King's Lynn & West Norfolk Detailed Assessment of Air Quality

Prepared by

Duncan Laxen, Penny Wilson

and Denise Welch

on behalf of

King's Lynn and West Norfolk Borough Council

November 2005

Air Quality Consultants Ltd 12 St Oswalds Road Bristol BS6 7HT
Tel: 0117 974 1086 Fax: 0117 946 6271 E-Mail: DuncanLaxen@aqconsultants.co.uk

Contents

Executive Summary

A Progress Report prepared as part of the second round of Review and Assessment of air quality for King's Lynn & West Norfolk Borough Council identified a monitoring location where the UK annual mean Air Quality Objective for nitrogen dioxide was at risk of being exceeded due to traffic emissions. It was concluded that additional monitoring should be carried out and reported in a Detailed Assessment, in order to determine the need for any extension to the existing Railway Road Air Quality Management Area (AQMA) for nitrogen dioxide.

This Detailed Assessment covers monitoring data available for 2004 and the first half of 2005 for the entire borough, focusing on the areas where there are exceedences at locations with relevant exposure.

The Detailed Assessment has determined that exceedences of the annual mean are likely at locations where there is relevant exposure, and therefore an extension to the Air Quality Management Area (AQMA) is required. This should include residential properties along Railway Road, Blackfriars Road, and London Road as a minimum.

Measurements of PM_{10} made within the South Quay AQMA show there have been no exceedences of the air quality objectives during 2004 and 2005. As future exceedences are unlikely, it is recommended that the South Quay AQMA be revoked.

1 Introduction

1.1 As part of the first round of the review and assessment process, King's Lynn and West Norfolk Borough Council completed a stage 3 review and assessment. This indicated that an Air Quality Management Area (AQMA) for PM_{10} should be declared for specific residential properties close to the South Quay docks as a result of fugitive emissions. Further Assessment at stage 4 recommended that this AQMA remain, and that another AQMA be declared for nitrogen dioxide for specific residential properties in Railway Road due to emissions from traffic. The Updating and Screening Assessment (USA) carried out during the second round of review and assessment concluded that there had been no significant changes since the first round, and that it was not necessary to proceed to a Detailed Assessment at that time. A subsequent Progress Report presented new short-term diffusion tube data that demonstrated there might be an exceedence of the nitrogen dioxide objective at the Southgates monitoring location. It was concluded that additional monitoring using diffusion tubes, and if possible, an automatic monitor, should be carried out and reported in a Detailed Assessment.

1.2 The aim of this Detailed Assessment is to determine whether the nitrogen dioxide air quality objectives are likely to be exceeded outside the Railway Road AQMA, and if so, whether the AQMA should be extended.

2 Methodology

Diffusion tubes

2.1 During 2004, nitrogen dioxide concentrations were monitored at 25 locations, described in Table 1, using diffusion tubes. Since January 2005, a further 38 monitoring locations have been added to increase the monitoring network, which are also described in Table 1. Maps showing the current monitoring locations surrounding the Railway Road AQMA, which are the focus of this Detailed Assessment, are included in Appendix 1.

2.2 King's Lynn and West Norfolk Borough Council deploys diffusion tubes prepared and analysed by Gradko (20% TEA in Water). In order to determine diffusion tube bias, triplicate diffusion tubes were collocated with the automatic monitor at Railway Road, King's Lynn. Further details of bias factors calculated using the data described above are available in Appendix 2. All diffusion tube results in this report have been adjusted using these 'local' bias factors.

2.3 Monitoring data for each location during the period 1st January 2005 to 30th June 2005 have been adjusted to an equivalent 2004 annual mean. These were calculated following guidance set out in LAQM.TG(03) (Defra, 2003) using monitoring data collected at two AURN sites at Northampton and St Osyth. Further details are provided in Appendix 3. Annual mean concentrations for 2005 were then estimated from both the measured 2004 annual mean value and the calculated 2004 annual mean equivalent, by scaling in line with nationally predicted trends (Defra, 2003).

Automatic Monitoring

2.4 King's Lynn and West Norfolk Borough Council own two automatic monitoring stations. Concentrations of nitrogen oxides (NO_x), nitrogen dioxide (NO_2) and PM_{10} are monitored in Railway Road, King's Lynn, within 1 m of the Railway Road AQMA, whilst PM_{10} is monitored at South Quays, King's Lynn within the South Quay AQMA. The sites have been in operation since 8th September 2002 and 5th March 2001 respectively.

2.5 The automatic monitors are serviced on a 6 monthly basis, with fortnightly calibrations. The data are ratified by netcen.

Mapping

2.6 The Ordnance Survey mapping included within this publication is provided by King's Lynn and West Norfolk Borough Council under licence from Ordnance Survey (Licence number LA086045) to fulfil its public function to improve public health. Persons viewing this map should contact Ordnance Survey copyright for advice where they wish to licence Ordnance Survey copyright material for their own use.

3 Results

3.1 The diffusion tube monitoring results for all locations in the Borough are presented in Table 1. Adjusted values are presented, as discussed in the Methodology section. The locations of the monitoring sites around King's Lynn and the Railway Road AQMA are shown in Appendix 1. The majority of the monitoring sites are located at the facades of buildings and are representative of relevant exposure.

Table 1: Measured Nitrogen Dioxide Concentrations (mg/m^3) using Diffusion Tubes

Location	Map Ref.	2004[a]	2004 Annual Mean equivalent[b]	2005[c]	2005[d]	Represent Relevant Exposure	Within Current AQMA
King's Lynn							
Kilham's Way		16.8	16.4	16.4	16.0	No	No
Edward Benefer Way		-	37.6	-	36.7	No	No
Austin St	1	38.2	**45.1**	37.3	**44.0**	**Yes**	**No**
Edinburgh Ct	2	34.0	38.9	33.1	37.9	Yes	No
Railway Road West	5	**51.9**	**55.3**	**50.6**	**53.9**	**Yes**	**No**
Railway Road East	6	**40.2**	**41.8**	39.2	**40.7**	**Yes**	**Yes**
Railway Road 1	3	-	**43.5**	**-**	**42.4**	**No**	**No**
Railway Road 2	7	-	**49.3**	**-**	**48.1**	**Yes**	**Yes**
Railway Road 3	4	-	39.8	-	38.8	Yes	No
Bus Station	8	38.8	**45.0**	37.9	**43.8**	**Yes**	**Yes**
Sainsbury's	9	**50.7**	**46.1**	**49.4**	**45.0**	**No**	**No**
Monitoring Station, Railway Road	10	33.8	36.1	33.0	35.2	Yes	No
Norfolk Street	11	-	36.4	-	35.5	Yes	No
Wellesley Street	12	-	38.9	-	38.0	Yes	No
Portland Street	13	-	29.7	-	29.0	Yes	No
Waterloo Street	14	-	31.4	-	30.6	Yes	No
St John's Terrace/Blackfriar's	17	33.2	36.9	32.4	36.0	Yes	No
Blackfriars Road 2	16	-	**43.6**	**-**	**42.5**	**Yes**	**No**
Blackfriars Road 1	15	-	39.9	-	38.9	Yes	No
St John's Terrace	18	-	33.6	-	32.7	Yes	No
St James' Junction	19	-	**44.3**	**-**	**43.2**	**No**	**No**
The Walks	20	21.5	22.4	20.9	21.8	Yes	No
London Road 1	21	28.6	**44.0**	27.9	**42.9**	**Yes**	**No**
London Road 2	24	-	36.3	-	35.4	Yes	No
London Road 3	25	-	**40.4**	**-**	39.4	Yes	No
London Road 4	27	-	**44.3**	**-**	**43.2**	**Yes**	**No**
London Road 5	28	-	**42.3**	**-**	**41.2**	**Yes**	**No**
London Road 6	26	37.8	**44.5**	36.8	**43.3**	**Yes**	**No**
London Road 7	23	-	**44.6**	**-**	**43.5**	**Yes**	**No**
London Road 8	22	-	**40.4**	**-**	39.4	Yes	No
Southgates	29	**42.4**	**44.5**	**41.3**	**43.3**	**No**	**No**
Vancouver Avenue 2	31	-	28.9	-	28.2	Yes	No
Vancouver Avenue 1	30	27.8	30.4	27.1	29.7	Yes	No
Hardwick Rd		29.6	31.4	28.9	30.6	Yes	No
Wisbech Road 1		-	28.4	-	27.7	Yes	No
Wisbech Road 2		-	23.6	-	23.0	Yes	No
Saddlebow Road 1		25.0	27.4	24.4	26.7	Yes	No
Saddlebow Road 2		36.0	**41.8**	35.1	**40.7**	**No**	**No**
Gaywood Road 3		-	35.4	-	34.5	Yes	No
Gaywood Road 1		30.5	33.9	29.8	33.1	Yes	No
Gaywood Road 2		31.5	33.1	30.7	32.3	Yes	No
The Swan, Gayton Road		37.4	39.4	36.4	38.5		No
Wootton Road		38.0	38.9	37.0	38.0	Yes	No
Tennyson Avenue 1		-	24.7	-	24.1	Yes	No
Tennyson Avenue 2		-	28.9	-	28.2	Yes	No
Saddlebow Road 3		-	24.4	-	23.8	Yes	No

Location	Map Ref.	2004[a]	2004 Annual Mean equivalent[b]	2005[c]	2005[d]	Represent Relevant Exposure	Within Current AQMA
Elm							
Wisbech Road 1		-	28.3	-	27.6	Yes	No
Wisbech Road 2		29.8	33.4	29.0	32.6	Yes	No
West Winch							
Main Road		31.6	38.3	30.8	37.3	No	No
South Wootton							
Low Road		24.8	26.1	24.2	25.4	Yes	No
Castle Rising Road		23.7	25.7	23.1	25.0	Yes	No
Hunstanton							
Hunstanton 1		-	15.8	-	15.4	No	No
Hunstanton 2		-	18.5	-	18.0	No	No
Downham Market							
Railway Road		-	27.6	-	26.9	Yes	No
Bridge Street		-	31.7	-	30.9	Yes	No
Lynn Road		-	34.1	-	33.2	Yes	No
Bexwell Road		-	36.3	-	35.4	Yes	No
Stoke Ferry							
Furlong Road		-	25.3	-	24.7	No	No
High Street		-	22.2	-	21.7	No	No
Buckenham Drive		-	19.1	-	18.6	No	No
Fincham							
Main Road 1		-	24.5	-	23.9	Yes	No
Main Road 2		-	22.4	-	21.8	Yes	No

Potential exceedences of the objective highlighted in bold.
[a] Bias adjustment factor of 0.96 determined from a collocation study with the automatic monitor in Railway Road.
[b] Measured concentrations between 1/1/05 and 30/6/05, adjusted using a bias adjustment factor (0.92) determined from a collocation study with the automatic monitor in Railway Road and adjusted to 2004 annual mean equivalent using an adjustment factor of 1.09 calculated from two AURN monitoring stations following guidance given in LAQM.TG(03) (Defra, 2003).
[c] Estimated from 2004 data using the future year projection factors available from Defra (2005).
[d] Estimated from 2004 annual mean equivalent data using the future year projection factors available from Defra (2005).

3.2 The bias adjusted diffusion tube results for locations in King's Lynn show that it is likely that the annual mean nitrogen dioxide objective of 40 µg/m^3 will be exceeded at relevant locations during 2005 outside of the area currently declared as an AQMA for nitrogen dioxide. An extension to the AQMA is therefore proposed.

3.3 Diffusion tube measurements at locations close to, but currently outside of the declared AQMA for nitrogen dioxide which indicate potential exceedences of the air quality objective at locations representative of relevant exposure include:

a) the one-way system encompassing Austin Street, Blackfriars Road and Railway Road (which experiences congestion outside of the peak traffic flow hours);

b) London Road; and

c) Southgates.

3.4 Whilst deciding where to draw the boundaries of the new and/or extended AQMA, King's Lynn and West Norfolk Borough Council must include, *as a minimum*, properties alongside the entire one-way system, including Wellesley Road, Portland Street and Waterloo Street (which run between Railway Road and Blackfriars and which would be affected by any change in traffic management implemented as part of an Action Plan), and the whole length of London Road to Southgates. Suggested minimum boundaries are presented in Appendix 1, however to allow for uncertainties in the monitoring data, and to avoid further amendments to the AQMA in future, it may be prudent to declare a slightly larger area.

3.5 It would not be necessary to extend the AQMA as far as Edward Benefer Way as there are no relevant receptors along the road, only retail units. In addition, there would be no requirement to extend the AQMA to the south of the roundabout at Southgates, as there are also currently no relevant receptors. The North Ouse Regeneration Area (NORA) is situated south of this roundabout and has provision for residential development. However, this is over half a kilometre from the Southgates monitoring location.

3.6 Measurements across the country have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded unless the annual mean nitrogen dioxide concentration is greater than 60 $\mu g/m^3$ (Laxen and Marner, 2003[1]). The Sainsbury's diffusion tube is located in an area which is not representative of relevant exposure for the annual mean objective, however members of the public may regularly stand waiting for buses for periods of an hour or more. The annual mean concentrations measured and predicted at this location (along with all other diffusion tube monitoring locations) are less than 60 $\mu g/m^3$ so it is unlikely that the 1-hour nitrogen dioxide objective is being exceeded at this location.

3.7 The bias adjusted diffusion tube results for villages outside of the areas outlined above suggest that it is *unlikely* that the annual mean nitrogen dioxide objective of 40 $\mu g/m^3$ will be exceeded at relevant locations. Therefore, no further AQMAs are required. The predicted concentration in 2005 at the Saddlebow Road 2 location exceeds the objective and monitoring will continue at this site, however, this site is not representative of relevant exposure, being located on a lamp

[1] Laxen and Marner, 2003. Analysis of the relationship between 1-hour and annual mean nitrogen dioxide at UK Roadside and Kerbside monitoring sites. Available from Defra, 2005.

post at the kerbside and over 10 m from the façade of the nearest relevant receptor. The results of this monitoring will be reported in future Progress Reports and Updating and Screening Assessments.

3.8 Nitrogen dioxide concentrations measured at the automatic monitoring site on Railway Road (Table 2) are in agreement with diffusion tube monitoring at the same location, both of which are below the air quality objective. The lower concentrations measured at this location are due to the position of the monitors outside of the street canyon at a relatively open road junction and also a greater distance from the kerb than other sampling locations at the facades of residential properties along Railway Road, within the AQMA.

Table 2: Measured Nitrogen Dioxide Concentrations (μg/m^3) using Automatic Monitor

Location	2004		2005	
	Annual mean	Hours > 200 μg/m^3	Annual mean[a]	Hours > 200 μg/m^3
Railway Road	33.8	0	34.2	0
Objective for 2005	**-**	**-**	**40**	**18**

[a] Adjusted to 2004 annual mean equivalent. Adjustment factor calculated from measurements made at two AURN monitors following guidance in LAQM.TG(03) (Defra, 2003).

Other Monitoring Results

3.9 PM_{10} concentrations measured at automatic monitoring stations on Railway Road and in South Quay both show levels well below the air quality objective (Table 3). The South Quay monitoring station is within the AQMA declared for PM_{10}, however, the operation which gave rise to the high levels of PM_{10} previously measured at the site has ceased and is unlikely to start again. As there have been no exceedences of the PM_{10} objective during 2004 and 2005, and as future exceedences are unlikely, the South Quay AQMA is no longer required. Therefore it is recommended that the South Quay AQMA be revoked.

Table 3: Measured PM_{10} Concentrations (μg/m^3) using Automatic Monitor

Location	2004		2005[a]	
	Annual mean	Days > 50 μg/m^3	Annual mean	Days > 50 μg/m^3 [b]
Railway Road	17.3	1	17.1	1
South Quay	21.0	9	20.7	4
Objective for 2004	**40**	**35**	**-**	**-**

[a] Estimated using the future year projection factors available from Defra (2005).
[b] Estimated from annual mean using the relationship in LAQM.TG(03) (Defra, 2003).

Monitoring by Neighbouring Authorities

3.10 Predictions of concentrations of nitrogen dioxide for 2005 from monitoring data collected by Fenland District Council in 2003 showed potential exceedences of the air quality objectives at locations of relevant exposure within Fenland. Therefore a Detailed Assessment was carried out. As part of the assessment, modelling took place which highlighted areas of exceedence at the border of Fenland DC and King's Lynn & West Norfolk BC. Monitoring has been carried out by King's Lynn & West Norfolk BC in this area on Wisbech Road, Elm at locations representative of relevant exposure. The results, which are included in Table 1, indicate that levels for 2005 are well below the objective at relevant locations within King's Lynn & West Norfolk Borough.

4 Conclusions

4.1 Monitoring data from King's Lynn & West Norfolk have been reviewed as part of this Detailed Assessment. The results confirm the findings of the Progress Report that there is a likelihood of the annual mean nitrogen dioxide objective being exceeded at relevant locations outside the existing AQMA. These include relevant locations at Southgates, Railway Road, Blackfriars Road and London Road. An extension to the Air Quality Management Area is therefore required for this area.

4.2 It is suggested that the existing AQMA be extended to include residential properties alongside the entire one-way system, including Wellesley Road, Portland Street and Waterloo Street which run between Railway Road and Blackfriars (Appendix 1, Figure A1). In addition, the AQMA should also include properties alongside London Road covering the area shown in Appendix 1, Figure A2.

4.3 PM_{10} concentrations measured at automatic monitoring stations on Railway Road and in South Quay both show levels well below the air quality objectives. The South Quay PM_{10} monitor is located within an AQMA, however, as there have been no exceedences of the PM_{10} objective during 2004 and 2005, and as future exceedences are unlikely, it is recommended that the South Quay AQMA be revoked.

Appendix 1 – Monitoring Locations

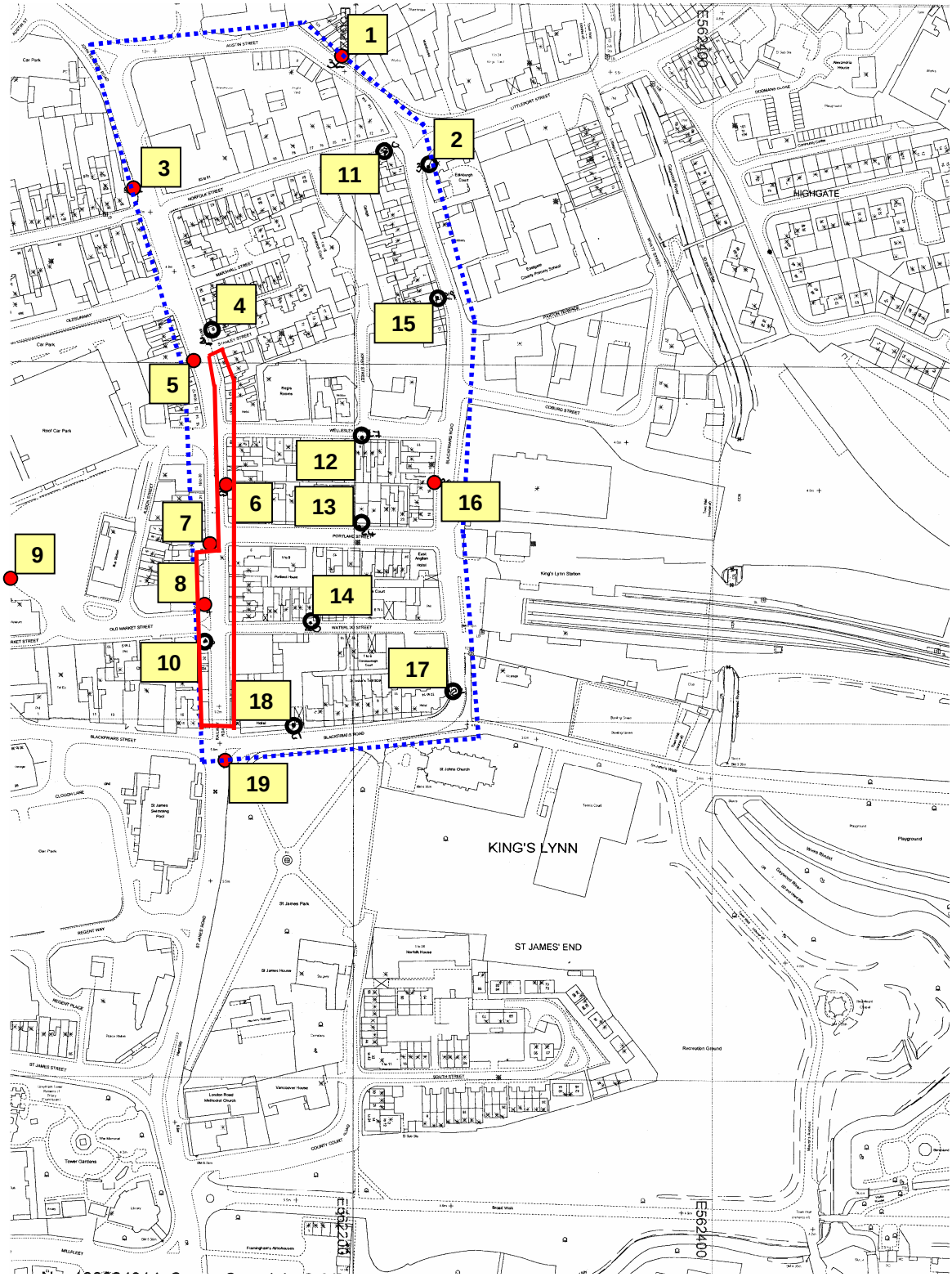

Figure A1: Monitoring locations in the centre of King's Lynn. Circles show locations of monitoring sites; numbers relate to Table 1. Filled red circles are locations where concentrations exceed the air quality objective for nitrogen dioxide in 2005. The red line shows the position of the current Railway Road AQMA. The dashed blue line encompasses areas of exceedence of the air quality objective and therefore shows the suggested minimum extension of the AQMA.

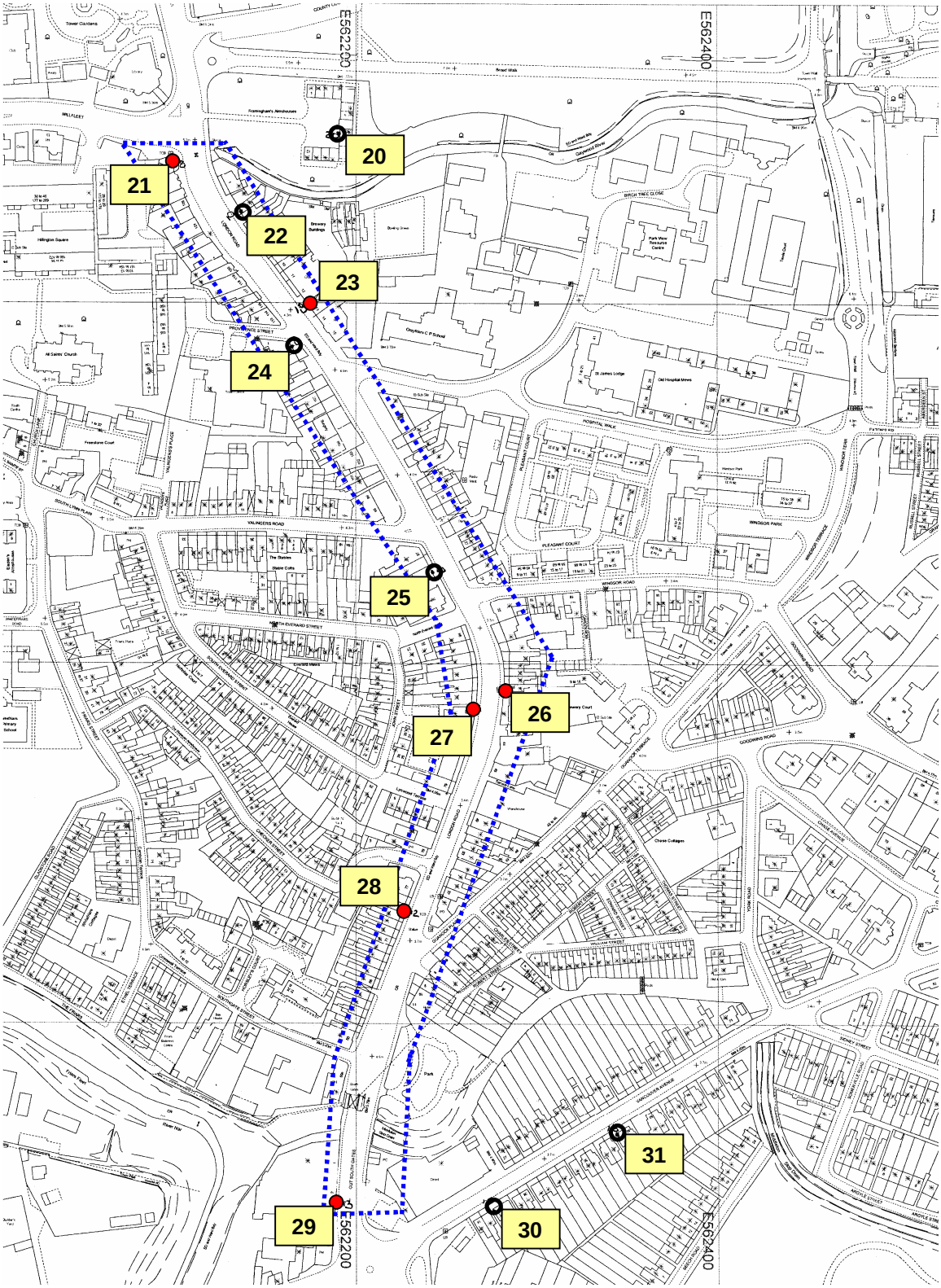

Figure A2: Monitoring locations to the south of King's Lynn centre. Circles show locations of monitoring sites; numbers relate to Table 1. Filled red circles are locations where concentrations exceed the air quality objective for nitrogen dioxide in 2005. The dashed blue line encompasses areas of exceedence of the air quality objective and therefore shows the suggested minimum extension of the AQMA.

Appendix 2 – Diffusion Tube Bias Adjustment

Diffusion tubes are known to exhibit bias when compared to results from automatic analysers. Therefore diffusion tube results need to be adjusted to account for this bias. One of the main factors influencing diffusion tube performance is thought to be the laboratory that supplies and analyses the tubes. King's Lynn and West Norfolk Borough Council use diffusion tubes that are supplied and analysed by Gradko. These are prepared using 20% TEA in water. In order to determine the bias exhibited by these tubes King's Lynn and Norfolk BC carried out a collocation study using triplicate tubes next to the automatic monitor in Railway Road.

The results taken into consideration in deriving bias adjustment factors to apply to the raw data are shown in Table A1. The resultant local factor for 2004 is **0.96**, whilst for the first six months of 2005, the local factor is **0.92**, indicating that overall, during both monitoring periods, the diffusion tube results over-estimated concentrations compared with those measured by the automatic monitor. The locally derived bias adjustment factor for 2004 of 0.96 is very similar to the overall factor of 0.94 for these diffusion tubes published on the Review and Assessment Helpdesk Website (available at http://www.uwe.ac.uk/aqm/review/diffusiontube300905.xls).

Table A1: Results of Diffusion Tube and Continuous Monitor Collocation Study at Railway Road

Date	Tube Average	Continuous Average	Bias adjustment factor
2004	35.3	33.8	0.96
Jan – June 2005	36.0	33.2	0.92

Appendix 3 – Adjustment of Short-term Data to Annual Mean

In order to present diffusion tube data for 2005, a factor has been applied to adjust the short-term mean data to an equivalent 2004 annual mean. This factor is based on the ratio of concentrations during the short-term monitoring periods in 2005 to those over a full calendar year in 2004 at two sites where long-term continuous monitoring data are available, in accordance with the guidance in LAQM.TG(03) (Defra, 2003). The Northampton (UB; 99%) and St Osyth (Rural; 97%) sites have been used for this purpose because they have reliable long term datasets (data capture >90%), are within 50 miles of King's Lynn, and are background sites, as recommended in LAQM.TG(03).

Table A2: Data used for adjustment of short-term nitrogen dioxide monitoring data to 2005 annual mean.

Monitoring Period	Northampton	St Osyth	NO_2 adjustment to 2005
Average 2004	20.0	16.2	-
Average 1/1/05-30/6/05	17.5	15.7	-
Adjustment factor 1/1/05-30/6/05 to 2005	1.14	1.03	**1.09**