



**Quarterly report on the monitoring of nitrogen dioxide in  
Penryn Street, Redruth,  
January 1st – March 31st 2008**

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Commissioned by Chris Selby, Environmental Protection Manager, Kerrier District Council, Cornwall.

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## 1.0 Introduction

Continuous nitrogen dioxide (NO<sub>2</sub>) monitoring began on the 11th April 2006 in Penryn Street, Redruth. The continuous monitoring programme stems from an ongoing NO<sub>2</sub> diffusion tube survey that indicated high concentrations of traffic-related NO<sub>2</sub> at this site.

### 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. 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 Ltd 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 also been exceeded.

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

Nitrogen dioxide (NO <sub>2</sub> )	Measured as	Concentration
	Annual mean	40 µg m <sup>-3</sup>
	1 hour mean, 18 exceedences	200 µg m <sup>-3</sup>

### 1.2 Penryn Street, Redruth

A Signal NO<sub>2</sub> continuous monitor is positioned in St Rumon's Gardens adjacent to Penryn Street (Appendix 1 and Plate 1). The monitor inlet head is positioned outside the gardens on Penryn Street (Plate 2) and is approximately 1 m from the roadside, the inlet head is partially sheltered by the aperture in the wall. A diffusion tube has been collocated with the inlet head.

Penryn Street transects Redruth town centre and forms part of the eastern town centre access, diverging from the A393, a primary route between Redruth and Falmouth. Traffic lights are located at either end of Penryn Street and regulate heavy traffic flow during the morning and evening rush hours. Penryn Street is lined by tall properties, including residential properties, shops and pubs, creating a 'canyon effect' compounding the poor air quality.

## 2.0 Equipment

The Signal equipment ('Street Nitrogen Oxides box' (Plate 1 and Appendix 1)) is an accredited monitoring method by regulators DEFRA and monitors oxides of nitrogen by drawing ambient air into the monitor via a pump.

As the inlet head of the Signal monitor is not located directly at the roadside a diffusion tube has been collocated with the inlet head and another at the roadside (approximately 30 metres from the inlet head). It is intended that the difference between the results for the two diffusion tubes will give an indication on the drop-off in concentrations from the roadside to the Signal inlet. The difference between the reported *number of days* and *number of days' valid data* is caused by data being tagged as invalid by the monitor; this can be for a number of reasons including monitor calibration.



Plate 1.



Plate 2.

Plate 1. The Signal continuous NO<sub>2</sub> monitor viewed from inside St Rumons Gardens.

Plate 2. The inlet head for the monitor situated in a recess viewed from Penryn Street.

### 3.0 Results

#### 3.1 3-month continuous monitoring summary (January 1<sup>st</sup> – March 31<sup>st</sup> 2008)

Table 2 is a summary of the data recorded during the period January 1<sup>st</sup> – March 31<sup>st</sup> 2008. For the 76.1 days of valid data a mean concentration of 32.3 µg m<sup>-3</sup> was recorded. A 15-minute mean concentration >40 µg m<sup>-3</sup> was recorded for 33% of the monitoring period.

Table 2. Summary of continuous monitoring data 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> )
01/1/2008	31/3/2008	91	76.1	83.6	149	32.3

#### 3.2 12-month continuous monitoring summary (April 1<sup>st</sup> 2007 – March 31<sup>st</sup> 2008)

Table 3 is a summary of the data recorded during the 12-month period April 1<sup>st</sup> 2007 – March 31<sup>st</sup> 2008. For the 302.7 days of valid data a mean concentration of 35.0 µg m<sup>-3</sup> was recorded. As the annual mean concentration was <40 µg m<sup>-3</sup> there was no exceedance of the NAQS annual objective regarding NO<sub>2</sub> concentration.

Table 3. Summary of continuous monitoring data for the period 1/1/2007 – 31/12/2007.

Start date	End date	No. of days	No. days valid data	%Data Capture	Maximum ( $\mu\text{g m}^{-3}$ )	Mean ( $\mu\text{g m}^{-3}$ )
01/04/2007	31/03/2008	366	302.7	82.7	149	35.0

### 3.3 A comparison of continuous monitoring and collocated diffusion tube

Collocated with at the continuous monitor's inlet head is a diffusion tube; this allows a comparative study of the two methods and also gives a degree of confidence to diffusion tube data collected in the CPR monitoring programme. The difference over the three month period (1/1/2008 – 31/3/2008) is  $6.4 \mu\text{g m}^{-3}$  (20%) and the difference over the 12-month period ending 31/3/2008 is  $7.6 \mu\text{g m}^{-3}$  (12%).

	Continuous Monitor	Collocated Diffusion Tube
3-month mean	$32.3 \mu\text{g m}^{-3}$	$38.7 \mu\text{g m}^{-3}$
12-month mean	$35.0 \mu\text{g m}^{-3}$	$39.3 \mu\text{g m}^{-3}$

## 4.0 Discussion

### 4.1 Exceedances

The mean  $\text{NO}_2$  concentration for the 76.1 day monitoring period between 1/1/2008 – 31/3/2008 was  $32.3 \mu\text{g m}^{-3}$ ; below the NAQS annual  $\text{NO}_2$  objective value of  $40 \mu\text{g m}^{-3}$ . The mean  $\text{NO}_2$  concentration for the 12-month period ending 31/3/2008 was  $35.0 \mu\text{g m}^{-3}$ ; this also falls below the NAQS annual objective.

The 3-month and 12-month mean concentrations recorded by the collocated diffusion tubes also do not exceed the NAQS annual objective. The discrepancy between the two monitoring methods over the 12-month monitoring period is statistically significant ( $p=0.004$ ); diffusion tubes are triplicate located at this site to investigate this further.

### 4.2 Data Capture

There was a data capture value of 83.6% for the 3-month period ending March 31st 2008 falling below the DEFRA data capture objective; 14.9 days of data were labelled invalid by the monitor as a result of temporary faults including a PC failure due to water damage for the first week of January. The 12-month data capture value was 82.7% also falling below the DEFRA objective.

### 4.3 Diurnal Patterns

The mean  $\text{NO}_2$  concentration recorded on weekdays, Saturdays and Sundays on Penryn Street for the period 1/1/2008 – 31/3/2008 was  $35.7 \mu\text{g m}^{-3}$ ,  $25.7 \mu\text{g m}^{-3}$  and  $24.2 \mu\text{g m}^{-3}$  respectively. Figure 1 plots the weekday, Saturday and Sunday diurnal  $\text{NO}_2$  concentration patterns as a 15-minute mean for the 76.1 day monitoring period.

The diurnal  $\text{NO}_2$  concentration pattern recorded in Penryn Street displays a typical traffic-related pollution scenario; that is  $\text{NO}_2$  concentrations increase in the morning, maintain a sustained high concentration throughout the day and decrease in the evening. Weekday concentration amplitudes are greater than those recorded at the weekend.

The weekday diurnal maximum concentration occurs in the morning coinciding with the school run. A further analysis of the 2007 data reveals the influence school related traffic has on  $\text{NO}_2$  concentrations in Penryn Street, as can be seen in Figure 2 term-time morning rush-hour concentrations can be  $15 - 20 \mu\text{g m}^{-3}$  higher than at similar times during holiday. It is suggested the implementation of school travel plans could significantly reduce the annual mean  $\text{NO}_2$  concentration observed in Penryn Street.

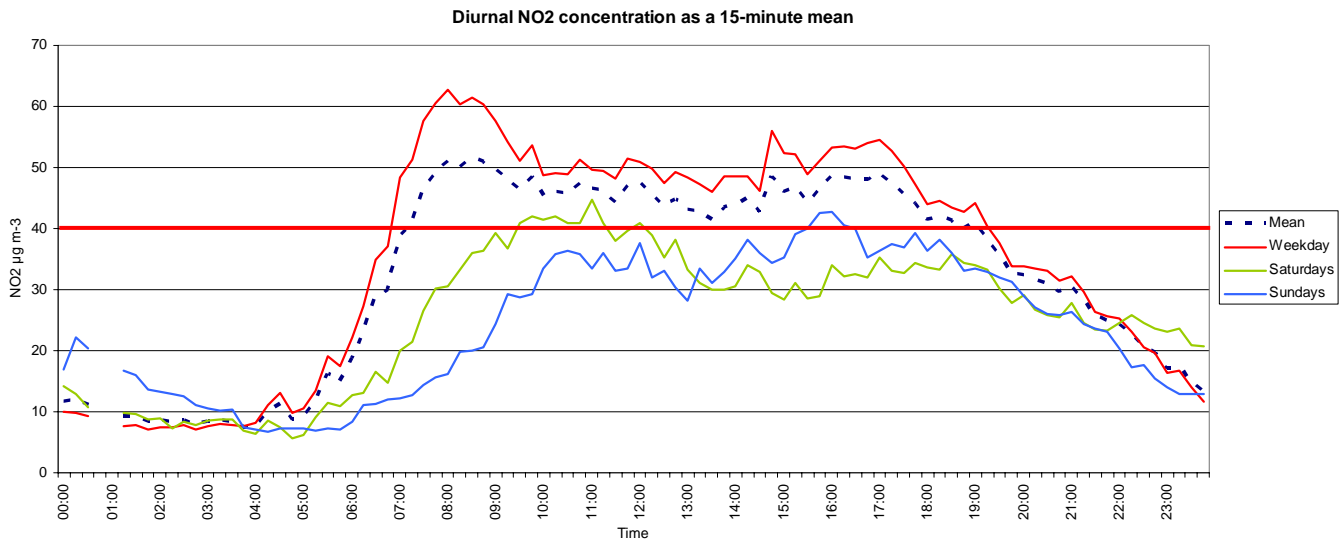


Figure 1. A comparison of diurnal patterns recorded in Penryn Street in the 3-month period ending 31/3/2008. The horizontal red line indicates the NAQS annual mean objective.

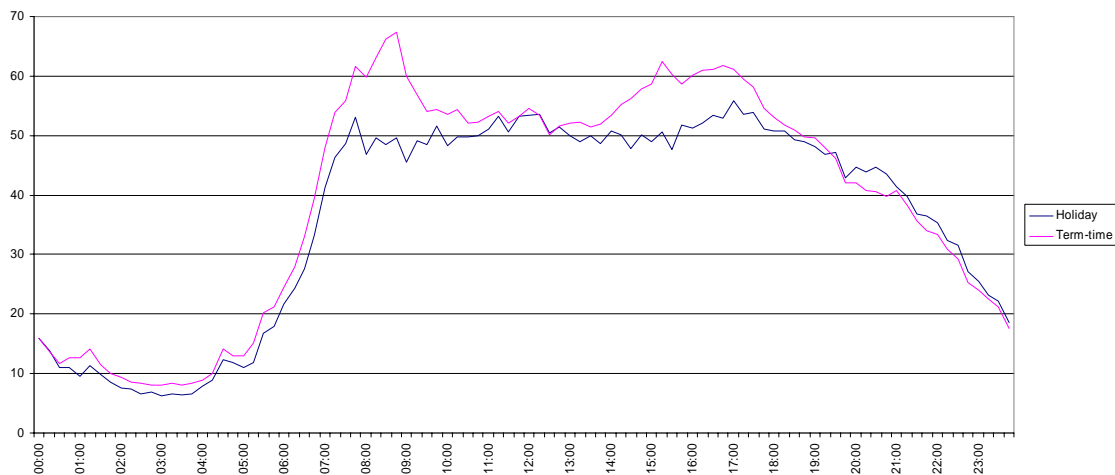


Figure 2. A comparison of term-time and school holiday diurnal NO<sub>2</sub> concentration patterns for 2007.

## 5.0 Conclusion

- The mean NO<sub>2</sub> concentration recorded in Penryn Street for January 1<sup>st</sup> – March 31<sup>st</sup> 2008 by the continuous monitor was 32.3 µg m<sup>-3</sup>; this resulted in no exceedances of the NAQS objectives for either the annual or 24-hour values.
- A data capture value of 83.6% was recorded by the continuous monitor for January 1<sup>st</sup> – March 31<sup>st</sup> 2008, falling below DEFRA's objective of 90%.
- There was a statistically significant difference in recorded NO<sub>2</sub> concentration between the continuous monitor and collocated diffusion tube methods.
- The diurnal NO<sub>2</sub> concentration pattern displays a typical traffic-related pollution scenario. A further analysis of diurnal data highlights the impact of the school run.

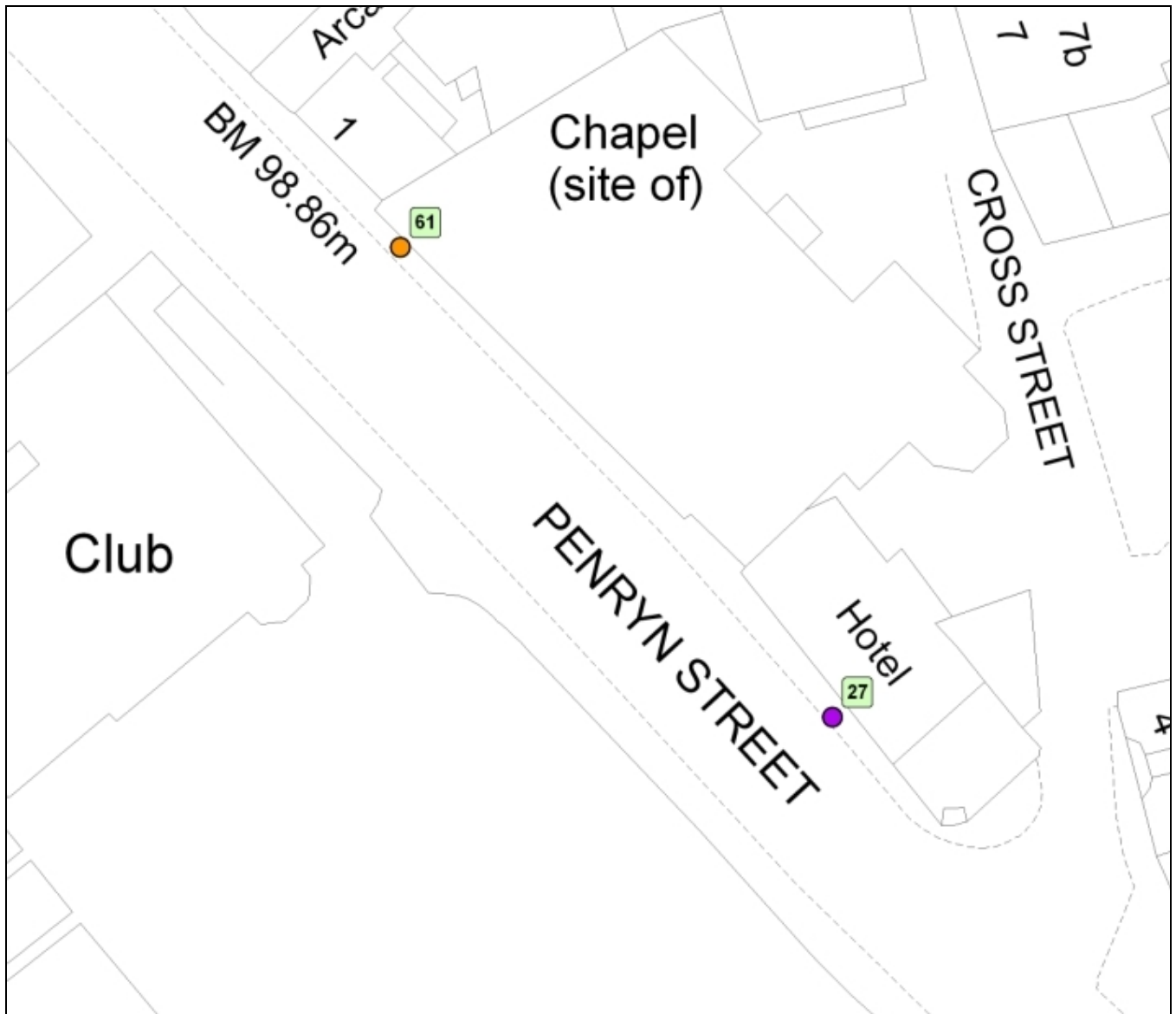
## Confidentiality

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

## Appendix 1



Appendix 1. Position of the diffusion tubes in Penryn Street, Redruth. Tube number 61 also marks the position of the continuous monitor inlet head.