Suffolk Coastal District Council

Air Quality Review and Assessment

Detailed Assessment for Adastral Close and Ferry Lane, Felixstowe

May 2008
(Version 2)

Prepared by AEA Technology plc under contract to Suffolk Coastal District Council

Title	Air Quality Review and Assessment: Detailed Assessment 2007
Customer	Suffolk Coastal District Council
Customer reference	
Confidentiality, copyright and reproduction	
File reference	
Reference number	ED05333/R2464- Issue 3

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Executive summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality, which culminated in the Environment Act, 1995. The Air Quality Strategy[1] provides a framework for air quality control through air quality management and air quality standards. These and other air quality standards[1] and their objectives have been enacted through the Air Quality Regulations in 1997, 2000 and 2002[2]. The Environment Act 1995 requires Local Authorities to undertake air quality reviews. In areas where an air quality objective is not anticipated to be met, Local Authorities are required to establish Air Quality Management Areas and implement action plans to improve air quality.

The first round of air quality review and assessments was completed by Suffolk Coastal District Council in 2001. The Council proceeded to the second round of review and assessment in which sources of emissions to air are reassessed to identify whether the situation has changed since the first round, and if so, what impact this may have on predicted exceedences of the air quality objectives.

The second round of review and assessment was undertaken in two steps. The first step was an Updating and Screening Assessment, which updated the Stage 1 and 2 review and assessments previously undertaken for all pollutants identified in the Air Quality Regulations. Where a significant risk of exceedence was identified outside the AQMA for a pollutant it was necessary for the local authority to proceed to a Detailed Assessment, equivalent to the previous Stage 3 assessments. Where a local authority does not need to undertake a Detailed Assessment, a Progress Report is required instead.

Suffolk Coastal District Council carried out an Updating and Screening Assessment (USA) in 2003 and concluded that a Detailed Assessment was required for nitrogen dioxide on the basis of diffusion tube measurements at the junction of Lime Kiln Quay Road and St Johns Street in Woodbridge and at the junction of A1214 and Bell Lane in Kesgrave. The USA also recommended that a Detailed Assessment be carried out for various other sources of emissions of oxides of nitrogen, sulphur dioxide, lead and PM_{10} because there was not sufficient information available to eliminate the possibility that the air quality objectives might be exceeded.

The second round Detailed Assessment was completed in 2005. Further investigation eliminated the possibility of exceeding the air quality objectives in the vicinity of most of the emission sources identified in the USA. A detailed monitoring study at locations close to the Kesgrave junction showed that it was unlikely that the air quality objective for nitrogen dioxide would be exceeded where there was relevant exposure of members of the public. A detailed monitoring and modelling study at locations close to the Woodbridge junction showed that it was likely that the air quality objective for nitrogen dioxide would not be met at a small number of residential properties. Suffolk Coastal District Council declared an AQMA to cover the affected properties in 2006. A Further Assessment has confirmed the need for the AQMA.

The third round Updating and Screening Assessment was completed in September 2006. The USA concluded that Detailed Assessment of sulphur dioxide, PM_{10} and nitrogen dioxide concentrations was required for areas of Felixstowe close to the Port of Felixstowe and the A14 approach road. This report is a Detailed Assessment for Suffolk Coastal District Council of the Port of Felixstowe and the A14 approach road as outlined in the Government's published guidance.

[1] Refers to standards recommended by the Expert Panel on Air Quality Standards. Recommended standards are set purely with regard to scientific and medical evidence on the effects of the particular pollutants on health, at levels at which risks to public health, including vulnerable groups, are very small or regarded as negligible.

The general approach taken to this Detailed Assessment was to:

- Collect and interpret additional data to support the detailed assessment, including detailed information about port operations and traffic flow data;
- Consider recent continuous monitoring and diffusion tube measurements;
- Use monitoring data from the continuous monitors and diffusion tubes to assess the ambient concentrations in the port area and to calibrate the output of modelling studies;
- Model the concentrations of sulphur dioxide, nitrogen dioxide and particulate matter, PM_{10}, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;
- Present the concentrations as contour plots and assess the uncertainty in the predicted concentrations;
- Consider whether the authority should declare an Air Quality Management Area and provide recommendations on the scope and extent of any proposed Air Quality Management Area.

Modelled sulphur dioxide concentrations were less than the air quality objectives for all locations outside the port boundary for all modelled scenarios. The scenarios modelled include the current situation and future years with the Felixstowe South and Bathside Bay developments. There is thus no potential for non-occupational exposure of members of the public to concentrations in excess of the air quality objectives for sulphur dioxide. Measured concentrations at the nearest residential location to the port (Adastral Close) confirm the results of the modelling study.

It is recommended that Suffolk Coastal District Council do not declare an Air Quality Management Area for sulphur dioxide.

Measurements indicate that the annual mean objective for nitrogen dioxide is currently exceeded at the Dooley Inn. The modelling study indicates that this is currently the only relevant receptor location at which the objective is not met.

The modelling study indicates that there is a risk that the objective for nitrogen dioxide will not be met at approximately fifteen additional properties at the west end of Adastral Close in 2010 and beyond following the Felixstowe South reconfiguration. Source apportionment studies indicate that container handling operations by rubber tyred gantry (RTG) crane and internal movement vehicles will potentially make the largest contribution to oxides of nitrogen concentrations both at Adastral Close and at the Dooley Inn in 2010. The Port of Felixstowe Environmental Statement 2006 recognises the need to reduce emissions from the RTGs and the Port has set up a joint initiative between the engineering and operations departments to identify electricity supply points, which will enable the RTGs to be switched off when idle, reducing both fuel consumption and overall emissions. The modelling studies indicate that reducing RTG emissions has the potential to reduce concentrations sufficiently that the air quality objective could be met both at Adastral Close and at the Dooley Inn.

It is recommended that Suffolk Coastal District Council declare an Air Quality Management Area for the annual mean nitrogen dioxide objective to cover the Dooley Inn. It is further recommended that the Council encourage the Port to make progress in identifying electricity supply points for the RTGs.

Current measurements at Adastral Close indicate that Suffolk Coastal District Council are not required to declare an Air Quality Management Area for PM_{10}. Dispersion modelling of the emissions from ships, roads and container handling operations at the port indicates that members of the public are not currently subject to relevant exposure to concentrations in excess of the objective. Port emissions may increase with the Felixstowe South Reconfiguration but it is predicted that the air quality objective for PM_{10} will continue to be met.

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Acronyms and definitions used in this report

AADTF	Annual Average Daily Traffic Flow
ADMS	an atmospheric dispersion model
AQDD	an EU directive (part of EU law) - Common Position on Air Quality Daughter Directives, commonly referred to as the Air Quality Daughter Directive
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network (Defra funded network)
base case	In the context of this report, the emissions or concentrations predicted at the date of the relevant air quality objective (2005 for nitrogen dioxide)
BAM	Beta attenuation monitor
CO	Carbon monoxide
d.f.	degrees of freedom (in statistical analysis of data)
DETR	Department of the Environment Transport and the Regions (now defra)
Defra	Department of the Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards (UK panel)
EU	European Union
GIS	Geographical Information System
IMV	Internal movement vehicle
kerbside	0 to 1 m from the kerb
Limit Value	An EU definition for an air quality standard of a pollutant listed in the air quality directives
n	number of pairs of data
NAEI	National Atmospheric Emission Inventory
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRTF	National Road Traffic Forecast
ppb	parts per billion (1 ppb is 1 volume of pollutant in 10^9 volumes of air
r	the correlation coefficient (between two variables)
receptor	In the context of this study, the relevant location where air quality is assessed or predicted (for example, houses, hospitals and schools)
roadside	1 to 5 m from the kerb
RTG	Rubber tyred gantry crane
SD	standard deviation (of a range of data)
TEA	Triethanolamine
TEMPRO	A piece of software produced by the defra used to forecast traffic flow increases
TEOM	Tapered Element Oscillating Microbalance
TEOM (Grav.)	TEOM Measurements expressed as the equivalent value from a gravimetric monitor
TEU	Twenty foot equivalent container
V/V	Volume ratio

1 Introduction

This section outlines the purpose of this Detailed Assessment for Suffolk Coastal District Council, and the scope of the assessment.

1.1 Purpose of the Detailed Assessment

The first round of air quality review and assessments is now complete and all local authorities should have completed all necessary stages. Where the likelihood of exceedences of air quality objectives has been identified in areas of significant public exposure, an air quality management area (AQMA) should have been declared. Suffolk Coastal District Council completed their first round assessment in 2001. The Stage 3 report concluded that there was a risk that annual mean air quality objective for nitrogen dioxide would not be met at properties close to the junction of the A1152 and the B1438 at Melton and the junction of Lime Kiln Quay Road and St Johns Street in Woodbridge. The Stage 3 report also concluded that there was a risk that air quality objectives for sulphur dioxide and particulate matter, PM_{10} would not be met near the Port of Felixstowe as the result of shipping emissions. However, the assessment was not conclusive and no AQMA was declared at that time.

Local authorities were required to proceed to the second round of review and assessment in which sources of emissions to air were reassessed to identify whether the situation had changed since the first round of review and assessment, and if so, what impact this may have on predicted exceedences of the air quality objectives. Such changes might include significant traffic growth on a major road, which had not been foreseen, construction of a new industrial plant with emissions to air, or significant changes in the emissions of an existing plant.

The second round of review and assessment was undertaken in two steps. The first step was an Updating and Screening Assessment, which updated the Stage 1 and 2 review and assessments previously undertaken for all pollutants identified in the Air Quality Regulations. Where a significant risk of exceedence was identified for a pollutant it was necessary for the local authority to proceed to a Detailed Assessment, equivalent to the previous Stage 3 assessments. Where a local authority did not need to undertake a Detailed Assessment, a Progress Report was required instead.

Suffolk Coastal District Council carried out an Updating and Screening Assessment (USA) in 2003 and concluded that a Detailed Assessment was required for nitrogen dioxide on the basis of diffusion tube measurements at the junction of Lime Kiln Quay Road and St Johns Street in Woodbridge and at the junction of A1214 and Bell Lane in Kesgrave. The USA also recommended that a Detailed Assessment be carried out for various other sources of emissions of oxides of nitrogen, sulphur dioxide, lead and PM_{10} because there was not sufficient information available to eliminate the possibility that the air quality objectives might be exceeded.

The second round Detailed Assessment was completed in 2005. Further investigation eliminated the possibility of exceeding the air quality objectives in the vicinity of most of the emission sources identified in the USA. A detailed monitoring study at locations close to the Kesgrave junction showed that it was unlikely that the air quality objective for nitrogen dioxide would be exceeded where there was relevant exposure of members of the public. A detailed monitoring and modelling study at locations close to the Woodbridge junction showed that it was likely that the air quality objective for nitrogen dioxide would not be met at a small number of residential properties. Suffolk Coastal District Council declared an AQMA to cover the affected properties in 2006. A Further Assessment has confirmed the need for the AQMA.

The third round Updating and Screening Assessment was completed in September 2006. The USA concluded that Detailed Assessment of sulphur dioxide, PM_{10} and nitrogen dioxide concentrations was required for areas of Felixstowe close to the Port of Felixstowe and the A14 approach road.

The purpose of the detailed assessment is to provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation of any necessary AQMAs. This report is a Detailed Assessment for Suffolk Coastal

District Council as outlined in the Government's published guidance. It takes into account future developments from the Felixstowe South reconfiguration and the Bathside Bay Container Terminal.

1.2 Overview of approach taken

The general approach taken to this Detailed Assessment was to:

- Collect and interpret additional data to support the detailed assessment, including detailed traffic flow data around potential hotspots;
- Consider recent continuous monitoring and diffusion tube measurements;
- Use monitoring data from the continuous monitors located at the Dooley Inn, Ferry Lane, Felixstowe and at Adastral Close, Felixstowe to assess the ambient concentrations produced and to calibrate the output of modelling studies;
- Model the concentrations of the pollutants around the potential hotspot, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;
- Present the concentrations as contour plots and assess the uncertainty in the predicted concentrations;
- Consider whether the authority should declare an Air Quality Management Area and provide recommendations on the scope and extent of any proposed Air Quality Management Area.

1.3 Relevant DEFRA documentation used

Technical Guidance has been issued in 'Review and Assessment: Technical Guidance' LAQM.TG (03) to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. Further guidance is provided in a series of Frequently Asked Question on the Review and Assessment website hosted by the University of the West of England. This detailed assessment has considered the procedures set out in this technical guidance.

1.4 Pollutants considered in this report

Table 1.1 lists the pollutants included in the Air Quality Regulations for the purposes of Review and Assessment. Nitrogen dioxide, sulphur dioxide and particulate matter, PM_{10} are considered in this report. The Updating and Screening Assessment concluded that detailed assessment of other pollutants was not required.

Table 1.1: Objectives included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 µg/m^3	running annual mean	31.12.2003
Authorities in England and Wales only	5.00 µg/m^3	annual mean	31.12.2010
Scotland and Northern Ireland only	3.25 µg/m^3	running annual mean	31.12.2010
1,3-Butadiene	2.25 µg/m^3	running annual mean	31.12.2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only	10.0 mg/m^3	maximum daily running 8-hour mean	31.12.2003
Authorities in Scotland only	10.0 mg/m^3	running 8-hour mean	31.12.2003
Lead	0.5 µg/m^3 0.25 µg/m^3	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 µg/m^3 not to be exceeded more than 18 times a year 40 µg/m^3	1 hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric)[c] All authorities	50 µg/m^3 not to be exceeded more than 35 times a year 40 µg/m^3	24 hour mean annual mean	31.12.2004 31.12.2004
Authorities in Scotland only[d]	50 µg/m^3 not to be exceeded more than 7 times a year 18 µg/m^3	24 hour mean annual mean	31.12.2010 31.12.2010
Sulphur dioxide	350 µg/m^3 not to be exceeded more than 24 times a year 125 µg/m^3 not to be exceeded more than 3 times a year 266 µg/m^3 not to be exceeded more than 35 times a year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

c. Measured using the European gravimetric transfer standard sampler or equivalent.
d. These 2010 Air Quality Objectives for PM10 apply in Scotland only, as set out in the Air Quality (Scotland) Amendment Regulations 2002.

In addition, the Air Quality Strategy, 2007 provides new objectives for particles ($PM_{2.5}$). These are an annual mean of 25 µg m^{-3} (12 µg m^{-3} in Scotland) to be achieved by 2020 and a target of 15% reduction in concentrations at urban background. These objectives for England, Wales and Greater London are not currently included in Regulations for the purpose of LAQM.

1.5 Locations that the Review and Assessment must concentrate on

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 1.2 summarises the locations where the objectives should and should not apply.

Table 1.2 Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	• 1,3 Butadiene • Benzene • Lead • Nitrogen dioxide • Particulate Matter (PM_{10})	• All background locations where members of the public might be regularly exposed.	• Building facades of offices or other places of work where members of the public do not have regular access.
		• Building facades of residential properties, schools, hospitals, libraries etc.	• Gardens of residential properties.
			• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term
24 hour mean and 8-hour mean	• Carbon monoxide • Particulate Matter (PM_{10}) • Sulphur dioxide	• All locations where the annual mean objective would apply.	• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
		• Gardens of residential properties.	
1 hour mean	Nitrogen dioxide Sulphur dioxide	All locations where the annual mean and 24 and 8-hour mean objectives apply.	Kerbside sites where the public would not be expected to have regular access.
		Kerbside sites (e.g. pavements of busy shopping streets).	
		Those parts of car parks and railway stations etc. which are not fully enclosed.	
		Any outdoor locations to which the public might reasonably be expected to have access.	
15 minute mean	Sulphur dioxide	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

2 Information used to support this assessment

This section lists the key information used in this review and assessment.

2.1 Review and assessment reports

This report draws upon earlier Review and Assessment reports published by Suffolk Coastal District Council. These include:

- Stage 3 report, 2001
- Updating and Screening report 2003
- Progress report 2005
- Updating and Screening report 2006

2.2 Maps and distances of receptors from roads

Suffolk Coastal District Council provided electronic OS LandLine™ data which were used in the Geographical Information System (GIS) in this assessment. The maps were used to provide details of the location of road centrelines and road widths. Individual buildings or groups of buildings (receptors) were also identified. The distances of these receptors from the road were accurately determined from the maps.

2.3 Road traffic data

Suffolk County Council provided traffic data from the Highways Agency for the A14 through Felixstowe. The data included 24-hour automatic count summaries for the period January 2005 to August 2007. The road traffic data is shown in Appendix 1.

Traffic flows for other major roads in Felixstowe were taken from the National Atmospheric Emissions Inventory data. Vehicles were assumed to travel at 50 kph in urban areas (approximately the speed limit), reducing to 5 kph on the approaches to junctions. The speed of 5 kph is representative of slow moving traffic: it is also the slowest speed for which emission factors are available.

A diurnal variation in traffic flow was derived from the traffic summary for the A14.

The base year for the traffic flows was 2005. Traffic flows were projected for future years using TEMPRO/NRTF scaling factors for the appropriate year.

2.4 Port information

Details of the operation of port facilities was obtained from various sources. These included the Felixstowe South Reconfiguration Environmental Statement and the Port of Felixstowe internet site (http://www.portoffelixstowe.co.uk/). Further details were obtained from the port operators (Gavin Reeve, personal communications).

2.5 Ambient monitoring

The assessment has considered continuous automatic monitoring data from monitoring stations located at Adastral Close, a residential road near the Port of Felixstowe and a roadside site near the Dooley Inn, Ferry Lane. Nitrogen dioxide, sulphur dioxide and particulate matter, PM_{10} were monitored throughout 2007 at the Adastral Close site. Nitrogen dioxide was monitored at the Dooley Inn site throughout 2007. Nitrogen dioxide was also monitored throughout 2006 at a roadside site at the junction of Lime Kiln Quay Rd, Thoroughfare and St John's St, Woodbridge.

Nitrogen dioxide concentrations were monitored at the continuous analyser sites by ozone chemiluminescence. Sulphur dioxide concentrations were measured by ultra violet fluorescence. Particulate matter concentrations were measured by unheated beta attenuation.

Quality assurance of the data from the continuous monitoring stations was carried out by AEA Energy and Environment following the same procedures used for sites within the Government's Automatic Urban and Rural Network. The procedures adopted for the calibrations were modelled on those developed by AEA Energy & Environment for use in the national monitoring networks. The calibrations were undertaken using certified calibration gas provided by Messer UK with traceability to National Metrology Standards obtained via regular UKAS Quality Control Audits. The audits provide a range of information that is utilised within the data management process for the data sets. Audit tests undertaken include accredited audit zero and span calibrations, linearity, NO_x converter efficiency, flow and leak checks as well as checks of the instruments sampling system. Data presented in this report have been fully ratified by AEA Technology.[2] The ratified data reports are included in Appendix 2.

The data sets were screened, scaled and validated using all available routine site calibrations, audit results and service engineer records. This was an ongoing process with checks made daily to ensure high data capture is achieved. A final process of data ratification ensures that the data provide the most accurate record of the pollution concentrations across the measurement period. The data management process adopted is that evolved and implemented by AEA Energy & Environment within the data management programme of the AURN UK national monitoring network. This process is expected to deliver data sets that meet the EU Data Quality Objective of a measurement uncertainty of better than 15%.

Suffolk Coastal District Council operates a network of nitrogen dioxide diffusion tubes throughout Felixstowe. The diffusion tubes are prepared with 50% triethylamine in acetone and are analysed by Harwell Scientific Services. Triplicate diffusion tubes are collocated with the continuous monitors. The locations of the diffusion tubes are listed in Table 2.2 and shown on a map of Felixstowe in Fig. 2.1.

[2] Issue 2 of the report contained unratified data in order to meet defra deadlines. The ratified data is similar to that reported in Issue 2 for sulphur dioxide and nitrogen dioxide, but there are significant differences for PM_{10}.

Table 2.2: Diffusion tube locations.

Site number	Type	Description of location	OS Grid reference
FLX 4	Urban background site	Lamppost at 37 Lynwood Avenue, Felixstowe.	(6)3080 (2)3542
FLX 12	Roadside site	Drainpipe on 119 Hamilton Road, Felixstowe.	(6)3036 (2)3489
FLX 13 a, b & c	Industrial / Road traffic site	Drainpipe on The Dooley Inn Public House, Ferry Lane, Felixstowe.	(6)2795 (2)3424
FLX 14 a, b & c	Industrial site	Drainpipe on 1 Adastral Close, Felixstowe.	(6)2860 (2)3284
FLX 17 a, b & c	Roadside site	Drainpipe on 38 Spriteshall lane, Trimley St Mary	(6)2881 (2)3632
FLX 18 a, b & c	Roadside site	Lamppost at 67 Kirton Road, Trimley St Martin	(6)2751 (2)3814
FLX 19	Urban background site	Lamppost at 4 Welbeck Close, Trimley St. Mary	(6)2849 (2)3601
FLX 20	Industrial / Road traffic site	Rear garden of 73 Glemsford Close, Felixstowe	(6)2867 (2)3398
FLX 21	Urban background site	Lamppost at 4 Kings Fleet Road, Felixstowe	(6)2925 (2)3443
FLX 22	Industrial site	Drainpipe on 13 Levington Road, Felixstowe	(6)2917 (2)3344
FLX 23	Roadside site	Drainpipe on 23 Heathgate Piece, Trimley St. Mary	(6)2854 (2)3659
FLX 24	Roadside site	Rear garden of 22 Brandon Road, Felixstowe	(6)2834 (2)3462
FLX 25	Roadside site	Drainpipe on 46 Rendlesham Road, Felixstowe	(6)2852 (2)3530
FLX 26	Industrial / Road traffic site	First floor window over front car park at The Dooley Inn, Ferry Lane, Felixstowe	(6)2796 (2)3423
FLX 27	Industrial / Road traffic site	First floor front window facing the Docks at The Dooley Inn, Ferry Lane, Felixstowe	(6)2795 (2)3424
FLX 28	Roadside site	Drainpipe 63 Blyford Way	(6)2840 (2)3487
FLX 29	Industrial site	Drainpipe 18 Adastral Close	(6)2871 (2)3289
FLX 30	Industrial site	Drainpipe 39 Adastral Close	(6)2873 (2)2328
FLX 31	Industrial site	Drainpipe 44 Adastral Close	(6)2863 (2)3279
FLX 32	Industrial site	Drainpipe 64 Adastral Close	(6)2883 (2)3287
FLX 33 a, b & c	Industrial site	Co-located with NOx analyser 1 Adastral Close	(6)2860 (2)3283

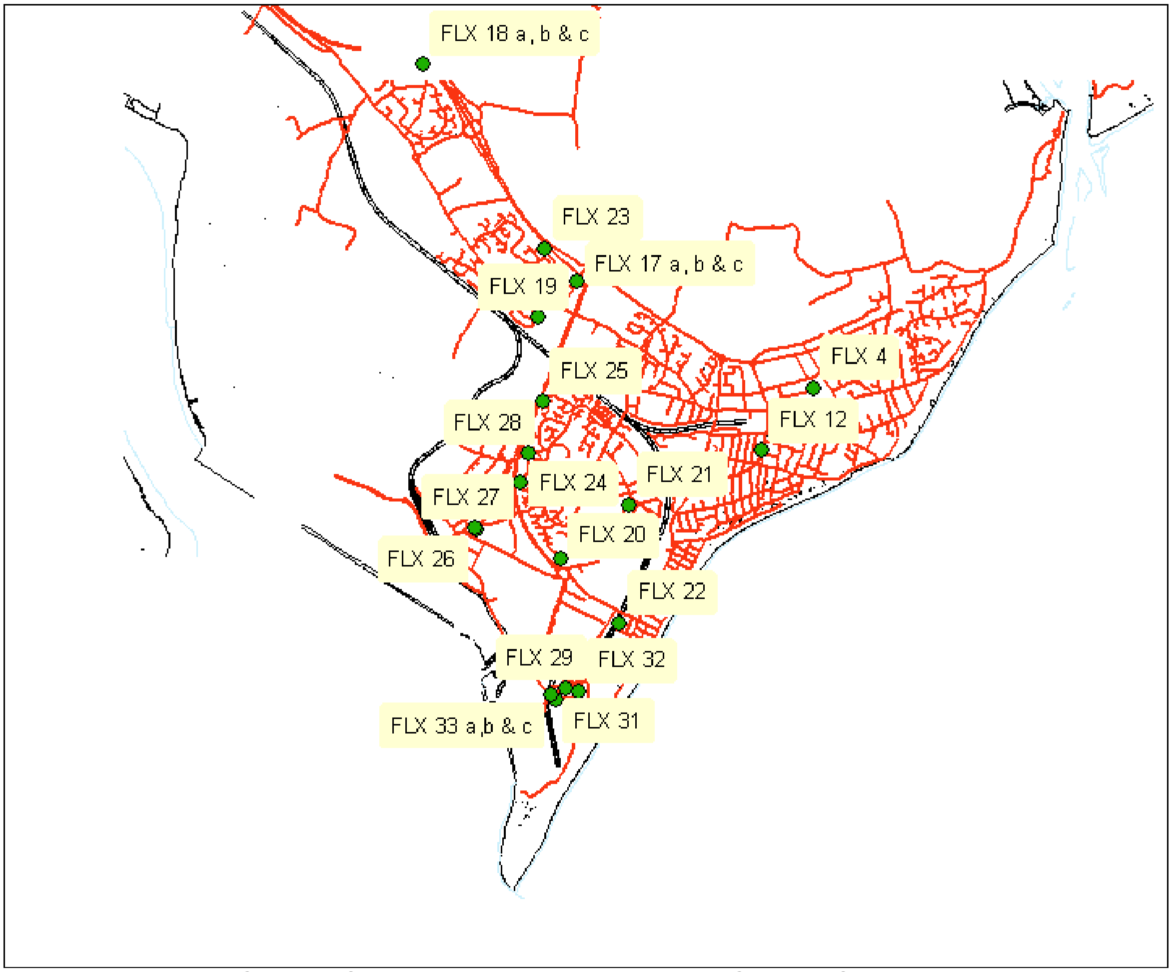
2.6 Emission factors

The vehicle emission factors used for national mapping were revised by defra and the devolved administrations[3] in 2001. The most recent emission factors have been used in this detailed assessment.

Emission factors for PM_{10} from tyre and brake wear were taken from the Air Quality Expert Group report on Particulate Matter in the United Kingdom.

[3] The new set of emission factors on the NAEI website (www.naei.org.uk/emissions/index.php) approved by DEFRA and DTLR for use in emissions and air quality modelling, following consultation of the TRL Report "Exhaust Emission Factors 2001: Database and Emission Factors" by TJ Barlow, AJ Hickman and P Boulter, TRL, September 2001

Fig. 2.1: Location of diffusion tubes in Felixstowe



3 Detailed assessment for sulphur dioxide

3.1 The national perspective

The largest contributor to UK emissions of sulphur dioxide is public electricity and heat production with approximately 49% of UK emissions in 2005. Refineries contribute approximately 9% of UK emissions in 2005. National and international maritime operations contributed approximately 14% of UK emissions. Domestic heating contributed approximately 3% of UK emissions.

Short-term exposure to high concentrations of sulphur dioxide causes constriction of the airways of the lung. This effect is particularly likely to occur in people suffering from asthma and chronic lung disease. The most stringent air quality objectives for sulphur dioxide have been set to limit short-term exposure. Local exceedences of the short-term objectives may occur in the vicinity of small combustion plant that burns coal or oil, in areas where solid fossil fuels are the predominant form of domestic heating and in the vicinity of major ports.

The Port of Felixstowe is the largest container port in the UK. The Felixstowe South Reconfiguration and the Harwich Bathside Bay development will increase the scale of these operations further. The impact of the port operations on sulphur dioxide concentrations is assessed in this section of the report.

3.2 Air quality standards and objectives

The Government and the Devolved Administrations have adopted three Air Quality Objectives for sulphur dioxide for the protection of human health. These are:

- 266 $\mu g\ m^{-3}$ as a 15 minute mean not to be exceeded more than 35 times in a year (the 99.9th percentile);
- 350 $\mu g\ m^{-3}$ as an hourly mean not to be exceeded more than 24 times in a year;
- 125 $\mu g\ m^{-3}$ as a 24-hour mean not to be exceeded more than three times a year.

These objectives were to be achieved before the end of 2005 and will continue to apply in subsequent years. The Air Quality Strategy 2007 confirmed these objectives.

The most stringent of these objectives is the 15-minute mean objective.

3.3 Conclusions of the first and second round of review and assessments for sulphur dioxide

The Stage 3 report for the first round of review and assessment concluded that there was a risk that air quality objectives for sulphur dioxide would not be met near the Port of Felixstowe as the result of shipping emissions. However, the assessment was not conclusive and no AQMA was declared at that time.

The second round Detailed Assessment also concluded that there was a risk of exceeding the air quality objectives for sulphur dioxide as the result of emissions from the Port of Felixstowe.

3.4 Background concentrations of sulphur dioxide

The estimated annual average background sulphur dioxide (SO_2) concentration provided by the UK background maps for 2001 was 3.1 μgm^{-3} averaged across Suffolk Coastal District. LAQM. TG(03) indicates that average concentrations in 2005 were expected to be 75% of this value; 2.3 $\mu g\ m^{-3}$.

3.5 Assessment of monitoring data

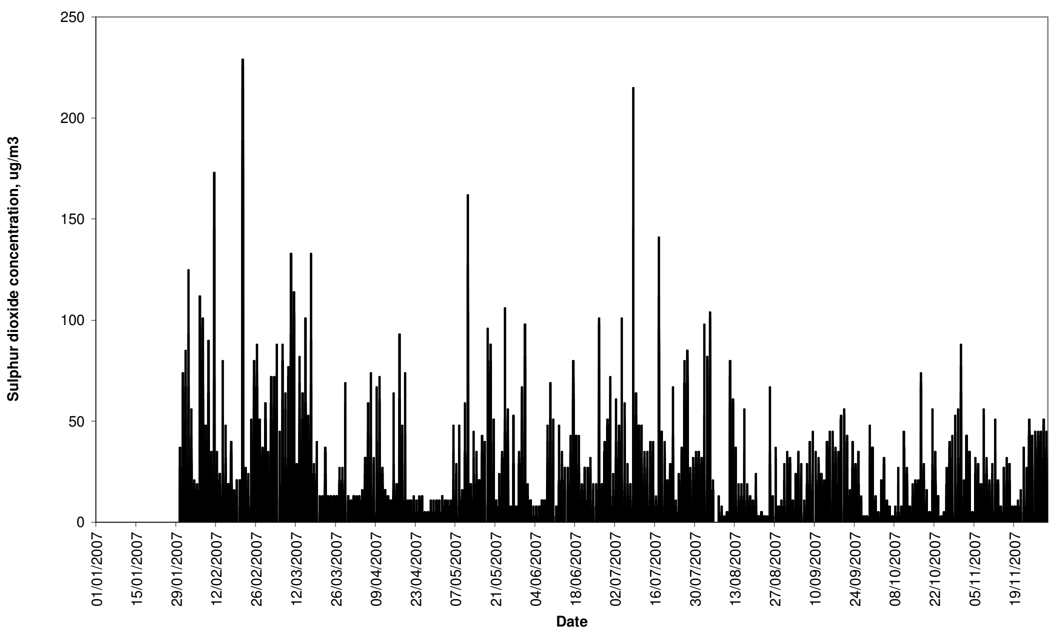
Sulphur dioxide concentrations were monitored throughout 2007 at Adastral Close, which is the nearest residential site to the Port of Felixstowe. Table 3.1 summarises the measured concentrations. There were no exceedences of the 15 minute mean standard of 266 $\mu g\ m^{-3}$, the 1 hour standard of 350 $\mu g\ m^{-3}$ or the 24-hour standard of 125 $\mu g\ m^{-3}$.

Table 3.1: Summary of sulphur dioxide concentration measurements at Adastral Close 2007

Statistic	Concentration, $\mu g\ m^{-3}$
99.9th percentile of 15 minute means	104
99.73 th percentile of 1 hour means	72
99.1th percentile of 24 hour means	29.1
Annual average	9.4

Fig. 3.1 shows the 15-minute sulphur dioxide concentrations measured at Adastral Close throughout 2007. On 11 August 2007, the maximum sulphur content of fuels used by ships in the North Sea was reduced to 1.5%. It is notable that the 15-minute mean concentration exceeded 100 $\mu g\ m^{-3}$ on 25 occasions in the year before this date, but on no occasion thereafter.

Fig. 3.1: 15 minute mean concentrations measured at Adastral Close



3.6 Dispersion modelling

The dispersion model ADMS4 was used to predict the concentrations of sulphur dioxide in the port area. The model took into account the emissions from:

- ships entering Harwich Harbour to travel to the Port of Felixstowe and to Harwich International Port;
- ships at berth at the Port of Felixstowe;
- dredging operations in Harwich Harbour;
- Rubber Tyred Gantry (RTG) and Internal Movement Vehicle (IMV) operations at the Port of Felixstowe.

Four scenarios were considered:

- Current case, 2007
- Current case, 2008
- Future case with the Felixstowe South Reconfiguration, 2010
- Future case with Felixstowe South Reconfiguration and Harwich Bathside Bay, 2010

The first phase of the Felixstowe South Reconfiguration will be operational in 2010 and the Bathside Bay development will not be operational until a later date. An assessment date of 2010 has been used here to provide a worst-case assessment of the potential impact on air quality.

Ships at the Port of Felixstowe currently dock at four quayside areas:

- Trinity Terminal has 2354 m of quayside with seven deep-sea container berths.
- Landguard Terminal has 554 m of quay with two container berths.
- The Dooley Ro-Ro Terminal has two quays. Ro-Ro 3 is 174 m long. Ro-Ro 4 is 250 m long.
- Smaller vessels, up to 137 m length can be berthed in the Dock Basin.

The Felixstowe South Reconfiguration will replace the Landguard Terminal and the Dock Basin with a new quay 1350 m long with four deep-sea container berths. The Bathside Bay development will provide a further four deep-sea container berths at Bathside Bay, Harwich.

Table 3.2 shows the number of ships entering the Port of Felixstowe and Harwich International Port during 2005 (Transport Statistics GB, 2006).

Table 3.2: Number of ships entering ports

Class of vessel	Deadweight, tonnes	Felixstowe	Harwich
Tankers	1-4,999	16	83
	5,000-19,999	6	43
	20,000-99,999	5	-
	100,000+	-	-
Ro-Ro vessels	1-4,999	342	831
	5,000-19,999	1,005	1,873
	20,000+	-	1
	1-4,999	225	3
Fully cellular container vessels	5,000-19,999	589	12
	20,000+	1,611	-
Other dry cargo	1-4,999	284	38
	5,000-19,999	158	42
	20,000-99,999	12	4
	100,000+	-	-
Total		4,253	2,930

Many of the major shipping lines operate scheduled container services through Felixstowe. These include Maersk Line, Cosco, MSC, Kawasaki K-Line and China Shipping line. In addition feeder services to other UK ports using small container ships, typically less than 5000 tonnes gross are provided by, for example, Feederlink. Most of the container ships have gross tonnage in excess of 20,000 tonnes. In the week 10 -18 September 2007(http://www.portoffelixstowe.co.uk/shipping/), there were twenty-five scheduled arrivals with gross tonnage in the range 20000-50000 tonnes, seventeen arrivals with gross tonnage in the range 50000-100000 tonnes and three scheduled arrivals with gross tonnage greater than 100000 tonnes. Table 3.3 shows typical main and auxiliary engine sizes for container ships. It also shows typical stack discharge heights.

Table 3.3: Typical engine sizes for container ships

Gross tonnage[4]	Main engine, MW	Auxiliary engines, MW	Number of containers, TEU*	Stack height, m
0-5000	3.3	2 x 0.32	450	25
5000-20000	9.6	2 x 0.96	957	30
20000-50000	36.5	4 x 1.7	4051	40
50000-100000	57	3 x 2.9	6200	45
>100000	69	4 x 2.7	9580	50
* Twenty foot equivalent				

The majority of the Ro-Ro ferries are operated by Norfolkline with 24 services per week to Scheveningen using four identical ships – Maersk Anglia, Maersk Flanders, Maersk Importer and Exporter. The engines on each of these ships are:

- Main Engines: 2 x Sulzer 8ZAL40S, 5475 kW / 7300 HP
- Aux. Engines: 2 x Sulzer 4SC6S20D, 780 kW / 1040 HP
- GT: 13,073 tonnes

There were approximately 3 million TEU (twenty-foot unit equivalent) annual container movements through the Port of Felixstowe in 2005. Following Felixstowe South Reconfiguration, the annual container movements through the port are projected to increase from 3.39 million TEU without the Reconfiguration in 2008 to 4.19 million TEU with the reconfiguration. This increased flow will be met partly by an increase in the number of ship movements, but also by an increase in the average size of the container ships. For this assessment it has been assumed that the number of ship movements increases pro-rata with container movements.

The Bathside Bay development at Harwich will provide additional handling capacity of 1.68 million TEUs. For this assessment, it has been assumed that the number of ship movements into Harwich Harbour will increase pro-rata with container movements, based on the current ship size distribution for the Port of Felixstowe.

The dispersion model used hourly sequential meteorological data for 2006 for Wattisham. Wattisham is approximately 35 km north-west of Felixstowe. The surface roughness was estimated to be 0.001 m (sea) in the vicinity of the port and 0.1 m in the vicinity of the meteorological site. The Monin-Obukov length (a parameter related to atmospheric turbulence) was limited to a minimum of 50 m in the modelling because stable night-time conditions are rare when the wind comes from the direction of the sea. The assessment has taken into account the contribution from background source emissions away from the port as follows. The annual average background concentration for the Suffolk Coastal District was added to the modelled annual average contributions from port operations to provide modelled predictions of the total annual average sulphur dioxide concentrations. A value of twice the annual average background concentration was added to the modelled port contribution to short-term peak (15 minute mean, 1-hour mean, 24-hour mean) concentrations to provide modelled predictions of the total short-term concentrations.

3.6.1 Moving ships

Incoming container vessels pick up a pilot at the Sunk Light vessel, approximately 15 miles offshore and travel dead slow ahead to the edge of the Stour where a tug is fixed. The vessel is then turned around near to the north bank of the Stour using bursts of main engine power dead slow ahead and astern, bow thrusters and tug assistance. Final manoeuvring alongside the berth is accomplished using bow thrusters. Outgoing container vessels move off the berth using thrusters and then travel dead slow ahead to the edge of the Stour channel. The ships then travel slowly out of the estuary before setting course once in open sea. For the purposes of this assessment, it has been assumed

[4] It has been assumed that container ship's deadweight and gross tonnage are broadly equivalent for the purposes of the assessment. Examination of ship specifications indicates that the assumption of equivalence is adequate for this purpose.

that the ships manoeuvre at a speed of 6 knots in the harbour area, with the main engines at 20% if capacity and auxiliary engines operating at 50% of capacity (Entec 2002)[5].

The modelling has treated the ship emissions manoeuvring in Harwich Harbour as a series of ten line sources commencing approximately 2km outside Landguard Point and connecting to berths at Trinity Terminal, Landguard Terminal (or Felixstowe South) and the Dooley Ro-Ro terminal. Ships typically take approximately half an hour to manoeuvre into berth from approaching Landguard Point. For the purposes of modelling it has been assumed, conservatively, that the whole of the emissions for each ship movement are emitted in a 15-minute period. Ships were assumed to arrive and depart at random intervals throughout the year at frequencies determined from the number of ship movements for each ship size category. Ships were allocated to berths according to their size. For the current situation, all ships >20,000 tonnes were allocated to the seven Trinity Terminal berths, and container ships in the 5,000-20,000 tonnes were allocated to the Landguard terminal. Feeder ships <5,000 tonnes were allocated to all nine berths. For the case with the Felixstowe South reconfiguration, all container ships accessing the port were allocated equally to the seven Trinity berths and the four FSR berths. Ro-Ro ships were allocated to the Dooley terminal.

The modelling assumed that emissions were released from moving ships at a height of 30-40 m above the water level through stack diameters in the range 1-3 m at a temperature of 150^{o}C and at an upward velocity of 9 m s^{-1}.

3.6.2 Ships at berth

The Norfolkline Ro-Ro ferries spend 4 hours between arriving and departing from the Dooley terminal. The duration of stay for container ships depends on the number of containers that are to be loaded onto the ship or offloaded onto the quay. Analysis of schedules for Maersk Line and MSC indicates that ships typically spend 20 hours at berth. However, it has been assumed that the smaller feeder ships (<5,000 tonnes) spend 4 hours at berth. For the modelling assessment, ship occupancy was allocated at random for each hour of the year to each of the berths with the frequency of occupation calculated from the total number of ship-hour occupancy of berths for each category of ship. The ships auxiliary engines were assumed to operate at 40 % of capacity while at berth. The main engines were assumed to operate for 5% of the time at berth at 20% of capacity (Entec 2002).

The dispersion modelling treated the emissions from ships at port as point sources at each berth location, 30-40 m above ground. No plume rise was assumed for these sources.

3.6.3 Ship emissions

The emissions of sulphur dioxide were calculated from the engine capacity, the engine load factor, the specific fuel consumption of the engines and the sulphur content of the fuel. The fuel consumption of ships manoeuvring in the harbour and at berth was estimated from specific fuel consumption factors taken from the Entec 2002 report. Table 3.4 shows specific fuel consumption estimates for ships manoeuvring and in port. Table 3.4 also shows emission factors for oxides of nitrogen and particulate matter, PM_{10}. Fuel consumption in port for the largest container ships was assumed to be less than 9.5 tonnes per day, based on estimates from the Felixstowe South Reconfiguration Environmental Statement.

Fig. 3.4: Specific fuel consumption and emissions from ships

Emissions, g/kWh	Container vessels		Ro-Ro vessels	
	Manoeuvring	In port	Manoeuvring	In port
Specific fuel consumption	219	223	228	227
NO_x emissions	14.0	13.7	12.5	13.0
PM_{10} emissions	2.3	1.5	2.3	1.4

The sulphur content of heavy fuel oil used by ships main engines was typically 2.7% until 11 August 2007. European Council Directive 2005/33/EC limited the sulphur content of fuels used by ships in the

[5] Entec, 2002. European Commission report of the Quantification of emissions from ships associated with ship movements between ports in the European Community.

North Sea Sulphur Emission Control Area to 1.5% from August 11 2007. Ships at berth use a range of fuels including marine gas oil, marine diesel and heavy fuel oil. For example, the Maersk S class ships use typically 9.5 tonnes of heavy fuel oil per day at berth. The sulphur content of marine diesel and gas oil is unlikely to exceed 1.5%. European Council Directive 1999/32/EC limits the sulphur content of marine diesel and gas oil to 0.2%, but the Directive does not apply to ships crossing a frontier to a non-EU country. It is thus difficult to establish a realistic average sulphur content for fuels used by ships at berth. The Dibden Terminal Combined Sources Impact Assessment, 2002 assumed that the average sulphur content was 0.75%: here it has been assumed that 50% of ships selected at random use fuels with a sulphur content of 1.5% and 50% use 0.2% sulphur content fuel.

3.6.4 Dredging

Harbour maintenance dredging is carried out in 4 or 5 main visits and 3 minor visits of plant to the Harbour:

* The 4 or 5 main visits, at approximately 10 week intervals, employ one large trailer hopper dredger (or two smaller ones) operating for about 8 days on each visit. During this time they work 24 hours per day but are only in the harbour for about 45 minutes in every 4 hours as they sail to sea to dispose of the material. A typical large ship visit would use about 400,000 litres of heavy fuel oil.

* The 3 minor visits take about 10 days each and occur between October and April each year. They use a small trailer hopper dredger operating in the harbour for 24 hours a day throughout the 10 day period. A typical small ship visit would use about 50,000 litres of marine diesel.

The emissions from harbour dredging operations were treated as a volume source in the dispersion modelling. The dredging operations were assumed to take place in an area approximately 1 km square in the vicinity of the Felixstowe South Reconfiguration. The emissions were assumed to be released at a height 20-30 m above sea level.

3.6.5 Container handling

Containers are off-loaded from the ships using rail-mounted quayside cranes. The container is then placed directly onto an Internal Movement Vehicle (IMV). An IMV is a tractor unit with a trailer, which takes the container to a designated stacking location. The IMV drives alongside the container stack and under a Rubber Tyred Gantry (RTG), which lifts the container onto the stack. Outside hauliers enter the port at the security gate and collect the container from the stack, with transfer made by an RTG. IMVs are also used to move containers between the stacking location and the railway terminals, where they are transferred to the railway wagons using rail mounted gantry cranes (RMG). Reach stackers are also used at the railway terminals to complement the RMGs.

The quayside cranes and RMGs are electrically-powered and so do not contribute to the port emissions. The Port of Felixstowe estimated that 15 million litres of diesel fuel are used annually in their container handling operations, of which 8 million litres per year is used by the RTGs. Table 3.5 lists the emission factors, taken from the National Atmospheric Emission Inventory database for off-road machinery and used to calculate emissions from container handling operations at the port.

Table 3.5: Emission factors for container handling operations at ports

Pollutant	Emission factor, kg/tonne
Sulphur dioxide	2.64
Oxides of nitrogen	43
Particulate matter, PM_{10}	4.3

EC Directive 99/32/EC will reduce the maximum sulphur content of gas oil and diesel fuel used by non-road sources to 0.1 % at the start of 2008. The emission factor for model runs after 2008 was reduced to 2 kg/tonne for model runs.

Rubber-Tyred Gantry cranes (RTGs) are the principal means of moving containers in and out of storage stacks. Each year, they use more than half of all diesel fuel consumed by the Port. Much of this fuel is used up when the machine is idling, since RTGs must not be switched off without being plugged into electrical shore supplies. Some shore supply points are available on the Port. The Port has set up a joint initiative (Environmental Report, 2006), the remit of which will be to identify shore supply needs and suitable locations, identify gaps and provide additional supply points, as required. This will enable RTGs to be switched off when left parked, saving fuel and consequently reducing emissions. It is expected that the Felixstowe South Reconfiguration will include supply points for the RTGs. For this assessment, a worst-case assessment has been made that assumed that the fuel use would increase pro-rata with the number of container movements: a best-case assessment has also been considered that assumed that a 50% reduction in RTG fuel use per container handled will be achieved.

The European Commission has set increasingly stringent emission standards for new non-road engines (Directive 2004/26/EC), These emission standards will apply to new RTGs and IMVs purchased for the Felixstowe South Reconfiguration. The emission standards will be implemented at various dates over the next few years to 2015. For this assessment, it has been assumed that exhaust emission factors of 20 kg NO_x /tonne fuel and 1 kg PM_{10}/tonne fuel will apply for new equipment installed for the Felixstowe South Reconfiguration (based on the Stage IIIA standards and fuel consumption of 200 g/kWh for the 535 kW Volvo TAD1642GE engines used in the RTGs).

The Port handled approximately 3 million TEUs in 2005, increasing to 3.39 million TEUs in 2008 without the Felixstowe South Reconfiguration (FSR) and 4.19 million with the FSR. Approximately 24 % of the containers are transhipped and do not leave the Port. Of the remaining containers, approximately 23% are shipped by rail, with the remainder shipped by road. The number of heavy goods vehicles associated with container operations was estimated assuming an average of 0.633 containers per TEU and 1.41 HGV movements per container.

The Ro-Ro ferries have the capacity to carry 120 HGVs and operate 24 services per week.

Each HGV movement was assumed to cover a distance of 1.1 km within the Port area at a speed of 10 kph. Table 3.6 lists the emission factors taken from the NAEI and used in this assessment for HGV movements within the port.

Table 3.6: Emission factors for HGV movements in port

	Emission factors, g (veh km)$^{-1}$		
	Oxides of nitrogen	PM_{10}	Sulphur dioxide
2007	19.81	0.72	0.02
2008	18.27	0.61	0.02
2010	14.51	0.43	0.02

The container handling operations and goods vehicle emissions were treated as two five metre deep volume sources in the dispersion modelling. The volume sources corresponded to handling areas in the area of the Trinity and Landguard terminals with a total area of 1.34 km^2.

3.6.6 Model verification

Modelled predictions of the concentrations at the Adastral Close monitoring site are compared with the measured values in Table 3.7. The model provides good estimates of the measured annual average and 24 hour mean concentration statistics, but has overestimated the measured 1-hour and 15 minute mean statistics. Use of the model more generally is therefore likely to produce conservative overestimates of short-term sulphur dioxide concentration statistics.

Table 3.7: Comparison of modelled and measured sulphur dioxide concentrations

Statistic	Concentration, µg m^{-3}	
	Measured	Modelled
99.9th percentile of 15 minute means	104	179
99.73th percentile of 1 hour means	72	115
99.1th percentile of 24 hour means	29.1	28.4
Annual average	9.4	9.8

3.6.7 Predicted concentrations

Fig. 3.2 shows the predicted 99.9th percentile of 15-minute mean concentrations for the current year (2007). The maximum predicted concentration of 400 µg m^{-3} is predicted within the port area. There are no areas outside the port boundary where the predicted concentration exceeds the objective of 266 µg m^{-3}.

Fig.3.3 shows the predicted 99.9th percentile of 15-minute mean concentrations for 2008. The predicted concentrations are slightly higher than for 2007 close to the Trinity terminal berths because the modelling was based on a higher throughput of containers (3.39 million TEU compared with 3 million TEU). At other locations, it is predicted that there are lower concentrations in 2008 because of the lower sulphur content of the fuels used for the ships main engines and for the container handling equipment. (RTGs and IMVs). There are no areas outside the port boundary where the predicted concentration exceeds the objective of 266 µg m^{-3}.

Fig. 3.4 shows the predicted 99.9th percentile of 15-minute mean concentrations for 2010 with the Felixstowe South Reconfiguration in operation. The predicted concentrations are smaller than those predicted for 2008 despite the greater container throughput because the sulphur content of the fuels used in port is reduced following EC Directive 2005/33/EC. There are no areas inside or outside the port boundary where the predicted concentration exceeds the objective of 266 µg m^{-3}.

Fig.3.5 shows the predicted 99.9th percentile of 15-minute mean concentrations for 2010 with both the Felixstowe South Reconfiguration and Harwich Bathside Bay in operation. The predicted concentrations are slightly greater than those predicted without the Bathside Bay facility in operation. There remain no areas inside or outside the port boundary where the predicted 99.9th percentile concentration exceeds the objective of 266 µg m^{-3}.

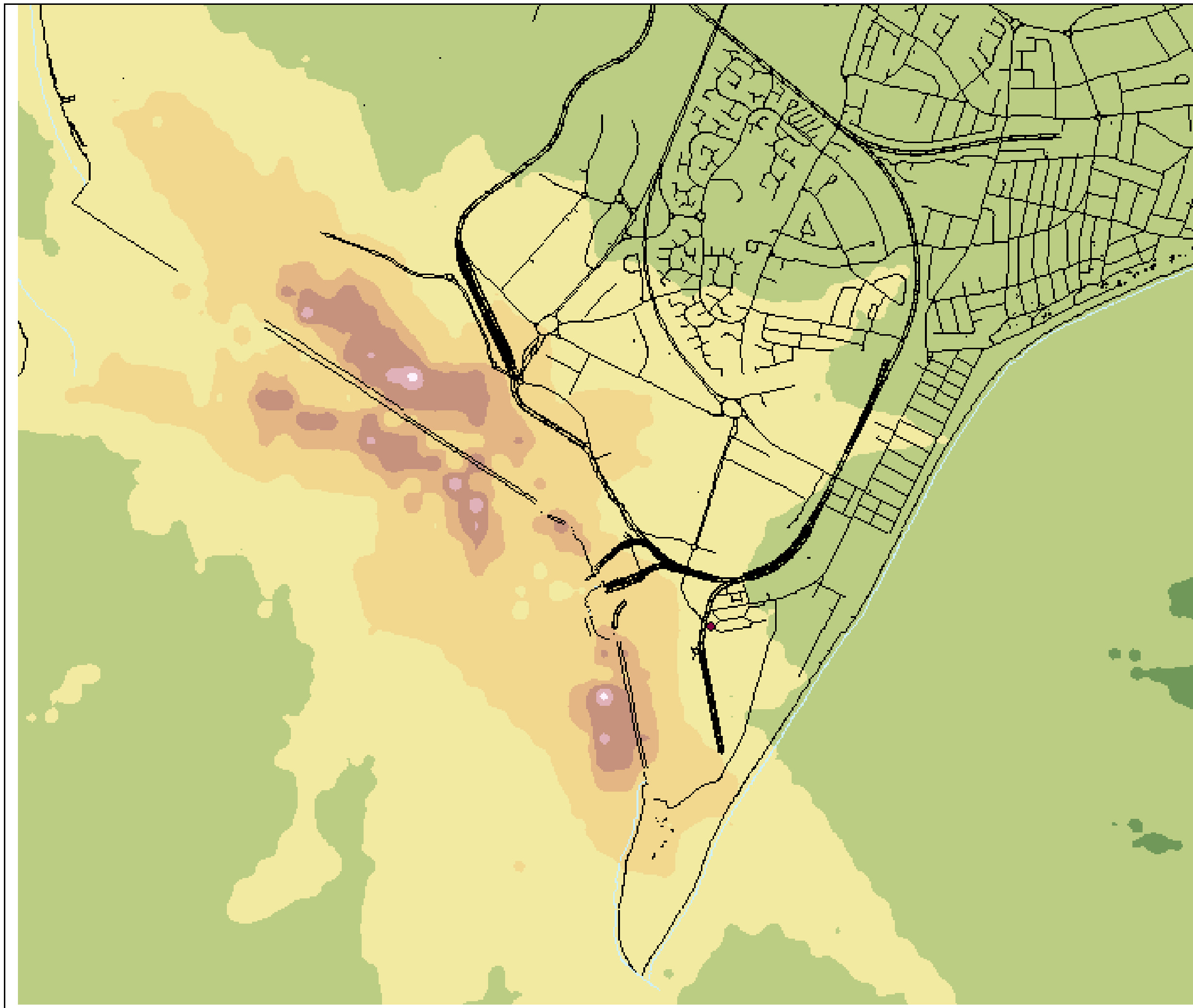
The 15-minute mean objective is the most stringent objective for sulphur dioxide. The modelling predicts that the 1-hour and 24-hour objectives will be met at all modelled locations for all scenarios.

3.7 Conclusion

Modelled sulphur dioxide concentrations are less than the air quality objectives for all locations outside the port boundary for all modelled scenarios. The scenarios modelled include the current situation and future years with the Felixstowe South and Bathside Bay developments. There is thus no potential for non-occupational exposure of members of the public to concentrations in excess of the air quality objectives. Measured concentrations at the nearest residential location to the port (Adastral Close) confirm the results of the modelling study.

It is recommended that Suffolk Coastal District Council do not declare an Air Quality Management Area for sulphur dioxide.

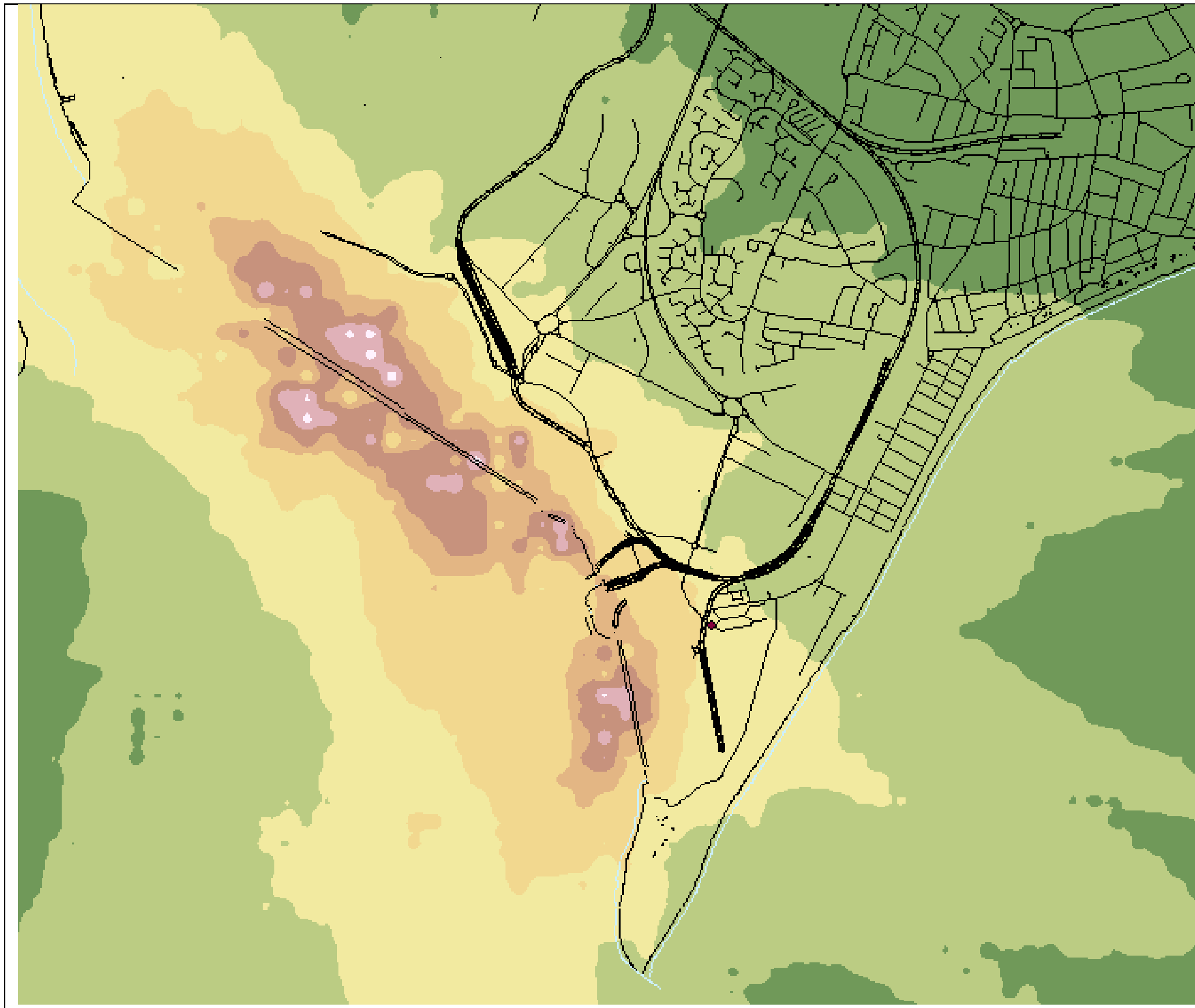
Fig.3.2: Predicted 99.9th percentile of 15 minute mean sulphur dioxide concentrations, 2007



99.9 %ile 15 minute mean sulphur dioxide, ug/m3

- <100
- 100-150
- 150-200
- 200-266
- 266-300
- 300-350
- 350-400
- >400

Fig.3.3: Predicted 99.9th percentile of 15 minute mean sulphur dioxide concentrations, 2008



99.9 %ile 15 minute mean sulphur dioxide, ug/m3

	<100
	100-150
	150-200
	200-266
	266-300
	300-350
	350-400
	>400

Fig.3.4: Predicted 99.9th percentile of 15 minute mean sulphur dioxide concentrations, 2010 with Felixstowe South Reconfiguration

99.9 %ile 15 minute mean sulphur dioxide, ug/m3

- <100
- 100-150
- 150-200
- 200-266
- 266-300
- 300-350
- 350-400
- >400

Fig.3.4: Predicted 99.9th percentile of 15 minute mean sulphur dioxide concentrations, 2010 with Felixstowe South Reconfiguration and Bathside Bay

99.9 %ile 15 minute mean sulphur dioxide, ug/m3

	<100
	100-150
	150-200
	200-266
	266-300
	300-350
	350-400
	>400

4 Detailed Assessment for Nitrogen Dioxide

4.1 The national perspective

The principal source of NO_x emissions is road transport, which accounted for about 37% of total UK emissions in 2004. Major roads carrying large volumes of high-speed traffic (such as motorways and other primary routes) are a predominant source, as are conurbations and city centres with congested traffic. Within most urban areas, the contribution of road transport to local emissions will be much greater than for the national picture.

Meeting the annual mean objective is considerably more demanding than achieving the 1-hour objective. National studies have indicated that the annual mean objective is likely to be achieved at all urban background locations outside of London by 2005, but that the objective may be exceeded more widely at roadside sites throughout the UK in close proximity to busy road links. Projections for 2010 indicate that the EU limit value may still be exceeded at urban background sites in London, and at roadside locations in other cities.

4.2 Standards and objectives for nitrogen dioxide

The Government and the Devolved Administrations have adopted two Air Quality Objectives for nitrogen dioxide, as an annual mean concentration of 40 μgm^{-3}, and a 1-hour mean concentration of 200 μgm^{-3} not to be exceeded more than 18 times per year. The objectives are to be achieved by the end of 2005 and in subsequent years. The Air Quality Strategy 2007 confirmed these two objectives.

4.3 Conclusions of the first and second round of review and assessments for nitrogen dioxide

The Stage 3 report for the first round of review and assessment concluded that there was a risk that annual mean air quality objective for nitrogen dioxide would not be met at properties close to the junction of the A1152 and the B1438 at Melton and the junction of Lime Kiln Quay Road and St Johns Street in Woodbridge. No AQMA was declared at that time. A Detailed Assessment was carried out in the second round of Review and Assessment. A detailed monitoring and modelling study at locations close to the Woodbridge junction showed that it was likely that the air quality objective for nitrogen dioxide would not be met at a small number of residential properties. Suffolk Coastal District Council declared an AQMA to cover the affected properties in 2006. A Further Assessment has confirmed the need for the AQMA.

4.4 Background concentrations for nitrogen dioxide

The estimated annual average background nitrogen dioxide (NO_2) concentration provided by the UK background maps for 2005 was 10.4 $\mu g\ m^{-3}$ averaged across Suffolk Coastal District falling to 8.7 $\mu g\ m^{-3}$ in 2010.

The estimated annual average background oxides of nitrogen (NO_x) concentration provided by the UK background maps for 2005 was 13.3 $\mu g\ m^{-3}$ averaged across Suffolk Coastal District falling to 11.2 $\mu g\ m^{-3}$ in 2010.

4.5 Assessment of monitoring data

Table 4.1 summarises the measurements of nitrogen dioxide concentrations for relevant periods at the continuous monitoring stations in Suffolk Coastal District and at nearby monitoring stations in defra's Automatic Urban and Rural Network.

Table 4.1: Continuous monitoring data

Site	Period	Data capture, %	NO_x, concentration, µg m^{-3} as NO_2	NO_2 Concentration, µg m^{-3}	
			Period average	Period average	99.8th percentile hourly
Adastral Close	30/01/07-31/12/07	98	59	30	107
	30/01/07-31/10/07	98	52.8	28.1	
The Dooley Inn	2007	98	108	42	124
	30/01/07-31/12/07	98	109.2	41.8	
	30/01/07-31/10/07	98	99.6	40.3	
St Osyth	2007	92	15.6	12.4	
	30/01/07-31/12/07	92	15.8	12.3	
	30/01/07-31/10/07	96	13.1	11.0	
Southend on Sea	2007	99	37.1	24.8	
	30/01/07-31/12/07	99	38.0	25.1	
	30/01/07-31/10/07	99	31.0	22.2	
Woodbridge	2006	96		44	

The monitoring site at Adastral Close provided nitrogen dioxide data for 11 months of the year. The period average measurements were adjusted to provide an estimate of the annual average concentration of 30 µg m^{-3} using a factor of 1.000 derived from the measurements at the Dooley Inn, St Osyth and Southend on Sea. Similarly, the annual average oxides of nitrogen concentration at the site was estimated to be 58.1 µg m^{-3} based on an adjustment factor of 0.984.

The concentrations measured at the Adastral Close site were substantially less than the air quality objectives for nitrogen dioxide. The annual average concentration of nitrogen dioxide measured at the Dooley Inn was slightly greater than the air quality objective of 40 µg m^{-3}. The 18th largest hourly concentrations at both sites (the 99.8th percentile) were substantially less than the hourly objective of 200 µg m^{-3}.

Concentrations of nitrogen dioxide are generally expected to decrease at background and roadside sites in future years as the result of reductions in emissions from the major sources. The UK air quality archive provides a factor of 0.895 for the expected reduction in nitrogen dioxide concentrations between 2007 and 2010 for roadside sites. Applying this factor indicates that the concentrations at the Dooley Inn site would be expected to decrease to 38 µg m^{-3} by 2010 if the major contributor to concentrations at this location was road traffic.

Table 4.2 shows the concentrations measured by diffusion tube at relevant locations in Felixstowe. The 2006 measurements have been corrected for diffusion tube bias using a national bias adjustment factor of 0.78 taken from the Review and Assessment Helpdesk Frequently Asked Questions for Harwell Scientific 50% TEA in acetone tubes. A local bias adjustment factor of 0.93 was also determined from co-located measurements at the Woodbridge site in 2006 as part of the earlier Further Assessment. The 2007 measurements have been corrected for diffusion tube bias using local bias adjustment factors of 0.863 calculated from co-located tubes at Adastral Close and 0.767 calculated from co-located tubes at the Dooley Inn monitoring site. The 2007 measurements used in the analysis were taken over the period February-October 2007: the diffusion tube measurements for this period have also been scaled to provide an estimate of the 2007 annual concentrations using a scaling factor of 1.10 determined from the measurements at the Dooley Inn, St Osyth and Southend on Sea. The diffusion tube measurements indicate that the air quality objective of 40 µg m^{-3} as an annual mean is currently exceeded at the Dooley Inn, but at no other site.

Concentrations in 2010 have been estimated using year adjustment factors taken from the UK air quality archive of 0.866 for 2006 data and 0.895 for 2007 data. The range of these estimates is also shown in Table 4.2. The maximum predicted concentrations in this range exceed the air quality objective in 2010 at the Dooley Inn: however, the more reliable estimate based on the continuous monitoring results indicates that the objective will be met (see above).

Table 4.2: Summary of diffusion tube data

Site no.	Site description	Concentration, µg m^{-3}							
		2006 raw	2006 local bias adjustment	2006 national bias adjustment	2007 raw	2007 local bias adjustment (Adastral Close)	2007 local bias adjustment (Dooley inn)	2010 min	2010 max
FLX 4	Lamppost at 37 Lynwood Avenue, Felixstowe.	26.1	24.3	20.4	21.3	20.1	17.9	15.8	21.0
FLX 12	Drainpipe on 119 Hamilton Road, Felixstowe.	36.6	34.0	28.5	34.4	32.5	28.9	24.7	29.4
FLX 13	Drainpipe on The Dooley Inn Public House, Ferry Lane, Felixstowe.	51.2	47.6	39.9				34.6	41.2
FLX 14	Drainpipe on 1 Adastral Close, Felixstowe.	43.2	40.2	33.7	35.1	33.2	29.5	26.1	34.8
FLX 17	Drainpipe on 38 Spriteshall lane, Trimley St Mary	34.7	32.3	27.1	33	31.2	27.7	23.5	28.0
FLX 18	Lamppost at 67 Kirton Road, Trimley St Martin	38.5	35.8	30.0	36.4	34.4	30.6	26.0	31.0
FLX 19	Lamppost at 4 Welbeck Close, Trimley St. Mary	31.7	29.5	24.7	29.3	27.7	24.6	21.4	25.5
FLX 20	Rear garden of 73 Glemsford Close, Felixstowe	34.5	32.1	26.9	30.6	28.9	25.7	22.7	27.8
FLX 21	Lamppost at 4 Kings Fleet Road, Felixstowe	33.7	31.3	26.3	29.3	27.7	24.6	21.8	27.1
FLX 22	Drainpipe on 13 Levington Road, Felixstowe	31.5	29.3	24.6	31	29.3	26.1	21.3	26.1
FLX 23	Drainpipe on 23 Heathgate Piece, Trimley St. Mary	38.2	35.5	29.8	37.5	35.5	31.5	25.8	31.6
FLX 24	Rear garden of 22 Brandon Road, Felixstowe	37.9	35.2	29.6	38.4	36.3	32.3	25.6	32.4
FLX 25	Drainpipe on 46 Rendlesham Road, Felixstowe	37.8	35.2	29.5	37	35.0	31.1	25.5	31.2
FLX 26	First floor window over front car park at The Dooley Inn, Ferry Lane, Felixstowe	52.4	48.7	40.9	52.5	49.7	44.1	35.4	44.3
FLX 27	First floor front window facing the Docks at The Dooley Inn, Ferry Lane, Felixstowe	47.2	43.9	36.8	46.2	43.7	38.8	31.9	38.9
FLX 28	Drainpipe 63 Blyford Way	38.7	36.0	30.2	35.4	33.5	29.8	26.2	31.2
FLX 29	Drainpipe 18 Adastral Close				32.3	30.6	27.2	24.1	27.2
FLX 30	Drainpipe 39 Adastral Close				29.2	27.6	24.5	21.7	24.6
FLX 31	Drainpipe 44 Adastral Close				33.8	32.0	28.4	25.1	28.5
FLX 32	Drainpipe 64 Adastral Close				29.1	27.5	24.5	21.7	24.5
FLX 33	Co-located with NOx analyser 1 Adastral Close				33.5	31.7	28.2	25.0	28.3

4.6 Overview of the air quality modelling

4.6.1 Summary of the models used

The contribution to oxides of nitrogen concentrations from the port operations was modelled using ADMS4 as described in Section 3. The modelling included emissions from the ships approaching the port, from ships in berth, from dredging, from container handling operations using RTGs and IMVs and from HGVs making deliveries to the port.

The air quality impact from roads has been assessed using our proprietary urban model (LADS Urban). There are two parts to this model:

- The *Local Area Dispersion System (LADS) model*. This model calculates background concentrations of oxides of nitrogen on a 1 km x 1 km grid. The estimates of emissions of oxides of nitrogen for each 1 km x 1 km area grid square were obtained from the 2005 National Atmospheric Emissions Inventory.
- The *DISP model*. This model is a tool for calculating atmospheric dispersion using a 10 m x 10 m x 3 m volume-source kernel derived from ADMS3.3 to represent elements of the road. The volume source depth takes account of the initial mixing caused by the turbulence induced by the vehicles. Estimates of emissions from vehicles have been calculated using the latest (and finalised for this round of Review and Assessment) vehicle emission factors.

Particular attention was paid to the avoidance of “double counting” of the contribution from major roads and shipping in the modelled areas. Thus the emissions from sections of roads modelled using DISP and shipping emissions (other transport) were removed from the LADS inventory.

The dispersion model used hourly sequential meteorological data for 2006 for Wattisham. Wattisham is approximately 35 km north-west of Felixstowe. The surface roughness was estimated to be 1 m in the vicinity of the roads and 0.1 m in the vicinity of the meteorological site. The Monin-Obukov length (a parameter related to atmospheric turbulence) was limited to a minimum of 10 m in the modelling, to allow for the heat island effects associated with the town.

A regional background oxides of nitrogen concentration of 15.5 µg m, measured at St Osyth for 2007 was added to the modelled oxides of nitrogen concentrations.

Empirical relationships developed for the Air Quality Expert Group (AQEG, 2004) were used to calculate nitrogen dioxide concentrations from the total oxides of nitrogen concentrations predicted by the models. The relationships take into account the background total oxidant concentration and the proportion of the oxides of nitrogen released from vehicles as nitrogen dioxide, here taken to be 14.1%.

4.7 Validation and verification of the model

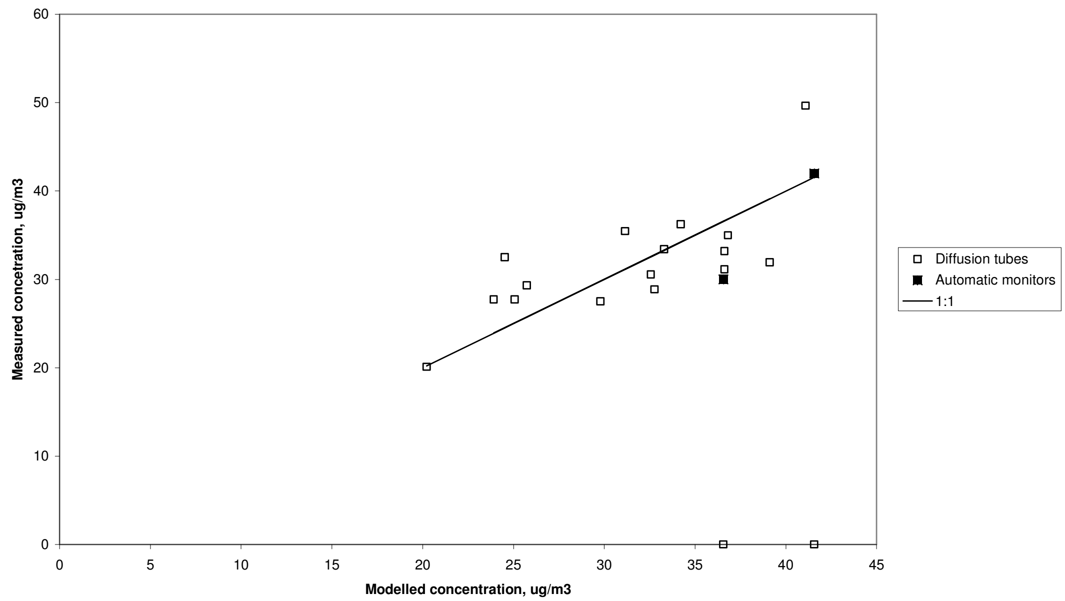
In simple terms, model validation is where the model is tested at a range of locations and is judged suitable to use for a given application. The modelling approach used in this assessment has been validated, and used in numerous **netcen** air quality review and assessments.

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Fig. 4.1compares the measured and modelled concentrations at the automatic monitoring sites and relevant diffusion tube sites: the diffusion tube measurements have been adjusted for bias on the basis of co-located measurements at Adastral Close and at the Dooley Inn.

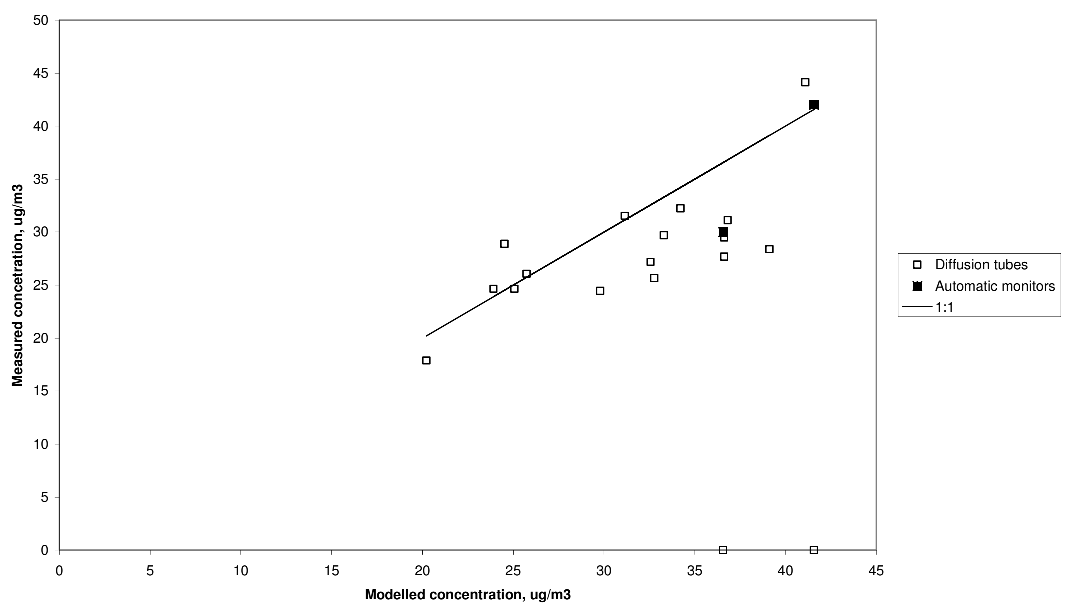
Bias adjustment is the process where the concentrations of the model are adjusted to agree with local air quality monitoring data. In this case, the model has provided satisfactory predictions of the measured concentrations and so no bias adjustment has been made to the modelled results.

Fig. 4.1: Comparison of modelled and measured nitrogen dioxide concentrations

Diffusion tubes adjusted based on co-located measurements at Adastral Close



Diffusion tubes adjusted based on co-located measurements at the Dooley Inn



4.8 Detailed modelling results

Fig.4.2 shows the annual mean modelled nitrogen dioxide concentrations for 2007 for the modelled area of Felixstowe. The predicted concentration exceeds the annual average objective of 40 $\mu g\ m^{-3}$ close to the port and close to the main heavy goods vehicle route out of the town along the A154 and the A14. Figs. 4.3, 4.4 and 4.5 show the predicted concentrations in more detail in the areas of Adastral Close, the Dooley inn and Spriteshall Lane. The only property at which there is relevant exposure of members of the public in excess of the annual mean objective is the Dooley Inn itself.

Fig. 4.6 shows the predicted annual mean NO_2 concentration for 2010 for the modelled area of Felixstowe. The assessment has been made assuming that both the Felixstowe South Reconfiguration and the Bathside Bay development in operation, although the Bathside Bay development makes little contribution to nitrogen dioxide concentrations in Felixstowe. The predicted concentrations depend on the assumptions made about future emissions from rubber tyred gantry cranes (RTGs). Fig. 4.6 shows both the worst case assuming no further provision of electricity supplies to the RTGs and the “best” case with a 50% reduction in RTG emissions per container movement. The predicted concentrations exceed the air quality objective of 40 $\mu g\ m^{-3}$ in some areas close to the port and close to the A154/A14 HGV route away from the port.

Fig. 4.7 shows the predicted annual mean NO_2 concentrations for 2010 in more detail for the area of Adastral Close. For the worst case, with no reduction in RTG fuel consumption per container movement, the predicted concentrations exceed the air quality objective at a small number of residential properties in Adastral Close. For the “best” case, with 50 % reduction in RTG fuel consumption per container movement, the nitrogen dioxide concentrations at residential properties in Adastral Close will remain below the objective concentration.

Fig. 4.8 shows the predicted annual mean NO_2 concentrations for 2010 in more detail for the area around the Dooley Inn. For the worst case, with no reduction in RTG fuel consumption per container movement, the predicted concentrations continue to exceed the air quality objective at the Dooley Inn. For the “best” case, with 50 % reduction in RTG fuel consumption per container movement, the predicted nitrogen dioxide concentrations at the Dooley Inn are less than the air quality objective.

Fig. 4.9 shows the predicted annual mean NO_2 concentrations for 2010 in more detail for the area around Spriteshall Lane. The predicted concentrations are less than the air quality objective.

Fig. 4.2: Modelled annual mean nitrogen dioxide concentrations, 2007

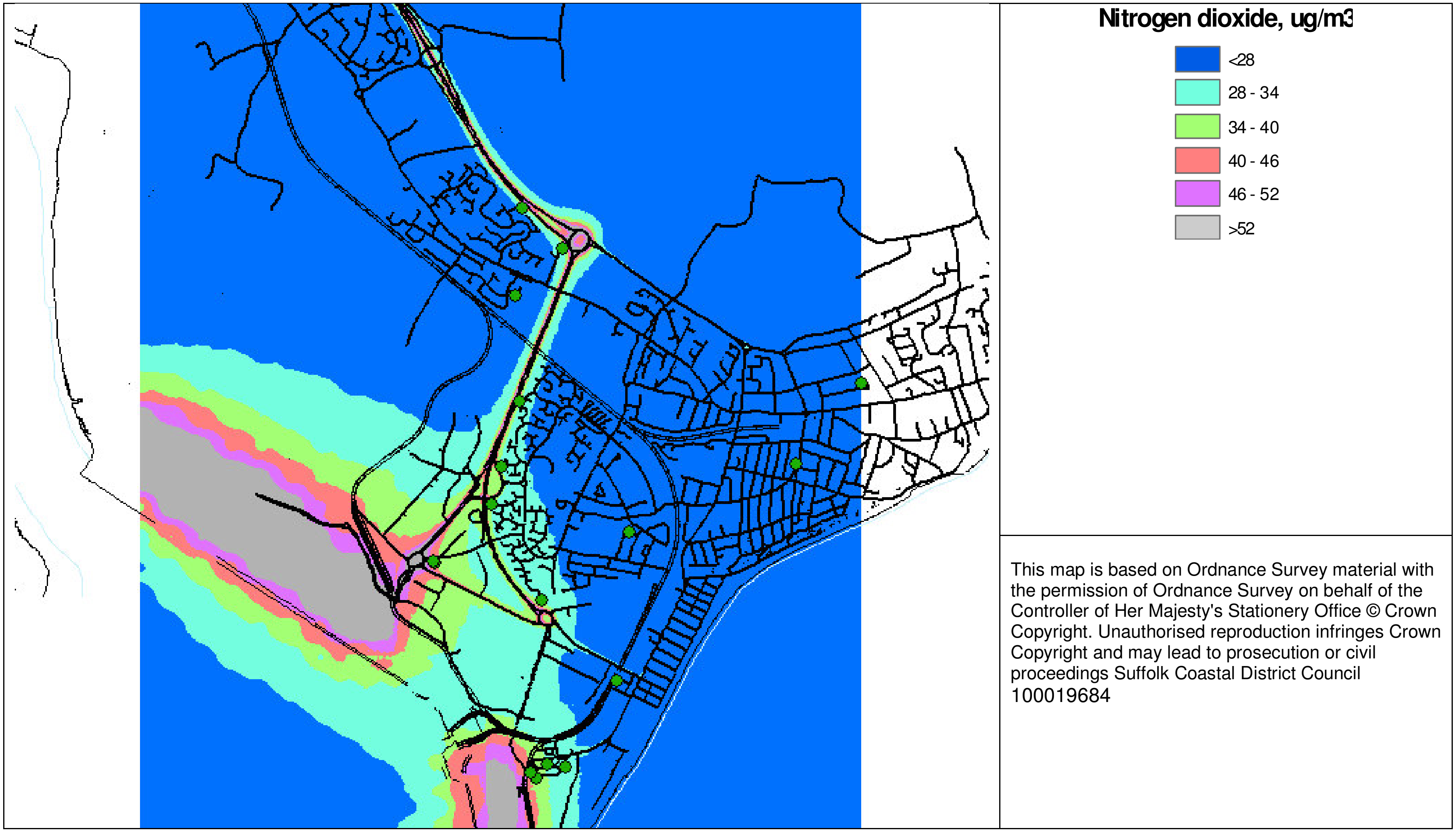


Fig. 4.3: Modelled annual mean nitrogen dioxide concentrations, 2007, Adastral Close

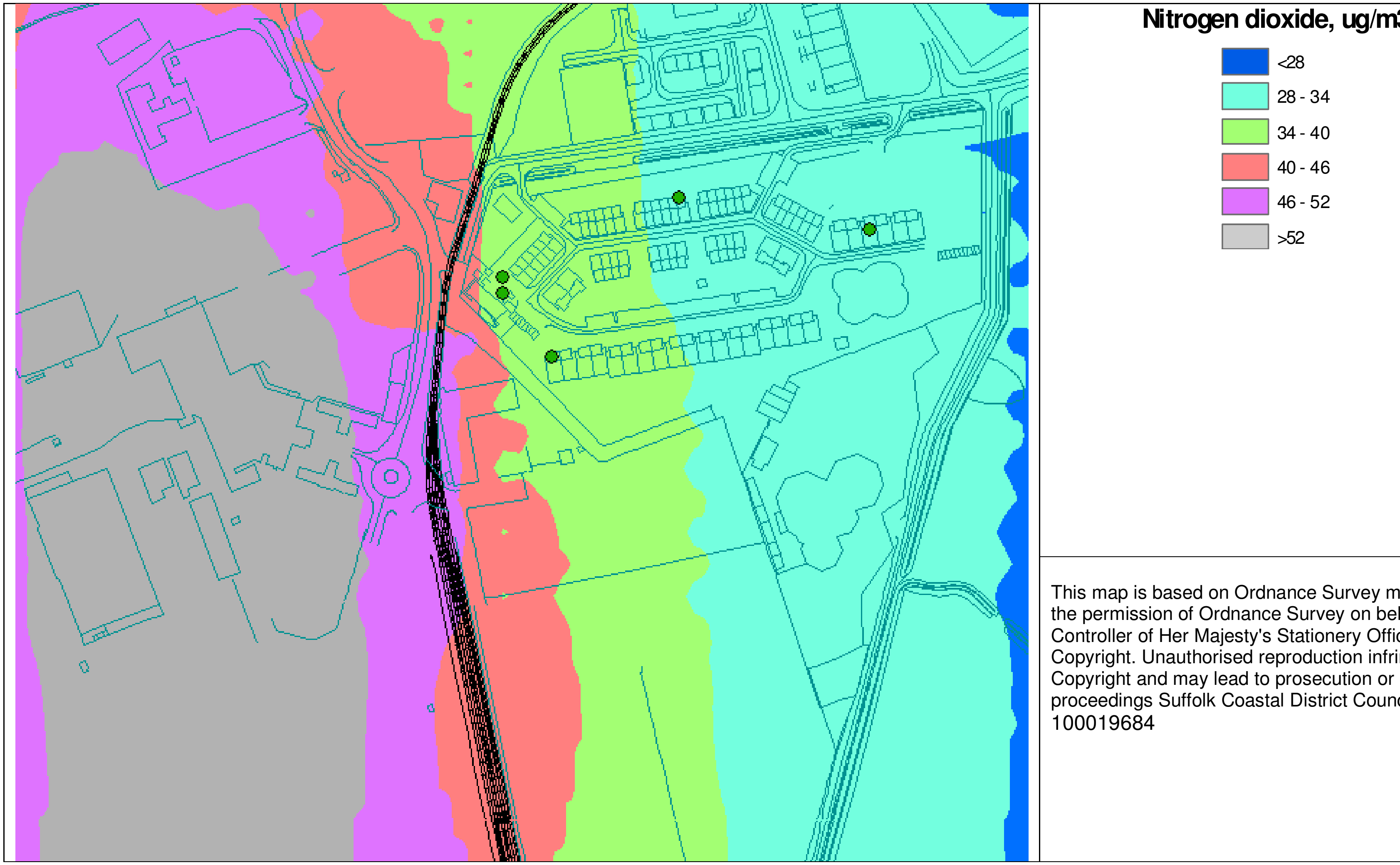


Fig. 4.4: Modelled annual mean nitrogen dioxide concentrations, 2007, the Dooley Inn

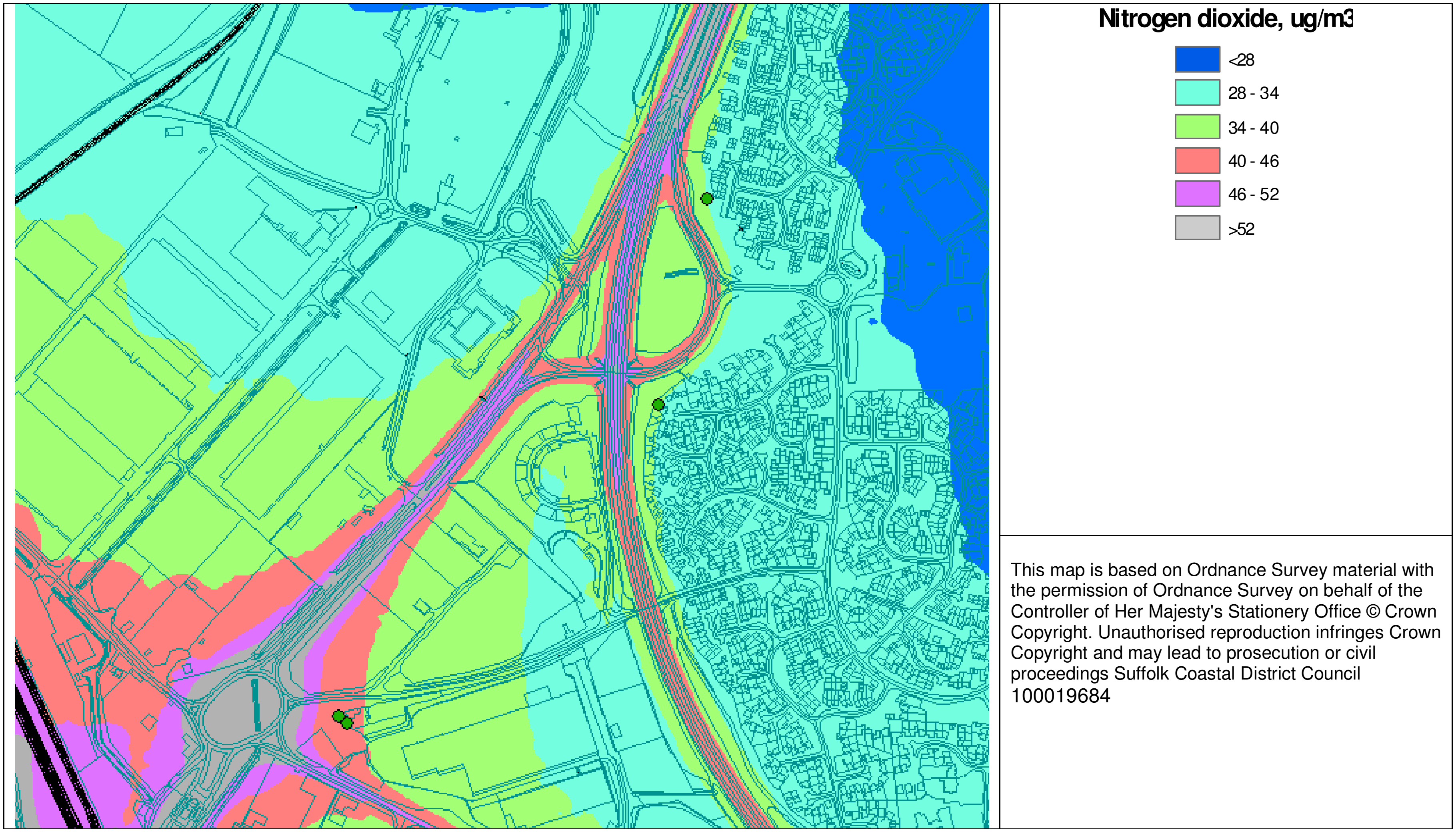


Fig. 4.5: Modelled annual mean nitrogen dioxide concentrations, 2007, Spriteshall Lane

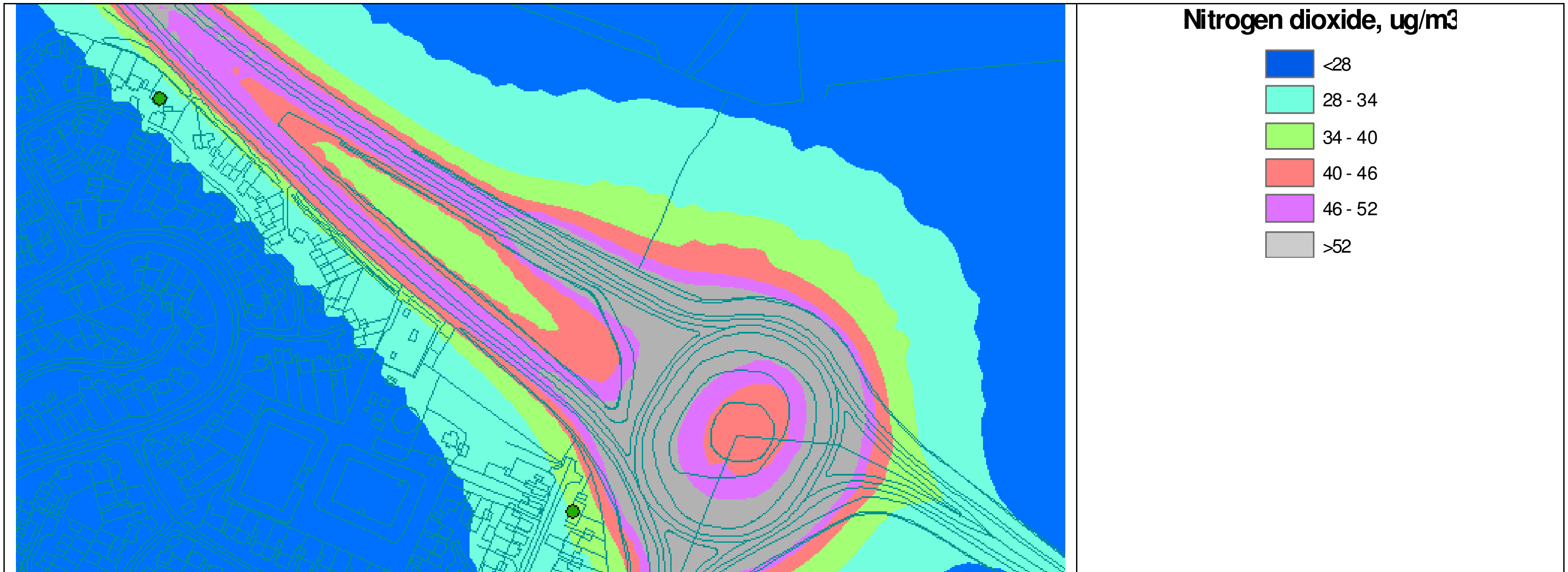
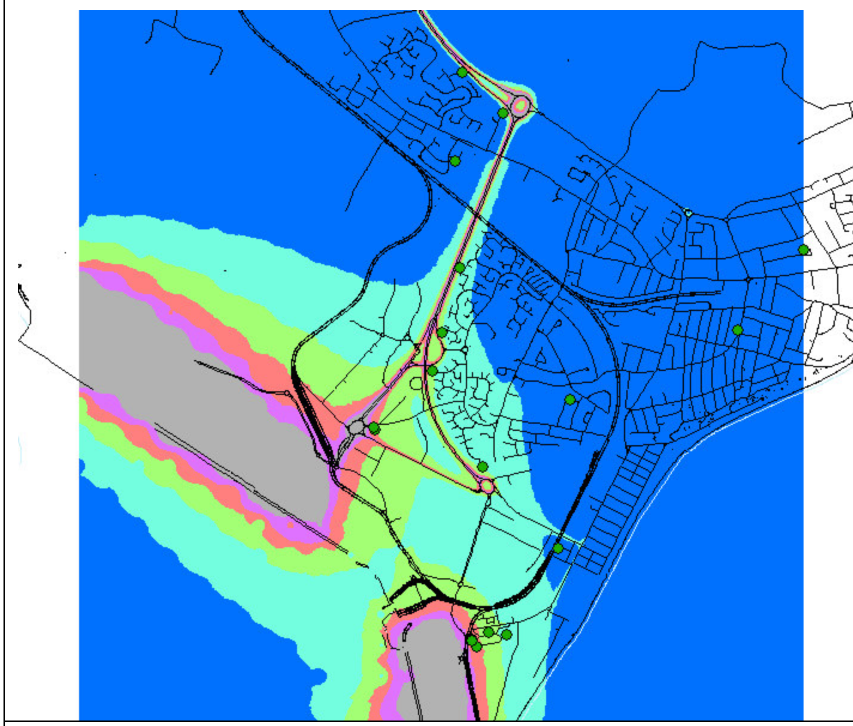
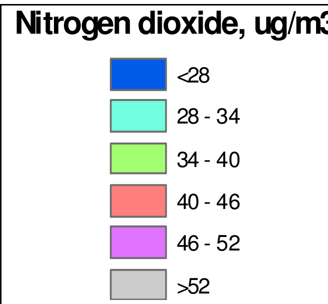


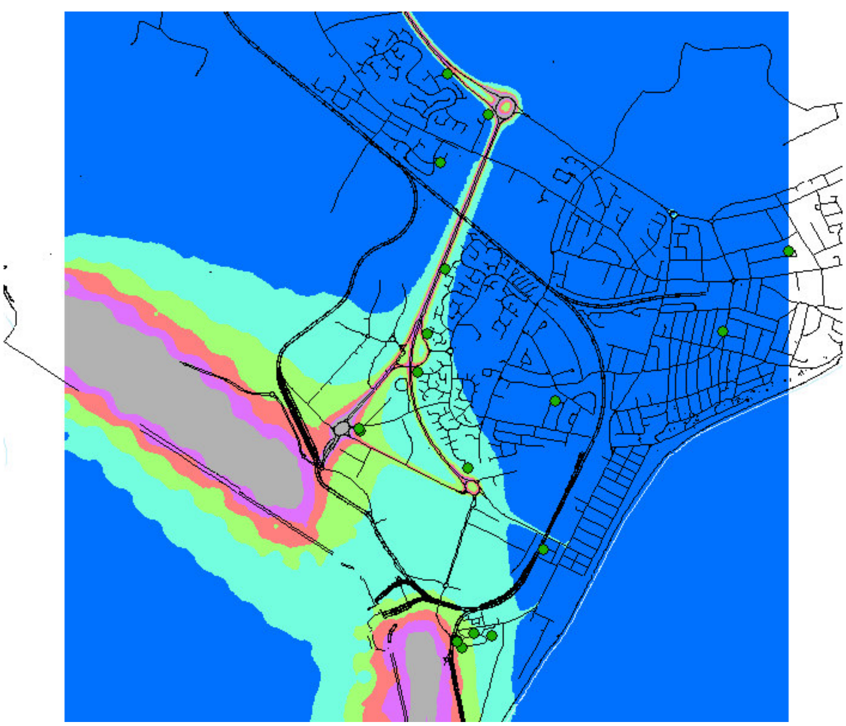
Fig. 4.6: Modelled annual mean nitrogen dioxide concentrations, 2010, modelled area of Felixstowe

Worst-case RTGs





Best case RTGs



4.7: Modelled annual mean nitrogen dioxide concentrations, 2010, Adastral Close

Worst-case RTGs

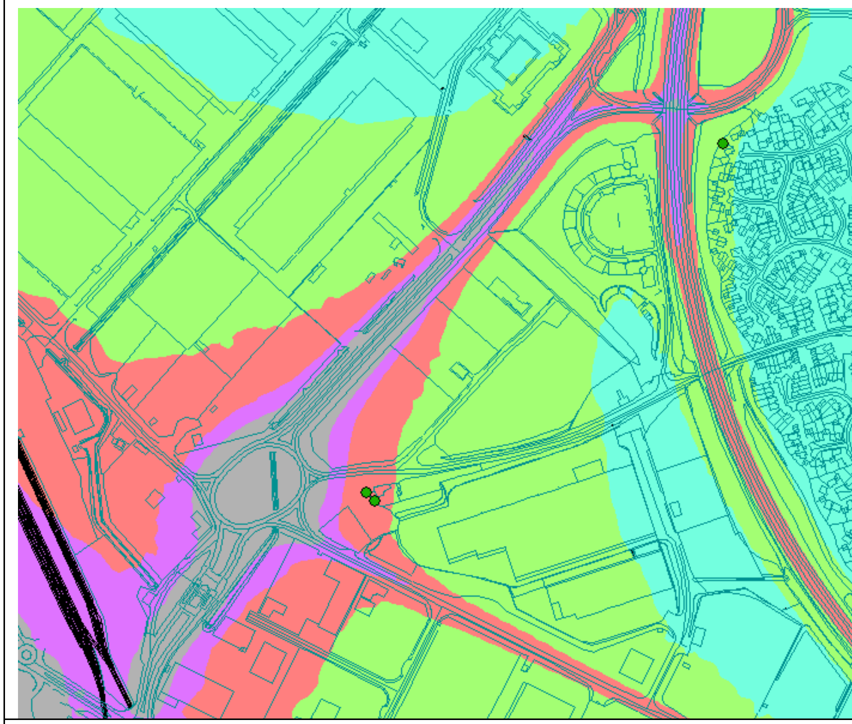
Nitrogen dioxide, ug/m3

- <28
- 28 - 34
- 34 - 40
- 40 - 46
- 46 - 52
- >52

Best case RTGs

4.8: Modelled annual mean nitrogen dioxide concentrations, 2010 near the Dooley Inn

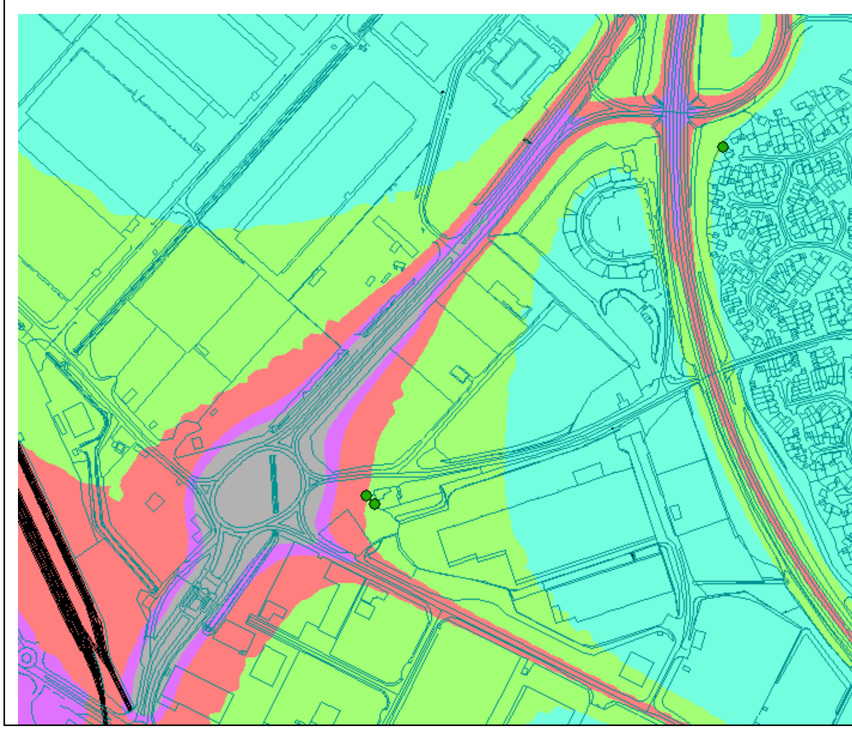
Worst-case RTGs



Nitrogen dioxide, ug/m3

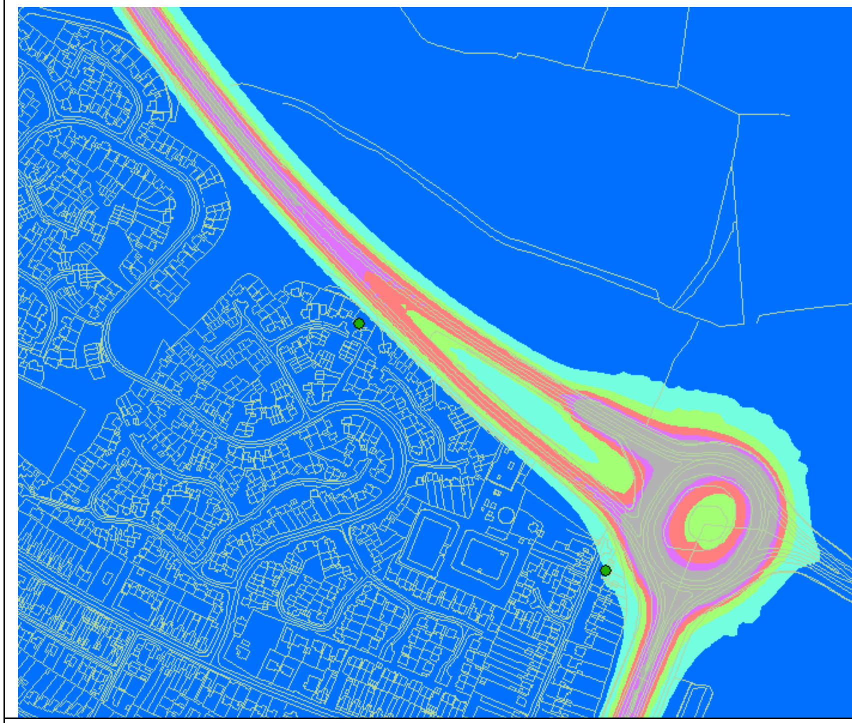
<28
28 - 34
34 - 40
40 - 46
46 - 52
>52

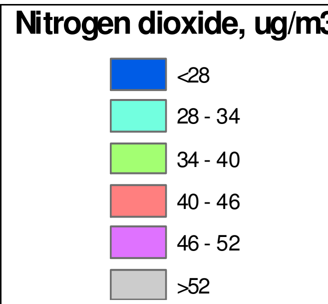
Best case RTGs



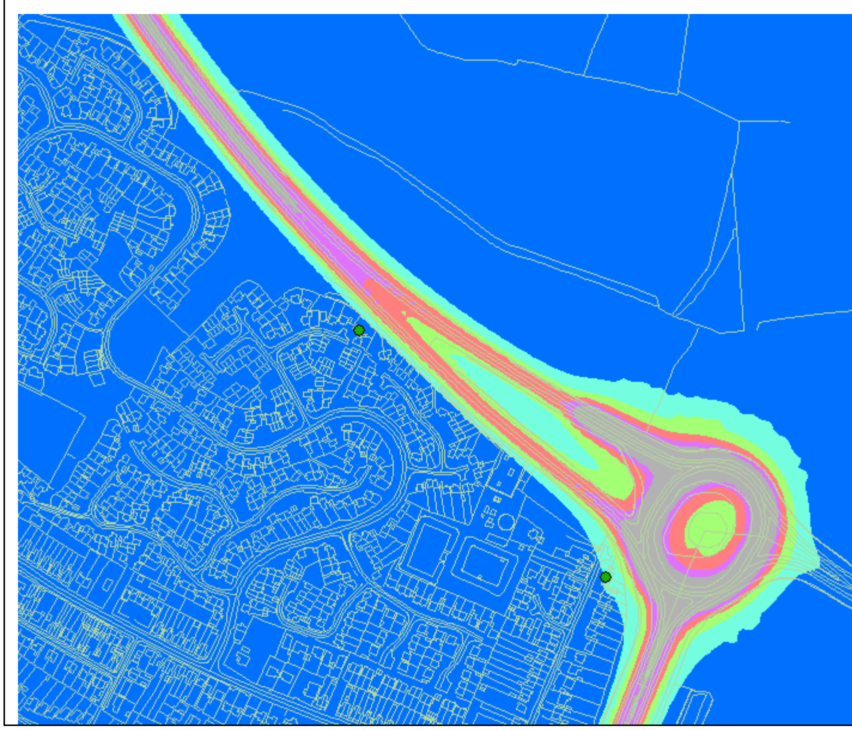
4.9: Modelled annual mean nitrogen dioxide concentrations, 2010, Spriteshall Lane

Worst-case RTGs





Best case RTGs



4.9 Source apportionment

4.9.1 Source apportionment of 'base case' predictions

Source apportionment is the process whereby the contributions from the sources of a pollutant are determined. In local air quality generally, the relevant sources could include: traffic; local background; industrial and domestic. Contributions from the different types of vehicles (for example, cars, lorries and buses) can also be considered to highlight which class of vehicle is contributing most to the emissions from traffic. Here, the emissions from port operations make a significant contribution. Source apportionment allows the most important source or sources to be identified and options to reduce ambient concentrations of pollutants can then be considered and assessed.

The source apportionment should:

- Confirm whether exceedences of NO_2 are due to road traffic
- Determine the extent to which different vehicle types are responsible for the emission contributions to NO_2: this will allow traffic management scenarios to be modelled/tested to reduce the exceedences
- Quantify what proportion of the exceedences of NO_2 is due to background emissions, or local emissions from busy roads in the local area. This will help determine whether local traffic management measures could have a significant impact on reducing emissions in the area of exceedence, or, whether national measures would be a suitable approach to achieving the air quality objectives

4.9.2 What is the 'base case'?

The base case in this assessment is defined as the annual mean concentrations that are predicted in 2010 in the absence of any measures to improve air quality in Suffolk Coastal District. They are the concentrations that should be relevant to defining the extent of Air Quality Management Areas.

4.9.3 Receptors considered

The most affected receptors where there is potential relevant public exposure outside have been considered. The only relevant location where the objective is currently exceeded is the Dooley Inn. The properties on Adastral Close nearest to the port are at risk of exceeding the objective in future years as the result of the Felixstowe South Redevelopment. Table 4.3 lists the receptor locations considered.

Table 4.3: Most affected receptors exceeding annual average objective

Description	Easting, m	Northing, m
The Dooley Inn	627950	234240
1 Adastral Close	628600	232830

4.9.4 Sources of pollution considered

We have considered the effect of the following sources in this detailed assessment at the receptors considered:

- Background
- Traffic
- Container handling operations
- Ships in berth
- Other shipping

The concentrations of oxides of nitrogen concentrations apportioned to each source category and the fractions of the total concentrations are shown in Table 4.4. Table 4.4 shows the contributions from the background and the modelled local source contributions at the two selected receptors. Table 4.4 shows the predicted contributions both for the worst case, with minimum improvement in emissions per container movement, and the "best " case with 50 % reduction in emissions per container movement.

Table 4.4: Apportionment of oxides of nitrogen concentrations at the most affected receptors

Source	Oxides of nitrogen concentration, µg m^{-3}			
	Adastral Close		The Dooley Inn	
	Worst case RTG	Best case RTG	Worst case RTG	Best case RTG
Background	15.8	15.8	19.4	19.4
Roads	0	0	13.5	13.5
Container handling	51.4	37.7	22.8	16.7
Ships in berth	16.8	16.8	21.0	21.0
Other shipping	2.4	2.4	3.1	3.1
Total	86.3	72.6	79.8	73.9
Fractions	Fractions, Adastral Close		Fractions, The Dooley Inn	
Background	0.18	0.22	0.24	0.26
Roads	0.00	0.00	0.17	0.18
Container handling	0.59	0.52	0.29	0.23
Ships in berth	0.19	0.23	0.26	0.28
Other shipping	0.03	0.03	0.04	0.04

The largest contributions to the predicted oxides of nitrogen concentrations at the selected receptors are from container handling operations at the port and from ships in berth. Road traffic makes a relatively small contribution to oxides of nitrogen concentrations at these receptors. The Dooley Inn is approximately 80 m from the nearest major road and Adastral Close is a small residential estate, relatively distant from major roads.

4.10 Conclusion

Measurements indicate that the annual mean objective for nitrogen dioxide is currently exceeded at the Dooley Inn. The modelling study indicates that this is currently the only relevant receptor location at which the objective is not met.

The modelling study indicates that there is a risk that the objective will not be met at approximately fifteen additional properties at the west end of Adastral Close in 2010 and beyond following the Felixstowe South reconfiguration. Source apportionment studies indicate that container handling operations by rubber tyred gantry (RTG) crane and internal movement vehicles will potentially make the largest contribution to oxides of nitrogen concentrations both at Adastral Close and at the Dooley Inn in 2010. The Port of Felixstowe Environmental Statement 2006 recognises the need to reduce emissions from the RTGs and the Port has set up a joint initiative between the engineering and operations departments to identify electricity supply points, which will enable the RTGs to be switched off when idle, reducing both fuel consumption and overall emissions. The modelling studies indicate that reducing RTG emissions has the potential to reduce concentrations sufficiently that the air quality objective could be met both at Adastral Close and at the Dooley Inn.

It is recommended that Suffolk Coastal District Council declare an Air Quality Management Area for the annual mean nitrogen dioxide objective to cover the Dooley Inn.

It is further recommended that the Council encourage the Port to make progress in identifying electricity supply points for the RTGs.

5 Detailed Assessment for PM_{10}

5.1 The national perspective

National UK emissions of primary PM_{10} have been estimated as totalling 150,000 tonnes in 2005. Of this total, around 15% was derived from road transport sources, around 16% was derived from other transport sources including shipping and around 12% was derived from industrial off-road mobile machinery. It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

The Government established the Airborne Particles Expert Group (APEG) to advise on sources of PM_{10} in the UK and current and future ambient concentrations. Their conclusions were published in January 1999 (APEG, 1999). APEG concluded that a significant proportion of the current annual average PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. These are regional scale pollutants and the annual concentrations do not vary greatly over a scale of tens of kilometres. There are also natural or semi-natural sources such as wind-blown dust and sea salt particles. The impact of local urban sources is superimposed on this regional background. Such local sources are generally responsible for winter episodes of hourly mean concentrations of PM_{10} above 100 $\mu g\ m^{-3}$ associated with poor dispersion. However, it is clear that many of the sources of PM_{10} are outside the control of individual local authorities and the estimation of future concentrations of PM_{10} are in part dependent on predictions of the secondary particle component.

5.2 Standards and objectives for PM_{10}

The Government and the Devolved Administrations have adopted two Air Quality Objectives for fine particles (PM_{10}), which are equivalent to the EU Stage 1 limit values in the first Air Quality Daughter Directive. The objectives are 40 μgm^{-3} as the annual mean, and 50 μgm^{-3} as the fixed 24-hour mean to be exceeded on no more than 35 days per year, to be achieved by the end of 2004. The objectives are based upon measurements carried out using the European gravimetric transfer reference sampler or equivalent.

5.3 Conclusions of the first and second rounds of review and assessment for PM_{10}

The first round Stage 3 review and assessment report concluded that there was a risk that 24-hour objective for particulate matter, PM_{10} would not be met near the Port of Felixstowe as the result of shipping emissions. However, the assessment was not conclusive and no AQMA was declared at that time.

The second round Updating and Screening Assessment recommended that a Detailed Assessment be carried out for various other sources of emissions of PM_{10} because there was not sufficient information available to eliminate the possibility that the air quality objectives might be exceeded. Further investigation eliminated the possibility of exceeding the air quality objectives in the vicinity of most of the emission sources identified in the USA.

5.4 Updating and screening assessment

The third round Updating and Screening Assessment was completed in September 2006. The assessment considered whether there were locations where further detailed assessment was required. The assessment identified:

- road junctions,

- roads with high flows of buses and/or heavy goods vehicles,
- new roads, roads with significantly changed flows,
- roads close to the objective during the second round of review assessment
- new industrial sources,
- industrial sources with substantially increased emissions or new relevant exposure,
- areas of domestic solid fuel burning
- quarries and landfill sites,
- aircraft.

The assessment followed the guidance set out in Technical Guidance LAQM.TG(03) and concluded that no further investigation was required for such sites that were in the District.

The USA concluded that Detailed Assessment of sulphur dioxide, PM_{10} and nitrogen dioxide concentrations was required for areas of Felixstowe close to the Port of Felixstowe and the A14 approach road.

5.5 Background concentrations for PM_{10}

The estimated annual average background PM_{10} concentration provided by the UK background maps[6] for 2005 was 19.7 μgm^{-3} gravimetric averaged across the District with a maximum concentration of 24.2 μgm^{-3} . The estimated annual average background PM_{10} concentration for 2010 was 18.2 μgm^{-3} averaged across Suffolk Coastal District with a maximum concentration of 22.4 μgm^{-3}.

5.6 Assessment of monitoring data

Table 5.1 summarises the 2007 measurements of PM_{10} concentrations at the continuous monitoring stations at Adastral Close. The measurements were made using a beta attenuation monitor and have been adjusted to provide a gravimetric equivalent concentration by dividing by a factor of 1.2 following advice given in the UK Air Quality Archive Air Quality Support FAQ.

Table 5.1: Continuous PM_{10} monitoring data

Site	Data capture	Annual average concentration, $\mu g\ m^{-3}$ gravimetric	Number of 24 hour exceedences of 50 $\mu g\ m^{-3}$
Adastral Close	76% of year	27	11

The annual average concentration at the monitor was less than the annual average objective of 40 $\mu g\ m^{-3}$. The average concentration exceeded 50 $\mu g\ m^{-3}$ on 11 days. Valid daily average measurements were only obtained on 282 days. Pro-rata, it is expected that the daily average concentration would exceed 50 $\mu g\ m^{-3}$ on 14 days.

The average concentration measured by the monitor has been corrected for missing hours in order to estimate the annual mean on the basis of monitoring data from the Thurrock, Southend-on-Sea and Norwich Centre Automatic Urban and Rural Network sites from 2007. The period adjustment factors are shown in Table 5.2. The corrected annual mean was 26.3 $\mu g\ m^{-3}$. Applying the relationship between the number of 24-hour exceedences of 50 $\mu g\ m^{-3}$ and the annual mean concentration given in Technical Guidance LAQM.TG(03) gives an estimate of 16 exceedences of the limit value. This is less than the objective of no more than 35 exceedences.

Table 5.2: Period adjustment factors

Site	Concentration, µg m^{-3}		Ratio
	Period mean	Annual mean	
Norwich Centre	22.0	21.5	0.978
Southend-on-Sea	20.3	20.8	1.025
Thurrock	23.6	22.6	0.958
Average			0.987

5.7 Detailed modelling

5.7.1 Dispersion model

The contribution to PM_{10} concentrations from the port operations was modelled using ADMS4 as described in Section 3. The modelling included emissions from the ships approaching the port, from ships in berth, from dredging, from container handling operations using RTGs and IMVs and from HGVs making deliveries to the port.

The LADS Urban roads model described in Section 4 was also used for PM_{10}. The same data and assumptions were used to characterise the traffic and the dispersion conditions.

The background concentration was estimated from the concentration maps presented in the UK Air Quality Archive (19.5 µg m^{-3} in 2005)

The LADS Urban model calculates the annual average PM_{10} concentration. The empirical relationship provided by Technical Guidance LAQM.TG(03) was then used to assess the number of exceedences of the 24 hour objective.

5.7.2 Validation and verification of the model

In simple terms, model validation is where the model is tested at a range of locations and is judged suitable to use for a given application. The modelling approach used in this assessment has been validated, and used in numerous **netcen** air quality review and assessments.

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. The modelled annual average concentration at the Adastral Close monitoring site was 25.5 µg m^{-3}. This concentration is only slightly less than the measured concentration of 26.3 µg m^{-3} (as adjusted for missing data). No adjustment of the model has therefore been made.

5.8 Dispersion modelling results

In this section, the predicted numbers of exceedences of the 24 hour objective limit of 50 µg m^{-3} predicted for 2007 and 2010 are presented as a series of colour plots. The numbers of exceedences are first shown over a wide area covering the modelled area of Felixstowe. More detailed plots are then shown around potential hotspots at Adastral Close, the Dooley Inn (Trinity Avenue roundabout) and Spriteshall Lane (Dock Spur roundabout).

Fig.5.1 shows the predicted number of exceedences over the whole of the modelled area of Felixstowe for 2007 and 2010. The predicted number of exceedences of the 24-hour objective limit of 50 µg m^{-3} does not exceed 35 except for areas within the port and close to the Trinity Avenue and Dock Spur roundabouts.

Fig.5.2 shows the area surrounding Adastral Close in more detail. The model predicts that the 24-hour average PM_{10} concentrations will not exceed 50 $\mu g\ m^{-3}$ on more than 35 days per year in this area in 2007. The model shows that the objective will not be exceeded in 2010 following the Felixstowe South reconfiguration.

Fig.5.3 shows the area surrounding the Trinity Avenue roundabout, including the Dooley Inn, in more detail. The model predicts that the 24-hour average PM_{10} concentrations will not exceed 50 $\mu g\ m^{-3}$ on more than 35 days per year at residential properties in this area in 2007 or in 2010.

Fig.5.4 shows the area surrounding the Dock Spur roundabout, including the Spriteshall Lane, in more detail. The model predicts that the 24-hour average PM_{10} concentrations will not exceed 50 $\mu g\ m^{-3}$ on more than 35 days per year at residential properties in this area in 2007 or in 2010.

Fig. 5.1: Modelled number of exceedences of the 24-hour standard, modelled area of Felixstowe

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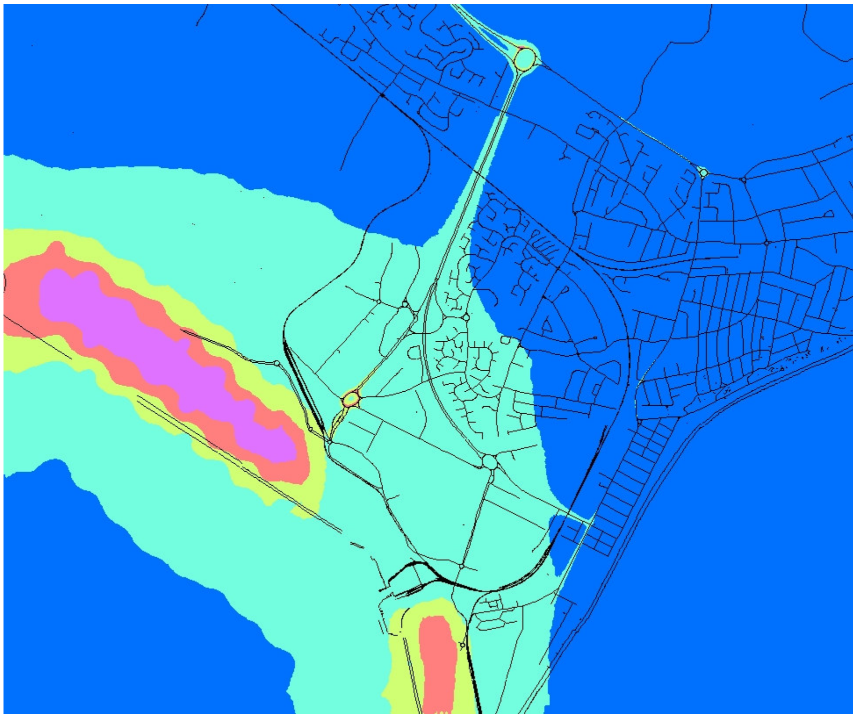
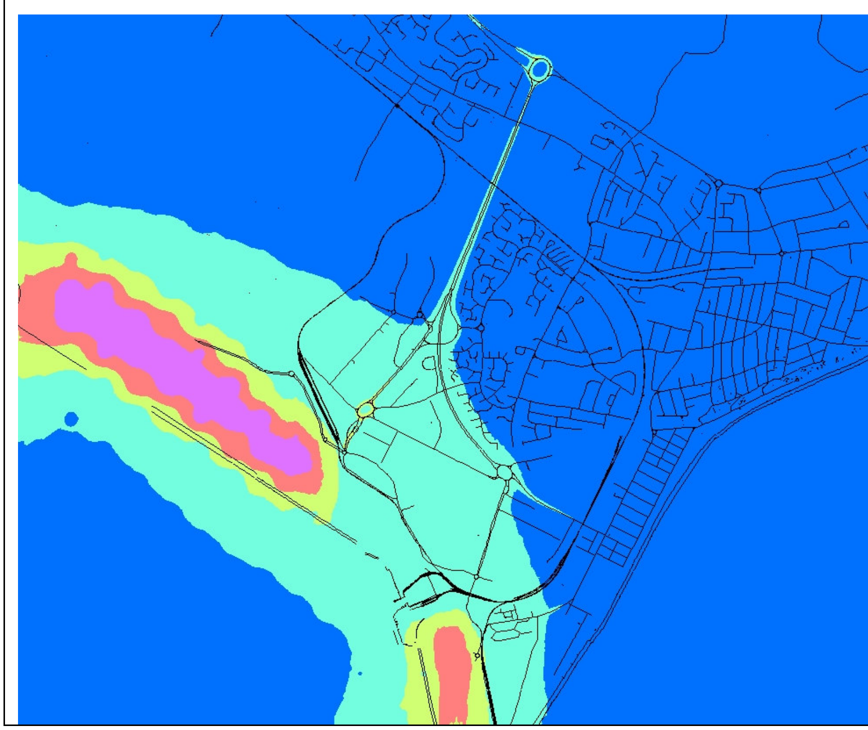
</td><td>Number of exceedences
<5
5-15
15-25
25-35
35-55
>55</td></tr>
<tr><td>2010
</td><td>This map is based on Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings Suffolk Coastal District Council 100019684</td></tr>
</table>

Fig. 5.2: Modelled number of exceedences of the 24-hour standard, Adastral Close

2007

Number of exceedences

- <5
- 5-15
- 15-25
- 25-35
- 35-55
- >55

2010

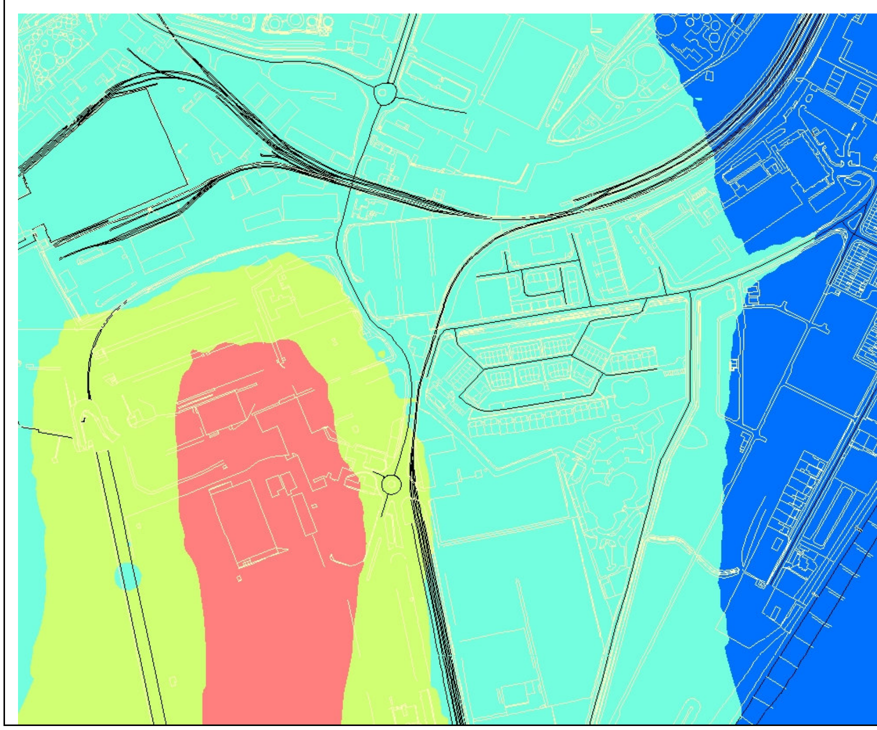
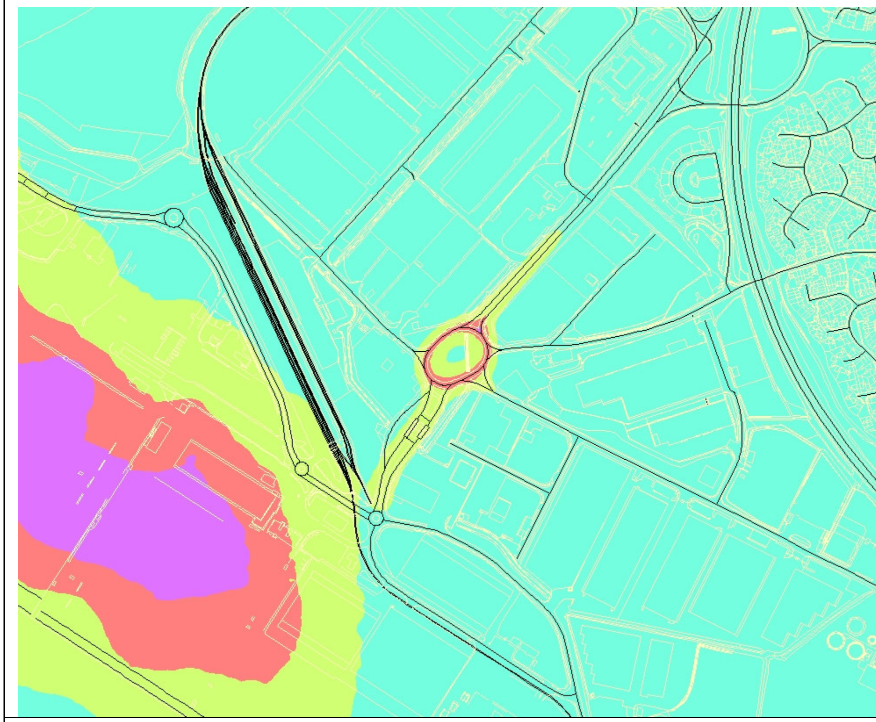


Fig. 5.3: Modelled number of exceedences of the 24-hour standard, the Dooley Inn

2007



Number of exceedences

- <5
- 5-15
- 15-25
- 25-35
- 35-55
- >55

2010

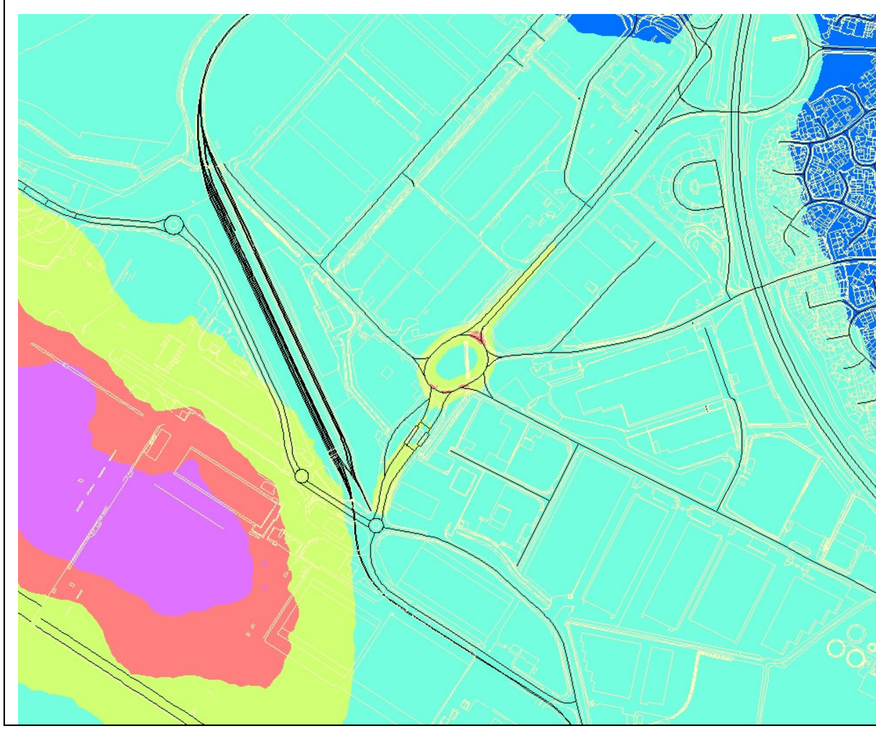
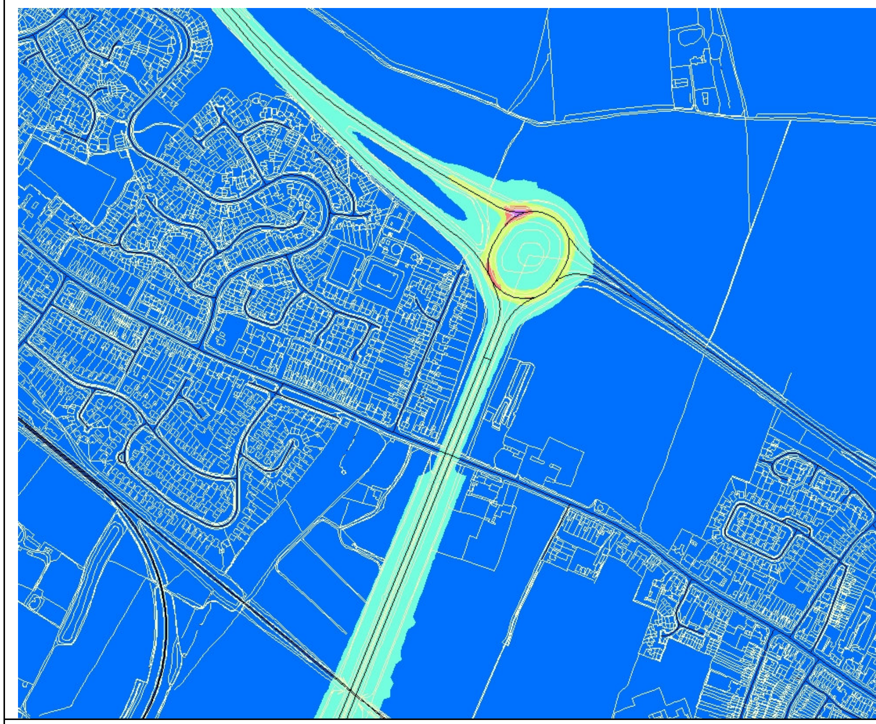


Fig. 5.4: Modelled number of exceedences of the 24-hour standard, Spriteshall Lane

2007 	**Number of exceedences** <5 5-15 15-25 25-35 35-55 >55
2010 	

5.9 Source apportionment

Table 5.3 shows the predicted contributions from relevant sources to the annual average concentration at the Adastral Close monitoring site for 2007 and 2010. The main contributions include the background concentration and contributions from ships in berth, other shipping, container handling equipment exhaust emissions and road emissions.

The source apportionment shows that largest component of the measured PM_{10} concentration is from background sources.

The next largest component of the PM_{10} concentrations at the Adastral Close site is from the exhaust emissions from RTGs and IMVs at the port. Ships in berth also contribute to the concentrations. Other shipping emissions and road traffic make a relatively small contribution to concentrations at this site.

The Felixstowe South Reconfiguration will add to the emissions from the port operations. Container handling exhaust emissions are expected to increase slightly as the result of the increase in container handling offset to some extent by improvements in emission standards for the new equipment. The contribution from ships in berth is expected to increase as more larger ships are berthed in the south of the port.

Table 5.3: Source apportionment of annual average PM_{10} concentrations

Source	Contribution, µg m^{-3}	
	2007	2010
Background	19.5	18.2
Container handling exhaust	4.2	4.6
Ships in berth	1.5	2.1
Other shipping	0.2	0.2
Roads	0.1	0.1
Total	25.5	25.2

5.10 Conclusion

Measurements of PM_{10} concentrations at Adastral Close indicate that the 24-hour limit value of 50 µg m^{-3} for this pollutant was not met on 11 days during 2007. Data capture at the site was 76% of hours in the year. Adjusting the annual mean to allow for the missing data gives an estimate of 14 exceedences, which is less than the objective of 35 exceedences. Suffolk Coastal District Council are therefore not required to declare an Air Quality Management Area based on the available monitoring data.

Dispersion modelling of the emissions from ships, roads and container handling operations at the port indicates that members of the public are not currently subject to relevant exposure to concentrations in excess of the objective. Port emissions may increase with the Felixstowe South Reconfiguration but it is predicted that the air quality objective will continue to be achieved in 2010.

6 Conclusions

Modelled sulphur dioxide concentrations are less than the air quality objectives for all locations outside the port boundary for all modelled scenarios. The scenarios modelled include the current situation and future years with the Felixstowe South and Bathside Bay developments. There is thus no potential for non-occupational exposure of members of the public to concentrations in excess of the air quality objectives for sulphur dioxide. Measured concentrations at the nearest residential location to the port (Adastral Close) confirm the results of the modelling study.

It is recommended that Suffolk Coastal District Council do not declare an Air Quality Management Area for sulphur dioxide.

Measurements indicate that the annual mean objective for nitrogen dioxide is currently exceeded at the Dooley Inn. The modelling study indicates that this is currently the only relevant receptor location at which the objective is not met.

The modelling study indicates that there is a risk that the objective for nitrogen dioxide will not be met at approximately fifteen additional properties at the west end of Adastral Close in 2010 and beyond following the Felixstowe South reconfiguration. Source apportionment studies indicate that container handling operations by rubber tyred gantry (RTG) crane and internal movement vehicles will potentially make the largest contribution to oxides of nitrogen concentrations both at Adastral Close and at the Dooley Inn in 2010. The Port of Felixstowe Environmental Statement 2006 recognises the need to reduce emissions from the RTGs and the Port has set up a joint initiative between the engineering and operations departments to identify electricity supply points, which will enable the RTGs to be switched off when idle, reducing both fuel consumption and overall emissions. The modelling studies indicate that reducing RTG emissions has the potential to reduce concentrations sufficiently that the air quality objective could be met both at Adastral Close and at the Dooley Inn.

It is recommended that Suffolk Coastal District Council declare an Air Quality Management Area for the annual mean nitrogen dioxide objective to cover the Dooley Inn. It is further recommended that the Council encourage the Port to make progress in identifying electricity supply points for the RTGs.

Current measurements at Adastral Close indicate that Suffolk Coastal District Council are not required to declare an Air Quality Management Area for PM_{10}. Dispersion modelling of the emissions from ships, roads and container handling operations at the port indicates that members of the public are not currently subject to relevant exposure to concentrations in excess of the objective. Port emissions are expected to increase as the result of the Felixstowe South Reconfiguration. However, it is predicted that the air quality objective for PM_{10} will continue to be achieved in 2010.

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Appendix 1

Traffic data

Contents

Felixstowe South, located on 'Port of Felixstowe Road' between Trinity Avenue and Walton Avenue junctions

Eastbound									
Period report between Saturday 1st Jan 2005 and Monday 31st Dec 2007 for site 6/30013391									
EB, A14, TMU site 6288/1 on link A14 eastbound between A154 near Felixstowe (Central) and A154 near Felixstowe (south)(E628336, N234360)									
Hourly Flows									
	bo **Mon**	baso **Tue**	ao **Wed**	wao **Thu**	bwaro **Fri**	so **Sat**	tso **Sun**	**Mn-Fr**	**Mn-Sn**
	x133	**x132**	**x133**	**x134**	**x134**	**x134**	**x133**	**Mean**	**Mean**
01:00	9	12	13	13	15	18	16	12	13
02:00	8	11	11	10	11	12	8	10	10
03:00	12	13	12	13	14	8	5	12	11
04:00	31	27	28	28	27	10	4	28	22
05:00	46	44	45	45	43	13	4	44	34
06:00	108	114	120	113	103	51	30	111	91
07:00	186	209	211	206	200	107	62	202	168
08:00	307	333	338	335	319	99	74	326	257
09:00	486	530	539	535	514	107	110	520	403
10:00	222	243	256	245	236	133	253	240	226
11:00	190	205	205	204	202	163	410	201	225
12:00	210	214	216	213	216	179	422	213	238
13:00	241	242	245	247	250	184	371	245	254
14:00	276	281	283	282	283	187	352	281	277
15:00	246	258	255	250	251	178	314	252	250
16:00	235	254	253	246	226	153	217	242	226
17:00	209	225	225	218	213	126	143	218	194
18:00	207	224	227	222	217	126	114	219	191
19:00	200	218	219	221	217	149	135	215	194
20:00	120	147	141	147	152	99	90	141	128
21:00	78	86	87	92	104	71	64	89	83
22:00	54	57	62	64	68	50	47	61	57
23:00	36	40	44	44	45	34	30	41	39
24:00:00	22	27	27	28	32	25	18	27	25
Totals									
07-19hr	3029	3227	3261	3218	3144	1784	2915	3175	2939
06-22hr	3467	3726	3762	3727	3668	2111	3178	3670	3377
06-24hr	3525	3793	3833	3799	3745	2170	3226	3739	3441
00-24hr	3739	4014	4062	4021	3958	2282	3293	3958	3624
AM Peak									
Time	09:00	09:00	09:00	09:00	09:00	12:00	12:00	09:00	09:00
Flow	486	530	539	535	514	179	422	520	403
PM Peak									
Time	14:00	14:00	14:00	14:00	14:00	14:00	13:00	14:00	14:00
Flow	276	281	283	282	283	187	371	281	277
Peak hourly flow was **1063** and occurred hour ending **9:00** on **Friday 02 Dec 2005**									
Peak daily flow was **5476** and occurred on **Friday 05 Aug 2005**									

Felixstowe South, located on 'Port of Felixstowe Road' between Trinity Avenue and Walton Avenue junctions

Westbound									
Period report between Saturday 1st Jan 2005 and Monday 31st Dec 2007 for site 6/30013392									
WB, A14, TMU site 6289/1 on link A14 westbound between A154 near Felixstowe (south) and A154 near Felixstowe (Central)(E628317, N234381)									
Hourly Flows									
	b **Mon**	b **Tue**	ao **Wed**	wao **Thu**	bw **Fri**	o **Sat**	to **Sun**	**Mn-Fr**	**Mn-Sn**
	x74	**x74**	**x75**	**x75**	**x76**	**x75**	**x74**	**Mean**	**Mean**
01:00	13	18	21	21	23	26	19	19	20
02:00	9	24	27	27	27	19	11	22	20
03:00	11	18	19	21	21	17	7	18	16
04:00	25	34	36	35	35	17	7	33	27
05:00	53	68	71	69	65	26	7	65	51
06:00	85	113	121	115	107	36	13	108	84
07:00	121	159	163	162	151	73	40	151	124
08:00	136	167	168	170	158	67	34	159	128
09:00	181	219	225	216	211	86	47	210	169
10:00	161	175	180	178	179	132	99	174	157
11:00	164	172	175	174	176	158	191	172	172
12:00	188	198	202	198	206	185	293	198	210
13:00	260	276	279	277	279	208	399	274	282
14:00	278	284	296	284	309	207	398	290	293
15:00	272	275	279	277	298	209	410	280	288
16:00	327	341	338	333	331	215	445	334	332
17:00	381	411	410	408	396	218	426	401	378
18:00	570	617	618	606	529	198	329	588	495
19:00	328	358	356	351	333	183	227	345	305
20:00	152	161	167	169	173	129	143	164	156
21:00	106	112	113	122	130	104	107	116	113
22:00	82	103	99	101	106	90	77	98	94
23:00	61	67	68	74	90	73	55	72	69
24:00:00	30	35	33	41	49	42	21	37	35
Totals									
07-19hr	3246	3493	3526	3472	3405	2066	3298	3428	3215
06-22hr	3707	4028	4068	4026	3965	2462	3665	3958	3703
06-24hr	3798	4130	4169	4141	4104	2577	3741	4068	3808
00-24hr	3994	4405	4464	4429	4382	2718	3805	4334	4028
AM Peak									
Time	12:00	09:00	09:00	09:00	09:00	12:00	12:00	09:00	12:00
Flow	188	219	225	216	211	185	293	210	210
PM Peak									
Time	18:00	18:00	18:00	18:00	18:00	17:00	16:00	18:00	18:00
Flow	570	617	618	606	529	218	445	588	495
Peak hourly flow was **812** and occurred hour ending **17:00** on **Sunday 01 May 2005**									
Peak daily flow was **5764** and occurred on **Sunday 01 May 2005**									

Felixstowe Mid, located between Trinity Avenue and Dock Spur Roundabout near cycle/ pedestrian bridge

Eastbound									
Period report between Saturday 1st Jan 2005 and Monday 31st Dec 2007 for site 6/30015299									
WB, A14, TMU Site 6491/1 on link A14 eastbound between A154 near Felixstowe (north) and A154 near Felixstowe (Central)(E628550, N235440)									
Hourly Flows									
	b **Mon**	bo **Tue**	o **Wed**	ao **Thu**	bo **Fri**	**Sat**	to **Sun**	**Mn-Fr**	**Mn-Sn**
	x39	**x39**	**x39**	**x38**	**x39**	**x40**	**x39**	**Mean**	**Mean**
01:00	39	58	62	60	66	82	58	57	60
02:00	36	53	56	57	56	57	35	51	50
03:00	56	64	69	68	65	45	20	64	55
04:00	118	110	113	111	111	48	15	112	89
05:00	182	180	184	184	177	65	12	181	140
06:00	343	363	374	366	352	184	73	359	293
07:00	723	782	794	799	757	506	314	771	667
08:00	750	821	834	836	779	278	124	804	631
09:00	1069	1175	1209	1213	1144	282	155	1162	892
10:00	518	577	599	590	577	347	346	572	507
11:00	464	500	511	506	510	413	611	498	502
12:00	518	540	549	550	571	448	643	545	545
13:00	621	656	667	657	681	459	613	656	622
14:00	720	766	779	764	777	442	582	761	690
15:00	647	688	731	696	719	432	535	696	635
16:00	660	695	724	689	688	397	437	691	612
17:00	630	672	697	668	669	367	342	667	577
18:00	727	782	803	774	750	404	307	767	649
19:00	794	854	878	859	821	511	454	841	738
20:00	364	430	421	420	408	219	213	408	353
21:00	250	280	281	289	284	148	173	276	243
22:00	218	235	249	245	223	114	134	234	202
23:00	165	184	200	197	173	100	105	183	160
24:00:00	113	130	134	133	133	87	66	128	113
Totals									
07-19hr	8118	8726	8981	8802	8686	4780	5149	8662	7606
06-22hr	9673	10453	10726	10555	10358	5767	5983	10353	9073
06-24hr	9951	10767	11060	10885	10664	5954	6154	10665	9347
00-24hr	10725	11595	11918	11731	11491	6435	6367	11492	10037
AM Peak									
Time	09:00	09:00	09:00	09:00	09:00	07:00	12:00	09:00	09:00
Flow	1069	1175	1209	1213	1144	506	643	1162	892
PM Peak									
Time	19:00	19:00	19:00	19:00	19:00	19:00	13:00	19:00	19:00
Flow	794	854	878	859	821	511	613	841	738
Peak hourly flow was **1350** and occurred hour ending **9:00** on **Monday 13 Nov 2006**									
Peak daily flow was **12747** and occurred on **Wednesday 31 Aug 2005**									

Felixstowe Mid, located between Trinity Avenue and Dock Spur Roundabout near cycle/ pedestrian bridge

Westbound									
Hourly Flows									
	bo **Mon**	bo **Tue**	**Wed**	o **Thu**	bo **Fri**	o **Sat**	tro **Sun**	**Mn-Fr**	**Mn-Sn**
	x69	**x69**	**x70**	**x69**	**x71**	**x70**	**x70**	**Mean**	**Mean**
01:00	45	95	100	103	107	104	58	90	87
02:00	34	76	83	82	87	73	35	72	67
03:00	49	72	74	76	80	64	26	70	63
04:00	99	127	130	133	132	84	22	124	103
05:00	204	254	262	266	257	121	33	248	199
06:00	311	394	408	409	396	187	74	383	311
07:00	494	604	628	621	603	343	186	590	497
08:00	532	610	614	614	581	247	103	590	471
09:00	622	713	726	725	699	309	122	697	559
10:00	478	539	566	566	559	431	245	541	483
11:00	473	490	504	522	521	497	399	502	486
12:00	516	528	544	550	568	549	545	541	542
13:00	654	690	714	709	731	584	645	699	675
14:00	648	681	703	707	744	514	629	696	660
15:00	614	643	656	664	717	488	617	658	628
16:00	716	748	770	764	798	452	628	759	696
17:00	864	925	933	941	943	452	572	921	804
18:00	1356	1466	1467	1460	1333	440	457	1416	1139
19:00	951	1048	1066	1054	999	484	464	1023	866
20:00	437	474	502	498	496	279	268	481	422
21:00	260	288	295	295	316	176	183	290	259
22:00	200	231	240	230	240	138	141	228	202
23:00	175	200	206	206	212	129	113	199	177
24:00:00	128	147	142	152	151	95	62	144	125
Totals									
07-19hr	8424	9081	9263	9276	9193	5447	5426	9047	8015
06-22hr	9815	10678	10928	10920	10848	6383	6204	10637	9396
06-24hr	10118	11025	11276	11278	11211	6607	6379	10981	9699
00-24hr	10860	12043	12333	12347	12270	7240	6627	11970	10531
AM Peak									
Time	09:00	09:00	09:00	09:00	09:00	12:00	12:00	09:00	09:00
Flow	622	713	726	725	699	549	545	697	559
PM Peak									
Time	18:00	18:00	18:00	18:00	18:00	13:00	13:00	18:00	18:00
Flow	1356	1466	1467	1460	1333	584	645	1416	1139

Peak hourly flow was 1766 and occurred hour ending 18:00 on Thursday 19 Oct 2006
Peak daily flow was 13205 and occurred on Friday 16 Mar 2007

A14 Trimley

Eastbound

Period report between Saturday 1st Jan 2005 and Monday 31st Dec 2007 for site 6/9927

EB, A14, TRIMLEY HEATH(E628400, N236800)

Hourly Flows

	b Mon	bwao Tue	wao Wed	waso Thu	bao Fri	s Sat	atso Sun	Mn-Fr	Mn-Sn
	x142	x142	x142	x142	x142	x143	x143	Mean	Mean
01:00	64	79	88	91	103	149	149	85	103
02:00	46	67	71	70	76	94	79	66	71
03:00	59	72	70	71	75	65	48	69	65
04:00	114	108	108	106	106	59	31	108	90
05:00	174	170	171	171	165	73	21	170	135
06:00	318	330	334	332	313	176	73	325	268
07:00	694	736	733	753	724	459	275	728	624
08:00	930	1010	1012	1020	983	381	183	991	788
09:00	1405	1557	1540	1566	1485	522	274	1510	1192
10:00	871	982	976	1015	948	758	703	958	893
11:00	909	997	993	1038	1000	968	1171	987	1010
12:00	1020	1072	1080	1099	1100	1100	1379	1074	1121
13:00	1090	1107	1132	1140	1174	1152	1397	1128	1170
14:00	1116	1150	1175	1153	1198	1106	1243	1158	1163
15:00	1120	1166	1174	1179	1222	1085	1173	1172	1159
16:00	1162	1208	1239	1219	1246	966	991	1214	1147
17:00	1264	1344	1375	1363	1364	884	838	1342	1204
18:00	1554	1648	1687	1643	1530	912	677	1612	1378
19:00	1282	1377	1404	1401	1335	883	734	1359	1202
20:00	693	785	803	844	840	564	474	793	714
21:00	466	517	527	557	569	370	381	527	483
22:00	395	442	462	477	429	286	287	441	396
23:00	304	360	377	381	348	264	212	354	320
24:00:00	169	198	213	214	261	242	126	211	203
Totals									
07-19hr	13723	14618	14787	14836	14585	10717	10763	14509	13432
06-22hr	15971	17098	17312	17467	17147	12396	12180	16999	15653
06-24hr	16444	17656	17902	18062	17756	12902	12518	17564	16177
00-24hr	17219	18482	18744	18903	18594	13518	12919	18388	16911
AM Peak									
Time	09:00	09:00	09:00	09:00	09:00	12:00	12:00	09:00	09:00
Flow	1405	1557	1540	1566	1485	1100	1379	1510	1192
PM Peak									
Time	18:00	18:00	18:00	18:00	18:00	13:00	13:00	18:00	18:00
Flow	1554	1648	1687	1643	1530	1152	1397	1612	1378

Peak hourly flow was **2575** and occurred hour ending **18:00** on **Thursday 05 Oct 2006**

Peak daily flow was **23562** and occurred on **Thursday 05 Oct 2006**

A14 Trimley

Westbound

Period report between Saturday 1st Jan 2005 and Monday 31st Dec 2007 for site 6/9928

WB, A14, TRIMLEY HEATH(E628400, N236800)

Hourly Flows

	b Mon	bwo Tue	wa Wed	waso Thu	bw Fri	s Sat	trso Sun	Mn-Fr	Mn-Sn
	x142	x142	x142	x142	x142	x143	x143	Mean	Mean
01:00	57	100	110	112	124	153	131	100	112
02:00	44	79	85	86	94	100	69	77	79
03:00	54	79	83	82	90	85	47	77	74
04:00	103	132	135	136	137	96	38	128	111
05:00	215	261	270	271	265	128	40	256	207
06:00	372	455	471	464	447	206	83	441	356
07:00	671	797	811	811	761	385	214	770	635
08:00	1227	1394	1384	1386	1294	444	216	1337	1049
09:00	1509	1721	1734	1721	1638	650	292	1664	1323
10:00	996	1103	1130	1128	1114	924	600	1094	999
11:00	907	945	964	972	1005	1050	897	958	962
12:00	937	958	969	1000	1022	1123	1098	977	1015
13:00	992	1013	1032	1050	1069	1163	1264	1031	1083
14:00	1063	1083	1109	1113	1150	1122	1235	1103	1125
15:00	1102	1134	1159	1173	1226	1088	1286	1158	1166
16:00	1211	1269	1289	1303	1316	1026	1303	1277	1245
17:00	1333	1424	1426	1431	1420	1042	1242	1406	1331
18:00	1618	1743	1727	1733	1613	919	990	1686	1477
19:00	1196	1310	1305	1324	1291	817	826	1285	1152
20:00	680	738	772	770	790	578	551	750	697
21:00	409	453	467	469	496	370	379	458	434
22:00	345	400	419	406	400	306	291	394	366
23:00	272	311	323	345	360	304	205	322	302
24:00:00	157	181	187	197	249	219	100	194	184
Totals									
07-19hr	14091	15097	15228	15334	15158	11368	11249	14981	13932
06-22hr	16196	17485	17697	17790	17605	13007	12684	17354	16066
06-24hr	16625	17977	18207	18332	18214	13530	12989	17871	16553
00-24hr	17470	19083	19361	19483	19371	14298	13397	18953	17494
AM Peak									
Time	09:00	09:00	09:00	09:00	09:00	12:00	12:00	09:00	09:00
Flow	1509	1721	1734	1721	1638	1123	1098	1664	1323
PM Peak									
Time	18:00	18:00	18:00	18:00	18:00	13:00	16:00	18:00	18:00
Flow	1618	1743	1727	1733	1613	1163	1303	1686	1477

Peak hourly flow was **2191** and occurred hour ending **18:00** on **Wednesday 17 Aug 2005**

Peak daily flow was **22335** and occurred on **Wednesday 31 Aug 2005**

NAEI traffic data

Censusid05	Rd_no	x	y	All	CAR	BUS	LGV	HGVr	HGVa	Moto	Speed
6482	A14	628800	236450	31096	23305	52	2684	790	3961	304	70
6702	A1021	630390	235000	8456	7485	130	611	117	13	100	30
26720	A154	629500	236000	13855	11910	33	1357	442	33	80	60
26721	A154	629585	234000	4477	3759	29	508	100	6	75	30
36496	A14	628360	235000	19211	13227	10	1265	642	3849	218	70
46728	A154	629930	235000	9299	8297	33	712	121	7	129	30
80990	A154	628160	234650	8414	5075	10	471	264	2507	87	0
99809	A14	628400	234250	7442	4860	5	852	267	1409	49	70
99811	A154	628250	234000	5359	3369	8	506	332	1109	35	30
99812	A154	629000	233650	7315	6049	11	938	224	45	48	30
99813	A154	629000	232990	3319	2386	38	788	57	25	25	30
37550	A1021	630000	234400	1658	1438	71	108	9	2	30	0
99810	A154	628160	234650	9123	5174	19	540	386	2937	67	30

Appendix 2

Automatic monitoring data reports

Produced by AEA Energy & Environment on behalf of Felixstowe

FELIXSTOWE DOOLEY
01 January to 31 December 2007

These data have been fully ratified by AEA Energy & Environment

POLLUTANT	NO_2	NO_X
Number Very High	0	-
Number High	0	-
Number Moderate	0	-
Number Low	8598	-
Maximum 15-minute mean	269 µg m^{-3}	2815 µg m^{-3}
Maximum hourly mean	199 µg m^{-3}	2078 µg m^{-3}
Maximum running 8-hour mean	144 µg m^{-3}	1358 µg m^{-3}
Maximum running 24-hour mean	107 µg m^{-3}	843 µg m^{-3}
Maximum daily mean	107 µg m^{-3}	843 µg m^{-3}
Average	42 µg m^{-3}	108 µg m^{-3}
Data capture	98.2 %	98.2 %

All mass units are at 20'C and 1013mb
NO_X mass units are NO_X as NO_2 µg m-3

Pollutant	Air Quality (England) Regulations 2000 and (Amendment) Regulations 2002	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	1	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	0	0
Nitrogen Oxides (NO_2)	Annual mean > 30 µg m^{-3}	1	-

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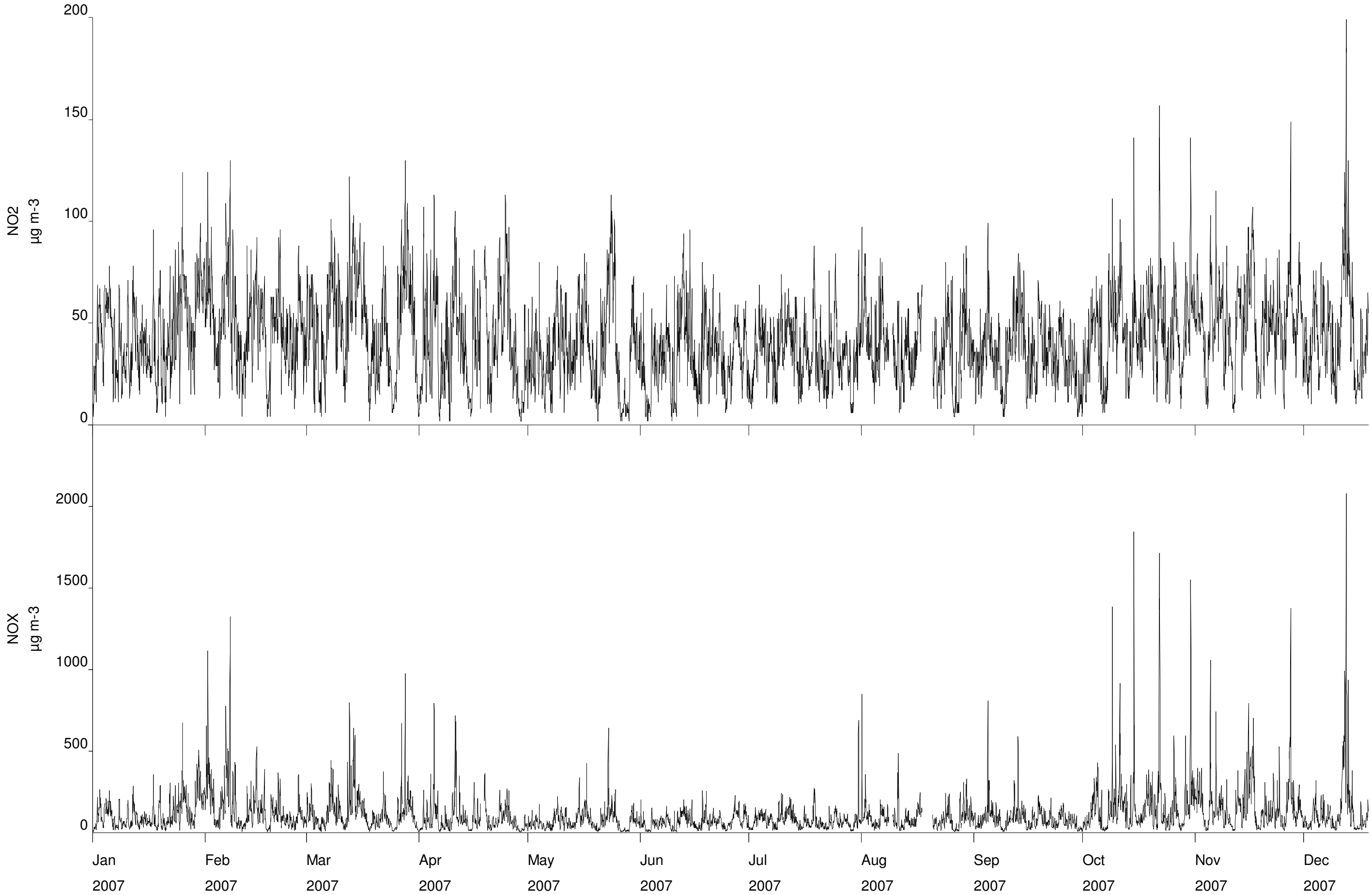
Felixstowe Dooley Air Monitoring
Hourly Mean Data for 01 January to 31 December 2007



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Produced by AEA Energy & Environment on behalf of Suffolk Coastal

FELIXSTOWE ADASTRAL CLOSE
01 January to 31 December 2007

These data have been fully ratified by AEA Energy & Environment

POLLUTANT	PM_{10}*+	NO_2	NO_X	SO_2
Number Very High	0	0	-	0
Number High	11	0	-	0
Number Moderate	155	0	-	0
Number Low	6550	7902	-	31758
Maximum 15-minute mean	161 µg m^{-3}	155 µg m^{-3}	1433 µg m^{-3}	229 µg m^{-3}
Maximum hourly mean	161 µg m^{-3}	143 µg m^{-3}	1232 µg m^{-3}	210 µg m^{-3}
Maximum running 8-hour mean	138 µg m^{-3}	120 µg m^{-3}	890 µg m^{-3}	93 µg m^{-3}
Maximum running 24-hour mean	104 µg m^{-3}	82 µg m^{-3}	431 µg m^{-3}	42 µg m^{-3}
Maximum daily mean	96 µg m^{-3}	76 µg m^{-3}	358 µg m^{-3}	41 µg m^{-3}
Average	27 µg m^{-3}	30 µg m^{-3}	59 µg m^{-3}	9 µg m^{-3}
Data capture	76.1 %	90.2 %	90.2 %	90.6 %

* PM_{10} Indicative Gravimetric Equivalent µg m-3
+ PM_{10} as measured by a BAM using a gravimetric factor of 0.83333 for Indicative Gravimetric Equivalent
All mass units are at 20'C and 1013mb
NO_X mass units are NO_X as NO_2 µg m-3

Pollutant	Air Quality (England) Regulations 2000 and (Amendment) Regulations 2002	Exceedences	Days
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 µg m^{-3}	12	12
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	0	0
Nitrogen Oxides (NO_2)	Annual mean > 30 µg m^{-3}	1	-
Sulphur Dioxide	15-minute mean > 266 µg m^{-3}	0	0
Sulphur Dioxide	Hourly mean > 350 µg m^{-3}	0	0
Sulphur Dioxide	Daily mean > 125 µg m^{-3}	0	0
Sulphur Dioxide	Annual mean > 20 µg m^{-3}	0	-

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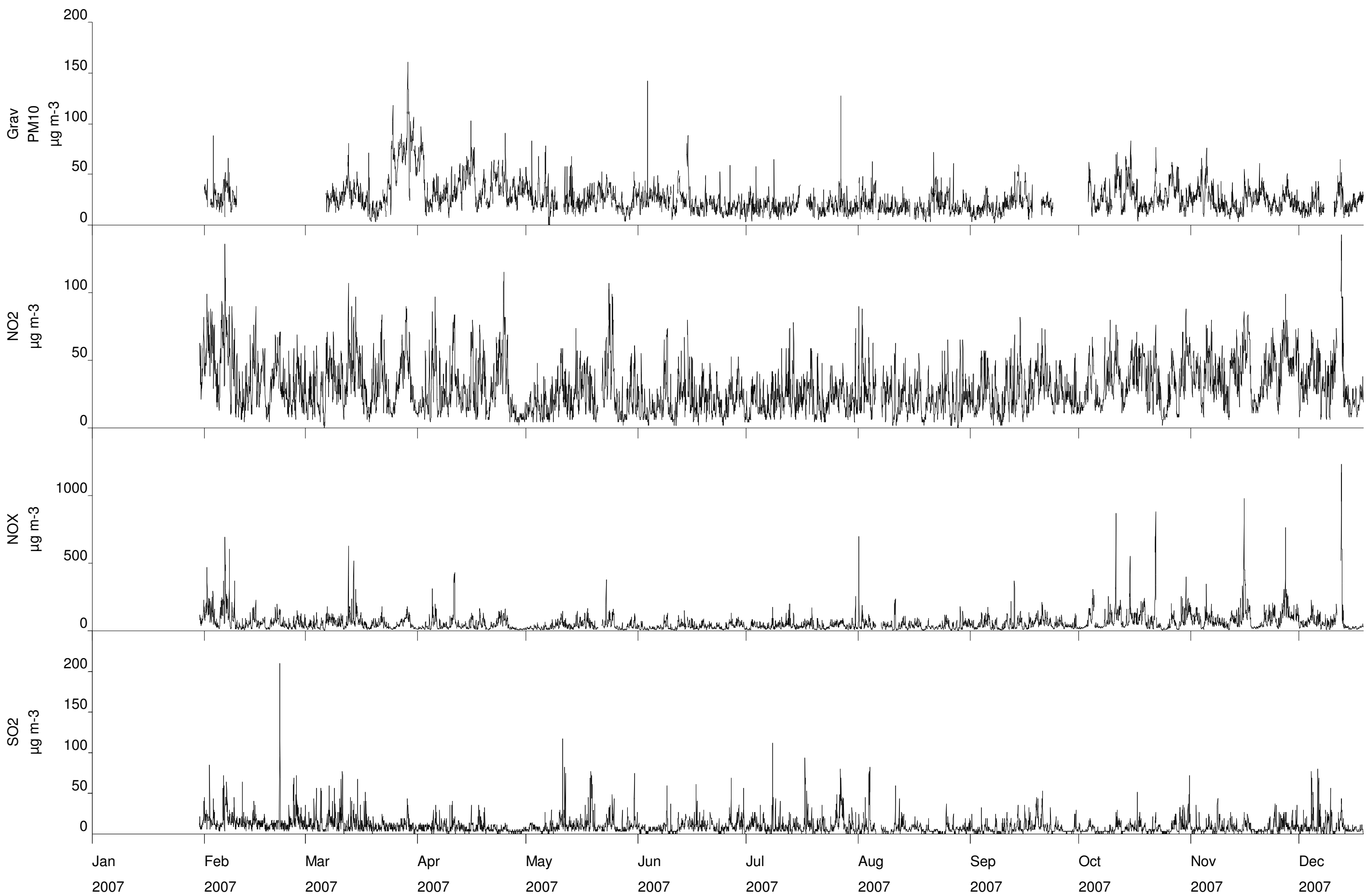
Felixstowe Adastral Close Air Monitoring
Hourly Mean Data for 01 January to 31 December 2007



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Produced by AEA Energy & Environment on behalf of Suffolk Coastal

FELIXSTOWE ADASTRAL CLOSE
30 January to 31 December 2007

These data have been fully ratified by AEA Energy & Environment

POLLUTANT	PM_{10}*+	NO_2	NO_X	SO_2
Number Very High	0	0	-	0
Number High	11	0	-	0
Number Moderate	155	0	-	0
Number Low	6550	7902	-	31758
Maximum 15-minute mean	161 µg m^{-3}	155 µg m^{-3}	1433 µg m^{-3}	229 µg m^{-3}
Maximum hourly mean	161 µg m^{-3}	143 µg m^{-3}	1232 µg m^{-3}	210 µg m^{-3}
Maximum running 8-hour mean	138 µg m^{-3}	120 µg m^{-3}	890 µg m^{-3}	93 µg m^{-3}
Maximum running 24-hour mean	104 µg m^{-3}	82 µg m^{-3}	431 µg m^{-3}	42 µg m^{-3}
Maximum daily mean	96 µg m^{-3}	76 µg m^{-3}	358 µg m^{-3}	41 µg m^{-3}
Average	27 µg m^{-3}	30 µg m^{-3}	59 µg m^{-3}	9 µg m^{-3}
Data capture	82.7 %	98.0 %	98.0 %	98.4 %

* PM_{10} Indicative Gravimetric Equivalent µg m-3
+ PM_{10} as measured by a BAM using a gravimetric factor of 0.83333 for Indicative Gravimetric Equivalent
All mass units are at 20'C and 1013mb
NO_X mass units are NO_X as NO_2 µg m-3

Pollutant	Air Quality (England) Regulations 2000 and (Amendment) Regulations 2002	Exceedences	Days
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 µg m^{-3}	12	12
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	0	0
Nitrogen Oxides (NO_2)	Annual mean > 30 µg m^{-3}	1	-
Sulphur Dioxide	15-minute mean > 266 µg m^{-3}	0	0
Sulphur Dioxide	Hourly mean > 350 µg m^{-3}	0	0
Sulphur Dioxide	Daily mean > 125 µg m^{-3}	0	0
Sulphur Dioxide	Annual mean > 20 µg m^{-3}	0	-

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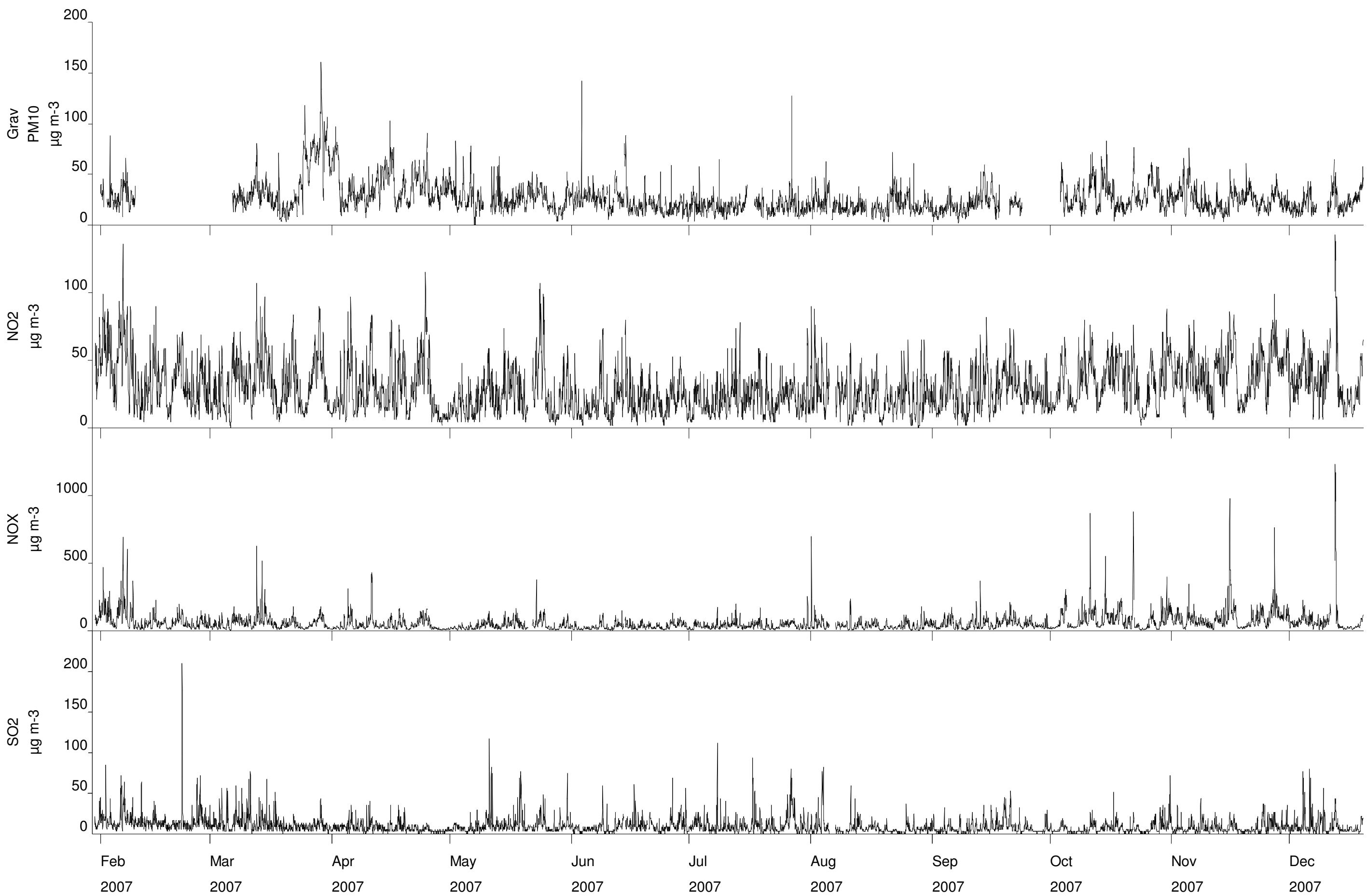
Felixstowe Adastral Close Air Monitoring
Hourly Mean Data for 30 January to 31 December 2007



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