Detailed Assessment of NO_2 at South Killingholme 2015

NORTH LINCOLNSHIRE COUNCIL

www.northlincs.gov.uk

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1 Executive summary

North Lincolnshire Council's Air Quality Progress Report 2011 identified a possible exceedance of nitrogen dioxide alongside the A160 in South Killingholme. For this reason, in October 2013 North Lincolnshire Council installed an air quality monitoring site to more accurately measure nitrogen dioxide, nitric oxide and nitrogen oxides at this location. Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes. Nitric oxide is not considered to be harmful to health, however, once emitted to the atmosphere it is rapidly oxidised to nitrogen dioxide (NO_2) which can be harmful to health. NO_2 can irritate the lungs and lower resistance to respiratory infections. Continued exposure to concentrations above the recommended air quality objectives may cause increased incidence of acute respiratory illness in children.

The main source of NO_2 is from road traffic emissions. At South Killinghome the principle source is from vehicles using the A160 dual-carriage way, which provides access to the Port of Immingham, local refineries and power stations. It is also the main route to the proposed Able Marine Energy Park, a deep water quay and manufacturing facility for the offshore wind energy industry.

To provide better access to the Port of Immingham and surrounding area, the Highways Agency are upgrading both the A160 and A180. It is anticipated that

construction will take approximately 16 months and should be completed by Autumn 2016.

The results of the real-time monitoring presented here indicate that air quality objectives for NO_2 have not been breached. The objectives are an annual mean not to exceed 40 µg m^{-3}, and an hourly mean of 200 µg m^{-3} not to be exceeded more than 18 times a year. The annual mean from the South Killingholme roadside monitor for 2014 was 28.5 µg m^{-3} and there have been no exceedances of the hourly objective. The data capture rate for the monitor is over 99%.

It is recommended that the monitor remain in situ for a period of at least 12 months to monitor the effects of the A160 upgrade and any potential increase in traffic, particularly HGVs.

Contents

2 Abbreviations

AQMA Air Quality Management Area.
AURN Automatic Urban and Rural Network.
DfT Department for Transport
Defra Department of the Environment, Food and Rural Affairs.
EPAQS Expert Panel on Air Quality Standards.
LAQM Local Air Quality Management.
LSO Local Site Operator.
NAQS National Air Quality Strategy.

NO Nitric Oxide, also known as Nitrogen Oxide, and Nitrogen Monoxide
NO_2 Nitrogen Dioxide.
NO_x Oxides of Nitrogen.
QA/QC Quality Assurance / Quality Control.
µg m^{-3} Micrograms (1 millionth of a gram) per cubic metre.

3 Introduction

The concept of Local Air Quality Management was introduced under Part IV of the Environment Act 1995. Chapter 82 of the Act placed a duty on all Local Authorities to review and assess air quality in their area. Air Quality Objectives can be deemed as the Governments medium term objectives. They are based on Air Quality Standards set by the Expert Panel on Air Quality Standards and are the maximum acceptable level of a pollutant in the air that will not present a risk to the health of the most susceptible groups in the population. The Air Quality Objectives include a date by which the Standards must be achieved. The length of time to achieve the Objective for each pollutant takes into account the costs to industry, the expected rate of improvements in available technology and the health effects on the country's population. The Air Quality (England) Regulations 2000 initially set Air Quality Objectives for seven pollutants that Local Authorities were responsible for reviewing. The most recent update of the objectives was presented in the National Air Quality Strategy 2007. These objectives must be achieved by varying dates, the latest being 31st January 2010. The Air Quality Objectives for NO_2 are listed in Table 1.

Table 1: Air quality objectives for NO_2

Pollutant	Air quality objective		Date to be achieved by
	Concentration	Measured as	
Nitrogen dioxide	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40 µg m^{-3}	Annual mean	31.12.2005

If an objective is unlikely to be achieved in North Lincolnshire where relevant receptors are present, then the Council must declare the affected area as an Air Quality Management Area (AQMA). Over 215 Local Authorities have to date declared AQMAs. This report aims to establish whether an NO_2 air quality objective

is being breached in an area of North Lincolnshire. If, after consultation, an AQMA is declared, the Council is then required to undertake a Further Assessment to determine the sources of the pollutant and the level of required emission reduction. This is followed by the development and implementation of an action plan setting out measures to reduce concentrations of the pollutant.

3.2 North Lincolnshire

North Lincolnshire is an area of around 85 000 hectares with a population of around 167 500, it is located on the southern side of the Humber estuary and occupying tracts of land on either side of the River Trent (Figure 1).

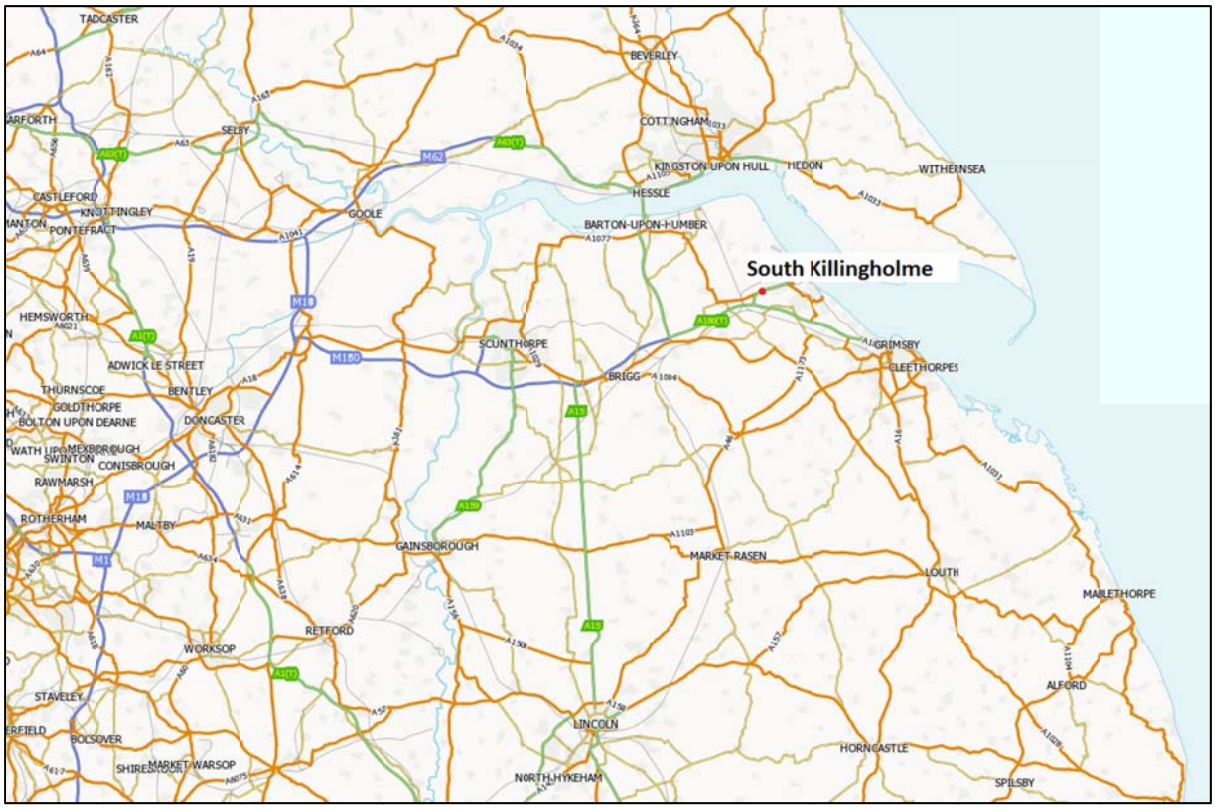


Figure 1: North Lincolnshire and the surrounding area.

A Parliamentary Order created the administrative area of North Lincolnshire in March 1995 and on 1st April 1996 the new unitary authority area of North Lincolnshire came into being. North Lincolnshire covers a large, mainly agricultural area. The pattern of settlements in the area reflects this with market towns surrounded by many small villages. The exception to this is the substantial urban area of Scunthorpe and the adjoining town of Bottesford.

The local economy of North Lincolnshire was built and still relies upon traditional industries such as steel manufacturing (and related industries) and agriculture. More recently there has been the establishment of two oil refineries and the introduction of several gas fired power stations.

North Lincolnshire Council has declared two Air Quality Management Areas due to continuing problems relating to PM_{10} (particulate matter less than 10 microns in diameter). One is for the annual mean objective and covers a small area in Low Santon. The other is for the daily mean objective and covers the integrated steelworks site and east Scunthorpe. (More information on the AQMA's can be found at www.nlincsair.info).

3.3 South Humber Bank

Large scale regeneration of the South Humber Bank area is underway, and the larger projects include:

Able Marine Energy Park will comprise a manufacturing facility for the offshore wind energy industry and a deep water quay facility for turbine components to be loaded onto vessels for transport to offshore wind farms.

C. Gen. will construct and operate a power project at North Killingholme, which comprises of a new 470 megawatt thermal generating station and associated development on land adjacent to the Humber Sea terminal.

National Grid River Humber gas pipeline replacement project involves a new 3.6 mile pipeline between Paull and Goxhill, which will help to deliver gas to all parts of the UK.

The Hornsea offshore windfarm includes onshore elements within the proposed project 2 development. These elements comprise an export cable landfill site, an onshore cable route corridor, a high voltage alternating current substation and an interconnection with the National Grid substation.

Whilst many of these developments only emit small volumes of pollutants, they will all increase the volume of traffic along the A160, which is a busy dual-carriage way that divides the village of South Killingholme, with the majority of the residential properties to the north of the A160.

The South Humber Bank is the largest area of undeveloped land fronting a deep water estuary in England, with approximately 1,000 hectares of land available for development. The local road network is reasonably lightly trafficked, but the A160 between the A180 and the Port of Immingham remain the biggest constraint to the area's development. With continued expansion of the area considerable growth in traffic is expected.

The Highways Agency therefore investigated ways to improve access to the Port of Immingham and improve traffic flow on the A160. Eight different options were looked at with the preferred route being announced on 22nd March 2010. The part of the scheme that will affect South Killingholme most directly involves relocating Habrough Roundabout to the west of its current position, with new link roads provided from the A160 to Ulceby Road, Top Road and Habrough Road.

A full Environmental Impact Assessment was required for the A160-A180 improvements, which included a section on air quality. The assessment concluded that under the Highways Agency guidelines the scheme should not have a significant adverse impact on local air quality.

4 South Killingholme

The village of South Killingholme is situated approximately 4 km west of the River Humber and the Port of Immingham, and approximately 20 km east of Scunthorpe. The village is situated alongside the A160 dual-carriage way, which as discussed earlier is the principal route to the western entrance of the Port of Immingham. Traffic data collected by the Department for Transport (www.dft.gov.uk) states that the volume of traffic along the A160 through Killingholme in 2014 was 12,000 vehicles per day, including 5,000 HGVs. There has been an air quality monitoring station at the school in South Killingholme since 2003, which measures PM_{10}, $SO_{2,}$ NO and NO_2. The roadside monitor was installed in October 2013 (Figure 2).

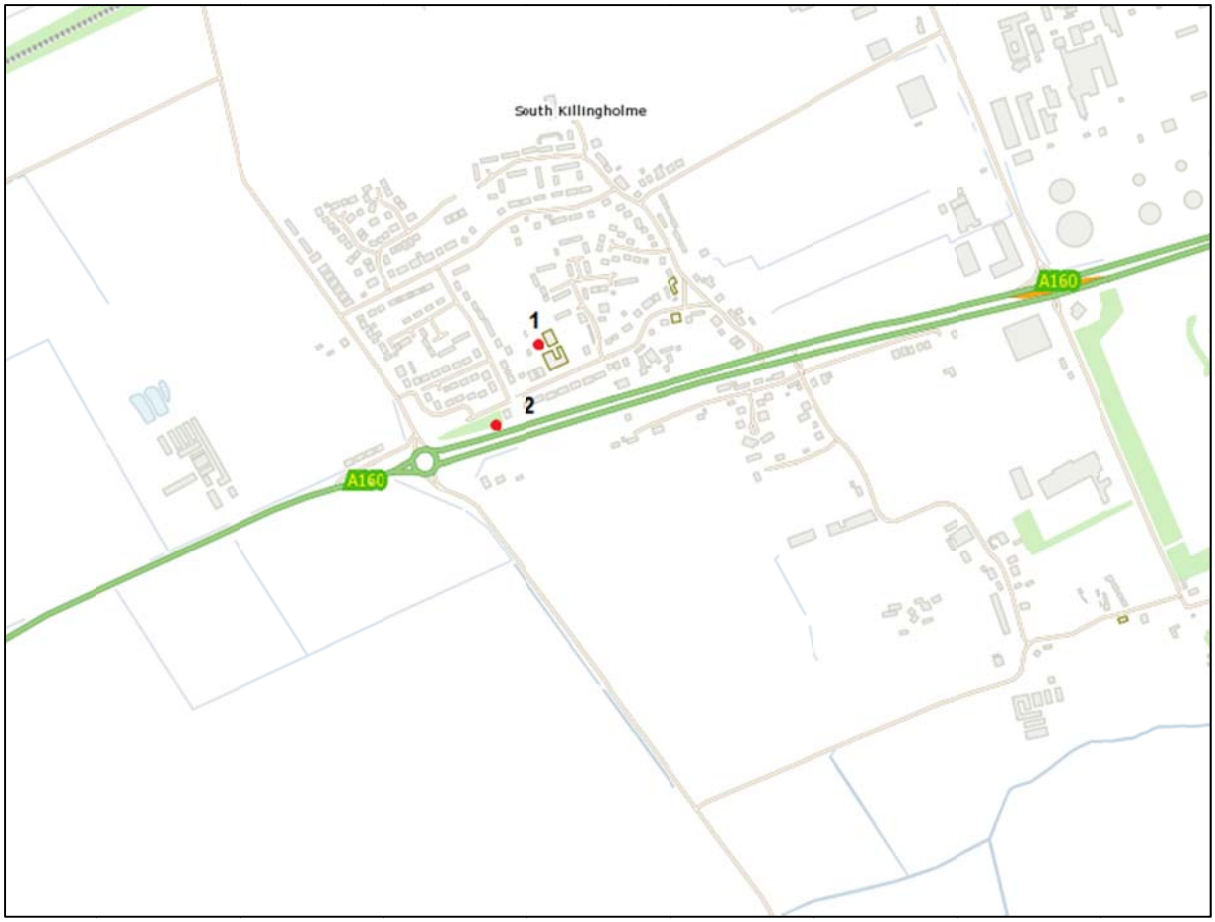


Figure 2: The air quality monitor at South Killingholme School (1) and the site of the roadside air quality monitor (2).

4.1 Monitoring techniques – diffusion tubes

Monitoring of NO_2 concentrations at South Killingholme is carried out using passive diffusion tubes which are widely used for this purpose throughout the UK. They absorb the pollutant from the surrounding air and require no power supply, although there is an uncertainty of ±20% with the annual mean. Diffusion tubes are small tubes that are generally attached to lamp posts at approximately 2m high, often next to roads. They are left in place for a period of one month, before being collected and sent off to a laboratory for analysis. There is a bias with the results as they tend to overestimate the concentration, especially if situated on busy roads. Three diffusion tubes are therefore always co-located next to a gas analyser; this enables a data correction factor to be determined. A new correction factor is calculated every calendar year. The method for determining the correction factor is detailed in Appendix A. There are seven diffusion tubes along the A160 in Killingholme (Figure 3), with the results of the four longer term tubes in Table 2. These results suggest

that there is still an exceedance from the two diffusion tubes situated nearest to the roundabout (DT21 and DT22).

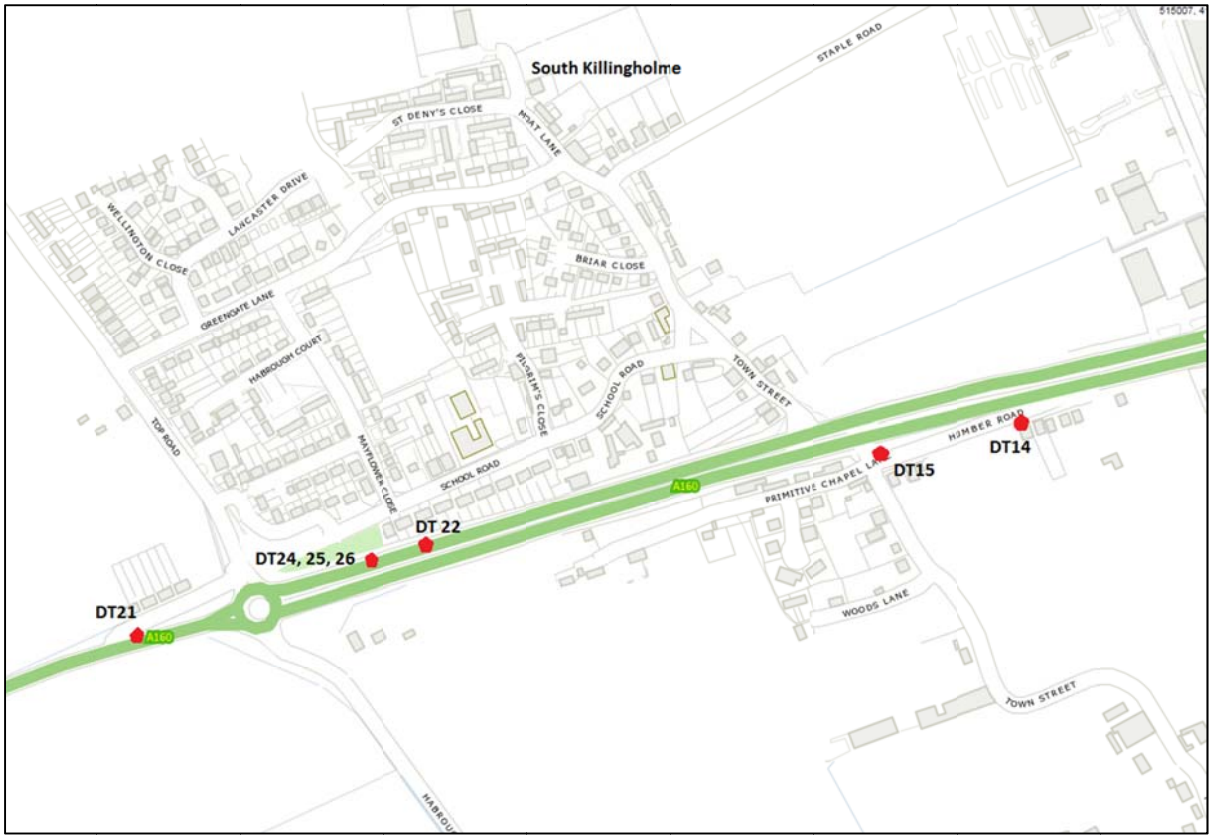


Figure 3: Position of the diffusion tubes in South Killingholme.

Table 2: Coordinates and results of diffusion tube data from the Killingholme area, along with the bias correction factor that was applied. The units are in µg m^{-3}.

Year	DT14 X515452 Y416107	DT15 X515279 Y416085	DT21 X514573 Y415901	DT22 X514827 Y415982	Bias correction factor
2014	27	35	43	52	0.88
2013	30	45	51	64	0.99
2012	21	30	38	43	0.67
2011	19	30	44	40	0.68

Diffusion tube data was used in the 2011 Progress Report, which highlighted the potential new exceedance of the air quality objectives. In October 2013, in partnership with the Highways Agency, three additional NO_2 diffusion tubes (DT 24, 25 and 26) were positioned approximately 30 m to the west of tube DT22 at grid reference X514782, Y415971. The new diffusion tubes confirmed that there was a

potential exceedance of the air quality objectives. The location of all of the diffusion tubes can be seen in Figure 3, with the results of the newer tubes shown in Table 3.

Table 3: Results from the three additional diffusion tubes. The units are in µg m^{-3}.

Year	DT24	DT25	DT26	Bias correction factor
2014	47	51	53	0.88
2013	47	41	52	0.99

Using the NO_2 with distance from roads calculator (http://laqm.defra.gov.uk/tools-monitoring-data/no2-falloff.html) it was possible to estimate what the annual mean concentration was at the nearest receptors to the diffusions tubes DT21 and DT22 (Table 4).

Table 4: Predicted annual mean concentration using 2014 diffusion tube results for the nearest receptors. The units for concentration are in µg m^{-3}.

	DT21	DT22
Distance from kerb	0.1 m	0.1 m
Distance from kerb to nearest receptor	20 m	20 m
Measured diffusion tube concentration	42.9	51.8
Estimated concentration at the receptor	24.7	27.1

Local Air Quality Management Technical Guidance TG(09) issued by Defra states:

> In view of the limitations of diffusion tubes, Local Authorities are advised not to rely upon diffusion tube data alone as the basis of a Detailed Assessment or declaration of an AQMA for NO_2.

4.2 Monitoring techniques – gas analyser

A gas analyser was therefore located approximately 10 m north of the A160 dual-carriage way inside a purpose made enclosure (Figure 4). The analyser was situated approximately halfway between the road and the nearest receptor. Nitrogen dioxide, nitric oxide and nitrogen oxides (which is a combination of nitric oxide and nitrogen dioxide) are the pollutants measured, although air quality objectives are only set for nitrogen dioxide.

Figure 4: The enclosure containing the gas analyser located at the side of the A160 dual-carriage way.

A Monitor Labs NO_x gas analyser was chosen for its durability, accuracy and ease of calibration. The California Analytical Model 600 CLD Analyser utilises the principle of chemiluminescence for analysing the NO or NO_x concentration within a gaseous sample. Planning permission (reference PA/2012/0477) was approved in 2013 with pollution measurements being recorded from October 2013. This instrument is calibrated every two weeks by exposing it to a calibration gas of known concentration, and this is then ratified by our data management company Ricardo-AEA. Wind direction and speed used in this assessment were collected from the Rowland Road AURN site at Scunthorpe.

5 Results

In 2014 there was a data capture rate of 99.8%, with only 20 hours of missing data over the course of the whole year. Neither the annual or hourly means were exceeded (Table 5).

Table 5: Results from the roadside South Killingholme air quality monitor.

Air quality objective		Results
Concentration	Measured as	
200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	0 exceedances, maximum hourly mean was 132µg m^{-3}
40 µg m^{-3}	Annual mean	28.5 µg m^{-3}

Combining the hourly NO_2 concentrations with wind speed and direction in a polar plot, the principle emission source can be attributed to vehicles using the A160 (Figure 5). The higher concentrations clearly track the A160 through South Killingholme. The monitor is situated on the North side of the A160 with the road running in an East North East direction. The higher pollutant concentrations are generally recorded when the wind direction is directly from the East, blowing much of the vehicle emissions towards the monitor. It must be noted that the highest concentrations recorded are well within the hourly air quality objectives.

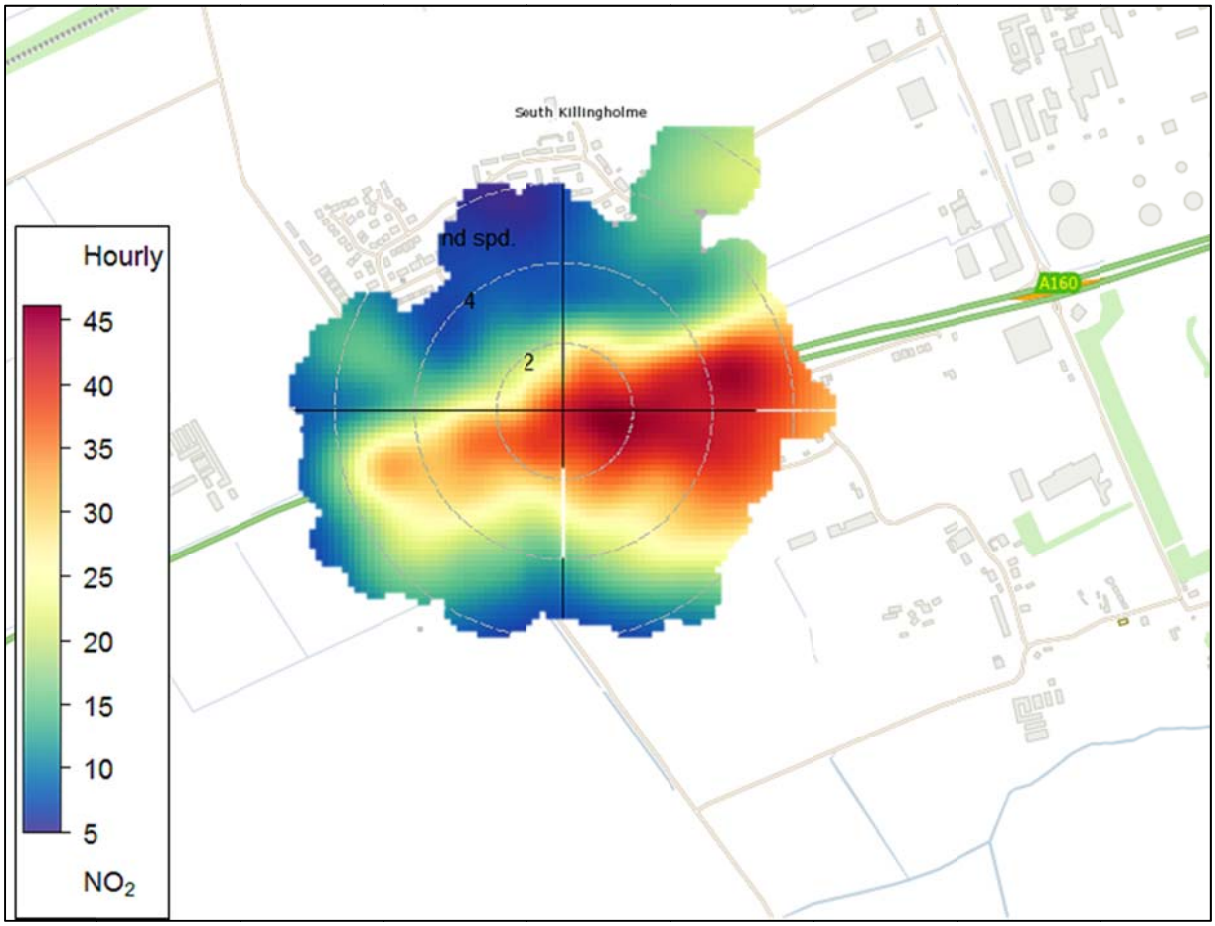


Figure 5: Polar plot overlaid onto the position of the roadside monitor, highlighting both the concentration and the direction of the pollutant source at South Killingholme. The units shown in the key for NO_2 are $\mu g/m^3$.

When viewing the diurnal plots there are two spikes in the NO_2 concentration which correspond to the morning and evening rush hours (Figure 6). There are also much lower concentrations recorded at the weekends.

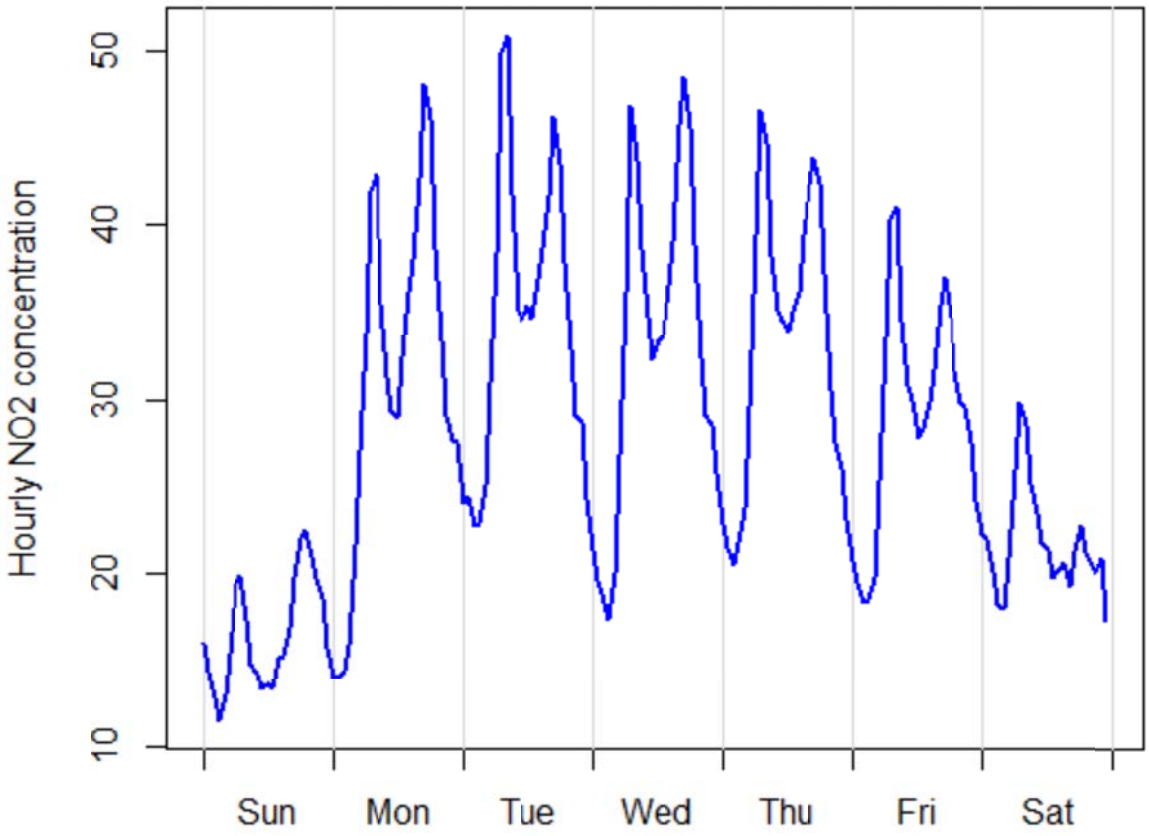


Figure 6: Diurnal plot of NO_2 concentration from the South Killingholme air quality monitor showing an increase in pollutants during the morning and afternoon rush hours.

There are also lower pollution concentrations during the summer months (Figures 7 and 8). The mosaic plot in figure 8 illustrates the mean pollutant concentration for each hour for every month and it shows that there are higher concentrations between 7 and 9 am, as well as 5 and 6 pm, except for during the summer months. This is predominantly due to reduced traffic movement during school holidays, combined with a lower volume of HGVs using the A160 during the three summer months. In depth traffic data from the A160 was collected by the Highways Agency. Traffic monitoring was carried out in November at 23 different sites around South

Killingholme and the A160. Whilst this traffic data cannot confirm the traffic volumes on the A160 during the summer months, the general consensus from published Highways Agency reports is that nearly all roads have a marked downturn in traffic volumes over the summer period.

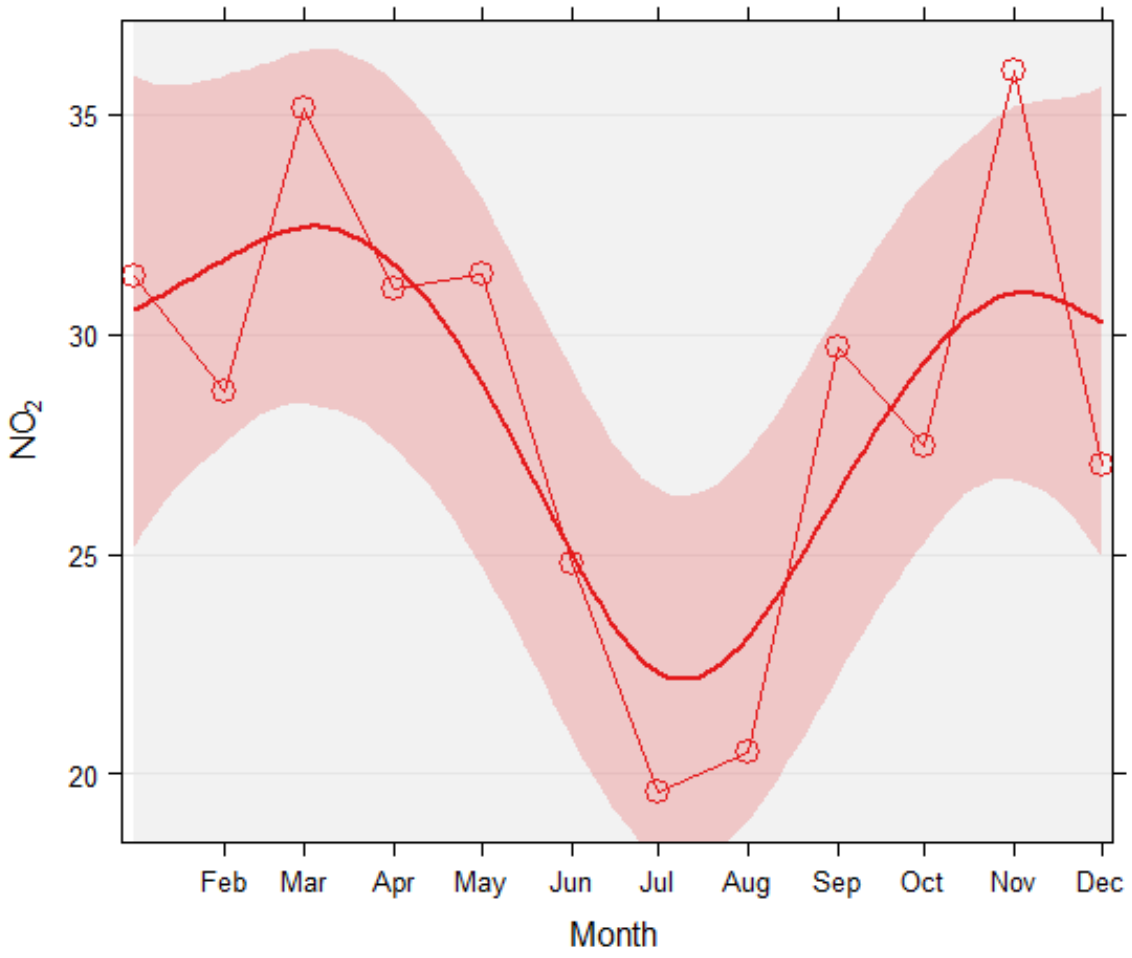


Figure 7: Monthly trend from the Killingholme monitor for 2014. There is a significant decrease in the pollutant concentration during the summer months. The points signify the monthly pollutant mean; the thick red line is the trend, whilst the shaded area signifies one standard deviation.

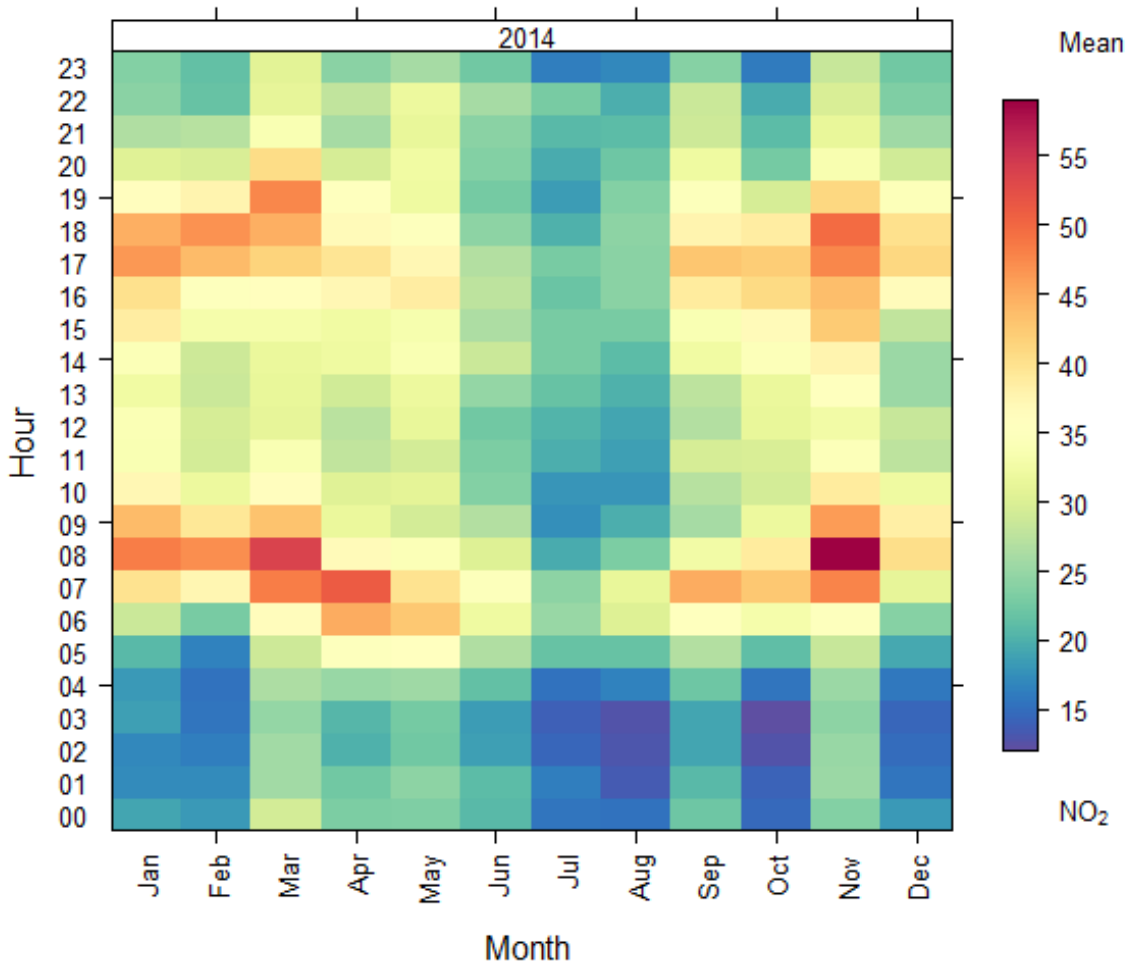


Figure 8: The mosaic plot shows the mean pollutant concentration for each hour for every month in 2014. It illustrates that there are higher concentrations between 7 and 9 am, as well as 5 and 6 pm, except for during the summer months.

5.1 Comparison with the South Killingholme School air quality monitoring station

To evaluate the confidence ratio of the roadside monitor data from the South Killingholme School air quality monitoring station was used as a comparison. This monitor is situated 150m from the A160 and has been in operation since 2003. The School monitor also uses a gas analyser to record NO_2 concentrations and as it is situated further from the dual-carriage way, the annual mean, as expected, is much lower at 22.1µg m^{-3}. A comparison of the data from this site with the data collected from the roadside monitor confirms the robustness of the data with a Pearson correlation coefficient of 0.83.

6 Conclusions

The 2014 data from the roadside air quality monitor at South Killingholme demonstrates that there is not an exceedance of the NO_2 hourly or annual concentrations. There is therefore no need to declare an Air Quality Management Area.

It would however be prudent to continue to operate the roadside air quality monitor for a period of at least twelve months from the completion of the A160 upgrade, to enable the impacts of the A160 improvements and the potential increases in traffic flows to the South Humber Bank to be assessed.

The council will also continue to screen the area with diffusion tubes alongside the A160 dual-carriage way to monitor the air quality. The NO_2 distance from roads calculator will also continue to be used to review the predicted concentrations at the receptors situated closest to the A160.

Appendix A: Diffusion Tube Bias Adjustment Factors

North Lincolnshire Council currently uses ESG for both supply and analysis of its Nitrogen Dioxide Diffusion Tubes. The Bias Adjustment factor for ESG in 2014 was 0.88.

Factor from Local Co-location Studies

North Lincolnshire Council has one ongoing co-location site, as discussed in section 4.1 of this report in 2011, situated at the Scunthorpe Town urban industrial site. Results can be seen in Table 6.

Table 6: The bias correction factor for 2014 calculated from the Scunthorpe Town monitor station.

Site	Analyser Annual Mean	Tube Annual Means	Bias Adjustment Factor
Scunthorpe Town	20	22	0.88

Discussion of Choice of Factor to Use

The decision to use a Bias Adjustment Factor generated from our own co-location study was reached due to the complexity of the issues within North Lincolnshire. As the AQMA's declared within North Lincolnshire are predominantly industry related it was felt that using an average of other authority figures would be unsuitable. The spreadsheet used to calculate the bias correction factor can be seen in Table 7.

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm^{-3}	Tube 2 µgm^{-3}	Tube 3 µgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	########	30/01/2014	32.0	26.2	32.3	30	3.4	11	8.5	17.2	88	Good	Good
2	30/01/2014	28/02/2014	27.1	27.6	29.1	28	1.0	4	2.6	14.5	98.7	Good	Good
3	28/02/2014	28/03/2014	38.9	25.3	31.7	32	6.8	21	16.9	32.8	99.7	Poor Precision	Good
4	28/03/2014	########	19.6	22.9	24.7	22	2.6	12	6.4	31.5	99.9	Good	Good
5	########	30/05/2014	22.5	21.8	19.5	21	1.6	7	3.9	19.4	100	Good	Good
6	30/05/2014	########	14.1	15.9	14.4	15	1.0	7	2.4	18.9	99.9	Good	Good
7	########	30/07/2014	15.3	15.8	14.5	15	0.7	4	1.6	20.3	88.6	Good	Good
8	30/07/2014	29/08/2014	18.3	17.9	19.1	18	0.6	3	1.5	16.3	76.6	Good	Good
9	29/08/2014	29/09/2014	15.7	15.3	10.9	14	2.7	19	6.6	30.3	99.7	Good	Good
10	29/09/2014	31/10/2014	25.1	25.6	28.5	26	1.8	7	4.6	15.2	99.2	Good	Good
11	31/10/2014	28/11/2014	36.2	29.8	34.6	34	3.3	10	8.3	24.2	58.6	Good	or Data Capture
12	28/11/2014	31/12/2014	27.8	32.3	34.5	32	3.4	11	8.5	12.7	94.1	Good	Good
13													
										Overall survey -->		Good precision	Good Overall DC

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

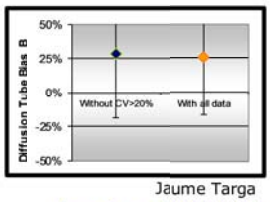
(Check average CV & DC from Accuracy calculations)

Site Name/ ID:

Precision: 11 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 10 periods of data
Bias factor A: 0.88 (0.62 - 1.51)
Bias B: 13% (-34% - 60%)
Diffusion Tubes Mean: 22 µgm^{-3}
Mean CV (Precision): 9
Automatic Mean: 20 µgm^{-3}
Data Capture for periods used: 94%
Adjusted Tubes Mean: 20 (14 - 34) µgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 11 periods of data
Bias factor A: 0.9 (0.65 - 1.46)
Bias B: 11% (-31% - 53%)
Diffusion Tubes Mean: 23 µgm^{-3}
Mean CV (Precision): 10
Automatic Mean: 21 µgm^{-3}
Data Capture for periods used: 95%
Adjusted Tubes Mean: 21 (15 - 34) µgm^{-3}



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Version 03 - November 2006

Table 7: Spreadsheet used to calculate the bias correction factor

Although the tube network is spread over a wide area of North Lincolnshire the tubes are situated in relatively similar situations, all at the same height and most of the tubes are situated on roadside lampposts. The co-location work has been ongoing since 2006 and has presented different adjustment factors each year. We have

confidence within our AURN continuous monitor at this location due to its strict calibration programme and ratification procedures carried out by Ricardo-AEA.

Any requests for information about Air Quality issues within North Lincolnshire, or requests to obtain a copy of this Report should be made to:

Environmental Health (Commercial)
Church Square House
PO Box 42
Scunthorpe
North Lincolnshire
DN15 6XQ
Email: environmental.health@northlincs.gov.uk

On request, this report will be made available on tape, in Braille, large type, or in a language other than English.

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