Leicester's Local Transport Plan
2011-2026

Leicester City's Air Quality Action Plan 2011-2016

Leicester City Council

LEICESTER'S LOCAL TRANSPORT PLAN
2011 TO 2026

LEICESTER CITY'S AIR QUALITY ACTION PLAN 2011 TO 2016

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LTP3 AIR QUALITY ACTION PLAN

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1. THE BACKGROUND

1.1 Legislation and Guidance

Leicester City Council has a duty under Part IV of the Environment Act 1995 (Section 85) and Guidance issued there under (Section 88) to publish and keep up to date an Air Quality Action Plan.

This Annex is issued in compliance with that duty.

The major source of relevant pollution in Leicester is nitrogen dioxide from motor vehicles. Where this is the case, statutory Guidance under the Act recommends that this Air Quality Action Plan should be integrated into the current Local Transport Plan. [DEFRA Policy Guidance Notes LAQM. PG(03) and LAQM PGA(05) (Addendum)].

Leicester City's Air Quality Management Area is a single, extensive area based around the City centre and the major road network (Fig. 1.5). It reflects a network wide problem, requiring network wide responses.

Not only is the key air quality issue in Leicester one which could only be ultimately resolved by transport-related initiatives, but also air quality is extensively referred to by the Department for Transport in its Guidance on Local Transport Planning : It therefore makes sense to integrate the two Plans.

It is recognised that the existing Air Quality Action Plan (Annex 11 of the Central Leicestershire Local Transport Plan 2006-11) is insufficiently robust to achieve the statutory Air Quality Objectives: Evidence of progress is given in this document. In addition, the development of the third Local Transport Plan, beyond 2011, provides the opportunity to revisit the action plan.

This Annex is therefore to be read in conjunction with the main Leicester Local Transport Plan 2011-2026 (LTP3). (Chapter 7 of the LTP3 deals specifically with air quality). It has two principal aims:

To avoid encumbering the main narrative of the Local Transport Plan with background detail about Local Air Quality Management.

To collate in one place all material relevant to Leicester City Council's specific duty under the Environment Act to produce its own Air Quality Action Plan, so that it can be referred to in a transparent way.

1.2 Why is Air Quality Important?

1.2.1 Mortality

Evidence to the Parliamentary Environment Audit Committee in 2010 indicates that poor air quality –

Reduces the life span of everyone in the UK by an average of 7 – 8 months;

Causes up to 50,000 premature deaths each year in the UK. (In Leicester, this equates to at least 750 premature deaths).

[House of Commons Environmental Audit Committee – Air Quality, Report of the Fifth Session 2009 - 10].

This compares with about 3,000 fatalities every year on the roads and about 11,000 deaths per year caused by passive smoking.

Studies show that the most deprived groups tend to live in areas of poorest air quality. This is compounded by the fact that people in this category are also affected by a range of stress factors.

1.2.2 Social Deprivation

The following is taken from Air Pollution in the UK, 2005 (DEFRA, August 2006). ‘Deprivation’, for the purposes of this study, is a combined index, by percentage of the population, of unmet needs in terms of income, employment, education and housing.

Analysis shows that the 30% of the population of England which is most deprived is urban and suffers the worst air quality, with respect to nitrogen dioxide and particulates (but not ozone). This effect is more pronounced if we consider the most deprived decile (10%) of the population. Conversely, the majority of the population living in the areas subject to the top 10% of levels of those pollutants is accounted for by the most deprived communities. In England, over 70% of the population living in the most PM_{10} polluted areas is characterised by being in the 4 most deprived deciles of the population (40%). There is a similar relationship for nitrogen dioxide.

National projections indicate that there is a worsening trend over the decade in the relationship between deprivation and exposure to bad air quality. Although more research is needed, there is also some evidence that deprived populations living in areas of poor air quality are more susceptible than the population as a whole to the harmful effects of air quality due to its combined impact with other social stressors. Analysis of the UK population demonstrates that the young are statistically more likely to live both in areas of social deprivation and of poor air quality.

Although the resident population of Leicester’s Air Quality Management Area is estimated to be about 3% of the City’s population (9,000 people), the affected people typically live in inner city areas and/or areas in close proximity to major roads, which correspond to areas of elevated social deprivation. Therefore, any improvement in air quality in these areas will have a disproportional benefit for the actual people most seriously affected.
Disadvantaged people tend to contribute least to atmospheric emissions and also tend to be the group least able to take action to address them.

A very good example of this problem is the St. Matthews estate, where flats and maisonettes are situated within a few metres of the inner ring road and much of the estate falls within the Air Quality Management Area. (Fig. 1.5)

Taking the mortality figures for the UK pro-rata, we can make the crude calculation that poor air quality would lead to about 250 premature deaths per annum in Leicester. However, because of the demographic factors referred to, this is almost certainly an underestimate, and the proportion of the UK mortality attributable to deprived / polluted areas within the City will be larger.

1.2.3 EU Deadlines

The UK's failure to meet EU air quality Objectives by the appropriate deadline could result in the Government being taken to the European Court and subjected to massive ongoing financial penalties. The Government is currently attempting to secure an extension to the time limit for meeting the limit values for nitrogen dioxide in urban areas.

1.3 Council Strategies Relevant to Air Quality.

Strategy	Actions and Targets	
	Specific Action	Headline Target
Corporate Plan 2003-2006	Make continual, measureable progress in environmental performance and reduce environmental impact	Meet EMAS targets for environmental improvement
	Improve access to public transport and promote alternative transport leading to reduced car use; develop safer routes to schools schemes; and implement traffic calming initiatives	Reduce car use to the city centre by 4% in peak periods by 2006
	Provide effective regulatory services for environmental health	Develop and implement Air Quality Action Plan by June 2004
Leicester's Community Plan/Strategy	Reduce car travel to the city centre and encourage and develop more journeys by cycling, walking and public transport	
	Ensure national air quality standards are met and increase awareness and understanding of air quality issues	
	Promote and deliver sustainable use of energy and resources	
Leicester's Neighbourhood Renewal Strategy	Reduce car travel to the city centre and encourage and develop more journeys by cycling, walking and public transport	
	Ensure national Air Quality standards are met and increase awareness and understanding of air quality issues	
	Increase awareness and understanding of air quality issues through the formal education system and amongst the wider community	

Strategy	Actions and Targets
Leicester's Environmental Strategy (Leicester Environment Partnership)	Minimising pollution: reduce and eliminate harmful emissions from vehicles and monitor air quality to identify pollutant levels and sources and make this information public
	Achieve sustainable transport: achieve the statutory air quality objectives; reduce the need to travel; reduce vehicle emissions; promote modal shift; reduce the distance over which goods and services are delivered

1.4 The National Air Quality Objectives

Statutory Objectives and Limit Values for various pollutants are laid down by Regulation, as detailed in the following table.
Table 1.5: Air Quality Objectives included in Regulations for the purpose of Local Air Quality Management in England.

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 µg/m³ 5.00 µg/m³	Running annual mean Running annual mean	31.12.2003 31.12.2010
1,3-Butadiene	2.25 µg/m³	Running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m³	Running 8-hour mean	31.12.2003
Lead	0.5 µg/m³ 0.25 µg/m³	Annual mean Annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 µg/m³ not to be exceeded more than 18 times a year 40 µg/m³	1-hour mean Annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric)	50 µg/m³, not to be exceeded more than 35 times a year 40 µg/m³	24-hour mean Annual mean	31.12.2004 31.12.2004
Sulphur dioxide	350 µg/m³, not to be exceeded more than 24 times a year 125 µg/m³, not to be exceeded more than 3 times a year 266 µg/m³, not to be exceeded more than 35 times a year	1-hour mean 24-hour mean 15-minute mean	31.12.2004 31.12.2004 31.12.2005

In practice, the key air quality issue is exceedance of the annual mean criterion for nitrogen dioxide caused by emissions from motor vehicles. This is discussed in detail in Section 3 of this document.

1.5 Progress with Air Quality in Leicester

- The Local Air Quality Management process can be summarised as follows:
- Environment Act 1995
- Government establishes National Air Quality Strategy
- Government sets statutory health-based air quality Objectives
- Local Authority Reviews and Assesses Air Quality against Objectives 2000)
- Projected failure to meet Objectives established
- Local Authority designates Air Quality Management Area (2000)
- Local Authority carries out further (“Section 84”) Review and Assessment in AQMA (2003)
- Source apportionment of exceedance and amount of reduction required established
- Local authority develops Air Quality Action Plan (2004)
- Air Quality Action Plan is integrated with Local Transport Plan (2005)
- Leicester fails to meet statutory Objective for Nitrogen dioxide (2005)
- Central Leicestershire Local Transport Plan 2006-11 (2006)
- Implementation and Progress Reporting
- Air Quality Management Area extended in Abbey Lane corridor (2008)
- Leicester highly unlikely to meet EU limit value for nitrogen dioxide (2010)
- Replacement Air Quality Action Plan developed in integration with the Leicester Local Transport Plan 2011

Fig 1.5

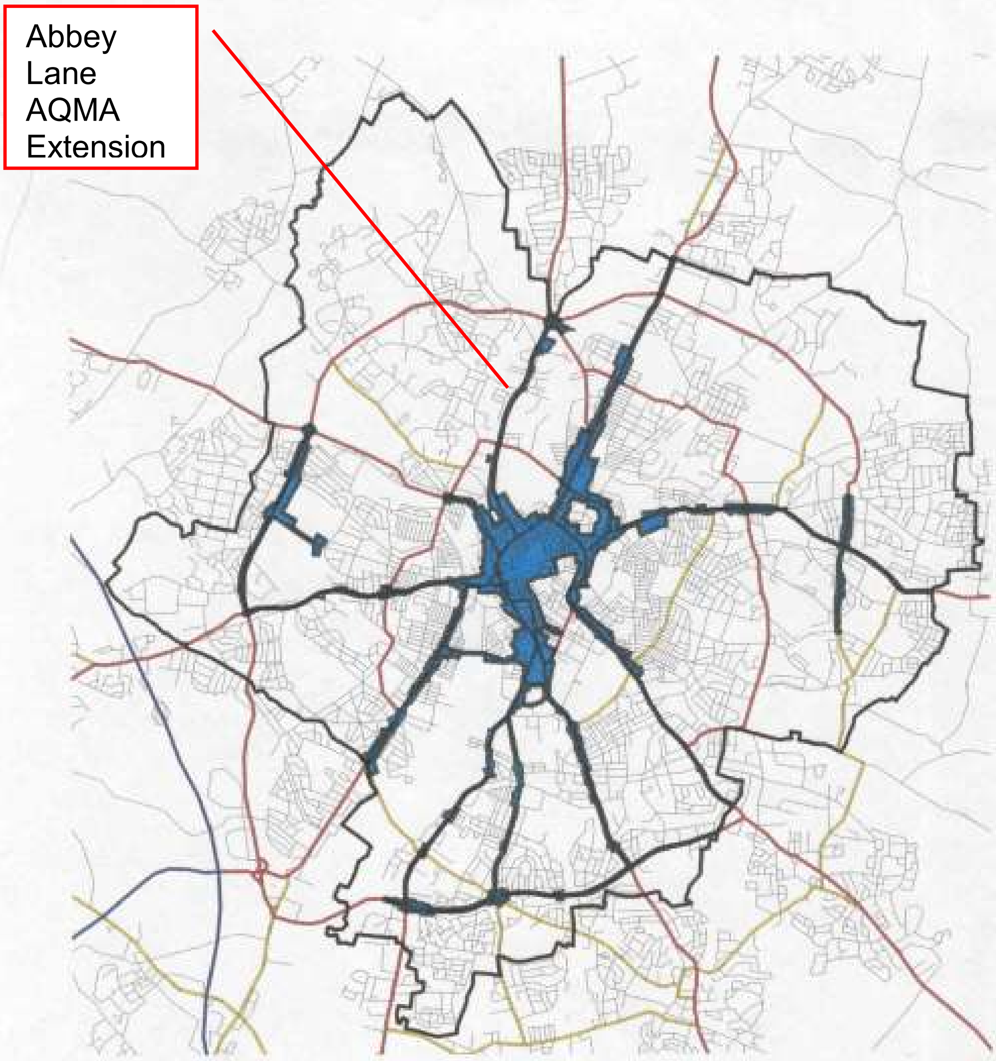


Figure 1

Air Quality Management Area (in force 29th December 2000)

THE CITY COUNCIL AIR QUALITY MANAGEMENT AREA IS SHOWN IN BLUE

2. AIR QUALITY ACTION PLANNING

2.1 The Low Emission Strategies Approach

2.1.1 Generic Strategy

Monitoring and modelling so far demonstrates that no measures, which are currently committed or at an advanced stage of development, will come close to achieving the Objective for Nitrogen dioxide (or achieve a sufficient reduction in carbon emissions)

It is therefore clear that to meet the Objective –

- No single measure will do the job; a broad package of interventions is needed;
- Progress will be a long haul, in incremental steps; and
- To achieve the full reduction required, the modelling to date suggests that radical, long-term measures may ultimately be required
- Considering generic strategies for reducing traffic emissions, all measures fall into three broad categories, by reducing:
  - Vehicle-miles within the Local Transport Plan area;
  - Emissions per vehicle-mile; and/or
  - Traffic flows past critical points (where relevant human exposure occurs).

In drawing up Leicester City Council's Air Quality Action Plan, all available options were considered and evaluated.

2.1.2 Policy Integration

There is a key triad of environmental imperatives:-

Air Quality – Emissions which are harmful to health at a local level, especially near to sources such as busy roads. The key air quality issue in Leicester is nitrogen dioxide: About 90% of the measured nitrogen dioxide in Leicester is derived from motor vehicles. Of this, about 60% is from heavy vehicles.

Climate Change – Greenhouse gas emissions which cause large-scale and potentially catastrophic climatic effects. The most important greenhouse gas is carbon dioxide. Over 20% of emissions are from motor vehicles and this sector is growing.
Sustainability – Making sure that our mode of life does not impair that of future generations, in a context of huge population growth and economic growth, impacting on finite resources.

These overlap but are not identical in their demands. As has now been clearly realised by Government (see Section 3.2), interventions can be identified which tackle both climate change (LTP3 chapter 8) and air quality (LTP3 chapter 7). Implementing these will give policy a greater coherence, direction and force. This approach will also present a few simple aims to the public, avoiding a confusing plethora of strategies and initiatives. This will enhance the likelihood of stakeholder understanding and acceptance.

Conversely, policy conflicts are possible, and even likely, unless there is detailed and rigorous assessment of policy options for all their consequences and their costs/benefits, before adoption.

Importantly, this approach will avoid wasteful activities and optimise the use of increasingly scarce resources.

Finally, opportunity costs of failing to act on various issues can be aggregated making the case for action more powerful.

It should be noted that Leicester City Council is signed up to the Low Emissions Strategies Development Programme, which is endorsed and funded by DEFRA, with the stated aim of, '…Using the Planning System to reduce transport emissions'.

Current Government Guidance strongly promotes the concept of pursuing the co-benefits of combating poor air Quality and climate emissions. The following section summarises the key recommendations of these documents.

It is worth noting that the 4M research programme, led jointly by Loughborough and Newcastle Universities, intends over the next 4 years to calculate the carbon footprint of Leicester by:

- Measuring the carbon released by traffic, the burning of fossil fuels in homes and places of work and the rate at which green plants and trees capture carbon and store it in the soil;
- Modelling the effects on the carbon budget from: road layouts, traffic volumes and traffic speeds, the way we use energy in our homes and places of work, and the way we look after green spaces;
- Mapping the sources and sinks of carbon for the whole city and comparing this with the social and economic well-being of its 270,000 inhabitants;
- Management studies which will investigate how to shrink the city's carbon footprint through: changing the road network and/or the provision of better public transport; alterations to the maintenance of green spaces and the treatment of waste; the use of renewable and low energy systems to provide power and light; and the operation of Individual Carbon Trading (ICT) schemes.

Clearly, in the longer term there is scope to utilise this knowledge base to evaluate or verify potential Action Plan interventions, particularly at the strategic level.

The more detailed analysis of selected interventions for the work reported in the TRL Report (see Section 2.8) includes an assessment of CO_2 emissions.

2.1.3 The UK Policy Context

a) Guidance on Local Transport Plans (Department for Transport, July 2009)

This is the basic guidance which sets the pattern for the forthcoming replacement Local Transport Plan, now under development. One of the stated key goals is to 'Contribute to Better Safety, Security and Health', including the aim to

"Reduce social and economic costs of transport to public health, including air quality impacts in line with the UK's European obligations,"

On air quality, the Guidance goes on to say:

"Local authorities are responsible for monitoring local air quality and implementing action plans to improve air quality where this is necessary. The majority of air quality action plans concern road transport emissions. Good co-operation between transport planning, air quality and spatial planning departments, as well as with partner organisations, is essential to ensure a strategic approach to improve quality of life for those living near to busy roads and junctions. Integrating Air Quality Action Plans with LTP's is strongly encouraged…"

It is important the LTP's are effectively co-ordinated with air quality, climate change and public health priorities – measures to achieve these goals are often complementary. Reducing the need to travel and encouraging sustainable transport can reduce local emissions, whilst improving public health and activity levels."

"The Department will continue to take an interest in the overall quality of an authority's LTP, and of its delivery, and may take these factors into account where this is relevant to its decisions, for example in relation to bids for challenge funding or major projects."

b) The Future of Urban Transport (Prime Minister's Policy Unit, 2008)

The DfT Study analyses the costed aspects of urban transport, including air quality under the following headings:

- Excess delays
- Accidents

- Poor Air Quality
- Physical inactivity
- Greenhouse gas emissions
- Noise and amenity

It is estimated that the aggregated measurable costs in the UK of transport in urban areas with populations in excess of 10,000, from congestion, accidents, poor air quality and physical inactivity/obesity are each roughly of the same order of magnitude i.e. around £10 billion per annum. In a time of economic stringency, there are therefore very large opportunity costs attached to failure to take effective action.'

c) Air Pollution – Action in a Changing Climate (DEFRA, 2010)

This Guidance document states that air pollution causes annual health costs of around £15 billion in the UK, comparable to the cost of obesity (£10 billion), and that many activities, particularly relating to transport and energy generation, contribute both to local air pollutions and wider global climate change. Specifically, the report makes the following comments:-

"Taking action to reduce the effects of climate change provides an excellent opportunity to deliver further benefits to both air pollution and greenhouse gas (GHG) emissions. Both arise from broadly the same sources and will therefore benefit from many of the same measures; so the combined benefits are substantially greater, when we compare them with the costs, rather than if we look at each group of benefits in isolation."

"Now is the right time to consider how we can achieve these additional benefits, particularly from improving public health, through a closer integration of air quality and climate change policies. In the much shorter term we face challenges in meeting our current air quality targets, especially in relation to nitrogen dioxide (NO_2)…"

"Government proposals to achieve air quality / climate change co-benefits will be realised through actions such as promoting ultra-low carbon vehicles, renewable sources of energy which do not involve combustion, energy saving efficiency measures and reducing agricultural demand for nitrogen."

"At the same time, we need to avoid, as far as possible, policies which tackle climate change but damage air quality, and vice versa…"

"…evaluation of a measure to increase the uptake of low emission vehicles showed that when viewed from an air quality perspective the benefits were marginal, with a cost of £61 million and benefits of around £72 million on an annual basis. However, the measure was also estimated to realise climate change benefits valued at £91 million, thus bringing the total annual benefits to around £163 million for the same cost of £61 million."

In the best case scenario, “Climate change action brings additional benefits through air quality improvements…and a high level of ambition is set for NO_2 emissions reduction”… In the worst –case scenario, action on climate change brings further costs through the deterioration of air quality: ”…Conventional biodiesel or bioethanol is the fuel of choice for road transport; our homes and businesses get their heat and power from localised combined heat and power plants, fuelled by gas or biomass; coal-fired electricity generation provides the UK base load, with post-combustion CCS fitted; biomass is widely used in homes as a heating fuel of choice in small boilers;…”

d) Low Emissions Strategies: Using the Planning System to Reduce Transport Emissions – Good Practice Guidance (DEFRA, January 2010).

The document fleshes out the Low Emissions Strategies (LES) approach (see Section 4.4). It addresses the need for policy co-ordination in the following terms:

“Climate change is the greatest long-term challenge facing the world today. There is strong and indisputable evidence that climate change is happening and that man-made emissions are its main cause. If left unchecked, climate change will have profound impacts on our societies and way of life. Action is needed now.

Air pollution still harms health and the environment: it is currently estimated to reduce the life expectancy of every person in the UK by an average of 7-8 months, with estimated equivalent health costs of up to £20 billion each year. There are significant benefits to be gained from further improvements.

Air pollution and climate change both arise from the emission to atmosphere of the products of combustion. They are intrinsically linked. National policy advises local authorities to ‘bear in mind the synergies between air quality and climate change, and the added benefits to the local, regional and global environment of having an integrated approach to tackling both climate change and air quality goals.’

Joined up policies are particularly important for the transport sector, which is by far the most common cause for the declaration of air quality management areas and is the only sector where carbon dioxide emissions continue to increase.”

e) An invitation to shape the Nature of England (DEFRA, July 2010)

This discussion document sets air quality and climate change emissions in the context of national policy objectives: ‘The rate of decline of some air pollutants is now leveling off and improvements are increasingly costly to achieve. However, air pollution still reduces life expectancy by an average of six months, with social costs estimated at £8 to £17 billion per year…. Working towards compliance with EU air quality limits for particulate matter (PM_{10}) and nitrogen dioxide (NO_2) in our urban areas is the short-term priority for the UK and other EU Member States. In the short term, the most pressing compliance challenge relates to NO_2 levels in large urban areas … (including London)'

2.1.4 National and Local Policy Goals

The options contained in the AQAP have been appraised as to the extent to which they move towards of national and local strategic goals -

a) National: Guidance on Local Transport Plans (Department for Transport, July 2009)

This sets out five key goals:

- Economic Growth
- Reducing Carbon Emissions
- Equality of Opportunity
- Safety, Security and Health
- Quality of Life and Healthy Natural Environment.

The DfT Guidance on transport planning advocates the application of the 'Eddington Approach', in order to develop and implement policy in a systematic way. This is set out schematically in Table 2.1.4/1:

Table 2.1.4 /1

Major Element	Eddington Approach	Detailed components	Time Scale
STRATEGY	Goals	Integrated corporate governance ~ Climate Change Strategy ~ Air Quality Action Plan ~ LDF ~ Social Policy Refine long-term 'One Leicester' vision in transport terms Establish evidence base Set long-term goals and targets A look ahead to where the implementation plan will lead at the end of the 'One Leicester' process.	Long-term perspective (? 25 years) Informs Implementation
	Challenges	Identify obstacles to long-term progress and how they are to be addressed. Identify policy conflicts. Quantify hidden ('opportunity') costs – Social Economic	
IMPLEMENTATION	Evaluate Options Select Options Set Priorities	Identify how options lead in direction of long-term goals. Cost-benefit analysis. Establish outline process and scheduling of actions.	Detailed short-term planning (? 3 year increments) Delivers Strategy
	Delivery	Detailed – Design Costing Scheduling	
	Monitoring of progress and impacts	Set baseline Establish detailed impacts of Preferred Package measures Set targets and profiles Monitor progress towards targets Feedback loop into next phase of planning	
		Review how implementation plan is delivering Strategic vision	Long-term future (25 years)

Unlike the wider Local Transport Plan delivery of this Air Quality Action Plan, while being time-based, is not required by the DEFRA guidance to operate within any specific time limits: It is therefore a useful vehicle for looking further ahead at possible scenarios.

It can also be said that it is legitimate to establish feasibility studies, or the investigation of barriers to more radical measures, as 'actions' within this Air Quality Action Plan.

b) Local: Leicester City Council's 'One Leicester' Priority Policy Areas

This is the key, overarching strategic policy framework for the Council and sets the following seven Priority Areas:

- Planning for People not Cars
- Reducing our Carbon Footprint
- Creating Thriving, Safe Communities
- Improving Wellbeing and Health
- Talking up Leicester
- Investing in Skills and Enterprise
- Investing in our Children

This envisages a 25-year time horizon which is a realistic one for developing and implementing the radical measure required to attain satisfactory levels of NOx (and, indeed, carbon dioxide) emissions from transport.

The key task is to collate and reconcile these long-term goals with the more immediate options identified in the wider LTP.

References to Air Quality are scattered throughout the DfT guidance and the local strategic policy 'shopping lists', explicitly or implicitly. Table 2.1.4/2 indicates how air quality fits into wider national and local transport priorities: The Five Key Goals set out in the DfT Transport Planning Guidance are cross-tabulated with the 'One Leicester' Goals. In addition, for comparison and completeness, the analogous 'Leicestershire Together' goals of Leicestershire County Council set are located in the column and row headings for comparison (green italics).

DfT sub-headings to their 5 key Goals are entered in normal type in the appropriate column row intersections. Areas where air quality inputs are significant are highlighted in the table in yellow, with comments in bold blue type.

Table 2.1.4/2

DfT 5 Goals → / One Leicester ↓	***Economic Growth*** ***[Leics: A prosperous, innovative and dynamic economy]***	***Carbon Emissions*** ***[Leics: A more effective response to Climate Change]***	***Safety, Security and Health*** ***[Leics: A healthier Leicestershire]*** ***[Leics. Cross-cutting theme: Air Quality in AQMA's]***	***Quality of Life / Healthy Nat. Env.*** [Leics: A safe, attractive place to live and work]	***Equality of Opportunity*** ***[Leics: Better life choices for vulnerable people and communities]***
Planning for people not cars	**Potential conflict** Environmental cost approach?	Car-free environments, reduced congestion and modal shift benefit both AQ and CC emissions			Improved public transport for disadvantaged groups.
Reducing our carbon footprint ***[Leics: A more effective response to Climate Change]***	**Potential conflict** Environmental cost approach? **Reduced congestion improves AQ and CC emissions**	Deliver quantified reductions in CC emissions to meet UK/EU targets. **These measures also benefit AQ - 'win-win' solutions**.			
Thriving, Safe Communities ***[Leics: Stronger more cohesive communities]*** ***[Leics: A safe, attractive place to live and work]***	- Reliable transport; - Access to labour markets; - Access to increased sustainable housing supply; - Proof against shocks. - Reduce gap in growth rates compared to other regions		- Reduce road accident casualties. - Reduced crime, fear of crime, antisocial behaviour and terrorism threat.		**Poor AQ affects deprived areas disproportionately** - Social inclusion through improved access. - Reduce gap in growth rates compared to other regions.
Improved Wellbeing and Health ***[Leics: A healthier Leicestershire]*** ***[Leics. Cross-cutting theme: Air Quality in AQMA's]***			**NB-Air Quality is a public health issue. Reduced social and economic impacts of AQ in line with EC obligations.** Promote more physically active travel.	Air Quality is a Quality of Life Issue. -Transport related noise. (Environmental Noise Directive). **NB-Noise synergies with AQ – similar areas are affected.** -Impact on natural environment. - Better journey experiences and interfaces. - Improved access for quality of life.	
Investing in Skills and Enterprise ***[Leics: A prosperous, innovative and dynamic economy]***	- Better Regulation; - VFM				Access to skills and opportunities.
Talking up Leicester City Council					
Investing in our Children	Access to education				Developing skills for life.

2.2 Assessment Methodology

2.2.1 Available Sources for Identifying and Appraising Policy Options Specific to Air Quality

In identifying and appraising policy options for inclusion in this AQAP, it has been possible to draw upon a wide range of material and assessment methods, for example:-

a) The existing Air Quality Action Plan (Annex 11 of the Central Leicestershire Local Transport Plan, 2006-11) (Section 2.3)

b) Work done by Leicester City Council under its Climate Change Strategies in assessing Low Emission automotive options.

c) City Council Land Use policies and initiatives (Section 2.5). This includes the Leicester Low Emissions Strategies Project: Leicester City Council is a partner in this national initiative and is developing –

A toolkit for assessing planning applications in relation to their associated transport emissions.

A parking SPD for Leicester, with particular reference to the New Business Quarter Project.

d) Work done in controlling emissions from static sources and assessing their significance in relation to transport emissions (Section 2.6).

e) Work done in response to the EC Noise Directive to assess and map transport noise and assess policy synergies with emissions management (Section 2.7).

f) The Transport Research Laboratory Study, *Revised Air Quality Action Plan Interventions*: This AQGS-funded study was undertaken for Leicester in response to the realisation that current Air Quality Action Planning was inadequate to make sufficient difference to emissions and investigated radical options aimed at substantial improvement (Section 2.8).

2.2.2 The Leicester Transport Options Assessment Report and Methodology

Centrally to developing the main Local Transport Plan (LTP-3), the Transport Strategy Team at Leicester City Council has produced an *Options Assessment Report*, which –

a) Sets out the underlying Goals and Objectives established by the Transport Plan Review Process, in the context of DfT transport planning Guidance and Leicester City Council's strategic policy objectives:-

The Goals are based upon the five key goals enunciated in the DfT Transport Planning Guidance and are closely linked to the Priorities stated in the 'One Leicester' strategy.

The Objectives realise the Goals in terms of specific transport themes which then are used to structure the chapters of main Local Transport Plan document.

The local transport goals and objectives are summarised as follows, together with comments on how they relate to Air Quality:

DfT Goals	Objectives (LTP Chapter Themes)	Air Quality Implications
Economic growth supported	To reduce congestion and improve journey times	Reduced congestion will tend to reduce emissions. Economic growth can conflict with this objective.
Carbon emissions reduced	To reduce carbon emissions	There is a strong synergy between reducing carbon and air quality emissions – integrated Low Emission Strategies approach.
Equality of opportunity promoted	To improve connectivity and access	Pollution adversely affects disadvantaged groups the most and they are the least able to do anything about it.
Better safety, security and health	To Improve safety, security and health	Air quality is a health issue.
	To improve air quality and reduce noise	Traffic derived air pollution and noise often affect the same areas.
Improved quality of life and a healthy natural environment	Improved quality of life	Air quality is a quality-of-life issue.
	Better maintained transport assets	
Population growth supported in a sustainable manner	To reduce congestion and improve journey times	Improved air quality is implicit in reduced congestion and improved sustainability: Per capita emissions are reduced.

b) Employs the Distilliate KonSULT Project (Knowledgebase in Sustainable Urban Land Use and Transport), a collaborative national initiative to provide information on policy options available to urban transport planners.

c) Identifies a classified list of available policy instruments.

d) Sets out parameters for assessing the performance of policy options in relation to changes in demand, supply and cost in the transport system.

The Assessment methodology then-

a) Applies criteria for sifting the available policy options for feasibility. This includes specific criteria for discarding options. The defined criteria can be summarised as:

Affordability – Cost and availability of funding
Alignment with Leicester's Strategic Transport Objectives
Alignment with the current (Central Leicestershire) longer term transport strategy.
Value for money
Political acceptability
Whether deliverable within, or beyond, the next four years.

Each sifting criterion is assigned a defined red, amber and green rating which is used to classify the feasibility / likelihood of realisation of each available policy option.

b) Establishes a prioritisation score against each of the available policy options for each of the established Objectives and themes of the LTP. The scoring was done on a five point scale ranging from -3 (likely to have a very significant adverse impact), through 0 (likely to have a broadly neutral impact, to +3 (likely to have a very significant positive impact).

2.2.3 Procedure for Evaluating Air Quality Options in Relation to the Main Transport Options Assessment Framework.

The options identified, discussed and appraised in the air quality-specific sources listed in Section 2.2.1 are mapped on to the general Transport Plan Options Assessment methodology explained in Section 2.2.2 (Section 2.9)

This cross-referencing is used to establish a ranked and prioritised set of policy options to carry forward in the Air Quality Action Plan (Section 2.10).

It is recognised that some options will be unsuitable for inclusion in the immediate LTP Delivery Programme because of financial, political and other constraints. Nonetheless the immediate programme should be informed by, and be aligned with, a longer-term strategic vision. This is implicit in the statutory Guidance on both Transport Planning in general and Air Quality

Action Planning in particular. Moreover, it is required by both the Government's and Leicester City Council's strategic aims (Section 2.1.4). The consolidated list of interventions (Section 2.10) is therefore divided into –

a) Options practicable in the context of the short-term delivery programme; and
b) Longer-term strategic options.

In the context of (b), it is considered legitimate to include a programme of 'actions' for inclusion within the short-term time frame, which are aimed at studying feasibility, funding and barriers to progress of more radical options in greater depth, with a view to developing specific proposals for their delivery.

2.4 The Existing AQAP (Annex 11 of the CLLTP 2006-11)

2.4.1 Carrying it forward in 2010

One important starting point for this Air Quality Action Plan is the previous one, integrated with the Central Leicestershire Local Transport Plan 2006-11, as Annex 11. In this section, consideration will be given to –

The principles adopted most of which remain valid;
Progress with the measures proposed;
Changes which affect selection of options;
Strategies and interventions which need to be carried forward, with or without modification.

2.4.2 Progress and Significant Changes

It is apparent from the monitoring data set out in Section 3.5 of this Annex that little progress has been made toward achieving the annual mean air quality limit values for nitrogen dioxide; indeed, in some roadside locations the situation has deteriorated somewhat.

Leicester's *Updating and Screening Assessment of Air Quality 2006* indicated that a Detailed Assessment of nitrogen dioxide was required for the Abbey Lane Corridor. This was duly completed and submitted to DEFRA in May 2007 (*Leicester City Council – Detailed Assessment of Air Quality: Abbey Lane, April 2007*). The Report recommended the extension of the Leicester AQMA 2000 Order to encompass a larger part of the main Abbey Lane corridor. The methodology and conclusions of this report were accepted by DEFRA upon appraisal.

It is estimated that the resident population of the Leicester Air Quality Management Area 2000 is about 9,000, or 3% of the City's population. The *Leicester City Council Air Quality Management Area Order 2000 (Variation) Order 2008* duly came into effect on 25th April 2008: This adds the 102 residential properties along the west (northbound) frontage of Abbey Lane, between its junctions with Byford Road and Langley Avenue, to the existing AQMA. (Figs. xxxx).

It was also a conclusion of that Detailed Assessment that the Leicester Air Quality Management Area 2000 as a whole needed to be re-modelled and its boundaries reviewed. This had clear implications for the Air Quality Action Plan, which was insufficiently robust to make satisfactory progress towards meeting the statutory nitrogen dioxide Objective. It was also apparent that radical measures would be required over a long time-scale to achieve this.

In the 2005 AQAP, various measures where considered and explicitly rejected since the political, financial and legal conditions were simply not in place to implement them. The short-terms prospects in these respects are, at time of writing, no better and possibly in some regards worse. Specific barriers to progress included:

- Lack of identifiable or available funding;
- High / disproportionate cost;
- Lack of appropriate statutory powers;
- Lack of public / political acceptability at that time;
- Doubtful efficacy or necessity;
- Adverse economic effects.

Conversely, the current DfT Guidance on Transport Planning is couched in terms of a 'strategic' component in addition to the more immediate 'delivery' component. Also, it should be noted that, while the Air Quality Action plan is required to be time-based, no specific time limits are specified. In addition, Leicester City Council's overarching 'One Leicester' strategy sets a time-scale of 25 years, which is perhaps a realistic one for bringing about the change necessary to meet air quality (and carbon) targets. Therefore, although some interventions clearly remain beyond to reach of practicable short-term transport planning, their merits are considered in this document.

For these reasons, an evidence-based modelling study was commissioned from the Transport Research Laboratory in 2008, which researched a package of hypothetical measures to substantially meet the air quality Objective. This is considered in Section 2.8 of this document.

Since 2005, the profile of climate change policy has steadily risen in the UK and within the Authority, together with an emphasis on policy integration with Local Air Quality Management:-

Practically, actions can be identified which might benefit both climate and air quality; this 'win-win' approach is now explicitly endorsed by Government.

In terms of the policy framework, several items covered by the AQAP now also fall within the purview of the City Council's Climate Change Strategy, explicitly or implicitly.

However, some policy areas raise challenges in reconciling air quality improvement with other agendas, e. g. vehicle fuel policy and regeneration.

The new Local Development Framework is at an advanced stage, to replace the current City of Leicester Local Plan. Leicester is a participant in the Low Emission Strategies Peer Group Project, which arose out of Round 8 of the Beacon Status Scheme, under the theme 'Delivering Better Air Quality". This offers the prospect of optimising use of the planning system to reduce transport emissions. An emerging package will be incorporated in the LDF documentation.

2.4.3 Methodology of the 2006 AQAP

The initial exercise was developed, largely using the principles put forward in the guidance published by the National Society for Clean Air and Environmental Protection[1]. Specifically, the following steps were taken:

- Identification of suitable options – this was undertaken through a workshop with key officers of Leicester City Council and Leicestershire County Council in June 2004.
- A public consultation exercise – via questionnaire and leaflet to all residents in Leicester based upon the findings of the Review and Assessment of air quality, carried out under Section 84 of the Environment Act 1995, in 2003 (see section 2.6 for results).
- Evaluation of the options – with regard to air quality impact, cost, feasibility and timescales. This was undertaken by the project team (Leicester City Council in partnership with the AQMRC, University of the West of England, Bristol) in consultation with transport and land-use planners within Leicester City Council.
- Prioritisation of the options – this was undertaken by the same project team as above. The vast majority of the options put forward at the workshop were initially considered feasible; however, a number were screened out upon further analysis. (See Section 2.2.2).

A number of participants from different sections of the Council attended a full day's workshop in June 2004. The attendees were split into groups covering options on five key themes:

- Emissions management
- Information and education

- Managing the road network
- Promotion and provision of alternatives
- Land-use planning

The initial exercise was for groups to come up with as many actions as possible under their own group's heading. They were, as a starting point, given some actions put forward in the document 'Transport in Central Leicestershire March 2004' written as part of the DfT's *Engaging with Local Authorities* project. Following work on their own group's options, each group was given the opportunity to add to each of the other four groups' work.

A rationalised list of the options was then progressed to the next stage of the assessment. The identified options were considered qualitatively against four specific criteria. The criteria were as follows:

- air quality impact as a result of the option being implemented (i.e. air quality improvement afforded);
- cost of measure;
- feasibility or practicability of option (including the wider non-air quality impacts);
- time scale of specific option

[1] Guidance on Air Quality Action Plans can be found at: http://www.nsca.org.uk/pages/topics_and_issues/local_air_quality_management.cfm

(a) Air Quality Impact

With respect to local air quality impacts, an evaluation was made as to whether the impact is low, medium or high. The following definitions have been used as far as possible when evaluating the air quality impact of options. However, in the time available for this draft of the Action Plan, dispersion modelling was not possible. Therefore the evaluation was inevitably based on the opinion of the authors of the report, and on those consulted.

Low: *imperceptible* (a step in the right direction). Improvements cannot be detected within the uncertainties of monitoring and modelling.

Medium: *perceptible* (a demonstrable improvement in air quality). An improvement of up to 2µg/m^3 could be shown by a modelling scenario. Improvement is not likely to be shown by monitoring due to confounding factors of the weather.

High: *significant*. Improvement of more than 2 ug/m^3 can be clearly demonstrated by modelling or monitoring (A significant improvement is likely to be delivered by a package of options rather than by a single intervention).

(b) Cost

In line with then current government guidance, with respect to the cost of implementing an option, a full, formal evaluation of the costs and benefits was not undertaken, and instead a judgement was made as to whether options present low, medium or high cost levels. Low cost is taken to be <£500K, medium cost is £500K - £3 million and high cost is over £3 million. This integrates with the air quality section in the document 'Transport in Central Leicestershire' written as part of the DfT's *Engaging with Local Authorities* project.

(c) Feasibility

Feasibility is difficult to quantify, the factors which have been considered as part of this evaluation are:

- Alignment / synergies with other Leicester City Council strategic initiatives.
- Wider non-air quality impacts (social, environmental or economic).
- Stakeholder acceptance / "political" feasibility.
- Availability of enabling legislation.
- Source of funding available or possible.

Some elements of feasibility, such as being complementary to existing LCC policies, whether legal powers are available etc. have been included in the descriptions of the options. Wider (non-air quality) impacts include an option's ability to affect other environmental criteria (noise, visual amenity and climate change gas emissions) and non-environmental parameters (social and economic issues). Qualitative, rather than quantitative descriptors have been provided, following an evaluation of each option in relation to the said non-air quality impacts.

The feasibility section of the evaluation also considers whether other options need to be considered along with the option in question (or conversely some options may not require implementation). The outcomes of the workshop, which included a brief evaluation of the options, also informed the process of evaluation.

(d) Timescale

Finally, consideration was given to the time scale of options. An evaluation as to whether an option can feasibly be implemented, and therefore begin to deliver air quality improvements, in the short, medium or long-term will be made. This has implication for an individual option's ability to assist with the delivery of the national air quality objectives. In terms of timescales, Short-term relates to those measures that can be implemented now, or which are actually ongoing. Medium-term relates to those which can be set in place within the lifetime of the LTP 2006-11. These measures are listed as interventions to be taken forward under the Local Transport Plan proper. Long-term options are those which are 6+ years (i.e. those which may, following feasibility studies etc., drive the formulation of LTP3, beyond 2011).

The consolidated, summary of transport options taken forward into the 2006 LTP represented a package of realistic, medium range measures, giving best value for money outcomes for Central Leicestershire. These were mainly centred upon improving bus services and managing demand for travel by car and are set out in Section 2.4.4, below because the Air Quality Action Plan is incorporated in the LTP, the identified range of “non-transport authority” measures was also included for completeness.

In the next Section, the possible options for intervention are detailed and assessed for their suitability for implementation, in the context of the Central Leicestershire Local Transport Plan 2006-11. The material was grouped in the themes, and evaluated according to the criteria, set out in above. The scoring according to the evaluation criteria used are summarised in a table relating to each theme. The time-scales of the various options were organised in accordance with the following Table:

Table 2.4.3/1: Time Scales in the 2006 AQAP

TIME FRAME	TIMESCALE / COST	STATUS
Short Term	Low cost / short-term 2006 - 11	Small effect on air quality “A step in the right direction” Ongoing or suitable for immediate implementation.
Medium Term	Medium cost / medium-term 2006 - 2011	Measurable effect on air quality Will only achieve ‘progress’ towards objective Can be included within next round of LTP (2006 – 2011) Air quality impact to be modelled or estimated and targets set in the LTP 200611.

Long Term	High cost / long-term 2011 onwards…?	Measures achieving total effect required on air quality: Radical and long-term Not practicable within scope of LTP 200611. Feasibility studies can be initiated in short / medium term as actions within Air Quality Action Planning (2005 or subsequent rounds): • Definition/Scoping of measures • Testing for stakeholder acceptability • Identification of funding source City Centre Access Strategy (CCAS)

A matrix explaining the summary ratings under each criterion, in the theme tables is given below. The measures then selected as being appropriate for inclusion in the 2006 Local Transport Plan according to the stated criteria are summarised in Section, with cross-references to the main Local Transport Plan.

Table2.4.3/2: Assessment Matrix Used in 2006 AQAP

HEADING	KEY TO DESCRIPTION / RATING
1. Measure	Brief description of interventions discussed in Section 2.3.
2. LTP reference	Paragraph reference in main Local Transport Plan 2006-11 document.
3. Programme	L = Local Transport Plan 2006-11. E = Environmental Health or Environment Unit programme.
4. Air Quality Impact	See Section 2.2 1 = LOW (a step in the right direction but difficult to quantify / measure.) 2 = MEDIUM (capable of being modelled but year-on-year measurement difficult due to weather variations, etc.) 3 = HIGH (Improvement > 2 microgrammes per cubic metre (annual mean NO2) clearly demonstrable by modelling.)
5. Adverse wider impacts	√ = Not significant enough to contraindicate implementation. X = Significant enough to contraindicate implementation. Relevant factors: (S) = Social (Ec) = Economic (Env) = Non-air quality environmental impacts.
6. Feasibility barriers	√ = Not significant enough to contraindicate implementation X = Significant enough to contraindicate implementation Relevant factors: L = Legal – lack of available statutory powers etc. F = Funding – non-availability of suitable source of funding P = Political – not politically acceptable at the present time. Q = Questionable efficacy or necessity in the context of Leicester.
7. Cost	See Section 2.2 3 = LOW (< £500 k.) 2 = MEDIUM (£500 k. - £3 m.) 1 = HIGH (> £3 m.) (NB: 'Low' has high rating and vice versa, to permit cost-benefit estimation). Other relevant factors: Benefits relating to other Shared Priorities etc. within the LTP which are sufficient to justify all, or a significant part, of the cost of the intervention: C = Congestion S = Road safety A = Accessibility H = Health SI = Social inclusion Significant benefits in these areas may result in an enhanced cost-benefit ranking (9), indicated by (+)
8. Cost-benefit rating	The product of (4) (air quality impact) and (7) (cost), above. (1= poor; 9 = good).
9. Cost-benefit ranking	Adjusted for other factors, synthesising (6) (feasibility), (7) (non-air quality benefits and (8) (cost benefit rating), together with an element of professional judgement. 0 = Zero: Costs completely disproportionate to any air quality benefits. 1 = Poor: Low priority. 2 = Medium: Consider implementation after higher ranked options. 3 = Good: Continuation or immediate implementation indicated.
10. Time-base	The time frame assigned for implementation of the measure. (See Table 2.2.3/1) O = Ongoing, with continuation / enhancement in LTP 2006-11 L = Within LTP 2006-11 (see appropriate section). X = Possible implementation beyond lifetime of LTP 2006-11, e.g. under City Centre Access Strategy. N = Never: Implementation unlikely at any time, due to overriding considerations of non-feasibility, disproportionate costs to benefits etc.
11. Indicator	The reference of any intermediate indicator used to assess progress along set trajectories to air quality targets. (See Section 3.7).

Table 2.4.3/3: Emissions Management - Options

MEASURE	LTP ref.	Programme	AQ impact	Adverse wider impacts	Feasibility Barriers	Cost	COBA rating	COBA ranking	Time base
Roadside emissions testing (statutory and voluntary)	Non-LTP	E	1	√ (S)	-	3	3	3	O
Campaigns to eliminate old / poorly maintained vehicles	22.4	L	2	√ (S)	-	2	4	2	L ?
Low Emission Zones	22.14	NIL	2	X (Ec)	X (Ec)	1	2	0	X
Control of vehicle size in City centre – Freight Hubs	22.6	L	2	√ (Ec)	√ (Ec)	1	2	2	X
Diverting through / heavy traffic from the Inner Ring Road	22.6	L	3	-	-	2	6	3	X
Minimum emission standards for buses	22.6	L	3	√ (Ec)	√ (Ec)	2	6	3	O
City Council vehicle fleet policy (new procurement and retrofit)	Non-LTP	E	3	-	√ (Ec)	2	6	3	O
Parterships / advice for other fleet operators	9.9 22.4	L	1	-	-	3	3	3	O
Promotion of alternative fuels	Non-LTP	L	1	-	-	3	3	2	O

Table 2.4.3/4: Information and Education - Options

MEASURE	LTP ref.	Programme	AQ impact	Adverse wider impacts	Feasibility Barriers	Cost	COBA rating	COBA ranking	Time base
Campaigns to influence driver behaviour	20 22 5	L, E	1	-	-	3 (S, H)	3+	3	O, L
Real time air quality information (VMS)		L	1	-	-	3	3	3	L ?
Education on air quality and health / sustainability	Non-LTP	E	1 (-2)	-	-	3 (SI)	3 – 6+	3	O, L
Website	Non-LTP	E	1	-	-	3	3	3	O
Promoting car free days	14.48	E	1	-	-	3	3	2	L
School curriculum and campaigns	6.5	E	1 (-2)	-	-	3 (H, SI)	3 – 6+	3	O, L

Table 2.4.3/5: Managing the Highway Network - Options

MEASURE	LTP ref.	Programme	AQ impact	Adverse wider impacts	Feasibility Barriers	Cost	COBA rating	COBA ranking	Time base
Parking restrictions / costs	14.37 14.45	L	2	√ (Ec)	-	-ve: Income (C, A)	6 +	3	O
Reallocation of road space	14.21 ff. 14.38 22.3	L	2	-	√ (P)	1 (C, A)	2+++	3	L
Enforcing speed limits / access restrictions	20.9 20.32 – 34 20.35	L	2	-	Policing	2 (S)	4+	3	L
Traffic calming and diverting rat runs	20.10	L	1 (-ve?)	-	-	2 (S)	3+	3	L
City centre and other 20 mph zones	20.9	L	2	-	-	3 (S)	6	3	L
Signing and route guidance (VMS)	14.28 14.43 18.57	L	1	-	-	2 (A)	1++	2++	L
Management of congestion from road works and events	14.49 ff.	L	2	-	-	2 (C)	4+	2	L
Junction improvements	14.41	L	2	-	-	1 (C, S, A)	2+++	2	L
Signalling improvements	14.26 14.39	L	1	-	-	2 (C, S)	2+	2	L

Table 2.4.3/6: Promotion and Provision of Alternatives - Options

MEASURE	LTP ref.	Programme	AQ impact	Adverse wider impacts	Feasibility Barriers	Cost	COBA rating	COBA ranking	Time base
Park and ride schemes	14.30 22.3	L	3	-	-	1 (C, A)	3+	3	L
Public transport information	14.27 18.12	L	2	-	-	2 (A, SI)	4+	3	O
Improved buses	14.17 18.7, 18.56	L	1 - 2	-	-	1 – 2 (A, SI)	1-4	3	O
Subsidised bus fares	18.6	L	2 - 3	-	√ (F)	1 (A, SI)	2 - 3	2	L ?
Improved bus facilities and circulation	14.29 18.9	L	2	-	-	1 (A, SI)	2	3	L
Commissioning additional bus services	18.1 – 6 18.50	L	1 - 2	-	√ (F)	1 (A, SI)	1 - 2	2	L ?
Off bus ticketing	14.36	L	1 - 2	-	-	3 (C)	3 - 6	3	O
Quality bus contracts	14.13	-	1 - 2	-	X (F)	1	1	0	X ?
Electric / guided buses and trams	14.7	-	1 - 2	X (Ec)	X (F, Q)	1	1	0	X / N ?
Travel Planning	14.44 18.51	L, E	1 - 2	-	-	3 (C)	3 – 6+	3	L
Council home working and flexible hours	14.44	E	1 - 2	-	-	3	3 – 6+	3	O
Safer routes to school	14.44	L	2	-	-	3 (A, H, SI)	6+	3	O
Cycling – promotion and facilitation	14.47 18.37 ff.	L	1		-	2 (A, H)	2+++	3	O
Walking – promotion and facilitation	14.47 18.44 ff.	L	1 - 2		-	2 (A, H)	2 – 4++	3	O

Table 2.4.3/7: Beyond 2011 - Options

Measure	LTP ref.	Programme	AQ impact	Adverse wider impacts	Feasibility Barriers*	Cost	COBA rating	COBA ranking	Time base
Potential Projects									
Trams and Electric / guided buses	14.7	NIL	1 - 2	X (Ec)	X (F, Q)	1	1	0	X / N ?
Road pricing (local initiative) (NB: Government is introducing a national scheme for lorries by 2008)	14.8 – 10 22.16	NIL	3	X (S, Ec)	X (L, F, P, Q)	1 (C)	3+	0	N
Workplace parking levy	14.11 22.13	NIL	2 - 3	X (S, Ec)	X (L, F, P, Q)	2 (C)	4 – 6+	1	X
Quality bus contracts	14.13 22.17	NIL	1 - 2	-	X (F)	1	1	0	X ?
Studies									
Leicester City Centre Access Strategy studies**	26.2	Traffic	3	? (S, Ec)	√ (L, F, P, Q)	3 (C, A)	9	3	L
Transport Innovation Fund bid	26.2	Traffic	3	?	√ (P, Q)	3 (Govt. funded?)	9	3	L

2.4.4 Options and Strategies Carried Forward to CLLTP 2006-11

Table 2.4.4/1: Programme Proposed: Local Transport Plan 2006-11
(Major schemes in bold type)

Measure	LTP-3 Assessment Reference Number	Programme Status	Remarks
Emissions Management			
Eliminating polluting vehicles	30	Not yet assigned.	Dependent on outcome of Government study
Freight hubs etc.	34	Ongoing LTP Air Quality	Voluntary co-operation by operators.
Diverting through traffic from the Inner Ring Road	12	No substantial progress	Improved signing.
Minimum emissions standards for buses	27	Ongoing – Euro Standards	Quality Bus Partnership.
Partnerships with other fleet operators	34	LTP Air Quality	Freight Quality Partnership
Information and Education			
Real time air quality / route information (VMS)	12	LTP Congestion Strategy	
Managing the Highway Network			
Reallocation of road space	15	LTP Congestion Strategy	Associated with general improvement in facilities: "Quality Bus Corridors"
Signing and route guidance (VMS)	12	LTP Congestion Strategy	Already provided for car parks. Network information to be added
Management of congestion from works / events	19	LTP Congestion Strategy	Traffic Management Act 2004
Junction improvements	28, 33	LTP Congestion Strategy	See Section 2.6 for details of schemes
Signalling improvements	20	LTP Congestion Strategy	Optimise existing SCOOT system. Includes SVD for buses
Parking restrictions / costs	21	LTP Congestion Strategy	More effective enforcement via Decriminalised Parking Enforcement
Enforcing speed limits / access restrictions	24	LTP Safety Strategy	Review of speed limits DfT guidance awaited
Traffic calming / diverting rat runs	24	LTP Safety Strategy	18 residential distributor roads and 15 areas on current priority list
City centre and other 20 mph zones	24	LTP Congestion Strategy	Review of speed limits DfT guidance awaited

C't'd

Measure	LTP-3 Assessment Reference Number	Programme Status	Remarks

Promotion and Provision of Alternatives			
Park and ride schemes	18	LTP Congestion Strategy: Towards end of period	Development of one further site in lifetime of LTP 2006-11?
Travel planning	1	Late LTP LTP Congestion Strategy	Council corporate scheme under development in 2005. Planning process will require for all commercial development. 100% of schools to be covered by 2011. Will contribute 5% reduction in peak commuter travel by 2011
Public transport information	26	Ongoing. LTP Congestion Strategy	StarTrak and StarText
Improved buses	27	Ongoing LTP Congestion Strategy	Quality Bus Partnership. Continued investment.
Subsidised bus fares	27	Ongoing. LTP Accessibility Strategy	Concessionary fares; 'Travel Aid' Scheme
Improved bus facilities and circulation	25	LTP Congestion Strategy	Quality Bus Partnership. Bus shelters
Commissioning additional bus services	27	Not yet assigned - LTP Accessibililty Strategy	Dependent on new funding streams, e.g. from DPE
Off bus ticketing / zonal fares	16	Not yet assigned - LTP LTP-2 Congestion Strategy	Via Quality Bus Partnership. Programme driven by roll-out of Quality Bus Corridors.
Safer routes to school	1	Ongoing. LTP Safer Roads Strategy	Safety, health and social inclusion benefits.
Cycling – promotion	2	Ongoing. LTP Congestion / Accessibility Strategies	Healthy and flexible mode of transport. Campaign of marketing and promotion in LTP-2. Extension of current 60 mile signed cycle route network. Current low numbers cycling mean that a substantial increase wlll only have a small effect on congestion.
Walking – promotion	2	Ongoing. LTP Congestion / Accessibility Strategies	Health / Social Inclusion benefits Campaign of marketing and promotion in LTP-2. Walking often an element in longer journeys: Improvement in walking routes/facilities programmed.

Table 2.4.4/2: Proposed Programme: "Non-LTP" Measures

Measure	LTP-3 Assessment Reference Number	Programme Status	Remarks
Emissions Management			
Roadside emissions management / control	30	No progress due to non-availability of resources.	Not self-funding and has to be met from existing resources / policing issues:-Statutory / voluntary emissions testing. Survey of efficacy of voluntary arrangement with Bus Operators to shut off engines when stationary – enforcement programme, if justified.
Council vehicle fleet policy	30	Council EMAS programme (Under periodic review by Environment Unit).	Progress will occur naturally with introduction of Euro IV vehicles. Progress with radical options / retrofit of existing vehicles unlikely within LTP 2006 timescale but serious cost implications.
Promotion of alternative fuels	30	Council EMAS programme (Under periodic review by Environment Unit).	City Council can influence by example. 5% biodiesel blend in use in Council vehicles. Pilots with battery vehicles, hybrids and alternative internal combustion fuels undertaken or in progress.
Information and Education			
Campaigns to influence driver behaviour	2	No progress due to non-availability of resources.	Target driving style, speed, short / unnecessary journeys. Emphasise economic benefits to driver.
Education on air quality and health / sustainability	2	No progress due to non-availability of resources.	Implications for air quality and health: • AQMA • Road users. Sustainability and Climate Change Issues.
Websites	2	Air quality info. website upgraded in 2010 (Pollution Control).	Periodic update of explanatory / educational text focussed on issues.
Promoting car free days	2	Periodic campaigns	
School campaigns	1	No recent progress due to non-availability of resources.	
Promotion and Provision of Alternatives			
Council home working and flexible hours	2	Some progress but needs to be extended, especially in light of accommodation issues.	Extended flexible hours in some Divisions. Provision of IT equipment for use at home with access to central servers via CITRIX software.

2.4 Vehicle Technology Options

Work is under way in Leicester City Council to evaluate and deploy alternative vehicle technologies. (It should be noted that various hybrids of available technologies also offer considerable advantages). Probably, the three most promising are tabulated below:-

Table 2.4 Vehicle Technology Options

Technology	Advantages	Disadvantages	Current Status in Leicester
Battery Electric	No emissions at point of use. Technology rapidly improving. Suitable for short range uses in polluted urban areas, i.e. Leicsester.	Short range. Requires charging points. Carbon emissions from generation depend on extent to which renewable sources of energy are used. Even using renewables, there are large transmission losses from generating station to charging point. Terraced housing creates charging problems.	Limited demonstration work undertaken. Suitable for council vehicles in car / light van applications. Bid for 'Plugged in Places' (PiP) in hand: Provision of charging points. Promotion of delivery vehicles in City Centre.
Hydrogen Fuel Cell	Zero harmful emissions at point of use. Technology rapidly developing.	Needs specialised refuelling facilities. Needs supply of hydrogen. Hydrogen prone to leak – careful design needed.	Letter of understanding signed by Leicester City Council to pilot 30 cars in 2012. Suitable for council vehicles in car / light van applications.
Biomethane	Highly carbon-negative.	Engine technology very similar to other internal	Government funding available but long-term

	NOx and Particulate (Air Quality) emissions better than for diesel. Can be manufactured from waste by anaerobic digestion. Simultaneously solves difficult and costly waste disposal issues. Leicester City Council could theoretically manufacture from own waste arisings. Mature technology, used in many countries and increasingly in the UK. Manufacturing technology readily available. Can be sourced relatively locally. Vehicles now available from leading manufacturers on an OEM basis. Gas can be injected into and drawn from the gas grid.	combustion engines. UK fiscal and regulatory framework needs to catch up. City Council locked into a waste disposal contract which involves other processing methods. Proposal to build a large waste incinerator in the County.	future of this clearly uncertain at present. Also funding doesn't cover full costs, leaving match funding to be found by Leicester City Council. Refuelling infrastructure available locally. Suitable for light council vehicles in car / light van applications and in medium / heavy applications

2.5 Land Use Planning and Regeneration Options

2.5.1 Potential Synergies and Conflicts with LAQM

Land-use planning frameworks extend over a much longer time-scale than that laid down in the current air quality objectives for nitrogen dioxide. The built environment turns over by approximately one percent each year. Although this may sound insignificant, planning is responsible for gradually re-shaping the City of Leicester, so can have profound implications for managing local air quality in the longer-term.

As with any unitary authority, land-use planning in Leicester operates at a number of different levels, from strategic policies set out in the LDF Core Strategy, through SPD's amplifying these, down to the day-to-day application of those policies in Development Control process. All have the potential to impact upon local air quality over various temporal scales.

The local planning process is a local decision-making process requiring the consideration of often mutually incompatible environmental and socio-economic factors, taking into account the overall vision of what Leicester is going to be in years to come. In this sense, the interface between Planning and Local Air Quality Management (LAQM) needs to be positively managed at the corporate level.

The Local Development Framework ensure that all significant developments are assessed for transport impact and appropriate conditions or legal agreements applied in order to secure appropriate provision. In particular, planning policies are in place to restrict parking provision for new development.

There will be many situations in which air quality considerations will parallel those relating to noise.

Proposals for residential development in close proximity to major roads need to be assessed in terms of the noise exposure categories laid down in Planning Policy Guidance PPG 24, *Planning and Noise*. In an analogous way, noise considerations may reinforce air quality indications for:

Refusal
Redesign/rearrangement, or
Introduction of engineering protection measures.

The EC Directive, "*…Relating to the Assessment and Management of Environmental Noise"* [COM (2000) 468] has been introduced into UK legislation with the requirement for urban agglomerations with more than 250,000 inhabitants to carry out noise mapping.

The noise maps have been published and, in a parallel with Air Quality Management Areas, may form the basis for local, remedial action plans.

Again, it is likely that this process will be complementary to Local Air Quality Management, inasmuch as similar kinds of developments will be affected in many cases, especially close to major roads. Also, similar protective measures may apply.

A number of potential conflicts between land-use planning and LAQM can be identified. Some examples are outlined below.

While it has been severely damped down by the current economic recession, the ongoing regeneration of the City centre has led to a burgeoning of new-build and converted residential accommodation. This is taking place in one of the areas encompassed within the Air Quality Management Area (AQMA) and so has the potential to expose residents to nitrogen dioxide exceedences. Care will therefore need to be taken with some proposals in terms of the positioning and arrangement of buildings and their internal design.

While the short-term effect is to increase exposure, in the longer term benefits may be derived from reduced need to travel into the City centre.

Proposals for City centre development and the revitalisation of economic activity, for example the Highcross shopping centre, opened in 2008 and New Business Quarter Office Core Redevelopment scheme, include extensive car parking facilities, and may attract a significant number of additional journeys. In other policy areas, the strategic aim is to reduce (rather than increase) the number of car journeys made into Leicester, with the aim of, *inter alia,* reducing levels of pollution.

In order to meet increasing renewable energy obligations under the City Council's planning policies, developers may opt for plant which burns woody biomass fuels, with potential implications for increased air quality emissions, particularly particulates. These have the potential to aggravate situations where vehicle emissions are already elevated, particularly in the City centre.

As the city evolves over time, there will inevitably be conflicts and trade-offs between different requirements and priorities. The environment must be safeguarded and enhanced but not at the expense of economic or social vitality, an issue of particular significance in the City centre.

The key point is that these conflicts are addressed openly. The inclusion of, perhaps temporary, trade-offs against air quality in the Air Quality Action Plan is acceptable, provided these are first considered in a coherent way and at an appropriate level. In this way, they become an integral part of the AQAP, provided that they are identified, addressed and justified.

Possible, hierarchical decision processes in relation to proposed development which might adversely affect, and which might be adversely affected by, poor air quality are as follows:-

Table 2.5.1/1

Factors Relevant to Developments likely to have an Adverse Effect on Air Quality:
The strategic, economic and social benefits of the proposal. The location of the proposal in relation to housing and other sensitive development. The potential of the proposal to generate emissions from fixed plant. The potential of the proposal to generate or redistribute traffic within the Air Quality Management Area or elsewhere. The traffic, pollution or other environmental information which it is appropriate to request from the developer. The possibilities of linking the development to transport modal shift or improvements in public transport. The possibility of securing relevant improvements through the negotiation of Section 106 agreements, and their future equivalents.

Table 2.5.1/2 Factors Relevant to Developments likely to be Adversely Affected by Air Quality:

In recommending approval or refusal:-

The economic and social benefits of the development in relation to the City Council's strategic planning objectives.

The availability of alternative locations for the proposal and/or the existence of preferred uses for the site of interest.

The extent to which the operation of the Air Quality Action Plan will effect a significant improvement in air quality within the area of interest and over what timescale.

The existence of other contraindications to the development, such as an adverse noise exposure category under PPG 24.

> Within this framework, if development is not excluded, careful attention should be paid to design. The following matters should be considered in descending order of preference/scale. These matters are relevant both in giving advance guidance to prospective developers and in seeking the modification of unacceptable applications.

On a large scale, guidance on, for example, PDA's should be framed so that sensitive uses are positioned in the most non-polluted zones of the area.

Consideration might be given to the co-ordination of a large scheme with measures designed to achieve local improvement in air quality, e.g. traffic re-routing, traffic calming, pedestrianisation.

On the scale of individual mixed developments, the arrangement of buildings/uses within the site should similarly be considered.

The establishment of a buffer zone should be considered, to separate areas of relevant exposure from the highway. This might only need to be a few metres wide and could be used to enhance amenity through the use of landscaping, or simply through more open layout. In very polluted areas, consideration may need to be given to treating even retail, leisure, industrial or office facilities in this way.

Consideration should be given to the orientation and internal layout of buildings: Habitable rooms might be placed away from the elevation fronting onto a major road. Similarly placement of such accommodation on the ground floor might be avoided, in favour of, e.g., retailing or residents' garaging.

Engineering solutions such as double-glazed, non-opening windows and mechanical ventilation may be feasible: However, these should only be considered as a last resort, where the scheme is desirable in the overall policy context but other measures are impracticable, and the only other option would be refusal.

Air Quality Action Plan – Planning draft text

2.5.2 Local Development Framework - Planning Policies and SPD's relevant to Air Quality

Local Development Framework policy is provided by the Core Strategy, saved policies of the City of Leicester Local Plan and Supplementary Planning Documents.

Core Strategy
Leicester's Local Development Framework (LDF) Core Strategy sets out the vision, objectives and spatial strategy for the City to 2026. It identifies a need for 25,600 new homes between 2006 and 2026. The Core Strategy was adopted by the Council in November 2010.

The LTP has been prepared in parallel with the Core Strategy and they have influenced each other to ensure that sustainable transport infrastructure is delivered to support new housing. Growth Fund monies have supported transport modelling to ensure that the most sustainable locations are chosen for new developments and appropriate transport interventions identified. Masterplanning of new developments will ensure that sustainable transport infrastructure is provided from the start.

The Core Strategy seeks to ensure that development reduces the scale and impact of future climate change and promotes the prudent use of resources and reduced energy use. It recognises the importance of treating air quality and climate change in an integrated way.

The following Core Strategy (CS) policies are relevant to local transport planning, in the context of Local Air Quality Management:

CS POLICY 1. LOCATION OF DEVELOPMENT sets the spatial strategy for development. In respect of transport it states that residential, employment and City Centre growth will be supported by investment in an efficient and integrated public transport network and alternatives to using the car. This will focus on movement within the City, travel to work routes and links to London and other important centres, to include:
Quality public transport corridors;
Park and ride;
Rail links;
Walking and cycling networks to provide links to key facilities; and
Investigating the feasibility of a tram network.

CS POLICY 2. ADDRESSING CLIMATE CHANGE AND FLOOD RISK seeks to ensure developments mitigate and adapt to climate change and reduce greenhouse gas emissions. It states: "Development should ensure a shift to the use of sustainable low emission transport to minimise the impact of vehicle emissions on air quality, particularly in Air Quality Management Areas. Development will be located where it is accessible by sustainable transport to support the use of public transport, walking and cycling as an alternative to the car. Higher density development will be located in areas with easy access to local facilities to reduce the need to travel.”

CS Policy 2 also seeks to ensure that best practice energy efficiency and sustainable construction methods are used, along with Combined Heat and Power, where feasible, to reduce greenhouse gas emissions.

Paragraph 4.3.16 of the supporting text to the policy states ‘Progressive carbon reduction targets will be applied with the aim of achieving local and national targets for zero carbon emissions. In policy terms, there is a large overlap both in causes and potential solutions between air quality and climate change, enabling ‘win-win’ solutions to be identified.’

CS POLICY 3. DESIGNING QUALITY PLACES sets design objectives for new development. The section on Connections, Movement and Inclusive Access includes the following requirements:
Improve access, connectivity and permeability within and through the development site and the wider area, whilst recognising and catering for the need for security and privacy in new development;
Encourage walking and cycling by designing layouts that prioritise safe, well connected pedestrian and cycle routes and restrict traffic speed, and
Meet the highest standards of accessibility and inclusion, based on inclusive design principles, and the need to create ‘lifetime neighbourhoods’.

CS POLICY 5. ASHTON GREEN sets out the sustainable development principles for this area. It states that good connectivity with surrounding areas, Beaumont Leys Centre and the City Centre will be important to provide access to shopping, leisure and employment opportunities. Walking, cycling and public transport links in particular will need to be high quality. Highway and transportation infrastructure required to ensure that Ashton Green is sustainable will emerge from the transport assessment which is currently being prepared to accompany the planning application.

CS POLICY 12. CITY CENTRE makes the City Centre the focus of public transport initiatives through:
New City Centre bus termini and routing strategy;
Improving bus interchange facilities;
Contributing towards City Centre Park and Ride bus stop facilities;
Continuing our partnership work with the rail industry to improve interchange at the railway station, particularly with infrastructure, information and through ticketing for bus to rail interchange; and
Reducing the separation of the railway station from the City Centre.

CS POLICY 14. THE TRANSPORT NETWORK requires development to be easily accessible to all future users, including those with limited mobility, both from within the City and the wider sub region. It should be accessible by alternative means of travel to the car, promoting sustainable modes of transport such as public transport, cycling and walking and be located to minimise the need to travel.

The Council will work with partners to develop and maintain a Transport Network that will maximise accessibility, manage congestion and air quality, and accommodate the impacts of new development. The policy then sets out the transport infrastructure required to achieve this network.

CS POLICY 15. MANAGING DEMAND FOR CAR USE sets out a range of transport policy measures that will meet the key aim of reducing Leicester's contribution to climate change and provide opportunities to manage congestion on the City roads.

Saved Local Plan policies
The City of Leicester Local Plan was adopted in 2006. Under the provisions of the 2004 Planning and Compulsory Purchase Act 2004 certain local plan policies are saved within the LDF. The following Local Plan policies are relevant to local transport planning, in the context of Local Air Quality Management:

PS10. RESIDENTIAL AMENITY lists the factors to taken into account when considering the amenity of existing or proposed residents. They include the impact of noise, light, vibrations, small and air pollution (individually or cumulatively) cause by the development and its use.

PS11. PROTECTION FROM POLLUTION establishes the principles for considering the effects of pollution as follows:
"Proposals which have the potential to pollute air, ground or water by reason of noise, dust, vibration, smell, light, heat, radiation or toxic discharge will not be permitted unless the health and amenity of users, neighbours and the wider environment can be assured.
Proposals that occur within or which would significantly affect Air Quality Management Areas (shown on Map 03) will be scrutinised closely. In such areas, the aims and requirements of any Air Quality Action Plans will be taken into consideration and proposals only allowed where they do not affect the fulfilment of the Plan.
Proposals that are sensitive to pollution will not be permitted close to existing polluting uses, unless by so doing developers can demonstrate that adequate measures have been taken to prevent or minimise the impact of pollution.
Proposals associated with alternative fuels and technology (such as refuelling and recharging infrastructure) will be supported."

BE16. RENEWABLE ENERGY **requires all major developments to provide an assessment of how they will contribute towards the regional targets for renewable energy. Planning permission will only be granted for major developments that realise their potential for meeting their energy requirements from renewable sources.**

Supplementary Planning Documents
a) Climate Change SPD
The Climate Change SPD supplements Core Strategy Policy 2 and contains information and guidance on sustainable development. It was adopted in January 2011.

It states that developers should be mindful of the large percentage of carbon emissions that result from transport and suggests they should plan to minimise the need for occupants to use their own transport and increase the facilities for low carbon transport such as electric vehicles.

b) Energy Efficiency and Renewable Energy SPD
The Energy Efficiency and Renewable Energy SPD was adopted in 2005 and updated in 2008. It provides guidance on the implementation of Policy BE16. It identifies access and movement measures that contribute to energy efficient cities and measures such as travel plans that can influence energy efficient behaviour.

2.5.3 LESDP NBQ project
Description of Project

Under the UK Low Emission Strategies initiative, DEFRA funding has been made available to develop planning policies which will reduce air quality and climate emissions from the transport sector. The following is an outline of the project:

Leicester City Council took part in Phase 1 of the Low Emission Strategies Programme as a Peer Group Member. The LES Programme assisted Leicester in organising a key officer low emission strategies workshop and also presented to the wider Leicestershire Sustainability Forum on low emission fuels and technologies.

The following project plan provides detail as to the project, as outlined by Leicester, and also information relating to proposed options for the Low Emission Strategies Programme to undertake the work in question.

An area of Leicester City Centre has been earmarked for urban regeneration as a New Business Quarter (NBQ). Leicester CC would like the LES programme to develop a strategy/toolkit for implementing and promoting LES within the scheme development.

In discussing quantitative approaches it was recognised that the resource available would not allow for a robust appraisal of a complex city centre development, however, mindful of the LES Toolkit development timelines, the possibility to undertake some rudimentary analysis with the Toolkit may be possible at a later stage when the Toolkit is available. This analysis, if conducted, would be additional to the project as outlined.

Proposed Project Methodology and Outputs, including Options for Quantitative Analysis. The following methodology was devised to undertake the Leicester City Council project. Key project outputs are stated:

Toolkit for Assessment of Transport Impacts of Developments
LES Guidance
City Centre Parking Strategy SPD

2.5.4 Summary of Options [> 2.10]

a) Application of LDF Policies

b) Application of relevant SPD's

c) Application of Emissions Toolkit

2.6 Pollution from Static Sources

It has been demonstrated in successive Air Quality Reviews and Assessments that emission of Nitrogen dioxide from fixed installations comprises a relatively insignificant proportion of the emissions inventory and does not, of itself cause predicted failures to comply with the relevant air quality Objectives. The key issue in that respect is nitrogen dioxide from traffic, concentrating in close proximity to the point of emission or formation, i.e. the major road network.

There are no major sources of nitrogen dioxide within Leicester, to which regulatory emission limits are applied under the Environmental Permitting Regulations regime. Combustion plant tends to be subject to regulatory activity when problems occur, e.g. a dark smoke or other emission giving rise to complaint. Activity relating to combustion emissions is more associated with energy efficiency. This is mainly aimed at emissions of carbon dioxide, although reductions in fuel consumption and improved plant efficiency will have a beneficial effect on the background nitrogen dioxide levels.

However, nitrogen dioxide resulting from stationary combustion sources is a significant component of the emissions inventory used for predictive dispersion modelling. Therefore, whilst not significant in delivering substantial reductions in nitrogen oxides, a rigorous energy policy will lead to lower overall nitrogen oxide and resulting nitrogen dioxide concentrations locally.

> *Leicester City's Energy Strategy (Leicester City Council, 1994) sets a target for 20% of the city's energy supply to come from renewable energy sources by 2020. Leicester is developing a city-wide approach to Energy Services through an Energy Service Company (ESCO). With this approach, the Council could generate electricity in the city utilising biomass fuel oil and natural gas to provide sustainable electricity at point of use for homes, businesses and public buildings. This has the potential to make the Council 85% efficient (compared to between 30-45% with national generation). Generating electricity this way can increase pollution locally (by, for example, producing NO_2 at relatively low levels and by increasing emissions from delivery lorries). Mitigation is unlikely to be achieved without designing in the solution (such as clean-burn technologies and flue gas emissions filters)*

during the specification of the plant. It is therefore important that such policies do not conflict with the key objectives of the AQAP, which are to reduce emissions within the city.

Refer to DH / CHP project.

2.7 Noise

Noise is addressed separately in this Local Transport Plan. However, since both noise and poor air quality affect the frontages of heavily trafficked roads, similar areas tend to be affected. (Compare Fig 1.4 in this Annex (AQMA) with Fig XX in chapter 7 (DEFRA Noise Action Planning Map (Environmental Noise (England) Regulations 2006).

Traffic management measures which may benefit both noise and air quality include:-

The re-routing of traffic away from sensitive receptors;

Restrictions on the type of traffic (e.g. heavy vehicles) that can use certain roads at certain times of day;

The design and building of new roads to provide an alternative route away from noise sensitive premises.

Imposing speed restrictions directly or as a consequence of congestion management schemes.
Measures through the operation of the national, regional and local transport and land use planning system:-

For large scale projects, an Environmental Impact Assessment is required by law, which normally includes a noise impact assessment. Mitigation of adverse noise impact through planning conditions or obligations, such as optimising route alignment and the use of road barriers, either through landscaping or purpose built walls or fences, included in the design.

2.8 Investigation of Radical Options- The TRL Report

The consultants Transport Research Laboratory (TRL) were commissioned to carry out a study to examine the question, 'What measures could be put in place to meet, or go a long way towards meeting, the statutory Air Quality Objectives?'. The study report was finalised in December 2009 (Revised Air Quality Action Plan Interventions, Savage A., Turpin K., and Price J., TRL CPR 585).

TRL carried out the following steps to produce a package of interventions that could potentially be incorporated into a revised AQAP for Leicester Council. These steps are based on Defra's recommendations in its Policy Guidance

(PG(03) and PG(09)) for elements to be included in a local authority AQAP (Defra, 2003 and 2009):

- Identification and quantification of source contributions to predicted objective exceedances.
- A review of recent local documents, policies and best practices.
- An initial assessment of potential interventions, and prioritisation of interventions for use in Leicester
- Consultation of interventions (a stakeholders workshop involving key disciplines was held and options evaluated and ranked).
- Detailed assessment and quantification of preferred interventions.
- Identification of a package of interventions for potential inclusion in a draft revised Air Quality Action Plan.

This approach represents a systematic, quantitative and evidence-based attempt to identify and evaluate the type and scale of interventions needed to address the shortfall in compliance with the Air Quality Objectives. Equally significantly, it examined and explicitly rejected a wide range of options before proposing an integrated package of measures.

Conversely, it was by no means apparent that the political, legal and financial conditions were in place to render the proposals in the study feasible; the situation is now, if anything, subject to greater constraints than when the study was reported. It cannot therefore be represented as a serious short-term manifesto for the current Local Transport Plan.

However the current DfT Guidance on Local Transport Planning sets out two distinct components –

Strategy;

Delivery.

While the former should clearly inform the detailed schemes and funding arrangements for the latter, it also sets the direction of travel for policy in the longer term.

2.8.1 Purpose of Report

This report considers how the Council could consider more radical interventions over a longer timescale, to take forward into LTP-3. The starting point of the study was a review of the existing Air Quality Action Plan (CLLTP 2006-11, Annex 11). The following is taken from the Introduction:-

"'Leicester City Council's current Air Quality Action Plan (AQAP) was produced in 2004 and is integrated into the second Central Leicestershire Local Transport Plan (LTP2) 2006-2011 (Leicester City Council, 2006). The

AQAP includes interventions funded through the LTP and non-infrastructure interventions outside of the LTP funding framework. Leicester City Council considers that its current AQAP is out of date and is insufficiently robust to allow significant progress towards the UK Air Quality Strategy (AQS) objectives, even with full implementation of the packages proposed in the current plan.

This report sets out the findings of a study carried out by TRL to examine a range of potential interventions that could be included in a revised AQAP. TRL has considered all existing interventions in current policies that are still relevant to take forward as well as some that have not been previously considered. These interventions have been consulted on with Leicester City Council and the impacts of those given the highest priority have been quantitatively assessed to provide evidence on the effectiveness of the interventions in terms of improving air quality. This report provides recommendations for a package of complementary interventions, with guidance on timescales and any barriers or constraints which need to be resolved.

It is considered essential that interventions to include in a revised AQAP are fully quantified and should be coordinated with other strategies and policies that are under active development. The AQAP feeds into a range of relevant documents produced by the Council, including the next round of Local Transport Planning (LTP3), the developing Climate Change Strategy, the Local Development Framework (LDF) and corporate One Leicester strategy. Recommendations for how to integrate the proposed interventions with future policies are provided in this report."

The Council has considered a number of interventions in the long term (beyond 2011) which have so far not been rejected. These include introducing a freight hub, Low Emission Zone (LEZ) and diverting traffic from the Inner Ring Road (IRR). The Central Leicestershire Local Transport Plan (LTP) (Leicestershire County Council and Leicester City Council, 2006) outlines a number of potential conflicts between land-use planning and LAQM, such as the ongoing regeneration of the city centre which has led to an increase in new-build and converted residential accommodation; proposals for city centre development (including the extension of the Shires shopping centre) and the City Centre Access Strategy, which is intended to consider the impacts of regeneration. However, as mentioned previously it is likely that for the LTP3, these more radical interventions and interventions will need to be considered to move towards meeting the NO_2 AQS objective.

2.8.2 Experience from other Cities

Introduction

This Section summarises the findings of relevant guidance and Air Quality Action Plans that have been produced by other UK cities to identify examples of best practice and potential interventions that could be transferred to Leicester.

The Environment Act 1995 requires Local Authorities to undertake Local Air Quality Management (LAQM) duties. Local Authorities must have regard to guidance issued by the Secretary of State when carrying out these duties (Defra, 2009). The most recent policy guidance (PG(09)) was released in February 2009 (Defra, 2009). This provides an overview of the process of preparing an Action Plan, including quantification of sources, consideration and evaluation of interventions and consultation. Defra has also produced practice guidance in conjunction with PG(09) for Local Authorities to use as information tools if they are considering establishing one of the schemes covered by the guidance. Practice guidance has been produced on, for example, economic principles for the assessment of local interventions to improve air quality, Low Emission Zones (LEZs), and interventions to encourage the uptake of low emission vehicles and retro-fitted abatement equipment on vehicles (Defra, 2009b, c, d). Other generalised documents, including the National Society of Clean Air (NSCA) guidance (NSCA, 2001) on Action Plans were consulted to provide examples of interventions and methods of evaluation. This guidance document also provides advice on how to monitor the effectiveness of interventions once they are implemented through a series of indicators.

Local and more relevant guidance to Leicester, including examples of best practice on integrating air quality within Local Transport Plans (LTP), have been reviewed. LTPs in Greater Manchester and Tyne and Wear, as well as the Central Leicestershire LTP, are considered as examples of good practice, particularly in the way they incorporate the mandatory indicator LTP8[i]. Recent progress towards this indicator and the intermediate outcomes in Leicester is given in the annual LTP progress report (Leicestershire County Council and Leicester City Council, 2008).

Examples of Interventions from other UK cities

AQAPs vary in size and scope according to the size of the city and extent of the air quality problem. To help identify appropriate interventions for inclusion in a revised action plan for Leicester, TRL has reviewed examples of AQAPs that are recognised as providing best practice and AQAPs that have been implemented in cities that are of a similar nature and size to Leicester. A summary outlining the examples of some of the interventions used in these cities is given below. This review also considered how the Local Authorities had linked their AQAPs to wider policies such as LTPs.

Belfast

Belfast City Council's AQAP is integrated into the Belfast Metropolitan Transport Plan (BMTP) 2015 which covers the council areas of Belfast, Carrickfergus, Castlereagh, Lisburn, Newtownabbey and North Down (Belfast City Council, 2009). Belfast City Council has undertaken qualitative assessment of a range of interventions including: cycling and walking and bus initiatives; emissions reduction techniques; changes to transport policy; introduction of parking policies; highways management strategies; and education. Interventions which were considered to have a comparatively high impact on air quality (scored 7 or more out of 10) include a quality walking and cycle network linking public transport nodes and attractions; implementing Quality Bus Corridors (QBC); bus priority interventions on the M1 and M2 roads; development of park and ride schemes including rail-based schemes; ITS interventions (integrated ticketing, travel information, Variable Message Signs (VMS), UTMC); highway capacity enhancements (road widening of motorways and dual carriageways); non strategic interventions, such as new roads; traffic calming and management interventions on local roads; operation of state of the art traffic control systems (*e.g.* VMS, CCTV traffic flow monitoring or telematics to manage accidents); parking policy to maximise short-term parking, control on-street parking, better enforcement and reduced spaces; imposition of maximum parking standards for developments (opportunities for car sharing, permit based parking); and supporting and promoting travel plans (Belfast City Council, 2006).

Bristol

Bristol City Council's AQAP has been integrated into the Joint LTP for the Greater Bristol Area (Bristol City Council, 2009). Interventions considered to have the greatest potential impact on air quality (*i.e.* those that scored of 7 or more out of scale of 1-10) in Bristol include: improvement of bus services to reduce dependence on private cars; stronger enforcement of motorway speed limits; reduced motorway speed limits around the AQMAs; de-trunking the M32 to produce opportunities for emissions reductions through speed management and more efficient use of road space; provision of advice and incentives for cleaning up large vehicles (including fitting exhaust after-treatments); introduction of a low emission zone regulating entry to an area based on environmental criteria and road user charging (with charges levied to encourage cleaner vehicles) (Bristol City Council, 2004).

Nottingham

Nottingham City Council has integrated its AQAP within the LTP (Nottingham City Council, 2008). The only intervention considered by Nottingham City Council and Nottinghamshire County Council to have a high impact on air quality is to make the A60 a strategic two-way traffic route, which would allow the central core area to expand. Other interventions which would have medium effect on air quality include: a two-way bus priority route (supporting improved public transport accessibility and reliability); trams; network extensions; upgrading the A52 ring road; a new river crossing; ring road highway and parking improvements; and a high frequency ring road orbital bus service (Nottingham City Council and Nottinghamshire County Council, 2006).

Oxford

Oxford City Council's AQAP has been integrated into the LTP for 2006-2011 (Oxford City Council, 2008). Oxford City Council's AQAP has assessed a range of interventions through ongoing monitoring of criteria such as total road transport emissions, vehicle mileage, traffic flows and vehicle passenger movements within the AQMA. Interventions which are expected to have a comparatively high impact on air quality (in terms of percentage NO_X reduction) include: retrofitting all buses and coaches; use of cleaner fuels by the Council's own fleet; and introduction of a Low Emission Zone (LEZ) (for buses, LGVs and HGVs, or for all vehicles). Smaller reductions in NO_X emissions are predicted from ensuring all buses and HGVs meet Euro 3 emission standard within 2 years; cross operator ticketing (as part of the Bus Quality Partnership) and bus gate enforcement in the central area (Oxford City Council, 2006).

Sheffield

The entire urban area in Sheffield is an AQMA for NO_2. Interventions in Sheffield City Council's AQAP were included on the basis that they will contribute to improving air quality across the city and to the future regeneration of Sheffield. Interventions are categorised in a series of packages including: improvement of public transport; traffic infrastructure development; traffic control; cleaner vehicles; actions to reduce emissions from industry; and eco-efficiency and planning. Examples of specific interventions which are predicted to result in a reduction of NO_X emissions of between 1 and 10% include the introduction of a Quality Bus Corridor and major expansion of park and ride provision (Sheffield City Council, 2006). A 5% reduction (approximately) in NO_X emissions is expected to result from imposition of minimum emission standards for vehicles routinely accessing sensitive areas (*e.g.* taxis and buses using the city centre); and a reduction in NO_X between 1 and 5% is expected from the introduction of VMS to smooth traffic flows on the M1 and on surrounding link roads, and from development of a joint Action Plan between the Council and HGV operators requiring access to Tinsley and Brinsworth. A greater than 10% reduction in NO_X emissions could result from a reduction of the speed limit on the M1 (Sheffield City Council, 2006).

Applicability to Leicester

Leicester's air quality problem is essentially network-wide in its causes (Leicestershire County Council and Leicester City Council, 2006) and therefore needs solutions that target the whole of the city centre as well as radial roads. These areas have different characteristics and issues, so there will be no single intervention to result in a significant improvement in air quality across the city.

Although characteristics of other UK cities will be different to Leicester, and thus the air quality issues will vary, there are likely to be some interventions that could be transferable to Leicester. Therefore, it is useful to know what has been successful in other cities and the reasons for this success. Evidence collected from these cities on the potential emissions benefits of certain interventions (*e.g.* the potential impacts of speed limits and VMS interventions to smooth traffic flow in Sheffield) could help in assessing the effectiveness of such interventions in Leicester.

In Leicester there will be certain interventions that are perhaps more applicable to the Outer Ring Road and areas outside the centre, where for example, there may be space to build a Park and Ride facility or widen the road space to incorporate bus lanes or high occupancy vehicle lanes. Within the city centre AQMA, interventions that discourage people from driving would be more suitable, including residential controlled parking, better facilities for cycling, pedestrian-only zones and active barriers to physically prevent vehicles from entering areas, perhaps at certain times of the day. Cordon interventions, such as a low emission zone (LEZ) could operate in specified zones of the city, such as within the Outer Ring Road or just the central area.

There may be certain schemes that have been successfully implemented in other cities but may not be effective in Leicester. For example, there will be many differences to the way other cities operate their public transport systems. Nottingham, for example, has one major bus operator which makes co-ordination of timetabling and ticketing easier than it would in Leicester, which has several competing bus operators.

Wider Impacts of Interventions

Greenhouse gases

When considering interventions for inclusion in an AQAP it is practical to also consider the likely impact these may have on energy consumption in the form of carbon dioxide (CO_2) emissions. On 21st January 2008, Leicester City Council's Cabinet resolved: "The Corporate Director is to investigate and implement integration of Local Air Quality Management into the Council's Climate Change Programme to ensure that synergies and initiatives are properly managed and exploited".

Developing a local air quality strategy or including air quality management as part of a transport strategy will help Leicester to deliver services in an integrated manner. A strategy can provide over-arching principles, agreed at a high-level, that ensure co-benefits and risks are considered when implementing different policies. For example, a strategy could acknowledge co-benefits of tackling PM_{10}, NO_2 and other greenhouse gases together and acknowledge any trade-offs between air quality management, planning and transport policy. This provides a consensus on which to base the development of individual plans, such as AQAPs, ensuring that interventions are 'proofed' to avoid unintended impacts of policies in one area upon another.

It is worth noting that the 4M research programme, led jointly by Loughborough and Newcastle Universities, intends over the next 4 years to calculate the carbon footprint of Leicester by:

- Measuring the carbon released by traffic, the burning of fossil fuels in homes and places of work and the rate at which green plants and trees capture carbon and store it in the soil;
- Modelling the effects on the carbon budget from: road layouts, traffic volumes and traffic speeds, the way we use energy in our homes and places of work, and the way we look after green spaces;
- Mapping the sources and sinks of carbon for the whole city and comparing this with the social and economic well-being of its 270,000 inhabitants;
- Management studies which will investigate how to shrink the city's carbon footprint through: changing the road network and/or the provision of better public transport; alterations to the maintenance of green spaces and the treatment of waste; the use of renewable and low energy systems to provide power and light; and the operation of Individual Carbon Trading (ICT) schemes.

Clearly, in the longer term there is scope to utilise this knowledge base to evaluate or verify potential Action Plan interventions, particularly at the strategic level. The more detailed analysis of selected interventions for the work reported here will include an assessment of CO_2 emissions.

Noise pollution

Although not part of an AQAP, the implementation of interventions that improve air quality could also reduce noise pollution. Statutory Noise Mapping and associated Noise Action Plans (NAPs) are expected to come into effect sometime this decade. Many of the areas currently affected by poor air quality are also affected by noise, as road traffic is the main source. Leicester City Council should therefore consider the noise impact as part of any package of interventions included in the AQAP.

Further consideration of interventions in Leicester

Taking into account the experience from other cities and best practice, a package of interventions were considered further for their potential to be implemented in Leicester.
As well as these broader measures, there are some potential measures that will be specific to Leicester (or Leicestershire). For example, the East Midlands Regional Assembly and East Midlands Development Agency (EMRA/EMDA) recently submitted a bid to the Minister for the East Midlands, as a regional funding priority of potential measures. Many of these could have potential air quality benefits. The minister is due to respond later this year. These measures include:
A new city centre bus terminal and routing scheme, within the Inner Ring Road, with an estimated cost of £67m, to commence in 2014 if approved.

A further Park and Ride site at Glenfield, to start in 2012, subject to approval. Site identified near County Hall with a minimum of 500 spaces but 1,000 being sought. This scheme will include bus lanes on relevant corridors.
A bus station at the top of the High Street to serve the proposed Park and Ride site at Enderby. Possible additional 'mini-bus terminal' near to the railway station.

2.8.3 Methodology

Based on the evidence collected from the literature review and taking into account Leicester's existing policies, interventions successfully implemented in other cities and other examples of best practice, TRL collated a list of 23 potential interventions that were consulted on at a workshop with Council representatives from relevant teams including Environmental Pollution Control, Transport Planning and practitioners involved in the Environmental Management and Audit Scheme (EMAS). During the workshop, each intervention was discussed and assessed according to its suitability for implementation in Leicester as well as likely impact on air quality (emissions and concentrations), climate change (CO_2), cost, feasibility and timescale for implementation.

This section provides a description of each of these interventions including a summary of the evidence of their effectiveness collected from other UK cities, where available, or from research literature. The likely relevance or feasibility of introducing each measure in Leicester is also outlined.

The ranking system that was used to assess all these measures during the stakeholder workshop is shown in

Table 2.8.3. Each intervention was awarded a score of low, medium, or high for each category. An overall score was awarded using the following method: low cost, high impact = A; high cost, high impact = B; low cost, low impact = C; high cost, low impact = D.

Table 2.8.3: Intervention evaluation categories.

Emissions	Air Quality (AQ)	Noise	CO_2	Cost	Social	2011-2016
Potential to reduce emissions from road traffic	Potential to reduce pollutant concentrations	Potential to reduce ambient noise levels	Potential to reduce emissions from road traffic	Relative cost factor (in terms of the average cost to implement all interventions)	Benefit to the local population (positive, negligible, negative)	Potential for implementation during the LTP3 period

The highest scoring interventions include resident controlled parking zones (CPZs) (Score A), HGV only lanes (Score A), road cleansing (Score A/B) and driver training (Score A/B). Interventions which scored ‘B’ (high cost, high impact) include active barriers, freight hubs, low emission zones and tunnels. The following were ranked as ‘C’ (low cost, low impact): red routes, flexible working, work place parking levy, titanium oxide and trialling innovative technologies (CNG vehicles, electric vehicles, bio fuels and hybrid vehicles).

Leicester City Council considers it important to implement transport and traffic-related interventions which benefit both air quality and climate change whilst avoiding policy clashes[ii]. Examples of interventions which can be characterised as ‘win-win’ include: adopting travel plans to address issues of staff commuting to work and business mileage; local Non-Governmental Organisations (NGOs) developing their own action plans; local and government fleet renewal; and engaging schools to self-assess carbon emissions[ii].

A ranked summary of interventions was developed for further evaluation, and the air quality and carbon impacts of these was modelled using the CERC ADMS-Urban dispersion model. Full details of the modelling methods are given in Section 2.8.6.

A ranked summary of interventions discussed in the workshop is given in Table 2.8.5/2. An indication is given of those interventions requiring an input from a traffic model to evaluate the change in emissions. ‘Possible’ notation suggests that traffic may choose to re-route as a consequence of the intervention.

.8.4 Interventions Considered

Description and Evidence Gathering

Based on the evidence collected from the literature review and taking into account Leicester’s existing policies, interventions successfully implemented in other cities and other examples of best practice, TRL collated a list of 23 potential interventions that were consulted on at a workshop with Council representatives from relevant teams including Environmental Pollution Control, Transport Planning and practitioners involved in the Environmental Management and Audit Scheme (EMAS). During the workshop, each intervention was discussed and assessed according to its suitability for implementation in Leicester as well as likely impact on air quality (emissions and concentrations), climate change (CO_2), cost, feasibility and timescale for implementation.

This section provides a description of each of these interventions including a summary of the evidence of their effectiveness collected from other UK cities, where available, or from research literature. The likely relevance or feasibility of introducing each measure in Leicester is also outlined.

a) Residential controlled parking zones (CPZs)

In terms of categorising interventions, CPZs are considered to be an example of a Low Emission Vehicle (LEV) scheme. LEV schemes are frequently focussed on city and town centres where land-use is dense, traffic is heavy, population exposure is high and where AQMAs have been declared, such as Leicester. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles owing to the high population density and therefore high potential health benefits. Defra has produced guidance on implementing LEV schemes (Defra, 2009c) by means of the following examples, some of which are discussed further in this Chapter:

London Low Emission Zone schemes
Quality Bus Partnership Agreements
Voluntary schemes with economic incentives such as Car Clubs
Discounted car parking charges

Controlled parking zones (CPZs) are areas where all on-street parking is subject to restrictions and enforcement during specified hours. Designated parking bays are typically shown by white road markings and areas where parking is not allowed are marked with yellow lines. Leicester City Council has decriminalised parking offences and currently has some CPZs operating in the city centre, which are enforced by designated Council officers. However, the Council does not control all on-street parking and a much more effective method of enforcement would be needed to extend the CPZs to other areas of the city.

The benefits of an effectively enforced CPZ include:

creating more parking spaces for residents, making it easier for local people to park in the street near their home;
discouraging people from outside the area from parking in the streets within the zone;
reducing traffic and congestion on streets within the CPZ due to a reduction in vehicles searching for parking spaces;
improving access for emergency vehicles;

Keeping traffic moving freely (Torbay Council, 2007).

In Camden, controlled parking was deemed by a focus group to have improved traffic flow, in line with the aims of the Council's Parking Solutions, which were implemented to reduce and control traffic (London Borough of Camden, 2001).

Resident CPZs can be considered as a stepping stone towards other interventions, such as encouraging alternatives to private car use and increasing modal shift, assisting with the uptake of workplace and school travel plans, or as a complementary intervention to congestion charging, for example (Islington Council, no date). Furthermore, CPZs that are effectively enforced could be taken one step further in terms of issuing permits relating to vehicle emissions. At the moment most of the schemes currently being operated are geared to reducing CO_2 emissions based on vehicle excise duty bandings, but in the future parking controls may be connected with the Euro Emission Standard of the vehicle.

b) No- car lanes (NCLs)

As the name of the intervention suggests, ‘no-car lanes’ involve the allocation of road space to vehicle types other than the car. For example, lanes dedicated for use by heavy duty goods vehicles (HDVs), which can lead to reduced congestion and increased safety by limiting the interaction between cars and HDVs. Use of the lanes can be restricted to fully laden goods vehicles, allowing more reliable journey times for efficient goods movement. ‘No-car lanes’ can be subject to a charge, whereby HDV fleet operators pay a fee in order to benefit from the more reliable journey time. A potentially negative impact of ‘no-car lanes’ concerns safety issues that can arise with access ramps to the designated lanes. For example, these sometimes require passenger cars to cross HDV lanes or vice versa.

Belfast City Council (Transport Policy, 2001) piloted HDV only lanes on its highway network. Examples of ‘no-car lanes’ also exist at Newcastle, Exeter and Maidstone. A study by Newcastle University found a ‘no-car lane’ to be the best form of priority lane in terms of environmental impact (measured by fuel consumption, particulate matter, hydrocarbons, CO_2, and NO_2) (Newcastle University, 2007). The first ‘no-car lane’ on the London Strategic Road Network was introduced on the Nine Elms Lane red route in Battersea in place of a traditional bus lane (the low number of buses using the road did not justify a traditional bus lane).

In the City of Norwich there is a proposal to use Newmarket Road inbound bus lane and the bus/loading only route through Castle Meadow/Red Lion Street used by vehicles making deliveries on behalf of the Norwich freight consolidation centre (*i.e.* a 12 month experimental TRO) (Norwich Highways Agency Joint Committee, 2008). A code of conduct and on-the-job training required to ensure consolidation centre drivers are aware of specific situations that could arise through use of the bus lane. Concerns were raised that other HGVs may use the bus lane and that there would not be adequate enforcement. The consolidation centre vehicles will have side liveries to identify them and liveries on the back of the vehicles. Allowing other HDVs to use the bus lane is not the aim and if successful, the situation would remain the same as during the trial, with consolidation centre vehicles the only freight vehicles that are allowed to use the bus lane.

c) Road cleansing

Road cleansing options include the following techniques:

Road surface cleaning (various wet and dry techniques);

Vehicle wheel washing;
Dust suppressants (e.g. Calcium chloride, calcium magnesium acetate).

Evidence indicates that road sweeping, even with modern vacuum-assisted sweepers, is not a particularly effective means of reducing PM_{10} concentrations. The effects of wet cleaning tend to be localised and short-lived. However, it can be a relatively low cost method of reducing particulates and contribute to a reduction in localised exceedences, for example during summer months.

Several London boroughs have implemented a Code of Practice for Construction Sites, which can be a useful means of controlling dust emissions, especially on local roads close to the site. For example, Lambeth has a code of practice related to demolition, site clearance and preparation, construction, and maintenance and repair (London Borough of Lambeth, 2009).

Air quality issues in Leicester are mainly concerned with NO_2, with particulate emissions not of major concern. As such, this intervention may not be of particular relevance for implementation as part of a revised AQAP for Leicester. However, in some cases, it may be appropriate to use planning conditions to control aspects of a development, provided these are not covered by the pollution permit and that a land use planning consideration can be clearly distinguished. For example, planning conditions could be used in respect of specifying transport modes, the hours of operation where these may have an impact on neighbouring land use, landscaping, plant and buildings, the timescale of the operations and impacts such as noise, vibrations, odour, air pollutants and dust from certain phases of the development such as demolition and construction (ODPM, 2004). Clearly, there is scope for Leicester City planners to give higher priority to reducing PM emissions caused by development in local communities.

d) Driver training

The concept of eco-driving can be defined as a way of driving that reduces fuel consumption, greenhouse gas emissions, air and noise pollution, and accident rates. Drivers trained in eco-driving techniques can reduce fuel consumption by up to 20% (Driverskills Ltd). For example, fleet driver training has been shown to result in improved safety and more fuel efficient driving techniques. A TRL ‘cohort’ study (Reed and Parkes, 2005) into the effects of truck driver training produced the following results:

Improvements in simulator performance
11% improvement in fuel economy
22% reduction in RPM under acceleration
50% increase in torque under acceleration
Transfer of training to real world (collation of data in the week before and week after each training session)
Mean overall improvement in fuel efficiency of 15.7%
Confidence interval suggests that 95% of drivers would improve by at least 6%

Leicester City Council already has driver awareness campaigns as part of their corporate travel plan and the concept of eco-driving is something that could be effectively incorporated into these campaigns.

Camden Council is planning to introduce 'smarter driver' training to raise awareness about fuel efficient driving to its fleet staff, with the aim of reducing fuel consumption and reducing emissions. The training will use an innovative monitor which displays changes in fuel consumption and exhaust emissions as the training vehicle is driven. (London Borough of Camden, 2008).

e) Environmental zones (active control using barriers)

Rising bollards can be effective when used to enforce Traffic Regulation Orders that are time-related or restrict access of particular vehicle types (DfT, 1997). Other applications include controlling the entry of small numbers of vehicles into otherwise pedestrianised areas and ensuring that bus gates are not used by other road users (DfT, 1997). Area bans, however, tend to divert rather than restrain traffic and the overall city-wide effect on emissions is likely to be small unless the restricted area is extensive (DfT, 1996). There is a policy overlaps here, related to 'environmental zones'. Leicester City Council could consider active barriers in certain areas of the city centre, for example to prevent large HGVs accessing the centre during peak travel times or as a mechanism for charging vehicles to enter the city centre. It is plausible to consider active barriers operating on roads connecting the city centre to the Inner Ring Road. Consideration must be given to any enforcement methods which may be needed for such a scheme. Active barriers in place on Horsefair Street and Market Street in Leicester city centre currently allow access to buses, taxis and some delivery vehicles.

Cheapside in Preston is a busy pedestrian area that is also used as a road for vehicles serving the market, shops and Town Hall complex. Most of the traffic using Cheapside is cutting through from the city centre to Ringway (this is not permitted at certain times). Through effectively preventing this 'cutting through', traffic would be allowed to disperse using other more suitable roads. Installing bollards which would only be raised during times when general traffic is currently banned is a way of implementing this measure. Those who need access through the bollards at all times (such as service vehicles and blue badge holders) could be issued with a pass to control the bollard and allow access (Transport for Lancashire, 2008). Initially, installing gates with variable times of operation would allow for further consultation over an experimental period (CIVITAS, 2007).

f) Freight hubs/consolidation centres

Out of town freight depots can be used when delivery times in urban areas are restricted according to noise regulations and hours of business. Access to the freight depot can be made available on a 24 hour basis with goods held until appropriate delivery times or transferred to more suitable delivery vehicles (*e.g.* electric or CNG powered vehicles). Leicester City Council already has a freight quality partnership and has considered the feasibility of siting a freight hub as part of their LTP3 plans. The issue here is finding a suitable site with sufficient land to facilitate a freight hub. Sunningdale Industrial Park is a possible site, with reasonable access to and from the outer ring road and M1 and to the city centre via Hinckley Road.

Experience from Bristol (Bristol City Council, 2006) has found benefits of introducing a freight hub (or Urban Consolidation Centre (UCC)). This acts as a central delivery hub on the periphery of the city where deliveries are streamlined and it has achieved a reduction of 70% in vehicle trips to the city centre from the 50 retailers using the facility (FQP Resource Sheet, no date).

g) Environmental zones (passive control using cameras)

Defra recently released a good practice guide on the implementation of environmental zones (Defra, 2009b). The guidance provides information on selecting methods for implementing this intervention, practical issues that have arisen in implementing previous examples of this intervention and advice on appraising potential costs and air quality benefits of the intervention in cost-effectiveness and cost-benefit analyses. It also provides detail on existing or planned examples of these schemes. In addition, Defra published further best practice guidance on encouraging the uptake of retro-fitted abatement equipment on vehicles (Defra, 2009d). Clearly, this will need to be considered in terms of environmental zones.

Although environmental zones have been considered for several UK cities, including Edinburgh and Manchester, the only scheme to be implemented to date in the UK is the London Low Emission Zone (LEZ) which commenced on 4 February 2008. The current scheme involves the tightening of the Emissions Standard to Euro IV for particulate matter, in January 2012. The London LEZ operates 24 hours a day, 7 days a week, including weekends and public holidays and on all public roads, including certain motorways within the Greater London boundary (except the M25). The following motorways are also included: M1 south of London Gateway Services; M4 east of Junction 3; and M4 spur to Heathrow (TfL, 2008).

London's LEZ is enforced using fixed and mobile cameras which read a vehicle's registration number plate as it enters or drives within the zone.This is then checked against a database of registered vehicles which comply with the LEZ Emission Standards, are exempt from the charge, or are registered for a 100% discount. If the vehicle does not comply with the LEZ Emission Standards or qualify for an exemption or discount, the driver will be required to pay the daily charge.

In London, the following impacts resulting from the LEZ have been predicted (TfL, 2008):

2% reduction in total road traffic PM_{10} emissions by end 2008 and 6% in 2012;
NO_X reduction of 4% by end 2010 and 10% by 2012;

Small benefit for CO_2 as there has been little overall impact on traffic flows. Any benefits from newer vehicles may be offset from fitting abatement equipment (increases fuel consumption).

Other cities that are currently considering introducing an environmental zone include Oxford and Glasgow. Information on potential costs and impacts would help Leicester in the decision making process on whether to consider an Environmental Zone. For example, Oxford has undertaken a feasibility study for the introduction of an LEZ for certain streets within the AQMA (Oxford City Council, 2006). The proposed scheme targets a reduction in NO_X emissions and involves the phased introduction of standards for buses and coaches initially, followed by HGVs and then cars at a later date if necessary (Oxford City Council, 2006). Analysis of the potential impact of this scheme found that an LEZ phased in for buses and HGVs could result in a 58% reduction in NO_X emissions in streets on the bus priority route, where the greatest reduction is required (Oxford City Council, 2006).

Glasgow City Council has released its 2008 AQAP draft proposals for consultation. One of the proposed interventions involves undertaking a feasibility study with a view to introducing LEZs in Glasgow. A study comparing the potential effects of an introduction of an LEZ with a 10% and 50% reduction in the number of HGVs on roads in Glasgow found that an LEZ would be the more effective option in terms of bringing about a reduction in NO_2 (Glasgow City Council, 2008).

h) Restricted parking and waiting zones (RPWZs)

Roads or entire routes can have stopping and parking restrictions in place which can be identified by coloured lines (*e.g.* purple or red *etc*) and delivery bays. Road signs indicate the times when parking or stopping is allowed.
In the West Midlands, RPWZs are in place on the A34 in Sandwell; the Black Country route in Birmingham, Walsall and Solihull; Black Country New Road in Sandwell and Walsall; and on the A38 Tyburn Road in Birmingham (other RPWZs also exist in the region). The Solihull pilot scheme won a National Transport Award and surveys on the route have shown that congestion is reduced, journey times are more reliable and that local businesses benefit from improved deliveries and better access to the national road network (Faber Maunsell, 2008).

Walsall Council (Walsall Council, 2009) reports that the benefits of RPWZs may include:

Improved safety for pedestrians, cyclists and general traffic
Journey time reductions
Improved journey time reliability
Lower and standardised kerb heights at crossings to benefit the mobility impaired
Environmental benefits such as reduced traffic noise and fumes
Providing a more pleasant environment for pedestrians and cyclists
Positive effect on frontage businesses as it is easier for people to park legally

RPWZs could potentially be designated to the major A roads in Leicester, such as those roads into the city centre and Outer Ring Road. For a red route to be an effective means of preventing vehicles from stopping and thus causing traffic congestion, they need to be effectively enforced through camera systems or enforcement officers.

i) Flexible working (hours/location)

Flexible working describes any working pattern adapted to suit an individual's needs with regards to working time, working location and working pattern (*e.g.* teleworking). Allowing staff to work remotely can result in multiple benefits for businesses in addition to reduced environmental impact.

According to Cairnes *et al* (2004), a British Telecom case study revealed the following key issues. The case study suggests that teleworking is likely to continue to grow steadily within BT. In other organisations, it was suggested that teleworking would be likely to grow more rapidly in areas where congestion charging or a workplace parking levy were brought in. It was also suggested that legislation to encourage flexible working would increase levels of teleworking, and that a higher public profile for teleworking could also encourage take-up. Some commentators have further highlighted that companies perceive teleworking to mean 'working from home five days a week' and that a greater awareness of the potential for part-time teleworking might help to increase participation.

When considering the impact of teleworking on the number of work trips, it is also important to remember that a small number of employees who telework all or most of the time, will have a larger effect than a greater number who only telework occasionally, and therefore scaling up the effects will be more sensitive to the size of the former group.

Workplace travel plans can be effective in tackling the challenge of providing a transport system that can support the movement of people and goods whilst ensuring that impacts on the local and global environment are within acceptable bounds (DfT, 2008a). A well designed travel plan can eliminate 15% of commuter car use for a single company and produce financial benefits and productivity improvements, saving businesses and staff money and time (DfT, 2008a). Leicester City Council already operates a flexible working system for their staff as part of their Corporate Travel Plan. The Council is looking at ways to extend this policy, for example, allowing staff to work remotely at another convenient location (such as within other companies) that are closer to home.

j) Workplace parking levy (WPL)

A workplace parking levy (WPL) is a charge that is made to employers for parking spaces provided for their staff or certain types of business visitors. It aims to encourage employers to persuade their staff to look at alternative ways to travel to and from work, such as using the bus, tram, park and ride or by walking or cycling. All local authorities have the power to introduce WPL schemes under the Transport Act 2008 (OPSI, 2008). National regulations are currently in the consultation phase and these are needed before any authority can implement a WPL (the regulations are required to address the imposition of penalty charges and the adjudication of disputes) (DfT, 2008a). Given the politically sensitive nature of WPLs, they are often considered to be prime examples of interventions whereby economic concerns are considered above environmental concerns.

Nottingham is currently considering the implementation of a WPL as 70% of peak traffic in the city is estimated to be comprised of commuters (Nottingham City Council, 2009). The Chamber of Commerce has claimed that WPLs, if introduced by every Local Authority in England, will cost the national economy £3.4 billion per year. In response to this claim, Nottingham City Council stated that traffic congestion costs the national economy over £10 billion per year and in the East Midlands, the cost is £935 million per year (Nottingham City Council, 2009). A study by PricewaterhouseCoopers (2007) determined that without the WPL, vehicle flows into Nottingham City Centre are forecast to grow by 8.5% over the period 2006-2021. With the implementation of the WPL, this growth will be restrained to 6.5% (PricewaterhouseCoopers, 2007).
Leicester City Council previously considered a WPL as a measure within their existing AQAP, to apply to selected locations within the city centre. However, this proposal was rejected for political reasons as well as economic issues. It is considered possible that the introduction of a WPL would deter businesses from locating in Leicester[iii]. However, it is worth taking note of case studies where a WPL has been successful to determine whether it should be re-investigated.

It is possible to realise the benefits of WPLs indirectly via the implementation of environmental zones. For example, if a zone were to be introduced in Leicester city centre, vehicles entering the zone would be controlled via strict emissions and CO_2 entry criteria. Hence, those vehicles currently subject to WPLs would be allowed to enter the zone and park providing that they meet the entry criteria, in which case, the overall effect on the environment would be positive. Penalty charging may also be used.

k) Titanium dioxide products

NO_X-reducing paint or road surfaces contain titanium dioxide (TiO_2), which is a strong photo-catalyst that breaks down NO_X into nitrates in the presence of sunlight and water vapour. When TiO_2 is exposed to UV light in the presence of water vapour, hydroxyl radicals (OH) and a superoxide ion (O_2^{-1}) are formed. These are highly reactive chemical species and hydroxyl radicals are very strong oxidisers which will attack all kinds of organic materials including those that make up living cells (Environmental Health Perspectives, 2001). Japan's Mitsubishi Materials Corporation has developed a paving stone ('Noxer') that uses the catalytic properties of TiO_2 to remove NO_X from the air, breaking it down into more environmentally benign substances that can then be washed away by rainwater (Environmental Health, 2001). When the surface of 'Noxer' is irradiated, oxygen is created, resulting in oxidation of NO[iv] to form nitric acid ions, which can be washed away or neutralised by the alkaline composition of the concrete (Environmental Health, 2001). Results of tests undertaken by Mitsubishi showed an 80% NO_X removal rate based on an intensity of UV light of 1-12 watts per square metre (Wm^{-2}) (the UV intensity of direct sunlight in summer is 20-30 Wm^{-2} compared to 1 Wm^{-2} on a cloudy winter day) (Environmental Health, 2001).

There are currently a few examples of small-scale trials of TiO_2 products in the UK and Europe, but to date, there has been little quantifiable evidence on their effectiveness *in situ* to reduce NO_x and NO_2. Practically, it is likely that a very large surface area would need to be covered with this product to have any noticeable improvement. This product also does not tackle the source of pollution, so is not seen as a long-term solution.

A recent trial undertaken in Congleton found a reduction in NO_2 concentrations from 55-68 μgm^{-3} to 43 μgm^{-3} resulting from the application of NO_X reducing coatings to residential properties, pavements and street furniture along West Road (Air Quality Bulletin, 2009). TiO_2 impregnated pavement has been tested in Camden, in the Holborn area during 2005-2006. 12 months of monitoring showed that annual mean NO_2 had reduced by 12% during day and night; however, it was not clear if this reduction was due to the paving or another factor such as a reduction in traffic or a change in weather conditions (London Borough of Camden, no date). Camden is also currently undertaking a trial in Holborn to investigate the efficiency of NO_X-reducing paint by painting a wall in an enclosed area. To measure the difference in air quality, one year's worth of roadside monitoring commenced in August 2008 and this is to be compared with one year of data from after the NO_X-reducing paint is applied. A previous study by the City of London (undertaken in 2006 using a similar method to that used by the London Borough of Camden, but for a shorter time period and with air quality concentrations recorded at 5 metres away from the painted wall) found no identifiable effect of the paint.

In Italy and Japan, much interest is being given to the use of photo-catalytic materials in urban environments to help keep the surface of buildings and the inside of road tunnels clean. The materials include paint, cement and mortar, which all contain TiO_2. For example, in 2002, 7,000 square metres of road surface in Milan, Italy were covered with a photo-catalytic cement-like material; residents in the area reported that it was noticeably easier to breathe and NO_X gases at street level were found to have been reduced by up to 60% (Hogan, 2004).

As far as can be ascertained, there are only a few locations in Leicester which could potentially benefit from TiO_2 coatings, these include the underpass sections of Braunstone Way. The road exhibits relatively high traffic flows through predominantly residential areas.

The product may also be suitable for busy roadside locations in AQMA hotspot areas to reduce local exposure, such as Uppingham Road, St Matthews Way, Narborough Road and Melton Road. Alternatively it could have the potential for use as a means to reduce overall NO_x background concentrations in the city.

The costs of these types of products are however substantial and during the current period of austerity due to the government's priority of reducing the budget deficit, are unlikely to be affordable in the near future. For the London Borough of Camden trails, they obtained funding from TfL through the Local Implementation Plan, although the product was supplied free of charge from the manufacturer. Neither of these would be likely in Leicester.

l) Trialling innovative vehicle technologies

(See also Section 2.4)

Before any Local Authority starts to investigate emissions-reducing technologies, it should consider whether it is more productive to reduce the vehicle weight per passenger and do shorter trips on foot or with bicycle rather than trialling new technologies. This way, the energy consumption may be such that it is easier to meet demand using renewable sources and the transport means also will be more affordable, something which might be an issue in the current economic situation.

Leicester City Council has worked with the Energy Saving Trust to conduct an audit of its vehicle fleet and has a procurement policy to purchase the lowest polluting vehicles or retro-fit existing vehicles to reduce emissions. The Council's EMAS group is responsible for reviewing targets and technologies to reduce fleet emissions and mileage. The Council currently participates in the National Low Emission Strategies project and is looking for solutions that are tailored to the Council's need but that do not involve considerable capital and ongoing costs.

The information below provides evidence of where alternative vehicle technologies have been successfully used by other Councils and evidence on their emissions benefits. Some of this information is taken from a study commissioned by the London Borough of Camden on life cycle emissions of alternative vehicle fuels (London Borough of Camden, 2006). This information may help Leicester City Council consider the different options to make decisions on which technologies may be suitable for their own fleet.

i) Compressed Natural Gas (CNG) vehicles and refuelling facility

Natural gas vehicles normally use spark-ignited engines with three-way catalysts. These provide low levels of regulated pollutants (PM, CO, NO_X and non-methane hydrocarbons). The same is, however, the case for other spark-ignition fuels (petrol and LPG) and with the exception of NO_X and PM for diesel engines. Compared to the majority of diesel engines, natural gas still maintains an air pollution advantage even beyond the significant reduction in emissions required to meet Euro 4 passenger cars and Euro V for heavy duty vehicles (EC, 2003). In the longer term, the limit values for NO_X and PM from diesel passenger cars, light commercial vehicles and heavy duty vehicles will be further tightened. In these conditions, it is likely that it will make little, if any, difference from an air quality point of view between 2009 and 2013, whether new ICE-based vehicles will be fuelled by gasoline, diesel, LPG or natural gas. Since the introduction of low-emission diesel vehicles and large-scale introduction of CNG vehicles will need about the same phasing-in time, there is no reason to expect significant long-term differences with regard to the impact on air quality between these technologies (EEA, 2007).

There remains, however, concern over the health impact of diesel emissions particularly in cities where more people are affected. In general, the bigger the city, the more severe is the impact. Therefore, big cities and/or cities with elevated levels of PM and NO_X pollution have good reason to consider measures to promote high-mileage vehicles (taxis, buses, certain types of distribution vehicles) operated on natural gas, biogas or other low emission technology. Such a change has already been undertaken in some cities in the EU. The fact that methane is the predominant hydrocarbon component in the exhaust gas and that methane is only slowly decomposed in the catalytic converter means that the quantity of noble metal (platinum) in the catalytic converter must be increased to approximately 6 times the normal quantity if methane emission has to be reduced to the level required by the current total hydrocarbon limit value. Since the elimination of methane offers only a marginal, if any, benefit for air quality, it would be advisable to develop a separate non-methane emission standard adapted to the actual impact on air quality as well as on the greenhouse effect (EC, 2003). Clearly, there is a strong argument to support the development of locally sourced bio-methane (perhaps via local authority intervention) on the grounds of reducing life cycle emissions ‘well to tank’ bringing a direct environmental and economic benefit to local communities. For example:

Leicester is currently facing a crisis with the disposal of putrescible waste (*i.e.* with no more landfill sites and the obvious political issues with incineration *etc.*). Controlled anaerobic processes would facilitate the disposal of organic waste with the benefit of producing useful bio-methane.

The fuel produced will be 'carbon negative', especially if manufactured locally. In terms of the air quality impact, methane would have NO_X and PM benefits over and above those from pursuing a (bio) diesel policy.

There is a seamless profile in terms of a fuel infrastructure from existing to optimal technologies. Methane gas can be readily piloted in existing internal combustion vehicles, refuelling from a 'tap'. Bio-methane could be developed from waste via the involvement of a local consortium. Leicester could produce fuel from its own reclamation functions.

A local process could emerge to re-form the bio-methane into hydrogen, as part of the 'hydrogen economy'

Camden Council is currently working with Veolia Environmental Services Ltd (a contractor of Camden Council) and Gasrec (the UK’s first commercial producer of liquid bio-methane fuel) to trial bio-methane as a clean transport fuel. This fuel is produced from landfill gas. The vehicle used in Camden Council’s trial is an Iveco Daily light commercial vehicle. The trial will involve comparison of the operation of this vehicle with existing vehicles running on CNG. The aim is to demonstrate that bio-methane is a commercially competitive and environmentally sound fuel that can be directly substituted for natural gas.

There is a school of thought considering bio-methane to be the most sustainable biofuel in terms of impact on resource depletion (compared to alternatives such as bio-diesel and bio-ethanol). Research commissioned by Camden Council investigating the life cycle environmental impacts of different transport bio-fuels found that bio-methane had the lowest overall environmental impacts (based on air quality and greenhouse gas emissions).

Benefits include:
Reduced particulate matter (80%) and nitrogen oxide emissions (50%) compared to conventional diesel;
CO_2 savings of up to 85% when considering the fuel life cycle;
Clearly, the capture of methane from landfill sites and conversion to bio-methane can help mitigate climate change as methane is a potent greenhouse gas;

The use of organic waste for bio-methane production means that waste may be redirected to specially prepared landfill or anaerobic digesters rather than conventional landfill sites, facilities of which are expensive to maintain and are fast depleting.

ii) Electric vehicles

Electric vehicles can be battery-electric, hybrid-electric or fuel cell-electric. Petrol hybrid-electric vehicles have recently exceeded battery-electric vehicles in annual sales in the UK (London Borough of Camden, 2006). The benefits of hybrid vehicles are discussed in Section 0.

Battery-electric vehicles utilise an on-board rechargeable battery to store electrical energy: the battery is recharged by connecting it to an electricity supply (London Borough of Camden). The technology utilises ‘regenerative braking’, whereby the battery is topped up when the brakes are applied (London Borough of Camden, 2006). A study into vehicle fleet electrification in Alabama found that replacing 10% of the fleet with electric vehicles would produce reductions of 1.79%, 4.37% and 1.44% in CO_2, NO_X and SO_2 emissions respectively from the light duty vehicle fleet (Lindly and Haskew, 2002). Indeed, CO_2 emissions per kilometre (km) are much lower for electric vehicles than for petrol or diesel powered cars, in the range of 20-50 g/km (Mayor of London, 2007). There are, however, some emissions penalties associated with electric vehicles, such as the use of non-renewable electricity for recharging (London Borough of Camden, 2006).

Life-cycle emissions from battery-electric vehicles (per km) are significantly reduced for CO and hydrocarbons; but significantly increased for particulates, NO_X and SO_2 due to emissions from power stations used to produce the energy source (if non-renewable energy sources are used to generate electricity) (London Borough of Camden, 2006).

Ownership costs for electric cars will be higher than petrol or diesel equivalents, primarily due to their higher purchase price and cost of batteries, which are typically leased. There may also be associated capital costs to install charging facilities. Reduced ownership costs include exemption from road tax[v] and in London, drivers of electric vehicles in London are currently exempt from the London congestion charge and have access to free or discounted parking spaces. To date, there are 73 electric vehicle recharging points in London and plans are in place by the London Mayor to implement electric car hire schemes (Newride, 2009). The overall life cycle costs of such vehicles will obviously vary according to their use and the lifetime of the vehicle.

On the positive side, we have secured electric charging points, through the planning process, in our prestigious Highcross shopping centre development. Building on this, Leicester is part of a successful Midlands bid, (including Nottingham and Derby), for funds from the second round of the Government's "Plugged in Places" initiative, for financing infrastructure to support use of electric vehicles. The Plugged in Places project presents us with an ideal opportunity to provide charging facilities for electric vehicles at a range of strategic locations across Leicester. The initiative dove-tails with the Government's 'Plug-In-Car Grant' of up to £5,000 per car for the new wave of electric vehicles to be launched in 2011. Together, these initiatives will enable motorists to switch to electric vehicles.

iii) Pure plant oil

Pure plant oil is produced by crushing and filtering oil-based crops to produce neat oil which can be used in some diesel engines. Pure plant oil is not widely used in the UK because vehicle manufacturers will not typically provide a warranty due to the modifications which would be required for a vehicle powered by pure plant oil. The degree of reduction in life cycle CO_2 emissions from vehicles using pure plant oil depends upon the manufacturing process, but is considered to produce fewer emissions than other forms of biodiesel (Energy Saving Trust, 2009). Arguments against promotion of fuel made from pure plant oil include the deforestation that occurs to create fuel feedstock (such arguments are still valid). It has been suggested that implementation of a sliding scale of taxation to encourage the use of fuel feedstock with good environmental credentials will counter this potential negative impact.

iv) Bio-ethanol/diesel

The term biofuel in this case refers to ethanol or diesel made from processing plant material or animal oils. Crops used to produce biofuels include corn, sugarcane and rapeseed. Bioethanol is usually mixed with petrol and biodiesel is either used on its own or in a mixture. Biodiesels include straight vegetable oils (SVOs), modified waste vegetable oils (WVOs) and oils produced by the esterification of energy crops such as oil seed rape, sunflower oil, palm oil and soybeans (London Borough of Camden, 2006).

No evidence could be found supporting the air quality benefits of using biofuels. Equally, no evidence was found suggesting bio-fuels have a detrimental effect on air quality. The Royal Society (2008) report on bio-fuels, however, concluded that biofuels have a potentially useful role in tackling the issues of climate change (*e.g.* CO_2 emissions) and energy supply. However, important opportunities to reduce greenhouse gas emissions from biofuels, and to ensure wider environmental and social benefits, may be missed with existing policy frameworks and targets. Unless bio-fuel development is supported by appropriate policies and economic instruments, there is a risk that society may become locked into inefficient bio-fuel supply chains that potentially create harmful environmental and social impacts. New technologies need to be accelerated that can help address these issues, aided by policies that provide direct incentives to invest in the most efficient biofuels.

The actual extent of total life cycle greenhouse gas emissions from biodiesel and bioethanol is strongly dependent on the crop grown and the fuel processing employed (London Borough of Camden, 2006).

Ownership and running costs of bio-ethanol/diesel vehicles will be the same as petrol or diesel equivalents where a low percentage blend is used. However if high percentage or pure blends are used, there may be additional costs to replace certain vehicle parts (e.g. rubber components) and to maintain the vehicle[vi].

v) Hybrid vehicles

Hybrid-electric vehicles (HEVs) are part battery-electric and part conventional vehicles which use a temporary energy storage device (usually a battery or capacitor) to enable the main engine to be operated at close to its maximum efficiency. Most hybrid vehicles operate in electric/zero-emission mode at low speed, making them ideal for urban driving. The efficiency of the technology leads to lower emissions of CO_2 than from ordinary petrol or diesel vehicles and all hybrid cars are Euro 4 compliant (London Borough of Camden, 2006).

In London, all new TfL-operated buses entering service after 2012 will be hybrid powered. Tests carried out at the Millbrook Proving Ground (TfL, no date) found that when compared with conventional diesel buses, hybrids deliver considerable environmental benefits, including:

- 89% reduction in NO_X
- 83% reduction in CO
- 40% reduction in fuel use
- 38% reduction in CO_2
- 30% reduction in perceived sound levels (noise reduced from 78 to 74 decibels)

Hybrid cars do cost more to purchase than a typical petrol or diesel model but will generally be cheaper than a pure electric vehicle. For a typical family car that costs £14,000 new, you might expect to pay £1,000-£2,000 more[vii]. However, many running costs of hybrids will be lower, as indicated below:

Reduced Vehicle Excise Duty

- Cheaper to run than conventional petrol or diesel vehicles; £10 will allow you to travel 165 miles in a petrol hybrid car
- Quieter than diesel or petrol vehicles
- Enhanced capital allowance rate of 100% in the first year
- Lower Personal Benefit in Kind (BIK) tax liability

In order to encourage take up of private hybrid vehicles, Westminster City Council has introduced a range of incentives (Westminster City Council, 2009). Hybrid vehicles receive:

Discounted resident parking in Westminster.

Hybrid vehicles that are classified as Band 4 on the PowerShift register are entitled to apply for the 'hybrid' Westminster Ecomark, a vehicle badge that is awarded to vehicles that are fuelled by gas or electricity. It identifies the vehicle as one that contributes to the reduction of air pollution in London and the owner can receive updates on what is happening in the field of electric and gas vehicles as well as occasional free gifts and invitations to events.
No congestion charge (subject to registration fee and conditions).

This section has briefly described issues involving innovative vehicle technologies. For Leicester City Council, it is feasible to pilot these technologies within council operations. The difficulty is communicating messages to the public as to their relative merits or otherwise. One way to manage this is to share knowledge through policy development in the form of intervention strategies. One might consider, for example, the role of the Council to promote vehicle technologies by developing access controls in the city centre. Consultation on entry criteria would certainly raise awareness and debate.

m) Free bus passes (smart card)

The Local Transport Act (LTA) 2008 includes provisions designed to enable more effective partnership working between local transport authorities and bus operators, aiming to promote accessibility, reduce congestion and support the Government's environmental objectives (DfT, 2009). Since April 2008, everyone who is resident in England and who is over 60 years of age or 'eligible disabled' has been entitled to a free annual bus pass valid for off-peak travel on local buses. In London, everyone under the age of 16 is eligible to travel free of charge on buses and trams (this includes residents and non-residents) and 16-17 year olds (and some 18 year olds) in full-time education or on a work-based learning scheme who live within a London borough can travel for free on buses and trams across the entire London bus network, including sections outside Greater London. Other cities, such as Nottingham, which have a single bus operator, have systems in place for smart cards, so could relatively easily operate a free or discounted bus pass system. This would be more difficult in Leicester which has several major bus operators, but the recent LTA 2008 and Quality Bus Partnerships may allow this type of measure to be realised in the future. This is something that would be investigated if this measure was taken further for detailed evaluation.

Case study: Denmark
'FynBus' public transport company in Odense Denmark is piloting a Security Management System (SMS) bus ticketing service. Ticketing messages are sent to mobile phones which are then shown to the drivers when boarding buses. They are cheaper than paying with cash, making the transaction process more attractive and simple. Clearly, another benefit is that this reduces the amount of cash held on buses and allows parents to manage the travel of their children more effectively (Civitas, 2008).

n) High occupancy vehicle (HOV) lanes

High occupancy vehicle (HOV) or carpool lanes, either created by using the hard-shoulder, widening roads, or utilising spare capacity in existing bus lanes, are an example of road space management that is intended to encourage drivers to share cars. They can also be used where the introduction of new bus lanes cannot be justified on bus frequency grounds. The basic principle is that only vehicles carrying two or more people, buses and two wheeled vehicles are permitted to use the lanes during hours of operation (HGVs may or may not be allowed access) (DfT, 2006). Only three non-motorway schemes of this type are in operation in the UK: in Leeds, South Gloucestershire (northern outskirts of Bristol) and North Somerset (A370 Long Ashton Bypass) (DfT, 2006). The city of Leeds HOV lane on Stanningley Road has resulted in a reduced journey time for cars using the lane of 3.5 minutes (the lane is 1.5 km long) (HOV Lane Info Sheet Issue 6a, 2002). This sort of intervention may be appropriate for roads in and out of the city centre in Leicester, but it would require the roads to be widened, otherwise it is likely to cause increased congestion if the road space for other vehicles is reduced.

o) City car clubs

City car clubs provide an alternative to personal car ownership. Cars are owned and maintained by a club, which pays for all tax, insurance, servicing, cleaning and fuel. Members pay a joining fee and then pay for each journey at an hourly rate. Cars are returned to a reserved parking bay for the next member to use.

The Environmental Change Institute has reported that on joining a car club, former car owners increase their use of non-car transport modes by 40% (Ledbury, 2004). In general, UK studies show that each car club typically replaces at least six private cars and hence can lead to emission reductions[viii].

One disadvantage of hourly charge rates is that it becomes prohibitively expensive to use the car for more than a few hours. Although by design to optimise the fleet, for daily use, it is often cheaper to rent vehicles from a hire company.

p) Car sharing

Car sharing allows several people to share private transport and is usually organised through networks for people that are regularly driving to the same place (*e.g.* work), or are travelling to a mutual destination. Car sharing allows people to benefit from the convenience of the car, whilst meeting new people and reducing congestion, pollution and the cost of travel. Leicester already actively support and promote car sharing schemes, particularly to reduce the numbers of people driving to the Council to work. The Council operate the Leicestershare.com website which is run in partnership with businesses within the city. This scheme has funding up to 2012 and in May 2008, there were more than 2,000 registrations and of these, more than 150 active car share partnerships existed. Clearly this would reduce vehicle kilometres travelled so would have air quality benefits, but much better evidence and statistics would be required to quantify this effect.

The Department for Transport (DfT) reports that a successful car sharing scheme can reduce commuter traffic by nearly a quarter (DfT, 2004). However, there is no clear evidence as to how this reduction translates to emission savings. Car sharing is analogous to car clubs where some research has been undertaken (Kollamthodi, 2005). In this research the total reduction in emissions due to an increase in the number of car clubs has been estimated based on the assumption that each person that joins a car club reduces their annual vehicle mileage by 4,500 miles per year, and that an average of 20 people use each car club car. Reductions in NO_X, PM_{10}, and CO_2 emissions are therefore due to a reduction in the total number of vehicle kilometres travelled each year.

The emissions savings attributable to the ASM business/home car sharing scheme has been assessed for Venice (Civitas, 2008). As well as individuals sharing journeys within cars, individuals were also encouraged to share cars to undertake their journeys. The car sharing scheme involved allowing individuals access to alternative vehicles. In general, it was found that emission reductions for CNG powered vehicles are in the order of 20-30% for CO_2 and CO and between 40-90% for HC and NO_X. The assessment also took into account the reduction in pollutant emissions that can be ascribed to the use of car sharing vehicles in substitution of private or company cars that are not compliant to Euro 4 Emission Standard and how the habits of the ASM car sharing service users have changed in terms of car use. Previous studies (Ryden *et al*, 2005, City of Bremen, 2004) have shown that car sharing tends to postpone the purchase of a car (typically a second car) or lead to people driving less by using more public transport or walking. This translates to a reduction in the overall average mileage per person and in a similar car sharing initiative this was estimated to be around 50% (Shaheen *et al*, 2003). This figure can be significantly increased when the car sharing scheme is adopted as a complete substitution of family or company cars.

Per member emission reductions expected from using a combination of conventional and CNG vehicles with reduced mileage equates to around 113 t/year (CO_2), 259 kg/year (CO), 29 kg/year (NO_X) and 27 kg/year (HC). The lowest possible estimate assumes all were Euro 4 car owners. ASM car sharing scheme is rapidly increasing its number of customers (citizens and companies) thus reaching a wider share of the Venice council population. The car sharing scheme is more appealing to the public as more cars and more collection and return points are made available. Other wider benefits include the lower number of cars circulating, reductions in traffic congestion and increased numbers of available parking places.

Case study: Promotion

Information necessary to promote car sharing has been reported in 'Smarter Choices: Changing the way we travel' (Dft, 2004). The following is drawn from CarShare Devon:

- 40 temporary road signs on regular commuting routes;
- Provocative radio adverts;
- 116 bus back adverts;
- Advertisements on the back of car park tickets;
- 5,000 leaflets sent out with NHS Trust wage slips;
- Leaflets sent to all staff at Plymouth University;
- Contact with over 500 employers with more than 50 staff;
- Publicity on all outgoing council franked mail;
- Displays at the Devon County Show and in large libraries;
- A message from the Chief Executive of Devon County Council on the bottom of all 24,000 staff wage slips.

q) Trams

Trams are reliable, fast and can carry many passengers; they are also electrically powered, producing almost no on-street pollution (Edinburgh Trams, no date). Edinburgh plans to have a tram network in place by 2011: phase 1 is currently being built (Edinburgh Trams, no date). Nottingham has an existing tram network (opened in March 2004) and a second phase of development is currently proposed, with construction due to start from 2010 onwards. Twenty million trips are expected to be made by passengers on the tram network in Nottingham when the second phase is complete, of which 30% are expected to be ex-car users, and in the first two years of its operation, 8.4 and 9.7 million passengers (respectively) used NET Line One (Nottingham's first tram system) (University of Nottingham, no date). The system is fully integrated with rail, car, Park and Ride and bus services.

An option to introduce trams or electric guided buses has previously been considered by Leicester, but hasn't as yet been taken forward due to reasons such as high infrastructure costs and the limited road space to construct a new tram system. This sort of measure obviously has a long implementation timescale and it would be worth taking note of the evidence from existing schemes on the impacts that trams have had on reducing residential car usage. Re-investigating the feasibility of a tram or personal rapid transport system is being considered by Leicester for the LTP3 (Leicestershire County Council and Leicester City Council, 2008). It should also be noted that feasibility studies of major transport infrastructure schemes are expensive.

r) Quality bus partnerships agreements/Bus quality contracts (emissions controls for buses)

A Quality Bus Partnership Agreement (QBPA) is a *v*oluntary agreement between one or more Local Authorities, which may or may not be local transport authorities, a bus operator and (optionally) third parties. It can range from a simple document detailing heads of agreement to a legally binding comprehensive and detailed document (Defra, 2009). In terms of regulating emissions from buses, QBPAs can be used to encourage the uptake of retrofit technology. The Local Authority can do much to facilitate the uptake by providing adequate facilities for bus services. The success of such approaches will necessarily rest on the efforts to engage with the vehicle operators in a detailed and consistent manner (Defra, 2009).

The UK Government is introducing changes to the Department for Transport's Bus Service Operators Grant (BSOG) to incentivise the use of low carbon buses and buses with smartcard and global positioning systems (DfT, 2008a). Other interventions which are being introduced and taken forward for further discussion with stakeholders include a distance based subsidy for use of low carbon buses; a review by 2011 with the intent of using a fuel efficiency cap or differential rates of BSOG in the future to further incentivise a switch to lower emission vehicles; replacement of BSOG for operators in the TfL network by payment of an equivalent sum passed directly to TfL; and funding of a SAFED (Safe and Fuel Efficient Driving) demonstration project to encourage fuel efficient driving in the bus and coach sector (DfT, 2008a).

The powers of the Local Transport Acts 2000 and 2008 enable local authorities to bring forward schemes in which they can determine which local bus services should be provided in their area, and to which standards, and can let contracts with bus operators giving them exclusive rights to provide services to the Authority's specification. The Authority may determine the routes, timetables, fares and ticketing arrangements for the bus services, and any other matters relating to their standards including the emissions standards of the vehicles used. The Local Authority, not the traffic commissioner, carries out enforcement and operation of quality contracts (Defra 2009d). This may be an ideal opportunity for Local Authorities, including Leicester, to overhaul existing bus contracts to take full advantage of the new powers to realise the full extent of environmental benefits. In making a sound case, Local Authorities will need to provide clear evidence including any benefits affecting other shared priority areas.

s) Lightweight canopies

A lightweight canopy is potentially relatively simple to construct and would have the same effect as a tunnel to cover a section of road with a light-weight plastic or glass canopy. Air pollution release is restricted to portals and vents and the canopies have the ability to entrain pollutants to areas where they can be scrubbed or treated to reduce concentrations. This will therefore reduce exposure to drivers and passengers in vehicles travelling within the canopy. However, the effectiveness of canopies at reducing road surface deposition and roadside PM concentrations remains unclear. A project by IPL (Air Quality Innovation Programme)[ix] is currently investigating the combination of a light-weight canopy with effective treatment of the polluted air, e.g. by using glass fibre mats to absorb particulates.

t) Southern relief road

Relief roads aim to redirect traffic from town or city centres by providing an alternative route for vehicles travelling through an urban area. For example, a new 1.5 km dual carriageway was opened in Sheffield in 2007 (between the Wicker and Penistone Road) which aims to:

Remove unnecessary through traffic from the City Centre by providing a dedicated route around it;
Improve access to the City Centre and adjacent areas for all those who need it, however they choose to travel;
Re-integrate Victoria Quays, the Law Courts, Exchange Riverside and the Wicker areas with the City Centre;Aid regeneration of the City Centre and areas immediately adjacent to the IRR;
Improve the City Centre environment.

A potential Southern relief road in Leicester would run between the A6 and M1 in South Central Leicestershire. Plans for this road are currently on hold as it is considered that other schemes are likely to be more cost-effective and can be implemented in the medium-term. However, these plans may be re-visited if the Pennbury Eco-town is built.

u) Carbon scrubbers / precipitators / vegetation barriers

There is limited research on the specification and application of emission control devices situated within public buildings such as railway stations and car parks. The devices tend to be very energy intensive and typically fitted as a retrofit device to an existing ventilation system to reduce levels of particulates. In an ambient urban context these devices have limited uses over and above natural agents such as roadside vegetation barriers and are more applicable to controlling emissions from tunnel portals which affect public exposure. With reference to vegetation barriers, LCC has pledged to plant 10,000 new trees in the city's parks, school grounds and streets by 2011.

v) School buses

Provision of school buses could reduce the number of ‘school-run’ trips undertaken by private motor vehicles. The Yellow School Bus Commission (YSBC) (chaired by David Blunkett) believes that dedicated school buses should be introduced across Britain to all primary and many secondary schools (YSBC, 2008). The Commission believes that the services would remove 180 million car journeys from Britain's roads each year, reducing congestion and cutting emissions (YSBC, 2008).

w) Planning - Section 106 agreements

Ways in which to better use planning systems were not specifically considered in the LCC/TRL consultation workshop but this is a means by which to gain funding for air quality improvements. As well as the contributions made by developers for air quality mitigation as part of their scheme development plan, Section 106 agreements have also been successfully used to extract money for air quality monitoring and impact assessments. For example, the London Borough of Greenwich (LBG) has experience of using planning agreements under Section 106 of the Town and Country Planning Act 1990. They have secured several agreements where the community has benefited. It includes the provision of affordable housing, the use of local labour and environmental impact mitigation measures.

The use of Section 106 agreements in relation to air quality is clearly stated in Planning Policy Statement 23 (PPS23) Annex 1 Pollution Control, Air and Water Quality Planning Obligation (ODPM, 2004): "Where it is not appropriate to use planning conditions to address the impact of a proposed development, it may be appropriate to enter into a planning obligation under Section 106 of the Town and Country Planning Act 1990". Agreements can include the purchase, installation, operation and maintenance of air quality monitoring equipment or provision of other assistance or support to enable authorities to implement any necessary monitoring or other actions in pursuit of an Air Quality Action Plan (PPS23, Annex 1). PPS23 has been actively implemented by Greenwich since the first LEZ controls on the Greenwich Peninsular development. It also forms part of Section 106 legal agreements, signed on 23 February 2004.

In 2006, LBG received a major application to develop the Woolwich Town Centre. The plans for this mixed use scheme included 960 residential units, community and or office blocks, retail store, retail, food and drink units, 1,172 car parking spaces and cycle parking. Successful negotiations between planners, air quality officers, the legal department and developers of the scheme ensured that the Section 106 agreement secured improvements in air quality within the designated AQMA. These included the following interventions:

- Provision of a car club;
- Controls on parking permits with 500 residential spaces with an annual charge of nil to £300 depending on Vehicle Excise Duty rating of the car;
- 10 electric vehicle charging points within the residential car park;
- 50% of delivery vehicles and 50% home delivery vehicles to meet Euro 5 rating by store opening and to be using bio-fuel (100% within 5 years). (Clearly, the use of biofuels in transferring such an intervention to Leicester would require careful consideration);

- £160,000 per annum for 10 years towards the Council's environment monitoring;
- 10 per cent renewable energy commitment;
- Building Research Establishment Environmental Assessment Method (BREEAM) 'excellent' rating for new builds;
- A combined heat and power plant (CHP);
- An auditing process on the implementation of these measures at five and ten years after store opening.

x) Tunnels

Underground or covered infrastructure provides an opportunity to improve air quality in the surrounding area and reduce noise pollution (Huijben, 2008). A tunnel or covering over a road can lower the pollutant concentration within the vicinity of the road by approximately 15-20% in densely populated cities with high background concentrations and by up to 20-25% when background concentrations are lower (Huijben, 2008). In the Netherlands, there were approximately 18 tunnels in use in 2008 and 15-20 at the planning or building stage (Huijben, 2008).

Polluted air is released from tunnels through an exit portal, where the concentrations of NO_2 and PM_{10} can be extremely high (Huijben, 2008). The problem is not usually significant however, because it is unlikely that there are sensitive receptors within the vicinity of the exit portal: this must be an important consideration at the planning and design stages.

This measure constitutes a 'last resort' long-term intervention for Leicester City Council and is not considered applicable to the revised AQAP, mainly due to the financial cost of implementing such a measure.

y) Road pricing

Road pricing can be employed to generate revenue for financing road infrastructure (*e.g.* toll roads), or for demand management purposes (*e.g.* congestion charging in city centres). The Durham City congestion charge was the first to be introduced in the UK in 2002. It was introduced in order to reduce the amount of traffic using Saddler Street (the only public access road to Durham Cathedral and Durham Castle) (Durham County Council, 2008). In 2003, a congestion charge was introduced in Central London. Studies found a 12% reduction in NO_X and PM_{10} emissions in the congestion charge zone between 2002 and 2003 and CO_2 emissions have reduced by 19.5% between 2002 and 2003 (Beavers and Carslaw, 2005).

Road pricing is not without controversy, particularly in light of its recent rejection in Manchester. Road pricing was part of a £1.5bn package of interventions including construction of tram lines and improved buses and trains. The public considered the intervention purely on the basis of individual cost, with a high estimate of £1,200 a year being reported (Carter, 2008). Recently, Boris Johnson, the Mayor of London, abolished the western extension of the London congestion charging zone. This may well have influenced the decision of voters in Manchester and equally have an effect on the decision making processes in other cities considering this intervention, including Cambridge, Bristol and Leeds.

The Manchester road pricing scheme would have been introduced in 2013, by which time 80% of the public transport improvements would have been completed. There would also have been discounts for the low-paid and exemptions for parts of the city that had to wait longer for improvements. Motorists would have been charged to cross two charging cordons during the morning and evening peak periods: the outer cordon roughly following the orbital M60 and the inner cordon surrounding the city centre. Opposition to the scheme suggested that other road taxes would need to be reduced significantly if road pricing by consent were to be realised.

Leicester previously rejected incorporating road pricing in its existing AQAP due to the political and economic circumstances at the time. The Council had concerns about the ability of road pricing to address congestion problems of the scale that exist in Leicester and decided that the costs to the city centre would seriously outweigh any benefits.

The UK government has carried out considerable research on introducing national road pricing schemes, but although the DfT is funding Transport Innovation Fund (TIF) studies within cities, there are currently no plans to take forward road pricing nationally. Other options are being considered to reduce congestion on major Highways Agency controlled roads, including introducing high-occupancy vehicle lanes on motorways and allowing cars to use the hard shoulder during busy times (hard-shoulder running).

2.8.5 Ranking of Scenarios for Detailed Assessment

Table 2.8.5/1

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
Resident CPZs	Currently only 10% of city. Needs better enforcement. Need this before looking at emission based charges.	M	M	M	M	M	Positive	Inner city	H	A
HGV only lanes	Would need better freight management strategy first so long-term solution.	H	H	H	L	L	Positive	Arterial / target areas	M	A
Road cleansing	May only be a summer solution but low cost as already have vehicles.	M/H (for PM)	M	L	L	L	Positive	Target areas	H	A/B
Driver training	Council already progressing this (including use of telematics to monitor its effects)	M	M	M	M	L	Positive	City wide	H	A/B
Active barriers	This would overcome enforcement issues	H	H	H	H	H	Negligible / Positive	Within IRR	H	B

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
	related to LEZs and would tie in with workplace parking levies. In the first phase there would be need to link up with local car parks. Second phase allow free access to car parks for LEVs. Strategy would need to be business friendly. Would tie in with traffic management and traffic calming interventions.									
Freight hubs	The main issue here is finding a location for such an operation within the City boundary. There has been a study on 'Urban Freight	M/H	M/H	M (in urban areas)	M	H	Positive	No sites available within the City boundary. Blaby perhaps	L	B

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
	Consolidation Centres' which will require reviewing									
Low emissions zones	LCC thought that camera enforcement might be prohibitively expensive however there was positive support for active barriers on major routes combined with traffic management to prevent non compliant vehicles finding alternative routes. LEZs need to be combined with other interventions to be successful.	H	H	L	M	H	Positive depending on the location of the cordon.	City boundary	L	B
Tunnels	A definite non-starter owing to the lack of space and severance issues occurring at portals. Issue was	H (ambient emissions can be controlled)	M/H	H	L	H	Positive	Variance locations	H	B

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
	also raised concerning in-vehicle exposure.									
Red routes	Need residential CPZs first Could not apply to many streets.	L	L	L	L	L	Negligible	Specific areas (e.g. Royal Infirmary)	M	C
Flexible working (hours /location)	Currently trialling in council but could expand to partnerships with other businesses/offices	L	L	L	L	L	Positive	City Wide	H	C
Work place parking levy	Difficult to manage on its own but can be easily managed in combination with active barriers within the IRR.	L	L	L	L	L	Negligible	City wide	H	C
Titanium oxide	No evidence to suggest that this intervention would have any significant impact	L	L	L	L	L/M	L	N/A	L	C
Trialling	CNG vehicles and	L	L	L	M/H	L	Negligible	City wide	H	C

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
innovative technologies (selected for discussion by the group)	refuelling facility(most promising and could be resourced from landfill sites)									
	EVs (LCC very keen to promote for niche applications)	L	L	L	L/M	L	Negligible	City wide	H	C
	Pure plant oil (Jatropha curcas)	L	L	L	L	L	Negligible	City wide	L	C
	Bio fuels (concerns over life cycle CO2 emissions)	L	L	L	L/M	L	Negligible	City wide	L	C
	Hybrids (Optimistic depending on drive configuration but not top of the agenda in terms of promoting new technologies. Some reservations on life cycle issues).	L	L	L	L	L	Negligible	City wide	H	C
	H2 (Might be considered but requires a strategy)	L/M	L	L	M	H	Positive	Selected areas	L	D

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
Free bus passes (smart card)	Smart card would need to work between bus companies of which 5 operate in Leicester.	M	L	L	L	H	Positive	City Wide	H	D
HOV only lanes	Non-starter as limited road width to introduce new lane/already have bus lanes More appropriate for routes in and out of city rather than IRR. Difficult to police.	M Could create congestion on other lanes	L	L	L	H	Negative	Arterial routes	L	D
City Car Club	Different routes -S106 developer pays for pool- limited opportunity -People set up own pool -Council staff use vehicles in own time. -City wide on street clubs – would need	L/M May make car more attractive so questions over shift in modes	L	L	L	H	Positive	Specific areas	H	D

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
	residential CPZs in areas with parking pressures first.									
Road Pricing	Probably a non starter owing to the experiences of Manchester and Derby. Differential charging. Centrally financed and fiscally neutral (i.e. fuel duty, road tax)	L	L	L	L/M	H	Negligible	Inner ring road/multi-purpose cordon	L	D
Trams	The only scheme being considered is for Pennbury eco town. It makes sense to concentrate funding for a major public transport scheme where there is a concentration of potential users. There is no evidence however those	L	L	M	L/M	H	Negligible	Pennbury to the City Centre	L	D

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
	residents will use the services, plus there would appear to be severe issues regarding space to provide a track. The Nottingham experience of social disruption doesn't bode well for the Leicester scheme.									
Quality bus contracts	Rationale provided on p.48 Annex 11 as to why QBC were not adopted for LPT2. More might be achieved in terms of delivering a more sustainable bus service if LCC become a Public Transport Executive.	L	L	L	L	H	Negligible	City wide	L	D
Emissions controls for	P+R buses for the three new sites will	L/M	L/M	L	L/M	H	Positive	Radials	L	D

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
buses	have E4 minimum standards.									
Lightweight canopies	A very expensive sticking plaster. Graffiti magnets. Couldn't be used in conservation areas.	L	M	M	L	H	Negligible	City wide	L	D
Southern relief road	There would appear to be mixed evidence as to what exactly the relief road would actually relieve. The consensus points to fact that should Pennbury be developed, its occupiers may call for the road to be developed to allow better access to the M1. This rather defeats the object of an Eco development. The purpose of the	L	L	L	L	H	Positive	South Leicester	L	D

Intervention	Comment	Emissions	AQ	Noise	Carbon	Cost	Social	Where might the intervention apply	2011 - 2016	Overall score
	relief road is to divert traffic away from the City centre. However geographically, the suggested route would not appear to offer that much in the way of relief.									
Carbon scrubbers/precipitators.	The main concern here was cost and the planning protocols. Basically a non-starter.	L	L	L	L	M/H	L	Rail stations, car parks.	L	D
School Buses	Not viable due to the spread of schools in the City. One or two schools already have their own buses.	L	L	L – But could have increased potential if new quiet buses were to operate wholesale within residential areas.	L	H - unless part-funded	Positive and negative (reduced congestion around schools, safer routes to school).	Individual areas	L	D

Table 2.8.5/2. Summary of ranked interventions.

Rank	Scored intervention (ranked from highest to lowest)	Scenario evaluation would require the use of a traffic model (Y/N)
1	Resident CPZs	N
2	No car lanes	Possible
3	Road cleansing	N
4	Driver training	N
5	Environmental zone (active control using barriers)	Possible
6	Freight hubs/consolidation centres	Y
7	Environmental zone (passive control using cameras)	N
8	Tunnels	N
9	Restricted parking and waiting zones (RPWZs)	N
10	Flexible working (hours /location)	N
11	Work place parking levy	N
12	Titanium oxide	N
13	Trialling innovative technologies (selected for discussion by the group)	N
14	Free bus passes (smart card)	N
15	HOV only lanes	N
16	City car club	N
17	Road pricing	Y
18	Trams	N
19	Quality bus partnerships agreements/Bus quality contracts (emissions controls for buses)	N
20	Emissions controls for buses	N
21	Lightweight canopies	N
22	Southern relief road	Y
23	Carbon scrubbers/precipitators/vegetation barriers.	N
24	School buses	N

The following describes four potential scenarios selected to reflect the range in the scoring:

Low cost high impact	(A)	No car lanes
High cost, high impact	(B)	Environmental zones/Active barriers
Low cost, low impact	(C)	Electric Vehicles (LCC are very keen to promote for niche applications).
High cost, low impact	(D)	Free bus passes (smart card)

2.8.6 Selection and Modelling of Options

Having explored the potential scenarios, LCC decided that the most effective form of evaluation, in terms of explaining the outcomes of conceptual scenarios, would be to consider interventions within a framework strategy called 'One Leicester Co_2nnect'. In essence, this strategy is designed to pull together wider air quality and climate change issues across the city without concentrating on a number of perhaps more piecemeal interventions, which although laudable, do not go beyond the vision required for a revised AQAP. The One Leicester Co_2nnect Strategy 1 considers a freight consolidation centre located in the vicinity of Sunningdale Industrial Park to the west of the City and a freight expressway (no car lane) on the Hinckley Road connected to the city centre environment zone using active barrier controls

The rationale supporting the strategy is for interventions that are more sustainable in terms of adapting to meet the required air quality standards and CO_2 emissions targets. Clearly, it would be beneficial if there were to be reductions in the number of trips undertaken both commercially and privately and if all trips were undertaken using low emission vehicles. Since there is little evidence of change occurring in the short to medium term, interventions are now required which will in effect force a change in behaviour across all sectors. The concept of the strategy is to operate a freight consolidation centre on the edge of the city mainly for those deliveries being made to the city centre. Specialised vehicles (perhaps pure electric or CNG powered) will shuttle to and from the city centre using a dedicated expressway between specific time periods. These vehicles will have free access to the environmental zone. All other vehicles wishing for free access to the zone will also need to meet specific emissions standards. All other vehicles will be charged for entry unless the users are resident within the zone.

Implicit within the strategy are several shared policy areas such as human exposure reduction to NO_X and PM pollutants, alternative vehicle technologies for freight deliveries and other modes, road safety aspects, noise issues, parking levies, traffic congestion and public awareness of environmental issues.

Atmospheric dispersion modelling was undertaken for the base year 2008 and future year 2013 using the Gaussian-based ADMS-Roads (Extra) software suite (version 2.3), developed by Cambridge Environmental Research Consultants (CERC)[x]. This future year was assumed as it is within the time horizon of the Council's LTP3 and the schemes were also considered appropriate to be implemented within 3-4 years. Full details of the methodology adopted are set out in Section 3.12

2.8.7 Results and Air Quality Impacts of Options

Some general observations and results from the modelling have been drawn out and are discussed below.

2008 baseline: All roads

- St Mathews Way monitoring site is showing an exceedance of the NO_2 annual mean (47.2 μgm^{-3}). This predicted concentration is slightly lower than the 2008 annual mean from the air quality monitoring analyser of 52 μgm^{-3}.
- Some of the receptors are showing high NO_2 concentrations because they are positioned for reference purposes in the centre of roads (*e.g.* LCC16, LCC20) or within gyratory systems (*e.g.* LCC 19)
- The highest modelled NO_2 annual mean result was 62 μgm^{-3} at receptor LCC3, just north of Burleys Flyover.
- The NO_2 annual mean concentration at New Walk monitoring site (Leicester Centre) was 38.5 μgm^{-3} (see **Error! Reference source not found.**).

2013 baseline: All roads

- The majority of receptors now meet the annual mean AQS objective for NO_2

2013 scenario with 2008 traffic base: Effects of the fleet only.

- Similarly to the 2013 baseline, exceedances of the NO_2 annual mean are still likely at 5 receptors although only two, LCC15 (Hinckley Road) and LCC35 (Charles Street) may be relevant receptors.
- The predicted NO2 annual mean concentration at the St Mathews Way monitoring site was 35.4 μgm^{-3}, which is below the objective
- No change in annual mean NO_2 was predicted at the New Walk monitoring site from 2008.

2013 base *with forecast traffic: Effects of the fleet and traffic activity*

- Only three exceedances of the NO_2 annual mean were recorded of which one, LCC35 may be relevant.

2013 with EZ and forecast traffic: Effects of the fleet, traffic and entry criteria.

- No changes in concentrations were found at the majority of receptors located outside of the EZ, except for some small reductions in annual mean NO_2 at receptors on the boundary of the zone or located just outside.
- Within the EZ, the percentage reduction in annual mean NO_2 at receptors owing to vehicles complying to the entry criteria ranged from between 0.2% to 12.3%. The maximum reduction was seen at receptor LC35 (Charles Street), where concentrations were predicted to meet the objective, compared to the 2013 baseline. Generally, the impact owing to the proposed entry criteria was negligible although there are a range of criterion that might be considered.

2013 with EZ and forecast traffic reduced by 15%: Effects of the fleet, reduction traffic and entry criteria.

- As expected this scenario resulted in the lowest NO_2 annual means at receptors within the EZ. The range of the reduction at receptors being between 0.02% and 15.7%.

2013 expressway with forecast flows: Effects attributable to the expressway only.

- No exceedances of the NO_2 annual mean were recorded for receptors LCC1 to LCC19 (on the expressway). NO_2 annual mean reduced at receptors by between 2.3% and 16.3% of the expressway over and above 2013 forecast traffic flows.

Overall, it would appear that the NO_2 annual mean concentrations at most receptors in the 2013 base situation with 2013 traffic flows either meet or are very close to meeting the objective. However these results are purely indicative at selected receptors and would be subject to greater scrutiny if a more detailed assessment was required. The council is therefore still advised to take actions to reduce emissions and consider these types of scenarios in their action plan.

With respect to PM_{10}, no exceedances or near exceedances were estimated to occur in year 2008 and future year 2013.

Aggregated baseline and scenario CO_2 emissions are shown in Table.2.8.7/1 Baseline (Hinckley and City Centre roads) emissions are slightly higher in year 2013. Traffic activity in 2008 was assumed for 2013. This increase possibly reflects the higher fuel consumption of heavy vehicles that meet the more stringent emissions standards by 2013. The forecast increase in traffic flow in 2013 results in the subsequent increase in fuel consumed and hence increases CO_2 emissions. The EZ entry criterion slightly negates the increase in CO_2 emissions as a result of forecast traffic growth and further emission reductions accrue from the proposed reduction in traffic entering the zone. Comparing emissions from the expressway only (i.e. without the EZ) with year 2013 (i.e. with forecast traffic growth) clearly shows that this strategy alone has caused a reduction in overall CO_2 emissions.

Table2.8.7/1 Aggregated CO_2 emissions

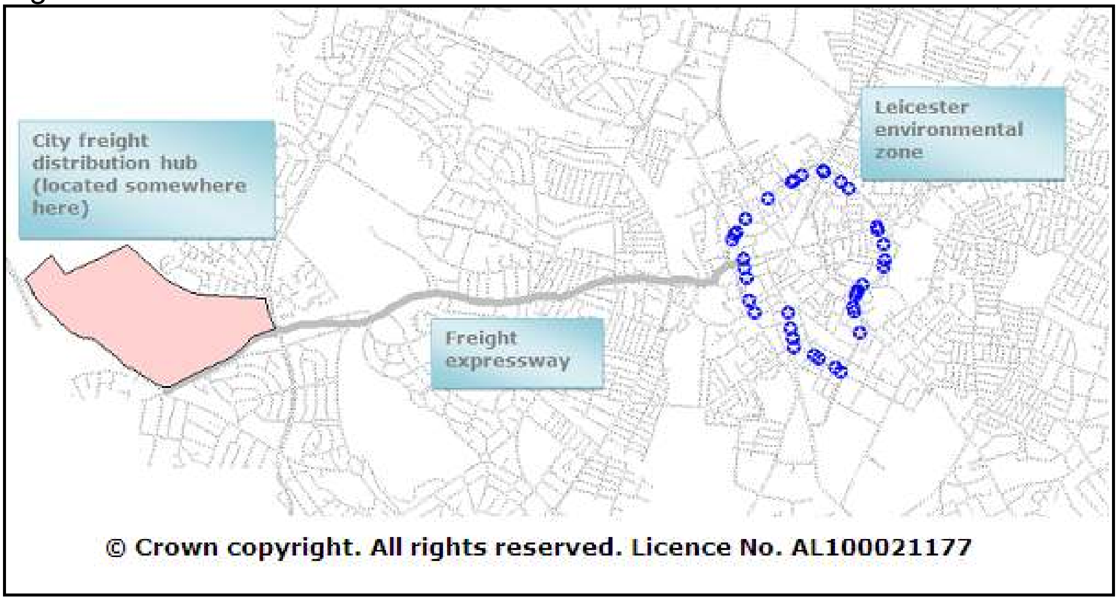
Link based CO_2 emissions (tonnes/year)					
2008	2013	2013 with forecast traffic	2013 EZ with forecast traffic	2013 EZ with 15% traffic reduction	2013 Expressway
61,214	61,445	62,810	62,776	60,544	61,370

Both the modelling of the EZ and the expressway scenarios have recorded reductions in the NO_2 annual mean over and above that of the do-nothing baseline in 2013. Both measures were based on assumptions concerning vehicle emissions criteria which can be strengthened if required. The criteria for the EZ for example, considered only heavy vehicles and could quite easily include passenger cars. Also, for the expressway, it was assumed that mainly diesel fuelled vehicles would operate along the route. However, should electric or CNG be considered then (particularly for electric) locally sourced emissions would be reduced more so to those reported here.

2.8.8 Options Forwarded for Final Assessment as AQAP Policy Options [>2.10] (*The 'Leicester Connect' Package*)

The two main scenarios are depicted in Fig. 2.8.8/1

Fig. 2.8.8./1



Scenario 1: Hinckley Road (A47 West) Freight Expressway

The One Leicester Co$_2$nnect Strategy 1 considers a freight consolidation centre located in the vicinity of Sunningdale Industrial Park to the west of the City and a freight expressway (*i.e*. a no car lane) on the Hinckley Road connected to the city centre environmental zone. The effect of this strategy on emissions and air quality concentrations was modelled and this section describes this scenario in more detail.

The theory behind the Hinckley Road freight expressway is to provide a means for goods vehicles to operate on a priority basis into the city centre (*i.e.* unimpeded by other modes). In practice this would involve lane segregation of the existing available road space, inevitably leading to increases in journey times. A consequence of this measure may well lead to traffic being displaced along alternative routes. However, evidence of displacement would typically require the running of traffic models. For this assessment the potential impact to the wider road network is not considered but recommended to be taken forward.

The expressway is assumed to operate in the inbound direction only as it is more important for retailers that goods are provided at prescribed times, which means that the return journey is not as critical. It was originally intended to include the IRR as part of the expressway but after further consideration of the emissions modelling it was concluded that more information about the traffic activity on adjoining radials would be required to investigate this scenario. Again, it would be recommended to consider these implications if taken forward. The modelled scenario therefore considers the emission impacts on the Hinckley Road only and once on the IRR freight access to the city centre is via High Street or freight vehicles can choose to rejoin the IRR entering the city centre at an alternative location.

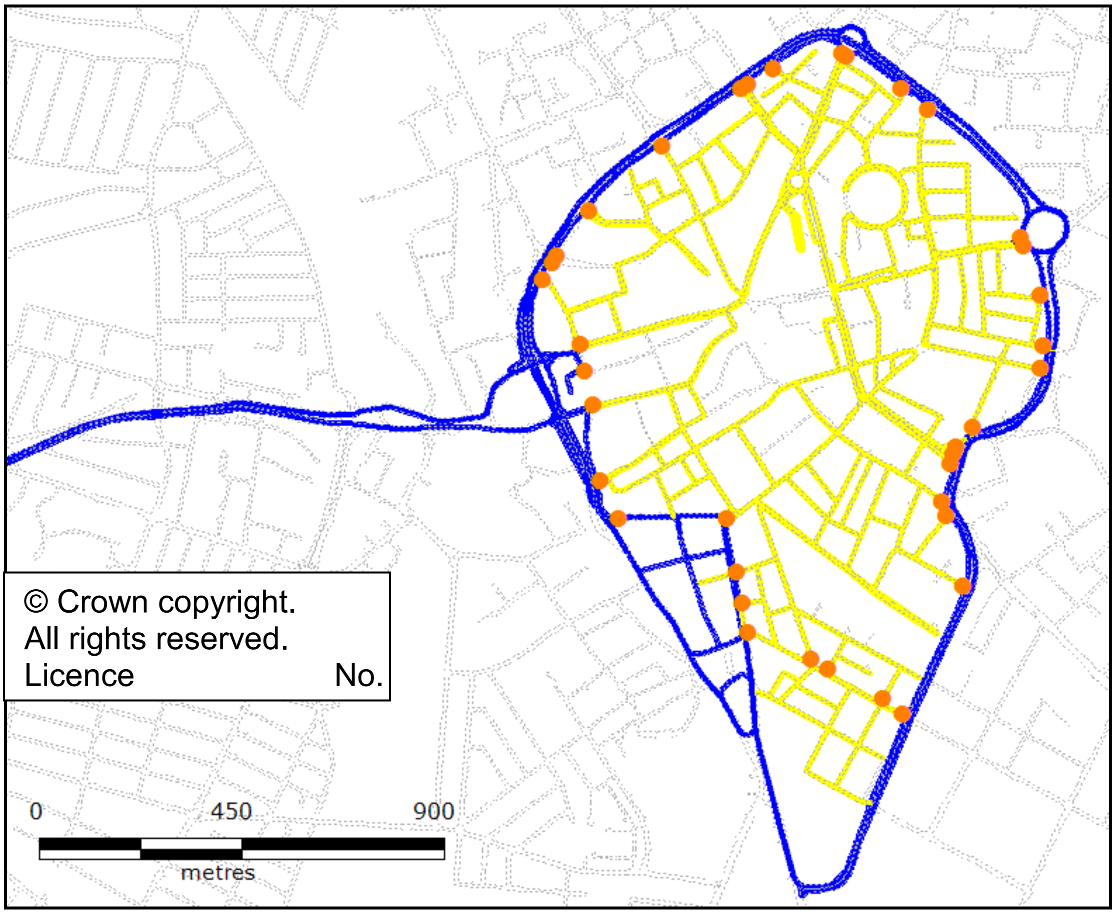
Scenario 2: Leicester City Centre Environmental Zone

The strategy for a city centre environmental zone (EZ) was developed into a scenario to include roads within the IRR. The concept initially involves controlling goods vehicles entering the zone at various locations (control points) either by using physical barriers or cameras that can record number plates. Both need enforcement mechanisms, however the former would rely on non-removable transponders which when fitted to vehicles would control the barrier and access to the zone. This information would give details of vehicle Euro emissions standards to allow or prevent access or access could be linked to CO_2 emissions.

Message boards prior to approaching barriers could inform drivers as to the status of their vehicle with reference to the access criteria (*i.e.* allowing the option to avoid accessing the zone). Clearly, drivers would need to be made aware as soon as possible perhaps via message boards on all radials. There would also need to be a mechanism to allow temporary access for non local vehicles and dispensation for non compliant vehicles that happen to reside within the zone. Camera enforcement would involve issuing fines to non-compliant vehicles via number plate recognition system similar to the system operated for the London Low Emission Zone. Similar to access controls, dispensation rules would need to be developed for businesses operating from within the zone.

In total, 223 roads were assumed to be included within the zone shown in Fig.2.8.8/2, all being accessed via control points.

Fig 2.8.8/2 Possible Leicester City Centre Environmental Zone



Key.Modelled Road Links: EZ – Yellow; Non-EZ – Blue. Access control points - Orange

Options Considered but not Modelled in the TRL Study

Certain options considered but not finally selected in the TRL Study (Section 2.3.4) had been given reasonably good rankings in other methodologies employed in this Annex and were therefore considered further. For the sake of completeness, these have been placed in the final ranking table (Section 2.9).

2.9 Options Considered in Sections 2.3 to 2.8 Collated Against Main LTP-3 Framework

Table 2.9 Leicester's Transport Policy Instruments – Priority-Scored and Tabulated against Interventions to Improve Air Quality / Climate Emissions

Policy Instrument	Policy No.	Relevant Objective (Strategy / LTP Chapter Theme)	Priority Score	LTP-2 AQAP 2006 (Section 2.3)	Vehicle Technology (Section 2.4)	Land Use Planning / Static Sources (S. 2.5, 2.6)	TRL Study – Radical Options (Section 2.8)
Working with Partners Company Travel Plans School Travel Plans Cycling Health Education Bus Rail Taxi Business Environment	24	Congestion Low Carbon Accessibility Safety, Security and Health Air Quality	13	Travel planning Safer routes to school School campaigns	Promote use of low emission vehicles with partners. Provision of fuelling facilities.		
Campaigns To Promote Walking and Cycling Road Safety Education Campaigns Flexible Working Hours, Home Working Teleconferences, Teleworking Salary Sacrifice	26	Congestion Low Carbon Air Quality Safety, Security and Health	13	Cycling promotion Walking promotion Campaigns to influence driver behaviour Education on air	Promote low emission vehicles		

Branding				quality and health / sustainability Websites Promoting car-free days Council home working and flexible hours			
Training Pedestrian Training Independent Travel Valuing People Greener Safer Driver Training Safer Driving with Age (SAGE) Cycle Training Cycle Mechanic Projects	30	Safety, Security and Health Low Carbon Air Quality	10				Driver Training Highly ranked
Public Transport Routing Bus rapid Transit Guided Bus Trolley Buses Trams Light Rail	10	Congestion Low Carbon Accessibility	9		Low emission modes of transport	Co-ordinate with development schemes	Trams ranked
Charging (pricing) Road user	18	Congestion Low Carbon	9		Incentivise low emission		Workplace paring levy

Workplace Parking Levy		Air Quality			vehicles		highly ranked Road pricing ranked
Cycles Cycle Routes & Lanes Advance Stop lines Cycle Parking Cycle Hire Schemes	32	Accessibility Safety, Security and Health	8		Promote electric cycles Provide charging points	Promote cycle use and facilities in development	
Public Transport Focused Development Encouraging public transport use through Land Use Planning Development Densities and Mix Development Pattern	1	Congestion Accessibility Low Carbon Air Quality	10		Promote low emission public transport vehicles	Promote and develop public transport in connection with development	
Bus Stations and Interchanges New Improved	3	Congestion Accessibility Low Carbon	9		Promote low emission public transport vehicles	Co-ordinate with major development projects, e.g. Cultural Quarter, New Business Quarter	
Rail New and Upgraded Rail Lines New Rail Stations	12	Congestion Accessibility	8		Electrification and low emission trains	Co-ordinate with major development projects, e.g.	

New Rail Services on Existing Lines						Cultural Quarter, New Business Quarter	
Land Use Measures Developer Contributions Value Capture Taxes Planning	23	Congestion Accessibility Air Quality	9		Application of relevant LDF Policies / SPD's (Climate, Parking etc.) Parking SPD based on LESDP principles – low emission vehicles Application of LESDP Emissions Toolkit for assessment of transport emissions from development EV Charging points	Application of relevant LDF Policies / SPD's (Climate, Parking etc.) Parking SPD based on LESDP principles Application of LESDP Emissions Toolkit for assessment of transport emissions from development S.106 agreements to reduce transport emissions	

						Control emissions from static sources (e.g. biomass boilers) which will aggravate transport pollution	
Journey Planning Personalised (PJP) Individualised Marketing Trip Planning	25	Congestion Air Quality Low Carbon	9				
Variable Message Signs Real-time Driver Information Systems Route Guidance Parking Guidance & Information Systems	28	Congestion Accessibility	9	Diverting through traffic from inner ring road Real-time air quality / route information (VMS) Signing and route guidance (VMS)			City centre Environmental Zone is principal recommendation with quantified AQ benefits
Pedestrian Facilities Pelican Toucan Refuge Drop Kerbs	29	Accessibility Safety, Security and Health	8			Co-ordinate with development schemes	

Routes Link Footpaths Rowip Community Safety Lighting							
Maintenance Roads Footway Cycle Routes Other TAMP	35	Safety, Security and Health Maintain Assets (TAMP)	9				Road cleansing highly ranked
Bus Corridors Quality Bus Corridors Bus Priority junctions Bus Lanes	2	Congestion Accessibility	7	Reallocation of road space. Quality bus corridors	Associated with low emission vehicles – permissive use		No car lanes highly ranked
Ticketing Off Bus Smart Card Interoperability Network	5	Congestion Accessibility	7	Off-bus ticketing / zonal fares			Free bus passes (smart card) ranked
Bus Fares Decrease Structure Concessionary	6	Congestion Accessibility	7				
Park & Ride New Improved	9	Congestion Accessibility	7	Park and ride schemes	Electric Vehicle charging facilities at Park and Ride sites	City centre access strategy	

Traffic Management Conventional Co-ordination of Streetworks Network Management	15	Congestion Maintain Assets	7	Management of congestion from works/events			City centre Environmental Zone is principal recommendation with quantified AQ benefits
Traffic Lights Urban Traffic Control (UTC) Systems Intelligent transport systems Information Technology Systems (ITS)	16	Congestion Low Carbon	8	Signalling improvements			City centre Environmental Zone is principal recommendation with quantified AQ benefits

Parking Standards Control of Car Parking Provision Control of Taxi Parking Provision On Street Charges Residents' Parking Schemes Parking Controls Physical Restrictions Regulatory Restrictions	17a	Congestion	7	Parking restrictions / costs	Provision of electric vehicle charging points	Application of relevant LDF Policies / SPD's (Climate, Parking etc.) Parking SPD based on LESDP principles – low emission vehicles	Resident CPZ's highly ranked Restricted parking and waiting zones (RPWZ's) highly ranked

Street Lights Community Safety	21	Safety, Security and health Low Carbon	7				
Maps General Cycle Walking Freight	31	Congestion Accessibility Low Carbon	8				
Accident Remedial Measures Traffic Calming Local Safety Schemes Speed and Red Light Running Cameras Vehicle Activated Signs	34	Safety, Security and health Congestion Quality of Life	8	Enforcing speed limits / access restrictions Traffic calming / diverting rat runs City centre and other 20 mph zones			
Bus Stops Additional Improved Level Access Bus Stops New Bus Shelters CCTV in Bus Shelters	4	Accessibility	6	Improved bus facilities and circulation			
Bus Information Static Real time passenger information	7	Congestion Accessibility Low Carbon	7	Public transport information			

Buses/services QBP Contracted/Supported Relocation/Operational Times Lower Emission	8a 8b	Congestion Low Carbon Low Carbon Air Quality	7 7	Minimum emission standards for buses Improved buses Subsidised bus fares Commissioning additional bus services	Low emission buses: Biomethane Hybrid etc.	Co-ordinate with development schemes	Quality bus partnership agreements / Bus quality contracts aimed at low emission buses ranked Emission controls for buses ranked
Roads Junction Improvements High Occupancy Vehicle (HOV) lanes Red Routes	14	Congestion	7	Junction improvements			City centre Environmental Zone is principal recommendatio n with quantified AQ benefits HOV lanes ranked
Car Schemes Car Clubs Car Share incl Ride Sharing Company Pool Cars	19	Congestion Accessibility	6		Promote low emission vehicles for car clubs etc.	Application of LESDP Emissions Toolkit for assessment of transport emissions from	City car club ranked

						development	
Low Emission Vehicles, Infrastructure & Initiatives Promotion Electric Car Charging Points Schemes/Zones Buses Taxis Low Carbon Signals Convert Street Lights to Low Carbon Other Low Emission Infrastructure such as low noise road surfacing, trees, etc.	20	Low Carbon Air Quality	7	Eliminating polluting vehicles Roadside emissions testing Council fleet policy Promotion of alternative fuels	Biomethane vehicles – manufacture of fuel from putrescible waste Hydrogen fuel cell vehicles – run pilot batch. Battery electric vehicles	Application of relevant LDF Policies / SPD's (Climate, Parking etc.) Parking SPD based on LESDP principles Application of LESDP Emissions Toolkit for assessment of transport emissions from development S.106 agreements to reduce transport emissions	City centre Environmental Zone is principal recommendation with quantified AQ benefits Use of low emission vehicles is highly ranked on assessment

						EV Charging points	
Buses/Services Low Floor	8c	Accessibility	5		Low emission vehicles		
Dial a Ride Service Levels	11	Accessibility Quality of Life	5		Low emission vehicles		
Major Road Improvements (over £2m) New Roads Junction Improvements	13	Congestion Accessibility	6	Junction improvements			
Freight FQP Home Deliveries Lorry Routes and Bans Lorry parks Transhipment Facilities Rail Water	22	Congestion Low Carbon Air Quality	7	Freight hubs Partnerships with other fleet operators	Provide charging points for battery electric goods vehicles.		City boundary freight consolidation centre plus freight-only expressway into City centre (A47 west corridor) is principal recommendation with quantified AQ benefits
Conventional Signs and Markings Directional signs Freight signs Walking Cycling	27	Congestion Safety, Security and Health	5				

Markings							
Motorcycles Routes & Lanes Parking	33	Accessibility	5		Low emission types. Charging points		
Parking New Off Street	17b	Accessibility	-4		Provide charging points for battery electric vehicles.	Enforce charging points for electric vehicles.	

2.10 What We Are Going To Do

The actions that will be taken forward are primarily contained in Leicester's Local Transport Plan (LTP). In addition to five key operational plans including this air quality action plan, the LTP consists of two key parts. Part A contains the Transport Strategy setting out our transport policies and individual strategies that comprise our overall transport strategy over the period 2011 - 2026. Part B is Leicester's First Implementation Plan for the period 2011 to 2015. The main purpose of the implementation plan is to act as a detailed business plan for implementing the interventions that will deliver the transport policies and strategies in part A. It has to balance up the various interventions with the likely funding streams and required outcomes and deliverability. Inevitably during a period of tight financial restraint, it has to prioritise which interventions to fund. It sets out the targets we are aiming to achieve, the LTP Programme to meet those targets and explains how we will be managing and monitoring progress over the next four years. Reduced funding is a key issue and so every opportunity will be taken to secure additional funding through bidding such as for the Local Sustainable Transport Fund for example. We will regularly review progress and consider the need for updates of the implementation plan every twelve months.

The programmes have been developed to maximise value for money and efficient delivery. We have analysed the best value for money solutions, against the targets, from the options available. Following a number of iterations, and having considered what realistically might be achieved on the ground, we have developed a programme to maximise the value delivered for the capital and revenue money likely to be available against the required outcomes.

The focus of the overall LTP3 programme will be on sustainable transport that will help grow the economy, protect and create jobs, whilst helping to improve air quality and reduce carbon emissions, encouraging active and safe travel and improving accessibility, with well maintained assets. Our immediate focus for the first implementation plan period will be to commence the delivery of a package of city centre bus improvements in order for us to realise the key transport outcomes for Leicester. Encouraging walking and cycling are also part of the strategy. The harder measures will be underpinned by softer measures taken forward by a smarter choices company or similar, should a strong business case emerge. The softer measures will include campaigns to promote more economical driving styles. We will install electric charging points for vehicles using our successful bid for funds from the Government's "Plugged in Places" initiative, for financing infrastructure to support use of electric vehicles. The Plugged in Places project presents us with an ideal opportunity to provide charging facilities for electric vehicles at a range of strategic locations across Leicester. We will also ensure electric charging points are installed at relevant major new developments through the planning process.

We have considered the possibility of introducing more radical measures such as road pricing or a workplace parking levy, bearing in mind the current economic situation and budget deficit. We currently have an open mind on road pricing and will be keeping the case for road pricing generally under review for the longer term. As regards a workplace parking levy, we will keep a watching brief on the development of the only scheme in the UK in Nottingham and keep the business case under review.

Summary

The “transport” strategy for Improving Air Quality in Leicester is focused on reducing air pollution caused by traffic by encouraging and facilitating more people to travel by public transport, walking and cycling. This will be achieved mainly through delivering the congestion strategy (LTP Chapter 4), the road safety and active travel (LTP Chapter 6) and the carbon reduction strategy (LTP Chapter 8). Leicester’s Air Quality Action Plan has been prepared on the basis of the need to be realistic and achievable in the context of the government’s current priority of reducing the budget deficit. This means that progress will not be as fast as we would like due to limited funding opportunities.

3. AIR QUALITY TARGETS

3.1 The Key Air Quality Issues

3.1.1 Nitrogen dioxide

Nitrogen dioxide is a toxic gas which aggravates respiratory and cardiovascular conditions in relatively high ambient concentrations. (Nitrogen dioxide, Expert Panel on Air Quality Standards, 1996). It has both acute, short-term effects at high concentrations and more insidious long-term effects at lower concentrations. For this reason, the UK statutory Objective includes both an hourly and an annual criterion.

Nitrogen dioxide is also involved in the atmospheric cycle of the formation and breakdown of ozone, another irritant pollutant.

All combustion processes generate some oxides of nitrogen from atmospheric nitrogen and oxygen but the internal combustion engine is particularly prone to this series of reactions due to the high temperatures and pressures involved.

Nitrogen dioxide (NO_2) is emitted directly from internal combustion engines ('primary NO_2') but also indirectly as nitric oxide (NO), which then oxidises to nitrogen dioxide. The combined emission is referred to as 'NOx'.

The Objectives for nitrogen dioxide are laid down in the Air Quality Regulations (England) (Wales) 2000 (as amended in 2002). The criteria are only relevant where exposure appropriate to the time-base of the Objectives occurs:

Table 3.1.1: Air Quality Objectives for Nitrogen dioxide

Indicator	Concentration	Relevant exposure	Date
Annual mean	40 $\mu g.m^{-3}$	Long term: Housing, other residential accommodation, schools, hospitals.	31-12-2005
1-hour mean, with not more than 18 exceedances per year.	200 $\mu g.m^{-3}$	Short term: Shops, pubs and restaurants, leisure facilities.	

There is also an EC Limit Value, using the same criteria, which the UK must meet by 2010.

The Review and Assessment process to date had demonstrated that nitrogen dioxide is the only pollutant currently of significance in terms of existing statutory standards. This is reflected in the area covered by the Leicester AQMA, which comprises the City centre as a whole, plus 'ribbons' extending along the main radial and peripheral roads. [Fig. 1]

It is estimated that the resident population of the Leicester Air Quality Management Area 2000 is about 9,000, or 3% of the City's population. The extension of the AQMA in the Abbey Lane corridor adds approximately 100 households to this total.

The vast majority of this pollutant in Leicester (90%) originates from motor exhaust emissions. Modelling shows that statutory annual mean Objectives for nitrogen dioxide will not be met in Leicester even in 2010 and it is this finding which forms the basis of Leicester's Air Quality Management Area (designated in 2000 and extended in 2008).

Modelling performed for target setting for the purposes in the Central Leicestershire Transport Plan 2006-11 showed that implementation would not meet the annual mean Objective criterion in all locations in 2010, at the end of the life of the Plan. These sites are all locations where there is actual residential exposure.

3.1.2 Ozone

Ozone is a secondary pollutant formed by a complex cycle of reactions involving the effects of sunlight on oxides of nitrogen and volatile organic compounds. The major source of these in Leicester is traffic emissions. Ozone has short-term and long-term health effects, including reduced lung function, and aggravated asthma and bronchitis. Of all pollutants, ozone has the smallest margin between typically observed ambient concentrations and those at which adverse health effects are experienced.

Almost every summer in Leicester, there are 'ozone incidents' lasting for several days. During spells of hot, still, sunny weather, ozone builds up to the level where Government standards are exceeded.

Asthma is a complex, multi-factorial condition which appears to involve dust, house-mites, pollen, allergic response and stress, as well as pollution. However, there is a measurable increase in acute, respiratory hospital emissions in Leicester following ozone incidents. (An Investigation into Hospital Admissions and Ozone Levels in Leicester, C. A. Mallon, 1995).

Paradoxically, there is no statutory duty on Leicester City Council to take measures to reduce ozone levels through the Air Quality Action Plan. This is because the government has determined that ozone is a transboundary problem, most appropriately addressed through international, governmental action.

Also, formation of nitrogen dioxide actually scavenges ozone out of the atmosphere in heavily trafficked urban areas, although it re-forms as part of the ozone chemical cycle downwind of the urban area. In turn, Leicester receives ozone from urban areas upwind, such as the West Midlands, which tends to increase our levels of nitrogen dioxide because increased levels of ozone permit conversion of more of the locally emitted NO into harmful NO_2.

Summer ozone is increasing and this is clearly implicated in failure to achieve the air quality Objective for NO_2. Reduction in the emission of precursors of ozone, i.e. NOx and volatile organics, is also of benefit in its own right.

3.1.3 Particulates (PM_{10})

These are particles 10 millionths of a metre or less in diameter. They have no fixed chemical composition and are derived from a large range of natural and man-made sources. A large proportion of local, man-made particulate is derived from traffic, in particular but not exclusively from the diesel engine.

Particulates cause inflammation of the airways that may exacerbate existing lung disease and increase allergic sensitivity. It is now thought that a very fine fraction of particulates (much smaller than PM_{10}) may be responsible for most of the harmful health effects observed.

Since 1995, there has been no evidence sufficient to justify declaring an Air Quality Management Area on the basis of exceedance of the statutory Objectives for particulates. However, since 2005, there has been evidence of deterioration at certain monitoring sites (Vaughan Way, Glenhills Boulevard) to the extent of the Objectives being approached or exceeded. This is currently being kept under observation to determine whether there is a significant annual trend.

The reasons for this are considered to be similar to those for the lack of progress in reducing nitrogen dioxide levels, i.e. increasing traffic volumes and congestion, coupled with increasing numbers of diesel light and heavy vehicles.

In 2006, the Pollution Control Team collaborated with the Division of Child Health at Leicester University (Leicester Teaching Hospitals) in a cohort study to investigate the incidence of respiratory symptoms in a cohort of 4,400 children in Leicester and Leicestershire, aged between 1 and 5 years in 1998. Periodic checks on the existence of symptoms were made by questionnaire and the correlation with levels of locally generated PM_{10} particulate was investigated, using the AIRVIRO dispersion model to determine levels of exposure at each child's residential address. (It is hoped to repeat and expand this study). The data was adjusted for a non-spatial index of socioeconomic status.

In 1990, it was found that 11% of 1 – 5 year olds had diagnosed asthma, 16% had wheezed and 13% had reported attacks in the last 12 months. At the start point of the study in 1998, the prevalence of asthma and wheeze had doubled. The study found a strong association between exposure to locally generated

PM_{10} levels (at residential addresses near main roads) and the incidence of wheeze and cough, which was independent of social confounding factors. There was also found to be clear evidence for a dose-response relationship, i.e. the higher the level of exposure, the more prevalent were the symptoms. (Locally generated particulate pollution and respiratory symptoms in young children, Pierse, Rushton, Harris, Kuehni, Silvermann and Grigg, BMJ Thorax Journal, 2006)

It should also be noted that there is a strong correlation between primary particulate and nitrogen dioxide concentrations close to busy roads, because of the common source of each of these pollutants. Although the study modelled primary particulates, for the sake of simplicity, it is therefore likely that the elevated levels of nitrogen dioxide present were contributing to these health effects.

3.1.4 Other Pollutants

None of the other pollutants prescribed for the purposes of Part IV of the Environment Act 1995 constitute a significant issue in Leicester. Following application of the prescribed methods for the 2009 statutory Updating and Screening Assessment, it was determined that it is not necessary to proceed to a further Detailed Assessment (as specified in the Statutory Guidance) for the following pollutants:

PM_{10} particulates
Benzene
1,3-Butadiene
Carbon monoxide
Lead
Sulphur dioxide

3.2 The Leicester AQ Monitoring Network

3.2.1 Description of Monitoring Sites

Details of monitoring sites are set out in Table 3.2.1 and Fig. 3.2.1.

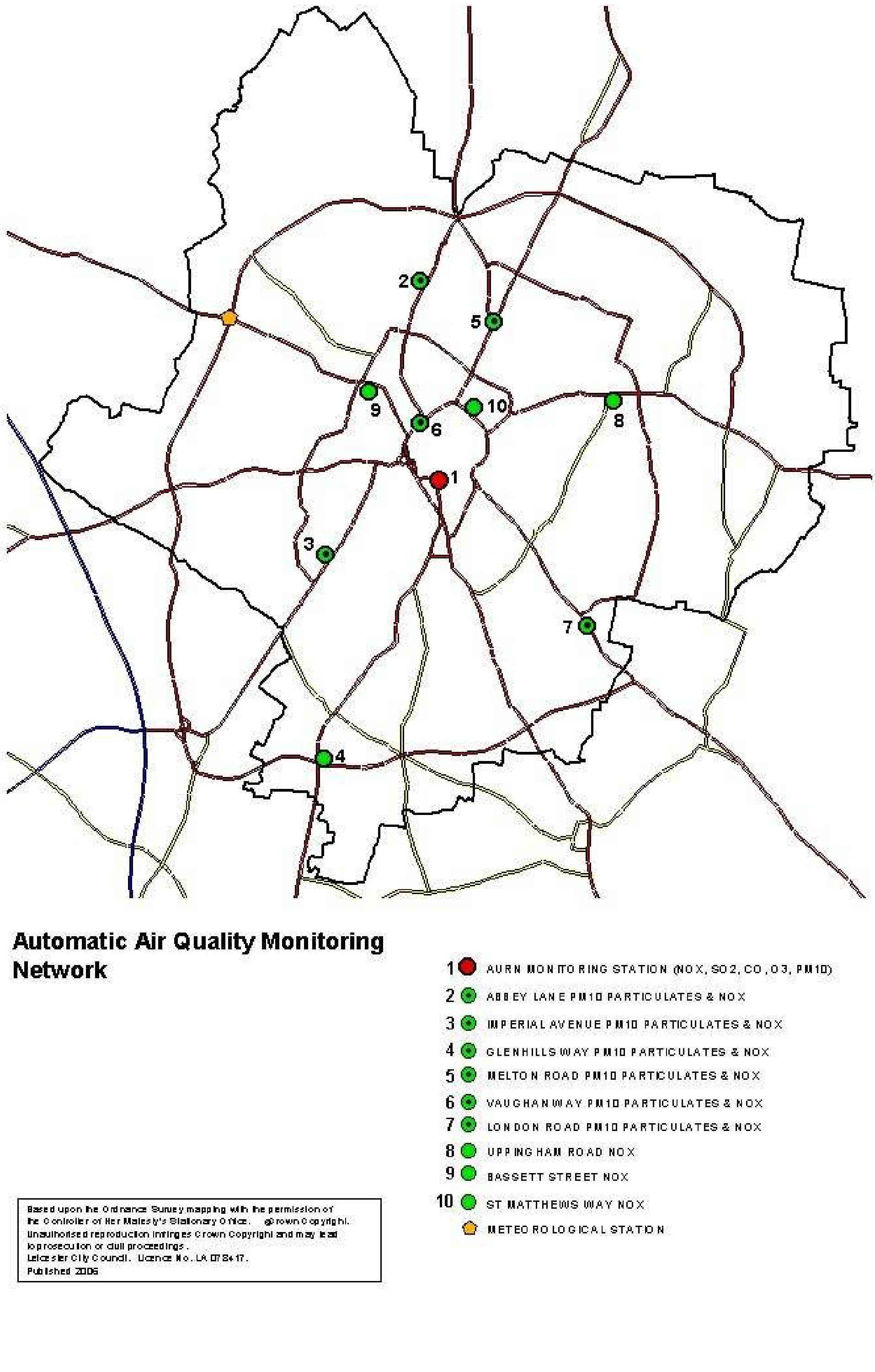
Table 3.2.1 Nitrogen dioxide - Details of Automatic Monitoring Sites

Site Name	Site Type	OS Grid Ref	Pollutants Monitored	In AQMA?	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (N/A if not applicable)	Worst-case Location?

AURN	Urban Background	X 458763 Y 304065	NO NO_2 CO2 O3 SO2	Y	N/A		
Abbey Lane	Roadside	X 458574 Y 306885	NO_2 PM_{10}	Y	0	7m	Y
Glenhills Way	Roadside	X 457083 Y 300156	NO_2 PM_{10}	Y	Y (11m)	3m	N
Imperial Avenue	Roadside	X 457245 Y 303040	NO_2 PM_{10}	Y	0	7.5m	Y
London Road	Roadside	X 460843 Y 302059	NO_2 PM_{10}	Y	N/A		N
Melton Road	Roadside	X 459528 Y 306316	NO_2 PM_{10}	Y	0	3m	Y
St Matthews Way	Roadside	X 459221 Y 305036	NO_2	Y	Y (7m)	2m	N.
Uppingha	Roadside	X	NO_2	Y	10m	2m	N

m Road		461188 Y 305306					
Vaughan Way	Roadside	X 458507 Y 304904	NO_2 PM_{10}	Y	N/A		N

Fig. 3.2.1



3.2.2 Data Quality Control

The data set out in this section is validated data from our network of automatic monitoring stations, which are maintained and calibrated to the same standard as the AURN network. . Nitrogen dioxide is monitored using chemiluminescent instruments.

3.3 Air Quality in Leicester – Nitrogen dioxide monitoring data

Table 3.3 summarises the full set of of annual mean nitrogen dioxide data from the Leicester monitoring network.

Table 3.3 Ratified Annual Mean NO_2 Monitoring Data for Leicester Automatic Sites
(Exceedances in red type)

Site	Year	Annual Mean (µg/m^3)	99.8th Percentile	Data Capture (%)
Imperial Avenue	1998 (Sep - Dec)	54	441	81
	1999	75		89
	2000	40		86
	2001	42		95
	2002	40		92
	2003	54		94
	2004	33		96
	2005	36	101	99
	2006	35		99
	2007	36		99
	2008	34		99
	2009	34		98
Melton Road	1998 (Nov - Dec)	63		93
	1999	63	504	72
	2000	57		91
	2001	61		94
	2002	69		95
	2003	63		92
	2004	50	114	88
	2005	52		99
	2006	50		99
	2007	53		99
	2008	53		100
	2009	56		97
St. Matthews Way	2001 (May - Dec)	61	264	60
	2002	63		95
	2003	65		95
	2004	60		96
	2005	52		98
	2006	58	141	87

	2007	56		99
	2008	51		91
	2009	56		97
Uppingham Road	2001 (May - Dec)	38	176	58
	2002	38		95
	2003	40		95
	2004	40		90
	2005	35	110	99
	2006	35		99
	2007	37		94
	2008	36		99
	2009	34		99
Glenhills Way	1999 (May - Dec)	69	288	78
	2000	63		92
	2001	63		95
	2002	61		79
	2003	71		92
	2004	67		94
	2005	57	174	97
	2006	68		100
	2007	66		99
	2008	67		99
	2009	75		99
Abbey Lane	1998 (Nov - Dec)	55		98
	1999	48		95
	2000	44		90
	2001	50		93
	2002	52		95
	2003	55		94
	2004	47		96
	2005	46		98
	2006	44		97
	2007	45		99
	2008	44		99
	2009	54		99
Vaughan Way	2005 (Aug - Dec)	49	146	41
	2006	53		99
	2007	56		99
	2008	57		99
	2009	57		99
London Road	2006 (Feb - Dec)	29	108	84

	2007	34		92
	2008	32		97
	2009	32		98

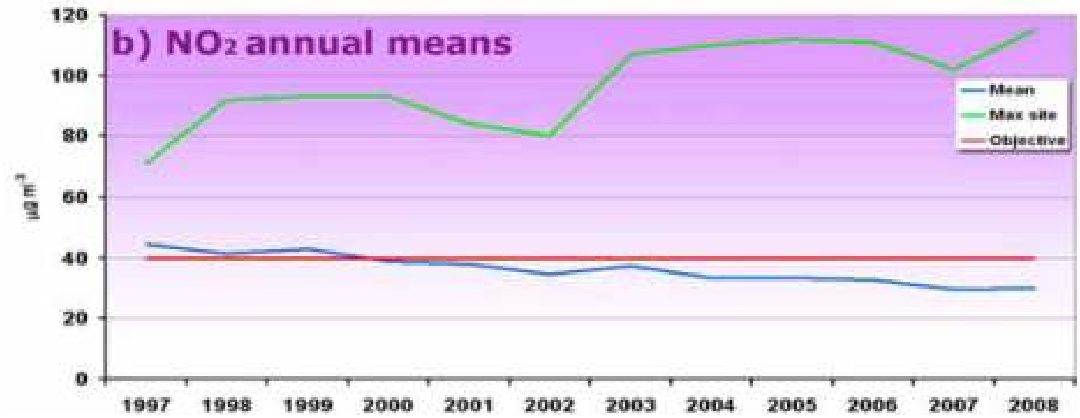
3.4 National and Local Trends – Nitrogen dioxide

3.4 1 National Trends

Concentrations of NO2 should have clearly declined between 1995 and 2008, as a result of reductions in emissions of NOx. These reductions have principally been in relation to emissions from road traffic, resulting from the Euro standards for new vehicles, and emissions from industry and power stations. Further reductions in UK-wide concentrations have been predicted as emissions decline further towards 2020.

UK monitoring network average NO2 concentrations (Figure 3.4.1) have been steadily declining over the last two decades and have been below the objective value since 2000; this trend looks set to continue. However, by contrast the highest concentrations of NO2 measured by the network appear to have been increasing over time at several of the busiest roadside monitoring sites. While this increase may have levelled off since 2003, concentrations at the most polluted sites remain well above the objective level. NO_2 limit exceedences are often seen close to roads, and recent trends in roadside measurements have shown that NO_2 is stable or increasing despite NOx emissions decreasing.

Fig 3.4.1



This increase in the relative proportion of NO_2 in overall NOx is making it harder to meet UK air quality Objectives and EU Limit values. Indeed, the UK has failed to meet 2010 European Legislative deadline for nitrogen dioxide and now faces legal proceedings.

Research has indicated that this is largely attributable to the increased proportion of primary NO_2 in the exhaust of diesel vehicles, associated with the increasing penetration of light diesel vehicles into the national fleet. Euro standards regulate NOx emissions, not NO_2 and some technology choices by vehicle manufacturers appear to be actually increasing the NO_2 : NOx ratio especially in diesels, while overall NOx (and CO_2) emissions are falling in newer vehicles. Less NOx is being emitted but more of it is being emitted as NO_2. Hence, increasingly stringent vehicle emissions standards are not being reflected in a fall in NO_2 levels at busy roadsides and, indeed may even be exacerbating the problem.

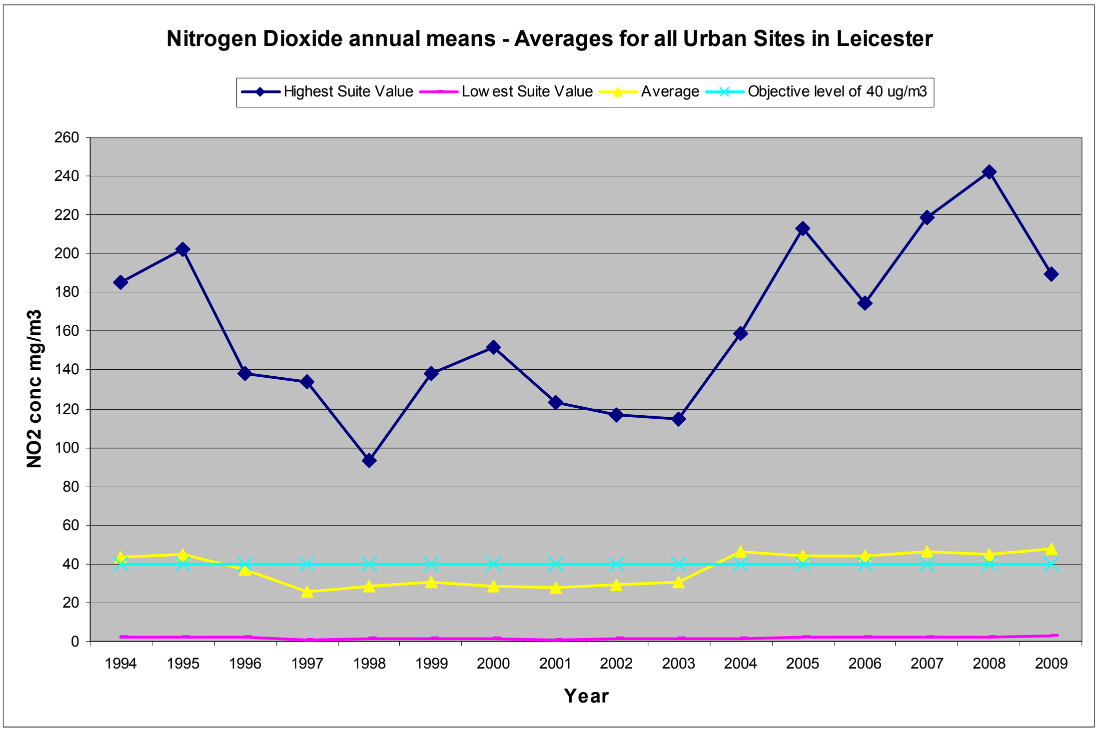
(UK Air Pollution, 2008 (DEFRA)).

3.4.2 Local Trends

The above comments about national trends are borne out by local monitoring data: It can be seen from Table XXX above that there is little evidence of a robust downward trend in the monitoring data. In fact, the situation appears to have deteriorated at certain locations. It was necessary to extend Leicester's AQMA (declared in 2000) in April 2008 to include an additional 102 houses on the northbound (western) frontage of Abbey Lane (see monitoring site at x 458574 / y 306885).

Fig. 3.4.2 shows the corresponding averages for all the Leicester urban nitrogen dioxide monitoring sites. A very similar pattern of significant increases in average maximum values at roadside sites can be seen. However, in the case of the Leicester data there is no observable decline even in the overall average mean values which have, if anything increased slightly.

Fig. 3.4.2



3.5 Progress Towards Previous Targets – Nitrogen dioxide

Given the above it is not surprising that there has been little progress towards achieving the air quality targets set for the Central Leicestershire Local Transport Plan 2006-11: Table 3.5/1 sets out measured values at receptor points compared to values predicted for 2010, when the impact of the Preferred Package of interventions for the Central Leicestershire Local Transport Plan 2006-11 were modelled, in 2006. It can be seen that the predicted reductions have not been realised and, in some cases, there is actually a deterioration compared to the 2003 – 05 averaged annual mean baseline.

Table 3.5/1 Nitrogen dioxide: Modelled* values for 2010 at Receptor Points corresponding to automatic monitoring stations, compared with -

- Smoothed measured baseline for 2003-05
- Modelled values for 2010 (LTP target - simulated implementation of LTP preferred package 2006 2011
- Smoothed measured values for 2007-09
- Measured annual mean values for 2009

The sites in bold type are Key Receptor Points, for which formal targets have been set for the Local Transport Plan 2006-11

Receptor Point	OS grid ref.	Type of site	LTP BASELINE (Average, measured annual mean NO_2 2003-5 ($\mu g.m^{-3}$))	LTP TARGET (Modelled Annual mean value for 2010)	Average, measured annual mean NO_2 2007-9 ($\mu g.m^{-3}$))	Measured annual mean values, 2009
Glenhills Way	457083-300156	Roadside	65	55	69	75
Abbey Lane	458574-306885	Roadside	49	42	48	54
Melton Road	459528-306316	Roadside	55	47	54	56
St. Matthews Way	459221-305036	Roadside	59	48	54	56

AUN (New Walk Centre)	458763-304065	Background	35	N/a		
Bassett Street	457788-305444	Roadside	39	43[1]		
Imperial Avenue	457245-303040	Roadside	41	< 40		
Uppingham Road	461188-305306	Roadside	38	< 40		
Vaughan Way (East Bond Street)	458507-304904	Roadside	50[3]	N/a		
London Road	460843-302059	Roadside	40[3]	< 40		

* Results obtained using AIRVIRO dispersion model

Considerable year-on-year fluctuations in annual means are observed at our monitoring sites, which makes it difficult to determine trends over small numbers of years. In Table 3.5/2 an attempt has been made to smooth the data by calculating 3-year rolling averages of the annual mean values for nitrogen dioxide at our receptor sites. Even taking this descriptor, there has by no means been a discernable fall over the last decade, in some cases the reverse.

Table 3.5/2 Three-yearly Rolling Averages –
Annual Mean Nitrogen Dioxide at Key Receptors

Annual Means	Melton Road	St. Matthews Way	Glenhills Way	Abbey Lane
1999	63			48
2000	57		63	44
2001	61		63	50
2002	69	63	61	52
2003	63	65	71	55
2004	50	60	67	47
2005	52	52	57	46
2006	50	58	68	44
2007	53	56	66	45
2008	53	51	67	44
2009	56	56	75	54
Three-year Rolling Averages				
1999-2001	60			47
2000-2002	62		62	49
2001-2003	64		65	52
2002-2004	61	63	66	51
2003-2005	55	59	65	49
2004-2006	51	57	64	46
2005-2007	52	55	64	45
2006-2008	52	55	67	44
2007-2009	54	54	69	48

3.6 Developments with Potential to Influence Air Quality

Where the characteristics and impacts of the following are known with any certainty, they have been taken into account in the dispersion modelling undertaken in connection with this Air Quality Action Plan. (See Section 3 for details).

3.6.1 District Heating / Combined Heat and Power Project

Leicester City Council has now signed a contract for a major project which will link existing district heating schemes and other major heat users in the City, using combined heat and power technology in order to effect a stepwise reduction in carbon emissions from building energy supply.

This will involve upgrading and linking the existing housing estate district heating schemes and various major buildings, including the Council offices.

While, at time of writing, the full details remain to be worked out, the proposed use of biomass combustion plant has potential air quality implications. The installations, and associated stacks and abatement equipment will be controlled by planning conditions and it is anticipated that emissions within the urban area will not be significant compared to traffic emissions and will not influence the extent of the Air Quality Management Area.

3.6.2 Development

a) Ashton Green

This major urban extension in the last remaining large undeveloped area of the City at the northern boundary is at the planning application stage, at time of writing. It has various potential implications for air quality:-

Additions to the road network and increased traffic on the existing network;

The use of biomass fuel in centralised or dispersed heating plant.

Again, these issues will be controlled by means of planning conditions and they are unlikely to make a significant contribution to levels of nitrogen dioxide, for example to the extent of necessitating an extension to the Leicester Air Quality Management Area.

b) The Highcross Shopping Centre

This major shopping development opened in September 2008 and included a 3,000 place multi-storey car park on the inner ring road. It clearly has the potential to attract a significantly increased number of journeys to the City Centre.

3.6.3 Road Schemes

The 2009 statutory Updating and Screening Assessment did not indentify any road schemes, or changes to flows on existing roads with the potential to have a significant impact on air quality emissions.

3.7 The Amount of Improvement Required

During drafting of the Central Leicestershire Local Transport Plan 2006-11, consideration was given to the four Key Receptor Points selected to set the principal Air Quality for the LTP. These are locations which were predicted not to achieve the annual mean Limit Value for nitrogen dioxide. This prediction has turned out to be true and, in fact, the shortfall was significantly underestimated (see Table 3.5/1).

Traffic reductions required to meet the annual mean Limit Values for nitrogen dioxide in 2010 at those sites have been calculated using the DMRB (Design Manual for Roads and Bridges) and verified against monitoring data at the site in question. The results are summarised as follows:

Key Receptor Point	Estimated reduction in traffic flow (AADT) needed to achieve the Limit Value in 2010 (%)
Abbey Lane	13
Melton Road	56
Saint Matthews Way	78
Glenhills Way	46

Scenario modelling of various park and ride schemes indicated that, were they to be implemented, they would result in reductions in maximum annual mean levels of, at the very most, 1 – 2 microgrammes per cubic metre of nitrogen dioxide (annual mean), on the adjacent corridors.

3.8 Methodologies for Target Setting

In Leicester City, it is clear from Section 3.4 above that interventions which -

Are within the scope of available legislation;
Have identifiable sources of funding; and
Are currently acceptable to the various stakeholders;

- are unlikely to achieve the full improvement in levels of nitrogen dioxide required within the life of the current Local Transport Plan. (Annual mean not to exceed 40 $\mu g.m^{-3}$)

Setting a single air quality for Leicester City Council's whole area is problematic:-

While excess levels of nitrogen dioxide are clearly a network wide problem -

Peak values for nitrogen dioxide levels differ widely over the zone of exceedance;

Different projects will exert different effects on different areas and parts of the road network;

Year on year, annual mean values will vary unpredictably with the vagaries of the weather and other extraneous factors.

The following general approach has been adopted to setting limits and associated trajectories for Leicester City: Receptor Points have been designated within the LTP area; these correspond to points on the highway network, where:

Automatic monitoring sites for nitrogen dioxide are located;
Exceedances of the Objective for nitrogen dioxide have been measured in the last 5 years OR mapped in the vicinity by dispersion modelling; and
Schemes contained in this Air Quality Action Plan are anticipated to have a significant influence on levels of nitrogen dioxide.
There is significant predicted population exposure.

The Receptor Points have the following purposes:-

Setting an air quality baseline for the Local Transport Plan;
Calibrating / validating predictive dispersion modelling of the measures contained in the Local Transport Plan;
Setting targets for the air quality-related measures contained in the LTP;
Verifying predictions of the impact of such measures over the life of the Local Transport Plan; and
Annual reporting of progress with air quality, under both DfT and DEFRA reporting requirements.

As with the Central Leicestershire Local Transport Plan 2006 – 11, targets were established for four key receptor points:

St. Matthews Way
Abbey Lane
Melton Road
Glenhills Way

In addition, the data for the national AURN background site at New Walk Centre was considered.

A nitrogen dioxide baseline was established, using the validated, average, measured annual mean value for each site over the three years 2007-9 . This approach to some extent smoothes out variations due to the weather and other extraneous factors. This baseline is centered upon 2008, which is the base year used for traffic and dispersion modelling.

Various methodologies and sources of data were considered for setting air quality targets for the Local Transport Plan Preferred Package. These were all subject to various difficulties and limitations, so the approach was taken of collating and comparing the results of the different methods in the light of the observed air quality data and trends detailed in Section 3.4 above. A composite estimate of the likely range of impact of the interventions proposed in the Local Transport Plan was then constructed.

Computer dispersion modelling using the AIRVIRO (SMHI) model.

Computer dispersion modelling, from a study commissioned for Leicester City Council from TRL consultants using the ADMS (CERC) model.

Extrapolation of monitoring data (Section 3.3), using the methodology set out in DEFRA Technical Guidance (LAQM.TG(09)).

Consideration of trends in the monitoring data over recent years.

Consideration of trends in intermediate (non-air quality) data.

Each approach is described in detail in Sections 3.9 to 3.12, below.

3.9 Dispersion Modelling (AIRVIRO Model)

3.9.1 General Considerations

Measured data provides the most accurate picture of the air pollution. It allows obtain the concentration of the various compounds at a specific place, and non-experts easily understand the results if they are well presented. The disadvantages on relying only on the measured data are as follows:
Single locations only are characterised (even if the results from various measurement stations sometimes may be generalised to larger areas)

They describe concentrations at present and archived data but say nothing about future air quality.

Having a network of hundreds of monitoring stations everywhere would make it possible to gain full knowledge of the ambient air quality, but the costs of such enterprise would be exorbitant. Simulation models offer a cheaper way of describing air quality conditions over large areas, as well as permitting statements about the future. They can also allow to study various scenarios, where air quality measurers are planned to be implemented or designed.
The simulations give the overall description, while the data should be used to confirm the validity of the model results. Validation of simulation results from measurements gives confidence in forecast simulations.
Simulation models are of great value in the interpretation of measured data.
In order to describe the existing or future pollution levels of an urban area we need to have a database full of information on sources of pollution, meteorological data:

Dispersion models used will give poor results if emissions are erroneously specified.

The meteorological parameters used in the modelling have to refer to locally determined conditions, preferably through profile measurements in masts. The wind model must be able to realistically cope with calm situations with weak vertical mixing (stable stratification), i.e. when critical pollution levels are likely to occur.

For urban applications (that is, a few tenths of a kilometre), the use of the Gauss plume models the best option: it is fast to run and is also well tested. Its empirical coefficients have been documented, compared and discussed for many years.

Model results should be presented in such a form that can be directly compared with national standards. This means that the simulations should cover not only specific weather conditions (present or historical) but also a time period specified by regulations (typically covering a whole year).

3.9.2 The AIRVIRO Model

The Airviro system is a tool for both data analysis and dispersion modelling. It is an integrated system that allows for measured and simulated values to be statistically evaluated over a given period.

Airviro has is a web based user interface. Airviro can be used from a PC or any other device running Internet Explorer 6 or later and Firefox. After logging in on Airviro the DISPERSION module can be selected. All data processing is made on the Airviro server and the results are transferred to the web browser.

Dispersion model was originally developed by INDIC, but now distributed, supported, and further developed by the Swedish Meteorological and Hydrological Institute (SMHI). The model is capable of grid, Gaussian, or canyon dispersion calculations. The model operates on a UNIX workstation, and includes modules for data collection, and dispersion calculations, and an emissions database. Dispersion calculations are performed in the Dispersion Module, using meteorological data collected from the Leicester meteorological mast together with emissions data from the emissions database. Emission sources for modelling using AIRVIRO are defined as point (e.g. industrial and commercial buildings), line (roads), or area (residential estates, or large industrial) sources.

The Leicester AIRVIRO model can be run on either a City or County map, zooming into a smaller area where greater detail is required. Emissions from the entire selected map are used for dispersion calculations; even where the zoom function has been used to select a smaller area for subsequent post modelled display.

The Gauss model was used for this modelling, this is a relatively accurate model and is suitable for use of the area required for this modelling. The Local Air Quality Management Technical Guidance, LAQM TG (03) describes this type of model as being suitable for use.

The following is a summary of how the Gauss model works taken from the manual for the Swedish Meteorological and Hydrological Institute’s AIRVIRO Modelling suite:

This model (Gauss) is used to simulate the distribution of ground concentrations of pollutants over urban or industrial areas with a typical scale of one or a few tenths of kilometres. The size of the application area is limited from below by the fact that the Gaussian model coefficients are not valid close to the source (distances below approximately one hundred metres). The upper limit is given by the fact that more or less stationary conditions should prevail for the time it takes for an air parcel to be advected through the area. One hour mean values are simulated, as it is known that the wind may be more or less constant during such a period (daily averages would not be sufficient). With wind speeds of 2 - 5 m/s, an air parcel would travel 7 - 18 km within one hour. This limitation of the Gaussian model should be kept in mind while performing simulations on scales larger than 20 km.

3.9.3 Calibrating and Validating the Model

The methodology adopted was identical to that used during the Stage 3 process, and this is detailed in full at Appendix E of the Stage 3 Review and

Assessment report. In order to estimate the uncertainty associated with the modelling outputs, the approach in the NSCA Guidance Note “Air Quality Management Areas: Turning Reviews into Action” was adopted.

a) Predicted annual means

Current annual mean levels for nitrogen dioxide were modelled, using Airviro at receptor points corresponding to monitoring stations. 2008 was the year selected, as full monitoring data was available and this also corresponded to the latest, updated TRIPS model.

(i) Systematic Error

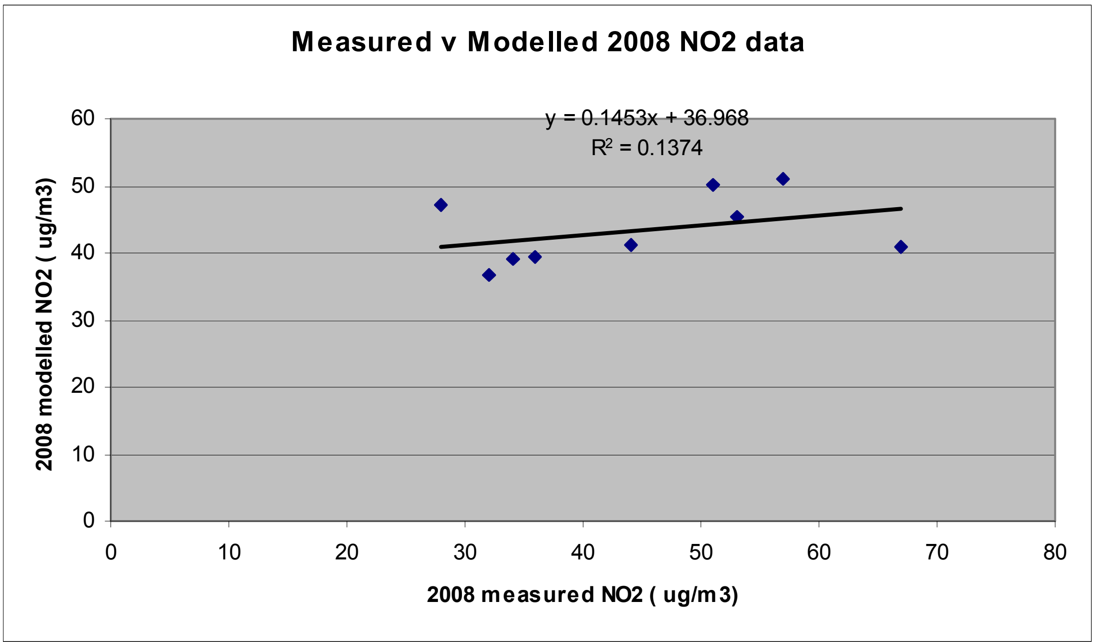
During Stage 3 work, it was noted that the model was subject to a systematic error in predicting values. There was a tendency to overpredict at background stations not directly affected by road traffic, whilst at roadside locations the model would underpredict. Monitoring stations were therefore classified according to their distance from road; for Stage 4 analysis, data from additional roadside monitoring stations were available.
In interpreting the modelling results across the entire mapped area it is necessary to take account of this systematic error. Direct comparison of monitored values with the model predictions at each monitoring station allowed a correction factor to be calculated:

Location	Distance from ker (m)	Monitored 2008 NO (ug/m3)	Modelled 2008 NO (ug/m3)	Adjustmen t factor	Modelled 2008 NO (ug/m3) (X adjustment factor)	Modelled 2016 NO (ug/m30) (X adjustment factor)
AURN	35	28	47.14	0.59	27.81	20.6972
Melton Road	3	53	45.52	1.16	52.8	39.9272
Imperial Ave	7.5	34	39.03	0.87	33.95	23.9424
Glenhills Way	3	67	40.81	1.64	66.99	41.4428
Abbey Lane	7	44	41.27	1.06	43.74	29.6694
Uppingha m Road	2	36	39.48	0.91	35.92	27.1271
St Matthews Way	2	51	50.16	1.016	50.96	37.62248
London Road	3	32	36.68	0.87	31.91	22.1589
Vaughan Way	3	57	51.05	1.11	56.66	41.5251

Mean		44.66667		1.025111		20.6972

The model predictions showed a similar pattern in over-predicting at the background sites, and under-predicting at the roadside locations. This is not surprising as the model is unable to account for the variability in emissions that will occur close to the road even over a long term averaging period such as the annual mean. This does, however, mean that the error will be more significant for the shorter averaging period required for the 1hour objective.
The ratios for monitored and modelled data were plotted in scatter graphs and a strong relationship was obtained, however it is clear that there is systematic error within the modelled data that needs to be accounted for.

Chart 3.9.3/1: Correlation between monitored and modelled data at automatic sites

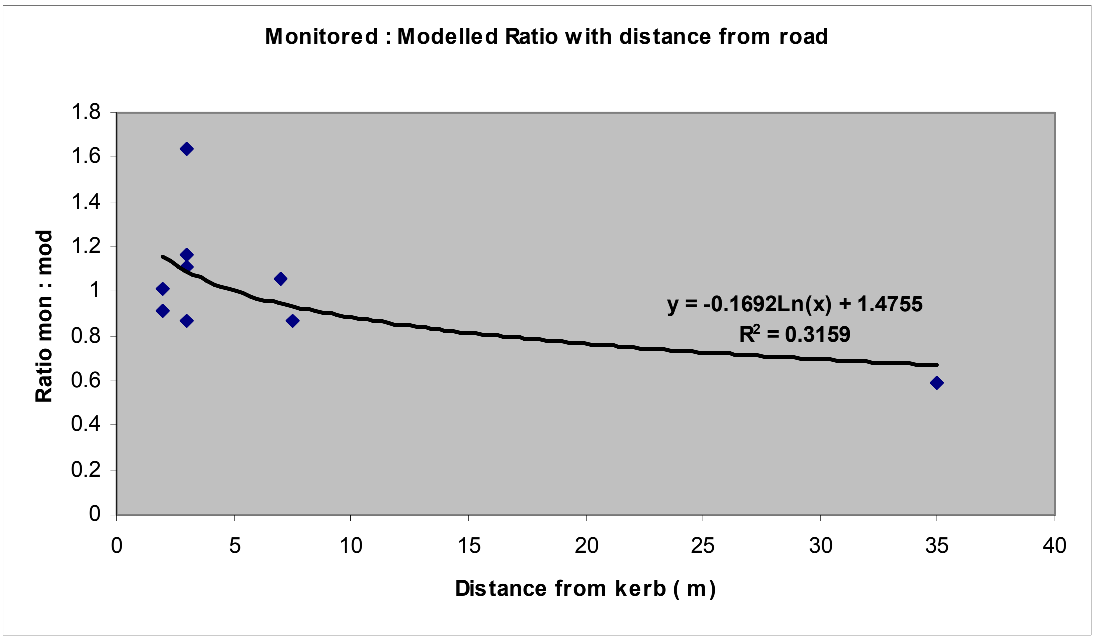


The modelling results from Stage 4 show an improved correlation between monitoring and modeled data. This modelling showed similar overall performance to that undertaken at Stage 3 in predicting non-roadside values, but showed a marked improvement at roadside receptor points.

Table 3.2.2.7/2: Comparison of model performance at Stage 3

	Stage 3 correction factor	Stage 4 correction factor
Background Sites	0.87	0.59
Roadside Sites	1.51	1.025

Chart 3.9.37/2: Kerb distance and model correlation



The relationship between kerbside distance and correlation of monitored and modelled data was also considered.
From the scatter plot, the correction factor is closest to unity at approximately 18 metres from the kerb. As distance from kerb increases, the correlation between modelled and monitored is reduced.

(ii) Random error

After the systematic error has been accounted for, there is still some error remaining within the modelling. There are greater difficulties in defining the degree of uncertainty using statistical analysis of the available data, due to the inherent uncertainties of modelling, together with assumptions or inaccuracies in input data. The method suggested in the NSCA Guidance Note was therefore used to calculate the standard deviation (SDM) for the model.

TABLE 3.9.3/1: MODELLING DEVIATION AT RECEPTOR POINTS

Receptor Point Modelling Deviation Standard Deviation

Receptor Point	**Modelling Deviation**	Standard Deviation of data (SD)
AURN	1.0364	1.913883
Melton Road	4.6689	
Imperial Ave	1.9082	
Glenhills Way	6.7031	
Abbey Lane	3.3612	
Uppingham Road	2.1988	
St Matthews Way	4.3783	
London Road	1.6176	
Vaughan Way	5.2501	

U = SD/Mean of monitored data

U= 5.164815/44.66 = 0.116
SDM = 0.116 x 40 =4.6 µg/m3

The standard deviation was calculated to be 2.4 µg/m3 for annual mean NO_2 , and the modelling maps are presented with the increments of +/- 1 SDM's. At stage 3, a conservative approach was taken and the boundary of the AQMA was drawn at the –2 SDM value to ensure that all likely exceedances were included within the AQMA.

3.9.4 Atmospheric Chemistry of Nitrogen Dioxide

The most important nitrogen oxides that are being monitored are nitrogen monoxide NO and nitrogen dioxide NO_2. Both together are called NO_x. The nitrogen molecules (N_2) in the air are very stable and it is not easy to oxidise them. This can only happen under extreme conditions. One example is during the combustion of fuel in a car engine. Most anthropogenic NO_x comes from this source. It can also happen during other very hot reactions, e.g. in the hottest parts of biomass burning flames. Across Europe road transport is the largest contributor of NO_2, accounting for 40% of total European NO_x (EEA 2010). The main reason for the invention of the catalytic converter for cars was, to avoid strong emissions of nitrogen oxides.
We find NO_x (= NO + NO_2) and other nitrogen oxides nearly everywhere in atmospheric chemistry. During the night, nitrate radicals NO_3 are formed and are the most active oxidants. Radicals are chemical species, which are very instable and usually react extremely fast.
If N_2O_5 is formed in polluted areas, it can react on droplets or wet surfaces with water and nitric acid HNO_3 is formed. HNO_3 contributes to the acid character of the rain. Nitric acid, which can also be formed during the day by oxidation of NO_2, is the main way how nitrogen oxides are removed again from the atmosphere, either by dry or by wet deposition (wash out by rain).
Nitric acid tryhydrate forms the particles on which the ozone hole developed.
Nitrogen oxides as gases are very important for the formation and degradation of tropospheric ozone, because they are involved in catalytic cycles. This is mainly, because NO_2 can be photolysed by the sunlight. It forms NO and this NO is oxidised again to NO_2. Ozone as well as organic peroxi-radicals (instable oxidised compounds) is involved in this cycle.

$NO + O_3 \rightarrow NO_2 + O_2$ Typical rate of the reaction - seconds
$NO_2 + hv$ (sunlight) $\rightarrow NO + O$ (+ $O_2 \rightarrow O_3$) Typical rate of the reaction - minutes

3.9.5 Correction for Exposure

Some monitoring sites are at the same distance from the adjacent highway as the nearest sensitive receptor, e.g. houses, and therefore give a good representation of exposure. However, in some cases the distance to nearest sensitive receptor is slightly different, compared to that to the monitoring station. Since compliance with the air quality Limit Value is only relevant where exposure is a factor, it should be borne in mind that an adjustment for distance needs to be made in these cases, in future assessments of whether the Limit Value is likely to have been met.

Evaluating the decay of annual mean levels of nitrogen dioxide with increasing distance from the source is attended with some uncertainty: Conversely, the measured annual mean of hourly values taken at an automatic site with proper maintenance and calibration protocols can be assigned a high degree of accuracy and precision. It should therefore be noted that it has been decided to quote target values derived for the LTP at the relevant automatic monitoring site.

Nonetheless, where receptors do not represent actual exposure (e.g. are closer to the highway than housing), a correction has been estimated to account for the difference in distance from the source road of automatic monitoring site and for the nearest sensitive receptor. Subject to its degree of uncertainty, this can be used to:

- Adjust the targets set for each site for exposure; and
- Correct observed values, when using monitored data to track progress towards the air quality targets, over the lifetime of the LTP.

3.9.6 Modelling Results

Table 3.9.6/1: Summary of Predicted Receptor Point Values, Corrected for Distance
(µg.m-3, Nitrogen dioxide)

Site	Baseline (µg.m-3, Nitrogen dioxide) (2007-09)	Predicted by model at monitoring site, 2016	Distance correction to nearest sensitive receptor (m)	Estimated value at sensitive receptor	Correction to be made to observed value, for distance to sensitive receptor
AURN	28.99	20.6972	-27	19.0983	1.5989
Melton Road	54.08	39.9272	0	39.9272	0
Imperial Ave	34.52	23.9424	0	23.9424	0
Glenhills Way	69.35	41.4428	11	34.8828	6.56
Abbey Lane	47.64	29.6694	0	29.6694	0
Uppingham Road	35.74	27.1271	10	26.7085	0.4186
St Matthews Way	54.32	37.62248	7	35.65144	1.97104
London Road	32.33	22.1589	20	21.4542	0.7047
Vaughan Way	56.96	41.5251	20	32.2122	9.3129

3.9.7 Limitations and Uncertainties of Modelling

Various issues have arisen when carrying out this dispersion model which have raised uncertainties with the reliability of the outputs: These can be summarised as follows:-

a. The Preferred Package

Due to the economic situation and fiscal constraints following the Comprehensive Spending Review in 2010, the funding available for the Preferred Package will be significantly reduced.

b. Traffic Modelling

It has not proved possible to develop and apply the proposed Leicester and Leicestershire Integrated Transport Model in time to use its outputs as inputs for the AIRVIRO model and data from the previous SATURN model have, perforce been utilised. The Emissions Database of the model is not therefore as up-to-date as is desirable to simulate the air quality outcomes of the period up to 2016.

c. Air Quality Trends

As has been discussed in Section 3.4, roadside nitrogen dioxide levels have not fallen as predicted and, in some situations appear to be deteriorating. Work is ongoing to analyse this anomaly but, in the meantime, it raises questions as to whether input data and, in particular vehicle emission factors (See (d) and (e) below) are overly optimistic.

d. Vehicle Emission Factors

The current emission factors for road transport have been revised in June 2010. The new emission factors incorporate the latest test data on vehicles meeting the new vehicle Euro emission standards, the formulae also address published future standards. The emission factors can be found at http://www.naei.org.uk/index.php In preparing the formulae, TRL addressed concerns raised in the public consultation.

After extensive scrutiny of the published emission factors it was concluded that there are several issues that concern us.

1. The mileage scaling factors they provided to DfT, which have a large impact on NOx, PM, HC and CO emissions appear not to recognize the potential for the '…early introduction of EURO classes that was flagged with DfT at the time'. TRL advised that DEFRA commissioned Bureau Veritas to advise on the final form and values of these factors for the EFT. However, there is no clear documentation (that can be found) as to what scaling factors Bureau Veritas eventually recommended to correct the above issue.

2. The EFT includes treatment of cars with failed catalytic converters, and the latest fleet projection documents (Murrells and Li, 2009). However it's not clear from the DfT, TRL or EFT documents as to how these vehicles should be modelled.

3. The EFT includes models for brake and tyre wear contributions to particulate matter – again it's not immediately clear where these models have come from. The QA document from the EFT doesn't seem to mention sources.

4. The EFT document makes basic assumptions on the fleet splits on roads (e.g. the number of motorcycle kms travelled as opposed to cars in the 'light duty' vehicles category) – again it isn't clear where these assumptions are drawn from.

Unfortunately all of the above mean that, the emissions factors underestimate emissions of NOx and PM. As these are the key pollutants of concern, the discrepancies definitely need to be sorted out.

e. Vehicle NOx / Primary NO_2 Ratio

Production of NOx and a vehicle's f-NO2 is governed by combustion and catalysts used in cars to reduce PM10 emissions. Current technology employed in diesel vehicles leads to greater production of total NOx and a greater f-NO2. This leads to a situation where the total amount of NOx can be regulated but the production of NO or NO2 (f-NO2) is not. The after treatment devices for exhaust of some cars cause additional formation of f-NO2. The situation is going to escalate with more vehicles of this type joining the UK fleet – around 42% of new car sales are predicted to produce more f-NO2. This in turn will cause a significant rise of f-NO2. In order to be able to predict air quality issues on roads, the problem with f-NO2 needs to be addressed. At the moment the on-road f-NO2 is poorly defined due to the uncertainty of f-NO2 productions by vehicles and the small number of on the road measurements (Simmons et al 2010).

3.9.8 Discussion and Conclusions for Air Quality Targets

Taking into consideration recent years' monitoring data, we have serious doubts as to the credibility of current dispersion modelling. This question is being addressed by DEFRA and others but it is not considered appropriate to use the model in isolation its current state as a basis for significant administrative decisions, for example Review and Assessment, with consequent implications for the existing AQMA, or for setting formal targets for the third Local Transport Plan.

It was therefore decided to include the model in a review of the outcomes of a range of estimative measures for predicting air quality and this is taken up in Sections 3.11 to 13, below.

3.10 The TRL Study (ADMS Model)

3.10.1 Modelling assessment approach

Atmospheric dispersion modelling was undertaken for the base year 2008 and future year 2013 using the Gaussian-based ADMS-Roads (Extra) software suite (version 2.3), developed by Cambridge Environmental Research

Consultants (CERC)11. This future year was assumed as it is within the time horizon of the Council‟s LTP3 and the schemes were also considered appropriate to be implemented within 3-4 years.

The ADMS-Roads model uses a number of input parameters to simulate the dispersion of pollutant emissions, predicting pollutant concentrations at specified receptors and across a user-defined area. For the work reported here the key parameters included link based emission rates and local meteorological conditions.

The model domain, considered for this assessment, included the Hinckley Road and Leicester City Centre areas. Pollutant concentrations were modelled at specific receptors along the Hinckley Road (the radial route into the city centre) and at selected receptors within the city centre (see Table 3.12.1 and Figure 3.12.1. Receptors within the city centre were located 100m apart along two transects (north/south and east/west). Two additional receptors were positioned to coincide with current monitoring sites at New Walk and St Mathews Way.

Table 3.10.1: Modelled receptor locations.

Receptor	**X**	**Y**	**Site information**	**Within AQMA? (Y/N)**
LCC1	454261	303589	Roadside	N
LCC2	454256	303597	Roadside	N
LCC3	454708	303842	Roadside	N
LCC4	454714	303835	Roadside	N
LCC5	455009	303977	Middle of roundabout	Y
LCC6	455371	304041	Roadside	Y
LCC7	455370	304055	Roadside	Y
LCC8	455887	304204	Roadside	Y
LCC9	455892	304197	Roadside	Y
LCC10	456332	304237	Roadside	Y
LCC11	456334	304248	Roadside	Y
LCC12	456912	304235	Roadside	Y
LCC13	456913	304254	Roadside	Y
LCC14	457697	304362	Roadside	Y
LCC15	457701	304383	Roadside	Y
LCC16	458186	304360	Roadside	Y
LCC19	458285	304361	Urban	Y
LCC20	458384	304361	Roadside	Y
LCC21	458484	304360	Urban	Y
LCC22	458584	304361	Urban	Y
LCC23	458685	304361	Roadside	N
LCC24	458785	304361	Roadside	N
LCC25	458886	304360	Urban	N
LCC26	458985	304361	Roadside	N
LCC27	459088	304361	Roadside	N

LCC28	459188	304361	Roadside	N
LCC29	459290	304360	Roadside	Y
LCC30	459390	304363	Roadside	Y
LCC31	458923	305217	Roadside	Y
LCC32	458923	305115	Urban	Y
LCC33	458925	305013	Roadside	Y
LCC34	458923	304914	Roadside	Y
LCC35	458923	304811	Roadside	Y
LCC36	458923	304710	Roadside	Y
LCC37	458928	304607	Urban	Y
LCC38	458922	304507	Urban	Y
LCC39	458924	304403	Urban	N
LCC40	458925	304298	Roadside	N
LCC41	458923	304194	Urban	N
LCC42	458923	304092	Roadside	N
LCC43	458923	303992	Urban	N
LCC44	458923	303887	Roadside	N
LCC45	458923	303787	Roadside	N
LCC46	458924	303687	Roadside	N
LCC47	458924	303585	Urban	N
LCC48	458923	303486	Urban	Y
LCC49	458922	303384	Urban	Y
LCC50	458923	303285	Roadside	Y
New Walk	458762	304065	Roadside	Y
St Matthews	459221	305036	Urban	Y

Figure 3.10.1/1: Modelled receptor locations: Leicester city centre.

The ADMS-Roads model was set up to model emissions from the road source only. The contribution of emissions from roads not modelled and other sources (such as rail and industries) in the local area, as well as regional sources, were accounted for using background files relevant to Leicester, according to the recommended methodology in TG (09) (Defra, 2009).

3.10.2 Detailed methodology

a) Background concentrations

Appropriate background concentrations of NO2 and PM10 were taken from the UK Air Quality Archive website (Defra, 2009). For PM10 a single average value was applied for the Hinckley Road and City Centre zones in accordance with the grid configuration shown in Figure 3.12.1/1 and for NO2 each receptor was assigned to a specific grid square with the appropriate background value.

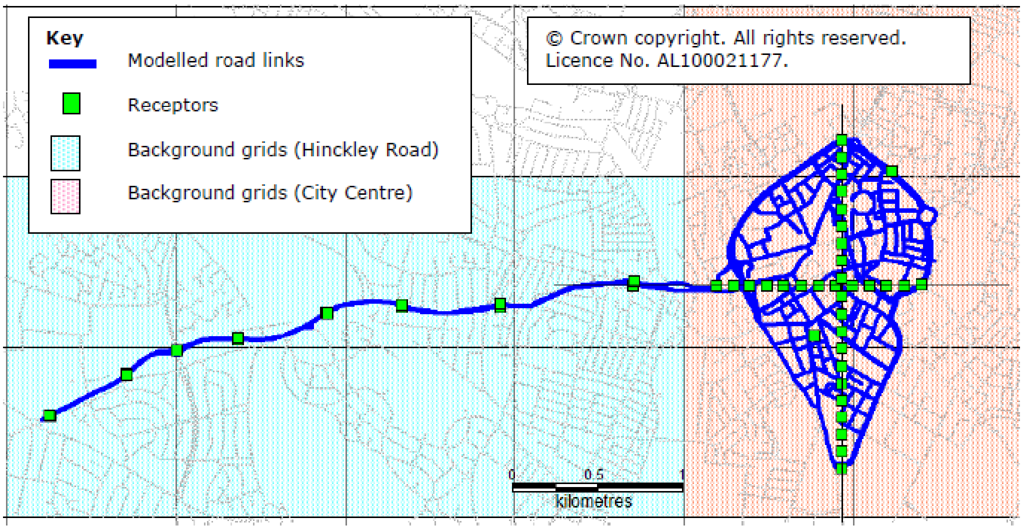


Figure 3.10.2/1: Assessment area: modelled road links, receptor locations and background grids.

b) Traffic activity

Annual average daily traffic (AADT) flows and vehicle speeds (km/h) for year 2004 were obtained from Leicester City Council emissions database (EDB) (LCC, 2009). The road type was determined from the EDB and used to identify a coarse fleet composition for each of the modelled road links in 2004. Traffic flows for each road type were forecast to 2008 and 2013 using factors obtained from the Automated Traffic Growth Calculator spreadsheet12 and assuming the same fleet composition as in 2004. The Automated Traffic Growth Calculator spreadsheet allows growth factors for each vehicle type, or for all vehicles, to be determined based on a geographical area or road type. In this case the area selected was the East Midlands and the area type selected was „large urban‟. Summarised traffic data are provided in Appendix E.

c) TEEM emission factor database

TEEM currently only includes a calculation method for hot exhaust emissions of certain regulated pollutants. Unregulated pollutants, cold-start emissions, evaporative emissions of VOCs and non-exhaust PM are not yet incorporated. The actual emission model in TEEM is currently a combination of emission factors and algorithms from different sources, but is presented within a common framework. The actual sources of the emission factors used are shown in Table 3.12.2/1. These are the most recent emissions factors available for assessment in the UK and identical to those available from the Department for Transport.

Table 3.10.2/1 Sources of hot exhaust emission factors for CO, NOx, PM and CO2.

Vehicle Category Level 1	Level 2	**DATA SOURCE**	**REFERENCE**
LDVs	Cars	NAEI14 for pre-Euro 1, COPERT IV15 for Euro 1 and later	http://lat.eng.auth.gr/copert/
	Taxis	Assumed equal to diesel cars > 2.0	http://lat.eng.auth.gr/copert/
	LGVs	NAEI	http://lat.eng.auth.gr/copert/
HDVs	Rigid HGVs	COPERT IV functions for level gradient and 50% load	http://lat.eng.auth.gr/copert/
	Artic. HGVs		http://lat.eng.auth.gr/copert/
	Buses		http://lat.eng.auth.gr/copert/
	Coaches		http://lat.eng.auth.gr/copert/
2-wheel vehicles	Mopeds	ARTEMIS	http://lat.eng.auth.gr/copert/
	Motorcycle	ARTEMIS	Elst et al. (2006)

The model uses „average-speed‟ functions, based upon the principle that the average emission factor for a certain pollutant and a given type of vehicle varies according to the average speed during a trip. The emission factors are stated in grammes per vehicle-kilometre (g vehicle-1 km-1).

d) Road vehicle fleet

For emission inventories and air pollution models traffic data are required for a large number of vehicle categories in order to reflect variation in emission behaviour. The hierarchical fleet structure employed in TEEM is illustrated in Figure 5.4. In this Figure, each stage in the sub-division of the traffic is termed a „Level‟. There are six levels in total, but not all the details are included below Level 3 in the Figure.
In order to estimate emissions from traffic, the proportion of each vehicle category in the traffic (*i.e.* at Level 6) needs to be defined.
Vehicle categories can also be considered as „coarse” and detailed. The coarse vehicle categories (Levels 0-2) are:

- Cars
- Taxis
- LGV's
- Rigid HGV's
- Articulated HGV's
- Buses
- Coaches
- Mopeds
- Motorcycles
- Other light-duty vehicles (This is an open category which is included to allow the user to define vehicles which are otherwise not covered in the fleet structure)

For these vehicle categories it is usually possible to obtain a correspondence with data from traffic surveys, although the vehicle categories might be defined differently in the traffic data and separate information for, say, cars/taxis or mopeds/motorcycles might not always be available. The coarse vehicle details for Leicester (levels 1 and 2) were obtained from the Leicester EDB 2004.

For each of the coarse categories a further sub-division into „detailed‟ categories (Levels 3-6) is required. The detailed categories take account of factors such as fuel type (e.g. petrol, diesel and alternatives such as liquefied petroleum gas (LPG)), engine size or weight, and compliance with emission control legislation. Information on these detailed categories is not routinely collected at the road link level, and therefore a fleet model is usually required, based on national or regional statistics. Given that the proportions of vehicles in the detailed categories vary from year to year (e.g. due to the introduction of new emission standards), a separate fleet model is required for each modelled year.

By default TEEM includes a fleet model for the year 2007. The fleet data are taken primarily from the fleet model used in the UK NAEI and Dore et al. (2008). For the work reported here, the existing fleet model was adjusted at levels 1, 2 and 6 to account for changes in the coarse vehicle composition and Euro standards applicable for year 2013.

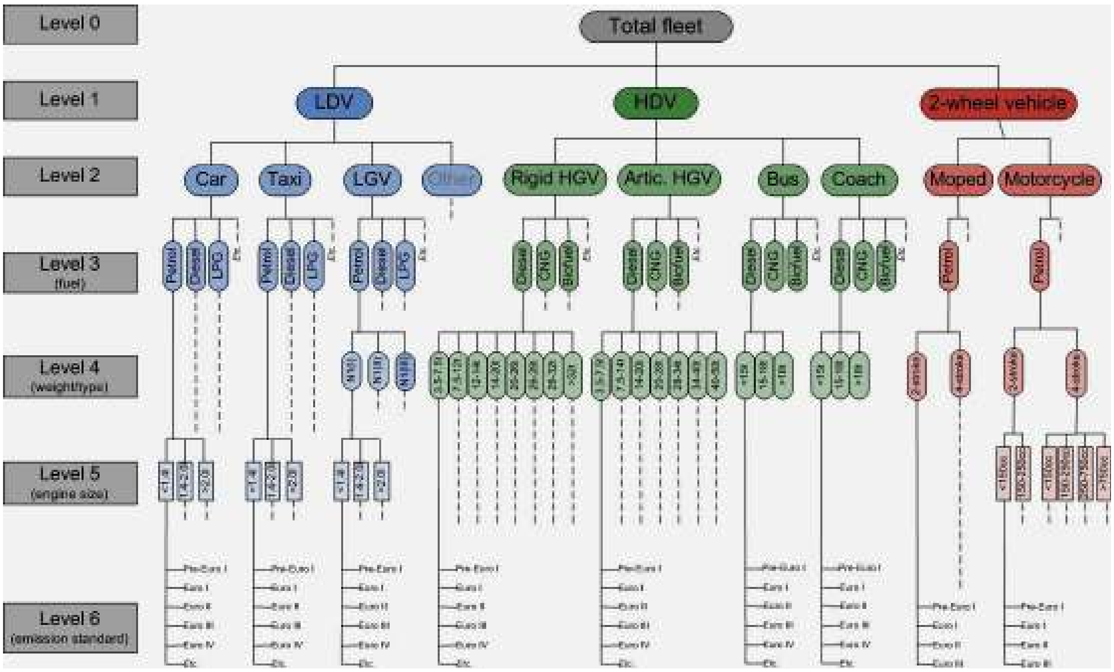


Figure 3.10.2/2 Hierarchical fleet structure for road vehicles.

e) Road geometry

The geometry of each road was determined using GIS mapping data. Road width is defined by the kerb-to-kerb measurement (km). The height of surrounding buildings is accounted for in the model wherever a „street canyon" effect is observed. For atmospheric dispersion modelling assessments, a street canyon is defined by the building heights being greater than the building-to-building road width (aspect ratio greater than 1.0). Street canyons can have a significant impact on local dispersion processes with vortex air flows established through wind shear across the roof of the canyon. This movement of air within the canyon can influence ground level concentrations, with elevated concentrations typically forming at the bottom of the leeward side of the canyon. No roads in this assessment were assumed to exhibit street canyon effects.

f) Atmospheric chemistry

The concentration of NO2 at a specific location is determined by a combination of emissions, meteorology and atmospheric chemistry. Some NO2 is emitted directly from vehicle exhaust (this is known as primary NO2), mainly from diesel vehicles. Emissions of NOX from vehicles are primarily in the form of nitrogen oxide (NO) (AQEG, 2007). Nitric oxide (NO) undergoes a chemical reaction with oxidants such as ozone (O3) to produce secondary NO2. At a roadside location, there is routinely an excess of NO, and thus the limit to the formation of NO2 is usually determined by the availability of O3. Therefore, at heavily trafficked roadside locations, there is not a linear relationship between changes in NOX emissions and NO2 concentrations.

Nitrogen dioxide concentrations were derived from the NOX concentrations that were estimated by the ADMS-Roads model. To do this, Defra‟s NOx – NO2 calculator17 available on the LAQM tools section of the UK Air Quality Archive website was used, specifying the correct year and the Leicestershire area. This is the recommended method as outlined in LAQM.TG(09), Defra, 2009. A primary NO2 fraction applicable for all UK traffic was assumed in this assessment.

f) Meteorological data

The ADMS-Roads model applies hourly sequential meteorological data to calculate atmospheric dispersion. This calculation involves a number of meteorological parameters including wind speed and direction, cloud cover and near surface temperature (the latter two parameters being important for the calculation of atmospheric buoyancy). Meteorological data Birmingham Airport has been used in this assessment. A wind rose obtained from data collected during 2008 at Birmingham Airport is illustrated in Figure 3.12.2/3. The dominant wind speed is from the south west, with maximum speeds of 8-9 ms-1.

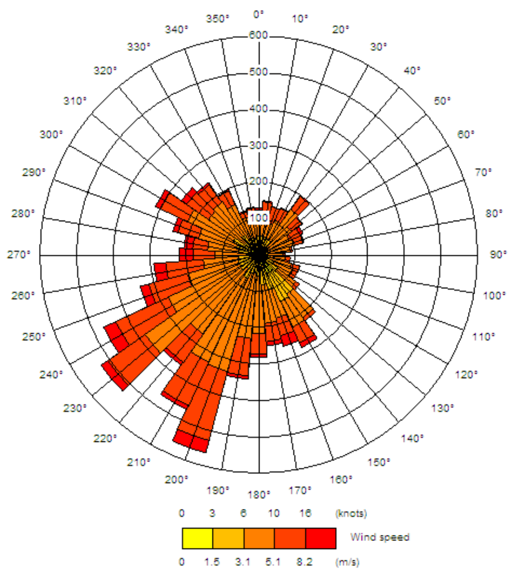


Figure 3.10.2/3 Wind rose based on 2008 data from Birmingham Airport meteorological station.

g) Surface roughness

The interaction of wind flow with the ground generates turbulence, influencing pollutant dispersion. The strength of this turbulence is dependent on the land use, with urban areas generating higher turbulence than open countryside. The ADMS-Roads user guide indicates that a surface roughness length of 1 m is suitable for cities and woodland and 0.5 m is suitable for parkland and open suburbia. This study used a surface roughness of 0.5 m for the modelling domain.

The ADMS-Roads model allows the user to specify the surface roughness length of the site where meteorological data has been recorded (used when the surface roughness length at the meteorological site differs from that at the area under assessment). In this way, the ADMS-Roads model modifies the meteorological data to accommodate differences in surface roughness between the modelling domain and the geographical area from which meteorological measurements are obtained. The surface roughness length at the meteorological site used in this study was assumed to be 0.2 metres.

3.10.3 Scenario 1: Hinckley Road Freight Expressway

As described in Section 5.2, the One Leicester Co2nnect Strategy 1 considers a freight consolidation centre located in the vicinity of Sunningdale Industrial Park to the west of the City and a freight expressway (*i.e*. a no car lane) on the Hinckley Road connected to the city centre environmental zone. The effect of this strategy on emissions and air quality concentrations was modelled and this section describes this scenario in more detail.

The theory behind the Hinckley Road freight expressway is to provide a means for goods vehicles to operate on a priority basis into the city centre (*i.e.* unimpeded by other modes). In practice this would involve lane segregation of the existing available road space, inevitably leading to increases in journey times. A consequence of this measure may well lead to traffic being displaced along alternative routes. However, evidence of displacement would typically require the running of traffic models. For this assessment the potential impact to the wider road network is not considered but recommended to be taken forward.

The expressway is assumed to operate in the inbound direction only as it is more important for retailers that goods are provided at prescribed times, which means that the return journey is not as critical. It was originally intended to include the IRR as part of the expressway but after further consideration of the emissions modelling it was concluded that more information about the traffic activity on adjoining radials would be required to investigate this scenario. Again, it would be recommended to consider these implications if taken forward. The modelled scenario therefore considers the emission impacts on the Hinckley Road only and once on the IRR freight access to the city centre is via High Street or freight vehicles can choose to rejoin the IRR entering the city centre at an alternative location.

In terms of the emissions modelling the Hinckley Road was divided into 92 links (30 in-bound, 32 out-bound and 30 on the expressway). Spatially, the expressway links are duplications of the in-bound links. Hence, in terms of air quality modelling, emissions from both sets of emission source activity are assumed to be dispersed from the same location in the road. Were this to be taken forward, delineation of source activity would be tested. For this assessment the impact of not segregating source activity is assumed to be negligible and perhaps more important for those receptors close to the air quality objective exceedance values.

The traffic flow (AADT) on Hinckley Road for the scenario in 2013 was assumed to be identical to that of the base case in the same year. The speed of vehicles on the non-expressway was as per the base case, whilst for the expressway, traffic was assumed to be travelling at an average speed of 40 km/h.
The baseline coarse vehicle fleet composition for Hinkley Road was extracted from the 2004 LCC EDB (*i.e.* the Hinckley radial profile) (see Section 5.3.3.1). This baseline was applied in years 2008 and assumed for 2013. The composition for the existing traffic and the expressway was developed from the baseline to account for scenario assumptions and is shown in Table 3.12.2/2.

Table 3.10.3/1 Coarse fleet composition.

	Fleet Composition						
	% Light Duty Vehicles	% Heavy Duty Vehicles	Light Duty Vehicles: Cars	Light Duty Vehicles: Light Goods Vehicles (LGVs)	Heavy Duty Vehicles		
			% Petrol %	% Petrol	% Buses	% Rigi	Heavy Goods Vehicles
Baseline: Hinckley Road Traffic 2008/2013	97	3	90 % Cars 87 13	10% LGVs 15 85	33	34	33
Scenario: Non-expressway lane traffic 2013	100	0	90 % Cars 87 13	10% LGVs 15 85	0 0		0
Scenario: Expressway	20	80	0% Cars	100 % LGVs			

lane Traffic 2013			0 0	5 95	33 67 0

The expressway scenario assumes that the consolidation centre will operate rigid vehicles that are less than 7.5 tonnes in weight as well as LGVs (*i.e.* vans between 2 and 3.5 tonnes). The Euro emissions standards thought appropriate for these vehicles on the expressway are shown in Table 5-5 (including buses), and for non-expressway traffic (i.e. the inbound lane for those vehicles other than HDVs) in Table 3.12.2/3.

Table 3.10.3/2: Euro standards of vehicles operating on the expressway in 2013.

	LGVs >2 <3.5 tonnes	Rigid HGVs <7.5 tonnes	All Buses
(%)			
Pre Euro	0	0	0
Euro I	0	0	0
Euro II	0	0	0
Euro III	0	0	0
Euro IV	4	4	0
Euro V	90	90	94
Euro VI	6	6	6

Table 3.12.3/3: Euro standards of vehicles operating on the non-expressway in 2013.

	Cars		**LGVs >2 <3.5 tonnes**	
	%			
	Petrol	**Diesel**	**Diesel**	**Petrol**
Pre Euro	0	0	0	0
Euro I	1	0	0	1
Euro II	5	2	3	5
Euro III	10	15	18	18
Euro IV	46	38	48	45
Euro V	38	45	31	31
Euro VI	0	0	0	0

The emissions standards of vehicles allowed to operate on the expressway would be periodically reviewed according to the latest technologies on engines, fuels and exhaust after-treatment devices. For the scenario it was considered reasonable that in 2013, Euro V vehicles would be relatively abundant. Finally, non consolidation centre vans would be assumed to operate within the non-expressway lane.

3.10.4 Scenario 2: Leicester City Centre Environmental Zone

The strategy for a city centre environmental zone (EZ) was developed into a scenario to include roads within the IRR (see Figure 5.6). The concept initially involves controlling goods vehicles entering the zone at various locations (control points) either by using physical barriers or cameras that can record number plates. Both need enforcement mechanisms, however the former would rely on non-removable transponders which when fitted to vehicles would control the barrier and access to the zone. This information would give details of vehicle Euro emissions standards to allow or prevent access or access could be linked to CO2 emissions.

Message boards prior to approaching barriers could inform drivers as to the status of their vehicle with reference to the access criteria (*i.e.* allowing the option to avoid accessing the zone). Clearly, drivers would need to be made aware as soon as possible perhaps via message boards on all radials. There would also need to be a mechanism to allow temporary access for non local vehicles and dispensation for non compliant vehicles that happen to reside within the zone. Camera enforcement would involve issuing fines to non-compliant vehicles via number plate recognition system similar to the system operated for the London Low Emission Zone. Similar to access controls, dispensation rules would need to be developed for businesses operating from within the zone.

In total, 223 roads were assumed to be included within the zone shown in

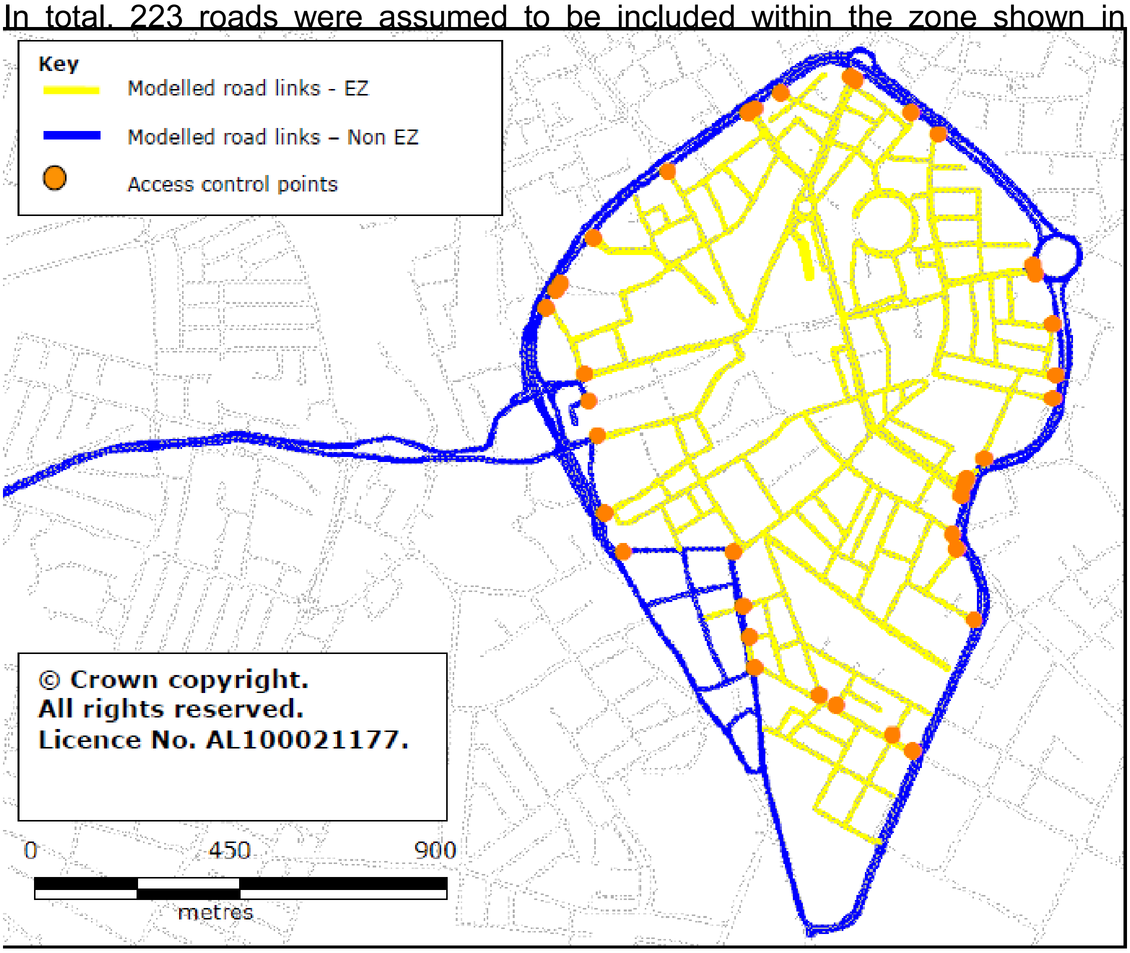


Figure 3.10.4: Proposed Leicester City environmental zone.

The modelling assessment involved testing two scenarios:

1. The impact within the zone in year 2013 with 2013 forecast traffic flows and speeds. This scenario was designed to test the direct effects of the emission based entry criteria compared to do-nothing.

2. The impact in year 2013 with an additional 15% reduction in traffic flows and no change in speed. This scenario considers a change in driving behaviour and perhaps some element of drivers switching to public transport.

All roads within the zone were characterised by a particular road type as defined by the Leicester EDB. In this way a generic coarse fleet composition was applied in a similar way to Hinckley Road. The following road types were considered:

- I/B - O/B Radial low HGV

- O/B Radial high HGV
- Local roads (2 Peaks)
- Local roads O/B
- Ring road low HGV (i.e. some links within the IRR had similar profiles to the IRR)
- Bus
- Cars Only AM/PM Peak
- Bus/Taxi

The following vehicle types would initially have entry criteria applied:

- LGVs (petrol and diesel)
- Rigid HGVs
- Articulated HGVs
- Buses

The 2013 base case and EZ emissions entry criteria are presented in Table 5-7. Access would be allowed for vehicles meeting Euro V emissions standards in 2013. The overall profile represents the fact that some vehicles will inevitably meet Euro VI standards whilst some may choose to pay a fine (*i.e.* in the case of camera enforcement) and some will have poorly maintained engines and no longer meet their original type approved emissions standard.

Table 3.10.3/4

	LGVs >2 <3.5 tonnes		Rigid HGVs		Artic HGVs		All Busses	
	2013 (base)	2013 (EZ)	2013 (base)	2013 (EZ)	2013 (base)	2013 (EZ)	2013 (base)	2013 (EZ)
	(%)							
Pre Euro	0	0	0	0	0	0	0	0

Euro I	0	0	0	0	0	0	1	0
Euro II	3	0	4	0	2	0	7	1
Euro III	18	2	22	3	19	3	25	2
Euro IV	47	3	16	2	16	2	17	2
Euro V	31	95	53	89	56	89	45	90
Euro VI	0	0	6	6	6	6	5	5

Depending on the success or otherwise, the EZ criteria could be strengthened to include passenger cars and or perhaps motorcycles. The potential impact of strengthening the criteria would require further investigation and has not therefore been included in this report.

3.10.5 Predicted Air Quality Levels

It should be noted that the receptors in this study were selected to the indicate the general impact of the proposals contained in the study. They are not therefore located specifically at receptor points selected for Review and Assessment and Transport Planning purposes, i. e. at co-ordinates corresponding to automatic nitrogen dioxide monitoring sites for calibration purposes (See Sections 3.8 and 3.9). The exceptions are sites at New Walk Centre (AURN site) and St. Matthews Way.

Nonetheless, for each receptor, the percentage change above a known baseline is given.

The evaluation of options in Section 2 of this Air Quality Action Plan makes it clear that the conditions are not in place to implement the more radical options identified and evaluated in the TRL Report within the lifetime of the implementation programme of the third Local Transport Plan (Part B). However, the full dataset is given for the sake of completeness in Table 3.10.5, below.

It can be seen from the data that implementation of the proposals would, given the accuracy of the modelling carried out, result in significant percentage reductions in annual mean values for nitrogen dioxide, and widespread compliance with the annual mean criterion, compared to the current situation. The study therefore gives an indication of what is possible in improving air quality given the feasibility of a package of more radical measures in the future.

Some key observations from the data are set out below:

2008 baseline: All roads

- St Mathews Way monitoring site is showing an exceedance of the NO_2 annual mean (47.2 μgm^{-3}). This predicted concentration is slightly lower than the 2008 annual mean from the air quality monitoring analyser of 52 μgm^{-3}.

- Some of the receptors are showing high NO_2 concentrations because they are positioned for reference purposes in the centre of roads (*e.g.* LCC16, LCC20) or within gyratory systems (*e.g.* LCC 19)
- The highest modelled NO_2 annual mean result was 62 μgm^{-3} at receptor LCC3, just north of Burleys Flyover.
- The NO_2 annual mean concentration at New Walk monitoring site (Leicester Centre) was 38.5 μgm^{-3} (see **Error! Reference source not found.**).

2013 baseline: All roads

- The majority of receptors now meet the annual mean AQS objective for NO_2

2013 scenario with 2008 traffic base: Effects of the fleet only.

- Similarly to the 2013 baseline, exceedances of the NO_2 annual mean are still likely at 5 receptors although only two, LCC15 (Hinckley Road) and LCC35 (Charles Street) may be relevant receptors.
- The predicted NO2 annual mean concentration at the St Mathews Way monitoring site was 35.4 μgm^{-3}, which is below the objective
- No change in annual mean NO_2 was predicted at the New Walk monitoring site from 2008.

2013 base *with forecast traffic: Effects of the fleet and traffic activity*

- Only three exceedances of the NO_2 annual mean were recorded of which one, LCC35 may be relevant.

2013 with EZ and forecast traffic: Effects of the fleet, traffic and entry criteria.

- No changes in concentrations were found at the majority of receptors located outside of the EZ, except for some small reductions in annual mean NO_2 at receptors on the boundary of the zone or located just outside.
- Within the EZ, the percentage reduction in annual mean NO_2 at receptors owing to vehicles complying to the entry criteria ranged from between 0.2% to 12.3%. The maximum reduction was seen at receptor LC35 (Charles Street), where concentrations were predicted to meet the objective, compared to the 2013 baseline. Generally, the impact owing to the proposed entry criteria was negligible although there are a range of criterion that might be considered.

2013 with EZ and forecast traffic reduced by 15%: Effects of the fleet, reduction traffic and entry criteria.

- As expected this scenario resulted in the lowest NO_2 annual means at receptors within the EZ. The range of the reduction at receptors being between 0.02% and 15.7%.

2013 expressway with forecast flows: Effects attributable to the expressway only.

- No exceedances of the NO_2 annual mean were recorded for receptors LCC1 to LCC19 (on the expressway). NO_2 annual mean reduced at receptors by between 2.3% and 16.3% of the expressway over and above 2013 forecast traffic flows.

Overall, it would appear that the NO_2 annual mean concentrations at most receptors in the 2013 base situation with 2013 traffic flows either meet or are very close to meeting the objective. However these results are purely indicative at selected receptors and would be subject to greater scrutiny if a more detailed assessment was required. The council is therefore still advised to take actions to reduce emissions and consider these types of scenarios in their action plan.

In conclusion, the TRL study is of great interest in terms of what interventions might be adopted in the longer term, in order to improve Leicester's air quality. However options appraisal (see Section 2) indicates that such radical measures and their predicted beneficial air quality outcomes, while remaining open as strategic possibilities for the future, are not feasible within the time frame up to 2016.

In addition, as with the AIRVIRO model (Section 3.9) consideration of the behaviour of emissions as measured in the real world suggests that the ADMS model might be subject to some of the same inaccuracies discussed in Sections 3.9.7 – 8).

Therefore, this modelling will not be used in isolation to set targets for LTP-3 although its predictions are included in Section 3.13, where a composite assessment of impacts is discussed.

Table 3.10.5 Predicted Reductions in Nitrogen dioxide values

Receptor ID	Total NO_2 ($\mu g/m^3$)						% reduction*				
	2008	2013	2013 with forecast traffic	2013 EZ with forecast traffic	2013 EZ with 15% traffic reduction	2013 Express way	2008-2013 base	2008-2013 with forecast flows	2013 with forecast flows-2013 EZ	2013 with forecast flows-2013 EZ with 15% traffic reduction	2013 with forecast flows-2013 Expressway
LCC1	34.70	23.17	23.56	23.55	23.55	22.54	-33.2	-32.1	0.0	0.0	-4.3
LCC2	37.96	24.72	25.23	25.22	25.22	23.04	-34.9	-33.5	0.0	0.0	-8.7
LCC3	35.35	23.65	24.08	24.08	24.07	22.08	-33.1	-31.9	0.0	0.0	-8.3
LCC4	35.34	23.60	24.02	24.02	24.02	22.80	-33.2	-32.0	0.0	0.0	-5.1
LCC5	28.16	20.48	20.69	20.68	20.68	20.22	-27.3	-26.5	0.0	0.0	-2.3
LCC6	33.03	22.32	22.70	22.70	22.69	21.83	-32.4	-31.3	0.0	0.0	-3.8
LCC7	34.95	23.23	23.68	23.68	23.68	21.56	-33.5	-32.2	0.0	0.0	-9.0
LCC8	35.66	23.40	23.86	23.86	23.86	21.89	-34.4	-33.1	0.0	0.0	-8.3
LCC9	35.00	23.14	23.58	23.58	23.57	22.51	-33.9	-32.6	0.0	0.0	-4.5
LCC10	31.85	22.85	23.10	23.10	23.10	22.50	-28.3	-27.5	0.0	0.0	-2.6
LCC11	34.97	24.2	24.62	24.62	24.62	23.07	-30.7	-29.6	0.0	0.0	-6.3

Receptor ID	Total NO_2 ($\mu g/m^3$)						% reduction*				
	2008	2013	2013 with forecast traffic	2013 EZ with forecast traffic	2013 EZ with 15% traffic reduction	2013 Expressway	2008-2013 base	2008-2013 with forecast flows	2013 with forecast flows-2013 EZ	2013 with forecast flows-2013 EZ with 15% traffic reduction	2013 with forecast flows-2013 Expressway
		5									
LCC12	30.63	22.39	22.56	22.56	22.55	22.14	-26.9	-26.3	0.0	0.0	-1.9
LCC13	31.95	23.05	23.27	23.27	23.27	21.90	-27.9	-27.2	0.0	0.0	-5.9
LCC14	42.12	39.10	32.35	32.34	32.33	31.24	-7.2	-23.2	0.0	-0.1	-3.4
LCC15	45.62	42.88	34.48	34.47	34.46	30.06	-6.0	-24.4	0.0	-0.1	-12.8
LCC16	57.63	52.63	41.95	41.93	41.87	35.11	-8.7	-27.2	0.0	-0.2	-16.3
LCC19	40.56	32.43	31.94	31.90	31.78	31.87	-20.0	-21.3	-0.1	-0.5	-0.2
LCC20	52.62	38.49	38.83	38.75	38.56	38.90	-26.9	-26.2	-0.2	-0.7	0.2
LCC21	38.60	31.49	31.27	31.03	30.71	31.42	-18.4	-19.0	-0.8	-1.8	0.5
LCC22	36.61	30.65	30.34	30.06	29.73	30.49	-16.3	-17.1	-0.9	-2.0	0.5
LCC23	35.62	30.17	29.83	29.56	29.29	29.95	-15.3	-16.3	-0.9	-1.8	0.4
LCC24	37.39	31.0	30.85	30.13	29.79	30.94	-16.9	-17.5	-2.3	-3.4	0.3

Receptor ID	Total NO_2 ($\mu g/m^3$)						% reduction*				
	2008	2013	2013 with forecast traffic	2013 EZ with forecast traffic	2013 EZ with 15% traffic reduction	2013 Expressway	2008-2013 base	2008-2013 with forecast flows	2013 with forecast flows-2013 EZ	2013 with forecast flows-2013 EZ with 15% traffic reduction	2013 with forecast flows-2013 Expressway
		8									
LCC25	34.79	29.62	29.32	29.08	28.90	29.38	-14.9	-15.7	-0.8	-1.4	0.2
LCC26	35.76	29.90	29.67	29.31	29.12	29.72	-16.4	-17.0	-1.2	-1.9	0.2
LCC40	35.75	30.02	29.70	29.37	29.18	29.75	-16.0	-16.9	-1.1	-1.8	0.2
LCC39	35.09	29.67	29.43	29.13	28.95	29.49	-15.4	-16.1	-1.0	-1.6	0.2
LCC38	36.03	30.07	29.94	29.42	29.18	30.01	-16.5	-16.9	-1.7	-2.5	0.2
LCC37	38.71	31.46	31.50	30.36	29.97	31.57	-18.7	-18.6	-3.6	-4.9	0.2
LCC36	45.84	35.60	36.01	33.29	32.50	36.06	-22.3	-21.4	-7.6	-9.7	0.1
LCC35	57.74	43.57	44.54	39.06	37.54	44.58	-24.5	-22.9	-12.3	-15.7	0.1
LCC34	40.11	31.83	32.01	30.86	30.46	32.04	-20.6	-20.2	-3.6	-4.8	0.1
LCC33	41.76	32.85	33.04	32.18	31.80	33.07	-21.3	-20.9	-2.6	-3.8	0.1
LCC32	39.86	32.0	32.22	31.85	31.68	32.24	-19.5	-19.2	-1.1	-1.7	0.1

Receptor ID	Total NO_2 ($\mu g/m^3$)						% reduction*				
	2008	2013	2013 with forecast traffic	2013 EZ with forecast traffic	2013 EZ with 15% traffic reduction	2013 Expressway	2008-2013 base	2008-2013 with forecast flows	2013 with forecast flows-2013 EZ	2013 with forecast flows-2013 EZ with 15% traffic reduction	2013 with forecast flows-2013 Expressway
		7									
LCC31	62.00	44.00	45.01	44.87	44.80	45.02	-29.0	-27.4	-0.3	-0.5	0.0
St Matthews	47.20	35.42	35.89	35.66	35.57	35.90	-25.0	-24.0	-0.6	-0.9	0.0
LCC27	40.26	31.88	31.82	31.08	30.72	31.85	-20.8	-21.0	-2.3	-3.5	0.1
LCC28	37.60	31.04	30.93	30.41	30.20	30.95	-17.4	-17.7	-1.7	-2.4	0.1
LCC29	38.87	31.56	31.52	31.25	31.14	31.53	-18.8	-18.9	-0.9	-1.2	0.0
LCC30	57.01	40.79	41.49	41.39	41.33	41.50	-28.5	-27.2	-0.2	-0.4	0.0
LCC41	34.88	29.92	29.41	29.18	29.04	29.45	-14.2	-15.7	-0.8	-1.3	0.1
LCC42	35.39	30.36	29.73	29.42	29.27	29.77	-14.2	-16.0	-1.0	-1.5	0.1
LCC43	31.88	27.58	26.86	26.68	26.59	26.89	-13.5	-15.7	-0.7	-1.0	0.1
LCC44	32.06	27.51	26.89	26.69	26.59	26.92	-14.2	-16.1	-0.7	-1.1	0.1
LCC45	34.21	28.1	27.72	27.29	27.09	27.74	-17.8	-19.0	-1.6	-2.3	0.1

Receptor ID	Total NO_2 ($\mu g/m^3$)						% reduction*				
	2008	2013	2013 with forecast traffic	2013 EZ with forecast traffic	2013 EZ with 15% traffic reduction	2013 Expressway	2008-2013 base	2008-2013 with forecast flows	2013 with forecast flows-2013 EZ	2013 with forecast flows-2013 EZ with 15% traffic reduction	2013 with forecast flows-2013 Expressway
		1									
LCC46	32.42	27.41	27.05	26.72	26.59	27.05	-15.5	-16.6	-1.2	-1.7	0.0
LCC47	30.90	26.70	26.25	26.16	26.11	26.26	-13.6	-15.0	-0.3	-0.5	0.0
LCC48	30.56	26.65	26.08	26.04	26.01	26.08	-12.8	-14.7	-0.2	-0.3	0.0
LCC49	30.94	27.29	26.30	26.28	26.26	26.30	-11.8	-15.0	-0.1	-0.2	0.0
LCC50	32.01	29.29	27.11	27.09	27.08	27.11	-8.5	-15.3	-0.1	-0.1	0.0
New Walk	38.48	38.92	33.62	33.48	33.37	33.68	1.1	-12.6	-0.4	-0.7	0.2

3.11 Extrapolation of Monitored Data

As a cross check on the dispersion modelling outputs, various methods were used to attempt to extrapolate measured, ratified annual mean nitrogen dioxide values for the year 2009, for the four key target receptor points:

This is set out in Table 3.13, and is further discussed in Section 3.13.

Using the revised 'Box 2.1' from DEFRA Technical Guidance LAQM.TG (09).

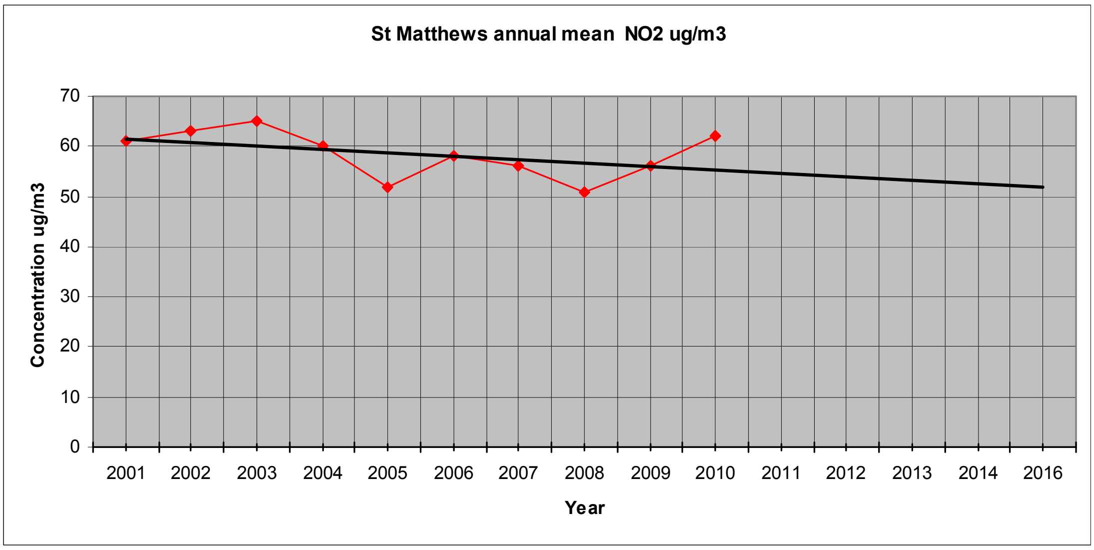
Each relevant annual mean monitored value for nitrogen dioxide for 2009 was multiplied by a correction factor of 0.61 (0.557/0.916), to give an estimated value for 2016.

Extrapolating existing annual mean datasets to 2016 using a 'line of best fit'

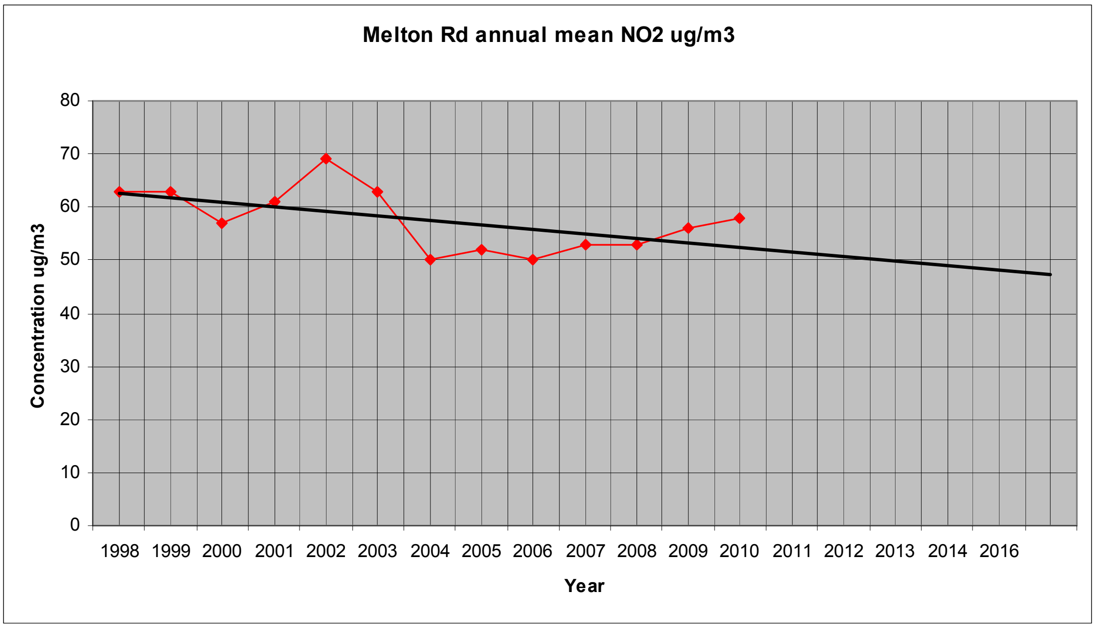
The following charts show this trend estimate (Fig 3.11 (b)): It will be noted that all sites show a distinct upturn since the middle of the last decade and that this is sufficient for the lines of best fit for Glenhills Way and Abbey Lane to actually show an upward trend.

Fig. 3.11 (b)

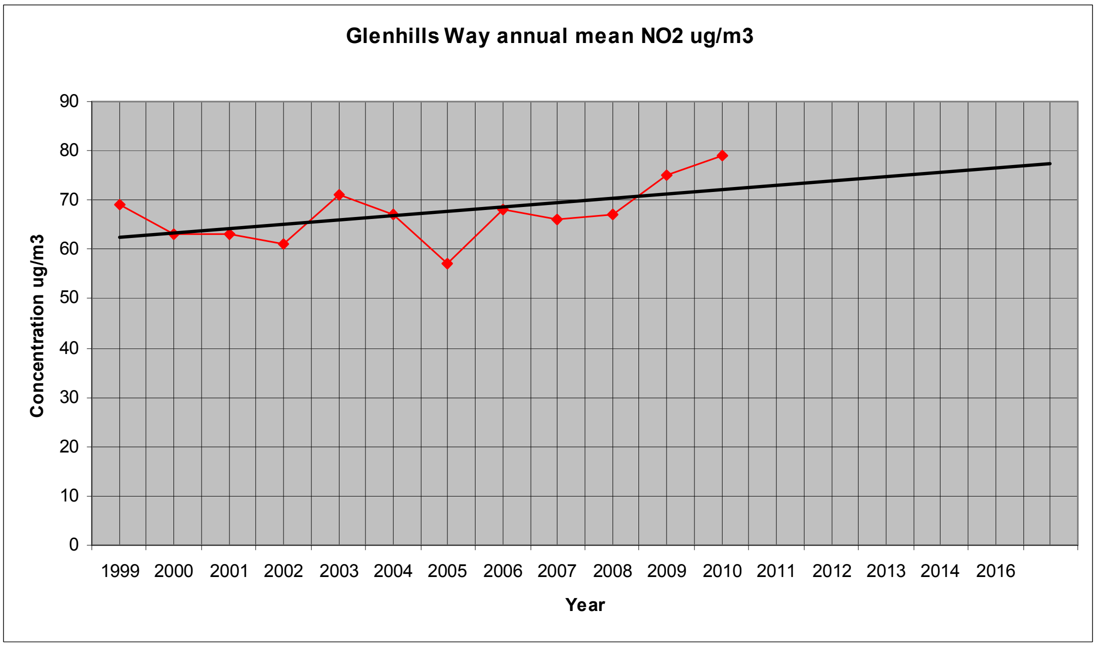
(a)



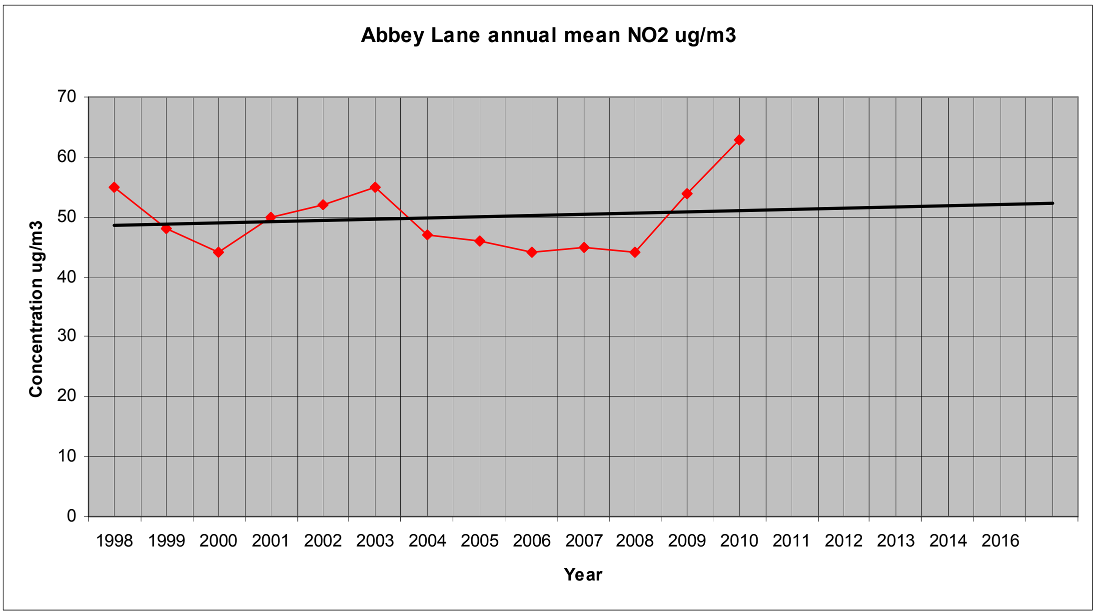
(b)


Melton Rd annual mean NO2 ug/m3
80
70
60
50
40
30
20
10
0
Concentration ug/m3
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2016
Year

(c)


Glenhills Way annual mean NO2 ug/m3
90
80
70
60
50
40
30
20
10
0
Concentration ug/m3
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2016
Year

(d)



Estimating the impact of changes during the LTP period using the 2009 annual mean data as a baseline.

Examination of trend data for annual mean nitrogen dioxide set out in Section 3.4 appears to justify a conservative approach to “guestimating” impacts for the Preferred Package of the LTP.

Clearly, the rollout of the LTP will produce different effects in different parts of the network and therefore at different receptor points. A baseline was established by taking the average annual mean value for nitrogen dioxide for the three years 2007-9 at each receptor / monitoring site. This smoothed out yearly fluctuations due to the weather and other extraneous factors. This was then corrected by deducting an estimated reduction for each site by 2016.

Estimates of the expected reduction in annual mean values at the various Leicester receptor sites, corresponding to automatic monitoring stations were based on scenario modelling previously carried out. In particular it should be noted that predictive modelling studies for previous park and ride schemes (See *Leicester Air Quality Review and Assessment Report 2003*, Section 3.2.2) yielded reductions of at most 1-2 μgm^{-3} on the affected corridors.

It is acknowledged that some factors are likely to offset any improvement: Growth in vehicle population, additional attractors from development in the City centre and, possibly, an inability to mitigate fully the effects of increased congestion.

It should be noted that, where a façade correction is required, a further adjustment needs to be added or deducted. Due to the existing uncertainties of this approach, this was disregarded in arriving at these estimates.

The following factors were considered:-

(a) ‘Hard’ measures rolled out under LTP-3

It should be noted that estimating the impact of a constrained range of options is problematic: Table 3.5/1 shows that, not only were modelled projections of the air quality impact of LTP-2 not met, annual mean values actually changed very little compared to the 2003 – 5 averaged baseline, and even possibly deteriorated in certain cases. For example, at the Abbey Lane receptor, the baseline was 49 microgrammes per cubic metre, the predicted target in 2011 was 42, but the measured value for 2009 was 54.

(b) ‘Soft’ initiatives contained in LTP-3

While the air quality impact of “hard” policy options, such as major traffic schemes, can be readily modelled, given suitable input data, the position with “soft” policy options, such as campaigns of education, promotion and facilitation, is more problematic:

Their air quality effects may be impossible to model;
The time-scale over which they operate may be indeterminate.

Consideration of options in this category, which were identified in the Air Quality Action Planning process, suggests that the aggregate effect of many “soft” measures is likely to be small and not detectable within the limits of modelling error. Attempts in the past in the UK to quantify these impacts have resulted in estimated improvements for individual initiatives which –

Give a spurious air of precision;
While small, are almost certainly far too high; and
When aggregated, therefore give an exaggerated impression of their total effect.

This is not to devalue these initiatives, especially educating people in the implications of their life-choices; the are just not directly quantifiable. A small improvement is therefore (somewhat optimistically) added.

(c) Improvements in vehicle technology penetrating the fleet

As has been noted in Section 3.4 above, recent monitoring data across the UK and elsewhere suggests that replacement of the fleet with newer vehicles is failing to have the predicted effect on levels of roadside nitrogen dioxide, for the reasons discussed. It may be that, at least in the time horizon up to 2016 the effect may be small, or even negative.

(d) The predicted reduction in regional background

This is taken from DEFRA data and approximates to 6 microgrammes per cubic metre per annum.

(e) Growth in the vehicle population

This can be readily estimated from DEFRA data

(f) Regeneration

Since the last LTP (2006-11) there has been considerable regeneration in the City centre, both in the form of new-build and converted apartment buildings, and the opening of the Highcross Shopping Centre, with extensive associated parking. This has had a measurable effect on air quality at some roadside sites. However, the current economic situation is clearly reducing economic activity, so predicting the level of regeneration up to 2016 is again problematic.

(g) Falling or rising congestion

Congestion is a useful surrogate of air quality emissions, while being difficult to simulate satisfactorily with current dispersion models. This is dealt with in more detail in Section 3.12. Measures to reduce congestion are, in the light of previous experience, unlikely to have a large effect, given the likely number of vehicles on the roads, in relation to available road capacity and the less-than-expected reduction in nitrogen dioxide emissions from those vehicles.

The range of estimates is tabulated below in Table 3.11 (c), with the corresponding estimates made in 2005 for comparison.

Table 3.11 (c) Estimated reductions in annual mean Nitrogen dioxide by 2011 (target values)

Factor	Estimated magnitude of change ($\mu g.m^{-3}$)	
	2005 estimate	2011 estimate
“Hard” traffic measures across the highway network, contained in the LTP-3	- 1 to - 3	0 to - 2
“Soft” initiatives contained in the LTP-3	- 1	0 to - 1
Improvements in vehicle technology penetrating the fleet	- 2 to - 3	0 to - 2
UK-wide fall in background levels	- 6	- 6
Growth in the local vehicle population	Difficult to predict but perhaps in the range + 1 to + 3	0 to +2
Regeneration of the City Centre: More residential accommodation, expansion of shopping centres etc. attracting more travel.		0 to +2
Increased congestion		-2 to +2

It will be noted that the estimates made in 2011 are, in the light of experience of the impact of changes in the intervening period on annual mean levels, less optimistic than those drawn up in 2005:

Year projection made	Aggregate Range of Change
2005	- 7 to - 12
2011	0 to - 9

3.12 Consideration of Intermediate (non-Air Quality) Data

Clearly some traffic indicators are a good surrogate of emissions for a given vehicle population. For example tackling congestion will have beneficial effects upon emissions and, consequently, air quality. It is therefore the case that consideration of the projected movement of these indicators will tend to shed some light upon the likely progress of air quality, subject to the other variables involved.

The following are the LTP-3 Better Air Quality Outcome Indicators:

Table 3.12

Indicator	Baseline / Year	Target 2014/15
L LTP 1 Congestion on locally managed A roads	3.6 minutes per mile (2009/10)	3.6 minutes per mile
L LTP 2 Public transport patronage	41 million (2009/10)	43 million
L LTP 8 Mode of travel to school (reduction of car share to) a) Primary b) Secondary	2009/10 Primary = 27.0% Secondary = 20.8%	Primary = 22.5% Secondary = 23.0%
L LTP 14 Area wide traffic	1397 m vkm	1446 m vkm

It can be seen that area wide traffic (millions of vehicle-kilometres) is predicted to increase slightly (3.5%). As has been discussed above, some of the other variables, and in particular vehicle emissions, are not necessarily improving as predicted a few years ago, with implications for congestion-related pollution.

3.13 Evaluation of Different Prediction Methods and Selection of Targets

3.13.1 DEFRA Guidance

The following guidance was issued by DEFRA (Review and Assessment Helpdesk) in September 2010:-

Defra and the devolved administrations have published "year –adjustment" factors for roadside NO2 concentrations, and background (1x1 km) maps for NOx and NO2 concentrations for all years up until 2020. Technical Guidance (LAQM.TG(09)) advises local authorities to use this information to adjust measured concentrations to future years (e.g. annual mean NO2 concentrations measured in 2009 can be projected forwards to 2013). Background maps for future years are also used to support modelling studies for Reviews and Assessments.

These projections are based on the Pollution Climate Modelling studies carried out on behalf of Defra and the devolved administrations, and take full account of current understanding of the expected changes in sector-based emissions up until 2020. They also take account of the expected changes to primary NO2 emissions.

However, recent analyses of historical monitoring data have identified a disparity between the measured concentrations and the projected decline in concentrations associated with the emissions forecasts. Trends in ambient concentrations of NOx and NO2 in the UK have generally shown two characteristics; a decrease in concentration from about 1996 to 2002-2004, followed by a period of more stable concentrations from 2002-2004 up until 2009.

As a whole, urban roadside sites show evidence that NOx concentrations have declined very weakly over the past 6 – 8 years. NOx concentrations at urban background sites broadly reflect the same trend, and have been close to stable over this same period. For NO2, levels have largely remained stable at urban roadside and background sites, but show a slight upward trend in inner London. At monitoring sites close to motorways and dual-carriageways, there is evidence that NOx concentrations have fallen at some, but not all locations, while NO2 concentrations have levelled off.
In all cases there are differences between individual sites (with some showing upward or downward trends) but overall, there is little evidence of a consistent downward trend in either NOx or NO2 concentrations, that would be suggested by emission inventory estimates.

The precise reason for this disparity is not fully understood, and is currently under investigation, but it is thought to be related to the actual on-road performance of diesel road vehicles when compared with calculations based on the Euro standards. Preliminary studies suggest that:

NOx emissions from **petrol** vehicles appear to be in line with current projections and have decreased by 96% since the introduction of the 3 way catalysts in 1993;

NOx emissions from **diesel cars**, under urban driving conditions, do not appear to have declined substantially, up to and including Euro 5. There is limited evidence that the same pattern may occur for motorway driving conditions.

NOx emissions from **HGV** vehicles equipped with SCR reduction are much higher than expected when driving at low speeds.

On this basis, it might also be expected that the forecast reductions in background NOx and NO2 concentrations associated with the road traffic component are optimistic. There is no evidence to suggest that background concentrations associated with the other (non-traffic) source contributions should not behave as forecast.

This disparity in the historical data highlights the uncertainty of future year projections of both NOx and NO2, but at this stage there is no robust evidence upon which to base any revised road traffic emissions projections.
Defra and the devolved administrations are currently investigating these issues, and once the reasons are fully understood updated guidance will be issued. However, the preliminary findings would suggest that the Euro standards will deliver only marginal, if any, reductions in NOx and NO2 concentrations until the Euro 6 emission standards begin, as is currently forecast, to play a major role (i.e. circa post-2015).

Where existing forecasting information is used for decision making or review and assessment and action planning work, local authorities may wish to take account of the emerging findings on the performance of different vehicle types, the performance of Euro standards overall, and the expected effect on forecast background concentrations.

3.13.2 Comparison of Quantitative Assessments

The following is a tabulation of the outputs of the various methods used to predict future air quality in Leicester:

Table 3.13.2: Comparative Tabulation of Results of Predictive Methods

Receptor	LTP-2 Baseline (2003-5 mean)	LTP-3 Baseline (2007-9 mean)	Measured Annual Mean (2009)	Unratified Annual mean (2010)	2016 Modelled (AIRVIRO)	AIRVIRO 2016 (corrected for distance)	TRL Study Prediction (2013)	2016 Extrapolated 2009 Monitoring Data (DEFRA LAQM TG(09))	2016 Extrapolated Monitoring Data (linear regression)	2016 Estimated impact of LTP package an external changes on 2009 monitored values
St. Matthews Way	59	54	56	62	38	36	35	34	52	47 - 56
Abbey Lane	49	48	54	63	30	30		33	52	45 - 54
Melton Road	55	54	56	58	40	40		34	48	47 - 56
Glenhills Way	65	69	75	79	41	35		46	76	66 -75
AURN	35						39			

3.13.3 Setting Air Quality Targets for the LTP

Consideration of the above predictions in conjunction with observed nitrogen dioxide data suggests that –

- Interventions likely to be feasible and in place by 2016 are unlikely to achieve the air quality Objectives for nitrogen dioxide;

- Past and current predictions using recognised nationally and locally deployed modelling methodologies are likely to be significantly underestimating annual mean levels;

- This has been the case over the lifetime of the 2006 – 11 LTP and the situation, if anything, appears to be deteriorating;

- There is significant uncertainty as to the progress of air quality in the next five years; This range of uncertainty is critical in the sense that it lies either side of the Objective criterion for nitrogen dioxide (40 microgrammes per cubic metre). I. e. it represents the difference between significant change for the better in air quality on the one hand and little or no change (or even some deterioration) on the other;

- More work needs to be completed nationally and locally in order to resolve these issues.

For these reasons, a range of values for each receptor point was calculated, framed between "high" and "low" scenarios, in order to compress the range of uncertainty somewhat. The following scenarios were assumed:

  - 'Pessimistic scenario': No improvement in fleet, small impact of LTP-3 interventions (1%)

  - 'Optimistic scenario': Predicted improvement in fleet realised, large impact of LTP-3 interventions (10%)

The various estimates are set out for comparison in Table 3.13.3, below. As can be seen and as stated, the issue with this range of projections is that they encompass the annual mean Air Quality Objective for nitrogen dioxide (40 microgrammes per cubic metre), i.e. they represent the different between achieving, or failing to achieve, the Objective.

A baseline was established by taking the average of the annual mean values for the three years 2007 - 2009.

The final LTP targets were set by using professional judgement to establish a likely, realistic compromise between the 'high' and 'low' potential outcomes. On balance, it is considered that an outcome towards the 'pessimistic/high' scenario is more likely in the short term to 2014/15. The values set still represent continuing exceedances of the air quality Objective criterion.

It should also be noted that while a five year time scale was adopted for purely air quality projections, for statutory Review and Assessment reasons, a shorter time scale (2014/15) was adopted for the formal LTP targets, in line with the shorter-term delivery programme.

The formal air quality targets set for the third Local Transport Plan (see Chapter 7) are set out in the highlighted column of Table 3.13.3, below.

Further work is being put in hand as soon as possible to refine and update these conclusions during the rollout of the LTP programme.

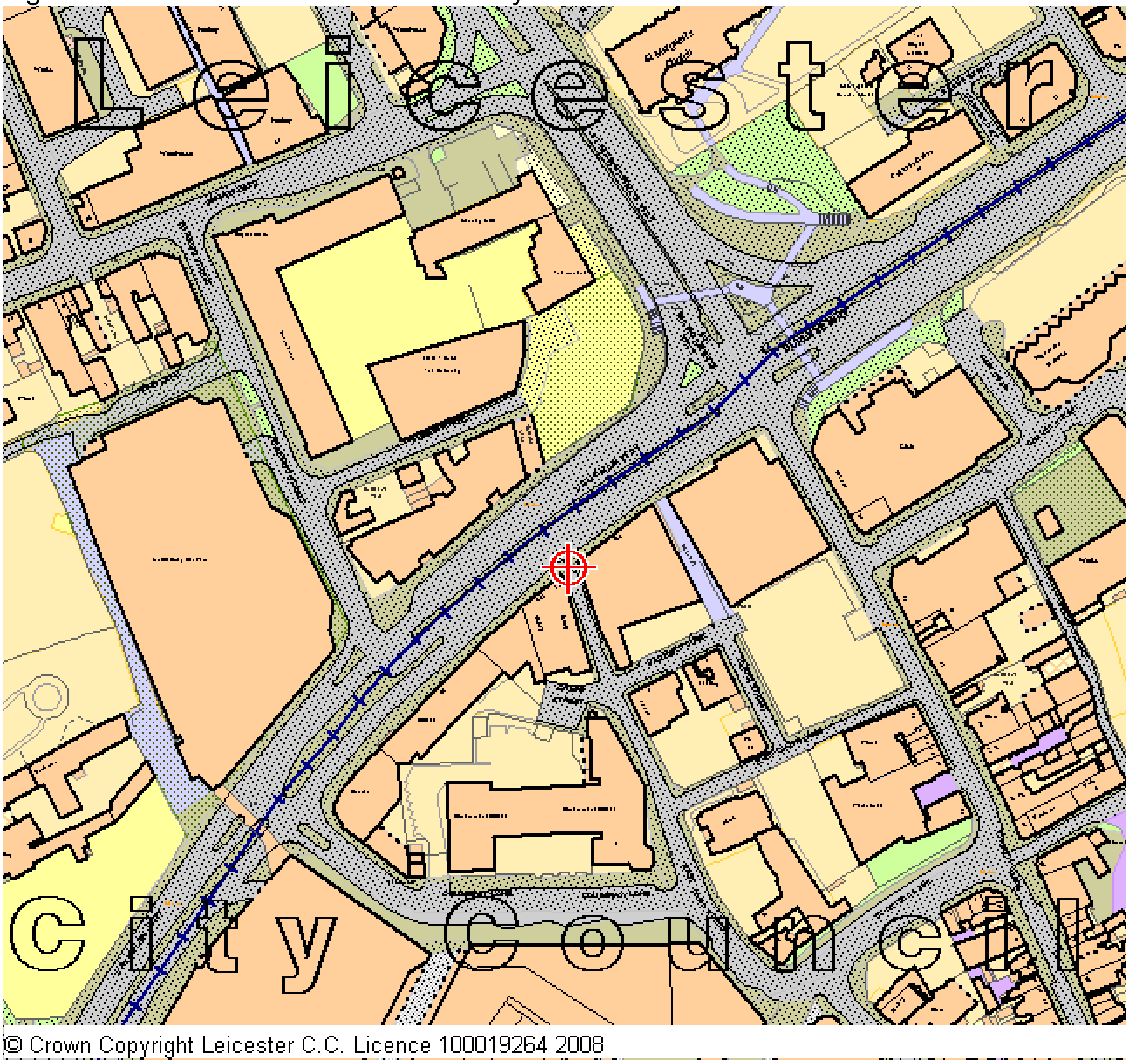
Table 3.13.3 Annual mean nitrogen dioxide (µg.m^{-3})

Receptor	Baseline (Average of measured annual mean values for 2007 – 09)	Extrapolated 2016 (Line of Best Fit) [3.11.b]	Extrapolated 2016 (DEFRA emission factors) [3.11.a]	Extrapolated 2016 (DEFRA) + 10% impact of measures [LOW SCENARIO]	Extrapolated 2016 (line of best fit) + 1% impac of measures) [HIGH SCENARIO]	FORMAL AIR QUALITY TARGETS SET FOR CHAPTER 7 OF MAIN LTP FOR 2014/15
St Matthews Way	54	52	34	31	52	48
Abbey Lane	48	52	33	30	52	45
Melton Road	54	48	34	31	48	50
Glenhills way	69	79	46	41	75	63

APPENDICES

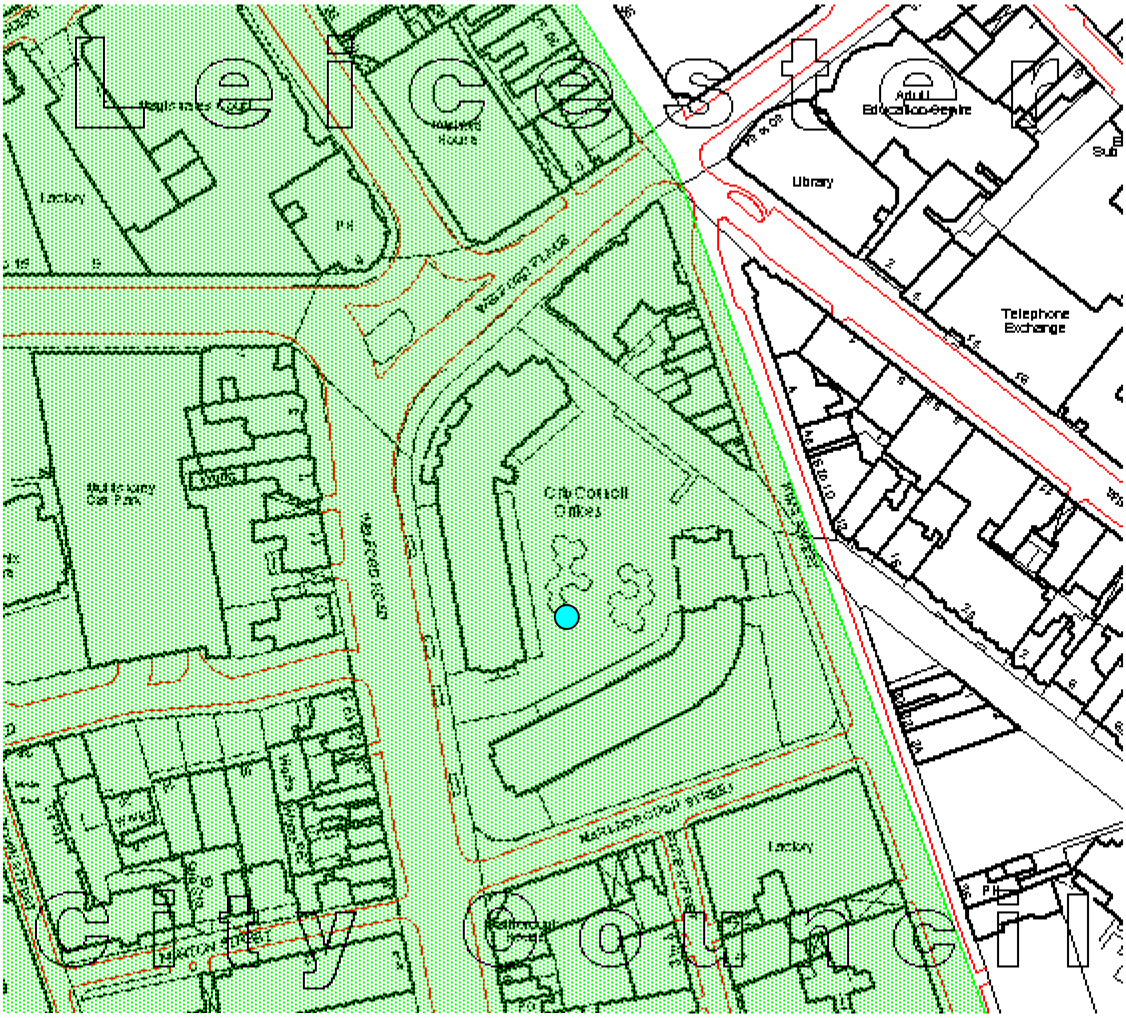
Appendix 1 – Air Quality Receptor Points

Fig. L1 Grid Ref. x 458507 / y 304904



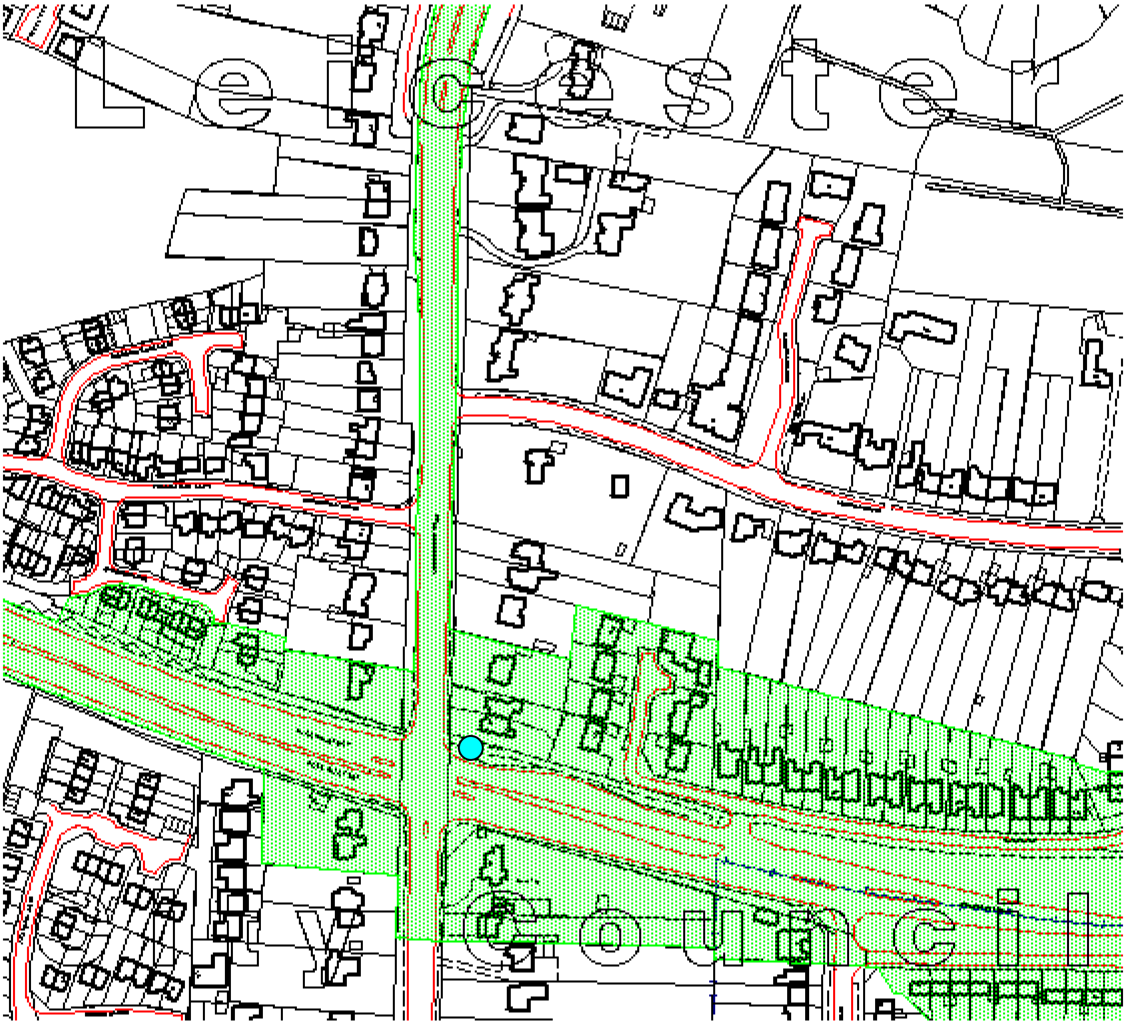
Vaughan Way

Fig. L2 Grid Ref. x 458763 / y 304065



AURN Site (New Walk Centre)

Fig. L3 Grid Ref. x 457083 / y 300156



Glenhills Way

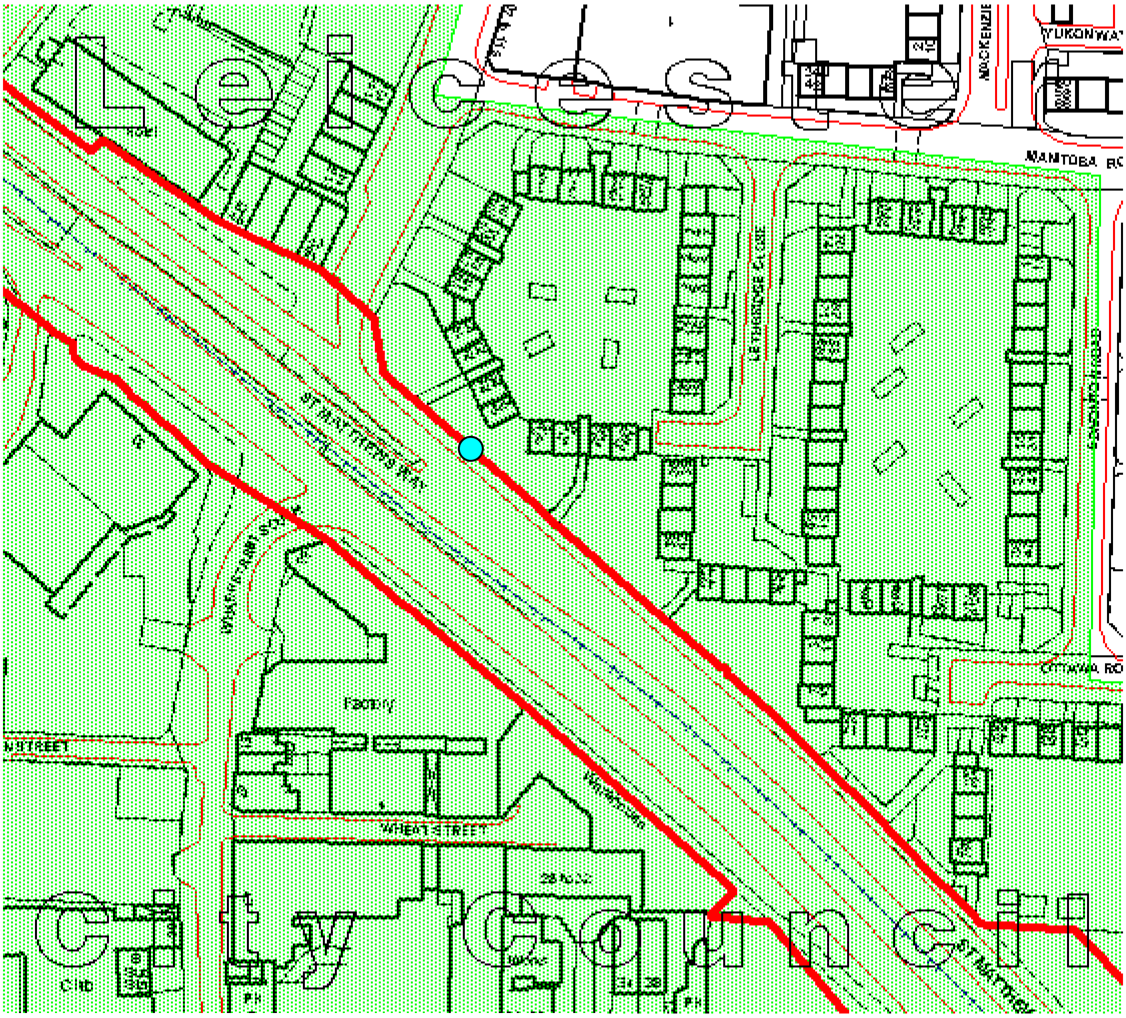
Fig. L4 Grid Ref. x 458574 / y 306885

Abbey Lane

Fig. L5 Grid Ref. x 459528 / y 306316

Melton Road

Fig. L6 Grid Ref. x 459221 / y 305036

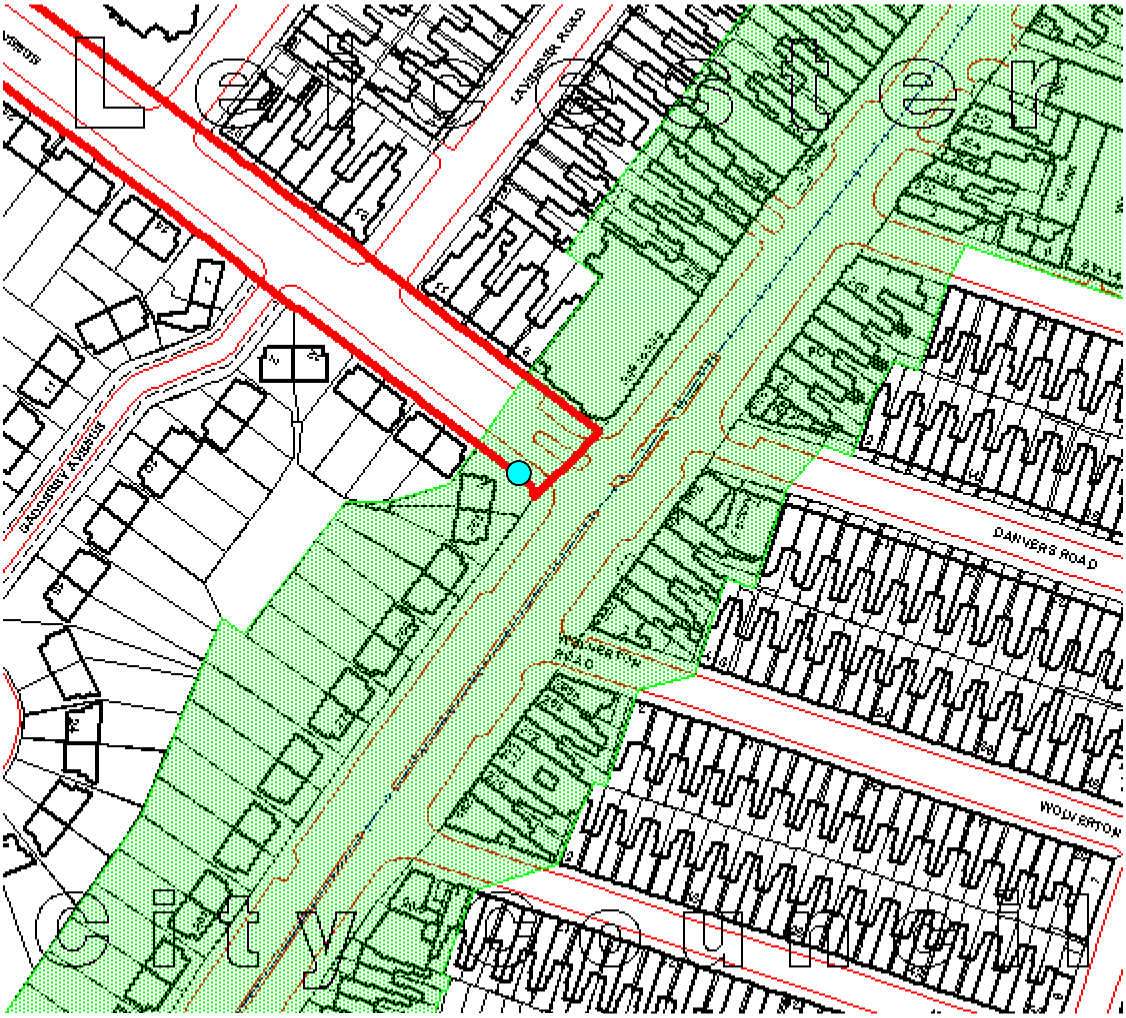


St Matthews Way

Fig. L7 Grid Ref. x 461188 / y 305306

Uppingham Road

Fig. L8 Grid Ref. x 457245 / y 303040



Imperial Avenue

[i] Action Planning good practice website at http://www.airquality.co.uk/archive/laqm/ap_goodpractice.php
[ii] Personal communication with Evan Davies on the 14th January 2009
[iii] Personal Communication with Evan Davies: Leicester City Council, March 2009
[iv] Personal Communication with Leicester City Council, March 2009
[v] http://www.whatgreencar.com/electriccars.php
[vi] http://www.whatgreencar.com/biodiesel.php
[vii] http://www.whatgreencar.com/hybridcars.php
[viii] Information from http://www.whatgreencar.com/carclubs.php
[ix] http://www.ipl-airquality.nl/project.php?name=overkapping
[x] http://www.cerc.co.uk/software/admsroads.htm