Greater Manchester's Outline Business Case to tackle Nitrogen Dioxide Exceedances at the Roadside

E4 Plans
E4.3 Monitoring and Evaluation Plan

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Table of Contents

1 Impacts[1]

1.1 These are the ultimate effects of the proposed Greater Manchester Clean Air Plan (GM CAP) on the three elements of sustainable development: environment, society and economy. The interventions in the proposed GM CAP are designed to act on air quality and that will therefore be the main variable of interest. However, in the sustainable development model, the three elements should be in balance and there is a requirement to understand the extent to which each has changed.

Environment

1.2 Air Quality might generally be understood as the extent of all pollution and particularly those with a known impact on human health. In the more specific context of the GM CAP, this means Nitrogen Dioxide (NO_2) because of the legal judgement referred to in the Strategic Case.

1.3 Air quality changes rapidly with distance from a road, and also along discrete sections of road between junctions, as vehicle behaviour and emissions can be altered by many factors such as congestion, gradients, merge/diverges/ pedestrian crossings, and road widths and curvature. The dispersion of these emissions can also be affected by the surrounding buildings, surfaces and topography.

1.4 Air quality, and particularly NO_2 concentrations, can vary within the year and between years due to a large number of factors, most notably meteorological conditions. Therefore, obtaining multiple baseline years before scheme commissioning is critical.

1.5 NO_2 can be measured using a range of techniques. Continuous Monitors (CMs) record minute-by-minute data but are relatively expensive to install and operate, whilst passive Diffusion Tubes (DTs) are very cheap and can therefore be deployed at a large number of locations readily and cost effectively, but only measure monthly concentrations meaningfully. A critical aspect of the prediction of NO_2 from vehicle traffic emissions is a parameter known as primary- NO_2 (the fraction of overall nitrogen oxides (NO_x) that are emitted directly as NO_2). This is very difficult to directly measure, but can be inferred if an ozone (O3) analyser is co-located with the NO_x/ NO_2 CM.

1.6 LAQM TG(16)[2] sets out the principles for designing a monitoring survey which utilise both types of analyser with co-location of DTs at CMs sites to understand systematic bias.

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[1] For the purposes of this document, “evaluation” refers to ex-post outcomes (travel behaviour) and impacts (non-transport effects on economy, society & environment), whereas “monitoring” is about delivery and proper operation of the interventions. They are, however, part of the same programme so the distinction is mainly relevant to expectations of reporting frequency: monitoring tends to short-term and frequent; evaluation has to wait for effects to materialise that do not change rapidly.

[2] Defra, Local Air Quality Management Technical Guidance (TG16), February 2018

1.7 The approach to monitoring set out in this project has been designed to understand the key influences on roadside NO_2 concentrations across a large and spatially diverse study area where exceedances are caused by complex and differing conditions. Locations of canyons, congestion and gradients are recognised as being more susceptible to uncertainty in emissions estimates and therefore additional monitoring is targeted in these locations, along with the key exceedance locations across the districts in Greater Manchester.

1.8 Additionally, the monetisation of the Air Quality impacts from the scheme includes changes to emissions of Particulate Matter (PM_{10}/$PM_{2.5}$) in relation to health, and carbon in relation to climate change. These pollutants and other environmental impacts such as noise are the subject of other Greater Manchester strategies with their own monitoring regimes and will be incorporated in the GM CAP evaluation.

Society

1.9 There is a challenge around the distribution of the costs and benefits of the transport system, and in the specific case of the GM CAP, the contribution of NO_2 to ill-health and the accessibility and financial costs resulting from the interventions experienced by different segments of the population.

1.10 The segments of most concern as identified in the Distributional Impacts (DI) Assessment were people on low incomes, children and the elderly.

1.11 Whilst there is an agreed relationship between NO_2 concentrations and human health, actual measurement of health such as life expectancy or incidence of disease is affected by many variables and it would be impractical to isolate any change in NO_2 as a cause. The best proxy will be a measure of exposure, which will be analysed spatially, particularly with respect to areas of deprivation and current exposure. Baseline data of this type has already been analysed in the DI Assessment.

1.12 Distribution of financial and other behavioural consequences that can be attributed to the GM CAP will not be detectable from any large-scale economic data and so will require specific surveys of firms and individuals, according to their circumstances and response to GM CAP Measures (see sections 4 & 5 below).

Economy

1.13 As with health, whilst relationships between transport and economic costs and activity might be understood well enough to model, observing the effects directly is difficult due to the strength of other variables. However, it should be possible to make some estimates of costs to business and barriers to employment from surveys of firms and workers, subject to the usual reservations about self-reporting of possibly controversial effects. These would be part of the after-only survey programme discussed below.

1.14 Health-related economic costs such as the National Health Service (NHS) and social care, productivity and absenteeism similarly have an assumed, modelled, relationship with air quality but not one that could be observed directly. Extrapolating from actual air quality outcomes will suffice.

1.15 The image of Greater Manchester is likely to be a contributing factor to economic growth and, although that relationship would be beyond the scope of the GM CAP, it may be worth measuring as an indicator of attractiveness of Greater Manchester as a place to invest or work. Awareness is required of whether cleaner air has become a selling point or whether the interventions are seen as an undue burden. The scope of a survey asking about the image of Greater Manchester would be businesses and residents both inside and outside Greater Manchester; perception questions would include transport and non-transport aspects of Greater Manchester, including environment in general and air quality in particular.

2 Outcomes

2.1 The first level of outcome down from impacts that should be measured are those with the most direct relationship with NO_2 concentrations. There is a requirement to understand how the product of volume of traffic, traffic composition, fuel type and speed has led to a change, or not, in air quality readings.

Traffic volumes

2.2 It is proposed that recording of traffic flows via Automatic Traffic Counters (ATCs) which are currently deployed across the Greater Manchester highway network as Business-as-Usual (BAU). Baseline data of this type has already been analysed in the preparation of the business case.

Traffic composition

2.3 The camera network deployed as part of the proposed GM CAP will provide the base level of data to assess changing traffic composition. Depending on the scope for avoiding cameras (whether intentionally or not), some random sampling using a mobile Automatic Number Plate Recognition (ANPR) cameras will be required to check that the traffic composition and fuel types in general use across the network matches those that are presented to static enforcement cameras or the highly-visible mobile cameras. A single mobile camera, separate (i.e. unmarked) from the enforcement fleet should be sufficient to collect an adequate sample covering multiple locations.

2.4 Baseline data used in the business case has been collected from a combination of existing traffic management and a short-term installation of cameras for the specific purpose of measuring composition.

3 Intermediate outcomes

3.1 There is a requirement to understand how the above factors have changed in response to the interventions. The main factor that the proposed GM CAP

is meant to act on is fuel type and vehicle age/Euro standard. The intention is not to reduce the amount of traffic or increase speeds, but these may vary independently and some interventions may incidentally affect the outcome. Use of ATCs and mobile data will provide the context for an understanding of the effect of the interventions that are mainly intended to affect vehicle emissions characteristics.

Observable responses to CAZs

3.2 The extent to which non-compliant vehicles continue to use zones through the payments system plus enforcement and random sampling will be measured. The baseline exists as described above.

Observable responses to fuel change initiatives

3.3 The operation of schemes will provide data on the extent of take-up, including payments and usage of Electric Vehicle (EV) charging points. The only baseline data relevant in this case is that on the current membership and usage of the GMEV scheme.

4 Behavioural & attitudinal responses

4.1 At this level there is a requirement to understand what is behind the observable responses to the interventions. There is a need to identify why people did what they did, which will require quantitative surveys and/or qualitative methods such as in-depth interviews or focus groups. There is an assumption that there are no practical baseline equivalents to these.

4.2 In each of the following cases several waves of surveys will need to be undertaken, possibly over several years, to allow for some responses to be made before the interventions, immediate upon implementation and in the short and long term post-implementation.

Clean Air Zones (CAZs)

4.3 The survey approach will depend on the type of user and how their travel changes, including whether they can choose to avoid the all-Greater Manchester zone.

4.4 Those making the same trips as previously that now enter a CAZ may:

1. have already been using a compliant vehicle and have changed nothing, and so don't pay;
2. not have had a compliant vehicle but have one now, so don't pay;
3. not have had a compliant vehicle and don't have one now, so pay; or
4. not have had a compliant vehicle and don't have one now, and cheat the system.

4.5 Of these, category 3 is of most interest and respondents will be identifiable through the penalty scheme contact details and an on-line survey is

proposed to ask about their reasons for paying. This would include what alternatives they had (awareness, availability, affordability, their proportion of discretionary trips) and, if they had plausible alternatives, why they rejected them in favour of paying. Trip-making frequency should also be collected and compared with the current frequencies in existing travel diary data to test for the possibility of trip-chaining that minimises the cost per trip of a fixed daily penalty.

4.6 Similar questions for category 2 will be required to understand the trade-offs they made and what sort of vehicle or fuel they switched to. Some of them may be easily contactable if they have participated in any of the incentives, but in the main there is a need to look for respondents in the general population. It is currently assumed that category 4 will be too small to affect outcomes, so it can be safely ignore it for evaluation purposes.

4.7 Of those who did something else, the proportions of trips diverted or supressed in response to a CAZ in the absence of changing a vehicle will need to be understood.

4.8 In each case, separate surveys will need to be designed for people travelling in the course of business, and transport providers (buses, taxis, own-account freight and haulage/logistics).

4.9 Questionnaire design will need to be informed by some qualitative work, to ensure that a full range of real-world responses and motivations are provided for. It is expected that depth interviews, either face-to-face or by phone would be appropriate for most businesses.

Response to incentives

4.10 Those who at least make contact in respect of any of the incentives should be easily contactable for the purpose of asking them about trade-offs they have made, similar to the general population of category 2 above.

5 Customer experiences and consequences

5.1 Following on from collecting insight into why people responded to the proposed GM CAP in the way they did, it is proposed that the same interviewing opportunity is used to measure how the interventions worked for people and to probe the consequences of the proposed GM CAP on the respondents and/or their organisations.

CAZs

5.2 For those in category 3 above, there is a requirement to check that they are satisfied with the operation of the penalty system in terms of things like accuracy of billing and ease of paying. For all others it needs be ensured that the zones and their rules were widely understood. A question on approval of the programme may be appropriate.

5.3 Category 1 may report faster journeys or less stress in the event of a general reduction in traffic. Businesses such as truck or bus operators may

have had more than one vehicle but not all compliant and in options where non-compliant vehicles from outside GM could make some trips without charge, it would be useful to observe whether re-allocating vehicles between tasks depending on their trip destinations might contribute to a shift in emissions away from CAZs to other locations.

5.4 In planning for the future, it will be important to understand the extent to which those in category 1 believe they make little or no contribution to air pollution and expect to continue to drive their class of vehicle indefinitely.

5.5 For those reporting diverting or supressing trips, the consequences of these in terms of cost, access to business opportunities or other changes will need to be explored.

5.6 Businesses or institutions who aren't directly involved in travel or freight movement have not been considered above but might nevertheless experience consequences at the end of the chain. Retailers would be a particular target for research to see whether effects of GM CAP on suppliers had translated into changes in trade. Getting at such effects would best be achieved through qualitative approaches: probably focus groups for retailers around particular locations and individual depths for large organisations.

Incentives

5.7 At the same time as asking those who responded to incentives about their decision-making, the operation of the incentive scheme was as expected should be tested with respect to its ease of use and satisfaction with delivery. It is proposed that insight from people is sought who didn't take advantage of an incentive to test awareness and perceived attractiveness of the offer.

Table 1: Summary of indicators and sources

	Indicators & Insights	Reporting frequency	Source	Indicative Cost to CAP
Impacts				
Environment	(1&2) Annual average NO_2 concentrations: (1) actual and (2) as modelled. Number exceeding 35/40/45/50 µg/m^3 Actual primary - NO_2 concentration for a variety of fleet mix sites to cross reference with JAQU sensitivity tests	6 monthly	(1) Diffusion tubes and continuous analysers at monitoring sites (2) Reference model (3) Continuous analysers with NOx/ NO_2/O_3	(1) 14 existing road traffic & 6 background stations £0, BAU (2) 4 New CMs with NO_x/ NO_2/O_3 @ £25k per unit for the first year, £5k per site maintenance pa thereafter. (3) 160 supplementary Diffusion Tube sites for GM CAP £100k for the first year, £60k pa thereafter
Society	Ratio of proportion of Lower Layer Support Output Analysis (LSOAs) having highest quintile of low incomes, children and elderly with exceedances to proportion of LSOAs having lowest quintile of low incomes, children and elderly with exceedances	Annual	Modelled & actual exceedances as above plus census. In-depth study of vulnerable groups (2 waves)	(1) Exceedances supplied by above. (2) Distribution analysis £20k (3) £30k per wave
Outcomes level 1: Air quality factors				
Traffic volumes	Total vehicle-kms by class	Annual	Existing stock of ATCs, manual counts and mobile data	£0, BAU
Traffic composition	Proportions of each vehicle class and fuel type observed: (1) on the Greater Manchester road network (2) crossing into CAZs	Monthly	(1) Mobile ANPR for Monitoring and Evaluation (M&E) only (2) Enforcement ANPR	(1) £50k purchase + £50k/year operation (2) As per Financial case
Traffic speed	Average link speeds, all vehicles		Existing mobile data	£0, BAU

	Indicators & Insights	Reporting frequency	Source	Indicative Cost to CAP
Outcomes level 2: Observable responses to interventions				
CAZ	Volume of non-compliant vehicles entering	Monthly	CAZ payments & enforcement system	Within Financial Case
	Regional and District Centre traffic composition	Annual	Cordon counts	£0, BAU
Incentives & other initiatives	Numbers taking up fuel change assistance	Monthly	System administration	£0, part of operations
Outcomes level 3: Behaviours and attitudes				
CAZ	Proportions of respondents who modify their behaviour in various ways (e.g. switch fuel, travel less) and who don't. Proportions of respondents who change behaviour citing GM CAP as principal reason.	Within 3 months post-implementation; Repeat 1 or 2 years after.	Survey of businesses	£150k
	Understanding of ranges of changes and reasons to inform survey design above.	One-off, post-implementation	Qualitative methods: focus groups and depth interviews	£50k
Incentives & other initiatives	Proportions of those taking up incentives of those enquiring. Proportions of reasons cited for taking up/not.	1, 2 and 3 years post-intervention	On-line survey of people who register an interest.	£15k

	Indicators & Insights	Reporting frequency	Source	Indicative Cost to CAP
Outcomes level 4: Customer experiences & consequences				
CAZ	(1) Proportions satisfied with their interaction with various aspects of the system. (2) In-depth understanding of impact on businesses and how they have responded. (3) Quantify effects on business	(1) Within 3 months post-implementation Repeat 1 and 2 years after. (2) Within 3 months post-implementation Plus one year later (3) 2 or 3 years post-implementation	(1) On-line survey using contact details from customer database (2) ca. 30 Qualitative interviews in each wave (3) On-line survey through business forums plus background local economic data e.g. business rates, retail vacancy rates, employment.	(1) Included in Incentives survey above (2) £24k (3) £15k
Incentives	Proportions satisfied with their interaction with various aspects of the system.	Within 3 months post-implementation	On-line survey using contact details from customer database	Included in £15k above