

Dumfries and Galloway Council

Local Air Quality Management

Environment Act 1995: Part IV

Air Quality Progress Report - 2007



Partisol Particulate Monitors (PM<sub>10</sub> & newly-commissioned PM<sub>2.5</sub>) at Buccleuch Street Dumfries

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## 1. Introduction

- 1.1 In terms of Part IV of the Environment Act 1995 every local authority is required to regularly review and assess the air quality in its area to determine whether the Government's air quality objectives will be met. Such reviews and assessments are generally carried out every three years. In the intervening years, unless a more detailed assessment is being carried out, an air quality progress report is required.
- 1.2 The specific atmospheric pollutants for which objectives have been set are:-
- nitrogen dioxide (NO<sub>2</sub>),
  - sulphur dioxide (SO<sub>2</sub>),
  - particulate matter (PM<sub>10</sub>),
  - benzene (C<sub>6</sub>H<sub>6</sub>),
  - 1,3 butadiene (C<sub>4</sub>H<sub>6</sub>),
  - carbon monoxide (CO),
  - lead (Pb),
  - polycyclic aromatic hydrocarbons (PAHs), and,
  - ozone (O<sub>3</sub>).
- 1.3 The objectives (see appendix 2) are based on standards set on health grounds and essentially consist of target concentrations to be achieved by specific dates. The current objectives which apply for the purposes of local air quality management (LAQM) in Scotland are prescribed in the Air Quality (Scotland) Regulations 2000 as amended by the Air Quality (Scotland) (Amendment) Regulations 2002. (Objectives for O<sub>3</sub> and PAHs have been set in the Government's Air Quality Strategy [January 2000] and addendum [February 2003] but have not been included in the regulations).
- 1.4 If the results of a review and assessment indicate that any of the prescribed objectives is/are not likely to be met by the requisite date the local authority is required to declare an air quality management area and to produce an action plan with a view to meeting the objective(s) concerned.

## 2. Background

- 2.1 The findings of the first review and assessment<sup>1</sup> of air quality in Dumfries and Galloway (commenced in 1998) were that the air quality objectives were likely to be met. As a consequence no air quality management areas were declared in Dumfries and Galloway. (which is still the position to date).
- 2.2 In 2003, as part of a second round of review and assessment Casella Stanger (consultants) were employed to carry out an initial updating and screening assessment<sup>2</sup> (USA) of air quality in Dumfries and Galloway. The consultants supported the conclusions of the first round but, in line with the Department for Environment, Food and Rural Affairs' (DEFRA's) revised technical guidance<sup>3</sup> in relation to sulphur dioxide, concluded that a detailed assessment at the ferry terminals at Stranraer and Cairnryan would be required.

<sup>1</sup> see references at appendix 1 on page 10

- 2.3 In 2004 a detailed assessment<sup>4</sup> of the influence of shipping on SO<sub>2</sub> levels at Cairnryan was carried out, the conclusion of which was that an air quality management area was not required. A further assessment will take place when Stena Line Ltd., relocates from Stranraer to Cairnryan (anticipated in 2008).
- 2.4 In 2005 the results of routine monitoring were detailed in a progress report<sup>5</sup>. The results reported were within the relevant objectives therefore there was no requirement to proceed to a detailed assessment for any of the relevant pollutants.
- 2.5 In 2006 the most recent updating and screening assessment<sup>6</sup> was carried out by Bureau Veritas consultants who concluded that the air quality objectives for benzene, 1,3-butadiene, CO, Pb, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> would be met and that consequently there was no requirement to undertake a detailed assessment for any of these pollutants.

### 3. Monitoring Results

#### 3.1 NO<sub>2</sub> (Automatic)

- 3.1.1 A continuous (chemiluminescent) NO<sub>2</sub> monitor (API M200a) is located at the Municipal Chambers, Buccleuch Street, Dumfries and forms part of the UK Automatic Urban and Rural Air Quality Monitoring Network (AURN). Results for the past 5 years are as shown in Table 1. All the results shown are based on ratified data. Ratification is carried out by the Quality Assurance and Control (QA/QC) Unit at AEA Energy & Environment.

Table 1 AURN NO<sub>2</sub> Results at Buccleuch Street Dumfries (Roadside Site)

Year	Annual Mean µg/m <sup>3</sup>	Number of exceedences of 200 µg/m <sup>3</sup> hourly mean	Data capture
2002	38.0	0	95.1%
2003	37.6	2	97.9%
2004	37.3	0	96.6%
2005	35.9	1	96.8%
2006	37.5	0	94.3%
<i>objective (by 31/12/05)</i>	≤ 40	≤ 18	≥ 90%

(µg/m<sup>3</sup> = microgrammes per cubic metre)

≤ = less than or equal to

≥ = greater than or equal to

- 3.1.1.1 Results in Table 1 meet the objectives.

- 3.1.2 Since December 2004 a continuous NO<sub>2</sub> monitor has been located at the Observatory<sup>7</sup> at Eskdalemuir as part of the AURN. The results for 2005 and 2006 are shown in Table 2. Ratification is carried out by the QA/QC unit at AEA Energy & Environment. (Ozone is also monitored at this site) (see appendix 6 for location map.)

Table 2 AURN NO<sub>2</sub> Results at Eskdalemuir (Rural Site)

Period	Annual Mean $\mu\text{g}/\text{m}^3$	Number of exceedences of 200 $\mu\text{g}/\text{m}^3$ hourly mean	Data capture
2005	3.8	0	92.8%
2006	4.3	0	89.1%
<i>objective (by 31/12/05)</i>	$\leq 40$	$\leq 18$ per year	$\geq 90\%$

( $\mu\text{g}/\text{m}^3$  = microgrammes per cubic metre) ( $\leq$  = less than or equal to) ( $\geq$  = greater than or equal to)

- 3.1.2.1 The data capture for 2006 is slightly low but otherwise the results in Table 2 meet the objectives.

### 3.2 NO<sub>2</sub> (Diffusion tubes)

- 3.2.1 NO<sub>2</sub> diffusion tubes are deployed for monthly exposure periods at the eleven sites shown in Table 3. Further details of the sites and location maps and are shown in appendices 3 and 5 respectively. The tubes are prepared and analysed by Bureau Veritas Laboratories (formerly Casella CRE Air) using UKAS-accredited method AQ/02 (10% triethanolamine [TEA] in water). Triplicate tubes are used at three sites at Buccleuch Street, Dumfries [Buccleuch Street (E), Buccleuch Street (W) and Buccleuch Street Bridge] whereas the rest of the sites have single tubes.

- 3.2.2 Measurement by diffusion tubes is less accurate than measurement by continuous (chemiluminescent) sampler. Diffusion tubes are however less expensive and more convenient to use. The performance of diffusion tubes supplied by different laboratories can vary significantly but when triplicate diffusion tubes are collocated with a continuous monitor a bias adjustment factor (a measure of how much the tube results deviate over a period from the chemiluminescent sampler results) can be calculated and applied to the results of all of the diffusion tubes used locally (from the same laboratory).

- 3.2.3 Results of collocation studies carried out by different local authorities using the same laboratory can be combined to give a national bias adjustment factor for the laboratory.

- 3.2.4 The diffusion tubes at Buccleuch Street (East) (Municipal Chambers) have been collocated with the AURN continuous NO<sub>2</sub> monitor since March 2003. The results of this local collocation study have been used to derive the bias adjustment factors shown in Table 3 (see appendix 4 for details of the bias adjustment calculation). Table 3 also shows averages obtained using a more sophisticated AEA Energy and Environment collocation bias adjustment spreadsheet which in addition to calculating the bias gives an estimate of the error in the tube results.

- 3.2.5 The national bias adjustment factors for Casella CRE Air (10% TEA in water) are:-
- 0.80 for 2005 (*amalgamation of 13 studies including Dumfries & Galloway's*)
  - 0.87 for 2006 (*amalgamation of 10 studies including Dumfries & Galloway's*)

3.2.6 The locally-obtained bias adjustment factors are 0.968 for 2005 and 0.971 for 2006. Use of the national bias adjustment factors would therefore give slightly lower averages than those shown in Table 3.

**Table 3 Diffusion Tube Results**

Location of tube		Annual Average 2006 $\mu\text{g}/\text{m}^3$	Annual Average 2006 (bias corrected x 0.971)	Annual Average using AEA Energy and Environment Spreadsheet	Average 2005 $\mu\text{g}/\text{m}^3$	Average 2005 (bias corrected x 0.968)	Annual Average using AEA Energy and Environment Spreadsheet
M74 Slip Rd	Lockerbie	29.2	28.4	28 ± 3	32.5	31.5	32 ± 2
*Buccleuch St. (E)	Dumfries	38.6	37.5	37 ± 4	37.4	36.2	36 ± 2
†Buccleuch St. (W)	Dumfries	36.2	35.2	35 ± 4	36.1	34.9	35 ± 2
Loreburn St.	Dumfries	26.5	25.7	26 ± 3	28.1	27.2	27 ± 2
St Michael St.	Dumfries	26.3	25.5	25 ± 3	26.7	25.8	26 ± 1
Argyll Drive	Dumfries	12.2	11.8	12 ± 1	12.1	11.7	12 ± 1
Charlotte St.	Stranraer	19.0	18.4	18 ± 2	20.2	19.6	20 ± 1
Port Rodie Car Park	Stranraer	16.5	16.0	16 ± 2	19.4	18.8	19 ± 1
A77 Cairnryan	Stranraer	20.2	19.6	20 ± 2	18.7	18.1	18 ± 1
†Buccleuch St. (S)	Dumfries	36.8	35.7	36 ± 3	These two new sites commenced in November 2005 therefore average annual data are not available for 2005		
Buccleuch St Bridge	Dumfries	33.2	32.2	32 ± 4			

\* Triplicate tubes collocated with automatic monitor

( $\mu\text{g}/\text{m}^3$  = microgrammes per cubic metre)

† Triplicate tubes

3.2.7 All the results in Table 3 are within the objective for the  $\text{NO}_2$  annual mean. ( $\leq 40 \mu\text{g}/\text{m}^3$ ). (The upper error limit at Buccleuch Street (E) (for 2006) is slightly above the objective according to AEA Energy and Environment's spreadsheet).

### 3.3 $\text{PM}_{10}$

3.3.1 A gravimetric  $\text{PM}_{10}$  Partisol Sequential Air Sampler is situated on a flat roof adjacent to the Municipal Chambers, Buccleuch Street, Dumfries and forms part of the AURN. (The monitoring site is close to a bus-stop.) Results for the past five years are as shown in Table 4. All the results are based on ratified data. Ratification is carried out by the QA/QC unit at AEA Energy & Environment.

**Table 4 AURN  $\text{PM}_{10}$  Results at Buccleuch Street, Dumfries**

Year	Annual Mean $\mu\text{g}/\text{m}^3$	Number of exceedences of 24-hour mean of $50 \mu\text{g}/\text{m}^3$	Data capture
2002	21.4	18	93.7%
2003	23.3	22	93.4%
2004	17.5	4	91.8%
2005	20.1	6	97.5%
2006	23.8	9	88.5%
2010 (projected)	22.3	7	N/A
objective	by 31/12/04	$\leq 40$	$\geq 90\%$
	by 31/12/10	$\leq 18$	

( $\mu\text{g}/\text{m}^3$  = microgrammes per cubic metre) ( $\leq$  = less than or equal to) ( $\geq$  = greater than or equal to)

3.3.2 The data capture for 2006 is slightly low but otherwise results shown in Table 4 meet the objectives that were to be achieved by 31/12/04. The projected 2010 results, obtained by using the methods outlined in the technical guidance<sup>3</sup> together with the LAQM tools available from the UK Local Air Quality Archive<sup>8</sup>, predict that the 2010 annual mean will not be met however it should be noted that there is no relevant exposure at this location. With regard to the three road junctions referred to in the 2006 updating and screening assessment that were predicted to marginally exceed the 2010 PM<sub>10</sub> objective, namely the junctions of Brooms Road/Annan Road, Buccleuch Street/Glasgow Street and Buccleuch Street/Whitesands, all in Dumfries, it is intended that traffic flows at these sites will be checked to see if they are in line with predictions, if necessary, by commissioning manual counts. The construction of a new by-pass south of Dumfries may help to alleviate pressure on these junctions. The new by-pass is listed as a medium-term priority in the Regional Transport Strategy (RTS)<sup>9</sup>. The RTS was submitted to the Minister for Transport on 30/03/07 for approval and the decision of the new Minister for Roads, Infrastructure and Climate Change is awaited.

### 3.4 CO

3.4.1 A continuous CO monitor (API M300) is located at the Municipal Chambers, Buccleuch Street, Dumfries and forms part of the AURN. Results for the past five years are shown in Table 6. All the results are based on ratified data. Ratification is carried out by the QA/QC unit at AEA Energy & Environment.

Table 6 AURN CO Results at Buccleuch Street, Dumfries

Year	Maximum 8-hour running mean (mg/m <sup>3</sup> )	Average 8-hour running mean (mg/m <sup>3</sup> )	Maximum hourly mean (mg/m <sup>3</sup> )	Data capture
2002	3.875	0.616	5.8	93.0%
2003	2.863	0.614	5.2	97.4%
2004	2.150	0.551	4.3	98.5%
2005	2.700	0.550	4.6	97.2%
2006	2.275	0.639	4.9	84.6%
<i>objective (by 31/12/03)</i>	≤ 10	N/A	N/A	≥ 90%

mg/m<sup>3</sup> = milligrammes per cubic metre

≤ = less than or equal to

≥ = greater than or equal to

3.4.1.1 The data capture for 2006 is slightly low but otherwise the results shown in Table 6 meet the objectives.

#### 4. New Local Developments

- A refuse-derived-fuel (RDF) waste treatment plant (also referred to as an Eco-Deco<sup>10</sup> plant after the Italian Company that designed it) has recently commenced operation at Dargavel (Locharmoss) near Dumfries. Treatment consists primarily of shredding, drying, separation of recyclable material and compaction. The RDF plant is part of the Council's Waste Management/Recycling Private Finance Initiative. The impacts on the pollutant levels of most relevance, PM<sub>10</sub> and NO<sub>2</sub>, (among others) were assessed as minimal.
- Construction of a pyrolysis plant (a type of incinerator) also referred to as an energy-from-waste (EFW) plant for which planning consent has been granted in respect of a site near the RDF plant at Dargavel has not commenced as yet. Impact of emissions on the pollutant levels of most relevance SO<sub>2</sub>, NO<sub>2</sub> and PM<sub>10</sub> (among others) have been assessed and the objectives are not considered likely to be breached.
- Construction of a 40 megawatt wood-burning power station is underway at Steven's Croft 2½ miles north of Lockerbie. The main fuel will be forestry-related materials in the form of small roundwood and sawmill co-products but the plant will be designed to burn a percentage of short-rotation coppice and recycled timber. The plant is expected to become fully operational by December 2007. The plant is adjacent to an existing sawmill. The impacts of emissions on the pollutant levels of most relevance, NO<sub>2</sub>, PM<sub>10</sub> and SO<sub>2</sub> (among others) have been assessed and the objectives are not considered likely to be breached.
- Following a public local inquiry in December 2006 a Harbour Empowerment Order (HEO) has been granted by the Scottish Ministers facilitating Stena Line Ltd's re-location from Stranraer to Cairnryan. Works are anticipated to be completed by the end of 2008. The impact of the intended move has been assessed and whilst increased levels of SO<sub>2</sub>, NO<sub>2</sub> and PM<sub>10</sub> have been predicted in the locality the objectives are not considered likely to be breached. As noted above a further assessment for SO<sub>2</sub> will be carried out subsequent to the move.
- Works have recently commenced on a new opencast coal site at Glenmuckloch near Kirkconnel. The site is in a relatively remote area with little relevant exposure.
- A major housing development is underway at Marchfield, an area on the north-eastern edge of Dumfries between Edinburgh Road and Lockerbie Road and extending to the A75 by-pass. This site is the largest development site in Dumfries and Galloway with an allocation to build 920 new houses. It represents a significant urban expansion and may add to road traffic levels in the town giving rise to increased levels of NO<sub>2</sub> and PM<sub>10</sub>. Provision will be made for cycleways, footways and bus services to provide alternative means of access to the town centre. This is the initial phase of a potentially larger development extending to 1300 - 1500 houses.
- A new Tesco superstore has been constructed at an edge-of-centre brownfield site at Lockerbie. This development has the potential to increase road traffic levels in the vicinity giving rise to increased levels of NO<sub>2</sub> and PM<sub>10</sub>, however this will to some extent be mitigated by the fact that the previous use of the site was as a lorry park and also that there is an existing supermarket adjacent to the site.

5. Conclusion

The results of air quality monitoring in Dumfries and Galloway indicate that the current air quality objectives for the relevant pollutants are being met. Projected PM<sub>10</sub> levels at the AURN monitoring site at Buccleuch Street, Dumfries indicate that the more stringent annual mean PM<sub>10</sub> objective of 18 µg/m<sup>3</sup> to be achieved by 31/12/10 will not be met, however there is no relevant exposure at this roadside site. With regard to three Dumfries road junctions referred to in the 2006 updating and screening assessment that were predicted to marginally exceed the 2010 PM<sub>10</sub> objective it is intended that traffic flows at these sites will be checked to see if they are in line with predictions, if necessary, by commissioning manual counts. New industrial developments are not considered likely to result in any of the relevant air quality objectives being breached, however the new housing development at Marchfield on the outskirts of Dumfries has the potential to cause increased traffic levels in the town centre resulting in increased levels of PM<sub>10</sub> and NO<sub>2</sub> levels. Monitoring will continue.

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- <sup>8</sup> Uk Local Air Quality Archive website.  
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- <sup>9</sup> SWESTrans South West of Scotland Transport Partnership Regional Transport Strategy  
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- <sup>10</sup> Ecodeco website.  
<http://www.ecodeco.it/>

## Air Quality Objectives

Substance	Air Quality Objective	Prescribed date
Benzene	$\leq 16.25 \mu\text{g}/\text{m}^3$ <i>(when expressed as a running annual mean)</i>	31 <sup>st</sup> December 2003
	$\leq 3.25 \mu\text{g}/\text{m}^3$ <i>(when expressed as a running annual mean)</i>	31 <sup>st</sup> December 2010
1,3 butadiene	$\leq 2.25 \mu\text{g}/\text{m}^3$ <i>(when expressed as a running annual mean)</i>	31 <sup>st</sup> December 2003
Carbon monoxide	$\leq 10 \text{mg}/\text{m}^3$ <i>(when expressed as a running 8-hour mean)</i>	31 <sup>st</sup> December 2003
Lead	$\leq 0.5 \mu\text{g}/\text{m}^3$ <i>(when expressed as an annual mean)</i>	31 <sup>st</sup> December 2004
	$\leq 0.25 \mu\text{g}/\text{m}^3$ <i>(when expressed as an annual mean)</i>	31 <sup>st</sup> December 2008
Nitrogen dioxide	$\leq 200 \mu\text{g}/\text{m}^3$ <i>(when expressed as an hourly mean)</i> <i>(not to be exceeded more than 18 times a year)</i>	31 <sup>st</sup> December 2005
	$\leq 40 \mu\text{g}/\text{m}^3$ <i>(when expressed as an annual mean)</i>	31 <sup>st</sup> December 2005
Particles (PM <sub>10</sub> )	$\leq 50 \mu\text{g}/\text{m}^3$ <i>(when expressed as a 24-hour mean)</i> <i>(not to be exceeded more than 35 times a year)</i>	31 <sup>st</sup> December 2004
	$\leq 50 \mu\text{g}/\text{m}^3$ <i>(when expressed as a 24-hour mean)</i> <i>not to be exceeded more than 7 times a year</i>	31 <sup>st</sup> December 2010
	$\leq 40 \mu\text{g}/\text{m}^3$ <i>(when expressed as an annual mean)</i>	31 <sup>st</sup> December 2004
	$\leq 18 \mu\text{g}/\text{m}^3$ <i>(when expressed as an annual mean)</i>	31 <sup>st</sup> December 2010
Sulphur dioxide	$\leq 350 \mu\text{g}/\text{m}^3$ <i>(when expressed as an hourly mean)</i> <i>(not to be exceeded more than 24 times a year)</i>	31 <sup>st</sup> December 2004
	$\leq 125 \mu\text{g}/\text{m}^3$ <i>(when expressed as a 24-hour mean)</i> <i>(not to be exceeded more than 3 times a year)</i>	31 <sup>st</sup> December 2004
	$\leq 266 \mu\text{g}/\text{m}^3$ <i>(when expressed as a 15-minute mean)</i> <i>(not to be exceeded more than 35 times a year)</i>	31 <sup>st</sup> December 2005

$\mu\text{g}/\text{m}^3$  microgrammes per cubic metre

$\leq$  - less than or equal to

Further Details of NO<sub>2</sub> Diffusion Tube Locations

Location of tube		Grid Reference	Type	Distance from edge of kerb (m)	Width of pavement (m)	Height of tube (m)
M74 Slip Rd	Lockerbie	NY133814	Intermediate	1.930	on grass	2.600
Buccleuch St. (E)	Dumfries	NX970762	Roadside	4.290	4.000	2.171
Buccleuch St. (W)	Dumfries	NX969762	Kerbside	1.000	2.640	2.700
Buccleuch St. (S)	Dumfries	NX970762	Kerbside	0.600	3.000	2.700
Buccleuch St. Bridge	Dumfries	NX968762	Roadside	5.000	4.200	3.000
Loreburn St.	Dumfries	NX974762	Kerbside	1.000	2.800	2.800
St. Michael St.	Dumfries	NX975756	Roadside	3.120	2.290	2.970
Argyll Drive	Dumfries	NX994788	Background	1.730	1.730	2.780
Charlotte St.	Stranraer	NX061608	Kerbside	0.500	2.570	2.620
Port Rodie Car Park	Stranraer	NX063610	Other	N/A	N/A	2.600
A77 Cairnryan	Stranraer	NX073674	Roadside	1.950	1.900	2.900

M74 Slip Rd., Lockerbie

Nearest houses are approximately 32m from the tube location. Tube location is approximately 100m from the M74.

Buccleuch St., East (E) & West (W), Dumfries

Both triplicate sets of tubes are on same side of street about 100m apart. Tubes at Buccleuch St (E) have been collocated with an automatic monitor since March 2003. Nearest houses are on Buccleuch Street approximately 100m to the west of tube location Buccleuch St.(W). Buccleuch Street is a shopping street close to the pedestrianised town centre.

Buccleuch Street, Dumfries (South)

New site commenced 4th November 2005. To investigate any possible canyon effect in Buccleuch Street this diffusion tube site is located on the opposite side of the street from the other three Buccleuch Street sites namely Buccleuch Street (East), Buccleuch Street (West) and Buccleuch Street Bridge.

Buccleuch Street Bridge, Dumfries

Monitoring at this new site, close to the junction of Whitesands and Buccleuch Street, Dumfries, was suggested by the Bureau Veritas consultant who carried out last year's USA on behalf of the Council. Monitoring commenced on 4th November 2005 directly outside a former house in multiple occupation (HMO) (see the first map in appendix 5) which had been for sale since before October 2005. Permission had been sought to put the diffusion tube (changed to triplicates at the start of March 2006) on a downpipe on the facade of the former HMO but permission was refused. Consequently the tubes were sited on a lamppost directly in front of the former HMO. However, the tubes were vandalised in March 2006, then again successively in June, July and August 2006, and because of this an alternative location was chosen on a downpipe of an adjacent building within 15 metres of the original and still close to the junction. The triplicate tubes were re-sited from 30/08/06.

**Further Details of NO<sub>2</sub> Diffusion Tube Locations**

Loreburn St., Dumfries

One-way street close to town centre. The nearest houses are situated on the first and second floors above a public house at Loreburn St. The facade of this building is 2.8m from the edge of the kerb.

Argyll Drive, Heathhall, Dumfries

Formerly used for sulphur dioxide diffusion tube location. In a residential area in the vicinity of rubber factories at Heathhall. Urban background for NO<sub>2</sub> monitoring purposes.

St. Michael St., Dumfries

At busy intersection, nearest houses are on opposite side of St Michaels Bridge Road.

Charlotte St., Stranraer

Busy shopping street - one-way traffic. Nearest houses are on opposite side of street on first floor above shops. Sunbathers in summer lie on grassy area just off pavement at the tube location.

Port Rodie Car Park

Car park for Stena Line ferry to Belfast/Larne.

A77 Cairnryan

On A77 at entrance to P&O ferry terminal to Larne.

## Collocation Study at Buccleuch Street Dumfries

Date	Average (continuous) ( $\mu\text{g}/\text{m}^3$ )	*R/P	Data capture %	Average Diffusion Tube ( $\mu\text{g}/\text{m}^3$ )	Ratio:- continuous/diffusion tube result
<b>2005</b>					
January	35.66	R	93.98	42.3	0.843
February	44.89	R	95.52	43.0	1.044
March	41.21	R	95.09	43.3	0.952
April	32.75	R	92.73	33.0	0.992
May	32.58	R	95.54	32.7	0.996
June	28.05	R	95.54	31.3	0.896
July	30.98	R	99.40	31.3	0.990
August	33.72	R	99.55	31.0	1.088
September	32.53	R	96.54	36.3	0.896
October	33.74	R	99.57	35.3	0.956
November	40.10	R	99.69	41.7	0.962
December	48.24	R	98.84	47.3	1.012
12-month average Jan-Dec 2005	36.20		96.83	37.38	0.969
Bias adjustment factor = continuous mean/diffusion tube mean = $36.20/37.38 = 0.968$ Diffusion tube bias = (diffusion tube mean minus continuous mean)/continuous mean = $(37.38 - 36.20)/36.20 = 0.033$ i.e. tubes over-read by 3%					
<b>2006</b>					
January	42.21	R	95.52	40.7	1.037
February	46.09	R	87.35	50.0	0.922
March	43.71	R	91.90	46.7	0.936
April	36.89	R	96.00	44.7	0.825
May	31.65	R	85.69	38.0	0.833
June	31.54	R	99.12	39.0	0.809
July	31.34	R	93.56	34.3	0.914
August	38.70	R	87.07	32.3	1.198
September	33.99	R	99.28	37.0	0.919
October	37.82	R	100	35.3	1.071
November	39.74	R	95.28	35.3	1.126
December	36.21	R	99.77	30.0	1.207
12-month average Jan-Dec 2006	37.49		94.21	38.61	0.983
Bias adjustment factor = continuous mean/diffusion tube mean = $37.49/38.61 = 0.971$ Diffusion tube bias = (diffusion tube mean minus continuous mean)/continuous mean = $(38.61 - 37.49)/37.49 = 0.299$ i.e. tubes over-read by 3%					
*R/P =Ratified or Provisional data.					

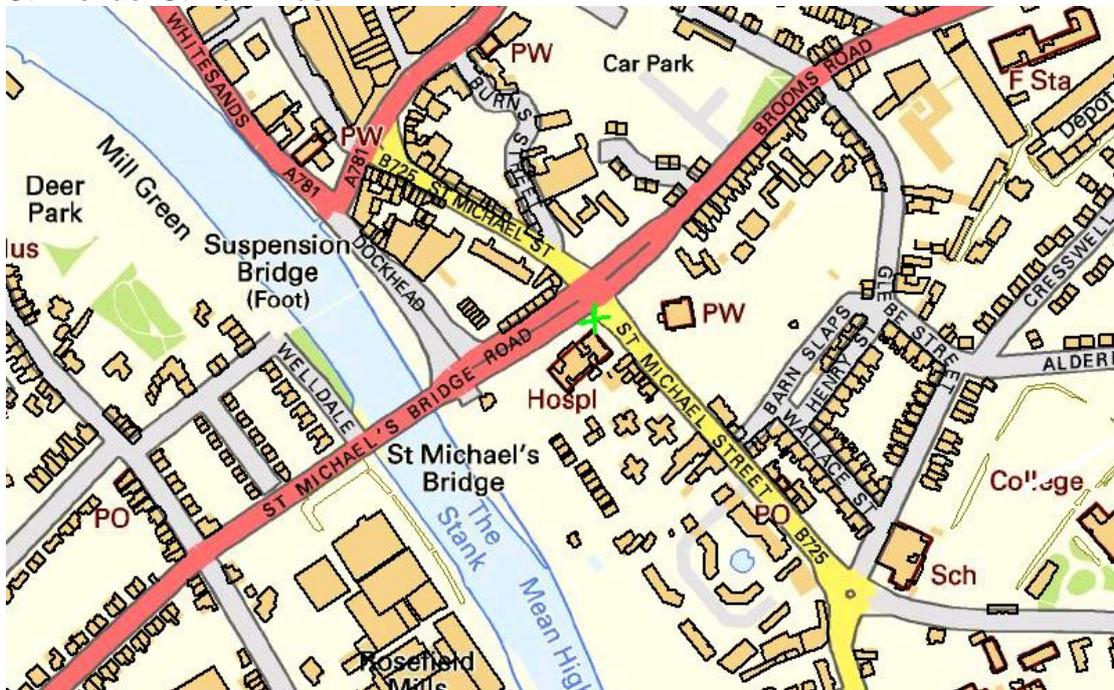
### Diffusion Tube Location Maps

### Appendix 5

Buccleuch St. Sites (from left to right) Bridge, West, South, East (AURN site) + Loreburn St, Dumfries



### St Michael St Dumfries



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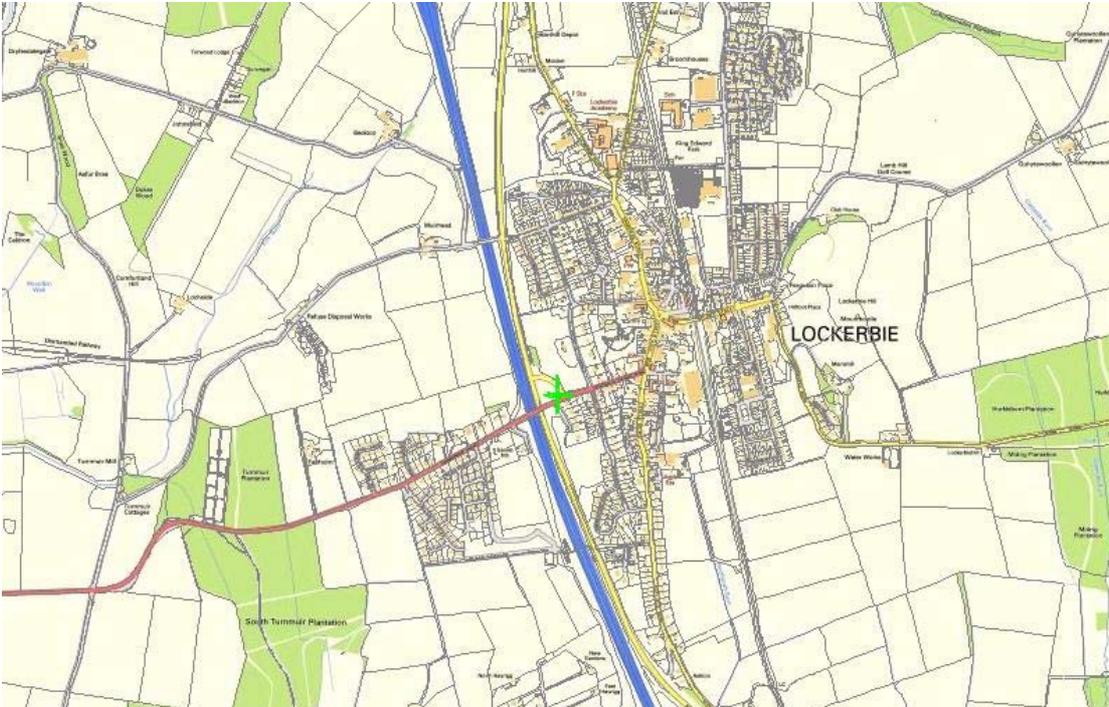
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**Diffusion Tube Location Maps (Continued)**  
**Argyll Drive, Heathhall, Dumfries**

**Appendix 5**



**M74 Lockerbie**

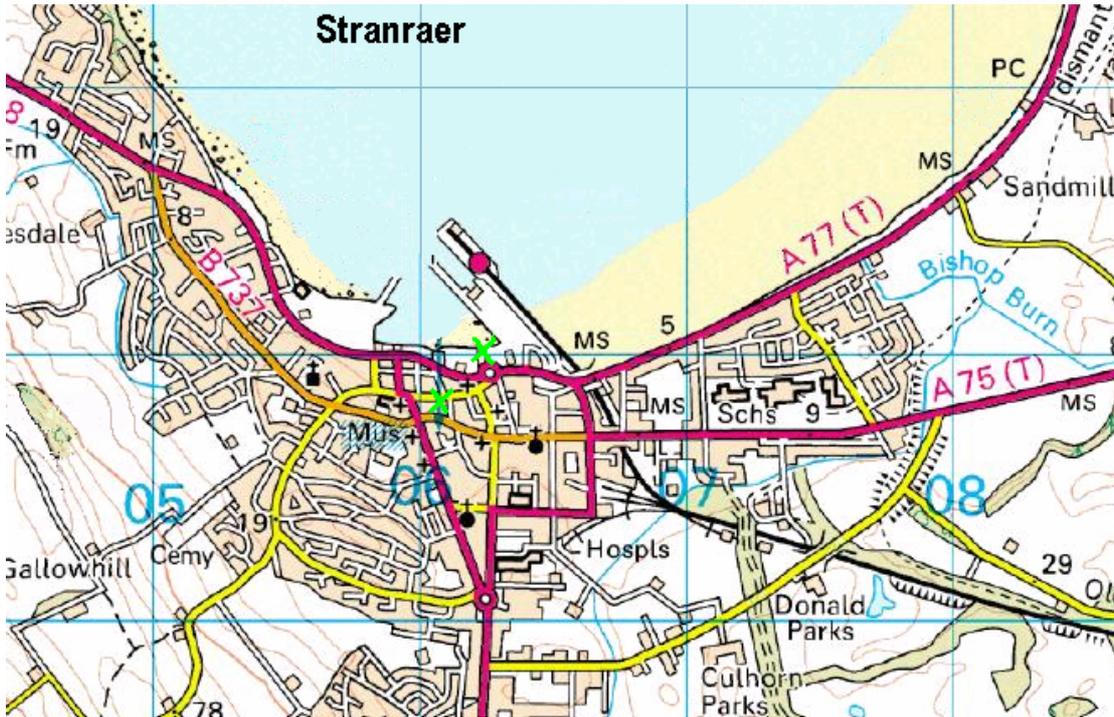


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**Diffusion Tube Location Maps (Continued)**

**Appendix 5**

**Port Rodie Car Park & Charlotte St Stranraer**



**A77 Cairnryan**



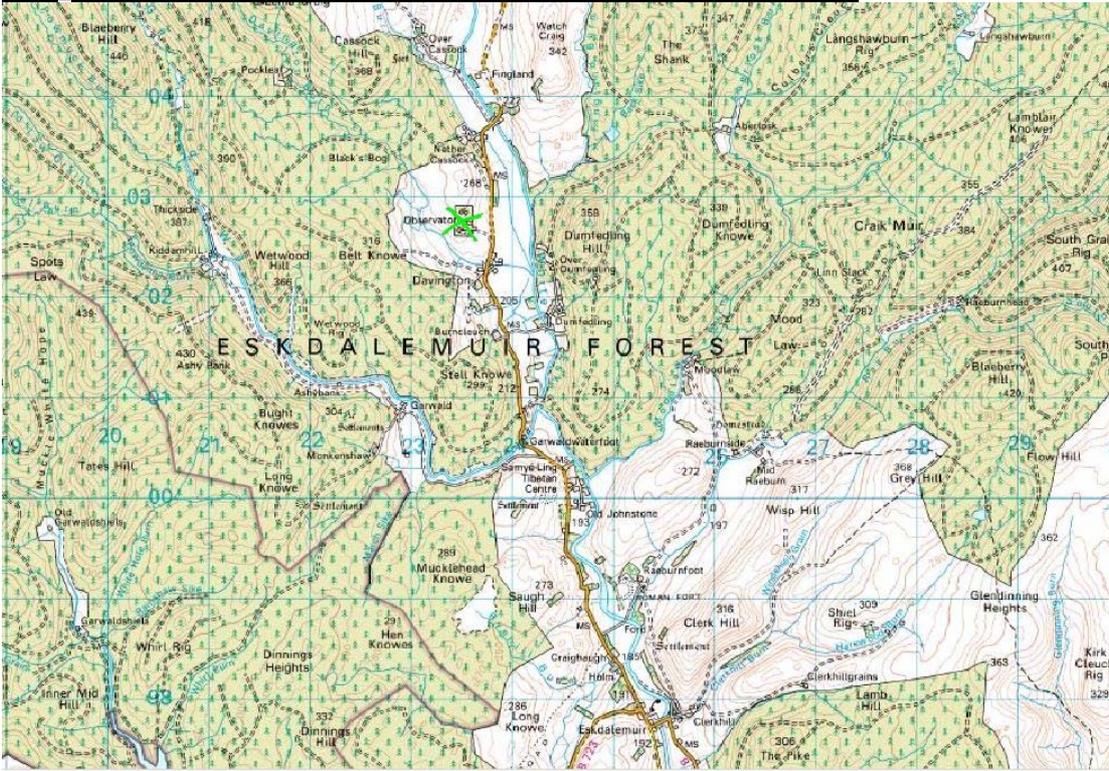
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### NO<sub>2</sub> Automatic Monitor Location at Eskdalemuir



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