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DETAILED AIR DISPERSION MODELLING ASSESSMENT OF PM_{10} ROAD TRAFFIC EMISSIONS IN DACORUM BOROUGH

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RSK NOTES

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Executive Summary

RSK Environment, Health and Safety Ltd (RSK) was commissioned by Dacorum Borough Council (DBC) to undertake a detailed air dispersion modelling assessment of particulate matter (PM_{10}) road traffic emissions in three hot spot locations identified in an earlier air quality study (LAQM detailed assessment) within their administrative area.

A detailed assessment of PM_{10} road traffic emissions has been undertaken for properties located alongside London Road in Apsley, Lawn Lane in Hemel Hempstead and the High Street in Northchurch.

The assessment identified that no exceedance of long- or short-term PM_{10} air quality objectives protective of human health was predicted in any of the study areas.

The assessment identifies that currently none of the hot spot locations should be declared as AQMAs based on modelled PM_{10} concentrations. However, these areas should be declared as AQMAs on the basis of predicted NO_2 concentrations close to the annual average air quality objective, as identified in the previous (2007) detailed assessment.

It is recommended that, as no PM_{10} monitoring data are currently available for any of the three hot spot areas, PM_{10} monitoring is considered at these locations to confirm the findings of this modelling study.

1 Introduction

RSK Environment, Health and Safety Ltd (RSK) was commissioned by Dacorum Borough Council (DBC) to undertake a detailed air dispersion modelling assessment of particulate matter (PM_{10})[1] road traffic emissions in three hot spot locations identified in a previous air quality study (produced in October 2007). The 2007 study (LAQM Detailed Assessment) assessed potential air quality impacts resulting from road traffic emissions in the borough, and identified that Air Quality Management Areas (AQMAs) should be declared at the following three locations for predicted exceedences of the annual average nitrogen dioxide (NO_2) air quality objective:

- London Road, Apsley;
- Lawn Lane, Hemel Hempstead; and,
- High Street, Northchurch.

The aforementioned study, which was completed by Air Quality Consultants (AQC) on behalf of DBC, focussed only on NO_X/NO_2 traffic emissions. It is of interest to DBC to also establish likely PM_{10} concentrations at the three hotspot locations before declaring the potential AQMAs, as PM_{10} is also considered to be a key pollutant associated with road traffic emissions.

This report outlines the methodology followed to assess potential air quality impacts resulting from local PM_{10} traffic emissions and details the outcomes of the assessment to assist DBC in making a more informed decision with respect to declaring the potential AQMAs at the three hot spot locations. The assessment has been undertaken following an update to the data included in the assessment undertaken by AQC in 2007.

[1] PM_{10}: Particulate matter with an aerodynamic diameter equal to or less than to 10 micrometers

2 Local Air Quality Management

The Government's Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DEFRA, 2007) provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. National and international measures are expected to achieve these objectives in most locations, but where areas of poor air quality remain, air quality management at a local scale has a particularly important role to play.

Part IV of the Environment Act 1995 requires local authorities to periodically review and assess current and likely future air quality in their area. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved by the due date. These locations must be designated as AQMAs and a subsequent action plan developed in order to reduce pollutant emissions in pursuit of the objectives.

Review and Assessment is a long-term, ongoing process, structured as a series of 'rounds'. Local Authorities in England, Scotland and Wales have now completed the first four rounds of Review and Assessment, with the fifth round underway.

Local Air Quality Management Technical Guidance (LAQM.TG(09)) (DEFRA, 2009) sets out a phased approach to the Review and Assessment process. This prescribes an initial Updating and Screening Assessment (USA), which all authorities must undertake. It is based on a checklist to identify any matters that have changed since the first round. If the USA identifies any areas where there is a risk that the objectives may be exceeded, which were not identified in the first round, then the Local Authority should progress to a Detailed Assessment (DA).

The purpose of this study is to predict likely PM_{10} concentrations at the three previously identified hot spot locations and to determine whether an exceedance of relevant air quality objective is likely (and the geographical extent of that exceedance). If the outcome of the assessment is that one or more of the PM_{10} objectives are likely to be exceeded, then an Air Quality Management Area (AQMA) should be declared by DBC. Subsequent to the declaration of an AQMA, a *Further Assessment* should be carried out to confirm that the AQMA declaration is justified; that the appropriate area has been declared; to ascertain the sources contributing to the exceedence; and to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform an Air Quality Action Plan, which will identify measures to improve local air quality.

It is the current understanding of RSK that, based on the 2007 detailed assessment, DBC is intending to declare AQMAs for annual average NO_2 concentrations at the three hot spot locations mentioned in Section 1. If this assessment for PM_{10} identifies any likely exceedences of relevant air quality objectives in these areas, then the AQMAs should also be declared for PM_{10}.

2.1 Air Quality Objectives

The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of

economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality Regulations, 2007 (Stationery Office, 2007). Table 2.1 below summarises air quality objectives relevant to this study. Appendix 1 provides a brief summary of the health effects of PM_{10}.

Table 2.1 Relevant Air Quality Objectives for Local Air Quality Management

Pollutant	Averaging Period	Exceedences Allowed per Year	Concentration (µg/m³)	Target Date
Particulate Matter (PM_{10})	Annual average	-	40	31.12.2004
	24-hour average	35	50	31.12.2004

The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For annual mean objectives, relevant exposure is limited to building facades of residential properties, schools and hospitals/care homes. The 24-hour objective applies at these locations as well as hotels and gardens of residential properties.

3 Assessment Methodology

3.1 Existing Air Quality

Air pollutant concentrations in the vicinity of an emission source will be related to both the emission source strength and the background concentration to which the emission source is added. Concentrations of PM_{10} within Dacorum borough have been taken from national maps of background concentrations available from the UK Air Quality Archive[2] and adjusted to the current year (2009) using the Year Adjustment Factors also available from the UK Air Quality Archive website. Annual average PM_{10} concentrations included in the assessment are presented below in Table 3.1.

Table 3.1 Background Annual Average PM_{10} Concentrations Included in Assessment

Hot Spot Area	Annual Average Particulate Matter (PM_{10}) Concentration ($\mu g\ m^{-3}$)
London Road, Apsley	18.90
Lawn Lane, Hemel Hempstead	18.90
High Street, Northchurch	17.24

3.2 Dispersion Model and Key Inputs

Annual average concentrations of PM_{10} for the year of 2009 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS-Roads). ADMS-Roads is widely used for assessments of this nature. The previous (2007) assessment was also undertaken using the ADMS-Roads model.

The dispersion of PM_{10} emissions resulting vehicle movements in the three hotspot areas has been undertaken by employing a full year of meteorological data for 2006 obtained from a meteorological monitoring station in Luton. The same receptor locations that were included in the 2007 assessment have been included in the assessment. The modelling methodology and the input data utilised are described in Appendix 2.

3.3 Modelling Uncertainty

There is an element of uncertainty in all measured and modelled data. All values presented in this report are best possible estimates, but uncertainties in the results might cause over-predictions or under-predictions. The assessment is based on the same traffic data that were used in the previous (2007) assessment, but updated to 2009 using the traffic growth factors discussed in Appendix 2. Any uncertainties inherent in the traffic data are reflected in the predicted PM_{10} concentrations. There will be additional uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example, it has been assumed that during each year, the vehicle fleet within the study area will conform to the national (UK) average composition; it has been assumed that the emissions per vehicle conform to factors published in DMRB[3]; it has been assumed that wind conditions measured in Luton during 2006 were representative of wind conditions in Dacorum; and it has been

[2] UK Air Quality Archive: http://www.airquality.co.uk
[3] DMRB: Design Manual for Roads and Bridges, Highway Agency, UK

assumed that the subsequent dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain. An important step in the assessment is verifying the dispersion model against measured data. However, no PM_{10} monitoring data are available near the three hot spot areas. For this reason, the adjustment factors used in the previous assessment for predicted roadside NO_x concentrations have been applied to the predicted PM_{10} concentrations in the respective hot spot areas, as per guidance provided in LAQM.TG (09).

The limitations to the modelling assessment should be borne in mind when considering the results set out in the following sections.

3.3.1 Derivation of Short-term PM_{10} Concentrations

LAQM.TG(09) recognises that dispersion models are inherently less accurate at predicting the number of exceedences of the 24-hour mean PM_{10} objective than predicting the annual mean objective. A relationship between annual mean PM_{10} concentrations and the number of exceedences of the 24-hour mean objective is described in LAQM.TG(09). This is presented below for reference:

Number of 24-hour mean exceedences = -18.5 + 0.00145 x annual mean^3 + (206/annual mean)

Annual mean PM_{10} concentrations have been predicted using ADMS-Roads and the number of 24-hour exceedences have been derived from the aforementioned relationship/equation.

4 Assessment Outcomes

Modelled annual mean PM_{10} concentrations for the year 2009 at each of the three hot spot locations are illustrated in the form of annual average PM_{10} concentration contour plots in Figures 4.1 to 4.3. Concentrations of NO_2 have also been predicted for the year 2009 at these locations. As expected, a marginal increase in NO_2 concentrations has been predicted, as the same traffic data (updated to 2009 using appropriate growth factors) was used in the current assessment. For this reason, no further discussion on NO_2 concentrations is included in this report.

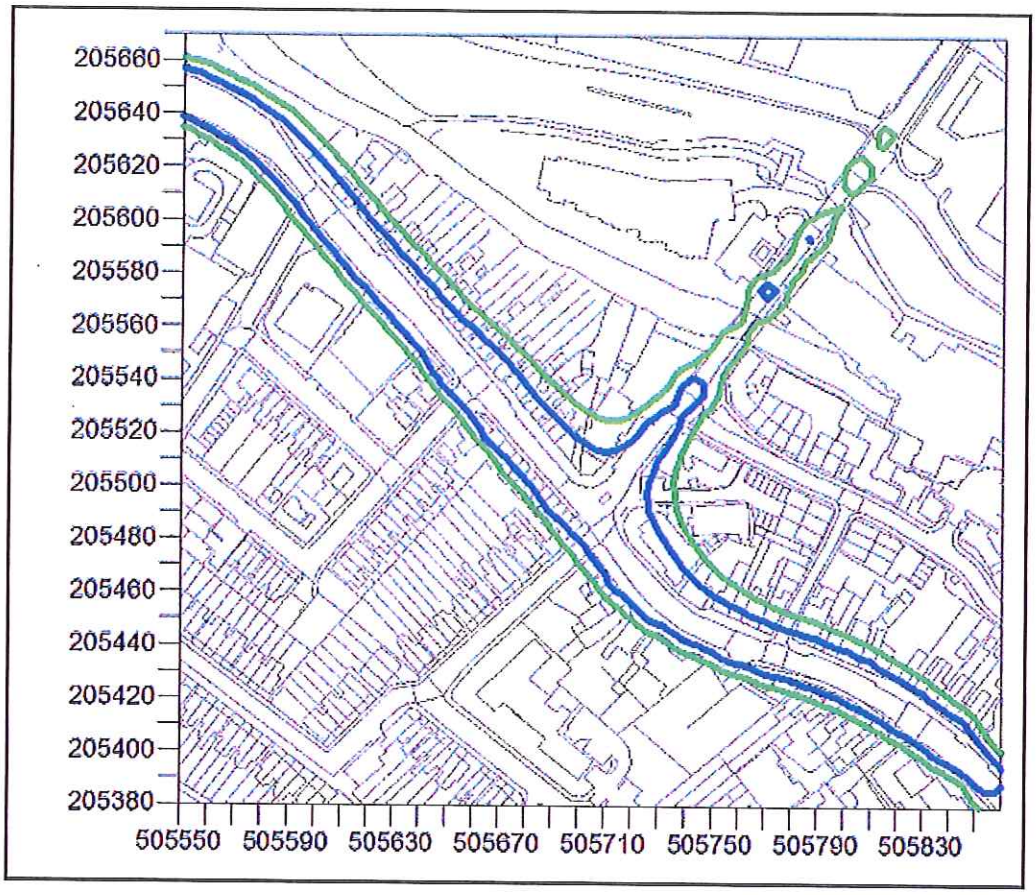
Figure 4.1 shows that adjusted annual average PM_{10} concentrations (including background PM_{10} concentrations) at the closest properties to London Road, Apsley are well below the annual average air quality objective. The highest predicted annual average concentration at the closest properties was 20.5 $\mu g/m^3$. A maximum of four exceedences of the 24-hour average PM_{10} objective was predicted.

Figure 4.2 shows that adjusted annual average PM_{10} concentrations (including background PM_{10} concentrations) at the closest properties to Lawn Lane, Hemel Hempstead are well below the annual average air quality objective. The highest predicted annual average concentration at the closest properties was 20.5 $\mu g/m^3$. A maximum of four exceedences of the 24-hour average PM_{10} objective was predicted.

Figure 4.3 shows that adjusted annual average PM_{10} concentrations (including background PM_{10} concentrations) at the closest properties to the High Street in Northchurch are well below the annual average air quality objective. The highest predicted annual average concentration at the closest properties was 19.6 $\mu g/m^3$. A maximum of three exceedences of the 24-hour average PM_{10} objective was predicted.

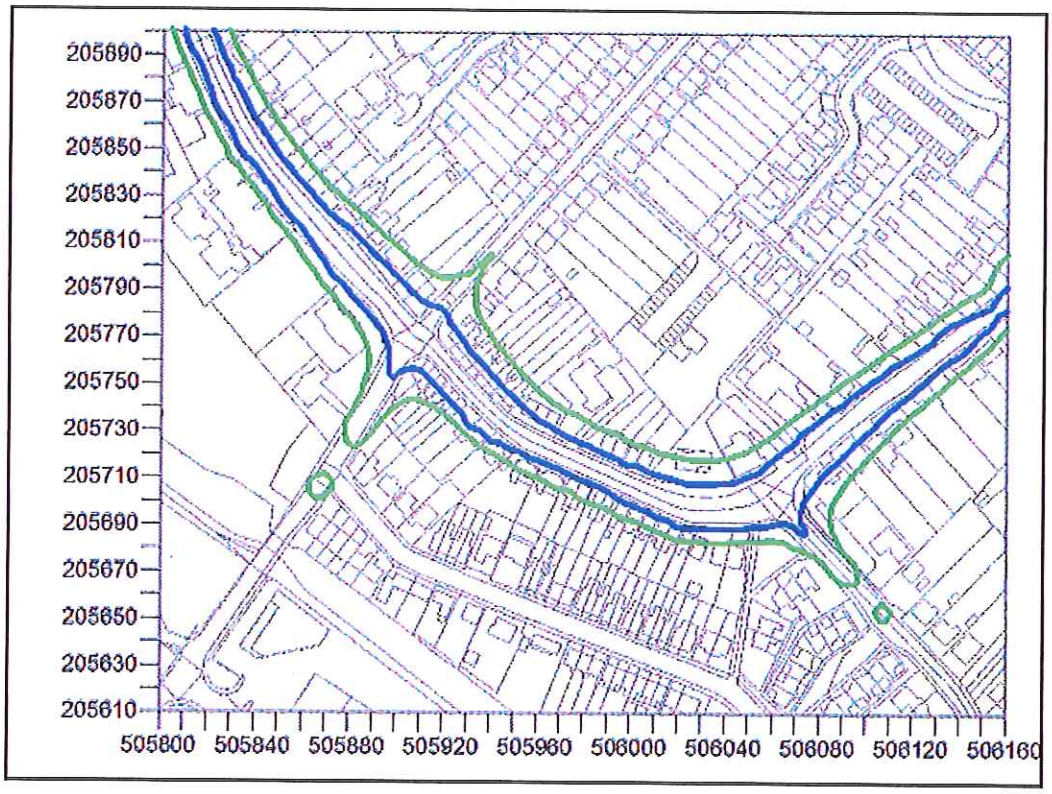
The assessment identifies that no exceedance of long- or short-term PM_{10} air quality objectives protective of human health was predicted within any of the study areas.

Figure 4.1 Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) for the Year 2009 along London Road, Apsley. The Blue Line Represents the 20.5 $\mu g/m^3$ Contour, whilst the Green Line Represents the 20 $\mu g/m^3$ Contour



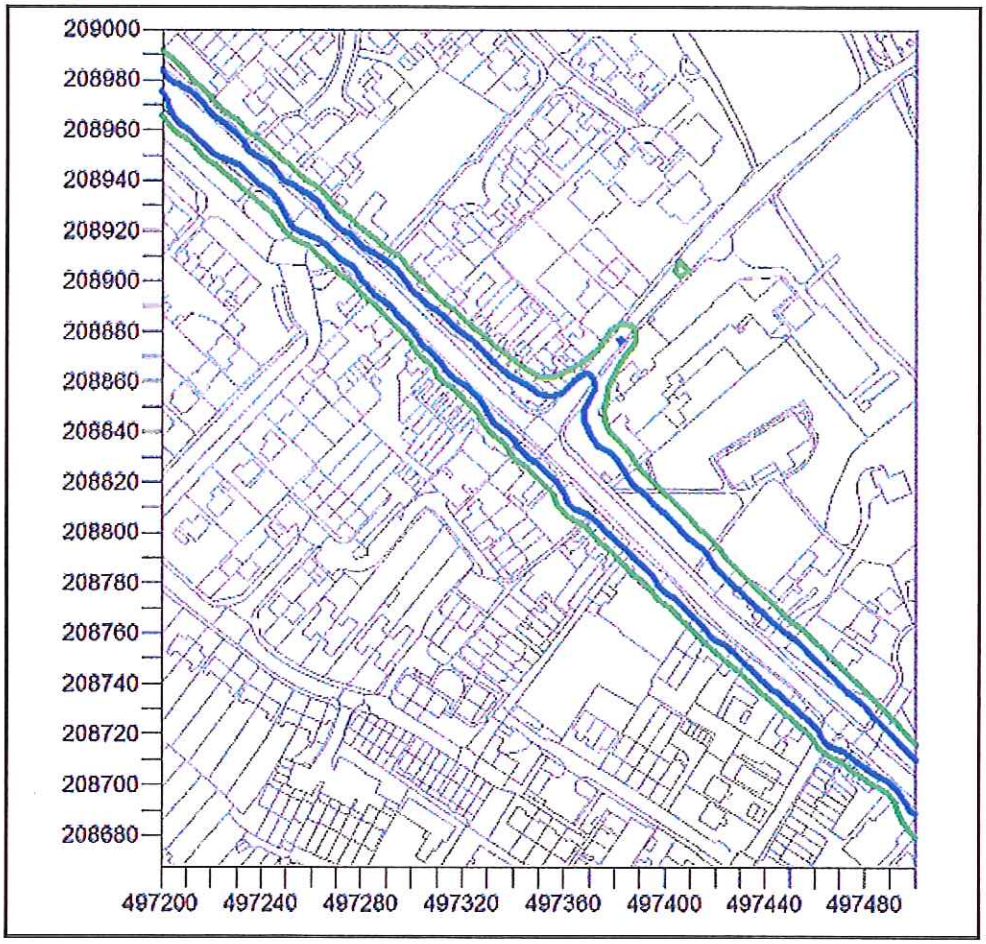
Note: The primary adjustment factor, 10.66, as derived from the previous assessment was applied to the model results

Figure 4.2 Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) for the Year 2009 along Lawn Lane, Hemel Hempstead. The Blue Line Represents the 20.5 $\mu g/m^3$ Contour, whilst the Green Line Represents the 20 $\mu g/m^3$ Contour



Note: The primary adjustment factor, 6.78, as derived from the previous assessment was applied to the model results

Figure 4.3 Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) in 2009 along the High Street, Northchurch. The Blue Line Represents the 19.6 $\mu g/m^3$ Contour, whilst the Green Line Represents the 19 $\mu g/m^3$ Contour



Note: The primary adjustment factor, 12.32, as derived from the previous assessment was applied to the model results.

5 Conclusions and Recommendations

A detailed assessment of PM_{10} road traffic emissions has been undertaken for properties located alongside London Road in Apsley, Lawn Lane in Hemel Hempstead and the High Street in Northchurch.

The assessment identified that no exceedance of long- or short-term PM_{10} air quality objectives protective of human health was predicted in any of the study areas.

The assessment identifies that currently none of the hot spot locations should be declared as AQMAs based on the modelled PM_{10} concentrations. However, these areas should be declared as AQMAs on the basis of predicted NO_2 concentrations close to the annual average air quality objective, as identified in the previous assessment study (AQC, 2007).

It is recommended that, as no PM_{10} monitoring data are currently available for any of the three hot spot areas, PM_{10} monitoring is considered at these locations to confirm the findings of this modelling study.

6 References

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7 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
AQMA	Air Quality Management Area
ADMS Roads	Atmospheric Dispersion Modelling System for Roads.
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometers in aerodynamic diameter.
NO_X	Nitrogen oxides.
NO_2	Nitrogen dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.

Appendix 1 – Summary of Health Effects of PM_{10}

Pollutant	Main Health Effects
PM_{10}	Fine particles can be carried deep into the lungs where they can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface-absorbed carcinogenic compounds into the lungs. Increases in PM_{10} daily average concentrations are associated with an increase in the number of hospital admissions for respiratory diseases and an increase in inhaler use among asthmatic patients.

Appendix 2 – Dispersion Modelling Methodology

Annual mean concentrations of PM_{10} during 2009 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS-Roads). ADMS-Roads if one of the dispersion models accepted for modelling within the Government's Technical Guidance.

Meteorological Data

The model has been run using a full year of meteorological data for 2006 from the meteorological station at Luton, which is approximately 15 km northeast of the three study areas.

Horizontal Road Alignment

Road alignment was based around Ordnance Survey road centreline data. Each carriageway of each road was entered into the model separately, where data were available. Those roads not explicitly included have been accounted for via the background component of the modelled results.

Traffic Data

The Department for Transport has made all UK 2005 traffic count data accessible via an interactive web-based map (DfT, 2007a). AADT flows, and the proportion of HDVs for London Road, Apsley and High Street, Northchurch have been determined from this map, as these provided more recent count data than were available from the Council. Data are not available from the DfT website for Lawn Lane, and therefore the most recent count data available (2004) were used.

The 2005 AADT data taken from the DfT website, and the 2004 count data for Lawn Lane have been factored forwards using growth factors derived from National Road Traffic Forecast (NRTF) factors (DETR, 1997), adjusted to local conditions using the TEMPRO System v5 (DfT, 2007b), to the assessment year of 2009. Traffic count data are not available for any minor roads within the study area. In these cases, a flow has been estimated based on local knowledge. The flows entered into the model for each study area are presented below in Table A4.1.

Table A4.1: Summary of Traffic Flows used in Assessment[a]

	2009	
	LGV AAHT	HDV AAHT
London Road, Apsley	587	13
Durrants Hill Road, Apsley	207	4
Lawn Lane westbound, Hemel Hempstead	252	19
Lawn Lane eastbound, Hemel Hempstead	230	17
Durrants Hill Road, Hemel Hempstead	206	4
Deaconsfield Road, Hemel Hempstead	83	1
Belswains Green, Hemel Hempstead	206	4
High Street, Northchurch west of New Road	362	15
High Street, Northchurch, east of New Road	513	14
New Road, Northchurch	147	4

[a] AAHT – Annual Average Hourly Traffic flow. When multiplied by 24 these give Annual Average Daily Traffic (AADT) flows.

Background PM_{10} Concentrations

Background concentrations of PM_{10} have been taken from national maps of background concentrations available from the UK Air Quality Archive.