AIR QUALITY REVIEW AND ASSESSMENT

DETAILED ASSESSMENT

DETAILED ASSESSMENT UNDER PART IV OF THE ENVIRONMENT ACT 1995.

APRIL 2004

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DETAILED ASSESSMENT

1. Introduction

1.1 General

This Detailed Assessment (DA) is part of the Local Air Quality Management Programme (LAQM) for the South Hams. Local Authorities have a statutory duty to prepare various such assessment reports on air quality in their areas under Part iv of the Environment Act 1995. Specifically, Detailed Assessments must be submitted when a previous Updating and Screening Report (USA – see below) has demonstrated the need for one.

In the South Hams, all of the statutory air quality work, together with additional air quality duties is drawn together, organised and co-ordinated in an Air Quality Strategy (SHDC, 2002).

The USA undertaken by South Hams District Council and submitted to the Department for Environment, Food and Rural Affairs (Defra) in May 2003, (SHDC, 2003) concluded that Detailed Assessments should be made at two locations. At both of these locations, only Nitrogen Dioxide (NO_2) required further assessment.

The locations at which these assessments were deemed necessary were at the façades of a row of domestic houses on Western Road, Ivybridge and at the façade of one domestic residence at Dean Prior, Buckfastleigh.

The following Detailed Assessment therefore describes the results of recent monitoring using NO_2 diffusion tubes and modelling using the advanced and updated AAQUIRE model at these sites. The results obtained are compared with the annual mean objective of 40µg/m^3, which is applicable for both 2005 and 2010. The hourly maximum objective for NO_2 is not assessed (neither was it investigated in the USA) as South Hams District Council (SHDC) has no continuous monitoring equipment available at present with which to do this. The assessments are undertaken in line with Government Guidance as far as possible(LAQM. TG(03), defra), and this is referred to throughout.

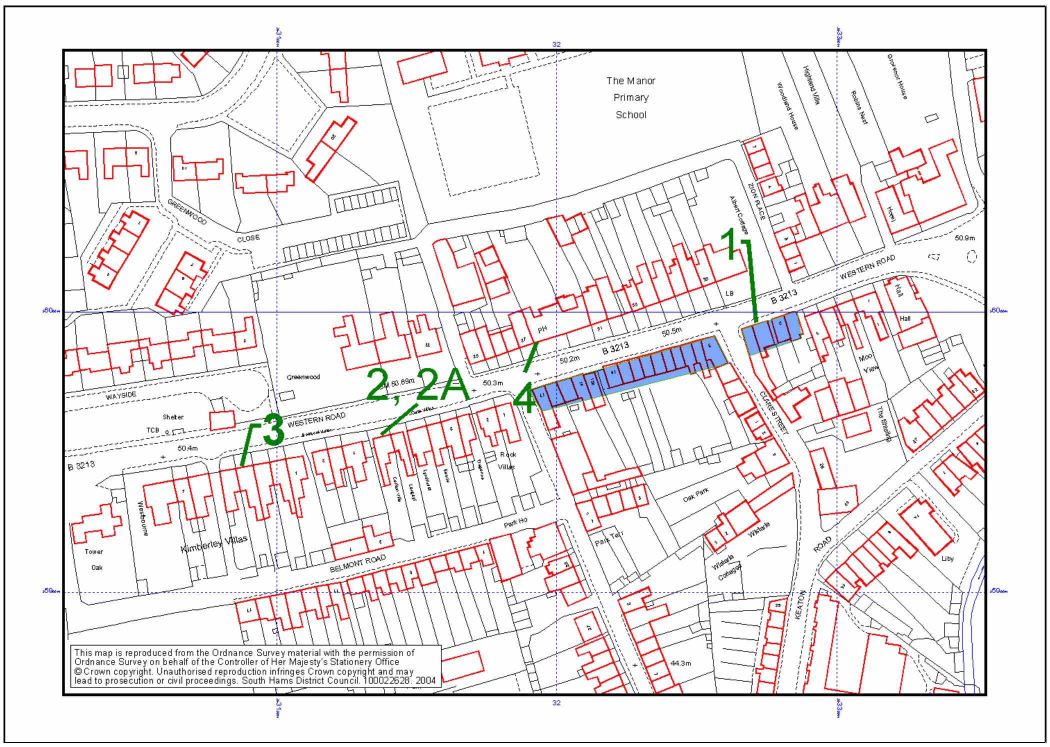
2. Detailed assessment - Western Road, Ivybridge.

2.1 Layout of Western Road

A plan of Western Road can be seen in Figure 1. The road is a two-way single carriageway B road which takes traffic into and out of the town of Ivybridge which has a population of around 12,000 (2001 census; www.devon.gov.uk). The annual average daily traffic flow is just over 10,000 (see table A, Appendix 1). Local anecdotal information also indicates that the road is used quite a lot by heavy goods vehicles visiting and leaving the Lee Mill industrial estate which is situated to the West of Ivybridge and which is also accessible directly from the main A38.

The air quality issue at Western Road arises because there are a number of domestic residential properties which directly front onto the pavement and whose facades are therefore around only one metre from the edge of the road (figure 1). Moreover, parked cars are present most of the time on the northern edge of the road thereby frequently causing a degree of traffic congestion.

Figure 1
Plan of Western Road, numbered points show locations of nitrogen dioxide diffusion tubes (see section below). Properties of particular current concern are highlighted.



2.2 Conclusions of USA regarding Western Road

The DMRB model run undertaken for the USA gave a projected annual mean of around 27 $\mu g/m^3$ for the properties directly fronting Western Road.

However, the results of NO_2 diffusion tubes located close to the facades of these houses produced a different picture. Diffusion tube results for the whole of 2002 were given in the USA which, when adjusted for bias, gave a result of 40.7 $\mu g/m^3$ (ie. just over the 40$\mu g/m^3$ objective level.) This result did reduce to 37.5 $\mu g/m^3$ when projected to 2005 using the correction factors given in Box 6.6, LAQM. TG(03) (see SHDC, 2003). However the final result was still close to the objective and the bias adjustment factor of 0.82 used in the USA was not fully validated and was quite low compared to similar others (eg. see the spreadsheet obtained via the Helpdesk on www.uwe.ac.uk/aqm/review and also Laxen and Wilson, 2002). Furthermore *actual* results obtained by the diffusion tubes up until the USA was written in mid 2003 did not appear to reduce over time as predicted by the defra correction factors (see section 2.4 below). For these reasons it was felt important to progress to a detailed assessment.

2.3 Recent NO_2 monitoring at Western Road – results.

Throughout 2003, diffusion tubes were located at the points numbered 1 and 2 shown on figure 1. From March onwards a second diffusion tube was co-located at point 2 (point 2A) for additional information on the accuracy of the tubes. Further tubes were places at points 3 and 4 at the beginning of 2004. The raw results and the bias-adjusted results for the first three tubes are shown in Table 1 below. The projections for future years, according to the correction factors given in Box 6.6, LAQM. TG(03) are given in Table 2 below. The bias adjustment factor of 0.88 has been obtained from a co-location study of three diffusion tubes and an automatic analyser situated in Plymouth and carried out in partnership with Plymouth City Council, as South Hams District Council does not yet have its own automatic analyser. The determination of the bias adjustment factor from this study is detailed in Appendix 2 and information on Quality Assurance and Quality Control of the diffusion tubes and of the Plymouth automatic analyser is provided in Appendix 3.

Table 1
Diffusion tube monitoring results, including bias adjustment, for locations in Western Road in 2003. Results in μg/m³.

	Point 1, figure 1	Point 2, figure 1	Co-located tube, Point 2A, figure 1
Jan 03	Missing	40.8	
Feb	54.23	59.42	
March	44.37	48.51	44.96
April	39.32	37.48	44.24
May	40.22	47.26	41.73
June	34.7	40.58	45.92
July	35.51	47.54	46.69
Aug	52.53	48.85	46.08
Sept	56.11	Missing	Missing
Oct	44.08	53.09	51.19
Nov	48.24	48.83	54.19
Dec	44.36	41.59	47.6
Mean	44.88 *	46.72 *	46.96 **
Bias adjusted mean (multiplied by 0.88 – see Appendix 2).	**39.49**	**41.11**	**41.32**

Notes to Table 1

* = mean of 11 results as one month's result is missing. Hence data capture for this year is at a rate of 11/12 months = 91.7%
** = mean of 9 results as this co-located tube was not sited until March 03 and one month's result is missing.

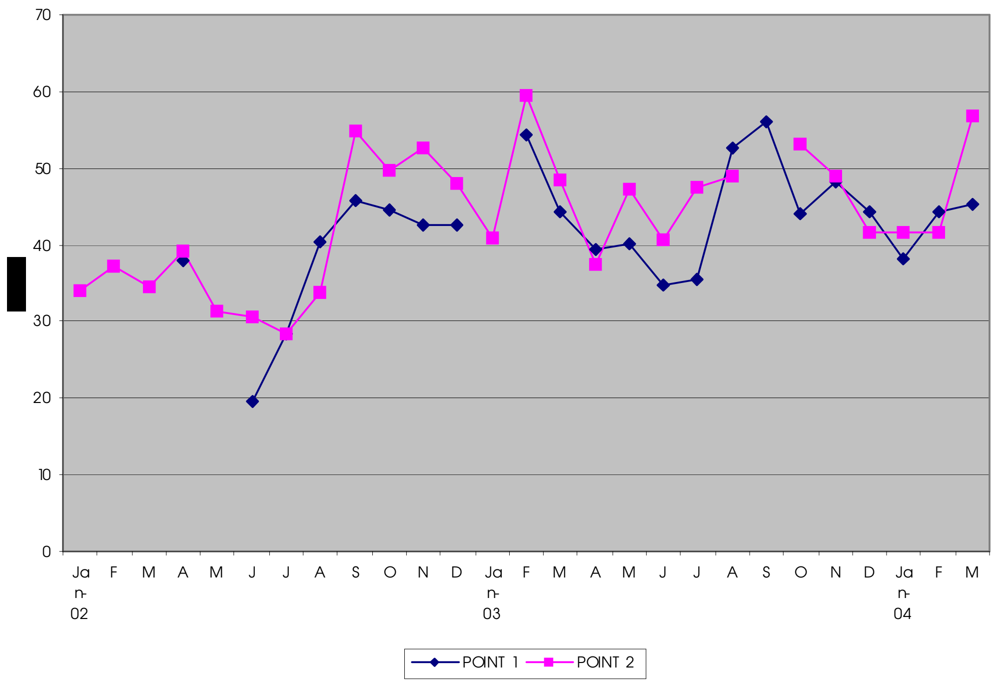
Table 2
Projected future annual mean concentrations of Nitrogen Dioxide (in μg/m³) using the correction factors given in Box 6.6, LAQM.TG(03) from bias-adjusted means given in Table 1, objective years are in bold.

	2003	2004	**2005**	2006	2007	2008	2009	**2010**
Point 1	39.49	38.43	**37.44**	36.21	35.91	33.53	32.11	**30.84**
Point 2	41.11	40.0	**38.97**	37.7	36.34	354.91	33..42	**32.11**
Point 2A	41.32	40.21	**39.17**	37.89	36.53	35.1	33.6	**32.28**

2.4 Recent NO_2 monitoring at Western Road – discussion.

Thus, bias-adjusted and extrapolated diffusion tube results produce a nitrogen dioxide concentration for 2005 which is on the borderline of compliance with the annual mean objective level of 40 $\mu g/m^3$. It is worthwhile noting however that the extrapolation to future years according to the defra guidance given in Box 6.6, LAQM.TG(03) which results in a reduction in NO_2 concentrations, may not be wholly realistic. This has been noted by other Local Authorities (see Air Quality Management, March 04, p6), and can be illustrated for the Western Road situation in a graph showing the trend of results from January 2002 through to March 2004 (figure 2). These results are not adjusted for bias as co-location comparison data are not available for each year shown.

Figure 2
Actual, unadjusted diffusion tube results for Western Road, Ivybridge, 2002-2004. Points 1 and 2 refer to the diffusion tube locations shown in Figure 1, above.



Furthermore, early results from the additional diffusion tubes (at points 3 and 4 on Figure 1) also show relatively high concentrations even though these tubes are set a few metres further back from the road than the nearest relevant locations which are monitored via the tubes at points 1,2 and 2A and which also continue to show high levels of Nitrogen Dioxide (see table 3).

Table 3 Actual, unadjusted, most recent results of diffusion tubes at Western Road, in μg/m3.

	Point 1	Point 2	Point 2A	Point 3	Point 4
Jan 04	38.19	41.68	41.16	34.28	32.1
Feb 04	44.36	41.59	47.6	35.12	35.12
March 04	45.40	56.75	55.56	42.41	39.43

2.5 Advanced modelling of Western Road – validity and data input.

The most recent version (2003) of the AAQUIRE Regional Air Quality Model developed by CES (now called Faber Maunsell) was used to undertake modelling for the detailed assessment. AAQUIRE uses dispersion algorithms based on the CALINE4 system for modelling road traffic. The model has been widely validated and used throughout the world (AAQUIRE manual 2000; 2003). The version of AAQUIRE used incorporated the latest emissions factors database for the UK. The meteorological data used was from Plymouth Airport meteorological station and was for the year 1995. This is older than is recommended in the Technical Guidance (LAQM. TG(03)), but is the most recent comprehensive data available from Plymouth which is the nearest meteorological station by far to the South Hams area (the next nearest from which suitable data are available being Yeovilton in Somerset.) The 1995 Plymouth meteorological data has previously been examined by CES and been deemed to be the most typical of met. data over 5 years, (SHDC, 2000).
The CALINE 4 model used incorporates default factors for the conversion of NOx to NO_2 and these default factors were used in the modelling exercises.

In addition to the integral model data, further data relating to vehicle composition, speed, geographical factors and background NO_2 concentrations were input to the model and are shown in Table 3. Vehicle counts were based on a survey undertaken by Devon County Council in November 2000 (see Appendix 1). It was not thought necessary to adjust the count for seasonal variations as the road is unlikely to be used by tourist traffic.
The total vehicle counts for future years were extrapolated forward using an estimated total traffic growth rate of 2% per year. This is an estimate made by Devon County Council for years to 2006 (DCC, 2000). It is likely to be an overestimate for years beyond this as national data show traffic growth slowing (DETR, 1999), but is useful for providing a worst-case screening factor for 2010 predictions.

The proportion of HGVs has been taken from a Highways Agency Automatic Traffic Count on the nearby A38. Again this is likely to provide a worst-case scenario as HGV proportions will be greater on the A38 which is the principal trunk road through South Devon.

AAQUIRE requires a further breakdown of vehicle categories according to whether engines are petrol or diesel, and, if petrol, fitted with a catalyst or not. Proportions for this were calculated by extrapolating the proportions given in the National Atmospheric Emissions Inventory traffic projections (from www.naie.org.uk) and slightly increasing the proportion without catalysts for future years – again to provide a worst case scenario and to reflect the assumed slightly older average age of cars in Devon compared to the national fleet.

Proportions of hot and cold engines were estimated – assuming a worst-case situation with a large number of colder engines. Average speed was also estimated based on experience of travelling frequently on the road at all times of the day.

Data relating to the road dimensions were obtained by measuring road width on the Cadcorp Geographical Information System used by the Council. Road width was increased by 1 metre either side which allowed for the pavements either side of Western Road. The right and left mix widths of the road were designated as zero to which indicates no significant dispersion of pollutants. This is recommended in the AAQUIRE manuals (CES, 1999; Faber Maunsell, 2003).

Background pollution levels were obtained from the grid square information given by the NAEI on www.naei.org.uk And these were extrapolated to future years as required according to the guidance given in LAQM.(TG04).

Table 3 Data input to AAQUIRE for modelling of Western Road, 2005 and 2010.

DATA INPUT	WESTERN ROAD
Surface roughness	Small town/forest
Class	1
Area modelled: SW grid point	63050 55900
Area modelled; NE grid point	63250 56050
Grid space	5
Receptor height	1.5
Year	2005
Road coordinates	63310 56015 63011 55942
Vehicles per hour	470 (05) 515 (10)
% HDV	14
Average speed km/hr	38
Road height	0
Road width	8+2
Road type	1 (flat)
Left mix width	0
Right mix width	0
% LDV petrol cold	4
%LDV petrol hot	6
% LDV petrol cold catalyst	25

% LDV petrol hot catalyst	40
% LDV diesel cold	5
% LDV diesel hot	20
% HGV cold	30
% HGV hot	70
Background conc.NOx (ug/m3)	18 (05) 12 (10)
Default Nox/NO_2 ratios applied.	Yes
Met data	Plym

2.6 Advanced modelling of Western Road – results and discussion

The results of the modelling are shown in Figures 3 and 4 below. It can be seen that, according to the model, nowhere is the concentration of nitrogen dioxide greater than 24µg/m^3 in 2005 and it is lower still in 2010. Some work was undertaken to try to verify the model (see Appendix 4), and this seems to confirm that the model is under-reading. However, the under-read is similar to that obtained by the Design Manual for Roads and Bridges (DMRB) for Western Road used in the USA (SHDC 2003). Using that screening model including a 'street canyon effect factor' a result of 27.5 µg at the nearest relevant location in 2005 was obtained.

Figure 3, Western Road modelled for 2005- results.

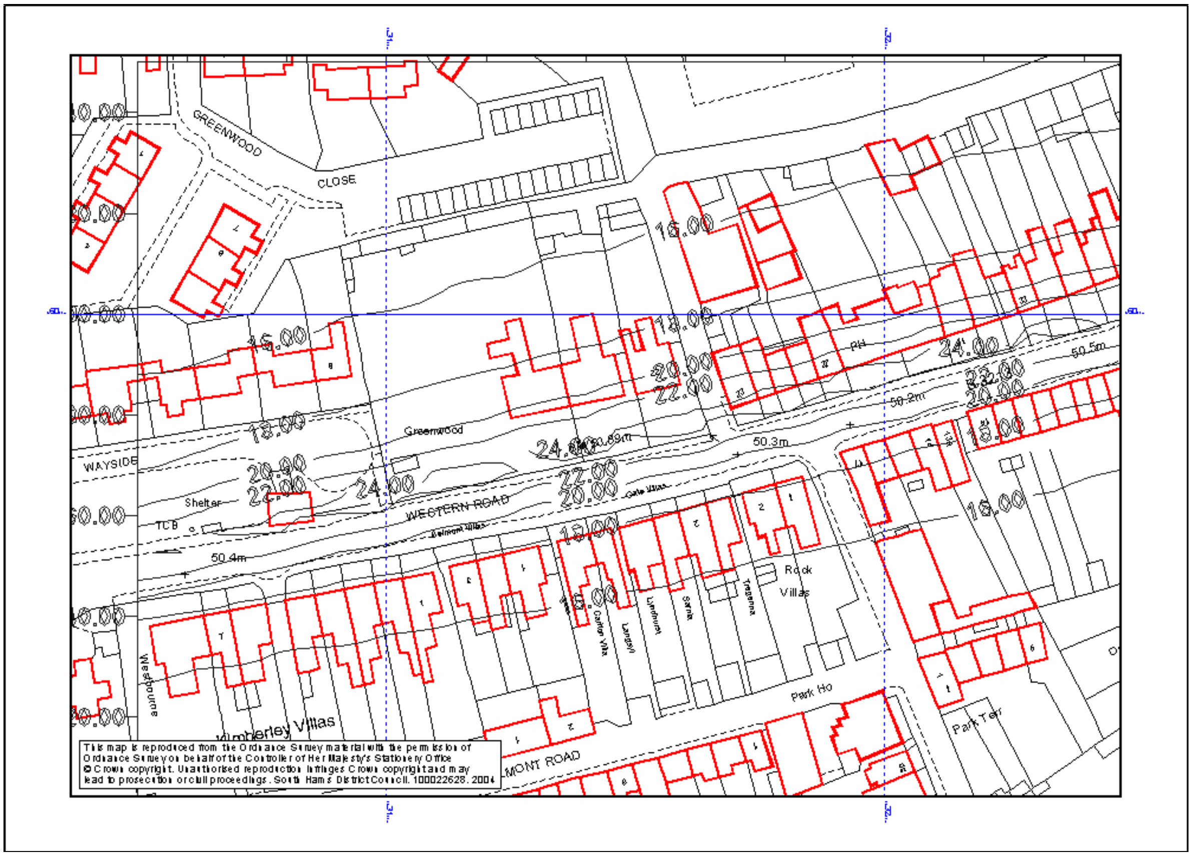
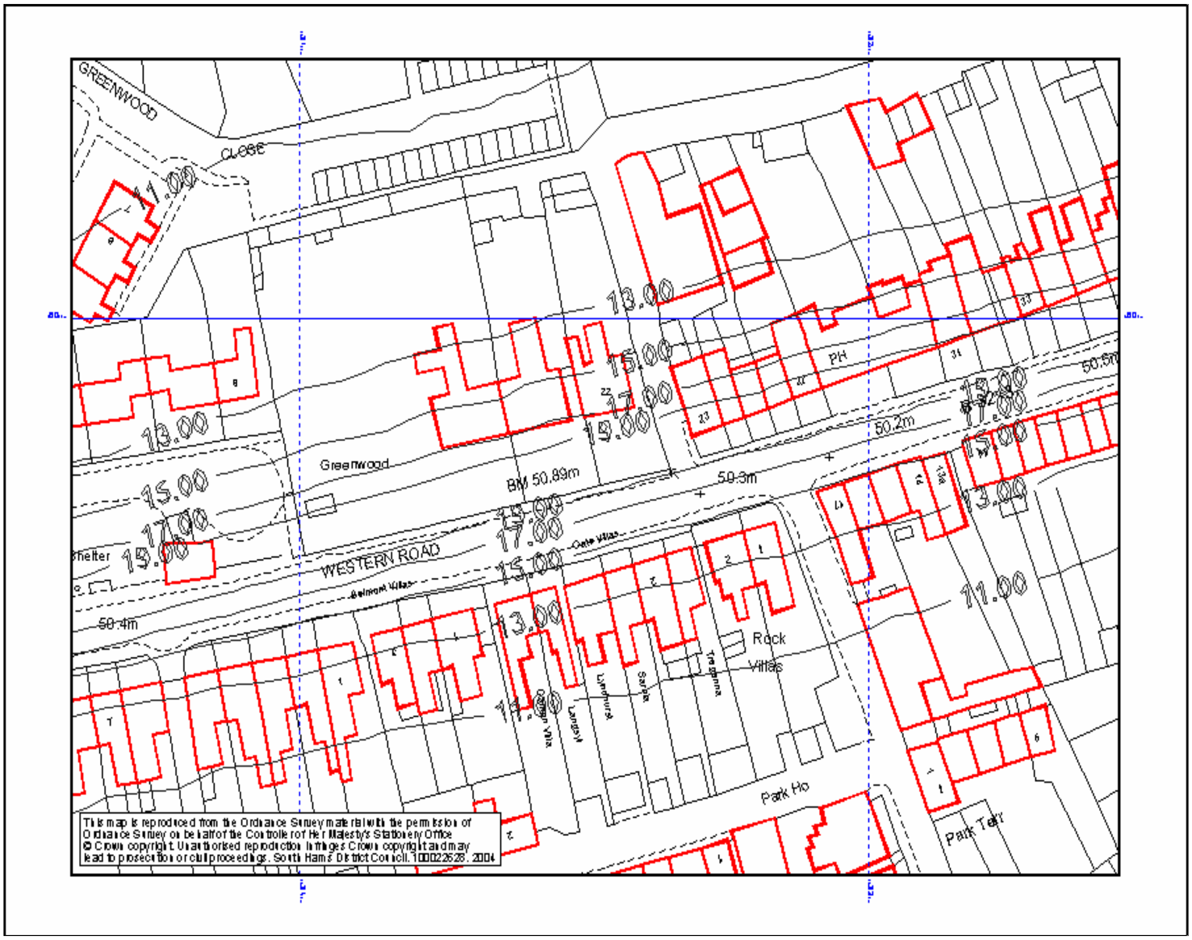


Figure 4, Western Road modelled for 2010 – results.



2.7 Detailed assessment of Western Road, conclusion

The diffusion tube results show relevant locations at Western Road to be on the borderline regarding the 2005 objective for annual average NO_2 concentrations. Furthermore, ongoing monitoring at this location indicates that the current concentrations are not falling in the way that the Government correction factors predict

The modelling exercise indicates no problem at Western Road but verification of the model does indicate that it is under-predicting significantly at this location, (Appendix 4). This may be because the total vehicle flow figures are relatively low and possibly the model is not fully accounting for the canyon effect at the road and/or the congestion which occurs there. It may also be that the default Nox:NO_2 ratios in the model are not appropriate in the local circumstances.

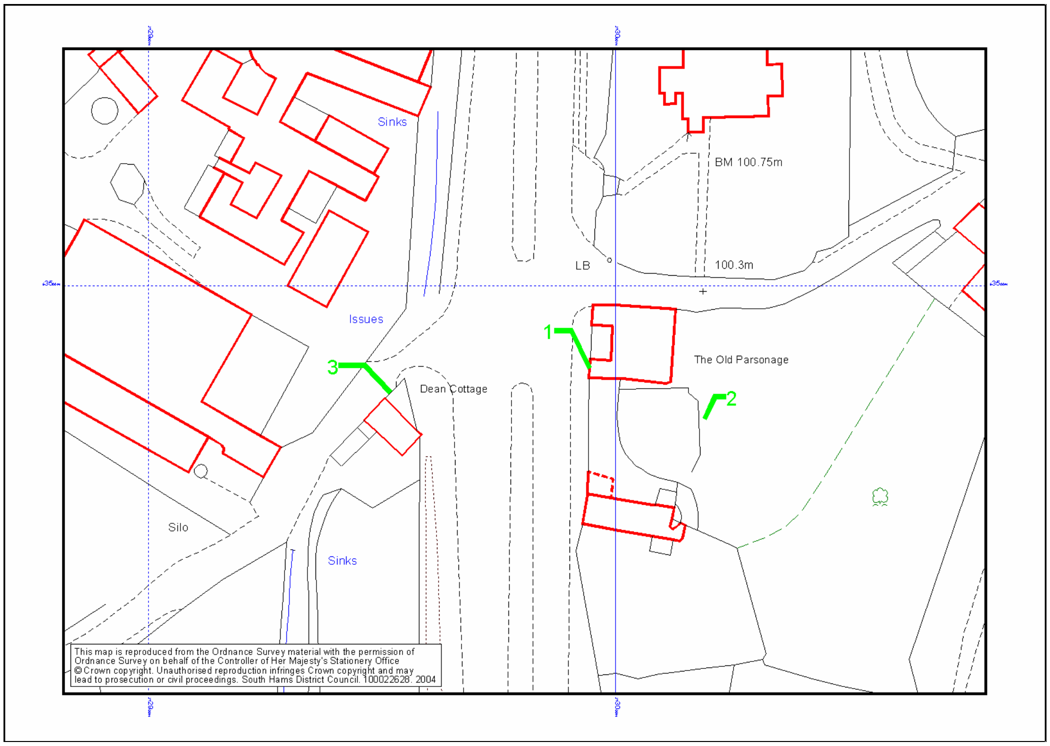
No firm conclusions can therefore yet be drawn for Western Road with regard to the need or otherwise to declare an Air Quality Management Area. Therefore it is proposed to monitor this area more thoroughly. In particular, SHDC has recently purchased its own automatic chemiluninescent nitrogen dioxide monitor and it is planned to site this in Western Road. Using data from this instrument, a much more detailed picture of the situation in Western Road, including hourly levels of Nitrogen Dioxide, will be available to make better informed decisions.

3. Detailed assessment – Dean Prior, Buckfastleigh

3.1 Layout of Dean Prior

Dean Prior is a tiny hamlet split in half by the A38 dual carriageway Devon Expressway. Figure 5 shows the plan of the hamlet, the numbers on the plan refer to locations of nitrogen dioxide diffusion tubes which are discussed below. Relevant locations at Dean Prior are the two residential properties in the south of the hamlet close to the A38. The other buildings on the plan are a church and farm yard barns. The church is not deemed to be a relevant location for the annual mean nitrogen dioxide objective as no-one will be present there over long periods of time.

Figure 5
Plan of Dean Prior; numbered points indicate position of NO_2 diffusion tubes, relevant locations are the two buildings adjacent to these points.



3.2 Conclusions of first round of Review and Assessment and USA regarding Dean Prior

Dean Prior was modelled in the third stage of the previous Review and Assessment on the previous version of AAQUIRE and the model run at that time produced a result of no more than 22 $\mu g/m^3$ at the relevant locations shown above (figure 5), (SHDC, 2000).

No diffusion tube monitoring data were available for Dean Prior at that time, though they were for the USA of 2003. The USA gave the bias adjusted mean for 2002-03 at the relevant location on the east of the A38 as 47.9 $\mu g/m^3$ and when projected forward to 2005 as 44.1 $\mu g/m^3$ (SHDC, 2003, pp18-19).

Since that time, diffusion tube monitors have been deployed on both sides of the A38 at Dean Prior at points representative of relevant locations, and the one on the eastern side has continued to show concentrations of nitrogen dioxide consistently above the objective annual mean level.

3.3 Recent NO_2 monitoring at Dean Prior- results

Throughout 2003, diffusion tubes were located at the point numbered 1 (and for the last 6 months at point numbered 3) shown on figure 5. These points are adjacent to the facades of the properties shown in figure 5. The raw results and the bias-adjusted results for these tubes are shown in Table 5 below. The projections for future years, according to the correction factors given in Box 6.6, LAQM. TG(03) are given in Table 4 below. The bias adjustment factor of 0.88 has been obtained from a co-location study of three diffusion tubes and an automatic analyser situated in Plymouth and carried out in partnership with Plymouth City Council as South Hams District Council does not yet have its own automatic analyser. The determination of the bias adjustment factor from this study is detailed in Appendix 2 and information on Quality Assurance and Quality Control of the diffusion tubes and of the Plymouth automatic analyser is provided in Appendix 3.

Point 2 on Figure 3 shows the location of a diffusion tube which was placed for a year from October 2001 until September 2002. Results from this tube cannot be bias-adjusted as no bias adjustment factor is available for that period – but the unadjusted results and their projection to future years are shown in tables 5 and 6. Table 6 also gives results from the tube at Point 1 (at the façade of the building adjacent to the A38, figure 5) for the same time period, for comparison.

Table 4 NO_2 Diffusion tube results at Dean Prior, 2003 and adjustment by bias-adjustment factor (in $\mu g/m^3$).

	Point 1 (figure 5)	Point 3 (figure 5)
Jan 03	57.47	
Feb	72.11	
March	68.63	
April	71.27	
May	63.85	
June	61.55	
July	68.34	29.33
Aug	75.2	Missing
Sept	84.17	35.99
Oct	77.26	26.54
Nov	77.42	32.16
Dec	54.6	24.95
Mean	69.32*	29.79**
Bias-adjusted mean	**61.0**	**26.2**

* average of 12 months' data (ie. 100% data capture).
** average of 5 months' data

Table 5 Projected future annual mean concentrations of Nitrogen Dioxide (in μg/m^3) at points 1 and 3 (figure 5) using the correction factors given in Box 6.6, LAQM.TG(03) from bias-adjusted means given in Table 4, objective years are in bold.

	2003	2004	**2005**	2006	2007	2008	2009	**2010**
Point 1 (figure 5)	61.0	59.4	**57.8**	55.9	53.9	51.8	49.6	**47.6**
Point 3 (figure 5)	26.2	25.5	**24.8**	24.1	23.2	22.2	21.3	**20.5**

Table 6, Unadjusted diffusion tube results for point 2, figure 5, ie. garden at Dean Prior, Oct 01- Sept 02, in μg/m^3.

	Point 2, figure 5, (Garden site)	*Point 1 (for comparision during same time period)*
October 01	22.5	*57.0*
November	26.1	*56.4*
December	41.5	*54.5*
January 02	21.5	*53.8*
February	22.5	*48.6*
March	17.1	*56.2*
April	19.0	*40.9*
May	19.3	*53.8*
June	16.7	*53.6*
July	15.5	*53.9*
August	18.1	*58.1*
September	15.3	*62.2*
Mean of 12 months	**21.3**	***54.08***

Table 7
Projected future annual mean concentrations of Nitrogen Dioxide (in ug/m3) at point 2 (figure 5) using the correction factors given in Box 6.6, LAQM.TG(03) from non-adjusted mean given in Table 6, objective years are in bold.

2003	2004	**2005**	2006	2007	2008	2009	**2010**
21.3	20.7	**20.2**	19.5	18.8	18.1	17.3	**16.6**

3.4 Discussion of monitoring results at Dean Prior

Bias-adjusted results for the diffusion tube at Point 1 in figure 5 show concentrations well above the 40µg/m^3 objective annual mean level currently, and in the projected years of 2005 and even 2010. Concentrations monitored on the other side of the road however (at point 3, figure 5) appear to be much lower although it is unfortunate that a full year's monitoring results are not available for this point. It is believed that this discrepancy in concentrations measured is due to the topography of the area. Vehicles driving south in the carriageway adjacent to point 1 are just beginning to ascend a hill, those driving north, (adjacent to point 3) on the other hand, have descended the hill. The higher concentration of NO_2 found at Point 1 is thus thought to be caused by the strain that motor vehicles are under as they travel at high speeds along this dual carriageway and then start to climb a fairly steep hill.

The relatively low concentrations of NO_2 found at point 2 (which is just 30 metres from point 1) does demonstrate that NO_2 levels do reduce quickly with distance away from their traffic sources (see Table 6 above).
Although only three diffusion tubes have been deployed at Dean Prior, it is felt that they are sufficient to show that only one residential property (the one by Point 1, figure 5) is likely to be in an area exceeding the annual mean air quality objective for NO_2 for 2005, and possibly 2010 too.

3.5 Advanced modelling of Dean Prior – validity and data input.

The most recent version (2003) of the AAQUIRE Regional Air Quality Model developed by CES (now called Faber Maunsell) was used to undertake modelling for the detailed assessment. AAQUIRE uses dispersion algorithms based on the CALINE4 system for modelling road traffic. The model has been widely validated and used throughout the world (AAQUIRE manual 2000; 2003). The version of AAQUIRE used incorporated the latest emissions factors database for the UK. The meteorological data used was from Plymouth Airport meteorological station and was for the year 1995. This is older than is recommended in the Technical Guidance (LAQM. TG(03)), but is the most recent comprehensive data available from Plymouth which is the nearest meteorological station by far to the South Hams area (the next nearest from which suitable data are available being Yeovilton in Somerset.) The 1995 Plymouth meteorological data has at least previously been examined by CES and been deemed to be the most typical of met. data over 5 years, (SHDC, 2000).

The CALINE 4 model used incorporates default factors for the conversion of NOx to NO_2 and these default factors were used in the modelling exercises.

In addition to the integral model data, further data relating to vehicle composition, speed, geographical factors and background NO_2 concentrations were input to the model and are shown in Table 8. Vehicle counts were based on an automatic traffic survey undertaken by the Highways Agency in 2002 at a point a few miles North on the A38 (see Appendix 1). There are no major vehicle inputs or outputs to the A38 between the point of the traffic count and Dean Prior. The total vehicle counts for future years were extrapolated forward using an estimated total traffic growth rate of 2% per year. This is an estimate made by Devon County Council for years to 2006 (DCC, 2000). It is likely to be an overestimate for years beyond this as national data show traffic growth slowing (DETR, 1999), but is useful for providing a worst-case screening factor for 2010 predictions.

The proportion of HGVs has been taken from the same Highways Agency Automatic Traffic Count.

AAQUIRE requires a further breakdown of vehicle categories according to whether engines are petrol or diesel, and, if petrol, fitted with a catalyst or not. Proportions for this were calculated by extrapolating the proportions given in the National Atmospheric Emissions Inventory traffic projections (www.naei.org.uk) and slightly increasing the proportion without catalysts for future years – again to provide a worst case scenario and to reflect the assumed slightly older average age of cars in Devon compared to the national fleet.

Proportions of hot and cold engines were estimated – it is reasonably that by far the majority of vehicles will have hot engines as the site is far from any major inputs of traffic to the A38. Average speed was also estimated based on experience of travelling frequently on the road at all times of the day. However, vehicles travelling south on this section of the A38 have to ascend a hill which starts at Dean Prior. The guidance (LAQM.TG(03)) suggests reducing speeds in modelling input data to account for hills, so in our model, average speed was put at 100 kph which is likely to be slightly slower than the actual average.

Data relating to the road dimensions were obtained by measuring road width on the Cadcorp Geographical Information System used by the Council. Road width was increased by 3 metres either side which is recommended by the AAQUIRE manual. The right and left mix widths of the road were designated as zero to which indicates no significant dispersion of pollutants. This is recommended in the AAQUIRE manuals (CES, 1999; Faber Maunsell, 2003).

Background pollution levels were obtained from the grid square information given by the NAEI (www.naei.org.uk) And these were extrapolated to future years as required according to the guidance given in LAQM.(TG04).

Table 8 Data input to AAQUIRE for modelling of Dean Prior 2005 and 2010

DATA INPUT	DEAN PRIOR
Surface roughness	Grassland
Class	1
Area modelled: SW grid point	72900 63400
Area modelled; NE grid point	73100 63800

Grid space	10 (05) 10 (10)
Receptor height	1.5 (05, 10)
Year	2005
Road coordinates	72977 63305 72996 63694
Vehicles per hour	1629 (05) 1799 (10)
% HDV	14
Average speed km/hr	100
Road height	0
Road width (includes 3 metres either side)	32+6
Road type	1 (flat)
Left mix width	0
Right mix width	0
% LDV petrol cold	2
%LDV petrol hot	8
% LDV petrol cold catalyst	7
% LDV petrol hot catalyst	63
% LDV diesel cold	2
% LDV diesel hot	18
% HGV cold	10
% HGV hot	90
Background conc.NOx ($\mu g/m^3$)	15 (05) 10 (10)
Default Nox:NO_2 ratios applied.	Yes
Met data	Plym

Figure 6; Modelling Results for Dean Prior for 2005 in μg/m3.

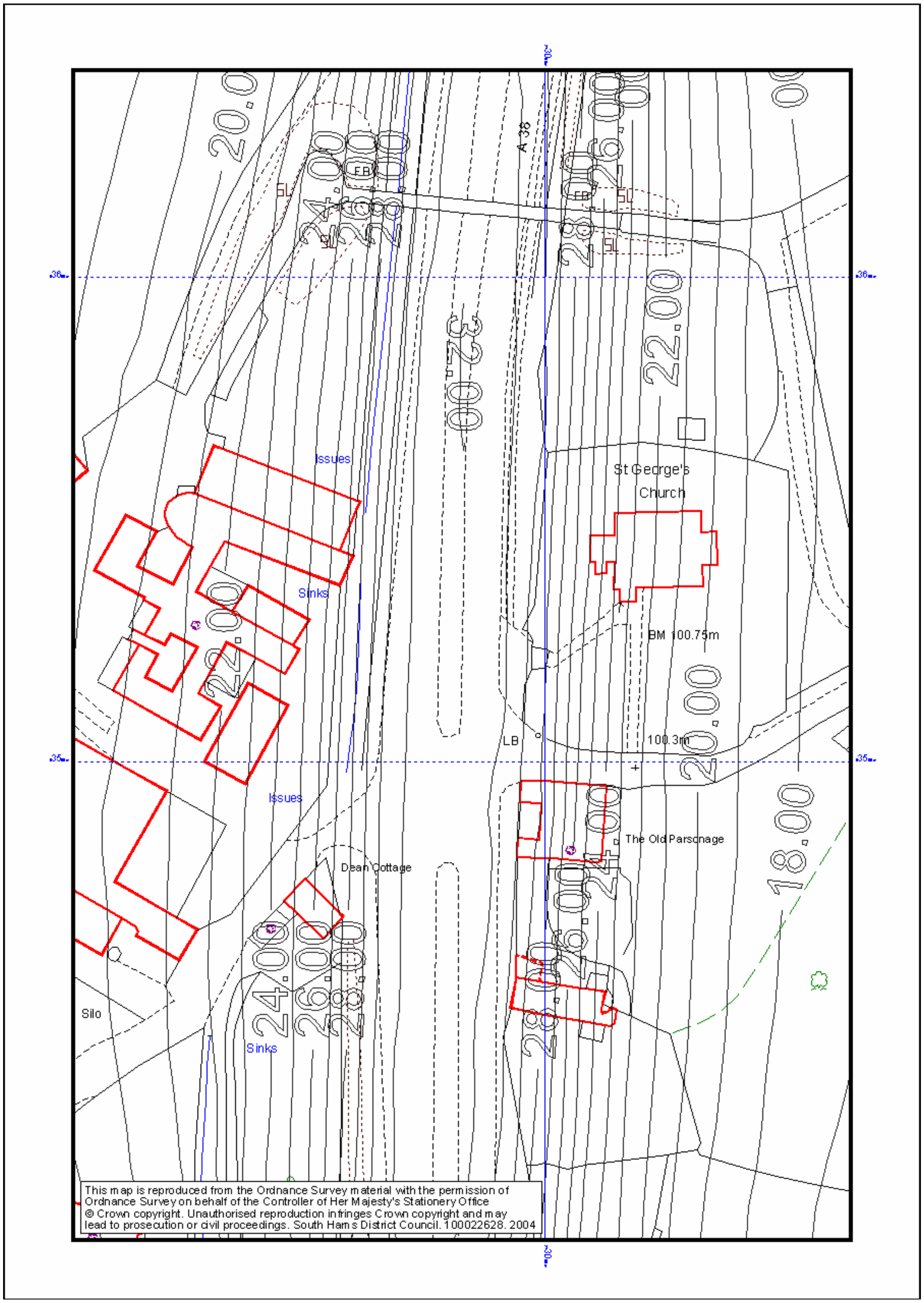
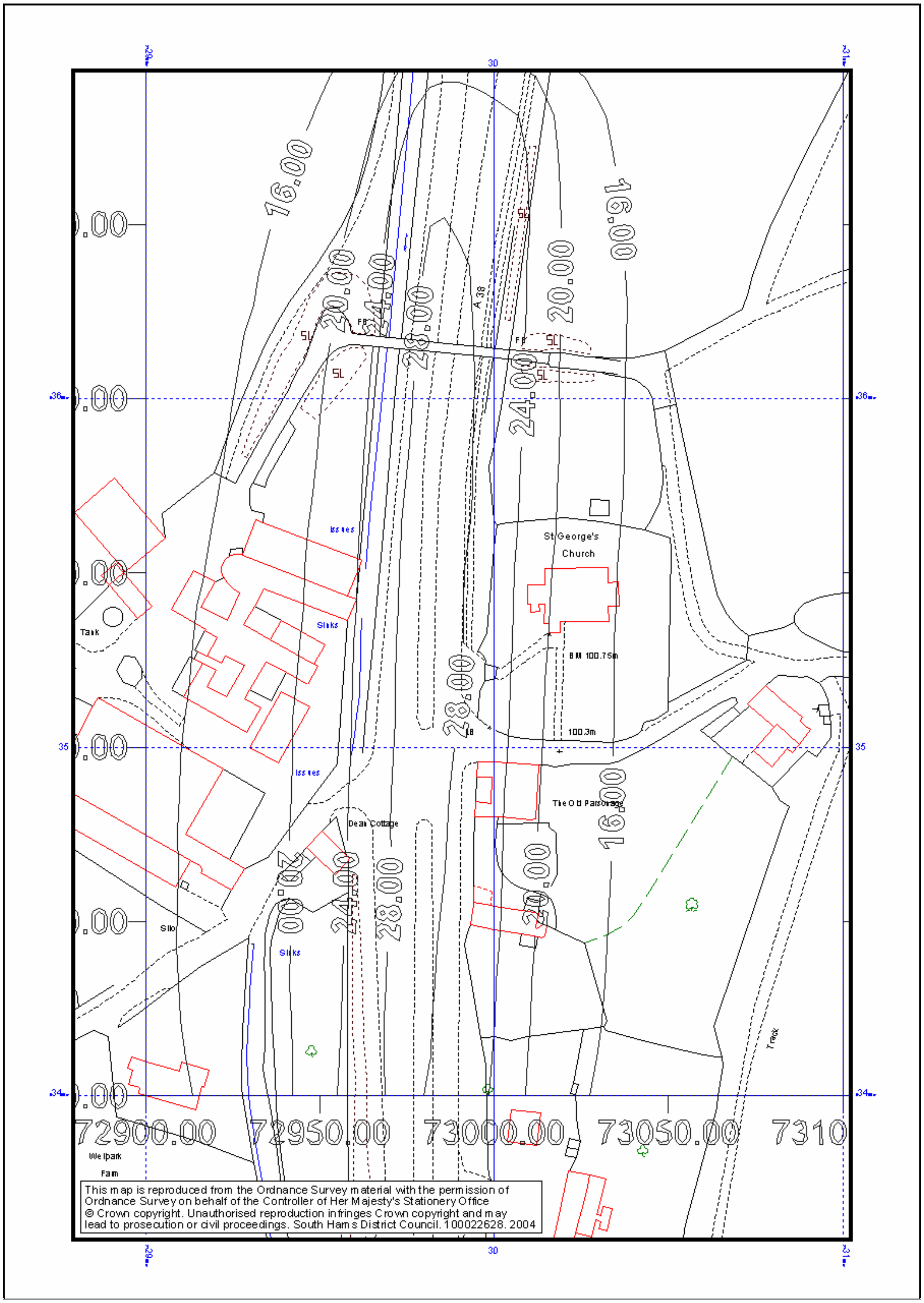


Figure 7; Modelling Results for Dean Prior for 2010 in μg/m3.



3.6 Detailed Assessment of Dean Prior – conclusions

The AAQUIRE model for Dean Prior shows very little likelihood of an exceedance of the annual mean objective for NO_2 in 2005 or 2010 at relevant locations at Dean Prior. This is in accordance with the AAQUIRE exercise undertaken for the third round of the first stage of Review and Assessment in 2000 for the same area but using the older AAQUIRE package, (SHDC, 2000). As can be seen in Appendix 4, it does appear that AAQUIRE is under-predicting significantly at this location.

Moreover, NO_2 diffusion tubes for the eastern side of Dean Prior, at the façade of a single property sited very close to the edge of the A38 show consistently high NO_2 concentrations. This is in contrast to the NO_2 tubes located on the western side of the road where the measurement is much more in line with that predicted by the AAQUIRE model for 2005. It is believed that the high concentrations found at the east side of the A38 here are due in large part to the hill which traffic on that side of the road has to ascend. As the guidance, LAQM.TG(04) recognises, models do not take hills properly into account.

There is only one property affected by these concentrations of NO_2 as there are no other relevant locations on the east side of the A38 (see section 3.1 above) and, because of the high levels found at the diffusion tube at the façade of that property, it is felt that this should be designated an Air Quality Management Area.

APPENDIX 1 SOURCES OF TRAFFIC DATA

Table A Summary of traffic data used in Updating and Screening Assessment

Location for which data used in USA	Vehicle Count	Source of data	% HDV	Source of data	Ave-rage spee d kph	Source of data
Western Road, Ivybridge	4399 E.B 5746 W.B. 10145 tot	DCC temp. count- average daily count for 7 days 21/11/00-27/11/00 at Exeter Rd, near Bridge Inn	14	Highways Agency ATC, 2002	38	Officers' estimate
A385, Station road and Bridgetown Hill, Totnes	17575 AADT (based on average of 7 day daily count)	Highways Agency ATC 2002	6	DCC temp. count, petrol station junction at 8-9am and 16.45-17.45pm	38	Officers' estimate
A38 at Dean Prior	18668 SB 18178 NB 36846 tot	Highways Agency ATC 2002, N of Buckfastleigh	14	Highways Agency ATC 2002, N of Buckfast-leigh	100	Officers' estimate

Abbreviations used in table

EB – East Bound
WB – West Bound
Tot – total
AADT – Annual Average Daily Traffic
HDV – Heavy Duty Vehicles
DCC –Devon County Council
ATC –Automatic Traffic Count

APPENDIX 2; CALCULATION OF BIAS ADJUSTMENT FACTOR.

Table B: Co-location data from Plymouth City Centre, Plymouth City Council, 2004

Date out	Date in	DT 1	DT 2	DT 3	mean DT	AUN Chem.	R=rat-ified
24.1.03	11.2.03	22.25	27.59	29.37	26.4	25.31	R
11.2.03	14.3.03	35.66	34.58	37.28	35.84	29.93	R*
14.3.03	9.4.03	32.31	36.04	36.04	34.8	33.65	R*
9.4.03	14.5.03	23.91	24.83	27.58	25.44	25.61	R
14.5.03	10.6.03	25.85	25.85	27.58	26.43	24.07	R
10.6.03	8.7.03	21.89	28.8	21.31	24.0	18.57	R*
8.7.03	5.8.03	25.42	24.84	23.11	24.46	23.7	R*
5.8.03	2.9.03	26.0	27.73	28.31	27.35	23.37	R
2.9.03	30.9.03	36.98	34.67	37.55	35.05	26.32	R
30.9.03	28.10.3	32.93	34.67	37.55	35.05	26.32	R
28.10.3	25.11.3	39.86	40.44	36.98	39.09	35.81	R
25.11.3	23.12.03	35.98	37.1	37.66	36.91	33.52	R

* indicate months where data capture on the chemiluminescent analyser was less than 90% - these months are therefore excluded from the calculation of the means.

The bias adjustment factor is therefore Dm/Cm of months where data capture is more than 90%. **Thus the calculation is 28.01/31.71 = 0.88**

Abbreviations used in table

DT = Diffusion Tube
AUN Chem – Automatic Urban Network Chemiluminescent
Dm = Diffusion tube mean
Cm = Chemiluminescent analyser mean.

APPENDIX 3 QUALITY ASSURANCE AND QUALITY CONTROL OF NO_2 DIFFUSION TUBES.

The tubes used by South Hams District Council and Plymouth City Council (for the co-location studies) are supplied, prepared and analysed by Gradko International Ltd. who lay down procedures for tube handling and exposure and compile a timetable for sample exposure – which is followed rigorously by officers of the Council. The preparation method used is 20% Triethanolamine (TEA) in Water.

Gradko have a quality assessment system in place for both the stock Triethanolamine solution and the made-up NO_2 diffusion tubes. In the first case, a stock solution containing a known amount of nitrite is received from AEA Technology Environment once a month. This is measured, and the results are used as part of the UK NO_2 Survey AQ/AC Scheme. This stock solution is used by Gradko International to check the u.v .spectrophotometer calibration graph (which is used in the tube analysis). In the second case, samples of tubes prepared for exposure are periodically spiked with known concentrations of nitrite solution and measured. Blank tube values are also monitored from each new batch of tubes prepared.

The accuracy of the lab measurements is also monitored by participation in an external Laboratory Measuremnt Proficiency Scheme ie. WASP (implemented by the Heatlh and Safety Laboratory at Sheffield). In addition, Gradko NO_2 analysis was included within the UK NO_2 Field Survey Intercomparison Report co-ordinated by AEA Technology, Environment in April 2003. This survey involved comparison with chemiluminescent measurements and the results showed that Gradko achieved an average bias of measurements from the reference value of –5.17%.

The NO_2 tubes located within Totnes also form part of the National Network of NO_2 diffusion tubes and are thus subject to yearly additional quality control by AEA Technology, Environment, who administer that survey.

Quality Assurance and Quality Control of Plymouth Automatic Urban Network (AUN) data

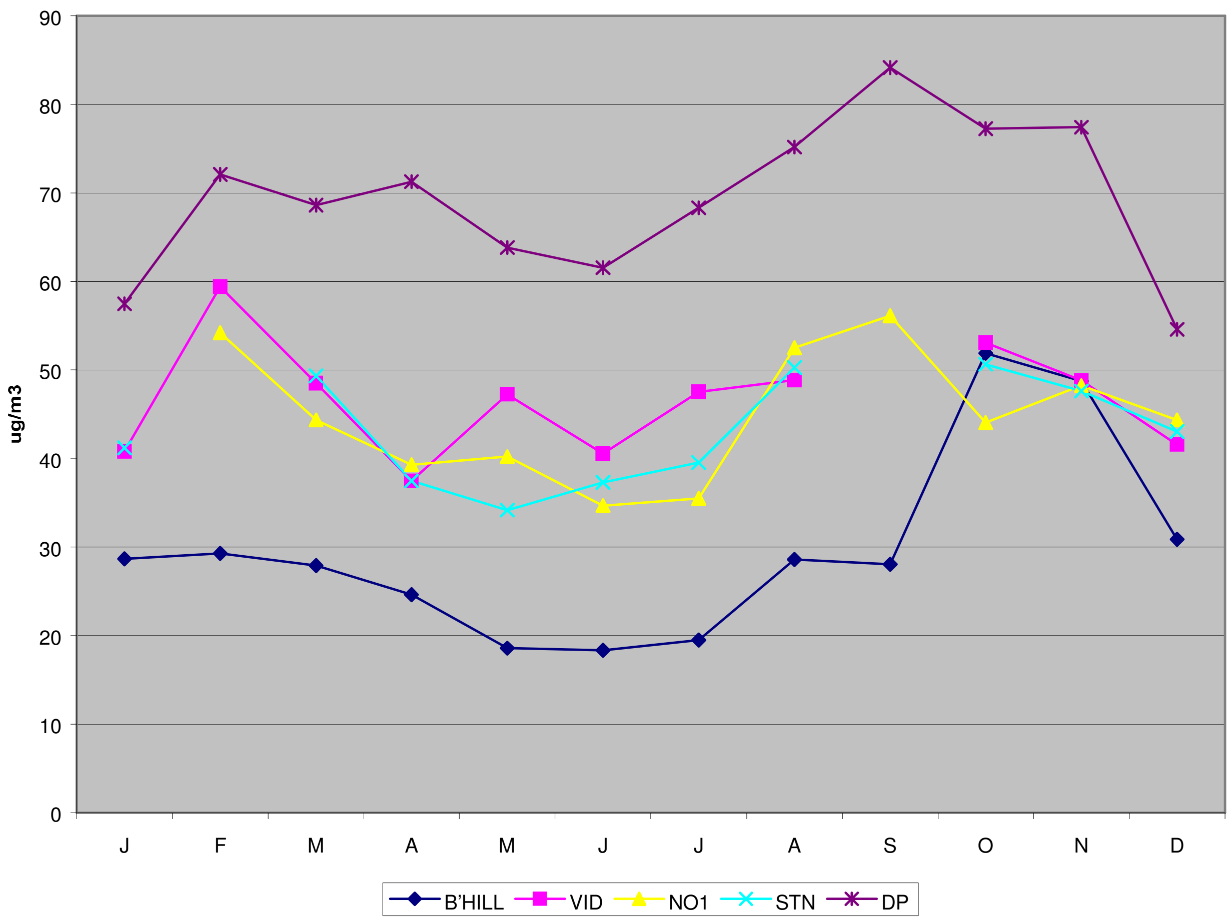
Monitoring data obtained from Plymouth City Council's automatic monitoring site in Armada Way is affiliated to the Department for Environment, Food and Rural Affairs (defra) AUN network. As such if follows all QA/AC procedures set out in the local site operators manual. Daily internal calibrations are conducted as well as fortnightly calibrations to check equipment performance and internal instrument parameters. Provisionally scaled data are available on the internet. Performance audits and intr calibrations are additionally conducted by agencies appointed by defra. The data are ratified every 6 months by netcen and are reported every 6 months in the AQ/AQ data ratification report for the Automatic Urban Network. This is a report produced for defra, the Scottish Executive, Welsh Assembly Government and the DoE in Northern Ireland.

Details of the site and a plan showing it's location can be found the air quality web site at www.airquality.co.uk.

APPENDIX 4; VALIDATION OF MODEL RESULTS

For model validation, five road side diffusion tubes were selected for which data for the whole of 2003 were available. The results from these tubes were first plotted on a graph (see figure i to check that all followed a reasonably consistent trend. The areas in which the diffusion tubes were located were then modelled using data for 2003 (see tables C and D below), and the modelling results (see figures ii to v) compared to the bias-adjusted means for each of the diffusion tubes (table E). It can be seen from this that the model is significantly under-predicting diffusion tube results for four of the five tubes.

Figure i   comparison of diffusion tube results



<u>Table C Input data for validation exercise</u>

DATA INPUT	WESTERN ROAD	DEAN PRIOR
Surface roughness	Small town/forest	grassland
Class	1	1
Area modelled: SW grid point	63136 55914	72900 63400
Area modelled; NE grid point	63300 56050	73100 63800
Grid space	15	5
Receptor height	1.5	2 (03) 1.5 (05, 10)
Year	2005	2005
Road coordinates	63310 56015 63011 55942	72977 63305 72996 63694
Vehicles per hour	449	1566 (03) 1629 (05) 1799 (10)
% HDV	14	14
Average speed km/hr	38	100
Road height	0	0
Road width (includes 3 metres either side)	8+2	32+6
Road type	1 (flat)	1 (flat)
Left mix width	0	0
Right mix width	0	0
% LDV petrol cold	4	2
%LDV petrol hot	6	8
% LDV petrol cold catalyst	25	7
% LDV petrol hot catalyst	40	63
% LDV diesel cold	5	2
% LDV diesel hot	20	18
% HGV cold	30	10
% HGV hot	70	90
Background conc.NOx (ug/m3)	21	5
Default NO_2:NOx ratios applied.	Yes	Yes
Met data	Plym	Plym

Table D Input data for model validation exercise

DATA INPUT	Station road	Bridgetown hill
Surface roughness	Small town	Small town
Class	1	1
Area modelled: SW grid point	80985 60427	80970 60450
Area modelled; NE grid point	81096 60516	81050 60550
Grid space	5	5
Receptor height	2.0	2
Year	2003	2002
Road coordinates	80107 60765 80334 60701	80970 60407 81104 60523
Vehicles per hour	747	732
% HDV	6	6
Average speed km/hr	38	38
Road height	0	0
Road width (includes 3 metres either side)	13+6	8+2
Road type	1 (flat)	1 (flat)
Left mix width	0	0
Right mix width	0	0
% LDV petrol cold	4	6
%LDV petrol hot	6	8
% LDV petrol cold catalyst	25	23
% LDV petrol hot catalyst	40	38
% LDV diesel cold	5	5
% LDV diesel hot	20	20
% HGV cold	30	30
% HGV hot	70	70
Background conc. (ug/m3)Nox	18	18
Default Nox:NO_2 ratios applied.	Yes	Yes
Met data	Plym	Plym

Figure ii) Validation exercise, Dean Prior, 2003, results in µg/m3, diffusion tube indicated by green spot.

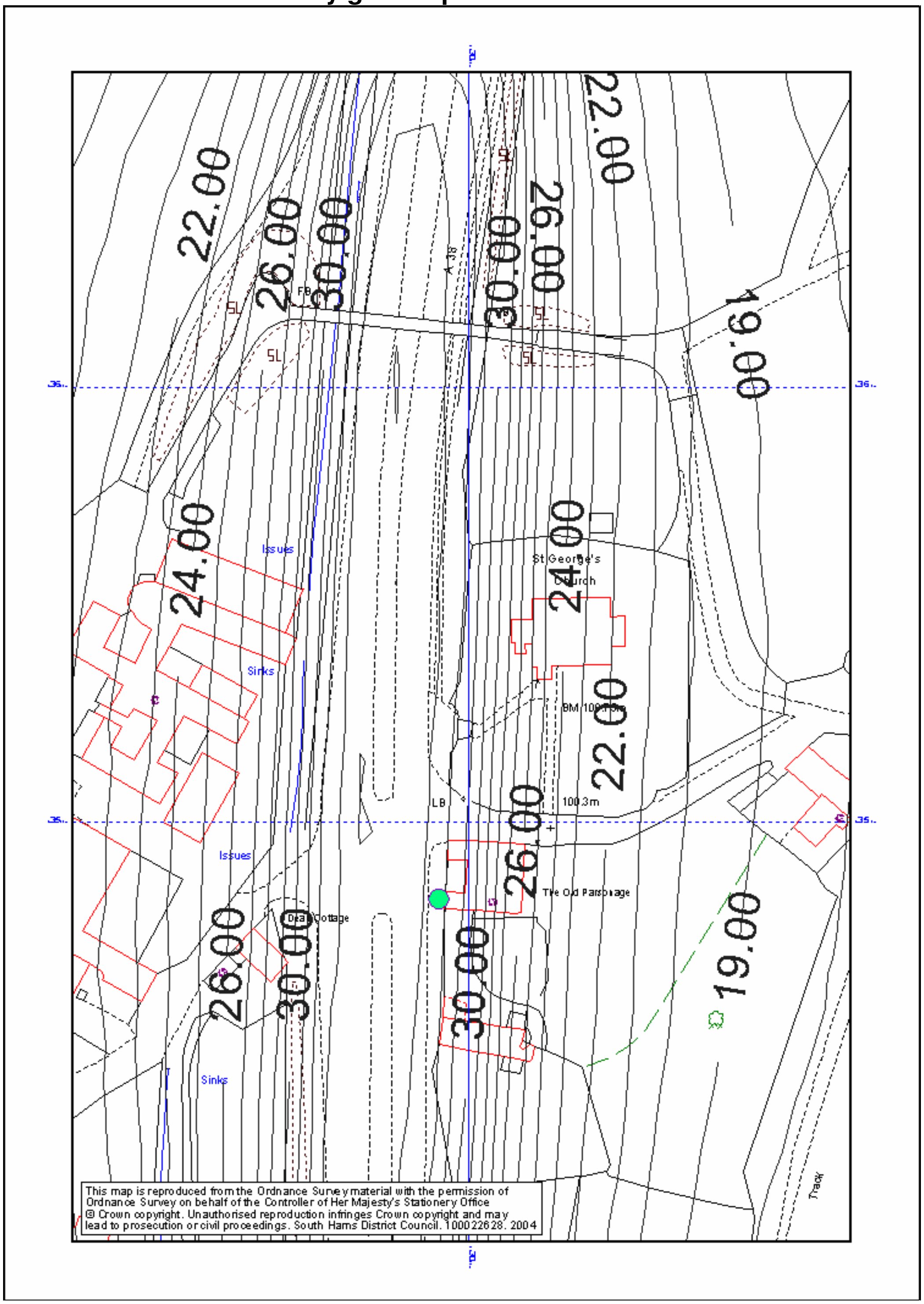


Figure iii Validation exercise, Western Road, 2003 (in ppb, therefore need to multiply results by 1.91), diffusion tube indicated by green spot.

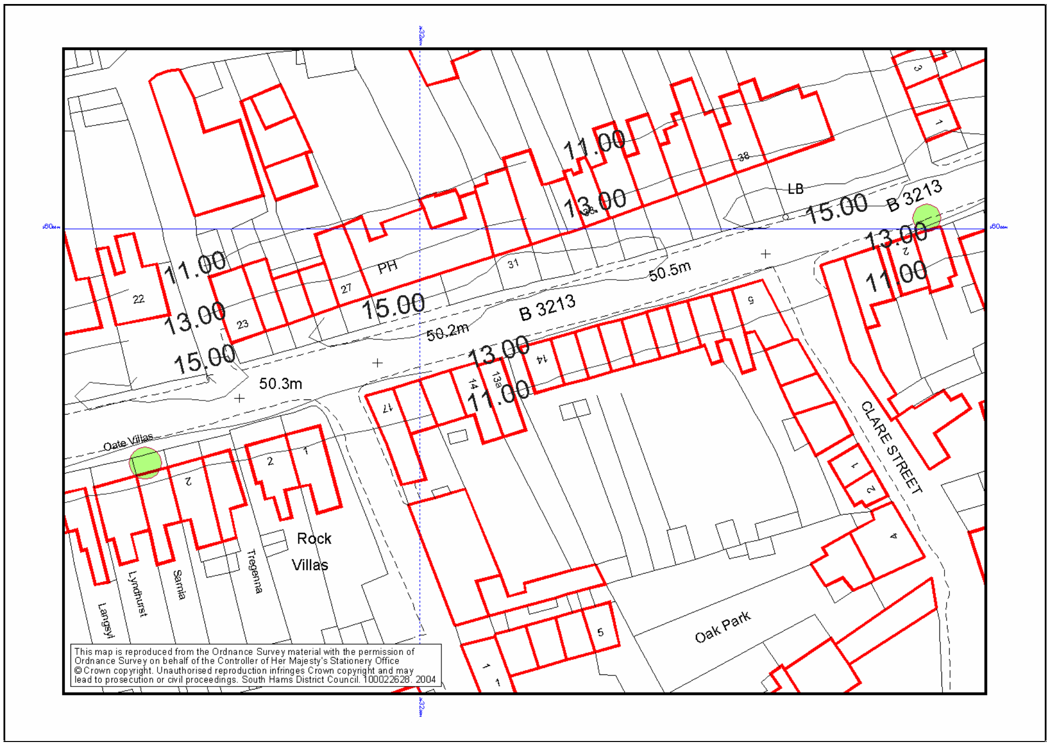


Figure iv; Validation exercise, Bridgetown Hill, (in ppb so need to multiply results by 1.91), diffusion tube indicated by green spot.

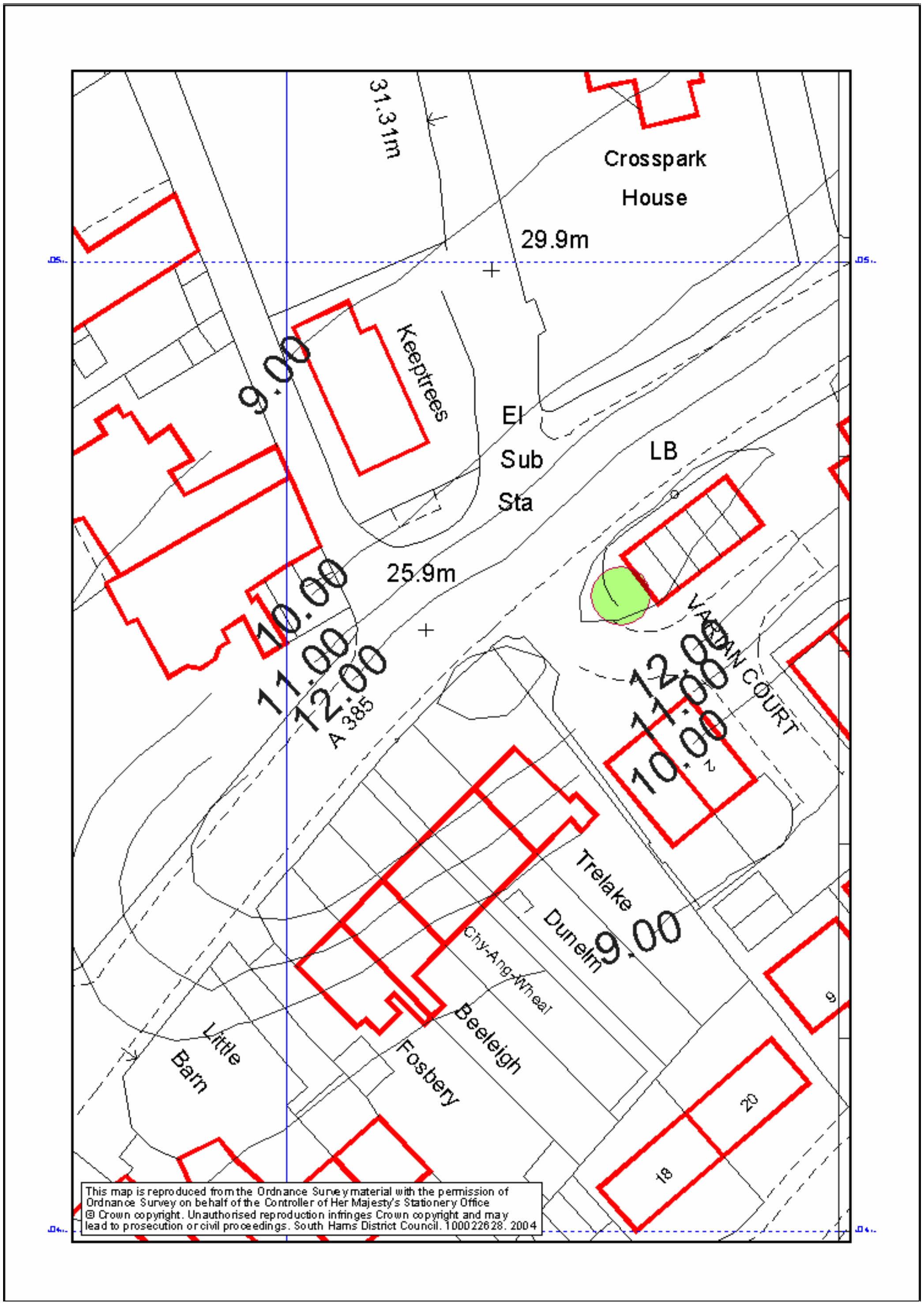


Figure v Validation exercise; Station Road, 2003 (in µg/m³), diffusion tube indicated by green spot.

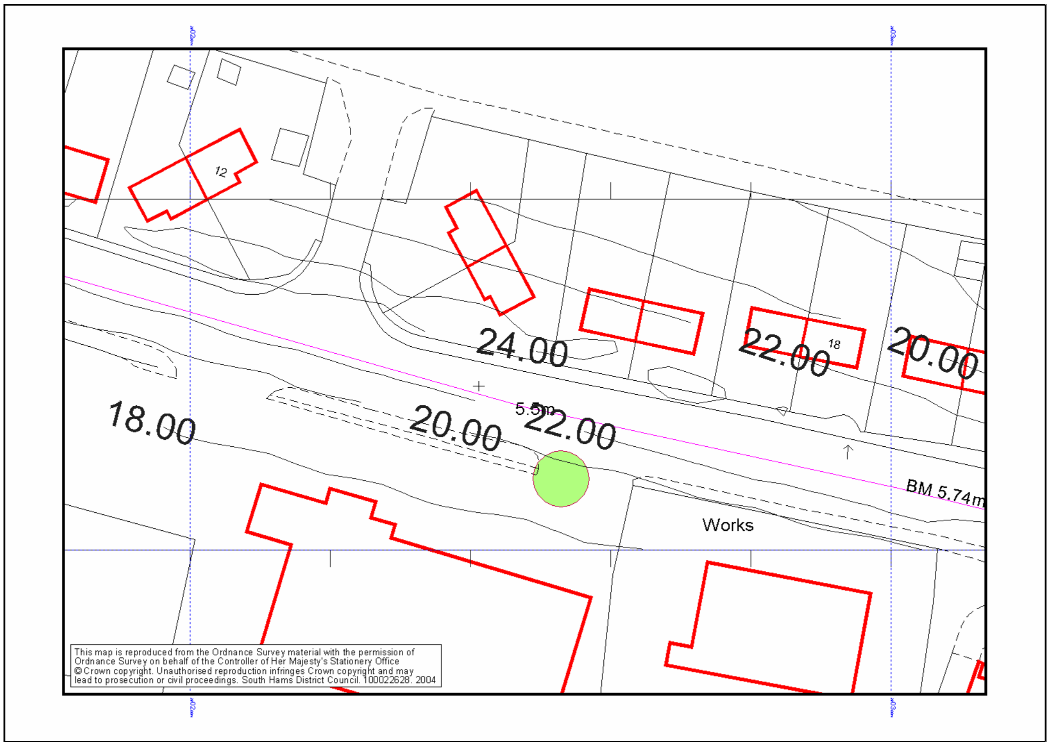


Table E; Comparison of validation model results with diffusion tube results – roadside locations, 2003 (NO_2 in µg/m³).

	Dean Prior	Western Road 1	Western Road 2	Bridge-town Hill	Station Road
Diffusion tube actual mean for 2003	69.3	44.9	46.7	29.6	43
Diffusion tube bias-adjusted mean for 2003	61	39.5	41	26	37.9
Model result	32	25	25	24	20

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