

Greater Manchester's Clean Air Plan to tackle Nitrogen Dioxide Exceedances at the Roadside: Option for Consultation

Analytical Assurance Statement



Salford City Council



Oldham Council

TRAFFORD COUNCIL



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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.

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1 Introduction

- 1.1 The purpose of an Analytical Assurance Statement (AAS) is to consider the limitations, uncertainties and risks in the evidence base, and the implications of these for decision makers.
- 1.2 It considers whether an appropriate procedure has been followed, in terms of the modelling process and the source data, and whether appropriate checks have been carried out. It considers whether appropriate expertise has been utilised, and whether sufficient time and resources have been allocated to the analysis.
- 1.3 An AAS was prepared in February 2019 to support the package of documents submitted as part of the Outline Business Case (OBC) submission.
- 1.4 The analysis at that stage needed to support the following decisions:
 - The agreement of forecast exceedances that must be tackled by the GM CAP through the **Target Determination** process and delivered in the shortest possible time;
 - The **identification of suitable measures** and packages of measures for appraisal; and
 - The **decision to proceed** with the development of a Full Business Case, including engagement and consultation with the public and stakeholders, on the basis of Option 8.
- 1.5 As such, that document considered the limitations, uncertainties and risks affecting the consideration of the:
 - Scale, nature and location of the challenge over time;
 - Type of interventions that will be necessary and effective to tackle this challenge; and
 - The suitability of Option 8 as the basis on which to proceed to the next stage and the likelihood of Option 8 delivering compliance as forecast.
- 1.6 JAQU guidance states that authorities should only make changes to the analysis between OBC and FBC:
 - In response to consultation; and
 - In response to feedback from the TIRP.
- 1.7 Feedback from the TIRP, DIRP and JAQU technical teams (summarised in the appendices to Note 1: Data, Evidence and Modelling Post-OBC approach) has resulted in many of the methodological changes set out here.

- 1.8 Stakeholder engagement and a 'conversation' with the public have since taken place and have led to some changes to the proposals requiring further analysis, particularly to discounts and exemptions proposed to the CAZ, Funding and Loan Finance proposals. Consultation has not yet taken place, and is planned for 2020.
- 1.9 Since the OBC, Option 8 has been developed into the proposed Package for Consultation. Detailed design work and supporting analysis has now been conducted for all measures in the GM CAP. This includes the specification of charge levels, discounts and exemptions and the design of schemes to help people, businesses and operators upgrade their vehicles via grants or loans, as well as sustainable journeys interventions to encourage people to make more sustainable travel choices.
- 1.10 This Analytical Assurance Statement has been prepared to support the proposed Package of Measures for Consultation. This document describes the improvements that have been made to the evidence base and modelling approach since the OBC submission and therefore the extent to which there have been changes regarding limitations, uncertainties and risks in the analysis. Finally, it identifies any remaining steps for the analytical work proceeding to FBC.
- 1.11 The analysis is needed to support the following decisions:
- The agreement of forecast exceedances that must be tackled by the GM CAP through the **revised Do Minimum forecasting** exercise, which updates the results set out as part of the Target Determination process;
 - The **specification of policies and scheme design for each of the identified measures** identified in Option 8, to form the Option for Consultation designed to meet the requirements of the Ministerial Direction; and
 - The **decision to proceed** with the consultation with the public and stakeholders, on the basis of the Package for Consultation.
- 1.12 This document should be read in conjunction with the February 2019 AAS.

2 Background

2.1 The GM CAP is underpinned by a programme of transport, emissions and air quality modelling to identify the scale of the poor air quality challenge and to test the effectiveness of these specific measures and packages of measures in combination. This process is described in the following reports:

- Local Plan Transport Modelling Tracking Table (T1), which is a live document, that is intended to demonstrate that the modelling requirements for the study are being met;
- Local Plan Transport Highway Model Validation Report (T2), which explains in detail how the road traffic model was validated against real-world data in the base year (2016);
- Local Plan Transport Modelling Methodology Report (T3), which describes the approach taken to forecast traffic in 2021 and beyond to 2023 and 2025; and
- Local Plan Air Quality Modelling Tracker Table (AQ1) and Methodology Report (AQ2), which provides an overview of the air quality modelling process and evidence base.

2.2 These reports were published at OBC and have been updated to support the consultation process.

2.3 The results of the analysis carried out at OBC were presented in the Strategic and Economic cases of the OBC and associated appendices, and in the following reports:

- Local Plan Transport Model Forecasting Report (T4), which describes the transport modelling process and results for the Greater Manchester Clean Air Plan Project; and
- Local Plan Air Quality Modelling Report (AQ3), which provides details of modelled NO_x and NO₂ concentrations for the base and forecast years, including comparisons with measured concentrations for the base year.

2.4 Revised versions of the Local Plan Transport Model Forecasting Report (T4) and Local Plan Air Quality Modelling Report (AQ3) have been produced setting out the process applied to testing of the Package for Consultation, and the results of that modelling. Summary results are also set out in Technical Note 29: Option for Consultation Modelling Summary Note.

2.5 The appraisal of the economic impacts and value for money of the GM CAP was presented in the Economic case of the OBC, and the methodology for this analysis is described in the following appendices:

- E1 – Economic Appraisal Methodology Report;
- E2 – Economic Appraisal Model; and
- E3 – Distributional Impacts Report.

2.6 The economic analyses and associated reports have not been updated as yet, but an update will be submitted with the FBC.

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3 **Appropriateness of the analytical process: limitations and risks**

Suitability of the models and modelling process

- 3.1 The modelling system used in the study consists of four components described in Table 3-1 with a discussion of their appropriateness for the project.

Reliability, robustness and limitations of the data sources

- 3.2 The analytical process has drawn on numerous data sources considered appropriate and relevant. By and large, the analysis relies on well-established data sources and on values provided by JAQU, WebTag and the Green Book. The data sources are more fully described in the relevant technical documents and appendices.
- 3.3 There were three local data sources referred to in the AAS at OBC stage; any changes to these and subsequent new data that has been collected since the OBC are summarised in Table 3-2.

Quality assurance and interaction with JAQU

- 3.4 Following the OBC submission, technical discussions recommenced in April 2019 on a regular fortnightly basis. Additional technical documentation has been provided to JAQU in the form of technical notes as follows:

- Note 1: Data, Evidence and Modelling: post-OBC approach;
- Note 2: Next steps for data collection and the development of analytical tools;
- Note 3: Analysis of the freight market;
- Note 4: Analysis of the coach market;
- Note 5: ANPR Surveys: Summary of Initial Findings;
- Note 6: Behavioural response assumptions and available data sources;
- Note 7: LGV and HGV Cost Models;
- Note 8: HGV Behavioural Responses;
- Note 9: LGV Behavioural Responses;
- Note 10: Taxi Behavioural Responses;
- Note 11: Analysis of Bus Upgrade Options to Deliver Air Quality Compliance;
- Note 12: Evidence of the impact of 2021 implementation of a CAZ C (without exemptions);
- Note 13: Traffic Impact on Neighbouring Authorities;
- Note 14: Local exceedances: Update;
- Note 15: Implications of the EFT update for GM;

- Note 16: GM CAP: Sensitivity testing of a CAZ C in 2023 with revised behavioural response assumptions;
- Note 17: Evidence supporting the decision not to progress with a GM-wide CAZ D;
- Note 18: Minibus Vehicle Research;
- Note 19: Taxi and Private Hire Vehicle Fleet Research;
- Note 20: Greater Manchester Specialised Goods Surveys: Results Summary;
- Note 21: Sensitivity test: Full Electric Bus Fleet;
- Note 22: Addendum to Note 3: GM Comparative Statistics;
- Note 23: Summary update of ongoing work on local exceedances;
- Note 24: Updates to the Modelling Tools post OBC Submission;
- Note 25: Modelling the Impacts of Sustainable Journey Measures;
- Note 26: Description of the approach to assessing the uptake of the funds;
- Note 27: Demand Sifting Tool Operating Manual;
- Note 28: Taxi and PHV Cost Model;
- Note 29: Option for Consultation Modelling Summary Note;
- Note 30: Alternative Sensitivity Test Modelling Summary;
- Note 31: Results of tests to assess the optimal charge levels for a Greater Manchester Clean Air Zone; and
- Note 32: Incremental Modelling of Package for Consultation.

3.5 The economic analyses have not yet been updated. A review of the economic modelling methodology is underway in order to reflect the feedback of the TIRP and DIRP and any new data sources. The methodology is based upon JAQU guidance, and the economic and financial assumptions draw on JAQU, WebTag and Green Book guidance.

3.6 The analysis has been carried out by specialists at TfGM and their consultants and has been checked through a quality assurance process in-house at each organisation.

Table 3-1: Modelling process description, discussion of appropriateness

Modelling process		Discussion as at OBC	Update as at Consultation
1	<p>An option sifting tool was developed in the first instance to allow measures to be tested in a quick and efficient way prior to any detailed assessments being undertaken using the highway and air quality models.</p> <p>This was further developed into a WebTAG-style variable demand model, named the Demand Sifting Tool, to allow the behavioural change of measures to be estimated before passing data on for further assessment using highway assignment and air quality models.</p>	<p>An appropriate variable demand model was not available and it would not have been possible to develop one in the time available.</p> <p>The demand sifting tool has been developed for the GM CAP and is considered appropriate. It relies on input data from stated preference surveys, discussed in more detail below.</p> <p>The demand sifting tool is an elasticity model, rather than one that represents each different behavioural response separately. It is not a full variable demand model and does not represent, for example, the impact of suppressed trips being released. As the primary response is vehicle upgrade (most relevant for a CAZ A-C) it was considered that the schemes that were being considered would not have a significant impact on highway congestion and therefore little impact on suppressed demand.</p>	<p>The Demand Sifting Tool approach is retained but the behavioural responses have been enhanced by the development of a series of bespoke cost models. These models reflect the local characteristics of the LGV, HGV, Hackney Cab and PHV fleets in GM.</p> <p>The cost models include additional choice options for LGV and HGV trips such that they can, for appropriate sectors and vehicle types, downsize (e.g. van to estate car) or consolidate to larger vehicles.</p> <p>Details of the development of these models has been reported to JAQU in a series of Technical Notes and the modelling approach is set out in T4. A Demand Sifting Tool Manual has been produced.</p>
2	<p>The highway assignment model (Saturn), which is used to provide details of traffic flows and speeds for input to the emissions model and forecasts of travel times, distances and flows for input to the economic appraisal</p>	<p>The GM CAP uses the do-minimum model developed for the appraisal of the planned extension of the Greater Manchester traffic model. This model was considered to be the most appropriate given its base year of 2013, (which was close to the 2016 base year required for the CAP project), and its forecast year of 2020, which was close to the opening year for the CAP proposal.</p> <p>TfGM's county-wide SATURN model is a well-established tool used for the assessment of numerous major schemes.</p>	<p>The highway modelling approach is unchanged but there have been updates to reflect:</p> <ul style="list-style-type: none"> ▪ Latest information on bus services and fleet operating within GM; and ▪ ppm / ppk values derived from the latest version of the WebTAG Databook. <p>Detailed analysis has been conducted of traffic composition, speeds and congestion at those locations identified as non-compliant in 2023 in Option 7 as tested at OBC ie: a GM-wide CAZ B scenario plus additional measures. These were selected as the sites most likely to determine the year of compliance, and</p>

Modelling process		Discussion as at OBC	Update as at Consultation
		<p>The traffic model validates well at a county level in terms of its link flow validation, although the journey time validation suggests that the modelled speeds in the peak hours tend to be too high on strategic links.</p> <p>Tests have been carried out to investigate how errors in the journey time validation might impact on modelled road traffic emissions for 2016 by applying adjustment factors to the modelled link speeds (at an aggregate level) to give a closer fit between the modelled and observed speeds across the County-as-a-whole. The results of these tests indicated that there was relatively little impact on the calculated emissions. Further details are available in the T2 report.</p>	<p>where further additional measures could potentially act to bring forward the year of compliance. As a result of this analysis, alongside a wider assessment of conditions at the locations, some revisions have been made to model inputs to better reflect real-world conditions.</p> <p>In those locations found to have significant exceedances, an exercise has been undertaken to identify potential traffic management and other relevant solutions.</p>
3	<p>The emissions model, which uses TfGM's EMIGMA (Emissions Inventory for Greater Manchester) software to combine information about traffic flows and speeds from the highway model with road traffic emission factors and fleet composition data from DEFRA's EFT to provide estimates of annual mass emissions for a range of pollutants including oxides of nitrogen (NOx), nitrogen dioxide (NO₂) particulate matter (PM₁₀ and PM_{2.5}) and CO₂.</p>	<p>The EMIGMA tool uses DEFRA's EFT v8.0 tool to calculate vehicle emissions and is considered best practice and appropriate. It draws on appropriate and relevant national and local data sources.</p> <p>The EFT uses data from the Copert modelling which, whilst appropriate for steady state conditions can be less reliable in congested or queuing conditions.</p>	<p>The latest version of DEFRA's EFT tool (version 9.1a) has now been incorporated into the modelling process. This updates the vehicle fleet mix particularly for the diesel/petrol fuel splits for passenger cars, to reflect more recent sales trends away from diesel.</p> <p>This does not alter the Base year or air quality verification, but does alter future year Do Minimum and with-action modelling results.</p>

Modelling process	Discussion as at OBC	Update as at Consultation
<p>4 The AQ modelling process, which uses ADMS-Urban software to combine information about mass emissions of pollution (from EMIGMA) and other data such as wind speed and direction, topography plus background datasets and atmospheric chemical reactions to predict total ambient pollutant concentrations.</p>	<p>The emission rates for each modelled scenario in EFT have been input into ADMS-Urban air quality dispersion model (v4.0.1.0), along with hourly meteorological data from Manchester Airport meteorological station for 2016. The meteorological hourly data set includes all key parameters such as wind speed, direction, temperature etc. This is considered an appropriate tool as applied.</p> <p>The outputs of the AQ modelling were verified against NO₂ monitoring data, which was located in relevant locations across Greater Manchester. This process is described further in AQ3.</p> <p>GM already has an extensive monitoring network of continuous monitors supplemented by diffusion tubes. However, not all of the PCM links are covered directly by the existing monitoring locations. Therefore, additional diffusion tube monitoring is being undertaken.</p>	<p>No change to the dispersion modelling process or verification has been applied from the OBC process.</p>

Table 3-2: Local Data Sources

Item	OBC Data Source and discussion	Update as at Consultation
1 Vehicle fleet composition	Utilised information from Automatic Number Plate Recognition (ANPR) cameras from 2016 and bus/taxi fleet data. This was used to inform the fleet mix in the base year and to forecast the future fleet mix.	<p>The OBC used available ANPR locations which were primarily associated with Manchester City Centre provided by Greater Manchester Police.</p> <p>A bespoke ANPR survey was undertaken in January 2019 over a period of a week at 42 locations, with locations chosen to provide a more representative picture of the GM fleet given the nature of the CAZ option being taken forward.</p> <p>The data has been linked with DVLA records to provide a comprehensive picture of vehicle age, type and fuel. These data were compared with the fleet projection used for the OBC and demonstrated it was consistent and robust.</p> <p>The latest GM licensing database has been interrogated to understand the age profile and vehicle type composition for Hackney Carriages and private hire vehicles (PHVs). Additional investigations have taken place into the volume of PHVs operating in GM which are licensed elsewhere.</p> <p>Copies of the UK Coach Fleet Database and Bus Fleet Databases were obtained and interrogated to improve the understanding of the coach and bus markets locally in GM, supported by operator discussions. DVLA records and a Minibus Market Analysis report, prepared by the Transport and Travel Research Limited (TTR) for the Low Carbon Vehicle Partnership (LowCVP) were used to improve knowledge of the minibus market.</p> <p>Bespoke specialised goods vehicle counts were also undertaken to inform the nature of service sectors using different vehicle types within GM.</p>

Item	OBC Data Source and discussion	Update as at Consultation
2 AQ Monitoring	<p>Ongoing monitoring of ambient NO_x / NO₂ concentrations at sites across Greater Manchester: the ADMS model has been validated against results from local air quality monitoring. This is described in more detail in the AQ2. Additional monitoring is being put in place to support scheme development and monitoring, to ensure monitoring is well aligned with the location of the last remaining sites of non-compliance</p>	<p>Additional air quality monitoring has been deployed in July 2019, and further monitoring will be needed to meet the requirement of the Monitoring and Evaluation project, and guidance issued by JAQU in 2019.</p>
3 Behavioural Responses	<p>Behavioural responses to a CAZ derived from a Stated Preference Survey conducted in Bristol in 2018, re-weighted to better reflect local characteristics. This replaced the use of survey data from London's ULEZ scheme, used in earlier iterations of the modelling. On balance, it was considered that Bristol was more similar to GM than London in terms of demographic and travel characteristics and therefore that this data was more suitable.</p>	<p>GM has carried out a review of all vehicle upgrade and behavioural response assumptions and has developed a revised approach for HGV, LGV, PHV and Hackney Cab responses. This means that the 100% upgrade assumption applied to Hackney Cabs at OBC has been replaced with an evidence-based behavioural response in the Consultation package.</p> <p>Initial updates on the revised methodology for each vehicle type were supplied to JAQU on 12th July. Updated notes were supplied to inform JAQU and the TIRP, alongside a table outlining how these notes relate to/replace the contents of the strategic modelling Technical Reports.</p> <p>A full update of the strategic modelling Technical Reports (T1-4, AQ1-3, AAS) has been completed and will be published alongside the Consultation. The series of technical notes supplied to date will also be published, subject to limitations in terms of commercially sensitive or personal data.</p> <p>The Bristol stated preference data is no longer being used. Sheffield stated preference data has been used to benchmark the new Cost Model output where appropriate.</p>

Item	OBC Data Source and discussion	Update as at Consultation
		See Appendix A for further details on a measure-by-measure basis.

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Time and resource constraints

- 3.7 In the time available since the OBC submission, significant additional resource has been committed to the development of the CAP proposal.
- 3.8 The areas of concern at the time of the OBC have been targeted and additional work undertaken to strengthen the evidence base and this work has been shared with JAQU. JAQU have indicated that they are satisfied with the modelling methodology applied in the assessment of the Package for Consultation.

Is there a risk that additional analysis would lead to different conclusions?

- 3.9 Considerable additional analysis has been undertaken since the OBC and reported to JAQU. This has included the exploration and testing of alternative options, such as a bringing forward the implementation of a CAZ C for vans to 2021 (set out in Note 12), the implementation of a GM-wide CAZ D (set out in Note 17) or the implementation of a CAZ D within the IRR. The work carried out to date suggests that there are no credible alternative options able to bring forward the date of compliance in Greater Manchester. A programme of sensitivity tests will be conducted prior to the submission of the FBC to further interrogate the uncertainty of the results. Whilst analytical work is still ongoing, and will continue to FBC, there has been no indication to date that different conclusions will be reached.
- 3.10 It is likely that additional economic modelling and analysis will be undertaken at FBC but it is unlikely that this would lead to different conclusions:
- The feasibility of carrying out analysis applying a fuller Distributional Impacts methodology as per JAQU's guidance is being investigated at present. If this analysis proves feasible, it will provide a more robust assessment of health benefits in particular, but it is unlikely that the headline conclusions in terms of distributional impacts will change, although it is possible that localised issues will emerge for specific groups.
 - It is anticipated that the economic modelling to support the FBC will incorporate results for 2023 (not included to date). This may change the values of costs and benefits but as these changes would affect all Options in the same way, this would not affect the conclusions.

4 Scale, nature and location of the challenge over time: limitations, uncertainty and risk.

- 4.1 The scale of the challenge revealed by the modelling provides us with a general level of certainty that facilitates decision making. Greater Manchester is not close to compliance, the exceedances are widespread with concentrations much greater than the legal limits (up to 57 $\mu\text{g}/\text{m}^3$ in 2021). The margin of error of the modelling, whilst not truly calculable, is very unlikely to be so great that Greater Manchester would in fact be compliant without action. Furthermore, the exceedances reflect the locations of previously identified AQ hotspots and reflect local knowledge of traffic patterns and congestion. Monitoring data has been used to validate the model and therefore the exceedances reflect real-world conditions. This is described further in AQ3.
- 4.2 A series of updates have been undertaken to improve the Do Minimum forecast. These comprise:
- Updates to the bus service data based on more recently available 2019 service patterns;
 - Updates to the demand matrices in line with changes to the projected splits of petrol, diesel and electric cars\taxis in version 9.1a of the EFT and the latest DfT figures for the projected fleet split (by vkms);
 - Updates to the values of time and distance, (PPM and PPK), used during the assignments using the latest values of time, GDP growth rates and vehicle operating costs derived from the WebTAG data book, May 2019.
- 4.3 Overall, these updates are considered to better reflect best practice and the more recent evidence which has emerged since the production of the OBC modelling process, and supply greater certainty in the reliability of the results.
- 4.4 Table 4-1 identifies the sources of uncertainty in the modelling of the challenge as identified in the original AAS. Commentary is now added with regard to the extent that the position has changed.
- 4.5 Monitoring will be required to ensure that the policy and proposals contained in the GM CAP remain appropriate throughout the lifetime of the interventions.

Table 4-1: Sources of uncertainty in the modelling of the challenge

Source of uncertainty	OBC Discussion	Update as at Consultation
<p>Vehicle purchasing / ownership patterns and trends</p>	<p>The projected fleet mix for buses and other road traffic in the forecast year is estimated, based on an assumption that the age profile of the vehicle fleet remains unchanged over time.</p> <p>ANPR data has revealed that the Greater Manchester fleet is older than the national average.</p> <p>There is some emerging national evidence of slowing new vehicle sales and of a shift from diesel to petrol in new car purchases.</p> <p>Sensitivity testing suggests that a slower change in the fleet age over time could result in mass NOx emissions for 2023 that are approximately 25% greater than the reference case.</p> <p>Monitoring of the fleet profile will be required. New ANPR survey data from 2019 will assist in determining the projection rate used between 2016 to 2021/23.</p>	<p>Additional ANPR data has been collected to improve the evidence base with regard to the fleet age profile, and temporal projection.</p> <p>Research has been undertaken into the vehicle renewal patterns of different market sectors and this has been incorporated into the LGV and HGV cost models, providing a more informed position on the likely behavioural responses to the CAAP.</p> <p>GM has applied EFT v9.1a, which has primarily affected the split of petrol and diesel cars, increasing the petrol and EV/hybrid fleet in line with more recent sales trends and again reducing uncertainty in terms of the accuracy of car emissions.</p>
<p>Trends in background emissions</p>	<p>Background emissions are based on the DEFRA background emissions maps 2015. Comparison of this with local background measurements suggests that the DEFRA maps are lower than monitored values.</p> <p>Background emissions are higher than average in parts of Greater Manchester, accounting for 25 µg/m³ at some non-compliant sites, after removal of the transport sector, in 2021.</p> <p>GM assumes that DEFRA will keep abreast of trends in background emissions. GM will apply any new guidance as it emerges where possible.</p>	<p>The Defra background maps were updated to a 2017 base year, however these are not consistent with the projections used in EFT 9.1a.</p> <p>Additionally, a 2016 dataset was not provided so the latest 2017 based maps cannot be used in the GM modelling which has a 2016 Base Year. This issue was flagged to JAQU before the mapping was released.</p> <p>Background concentrations vary each year for many environmental factors, so assumptions based on the Base Year are subject to projection uncertainty, which cannot readily be addressed without altering assumptions that affect the Base Year verification and Target Determination results.</p>

Source of uncertainty	OBC Discussion	Update as at Consultation
Traffic growth trends	<p>The SATURN model forecasts traffic growth of around 12% between 2016 and 2025, reflecting population and economic growth. Current trends suggest traffic is not growing at this rate and therefore sensitivity testing of a low traffic growth scenario has been carried out.</p> <p>Sensitivity testing suggested that a plausible low growth scenario resulted in relatively small reductions in vehicle kms and NOx emissions of about 6% relative to the dominant scenario.</p>	Note that a correction has been applied in the revised Do Minimum modelling ensuring that van growth is correctly represented.
Fuel costs and other wider changes in costs/travel time	<p>Traffic modelling assumes fuel costs as recommended by WebTag. In theory, if fuel costs or other similar costs were to change in future, it could have an impact on vehicle purchasing choices and on kilometres travelled.</p> <p>Sensitivity testing of the GM CAP has demonstrated that the conclusions are not sensitive to fuel costs.</p>	No change
Effectiveness of future emissions standards	<p>It is assumed that future emissions standards perform as planned. The performance of earlier emissions standards against forecasts has been variable.</p> <p>This is a known source of uncertainty that cannot meaningfully be mitigated at a local level.</p>	No change
Assumptions about real-world emissions	<p>Emissions rates have been based on the EFT version 8.0. The emissions rates of vehicles in the real world may differ from those modelled. The analysis in the base year is calibrated to real data and so this is internalised into the analysis. However, this cannot be adequately weighted to differing vehicle types/ages/fuel types which affects future year assumptions as the fleet renews over time.</p> <p>This is a known source of uncertainty that cannot meaningfully be mitigated at a local level.</p>	This is not altered from OBC position, because EFT 9.1a is also based on Copert.

Source of uncertainty	OBC Discussion	Update as at Consultation
<p>Assumptions about the impact of urban canyons</p>	<p>Greater Manchester is a complex urban environment. Overall, it is considered likely that there is considerable variation of modelled concentrations in central Manchester due to the presence of canyons. The assessment has applied a recognised best practice approach to representing model predictions in the vicinity of canyons. It is also noted that the highly variable and complex nature of modelling this type of environment is not readily compatible with the overall approach of the EU Air Quality Directive, which indicates model outputs should be representative of relatively long stretches of road, not affected by changes to traffic flow or junctions. Canyons are a similar effect resulting in spatial discrepancy in NO₂ concentrations.</p> <p>JAQU guidance recognises this issue and recommends additional Scheme Evaluation Monitoring is implemented in canyon locations, but not that this should be done to inform the Target Determination process / Options Appraisal of OBC which would like to delay the programme by 6-12 months.</p>	<p>The approach to modelling canyons followed best practice, both in the application of the canyons module, with a canyons file produced for GM by CERC (the ADMS model developer), but by applying a separate AQ model verification zone around the IRR area where the canyons module was used explicitly. However, even with this approach the uncertainty in predictions is highly sensitive to the local effects of canyons, and several of the last locations to comply are found inside the IRR area.</p> <p>Additional air quality monitoring has been deployed in July 2019, and further monitoring will be needed to meet the requirement of the Monitoring and Evaluation project, and guidance issued by JAQU in 2019.</p> <p>These sites included many in the canyon locations where exceedances had been predicted in the AQ modelling. Sufficient data is not yet available to draw meaningful conclusions on annual mean NO₂ concentrations.</p>
<p>Gradients and Topography</p>	<p>The effects of gradients have not been able to be incorporated in the timescales. The locations of significant gradients were reviewed and it is considered that this would have only a limited effect on verification or key output sites. Topography of the road network is difficult to determine as the road network is not always at grade.</p> <p>However, the last points of compliance in the modelling are not significantly affected by gradients.</p>	<p>No change.</p> <p>Incorporation of gradient into the modelling would have required updating Target Determination, because we would have had to alter the Base year modelling and verification process.</p> <p>This was not considered proportionate because the last points of compliance in the modelling are not significantly affected by gradients.</p>
<p>Assumptions about bus service patterns and fleet profile</p>	<p>The highway modelling is based on 2015 bus service patterns. Bus mileage has, however, been falling in recent years and it is possible that this approach over-estimates likely future bus mileage.</p>	<p>The traffic model has been updated to reflect the latest information on service patterns and fleet profiles from 2019.</p>

Source of uncertainty	OBC Discussion	Update as at Consultation
	<p>There is uncertainty around bus vehicle upgrade patterns. The impact of new funding to support the purchase of electric buses has not been incorporated in the analysis.</p>	<p>The GM bus market is complex with numerous operators and fleet age profiles which reflect uncertainty around the future direction for bus service provision in GM.</p> <p>Proactive engagement with the bus operators has shown a good awareness of the CAP and a willingness to improve their fleets. Uncertainty will remain however around the commercial decisions to be made until the level of potential financial support can be confirmed.</p>
<p>Assumptions about future growth and related schemes</p>	<p>The GMVDM matrices were used to calculate demand changes; these matrices included early estimates of GMSF (Greater Manchester Spatial Framework) growth, which were not available at the time that the 2021 CAP matrices were developed. It needs to be born in mind, however, that the GMSF is still open to consultation and will be subject to uncertainty. Overall traffic growth has also been constrained to NTEM forecasts.</p> <p>It was decided as part of this process to also include all of the 2025 schemes in the 2023 networks, to ensure that both networks were topologically the same. This approach was adopted to avoid having to update the road width and street canyon files that had been developed for use with the 2025 dispersion model, which would have been time-consuming and could have delayed the project.</p>	<p>A review will be undertaken prior to FBC submission to assess whether any approved schemes are expected to affect the topology of the road network and review the assumed networks for 2023 and 2025.</p>
<p>Other assumptions about road network and weather conditions affecting air quality forecasting</p>	<p>The GM region is a very large study area, with a diverse range of topography and surface features. Additionally, road transport fleet age may vary depending on the nature of road type or function.</p> <p>This area has necessarily been modelled as a homogenous area in ADMS.</p>	<p>No change</p>

5 Effectiveness and suitability of interventions: limitations, uncertainty and risk

- 5.1 The evidence suggests that the measures that can be effective in tackling air quality are those that clean up the fleet, encourage changes in driver behaviour, and encourage the use of more sustainable modes of travel. The GM CAP includes measures to achieve this and is situated in a wider context of action to improve public transport and active travel options and reduce the need to travel by car. The scale of the challenge means that bespoke site-by-site measures such as traffic management were not feasible as the primary solution, although such interventions may still be recommended at the most persistent sites of exceedance and these have been investigated as part of the Local Exceedances work.
- 5.2 The sources of uncertainty in the modelling of the impacts of each measure as identified at OBC are described below together with updates where the evidence base or methodology has changed as a consequence of recent work.
- 5.3 Across all the proposals, an assumption has been made that the local and national policy landscape remains as now. In reality, the choices of fleet managers and vehicle owners would be - and are being - influenced by emerging policy measures and changing conditions such as the consultation on bus reform, Minimum Licensing Standards, and Brexit. Where clarity emerges in time to be taken into account, the implications for the GM CAP proposals will be reflected into the modelling and appraisal process.

Clean Air Zone

- 5.4 There is inevitable uncertainty in terms of quantifying the response of drivers in Greater Manchester to the introduction of a charging Clean Air Zone, and in assessing the appropriateness of the charge levels applied in the analysis. A scheme on the scale proposed has not been implemented in any UK city to date and thus there is no real-world evidence of how drivers will respond. The sources of uncertainty are described in Table 5-1 as identified in the original AAS with commentary added with regard to the extent that the position has changed since OBC submission.

Table 5-1: Sources of uncertainty in modelling a Greater Manchester Clean Air Zone

Source of uncertainty	OBC Discussion	Update as at Consultation
<p>Vehicle purchasing/ ownership patterns and trends</p>	<p>A series of assumptions have been made about upgrade choices and costs, for example that drivers would not choose to downgrade their vehicle as a result of the GM CAP.</p> <p>If further evidence becomes available that challenges these assumptions, the number of vehicles in-scope could potentially be altered, and the base level altered. However, this would be relatively consistent between scheme options and thus would be unlikely to affect the decision to proceed with Option 8.</p> <p>In behavioural response terms, the primary impact is on the costs and benefits of the proposals, and on the mitigating measures that may be required.</p>	<p>The cost models developed for LGV and HGV allow for drivers to downgrade (LGV to estate car, HGV to LGV etc.) where appropriate based on a consideration of the market sector they operate in.</p> <p>The cost model developed for Taxi / PHV includes the functionality to allow downgrade from Hackney operation but this has not been implemented. Further detailed research would be required into the commercial operation of this sector to enable a robust assessment. It is currently assumed that the choice to operate a Hackney (rather than PHV) would not be impacted by the CAP as the charge would apply equally to both modes.</p> <p>Further work has been done to substantiate the cost assumptions being used for upgraded vehicles and for the feasibility, availability and cost of retrofit.</p> <p>In addition, comparing the original and new ANPR surveys conducted in GM has provided greater confidence that our assumptions about vehicle purchasing patterns are correct.</p>
<p>Behavioural responses</p>	<p>Our assumptions in terms of how drivers would respond to a CAZ in Greater Manchester have been based upon data collected in Bristol, as discussed in Table 3-2 above. This is the best data available and is considered more appropriate than applying survey data from London.</p> <p>New information from Sheffield is now available, and this needs to be tested to see whether it corroborates existing assumptions.</p>	<p>The Bristol stated preference data is no longer used – see Table 3-2.</p> <p>See Appendix A for further details on a measure-by-measure basis.</p>

Source of uncertainty	OBC Discussion	Update as at Consultation
	<p>GM will also consider any 'revealed preference' data that becomes available from other cities as schemes are launched elsewhere.</p>	
<p>Frequency of travel</p>	<p>The cost effectiveness of different behavioural responses depends in part on the frequency of travel.</p> <p>We have identified the need for better data and new data collection is underway using ANPR surveys. We will also investigate the feasibility of further data collection to improve our knowledge.</p> <p>However, given the regional scale of the scheme, it is likely that the majority of vehicles in-scope will be local and therefore travel frequently and so this is less influential than for a smaller scheme.</p>	<p>New ANPR data has been collected however there remains a degree of uncertainty with regard to trip frequency particularly for freight (LGV and HGV) vehicles travelling into GM from outside.</p> <p>There will be a high degree of variation which may not have been captured adequately by the ANPR e.g. long-distance HGVs which visit infrequently and similarly coach traffic relating to particular events.</p>
<p>Infrequent and long distance travel</p>	<p>We have assumed that long distance travellers (>50 miles trip length) do not respond, which seems reasonable.</p> <p>However, we cannot take account of the possible impacts of schemes in other cities on the national fleet profile. It seems reasonable to assume that if many cities introduced similar schemes, this would have a meaningful effect on the national fleet profile for in-scope vehicles, by affecting operators' abilities to relocate a non-compliant fleet, or the total cost of becoming compliant vs upgrading.</p>	<p>No change.</p>
<p>Cost of upgrade</p>	<p>It is possible that the introduction or expectation of CAZs increases the price of compliant vehicles, and/or decreases the value of non-compliant vehicles. This has not been taken into account in the analysis.</p>	<p>We have allowed for market distortion to be considered as part of the functionality of the cost models. This has not been implemented in the core reporting but can be used for sensitivity testing.</p>

Source of uncertainty	OBC Discussion	Update as at Consultation
		<p>The extent to which this distortion occurs will be dependent on the number and scope of other CAZ projects around the country and factors in the vehicle supply chain and potential retrofit technology which are outside the control of GM. Indications for LGVs are that the issue is relatively minor for a 2023 charging scheme, but could materially affect responses in 2021 when the market supply of compliant second-hand vehicles would be constrained. There is also evidence that the availability of compliant Euro 6 diesel Hackney Cabs is very limited.</p>
Impact of discounts and exemptions	<p>The analysis conducted to date assumes all vehicles are in scope for the CAZ and does not take into the possible impact of discounts and exemptions. These will be developed at FBC and are subject to public consultation.</p>	<p>A series of proposed discounts and exemptions have been developed with supporting policy documentation that will be subject to the planned public consultation exercise. All major discounts and exemptions are included in the core model runs.</p> <p>Work has been conducted, as is presented in Note 12: 'Evidence of the impact of a 2021 CAZ C', to demonstrate that removing the LGV temporary exemption cannot bring forward compliance. This was supplied to JAQU on 12th July and further discussions and evidence sharing have taken place since then. Revised estimates of the number of LGVs expected to upgrade to new and second-hand vehicles were supplied to JAQU on 22nd October 2019 and further evidence on the issues with removing the LGV temporary exemption was supplied by letter on 1st November. A freight data annex was supplied on 22nd January 2020 providing freight fleet data.</p>

Source of uncertainty	OBC Discussion	Update as at Consultation
Re-routeing or change of destination	For the region-wide CAZ proposals, the demand responses to charging are applied in the demand sifting tool rather than in the highway assignment model. Therefore possible changes to origins and destinations are not captured. The GM-wide nature of the schemes reduces the likely effect of destination change at the last point of compliance.	Investigations have been undertaken using the assignment model to check on the risk of diversion. Involved liaison with infrastructure team (signing etc.) to ensure impact minimal.
Access to equity or credit to facilitate behaviour change	None.	<p>It has been assumed in simple terms that vehicle owners will take the lowest cost option, upgrading if this saves money compared to paying the charge. This in turn assumes that vehicle owners have the equity and/or access to credit to enable them to make the best financial choice. However, evidence suggests that people and businesses are not always able to save money if to do so involves a large up-front capital investment.</p> <p>At present around one third of credit applications are refused. Those with poor credit ratings, low or unreliable incomes, or who need to purchase a high value vehicle may struggle to access the credit they need to upgrade.</p> <p>The CAZ will bring forward investment in fleet upgrade. This will affect the credit worthiness of applicants, as they will have had less time to accrue a deposit, may need to purchase a higher value vehicle than normal, and may need to finance multiple vehicles at one time. As a result, total indebtedness will rise, affordability will fall and they may either face more expensive credit or be refused.</p>

Source of uncertainty	OBC Discussion	Update as at Consultation
		<p>Thus, there is a risk that the models over-state the likelihood that vehicles upgrade, if upgrade is not possible or affordable due to a lack of equity or credit. The provision of grants and/or loans to assist upgrade will mitigate this risk, as well as mitigating negative socio-economic impacts on in-scope groups. It could be considered that the 'with grants' behavioural responses are more robust than the 'CAZ only' responses.</p>

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Vehicle Renewal Schemes to help people, businesses and operators upgrade

- 5.5 The scale of change required to the vehicle fleet in Greater Manchester, and the speed with which that change is required, means that vehicle renewal schemes - in other words, schemes providing grants or loans to support the upgrade of vehicles - are considered an essential part of the package. Although similar proposals are emerging elsewhere, there is limited real-world data on the effectiveness of such schemes and thus uncertainty in the assumptions applied. The proposed schemes include a Clean Bus Fund, Clean Commercial Vehicles Fund and Clean Taxi Fund, providing grants towards the purchase of a compliant vehicle. Each of these Funds is represented in the modelling.
- 5.6 For buses, a lack of evidence in terms of the relationship between charges, grant offers and behaviour change means that an assumption has been applied that all buses become Euro VI compliant, based upon both the imposition of charges and the supply of grants towards retrofit or replacement of buses.
- 5.7 For commercial vehicles and taxis, grant values have been incorporated into the Cost Models, reducing the assumed cost of upgrade for in-scope vehicles.
- 5.8 A Loan Finance scheme is also proposed, offering preferential access to loans at a reduced cost compared to market rates. These proposals have not currently been quantified or considered within the modelling and thus are not considered below.
- 5.9 The level of uncertainty prevalent at OBC is described in Table 5-2 from the original AAS with commentary added with regard to the extent that the position has changed since submission.

Other proposals

- 5.10 The GM CAP includes proposals to support the uptake of electric vehicles (EVs) and to promote sustainable travel. Government forecasts of the car and van fleet, by fuel type, are included in the underlying assumptions, derived from the EFT. Beyond this, uptake of Zero Emissions Capable taxis has been assumed as a result of the CAP, derived from GM's Taxi Cost Model and informed by survey data collected in Sheffield. This is based on the assumption that the provision of grants and dedicated charging infrastructure will encourage uptake of electric taxis.
- 5.11 Modelling has been carried out to estimate the impacts of a programme of activity to promote sustainable travel.
- 5.12 Table 5-3 describes the sources of uncertainty in these proposals.

Table 5-2: Sources of uncertainty in modelling Vehicle Renewal Schemes

Proposal	OBC Discussion	Update as at Consultation
Clean Commercial Vehicle Fund	<p>Assume that all those eligible for upgrade schemes utilise them and that the funds are sufficient to support upgrade.</p> <p>More work is required at FBC to support an appraisal of effectiveness and value for money.</p>	<p>Analysis has been carried out to better understand the scale and composition of the in-scope fleets. Tests have been conducted using the new Cost Models to assess the likely uptake and impact on behavioural choices of Funding offers at different levels and under different conditions (such as with or without scrappage).</p> <p>The availability of better data and tools has reduced uncertainty, although there remains limited evidence on the uptake and effectiveness of similar schemes.</p> <p>There is a risk that if the grants are insufficient to promote upgrade, or that uptake of grants is poor for some other reason, that a greater proportion of drivers will choose to stay and pay. Similarly, there is a risk that if insufficient funds are available, a greater proportion of drivers will choose to stay and pay. This could affect the year of compliance for GM.</p>
Clean Bus Fund	<p>Assume that 100% of buses are compliant by 2021.</p> <p>No evidence was available on how buses would respond to pricing to allow a more sophisticated analysis of behavioural response.</p> <p>Whilst the assumption that 100% of buses will be compliant by 2021 may be overly optimistic, mechanisms exist to support bus retrofit and to prioritise those routes with the greatest impact on air quality. Greater Manchester has also received new funding for electric buses, not accounted for in this analysis. It is likely that compliance can be achieved on most routes by 2024 at the latest.</p>	<p>New data has been collated from bus operators on the fleets and services operating in GM. Analysis has been carried out to assess which vehicles can be retrofitted and which must be replaced. Detailed discussions are underway with bus operators to agree a plan in order to achieve a fully compliant bus fleet.</p> <p>It is assumed that a fully (or near to) compliant bus fleet can be achieved by 2023 and therefore that, although the assumption that all buses are compliant by 2021 is overly optimistic, this is less likely to affect the year of compliance for GM.</p>

Proposal	OBC Discussion	Update as at Consultation
<p>Clean Taxi Fund (Hackney Cabs)</p>	<p>Assume that 100% of hackney carriages are compliant by 2021.</p> <p>No evidence was available on how taxis would respond to pricing to allow a more sophisticated analysis of behavioural response.</p> <p>Whilst the assumption that 100% of hackney carriages will be compliant by 2021 may be overly optimistic, it is likely that compliance can be achieved for the majority of the fleet by 2024 at the latest.</p>	<p>Updated data has been collated from licensing authorities on the scale and composition of the hackney cab fleet. The assumption that all hackney carriages would be fully compliant has been replaced with an evidenced behavioural response assumption derived from a Cost Model. This model also allows the assessment of the likely impact on behavioural choices of Funding offers at different levels and under different conditions (such as with or without scrappage). It is assumed that drivers and operators will take advantage of the Fund and upgrade their vehicle.</p> <p>It is assumed that Funding will be available for ZEC hackney cabs only. There is a risk that, without sufficient electric vehicle charging infrastructure, this upgrade will not happen, with drivers either choosing to upgrade to Euro 6 diesel (subject to availability), stay and pay or change their operations.</p> <p>The proposed temporary exemption for Wheelchair Accessible Vehicles (most of the hackney cab fleet) to 2023 gives owners more time to prepare, increasing the pool of vehicles available and reducing the cost of upgrade. This increases certainty that the upgrade response as forecast will materialize.</p> <p>There is a risk that if the grants are insufficient to promote upgrade, or that uptake is poor for some other reason, that a greater proportion of drivers will choose to stay and pay. Similarly, there is a risk that if insufficient funds are available, a greater proportion of drivers will choose to stay and pay.</p> <p>The availability of better data and tools has reduced uncertainty and it is still considered likely that compliance can be achieved for the majority of the fleet by 2024 at the latest.</p>

Proposal	OBC Discussion	Update as at Consultation
<p>Clean Taxi Fund (Private Hire Vehicles)</p>	<p>Assume that drivers and operators will take advantage of the Clean Taxi Fund and upgrade to a compliant vehicle. This can be achieved at lower cost than for London-style hackney carriages.</p> <p>There is an increasing trend for drivers to be licensed outside the region in which they operate. We do not know how many drivers are licensed elsewhere but operate in GM, what vehicles they driver, or how they will respond to the scheme.</p> <p>It is likely that compliance can be achieved for the majority of the fleet by 2024 at the latest.</p>	<p>Updated data has been collated from licensing authorities on the scale and composition of the PHV fleet, and data has been derived from FOI requests to better understand the scale of out-of-region licensing in the region. The Operational Cost Model allows for the assessment of the likely impact on behavioural choices of Funding offers at different levels and under different conditions (such as with or without scrappage).</p> <p>There is a risk that if the grants are insufficient to promote upgrade, or that uptake is poor for some other reason, that a greater proportion of drivers will choose to stay and pay. Similarly, there is a risk that if insufficient funds are available, a greater proportion of drivers will choose to stay and pay.</p> <p>The availability of better data and tools has reduced uncertainty and it is still considered likely that compliance can be achieved for the majority of the fleet by 2024 at the latest.</p>

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Table 5-3: Sources of uncertainty in modelling other proposals

Proposal	OBC Discussion	Update as at Consultation
Uptake of EVs	<p>The GM CAP proposes very significant investment in EV infrastructure and promotion, with a commensurate impact on uptake and therefore emissions.</p> <p>There is uncertainty about the uptake of any new technology, and this would be subject to many factors beyond local control.</p>	<p>A review of the available evidence has been carried out. Survey evidence shows that GM residents consistently cite a lack of charging points as a barrier to EV uptake. However, there was insufficiently strong evidence supporting a quantified relationship between investment in EV charging infrastructure and increased uptake of EVs. As a result, no increase in EV uptake has been applied in the modelling.</p> <p>This is a conservative approach that reduces uncertainty. It is plausible that major investment in EV infrastructure would encourage greater EV uptake, which would act to reduce NOx emissions and increase the likelihood that compliance was achieved in the forecast year.</p> <p>Note that it has been assumed that the grants, supported by investment in dedicated charging infrastructure, do deliver upgrade to ZEC hackney cabs. The quantification has been based upon the impact of the grants as assessed in the Cost Model, but survey evidence suggests that investment in charging infrastructure would reduce the risk that these responses are not realised.</p>
Impact of sustainable travel programme	<p>The impact of the proposals for promoting sustainable journeys have not been modelled but local and national evidence suggests that such programmes can be effective in driving behaviour change.</p> <p>It is therefore possible that the impacts on car purchasing choices in particular have been underestimated in the analysis.</p>	<p>Evidence has been gathered demonstrating the impact of similar sustainable journeys proposals on mode shift in GM and elsewhere. This has been reflected in the application of mode shift in the Saturn model at targeted locations. The impacts are small in scale in aggregate, although more significant at some sites, but act to increase certainty that compliance can be achieved in the forecast year.</p>

6 **Appropriateness of the preferred option: limitations, uncertainty and risk.**

- 6.1 In general, the similarity of the options under consideration means that most limitations, sources of uncertainty and risks affect all Options under consideration in broadly the same way.

Does the evidence suggest that the proposed Consultation Option will be sufficient to achieve compliance in the shortest possible time?

- 6.2 The proposed Consultation Option is forecast to achieve compliance in 2024, as set out in the Ministerial Direction of 9th July 2019. No feasible Options were identified that could achieve compliance prior to 2024.
- 6.3 The cross-sectional approach to modelling, where the impacts in later years pivot off the do-minimum and not the do-something outputs from earlier years, means that the effectiveness of the measures as a package, and early responses to forthcoming measures, is likely to be underestimated. For example, the modelling cannot explicitly account for the early impact of an anticipated scheme on purchasing and travel choices. In practice, it is assumed that Funds would be supplied from 2021, but the benefits of those Funds in terms of vehicle upgrade are represented only from the year charging is applied to that vehicle type (and exemptions expire).
- 6.4 The modelling also assumes blanket implementation of measures, but the targeting of measures to those vehicles most likely to travel in non-compliant locations could bring early benefits and mitigate against the risk of failure to deliver compliance in the forecast year.

Does the evidence suggest that early implementation of measures could bring forward the year of compliance?

- 6.5 All measures are proposed for implementation by 2021; measures to communicate the message, encourage the uptake of the cleanest vehicles, and help people, businesses and operators upgrade their vehicles will be implemented as early as possible. Earlier delivery of a GM-wide CAZ is not feasible and would not allow vehicle owners sufficient time to prepare.
- 6.6 It is proposed that LGVs are offered a two-year exemption, so that they are in-scope for the CAZ from 2023. It is not currently considered feasible to implement such a large scale charging schemes for LGVs earlier due to the limited availability and high cost of compliant vehicles.
- 6.7 Removal of the two-year exemption period would not bring forward the year of compliance, as compliance is not achieved in the year the exemption expires (2023) but in 2024, and therefore requires reductions beyond those delivered by the CAZ C.

- 6.8 Temporary exemptions to 2023 are also proposed for Wheelchair Accessible taxis (hackney cabs and PHVs) and GM-registered coaches. This reflects the high cost of upgrade of these vehicles and their social importance in providing travel services to vulnerable groups. Neither proposal affects the year of compliance.
- 6.9 In practice, the availability of funding from 2021 to support the upgrade of vehicles subject to a temporary exemption to 2023 will deliver early benefits not reflected in the modelling.

Does the evidence suggest that the preferred Option is proportionate?

- 6.10 Modelling at OBC demonstrated that CAZ schemes covering a smaller geographical area, such as the town centre-based approach assessed as Option 4, were less effective and did not deliver compliance in the shortest possible time.
- 6.11 Modelling further demonstrated that CAZ schemes at a lower level, involving a CAZ A or CAZ B only as tested in Option 7, were less effective and did not deliver compliance in the shortest possible time.
- 6.12 Therefore, it is reasonable to conclude that the preferred option is proportionate and necessary in terms of its impact on air quality.
- 6.13 The economic appraisal carried out at OBC suggested that Option 8, which has formed the basis of the Consultation Option, delivered the best Net Present Value of the options tested. Further economic modelling and sensitivity testing of the post-Consultation Option will be submitted at FBC but it is not considered likely that any alternative option is cheaper or better value for money.
- 6.14 Consequently, the conclusion presented in the GM CAP, that Option 8 is the cheapest option and provides the best value for money, is not considered overly sensitive to the assumptions applied in the economic modelling.

7 Conclusion

7.1 In conclusion, the evidence suggests that whilst the forecast date of compliance in both the Do Minimum and Do Something scenarios are sensitive to various assumptions made in the analysis, these assumptions are either largely beyond the reasonable control of local authorities and require ongoing monitoring and if necessary revisions to the proposals as their real-world impacts emerge. Some assumptions can only be mitigated via revisions to national guidance.

7.2 At OBC, it was considered that the evidence was sufficient to support the following decisions:

- The agreement of forecast exceedances that must be tackled by the GM CAP through the **Target Determination** process;
- The **identification of suitable measures** and packages of measures for appraisal; and
- The **decision to proceed** with the development of a Full Business Case, including engagement and consultation with the public and stakeholders, on the basis of Option 8.

7.3 At this stage, and whilst more work is likely to be required, it is considered that the evidence is sufficient to support the decisions to proceed with public consultation on the basis of the Consultation Option (derived from Option 8).

8 Next steps

8.1 JAQU guidance states that authorities should only make changes to the analysis between OBC and FBC:

- In response to consultation; and
- To respond to feedback from the TIRP.

8.2 Since OBC submission, stakeholder engagement and a 'conversation' with the public have taken place. Evidence has been gathered via data collection and surveys and new tools have been developed. Detailed design work has been carried out for each of the measures, many of which were at a preliminary stage at OBC.

8.3 In the next phase, public consultation will be carried out, likely to lead to changes to the proposals requiring further analysis. Detailed design work continues and supporting analysis will be required.

8.4 Therefore, GM anticipates that further analysis will be required to support the FBC.

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Appendix A

Table 1 - GM CAP: Summary of modelling methodology for Consultation Package

Intervention (Implementation/CAF)	Approach at OBC	Approach for Consultation Package	Notes
(I) Bus Fund supported by CAZ A for buses	Assumed 100% uptake in all three years	No change.	Analysis of delivery trajectory suggests that benefits will be over-stated in 2021 but that all buses could be retrofit/replaced by 2023. Impact of CAZ and Funding have not been disaggregated for bus.
(I) CAZ A for Hackney Cabs	Assumed 100% uptake in all three years.	Behavioural responses to charge derived from Taxi and Private Hire Operational Cost Model (OCM).	Taxi and PHV OCM results benchmarked against Sheffield Survey data.
(I) CAZ A for Private Hire Vehicles	Behavioural responses derived from SP data (combined Car/LGV SP data from the Bristol study), weighted to GM characteristics and to account for use for business and personal trips, and higher upgrade costs.	Behavioural responses to charge derived from Taxi and Private Hire OCM.	Taxi and PHV OCM results benchmarked against Sheffield Survey data.
(I) CAZ B for HGVs	A logistic regression model was used to produce a response curve for the 'Pay Charge' option. This used two data points; the first from JAQU Freight Response guidance (with the 'Change Mode' response removed), and the second from VTPI research. Other responses were taken from the JAQU guidance.	Behavioural responses to charge derived from Freight OCM.	Model is segmented by vehicle size, industry sector and business size, including use of new GM specialised goods vehicle surveys. Behavioural responses now include consolidation into larger vehicles and down-sizing to a smaller vehicle (including LGV).

Intervention (Implementation/CAF)	Approach at OBC	Approach for Consultation Package	Notes
(I) CAZ B for coaches	Not modelled – coaches are not included in the Saturn demand matrices.	No change.	Off-model analysis has been carried out to understand the coach fleet, market and travel patterns. A simple Coach OCM has been developed to allow testing of the impact of the charge and Funds. ANPR analysis demonstrates that coaches represent an insignificant proportion of total traffic flow and NOx emissions.
(I) CAZ C for LGVs	Behavioural responses derived from SP data (combined Car/LGV SP data from the Bristol study), weighted to GM characteristics and to account for use for business and personal trips, and higher upgrade costs.	Behavioural responses to charge derived from Freight OCM.	Model is segmented by vehicle size, industry sector and business size, including use of new GM specialised goods vehicle surveys. Behavioural responses now include consolidation into larger vehicles (including HGV) and down-sizing to a smaller vehicle (including car).
(I) CAZ C for minibuses	Not modelled – minibuses are not included in the Saturn demand matrices.	No change.	Off-model analysis has been carried out to understand the minibus fleet, market and travel patterns. A simple Minibus OCM has been developed to allow testing of the impact of the charge and Funds. ANPR analysis demonstrates that minibuses represent an insignificant proportion of total traffic flow and NOx emissions.
(I) Sustainable Journeys	Not modelled.	Mode shift applied in Saturn model based on evidence from previous Sustainable Journeys programmes in GM and elsewhere.	Measures assumed to be targeted at key local exceedance points.
(CAF) Charging infrastructure for Electric Vehicles	Increase in EV uptake of cars and LGVs assumed on the basis of bringing forward the Committee on Climate Change sales pathway by three years.	Not included in the Consultation Package modelling.	Has been removed from the modelling due to a lack of sufficiently strong evidence of the relationship between investment in charging infrastructure and uptake of EVs.

Intervention (Implementation/CAF)	Approach at OBC	Approach for Consultation Package	Notes
(CAF) Clean Taxi Fund for Hackney Cabs and PHVs	Reduction in upgrade cost applied.	Estimated uptake of Funds and impact on behavioural responses to charge derived from Taxi and Private Hire OCM and applied in strategic modelling.	Funds applied in first year of charging but likely to open prior to charging. Therefore, likely to be underestimating benefits in early years for WAV vehicles (where sunset exemption to 2023 applies).
(CAF) Clean Commercial Vehicles Fund for HGVs and LGVs	Reduction in upgrade cost applied for HGVs and LGVs.	Estimated uptake of Funds and impact on behavioural responses to charge derived from Freight OCM and applied in strategic modelling.	Uptake applied to GM-based SMEs only.
(CAF) Clean Commercial Vehicles Fund for coaches and minibuses	Not modelled.	No change.	Estimated uptake of Funds and impact on behavioural responses to charge derived from simple Coach and Minibus OCMs but not applied in strategic modelling.
Vehicle Finance	Not modelled.	No change.	Analytical tool developed to assess uptake in different scenarios but not applied in strategic modelling.
LA Fleet upgrade	Not modelled.	No change.	Measure no longer included in package.
LA Parking	Not modelled.	No change.	No funding requested.