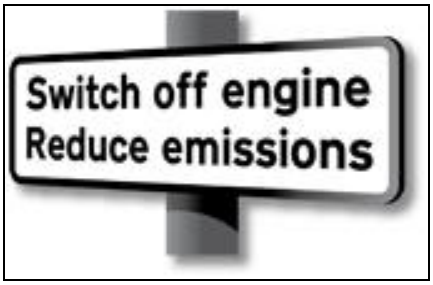




Clean Air Fund – End of Programme Report

FINAL

January 2013

CLEANER AIR FOR LONDON

SUPPORTING DOCUMENTS

1. TfL Customer Research - 'No Engine Idling' Campaign Proposition Testing (September 2011)
2. TfL Customer Research - 'No Engine Idling' Pre and Post Campaign Customer Research (March 2012 and October 2012)
3. London Sustainability Exchange – Cleaner Air 4 Schools Final Evaluation Report (May 2012)
4. TfL Research - On Street Surveys of Driver Engine Idling (April 2012 & November 2012)
5. Imperial College London Research - The role of shrubs and perennials in the capture and mitigation of particulate air pollution (PM_{10}) in London (May 2011)
6. TfL Customer Research – Clean Air Fund Green Infrastructure (December 2011)
7. Transport for London, Targeted Application of Calcium Magnesium Acetate (CMA) Pilot Study Monitoring Report (August 2011) (URS)
8. King's College London Research – Evaluation of the impact of dust suppressant application on ambient PM_{10} concentrations in London (November 2012)

Executive Summary

1. Background

The Mayor's Air Quality Strategy (MAQS) was published in late 2010. It highlighted that the vast majority of London already meets the European Union (EU) limit value for annual mean Particulate Matter (PM_{10}) concentrations. It did, however, identify a small number of locations where there was a risk of exceeding the EU daily mean limit values.

The Mayor has implemented an ambitious package of measures to address PM_{10} emissions from diesel vehicles operating in London, including tightening the Low Emission Zone standards for heavy diesel vehicles, retiring the oldest diesel taxis and bringing in over 1,600 hybrid buses over the next four years. To complement these longer term and London-wide air quality measures the Mayor also committed to apply short term and targeted local measures to help London meet the EU limit values for PM_{10}.

2. The Clean Air Fund Programme

In March 2011, the Mayor secured £5m funding from the Department of Transport (DfT) to enable Transport for London (TfL) to deliver a programme of these innovative local measures in London's varied environment. The programme was focused on reducing PM_{10} emissions and concentrations at three PM_{10} priority locations in central London. These three locations were identified in the air quality modelling undertaken to inform the development of MAQS. The delivery of measures was also extended to target other identified local PM_{10} hot spots in London, for example at a number of industrial waste and construction sites. The programme objectives were:

- To deliver a package of innovative, short-term and targeted local measures to reduce local PM_{10} concentrations and help address the risk of PM_{10} limit values being exceeded in London;
- To provide evidence of the effectiveness of the local measures delivered; and
- To increase awareness of the MAQS and understanding of air quality issues and to engage with public, businesses, boroughs and other stakeholders.

The five workstreams of local measures agreed by TfL, the Greater London Authority and the DfT are summarised below:

(1) Fitment of diesel particulate filters to reduce emissions of PM_{10} from buses on selected routes running through the three MAQS PM_{10} priority locations;

(2) A 'No Engine Idling' programme of measures to reduce emissions of PM_{10} emissions from vehicles left idling unnecessarily by drivers. This programme included deployment of TfL taxi marshals at busy central London ranks to better manage ranks and discourage unnecessary engine idling;

(3) New Green Infrastructure (GI) (green screens, green walls and tree planting) at identified local PM_{10} hot spots to trap local PM_{10} emissions;

(4) An expanded trial of targeted cleaning and the application of dust suppressants to further evaluate its effectiveness in reducing local PM_{10} concentrations on road corridors and at industrial waste and construction sites; and

(5) Business focused transport measures and engagement activity delivered within the three MAQS PM_{10} priority locations to reduce PM_{10} and other emissions associated with staff and business travel and deliveries.

3. Programme Conclusions and Next Steps

The CAF programme has delivered a wide range of local measures targeting both a reduction in local PM_{10} emissions and concentrations. The measures were delivered over an 18 - 24 month period. The delivery achievements are summarised in **Table 1** and **Figure 1**.

Overall the programme has been a success and delivered tangible impacts on awareness, behaviour and PM_{10} emissions and concentrations. The CAF programme demonstrates that many of these local measures can play a supporting role to longer term and London wide emissions reduction measures, particularly when seen in the context of their wider benefits, and should continue to be delivered. **Table 2** sets out some of the key findings of each of the CAF workstreams highlighting tangible impacts on local PM_{10} emissions and local PM_{10} concentrations, and also changes in awareness and behaviour which will also deliver a reduction in emissions.

The CAF programme has benefitted from involving a significant number and a wide range of stakeholders. Delivery of the programme measures has also promoted wider public awareness of the other longer term measures being delivered as part of the Mayor's Air Quality Strategy to reduce pollution at source, for example the tightening of the Low Emission Zone standards and the introduction of taxi age limits.

TfL and the GLA will now build on the successes of the CAF programme and disseminate the findings and lessons learnt from this programme. The findings will be shared with partners and stakeholders both within the UK and Europe, including:

- at the January 2013 Cleaner Air Conference (hosted by the GLA, Environmental Protection UK and the Air Pollution Research in London)
- with the Air Quality Initiative of the Regions EU group
- the Joint Air Quality Initiative of North West Europe
- at sub-regional air quality meetings with London boroughs

To support boroughs in improving local air quality, raising awareness and reducing human exposure, a new Mayor's Air Quality Fund is being created. A total of £6m has been allocated in the latest TfL business plan for this fund over the next 3 years. Drawing on the lessons learnt and findings of CAF this additional funding will be available to boroughs which prioritise air quality and achieve 'Cleaner Air Borough' status. Subject to further proposals, TfL will increase resources available to around £20m once the initial fund spending has been assessed for its impact.

4. Individual CAF Measures Conclusions

Diesel Particulate Filters on Selected Bus Routes: Fitting diesel particulate filters (DPFs) to specific buses is a cost-effective measure which delivers up to 77% PM_{10} exhaust emissions reduction at source. This measure can be targeted at specific buses on specific routes but requires considerable technical input to ensure the filters are appropriate for the type of bus and engine. It is also important to carefully consider the more targeted benefits of a retrofit programme against the potentially wider emissions and noise reduction benefits of new Euro VI and diesel-electric hybrid vehicles.

'No Engine Idling' Programme: Monitoring around the CAF package of 'No Engine Idling' measures has shown positive indicators of the effectiveness of the programme and campaign in both establishing awareness of the issue amongst drivers and in changing driver behaviour. For example:

- The campaign achieved a good level of driver awareness (25%) and recognition (40%).
- Observed engine idling on-street in the three MAQS PM_{10} priority locations was reduced overall by approximately 5% and was significantly lower amongst certain vehicles types after each phase of the campaign. In November 2012 there was 11% less engine idling observed in coaches, a 16% reduction for HGVs, a 12% reduction for taxis and a 13% reduction for cars (compared to pre-campaign surveys from Dec 2011).
- Taxi marshalling proved a very effective way of engaging with taxi drivers and had some success in reducing idling. Overall there was an average 9% observed reduction in engine idling at marshalled taxi ranks.
- The smarter driver training for taxi and private hire drivers was successful and drivers achieved a 25% (taxis) and 12% (private hire) reduction in fuel consumption by changing their driving behaviours, also reducing their emissions.

However, changing driver behaviour takes time and to embed the message with drivers there will need to be a sustained and ongoing delivery of the 'No Engine Idling' message.

Green Infrastructure: As part of the CAF programme, Imperial College London undertook research to determine the ability of Green Infrastructure (GI) measures (including those delivered as part of CAF) to trap PM_{10}. The findings of this research help to support the growing evidence base that the delivery of GI can improve urban air quality. The research confirmed that the delivery of GI measures has a small direct local air quality benefit by trapping PM_{10}. They have proven to represent positive and worthwhile supporting measures within in a package or strategy of local measures, particularly in the context of their wider environmental and awareness raising benefits.

Expanded Trial of Cleaning and Application of Dust Suppressants: Following experience and evidence from other towns and cities in Europe, TfL has now completed an extensive trial of the effectiveness of dust suppressants in reducing local PM_{10} concentrations. The research undertaken by King's College London as part of this trial provided evidence of a beneficial effect of the application of dust suppressants at some road locations and industrial sites during the trial. It has therefore assisted in identifying a typology of the places where the application of dust suppressants can help reduce local PM_{10} concentrations.

Overall the trial highlighted that dust suppressant application was most effective in locations with unusually high local levels of *resuspended* PM_{10} and that application had no identifiable effect in some more typical roadside locations, even where *total* PM_{10} levels are elevated. A methodology has been developed for assisting in identifying the specific locations where the application of dust suppressants is likely to be most beneficial.

In summary, the results from the sites used to monitor the effectiveness of the trial were:

- **Road Corridor Sites** - the strongest evidence of a positive effect was found at the A3211 Upper Thames Street study site. The estimated impact was an average reduction in total PM_{10} concentration of approximately 16%. There were unclear results at the A2 Blackheath location and no effect was monitored at the three other road locations including at the A501 Marylebone Road site.
- **Industrial Study Sites** - the analysis identified beneficial impacts of dust suppressant application on the roads adjacent to the monitoring sites and/or on the process yard at three of the four sites studied. The most robust findings were at Horn Lane. A clear drop in local PM_{10} concentrations occurred in the hour following on-site application of between 31% and 59% relative to the control.

The findings therefore strongly support the role of dust suppressants to reduce local PM_{10} concentrations in very specific locations where the proportion of local resuspended PM_{10} is high and the surface area applicable for treatment can be maximised. In these targeted locations it is likely to have a significant impact on local PM_{10} concentrations. Examples include within and on roads around industrial waste transfer sites, construction and demolition sites; and at major road works were there is significant dust generating activity. Any future application along road corridors would need to reflect the findings of this trial and any locations proposed would need to be identified based on the methodology developed.

Business Focused Transport Measures and Engagement Activity: The evidence from this work strongly suggests that many businesses are not fully aware of, or understand, the extent of the impact of their activities on air quality. The positive uptake of the CAF measures by some businesses did provide some evidence that engagement work around tangible transport measures can change travel behaviour and in turn help to deliver air quality benefits.

The key conclusion that became very clear through engagement with the business community is that there is a real opportunity to educate and raise awareness of issues relating to air pollution. This would significantly improve the understanding of the impacts of particulate matter on public health, and help businesses to distinguish between carbon emissions and air quality in terms of Corporate & Social Reporting (CSR) protocols. The development of a package of financially attractive business case examples that provide evidence of real financial savings is a significant key to unlocking change, particularly for businesses not operating vehicle fleets and therefore indirectly influence air quality.

Table 1: Summary of Key CAF Programme Delivery Achievements

Workstream	Summary of Delivery Achievements
Diesel Particulate Filters on Selected Buses	• Diesel Particulate Filters (DPF) fitted on 120 vehicles on routes 10, 148, 205, 49, 7 (estimated fitment programme completion - end of March 2013).
'No Engine Idling' Programme (incl. Taxi Marshalling)	• Awareness raising and education campaign delivered in Jan/Feb 2012 and Sept/Oct 2012. • Engagement activity with transport operators, transport industry bodies, boroughs, schools. • 'No Engine Idling' signs delivered in three MAQS PM_{10} priority locations. • Five taxi marshals deployed in central London particularly at ten mainline stations. • Smarter driving training programme delivered for taxis, private hire and fleet drivers.
Green Infrastructure	• Two trial green walls at Edgware Road LU station on Marylebone Road and The Mermaid building on Upper Thames Street. • Trial of 50 planted towers on Thames Street. • 600 new street trees plus new shrubs planted in PM_{10} priority hot spots along the TLRN.
Expanded Trial of Cleaning and Applications of Dust Suppressants	• Trial application of dust suppressants along 6 road corridors (20 miles) (A3211 Victoria Embankment / Upper Thames Street, A501 Marylebone Rd/Euston Rd, A4202 Park Lane, A2 Earls Court Rd, A12 and A102 Blackwall Tunnel Approaches). • Trials of CMA applications, targeted cleaning and green infrastructure at six industrial waste sites and two construction sites. • Targeted PM_{10} cleaning (tunnels, flyovers, roads).
Business Focused Transport Measures and Engagement	• Engagement with over 600 businesses in targeted areas. • Nine Delivery Servicing Plans prepared with businesses. • Electric Charge Points (cars/LGVs) at business premises. • 12 electric pool bikes were piloted at trials with 6 employers. • Eight Revised Business Best Practice Guides (including air quality advice) published and promoted.

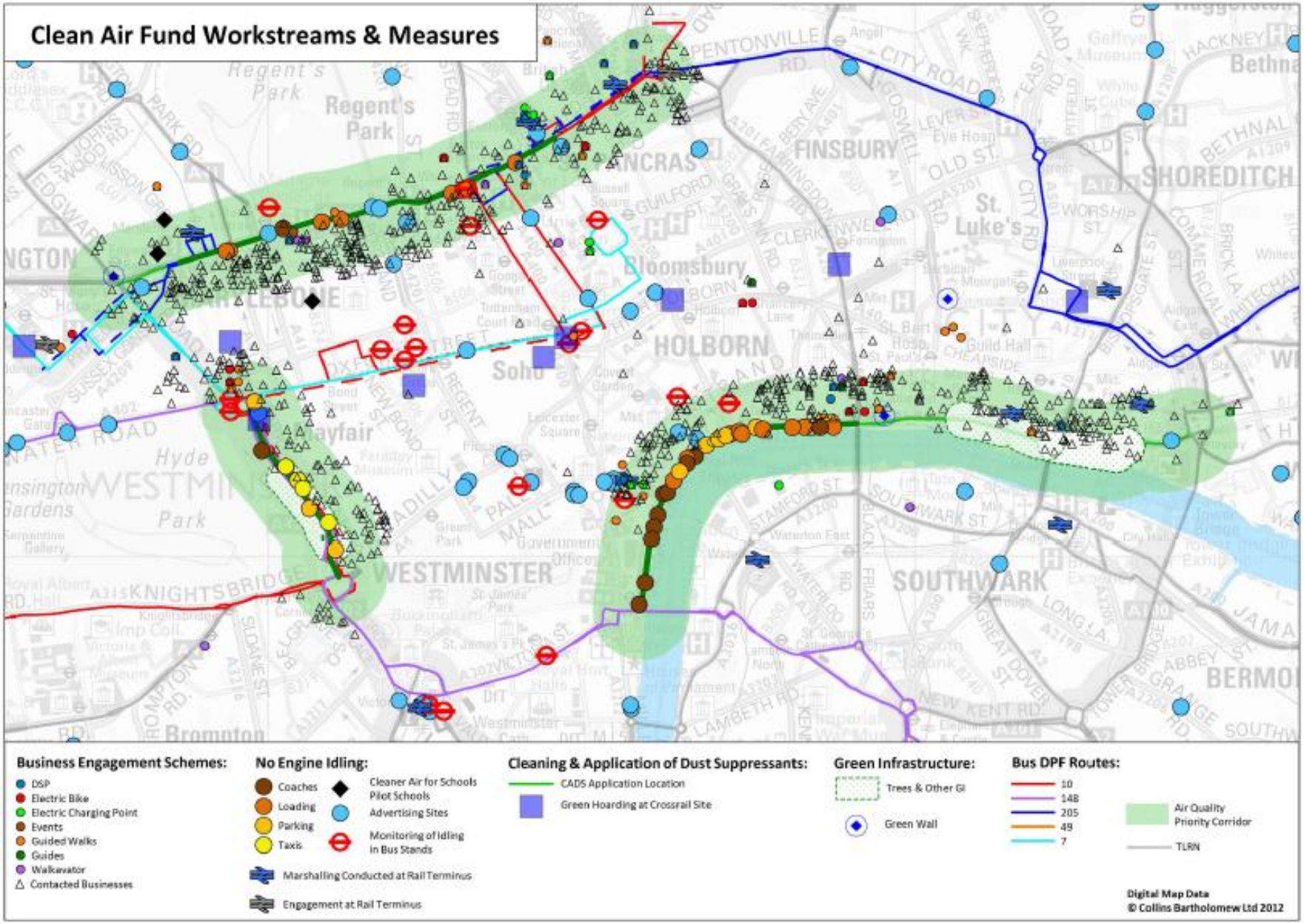
Table 2: Comparison of Clean Air Fund Measures

Workstream	Cost £000	Effectiveness of Workstreams: Some Key Indicators
Diesel Particulate Filters on Selected Bus Routes	980	• DPFs fitted deliver a 77% reduction in bus PM_{10} exhaust emissions. • On the five routes fitted this represents a reduction of 580kg in annual PM_{10} emissions (580kg is a 5% reduction in the annual PM_{10} emissions from all buses operating in central London) • Fitting DPFs on routes 10 and 205 will result in a 33% reduction in total bus exhaust PM_{10} emissions on Euston Road.
'No Engine Idling' Programme (incl. Taxi Marshalling)	1,180	• The TfL 'No Engine Idling' campaign achieved a good level of general awareness (25%) amongst drivers of 'turn off your engine' advertising and good prompted recognition (40%); • Observed engine idling on-street in the three MAQS PM_{10} priority locations was significantly lower amongst certain vehicles by November 2012. There was less engine idling observed in coaches (-11%), HGVs (-16%), taxis (-12%) and cars (-13%). • Observed engine idling at marshalled taxi ranks also reduced by 9% (on average). • Taxi and PHV drivers participating in the smarter driving training achieved average fuel savings of 25% and 12% respectively, helping reduce PM_{10} emissions.
Green Infrastructure	1,110	• CAF research confirmed that sampled GI, including shrubs, traps small quantities of PM_{10} including estimating that the 200m^2 Edgware Road Green Wall trapped 500g of PM_{10} in a three month period.

Expanded Trial of Cleaning and Applications of Dust Suppressants	1,430	• *Road corridor sites*:
		  ○ Evidence of a positive effect was found at the A3211 Upper Thames Street study site (reduction in total PM_{10} concentration of approximately 16%).
		  ○ Reduction seen in average total PM_{10} concentrations (approx. 12%) at A2 Blackheath but it was not clear that this was due to the application of dust suppressants.
		  ○ No effect was monitored at the three other roadside locations used in studying the trial.
		• *Industrial study sites:*
		  ○ At Horn Lane a clear drop in local PM_{10} concentrations occurred in the hour following on-site application of between 31% and 59% relative to the control.
		  ○ Analysis at Manor Road also saw a similar decrease in local PM_{10} (41%) associated with on-site application of dust suppressants.
		  ○ Some limited benefit of application was identified at the Neasden Lane site.

Business Focused Transport Measures	300	• A range of transport measures were delivered jointly through positive engagement with over 600 businesses. The uptake of the CAF measures by some businesses did provide some evidence that engagement work around tangible transport measures can change travel behaviour and in turn help to deliver air quality benefits.

Figure 1: Location of Clean Air Fund activities and measures in Central London



Clean Air Fund: End of Programme Report

1. Introduction

1.1 Purpose of Report

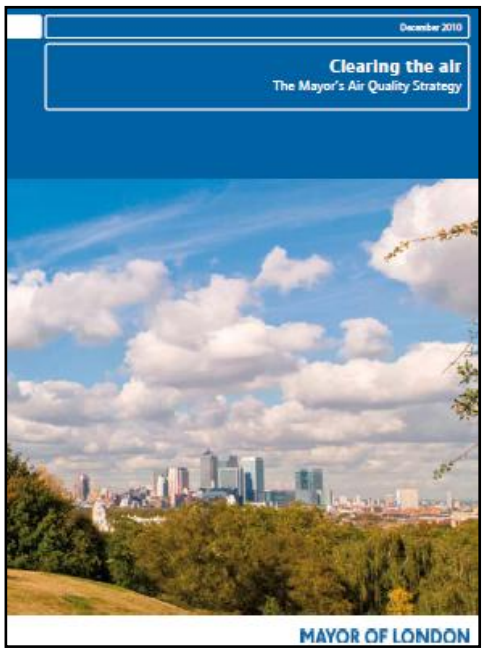
This report describes the measures delivered as part of the Clean Air Fund (CAF) programme, the key lessons learnt during delivery and the key findings on the effectiveness of these local measures in reducing Particulate Matter (PM_{10}) pollution. It will be used to help share lessons learnt from this successful programme and to disseminate best practice to other public authorities and air quality stakeholders, policy makers and practitioners.

The report is set out in the following structure:

- A background to the programme.
- A review of each of the CAF local measures and findings around their effectiveness.
- Conclusions and recommended next steps.

2. Background

2.1 The Mayor's Air Quality Strategy



The Mayor's Air Quality Strategy (MAQS) was published by the Greater London Authority (GLA) in late 2010. The MAQS highlights that:

- air pollution not only harms the environment but also health and wellbeing;
- independent research commissioned by the Greater London Authority (GLA), as part of work to develop the MAQS, quantified the seriousness of the exposure to particulate matter to the health of Londoners as it aggravates both respiratory and cardio vascular conditions.
- two pollutants cause most concern within London: particulate matter (PM_{10}) and nitrogen dioxide (NO_2);
- London already meets the European Union (EU) Limit Value for annual mean PM_{10} concentrations and is forecast to continue to do so;
- there are a small number of location where there is a risk of local levels of PM_{10} exceeding the daily mean EU air quality limit values;
- most PM_{10} emissions in London are caused by road traffic, with engine emission and tyre and brake wear being the main sources; and
- the challenge of cleaning London's air is made more difficult because a significant amount of the pollution sources are not within London. Much is blown in from continental Europe.

The overarching aim of the MAQS is to reduce air pollution in London so that the health of Londoners is improved. It describes the measures already announced or underway that will reduce emissions in London including:

- tighter Low Emission Zone standards for diesel engine vehicles were introduced in January 2012. Some 94 per cent of HGVS, buses and coaches and some 98 per cent of vans and minibuses driving in London now meet these new requirements. TfL buses met this standard prior to the LEZ implementation.
- tough age limits for taxis and PHVs were introduced, leading to the retiring of around 2,300 of the oldest, most polluting taxis this year alone, in addition to introducing minimum Euro standard requirements for all new licensed taxis and private hire vehicles.
- a total of 1,600 hybrid buses will be delivered. 455 cleaner hybrid buses will be in service by March 2013 and 600 New Buses for London, which emit over 50 per cent less NO_x than a standard diesel bus, by April 2016.
- retrofitting up to 1,000 of London's Euro III buses to reduce their NO_x emissions.
- record investment in cycling.
- retrofitting 55,000 homes and 400 public buildings with energy efficiency measures, saving tonnes of NO_x emissions.

- reducing emissions from new developments by using the London Plan.
- investing heavily in green infrastructure with a target of a 5% increase in London's tree cover by 2025.

To complement the London-wide measures included in the Strategy, the Mayor committed to apply targeted 'local measures' to help London meet the EU limit values for PM_{10} as soon as possible and to investigate further measures to implement in the future. These local measures were identified following a study commissioned by TfL to understand the potential of a range of possible local measures to address high levels of PM_{10} at a range of locations across London. This study considered a wide range of evidence from the UK and Europe on the effectiveness of potential local measure[1].

Local measures were identified as a pragmatic step allowing the areas with highest concentrations to be targeted swiftly in parallel with longer-term London-wide and modally focused measures. Some potential local measures identified in the MAQS included road cleaning and the application of dust suppressants; 'No Engine Idling' measures; deployment of lower emission buses in priority locations and trials of green walls and other green infrastructure.

2.2 Particulate Matter Pollution and Modelling

Particulate matter (PM) is a complex assemblage of non-gaseous material of varied chemical composition. It is categorised by the size of the particle (for example PM_{10} is particles with a diameter of less than 10 microns (μm)). Most PM emissions in London are caused by road traffic, with engine emission, tyre and brake wear and road surface abrasion being the main sources. Road transport is the dominant source of PM_{10} emissions within central London, contributing around 79 per cent in 2008, 80 per cent in 2011 and is predicted to contribute 75 per cent in 2015.

Air quality modelling undertaken to inform the development of the MAQS identified that the vast majority of London already meets the EU limit value for annual mean PM_{10} concentrations and are forecast to continue to do so. However, the modelling identified three priority locations in central London where there is considered to be a greater risk of exceeding the EU limit value for annual mean PM_{10} concentrations. The three locations identified were:

(1) Marylebone Road and Euston Road;

(2) Marble Arch and Hyde Park Corner (Park Lane); and

(3) Victoria Embankment, Upper Thames Street and Tower Hill.

2.3 The Clean Air Fund Programme

In March 2011, the Mayor secured £5m funding from the DfT to enable TfL to deliver a package of innovative local measures in London's varied environment. The programme was focused on reducing PM_{10} emissions and concentrations at the three MAQS PM_{10} priority locations in central London and at other local PM_{10} hot spots identified through the London air quality monitoring network. The agreed scope of the local measures workstreams is outlined in **Table 2.1** below.

[1] Local Measures for PM10 Hot spots in London – report by Air Quality Consultants (AQC) and TRL (December 2009)

Table 2.1: Scope of the Clean Air Fund Local Measures

Workstream	Scope
Diesel Particulate Filters on Selected Bus Routes	• To fit and evaluate the use of Diesel Particulate Filter (DPF) technology on vehicles currently identified as operating in the three MAQS PM_{10} priority locations in central London.
'No Engine Idling' Programme (incl. Taxi Marshalling)	To promote driver behaviour change, and specifically discourage unnecessary engine idling. An integrated plan of measures is proposed including: • stakeholder engagement (initially targeted at professional drivers); • wider driver awareness raising and education campaign; and • on-street signs. Five taxi marshals will be employed to: • marshal at taxi ranks (at targeted locations in central London), encourage taxi sharing and discourage unnecessary engine idling at ranks. • promote smarter driving and the uptake of smarter driver training courses.
Green Infrastructure	• Trial of green walls. • Trial of green screens (vegetated barriers). • Greening activity at PM_{10} priority hot spots – including tree planting and shrub planting.
Targeted Cleaning and Application of Dust Suppressants	• Intensified and extended trial application of CADS at initial trial locations and other targeted sites. • Optimising CADS application by further monitoring of extended trial and reviewing ways to optimise the amount of CMA applied. • Deployment of CADS at construction sites and industrial waste sites. • Targeted cleaning in the three MAQS PM_{10} priority locations and other PM_{10} hot spots.
Business Focused Transport Measures & Engagement Activity	• Engagement with over 600 businesses in the three MAQS PM_{10} priority locations focusing on delivery servicing plans and business travel. • Delivery servicing plans (DSP) – implementing a minimum of six DSPs. • Electric Charge Points (cars/LGVs) – match funding of EVCPs (up to 30) at business premises. • Implementation of three electric pool bike pilots at businesses.

2.4 Programme Objectives

The CAF programme had the following objectives:

- to deliver a package of innovative, short-term and targeted local measures in 2011/12 to help address the risk of PM_{10} limit values being exceeded in London;
- to provide evidence of the effectiveness of the local measures implemented; and
- to increase awareness of the MAQS and understanding of air quality issues and to engage with public, businesses, boroughs and other key stakeholders.

2.5 Programme Monitoring and Evaluation

The main benefits sought as a result of the delivery of this programme were short-term improvements in local air quality, specifically targeted at reducing local particulate matter emissions and concentrations. However, local measures are a relatively new approach to reducing local PM_{10} emissions and concentrations. Due to the impact of the weather, non-transport and external sources of pollution and a range of other variables, it was always understood that it would be very difficult to monitor and quantify the direct impact of individual local measures on air quality.

A monitoring and evaluation framework was developed for the CAF programme and agreed with both the DfT and GLA. To help understand the effectiveness of the local measures delivered in achieving key programme outcomes a range of different workstream datasets, information sources were identified and indicators developed. This approach is set out in **Figure 2.1** but included:

- Use of existing kerbside monitoring equipment to measure local PM_{10} concentrations.
- Estimates of PM_{10} volumes trapped.
- Proxy indicators information to infer or estimate air quality impacts e.g. observations of driver idling.
- Commissioning academic research, including use of leading research institutions King's College London and Imperial College London (part of the Air Pollution Research Group in London).
- Public and business attitude and behavioural surveys.

Figure 2.1: Clean Air Fund Monitoring and Evaluation Framework

Workstreams	Outputs	Outcomes	Indicators
Bus Diesel Particulate Filters (DPFs)	DPFs fitted on bus routes running through three MAQS PM_{10} priority locations	Reduction in PM_{10} emissions	• DPF performance (% reduction in PM10 emissions) • Number of buses fitted • Estimated weight of PM_{10} trapped
No Engine Idling Camapign	Campaign material e.g. roadside posters, radio ads, website On street signs Driver & stakeholder engagement (incl. taxi marshalling)	Increased driver awareness Reduction in driver engine Idling & PM_{10} emissions Stakeholder support	• Driver campaign awareness • Driver attitudes • Claimed driver behaviour change • Observed engine idling by taxis, bus, coach • Taxi driver questionnaires • Smarter driver training results
Green Infrastructure (GI)	Trial of green walls Planted towers GI planting on TLRN at PM_{10} hot spots	Reduction in local PM_{10} concentrations (by trapping PM) Wider environmental & streetscape benefits	• Wider research on air quality benefits of GI • Estimated quantity of PM_{10} trapped by GI • Number of GI installation sites • Public attitudes to GI
Cleaning & Application of Dust Suppressants (CADS)	Extended trial application of dust suppressants Targeted intensive cleaning programme	Reduction in local PM_{10} concentrations Enhanced street cleanliness	• Wider research on air quality benefits of CADS • Local PM_{10} concentrations at selected LAQN monitoring sites on trial corridors
Business Focused Transport Measures & Engagement Activity	Business engagement activity three MAQS PM_{10} priority locations Transport measures – delivery servicing plans, electric charge points, electric cycles, walking maps	Improved air quality awareness among businesses Change in business transport activity & employee travel behaviour	• Metrics on engagement activity and uptake e.g. number of DSPs developed • Case studies and pilot outputs

3. Diesel Particulate Filters on Buses on Selected Routes

3.1 Introduction

This workstream has been focussed on the retrofitting of Diesel Particulate Filters (DPFs) to buses operating on routes running through the three MAQS priority locations in central London to directly reduce emissions of PM_{10} at source. The programme included working with suppliers to further develop bus DPF retrofit technology and the retrofit of DPFs to 120 buses (Euro IV and Euro V) on the selected routes.

Whilst London's bus fleet is already one of the cleanest in the UK, emissions from buses currently contribute up to 10% of all PM_{10} emissions from all vehicles in central London (Mayors Air Quality Strategy, 2010). TfL has taken considerable steps in the last 10 years to reduce the environmental impact of its bus fleet by introducing modern, cleaner vehicles to the fleet and fitting DPFs to Euro II and Euro III buses. As a result, emissions of PM_{10} from the fleet have dropped from over 200 tonnes in 1997 to 15 tonnes in 2011.

Diesel Particulate Filter Technology

The DPFs fitted as part of the CAF programme are designed to trap large quantities of the particulate matter emitted from the vehicle's exhaust. The technology uses a continuously regenerating trap that captures and then burns off the trapped particles within the system, releasing much cleaner emissions into the environment.

Figure 3.1: An illustration of a Diesel Particulate Filter

The DPFs developed and fitted using CAF funding are being fitted to newer Euro IV and V standard buses, which already have low emissions of PM_{10}. However, the further reductions in emissions achieved by retrofitting DPFs to buses are still very significant. Due to the prototype DPF development and testing timescales, discussions with operators about impact on vehicle warranties, the need to keep operational disruptions to a minimum and the increase in the number of vehicles to be fitted (from 96 to 120), the delivery programme has been extended until March 2013.

Developing and Targeting the Measure

To achieve the greatest possible PM_{10} emissions reductions within the three MAQS PM_{10} priority locations the focus was on retrofitting 120 vehicles on 5 bus routes operating through, or close to, those areas. In order to undertake the programme of DPF fitments, TfL sought the support of the relevant bus manufacturer and operators. This support was needed as retrofitting equipment to a vehicle can have negatively impact on engine performance, reliability and/or emissions. TfL engaged early on with the engine manufacturer and bus operators to inform them of intentions and to seek their support and input to the programme.

Two market-leading companies were asked to develop their existing DPFs products to enable them to be fitted to the relevant Euro IV and V bus engines. Once prototype products had been developed by the two companies, these were retrofitted to two buses to undergo emissions and tested at the Millbrook Proving Ground. Testing of the two DPFs proved to be successful, with impressive results achieved by both prototypes. These tests showed a reduction of 77% of PM_{10} emissions. Following the successful emissions testing programme, the prototype DPFs underwent durability testing on buses in service to confirm their suitability for full deployment before retrofitting all 120 buses on the selected routes.

3.2 Bus Measures Delivered

Diesel Particulate Filters (DPF) are being fitted on 120 vehicles on routes 10, 148, 205, 49, 7 with completion by March 2013. These routes were selected as they run along or through the three MAQS PM_{10} priority locations.

3.3 Costs

The estimated final total cost for implementing the Bus DPF workstream is £980,000 over the period May 2011 to March 2013 as shown in below.

Table 3.1: Bus Diesel Particulate Filter Workstream Costs

Activity	Costs (£000s)
Development and testing of prototype DPFs	20
Supply and fitment of DPFs	960
Total	**980**

* All Figures include actual and committed spend as at January 2013

3.4 Conclusions, Lessons Learnt and Next Steps

Some key benefits of this workstream are:

- Fitting 120 buses with DPFs will result in a 77% or 579kg reduction in annual PM_{10} emissions from buses operating on routes 7, 10, 49, 148, 205.This represents a 5% reduction in the annual PM_{10} emissions from all buses operating in central London (figures from the Mayor's Air Quality Strategy 2010).
- Fitting DPFs to buses operating on routes 10 and 205 will result in a 33% reduction in bus exhaust PM_{10} emissions on Euston Road (based on modelling).

Overall Effectiveness of Retrofitting DPFs

- The DPF retrofit measures being delivered as part of the CAF programme on Euro IV and V buses, clearly demonstrate that this type of measure is a very effective way of reducing PM_{10} emissions at their source. It also highlights that this type of measure can be targeted geographically to address local air pollution hot spots. It demonstrates that even on the newer Euro IV and V buses the retrofit of a DPF can achieve a large further reduction in emissions at source of 77%.
- It is important to carefully consider the more targeted benefits of a retrofit programme (to vehicles whose contract life may be limited) against the potentially wider emissions and noise reduction benefits of new Euro VI and diesel-electric hybrid vehicles.

Technical Issues and Costs

- The cost of fitting DPFs as part of the CAF programme was approximately £8,000 per bus. The CAF programme has shown that a retrofit programme can be tailored and targeted relatively easily, but is dependent on the availability of funding and the availability of buses.

Operators and Manufacturers

- It is important to engage with the relevant bus operators as early as possible regarding any proposed retrofitting of DPFs. This engagement takes time and the main issues that arose in discussions with operators bus operators focused on the impact on the engine warranty, ongoing maintenance costs and the potential impact on fuel efficiency. To address the issues raised over engine warranties a consequential damage warranty was provided by the DPF supplier. Extensive testing and monitoring of the prototype DPFs was undertaken to demonstrate to operators that there were no significant ongoing impacts on maintenance and fuel efficiency.
- Bus operators and transport authorities will be anxious to keep any operational disruption caused by the work necessary to retrofit DPFs to vehicles to an absolute minimum. As a result a reasonable programme of DPF fitment needs to be developed with operators and suppliers.
- The result is although DPF fitment has a significant impact in reducing PM_{10} emissions, any future retrofit programme needs to be carefully planned with bus operators and manufacturers to overcome warranty, technical fitment issues and to limit operational down time with buses taken out of service.

4. ‘No Engine Idling’ Programme (including Taxi Marshalling)

4.1 Introduction

The ‘No Engine Idling’ programme was designed and implemented to raise awareness and educate London drivers about the negative impacts of unnecessary engine idling and to encourage drivers to change their behaviours and switch off their engine where possible. Leaving a vehicle’s engine running unnecessarily adds to local concentrations of harmful pollutants (PM_{10}, NOx etc) as well as creating a noise and vibration nuisance.

In 2011 TfL conducted a survey of over 1,750 vehicles parked or loading at the side of the road in central London. This survey showed that 59% of drivers left their engines running rather than switching them off. Many of these drivers actually left their engines running for lengthy periods of time.

Figure 4.1: ‘No Engine Idling’ Campaign Poster

To be able to deliver an effective behavioural change campaign around engine idling customer research was carried out with London-based drivers and transport operators to explore perceptions of engine idling and views on options to change behaviour[2]. A key insight from this showed that drivers don’t spontaneously understand the ‘No Engine Idling’ message but once they do there is a willingness to adapt their behaviour.

A number of message themes were identified as being most likely to be effective at encouraging behaviour change:

- collective responsibility for London;
- impact on Londoners’ health;
- financial consequence;
- being a good driver; and
- busting myths.

Further activity undertaken to assist in formulating the campaign included:

- a review of academic research in this area;
- a review of existing approaches to reducing engine idling in London, elsewhere in the UK and overseas;
- a technical study of the impacts on emissions and fuel consumption caused by turning off a vehicle’s engine rather than allowing it to idle;
- discussions with transport industry representatives, groups and operators (Confederation of Passenger Association, Freight Transport Association, Road Haulage Association, TfL Coach Forum)

[2] Transport for London No Idling Proposition Development Research (September 2011)

Engine research was also undertaken to identify the impacts on emissions and fuel consumption caused by turning off a vehicle's engine rather than allowing it to idle. Analysis of the different pollutant emissions generated and fuel consumption concluded that switching off the engine rather than leaving it idling, if a vehicle is expected to be stationary for one minute or longer, will lead to an overall reduction of both emissions and fuel consumption.

There are locations where engine idling tends to regularly occur, including bus stands, coach parking bays, taxi ranks and stands and outside tourist attractions, hotels, shops and schools. These locations are dispersed across London and cater for a variety of different vehicle types and uses. As a result there was felt to be a benefit in delivering a London-wide campaign targeted towards all drivers.

4.2 'No Engine Idling' Measures Delivered

A programme of 'No Engine Idling' measures was developed based around raising awareness and educating drivers about its impacts rather than relying on enforcement. The programme consisted of:

(1) a London-wide education and awareness raising campaign for all drivers using a variety of communications and media channels;

(2) delivery of signage aimed at drivers within the three MAQS PM_{10} priority locations; and

(3) stakeholder engagement activity, including engagement targeted at professional drivers such as taxi marshalling and driver training.

Enforcement is a reactive approach and does not help to educate drivers about the reasons why engine idling is a problem or why they should make a change to their behaviour. In order to enact large-scale effective behavioural change, drivers need to be fully informed on the links between engine idling and pollution and the impacts it can have on health. To achieve this requires a range of measures rather than punishing drivers for an offence they may not realise they have committed.

(1) Education and Awareness Raising Campaign

The London-wide awareness raising campaign was designed to target over 3 million drivers of all vehicle types and delivered in two phases. The first phase ran throughout January 2012 and a subsequent phase ran in September 2012. The key themes that used throughout the campaign included:

- engine idling contributes to heart and respiratory illness;
- switching your engine off will reduce emissions and save fuel if you will be stationary for over a minute; and
- engines should be switched off when parked, waiting or loading at the roadside.

A number of media channels were used to ensure the campaign achieved high levels of visibility to drivers across London:

(a) Posters were produced and displayed in prominent locations (at over 1100 roadside bus shelters, on the rear of over 300 buses and at 290 large format roadside advertising hoardings) across London (see **Figure 4.1**).

(b) 30 second radio adverts were broadcast regularly (including during prime drive time periods) over a total of 8 weeks on several London-wide commercial radio stations, including Absolute, Magic 105.4, Kiss, Capital, Heart, XFM, Smooth, LBC 97.3, talkSPORT.

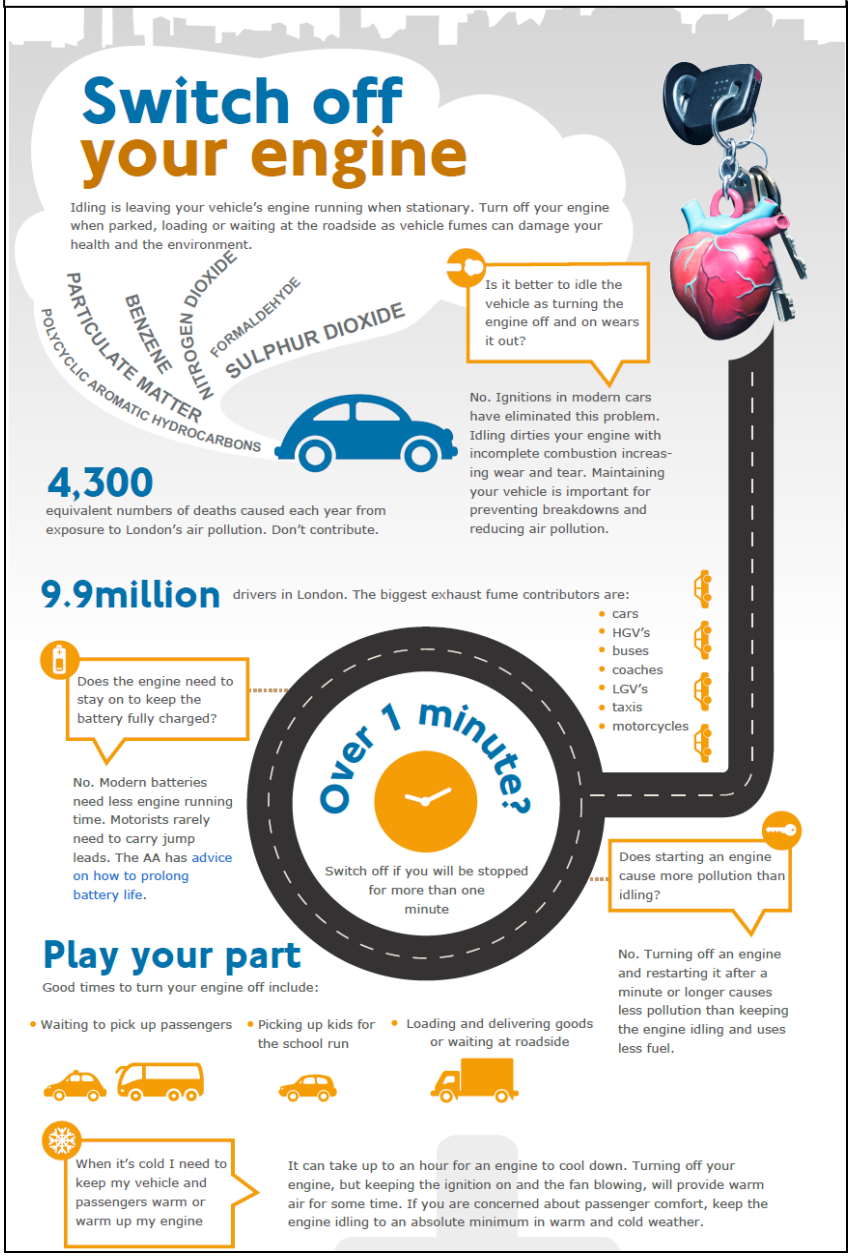
(c) Leaflets and posters were produced and distributed to drivers, operators and other campaign partners.

(d) A dedicated web page (see **Figure 4.2**) was created to provide a large amount of information on the campaign, including the key messaging and myth-busting information. Linking no-engine idling banners were presenting on the TfL homepage during the campaign periods.

(e) Direct communications were sent to approximately 1.5m email addresses of drivers in the London area held and TfL customer databases

Awareness of campaign was supported by a number of press releases and a joint media launch event held on Park Lane with Asthma UK and the Confederation of Public Transport. This resulted in good coverage in the London-wide and local media.

Figure 4.2: TfL 'No Engine Idling' Website Infographic



(2) Targeted Driver Information Signs

To deliver a permanent reminder to drivers in the three MAQS PM_{10} priority locations, on-street signs were installed to remind drivers to turn their engines off when parked, loading or waiting at the roadside. Signs were located at 50 parking, waiting and loading locations along the Transport for London Road Network (TLRN) including parking and loading bays for coaches, taxis, delivery vehicles and general traffic. To minimise street clutter the signs were all mounted an existing signage posts and signs were only located within the three MAQS PM_{10} priority locations. The standard highway sign design (see **Figure 4.3**) can now be used by London Boroughs (with DfT approval).

Figure 4.3: On Street Signs

(3) Stakeholder Engagement

The awareness raising campaign was supported by a programme of active engagement with the owners and operators of the vehicle groups (buses, coaches, taxis, HGVs and vans). TfL identified and spoke to a wide range of stakeholder organisations, including boroughs. The vast majority were supportive of the campaign and pledges to do their part to reduce engine idling. Asthma UK was chosen as a partner for the campaign as it is a well-recognised and has a clear interest in reducing harmful emissions.

- **Taxi and private hire vehicle drivers**

A substantial package of work within the wider 'No Engine Idling' campaign, was a programme of taxi marshalling, driver engagement and driver training. A team of five taxi marshals was recruited, consisting of staff from TfL's Taxi and Private Hire directorate. These TfL marshals were appointed to work from July 2011 to March 2012 and were deployed at busy taxi ranks at rail termini in central London. The activities completed by the marshals and the TfL taxi and private hire team included:

- Engagement with taxi drivers to encourage them to switch their engines off when they are stationary on the ranks, promoting other smarter driving behaviours to drivers and promoting the smarter driver training courses. This role

Figure 4.4: Taxi Marshalling Leaflet

included distributing leaflets containing key messages (**Figure 4.4**).

- Management of queues at the ranks to make the waiting and boarding process more efficient and reduce the time spent on-rank by taxis.
- Working in partnership with the Energy Savings Trust to create a smarter driving course for black cab and private hire vehicle (PHV) drivers and providing funding for drivers to attend the course. The smarter driver training discouraged unnecessary engine idling as well as other driver practices (reducing harsh braking, acceleration etc) that help reduce fuel consumption and emissions. Over 300 PHV drivers and 80 taxi drivers completed the course.
- Monitoring numbers of taxis idling on ranks and conducting surveys with drivers to understand driver behaviour.

The taxi marshals were deployed to most of the principal central London rail station termini (St Pancras, Euston, Waterloo, Marylebone, Charing Cross, London Bridge, Victoria, Cannon Street, Liverpool Street and Fenchurch Street) to conduct marshalling at their taxi ranks. Marshalling was conducted in shifts (in teams of two or three) to cover the busy morning and afternoon peaks and other times when marshalling was in greatest demand.

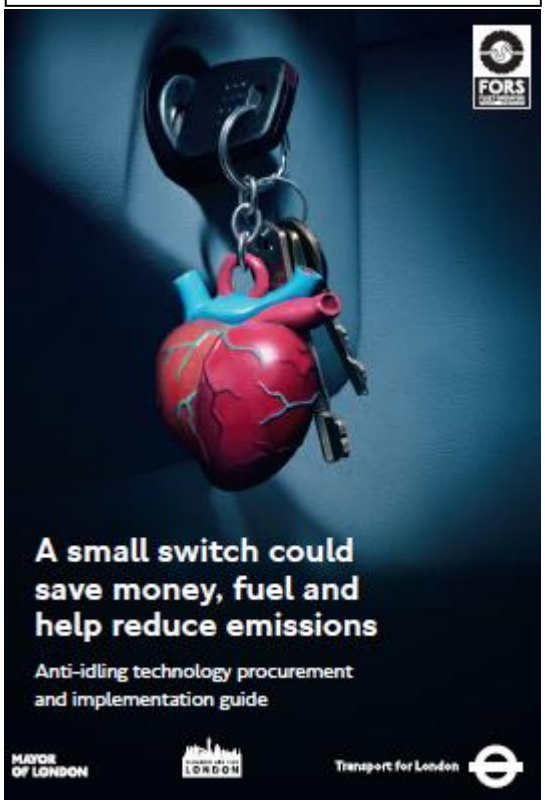
- **Freight and Fleet Operators**

Engagement work was undertaken with the freight and fleet industry (through the Road Haulage Association (RHA), Freight Transport Association (FTA), Confederation of Passenger Transport (CPT) and other channels). Each industry representative organisation pledged their support for TfL's work and distributed 'No Engine Idling' material or messages to their members:

- FTA distributed 'No Engine Idling' messaging in their e-news (to 12,800 contacts) and included an editorial on the issue in Freight Magazine in December 2011 (10,000 copies)
- RHA distributed 'No Engine Idling' messaging to 6,700 of their members covering small, medium and large companies (incl. 80 of the Motor Transport Top 100 transport companies)
- CPT Bus and Coach members (approx. 1,500) received notification through CPT media and the collective industry press distributed messages to non CPT members.

To supplement this wider engagement work TfL has also delivered a programme of engagement work focused 'No Engine Idling' measures through its own Freight Operator Recognition Scheme (FORS), a scheme set up to encourage freight operators to become safer, greener and more efficient. The work delivered through the TfL freight team included:

Figure 4.5: Freight & Fleet Operator Toolkit



- developing and delivering an accrediting a driver certificate of professional competence course (focussing on fuel use, engine idling and smarter driving techniques);
- delivering a 'launch event' and workshops for transport managers and operators to promote technology to reduce engine idling, and implement driver training and incentive schemes.
- creation of a procurement guide to assist commercial operators to take up in-cab anti-idling technology;
- developing a 'toolkit' of information and material to promote the 'No Engine Idling' campaign to fleet managers and drivers – see **Figure 4.5**.

- **Bus and Coach Operators**

TfL has been working with bus operators for some time to discourage unnecessary engine idling by bus drivers at both bus stands and in bus stations and garages. As part of the CAF programme a workshop was held with bus operators to introduce the 'No Engine Idling' campaign and to share best practice. A programme of monitoring of engine idling at central London bus stands was also undertaken to inform further targeted engagement with operators. To target coach drivers the 'No Engine Idling' message was updated in the new 2012 London Coach Parking Map and distributed to approximately 6,000 operators in April 2012.

- **Schools**

This work centred on the **Cleaner Air 4 Schools Project** run by London Sustainability Exchange (LSx) (see **Figure 4.6**). This focused on explaining the causes and effects of poor air quality and encouraging behaviour change amongst parents. It involved students, teachers, parents and governors from three schools (Christ Church Bentinck School, St Vincent's Catholic Primary School and St Edward's Roman Catholic Primary School), all located near the Marylebone Road. The work involved 17 champions who participated in citizen science and social marketing activities to increase awareness of air quality issues and influence behaviour change across the wider school community. The children were closely engaged in the work and were key in increasing awareness and advocating behaviour change amongst their parents. In total, 3,491 participants spend 1,447 hours taking part in Cleaner Air Activities. The final evaluation[3] of the work was reported by LSx, including feedback from parents following the project was very positive:

- 73% of parents had heard about the CA4S project;
- 64% of parents felt they had learnt about local air quality issues and actions they could take to reduce pollution;
- Although 60% of parents who responded did not travel by car, of the remainder 35% reported travelling less frequently by this mode, and a net 11% reported idling their engine less frequently; and
- The surveys did identify that there was a small reduction in engine idling of 10% in the one school where it was a perceived problem.

[3] London Sustainability Exchange: Cleaner Air for Schools – Final Evaluation Report (May 2012)

Feedback from teachers was also very encouraging: *"The children absolutely loved it and have been inspired to really take things further. We don't have to stop do we? They've come up with loads of new ideas for projects and things and want to keep going"* Teacher champion at St Edward's School.

Using the feedback from this pilot project the GLA are developing a toolkit of resources to help other primary schools across London deliver similar projects.

Figure 4.6: Cleaner Air for Schools Project Briefing

4.3 Costs

The costs of the programme is summarised in **Table 4.1** below.

Table 4.1: 'No Engine Idling' Workstream Costs

Activity	Costs (£000s)
Customer Research, Technical Research and Campaign Development Activity	60
Education & Awareness Raining Campaign - Phase 1 (Dec 11- Feb 12)	290
Education & Awareness Raining Campaign - Phase 2 (Sept - Oct 12)	350
Driver 'Switch Off Engine Signs	20
Taxi Marshalling and Smarter Driver Training for Taxi and PHV Drivers	260
Other Stakeholder Engagement Activity (including schools engagement, freight operator engagement and driver training)	130
Monitoring (including on-street surveys, bus stand surveys)	70
Total	**1,180**

** All Figures include actual and committed spend as at December 2012*

4.4 Monitoring and Evaluation

(a) Campaign Research

Customer research was conducted with London drivers to measure their awareness of the campaign, their attitudes towards problems caused by unnecessary engine idling and their claimed engine idling behaviour[4]. London drivers were interviewed before and after the campaign ran in January 2012. Drivers were interviewed again in October 2012 following the second phase of the campaign. In summary, the customer research showed:

- a good new campaign penetration amongst London drivers in comparison with other new public campaigns delivered by TfL including:

[4] Transport for London 'No Engine Idling' Pre and Post Campaign Customer Research (Mar 2012 & Nov 2012)

- a good level of general awareness (25%) amongst drivers of 'turn off your engine' advertising;
- good promoted recognition (40%) of the TfL 'No Engine Idling' campaign material;

- some positive indicators of a change in driver attitudes after the campaign regarding the importance of not leaving engines idling unnecessarily and the benefits of doing so; and
- a small decrease in the claimed incidence of engine idling amongst London drivers, falling from 46% to 39% following both campaign phases.

On-Street Monitoring

On-street monitoring of engine idling was conducted before and after the campaign. Surveys were conducted at Park Lane, Victoria Embankment, Marylebone Road/Euston Road and Cromwell Road/Brompton Road[5]. These results indicate a positive impact as a result of the initial marketing campaign and other work stream activities, although monthly variations in driver engine idling behaviour make it difficult to draw firm conclusions. It is worth noting that significant engagement activity with freight operators took place after March 2012 and may explain the significant reduction in observed engine idling amongst HGVs between March and October 2012.

Table 4.2: Observed On-Street Engine Idling by Vehicle Type

Vehicle Type	% Idling Pre-Campaign (Dec 11)	% Idling Post-Campaign (Mar 12)	% Idling Post-Campaign (Oct 12)	% change in Idling (Pre-Survey & Mar 12)	% change in Idling (Pre-Survey & Oct 12)
Coach	73%	63%	62%	-10%	-11%
HGV	49%	48%	33%	-1%	-16%
Bus	47%	26%	48%	-21%	+1%
Taxi/PHV	83%	70%	72%	-13%	-12%
LGV	35%	29%	29%	-6%	-6%
Car	60%	45%	47%	-15%	-13%
Motorcycle	47%	28%	53%	-19%	+6%
All Vehicles	**59%***	**54%****	**56%**	**-5%**	**-3%**

* Dec 11 – 1770 vehicles observed
* Mar 12 – 1813 vehicles observed
* Oct 12 – 1991 vehicles observed

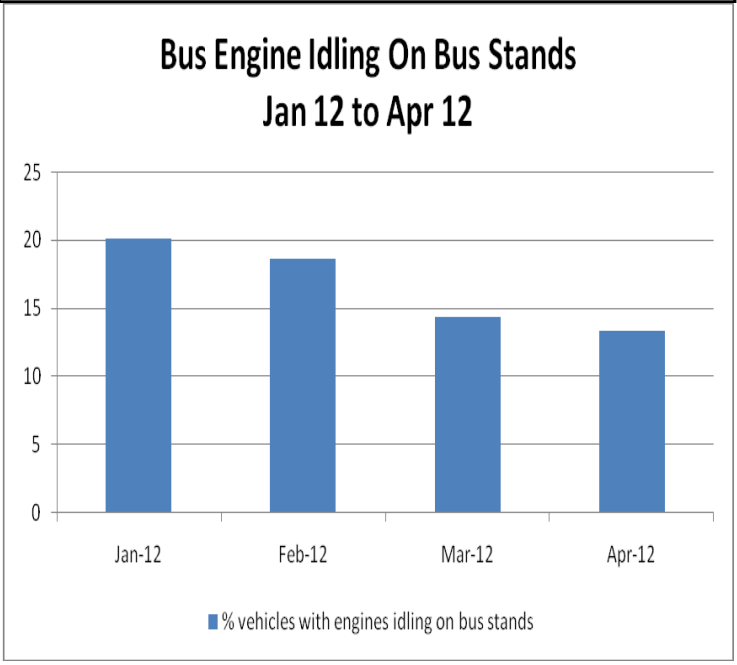
[5] Transport for London – Vehicle Idling Surveys (Apr 2012 & Nov 2012)

Monitoring of Engine Idling on Bus Stands

CAF funded monitoring of buses at bus stands in central London showed that on average 17% of drivers left their vehicles with the engine idling whilst stationary at bus stands during the period from January 2012 to April 2012.

As shown in **Figure 4.7** there was a 7% reduction in bus idling at monitored stands in Central London during that period. These results are consistent with results for buses from in the on-street surveys. Some care should be taken with these results as they may reflect some seasonal variation in engine idling.

Figure 4.7: Bus Engine Idling Monitoring



Monitoring of Engine Idling at Taxi Ranks at Rail Termini

Monitoring undertaken by the taxi marshals show that a high percentage of taxis drivers were observed to be unnecessarily idling their engine whilst waiting on ranks at central London rail termini.

Table 4.3: Observed Taxi Engine Idling at selected mainline Station Ranks

Location	CAF Marshalling Hours (Jul 2011 - Mar 2012)	Start of Marshalling Programme (Jul-Sept 2011)		End of Marshalling Programme (Jan-Feb 2012)	
		Taxis observed	% Engine Idling	Taxis observed	% Engine Idling
Euston	71	330	96%	1987	72%
Fenchurch Street	97	99	48%	110	49%
Liverpool Street	137	357	55%	310	87%
Marylebone	108	208	71%	140	83%
St Pancras	268	432	85%	1645	67%
Waterloo	229	469	90%	1229	83%
Kings Cross*	*Existing Marshals*	180	88%	116	89%
Paddington*		561	100%	830	92%
Total		**2,636**	**84%**	**7,483**	**75%**

*Whilst observations were undertaken by the marshalls at King's Cross and Paddington no on-rank CAF marshalling activity was completed due to construction work in the area and the presence of existing marshals. Note: No marshalling was undertaken at Victoria at the request of Network Rail.

Overall, observations completed by the taxi marshals at the end of their deployment show a 9% drop in taxi engine idling at marshalled ranks during the CAF programme. There were some notable reductions at certain ranks for example at Euston, St Pancras

and Waterloo station ranks. There was an increase observed at Liverpool Street although it is unclear why this was the case. Whilst overall this indicates clearly that taxi driver behaviour around engine idling is well established is does indicate that marshalling and the presence of marshals can have a positive impact in reducing taxi idling, particularly when targeted at certain ranks.

Taxi Marshalling Feedback

The main observations made by the five Taxi Marshals were that:

- a presence of Taxi Marshals made the drivers queuing in ranks much more likely to switch off their engines, particularly at quieter times of day;
- generally the presence of the marshals was welcomed by taxi drivers. Their broader role in improving the management of ranks was seen as positive by drivers and helped engagement on issues such as engine idling and air quality issues;
- marshalling was more effective at some ranks where the design of the rank helped the marshals manage the queues and encourage drivers to switch off their engines e.g. St Pancras. Whereas the arrangement for taxis and design of some ranks at some stations made effective marshalling more difficult e.g. Victoria; and
- the opportunity to spend time directly talking with drivers gave the opportunity to highlight the need to think differently about their driving behaviours and to consider the air quality impacts. However, some drivers have well established behaviours and attitudes.

The marshals also highlighted a range of wider management and customer service benefits arising from their deployment at ranks including:

- helping to speed up passenger boarding times;
- assisting passengers in wheelchairs, passengers with other mobility impairments, elderly passengers and passengers with pushchairs and luggage;
- assisting passengers from abroad and helped drivers overcome language barriers;
- locating credit card taxis for passengers without cash;
- answering drivers technical questions on new technology e.g. Euro V engine standard, particulate filters etc; and
- providing a presence that discouraged illegal ranking by taxis.

Taxi Driver Questionnaires

To help inform the 'No Engine Idling' campaign development, and also as part of the marshals engagement work with drivers, a survey of taxi drivers was also conducted by the marshals themselves. It was undertaken before the campaign to understand whether they are likely to switch off their engines when waiting on-rank, reasons for engine idling and driver awareness of the associated issues arising from unnecessary engine idling. The survey was not conducted following the marshalling activity as the monitoring at this time focused the observed engine idling by taxi drivers reported above.

Analysis of the questionnaire results show that many drivers (82%) claim to switch their engines off when stationary on the rank, with 65% saying they normally do so when

stationary for more than a few minutes. Reasons identified by drivers for not switching engines off were 'the need to keep moving forward in the rank' (64%), 'to keep the air conditioning or heating on' (9%) or because 'it will damage the engine' (12%).

Smarter Driving Training for Taxi and Private Hire Vehicle Drivers

Uptake of the smarter driver training was good amongst private hire drivers but it was challenging to get licensed taxi drivers to take the course. Taxi drivers were concerned about the potential loss of income they could incur whilst taking the training course. **Figure 4.8** shows the taxi used for the CAF smarter driver training.

Figure 4.8: Taxi used for CAF Smarter Driver Training

Drivers participating in the CAF smarter driving training received data showing the fuel consumption, cost and emissions (CO_2) savings achieved following the smarter driving instruction, as summarised below. **Table 4.4** shows the average reductions in fuel consumption achieved by both taxi and private hire vehicle drivers during the smarter driver training. The estimated average annual fuel cost saving is also shown. This shows some very positive estimated fuel and CO_2 emission savings for both sets of drivers.

Whilst it is not possible to directly estimate the reduction in other pollutant emissions, such as PM_{10}, based on a reduction in fuel use, it is considered a reasonable assumption to infer a reduction in emissions of other pollutants, including PM_{10}.

Table 4.4: Smarter Driver Training (Jan – Jun 2012)

	Number completing course	Average MPG (before)	Average MPG (after)	Average % savings	Average Annual Fuel Cost Saving*	Average Annual CO_2 Emission Saving*
Taxi drivers	82	19.9	26.5	24.8	£1,709	3,169kg
PHV drivers	339	39.5	45.1	12.2	£799	1,567kg

**based on estimated annual mileage*

Frieght Anti-Idling Toolkit

Research was also completed to help understand the effectiveness of the anti-idling toolkit developed specifically for Freight and Fleet operators. The research comprised of online surveys that were completed by 179 companies registered with FORS. It found that:

- 44% of respondents had seen the anti-idling pack/tool kit.
- The pack was well used by those who had seen it (each toolkit component had been looked at by at least 83% of those who had seen the pack).
- Both the pack and website were rated highly in terms of usefulness by those who had read them (just over 70% rating each as 7 or higher out of 10 for usefulness).

- 78% of those who had seen the anti-idling campaign had taken some action as a direct result. The most likely actions related to spreading guidance and advice on how to reduce idling for example by giving a driver briefing or putting up posters.

4.5 Conclusions, Lessons Learnt and Next Steps

Unnecessary engine idling clearly represents a driver behaviour that is common in London. Whilst the emissions generated are generally only likely to represent a very small percentage of local emissions of PM_{10}, at a London wide level it does generate a large volume of unnecessary and harmful emissions. The CAF programme has allowed TfL and its partner organisations to deliver a wide range of measures targeted at reducing unnecessary engine idling in London quickly. The campaign has also had wider benefits in raising public awareness and understanding of the links between air quality and public health in London.

Monitoring around this package of 'No Engine Idling' measures has shown some positive indicators of the effectiveness of a package of measures in both establishing awareness of the issue amongst drivers and in changing driver behaviour to reduce unnecessary engine idling:

- the campaign achieved a good level of driver awareness (25%) and recognition (40%).
- observed engine idling on-street in the three MAQS PM_{10} priority locations was reduced by around 5% overall and was significantly lower amongst certain vehicles types after each phase of the campaign. In November 2012 there was 11% less engine idling observed in coaches, a 16% reduction for HGVs, a 12% reduction for taxis and a 13% reduction for cars (compared to surveys in December 11 before the campaign).
- Overall there was an average 9% observed reduction in engine idling at marshalled taxi ranks.

The CAF programme and 'No Engine Idling' campaign have helped raise the profile of this issue and increased awareness amongst drivers. Whilst all components of the CAF work on 'No Engine Idling' appear to have had some positive role, sustaining behaviour change is likely to be achieved most cost effectively through targeted stakeholder engagement and marketing work with professional driver groups, transport operators and their transport industry representatives. In the future at TfL, this will be achieved through continuing to embed the message into existing driver communication channels and engagement work with taxi, private hire, coach, bus and fleet vehicle drivers.

The work around taxi marshalling proved an effective way of engaging directly with taxi drivers and had some measurable success in reducing idling at certain taxi ranks. More broadly it helped to raise awareness of air quality issues and had a wide range of customer service benefits. Marshalling also helped identify the taxi rank design arrangements that can help discourage idling by drivers, which will be used to inform future work on rank design.

The smarter driver training for taxi and private hire drivers showed it is possible for drivers to achieve a significant reduction in fuel consumption (24.8% and 12.2% respectively) by changing their driving behaviour. This clearly suggests that further driver training targeted at professional driver groups would be a very effective way of reducing emissions generally and in central London.

TfL will continue to deliver the ‘No Engine Idling’ message and embed it into existing driver communication channels and engagement work with all drivers and transport operators. TfL and the GLA will also work with other partners, including boroughs and transport industry representatives, to also continue to promote the ‘No Engine Idling’ message in London. Further opportunities for further targeted smarter driver training will also be promoted.

5. Green Infrastructure

5.1 Background

There is a growing body of research showing that Green Infrastructure (GI) has the ability to trap particulate matter deposited on the surface of the GI which can help improve urban air quality. For example a recent study[6] shows that increasing deposition by the planting of vegetation in street canyons can reduce street-level concentrations in those canyons by as much as 40% for NO_2 and 60% for PM.

CAF programme funding of £1million was allocated for the implementation of the GI measures outlined below and for research into their benefits. This programme also complements the Mayor's wider urban greening programme.

- **Tree and shrub planting**: As part of the CAF programme GI measures were implemented at roadside locations as close as possible to PM_{10} hot spots in London, including along road corridors on either side of the PM_{10} hot spots. The selection of species on the Transport for London Road Network (TLRN) was based on the TfL Arboriculture & Landscape Managers' knowledge of the locations, the known ability of a particular species to grow in the highway environment and amenity considerations.
- **Green screens**: Options for locating green screens between the source (vehicles) and receptors (pedestrians) on the TLRN were limited. It was decided that green screens should not be placed along the kerb-line to create new barriers to pedestrian movement. As an alternative TfL procured and placed 50 planted towers on the wider footway along Lower Thames Street, taking care to avoid the obstruction of sightlines and pedestrian clear zones.
- **Green walls**: The 200m^2 south-east facing walls of Edgware Road (Bakerloo) LU station building were selected for the trial of a green wall (see **Figure 5.1**). This is adjacent to the Marylebone Rd, one of the three MAQS PM_{10} priority locations. The green wall was completed in November 2011 and will be maintained for three years. A variety of herbaceous and shrubby plant species were chosen for their leaf and habit (growth) characteristics in addition to the ability of the plants to grow in a green wall (vertical) arrangement at that location/aspect. It was designed to provide continuous living cover in all

Figure 5.1: Green Wall on Edgware Road London Underground Station next to Marylebone Rd

[6] Thomas A. M. Pugh, A. Robert MacKenzie, J. Duncan Whyatt, and C. Nicholas Hewitt, Lancaster Environment Centre, Lancaster University, 'Effectiveness of Green Infrastructure for Improvement of Air Quality in Urban Street Canyons' (June 2012)

seasons. A second 120m^2 green wall was also delivered on the facade of The Mermaid building adjacent to Upper Thames Street (one of the three MAQS PM_{10} priority locations) in July 2012.

5.2 Green Infrastructure Measures Delivered

The CAF GI measures delivered is summarised in **Table 5.1**.

Table 5.1: CAF GI Measures

Location	Deliverables on TLRN
Westminster - Park Lane (south)	• 105 trees (Birch and London Plane) • New shrub bed (54m^2) and existing shrub beds replanted
Westminster – Marylebone Road	• 200 m^2 green wall installed on wall of Edgware Road LU station.
Lambeth - Bondway Interchange	• 2 London Plane trees. • Shrub bed replanted (18m^2)
Greenwich - Woolwich Flyover (A102 rear of Tunnel Avenue)	• 58 trees (Western Red Cedar & Silver Birch) • 366 smaller trees and shrubs (variety)
Hounslow – Brentford (A4)	• 22 trees (Blue Cedar, Sweet Gum, Oriental Plane, Quercus ilex)
City of London – Upper & Lower Thames Street	• 6 trees (London Plane) • Shrub beds replanted (20m^2) • 50 planted towers placed on Lower Thames St. • The Mermaid green wall adjacent to Upper Thames Street
Southwark - A2 Old Kent Road	• 14 trees (London Plane) • All shrub planters in central reserve replanted (617m^2).
Lambeth – A23 Brixton Road	• 18 trees (London Plane)
Ealing – A40, A406 Hanger Lane Gyratory	• 75 trees (Sycamore and Ginkgo)
Hounslow – A4 Heston Road	• 40 trees (Field Maple)
Tower Hamlets – Blackwall (N of Tunnel)	• 64 trees (Birch, Scots Pine, Sweet Gum, Norway Maples. • 19 smaller trees (Mountain Pine)
Ealing – A40 Western Avenue	• 200 Large-leaved Lime trees
Camden - Swiss Cottage	• Shrub planter replanted (20m^2).
Hackney - Old Street	• Shrub bed replanted (20m2)
SUMMARY	• **604 Trees** • **2 Green Walls** • **385 Smaller Trees and Shrubs** • **Shrub beds – new and replanted (c750m^2)**

5.3 Costs

The costs of the GI workstream is summarised in **Table 5.2** below.

Table 5.2: Green Infrastructure Workstream Costs

Activity	Costs (£000s)
Additional tree and shrub planting at PM_{10} hot spots on the TLRN	790
Green Wall at Edgware Road	150
Funding for supporting 3rd Party GI (The Mermaid Green Wall, City of London Tree Planting)	100
Academic and customer research on GI benefits	70
Total	**1110**

** All Figures include actual and committed spend as at December 2012*

5.4 Monitoring and Evaluation

As part of the CAF programme, Imperial College London undertook research[7] to determine the ability of GI measures to trap particulate matter. This took place during the summer of 2011. The first part of the study involved a literature review which revealed that most studies of particulate deposition to leaf surfaces were focused on trees. Beech, birch, lime, oak and horse chestnut were all found to have relatively high particulate capture potential. Evergreen coniferous species appeared to be the most effective. The efficiency was attributed to specialised leaf qualities.

The research project also investigated leaf capture potential of a number of shrubs using the Marylebone Road as the test site. Field samples were collected from a range of shrub species. A leaf washing methodology was used to determine the weight of PM_{10} on each different species. The research highlights that plant species which contained hairs, sticky surfaces, deeply impressed veins and small leaves all showed enhanced particulate capture supporting findings on trees. The research concluded that certain leaf characteristics can greatly determine the effectiveness of different species to capture particulates.

Overall this work concluded that urban greening strategies designed to reduce the concentration of particulate matter from the atmosphere can be used as a supplementary approach to measures and policies designed to reduce emissions at source.

TfL commissioned Imperial College London to continue this research, taking samples from some of the GI measures implemented under the Clean Air Fund programme[8]. This work took place between December 2011 and May 2012. The research further investigated the ability of GI to capture and mitigate particulate matter in central London, using the same leaf washing and filtration methodology to look at two fractions of particulate matter; PM_{10} on a range of different GI including green towers green walls and roadside shrub beds. By measuring the surface density of particulate matter captured on leaves (the mass of particulate matter captured divided by surface area of

[7] Hannah Smith, Centre for Environmental Policy, Imperial College London, 'The use of vegetation to mitigate particulate pollution in urban environments: a technique for London to meet one of its air pollution targets?' (September 2011)

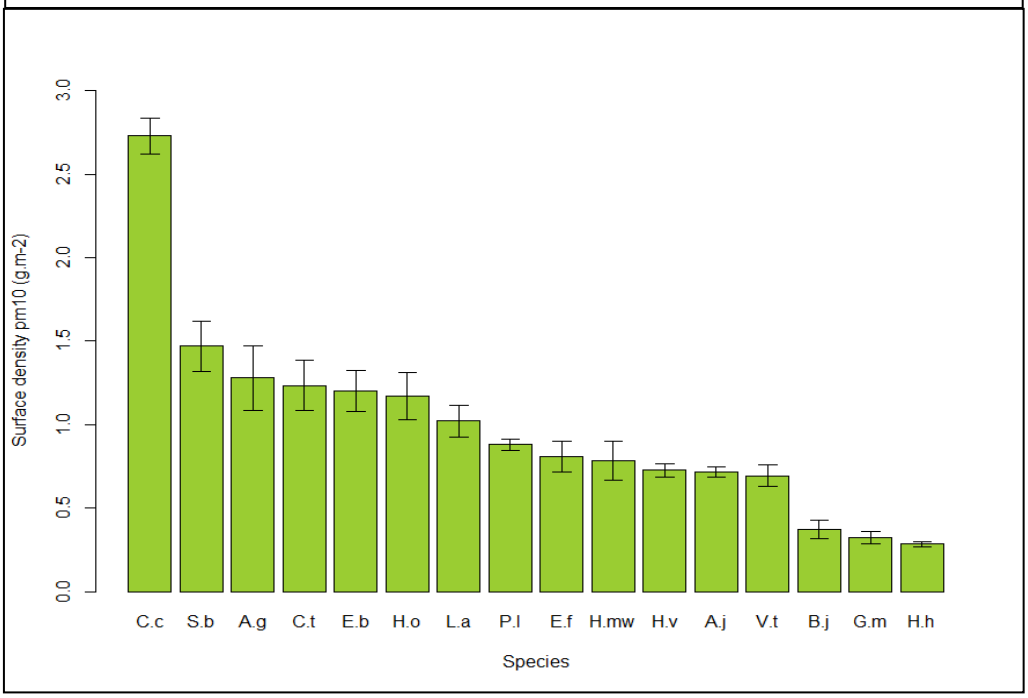
[8] Kyle Shackleton*, Hannah Smith, Linda Davies, Nigel Bell, Centre for Environmental Policy, Imperial College London, 'The role of shrubs and perennials in the capture and mitigation of particulate air pollution (PM_{10}) in London' (May 2012)

the leaves), both the efficacy and efficiency of different plant species at particulate matter capture can be estimated.

The primary question was to ascertain which plants and leaf surface characteristics (e.g. hairiness) are the most efficient at particulate capture. Over the winter of 2011-2012, leaves were sampled from 17 plant species, predominantly evergreen shrubs, from four PM_{10} hot spots: Lower Thames Street (planted towers); Park Lane (shrub beds); Swiss Cottage (shrub bed); and Marylebone Road (green wall). Some of these results from this research are shown in **Figure 5.2** below. The plant species sampled were:

- Acorusgramenius (Dwarf Sedge)
- Carextestacea (Orange New Zealand Sedge)
- Erysimumbicolor
- Euonymus fortune (Emerald 'n' Gold)
- Geranium maculatum (Wild Geranium)
- Heucheravillosa (Hairy alumroot)
- Lavendula angustifolia (Common lavender)
- Stachys byzantia (Lamb's Ear)
- Acuba japonica (Spotted laurel)
- Convolvulus cneorum (Silverbush)
- Prunuslaurocerasus
- Hedera helix (English Ivy)
- Berberisjuliance (Wintergreen barberry)
- Hebe ('Mrs Winder')
- Viburnum tinus

Figure 5.2: Mean surface density of PM_{10} capture across each plant species (± 1 standard error) (Imperial College London 2012)



The results from this research supports the growing body of research showing that Green Infrastructure (GI) has the ability to trap particulate matter deposited on the surface of the GI which can help improve urban air quality. It has helped demonstrate that GI can be used as a supplementary measure to emissions reduction, particularly when viewed in the context of its wider environmental benefits. These wider environmental benefits include improvements to regulating ecosystem services such as climate with respect to lowering temperatures through transpiration and shading, mitigating hazards such as avoidance of flooding due to increased surface areas for water drainage and increased uptake of rain water by vegetated surface and, of course, improvements in air quality through adsorption of particulate matter and some uptake of other air pollutants. Further benefits accrue from increased biodiversity both directly from additional vegetation but also from the provision of food sources for wildlife. Cultural benefits are of prime importance with aesthetics being one of the main benefits mentioned by people living and working in the vicinity of green walls.

Customer research was also undertaken to seek the views of people passing by or working close to the green wall at Edgware Road LU station and the planted towers on Lower Thames Street. Clean air was seen as an important issue for Londoners and businesses, and most supported the installation of further planted towers and green living walls in their areas[9].

5.5 Conclusions, Lessons Learnt and Next Steps

The CAF has allowed TfL and its partner organisations to deliver a range of GI measures at or close to many of the PM_{10} hot spots in London and over a relatively short time period. The CAF funded research supports previous research and suggests that GI can be used as a supplementary measure to measures and policies that tackle PM_{10} emissions at source, but should be viewed in the context of its wider benefits. Mature trees are the most effective GI measure to trap PM_{10}. Extensive tree planting is clearly not always possible in dense urban areas. Therefore, green walls and planted towers (see **Figure 5.3**) can offer value as a more immediate GI measure where tree planting is not a practical option.

Figure 5.3: Planted Towers on Thames Street, City

The trial green wall at Edgware Road LU station demonstrated that this type of GI can trap PM_{10}, deliver wider environmental benefits and provide a high profile deliverable. This helped to generate stakeholder interest in the programme and to highlight the air quality and wider benefits of GI.

Delivery of GI measures is generally supported by the public and local stakeholders, however, their function in trapping PM_{10} and wider

[9] Transport for London Green Infrastructure Customer Research Report (December 2011)

environmental benefits is not immediately understood by the public. Future delivery of GI measures will give further opportunities to communicate these benefits. The research completed as part of the programme demonstrates that there is clear public support for further delivery of GI (including Green Walls) by the GLA group, Business Improvement Districts, TfL and other delivery bodies in London.

The results of the research and the lessons learned from the trials of green walls and green screens will be shared with interested parties to further the understanding of the benefits of GI.

6. Targeted Cleaning and the Application of Dust Suppressants

6.1 Introduction

A trial of the use of the application of Calcium Magnesium Acetate (CMA), to act as 'dust suppressants', was one of the local measures identified within the Mayor's Air Quality Strategy that could help address PM_{10} pollution at hot spots in London. The trial of this local measure was developed following experience from other European towns and cities that provided evidence that its use resulted in reductions in daily PM_{10} concentrations at the roadside. This experience suggested that the targeted application of dust suppressants along road corridors could form part of a package of measures to reduce daily PM_{10} concentrations. The use of the terminology 'dust suppressants' was borrowed from European counterparts.

The use of dust suppressants by TfL was the first time in the UK that this measure had been trialled. CMA is sprayed onto the road surface and works by binding existing particulate matter it comes into contact with to the road surface. For a period of time this prevents the particulate matter from becoming re-suspended into the air.

6.2 Pilot Study of CADS (Phase 1)

In 2010 TfL implemented an initial pilot study of targeted cleaning and application of dust suppressants (CADS) along the lengths of the Marylebone Road / Euston Road and Victoria Embankment / Upper Thames Street corridors. The interim results from monitoring completed as part of the the pilot study[10] provided a positive initial indicators that repeated applications of dust suppressants could be effective, showing a reduction in PM_{10} concentrations of 10 to 14 per cent over 24-hour periods at Victoria Embankment / Upper Thames Street.

6.3 Expanded Trial of CADS (Phase 2)

The recommendations and findings from the pilot study were used to inform the design of an expanded trial and study of cleaning and dust suppressants in 2011/12. This was funded as part of the CAF programme and focused on trialling the use of CMA in a range of different locations across London, particularly:

(1) along a range of TLRN road corridors with different street characteristics and physical layouts (street canyons, open locations, single lane, two lane) but with high levels of local PM_{10} pollution (monitored and modelled). This was to allow an evaluation across a range conditions. The corridors applied with CMA totalled a length of 20 miles; and

(2) along roads close to and within construction and industrial waste sites with high levels of local PM_{10} pollution.

TLRN Corridor Application of CMA

The phase 2 trial application targeted six road corridors. Application took place along 20 miles of road corridor across London as summarised in **Figure 6.1** and listed below:

- A501, Marylebone Road and Euston Road;
- A3211, Victoria Embankment, Upper Thames Street and Tower Hill;
- A402, Marble Arch to Hyde Park Corner (Park Lane);
- A3220, Earls Court Road and A4, Cromwell Road;
- A2, Old Kent Road, New Cross Road and Blackheath Road; and
- A102 and A12, Blackwall tunnel approaches.

[10] Transport for London, Targeted Application of Calcium Magnesium Acetate (CMA) Pilot Study Monitoring Report (August 2011) (URS)

The six road corridors selected included the three PM_{10} priority locations identified in MAQS and also three other corridors shown to have high levels of PM_{10} pollution by air quality monitoring (London Air Quality Monitoring Network). These sites were selected to ensure the expanded CAF trial covered a number of urban road corridors with a range of geographical and traffic characteristics, including street canyon situations.

Figure 6.2: 6 Road corridors (covering 20 miles) that received regular applications of CMA as part of the CAF trial

CMA is a biodegradable substance which was applied using modified winter service salting trucks (see **Figure 6.2**). Key features of CMA and its trial application were:

- CMA is a clear liquid and was applied at 10g/m^2 on the carriageway;
- Regular applications of CMA on these road corridors occurred nightly from Sunday night to Thursday night to target the weekday morning traffic peaks;
- CMA was not spread when it rained or when salt was applied to the road; and
- CMA appears as a light mist, and at the concentration applied for the project, has no impact on skid resistance. In both 2010 and 2011 SCRIM (Sideway-force Coefficient Routine Investigation Machines) tests were undertaken to conclusively confirm that CMA has no impact on the surface friction of the carriageway surface at the trial application rates.

Figure 6.2: Winter Servicing Vehicle fitted to Apply Dust Suppressants

Targeted cleaning to reduce PM_{10}

The Clean Air Fund programme also allowed for the delivery of an enhanced and complimentary programme of targeted deep cleaning to help reduce PM_{10} resuspension. A number of deep cleaning methods were trialled. Based on on-site inspections the most effective deep cleaning measure was high-pressure hot water washing combined with a street sweeper, which cleaned surfaces and removed the accumulated dirt.

The targeted cleaning package as part of the phase 2 trial consisted of:

- Deep cleaning along Upper Thames Street, Blackfriars Bridge and London Bridge using power spray washers, hand scrubbing, tunnel cleaning machines and sweeping;
- Deep cleaning on roads around industrial waste sites which had significant accumulation of detritus which required removal to reduce its potential for re-suspension; and
- Deep cleans along the A12 and A102 Blackwall tunnel approaches and the A2 corridor.

Industrial Waste Sites

The London Air Quality network has a number of sites across London categorised as 'industrial', reflecting the proportion of PM_{10} resulting from local industrial sources. They rank as some of the most polluted sites in London. The most common uses of these sites are for industrial and construction waste transfer (aggregating waste from mixed skip loads to large sorted container size loads). Both the site activity and the movement of vehicles to and from the site can generate local PM_{10} pollution. Activity at these sites is regulated by either the Environment Agency (EA) or the local borough (depending on the type of permit regulating the activity).

In September 2011 the GLA, EA, relevant local authority officers and TfL agreed as part of the CAF programme to trial the delivery of a package short and long term measures at these sites with the aim of reducing PM_{10}, including the use of dust suppressants. It comprised:

Figure 6.3: Neasden Lane Industrial Site: Internal haul road with privately run sweeper, which also applied CMA

- TfL supplying CMA to the operators for self application of CMA on roads within sites (see **Figure 6.3**);
- application of CMA by TfL on road carriageways around and leading to the site;
- the delivery of local cleaning by the local on the roads around and leading to the site; and
- the EA increasing enforcement levels.

These trials, started in January 2012 and continued through the summer of 2012, at Lewisham (Mercury Way); Ealing (Horn Lane); Brent (Neasden Lane), Bexley (Manor Road) and Sutton (Beddington Lane).

Construction Sites

With high volumes of dust and vehicle emissions construction sites can also be major sources of local PM_{10} pollution (see **Figure 6.4**). As part of CAF the aim has been to work with large construction projects, e.g. Crossrail, to undertake a number of trials that examine the use of CMA dust suppressants on sites rather than simply using water. These trials have been designed to deliver air quality improvement and to develop processes to inform the revision of the Construction Site Best Practice Guidance.

Two suitable trial sites identified were: (1) Pudding Mill Lane Site: This is a large Crossrail construction site next to the 2012 Olympic Park. It has a large internal haul road (500m) for transferring of materials thought the site. (2) Limmo Site: This Crossrail site will cater for the construction of two shafts. It a large site of 2 hectares and the majority of the site is open aggregate. As part of the programme TfL also worked with Crossrail to install green screens on a number construction site hoarding to help trap particulate matter and offer other local environmental benefits.

Figure 6.4: Crossrail Site at Pudding Mill Lane

6.3 Costs

The costs of the CADS workstream is summarised in **Table 6.1** below.

Table 6.1: CADS worksteam costs

Activity	**Costs (£000s)**
CMA road corridor application (including development, plant and management)	460
Industrial waste sites and construction sites (CAF measures) (CMA application, targeted cleaning and green screens)	460
Targeted PM_{10} cleaning	330
Monitoring and research	180
Total	**1,430**

** All Figures include actual and committed spend as at December 2012*

6.4 Monitoring and Evaluation

TfL engaged URS Infrastructure and Environment Ltd (URS) and King's College London (Kings) (one of the UK's leading research universities) to provide robust monitoring data and to study whether the trial application of dust suppressants was effective at reducing local PM_{10} concentrations on road corridors and at the industrial waste sites.

Due to its scale and complexity, this study required large datasets incorporating a range of air pollutants, meteorological, traffic and road surface metrics. In all, over 2 million unique measurements were analysed. The primary source of pollution measurements was the London Air Quality Network (LAQN – www.londonair.org.uk). These monitoring sites are independently operated to defined standards and the data is ratified to defined quality standards for DEFRA. As reference equivalent monitoring equipment was used, the results will be directly applicable to EU limit value exceedence calculations.

A suite of analysis techniques were used by King's College to study the impact of the expanded trials of CMA applications, drawing on data from existing LAQN monitoring sites located along the six road corridors. Data was used from five study sites located along five of the road corridors treated with CMA during the trial. The sites were at A501 Marylebone Road; A3211 Upper Thames Street; A2 Blackheath and A2 New Cross and A12 Blackwall Tunnel Approach. Data was also used from four study sites located at four of the industrial waste sites treated with CMA. The sites were at Lewisham (Mercury Way); Ealing (Horn Lane); Brent (Neasden Lane) and Bexley (Manor Road).

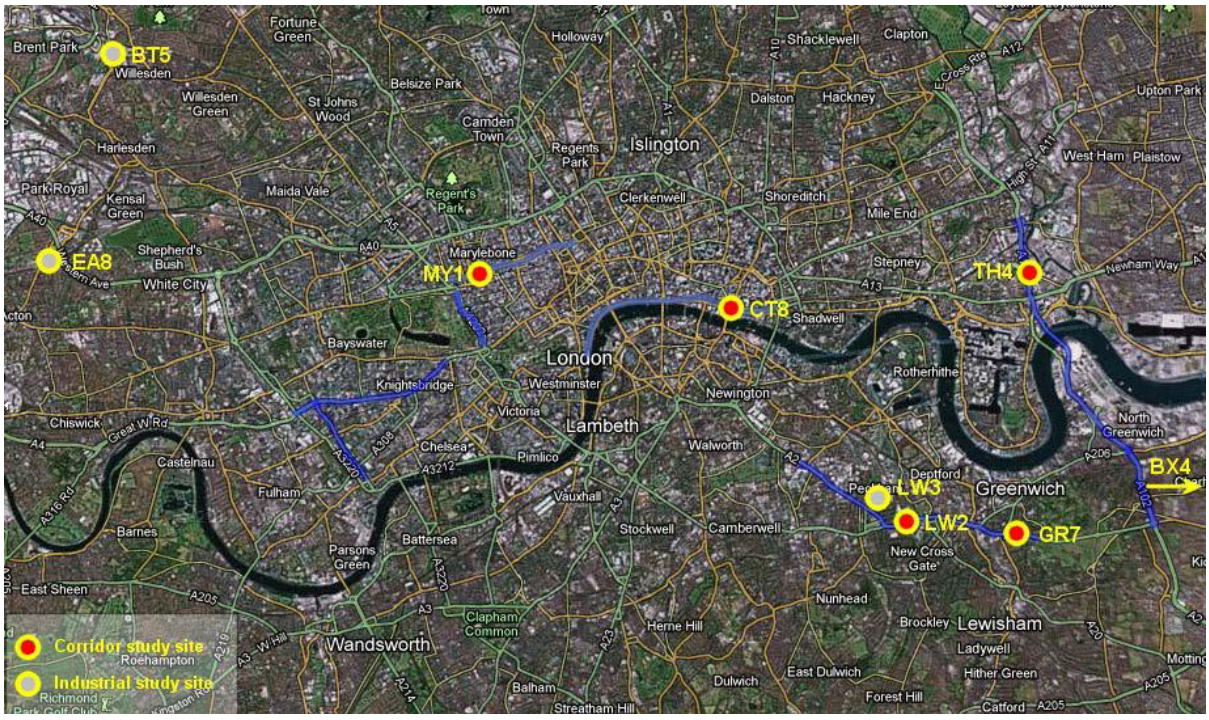


Figure 6.5: Location of the study sites in relation to the CMA application road corridors (blue lines)

Research Findings

Below is a summary of the findings of the research completed by King's College London. The latest research now represents a more comprehensive study that shows some variability in results[11]. This is not unexpected as establishing cause and effect of local air quality issues and the impact of interventions, such as the CMA application, can be extremely challenging due to the wide range of influences on PM_{10} pollutant concentrations.

The range of influences that can lead to variable results include: differing street environments, local wind patterns, other meteorological conditions (e.g. temperature), traffic characteristics (speeds, flows, proportion of heavy goods vehicles), local sources of PM_{10} (e.g. different land uses, adjoining untreated roads, construction sites), CMA application rates, numbers of traffic lanes treated and the location of monitors The challenge for the evaluation of this trial was to disaggregate the impacts of this wide range of complex variables and show a reduction in PM_{10} arising from the application of CMA over a relatively short period.

- **TLRN road corridor application of CMA**

(i) Of the road corridor sites, the strongest evidence of a positive effect was found at the A3211 Upper Thames Street study site (part of the Upper Thames Street/Victoria Embankment corridor used in the pilot study in 2010/11). This effect was only seen at higher application rates i.e., two or three applications per day. The estimated impact on local PM_{10} concentrations was a decrease of approximately 38% ± 11%. This equates to an average reduction in total PM_{10} of approximately 16%, based on mean concentrations during the study period. It was observed that these results are uncertain, due to location of the monitoring site under a bridge and Kings concluded that the result is not applicable to the whole of the A3211 Victoria Embankment, Upper Thames Street and Tower Hill corridor.

(ii) At the A2 Blackheath site local PM_{10} concentrations were 44% ± 7% lower than expected in comparison with pre-trial concentrations, equating to a decrease in total PM_{10} mass of approximately 12%. This decrease was timed closely with the commencement of the trial and was sustained through to the end of the analysis period. There was no significant difference in the magnitude of reduction between CMA and non CMA days, despite application being suspended for a period of 24 days mid-way through the trial. Photographic evidence indicated that the construction of a local block of flats was underway before and during the trial. It is likely that the completion of the construction phase of these building works was responsible for a proportion of the reduction in local PM_{10} concentrations, but the analysis was not able to separate the effect of CMA application from changes in construction activity.

(iii) The A501 Marylebone Road study site did not demonstrate any clear effect of CMA application, even during high application rate periods. However, understanding why there is no clear monitored impact is not straightforward. The results at the A501 Marylebone Road site may be due to a small effect of CMA being swamped by resuspended PM_{10} being blown along the street canyon from other locations or from surfaces other than the treated road e.g. buildings and footways.

[11] Ben Barratt, David Carlshaw, Gary Fuller, David Green and Anja Tremper, King's College London, Environmental Research Group 'Evaluation of the impact of dust suppressant application on ambient PM10 concentrations in London' (Non Technical Summary) (Nov 2012)

(iv) No significant effect of CMA application was found at A2 New Cross and A12 Blackwall. This is potentially due to low local PM_{10} roadside source levels being detected at the monitor as the A2 New Cross monitor is not positioned to capture the highest PM_{10} road contributions during prevailing wind conditions. The lack of identifiable effect at A12 Blackwall may be related to the fact that only one lane in each direction was treated with CMA. It is also an open location which makes it likely that resuspended particulate matter from sources other than the two traffic lanes were dominant.

- **Industrial Waste Sites**

(v) Of the four industrial study sites, the analysis identified beneficial impacts of CMA application on the roads adjacent to the monitoring sites and/or on the process yard at three sites. At the fourth, Mercury Way, no robust analysis was possible due to limited measurements and CMA applications. The most robust findings were at Horn Lane. A clear drop in local PM_{10} concentrations occurred in the hour following on-site CMA application of between 31% and 59% relative to the control. A lesser decrease was associated with the on-road applications. Analysis at Manor Road was restricted due to a lack of pre-trial period, but a similar decrease in local PM_{10} (41%) was associated with on-site CMA application. The complexity of the industrial area surrounding the Neasden Lane study site made robust analysis difficult, but some limited benefit of CMA application was identified.

Table 6.2: Summary of King's College London Study Findings

Site Name	Site Description	Results
Neasden Lane, Brent	Large mixed industrial site	Limited analysis possible due to small number of application days and mixed on-site applications. Tentative 22% reduction in local PM10 compared to non CMA days following on-site application.
Horn Lane, Acton	Medium industrial site	On-road application: 18% reduction in local PM10 compared to non CMA days. On-site application: 36% reduction in local PM10 compared to non CMA days.
Manor Road, Erith	Medium industrial site	On-site application: mean 41% reduction in local PM10 compared to non CMA days. On-road application: analysis not possible.
A2 Blackheath	Road corridor impacted by emissions from construction site opposite.	44% reduction in local PM10 compared to pre-trial period, equating to a decrease in annual mean of c. 12%. No effect compared to non CMA days.
A3211 Upper Thames Street	Congested road corridor beneath a wide bridge.	Daily CMA application >10 mg m-2 only: 38% reduction in local PM10 compared to non CMA days, equating to a decrease in annual mean of c. 16%. No effect at 10 mg m-2 application rate.
Mercury Way, Lewisham	Small industrial site.	No robust results due to limited monitoring and few on-site application days.
A501 Marylebone Road	Heavily trafficked road corridor in a street canyon.	The analyses could not identify any significant effect.
A2 New Cross	Single lane road corridor.	The analyses could not identify any significant effect.
A12 Blackwall	Heavily trafficked road corridor in an open location, partial application.	The analyses could not identify any significant effect.

6.5 Conclusions, Lessons Learnt and Next Steps

Following experience and evidence from other towns and cities in Europe, TfL has now completed an extensive trial of the effectiveness of dust suppressants in reducing local PM_{10} concentrations. The CAF programme funding enabled TfL to expand an initial trial completed by TfL in summer 2011 and to expand the trial of this local measure along a wider range of road corridors (covering 20 miles in length) and at other locations in London. This has helped increase understanding of the effectiveness of this measure in London's varied urban environment and assisted in identifying a typology of the place where the application of dust suppressants can help reduce local PM_{10} concentrations.

This trial provided evidence of a beneficial effect of CMA application on roads and industrial sites. It highlighted that CMA application is most effective in locations with unusually high local levels of PM_{10} most likely due to *re-suspension* and that application had no identifiable effect in some more typical roadside locations, even where *total* PM_{10} levels are elevated. A method for identifying locations where CMA application is likely to be most beneficial has been presented as part of the study by King's College and is included in their final report. This is an area of further work which could be developed to understand which types of locations may benefit from dust suppressant application.

The findings therefore strongly support the role of dust suppressants to reduce local PM_{10} concentrations in very specific locations where the proportion of local resuspended PM_{10} is high and the surface area applicable for treatment can be maximised. In these targeted locations it is likely to have a significant impact on local PM_{10} concentrations. Examples include within and on roads around industrial waste transfer sites, construction and demolition sites; and at major road works were there is significant dust generating activity.

- **Road Corridor Application**

The expanded trial of CMA application on six road corridors demonstrated that this local measure represents a solution that can quickly be integrated into existing highway operational activities. It covered a range of road corridors with different geographical and traffic characteristics, including street canyon situations. Along these road corridors there are clearly a wide range of features and local characteristics that affect the potential effectiveness of CMA.

Evidence of a positive effect was found at one of the roadside study sites, however, the application of CMA was shown to have no identifiable effect at a number of the other sites, even where *total* PM_{10} levels were elevated. The two dominant reasons for this were felt to be that:

(1) in typical urban locations the proportion of total PM_{10} mass arising from re-suspended particulate matter appears to be small; and/or

(2) the area suitable for treatment with CMA (the road surface) is small relative to the total surface area giving rise to re-suspended particulate matter.

Any future application along road corridors would need to reflect the findings of this trial and locations proposed would need to be identified based on the methodology developed.

- **Application of dust suppressants at Industrial Waste Sites and Construction Sites**

The work at industrial waste sites was successfully delivered as it was able to build on established working relationships and provide strategic assistance. This allowed direct local action focused on issues common at industrial waste sites across London. Using dust suppressants at these sites represents a sustainable method of targeted pollution

at the source before dispersion to areas outside of the site occurs. Though initially funded by the Clean Air Fund programme there are opportunities in the longer term for operators to self-fund ongoing delivery. The cost implication for operators is minimal and operators were able to develop simple systems and use existing machinery to apply CMA on sites.

The very positive results from the trial and study at industrial sites support the view that continuing application of CMA on and around the industrial study sites is likely to have a significant impact on PM_{10} concentrations. At sites with a complex combination of dust generating processes, detailed studies should be carried out by local permitting agencies to identify sources in the area. CMA application is likely to be most beneficial when it is applied frequently and across as wide an area as possible.

The regular damping down already undertaken at many construction sites suggested that there may also be significant opportunities to reduce pollution in London by applying CMA within and near construction sites. This is not always the case as it became apparent as part of this trial that CMA reacts with Bentonite (a slurry used at many construction sites) to increase it's the viscosity and permeability. This trial has focused on two construction sites and for operational reasons insufficient operational records on the application have yet to be provided by the operator to allow meaningful analysis. However, a review of international research and the findings at the industrial sites support the implementation of dust suppressant application at other locations with potentially high levels of local PM_{10} attributed to re-suspension, such as construction sites.

Targeted cleaning

The CAF funded PM_{10} focused deep cleaning employed more intensive cleaning techniques than the existing maintenance regime to tackle specific issues at PM_{10} hot spots. It is beneficial but is not a cost effective widespread measure for reducing local PM_{10} concentrations. This is primarily due to the intense labour requirements of cleaning areas that are inaccessible to machines. Isolating the air quality benefits is extremely difficult and would need to be part of a further bespoke study.

Clearly it is important that regular business as usual road sweeping regimes are maintained and there may also be opportunities for further targeted deep cleaning at PM_{10} hot spots where it is apparent that there are large amounts of dust and particulate matter on highway surfaces.

7. Business Focused Transport Measures and Engagement Activity

7.1 Background

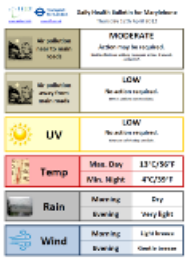
The objective of the business engagement activities was to educate employers how they can mitigate their impact on local air quality. The measures that were proposed focussed on changes to staff commuting behaviours (more walking & cycling), business travel, and deliveries of goods and other servicing activities.

7.2 Business Focused Measures Delivered

The transport focused business engagement activity delivered as part of the CAF programme is summarised in the table below.

Table 7.1: Business Focused Transport Measures and Engagement

Activity/Description	Achievement
Business Engagement – dialogue with businesses located near the three MAQS PM_{10} priority locations in central London, focusing on responsible procurement, reducing business travel and deliveries.	**642** businesses were directly engaged in the programme by 31 March 2012, with information sent to over 1,000 employer organisations.
Revised Best Practice Guidance - existing TfL Best Practice Guides and case studies revised to highlight air quality issues and raise awareness. 	Publication of **8** Guides, available on the TfL website: Car Share Guide; Cycling for Business; Parking Management; Pool Bikes for Business; Workplace Cycle Parking; Smarter Working Guide; Sustainable Fleet Management Guide; Sustainable Business Travel.
Electric Pool Bikes – trials with employers to promote reduced vehicle use for short local trips.	**6** businesses participated in the electric bike trial using **12** bikes, and capture of GPS tracking data presented through a unique graphic visualisation video.
Electric Vehicle Charge Points - providing match funding for installation at business premises to encourage use/local uptake of electric vehicles. 	**13** charging points were provided to businesses.
Delivery & Servicing Plans – worked in partnership with businesses to develop delivery servicing plans to better understand their supply chain, procurement practices and identify way of achieving more sustainable service patterns.	**9** businesses participated in the DSP trial, and data analysis exercise undertaken to present results to partners.

Walking Initiatives – development of measures to encourage employees to use different routes, avoiding areas of concern, and to promote walking for short distance work related trips.		• **2** 'Walkavator' training courses delivered in partnership with YMCA. Ten people representing organisations with more than **15,000** employees attended. • **12** area based linear and circular guided walks delivered, attracting **220** people. • **3** 'self-guided' walking routes were designed and uploaded onto www.WalkIt.com. • bespoke Legible London maps were designed for **22** businesses.
airTEXT Daily Health Bulletins – promotion of bespoke airTEXT daily health bulletins for employers delivered by text message in each area. Development of free to download mobile app.		Daily health bulletins are now available (from April 2012) and businesses can sign up to receive the information. A number of businesses (who in total employ more than **7,000** people) have already signed up.

7.3 Costs

The costs of the Business Engagement programme is summarised in Table 7.2.

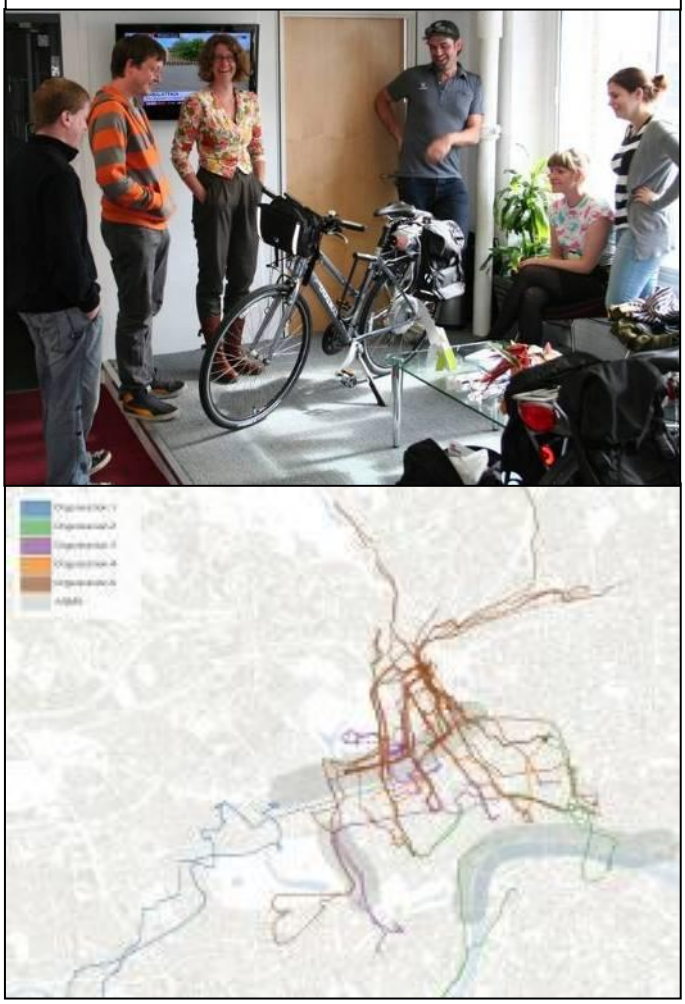
Table 7.2: Workstream Costs

Activity	Description	Costs (£000s)
Engagement	Embedded and external consultancy support for delivery of measures	85
Measures	Walking initiatives, electric bike trial, DSP, Electric Vehicle Charging Points.	140
Information	Events, Business Guides, AirTEXT, Legible London Maps	75
Total		**300**

7.4 Monitoring and Evaluation

Electric pool bikes: Six organisations were chosen from an initial pool of over 20 organisations who showed interest, all of whom were located adjacent to the three priority corridors. If further resources had been available, some of the employee liability insurance and risk issues that were apparent could have been addressed.

Figure 7.1: Electric Pool Bikes were trialled at 6 employers & GPS plots show their use



There is also further opportunity to highlight the potential for reducing business travel costs through electric bikes, as most purchasing decisions were based on value-judgements as opposed to sound data. For example very few organisations had access to reliable data about the amount that they spend on taxi trips in Central London. Nevertheless, the trial demonstrated nearly 20% of trips replaced taxi journeys and are therefore likely to have resulted in a small reduction in emissions. 24% of mileage was within the three MAQS PM_{10} priority locations. In terms of journey times, the average speeds of the bikes were 10.8mph, indicating that these are entirely competitive with taxis in central London.

The GPS tracking devices fitted to the bikes were generally robust, with a valuable learning being that storage in underground locations compromised signal strength. The journey tracks provided have significant potential in the analysis of decision making regarding infrastructure, and have been subsequently deployed on the Barclays Cycle Hire, providing unique visualisations of the most frequent patterns of use.

Given the size of the pilot study, the number of trips made by the electric bikes were too few to provide statistically robust proof that they were used for longer trips than might be undertaken by conventional pool bikes, and it is possible that some trips had the unintended impact of reducing walking trips. This suggests that range anxiety is unlikely for an electric bike in an urban environment, and that smaller (and cheaper) battery packs might be appropriate.

Delivery and Servicing Plans (DSPs): Many of the businesses had not previously considered their delivery and servicing arrangements in relation to air quality. The evidence strongly suggests that most businesses are not fully aware of the extent of the wider impacts of their supply chain activities. This suggests that there is an opportunity to raise awareness through Corporate & Social Responsibility reporting, particularly in terms of leveraging existing carbon reporting protocols. The DSPs helped to quantify understanding by capturing data about existing delivery and servicing arrangements,

such as the times of day and weekday that the activities took place; the average time spent making a delivery; the total number of recorded deliveries; collections and servicing trips; and where the vehicle was parked.

But the significant opportunity lies in developing the basic vehicle movement data into a tangible series of interventions that have the dual purpose of delivering air quality improvements and a bottom line benefit to those implementing them. To date, this link between driving business efficiency and improving air quality has been largely overlooked, and developing a business case that pulls together consolidation, reduction in deliveries and fleet emissions to demonstrate the full costs and benefits will be key to empowering the private sector to take effective action.

The trial provided useful information about the complex and linked 'triggers' that will motivate the business community had to become involved, although the complexity of these relationships is not to be underestimated. The regulatory framework, financial savings, health and safety mitigation, supplier and procurement management, reporting and KPI requirements and the trade off between storage and transport costs all demonstrate the complexity of the task, and in particular, the impacts of 'just in time' supply chain economics are key to understanding the drivers behind the transport and servicing activity.

DSP Case Study: *The* ***Wellcome Trust*** *is a global charitable foundation dedicated to achieving improvements in human and animal health. It employs over 500 staff at its offices on Euston Road. The data showed that over 500 two way vehicle movements covering deliveries, collections and servicing trips were recorded over the course of a typical 7 day week.*

Outcomes of the DSP:

- *Delivery & servicing issues are now on the management meeting agenda*
- *Opportunity to work towards implementing changes – out of hour deliveries / consolidating deliveries*
- *Active promotion of TfL Freight Operator Recognition Scheme (FORS)*
- *Investigating whether procurement guidelines can be revised to minimise deliveries, influence vehicle choice and mandate being a FORS member*
- *Raised awareness of air quality issues as part of wider Corporate & Social Responsibility reporting*

Walking Initiatives: The Walkavator Training Course received positive interest from the business community. The 'Guided Walks' initiative was very popular and there was significant demand for additional lunchtime walks. Feedback suggested that the initiative increased the numbers of people walking who would not otherwise do so at lunchtime, although a larger pilot would be required to quantify if they change habitual commute patterns away from those areas experiencing poor air quality.

The involvement of Business Improvement Districts and business networks proved very successful in being able to deliver and market the walks to the business community.

Electric Vehicle Charging Points (EVCPs): Interest in electric vehicles was found to be much higher than anticipated, but there are still clearly cost barriers to be overcome that include installation costs, maintenance fees, landlord permission and a general lack of understanding about the how to utilise electric vehicles most efficiently.

Many businesses in the three MAQS PM_{10} priority locations do not have car parking or operate fleets, so the potential to replace conventionally fuelled vehicles with EV's may actually be more relevant in a pan-London wide context. The benefits of hybrid vehicles were more understood, with many businesses having signed up to contracts with taxi and private hire companies offering a hybrid fleet, for example, Toyota Prius vehicles.

7.5 Conclusions, Lessons Learnt and Next Steps

The evidence from this work strongly suggests that many businesses are not fully aware of, or understand, the extent of the impact of their activities on air quality. The positive uptake of the CAF measures by some businesses did provide some evidence that engagement work around tangible transport measures can change travel behaviour and in turn help to deliver air quality benefits.

The key conclusion that became very clear through engagement with the business community is that there is a real opportunity to educate and raise awareness of issues relating to air pollution. This would significantly improve the understanding of the impacts of particulate matter on public health, and help businesses to distinguish between carbon emissions and air quality in terms of Corporate & Social Reporting (CSR) protocols. This was particularly the case for smaller and medium businesses, who generally do not employ staff in environmental or CSR type functions.

There is a significant opportunity for local government to take a lead in developing strategies and mechanisms which address the wider picture, and provide clear direction whereby individual businesses and employers can then take action at a more local level. Without this support, many businesses could take the view that the topic is simply too large and too difficult for them to influence on an individual basis.

One clear opportunity is to developing strategies and mechanisms to influence supply chain issues which would remove a clear barrier to progress. This would help the business community, who are already pre-occupied with the current economic climate, financial efficiency and in some cases, business survival, and would therefore deliver ready made opportunities to make cost savings that also address what are perceived to be externally owned initiatives.

With the successful delivery of the 2012 Games, there is also a clear opportunity to push ahead with air quality initiatives, particularly as there are a significantly reduced number of other programmes competing for attention. The issue of providing effective information and resource to the business community, particularly amongst smaller employers, should be exploited and the legacy of the 2012 Games time engagement programmes provide a clear focus on how this can be achieved most effectively.

The development of a package of financially attractive business case examples that provide evidence of real financial savings is a significant key to unlocking change, particularly for businesses who do not operate vehicle fleets and therefore indirectly influence air quality. This is particularly important when considering the type of business activity along the three air quality corridors, where most employers do not own or operate commercial vehicles, and are reliant on servicing by third parties based elsewhere in London or beyond.

Understanding of the issues relating to air quality is therefore a key opportunity to deliver change within the business community, and an increase in engagement and awareness raising is fundamental to achieving this goal. The 'No Idling' campaign demonstrated that where there was a clear financial benefit for change, there was an enthusiastic response from the business community and real buy-in. Any future business related campaigns should implicitly demonstrate the link between the impacts of the travel

behaviour on the transport network, and give clear examples of tangible benefits to the business community.

8. Conclusions and Recommended Next Steps

8.1 Clean Air Fund Programme Conclusions

The CAF programme has delivered a wide range of local measures targeting both a reduction in local PM_{10} emissions and concentrations. The measures were delivered over an 18 - 24 month programme as shown in **Figure 8.1**.

Overall the programme has been a success and delivered tangible impacts on awareness, behaviour and PM_{10} emissions and concentrations. The CAF programme demonstrates that many of these local measures can play a supporting role to longer term and London wide emissions reduction measures, particularly when seen in the context of their wider benefits, and should continue to be delivered.

A summary of the key findings and conclusions of each workstream is provided below.

Diesel Particulate Filters on Selected Bus Routes: Fitting diesel particulate filters (DPFs) to specific buses is a cost-effective measure to deliver up to 77% PM_{10} exhaust emissions reduction at source. This measure can be targeted at specific buses on specific routes but requires considerable technical input to ensure the filters are appropriate for the type of bus and engine. It is also important to carefully consider the more targeted benefits of a retrofit programme against the potentially wider emissions and noise reduction benefits of new Euro VI and diesel-electric hybrid vehicles.

'No Engine Idling' Programme: Monitoring around the CAF package of 'No Engine Idling' measures has shown positive indicators of the effectiveness of the programme in both establishing awareness of the issue amongst drivers and in changing driver behaviour. For example:

- The campaign achieved a good level of driver awareness (25%) and recognition (40%).
- Observed engine idling on-street in the three MAQS PM_{10} priority locations was reduced overall by approximately 5% and was significantly lower amongst certain vehicles types after each phase of the campaign. In November 2012 there was 11% less engine idling observed in coaches, a 16% reduction for HGVs, a 12% reduction for taxis and a 13% reduction for cars (compared to surveys in December 11 before the campaign).
- Taxi marshalling proved a very effective way of engaging with taxi drivers and had some success in reducing idling. Overall there was an average 9% observed reduction in engine idling at marshalled taxi ranks.
- The smarter driver training for taxi and private hire drivers was successful and drivers achieved a 25% (taxis) and 12% (private hire) reduction in fuel consumption by changing their driving behaviours, also reducing their emissions

Changing driver behaviour takes time and to embed the message with drivers there will need to be a sustained and ongoing delivery of the 'No Engine Idling' message.

Green Infrastructure: As part of the CAF programme, Imperial College London undertook research to determine the ability of GI measures (including those delivered as part of CAF) to trap PM_{10}. The findings of this research helped to support the growing evidence base that the delivery of GI can improve urban air quality. The research confirmed that the delivery of GI measures has a small direct local air quality benefit by trapping PM_{10}. They have proven to represent positive and worthwhile supporting measures within in a package or strategy of local measures, particularly in the context of their wider environmental and awareness raising benefits.

Expanded Trial of Cleaning and Application of Dust Suppressants: Following experience and evidence from other towns and cities in Europe, TfL has now completed an extensive trial of the effectiveness of dust suppressants in reducing local PM_{10} concentrations. The research undertaken by King's College London as part of this trial provided evidence of a beneficial effect of the application of dust suppressants at some road locations and industrial sites during the trial. It has therefore assisted in identifying a typology of the places where the application of dust suppressants can help reduce local PM_{10} concentrations.

Overall the trial highlighted that dust suppressant application was most effective in locations with unusually high local levels of *resuspended* PM_{10} and that application had no identifiable effect in some more typical roadside locations, even where *total* PM_{10} levels are elevated. A methodology has been developed for assisting in identifying the specific locations where the application of dust suppressants is likely to be most beneficial.

In summary, the results from the sites used to monitor the effectiveness of the trial were:

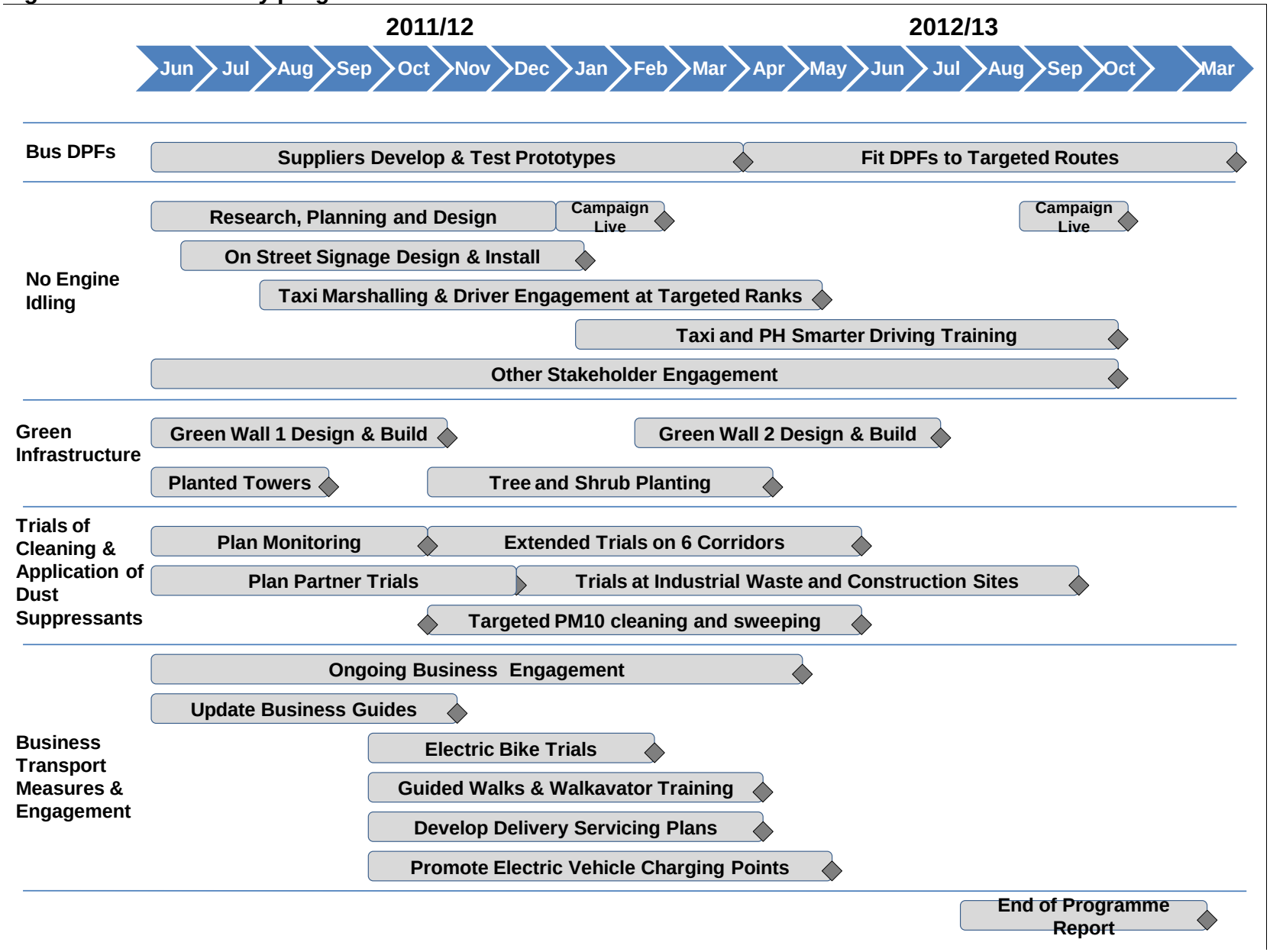
- **Road Corridor Sites** - the strongest evidence of a positive effect was found at the A3211 Upper Thames Street study site. The estimated impact was an average reduction in total PM_{10} concentration of approximately 16%. There were unclear results at the A2 Blackheath location and no effect was monitored at the three other road locations including at the A501 Marylebone Road site.
- **Industrial Study Sites** - the analysis identified beneficial impacts of dust suppressant application on the roads adjacent to the monitoring sites and/or on the process yard at three of the four sites studied. The most robust findings were at Horn Lane. A clear drop in local PM_{10} concentrations occurred in the hour following on-site application of between 31% and 59% relative to the control.

The findings therefore strongly support the role of dust suppressants to reduce local PM_{10} concentrations in very specific locations where the proportion of local resuspended PM_{10} is high and the surface area applicable for treatment can be maximised. In these targeted locations it is likely to have a significant impact on local PM_{10} concentrations. Examples include within and on roads around industrial waste transfer sites, construction and demolition sites; and at major road works were there is significant dust generating activity. Any future application along road corridors would need to reflect the findings of this trial and any locations proposed would need to be identified based on the methodology developed.

Business Focused Transport Measures and Engagement Activity: The evidence from this work strongly suggests that many businesses are not fully aware of, or understand, the extent of the impact of their activities on air quality. The positive uptake of the CAF measures by some businesses did provide some evidence that engagement work around tangible transport measures can change travel behaviour and in turn help to deliver air quality benefits.

The key conclusion that became very clear through engagement with the business community is that there is a real opportunity to educate and raise awareness of issues relating to air pollution. This would significantly improve the understanding of the impacts of particulate matter on public health, and help businesses to distinguish between carbon emissions and air quality in terms of Corporate & Social Reporting (CSR) protocols. The development of a package of financially attractive business case examples that provide evidence of real financial savings is a significant key to unlocking change, particularly for businesses who do not operate vehicle fleets and therefore indirectly influence air quality.

Figure 8.1: CAF delivery programme and timescales



8.2 CAF Next Steps

TfL and the GLA will build on the successes of the Clean Air Fund programme and some next steps in relation to the programme and local measures delivered are:

- To disseminate best practice TfL, GLA and DfT will distribute this report and share its key findings with other public authorities, other stakeholders and EU partners.
- TfL is committed to delivering further significant reductions in bus emissions by:
    - delivering 1,600 cleaner hybrid buses (including 600 New Bus for London vehicles) by 2016, which will emit over 50% less NO_x than a standard diesel bus;
    - retrofitting up to 900 of London's older buses to reduce their NO_x emissions.
- TfL will continue to deliver the 'No Engine Idling' message and embed it into existing driver communications and engagement work with drivers and transport operators. TfL and the GLA will also work with other partners, including boroughs and transport industry representatives, to also continue to promote the 'No Engine Idling' Message in London. Further opportunities for further targeted smarter driver training will also be promoted.
- The experience gained by the taxi marshalling has helped identify the taxi rank design arrangements that can help discourage idling by drivers. This will be used to inform future work on taxi rank design or modification undertaken by TfL.
- The results of the research and the lessons learned from the trials of green walls and green screens will be shared with interested parties to further the understanding of the benefits of GI. TfL will use these lesson learnt to support further delivery of GI (including Green Walls) by the GLA group, Business Improvement Districts and other delivery bodies in London.
- TfL and the GLA will share the findings of the extensive trial and study into the effectiveness of dust suppressants in London with key stakeholders and interested European partners. Given the results from the study TfL and the GLA will:
    - Work with the Environment Agency, boroughs and site operators to develop good practice guidance for operators and continue and expand on-site application of dust suppressants such as CMA at industrial waste sites in London.
    - Promote the use of dust suppressants such as CMA by including this measure in the Mayor of London's Supplementary Planning Guidance 'The control of dust and emissions from construction and demolition'.
- Both TfL and the GLA will continue to deliver and support business engagement campaigns to promote the use of lower emission modes of transport and other measures to improve local air quality. TfL will embed key air quality messages into business engagement material and activity.

8.3 TfL Business Plan (December 2012)

Clean air is a major factor in making a city a safe and pleasant place to live, work and visit. To help deliver this TfL's latest business plan proposes investment over the next decade that will ensure a fast, safe and reliable public transport service coupled with record ongoing investment in walking and cycling. This helps reduce the number of

vehicles on the roads and therefore cut emissions. This is the major way in which TfL improves London's air quality, but there are other direct ways that can further enhance the effect, such as the Low Emission Zone and ensuring its vehicle fleet meets the highest standards.

Some of the further measures to improve air quality included in the business plan are:

- Investing in clean bus technology including hybrid buses and retrofitting older buses as outlined above.
- Continuing TfL's Electric Vehicle Delivery (EVD) project, with more than 50 Source London partners, to support the growth of public and workplace charge points.
- Working with the freight industry, businesses and boroughs to reduce freight vehicle emissions on last mile deliveries by promoting supply chain consolidation; improvements to journey planning; the adoption of an out-of-hours delivery approach; and the uptake of alternative and cleaner fuelled vehicles.
- Investing in environmentally friendly infrastructure, such as green walls and roofs.

8.4 Mayor's Air Quality Fund

To support boroughs in tackling local air quality hotspots, raising awareness and reducing human exposure, a new Mayor's Air Quality Fund is being created. A total of £6m has been allocated in the TfL business plan for this fund. Drawing on the lessons learnt and findings of CAF this additional funding will be available to boroughs which prioritise air quality and achieve 'Cleaner Air Borough' status. Businesses, schools and other groups will be encouraged to take part in these projects to increase the funding available and maximise impact. Projects which could be funded include: developing low emission 'green zones'; freight consolidation and improved last mile logistics; air quality improvements to high streets; and trials of new low-emission technologies. Subject to further proposals, TfL will increase resources available to around £20m once the initial fund spending has been assessed for its impact.