Low Emission Planning: Policy Appraisal Note

Prepared by Green Sphere on behalf of the Low Emission Partnership

Authors: Katherine Stanger and Rob Pilling

Low Emission Strategies

Building on Good Practice

This **Report** presents the results and conclusions of work to investigate the scale of emissions harm posed by different development sites, and to estimate the potential emissions benefits of low emission mitigation measures.

- Details and discussion regarding the methodology are listed in a working file.
- The study identifies a range of further and potential follow on work this is highlighted in green throughout and a structured summary is provided in Section 7.

Please contact Green Sphere to discuss any aspects of the work: Rob@green-sphere.co.uk.

Low Emission Planning – Policy Appraisal Note

Executive Summary

Reference Sites

Six reference sites were selected to reflect common types of development. Base emissions and associated damage was estimated for each site using a combination of tools published by the Low Emission Partnership, Defra and DECC[1]. The analysis covered NO_X, PM_{10} and CO_2. PM_{10} was divided into exhaust and non-exhaust components. Illustrative actions were selected, and a benefit appraisal provided estimates of potential reductions in site emissions and damage. (Note: CO_2 data is included for completeness, though it is recognised that the extent to which these emissions are considered in combination with air quality impacts varies between different local authorities)

These results provide general site-level estimates of emissions harm associated with existing and planned development, and also provide a guide to likely benefits of some illustrative measures. They are of value in both policy development and also to help inform appraisal of a developer's own emission assessment. Further work to sensitivity test and extend the analysis would provide additional value.

Area Assessment

An area assessment method was established, based upon aggregating actual or projected developments grouped under the different reference site types. The approach was tested using a list of major planning applications recently processed in Bradford. Aggregated emissions and damage costs were calculated, illustrative actions were applied and the associated benefits were assessed

The assessment estimated a total of £1.4 million in air quality damage costs over a five year period (rising to £7 million if CO_2 is included). Residential developments are responsible for half of all emissions damage, followed by food retail, and other land uses. Application of trip reduction and technical measures projected overall reductions of 10-13% across all pollutants.

Comparison to the real world outcomes indicated that the illustrative measures applied, reflect a reasonable scope, though it was not possible to evaluate the respective extent and intensities without a more detailed examination. For one specific site, it was noticed that that the emission damage calculated by the area method compared encouragingly with the financial contribution achieved at the site.

Technical Notes

The assessment work described above was undertaken in accordance with LEP Emission Assessment Guidelines[2], which in turn is broadly consistent with published and adopted planning policies such as those by Mid Devon, Bradford, West Midlands and Sussex-Air. The main difference between the LEP guidelines and those published policies is the greater detail and coverage given to benefit appraisal. Also, the LEP guidelines identify a range of method options and possible assumptions overall, rather than being prescriptive in places, on which to adopt.

The site level assessment utilises LET land use based trip factors (rates/distances), combined with EFT (v6.0.1) emission factors and published DEFRA/DECC damage cost factors. The benefit assessments draw heavily on LET methods and data encapsulated therein. Area level assessment was achieved through simple scaling of reference site results according to the aggregated area of each associated development type.

This study is believed to be the first of its kind and consequently it is prudent to treat the results as an initial illustration of headline trends and underlying methodology. Further work is recommended in Section 7, which will strengthen confidence overall and extend possible applications.

[1] Tools / methodologies used: The Low Emission Partnership's Low Emission Toolkit (LETv1.1); Defra's Emission Factor Toolkit (EFTv6.0.1); Defra/DECC 2013 Damage Cost Factors and Economic Approach

[2] Low Emission Partnership (2014) *Emission Assessment for Development Site Appraisal Technical Guidelines*. Nov 14 EMA-TG-1.0.

In particular please note that:
- The benefit calculations are based on a relatively new methodology and have not yet been subject to the same level of testing and review as those for base fleet (harm) assessment.
- Estimate of service sub-fleets (in this analysis, relevant to residential and commercial development) are based on site service fleet assumptions contained within the LET. However, an alternative approach, also supported by the LET suggests a higher contribution. Work to refine/reconcile the methods is ongoing.

Policy Conclusions

Currently adopted policies have relatively well developed methods for base fleet assessment, but are less prescriptive and provide little guidance on how to approach benefit assessment. The results presented here are based heavily on methods and data encapsulated with the LEP's Low Emission Toolkit and have proved generally effective. Looking forwards, the overall methodology and evidence base is evolving rapidly, with potential for further improvements, standardisation and streamlining, including development of additional short-cut methods/tools.

Under the model assumptions[3]:
- Food retail is a stand out site for attracting trips and generating emissions. Public access cars make up the majority of trips and emissions, although HGV trips are also significant (particularly for NO_X and CO_2).
- Housing is dominated by emissions from domestic car use.
- Non-food retail is dominated by public access, with relatively low HGV compared with food retail.
- Commercial is dominated by public access (business) trips, though this will vary with the nature of the business.

Non-exhaust PM_{10} emissions (brake, tyre wear and abrasion) dominate over the exhaust component throughout. This affects which measures provide the most direct PM benefit – crucially adding weight to trip reduction (which affects *total* PM) compared to engine technology solutions (largely affecting only PM *exhaust*). This has broad implications, not least for the prominence given to electric vehicle promotion due to air quality and public health credentials.

Damage costs are an important and potentially powerful metric for mediating air quality agreements and are gaining recognition within policy and practice. Results illustrate how site damage costs tend to be dominated by CO_2 (where included) and PM_{10}, with NO_X reductions being less valued. This creates a risk that sole reliance on damage costing within site appraisal can underplay the importance of NO_X reduction, especially in areas where air quality objectives are exceeded. Explicit consideration of bulk NO_X reductions and/or abatement costing may help to improve the balance of mitigation plans derived in this way.

From a damage cost perspective, the on-site technical measures examined provide relatively small benefits compared both to base harm and also to that of an effectively implemented traditional travel plan. Consequently, travel plans are likely to remain the most significant on-site measure in terms of directly reducing emissions harm; site residuals are likely to remain high, at around 80-95% of base harm; and the pursuit of financial contributions for compensatory off-site measures appears increasingly important.

Nonetheless, some technical measures may provide more significant benefits in terms of bulk NO_X. They may also be of strategic or of indirect importance in facilitating and laying a platform for a longer term transition towards low emission transport. Therefore, it is important not to overlook the important direct and indirect benefits that can be achieved using on-site technical measures. Careful adherence to the mitigation hierarchy (Trips > Tech > Off-site) will help to ensure this.

Inclusion of CO_2 alongside air quality pollutants has potential to help join up the two issues. One attraction is the boost this gives to the monetisation of harm, potentially opening the door to stronger and more ambitious mitigation. It should also support more efficient and coherent design, implementation and monitoring of measures.

The approach, however is not without risk. Firstly, by increasing complexity there is potential to simply dilute management and technical resource. Secondly, the bigger numbers involved with CO_2 have potential to drown out the air quality concerns and even encourage an artificial play-off of between the two. Nonetheless similar, albeit less explicit, risks occur even without combined assessment, so providing it is done well, with realistic resource, and intelligent interpretation then the combined approach appears more desirable than simply accepting an arbitrary and unpredictable balance of outcome which fails to drive towards co-delivery of maximum benefit all round.

[3] Observations on relative impact of service fleet vehicles are provisional, subject to further method investigation and refinement

Further Work

The study identifies a range of further and potential follow on work. This is highlighted in green throughout and a structured summary is provided in Section 7. Headline Recommendations are as follows:

- Repeat and extend the area wide analysis using different examples and situations
- Extend the scope of the area assessment method and package as a user friendly tool
- Undertake standardisation of key measures and impact assumptions
- Update and refine LET trip and emission factors

Contents

1. Introduction

1.1. This work provides reference tables and calculation methods to estimate emissions damage (in tonnes and £) from road transport associated with development sites. It provides a typology of applicable on-site actions to mitigate the emissions impacts. It then demonstrates how the impacts of actions may be quantified to estimate emissions damage avoided (benefit assessment).

1.2. The methods are also applied to a list of real planning examples from Bradford Metropolitan District Council, exploring the scale of emissions damage (and potential for action) across a local authority area.

1.3. Main outputs within this report are:

- Reference sites for different land uses, with estimates of base harm, potential actions, and subsequent emission benefits
- Area snapshot of real planning examples across local authorities

1.4. Additional evaluation and development of tools:

- Summaries of Reference Site and Area Methodologies
- Trip rate calculator (using trip rate defaults from the Low Emission Toolkit (LET))
- Damage cost calculator (with the latest IGCB / DECC data, plus uplift / discounting)

1.5. Other Low Emission Partnership work (and work stream codes):

- Planning Guidance (PG)
- Indicators (IFP)
- Emissions Assessment Methodology (EMA)
- Development of Low Emission Toolkit (LET)
- Links to Guidance for practitioners, incl. Resources Table on the Hub (R-Tab) and Manager's Guide (MG)

1.6. The following tools / calculation methods have been used:

Estimating annual vehicle journeys:	Default trip rates within the LET[4] (based on TRICS Version 2010(a) v6.5.2 Build 14.35)
Calculating emissions damage (t/a):	Defra Emission Factor Toolkit version 6.0.1[5]
Calculating air quality damage costs:	IGCB 2013 Damage Cost Factors[6], plus inflation, uplift and discounting according to Defra Economic Guidance (2011)[7]
Calculating CO2 damage costs:	DECC 2013 non-traded carbon price[8], plus inflation and discounting according to DECC Economic Guidance (2009)[9]

1.7. Working notes and further details of the methodology are recorded separately.

[4] Low Emission Partnership (2011) Low Emission Toolkit version 1.1. Available online at: http://www.lowemissionstrategies.org/les_toolkit.html

[5] Defra Emission Factor Toolkit. Available online at: http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

[6] Defra IGCB Damage Cost Factors (last update 10 May 2013): https://www.gov.uk/air-quality-economic-analysis

[7] Defra Feb 11 Air Quality Damage Cost Guidance, Feb 2011: https://www.gov.uk/air-quality-economic-analysis

[8] DECC (2013) Tables to support the DECC/HM Treasury Green Book Supplementary appraisal guidance on valuing energy use and greenhouse gas emissions (16 Sept 2013). Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/248604/2013_Appraisal_Guidance_-_Toolkit_Tables_-_FINAL.xlsx

[9] DECC (2009) *A brief guide to the new carbon values and their use in economic appraisal* (July 2009)

2. Reference Sites

2.1. Six reference sites were selected to reflect common types of development. Sites were described by identifying component sub-fleets and estimating associated annual mileage for each using the Low Emission Toolkit and associated default assumptions.

2.2. Global parameters (year, road type, speed and PM_{10} damage cost factors) were kept constant for all sites. Trip rates (and therefore emissions and damage costs) are dependent on the size of the development and its location.

2.3. **Table 1** lists the reference sites and modelling parameters. **Table 2** provides a summary of development types and global parameters within the assessment methodology. This shows the breadth of possible modelling options and identifies future work opportunities.

2.4. Potential further work:

- Further sites to model using this methodology, e.g.: Education (nursery), Health (nursing home), Leisure (restaurant), Industrial site (general industrial unit)
- Sensitivity testing would be useful to explore the influence of the following global parameters:
  - Year (2015, 2020, 2025): Emissions reduce in later years with changes in fleet composition
  - Speed (slow urban / Inner London = 21 kph): Emissions increase at lower speeds
  - PM_{10} damage costs: *Inner conurbation* is approx. 2x higher and *urban small* approx. 75% of PM_{10} Transport Average figure

Table 1: Reference sites and key parameters

Site	Size	Location	Sub-fleets
Housing (Medium)	50 residential units	Town centre	Domestic (cars) Service (LGVs, HGVs)
Housing (Large)	500 residential units	Edge of town	Domestic (cars) Service (LGVs, HGVs)
Food retail	9,500 sqm gross floor area (GFA)	Edge of town	Public access (cars) Commuting – staff (cars) Heavy fleet (HGVs)
Non-food retail	3,000 sqm gross floor area (GFA)	Edge of town	Public access (cars) Commuting – staff (cars) Heavy fleet (HGVs)
Commercial	1,500 sqm gross floor area (GFA)	Town centre	Commuting – staff (cars) Business (cars) Service fleet (LGVs, HGVs)
Industrial (Fleet Depot)	50 HGVs	Edge of town	Heavy fleet (HGVs)
Global parameters for all sites (required for emissions and damage cost calculations):			
Year: 2016		**Road type:**	Urban (not London)
Speed: 48 kph		**PM10 damage cost:**	PM10 Transport Average

Table 2: Site landscape (LET land uses and global parameter ranges). Reference sites highlighted in **Blue**

Site	Land use types for which LET provides land use specific traffic data defaults	Location
Housing	- Private housing - Non-private housing - **Mixed housing** - Retirement housing	- Town centre - Edge of centre - Suburban - Edge of town - Free standing
Food retail	- **Food retail** - Discount food - Retail park including food	
Non-food retail	- **Non-food retail** - Shopping centre - Retail park excluding food - Car showroom	
Education	- Nursery - Primary school - Secondary school - College	
Health	- Hospital - GP Surgery - Nursing home	
Leisure	- Hotel - Restaurant - Pub - Fast food - Cinema - Bowling alley - Leisure centre - Swimming pool - Ice rink - Bingo hall - Fitness club - Place of worship - Theatre - Golf course	
Commercial	- **Office**	
Industrial	- Industrial - Warehousing - Civic amenity site	

Global parameters (EFT emissions and IGCB damage costs):

Year:	2010-2025	**Road type:**	Not London: Urban, Motorway, Rural London: Central, Inner, Outer, Motorway
Speed:	5-140 kph	**PM10 damage costs:**	PM_{10} Transport Average London: Central, Inner, Outer Conurbation: Inner, Outer Urban (Popn): Big (>250k), Large (>100k), Med (25k), Small (10k) Rural

3. Harm

3.1. Emission damage was estimated for each of the reference sites using the methodologies described in the introduction: activity data calculated using LETv1.1 defaults; emissions calculated using EFTv6.0.1, damage costs calculated using IGCB (2013) and DECC (2013). Results are presented in **Table 3**, **Table 4** and **Table 5**.

Table 3: Baseline damage costs for reference sites, over 5 years

Reference Site	£AQ Damage Costs (5 years)	£AQ+CO2 Damage Costs (5 years)
Housing (Central, 50 Units)	£7,500	£40,000
Housing (Edge, 500 Units)	£120,000	£635,000
Food retail (Edge, 10 000 m2)	£635,000	£3,315,000
Non-food retail (Edge, 3000 m2)	£50,000	£270,000
Commercial (Central, 1500 m2)	£15,000	£85,000
Fleet Depot (Edge, 50 HGV)	£120,000	£640,000

Table 4: Baseline Harm – annual emissions and damage costs by pollutant [Simple version –c.f. Table 5 below]

Reference Site	Annual journeys by vehicle fleet		Base Impacts (Annual)		
		annual vkm		t/yr	£DC/yr
Housing (Med) (Central, 50 Units)	Domestic (cars) Service (LGVs, HGVs)	711,000 5,000	NO_X PM_{10} CO_2 **=> Total**	0.2 0.02 95	£200 £1,300 £6,300 **£7,800**
Housing (Large) (Edge, 500 Units)	Domestic (cars) Service (LGVs, HGVs)	11,700,000 5,000	NO_X PM_{10} CO_2 **=> Total**	3 0.4 1,537	£3,500 £20,900 £102,400 **£126,800**
Food retail (Edge, 10 000 m2)	Heavy fleet (HGVs) Commuting – staff (cars) Public access (cars)	1,390,000 837,000 53,543,000	NO_X PM_{10} CO_2 **=> Total**	17 2 8,045	£19,200 £107,500 £536,200 **£662,900**
Non-food retail (Edge, 3000 m2)	Heavy fleet (HGVs) Commuting – staff (cars) Public access (cars)	59,000 134,000 4,540,000	NO_X PM_{10} CO_2 **=> Total**	1.4 0.2 652	£1,500 £8,800 £43,400 **£53,700**
Commercial (Central, 1500 m2)	Commuting – staff (cars) Business (cars) Service fleet (LGVs, HGVs)	251,000 1,260,000 5,000	NO_X PM_{10} CO_2 **=> Total**	0.4 0.05 200	£500 £2,700 £13,400 **£16,500**
Fleet Depot (Edge, 50 HGV)	Heavy fleet (HGVs)	2,400,000	NOx PM CO2 **=> Total**	5 0.3 1,570	£5,200 £18,500 £104,700 **£128,400**

Table 5: Baseline Harm – annual emissions and damage costs by vehicle fleet and pollutant

[c.f. Simpler table above. Relative contributions of the different fleets is useful in considering mitigation options]

Reference Site		Annual vkm		NO_X	PM_{10} (exh)	PM_{10} (non-ex)	CO_2	Total
Housing (Med) (Central, 50 Units)	Domestic (cars) Service (LGVs, HGVs) **=>Total**	711,000 5,000 **716,000**	t/a t/a **t/a** **£/a**	0.19 0.005 **0.2** **£217**	0.003 0.00004 **0.003** **£161**	0.017 0.00026 **0.018** **£1,123**	93 1 **95** **£6,308**	**£7,808**
Housing (Large) (Edge, 500 Units)	Domestic (cars) Service (LGVs, HGVs) **=>Total**	11,702,000 5,000 **11,707,000**	t/a t/a **t/a** **£/a**	3.17 0.005 **3.18** **£3,487**	0.05 0.00004 **0.05** **£2,608**	0.32 0.00026 **0.32** **£18,243**	1,535 1 **1,537** **£102,430**	**£126,768**
Food retail (Edge, 10 000 m2)	Heavy fleet (HGVs) Commuting – staff (cars) Public access (cars) **=>Total**	1,390,000 837,000 53,543,000 **55,769,000**	t/a t/a t/a **t/a** **£/a**	2.73 0.23 14.51 **17.47** **£19,183**	0.03 0.004 0.21 **0.2** **£13,451**	0.16 0.026 1.50 **1.7** **£94,087**	909 110 7,026 **8,045** **£536,175**	**£662,896**
Non-food retail (Edge, 3000 m2)	Heavy fleet (HGVs) Commuting – staff (cars) Public access (cars) **=>Total**	59,000 134,000 4,538,000 **4,731,000**	t/a t/a t/a **t/a** **£/a**	0.12 0.04 1.23 **1.38** **£1,518**	0.002 0 0.02 **0.02** **£1,097**	0.008 0 0.12 **0.13** **£7,676**	39 18 595 **652** **£43,432**	**£53,722**
Commercial (Central, 1500 m2)	Commuting – staff (cars) Business (cars) Service (LGVs, HGVs) **=>Total**	251,000 1,265,000 4,000 **1,521,000**	t/a t/a t/a **t/a** **£/a**	0.07 0.34 0.005 **0.42** **£456**	0.001 0.005 0.00004 **0.006** **£340**	0.009 0.035 0.00026 **0.044** **£2,377**	33 166 1 **200** **£13,351**	**£16,524**
Fleet Depot (Edge, 50 HGV)	Heavy fleet (HGVs)	**2,400,000**	t/a £/a	4.72 **£5,188**	0.06 **£3,104**	0.27 **£15,419**	1,570 **£104,656**	**£128,367**

Land Use Trends

3.2. The results indicate that, *under the model assumptions*[10]:

- **Food retail** is a stand out site for attracting trips and generating emissions. Public access cars make up the majority of trips and emissions, although HGV trips are also significant (particularly NO_X and CO_2).
- **Housing** is dominated by emissions from domestic car use.
- **Non-food retail** is dominated by public access, with relatively low HGV compared with food retail.
- **Commercial** is dominated by public access (business) trips, though this is likely to vary depending on the nature of the business.

Influence of outcome metrics

3.3. Damage costs are an important and potentially powerful metric for mediating air quality agreements and are gaining recognition within policy and practice. Results illustrate how site damage costs tend to be dominated by CO_2 (where included) and PM_{10}, with NO_X reductions being less valued. This creates a risk that sole reliance on damage costing within site appraisal would underplay the importance of NO_X reduction, especially in areas where air quality objectives are exceeded. Explicit consideration of bulk NO_X reductions and/or abatement costing[11] may help to improve the balance of mitigation plans derived in this way.

3.4. Non-exhaust PM_{10} emissions (brake, tyre wear and abrasion) dominate over the exhaust component (see below). This dramatically affects which measures are likely to provide most direct PM benefit – crucially adding weight to trip reduction (which affects *total* PM) compared to engine technology solutions (largely affecting only PM exhaust[12]). This has broad implications, not least for the overall priority given to electric vehicle promotion off the back of air quality/public health credentials.

Dominance of Non-Exhaust PM_{10}

3.5. Total PM_{10} includes exhaust (tailpipe) emissions, as well as non-exhaust components (brake, tyre wear and abrasion). The breakdown is provided by the EFT. **Table 6** gives the proportion of non-exhaust PM_{10} emissions by vehicle type for the reference year (2016). The proportion of non-exhaust PM_{10} is greater than 80% for all vehicle types.

3.6. These observations are based on the non-exhaust emission factors within the EFT. These are fairly coarse data when compared with the exhaust fraction. The LEP is undertaking further work to understand the quality of these data, correlation to real world trends and the implications.

Table 6: PM_{10} emissions by source fraction for vehicles in reference sites (for the modelled year of 2016)

Vehicle type	Non-exhaust PM10 in reference year (2016)
Cars	87%
LGVs	86%
HGVs	83%

[10] Caveat on Service Fleet Data: Assumptions regarding the significance of service vehicles (in this analysis, relevant to residential and commercial sites) are based on site service fleet assumptions contained within the LET. An alternative approach, also supported by the LET suggests a higher contribution. Work to refine/reconcile the methods is ongoing. Conclusions regarding relative impact of service fleet vehicles should therefore be considered provisional at this stage.
=> Review/refinement of LET heavy fleet data

[11] Defra provides guidance on abatement costing (https://www.gov.uk/government/publications/air-quality-abatement-cost-guidance). The LEP is exploring application of the methodology at specific sites.
=> Incorporation of abatement costing with damage cost methodologies

[12] A report commissioned by the LEP highlighted that most low carbon vehicles now have regenerative brakes (as well as friction brakes for hard braking). Regenerative brakes produce virtually no emissions. Under normal operating conditions with a non-aggressive driver, brake wear should be close to zero. (Brake wear is 40-50% of total non-exhaust in an urban area). (ref. TRL. Dec-14. Briefing paper on non-exhaust particulate emissions from road transport.)

4. Action

4.1. **Table 7** provides a typology of the range of planning measures available. It is also provides an indication of the applicability of measures to different sub-fleets.

Table 7: Typology of planning measures

Broad type	Sub-type	Measure	Fleet exclusions
Trip Reduction	Communication	Travel advice and information	*<<none>>*
	Active Travel	Walking (footpaths, bridges, road crossing points) Cycling infrastructure Cycle storage facilities Cyclist changing and drying facilities Cycle hire schemes Incentives to purchase bikes	Do not apply to Service or Heavy Fleets
	Public Transport	Bus lanes, bus stops, bus information Incentives to use public transport New, upgraded and supported bus services	
	Car use	Standard car club Car sharing scheme Parking restraint Parking charges/incentives	
	Management	Travel plan management and reporting	*<<none>>*
Technology Measures	Communication	Information on low emission fuels and technology	*<<none>>*
	Parking	Emission based parking allocation Emission based parking charges/Incentives	Do not apply to Service, Heavy or Grey Fleets
	Standards	Access controls (Site-based LEZ, incl. service vehicle agreements)	*<<none>>*
	Vehicles	On site fleet (incl. light & heavy)	Do not apply to Domestic, Commuting or Public Access
		Low emission buses to service the site	
		Refuse collection vehicles	
		Social transport (incl. school minibuses)	
		Car club vehicles	*<<none>>*
	Infrastructure	Low emission taxi rank Electric vehicle charging facilities (cars & bikes)	*<<none>>*
	Management	Tech measures plan management and reporting	*<<none>>*
Financial Contribution	Local measures		*<<none>>*
	Local monitoring		*<<none>>*
	Fund Management	Action Planning, Implementation & Reporting	*<<none>>*

4.2. Illustrative actions were identified for each reference site. Respective target sub-fleets were identified and impacts were ascribed in both qualitative and quantitative terms.

Table 8: Measures applied to reference sites and impacts on respective sub-fleets (NB these are *sub-fleet impacts*, so overall site fleet impact will be smaller)

Action	Targeted sub-fleet(s)	Physical Measures	Impact Description	Sub-fleet Impact factors
Travel Plan	Housing: Domestic (cars) Retail: Public access (cars) Commercial: Staff trips (cars); Public access/Business (cars)	Effective implementation of a traditional travel plan	Annual car trips reduced by 10%. *=> all emissions reduced by 10%*	NO_X ↓ 10% PM_{10} ↓ 10% CO_2 ↓ 10%
EV infrastructure	Retail: Public access (cars) Commercial: Public access/Business (cars)	Installation of standard / good practice levels of EV infrastructure	Measure stimulates a 1% shift to electrics cars [1] 100% reduction of exhaust emissions from electric cars. No impact on non-exhaust PM10	NO_X ↓ 1% PM_{10} (exh) ↓ 1% CO_2 ↓ 1%
EV car club	Housing: Domestic (cars) Commercial: Staff trips (cars)	Establishment of a car club, which provides use of electric vehicles to its members	Trips: 10% membership of 'would-be' car owners. Car Club reduces members' travel 50% of vkm Overall effect reduces car trips by 10% x 50% = 5% Emissions 100% reduction of exhaust emissions from electric cars (applicable to member journeys) Measure Interaction adjustment Trip reduction (5%) considered as part of travel plan So measure is assessed for EV journey shift only (5%) => 5% reduction on all tail pipe emissions	NO_X ↓ 5% PM_{10} (exh) ↓ 5% CO_2 ↓ 5%
Zero staff parking	Retail: Staff trips (cars)	Severe restrictions on staff parking, which effectively eliminates staff car travel.	Annual staff car trips reduced by 100%. *=> all staff car emissions reduced by 100%*	NO_X ↓ 100% PM_{10} ↓ 100% CO_2 ↓ 100%
Site LEZ (HGVs Euro V+)	Retail: Heavy fleet (HGVs) Fleet Depot: Heavy fleet (HGVs)	Site based low emission zone, such that all HGVs operating at the site are Euro V or newer	Baseline HGV fleet (mixed Euro standard vehicles) is replaced with LEZ HGV fleet consisting of Euro V+ [2] => all tailpipe emissions reduced by varying amounts (see site specific impact factors, right)	NO_X ↓ 33% PM_{10} ↓ 47% CO_2 ↓ 0.3%

Notes:

[1] Where a travel plan was combined with an EV measure the combined impact of both measures was calculated by first applying the trip reduction measure (Travel Plan => 10% reduction in total trips), then applying the technology measure to the residual trips (EV=>5% reduction in exhaust emissions).

[2] LET v1.1 was used to model site based LEZ. Consequently, fleet composition and emission factors reflect EFT v4.2 rather than the current EFT 6.0.

[3] EV measures assume 0% impact on non-exhaust PM_{10} for simplicity. Note TRL comments on impacts of regenerative braking (footnote 12).

Action Definition

4.3. Structured definition of actions requires the following elements:

- Title
- Target Sub Fleet
- Physical Measures
- Impact Description
- Impact Factors
- Implementation costs
- Assessment Method

=> Guidelines for action definition and data capture/library development of implemented actions would rapidly strengthen the underlying evidence base for low emission assessment

Choice and Specification of Measures

4.4. The measures in **Table 8** were selected to illustrate a range interventions, a range of impact types and associated benefit assessment methods. ***They are not optimised mitigation recommendations.***

4.5. The assigned impact descriptions and factors are ***'realistic but optimistic'*** estimates, intended to illustrate the scale of potential benefit that might arguably be achieved..

4.6. Notes on Specific Measures:

- EV measures modelled assumed either a 1% or 5% switch from petrol/diesel to electric vehicles. These impact assumptions were selected to demonstrate functionality and scale of effect. (Note: Market share of sales of EVs as proportion of total new car sales is currently significantly less than 1%[13]).
  => Further work is required both with regards realistic transformational effects and also the extent to which it is appropriate to attribute emission benefit to what is an enabling rather than direct mode of action.
- EV measures assumed no impact on non-exhaust PM_{10} for simplicity. Note TRL comments regarding impacts of regenerative braking (footnote 12).
- 'No staff parking' was also chosen to demonstrate scale of effect. It is unlikely to be a practical/popular measure in many cases. Less severe constraints on staff travel may be best considered together under the umbrella of a staff travel plan.
- Data for site-based LEZ provide a good illustration, but interpretation requires caution since they are based on LET emission factors and fleet composition data (derived from EFT v4.2, whereas the latest version of the EFT is v6.0.1). => Work is ongoing within the LEP to update LET datasets.

=> Significant further work is required to develop and refine measure specific guidelines and performance standards, which can then be tuned according to site specific circumstances and requirements (NB this is now a crucial development goal)

Trip Reduction and Technical Measures

4.7. Categorisation of action as trip reduction or technical measures has been useful in development work as it reflects the traditional divide between travel planning and LES. However this distinction is more accurately applied to impact mode (i.e. reduce fleet miles or change fleet emission factors) rather than the action itself, and consequently when applied to physical measures the distinction can be ambiguous. For example, a low emission car club clearly spans both categories; as does a 'low emission' or 'enhanced' travel plan that includes information/incentives on electric vehicles.
=> LEP guidance update will provide recommendations on measure typology/terminology (due Jan 15)

[13] Ref: Report for the Committee on Climate Change (2013): Pathways to high penetration of electric vehicles (*"electric cars and vans represented 0.1% of light duty sales in 2012"*) Available online at: http://www.theccc.org.uk/wp-content/uploads/2013/12/CCC-EV-pathways_FINAL-REPORT_17-12-13-Final.pdf

5. Benefits

Results

5.1. **Table 9** presents estimated annual benefits at sub-fleet level. **Table 10** translates these to site level cumulated over five years (and **Table 11** presents the latter perspective, with a little more detail). These results are provisional, since the methods used have not yet been subject to the same level of testing and review as those for base fleet assessment. Benefits are presented in terms of bulk emission reductions and also as damage avoided. It should be noted that translation from sub-fleet to site level depends on the relative size of the sub-fleets in relation to the overall site (e.g. for Food Retail, staff trips make up a small proportion of total vkm, consequently even a 100% reduction in staff emissions has a relatively small impact on the site overall).

Observations

5.2. Trip reduction measures (illustrative measure - travel plan) have the potential to provide the most significant emission reductions because they affect all pollutants, including non-exhaust PM_{10}.

5.3. Some on-site technical measures (e.g. site LEZ) have potential to significantly reduce NO_X emissions. However, overall they are unlikely to make significant in-roads on site PM_{10} or CO_2 and therefore on site damage costs. This is due to: (i) the dominance of non-exhaust PM; and (ii) the likely low site-level infiltration of ultralow CO_2 technologies that is achievable. (For example, at the Fleet Depot, converting all HGVs to Euro V+ had a significant impact on NO_X emissions , 33% reduction. However, PM_{10} impacts were much lower and there was no impact on CO_2.)

5.4. Despite application of Trip Reduction and On-site Technical Measures using relatively optimistic impact assumptions, the residual impact for all sites remains high. A typical range of 80-95% of base emissions harm is suggested as a reasonable working reference point.

5.5. Overall:

- Travel plans are likely to remain the most significant on-site measure in terms of directly reducing emissions harm; site residuals are likely to remain high, at around 80-95% of base harm; and the pursuit of financial contributions for compensatory off-site measures appears increasingly important.
- Some technical measures may provide more significant benefits in terms of bulk NO_X reductions (or from an abatement costing perspective). They may also be of strategic or indirect importance in terms of facilitating and laying a platform for a longer term transition towards low emission transport. Therefore, it is important not to overlook the important direct and indirect benefits that can be achieved using on-site technical measures and careful adherence to the mitigation hierarchy (Trips > Tech > Off-site) will help to ensure this.

=> Given their potentially pivotal role in reducing emissions damage, it is important to carefully consider the role of trip reduction work (especially travel plans) within low emission planning policies, including integration with the associated travel assessment/travel planning processes.

=> A further driver for integration is the observation that the technical/trip reduction distinction is most accurately made in terms of impact mode, since categorisation of some physical measures is ambiguous.

Table 9: Action packages for reference sites (These are **site fleet impacts**, combining impact of measure and the relative size(s) of the target sub-fleet(s))

Reference Site	Base Impacts (Annual)	t/yr	£DC/yr	Actions considered	Benefit Assessment	NOx	PM10	CO2
Housing (Med) (Central, 50 Units)	NO_X PM_{10} CO_2 **=> Total**	0.2 0.02 95	£200 £1,300 £6,300 **£7,800**	M1: Resid. Travel Plan: 10% ↓ dom. car trips M2: Resid. EV: assume ~5% dom. car exhaust	M1: M2: **=>All**	↓ 10% ↓ 5% **↓ 15%**	↓ 10% ↓ 1% **↓ 10%**	↓ 10% ↓ 5% **↓ 15%**
Housing (Large) (Edge, 500 Units)	NO_X PM_{10} CO_2 **=> Total**	3 0.4 1,537	£3,500 £20,900 £102,400 **£126,800**	M1: Resid. Travel Plan: 10% ↓ dom. car trips M2: Resid. EV: assume ~5% dom. car exhaust	M1: M2: **=>All**	↓ 10% ↓ 5% **↓ 15%**	↓ 10% ↓ 1% **↓ 11%**	↓ 10% ↓ 5% **↓ 15%**
Food retail (Edge, 10 000 m2)	NO_X PM_{10} CO_2 **=> Total**	17 2 8,045	£19,200 £107,500 £536,200 **£662,900**	M1: Site Travel Plan: 10% ↓ public car trips M2: Site EV: assume ~1% public car exhaust M3: Staff Parking: No staff parking M4: Site based LEZ (HGVs Euro V+)	M1: M2: M3: M4: **=>All**	↓ 8% ↓ 1% ↓ 1% ↓ 5% **↓ 16%**	↓ 9% ↓ 0.1% ↓ 1% ↓ 1% **↓ 11%**	↓ 9% ↓ 1% ↓ 1% ↓ 0.04% **↓ 11%**
Non-food retail (Edge, 3000 m2)	NO_X PM_{10} CO_2 **=> Total**	1.4 0.2 652	£1,500 £8,800 £43,400 **£53,700**	M1: Site Travel Plan: 10% ↓ public car trips M2: Site EV: assume ~1% public car exhaust M3: Staff Parking: No staff parking M4: Site based LEZ (HGVs Euro V+)	M1: M2: M3: M4: **=>All**	↓ 9% ↓ 1% ↓3% ↓3% **↓ 15%**	↓ 9% ↓ 0.1% ↓3% ↓0.4% **↓ 12%**	↓ 9% ↓ 1% ↓3% ↓0.02% **↓ 13%**
Commercial (Central, 1500 m2)	NO_X PM_{10} CO_2 **=> Total**	0.4 0.05 200	£500 £2,700 £13,400 **£16,500**	M1: Staff Travel Plan: 10% ↓ staff car trips M2: Staff EV: assume ~5% staff car exhaust M3: Site Travel Plan: 10% ↓ other car trips M4: Site EV: assume ~1% other car exhaust	M1: M2: M3: M4: **=>All**	↓ 2% ↓ 1% ↓ 8% ↓ 1% **↓ 12%**	↓ 2% ↓ 0.1% ↓ 8% ↓ 0.1% **↓ 10%**	↓ 2% ↓ 1% ↓ 8% ↓ 1% **↓ 12%**
Fleet Depot (Edge, 50 HGV)	NO_X PM_{10} CO_2 **=> Total**	5 0.3 1,570	£5,200 £18,500 £104,700 **£128,400**	M1: Site based LEZ (HGVs Euro V+)	M1:	↓ 33%	↓ 8%	↓ 0.3%

Note: The percentage reductions presented in the benefit assessment represent impacts on the site fleet as a whole. These can be compared with the impacts on the sub-fleets as described in Table 8 above. For example, "No staff parking" results in a 100% emissions reduction for the staff cars sub-fleet, but only 1% emissions reduction across the site as a whole. This reflects the baseline emissions impact of the staff cars sub-fleet, compared with the site as a whole.

Table 10: Benefits of measures for reference sites, over 5 years

Reference Site	Actions	Benefits Assmt		Damage Avoided (5yr) £AQ	Damage Avoided (5yr) £AQ+CO2
Housing (Med) (Central, 50 Units)	Travel Plan: 10% ↓ car trips EV: ~5% car exhaust	NO_X PM_{10} CO_2	↓ 15% ↓10% ↓15%	£830	£5,500
Housing (Large) (Edge, 500 Units)	Travel Plan: 10% ↓ car trips EV: ~5% car exhaust	NO_X PM_{10} CO_2	↓ 15% ↓11% ↓15%	£13,700	£90,400
Food retail (Edge, 10 000 m2)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust Parking: No staff parking LEZ (HGVs Euro V+)	NO_X PM_{10} CO_2	↓ 16% ↓11% ↓11%	£74,900	£370,000
Non-food retail (Edge, 3000 m2)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust Parking: No staff parking LEZ (HGVs Euro V+)	NO_X PM_{10} CO_2	↓ 15% ↓12% ↓13%	£6,600	£34,300
Commercial (Central, 1500 m2)	Travel Plan: 10% ↓ car trips EV: ~5%/1% staff / car exh	NO_X PM_{10} CO_2	↓ 12% ↓10% ↓12%	£1,600	£9,400
Fleet Depot (Edge, 50 HGV)	M1: LEZ (HGVs Euro V+)	NO_X PM_{10} CO_2	↓ 33% ↓8% ↓0.3%	£15,800	£17,600
Note: It would be useful to have reference capital/operating costs to the developer for implementation of the various measures, as a means of contextualising the emissions benefits. The LET includes some reference costs (although these are 2010 prices). Further work is required to develop this information.					

Table 11: Benefits assessment for reference sites (incl. pollutant details)

	Base Impacts (Annual)	t/yr	£DC/yr	Actions	Damage Avoided (Annual)	t/yr	£DC/yr	Residual Impacts (Annual)	t/yr	£DC/yr
Housing (Med) (Central, 50 Units)	NO_X PM_{10} CO_2 => **Total**	0.20 0.023 95	£217 £1,284 £6,308 **£7,808**	**All measures** M1: Travel Plan (10% ↓ car trips) M2: EV (5% ↓ car exhaust)	NO_X PM_{10} CO_2 => **Total**	0.03 0.002 14	£32 £134 £933 **£1,099**	NO_X PM_{10} CO_2 => **Total**	0.17 0.021 81	£185 £1,149 £5,375 **£6,710**
Housing (Large) (Edge, 500 Units)	NO_X PM_{10} CO_2 => **Total**	3.2 0.37 1,537	£3,487 £20,851 £102,430 **£126,768**	**All measures** M1: Travel Plan (10% ↓ car trips) M2: EV (5% ↓ car exhaust)	NO_X PM_{10} CO_2 => **Total**	0.48 0.04 230	£522 £2,214 £15,351 **£18,087**	NO_X PM_{10} CO_2 => **Total**	2.7 0.33 1,307	£2,965 £18,637 £87,079 **£108,681**
Food retail (Edge, 10 000 m2)	NO_X PM_{10} CO_2 => **Total**	17.5 1.9 8,045	£19,183 £107,538 £536,175 **£662,896**	**All measures** M1: Travel Plan (10% ↓ car trips) M2: EV (1% ↓ car exhaust) M3: Parking (100% ↓ staff trips) M4: LEZ (HGVs Euro V+)	NO_X PM_{10} CO_2 => **Total**	3 0.2 886	£2,992 £11,980 £59,038 **£74,009**	NO_X PM_{10} CO_2 => **Total**	14.7 1.7 7,159	£16,191 £95,558 £477,138 **£588,887**
Non-food retail (Edge, 3000 m2)	NO_X PM_{10} CO_2 => **Total**	1.4 0.16 652	£1,518 £8,773 £43,432 **£53,722**	**All measures** M1: Travel Plan (10% ↓ car trips) M2: EV (1% ↓ car exhaust) M3: Parking (100% ↓ staff trips) M4: LEZ (HGVs Euro V+)	NO_X PM_{10} CO_2 **=> Total**	0.2 0.02 83	£230 £1,092 £5,546 **£6,868**	NO_X PM_{10} CO_2 **=> Total**	1.2 0.14 568	£1,287 £7,681 £37,886 **£46,854**
Commercial (Central, 1500 m2)	NO_X PM_{10} CO_2 => **Total**	0.42 0.049 200	£456 £2,717 £13,351 **£16,524**	**All measures** M1: Travel Plan (10% ↓ staff trips) M2: EV (5% ↓ staff exhaust) M3: Travel Plan (10% ↓ car trips) M4: EV (1% ↓ car exhaust)	NO_X PM_{10} CO_2 => **Total**	0.05 0.005 23	£53 £276 £1,546 **£1,875**	NO_X PM_{10} CO_2 **=> Total**	0.37 0.044 177	£404 £2,442 £11,804 **£14,650**
Fleet Depot (Edge, 50 HGV)	NO_X PM_{10} CO_2 => **Total**	5 0.33 1,570	£5,188 £18,523 £104,656 **£128,367**	**All measures** M1: LEZ (HGVs Euro V+)	NO_X PM_{10} CO_2 => **Total**	2 0.03 5	£1,710 £1,448 £356 **£3,514**	NO_X PM_{10} CO_2 **=> Total**	3 0.31 1,565	£3,477 £17,076 £104,300 **£124,853**

6. Area Emissions Assessment

6.1. An area assessment method was established, based upon grouping actual or projected developments across a given area and timescale under the different reference site types, aggregating development areas and scaling associated harm/benefits. The approach was tested using a list of major planning applications recently processed in Bradford. Aggregated emissions and damage costs were calculated, illustrative actions were applied and the associated benefits were assessed. **Table 12** summarises the planning applications, **Table 13** outlines the base harm, and **Table 14**, **Table 15** and **Table 16** provide the benefits.

6.2. Note that the following sites were excluded from the appraisal, since they fell outside of the current scope of the area tool:

i) Petrol filling station [requires additional interrogation of TRICS data to develop LET trip rates]
ii) Energy from waste recycling centre [requires additional interrogation of TRICS data]
iii) Road infrastructure (swing bridge) [requires additional interrogation of TRICS data]

6.3. Harm - Action - Benefit summary:

Harm
The total emissions damage for air quality is estimated as £1.4 million over five years
This rises to £7.2 million if CO_2 is included
Residential developments are responsible for the highest proportion of emissions damage (50%)
Followed by Food Retail (27%), Leisure (10%), Non-food retail (7%), Industrial (4%) and Health (1%)

Actions Applied[14]
- Travel plans, resulting in 10% reduction in car trips (applied to all sites)
- EV infrastructure, stimulating a 1% switch from petrol/diesel to electric vehicles (applied to all sites)
- On site LEZ – all HGVs to be Euro V or cleaner (applied to all sites except residential)

Benefits
The measures led to an overall reduction of 13% for NO_X and 10% for PM_{10} and CO_2
The Travel Plan accounted for 90% of the damage avoided (£132 k per annum)
Five-year air quality emission reduction was valued at £144 k (rising to £733 k with CO_2).
Five-year residual air quality emissions damage was valued at £1.2 million (rising to £6.4 million with CO_2).

6.4. The results reiterate the conclusions noted in **Section 5**, that in the absence of significant additional on-site technical measures:
- travel plans are likely to remain the most significant on-site measure in terms of direct damage reduction;
- site residuals are likely to remain high, at around 80-95% of base harm; and
- securing a financial contribution, to provide local compensatory reductions against site residuals is important.

6.5. Equally it is important that useful direct and indirect benefits that can be achieved using on-site technical measures, especially for the reduction of NO_X, are not overlooked or drowned out by exclusive consideration of direct damage costs.

[14] Measures were selected to illustrate a range of interventions, a range of impact types and associated benefit assessment methods. They are not optimised mitigation recommendations, but are designed to illustrate the scale of potential benefits, using 'realistic though optimistic' impact assumptions.

Comparison to the actual planning outcomes

6.6. Detailed analysis of site specific data relating to the actual Bradford agreements was beyond the scope of this work. However, for one site, it was noted that the five-year emission damage calculated by the area method compared encouragingly with the financial contribution achieved at the site (440 residential units: developer's financial contribution: £62,000, Area Assessment calculation: £85,000).

6.7. In terms of measures secured, the Bradford examples show the impact of the introduction of their own planning guidance. Applications submitted prior to its adoption resulted in no on-site technical mitigation, whilst those coming afterwards attracted various measures including: EV charging points, CEMP (Construction Environmental Management Plan), Low Emission Travel Plan and Site Low Emission Strategy. The latter requires consideration of low emission vehicle technology, fleet specifications, procurement policies, driver training, anti-idling measures and the setting of emission reduction targets). One site secured an electric mini bus for local resident use and one secured a contribution towards a pedestrian bridge. The scope of measures outlined above is well reflected by the illustrative measures included in the area assessment. It is more difficult to draw conclusions on the respective extent and intensities without a more detailed examination.

Table 12: Summary of Bradford major Planning Applications (2013-4)

Land Use Broad (and narrow) for modelling purposes	Size	(Units)	Location for modelling purposes	Site details
Residential (Mixed housing)	3,619	dwellings	Suburban	18 sites, varying in size from 58 to 600 units. Mixed housing not specified, but selected as mid value to model.
Retail (Food Retail)	6,738	sqm GFA	Suburban	3 sites, one included a petrol station
Retail (Non-food retail)	4,466	sqm GFA	Suburban	2 sites, incl. 1 multipurpose application (coffee shop, newspaper shop, hair salon)
Employment (Industrial)	5,552	sqm GFA	Suburban	3 sites modelled: (i) general industrial use; (ii) industrial B1/B2; (iii) car servicing 2 Energy from Waste plants were also listed, but not modelled
Health (Care Home)	5,746	sqm GFA	Suburban	2 sites: (i) care home; (ii) building containing extra care apartments, nursery, day centre)
Leisure (Restaurant)	3,156	sqm GFA	Suburban	4 sites, incl. 3 restaurants and one multipurpose application (A1-A5 = non-food retail, office, restaurant, pub, takeaway)

Notes:

Location set as suburban for all sites, for ease of modelling. To provide more detailed results, the site locations in relation to town centre / edge of town etc. could be included as separate categories.

Likewise for land use. Sites here were collated into one narrow land use. Additional categories could be created for more detailed analysis.

=> Further work – it would be useful to look at scale and thresholds – including whether any measures are more applicable to bigger sites, etc.

Table 13: Bradford Planning Applications – Summary Harm

Land Use	Size	Fleet	Annual ave km (LET Trip Method)		NOX	PM10	CO2	Total
Residential (Mixed housing)	3,619 dwellings	Domestic (cars)	67,501,738	**t/a** **£/a**	**18.3** **£20,084**	**2.15** **£120,177**	**8,858** **£590,353**	**£730,615**
Retail (Food Retail)	6,738 sqm GFA	Public access (Cars) Heavy fleet (HGVs) **=> Total**	29,873,403 1,217,487	t/a t/a **t/a** **£/a**	8.1 2.40 **10.5** **£11,520**	1.0 0.17 **1.12** **£62,582**	3,920 797 **4,717** **£314,356**	**£388,458**
Retail (Non-food retail)	4,466 sqm GFA	Public access (Cars) Heavy fleet (HGVs) **=> Total**	8,941,264 65,671	t/a t/a **t/a** **£/a**	2.4 0.13 **2.6** **£2,802**	0.3 0.01 **0.29** **£16,426**	1,173 43 **1,216** **£81,062**	**£100,290**
Employment (Industrial)	5,552 sqm GFA	Business (Cars) Heavy fleet (HGVs) **=> Total**	2,514,651 624,912	t/a t/a **t/a** **£/a**	0.7 1.23 **1.9** **£2,099**	0.1 0.09 **0.17** **£9,300**	330 409 **739** **£49,243**	**£60,642**
Health (Care Home)	5,746 sqm GFA	Public access (Cars) Heavy fleet (HGVs) **=> Total**	368,464 81,364	t/a t/a **t/a** **£/a**	0.1 0.16 **0.26** **£285**	0.01 0.01 **0.023** **£1,284**	48 53 **102** **£6,771**	**£8,340**
Leisure (Restaurant)	3,156 sqm GFA	Public access (Cars) Heavy fleet (HGVs) **=> Total**	12,962,313 130,685	t/a t/a **t/a** **£/a**	3.5 0.26 **3.8** **£4,139**	0.4 0.02 **0.43** **£24,086**	1,701 86 **1,786** **£119,064**	**£147,289**
		Total (Cars) **(HGVs)** **=> Total**	**122,161,833** **2,120,120**	t/a t/a **t/a** **£/a**	33 4.2 **37.3** **£40,930**	3.9 0.29 **4.19** **£233,855**	16,030 1,387 **17,417** **£1,160,848**	**£1,435,634**

Notes:

No staff trips were modelled.

No service fleets were modelled.

Residential was also modelled using an alternative method in the LET. Estimating no. cars (equal to no. dwellings = 3,619) and multiplying by annual average km (14,518 km) = 51,454,942 km/yr

Table 14: Bradford Planning Applications – Summary Benefits by Land Use

Land Use	Actions	Benefits Assmt		Damage Avoided (annual) NOx	PM_{10}	CO_2	Total
Residential (Mixed housing)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust	NOx ↓ 11% PM10 ↓10% CO2 ↓11%	t/a £DC/a	2.0 £2,209	0.2 £12,168	974 £64,939	**£79,316**
Retail (Food Retail)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	t/a £DC/a	1.7 £1,845	0.1 £6,119	434 £28,920	**£36,885**
Retail (Non-food retail)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	t/a £DC/a	0.3 £339	0.03 £1,651	129 £8,612	**£10,602**
Employment (Industrial)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	t/a £DC/a	0.5 £528	0.01 £830	38 £2,512	**£3,870**
Health (Care Home)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	t/a £DC/a	0.06 £70	0.002 £115	5 £367	**£552**
Leisure (Restaurant)	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	t/a £DC/a	0.5 £517	0.04 £2,415	187 £12,490	**£15,422**
Total (all dev.)	*<<See individual land uses>>*	**NOx ↓ 13% PM10 ↓10% CO2 ↓10%**	**t/a £DC/a**	**5 £5,509**	**0.4 £23,300**	**1,768 £117,838**	**£146,647**

Table 15: Benefits of measures for Bradford sites, over 5 years

Land Use	Base Harm (5yr) £AQ	Base Harm (5yr) £AQ+CO2	Actions	Benefits Assmt	Damage Avoided (5yr) £AQ	Damage Avoided (5yr) £AQ+CO2	Residual Impact (5yr) £AQ	Residual Impact (5yr) £AQ+CO2
Residential (Mixed housing)	£701 k	£3.7 M	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust	NOx ↓ 11% PM10 ↓10% CO2 ↓11%	£72 k	£397 k	£629 k	£3.3 M
Retail (Food Retail)	£371 k	£2 M	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	£40 k	£184 k	£331 k	£1.8 M
Retail (Non-food retail)	£96 k	£501 k	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	£10 k	£53 k	£86 k	£448 k
Employment (Industrial)	£57 k	£303 k	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	£7 k	£19 k	£50 k	£284 k
Health (Care Home)	£7.8 k	£42 k	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	£0.9 k	£2.8 k	£6.9 k	£39 k
Leisure (Restaurant)	£141 k	£736 k	Travel Plan: 10% ↓ car trips EV: ~1% car exhaust LEZ (HGVs Euro V+)	NOx ↓ 13% PM10 ↓10% CO2 ↓10%	£15 k	£77 k	£126 k	£659 k
Total (all dev.)	**£1.4 M**	**£7.2 M**	*<<See individual land uses>>*	**NOx ↓ 13%** **PM10 ↓10%** **CO2 ↓10%**	**£144 k**	**£733 k**	**£1.2 M**	**£6.4 M**

Table 16: Bradford Planning Applications – Summary Benefits by Measure

Actions	Benefits Assmt		Damage Avoided (annual) NOx	PM_{10}	CO_2	Total
Travel Plan: 10% ↓ car trips	NOx ↓ 10% PM10 ↓10% CO2 ↓10%	t/a £DC/a	3.3 £3,635	0.39 £21,749	1,603 £106,840	**£132,224**
EV: ~1% car exhaust	NOx ↓ 1% PM10 ↓ 0.1% CO2 ↓ 1%	t/a £DC/a	0.3 £363	0.005 £272	160 £10,684	**£11,319**
LEZ (HGVs Euro V+)	NOx ↓ 33% PM10 ↓ 8% CO2 ↓ 0.3%	t/a £DC/a	1.4 £1,511	0.02 £1,279	5 £314	**£3,104**
Total (all dev.)	**NOx ↓ 13%** **PM10 ↓ 10%** **CO2 ↓ 10%**	**t/a** **£DC/a**	**5** **£5,509**	**0.4** **£23,300**	**1,768** **£117,838**	**£146,647**

7. Further Work

Further work is recommended, which will consolidate and extend both the evidence and methodology for low emission planning policy design, implementation and appraisal:

7.1. Policy Appraisal

- Repeat the area assessment with other local authority data, including:
  - + ex-post appraisal of completed planning agreements;
  - + ex-ante appraisal of proposed or recently implemented planning policies; and
  - + forward projections to inform regional/national view on progress and opportunities
- Capture results in a standard format and use to:
  - + refine and extend headline policy conclusions; and
  - + inform future method streamlining and creation of short-cut tools

7.2. Standardisation of measures and impact assumptions

- Detailed review of selection and physical specification of measures
- Detailed review of measure implementation costs
- Detailed review of impact assumptions and associated evidence base
- Further development and guidelines on benefit assessment methodology
- Peer review and consensus building on measures and impact assumptions

7.3. Reference Sites

- Develop reference sites for other land uses / locations
- Explore sensitivities in global parameters (e.g. year, speed, road type, PM10 damage cost locations)
- Consolidate a robust list of standard sites and accompanying harm and benefit data

7.4. Datasets and Support Tools

- Update and refine LET land use based trip factors (rates/distances)
- Update LET emission factors to reflect EFTv6.0.1
- Extend scope of area assessment (i.e. with regards to global parameters, land use and measure)
- Develop an Area Emissions Assessment Tool (i.e. a user friendly package with instructions)