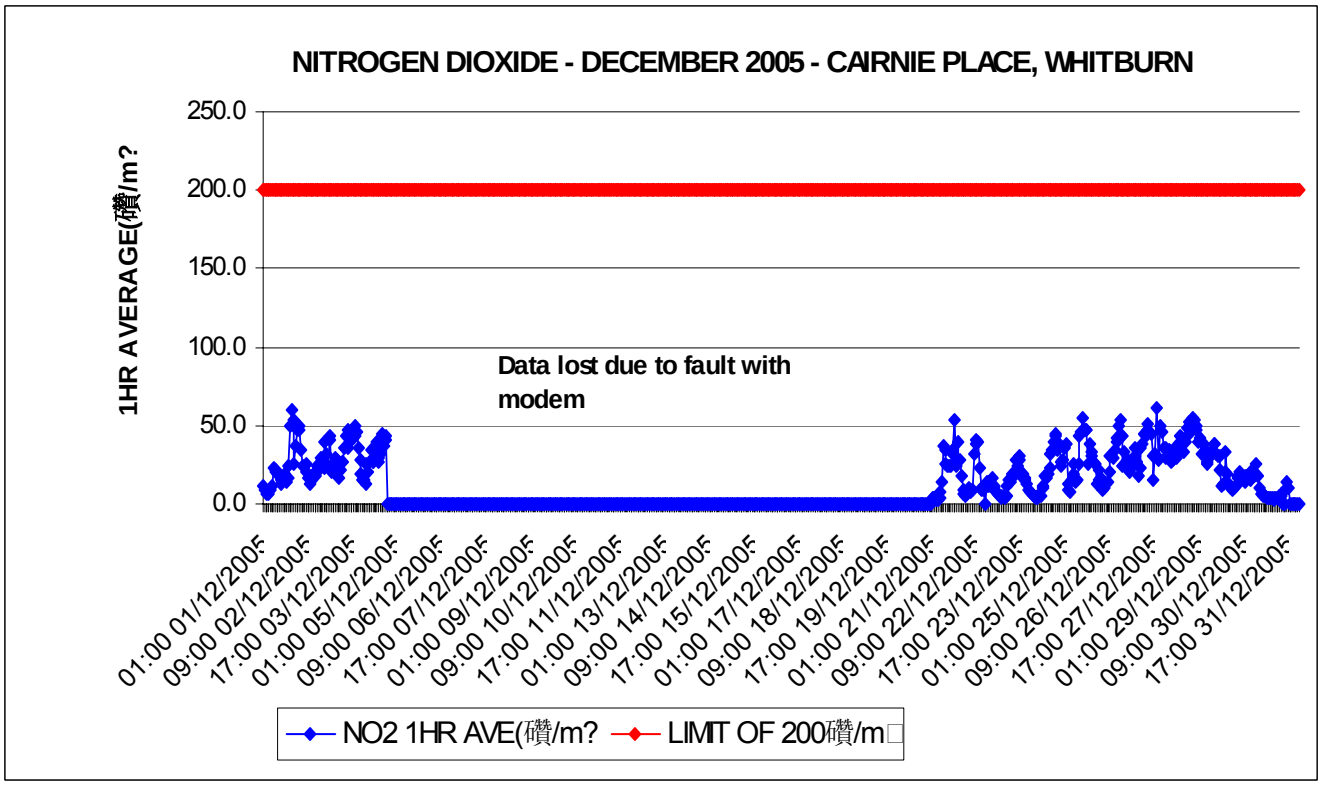


Figure 5.11 – Cairnie Place,Whitburn – January 2006 – 1hr average

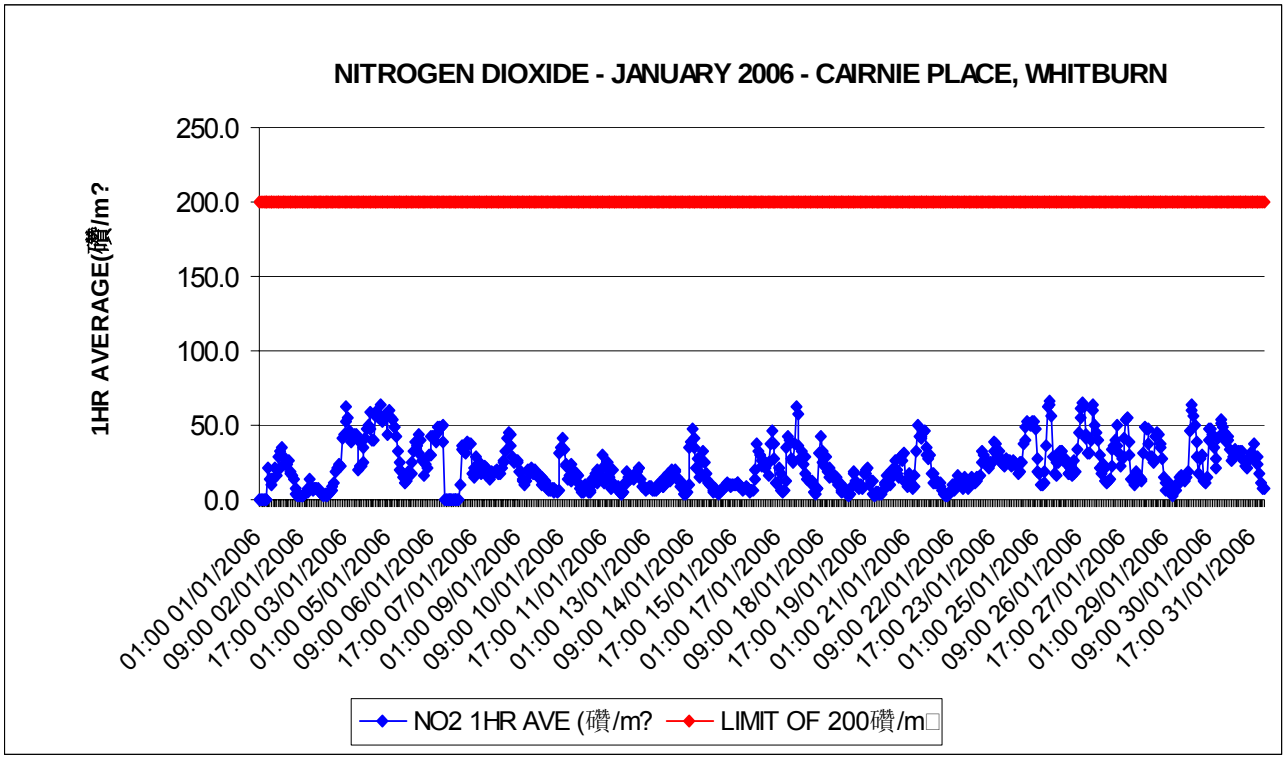
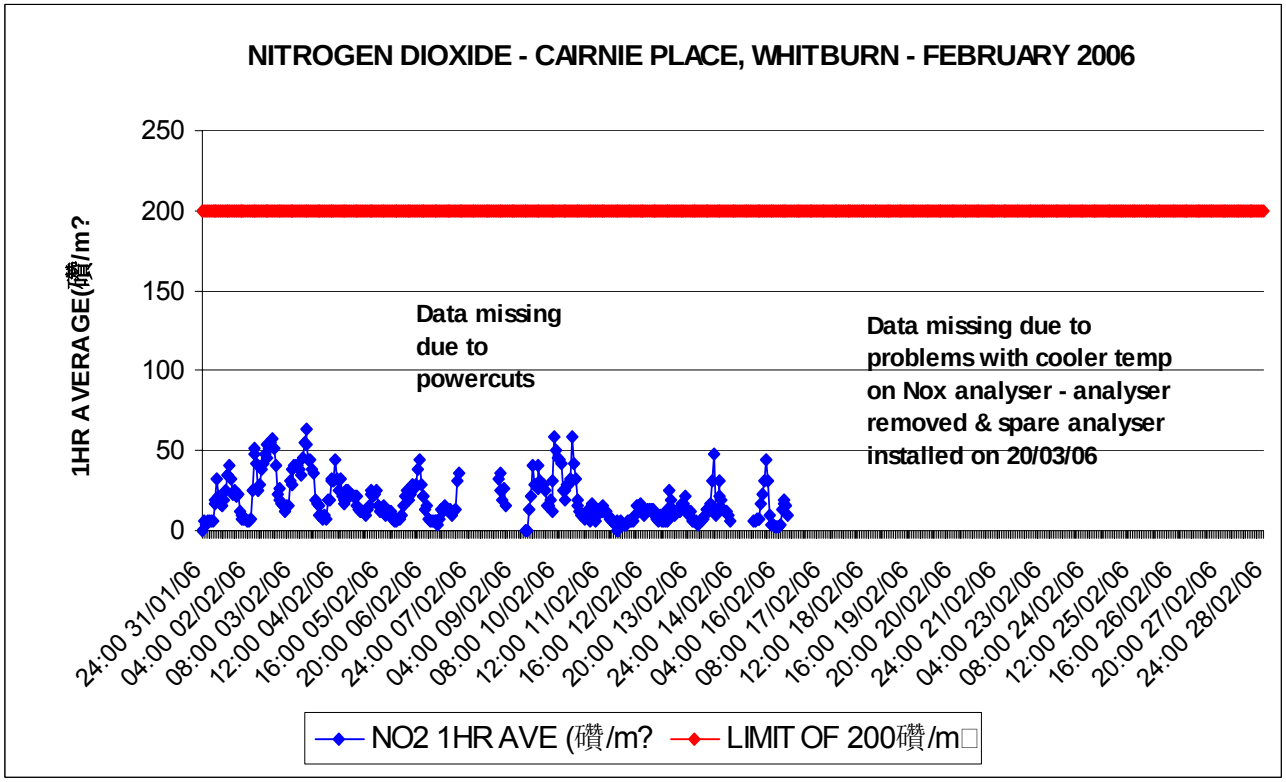


Figure 5.12 – Cairnie Place, Whitburn – February 2006 – 1hr average



7.7 Table 5.2 - Cairnie Place, Whitburn – monthly & annual averages

MONTHLY AVERAGE	NO_2 (µg/m³)
March-05	16.4
April-05	10.6
May-05	10.4
June-05	10.4
July-05	8.5
Aug-05	8.6
Sept-05	10.8
Oct-05	20.1
Nov-05	29.6
Dec-05	24.4
Jan-06	22.1
Feb-06	10
ANNUAL AVERAGE (12 MONTHS)	**15.2**

From the graphs figures 5.1 to 5.11 the highest reading for the 1hr mean for nitrogen dioxide from March 2005 to February 2006 was 134.1µg/m³, which meets the 1hr standard of 200µg/m³ for 31.12.2005. Table 5.2 shows that there was a 12 month average of 15.2µg/m³ for nitrogen dioxide when the Groundhog was located at Cairnie Place, Whitburn which meets the annual mean of 40µg/m³.

7.8 REAL-TIME MONITORING RESULTS: LINLITHGOW HIGH ST

Figure 5.13 – Linlithgow High St – 22/12/2005 to 31/12/2005

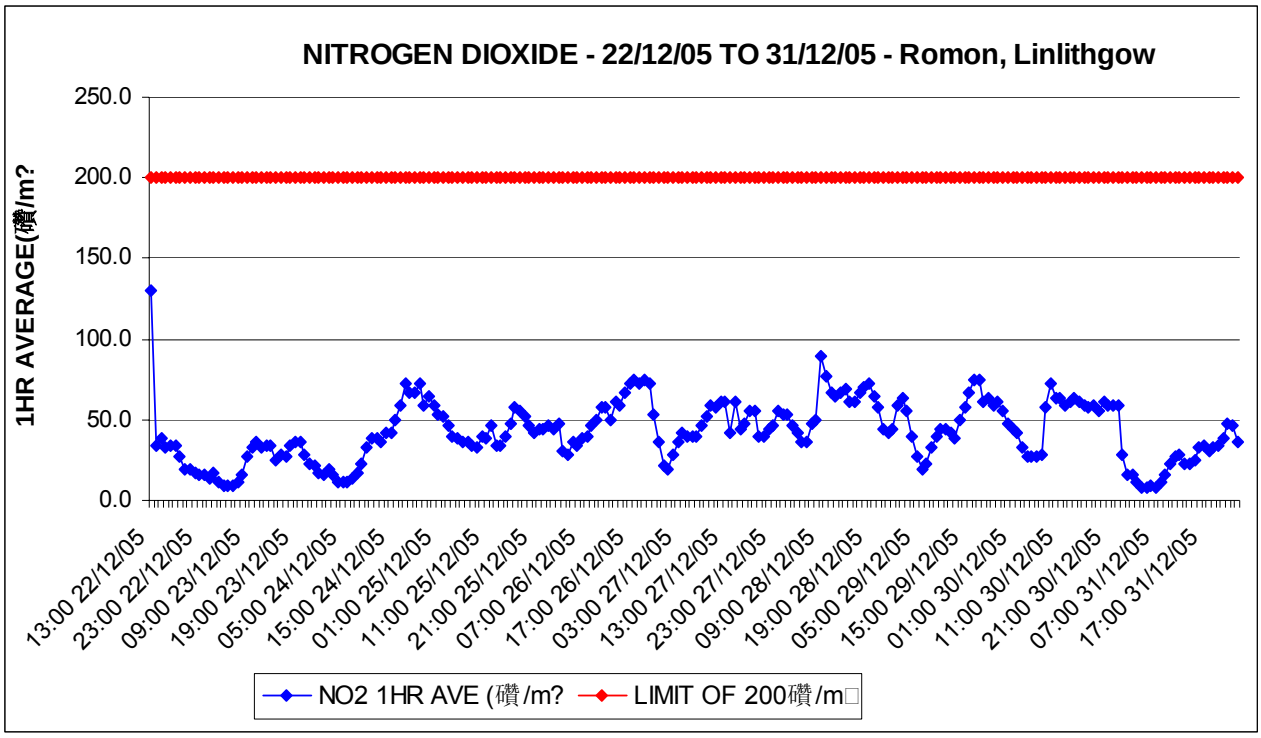


Figure 5.14 – Linlithgow High St – January 2006 – 1hr average

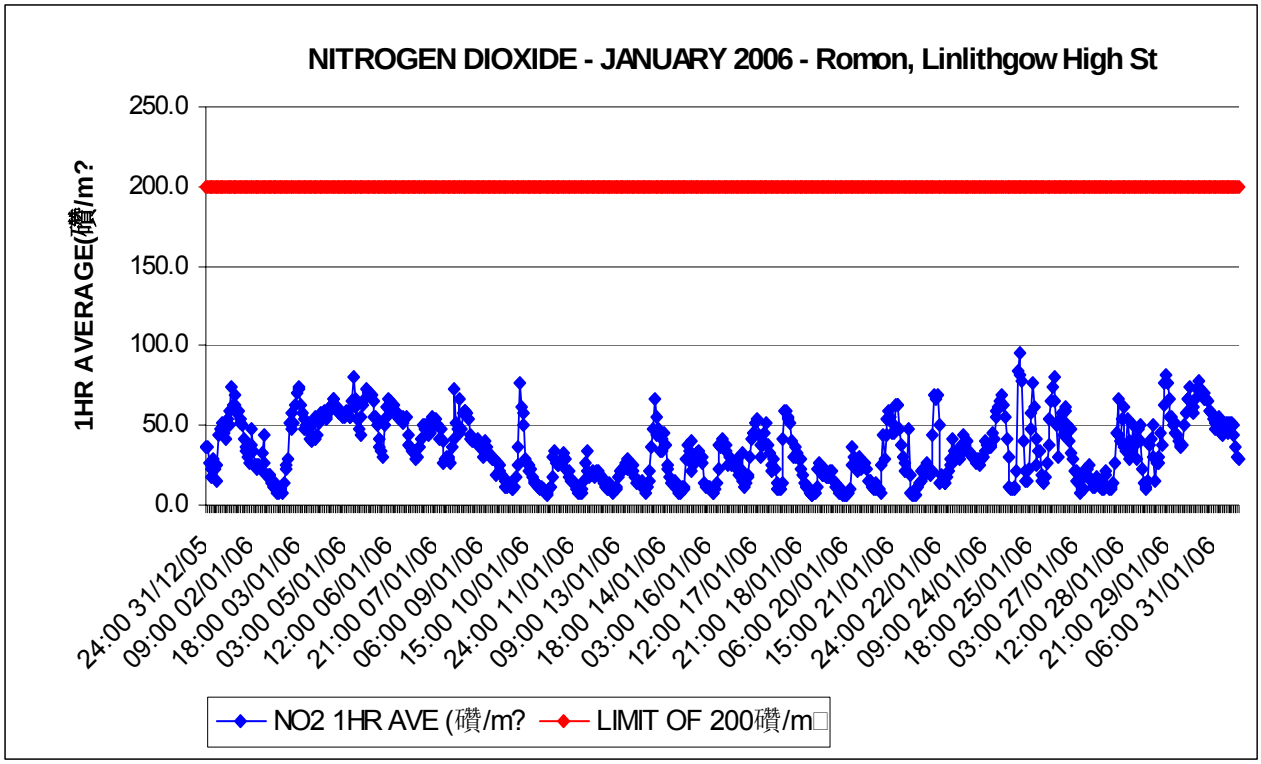


Figure 5.15 – Linlithgow High St – February 2006 – 1hr average

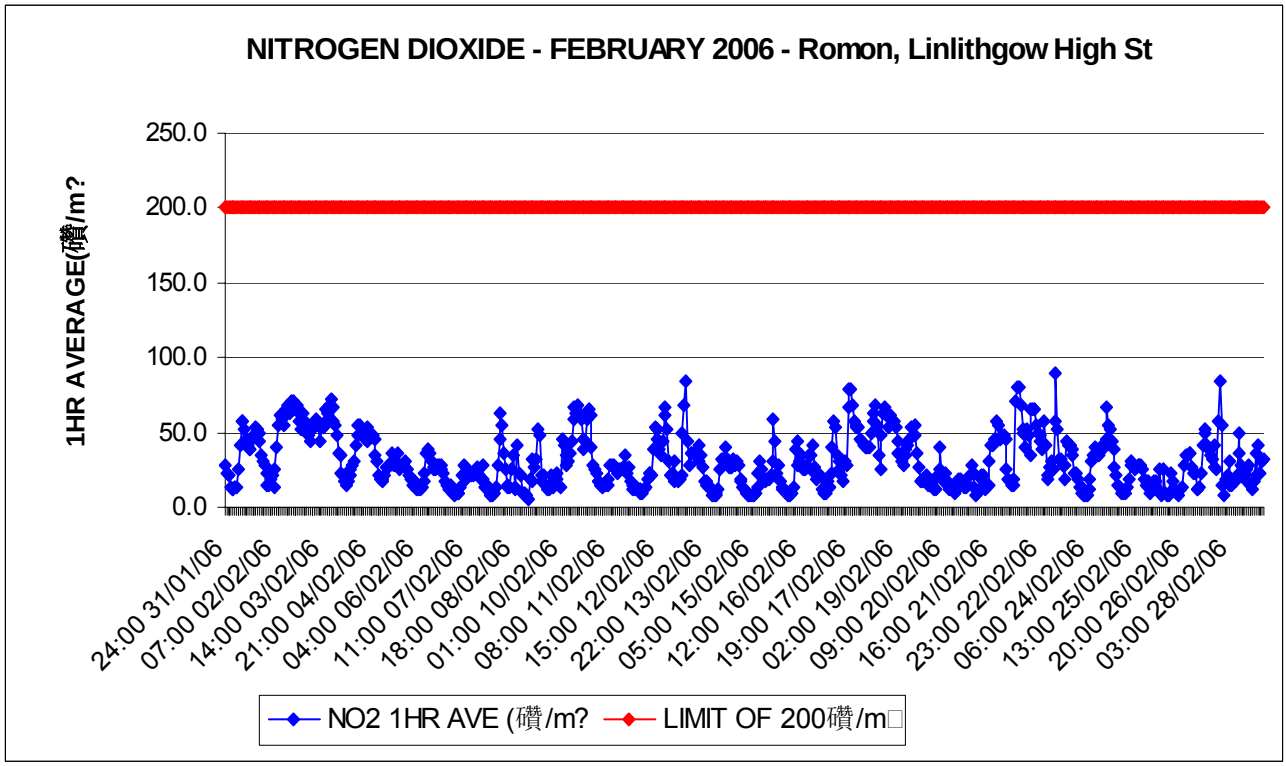


Figure 5.16 – Linlithgow High St – March 2006 – 1hr average

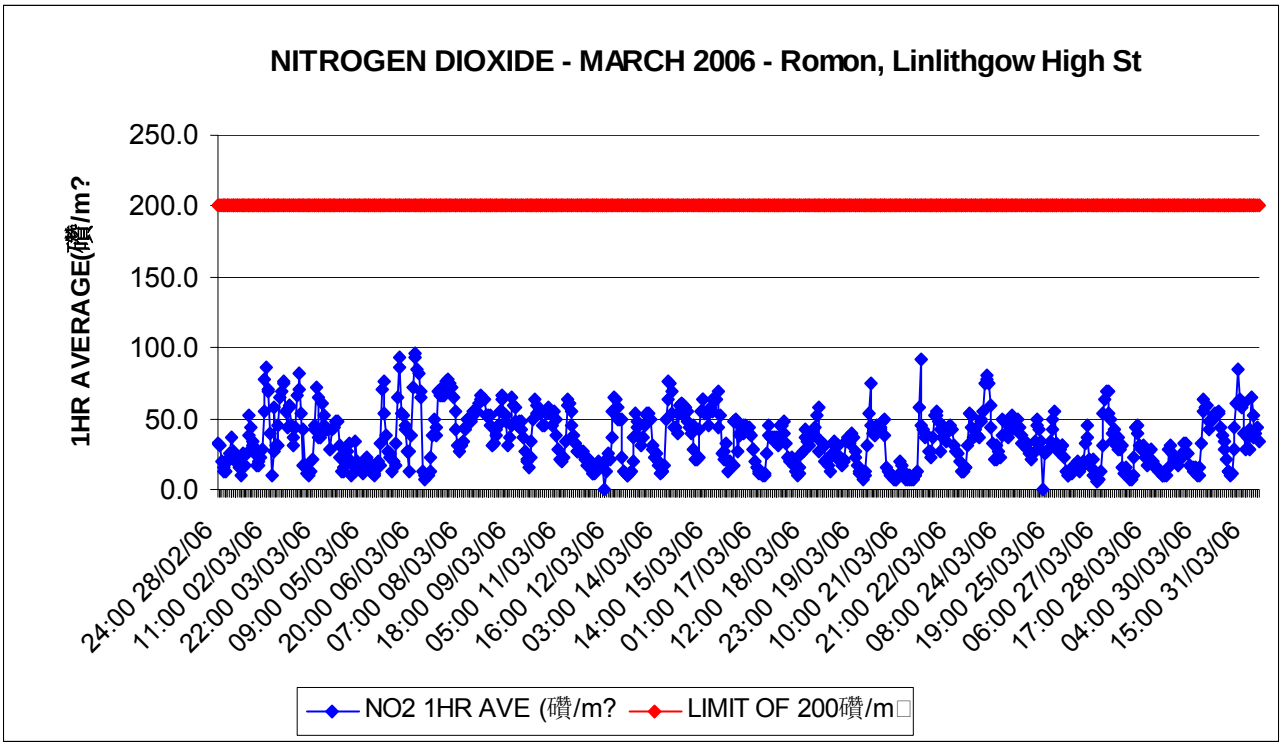


Table 5.3 – High St, Linlithgow (Romon) – monthly & period means

Monthly average	NO_2 (µg/m³)
Dec-05	42
Jan-06	34
Feb-06	31
Mar-06	34
Period mean (four months)	**35**

From the graphs figures 5.13 to 5.16 the highest reading for the 1hr mean for nitrogen dioxide at Linlithgow High Street from December 2005 to March 2006 was 129.9µg/m³, which meets the 1hr standard of 200µg/m³ for 31.12.2005. Table 5.3 shows that there was a 4 month average of 35µg/m³ for nitrogen dioxide with the Romon located at Linlithgow High St, which meets the annual mean of 40µg/m³. Monitoring of Nitrogen dioxide will continue at Linlithgow High Street.

7.9 Streetbox data – co-located with real-time NOX analyser at Cairnie Place

Figure 5.17 – Streetbox Data – May 2005

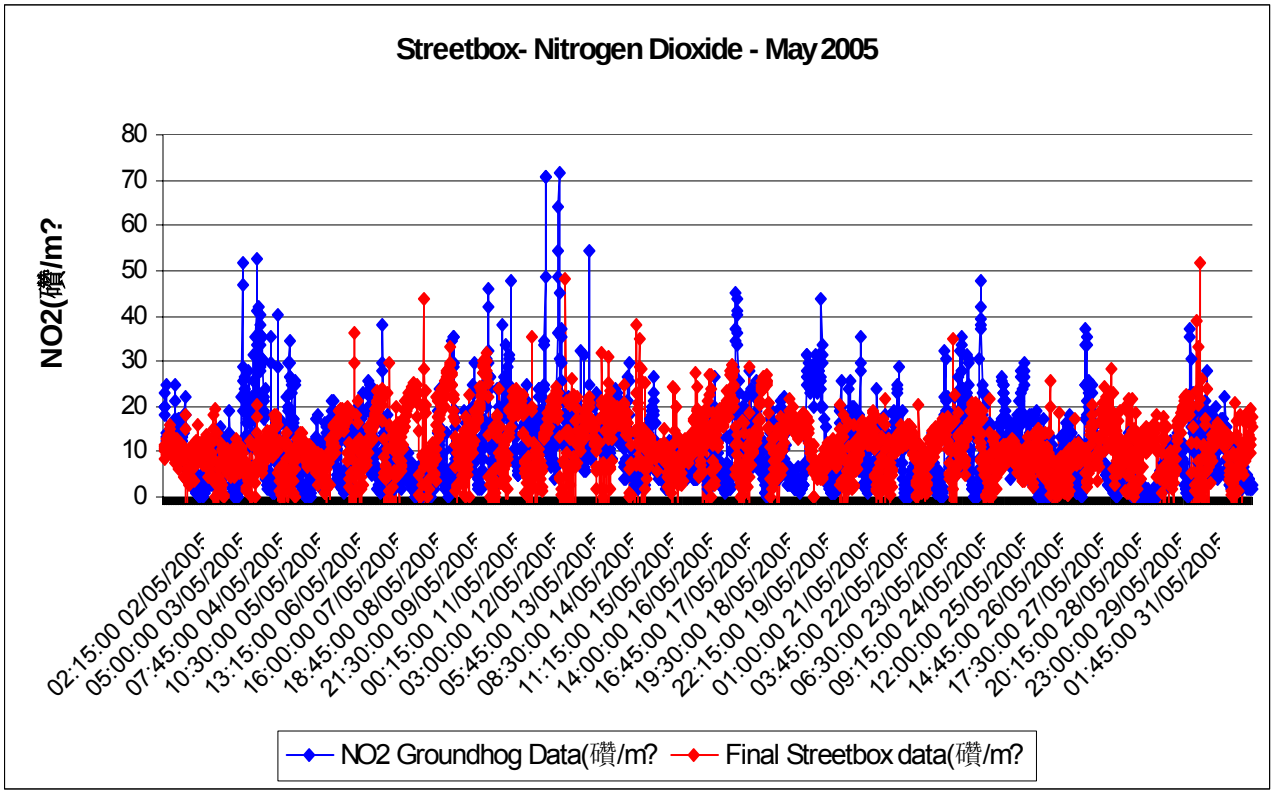


Figure 5.18 – Streetbox Data – June 2005

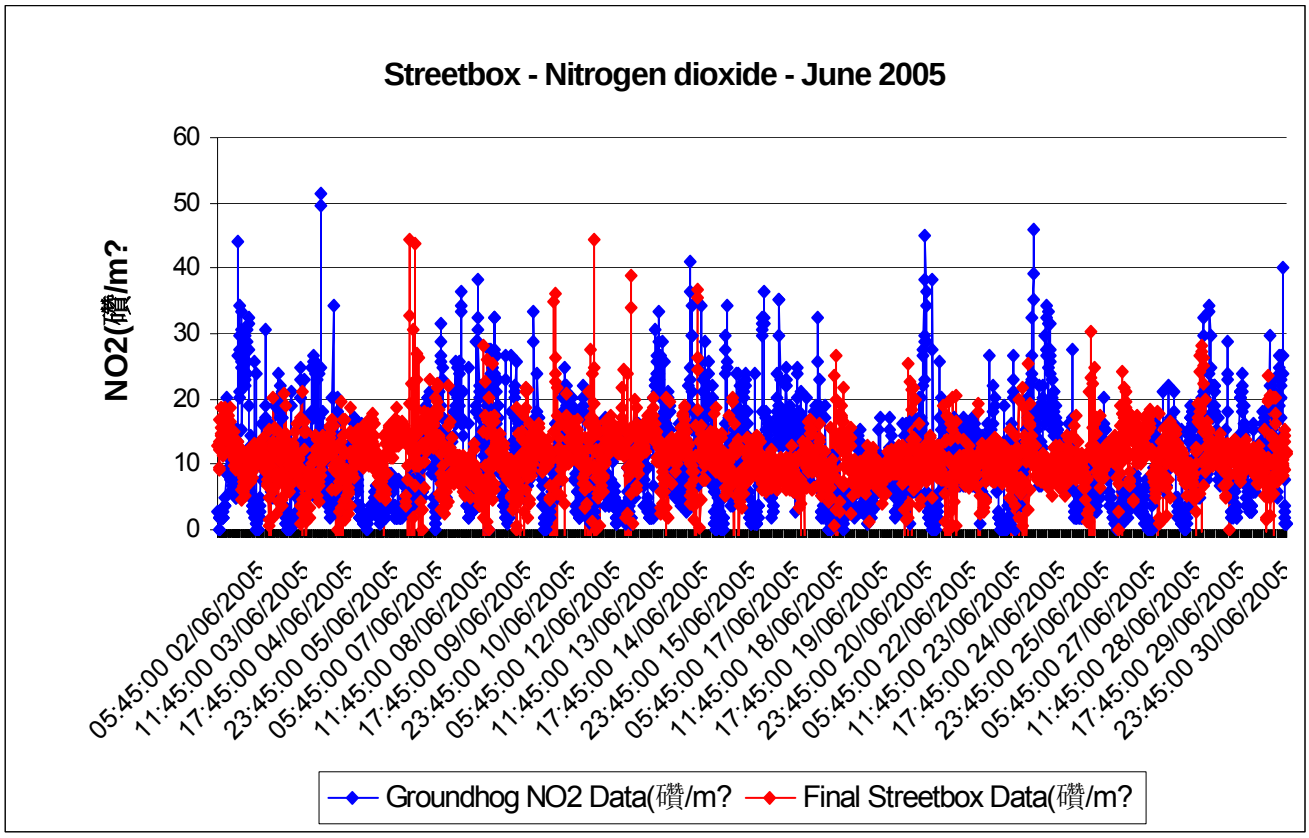


Figure 5.19 – Streetbox Data – July 2005

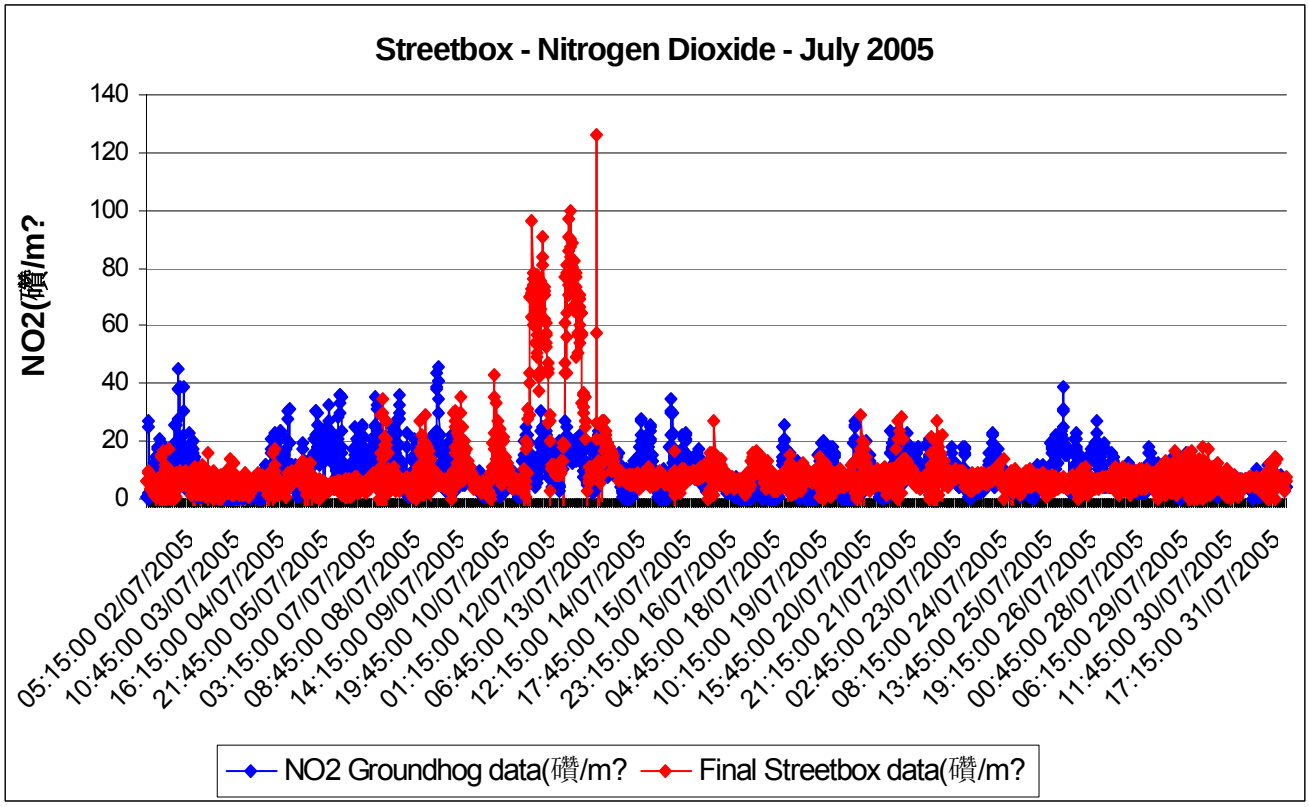


Figure 5.20 – Streetbox Data – August 2005

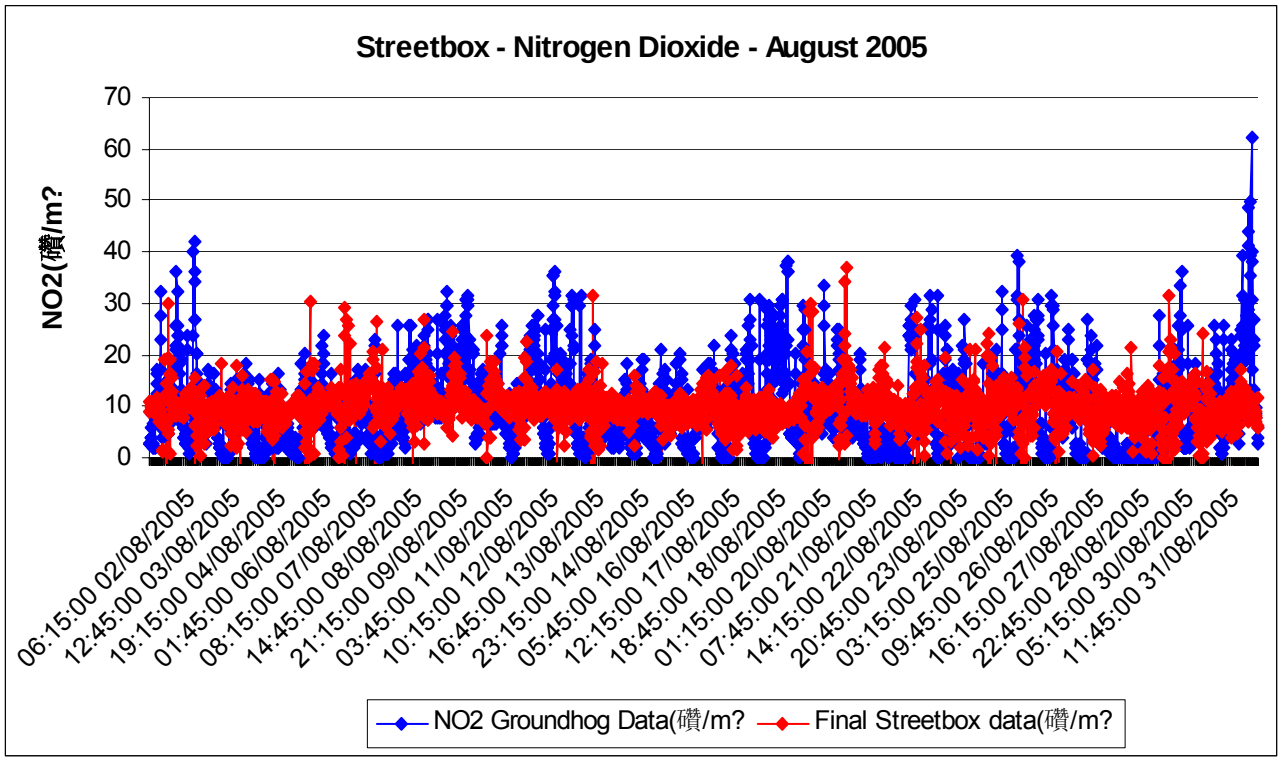


Figure 5.21 – Streetbox Data – September 2005

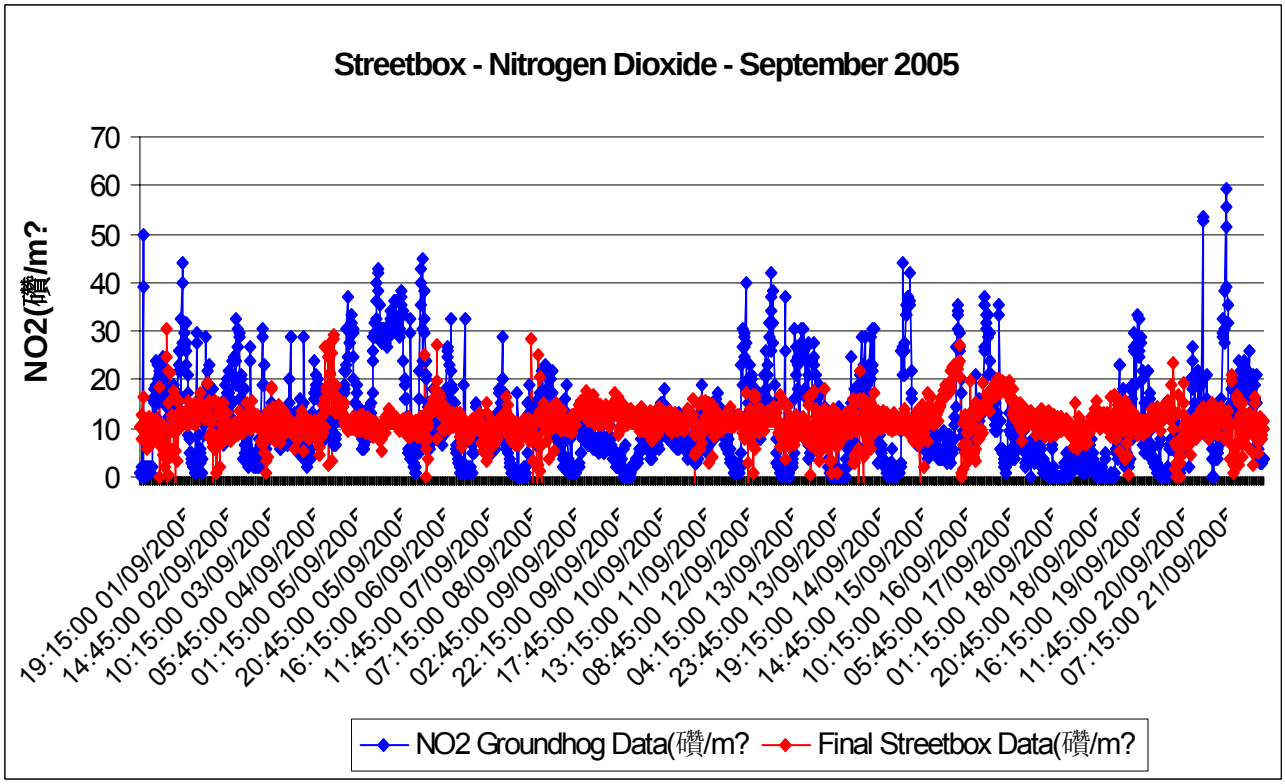


Figure 5.22 – Streetbox Data – October 2005

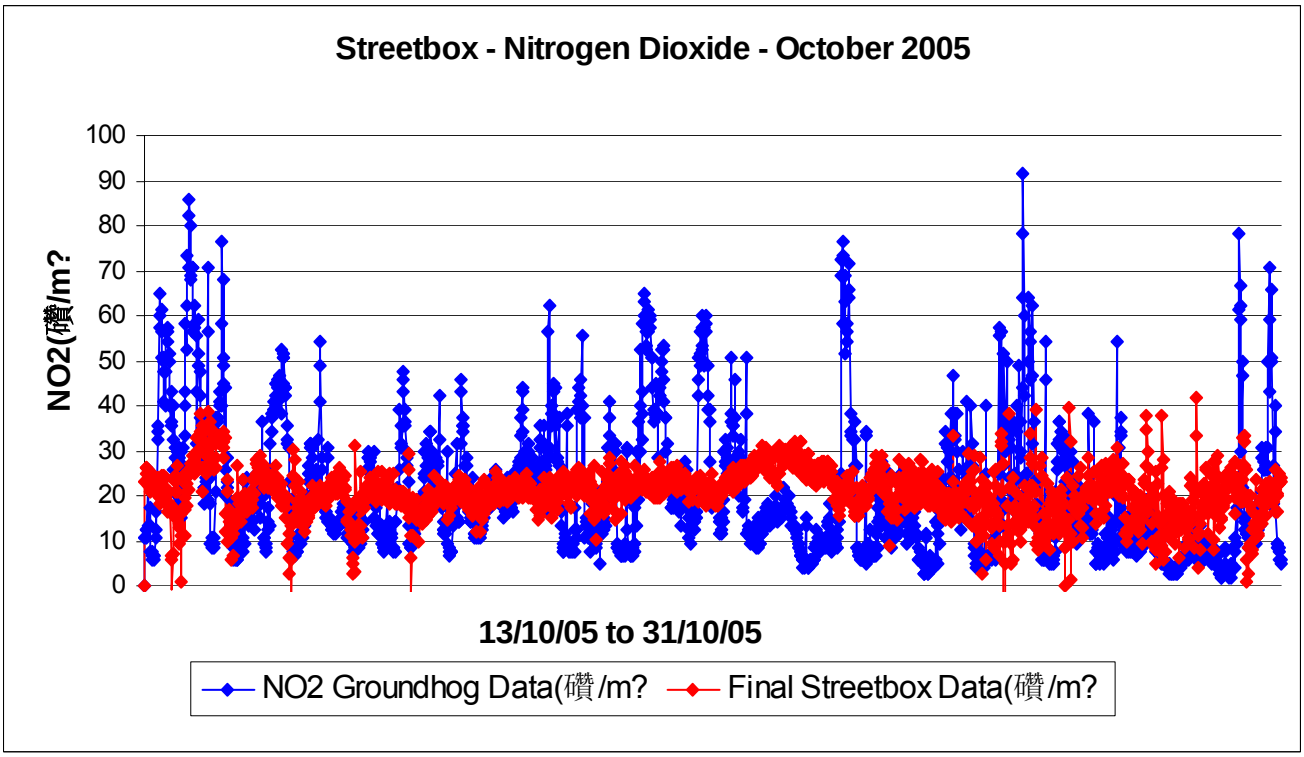
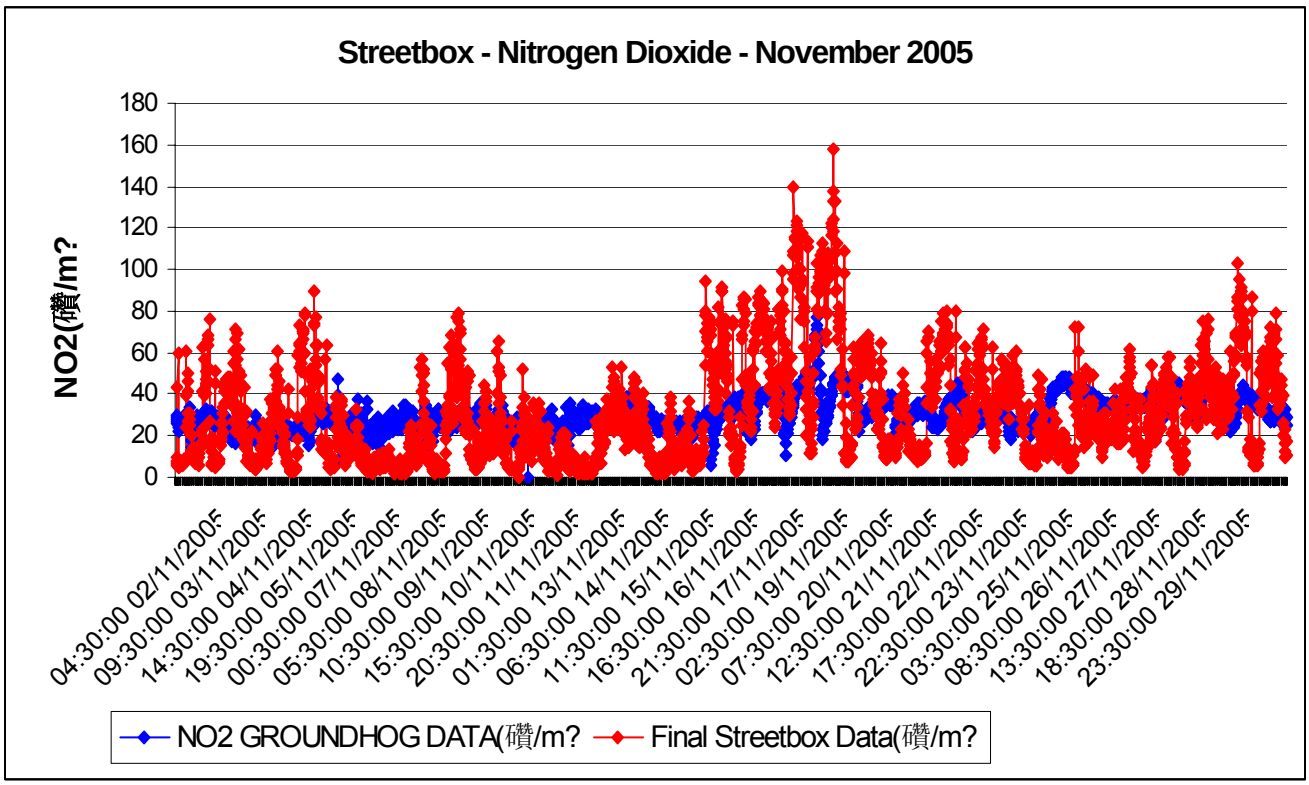


Figure 5.23 – Streetbox Data – November 2005



7.10 Streetbox NO2 and real-time analyser NO2 comparison

Environmental Health provided SEPA statisticians with six months of data from May to November 2005. Both the real-time analyser and streetbox were running side-by-side during this time and logging every 15 minutes.
It was concluded from the report that the Streetbox should only be used for measuring nitrogen dioxide but only for a monthly and annual mean and not for a 1-hr average. The Streetbox should not be used for measuring PM_{10} as there was no evidence of a relationship between the instruments for monthly mean $PM_{10.}$ The full report from SEPA can be seen in Appendix 1.4.

7.11 Updating and Screening Assessment Summary Checklist for Nitrogen Dioxide

Item	Response
P) Monitoring data outside an AQMA	This authority currently has two real-time nitrogen dioxide analysers at a roadside location, a Streetbox for measuring nitrogen dioxide and six diffusion tube sites. There have been no exceedences of the 1hr mean of 200µg/m³ for either sites and the annual mean of 40µg/m³ is also being achieved.
Q) Monitoring data within an AQMA	Not applicable as no AQMA for Nitrogen Dioxide.
R) Narrow congested streets with residential properties close to the kerb	Linlithgow High Street where the Romon300 is located is the best example of a narrow congested street with properties close to the kerb.
S) Junctions.	Not applicable
T) Busy streets where people may spend 1-hour or more close to traffic	Not applicable
U) Roads with high flow of buses and/or HGVs.	Not applicable
V) New roads constructed or proposed since the previous round of R&A	Not applicable – no new roads constructed since previous review and assessment
W) Roads with significantly changed traffic flows, or new relevant exposure	Not applicable
X) Bus Stations	There are no bus stations or bus depots within West Lothian with flow of vehicles greater than 1000 bus movements per day.
Y) New industrial sources.	Not applicable – no new industrial sources identified
Z) Industrial sources with substantially increased emissions, or new relevant exposure	Not applicable – no new industrial sources identified with increased emissions or new relevant exposure
AA) Aircraft	There are no airports within this authority

7.12 CONCLUSION FOR NITROGEN DIOXIDE

The real-time monitoring data for Cairnie Place, Whitburn and High Street, Linlithgow indicates that there is not a problem with nitrogen dioxide in West Lothian with no exceedences in the last twelve months. A few problems were encountered with the real-time analyser cooler temperature at Cairnie Place, Whitburn resulting in four weeks lost data but a spare analyser has been located at the Groundhog since 20th March 2006 while tests are carried out on the analyser. West Lothian are considering submitting a bid to the Scottish Executive next year to replace the NOX analyser at Cairnie Place.
West Lothian now have a Romon300 roadside NOX analyser located at Linlithgow High Street which replaces the Groundhog now located at Cairnie Place, Whitburn.
There is no longer a national network for diffusion tubes but West Lothian will continue with the existing sites.
The Streetbox has now been located with a real-time analyser for a period of six months and will now be placed at either Broxburn town centre or Alderstone Rd, Livingston when a suitable site is found. Statisticians at SEPA have assisted West Lothian in assessing this data and the streetbox will only be used for monitoring a monthly and annual mean for nitrogen dioxide.

It is not necessary for West Lothian to proceed to a detailed assessment for nitrogen dioxide but real-time monitoring of nitrogen dioxide will continue at Cairnie Place, Whitburn and High Street, Linlithgow. West Lothian are considering increasing diffusion tubes in Livingston as it has been sometime since a survey has been done in this area. West Lothian will also use DMRB models and traffic data to monitor any traffic increases.

8.0 Review & assessment for PM_{10}

8.1 INTRODUCTION

Monitoring for PM_{10} has continued during 2005 using the TEOM analyser in the Groundhog located at Cairnie Place, Whitburn. It has been located there since 31st January 2005. West Lothian purchased a roadside real-time analyser, which contains a TEOM analyser. This has been located at Linlithgow High St since 22nd December 2005. West Lothian also purchased a Streetbox in 2004 for measuring PM_{10} and a six-month co-location study has now been completed with the TEOM analyser.

8.2 Standard and Objective for PM_{10}

The Air Quality (Scotland) Regulations 2000 and amendment regulations 2002 set the following objectives: -

- 24-hour mean of 50µg/m³ not to be exceeded more than 35 times a year to be achieved by 31.12.2004
- Annual mean of 40µg/m³ to be achieved by 31.12.2004

For local authorities in Scotland only there are two objectives for 2010: -

- 24-hour mean of 50µg/m³ not to be exceeded more than 7 times a year to be achieved by 31.12.2010
- Annual mean of 18µg/m³ to be achieved by 31.12.2010

8.3 MONITORING DATA RESULTS

Figures 6.1 to 6.14 show the results for PM_{10} at Cairnie Place, Whitburn from February 2005 to March 2006 and show the 24-hour mean for each month. Figures 6.15 to 6.20 show the results for PM_{10} at Linlithgow High Street from 23rd December to March 2006 and also show the 24-hour mean for each month.
The PM_{10} from the TEOM have been converted into gravimetric concentrations by multiplying the monthly results by the 1.3 default factor. The annual average results have been multiplied by both the 1.3 and 1.14 factor.

8.4 PM_{10} RESULTS – CAIRNIE PLACE, WHITBURN

Figure 6.1 – Cairnie Place, Whitburn – February 2005

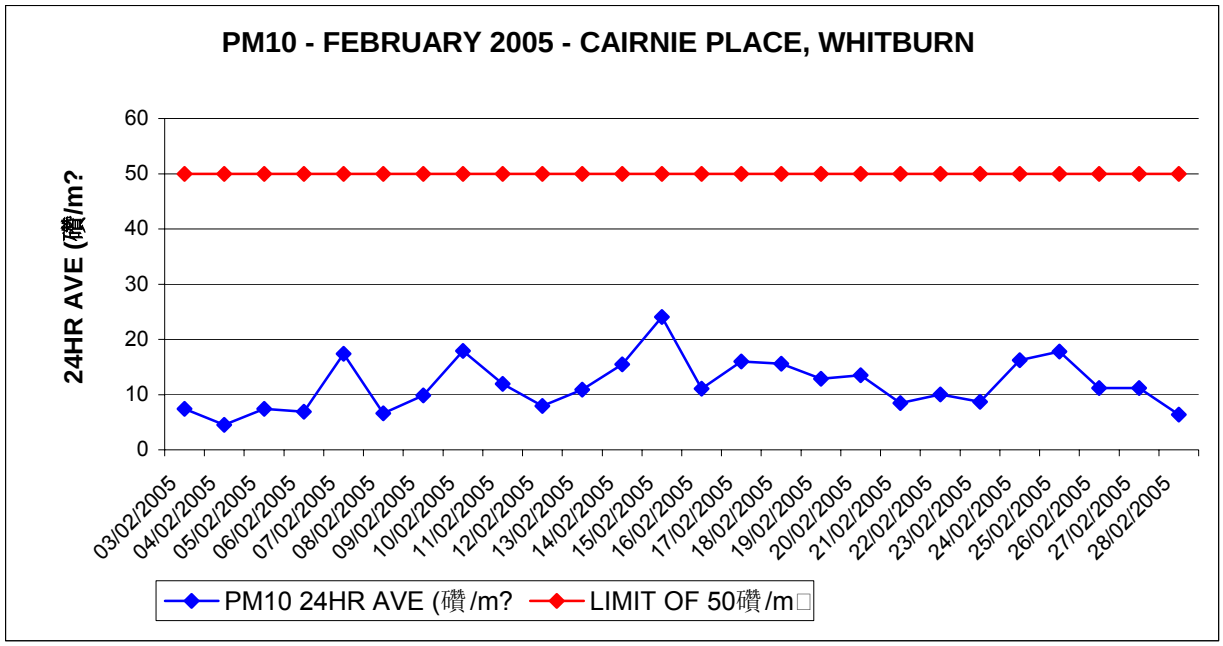


Figure 6.2 – Cairnie Place, Whitburn – March 2005

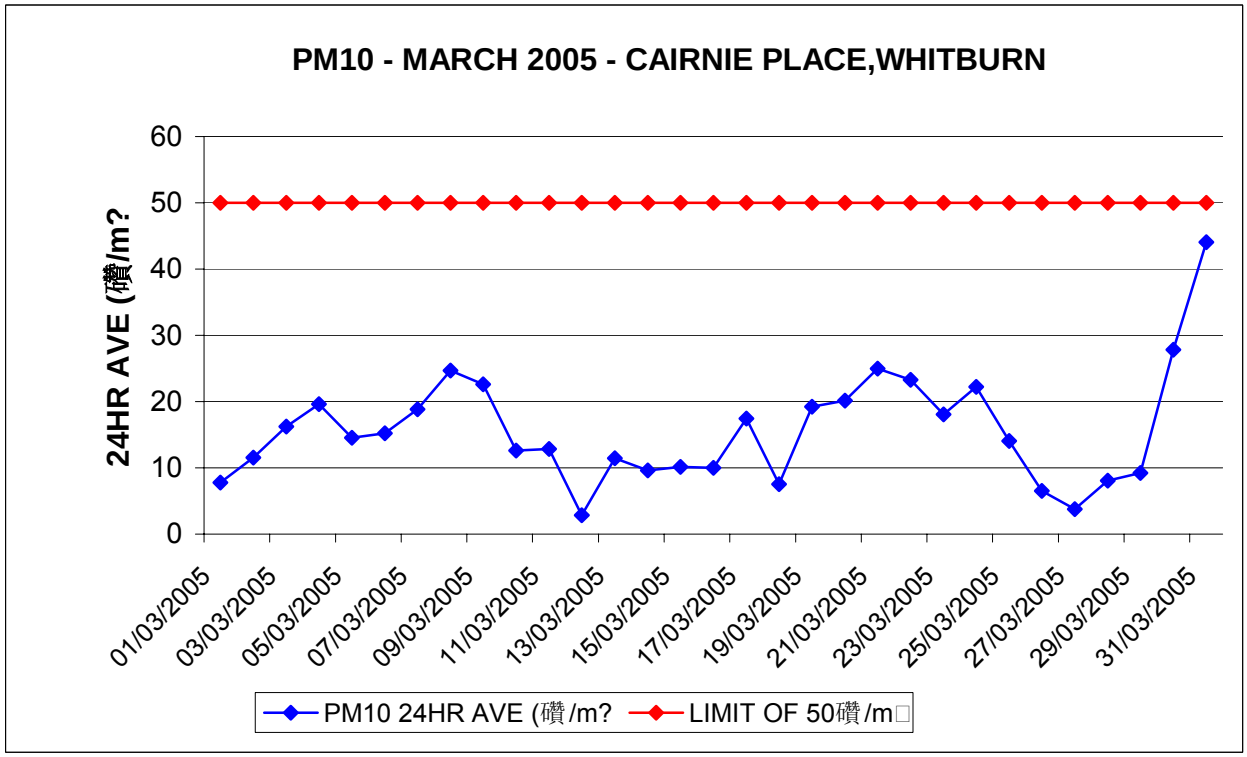


Figure 6.3 – Cairnie Place, Whitburn – April 2005

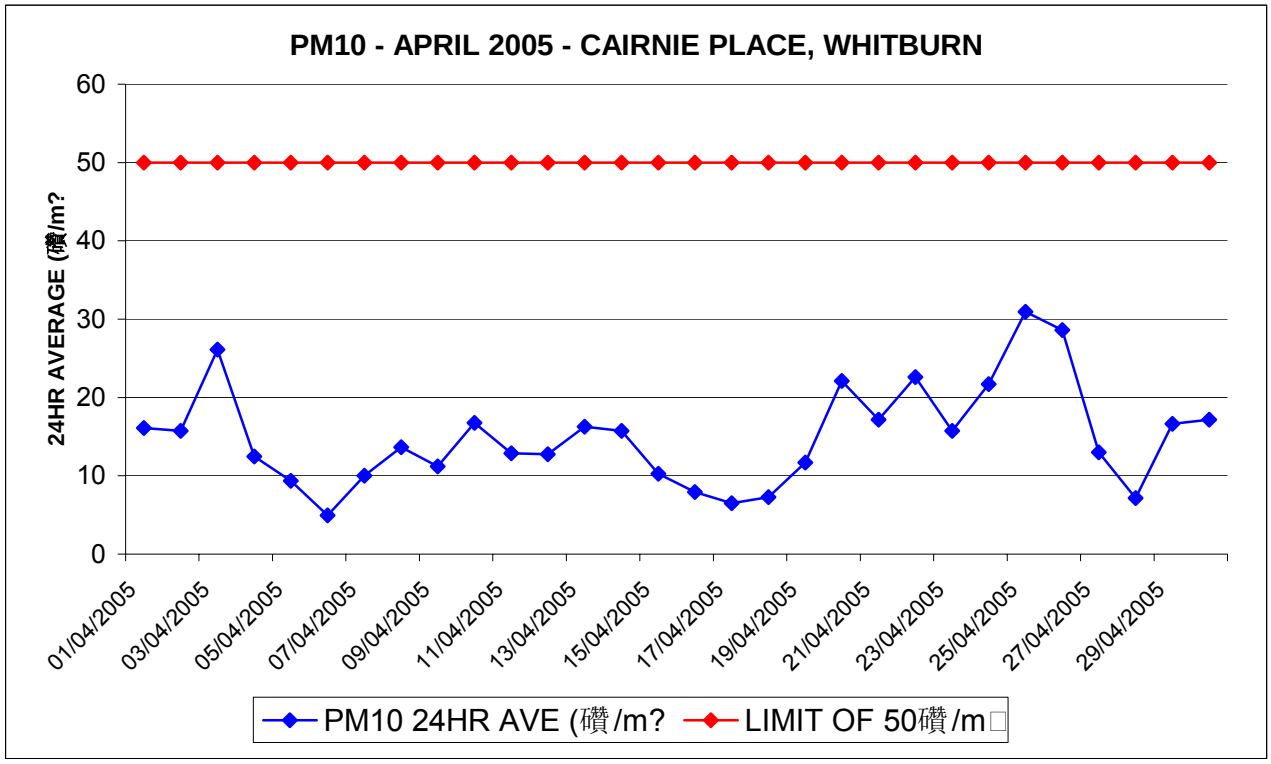


Figure 6.4 – Cairnie Place, Whitburn – May 2005

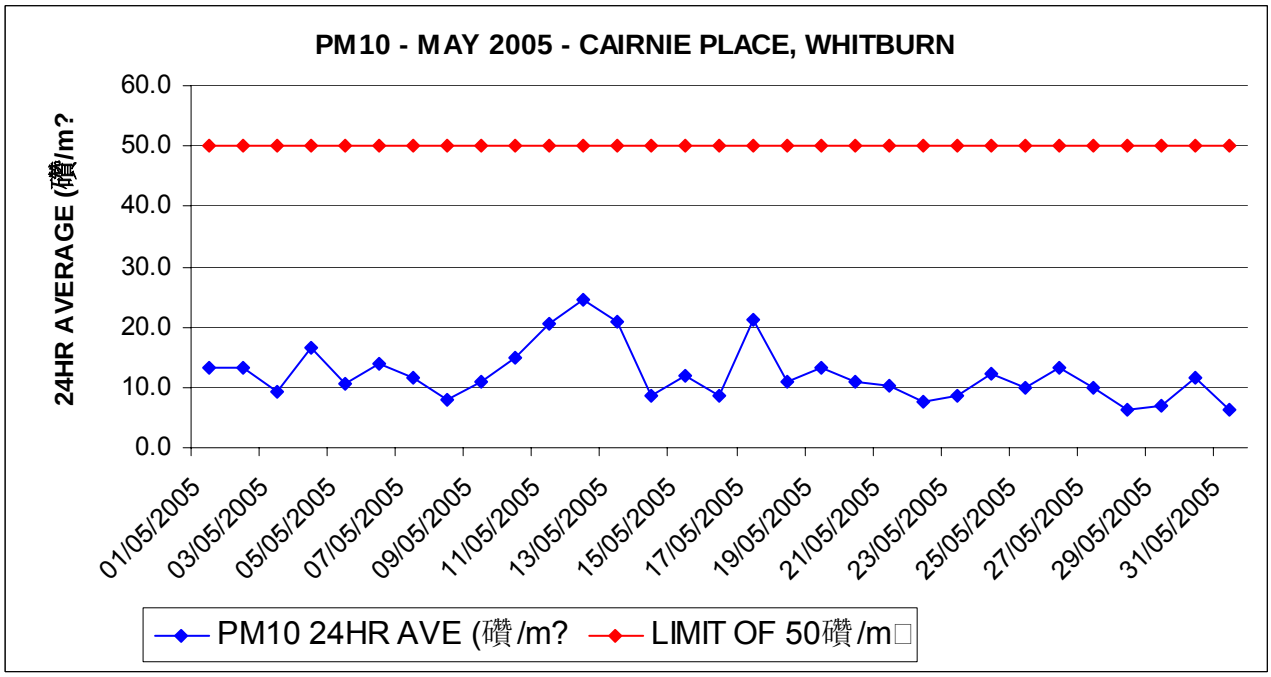


Figure 6.5 – Cairnie Place, Whitburn – June 2005

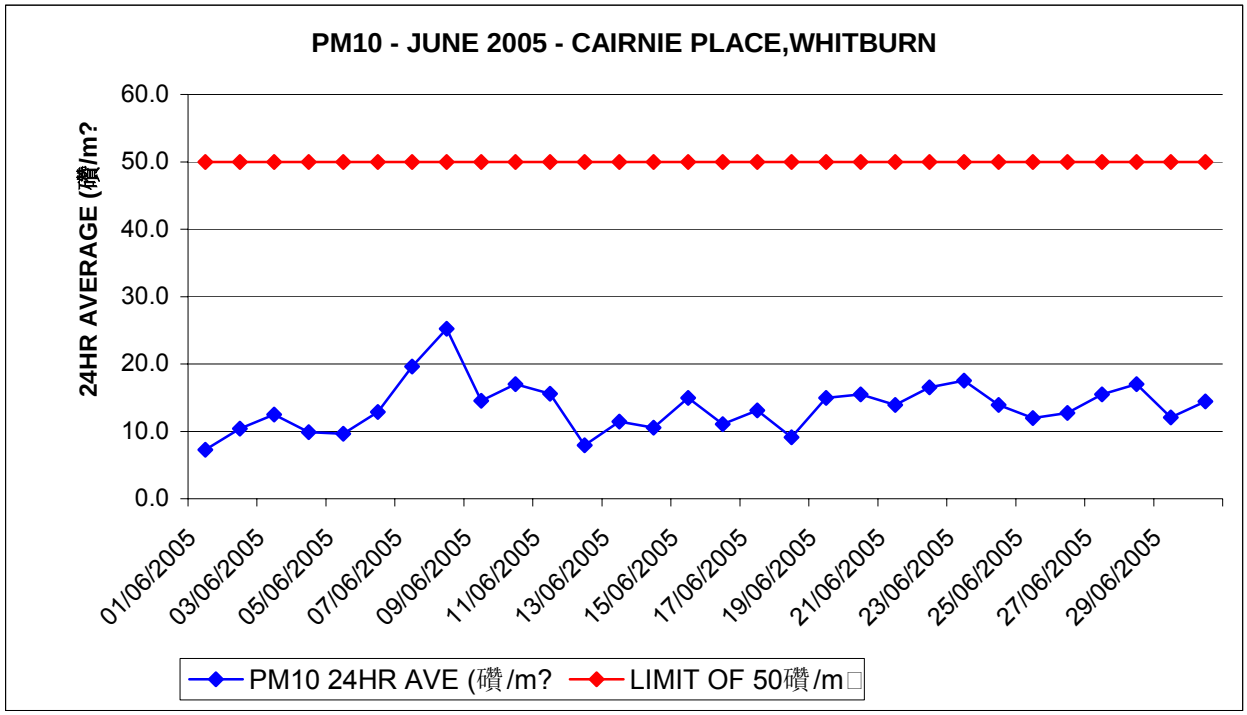


Figure 6.6 – Cairnie Place, Whitburn – July 2005

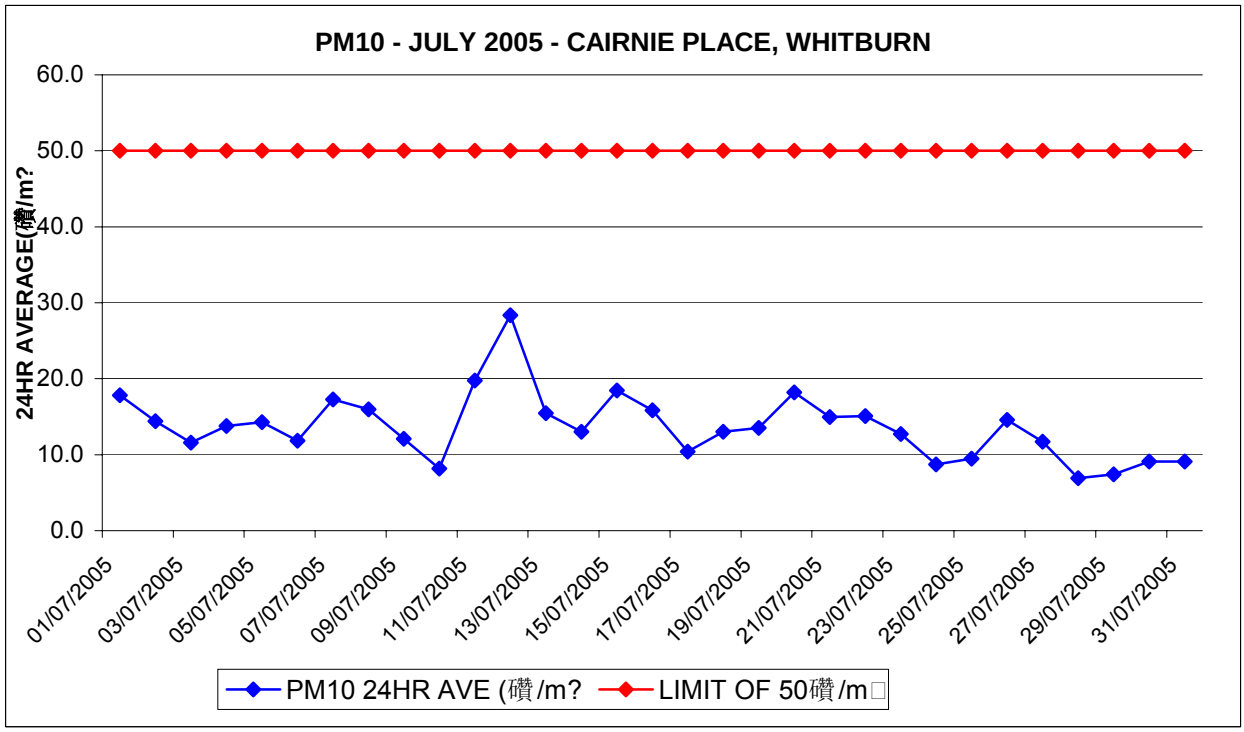


Figure 6.7 – Cairnie Place, Whitburn – August 2005

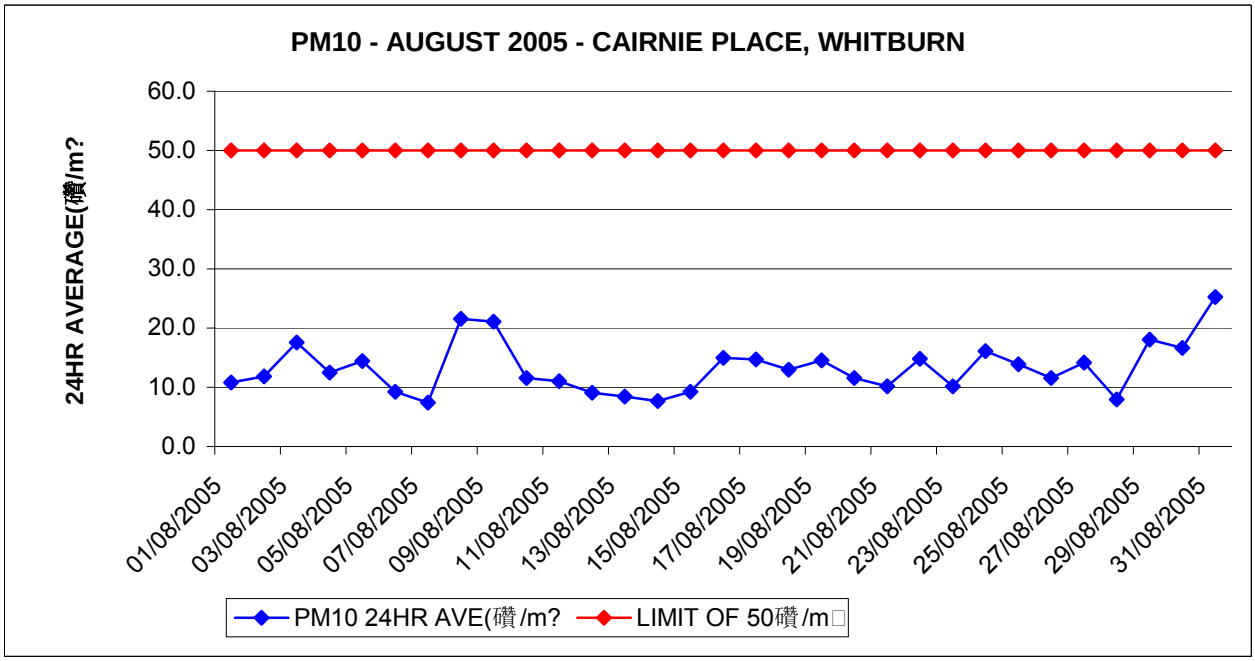


Figure 6.8 – Cairnie Place, Whitburn – September 2005

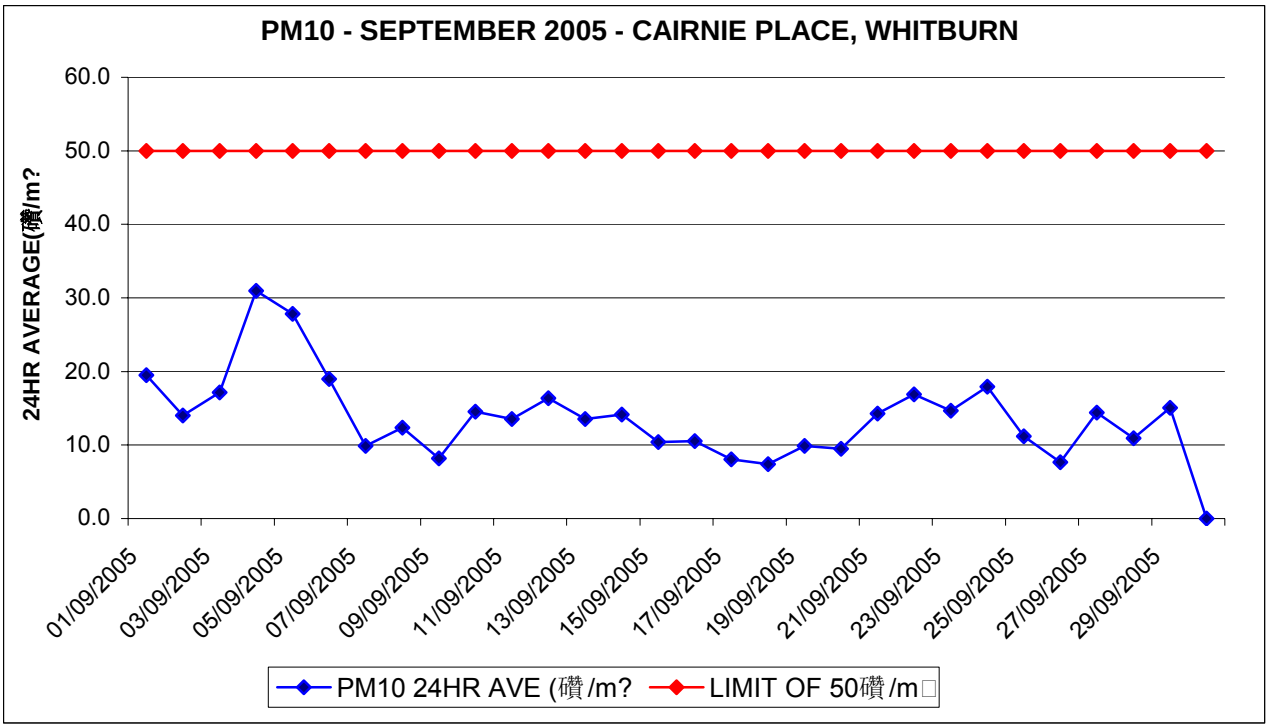


Figure 6.9 – Cairnie Place, Whitburn – October 2005

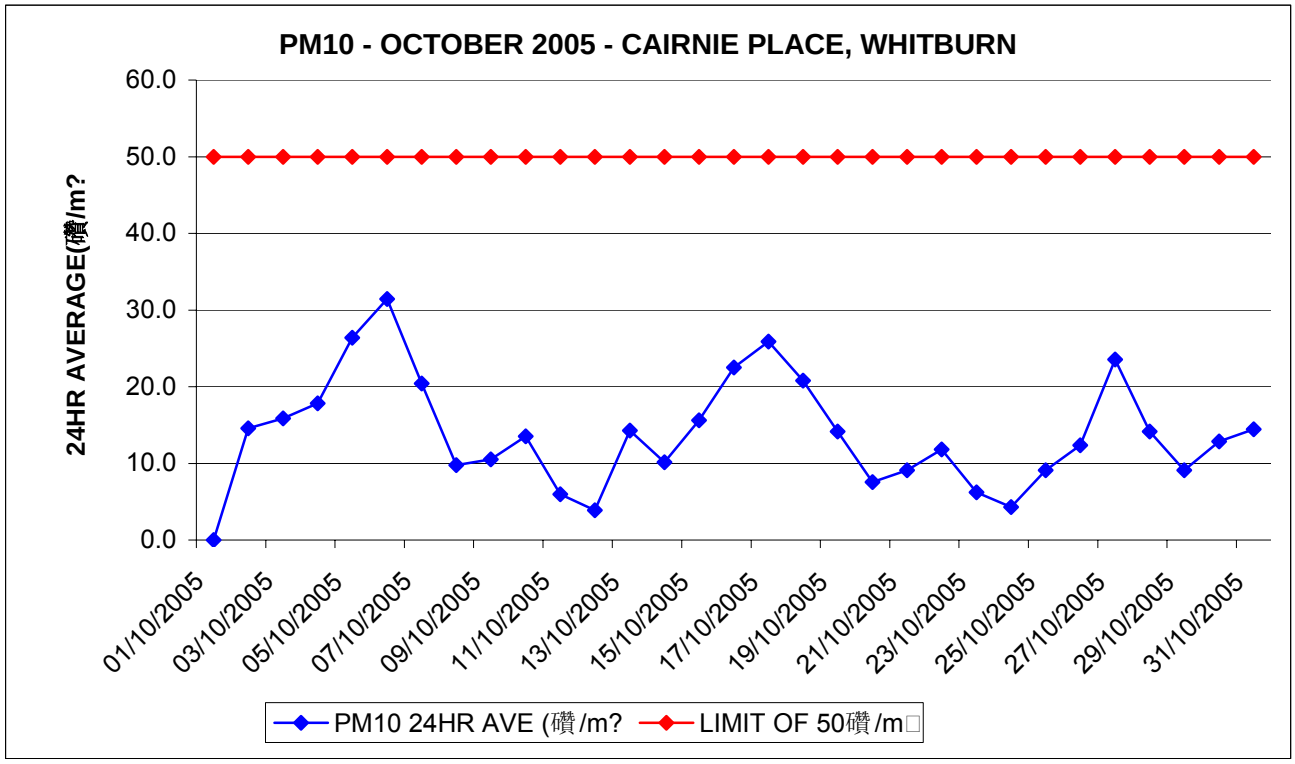


Figure 6.10 – Cairnie Place, Whitburn – November 2005

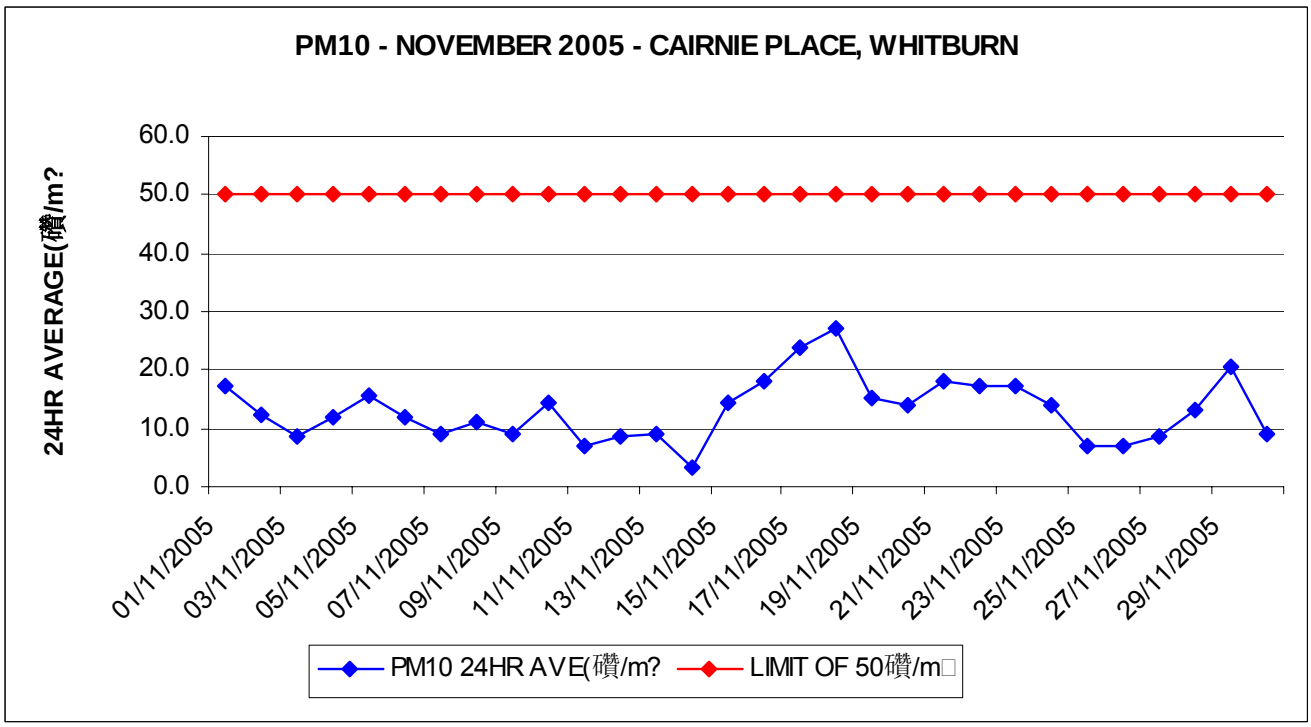


Figure 6.11 – Cairnie Place, Whitburn – December 2005

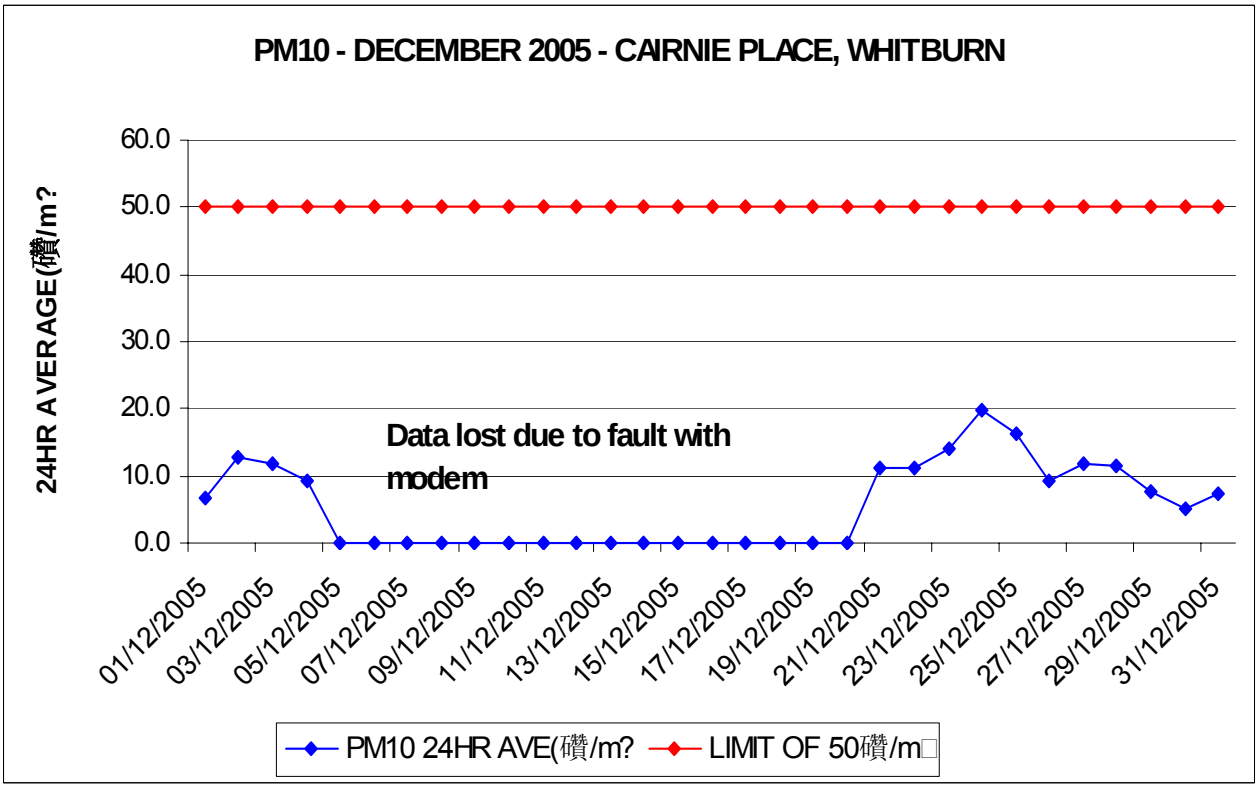


Figure 6.12 – Cairnie Place, Whitburn – January 2006

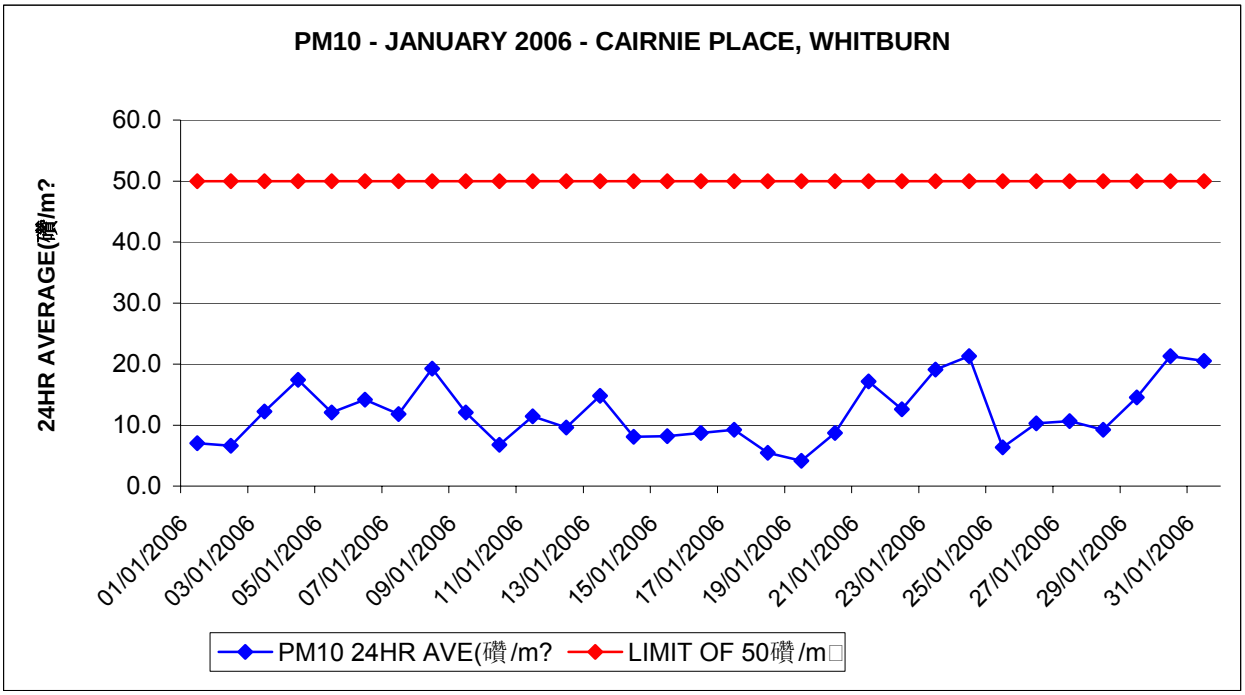


Figure 6.13 – Cairnie Place, Whitburn – February 2006

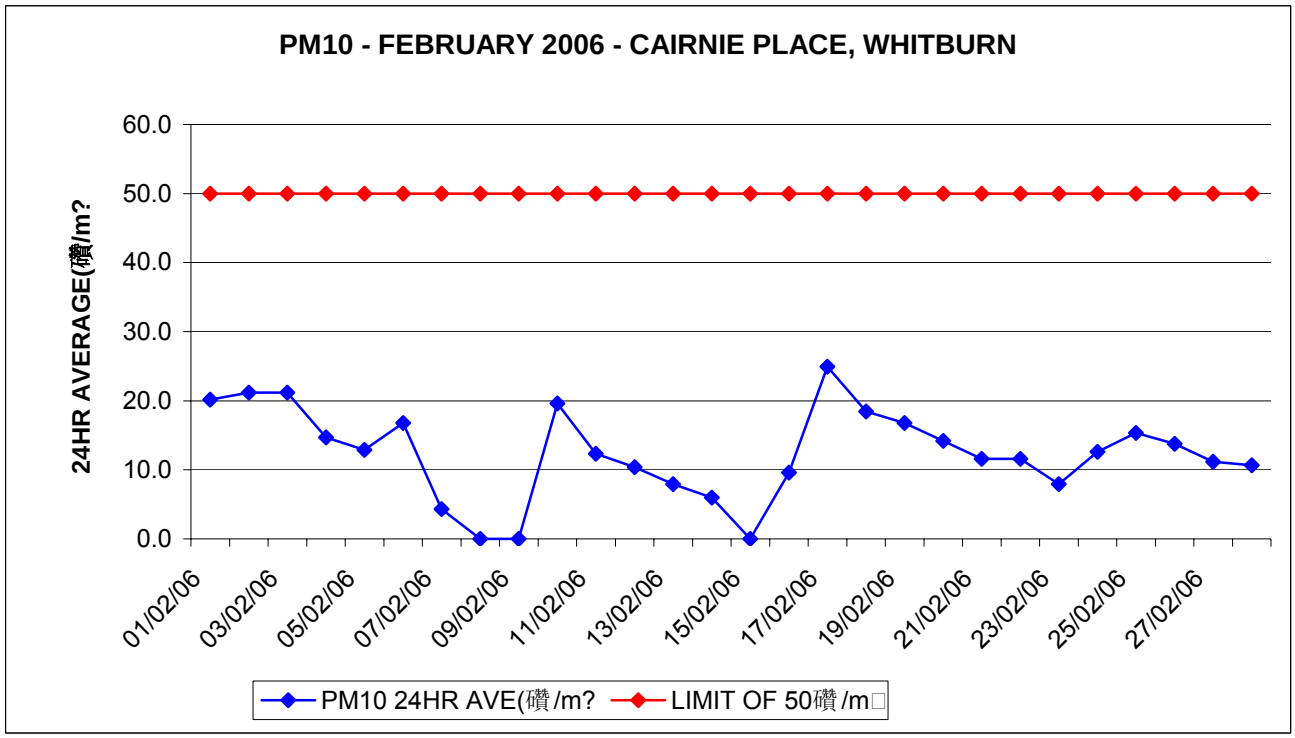
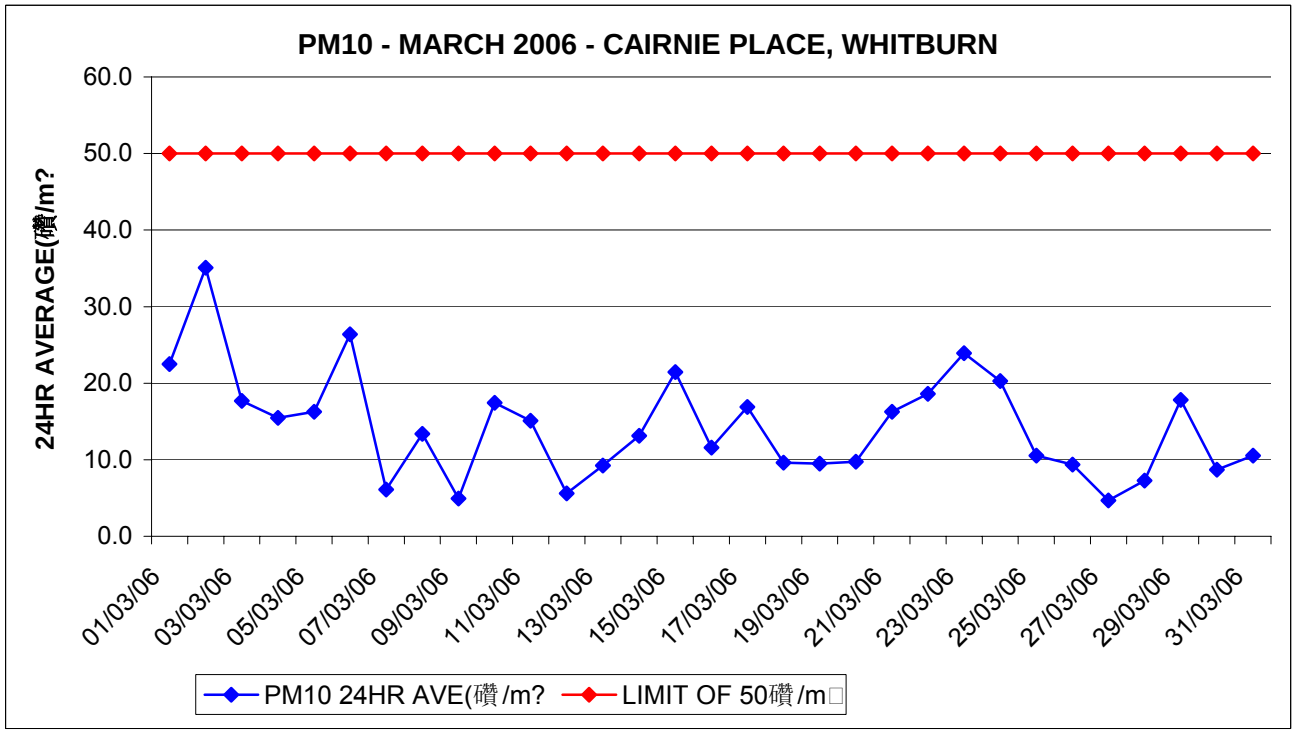


Figure 6.14 – Cairnie Place, Whitburn – March 2006



8.5 PM_{10} – Cairnie Place, Whitburn – Feb 2005 to March 2006 Monthly & Annual Average

As the figures 6.1 to 6.14 show there were no exceedences of the 24-hour objective and therefore the 24-hour objective for 2010 is unlikely to be exceeded. Some data was lost from the Groundhog from 5th to 20th December 2005 due to the Gsm modem having to be replaced. There were also power cuts at the Groundhog on 8th, 9th and 15th February 2006 when data was also lost. The monthly and annual average results for PM_{10} can be seen below.

Table 6.1 – monthly and annual averages for PM_{10} – February 2005 to March 2006

MONTHLY AVERAGE	PM_{10} (µg/m³)
February 2005	12
March 2005	16
April 2005	15
May 2005	12
June 2005	14
July 2005	14
August 2005	13
September 2005	14
October 2005	14
November 2005	13
December 2005	11
January 2006	12
February 2006	12
March 2006	14
Annual Average (1.3 factor)	**13µg/m³**
Annual Average (1.14 factor)	**11.4µg/m³**

Table 6.1 shows an annual average of 13µg/m³when multiplied by the 1.3 default factor and an annual average of 11.4µg/m³ when multiplied by the 1.14 default factor. The PM_{10} 2010 objective of 18µg/m³ is therefore being achieved.

8.6 PM_{10} RESULTS – ROMON, LINLITHGOW HIGH ST

Figure 6.15 – Romon, Linlithgow High St – 24/12/2005 to 31/12/2005

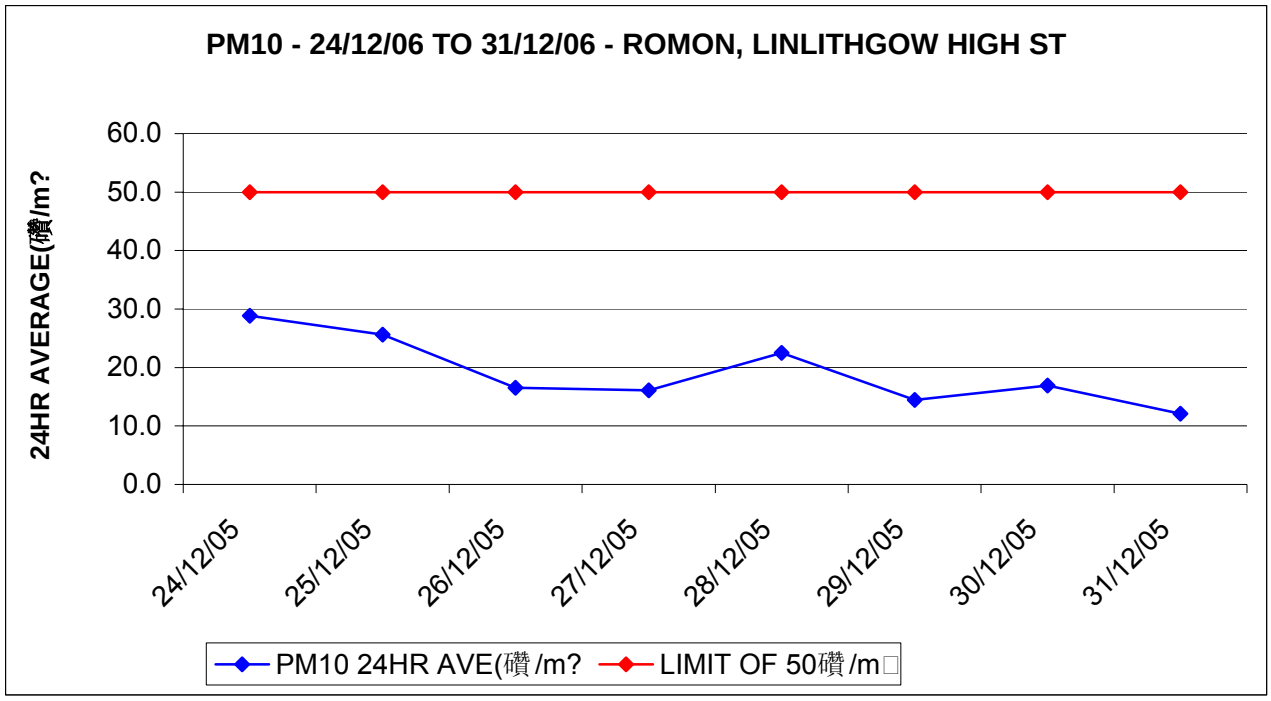


Figure 6.16 – Romon, Linlithgow High St – January 2006

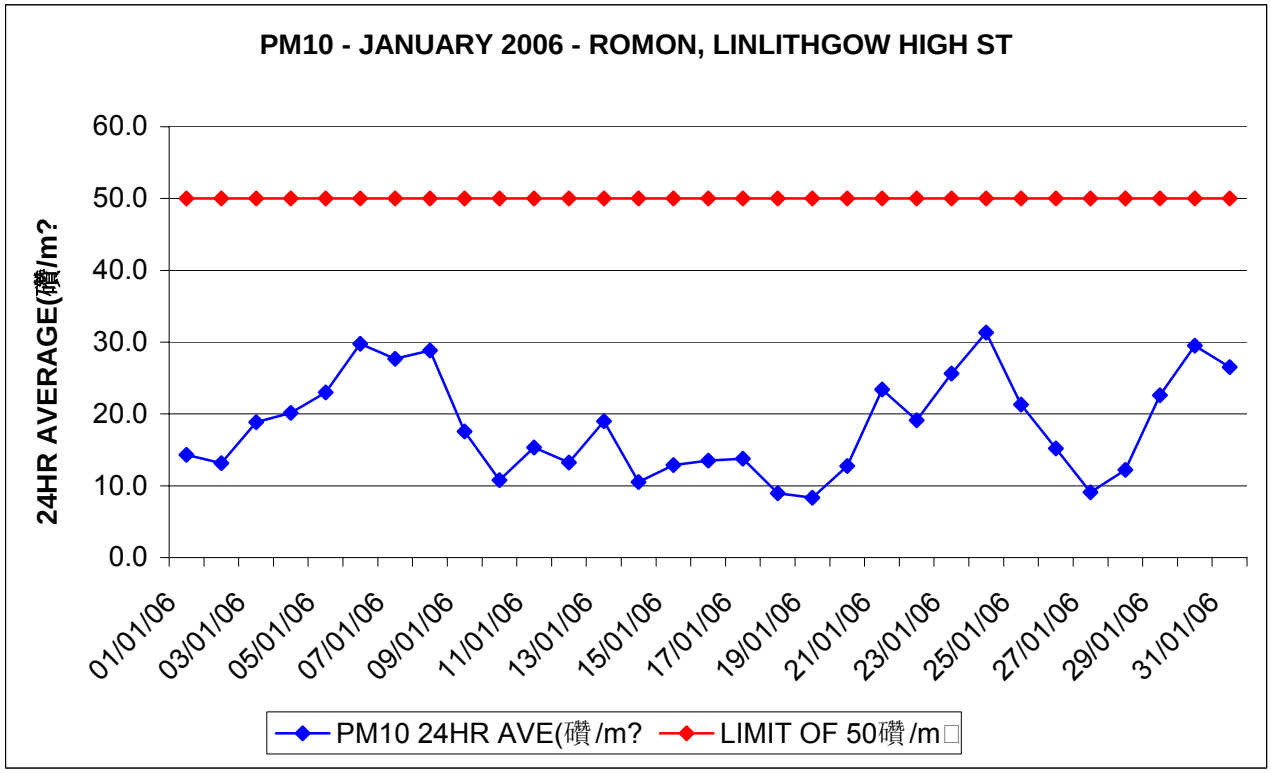


Figure 6.17 – Romon, Linlithgow High St – February 2006

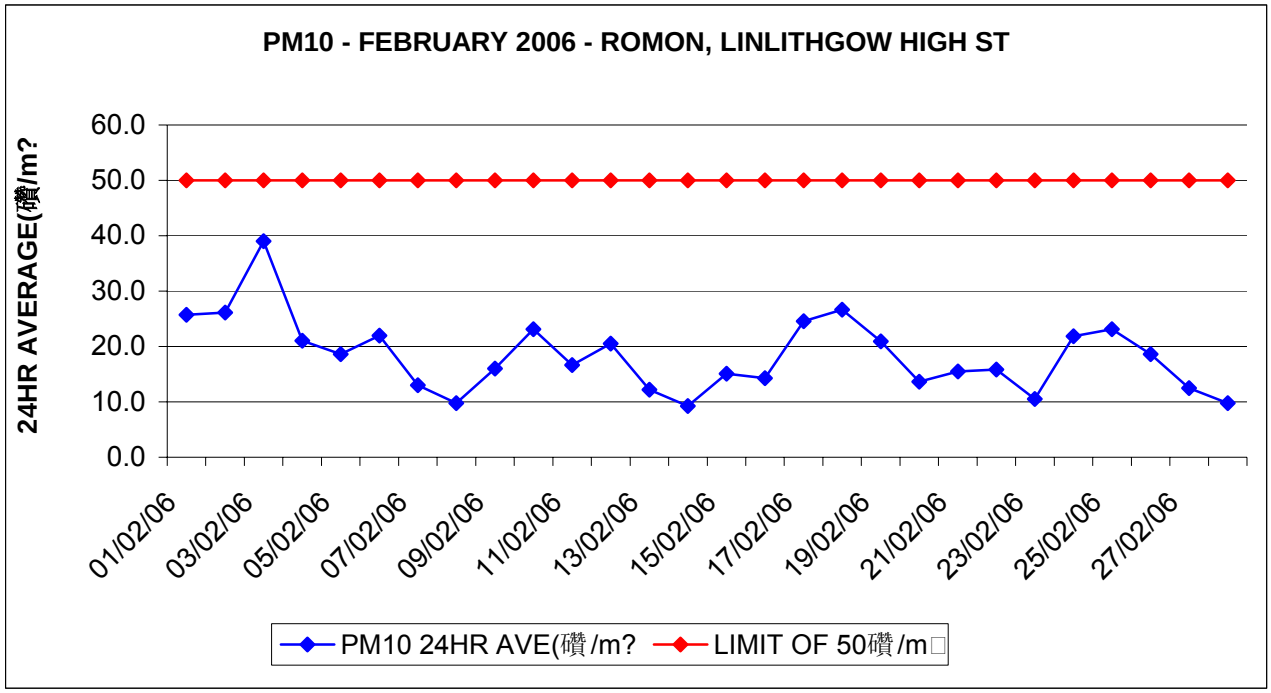


Figure 6.18 – Romon, Linlithgow High St – March 2006

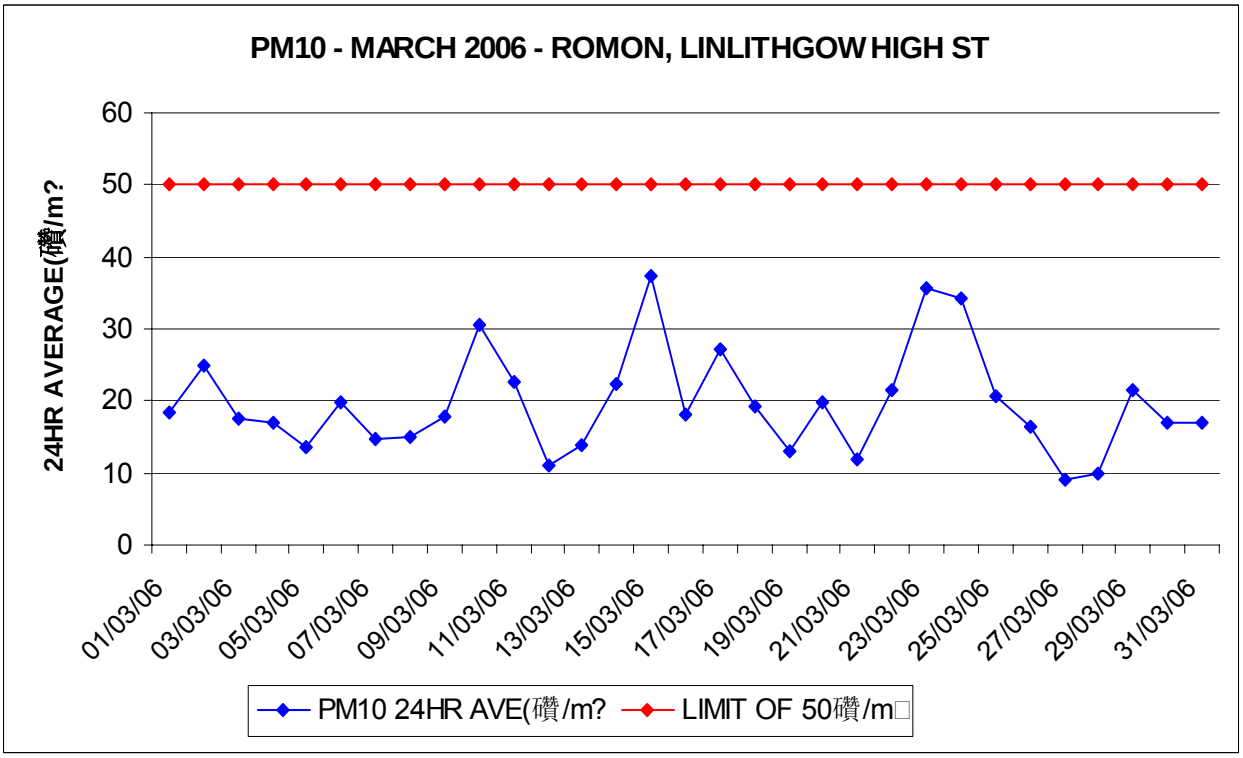


Figure 6.19 – Romon, Linlithgow High St – April 2006

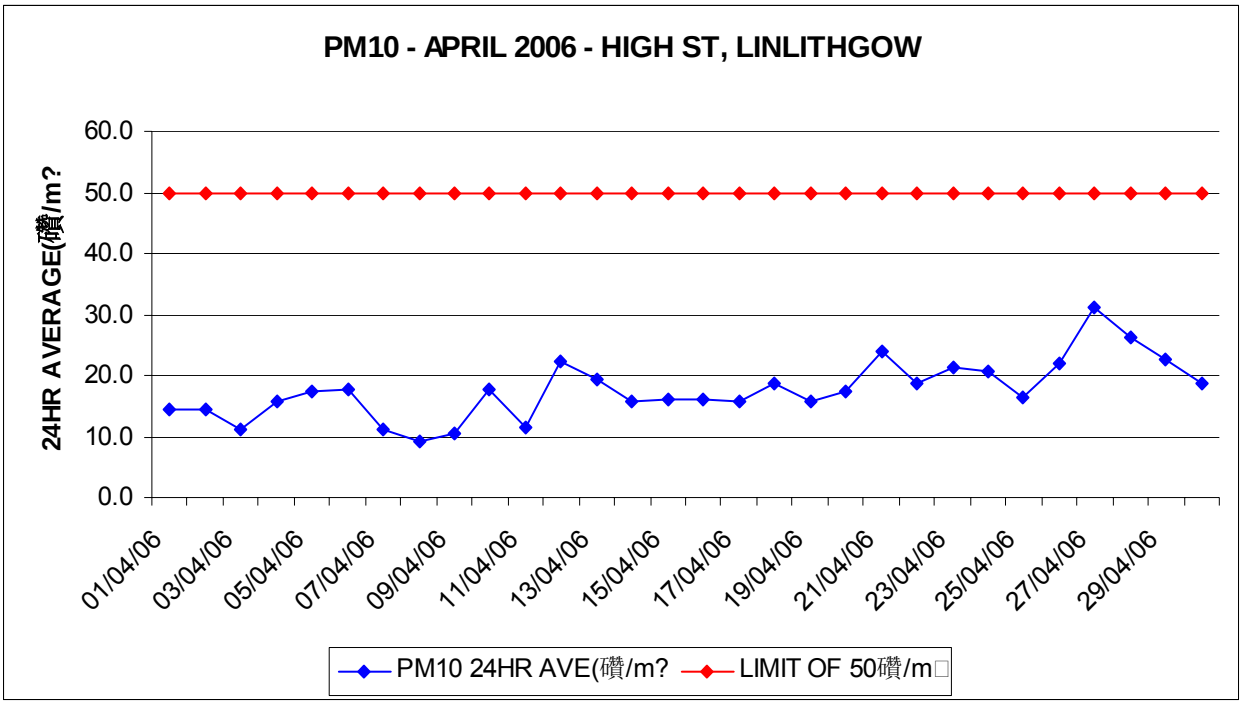
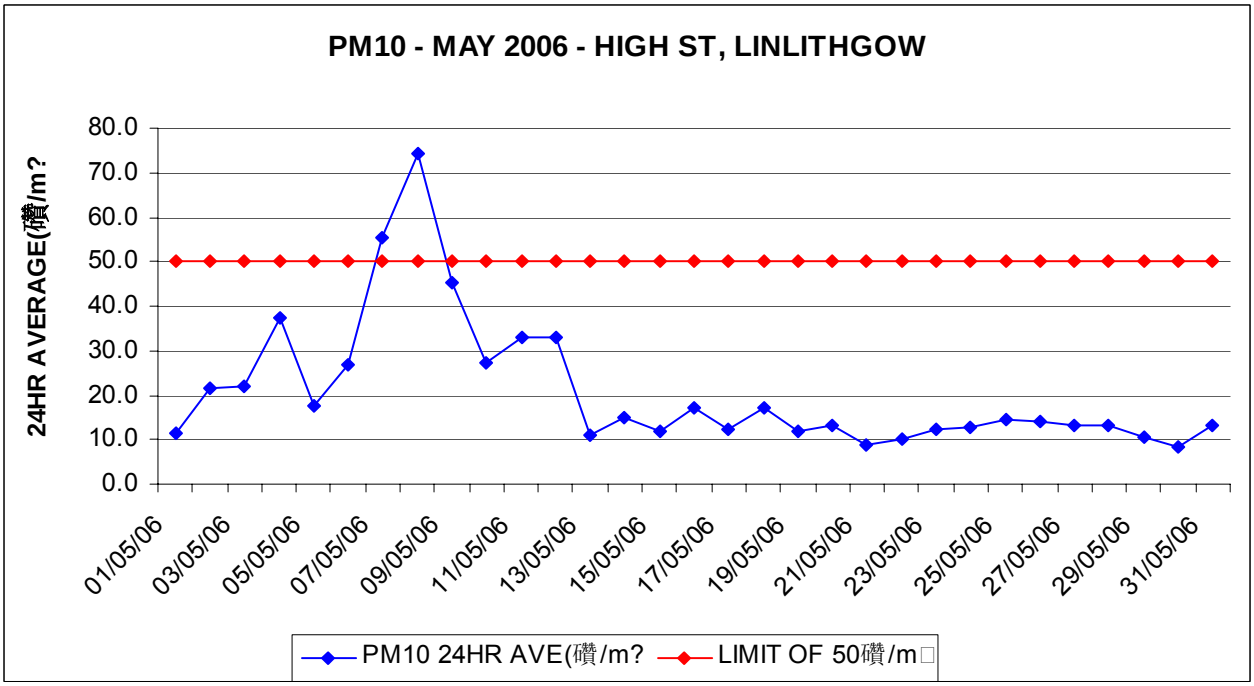


Figure 6.20 – Romon, Linlithgow High St – May 2006



8.7 PM_{10} – Romon, Linlithgow High St – 24th December 2005 to 31st March 2006

Table 6.2 - Monthly & Period mean Average

Monthly average	PM_{10} (µg/m³)
December 2005	19.1
January 2006	18.3
February 2006	18.4
March 2006	19.7
April 2006	17.6
May 2006	20.8
Period mean (1.3 factor)	**18.9**
Period mean (1.14 factor)	**17**

Table 6.2 shows a period mean of 18.9µg/m³when multiplied by the 1.3 default factor and a period mean of 17µg/m³ when multiplied by the 1.14 default factor. In previous reports where the Groundhog has been located at Linlithgow High St, particularly over the winter months this has also shown higher readings.

The monitoring equipment in Linlithgow was not installed until late December 2005. This means that data is available for only 6 months (December 2005 to May 2006). This period includes winter, when particulates from traffic may be higher due to colder operating conditions. In addition, monitors throughout Scotland detected PM10 exceedences on 7 to 8 May 2006. This was believed to be caused by large scale crop stubble burning in northern Russia. The view of the Scottish Executive is sought as to whether as a national event, these readings will be discounted for local air quality management purposes.

Further monitoring will continue at Linlithgow High Street.

8.8 Updating and Screening Assessment Summary Checklist for PM_{10}

Item	Response
BB) Monitoring data outside an AQMA	This authority currently has two PM_{10} monitors (TEOM) at roadside locations. All 24hr mean data has been multiplied by 1.3 as per guidance and the annual average has been multiplied by 1.3 and 1.14. Cairnie Place had an annual mean of 13µg/m³ and Linlithgow High St had an average of 18.9µg/m³, but this was only over 6 months. It is unlikely that the PM_{10} objectives will be exceeded at either location, as there have been two exceedences at Linlithgow High St but this is associated with a national PM10 event. There have been no exceedences at Cairnie Place in the last 12 months.
CC) Monitoring data within an AQMA	Not applicable as no AQMA for PM_{10}
DD) Busy roads and junctions in Scotland	Not applicable
EE) Junctions.	Not applicable
FF) Roads with high flow of buses and/or HGVs.	Not applicable
GG) New roads constructed or proposed since last round of R&A	Not applicable – no new roads have been constructed or proposed since 1st & 2nd Stage review & assessment.
HH) Roads with significantly changed traffic flows, or new relevant exposure.	Not applicable
II) Roads close to the objective during the second round of Review and Assessment	Not applicable
JJ) New industrial sources.	Not applicable – there are no new industrial sources
KK) Industrial sources with substantially increased emissions, or new relevant exposure	Not applicable – there are no industrial sources with substantially increased emissions of PM_{10}
LL) Areas of domestic solid	This was reviewed in the 1st and 2nd stage review & assessment

fuel burning	of air quality. No significant areas of domestic coal burning were identified and there has been no change to this
MM)Quarries / landfill sites / opencast coal / handling of dusty cargoes at ports etc.	Reclamation work is currently in progress at the former Polkemmet Colliery, but there have been no exceedences of either the monthly or annual objective for PM_{10} at Cairnie Place, Whitburn.
NN) Aircraft	There are no airports within this authority

8.9 CONCLUSION FOR PM_{10}

The real-time monitoring data results for PM_{10} at Cairnie Place, Whitburn and High Street, Linlithgow indicates that in West Lothian the standards for PM_{10} are being achieved and that the 2010 objective will be achieved. Linlithgow High Street had a period mean of 18.9µg/m³ (when applied by 1.3 factor but an average of 17µg/m³ when applied by 1.14 factor) but this is only over a period of six months. Although this is above the 2010 objective of an annual mean of 18µg/m³, monitoring of PM_{10} will continue for at least 6 months as recommended in TG (03), pg 37 updated guidance.
There were only two exceedences of the 24-hr objective of 50µg/m³ for High Street, Linlithgow. These exceedences occurred on 7th & 8th May 2006 but this is associated with a national PM10 event..
It is concluded that there is no need to proceed to a detailed assessment for PM_{10} but real-time monitoring will continue at Cairnie Place, Whitburn and High Street, Linlithgow.

9.0 Review & assessment for Sulphur dioxide

9.1 INTRODUCTION

Monitoring for sulphur dioxide has continued using the real-time analyser located in the Groundhog and with two 8-port bubblers used for measuring daily levels of sulphur dioxide. The 8-port bubblers are located at Atlas Cottages, Armadale and Brucefield Church, Whitburn. There is no longer a national air-quality network for sulphur dioxide and this ceased on 31.12.2005. Therefore the 8-port bubbler at Brucefield Church, Whitburn was removed on 4th January 2006. This 8-port bubbler was then located at Netherton Place, Whitburn for monitoring near to Polkemmet Colliery. West Lothian has been working in partnership with SEPA since March 2005 at Atlas Cottages as they supplied a real-time analyser to monitor 15min, 1hr and 24hr averages at Atlas Cottages.

9.2 Standard and Objective for Sulphur Dioxide

The Air Quality (Scotland) Regulations 2000 and amendment regulations 2002 set the following objectives: -

- **1-hour mean of 350µg/m³ not to be exceeded more than 24 times a year**
- **24-hour mean of 125µg/m³ not to be exceeded more than 3 times a year**
- **15-minute mean of 266µg/m³not to be exceeded more than 35 times a year**

9.3 MONITORING DATA RESULTS

Figures 7.1 to 7.3 show the monthly maximum for the 15-min mean, 1-hr mean and 24-hr mean for sulphur dioxide from February 2005 to March 2006 when the Groundhog was located at Cairnie Place, Whitburn.

Figure 7.1 – Cairnie Place – February 2005 to March 2006 – 15min mean monthly max

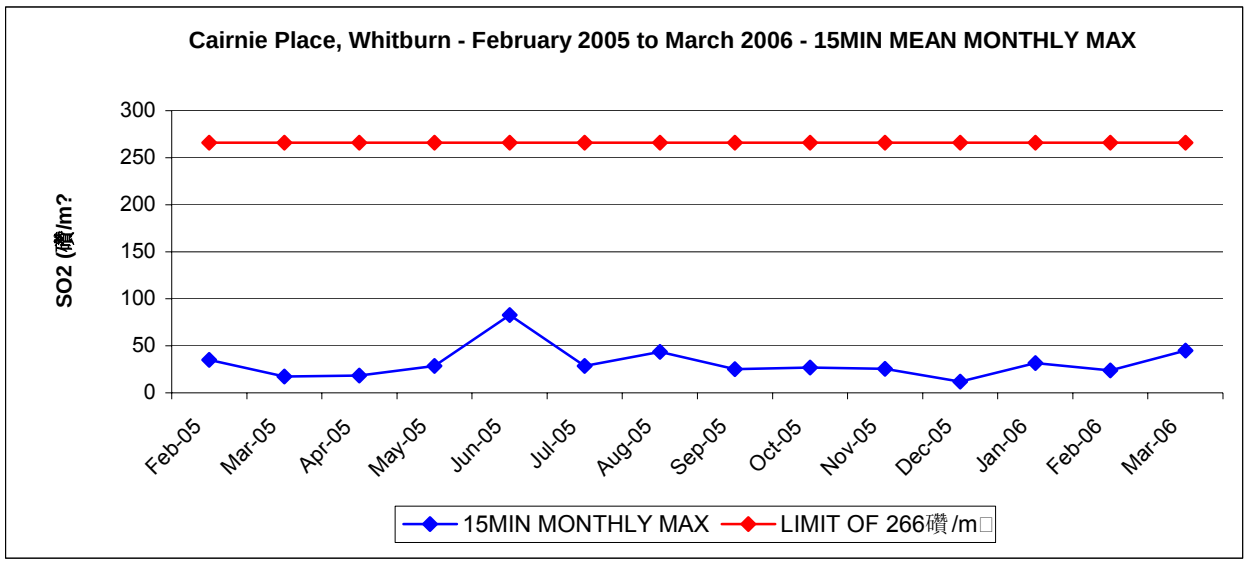


Figure 7.2 – Cairnie Place – February 2005 to March 2006 – 1hr mean monthly max

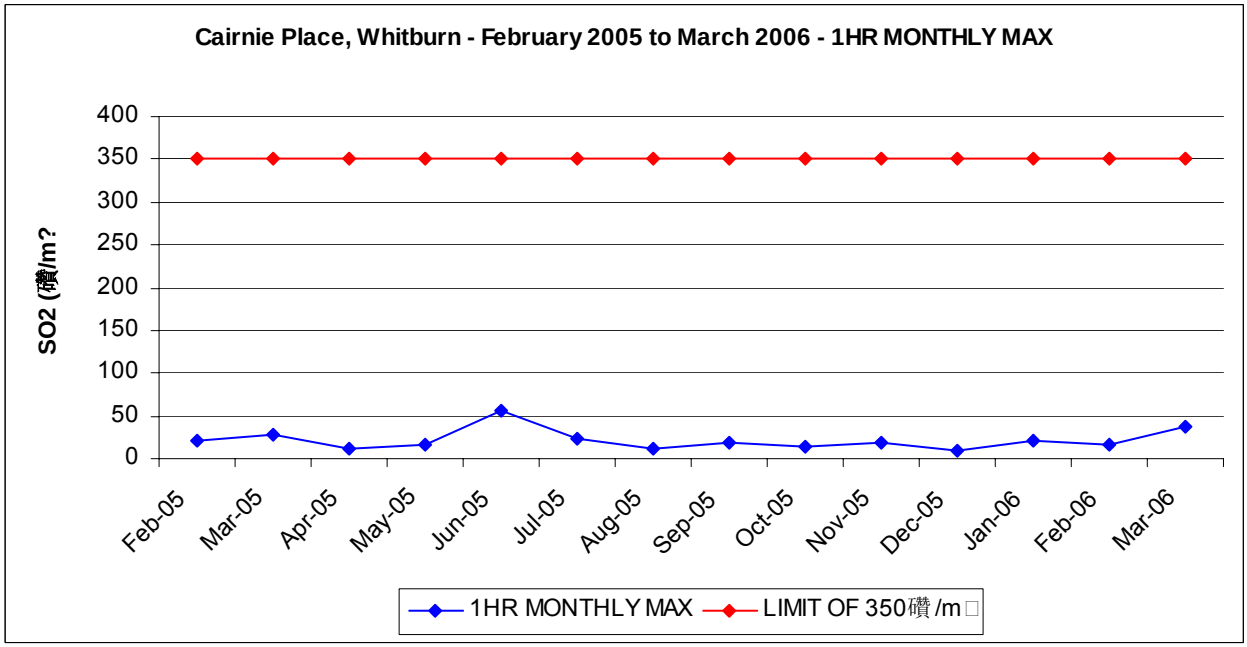
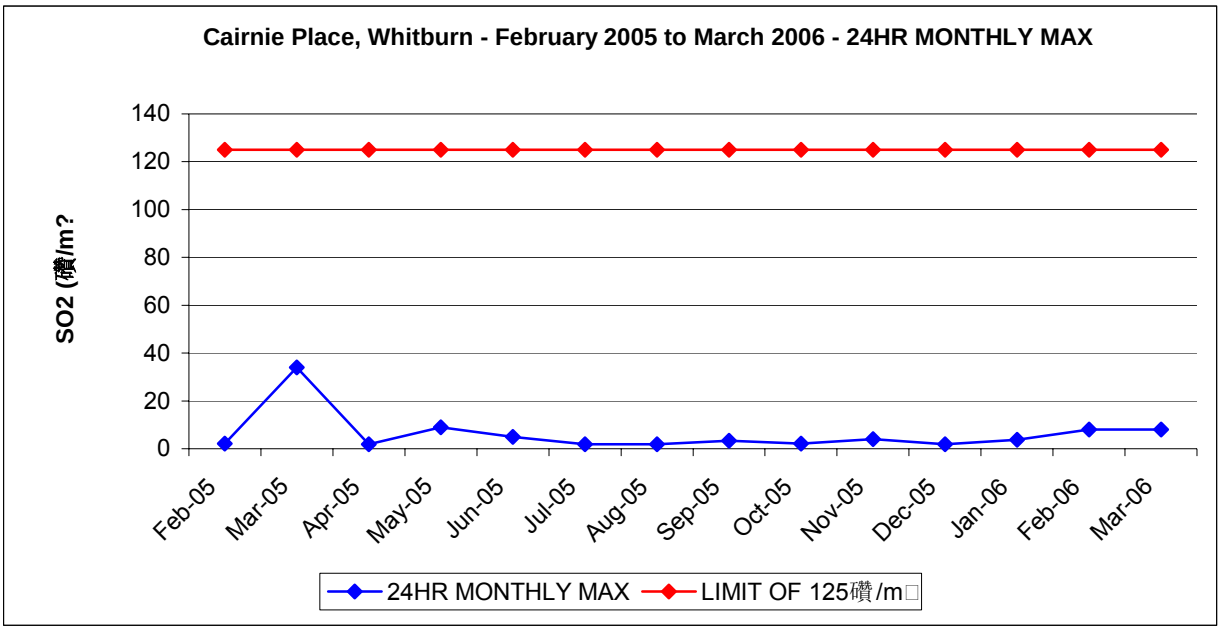


Figure 7.3 – Cairnie Place – February 2005 to March 2006 – 24hr mean monthly max



It can be seen from the graphs (figs 7.1 to 7.3) that from February 2005 to March 2006 there have been no exceedences for any of the three objectives for sulphur dioxide.

9.4 8-port Bubbler Sulphur Dioxide Results

Figures 7.4 & 7.5 show the monthly maximum daily 24-hour levels for the two 8-port bubblers. The maximum daily mean concentration for readings over 100µg/m³ has been multiplied by 1.25 to take account of a tendency for the bubblers to under-read at high concentrations as recommended by the review and assessment help desk.

There is no longer a national network for the 8-port bubblers and therefore the bubbler at Brucefield Church was removed on 04/01/2006.

Environmental Health currently has two bubblers located at Atlas Cottages, Armadale and Netherton Place, Whitburn. The results shown are from March 2005 to February 2006 for Atlas Cottages and from March 2005 to December 2005 for Brucefield Church.

Figure 7.4 – Atlas Cottages, Armadale – monthly maximum 24-hour level

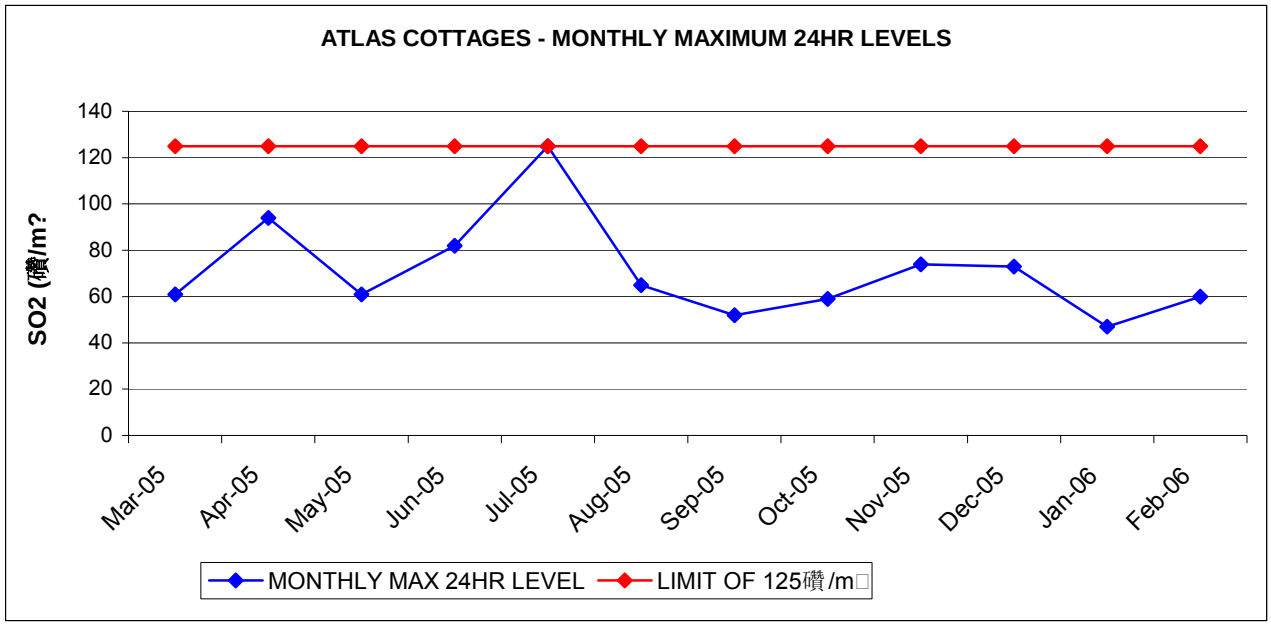
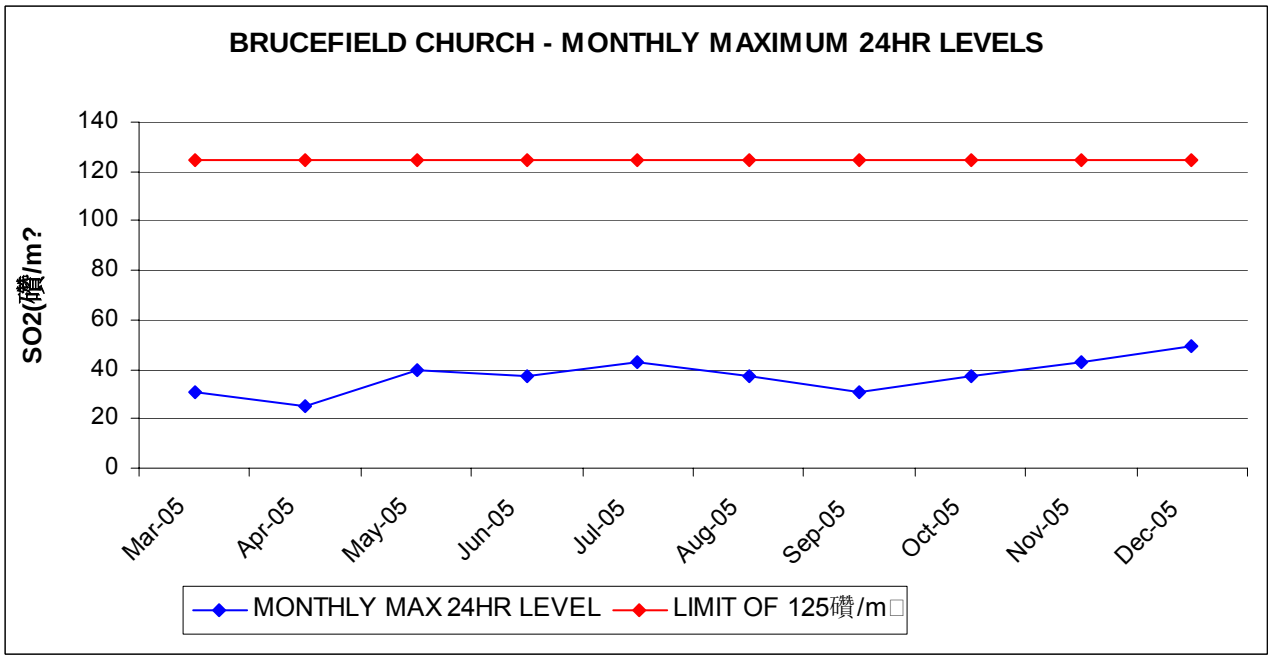


Figure 7.5 – Brucefield Church, Whitburn – monthly maximum 24-hour level



9.5 *Figure 7.6 - SEPA Real-time analyser & 8-port bubbler results – Atlas Cottages - 5th March 2005 to 16 March 2006*

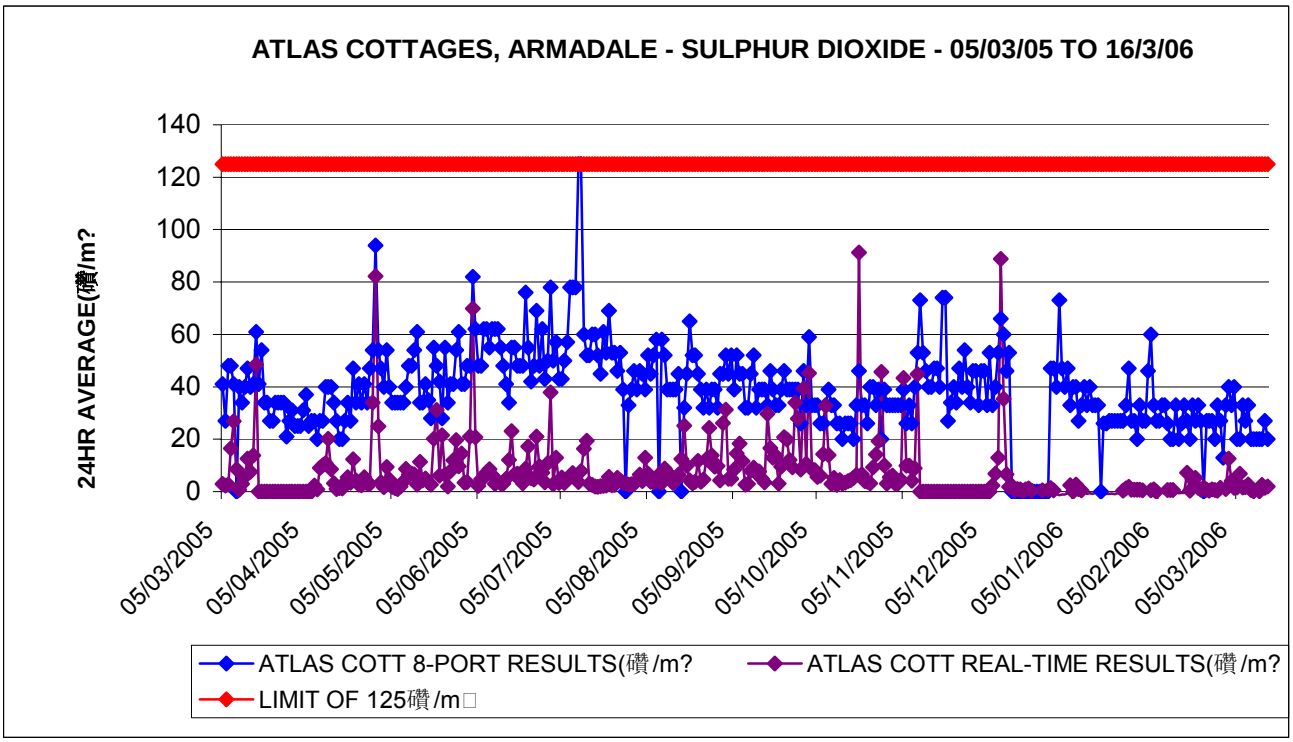


Figure 7.6 above shows that the real-time analyser located at Atlas Cottages has not had any exceedences of the 24-hr objective. The 8-port bubbler results are consistently higher than those detected by the SEPA real time analyser.

The 8-port bubbler did have two exceedences on 11th and 12th July 2005 but the real-time analyser did not indicate these exceedences. This would appear to be the result of the 8-port bubbler over reading levels of sulphur dioxide. This is exacerbated by the multiplication of any readings over 100µg/m3 by 1.25 in accordance with technical guidance. Therefore no action is being planned in response to these two exceedences.

West Lothian would like to take this opportunity to thank SEPA for their assistance in carrying out this study to establish the relationship between the bubbler results and those of a real-time analyser. West Lothian is currently awaiting a report from SEPA's statisticians.

9.6 Updating and Screening Assessment Summary Checklist for Sulphur Dioxide

Item	Response
OO) Monitoring data outside an AQMA	This authority currently has one real-time SO_2 analyser at a roadside location. There have been no exceedences of any of the three objectives for sulphur dioxide. This authority also currently has two 8-port bubblers located at Atlas Cottages, Armadale and Netherton Place, Whitburn. A real-time analyser was located at Atlas Cottages on 4th March 2005 by SEPA as a co-location study with the 8-port bubbler. This study has indicated that the 8-port bubbler does tend to over-read levels of sulphur dioxide.
PP) Monitoring data within an AQMA	Not applicable as no AQMA for sulphur dioxide
QQ) New industrial sources.	Not applicable – there are no new industrial sources
RR) Industrial sources with substantially increased emissions, or new relevant exposure	Not applicable – there are no new industrial sources with substantially increased emissions
SS) Areas of domestic coal burning	There are no areas in West Lothian where significant coal burning takes place as most houses in West Lothian now have gas or electric central heating.
TT) Small Boilers > 5 MW (thermal).	There are no boiler plants in West Lothian that burn coal or fuel oil. St John's Hospital boilers run on gas with a backup of fuel oil in case the system breaks down.
UU) Shipping	Not applicable as there is not a harbour in West Lothian.
VV) Railway Locomotives	Not applicable as all trains in West Lothian are passing through and do not stop at the station for any length of time.

9.7 CONCLUSION FOR SULPHUR DIOXIDE

The real-time monitoring data for sulphur dioxide indicates that there is not a problem with this pollutant in West Lothian as there have been no exceedences of the 15min, 1hr or 24hr objective.

The 8-port bubbler located at Atlas Cottages, Armadale next to Caradale, Brickworks has been co-located with a real-time analyser supplied by SEPA since March 2005. The results from this study can be seen on page 51, Fig 7.6. The real-time analyser did not give any exceedences of the 24-hr objective of 125µg/m³. This indicates that the 8-port bubbler does tend to over read levels of sulphur dioxide. Fig 7.6 shows that both the real-time analyser and 8-port bubbler show the same pattern of levels of sulphur dioxide but the two exceedences shown by the 8-port bubbler on the 11th and 12th July 2005 are not revealed by the real-time analyser. The study with SEPA at Atlas Cottages has now been completed and SEPA are due to send a report on their findings to West Lothian. The 8-port bubbler is currently still located at Atlas Cottages and will remain there in the near future.
There is no need for West Lothian Council to proceed to a detailed assessment this year.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions for Benzene

There are no significant industrial sources of benzene located either within West Lothian or neighbouring areas which are likely to adversely affect air quality.

Monitoring has indicated that the two air quality standards and objectives of 16.25µg/m³ for 2003 and 3.25µg/m³ for 2010 are currently being complied with in West Lothian. Monitoring of benzene has been carried out near to the Shell petrol station at the Lizzie Bryce roundabout. This monitoring was carried out over two years and there were no exceedences during this time.

There is no requirement to proceed to a detailed assessment for Benzene.

10.1.1 Recommendation for Benzene

Monitoring of benzene will continue at the existing sites.

10.2 Conclusions for 1,3 – Butadiene

There are no significant industrial sources of 1,3 – butadiene located either within West Lothian or neighbouring areas which are likely to adversely affect air quality.

There is no requirement to proceed to a detailed assessment for 1,3 – butadiene.

10.2.1 Recommendation for 1,3 – Butadiene

There is no need to monitor for this pollutant.

10.3 Conclusions for Carbon monoxide

There are no significant industrial sources of carbon monoxide located either within West Lothian or neighbouring areas which are likely to adversely affect air quality.

Real time monitoring has indicated that the air quality standard and objective of 10mg/m³ is currently being achieved.

10.3.1 Recommendation for Carbon monoxide

Real- time monitoring of Carbon monoxide will continue at Cairnie Place, Whitburn.

10.4 Conclusions for Lead

There are no new industrial sources of lead in West Lothian and no new sources with substantially increased emissions of lead.

There is no requirement to proceed to a detailed assessment.

10.4.1 Recommendation for Lead

No monitoring of lead will be carried out in West Lothian.

10.5 Conclusions for Nitrogen dioxide

Real-time monitoring of Nitrogen dioxide has indicated that there has been no exceedence of the 1-hr mean of 200µg/m³ at Cairnie Place, Whitburn or High Street, Linlithgow. The annual mean of 40µg/m³ is also being achieved at both sites.

There is no requirement to proceed to a detailed assessment.

The Streetbox was co-located with the real-time Nox analyser and Teom analyser at Cairnie Place, Whitburn over a period of six months. The data was sent to SEPA statisticians to assess the suitability of the Streetbox for Local air quality management use. SEPA concluded that the Streetbox may only be used for obtaining monthly NO2 means (and, by assumption, annual means). Therefore, the Streetbox will only be used as a screening tool for monitoring monthly and annual averages of Nitrogen dioxide.

A new site will now be found for the Streetbox, which is likely to be Broxburn town centre, where the highest diffusion tube levels have been obtained.

10.5.1 Recommendation for Nitrogen dioxide

Real-time monitoring for Nitrogen dioxide will continue at Cairnie Place, Whitburn and Linlithgow High Street.

Screening at Broxburn is now to be initiated due to diffusion tube results for 2005.

10.6 Conclusions for PM_{10}

Real-time monitoring of PM_{10} at Cairnie Place, Whitburn has indicated that there has been no exceedence during 2005 of the 24-hr objective of 50µg/m³. An annual average of 13µg/m³ has also been achieved which meets the objective for 2010.

Real-time monitoring of PM_{10} at Linlithgow High Street indicated that there were two exceedences of the 24-hr objective of 50µg/m³. These are likely to have been due to a national PM10 event on 7 to 8 May 2006.
A six-month mean of 18.9µg/m³ (using the 1.3 factor) was obtained which exceeds the 2010 objective. However this was not for a full twelve months (December 2005 to May 2006) and included winter. Further monitoring to give a full year's date is ongoing.

There is no requirement to proceed to a detailed assessment provided that the objective of 18µg/m³ annual mean is not exceeded in Linlithgow High Street.

10.6.1 Recommendation for PM_{10}

Monitoring for PM_{10} will continue at High Street, Linlithgow and Cairnie Place, Whitburn over the next 12 months. The real-time analyser at Cairnie Place, Whitburn is located near to the former opencast colliery at Polkemmet and reclamation work has been underway since 2004 without exceedences.

10.7 Conclusions for Sulphur dioxide

There are no new industrial sources of Sulphur dioxide in West Lothian and no industrial sources with substantially increased emissions of Sulphur dioxide.

The real-time analyser results at Cairnie Place have indicated that there has not been any exceedence of the 1-hour mean of 350µg/m³, the 24-hour mean of 125µg/m³, or the 15-minute mean of 266µg/m³.

West Lothian currently have an 8-port bubbler located at Atlas Cottages, Armadale which showed two exceedences of the 24-hr objective on 12th and 13th July 2005. A real time analyser located by SEPA at the same address did not show any exceedence. For the reasons given on page 51, no action will be taken on these exceedences.

The 8-port bubbler located at Brucefield Church, Whitburn did not indicate any exceedences of the 24-hr objective. This bubbler has now been removed from Brucefield Church, as there is no longer a national network for 8-port bubblers.

There is no requirement to proceed to a detailed assessment.

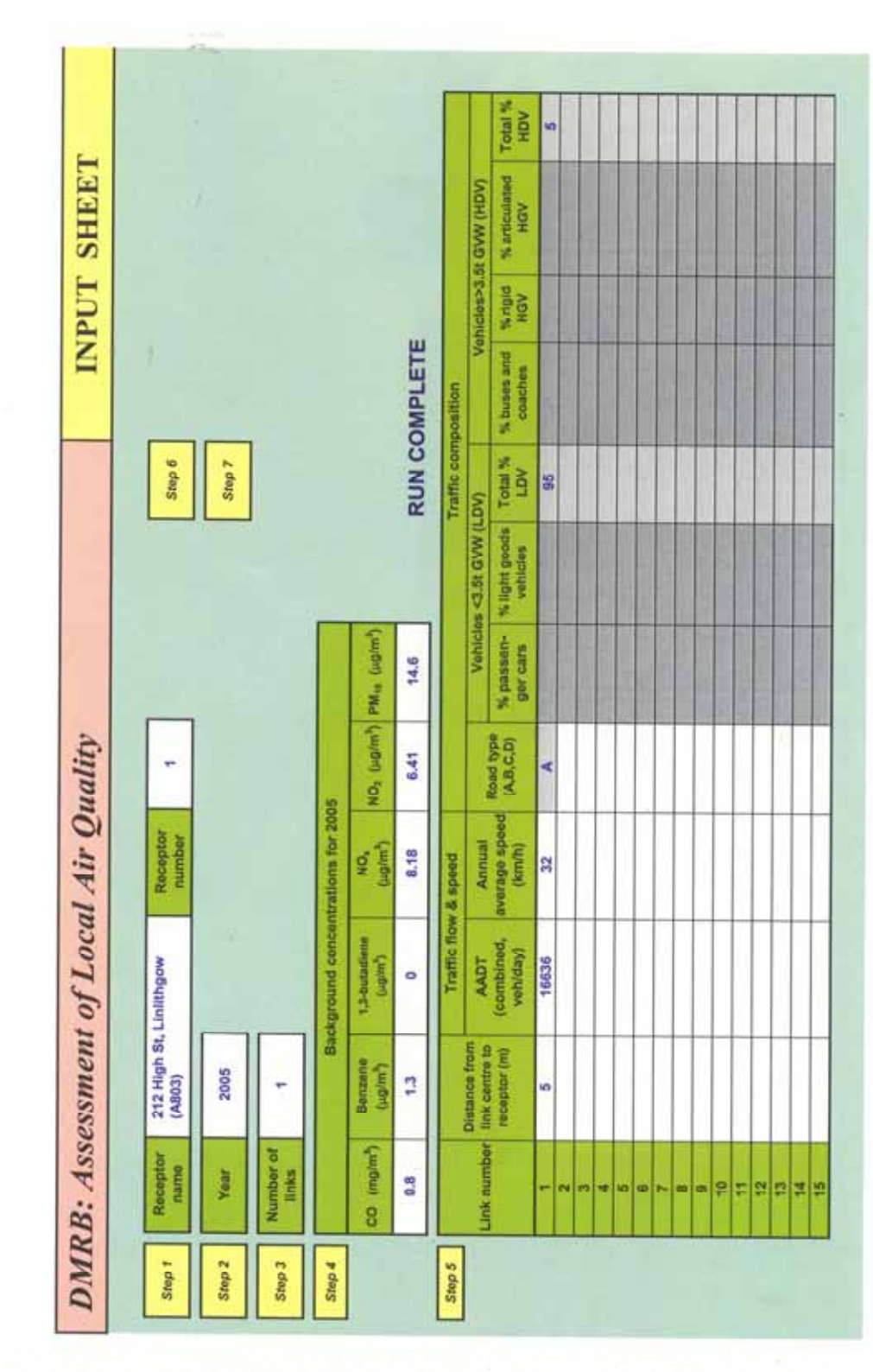
10.7.1 Recommendation for Sulphur dioxide

Monitoring for Sulphur dioxide will continue in the future at Cairnie Place, Whitburn and Atlas Cottages, Armadale.

West Lothian Council are currently considering Broxburn and Livingston for future real-time monitoring of Carbon monoxide, Nitrogen dioxide, Sulphur dioxide and PM_{10}.

Appendix 1.1 – DMRB Models

11.1 DMRB, Linlithgow High St – Input sheet



DMRB: Assessment of Local Air Quality

INPUT SHEET

Step 1 — Receptor name: 212 High St, Linlithgow (A803) | Receptor number: 1

Step 2 — Year: 2005

Step 3 — Number of links: 1

Step 4 — Background concentrations for 2005

CO (mg/m³)	Benzene (µg/m³)	1,3-butadiene (µg/m³)	NO_x (µg/m³)	NO_2 (µg/m³)	PM_{10} (µg/m³)
0.8	1.3	0	8.18	6.41	14.6

Step 5 — Traffic flow & speed; Traffic composition

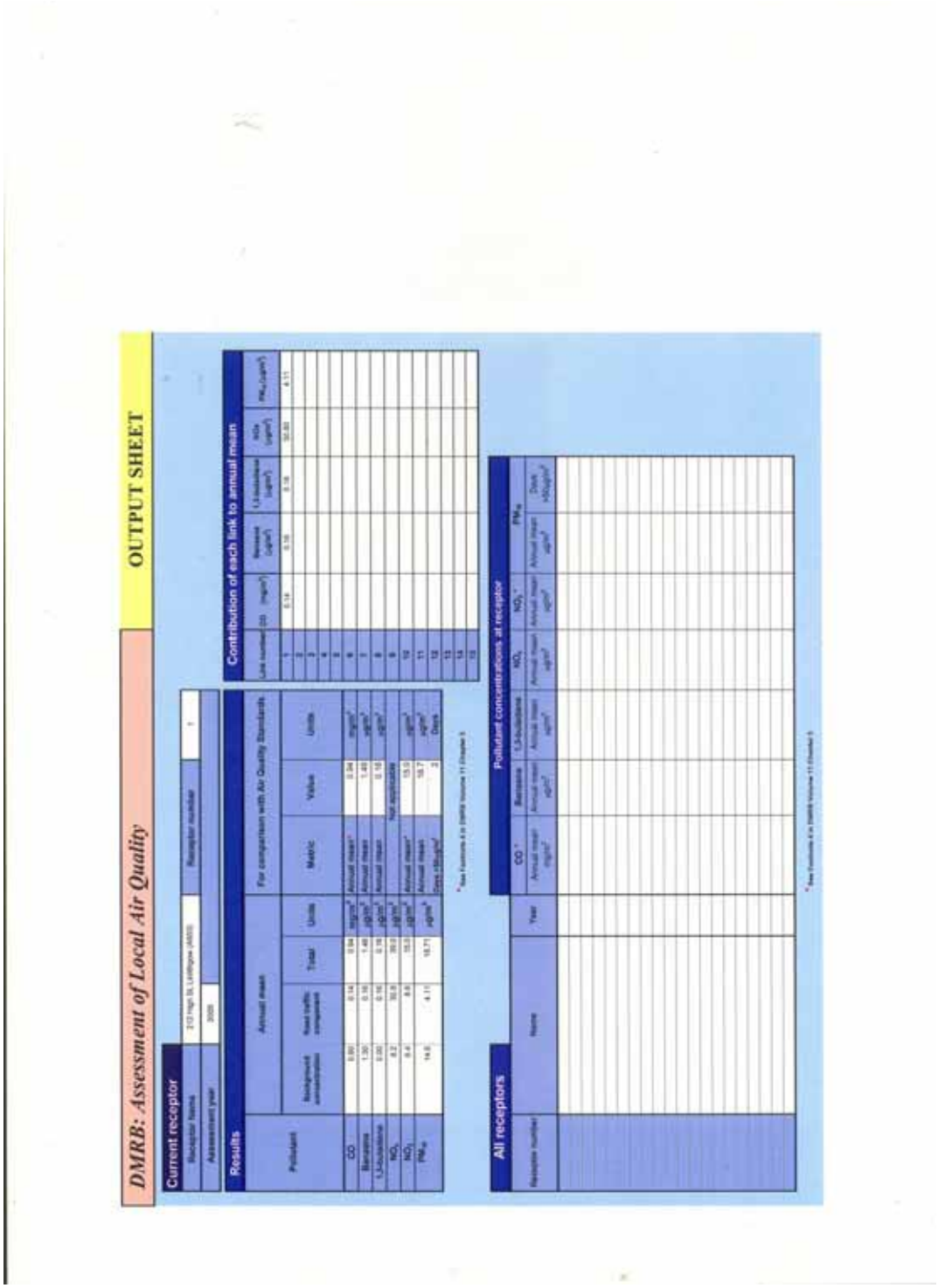
Link number	Distance from link centre to receptor (m)	AADT (combined, veh/day)	Annual average speed (km/h)	Road type (A,B,C,D)	Vehicles <3.5t GVW (LDV): % passenger cars	% light goods vehicles	Total % LDV	Vehicles>3.5t GVW (HDV): % buses and coaches	% rigid HGV	% articulated HGV	Total % HDV
1	5	16636	32	A			95				5
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

Step 6

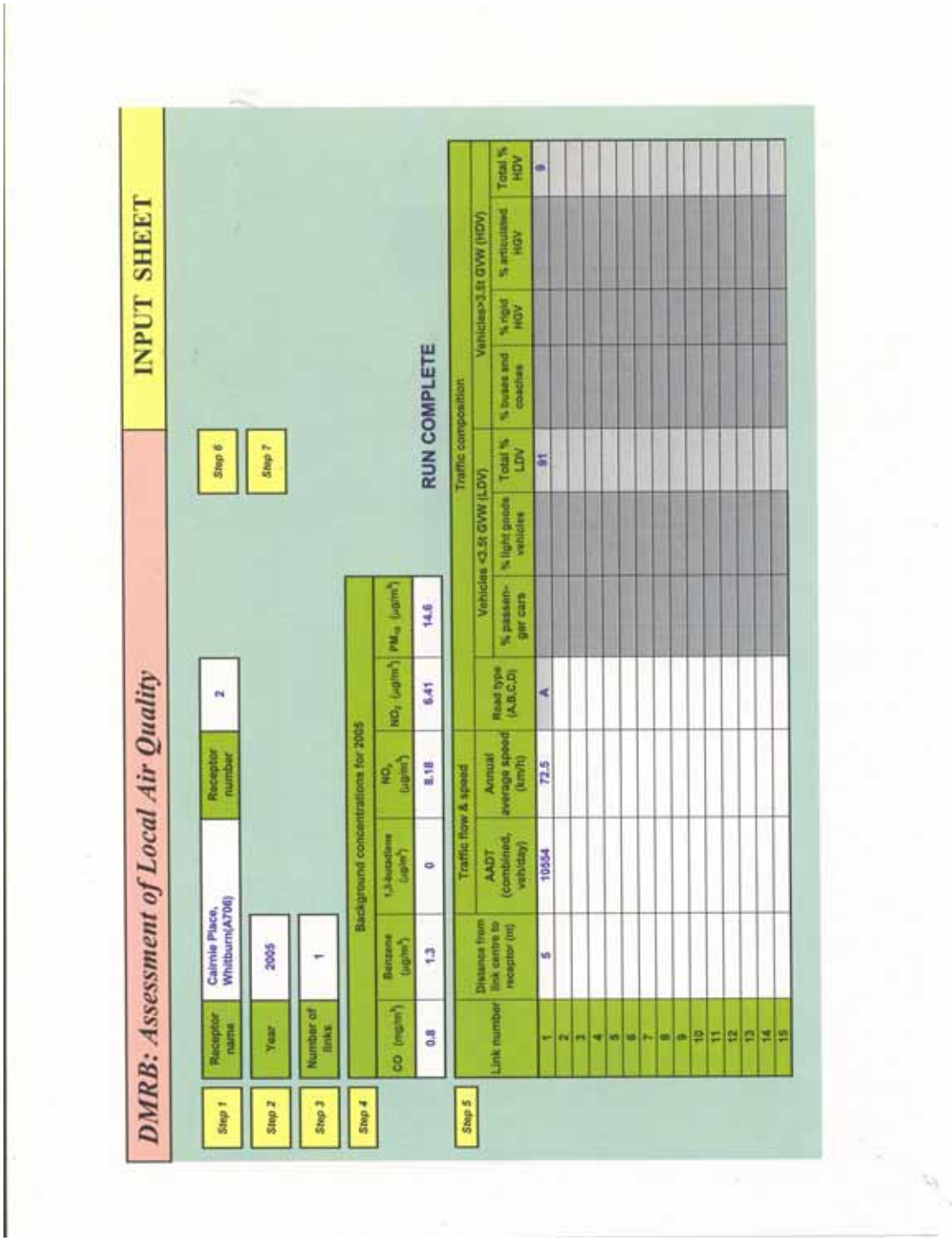
Step 7

RUN COMPLETE

11.2 Linlithgow High St – Output sheet



12.1 DMRB, Cairnie Place, Whitburn – Input Sheet



DMRB: Assessment of Local Air Quality

INPUT SHEET

Step 1 — Receptor name: Cairnie Place, Whitburn(A706) — Receptor number: 2

Step 2 — Year: 2005

Step 3 — Number of links: 1

Step 4 — Background concentrations for 2005

CO (mg/m³)	Benzene (ug/m³)	1,3-butadiene (ug/m³)	NO_2 (ug/m³)	NO_2 (ug/m³)	PM_{10} (ug/m³)
0.8	1.3	0	8.18	6.41	14.6

Step 5 — Traffic flow & speed; Traffic composition

Link number	Distance from link centre to receptor (m)	AADT (combined, veh/day)	Annual average speed (km/h)	Road type (A,B,C,D)	Vehicles <3.5t GVW (LDV): % passenger cars	% light goods vehicles	Total % LDV	Vehicles>3.5t GVW (HDV): % buses and coaches	% rigid HDV	% articulated HDV	Total % HDV
1	5	10554	72.5	A			91				9
2											
3											
4											
5											
6											
7											
8											
9											
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11											
12											
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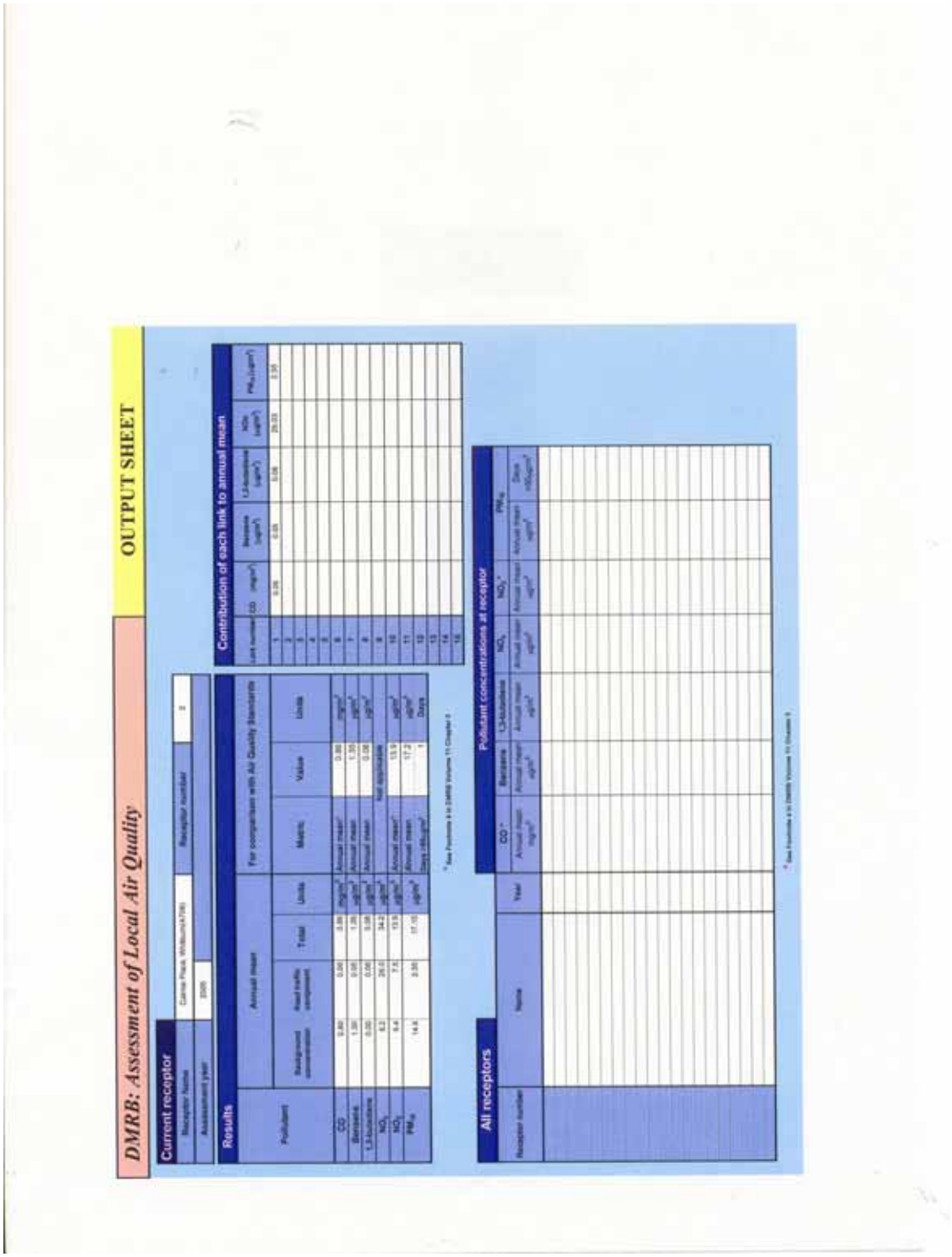
15											

Step 6

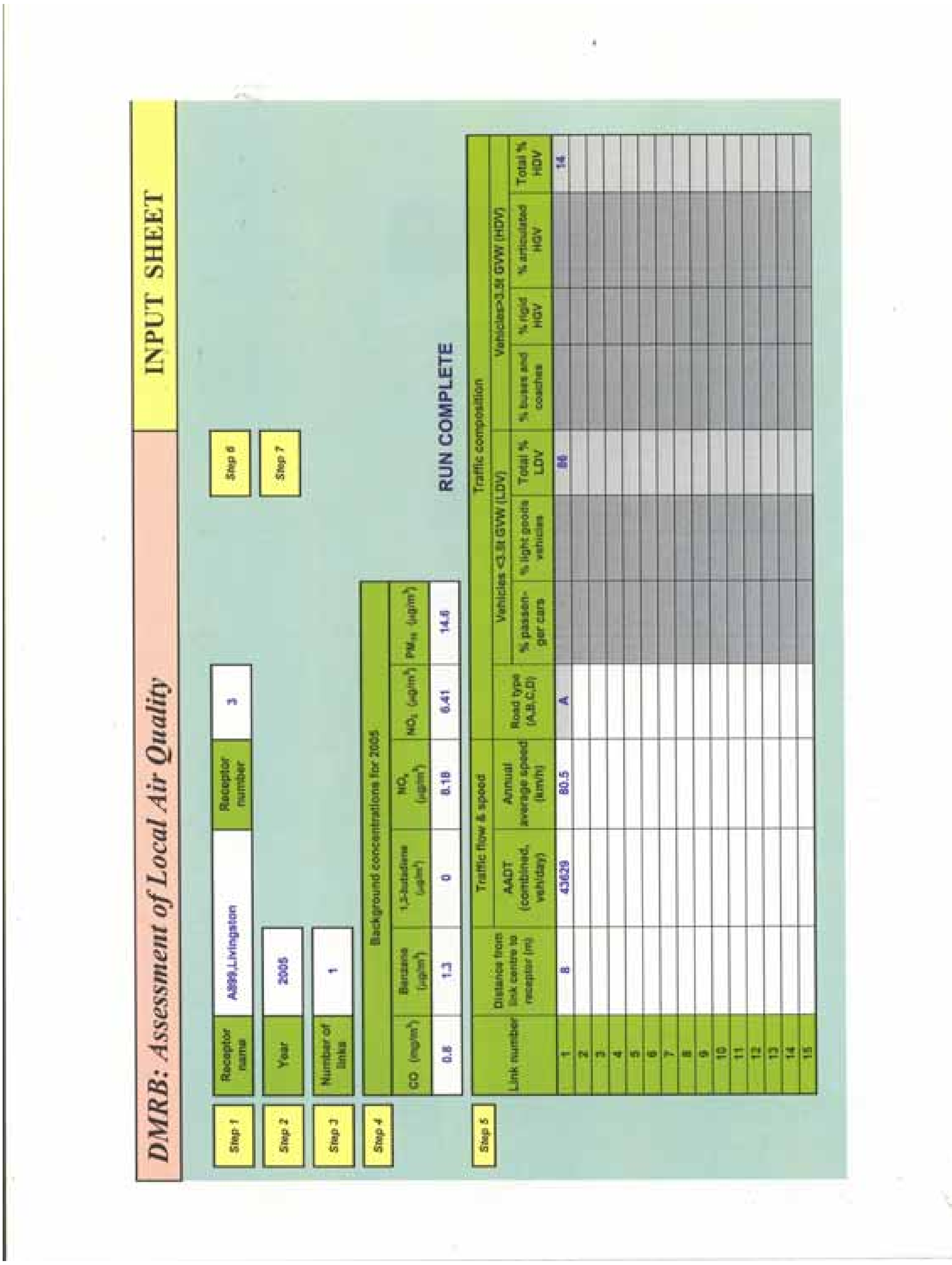
Step 7

RUN COMPLETE

12.2 Cairnie Place, Whitburn – Output Sheet



13.1 DMRB, A899 Livingston – Input Sheet



DMRB: Assessment of Local Air Quality — INPUT SHEET

Step 1 — Receptor name: A899,Livingston — Receptor number: 3

Step 2 — Year: 2005

Step 3 — Number of links: 1

Step 4 — Background concentrations for 2005

CO (mg/m³)	Benzene (µg/m³)	1,3-butadiene (µg/m³)	NO_x (µg/m³)	NO_2 (µg/m³)	PM_{10} (µg/m³)
0.8	1.3	0	8.18	6.41	14.6

Step 5

Step 6

Step 7

RUN COMPLETE

Link number	Traffic flow & speed: Distance from link centre to receptor (m)	AADT (combined, veh/day)	Annual average speed (km/h)	Traffic composition: Road type (A,B,C,D)	Vehicles <3.5t GVW (LDV): % passenger cars	% light goods vehicles	Total % LDV	Vehicles>3.5t GVW (HDV): % buses and coaches	% rigid HGV	% articulated HGV	Total % HDV
1	8	43629	80.5	A			86				14
2											
3											
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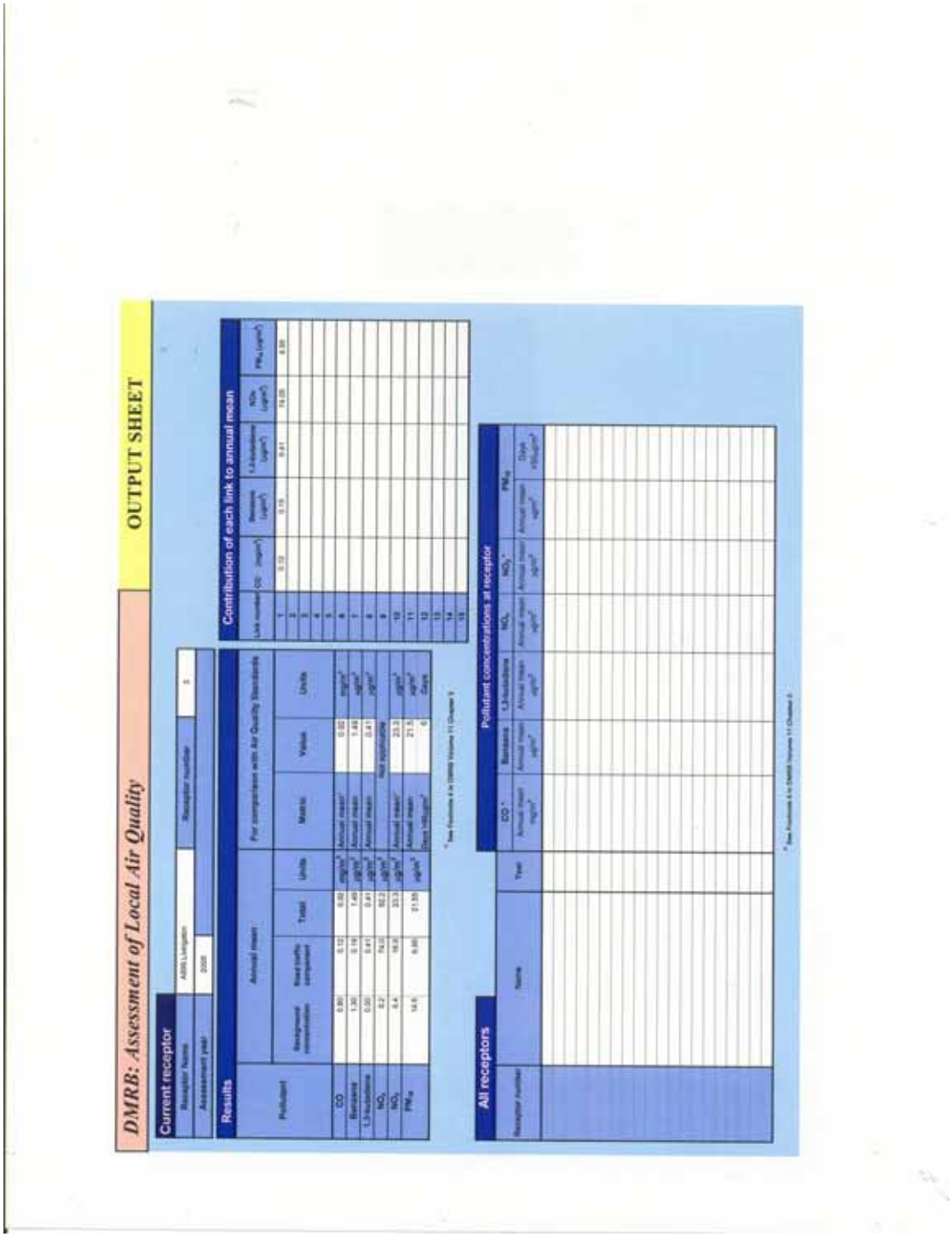
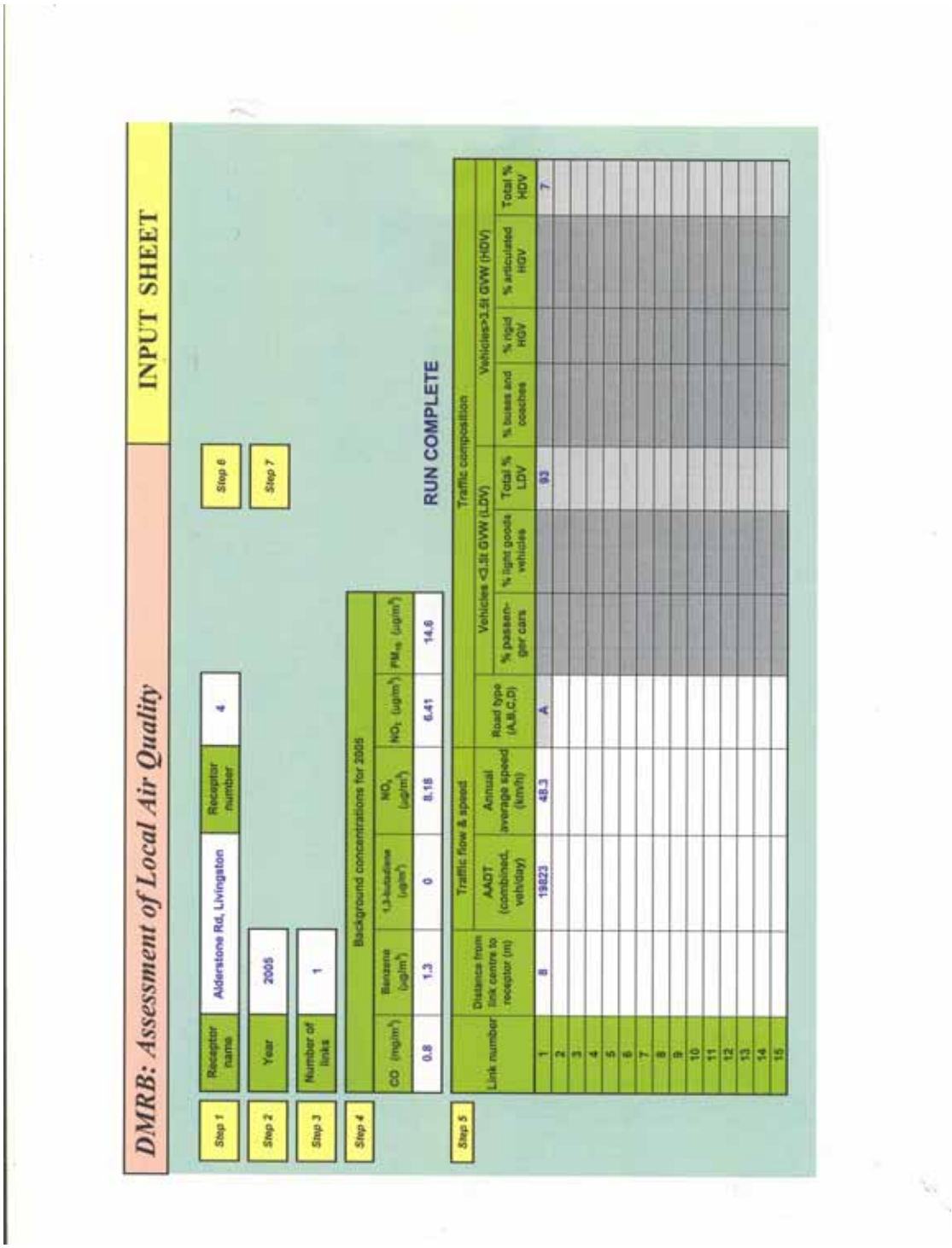
13.2 A899, Livingston – Output Sheet



14.1 DMRB, Alderstone Rd, Livingston – Input Sheet



DMRB: Assessment of Local Air Quality

INPUT SHEET

Step 1 — Receptor name: Alderstone Rd, Livingston — Receptor number: 4

Step 2 — Year: 2005

Step 3 — Number of links: 1

Step 4 — Background concentrations for 2005

CO (mg/m³)	Benzene (µg/m³)	1,3-butadiene (µg/m³)	NO_x (µg/m³)	NO_2 (µg/m³)	PM_{10} (µg/m³)
0.8	1.3	0	8.18	6.41	14.6

Step 5 — Traffic flow & speed; Traffic composition

Link number	Distance from link centre to receptor (m)	AADT (combined, veh/day)	Annual average speed (km/h)	Road type (A,B,C,D)	Vehicles <3.5t GVW (LDV): % passenger cars	% light goods vehicles	Total % LDV	Vehicles>3.5t GVW (HDV): % buses and coaches	% rigid HGV	% articulated HGV	Total % HDV
1	8	19823	48.3	A			93				7
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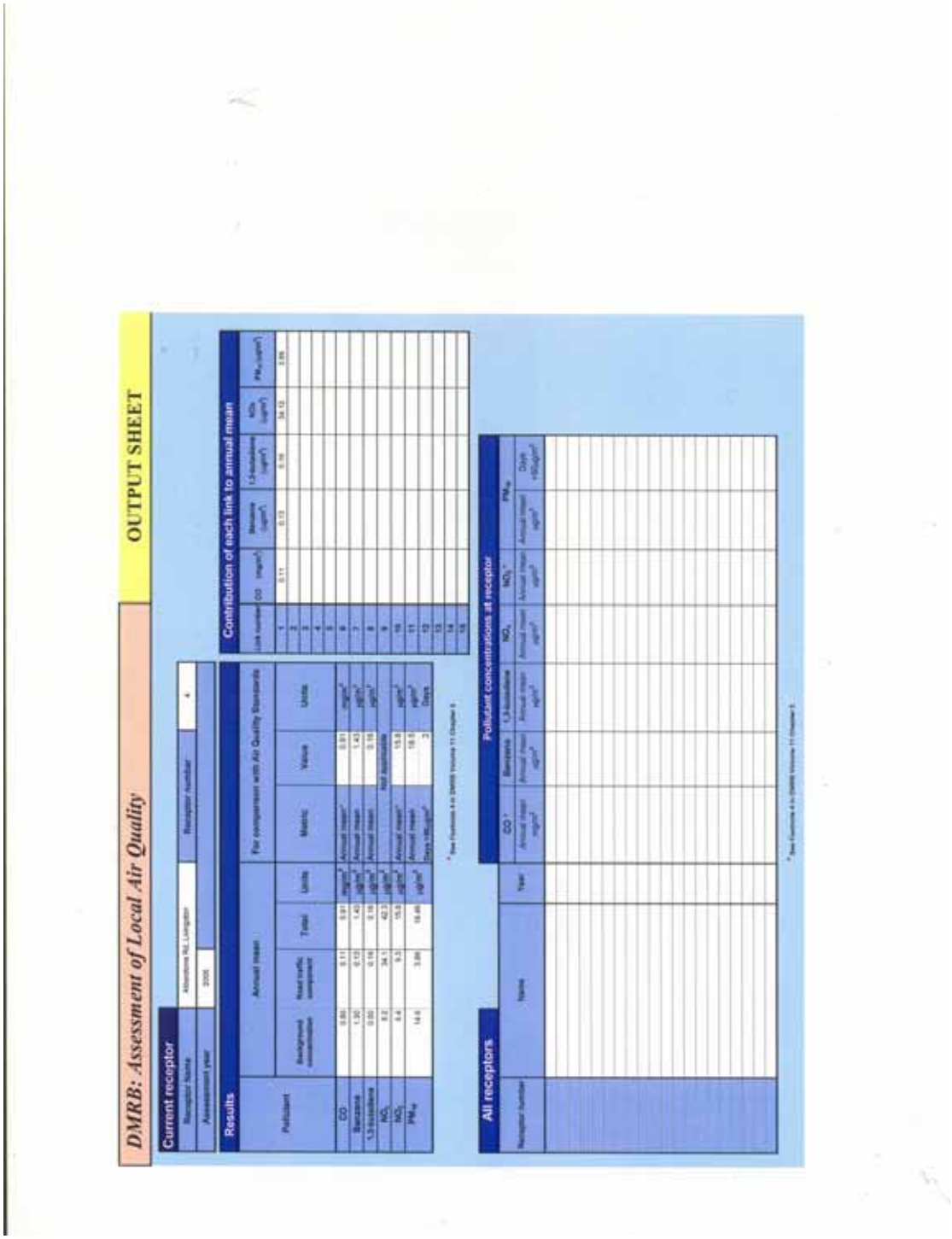
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

Step 6

Step 7

RUN COMPLETE

14.2 Alderstone Rd, Livingston – Output Sheet



Appendix 1.2 -Photo locations of Groundhog & Romon300

Cairnie Place, Whitburn

Romon300, Linlithgow High St

Appendix 1.3 –
Location maps of Groundhog & Romon300

Cairnie Place, Whitburn

High St, Linlithgow

Appendix 1.4 – SEPA report on Streetbox Data

Report on Air Quality Data
Fiona Carse 18 May 2006

John Lamb provided me with NO2 and PM10 data for 2 instruments, the Streetbox and the Groundhog, which had been running side-by-side in Whitburn, logging data every 15 minutes, during May – November 2005.

John wanted to know whether the Streetbox gives the same results as the Groundhog, to investigate the possibility of using Streetbox instruments in future monitoring programmes. The Groundhog is an accepted industry-standard instrument that is used throughout the UK; the Streetbox is a newer and less expensive instrument.

John said that there are four air quality standards to be assessed using the data:

- NO2: hourly mean and annual mean
- PM10: daily mean and annual mean

Therefore I have examined the data over the following time periods:

15 minute (raw data)
Hourly
Daily
Monthly (to approximate for annual data, as we have < 1 year of data)

I imported the raw data from monthly Excel files into S-Plus and merged it together into one data set. I manipulated this data set to calculate dataframes of hourly, daily and monthly means for each instrument and each parameter, these dataframes were then used to perform statistical analyses in S-Plus.

Basically I have tried to assess whether the two instruments are giving the same readings, and if not, establish whether there's a linear relationship between Streetbox and Groundhog that would allow Streetbox to be used. In doing this, I am making some important assumptions: that the Groundhog data is "good" i.e., is measured without error; the instruments are measuring the same sample (i.e., the same air), and that the instruments have their clocks set the same.

A. Visual inspection of data
See the figures in Annex A. For NO2 (figures A1 to A3, the raw data is quite difficult to interpret visually but you can begin to see that the Streetbox does not capture the full range of data measured by Groundhog. Also the Streetbox produces a lot of negative values, which don't really make sense when the units are ppb. These effects can be seen more clearly in the hourly average NO2 plots. It is in the hourly mean plots that you can begin to see that the Streetbox data does not always follow the same pattern as the Groundhog, both for large 'events' e.g., in July and November, and for smaller scale patterns (the Streetbox often shows a peak when Groundhog has a trough, and vice versa. In general, the Streetbox seems to be less sensitive to varying NO2 concentrations than Groundhog. The monthly means look very similar, so Streetbox and Groundhog appear to measure the same values when coarsely averaged to the scale of months.

To illustrate that the differences between hourly mean NO2 concentrations are not consistent, I've plotted difference data, month by month (see figure A4). This shows that both the size and the direction of the difference varies in time and that there is unlikely to be a simple offset that can be applied to 'fix' the Streetbox hourly mean data. The pattern in the difference data suggests there might be some sort of offset (clocks set differently?) that I will investigate further in section F.

For PM10 (figures A5 to A7), the graphs look poor – both the raw and daily mean graphs show that Streetbox is measuring approximately 0 whilst Groundhog is giving values of

approx 10 most of the time, with occasional peaks up to approx 100. The comparison of monthly means also suggests that the values from the 2 instruments are very different.

B. Test differences between simultaneous measurements

If the instruments perform identically, they should given the same readings at the same point in time, so I wanted to assess whether simultaneous measurements gave the same values for each instrument. To assess whether each pair of readings are the same, I initially planned to use the paired t-test. Unfortunately the differences between datasets did not conform to the normal distribution (tested using the Shapiro-Wilk method), so a paired t-test was not a valid method. Instead, I used a non-parametric version of the paired t-test, called the Wilcoxon Signed Rank test (NB. This is still not a perfect test as some of the hourly mean data showed signs of serial correlation, but I've used it anyway).

The null hypothesis of the test is that the data pairs are the same (i.e., the differences are zero). The test showed that the results from the 2 instruments are significantly different for all data pairs at all time-averages. There were only 2 exceptions: the data were found to be the same across both instruments for daily mean NO2 and for monthly mean NO2.

Summary from 'difference of data pairs' tests: Streetbox is not able to generate raw NO2 data, or hourly NO2 mean data that matches the equivalent Groundhog data. It is not able to generate PM10 data that matched Groundhog at any temporal resolution. From this test, I would conclude that Streetbox is only useful for checking compliance with the annual NO2 standard.

C. Test of Precision (Variability)

If the 2 instruments are performing the same, you would expect the paired differences to be zero (as discussed above) and you would also expect the variability of the data to be roughly the same, i.e., you would hope that the 2 instruments have the same level of precision. I have tested this for Streetbox and Groundhog by using the F-test: this has a null hypothesis that the ratio of data variances is 1 (i.e. the variances are the same). This test assumes that the data are normally distributed – the assumption is not met be the data but I've run the test quickly to see if it yields any informative results. The test results (see table C1) show that there is only one case in which $p > 0.05$ and we can accept the null hypothesis that the variances are the same – this is the monthly mean NO2 data. In all other cases, the F value (ratio of variances) is greater than 1, which tells us that the Groundhog instrument is measuring a wider range of values than the Streetbox. This suggests that the instruments are not performing the same – given that we have assumed that the groundhog data is "good", this result suggests that the Streetbox is not sufficiently sensitive to environmental levels of NO2 and PM10.

Table C1:

data	varGHOG	varSTR	FValue	PValue
MonthlyDF$GHOG.NO2 and MonthlyDF$STR.NO2	17.655	17.838	0.99	0.99
DailyDF$GHOG.NO2 and DailyDF$STR.NO2	32.025	20.44	1.567	0.002
HourlyDF$GHOG.NO2 and HourlyDF$STR.NO2	55.084	28.164	1.956	0
alldata$GHOG.NO2 and alldata$STR.NO2	60.146	33.387	1.801	0
MonthlyDF$GHOG.PM10 and MonthlyDF$STR.PM10	0.271	0.011	24.593	0.001
DailyDF$GHOG.PM10 and DailyDF$STR.PM10	13.636	0.03	451.387	0
HourlyDF$GHOG.PM10 and HourlyDF$STR.PM10	37.567	0.193	195.138	0
alldata$GHOG.PM10 and alldata$STR.PM10	48.649	0.348	139.605	0

D. Test for relationships - Correlation

[see Annex A, figure A8, for scatterplots of Streetbox data against Groundhog data]

To assess whether there's any relationship between results from the instruments I used a linear correlation test called Spearman's Rank Order Correlation (again, a non-parametric method because the data are not normally distributed). This just tells you if there is a linear relationship, not the size of slope. The null hypothesis of the test was that correlation coefficient $(r) = 0$ (i.e. there's no relationship between the instruments' data). See table D1 for results of the correlation test. In only 1 case we can accept the null hypothesis ($p > 0.05$): there is no evidence for a relationship between instruments for monthly mean PM10 data.

There *is* evidence for a relationship between monthly and daily mean NO2 data. There is also evidence for a weak relationship (r close to 0) for the rest of the data pairs.

Table D1:

Data	CorCoeff	PValue
MonthlyDF$GHOG.NO2 and MonthlyDF$STR.NO2	0.96429	0.02
DailyDF$GHOG.NO2 and DailyDF$STR.NO2	0.58287	0
HourlyDF$GHOG.NO2 and HourlyDF$STR.NO2	0.31884	0
alldata$GHOG.NO2 and alldata$STR.NO2	0.30223	0
MonthlyDF$GHOG.PM10 and MonthlyDF$STR.PM10	0.67857	0.106
DailyDF$GHOG.PM10 and DailyDF$STR.PM10	0.20187	0.005
HourlyDF$GHOG.PM10 and HourlyDF$STR.PM10	0.07089	0
alldata$GHOG.PM10 and alldata$STR.PM10	0.0464	0

Correlation test summary: There is a reasonably strong correlation between Streetbox and Groundhog for daily and monthly mean NO2 data. There is no correlation between monthly mean PM10 data. There are statistically significant ($p < 0.05$) but unconvincing correlations between the rest of the data pairs. This suggests that it's worth investigating relationships further using a regression method. Again, I found that the Streetbox monthly mean NO2 data may be reliable – therefore the Streetbox might be OK for assessing the annual compliance of NO2. However, in terms of the other standards set (daily & annual PM10, hourly NO2), this correlation test indicates that the Streetbox is not performing well enough to replace the Groundhog.

E. Test for relationships - Regression

The correlation tests in section D showed significant ($p < 0.05$) relationships between all data pairs (except monthly mean PM10). These relationships were investigated further using linear regression. Linear regression is normally used where there is perceived 'cause and effect' taking place, with 'cause' on the x axis and 'effect' on the y axis. The technique assumes that the relationship between 2 variables can be described by a straight line, that 'cause' is measured without error, and the variation in 'effect' is the same whatever the value of 'cause'. It's reasonable to accept these assumptions for this air quality data. As Groundhog is the "good" data, it's safest to use it on the x-axis as we can assume it's measured without error. I would expect to see a slope of 1, intercept of 0, and R^2 of 1 if the instruments were performing identically.

The regression results (see table E1, and Annex E) suggest that there are only 2 cases in which Streetbox performs 'predictably' compared with Groundhog:

- NO2 monthly means
- NO2 daily means

Therefore the Streetbox could potentially be used to measure compliance with an annual mean standard, using the equation for monthly mean data values:

TRUE_NO2 = (STR_NO2 x 0.995) + 0.042

(by re-arranging the equation from regression STR = (GHOG*1.005) – 0.042).

The scatterplots with linear regression lines shown in Annex E suggest that hourly Streetbox NO2 data cannot be reliably converted to a 'true' value using the linear relationship, as the relationship is not strong enough.

Table E1 (STR against GHOG):

Data		Slope	SESlope		Intercept		R2
NO2Monthly		1.005	0.005	-0.042		1	
NO2Daily		0.6	0.038		2.967		0.564
NO2Hourly		0.343	0.009		4.874	0.23	
NO2AllData		0.315	0.005		5.084		0.178
PM10Monthly	0.137	0.066	-1.569	0.46			
PM10Daily		0.011	0.003	-0.273	0.057		
PM10Hourly		0.005	0.001		-0.21		0.005

PM10AllData 0.004 0.001 -0.195 0.002

In the case of all of the other data pairs the slope is ≠ 1 and the R^2 are poor (<< 1), which means that it is not a good idea to try to predict a 'true' NO2 or PM10 value from Streetbox using the linear relationships in table E1. Once again, I conclude that the only one of the four standards that Streetbox can reliably test is the annual mean NO2 standard.

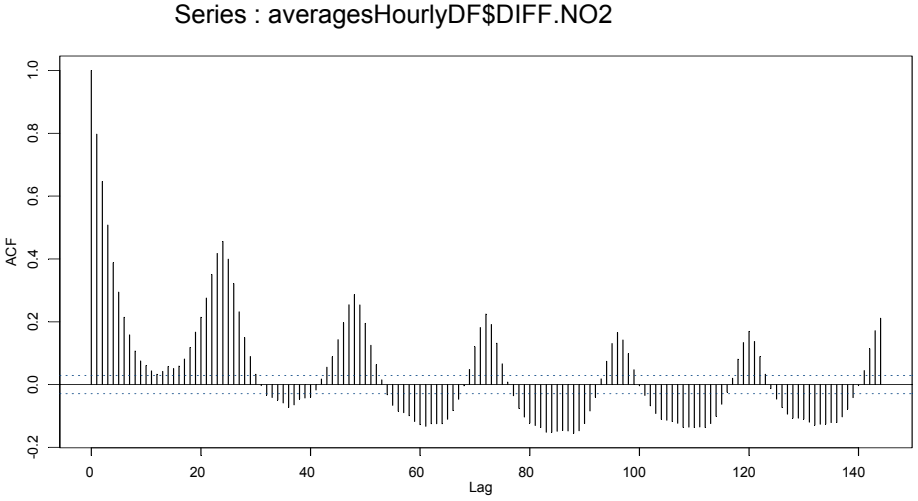
F. Test for relationships – incorporating time lag

There was an interesting pattern in the hourly NO2 difference data (see Annex A, figure A4), with a series of peak and troughs following a regular (possibly daily) pattern. That is, the differences between instruments don't seem to be completely random. Together with the fact that the NO2 monthly means are so highly similar across both instruments, this pattern in the differences merits further attention. I aimed to see if it's possible to obtain any reliable hourly NO2 data from Streetbox that could be used to test compliance with the hourly standard.

I used autocorrelation (acf function in S-Plus) on the hourly difference data to look for likely lag period to test. Plot F1 shows that there is significant serial correlation in the differences, with the most significant correlations occurring around lag values of 0, 24, 48, etc (i.e., there is a diurnal effect in the NO2 data such that, for example, the difference between Streetbox and Groundhog NO2 at 2pm on Monday is similar to that at 2pm on Tuesday). This ACF analysis suggests it's worth running some lagged correlation tests to see whether the relationship between hourly NO2 means can be improved.

If the 2 hourly datasets have matching diurnal patterns but are shifted in time (due to one of the clocks being wrong), then you would expect to see a diurnal pattern in the differences and a poor correlation coefficient between the 2 datasets. However, shifting the data in time would produce an improved correlation coefficient as the 2 patterns align. I will try this approach on the NO2 hourly datasets to see if there is a 'clock problem' as well as the diurnal effect we can see in plot F1.

Plot F1:



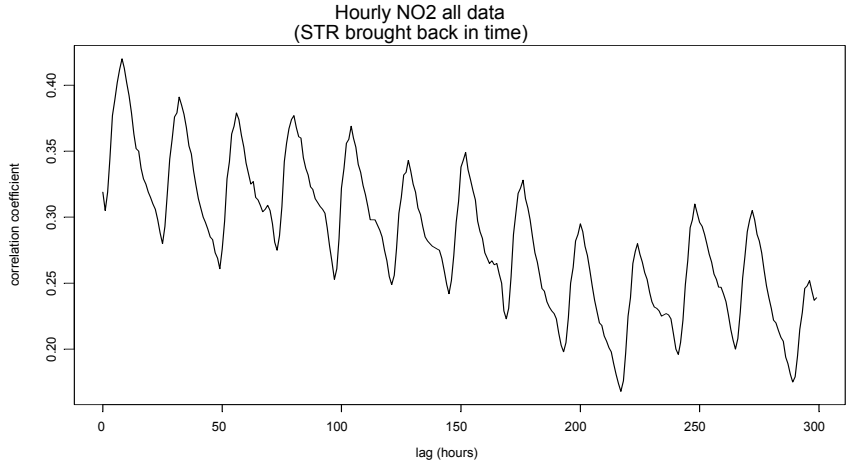
I carried out a test on the NO2 hourly mean data to check for improved correlation by introducing time lags (if the clocks are offset from each other, this will check whether the relationship between instruments for NO2 improves). I obtained correlation coefficients (using the same method as section D) for multiple time lag scenarios – for example, for a lag of 2 hours, I correlated the all but the last 2 rows of GHOG data with all but the first 2 rows of the Streetbox data – effectively bringing the Streetbox data backwards in time (9am becomes 7am). Plot F2 shows the correlation coefficients for lags of 0 to 299 hours. The plot shows that the maximum correlation coefficient occurs at a lag of 8 hours. Lag of zero has r=0.319

(as also found in section D). This can be improved to r=0.42 by lagging the data by 8 hours (i.e., the clock in Streetbax may be 8 hours faster than that in Groundhog).

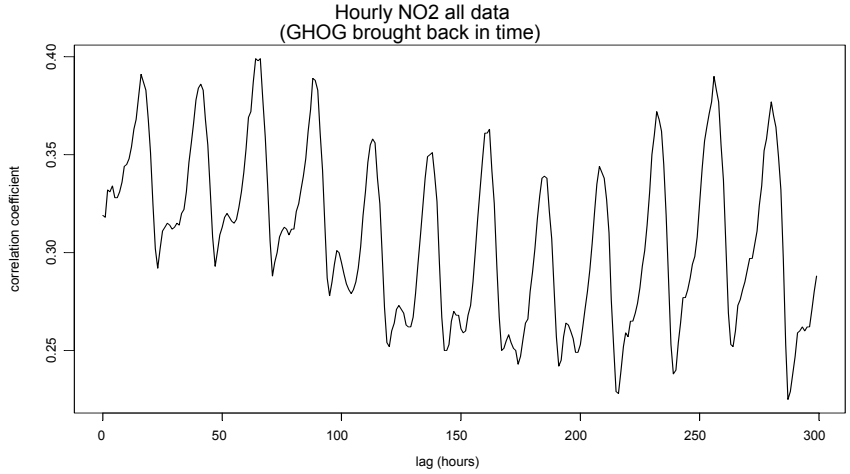
I also tried the analysis the other way round, bringing the Groundhog data back in time (see plot F3). The best correlation coefficienct obtained was r=0.399 at a lag of 64 hours (ie suggesting that the Groundhog clock might be 64 hours faster than that in Streetbox – this seems fairly unlikely).

The results in plot F2 suggests that there might be a clock problem: namely that the Streetbox clock might be 8 hours faster than Groundhog. However, it does not produce a dramatic improvement in the relationship between the hourly NO2 datasets. I would have hoped to see a bigger jump in the value of correlation coefficient.

Plot F2:

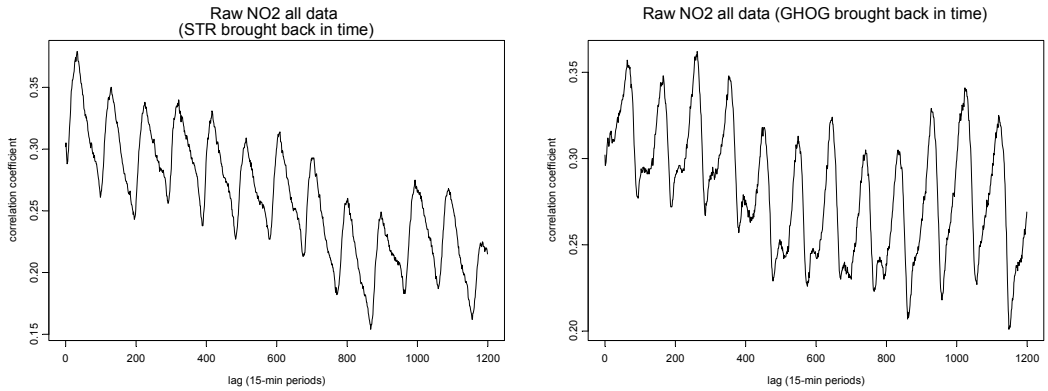


Plot F3:



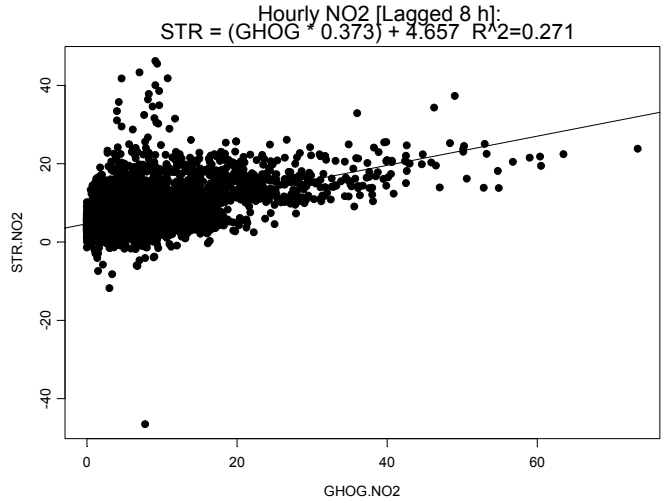
I also checked that the results were reproducible if I performed lags on the raw (15 minute) NO2 data, the 2 plots in Plot F4 show very similar patterns.

Plot F4:



I was hoping that the time-lag exercise would have produced significantly larger correlation coefficients, suggesting that the NO2 data might be reliable if a clock problem could be identified in the instrument. The improvement from r of 0.319 to 0.42 is not impressive, and this is borne out by performing linear regression on the datasets lagged by 8 hours is to improve the slope marginally (from 0.343 to 0.373) and to improve the R2 value slightly (from 0.23 to 0.271). This is still not good enough to allow Streetbox to measure NO2 for the hourly standard, in my opinion.

Plot F5:



In summary, the time-lag correlation analysis produces rather disappointing results. There is a possibility that the Streetbox clock is 8 hours faster than the Groundhog, but this does not make a dramatic difference to the correlation coefficient of the relationship between them.

G. Summary

I conclude that the Streetbox instrument should be as reliable as Groundhog for obtaining monthly NO2 means (and, by assumption, annual means). Streetbox does not perform the same as Groundhog in terms of hourly NO2 means. So Streetbox could be used to assess compliance with the annual mean NO2 standard only. For PM10, I conclude that Streetbox is wholly unsuitable as it appears to be reading zero at all times, therefore it is not suitable for providing data to assess either the daily or the annual standards. Overall, I would conclude that Streetbox does not perform the same as Groundhog.

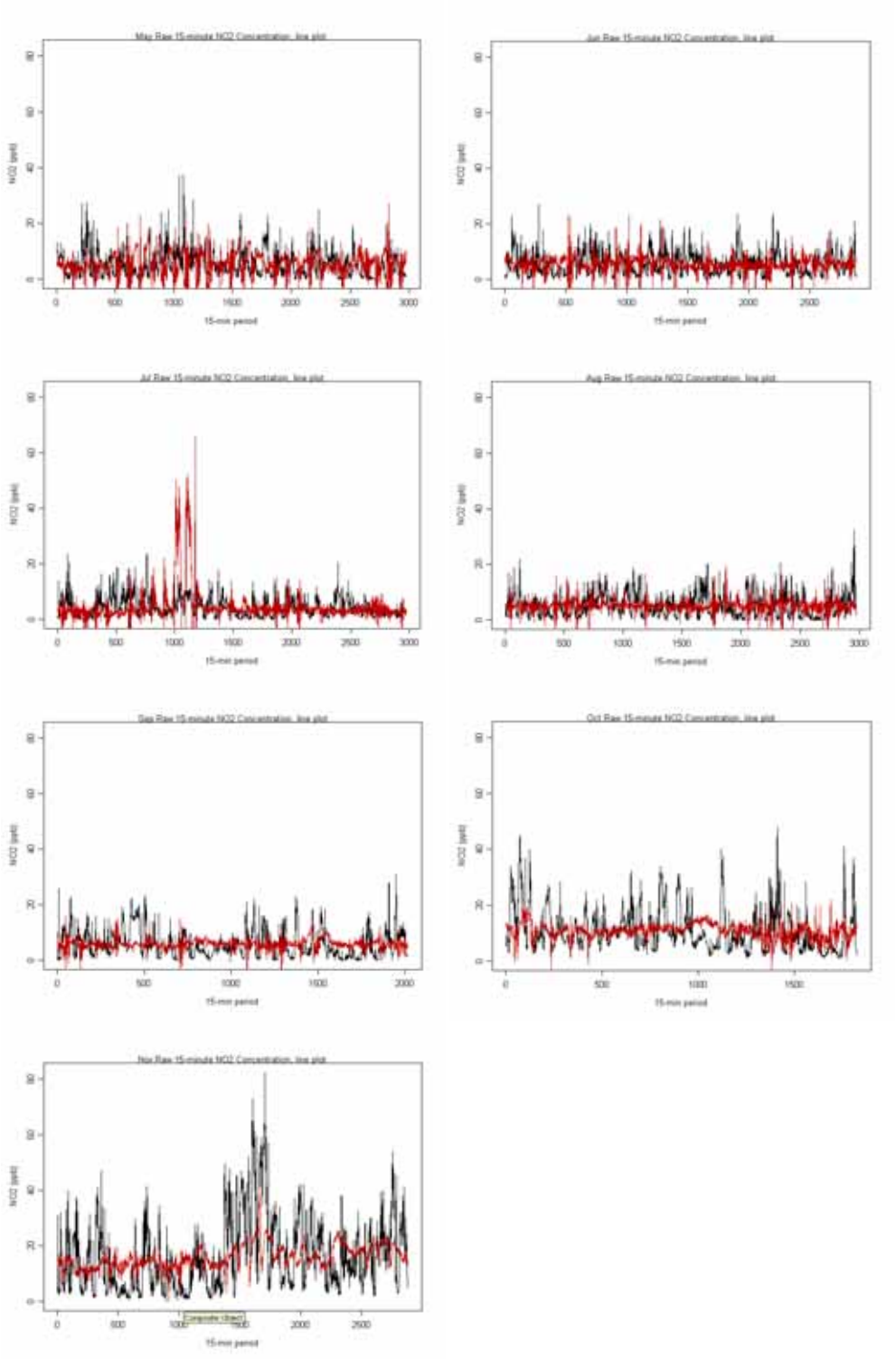
The statistical analysis in section F hinted that there may be a clock (time lag) problem, and that Streetbox performance might actually be slightly better for NO2 than it currently seems to be. If any further research were to be done on the performance of Streetbox compared to

Groundhog, I would suggest that the clocks are synchronised at the start of the comparison and checked regularly throughout. If it's possible to control the conditions, so that we can be sure that the instruments are measuring the same air sample at the same time, this would help to reduce uncertainties.

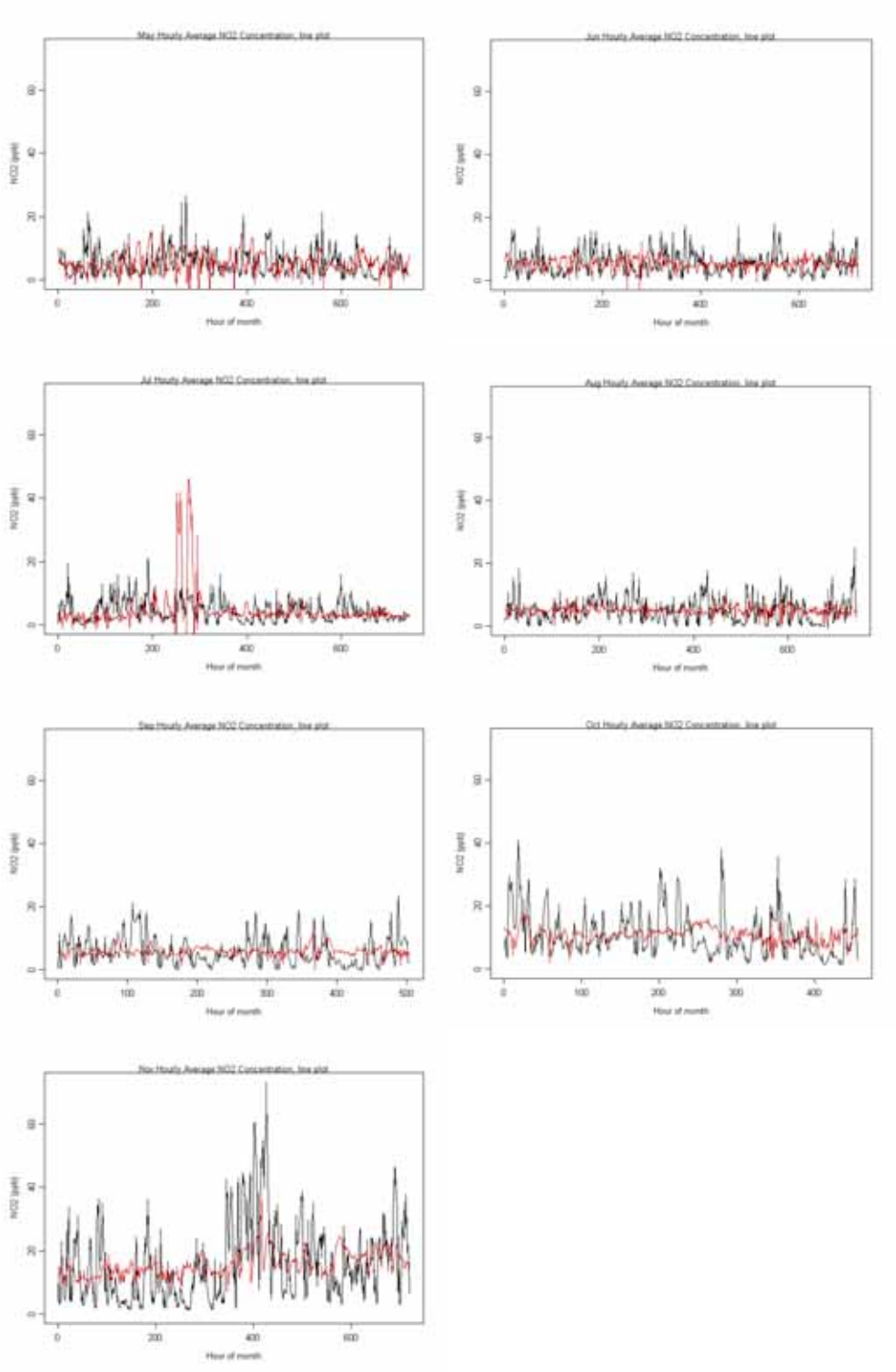
Annex A. VISUAL INSPECTION OF DATA

NO2 data: presented as raw data, hourly mean data (one month per graph) and monthly mean data. Streetbox data are in red, Groundhog in black.

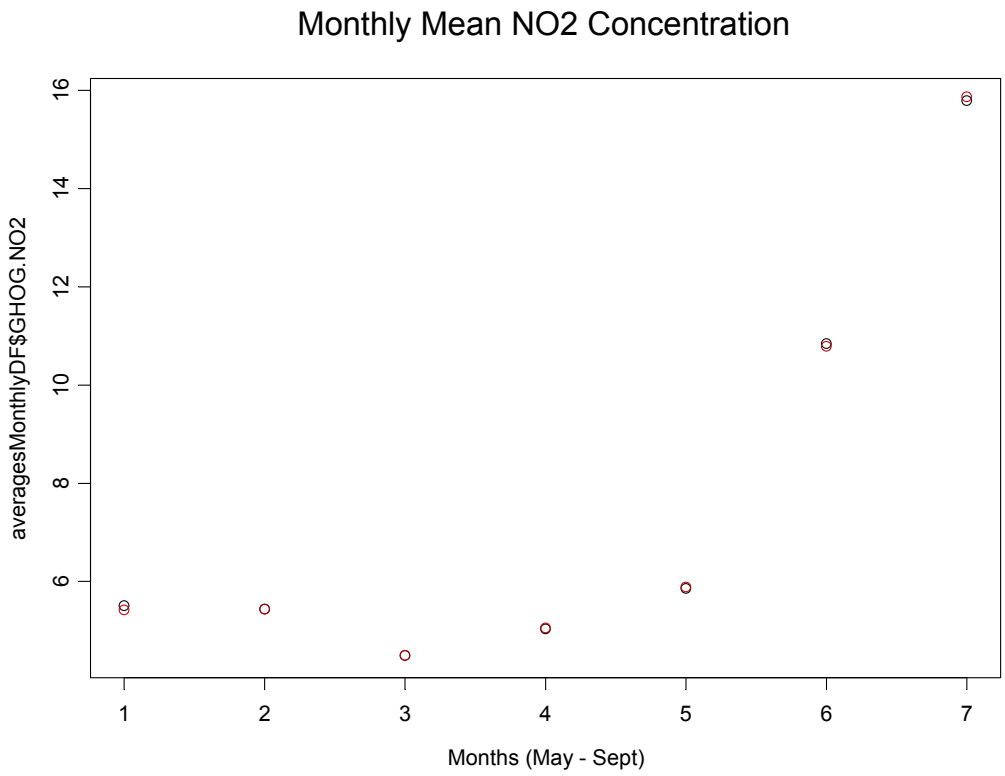
A1. Raw NO2 data: the 15-minute raw data is shown below. Streetbox contains a lot of negative values, particularly May – August. This suggests the instrument is not performing well with respect to NO2.



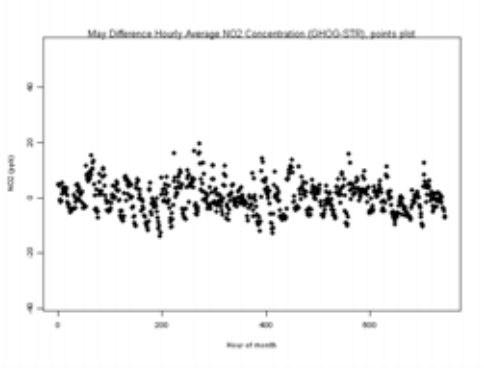
A2. Hourly average NO2 data: It's easier to see what's going on when you look at hourly mean data (compared with the raw data). Generally Streetbox seems to be less sensitive to varying concentrations, this is noticeable from June onwards. In July, Streetbox observes high values (approx 40 ppb) that Groundhog does not measure. In November, Streetbox misses high values (up to 60 ppb) that Groundhog measures. Some Streetbox hourly means are negative, I've set the lower limit of the y-axes as 0 but you can see the data is less than 0 on many occasions in May, June and July.

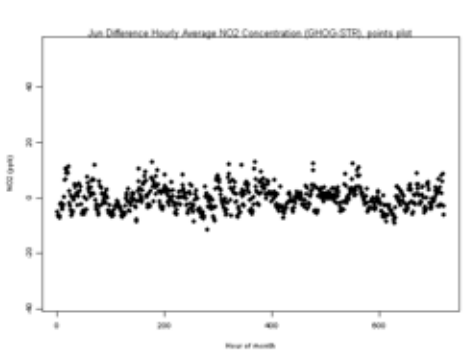


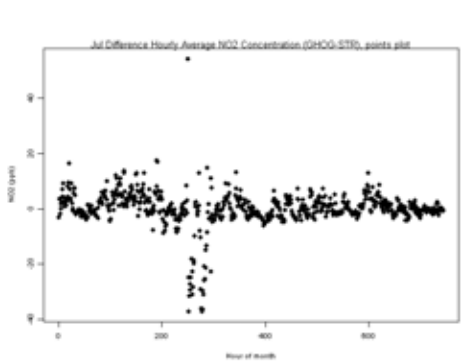
A3. Monthly Mean NO2: The Streetbox and Groundhog monthly means are very similar, this suggests that an annual mean obtained from Streetbox should be reliable.

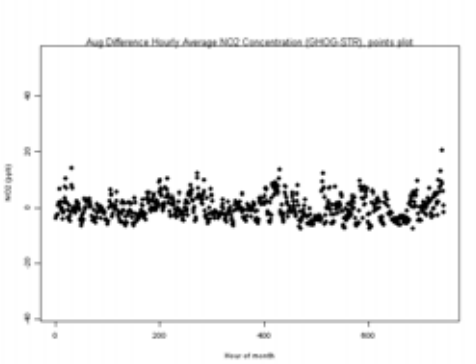


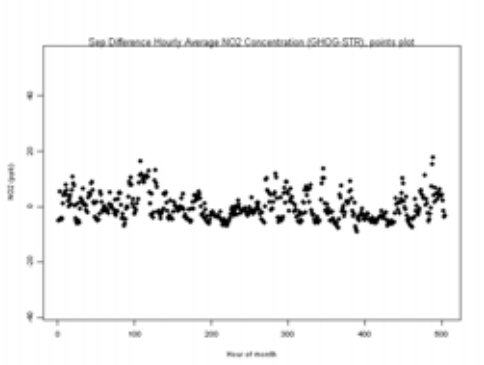
A4. Hourly average NO2 DIFFERENCES: I've plotted the hourly NO2 difference dataset (Groundhog minus Streetbox) to illustrate the fact that there is not a consistent / easily predictable difference between the 2 instruments.

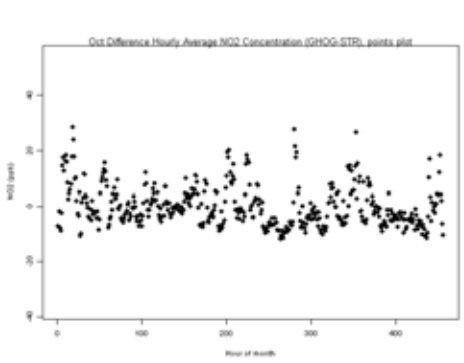


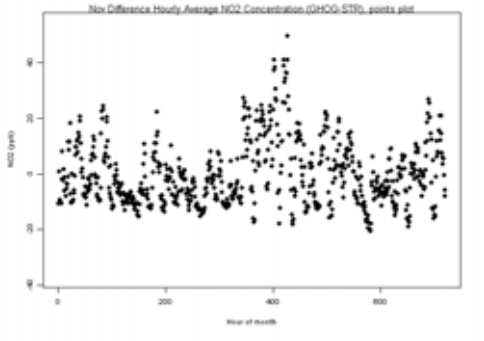






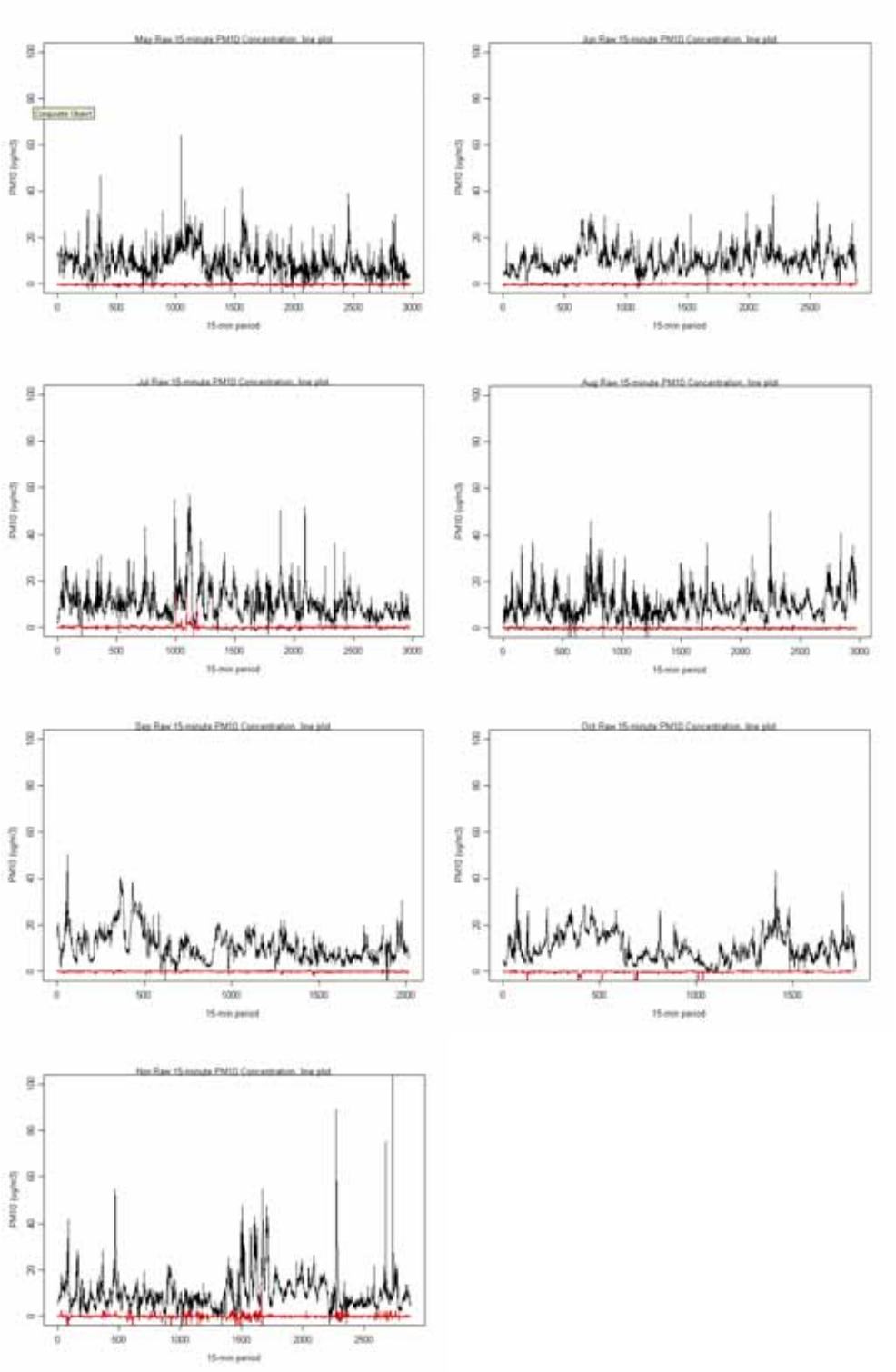




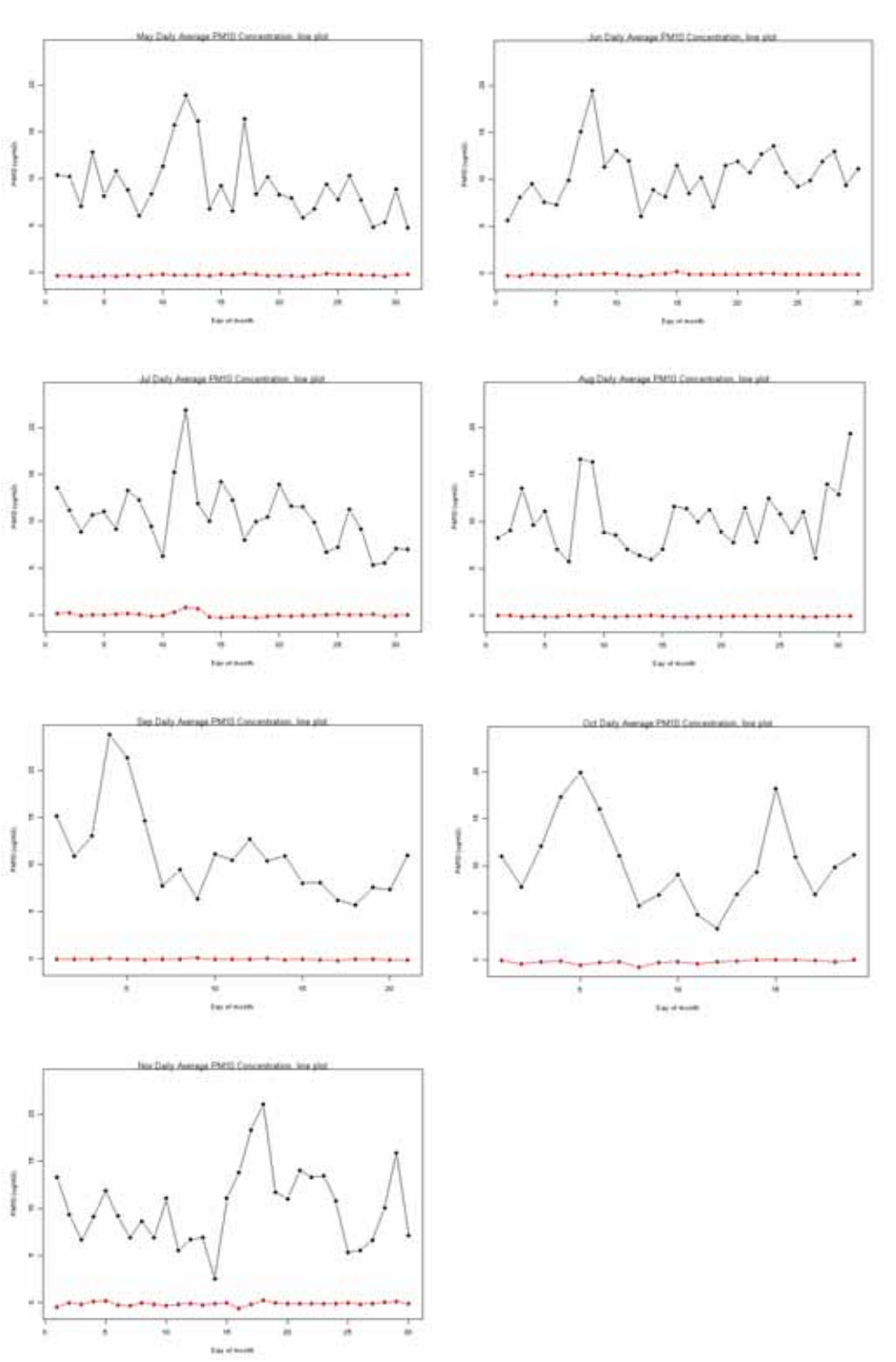


A5. PM10 data: presented as raw data, daily mean data (one month per graph) and monthly mean data. Streetbox data are in red, Groundhog in black.

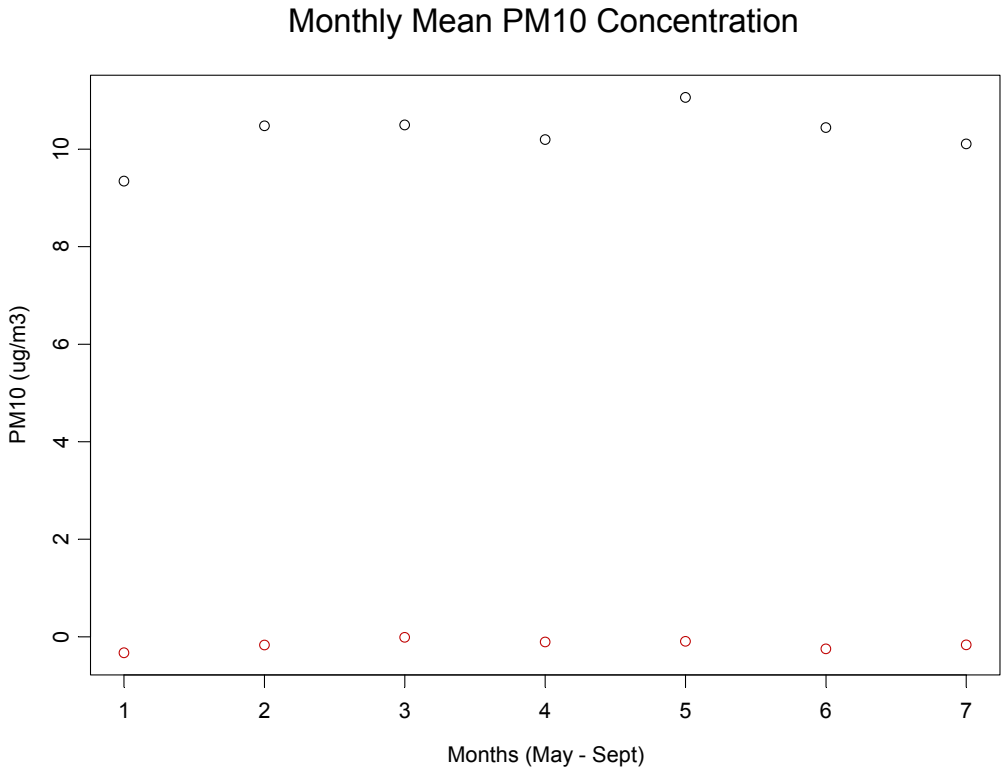
Raw PM10 data: the 15-minute raw data is shown below. Generally Streetbox seems to have no sensitivity and is measuring approximately zero at all times.



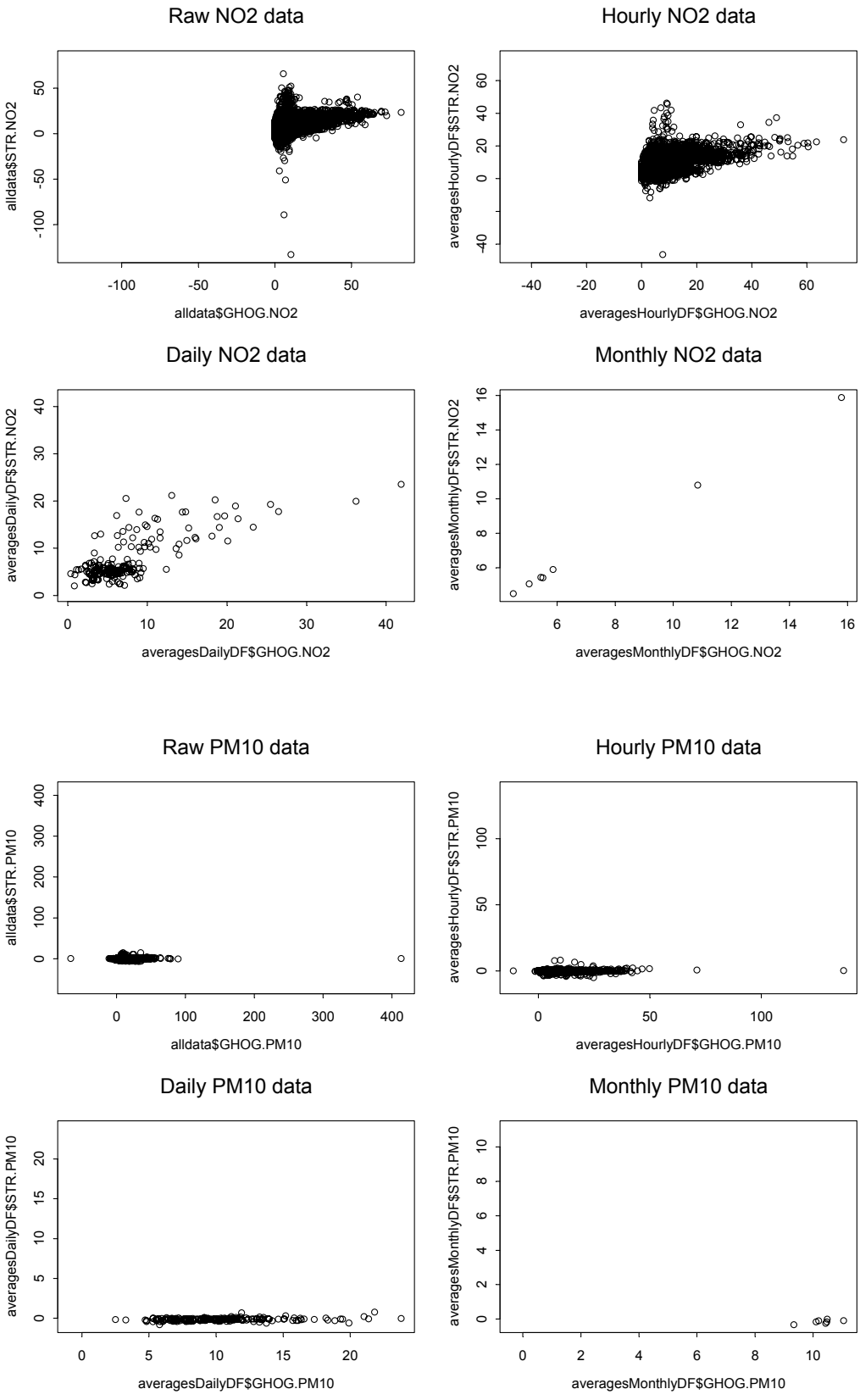
A6. Daily average PM10 data: In the daily mean data you can clearly see that Streetbox seems to have no sensitivity and is measuring approximately zero at all times, totally missing the values and variability that Groundhog is measuring.



A7. Monthly Mean PM10: The Streetbox and Groundhog monthly means are very different, this suggests that an annual mean obtained from Streetbox would be unreliable. It seems to me that the Streetbox performs badly at measuring PM10.



A8. Scatterplots of all data at all time scales: Streetbox on y axis against Groundhog on x axis. Axes set the same lengths to give true impression of data quality (hoping for y = x).



Annex E: Linear Regression results for NO2 and PM10 at all temporal resolutions (axis limits automatic).