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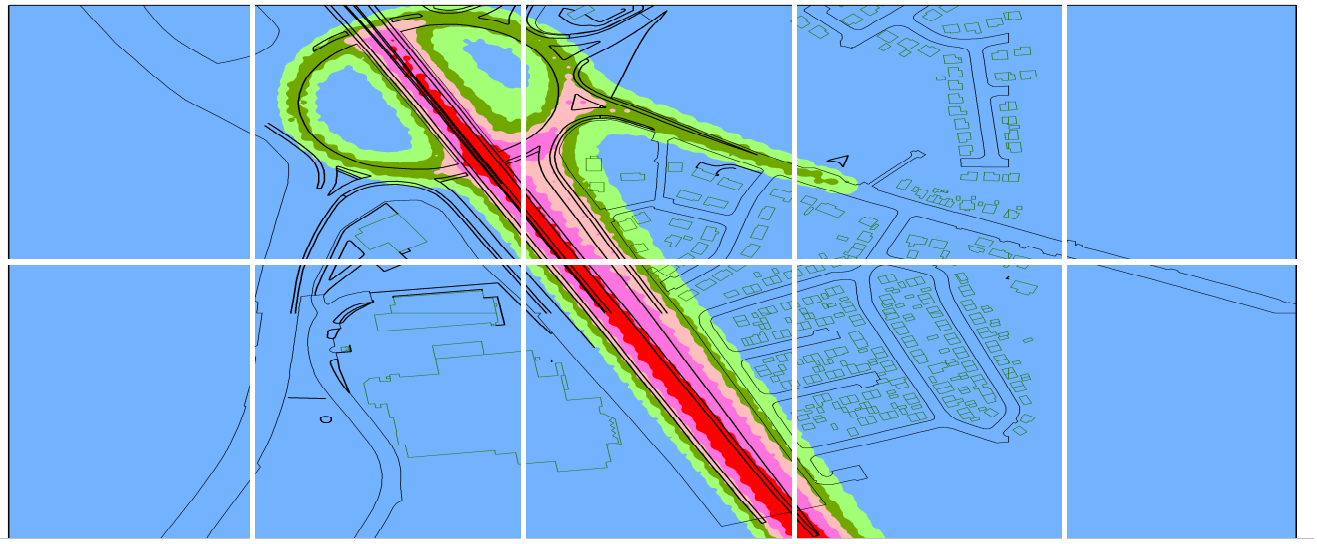

Air Quality Review and Assessment-Detailed Assessment

Report to Newtownabbey Borough Council
AEAT/ENV/R/2700
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Executive summary

The Government prepared the Air Quality Strategy for England, Scotland, Wales and Northern Ireland for consultation in August 1999. It was published in January 2000 (DETR, 2000). A revised version was published in July 2007 (DEFRA, 2007).

At the centre of the Air Quality Strategy is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set.

Local authorities are required to review and assess the air quality in their areas from time to time to determine whether the air quality objectives are likely to be met.

Newtownabbey Borough Council carried out the **first round** of review and assessment in 3 Stages, and concluded that an Air Quality Management Area (AQMA) should be declared in Ballyclare area for particulate matter (PM_{10}) from domestic sources. The AQMA in Ballyclare was declared in October 2004. A further Stage 4 review and assessment was completed in 2005, and concluded that on the basis of modelling results Newtownabbey Borough Council could consider revoking the AQMA for PM_{10}.

The **second round** of review and assessment is now in progress. Newtownabbey Borough Council carried out the Updating and Screening Assessment in 2006, and concluded that it is unlikely that the objective for the seven pollutants listed in Air Quality Strategy would be exceeded. Taking into account the USA conclusion and the PM_{10} modelling results completed in Ballyclare area, the Council revoked the AQMA in Ballyclare in November 2006.

The Newtownabbey Borough Council carried out a Progress Report in 2007. This report concluded that there are three areas namely Sandyholme Way/Sandyknowes Avenue, Antrim Road, Elmfield and Main Street, Ballyclare where the nitrogen dioxide objective would not be met. The Progress Report also concluded that these three areas should be declared as AQMAs and a Detailed Assessment carried out for each area. These three areas were declared as AQMAs in January 2008.

Newtownabbey Borough Council has commissioned AEA to undertake a 6-month NO_2 monitoring at the three AQMAs followed by a Detailed Assessment modelling in order to be able to redefine AQMAs and designate any areas of exceedences. This Detailed Assessment also assessed the contribution of various sources to NO_X concentrations (source apportionment).

This report is a Detailed Assessment for Newtownabbey Borough Council as outlined in the Government's published guidance.

The general approach taken to this Detailed Assessment was to:

- Identify potential "hot spots" where there is expected to be the greatest potential for public exposure in the general area identified in the Updating and Screening Assessment as being at risk of exceedence;
- 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 diffusion tubes to assess the ambient concentrations produced by the road traffic and to calibrate the output of modelling studies;
- Model the concentrations of nitrogen dioxide around the potential hotspots, 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;
- Assess the contribution made from various sources to the pollutant 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.

The results from the diffusion tube survey and automatic continuous monitoring of nitrogen dioxide in 2007 confirmed that the annual mean objective of 40μg m^{-3} had not been met in 2007 at Sandyknowes, Antrim Road, Elmfield and Main Street, Ballyclare.

Both the annual mean and hourly mean nitrogen dioxide objectives were exceeded in Antrim Road, Elmfield in 2007. The automatic monitoring site is located in AQMA 3 (Antrim Road, Elmfield), which was declared based on the breach of the nitrogen dioxide annual mean objective. It is suggested that the Council should amend the AQMA order of this area to include the nitrogen dioxide hourly mean objective and should also consider Action Plan measures that would take this into consideration.

Main Street, Ballyclare (AQMA 2)

Ballyclare AQMA has been modelled and monitored and the results suggest the following:

- The modelled nitrogen dioxide concentrations in Main Street, Ballyclare have marginally exceeded the objective of 40μg m^{-3} in 2007;
- The measured nitrogen dioxide concentrations in Main Street, Ballyclare were above the objective of 40μg m^{-3}, with a maximum measured concentration of 44.3 μg m^{-3}.

The predicted nitrogen dioxide concentrations on the leeward side (left side) of the street canyon are above the objective and have a good agreement with the average measured values. The predicted nitrogen dioxide concentrations on the windward side (right side) of the street canyon are below the objective and have a good agreement with the average measured values. The predicted modelled concentrations for 2010 show that nitrogen dioxide concentrations in the AQMA 2 will be below the objective.

On the basis of the average modelled and measured results in Main Street, Ballyclare (AQMA 2), it is recommended that AQMA 2 is retained for present. It is also recommended that the leeward side of the street canyon is monitored.

Antrim Road, Elmfield (AQMA 3)

Antrim Road, Elmfield AQMA has been modelled and the modelling results suggest the following:

- The modelled nitrogen dioxide concentrations in the AQMA 3 area are above the objective of 40μg m^{-3} in 2007;

- The measured nitrogen dioxide concentrations in AQMA 3 are above the objective with a maximum measured concentration of 43.9 μg m^{-3}.

The predicted nitrogen dioxide concentrations in AQMA 3 are above the objective on the facades of the buildings in Antrim Road, Elmfield. The measured nitrogen dioxide concentrations in declared AQMA 3 are above the objective. On the basis of the modelled and measured results in the AQMA 3 it is recommended that the Council retain the declared AQMA 3.

It is also recommended that AQMA 3 is extended to include the residential properties on the north east side of Antrim Road, Elmfield where the modelling showed exceedances.

Sandyknowes (AQMA 4)

Sandyknowes AQMA 4 has been modelled and monitored and the results suggest the following:

- The modelled nitrogen dioxide concentrations in the Sandyknowes area were below the objective of 40μg m^{-3} in 2007;
- The measured nitrogen dioxide concentrations in Sandyknowes AQMA were above the objective with a maximum measured concentration of 44.7 μg m^{-3}.

The predicted nitrogen dioxide concentrations in AQMA 4 are below the objective on the facades of the buildings in the Sandyknowes area. The measured nitrogen dioxide concentrations are above the objective. On the basis of the measured results in the AQMA 4 and taking into consideration that pollution concentrations are variable due to meteorological conditions from year to year it is recommended that the Council retain the declared AQMA 4.

Table of contents

1 Introduction

This section outlines the purpose of this Detailed Assessment for Newtownabbey Borough Council, and the scope of the assessment.

1.1 National Air Quality Strategy

The Government prepared the Air Quality Strategy for England, Scotland, Wales and Northern Ireland for consultation in August 1999. It was published in January 2000 (DETR, 2000). A revised version was published in July 2007 (DEFRA, 2007).

At the centre of the Air Quality Strategy is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 1-1.

1.2 The Environment (Northern Ireland) Order 2002

The Environment (Northern Ireland) Order 2002 introduced a statutory obligation on local government to review and assess the air quality in their areas from time to time to determine whether the air quality objectives are likely to be met. Local Air Quality Management Policy Guidance is designed to help local authorities with their Local Air Quality Management (LAQM) duties under Part III of the Environment (NI) Order 2002. The Air Quality Regulations (NI) 2003 provides the statutory basis for the LAQM system.

1.3 Purpose of the Detailed Assessment

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality is considered in local authority decision-making process.

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, followed by a further Stage 4 review and assessment, and the formulation of an action plan to eliminate exceedences.

Newtownabbey Borough Council carried out the **first round** of review and assessment in 3 Stages, and concluded that an Air Quality Management Area (AQMA) should be declared in Ballyclare area for particulate matter (PM_{10}) from domestic sources. The AQMA in Ballyclare was declared in October 2004. A further Stage 4 review and assessment was completed in 2005, and concluded that on the basis of modelling results Newtownabbey Borough Council could consider revoking the AQMA for PM_{10}.

The **second round** of review and assessment is now in progress. Local authorities were required to proceed 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 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 assessment is carried out in two steps. The first step is an Updating and Screening Assessment (USA), which updates 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 is identified outside the AQMA for a pollutant it is necessary for the local authority to proceed to detailed assessment. Where a local authority does not need to undertake assessment, a Progress Report is

required instead. The details of the steps in the second round of review and assessment are summarised in Table 1-1.

Newtownabbey Borough Council carried out an Updating and Screening Assessment in 2006, and concluded that it is unlikely that the objective for the seven pollutants listed in Air Quality Strategy would be exceeded. Taking into account the USA conclusion and the PM_{10} modelling results completed in Ballyclare area, the Council revoked the AQMA in Ballyclare in November 2006.

The Newtownabbey Borough Council carried out a Progress Report in 2007. This report concluded that there are three areas: Sandyholme Way/Sandyknowes Avenue, Antrim Road, Elmfield and Main Street, Ballyclare where the nitrogen dioxide objective would not be met. The Council proposed to declare these three areas as AQMAs for nitrogen dioxide. These three areas were declared as AQMAs in January 2008. These can be seen in: Figure 1-1 - AQMA 2 – Main Street, Ballyclare, Figure 1-2 - AQMA 3 – Antrim Road, Elmfield and Figure 1-3 - AQMA 4 – Sandyknowes.

Therefore, the Council is required to undertake a Detailed Assessment of these areas to ascertain the concentrations at relevant exposure locations and the geographical extent of the exceedence area. The Council have therefore requested AEA to provide an air quality Detailed Assessment, which indicates whether the UK air quality objectives are likely to be exceeded in this area as a result of the presence of traffic and, if so, to assess the distance from the road up to which the objectives are exceeded.

Table 1-1 Brief details of steps in the second Round of the Air Quality Review and Assessment process

Level of Assessment	Objective	Approach
Updating and Screening	To identify those matters that have changed since the last review and assessment, which might lead to a risk of an air quality objective being exceeded	Use a checklist to identify significant changes that require further consideration. Where such changes are identified, then apply simple screening tools to decide whether there is sufficient risk of an exceedence of an objective to justify a Detailed Assessment
Detailed Assessment	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 or amendment of any necessary AQMAs	Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.
Annual Progress Reports	Local authorities should prepare annual air quality Progress Reports between subsequent rounds of reviews and assessments. The concept is that this will ensure continuity in the LAQM process.	The precise format for the Progress Report has not yet been determined, but will essentially follow the checklist approach that is set out in subsequent chapters of this document. Further details on the Progress Reports are provided via the Helpdesks. It is envisaged that these Progress Reports could be useful for the compilation of annual 'state of the environment' reports that many authorities already prepare.

This is a Detailed Assessment for Newtownabbey Borough Council as outlined in the Government's published guidance.

Figure 1-1 Air Quality Management Area 2, Main Street, Ballyclare, Newtownabbey

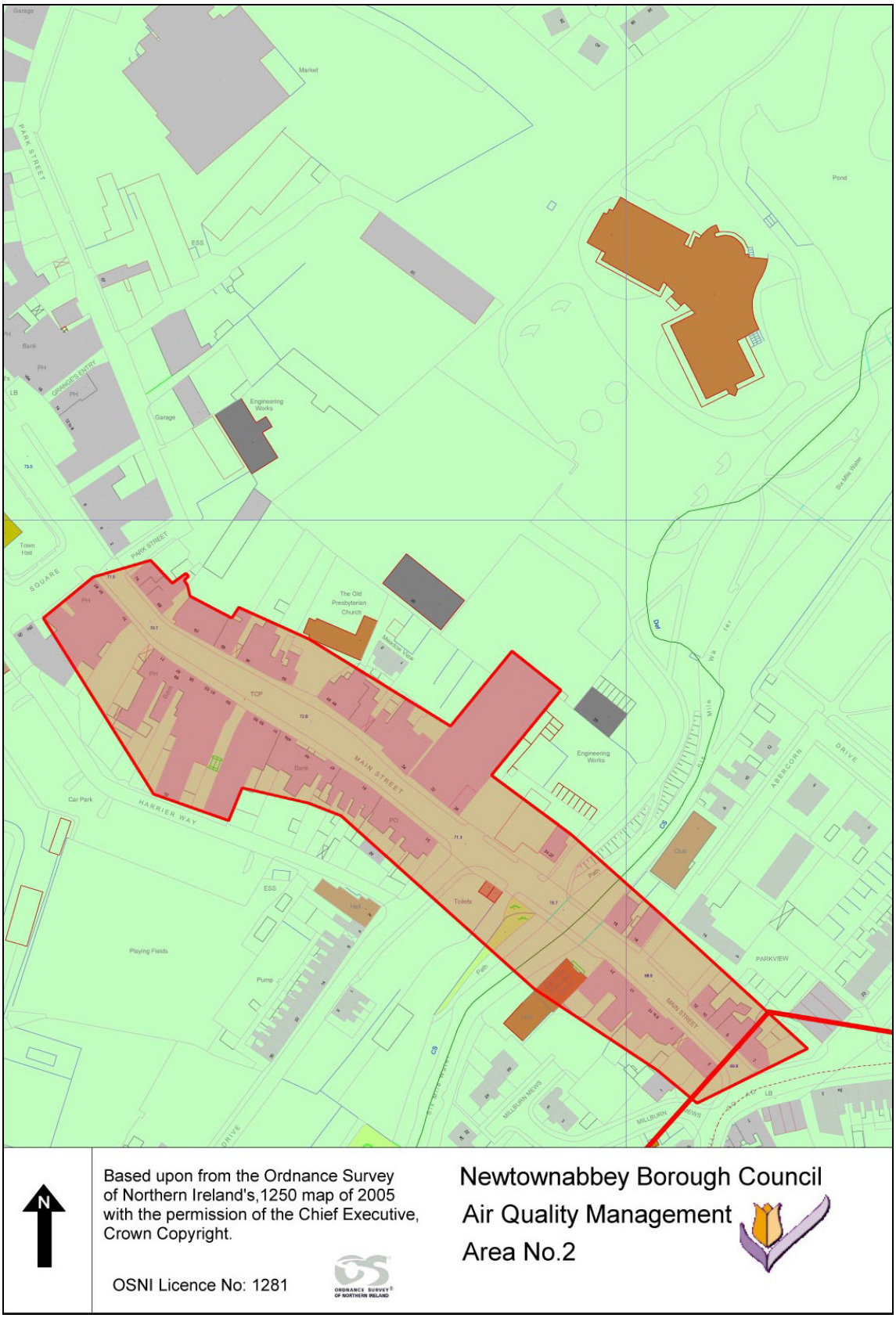


Figure 1-2 Air Quality Management Area 3, Antrim Road, Elmfield, Newtownabbey

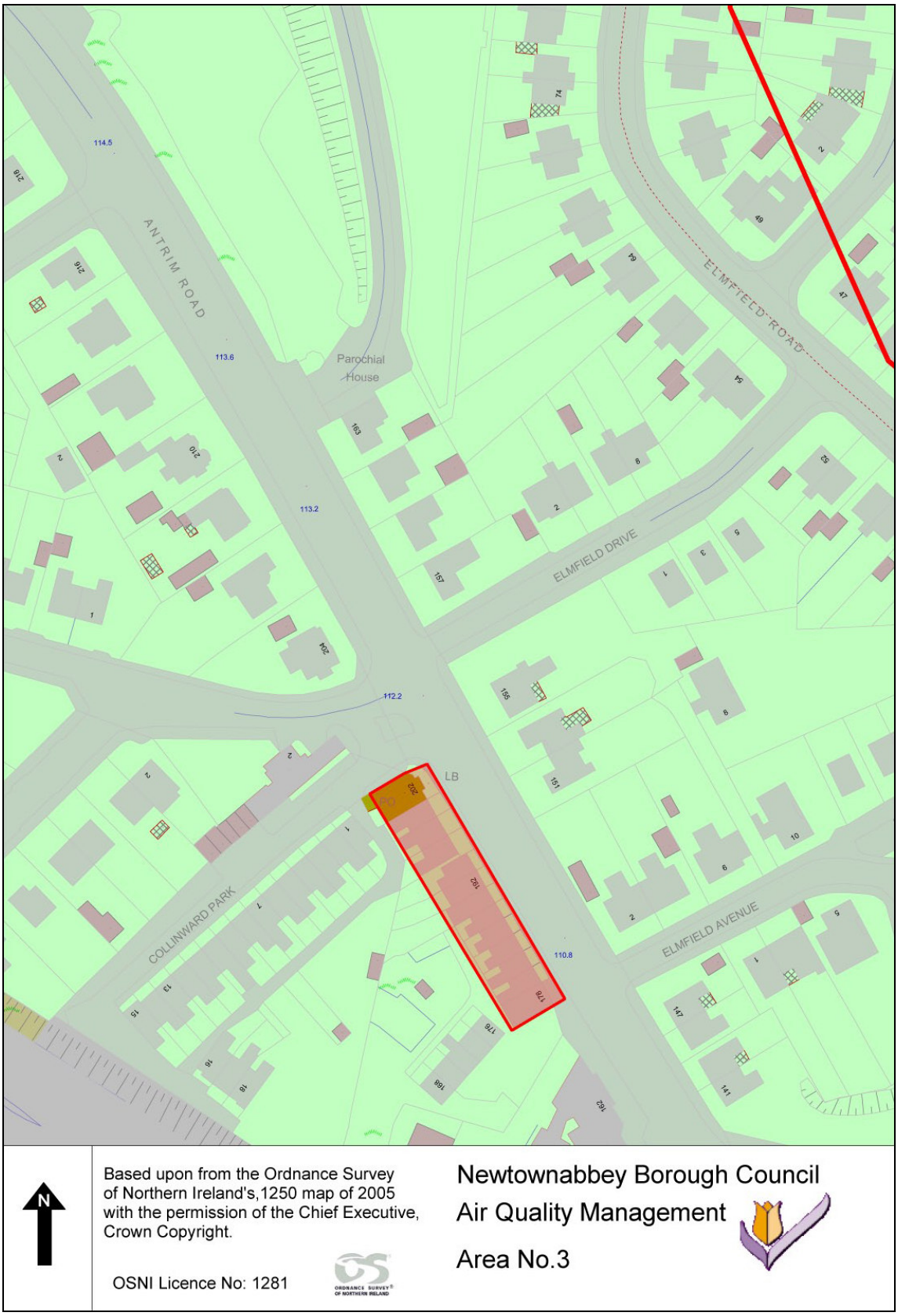
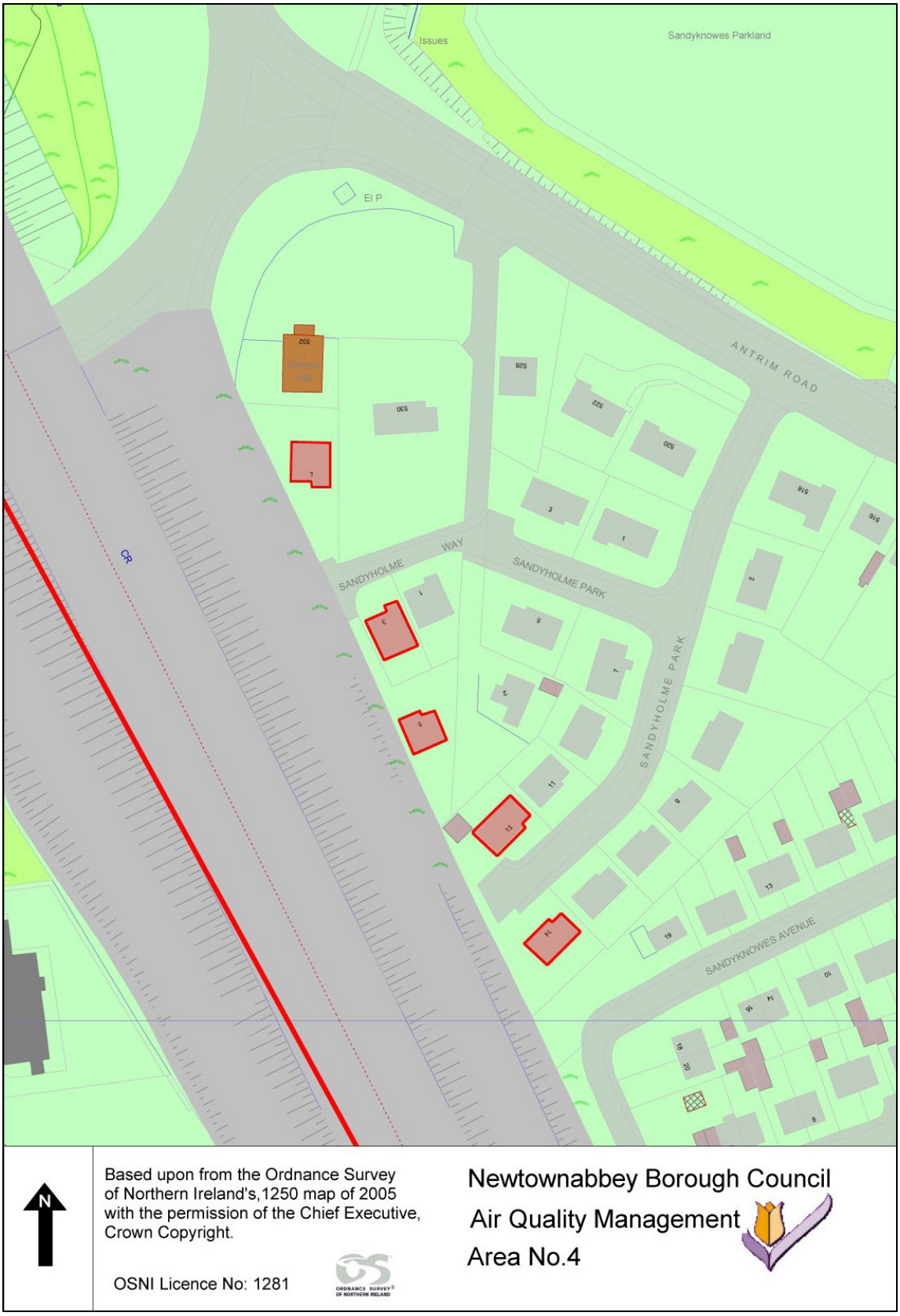


Figure 1-3 Air Quality Management Area 4, Sandyknowes, Newtownabbey



1.4 Overview of the approach taken

The general approach taken to this Detailed Assessment was to:

- Identify potential "hot spots" where there is expected to be the greatest potential for public exposure in the general area identified in the diffusion tube survey. These ''hot spots'' were:
    1. Traffic lights – Antrim Road, Emfield
    2. Traffic lights – Main Street, Ballyclare
    3. M2 onslip - Sandyknowes
- 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 diffusion tubes to assess the ambient concentrations produced by the road traffic and to calibrate the output of modelling studies;
- Model the concentrations of nitrogen dioxide around the potential hotspots, 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;
- Assess the contribution made from various sources to the pollutant concentrations;
- Confirm the Air Quality Management Area already declared and provide recommendations if the declared AQMAs should be redefined.

1.5 Relevant DEFRA documentation used

This report takes into account the guidance in LAQM.TG(03), published January 2003 and updated guidance available as Frequently Asked Questions on the Review and Assessment website hosted by the University of the West of England (UWE).

1.6 Pollutants considered in this report

Table 1-2 lists the pollutants included in the Air Quality Regulations for the purposes of Review and Assessment. Nitrogen dioxide is considered in this report.

Table 1-2 Objectives included in the Air Quality Regulations (NI) 2003 for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 μg m^{-3}	Running annual mean	31.12.2003
	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	10.0 mg m^{-3}	Maximum daily running 8-hour mean	31.12.2003
Lead	0.5 μg m^{-3}	Annual mean	31.12.2004
	0.25 μg m^{-3}	Annual mean	31.12.2008
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
Particles (PM_{10}) (gravimetric)	50 μg m^{-3}, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40 μg m^{-3}	Annual mean	31.12.2004
Sulphur dioxide	350 μg m^{-3}, not to be exceeded more than 24 times a year	1-hour mean	31.12.2004
	125 μg m^{-3}, not to be exceeded more than 3 times a year	24-hour mean	31.12.2004
	266 μg m^{-3}, not to be exceeded more than 35 times a year	15-minute mean	31.12.2005

1.7 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 1-3 summarises the locations where the objectives should and should not apply.

Table 1-3 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.	

It is unnecessary to consider exceedences of the objectives at any location where public exposure over the relevant averaging period would be unrealistic. Locations should also represent non-occupational exposure.

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 on information presented in previous Review and Assessment reports:

Newtownabbey Borough Council has completed the following review and assessments of air quality to date:

- Stage 1 (2001);
- Stage 2 and 3 update (2004);
- Stage 3 –Domestic Fuel Combustion (2004);
- Stage 4 (2005);
- Progress report (2005);
- Updating and Screening Assessment (2006);
- Progress Report (2007).

2.2 Maps and distances of receptors from roads

Newtownabbey Borough Council provided electronic OS LandLine™ data, which were used in the Geographical Information System (GIS), used 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

Newtownabbey Borough Council provided traffic data for the roads assessed. The data included:

- One hour manual traffic counts for light and heavy duty vehicles;
- Vehicle speeds

Traffic counts provided by Newtownabbey Borough Council were used with the DfT Road Traffic spreadsheet (Tables 3.1, 3.2 and 3.3) to derive the Annual Average Daily Traffic for the M2 on-slip road, Antrim Road, Elmfield, and Main Street, Ballyclare. Additional traffic data for the M2 motorway were obtained from the Department for Regional Development, Road Service Division in Northern Ireland. The base year for the traffic flows was 2008. The 2008 traffic data was projected to 2010 based on the information obtained from the Department for Regional Development, Road Service Division in Northern Ireland, which assumed that the traffic growth will be 3%.

Newtownabbey Borough Council provided traffic queue information. The information indicated traffic queues in both directions in peak hours in Main Street, Ballyclare starting at Park Street and finishing at 28 Main Street, and in Antrim Road, Elmfield, from the traffic lights at 202 Antrim Road, Elmfield to 141 Antrim Road, Elmfield. Emissions from stationary traffic in queues were estimated using the emission factor for vehicles moving at 5 km h^{-1} and taking account of the proportion of the time stationary vehicles are present and the length of road over which emissions take place. The average length of a vehicle queue was based on the information provided by Newtownabbey Borough Council and satellite photographs of the area from Google Earth (2008) and the assumption that a car length is 5 metres.

2.4 Ambient Monitoring

The assessment has considered continuous automatic monitoring data for 2007 from four continuous monitoring stations in Newtownabbey Borough Council. Oxides of nitrogen, nitrogen dioxide and nitric oxides concentrations have been monitored at Sandyknowes (OS 330542 383012) since 2003. This is a roadside site located near Sandyknowes roundabout adjacent to the on-slip road of the M2 motorway (southbound). There are also continuous monitoring stations operating in Main Street, Ballyclare (OS 328851 391134) since December 2007 and Antrim Road, Elmfield (OS 332305 381697) since January 2008. Shore Road site was a long term site operating from April 2003 to September 2007 in Newtownabbey Borough Council.

Sandyknowes, Shore Road, Main Street, Ballyclare and Antrim Road, Elmfield continuous monitoring stations are part of the Calibration Club managed by AEA. Data from these sites are quality assured to the AURN standards as part of the Calibration Club.

Nitrogen dioxide concentrations are measured by ozone chemiluminescence. Ozone chemiluminescence is the reference method specified by the EU NO_2 Directives. Routine calibration of the NO_x analyser was undertaken by the Calibration Club of AEA, using on-site certified calibration gas cylinders provided by Messer UK and traceable to National Calibration Standards. In addition a QA/QC audit which includes calibration of the analyser using zero and span gas standards, and other tests, including for linearity and NO_x converter efficiency was undertaken by AEA. Data are fully ratified by AEA staff using procedures as applied to data from the AURN UK national monitoring network sites.

The locations of the automatic continuous monitoring stations are included in Table 2-1 and also shown in Figures 2-1, 2-2 and 2-3.

Table 2-1 Automatic continuous monitoring stations in the investigated areas

Site	X Grid reference	Y Grid Reference	Type
Sandyknowes	330542	383012	Roadside
Ballyclare, Main St	328851	391134	Roadside
Antrim Road, Elmfield	332305	381697	Roadside
Shore Road	334700	380400	Roadside

Newtownabbey Borough Council operates a network of nitrogen dioxide diffusion tubes across the Borough. The diffusion tubes are exposed for a four-week period. In 2007 the diffusion tubes were analysed by two different laboratories, from January to October by Lambeth Scientific Services Limited and from November until now by Gradko Services using 20% triethylamine in water. Additionally to the Council's network, AEA carried out an extensive diffusion tube survey in the three investigated areas: Sandyknowes, Antrim Road, Elmfield and Main Street, Ballyclare. The study took place from November 2007 until April 2008. The annual mean concentrations from the six-month study were estimated following the guidance given in LAQM TG(03). The tubes from AEA study were analysed by Gradko Services also using 20% triethylamine in water. The locations of the diffusion tubes from the Council network are listed in Table 2-2 and AEA's six-month study diffusion tubes locations are listed in Table 2-3. The locations of the diffusion tubes are also shown in Figures 2-1, 2-2 and 2-3. In

addition, diffusion tubes were collocated with the Sandyknowes monitoring site (AEA study diffusion tube 1, 2 and 3 and Council study diffusion tubes 36, 37 and 38) in 2007.

The location of the monitoring station Antrim Road, Elmfield in Figure 2-2 also represents the location of the co-located diffusion tubes C43 and C58.

Table 2-2 Diffusion tubes' locations Council's network

Tube Number	Location	Easting	Northing
Site 1 (C1)	**Main Street, Ballyclare**	**328854**	**391134**
Site 59 (C59)	**Main Street, Ballyclare**	**328854**	**391134**
Site 57 (C57)	**7 Sandyholme Way**	**330514**	**382939**
site 12 (C12)	**7 Sandyholme Way**	**330514**	**382939**
Site 5 (C5)	Ulster Bank, Hightown Road	331697	382250
Site 8 (C8)	Braden Heights, Rathcoole	333898	381926
Site 11 (C11)	**44 Sandyknowes Avenue**	**330675**	**382586**
Site 16 (C16)	Doagh Village	326136	389539
Site 20 (C20)	A8/Motorway at Sandyknowes	330499	383141
Site 36 (C36)	**NOx Analyser Antrim Road, Elmfield**	**330545**	**383011**
Site 37 (C37)	**NOx Analyser Antrim Road, Elmfield**	**330545**	**383011**
Site 38 (C38)	**NOx Analyser Antrim Road, Elmfield**	**330545**	**383011**
Site 43 (C43)	**Antrim Road, Elmfield at Elmfield Lights**	**332305**	**381697**
Site 58 (C58)	**Antrim Road, Elmfield at Elmfield Lights**	**332305**	**381697**
Site 46 (C46)	**12 Collinbridge Road**	**332193**	**381666**
Site 47 (C47)	**13 Sandyholme Park**	**330554**	**382848**
Site 48 (C48)	**24 Sandyknowes Avenue**	**330631**	**382729**
Site 49 (C49)	**6 Sandyknowes Gardens**	**330641**	**382771**
Site 50 (C50)	**45 Burney's Lane**	**331025**	**382224**
Site 51 (C51)	196 Shore Road	334758	380501
Site 52 (C52)	10 Mill Road	334354	380226
Site 56 (C56)	**5 Sandyholme Park**	**330589**	**382908**

*Sites in **bold** are situated in 3 areas of study*

Table 2-3 Diffusion tubes' locations AEA study

Tube Number	Location	Easting	Northing
Sandyknowes area			
Tube 01	NOx Analyser Antrim Road, Elmfield	330535	383013
Tube 02	NOx Analyser Antrim Road, Elmfield	330535	383013
Tube 03	NOx Analyser Antrim Road, Elmfield	330535	383013
Tube 04	5 Sandyholme Way (Post on fence M2)	330537	382884
Tube 05	5 Sandyholme Way (Garden fence – driveway)	330540	382887
Tube 06	5-7 Sandyholme Way (Fence M2)	330527	382908
Tube 07	7 Sandyholme Way (Fence M2)	330512	382938
Tube 08	7 Sandyholme Way (co-located with C12 and C57)	330514	382939
Tube 09	7 Sandyholme Way (Fence M2, further down from Tube 07)	330509	382944
Tube 10	7 Sandyholme Way (Further down from Tube 08)	330514	382944
Tube 11	8 End Sandyholme Park (Lamppost, align with C47)	330565	382830
Tube 12	10 Sandyholme Park (Lamppost)	330591	382847
Tube 13	T bet Sandyknowes Avenue	330607	382747
Tube 14	2 Sandyknowes Gardens (Lamppost)	330621	382759
Tube 15	24 Sandyknowes Avenue	330617	382722
Antrim Road, Elmfield			
Tube 16	Antrim Road, Elmfield (Traffic lights, outside Pizza Hut)	332361	381606
Tube 17	Antrim Road, Elmfield (Bridge Café)	332338	381637
Tube 18	178 Antrim Road, Elmfield	332326	381656
Tube 19	Elmfield Drive (157 Antrim Road)	332302	381745
Tube 20	180 Antrim Road, Elmfield	332323	381662
Tube 21	184 Antrim Road, Elmfield	332319	381669
Tube 22	190 Antrim Road, Elmfield	332312	381679
Tube 23	198 Antrim Road, Elmfield (Co-located with c58 and C43)	332302	381701
Tube 24	202 Antrim Road, Elmfield	332294	381708
Tube 25	1 Collinward Park, Elmfield (Lamppost)	332281	381712
Tube 26	5 Collinward Park, Elmfield (Lamppost)	332263	381686
Tube 27	Antrim Road, Elmfield (Lamppost, Little Island in front of SPAR shop)	332290	381721
Tube 28	206 Antrim Road, Elmfield (Lamppost)	332274	381752
Tube 29	163 Antrim Road, Elmfield (Lamppost)	332274	381788
Tube 30	161 Antrim Road, Elmfield	332288	381771
Main Street, Ballyclare			
Tube 31	17 Main Street, Ballyclare (Lamppost)	329005	391005
Tube 32	Main Street, Ballyclare (Lamppost – over the river)	328967	391034
Tube 33	45-47 Main Street, Ballyclare (Lamppost)	328882	391097
Tube 34	49-49a Main Street, Ballyclare (Lamppost)	328864	391108
Tube 35	55 Main Street, Ballyclare (Lamppost)	328843	391120
Tube 36	Harrier Way, Ballyclare (Top of alleyway)	328827	391078
Tube 37	63-65 Main Street, Ballyclare (Lamppost)	328824	391134
Tube 38	75-77 Main Street, Ballyclare (Lamppost)	328795	391157
Tube 39	83 Main Street, Ballyclare (Lamppost)	328777	391178
Tube 40	68 Main Street, Ballyclare (Post)	328808	391161
Tube 41	58 Main Street, Ballyclare	328830	391148
Tube 42	56 Main Street, Ballyclare (Post)	328845	391137
Tube 43	50 Main Street, Ballyclare (co-located with C1 and C59)	328852	391133
Tube 44	42 Main Street, Ballyclare	328889	391114
Tube 45	32 Main Street, Ballyclare	328926	391081

Figure 2-1 Monitoring sites' locations in Sandyknowes, 2007

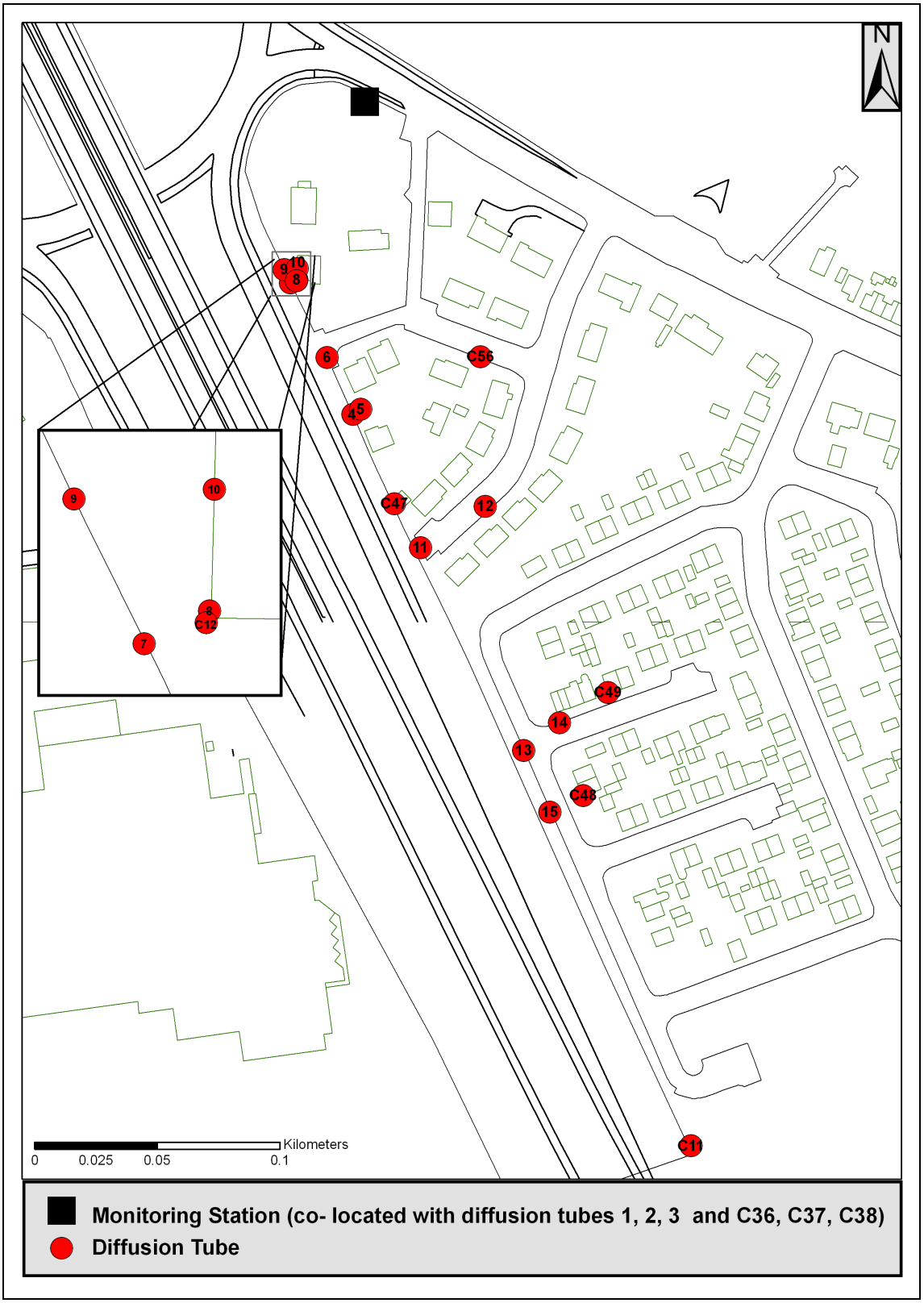


Figure 2-2 Monitoring sites' locations in Antrim Road, Elmfield, 2007

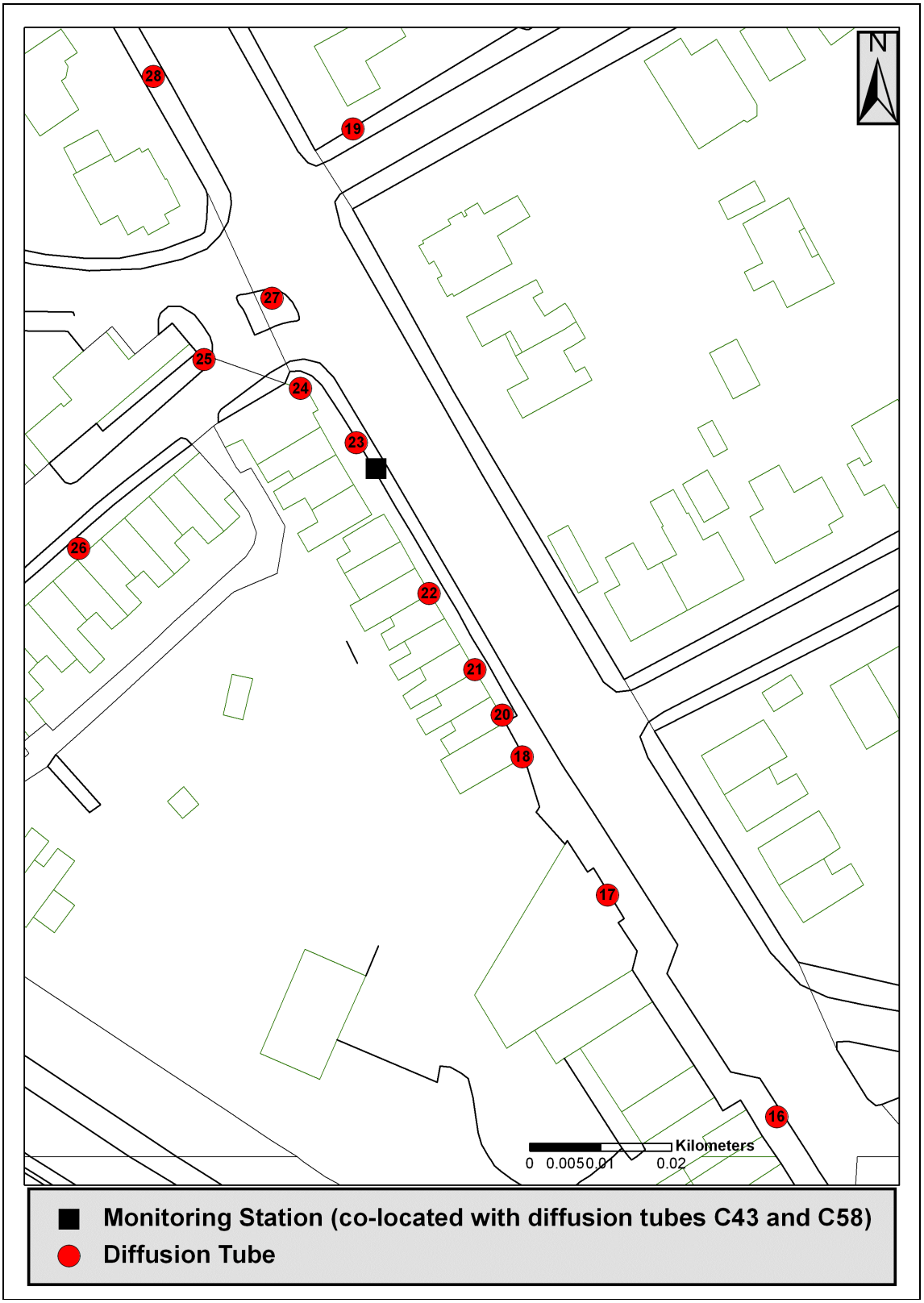
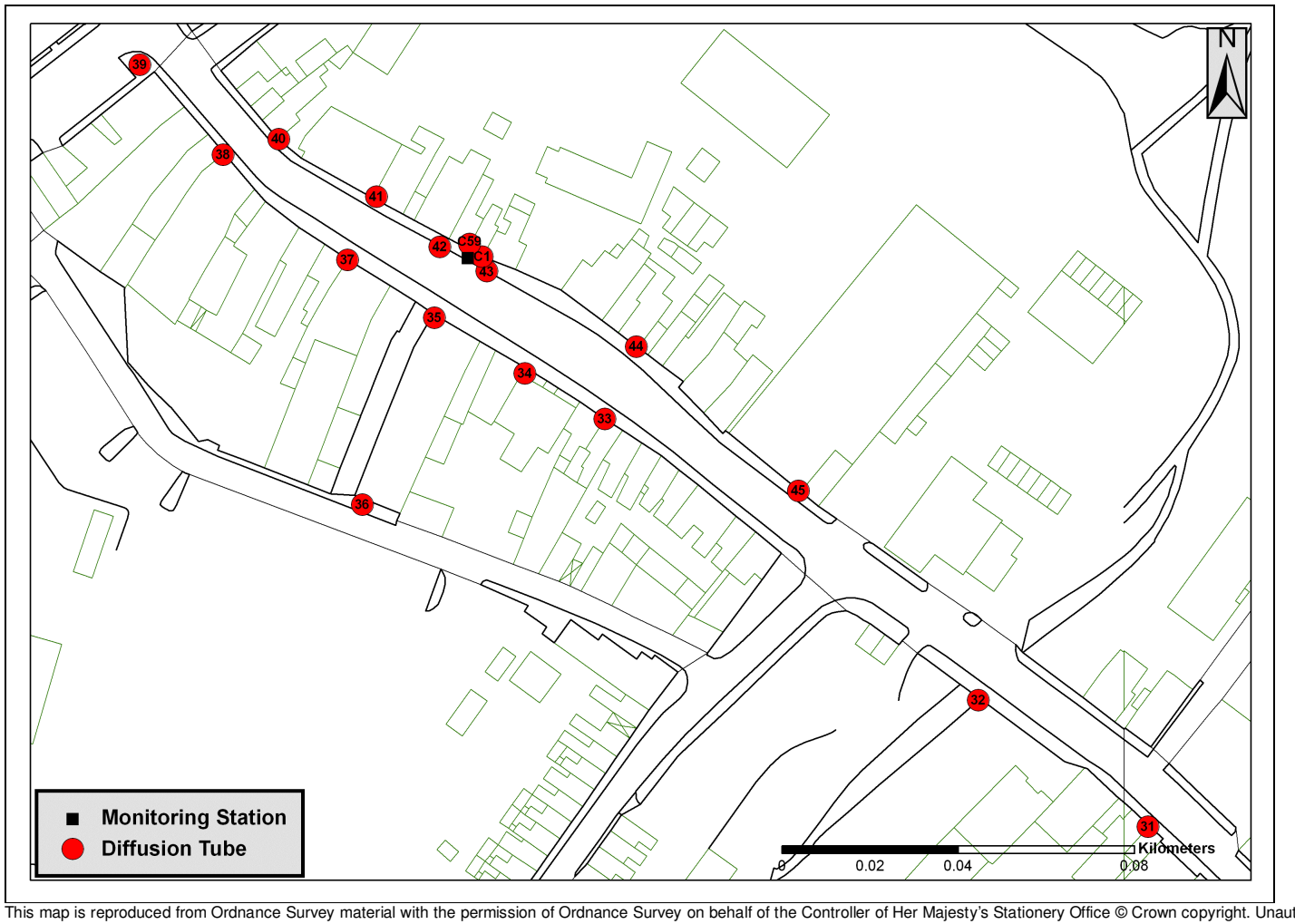


Figure 2-3 Monitoring sites' locations in Main Street, Ballyclare, 2007



2.5 Emission factors

The vehicle emission factors used for national mapping have recently been revised by DEFRA and the devolved administrations. The most recent emission factors have been used in this detailed assessment.

3 Detailed Assessment for Nitrogen Dioxide

3.1 The national perspective

The principal source of NO_x emissions is road transport, which was accounted for about 37% of total UK emissions in 2005. 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. If annual mean is achieved, the modelling suggests that the hourly objectives will also be achieved. 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.

3.2 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 μg m^{-3}, and a 1-hour mean concentration of 200 μg m^{-3} not to be exceeded more than 18 times per year. The objectives were to be achieved by the end of 2005 and 2010.

3.3 Background concentrations for nitrogen dioxide

The estimated annual average background nitrogen dioxide concentration provided by the UK background maps for 2007 was 7.4 μg m^{-3} averaged across Newtownabbey Borough with a maximum concentration of 17.2 μg m^{-3}.

The estimated annual average background oxides of nitrogen concentration provided by the UK background maps, for 2007 was 9.2 μg m^{-3} averaged across Newtownabbey Borough with a maximum concentration of 21.8 μg m^{-3}.

3.4 Assessment of monitoring data

3.4.1 Continuous monitoring data

Table 3-1 summarises the measurements of nitrogen dioxide concentrations at continuous monitoring stations in Newtownabbey Borough Council in 2007. The data measured in 2008 at Main Street, Ballyclare and in Antrim Road, Elmfield were scaled down to 2007 following the instruction from TG(03) – Box 6.5. Data from Belfast Centre, Derry, Dumfries, Fort William, and Inverness monitoring sites were used to calculate the factors used to scale down the concentrations to 2007.

Table 3-1 Continuous monitoring data

Site	Period	NO_2 annual mean concentration, µg m^{-3}	Data capture %	NO_2 hourly mean exceedances µg m^{-3}
Sandyknowes	2007	34.0	94.9	6
	Jan – Nov 2008	33.0	98.0	3
Shore Road*	Jan - Sep 2007	28.0	97.1	0
Main Street, Ballyclare	2007	35.9	n/a	-
	Jan – Nov 2008	37.0	99.0	0
Antrim Road, Elmfield	2007	51.6	n/a	-
	Jan – Nov 2008	52.0	89.9	35

- ***Shore Road*** *monitoring station was decommissioned in September 2007*
- *Air Pollution Reports for each monitoring station - Appendix 3*

Both the annual mean and hourly mean nitrogen dioxide objectives were exceeded in Antrim Road, Elmfield in 2007. The automatic monitoring site is located in AQMA 3 (Antrim Road, Elmfield), which was declared based on the breach of the nitrogen dioxide annual mean objective. It is suggested that the Council should amend the AQMA order of this area to include the nitrogen dioxide hourly mean objective and should also consider Action Plan measures that would take this into consideration. The 2007 annual mean nitrogen dioxide concentration measured at Sandyknowes, Shore Road and Main Street, Ballyclare was below the air quality objective of 40 µg m^{-3}.

3.4.2 Diffusion Tube Results

Diffusion tube measurements for nitrogen dioxide were taken at many locations during 2007. However, this report only considers the measurements taken and analysed over the six-month period, November 2007 to April 2008, from the Council's survey and extensive AEA study for the same period.

The laboratory bias correction factor was calculated using the diffusion tube spreadsheet tool and co-location study at Sandyknowes monitoring station. This diffusion tube spreadsheet tool is published by Air Quality Consultants Ltd on behalf of Defra, the Welsh Assembly Government, the Scottish Executive and the Department of the Environment Northern Ireland and it is available on the UWE website (2008). In 2007, the diffusion tubes in Newtownabbey Borough Council, were analysed by two different laboratories:

- from January to September 2007 by Lambeth Scientific Services;
- from October 2007 onwards by Gradko Services.

A bias adjustment factor of 1.07 was calculated, for the study carried out from January to September, from the - diffusion tube - spreadsheet tool, which used 13 studies from Lambeth Scientific Services for 2007(Appendix 2 – Table A2-1). The measured results from the study conducted from January to September are listed in the Table 3-3A. The laboratory performance for this study was not considered satisfactory. The measured results from this survey are presented to show the continuity of monitoring in Newtownabbey Borough Council, however the results were not used for to validate the model.

The bias adjustment factor of 0.89 was calculated from 17 studies from Gradko Services for 2007 using the diffusion tube spreadsheet tool, for the Council Study commenced in October 2007 and AEA study started in November 2007 (Appendix 2 – Table A2-2).

A local co-location study is carried out by exposing triplicate tubes at the location of the automatic station. The Council carried out a co-location study at Sandyknowes, which was duplicated during the six month extensive study carried out by AEA. A bias adjustment factor of 0.83 was calculated from the diffusion tubes co-located with the Sandyknowes site. This was done using the AEA Energy and

Environments "Spreadsheet for calculating Precision, Accuracy and Bias Adjustment factors of Diffusion Tubes'' (Appendix 2 – Table A2-3).

Both bias adjustment factors calculated from these two studies were applied to the raw diffusion tube data from two surveys analysed by Gradko Services laboratory.

To predict 2010 concentrations, the "Year Adjustment Calculator (v2.2a)" was used from the UK National Air Quality Information Archive website (2008). A factor of 0.90 was applied to estimate the annual average concentrations in 2010 from 2007 data.

Table 3-2 shows the nitrogen dioxide concentration measured by diffusion tubes located within the three AQMAs from the AEA study.

Table 3-2 Annual Mean Nitrogen Dioxide, µg m^{-3}, AEA study

Tube Number	Location	2007 Annual Mean	Corrected with Local Bias Factor		Corrected with National Bias Factor	
			2007 Annual Mean	Scaled to 2010	2007 Annual Mean	Scaled to 2010
Sandyknowes area						
Tube 01	NOx Analyser Antrim Road, Elmfield	41.0	34.1	31.4	36.5	32.9
Tube 02	NOx Analyser Antrim Road, Elmfield	41.5	34.4	31.7	36.9	33.2
Tube 03	NOx Analyser Antrim Road, Elmfield	41.9	34.8	32.0	37.3	33.6
Tube 04	5 Sandyholme Way (Post on fence M2)	53.4	**44.3**	**40.8**	**47.5**	**42.8**
Tube 05	5 Sandyholme Way (Garden fence – driveway)	41.2	34.2	31.5	36.7	33.0
Tube 06	5-7 Sandyholme Way (Fence M2)	48.8	**40.5**	37.3	**43.4**	39.1
Tube 07	7 Sandyholme Way (Fence M2)	47.4	39.4	36.3	**42.2**	38.0
Tube 08	7 Sandyholme Way (co-located with C12 and C57)	45.3	37.6	34.6	**40.3**	36.3
Tube 09	7 Sandyholme Way (Fence M2, further down from Tube 07)	47.8	**39.7**	36.6	**42.6**	38.3
Tube 10	7 Sandyholme Way (Further down from Tube 08)	40.1	33.3	30.7	35.7	32.1
Tube 11	8 End Sandyholme Park (Lamppost, align with C47)	45.3	37.6	34.7	**40.4**	36.3
Tube 12	10 Sandyholme Park (Lamppost)	37.2	30.9	28.5	33.2	29.8
Tube 13	T bet Sandyknowes Avenue	46.3	38.5	35.4	**41.2**	37.1
Tube 14	2 Sandyknowes Gardens (Lamppost)	43.5	36.1	33.3	38.7	34.9
Tube 15	24 Sandyknowes Avenue	50.4	**41.8**	38.5	**44.9**	**40.4**
Antrim Road, Elmfield						
Tube 16	Antrim Road, Elmfield (Traffic lights, outside Pizza Hut)	50.2	**41.6**	38.3	**44.6**	**40.2**
Tube 17	Antrim Road, Elmfield (Bridge Café)	49.7	**41.2**	38.0	**44.2**	**39.8**
Tube 18	178 Antrim Road, Elmfield	47.8	**39.7**	36.6	**42.6**	38.3
Tube 19	Elmfield Drive (157 Antrim Road)	35.4	29.4	27.1	31.5	28.4
Tube 20	180 Antrim Road, Elmfield	52.5	**43.6**	**40.2**	**46.8**	**42.1**
Tube 21	184 Antrim Road, Elmfield	53.5	**44.4**	**40.9**	**47.6**	**42.9**
Tube 22	190 Antrim Road, Elmfield	53.9	**44.7**	**41.2**	**47.9**	**43.1**
Tube 23	198 Antrim Road, Elmfield (Co-located with c58 and C43)	53.5	**44.4**	**40.9**	**47.6**	**42.8**

Tube Number	Location	2007 Annual Mean	Corrected with Local Bias Factor		Corrected with National Bias Factor	
			2007 Annual Mean	Scaled to 2010	2007 Annual Mean	Scaled to 2010
Tube 24	202 Antrim Road, Elmfield	35.6	29.6	27.2	31.7	28.5
Tube 25	1 Collinward Park, Elmfield (Lamppost)	35.0	29.0	26.8	31.2	28.1
Tube 26	5 Collinward Park, Elmfield (Lamppost)	33.6	27.9	25.7	29.9	26.9
Tube 27	Antrim Road, Elmfield (Lamppost, Little Island in front of SPAR shop)	43.7	36.3	33.4	38.9	35.0
Tube 28	206 Antrim Road, Elmfield (Lamppost)	47.9	**39.7**	36.6	**42.6**	38.3
Tube 29	163 Antrim Road, Elmfield (Lamppost)	43.2	35.8	33.0	38.4	34.6
Tube 30	161 Antrim Road, Elmfield	31.1	25.8	23.7	27.6	24.9
Main Street, Ballyclare						
Tube 31	17 Main Street, Ballyclare (Lamppost)	52.9	**43.9**	**40.4**	**47.1**	**42.4**
Tube 32	Main Street, Ballyclare (Lamppost – over the river)	27.8	23.1	21.3	24.8	22.3
Tube 33	45-47 Main Street, Ballyclare (Lamppost)	46.2	38.4	35.3	**41.1**	37.0
Tube 34	49-49a Main Street, Ballyclare (Lamppost)	46.8	38.8	35.7	**41.6**	37.5
Tube 35	55 Main Street, Ballyclare (Lamppost)	23.0	19.0	17.6	20.5	18.4
Tube 36	Harrier Way, Ballyclare (Top of alleyway)	19.9	16.6	15.2	17.7	16.0
Tube 37	63-65 Main Street, Ballyclare (Lamppost)	43.8	36.4	33.5	38.9	35.1
Tube 38	75-77 Main Street, Ballyclare (Lamppost)	48.1	**39.9**	36.8	**42.8**	38.6
Tube 39	83 Main Street, Ballyclare (Lamppost)	32.6	27.0	24.9	29.0	26.1
Tube 40	68 Main Street, Ballyclare (Post)	32.4	26.9	24.8	28.8	25.9
Tube 41	58 Main Street, Ballyclare	33.6	27.9	25.7	29.9	26.9
Tube 42	56 Main Street, Ballyclare (Post)	40.3	33.5	30.8	35.9	32.3
Tube 43	50 Main Street, Ballyclare (co-located with C1 and C59)	34.2	28.4	26.1	30.4	27.4
Tube 44	42 Main Street, Ballyclare	29.7	24.7	22.7	26.4	23.8
Tube 45	32 Main Street, Ballyclare	38.6	32.0	29.5	34.4	31.0

Table 3-3A shows the nitrogen dioxide concentration measured by diffusion tubes from the Council study, from January to September 2007. These diffusion tubes were analysed by Lambeth Scientific Services laboratory.

Table 3-3A Annual Mean Nitrogen Dioxide, µg m^{-3}, Council study (Lambeth Scientific Services)

Tube Number	Location	2007 Annual Mean	Corrected with National Bias Factor	Scaled up 2010
Site 1	**Main Street, Ballyclare**	24.3	25.9	22.8
Site 59	**Main Street, Ballyclare**	-	-	-
Site 57	**7 Sandyholme Way**	-	-	-
Site 12	**7 Sandyholme Way**	26.7	28.5	25.1
Site 5	Ulster Bank, Hightown Road	22.4	23.9	21.1
Site 8	Braden Heights, Rathcoole	10.9	11.7	10.3
Site 11	**44 Sandyknowes Avenue**	28.1	30.1	26.5
Site 16	Doagh Village	19.3	20.7	18.2
Site 20	A8/Motorway at Sandyknowes	21.4	22.9	20.2
Sites 36,37,38	**NOx Analyser Antrim Road**	28.3	30.3	26.6
Site 39,40,41	NOx Analyser Shore Road	21.0	22.5	19.8
Site 43	**Antrim Road at Elmfield Lights**	30.0	32.1	28.2
Site 58	**Antrim Road at Elmfield Lights**	-	-	-
Site 45	B&Q Lamppost	24.0	25.7	22.6
Site 46	**12 Collinbridge Road**	28.6	30.6	26.9
Site 47	**13 Sandyholme Park**	31.0	33.2	29.2
Site 48	**24 Sandyknowes Avenue**	24.3	25.9	22.8
Site 49	**6 Sandyknowes Gardens**	22.2	23.8	20.9
Site 50	**45 Burney's Lane**	27.7	29.6	26.1
Site 51	196 Shore Road	22.6	24.1	21.2
Site 52	10 Mill Road	24.7	26.4	23.2
Site 56	**5 Sandyholme Park**	19.3	20.6	18.2

The nitrogen dioxide concentrations measured at all sites were below the air quality objective.

Table 3-3B shows the nitrogen dioxide concentration measured by diffusion tubes from the Council study, from October 2007 to April 2008. These diffusion tubes were analysed by Gradko Services laboratory.

Table 3-3B Annual Mean Nitrogen Dioxide, µg m^{-3}, Council study (Gradko Srvices)

Tube Number	Location	2007 Annual Mean	Corrected with Local Bias Factor		Corrected with National Bias Factor	
			2007 Annual Mean	Scaled to 2010	2007 Annual Mean	Scaled to 2010
Site 1	**Main Street, Ballyclare**	**36.2**	**30.0**	**27.7**	**32.2**	**29.0**
Site 59	**Main Street, Ballyclare**	**32.7**	**27.2**	**25.0**	**29.1**	**26.2**
Site 57	**7 Sandyholme Way**	**43.2**	**35.9**	**33.1**	**38.5**	**32.8**
Site 12	**7 Sandyholme Way**	**41.0**	**34.0**	**31.3**	**36.5**	**27.8**
Site 5	Ulster Bank, Hightown Road	29.1	24.2	22.3	25.9	23.3
Site 8	Braden Heights, Rathcoole	24.0	19.9	18.4	21.4	19.2
Site 11	**44 Sandyknowes Avenue**	**41.4**	**34.3**	**31.6**	**36.8**	**33.1**
Site 16	Doagh Village	28.6	23.8	21.9	25.5	22.9
Site 20	A8/Motorway at Sandyknowes	34.9	29.0	26.7	31.1	28.0
Site 36	**NOx Analyser Antrim Road, Elmfield**	**41.9**	**34.7**	**32.0**	**37.3**	**33.5**
Site 37	**NOx Analyser Antrim Road, Elmfield**	**44.1**	**36.6**	**33.7**	**39.3**	**35.3**
Site 38	**NOx Analyser Antrim Road, Elmfield**	**40.3**	**33.5**	**30.8**	**35.9**	**32.3**
Site 43	**Antrim Road, Elmfield at Elmfield Lights**	**51.0**	**42.3**	**39.0**	**45.4**	**40.8**
Site 58	**Antrim Road, Elmfield at Elmfield Lights**	**50.7**	**42.0**	**38.8**	**45.1**	**40.6**
Site 46	**12 Collinbridge Road**	**39.2**	**32.5**	**30.0**	**34.9**	**31.4**
Site 47	**13 Sandyholme Park**	**50.3**	**41.7**	**38.4**	**44.7**	**40.3**
Site 48	**24 Sandyknowes Avenue**	**34.3**	**28.5**	**26.2**	**30.5**	**27.5**
Site 49	**6 Sandyknowes Gardens**	**30.7**	**25.5**	**23.5**	**27.3**	**24.6**
Site 50	**45 Burney's Lane**	**35.1**	**29.2**	**26.9**	**31.3**	**28.1**
Site 51	196 Shore Road	35.8	29.7	27.4	31.9	28.7
Site 52	10 Mill Road	33.0	27.4	25.2	29.4	26.4
Site 56	**5 Sandyholme Park**	**35.9**	**29.8**	**27.5**	**32.0**	**28.8**

*Sites in **bold** are situated in 3 areas of study*

The AEA study was conducted only in three investigated areas while the Council's survey is widely spread around the Borough with some tubes located in the designated AQMAs. There were exceedances of the nitrogen dioxide annual mean objective in all three areas. The highest nitrogen dioxide annual mean concentration was measured at the following locations:

- 5 Sandyholme Way (Sandyknowes - AQMA) - location of Tube 04 of 44.3 µg m $^{-3}$;
- 190 Antrim Road (Elmfield - AQMA) - location of Tube 22 of 44.7 µg m $^{-3}$;
- 17 Main Street (Ballyclare – AQMA) - location of Tube 31 of 43.9 µg m $^{-3}$.

These concentrations were derived when a local bias adjustment factor was used.

However, when a national bias adjustment factor was used, more diffusion tubes measured concentrations of nitrogen dioxide above the objective of 40 µg m $^{-3}$ and the highest nitrogen dioxide annual mean concentration was measured at:

- 5 Sandyholme Way (Sandyknowes - AQMA) - location of Tube 04 of 47.5µg m $^{-3}$;
- 190 Antrim Road (Elmfield – AQMA)- location of Tube 22 of 47.9 µg m $^{-3}$;
- 17 Main Street (Ballyclare – AQMA) - location of Tube 31 of 47.1 µg m $^{-3}$.

3.5 Overview of the air quality modelling

3.5.1 Summary of the models used

To model the air quality impact from roads in Sandyknowes and Antrim Road, Elmfield our proprietary urban model (LADS Urban) was used. 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 2006 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 ADMS4 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 vehicle emission factors.

The air quality impacts from roads in Main Street, Ballyclare have been assessed using *the AEOLIUSF VERSION 1.4 model (AEOLIUS)*. This model calculates hourly concentrations of air pollutant concentrations in street canyons, taking account of wind direction and street orientation. It was developed by the Met Office and is used in Review and Assessment air quality modelling where street canyon effects are present.

Concentrations of NO_2 from road traffic emissions were modelled with a resolution of 10 m close to the roads as recommended in the Technical Guidance LAQM.TG (03).

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

Hourly sequential meteorological data for the nearest suitable meteorological station with adequate data capture was obtained at Belfast Aldergrove for 2007 and was used for this assessment. The meteorological data provided information on wind speed and direction and the extent of cloud cover for each hour of the year.

A surface roughness of 1 m was used in the modelling to represent the urban conditions corresponding to the most exposed sites. A limit for the Monin-Obukhov length of 30 m was applied to take into account the urban heat effect in the town. An intelligent gridding system was used with receptors at 10 m intervals on a rectangular grid within 150 m of the modelled roads and more widely spaced receptors elsewhere.

A rural background oxides of nitrogen concentration of 9.2 $\mu g\ m^{-3}$ was estimated for 2007 from the UK background maps for the area of Newtownabbey Borough Council.

The AEOLIUS model was used to calculate the annual average concentrations in the street canyon along Main Street, Ballyclare. This was done because Main Street, Ballyclare has buildings on both sides of the road forming a street canyon, which can lead to the formation of vortices and re-circulation of air flow that can trap pollutants and restrict dispersion. Street canyons can generally be defined as narrow streets where the height of buildings on both sides of the road is greater than the road width. Locations on the windward side of a canyon can have greater dispersion and ventilation leading to lower pollutants levels, while pollutants can become trapped on the leeward side, particularly when wind directions are perpendicular to the orientation of the street. However, over short time periods wind flows can reverse, this highlight the level of complexity of dispersion in these circumstances. A building height of 10 m and road width of 8 m was used in the model.

The netcen primary NO_2 model (AQEG 2007) was used to calculate nitrogen dioxide concentrations from the oxides of nitrogen concentrations predicted by LADS Urban. The model takes into account the background ozone, nitrogen dioxide and nitric oxide concentrations, the proportion of the oxides of nitrogen released from vehicles as nitrogen dioxide and the exposure of the site to sunlight.

All the models used in this assessment make a number of assumptions during the calculations. These include no consideration of terrain relief over the surface being modelled. Modelling of pollutant concentrations on roads can sometimes provide misleading information on produced contour maps. For example, polygons and circles on certain areas of the contour maps, e.g. roundabouts or the centres of roads can be generated. This is not a deficiency in the model – it is an artefact of the data and the use of discreet receptor points. As such, these additional features should be ignored and the wider context and implications of the contour maps be considered.

3.5.2 Validation and verification of the LADS model (Sandyknowes and Antrim Road, Elmfield AQMA's)

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 **AEA** air quality review and assessments.

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Table 3-4 compares modelled predictions using LADS Urban of oxides of nitrogen and nitrogen dioxide concentrations with measured values at the diffusion tubes locations in the study areas.

The model gave a good agreement between the modelled and the measured oxides of nitrogen concentrations for most of the diffusion tubes locations. Modelled nitrogen dioxide concentrations were compared with measured nitrogen dioxide concentrations.

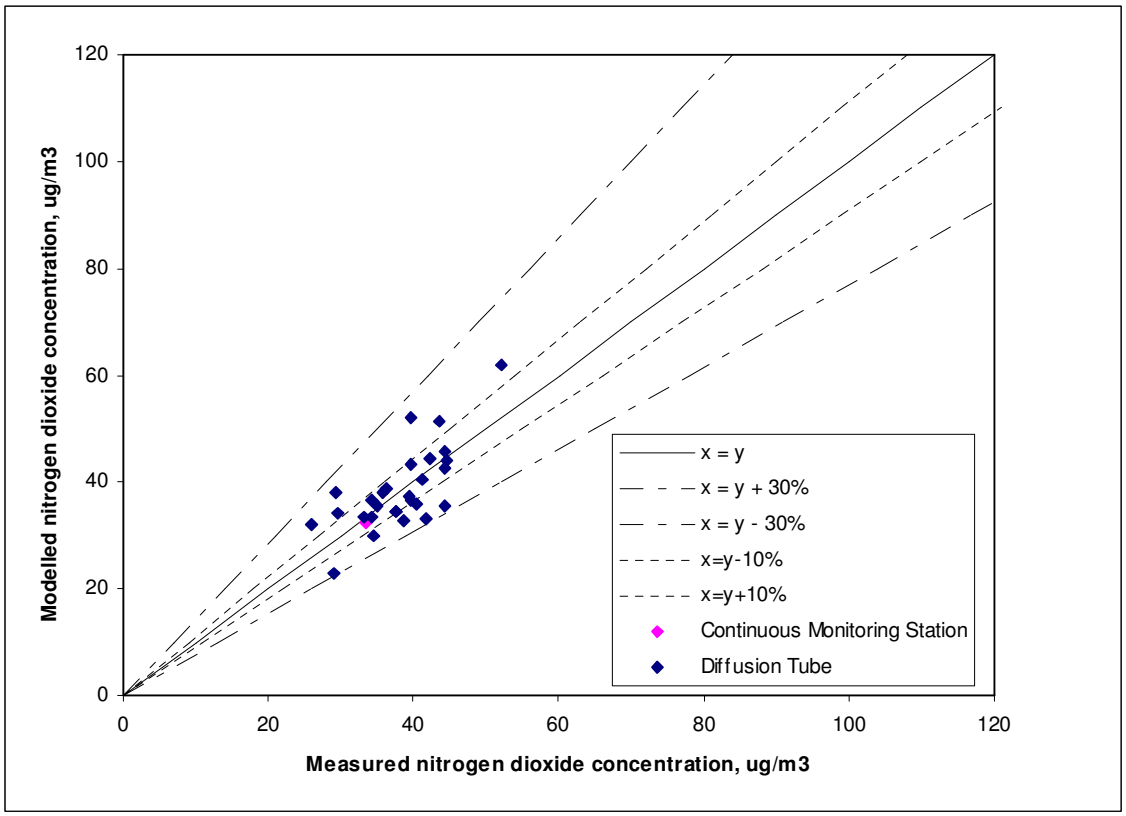
Table 3-4 and Figure 3-1 show the comparison between the modelled nitrogen dioxide with measured nitrogen dioxide. As can be seen in Table 3-4, all modelled nitrogen dioxide results have an acceptable agreement with the nitrogen dioxide measured concentrations.

Table 3-4 Comparison of modelled and measured nitrogen dioxide concentrations, 2007

Tube number	Location	Nitrogen dioxide concentration, µg m^{-3}		Difference %
		Modelled	Measured (Local Bias Adjustment Factor applied)	
Tube 9	7 Sandyholme Way (Fence M2)	36.4	39.7	-8
Tube 7	7 Sandyholme Way (Fence M2)	37.2	39.4	-6
Tube 8	7 Sandyholme Way	34.5	37.6	-8
Tube10	7 Sandyholme Way (Fence M2)	33.4	33.3	0
Tube 6	5-7 Sandyholme Way (Fence M2)	35.9	40.5	- 11
Tube 1-3	NOx Analyser Antrim Road, Elmfield	29.8	34.4	-13
Tube 4	5 Sandyholme Way (Post on fence M2)	35.5	44.3	-20
Tube 5	5 Sandyholme Way (Garden fence)	33.3	34.2	-3
Site 36-38 (C36-C38)	NOx analyser Antrim Road, Elmfield	35.6	34.9	2
Tube 11	8 End Sandyholme Park (Lamppost)	34.5	37.6	-8
Tube 13	T bet Sandyknowes Avenue	32.7	38.5	-15
Tube 15	24 Sandyknowes Avenue	33.0	41.8	-21
Site 11 (C11)	44 Sandyknowes Avenue	36.7	34.3	7
Tube 28	206 Antrim Road, Elmfield (Lamppost)	43.3	39.7	9
Tube 29	163 Antrim Road, Elmfield (Lamppost)	38.1	35.8	6
Tube 25	1 Collinward Park	22.8	29.0	-21
Tube 30	161 Antrim Road, Elmfield	31.9	25.8	24
Tube 27	Antrim Road, Elmfield (Lamppost)	38.9	36.3	7
Tube 24	202 Antrim Road, Elmfield	34.0	29.6	15
Tube 19	Elmfield Drive	37.8	29.4	29
Tube 23	198 Antrim Road, Elmfield (Lamppost)	45.7	44.4	3
Site 58 (C58)	Antrin Road at Elmfield Lights	61.8	52.0	19
Tube 22	190 Antrim Road, Elmfield	44.0	44.7	-2
Tube 21	184 Antrim Road, Elmfield	42.5	44.4	-4
Tube 20	180 Antrim Road, Elmfield	51.4	43.6	18
Tube 18	178 Antrim Road, Elmfield	52.0	39.7	31
Tube 17	Antrim Road, Elmfield (Bridge Café)	40.3	41.2	-2
Tube 16	Antrim Road, Elmfield (outside Pizza Hut)	44.3	41.6	5
Sandyknowes MS	Antrim Road	37.2	33.5	11

The model predicts well the adjusted diffusion tube data in Newtownabbey in 2007. In the modelled areas the model predicts within 30% of the diffusion tube value at 27 of 28 sites and within 10% at sixteen of twenty-eight sites.

Figure 3-1 The agreement between modelled and measured NO_2 concentrations, Sandyknowes and Antrim Road, Elmfield



There are a number of possible explanations accounting for the discrepancies between measured and modelled concentrations. Uncertainty regarding traffic speeds, queuing and congestion are likely to have led to some errors in the calculation of emissions.

3.5.3 Validation and verification of the AEOLIOUS model (Ballyclare AQMA)

Tables 3-5 and 3-6 present the modelled and measured nitrogen dioxide concentrations for 2007 in Newtownabbey Borough Council along Main Street, Ballyclare.

Modelled nitrogen dioxide concentrations were compared with measured nitrogen dioxide concentrations. The model gives an acceptable agreement between the modelled and the measured nitrogen dioxide concentrations for the average concentration of the diffusion tubes located on the leeward and windward side of the road.

The model predicts well the nitrogen dioxide concentrations on both sides of the street canyon. The percentage difference between modelled and measured nitrogen dioxide concentrations (corrected with the local bias adjustment factor) for the leeward side (left hand side) of the street canyon was 13% and for the windward side (right hand side) of the street canyon was 18%. However when the national bias adjustment factor was used to correct the raw diffusion tube data, the percentage difference for the leeward side of the street canyon was 6.8% and for windward side of the street canyon was 11.6%.

Table 3-5 Modelled and measured nitrogen dioxide concentrations on the leeward side of the street canyon, Main Street, Ballyclare, 2007

Diffusion Tube No	2007 Annual Mean	2007 NO_2 Average corrected with Local Bias Adjustment Factor	2007 NO_2 Average corrected with National Bias Adjustment Factor	Modelled NO_2 concentrations
31	52.9	**35.4**	**37.9**	40.5
32	27.8			
33	46.2			
34	46.8			
37	43.8			
38	48.1			
39	32.6			

Diffusion tube No 31 measured the highest concentration on the leeward side of the road this could be because the location of the tube was close to a traffic junction. Diffusion tube 35 was located on the leeward side of Main Street, Ballyclare. This diffusion tube measured lower nitrogen dioxide concentrations than the rest of the diffusion tubes placed on this side of the road. This is because tube No 35 was located next to a pathway and not in the street canyon.

Table 3-6 Modelled and measured nitrogen dioxide concentrations on the windward side of the street canyon, Main Street, Ballyclare, 2007

Diffusion Tube No	2007 Annual Mean	2007 NO_2 Average corrected with Local Bias Adjustment Factor	2007 NO_2 Average corrected with National Bias Adjustment Factor	Modelled NO_2 concentrations
40	32.4	**28.8**	**30.9**	34.5
41	33.6			
42	40.3			
43	34.2			
44	29.7			
45	38.6			
C1	36.2			
C59	32.7			

3.5.4 Model uncertainty

The results of dispersion modelling of pollutant concentrations are necessarily uncertain because of the uncertainties in the estimation of rates of emission, meteorological data and dispersion conditions. Table 3-7 shows confidence levels for modelled nitrogen dioxide concentrations based on a statistical analysis of a comparison of modelled and measured concentrations in London TG(03). In this report, we present predicted concentrations as contour plots superimposed on a map of the local area. The concentration values selected reflect the uncertainty bands shown in Table 3-7. Predicted concentrations in excess of 40 $\mu g\ m^{-3}$ indicate that there is more than 50 % chance of exceeding the annual average objective for nitrogen dioxide. Public exposure in these areas should be considered in order to assess whether it will be necessary to declare an Air Quality Management Area for nitrogen dioxide.

Table 3-7 Confidence levels for modelled concentrations for future years based on symmetrical concentration intervals and concentration intervals derived purely from the statistics

Description	Chance of exceeding objective	Likelihood of exceeding annual average objective	Likelihood of exceeding hourly average objective
Very unlikely	Less than 5%	< 28	<32
Unlikely	5 to 20%	28 to 34	38-52
Possible	20 to 50%	34 to 40	52-67
Probable	50 to 80%	40 to 46	67-82
Likely	80 to 95%	46 to 52	82-95
Very likely	More than 95%	> 52	>95

3.6 Detailed modelling results

In this section, nitrogen dioxide concentrations modelled for 2007, and predicted for 2010 are presented for three investigated areas. The results for Main Street, Ballyclare are presented in the tables and for Sandyknowes and Antrim Road, Elmfield are presented as a series of contour plots. The plots show the areas around the potential hotspots identified by the diffusion tube survey in 2007. The residential buildings are illustrated in green colour.

3.6.1 Main Street, Ballyclare (AQMA 2) scenarios for 2007 and 2010

Tables 3-8 and 3-9 present the modelled and measured nitrogen dioxide concentrations for 2007 in Newtownabbey Borough Council along Main Street, Ballyclare. It has been assumed that during the rush hour period (four hours a day) Main Street is congested with slow moving traffic. Main Street, Ballyclare is an example of a street canyon. Many models cannot accurately predict concentrations within street canyons due to the complex nature of the dispersion in these environments. Many physical parameters affect the pattern of dispersion within a street canyon such that very complicated wind flows and vortices may form under certain conditions making it very difficult to fully understand and predict accurately the concentrations at specific locations.

Table 3-8 Modelled and measured nitrogen dioxide concentrations on the leeward side of the street canyon, Main Street, Ballyclare, 2007

Diffusion Tube No	Local Bias Adjustment Factor	National Bias Adjustment Factor	Modelled NO_2 concentrations
31	43.9	47.1	40.5
32	23.1	24.8	
33	38.4	41.1	
34	38.8	41.6	
37	36.4	38.9	
38	39.9	42.8	
39	27.0	29.0	
Average	**35.4**	**37.9**	

Table 3-9 Modelled and measured nitrogen dioxide concentrations on the windward side of the street canyon, Main Street, Ballyclare, 2007

Diffusion Tube No	Local Bias Adjustment Factor	National Bias Adjustment Factor	Modelled NO_2 concentrations
40	26.9	28.8	34.5
41	27.9	29.9	
42	33.5	35.9	
43	28.4	30.4	
44	24.7	26.4	
45	32.0	34.4	
1	30.0	32.2	
59	27.2	29.1	
Average	**28.8**	**30.9**	

Table 3-8 shows that both modelled and measured concentrations on the leeward side of the street canyon, Main Street, are high and close to or exceeding the air quality objective in 2007. Table 3-9 shows that modelled and measured nitrogen dioxide concentrations on the windward side of the street canyon are below the objective of 40μg m^{-3}.

The model predicts that it is ***probable*** that the nitrogen dioxide annual mean has been exceeded in 2007 on the leeward side of the street canyon and that it is ***possible*** that the nitrogen dioxide annual mean has been exceeded in 2007 on the windward side of the street canyon.

Tables 3-10 and 3-11 present the modelled and scaled up measured nitrogen dioxide concentrations for 2010 in Newtownabbey Borough Council along Main Street, Ballyclare.

Table 3-10 Modelled and measured nitrogen dioxide concentrations on the leeward side of the street canyon, Main Street, Ballyclare, 2010

Diffusion Tube No	Local Bias Adjustment Factor	National Bias Adjustment Factor	Modelled NO_2 concentrations
31	40.4	42.4	35.4
32	21.3	22.3	
33	35.3	37.0	
34	35.7	37.5	
37	33.5	35.1	
38	36.8	38.6	
39	24.9	26.1	
Average	**32.6**	**34.1**	

Table 3-11 Modelled and measured nitrogen dioxide concentrations on the windward side of the street canyon, Main Street, Ballyclare, 2010

Diffusion Tube No	Local Bias Adjustment Factor	National Bias Adjustment Factor	Modelled NO_2 concentrations
40	24.8	25.9	30.2
41	25.7	26.9	
42	30.8	32.3	
43	26.1	27.4	
44	22.7	23.8	
45	29.5	31.0	
1	27.7	29.0	
59	25.0	26.2	
Average	**26.5**	**27.8**	

The predicted nitrogen dioxide concentrations on leeward and windward sides of the street canyon are below the objective of 40μg m^{-3}.

The model predicts that it is ***possible*** that the nitrogen dioxide annual mean will be exceeded in 2010 on the leeward side of Main Street, and that it is ***unlikely*** that the nitrogen dioxide annual mean will be exceeded in 2010 on the windward side of the street canyon.

Taking into consideration that the modelled and measured nitrogen dioxide concentration on the leeward side of the road are above the objective and that the predicted measured concentrations in 2010 are close to the objective it is recommended that Newtownabbey Borough Council continue to monitor the area and retain the declared AQMA.

3.6.2 Antrim Road, Elmfield (AQMA 3) scenarios for 2007 and 2010

Figure 3-2 shows the modelled annual mean nitrogen dioxide concentrations in 2007, in Antrim Road, Elmfield. The modelling has taken into account queuing traffic at traffic lights in Antrim Road, Elmfield.

The model has predicted that the annual mean objective of 40µg m^{-3} for nitrogen dioxide has been exceeded in Antrim Road, Elmfield in 2007.

The model predicts that it is ***very likely*** that the annual mean objective has been exceeded in 2007.

Figure 3-3 shows the modelled nitrogen dioxide concentrations for 2010 in Antrim Road, Elmfield. The plot shows that nitrogen dioxide concentrations are expected to decrease, however the concentrations at facades of residential properties in the area will still exceed the objective of 40µg m^{-3}.

The model predicts that it is ***likely*** that the annual mean objective will be exceeded in 2010.

Taking into consideration that the model predicts exceedances at the facade of the building in 2007 and 2010, and that the estimated measured concentrations are above the objective of 40µg m^{-3}, it is recommended that Newtownabbey Borough Council continue to monitor this area of Antrim Road, Elmfield.

The measured nitrogen dioxide concentrations above or close to the objective in Antrim Road, Elmfield are presented in Table 3-12.

Table 3-12 Measured nitrogen dioxide concentrations above or close to the objective in Antrim Road, Elmfield, 2007

Diffusion Tube No	Corrected with Local Bias Adjustment Factor	
	2007 Annual Mean	Scaled up to 2010
16	41.6	38.3
17	41.2	38.0
18	39.7	36.6
20	43.6	40.2
21	44.4	40.9
22	44.7	41.2
23	44.4	40.9
28	39.7	36.6
C58	42.0	38.8
C43	42.3	39.0

Newtownabbey Borough Council should retain the declared AQMA in Antrim Road, Elmfield and also extend the AQMA to the residential properties where the predicted nitrogen concentration is above the objective.

Figure 3-2 Modelled NO_2 concentrations in Antrim Road, Elmfield, Newtownabbey Borough Council 2007

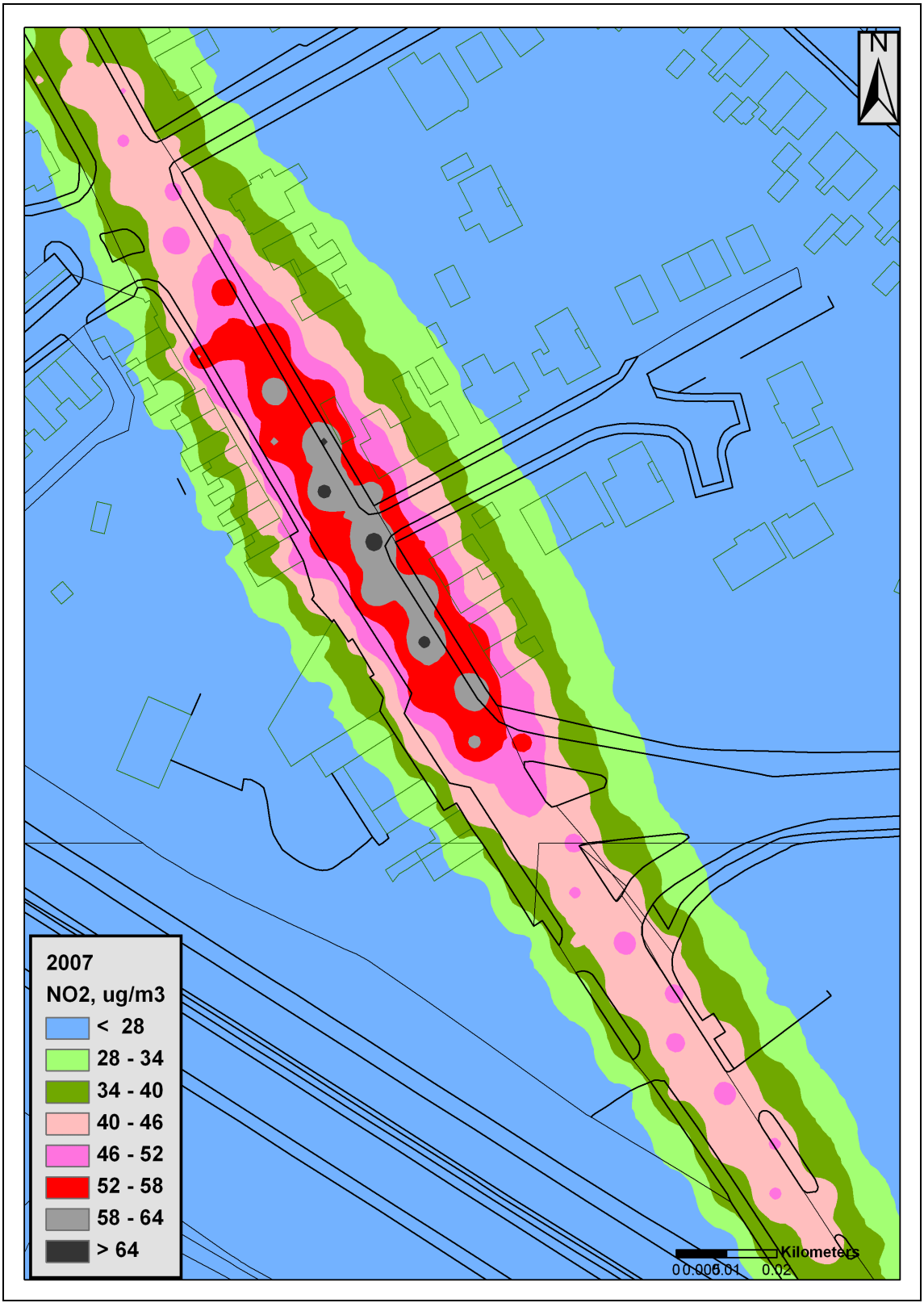
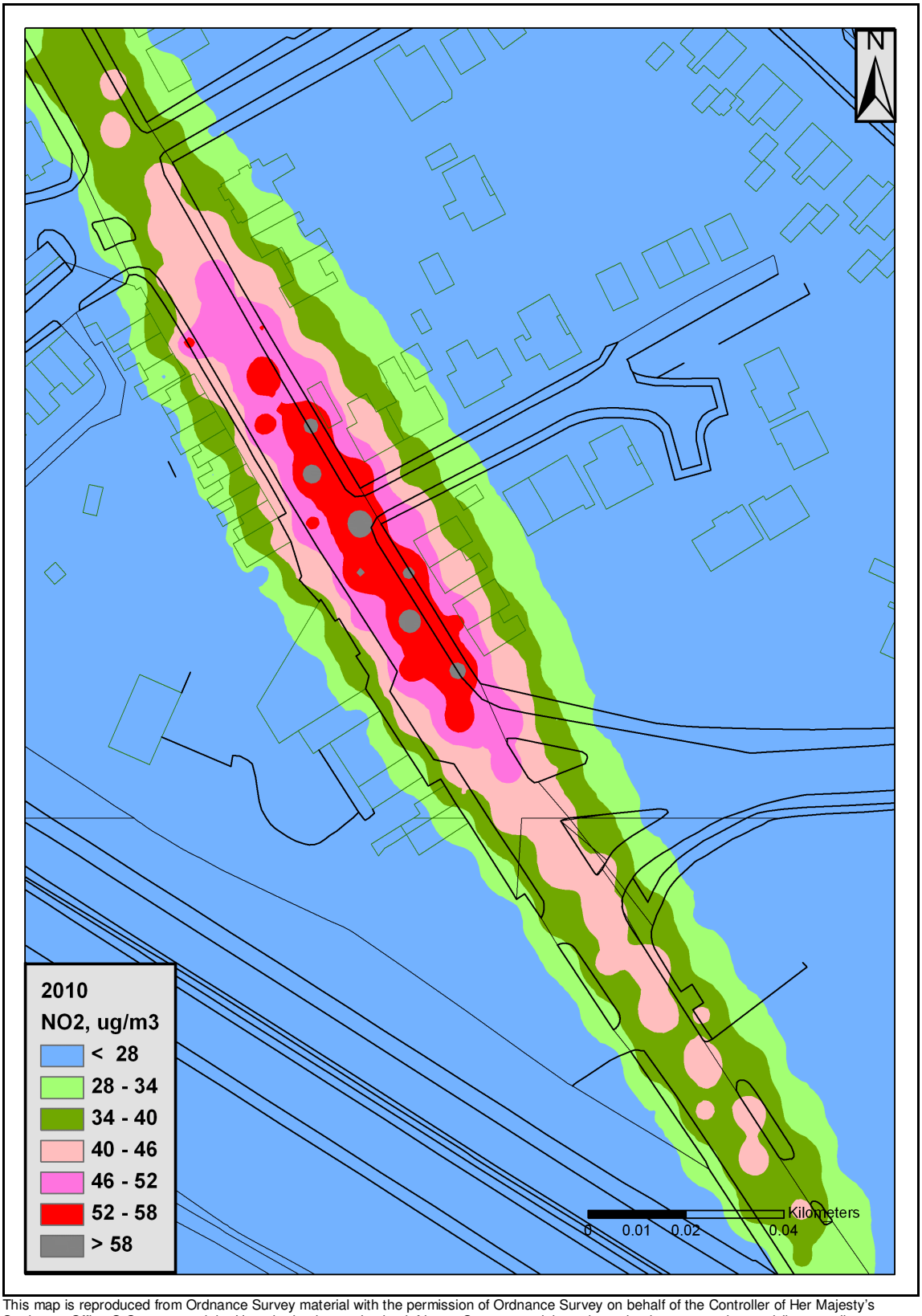


Figure 3-3 Modelled NO_2 concentrations in Antrim Road, Elmfield, Newtownabbey Borough Council 2010



3.6.3 Sandyknowes (AQMA 4) scenarios for 2007 and 2010

Figure 3-4 shows the modelled nitrogen dioxide concentrations for 2007 in Sandyknowes. The predicted concentrations have not exceeded the objective of 40 μg m^{-3} at residential properties in the area.

The model predicts that it is ***possible*** that the nitrogen dioxide annual mean has been exceeded in this area in 2007.

Figure 3-5 shows the predicted concentrations for 2010. The plot shows that nitrogen dioxide concentrations are expected to decrease so that the concentrations in the area will meet the objective of 40 μg m^{-3}.

The model predicts that it is ***unlikely*** that the nitrogen dioxide annual mean will be exceeded in this area in 2010.

The predicted nitrogen dioxide concentrations in AQMA 4 shown in Figure 3-4 are below the objective on the facades of the buildings in the Sandyknowes area. The measured nitrogen dioxide concentrations are above the objective.

The measured nitrogen dioxide concentrations above or close to the objective in Sandyknowes area, are presented in Table 3-13.

Table 3-13 measured nitrogen dioxide concentrations above or close to the objective in Sandyknowes area

Diffusion Tube No	Corrected with Local Bias Adjustment Factor	
	2007 Annual Mean	Annual Mean scaled up to 2010
4	44.3	40.8
6	40.5	37.3
9	39.7	36.6
15	41.8	38.5
C47	41.7	38.4

On the basis of the measured results in the AQMA 4 and taking into consideration that pollution concentrations are variable due to meteorological conditions from year to year it is recommended that the Council retain the declared AQMA 4.

Figure 3-4 Modelled NO_2 concentrations in Sandyknowes, Newtownabbey Borough Council for 2007

Figure 3-5 Modelled NO_2 concentrations in Sandyknowes, Newtownabbey Borough Council for 2010

3.7 Source apportionment

3.7.1 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, 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. 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 that exceedences of nitrogen dioxide are due to road traffic;
- Determine the extent to which different vehicle types are responsible for the emission contributions to nitrogen dioxide: this will allow traffic management scenarios to be modelled/tested to reduce the exceedences;
- Quantify what proportion of the exceedences of nitrogen dioxide 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.

3.7.2 What is the 'base case'?

The base case in this assessment is defined as the annual mean concentrations of nitrogen dioxide that are predicted in 2007 in the absence of any measures to improve air quality in Newtownabbey. These are the concentrations that should be relevant to defining the extent of Air Quality Management Areas.

3.7.3 Receptors considered, Sandyknowes area and Antrim Road, Elmfield,

The most affected receptors where there is potential relevant public exposure outside have been considered: these are shown in Table 3-14 and Figures 3-6 and 3-7.

Table 3-14 Most affected receptors exceeding annual average objective

General Area	Description	OS Grid reference of receptor
Sandyknowes (R1)	Facades of the building	330512; 382976
7 Sandyholme Way (R2)	Facades of the building	330514; 382938
3 Sandyholme Way (R3)	Facades of the building	330537; 382893
14 Sandyholme Park (R4)	Facades of the building	330508; 382813
2 Sandyknowes Gardens (R5)	Facades of the building	330619; 382766
24 Sandyknowes Avenue (R6)	Facades of the building	330628; 382733
30 Sandyknowes Avenue (R7)	Facades of the building	330660; 382669
157 Antrim Road, Elmfield (R8)	Facades of the building	332296; 381705
202 Antrim Road, Elmfield (R9)	Facades of the building	332300; 381748
190 Antrim Road, Elmfield (R10)	Facades of the building	332313; 381679
178 Antrim Road, Elmfield (R11)	Facades of the building	332323; 381661
147 Antrim Road, Elmfield (R12)	Facades of the building	332353; 381650

Figure 3-6 Receptors' locations, Sandyknowes

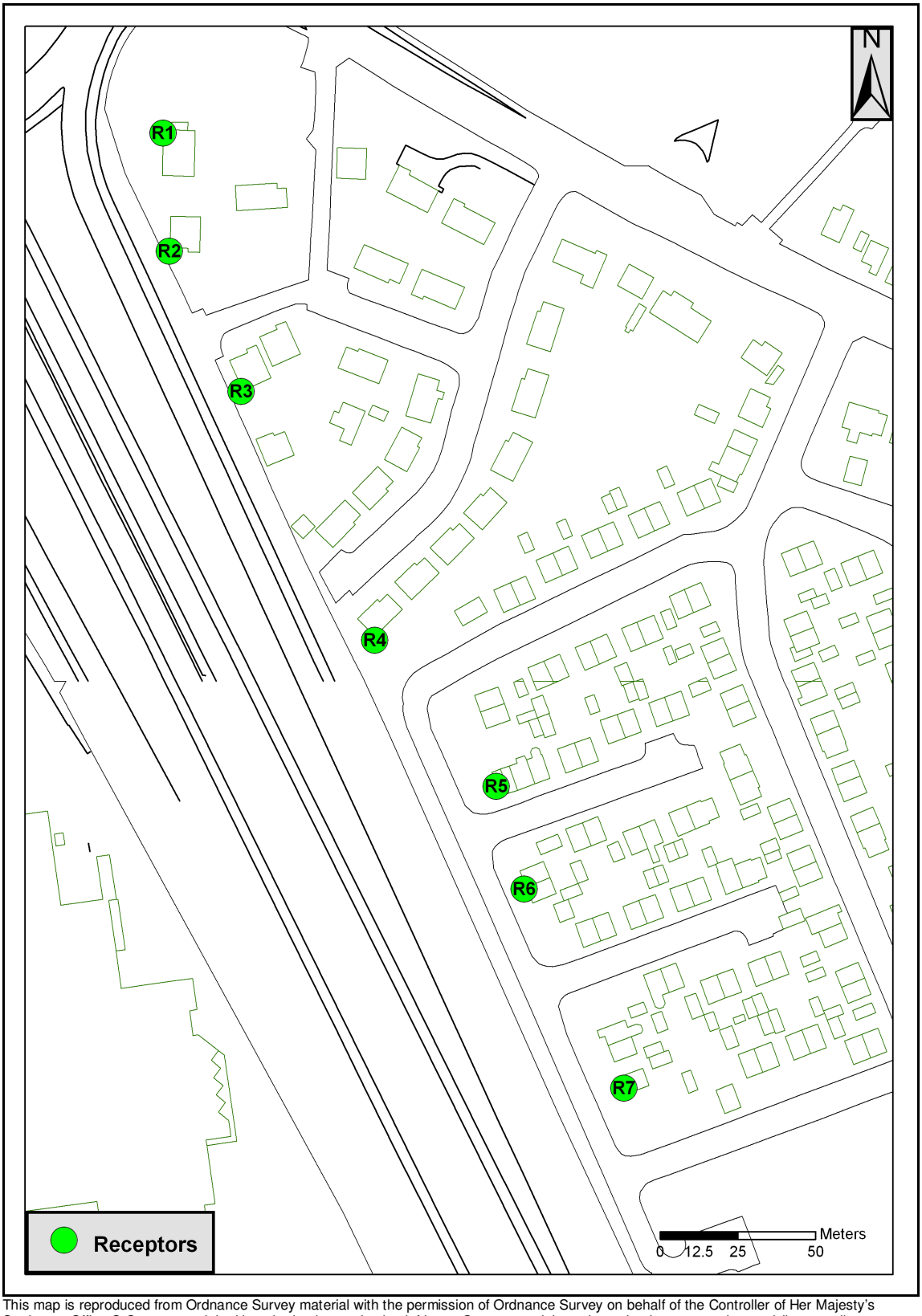


Figure 3-7 Receptors' locations, Antrim Road, Elmfield

3.7.4 Receptors considered in Main Street, Ballyclare

As mentioned earlier Main Street, Ballyclare forms a street canyon. It has, therefore, been assumed that the leeward side (left hand side of the street) of the canyon was considered to be a receptor. The same assumption was taken for the windward side (right hand side of the street) of the street canyon.

3.7.5 Sources of pollution considered

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

- Background from sources outside the local area;
- Traffic;
- Heavy duty vehicles (buses, coaches and heavy goods);
- Stationary vehicles in queue.

The concentrations of oxides of nitrogen from the LADS model apportioned to each source category and the fractions of the total concentrations are shown in Table 3-15 and Table 3-16. These two tables show the contributions from the rural background, modelled background contribution from Newtownabbey and surrounding district sources and the modelled local roads contribution. It then shows the break-down of the local road contribution between heavy and light duty vehicles and between moving and stationary vehicles (in queues). Stationary vehicles were not considered in the traffic flow in the Sandyknowes area since the area covers the M2 on-slip road and M2 motorway.

Table 3-15 Apportionment of oxides of nitrogen concentrations at most affected receptors LADS Model results, Sandyknowes area

NOx concentrations source apportionment, μg m^{-3}								
Area	Total	Rural background	Modelled background	Local roads	Local HDV	Local LDV	Moving vehicles	Stationary vehicles
Sandyknowes (R1)	62.5	7.5	17.6	37.4	29.9	7.5	37.4	n/a
7 Sandyholme Way (R2)	77.0	7.5	17.8	51.7	41.2	10.4	51.7	n/a
3 Sandyholme Way (R3)	71.9	7.5	17.8	46.6	37.2	9.4	46.6	n/a
14 Sandyholme Park (R4)	63.7	7.5	17.9	38.3	30.5	7.8	38.3	n/a
2 Sandyknowes Gardens (R5)	50.7	7.5	17.8	25.4	20.2	5.2	25.4	n/a
24 Sandyknowes Avenue (R6)	54.4	7.5	17.9	29.0	23.1	5.9	29.0	n/a
30 Sandyknowes Avenue (R7)	53.0	7.5	18.0	27.5	21.9	5.6	27.5	n/a

Table 3-16 Apportionment of oxides of nitrogen concentrations at most affected receptors LADS Model results, Antrim Road, Elmfield

NOx concentrations source apportionment, μg m^{-3}								
Area	Total	Rural background	Modelled background	Local roads	Local HDV	Local LDV	Moving vehicles	Stationary vehicles
157 Antrim Road, Elmfield (R8)	84.4	7.5	11.8	65.1	47.9	17.2	42.3	22.8
202 Antrim Road, Elmfield (R9)	87.0	7.5	11.7	67.8	49.9	17.9	44.0	23.8
190 Antrim Road, Elmfield (R10)	126.2	7.5	11.8	106.9	78.7	28.2	69.6	37.3
178 Antrim Road, Elmfield (R11)	144.4	7.5	11.8	125.0	91.9	33.1	82.0	43.0
147 Antrim Road, Elmfield (R12)	188.5	7.5	11.8	169.2	124.0	45.2	114.1	55.1

Table 3-17 presents the concentrations of nitrogen of oxides from Aeolius model apportioned to each source category and the fractions of the total concentrations.

Table 3-17 Apportionment of oxides of nitrogen concentrations at most affected receptors, Aeolius Model results, Main Street, Ballyclare

Contribution to oxide of nitrogen concentration, µg m^{-3}							
Area	Total	Rural background	Local roads	Local HDV	Local LDV	Moving vehicles	Stationary Vehicle
Leeward side	83	7.5	75.5	48.9	26.6	48.2	27.3
Windward side	101	7.5	93.5	60.5	33.0	59.7	33.8

It can be seen from the table that although the HDVs are only a small percentage of AADT, they still make a large contribution to the local roads oxides of nitrogen concentrations. The stationary vehicles make a considerable contribution to the concentration of oxides of nitrogen in local roads.

3.7.6 Summary of source apportionment

Table 3-18 shows the percentage contributions to the NOx concentration from different sources in Sandyknowes AQMA.

Table 3-18 Percentage of NOx concentrations, Sandyknowes area

Percentage of NOx concentrations, Sandyknowes area								
Area	Total	Rural background	Modelled background	Local roads	Local HDV	Local LDV	Moving vehicles	Stationary vehicles
Sandyknowes (R1)	100	12.0	28.2	59.8	79.9	21.1	100	n/a
7 Sandyholme Way (R2)	100	9.7	23.1	67.1	79.7	20.1	100	n/a
3 Sandyholme Way (R3)	100	10.4	24.8	64.8	79.8	20.2	100	n/a
14 Sandyholme Park (R4)	100	11.8	28.1	60.1	79.6	20.4	100	n/a
2 Sandyknowes Gardens (R5)	100	14.8	35.1	50.1	79.5	20.5	100	n/a
24 Sandyknowes Avenue (R6)	100	13.8	32.9	53.3	79.7	20.3	100	n/a
30 Sandyknowes Avenue (R7)	100	14.2	34.0	51.9	79.6	20.4	100	n/a

It can be seen from Table 3-18 the contribution to the NOx concentrations in Sandyknowes area are:

- 12% (on average) - rural background;
- 29% (on average) - modelled background;
- 58% (on average) - local roads are.

This confirms that the exceedances of NO_2 in Sandyknowes AQMA are due to road traffic. Nearly 80% of NOx concentrations are contributed from HDVs.

Table 3-19 shows the percentage contributions of NOx concentration from different sources in Antrim Road, Elmfield.

Table 3-19 Percentage of NOx concentrations, Antrim Road, Elmfield

Percentage of NOx concentrations, Antrim Road, Elmfield								
Area	Total	Rural background	Modelled background	Local roads	Local HDV	Local LDV	Moving vehicles	Stationary vehicles
157 Antrim Road, Elmfield (R8)	100	8.9	14.0	77.1	73.6	26.4	65.0	35.0
202 Antrim Road, Elmfield (R9)	100	8.6	13.4	77.9	73.6	26.4	64.9	35.1
190 Antrim Road, Elmfield (R10)	100	5.9	9.4	84.7	73.6	26.4	65.1	34.9
178 Antrim Road, Elmfield (R11)	100	5.2	8.2	86.6	73.5	26.5	65.6	34.4
147 Antrim Road, Elmfield (R12)	100	4.0	6.3	89.8	73.5	26.7	67.4	32.6

It can be seen from Table 3-19 the contribution to the NOx concentrations in Antrim Road, Elmfield are:

- 7% (on average) - rural backgroun;
- 10% (on average) - modelled background;
- 83% (on average) - Local roads.

This confirms that the exceedances of NO_2 in Antrim Road, Elmfield are due to road traffic. Nearly 74% of NOx concentrations are contributed from HDVs.

Table 3-20 shows the percentage contributions to the NOx concentration from different sources in Main Street, Ballyclare.

Table 3-20 Percentage of NOx concentrations, Main Street, Ballyclare

Percentage of NOx concentrations, Main Street, Ballyclare							
Area	Total	Rural background	Local roads	Local HDV	Local LDV	Moving vehicles	Stationary Vehicle
Leeward side	100	9.0	91.0	64.8	35.2	63.8	36.2
Windward side	100	7.4	92.6	64.7	35.3	63.9	36.1

It can be seen from Table 3-20 that the contribution to the NOx concentrations in Main Street, Ballyclare are:

- 8 % (on average) - rural background;
- 92 % (on average) - local roads.

This confirms that the exceedances of NO_2 in Main Street, Ballyclare due to road traffic. Nearly 65% of NOx concentrations are contributed from HDVs.

3.8 Action plan scenarios

Newtownabbey Borough Council considered a range of options in developing Air Quality Action Plans for the Air Quality Management Areas. Action Plan scenarios were run for AQMA 2, AQMA 3 and AQMA 4. The key options are summarised below for AQMA 4, AQMA 3 and AQMA 2.

3.8.1 Sandyknowes (AQMA 4)

Two scenarios have been considered to investigate the potential improvement in air quality in the Sandyknowes area. The first scenario considered a 50% reduction in HDVs in traffic on the M2 on-slip road and M2 motorway. The second scenario considered a 50% reduction in HDVs on the M2 on-slip road. The daily traffic flow on the M2 was considered to be the same.

Table 3-21 presents the modelled nitrogen dioxide concentrations for 2007 and 2010 in Sandyknowes AQMA.

Scenario 1 shown in table 3-21 and Figure 3-8 considered a 50% reduction in HDVs in traffic on the M2 on-slip road and M2 motorway. The predicted concentrations have not exceeded the objective of 40 μg m^{-3} at residential properties in the area. There is considerable reduction in the nitrogen dioxide concentration at the receptors' locations. Scenario 1 shows that reductions in nitrogen dioxide concentrations of 5.2 μg m^{-3} (on average) are possible in Sandyknowes area.

Scenario 2 shown in Table 3-21 and Figure 3-9 considered a 50% reduction in HDVs in traffic on the M2 on-slip road. The traffic flow on the M2 motorway was not changed. The predicted concentrations have not exceeded the objective of 40 μg m^{-3} at residential properties in the area. Both scenarios show exceedances in Antrim Road, Elmfield and at the facades of the residential properties.
Scenario 2 shows that reductions in nitrogen dioxide concentrations of 4 μg m^{-3} (on average) are possible in Sandyknowes area.

Table 3-21 Predicted nitrogen dioxide (μg m^{-3}) concentrations at selected receptors for the Action Plan, AQMA 4

Receptor location	Year	Base concentration	Scenario 1	Scenario 2
Sandyknowes (R1)	2007	30.1	25.8	26.8
7 Sandyholme Way (R2)		34.7	29.4	30.7
3 Sandyholme Way (R3)		33.2	28.3	29.6
14 Sandyholme Park (R4)		30.5	26.4	27.7
2 Sandyknowes Gardens (R5)		25.9	23.0	24.0
24 Sandyknowes Avenue (R6)		27.2	24.0	25.1
30 Sandyknowes Avenue (R7)		26.7	23.6	24.7
Sandyknowes (R1)	2010	26.2	22.7	16.7
7 Sandyholme Way (R2)		30.1	25.7	20.1
3 Sandyholme Way (R3)		28.8	24.8	19.1
14 Sandyholme Park (R4)		26.5	23.2	17.3
2 Sandyknowes Gardens (R5)		22.7	20.4	14.1
24 Sandyknowes Avenue (R6)		23.8	21.2	15.1
30 Sandyknowes Avenue (R7)		23.4	20.9	14.7

3.8.2 Antrim Road, Elmfield (AQMA 3)

Two scenarios have been considered to investigate the potential improvement in air quality in Antrim Road, Elmfield. The first scenario considered a 15% reduction in the traffic flows in Antrim Road, Elmfield. The second scenario considered a 50% reduction in HDVs in Antrim Road, Elmfield.

Table 3-22 presents the modelled nitrogen dioxide concentrations for 2007 and 2010 in Antrim Road, Elmfield.

Scenario 1 shown in Figure 3-10 considered a 15% reduction in traffic flow. Scenario 2 shown in Figure 3-11 considered a 50% reduction in HDVs in the traffic flow in Antrim Road, Elmfield.

Both scenarios show exceedances in Antrim Road, Elmfield and at the facades of the residential properties.

Scenario 1 shows that reductions in nitrogen dioxide concentrations of 3 µg m^{-3} (on average) are possible along Antrim Road, Elmfield with a reduction of 15% in traffic flow. Scenario 2 shows that reductions in nitrogen dioxide concentrations of 8 µg m^{-3} (on average) are possible along Antrim Road, Elmfield with a reduction of 50% in HDV in traffic flow.

Table 3-22 Predicted nitrogen dioxide concentrations (µg m^{-3}) at selected receptors for the Action Plan, AQMA 3

Receptor location	Year	Base concentration	Scenario 1	Scenario 2
157 Antrim Road, Elmfield (R8)	2007	36.4	33.6	29.4
202 Antrim Road, Elmfield (R9)		37.1	34.2	29.9
190 Antrim Road, Elmfield (R10)		46.4	43.0	37.6
178 Antrim Road, Elmfield (R11)		49.9	46.5	40.7
147 Antrim Road, Elmfield (R12)		57.5	54.3	47.7
157 Antrim Road, Elmfield (R8)	2010	31.5	29.1	25.6
202 Antrim Road, Elmfield (R9)		32.2	29.6	26.1
190 Antrim Road, Elmfield (R10)		40.6	37.4	32.8
178 Antrim Road, Elmfield (R11)		43.8	40.4	35.6
147 Antrim Road, Elmfield (R12)		50.7	46.9	42.1

3.8.3 Main Street, Ballyclare (AQMA 2)

One scenario has been considered to investigate the potential improvement in air quality in Main Street, Ballyclare. This scenario considered a 50% reduction in HDVs in Main Street, Ballyclare.

Table 3-23 presents the modelled nitrogen dioxide concentrations for 2007 and 2010 in Main Street, Ballyclare.

A 50% reduction in HDVs shows no exceedances in Main Street, Ballyclare at the leeward and windward sides of the street canyon.

This scenario shows that reductions in nitrogen dioxide concentrations of 4 µg m^{-3} (on average) are possible on the leeward side of the street canyon and 1.3 µg m^{-3} (on average) are possible on the windward side of the street canyon.

Table 3-23 Predicted nitrogen dioxide concentrations (µg m^{-3}) for the Action Plan at leeward and windward side of Main Street, Ballyclare, AQMA 2

Receptor location	Year	Base concentration	Scenario 1
Leeward side	2007	35.8	31.7
Windward side		29.2	27.9
Leeward side	2010	32.6	27.7
Windward side		26.5	24.3

Figure 3-8 Modelled NO_2 concentrations in Sandyknowes, Newtownabbey Borough Council 2007, Scenario 50% reduction in HDV in the traffic on M2 onslip road and M2

Figure 3-9 Modelled NO_2 concentrations in Sandyknowes, Newtownabbey Borough Council 2007, Scenario 50% HDV reduction in the traffic on M2 onslip road

Figure 3-10 Modelled NO_2 concentrations in Antrim Road, Elmfield, Newtownabbey Borough Council 2007, Scenario 15% reduction in all the traffic

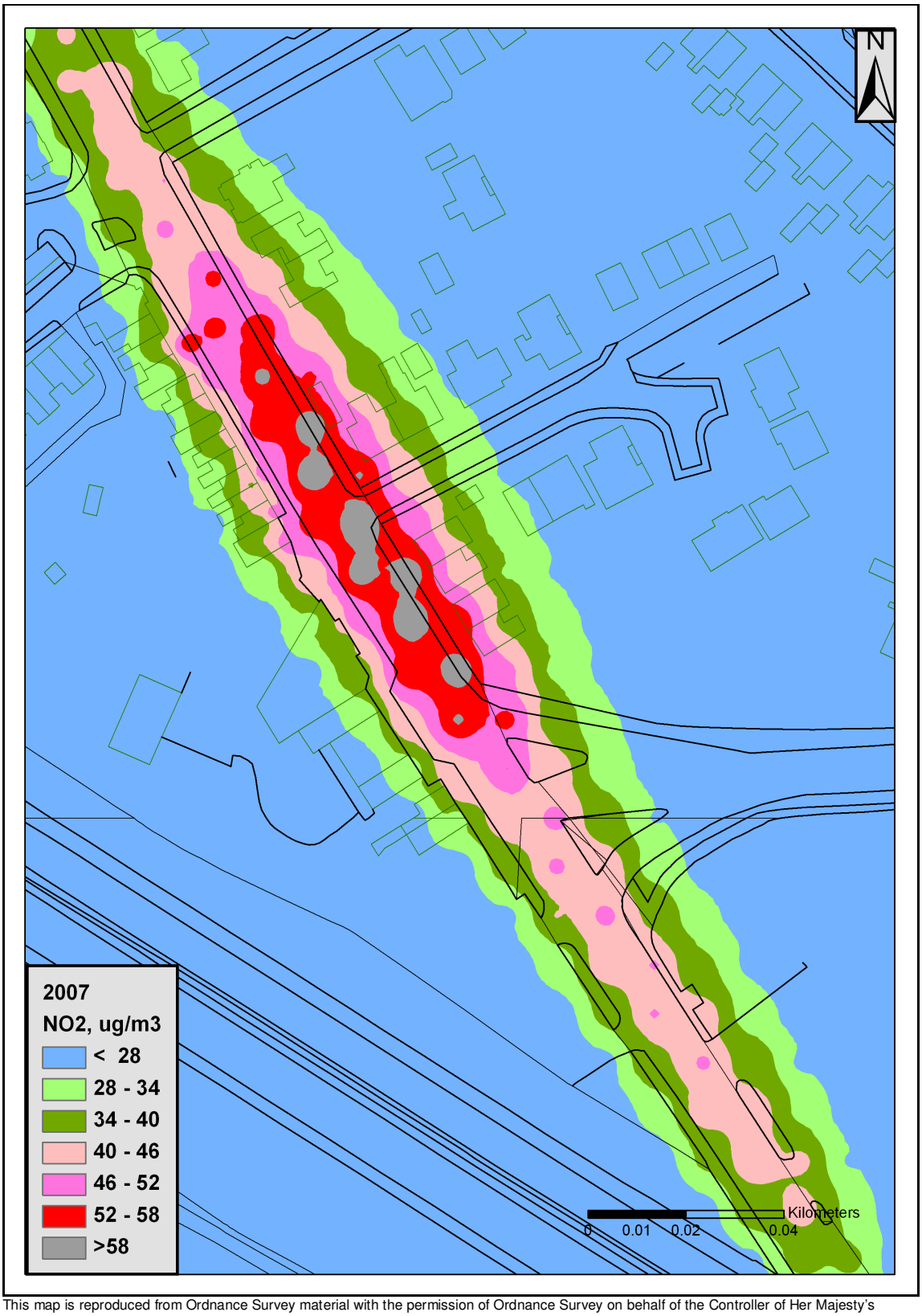
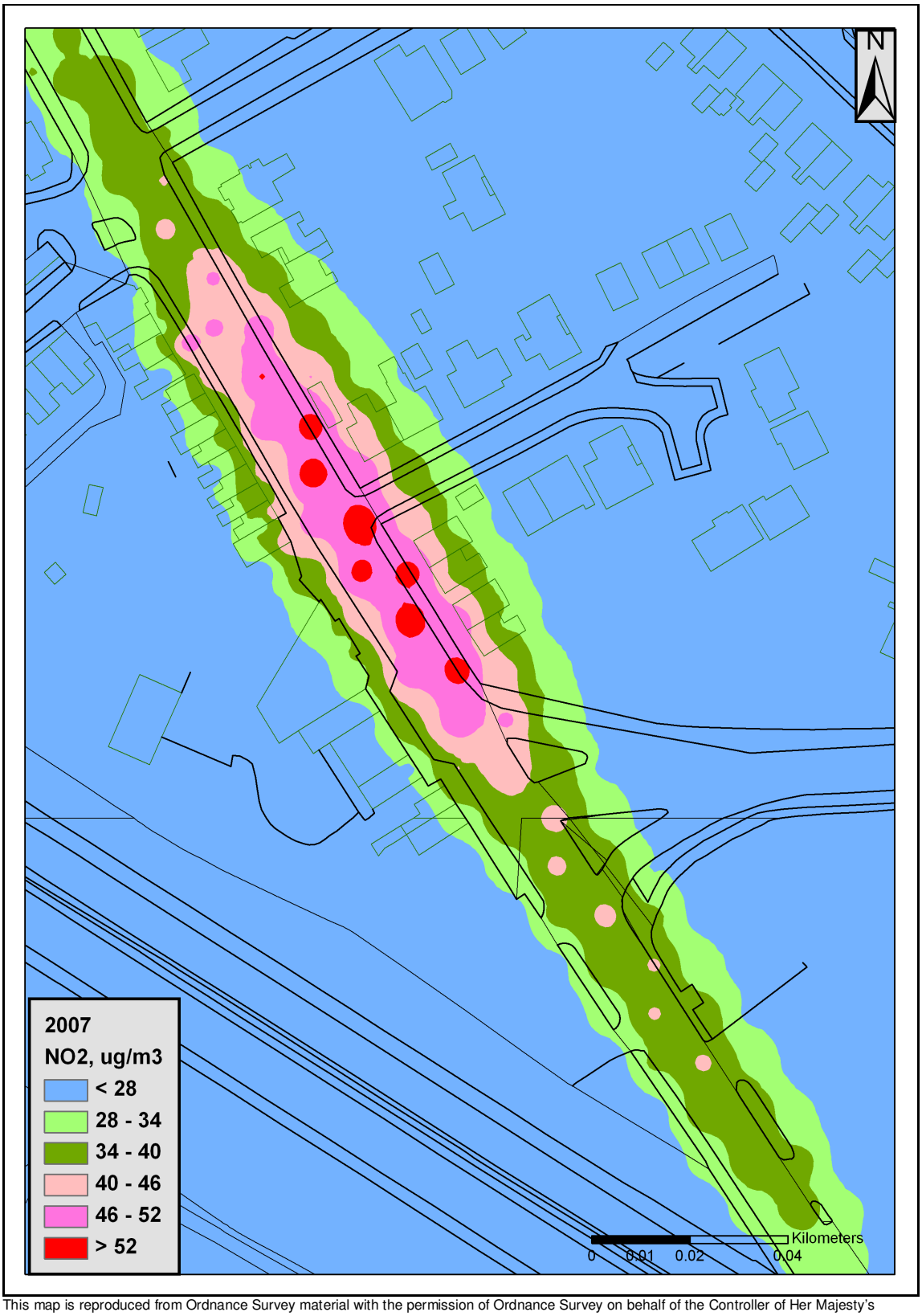


Figure 3-11 Modelled NO_2 concentrations in Antrim Road, Elmfield, Newtownabbey Borough Council 2007, Scenario 50% reduction in HDV in the traffic



4 Conclusions

The results from the diffusion tube survey and automatic continuous monitoring of nitrogen dioxide in 2007 confirmed that the annual mean objective of 40μg m^{-3} had not been met in 2007 at Sandyknowes, Antrim Road, Elmfield and Main Street, Ballyclare.

Both the annual mean and hourly mean nitrogen dioxide objectives were exceeded in Antrim Road, Elmfield in 2007. The automatic monitoring site is located in AQMA 3 (Antrim Road, Elmfield), which was declared based on the breach of the nitrogen dioxide annual mean objective. It is suggested that the Council should amend the AQMA order of this area to include the nitrogen dioxide hourly mean objective and should also consider Action Plan measures that would take this into consideration.

Main Street, Ballyclare (AQMA 2)

Ballyclare AQMA 2 has been modelled and monitored and the results suggest the following:

- The modelled nitrogen dioxide concentrations in Main Street, Ballyclare have marginally exceeded the objective of 40μg m^{-3} in 2007;
- The measured nitrogen dioxide concentrations in Main Street, Ballyclare were above the objective of 40μg m^{-3}, with a maximum measured concentration of 44.3 μg m^{-3} (Table 3-2)

The predicted nitrogen dioxide concentrations on the leeward side of the street canyon presented in Table 3-8 are above the objective and have a good agreement with the average measured values. The predicted nitrogen dioxide concentrations on the windward side of the street canyon presented in Table 3-9 are below the objective and have a good agreement with the average measured values. The predicted modelled concentrations for 2010 presented in Table 3-10 and 3-11 show that nitrogen dioxide concentrations in the AQMA 2 will be below the objective.

On the basis of the average modelled and measured results in Main Street, Ballyclare, AQMA 2, it is recommended that AQMA 2 is retained for present. It is also recommended that the leeward side of the street canyon is monitored.

Antrim Road, Elmfield (AQMA 3)

Antrim Road, Elmfield AQMA 3 has been modelled and monitored and the results suggest the following:

- The modelled nitrogen dioxide concentrations in the AQMA 3 area are above the objective of 40μg m^{-3} in 2007;
- The measured nitrogen dioxide concentrations in AQMA 3 are above the objective with a maximum measured concentration of 43.9 μg m^{-3} (Table 3-2).

The predicted nitrogen dioxide concentrations in AQMA 3 shown in Figure 3-2 are above the objective on the facades of the buildings in Antrim Road, Elmfield. The measured nitrogen dioxide concentrations in declared AQMA 3 are above the objective. Also the predicted modelled concentrations for 2010 shown in Figure 3-3 show that nitrogen dioxide concentrations in the AQMA 3 will be above the objective.

On the basis of the modelled and measured results in the AQMA 3 it is recommended that the Council retain the declared AQMA 3.

It is also recommended that AQMA 3 is extended to include the residential properties on the north east side of Antrim Road, Elmfield where the modelling showed exceedances (Figure 3-2).

Sandyknowes (AQMA 4)

Sandyknowes AQMA 4 has been modelled and monitored and the results suggest the following:

- The modelled nitrogen dioxide concentrations in the Sandyknowes area were below the objective of 40μg m^{-3} in 2007;
- The measured nitrogen dioxide concentrations in Sandyknowes AQMA were above the objective with a maximum measured concentration of 44.7 μg m^{-3} (Table 3-2).

The predicted nitrogen dioxide concentrations in AQMA 4 shown in Figure 3-4 are below the objective on the facades of the buildings in the Sandyknowes area. The measured nitrogen dioxide concentrations are above the objective. The predicted modelled concentrations for 2010 presented in Figure 3-5 show that nitrogen dioxide concentrations in the AQMA 3 will be below the objective.

On the basis of the measured results in AQMA 4 and taking into consideration that pollution concentrations are variable due to meteorological conditions from year to year it is recommended that the Council retain the declared AQMA 4.

5 References

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Acknowledgments

We are grateful for the help of Vanessa Hodgen from Newtownabbey Borough Council

Appendices

Appendix 1

Traffic Data

Figure A1-1 Annual Average Daily Traffic, Sandyknowes M2 on-slip

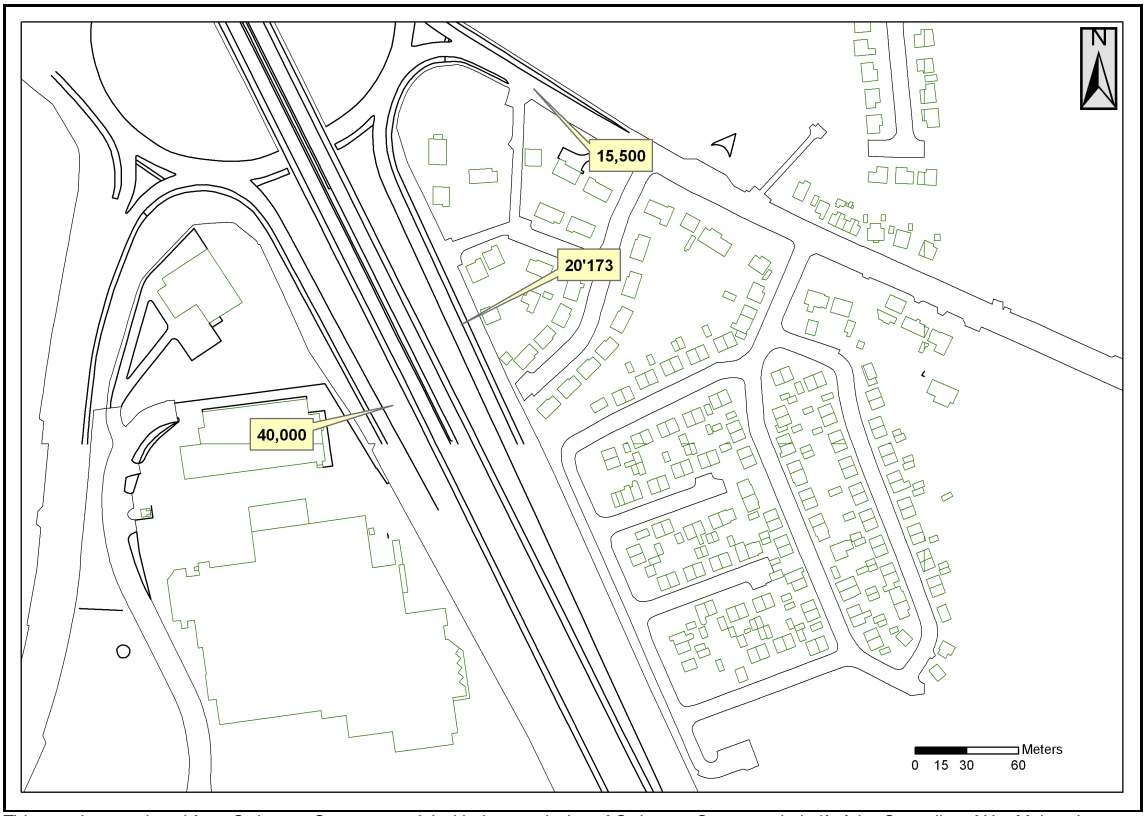


Table A1-5-1Traffic data from the Council, Sandyknowes, M2 on-slip towards Belfast

Date	13.06.08	17.06.08
Start time	12:05	08:10
End time	13:05	09:10
Cars	840	1644
Buses	4	26
HGV	162	220

Table A1-5-2Traffic data in Sandyknowes

Location	AADT	% HDV	Speed (mph)
M2 on-slip towards Belfast	20,173	20	30-40
M2	40,000	20	70
Antrim Road, Elmfield	15,500	10	30

Figure A1-2Annual Average Daily Traffic, Main Street, Ballyclare

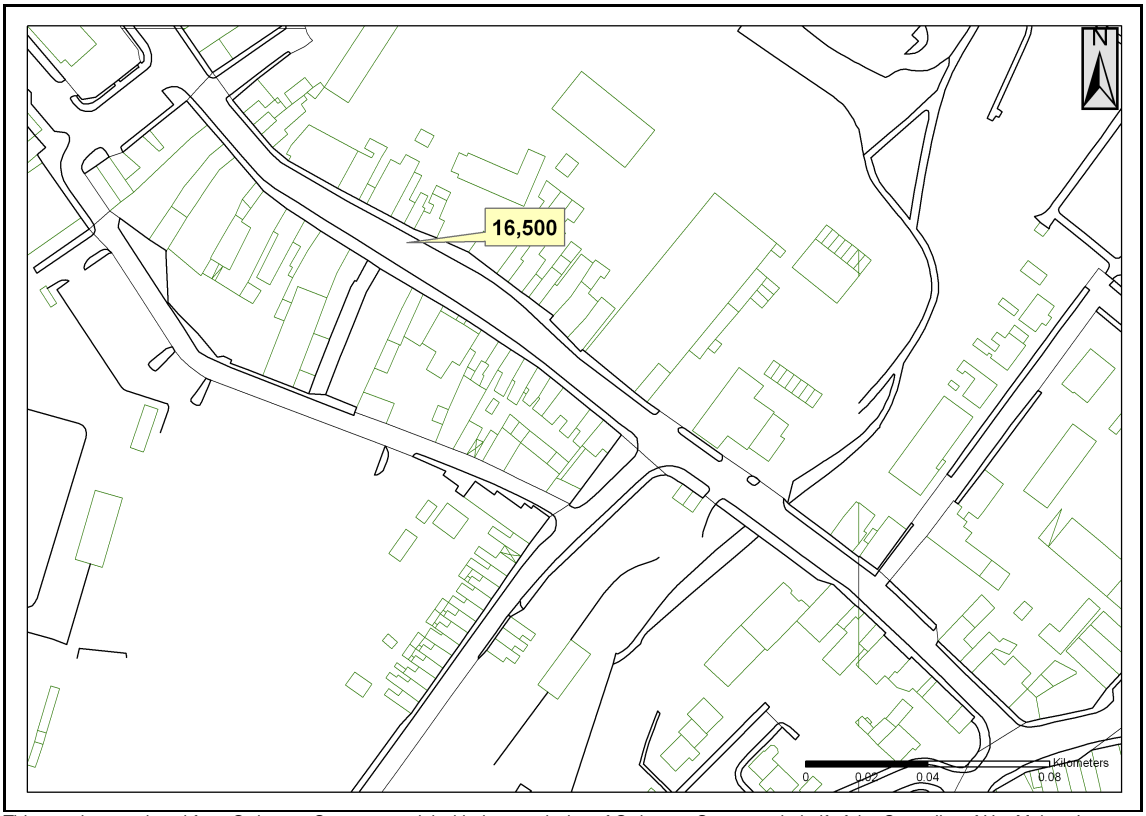


Table A1-5-3Traffic data from the Council for Main Street, Ballyclare

Date	13.06.08	16.06.08	18.06.08	13.06.08	23.06.08
Start time	11:15	08:30	15:05	11:15	13:00
End time	12:15	09:00	16:05	12:15	14:00
Cars	498	665	1131	554	1125
Buses	8	31	28	6	16
HGV	16	31	29	10	32

Table A1-5-4Traffic data in Main Street, Ballyclare

Location	AADT	% HDV	Speed (mph)
Main Street, Ballyclare	16,500	7.5	30

Figure A1-3 Annual Average Daily Traffic, Antrim Road, Elmfield

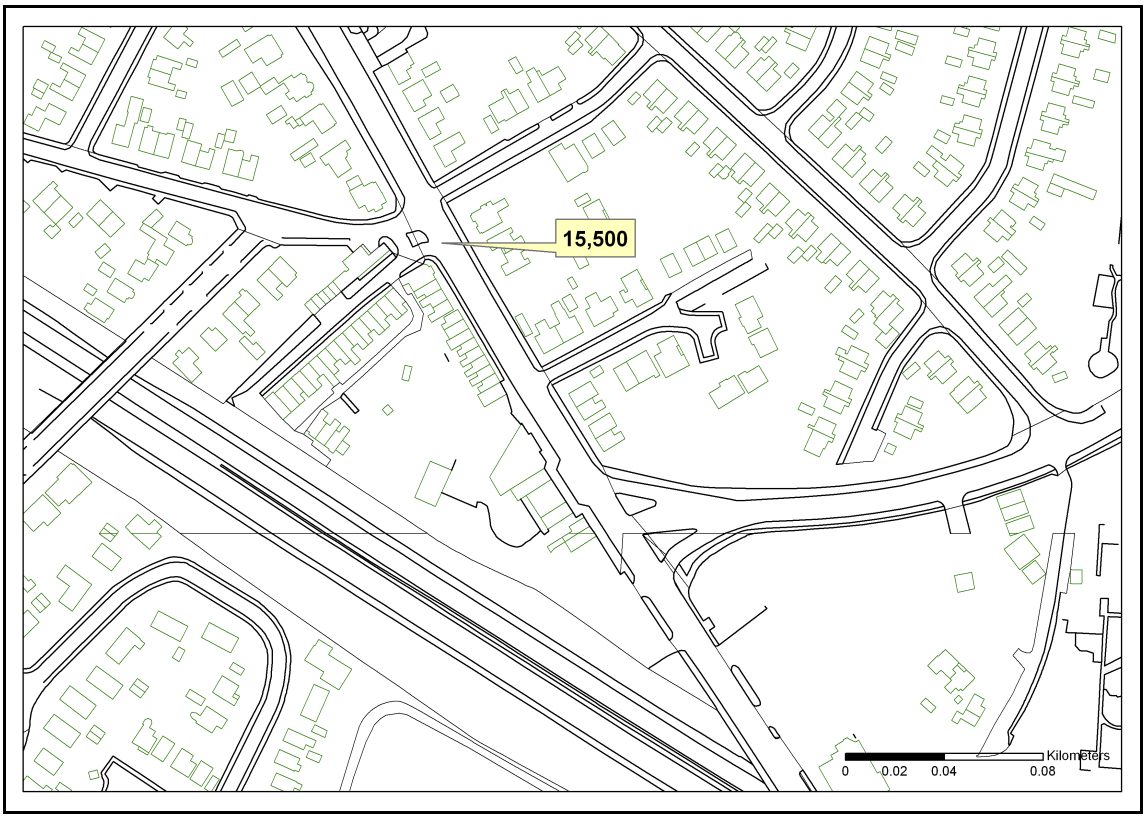


Table A1-5-5Traffic data from the Council, Antrim Road, Elmfield

Date	19.06.08	23.06.08	24.06.08
Start time	08:15	08:30	08:30
End time	09:15	09:30	09:30
Cars	550	468	1600
Buses	36	10	36
HGV	36	13	42

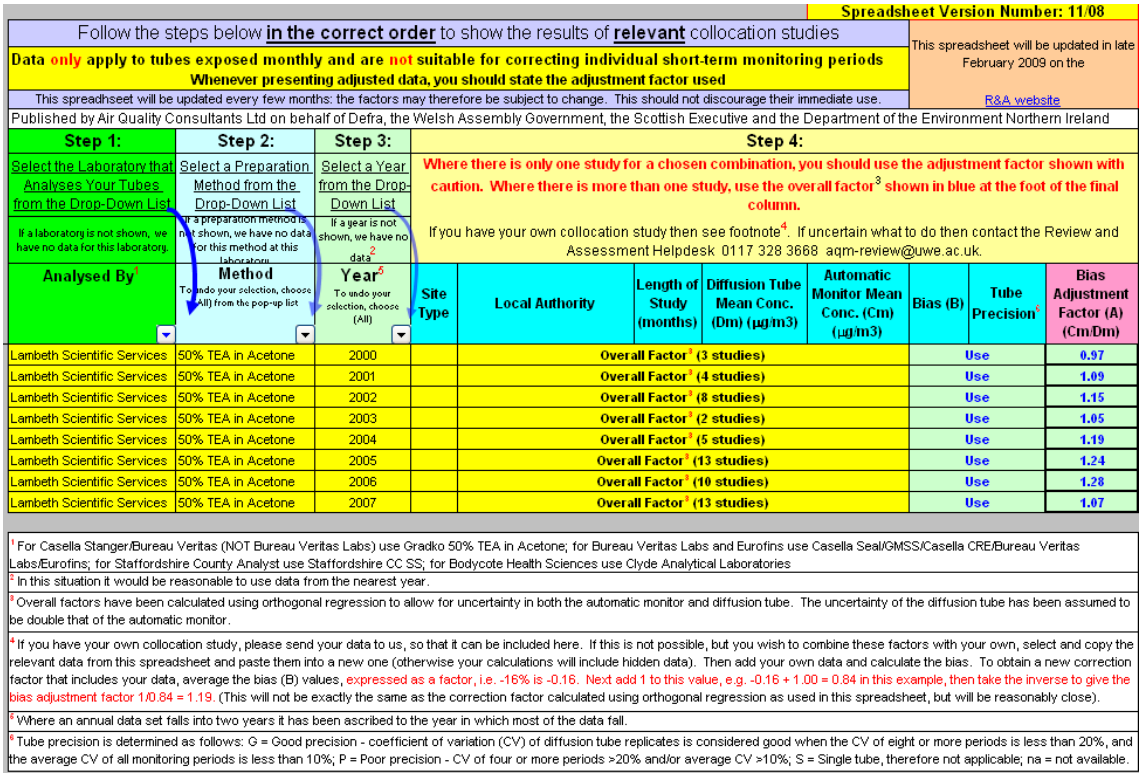
Table A1-5-6 Traffic data in Main Street, Ballyclare

Location	AADT	% HDV	Speed (mph)
Antrim Road, Elmfield	15,500	10	30

Appendix 2

Bias adjustment calculation

Table A2-1 Bias adjustment UWE spreadsheet, Lambeth Scientific Services



Spreadsheet Version Number: 11/08

Follow the steps below **in the correct order** to show the results of **relevant** collocation studies

This spreadsheet will be updated in late February 2009 on the R&A website

Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods

Whenever presenting adjusted data, you should state the adjustment factor used

This spreadhseet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

Published by Air Quality Consultants Ltd on behalf of Defra, the Welsh Assembly Government, the Scottish Executive and the Department of the Environment Northern Ireland

Step 1: Select the Laboratory that Analyses Your Tubes from the Drop-Down List. If a laboratory is not shown, we have no data for this laboratory.

Step 2: Select a Preparation Method from the Drop-Down List. If a preparation method is not shown, we have no data for this method at this laboratory.

Step 3: Select a Year from the Drop-Down List. If a year is not shown, we have no data[2]

Step 4: Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.

If you have your own collocation study then see footnote[4]. If uncertain what to do then contact the Review and Assessment Helpdesk 0117 328 3668 aqm-review@uwe.ac.uk.

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[5] (To undo your selection, choose (All))	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) (µg/m3)	Automatic Monitor Mean Conc. (Cm) (µg/m3)	Bias (B)	Tube Precision[6]	Bias Adjustment Factor (A) (Cm/Dm)
Lambeth Scientific Services	50% TEA in Acetone	2000		Overall Factor[3] (3 studies)				Use		0.97
Lambeth Scientific Services	50% TEA in Acetone	2001		Overall Factor[3] (4 studies)				Use		1.09
Lambeth Scientific Services	50% TEA in Acetone	2002		Overall Factor[3] (8 studies)				Use		1.15
Lambeth Scientific Services	50% TEA in Acetone	2003		Overall Factor[3] (2 studies)				Use		1.05
Lambeth Scientific Services	50% TEA in Acetone	2004		Overall Factor[3] (5 studies)				Use		1.19
Lambeth Scientific Services	50% TEA in Acetone	2005		Overall Factor[3] (13 studies)				Use		1.24
Lambeth Scientific Services	50% TEA in Acetone	2006		Overall Factor[3] (10 studies)				Use		1.28
Lambeth Scientific Services	50% TEA in Acetone	2007		Overall Factor[3] (13 studies)				Use		1.07

[1] For Casella Stanger/Bureau Veritas (NOT Bureau Veritas Labs) use Gradko 50% TEA in Acetone; for Bureau Veritas Labs and Eurofins use Casella Seal/GMSS/Casella CRE/Bureau Veritas Labs/Eurofins; for Staffordshire County Analyst use Staffordshire CC SS; for Bodycote Health Sciences use Clyde Analytical Laboratories

[2] In this situation it would be reasonable to use data from the nearest year.

[3] Overall factors have been calculated using orthogonal regression to allow for uncertainty in both the automatic monitor and diffusion tube. The uncertainty of the diffusion tube has been assumed to be double that of the automatic monitor.

[4] If you have your own collocation study, please send your data to us, so that it can be included here. If this is not possible, but you wish to combine these factors with your own, select and copy the relevant data from this spreadsheet and paste them into a new one (otherwise your calculations will include hidden data). Then add your own data and calculate the bias. To obtain a new correction factor that includes your data, average the bias (B) values, expressed as a factor, i.e. -16% is -0.16. Next add 1 to this value, e.g. -0.16 + 1.00 = 0.84 in this example, then take the inverse to give the bias adjustment factor 1/0.84 = 1.19. (This will not be exactly the same as the correction factor calculated using orthogonal regression as used in this spreadsheet, but will be reasonably close).

[5] Where an annual data set falls into two years it has been ascribed to the year in which most of the data fall.

[6] Tube precision is determined as follows: G = Good precision - coefficient of variation (CV) of diffusion tube replicates is considered good when the CV of eight or more periods is less than 20%, and the average CV of all monitoring periods is less than 10%; P = Poor precision - CV of four or more periods >20% and/or average CV >10%; S = Single tube, therefore not applicable; na = not available.

Table A2-2 Bias adjustment UWE spreadsheet, Gradko Services

Follow the steps below **in the correct order** to show the results of **relevant** collocation studies

This spreadsheet will be updated in late September 2008 on the R&A website

Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods

Whenever presenting adjusted data, you should state the adjustment factor used

This spreadhseet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

Published by Air Quality Consultants Ltd on behalf of Defra, the Welsh Assembly Government, the Scottish Executive and the Department of the Environment Northern Ireland

Step 1: Select the Laboratory that Analyses Your Tubes from the Drop-Down List. If a laboratory is not shown, we have no data for this laboratory.

Step 2: Select a Preparation Method from the Drop-Down List. If a preparation method is not shown, we have no data for this method at this laboratory.

Step 3: Select a Year from the Drop-Down List. If a year is not shown, we have no data[2].

Step 4: Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.

If you have your own collocation study then see footnote[4]. If uncertain what to do then contact the Review and Assessment Helpdesk 0117 328 3668 aqm-review@uwe.ac.uk.

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[5] (To undo your selection, choose (All))	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) (µg/m3)	Automatic Monitor Mean Conc. (Cm) (µg/m3)	Bias (B)	Tube Precision[5]	Bias Adjustment Factor (A) (Cm/Dm)
Gradko	20% TEA in Water	2007	R	Dartford Council	12	60	55	9.1%	G	**0.92**
Gradko	20% TEA in Water	2007	R	Macclesfield BC	12	37	33	10.8%	G	**0.90**
Gradko	20% TEA in Water	2007	R	Macclesfield BC	12	56	44	28.0%	G	**0.78**
Gradko	20% TEA in Water	2007	R	Macclesfield BC	10	28	27	5.7%	G	**0.95**
Gradko	20% TEA in Water	2007	K	South Lakeland DC	11	45	41	10.2%	G	**0.91**
Gradko	20% TEA in Water	2007	UB	Coventry CC	12	24	19	27.4%	G	**0.79**
Gradko	20% TEA in Water	2007	R	Coventry CC	10	52	46	13.5%	P	**0.88**
Gradko	20% TEA in Water	2007	R	Coventry CC	12	40	30	35.6%	P	**0.74**
Gradko	20% TEA in Water	2007	R	Coventry CC	12	41	36	13.9%	G	**0.88**
Gradko	20% TEA in Water	2007	R	Ellesmere Port & Neston BC	12	46	45	4.2%	G	**0.96**
Gradko	20% TEA in Water	2007	B	Dudley MBC	11	30	30	0.4%	G	**1.00**
Gradko	20% TEA in Water	2007	R	Dudley MBC	12	48	44	10.1%	G	**0.91**
Gradko	20% TEA in Water	2007	Rural	Dudley MBC	10	19	19	1.4%	G	**0.99**
Gradko	20% TEA in Water	2007	R	Rushmoor BC	12	43	37	14.2%	G	**0.88**
Gradko	20% TEA in Water	2007	B	St Albans DC	11	25	23	11.5%	G	**0.90**
Gradko	20% TEA in Water	2007	O	North Warwickshire BC	11	54	44	21.4%	G	**0.82**
Gradko	20% TEA in Water	2007	K	AEA Tech Intercomparison	12	109	103	6.2%	G	**0.94**
Gradko	20% TEA in Water	2002		**Overall Factor[3] (14 studies)**				**Use**		**1.00**
Gradko	20% TEA in Water	2003		**Overall Factor[3] (12 studies)**				**Use**		**0.96**
Gradko	20% TEA in Water	2004		**Overall Factor[3] (11 studies)**				**Use**		**0.91**
Gradko	20% TEA in Water	2005		**Overall Factor[3] (14 studies)**				**Use**		**0.97**
Gradko	20% TEA in Water	2006		**Overall Factor[3] (10 studies)**				**Use**		**0.98**
Gradko	20% TEA in Water	2007		**Overall Factor[3] (17 studies)**				**Use**		**0.89**

[1] For Casella Stanger/Bureau Veritas (NOT Bureau Veritas Labs) use Gradko 50% TEA in Acetone; for Bureau Veritas Labs and Eurofins use Casella Seal/GMSS/Casella CRE/Bureau Veritas Labs/Eurofins; for Staffordshire County Analyst use Staffordshire CC SS

[2] In this situation it would be reasonable to use data from the nearest year.

[3] Overall factors have been calculated using orthogonal regression to allow for uncertainty in both the automatic monitor and diffusion tube. The uncertainty of the diffusion tube has been assumed to be double that of the automatic monitor.

[4] If you have your own collocation study, please send your data to us, so that it can be included here. If this is not possible, but you wish to combine these factors with your own, select and copy the relevant data from this spreadsheet and paste them into a new one (otherwise your calculations will include hidden data). Then add your own data and calculate the bias. To obtain a new correction factor that includes your data, average the bias (B) values, expressed as a factor, i.e. -16% is -0.16. Next add 1 to this value, e.g. -0.16 + 1.00 = 0.84 in this example, then take the inverse to give the bias adjustment factor 1/0.84 = 1.19. (This will not be exactly the same as the correction factor calculated using orthogonal regression as used in this spreadsheet, but will be reasonably close).

Table A2-3 Bias adjustment calculation, AEA spreadsheet

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Diffusion Tubes Measurements										Automatic Method		Data Quality Check	
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	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
1	01/11/2007	27/11/2007	47.1	47.2	54.3	50	4.1	8	10.3	41	75.3	Good	Good
2	28/11/2007	02/01/2008	42.9	43.2		43	0.3	1	2.3	32	99.8	Good	Good
3	02/01/2008	30/01/2008	36.7	41.2	40.7	40	2.4	6	6.0	31	99.7	Good	Good
4	30/01/2008	27/02/2008	44.7	44.4	49.3	46	2.8	6	6.9	38	99.3	Good	Good
5	27/02/2008	02/04/2008	34.1	34.4	37.0	35	1.6	5	4.0	32	94.4	Good	Good
6	02/04/2008	30/04/2008	40.7	38.3	41.2	40	1.5	4	3.8	36	98.7	Good	Good
7													
8													
9													
10													
11													
12													
13													
											Overall survey -->	Good precision	Poor 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 6 out of 6 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%

Bias calculated using 6 periods of data

Bias factor A 0.83 (0.77 - 0.9)

Bias B 21% (11% - 30%)

Diffusion Tubes Mean: 42 µgm^{-3}

Mean CV (Precision): 5

Automatic Mean: 35 µgm^{-3}

Data Capture for periods used: 75%

Adjusted Tubes Mean: 35 (33 - 38) µgm^{-3}

Accuracy (with 95% confidence interval) WITH ALL DATA

Bias calculated using 6 periods of data

Bias factor A 0.83 (0.77 - 0.9)

Bias B 21% (11% - 30%)

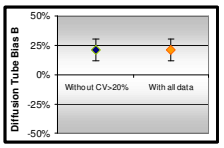
Diffusion Tubes Mean: 42 µgm^{-3}

Mean CV (Precision): 5

Automatic Mean: 35 µgm^{-3}

Data Capture for periods used: 75%

Adjusted Tubes Mean: 35 (33 - 38) µgm^{-3}



Jaume Targa
jaume.targa@aeat.co.uk

Version 03 - November 2006

Appendix 3

Air Pollution Report

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

NEWTOWNABBEY SANDYKNOWES
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	8316	-
Maximum 15-minute mean	296 µg m^{-3}	1881 µg m^{-3}
Maximum hourly mean	264 µg m^{-3}	1751 µg m^{-3}
Maximum running 8-hour mean	142 µg m^{-3}	825 µg m^{-3}
Maximum running 24-hour mean	87 µg m^{-3}	446 µg m^{-3}
Maximum daily mean	79 µg m^{-3}	340 µg m^{-3}
Average	34 µg m^{-3}	73 µg m^{-3}
Data capture	94.9 %	94.9 %

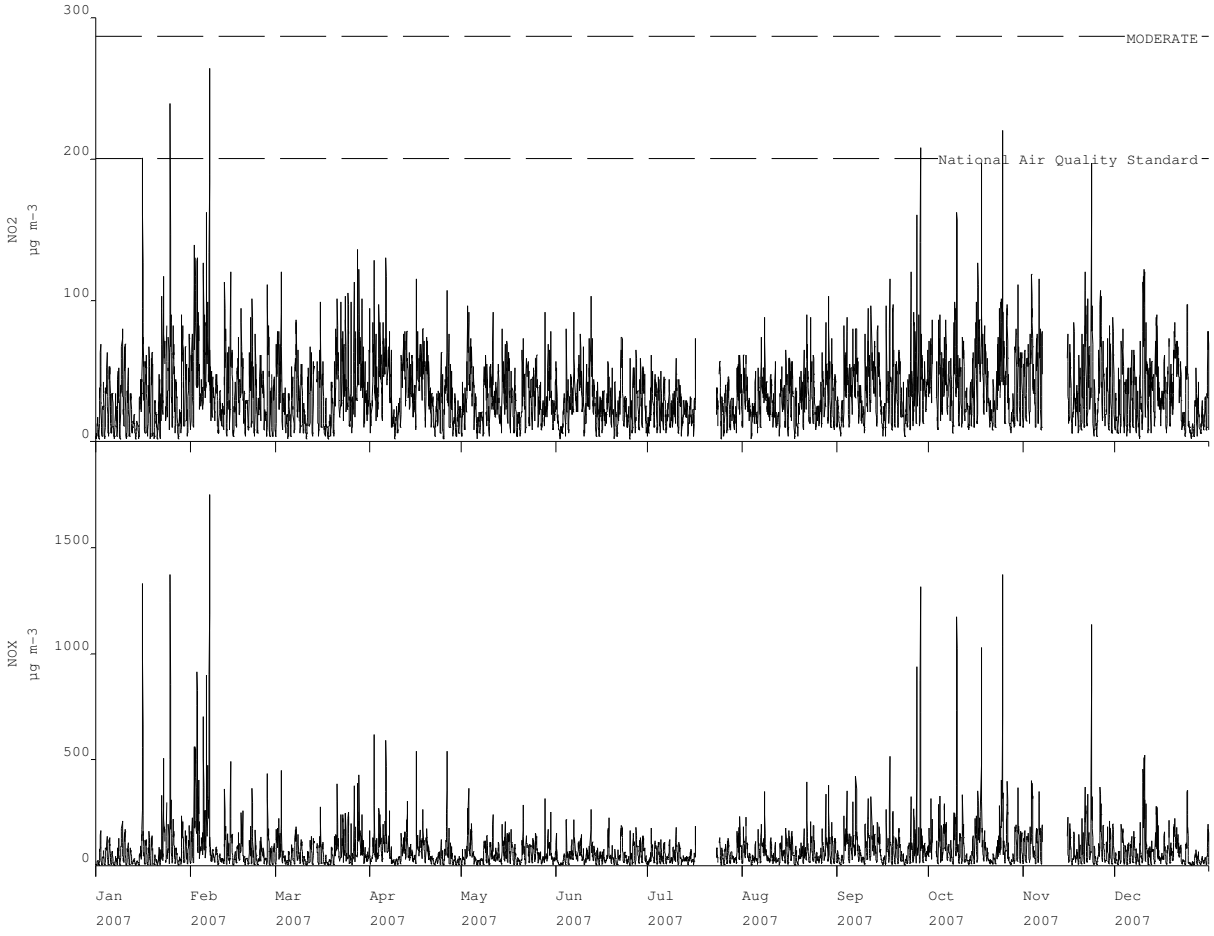
All mass units are at 20'C and 1013mb
NO_X mass units are NO_X as NO_2 µg m-3

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	6	5
Nitrogen Oxides (NO_2)	Annual mean > 30 µg m^{-3}	1	-

Air Pollution Report

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

Newtownabbey Sandyknowes Air Monitoring
Hourly Mean Data for 01 January to 31 December 2007



Air Pollution Report

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

NEWTOWNABBEY SANDYKNOWES
01 January to 03 November 2008

These data are provisional from 01/04/2008 and may be subject to further quality control

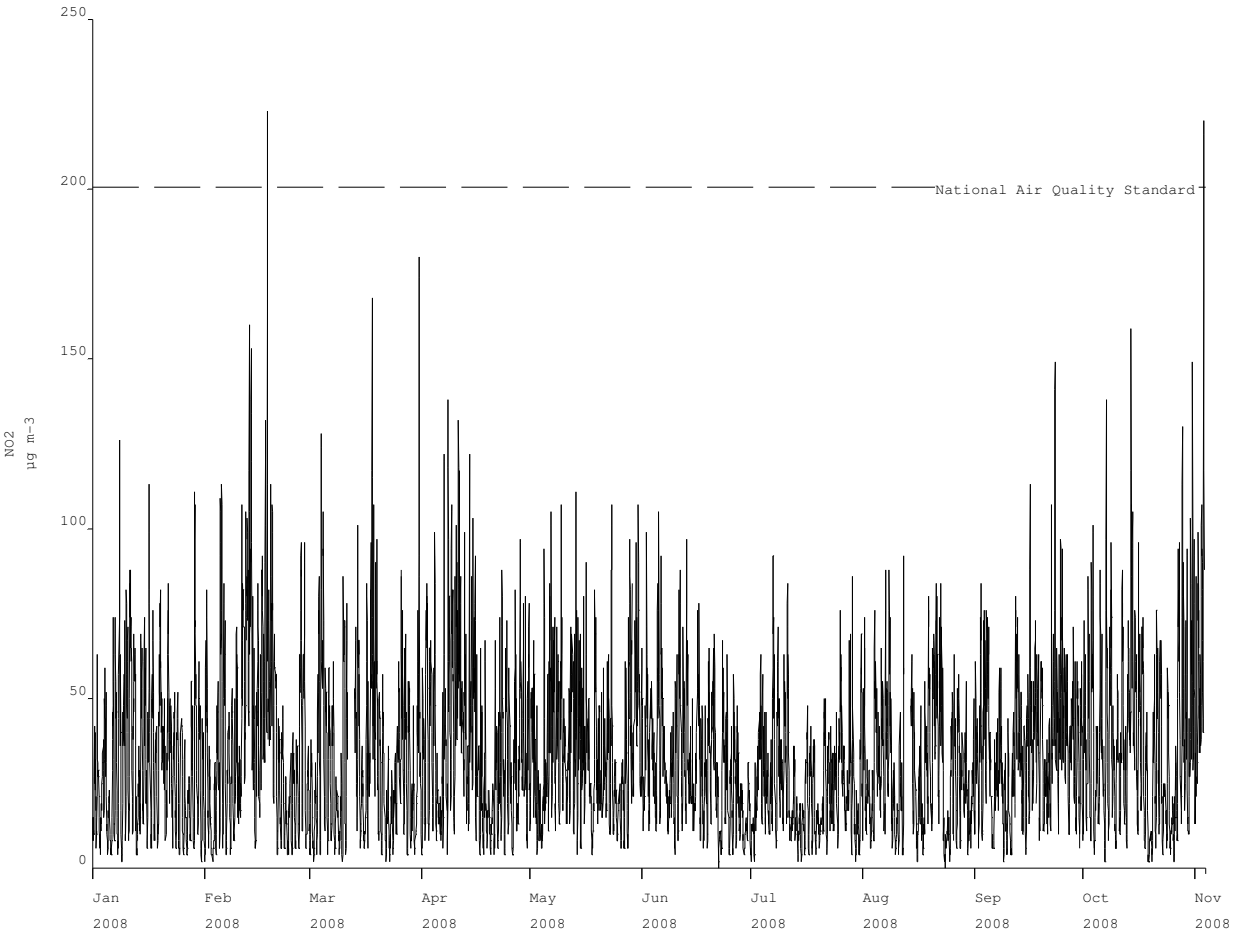
POLLUTANT	NO_2
Number Very High	0
Number High	0
Number Moderate	0
Number Low	7259
Maximum 15-minute mean	267 µg m^{-3}
Maximum hourly mean	223 µg m^{-3}
Maximum running 8-hour mean	150 µg m^{-3}
Maximum running 24-hour mean	98 µg m^{-3}
Maximum daily mean	92 µg m^{-3}
Average	33 µg m^{-3}
Data capture	98.2 %

All mass units are at 20'C and 1013mb

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	3	2

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

Newtownabbey Sandyknowes Air Monitoring
Hourly Mean Data for 01 January to 03 November 2008



Air Pollution Report

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

NEWTOWNABBEY SHORE ROAD
01 January to 19 September 2007

These data have been fully ratified by AEA Energy & Environment

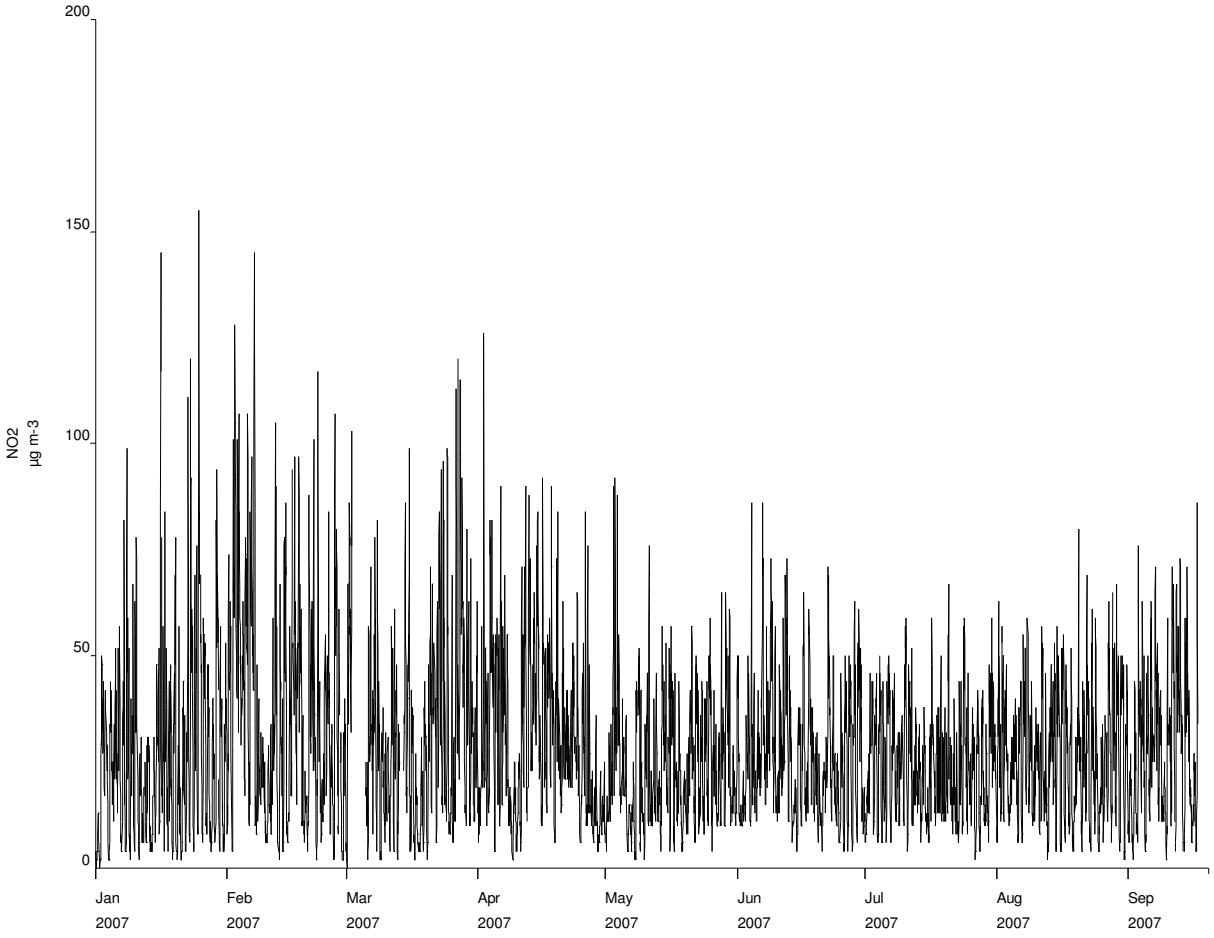
POLLUTANT	NO_2
Number Very High	0
Number High	0
Number Moderate	0
Number Low	6106
Maximum 15-minute mean	174 µg m^{-3}
Maximum hourly mean	155 µg m^{-3}
Maximum running 8-hour mean	108 µg m^{-3}
Maximum running 24-hour mean	78 µg m^{-3}
Maximum daily mean	65 µg m^{-3}
Average	28 µg m^{-3}
Data capture	97.1 %

All mass units are at 20'C and 1013mb

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	-	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	0	0

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

Newtownabbey Shore Road Air Monitoring
Hourly Mean Data for 01 January to 19 September 2007



Air Pollution Report

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

NEWTOWNABBEY BALLYCLARE MAIN ST
01 January to 01 November 2008

These data are provisional from 20/12/2007 and may be subject to further quality control

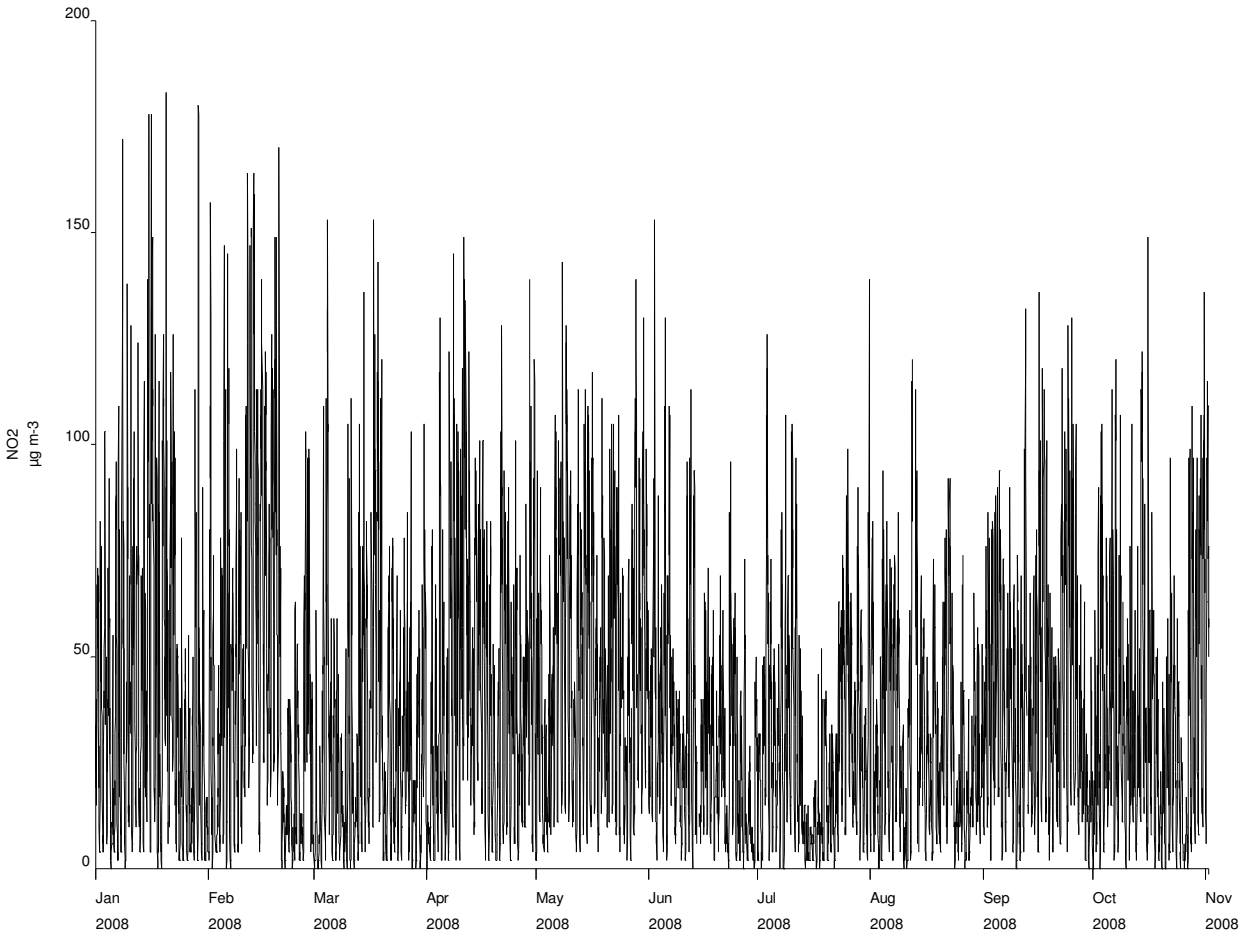
POLLUTANT	NO_2
Number Very High	0
Number High	0
Number Moderate	0
Number Low	7279
Maximum 15-minute mean	411 µg m^{-3}
Maximum hourly mean	183 µg m^{-3}
Maximum running 8-hour mean	146 µg m^{-3}
Maximum running 24-hour mean	103 µg m^{-3}
Maximum daily mean	96 µg m^{-3}
Average	37 µg m^{-3}
Data capture	99.1 %

All mass units are at 20'C and 1013mb

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	0	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	0	0

Produced by AEA Energy & Environment on behalf of Newtownabbey BC

Newtownabbey Ballyclare Main St Air Monitoring
Hourly Mean Data for 01 January to 01 November 2008



Air Pollution Report

NEWTOWNABBEY ANTRIM ROAD
01 January to 01 November 2008

These data are provisional from 01/04/2008 and may be subject to further quality control

Antrim Road Glengormley

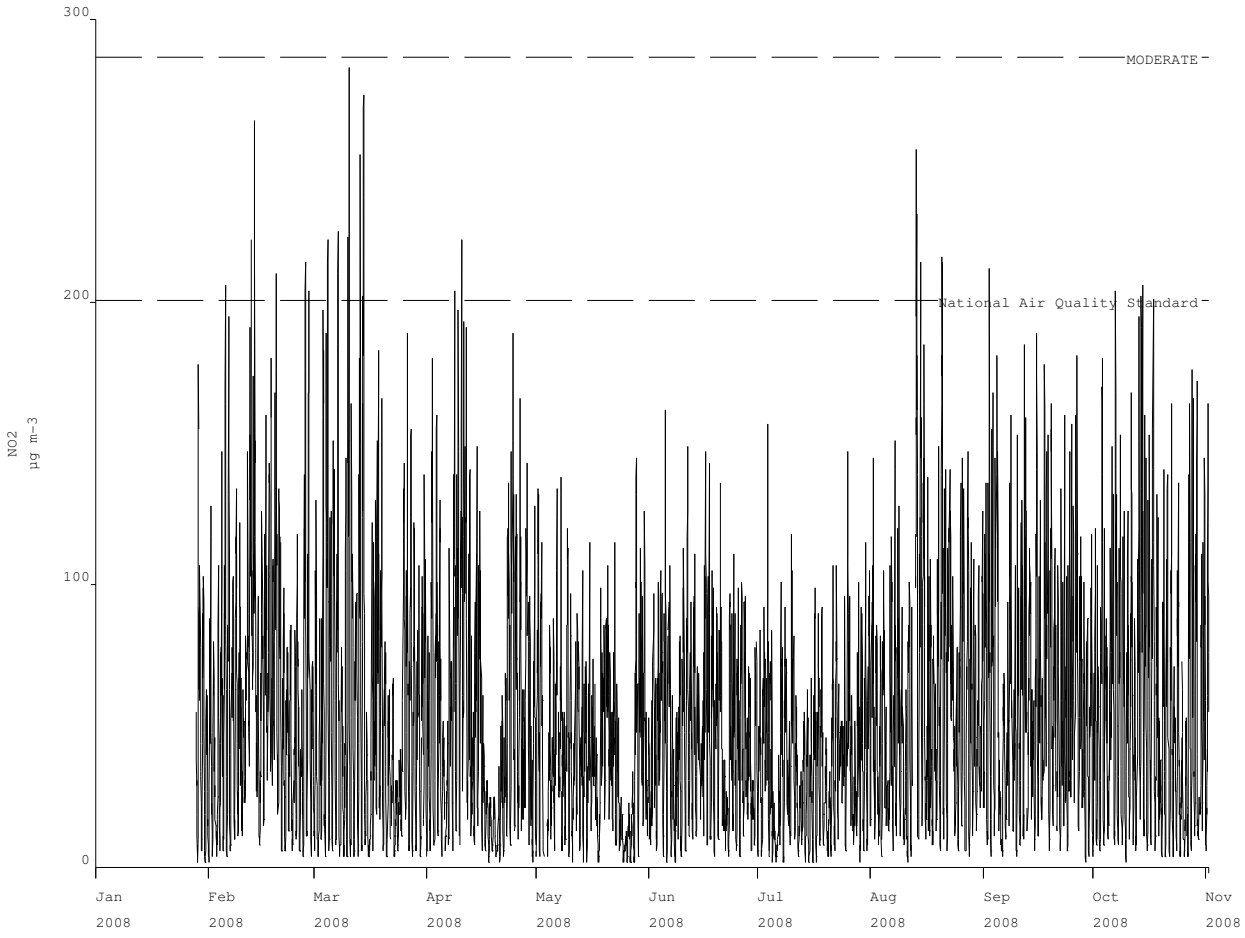
POLLUTANT	NO_2
Number Very High	0
Number High	0
Number Moderate	0
Number Low	6583
Maximum 15-minute mean	434 µg m^{-3}
Maximum hourly mean	283 µg m^{-3}
Maximum running 8-hour mean	219 µg m^{-3}
Maximum running 24-hour mean	122 µg m^{-3}
Maximum daily mean	115 µg m^{-3}
Average	52 µg m^{-3}
Data capture	89.6 %

All mass units are at 20'C and 1013mb

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
Nitrogen Dioxide	Annual mean > 40 µg m^{-3}	1	-
Nitrogen Dioxide	Hourly mean > 200 µg m^{-3}	35	20

Produced by AEA Energy & Environment on behalf of Newtownabbey

Newtownabbey Antrim Road Air Monitoring
Hourly Mean Data for 01 January to 01 November 2008



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