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

# Options Appraisal Report



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**Table of Contents**

# 1 Introduction

1.1 This document provides a summary of the optioneering process undertaken in the development of the Greater Manchester Clean Air Plan (GM CAP).

1.2 The process involved a combination of approaches, including:

- Internal workshops with Transport for Greater Manchester (TfGM), the Steering Group of local authority officers, and their consultants to draw up long list of measures;
- Extensive discussions with industry experts including vehicle fleet managers, manufacturers and air quality analysts, as well as with Joint Air Quality Unit (JAQU) specialists;
- Stakeholder engagement with local authorities (beyond the Steering Group), business groups and politicians;
- The development of bespoke tools to analyse the findings of this research including air quality modelling, traffic modelling and multi-criteria assessment toolkits.
- The application of an iterative approach as the team learned more about the priorities and concerns of the stakeholder groups, and the risks, impacts and effectiveness of the measures. A series of sifting processes were undertaken in working towards the final solution.

1.3 Nearly 100 separate measures have been considered in the development of the GM CAP under consideration for the Outline Business Case (OBC). These measures have been carefully tested and reviewed by industry experts through a high-level assessment process.

1.4 The measures have been narrowed down and combined into three Options of packages of measures for modelling and analysis in the OBC. This appendix describes the timeline and the processes that were undertaken to move from the initial identification of potential measures to the proposal of the three best performing options fully appraised in the OBC.

# 2 Critical Success Factors

2.1 Throughout the optioneering process, options have been assessed against the UK Government's Critical Success Factors (CSF). The Primary Critical Success Factors were set by the Joint Air Quality Unit (JAQU), whilst the Secondary Critical Success Factors were set during the Strategic Outline Case (SOC) process, to understand a wider range of impacts of different measures, beyond those considered critical within the JAQU guidance. The Secondary Critical Success Factors were developed in discussion with JAQU.

**Primary CSF**

- **Reduction in NO2 emissions:** the likelihood that the measure/option will contribute significantly to a reduction in $NO_2$ concentrations, enough to achieve compliance with the EU Limit Values in the shortest possible time.
- Feasibility: the likelihood of the measure being implemented in the shortest possible time to deliver the desired $NO_2$ reduction and achieve compliance.

**Secondary CSF**

- **Strategic fit with local strategies and plans:** ensuring the alignment of the option with longer term economic, social and environmental goals and that the risk of unintended consequences is minimised.
- **Value for money:** an indication of the costs and benefits of each option.
- **Distributional impact:** in order to understand the potential impacts, both positive and negative on different groups within society, with a particular focus on the most vulnerable. It is of vital importance that the plan does not result in significant economic or social impacts for the region or those living, working or doing business within it.
- **Deliverability** - A series of measures assessing the deliverability of the options, in terms of:
  - Affordability of the cost of implementation,
  - Supply-side capacity and capability
  - Achievability of delivering the option

# 3 Timeline

3.1 The development of the Options and the individual measures has been ongoing for over a year and has progressed through four key phases. Table 1 summarises these, highlighting the process and approval decisions undertaken.

**Table 1: Timeline of option development process**

| Phase | Stage | Process Undertaken | When | Approval |
|---|---|---|---|---|
| **Phase 1:**<br>**Strategic Outline Case** | Identification of a long list of nearly 100 measures in 12 categories. With shortlisting to 17 measures. | Brainstorming of all measures – shortlisting using professional judgment against the Critical Success Factors. | Winter / Spring 2018 | LA governance and submitted to JAQU in Spring 2018. |
| **Phase 2:**<br>**Target Determination** | Identification of the local air quality challenge. | Modelling & analysis to identify the scale of the challenge and points of exceedance of air quality levels in 2021, confirmation of locations of non-compliance to be addressed by the CAP. | Spring / Summer 2018 | Submitted to JAQU and approved by them for publication as a GMCA paper in Autumn 2018. Final confirmation that Target Determination has been completed expected from JAQU by end February. |
| **Phase 3:**<br>**High Level assessment** | a. Expansion of shortlisted measures to 95 implementation options. | Detail was added to the shortlisted measures, which were expanded to give multiple variants on how they could be delivered. Subsequently this provided a list of 95 implementation options. | Summer 2018 | Steering Group and engagement with Executive Members and Leaders. |
| | b. Examination of the 95 implementation options and identification of measures | Stakeholder engagement - industry expert feedback - capacity assessments - traffic and air quality modelling – application of bespoke MCA toolkit. | Summer 2018 | |

| Phase | Stage | Process Undertaken | When | Approval |
|---|---|---|---|---|
| | c. Aggregation of measures into 6 Clean Air Plan Options. | Aggregation based on differing measures of incentives, parking and scales/severity of CAZ. | Autumn 2018 | |
| **Phase 4a:**<br>**Appraisal of 6 options and further shortlisting for full economic analysis** | a. Selection of 3 Clean Air Plan Options to progress to full analysis. | Modelling and appraisal. | Late 2018 | Discussed with Steering Group, Executive members and Leaders<br>Concerns were raised and the need for further refinement identified. |
| **Phase 4b:**<br>**Re-evaluation** | b. Addition of two further Options, as the risk of unintended socio-economic consequences was not fully understood and other options have not been explored in sufficient depth to be ruled out. | Further analysis on the CAZ D Clean Air Plan Options was undertaken to understand socio-economic implications and further traffic and air quality modelling carried out to consider alternatives. | Early 2019 | To be approved via full LA governance and submitted to JAQU in March 2019. |

# 4 Phase 1 Strategic Outline Case (SOC)

4.1 In developing the SOC a long list of nearly 100 measures were identified as potential interventions that could either be implemented in isolation or as a package of measures to support the delivery of the Primary CSF. The measures were identified through desk-top research, measures from other cities and input from a range of stakeholders. These measures were grouped in 12 categories as shown in

4.2 Table 2 below.

**Table 2: Categorisation of measures**

| Number | Category | Description |
|---|---|---|
| 1 | Clean Air Zone | Charge-based zones of different vehicle classes and geographies |
| 2 | Financial | Subsidy schemes, incentives, tax exemptions |
| 3 | Education / Awareness | Publicity, engagement, non-charge-based CAZ |
| 4 | Planning | Planning (developer) requirements, pedestrianisation |
| 5 | Business | Reward schemes or mandates that impact private businesses |
| 6 | Cycling & Walking | Active travel infrastructure, skills/training, cycle share |
| 7 | Parking | Parking provision and pricing, park & ride |
| 8 | Public Transportation | Public transport infrastructure, bus emissions standards or retrofitting, car sharing, concession fares, route restrictions |
| 9 | Alternative Fuel Infrastructure | Infrastructure to support uptake of non-petrol/diesel vehicles |
| 10 | Traffic Control Infrastructure | Traffic management strategies and infrastructure |
| 11 | Freight | Consolidation centres, permitting / restrictions |
| 12 | Taxis | Incentives / infrastructure to encourage transition to alternative / cleaner vehicles |

4.3 The long list was reduced to 17 measures through qualitative impact scoring; a yes/no deliverability assessment; and an extensive document review, with the objective of applying the metrics that correspond to Primary and Secondary Success Factors. The documents contained within the review included:

- GM Air Quality Action Plan
- GM Low Emission Strategy
- GM 2040 Strategy
- Data shared from Birmingham City Council
- Birmingham City Council website
- Ricardo Evidence Review of measures 2014 (Edinburgh, Richmond, York)
- Air Quality Plan 2015 West Midlands UK0035
- Air Quality Plan 2017 West Midlands UK0035

- Birmingham Connected Technical Package 1, 2, and 3
- UK Air Quality Plan 2017
- TfWM website
- Ongoing testing by Highways England/Department for Transport on Gas to Liquid (GtL) as an alternative fuel
- NICE guideline on Air Pollution: outdoor air quality and health
- Leicester integrated traffic management research
- Blueprint for low carbon fuel infrastructure
- West Yorkshire Low Emission Strategy (LES)
- TfGM Charge-based CAZ initial feasibility work 2017

4.4 Table 3 below provides a summary of the resulting shortlisted measures.

**Table 3: Strategic Outline Case Shortlisted Measures**

| Reference | Measure | Description |
|---|---|---|
| | **CAZ** | |
| 1 | Charge-based CAZ - Category B or C; different geographical boundaries / time restrictions | Category B includes non-compliant bus, coach, taxi/PHV and HGV.<br>Category C includes the above plus non-compliant LGV |
| 2 | Charge-based CAZ - Category D; different geographical boundaries / time restrictions | Category D includes all of Category C plus non-compliant private cars |
| | **Parking** | |
| 3 | Differential parking charges | Related to usage/capacity (e.g. different charges for times of day to reduce congestion); vehicle type (e.g. free for electric or reduced for car sharers or for emission standard/engine size); residential parking zones and; workplace parking levy |
| | **Public Transport** | |
| 4 | Retrofitting or upgrade of public transport fleet and introduction of stringent emissions standard through contracts or partnership | Retrofitting of public transport fleet to cleaner alternatives. Set stretching targets to improve the efficiency of fleet and specify emission standards in bus contracts |
| 5 | Increase capacity of public transport on specific routes | |
| | **Infrastructure - Alternative Fuels** | |
| 6 | Switch bus, HGV/LGV depot fuelling stations or GM fleet to GtL | Use of GtL fuel as a diesel alternative. (if Public Transport retrofit is standard measure then would not need GtL for commercial bus but could apply to community transport) |
| 7 | LGV – Electric Vehicle (EV) incentivisation | Additional EV charging points; promotion of EVs |
| 8 | Improve Local Authority fleet to electric/LPG/low emission through a procurement policy | |
| | **Infrastructure - Traffic Control** | |

| Reference | Measure | Description |
|---|---|---|
| 9 | Congestion Plan traffic management – increased capacity | Providing more highway capacity – review of existing junction improvement plans. Assess existing schemes to understand potential benefit on specified links; with a view to bringing schemes forward sooner |
| 10 | Congestion Plan traffic management – encouraging alternatives | Encouraging alternative travel choices – road space reallocation in order to suppress latent car demand released through implementation of other measures |
| 11 | Congestion Plan traffic management – network management | Signal optimisation – changes to traffic signal timing to optimise flows in order to reduce congestion on specified links |
| | **Taxis** | |
| 12 | Incentives for private hire vehicles to change to EV vehicles. Installation of rapid EV infrastructure for taxi and private hire vehicles. | Incentivise private hire vehicles to changes to EV/ULEV vehicles through reduced licence fees/ free top up at taxi charge points |
| 13 | Retrofitting of Hackney Carriages to LPG/Euro 6. Increase LPG refuelling infrastructure | Retrofitting of Hackney Carriages to LPG/Euro 6 |
| | **Non-charge-based CAZ awareness activities** | |
| 14 | Communications campaigns/awareness raising of health and cost benefits of different modes | Communications campaigns/awareness and signage |
| 15 | Travel choices programme (businesses & individuals) | Dependent on scale of programme |
| 16 | Active travel programme – engagement | Encouraging a switch to active travel modes |
| | **Cycling & Walking** | |
| 17 | Active travel programme – infrastructure | Provision of measures to encourage modal shift to active travel to PT hubs and for short journeys |

# 5 Phase 2 - Target Determination

## Government Air Quality Plans

5.1 Government Air Quality Plans have delegated responsibility for meeting legal Limit Values to local authorities where national Pollution Climate Mapping (PCM) modelling predicted concentrations of $NO_2$ on stretches of road would exceed the Limit Values beyond certain timeframes. Eight Greater Manchester local authorities have been directed to undertake feasibility studies to identify measures for reducing $NO_2$ concentrations within the "shortest possible time". These studies must produce a series of business cases for assessing and implementing the relevant measures in a Clean Air Plan.

5.2 The National Plan identified eleven areas of road, across seven local authorities within Greater Manchester, where the national Pollution Climate Model predicts $NO_2$ concentrations are likely to exceed the statutory $NO_2$ annual mean EU Limit Value beyond 2020. A further ministerial direction in March 2018 identified Oldham Metropolitan Borough Council as one of 33 local authorities with "shorter-term $NO_2$ problems" and required it to produce a feasibility study.

## Local Air Quality Modelling

5.3 As the predictions in the national model are based on national scale assumptions and datasets, they must be verified against local evidence before any detailed assessment of options for reducing $NO_2$. Subsequently, during their feasibility studies, local authorities must submit 'Initial Evidence' to define and confirm the local air quality problem and model concentrations of $NO_2$ in 2021 based on a "do minimum" scenario.

5.4 As part of their feasibility studies, local authorities must gather local evidence and conduct local modelling to confirm their $NO_2$ problem and model predicted concentrations of $NO_2$ beyond 2020 based on a "do minimum" scenario. This scenario is based on historical patterns of vehicle turnover, already planned junction improvements and road layout changes.

5.5 The analysis has revealed a wider $NO_2$ problem than that initially identified by the Government's National Plan. Whilst the local model is generally in agreement with the PCM exceedances, it predicts a greater spatial distribution of exceedances and higher concentrations of $NO_2$ than those initially identified. Sections of road with concentrations of $NO_2$ over 40 $\mu g/m^3$ are located across all 10 Greater Manchester local authorities, in a similar distribution to the air quality problems identified in the established Air Quality Management Area.

5.6 Local modelling identified 152 stretches of road (road links) where concentrations of $NO_2$ are forecast to exceed the legal Limit Value (40 µg/m$^3$) beyond 2020. 112 of these road links are on the national PCM model, which have the highest car use and heavy freight flows. 40 of these are shorter stretches of local roads, around town centres across Greater Manchester. These are routes that are frequently used by buses and vans, which are not included in the national model.

5.7 In total, there are 250 points of exceedance identified in the local modelling in 2021, including 62 with concentrations between 45 µg/m$^3$ and 50 µg/m$^3$, and 13 with concentrations over 50 µg/m$^3$.

5.8 The main reasons for the differences between local and national models include: the vehicles using Greater Manchester's roads are typically older than the national average (especially buses and taxis); local traffic data showed that, in some areas, vehicles are moving more slowly than the national modelling anticipated; and because local modelling also showed higher background concentrations of $NO_2$.

5.9 In addition, higher concentrations of $NO_2$ were identified in the regional centres (particularly Manchester city centre) due to the volume of demand on these roads, and to something referred to as the 'canyon effect'. This term refers to the reduced air flow and circulation caused by tall buildings or in densely built up areas that acts to reduce the diffusion and dissipation of air pollutants that occurs in more open or low-rise locations.

**Implications for the Greater Manchester Clean Air Plan**

5.10 After receiving the 'Initial Evidence' from Greater Manchester, JAQU undertook a process called 'Target Determination', which involves comparing the outputs of the local and national modelling, verifying the local modelling process and then agreeing the forecast exceedances. JAQU also ensures consistent approaches to local modelling are being used by different local authorities.

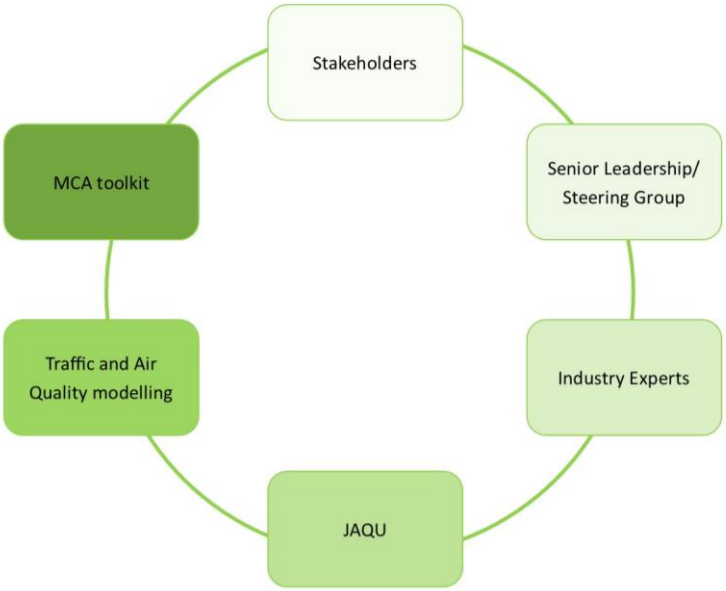
5.11 The outcome of this process is an agreement of the $NO_2$ exceedances that Greater Manchester must resolve when determining possible solutions. This agreement has been reached and GM awaits formal confirmation of this from JAQU. Once the Greater Manchester modelling is agreed by Government, illegal exceedances in all ten local authority areas need to be addressed.

5.12 The clear disjoint between the PCM modelling and the local air quality modelling raised implications for the Clean Air Plan as a whole. The area of coverage is more wide-ranging and the extent of exceedance more severe than envisaged during the development of the SOC. As such the feasibility study work going forward needed to embrace this data and the scope and scale of the interventions required. The Target Determination analysis very much set the scene for the development of the High-Level Assessment under Phase 3 of the process.

## 6 Phase 3 – Stages a & b – High Level Assessment and Refinement

6.1 Figure 1 illustrates the iterative and concurrent process undertaken in the high level assessment of the measures. The principle is that no one element took precedent and the information received as the assessments progressed fed back again to the other elements. This process was carried out at each stage of Phase 3.

**Figure 1: Iterative relationship process diagram**




6.2 Technical leads were appointed for the shortlisted measures, and these were examined in much greater detail. The key focus of the measure development was to understand the ability of each measure to address the CSF.

6.3 To this end, where possible the measures were modelled through the traffic and air quality modelling suite to determine their fit with the air quality compliance CSF. Details of deliverability and achievability were developed to determine timeframes for implementation and the capacity of industry to achieve tight timescales. Associated costs were also considered in the assessment of each measure.

6.4 Table 4 below provides a summary of each of the measures, the assessment that has been carried out, and the implications for the CAP.

**Table 4: Measures Summaries and Optioneering Considerations**

| Measure - reference | Description | Discussion |
|---|---|---|
| **Clean Air Zone (CAZ)** | | |
| 1 CAZ - B or C;<br>2 CAZ - D; | The purpose of a Clean Air Zone (CAZ) is to create a financial disincentive to driving a non-compliant vehicle, by imposing a daily charge on those driving into, within or through a specified zone.<br>The Government has specified four categories of CAZ:<br>• Category A: buses, taxis and private hire vehicles<br>• Category B: as Category A, plus HGVs and coaches<br>• Category C: as Category B plus LGVs and minibuses<br>• Category D: as Category C plus cars and motorcycles and moped<br>Compliant vehicles are defined as:<br>• Buses, coaches, HGVs and Vans – Euro 6<br>• Cars – Euro 4 or newer petrol or Euro 6 diesel<br>• Motorcycles and mopeds – Euro 3 or newer<br>CAZs differ from Congestion Charging Zones in that:<br>• The objective of a CAZ is for a reduced number of the most polluting vehicles to travel in the zone, and to encourage vehicle upgrade. Thus, the charge is only applied to the most polluting vehicles. Over time, the revenue reduces as fewer vehicles are required to pay.<br>• The objective of a Congestion Charge is to reduce the total volume of traffic within a zone, by | Options were considered for CAZ categories B, C and D.<br>And for geographic boundaries including:<br>• Inner relief route<br>• Intermediate ring road<br>• M60 crossing points<br>• Satellite zones around main GM town centres<br>• GM wide boundary<br>The potential for the measures to achieve compliance in the shortest possible time was strong but it was clear that no single measure could deliver compliance by 2021 GM-wide. It also became clear that any CAZ would need to be supported by measures to help upgrade the fleet, as there was a risk that a CAZ without such support would be ineffective, with high levels of non-compliance and the risk of perverse consequences such as a reduction in bus or taxi provision.<br>It was considered that the socio-economic implications on GM could be significant, particularly of options including satellite zones around town centres and all CAZ D proposals. An initial assessment of the role of discounts and exemptions was undertaken, to be progressed further through stakeholder engagement at a later stage.<br>Deliverability by 2021 was considered challenging for some measures.<br>The effectiveness of the CAZ measures is described in more detail in Section 7 below. |

| Measure - reference | Description | Discussion |
|---|---|---|
| | encouraging people to travel by another mode or change their journey. Charges are applied to all vehicles and it is to be expected that most people will stay and pay. As such, schemes are highly profitable and provide resources for public transport, active travel and other measures. | |
| **Parking** | | |
| 3 Workplace Parking Levy (WPPL) | Free parking at workplaces acts as an incentive to travel by car. Placing a levy on that parking encourages workplaces and individuals to consider the value of that parking space and of their decision to travel by car. Limiting or charging for parking deters car travel.<br><br>Workplace Parking Levies work by imposing a levy on all workplaces above a certain size within a specified area, based on the number of parking spaces available to staff, visitors and customers. Workplaces can opt to reduce the amount of parking offered or pay the levy. They are not required to pass on the levy to staff, visitors or customers but can choose to do so. | A WPPL has been shown to be effective in Nottingham in reducing the amount of parking offered to staff, visitors and customers at city centre workplaces, and has raised revenues to improve public transport provision in the city.<br><br>However, a WPPL would be slow and complex to deliver and is not efficiently targeted at the core goal of reducing NOX emissions. Not all workplaces pass on the levy and the levy is applied to all parking spaces, regardless of the emissions standard of the vehicle parked in it. This would mean that workers/visitors/customers at sites where they charge was not passed on could continue to travel in a non-compliant vehicle unaffected, whereas someone with an EV may have to pay at a site where the charges are being passed on. In summary, WPPLs are an effective measure where the goal is to deter car travel in general and support public transport and active travel infrastructure improvements but are not likely to deliver compliance in the shortest possible time. |
| 3 Differential Parking charges: Residents Parking | Limiting or charging for parking deters car travel. Applying higher or lower charges depending on the vehicle emissions could change purchasing patterns.<br><br>Some local authorities in London have introduced differential charges for residents' parking permits based on the emissions of the vehicle. It is also possible to introduce differential parking charges into | While this may act as a deterrent to purchasing a dirtier vehicle/incentive to purchase a cleaner vehicle, it would be extremely difficult and expensive to implement in Greater Manchester, where the vast majority of on street parking is currently uncontrolled. In some districts, there are no controlled parking zones. Furthermore, the measure would be less effective in suburban areas where most households can park off street. In summary, it is unlikely that this measure can be |

| Measure - reference | Description | Discussion |
|---|---|---|
| | public car parks where a number plate is recorded, so that vehicles with worse emissions are charged at a higher rate. | implemented, and it would not deliver compliance in the shortest possible time.<br><br>Differential parking charges in public car parks could be an effective deterrent if applied universally but a key issue is that the ownership of parking is not wholly within the powers of the local authority and there is a key risk that drivers would simply choose to park in an unaffected private car park, or travel elsewhere for example to out of town retail destinations offering free parking. The timescale for implementation would be long as changes could only be made at contract re-let stages. Contracts are let for many years. In summary, this measure would be very slow to implement and have only limited impact and so does not deliver compliance in the shortest possible time. |
| 3 Differential Parking charges: Free or priority parking for ULEVs | Offering free or priority parking to ULEVs could be an effective incentive to help overcome the cost barrier to purchasing an EV.<br><br>Free parking or parking spaces for ULEVs can only be provided in public car parks or on street where parking is controlled | This measure could act as an incentive, if implemented alongside promotion for EVs and the installation of charge points. However, there are some concerns that this benefit would go primarily to wealthier members of society. This measure has been included as an option for local authorities to consider when setting their parking strategies to ensure they align with the goals of the CAP. |
| 3 Reduce parking availability | Readily available, low cost or free parking encourages people to travel by car by making it cheap and convenient. In some locations, where other options are available, it may be appropriate to re-consider the availability or cost of parking. This could include measures such as converting long stay to short stay parking; enforcing planning conditions so that land awaiting development cannot be used as 'infill parking; or removing free parking by implementing controlled parking zones. | This measure could act as a disincentive to travel by car, if applied in appropriate locations. This measure has been included as an option for local authorities to consider when setting their parking strategies to ensure they align with the goals of the CAP. |

| Measure - reference | Description | Discussion |
|---|---|---|
| 3 Act on parking at council worksites | There is an opportunity for local authorities to lead by example to encourage sustainable travel and cleaner vehicles through policies affecting council staff.<br><br>GM's authorities are committed to leading the way and in some places are already exploring options to limit the availability of parking for staff, prioritise cleaner vehicles or encourage car sharing or travel by sustainable modes. | These measures would have a limited impact on air quality overall but are available to local authorities wishing to take local action and lead by example in support of the GM CAP. |
| **Public Transport** | | |
| 4 Public Transport fleet retrofit | The current bus fleet in GM is just under 2000 vehicles and less than 10% of these are compliant Euro VI. Of the remainder most (c1,300) are Euro IV and V with around 350 older buses still operating in the region. The current fleet replacement rate is around 7% per annum.<br><br>Given the age of the fleet and the current replacement rate it will be far beyond 2021 before the bus fleet is compliant.<br><br>Technology is available to retrofit buses older than Euro VI to comply with Euro VI emissions standards. | Greater Manchester has a deregulated bus service, and service provision is subject to commercial decisions made by private bus operators. Buses contribute significantly to poor air quality, but imposing charges without support to retrofit or renew the fleet creates the risk that operators will choose to reduce the frequency of bus services or withdraw routes altogether rather than upgrade their fleets. This is contrary to Greater Manchester's goal to increase the share of journeys made by public transport, and risks reducing accessibility for the poorest and most vulnerable members of society.<br><br>Greater Manchester secured £3m from the Clean Bus Technology Fund to upgrade around 170 buses, this activity is underway. The oldest buses cannot sensibly be retrofit as they are close to (or beyond) the end of their suitable operational life. The proposal is for a bus fund the replace / retrofit the fleet as appropriate through support to operators. Operators suggest they have the capacity to undertake the process within three years.<br><br>This measure is both effective and necessary. Modelling suggests that delivering a compliant bus fleet could reduce exceedances by one third whilst protecting the bus service |

| Measure - reference | Description | Discussion |
|---|---|---|
| | | offer. This measure is therefore included in all Best Performing Options. |
| 5 Public Transport Capacity | Reducing the need to travel by car by improving the quality of the alternatives has been proven to be effective in delivering mode shift from the car to sustainable modes and reducing traffic volumes. Lower traffic levels and reduced congestion lead to lower emissions.<br><br>Consideration of increases in the capacity of all PT modes, including bus, Metrolink and rail. | In the longer term, improving the public transport offer in the region is the most sustainable way to reduce emissions. However, it was clear that it would not be possible to implement changes to the frequency and capacity of rail or Metrolink services, beyond the improvements already planned and underway, within the very short timescales required. The deregulated bus service means that GM's local authorities lack the powers to offer new or more frequent bus services. Consequently, no specific proposals are included in the GM Cap for public transport capacity improvements. GM has committed to providing bus operators with data to support the provision of additional commercial services where demand allows. The GM CAP is placed within the context of the ambitious plans for public transport improvements set out in GM's Transport Delivery Plan, published in January 2019. |
| **Infrastructure – Alternative Fuels** | | |
| 6 Gas to Liquid (GTL) conversion | GTL is an alternative synthetic fuel source that can be used in existing vehicles without the need for retrofitting or upgrading.<br><br>Testing from DfT showed a 12.0% reduction in NOx emissions for GTL use in a Euro IV engine (416 mg/km) and an 18% (10 mg/km) reduction in a Euro VI engine, based on an 18t rigid truck. Equivalent results for Euro V and III were calculated at 278 mg/km (9%) lower for Euro V and 447 mg/km (9%) for a Euro III. Benefits are greater for older, heavier, more polluting vehicles. | Availability of the fuel is low at present, but discussions with industry have intimated that this should not be a problem if a GTL policy was pursued.<br><br>GTL has a premium of between 5 and 10p per litre and this is likely to cause a barrier in a highly competitive haulage industry. Support to cover the premium direct to hauliers is likely to hit state aid issues, but central government taxation treatment could support sider implementation.<br><br>However, stakeholder engagement indicated significant concerns within the industry about the implications of GTL retrofit in terms of the maintenance of vehicles and the risk of invalidating warranties. |

| Measure - reference | Description | Discussion |
|---|---|---|
| | The concept was to provide incentive funds to elements of the HGV GM vehicle fleet to convert their vehicles. | The decision was made not to progress with this measure |
| 7 EV incentivisation | Electric vehicles emit zero NOx emissions. Conversion of the car and LGV fleet across Greater Manchester to EV would provide a positive impact on air quality. Currently less than 0.5% of the car and LGV fleet in GM are EV's<br><br>Modelling suggests that the ambitious EV growth projections resulting from additional investment in EV charging infrastructure would lead to a 5% reduction in NOx emissions across GM.<br><br>The proposed measure is to facilitate a shift to electric vehicles achieved via further expansion of the Greater Manchester Electric Vehicle charging network. | TfGM is currently progressing expansion of the GMEV EVCI network with plans for installing a minimum of 24 dual point rapid chargers by September 2019 as part of the Early Measures project funded by JAQU.<br><br>The increasing appeal of EV and the provision of supporting infrastructure is expected to significantly increase the EV fleet across GM. The EV charging network is an important element of that.<br><br>This measure is effective in supporting the delivery of compliance in the shortest possible time and is therefore included in all Best Performing Options. |
| 8 Local Authority fleet to electric / LPG / low emission | A local authority fleet that operates with low emission vehicles can play a part in cleaner air for the region. Currently, less than 2% of the fleet is EV and 57% is older than Euro IV. Most local authority vehicles are HGVs and LGVs.<br><br>The proposal is to improve the emissions quality of the LA fleet and some emergency service vehicles through replacement and retrofit. | It is not economic to upgrade the whole fleet given the highly specialized nature of some of the vehicles and their low usage (for example, gritting lorries). The ability to upgrade the fleet quickly is partly constrained by the extent of existing leases entered into by the LA's. It will be challenging to ensure there are no Euro V or older vehicles and a reasonable take up of EV vehicles by 2021.<br><br>The small size of the LA fleet in relation to the overall network (>0.1%) means that conversion is unlikely to have a significant impact on overall AQ. However, the marketing and messaging associated with LA compliance is a strong factor in support of the intervention. |
| **Infrastructure – Traffic Control** | | |

| Measure - reference | Description | Discussion |
|---|---|---|
| 9 Congestion Plan traffic management – increased capacity | Increased vehicle speeds, reduced congestion and reduced idling time has a significant impact on local air quality. Many of the air quality exceedances are around key congested junctions and links, so reducing that congestion could be effective in tackling air quality. The intervention considered a variety of techniques to increase network capacity, typically involving additional road space or road space reallocation such as:<br>• Increased turning lane length<br>• Additional lane capacity<br>• Road space reallocation<br>• Access road closure | Traffic management measures could prove useful in the reduction of exceedances at key network points. But at a network level, the approach is likely to either reassign traffic to other parts of the network or improve road conditions such that additional traffic is generated. Therefore, whilst this approach may be successful for isolated sections of road, it does not provide a strategic approach to the region-wide air quality challenge facing GM. Traffic management measures are being progressed separately as part of the GM Congestion Deal. Implementation may also be challenging in some locations due to road space constraints, and there is a risk that this approach would conflict with the goal to improve conditions for cyclists and pedestrians.<br>In summary, whilst this measure may be revisited at a later stage, it does not form part of the GM CAP strategic approach. |
| 10 Congestion Plan traffic management – encouraging alternatives | Reducing the number of car journeys by encouraging the use of alternative modes or more efficient use of vehicles (such as through car sharing) is an effective way to reduce traffic and therefore air quality. One way to achieve this is by prioritising road space for more sustainable modes (such as cyclists or pedestrians), for cleaner vehicles, or for vehicles with more than one occupant. | In the long term, encouraging more sustainable methods of travel has the potential to reduce traffic and improve air quality. However, evidence suggests that in an urban environment allocating road space to High Occupancy Vehicles or electric vehicles creates risks of traffic reassignment and therefore the redistribution of air quality hotpots. In the longer term, for example as the EV fleet becomes larger in number, such measures could become more suitable.<br>The Streets for All programme has involved the reallocation of road space to more sustainable modes – these schemes have been successful in Manchester in key locations such as Oxford Road. The AQ benefits in the immediate location appear to be strong. However, the impact of displacement on adjacent roads is a potential concern and not yet fully understood. Implementation timetables are likely to be significant. |

| Measure - reference | Description | Discussion |
|---|---|---|
| 11 Congestion Plan traffic management – network management | This intervention considered a variety of Network Management techniques aimed at improving traffic flow:<br>• Advanced warning (VMS)<br>• Signal optimization<br>• Scoot/MOVA signal flow systems<br>• Priority Vehicle signal activation | Each of the options has the potential to improve AQ in the local vicinity and could prove useful in the reduction of exceedances at key network points. However, the approach is likely to reassign traffic to differing parts of the network and whilst successful for isolated sections of road, on balance may not provide significant AQ improvements. |
| **Taxis** | | |
| 12 Taxis / PHV to EV | There are more than 13k taxis and private hire vehicles (PHVs) licensed in GM at present. Of these, 85% of taxis and two thirds of PHVs are currently non-compliant. Taxis and PHV are typically older and more polluting than the average vehicle. They also drive higher mileages per annum, particularly in urban areas and the city centre. Therefore they have a greater than average per-vehicle impact on air quality.<br>The proposal is to provide financial incentives to operators to upgrade to a cleaner vehicle, as well as supporting EV charging infrastructure. | Stakeholder feedback suggests take up could be strong and modelling has considered a scenario with up to 30% uptake from the fleet. Vehicle availability (new vehicles) is widespread, but the second-hand market is still relatively immature.<br>Measures to support the uptake of EVs by private hire and taxi drivers can be effective in supporting the delivery of compliance in the shortest possible time and are therefore included in all Best Performing Options. |
| 13 Taxis - Retrofit to LPG/Euro 6 | As described above, most hackney cabs operating in GM are older than Euro 6. For London-style hackney cabs (not required in all local authorities), the technology to retrofit to LPG or Euro 6 is well developed and operators have suggested they are keen on this approach. | Retrofit is a cost effective way of achieving compliance for London-style hackney cabs which are expensive to replace and have a long operational life. The key limitation is the industry capacity to undertake widespread retrofitting program, which is not well developed.<br>It is more difficult to retrofit older diesel engines and the cost of the fitting process will be greater than the value of the vehicles making the VFM of such a process poor. It is therefore recommended that retrofit of newer non-compliant hackney |

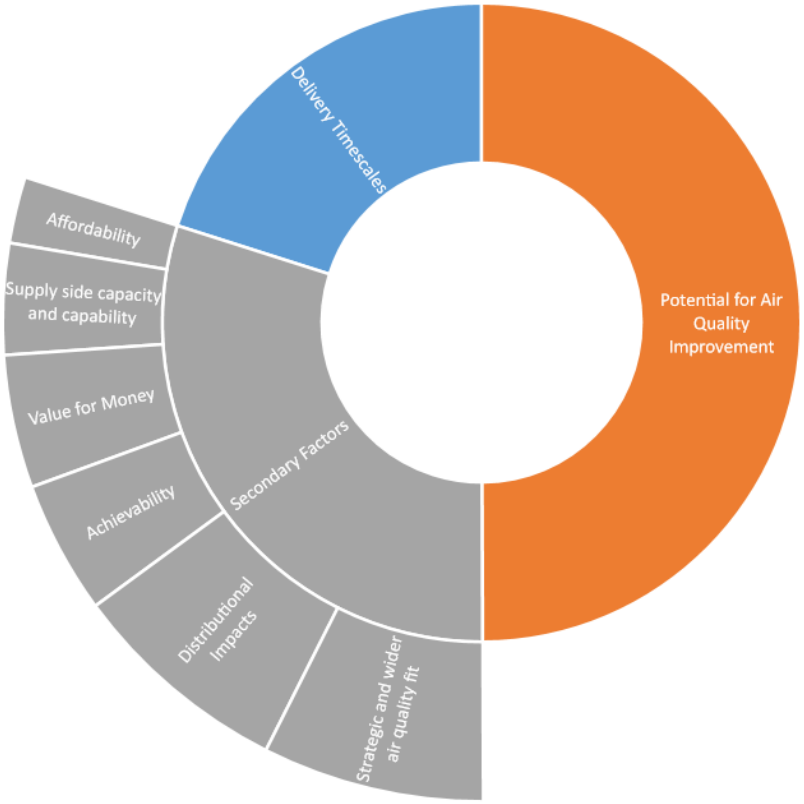
| Measure - reference | Description | Discussion |
|---|---|---|
| | | cabs is included as part of a basket of measures to support fleet upgrade in all Best Performing Options. |
| **Non-Charge based CAZ awareness activities** | | |
| 14 Campaigns / awareness raising of health and cost benefits of different modes | Evidence suggests that awareness of air quality issues is growing, but people are still confused as to what poor air quality means, where pollution comes from and what solutions would be effective.<br><br>Ongoing communications activity is proposed to help the residents and businesses of Greater Manchester understand the nature of the air quality challenge and what action they can take to reduce emissions. Communications will also be required to support each workstream, promoting awareness and ensuring people understand the opportunities and implications for them. | Initial research, including focus groups, was carried out in summer/autumn 2018 around perceptions of air pollution in Greater Manchester. This demonstrated that there was a fundamental lack of understanding of the causes and awareness of air quality issues.<br><br>The outputs from this research highlighted the need to raise awareness and understanding of air pollution as a health issue through public campaign activities. An initial phase of activity was delivered during Autumn 2018, the “Lets clear the air” campaign.<br><br>Communications will be embedded across the programme in all Best Performing Options. |
| 15 Travel choices programme (businesses & individuals) | Guidance on outdoor air quality and health (NG70) recommends taking a number of actions in combination, because multiple interventions, each producing a small benefit, are likely to act cumulatively to produce significant change. Addressing fleets, driver training, increasing walking and cycling, and awareness raising are recommended by the guidance, and are proposed.<br><br>The Sustainable Journeys proposals are for a support programme of targeted, effective education, promotional, influencing and enabling measures and incentives to help people and businesses understand how they will be affected by air quality and the GMCAP and how best they can adapt in order to reduce their NOx emissions. | Business, school and community engagement programmes have been proven to be effective in delivering mode shift to sustainable travel and raising awareness of sustainable choices. For example, evaluation of the LSTF project demonstrated that TfGM’s Travel Choices business travel behaviour change programme achieved a 24% reduction in staff who drive to work alone for five days a week or more (from 46% to 35% of commuters) amongst other positive outcomes.<br><br>Sustainable journeys measures will provide a positive means of interacting with those affected by the other CAP measures. Whilst it is not possible to calculate a quantified air quality benefit for this measure, it is clear that targeted behaviour change interventions could improve awareness of the GM CAP |

| Measure - reference | Description | Discussion |
|---|---|---|
| | The measure includes:<br>• Business engagement<br>• School and education engagement<br>• Community engagement | and of air quality more generally, and enhance the effectiveness of other interventions.<br>A programme of sustainable journeys interventions is therefore included in all Best Performing Options. |
| **Cycling and Walking** | | |
| 16 Active travel programme – engagement | Investment in infrastructure to promote active travel is a sustainable way to deliver air quality improvements and healthier lifestyles. Engagement activity encourages uptake and makes investment in infrastructure more effective. Travelling by cycle and on foot is emission free.<br>Measures could include improved crossings, cycle routing on quieter roads, pedestrian and cycle improvements at junctions and cycle parking. | GM has an ambitious programme of investment in active travel underway, forming the Bee Network – a network that will guarantee quality and ease of use. The focus is on a network approach rather than piecemeal improvements to allow a safe end to end journey.<br>The GM CAP is placed within the context of the £200m of improvements in cycling and walking planned for the same period. |
| 17 Active travel programme – infrastructure | | |

6.5 Many measures could be implemented in a number of ways and at different scales. The headline list of 17 measures was expanded to create several more specific delivery options, creating a full list of 95 implementation options.

6.6 Each of the 95 implementation options were scored on a scale of 1 to 5 as to how well it would deliver against the primary and secondary CSF. Figure 2 outlines the composition of the CSF in terms of primary and secondary factors.

**Figure 2: Composition of Critical Success Factors**

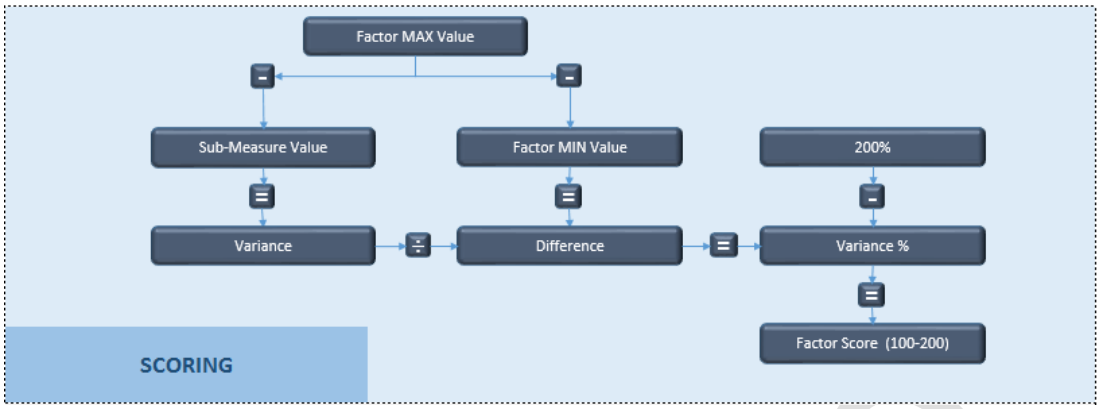



6.7 The 95 implementation options (covering the 17 measures) were then subject to Multi-Criteria Analysis (MCA). The MCA process is described in detail in a separate Multi-Criteria Analysis Model. A summary of the MCA toolkit is presented below.

**Summary of multi-criteria analysis toolkit**

6.8 The MCA toolkit uses a pro-rata scoring system whereby the Primary CSF input scores within each implementation measure/option are converted to their relative position on a 100-200 scale see Figure 3 below.

**Figure 3: Pro-rata scoring of an implementation option (sub-measure) / Option at CSF level**




6.9 Using this scoring mechanism, the best performing implementation measure / option scores 200 whilst the lowest performing scores 100. The rationale for adopting a 100-200 scale rather than 0-100 is that the lowest performing implementation measure / Options still contribute towards achieving a benefit, but this would not be recognised if a score of 0 was assigned.

6.10 To inform the pro-rata scoring of the 'Delivery Timescales' and 'Potential for Air Quality Improvements' CSF, the raw scoring (1-5 range) is either used directly (Coarse Filter Model) or averaged (Options Model) for pro-rata conversion.

6.11 To inform the pro-rata scoring of the 'Secondary Factor' CSF, an intermediate calculation is required. For the six Secondary CSF, the raw scoring is converted to the pro-rata range for each implementation option / Option. These scores are progressed to provide a '2nd Weighted Score'. The resultant score is then used to inform the overall 'Secondary Factors' score at the Primary CSF level for pro-rata conversion.

6.12 The MCA tool considered different scenarios with slightly changing prioritised ranking of the JAQU CSF. The purpose of the scenario testing was to sensitivity test the outputs and to improve the robustness of the rankings produced. The prioritisation always had the primary factors above the secondary factors but the prioritisation within these levels would change with each scenario.

6.13 The whole process was dynamic and iterative, using both the analytical team and the Steering Group to inform the process. Details of measures were fed into the MCA toolkit to support the optioneering and where new ideas or information were developed these were again fed back through the process.

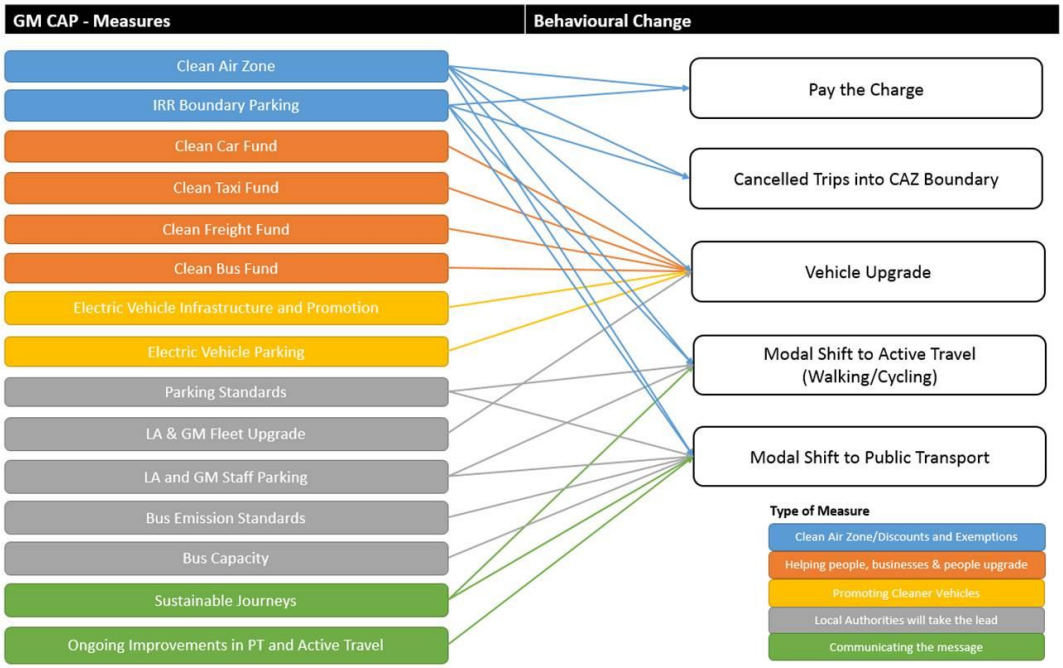
6.14 A key outcome of the iterative measure-development process was the development of a scrappage scheme measure. Scrappage/vehicle disposal emerged as a measure for consideration because:

- It became clear that a CAZ would be required, and at a much larger scale than initially anticipated. This meant that a large number of vehicle owners would be required to upgrade their vehicle.

- Analysis showed that the Greater Manchester vehicle fleet was older than the national average, reflecting many factors including deprivation in the region and the large number of very small businesses. This raised concerns about the affordability of upgrade and the validity of the behavioural response assumptions used (which were based on data from Bristol).
- Concerns were raised that residents and businesses could not have anticipated the measures and the message of the GM CAP, because Government policy had promoted diesel vehicles as a low carbon 'greener' option for many years.
- More recently, analysis has confirmed that older commercial vehicles are more likely to be owned by sole traders, who may find upgrade unaffordable.
- In summary, the goal of the GM CAP is to deliver a cleaner fleet and clean air, not to impose penalties on people who can't comply. Schemes that help small businesses, sole traders, not-for-profit organisations and residents to upgrade their vehicles can be beneficial for air quality and prevent socioeconomic damage as a result of the GM CAP.

6.15 The final result of the process was a shortlist of measures that had scored consistently well and now provided a more detailed description of the more valuable ways in which measures could be implemented in the Greater Manchester area. Figure 5 identifies the measures that were identified and the how they align with the behavioral changes being targeted.

**Figure 4: Shortlisted GM Clean Air Plan Measures and anticipated behavioural change**

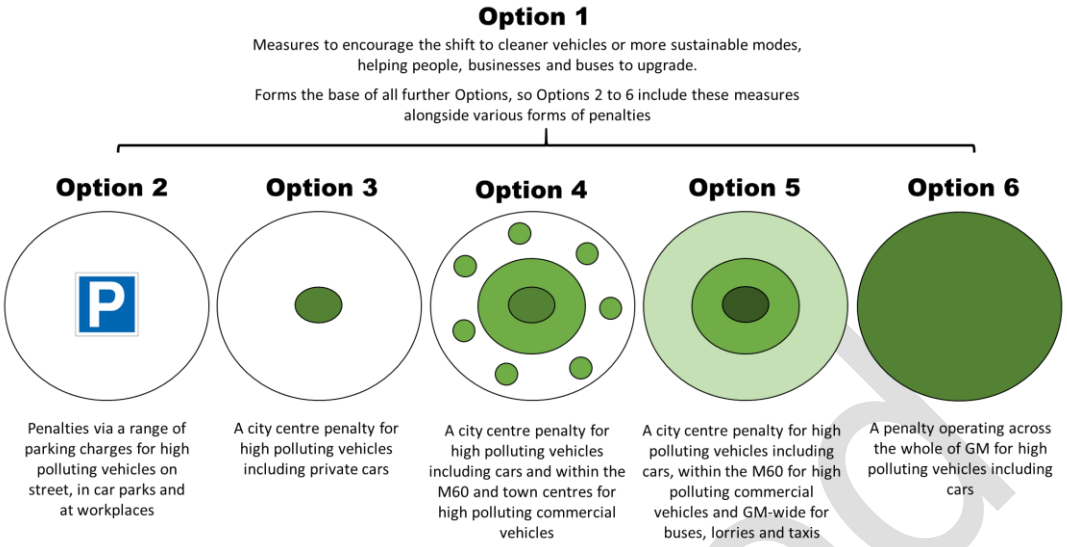



# 7 Phase 3 - Stage C - Identification of the 6 Clean Air Plan Options

7.1 The assessment of the measures as outlined in the section above and the packaging of the elements into CAP options was done concurrently, reflecting the challenging timescale to deliver the OBC. Creating 'packages' of measures was necessary as it was clear that no single measure would be able to deliver compliance in the shortest possible time, and instead the potential for many of the measures to support each other in achieving the aims of the CAP is a central theme, with the "whole" (Options) greater than the sum of the parts (Measures). Six Clean Air Plan Options were developed and are summarised in Figure 5.

7.2 What became apparent in the assessment of the measures is that undertaking individual measures in isolation risks unintended consequences and behaviours. As noted in the measures summary table (Table 4) many traffic management measures can cause re-routing and impact on alternative routes, additionally the age of the GM fleet and affordability to residents/businesses is such that wider incentives would be needed to ensure a CAZ delivered fleet upgrade rather than just enforcing penalties. Moreover, the paucity of infrastructure to support behavioural change (EV charging points, for example) all lead to the need to include measures beyond the wider constraints that may be proposed.

**Figure 5: Clean Air Plan Options**




7.3 The process behind the identification of these Clean Air Plan Options was to look at a range of options with a goal of:

- Establishing whether some sort of constraint measure would be necessary, or whether compliance could be achieved with incentive measures only.
- Establishing the forms of constraint measure that could be effective without employing a CAZ (for example, parking restraint).
- Testing different CAZ options to establish what scale of intervention might be necessary and develop an understanding of the high-level impacts (socio-economic / distributional) of such a scheme.

7.4 Options 1 and 2 seek to minimise emissions without a charging CAZ. Option 1 relies entirely on measures that provide active encouragement of cleaner vehicles and making sustainable modes more attractive. Option 2 adds in parking penalties and restrictions that dissuade the use of non-compliant vehicles. Options 3 – 6 all then include different forms of charging CAZs. In each case, the CAZ Options and Option 2 (parking) assumes the incentive measures (as per Option 1) are in place. This is considered an essential element of the CAP.

7.5 To determine the preferred options and sifting for more detailed analysis, traffic and air quality modelling was carried out where it was possible to do so. The MCA toolkit was used in conjunction with the modelling to determine the best performing options. A key element at this stage was wider stakeholder engagement with fleet operators and industry experts; as well as continued dialogue with JAQU to gain their support, insight and knowledge of experiences in other cities. This wider engagement has proven invaluable to informing the structure of the measures and raising awareness of the CAP within Greater Manchester.

7.6 More detailed analysis was undertaken as data sets were further developed. Some examples of the type of questions that were asked were:

- What is the composition of the vehicle fleet in Greater Manchester?
- How much of the traffic is local (from within GM) and how much is travelling into or through the region from elsewhere? What is the impact of the Highways England network on traffic and air quality in GM?
- What is the price and availability of upgrade and retrofit options for each vehicle type?
- What discounts and exemptions could reasonably be considered and how could these work?
- What charge levels would be reasonable and effective? – comparison of actual/proposed charge levels in other cities and their demographics compared to those of GM
- Who owns non-compliant vehicles and what are the potential impacts on them of a CAZ?

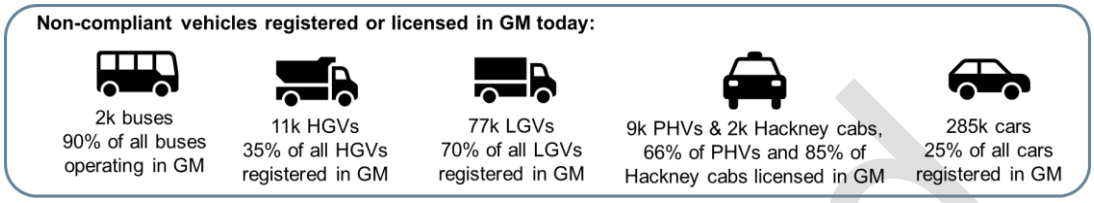
7.7 In many cases, this work identified gaps in our data and knowledge that it was not possible to resolve within the time available, and many of these issues will need to be revisited at FBC. In particular, for example, Greater Manchester has concerns about the cost and availability of second hand LGVs and lacks information about LGV purchasing and ownership patterns. As a result, the decision was taken to delay the implementation of a CAZ C to 2023 as it appeared that the price and availability of LGVs would be prohibitive if implemented in 2021. If these concerns are accurate, it could mean that if implemented in 2021, a CAZ C may be ineffective in delivering its core goal of compliance in the shortest possible time, whilst imposing unacceptable costs and economic damage on small businesses across the region.

7.8 Similarly, Greater Manchester has serious concerns about the cost and availability of compliant London-style hackney cabs and has sought clarification from JAQU, not yet provided, that they have evidence that sufficient vehicles will be available to meet the national demand imposed by the potential CAPs in cities across the UK including London.

7.9 There also remains concern about the impact of the Highways England network, and of through traffic particularly HGVs travelling on the east-west corridor from Leeds – Liverpool. Discussions are underway with JAQU and Highways England to agree the evidence and identify a satisfactory resolution.

7.10 A key issue that was identified was the age and composition of the respective fleets that could be affected by the scheme. This highlighted that Greater Manchester has an older than the UK average fleet and this, allied with lower than average incomes, meant that the need for financial support to effect behavioural change was amplified. Figure 6 shows the number and proportion of non-compliant vehicles in Greater Manchester in 2018.

**Figure 6 Composition of Greater Manchester vehicle fleet**




# 8 Phase 4 - Stage a - Appraisal of 6 options and further shortlisting for full economic analysis

8.1 This stage involved the assessment of each option again against the CSF. Three 'best performing' options were selected and subjected to further refinement and appraisal.

8.2 A brief summary of the initial assessment is provided in Table 5 below.

**Table 5: Outcome of the Initial Appraisal of Six CAP Options**

| Option | Evaluation | Outcome |
|---|---|---|
| **Option 1:** Measures to encourage the shift to cleaner vehicles or more sustainable modes, helping people, businesses and buses to upgrade.  | Assessment of a range of measures suggests that:<br>1. Some are not likely to be effective in tackling air quality, such as conversion from Gas to Liquid fuels or junction improvement schemes;<br>2. Some could be effective but are not deliverable within the timescale, such as new public transport capacity; and<br>3. Some could be effective with measures to deter the use of dirtier vehicles, such as incentives to upgrade & scrap vehicles, promotion of electric vehicles, and measures to promote sustainable travel choices. | On its own, does not deliver compliance in the shortest possible time.<br>Effective and feasible measures have been incorporated into the Best Performing Options for full evaluation. |
| **Option 2:** Penalties via a range of parking charges for high polluting vehicles on street, in car parks and at workplaces  | Parking measures have limited effect on the heaviest and dirtiest vehicles such as HGVs and buses and only affect those cars and vans that need to park in public places – so those with private off-street parking are not affected regardless of how dirty their vehicle is. In practice, would be expensive and slow to deliver due to existing contract restrictions. | Does not deliver compliance in the shortest possible time. Will not be progressed. |
| **Option 3:** A city centre penalty for high polluting vehicles including private cars  | A city centre penalty for high polluting vehicles would be effective in the city centre and have some effect on approach roads but would leave around 200 sites non-compliant across the remainder of GM, with non-compliance remaining in the city centre at some sites. Does not deliver compliance in the shortest possible time. | Does not deliver compliance in the shortest possible time. Will not be progressed. |
| **Option 4:** A city centre penalty for high polluting vehicles including cars and within the M60 and town centres for high polluting commercial vehicles  | Option 4 would reduce the number of non-compliant sites by around 80% in 2021. Concerns remain about whether customers would be able to understand and therefore respond to such a complex set of boundaries, and about the economic impact on town centres and deprived areas within the M60. | Initial evaluation suggests this Option may deliver compliance in the shortest possible time. A revised version of this Option, reflecting lessons learned, will be subject to a full evaluation as a Best Performing Option. |
| **Option 5:** A city centre penalty for high polluting vehicles including cars, within the M60 for high polluting commercial vehicles and GM-wide for buses, lorries and taxis  | Option 5 would reduce the number of non-compliant sites by around 80% in 2021. Concerns remain about the appropriateness of a boundary at the M60, given the distribution and cause of AQ hotspots in the area and the level of deprivation. Concerns also remain about the viability & effectiveness of applying penalties to vans on a large scale given the limited availability/high cost of compliant vans in 2021. | Initial evaluation suggests this Option may deliver compliance in the shortest possible time. A revised version of this Option, reflecting lessons learned, will be subject to a full evaluation as a Best Performing Option. |
| **Option 6:** A penalty operating across the whole of GM for high polluting vehicles including cars  | A GM-wide penalty for high polluting vehicles does not deliver compliance in 2021, with more than 20 sites remaining non-compliant despite significant trips per day being subjected to a penalty. Furthermore, the modelling results are not considered credible as the method is not appropriate for a region-wide scheme for car drivers, and it is likely that behavioural responses have been over-estimated. Delivery of a scheme on this scale would be slow, complex and risky, and very considerable social and economic impacts would be likely and need mitigating. | Does not deliver compliance in the shortest possible time and risk that contravenes GM's wider statutory duties. Will not be progressed. |

8.3 Those incentives measures found to be both effective and deliverable in the measures assessment exercise described in Table 4 were adopted for all further options. In isolation, **Option 1** does not achieve compliance in the shortest possible time. However, there are important elements within the package of measures that are required to support the success of the other Options. In particular, measures were taken forward to communicate the message and promote sustainable journeys; promote the uptake of the cleanest vehicles; and provide help to upgrade buses, taxis, commercial and private vehicles.

8.4 **Options 2 and 3** were ruled out as they did not deliver compliance in the shortest possible time:

- **Option 2** – Parking measures have a limited effect on the heaviest and dirtiest vehicles, such as HGVs and buses. They only affect those cars or vans that need to park in an area and not those passing through, or those with uncontrolled or off-street parking available. A Workplace Parking Levy has been shown to be effective in deterring car travel and supporting investment in more sustainable modes in the only UK example (in Nottingham), but the implementation timeframe is slow and the measure is poorly targeted in terms of its effect on the dirtiest vehicles. There are very few controlled parking zones or residents' parking permit schemes in place across the region and thus it would be difficult and expensive to deliver differential parking on-street. Off street, public parking is managed through contracts owned by the ten districts, running to different timescales and with limited flexibility in the short term. In summary, using parking as the constraint measure appeared challenging to implement, poorly targeted and not likely to deliver compliance in the shortest possible time.
- **Option 3** – A City Centre penalty for high polluting vehicles would be effective in the city centre and have some effect on the key radial routes into to the city centre. However, air quality modelling has shown that a city centre CAZ D, with no further CAZ measures across the remainder of GM, would leave around 200 sites non-compliant within the wider region in 2021, including some sites of non-compliance within the city centre itself. It has therefore been demonstrated that the option does not deliver compliance in the shortest possible time and has been rejected.

8.5 **Options 4 and 5** were the best performing options, based upon the initial assessment, although neither delivered compliance in the modelled year of 2021. Both removed around 80% of sites of non-compliance, with around 40-50 sites remaining non-compliant in these initial model runs for 2021. As a result, both Options 4 and 5 were progressed to full appraisal as the best performing options.

8.6 **Option 6**, was developed initially as a theoretical 'maximum case', primarily to understand whether compliance could be achieved under any scenario by 2021. Importantly, the modelled scenario did not take account of the feasibility of delivering such a scheme or include the full package of supporting measures that would be required.

8.7 The assessment assumes that all of the options can be delivered by 2021. It is very unlikely that Option 6 could be delivered in that timescale. All aspects of the scheme, from the technical work required to design the scheme, to the scale of the infrastructure provision and customer service offer required to deliver it, would be slow, complex and subject to considerable risk. The 'all or nothing' nature of this proposal presents a risk that no real improvements to air quality would be achieved for quite some time, and the time to compliance would be highly uncertain.

8.8 Additionally, Option 6 has been ruled out for a number of reasons:

- The scale of the intervention across the whole of GM is considered to be potentially undeliverable in physical terms.
- The modelling undertaken is not considered credible, due to the required assumptions that have had to be made about behavioural change. The basis for the analysis has been figures based on JAQU evidence reassessed against GM conditions. However, in designing the analysis it was never envisaged that the scheme would roll out across such a wide geographic reach and it is likely given this that the behavioural responses would be very different. Specifically:
- The modelling assumes fixed values for the non-compliant cars to be sold and fixed costs of compliant cars to be purchased. A region-wide scheme for cars would have a material impact on the market, devaluing non-compliant cars and increasing the price of compliant cars. This means that the assumptions in terms of fleet upgrade are not valid and likely to be overly optimistic.
- The modelling also forecasts substantial mode shift from car to public transport, but for many of the diverse trips across the wider city-region there is simply not a viable public transport alternative available (at this time) and this mode shift is not likely to materialise.

8.9 In practice, therefore, mode shift has been over-estimated in the assessment of this GM-wide option, with more people expected not to switch modes and, rather, to choose to pay. It would not be possible in the required timescales to deliver transformative public transport improvements to facilitate this mode shift. This would therefore significantly delay compliance.

8.10 Clearly, a scheme on this scale would raise very significant issues in terms of the economic and social impact on the region, and widespread mitigation measures would be required that are not likely to be feasible.

8.11 In summary, Option 6 would not deliver compliance in the shortest possible time, a fundamental CSF for the program, and would perform even more poorly in terms of reducing human exposure as there would be a long period without action on the ground; during which time considerable progress towards compliance would be expected with options 4 and 5.

**Shortlisting of best performing options**

8.12 The analysis found that no Option (not even a GM-wide CAZ D) could deliver compliance by 2021. Options 4 and 5 (incorporating the best performing incentives measures from Option 1) offer the best opportunity to deliver compliance in the shortest possible time and the Steering Group agreed that these Options should be progressed to full appraisal.

8.13 Some adaptations were made to the specification of the Options based on lessons learned throughout the high level assessment process:

- Various incentives measures were judged to be ineffective (e.g.: Park & Ride, GTL conversion for HGVs) or undeliverable in the timescale/with existing powers (e.g.: public transport improvements beyond the existing programme) and have been excluded. See Table 5 above for more detail.
- Vehicle Renewal Schemes to help businesses and residents upgrade their vehicle have been included, as discussed above.
- The initial assessment suggested that the second-hand van market would not be sufficiently mature by 2021 to support a large-scale CAZ for vans – a lack of available affordable compliant vehicles could result in a higher than predicted proportion of vehicles 'staying and paying' rather than upgrading and create substantial risk of economic damage. Therefore, implementation of the regional schemes has been divided into two phases: Phase 1 is a CAZ B encompassing buses, hackney cabs and PHVs, HGVs and coaches; and Phase 2 is a CAZ C including vans and minibuses. In practice, this may be delivered as a single scheme with a temporary exemption placed on Light Goods Vehicles for a period of perhaps two years.
- Finally, and related to the decision above, the M60 boundary in Option 5 has been abandoned, with the schemes being implemented within the IRR and GM-wide instead. Applying an additional boundary adds cost and complexity to the scheme, and risks customer confusion. Further analysis showed that the M60 boundary does not reflect where the outstanding locations of non-compliance remain post-2021, many of which are outside this zone. Therefore, it does not make sense in terms of delivering compliance in the shortest possible time to implement a second phase solely in this zone.
- Two variants of option 5 were explored, one including a CAZ D within the IRR (Option 5(i)) and one where the CAZ D was enhanced so that all diesel cars and PHVs were considered non-compliant (Option 5(ii)).

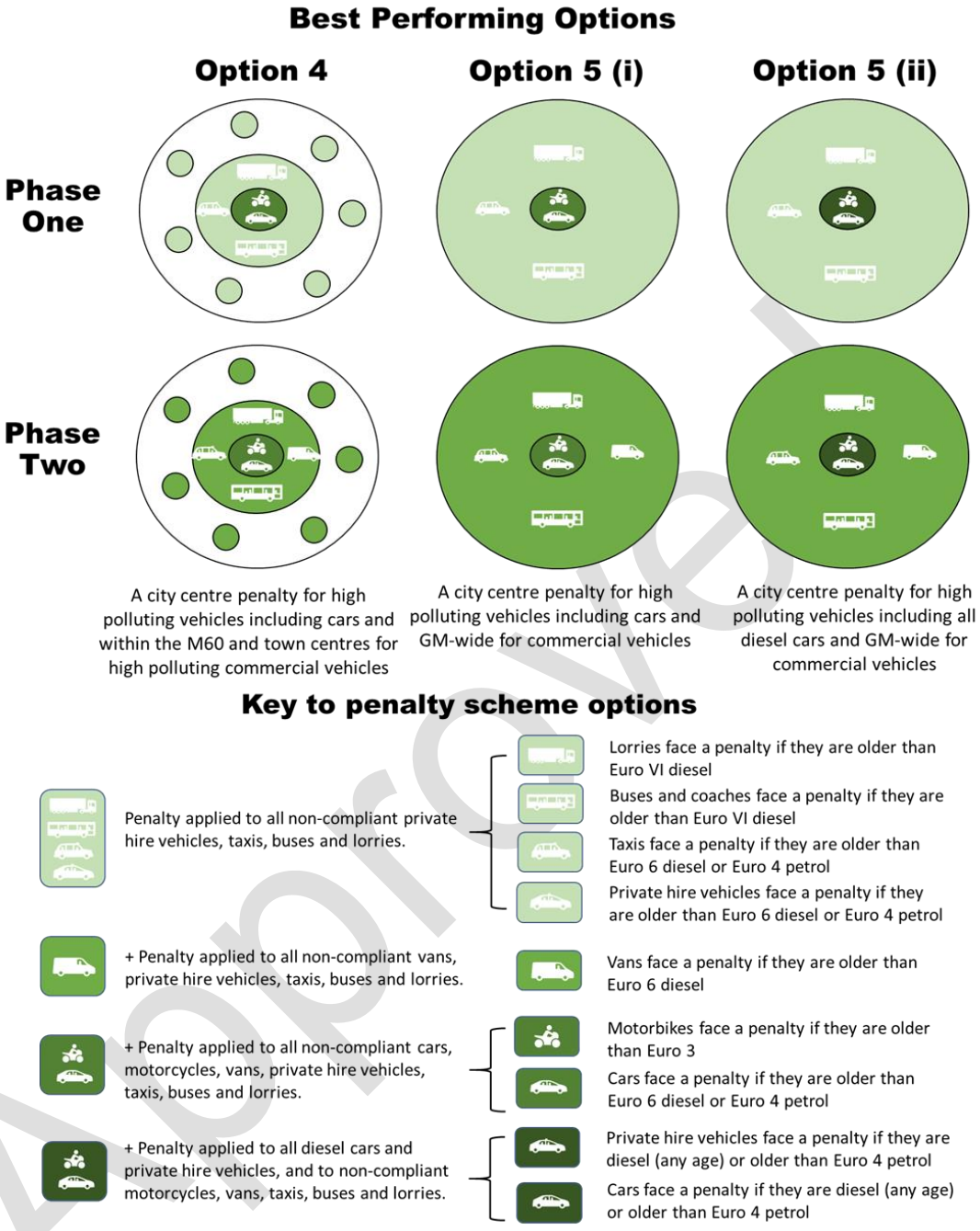
8.14 Three CAP Options were taken forward to full appraisal, those considered most likely to deliver compliance in the shortest possible time, based on the initial 2021 modelling. These are outlined below and illustrated in

8.15 Figure 7.

- **Option 4:** a Clean Air Zone category D within the Inner Relief Route (IRR) to be delivered in Phase 1 alongside a Clean Air Zone category B within the M60 and satellite towns. In Phase 2, the Clean Air Zone within the M60 and satellite towns extends to a category C. The CAZ proposals are supported by measures to communicate the message, promote cleaner vehicles and help people, businesses and buses upgrade.
- **Option 5(i):** a Clean Air Zone category D within the IRR to be delivered in Phase 1 alongside a Clean Air Zone category B across Greater Manchester. In Phase 2, the Clean Air Zone across Greater Manchester extends to a category C. The CAZ proposals are supported by measures to communicate the message, promote cleaner vehicles and help people, businesses and buses upgrade.
- **Option 5(ii):** an enhanced Clean Air Zone category D within the IRR such that all diesel cars and private hire vehicles would be subject to a penalty as well as non-compliant petrol vehicles and larger diesel vehicles older than Euro 6. To be delivered in Phase 1 alongside a Clean Air Zone category B across Greater Manchester. In Phase 2, the Clean Air Zone across Greater Manchester extends to a category C. The CAZ proposals are supported by measures to communicate the message, promote cleaner vehicles and help people, businesses and buses upgrade.

8.16 As none of the Options delivered compliance by 2021, it was necessary to develop new modelling tools to allow the assessment of traffic and air quality in later years. New models were developed in Autumn 2018 for 2023 and 2025. The modelling methodology was also re-vamped in Summer 2018 for 2021 based upon newly emerged JAQU guidance, and this revised methodology was applied to all three modelled years. Therefore, the best performing options were re-modelled for 2021, 2023 and 2025 as part of the full appraisal process in the next stage.

**Figure 7: Three CAP Options for further analysis**



# 9 Phase 4 – Stage b – Re-evaluation, including addition of two new CAP Options

9.1 Throughout Autumn 2018, revised traffic and air quality modelling was carried out for the three best performing options (4, 5i and 5ii). The results were analysed through a full economic and financial evaluation. During this time key elements of the OBC were developed further in terms of the management and commercial delivery processes associated with these proposals; and the capital, operating and maintenance costs of the proposals.

9.2 This analysis showed that Option 5i was the preferred option, as it could deliver compliance in the shortest possible time, at the lowest cost, and was the most feasible of the three options. Option 5i was predicted to achieve compliance in 2024, three years prior to compliance being achieved in the do minimum (without action) scenario.

9.3 Government guidance stipulates that CAP schemes need to be assessed against a benchmark Option that has to include a CAZ. The benchmark scheme then acts as the measure against which other Options are assessed in terms of the CSF. Following consultation with JAQU, Option 5i was selected as the benchmark as it achieves compliance in the shortest possible time and at the lowest cost.

9.4 Following an initial evaluation in December 2018 by the ten local authorities of the appraisal results set out in brief above, concerns were raised that there was insufficient information to enable a decision to be made. In particular, the concerns were that:

- the risk of negative socio-economic impacts was not sufficiently understood
- other options had not been explored in sufficient depth to be ruled out

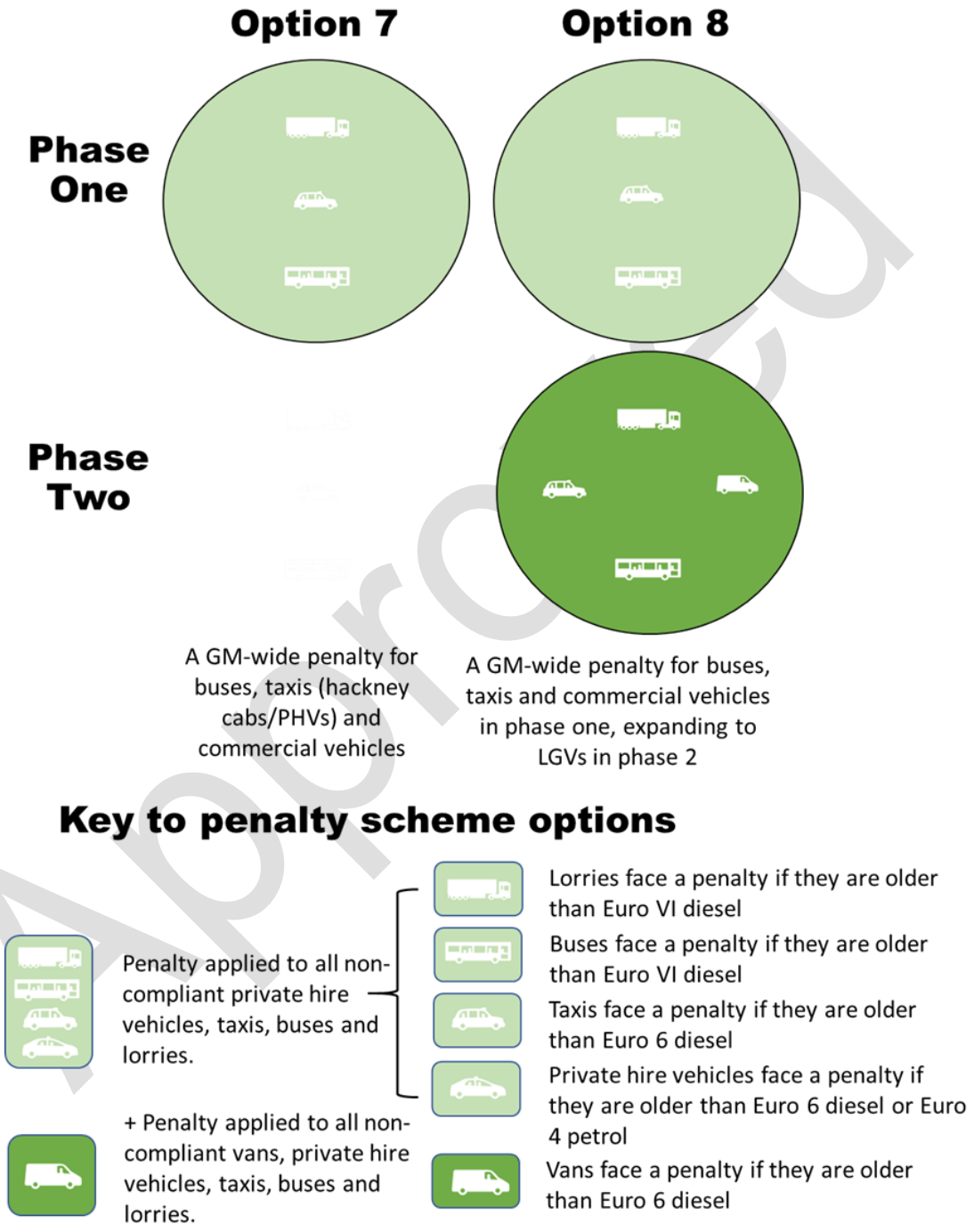
9.5 Further analysis was undertaken to better understand the risk of unintended socio-economic consequences arising from Option 5i and a decision was made to explore the potential effectiveness and impacts of two further options not previously considered. The options were assessed using the same process as applied to the six options considered in the high-level assessment stage.

9.6 The two additional CAP options are described below and illustrated in Figure 8:

- Option 7: a Clean Air Zone category B across Greater Manchester to be implemented in a single phase. The CAZ proposals are supported by measures to communicate the message, promote cleaner vehicles and help businesses and buses upgrade.

- Option 8: a Clean Air Zone category B across Greater Manchester implemented as Phase 1. In Phase 2, the Clean Air Zone across Greater Manchester extends to a category C. The CAZ proposals are supported by measures to communicate the message, promote cleaner vehicles and help businesses and buses upgrade.

**Figure 8 – CAP Options 7 and 8**




9.7 Table 6 below provides a summary of the exceedance points across local authorities for each AQ modelled option and the number of exceedances identified in each year.

9.8 This indicates that the shortest possible time in which compliance can be achieved with any Option is 2024. Options 5i, 5ii and 8 are all predicted to deliver compliance in 2024.

9.9 The modelling indicated that Option 4 would achieve compliance in 2025 and Option 7 in 2026. Both options have therefore been ruled out as not delivering compliance in the shortest possible time and were not progressed to full appraisal.

**Table 6: CAP Options summary of results (number of locations of exceedance by local authority)**

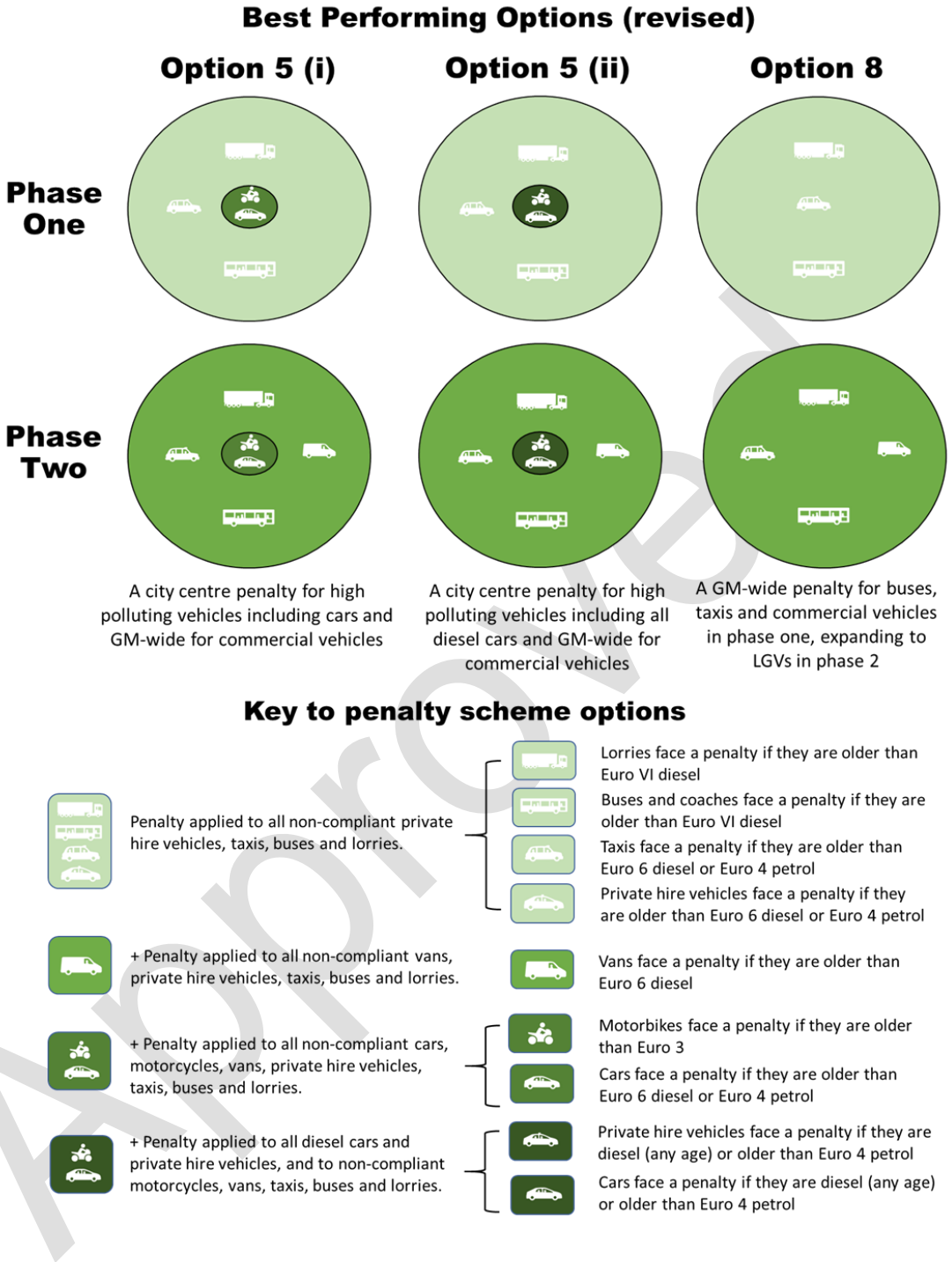
| Scheme Options | Compliant sites | | Non-compliant sites | | | |
|---|---|---|---|---|---|---|
| | Very compliant (below 35 µg/m³) | Compliant but close (35 to 40 µg/m³) | Non-compliant (>40 to 45 µg/m³) | Very non-compliant (>45 to 50 µg/m³) | Extremely non-compliant (>50 µg/m³) | Total non-compliant (>40 µg/m³) |
| **2021** | | | | | | |
| Do Minimum | 16,281 | 603 | 175 | 62 | 13 | **250** |
| Option 4 | 16,820 | 250 | 56 | 8 | 0 | **64** |
| Option 5(i) | 16,879 | 200 | 50 | 5 | 0 | **55** |
| Option 5(ii) | 16,892 | 193 | 44 | 5 | 0 | **49** |
| Option 7 | 16,830 | 233 | 61 | 10 | 0 | **71** |
| Option 8 | 16,836 | 227 | 62 | 9 | 0 | **71** |
| **2023** | | | | | | |
| Do Minimum | 16,856 | 210 | 58 | 10 | 0 | **68** |
| Option 4 | 17,056 | 69 | 9 | 0 | 0 | **9** |
| Option 5(i) | 17,081 | 51 | 2 | 0 | 0 | **2** |
| Option 5(ii) | 17,087 | 46 | 1 | 0 | 0 | **1** |
| Option 7 | 17,037 | 85 | 12 | 0 | 0 | **12** |
| Option 8 | 17,072 | 59 | 3 | 0 | 0 | **3** |
| **2025** | | | | | | |
| Do Minimum | 17,068 | 58 | 8 | 0 | 0 | **8** |
| Do Something | Options 5(i), 5(ii) and 8 are fully compliant by 2024, Option 4 by 2025 and Option 7 by 2026 | | | | | |

### Summary of best performing options progressed to full appraisal

9.10 A full economic appraisal has been carried out for the three 'best performing options', encompassing the two refined CAP Options (5i and 5ii) that emerged from the high-level assessment process in Summer 2018, and the additional CAP Option 8 identified in January 2019. These are illustrated in Figure 9 below. The results of this assessment are provided in Section 1.7 of the Strategic Case and in the Economic Case.

9.11 Preliminary socio-economic analysis of the potential impacts of the Option 5 CAZ D schemes has been undertaken using Greater Manchester Travel Diary Survey Data. This suggests that the proportion of trips into the city centre that are made by car is relatively small and has been declining year-on-year in the morning peak period over the past two decades (only 2% of all GM car or van trips have a destination within the Manchester Salford Inner Relief Route (MSIRR)). The dominant trip purposes for travel into the city centre are commuting and shopping; but commuting is the trip purpose with the highest reliance on travel by car (44% of all car trips into MSIRR are journeys to work). Therefore, workers are likely to be the group most impacted by any city centre CAZ D scheme. Additional early analysis of census journey to work data and Acorn segmentation data, suggests that a small but significant proportion of these car trips are currently made by people from some of Greater Manchester's most deprived areas, who would be least able to upgrade their vehicle or pay a CAZ charge (we believe that at least 6,000 car driver commuters are currently travelling to the city centre from our most deprived communities). On that basis, there are some concerns about the potential socio-economic impacts of adopting a CAZ D scheme in the city centre, which is reflected in the "amber" rating of socio-economic impacts of the CAZ D options within the OBC economic case.

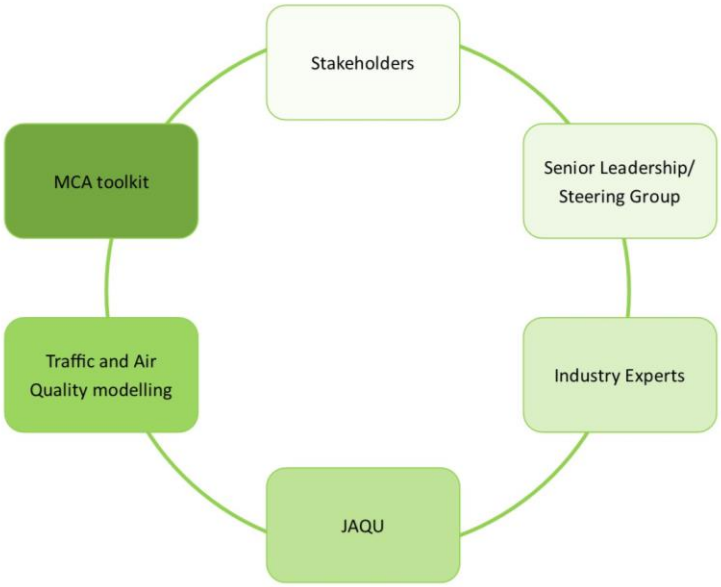
**Figure 9: Best performing CAP Options for full appraisal**



# 10 Conclusion

10.1 A rigorous process has been followed, which included a combination of engagement with stakeholders and industry experts; bespoke modelling of air quality / traffic; and multi criteria analysis. The process was iterative (see Figure 10 below) and during the development and analysis of Options, the identification of what is deliverable and the likely response from key stakeholders was an important element.

**Figure 10: Iterative relationship process diagram**




10.2 This process has encompassed an initial sifting exercise; Target Determination to identify the scale of the challenge; a high level assessment of options and measures; and a more detailed appraisal of the best performing options (set out in the main body of the OBC.

10.3 The output of this process has been to identify an effective and deliverable package of non-CAZ measures that form the foundation of all best performing options. Three options, with different CAZ proposals, have been identified as the best performing options, able to achieve compliance in the shortest possible time. These are Options 5i/ii, and 8. These have been subject to a full strategic and economic appraisal, costs have been developed, and a management and commercial approach to delivery has been identified.

10.4 As set out in the OBC, the outcome of this full appraisal was that Option 8, a GM-wide CAZ B in 2021 expanding to a CAZ C in 2023, has been identified as the best performing option and will proceed as the GM CAP.