Derry City Council

Local Air Quality Management

Detailed Assessment and

Further Assessment

Technical Report No: BV/AQ/AGGX0813/EC/2486

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DOCUMENT INFORMATION AND CONTROL SHEET

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Executive Summary

The Further Assessment of the Air Quality Management Area (AQMA) in Creggan Road / Infirmary Road in Derry has been undertaken together with the Detailed Assessment of Buncrana Road / Racecourse Road junction and Dale's Corner junction, both required by DoE(NI) as part of the Local Air Quality Management regime, following the findings of the last air quality Updating and Screening Assessment (USA) in 2006.

The findings of this report are the following:

Further Assessment of the AQMA in Creggan Road / Infirmary Road

Based on both modelled and monitored results, the AQMA at Creggan Road / Infirmary Road junction is still required. However, there is no need to extend the AQMA, as previously suggested in the USA 2006.

Projection to year 2010 of both monitoring and modelled results showed that NO_2 will still exceed the annual mean Air Quality Strategy (AQS) objective.

Source apportionment showed that traffic-induced NO_x concentrations account for more than 50% of the total NO_x at almost every specific receptor at the junction, with a maximum contribution of 80% in Creggan Road. Heavy goods vehicles (HGVs) and cars contribute up to respectively 33% and 26% in Creggan Road. Heavy-duty vehicles (HGVs + buses) reach up to 48% of the overall NO_x concentration in the AQMA.

Contribution of domestic combustion sources and the Coolkeeragh power plant, located 7km from the AQMA, were also calculated, and it was concluded that their impact was negligible.

Based on predicted NO_x concentrations at the worst-case location, NO_x reduction analysis showed that a minimum of about 48µg/m^3 decrease in NO_x concentrations (equivalent to 30% improvement in NO_x) would be required in the AQMA to comply with the annual mean NO_2 AQS objective. The formulation of an Action Plan should aim to reduce the levels of NO_x within the AQMA by this amount.

Detailed mapping of modelling results within the AQMA indicated that the major contribution to the pollution levels registered in Creggan Road is associated with uphill traffic flows. It is suggested that traffic restrictions will be applied to the South bound link of Creggan Road to help to eliminate the registered exceedences.

Detailed Assessment of Buncrana Road / Racecourse Road

Both monitoring data and predicted results showed that NO_2 concentration was unlikely to exceed the AQS objective at relevant exposure locations near Buncrana Road / Racecourse Road junction.

Therefore, an AQMA is not required at this junction.

Detailed Assessment of Dale's Corner

Based on monitoring and predicted results, there is no exceedence of the NO_2 annual mean AQS objective at relevant exposure locations near Dale's Corner junction. However, predicted results showed that NO_2 levels at the façade of 1 Ebrington Terrace, at the corner of Limavady Road / Glender Mott Road, is close to the objective. Although the ground floor is not relevant of public exposure, there are dwellings at the first and second floors. Therefore, although an AQMA is not required at this location, it is recommended that Derry City Council install a new diffusion tube or relocate a tube at the façade of this building to confirm that this location is not at risk.

1 Introduction

1.1 Project Background

Bureau Veritas was commissioned by Derry City Council (DCC) to undertake the air quality Detailed Assessment of Buncrana Road/Racecourse Road and Dale's Corner junctions in Derry city centre, and the Further Assessment of the Derry Air Quality Management Area (AQMA) at Creggan Road/Infirmary Road junction. Both assessments are required by the Department of Environment in Northern Ireland (DoE(NI)) as part of the Local Air Quality Management (LAQM) system, introduced under the Environment (NI) Order 2002. The two junctions outside the current AQMA require a Detailed Assessment, following the findings of the last air quality Updating and Screening Assessment published in 2006.

Part III of the Environment (NI) Order 2002 places a statutory duty on Local Authorities to periodically review and assess the air quality within their area. The Detailed Assessment is a requirement of the Second Round of Review and Assessment for Local Authorities that have identified areas where there is a risk of exceedence of an Air Quality Strategy (AQS) objective.

The Further Assessment is a requirement of the Second Round of Review and Assessment for Local Authorities that have declared an AQMA. It is intended to supplement information within the AQMA.

1.2 Air Quality Strategy Objectives

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS)[1] (along with its addendum[2]) contains national air quality standards and objectives established by the Government to protect human health. The objectives for seven pollutants have been prescribed within the Air Quality (England) Regulations 2000[3], the Air Quality (England) (Amendment) Regulations 2002[4] and the Air Quality Regulations (NI) 2003[5] (benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, sulphur dioxide and particulates). The AQS objectives set in regulation in Northern Ireland are shown in Table 1.1.

The Air Quality Standards Regulations (Northern Ireland) 2007[6] came into force on 28th May 2007. This brings together in one statutory instrument the governments requirements to fulfil separate EU Daughter Directives through a single consolidated statutory instrument, which is fully aligned with proposed new EU Air Quality Directive (CAFE)[7].

Provision objectives set out in the addendum to the AQS for the assessment of PM_{10} (in response to the proposed EU Limit Values) are not included within the Regulations 2007 as these are unlikely to be considered further within the proposed new EU Air Quality Directive (CAFE).

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[1] DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland – Working together for Clean Air, The Stationery Office

[2] Defra (2002) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, The Stationery Office

[3] DETR (2000) The Air Quality Regulations 2000, The Stationery Office

[4] Defra (2002) The Air Quality Regulations 2002,The Stationery Office

[5] Statutory Rule 2003 No. 342

[6] Statutory Rule 2007 No. 265

[7] http://ec.europa.eu/environment/air/cafe/index.htm

Table 1.1 - AQS Objectives and Standards for Northern Ireland

Pollutant	Objective	Measured as	To be achieved by	Regulations 2007
Benzene All Authorities	16.25 µg/m^3	Running Annual Mean	31-Dec-03	
Benzene Authorities in Scotland and Northern Ireland only	3.25 µg/m^3	Running Annual Mean	31-Dec-10	01-Jan-10
1,3-Butadiene	2.25 µg/m^3	Running Annual Mean	31-Dec-03	
Carbon monoxide Authorities in England, Wales and Northern Ireland only	10.0 mg/m^3	Maximum daily running 8 Hour Mean	31-Dec-03	
Lead	0.5 µg/m^3	Annual Mean	31-Dec-04	
	0.25 µg/m^3	Annual Mean	31-Dec-08	
Nitrogen dioxide [a]	200 µg/m^3 Not to be exceeded more than 18 times per year	1 Hour Mean	31-Dec-05	01-Jan-10
	40 µg/m^3	Annual Mean	31-Dec-05	01-Jan-10
Particles (PM_{10}) (gravimetric) [b] All authorities	50 µg/m^3 Not to be exceeded more than 35 times per year	24 Hour Mean	31-Dec-04	
	40 µg/m^3	Annual Mean	31-Dec-04	
Sulphur dioxide	266 µg/m^3 Not to be exceeded more than 35 times per year	15 Minute Mean	31-Dec-05	
	350 µg/m^3 Not to be exceeded more than 24 times per year	1 Hour Mean	31-Dec-04	
	125 µg/m^3 Not to be exceeded more than 3 times per year	24 Hour Mean	31-Dec-04	

a - The objectives for nitrogen dioxide are provisional

b - Measured using the European gravimetric transfer sampler or equivalent

The Regulations 2007 include requirements for the assessment of $PM_{2.5}$, Arsenic, Cadmium, Nickel and Benzo(a)pyrene. These are required to be assessed by Member Sates in response to the

proposed new EU Air Quality Daughter Directive (CAFE) but local authorities are not currently required to assess against these within LAQM, subject to the ongoing Air Quality Strategy Review[8].

In April 2006, Defra published a draft for the Review of the AQS for consultation. The draft AQS Review introduced a new approach, exposure reduction, to air quality management for non-threshold pollutants. This approach comprises of two basic elements:

- air quality objectives/limit values or " concentration cap"; and
- an objective based on reducing average exposure across the most heavily populated areas of the country (percentage reduction/exposure reduction).

The Review proposes that the AQS objectives in Table 1.1 are retained. With regard to the provisional long-term PM_{10} objective, the Review suggests several courses of action. These include replacing the provisional PM_{10} objective with an exposure reduction objective for $PM_{2.5}$ and concentration cap or retaining the provisional PM_{10} objective until an exposure reduction target is agreed at EU level.

The AQS objectives take into account EU Directives that set limit values which member states are legally required to achieve by their target dates. The UK's AQS objectives are equal to, or more stringent than the EU limit values (no Member State may promulgate air quality standards that are weaker than the EU Limit Values).

The locations where the AQS objectives apply are defined in the AQS as locations outside buildings or other natural or man-made structures above or below ground, where members of the public are regularly present and might reasonably be expected to be exposed [to pollutant concentrations] over the relevant averaging period of the AQS objective. Typically these include residential properties and schools/care homes for longer period (i.e. annual mean) pollutant objectives and high streets for short-term (i.e. 1-hour) pollutant objectives.

1.3 Summary of Review and Assessment

1.3.1 The First Round of Review and Assessment

Between 2001 and 2004, DCC undertook its 3 Stages of the First Round of Review and Assessment of air quality, which assessed the sources of seven air pollutants of concern to health: carbon monoxide, benzene, 1,3 butadiene, lead, nitrogen dioxide (NO_2), sulphur dioxide and fine particulates (PM_{10}).

Stages 1, 2 and 3 were completed in August 2001, February 2004 and November 2004 respectively. The conclusions were that the NO_2 annual mean AQS objective was likely to be exceeded at the Creggan Road/Infirmary Road junction in Derry City Centre; therefore, an AQMA was required at this junction for NO_2. The AQMA was declared in February 2005, and DCC produced an Action Plan (draft) in November 2006.

In parallel, DCC produced its air quality Progress report in June 2005, which provided a review on all air quality issues in the District Council.

[8] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. A consultation document on options for further improvements in air quality. April 2006. Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, The National Assembly for Wales and the Department of the Environment for Northern Ireland

The Second Round of Review and Assessment began with an Updating and Screening Assessment (USA), in 2006. DCC completed this stage in September 2006. The report concluded that NO_2 concentrations were likely to breach the annual mean AQS objective at two new locations outside the AQMA, in Dale's Corner and at the Buncrana Road/Racecourse Road junction. Therefore, a Detailed Assessment is required at these junctions.

Moreover, the report suggested that the AQMA in Creggan Road/Infirmary Road might need to be extended. Therefore, a Further Assessment of the AQMA is required to determine if it needs to be amended.

1.4 Scope and Methodology of the Detailed and Further Assessments

1.4.1 Detailed Assessment

The approach to the Detailed Assessment is to provide the Local Authority with an opportunity to supplement the information they have gathered in their earlier review and assessment work and more accurately assess the impact of pollution sources on local receptors at identified hotspots through dispersion modelling. The aim of the dispersion modelling is to reflect the results from local monitoring sites across the whole assessment area and allow comparison of pollutant concentrations against the AQS objectives for NO_2.

The Detailed Assessment will identify with reasonable certainty whether or not there is likely to be an exceedence of the objectives and if so, define the extent and magnitude of the exceedence.

Moreover, in case that the two junctions requiring a Detailed Assessment prove to exceed the NO_2 AQS objectives, and that new AQMAs are required, the assessment will also take into account the steps involved in a Further Assessment, as described below. This especially includes the source apportionment and the determination of the reduction in pollutant concentrations required to meet the AQS objectives.

1.4.2 Further Assessment

A Further Assessment is required in the AQMA, following evidence that the area may need to be extended, due to potential exceedences outside the boundaries of the AQMA. The approach of the Further Assessment is to confirm whether the AQMA needs to be refined. The methodology is based on dispersion modelling and includes the following:

- Review of additional monitoring since the declaration of the AQMA – including continuous monitoring and diffusion tubes;
- Source apportionment of pollutants including relevance of background, industrial (if relevant), and different vehicle classification on the roads of concern, and identification of the most significant roads;
- Identification of improvement in pollutant concentrations that is required to meet the objectives in the AQMA;
- Technical justification for measures to be taken within the action plan provided measures have been identified;
- Identification of any additional policy measures that may have to be implemented after declaration; and
- Identification of any local developments, such as industrial, residential or road schemes that may affect future air quality within the AQMA.

Detailed dispersion modelling has been carried out, including the latest monitoring data, background information and meteorological data. The dispersion modelling has been undertaken using the ADMS-Urban (v2.2) dispersion model and based on the Derry emissions inventory carried out by

AEA in 2004 and updated by Bureau Veritas for 2006 and 2010 for the study areas. NO_x emissions from road traffic, domestic combustion and the Coolkeeragh power plant have been included in the model set-up as well as primary NO_2 traffic emissions.

Nitrogen dioxide diffusion tube monitoring carried out within the assessment area has been used to verify the modelled results. DCC has placed a number of passive diffusion tubes throughout Derry city centre to monitor NO_2 concentrations. In total, 15 diffusion tubes have been used for the verification of dispersion modelling. The bias adjustment factor for diffusion tubes in 2005 and 2006 has been estimated based on both local monitoring and diffusion tubes national surveys available on the Review and Assessment Helpdesk website[9]. Monitoring has been annualised when necessary in accordance with methodology in the Technical Guidance (LAQM.TG(03)) and results are presented in this report.

Pollutant concentrations have been predicted for the current year, assumed 2006, and future year 2010 for nitrogen oxides (NO_x) and nitrogen dioxide (NO_2), in line with the relevant UK Air Quality Objectives and EU Air Quality Limit Values. The dispersion modelling has been undertaken in accordance with the methodologies provided in the Technical Guidance (LAQM.TG(03)) and DoE(NI) Guidance for Detailed and Further Assessments.

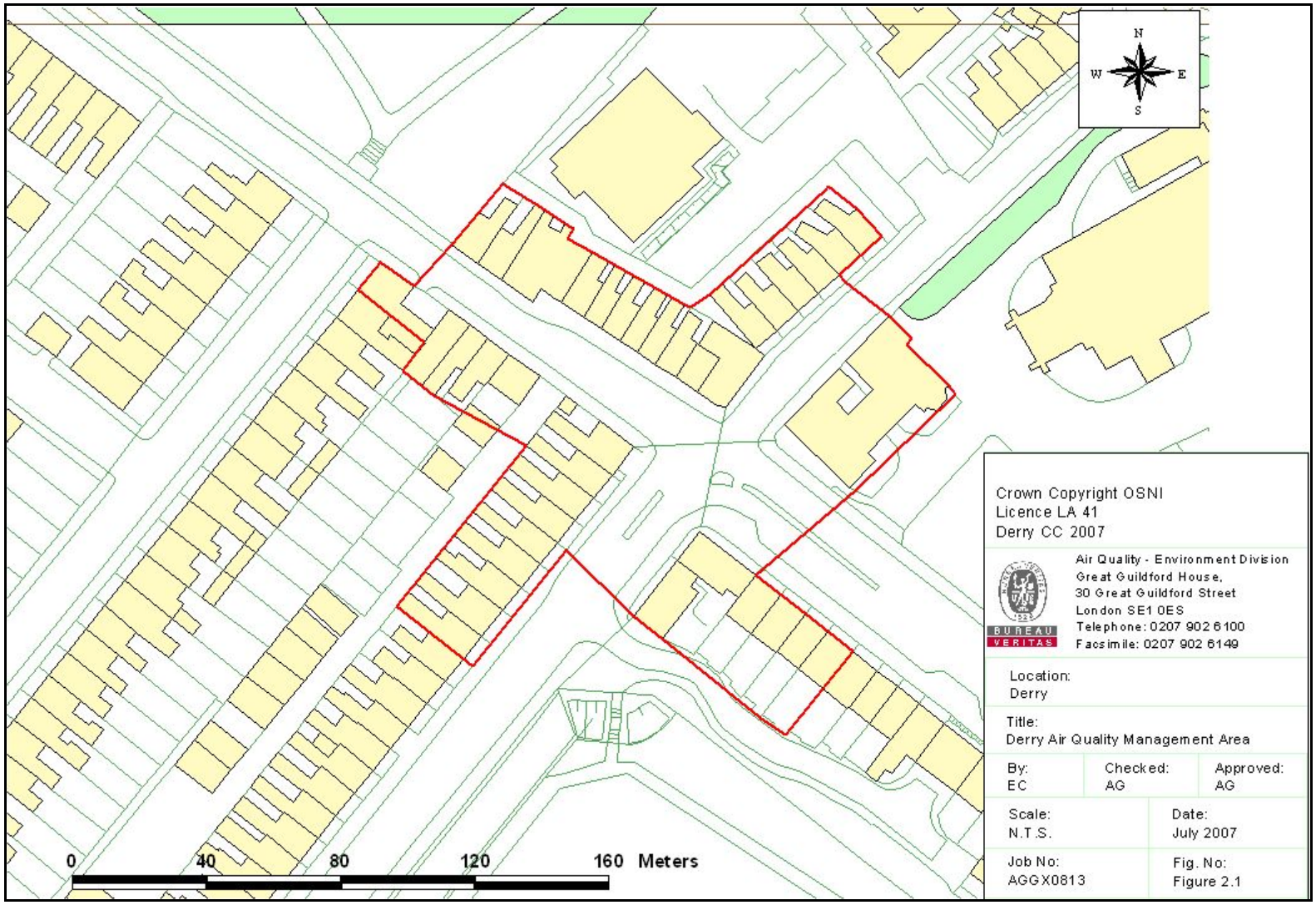
2 Baseline Information

2.1 Derry Air Quality Management Area

In February 2005, DCC declared an AQMA in Derry for an area encompassing parts of Creggan Road, Windsor Terrace on Infirmary Road, Creggan Street and Marlborough Terrace on Lone Moor Road. The designated AQMA is shown in Figure 2.1.

[9] www.uwe.ac.uk/aqm/review/

Figure 2.1 – Derry Air Quality Management Area



2.2 Traffic sources

Traffic data were extracted from Derry EMIT Emissions Inventory 2004, and vehicle flows have been projected to years 2006 and 2010 for the relevant roads, based on traffic growth information provided by Derry City Council.

The roads considered in the assessment are:

Creggan Road/Infirmary Road junction:

- Creggan Road;
- Creggan Street;
- Infirmary Road;
- Lone Moor Road;

Buncrana Road/Racecourse Road junction:

- Buncrana Road;
- Racecourse Road;
- Road leading to Pennyburn Industrial Estate;

Dale's Corner junction:

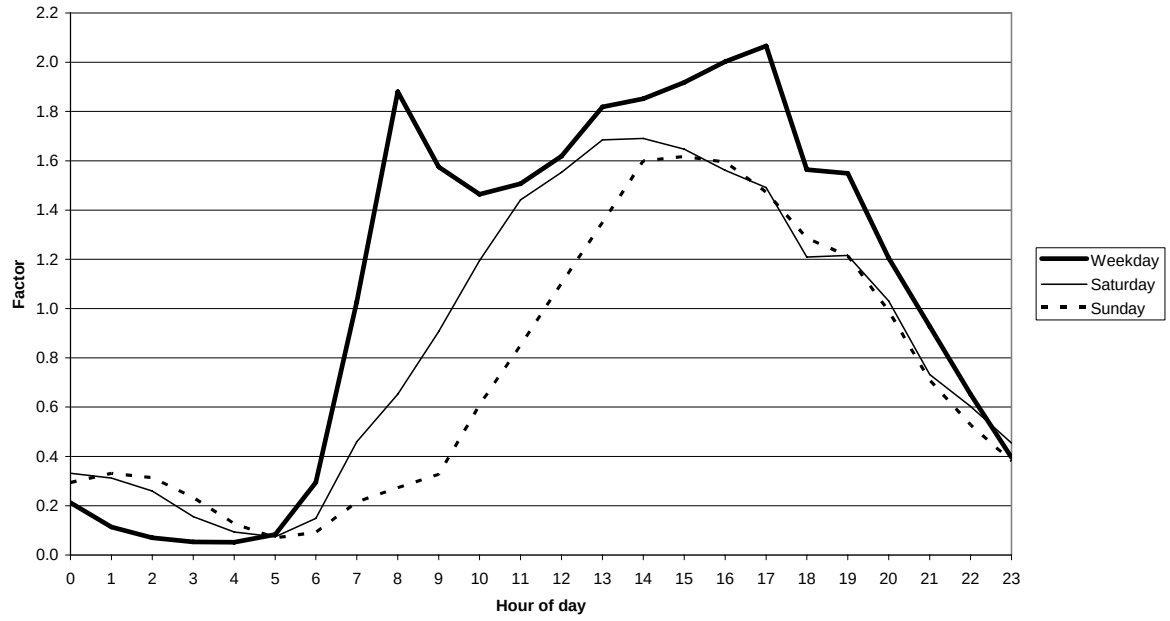
- King Street;
- Limavady Road;
- Glender Mott Road;
- Clooney Terrace.

Breakdown of vehicle flow category was available in the emissions inventory database, and was included in the model set-up (cars, light goods vehicles, buses and coaches, heavy-goods vehicles).

The traffic data for each road link are given in the Appendix 1. The roads taken into account in the model set-up are provided in Figure 3.2.

The variations of traffic flow with time were used as diurnal patterns in the model. Diurnal patterns for all the roads included in the model set-up were based on data from Buncrana Road, as it was the only available data. The diurnal profile used in the model is shown in Figure 2.2 below.

Figure 2.2 – Diurnal pattern of traffic flow in Buncrana Road



2.3 Other sources

DCC required that the impact of domestic combustion sources and the Coolkeeragh power plant emissions be considered in this assessment. Data for those sources were extracted from the Derry Emissions Inventory 2004, updated for 2006 and 2010 for the study area. Given the low level of emissions from domestic sources and the distance of the power plant from the sites to be assessed (about 6km to 7km from all sites) it is anticipated that the impact of these sources is insignificant. However, the sources have been included in the model set-up and model runs have been carried out at specific receptors at the three junctions to be assessed.

Domestic sources are aggregated in 1km * 1km grid cells in the emissions inventory. For each site, the closest cells have been taken into account in the model set-up as volume sources.

The Coolkeeragh power station, located 6km Northeast of Derry City Centre, has recently changed from heavy fuel oil-fired to gas-fired system. A combined cycle gas turbine (CCGT) was constructed between 2002 and 2005, and operation started early 2005. Two combustion turbine generators operating in open cycle (OCGT) were retained for emergency generation.

Therefore, the emissions inventory had to be updated with new emissions rates. Stack parameters and NO_x emissions from the power station were based on the Air Quality Modelling report carried out in March 2005 with ADMS 3.

Although the CCGT is generally fired on natural gas, it also has the capability of being fired on distillate oil, which has been retained for the modelling scenario. CCGT Generator and also emergency generators OCGT 1 and 2 were all assumed to operate all year. This is considered to be a worst case scenario. Parameters are provided in Table 2.1.

Table 2.1 - Coolkeeragh power station stack parameters

Stack	Irish OS Grid (X,Y in m)	Stack Height (m)	Stack Diameter (m)	Flow Rate (m^3/s)	Exit Velocity (m/s)	Exit Temp (°C)	NO_x emission rate (g/s)
CCGT	248230, 422160	70	6	848	30	135	68.8
OCGT 1	248230, 422160	35	3.7	667	62	356	99
OCGT 2	248230, 422160	35	3.7	667	62	356	99

2.4 New developments

Local developments may affect future air quality within the area of the AQMA and as such, it is important to account for any new residential/commercial development, road scheme, or industrial process in the Detailed Assessment.

There is no known significant development in Derry which is expected to affect air quality within the current assessment area.

2.5 Air Quality Monitoring Data

2.5.1 Continuous Monitoring

A continuous NO_x/NO_2 monitoring station is installed at Brooke Park. The station is located in the south east corner of the Park, just outside the AQMA, around 60m from Infirmary Road. It is classified as an urban background site, and is part of the UK Automatic Urban and Rural Network (AURN). DCC also operates a roadside NO_x/NO_2 continuous monitoring station at Dale's Corner, at the junction of King Street and Limavady Road. For years 2004 and 2006, results have been annualised based on Brooke Park AURN station (located 1.3km from Dale's Corner), as data capture was low and several month data were missing. Ratified results[10] for years 2004 to 2006 are presented in Table 7.1.

[10] Results from Brooke Park AURN station have been obtained from the UK Air Quality Archive website - www.airquality.co.uk. Results for Dale's Corner analyser were collated from the Northern Ireland Air Quality network - www.airqualityni.co.uk

Table 7.1 Ratified Results for Derry's NO_x/NO_2 Air Quality Monitoring Station (2004 to 2006)

Location	X	Y	Year	NOx annual mean (µg/m^3)	NO2 annual mean (µg/m^3)	No. of hourly means > 200µg/m^3	Data Capture (%)
AURN station Brooke Park	242962	417217	2004	22	15	0	92
			2005	18	12	0	92
			2006	19.3	12.2	0	88
Dale's Corner	244178	416760	2004	97.1	**42.5**[a]	9	72
			2005	105	**62**	8	81
			2006	70.6	38.6[b]	1	67
AQS Objectives				-	40	18	-

a – Average based on 7 month-period was 48µg/m^3 - – Results annualised based on Brooke Park AURN station

b – Average based on 5 month period was 34.2µg/m^3 – Results annualised based on Brooke Park AURN station

Results at Brooke Park station in the past 3 years were well below the NO_2 AQS objectives, and data capture was high.

Results for roadside site at Dale's Corner station were well above the NO_2 annual mean AQS objective in 2005, and slightly above in 2004. Data capture in 2004 was low (72%), due to a series of missing data from May to August essentially. Results for 2006 were below the annual mean objective, but data capture was very low as well (67%). This was apparently due to calibration problems.

The annualisation was carried out based on one AURN monitoring station only, as there was no other site available. However, the station is very close to the modelled sites (less than 100m north of Creggan Road / Infirmary Road junction); therefore the uncertainty is reduced as it is in a very similar environment.

While the results in 2004 and 2006 show a consistent annual mean around 40µg/m^3, results for 2005 showed a much higher average of 62µg/m^3. It is not clear why there was such a difference compared to the other years.

2.5.2 Diffusion Tubes

In 2006, DCC had 24 NO_2 diffusion tubes in Derry, of which two sets of triplicates co-located with the continuous monitoring stations at Dale's Corner and Brooke Park. 15 of these diffusion tubes, near modelled roads, have been used for model verification. Until August 2006, the diffusion tubes were supplied and analysed by Lambeth Scientific Services Ltd utilising the 50% TEA[11] in acetone preparation method. DCC then changed supplier (Bureau Veritas Labs) in September and new monitoring data for the last three months in 2006 were prepared with the 10% TEA in water.

Consequently, the annual mean could not be determined directly, as the two methodologies are different. The results from Lambeth diffusion tubes showed high variability and hence the 2006 annual mean was calculated based on the annualisation of the 6-month data from Bureau Veritas

[11] TEA-Triethanolamine

Labs, from October 2006 to March 2007. However, the monthly data and annualised results from Lambeth have also been included in Appendix 2 for information.

The technical Guidance LAQM.TG(03) suggests that the annualisation should be based on 2 to 4 background sites. However, as mentioned in Section 2.5.1, the only NO_x/NO_2 background site available is the Brooke Park AURN monitoring station. Therefore the annualisation has been carried out based on this station only.

A bias correction factor has been applied to the data, which is an estimate of the difference between diffusion tube concentrations and continuous monitoring, the latter assumed to be a more accurate method of monitoring. The Review and Assessment Helpdesk[12] provides bias factors based on a number of co-located sites, as part of a national diffusion tube survey. The average bias factor for the Bureau Veritas Labs method was 0.87 in 2006, but a conservative factor of 1 was applied, as half of the raw data used were from 2007.

This method proved to be more reliable than calculating a local bias factor from the collocated diffusion tubes at the two monitoring stations in Derry (Brooke Park and Dale's Corner). Bias factor from Dale's corner triplicates has been unusually high in the past two years, and analysis of continuous monitoring data, (see section 2.5.1) shows that the level of uncertainty is high for this station; therefore there is little confidence in the associated bias factor.

2006 adjusted results have been projected to 2010 based on the Year Adjustment Calculator spreadsheet provided by the Review and Assessment Helpdesk. A factor of 0.87 was used for roadside sites and 0.90 for urban background sites. The results for year 2006 and projection to year 2010 are shown in Table 2.2. The locations of the diffusion tubes within Derry are shown in Figure 2.3.

Data capture was good at all tubes and collocated tubes (A1, A2, A3 at Brooke Park; D1, D2, D3 at Dale's Corner) showed low variability in results.

Two diffusion tubes (C1 and C2) exceeded the NO_2 annual average AQS objective in Derry in 2006. Both tubes are located at the same location within the AQMA outside 3, Creggan Road.

There are two other sites that are below 40µg/m^3 but relatively close: D5 in Glendermott Road (34.2µg/m^3) and P4 in Collon Terrace (35.9µg/m^3). Given the uncertainties in diffusion tube results (due to the annualisation and bias correction factor) these sites will have to be carefully monitored in the next stage of LAQM. Sites D5 and P4 were also highlighted in the previous USA, as they exceeded the AQS objective in 2005. However, the bias factor used to adjust results was quite high (1.5). These two sites are part of the Detailed Assessment at Dale's Corner and Buncrana Road/Racecourse Road junction.

Projected results to 2010 show that tubes C1 and C2 in Creggan Road will still exceed the NO_2 annual mean AQS objective. Therefore, the AQMA is still required at Creggan Road/Infirmary Road junction.

It is recommended that DCC keep on monitoring all sites within Derry and work on improving data capture and quality control, especially at Dale's Corner, where the continuous monitoring station is installed. High variability in results at the monitoring station could be reduced by periodically reviewing automatic and/or manual calibration and comparing monthly results with the triplicate diffusion tubes.

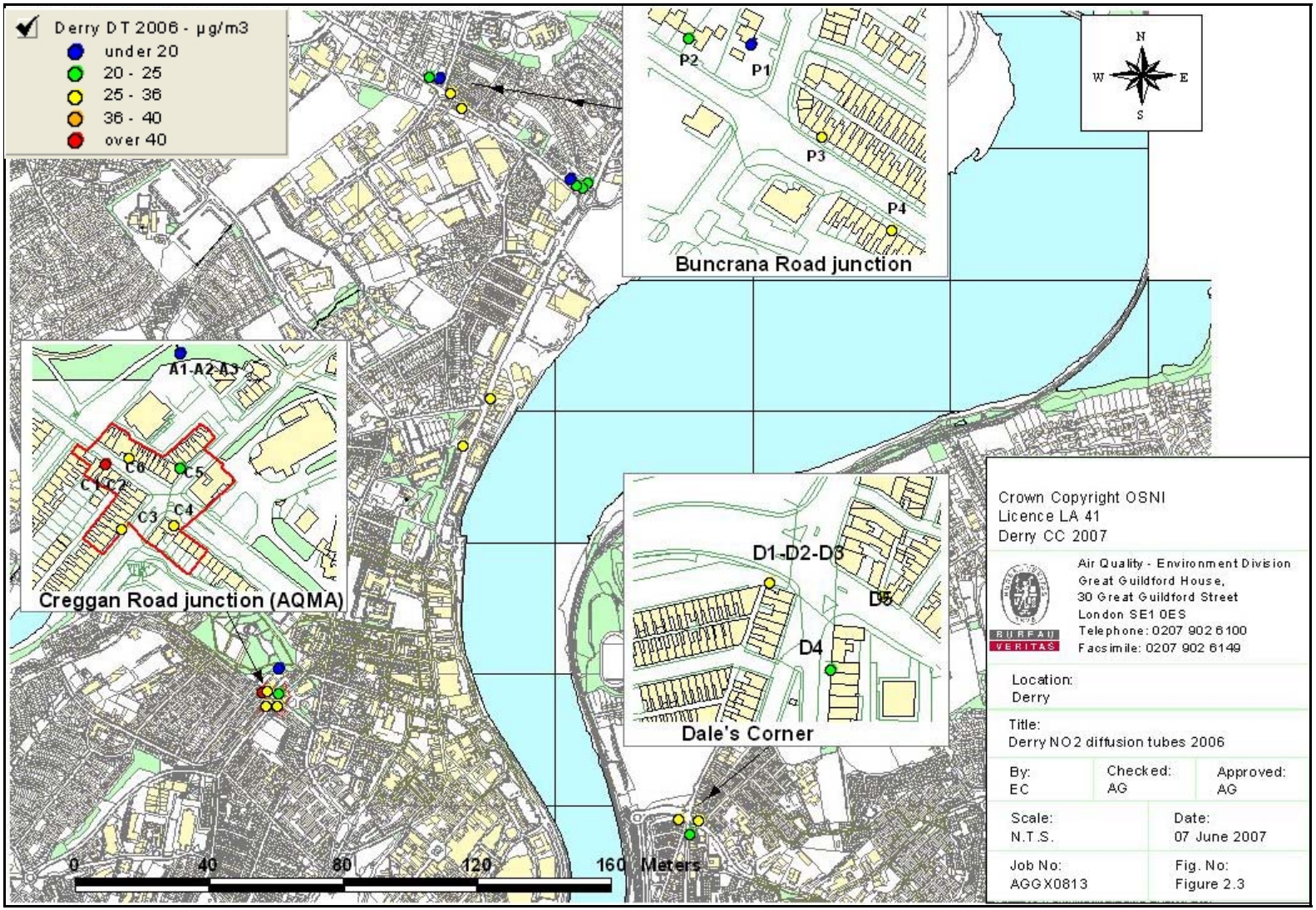
[12] www.uwe.ac.uk/aqm/review

Table 2.2 - Diffusion Tube Results in Derry City Centre (annualised and bias corrected) – 2006

c	Name	X	Y	Type	Site used for verification	Within AQMA	2006 annual mean (µg/m^3)	Data Capture (%)	2006 projected to 2010 (µg/m^3)
A1	Brooke Park	242962	417217	B	No	No	14.4	100	13.0
A2	Brooke Park	242962	417217	B	No	No	14.7	100	13.2
A3	Brooke Park	242962	417217	B	No	No	15.1	100	13.6
C1	3 Creggan Rd	242913	417144	R	Yes	Yes	**49.9**	100	**43.4**
C2	3 Creggan Rd	242913	417144	R	Yes	Yes	**49.7**	100	**43.3**
C3	6 Marlborough Terrace	242923	417102	R	Yes	Yes	26.1	100	22.7
C4	22A Creggan Street	242958	417104	R	Yes	Yes	33.0	100	28.7
C5	10 Windsor Terrace	242962	417142	R	Yes	Yes	23.8	100	20.7
C6	14 Creggan Road	242928	417148	R	Yes	Yes	27.8	100	24.2
D1	Monitor	244178	416760	R	Yes	No	28.8	100	25.1
D2	Monitor	244178	416760	R	Yes	No	26.8	100	23.3
D3	Monitor	244178	416760	R	Yes	No	30.3	100	26.3
D4	52 Clooney Terrace	244210	416714	R	Yes	No	21.4	100	18.6
D5	5 Glendermott Road	244238	416753	R	Yes	No	34.2	100	29.7
F1	2 Farren Park	243902	418692	R	No	No	22.0	100	19.1
F2	3 Farren Park	243884	418678	R	No	No	24.3	100	21.2
F3	5 Farren Park	243868	418688	R	No	No	20.9	100	18.2
F4	9 Farren Park	243846	418706	R	No	No	19.6	100	17.1
P1	53 Messines Park	243449	419013	R	Yes	No	18.1	100	15.7
P2	57 Messines Park	243418	419016	R	Yes	No	22.3	100	19.4
P3	19 St Patricks Terrace	243484	418967	R	Yes	No	25.9	100	22.5
P4	5 Collon Terrace	243519	418921	R	Yes	No	35.9	100	31.2
S1	99 Strand Road	243522	417894	R	No	No	32.6	100	28.4
S2	Rockmills	243607	418037	R	No	No	27.4	100	23.8

In bold, exceedence of the NO_2 annual mean AQS objective - R = Roadside, B = Urban background site

Figure 2.3 – Derry City Centre - Diffusion tubes results 2006



2.5.3 Background Concentrations

Local air quality monitoring and updated pollutant background maps[13] have been considered when determining appropriate background concentrations for this assessment.

NO_2 concentration from the background maps for year 2006 is 10µg/m^3 within Derry City Centre. This is consistent with the 2006 NO_2 annual mean monitored at the Brooke Park urban background AURN station (12.2µgm^3). This station was deemed more representative of the local background concentrations in Derry and NO_x and NO_2 results from Brooke Park have been used in this assessment.

Background NO_x and NO_2 concentrations for year 2010 have been derived based on the Year Adjustment Calculator spreadsheet from the Air Quality Archive website[14].

Based on the above information, Table 2.3 shows the background NOx and NO_2 concentrations that have been used for this assessment for both years.

Table 2.3 - Background Concentrations for Derry City Centre (µg/m^3)

Pollutant	2006 Background (µg/m^3)	2010 Background (µg/m^3)
NO_x	19.3	16.2
NO_2	12.2	10.9

3 Dispersion Modelling Methodology

Detailed dispersion modelling of NO_x has been undertaken using the Cambridge Environmental Research Consultants (CERC) Ltd ADMS-Urban (version 2.2) advanced Gaussian air dispersion model. Conversion to NO_2 has been carried out using the NO_x/NO_2 ratio based on the updated conversion method recommended by the Defra[15].

ADMS-Urban has been extensively used in local air quality management and has formed the basis for many AQMA declarations. A number of validation studies have been completed, showing overall good agreement between model outputs and observations at continuous monitoring sites. ADMS-Urban includes a module that takes into the account the effects of street canyons.

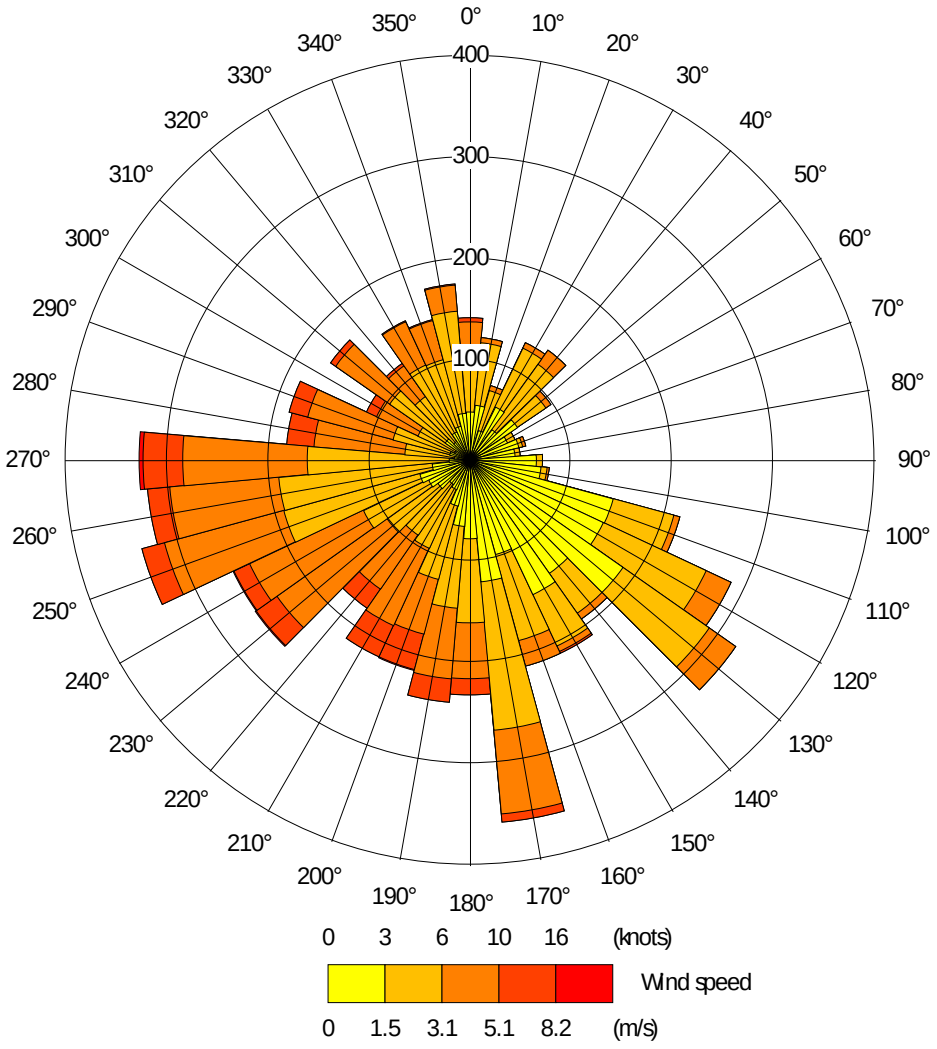
[13] Estimated Background Air Pollution Data - http://www.airquality.co.uk/archive/laqm/laqm.php

[14] http://www.airquality.co.uk/archive/laqm/tools.php

[15] R&A Helpdesk, 2 April 2007 - http://www.uwe.ac.uk/aqm/review/mfaqroad.html - This method supersedes the method described in LAQM.TG (03).

Dispersal of pollutant emissions is entirely dependent upon the prevailing meteorological conditions at the time of emissions release. Hourly sequential meteorological data from the closest Met Office station (Ballykelly, 10 miles North East of Derry) has been used in this assessment, based on year 2006. The wind rose for meteorological data is shown in Figure 3.1.

Figure 3.1 – Ballykelly 2006 Hourly Sequential Meteorological Data



For traffic data, the diurnal pattern mentioned in Section 2.2 has been applied to all roads in the assessment for both 2006 and 2010 scenarios. Speed data have been based on both speed limits in Derry City Centre and local knowledge. Speed has been reduced near junctions and approach links. The modelled roads are provided in Figure 3.2. Emission data for vehicles have been calculated in EMIT, following the update of traffic flows for relevant years (2006 and 2010).

Domestic sources and the stacks from the Coolkeeragh power station were modelled respectively as volume sources and point sources.

Figure 3.2 – Modelled roads in Derry City Centre

A - Creggan Road / Infirmary Road.

B - Buncrana Road / Racecourse Road.

C - Dale's Corner.

4 Results

4.1 Model Verification

Model verification at specific locations has been carried out prior to predicting concentrations within the whole domain. The objectives of the model verification are:

- to evaluate model performance,
- to show that the baseline is well established, and
- to provide confidence in the assessment.

The comparison of the model versus monitoring has been carried out using local NO_2 monitoring data from 15 roadside diffusion tubes in Derry. The results for the annual mean NO_2 are presented in Table 4.1.

During the verification process, Bureau Veritas aim to show that all final modelled NO_2 concentrations are within 25% of the monitored NO_2 concentrations. Modelled results may not compare as well at some locations for a number of reasons including:

- Errors in traffic flow and speed data estimates;
- Model setup (including street canyons, road width, receptor location);
- Model limitations (treatment of roughness and meteorological data);
- Uncertainty in monitoring data (notably diffusion tubes, e.g. bias adjustment factors and annualisation of short-term data).

The above factors were all investigated, as part of the model verification process to minimize the uncertainties as much as is practicable. Especially, NO_2 background concentration has been investigated to make sure that the chosen background data reflected accurately the conditions of atmospheric dispersion within Derry. Sensitivity tests have been carried out regarding vehicle speed and the width of street canyons. Canyon width has been adjusted to make sure that the diffusion tubes at facades were effectively within street canyons.

As shown in Table 4.1, the comparison of modelled versus monitored indicates that most of the final modelled NO_2 results are within 25% of monitored concentrations for 2006.

Creggan Road/Infirmary Road junction shows variability in results. At sites C1 and C2 (site locations that exceeded the AQS objective) the model under predicts by 10%. However, the predicted results are above 40µg/m^3, which confirms the monitoring results. On the other hand, the model over predicts by 15% at tube C6, the other side of Creggan Road, where monitored NO_2 level is only 27.8 µg/m^3. Overall, the modelled results are in good agreement with monitoring data and clearly show the impact of the steep slope in Creggan Street/Creggan Road, as vehicles going uphill are likely to release higher emissions at lowers speeds, thus increasing NO_2 levels on one side of the road (uphill, tubes C1 and C2) while the other side does not exceed the AQS objective (downhill, tube C6). Section 4.2.3 presents detailed mapping results of the modelling exercise splitting traffic emissions per link for Creggan Road North and South bounds.

The high over prediction at site C5 outside 10 Windsor Terrace may be due to the location of the diffusion tube. This site is shielded by the building at 1 Infirmary Road, and it is likely that local wind effect (vortex or air recirculation) has an impact on monitoring levels, which cannot be reproduced with a Gaussian model.

Model verification at Buncrana Road/Racecourse Road shows good agreement at sites P1 and P2. The discrepancy between modelled and monitored results at sites P3 and P4 is not clear, as it is surprising that diffusion tube P4 shows NO_2 level 10µg/m^3 higher than tube P3. This might be due to the fact that P3 is located in a more open area than P4, although NO_2 would be expected to be higher at P3, since it is much closer to the busy junction (which is what the model predicts).

All other modelled results show good agreement with monitoring data, especially at Dale's Corner, where results fall within 15% of the monitoring data.

Table 4.1 – Verification results at monitoring sites in Derry

Area	ID	Name/Location	Type	Within AQMA	2006 Predicted Total NO_2 ($\mu g/m^3$)	2006 Monitored NO_2 ($\mu g/m^3$)	Difference predicted / monitored ($\mu g/m^3$)	Difference predicted / monitored (%)
Creggan Road (AQMA)	C1	3 Creggan Rd	R	Yes	**44.3**	**49.9**	-5.6	-11%
	C2	3 Creggan Rd	R	Yes	**44.3**	**49.7**	-5.4	-11%
	C3	6 Marlborough Terrace	R	Yes	35.8	26.1	9.7	37%
	C4	22A Creggan Street	R	Yes	30.7	33	-2.3	-7%
	C5	10 Windsor Terrace	R	Yes	38.4	23.8	14.6	61%
	C6	14 Creggan Road	R	Yes	32.1	27.8	4.3	15%
Dale's Corner	D1-2-3	Dale's Corner CM station	R	No	26.1	28.6	-2.5	-9%
	D4	52 Clooney Terrace	R	No	24.6	21.4	3.2	15%
	D5	5 Glendermott Road	R	No	33.1	34.2	-1.1	-3%
Buncrana / Racecourse	P1	53 Messines Park	R	No	22.0	18.1	3.9	22%
	P2	57 Messines Park	R	No	22.4	22.3	0.1	0%
	P3	19 St Patricks Terrace	R	No	33.1	25.9	7.2	28%
	P4	5 Collon Terrace	R	No	26.5	35.9	-9.4	-26%

4.2 Modelled NO_2 concentrations

Annual average concentrations for NO_2 were predicted for the baseline year 2006 and future year 2010 at a number of specific receptors representing relevant public exposure (façade of properties, see Figure 4.1 to Figure 4.3), in addition to a 5m-grid spacing across the assessment areas for the production of contour maps. All results have been predicted at 1.5 m from the ground.

All predicted results are shown in Figure 4.4 and Figure 4.7. They have been produced based on the final model setup used for model verification as described in Section 4.1. For predictions for year 2010, the same verification methodology has been applied, but relevant projected background concentrations and traffic growth factor have been applied.

Table 4.2 summarises the predicted NO_2 results for both years at the specific receptor locations in the three areas assessed.

Table 4.2 – Predicted NO_2 annual mean concentrations at specific receptors

Area	ID	Name/Location	X (m)	Y (m)	Z (m)	Within AQMA	Predicted NO_2 2006 ($\mu g/m^3$)	Predicted NO_2 2010 ($\mu g/m^3$)
Creggan Road / Infirmary Road (AQMA)	1	4 Creggan Rd	242946	417137	1.5	Yes	**41.7**	37.4
	2	35 Creggan Rd	242795	417225	1.5	No	24.2	21.6
	3	21 Marlb Terrace	242872	417039	1.5	No	28.8	25.8
	4	1 Marlb St	242878	417170	1.5	No	39.9	35.8
	5	2 Marlb Terrace	242934	417117	1.5	Yes	39.2	35.1
	6	23 Marlb Terrace	242940	417095	1.5	Yes	26.7	24.0
	7	4 Creggan St	243039	417040	1.5	No	21.8	19.5
	8	12 Creggan St	243006	417066	1.5	No	23.9	21.4
	9	18 Creggan St	242977	417089	1.5	Yes	24.9	22.3
	10	4 Infirmary Rd	243007	417183	1.5	No	28.3	25.3
	11	6 Infirmary Rd	242983	417161	1.5	Yes	30.0	26.9
Dale's Corner	12	17 Melrose Terrace	244190	416755	1.5	No	31.1	31.5
	13	1 Alfred Street	244161	416756	1.5	No	20.9	19.7
	14	43 Clooney Terrace	244207	416661	1.5	No	19.6	19.9
	15	7 Glendermott Rd	244244	416749	1.5	No	31.6	31.3
	16	15 Glendermott Rd	244275	416725	1.5	No	29.9	29.3
	17	2 Columba Terrace	244255	416888	1.5	No	25.7	24.1
	18	4 Ebrington Terrace	244221	416794	1.5	No	26.1	24.8
	19	27 Alfred Street	244102	416744	1.5	No	19.0	17.7
	20	53 Clooney Terrace	244210	416719	1.5	No	24.7	25.7
Buncrana Road / Racecourse Road	21	15 St Patricks Terra	243496	418959	1.5	No	33.7	33.9
	22	12 Collon Terrace	243495	418937	1.5	No	27.5	27.2
	23	7 St Patricks Terrac	243529	418937	1.5	No	27.9	27.6
	24	2 St Patricks Terrac	243549	418924	1.5	No	27.5	27.1
	25	61 Buncrana Rd	243399	419025	1.5	No	22.3	22.1
	26	14 Buncrana Rd	243368	419012	1.5	No	20.8	20.1
	27	8 Buncrana Rd	243435	418977	1.5	No	27.0	26.9
	28	22 St Patricks Terra	243472	418982	1.5	No	27.7	27.6
	29	4 Messines Terrace	243486	419031	1.5	No	21.4	20.9
	30	47 Racecourse Rd	243470	419064	1.5	No	22.2	17.8
	31	2 Pennyburn	243429	418903	1.5	No	18.7	17.2
	32	2 Maybrooke Terrace	243596	418893	1.5	No	24.4	23.9

Figure 4.1 – Location of specific receptors – Creggan Road / Infirmary Road

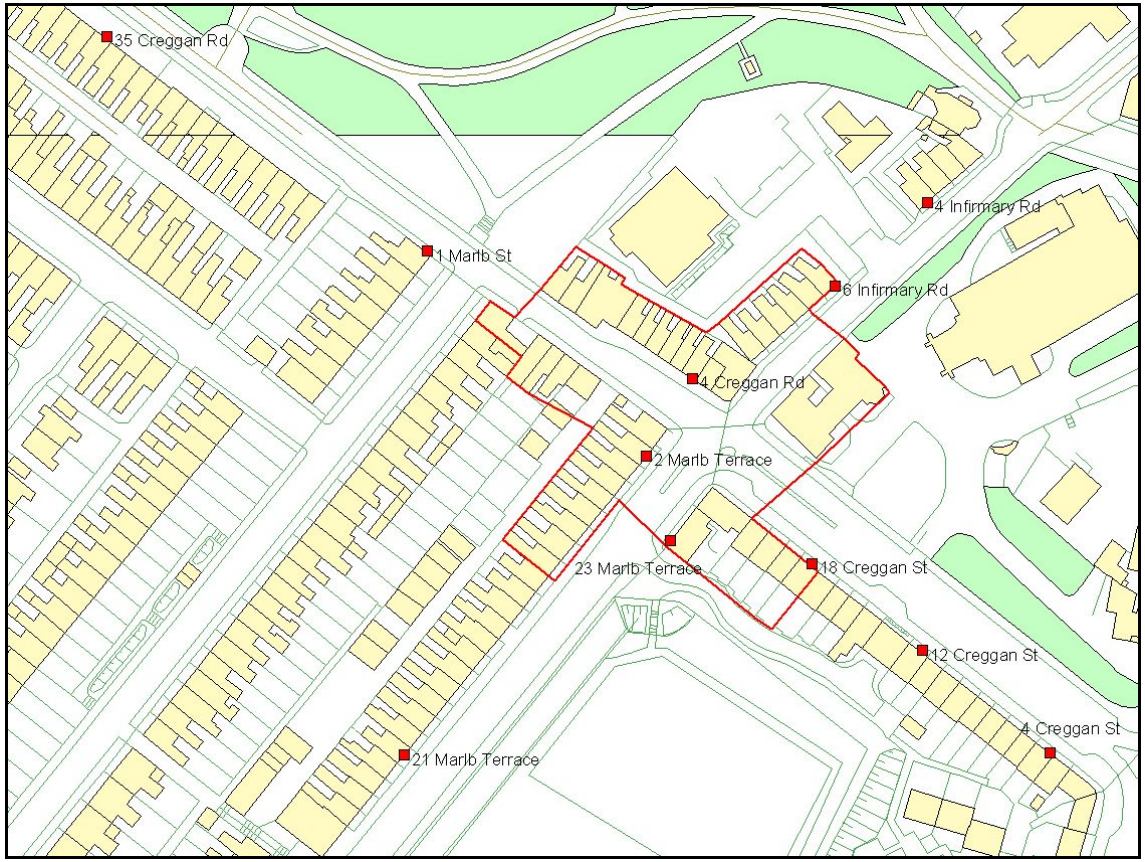


Figure 4.2 - Location of specific receptors – Buncrana Road / Racecourse Road

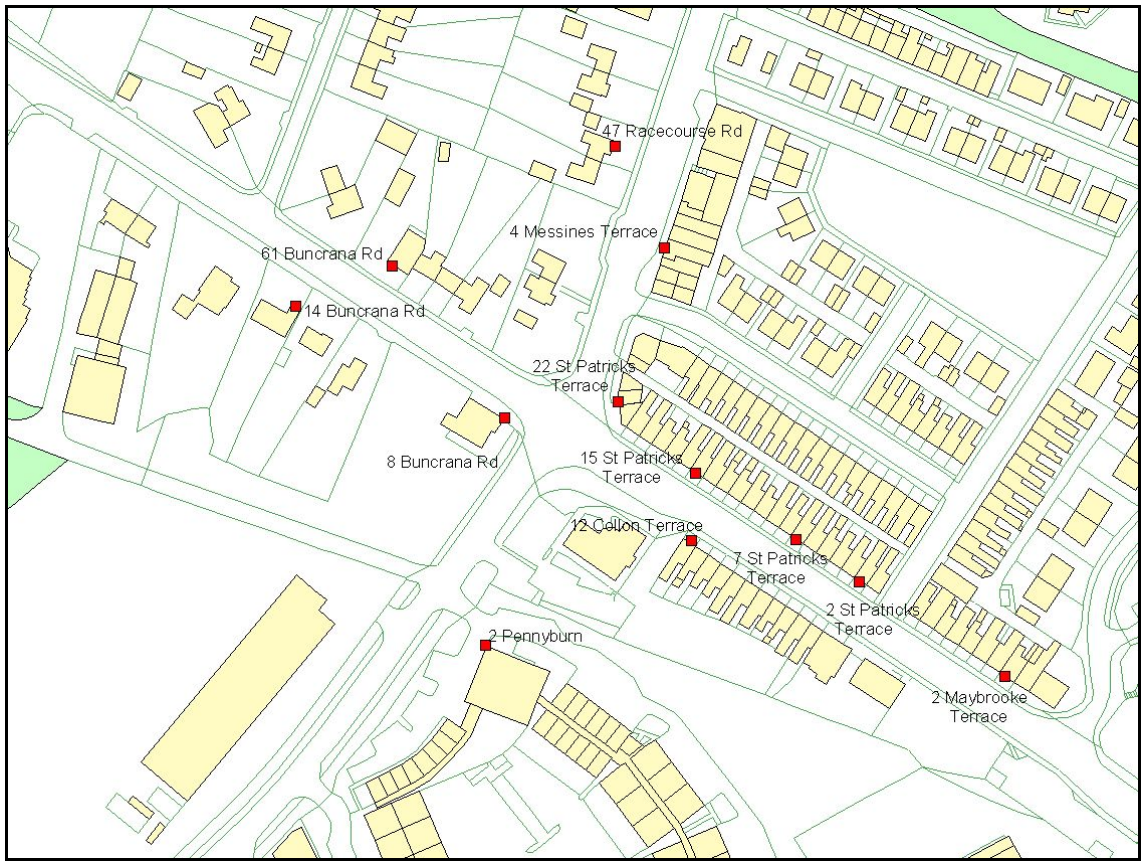
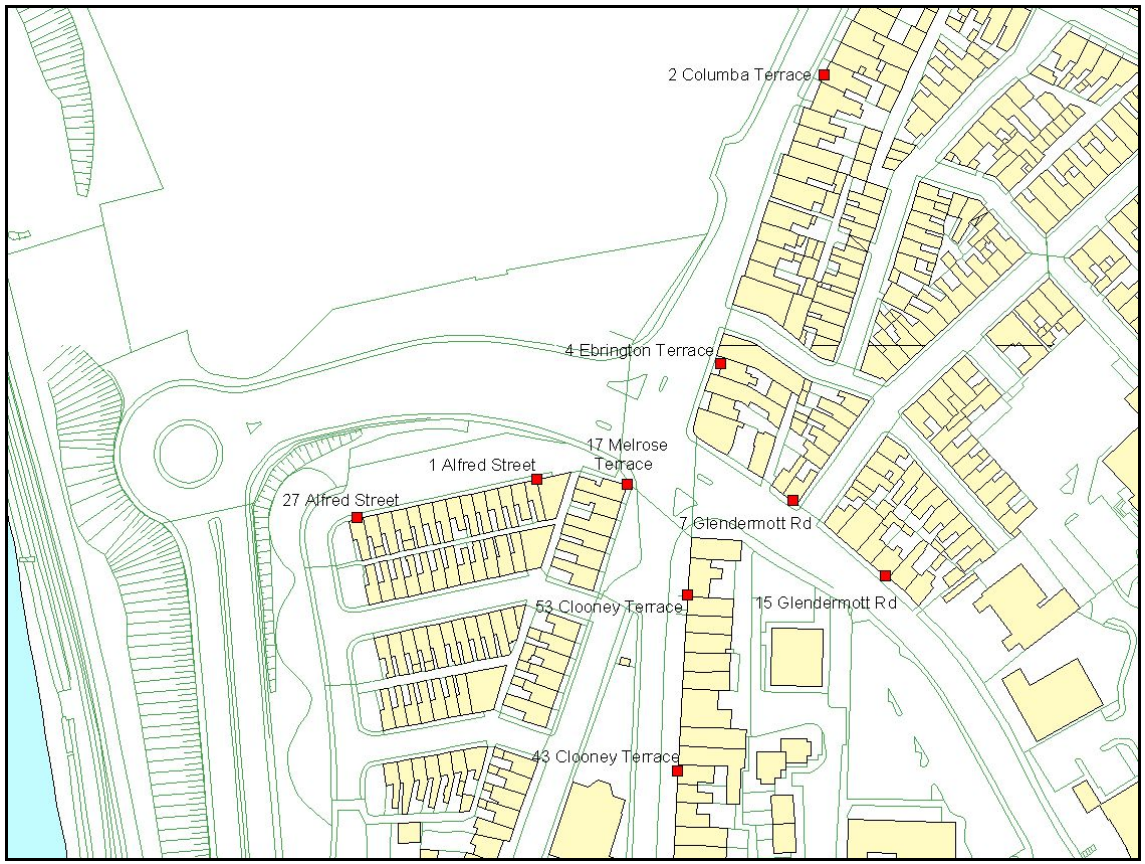


Figure 4.3 - Location of specific receptors – Dale's Corner



4.2.1 2006 Results

4.2.1.1 AQMA – Creggan Road / Infirmary Road

As shown in Table 4.2, NO_2 concentrations in 2006 at facades of properties near Creggan Road / Infirmary Road junction are predicted to be mostly below the annual mean AQS objective of 40µg/m^3. However, results at specific receptor 1 outside 4, Creggan Road (49.7 µg/m^3) shows that some properties were still predicted to exceed the AQS objective in 2006.

Likewise, model verification showed that the model under predicted NO_2 concentrations in Creggan Road (northwest bound) at sites C1/C2. As monitoring site opposite (C6) showed much lower concentrations, well below the objective, it is clear that the main issue within the AQMA is the steep slope in Creggan Road, leading to increased emissions of vehicles going uphill.

Figure 4.4 shows clearly the predicted NO_2 concentration contours of 40 µg/m^3 and 36µg/m^3 in the AQMA. Contour line 36µg/m^3 is shown to account for random model error since, as suggested by the Technical Guidance LAQM.TG(03), locations where modelled NO_2 concentrations are between 36 µg/m^3 and 40 µg/m^3 may exceed the annual mean AQS objective. The figure confirms that most of the facades of properties at Creggan Road / Infirmary Road junction are within the 40µg/m^3 area. Moreover, most of the properties in the AQMA are within the 36 µg/m^3 area, especially along Creggan Road.

However, all properties outside the boundaries of the AQMA are outside the 36µg/m^3 area. Therefore, extending the AQMA is not required at this junction, and the extents of the AQMA should remain unchanged. It is advised that DCC keep on monitoring NO_2 concentrations at the junction and ensure that data capture remain high at all sites.

4.2.1.2 Buncrana Road / Racecourse Road junction

Predicted results at specific receptors near Buncrana Road / Racecourse Road junction are all below the NO_2 annual mean AQS objective of 40µg/m^3, as shown in Table 4.2. NO_2 annual mean at specific receptor outside 15 St Patrick's Terrace was predicted to be 34 µg/m^3 in 2006, while the others were under 30 µg/m^3. Predicted contours of NO_2 concentrations in Figure 4.5 confirm that all properties along Buncrana Road or Racecourse Road were expected to be under the AQS objective, and even under 36 µg/m^3.

Adjusted 2006 monitoring results at the four diffusion tubes in Buncrana Road and Racecourse Road were also below the AQS objective. Therefore, an AQMA at this junction is not required. However, it is recommended that DCC keep on monitoring this junction carefully to ensure the levels will still comply with regulations.

4.2.1.3 Dale's Corner

Predicted results at specific receptors near Dale's Corner junction are all below the NO_2 annual mean AQS objective of 40 µg/m^3. NO_2 annual mean at specific receptors outside 17 Melrose Place and 7 Glender Mott Road were predicted to be around 31µg/m^3 in 2006, while the others were all under 30 µg/m^3. Predicted contours of NO_2 concentrations in Figure 4.6 confirm that all properties at risk along Buncrana Road or Racecourse Road were expected to be under the AQS objective, and even under 36µg/m^3, except property at 1 Ebrington Terrace (Limavady Road), which is within the 36µg/m^3 area (but below 40µg/m^3). This building, located at the corner of Limavady Road / Glender Mott Road, is not relevant of public exposure, as the ground floor is a Lloyds pharmacy, but there are dwellings at the first and second floors. Although predicted NO_2 concentrations are under the objective, it is recommended that DCC install a new diffusion tube or relocate a tube at the façade of this building.

Adjusted 2006 monitoring results at the four diffusion tubes in Buncrana Road and Racecourse Road were also below the AQS objective; therefore an AQMA at this junction is not required. However, it is

recommended that DCC keep on monitoring this junction carefully to ensure NO_2 levels will still comply with regulations.

4.2.2 2010 Results

Figure 4.7 to Figure 4.9 show predicted NO_2 annual mean concentration for year 2010 for the three junctions assessed. Table 4.2 shows that the annual mean NO_2 AQS objective should be met at all specific receptors in 2010. However, Figure 4.7 shows that Creggan Road / Infirmary Road junction will still be at risk of exceeding the objective in 2010 at several façades of properties, all within the current AQMA.

Table 4.2, Figure 4.8 and Figure 4.9 show that all properties close to Buncrana Road / Racecourse Road junction and Dale's Corner are expected to meet the NO_2 AQS objective by 2010.

4.2.3 Derry's AQMA - Detailed Mapping of Results – Action Plan Advise

Figure 4.10 shows the predicted NO_2 annual mean modeling results within the AQMA for 2006 at a high spatial scale. The road links for the Northwest and Southwest bounds were modelled in detail and the NO_2 annual mean values are presented. The results clearly show the shift in pollution levels associated with traffic emissions – traffic emissions related to uphill flows create higher pollution levels of exposure on the Northwest bound link as opposed to emissions associated with downhill flows. To help the removal of exceedences within the AQMA it is advised that DCC uses traffic management procedures limiting or removing totally traffic flows uphill Creggan Road.

4.2.4 Summary of results

- Based on monitoring and modelled results, it is recommended that the AQMA remain at Creggan Road / Infirmary Road junction. The AQMA is not required to be extended.

- Based on predicted results, it is recommended that DCC install/relocate a diffusion tube at Dale's Corner outside 1, Ebrington Terrace. The building is at the corner of Limavady Road / Glender Mott Road and although predicted results are below the AQS objective, it is important to confirm NO_2 levels, as this location is the most exposed to the impact of heavy traffic at Dale's Corner junction.

- Based on predicted and monitoring results, it is likely that NO_2 AQS objectives will be met by 2010, although levels in the AQMA will still be close to 40µg/m^3. Moreover, both monitoring and modelled projections to 2010 are subject to uncertainties and it is necessary that diffusion tubes at all locations remain to continue monitoring these junctions and confirm the results of this assessment.

Figure 4.4 - Predicted Annual Average NO_2 Concentrations 2006 – Creggan Road

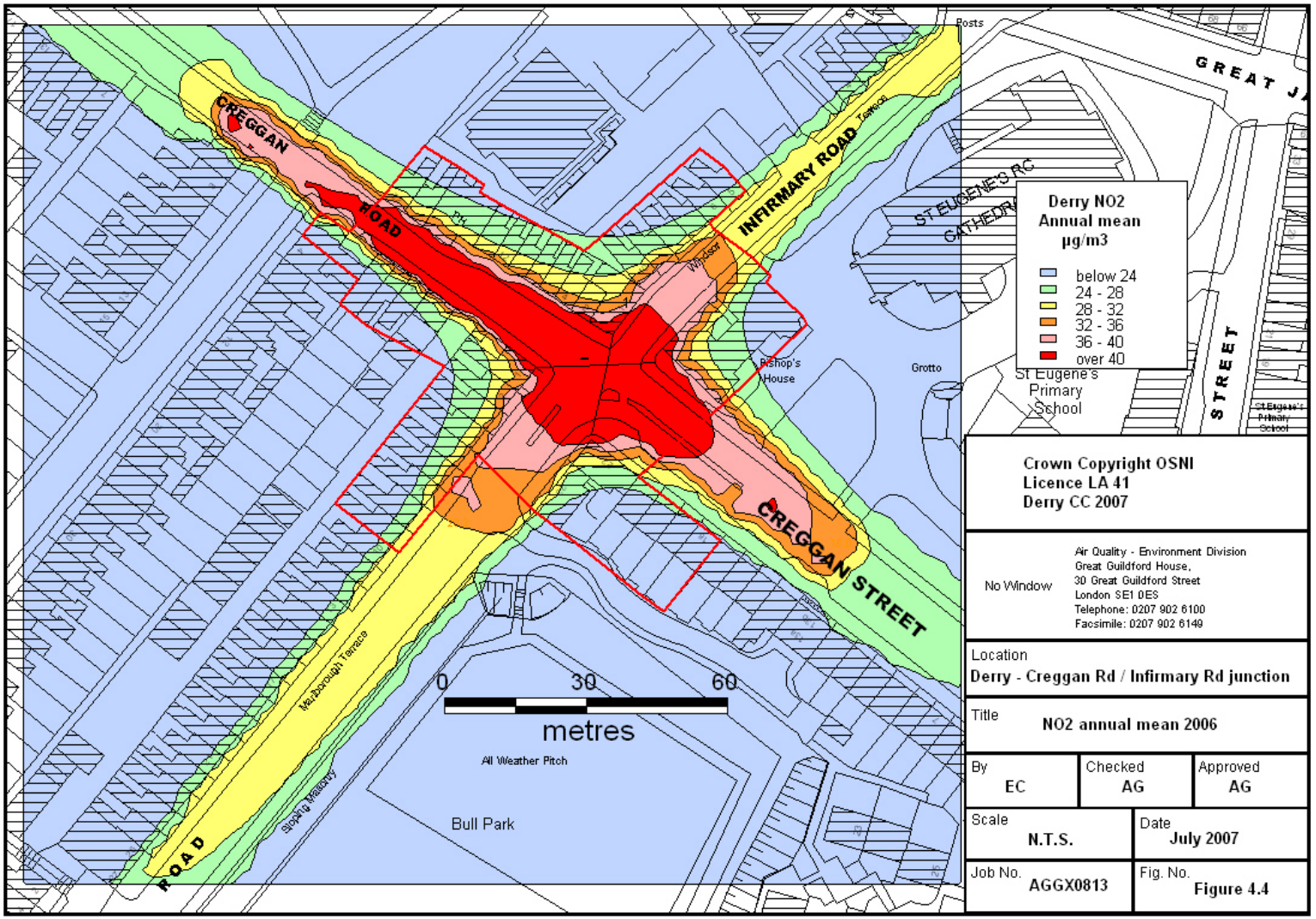


Figure 4.5 - Predicted Annual Average NO_2 Concentrations 2006 – Buncrana Road

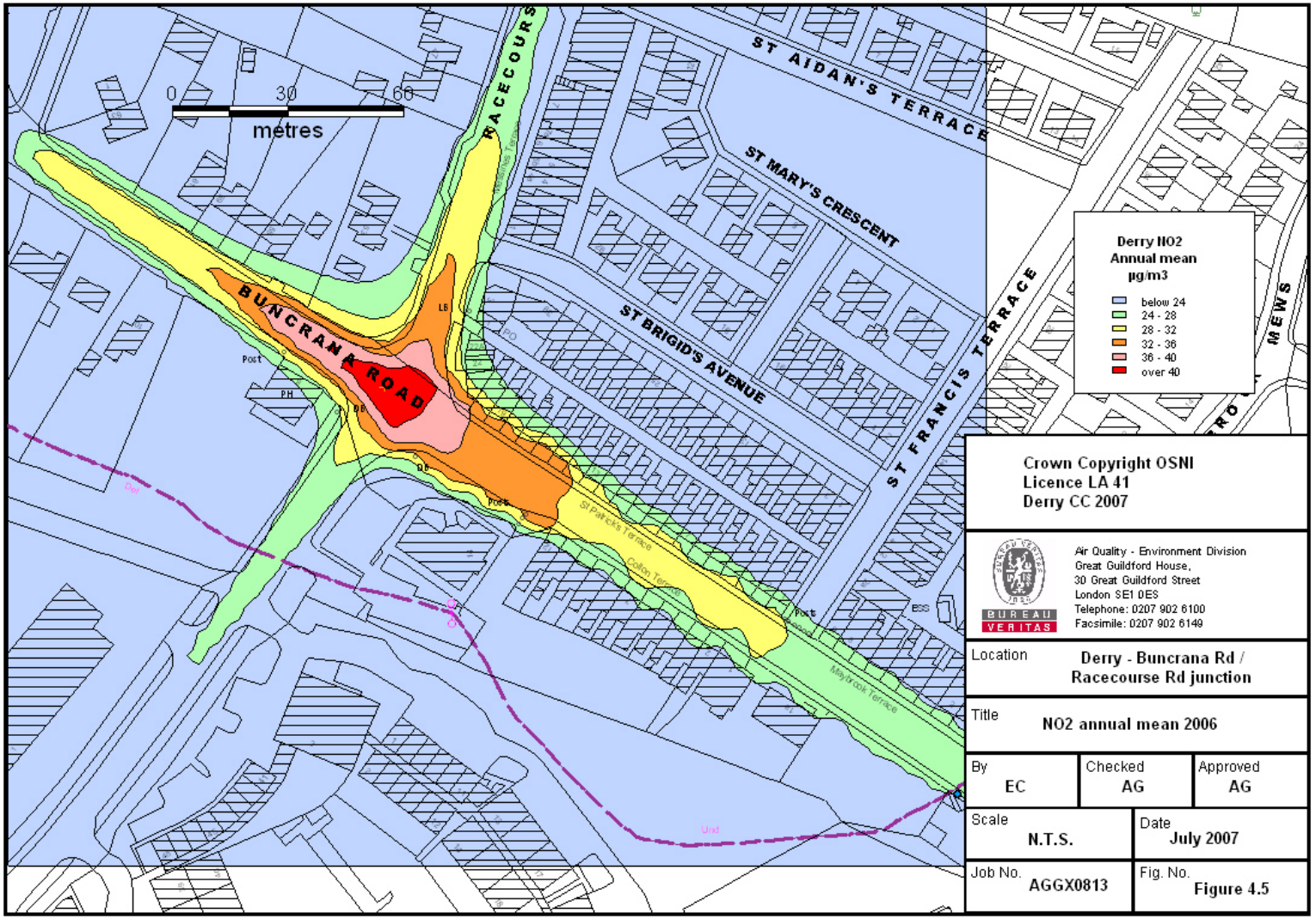


Figure 4.6 - Predicted Annual Average NO_2 Concentrations 2006 – Dale's Corner

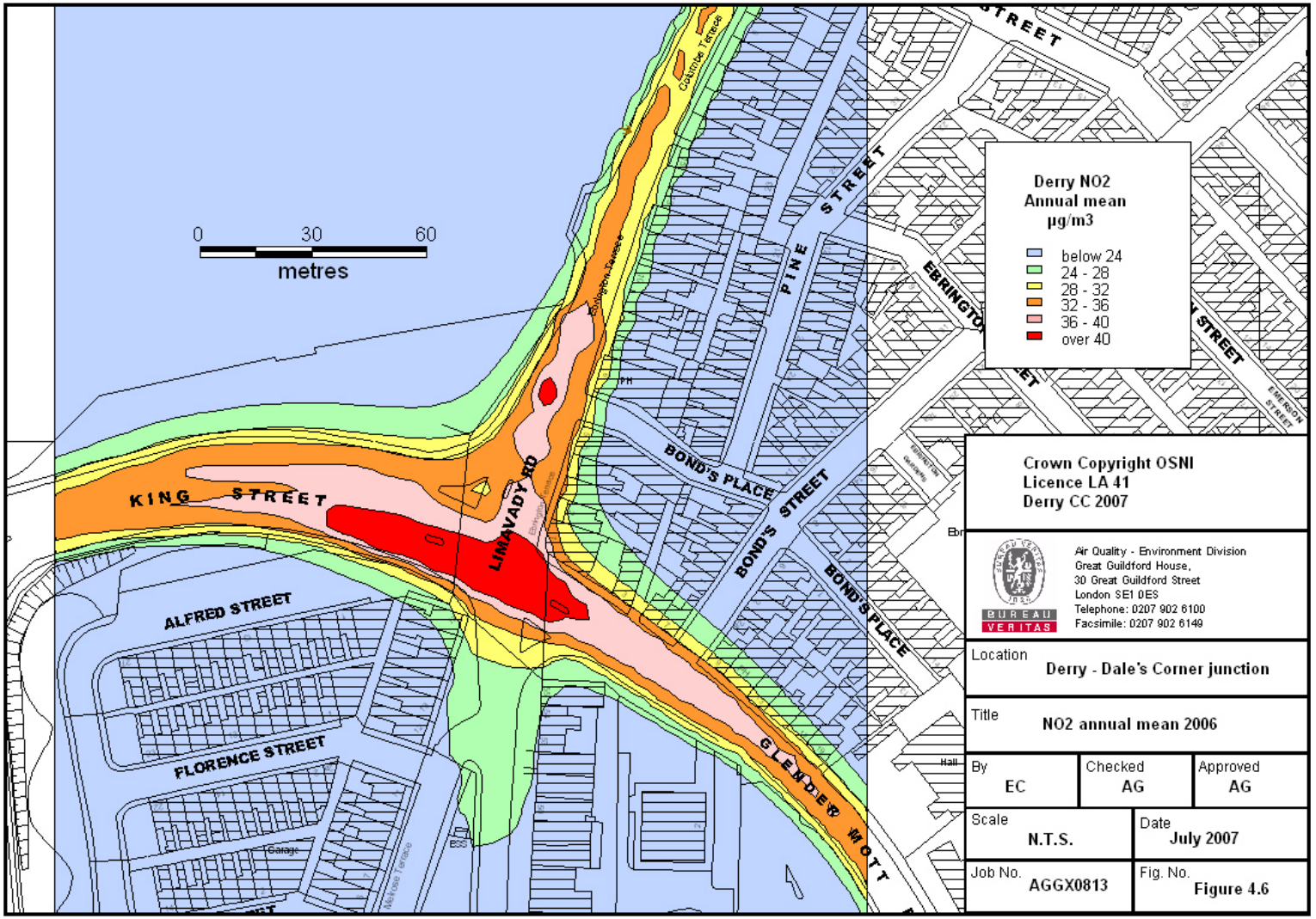


Figure 4.7 - Predicted Annual Average NO_2 Concentrations 2010 – Creggan Road

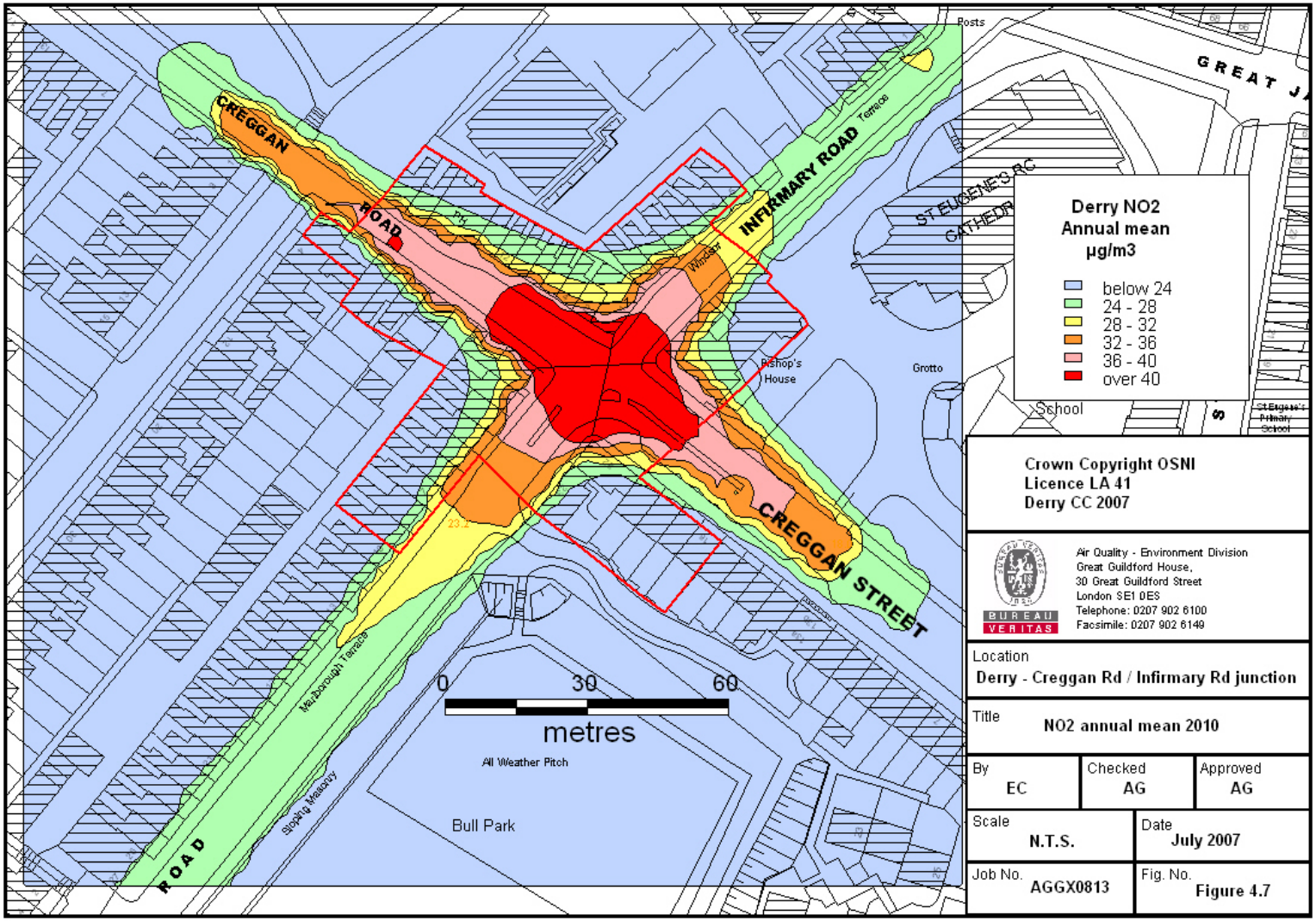


Figure 4.8 - Predicted Annual Average NO_2 Concentrations 2010 – Buncrana Road

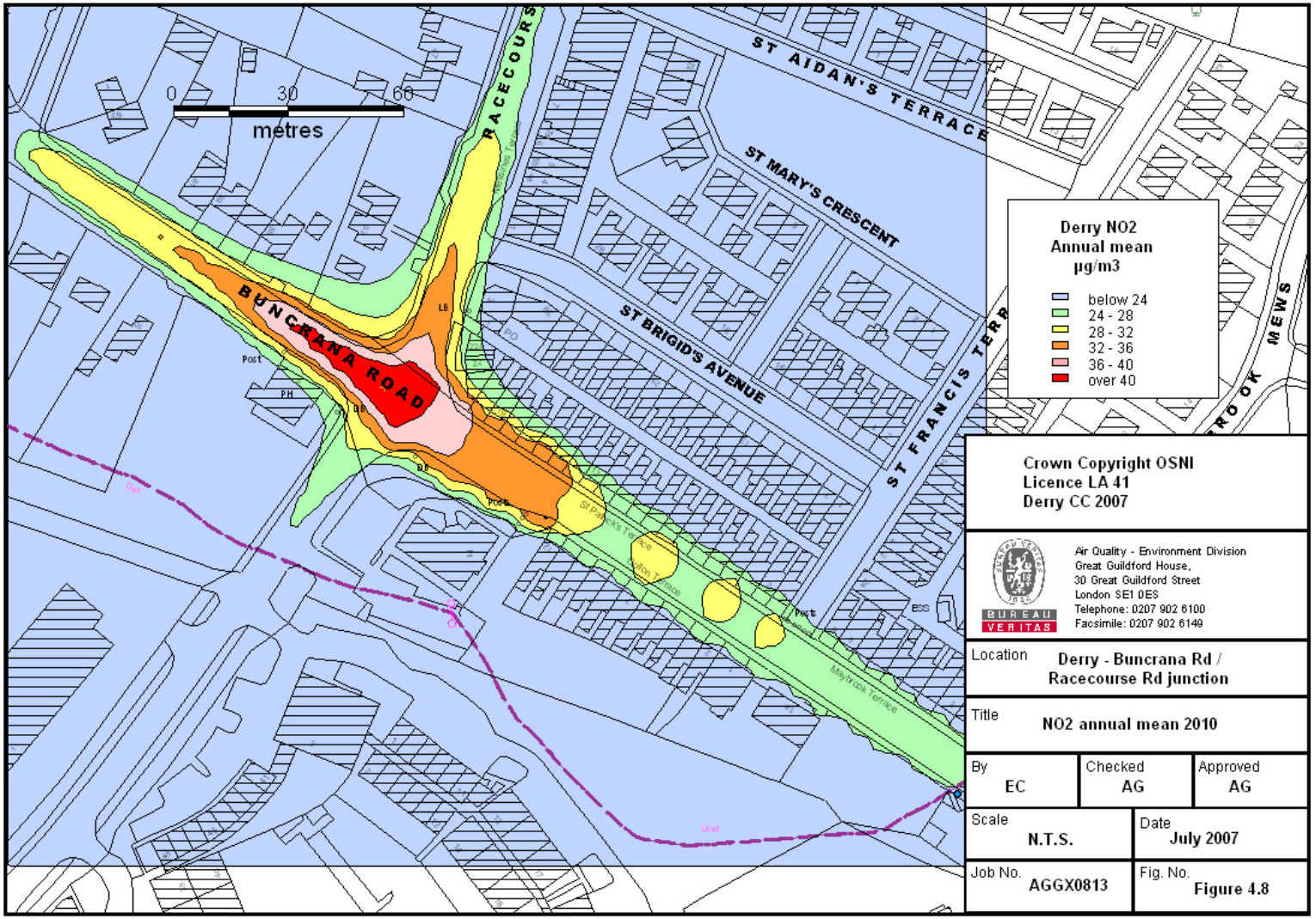


Figure 4.9 - Predicted Annual Average NO_2 Concentrations 2010 – Dale's Corner

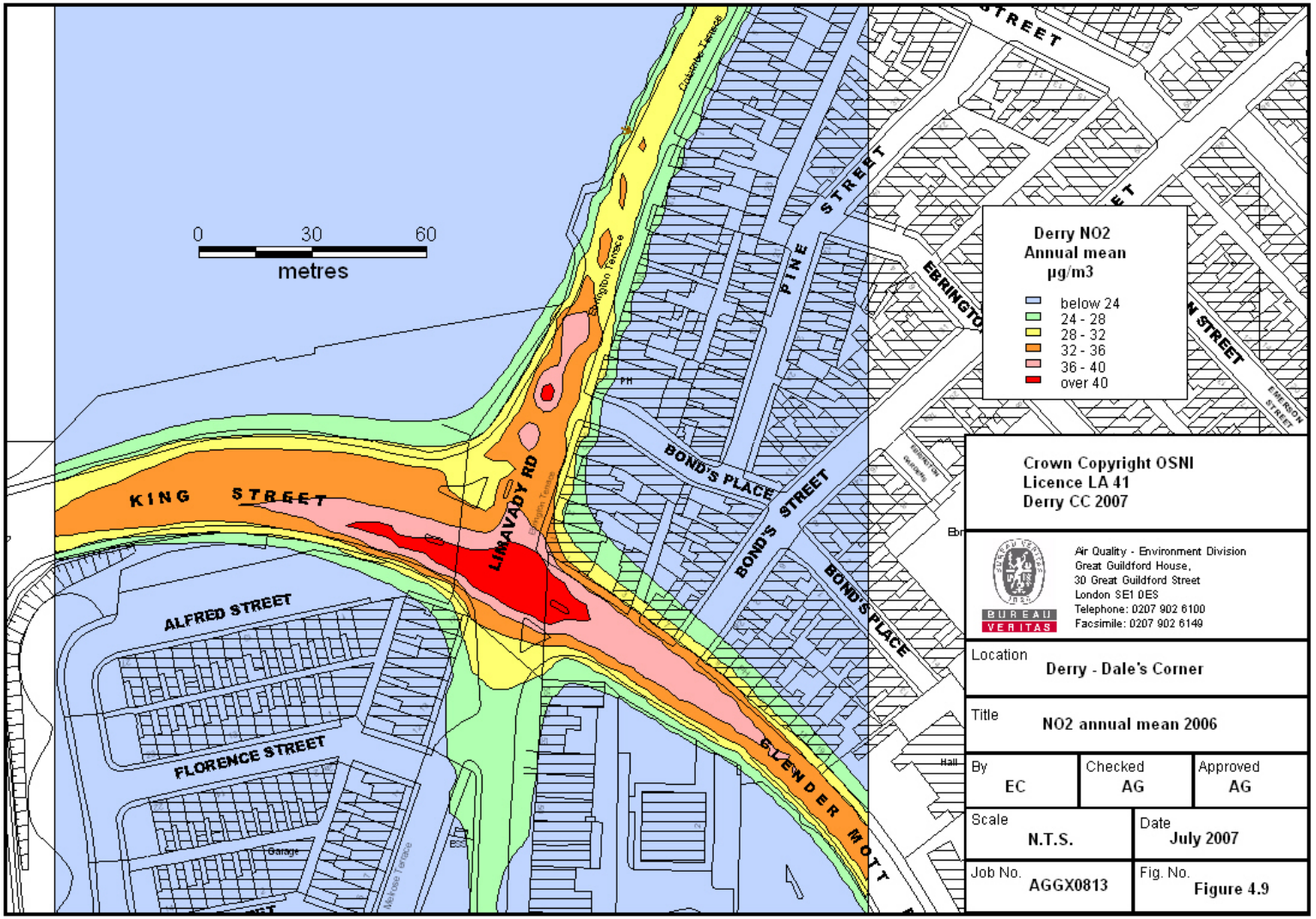
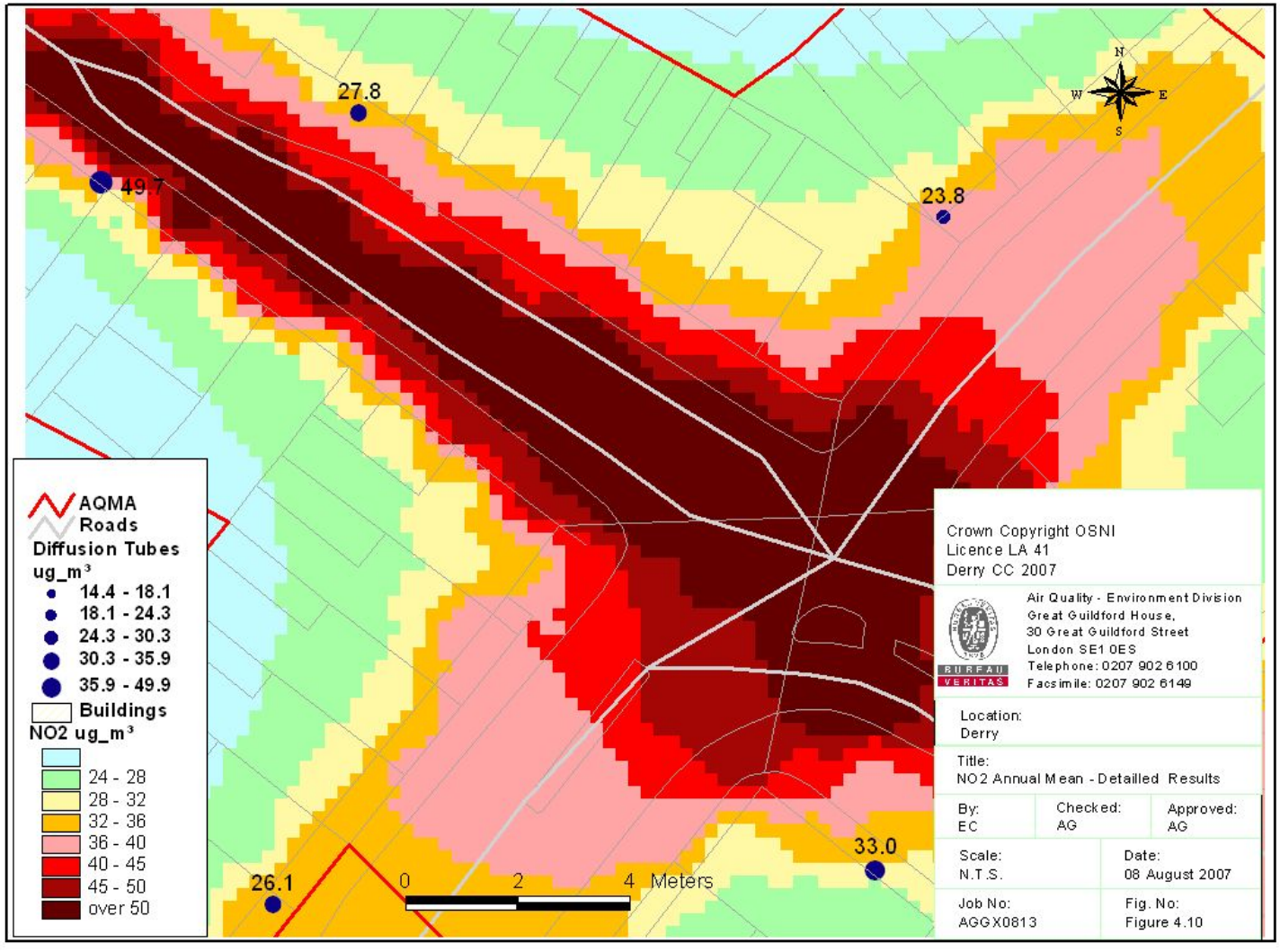


Figure 4.10 - Predicted Annual Average NO_2 Concentrations 2006 – Creggan Road – Detailed Mapping of results



4.3 Source Apportionment

Modelling was undertaken to provide NO_x source apportionment at specific receptors representative of relevant exposure within Derry City Centre in the AQMA, as required in the Further Assessment. The source apportionment was based on the percentage of the traffic flow and emission factors from the following vehicle classification:

- Cars;
- Buses and coaches;
- Light Goods Vehicles (LGVs);
- Heavy Goods Vehicles (HGVs).

In addition, contribution from domestic combustion sources and the Coolkeeragh power station was assessed at specific receptors for each area modelled. Sensitivity tests showed that both power plant emissions and domestic emissions are negligible, as they have no significant impact on NO_2 concentrations at the modelled sites in Derry. All three junctions are mainly impacted by urban traffic emissions.

Table 4.3 shows the vehicle apportionment on the closest road link to the specific receptors at the three junctions, based on 2006 traffic data. Table 4.4 shows the source contributions of predicted NO_x concentrations for 2006 at the same receptors. HGVs and buses are commonly associated and described as HDVs (Heavy Duty Vehicles), whose contribution has also been reported.

The results of the source apportionment indicate that traffic-induced NO_x remains the main contributor at nearly all sites. Results are discussed in detail for each site below.

4.3.1 Creggan Road / Infirmary Road junction (AQMA)

- Traffic contributes up to 81% of the overall NO_x concentration in the AQMA (specific receptor outside 4, Creggan Road, which shows the highest NO_x concentration overall);
- HGVs and cars are the main contributors (between all categories of vehicles), with a maximum of respectively 35% and 26% of the total predicted NO_x (most of the receptors between 20% and 30%);
- Buses and coaches account for up to 15% of the overall NO_x concentrations (with most of the receptors between 8% and 12%);
- LGVs contribute between 6% and 10%;
- Buses and HGVs put together (HDVs) account for up to 48% of the total contribution.

These contributions have to be compared to the relative weight of traffic flow from each vehicle category, as shown in Table 4.3. More than 85% of the traffic is made up of cars, versus 10% of LGVs, 3% of HGVs and 1% to 2% of buses and coaches.

4.3.2 Buncrana Road / Racecourse Road junction

- Traffic contributes up to 79% at Buncrana Road / Racecourse Road junction (receptor 15 St Patrick's Terrace, where predicted NO_x concentration is highest);

- HGVs represents up to 40% of total NO_x, with most of the receptors showing a contribution between 25% and 35%;
- Cars contribute to a maximum of 24% of the total predicted NOx along St Patrick's Terrace (most of the receptors around 15%-25%);
- Buses and coaches account for up to 12% of the overall NOx concentrations (with most of the receptors between 5% and 10%);
- LGVs contribute between 3% and 6%;
- Buses and HGVs put together (HDVs) account for up to 52% of the total contribution (15 St Patrick's Terrace).

These contributions compare to the relative weight of traffic flow from each vehicle category: up to 88% of the traffic is made up of cars, versus 6% of LGVs, 4% of HGVs and 1% to 2% of buses and coaches.

4.3.3 Dale's Corner junction

- Traffic contributes up to 73% of the total NOx at Dale's Corner junction (receptor outside 7 Glender Mott Road, where predicted NOx concentration is highest);
- HGVs represents up to 37% of total NO_x (Columba Terrace), with most of the receptors contributing between 25% and 35%;
- Cars contribute to a maximum of 27% of the total predicted NOx along Glender Mott Road (most of the receptors around 15%-25%);
- Buses and coaches account for up to 11% of the overall NOx concentrations (with most of the receptors between 5% and 10%);
- LGVs contribute between 5% and 10% near the junction;
- Buses and HGVs put together (HDVs) account for up to 41% of the total contribution (Columba Terrace).

These contributions compare to the relative weight of traffic flow from each vehicle category. I average, 90% of the traffic is made up of cars, versus 5%-10% of LGVs, 3% to 6% of HGVs and 1% to 2% of buses and coaches.

Table 4.3 – Traffic flow – Vehicle apportionment at specific receptors

Area	ID	Name/Location	AADT 2006	Vehicle apportionment			
				Cars	Buses and coaches	LGVs	HGVs
Creggan Road / Infirmary Road (AQMA)	1	4 Creggan Rd	12394	85%	2%	11%	3%
	2	35 Creggan Rd	12394	85%	2%	11%	3%
	3	21 Marlb Terrace	15345	85%	2%	10%	3%
	4	1 Marlb St	12394	85%	2%	11%	3%
	5	2 Marlb Terrace	15345	85%	2%	10%	3%
	6	23 Marlb Terrace	15345	85%	2%	10%	3%
	7	4 Creggan St	11456	85%	1%	10%	3%
	8	12 Creggan St	11456	85%	1%	10%	3%
	9	18 Creggan St	11456	85%	1%	10%	3%
	10	4 Infirmary Rd	9971	85%	1%	11%	3%
	11	6 Infirmary Rd	9971	85%	1%	11%	3%
Dale's Corner	12	17 Melrose Terrace	10550	85%	2%	11%	3%
	13	1 Alfred Street	30711	93%	1%	2%	4%
	14	43 Clooney Terrace	10550	85%	2%	11%	3%
	15	7 Glendermott Rd	24455	85%	1%	10%	3%
	16	15 Glendermott Rd	24455	85%	1%	10%	3%
	17	2 Columba Terrace	15149	91%	1%	3%	6%
	18	4 Ebrington Terrace	15149	91%	1%	3%	6%
	19	27 Alfred Street	30711	93%	1%	2%	4%
	20	53 Clooney Terrace	10550	85%	2%	11%	3%
Buncrana Road / Racecourse Road	21	15 St Patricks Terra	16526	88%	2%	6%	4%
	22	12 Collon Terrace	16526	88%	2%	6%	4%
	23	7 St Patricks Terrac	16526	88%	2%	6%	4%
	24	2 St Patricks Terrac	16526	88%	2%	6%	4%
	25	61 Buncrana Rd	17085	88%	2%	6%	4%
	26	14 Buncrana Rd	17085	88%	2%	6%	4%
	27	8 Buncrana Rd	17085	88%	2%	6%	4%
	28	22 St Patricks Terra	16526	88%	2%	6%	4%
	29	4 Messines Terrace	14629	83%	1%	12%	4%
	30	47 Racecourse Rd	14629	83%	1%	12%	4%
	31	2 Pennyburn	9690	85%	2%	11%	3%
	32	2 Maybrooke Terrace	16526	88%	2%	6%	4%

Table 4.4 - Source apportionment of NO_X concentrations at specific receptors in the AQMA

Area	ID	Location	Predicted Total NO_x 2006 (µg/m^3)	NO_x Contribution					
				Background	Total Traffic	Cars	LGVs	Buses and coaches	HGVs
Creggan Road / Infirmary Road (AQMA)	1	4 Creggan Rd	105.2	18%	81%	26%	8%	15%	33%
	2	35 Creggan Rd	40.8	47%	52%	20%	7%	8%	17%
	3	21 Marlb Terrace	50.9	38%	62%	24%	9%	9%	20%
	4	1 Marlb St	78.9	24%	75%	28%	10%	12%	26%
	5	2 Marlb Terrace	77.9	25%	75%	26%	9%	12%	28%
	6	23 Marlb Terrace	46.5	41%	58%	21%	7%	9%	21%
	7	4 Creggan St	35.9	54%	45%	18%	6%	6%	15%
	8	12 Creggan St	40.3	48%	51%	20%	7%	8%	17%
	9	18 Creggan St	42.4	46%	54%	18%	6%	9%	20%
	10	4 Infirmary Rd	49.7	39%	61%	24%	8%	9%	20%
	11	6 Infirmary Rd	54.0	36%	64%	24%	8%	9%	22%
Dale's Corner	12	17 Melrose Terrace	71.5	27%	72%	24%	10%	9%	29%
	13	1 Alfred Street	40.4	48%	51%	17%	7%	4%	23%
	14	43 Clooney Terrace	37.0	52%	47%	18%	6%	6%	16%
	15	7 Glendermott Rd	73.3	26%	73%	26%	9%	11%	27%
	16	15 Glendermott Rd	67.5	29%	71%	27%	10%	10%	24%
	17	2 Columba Terrace	54.3	36%	64%	21%	2%	4%	37%
	18	4 Ebrington Terrace	55.4	35%	64%	20%	5%	5%	34%
	19	27 Alfred Street	27.5	70%	28%	11%	2%	2%	13%
	20	53 Clooney Terrace	51.3	38%	62%	22%	8%	9%	23%
Buncrana Road / Racecourse Road	21	15 St Patricks Terra	90.3	21%	79%	22%	5%	12%	40%
	22	12 Collon Terrace	66.6	29%	71%	23%	5%	10%	33%
	23	7 St Patricks Terrac	68.1	28%	72%	24%	5%	10%	33%
	24	2 St Patricks Terrac	66.5	29%	71%	24%	5%	10%	33%
	25	61 Buncrana Rd	48.2	40%	60%	19%	4%	8%	28%
	26	14 Buncrana Rd	33.2	58%	42%	14%	3%	6%	19%
	27	8 Buncrana Rd	64.5	30%	70%	20%	5%	11%	34%
	28	22 St Patricks Terra	67.1	29%	71%	21%	6%	10%	35%
	29	4 Messines Terrace	45.3	43%	57%	18%	6%	6%	27%
	30	47 Racecourse Rd	36.5	53%	47%	16%	6%	5%	21%
	31	2 Pennyburn	28.1	69%	31%	10%	3%	5%	13%
	32	2 Maybrooke Terrace	55.5	35%	65%	22%	5%	9%	30%

4.4 NO_x reduction

A requirement of the Further Assessment is to determine the amount of NO_2 reduction (as NO_x) required at the worst-case receptors within the AQMA. This approach highlights the maximum reduction in NO_2 (as NO_x, in $\mu g/m^3$) required and assumes that other specific receptor will require less of a reduction. The worst-case receptor within the AQMA is deemed to be diffusion tube C1 outside 3, Creggan Road, as this tube showed the highest NO_2 concentration in 2006 (49.9 $\mu g/m^3$).

In order to determine the amount of NO_x reduction required, the annual mean AQS objective of 40$\mu g/m^3$ NO_2 has been calculated to be an equivalent NO_x concentration of 117.9 $\mu g/m^3$ based on the predicted results. The results are shown in Table 4.5.

Based on predicted NO_x concentrations at diffusion tube C1, a minimum NO_x reduction of 48$\mu g/m^3$ (equivalent to a 29% improvement in NO_x) would be necessary to comply with the AQS objective and an NO_2 reduction of 10$\mu g/m^3$ (equivalent to a 20% improvement in NO_2) would be required.

Consequently, the formulation of an Action Plan should aim to reduce the levels of NO_x / NO_2 within the AQMA by this amount.

Table 4.5 – Worst case NO_x and NO_2 reduction required

ID	Receptor name	Estimated NO_x 2006	NO_x (equivalent to 40$\mu g/m^3$ NO_2) $\mu g/m^3$	Reduction required		Monitored NO_2 2006	NO_2 AQS objective $\mu g/m^3$	Reduction required	
				$\mu g/m^3$	%			$\mu g/m^3$	%
C1	3 Creggan Road	165.8	117.9	47.9	28.9%	49.9	40	9.9	19.8%

5 Conclusions

The Further Assessment of the Air Quality Management Area (AQMA) in Creggan Road / Infirmary Road in Derry has been undertaken together with the Detailed Assessment of Buncrana Road / Racecourse Road junction and Dale's Corner junction, both required by DoE(NI) as part of the Local Air Quality Management regime, following the findings of the last air quality Updating and Screening Assessment (USA) in 2006.

The latest NO_2 monitoring data in Derry City Centre has been reviewed. Updated results for year 2006 showed that the NO_2 annual average AQS objective was still exceeded in the AQMA.

Annual average concentrations of NO_x and NO_2 have been predicted through dispersion modelling of traffic emissions at specific receptors relevant of public exposure within Derry City Centre for both years 2006 (baseline) and 2010. Domestic combustion sources and emissions of the Coolkeeragh power station located Northeast of Derry City Centre have also been accounted for in the model set-up.

Concentrations have also been predicted on a grid of receptors for the production of concentration maps at each site. Modelling accounted for a detailed breakdown of vehicle types. The latest meteorological and background concentration data for year 2006 have been considered.

Results have been compared to 2006 monitoring data, based on roadside sites. Source apportionment and the NO_x reduction required to comply with regulations have also been carried out as part of the Further Assessment of the AQMA in Creggan Road / Infirmary Road.

The findings of this report are the following:

Further Assessment of the AQMA at Creggan Road / Infirmary Road junction

Both monitoring data and predicted results showed that NO_2 concentrations still exceeded the annual mean Air Quality Strategy objective at relevant exposure locations within the AQMA in 2006. Projected results for year 2010 indicate that the AQS objective will still be breached if no action is taken to further reduce NO_x levels.

Therefore, the AQMA in Creggan Road / Infirmary Road is still required. However, based on updated monitoring data and predicted results, the extension of the current AQMA to encompass further dwellings is not required.

NO_x source apportionment was carried out at specific receptors representative of relevant exposure within the AQMA. It accounted for a detailed breakdown of vehicle classification. Results showed that traffic-induced NO_x concentrations account for more than 50% of the total contribution at almost every location, and up to 80% in Creggan Road. Heavy goods vehicles (HGVs) and cars contribute respectively up to 33% and 26%, while heavy-duty vehicles (HDVs, i.e. including buses) reach up to 48% of the overall NO_x concentration in Creggan Road.. HDVs have a much more significant impact than cars, as they account for only 5% of the total vehicle flow at this junction (while cars represent at least 85% of total flow).

Based on predicted NO_x concentrations at the worst-case location, NO_x reduction analysis showed that a minimum of 48µg/m^3 decrease in NO_x concentrations would be required to comply with the NO_2 annual mean AQS objective (about 30% reduction in NO_x). The formulation of an Action Plan should aim to reduce the levels of NO_x within the AQMA by this amount.

Detailed Assessment of Buncrana Road / Racecourse Road junction

Both updated monitoring data and predicted results showed that NO_2 concentration was unlikely to exceed the AQS objectives at relevant exposure locations near Buncrana Road / Racecourse Road junction. **Therefore, an AQMA declaration is not required at this junction.**

Detailed Assessment of Dale's Corner junction

Both monitoring and modelled results showed that NO_2 concentrations are unlikely to exceed the AQS objectives at relevant exposure locations near Dale's Corner junction.

Although results from the continuous monitoring analyser at Dale's Corner in the past years suggested that the NO_2 annual mean could breach the AQS objective, the monitoring station is not at a location of relevant public exposure (although not far from dwellings in Melrose Terrace). Moreover, data capture was poor in 2006 and there was concern due to the high variability in the results in the last three years. Bias factor based on this station and the triplicate tubes at Dale's Corner was also unusually high.

Therefore, it is recommended that Derry City Council ensure that good quality assurance / quality control is carried out at Dale's Corner continuous monitoring station (and co-located diffusion tubes), which will improve confidence in the monitoring data.

However, predicted results showed that NO_2 levels at the façade of 1 Ebrington Terrace, at the corner of Limavady Road / Glender Mott Road, was close to the objective, and projected results show that this will still be the case in 2010. Although the ground floor is not relevant of public exposure, there are dwellings at the first and second floors. **Therefore, although an AQMA is not required at this location, it is recommended that Derry City Council install a new diffusion tube or relocate a tube at the façade of this building to confirm that this location is not at risk.**

Appendix 1 – Traffic Data

Table A 1 – Derry traffic data (from EMIT Emissions Inventory database 2004)

Run 1 **Creggan Rd Jct (AQMA)**

NAME	EMIT ID ROAD	EMIT SOURCE NAME	AADT 2004	CARS	LGVs	BUSES AND COACHES	RIGID HGVs 2 AXLES	RIGID HGVs 3 AXLES	RIGID HGVs 4+ AXLES	RIGID HGVs 3&4 AXLES	Total HGVs
Creggan Road	69	Road72	11578	9852	1216	174	208	35	24	69	336
Creggan Street	70	Road73	10154	8642	1066	152	182	30	21	61	294
Infirmary Road	67	Road70	8495	7230	892	127	152	25	18	51	246
Lone Moor Road	68	Road71	13108	11155	1376	197	235	39	27	79	380

Run 2 **Dale's Corner Jct**

NAME	EMIT ID ROAD	EMIT SOURCE NAME	AADT 2004	CARS	LGVs	BUSES AND COACHES	RIGID HGVs 2 AXLES	RIGID HGVs 3 AXLES	RIGID HGVs 4+ AXLES	RIGID HGVs 3&4 AXLES	HGVs
King Street Eastbound	33	Road39	12571	11690	302	88	216	36	25	214	491
King Street Westbound	35	Road40	14750	13718	354	103	253	42	29	251	575
Glender Mott Road	72	Road75	21602	18382	2268	324	388	65	45	130	628
Clooney Terrace	71	Road74	8380	7132	880	126	150	25	17	50	242
Limavady Road Northbound	5	Road13	6941	6302	201	49	168	28	19	174	389
Limavady Road Southbound	36	Road41	6941	6302	201	49	168	28	19	174	389

Run 3 **Buncrana / Racecourse Jct**

NAME	EMIT ID ROAD	EMIT SOURCE NAME	AADT 2004	CARS	LGVs	BUSES AND COACHES	RIGID HGVs 2 AXLES	RIGID HGVs 3 AXLES	RIGID HGVs 4+ AXLES	RIGID HGVs 3&4 AXLES	HGVs
Buncrana Road (West)	1	Road1	14510	12711	914	261	283	47	33	261	624
Buncrana Road (East)	12	Road2	14510	12711	914	261	283	47	33	261	624
Racecourse Road	88	Road9	12780	10620	1585	102	299	50	35	89	473
Pennyburn (opposite Racecourse)	63	Road67	9264	7883	973	139	166	28	19	56	269

Table A 2 – Traffic data projected to 2006

Run 1 **Creggan Rd Jct (AQMA)**

NAME	LOCAL GROWTH FACTOR 2004-2006	AADT 2006	2006 CARS	2006 LGVs	2006 BUSES AND COACHES	2006 RIGID HGVs 2 AXLES	2006 RIGID HGVs 3 AXLES	2006 RIGID HGVs 4+ AXLES	2006 RIGID HGVs 3&4 AXLES	2006 HGVs
Creggan Road	1.071	12394	10547	1302	186	223	37	26	74	360
Creggan Street	1.128	11456	9750	1203	171	205	34	24	69	332
Infirmary Road	1.174	9971	8486	1047	149	178	29	21	60	289
Lone Moor Road	1.171	15345	13059	1611	231	275	46	32	92	445

Run 2 **Dale's Corner Jct**

NAME	LOCAL GROWTH FACTOR 2004-2006	AADT 2006	2006 CARS	2006 LGVs	2006 BUSES AND COACHES	2006 RIGID HGVs 2 AXLES	2006 RIGID HGVs 3 AXLES	2006 RIGID HGVs 4+ AXLES	2006 RIGID HGVs 3&4 AXLES	2006 HGVs
King Street Eastbound	1.089	13685	12726	329	96	235	39	27	233	535
King Street Westbound	1.154	17026	15834	409	119	292	48	33	290	664
Glender Mott Road	1.132	24455	20810	2568	367	439	74	51	147	711
Clooney Terrace	1.259	10550	8979	1108	159	189	31	21	63	305
Limavady Road Northbound	1.108	7693	6985	223	54	186	31	21	193	431
Limavady Road Southbound	1.074	7456	6770	216	53	180	30	20	187	418

Run 3 **Buncrana / Racecourse Jct**

NAME	LOCAL GROWTH FACTOR 2004-2006	AADT 2006	2006 CARS	2006 LGVs	2006 BUSES AND COACHES	2006 RIGID HGVs 2 AXLES	2006 RIGID HGVs 3 AXLES	2006 RIGID HGVs 4+ AXLES	2006 RIGID HGVs 3&4 AXLES	2006 HGVs
Buncrana Road (West)	1.177	17085	14967	1076	307	333	55	39	307	735
Buncrana Road (East)	1.139	16526	14477	1041	297	322	54	38	297	711
Racecourse Road	1.145	14629	12157	1814	117	342	57	40	102	541
Pennyburn (opposite Racecourse)	1.046	9690	8245	1018	145	174	29	20	59	281

Table A 3 – Traffic Data projected to 2010

Run 1 **Creggan Rd Jct (AQMA)**

NAME	LOCAL GROWTH FACTOR 2004-2010	AADT 2010	2010 CARS	2010 LGVs	2010 BUSES AND COACHES	2010 RIGID HGVs 2 AXLES	2010 RIGID HGVs 3 AXLES	2010 RIGID HGVs 4+ AXLES	2010 RIGID HGVs 3&4 AXLES	2010 HGVs
Creggan Road	1.227	14204	12087	1492	213	255	43	29	85	412
Creggan Street	1.436	14581	12410	1531	218	261	43	30	88	422
Infirmary Road	1.617	13736	11691	1442	205	246	40	29	82	398
Lone Moor Road	1.604	21030	17897	2208	316	377	63	43	127	610

Run 2 **Dale's Corner Jct**

NAME	LOCAL GROWTH FACTOR 2004-2010	AADT 2010	2010 CARS	2010 LGVs	2010 BUSES AND COACHES	2010 RIGID HGVs 2 AXLES	2010 RIGID HGVs 3 AXLES	2010 RIGID HGVs 4+ AXLES	2010 RIGID HGVs 3&4 AXLES	2010 HGVs
King Street Eastbound	1.290	16218	15082	390	114	279	46	32	276	633
King Street Westbound	1.538	22684	21097	544	158	389	65	45	386	884
Glender Mott Road	1.451	31343	26671	3291	470	563	94	65	189	911
Clooney Terrace	1.995	16721	14231	1756	251	299	50	34	100	483
Limavady Road Northbound	1.361	9450	8580	274	67	229	38	26	237	530
Limavady Road Southbound	1.240	8604	7812	249	61	208	35	24	216	482

Run 3 **Buncrana / Racecourse Jct**

NAME	LOCAL GROWTH FACTOR 2004-2010	AADT 2010	2010 CARS	2010 LGVs	2010 BUSES AND COACHES	2010 RIGID HGVs 2 AXLES	2010 RIGID HGVs 3 AXLES	2010 RIGID HGVs 4+ AXLES	2010 RIGID HGVs 3&4 AXLES	2010 HGVs
Buncrana Road (West)	1.633	23689	20752	1492	426	462	77	54	426	1019
Buncrana Road (East)	1.477	21436	18779	1350	386	418	69	49	386	922
Racecourse Road	1.500	19170	15930	2378	153	449	75	53	134	710
Pennyburn (opposite Racecourse)	1.144	10601	9021	1113	159	190	32	22	64	308

Appendix 2 – Monitoring Data – Diffusion tubes

Table A 4 – Bias adjustment factors for Lambeth

Bias correction factor Brooke Park 2006	0.99
Bias correction factor Dales Corner 2006	1.58
Bias correction factor UK national studies Lambeth 2006	1.34

Table A 5 – Lambeth diffusion tube results 2006 – bias corrected

No.	Site Ref	Name / Location	2006 diffusion tube results (µg m³)								Average		Annualisation (based on AURN station @ Brooke Park	2006 Annual average (bias corrected with adjustment factor)		
			Jan	Feb	Mar	April	May	June	July	Aug	Lambeth	Lambeth excl. August		Based on Brooke Park AURN station	Based on Dales Corner station	Based on national collocation studies
CREGGAN RD																
1	C1	3 Creggan Rd	56	50	40	54	21	55	48	16	42.5	46.3	**47.4**	**47.1**	**75.0**	**63.2**
2	C2	3 Creggan Rd	39	24	40	56	34	49	41	27	38.8	40.4	**43.2**	**43.0**	**68.4**	**57.7**
3	C3	6 Marlborough Terrace	16	25	28	26	27	25	24	15	23.3	24.4	25.9	25.8	**41.0**	34.6
4	C4	22A Creggan Street	39	37	29	36	31	34	28	16	31.3	33.4	34.8	34.7	**55.1**	**46.5**
5	C5	10 Windsor Terrace	14	26	22	29	17	21	19	10	19.8	21.1	22.0	21.9	34.8	29.4
6	C6	14 Creggan Road	25	38	28	26	14	23	25	12	23.9	25.6	26.6	26.5	**42.1**	35.5
DALES CORNER																
7	D1	Monitor	26	24	29	28	19	21	28	9	23.0	25.0	25.6	25.5	**40.6**	34.2
8	D2	Monitor	31	16	21	24	23	26	21	9	21.4	23.1	23.8	23.7	37.7	31.8
9	D3	Monitor	32	32	17	24	10	20	27	8	21.3	23.1	23.7	23.6	37.5	31.6
10	D4	52 Clooney Terrace	32	18	11	16	15	11	18	8	16.1	17.3	18.0	17.9	28.4	24.0

11	D5	5 Glendermott Road	30	44	38	41	32	31	32	20	33.5	35.4	37.3	37.1	**59.1**	**49.8**
FARREN PARK																
12	F1	2 Farren Park	24	24	21	12	15	19	14	10	17.4	18.4	19.4	19.3	30.7	25.9
13	F2	3 Farren Park	33	27	20	21	17	17	17	10	20.3	21.7	22.6	22.5	35.7	30.1
14	F3	5 Farren Park	27	25	21	22	17	11	22	9	19.3	20.7	21.5	21.3	34.0	28.6
15	F4	9 Farren Park	15	20	14	17	15	15	18	7	15.1	16.3	16.9	16.8	26.7	22.5
PENNYBURN																
16	P1	53 Messines Park	8	9	17	10	11	13	18	7	11.6	12.3	13.0	12.9	20.5	17.3
17	P2	57 Messines Park	18	18	30	13	19	25	29	11	20.4	21.7	22.7	22.6	35.9	30.3
18	P3	19 St Patricks Terrace	32	34	26	26	26	24	22	12	25.3	27.1	28.1	28.0	**44.5**	37.6
19	P4	5 Collon Terrace	17	15	29	40	29	28	35	14	25.9	27.6	28.8	28.7	**45.7**	38.5
STRAND RD																
20	S1	99 Strand Road	32	25	32	25	35	31	28.5	14	27.8	29.8	31.0	30.8	**49.1**	**41.4**
21	S2	Rockmills	39	31	25	9	25	22	27	6	23.0	25.4	25.6	25.5	**40.6**	34.2
AURN STATION																
22	A1	Brooke Park	23	19	18	9	9	5	5	6	11.8	12.6	13.1	13.0	20.7	17.5
23	A2	Brooke Park	22	25	11	8	10	5	5	4	11.3	12.3	12.5	12.5	19.8	16.7
24	A3	Brooke Park	18	10	15	11	12	5	5	3	9.9	10.9	11.0	10.9	17.4	14.7