Greater Manchester's Clean Air Plan to tackle Nitrogen Dioxide Exceedances at the Roadside

Note 17: Evidence supporting the decision not to progress with a GM-wide CAZ D

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Version Status:	APPROVED	**Prepared by:**	Prepared by: Transport for Greater Manchester on behalf of the 10 Local Authorities of Greater Manchester
Authorised by: **Date:**	Ian Palmer December 2019		

COVID-19 Pandemic Statement

This work has not considered the impact of the COVID-19 pandemic. Whilst we are continuing, where possible, to develop the Greater Manchester Clean Air Plan, the pandemic has already had an impact on our ability to keep to the timescales previously indicated and there may be further impacts on timescales as the impact of the pandemic becomes clearer.

We are also mindful of the significant changes that could result from these exceptional times. We know that the transport sector has already been impacted by the pandemic, and government policies to stem its spread. The sector's ability to recover from revenue loss, whilst also being expected to respond to pre-pandemic clean air policy priorities by upgrading to a cleaner fleet, will clearly require further thought and consideration.

The groups most affected by our Clean Air Plan may require different levels of financial assistance than we had anticipated at the time of writing our previous submission to Government.

More broadly, we anticipate that there may be wider traffic and economic impacts that could significantly change the assumptions that sit behind our plans. We have begun to consider the impacts, and have committed to updating the government as the picture becomes clearer over time.

We remain committed to cleaning up Greater Manchester's air. However, given the extraordinary circumstances that will remain for some time, this piece of work remains unfinished until the impact of the COVID-19 pandemic has been fully considered by the Greater Manchester Authorities.

1. Introduction

Greater Manchester (GM) is producing a Clean Air Plan (CAP) to protect and promote the health of its population by improving air quality and reducing our impact on the environment. In so doing, the local authorities within Greater Manchester are also complying with the UK Air Quality Plan which requires the creation of Greater Manchester's Clean Air Plan (GM CAP) and which sets out clear guidance on how the Plan should be developed.

The primary aim of the GM CAP is to reduce NO_2 concentrations in Greater Manchester to below the EU Limit Value in the shortest possible time. In addition to achieving this primary aim, GM has also sought to develop GM CAP interventions that align with GM's wider strategic goals and do not undermine the Greater Manchester Combined Authority (GMCA) and ten local authorities' other statutory and legal duties. This approach will minimise the risk of significant unintended negative economic, social or environmental consequences resulting from the implementation of the CAP.

In developing the GM CAP, the assessment has taken account of the need to:

- ensure that compliance is achieved as soon as possible;
- choose a route to compliance which reduces human exposure as quickly as possible;
- ensure that compliance with the EU Limit Value is not just possible but likely.

It has also considered the feasibility and deliverability of the options under consideration.

This Note builds upon the analysis within the GM CAP Outline Business Case (OBC) in relation to the issues surrounding the introduction of a CAZ D across the whole of GM, as an alternative to current proposals for the GM CAP.

This Note responds to the request contained within the Ministerial letter from Andrew Jackson (JAQU) to Simon Warburton (TfGM) dated 23rd May 2019 in relation to: *"Demonstrating that a GM CAZ D cannot bring forward compliance, including outlining the delivery challenges discussed for a GM wide CAZ D".*

This Note is structured as follows:

2. Background: GM's Option Development Process for the OBC

This section identifies the option appraisal stages within the OBC, identifies where within that process the GM-wide CAZ D option (Option 6) was considered, why it was not taken forwards for the final stages of option appraisal and the process towards selecting the preferred option (Option 8).

3. Context of car ownership and use in GM

Further to discussion of the OBC process in the previous section, this section sets out the context of the proposed CAP in relation to car ownership and use in GM, discussing the degree of car dependency across the potential GM-wide CAZ D coverage.

4. Why a GM-wide CAZ D is not considered deliverable

This section considers the relative challenges of a GM-wide CAZ D from an infrastructure, implementation and operation perspective, relative to alternative options, and the risk which a GM-wide CAZ D would generate with respect to the opening year of the scheme and in it turn, the year of compliance.

5. Modelling compliance of a GM-wide CAZ D

This section reviews the methodology applied for modelling the impact of a GM-wide CAZ D and discusses the limitations of the tools available in terms of assessing such a scheme.

6. When would compliance be achieved with a GM-wide CAZ D

This section sets out GM's conclusions on when compliance would be forecast to be achieved with a GM-wide CAZ D, relative to the final options (which all had the same year of compliance forecasted), based on the modelling available, and taking into account the limitations of the modelling methodology as set out in section 5.

7. Concerns about negative socio-economic and health impacts

This section considers the potential negative socio-economic impacts that could arise from a GM-wide CAZ D and the risk that resulting negative impacts on health may outweigh health benefits arising from improved air quality.

8. Conclusions

This section considers the findings of this Note, comments on the previous justification for discounting a GM-wide CAZ D during the OBC option appraisal and concludes whether the additional information presented here alters the OBC conclusion that the CAZ D should not be taken forwards.

2. Background: GM's Option Development Process for the OBC

GM has considered a wide range of Measures that could help reduce roadside NO_2 levels. Extensive work has been carried out to help develop a proposed package of Measures, following instruction from Government.

The current proposals do not include cars, other than taxis and private hire vehicles (PHVs). These proposals represent the preferred option following a comprehensive long list sifting stage and final options appraisal as documented in the OBC.

Table 1 summarises the main phases of the option development process.

Table 1. Timeline of option development process

Phase	Stage	Process Undertaken	When	Approval
Phase 1: **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: **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: **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	
	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: **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 Concerns were raised and the need for further refinement identified.
Phase 4b: **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.

Full information on the Options Appraisal process and context of the discounted GM-wide CAZ D (Option 6) at that stage, can be found in the OBC documentation which is published at www.CleanAirGM.com and a summary is provided below.

As noted above, the option of a GM-wide CAZ D has been considered within the GM CAP OBC documentation as Option 6 and that consideration, as well as further supporting evidence for the position arrived at in the OBC will be discussed within this Note.

The goal of a CAZ D is to encourage private car drivers to upgrade to a compliant vehicle – for cars this would be; a petrol vehicle at Euro 4 or newer, a diesel Euro 6, or an electric or hybrid-electric car. A CAZ D would also be expected to encourage mode shift to sustainable travel modes.

The potential benefits of a GM-wide CAZ D are obvious: two thirds of total NOx emissions come from cars across GM and there are around 285,000 non-compliant cars currently registered in GM.

The scale, spatial spread, and complex variety of causes of exceedances across GM means that a city centre scheme, as proposed for Birmingham for example, would not achieve compliance in all the worst performing locations.

It was originally assumed by the UK Government that GM would bring forward proposals to achieve compliance in 2021. However, the Target Determination process revealed that the initial modelling carried out nationally had under-estimated the scale of the problem in GM, with the number of exceedances increasing from 11 links based on PCM modelling to 250 points (equivalent to approximately 150 links), based on local modelling. The local modelling also showed that concentrations were higher than previously modelled, and that, without action, compliance would not be achieved until 2027.

GM carried out modelling of a range of different charging-CAZ and non-CAZ Measures to support the development of a series of six Options. As the modelling progressed, it became increasingly evident that compliance by 2021 may not be achievable under any option. The test of a GM-wide CAZ D was therefore carried out as a theoretical ‘maximum case’ to test this hypothesis (and incorporated into the Options assessment process as Option 6). It was recognised at the time that the modelling process was not fully appropriate to support an accurate assessment of such a scheme.

Option 6 (GM-wide CAZ D) was assessed as part of the initial Options sifting exercise alongside five other Options using a multi-criteria analysis tool, taking into account JAQU’s primary and secondary success factors, and ruled out at that stage. This is a standard approach for options sifting, and is similar to the approach set out for transport projects using the ‘Early Assessment and Sifting Tool’ as recommended by the Department for Transport (DfT). Only those options judged to perform strongly at a sifting stage are progressed to full appraisal. GM’s own success factors included the determining success factor of 'compliance in the shortest possible time' and the primary success factors 'reduction in NO_2 emissions' to achieve compliance with limit values and reduce human exposure and 'feasibility' to ensure compliance is not just possible but likely.

Strategic Outline Case

The first output of the Greater Manchester feasibility study was the Strategic Outline Case (SOC) that was approved by the ten Greater Manchester local authorities and submitted to Government in March 2018. In this document, a long-list of 96 options for Measures was presented and sifted to a shortlist of 17 based on the Government’s Primary Success Criteria (reduction of NO_2 concentrations in the “shortest possible time”).

The SOC described the complex causes of exceedances across Greater Manchester, relating to high volumes of traffic, slow traffic speeds, the composition and age of the fleet, and the urban geography (particularly canyons caused by high buildings). The profile at each site is different, but the scale of the challenge means that the solutions are inter-related. Localised solutions such as re-routing traffic or tackling local pinch points will clearly be insufficient to tackle the region-wide problem, and risk simply moving the problem elsewhere. This meant that any effective proposals

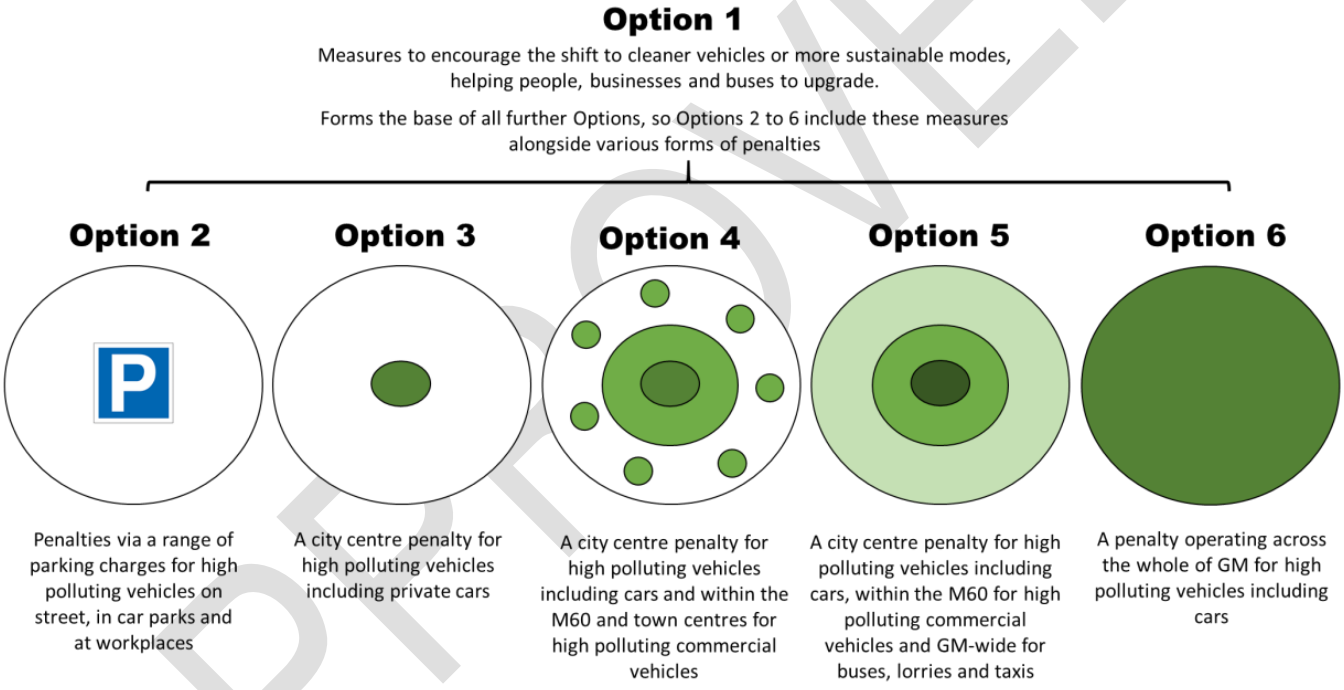
needed to involve a package of Measures able to tackle the problem holistically and beyond authority boundaries, to avoid the unintended consequences of action in one authority on the problem in another.

OBC Initial assessment exercise

A series of six options, containing packages of Measures including CAZ schemes at different categories and a range of geographies, were developed in response to the problem as revealed by local modelling. These Measures were further refined from the shortlist, involving the development and assessment of more detailed proposals for each type of Measure. As a result of this process, some Measures were rejected as being ineffective or not deliverable within the timescales and with existing powers.

Of these initial six options, Option 6 included a GM-wide CAZ D. The composition of the six options is shown in **Figure 1**.

Figure 1. Summary of six Options for initial appraisal



The six options were assessed against the UK Government's Primary Success Criteria:

- Reduction in NO_2 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.
- Feasibility: the likelihood of the Measure being implemented in the shortest possible time to deliver the desired NO_2 reduction and achieve compliance. This should consider real-life factors that could delay implementation such as the ease of putting governance systems in place to facilitate local government cooperation and the local authorities having the jurisdiction to implement such Measures/options. It should also consider the likelihood of the Measure being effective.

The options were further assessed against a series of Secondary Success Criteria as set out in the SOC and agreed with JAQU, as follows:

- 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: a high-level indication of the costs and benefits of each option, noting that a more detailed cost benefit analysis is presented for the best performing options in the Economic Case, which will be further refined for the preferred option in the FBC.
- 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 disproportionately negative economic or social impacts for the region or those living, working or doing business within it.
- Deliverability of the options, in terms of the affordability of the cost of implementation, the supply-side capacity and capability to deliver the Measures outlined in the options, and the achievability of delivering the option, considering potential issues such as obtaining the resources to implement and operate a Measure/option.

A brief summary of the outcomes of the initial appraisal of these Options is presented in **Figure 2** below.

Figure 2. Summary of assessment of initial six 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: 1. Some are not likely to be effective in tackling air quality, such as conversion from Gas to Liquid fuels or junction improvement schemes; 2. Some could be effective but are not deliverable within the timescale, such as new public transport capacity; and 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. 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.

Note that whilst all options were modelled in 2021, Option 6, a GM-wide CAZ D is not in fact considered deliverable in 2021. Option 6, a GM-wide CAZ D, was discounted at this stage, as it was not deliverable in 2021 and it was not considered likely that it would deliver compliance in the shortest possible time, a fundamental critical success factor for the programme, 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. It was considered unlikely that a GM-wide CAZ D could be delivered by 2021, and therefore this approach presented a risk that no real improvements to air quality would be achieved for some time as well as leaving the compliance date highly uncertain.

The basis for eliminating Option 6 as set out in the Options Appraisal Report, is set out below.

OBC Option 6 discussion

"Option 6, was developed initially as a theoretical 'maximum case', primarily to understand whether compliance could be achieved under any scenario by 2021.

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.

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. 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. 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.

In summary, Option 6 would not deliver compliance in the shortest possible time, a fundamental CSF for the programme, 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."

Best performing options

Following the initial appraisal of the six options, three options were developed as the 'best performing' options.

These options were derived from Options 4 and 5 but were adapted to reflect a deeper level of understanding of the issues that emerged throughout the initial options appraisal process. As such, they were considered more likely to deliver effective reductions in NOx emissions and greater compliance than the options as initially specified. The three developed options were Option 4, Option 5i and Option 5ii.

- Option 4: A CAZ Category D within the Inner Relief Route (IRR) to be delivered in Phase 1 (in 2021) alongside a CAZ Category B within the M60 and satellite towns. In Phase 2 (in 2023), the CAZ within the M60 and satellite towns extends to a Category C. The CAZ proposals incorporate required Measures to communicate the message, promote cleaner vehicles and help people, businesses and bus operators upgrade.
- Option 5i: A CAZ Category D within the IRR to be delivered in Phase 1 (in 2021) alongside a CAZ Category B across Greater Manchester. In Phase 2 (in 2023), the CAZ across Greater Manchester extends to a Category C. The CAZ proposals incorporate required Measures to communicate the message, promote cleaner vehicles and help people, businesses and bus operators upgrade.
- Option 5ii: An enhanced CAZ 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, reflecting that even compliant diesel cars have higher emissions affecting air quality than their petrol equivalents. To be delivered in Phase 1 (in 2021) alongside a CAZ Category B across Greater Manchester. In Phase 2 (in 2023), the CAZ across Greater Manchester extends to a Category C. The CAZ proposals incorporate required Measures to communicate the message, promote cleaner vehicles and help people, businesses and bus operators upgrade.

Modelling carried out to support the appraisal process indicated that Option 4 would not achieve compliance until 2025, whereas Options 5i and 5ii were forecast to achieve compliance in 2024. Option 4 was therefore discounted from further consideration.

Further to discussions with the ten local authorities two additional options were developed;

- Option 7: A CAZ Category B across Greater Manchester to be implemented in a single phase. The CAZ proposals incorporate required Measures to communicate the message, promote cleaner vehicles and help businesses and bus operators upgrade.
- Option 8: A CAZ Category B across Greater Manchester implemented as Phase 1. In Phase 2, the CAZ across Greater Manchester extends to a Category C. The CAZ proposals incorporate required Measures to communicate the message, promote cleaner vehicles and help businesses and bus operators upgrade.

Modelling indicated that Option 7 was not likely to be sufficient, delivering lower emissions benefits in each year than Options 5i, 5ii and 8 and reaching compliance two years later. Therefore, this option was not progressed to full appraisal.

Modelling indicated that Option 8 could deliver compliance in the same year (2024) as Options 5i and 5ii. It was therefore subjected to a full appraisal using the same methodology as applied to those options.

All three of the final options (5i, 5ii and 8) were identified as delivering compliance by 2024 and were subject to a detailed appraisal process. This means that every site within GM is predicted to have annual mean NO_2 concentrations within the legal limit of 40 micrograms per cubic metre (µg/m3) by 2024. Without action, compliance is expected to be achieved GM-wide in 2027.

Selecting the preferred option

The preferred option was selected on the basis of which of the best performing options delivers compliance in the shortest possible time, and taking into account:

- the results of traffic and air quality modelling, which predict the response to a range of Measures;
- an off-model assessment of the possible impacts of Measures that cannot be modelled;
- an assessment of how realistic these predicted impacts are and how likely they are to be achieved; and
- assessments carried out in the economic, management, commercial and financial cases which appraise the options against the success factors outlined below in **Table 2**.

This approach was adopted according to Government guidelines.

It was concluded from the modelling carried out that there was greater certainty in the estimated year of compliance for Options 5i and particularly 5ii, as they consistently delivered lower concentrations in the modelled years. However, this had to be considered against the risk that delivery was subject to significant risks that appeared to make achieving compliance in the shortest possible time less likely. Options 5i and 5ii involved implementing an additional CAZ that would involve private cars, alongside the region-wide CAZ proposed in all three Options. This was considered to create a challenge of feasibility, in terms of obtaining approvals and managing risks, and of deliverability, in terms of the achievability of delivering proposals of this scale, and of obtaining the necessary human and financial resources.

Option 5ii carries additional risk of failure due to its innovative nature. Due to a lack of evidence on the effectiveness and impacts of such a proposal, the forecasts for this option should be considered particularly uncertain.

It was considered that Options 5i and 5ii may cause unacceptable and significant unintended consequences to distributional impacts, particularly in terms of the impact on the affordability for residents, the impact on the local economy, and the impact on the quality of life of local residents. There were particular concerns in terms of the potential impacts on low income car-dependent workers, small businesses, and city centre retail. Option 8 delivers compliance in the same year without the same potential risk of damaging economic impacts.

Table 2. Success factors against which the best performing Options have been appraised

Factor and description	Code	Criteria
Determining success factor		
Compliance in the shortest possible time	C1	Which option reduces to zero the number of locations in GM predicted to be in exceedance of the legal limits of NO_2 concentrations in the shortest time?
Primary success factors		
Reduction in NO_2 emissions	N1	Which option delivers the greatest reduction in the number of locations in Greater Manchester in exceedance (presumed to represent human exposure) in each year prior to compliance being achieved?

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 and reduce human exposure as quickly as possible.	N2	Which option delivers the greatest reduction in NO_2 concentrations at the roadside across Greater Manchester in each year prior to compliance being achieved, and upon compliance?
	N3	Does the option deliver compliance without putting other sites in Greater Manchester closer to exceedance (defined as concentrations of 38-40µg/m3) than without action?
Feasibility The likelihood of the Measure being implemented in time to deliver the desired NO_2 reduction, ensuring that compliance is 'not just possible but likely'.	F1	Are the Measures proposed within the legal powers of the Greater Manchester local authorities?
	F2	Can a governance route be developed to enable timely local government joint working as required for delivery?
	F3	What is the likelihood of the Measures being effective?
	F4	Is delivery of the option subject to significant risks that make achieving compliance in the shortest possible time, less likely?
Secondary (local) success factors		
Strategic fit with local strategies and plans The alignment of this Measure/option with policy/strategic aims at a local and regional level. Ensuring that the proposals set out in the option are aligned with the following vision for Greater Manchester as set out in key strategies and plans.	S1	Air quality and climate change: The Greater Manchester Strategy (Oct 2017) states that Greater Manchester should be "a place at the forefront of action on climate change with clean air and a flourishing natural environment" including by "reducing congestion and improving air quality".
	S2	Transport: The Greater Manchester Transport Strategy 2040 states a vision for "world class connections that support long-term sustainable economic growth and access to opportunity for all".
	S3	Growth: The Greater Manchester Strategy sets out "plans to build more than 10,000 more homes every year from now until 2035".
	S4	Economy: The Greater Manchester Strategy sets out a vision for "a thriving and productive economy in all parts of Greater Manchester" offering "good jobs, with opportunities for people to progress and develop".
Value for money A high-level indication of the costs and benefits of each Option.	V1	Estimated value for money of the option, compared to the risk of inaction
Distributional impact	Q1	Health benefits
	Q2	Accessibility (in terms of journey time and connectivity to opportunities and services)
	Q3	Affordability (for users)

The potential impacts, both positive and negative on different groups within society, with a particular focus on protecting the most vulnerable. Overarching imperative to ensure that the Plan does not result in overly detrimental economic or social impacts for the region or those living, working or doing business within it.	Q4	Impact on the local economy – considering low income workers, small businesses, town centres and key sectors
	Q5	Impact on the quality of life of local residents and on equalities
Deliverability Whether the Measures can be delivered within the time and funding available, and with the knowledge, skills and resources available in the delivery bodies and the wider market.	D1	The Affordability of the cost of implementation (for the public sector)
	D2	The Supply-side capacity and capability to deliver the Measures outlined in the option
	D3	The Achievability of delivering the option, considering potential blockers that exist such as difficulty with scale or obtaining resources (such as staff) to implement and operate a Measure/option

Critically, Greater Manchester has considered the risks in terms of when and how the Measures will be delivered. It was considered that taking account of the risk of non-delivery in this way supports the preferred option in delivering compliance in the shortest possible time, minimising human exposure over the lifetime of the Plan and being 'likely not just possible' to achieve its goals.

Greater Manchester has taken account of its wider responsibilities to its people and businesses, and has sought to develop proposals that bring the most benefit, with the least detrimental impact. In particular, evidence suggests that some of Greater Manchester's most vulnerable residents are most likely to suffer the effects of poor air quality, and Greater Manchester has aimed to bring forward a plan that improves air quality for those residents without damaging their quality of life in other ways.

Option 8 presents many delivery challenges, but is more feasible and achievable than Options 5i and 5ii and thus offers greater confidence that compliance can be achieved in the shortest possible time. Further to that, it also presents the lowest net cost to the people directly impacted and public funding requirement.

While GM's current preferred option does not include private cars within the scope of the Clean Air Zone, the GM Clean Air Plan does aim to deliver benefits in terms of encouraging residents to consider their use of car and to switch to cleaner fuels or more sustainable modes of travel. More work will be carried out at FBC to better understand the support needed and to target effort and funds where they can be most effective in delivering air quality benefits and mitigating socioeconomic impacts.

During the option development process there has been a clear focus on the year of compliance and human exposure, which includes an assumption that scheme start date would be in 2021 (the original target date for compliance). It is very unlikely that the GM-wide CAZ D, considered as Option 6, could be delivered in the identified 2021 delivery year timescale, however. 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 (impacting net human exposure), and the time to compliance would be highly uncertain. On this basis, the option appraisal process correctly removed Option 6 at the appropriate stage of preferred option development.

Provision of additional information

JAQU have requested additional information in relation to the GM-wide CAZ D option, specifically:

> *"Demonstrating that a GM CAZ D cannot bring forward compliance, including outlining the delivery challenges discussed for a GM wide CAZ D"*

As set out above, the option of a GM-wide CAZ D has been considered within the GM CAP OBC documentation as Option 6, and was discounted from further consideration at the initial assessment stage of the OBC. Further supporting evidence for the position arrived at in the OBC will be discussed within this Note, structured to tackle each issue in turn as set out in the Options Appraisal Report and text above.

3. Context of car ownership and use in GM

It is important to consider the context which a GM-wide CAZ D would be required to operate in, so as to in turn understand the complexity of implementation, the potential impact and possible responses of the GM population.

In total, there are over 1.1m cars registered to an address in GM, of which around 200-250k are expected to remain non-compliant by 2021.

The forecast split of diesel and petrol cars by European engine emissions standard for 2021 within GM local authorities is presented below, based on DVLA data projected forwards. In total, 41% of diesel cars (around 164,000 cars in total) and 4% of petrol cars (29,000 cars in total) are estimated to remain non-compliant in 2021. Of these, nearly two thirds are Euro 5 diesel cars (63%).

Table 3. Numbers of Cars within GM Local Authority areas by compliance status and fuel type, forecast for 2021.

GM Local Authority	NC diesel	C diesel	All diesel	NC petrol	C petrol	All petrol	All NC	All C	Total
Bolton	18,300	23,700	**42,000**	3,000	71,800	**74,800**	21,300	95,500	**116,800**
Bury	12,100	22,200	**34,300**	2,100	60,900	**63,000**	14,200	83,100	**97,300**
MCC	23,000	27,400	**50,300**	3,700	88,700	**92,400**	26,700	116,100	**142,700**
Oldham	13,200	17,300	**30,500**	2,000	54,200	**56,200**	15,200	71,500	**86,700**
Rochdale	13,800	17,500	**31,300**	2,000	52,000	**54,000**	15,800	69,500	**85,300**
Salford	12,100	17,100	**29,200**	2,000	56,000	**58,000**	14,100	73,100	**87,200**
Stockport	19,300	27,200	**46,500**	4,700	91,100	**95,900**	24,000	118,300	**142,400**
Tameside	13,700	16,600	**30,300**	2,500	60,900	**63,500**	16,200	77,500	**93,800**
Trafford	14,700	42,300	**57,000**	3,300	69,100	**72,400**	18,000	111,400	**129,400**
Wigan	23,400	29,000	**52,400**	3,600	89,700	**93,300**	27,000	118,700	**145,700**
Grand Total	**163,700**	**240,300**	**404,000**	**29,100**	**694,400**	**723,500**	**192,800**	**934,700**	**1,127,500**

Source: DVLA data projected forwards by TfGM

Key: C = Compliant, NC = Non-compliant (marked in red)

4. Why a GM-wide CAZ D is not considered deliverable

A scheme affecting private cars on this geographical scale is unprecedented – GM covers 1,280km^2 whereas in comparison the CAZ D scheme proposed in Birmingham covers just 8km^2. In order to develop, consult upon and deliver such a scheme, considerable planning activity would be required, encompassing research and data collection; modelling and analysis; policy development and scheme design; impacts assessments amongst other activities.

Our experience of planning, securing funding and resource, commissioning, undertaking research and delivering credible subsequent analysis for appropriate use in the appraisal process would typically take between 1 – 2 years. The inner London ULEZ scheme was under development for at least two years (from initial public conversation in July 2016 to Mayoral approval in June 2018), and London was starting from a position of relative strength in terms of their ability to develop and deliver such a scheme having road pricing schemes in place from 2003 and having implemented several emission-based charging variations and schemes since then. In comparison, GM has no experience of implementing an emissions-based charging scheme and does not have the data and tools necessary to do so readily available.

At the time of appraisal (end of Sept 2018), Greater Manchester authorities were under an instruction from the Government to have submitted an OBC by the end of December 2018 with an expectation of implementation by 2021. It was not considered likely that the planning activity required for a GM-wide CAZ D could be delivered in the time allowed.

Beyond this, there are several reasons to believe that a scheme on this scale could not be delivered within the timescale required, related to the provision of a sufficient camera network; boundary considerations; and the provision of customer management services. These are considered in turn below.

Provision of an ANPR camera network sufficient to ensure the required behavioural change

It is not considered feasible to deliver a network of ANPR cameras providing coverage that is sufficient to ensure that private car drivers are not readily able to evade a charge. For a scheme to be viable, it needs to be more likely than not that a journey made in a non-compliant vehicle will be captured by a camera to enable enforcement. Therefore, the network needs to have sufficient density of coverage to achieve this for all vehicles in scope.

The preferred option involves the delivery of a GM-wide CAZ C and thus the installation of a network of cameras GM-wide. This is considered challenging but achievable because:

- For heavy vehicles – buses, coaches and HGVs – affected by a CAZ A and B, most travel takes place in the nearside lane and on the major road network. Journeys are typically long, as shown in **Figure 3**, and vehicles are used throughout the day every day. This makes enforcement easier and more effective for these groups.
- Smaller commercial vehicles such as taxis and vans are more likely to travel on local roads and to some extent are able to deploy ‘rat running’ to avoid the major road network. However, given that they are likely to make multiple journeys and spend several hours on the road on an average day, it is considered likely that they would pass at least one camera on an average day. ‘Floating’ enforcement cameras will increase the likelihood of capture and deter evasion. The challenge is greater in terms of capturing those LGVs that are used on a more commuter-style pattern, but usage through the week, in terms of the number of days a vehicle is used, remains high.
- In summary, the currently proposed GM-wide CAZ C affects a relatively small proportion of traffic flow, reducing over time, and particularly affects vehicles travelling primarily in the nearside lane or with high daily mileage which are therefore easier to capture with a more limited camera network.

However, much more extensive camera coverage would be required to enforce a GM-wide CAZ D and this is not considered deliverable within the timeframes that would be required in order to achieve compliance in the shortest possible time. This is because:

- Many trips made by private car are short and made largely or exclusively on the residential and minor road network. A third of private car journeys made by GM residents on an average day are under 2km and nearly two thirds are under 5km.
- Furthermore, on an average day, cars spend around 95% of the time parked and many cars will be used only to make one or two short journeys on the local road network on an average day, or are not used every day.
- Thus, in a CAZ D scenario high volumes of traffic in all lanes would be affected, with a very large number of vehicles in scope on an average day that are making just a few, very short journeys on the minor road network.
- This means that providing an effective enforcement system for cars would be much more difficult. The camera network required to enforce a GM-wide CAZ D would be much more extensive than that required to enforce a GM-wide CAZ C. It was not considered likely at the sifting stage that a sufficiently dense camera network could be delivered by 2021.
- Subsequent work has looked in more detail at the risk of 'rat-running' to avoid an enforcement network (in the context of a GM-wide CAZ C), based on a scenario in which 850 ANPR cameras were installed across GM to maximise coverage. Within this scenario, it was estimate that circa 35 cameras would be installed in Ashton-under-Lyne Town Centre and its immediate environs. **Figure 4** shows the enforced routes (grey links) and unenforced routes (red links) in Ashton-under-Lyne, the latter of which could be used for 'rat-running'. This analysis suggested that in total 2,550 cameras would be required across GM to minimise the risk of 'rat-running'.
- Identifying suitable sites to install ANPR cameras is challenging, as cameras must be installed on straight sections of road where they have a clear view of free-flowing traffic. Many locations in GM will not meet these requirements due to the density of junctions, frontage development and kerbside activity. Designing a camera network on this scale that meets the enforcement and engineering requirements would take considerable time.
- Stakeholder engagement with potential suppliers has suggested that around 100 cameras could be installed a month, assuming it was possible to install the cameras on existing lighting columns. More work is required to better understand whether these assumptions are realistic. However, if this did prove reliable, it would suggest that it would take just over two years to install the cameras required, assuming around 2,500 cameras.
- In reality, it is unlikely that it would be possible to utilise existing street lighting columns in all cases. The lead times for installation on new poles are onerous, due to there being a long lead in time for the provision of new power connections, with an initial view from Electricity North West estimating 10 new connections would be possible per month.
- The extent to which roadside technology would need to be upgraded to store an increased amount of data is unclear. It may be necessary to install roadside cabinets in addition to ANPR cameras. It is unlikely that the requirement for roadside cabinets could be confirmed without first obtaining detailed volumetrics for each ANPR camera site, which would affect delivery timeframes.
- Taking into account the time needed to identify suitable sites, procure capacity, install the sites, and to test the effectiveness of the network, it is unlikely that a camera network to enforce a GM-wide CAZ D could be in place until end 2022 at the earliest.

Figure 3. Trip length distribution by vehicle type from GM Saturn model.

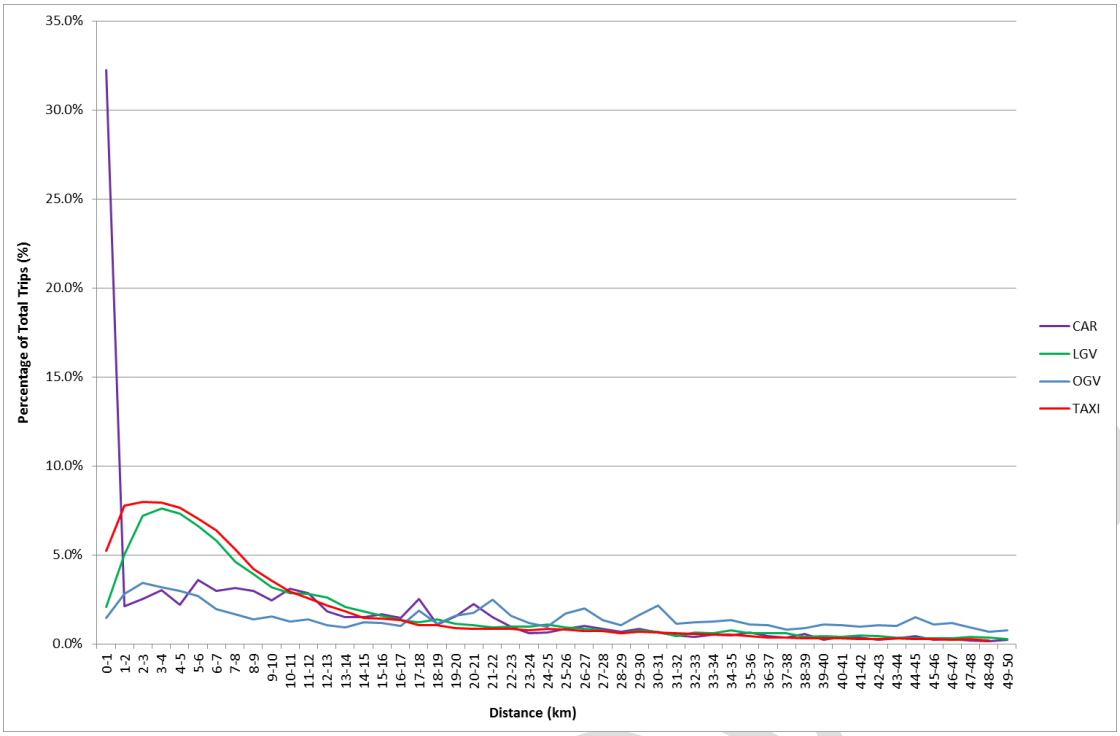
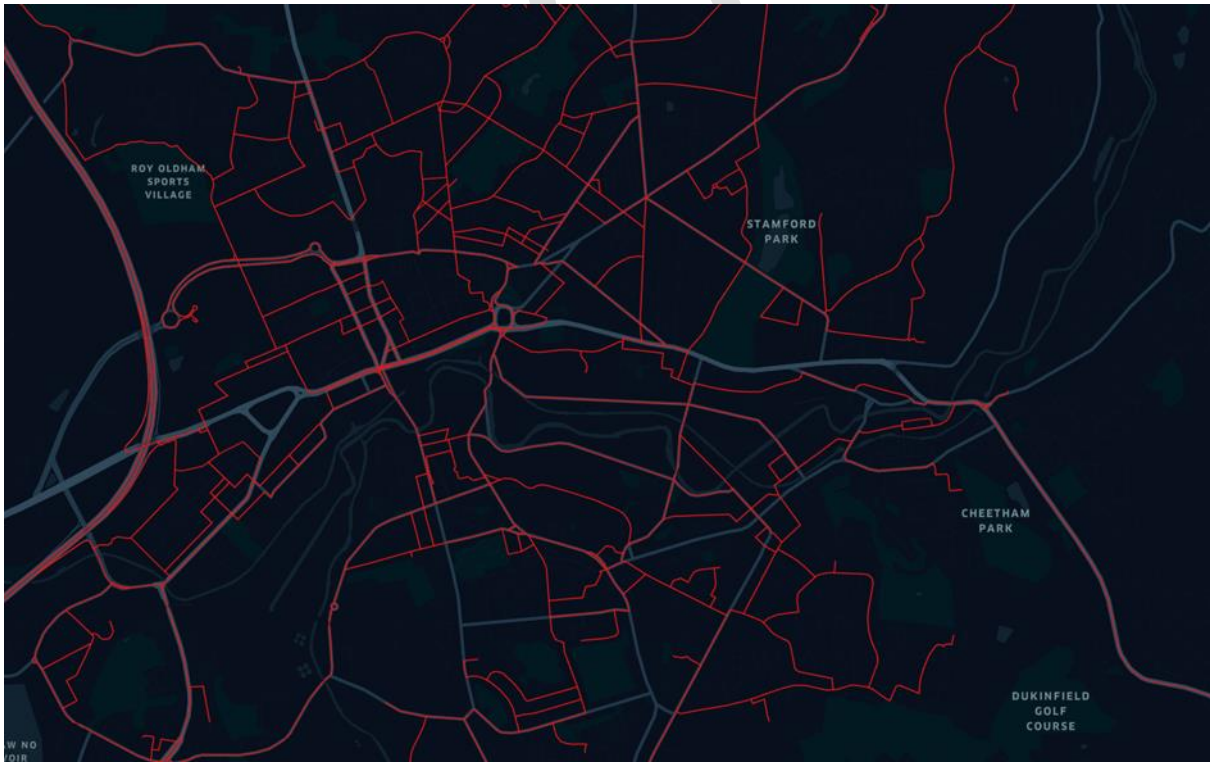


Figure 4. Example Study Area Camera Positioning - highlighting potential CAZ C 850 camera distribution with ANPR locations (grey) and uncaptured local roads (red).



Boundary considerations

Providing a safe, enforceable boundary with a coherent signage arrangement for a charging zone of this size (covering an area of 1,280km^2) is challenging. There are 52 motorway junctions and numerous formal and informal junctions with trunk roads in GM acting as the boundary to the scheme.

These challenges have not yet been overcome and are the subject of work between TfGM, HE and their respective design teams. Since undertaking the initial appraisal, GM has developed a better understanding of the challenges that must be overcome in order to deliver a GM-wide CAZ C, and is better able to assess the potential additional challenges that would be presented by a GM-wide CAZ D. It is clear that a GM-wide CAZ D would likely increase the difficulty in designing a satisfactory signage plan and may necessitate changes to the CAZ/SRN boundary, which could result in delays to the "go live" date of the CAZ.

In a GM-wide CAZ D scenario, it is expected that verge-side signage only would not be acceptable. This would mean that amendments to gantry signs would be required, a more complex process.

Furthermore, concerns have been raised by a number of the eight neighbouring authorities that the implementation of a CAZ C may lead to vehicles reassigning on their highway network (in other words, changing their route to avoid the charging zone, resulting in negative highway safety, operational and environmental impacts. This would be a greater concern in the case of a CAZ D, which would involve many more vehicles and in particular many more infrequent travellers.

Therefore, it is anticipated that, if a CAZ D were proposed then this could result in objections from of some or all of the 8 neighbouring authorities (who will be consultees for any proposed road user charging scheme under the Transport Act 2000), which could, in turn, necessitate changes to the proposed boundary. This would then impact the programme and possibly delay the "go live" date of the CAZ.

Customer Management

A GM-wide CAZ D brings hundreds of thousands of people in scope, needing to upgrade their vehicle or pay a charge. It was clear at options sifting stage that the implications of this in terms of the scale of customer information and interactions would be substantial. New analysis (based on assumptions as set out in the OBC) suggests that:

- A minimum of 12,500 PCNs per day would be issued with a GM-wide CAZ D.
- It is anticipated that a significant amount of the PCN recipients (say 20%) would request clarification or raise a query resulting in approximately 2,500 queries every day. Consequently, GM would require staff to handle these queries, whether received electronically or via telephone. An initial estimate would suggest that around 50 FTEs per day would be required to engage with these queries alone.
- Of the PCNs that would be issued under a proposed scheme, it is estimated that around 30% would go unpaid, requiring a high level of case management. This equates to 3,750 cases per day being passed for legal enforcement which is estimated to require an additional 30 FTE per day.

It would be complex and time consuming to put in place the capability to deliver this. Given the relatively short-term nature of the staffing requirement (as customer interactions volumes will spike in the first few months and drop rapidly as people increasingly move to compliant vehicles), recruiting and training such high numbers of staff, or outsourcing such a requirement, would be highly problematic and likely to result in delay.

5. Modelling compliance of a GM CAZ D

The initial evidence produced for the target determination process indicated that the scale of poor air quality needed to be understood in the overall context of the measures set out in the government's CAZ Framework. Providing an absolute maximum case scenario (or Benchmark CAZ) with the tools available was a proportionate approach applied to assist in developing the terms of reference for:

- the subsequent design of more realistic operating scenarios; and
- focussing of refinement of the necessary datasets, behavioural responses and modelling functionality for potential measures.

Development and Limitations of the Modelling Process

The JAQU guidance sets out four behavioural responses:

- Upgrade
- Change mode
- Cancel trip
- Pay charge

The underpinning research in the available guidance available during the OBC appraisal was primarily drawn from surveys carried out to inform the development of an inner London Ultra Low Emission Zone, and this evidence was used as the basis of the modelling carried out at the sifting stage. Subsequently, new surveys carried out in Bristol to support the development of a city centre CAZ became available, and these were used to inform the assumptions for the appraisal-stage modelling of Options 4, 5(i), 5(ii), 7 and 8. GM recognised that neither of these approaches were compatible with a regional scale scheme as proposed in GM, because the locales they were derived from either had a:

- high density multi-modal public transport system, with an existing freight Low Emission Zone and low household car ownership; or
- very small city centre scheme premise.

Whilst GM applied best endeavours to adapt the behavioural responses available, these were not considered to be fully appropriate for a robust assessment at a GM-wide CAZ D scale scheme for the following reasons:

- The responses are considered inappropriate and overly optimistic for a regional scale scheme which involved charging of private cars. This is because, on a regional scale, the assumed level of public transport provision implicit in the fixed percentage for 'change mode' is not consistent with the provision of public transport option available in GM. In reality, drivers would not be able to change mode at the scale forecast here.
- The behavioural responses available to those affected by a city centre scheme (and to a lesser extent, the inner London proposal) are different to the responses available to those affected by a region-wide scheme.

These considerations are outlined in greater detail below.

There is no equivalent scheme in the UK, nor internationally, and therefore new primary research would need to be undertaken to inform any modelling and appraisal process.

Commencing this research at this stage was not considered an appropriate step because:

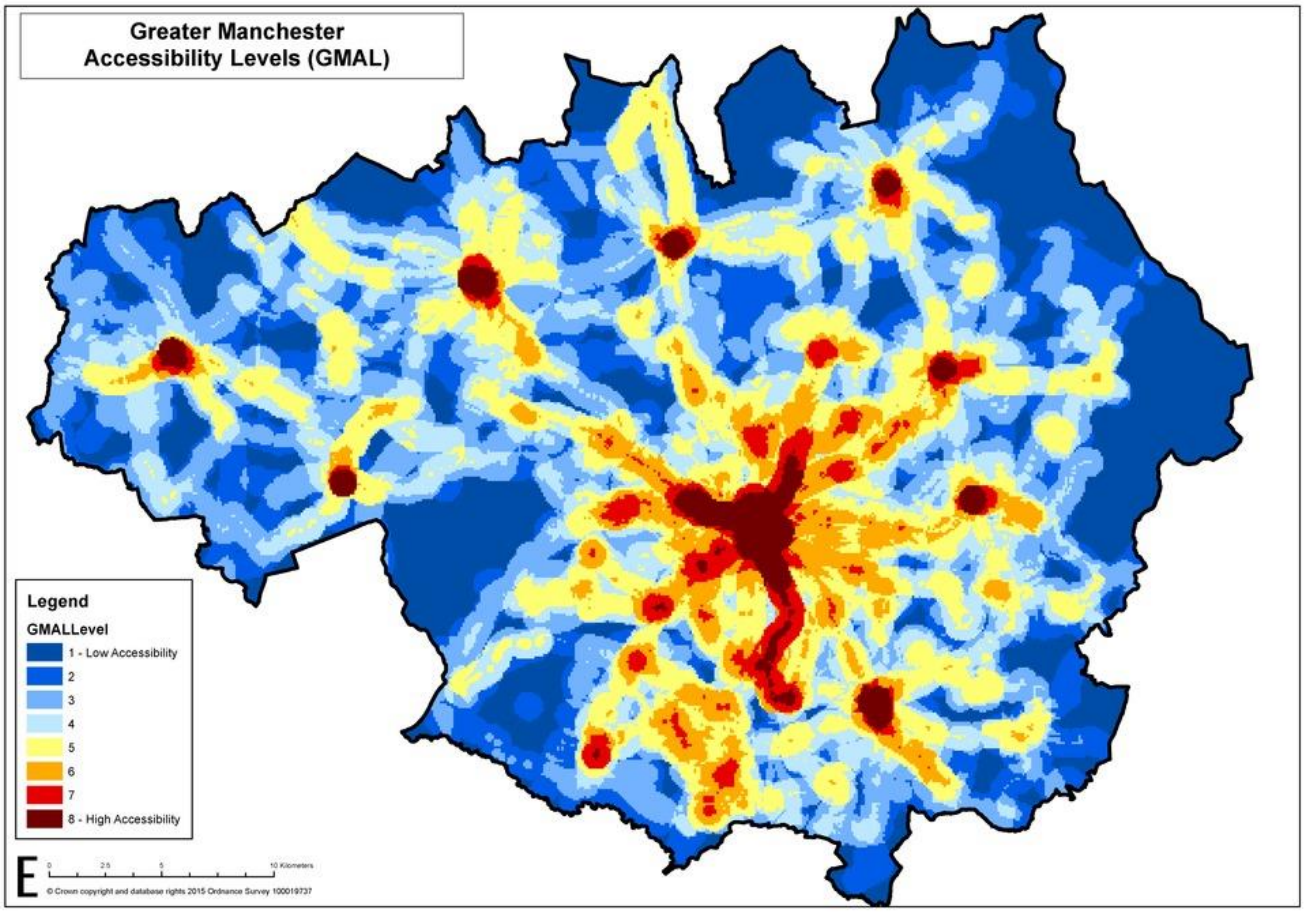
- The initial evidence indicated that Option 6 would not necessarily deliver compliance more quickly than alternative options being considered, which could be realistically be appraised more robustly within JAQU's timeframes.
- The inherent lower feasibility of a scheme at this scale.
- Extended programme implications and therefore delivery of the scheme in the shortest possible time.
- The proportionate high level appraisal of the option was needed only as a phase of scheme development.

In summary, the previous GM-wide CAZ D assessment is seen as over-stating the impact on NO_2 reduction. Note that the previous modelling, while overly optimistic, was considered suitable for the purpose of identifying the likely best performing options for more detailed appraisal – but not as a credible forecast of when "compliance is not just possible but likely".

Availability of alternative modes and credibility of mode shift assumptions

The behavioural response assumptions underpinning the modelling carried out during the options sifting stage of the GM CAP OBC were based upon surveys carried out in inner London, which has a dense and integrated public transport network. As a result, the model predicts significant mode shift from car to public transport. However, beyond Manchester city centre, access to public transport alternatives is much more limited in GM than inner London, and for many of the diverse trips taking place across the wider city region there is simply not a viable public transport alternative available. **Figure 5** shows accessibility levels across GM.

Figure 5. GM Accessibility Levels



Source: TfGM

It would not be possible in the required timescales to deliver transformative public transport improvements to facilitate this mode shift. This shows that access to public transport for journeys to destinations other than central Manchester and major town centres is low.

- In total 40% of the GM population of 2.8 million people live in areas with the least access to public transport (GMAL rating 1 to 4), 50% in areas with moderate access to public transport (GMAL ratings 5 and 6), and just 10% in areas with the best access to public transport (GM ratings 7 and 8).
- Travel patterns across the region reflect public transport accessibility. Analysis of Census data shows that 29% of commuters traveling into Manchester from the rest of GM did so by public transport in 2011. However, commuters travelling to work elsewhere in GM were much less likely to use public transport, with only 11% doing so.
- In order for a CAZ D across GM to be a viable proposition, a step-change in the quality of the public transport network for orbital movements would be necessary in order to provide a viable alternative to the car. This issue is recognised by the Greater Manchester Transport Strategy 2040.
- In January 2019, TfGM published the Draft Delivery Plan covering the period 2020 to 2025 as part of the 2040 Transport Strategy. This identifies proposals for studies to develop a rapid transit network across Greater Manchester including various tram proposals. The Delivery Plan identifies that whilst such schemes will be required to achieve the long-term vision, they will not be delivered within the period 2020 to 2025. Based on experience of recent expansions to the Metrolink network, the time from funding approval through to scheme opening would typically be a minimum of 7 years (assuming Transport and Works Act powers are required).

Introducing a CAZ D where there is not a public transport alternative available, means that people only have the choice of paying the charge or upgrading their vehicle. This would, in reality, likely deliver lower emissions benefits than forecast at the sifting stage for Option 6.

Impact of the scale of the scheme on available behavioural responses

A number of locations across England have developed and submitted CAP business cases.

Leeds will be implementing a partial city CAZ B (plus), having concluded that a CAZ D was not the preferred option, due to the direct and indirect negative economic costs on local people and businesses. The Leeds CAZ B covers approximately 90km^2, compared to a city size of 550 km^2. A larger CAZ was explored but discounted by Leeds Council.

Birmingham will be implementing a CAZ category D (affecting all vehicle types including cars) within the city centre, bounded by the A4540 Middleway Ring Road, an area of around 8km^2 and with under 100k residents. This is compared to a city size of 270 km^2 and total urban area for Birmingham of around 600 km^2. The West Midlands Combined Authority, in which it sits, covers approximately 900 km^2. A larger CAZ was explored but discounted by Birmingham Council.

Bath have announced their intention to proceed with a CAZ category C (affecting buses, coaches, taxis, minibuses and LGVs) in the city centre, covering an area of approximately 3km^2.

In context, GM's Option 5 explored the option of a CAZ D within its equivalent inner ring road, covering approximately 4 km^2. Manchester's city size is 115 km^2 and the urban area is approximately 630 km^2. GM's preferred Option 8 covers the whole of GM, an area of 1,280 km^2.

Figure 6. Comparison of proposed CAZ Areas by size

Source: Relevant authority submissions

CAZ schemes work by encouraging vehicle owners to upgrade to a cleaner vehicle in order to avoid paying a daily charge. The more frequently a driver is likely to be subject to a charge, the more likely they are to choose to upgrade as this will offer better value for money. In comparison, infrequent travellers are more likely to choose to stay-and-pay as it is not worth their while to upgrade.

CAZ schemes do not aim to raise money and therefore in simple terms the most successful schemes will be those where the highest proportion of vehicles upgrade (balanced against the wider impacts of this change).

Although thousands of vehicles visit Greater Manchester each day from across the country, the vast majority of travel in Greater Manchester is wholly contained within the region, in other words both the origin and destination of the trip are within Greater Manchester. Furthermore, the majority of journeys on the road network are made by those who live in the region, or by businesses with operations based in the region.

This means that most vehicles affected by the CAZ will be affected for nearly every journey they make – they are not able to travel from their home or base without moving within the CAZ. For non-compliant commercial vehicles, this could mean incurring a charge on perhaps around 250 working days a year; for vehicles also used for private travel, such as cars and private hire vehicles, non-compliant vehicles could face charges nearly every day.

Based upon the charges proposed in the OBC, this could impose costs per vehicle of around £25,000 for HGVs (based on 250 working days) and up to £2,700 for cars (assuming near daily use).

In comparison, for a city centre scheme, most travel will be inbound, with relatively little travel contained entirely within the zone, and far few residents and businesses operating from the zone where all journeys would be captured. It is also common to offer some discounts and exemptions to residents and businesses operating within a city centre zone.

Therefore, it can reasonably be assumed that the behavioural responses generated by a region-wide scheme will differ from those generated by a city centre scheme.

The inner London ULEZ scheme covers a wider area than just the city centre, but does not cover the majority of Greater London, and excludes outer London which has higher car ownership and

use. It is likely that the behavioural responses would therefore sit somewhere between those for a city centre scheme and those for a region-wide scheme.

For a city centre or smaller scale scheme, drivers can make some choices not available to those affected by a region-wide scheme, including:

- Where more than one vehicle is available, businesses based outside the city centre can prioritise their fleet to ensure that only the newer, compliant vehicles travel into the CAZ, with any non-compliant vehicles operating only outside the zone. This can reduce costs, avoiding charges incurred and limiting upgrade costs, but is not available to those based inside the zone. For a region-wide scheme, most of those affected will be based within the zone and thus their entire fleet must comply or be subject to a charge.

- Similarly, households with more than one car may be able to structure their usage to avoid city centre CAZ D charges by driving only their compliant vehicle into the zone (if they have one), or could limit upgrade costs by upgrading only one vehicle.

- One possible response is for those based outside of the zone to choose not to accept work or activities within a CAZ, if they consider it is not cost effective for them to either upgrade or pay the charge. This option is not available to those based within the zone, and as the scale of a CAZ increases, more and more of those affected will be based within the zone such that all their operations are affected. They then face the far more radical choice of relocating to outside the region, or continuing to travel/operate and either upgrading their fleet or paying the charge.

- Similarly, for a city centre scheme, drivers may choose to change destination to achieve the same purpose, for example visiting another branch of a store outside the affected zone. Whilst this may happen at the boundary of a regional scheme (albeit limited by the fact that more of the available destinations within a reasonable travel distance will be within the zone), changing destination is not an option for those based within the zone.

- Finally, where drivers are making through trips, they may simply choose to change route to avoid entering the zone. Long distance through-traffic would be able to travel through Greater Manchester on the Highways England network, but otherwise the opportunity to divert is likely to be limited to those local trips crossing just in-and-outside the boundary.

Some behavioural responses will be common to those affected by a city centre or regional scheme, but the probability of making each choice is likely to be different:

- Those affected by a region-wide scheme are more likely to choose to upgrade their vehicle, given the frequency with which they would otherwise incur a charge, than those affected by a city centre scheme, on average.

- Conversely, we might expect that a smaller proportion of those affected by a region-wide scheme choose to stay-and-pay than for a city centre scheme, where infrequent travelers are likely to make up a higher proportion of the total.

- Finally, in some cases drivers have the opportunity to switch vehicle type, for example trading down from an HGV to LGV, an LGV to a car, or a Hackney Cab to a private hire vehicle. This is most likely to happen either where some vehicle types are out of scope for a charge, or where switching vehicle type offers a cheaper way to upgrade. This is therefore perhaps more likely to happen in the context of a region-wide CAZ C than a city centre CAZ D.

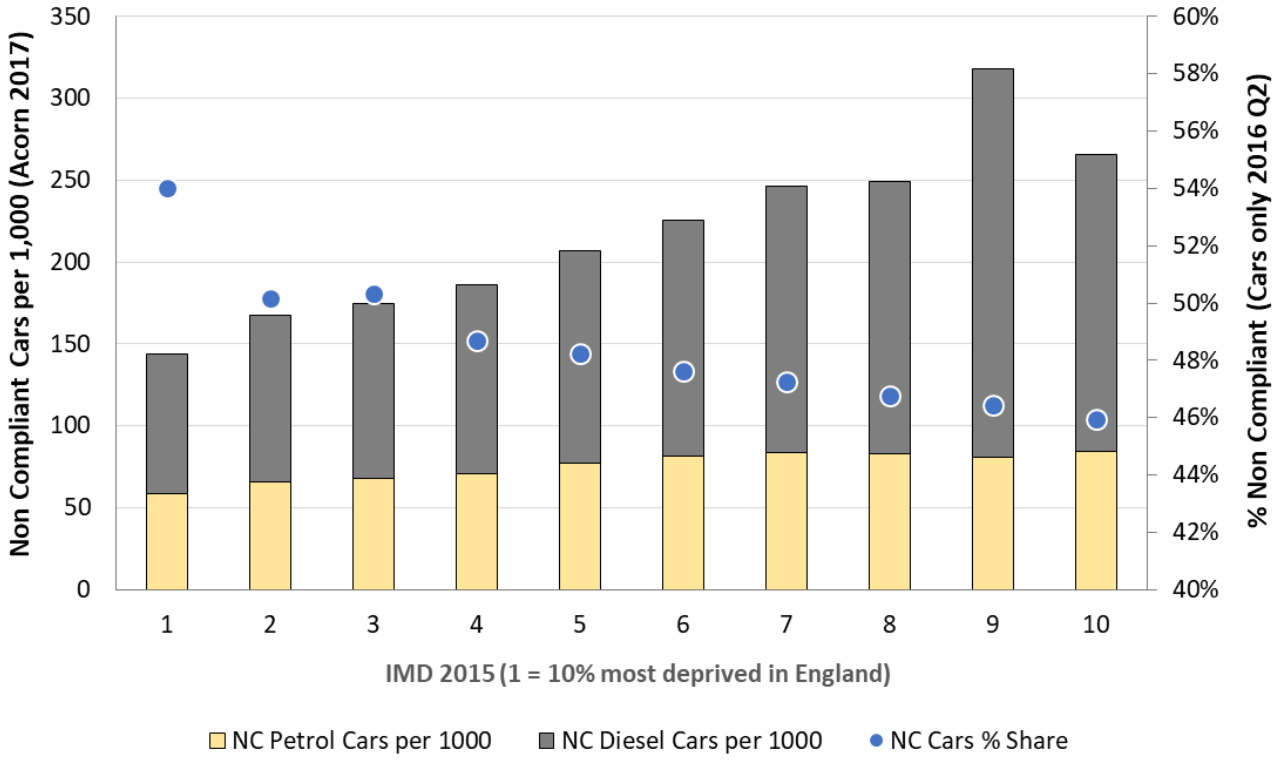
In summary, this means that applying behavioural response assumptions derived from smaller scale schemes to a region-wide scheme may not be accurate. Whilst this approach is reasonable as a very high-level indicative test scenario, it is not considered scalable nor robust for the application to a regional-scale charging-CAZ for a detailed business case itself. For a scheme where the potential negative impacts are so significant, it is necessary for the underpinning evidence base to be far more robust than that available. Detailed scheme specific research would need to be undertaken, which could not be completed within the available programme of works, and with no expectation that it would produce a more effective or efficient scheme design that could be delivered in the shortest possible time as an outcome.

Availability of compliant cars and credibility of upgrade cost assumptions

In total, there are 1.1 million private cars registered in GM, and forecasting suggests that around 250,000 of these will remain non-compliant in 2021. The upgrade assumptions do not take into account the risk that the value of non-compliant cars falls, or that the cost of compliant cars rises. There is a risk that, if this happens, it becomes unaffordable for lower income car owners to upgrade and therefore they are trapped into retaining their vehicle. This in turn would mean that the emissions benefits would be less than currently forecast, as well as reducing accessibility.

This is considered a significant risk under a GM-wide CAZ D scenario because, whilst household car ownership increases with income and as a result, there are more non-compliant cars per head of population in wealthier areas, non-compliant cars as a proportion of all cars owned is highest in the most deprived areas, and in particular ownership of non-compliant petrol cars is disproportionately high in more deprived areas (shown in **Figure 7**). Therefore, the availability of affordable upgrade options is vital to achieving air quality benefits and to avoid negative socio-economic impacts.

Figure 7. Ownership of non-compliant cars per head of population, by deprivation



Source: TfGM

Over the same time period as the proposed GM CAP, CAZ schemes affecting cars are confirmed to open in Birmingham city centre and across inner London. More schemes are expected to emerge as further cities and districts come forward with their CAP proposals. This will result in an increase in the demand for compliant second-hand cars and potentially a loss of residual value for non-compliant cars:

- Research by Statista suggests that three quarters of people are not willing to travel more than 40 minutes to purchase a used car.[1] Analysis of the Autotrader website (which represents about 80% of used car suppliers) suggests that there are currently around 70k compliant second-hand cars available for sale within 45 miles of the centre of GM. This compares to the total number of non-compliant cars within GM being modelled in the OBC as over 250,000 in 2021.
- In order to avoid affordability restrictions on private car upgrade potential, grants from Government would be required. The OBC identified a car vehicle upgrade cost of around £13,000 and with around 250,000 non-compliant cars in GM, costs of up to £3.3bn would be incurred by GM residents. In order to mitigate the negative socio-economic impacts arising from these costs, a large support fund would be required, likely to be greatly in excess of the current combined CAP funding pots that the UK government has committed to support local authorities to deliver their clean air plans.

In conclusion, it is considered a credible risk that a scheme of the scale proposed in Option 6, in combination with the schemes expected to go live elsewhere, would affect the cost of upgrading to a compliant vehicle, with the risk that a lower rate of upgrade than forecast and consequently lower than forecast emissions reductions would be achieved.

6. When would compliance be achieved with a GM-wide CAZ D

As described above, modelling was carried out at the sifting stage, using an earlier version of the model than used for the detailed appraisal of the best performing options, and prior to the development of models for 2023 and 2025. Note that Option 6 – as per all options – was modelled as though it were to be delivered in 2021, but it is not in fact considered deliverable in 2021.

Nevertheless, it is possible to draw conclusions about the likely results of modelling for years beyond 2021, based on the modelling of option 5(i), which includes a CAZ D in the inner ring road and is forecast to achieve compliance in 2024, the same year as the preferred option (Option 8). Option 5(i) is used here for comparison because it is the most similar to Option 6 in terms of the CAZ proposal.

Within the Demand Sifting Tool (DST), the impact of a CAZ is to add a cost to non-compliant vehicles which pass through it, which results in a behavioural response. This will apply irrespective of at which point in their journey the vehicles pass the respective CAZ boundary, it is a binary impact. Therefore, the DST response of modelled trips with an origin or destination within the IRR is essentially the same for an IRR CAZ D as for a GM-wide CAZ D.

Hence for modelled points within the IRR area, the net AQ conditions will be broadly similar with Option 5(i) (a CAZ D in the IRR) and Option 6 (a GM-wide CAZ D), acknowledging that the dispersion nature of the AQ modelling could result in some very minor variation in impact close to the inner CAZ boundary.

The approach here therefore, is to analyse the exceedance point distribution for Option 6 within the IRR for 2021 and compare against Option 5(i), where both scenarios include the same CAZ conditions for the IRR area, and then to consider the implications for 2023 and the expected year of compliance for both options.

Modelling of Option 6 in 2021, as reported in the OBC, suggested that if a GM-wide CAZ D were to be implemented in 2021 – which is not in fact considered possible - there would be 21 points of exceedance above the NO_2 limit value under a GM-wide CAZ D scenario, almost half of which are located within the IRR.

[1] https://www.statista.com/topics/2190/the-uk-used-car-industry/

The Option 6, GM-wide CAZ D, exceedance points within and just beyond the IRR for 2021 are shown in **Figure 8**. This shows 9 remaining exceedances within the IRR in 2021 with a GM-wide CAZ D, subject to all the caveats with regards to model reliability as set out above.

Crucially, the distribution of exceedances forecast for Option 6 is very similar to that forecast for Option 5(i), as shown in **Figure 9**. The Option 5(i) results are based upon a later version of the model based on slightly different assumptions, but we can see the same pattern with exceedances on Quay Street, on and around Deansgate, on Shudehill and just north of Piccadilly Gardens within the IRR, and on Regent Road and the A6 just outside the IRR.

Figure 8. Option 6 (GM-wide CAZ D) locations of 40 ug/m3 exceedances in 2021

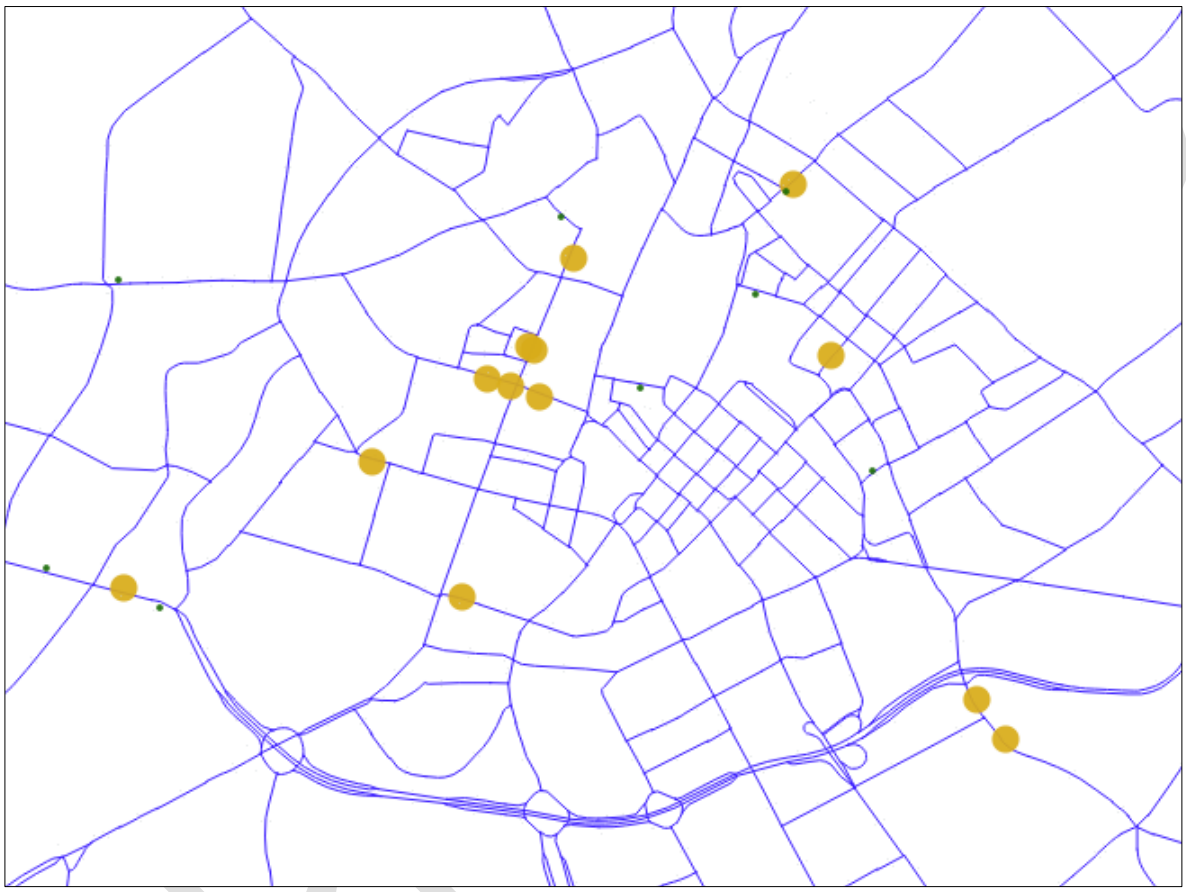
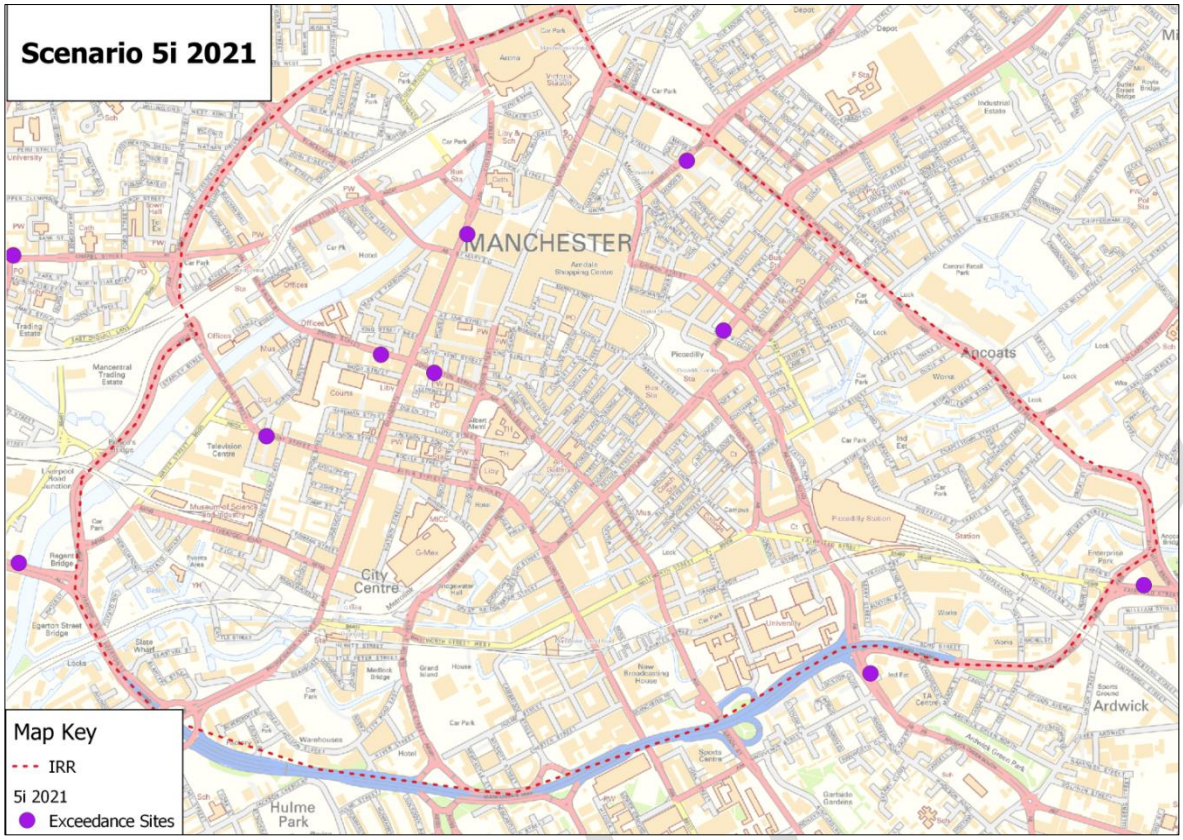
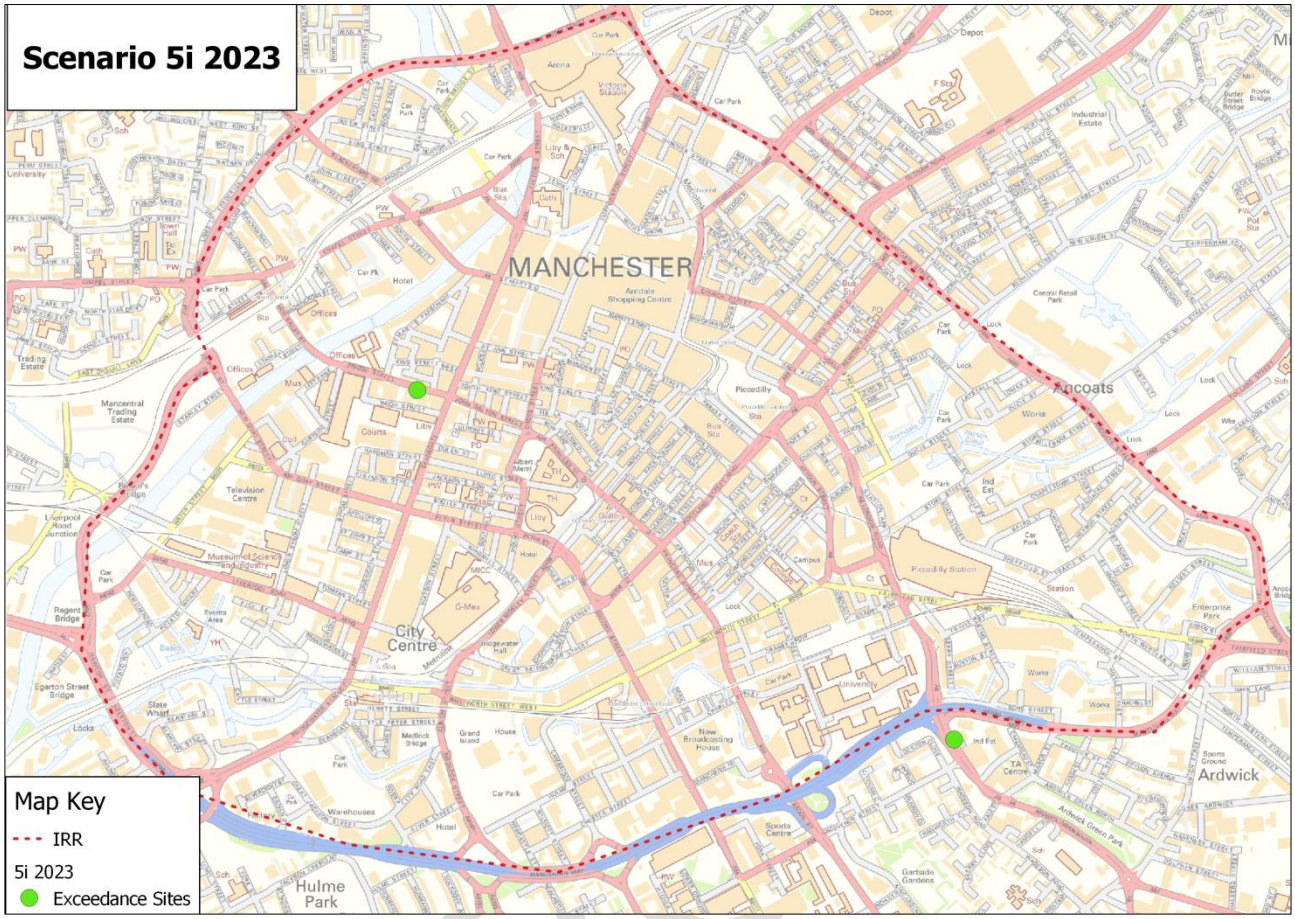


Figure 9. Option 5(i) (IRR CAZ D) locations of 40 ug/m3 exceedances in 2021



Compliance is forecast to be achieved in 2024 for Option 5(i), as Option 8, and therefore some locations remain non-compliant in 2023. Both points shown in **Figure 10** as non-compliant in Option 5(i) in 2023 match exceedance locations predicted for Option 6 in 2021 (based on 2021 implementation, which is not considered deliverable).

Figure 10. Option 5(i) (IRR CAZ D) locations of 40 ug/m3 exceedances in 2023



For the exceedance location within the IRR in particular, given the correlation of 2021 data and discussion of the DST and AQ modelling above, it is considered that this point would similarly remain as an exceedance point for Option 6 in later years, acting as a compliance limiter across GM as a whole.

Consequently, it is considered that the year of compliance for GM would be expected to be the same with Option 6 – a GM-wide CAZ D – and the best performing options including both Options 5(i) and 8 even if Option 6 were deliverable in 2021. In fact, it seems likely that a GM-wide CAZ D could not be delivered until end 2022 or 2023.

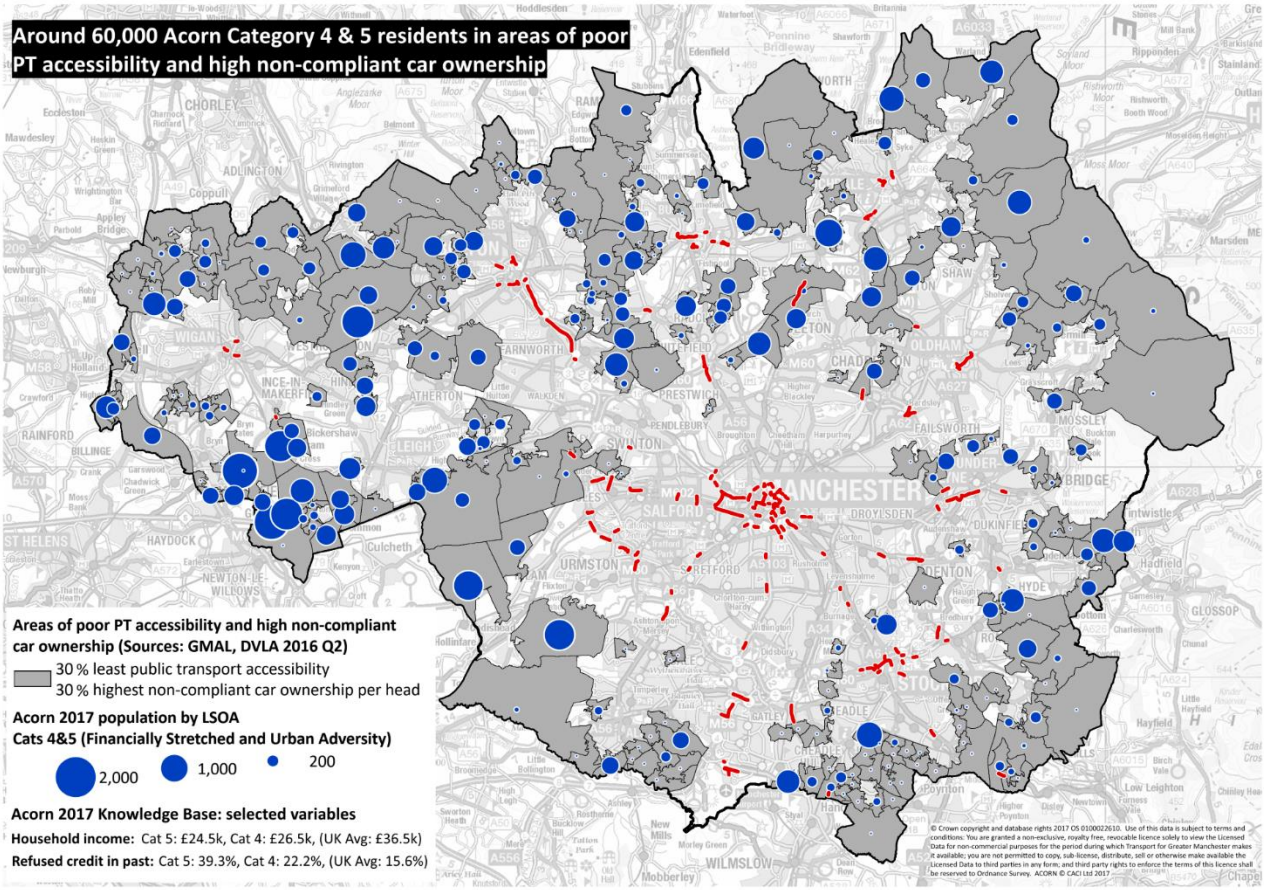
7. Concerns about negative socio-economic and health impacts

GM considers that there is a risk that a GM-wide CAZ D would result in negative socio-economic impacts such as a loss of employment or access to education, impoverishment of low-income car dependent households, and a reduced ability to participate in community and social life. There is a credible risk that the resulting negative impact on health would outweigh the health benefits derived from improved air quality. In total, a GM-wide CAZ D would impose very substantial costs on the people of GM; for example, if all resident drivers of non-compliant vehicles paid the charge, this would impose costs of around £700m per year, or if all upgraded their vehicles this would impose a cost of around £3.3bn on the households of GM.

Greater Manchester contains some of the most deprived areas in England. Across GM, some of the most deprived areas have poor public transport accessibility and in these areas people are more likely to own a non-compliant car.

Around 60,000 Acorn Category 4 and 5 ('Financially stretched' and 'Urban adversity') residents live in areas that are ranked within both the 30% least accessible by public transport, and the 30% highest for non-compliant car ownership per head, as shown in Figure 11.

Figure 11. Areas of poor public transport accessibility and high non-compliant car ownership, for Acorn categories 4 and 5 representing more deprived communities



Source: TfGM

Although households on lower incomes are less likely to own a car, where they do own a car they are more likely to own an older, non-compliant car. Households on low incomes have less ability to absorb additional costs, are less likely to have savings and are more likely to have been refused credit in the past. Nationally, 53% of young adults on average have no money saved and of the 47% who do have some money saved, the average have just £1,600 and 40% have less than £1,000.[2]

Those on low incomes, with little or no savings, or with limited access to credit may not be able to afford to upgrade to a compliant vehicle, or to pay the charge. There is a significant risk that the costs imposed by a GM-wide CAZ D could force people out of employment or education, as well as limiting people's ability to travel to see their friends and family. In turn, this could lead to social isolation and hardship. It is possible that the damage to health caused by the charge could outweigh the health benefits of clean air, although further research would be required to substantiate this.

Support would be required to help those on low incomes upgrade their vehicle and the scale of a GM-wide CAZ D would mean that the cost to the public purse of such support would be extremely high.

[2] ONS Wealth and Assets Survey

GM has not carried out an impacts assessment of Option 6, as it was not progressed beyond the sifting stage. However, the number of vehicles in scope, and the fact that these are owned by private households including many low income households, suggests that the impacts would be considerable and may not be able to be mitigated.

8. Conclusions

A GM-wide CAZ D was assessed as Option 6 as part of the initial Options sifting exercise alongside five other Options, using a multi-criteria analysis tool and taking into account JAQU's primary and secondary success factors, and ruled out at that stage. This is a standard approach for options sifting, and is similar to the approach set out for transport projects using the 'Early Assessment and Sifting Tool' as recommended by the Department for Transport (DfT). Only those options judged to perform strongly at a sifting stage are progressed to full appraisal. GM's own success factors included the determining success factor of 'compliance in the shortest possible time' and the primary success factors 'reduction in NO_2 emissions' to achieve compliance with limit values and reduce human exposure and 'feasibility' to ensure compliance is not just possible but likely.

Key conclusions from the OBC assessment of Option 6, a GM-wide CAZ D scenario, were as follows:

- It is very unlikely that Option 6 could be delivered by 2021 and it appears unlikely that it could be delivered much before 2023. 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. Moreover, 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 as a result;
- The scale of the intervention across the whole of GM is considered to be potentially undeliverable in physical terms and significantly risk delay to compliance as a result;
- It would not be possible in the required timescales to deliver transformative public transport improvements to facilitate sufficient mode shift. This would therefore significantly risk delay to compliance in order to have sufficient provision – which itself would incur substantial additional cost;
- 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; and
- In summary, Option 6 would not deliver compliance in the shortest possible time, a fundamental Critical Success Factor (CSF), 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 Option 8.

Further, it is noted that a scheme affecting private cars on this geographical scale is unprecedented:

- GM covers 1,280km^2 whereas in comparison the CAZ D scheme proposed in Birmingham covers just 8km^2. There are 1.1 million cars registered to households across Greater Manchester, of which around 200-250k are expected to remain non-compliant by 2021.
- Case study analysis of Leeds and Birmingham CAP submissions, shows that similarly to GM, they discounted expansions to their respective CAZ areas due to implementation considerations, anticipated construction and user costs and consideration that there would be limited impact on air quality compliance targets.

- These less comprehensive CAZ definitions in terms of geographic coverage and in the case of Leeds, lesser degree of CAZ, were accepted by JAQU on the basis that they did not bring forward compliance, despite the submissions acknowledging some improved air quality under alternative options.

The analysis within this Note reinforces the OBC conclusions and highlights additional aspects:

- In order to develop, consult upon and deliver such a scheme as a GM-wide CAZ D, considerable planning activity would be required, encompassing research and data collection; modelling and analysis; policy development and scheme design; impacts assessments amongst other activities. Our experience is that this activity would typically take up to 2 years.
- There are several reasons to believe that a scheme on this scale could not be delivered within the timescale required, related to the feasibility of providing a sufficient camera network; boundary considerations and the need to minimise diverting traffic and tackle any safety concerns; and the provision of customer management services at a sufficient scale and quality within the time available.
- Therefore, a GM-wide CAZ D would pose an unacceptable delivery risk and as a result, would threaten the ability of the CAP to deliver compliance by the preferred option date of 2024 or to deliver earlier reductions in human exposure.
- Whilst GM applied best endeavours to adapt the behavioural responses available, these were not considered to be fully appropriate for a robust assessment at a GM-wide CAZ D scale scheme for the following reasons:
  - The responses are considered inappropriate and overly optimistic for a regional scale scheme which involved charging of private cars. This is because, on a regional scale, the assumed level of public transport provision implicit in the fixed percentage for 'change mode' is not consistent with the provision of public transport option available in GM. Introducing a CAZ D where there is not a public transport alternative available, means that people only have the choice of paying the charge or upgrading their vehicle. This would in reality likely deliver lower emissions benefits than forecast at the sifting stage for Option 6.
  - The behavioural responses available to those affected by a city centre scheme (and to a lesser extent, the inner London proposal) are different to the responses available to those affected by a region-wide scheme.
- Furthermore, it is considered a credible risk that a scheme of the scale proposed in Option 6, in combination with the schemes expected to go live elsewhere, would affect the cost of upgrading to a compliant vehicle, with the risk that a lower rate of upgrade than forecast and consequently lower than forecast emissions reductions would be achieved.

Based on the available modelling – based on an implementation date of 2021 which is not in fact considered deliverable - the evidence suggests that a GM-wide CAZ D would not bring forward compliance compared to the preferred option:

- The modelling was considered suitable for the purpose of identifying the likely best performing options for more detailed appraisal, but not as a credible forecast of when "compliance is not just possible but likely".
- The evidence available now suggests that even a GM wide CAZ D scheme would converge to the same final points of non-compliance in the city centre, meaning that (assuming delivery prior to 2024 was possible) compliance would be likely to be achieved at around the same time.

Some of the most deprived areas in England are located in the areas of GM where people are most likely to own a non-compliant car, and also have limited access to public transport. Around 60,000 people live in deprived communities with high levels of non-compliant car ownership and poor public transport accessibility. A GM-wide CAZ D would have dramatic ramifications across the north-west region and country as a whole, the scale of which should not be underestimated.

On the above basis, the conclusion is that a GM-wide CAZ D scenario is not a viable option to warrant further consideration and was correctly discounted during the OBC option sifting stage.