

www.defra.gov.uk

Local Air Quality Management

Practice Guidance 3

Practice Guidance to Local Authorities on Measures to Encourage the Uptake of Low Emission Vehicles

February 2009



Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London SW1P 3JR
Telephone 020 7238 6000
Website: www.defra.gov.uk

© Crown copyright 2009
Copyright in the typographical arrangement and design rests with the Crown.

This publication (excluding the royal arms and departmental logos) may be re-used free of charge in any format or medium provided that it is re-used accurately and not used in a misleading context. The material must be acknowledged as crown copyright and the title of the publication specified.

Information about this publication and further copies are available from:

Defra
3C Ergon House
Horseferry Road
London
SW1P 2AL

Tel: 020 7238 1677

Email: air.quality@defra.gsi.gov.uk

This document is available on the Defra website:
www.defra.gov.uk/environment/airquality/index.htm

Published by the Department for Environment, Food and Rural Affairs

Executive summary

- i. This guidance is principally for local authorities in England to have regard to, if relevant, in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995. This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by providing relevant policy and technical guidance on a specific transport measure – **encouraging uptake of Low Emission Vehicles**. The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.
- ii. Low Emission Vehicle schemes are defined areas or locations where the most polluting of vehicles are restricted, deterred or discouraged from access and use. The aim is to improve air quality in a particular area by reducing the number of more polluting vehicles being used in a particular area by setting particular emission standards or criteria. A supplementary benefit of Low Emission Vehicle schemes may be to reduce carbon dioxide emissions in addition to emissions of local air pollutants. For example one useful definition of an Low Emission Vehicle is a vehicle with emissions better than the Euro 4/IV standard and with carbon dioxide emissions better than 140g/km.
- iii. Low Emission Vehicle schemes are operating in several UK and overseas towns and cities. Significant existing schemes in the UK include:
 - the London Low Emission Zone scheme which from July 2008 requires that all heavy duty vehicles achieve at least a Euro III emission standard for particulate matter smaller than 10 µm;
 - Quality Bus Partnership Agreements in South Yorkshire requiring Euro III buses on designated routes;
 - discounted car parking charges of up to 100% for vehicles with zero local emissions in Westminster and lesser discounts for Low Emission Vehicles in other locations;
 - voluntary schemes with economic incentives such as Car Clubs that have successfully cut operators costs and emissions.
- iv. Voluntary options should not be discarded prematurely but in situations where more formal enforcement is required the options for implementing Low Emission Vehicle schemes in the UK are:
 - Traffic Regulation Orders under the Road Traffic Regulations Act 1984 (commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme) and Section 106 agreements as planning conditions for site usage under guidance contained in Planning Policy Statement 23: Planning and Pollution Control (2004);
 - For local bus services, contract conditions of tendered services, Quality Partnership Schemes and Bus Quality Contracts.

- v. Schemes should be developed via appraisal and this guidance provides information on assessing emissions, air quality and costs assessments. It also provides information on using this data in cost-effectiveness and cost-benefit analyses that are consistent with a generic guidance provided alongside this guidance. Local authorities are strongly encouraged to refer to this guidance note too.
- vi. Low Emission Vehicle schemes are frequently focussed on city and town centres, where land-use is dense, traffic is heavy, population exposure is high and where Air Quality Management Areas may have been declared. 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. Previous studies have suggested that the most efficient vehicles to target in a scheme with enforceable restrictions are diesel powered Heavy Duty Vehicles due to their cost-effectiveness relative to schemes that would restrict other vehicle types.
- vii. The most cost-effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will typically be to use existing systems and sources of information as far as possible. A significant number of Low Emission Vehicle schemes are now in place or under development in Europe. Examples range from manual enforcement methods to high tech camera based systems. Selection between such schemes will depend on the relevant constraints for example a scheme which has low operating costs will tend to be more attractive if there are strong budgetary constraints. However, such considerations needs to be carefully balanced against other impacts such as the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme may be undermined.

Table of contents

1	Introduction	1
1.1	Purpose of this Guidance Document	1
1.2	Background to the Guidance	1
1.3	How should the guidance be used?	2
1.4	Definitions of Low Emission Vehicle Schemes	3
1.5	Economic rationale for Low Emission Vehicle uptake schemes	4
2	Options for Low Emission Vehicle uptake schemes	7
2.1	Legal basis for implementation	9
2.2	Scheme design	19
2.3	Location of boundaries	20
2.4	Vehicle emission standards	20
2.5	Management of permitted vehicles	23
2.6	Enforcement powers and penalties	25
2.7	Vehicle detection	27
3	Developing and appraising Low Emission Vehicle schemes	30
3.1	Generic Effects of the Scheme	30
3.2	Emissions/Air Quality Impact Assessment	32
3.3	Costs Assessment	36
3.4	Cost-effectiveness and cost-benefit Assessment	37
4	Worked example	41
4.1	Introduction	41
4.2	Emissions assessment	41
4.3	Cost-effectiveness and cost-benefit assessment	48
5	Examples of Low Emission Vehicle uptake schemes	55
6	Conclusion	64

Appendices

Appendix 1 Glossary

Appendix 2 References

1 Introduction

1.1 Purpose of this Guidance Document

- 1.1. This guidance is principally for local authorities in England to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995.¹ This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by specifically providing relevant policy and technical guidance on a specific transport measure – **encouraging uptake of Low Emission Vehicles (LEV)**.
- 1.2. The guidance provides information on identifying options to realise the potential benefits from this type of scheme, practical issues that have arisen in previous implementations, and evaluating costs and benefits of options in either cost-effectiveness or cost-benefit analyses. It also provides detail on existing or planned examples of these schemes.

1.2 Background to the Guidance

- 1.3. The guidance has been developed to be consistent with key government guidance on appraising new policy and road transport policies in particular.
- 1.4. The Government Green Book requires that there should be an economic assessment of the social costs and benefits of all new policies projects and programmes. Within the Green Book and related HM Treasury guidance on assessment of the Business Case (5 Case Model), policies are considered under the following five components.
- **Applicability:** LEV schemes potentially contributes towards strategic objectives in the areas of environment (air quality and climate change).
 - **Appropriateness:** Guidance is given to help develop policies for which costs and benefits are either balanced or overall beneficial in economic terms.
 - **Attractive:** Guidance is given in this document to help authorities to prepare their commercial case for LEV schemes by considering scheme costs including those falling on vehicle operators.
 - **Affordable:** Guidance is given in this document to help authorities to prepare budgets for LEV scheme costs.
 - **Achievable:** Guidance is given in this document on existing examples of LEV schemes and key implementation issues including enforcement powers and other practical considerations.
- 1.5. As far as possible this guidance is also consistent with the government's New Approach to Transport Appraisal (NATA). In practical terms NATA guidance is delivered via the web-based Transport Analysis Guidance (webTAG). In particular this includes guidance on how to conduct a transport policy or scheme appraisal that meets the Department for Transport (DfT) guidelines.

¹ Separate policy guidance will be issued by the devolved administrations in Scotland and Northern Ireland. The technical guidance that accompanies this guidance covers the whole of the UK.

Although every care has been taken to ensure consistency if contradictions do occur, for example as guidance changes, then primacy should be given to this guidance in the consideration of air quality impacts (air quality and climate change effects) and webTAG guidance for wider transport impacts.

- 1.6. These sources of guidance have been consulted during the development of this guidance document so that a high degree of consistency with overarching governmental guidance on economic appraisal and road transport appraisal in particular have been achieved.

1.3 How should the guidance be used?

- 1.7. The guidance is advisory not mandatory. Local authorities that have declared Air Quality Management Areas (AQMAs) must have regard to the guidance when developing their Air Quality Action Plans. However, the guidance is also suitable and recommended for those other local authorities that are considering implementing measures to improve local air quality.

- 1.8. Local authorities should have regard to this guidance in conjunction with other relevant guidance with regard to LAQM duties. These guidance documents are:

- Local Air Quality Management Technical Guidance 2009.
- Local Air Quality Management Policy Guidance 2009 including
 - Practice Guidance on the Economic Principles for the assessment of local measures to improve air quality,
 - Practice Guidance relating to Low Emission Zones (LEZ),
 - Practice Guidance relating to measures to encourage the uptake of retrofit abatement equipment in existing vehicles.

- 1.9. It is advised that local authorities give regard to all guidance documents on local air quality measures rather than just this one. Each one contains important information, some of the guidance overlaps between documents and local authorities are also strongly recommended to follow the general guidance on the economic principles of local air quality assessments regardless of the measure being considered.

- 1.10. It is highlighted that the specific measures in the guidance are not the only measures that local authorities should examine when considering how to improve local air quality. The relevant policy guidance is clear that local authorities should be prepared to consider all possible measures if relevant. However, there is now an increasing amount of experience in implementing these particular measures in the UK and in other countries. Where possible this guidance document therefore presents relevant details of this experience in order to highlight current practice in implementing LEV schemes.

- 1.11. Further help on the guidance can be obtained from Defra (air.quality@defra.gsi.gov.uk), or by contacting the Local Authority Air Quality Action Plan Helpdesk (Telephone:0870 190 6050 Email: lasupport@aeat.co.uk)

1.4 Definitions of Low Emission Vehicle Schemes

Local Incentive Schemes for the Uptake of Low Emission Vehicles

- 1.12. These are schemes that promote the use of LEVs above other vehicle types. There are already a number of national schemes of this type such as differentiating vehicle excise duty (VED) according to carbon dioxide (CO₂) emissions. This guidance therefore focuses on actions local authorities could take to incentivise the uptake of LEVs.
- 1.13. A scheme may be implemented in a geographically defined area where the most polluting vehicles are restricted, deterred or discouraged from access and use. The aim is to reduce the number of more polluting vehicles being used in a particular area by setting particular emission standards or criteria, with the aim of improving the air quality.

Low Emission Vehicles

- 1.14. There is currently no universal definition of a LEV. All current definitions are expressed in relative terms; i.e. replacement by a LEV could mean replacing any existing vehicle with any vehicle that has lower emissions.
- 1.15. For any given scheme it is important to define the LEV in terms of the desired outcome in emission and/or air quality terms. This means that the LEV must be defined in terms of an emission standard or standards. The standard could include one or more of the following possibilities.
- So-called Euro standards that regulate emissions of nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOC) and particulate matter (PM) from conventional petrol and diesel powered road vehicles.
 - Vehicle Excise Duty banding A-M which defines vehicles in terms of their CO₂ emissions.
 - It may also be possible to set less formal emission standards associated with non-conventional powered road vehicles such as hydrogen or electric powered vehicles. However, such an approach may promote one technology above others whereas Euro standard and VED-based emission standards are technology neutral. Local authorities are recommended to adopt technology neutral approaches to allow vehicle operators to comply with standards by the most cost-effective route for them.
- 1.16. It should be noted that Defra and DfT are considering how local authorities should approach vehicle classification to ensure that there is a level of consistency between schemes. This work may also be relevant to LEV standards as a consistent standard may increase the effectiveness of specific schemes by allowing the realisation of economies of scope across different schemes.
- 1.17. For example, a local authority may decide to provide an incentive for light duty vehicles (LDVs) that comply with a given Euro standard and/or achieve a given VED banding or better. It is important that local authorities define

both these standards and the year in which they must be achieved in order to qualify. Clearly there will be co-benefits from setting standards that address both local pollutant and CO₂ emissions and local authorities are recommended to follow this dual approach when considering LEV schemes.

- 1.18. The analysis within the revision of the UK Air Quality Strategy found a significant net benefit (£63-£112 million annually for the UK, a benefit to cost ratio of around two) may accrue from a policy to incentivise the uptake of diesel and petrol cars with emissions better than the Euro 4 standard and with CO₂ emissions better than the then current voluntary threshold within the manufacture industry (140g/km). Local authorities are encouraged to consider LEV schemes around this level of ambition. This approach is expanded upon in section 1.5 below.

Incentives and enforcement

- 1.19. In the context of these schemes, 'incentives' could mean there being one of the following:

- penalties for the use of non-LEVs;
- discounts for the use of LEVs;
- a mixed situation where high emitters are penalised and low emitters are given discounts. Such a scheme could potentially be fiscally neutral.

- 1.20. This guidance will focus on enforceable restrictions of traffic and parking on the public highway and planning obligations to control vehicle use and parking at private development sites via penalties or discounts, as a basis for setting up a LEV scheme.

Overlap with other guidance

- 1.21. From the definitions above it is seen that there is an overlap with the Practice Guidance on LEZ; i.e. these types of scheme promote the use of LEVs via access or parking controls. This guidance includes summary information from the practice guidance on LEZ where appropriate. However, it is recommended that the other practice guidance on LEZ be considered for a more complete set of recommendations concerning encouraging the uptake of LEZs.

1.5 Economic rationale for Low Emission Vehicle uptake schemes

- 1.22. The economic rationale for LEV schemes is linked to the external costs of operating a high polluting vehicle. Those undertaking polluting activity are placing costs on society as a whole through adverse health impacts and damage to ecosystems and the wider environment. The separation of private transport benefits and public impacts means that individuals are likely to undertake transport beyond the socially-optimal level, unless there is an intervention. To address this, in relation to air quality for example, there are specific concentration limit values that have been defined and implemented to prevent unacceptable societal damages. Schemes described in this guidance document seek to provide additional incentive in order to make progress towards the limit values by reducing the external costs of transport.

- 1.23. Low Emission Vehicle incentive schemes are focussed on replacing the use of high emitting vehicles with ones with lower air pollutant emissions. The main impacts of such behavioural changes are likely to be:
- reduced emissions and improved air quality, hence contributing to UK environmental, health and economic objectives;
 - reduced consumer transport costs from using more efficient modes of transport;
 - higher vehicle replacement costs but overall improved fuel efficiency.
- 1.24. A LEV policy scenario was studied during the revision of the UK Air Quality Strategy (Defra, 2007). The scenario assumed that from 2006 onwards diesel and petrol cars when replaced are replaced by new cars with emissions that are better than Euro 4 standard for NO_x and PM₁₀ and better than the current industry voluntary agreement for carbon. Relative to a Euro 4 car (diesel all road types) this would be equivalent to an 80% reduction in NO_x, 92% reduction in PM₁₀ and 29% reduction in CO₂ emissions. The equivalent values for petrol cars are 38% NO_x reduction, 0% PM₁₀ reduction and 34% CO₂ reduction. These values clearly demonstrate the significant potential for emissions reductions under this definition of a LEV.
- 1.25. Assuming a 20% take-up rate in diesel LEVs by 2020 and a 25% take-up rate in petrol LEVs by the same date, modest improvements in NO₂ and PM₁₀ concentrations were estimated. It should be noted that the national modelling approach cannot address all locally identified concentration hot-spots so that the localised impact of the LEV scenario may have been underestimated in the national analysis. Significant health benefits were estimated to accrue from the LEV scenario.
- 1.26. The additional cost of the engine technology within LEVs was estimated at between £600 and £1,200 per vehicle. Note that to some extent this additional cost would be offset to a large extent by improved fuel efficiency meaning cheaper unit travel costs. Both cost impacts were included in the Air Quality strategy analysis.
- 1.27. Comparison of the costs and health benefits found overall annual net benefits in the range £60-£110 million. The conclusion of the national level analysis is that an LEV incentive scheme could deliver substantial net benefits. The substantial emissions reductions relative to Euro 4 vehicles is likely to also have a significant beneficial effect on air quality in concentration hot-spots (AQMA). Under this rationale, local authorities are therefore encouraged to consider LEV schemes consistent with the Air Quality Strategy definition: diesel and petrol cars when replaced are replaced by new cars with emissions that are better than Euro 4 standard for NO_x and PM₁₀ and better than the current industry voluntary agreement for carbon. From 2008 onwards even more stringent Euro standards such as Euro 5 requiring reductions in NO_x emissions will come onto the market. Therefore, in future years the definition of an LEV should focus on achieving Euro 5 standards and better.
- 1.28. The guidance document on LEZ concludes that vehicles commonly targeted in a scheme with enforceable emissions-based restrictions are Heavy Duty

Vehicles (HDVs) (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. Information in the guidance illustrated the key points that schemes should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Therefore, between now and 2010-2012 a Euro III standard should be considered as the minimum standard for LEZ schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing with time.

2 Options for Low Emission Vehicle uptake schemes

2.1. The purpose of this chapter is to provide practical guidance on available options for LEV schemes. Options include the different legal bases under which local authorities are empowered to introduce schemes and the various aspects of scheme design such as boundaries, emissions criteria, management and enforcement. The chapter structures these options and the headings are introduced in the left hand column of the table below. The table also summarises key aspects associated with the headings and options whereas the relevant text following the table expands on this to provide more detail in each case.

Table 1: Structured options and key aspects for introducing Low Emission Vehicle uptake schemes

Scheme options	Vehicle restrictions	Parking restrictions	Using the planning system	Bus fleet conditions
Legal basis	Traffic Regulation Order (TRO) under Road Traffic Regulations Act 1984 (RTRA 1984). Enables access by permitted vehicles, which can be based on environmental criteria.	Traffic Regulation Order under RTRA 1984. Enables differential charging, which can be based on environmental criteria.	S106 agreement. Enables obligations based on environmental objectives.	Contract conditions for contracted services. Quality Bus Partnership Agreements (QBPA), Quality Partnership Schemes (QPS) or bus quality contracts (QC) for local commercial services. Enables conditions based on environmental objectives.
Scheme design				
Location of boundaries	May determine scheme capital and operating costs. Should take account of any source apportionment results and extent of activity in AQMAs by vehicle type.			
Vehicle emission standards	<p>Recommended to be based on both:</p> <ul style="list-style-type: none"> • Euro standards or vehicle age as a proxy; • CO₂ rating or engine size depending on vehicle age. <p>Technology neutral standards allow operators flexibility in how they comply. Basing standards on in-service emissions is not practicable. Phased approach to tightening standards in future years ensures benefits continue over time.</p>			
Management of permitted vehicles	Scheme rules must be accessible to all vehicle owners.	UK schemes have tended to focus on residents parking or season ticket holders, which provides a management	See Government policy on planning obligations – www.communities.gov.uk/publications/planningandbuildin g/circularplanningo	Management of permitted vehicles is responsibility of contracting authority, local traffic authority or traffic

Scheme options	Vehicle restrictions	Parking restrictions	Using the planning system	Bus fleet conditions
		system to build upon.	bligations	commissioner depending on the approach taken.
Enforcement powers and penalties	Outside London the relevant moving vehicle offences are currently enforceable by Police. Powers under Traffic Management Act 2004 (TMA 2004) may provide civil enforcement powers to local authorities. These are necessary to effectively enforce a scheme.	Traffic Management Act 2004 now provides for the civil enforcement of most types of parking contraventions. Local authority appointed Civil Enforcement Officers can issue Penalty Charge Notices (PCN) for parking contraventions.	Guidance on enforcement of planning conditions is available at www.communities.gov.uk/documents/planningandbuilding/pdf/324923.pdf . ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides guidance on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).	Responsibility for enforcement will also vary as above depending on the approach taken. Levels of penalties would range from no penalty for partnership agreements through to termination of contract or removal of licence to operate on routes covered by quality partnership or contract schemes
Vehicle detection	Various methods, which can be combined in one scheme: <ul style="list-style-type: none"> • manual observation; • Automatic Number Plate Recognition (ANPR) cameras (fixed sites or mobile units); • Tag and beacon or swipe-card technology². 	Generally done by manual observation, although camera (CCTV) systems have been used.	In principal the same methods as for Traffic Restrictions would be available	In principal the same methods as for Traffic Restrictions would be available although simple manual methods will have significant advantages.

² It must be noted that any new on board equipment will need to be consistent with the European Electronic Tolling Service (EETS)

2.1 Legal basis for implementation

2.2. Based on this guidance note's scope of coverage the following section covers two main routes to setting up an area (or zones) with traffic or parking controls based on vehicle emission criteria:

- Traffic Regulation Orders for enforceable restrictions on the public highway; and
- Section 106 agreements as planning obligations for development sites and private land.

2.3. Apart from these authorities can also consider setting up schemes for buses or coaches using:

- quality bus partnership agreements,
- contract conditions of tendered services,
- quality partnership scheme,
- bus quality contracts.

Traffic Regulation Order - Traffic and parking orders

2.4. There are several types of enforceable restrictions that can be employed by highway authorities under current legislation. The general basis for these is the TRO. Traffic Regulation Orders are commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme. For example, TRO can be used to restrict access to a given area or to certain types or weight of vehicle or during specific time periods. Traffic management schemes are typically focused on historic or busy commercial centres, where the effects of traffic on safety, noise and pollution levels can be quite dramatic, and also in sensitive residential neighbourhoods.

2.5. Highway authorities are empowered under the RTRA 1984 to make TROs to regulate the speed, movement and parking of vehicles and to regulate pedestrian movement. Traffic Regulation Orders are required for any enforceable restriction on the highway. They may be made under the terms of the RTRA 1984 or, for "special events", the Town Police Clauses Act 1847. The RTRA 1984 specifies what restrictions a TRO may impose. The Local Authorities Traffic Orders (Procedure) (England) Regulations 1996 lay down the legal requirements for making and implementing a TRO.

2.6. The main points relating to the making of Orders that may be used for enforceable restrictions are summarised as follows:

- i The Highway Authority may restrict any/all classes of vehicle from using any road or from carrying out certain activities in any road either permanently or on certain days/dates /times, provided that it specifies a valid reason (as defined in the RTRA 1984) in the statement of reasons. They may do this by making restrictions, which prohibit, restrict or regulate the use of any road by vehicular traffic or specified classes of vehicle. Restrictions may require traffic to proceed in a certain direction, restrict waiting or loading or prohibit through traffic.

- ii valid reasons for making an Order include:
 - a) for avoiding danger to persons or other traffic using the road or any other road or for preventing the likelihood of any such danger arising, or
 - b) for preventing damage to the road or to any building on or near to the road, or
 - c) for facilitating the passage on the road or any other road of any class of traffic (including pedestrians), or
 - d) for preventing the use of the road by vehicular traffic of a kind which, or its use by vehicular traffic in a manner which, is unsuitable having regard to the existing character of the road or adjoining property, or
 - e) (without prejudice to the generality of paragraph (d) above) for preserving the character of a road in a case where it is specially suitable for use by persons on horseback or on foot, or
 - f) for preserving or improving the amenities of the area through which the road runs, or
 - g) for any of the purposes specified in paragraphs (a) to (c) of subsection (1) of section 87 of the Environment Act 1995 (EA 1995).

2.7. As noted, under point g), the EA 1995 broadened the purposes for which a TRO might be made to include the pursuit of environmental objectives. The relevant parts from the EA 1995 are Section 36 of Schedule 22, which states that TRO can be used “with respect to the assessment or management of the quality of air”. This is relevant to a traffic or parking control scheme designed to maximise environmental benefits.

2.8. Orders can be made that apply to certain classes of vehicle, or to set up a permitting system to exempt certain vehicles from the controls. The criteria for permission (or permit) is defined by the Authority making the TRO. Therefore, it can be based on an environmental/emission standard linked to local objectives and circumstances. This approach has been used in a priority access scheme in the city of Bath.

2.9. All local authorities need to develop a parking strategy covering on- and off-street parking. Many different types of on-street parking schemes can be created under the powers provided in Part IV of the RTRA 1984. Local authorities use TROs to put parking schemes in place and appropriate traffic signs and road markings so that the public know what the restrictions mean.

2.10. A highway authority has the power to set charges for parking permits pursuant to the Road Traffic Regulation Act 1984 (as amended) and in doing so may set differential charges for different types of vehicle. In exercising its duties under the 1984 Act, a highway authority is under a duty to secure the expeditious, convenient and safe movement of traffic (including pedestrians) and suitable and adequate parking on and off the road. In meeting these duties, the highway must have regard to:

- the effect on amenities of any locality;
- the strategy prepared under s.80 EA 1995;
- any other matters appearing to the local authority to be relevant.

- 2.11. These matters provide a legal basis for the differential charging based on CO₂ and other emissions.
- 2.12. The signing of a vehicle access control scheme should be one of the first elements to consider when designing a scheme, to ensure it can be legally signed. It is important that the design of all sign faces is considered when drawing up the TRO. All signs used for a scheme should be in accordance with the Traffic Signs Regulations and General Directions and used as described in the Traffic Signs Manual. Sometimes the objectives for vehicle access control schemes have led to designs for which no suitable sign is prescribed in Traffic Signs Regulations and General Directions. In such cases it is necessary to seek authorisation for a specific sign from the DfT, before any variation to the prescribed signing takes place. Considering all the available prescribed signing must be a first step.

Planning conditions

- 2.13. Local planning authorities can impose conditions on planning permissions only where there is a clear land-use planning justification for doing so. Conditions should be used in a way which is clearly seen to be fair, reasonable and practicable. One key test of whether a particular condition is necessary is if planning permission would have to be refused if the condition were not imposed. Otherwise, such a condition would need special and precise justification. Unless otherwise specified, a planning permission runs with the land. Exceptionally, however, the personal circumstances of an occupier, personal hardship, or the difficulties of businesses which are of value to the welfare of the local community, may be material to the consideration of a planning application. In such circumstances, a permission may be made subject to a condition that it is personal to the applicant. Such arguments will seldom outweigh the more general planning considerations, however. See The Planning System: General Principles - www.communities.gov.uk/publications/planningandbuilding/planningsystem - for more information, including on enforcement. It should be noted that planning conditions cannot be used to require financial contributions. See Circular 11/95: Use of conditions in planning permission (www.communities.gov.uk/publications/planningandbuilding/circularuse).
- 2.14. Where it is not possible to include matters that are necessary for a development to proceed in a planning condition, developers may seek to negotiate a planning obligation under section 106 of the Town and Country Planning Act 1990 (as amended by the Planning and Compensation Act 1991). Planning obligations should meet the Secretary of State's policy tests set out in Circular 05/05 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations); i.e. they should be:
- necessary;
 - relevant to planning;
 - directly related to the proposed development;
 - fairly and reasonably related in scale and kind to the proposed development; and

- reasonable in all other respects.
- 2.15 The use of planning obligations must be governed by the fundamental principle that planning permission may not be bought or sold. It is therefore not legitimate for unacceptable development to be permitted because of benefits or inducements offered by a developer which are not necessary to make the development acceptable in planning terms. Planning obligations are only a material consideration to be taken into account when deciding whether to grant planning permission, and it is for local planning authorities to decide what weight should be attached to a particular material consideration.
- 2.16. In terms of air quality, the impact of a development on air quality should be considered with regard to Planning Policy Statement 23 (often referred to as PPS23), particularly Annex 1
www.communities.gov.uk/publications/planningandbuilding/pps23annex1.
- 2.17. Both environmental impacts of a development and location of a development (whether it is close to a source of pollution or contributing further to an existing problem) can be taken into account as material planning considerations.
- 2.18. A useful document on the subject of low emission strategies - using the planning system to reduce transport emissions - has been produced by the Beacons Low Emission Strategies Group (2008). Broader guidance, aimed at ensuring that air quality is properly accounted for in local development control processes, has been produced by the NSCA (now Environmental Protection UK) as 'Development Control: Planning for Air Quality' (updated in 2006).

Approaches for Buses

- 2.19. The approaches discussed here will ultimately be affected by the progress and outcome of the Local Transport Bill, which is still being debated. Once this Bill is enacted work will begin to produce final regulations and guidance before the provisions of the Bill can commence. Local Traffic Authorities are therefore advised to monitor the progress of the Bill, regulations and guidance when considering using these approaches to regulate bus emissions.
- 2.20. It is also noted that local passenger transport is a function of the Passenger Transport Authorities or Executives in metropolitan areas, and county councils elsewhere whereas LAQM is a function of district authorities. This is therefore a clear case where, in two-tier authorities there will need to be close liaison between the two tiers to implement such schemes.

Quality Bus Partnership Agreement

- 2.21. To set up a QBPA the local authority provides and maintains facilities to improve local bus services, which helps make bus travel more reliable and attractive. In return the main bus operators using the infrastructure agree to make improvements to their fleet or service levels.

- 2.22. A voluntary or partnership approach to the scheme could in theory be low cost to the authority. However, QBPA generally work by both parties investing in the improvement to services, voluntary agreement on an ambitious emissions reduction programme could be easier to achieve if complementary measures are also introduced that significantly improve the commercial environment for bus operations.
- 2.23. It is a voluntary agreement, entered into freely on both sides, with generally a non-binding document setting out the terms. Note that agreements are constrained by general legislation such as the Competition Act 1998 but that the Local Transport Bill would, however, introduce a new competition test that could make it easier for local authorities to enter into agreements with several bus operators, rather than separate agreements with each. Examples of schemes given listed earlier in this section illustrate the actions that several authorities are undertaking to include emissions based criteria within their Agreements.
- 2.24. An authority could decide at any time whether they wish to try to use a QBPA approach to setting up a scheme. Taking forward a bus emission reduction strategy based on a QBPA can be divided into the following two stages.

Preparation

- Authority prepares evidence base, scenario(s) and preferred outcome for future bus fleet profiles for all local commercial service providers, tourist coach, express coach and city tour services, including:
 - Target emission reduction;
 - A possible target for carbon reduction.
- Authority prepares negotiation framework with outline of process, actions and timescales based both on a voluntary approach and using mandatory options (if they prove necessary) taking into account:
 - Target implementation dates;
 - Target emission standards (plus phasing, proportions etc);
 - Preferred timescale for achieving emission reductions (via process);
 - Key milestones en route (such as those below);
 - Any decision points related to the accompanying political processes.

Negotiation

- Authority enters negotiations with bus operators for raising emissions standards through voluntary means, within a timetable for achieving the preferred (or next-best) outcome and commitment to move to more enforceable approaches such a Quality Contract Schemes described later.
 - Evaluate the proposals of the bus operators if they fall short of the Authorities preferred scenario, quantify shortfall, and make a decision if the bus operator proposals are acceptable. Assessment should include evaluation of emissions and any requests for additional expenditure on highways or roadside infrastructure.
- 2.25. If the negotiation route with one or more operators does not produce the result the Authority wishes for, then there are more enforceable options described later.

- 2.26. Quality Bus Partnership Agreement is an approach that authorities could use with smaller bus operators and authorities may wish to avoid scenarios where smaller operators are forced to be uncompetitive relative to bigger operators offering increasingly high-quality services that capture a greater market share. However, choosing the QBPA approach may mean the Council accepting that they cannot include smaller operators in any meaningful way in the scheme. The impact of smaller operators on overall emissions should be assessed in preparation for this outcome, and taken into account when decisions about which approach will be used to set up the scheme. A key issue may be whether the main bus operators will still participate in a voluntary scheme of higher emission standards even if smaller operators refuse to join.
- 2.27. Within the QBPA approach there could be some scope for reaching agreement with coach and city tour service providers. They are users of roadside infrastructure in the city and a business that operates from the city, and therefore may wish to benefit from infrastructure improvements.

Contract conditions of tendered services

- 2.28. Tendered services are time-limited contracts to provide a service for:
- subsidised public services;
 - education department (i.e. school buses); and
 - other contracts (for example, Park and Ride buses).
- 2.29. Local authorities have the power to regulate the emissions performance of tendered services including subsidised services, educational contracts and other specialised contracts. Many councils do not currently specify emissions criteria in their contracts. However pricing preference schemes (whereby commitments to operate new vehicles on the contracted routes get a preferred weighting during procurement assessments) have the effect of encouraging the use of brand new vehicles on subsidised bus routes when their contracts are renewed. It is considered possible that authorities could vary such pricing preference schemes to encourage the uptake of abatement equipment as well as the use of new vehicles where appropriate. Subsidised public services are regulated by Bus Service management function within local authorities.
- 2.30. To fully understand the timeline and decision points for influencing the tendered service bus fleet, it will be necessary to catalogue each of the tendered service contracts, noting the number of vehicles, anticipated vehicle mileage, duration of contract and contract end date. This will show the scope and future opportunities for influencing the take-up of newer vehicles. It is suggested that this work could be done in parallel with any preparation work for negotiation on commercially operated services, though the QBPA.

Quality Partnership Schemes

- 2.31. Statutory QPS apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). From this it follows that contracted schools services (i.e. not charging “separate fares”)

and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, are within the definition of local service and could be regulate by this route.

- 2.32. It is suggested that the use of a QPS be considered in parallel to the BQPA route, as it would provide a contractual framework for the scheme should the authority decide they will provide additional infrastructure and investment for bus services in the city in exchange for faster than currently planned fleet turnover.
- 2.33. Under a statutory QPS, the local authority - for these purposes, county councils, unitary authorities and Passenger Transport Authorities - draws up a scheme, aimed at implementing the policies in its local bus strategy. The bus strategy forms part of the local transport policies required under section 108 of the Transport Act 2000. A QPS in effect represents a commitment on the part of the authority to provide certain facilities to improve local bus services, and to maintain them throughout the life of the scheme; and an obligation on the part of participating bus operators to meet the quality standards prescribed in the scheme when using the facilities in question.
- 2.34. The cost of the scheme to the authority will largely be comprised of any investment in roadside infrastructure, bus priority etc. This is probably what bus operators would prefer to see in any QBPA so the cost to the authority may not be any greater than that of the voluntary approach.
- 2.35. Such schemes have statutory force and would be registered with the Traffic Commissioner, who can prevent non-compliant operations from using corridor facilities. In this respect, a QPS varies from a QBPA, the latter being entirely voluntary.
- 2.36. The essence of a QPS is that:
- the Authority and where appropriate District Councils provide facilities to improve bus operation – including bus lanes and other priority measures and facilities like stops and shelters;
 - the Authority also specifies a quality level for buses that must be met by bus operators as a condition of using the facilities provided.
- 2.37. Department for Transport guidance notes that the specified standard of services should be one which can be reasonably met by any operator, unless the standard is higher but the benefits derived from its application outweigh the costs of compliance. For instance, a requirement to operate buses with facilities to give a high standard of accessibility for disabled people will probably be considered reasonable, as the benefit to the travelling public would justify any operator investment. However a requirement to operate vehicles built by a particular manufacturer or to a particular design is likely to be unreasonable.
- 2.38. A key question is therefore what is the standard of service the main bus operators and smaller bus operators would find reasonable to offer in return for incentives by the Authority? The QPS is still a partnership between the

Authority and one or more operators, so the key question is finding out what grounds there are for reaching an agreement. As per the QBPA process, the Council(s) should determine what their minimum or target emission standard is, based on air quality impacts, in order to assess the position of any given bus operator.

- 2.39. The participating bus operators are then obliged to meet the quality standards prescribed in the scheme when using these facilities, and must give a written undertaking to the traffic commissioners to provide the service to the specified standard. Quality standards can relate to the vehicles to be used, and this can include the percentage of vehicles that meet a given Euro standard either due to vehicle replacement or due to retrofitting abatement equipment.
- 2.40. Quality Partnership Schemes address the potential problem found in voluntary approaches that operators who do not agree to raise their standards cannot be excluded from using the new facilities. Bus operators might be reluctant to enter partnerships and spend money if they can be undercut by low cost, low quality rivals. Therefore the number of vehicles provided by smaller operators and their ability to increase investment in vehicles will need to be considered by authorities. If sufficient services can be provided by those operators willing and able to meet the QPS standards, provision of bus services would not suffer as a result of some operators being excluded from using the routes/areas covered by a QPS.
- 2.41. Operators that choose to continue to operate along a route subject to a QPS but which are not participating in the Scheme, will need to give thought to what, if any, stopping points they observe. They will need to satisfy the Traffic Commissioner that they are neither using the facilities included in the Scheme, nor are they planning to stop in places that will create adverse traffic congestion or safety impacts.
- 2.42. The Act in its current form specifically excludes the Authority from specifying timetables and fares as part of the scheme. In this respect, a QPS scheme differs from the provisions of a Quality Contract (discussed later in this guidance), and QPS represents something of a half-way house between a voluntary BQPA and a QC Scheme.
- 2.43. The Local Transport Bill currently before Parliament would make significant changes to QPS while retaining its essential nature. In particular, it would allow Authorities to specify frequencies, timings and maximum fares in a scheme, subject to safeguards to give existing operators in the area the opportunity to object to such a proposal, and to ensure that all relevant operators are involved in subsequent fare reviews. (However, operators would not have a similar right to object to provisions about vehicle standards). The Bill also contains provisions to restrict the registration of new services, or the variation or cancellation of existing ones, in the area of the scheme if these would be detrimental to the operation of the scheme. These would not necessarily apply in every scheme, this being for the Authority to determine. The Local Transport Bill provisions would not prevent an Authority from making a scheme of the kind permitted under the existing legislation, they simply add further options. The Bill would be supplemented by

regulations and guidance, drafts of which are available at www.dft.gov.uk/pgr/regional/localtransportbill/ltdraftguidance.pdf and may be subject to consultation and further amendment

2.44. From DfT Guidance on QPS in England, the following milestones and decision points can be picked out.

- Preliminary discussions with bus operators can be anticipated to take a number of months. Local transport authorities are advised to make informal contact with bus operators at an early stage of planning a QPS, and with the Highways Agency where there is potential for impact on the trunk road network. This will ensure that the published proposals come as no surprise and that operators have a chance to comment on the feasibility and acceptability of the proposals.
- Having drafted a QPS, the local transport authority making it is obliged to publish it and undertake a formal consultation exercise in accordance with section 115 of the Transport Act 2000. The local transport authority (or authorities) would publish a notice of the proposed QPS in one or more newspapers circulating in the area it would cover. Either the notice itself must give full details of the facilities covered by the Scheme and the standard of service required, or it must state where such details may be inspected. Formal consultation does not have to last a specified length of time, so around three months could be considered sufficient.
- After giving notice, the local transport authority must formally consult the stakeholders. It is obligatory to consult:
 - all operators of local bus services that they think would be affected by the QPS;
 - organisations representing the users of local bus services (in the absence of a known local group, the local transport authority should consult the national organisation, Bus Users UK, which can be found at www.bususers.org);
 - other relevant local authorities that they think would be affected by the QPS - these include other local transport authorities, metropolitan district councils, and also, where appropriate, adjoining local transport authorities in London, Wales or Scotland;
 - the Traffic Commissioner for each traffic area affected by the QPS;
 - the chief officer of police for each police area affected by the QPS.
- The local transport authority should also consult any other persons they think fit. This could well include non-metropolitan district councils whose policies (for example on planning or on [off-street] parking) could be affected by the Scheme, and those affected by the proposed works (i.e. development of the facilities) required prior to the Scheme's commencement.
- There is no fixed time limit for consultation but sufficient time should be allowed to ensure that those who are likely to have views have a reasonable opportunity to make a considered response. Central Government's practice is to allow a minimum of 12 weeks for consultation except in cases of urgency.
- Following consultation, the local transport authority may make the QPS, either as originally proposed or with modifications. The date of coming into operation must not, in any event, be less than three months after the

date on which the QPS is made. But if one or more traffic regulation orders are needed to give effect to the Scheme then the date must also be at least three months after the date on which the order (or the latest of those orders) is made. However, these are only minimum times, and the important issue is that sufficient time is allowed for the local transport authority to provide all the necessary facilities and for operators to provide services to the specified standard.

- Once the QPS has been made, within 14 days, a further notice must be published in one or more newspapers circulating in the area to which the Scheme relates.
- Although the QPS must specify a date of coming into operation, there may be instances where, due to unforeseen circumstances, it becomes impossible to make all the necessary arrangements by that date. There is therefore a provision for postponing the date for up to (but no more than) 12 months from the original proposed implementation date.
- The Transport Act 2000 provides that a QPS must remain in operation for at least five years. There is no upper limit, but local transport authorities should bear in mind that policies and service requirements are likely to change over time and that Schemes should therefore be reviewed at reasonable intervals.

2.45. The Local Transport Bill, if enacted, will make certain changes to the provisions for QPS, and regulations and statutory guidance made under these provisions will also be relevant. However, the changes will not fundamentally affect issues concerning vehicle emissions standards.

2.46. Current progress of the Local Transport Bill can be found here, showing the latest round of reading in the Commons/Lords:
<http://services.parliament.uk/bills/2007-08/localtransporthl.html>

Bus Quality Contract Schemes

2.47. As with QPS, statutory QC Schemes apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). Therefore it is reiterated that contracted schools services (i.e. not charging “separate fares”) and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, is within the definition of local service and so could be regulate by this route.

2.48. Smaller operators are not particularly excluded from such a scheme, but they may find it difficult to offer the level of service or investment required in competition with larger operating groups for a QC, in cases where they run an older than average fleet.

2.49. The powers of the Transport Act 2000 enable local authorities to bring forward schemes in which they can determine what local bus services should be provided in their area, and to what 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 QC contracts.

- 2.50. Under the existing legislation a QC scheme must relate to the implementation of a bus strategy, and the making of a scheme must be 'the only practicable way' of implementing the bus strategy. Schemes require Ministerial approval.
- 2.51. No schemes are currently in operation. However, the Local Transport Bill includes a number of changes to the legislation aimed at making this a more realistic option for Authorities with a good case for using it. In particular, the Bill would replace the "only practicable way" criterion with new, more objective criteria based on increasing bus use and improving service quality. In England, an Approvals Board, chaired by a traffic commissioner, would approve schemes, rather than the Secretary of State, with a right of appeal to the Transport Tribunal.
- 2.52. Given the lack of experience of introducing these schemes it is difficult to make sound estimates over timescales. However, DfT has estimated that a "small uncontroversial scheme" could go through the statutory processes from statutory notice prior to consultation in 15 months. "For complicated schemes we may need to add up to ten months for the tendering process and for appeal (by any operator) to the Transport Tribunal perhaps a further three months." In addition, an approvals board that requires any scheme modifications will mean further consultation.
- 2.53. There are details about guidance and obligations for consultation for QC schemes set out in DfT guidance on the subject in 'Quality Contract schemes for bus services: Guidance to English local authorities' found via this link: www.dft.gov.uk/pgr/regional/buses/quality/. This will be revised by the Local Transport Bill in due course.

2.2 Scheme design

- 2.54. The starting point for the design of any LEV scheme should be the scheme objectives, i.e. the targeted replacement of older vehicles with newer lower emitting ones. Having established the objectives and indications of the potential location(s) for the zone in which the vehicles are to be regulated, there are further design considerations local authorities need to take into account. Key issues in the design of a zone where LEV are prioritised over the most polluting vehicles are organised in this section under the following headings:
- location of boundaries;
 - vehicle emission standards;
 - management of permitted vehicles;
 - enforcement powers and penalties;
 - vehicle detection.

2.3 Location of boundaries

2.55. The location of boundaries is an important component of scheme design either in cordon or area-wide schemes. An early indication of the options for boundaries may be important since significant infrastructural and operating costs (if relevant) will largely be determined by the location. The geographical extent of schemes would necessarily take into account of the conclusions of LAQM Review and Assessments that have identified which vehicle types are contributing to the level of exceedence observed in the AQMA and how much of their activity is focussed in these areas.

2.4 Vehicle emission standards

2.56. The approach for defining LEV standards on which to base enforceable restrictions (on the public highway or at development sites) could be determined in one or a combination of ways. The following criteria are relevant to schemes which target local pollutants:

- Euro standards (the term for European type approval standards for new vehicles, which includes the emission performance against a defined test cycle);
- age of vehicle/ year of first registration. Note that in practice this criteria is almost identical to the Euro standard one i.e. year of first registration can be taken as a proxy for Euro standard in almost all cases;
- a particular fuel/technology combination (if they are considered to have particular benefits, such as hybrid, gaseous or renewable fuels).

2.57. For schemes in which the CO₂ reduction is an objective then the following criteria are a relevant basis for defining permitted vehicles:

- engine size (as a proxy for fuel consumption, and hence CO₂ output); and/or
- CO₂ output.

2.58. Authorities should be aware that setting a carbon reduction objective only may be counter-productive in air quality terms since it may lead to increased uptake of diesel-engined vehicles (being in general more fuel efficient). Authorities should therefore consider whether a Euro-standard objective should be set at the same time.

2.59. Existing LEV that target local pollutants most commonly use Euro standards as the basis for setting emission criteria. In a number of cases there exist supplementary criteria to allow some exemption (or time-extensions) for retrofitting emission abatement technology. Age as a proxy for Euro standard is also a common accompanying basis.

2.60. For UK based parking schemes CO₂ emissions and engine size as a proxy of emissions are the most common focus, and some mainland European schemes include discounts for alternative fuels, and Austria (Graz) for a combination of low CO₂ and high Euro standard (for toxic pollutants).

- 2.61. A feature of schemes that promote the uptake of LEVs is that their local environmental benefits will reduce over time unless the defined emissions standards and incentives are reviewed and revised periodically. For example, a scheme that provides incentives for compliance with Euro IV emissions limits or better will no longer provide local benefits once all vehicles in the fleet are compliant with that standard. Therefore, local authorities should consider a phased approach whereby tighter emission standards are required in future years to qualify for the incentive. The London LEZ is an example of this approach.
- 2.62. Whatever the criteria used, it is essential that they are open to and operable by any normal user. This would rule out region or country specific standards that might not be available to vehicle owners across Europe.

Local Pollutant Criteria

- 2.63. Euro standards describe the emissions criteria that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU. Euro I vehicles began to be produced for a EC-specific type approval standard that came into force in 1993, with pre-Euro vehicles generally being those registered before this date. Note that Euro standards actually include more criteria than simply emissions and form the standards that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU.
- 2.64. The dates at which these standards came into force for various vehicle types are shown in Table 2 below.

Table 2: Introduction dates for European emission standards

Vehicle class	Euro 1/I	Euro 2/II	Euro 3 /III	Euro 4/IV	Euro 5/V	Euro 6/VI
Passenger cars (for example private hire taxi)	31/12/92 – 01/01/97	01/01/97 – 01/01/01	01/01/01 – 01/01/06	01/01/06 - 01/01/11	01/01/11 - 01/09/15	01/09/15 -
Light commercial Class I – up to 1.3 tonnes	01/10/94 – 01/10/97	01/10/97 – 01/01/01	01/01/01 – 01/01/06	01/01/06 - 01/01/11	01/01/11 - 01/09/15	01/09/15 -
Light commercial Class II/III - between 1.3 and 3.5 tonnes	01/10/94 – 01/10/97	01/10/98 – 01/01/02	01/01/02 – 01/01/07	01/01/07 - 01/01/12	01/01/12 - 01/09/16	01/09/16 -
Heavy duty - over 3.5 tonnes (inc. N2 & N3 and PSV M2 & M3)	10/10/93 – 01/10/96	01/10/96 – 01/10/01	01/10/01 – 01/10/06	01/10/06 - 01/10/09	01/10/09 -	na

- 2.65. It should be noted that there can be a time lag between when a vehicle is manufactured (to a particular Euro standard) in order to be Type Approved and when the vehicle is finally sold to the initial purchaser as new, and registered (with DVLA). However, it is also the case that some manufacturers

can produce vehicles to a specification that will meet the next Euro standard (on emissions) before the mandatory deadline, so it is possible to purchase buses that considerably exceed Euro 4 standards before the standards for Euro 5 are fully in place.

- 2.66. The benefits of using Euro standards for a scheme design are that they describe the emission performance in a well defined way, based on an approved testing procedure that defines the manufacturing process. They are criteria against which any vehicle in Europe can be judged; therefore it is interoperable across countries. One drawback is that information about an individual vehicle's Euro standard is not always easy to access by its owner or the scheme operator, particularly for heavier or older vehicles.
- 2.67. The benefits of using age-based standards are simplicity and smooth progression (on an annual basis) of vehicles that will not comply with the scheme rules. The latter may be advantageous for forward investment and planning. The drawback is a potentially arbitrary cut-off point for vehicle moving from compliant to non-compliant status. A vehicle could be the wrong side of the age-criteria but have been manufactured to the same Euro standard as a slightly younger vehicle.
- 2.68. In practice, if a Euro standard basis is chosen for the scheme, it is useful to provide for some age-based proxies for vehicles when necessary in order to simplify the registration/certification process for vehicles where Euro standard information is hard to find. For example the experience from the London LEZ is that information on HDV Euro standards is not always readily available. In the UK this information is recorded for cars and vans, but not Heavy Goods Vehicles (HGV). Therefore, while the London LEZ expresses its emission criteria in terms of emissions standard in many cases vehicles are assessed using an age-as-proxy-for Euro standard. For any large-scale LEV scheme it is suggested that similar systems would be applicable in England, based on lessons learned and processes developed by Government agencies from the London implementation.
- 2.69. The level of a vehicle's local pollutant emissions are primarily influenced by the vehicle technology rather than the properties of the fuel. Alternative fuels do not necessarily offer air quality benefits. However, gaseous fuels generally emit less CO₂ than petrol and biofuels can offer lifecycle CO₂ emissions reductions. As a result there may be local and specific arguments for including alternative fuels and technologies in the list of compliant vehicles, perhaps if carbon reduction is a stated focus of the scheme.
- 2.70. It should be noted that there is no reliable approach for basing a scheme on emissions performance 'in service'. However, this has not proved a barrier to the introduction of a LEZ in the UK (London) or other European countries, as they use age and/or Euro standards as a basis.

Carbon dioxide Emission Criteria

- 2.71. For CO₂ focussed schemes the most common criteria engine size and CO₂ emissions can be found from vehicle registration records and for passenger cars from the VCA website (www.vcacarfueldata.org.uk/index.asp). From 1

March 2001 all new petrol and diesel cars had a published CO₂ emission level in grams per kilometre and the VED payable on these vehicles is related to their CO₂ emissions. The banding system is shown in Table 3.

Table 3: Current definition of Vehicle Excise Duty banding with carbon dioxide emissions

CO ₂ Emission Value	Vehicle Band
Less than or equal to 100g/km	Band A
More than or equal to 101g/km but less than or equal to 120g/km	Band B
More than or equal to 121g/km but less than or equal to 150g/km	Band C
More than or equal to 151g/km but less than or equal to 165g/km	Band D
More than or equal to 166g/km but less than or equal to 185g/km	Band E
More than or equal to 186g/km but less than or equal to 225 g/km	Band F
More than or equal to 226g/km	Band G

- 2.72. Cars first registered prior to this date pay a VED rate related to their engine size. Note that this is not necessarily an accurate approximation of their unit (g/km) CO₂ emissions.
- 2.73. From 2009 VED will be restructured to incorporate six new bands (hence bands A-M), which will increase the financial difference between the most and least polluting cars. Further VED changes include:
- reducing the standard rate of VED in 2009-10 for all new and existing cars that emit 150g/km of CO₂ or less and increasing the standard rate of VED on the most polluting cars;
 - from 2010-11, extending the zero rate of VED to all new cars that emit 130g/km of CO₂ during the first year of ownership;
 - introducing a new first-year rate of £950 for new, high CO₂-emitting cars;
 - aligning the alternative fuel and standard rates of VED in 2011.
- 2.74. Therefore all carbon-focussed schemes, even one that only includes passenger cars, should take account of the variety of ways that vehicles in the existing fleet are defined via the VED system to ensure the schemes are open and fair. The benefits of using VED bands for scheme design are that they describe the CO₂ emission performance in a well-defined way (for cars registered after 2001), based on their registration documents. The drawbacks include the difficulties including pre-2001 registered vehicles in schemes.
- 2.75. It is not relevant to use an age-based standard for regulating CO₂ emissions since vehicles will be defined according to their VED-banding regardless of their age – i.e. it is not possible to account for changes in fuel economy with increasing vehicle age via a simple VED-band based system.

2.5 Management of permitted vehicles

- 2.76. The scheme operator maintains the definition of what is a permitted vehicle. Processes are required to verify the emission standard of a particular vehicle. Certification processes may be necessary, or useful to include in a scheme if

they already exist, if there is likely to be a lack of information about potential users of the scheme.

- 2.77. Management of the permission to enter the zone requires information and identification of individual vehicles with administration systems to cross-check permissions.
- In a large scheme covering a number of types of vehicle this would probably require the creation of a database with links to the DVLA records, as for the London LEZ.
 - If a scheme is small-scale, affecting relatively few vehicles or one focussed on local fleets, then a basic permit management and verification system might be sufficient using vehicle registration documents. This might be the case for schemes focussing on bus and coach fleets or residential parking.
- 2.78. UK parking schemes are based on resident parking permits or season ticket holders, which provides an administrative basis for managing new users. Schemes such as Winchester discount on parking for A and B-band CO₂ rated car was limited at launch to Season ticket holders at long stay car parks. At the end of the trial period, the concept was extended to residents parking schemes in and around the city centre. The discounts are not available for short-stay Pay and Display, Park and Ride, Pay on Foot or Pay on Exit car parks. Including more open types of parking within a scheme would involve more complex management systems, and higher running costs.
- 2.79. Management of permitted vehicles in a scheme focussed on a development site should be more straightforward compared to the public highway. Through-traffic is not normal and all vehicles are destined for privately controlled parking. The costs of administering any scheme would be expected to be borne by the developer, or ongoing management company set up by the developer or development occupiers.
- 2.80. In the case of bus fleets the management and cost of maintaining information on permitted vehicles would be borne by the authority concerned with the approach adopted as follows:
- Quality Bus Partnership Agreement – the Local Traffic Authority;
 - Contract conditions – the contracting Authority;
 - Quality Partnership Schemes – the Traffic Commissioner;
 - Quality Contract Schemes - the county council, unitary or Passenger Transport Authority.
- 2.81. Once a vehicle owner has checked with the scheme rules whether their vehicle complies or not they must be able to prove the status of their vehicle against the scheme rules. The vehicle registration mark (VRM) shown on the number plate can be used if this information is linked with the data used to verify the emissions criteria. Alternatively, or as a supplement, a specific sticker or plate may be issued by the scheme operator following verification of a qualifying emission standard. Relevant emission data on different vehicle

types and models can be obtained from www.vcacarfueldata.org.uk/ (note that information on some vehicles is not available on this site).

2.6 Enforcement powers and penalties

Traffic and parking orders

Parking enforcement

- 2.82. Local authorities have long been responsible for managing all on-street and some off-street parking, whether directly or indirectly. The powers to control waiting and loading and to provide and charge for on-street parking are provided by the RTRA 1984, with various amendments since such as by the Road Traffic Regulation (Parking) Act 1986, and most recently the TMA 2004.
- 2.83. The Road Traffic Act 1991 significantly changed the way that on-street parking restrictions are enforced. Before 1991, the police and traffic wardens were responsible for enforcement and income from fixed penalty notices (FPNs) went to the Exchequer. However, the police service found itself increasingly unable to resource parking enforcement. The 1991 Act made it optional for local authorities (not London boroughs) to take on the civil enforcement of non-endorsable parking contraventions. When a local authority takes over this power from the police, staff employed directly or indirectly by them issue PCNs and the local authority keeps the income for operation of the scheme.
- 2.84. Part 6 of the TMA 2004 now provides for the civil enforcement of most types of parking contraventions. It replaces Part II and Schedule 3 of the Road Traffic Act 1991 and some local legislation covering London only. The TMA 2004 and the associated regulations have given to English authorities outside London many powers already available to authorities in London, giving greater consistency across the country while allowing for parking policies to suit local circumstances.
- 2.85. It is assumed that most Authorities interested in using variable parking charges to incentivise lower emission vehicles will also be those interested in taking up the powers available to them under the TMA 2004. Therefore, this guidance note is written with these latest regulations in mind and the environment of Civil Parking Enforcement that they provide.

Traffic enforcement

- 2.86. The TMA 2004 provides a single framework to make regulations for civil enforcement by local authorities or parking and waiting restrictions, bus lanes and some moving traffic offences. It is therefore a very important piece of legislation for local traffic authorities that wish to better manage their road networks and take on aspects of enforcement that may not be a priority for the Police.
- 2.87. Regulations under Schedule 7 to the Traffic Management Act 2004 would allow local traffic authority appointed Civil Enforcement Officers the powers to

monitor and penalise a range of moving traffic offences such as stopping in boxed junctions and making banned turns. This would complement civil enforcement powers already available for parking management. Powers for moving vehicle enforcement may be extended in the future for authorities in England with regulations provided by DfT. Updates are available via www.dft.gov.uk/pgr/roads/tpm/tmaportal/.

- 2.88. Extending civil enforcements powers would enable Highway Authorities outside London to use camera evidence of traffic contraventions. This would provide such authorities parity with those in London where legislation has enabled the adoption of civil enforcement of moving vehicle contraventions.
- 2.89. If powers are extended by the Schedule 7 regulations then road traffic signs described by the TMA 2004 for civil enforcement might be used to sign a zone where LEVs are incentivised. For example 'motor vehicles prohibited' (sign 619) can include the supplementary text 'except for permitted vehicles'. This appears sufficient to legally sign an access control scheme.
- 2.90. Civil penalties for moving vehicle contraventions (under TMA 2004) may be the same as currently applied to bus lane, parking and other similar moving traffic offences. Parking penalty charges are set at different bands and levels, up to £70 outside London, with discount or further charge depending when paid. It would be appropriate for a Highway Authority to consider the level of penalty charge required for effective enforcement. A supplementary local authority circular or relevant guidance is a mechanism that would enable a variation of the PCN charge in certain circumstances.

Planning obligations

- 2.91. Section 106 of the Town and Country Planning Act 1990 introduced the concept of planning obligations, which comprises both planning agreements and unilateral undertakings. It enables a planning obligation to be entered into by means of a unilateral undertaking by a developer as well as by agreement between a developer and a local planning authority.
- 2.92. Section 106(1) provides that anyone with an interest in land may enter into a planning obligation enforceable by the local planning authority. Such obligations may restrict development or use of land; require operations or activities to be carried out in, on, under or over the land; require the land to be used in any specified way; or require payments to be made to the authority either in a single sum or periodically.
- 2.93. Section 106(5) provides for restrictions or requirements imposed under a planning obligation to be enforced by injunction.
- 2.94. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides existing policy on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).

- 2.95. In the case of the Greenwich Peninsula development, the obligation to develop the low emission zone aspects of the development in more detail falls on the developer, and the obligation to comply is borne by the developer and the future occupiers.

Bus-based schemes

- 2.96. The previously discussed legal bases for bus focussed schemes included detail on which authority would have responsibility for enforcing the scheme. In summary the responsibility for enforcement will vary.

- Quality Bus Partnership Agreements are generally non-binding documents so that the ability to force non-compliant operators to comply is weak.
- Criteria for tendered services can clearly be enforced via the contracting authority via the conditions of contract.
- The Traffic Commissioner who can prevent non-compliant operations from using the facilities provided by the authority can enforce Quality Partnership Schemes.
- Bus Quality Contract Schemes would be enforced and operated by the local traffic authority and not the Traffic Commissioner.

- 2.97. Note that apart from QPS the local traffic authority would be responsible for enforcement; unless the district authority also lets tendered services so that they too may have responsibility. These authorities would therefore need there to be adequate systems and resources to check the compliance of vehicles. The potential penalties involved are the withdrawal of contract and any incentives associated with this.

2.7 Vehicle detection

- 2.98. This section identifies the likely approaches for detecting vehicles and determining which do not comply with the criteria. For traffic, parking or development control schemes it is assumed that powers under the TMA 2004 for civil enforcement of both parking and moving vehicle contraventions on the public highway are available and have been taken up.

- 2.99. Identification of a vehicle that complies with scheme criteria could be via a paper permit, windscreen sticker, or by the VRM on the number plate. A scheme design could require the vehicle to self-identify itself, by use of a transponder or a proximity smart card.

- 2.100. Detection of a vehicle for subsequent identification of emission status could be carried out by a variety of methods, sometimes in combination:

- Manual methods, whereby enforcement personnel visually check vehicles travelling within or parked within the scheme area for identification marks (VRM and/or a permit/sticker). In the mainland Europe examples of LEZ the checks would tend to focus on older looking vehicles and might use a mixture of manual recording and possibly photography. Some post-checking against a database of compliant vehicles would then be necessary.

- Digital cameras and ANPR – all passing number plates are recorded and recognised using Optical Character Recognition (OCR) for matching against a database of vehicles. A network of cameras could be installed on the key routes into/out of the boundary of the scheme and possibly at key junctions within the zone if it is very large. As a supplementary, or alternative approach, mobile ANPR cameras could be used to monitor key junctions and/or ‘hot-spots’ of possible non-compliance.
- Dedicated Short Range Communication (DSRC) – tags and beacons, more suitable for schemes with relatively few and pre-determined users which comply with the scheme criteria. Tags or proximity smartcards are commonly issued to vehicle owners for accessing private car parks, or can be scanned through a wind-screen, and have also been used to trigger bollards which control access on the public highway.

Manual Detection

- 2.101. The benefits of manual detection methods are lower capital costs, and some flexibility over future operating costs if enforcement levels can be reduced. Manual enforcement is suitable for parking schemes, whether on-street parking on development sites. A drawback of manual enforcement is the limit on the number and speed of vehicles that can be checked by a person. However, existing schemes show this approach should not be ruled out.
- 2.102. The London Lorry Control Scheme (commonly referred to as ‘The London Lorry Ban’) is an example of a successful manually enforced scheme. A small team of five officers manage to cover the prescribed route network across London and actively investigate some 500-600 vehicles a month. Officers position themselves at junctions known to be attractive, but controlled, routes for HGV. In addition, they will respond to complaints from residents of vehicles ‘off-route’. The main objective is deterrence and to assist HGV drivers with better route planning in order to raise compliance rates. This scheme, and those LEZ enforced manually in other European countries, indicate that manual detection could be a basis for enforcement. Detection of HDV is likely to be more successful than LDV, as HDV are larger and less numerous.
- 2.103. In most urban areas of the UK it might also be anticipated that compliance by bus fleets could be detected manually due to the smaller number of operators, vehicles and layover locations.

Automated Detection

- 2.104. The TMA 2004 regulations currently give the power to authorities throughout England to issue PCNs for parking contraventions detected with a camera and associated recording equipment (approved device). Regulations from the Act may also be prepared for moving vehicle contraventions. Cameras can only be used by Highway Authorities in a civil enforcement environment. There is current experience of using camera enforcement within London for moving traffic enforcement, and outside London for bus lane enforcement. The Secretary of State must certify any type of device used solely to detect contraventions and once certified they may be called an ‘approved device’.

- 2.105. The benefits of such automated enforcement systems are that high speed and volume flows of vehicles can be detected and recorded, and that every vehicle can be checked. Drawbacks can include the relative inflexibility of fixed camera systems once they are installed, and the up-front capital costs.
- 2.106. Automatic Number Plate Recognition cameras can provide one part of such an automated system. They are able to capture 90%+ of passing number plates. Automatic Number Plate Recognition cameras are used in the London Congestion Charge Scheme (CCS) and for the London LEZ. In the London CCS, images are kept for checking of vehicles whose details are not in a database of vehicles for which a charge has been paid (or registered as exempt). In order to cover 'hotspots' of non-permitted vehicles within the LEZ, mobile (van-based) enforcement units could be suitable.
- 2.107. There will be additional options for identification and detection of vehicles entering development sites, depending on the layout and approach for managing traffic and parking. Development sites generally have a limited number of entry and exit points, and are able to use manual or automatic barriers at these and at entrances to car parks. The road network tends to discourage through-movement, and access by non-residents or visitors. These factors enable greater opportunity for checks on vehicles. Parking permit and management systems provide opportunities for further identification and detection, to verify against a permitted vehicle database.
- 2.108. It should be noted that it is not strictly necessary to achieve a 100% detection level for a scheme to be effective. The level of compliance, and impact non-compliance has on emission impacts, will impact on the value for money of any scheme. However, the aim should be to achieve a balance with sufficient enforcement to provide an effective deterrent, in order to achieve the scheme objectives.

3 Developing and appraising Low Emission Vehicle schemes

3.1. Schemes may be designed using the options introduced in the previous chapter. Local authorities will need to appraise these options to make decisions on the most appropriate and cost-effective for a scheme in their area. This chapter provides guidance on the most important aspects of appraisal in particular regarding appraising the cost-effectiveness and benefits of schemes in terms of air quality objectives.

3.2. The chapter is structured as follows.

- The overall or generic effects of schemes are defined.
- A staged approach to appraising emissions and air quality effects of scheme designs introduced. Staging the appraisal may allow a number of designs to be scoped out of the appraisal at an early stage on grounds of negligible benefits.
- The important types of capital and operating costs are introduced to allow a realistic appraisal of scheme design costs and costs to operators to be drawn up during appraisal.
- Guidance on using emissions and costs data to complete cost-effectiveness and cost-benefit appraisals is then provided.

3.1 Generic Effects of the Scheme

3.3. It is likely that LEV schemes will have significant impacts on environmental objectives. Indeed improving the environment is a key objective of such schemes. The nature of the impacts will be scheme specific and depend on the scheme location and the scheme's impact on vehicle emissions by location and the composition of traffic. The environmental impacts of a scheme will also depend on the extent to which the LEV is combined with other measures. Table 4 describes qualitatively the potential impacts of these schemes.

Table 4: Qualitative assessment of the potential impacts of a Low Emission Vehicle scheme

Impact	Qualitative assessment	Notes/assumptions
Inside scheme zone		
Pollutant emissions (NO _x , PM ₁₀)	✓	True for Euro-standard based schemes. Schemes may address NO _x and PM ₁₀ either individually or not.
CO ₂ emissions	✓	Assuming VED-based schemes
	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	✓	Newer vehicles are typically quieter
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	X	Most schemes have low costs. Could be partly offset by revenue raised by the scheme from non-compliant vehicles
Costs to operators	X	Potential vehicle replacement costs before end of commercially useful life. Potential operating cost savings or increases
Outside scheme zone		
Pollutant emissions (NO _x , PM ₁₀)	-	Older vehicles may be sold for use in areas outside the zone but compliant vehicles that use the zone are also active outside of the zone
CO ₂ emissions	-	
	-	Assuming a Euro-standard based scheme
Noise	-	Older vehicles may be sold for use in areas outside the zone but compliant vehicles that use the zone are also active outside of the zone
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	-	Potentially no regulatory costs outside of zone
Costs to operators	-	Potentially neutral operator costs if travel time impacts are neutral

Notes:

1. Qualitative assessment: ✓ symbolises a beneficial impact, x symbolises a negative impact, - symbolises a neutral impact.
2. Low Emission Vehicle incentive schemes are potentially unlikely to have significant non-air quality impacts. Therefore local authorities are advised to have regard to the generic guidance on the economic principles that apply when assessing these schemes. This guidance provides more detail on actions to take to assess significant non-air quality impacts.

3.2 Emissions/Air Quality Impact Assessment

3.4. Local authorities are advised to proceed through a staged process to assess the potential emissions and air quality impacts. These stages are:

- a screening stage (to identify the potential of such schemes);
- intermediate stage (consistent with LAQM methods and duties such as action planning and progress reporting);and
- detailed stage (using the webTAG from DfT on appraising road transport schemes).

3.2.1 Screening assessment

3.5. The purpose of a screening assessment is to quickly assess the potential benefits of a scheme. It is intended to be simple and to use a minimum of information that is available.

3.6. At a basic level LEV schemes are intended to replace older or more polluting vehicles with ones with more stringent emissions standards, for example, a shift from Euro II or older vehicles to Euro IV vehicles, or better. In these basic terms the potential benefit from a LEV scheme is therefore associated with the reduction in unit emissions (or emission factors).

3.7. A broad assessment could proceed as follows.

1. Define a zone inside which a LEV scheme might operate and identify those vehicle types that the scheme would seek to regulate.
2. Assemble from transport models or otherwise estimate the annual activity (veh km) of those vehicle types within the zone. One way of estimating activity is to multiply traffic volumes by link length and then to sum over all links in the zone.
3. Define a year in which the scheme may start.
4. Use the emissions factor toolkit for vehicle emissions (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) to obtain the year and vehicle type specific emission factors for NO_x and PM₁₀ (g/veh km).
5. Multiply activity by emission factor to estimate the basecase emissions.

3.8. The effect of scheme depends on the emission standard set. For example, the London LEZ scheme requires HDVs to achieve at least a Euro III standard for PM₁₀ by 7 July 2008.

1. The effect is to change the weighted emission factors for HDV types (see worked example in later section).
2. Recalculate the product of the activity and the emission factors to estimate the annual emissions with the scheme in operation.
3. The difference from the base-case is the potential emissions benefit of the scheme.
4. In combination with screening assessments of other schemes the relative attractiveness of each scheme in emissions terms can be compared.

3.9. Note that this simple approach to assessing LEV schemes does not address potentially important effects such as the re-distribution of traffic and the contribution to emissions from congested conditions. Intermediate or detailed assessments are advised to address these issues more fully.

3.2.2 Intermediate assessment guidance

3.10. For an intermediate assessment Local authorities are advised to have regard to the related guidance documents on generic economic principles for assessment local air quality schemes. This guidance document provides background information on emissions and air quality impact assessments. In particular it sets out recommendations on:

- developing a detailed baseline emission inventory;
- potential sources of data for the inventory;
- available tools for estimating the emission impacts of transport measures;
- having regard to the technical guidance on further assessment of local air quality for assessing compliance against the air quality objectives.

3.11. The underlying principle for emissions or air quality impact assessment is to firstly define the baseline or business as usual emissions or air quality. This is the case that currently applies and would apply in future years if no additional action were taken. Once the baseline case has been defined the effects on baseline emissions and or air quality from new policies can be assessed. Emissions and air quality assessments are technical tasks. Therefore local authorities are referred to the guidance document Local Air Quality Management Technical Guidance 2008 for additional information.

3.12. Inventory should be sufficiently detailed to allow the impacts of a range of potential policies to be assessed. A detailed emission inventory allows baseline and with-policy emissions to be calculated that account for:

- the impacts of national policies such as Euro standards for vehicle emissions;
- the impacts of local transport policy on traffic growth and other actions to which the local authority is already committed including transport policies and new developments;
- road transport activity potentially disaggregated by zone and vehicle type. This allows the effects of policies that reduce activity, move its location or switch from one transport mode to another to be assessed;
- the contribution from stationary traffic. This allows policies that reduce congestion to be assessed;
- fleet numbers and ages for key vehicle types. This allows the effects of policies to promote the uptake of newer vehicles to be assessed.

3.13. By assessing the impacts of measures on the baseline emissions the local authority can then more accurately assess the potential cost-effectiveness and air quality health benefits associated with the measures.

3.14. Potential sources of data from which to develop emission inventories are summarised below:

- **Source activity:** Road transport models can provide average speed and annual average daily flow data disaggregated by road link and usually split between light and heavy-duty vehicles. More detailed surveys have been used to disaggregate HDV types between buses and HGVs. Furthermore, some traffic models also provide link specific data on the daily average time that traffic is stationary at junctions and the average length of these queues. These data are necessary to estimate the potential contribution from congestion.
- **Vehicle emission factors:**
 - The Air Quality Archive local authority emissions toolkit (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) has tools that allow calculation of road traffic exhaust emissions for different vehicle categories and splits, at various speeds, and on different road types. This tool also calculates emission factors in future years.
 - Local authorities may also consider using the tool Defra has developed to be used by local authorities in calculating emissions of NO_x and PM₁₀ under the new performance indicator framework (i.e. NI 194: Air quality – percentage reduction in NO_x and primary PM₁₀ emissions through local authority's estate and operations) www.defra.gov.uk/environment/airquality/local/indicator.htm. This tool can be used to indicate the potential difference in emissions due to replacement by one vehicle type with another or due to a reduction in annual mileage.

Specific fleet inventories:

- 3.15. In the case of specific and relatively small fleets (such as the local authorities own fleet or commercially operating bus fleets) it is recommended that a specific fleet inventory is developed. A key reason for this is that the distribution of vehicle ages within these fleets can typically vary quite significantly from the national average age distribution. For example, the local bus fleet may be significantly older or younger than the national average. For better accuracy it is therefore recommended to list the age and abatement equipment of each vehicle. In these cases local authorities should attempt to work in partnership with commercial and other fleet operators to obtain the relevant data.
- 3.16. Other key factors in the inventory: To be useful as a policy assessment tool, local authorities are advised to consider including the following additional capabilities in their local inventories.
 - Compliance rates. Depending on the range of regulatory approaches being considered to enforce a local measure (strong or weak) then a greater or lesser rate of compliance may be expected. If this is a significant factor then local authorities should include the capability within their inventory for assessing the emissions impact of compliance rates less than 100%.
 - Compliance year (or year that the measure under consideration would come into force). Natural vehicle replacement rates mean that on average the national fleet unit emission factors decrease over time. If the compliance year is in the future then local authorities are advised to

include this effect in their inventory. Otherwise the inventory is likely to overestimate the potential emissions impact of a local measure.

Air Quality Assessment

- 3.17. Air quality assessments use monitoring, dispersion model and Geographical Information Systems (GIS) data to assess a) where the air quality objectives are exceeded and b) whether there is relevant exposure at these locations. The methods to be used in these assessments are provided in detail in Local Air Quality Management Technical Guidance 2008 and local authorities are recommended to have regard to this guidance.
- 3.18. For assessing the effects of local measures it is most appropriate to consider the exercise as a formal Further Assessment i.e. this is the most detailed of review and assessment technical activities and is designed to estimate the contribution of different sources to the local air quality (source apportionment).
- 3.19. An appropriate further assessment allows air quality arising from baseline and with-policy cases to be calculated that account for the same criteria as those described for detailed emission inventories. By assessing the impacts of measures on the baseline air quality the local authority can then more accurately assess the potential effect on compliance with the air quality objectives associated with the measures.

Specific guidance on assessing low emission vehicle incentive schemes

- 3.20. These schemes aim to change the emission factors of vehicles that circulate in an authority by promoting the uptake of newer vehicles. Therefore the emissions and air quality assessments should be designed to include the following parameters or indicators:
- annual average daily road transport activity (veh.km) disaggregated by vehicle type and road links;
 - implementation year (so that future underlying changes in emission factors are accounted for);
 - fleet inventories (number of vehicles, their breakdown by euro standard or vehicle excise duty band) for vehicle types affected by the measure.
- 3.21. During the design phase of a LEV scheme local authorities should assess the effect (or range of effects) of the scheme on these indicators. In particular the effects of requiring a minimum Euro and/or VED standard by an implementation date for specific vehicle types will be a key impact. Local authorities should include an assessment of the likely rate of compliance with the scheme, which may vary according to the 'strength' of the approach used to regulate the scheme. Applying these changes to the baseline emission inventory and air quality dispersion model will estimate the potential emissions and air quality benefits of the measure.

3.2.3 Detailed assessment guidance

- 3.22. If assessment of the scheme proceeds to the need for a formal road scheme appraisal consistent with the NATA then local authorities should have full regard for the detailed guidance on completing these appraisals.
- 3.23. The full Transport Analysis Guidance can be found online at www.webtag.org.uk/. Unit 3.3.3 contains the specific guidance on local air quality assessment.

3.3 Costs Assessment

- 3.24. The main factors that will affect a consideration of cost and timescale for setting up and operating a LEV scheme are the types or sub-categories of vehicles that are to be included (and any differences in standards), the size of the scheme and the level of technology used for detection and enforcement. Together these factors contribute much to the level of complexity of a scheme's design.
- 3.25. Typically, the greater the number of vehicle types within the scheme, the greater the number of vehicles, so set-up and running costs associated with a scheme will tend to rise. In broad terms, the size of the UK fleet rises proportionately from bus/coach to HGV to Light Goods Vehicles (LGV) (vans) to passenger cars. Therefore, a scheme which includes only HDV will tend to cost the scheme operator less than one which only includes passenger cars, all other things being equal. This does not yet take into account operator costs. This relationship fits well with the known contribution to emissions (per vehicle) that tends to show that, due to engine size and power output, each HDV produces more pollutant emission than each passenger car.
- 3.26. A larger scheme will tend to cost more to set up and operate, if all other factors remain equal. Hence, a small number of strategic access points that effectively controls most of the cross-city traffic or parking in a historic urban area is considerably cheaper than a large city centre scheme with urban dual carriageway through-routes.
- 3.27. The third major factor is the level of technology used. High technology schemes, based on ANPR cameras, will tend to have greater set-up and running costs than paper or sticker-based schemes. However, the relationships is not as simple as that because issues around detection/compliance rate mean that a scheme's more costly operating basis (i.e. technology) may be more *effective* to the extent it is actually more cost-effective. So, for example, there may be concerns about a windscreen sticker-based system working in the UK context. However, if a windscreen sticker-based system works effectively in the UK context, it will tend to be more cost-effective than one closely monitored by camera systems.
- 3.28. These three factors (vehicle type, scheme size and technology basis) will tend to interact with one another to produce variations in complexity, and hence cost.

3.29. Considering the various cost elements that might be relevant to any scheme, we can divide these into capital costs (i.e. set-up or investment costs) and operating costs. A list of generic cost categories is set out in Table 5.

Table 5: Potential cost items for Low Emission Vehicle set-up and operation

Capital costs	Operating costs
<ul style="list-style-type: none"> • Scheme design and planning • Legal/ set-up costs • Consultation process • Marketing and information campaign • Traffic management / safety • Roadside equipment (signing, detection, enforcement) • Central administration and IT systems (vehicle record, certification, enquiry handling) 	<ul style="list-style-type: none"> • Accommodation • Staff costs • Any new vehicle identification method (for example windscreen stickers) and the issuing process for this • Equipment / software replacement and maintenance costs • Supplies, services and transport

3.4 Cost-effectiveness and cost-benefit Assessment

3.30. Cost-effectiveness analysis and Cost-Benefit Analysis are both methods for economic appraisal. The Practice Guidance on Economic Principles provides more detailed information on these techniques and how to use them. This section summarises the key points.

3.31. Cost-effectiveness compares different ways of achieving the same objective. It is relevant for air quality when looking to achieve (or to make progress towards) the reduction of air quality exceedences, i.e. legally binding concentrations that must not be exceeded. However, such a cost-effectiveness analysis focuses only on one objective, and does not consider other Government environmental goals. The benefit of cost-effectiveness analysis is that it allows the relative attractiveness of different options or combinations of measures to be assessed, in order to achieve the overall objective (the removal of the exceedence) in the most cost-effective way, i.e. economically efficiently.

3.32. Cost-benefit analysis assesses whether the total benefits of a project or policy exceed the costs. It is therefore an absolute measure and can assess value for money. It quantifies costs and benefits in monetary terms, including values not captured by markets (i.e. the full costs and benefits to society). The UK Government, in its guidance for economic appraisal, favours the use of cost-benefit analysis. This is also the main part of the approach used in local transport appraisal – and has been the case for many years. Cost-benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence. The results of a cost-benefit analysis can then be used to update the cost-effectiveness analysis to consider all environmental goals, by working with ‘net’ cost-effectiveness, where the capital and scheme costs are expressed net of all environmental costs or benefits, before the cost-effectiveness ranking.

- 3.33. Note that these two techniques can be complementary. Cost-effectiveness is part of both techniques, but in cost-benefit analysis, the analysis is extended to compare directly to the benefits of the proposals.
- 3.34. In order to undertake either cost-effectiveness analysis or cost-benefit analysis, it is necessary to collate and assess information on costs for use in an economic framework. It is highlighted that practitioners often confuse financial and economic appraisal. An economic appraisal considers the costs in terms of society as a whole and the overall value for money. A financial appraisal looks at the affordability of a proposal, and is more likely to be more familiar as it will be similar to local budgetary framework, financial costs and accounts (an accountancy based perspective). For any scheme, both the economic and financial case for a proposal will be important, as it will be necessary to show the wider value for money of a proposal, but also ensure that from the local authority perspective, it is affordable. However, for cost-effectiveness analysis and cost-benefit analysis, the economic assessment should be used. The Practice Guidance on Economic Principles provides more details.
- 3.35. In economic appraisal, all historic and future cost estimates need to be expressed in equivalent terms, so they can be directly compared. The Practice Guidance on Economic Principles provides details of how to analyse cost information so it can be used in cost-effectiveness and cost-benefit analysis. This is likely to require some analysis of cost data (including future costs). It is also necessary to work within an economic framework in the assessment of costs, which requires analysis of all costs (not just those that occur to the local authority in the local authority area), and has to exclude all transfers, such as VAT, taxes or charges. The Practice Guidance on Economic Principles provides more details.
- 3.36. To undertake a scoping cost-effectiveness analysis, the annual emissions benefits of a measure, as estimated using the approach set out in the previous section, are combined with the cost data, where costs are expressed as an equivalent annual costs. The annual emission benefits are divided by the equivalent annual cost to give the cost (£) to reduce one tonne of emissions (cost per tonne). This gives the cost-effectiveness of a measure – and this allows different options to be compared – those with the lowest cost per tonne abated (the lower cost per tonne) are the most cost-effective. Note that in the case of an AQMA, the relevant metric is likely to be the emissions abated in the area of the exceedence, though more accurately, it is the cost per level of air quality improvement ($\mu\text{g m}^{-3}$). However, such an analysis only considers one environmental goal, and it is also necessary to consider other environmental objectives in a ‘net’ cost-effectiveness analysis to correctly prioritise measures (see below).
- 3.37. It is also possible to use the cost-effectiveness ranking to build up an action plan towards the reduction of an exceedence. Those measures that are most cost-effective, i.e. that achieve greatest air quality improvements for least cost should be included first in the plan. Progressively less cost-effective options are then added until the target air quality improvement is achieved, or until proportional progress towards the target can be demonstrated. Undertaking analysis in this way will also provide a total cost of compliance.

Note, however, that cost-effectiveness works only with a single pollutant. To address this, it is possible to work with the 'net cost-effectiveness' to consider other environmental objectives. Moreover, the cost-effectiveness of a measure is only one element of the options, and other factors will be important in determining the overall ranking of measures, including the wider assessment, legal and technical issues, practicality and acceptability.

- 3.38. To undertake a cost-benefit analysis, the same information on emissions and costs is used, though there are important differences. First, the emissions benefits are expressed in monetary terms. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants, such as NO_x and PM₁₀) are estimated, along with the monetary values for other environmental effects such as greenhouse gas emissions, using the Government damage cost (the Shadow Price for Carbon). This is used to generate the total present value of benefits, which can be compared against the total present value of costs of the options (note cost-benefit analysis works with the total stream of costs, i.e. the present value, not the annualised costs used in cost-effectiveness analysis above).
- 3.39. The cost-benefit analysis simply compares the present value of the stream of benefits divided by the present value of the stream of costs, to generate a net present value (NPV). The NPV is the primary criterion for deciding whether government action can be justified, i.e. whether a scheme has a positive net present value. A higher NPV indicates an option is preferable. However, other factors will be important in determining the overall ranking of measures, including any other benefits or costs, legal and technical issues, practicality and acceptability.
- 3.40. The cost-benefit analysis results can be used to provide a 'net' cost-effectiveness analysis. The 'net' cost effectiveness is equal to the present value of costs less present value of benefits / by reduction in tonnes pollutant, or in the above case where the cost-effectiveness analysis is concerned with air quality targets in a given year, is equal to annualised costs less annualised benefits / by reduction in tonnes pollutant (or µg m⁻³). The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other environmental objectives, i.e. reductions of other air quality pollutants or changes in greenhouse gas emissions, and so provides a more holistic overall ranking method for planning.
- 3.41. Previous studies have looked at the cost-effectiveness and cost-benefit analysis of retrofit schemes. These include for example, the Interdepartmental Group on Costs and Benefits (IGCB) Economic Analysis to Inform the Review of the Air Quality Strategy (www.defra.gov.uk/environment/airquality/publications/stratreview-analysis/index.htm), the London LEZ (www.tfl.gov.uk/roadusers/lez/default.aspx). A worked example is included in the following section.

3.42. A number of studies have examined the balance of costs, benefits and the effectiveness of these schemes. A consistent set of conclusions has emerged from these studies that local authorities should consider when examining these schemes for their region.

- Cost-effective schemes and enforcement are possible for small specific parts of the fleet (such as buses and taxis) but that are typically significant emitters in AQMAs. However, they are still significant in terms of operator cost.
- Regulating emissions from larger, less regulated parts of the fleet is increasingly costly, much less cost-effective and potentially provide very few local air quality benefits.
- Overall it is judged that there may be significant air quality benefits (in terms of compliance with the air quality objectives at least) in introducing schemes to replace older diesel-fuelled HDV particularly where they undertake a significant share of the road transport activity within an AQMA or urban centre.
- This means that authorities may currently prioritise their efforts to regulate emissions via LEV incentive schemes in the following order of decreasing priority: buses and coaches>taxis>HGVs>private cars.

4 Worked example

4.1 Introduction

4.1. To illustrate how the guidance in chapter 3 may work in practice the following worked example provides guidance on assessing emissions effects, costs and cost-effectiveness and cost benefit assessment.

4.2. This worked example assumes a policy is implemented to replace existing buses with new vehicles. The example illustrates the effect of:

- varying the emission standard with which the buses must comply.
- varying the year by which buses must comply (i.e. the implementation year).

4.2 Emissions assessment

4.2.1 Do minimum or baseline case

4.3. This policy would affect buses only. The first step would be to collate information on:

- number of vehicles potentially affected;
- their age (i.e. when first registered) and whether they already have abatement equipment fitted;
- planned replacement rates (i.e. how long each is expected to remain in service).

4.4. This information is best obtained from the vehicle operators and this provides an opportunity to engage with these key stakeholders at an early stage of policy development.

4.5. It is also necessary to collate estimates of the total annual vehicle kilometres travelled by these vehicles. The total can again be calculated from data supplied by operators. Note that if the policy to retrofit abatement equipment will only be enforced in a specific zone that the total annual vehicle kilometres travelled by these vehicles in that zone should be estimated. This can be estimated by multiplying the total link length on bus routes by their annual service frequency.

4.6. Note that this example will deal with a single fleet representative of all buses operating in an area but it is possible to disaggregate this fleet according to type of bus operation (commercial, contracted, etc) and/or operator. This level of dis-aggregation may be important depending on the enforcement approach being considered and also if there are significant differences between the fleets of different operators. An example of the collated data is shown in Table 6.

Table 6: Baseline bus data

Number of buses	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	36	36	36	36	12	8
Euro III	72	78	53	53	53	53	49	46	46
Euro III + CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total number of buses	151	150	149	149	149	149	149	149	149
Total veh.km (millions) in central zone	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Total veh.km (millions)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

CRT is Continuously Regenerating Particle Trap

4.7. Note that these data illustrate:

- the ongoing effects of existing vehicle replacement policies;
- that some Euro II and Euro III vehicles already have particulate traps fitted to abate their PM emissions. Manufacturers should be consulted for information on the abatement efficiency of their equipment. In this example the abatement efficiency is assumed to be 90% effective in terms of PM emissions and to have no impact on NO_x emissions. The NO_x abatement efficiency for this system is assumed to be 60%.

4.8. The next step is to calculate the trend in emission rates for the baseline case. Emission rate/speed data disaggregated by vehicle type and Euro standard are available from the National Atmospheric Emissions Inventory (NAEI) web pages. Using these rates and the data illustrated above the baseline trend in emission rates (average weighted by vehicle age and abatement equipment if relevant) can be calculated. These are presented in Table 7.

Table 7: Age and abatement-weighted emission rates at 30 kph

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO _x (g/km)	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.83
PM (mg/km)	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	51.63

4.9. Note that this example takes a simple view that an average speed of 30 kph is representative of bus activity. Detailed analysis should include consideration of emissions associated with bus stops, layovers and journey delays due to congestion if these are relevant to the case.

- 4.10. Emission rates and activity data from the first table are multiplied to estimate the baseline bus emissions in Table 8.

Table 8: estimated baseline bus emissions

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO _x emissions (tonnes) in central zone	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.78
Total NO _x emissions (tonnes)	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	12.74
PM ₁₀ emissions (tonnes) in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM ₁₀ emissions (tonnes)	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23

- 4.11. Note that the estimates illustrate a decline in emissions over time due to vehicle replacement plans and more stringent Euro standards in new vehicles. In particular there is a large relative decrease in PM₁₀ emissions between 2007 and 2008 due to the introduction of particulate filter equipment to the majority of the Euro II vehicles.

4.2.2 Estimated effect of varying the emission standard to be achieved

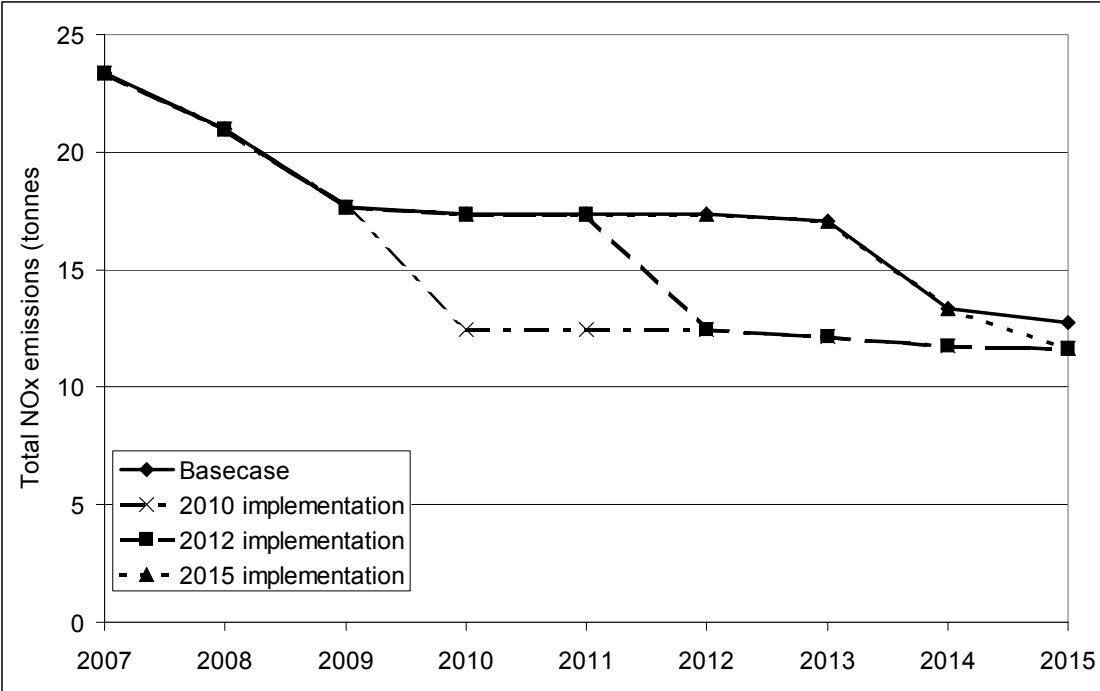
- 4.12. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting future emission standards.
- 4.13. From 2009 onwards there would normally be only Euro II vehicles remaining that have PM abatement fitted. This however would have no influence on NO_x emissions so that the vehicles would not be fully compliant with the Euro III standards. Also between 2009 and 2013 the fleet is almost fixed in terms of its age profile, i.e. planned investments in Continuously Regenerating particle Traps (CRT) systems and new vehicles during 2007/08 are the only major investments during the period. From 2014 onwards planned replacement of existing Euro II and III vehicles starts.
- 4.14. From 2008 onwards Euro V standard vehicles are increasingly available. Theoretically it would be possible for a fleet operator to buy vehicles second-hand if they are compliant with whatever euro standard is selected as the criteria for a scheme but this example assumes that replacement is always to a brand-new vehicle.
- 4.15. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur if the fleet had by 2010 to achieve:
- a Euro III standard (requires all pre-Euro III vehicles to be replaced)
 - a Euro IV standard (requires all pre-Euro IV vehicles to be replaced)
 - a Euro V standard (requires all pre-Euro V vehicles to be replaced)
- 4.16. The tables include a calculation of the difference in annual emissions relative to the base case.

Criteria	Euro III standard									Euro IV standard									Euro V standard								
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0	9	45	38	0	0	0	0	0	0	9	45	38	0	0	0	0	0	0
Euro III	72	78	53	53	53	53	49	46	46	72	78	53	0	0	0	0	0	0	72	78	53	0	0	0	0	0	0
Euro III+CRT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5	7	12	12	0	0	0	0	0	0
Euro V	0	11	46	84	84	84	88	96	98	0	11	46	137	137	137	137	142	144	0	11	46	149	149	149	149	149	149
Total	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149
Emission rate																											
NO _x (g/km)	5.19	4.67	3.92	2.77	2.77	2.77	2.70	2.61	2.59	5.19	4.67	3.92	1.86	1.86	1.86	1.86	1.81	1.80	5.19	4.67	3.92	1.75	1.75	1.75	1.75	1.75	1.75
PM (mg/km)	123.53	72.52	54.30	56.34	56.34	56.34	53.89	52.06	52.06	123.53	72.52	54.30	23.96	23.96	23.96	23.96	23.96	123.53	72.52	54.30	23.96	23.96	23.96	23.96	23.96	23.96	
Emissions (tonnes)																											
NO _x in central zone	16.08	14.46	12.16	8.59	8.59	8.59	8.38	8.08	8.03	16.08	14.46	12.16	5.76	5.76	5.76	5.76	5.63	5.57	16.08	14.46	12.16	5.43	5.43	5.43	5.43	5.43	5.43
Total NO _x	23.34	20.99	17.65	12.47	12.47	12.47	12.16	11.73	11.65	23.34	20.99	17.65	8.36	8.36	8.36	8.36	8.17	8.09	23.34	20.99	17.65	7.89	7.89	7.89	7.89	7.89	7.89
PM ₁₀ in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.38	0.22	0.17	0.07	0.07	0.07	0.07	0.07	0.07	0.38	0.22	0.17	0.07	0.07	0.07	0.07	0.07	0.07
Total PM ₁₀	0.56	0.33	0.24	0.25	0.25	0.25	0.24	0.23	0.23	0.56	0.33	0.24	0.11	0.11	0.11	0.11	0.11	0.11	0.56	0.33	0.24	0.11	0.11	0.11	0.11	0.11	0.11
Difference from Baseline (tonnes)																											
NO _x in central zone	0.00	0.00	0.00	3.38	3.38	3.38	3.38	1.13	0.75	0.00	0.00	0.00	6.21	6.21	6.21	5.99	3.58	3.21	0.00	0.00	0.00	6.53	6.53	6.53	6.32	3.77	3.34
Total NO _x	0.00	0.00	0.00	4.90	4.90	4.90	4.90	1.63	1.09	0.00	0.00	0.00	9.01	9.01	9.01	8.70	5.20	4.65	0.00	0.00	0.00	9.49	9.49	9.49	9.18	5.48	4.85
PM ₁₀ in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.09	0.09	0.09	0.09	0.09	0.09
Total PM ₁₀	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.14	0.13	0.12	0.12	0.00	0.00	0.00	0.14	0.14	0.14	0.13	0.12	0.12

4.2.3 Estimated effect of varying the implementation year

- 4.17. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting the year by which standards should be achieved.
- 4.18. In this example it is assumed that the emission standard to be achieved is Euro III (i.e. all pre-Euro III vehicles are replaced.) The effects of requiring this change by 2010, 2012 and 2015 are examined.
- 4.19. Examining the baseline bus data table it can be seen that the 2010 compliance date will affect 36 vehicles, the 2012 date would also affect these 36 vehicles whereas the 2015 date will affect only eight due to the natural replacement rate of vehicles over this period. The 2012 compliance date would require similar costs to the 2010 date but since it comes two years later would have an overall lesser benefit associated with it. The 2015 compliance date is likely to require lower costs but would also have a lesser effect.
- 4.20. This discussion illustrates the important point that setting an early compliance date will achieve more local air quality and emission benefits but usually at higher costs.
- 4.21. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur for the examples that if the fleet complies with the Euro III standard by:
- a) 2010 (replacement of 36 Euro II vehicles)
 - b) 2012 (replacement of 36 Euro II vehicles)
 - c) 2015 (replacement of eight Euro II vehicles)
- 4.22. Figure 1 illustrates the trends in emissions due to the different implementation dates.
- 4.23. Key points to note in the graph are that the 2010 implementation date would deliver several years of benefits relative to the base case, whereas the 2012 case would deliver an identical benefit but for a shorter period. However, as time passes the gap between the base case and the Euro III standard decreases due to natural replacement of older vehicles. By 2015 the benefits due to the Euro III standard is very small. The policy of requiring the Euro III standard by 2015 would only deliver a small benefit – this policy delivers too little too late.

Figure 1: Graph of annual nitrogen oxides emissions for the base case, 2010, 2012 and 2015 implementation dates for a Euro III standard.



Criteria	2010 compliance date									2012 compliance date									2015 compliance date								
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0	9	45	38	36	36	0	0	0	0	9	45	38	36	36	36	36	12	0
Euro III	72	78	53	53	53	53	49	46	46	72	78	53	53	53	53	49	46	46	72	78	53	53	53	53	49	46	46
Euro III+CRT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	84	84	84	88	96	98	0	11	46	48	48	84	88	96	98	0	11	46	48	48	48	52	84	98
Total	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149
Emission rate																											
NO _x (g/km)	5.19	4.67	3.92	2.77	2.77	2.77	2.70	2.61	2.59	5.19	4.67	3.92	3.86	3.86	2.77	2.70	2.61	2.59	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.59
PM (mg/km)	123.53	72.52	54.30	56.34	56.34	56.34	53.89	52.06	52.06	123.53	72.52	54.30	54.41	54.41	56.34	53.89	52.06	52.06	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	52.06
Emissions (tonnes)																											
NO _x in central zone	16.08	14.46	12.16	8.59	8.59	8.59	8.38	8.08	8.03	16.08	14.46	12.16	11.97	11.97	8.59	8.38	8.08	8.03	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.03
Total NO _x	23.34	20.99	17.65	12.47	12.47	12.47	12.16	11.73	11.65	23.34	20.99	17.65	17.37	17.37	12.47	12.16	11.73	11.65	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	11.65
PM ₁₀ in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.38	0.22	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM ₁₀	0.56	0.33	0.24	0.25	0.25	0.25	0.24	0.23	0.23	0.56	0.33	0.24	0.24	0.24	0.25	0.24	0.23	0.23	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23
Difference from Baseline (tonnes)																											
NO _x in central zone	0.00	0.00	0.00	3.38	3.38	3.38	3.38	1.13	0.75	0.00	0.00	0.00	0.00	0.00	3.38	3.38	1.13	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
Total NO _x	0.00	0.00	0.00	4.90	4.90	4.90	4.90	1.63	1.09	0.00	0.00	0.00	0.00	0.00	4.90	4.90	1.63	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09
PM ₁₀ in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PM ₁₀	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.2.4 Conclusions

- 4.24. In terms of emissions and air quality benefits the main points to be considered for any vehicle replacement policy are as follows.
1. To set an appropriate emission standard to achieve an outcome where there are local emissions reductions relative to the base case. The higher the Euro standard the bigger the potential reductions.
 2. To set an appropriate implementation year to achieve an outcome where there are local emissions reductions relative to the base case. Earlier is better.
 3. To consider setting further Euro standards and implementation years (i.e. subsequent phases of emission reduction) otherwise the benefits of the policies will be eroded over time by natural vehicle replacement rates.
 4. That the emission standards and implementation years have to be balanced up against issues of costs but also the level of action required to achieve the air quality objectives in the AQMA.

4.3 Cost-effectiveness and cost-benefit assessment

- 4.25. A simple example is given below on cost-effectiveness analysis and cost-benefit assessment for low emission vehicles. Note that this example does not follow-on from the detailed emissions example above, it is a separate example to illustrate the concepts.

4.3.1 Cost-effectiveness analysis

- 4.26. The first example is to generate some simple cost-effectiveness values for different LEVs. The estimated capital and running costs of abatement equipment is summarised below, along with the lifetime. Note that for the economic analysis, it is the resource costs (technology costs) that are used, rather than the market prices. For the financial analysis, the market prices are relevant. The example is based on the examples given in the IGCB analysis of the Air Quality Strategy Review. They assume Exhaust Gas Recirculation (EGR) technology to LDVs and Selective Catalytic Reduction (SCR) to HDVs. In this case, the analysis considers the additional marginal cost of these technologies in new vehicles, not the absolute cost of the vehicles. The input data is shown in the example below, though note there are additional variations on these specific technologies in the full IGCB analysis.

Table 9: Cost input data

Equipment – heavy vehicle	Resource Costs (£)	Annual additive cost	Change in fuel efficiency	Lifetime
SCR (new rigid HGV)*	430 - 800	219	-6%	10 years
EGR (new LGV) *	288	12	-2%	6 years

* source: IGCB Economic Analysis to Inform the Review of the Air Quality Strategy, based on value for articulated HGVs.

- 4.27. In this example here, only the direct costs of the fuel penalty are included. In more in depth analysis, for example as in the case of the IGCB analysis, the additional negative impact on fuel economy is considered, as the higher costs causes less vehicle kilometres to be driven (rebound effects). These might in turn affect the emissions of pollutants (reducing them) but has other welfare effects.
- 4.28. The costs of these individual options over their lifetime has to be calculated, and expressed in equivalent terms, as a present value of costs. In each case, the costs in each year are multiplied by the discount factors, to allow the discounted costs to be estimated. The sum of these discounted costs gives the present value of costs. These are then converted to an equivalent annual cost for the cost-effectiveness analysis (using either the Equivalent Annualised Cost equation³, or the excel formula, see worksheet example). As an example, the values for the SCR estimation (low resource cost) are shown below.
- 4.29. As well as operating and capital costs, there are also the changes in fuel efficiency in this case. If there is a positive impact of fuel economy, the vehicle will have greater mileage per litre of fuel compared to the situation without the new technology. If there is a negative impact on fuel economy, the reverse is true. These changes lead to direct costs for the operator. Note there are also wider effects on fuel economy, because when fuel economy increases (for example), all other things being equal, the marginal cost of driving falls, this causes demand in the more fuel efficient vehicles to rise. These additional effects (the rebound effect) are not taken into account here, and require more detailed economic analysis. There are also associated welfare effects due to rebound effects, though again these are not considered here and require more detailed analysis.
- 4.30. In the case of the two technologies here, there is a negative impact on fuel economy, so the new vehicles will use more fuel per km compared to the comparative Euro standard. The additional fuel consumption cost is calculated based on the increased fuel use, and the resource costs of fuel, i.e. no tax is included. Data on average fuel consumption of rigid vehicles, and data on fuel prices (without tax) are available from the DfT statistics, www.dft.gov.uk/pgr/statistics/datatablespublications/tsqb/2007edition/section3energyenvironment.pdf Table 3.3 and annual mileage from Table 3.4 for rigid vehicles. Data on vehicle mileage is available from DfT road freight statistics, it is assumed that for a larger rigid vehicle, annual mileage of 50,000km www.dft.gov.uk/162259/162469/221412/221522/222944/285840/01_Road_Freight_Stats_2006_1.pdf

³ Equivalent annualised cost = NPV multiplied by

$$\left[\frac{r(1+r)^n}{(1+r)^n - 1} \right]$$

where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the scheme length in years.

Table 10: Estimation of Present Value of Costs, and Equivalent Annual Cost – Rigid Selective Catalytic Reduction

SCR	Year (relative to base year)									
	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Equipment (£)										
Resource cost	430									
Maintenance	219	219	219	219	219	219	219	219	219	219
Fuel penalty	1029	1029	1029	1029	1029	1029	1029	1029	1029	1029
Total	1,678	1,248	1,248	1,248	1,248	1,248	1,248	1,248	1,248	1,248
Discount factor	1.000	0.966	0.933	0.902	0.871	0.842	0.814	0.786	0.759	0.734
Discounted cost	1,678	1,206	1,165	1,125	1,087	1,051	1,015	981	948	916
Present value	11,172									
Equivalent annual cost	1,343									

Source: fuel prices (no tax) from Department for Transport, Transport Statistics Great Britain (TSGB), 2007, Table 3.3 and annual mileage from Table 3.4 for rigid vehicles.

www.dft.gov.uk/pgr/statistics/datatablespublications/tsgb/2007edition/section3energyenvironment.pdf

Data on freight annual mileage is available from DfT freight statistics, for example

www.dft.gov.uk/162259/162469/221412/221522/222944/285840/01_Road_Freight_Stats_2006_1.pdf

4.31. The values for all technologies are summarised below.

Option	SCR for rigid	EGR for LDV
Present value (sum)	11,172 to 11,542	600
Equivalent annualised cost	1,343 to 1,388	113

4.32. This provides an estimate of the annualised costs of the equipment, which can be compared with the annual tonnes abated from each option, to estimate the cost-effectiveness. Again, in this case it is the marginal improvement above the alternative (associated with the technology of the LEV) that is important.

- For the SCR, abatement efficiency is assumed to lead to a 50% reduction in new NO_x emissions.
- For the EGR, abatement efficiency is assumed to lead to a 20% reduction in new NO_x emissions and a 90% reduction in PM emissions.

4.33. The annual emissions benefits of each scheme are based on the vehicles driving in urban conditions, 30 kph, are shown below from the NAEI web pages. We assume each vehicle drives 20,000 km a year in the central zone. If it is assumed that there is a constant abatement efficiency across all vehicle types and Euro standards, then the cost-effectiveness is determined by the equivalent annual cost above, divided by the annual emissions reduction. The values are shown for the SCR in Table 11.

Table 11: Cost-effectiveness Analysis Selective Catalytic Reduction

	Emissions gNO _x /km	NO _x Tonnes per year in central zone	Equivalent annualised costs	Cost per tonne
Euro IV	3.629	0.07259		
LEV	1.815	0.03629		
Difference	1.815	0.036	1,343 to 1,388	£37,011 to £38,237

4.34. The same approach is applied to EGR for a LDV. The results, in Table 12 below, shows that for NO_x the EGR technology for LGVs is less cost-effective than SCR for rigids shown in Table 11 above. However (see above) the EGR technology tackles both pollutants. This highlights one of the problems with cost-effectiveness, as the approach can only assess one pollutant at a time. The cost-effectiveness analysis also does not take other environmental considerations into account, notably greenhouse gas emissions. It is possible to address other pollutants and greenhouse gases by estimating 'net' cost-effectiveness of options to correctly prioritise measures taking other objectives into account (see later discussion).

Table 12: Cost-effectiveness Analysis Exhaust Gas Recirculation

	Emissions gNO _x /km	NO _x Tonnes per year in central zone	Equivalent annualised costs	Cost per tonne of NO _x
Euro IV	0.051	0.00102		
LEV	0.005	0.00010		
Difference	0.046	0.0017	113	£66,302

	Emissions gPM ₁₀ /km	PM ₁₀ Tonnes per year in central zone	Equivalent annualised costs	Cost per tonne of PM ₁₀
Euro IV	0.425	0.00849		
LEV	0.340	0.00679		
Difference	0.085	0.002	113	£122,764

4.35. The overall benefits of options can be assessed using assessed with cost-benefit analysis, and this highlights the complementary role for using the two together.

4.3.2 Cost-benefit analysis

4.36. The first stage in a cost-benefit analysis is to estimate the monetary value of the benefits.

4.37. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the

benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants) are estimated.

- 4.38. As an example, the values for annual NO_x emissions reductions from a SCR on a rigid HGV was shown above. However, in this case, it is necessary to look at the full benefits of the scheme (the full value to society) rather than the benefits that only occur in the central zone. For this, it is assumed that the vehicle also has an annual mileage of 20,000 km in the outer zone of the city. The total benefits are therefore twice as big as the table above (0.036*2 tonnes per year)
- 4.39. The values are then entered in the damage cost calculator. In this case, we assume a 2008 start date, a ten year lifetime, and one pollutant, NO_x.
- 4.40. The spreadsheet output is shown below (note benefits extend out to 2017).

1. What length (in years) is your policy appraisal?	10	
2. What is the base year for the appraisal?	2008	
3. What pollutant are you assessing? (click box to select from drop-down menu)	1	
4. Input the annual changes in emissions below (in tonnes)		

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Change in emissions (tonnes)	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259	0.07259

CALCULATED RESULTS

Central Estimate Present Value	£	<input style="width: 90%;" type="text" value="0.00"/>	Million
	£	<input style="width: 90%;" type="text" value="640"/>	

- 4.41. The central estimate is of £640 present value of benefits. These can be compared against the present value of costs in the earlier table, which were much higher. This shows that in this case, the NPV is negative (so costs are higher than benefits). However, consideration of this technology with additional particulate control would be likely to improve the NPV.
- 4.42. A similar analysis is undertaken with EGR abatement equipment. Note for this analysis it is necessary to include both NO_x and PM₁₀ emissions benefits. Note for PM₁₀ the location of the emissions has to be estimated, i.e. the split by location. The monetary benefits of NO_x and PM₁₀ are added together to give the total present value of benefits, and these are compared against costs.

Table 13: Cost-Benefit Analysis Results (Air Quality only)

Equipment - bus	Present Value Benefits	Present Value Costs	Net Present Value
EGR LGV	724	600	124
SCR rigid	640	11,172 to 11,542	-10,532 to -10,902

- 4.43. The results show the EGR new vehicle has a positive NPV.
- 4.44. However, with LEVs, it is also necessary to take account of any effects on fuel consumption and greenhouse gas emissions in the cost-benefit analysis. As outlined earlier, the LEV options here lead to increases in fuel consumption compared to the baseline technology. They will therefore lead to higher CO₂ emission per km.
- 4.45. As well as Government values on the benefits of air quality improvements (the damage costs), there are also estimates for valuing greenhouse gas emissions. These value the wider social benefits of reductions, rather than the costs of measures and policies needed to reduce greenhouse gas emissions. The values, and guidance on use, can be found on the Defra web-site⁴, under the section on the Shadow Price of Carbon (SPC), see also the Practice Guidance of Economic Principles. This guidance allows the changes in greenhouse gas emissions (and likewise if there were CO₂ benefits) to be valued in economic terms, and added to the overall cost-benefit analysis. As with the damage costs for air quality above, the shadow price of carbon is expressed as the economic benefit for a reduction of 1 tonne of CO₂ emission (or carbon dioxide equivalent (CO₂e)). In this example, the additional greenhouse gas effects are not included, but they would reduce the NPV of the options above. Similarly, for LEVs that reduced greenhouse gas emissions, this would increase the NPV.
- 4.46. The same approach can be used to build up the analysis of cost-effectiveness analysis and cost-benefit analysis for entire schemes, as with the emissions benefit example above.
- 4.47. The information from a cost-benefit analysis can also be used to consider other environmental objectives as part of a 'net' cost-effectiveness analysis. For the case of air pollution, where we are concerned with achieving air pollution targets in a given year, this is estimated from the estimation of annualised costs less annualised benefits / by reduction in tonnes pollutant. The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other air quality pollutants, and greenhouse gas emissions, in the cost-effectiveness ranking and so provides a more holistic overall ranking method. In the example above, it would allow a consideration of both NO_x and PM₁₀ benefits in the cost-effectiveness analysis of EGR (compared to SCR). The estimation of net cost-effectiveness analysis would take the information above from the cost-benefit analysis, but convert the present value of benefits into an equivalent annual term. This is then subtracted from the equivalent annual costs, and divided by emissions improvements, to

⁴ www.defra.gov.uk/environment/climatechange/research/carboncost/step1.htm

estimate the net cost-effectiveness. This allows both pollutants (for example NO_x and PM₁₀ benefits) to be taken into account when undertaking ranking options. An example of a net cost-effectiveness analysis is given in the Practice Guidance on retrofitting vehicles. Note that the net cost-effectiveness analysis should also take greenhouse gas emissions changes, and the economic benefits (from the Shadow Price for Carbon valuation) into account.

- 4.48. Note that there are some different issues when considering vehicle replacement, rather than just the consideration of alternative new vehicles as above. In the case where vehicles are replaced, it is important to consider what happens to the replaced vehicles. This can be very complex, and depends on operator behaviour, market values, etc. As an example, in a case where an older vehicle is retired prematurely, it is necessary to consider the useful resources that are being lost. This is usually estimated by calculating the market value of the vehicles in the year that they are being retired⁵ – and the additional costs added to the calculation - though in this case the emission benefits are greater as an older vehicle with higher emissions is being retired early. There may also be other effects in such a case with changes in fuel efficiency (as above). In other cases, vehicles maybe moved to other routes (fleet switching) without retirement, or vehicle maybe sold on.

⁵ This approach was used in the IGCB analysis, and reflects an estimate of the value of the service the vehicle would have provided for the rest of its lifetime, had it not been retired early.

5 Examples of Low Emission Vehicle uptake schemes

- 5.1. The purpose of this chapter is to provide key information on existing or planned LEV schemes. This includes a brief description of how key implementation and enforcement issues are addressed in these schemes.
- 5.2. Traffic control schemes are common in UK towns and cities. Linking a variety of access control schemes on sections of the public highway builds up the overall traffic management approach in many city and town centres. A small number of such traffic control schemes in the UK have either been designed to include emission criteria or have been examined for such a modification, and are therefore can be considered small-scale examples of LEV uptake schemes.
- 5.3. A selection of relevant schemes includes:
 - buses and coaches: Quality Bus Partnerships and Quality Bus Corridors in South Yorkshire among others;
 - Heavy Goods Vehicles: the London LEZ among others;
 - cars: car clubs, parking charges electric and vehicle charging schemes in London and other locations.
- 5.4. These schemes achieve their emission objectives via a variety of routes; either by applying regulatory or access controls or charges to more polluting vehicles and discounts to less polluting vehicles, or by simply providing economic incentives to cause voluntary behaviour change.
- 5.5. Key summary information on the schemes is provided in Table 14 whereas more detailed information is found in the following text sections.

Table 14: Summary of key information on example schemes in this guidance

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Management of vehicle	Comments (Strengths/weaknesses)
South Yorks A6135 and quality bus corridor	QPS	Specific bus service routes	Bus fleet	Minimum number of Euro IV vehicles and review of complete fleet	Traffic Commissioner	Vehicle registration documents	Relatively simple enforcement
London bus emission strategy	Transport for London specifications	Greater London	London Bus fleets	Minimum of Euro II plus particulate filter and moving to diesel-electric hybrid vehicles in the future	Transport for London		QPS or quality contract schemes are needed outside London to exert a similar level of control over commercial services
Oxfordshire	QBPA	Oxford City	Bus fleets	Under review	Under review		A range of approaches may be necessary to regulate emissions from all relevant bus fleets
Shrewsbury	QBPA	Specific bus service routes	Commercial bus fleets	Euro II minimum with target for introducing Euro IV within five years	Agreement means no legal enforcement	Vehicle registration documents	Weak enforcement and care needed to ensure emission standards are strong enough to achieve objectives.
London - LEZ	Charge	Greater London	HDV (HGV, Coach etc), with heavy vans to be added later.	From 4th Feb. 2008, a standard of Euro 3 for PM for lorries over 12 tonnes Gross Vehicle Weight (GVW), and buses and coaches over 5 tonnes GVW. From July 2008, a standard of Euro 3 for PM for lorries between 3.5 and 12 tonnes, buses and coaches. From Oct. 2010, a standard of Euro 3 for PM for larger vans and minibuses. From Jan. 2012, a standard of Euro 4 for PM for lorries	Large network of ANPR cameras. Penalty for non-compliance and non-payment is £500/£1000 depending vehicle size.	Compliant vehicles self-registered via number plate and DVLA records. Non-standard cases and retrofit vehicles required to register vehicle, and retrofit vehicles inspected annually by VOSA. Daily charge (£200 or £100, depending on the size/type of	Phased approach to ensure tightening emission standards.

Scheme	Basis	Area	Vehicles	Standards (retrofit/incentives)	Enforcement	Management of vehicle	Comments (Strengths/weaknesses)
				over 3.5 tonnes GVW, buses and coaches over 5 tonnes GVW.		vehicle) for vehicles who do not comply. Retrofit for PM possible.	
Edinburgh and other car clubs	Commercial	No designated area within the authority	Private cars	Switch from individual to joint 'ownership' of cars.	None. Financial incentives	Owners registered on club database	Good financial incentives for many users. Not all urban areas economically attractive to commercial car club operators
LB Croydon and Westminster	Parking discounts	Designated parking bays in the boroughs	Private cars	Switch from conventional to zero local emission vehicles	None. Financial incentives	Register of permits	Good financial incentives for users.
LB Richmond, Winchester, Stockholm and Graz	Discounted car parking fees	Whole borough or urban centres	Private cars	Incentives to operate low carbon emitting and/or latest Euro-standard vehicles	Financial incentives	Register of permits	Good financial incentives for users.
Greenwich Peninsula	Planning obligation	190 acres of development site.	All vehicles.	Various, depending on land-use and vehicle type. Based on Euro standards.	Non compliance will be a breach of the agreement	Retrofitting of HDV possible for PM.	Management and operation is responsibility of developer.

Bus and coach schemes

South Yorkshire Public Transport Executive

- 5.6. A route in North Sheffield, following the A6135 between Spital Hill and Chapeltown, including Firth Park centre is part of the Sheffield QPS. As is usual in QPS new facilities have been provided for this route including new bus lane, raised kerbs for accessible boarding, new shelters and real time bus frequency and traffic management information. At the same time the QPS specifies minimum standards for the buses using these services. These standards include accessibility and safety considerations but of particular relevance is the result that 105 buses that are at least Euro III standard are operating in the scheme.
- 5.7. Elsewhere in Doncaster, a Quality Bus Corridor scheme operates. The conditions of the scheme require at least 18 Euro 4 standard vehicles to operate on the routes and for there to be a review of the whole fleet during 2008.

London

- 5.8. The London Bus Emission Strategy is a long-term programme of bus upgrading in part to improve the fleet's emissions performance. As at March 2007 there were 8181 vehicles in the fleet. In advance of the London LEZ going operational the fleet was improved via vehicle replacement and emissions abatement retrofits (further information on the London LEZ can be found in Chapter 5 of the Practice Guidance on LEZ). As a result the fleet contained 36% Euro II vehicles plus particulate filters, 61% Euro III vehicles plus particulate filters and 3% Euro IV vehicles with in-built SCR or EGR NO_x abatement (further information on retrofitting can be found in the Practice Guidance on retrofitting abatement equipment).
- 5.9. In addition to local pollutant emission reductions the London bus fleet priority is also to reduce carbon emissions. As a result there is now a short-medium term strategy to replace conventional diesel powered vehicles with diesel-electric hybrid vehicles and a long-term strategy to replace vehicles with hydrogen fuel-cell technology. These technologies are already under trial in London and are predicted to result in further reductions of local pollutant emissions and NO_x emissions in particular.
- 5.10. Current plans are to introduce 800 hybrid vehicles by the end of financial year 2011/12 and for all vehicle replacements post April 2012 to be a hybrid vehicle. Relative to a Euro IV vehicle these will be specified to achieve 80% reduction in hydrocarbons, 95% less CO, 30% drop in CO₂, 15% reduction in NO_x and be equivalent to Transport for London's (TfL) PM standard for Euro IV.

Oxfordshire

- 5.11. The County and City Councils has an ongoing review of the costs and effects of introducing an emissions protocol into a QBPA (and other approaches to regulating emissions from commercial bus fleets). Currently contracted bus services are let with 'price preference' conditions whereby tenders that

include commitment to operate new vehicles are given additional credit when assessed. This has the effect of promoting the use of new vehicles when contracts are renewed.

Shrewsbury

- 5.12. A QBPA includes commitment by operators starting from 2005 to operate Euro II buses as a minimum and to renew or refurbish buses on specified routes within five years with existing buses likely to be replaced with Euro IV vehicles.

Heavy Goods Vehicles

London – Low Emission Zone

- 5.13. The London LEZ started operation in 2008. The aim of the scheme is to improve air quality in the city by deterring the most polluting vehicles from driving in the area. The vehicles affected by the LEZ are older diesel-engine HDVs including lorries, buses, coaches, large vans, minibuses and other heavy vehicles that are derived from lorries and vans, such as motor caravans and motorised horse boxes. Cars and motorcycles are not affected by the scheme. As a result, the scheme tends to target heavy diesel-powered vehicles, thereby prioritising PM reduction. The largest number of vehicles that will potentially be affected in the first phase of the scheme are HGVs.
- 5.14. The LEZ commenced on 4 February 2008 for lorries over 12 tonnes, with different vehicles affected over time and tougher emissions standards due to be introduced in January 2012.
- 5.15. The London LEZ emission standards describe the minimum Euro standard which vehicles must meet to be exempt from a charge. Meeting these emission standards can be done by using a vehicle whose engine was type approved to this standard (or better) or by retrofitting exhaust after-treatment technology to raise the emission standard (further information on retrofitting can be found in the Practice Guidance on retrofitting abatement equipment). The standards by vehicle/weight and timescale are:
- from 4 February 2008, a standard of Euro III for PM for lorries over 12 tonnes;
 - from 7 July 2008, a standard of Euro III for PM for lorries between 3.5 and 12 tonnes and buses and coaches over 5 tonnes;
 - from 4 October 2010, a standard of Euro III for PM for larger vans and minibuses;
 - from 3 January 2012, a standard of Euro IV for PM for lorries over 3.5 tonnes and buses and coaches over 5 tonnes.
- 5.16. The London LEZ actually operates as a road charging scheme. The important differentiator is that polluting vehicles are not banned from entering the London LEZ, they simply incur a discouragingly high charge to enter or their drivers risk a penalty if they do not pay. It was set up using a Scheme Order, which is the same legal basis as the London CCS. However, it is not a congestion charge as the objective is not to reduce traffic levels.

- 5.17. The London LEZ began operation in 2008. Transport for London has planned a work programme that will undertake an analysis of the schemes impact and it is expected that results will be made public in due course. The scheme has been scrutinised closely during its development and a recent TfL analysis of the potential impacts of the scheme (TfL, 2007) found the following. The LEZ is anticipated to produce significant air quality benefits both within and beyond the LEZ boundary. In 2008 the scheme is expected to reduce the area of Greater London that exceeds the daily PM₁₀ limit by 7% and by 15% by 2012. By 2010 the scheme is expected to reduce the area of Greater London that exceeds the annual mean NO₂ limit by 4% and by 16% by 2012. Health benefits associated with these changes are estimated to be £170-250 million due to predicted reduction in illness and extended life expectancy (years of life gained).
- 5.18. Further information on LEZs can be found in the Practice Guidance on LEZ. Information on a wide number of other current and planned low emission zones across Europe can be found via the EU-wide LEZ Network (www.lowemissionzones.eu). The web site provides information about network members' schemes and is a mechanism for members to publicise access restrictions on a pan-Europe basis.

Safe and Fuel Efficient Driving

- 5.19. The Safe and Fuel Efficient Driving (SAFED) Scheme for HGV and vans is a national scheme for training drivers in safe and fuel efficient practices. Information on the scheme can be found at www.safed.org.uk/. Although the scheme does not attempt to regulate the uptake of LEVs it does provide incentives for operators to change behaviour change that results in fuel savings. These translate into cost savings and emissions reductions so that the scheme does have a beneficial environmental impact.
- 5.20. The SAFED scheme provides high quality driver development training with proven, significant fuel saving benefits. Training Guides exist for both the HGV driver and van driver trainers. These are available from the Freight Best Practice programme and can be downloaded from www.freightbestpractice.org.uk or ordered from the Hotline on 0845 877 0877. In addition case studies of HGV fleets using SAFED have been published and case studies of van fleets are soon to be published.
- 5.21. To illustrate the potential benefits of SAFED training Leeds City Council had its van drivers trained and evaluated its annual fuel cost savings as a result of the training at £253,000 and CO₂ emission savings of 707 tonnes. In another case Salisbury District Council trained 80 van drivers and evaluated its annual fuel cost savings at £28,000 and CO₂ emission savings of 80 tonnes.

Cars

Car Clubs

- 5.22. Commercially run car clubs offer a cost-effective alternative to car ownership in urban areas. Club members pay a subscription fee and pro rata hourly or

distance based charge to drive a club car rather than pay maintenance, tax, insurance and MOT costs associated with car ownership. Car club cars are usually recently registered vehicles and hence have among the lowest emissions of on-road vehicles in their class.

Edinburgh City Car Club

- 5.23. The aim of the scheme is to tackle congestion, pollution and parking pressures in the city, while recognising the importance of the car. It was originally designed as a pilot project, and received funding of £250,000 from the City of Edinburgh and the (then) Department for the Environment, Transport and the Regions (DETR) and the Scottish Office. This covered project set up costs, in-car telematics, provision of designated on street parking bays and monitoring and evaluation of the project. Further funding of £40,000 for promotion and marketing were used in a re-launch in November 2001. As of June 2005, the club was supporting 28 cars and 522 members.
- 5.24. Access to the cars is by Smartcard, which only allows entry to a member during a pre-booked period. A computer terminal in the car interfaces with the booking software, allowing members to make or extend bookings, as well as enabling automation of invoicing. Bookings, which can also be made by phone or internet, are by the hour, day or weekend. Members can make longer bookings at a preferential rate. Members now also have reciprocal membership of other CityCarClubs around the UK, giving them the option of using public transport for longer journeys while still having access to a car at their destination.
- 5.25. Membership costs £15 per month and usage rates are either around £3 per hour or 18p per mile. These rates include full comprehensive insurance and VAT costs.
- 5.26. Schemes also operate in Sheffield, Leeds, Bristol, Swansea, Liverpool, Manchester, Birmingham, Newcastle and other locations. Essentially the schemes are similar in providing an online booking system and flexible hire model. Costs are broadly similar across the UK. More information and case studies of UK car clubs can be obtained from <http://www.carplus.org.uk/>.
- 5.27. Carplus, the national charity promoting responsible car use, has estimated that a typical owner that drives less than 6,000 miles per year may save between £1,000 to £1500 per year at 2005 prices relative to operating their own vehicle. Increased fuel costs may translate to larger savings in 2008. Club members typically give up their car or second car on joining. On average, in the UK each car club vehicle replaces six privately owned cars. Car club members also generally reduce their annual travel. Car club vehicles are usually one to two years old and hence have lower emissions than the fleet average.
- 5.28. Carplus has estimated that the overall reduction in mileage and shift to newer vehicles produces savings of 0.7 tonnes of CO₂ per member per year in the UK. Savings in emissions of NO_x and PM₁₀ have not been quantified or estimated. However, reduced mileage and a shift to newer vehicles would in principle deliver emissions savings in local pollutants.

Parking Controls

- 5.29. Historically, parking controls have been used to manage demand for scarce road space and to support the safe and efficient flow of traffic. PPG 13 notes that the availability of car parking has a major influence on the means of transport people choose for their journeys. It goes on to summarise that some studies suggest that levels of parking can be more significant than levels of public transport provision in determining means of travel (particularly for the journey to work) even for locations very well served by public transport.
- 5.30. A number of local traffic authorities have adjusted the operation of their parking management schemes with more specific environmental objectives that aim to discourage use of the most polluting vehicles and simultaneously incentivise lower emission vehicles.
- 5.31. A range of approaches to parking controls can be seen in these examples, which include discouragement and/or incentives for one or both of toxic pollutants and greenhouse gas emissions.
- City of Westminster and London Borough of Croydon parking charge discounts for electric vehicles.
 - In Westminster electric vehicles may park in a nominated car park for no cost other than an annual administration fee of £205 and a refundable £75 fee for the access key and cable equipment to allow charging. This is a saving of over £6,000 annually compared to a normal vehicle parking permit. There are 50 charging bays in car parks across the Borough and 12 on-street charging bays for this purpose.
 - Croydon offers electric vehicle operators a 50% discount on season ticket costs in council owned car parks.
 - Information on all London-based electric vehicle uptake schemes can be found at www.electricparking.com/lists.html.
 - London Borough of Richmond parking permit scheme with charges based on CO₂ ratings or engine sizes.
 - From April 2007 Richmond supplies most parking permits in the Borough according to CO₂ emissions or engine capacity. For vehicles first registered before March 2001 charges are based on engine size and annual residential permits vary from £75 for engines less than 1L up to £450 for engines greater than 3L. For vehicles first registered after March 2001 charges are based on CO₂ emissions detailed on the vehicle registration and annual residential permits vary from £0 for emissions up to 100g/km and £450 for emissions greater than 225g/km. Details can be obtained from www.richmond.gov.uk/home/transport_and_streets/motor_vehicles_roads_and_parking/parking/car_parking_permits.htm.
 - City of Winchester parking permit scheme discounts for vehicles in the two lowest CO₂ emission bands:
 - Annual resident parking permits are usually £22. However, if the vehicles was registered since March 2001 and is in VED band A (up to 100 g/km CO₂ emission rate) a 75% discount applies. If the vehicle is

in band B (101-120 g/km CO₂) a 50% discount applies. There is no discount for vehicles registered before March 2001 regardless of engine size.

- City of Stockholm parking discounts.
 - Annual residential parking permits normally cost around £450 in Stockholm. However, owners of electric vehicles, biomethane vehicles and hybrid vehicles do not have to pay. Over 400 vehicles have so far taken advantage of this scheme. In addition commercial enterprises can also apply for free permits if they use the city centre extensively and operate these cleaner vehicle types; an annual saving of around £700.
- City of Graz (Austria), discount on parking charges for vehicles with a combination of latest Euro pollutant emission standards and low CO₂ rating.
 - Vehicles are eligible for a 30% reduction in on-street and car park parking fees if they are of Euro IV standard and have CO₂ emissions less than 140g/km (130g/km for diesel vehicles).

Parking controls via planning obligations

- 5.32. The transportation aspect of development control is usually only one of a number of factors that relate to a development proposal. However, the development control process provides an opportunity to influence future use and access to a site in the medium to long term.
- 5.33. The Greenwich Peninsula Low Emission Strategy places restrictions on the use of more polluting vehicles, with compliance being an agreed obligation of the sale of land for development, and will also be passed directly on to dwelling purchasers.
- 5.34. Low Emission Zone controls are applicable to the Greenwich Peninsula development (Dome/MDL) and form part of the Section 106 legal agreement, signed on the 23 February 2004. The Greenwich Peninsula LEZ will apply to the 190 acres of land approved for development on the 17th April 2003. The LEZ will apply until the completion of the development, anticipated in 2021. A range of controls are initially outlined for different aspects of the development where an impact on air quality is envisaged.
- 5.35. Residential parking permits will be given to vehicles that comply with:
- affordable Housing – Euro 3 after 1 January 2009 or 36 months after the residential block is completed, whichever comes sooner; and
 - private Residential – Euro 4 after 1 January 2009 or 36 months after the residential block is completed, whichever comes sooner.
- 5.36. The annual parking service charge will be free/less for compliant vehicles, with an incentive for vehicles to exceed the compliance standard. Non-compliant vehicles will be surcharged a public transport levy that will go towards initiatives aimed at encouraging residents not to own a car, for example Car Club, transport voucher, cycle voucher.

6 Conclusion

- 6.1. A range of schemes have been and could be developed by local authorities to directly influence the emission standards of vehicles downward in sensitive areas on the public highway or private land. Although a standard definition for LEVs has not been adopted throughout the UK or the EU the examples illustrate that incentives are potentially very high for vehicles with zero local emissions (for example, Westminster scheme). At the UK national level analysis has suggested that significant local pollutant and CO₂ emissions reduction might accrue from a significant shift towards Euro IV cars with CO₂ emissions below 140g/km in the short to medium term and that this would achieve a net benefit. For HDVs there will be significant benefits from accelerating the shift to Euro V vehicles in the medium term.
- 6.2. A key conclusion is that schemes that aim to reduce either air quality strategy pollutants or carbon emissions may be counterproductive in having no effect or a negative effect on the emissions not regulated by the scheme criteria. There is a greater strategic benefit in setting emissions criteria for both carbon and pollutant emissions.
- 6.3. Existing schemes have been implemented by a wide variety of approaches illustrating the large number of options available to local traffic authorities to introduce an element of emissions control into their policies regardless of vehicle type.
- 6.4. At the voluntary level authorities can encourage the uptake of LEVs via Quality Bus Partnership Schemes or Car Clubs. In both cases the authority can do much to facilitate uptake for example by seed funding Car Clubs or providing adequate facilities for Car Clubs and Bus services. The success of such approaches will necessarily rest on the efforts to engage with the vehicle operators in a detailed and constant manner.
- 6.5. If voluntary approaches are not realistic then there is a range of methods to encourage or compel the uptake of LEVs.
- 6.6. Cars emissions could be managed via discounted parking charges or residential permits or by discounts and penalties for circulating in a defined zone. These traffic and parking restrictions can be developed into such schemes by the Highway Authority, and development control schemes (supplementary planning documents) by Planning Authorities. The schemes in Westminster and Greenwich are good examples of parking and development control schemes. So far the revised London CCS and LEZ Schemes are the most developed instance of controlling emissions via traffic access restrictions but smaller schemes of these types are being considered or implemented in other area of the UK.
- 6.7. Traffic access restrictions may be the only practical approach to manage emissions from HGV (and could be used to manage all vehicle types) unless significant traffic could be regulated via development control schemes. Again the Greenwich Peninsula scheme is a good example of attempting to manage emissions from these vehicles as far as possible. These schemes tend to be focussed on city and town centres, where land-use is dense, traffic

is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles. Small areas, road networks with limited access points, and areas with existing traffic restrictions (for example pedestrian zones) provide the scope for adding LEV components at lower cost than areas without, and if air quality assessments justify it can be the most cost-effective areas to tackle first.

- 6.8. For buses there are a number of approaches are these are necessary since bus and coach services are supplied under a variety of commercial, contracted and ad hoc models. The options for regulating emissions of commercial services are changing with the advent of the Local Transport Bill. Once regulations under this are produced there should be an improved route to including emissions based criteria within QPS and QC Schemes. Emissions based contract conditions could and are being included now for contracted services in some local authorities.
- 6.9. Since many buses undertake a large proportion of their activity in urban centres (and by extension within many AQMAs) and since there are still many Euro III or older vehicles in fleets – local authorities are strongly encouraged to fully explore all of the available voluntary and regulatory options to manage emissions from these vehicles.
- 6.10. Cars are the most numerous vehicle types on the road hence large potential benefits are possible from reducing their unit emissions. They do not necessarily contribute significantly in urban centres but since their use is so widespread approaches to reduce their emissions will be useful in reducing emissions and improving air quality area-wide. The approaches of Richmond and Westminster demonstrate that emissions management can be simply added to the existing parking permit schemes and could be used in a phased way to continue to reduce emissions.
- 6.11. Within scheme design and appraisal the environmental objectives of the scheme are a key consideration. Source apportionment should be used to determine which vehicles and which pollutants are the most relevant to target and to determine the cost-effectiveness of various options.
- 6.12. From existing examples, common vehicles that are targeted in a scheme with enforceable restrictions are HDV (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. The worked example in this guidance illustrated the key points that the scheme should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. However, local authorities will need to consider their own case, costs and benefits when setting emission standards and compliance dates.
- 6.13. Similar standards within a country are useful, but not essential to setting up and operating a LEV scheme. The Euro standards and VED CO₂ emissions banding designations are successfully used as definitions of compliant vehicles in many cases. When choosing standards, co-operation between neighbouring authorities can be useful, to harmonise standards and reduce competition between those with schemes and those without.

- 6.14. In traffic access control schemes the most common toxic pollutant to target is PM but this is by no means the case for all schemes particularly parking control schemes where reduced NO_x and CO₂ emissions are encouraged too. Local authorities are encouraged to consider all emissions holistically in the context of their local air quality and climate change policies and objectives.
- 6.15. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Unfortunately, existing systems will probably not provide a complete solution and the example LEZ showed that new systems and processes were required (see Practice Guidance on LEZs). Taking a practicable approach to completing gaps in information, and making the scheme as straightforward as possible for the user is recommended. There may need to be some trade-off between the optimum operation of a scheme (for emission reduction and cost) against ease of use and acceptance. The examples of parking permit based schemes or QBPA's illustrate that management solutions need not be complex.
- 6.16. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.
- 6.17. Relevant UK parking incentives for lower emission vehicles have been based on, or adapted from, more traditional residential parking or season ticket holder schemes. This provided the local authority with a proven and existing administration system in many cases, which for only a small additional cost can be tailored to local environmental objectives. Having an existing scheme on which to base a parking incentive scheme appears to date to be a factor in successful operation. On-street pay and display parking with discounts for cleaner vehicles will require additional systems and processes, which are likely to be more costly than adapting an existing season ticket holder scheme for major off-street car parks.
- 6.18. Planning condition and obligation schemes can have significant potential for specific locations. The cost of designing and operating a planning condition and obligation scheme can be borne by the developer. A scheme can apply to both construction and operational phases of a development, with obligations passed on to future occupiers. Such an approach provides a useful method of incorporating vehicle specific environmental criteria into planning decisions.
- 6.19. The assessment of emissions, air quality, cost-effectiveness and cost-benefits of such schemes may be a necessary task in order to develop the evidence to allow decisions on such schemes to be determined. This is particularly true of schemes with either significant costs or ones that affect many vehicle operators. The guidance makes it clear that existing capacity and tools to assess emissions and air quality may have to be supplemented with specific local data to improve the accuracy of assessments. Local authorities that wish to consider LEV schemes are therefore encouraged to

plan their data and assessment needs in advance of any stage where the costs and benefits of different scheme options are to be assessed.

Appendices

Appendix 1: Glossary

Appendix 2: References

Appendix 1: Glossary

ANPR	Automatic number plate recognition
AQMA	Air Quality Management Area
CCS	Congestion Charge Scheme
CO	Carbon monoxide
CO ₂	Carbon dioxide
Defra	Department for Environment Food and Rural Affairs
DfT	Department for Transport
DSRC	Dedicated Short Range Communication
EA 1995	Environment Act 1995
EGR	Exhaust Gas Recirculation
FPN	Fixed Penalty Notice
GIS	Geographical Information Systems
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IGCB	Interdepartmental group on costs and benefits
LAQM	Local air quality management
LDV	Light Duty Vehicle
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
LGV	Light Goods Vehicles
NAEI	National Atmospheric Emissions Inventory
NATA	New Approach to Transport Appraisal
NO _x	Oxides of nitrogen or nitrogen oxides
NO ₂	Nitrogen dioxide
OCR	Optical Character Recognition
NPV	Net Present Value
PCN	Penalty Charge Notice
PM ₁₀	Particulate matter smaller than 10 microns
QBPA	Quality Bus Partnership Agreement
QPS	Quality Partnership Schemes
QC	quality contracts
RTRA 1984	Road Traffic Regulation Act 1984
SAFED	Safe and Fuel Efficient Driving

SCR	Selective Catalytic Reduction
SPC	Shadow Price for Carbon
TfL	Transport for London
TMA 2004	Traffic Management Act 2004
TRO	Traffic Regulation Order
VED	Vehicle Excise Duty
VOC	Volatile organic compounds
VRM	Vehicle Registration Mark
WebTAG	Web-based Transport Analysis Guidance

Appendix 2: References

Defra (2007). An Economic Analysis to inform the Air Quality Strategy volume 3, Updated Third Report of the Interdepartmental Group on Costs and Benefits

NSCA (2006). Development Control: Planning for Air Quality.

TfL (2007). Report to the Mayor following consultation with stakeholders, businesses, other organisations and the public on the Scheme Order 2006