



**AIR QUALITY UNIT**



**Report on the nitrogen dioxide diffusion tube and continuous  
monitoring in Dennison Road, Bodmin**

**January 1<sup>st</sup> – March 31<sup>st</sup> 2008**

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# Report on the nitrogen dioxide diffusion tube and continuous monitoring in Dennison Road, Bodmin

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Produced by: Air Quality Unit, Cornwall College, TR15 3RD

Commissioned by: Mike Roberts, Principal EHO. North Cornwall District Council, Cornwall.

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## 1.0 Introduction

Nitrogen dioxide (NO<sub>2</sub>) monitoring in Bodmin stems from previous monitoring programmes beginning in 2003 that indicated high concentrations of traffic-related pollution. A continuous monitor was installed in 2006 at the corner of Dennison Road and Turf Street as this was highlighted as an area of particular concern.

## 1.1 Nitrogen dioxide

NO<sub>2</sub> is not only a health damaging pollutant but also a proxy measure for other traffic-related pollutants. The UK Government's National Air Quality Strategy (NAQS) objectives for NO<sub>2</sub> (DEFRA, 2000) are given in Table 1 below. As stated in the LAQM.TG(03) the NAQS annual mean objective applies to 'air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present'. The NAQS 1-hour mean objective is more specific and only applies to those locations where members of the public are regularly present for an hour or more, in locations close to heavily trafficked roads. Air Quality Consultants state that if an annual mean concentration exceeds 60 µg m<sup>-3</sup> then it is likely that the NAQS 1-hour mean objective would have been exceeded.

Table 1. NAQS objectives for NO<sub>2</sub>.

Nitrogen dioxide (NO <sub>2</sub> )	Measured as	Concentration	Objective deadlines
	Annual mean	40 µg m <sup>-3</sup>	31st Dec 2005
	1 hour mean (18 exceedances)	200 µg m <sup>-3</sup>	

## 1.2 NO<sub>2</sub> background concentrations

Background NO<sub>2</sub> concentration for the surveyed area in Bodmin for 2008, as estimated by the National Environment Technology Centre (NETCEN), is ~8.2 µg m<sup>-3</sup>. This figure is recommended for use by Local Authorities in LAQM TG.(03).

## 1.3 Bodmin and Dennison Road

The town of Bodmin (SX074667) is located in North Cornwall. The A30, Cornwall's primary trunk road, bypasses Bodmin to the south; however the A389, including Dennison Road and Higher Bore Street/St Leonards, is a major route for accessing north Cornwall and runs east-to-west through Bodmin. The A389 carried an annual average daily traffic (AADT) volume of ~14,360 vehicles in 2007, including medium and heavy goods vehicles.

An AirPointer monitor is mounted on a lamppost against the façade of residential houses at the eastern end of Dennison Road. The eastern end of Dennison Road is lined on one side by tall residential properties and on the other a tall hedge creating a canyon street effect that compounds poor air quality. Higher Bore Street is characterised by its proximity to the Five Ways roundabout, a pedestrian crossing and houses situated close to the road.

## 2.0 Equipment

### 2.1 Continuous monitor

The Air Monitors' AirPointer (Plate 1) monitors oxides of nitrogen and is a DEFRA accepted method of NO<sub>2</sub> data collection. The AirPointer is a chemiluminescent monitor which, due to its relatively small size, can be mounted on street furniture (lamppost etc) at the epicentre of the pollution hotspot. The monitor records NO<sub>2</sub> concentration every minute which enables detailed analysis and increases the understanding of the problem.

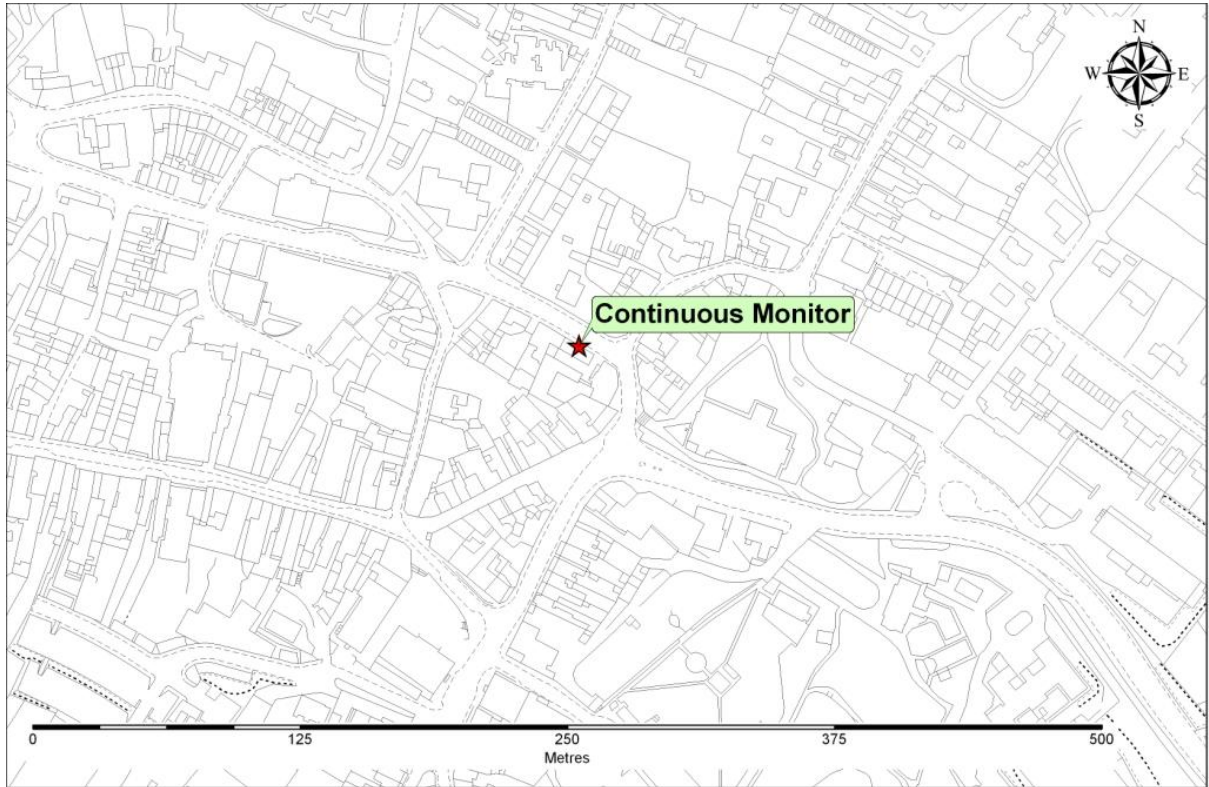
### 2.2 Diffusion tubes

Diffusion tubes are a relatively cheap method of monitoring NO<sub>2</sub> which provides monthly means for NO<sub>2</sub> concentrations for the area in which they are deployed. Diffusion tubes have been used extensively in North Cornwall and have provided useful data regarding the extent of the air pollution problems in the district. A diffusion tube collocated with the continuous monitor has been used for comparative purposes. Tubes are supplied by Gradko International and the preparation method is 20% TEA (triethanolamine) in water. Tubes are exposed for monthly periods and are deployed at the beginning of each month.

In field inter-comparison exercises and QC testing undertaken by the Workplace Analysis Scheme for Proficiency (WASP) programme for NO<sub>2</sub> diffusion tube analysis (operated by the Health and Safety Laboratory), tubes supplied by Gradko International (Type 1, 20% triethanolamine (TEA) in water) performed well and had a Relative Standard Deviation (RSD) of standardised results for 2003 of 7%; significantly below the median of 12% for all participating laboratories. Gradko International was also given a Performance Score of "Good" for QC solution analysis for 2003 (Loader *et al*, 2005). For all tube results, the DEFRA bias adjustment factor of 0.87 is applied (<http://www.uwe.ac.uk/aqm/review/diffusiantube300307.xls>).



Plate 1. The AirPointer in Dennison Road



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Figure 1. The location of the AirPointer in Dennison Road, Bodmin.

### 3.0 Results

#### 3.1 Continuous monitoring

##### 3.1.1 Dennison Road AirPointer Summary (1/1/2008 – 31/3/2008)

Table 2 provides a summary of the continuous monitoring data for the period 1<sup>st</sup> January to the 31<sup>st</sup> March 2008. The mean NO<sub>2</sub> concentration recorded in Dennison Road for the 90.7 valid days monitoring was 47.6 µg m<sup>-3</sup> with a maximum 15-minute mean concentration of 332 µg m<sup>-3</sup>. The monitoring period mean recorded concentration would potentially exceed the NAQS annual mean objective and there was 1 exceedance of the NAQS 1-hour mean objective of a permitted 18.

Table 2. A summary of the continuous monitoring data in Dennison Road for the period 1/1/2008 – 31/3/2008

Start date	End date	No. of days	No. days valid data	%Data Capture	Maximum (µg m <sup>-3</sup> )	Mean (µg m <sup>-3</sup> )
1/1/2008	31/3/2008	91	90.7	99.6	332	47.6

##### 3.1.2 Dennison Road AirPointer Summary (1/4/2007 – 31/3/2008)

Table 3 provides a calendar year summary of continuous monitoring data for the year ending 31/3/2008. The annual mean NO<sub>2</sub> concentration recorded on Dennison Road was 45.5 µg m<sup>-3</sup>, exceeding the NAQS annual objective for NO<sub>2</sub>, there were also 8 exceedances of the NAQS 1-hour mean objective of a permitted 18.

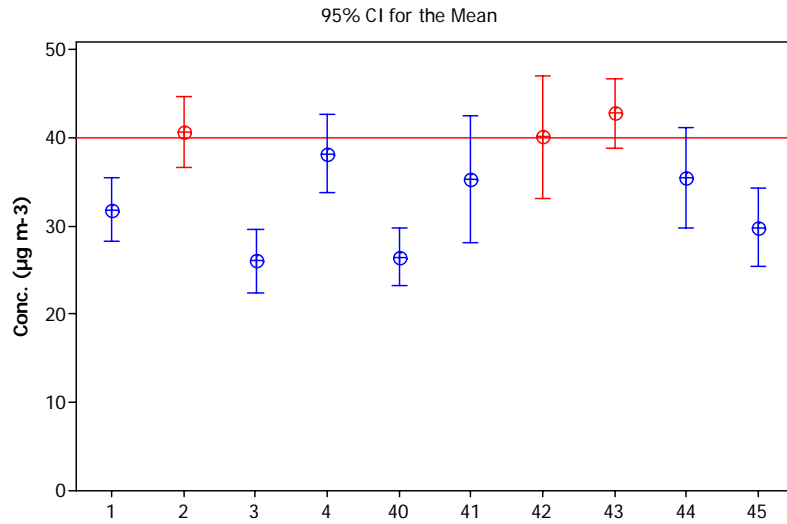
Table 3. A summary of the continuous monitoring data in Dennison Road for the period 1/4/2007 – 31/3/2008

Start date	End date	No. of days	No. days valid data	%Data Capture	Maximum (µg m <sup>-3</sup> )	Mean (µg m <sup>-3</sup> )
1/4/2007	31/3/2008	366	273.5	74.7	332	45.5

#### 3.2 Diffusion tubes

When analysing diffusion tube data it is preferable to use a large dataset as opposed to individual monthly values as a more reliable conclusion can be drawn. There were 10 sites (highlighted in red in Figure 3a and b) that exceeded the NAQS annual mean objective for NO<sub>2</sub> concentrations. Exceeding tubes are located in Higher Bore Street (Figure 3a) and along Dennison Road (Figure 3b).

(a)



(b)

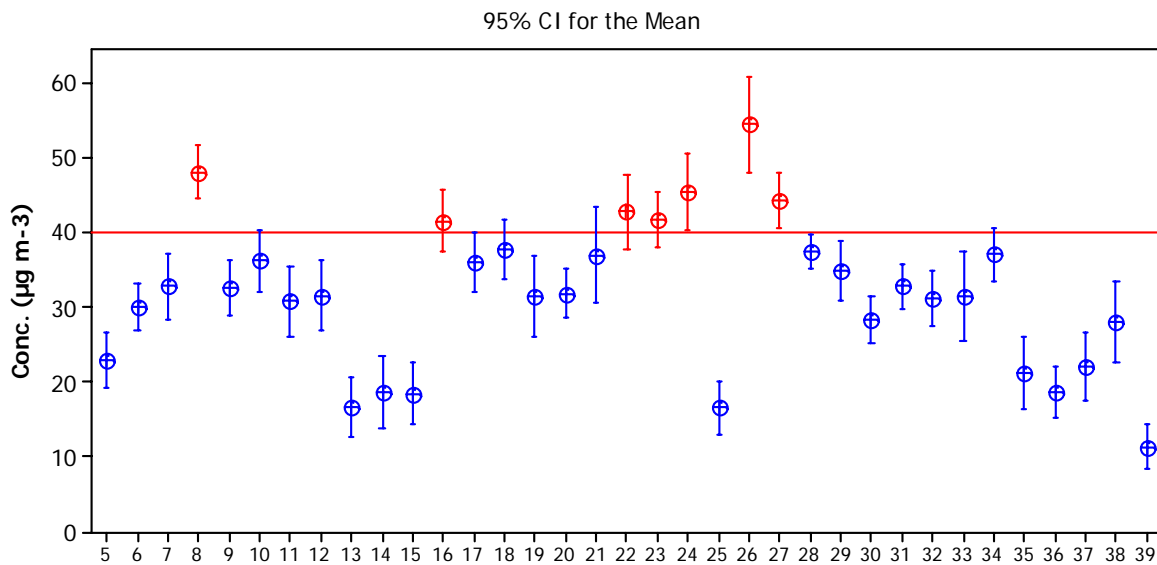
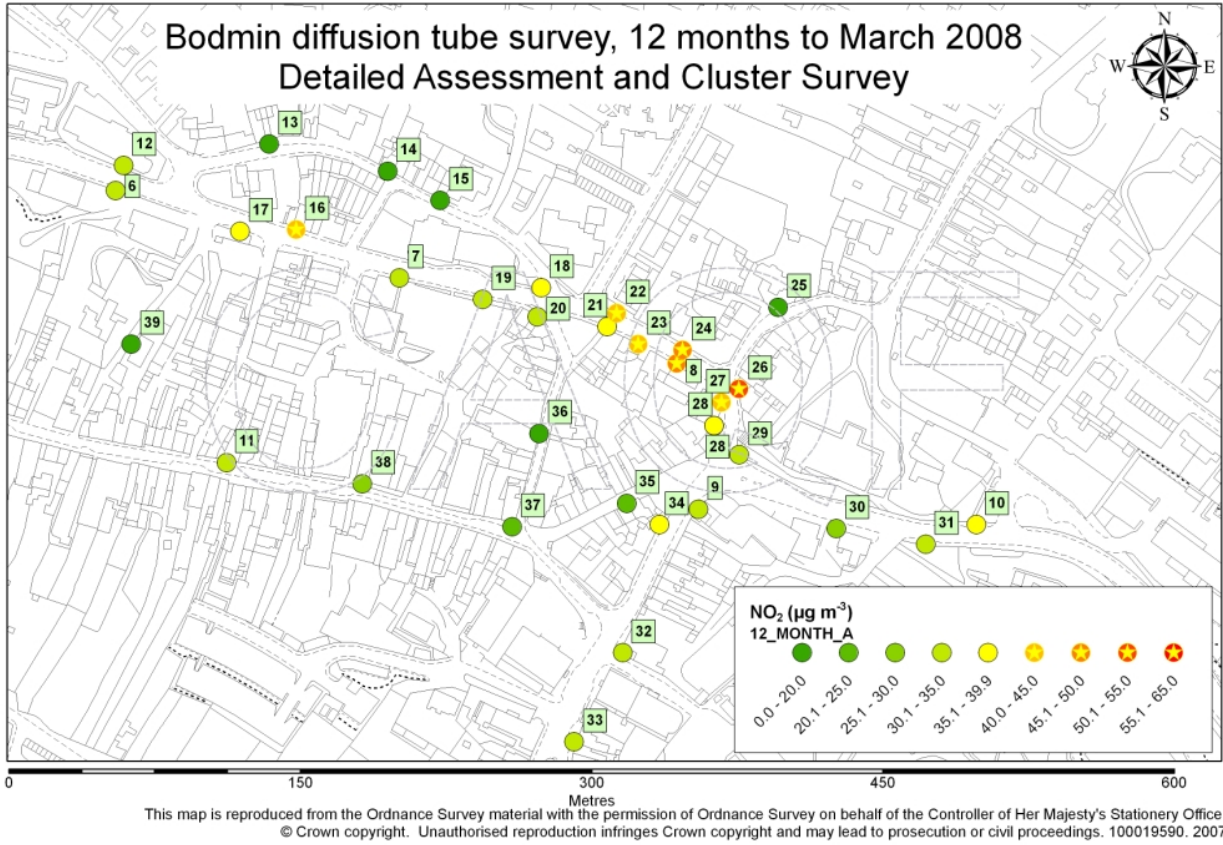


Figure 3. 12-month mean NO<sub>2</sub> concentration recorded by diffusion tubes in Bodmin (a) west and (b) east; the red line indicates the NAQS annual mean objective concentration (for exact site locations refer to Figure 4).

(a)



(b)

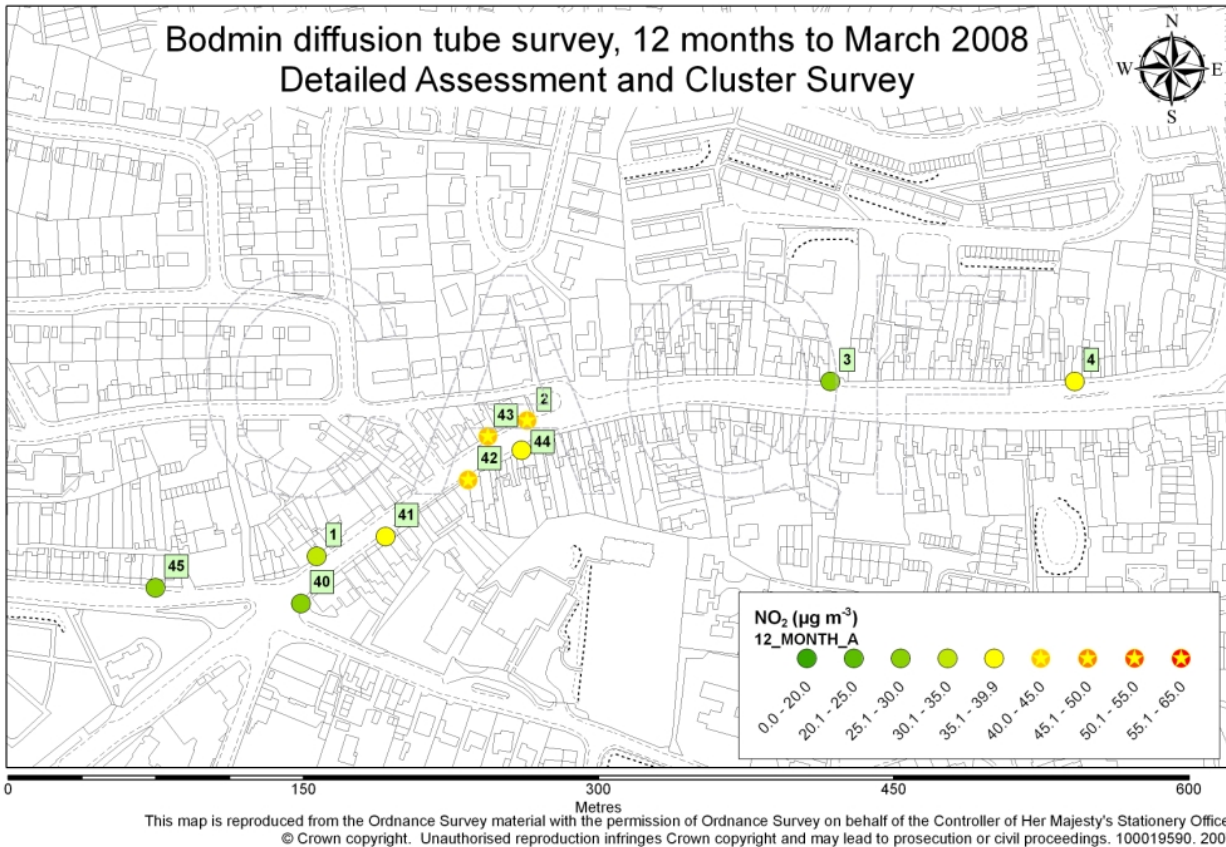


Figure 4. Map (a) Higher Bore Street and (b) Dennison Road and Bodmin town centre displaying the location and annual mean NO<sub>2</sub> concentration.

## 4.0 Discussion

### 4.1 Exceedances

The mean concentration recorded over the 3-month and 12-month monitoring periods ending 31/3/2008 by the continuous monitor located in Dennison Road was  $47.6 \mu\text{g m}^{-3}$  and  $45.5 \mu\text{g m}^{-3}$  respectively; both exceeding the NAQS annual mean objective. In the 12-months ending 31/3/2008 there were eight exceedances of the NAQS 1-hour objective (one recorded in the last 3 months) of a permitted 18 annually.

Ten of the 45 diffusion tubes exceeded the NAQS annual mean objective. Exceeding sites are located along the Dennison Road/Higher Bore Street corridor, particularly the eastern end of Dennison Road around the sharp corner (Figure 4b) and the junction of Higher Bore Street and Midway Road (Figure 4a).

### 4.2 Data capture

The continuous monitor recorded a data capture value for the 3-month and 12-month period ending 31/3/2008 of 99.8% and 74.7% respectively. The 3-month value exceeds DEFRA's data capture requirement of 90%; the 12-month value does not meet DEFRA's stipulated 90% data capture, due to a hard drive failure in August 2007.

### 4.3 Diurnal patterns

The mean diurnal  $\text{NO}_2$  concentration recorded on weekdays, Saturdays and Sundays in Dennison Road were  $50.2 \mu\text{g m}^{-3}$ ,  $46.0 \mu\text{g m}^{-3}$  and  $36.4 \mu\text{g m}^{-3}$  respectively for the period 1/1/2008 – 31/3/2008 (Figure 5). As illustrated in Figure 5 the pollution scenario in Dennison Road has a classic traffic-related pattern. That is, pollution concentrations increase in the morning, are sustained during the day and fall in the evening; weekday pollution amplitudes are greater than those observed at weekends.

This phenomena is closely correlated to traffic volume as highlighted in the recent source apportionment study for Dennison Road (Winkler, 2007). The report concludes that medium goods vehicles (vehicles between 3.5 and 7.5 tonnes) are a significant contributor to pollution concentrations.

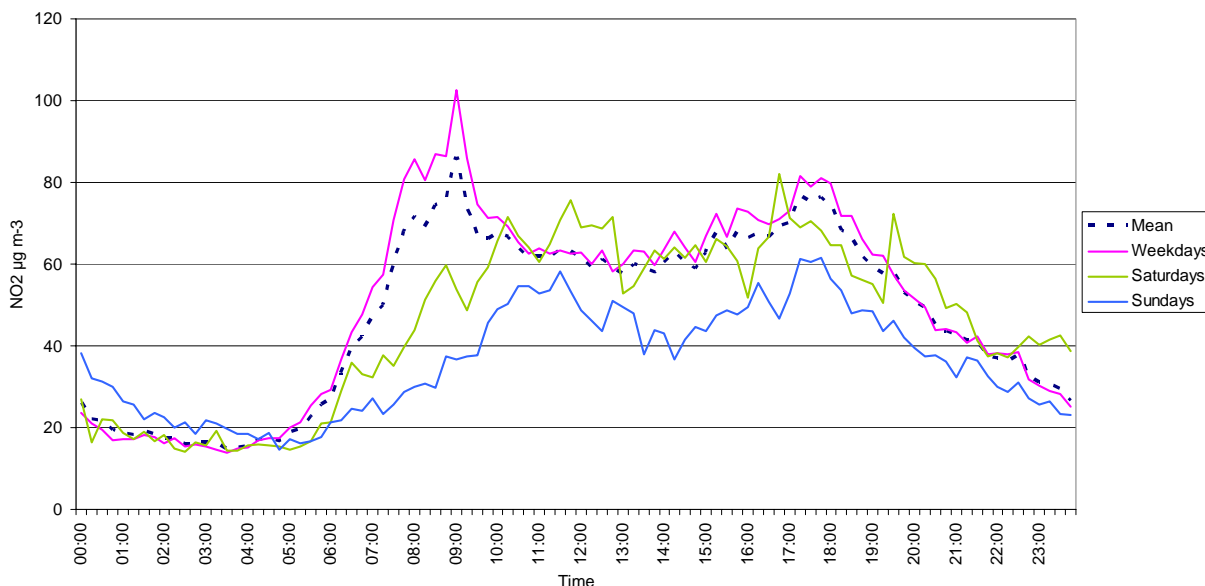


Figure 5. Diurnal  $\text{NO}_2$  concentrations recorded in Dennison Road for the period 1/1/2008 – 31/3/2008 for weekdays, Saturdays, Sundays and the monitoring period mean (the red line indicates the NAQS annual objective for  $\text{NO}_2$  concentration).

#### 4.4 Collocated diffusion tube and continuous monitor

A two sample paired t-test statistical analysis reveals that there is no statistical difference between the diffusion tube monthly values and the continuous monitor means calculated over the same periods ( $p = 0.323$ ). The degree of agreement is increased ( $p = 0.862$ ) by removing monthly continuous monitor mean values where data capture is less than the DEFRA objective of 90% (this is done as data recorded in months with <90% may not be representative). This agreement between the two methods allows for confidence of the two methods.

#### 5.0 Conclusion

- The mean NO<sub>2</sub> concentration recorded by the continuous monitor in Dennison Road for the 3-month and 12-month periods ending 31/3/2008 were 47.6 µg m<sup>-3</sup> and 45.5 µg m<sup>-3</sup> respectively; these values exceed the NAQS annual objective for NO<sub>2</sub> of 40 µg m<sup>-3</sup>.
- Data capture by the continuous monitor was 99.8% and 74.7% for the 3-month and 12-month periods respectively. DEFRA's data capture objective is 90%; however, an exceedance of the NAQS objectives can be reported with <90% data capture.
- Of the 45 diffusion tubes deployed in the Bodmin area 10 recorded annual means >40 µg m<sup>-3</sup> and therefore exceed the NAQS annual objective; these were located at the eastern end of Dennison Road and Higher Bore Street.
- Traffic-related pollution is suggested as the primary source, evident in the diurnal concentration patterns and the lack of any local industrial sources.
- A statistical analysis of the diffusion tube and continuous monitoring methods reveals a high degree of agreement between the two monitoring methods.

#### Confidentiality

All sampling results from the monitoring sites in North Cornwall District will be the property of North Cornwall District Council, and will be subject to strict confidentiality and not disclosed to any third party without prior formal permission from North Cornwall District Council.

#### Disclaimer

Cornwall College cannot accept any responsibility for the use to which the information is put nor for decisions, inferences or conclusions that are made on the basis on the information provided. No responsibility is taken for the accuracy of the sampling unless this is done under our own supervision.