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

# Analytical Assurance Statement

Bolton Council

Salford City Council

Bury Council

Stockport Metropolitan Borough Council

Manchester City Council

Tameside Metropolitan Borough

Oldham Council

Trafford Council

Rochdale Borough Council

Wigan Council



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# 1 Introduction

1.1 The purpose of this document is to consider the limitations, uncertainties and risks in the evidence base, and the implications of these for decision makers.

1.2 It starts by considering whether an appropriate process 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 The analysis at this stage needs 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.

1.4 As such, this document considers 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.

1.5 In particular, consideration is given to whether the differing assumptions in areas of uncertainty could affect when compliance will be achieved in the Do Minimum and Do Something scenarios. The proposals are considered in terms of whether they are sufficient to meet the challenge in a range of scenarios, and whether there is a risk that the proposals may prove to be excessive or inappropriate, or alter which option is selected.

Finally, it identifies the next steps for the analytical work proceeding to FBC.

## 2 Background

2.1 The GM CAP is underpinned by a programme of transport and air quality modelling to identify the scale of the challenge and test the effectiveness of these measures and packages of measures. 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.

2.2 The results of this analysis are 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 for the Greater Manchester Clean Air Plan Project; and
- Local Plan Air Quality Modelling Report (AQ3), which provides details of modelled NOx and NO2 concentrations for the base and forecast years, including comparisons with measured concentrations for the base year.

2.3 The appraisal of the economic impacts and value for money of the GM CAP is 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.

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

### 3.1 Suitability of the models and modelling process

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

**Table 3-1: Modelling process description and discussion of appropriateness**

| | Modelling process | Discussion |
|---|---|---|
| 1 | 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.<br><br>This was further developed into a 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. | An appropriate variable demand model was not available and it would not have been possible to develop one in the time available.<br><br>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.<br><br>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. |
| 2 | 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 | 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.<br><br>TfGM's county-wide SATURN model is a well-established tool used for the assessment of numerous major schemes.<br><br>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.<br><br>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. |

| Modelling process | | Discussion |
|---|---|---|
| 3 | The emissions model, which uses TfGM's EMIGMA (Emissions Inventory for Greater Manchester) software to combine information about traffic flows and speeds form 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 ($NO_2$) particulate matter ($PM_{10}$ and $PM_{2.5}$) and $CO_2$. | 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.<br><br>The EFT uses data from the Copert modelling which, whilst appropriate for steady state conditions can be less reliable in congested or queuing conditions. |
| 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. | The emission rates for each modelled scenario in EFT have been inputted 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.<br><br>The outputs of the AQ modelling were verified against $NO_2$ monitoring data, which was located in relevant locations across Greater Manchester. This process is described further in AQ3.<br><br>GM already has an extensive monitoring network of continuous monitors supplemented by diffusion tubes. However, by definition not all of the PCM links are covered directly by the existing monitoring locations. Therefore, additional diffusion tube monitoring is being undertaken. |

## 3.2 Reliability, robustness and limitations of the data sources

3.2.1 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. These were supplemented by three local data sources:

- Information about the vehicle fleet composition in Greater Manchester including from Automatic Number Plate Recognition (ANPR) cameras from 2016 and bus/taxi fleet. This has been used to inform the fleet mix in the base year and to forecast the future fleet mix. Given the significance of the data, a decision was made to undertake a project-specific survey exercise in January 2019, to inform the FBC.

- Ongoing monitoring of ambient NOx / $NO_2$ 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-complaince.

- 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. New evidence from Sheffield has just been published, which was not available at the OBC phase and will need to be reviewed and considered for the FBC.

## 3.3 Quality assurance and interaction with JAQU

3.3.1 The traffic and air quality modelling process has been agreed with JAQU via ongoing technical discussions throughout the lifetime of the project.

3.3.2 The economic modelling methodology is based upon JAQU guidance, and the economic and financial assumptions draw on JAQU, WebTag and Green Book guidance.

3.3.3 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.

## 3.4 Time and resource constraints

3.4.1 The analysis has drawn on the best data and tools available at the time, and has considered new data sources as they have emerged. The time available to conduct analysis was limited, and the key analytical limitations imposed by this were:

- As described above, a variable demand model with the appropriate segmentation and behavioural responses was not available and there was not time to develop one. A demand sifting tool was developed to estimate behavioural responses.
- As the scale of the challenge and likely solutions became clearer, new measures emerged. A simplified representation of the electric vehicle, vehicle renewal and loan finance proposals has been included and more work will be required at FBC to refine these assumptions.
- There was limited time available for sensitivity testing and therefore this focussed on the preferred option (Option 8) and on those aspects considered most likely to affect the recommended course of action, reflecting JAQU guidance and local conditions.
- A simplified methodology was applied for distributional impacts analysis, as agreed with JAQU. The size of the model outputs and processing power required meant that analysis using the methodology set out by JAQU could not be completed in time.
- It was considered appropriate to conduct economic modelling for 2021 and 2025 and to interpolate between the years.

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

3.5.1 It is unlikely that additional analysis, based on the data available at the time, would lead to different conclusions in terms of the scale and nature of the challenge, or in terms of the key interventions required ie a CAZ category C supported by interventions to clean up the fleet and deliver compliance. Neither of these aspects depend on marginal values (eg: with very few sites very close to the point of compliance).

3.5.2 Additional economic modelling and analysis may be undertaken at FBC but it is unlikely that this would lead to different conclusions:

- Analysis applying the full Distributional Impacts methodology as per JAQU's guidance may be undertaken at FBC 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.
- Further economic modelling may be undertaken at FBC incorporating 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.

3.5.3 Further analysis may be required to support an FBC in terms of the following aspects:

- Refined quantification of behavioural responses to a CAZ;
- Disaggregated assessment of the impacts of vehicle renewal/loan finance schemes; and
- Assessing the impacts of discounts and exemptions, and any other changes arising from consultation, in the full AQ modelling process.

3.5.4 This analysis will inform the further decisions to be made at FBC but will not change our assessment of the scale and nature of the challenge and likely solutions necessary, as presented in the OBC.

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

4.1.1 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 55 µg/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.

4.1.2 Local modelling revealed that none of the available interventions was able to achieve compliance in 2021. Therefore, the GM CAP process is more dependent on the modelling of later years (2023 and 2025). As the modelled year moves further from the present, the certainty of trends, assumptions and the impact of wider interventions (such as highway schemes) inevitably decreases. Whilst we can be confident that there are widespread and significant exceedances in 2021 that require a large-scale intervention, in later years, the exceedances are fewer and closer to the point of compliance and therefore certainty is inevitably reduced.

4.1.3 Table 4-1 identifies the sources of uncertainty in the modelling of the challenge, which in many cases are derived from national assumptions and will be common across all cities and regions. Notwithstanding this uncertainty, it is clear that there will be widespread non-compliance in 2021. Historically, air quality improvements have been slower than forecast and in general, the factors identified below appear more likely to delay than bring forward compliance.

4.1.4 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 | Discussion |
|---|---|
| Vehicle purchasing/ ownership patterns and trends | 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.<br><br>ANPR data has revealed that the Greater Manchester fleet is older than the national average.<br><br>There is some emerging national evidence of slowing new vehicle sales and of a shift from diesel to petrol in new car purchases.<br><br>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.<br><br>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. |
| Trends in background emissions | 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.<br><br>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.<br><br>GM assumes that DEFRA will keep abreast of trends in background emissions. GM will apply any new guidance as it emerges where possible. |
| Traffic growth trends | 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.<br><br>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 do-minimum scenario. |
| Fuel costs and other wider changes in costs/travel time | 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.<br><br>Sensitivity testing of the GM CAP has demonstrated that the conclusions are not sensitive to fuel costs. |
| Effectiveness of future emissions standards | It is assumed that future emissions standards perform as planned. The performance of earlier emissions standards against forecasts has been variable.<br><br>This is a known source of uncertainty that cannot meaningfully be mitigated at a local level. |
| Assumptions about real-world emissions | 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 |

| Source of uncertainty | Discussion |
|---|---|
| | be adequately weighted to differing vehicle types/ages/fuel types which affects future year assumptions as the fleet renews over time.<br><br>This is a known source of uncertainty that cannot meaningfully be mitigated at a local level. |
| Assumptions about the impact of urban canyons | 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 spatial discrepancy in $NO_2$ concentrations.<br><br>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. |
| Gradients and Topography | 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.<br><br>However, the last points of compliance in the modelling are not significantly affected by gradients. |
| Assumptions about bus service patterns and fleet profile | 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.<br><br>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. |
| Assumptions about future growth and related schemes | 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.<br><br>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. |

| Source of uncertainty | Discussion |
|---|---|
| Other assumptions about road network and weather conditions affecting air quality forecasting | 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.<br>This area has necessarily been modelled as a homogenous area in ADMS. |

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

5.1.1 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 and / or in a compex urban network simply lead to the problem moving elsewhere. Similarly, the scale of reductions required in a short period of time made constraint measures inevitable. The proposals reflect Government guidance in terms of the type of schemes that were likely to be necessary and effective.

5.1.2 The sources of uncertainty in the modelling of the impacts of each measure are described below.

## 5.2 Clean Air Zone

5.2.1 The efficacy of Clean Air Zones has been demonstrated in other cities and the principle that applying a daily charge provides an incentive to upgrade is well established.

5.2.2 Nevertheless, there is 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. These are described in Table 5-1.

5.2.3 In most cases, it is considered likely that variations in these assumptions may affect the trajectory towards compliance, but are less likely to affect the forecast year of compliance with the GM CAP.

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

| Source of uncertainty | Discussion |
|---|---|
| Vehicle purchasing/ ownership patterns and trends | 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. |

| Source of uncertainty | Discussion |
|---|---|
| | 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.<br>In behavioral response terms, the primary impact is on the costs and benefits of the proposals, and on the mitigating measures that may be required. |
| Behavioural responses | 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.<br>New information from Sheffield is now available, and this needs to be tested to see whether it corroborates existing assumptions.<br>GM will also consider any ‘revealed preference’ data that becomes available from other cities as schemes are launched elsewhere. |
| Frequency of travel | The cost effectiveness of different behavioural responses depends in part on the frequency of travel.<br>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.<br>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. |
| Infrequent and long distance travel | We have assumed that long distance travellers (>50 miles trip length) do not respond, which seems reasonable.<br>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. |
| Cost of upgrade | 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. |
| Impact of discounts and exemptions | 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. |
| 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 a variable demand model or in the highway assignment model. This means that possible re-routeing effects and 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. |

## 5.3 Vehicle Renewal Schemes to help people, businesses and operators upgrade

5.3.1 The scale of change required to the vehicles fleet in Greater Manchester, and the speed with which that change is required, means that vehicle renewal schemes 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 in the analysis here, described in Table 5-2.

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

| Proposal | Discussion |
|---|---|
| Clean Air Fund for Freight | Assume that all those eligible for upgrade schemes utilise them and that the funds are sufficient to support upgrade.<br>More work is required at FBC to support an appraisal of effectiveness and value for money. |
| Clean Air Fund for Buses | Assume that 100% of buses are compliant by 2021.<br>No evidence was available on how buses would respond to pricing to allow a more sophisticated analysis of behavioural response.<br>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. |
| Clean Air Fund for Taxis: Hackney carriages | Assume that 100% of hackney carriages are compliant by 2021.<br>No evidence was available on how taxis would respond to pricing to allow a more sophisticated analysis of behavioural response.<br>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. |
| Clean Air Fund for Taxis: Private hire vehicles | Assume that drivers and operators will take advantage of the Clean Air Fund for taxis and upgrade to a compliant vehicle. This can be achieved at lower cost than for London-style hackney carriages.<br>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.<br>It is likely that compliance can be achieved for the majority of the fleet by 2024 at the latest. |

## 5.4 Other proposals

5.4.1 The GM CAP includes proposals to support the uptake of electric vehicles (EVs) and to promote sustainable travel. The assumed impacts of proposals to support the uptake of EVs are included in the emissions modelling. The assumed impacts of a programme of activity to promote sustainable travel have not been quantified. Table 5-3 describes the sources of uncertainty in these proposals.

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

| Proposal | Discussion |
|---|---|
| Uptake of EVs | The GM CAP proposes very significant investment in EV infrastructure and promotion, with a commensurate impact on uptake and therefore emissions.<br>There is uncertainty about the uptake of any new technology, and this would be subject to many factors beyond local control. |
| Impact of sustainable travel programme | 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.<br>It is therefore possible that the impacts on car purchasing choices in particular have been underestimated in the analysis. |

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

6.1.1 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.

## 6.2 Does the evidence suggest that the preferred Option will be sufficient to achieve compliance in the shortest possible time?

6.2.1 The preferred Option (8) is forecast to achieve compliance in 2024. No feasible Options were identified that could achieve compliance prior to 2024.

6.2.2 For all Options, 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.

6.2.3 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.

6.2.4 The evidence as it stands suggests that it would be disproportionate to proceed with Options 5(i) and 5(ii) as the additional measures do not bring forward the year of compliance.

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

6.3.1 All measures are proposed for implementation by 2021; where possible, measures to communicate the message, encourage the uptake of the cleanest vehicles, and help people, businesses and operators upgrade their vehicles will be implemented earlier. Earlier delivery of a GM-wide CAZ is not feasible and would not allow vehicle owners sufficient time to prepare.

6.3.2 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.

6.3.3 Removal of the two-year exemption period would not bring forward the year of compliance, as compliance is not achieved in the implementation year but in 2024, and therefore requires reductions beyond those delivered by the CAZ C.

6.4 Does the evidence suggest that the preferred Option is proportionate?

6.4.1 Modelling 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.

6.4.2 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.

6.4.3 Therefore, it is reasonable to conclude that the preferred option is proportionate and necessary in terms of its impact on air quality.

6.4.4 The economic sensitivity testing – provided as Appendix 1 to this document - suggest that the Net Present Value for Option 8 is sensitive to the assumptions tested. However, the impacts of variations to these assumptions would be experienced in broadly the same way across all the Options under consideration. It is not considered likely that such variations would improve Options 5(i) or 5(ii) such that they became cheaper or better value for money than Option 8.

6.4.5 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

7.1.1 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:

1. Beyond the reasonable control of local authorities and require ongoing monitoring and if necessary revisions to national guidance; or
2. Broadly consistent in impact across the three Options under consideration (Options 5(i), 5(ii) and 8) and therefore do not materially affect the recommendations made in the GM CAP.

7.1.2 Therefore, whilst more work is likely to be required, as set out below, it is considered that the evidence is 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.

## 8 Next steps

8.1.1 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.

8.1.2 However, stakeholder engagement, a ‘conversation’ with the public and public consultation are planned in the next phase and are likely to lead to changes to the proposals requiring further analysis.

8.1.3 Furthermore, whilst some elements of the proposed package have been developed in some detail, others are at a preliminary stage and require more detailed design work and supporting analysis. This includes the specification of discounts and exemptions and the design of schemes to help people, businesses and operators upgrade their vehicles via grants or loans.

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

## APPENDIX A: ECONOMIC SENSITIVITY TESTING

## 9 Overview

9.1.1 This report presents the results of the economic modelling sensitivity tests for the Greater Manchester Clean Air Plan Project. This report is included as an Appendix to the Analytical Assurance Statement. Other related documents include:

- The Economic Case of the OBC presents the results of the economic modelling;
- Appendix E1 - Economic Appraisal Methodology Report describes the methodology applied to the economic modelling; and
- Appendix E2 is a copy of the economic model.

9.1.2 The purpose of this report is to assess the extent to which changes to the assumptions made in the CAP analysis could affect the conclusions of the OBC and specifically the evaluation of the Net Present Value and of the value for money of the proposals.

9.1.3 The purpose of the analysis is to help understand which aspects of the modelling the results are most sensitive to and ultimately to help answer the questions:

- Is the preferred option the right proposal?
- Is it excessive, so that the costs outweigh the benefits?

9.1.4 Even where it is shown that the conclusions are insensitive to any given assumption, more work may be required at FBC to meet other analytical objectives. For example, to demonstrate to stakeholders that the scheme is proportionate and necessary.

9.1.5 The sensitivity testing will feed into:

- The development of the FBC data, evidence and modelling work streams, to determine the work required to improve the assumptions; and
- Monitoring and evaluation plans, to ensure that the proposals reflect emerging trends and real-world conditions.

## 10 Sensitivity Tests

10.1.1 Section 7 (Uncertainty and Sensitivity Analysis) of JAQU’s Options Appraisal Package 1 sets out the need for local authorities to identify the key uncertainties in their local plans and to model appropriate sensitivity scenarios based on this. Additionally, JAQU’s Technical Independent Review Panel (TIRP) has consistently stressed the importance of robust sensitivity testing.

10.1.2 For the economic appraisal there are a number of sensitivity tests which have been agreed to be tested and are detailed in Table 10-1.

**Table 10-1: Sensitivity tests of the economic model**

| Area of uncertainty | Suggested sensitivity test |
|---|---|
| Implementation cost | High and low Optimism Bias (OB) adjustments |
| Damage costs | High and low damage cost values |
| Carbon prices | High and low carbon prices |
| Welfare impacts | Use 0 and 1 instead of 0.5 in the 'rule of a half' |

## 11 Methodology

11.1.1 The sensitivity tests have been carried out within the economic model. The parameters listed in Table 10-1 have been adjusted following the methodology described in the following sections and the model has been run in order for each scenario to estimate the results reported below.

Implementation costs

11.1.2 The sensitivity tests on the implementation costs have been carried out modifying the Optimism Bias used in the cost estimation based on the WebTAG recommended values for OBC. For the low case all the costs are set to an OB of 15%, apart for IT costs which is set to 100%. For the High case scenario all the costs have been increased by 20%.

Damage costs

11.1.3 The estimation of the damage costs done in the OBC are built up from LSOA level and use the associate damage costs for a range of health pathways (respiratory hospital admissions, mortality etc.). These values do not have associated high and low ranges.

11.1.4 The Department for Environment, Food & Rural Affairs (DEFRA) provides damage costs values updated to January 2019[1]. The percentage difference between the high and low case damage costs and the central case damage cost has been used to estimate the damage costs used in the sensitivity tests, which are reported in Table 11-1.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770576/air-quality-damage-cost-guidance.pdf

**Table 11-1: Damage costs used in the sensitivity tests**

| Pollutant | DEFRA damage costs | | | | | Damage cost used in the OBC (£/t) | Estimated High damage cost (£/t) | Estimated Low damage cost (£/t) |
|---|---|---|---|---|---|---|---|---|
| | Central damage cost (£/t) | High damage cost | | Low damage cost | | | | |
| | | (£/t) | % resp. to central case | (£/t) | % resp. to central case | | | |
| NOX | 6,199 | 23,153 | 373% | 634 | 10% | 5,900 | 22,035 | 603 |
| PM | 105,836 | 327,928 | 310% | 22,588 | 21% | 124,938 | 387,114 | 26,665 |

Carbon price

11.1.5 The $CO_2$ emissions are monetised using carbon prices reported in the WebTAG. These impacts are uncertain and therefore high and low carbon prices are provided by JAQU and have been used to run the sensitivity tests. The WebTAG version of June 2018 has been used to be consistent with the values estimated in the central case of the OBC.

Welfare impacts

11.1.6 In line with WebTAG guidance welfare impacts have been assessed using the Rule of a Half (ROH). This means that welfare impacts have been assumed to be 0.5 times the full cost of an action. Given the limitations of this approach two sensitivity tests have been carried out using 0 and 1 rather that the ROH.

## 12 Results

12.1.1 The results of the sensitivity tests compared with the core scenario (Option 8) are reported in Table 12-1. The impacts which resulted in a change have been highlighted in red.

Implementation costs

12.1.2 The high-cost case results highlight an increase of implementation costs of £35m and an increase of financial subsidy of £6m, resulting in a total NPV of -£104m (-£30m from the core case).

12.1.3 The low-cost case results only in a reduction to the implementation costs of £14m, which brings the NPV to a total of -£60m (+£14m from the core case).

Damage costs

12.1.4 The change in damage costs in the high case is estimated to be +£93m for $NO_2$ reduction and +£72m for PM reduction, which brings the NPV to £91m (+£165m from the core case).

12.1.5 In the low case the change is estimated to be -£30m for $NO_2$ reduction and -£27m for PM reduction, which lowers the NPV to -£132m (-£58m from the core case).

Carbon price

12.1.6 The change in carbon price in the high case is estimated to be +£40m, which increases the NPV to -£33m (+£41m from the core case).

12.1.7 In the low case the change is estimated to be -£41m, which lowers the NPV to -£115m (-£41m from the core case).

Welfare loss

12.1.8 The estimation of the welfare loss using 1 rather than the ROH reduces the benefits of £142m, lowering the NPV from -£74m to -£217m while using 0 rather than the ROF increase the NPV to £68m (+£142m from the core case).

## 13 Conclusion

13.1.1 Local authorities are required to identify which option(s) bring compliance with the EU Limit Value in the shortest possible time. In Greater Manchester, Options 5(i), 5(ii) and 8 are each forecast to achieve compliance in 2024, the shortest time of any of the Options tested.

13.1.2 These Options have been assessed against the Success Factors as set out in the Strategic Outline Case. This exercise concluded that Option 8 delivered compliance at the lowest delivery cost, with the least delivery risk and with the least risk of negative socio-economic consequences.

13.1.3 The tests conducted here show that the Net Present Value for Option 8 is sensitive to the assumptions tested. However, the impacts of variations to these assumptions would be experienced in broadly the same way across all the Options under consideration. It is not considered likely that such variations would improve Options 5(i) or 5(ii) such that they became cheaper or better value for money than Option 8.

13.1.4 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.

**Table 12-1: Sensitivity test results**

| Primary/ Secondary Success Criteria | Impact | Base scenario | Optimism Bias | | Damage cost | | Carbon price | | Welfare impact | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | “High scenario” | “Low scenario” | “High scenario” | “Low scenario” | “High scenario” | “Low scenario” | ROH=1 | ROH=0 |
| **Health and Environmental Impacts (positive value indicates benefit, negative value indicates disbenefit)** | | | | | | | | | | |
| • Reduction in $NO_2$ emissions<br>• Strategic fit with local strategies and plans<br>• Value for money | $NO_2$ reduction | £52m | £52m | £52m | £145m *(+£93m)* | £22m *(-£30m)* | £52m | £52m | £52m | £52m |
| | PM reduction | £49m | £49m | £49m | £121m *(+£72m)* | £22m *(-£27m)* | £49m | £49m | £49m | £49m |
| | Avoided health and social cost | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | GHG emission reduction | £82m | £82m | £82m | £82m | £82m | £122m *(+£40m)* | £41m *(-£41m)* | £82m | £82m |
| **User Costs and Benefits (positive value indicates benefit, negative value indicates disbenefit)** | | | | | | | | | | |
| • Strategic fit with local strategies and plans<br>• Value for money | Health benefits of active travel | £18m | £18m | £18m | £18m | £18m | £18m | £18m | £18m | £18m |
| | Welfare loss (trips re-moded) | -£17m | -£17m | -£17m | -£17m | -£17m | -£17m | -£17m | -£34m *(-£17m)* | £0m *(+£17m)* |
| | Welfare loss (trips cancelled) | -£39m | -£39m | -£39m | -£39m | -£39m | -£39m | -£39m | -£78m *(-£39m)* | £0m *(+£39m)* |
| • Value for money | Vehicle fleet upgrade<br>*Includes cost of upgrade, loss of asset value, transaction cost and fuel switch costs, less any financial subsidy from the funding measures* | -£10m | -£4m *(+£6m)* | -£10m | -£10m | -£10m | -£10m | -£10m | -£97m *(-£87m)* | £76m *(+£86m)* |
| | Congestion effects on travel time | £136m | £136m | £136m | £136m | £136m | £136m | £136m | £136m | £136m |

| Primary/ Secondary Success Criteria | Impact | Base scenario | Optimism Bias | | Damage cost | | Carbon price | | Welfare impact | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | "High scenario" | "Low scenario" | "High scenario" | "Low scenario" | "High scenario" | "Low scenario" | ROH=1 | ROH=0 |
| | Congestion effects on vehicle operating costs | £73m | £73m | £73m | £73m | £73m | £73m | £73m | £73m | £73m |
| | **PVB** | **£344m** | **£350m**<br>*(+£6m)* | **£344m** | **£510m**<br>*(+£166m)* | **£287m**<br>*(-£57m)* | **£385m**<br>*(+£41m)* | **£304m**<br>*(-£40m)* | **£202m**<br>*(-£142m)* | **£487m**<br>*(+£142m)* |
| **Cost to the Public Sector (positive value indicates cost, negative value indicates savings)** | | | | | | | | | | |
| • Affordability<br>• Value for money | Implementation Cost | £270m | £306m<br>*(+£36m)* | £256m<br>*(-£14m)* | £270m | £270m | £270m | £270m | £270m | £270m |
| | Operating and Maintenance | £148m | £148m | £148m | £148m | £148m | £148m | £148m | £148m | £148m |
| | **PVC** | **£419m** | **£454m**<br>*(+£35m)* | **£404m**<br>*(-£15m)* | **£419m** | **£419m** | **£419m** | **£419m** | **£419m** | **£419m** |
| | NPV | -£74m | -£104m<br>*(-£30m)* | -£60m<br>*(+£14m)* | £91m<br>*(+£165m)* | -£132m<br>*(-£58m)* | -£33m<br>*(+£41m)* | -£115m<br>*(-£41m)* | -£217m<br>*(-£142m)* | £68m<br>*(+£142m)* |